



Illinois Construction Manual

March 2021



CONSTRUCTION MANUAL

Prepared and Published by

Illinois Department of Transportation
Office of Highways Project Implementation

Springfield, Illinois
March, 31 2021

PREFACE

The IDOT *Construction Manual* has been developed to assist with ensuring uniform construction inspection practices during the administration of IDOT construction contracts. The instructions and procedures in this *Manual* are written and intended for use by IDOT Resident Engineers, technicians and inspectors.

The *Manual* has been structured based on, and is a companion document to, the IDOT *Standard Specifications for Road and Bridge Construction*. However, the *Manual* is not part of IDOT construction contracts. The *Construction Manual* is intended as a guide for field personnel. The *Manual* has been compiled to clarify the *Standard Specifications* and to suggest uniform procedures in highway construction field work. The *Standard Specifications*, Supplemental Specifications, plans, proposals, special provisions and supplementary documents are binding elements of the contract. Nothing in this *Manual* impacts the contract documents unless noted otherwise in the previously mentioned binding contract elements).

The *Construction Manual* provides guidance for Division 100 through Division 800, which corresponds to Divisions within the *Standard Specifications for Road and Bridge Construction*. Due to the constantly changing parameters in construction, users of this *Manual* should review all of the contract documents.

Many additional documents are available that field personnel will need for contract administration. The *Construction Manual* references these documents in applicable locations and provides hyperlinks to some of the documents.

Please submit any proposed revisions to the *Construction Manual* to the Central Bureau of Construction.

Document Control and Revision History

The Illinois Department of Transportation Construction Manual is owned by the Office of Highways Project Implementation, Bureau of Construction. The manual is reviewed during use for adequacy and updated by the Bureau of Construction as necessary to reflect current policy.

Distribution

This manual is intended to be used electronically as it includes hyperlinks within and resources external to the document. Portable Document Format (PDF) has been selected as the primary distribution format, and the official version of the manual is available on the [Policy Center](#) site on Inside IDOT.

The information contained in this manual is current as the date of issuance. Employees are responsible for ensuring use of the most current version of any document. All current policy documents are available on the [Policy Center](#) on InsideIDOT.

Revision History

Revision Date	Description	Approval
3/31/2021	Corrected and removed hyperlink to the documentation guide in division 100	Tim Kell
3/31/2021	Revised section 108.02-1	Tim Kell
3/31/2021	Revised section 108.02-2	Tim Kell
3/31/2021	Removed performance bonds from section 108.04	Tim Kell
3/31/2021	Miscellaneous text edits in section 108.04	Tim Kell
3/31/2021	Added new section 108.08m	Tim Kell
3/31/2021	Miscellaneous text edits in section 108.08-5	Tim Kell
3/31/2021	Revised example calculations in section 109.05	Tim Kell
3/31/2021	Removed performance bonds from section 109.08-1	Tim Kell
3/31/2021	Removed performance bonds from section 109.08-2	Tim Kell
3/31/2021	Removed performance bonds from section 109.08-2iii	Tim Kell
3/31/2021	Revised introductory to Division 201	Tim Kell
3/31/2021	Corrected and removed hyperlink to the documentation guide in division 200	Tim Kell
3/31/2021	Clarified NPDES acronym in section 201.01	Tim Kell
3/31/2021	Miscellaneous text edits in section 201.04	Tim Kell
3/31/2021	Miscellaneous text edits in section 201.05	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.01	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.03-1	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.03-2a	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.03-2b	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.03-2c	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.03-3	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.03-4	Tim Kell
3/31/2021	revised channel excavation bullet point text in section 202.04	Tim Kell
3/31/2021	Miscellaneous text edits in section 202.05	Tim Kell
3/31/2021	Miscellaneous text edits in section 204.01	Tim Kell
3/31/2021	Miscellaneous text edits and fixed figure number in section 204.06	Tim Kell
3/31/2021	Miscellaneous text edits in section 205.04	Tim Kell
3/31/2021	Miscellaneous text edits in section 205.06-1	Tim Kell

Revision Date	Description	Approval
3/31/2021	Miscellaneous text edits and fixed figure number in section 205.06-2	Tim Kell
3/31/2021	Deleted reference to District Materials Engineer and fixed figure number in section 205.06-3	Tim Kell
3/31/2021	Added guidance regarding sufficient pipe coverage in section 205.06-4	Tim Kell
3/31/2021	Miscellaneous text edits in section 205.06-5	Tim Kell
3/31/2021	Revise various earthwork/embankment examples in section 205.06-6a	Tim Kell
3/31/2021	Revise various earthwork/embankment examples in section 205.06-6b	Tim Kell
3/31/2021	Added earthwork/embankment example in section 205.06-6c	Tim Kell
3/31/2021	Miscellaneous text edits and fixed hyperlink to documentation guide in section 208.03	Tim Kell
3/31/2021	Delete Section 210	Tim Kell
3/31/2021	Corrected and removed hyperlink to the documentation guide	Tim Kell
3/31/2021	Corrected and removed hyperlink to the documentation guide in division 400	Tim Kell
3/31/2021	Miscellaneous text edits in section 406.02	Tim Kell
3/31/2021	Corrected and removed hyperlink to the documentation guide in division 500	Tim Kell
3/31/2021	Miscellaneous text edits in section 542.04-8	Tim Kell
3/31/2021	Added reference the Employee Safety Code Manual in section 550.04-3	Tim Kell
3/31/2021	Added heading and miscellaneous text edits in section 669.01	Tim Kell
3/31/2021	Added heading and miscellaneous text edits in section 669.03	Tim Kell
3/31/2021	Added heading and miscellaneous text edits in section 669.04	Tim Kell
3/31/2021	Added heading and miscellaneous text edits in section 669.05	Tim Kell
3/31/2021	Added new section 669.07	Tim Kell
3/31/2021	Added new section 669.09	Tim Kell
3/31/2021	Added new section 669.11	Tim Kell
3/31/2021	Added new Additional Resources and Training section to 669	Tim Kell
3/31/2021	Miscellaneous text edits in section 780.04	Tim Kell

Table of Contents**IDOT CONSTRUCTION MANUAL****Division 100 — General Requirements and Covenants**

Section 100	General Guidelines
Section 104	Scope of Work
Section 105	Control of Work
Section 106	Control of Materials
Section 107	Legal Relations and Responsibilities to Public
Section 108	Prosecution and Progress
Section 109	Measurement and Payment

Division 200 — Earthwork, Landscaping, and Erosion Control

Section 201	Clearing, Tree Removal and Protection, Care and Repair of Existing Plant Material
Section 202	Earth and Rock Excavation
Section 203	Channel Excavation
Section 204	Borrow and Furnished Excavation
Section 205	Embankment
Section 208	Trench Backfill
Section 211	Topsoil and Compost
Section 212	Final Shaping, Trimming, and Finishing
Section 250	Seeding
Section 251	Mulch
Section 280	Temporary Erosion and Sediment Control
Section 282	Filter Fabric
Section 284	Gabions and Slope Mattress

Division 300 — Subgrades, Subbases, and Base Courses

Section 300	Definitions
Section 301	Subgrade Preparation
Section 302	Soil Modification
Section 310	Lime Stabilized Soil Mixture
Section 311	Granular Subbase
Section 312	Stabilized Subbase
Section 351	Aggregate Base Course
Section 352	Soil-Cement Base Course
Section 353	Portland Cement Concrete Base Course
Section 354	Portland Cement Concrete Base Course Widening
Section 356	Hot-Mix Asphalt Base Course Widening

Division 400 — Surface Courses, Pavements, Rehabilitation, and Shoulders

Section 400	Definitions
Section 402	Aggregate Surface Course
Section 403	Bituminous Surface Treatment (Class A-1, A-2, A-3)
Section 406	Hot-Mix Asphalt Binder and Surface Course
Section 407	Hot-Mix Asphalt Pavement (Full Depth)
Section 408	Incidental Hot-Mix Asphalt Surfacing

Section 420	Portland Cement Concrete Pavement
Section 421	Continuously Reinforced Portland Cement Concrete Pavement
Section 424	Portland Cement Concrete Sidewalk
Section 440	Removal of Existing Pavement and Appurtenances
Section 442	Pavement Patching

Division 500 — Structures

Section 500	General
Section 501	Removal of Existing Structures
Section 502	Excavation for Structures
Section 503	Concrete Structures
Section 504	Precast Concrete Structures
Section 505	Steel Structures
Section 506	Cleaning and Painting New Steel Structures
Section 508	Reinforcement Bars
Section 509	Metal Railings
Section 512	Piling
Section 515	Name Plates
Section 516	Drilled Shafts
Section 520	Bridge Expansion Joints
Section 542	Pipe Culverts
Section 550	Storm Sewers
Section 562	Water Service Line
Section 582	Hot-Mix Asphalt Surfacing on Bridge Decks
Section 584	Grouting of Anchor Rods and Bars
Section 593	Controlled Low-Strength Material, Backfill
Appendix 500.A	Overhang Forming Example
Appendix 500.B	Drilled Shaft Inspector's Guide

Division 600 — Incidental Construction

Section 601	Pipe Drains, Underdrains and French Drains
Section 602	Catch Basin, Manhole, Inlet, Drainage Structure and Valve Vault Construction, Adjustment and Reconstruction
Section 606	Concrete Gutter, Curb, Median and Paved Ditches
Section 610	Shoulder Inlet with Curb
Section 611	Treatment of Existing Field Tile Systems
Section 630	Steel Plate Beam Guardrail
Section 631	Traffic Barrier Terminals
Section 664	Chain Link Fence
Section 665	Woven Wire Fence
Section 669	Removal and Disposal of Regulated Substances

Division 700 — Work Zone Traffic Control and Protection, Signing, and Pavement Marking

Section 701	Work Zone Traffic Control and Protection, Signing and Pavement Tracking
Section 703	Work Zone Pavement Marking
Section 704	Temporary Concrete Barrier
Section 720	Sign Panels and Appurtenances
Section 724	Remove and Relocate Sign Panel and Sign Panel Assembly
Section 727	Sign Support – Breakaway
Section 780	Pavement Striping

Division 800 — Electrical

Section 801	Electrical Requirements
Section 804	Electrical Service Installation – Lighting
Section 810	Underground Raceways
Section 816	Unit Duct
Section 821	Roadway Luminaires
Section 825	Lighting Controller
Section 830	Light Poles
Section 836	Pole Foundation
Section 838	Breakaway Devices
Section 857	Traffic Actuated Controller
Section 873	Electric Cable
Section 875	Traffic Signal Post
Section 886	Detector Loop
Section 890	Temporary Traffic Signal

Appendices

Appendix A	IDOT Construction Memoranda
------------	---

DIVISION 100

General Requirements and Covenants

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 100. GENERAL GUIDELINES	101-1
100.01 IDOT ORGANIZATION	101-1
100.01-2 Central Office	101-1
100.01-3 Department Districts	101-13
100.02 ILLINOIS STATE AGENCIES	101-17
100.02-1 Illinois Environmental Protection Agency	101-17
100.02-2 Illinois Department of Natural Resources	101-17
100.02-3 Illinois State Toll Highway Authority	101-17
100.03 FEDERAL AGENCIES	101-17
100.03-1 Federal Highway Administration (FHWA).....	101-17
100.03-2 US Environmental Protection Agency (USEPA).....	101-18
100.03-3 US Army Corps of Engineers (USACE).....	101-18
100.03-4 US Coast Guard	101-19
SECTION 104. SCOPE OF WORK	101-19
104.01 INTENT OF THE CONTRACT	101-19
104.01-1 General.....	101-19
104.01-2 Content of Contract	101-20
104.02 ALTERATIONS, CANCELLATIONS, EXTENSIONS, DEDUCTIONS AND EXTRA WORK	101-20
104.02-1 General.....	101-20
104.02-2 Contract Change Process	101-21
104.03 DIFFERING SITE CONDITIONS	101-31
104.03-1 Guidance	101-31
104.03-2 FHWA Guidance	101-32
104.05 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK	101-32

104.06	FINAL CLEAN UP	101-33
104.07	VALUE ENGINEERING PROPOSALS	101-33
104.07-1	General.....	101-34
104.07-2	Concept Phase Review	101-34
104.07-3	VE Proposal Review.....	101-35
SECTION 105.	CONTROL OF WORK.....	101-36
105.01	AUTHORITY OF ENGINEER.....	101-36
105.03	CONFORMITY WITH CONTRACT	101-36
105.03-1	General.....	101-36
105.03-2	Erosion and Sediment Control	101-36
105.03-3	Traffic Control.....	101-37
105.04	PLANS.....	101-37
105.04-1	Definitions.....	101-37
105.04-2	Shop Drawing Procedures	101-38
105.07	COOPERATION WITH UTILITIES.....	101-40
105.08	COOPERATION BETWEEN CONTRACTORS	101-40
105.09	SURVEY CONTROL POINTS.....	101-40
105.09-1	Purpose of Construction Surveys.....	101-41
105.09-2	Procedures	101-41
105.10	AUTHORITY AND DUTIES OF RESIDENT ENGINEER.....	101-41
105.10-1	General.....	101-41
105.10-2	Interaction with Contractor	101-42
105.10-3	Assignment to Field Work	101-42
105.10-4	Project Personnel Operation and Safety	101-43
105.10-5	As-Built Plans	101-45
105.11	DUTIES OF THE INSPECTOR.....	101-45
105.11-1	General.....	101-45

105.11-2 Duties	101-45
105.11-3 Interaction with Contractor	101-46
105.13 FINAL INSPECTION	101-47
SECTION 106. CONTROL OF MATERIALS	101-48
106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS	101-48
106.01-1 Field Construction Staff	101-48
106.01-2 References	101-48
106.01-3 Iron and Steel Products	101-49
106.01-4 Preconstruction Conference	101-50
106.01-5 PFP vs QCP vs QC/QA vs Non QC/QA	101-50
106.02 UNACCEPTABLE MATERIALS	101-51
106.06 STORED MATERIALS	101-51
SECTION 107. LEGAL REGULATIONS AND RESPONSIBILITY TO PUBLIC.....	101-51
107.01 LAWS TO BE OBSERVED	101-51
107.01-1 General.....	101-51
107.01-2 Employment-Related Legal Requirements.....	101-51
107.04 PERMITS AND LICENSES	101-52
107.04-1 Local Requirements	101-52
107.07 FEDERAL AID PROVISION.....	101-52
107.07-1 General.....	101-52
107.09 PUBLIC CONVENIENCE AND SAFETY	101-52
107.09-1 Emergency Notification	101-52
107.09-2 Lane Width Restrictions	101-52
107.09-3 Protecting the Construction Site.....	101-52
107.09-4 Acceptable Work During Legal Holidays	101-53
107.11 INSURANCE REQUIREMENTS FOR RAILROAD – HIGHWAY CROSSINGS	101-53

107.12	PROTECTION OF RAILROAD TRAFFIC AND PROPERTY	101-53
107.12-1	Grade Separations	101-53
107.12-2	Grade Crossings	101-54
107.12-3	Inspection	101-55
107.16	EQUIPMENT ON PAVEMENT AND STRUCTURES.....	101-57
107.19	UNEXPECTED REGULATED SUBSTANCES	101-58
107.20	PROTECTION AND RESTORATION OF PROPERTY	101-58
107.20-1	Mailboxes	101-58
107.22	APPROVAL OF PROPOSED BORROW AREAS, USE AREAS AND/OR WASTE AREAS	101-59
107.23	PROTECTION OF STREAMS, LAKES, RESERVOIRS, NATURAL AREAS, WETLANDS, PRAIRIE AREAS, SAVANNAHS AND ENDANGERED AND THREATENED SPECIES	101-59
107.23-1	General.....	101-59
107.23-2	Section 404 Permit	101-59
107.23-3	Erosion and Sediment Control	101-59
107.23-4	Municipal Separate Storm Sewer Systems (MS4)	101-60
107.25	PROTECTION AND RESTORATION OF TRAFFIC SIGNS	101-60
107.28	CONTRACTOR SAFETY RESPONSIBILITY	101-60
107.28-1	General.....	101-60
107.28-2	Occupational Safety and Health Act (OSHA)	101-60
107.28-3	Hazardous Materials	101-61
107.28-4	Work Suspension	101-61
107.30	CONTRACTOR'S RESPONSIBILITY FOR WORK	101-62
107.32	FURNISHING RIGHT-OF-WAY	101-63
	SECTION 108. PROSECUTION AND PROGRESS	101-63
108.01	SUBCONTRACTING.....	101-63
108.02	PROGRESS SCHEDULE	101-63

108.02-1	General.....	101-63
108.02-2	Types of Project Schedules.....	101-66
108.03	PROSECUTION OF THE WORK.....	101-69
108.03-1	Summary.....	101-69
108.03-2	Payment Procedures.....	101-70
108.03-3	Loss of Efficiency.....	101-71
108.03-4	Example.....	101-72
108.04	WORKING DAYS.....	101-75
108.06	LABOR, METHODS AND EQUIPMENT.....	101-76
108.06-1	General.....	101-76
108.06-2	Experimental Features.....	101-76
108.07	SUSPENSION OF WORK.....	101-78
108.07-1	General.....	101-78
108.07-2	Work Suspension vs Stop Work.....	101-78
108.07-3	Procedure.....	101-78
108.08	DETERMINATION AND EXTENSION OF CONTRACT TIME.....	101-79
108.08-1	Introduction.....	101-79
108.08-2	Types of Contract Time.....	101-79
108.08-3	Initiation of Charging Time.....	101-80
108.08-4	Charging Time.....	101-80
108.08-5	Conclusions.....	101-85
108.08-6	Examples.....	101-86
108.10	DEFAULT ON CONTRACT.....	101-87

SECTION 109. MEASUREMENT AND PAYMENT	101-88
109.01 MEASUREMENT OF QUANTITIES.....	101-88
109.01-1 Documentation	101-88
109.01-2 Accuracy of Measurement.....	101-89
109.01-3 Weight Checks	101-89
109.01-4 QC Checks By Contractor	101-89
109.01-5 Weighing	101-89
109.04 PAYMENT FOR EXTRA WORK	101-90
109.04-1 General.....	101-90
109.04-2 Method of Payment Definitions	101-90
109.04-3 Lump Sum or Agreed Unit Price.....	101-91
109.04-4 Force Account	101-91
109.05 EXPENSES INCURRED BY THE DEPARTMENT	101-92
109.07 PARTIAL PAYMENTS.....	101-92
109.07-1 Progress Payments	101-92
109.07-2 Material Allowances	101-96
109.08 ACCEPTANCE AND FINAL PAYMENT.....	101-98
109.08-1 Final Payment	101-98
109.08-2 Contract Closeouts.....	101-98
109.09 CONTRACT CLAIMS	101-104
109.09-1 Claims Avoidance.....	101-104
109.09-2 Claims Review.....	101-105
109.09-3 Types of Costs	101-106
109.09-4 Processing.....	101-109

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 100-1 — ILLINOIS DEPARTMENT OF TRANSPORTATION ORGANIZATION	101-2
Figure 100-2 — DISTRICT/REGION BOUNDARIES AND OFFICE LOCATIONS	101-14
Figure 100-3 — SHOP DRAWING REVIEW PROCEDURES (Other Than Structures)	101-39
Figure 100-4 --- PROGRESS SCHEDULE (Example Bar Chart).....	101-66
Figure 100-5 — LOSS OF EFFICIENCY (LOE) FACTOR.....	101-72

Division 101

GENERAL REQUIREMENTS AND COVENANTS

SECTION 100. GENERAL GUIDELINES

100.01 IDOT ORGANIZATION

Figure 100-1 presents the organization of the Illinois Department of Transportation.

100.01-2 Central Office

100.01-2(a) Central Bureau of Construction

General

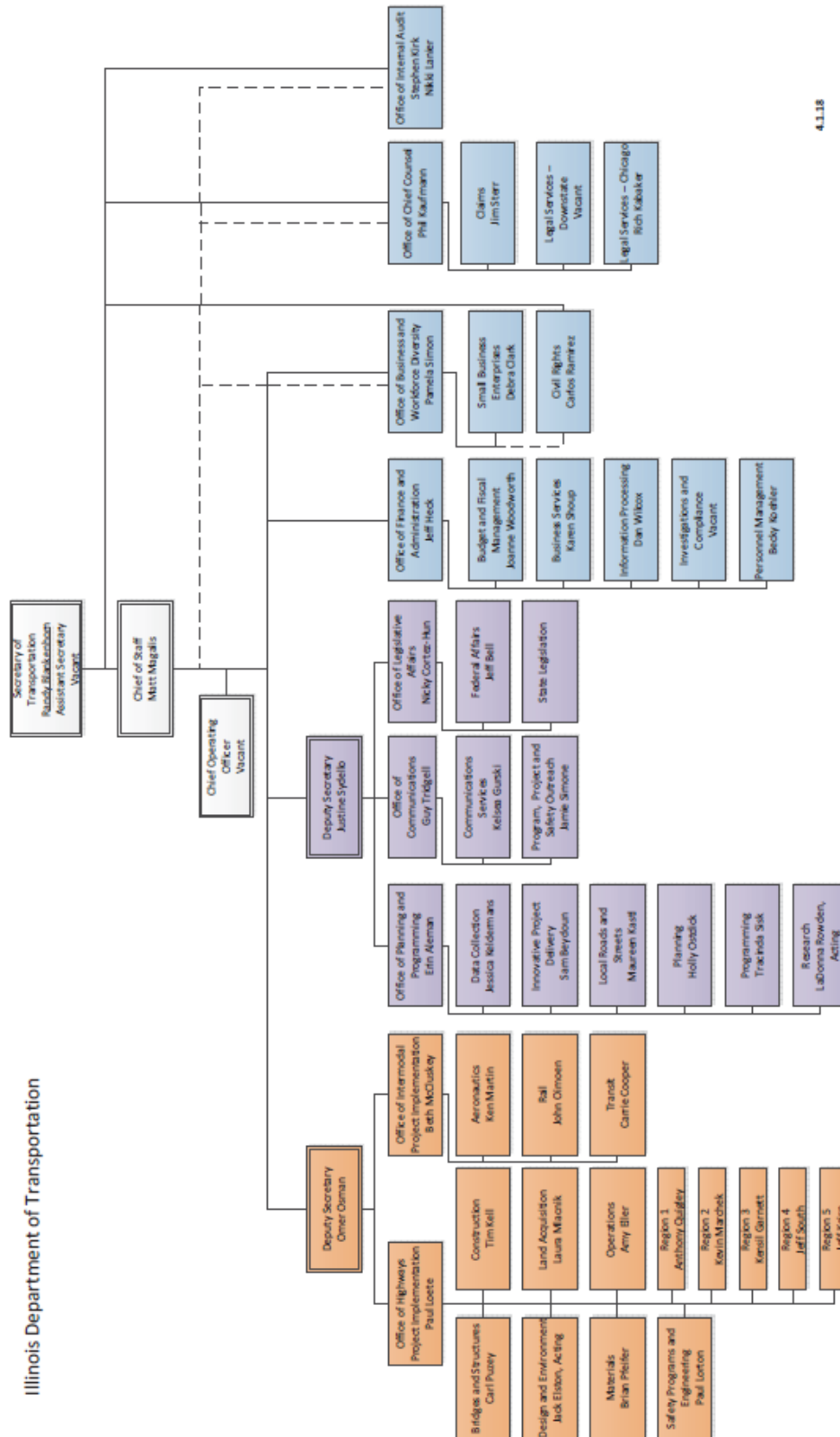
The Central Bureau of Construction is responsible for providing policies that result in quality construction, approving modifications in contracts, providing uniform contract interpretation, prequalifying Contractors and prequalifying consultants for construction engineering, processing Contractor payments and other responsibilities associated with State highway construction.

The Bureau determines Contractors' financial prequalification and work ratings for various types of construction and analyzes Contractors' requests for authorization to bid on Department lettings. The Bureau bills local agencies, processes change orders, approves alterations in contract work and approves requests for extensions of contract time.

Construction Reviews by the Central Bureau of Construction

General construction policies and uniform practices are developed by the Central Bureau of Construction and administered by the District Construction offices. Active construction contracts are inspected by Project Review Engineers at periodic intervals during the construction season.

Figure 100-1 — ILLINOIS DEPARTMENT OF TRANSPORTATION ORGANIZATION



4.1.18

Uniform Construction Practice

With the nine Districts in immediate charge of construction work, certain differences in the interpretation of the specifications and in construction policies may develop. To ensure uniformity, the Bureau of Construction provides general review of construction work performed in all Districts. This is accomplished by Project Review Engineers who are assigned to the various Districts. They review the work at various intervals during construction. This is a cooperative activity and is intended to improve the uniformity of administration of policies, interpretation of the specifications and improve the overall quality of work performed by the Department. Suggestions concerning interpretation of policies and contract requirements may be given to your District Construction Field Engineer/Area Supervisor by representatives of the Central Bureau of Construction.

100.01-2(b) Central Bureau of Materials

General

The Central Bureau of Materials (CBM) has several areas of responsibility directly related to construction functions. CBM is responsible for ensuring the quality of all materials, through testing and certification, incorporated into the State highway system. These responsibilities include the following:

- Verifying and/or approving asphalt, concrete and cement-treated base mixes
- Performing tests that the Districts do not have the equipment or capability to perform
- Performing independent assurance testing, quality assurance control and materials certification
- Conducting lab inspections
- Developing Statewide materials policies and procedures
- Maintaining the IDOT [Project Procedures Guide](#) (PPG) to include current policies and procedures
- Maintaining and calibrating sampling and testing equipment
- Consulting and advising on construction problems related to materials, soils, surfacing design or geology
- Providing Inspector and technician training on proper testing
- Testing and approving Qualified Products List (QPL) products and pre-inspected materials.

The following provides a brief description for each of the Sections within the CBM.

Materials Testing Section

The primary responsibility of the Materials Testing Section is testing and acceptance of all materials required for construction, either by providing guidance to the District labs or performing the testing in the Central Office.

The Materials Testing Section includes 10 laboratories that perform tests on hot-mix asphalt, Portland cement concrete, aggregate, soils, reinforcing steel, paint, and almost every other material used for highway construction. The laboratories are staffed with engineering technicians, geologists and chemists that are responsible for Statewide materials testing. The Materials Testing Section coordinates research efforts evaluates new test methods and serves as consultants to the Districts on a wide variety of technical problems. Materials research is conducted in the CBM laboratories, in the field and in conjunction with universities.

The Materials Testing Section also includes a Geotechnical Unit that is responsible for geotechnical engineering for roadway elements (e.g., pavement subgrades, fill/cut stability). Actual field conditions encountered during construction may differ from those anticipated from field and laboratory evaluations conducted during the design phase. Therefore, the Geotechnical Unit assists the IDOT field construction staff in resolving problems that arise during construction. The Geotechnical Unit is frequently contacted on an as-needed basis by the District to assist with geotechnical related problems encountered in the field (e.g., subgrades, embankments). Section 203 of this *Manual* identifies several highway excavation/embankment features for which the Resident may contact the Geotechnical Unit for assistance.

Administrative Services Section

The Administrative Services Section manages the Materials Integrated System for Test Information and Communication (MISTIC) and the Test Information Unit. This Section supports MISTIC, IDOT's materials testing and inspection databases, and the Statewide materials certification review process. The MISTIC and Test Information Unit also maintains the Trained Technician database and a Statistical Analysis System (SAS) data warehouse that provides many users throughout IDOT with interactive access to key materials testing and inspection data and laboratory inspection information.

100.01-2(c) Bureau of Bridges and Structures

The Bureau of Bridges and Structures (BBS) is responsible for developing the structural design policies, practices and criteria for the Department. BBS:

- Provides the detailed planning and design of highway structures
- Develops bridge standards
- Performs preliminary engineering for structural elements
- Prepares highway structure plans
- Conducts special bridge and structure studies
- Inspects structural steel
- Reviews consultant structure plans for structural adequacy
- Provides review and guidance for local agency project development

Bridge Design Section

The Bridge Design Section is the Department's focal point for the preparation of all in-house structural details. The Section has the day-to-day responsibility to develop structural plans from the general plan and elevation to the Plans, Specifications and Estimate (PS&E) advertisement. The specific functional responsibilities of the Bridge Section are to:

- Prepare all necessary PS&E elements for structural items, including construction plans, Special Provisions, quantities and engineering cost estimates
- Investigate and implement revisions to the IDOT *Standard Specifications for Road and Bridge Construction* (structural elements)
- Approving all fabrication shop drawings for bridge and traffic structures (see Section 105.04 of this Manual and Article 105.04 of the Standard Specifications)
- Regulating material usage and utilization of new fabrication and welding processes
- Inspecting the fabrication, welding and nondestructive testing of weldments for steel bridges and sign structures
- Participate, as needed, in the field construction of structural elements, including:
 - + Reviewing and approving construction shop drawings and structural submittals. (see Section 105.04 of this *Manual* and Article 105.04 of the *Standard Specifications*)
 - + Performing periodic field construction inspections, observations and reviews
 - + Reviewing and commenting on construction change orders when requested by the Bureau of Construction (see Section 104.02 of this *Manual* and Article 104.02 of the *Standard Specifications*)

Bridge Planning Section

The responsibilities of the Bridge Planning Section include:

- Providing the preliminary engineering functions for bridge design (e.g., hydraulics of the waterway opening)
- Developing and preparing type, size and location plans for bridges and structures to establish the structure type
- Reviewing Bridge Condition Reports

The Bridge Planning Section also includes the Foundations and Soils Unit. The Unit is responsible for subsurface investigations required for Department projects (e.g., bridge foundations) and performs the geotechnical design of bridge foundations and earth-retaining systems. The IDOT *Bridge Manual* and IDOT *Geotechnical Manual* document the policies, procedures and practices used by the Foundations and Soils Unit.

The Foundations and Soils Unit is the primary point of contact between the Department field construction personnel on foundations. In this capacity, the Unit serves as “technical advisors” to the Residents on geotechnical issues related to:

- Review of plans and specifications
- Interpretation of Special Provisions
- Response to requests for information (RFIs)
- Review of change orders
- Preparation of reports/documentation

Actual field conditions encountered during construction may differ from those anticipated from field and laboratory evaluations conducted during the design phase. Therefore, the Foundations and Soils Unit assists the Department field construction staff in resolving problems that arise during construction. The following summarizes the Unit’s involvement:

1. Troubleshooting. The Foundations and Soils Unit may be contacted on an as-needed basis by the Resident to assist with geotechnical related problems encountered in the field (e.g., backfill around structures). Section 502 of this *Manual* identifies several foundation issues for which the Resident may contact the Foundations and Soils Unit for assistance.
2. Driven Piles. The Foundations and Soils Unit works with field construction personnel during pile driving operations with respect to:
 - Ensuring adequate pile capacity and tip elevation
 - Pile driving log evaluation
 - Pile hammer acceptance (before driving pile)

See Section 512 of this *Manual* for more discussion.

3. Drilled Shafts Representatives of the Foundations and Soils Unit may be on-site during certain critical phases of drilled shaft construction, including:
 - During drilling
 - Judging the acceptability of the actual soils exposed after excavation
 - Static capacity tests (if performed)

See Section 516 of this *Manual* for more discussion.

4. Spread Footings. The Foundations and Soils Units may observe footing excavations to ensure that the bearing soils have adequate capacity. See Section 503.13 of this *Manual*.

Services Development Section

The functions of the Services Development Section include:

- Managing the Bureau’s data processing and automation equipment systems
- Providing administrative, personnel and training services for the Bureau

- Maintaining and enhancing the automated filing and record retrieval system for project files, personnel files, structural design library, etc.

Structural Services Section

The responsibilities of the Structural Services Section include:

- Managing the Illinois Bridge Inspection Program to ensure compliance with the National Bridge Inspection Standards (NBIS)
- Providing the Department's structure ratings, structural analyses, permit load approvals and investigations and load limit designations on all structures within the State
- Administering and managing the enhancement and coordination of the IDOT Bridge Management System (BMS)
- Developing policies and procedures for paint and lead paint containment specifications and guidelines to achieve the effective maintenance of State highway bridges

100.01-2(d) Bureau of Design and Environment

The Bureau of Design and Environment (BDE) is responsible for developing standards, specifications and policies for the State highway system. BDE develops highway standards and provides support services for District highway design programs, coordinates and prepares Federal-aid program documents and processes plans and contract documents through the letting and contract award stage.

Aerial Surveys Section

1. Surveys and Photo Services Unit. The Surveys and Photo Services Unit, in combination with the District field survey crews, is responsible for aerial surveying needs required for the Department's program of projects.
2. Mapping Unit. The Mapping Unit is responsible for providing precise topographic maps in digital format for use with a Computer Aided Design and Drafting (CADD) interactive graphic system.

Project Development and Implementation Section

In general, the Project Development and Implementation Section is responsible for:

- Reviewing and checking project plans prepared by the Districts and consultants for accuracy, completeness and engineering validity
 - Reviewing Special Provisions
1. Program Support Unit. The Program Support Unit is responsible for:
 - Determining project letting dates

- Clearing projects for advertising and awarding
- Processing CA/Project Status forms
- Determining the proper FHWA funding type and assigning project numbers
- Authorizing project funding
- Obtaining authorization from FHWA for all Federally funded projects including the advertisement of projects, conduct of lettings and execution of contracts
- Ensuring that plans are prepared in accordance with agreements with local agencies or other State agencies

2. Project Management Unit. The Project Management Unit is responsible for the following:
- Determining the official engineer's estimate for all projects offered for letting by the Department of Transportation.
 - Analyzing bids received on lettings and presenting disposition recommendations to the awards committee
 - Maintaining data on price trends
 - Preparing the average unit prices used for cost estimates
 - Reviewing and processing plans, proposals and legal contract documents through the letting stage
 - Preparing the Transportation Bulletin to advertise contracts for letting
 - Determining and maintaining pay item numbers
 - Issuing plans and proposals, maintaining listing of bidders, opening and reading bids and processing bids for the award and execution of contracts

Environment Section

Construction often involves a number of activities that may require coordination with the Environment Section, including:

- Erosion control
- Impacts on habitat for endangered species
- Historical bridges
- Archaeological sites

In addition, the Environment Section provides guidance:

- To Districts and to Department divisions on the *National Environmental Policy Act*
- On Federal and State environmental statutes, rules and regulations applicable to specific projects
- On report preparation
- On coordination with other State and Federal agencies

During preconstruction, the Districts serve as the primary coordinator for project studies. The Central Environment Section conducts environmental surveys, provides special technical expertise, reviews environmental documents (prepared by the Districts), prepares portions of environmental documents as needed and, where necessary, approves environmental documents for the Department.

1. Coordination Unit. The Coordination Unit is responsible for administering the Central Office review of environmental documents and issuing State environmental approvals.
2. Natural Resources Unit. The Natural Resources Unit is responsible for:
 - Operating and managing the environmental resource surveys for individual projects to identify impacts on biological and wetland resources
 - Providing technical expertise on biological resource identification, impact evaluation, mitigation, protection and management in project development, plan preparation, construction and operations
 - Providing technical expertise and guidance on water resources including wetlands, water quality, flood plains and Section 404 permits through the planning, design, construction and operation phases
 - Providing liaison between the Districts and the Central Office and with local, State and Federal resource and regulatory agencies
3. Cultural Resources Unit. The Cultural Resources Unit is responsible for:
 - Directing and managing the cultural resources portion of the environmental resource surveys
 - Providing technical expertise regarding prehistoric and historic archaeological sites and historic buildings and bridges
 - Meeting with historic resource agencies at the State and Federal levels
 - Providing guidance to District and Central Offices
4. Geologic and Waste Assessment Unit. The Geologic and Waste Assessment Unit is responsible for:
 - Managing and directing geologic and special waste surveys on individual projects to identify potential impacts on special waste sites and geological resources (e.g., groundwater, sand, gravel) and potential impacts from geological hazards (e.g., landslides, mine subsidence, earthquakes)
 - Providing technical expertise and training on special waste problems and evaluations (e.g., underground storage tanks, public health concerns, asbestos, landfills) and expertise on geologic resources and hazards in project development, construction and operations
 - Providing liaison between the Districts and Central Office with the appropriate resource and regulatory agencies

Preliminary Engineering Section

1. Consultant Unit. The Consultant Unit is, in general, responsible for all activities with respect to consultants up to and including selection of the consultant.
2. Agreements Unit. The Agreements Unit is responsible for preparing and securing agreements with architectural/engineering consultant firms (after selection), railroad companies, utilities, local agencies and other State agencies.
3. Electrical and Mechanical Unit. The Electrical and Mechanical Unit is responsible for:
 - Preparing plans for all roadway lighting projects except for District One
 - Developing and disseminating Statewide design criteria, practices and policies on roadway lighting
 - Providing technical review of electrical designs for pumping stations

Policy and Procedures Section

In general, the Policy and Procedures Section is responsible for monitoring, evaluating and approving project studies prepared by the Districts to ensure uniformity of policy compliance and to assist on special problems.

1. Standards and Specifications Unit. The Standards and Specifications Unit is responsible for:
 - Developing the *Highway Standards* used in contract plans
 - Initiating or reviewing requests for new or revised *Standard Specifications for Road and Bridge Construction* and evaluating their feasibility and impact
 - Obtaining FHWA approval for new specifications
 - Initiating or reviewing requests for new or revised Special Provisions and details for road and bridge construction and evaluating their applicability
 - Publishing the *Standard Specifications* and Supplemental Specifications and Recurring Special Provisions books
2. Environmental Policy Unit. The Environmental Policy Unit, in general, prepares the written documentation necessary to ensure that the Department complies with all applicable State and Federal environmental legislation, regulations and guidelines.
3. Bicycle and Pedestrian Coordination Unit. The Bicycle and Pedestrian Coordination Unit provides policy and coordinating functions for bicyclist and pedestrian programs and for the Illinois Transportation Enhancement Program.

4. Engineering Policy Unit. The Engineering Policy Unit is responsible for researching, preparing and disseminating design policies and procedures for Phase I and Phase II engineering activities to the Districts and Central Office.

100.01-2(e) Bureau of Local Roads and Streets

The Bureau of Local Roads and Streets (BLRS) is responsible for administering the expenditure of various funds for transportation purposes available to local government agencies. Additionally, the Bureau renders guidance and assistance to local agencies in planning, financing, designing, constructing and maintaining local highway and street systems.

In general, if Federal-aid funds are used in construction, the Department administers the construction project identically to a project on the State highway system. If the construction project is funded through another source (e.g., Municipal Fuel Tax (MFT)), the Department administers the construction as a "local" project. The Department has developed local specific specifications and Special Provisions for application to a local government construction project.

See the IDOT [Bureau of Local Roads and Streets Manual](#) for a complete description of the functions of the BLRS.

100.01-2(f) Bureau of Operations

In general, the Bureau of Operations is responsible for the operation of the State highway system and its intersections with local highways. The Traffic Operations Section within the Bureau performs the following activities:

- Develops standards and specifications to ensure the uniform application of traffic control devices on all streets and highways
- Processes all applications for oversized and overweight vehicle movements
- Promotes a wide range of activities to inform the public of traffic conditions, laws and operational safety

The Maintenance Operation Section within the Bureau develops policies regarding oversized and overweight permit movements on State highways and reviews and issues permits.

100.01-2(g) Bureau of Safety Programs and Engineering

The Bureau of Safety Programs and Engineering (BSPE) is responsible for providing the Department with coordinated engineering safety efforts for both State and local roadways. The Bureau performs the following activities:

Develops, maintains and implements the Illinois Comprehensive Safety Plan

- Develops roadside safety policies regarding roadside hardware and appurtenances used in contract plans
- Develops work zone traffic control policies and requirements to be included in contract plans

100.01-3 Department Districts**100.01-3(a) General**

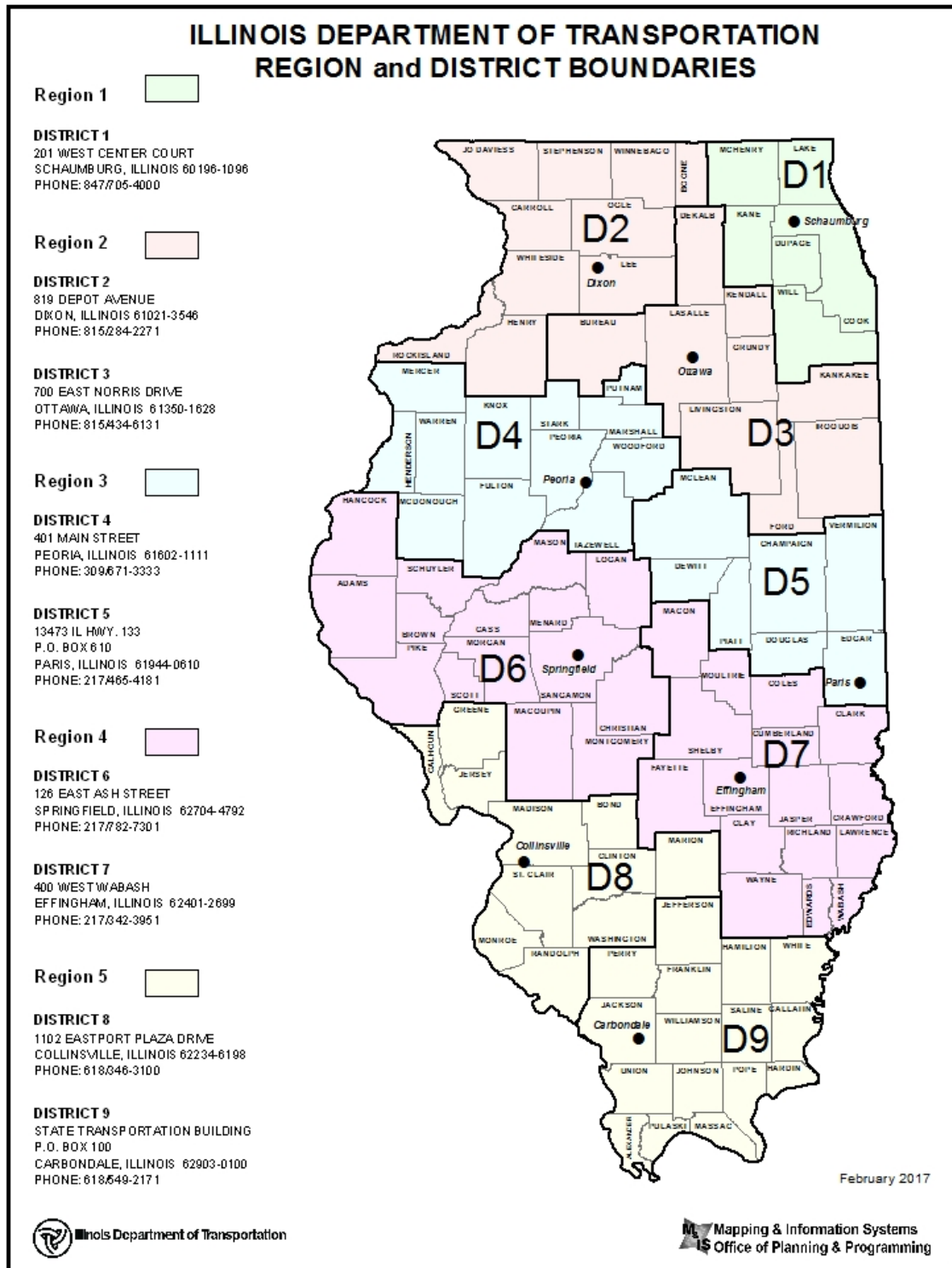
Section 100.01-3 discusses the responsibilities of selected District units that are involved in the Department's construction program on a day-to-day basis. See Figure 100-2 for District/Region boundaries and office locations.

The basic function of the District Office is to provide the necessary field services for many Department activities within its geographic boundaries. For many of these activities, the functional units within the District Office replicate those within the Central Office. In these cases, the Central Office Bureaus set Statewide policies and procedures and support the District Office; the District units perform the majority of the field work. One notable exception is for the design of structures. All structures are designed by the Bureau of Bridges and Structures.

In summary, the major construction related functions assigned to the Districts include the following:

- Administering construction contracts for individual projects
- Inspecting Contractors' project work
- Preparing progress and final pay estimates
- Preparing change orders for submission to the Central Bureau of Construction for processing
- Conducting final inspections
- Public outreach and communication related to individual projects

Figure 100-2 — DISTRICT/REGION BOUNDARIES AND OFFICE LOCATIONS



100.01-3(b) District Project Implementation Engineer

The District Project Implementation Engineer is responsible for administering the construction functions assigned to the District. The District Construction Engineer and District Materials Engineer report to the District Project Implementation Engineer. The District Construction Engineer (DCE) works with the Construction Field Engineers/Area Supervisors to assemble the field construction staff for each Department construction project. The staffing for each project is determined on a case-by-case basis, based on current staffing levels, the size, complexity and nature of the work (e.g., roadway, structures, traffic), etc.

The DCE supervises the Construction Field Engineers/Area Supervisors who supervise the Residents. The Construction Field Engineers/Area Supervisors are the Resident's primary source of direction for the proper administration of construction contracts and advice on construction issues. The Construction Field Engineers/Area Supervisors will periodically visit each construction project to evaluate project progress and to address any specific issues that may have arisen. DCEs are responsible for administering the District construction operating budget and monitoring the use of manpower.

100.01-3(c) Field Construction StaffOrganization/Activities

The organizational structure for field construction staff is determined on a case-by-case basis.

Residents

Residents are responsible for administering and managing one or more construction projects. They function as the highest level of authority for the construction project on a day-to-day basis. Section 105.10 of this *Manual* discusses the authority and duties of the Resident in detail. In summary, the Resident responsibilities include:

- Supervising engineering surveys, inspection, testing and record keeping
- Evaluating and assessing contract time
- Interpreting plans and specifications
- Preparing, at a minimum, monthly progress pay estimates for Contractor payment
- Initiating and preparing change orders
- Documenting pay quantities
- Evaluating and documenting compliance with the contract documents
- Managing assigned field staff
- Approving work and materials

Each Resident is assisted by a staff to perform office, inspection and testing duties.

Although the Resident reports directly to the District Bureau of Construction, the Resident often communicates directly with the functional units within the District Office. The Resident may also communicate directly with the Central Office. The Resident should keep their Construction Field Engineer/Area Supervisor informed of any communication with the Central Office.

Contractor Superintendent

The Contractor Superintendent is the highest-level individual representing the Contractor at the construction site on a daily basis. The Superintendent supervises Contractor personnel (e.g., equipment operators, quality control staff, laborers), and the Superintendent coordinates the work of all Subcontractors. For day-to-day issues that may arise during the course of construction, the Resident and construction staff generally has unrestricted access to Contractor and Subcontractor personnel. However, when any significant issues arise, the Department's field personnel will notify the Resident, and the Resident will work directly with the Contractor Superintendent. See Sections 105.10 and 105.11 of this *Manual* for more discussion on relations with the Contractor.

Field Inspectors

All Field Inspectors report to the Resident. Section 105.11 of this *Manual* discusses the authority and duties of the Inspector in detail. In summary, the responsibilities of the Inspectors include:

1. Materials Testing. Inspectors shall be trained for the materials being sampled and field tested.
2. Traffic Control. Inspectors are responsible for ensuring that the Contractor's traffic control plan meets the requirements of the contract documents.
3. Environmental. The contract documents describe the environmental commitments made during project design, and they document those permits that are the responsibility of the Contractor (e.g., National Pollutant Discharge Elimination System Permit (NPDES)). See Section 107.23 of this *Manual* for more information. Inspectors monitor the Contractor for compliance with the project-specific environmental permits, plans, documents, etc.
4. Roadway. Roadway items include the subgrade grading (i.e., earthwork), earth retaining systems and pavement structure. The inspection and testing of roadway work involves the observation and documentation of the construction work performed by the Contractor to ensure compliance with the contract documents. Divisions 200 to 400 (and portions of Division 600) of this *Manual* provide guidance to roadway Inspectors.
5. Bridge. Structural items include concrete structures, steel structures and piling. Bridge inspection and testing requires the Inspector to have copies of all shop drawings prepared by the Contractor. Photographs are invaluable to identify and document the progress of structure construction and to transmit requests for information to the designer through the Resident. Division 500 of this *Manual* provides guidance to bridge Inspectors.
6. Drainage. Drainage items include box culverts, pipe culverts, drop inlets, inlet grates and underground closed drainage systems. Drainage inspections include the inspection of delivered structures and pipe for damages in delivery, installation and the required material for backfill and placement of drainage structures. Divisions 500 and 600 of this *Manual* provide guidance to drainage Inspectors.

7. Traffic. Traffic items include both the permanent and temporary signs and devices, pavement markings, traffic signals, lighting, etc. Divisions 600 through 800 of this *Manual* provide guidance to traffic control Inspectors.

100.02 ILLINOIS STATE AGENCIES

Section 107 discusses coordination with State agencies in more detail.

100.02-1 Illinois Environmental Protection Agency

IDOT interacts with the Illinois EPA on air and water quality issues such as non-attainment areas, erosion control measures (e.g., ditch checks, perimeter erosion barriers), storm water runoff permits, special waste management, petroleum release and underground storage tanks. The necessary permits, certifications, approvals, etc., have been obtained during the design phase directly from IEPA.

100.02-2 Illinois Department of Natural Resources

IDOT interacts with the Illinois DNR on highway projects that have impacts on the project such as on State parks or other land leases or State-owned land.

100.02-3 Illinois State Toll Highway Authority

Districts 1, 2 and 3 contain facilities that are under the jurisdiction of the Illinois State Toll Highway Authority. IDOT has projects that impact the Toll Authority (e.g., replacing a State highway bridge over the toll road). The coordination with the Toll Authority during construction is comparable to IDOT projects that impact railroads on local facilities.

100.03 FEDERAL AGENCIES

Section 107 discusses coordination with Federal agencies in more detail.

100.03-1 Federal Highway Administration (FHWA)

FHWA and IDOT work under a Stewardship and Oversight Agreement, which establishes the policies and procedures that IDOT must follow to secure Federal-aid funding in its administration of the IDOT transportation program. At the national level, FHWA performs periodic Risk Assessment Reviews on an as-needed basis. Therefore, as part of its program-wide oversight of the IDOT transportation program, FHWA may perform a review of the IDOT construction program.

All State and local agency contracts that include Federal-aid participation must follow all requirements of the Federal Highway Administration (FHWA). The FHWA has active involvement in all Federal-aid (FA) projects during Phase I (planning), Phase II (design), and Phase III (construction) as explained in Chapter 4 of the Bureau of Design and Environment Manual which contains the Stewardship and Oversight Agreement between IDOT and the Illinois Division of the FHWA. For most construction contracts the Department is exempt from direct Federal oversight. On such exempt contracts, Federal law requires the State to administer the contract for the FHWA in accordance with Federal regulations and any agreements between IDOT and FHWA. Projects

that the FHWA chooses to have oversight of the work will be labeled as a Project of Division Interest (PoDI) or a Project of Corporate Interest (PoCI).

The contract for the Federal-aid project is awarded by the Department with the concurrence of FHWA. Supervision of construction is a function of the Department. However, for projects identified by the FHWA as PoDI or PoCI the FHWA will provide the Department the aspect of the construction they will have direct oversight. This could include but is not limited to the approval of contract changes, inspection of work, or final inspection. The FHWA will select the PoDI and/or PoCI on an annual basis that coincides with the Federal fiscal year. The Central Bureau of Construction will provide that list to the district bureaus of construction. The list will indicate what aspect of the work the FHWA will have oversight.

The relationship between the FHWA and the Department does not directly involve Contractors. FHWA will inspect the Department's performance, not the Contractor's. FHWA does not have the responsibility to interact directly with the Contractor.

Department employees should cooperate with FHWA in its inspections. Their comments should be noted in the Project Diary, and issues that require action should be promptly referred to the Resident. When the Resident and a representative from FHWA inspect any Interstate project, note any necessary extra work and any proposed changes. All major changes on FHWA PoDI or PoCI contracts must have concurrence from FHWA before any work is started. Refer to Construction Memorandum No. 4, Contract Changes, in Appendix A and Articles 104.02 and 109.04 in the *Standard Specifications*.

100.03-2 US Environmental Protection Agency (USEPA)

USEPA is responsible for the following, which are often required on IDOT construction projects:

1. Section 401 Water Quality Certification. USEPA administers compliance with Section 401 of the *Clean Water Act*. In almost all cases, if a Section 404 USACE Permit is required, a Section 401 Water Quality Certification is required.
2. Section 402 NPDES Permit. USEPA administers the National Pollutant Discharge Elimination System (NPDES) Program under Section 402 of the *Clean Water Act*. The NPDES Permit for construction activities requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP).

In Illinois, USEPA has delegated Section 401 and Section 402 authority to the Illinois Environmental Protection Agency (IEPA). See Subsection 100.02-1 of this *Manual*.

100.03-3 US Army Corps of Engineers (USACE)

USACE administers the Section 404 Program under the *Clean Water Act*, which prohibits the unauthorized discharge of dredged or fill material into the waters of the United States including wetlands. Such discharges require a Section 404 Permit. The term "discharge of fill material" includes the addition of rock, sand, dirt, concrete, etc., incidental to construction. USACE has granted Nationwide General Permits for various categories of minor activities involving discharge of dredged or fill material. USACE has also issued Regional General Permits for other categories

of activities within specific Corps Districts. If neither of these apply, then an Individual Section 404 Permit may be required.

The contract documents specify Contractor requirements pursuant to any Section 404 Permits obtained during the preconstruction phase. In addition, the Contractor is responsible for obtaining any other Section 404 Permits that may be required due to construction activities (e.g., haul roads, temporary fills) that the Contractor elects to use to construct the project.

100.03-4 US Coast Guard

During the design phase, if necessary, a Section 9 permit is obtained from the US Coast Guard (USCG) for construction of bridges or causeways over navigable waters of the United States.

SECTION 104. SCOPE OF WORK

104.01 INTENT OF THE CONTRACT

As defined in Article 101.09, the contract is “the written Agreement between the Department and the Contractor setting forth the obligations of the parties thereunder. . .” The contract includes the invitation for bids, proposal, letter of award, contract form and contract bond, *Standard Specifications for Road and Bridge Construction*, Supplemental Specifications, Special Provisions, general and detailed plans, and any Agreements required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

104.01-1 General

The Department, or more specifically the Secretary of Transportation, is given authority by the Legislature to enter into contracts to construct and maintain highways, airports and other transportation facilities. The general powers of the Secretary and the Department are enumerated in the Illinois Compiled Statutes (ILCS), 20 ILCS 2705, *Civil Administrative Code of Illinois*. The laws governing the methods of procuring highway construction and making changes to existing contracts are:

- [30 ILCS 500, Illinois Procurement Code](#)
- [30 ILCS 105, State Finance Act](#)
- [720 ILCS 5, Criminal Code](#)

Additionally, 44 Illinois Administrative Code Part 6, Contract Procurement, promulgated under the authority of the Illinois Procurement Code, further refines the provisions for contract procurement as applied to the Illinois Department of Transportation.

Once the contract is executed (signed) by both the Contractor and the Department, it becomes a binding, legal relationship in accordance with the terms set out in the contract. Ultimately, enforcement and interpretation of contract language could be determined by the Court of Claims, the final arbiter of all contract disputes.

Through the various procurement laws, the Legislature has made it clear that, as practicable, all construction contracts are to be executed through a competitive bidding system, with awards made to the lowest responsive and responsible bidder. Specific work efforts within a contract may be paid for on a force account or agreed unit price basis. As specified in the contract, the clear intent is to pay for as much work as possible on the basis of competitively bid unit prices.

104.01-2 Content of Contract

The contract documents define the performance requirements for the Scope of Work through the plans, specifications, drawings, plan notes, etc. Where there is doubt or disagreement on the intent of the contract documents, the Engineer should provide an interpretation, make a decision or, through the District or Central Office, contact the designer for assistance. Any issue related to the intent of the contract that cannot be resolved at the project level should be directed to the Construction Field Engineer/Area Supervisor. Also, see Article 105.01 "Authority of Engineer."

104.02 ALTERATIONS, CANCELLATIONS, EXTENSIONS, DEDUCTIONS AND EXTRA WORK

104.02-1 General

104.02-1(a) Introduction

Changes to the contract should not be viewed as a negative action, but as an important contract administrative tool. These are amendments to the original contract between the Department and the Contractor. Contract changes are used to authorize and document revisions to the contract documents such as to:

- Eliminate contract items
- Alter the quantities of contract items
- Provide for extra work that is performed at agreed prices or force account
- Allow other changes that are germane to the contract

Upon execution, contract changes become an integral part of the contract and are binding to all parties.

The Engineer and the Contractor must collaborate to review the details of any proposed contract changes so that a solution can be developed. It is important that, when these situations occur, the timely processing of changes are discussed, documented and the appropriate approval granted.

104.02-1(b) Fairness

Article 104.02 states the following:

If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

To determine fairness, the Resident should check with the District Estimator (who must approve agreed unit prices (AUPs)). If an agreement cannot be reached, the Resident can direct the Contractor to perform the work as force account (Article 109.04).

The Resident should also view fairness from the perspective of the competitive bidding process. For example, a requested change to permit an access control break or a median turnaround, which was prohibited in the bid package, can give the Contractor an unfair advantage compared to other bidders, because other bids did not anticipate that the Department would change its position on access control.

104.02-1(c) Discussion/Coordination with Project Designers

The Resident should discuss contract changes with other construction personnel and subject matter experts. These discussions can help to determine the need for a change, to identify a preliminary scope and cost of the change, to discuss Federal eligibility and to ensure consistency of changes Statewide.

Although designers do not have approval or disapproval authority for changes, their project development knowledge should be considered. Include them in discussions for all major contract changes. The designer's input is critical on issues that may impact conditions where the Department has received permits by regulatory agencies. For example, any change in geometric design, including changes in slopes, should be discussed with the designer, because this could impact permanent or temporary facility permits. This will ensure compliance with regulatory agencies.

104.02-2 Contract Change Process

104.02-2(a) Construction Memorandum No. 4

Department policy concerning the approval and processing of contract changes is detailed in Construction Memorandum No. 4. This policy is designed to conform Department procedures to the Illinois Procurement Code, the State Finance Act, the Criminal Code, Procurement Rules promulgated in accordance with the Illinois Procurement Code, and Departmental Orders.

The laws and directives apply particularly to the approval and publication of contracts and contract changes. Some of the terms used in these laws are used in a different sense than they are in Construction Memorandum No. 4. To understand the policy contained in this memorandum, Section 104.02-2 defines and discusses many relevant terms.

104.02-2(b) Contract Quantities

Contract quantities are the total quantity of a pay item that has been approved for payment. Contract quantities may be further delineated as either "original contract quantities" or "adjusted contract quantities" to distinguish between the pay items and quantities shown on the original contract proposal (schedule of prices) and those pay items that have been added or pay item quantities that have been increased or decreased by authorization above or below the original contract quantities.

104.02-2(c) Obligation of Funds

After a contract is executed, the funds necessary to pay for the work contemplated in the contract are available by appropriation. An appropriation is a portion of the State budget set aside by the Legislature to pay for defined goods or services. IDOT must file a Contract Obligation Document (COD) with the Comptroller to obligate State funds for the future payment of work under the terms of the contract. The obligation reserves a portion of the appropriation for the specific contract. The total value of this obligation is equal to the total value of the contract, as determined by multiplying the contract quantity of each pay item by the respective unit prices and summing the products.

All payments to the Contractor are made against this obligation. Total payment to the Contractor will not, in any case, be allowed to exceed the obligated amount. If the value of work performed under the contract is increased, the value of the obligation must also be increased. When final payment is made to the Contractor, the value of the obligation must be adjusted, up or down, to match the value of the final payment. [Form BC 22](#) "Authorization of Contract Changes" is the instrument for initiating this adjustment in the obligation.

104.02-2(d) Contract Change

A contract change is a change order or contract adjustment as defined in Construction Memorandum No. 4. All contract changes that affect the pay items or pay item quantities are submitted to the Central Bureau of Construction on Form BC 22: Authorization of Contract Changes. There are four broad categories of contract changes submitted on Form BC 22:

1. Balancing quantities adjust the contract pay quantities to the final measured in place work.
2. Extra work is an addition of work that is not included in the original contract. Extra work may also include modification of the specifications for the work included in the original contract.
3. Work that is included in the original contract may be deleted from the contract.
4. Payment for the contract work may be adjusted based on the performance of the work, as provided for in the contract.

See Construction Memorandum No. 4 for submitting [Form BC 24: Request for Procurement Policy Board Waiver](#).

A contract change has three parts:

- The written approval of the change
- The written directive to the Contractor to perform the work involved in the change
- The obligation of funds necessary to pay for that work

To assist the Department with the administration and approval of contract changes, each change requested by the Districts will be classified as either a major change or a minor change. A single

contract change includes all of the various pay item quantity and funding changes involved in the changed work effort.

104.02-2(e) Authorization Approval Process

The following applies:

1. Approval Authority. The Illinois Procurement Code grants authority to the Secretary of Transportation, in conjunction with the Executive Ethics Commission, to appoint the Contract Procurement Officer (CPO) to enter into contracts and, within limits, to modify the terms of contracts already executed. The Illinois Procurement Code allows the CPO to delegate part of this authority. Only those persons to whom sufficient authority has been delegated may legally approve changes to the contract. This delegation of authority is in terms of the scope, type and value of the change contemplated.
2. Written Approval of Contract Changes. Before the Contractor can be directed to perform any work, the work must be approved. The work included in the original contract is already approved and directed. The Illinois Procurement Code requires that, when the total value of contract changes reaches a certain threshold, all subsequent approvals of contract changes will be made in writing; the threshold varies based on the original contract value. The Criminal Code requires that, when a change order or series of change orders increases or decreases the contract value by \$10,000, or changes the contract time limit by 30 days or more, all subsequent approvals of change orders will be made in writing. To satisfy both of these codes, Article 104.02 requires that all changes in the physical work or the contract quantities shall be authorized in writing by the Resident before the work is started.

Therefore, all work to be performed under the contract will be approved in writing before any work is performed. The written approval must be signed by a person with sufficient approval authority. Although the instrument of this approval may take many forms, the most common are Form BC 22: Authorization of Contract Changes or [Form BC 2256: Prior Approval Authorization of Contract Change](#). State law requires that the written approval contain a description of the change, the reason for the change, and a statement that the change is germane and an explanation of why it is considered germane.

A special case occurs for balancing quantities, in which the contract itself is considered the written approval to perform the work.

3. Written Directive to Proceed. The directive to the Contractor to proceed with the work binds the Department to make good on the agreed payment for the work, when the work is completed in accordance with the agreement. However, those officials and employees approving the work must do so with sufficient authority that will allow the obligation of additional funds, because the State cannot make payment on the work until sufficient funds have been obligated through the Comptroller.

The contract authorizes and directs the Contractor to perform all work shown on the plans up to the contract quantity. The Contractor will not be paid for any work that exceeds the lines, grades and dimensions given in the contract without direction to do so. Likewise,

the Contractor will not be paid for any quantities in excess of the contract quantities placed without direction to do so. Article 104.02 requires that the directive to proceed with extra work or quantities be given in writing before the work starts.

Illinois court decisions have established the following principles in determining whether a Contractor may obtain payment for any extra or additional work:

- The work was extra (i.e., not within the original scope of the project).
- The extra work was ordered by the owner or an authorized person.
- Before the extra work was begun, the owner agreed to pay for the additional work, either by the words or conduct of the owner or authorized person.
- The extra work was not a voluntary contribution by the Contractor.
- The extra work was not necessary due to any fault of the Contractor.

An essential issue is the approval for the Contractor to proceed with the work, and who is authorized to give that approval. When through word or action an authorized officer directs such work, the Department becomes obligated to pay the Contractor for the extra work. However, care must be taken to comply with the various provisions mentioned above.

Except in the special case of balancing quantities, all directives to proceed with extra work or quantities will be made in writing. The written directive must include, at a minimum, a sufficiently precise description of the work to be performed, including references to any Standard Specifications that govern the work and the signature of the person issuing the directive. This directive may take many forms, the most common are Form BC 22: Authorization of Contract Changes, Form BC 2256: Prior Approval Authorization of Contract Change or a letter, memo or email from the person directing the change. The written approval and the written directive may, in fact, be the same document.

104.02-2(f) Balancing Quantities

The contract is the written approval to perform the work described by the contract, to the “lines and grades shown on the plans,” etc. However, the contract specifies the amount of work not only in terms of the final dimensions for the work, but also in terms of the contract quantities of the various pay items necessary to complete that work.

As stated in Article 104.01, “the quantities appearing in the bid schedule are approximate and are prepared for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished according to the contract.”

The difference between the contract quantity and the actual quantity of a pay item is referred to as a balancing quantity. Because the contract quantities are recognized as estimated, if the balancing quantity is of a magnitude that reasonably represents, under the circumstances, the actual amount of work required by the contract, the directive to perform an additional, balancing

quantity in excess of the contract quantity may be given verbally or by physical layout of the work, without the need for a separate, written directive to the Contractor.

Before the contract can be closed, contract quantities must be adjusted up or down to match the final quantity of work performed, so that the obligation of State funds matches the final payment to the Contractor. BC 22 Forms that include only such balancing adjustments to the pay items are frequently referred to as balancing authorizations. Balancing authorizations should be done during the construction as work is being completed to avoid an authorization for over \$250,000 at the end of the project. Note, however, that even though the Contractor may be directed verbally or by action to perform additional, balancing quantities, payment cannot be made for such quantities until an authorization (Form BC 22) is submitted and approved to adjust the contract quantities.

Any contract change that affects the work to be performed under the contract, other than that needed to balance quantities, requires a specific, written directive to the Contractor. The directive may be to perform extra work. The directive may also be to not perform work which is already authorized by the contract.

104.02-2(g) Plan Quantity Error

Technically, any difference between the estimated contract quantities and the actual quantity of pay items needed to perform the work specified by the contract is a balancing quantity. However, for the purpose of the approval authority and procedures, a quantity is considered balancing only when the estimated quantity reasonably represents the actual amount of work to be performed. The reasonableness of a quantity estimate depends on many factors, including the type of work, the circumstances of the work, the methods used to determine the plan quantities and, possibly, the value of the difference in quantities. Determining the reasonableness of a balancing quantity requires good judgment on the part of the Resident.

If a balancing quantity exceeds a reasonable magnitude, then this quantity is considered a plan quantity error; this requires special attention. If the error involves a significant overestimation of the actual quantity needed, the Contractor is still limited to placing the work to the lines, grades, etc., specified in the contract. Two potential problems may still arise:

1. Although the Contractor is limited by the contract specification of the work, the Resident must be especially careful to not give any word or action that may be construed as giving the Contractor sufficient direction to proceed with the extra, unneeded quantities. The Resident must be aware at all times of the progress of work and the quantity of work that is necessary.
2. In some cases, the work is not specified by dimensions in the contract but, rather, by the quantity. For example, an estimated quantity of patching or repair work may be included in the plans, without specifying the location of that work. In this case, the Resident must ensure that the scope of such work is that which was intended by the designer.

Conversely, if the error involves a significant underestimation of the actual quantity needed, the Contractor is still limited by the contract quantity in the amount of work to be performed without additional direction. The main problem with this situation is that authorizing the additional

quantities necessary to perform the entire work may involve increasing the value of the contract beyond what was expected when the original contract was executed. In this case, the Department will carefully consider whether the additional quantities of work will be authorized, or the scope of work involved will be “deleted” from the contract. Payment for the additional quantities is governed by Article 104.02. For significantly underestimated quantities, the Resident must again be especially careful not to give any work or action that may be construed as giving the Contractor sufficient direction to proceed with the additional, unauthorized quantities.

In either case, authorization of quantities involved in a plan quantity error are governed by the levels of delegated approval authority and require additional written approval and direction to proceed with such work.

104.02-2(h) Extra Work

As defined in Article 101.18, extra work includes both the addition of new types of work for which pay items were not included in the original proposal, and additional quantities of existing pay items to pay for work at locations not included in the plans. Work categorized as anticipated additions and unpredictable additions is also considered extra work.

104.02-2(i) Cancellation of Work

Although most of the discussion of contract changes in the *Construction Manual* addresses adding value to the contract, it should be noted that canceling work included in the contract also requires written approval and written direction. Cancellation of work is considered a change order and is also covered by the Criminal Code. Unless otherwise directed in writing, the Contractor is authorized to perform work included in the contract. Payment for partially completed work that has been canceled is covered by Article 109.06.

104.02-2(j) Extra Work Effort

An extra work effort includes all of the various types of work necessary to produce a defined change in the project. An extra work effort may include work paid under one or more pay items.

Many of the dollar limits set by laws are in relation to an entire work effort, rather than the value of the individual pay item quantities that are necessary to produce the result that is the object of the extra work effort. Limits on delegation of approval authority from the Secretary of Transportation are also in relation to the type or value of an extra work effort. Because of this, judgment is required in defining the scope of a single extra work effort.

A question arises when the same type of extra work is performed at more than one location. One guideline for determining the scope of the extra work effort is that, if the description and reason for the change is the same for extra work at different locations, then the work may be considered as part of the same work effort. Remember that the law states that contract changes shall not be artificially divided so as to avoid the provisions in the law.

104.02-2(k) Change Order vs. Contract Adjustment

As defined by the Criminal Code, a change order is “a change in a contract term, other than as specifically provided for in the contract, which authorizes or necessitates any increase or decrease in the cost of the contract or the time to completion.” A change order is a type of contract change that either modifies the requirements for a pay item already included in the contract or adds a new type or scope of work that was not included in, or anticipated by, the original contract.

For example, increasing the diameter of a storm sewer is a change in specifications and is, therefore, a change order. The pay items and quantities involved in this work effort includes the addition of the new, larger pipe, the deletion of the quantity of the original pipe and, possibly, the increase in trench backfill quantity required for the larger trench.

In the past, the terms “change order” and “authorization” have been used interchangeably. To help administer contract changes, the term change order will be used to refer only to such contract changes that modify the work called for in the contract, or that increase or decrease the contract completion time by 30 days or more (as noted in the Criminal Code). The term “authorization” is used more generically to refer to all contract changes (not just change orders) submitted on Form BC 22.

All contract changes that are not considered change orders are referred to as “contract adjustments.” A contract adjustment is a change in pay items or pay item quantities needed to pay for either the actual work required to be performed to complete the work called for in the plans or extra work provided for in the contract.

For example, contract changes to balance as-built quantities against plan quantities are considered contract adjustments. The addition of a new pay item, such as “Subgrade Repair,” which is called for as a contingency in the Specifications, would also be considered a contract adjustment.

104.02-2(l) Change Category

To help manage the large number of changes that occur on all construction projects, the Resident will assign each authorization line item a category code representing a change category that describes the type or reason for the change. These change categories are described in detail in Attachments 1 and 2 in Construction Memorandum No. 4.

The category codes allow Statewide summary reports on the causes of contract changes. Individual authorizations already fully describe the descriptions and reasons for the changes. However, when management desires to obtain a sense of changes for Statewide authorizations, it is impossible, practically speaking, to review and tabulate the thousands of authorizations that are approved every year. The change categories, then, provide that information in a way that allows for computer summarization and reporting, and are an important tool for managing trends in plan quality (State plans only) and State spending.

104.02-2(m) Germaneness

This is defined in the Department's rules promulgated under the Illinois Procurement Code: "In relationship to the modification, alteration or amendment of the terms of a contract by [contract change], the term 'germane' means a change that is related to the original terms of the contract but that is not so substantial a departure from the original as to constitute a new contract."

There is no exact definition of what is or is not germane. The germaneness requirement is intended to promote careful planning by the person or agency before entering into a contract to purchase goods or services. The Legislature mandates that, as much as possible, goods and services (in this case, construction contracts) be procured under a competitive, sealed, bidding system. Additional work added to an existing contract is not subject to competitive bidding. Therefore, the purpose of the germaneness requirement is to limit the amount of additional work that is not competitively procured.

There are different opinions on what is considered germane. A judgment of germaneness is an attempt to conform to the Legislature's intent in establishing the germaneness requirement based on:

- The various procurement requirements written into law
- The specific procurement rules approved for the Department by the legislative Joint Committee on Administrative Rules
- Legal opinions offered by the Attorney General
- Audit results from the Auditor General

A contract change is considered germane if the change is within the intended scope and quantity of the original proposed contract. In this sense, germaneness determinations have a "nature of the work" aspect and a "value" aspect. A contract change is also considered germane if the change is needed to complete the work directed by the contract.

Generally, any type of work that is not shown on the plans or included in the specifications, and that is not required to complete the work as bid, is not germane to the contract. For example, regrading a ditch is not germane if no work of this type is included in, or needed to complete, the original contract. In contrast, modifying the excavation quantities for regrading work included in the plans is germane, if those additional quantities are necessary to produce the drainage result clearly intended by the contract. As another example, adding a second entrance to an adjacent property may not be germane, but adding a field entrance that was unintentionally omitted from the plans is germane, if the entrance is necessary to allow for egress to the property as required by law.

Other examples include:

- Work outside the physical limits of the contract is not considered germane, if the work is not necessary to complete the work in the original contract or if the work is not necessary to provide the proper performance of the work in the original contract.

- Extra work efforts that significantly increase the cost of the contract may also not be germane, even though the work might otherwise be considered necessary to complete the work in the contract.
- Significant changes in quantities may or may not be considered germane. Modifying contract quantities to account for plan quantity errors is germane, if the magnitude of the change does not alter the nature of the work.

104.02-2(n) Emergency Contracts

Note that only the Chief Procurement Officer can enter into emergency contracts.

104.02-2(o) Small Purchases

The Illinois Procurement Code defines a small purchase limit below which new contracts and contract changes will be exempt from the advertisement requirements of the Code. The Code sets the small purchase limit at \$30,000 as of July 1, 1998 and provides for adjustments for inflation to be issued on July 1 of each subsequent year. The rules established by the Chief Procurement Officer, based upon the authority in the Code, have adjusted this limit to \$100,000 for highway construction contracts and contract changes. The Department may adjust this figure in reliance on the germaneness determination also set out in the Code.

In some sense, the Legislature provided a means to accomplish “small” additions to existing contracts without a requirement for germaneness. A small purchase is, in a technical sense, a separate contract that is conveniently paid for under the mechanisms of an existing contract. From the Contractor’s perspective, a small purchase is indistinguishable from any other change ordered under the contract and paid for in accordance with Article 104.02. However, Article 101.18 defines Extra Work as “an item of work not provided for in the contract as awarded but found essential and germane to the satisfactory completion of the contract within its intended scope as determined by the Engineer.” (Emphasis added.) Taken together, these two provisions (in the law and in the contract) allow for changes that are still within the realm of work that was bid on by the Contractor but do not meet the stricter germaneness standards of the Illinois Procurement Code.

In fact, the majority of changes performed each year fall below the current \$100,000 small purchase threshold. Because all Departmental spending is subject to the oversight of the Chief Procurement Officer and the Legislature, it is not within the best interest of the Department and its mission to be seen as abusing the small purchase exemption as a way around meeting the overall intentions of the competitive bidding requirements. It is, for this reason, that Central Office approval is required for small purchases.

Although the Illinois Procurement Code allows non-germane small purchases to be added to an existing contract, these additions are still subject to the requirements of the Criminal Code and the State Finance Act. The Criminal Code still requires that for change orders a written determination be made that the change is germane or in the best interest of the State or not contemplated at the time the contract was signed. (There is a minimum threshold for this determination requirement, but Department policy requires that all changes have a written

determination.) So, if a contract change is procured as a small purchase (because of non-germaneness), there is still a requirement for a written determination.

104.02-2(p) Coordination with FHWA

For contracts that do not involve FHWA oversight, the Department is solely responsible for ensuring that all work and procedures conform to Department policy and specifications. The Department administers all aspects of the contract without direct FHWA oversight. On contracts identified as Projects of Division Interest (PoDI) or Projects of Corporate Interest (PoCI), the FHWA takes active oversight in selected aspects of construction for the project. See section 100.03-1 for an explanation of PoDI and PoCI.

For projects identified as PoDI or PoCI for which the FHWA has chosen to have oversight of contract changes, the FHWA must give prior written approval of all major changes before work on the subject change is begun. (The Department's agreement with FHWA also stipulates that all time extensions must be approved by FHWA in addition to the Central Bureau of Construction.)

The Central Bureau of Construction will advise the Districts on which contracts are PoDI or PoCI. The FHWA approval will be obtained as early as possible in the contract change development process. The District should keep FHWA staff and the Central Bureau of Construction Project Review Engineers aware of pending major changes during project visits or through telephone calls. FHWA approval of all major changes will be coordinated through the Central Bureau of Construction. FHWA approval must be in writing (an email or fax from the FHWA Engineer is sufficient written documentation), and the approval is to be documented on Form BC 22 or on Form BC 2256 submitted with Form BC 22. The Central Bureau will send a copy of all authorizations on PoDI and PoCI projects to FHWA (including Form BC 22s that did not require prior FHWA approval).

104.02-2(q) Finance Code Requirements

The Illinois State Finance Act (30 ILCS 105/9.02) requires that, when a single or cumulative contract change results in a net change that increases the contract value to or by \$250,000 in a fiscal year, before funds may be obligated for such a change, Form BC 22: Authorization of Contract Changes, must have the signatures of the Secretary, Director of Highways, Director of Finance & Administration and Chief Counsel and the Chief Procurement Officer. (Departmental Order 2-2)

To give full force to the intent of the State Finance Act, the Secretary has also ordered that, for contracts with an awarded value in the range of \$200,000 to \$1,000,000, a single or cumulative change order resulting in a net change that is equal to or greater than 25% of the awarded contract amount in a fiscal year will also require the five signatures.

The State Finance Act places direct responsibility of oversight for large changes in the value of a contract on the executive officers of the Department. Because this law contemplates the total value of contract changes, rather than the specific objects of the changes, it would be extremely burdensome to stop the work to obtain these signatures on the particular authorization that triggers this law. The approval procedures noted above are intended to assure full review and oversight of all changes at an appropriate level of oversight that provides assurance to these

officers that valid and lawful approvals have been given. It is absolutely essential, therefore, that all persons invoking delegated authority follow these procedures meticulously to ensure that all legal requirements and Department regulations are followed.

The Central Bureau of Construction will coordinate with the executive officers to obtain these signatures. It is understood that these signatures may be obtained after the work has already been ordered, when Form BC 22 includes only minor changes approved at the District level. The Central Bureau of Construction will obtain these signatures for all major changes before the work is approved.

104.02-2(r) Documentation (Determination Statement)

The Criminal Code requires that, when a change order exceeds \$10,000 or adds 30 days to the duration of the work, a written determination must be made at the time of approval of the change order. The written determination must state one of the following:

- “The undersigned determine that the circumstances said to necessitate the change in performance were not reasonably foreseeable at the time the contract was signed.”
- “The undersigned determine that the change is germane to the original contract as signed.”
- “The undersigned determine that the change order is in the best interest of the unit of State or local government and authorized by law.”

On the other hand, the Procurement Code requires that all additions to a contract be germane. In addition, when the value of an addition – that is, the net value of an additional work effort – exceeds certain thresholds (depending on the value of the original contract), the Procurement Code requires that a written determination be made as to why the change is considered germane. Examples of germaneness statements that can be used for written determination of Form BC 22 are shown on Construction Memorandum 4.

Additions of time will be granted using [Form BC 2019: Request for Extension of Time](#) and according to Article 108.08 of the *Standard Specifications*.

104.03 DIFFERING SITE CONDITIONS

104.03-1 Guidance

Section 104.03 of this *Manual* provides guidance on enforcing Article 104.03. In most cases, the Construction Field Engineers/Area Supervisors will make this determination with guidance from the Central Bureau of Construction.

The first type is defined in Article 104.03 as subsurface or latent physical conditions encountered at the site differing materially from those indicated in the contract. One example would be larger rock, such as encountering cobbles and boulders instead of sand in a soil boring strata. Another example would be rock that is harder to drill, such as where granite instead of limestone was

encountered. For the Contractor to receive additional compensation, the Contractor must prove the following:

- The contract documents must have affirmatively indicated or represented the subsurface or latent physical conditions.
- The Contractor must have acted as a reasonably prudent contractor in interpreting the contract documents.
- The Contractor must have reasonably relied on the indications of the subsurface or latent physical conditions in the contract.
- The subsurface or latent physical conditions actually encountered within the contract area must have differed materially from the conditions indicated in the same contract area.
- The actual subsurface conditions or latent physical conditions encountered must have been reasonably unforeseeable.
- The Contractor-claimed excess costs must be shown to be solely attributable to the materially different subsurface or latent physical conditions within the contract site.

The second type is defined in Article 104.03 as unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work. An example of this would be a hazardous waste deposit. For the Contractor to receive additional compensation, the Contractor must prove the following:

- That it did not know about the condition
- That it could not have reasonably anticipated the condition after a review of the contract documents, a site inspection and the Contractor's general experience in that area
- That the condition was unusual because it varied from the norm in similar construction work

When a differing site condition occurs, the Resident should notify their Construction Field Engineer/Area Supervisor and the design engineer.

104.03-2 FHWA Guidance

For additional information on differing site conditions specifically related to geotechnical investigations, see "Geotechnical Guideline No. 15" in the FHWA [Geotechnical Engineering Handbook](#).

104.05 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

Article 104.05, paragraph 1 states the following:

The Contractor with the approval of the Engineer, may use on the work such stone, gravel, sand, or other material determined suitable by the Engineer as may be found in the excavation, and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used.

An example is where the Contractor, while performing the excavation shown in the contract plans, finds material that it desires to use as trench backfill. When this happens, the Resident should submit a sample to the District Bureau of Materials for testing and approval before use.

Based on Article 104.05 of the *Standard Specifications*, the Contractor may request acceptance of on-site material for use on the project. As an example, removal items (e.g., concrete structures, pavement) may be crushed to meet the material requirements of base materials. The Contractor is responsible for providing documentation for the materials provided and for the quality of the materials.

Written authorization is required for excavation outside the planned slope and grade lines and is only provided where it benefits the State.

The Resident must provide approval before any use of materials that is inconsistent with the planned use.

104.06 FINAL CLEAN UP

The Resident will prepare a punch list for final clean-up based on those items listed in Article 104.06 and items identified by Department field staff. This list should include offsite areas used temporarily during construction by the Contractor for borrow, use and waste areas.

In preparation for final clean up, the Resident should consider taking photographs and/or video of the site before construction begins. This will create a record and “base” to work from in establishing the punch list, which can defuse problems at the final cleanup stage of the project.

104.07 VALUE ENGINEERING PROPOSALS

Article 104.07c(7) states the following:

In determining the estimated net savings, the right is reserved to disregard the contract bid prices if, in the judgment of the Engineer, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

In most cases, the Central Bureau of Construction will make this determination. Examples of cases where the Resident may refuse to use contract bid prices are:

- Unbalanced bids
- Front-end loaded bids

The Resident should check with the District Estimator to determine the reasonableness of the prices in question.

104.07-1 General

A VE Proposal can be an alternative material or other innovation originated by the Contractor that is intended to provide a cost savings to the project. The proposed work must maintain or enhance the function and quality of the project. The net cost savings is shared between the Contractor and the Department.

VE Proposals should be evaluated in a timely manner and every reasonable effort should be made to complete the response within the time frame given in Article 104.07.

The Central Bureau of Construction will be the point of contact and will be responsible for coordinating the review of the Proposal and tracking progress. The Central Bureau of Construction will share lessons learned to incorporate innovative practices into future Department projects, either at the planning phase or into future VE Proposals.

104.07-2 Concept Phase Review

VE Proposal evaluations require a two-step process. The initial step is the Concept Phase, which is intended to screen Proposals to determine if a detailed investigation is warranted.

Proposals judged to have a reasonable potential for meeting service requirements and cost-effective objectives will advance to the VE Proposal stage, which will include analysis and investigation.

The following examples generally will not qualify as a VE Proposal and should be rejected:

- An alternative construction method or concept that does not meet current design policy or standard.
- Deletions of pay items.
- Deletions of specifications.
- A design that was previously considered in the design phase. For example, changing pavement type from full-depth HMA to concrete.
- Proposing a change which is a lower standard. For example, steepening an embankment's design slope.

The involved Department units will conduct a review of the concept that relates to their functional areas. This is a cursory review to determine if the Proposal warrants detailed investigation and analysis. The review should only require sufficient detail to identify obvious problems in design standards, service requirements, materials properties and other factors affecting performance and operation.

The Central Bureau of Construction will notify the Contractor, in writing, of the acceptance or rejection of the concept.

104.07-3 VE Proposal Review

The internal Department VE Proposal review includes the following steps:

1. The Central Bureau of Construction will notify the involved Department units to proceed with detailed investigations and of the due date for submitting its review.
2. The purpose of the review is to ensure that the essential functions of the project are not impaired. This may include re-design, design review, review of consultant designs, materials tests and evaluation, quantity calculations and cost estimates. This stage may include internal Department meetings and/or meetings with the Contractor and their consultants to clarify and negotiate solutions to problems.
3. Each of the appropriate Department units will submit a review to the Central Bureau of Construction, which will include a recommendation on whether or not the VE Proposal should be accepted.
4. The Central Bureau of Construction will determine whether or not to accept the Proposal and will notify the Contractor, in writing, of the decision.

SECTION 105. CONTROL OF WORK

105.01 AUTHORITY OF ENGINEER

See Article 108.07 of the *Standard Specifications* for a discussion on work suspension.

105.03 CONFORMITY WITH CONTRACT

105.03-1 General

In determining close conformity with the contract, engineering judgment is based on a resulting service life that is not diminished. An appropriate adjustment in the contract price may be warranted. This is usually accomplished by authorization and is considered a “credit” to the contract. Otherwise, the contract modification is known as “taking a credit for out-of-spec material.” The following cost categories are recommended for consideration in determining the adjustment but are not considered inclusive.

105.03-1(a) Engineering Costs

Undue engineering time incurred by the Department to review unacceptable work or material, and time to inspect corrective work, may warrant an adjustment in the contract price. This may occur when there is the repeated review of unacceptable work or material or, for example, a lengthy structural engineering analysis is performed.

When consultants are used for the additional engineering time, documentation is straightforward by invoice. For Department District and/or Central Office personnel, contact the Bureau of Design & Environment, Preliminary Engineering Section for the hourly rate and multiplier to use.

105.03-1(b) Future Inspection and Monitoring Costs

Undue future inspection and monitoring time incurred by the Department may warrant an adjustment in the contract price. This may occur for repairs performed to new construction, such as a bridge. Inspections of a bridge may take longer because of extra time to check the performance of a repair.

105.03-1(c) Future Maintenance Costs

A repair on new construction may not be sufficient to last for the entire service life. Thus, timely maintenance may be needed. If the probability of future maintenance or rehabilitation is high, an adjustment in the contract price may be warranted.

105.03-2 Erosion and Sediment Control

If a deficiency is observed with respect to erosion and sediment control (Article 105.03(a)), document the deficiency and then consult Table A “Deficiency Deduction Gravity Adjustment Factors” in Article 105.03(a) of the *Standard Specifications* to calculate the monetary deduction for the unacceptable work. An example calculation for the Deficiency Deduction is based on the following:

- Violation – Intrusion into protected resource
- Area Disturbed – 7 acres

The Resident notifies the Contractor of the violation and allows three calendar days for corrective action (i.e., return the protected resource to its original condition). The Contractor actually uses six calendar days to comply with the Resident’s order. Determine the Gravity Adjustment Factor based on the type of violation and the number of acres of soil disturbed. From Table A, use the Intrusion into Protected Resources row and read over to the second column (5 to 10 acres) to identify the applicable range for the Gravity Adjustment Factor (1.0 – 5). Because the area disturbed is 7 acres, prorate as follows:

$$\text{Gravity Adjustment Factor} = 1 + \left[\frac{7 - 5}{10 - 5} (5 - 1) \right] = 2.6$$

The deduction is calculated as follows:

$$\begin{aligned} \text{Deduction} &= (\$1000)(2.6)(6 \text{ days} - 3 \text{ days}) \\ \text{Deduction} &= \$7800 \end{aligned}$$

where the \$1000 is the daily monetary deduction from Article 105.03(a). Section 280 provides additional discussion on contract conformity with respect to erosion and sediment control.

105.03-3 Traffic Control

If a deficiency is observed with respect to traffic control (Article 105.03(b)), document the deficiency and determine the proper course of action to correct the deficiency. The *Standard Specifications* distinguish between deficiencies for which the Contractor is given time to correct and those for which the deduction is “immediate.” Examples of immediate deductions include:

- Closing a road with no advance warning signs
- Moving equipment across the pavement or bridge obstructing traffic
- Failure to provide protection to traffic from falling objects and/or materials
- Failure to provide traffic control surveillance as directed by the Resident
- Use of non-certified flaggers
- Non-compliance to repeated instructions from the Engineer to correct deficiencies

Use discretion when applying the immediate deduction.

105.04 PLANS

105.04-1 Definitions

As used in the *Standard Specifications*, the following definitions apply:

1. Shop Drawings. A shop drawing is a drawing or set of drawings produced by the Contractor, supplier, manufacturer, Subcontractor or fabricator. They are detailed construction and fabrication drawings that show the proposed material, shape, size and assembly of the individual parts and how the entire unit will be installed. Shop drawings are typically required for prefabricated components and normally show more detail than

the contract documents. Examples of these include structural steel, trusses, aluminum and prestressed concrete elements, precast box culverts, three-sided precast concrete structures and noise walls.

2. Working Drawings. Working drawings are all drawings that are created after contract award. This includes items such as a bridge demolition plan, beam erection plan, revised plan sheets, shop drawings and layout drawings. A working drawing is a blueprint that is subject to clarifications but is complete with sufficient plan and section views (with dimensions, details and notes) to enable the depicted item's construction or replication without additional information.
3. Layout Drawings. Layout drawings include all survey drawings required in the layout of the various construction items such as the paving plan, bridge deck pour sequence layout, beam alignment layout, etc.

105.04-2 Shop Drawing Procedures

The Contractor, fabricator and/or material supplier is responsible for the timely submittal and distribution of shop drawings required by the contract. The Contractor must provide shop drawings for specific items of work as identified in the *Standard Specifications*. The Contractor shall submit to the Resident all drawings with the required number of copies specified in the contract. The Resident will review each shop drawing for completeness based on the requirements of the contract documents and forward these to the responsible Department personnel, who will review the drawings and submittals.

This discussion prescribes requirements for the submittal, routing and approval of shop drawings other than structures on Department highway construction contracts. For structure-related items, refer to the [Shop Drawing Procedures Memorandum](#) issued by the Bureau of Bridges and Structures. This Memorandum contains detailed instructions and distribution flowcharts for most structural items requiring shop drawing review by either a Consultant or the Bureau of Bridges and Structures (BB&S). The applicable structural items are listed on p. 2 of the BB&S Memorandum.

See Figure 100-3 for a summary of required shop drawings other than those in the BB&S "Shop Drawing Procedures Memorandum." Other project-specific items not included in this list may also require approved shop drawings. The Resident shall keep one copy of all shop drawing submittals in the project file.

The Resident will provide the Department field inspection staff with the approved shop drawings for construction. The Contractor must not change the details approved without revised, approved plans.

Figure 100-3 — SHOP DRAWING REVIEW PROCEDURES (Other Than Structures)

Shop Drawing	Standard Specifications Article	Resident Forwards To	Time Frame for Department Review
Continuously Reinforced Concrete Pavement (CRCP) Chair Supports	Article 421.04(a)	Pavement Design Engr. in Policy and Procedures Unit of CBM	30 days
Piling – Load Test Frames	Article 512.04	BB&S	30 days
Sluice Gates	Article 607.06	Hydraulics Unit in BB&S	30 days
Flap Gates	Article 608.03	Hydraulics Unit in BB&S	30 days
Non-Traffic Signal Installations – Electrical	Article 801.05(a)	Electrical Unit in BDE. District One — to District Bureau of Traffic	30 days
Controller	Article 1068.01(f)	Electrical Unit in BDE. District One — to District Bureau of Traffic	30 days
Temporary Water Filled Barrier	Article 1106.02(k)	BSPE	30 days
Bicycle Racks	Check Sheet #18	Resident approves	30 days
Concrete End Sections for Pipe Culverts	BDE Special Provision dated January 1, 2013	BB&S	30 days
Drilled Soldier Pile Retaining Wall (Lagging)	Article 522.08	BB&S	30 days
Driven Soldier Pile Retaining Wall (Geotextile Fabric)	Article 522.08	BB&S	30 days
Geotextile Retaining Walls (Geotextile Fabric)	Article 522.11	BB&S	30 days
Segmental Concrete Block Wall	Article 522.12	BB&S	30 days
Precast Modular Retaining Wall	Article 522.10	BB&S	30 days
Aggregate Column Ground Improvement	GBSP #71	BB&S	30 days

105.07 COOPERATION WITH UTILITIES

The State of Illinois allows the use of its public right of way by public utilities to lessen the utility costs paid by the populace of the State. The use/occupancy of this right of way is governed by the polices set forth in the IDOT publication, *Accommodation of Utilities on Right-of-Way of the Illinois State Highway System*. New utilities may be installed once they are permitted by the District Utility Permit Section. This may include installing new utilities while a portion of the Right-of-way is under contract for improvements.

Many existing underground and above ground utility facilities may be present within the right-of-way. Each known utility should be addressed within the contract Special Provisions (e.g. a status of utilities special provision). The special provision should include, at a minimum, utility contact information and anticipated relocation dates (if required).

Utility conflicts can be very detrimental in terms of time delays and costs. Therefore, coordination between the Contractor and the utility company should be closely monitored and documented. The Contractor's progress schedule must properly accommodate/reflect any utility relocation shown in the contract. The Resident should contact the District Utilities Section to become familiar with the utility coordination which has been performed (and is to be performed) to facilitate contract construction. The Resident must monitor the utility work to ensure it is being performed in the prescribed timeline and placement as agreed upon by the District with the utility company. Typically, permitted utilities are not paid for relocating activities. Exceptions may include a revision to the final plans which requires a utility to relocate a second time and utilities which have documented a "prior right" to the Department.

See Article 107.20, 107.37, 107.38, 107.39 and 107.40 of the Standard Specifications for more discussion on utilities.

105.08 COOPERATION BETWEEN CONTRACTORS

Article 105.08 applies when:

- Two or more Contractors are working at the same time on the same project
- Two or more Contractors are working on different projects but must coordinate their work

Ensuring that Contractors cooperate with each other can be challenging. As soon as a Contractor's access is restricted, or the Contractor has to perform work out of sequence, the Contractor may attribute the difficulties to an adjacent Contractor. Anticipating areas of conflict and meeting ahead of time to resolve common issues are the best methods to ensure that Contractors work together.

105.09 SURVEY CONTROL POINTS

This Section provides guidance to Department field construction personnel with respect to construction surveys; it does not address construction survey methods, techniques, etc. If checked in the contract documents, Check Sheet #10 is used to identify the responsibilities of the Department and Contractor for construction layout stakes.

105.09-1 Purpose of Construction Surveys

The basic purpose of construction surveys is to verify the horizontal and vertical control points required for the construction of a project, which were established during the initial location (preconstruction) survey. Construction staking establishes basic line and grade controls, delineates working areas, and serves as a base to verify the locations and quantities of completed work. This includes items such as taking basic measurements necessary to determine quantities and documenting these measurements to substantiate the final payment made to the Contractor. When performing Contractor staking, the Department provides the control points for establishing lines and grades, and the Contractor sets stakes for bridge layout, pavement stakes, grading stakes, method of operation and/or specific equipment and for their convenience.

Arrangements for cross ties should be made if the survey control points are likely to be disturbed during construction. Temporary benchmarks should be set.

105.09-2 Procedures**105.09-2(a) Coordination with Contractor**

Detailed planning and cooperation with the Contractor are required so that staking can begin as soon as is reasonably possible and as far in advance of construction as weather and soil conditions permit.

105.09-2(b) Checking Contractor's Staking

To check Contractor staking, inspections and random checks of the layout and control work should be conducted. The Contractor is responsible for securing proper dimensions, lines, grades and elevations for all parts of the work, and Department inspection will not relieve the Contractor of this responsibility. The Contractor must submit the required level of notes and/or other data for the work as defined in the contract.

105.09-2(c) Errors

If there is an apparent error with respect to line and grade, the Resident should contact the designer for an explanation and resolution.

105.10 AUTHORITY AND DUTIES OF RESIDENT ENGINEER**105.10-1 General**

The Resident, including all of his/her staff, is responsible for the administration of the construction and documentation requirements for the contract. The Resident reports directly to the Construction Field Engineer/Area Supervisor. The Resident is expected to accept delegated responsibility and to make decisions within the authority delegated to him/her. A Resident's first duty is to enforce the contract requirements. The Resident assigns inspection duties and must maintain daily contact with the Contractor's personnel to efficiently provide the engineering services necessary for the Contractor's continued progress.

The Resident is responsible for the acceptability of materials, work performed and interpretations of plans and specifications. The Resident has the authority to suspend or reject any work that does not comply with the contract requirements.

The Resident assures contract compliance with respect to payrolls, pay estimates, erosion control, EEO bulletin boards, traffic control, documentation, inspection, State and Federal regulations, etc. In addition, the Resident is authorized and expected to make the day-to-day decisions as his/her experience and construction knowledge permit. However, the Resident is not authorized to revise, delete or change the contract provisions.

The Resident must present proposed contract, plan or specification changes or interpretation issues to his/her Construction Field Engineer/Area Supervisor for review. Other involved Bureaus and FHWA can then be notified and their approval obtained before changes are authorized.

The Resident is responsible for the accuracy of the field records and inspection reports as they are recorded.

See the Construction Inspector's Checklist for Contract Administration.

105.10-2 Interaction with Contractor

The Resident exercises authority through the Contractor's superintendent or designated representative. Do not give direct orders to workers, Subcontractors or suppliers. The Resident can offer suggestions to Contractors if it appears that the work could result in non-compliance but use care so that suggestions are not interpreted as a directive.

105.10-3 Assignment to Field Work

The Resident is responsible for the following:

1. Supplies. When assigned to a project, the Resident will receive from the District office the necessary equipment, record books and other office supplies. The District Construction Engineer, or delegate, will instruct the Resident in the proper use of the material and equipment assigned.

The Resident may be required to sign for State equipment provided. If there are instructions to transfer all or a part of the equipment to someone else, do not neglect to have a proper transfer signed by him/her. The Resident will be held responsible for equipment not returned or not properly accounted for. Employees to whom Department-owned equipment is assigned, and who through carelessness or neglect cause unreasonable depreciation or need of repairs or losses, may be charged all, or a portion, of the resulting expense as determined by the Region Engineer.

When an employee leaves the Department, all Department-owned property must be returned before final warrant is delivered. This includes all equipment that has been assigned to the employee by the District.

2. Establishing Headquarters. Notify the District immediately of the Resident's project mailing address, telephone numbers and email addresses.
3. Public. The Resident is the Department's public relations person when interacting with those individuals in the general public that the contract may involve or inconvenience. The development of good public relations may avoid complaint letters written to the Governor and the Department concerning highway construction problems. Complaints should be addressed promptly in a tactful and considerate manner. The number of complaints can be minimized if the District and Resident keep the public informed of the status of the work in progress.

Address comments and concerns from the public to convey a favorable impression of the Department. Explain the work to the public as necessary, but carefully refrain from providing information that might be misconstrued. Refrain at all times from loose talk, gossip or comments with respect to Department policies, the highway program and improvements that are pending or proposed.

4. News Media Publicity. District offices will release information directly to local news media on items of local interest highway work. The publication of such information should be encouraged. The Region Engineer will determine the procedure for each District for news releases. See Department Policy OC-01 "Policy on Public Involvement."
5. Magazine Articles. Project personnel may be approached by technical magazines for articles pertaining to construction, and the writing of such articles is encouraged. All such articles must be submitted to the Region Engineer for approval before they are submitted for publication.
6. Letters of Endorsement. The Department receives requests for letters of endorsement of Contractors or individuals, or recommendations for machinery, materials, etc. Under no circumstances shall any employee provide any letters of endorsement or recommendations for these items. These requests must be referred to the Region Engineer, along with any comments, who will ensure that they go through the proper channels.
7. Investigational Work. Field personnel assigned to investigational work must understand that investigational work is confidential and that IDOT staff are not authorized to discuss the work with anyone outside the Department.
8. Presence on the Job. When unable to be at the jobsite, the whereabouts of the Resident should be known so that s/he can be contacted when needed.

105.10-4 Project Personnel Operation and Safety

The Resident is responsible for ensuring compliance with the following safety practices.

105.10-4(a) General

On construction contracts, special attention to safety is necessary when the work being performed is near traffic or in the vicinity of construction activities. All employees, especially those in supervisory capacities, must emphasize the safety of the employees under their direction and recognize the hazards that may exist in the performance of their duties. When a condition exists in which the use of protective equipment is required, the Construction Field Engineer/Area Supervisor must ensure that the employee is furnished safety equipment and that its use is enforced. Any benefit provided under the Workmen's Compensation Law may be jeopardized where injury is caused by the willful failure of the employee to use safety devices provided.

The Resident is responsible for safety procedures for work performed by the Department and must ensure proper use of safety devices such as safety vests, traffic control devices, etc. Where the work is not adequately protected by the contract traffic control, provide supplemental safety devices and measures. When on or near the pavement, do not use red flags for waving signals between the instrument person and the other workers when surveying. Such use might confuse the traveling public.

105.10-4(b) Safe Practices

Before starting work involving exposure to vehicular traffic, the supervisor in charge should warn employees of the potential traffic hazards. The supervisor should instruct all employees, and especially new employees, in the safe manner of performing the work and in the proper use of warning signs and devices. During the course of the work, the supervisor will require all employees to conform to safe practices.

All employees must be constantly on the alert. They should face approaching traffic as much as possible. Never enter or cross a traffic lane without first watching for approaching cars and waiting until the way is clear.

All survey work, as practical, should be conducted clear of the travel lanes. Exposure to traffic may be substantially reduced by making surveys from offset lines run on the shoulders, or at some greater distance from the pavement. Minimize crossing traffic lanes by taking measurements on only one side of the highway at a time.

Taking measurements in a traffic lane should be performed as quickly as possible. Avoid standing in or adjacent to a traffic lane while discussing the work or while transmitting or recording readings.

Avoid hazards associated with peak traffic volumes by adjustment of working hours to take advantage of off-peak traffic conditions.

Provide necessary protection for personnel performing such work as surveying, painting numbers on pavement, or taking measurements from or on the pavement where the individual is unable to watch for traffic. Use appropriate traffic control to direct traffic past individuals when on the pavement or within 2 ft of the pavement.

Employee vehicles without warning lights shall be legally parked at least 15 ft from the edge of the traveled way. Never leave these vehicles where they may be a potential hazard due to their

proximity to a lane of moving traffic or by obstructing sight distance. Park all vehicles on one side of the pavement. Vehicles parked 2 ft to 15 ft from the pavement edge must have a warning light operating.

Conduct the work such that vehicular traffic is not subjected to unnecessary inconveniences or accident hazards. When necessary to stop traffic, keep delays to an absolute minimum.

For materials, refer to the Safety Data Sheets (SDS) for the type of work being performed. Also, see Section 107.28-3 of this *Manual*.

The Department's [Employee Safety Code](#) and the [Traffic Control Field Manual for IDOT Employees](#) have additional information on safety. Also, see the safety portal on the IDOT website.

See Section 107.28 of this *Manual* for the Contractor's responsibility regarding safety.

105.10-5 As-Built Plans

The Resident is responsible for providing the District with an as-built set of plans at the completion of a contract. As-built plans shall fully document all field revisions, including any changes by the Bureau of Bridges and Structures, made during the construction phase of the contract. The importance of this set of plans cannot be overemphasized. Maintenance activities and plans for future contracts are prepared using the as-built plans. If the as-built plans do not fully reflect the actual constructed conditions, additional time and money may be needlessly spent on future improvements. This is especially true of changes made on bridges and structures.

The as-built plans should be so marked, dated as appropriate and sent to the District Bureau of Operations. The District will transmit the plans to the Central Bureau of Bridges and Structures so that any structure changes can be verified before the plans are sent to the Microfilming Unit. The plans and a copy of the microfilm will be returned to the District.

105.11 DUTIES OF THE INSPECTOR

105.11-1 General

The Inspector enforces the requirements specified in the contract documents. The Inspector's job is to review all phases of the Contractor's work to ensure that his/her instructions are being followed and to inform the Resident of progress, problems and instructions to the Contractor. Unless field inspection is aggressively implemented and well documented, the completed contract may have unknown quality and a potential for high maintenance costs. Often the Inspector's work is the deciding factor in whether or not the specified level of quality is attained.

The Inspector should be adequately equipped with the tools for the job (e.g., field book, thermometers, safety vests, string lines, straight edges, tape measures, etc.).

105.11-2 Duties

More specifically, inspection duties include:

- Inspecting and measuring the Contractor's workmanship, materials and methods for compliance with the contract documents.
- Documenting inspection observations and measurements including summaries of labor equipment and material usage.
- Measuring work for payment.
- Inspecting construction operations for compliance with traffic control and erosion control requirements.

105.11-3 Interaction with Contractor

105.11-3(a) General

In general, the Inspector is not responsible for directing or controlling the Contractor's equipment or method of operation. However, it is not sufficient for the Inspector to simply stand by and observe operations as they progress. The Inspector must take an active part in the actual functioning of the construction. The Inspector should observe the Contractor's activities and, if a potentially significant problem arises:

- Notify the Resident
- Discuss this with the Contractor
- Document the situation

The Inspector should have a working knowledge of the construction equipment being used by the Contractor to determine by visual inspection whether the equipment is in good mechanical condition and properly adjusted.

The Inspector should avoid giving specific instructions regarding the operation or adjustment of equipment, use of various construction methods, etc. If such instructions are given and the quality of the work becomes deficient, the Department may be held responsible for the outcome. Discuss defective work or work not in conformance to the contract documents with the Contractor for corrective action. Documentation of these conversations is important.

105.11-3(b) Rules

The Inspector should adhere to the following "rules" when working with the Contractor:

- Meet with the Contractor daily to discuss quality issues and progress.
- Point out recurring non-compliance issues to the Contractor no matter how unpleasant it becomes. Document these discussions.
- Keep the Contractor informed of your inspection time and access requirements.
- Adjust your inspection schedule if the Contractor experiences delays (be flexible).

- Escalate chronic, unresolvable, non-compliance issues no matter how small they are.
- Develop a feel for how the Contractor plans and executes the work and adjust the daily work hours accordingly.
- Keep ahead of the Contractor by looking through the contract documents to see what could get the Contractor into trouble later on.
- Build a relationship based on cooperation and professional courtesy.
- Always be willing to help the Contractor clarify and interpret the project plans and specifications.
- Do not allow the Contractor to rush you by cutting short your inspection time.
- Do not close the lines of communications between you and the Contractor no matter how difficult things become.
- Do not delay inspections to the very last minute.
- Do not keep to yourself defects you see in the Contractor's work.
- Do not compromise yourself or the specifications just to meet a schedule (escalate instead).
- Do not become reactionary if the Contractor ignores you or does not take you seriously. Elevate the matter up the chain-of-command. Maintain professional conduct at all times.
- Do not get into a power struggle with the Contractor over construction progress versus inspection time.
- Do not direct the Contractor on how to perform the work.

105.13 FINAL INSPECTION

The final inspection is for the completeness of the work and the acceptability of ground conditions. When the physical work on the project is complete, the Resident, Construction Field Engineer/Area Supervisor, District Construction Engineer and other Department personnel plus the Contractor perform the final inspection to identify any remaining work.

Section 109.08 provides Department procedures for contract closeouts, including final inspection. The Resident should maintain a running list of deficiencies throughout the project but should not wait until the end of the project to notify the Contractor of any necessary work. The Resident should ensure that the final inspection is performed as soon as possible after the work is completed. The final inspection punch list should be given to the Contractor with sufficient time to correct the deficiencies before the contract time expires. This has been a problem on completion date contracts. Delaying the final work impacts the Contractor's bonding and

insurance, because they are not released until the contract has been accepted by the Department. The contract may be re-inspected, if needed, to ensure that all punch list items are complete.

SECTION 106. CONTROL OF MATERIALS

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS

106.01-1 Field Construction Staff

For the Department's field construction staff, it is an important responsibility to fulfill the requirements of the CBM Project Procedures Guide (PPG). All materials incorporated into the project shall have evidence of inspection according to the PPG. The Contractor is responsible for furnishing the necessary documents that certify material acceptability according to the PPG. See Section 106.01-2(a).

The PPG is the basic reference for field construction staff for sampling materials. The field construction staff is also responsible for ensuring that all hard copy test results and evidence of material inspections are submitted to the District Materials Office for timely entry into the Department's Materials Integrated System for Test Information and Communication (MISTIC) system. Coordinate with the District Physical Test Engineer for specific procedures.

106.01-2 References

All of the following references may be found on IDOT's website.

106.01-2(a) *Project Procedures Guide*

The Project Procedures Guide is a guide and reference source for determining sampling frequencies and inspection procedures for highway construction, including permanent and temporary items. The PPG applies to sampling and testing for all materials. It does not apply to HMA and PCC items on QC/QA projects including projects utilizing end performance specifications such as Pay for Performance (PFP) or Quality Control Performance (QCP).

106.01-2(b) *Manual of Test Procedures for Materials*

The CBM maintains the [Manual of Test Procedures for Materials](#). The test procedures are applicable to quality control, quality assurance and acceptance testing required by construction contracts. The procedures are applicable to testing performed by the Contractor, the Department or consultants retained by either.

106.01-2(c) *Manual for Materials Inspection*

CBM maintains the [Manual for Materials Inspection](#). The *Manual* provides a source for the Materials Integrated Systems for Test Information and Communication (MISTIC) information essential to inspection. This manual includes QC/QA, PFP and QCP documents.

106.01-2(d) *Other Materials References*

Other IDOT materials references include:

- [Subgrade Stability Manual](#)
- [Geotechnical Manual](#)
- [Manual of Aggregate Quality Test Procedures](#)
- [Manual for Fabrication of Precast Prestressed Products](#)
- [Fastener Identification Guide](#)

106.01-3 Iron and Steel Products

106.01-3(a) Definitions

When ensuring compliance with Article 106.01 of the *Standard Specifications*, the following definitions apply:

1. Melting. The process of heating a solid until it melts. In the steel industry, placing scrap steel into a furnace and melting it so that it can be recycled into new steel products. If this process occurs in the US, the resulting product would be considered made in the US regardless of where the scrap came from.
2. Smelting. The process from which iron is extracted from rock or dirt and molten metal is produced. If this process occurs in the US, the resulting product would be considered made in the US regardless of where the ore came from.
3. Domestic Origin. Having all manufacturing processes occurring within the US.
4. Manufacturer's Certification. A document furnished by the manufacturer containing the following: Name, address and location where the manufacturing process occurred; heat numbers or any other identification used to identify the material; and signed statements from the manufacturer attesting to the domestic origin of the materials.
5. Mill Test Report. A report from the producing mill on the base metal listing the chemical analysis, physical analysis, heat or lot numbers and specification used to manufacture the material.
6. Heat Numbers. An identification number used by a manufacturer to track each batch of steel manufactured at a certain location.
7. Bill of Lading. A shipping ticket that accompanies a product to the job site and that identifies the product, source and lot.

Inspection is based on the following Federal and State requirements. Article 106.01 in the *Standard Specifications* ensures compliance with these legal requirements.

The Buy America requirements in 23 Code of Federal Regulations (CFR) 635.410 apply to all Federal-aid projects and apply to all steel, iron materials and manufactured iron regardless of the percentage they comprise in a manufactured product or the form they may take. Ensure that the Contractor is aware of the Specification at the preconstruction conference.

The Contractor must furnish and install only domestic steel and iron materials. To be considered a domestic material, all manufacturing processes must take place domestically. The manufacturing process for steel and iron products is considered complete when the product is ready for use in items such as fencing, posts and girders. If a domestic product is taken out of the United States for any process, it becomes a foreign source of material.

30 ILCS 565, titled the *Steel Products Procurement Act*, presents the State law regarding the use of domestic iron and steel products in Illinois public works construction contracts. State law is generally more restrictive than the Federal provisions and, typically, determines the compliance on highway construction projects.

Both State and Federal laws allow small amounts of foreign steel to be used on construction contracts. Refer to Construction Memoranda 87 and 88 for exemptions to Buy America and the *Steel Products Procurement Act*.

106.01-4 Preconstruction Conference

Appendix A presents Construction Memorandum No. 70 "Preconstruction Conference Guidelines," which is typically conducted by the District Field Engineer / Area Supervisor. The Contractor must provide a list of materials suppliers to the Department at the conference.

106.01-5 PFP vs QCP vs QC/QA vs Non-QC/QA

The materials sampling and testing responsibilities of the Department's field construction staff vary based on the applicable specifications for the project:

1. Pay for Performance (PFP). The Contractor is responsible for all sampling. The Contractor performs QC tests; acceptance tests are performed by the Department. Payment adjustments for acceptable work are based on the statistical deviation of test results. In other words, the Contractor is assessed an incentive or disincentive for its ability to provide consistent mix parameters.
2. Quality Control for Performance (QCP). The Contractor is responsible for all sampling. The Contractor performs QC tests; acceptance tests are performed by the Department. Payment adjustments for acceptable work are based directly on each test result.
3. QC/QA. Materials sampling and acceptance testing programs, which allow Contractor QC sampling and testing in conjunction with the Department's QA and independent assurance sampling and testing.
4. Non-QC/QA. The Department is responsible for all sampling and testing. This is often referred to as "method specifications."

Where PFP, QCP or QC/QA applies to a project, the Contractor must submit a plan for Department approval. As part of the plan, District Materials approves the HMA, PCC and aggregate laboratories according to the CBM Policy Memorandum "Minimum Private Laboratory Requirements for Construction Materials Testing or Mix Designs."

106.02 UNACCEPTABLE MATERIALS

Any unacceptable material should be reported to District Materials. This includes materials that were allowed to stay in place with a credit for deficient work.

106.06 STORED MATERIALS

Contractors must obtain approval to store materials within the Department's right-of-way. Contact the Bureau of Bridges and Structures if a request is received to store materials on any structure.

Do not assume that previously approved materials will remain acceptable throughout their time in a storage site. Inspect stored materials prior to their incorporation into the work.

Article 106.06 discusses storing materials on right-of-way:

The Contractor may use the right-of-way for storage of materials, but the stockpiles shall be confined to such cleared areas as approved by the Engineer.

The storage area should be inspected considering safety, environmental impacts and aesthetics. Potentially damaging practices include stacking too high (causing bending, denting or crushing), exposing to weather or providing inadequate base (causing soiling, staining or rusting).

Other issues include:

- Sight distance could be an issue.
- Roadside clear zones have to be maintained.
- Hazardous materials need to be identified.
- Upon completion, the used area has been cleaned up and seeded.

SECTION 107. LEGAL REGULATIONS AND RESPONSIBILITY TO PUBLIC

107.01 LAWS TO BE OBSERVED

107.01-1 General

Contractors are required to follow the law, and they are expected to know which laws apply to their work. Highway construction involves a wide variety of laws and, the more complex the project, the more complex are the applicable legal requirements. The Contractor must bear any cost and inconvenience associated with compliance with laws, regulations, permits, certifications, etc.

107.01-2 Employment-Related Legal Requirements

Construction projects have strict rules, both Federal and State laws and regulations, concerning Contractor employment practices. These provisions are part of every contract and must be strictly followed.

107.04 PERMITS AND LICENSES

107.04-1 Local Requirements

Local ordinances such as haul restrictions and permit fees are often cumbersome for the Contractor. For example, most Illinois cities require a connection fee and permit when a Contractor taps into a city waterline. Some cities require a permit to use and haul explosives. Permits associated with construction and installation activities (e.g., noise, hauling, dust control, connecting to utilities) are the Contractor's responsibility.

107.07 FEDERAL AID PROVISION

107.07-1 General

The Federal Highway Administration (FHWA) ensures that the State DOTs comply with all applicable Federal laws in their expenditure of Federal funds and to ensure that the State DOTs meet the applicable engineering requirements for their proposed highway projects. See Section 100.03-1 for more discussion.

107.09 PUBLIC CONVENIENCE AND SAFETY

107.09-1 Emergency Notification

Emergencies include public safety, accidents, HAZMAT, environmental, law enforcement, fires, etc. Before project construction starts, the Resident should prepare an "emergency notification" list for the project office that is in plain view for emergencies. Specifically for traffic control during construction, see [Form BSPE 725: Traffic Control Authorization Request](#).

107.09-2 Lane Width Restrictions

The resident should notify the District Bureau of Operations of lane width restrictions 21 days in advance of the date when the lane width restriction will occur using Form OPER 2410. Contact the District's Traffic Control Supervisor for the notification. In addition, see IDOT [Safety Engineering Policy 4-15](#), "Work Zone Safety and Mobility: Positive Protection of Workers, Drop-offs and Temporary Concrete Barrier."

107.09-3 Protecting the Construction Site

The construction site should be reasonably safe after working hours. Temporary fencing requirements must be enforced. During nonworking hours, individuals should be prevented from entering the more dangerous areas of the construction site. The Contractor should take precautions (i.e., removing ladders, blocking openings, locking equipment) to make the site reasonably safe. Also, see Article 701.10 in the *Standard Specifications* for the need for full-time traffic control surveillance.

107.09-4 Acceptable Work During Legal Holidays

Article 107.09 identifies the duration of the legal holidays for which no lane closures are acceptable. However, the Contractor is allowed to perform off-road work if the construction traffic does not enter or exit the work zone. This should be discussed at the preconstruction conference.

The Resident must judge what is practical and what is impractical. Joint cooperation between the Department and Contractor is important. For example, the public expects that all lanes for an Interstate 3R project will be open. However, if the Contractor has rubblized one or more travel lanes, opening these lanes for a legal holiday is probably impractical. As another example, it is impractical to have all travel lanes open during a legal holiday for a bridge project constructed in stage construction.

107.11 INSURANCE REQUIREMENTS FOR RAILROAD – HIGHWAY CROSSINGS

The Contractor shall not be permitted to perform any work on or over the right-of-way of a railroad, without Railroad protective liability insurance. This insurance is typically required when work will be performed within 50 ft of a railroad track. The District Office will inform the Resident when the required Railroad protective liability insurance has been approved by the Railroad(s) and provide the expiration date of each policy. Approval of the Contractor's Railroad insurance is coordinated through the Bureau of Design and Environment's Contracts Office. The Contractor will submit its insurance to the Contracts Office who will then forward the policy to the applicable Railroad. The Contract Office will inform the District when the Railroad insurance is provided.

The Resident must ensure that the Railroad protective liability insurance has been approved before work begins and that work does not continue past the expiration date without the policy being renewed.

107.12 PROTECTION OF RAILROAD TRAFFIC AND PROPERTY**107.12-1 Grade Separations****107.12-1(a) Highway Overheads**

When the grade separation is an overhead highway structure, the Department designs the plans and ensures that the concerns of the Railroad are considered. These include that:

- Standard clearances are maintained
- Drainage conditions are addressed
- Any communication and signal line and signal changes are considered

Department plans are always submitted to the Railroad for input. Invite an authorized representative of the Railroad to the preconstruction conference. The Contractor's progress schedule, falsework arrangement and proposed equipment shall be provided to the Railroad representative at the preconstruction conference so that the Railroad has full knowledge of the work. If the Railroad's representative does not attend the preconstruction meeting, they shall be contacted, and the work shall be coordinated as necessary.

107.12-1(b) Railroad Overheads

The Railroad is more involved in overhead railroad structures than with highway overheads. The Railroad may assign a full-time or part-time engineer to the project. At a minimum, the Railroad will provide a point of contact for coordination of all construction activities. Plans for these structures can be designed by the State, but the Railroad reviews and approves the design of all railroad structures.

The specifications used are one of or a combination of:

- Those of the Railroad taken bodily (AREMA specifications)
- Area specifications
- A modification of these
- A modification of the State's specifications

In addition, Division 100 of the IDOT *Standard Specifications*, General Requirements and Covenants, is always included if the State is involved with the contract. The building of the structure is completed in accordance with the provisions of the agreement between the Railroad and the Department in one of the following methods:

- The State may award a contract in its usual process, with the Railroad not participating.
- The State may award a contract for a portion of the work, arranging with the Railroad to do the remainder either by contract or with its own forces on a force account basis.
- The Railroad may perform the entire job with its own forces on a force account basis.
- The Railroad may award a contract for a portion of the work, doing the remainder with its own forces on a force account basis, with the State doing none of the work.
- The Railroad may award a contract for all work involved, with the State not participating.

If a State contract, notify the proper Railroad official of the Contractor's working plans, etc., as stated above for highway overheads.

107.12-2 Grade Crossings**107.12-2(a) Approach Grades**

The design of approach grades to railroad crossings should have been discussed with and accepted by the Railroad prior to the letting of a contract. A considerable length of time usually elapses between the field checking of the plans and the awarding of the contract. During the time lapse, the Railroad may have adopted changes in policy. Where a highway crosses a railroad at grade, contact the Railroad Division Engineer and mutually agree whether or not any changes in the grade of the track should be made. The drainage characteristics in the area of the crossing should be evaluated, so that any anticipated changes can be discussed with the Railroad.

107.12-2(b) Surfacing and Drainage

There may be cases where the State must assume the expense involved in changing the grade of the Railroad tracks and to provide a surface over the tracks. Normally, resurfacing of the grade crossing proper (that portion of the grade crossing over the crosstie area plus an additional 24 in. (600 mm) outside the outer rail) for the full width of the pavement, plus usable shoulder, remains an obligation of the Railroad.

The riding quality of the grade crossing proper should be equal to the adjacent highway surface. This depends almost entirely upon the original construction or any major reconstruction of the surface. It is important that quality materials and approved methods of construction be used.

Adequate drainage is essential. This may involve the use of additional drainage structures or other facilities as the work progresses. The drainage configuration is usually specified in the Railroad agreement. Any changes in the drainage configuration from the Railroad agreement will require written approval from the Railroad.

107.12-3 Inspection

In addition to the contract documents for either highway or railroad overheads, the Resident must have a copy of:

- The Commerce Commission Order
- The agreement between the Railroad and the Department
- The detailed estimate prepared by the Railroad for work to be performed by the Railroad.

These items are available from the District Office. The following items are addressed only in a general manner in Section 107.12-3. The requirements for a specific project are set forth in the documents above.

107.12-3(a) Railroad Engineer

The Railroad Engineer will stay in contact with the work at their discretion. Ensure that all work performed under the contract on the Railroad right-of-way is performed to not interfere with the movement and safety of trains. Where the safety of railroad traffic during construction is concerned, the Railroad Engineer will have jurisdiction, and his/her decision for methods, procedures and measures used shall be final. The Contractor should submit sheet piling designs, demolition plans, beam erection plans, etc., for the Railroad Engineer's review and approval well in advance of performing the work to allow ample review time.

107.12-3(b) Railroad Overheads

For a railroad overhead where the Railroad's design and specifications, either in whole or in part, are used, the Railroad may have a full-time or part-time Engineer on the work. If a State contract, Department inspections will be the same as on regular State work, except that the interpretation must be based on the Railroad specifications as set forth in the contract, not on the Department's specifications.

107.12-3(c) Railroad Contract

If the Railroad executes the contract, its Engineer is in responsible charge and will provide the construction inspection. However, if there are serious differences of opinion, objectionable practices or violations of the specifications, these should be reported immediately to the Construction Field Engineer/Area Supervisor. Provide the Railroad Engineer definitive information on the alignment and grade of the roadway. Occasionally, there are instances where the Railroad starts work before receiving this information, with the result that the structure is not consistent with the roadway design. As soon as the District Office has received notice of a railroad grade separation, arrangements should be made with the Railroad to discuss the location. Arrangements should be made to set permanent stakes and benchmarks as necessary for the structure to be built consistent with the pavement plans. An occasional check on the lines and grades is suggested.

107.12-3(d) State Responsibility

When Federal funds participate in the cost of the work, the State is responsible for proper inspection and execution of the work, and for compliance with all Federal restrictions and regulations, even when the State is not a party to the contract. FHWA will not work directly with the Railroad.

107.12-3(e) Change from Specifications

The Department should adhere to the Railroad specifications as closely as if the State specifications apply. For minor details, use judgment in variations encountered by either the State or the Railroad Engineer. However, a decision should be obtained, in writing, with concurrence from the Railroad Engineer. In no case shall major changes in the approved plans or specifications be made without the consent and approval, in writing, of the Department and the Railroad.

107.12-3(f) State Contract

When the contract is between the Department and the Contractor, the Railroad Engineer has no authority to overrule the Department or the *Standard Specifications*. Matters pertaining to the safety of the railroad should be brought to attention of the Construction Field Engineer/Area Supervisor. The Railroad cannot grant concessions or make any change in the contract without the approval of the Department. In this case, the Railroad has no authority over the Contractor except through the Department.

107.12-3(g) Temporary Crossing

If necessary, to construct a temporary railroad grade crossing for the convenience of the Contractor, it is the Contractor's responsibility to obtain an agreement with the Railroad concerning its construction, maintenance and protection. The cost of providing flaggers for use on the crossing shall be paid by the Contractor.

107.12-3(h) Payment

Refer to Construction Memorandum No. 46, Field Control of Railroad and Utility Adjustments, in Appendix A for the proper procedures for recordkeeping for railroad adjustments.

When the Railroad performs any part of the work with its own forces or provides flagging protection, except for a temporary crossing, the Department must have sufficient documentation to enable a check on all items when the Invoice is sent to the District Office for approval. Such work is usually performed on an actual cost basis not to exceed the estimated sum. Use the detailed estimates, as prepared by the Railroad, in checking the work performed. The Railroad cannot be reimbursed for any work not shown in the Railroad agreement or on these estimates unless the Railroad agreement is amended to reflect the additional or changed work. If the Railroad insists on improvements not indicated in the Railroad agreement or in the estimate, the work will be at the Railroad's expense. Most Railroads have approved schedules for the allowable rates for services and supplies. A copy of this is provided by the District Office.

107.12-3(i) Federal Participation

Agreements between the State and the Railroad covering work performed by the Railroad at State expense on projects in which Federal funds participate usually stipulate that the Railroad will be paid only those charges approved by FHWA for reimbursement to the State. When the work will be paid entirely from State funds, reimbursement to the Railroad is determined by the terms of the agreement.

107.12-3(j) Resident Responsibility

The responsibility of the Resident for Railroad Invoices is to maintain a record of materials used and labor employed, including non-temporary crossing flagging costs, as the work progresses. The Resident will then be able to approve the charges for the amount of materials and labor used. The cost of materials and the rates paid for labor will be determined by an audit of the Railroad's books and need not be checked in detail in the field. The Railroad should be instructed to submit to the District Office copies of all Invoices on its letterhead. If the agreement provides for progress payments before the project is completed, the Invoices should be consecutively numbered and should clearly show the dates of the period of time covered by each Invoice. The final Invoice should be marked "Final."

107.16 EQUIPMENT ON PAVEMENT AND STRUCTURES

On certain contracts (e.g., roadway construction on new alignment, construction/reconstruction of bridges in rural locations), Contractors may require the use of local agency roads for haul for the contract work. When the nature of the improvement is such that there will be a predictable

concentration of unusually heavy loads that may necessitate repair and maintenance of local agency roads, the designer may designate in the contract one or more local agency roads in the vicinity of the construction contract as haul roads. When this is the case, the District will have entered into a Letter of Understanding with the local agency to establish the financial responsibility of the State for repairing and maintaining haul roads. The types of repairs and maintenance, together with the methods of payment for the work, will be clearly provided for in the contract.

In many cases, however, the designer may not use the above procedure because the nature of the improvement and/or the condition and type of local agency road(s) is such that undue distress is not likely. If the Contractor damages a local agency road or bridge, the Contractor will be required to restore such property at their own expense.

The District should invite County Engineers/Superintendents of Highways and Township Commissioners to the preconstruction conference when it is likely that the Contractor will use local agency roads as haul roads. This will aid the Contractor and local agency officials in arriving at an agreeable plan for use of the local agency roads and the division of responsibility for their maintenance.

107.19 UNEXPECTED REGULATED SUBSTANCES

When unexpected regulated substances are uncovered by the Contractor, the Department's process for evaluation and resolution is the same as the process conducted during preconstruction for known substances. Section 27-3 of Chapter 27 "Environmental Surveys" of the IDOT [BDE Manual](#) discusses the process for special wastes.

The District Environmental Coordinator will initiate the process by submitting an Environmental Survey Request (ESR) to the Geologic and Waste Assessment Unit in the Bureau of Design and Environment Section. The outcome of the process could be to:

- Remove and dispose of the substances
- Remediate the presence of the substances
- Do nothing

In some cases, the provisions of Section 669 may be applicable. In all cases, the Contractor cannot resume work until direction is received from the BDE for proper management of the regulated materials.

107.20 PROTECTION AND RESTORATION OF PROPERTY

107.20-1 Mailboxes

If mailboxes are to be relocated, it is advisable to consult with the local Postmaster for preferred locations. See [Standard 406201](#) for location and design details for mailbox turnouts.

107.22 APPROVAL OF PROPOSED BORROW AREAS, USE AREAS AND/OR WASTE AREAS

In part, Article 107.22 requires that the Contractor designate all borrow, use and/or waste areas for approval by the Engineer prior to their use. Section 27-2 of Chapter 27, Environmental Surveys, of the IDOT BDE Manual provides a detailed discussion on the process to evaluate the environmental impacts of a Contractor-supplied borrow, use, and/or waste site.

107.23 PROTECTION OF STREAMS, LAKES, RESERVOIRS, NATURAL AREAS, WETLANDS, PRAIRIE AREAS, SAVANNAHS AND ENDANGERED AND THREATENED SPECIES

107.23-1 General

State and Federal environmental resource agencies are responsible for administering, managing and monitoring compliance with the legal requirements related to the prevention of water pollution. These may pertain to impacts generated by construction activities or to impacts precipitated by the permanent facility. This Section briefly discusses three of the most common laws and regulations related to water pollution. Contact the District Environmental Coordinator if any questions arise.

107.23-2 Section 404 Permit

The US Army Corps of Engineers (USACOE) administers Section 404 of the *Clean Water Act*. The Section 404 Permit regulates dredge and fill within waters of the US.

The Department secures Section 404 Permits for permanent structures within waters of the US such as bridges, culverts, riprap, etc. Once secured, the preconstruction permit and its conditions are incorporated into the contract as a Special Provision. The Contractor must apply for a Section 404 Permit from the USACOE for temporary work that impacts waters of the US that is not covered by the Department's Section 404 Permit.

107.23-3 Erosion and Sediment Control

The National Pollutant Discharge Elimination System (NPDES), also known as Section 402 of the *Clean Water Act*, authorizes the US Environmental Protection Agency (USEPA) to regulate point and non-point discharges of pollutants. The discharge is subject to controls established by USEPA to meet the objectives for water pollution prevention and control. These result in requirements for installation and maintenance of appropriate erosion and sediment control measures for the term of construction, until the site has been revegetated. The Federal law (Section 402) is administered by the Illinois Environmental Protection Agency (EPA).

NPDES requires that best soil management practices for erosion and sediment control be applied in any land-use activity. Highway construction is considered a land-use activity. Best management practices on Department projects require comprehensive and realistic erosion control plans and timely installation of temporary and permanent erosion control measures.

Section 280 of this *Manual* discusses erosion and sediment control and the NPDES requirements in more detail. Also, see the Construction Inspector's Checklist for Erosion Control.

107.23-4 Municipal Separate Storm Sewer Systems (MS4)

Stormwater runoff is transported through Municipal Separate Storm Sewer Systems (MS4s), from which it is often discharged untreated into local water bodies. To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain a NPDES permit and develop a stormwater management program to reduce the contamination of stormwater runoff and prohibit illicit discharges. ILR-40 is the IDOT statewide permit and the ILR-10 is the job-specific construction permit.

107.25 PROTECTION AND RESTORATION OF TRAFFIC SIGNS

Instruct the Contractor to follow the MUTCD for the placement of signs. Document the stations and offsets for all existing signs that are likely to be moved; a photo inventory of existing signs may be useful. Consult the Bureau of Operations to access the Department's sign inventory (by mile stations). Instruct the Contractor to 100% cover all signs that do not apply.

107.28 CONTRACTOR SAFETY RESPONSIBILITY

107.28-1 General

The importance of a safe environment cannot be overemphasized. Most construction accidents are due to unsafe acts. The unsafe act can usually be traced to a momentary lapse of attention, inadequate training or inexperience. Construction sites are unpredictable places and employees must be constantly aware of what is going on around them.

107.28-2 Occupational Safety and Health Act (OSHA)

The Contractor, according to the contract documents, has direct responsibility for compliance by law and under Section VIII of FHWA Form 1273, entitled SAFETY: ACCIDENT PREVENTION, which is a part of all Federal-aid contracts. Department personnel do not have the authority to enforce or direct the Contractor. However, if Department project personnel observe unsafe practices by any Contractor/Subcontractor, take the following actions:

1. The Department employee should bring the safety infraction to the attention of the individual involved and the Resident. Record the notification and the Contractor's response in the Project Diary.
2. If the issue is not resolved or continues, the Construction Field Engineer/Area Supervisor should be notified, followed by the Resident notifying the project Superintendent in writing. Record the notification and the Contractor's response in the Project Diary.
3. If a solution is still not reached, the Resident has the authority under Article 108.07 of the *Standard Specifications* to suspend work wholly or in part, depending on the situation, to correct the unsafe working conditions. The District Construction Engineer (DCE) shall

approve the suspension of work, if necessary. The Resident will promptly notify the DCE if the violation is not corrected at the end of the time stated in the written notice.

The Contractor is responsible for providing safe access to the construction site for Department employees. For example, trench safety, cofferdams, confined space entry and fall protection are major safety concerns for inspection, for which OSHA has strict standards that the Contractor must meet.

107.28-3 Hazardous Materials

107.28-3(a) Safety Data Sheets

The Contractor is required by law and by the contract documents to furnish Safety Data Sheets (SDS) to everyone at the project site. The *Superfund Amendments and Reauthorization Act* (SARA) requires that Safety Data Sheets be made available if a facility has on site at any time chemicals in the following quantities:

- Greater than 10,000 pounds or the threshold planning quantity (TPQ) for a hazardous substance
- Greater than 500 pounds or the TPQ for extremely hazardous substances

Chemical manufacturers are required to send an SDS with the initial shipment of a chemical. The SDS contains detailed information about physical and chemical properties of the chemical, the physical and health hazards, safe handling precautions, spill/clean-up procedures and emergency and first-aid procedures.

107.28-3(b) Accidents

When hazardous materials are spilled, accidentally discharged or encountered at the project site, the following actions should be taken, and the proper authorities notified of a hazardous material situation. In addition, the Resident should take the following actions:

- Call 911
- Call Construction Field Engineer/Area Supervisor
- Call radiation safety offices if applicable
- Work with the Contractor to keep workers safe

See the "[Emergency Response Guidebook](#)" published by the US Department of Transportation, Pipelines and Hazardous Materials Safety Administration. This document helps identify hazardous materials, the potential danger of each material and some basic precautionary measures that can be taken. However, experts should handle the more serious hazardous material incidences.

107.28-4 Work Suspension

Residents are empowered to suspend the work (or halt production of a specific item of work) if there are unsafe operations at the project site. See Article 108.07 of the *Standard Specifications*

and Section 108.07 of this *Manual*. However, some judgment is needed in deciding whether to take this action or to allow the Contractor to continue work until corrective action can be taken. The following presents some questions to consider when making this decision:

1. Is an unsafe condition away from the main site activities? Can the area be isolated or barricaded until the condition is made safe?
2. Are the workers' activities jeopardizing their own or other people's safety?
3. Could the Contractor's operation cause property damage or injury to those not associated with the construction?
4. Can something be done to make the hazard temporarily safe?

107.30 CONTRACTOR'S RESPONSIBILITY FOR WORK

107.30-1 General

Article 107.30 of the *Standard Specifications* allows the Contractor to request that the Department grant partial acceptance of work and assume responsibility for maintenance. Some judgment is necessary. This is acceptable for safety-related items (e.g., guardrail, traffic signals) that has been constructed in conformance with the contract documents and inspected by the Department. However, the Department cannot accept a partially completed bridge.

107.30-2 Motorist Caused Damage

It is not uncommon for motorist to damage highway infrastructure (e.g. guardrail) within the limits of an active work zone. Damage can occur to infrastructure elements that are or are not part of the contract work. When the motorist causing the damage is known, efforts are made (either by the Department or the Contractor as applicable) to recover damage costs from the motorist's insurance. To assist with recovery efforts from the applicable motorist's insurance, it is a best practice to obtain a copy of the accident report and take photographs of the damage.

Contract work (including added work) is under the Contractor's charge and care until the date of final inspection unless the Department assumes responsibility for portions of the work. Thus, when work completed by the Contractor but not accepted for responsibility by the Department is damaged, the repairs are done by the Contractor at their cost. In this situation, the Department should assist the Contractor with their recovery efforts from the insurance company liable for the damage as applicable. This assistance normally involves providing a crash report and photographs.

Non-contract work, and work for which the Department has assumed responsibility, is not under the charge and care of the Contractor. The following is guidance applies when infrastructure within the work zone, not under the Contractor's charge and care, is damaged and the decision is made to repair the damage via the contract:

1. The Resident should ensure the District Claims Office is made aware of motorist-caused appurtenance damage and provide the Claims Office with applicable photographs. (If

- the Resident does not have a copy of the crash report, the Claims Office should be able to obtain one.) The Claims Office must provide a Claim Number for tracking purposes
2. The Resident must prepare an authorization of contract changes and direct the Contractor to complete the work effort in accordance with Construction Memorandum 4. The authorization's reason must include the statement Repair of Motorist-Caused Damage Claim No. _____. The added work should utilize the Motorist Caused Highway Damage (MCHD) fund key. The Central Bureau of Construction can provide the MCHD fund key if not already known.
 3. As repair work is completed the Resident handles the payment as they normally would handle. (The difference is MCHD funding will be utilized in lieu of construction funds.)
 4. After repair work is complete, provide the District Claims Office with applicable vouchered pay estimates and a copy of the approved authorization for their use in pursuing recovery.

107.32 FURNISHING RIGHT-OF-WAY

The District Office should have all right-of-way stipulations and agreements. Any commitments to property owners will be in the General Notes within the contract documents. These papers frequently document that specific items of work are performed by the Department for the owner at the time the road is built. Property owners should be notified in writing to move fences, buildings, etc. This should be done as soon as possible after the contract is executed. The Contractor should be cautioned not to enter property before the owners have been notified nor before the expiration of the time limit as noted in the conveyance statements. Most Districts have a standard form of notification to property owners.

SECTION 108. PROSECUTION AND PROGRESS

108.01 SUBCONTRACTING

The Resident should be aware of all Subcontractors that will perform work on the project. Retain a copy of the [Form BC 260A: Request for Approval of Subcontractor](#), in the project file. Verify if the Subcontractor is a Disadvantaged Business Enterprise. No Subcontractor should be allowed to start work until the Subcontractor is approved. A Subcontractor cannot be approved without a current Subcontractor Registration Number. See Construction Memorandum No. 30 in Appendix A for additional information on policies and procedures for the approval of Subcontractors.

108.02 PROGRESS SCHEDULE

108.02-1 General

The progress of work has significant impacts to the Department and the public, including:

- The Department incurs direct costs with respect to the on-site presence of its construction staff in labor, equipment, etc.

- Construction projects frequently involve disruption to traffic, which results in a cost and inconvenience to the traveling public.
- Construction projects can impact adjacent and nearby businesses and residences.
- Failure to complete a project on time results in a negative public image for the Department.

Thus, it is important to continually evaluate if work is progressing on schedule, ahead of schedule, or if it is behind schedule. This evaluation is performed using the progress schedule. The progress schedule is the Contractor's statement of how the work will be completed within the contract time limits. The initial schedule (also referred to as the "original" or "baseline" schedule) should reflect all contract requirements and existing conditions as known at the time of bid. The amount of detail included in the schedule should correspond to the complexity of the project work or conditions. The schedule is used to determine if actual work is progressing as expected. The schedule is an essential tool for the proper charging of working days (when the contract contains working days) by the Resident. The schedule is also used when evaluating any issues of delays that develop during the work.

The original progress schedule is to be submitted, by the Contractor, prior to start of work, and preferably prior to the preconstruction conference. The District is responsible for reviewing and approving the schedule. The District review is typically performed by the Resident (or the Resident's supervisor). The District Construction Engineer is responsible for approving the schedule. Timely review of this schedule is essential. Typically, the review should be completed within 14 calendar days. The schedule does not modify any contract time requirements. However, as a practical matter, an improper schedule approved by the District can bias any later discussions concerning delays; therefore, the reviewer must carefully consider the following when reviewing the original schedule.

1. Is the progress schedule signed by the Contractor?
2. Is the progress schedule legible?
3. Is the start date per contract specifications?
4. Are all work related items accounted for in the progress schedule?
5. Is the controlling item clearly identified at all points in time?
6. Is the work shown in a continuous manner and without overlap of controlling items? Dual controlling items are typically not permitted.
7. Is the actual number of working days or workable days shown for each controlling item?
8. Are any critical non-work items accounted for on the schedule? A non-work item, such as the adjustment of a utility, is acceptable on the progress schedule, and in some cases may be a controlling item.

9. Is the work to be performed shown in a logical sequence and within specified contract requirements? For contract requirements, items of seasonal nature or items that are restricted to temperature and/or calendar dates must be considered. Department provided items may also need to be considered.
10. Are the production rates reasonable for a controlling item and do they justify the activity duration? The production rate may influence an extension of time if additional work is added.
11. Is the work to be performed by DBE firms shown on the progress schedule?
12. Are Trainees and their craft shown for each work item on the progress schedule?
13. Is “final cleanup and punch list”, “final cleanup”, or “punch list” shown as a controlling item(s)? This should be done in most cases.
14. When the contract contains working days, is the sum of all indicated working days equal to the contract number of working days?
15. For contracts with a completion date, does the sum of all workable days provide for a completion equal to the contract completion date? The schedule should show the use of all available time in a contract.

The Contractor is fully responsible for scheduling the resources to complete all work, the Contractor has considerable latitude in preparing the schedule with respect to the sequence of work, rates of progress, etc., subject to any specific contract requirements.

As stated in Article 108.02, no payment under the contract will be made until an initial progress schedule has been submitted for approval; thus, pay estimates should not commence until the initial progress schedule has been submitted. However, withholding further pay estimates when an updated schedule is required should only be considered under certain circumstances, and the Central Bureau of Construction should be consulted before any action is taken by the District.

When work progress is behind schedule (ten working days when the contract contains working days; 14 calendar days when the contract has a completion date) the Contractor must provide a satisfactory revised schedule. The considerations shown above apply when determining if the revised schedule is acceptable. However, it may be necessary for a Contractor to show non-compliance with the contract time limits. Acceptance of a revised schedule not complying with the contract time limits does not change the contract time limits (i.e. does not constitute an approved time extension). (E.g. the Contractor may be unable to recover the loss of time, the Contractor may be in dispute with extension of time, etc.) Regardless, a satisfactory revised progress schedule should be accepted instead of approved. If the Contractor's work is more than 10 working days (working day contract) or 14 calendar days (completion date contract) behind as determined by the District, the Engineer determines the controlling item of work as appropriate until a satisfactory revised schedule is submitted.

Also, see Section 108.04 for more discussion on progress schedules.

108.02-2 Types of Project Schedules

The Contractor for all Department construction projects must submit to the Department one of two basic project schedule types:

1. **Bar Chart**. A bar chart is a commonly used type of progress schedule, especially on relatively simple projects, as documented on [Form BC 255: Progress Schedule](#). The chart will show the actual work items to be constructed. Non-work items are normally excluded such as utility adjustments or Contractor submittals for Department approval. Figure 100-4 illustrates a typical bar chart progress schedule.
2. **Critical Path Method**. A Critical Path Method (CPM) schedule is created using scheduling software. A CPM schedule may be used on any type of project and is almost always used on complex projects. A CPM Schedule will show work items and may also show non-work items such as utility adjustments or Contractor submittals for Department approval. A benefit of a CPM schedule over a Bar Chart schedule is that a CPM shows the relationships, or dependencies between project activities. These relationships can be very useful in identifying those activities that control the project duration. A critical path is the longest sequence of tasks that must be done successfully in order to complete the project on time. Other activities, not on the critical path, typically have float in them. Float is a term that describes how long an activity can be delayed before it begins to impact the project schedule. Activities along the critical path will have zero float. By utilizing the relationships and float, it allows one to recognize how a delay to a non-critical activity may impact the overall project schedule and could possibly change the critical path.

Figure 100-4 — PROGRESS SCHEDULE (Example Bar Chart)

County DuPage
 Section 2014-061-RS
 Route FAI 55
 District One
 Contract No. 60Y96
 Job No. C-91-043-15
 Project ACSTP-5-5(454)

2016 AUG -5 AM 11:06



Progress Schedule
 Sheet 1 of 2
 Starting Date August 8, 2016
 Date of Estimated Completion September 15, 2016

Date of Award July 6, 2016 Execution Date 7/19/16
 Contract Working Days 20
 Contractor _____ s

Month - (Begin with starting month)	August	September	TOTAL WD's	PROGRESS
Projected Working Day Per Month	15	5	20	
Work Item	Quantity & Units	Daily Production Rate		
Traffic Control	1 LS	1/20 LS		Proposed DBE/WBE Trainees
Milling	16,667 SY	8,334 SY		Proposed DBE/WBE Trainees
Bit. Patching	835 SY	119 SY		Proposed DBE/WBE Trainees
Concrete Items	38 SY	38 SY		Proposed DBE/WBE Trainees
Poly Level Binder	700 Ton	350 Ton		Proposed DBE/WBE Trainees
Bit. Surface	1416 Tons	708 Ton		Proposed DBE/WBE Trainees
Agg Shoulders	260 Ton	260 Ton		Proposed DBE/WBE Trainees

cc - Contractor
 Engineer of Construction
 Regional Engineer
 Resident

LEGEND

WDS	Controlling	Non-Controlling
WDS	Proposed DBE/WBE	Proposed DBE/WBE
XXXXXX	Craft	Trainees

Contractor
 Date
 District Construction Engineer
 Date

108.03 PROSECUTION OF THE WORK

108.03-1 Summary

If the Contractor falls behind schedule, and the delay is the Contractor's responsibility, the Contractor is required to accelerate its progress as necessary to return to the original schedule, with no additional compensation due.

However, when the Department causes a delay in completion, such as by the addition of extra work on the critical path, or when for public convenience the Department suspends the work, the Contractor is normally due an adjustment of the contract time limit. At the Department's discretion, rather than extend the contract completion date, the Contractor may be directed to accelerate progress in the work. The direction to accelerate must be approved by the Central Bureau of Construction, as noted in Construction Memorandum No. 4, Contract Changes, in Appendix A.

The purpose of Department-directed acceleration is, essentially, an attempt to recoup contract time for a delay that was not the fault of the Contractor. There are direct and indirect expenses involved in accelerating the work that are not reflected in the bid prices. Payment for acceleration is intended to reimburse the Contractor for legitimate expenses beyond the expenses that the Contractor would have incurred at the Contractor's planned rate of progress.

For acceleration authorized by the Department, the Contractor will be reimbursed for the following items:

- Premium time worked due to the acceleration. It is less expensive for the Contractor to perform work at standard labor rates rather than at premium overtime rates. Premium time is the additional wage paid for hours worked at the overtime rates. For example, if a person works a 50-hour week, and 10 of those hours are paid at time-and-a-half, then the premium time paid is 10 times one-half (i.e., the $\frac{1}{2}$ part of $1\frac{1}{2}$ OT wage rate) times the basic hourly wage rate.
- Premium charges for material delivery. For some materials there are additional charges for delivery outside normal business hours, such as on weekends. Reimbursement will not include the 15% markup for materials that is included on normal force account bills.
- Lost productivity or efficiency for project personnel and equipment due to working prolonged periods of overtime. Unanticipated loss of productivity cannot be accounted for in the Contractor's contract bid prices.
- Additional administrative costs necessary to monitor overtime, maintain appropriate documentation and produce invoices for the acceleration. This type of expense is already included in the labor and material markups paid on standard force account billings.

108.03-2 Payment Procedures**108.03-2(a) Agreed Unit Price**

An agreed unit price is an acceptable method of payment only when the Contractor's method of accelerating is relatively uniform, or the needed efforts are definable.

Agreed unit prices for the work paid on an accelerated basis may be negotiated between the Department and the Contractor. These unit prices will include all costs associated with the work, including acceleration costs.

When the Contractor submits a proposed unit price in this manner, the Contractor should show a breakdown of the various costs involved in the unit price. The basic cost of the work must still meet the guidelines of acceptable unit prices. The Department must be able to evaluate the reasonableness of the proposed prices.

108.03-2(b) Force Account

When there are no contract unit prices for the work that is being accelerated, and the entire accelerated work is paid on a force account basis, then premium labor charges, premium material delivery charges, and office overhead expenses are already included in the normal force account billing procedures. Also, because the force account billing covers the entire period of acceleration, loss of efficiency is already incorporated; therefore, no separate markup for this loss is allowed.

108.03-2(c) Contract Unit Prices Plus Modified Force Account

If contract unit prices already exist for the work, and no agreement can be reached on an accelerated unit price, then the work is paid at the contract prices plus a modified force account billing. In this case, the modified force account will include only the additional charges associated with the accelerated work:

- Premium wages for work time over and above the Contractor's normal schedule. The "normal" schedule is the schedule already established by the Contractor, or the reasonable, estimated schedule shown on the approved progress schedule, if no work of this type has been performed yet. These premium wages include only that portion of the wages incurred because of the accelerated schedule. It is assumed that the contract unit prices include all wages, etc., necessary to perform the work at the rate of progress shown on the Contractor's progress schedule.

For example, assume that the Contractor normally works a 5-day, 40-hour workweek, and the Contractor expected to perform certain pay item work in those five days. If the Department directs the Contractor to compress the work scheduled for that week into four days instead of five, then the Contractor may be required to pay overtime rates on eight of those forty hours. Because the Contractor expected to complete the work at standard wage rates, the additional overtime wages can be attributed to the Department's direction to accelerate. The premium wages paid for acceleration are the difference between the

total wages paid, and the unaccelerated wage rates that the Contractor would normally have paid.

- Generally, there is additional clerical work associated with acceleration, over and above the normal clerical work needed to support the Contractor's normal work schedule. This clerical work will be paid at a flat rate of \$100.00 for each bill submitted.
- Documented premium charges for delivery of materials to meet the accelerated project schedule. For example, weekend delivery of concrete may include an additional charge from the producer. If the accelerated schedule causes the Contractor to incur such charges that would not otherwise have been incurred, then the Department as part of the acceleration payment pays these charges.
- Loss of productivity, or efficiency, for both personnel and equipment, in accordance with the payment schedule described in Section 108.03-3.
- The modified force account billing from the Contractor must be notarized. Certified copies of the applicable payroll records are submitted with the Contractor's bill. [Form BC 635: Extra Work Daily Report](#), or a comparable form, should be used to document the accelerated hours in a manner similar to normal force account work.

108.03-3 Loss of Efficiency

A number of studies have shown that when workers work extended hours for an extended number of days, the productivity or efficiency of the workers begins to decline. Therefore, it becomes more expensive to complete the same amount of work. Loss of efficiency also impacts the production of equipment when the operator of that equipment is affected by the loss of efficiency. The studies also note that worker efficiency quickly returns to normal levels once the schedule returns to normal hours.

Loss of efficiency is very difficult to document. To ease both the documentation burden for the Contractor and the verification burden for the Department, the Department has established the following method of adjusting payment to account for this. This procedure is used only for Department-directed acceleration. If the Contractor submits a claim for loss of efficiency for work not directed by the Department, then the Contractor will still be required to provide detailed documentation of actual loss to support the claim.

Payment for loss of efficiency will be paid by adjusting the labor and equipment rates by a loss of efficiency (LOE) factor. See Figure 100-5. LOE factors will be applied to those individuals, and any equipment operated by those individuals, who work 5 or more hours overtime per week in excess of either the Contractor's normal weekly work schedule or 40 hours, whichever is greater, when the accelerated schedule extends for two or more weeks.

Figure 100-5 — LOSS OF EFFICIENCY (LOE) FACTOR

Overtime Hours Worked, OT in excess of normal work week	% Additive to Straight Time Hours (Weeks 2-4)	% Additive to Straight Time Hours Beginning Week 5
Less than 5 hours	0	0
5 hours or more, but less than 15 hours	2.5	5
15 hours or more, but less than 25 hours	5.0	10
25 hours or more	7.5	15

The LOE factor will be applied to each individual, beginning with the second consecutive week that individual has been performing the accelerated work. If the individual is an operator, then the same LOE factor will also be applied to any pieces of equipment that individual operates for the duration that equipment is used. Loss of efficiency will not be applied to any equipment downtime. Loss of efficiency will also not be paid for labor when workers are paid but not working; for example, when workers are sent home early due to rain.

No loss of efficiency will be paid for office overhead or project supervision.

108.03-4 Example

The following example shows four individuals involved in an accelerated work effort, and what compensation will be paid for the acceleration under different circumstances. This example only applies when the work is paid at contract unit prices and the acceleration costs are billed on a modified force account basis.

GENERAL REQUIREMENTS AND COVENANTS

March 31, 2021

Name	Class.	Day						Time			Premium Time	Efficiency	
		Mon	Tue	Wed	Thur	Fri	Sat	Total	Std	OT		Time	%
Normal Schedule													
Fred Black	LAB	8	8	8	8	8		40	40	0			
Paul Abel	LAB	10	10	10	10	10	8	58	40	18			
Ed Noonan	OP	8	8	8	8	8		40	40	0			
Theresa Birch	OP	10	10	10	10	10	8	58	40	18			

Week 1

Fred Black	LAB	10	10	10	10	10		50	40	10	10	0	
Paul Abel	LAB	10	10	10	10	10	10	60	40	20	2	0	
Ed Noonan	OP	10	10	10	10	10	10	60	40	20	20	0	
End loader		10	10	10	10	10	10	60					
Theresa Birch	OP	10	10	10	10	10	10	60	40	20	2	0	
Backhoe		10	10	10	10	10	10	60					

Week 2

Fred Black	LAB	10	10			10	10	40	40	0	0	0	0
Paul Abel	LAB	10	10	10	10	10	10	60	40	20	2	60	0
Ed Noonan	OP	10	10	10	10	10	10	60	40	20	20	60	0.05
Backhoe		10	4					14				14	0.05
End loader			6	10	10	10	10	46				46	0.05
Theresa Birch	OP	10	10	10	10	10	10	60	40	20	2	60	0
Backhoe		10	10	10	10	10	10	60	40			60	0

Week 3

Fred Black	LAB	10	10	10	10	10	8	58	40	18	18	0	0
Paul Abel	LAB	10	10	10	10	10	8	58	40	18	0	0	0
Ed Noonan	OP	10	10	10	8	0	8	46	40	6	6	42*	0.025
End loader		10	10	10	4		8	42				42	0.025
Downtime					4			4					
Theresa Birch	OP	10	10	10	10	10	8	58	40	18	0	0	0
Backhoe		10	10	10	10	10	8	58				0	

* In this example, Ed Noonan actually worked only four hours on Thursday due to equipment breakdown, even though union agreements would require the Contractor to pay a full eight-hour day.

Sample billing for acceleration costs for Week 1:

Sept. 1999	Days						Total Hours	Normal Hours	Rate	Premium Time		Efficiency Loss		
	13	14	15	16	17	18				Hrs	Amount	Hrs	%	Amount
Fred Black	10	10	10	10	10	10	50	40	39.20	10	196.00			
Paul Abel	10	10	10	10	10	10	60	58	39.20	2	39.20			
Ed Noonan	10	10	10	10	10	10	60	40	45.75	20	457.50			
Theresa Birch	10	10	10	10	10	10	60	58	45.75	2	45.75			
Total:										\$738.45				

Sample billing for acceleration costs for Week 2:

Sept. 1999	Days						Total Hours	Normal Hours	Rate	Premium Time		Efficiency Loss		
	20	21	22	23	24	25				Hrs	Amount	Hrs	%	Amount
Paul Abel	10	10	10	10	10	10	60	58	39.20	2	39.20			
Ed Noonan	10	10	10	10	10	10	60	40	45.75	20	457.50	60	5.0	137.25
Theresa Birch	10	10	10	10	10	10	60	58	45.75	2	45.75			
Subtotal:										\$542.45		\$137.25		
Total:										\$679.70				

<u>Equipment</u>	<u>Operator</u>	<u>20</u>	<u>21</u>	<u>22</u>	<u>23</u>	<u>24</u>	<u>25</u>	<u>Rate</u>	<u>Efficiency Loss</u>		
									<u>Hrs</u>	<u>%</u>	<u>Amount</u>
Hydraulic excavator, crawler mounted, 200hp, 1.75cy bucket	Ed Noonan	10	4					125.05	14	5.0	87.54
Tractor loader, wheel mounted, 160hp	Ed Noonan		6	10	10	10		53.95	46	5.0	124.09
									Total:		\$211.63
Total Labor:		483.62									
Total Equipment:		<u>244.65</u>									
Total Billing:		\$728.27									

Sample billing for acceleration costs for Week 3:

Sept. 1999	<u>26</u>	<u>27</u>	<u>28</u>	<u>29</u>	<u>30</u>	<u>1</u>	<u>Hours</u>	<u>Rate</u>	<u>Premium Time</u>		<u>Efficiency Loss</u>			
									<u>Hrs</u>	<u>Amount</u>	<u>Hrs</u>	<u>%</u>	<u>Amount</u>	
Fred Black	10	10	10	10	10	8	58	39.20	18	352.80				
Ed Noonan	10	10	10	8	10	8	46	45.75	6	<u>137.25</u>	42	2.5	<u>48.04</u>	
									Subtotal		\$490.05			\$48.04
											\$538.09			

<u>Equipment</u>	<u>Operator</u>	<u>26</u>	<u>27</u>	<u>28</u>	<u>29</u>	<u>30</u>	<u>1</u>	<u>Rate</u>	<u>Efficiency Loss</u>		
									<u>Hrs</u>	<u>%</u>	<u>Amount</u>
Tractor loader, wheel mounted, 160hp	Ed Noonan	10	10	10	4		8	53.95	42	2.5	<u>56.65</u>
									Total:		\$56.65
Total Labor:		538.09									
Total Equipment:		<u>56.65</u>									
Total billing:		\$594.74									

Comments:

- Premium time amounts in the above examples are calculated as one-half the wage rate (assuming time and a half overtime rates), times the number of accelerated premium time hours. It is assumed that, except for efficiency loss, that the total number of man-hours to complete the work is already included in the bid price. Therefore, payment is made only for the additional overtime charge for those hours in which the Contractor had expected to perform at the standard wage rate.
- No efficiency loss is paid the first week. Efficiency loss is paid on an individual, and any equipment operated by that individual, starting the second week that the individual works an accelerated schedule. A week of Department-directed work is eligible for LOE adjustment only if, during the previous week of Department-directed work, the total hours exceeded the greater of 40 hours or the Contractor's normal schedule.
- Premium time is paid only for those overtime hours in excess of the individual's normal schedule or 40 hours, whichever is greater.
- In week 3, Fred Black is not paid for loss of efficiency, because his schedule in week 2 is not accelerated.

- In week 2, loss of efficiency for equipment operated by Ed Noonan is paid only for those hours in which he operated the particular equipment. The LOE factor for each is the same as the operator's because it is the operator's inefficiency that affects the equipment inefficiency.
- Loss of efficiency is not paid for either Paul Abel or Theresa Birch, because neither individual's accelerated schedule exceeds the normal work schedule by more than 5 hours. However, both would still have been eligible for LOE pay in week 3, had their hours exceeded their normal schedules.
- In week 3, no loss of efficiency is paid on Ed Noonan's backhoe during downtime. In this example, Ed Noonan does not work for the remaining four hours of the day in which the equipment broke down, so loss of efficiency is not paid for the remaining 4 hours of the day. LOE factors are applied only to those hours in which the individual actually worked or the equipment was actually used.

108.04 WORKING DAYS

Proper charging of working days is one of the most important duties of the Resident. Equally important is the review by the Contractor of the Weekly Report to determine if an objection exists. Working day charges (for a working day contract) and workable days (for a completion date contract) are shown on the [Form BC 239: Weekly Report of Resident](#).

The Contractor shall submit a progress schedule for every working day contract or completion date contract. The progress schedule lists the controlling items and the expected daily rate of progress to complete the work on time. To properly monitor the progress on both types of contracts, working day or workable day charges must be shown on the Weekly Report. If the Contractor's work is more than 10 working days (working day contract) or 14 calendar days (completion date contract) behind the progress schedule, a revised satisfactory schedule should be submitted. The Engineer may select the controlling item of work until one is submitted.

Generally, the Resident is required to make entries in the Project Diary and submit Weekly Reports from beginning to end of the physical work on the project (see the IDOT Project Documentation Guide). However, the Resident can suspend preparation and submission of the Weekly Reports if all work on the project is officially suspended by the Department per Article 108.07, Suspension of the Work, or during Contractor-initiated winter shutdowns. To suspend Weekly Reports, the Resident should enter the date of suspension in the "Suspension" field of Form BC 239, and make a note in the summary of operations area of the report such as "Weekly Reports suspended during Contractor's winter shutdown." When normal work resumes, the submittal of Weekly Reports should also resume, and the Resident should enter the date in the "Resumed" field of the Weekly Report. Weekly Reports do not have to be submitted after the work is reported as 100% complete.

Explain clearly in the Project Diary the reason for any time charge suspension. Do not use the reason "Weather" without explaining what made it inclement and how this affected the work. For example, if the nature of the inclement weather was "high winds that made it impractical to paint or apply vegetative mulch," note this level of detail in the Project Diary.

Some contract work items have establishment periods that may extend beyond the completion of all physical work on the project. This type of time charge suspension should also be explained in the Project Diary.

Section 108.08 discusses working day contracts within the context of contract time extensions.

108.06 LABOR, METHODS AND EQUIPMENT

108.06-1 General

The approval of any type of equipment or a new method of construction shall not be given without first referring the issue to the Central Bureau of Construction through the District Office. This policy enables the Department to ensure uniform construction practices. The Department may have the proposal under consideration and may not be in a position to render a decision until more information is available. When new equipment and methods have been approved, a record of the performance of the equipment and the results obtained will be documented. This information will then be incorporated into a detailed report that is sent to the Region Engineer, who sends a copy to the Central Bureau of Construction. This report will also contain any conclusions or recommendations by the District.

108.06-2 Experimental Features

108.06-2(a) General

The FHWA Federal-aid Policy Guide G 6042.4, Chapter 6, "Construction Projects Incorporating Experimental Features" dated December 9, 1991, prescribes the objectives and provides guidelines relating to the development, inspection, financing and reporting of Federal-aid highway construction projects that include experimental features.

An experimental feature may be a material, process, method, equipment item, traffic operational device or other feature that:

- Has not been sufficiently tested under actual service conditions to merit acceptance without reservation in normal highway construction
- Has been accepted but needs to be compared with alternative acceptable features for determining their relative merits and cost effectiveness

108.06-2(b) Work Plan

Experimental features are generally included and approved in a project before the project is advertised for bids. For an experimental feature to be authorized or approved for inclusion in a Federal-aid project, an experimental features work plan must be prepared and submitted to FHWA for approval. The work plan shall be submitted through the CBM, prior to advertising. This work plan shall contain or reflect the following items of significant information:

1. A description of the experimental feature.

2. The objectives of the experiment in terms of the purpose, how the results might be utilized, the economic benefits (e.g., savings in time, money, lives) and, finally, how the results of the experiment may be implemented and applied to other construction projects.
3. Reference to any specific research on the subject that supports the basic concept of the experimental feature being suggested.
4. The plan of the study and the evaluation process. This should outline the measurements to be made and the characteristics to be evaluated. This should also include the frequency of inspections (at least one a year) and the reporting anticipated during and after construction.
5. The methods or means of constructing the experimental feature and the materials, process, technique and/or equipment necessary to the experiment that are a departure from normal construction procedures.
6. The estimated additional cost of the experimental feature. Higher costs are normally anticipated, but the experimental feature should not be excluded for that reason.
7. Details of the control section. A control section shall be provided in all approved experimental projects unless the nature of the experiment is such that a control section would serve no purpose. A sketch showing the location of the experimental section and the control section is included with the work plan. Plan drawings and any special provisions pertaining to the experimental feature should also be provided.
8. The estimated time or duration necessary to complete all aspects of the evaluation.

108.06-2(c) Construction

When the work plan has been approved by FHWA, a copy of this plan should be forwarded to the Resident so that the Resident is aware of the nature of the experimental feature.

Because even small changes in an experimental feature can jeopardize the research, all changes involving experimental features in a project must have prior approval regardless of whether they are major or minor changes. The request for the change should state clearly what effect the proposed change is expected to have on the research. Requests shall be submitted to the CBM.

Existing policy also permits the inclusion of experimental features in construction projects that are already in progress by submitting a change order. In such cases, the preparation of an experimental features work plan, as outlined above, will be required. Assistance during the preparation of work plans is available from the Central Bureau of Construction and the Bureau of Materials.

108.06-2(d) Reporting

After FHWA approval of the work plan, the originating agency will provide the information required to complete Form 1461, Experimental Project Report. Form 1461 will then be prepared by CBM and forwarded to FHWA. After initial submittal, the District or Bureau responsible for monitoring

the experimental feature shall prepare Form 1461 annually (by September 15 of each year) and submit the form to the Engineer of Physical Research for an overall submittal to FHWA by October 1 of each year. Form 1461 shall also be used periodically to update the status if appropriate information of interest on the experimental feature develops.

CBM will prepare the final Form 1461 after receiving the required information from the originating agency. CBM will then submit the form to FHWA concurrent with the final report, which is prepared by the District or Bureau responsible for the project.

108.07 SUSPENSION OF WORK

108.07-1 General

Should a work suspension be deemed necessary for reasons not within the Contractor's control, the Resident will inform the Contractor and document this in the Project Diary explaining the order to suspend work and the reasons.

Should it become necessary to suspend work for an indefinite period of time, the Contractor is required to protect the construction that has been partially or fully completed by providing adequate drainage for the roadway, opening ditches, maintaining traffic control devices, erosion control, installing shoulder drains or undertaking any other precautions the Resident may direct. The Contractor should store all materials in an acceptable manner so that they will not be a hazard to the traveling public or become damaged or stolen during the period of suspension.

A "partial" suspension of work may be appropriate in some cases. For example, the Resident may suspend work on a bridge, but authorize continued work on the roadway portion of the project.

108.07-2 Work Suspension vs Stop Work

Department personnel must be careful when using the terms "suspension," "shutdown," "stop work," etc. The only "shutdown" recognized by the Department is the "winter shutdown" (see Construction Memorandum No. 77 in Appendix A). If the Resident wants to cease all project work, the Resident should "suspend the work" and issue a "work suspension." However, if the Resident wants to "stop work" on a specific item of project work, the directive to the Contractor must be clear as to what is being ordered. Examples include:

- Halting aggregate production because of out-of-specification material
- Stopping a Contractor from priming because the surface is muddy, full of debris, etc.

The Resident should communicate the suspension or stop work order in writing.

108.07-3 Procedure

The Resident has the authority to suspend the Contractor's work. However, the Resident must consult his/her Construction Field Engineer/Area Supervisor and, if practical, notify the Central Bureau of Construction before taking this action. Work suspensions expose the Department to a potential liability risk, and a work suspension can lead to a request for a time extension, which

only the Central Bureau of Construction can approve. The suspension should be well documented.

108.08 DETERMINATION AND EXTENSION OF CONTRACT TIME

108.08-1 Introduction

One of the most important and sometimes difficult parts of contract administration is the control of Contractor progress. Once a contract is awarded, the public is very anxious to be able to use the facility. The contract time limit is specified in the contract, and a schedule of liquidated damages has been established to promote the timely completion of contracts. This ensures that the public will not be unduly inconvenienced and can realize the benefits of the new facilities.

In establishing the contract time limit, the State will consider all factors, and the Contractor should recognize that the time allowed is part of the contract. Contract time administration requires exceptional judgment by all parties to the contract. The Contractor should examine the contract time limit when evaluating a bid on a contract. The Contractor's responsibility is to the highway user, the State, the construction industry and itself to complete the work within the specified time limit. If the Contractor believes that the time allowed is insufficient, the Contractor should not bid on the contract.

See Section 66-2.04 of the IDOT BDE Manual for an in-depth discussion on establishing contract time.

108.08-2 Types of Contract Time

108.08-2(a) Working Day Contract

The contract will specify a number of working days in which the work shall be completed. A working day is defined as any calendar day between May 1 and November 30 inclusive, except Saturdays, Sundays and legal holidays observed by the Contractor's entire work force in Illinois, when conditions are such that the Contractor could be expected to do a full day's work on the controlling item as shown on the progress schedule.

108.08-2(b) Completion Date Contract

Completion date contracts will have a date specified for when the Contractor shall complete all work. Workable days must be tracked to evaluate the Contractor's progress. A workable day is defined as any day of the week, Sunday through Saturday, exclusive of legal holidays observed by the Contractor's entire work force in Illinois. A day should be indicated as workable when conditions are such that the Contractor could be expected to do a full day's work on the controlling item as shown on the progress schedule.

108.08-2(c) Completion Date Plus Working Day Contract

Completion date plus working day contracts are used when a facility must be open to traffic by a specific date, but all work does not have to be completed by the completion date. The latest possible completion of specified work items in the contract is set by the completion date specified

in the contract, and it allows a number of working days in the contract to complete the remaining work. The tracking of workable days and charging working days will be as discussed under completion date contract and working day contract.

108.08-2(d) Completion Date (via Calendar Day) Contract

Completion date (via calendar day) contracts are used when the work must be completed in a specific timeframe, not by a specific date. A completion date (via calendar day) contract is a completion date contract with a floating start date. The specified number of calendar days sets a date of project completion at the time the contract is started; therefore, the Contractor is not affected by a late award. The contract is then administered as a completion date contract. Workable days must be tracked to evaluate the Contractor's progress. The definition and the tracking of a workable day will be as discussed under completion date contract.

108.08-2(e) Completion Date (via Calendar Day) Plus Working Day Contract

Completion date (via calendar day) plus working day contracts are used when a facility must be open in a specific timeframe, not by a specific date, but all work does not have to be completed by the completion date. A date of completion is established by the specified number of calendar days in the contract at the time the contract is started and allows a number of working days to complete the remaining work. The tracking of workable days and charging working days will be as discussed under completion date contract and working day contract.

108.08-3 Initiation of Charging Time

The charging of contract time starts when the Contractor begins actual construction work, but no later than ten days after execution and approval of the contract, unless otherwise provided in the contract or directed by the Engineer. The execution of the contract is the date on which the Secretary of Transportation signs the contract and bond. Under no circumstances can work begin prior to execution of the contract. If the question arises as to the status of contract execution, the Contracts Office of the Central Bureau of Design and Environment should be contacted.

There are some cases when it is not in the public interest to start work within ten days of contract execution and the starting date is delayed. The Regional Engineer may grant a delay in starting work. Such delayed starting dates must be documented in the contract files and a specific calendar date established as the new starting time. If necessary, this date may later be modified in writing. However, no open-ended delayed starting dates will be approved. Notice of the delayed start must be distributed to the Central Bureau of Construction, the Contractor and other local agencies, if appropriate. The formalized statement granting the delay may be contained in the preconstruction conference minutes with an explanation of the reasons for the delay.

108.08-4 Charging Time

The charging of time must promote Contractor progress but must also consider those conditions beyond the Contractor's control that impede or halt progress. This is essential for the equitable treatment of all Contractors and the Department's standing with the construction industry. The following partial list explains the Department's policy for properly charging contract time.

108.08-4(a) Legal Holidays

Holidays exempted as working/workable days are not those observed by Federal, State and local governments but, rather, those observed by the Contractor's entire work force in Illinois. For the purpose of charging working days, this is best determined by the presence of workers and the rate of pay they are receiving:

- If no forces are working, a working day should not be charged.
- If all forces are receiving premium time pay, a working day should not be charged.
- If some of the forces working are receiving straight time pay, and work on the controlling item can be performed, a working day should be charged.

On completion date and completion date (via calendar day) contracts, legal holidays observed by the Contractor's entire workforce should not be indicated as workable.

108.08-4(b) Partial Days

The length of the workday in hours will be determined by the Contractor's established practice but may not be less than eight hours. Partial day charges shall be based on the proportionate part of the established workday, if applicable, rather than the normal eight-hour workday. Partial day charges should be rounded down to the nearest one-quarter, one-half or three-quarters of a working day.

108.08-4(c) Adverse Weather Conditions

When there is a potential for adverse weather conditions that would prevent work on controlling items such as PCC or bituminous pavement or bridge deck pours, the Contractor must make a decision very early whether to risk the cost that would be incurred in starting a plant and mobilizing a sizable work crew that might not be able to work. If forecasts are for possible adverse weather conditions and the Contractor elects not to work, a working day shall not be charged even though the adverse weather may not develop.

When adverse weather conditions develop and cause the Contractor to prematurely halt work on the controlling item, a partial working day shall be charged. For example, a Contractor has established a practice of working 12 hours a day on a particular controlling item. If weather conditions are such that the Contractor can only work six hours on that item, then only one-half, rather than three-quarters, of a working day shall be charged.

When job conditions due to recent adverse weather prevent work on the controlling item, a working day shall not be charged. In addition, when job conditions due to recent adverse weather prevent full work efficiency on the controlling item, a partial working day shall be charged.

With respect to adverse weather conditions, on completion date and completion date (via calendar day) contracts, workable days are indicated in the same manner as working days are charged on working day contracts.

108.08-4(d) Availability of Equipment

The Contractor is responsible for furnishing sufficient equipment and labor to perform the work in accordance with the approved progress schedule. If needed equipment is not available, a day normally should be charged but there are exceptions.

The Contractor may start work the day after the preconstruction conference on the controlling item of earth excavation, but it may take several days to deliver and assemble an “equipment spread” at the jobsite. If the approved progress schedule has earth excavation as the controlling item of work and shows a production rate of 2000 cubic yards (1500 cubic meters) per day and the Contractor is only able to accomplish 1000 cubic yards (750 cubic meters) per day during the initial startup, then only one-half of a working day should be charged.

If the Contractor experiences a breakdown of a major item of equipment, such as a bituminous or PCC plant or paver, and field repairs cannot be made, a review of day charges may be considered. A full or partial working day should be charged on the day of the breakdown based on the production attained. Working days should not be charged during the subsequent breakdown period provided that the Contractor is making a good faith effort to repair or replace the broken equipment. If the Contractor experiences intermittent equipment failures and continues work, but the permanency or time required for field repairs does not permit the approved production rate to be realized, then a partial working day should be charged based on the production attained.

The breakdown of minor equipment such as a truck, roller or scraper would not qualify as an exemption of a working day charge because these items are considered to be part of the Contractor’s fleet and many of these items are readily available on a rental basis.

If added work that results from differing site conditions becomes controlling and the work requires different items of equipment than currently on the jobsite, the Contractor shall be given a reasonable period of time to acquire or deliver the equipment without being charged a working day.

On completion date and completion date (via calendar day) contracts, equipment availability has no impact on determining whether or not a day is workable (i.e., even if needed equipment is unavailable, the day should be recorded as workable).

108.08-4(e) Availability of Material

The Contractor is responsible for furnishing material, and the unavailability of material does not justify an exemption of a working day charge unless it is beyond the control of the Contractor. Examples that are beyond the control of the Contractor include:

- Area wide shortages due to reduced production or strikes, lockouts, wrecks or freight embargoes
- Material furnished under a separate contract such as fabricated structural steel

- Design change or delays exceeding the time frames allowed under Article 105.04 in approving shop drawings
- Material that was approved at the plant but was damaged in transit and is of a unique nature requiring considerable time for replacement

On completion date and completion date (via calendar day) contracts, days should be indicated as workable unless the material delivery delay is caused by strikes, lockouts, wrecks or freight embargoes.

108.08-4(f) Strikes

Working days shall not be charged during a labor strike that is beyond the Contractor's control. The Contractor may not be able to resume work immediately after the strike is settled. If the Contractor must remobilize personnel and equipment or replenish depleted stockpiles, a working day shall not be charged.

On completion date and completion date (via calendar day) contracts, days should be indicated as workable. However, it should be noted if the strike (or other labor disruption) lasts more than five calendar days.

108.08-4(g) Utility Adjustments

When a utility adjustment (required through no fault of the Contractor and beyond the Contractor's control) prevents the Contractor from working on the controlling item, a working day shall not be charged. An example would be when the Contractor is prevented from completing an earthwork related controlling item because utility lines have not been relocated.

When a utility adjustment (required through no fault of the Contractor and beyond the Contractor's control) prevents full work efficiency on the controlling item, a partial working day shall be charged. An example would be where the Contractor's progress on storm sewer work is affected by required utility adjustments not shown or addressed in the contract documents.

With respect to utility adjustments on completion date and completion date (via calendar day) contracts, workable days are indicated in the same manner as working days are charged on working day contracts.

108.08-4(h) Railroad Adjustments

When a railroad adjustment beyond the Contractor's control prevents the Contractor from working on the controlling item, a working day shall not be charged. An example would be where all other work on the contract is nearly complete and the Contractor is unable to complete the approaches to a railroad crossing during normal construction operations because the Railroad failed to complete its crossing adjustment as per the Railroad-State agreement.

With respect to railroad adjustments on completion date and completion date (via calendar day) contracts, workable days are indicated in the same manner as working days are charged on working day contracts.

108.08-4(i) Special Permits

When delays occur in obtaining special permits through no fault of the Contractor, and progress on the controlling item is prevented, a working day should not be charged. The Contractor must furnish documentation showing that the permit application was submitted in a timely manner. An example would be where a ditch under the jurisdiction of a drainage district crossed State right-of-way and a permit for a temporary crossing was needed for the Contractor to haul material to the jobsite and the permit was applied for in a timely manner, but approval was not granted in a timely manner.

With respect to special permits on completion date and completion date (via calendar day) contracts, workable days are indicated in the same manner as working days are charged on working day contracts.

108.08-4(j) Department Conduct

When conduct of the Department prevents the Contractor from working on the controlling item, and the prevention is not due to the acts or omissions of the Contractor, a working day shall not be charged. Following is a partial list of examples:

1. Date Restriction Department Conduct Example. Per Article 780.05, thermoplastic pavement markings may not be placed later than November 1 or earlier than April 15. If the controlling item on November 5 is thermoplastic pavement markings, a working day shall not be charged.
2. Archaeological Site Department Conduct Example. Per Article 107.21, when aboriginal records or antiquities are uncovered unexpectedly, the Contractor shall notify the Engineer of their presence and shall not disturb them until written permission is granted. If an unexpected archaeological site is found and prevents the Contractor from working on a controlling item, no working day shall be charged until the Contractor is given written notice to proceed.
3. Utility Adjustment Conduct Example. The Department will make provisions to have all utilities that conflict with the work to be relocated before construction begins or by a specified date included in the contract. If the utility is not relocated as indicated in the contract and remains in conflict with work on the controlling path of the progress schedule, a working day shall not be charged.

With respect to Department conduct on completion date and completion date (via calendar day) contracts, workable days are indicated in the same manner as working days are charged on working day contracts.

108.08-4(k) Final Cleanup

The days allotted in the contract include the time required for final cleanup or "punch list" work. Final cleanup should be included as an item on the progress schedule and working days should be charged during the period when final cleanup is controlling to promote prompt contract

finalization. If the final inspection was delayed and the Contractor has demobilized its work force, a reasonable period of time may be granted before the charging of working days is resumed.

With respect to final cleanup on completion date and completion date (via calendar day) contracts, workable days are indicated in the same manner as working days are charged on working day contracts.

108.08-4(l) Subcontracted Work

The prime Contractor is held responsible for the diligent and proper prosecution of all work even though a portion of that work is sublet. The exemption of full or partial day charges for valid reasons would apply to work being performed by a Subcontractor as well as to that being performed by the prime Contractor.

108.08-4(m) Curing of Concrete

For working day contracts, when curing of concrete is shown on the progress schedule as a controlling item immediately following a concrete construction (e.g. bridge deck placement) controlling item and the curing must be completed before resuming work on the controlling item (e.g. parapet placement), typically a working day should not be charged during the curing period.

On completion date and completion date (via calendar day) contracts, curing days should be indicated as workable.

108.08-5 Conclusions

The proper charging of contract time and the fair and prompt consideration of time extensions are important duties. The prompt consideration of a time extension prevents unnecessary self-acceleration of the project by the Contractor. Equally important is the review by the Contractor of the Resident's Weekly Report and timely notification by the Contractor of objections to day charges. It is the responsibility of the Contractor to provide the documentation required to support a claim for relief of day charges.

The Department must recognize that there are delays beyond the control of the Contractor that may require the specified contract time to be reviewed and possibly adjusted via a time extension. In all time extension cases, there must be support to show that a delay occurred and was caused by one of the conditions specified in Article 108.08 of the *Standard Specifications*.

On working day contracts, there must be verification that the delay was not accounted for in the original charging of working days by the Resident. It is not intended to grant duplicate relief for the same delay. If no working day charges were originally made, no further relief can be granted. Likewise, the same delay can only be considered under one of the specified circumstances. The Contractor must provide the documentation required to support a claim for additional time.

Delays should be verified and documented in writing in a timely manner when they occur. On completion date and completion date (via calendar day) contracts, the Contractor must notify the Department within 21 calendar days of the commencement of each such delay.

As an example, if a material is delayed due to supplier strikes or government priority, advise the Contractor to obtain a letter to this effect immediately.

108.08-6 Examples

The following conditions and examples should be used in determining whether a review and adjustment of contract time is warranted.

108.08-6(a) Working Day Contracts

Per Article 108.08(a), if the Department finds that the quantities of work done, or to be done, are in excess of the estimated quantities by an amount sufficient to warrant additional time, a time extension may be granted. The Department can also grant a time extension if the Department changes contract requirements that affect the Contractor's progress.

Common examples of added quantities that may give merit to a time extension would be earth excavation, embankment and field tile. The required adjustment to time can be calculated by dividing the added quantity by either the progress schedule rate or actual production rate. This determination is made by the District.

Another example of added quantities would be when earthwork has been completed but, due to field conditions, the Department determines that additional work is required. Actual production rates could vary considerably from those experienced on the initial contract work.

An example of changed contract requirements would be when work was completed at an intersection, but traffic flow did not function as intended and additional work was required to improve the traffic flow through the intersection.

Another example of changed contract requirements would be opening pavement to through traffic when the contract specified that the pavement would be closed to all but local traffic. The time adjustment could be based on actual production rates versus the Contractor's progress schedule production rates.

If after final quantities have been determined and the contract cost is increased from the awarded cost, additional working days may be requested for the Contractor in the ratio of final contract cost to the awarded contract cost:

$$\left[\frac{\textit{Final Cost}}{\textit{Awarded Cost}} \times \textit{Awarded Days} \right] - \textit{Awarded Days} = \textit{Extension Days}$$

108.08-6(b) Completion Date and Completion Date (via Calendar Day) Contracts

Per Article 108.08(b), when completion date and completion date (via calendar day) contracts are specified, it is understood that time is of the essence. It must also be understood that the occurrence of unworkable days during contract prosecution does not automatically justify the need for a time extension. Unworkable days are anticipated when the contract time limit is specified.

An example would be four unworkable days occur in April due to rain. Multiple rain days in April would have been anticipated when establishing the contract time limit (and should have been anticipated by the Contractor). Four rain days in April would not be considered extraordinary conditions of weather. Thus, a time extension would not be justified.

On completion date and completion date (via calendar day) contracts, a time extension may be warranted if a delay in work on the controlling item beyond the reasonable control of the Contractor results from the causes specified in Article 108.08(b).

Working day contract time extensions may be initiated by the Department or the Contractor. Completion date and completion date (via calendar day) contract time extensions must be initiated by the Contractor. After a request for a time extension is received, the District needs to evaluate the request for completeness and relevance. After District review, the entire package with the District's recommendation should be submitted to the Central Bureau of Construction for review. The Central Bureau of Construction may accept, revise or deny the District's recommendation. The approval authority rests with the Central Bureau of Construction on final completion dates. See [Form BC 2019: Request for Extension of Time](#). The approval authority rests with the District for interim completion dates.

108.10 DEFAULT ON CONTRACT

When a Contractor is not performing satisfactorily, the Resident notifies the District Construction Field Engineer/Area Supervisor, who works with the Central Bureau of Construction to address the problem. If a Contractor refuses to cooperate to correct deficient work or progress to complete the project, the Department may find the Contractor in default of contract. Defaulting a Contractor is a major action against the Contractor and this decision should not be made lightly.

Notification of contract default is a function of the Central Bureau of Construction who will oversee the default process. A ten-day notice letter signed by the Director of Highways is sent to the Contractor via certified mail. The letter provides the Contractor with ten days to address the problem. If no response is received or the response is unacceptable, the situation proceeds to default pursuant to Article 108.10. The Secretary of Transportation signs the letter, who is the only individual authorized to sign a letter of default.

SECTION 109. MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES

109.01-1 Documentation

109.01-1(a) Department Documents

The IDOT [Documentation of Contract Quantities](#) publication provides detailed information on calculating quantities for payment. All Department field staff must have an in-depth knowledge of this publication. The following also apply to documentation:

- Construction Memorandum No. 33, Operational Review of Contract Quantities, in Appendix A, discusses procedures for District reviews of project support documentation for contract quantities.
- Construction Memorandum No. 81, District Construction Project File Requirements, in Appendix A, presents requirements for the retention of District construction files (e.g., retainage).

109.01-1(b) General

Contract work, as bid by the Contractor, is measured and paid as contract pay items. The contract documents will specify the following information for each item:

- The unit of measure
- The method of measurement
- The estimated quantity
- The system for the unit of measure (i.e., US Customary or metric (SI))

Each contract item represents a unique construction element of the project (e.g., guardrail, pipe culvert, riprap). Contract items may be measured by units of each, length, area, volume, weight or lump sum. The contract documents also include the estimated quantity of each contract item. The actual quantities of the various contract items performed by the Contractor must be determined by measurement and calculation, unless [Form BC 981: Agreement on Accuracy of Plan Quantities](#), is signed.

Differences often exist between the estimated quantities shown in the contract documents and the actual quantities that result during construction. If necessary, contact the designer to discuss the project quantities (e.g., how were the quantities calculated?). If necessary, request additional backup quantity information, such as earthwork calculations, to assist in determining the planned quantity for a specific item for payment, or if there is a suspected conflict or discrepancy with the field-calculated earthwork based on the project staking notes.

109.01-2 Accuracy of Measurement

All pay item quantity documentation is subject to audit and review and, therefore, must be complete, accurate and established in a manner that is clear, concise and easily followed and understood by personnel unfamiliar with the project.

All contract quantities must have written data to support payment. The source document should include all pertinent information on the location, method of measurement (e.g., tons, cubic yards, square yards, lump sum, pounds, each), dates of installation, etc.

Measure and calculate contract item quantities to a degree of accuracy according to Section B of the IDOT Documentation of Contract Quantities.

109.01-3 Weight Checks

This Section presents the Department's policy for the performance of independent weight checks for pay items where the method of measurement for payment is based on weight.

The IDOT Documentation of Contract Quantities outlines three types of weight checks that must be performed by State (or local agency) representatives. They include one for weekly independent weight checks, and two types (that should be alternated) for ticket weights determined from batch weights.

The weekly independent weight check will be documented on [Form BIC 2367](#). A copy of Form BIC 2367 (performed by Department personnel) will be forwarded to the Central Bureau of Construction and the Bureau of Investigations and Compliance.

The two weight checks for batch plants may be reported on 1) the Bituminous Daily Plant Output Report, Form MI-305, or 2) the Independent Weight Check, Form BIC 2367, or 3) other methods using the format described in the IDOT Documentation of Contract Quantities. Results shall be placed in the job file. Do not forward copies to the Central Bureau of Construction nor to the Bureau of Investigations and Compliance.

109.01-4 QC Checks By Contractor

The IDOT Documentation of Contract Quantities outlines the scale checks that must be performed by Contractors as part of the QC process. The scale checks will be documented on Form BIC 2367 and/or the Bituminous Daily Plant Output Report. Copies of QC checks by the Contractor should not be forwarded to the Central Bureau of Construction nor to the Bureau of Investigations and Compliance.

109.01-5 Weighing

See the IDOT Documentation of Contract Quantities. If loads or portions of loads are rejected, notes explaining the reason should be made on the respective load ticket or invoice, initialed and dated by the authorized Department Inspector.

At the discretion of the Department, in lieu of paper delivery tickets, the Contractor may employ the use of an automated electronic ticket (i.e. "e-ticket") system. If the District desires to approve

the Contractor's request, the District should coordinate Department approval with the Central Bureau of Construction. At a minimum, the automated e-ticketing system shall provide electronic, real-time tickets meeting the same criteria as per Article 109.01 of the Standard Specifications for Road and Bridge Construction, 3rd paragraph. Approved electronic tickets shall be considered to meet the Standard Specifications for Road and Bridge Construction in reference to "automatic printer", "delivery ticket", or any other reference to printed tickets.

It is anticipated an e-ticket system should satisfy the following:

1. E-tickets must contain all ticket data required by specification
2. The Department needs the ability to receive an e-ticket via e-mail (on a ticket by ticket basis) after an e-ticket is accepted. (This serves as a check against ticket data stored on a vendor website.)
3. The Department needs the ability to add comments to an e-ticket (e.g. test results, when only partial tonnage from a load is used, inspector initials, etc.)
4. The Department needs the ability for a RE/Inspector to safely identify which load they are accepting. (E.g. truck numbers should be readily displayed on side of trucks. In addition, the truck number and load number should readily be displayed on an e-ticket.)
5. The Department needs the ability to accept or reject an e-ticket
6. The Department needs the ability to undue an "accept" or "reject" action
7. Online e-ticket reporting functionality should be exportable. (E.g. the Department needs the ability to summarize e-tickets for a specific date or range of dates and export data to excel.)

109.04 PAYMENT FOR EXTRA WORK

109.04-1 General

The Department reserves the right to require the performance of extra work to satisfactorily complete the contract work. It is in the best interest of both the Department and the Contractor to anticipate extra work whenever possible. Options for completing any extra work should be discussed with both the Contractor and Construction Field Engineer/Area Supervisor. A Contractor shall not begin this work without written authorization from the Department. Refer to Article 104.02 and Construction Memorandum No. 4 in Appendix A for extra work payment.

109.04-2 Method of Payment Definitions

The basic method of payment to the Contractor for extra work will be one of the following:

1. Contract Unit Prices. This method uses existing items and unit prices in the bidding schedule.

2. Agreed Unit Price (AUP)/Lump-Sum Price. AUP establishes new items and unit prices to pay for extra work. In general, an agreed unit price approach is used when there is a key component (e.g., cubic yards of structural concrete) of the overall construction element that can be used to provide payment for the Contractor's work. The AUP approach is best suited when the work can be quantified in advance.

Lump sum is used for payment for extra work when it is appropriate to pay for the completed work as a unit; i.e., the lump-sum price is the total agreed cost for all work associated with the construction of an overall construction element. It includes the cost of all materials, labor and equipment. This method is appropriate when it can be determined that there will be no changes or adjustments to the original scope or quantity of extra work agreed upon.

3. Force Account. A force account compensates the Contractor for extra work based on the actual hours worked and the equipment and materials used (i.e., time and materials). It is more cumbersome and administratively complex than either an agreed unit price or lump-sum price payment. Force account is best used when:
 - Defining the work clearly and accurately enough for a change order with an agreed unit or lump-sum price is too difficult
 - The extra work needs to begin immediately
 - The Department and the Contractor cannot agree on an agreed unit or lump-sum price for the extra work

109.04-3 Lump Sum or Agreed Unit Price

Either the Resident or the District Office will receive a letter from the Contractor proposing payment for extra work at a lump sum price or an agreed unit price. This request is forwarded to the District estimator who either approves or rejects the price. If the lump sum or agreed price is approved, the Contractor shall be given written confirmation of the approved method of payment and permission to proceed with the work. If the request is denied, one or two options exist — either the Contractor may resubmit the proposal with changes, or the Department will direct the Contractor to proceed under a force account basis.

109.04-4 Force Account

If it becomes necessary to do extra work under a force account basis, the Contractor shall perform the work in the most expedient and economical manner possible. This shall be discussed before the work actually begins. In this discussion, the labor force required, equipment to be used, and any material needed will be determined. After these issues are resolved, the extra work may proceed.

On a force account, the Resident should agree with how the work will be performed and the labor, materials and equipment that the Contractor will use before the work is performed. The Resident can also decide what to include and exclude on a force account.

Each day that the Contractor proceeds working on the extra work, an Extra Work Daily Report, [Form BC 635: Extra Work Daily Report](#), shall be completed. Form BC 635 shall then be signed by both the Contractor's and Department's representatives. The original shall be given to the Contractor for future billing and a copy retained in the job file. Upon receiving the force account billing from the Contractor, the Resident shall check it for accuracy with the Extra Work Daily Report, Form BC 635, in the job file. The Contractor billing should resemble that shown in the IDOT Documentation of Contract Quantities. Once checked, processing for payment may proceed.

When extra work is performed by an Engineering firm hired by the Contractor, the cost should be administered as work performed by an approved Subcontractor per article 109.04(b)(7).

It is recommended that an authorization for an estimated amount is processed before the work begins.

Refer to Construction Memorandum No. 9 in Appendix A for procedures to process a force account bill.

109.05 EXPENSES INCURRED BY THE DEPARTMENT

The following are examples of items that typically apply to Article 109.05:

1. Utility work such as residential service hookup (beyond the meter) and utility service drops
2. Railroad flagger bills in accordance with Article 107.12
3. Utility charges that are the responsibilities of the Department.

To calculate the administrative cost, the following example is provided to ensure consistent interpretation of the specification. If the Contractor received three railroad flagger invoices for \$5000 each and issued one payment of \$15,000 for the three invoices, the administrative cost is $(0.05 \times 10,000) + (0.01 \times 5,000) = \550 . If the Contractor received three railroad flagger invoices for \$5000 each and issued three payments (one payment for each invoice), the administrative cost would be $(0.05 \times 5,000) + (0.05 \times 5,000) + (0.05 \times 5,000) = \750 .

109.07 PARTIAL PAYMENTS

One of the most important duties of the Resident is to submit pay estimates for quantities of completed work. The contract between the State and the Contractor differentiates two types of payments to the Contractor – partial payments (Article 109.07) and final payments (Article 109.08). The Resident's work on a project is not complete until the final payment has been made to the Contractor.

109.07-1 Progress Payments

109.07-1(a) Frequency of Progress Pay Estimates

Due to the large dollar value and duration of many contracts, Article 109.07 of the *Standard Specifications for Road and Bridge Construction* provides for partial payment to the Contractor

for work completed to date. A partial payment, commonly referred to as a progress payment, is initiated by the Resident when he/she completes and submits a pay estimate. Article 109.07 specifies that a partial payment will be made to the Contractor at least once per month. However, if the State is the awarding authority, payment will be made only if the value of the payment is \$1,000 or greater.

Depending on the size of the contract, progress pay estimates may be submitted on a more frequent basis. Normally, pay estimates are not submitted more often than twice a month. However, on a multimillion-dollar project, progress pay estimates may be submitted weekly if sufficient work has been completed to justify that schedule. The Resident may wish to discuss the payment schedule with the prime Contractor to ensure that all involved know when payments can be expected.

Each pay estimate must be processed individually by the Central Bureau of Construction. Due to the time required to process each payment, pay estimates should not be submitted more frequently than once per week. Two or more estimates should never be submitted at the same time.

109.07-1(b) Submittal of Progress Pay Estimates

Pay estimate entries may be made using CMMS, ICORS, or on preprinted forms. If CMMS or ICORS is used, pay estimates should be emailed with a statement indicating the Resident's approval for the contract and pay estimate number (i.e., "I hereby approve this estimate for payment.").

On State let State Contracts CMMS or ICORS must be used. Pay estimates must be emailed, by the Resident, to DOT.PayEST@illinois.gov. Copies of the pay estimate should be sent to the prime Contractor.

On State let local agency contracts, if using CMMS or ICORS, and after the local agency employee in responsible charge of the contract includes a statement indicating their approval of the estimate (i.e., "I hereby approve this estimate for payment."), pay estimates should be emailed to the District contact. After the estimate is approved in the District, the pay estimate, along with a statement indicating the District's approval (i.e., "I hereby approve this estimate for payment."), should be emailed to DOT.PayEST@illinois.gov and the Contractor.

On State let local agency contracts, if not using CMMS or ICORS, three copies should be mailed to the District contact for approval and one copy retained in the project file. Two sets of signature approvals are required — one from the local agency employee in responsible charge of the contract, and the other from an IDOT employee overseeing the local agency's contract (i.e. the District contact).

109.07-1(c) Quantities to Submit on a Progress Pay Estimate

On progress pay estimates, the payment quantities for most pay items may be estimated. Estimates can be made for either the quantity of completed work (e.g., volume of earth excavation completed) or the percentage of work completed. The basis for all estimates should be clearly stated in the Resident's documentation. Quantities paid must be assigned to the correct fund

code and County, Construction, Safety (CCS) Code, because these must be correct by the end of the project. These codes may appear to be random but are not. They are utilized to ensure that proper funding is charged for the project from State, Federal and local sources.

The Project Procedures Guide provides information for what is acceptable evidence of material inspection. This is a critical item and the Resident must have the evidence in their files, if the evidence is a document (i.e., tickets or an inspection report).

The pay estimate will include the quantities for all pay item work completed in accordance with the contract. It is in the best interest of the State that the Contractor is paid promptly for all work properly performed. All quantities, which are submitted on a pay estimate, must be supported by acceptable documentation. See Section 109.07-1(e).

All work accepted for progress payment must be maintained in acceptable condition until final payment. For example, new drainage structures must be clean at the time of final inspection. The cost of maintaining newly installed structures is included in the cost of the drainage structures. Ordinarily, it is not necessary to withhold a percentage of the payment for the item for such contingencies. Withholding must be discussed with the Resident's Construction Field Engineer/Area Supervisor.

The Resident must use discretion when deciding how to pay for work that is partially completed. The Resident must never pay the full price for partially completed pay item quantities. The following general principles apply:

1. The value of the partially completed work. The norm is to pay the Contractor for completed units of pay item work. However, if the Contractor is bearing a large cost for partially completed work, typically for lump sum or each item, it may be in the interest of the State to pay a calculated percentage of the pay item cost. Examples of incomplete work include intermediate lifts on bituminous pavement and traffic control (for which the Department has set up a partial payment schedule).
2. Risk to the State if the work is not eventually completed by the Contractor or if the work is not completed in a timely manner. This may happen, for example, if the Contractor goes out of business before the work is completed. Control of payment for partially completed work is one of the Resident's most effective tools for encouraging the Contractor to comply with the terms of the contract.
3. Risk of damage to partially completed work. For example, the Department does not ordinarily pay for traffic signal control cabinets installed but not yet tested.

109.07-1(d) Effect of Change Authorizations on Pay Estimates

When additional work has been added to a contract, whether it is due to a routine change in contract quantities or an addition of new work to the contract, the Contractor needs to be paid for the completed work in a timely manner. To accomplish this, a change authorization adding the work should be submitted as soon as a contract addition is known. If the work will be done on a force account basis, an authorization using the estimated costs should be submitted as early as possible, with a revised authorization submitted when final costs are known. There are a number

of pay items that have been set up for specific items on change authorizations. A list of these items is included in Construction Memorandum No. 4, Contract Changes – Articles 104.02 and 109.04.

Balancing authorizations should be submitted as work under various pay items are completed, rather than waiting until the end of the project to submit a single balancing authorization for all of the pay items.

109.07-1(e) Items NOT to Submit on a Progress Pay Estimate

1. Never pay for work for which you do not have adequate evidence of material inspection. Section 106, Control of Materials, of the *Standard Specifications* discusses approval of materials incorporated into the work.
2. Never pay for work that has not been performed. For example, at the end of the fiscal year in June, payments may be temporarily delayed while the Comptroller performs their end-of-year accounting and establishes the appropriations for the upcoming fiscal year. On the last pay estimate of the fiscal year, it is illegal to pay for quantities of work that the Contractor intends to perform in the immediate future.
3. Never “swap” pay items. It is illegal to pay for work covered by one pay item by submitting it on the pay estimate as a different pay item, no matter how similar in description or price the pay items are. If a new type of work is required, then a new pay item (agreed unit price or force account) must be added to the contract by a change authorization.
4. Never bury non-pay item costs in the contract. For example, if an engineering mistake is made in laying out an item, causing the Contractor to have to perform the work twice, the extra cost should be submitted on an authorization as extra cost due to an engineering error. It is not acceptable to pay for the work twice under the pay item.
5. Never pay for work that is not complete in accordance with the contract specifications. If it is decided that non-compliant work may remain in place, a credit for non-compliant work/material may be pursued.
6. Never pay for work for which you do not have adequate documentation to support the quantity paid. For example, if the Contractor refuses to cooperate in weighing a tonnage item on an approved scale (when required by the contract), then do not pay for the unsupported quantity unless directed to do so by your Construction Field Engineer/Area Supervisor.

Paying for work in other than the approved manner may constitute a felony. Residents should be careful to follow the policies and procedures enumerated in the above related to payments.

109.07-1(f) Corrections to Pay Estimates

If errors are discovered in the project quantity documentation, the errors must be corrected as soon as possible. The quantity must also be updated as soon as possible so that the correction

can be reflected no later than the next pay estimate. This is especially important if the error being corrected resulted in a large overpayment to the Contractor.

If an error is discovered in the preparation of a pay estimate after submitting the estimate, under most circumstances, if the error is discovered immediately, the correction can be made over the telephone. In this case, the Resident should contact the District Construction Office which, in turn, will contact the Central Bureau of Construction to make the correction. Any corrections made by telephone should be documented in the project diary, and the quantity book must be updated to reflect the correction on the next pay estimate.

109.07-2 Material Allowances

Article 109.07 permits the Department, at its discretion, to pay the Contractor for costs incurred in supplying non-perishable materials under certain conditions.

The intent of this provision is to pay the Contractor for costs incurred for a particular contract for payment that would not normally be made until the materials are incorporated into the project. It is not the intent of this provision to pay material allowances for stocks of materials that can easily be acquired by the Contractor to meet project scheduling.

A material allowance is different from a payment for partially completed work. In the case of a partially completed pay item, material is consumed as work progresses and the Contractor is paid based on work accomplished. For material allowances, none of the covered material is yet incorporated into the project pay items.

The following conditions must be met to qualify for a material allowance:

1. The Contractor must submit acceptable evidence of passing material inspection(s).
2. The material must be non-perishable and is intended for use only on a specific contract.
3. The material should normally be ready to incorporate into the work. For example, structural steel must be fabricated. Form BBS 59 shall be used as documentation to substantiate the material allowance for fabricated structural steel.
4. All material for which an allowance is to be paid must be in secure storage on the project or at a location acceptable and accessible at any time by the Department. The material must be properly protected from damage. If the material becomes damaged or otherwise unacceptable, it shall be removed from the material allowance. If stored off the project site, the location must be such that the Resident can maintain reasonable control, either directly or through District staff. The State must be able to "take possession" of the material if the Contractor should default on the contract. For this reason, certain materials such as borrow cannot be considered for an allowance due to the problems the Department would encounter in taking title under this situation.
5. The Contractor must present proof of payment within 60 days after receiving payment from the Department or the material allowance will be reclaimed. Proof of payment could include:

- Copies of canceled checks (front and back)
 - Copies of checks with some form of verification from the financial institution
 - A copy of an invoice from the Supplier marked "Paid by check number _____," which also includes the date, signature and title of the supplier's representative
 - Other acceptable documentation
6. There must be a clear benefit to the Department and the Contractor for purchasing the material in advance. For example:
- There is a perceived or potential national or regional shortage of the material.
 - The time required to prepare the material is critical to meeting the contract schedule.
 - The cost of the material is expected to rise before the material is to be incorporated into the work.
7. Materials that can be readily supplied to the contract and materials that are expected to be incorporated within 60 calendar days should not be included in material allowances.
8. The inclusion of a material on a material allowance should not place an undue burden on the District with extra inspections or other monitoring requirements.
9. Because other costs are included with the material cost in the unit price of a pay item, the dollar value of the material allowance should represent only the bare material cost- and cost-plus transportation shall not exceed 70% of the cost of the corresponding pay item(s). Paying for more than 70% of the pay item cost can be considered in special situations but under no circumstances shall the value of the material allowance equal the value of the corresponding pay item work.
10. No allowance will be made for fuels, form lumber, falsework, temporary structures or other work that will not become an integral part of the finished construction.
11. As the materials are incorporated into the project and paid as a normal pay item, the value of the material allowance(s) will be reduced on the same pay estimate.
12. The following items are typically acceptable for material allowance payment:
- Fabricated structural steel
 - Complete bridge bearing assemblies
 - Precast structural units (e.g., beams, deck planks)
 - Fabricated sign trusses
 - Mast arms

- Items impacted by a regional or statewide shortage
- Groups of items common except for type or size (e.g., pipe for culverts or storm sewers)

13. All material allowances must be submitted by the prime Contractor. Direct submittals from subcontractors or material suppliers will not be allowed.

To maintain uniformity in the payment of material allowances, the Bureau of Construction is always available for consultation on special situations involving material allowances. This is strongly encouraged for such issues as perceived material shortages and for non-typical material allowances.

109.08 ACCEPTANCE AND FINAL PAYMENT

109.08-1 Final Payment

The final payment is based on those completed pay item quantities included in the original contract documents and those quantities that have been added by an approved change order. A representative of the State or local agency must be present for all measurements taken for final payments. Payments shall not be based on Contractor measurements.

Final payment is normally made to the Contractor only after the following conditions have been met:

1. All physical work has been satisfactorily completed and accepted.
2. All documentation requirements have been satisfactorily completed.
3. All materials incorporated into the work have been certified.
4. The Contractor has agreed to final quantities.
5. DBE payment agreement forms have been submitted to document compliance with DBE goals (if required).
6. All appropriate EEO forms and payrolls have been filed.

109.08-2 Contract Closeouts

Contract closeouts are an important part of the overall contract administration process. Until a project is closed and the Contractor receives the final payment, the project is not complete. The following closeout process has been developed as a guide to facilitate the timely closeout of projects. Recognizing that projects differ in complexity and size, the time frames given may need to be adjusted in certain situations.

The positions listed are suggestions of who may perform the duties. The actual individual or position completing a process will vary depending on the District, available personnel, if a local agency is involved and other factors. All projects should be closed within six months of the final

inspection. However, there will occasionally be projects with performance requirements, liens, warranties, claims or other special circumstances that may require additional time.

I. WEEKLY REPORT OF RESIDENT (Form BC 239) submittal, Final Inspection and Punch List (Article 105.13) time frames.

- A. The Resident submits Form BC 239 at 99.5% a maximum of 3 days from the date all physical work was complete.
- B. The Resident performs inspection a maximum of 2 days after the physical work complete date to determine initial punch list.
 1. No initial punch list by the Resident.
 - a. The Resident contacts the Construction Field Engineer/Area Supervisor to perform final inspection. The Construction Field Engineer/Area Supervisor conducts the final inspection, including other Bureaus and local agencies as necessary, within ten days and, if all work is completed, the Resident submits Form BC 239 at 100% within three days.
 - b. If a punch list is developed, the Resident submits Form BC 239 at 99.9% within 3 days. The Contractor is allowed 5-7 days to re-mobilize to perform punch list items before Resident begins to charge working days. When punch list items have been completed to the satisfaction of the Resident and Construction Field Engineer/Area Supervisor, the Resident submits Form BC 239 at 100% within three days.
 2. Initial punch list issued by Resident.
 - a. Resident issues initial punch list to Contractor and submits Form BC 239 at 99.9% within 3 days. The Contractor is allowed 5-7 days to re-mobilize to perform punch list items before Resident begins to charge working days. If possible, this initial punch list is given to the Contractor prior to their demobilization. When initial punch list items have been completed to the satisfaction of Resident, the Resident contacts Construction Field Engineer/Area Supervisor to conduct the final inspection. The Construction Field Engineer/Area Supervisor conducts the final inspection including other Bureaus and local agencies as necessary and, if all work is completed, the Resident submits Form BC 239 at 100% within three days.
 - b. If a subsequent punch list is issued to the Contractor, the Contractor is allowed 5-7 days to re-mobilize to perform punch list items before Resident begins to charge working days. When punch list items have been completed to the satisfaction of Resident and Construction Field Engineer/Area Supervisor, the Resident submits Form BC 239 at 100% within three days.
- C. Once the 100% weekly report is received, Support checks database for any outstanding items that need to be addressed (e.g., extension of time, liquidated damages, Operations approval, coring waiver) and notifies appropriate personnel to resolve as soon as possible.

- D. Support personnel generate the "Final Inspection Letter(s)" for signature and distribution and begins preparation of office and Equal Employment Opportunity (EEO) files and plan retention. Support personnel begin to manage and assemble all final documents for final paperwork submittal to Central Bureau of Construction. Another option is the Resident or Construction Field Engineer/Area Supervisor generates the "Final Inspection Letter(s)" for signature, distribution and cc's to Support.
- E. If the above guidelines are not met, non-compliance notifications may be sent by Support to the appropriate personnel, and the Construction Engineer is copied. The Construction Engineer will intervene if warranted. All time frames can be extended to allow for mitigating circumstances.

II. CONTRACT RECORDS AND AUTHORIZATION SUBMITTALS AND TIME FRAMES AFTER 100% COMPLETION DATE FROM FORM BC 239 IS KNOWN.

- A. The Support Office must receive the contract records (job boxes) within 30 days after the 100% completion date for documentation and material certification reviews to commence. The Resident is required to contact the Support Office with an explanation if the 30-day time frame will not be met.
- B. The Resident submits to the Construction Field Engineer/Area Supervisor a balancing authorization of all remaining outstanding contract pay items, except outstanding force account work (see II.C.), within 30 days after 100% completion date and notifies Support of any outstanding authorizations. At this point, the Resident and Contractor have tentatively agreed to "final" quantities. If there are no outstanding extra work invoices (see II.C.), this authorization will be marked by Resident as "Final."
 - 1. The Construction Field Engineer/Area Supervisor checks the authorization for errors and omissions. All District signatures are obtained per Construction Memorandum No. 4 in Appendix A. Support will again check for errors, omissions and BCM screen 64 for 4 (four) signature status. Support will then input authorization data into the District Project Implementation Support database for tracking purposes and to facilitate in the creation of the Net Cost of Section. The processing is completed, and the authorization is mailed to CBC. The target time for this process is 2 days.
 - 2. Support monitors Report to Web daily for authorization posting by CBC and notifies and processes.
 - 3. The Resident will contact Support personnel if the contract will have no authorizations.
- C. The Resident must receive all extra work invoices from the Contractor within 60 days after completion of the work (Article 109.04) for the Contractor to be paid for any extra work. This also includes items paid for by Article 109.05. The Resident will only accept corrected invoices after the 60-day parameter has lapsed. Resident submits the marked "Final" authorization to Construction Field Engineer/Area Supervisor 80 days after 100% completion date.

- D. If the above guidelines are not met, non-compliance notifications may be sent by Support to the Resident, and the Construction Engineer is copied. The Construction Engineer will intervene if warranted. All time frames can be extended to allow for mitigating circumstances.
- E. Once the acceptable contract files are submitted to the District office, the contract becomes the responsibility of the District. Implementation Support staff in direct charge of closing out the contract may create and sign the final “balancing” pay estimate that does not involve significant contract administration issues when the Resident is not available to do so. Construction Field Engineer/Area Supervisor or higher-line authorities may also create and sign the final pay estimate, or any future pay estimates that may involve significant contract administration issues as needed when re-opening the contract when the Resident is not available to do so.

III. FINAL QUANTITY SUBMITTAL AND TIME FRAMES AFTER “FINAL” AUTHORIZATION HAS BEEN POSTED BY CBC.

- A. Support personnel download the Final Quantity Approval Sheets from mainframe TSOA program. These are mailed certified to the Contractor for its signature of approval with a cover letter stating the need for the following submittals. The Final Quantity Approval Sheets must be checked against the hard copy of the Final Pay Estimate by Support and, if any payments have not been made by the Resident, they are verified and added to the Final Pay Estimate for submittal with final paperwork. As an alternative, a Final Pay Estimate from BCM may be used if the Contractor’s signature and date are still collected.

It is not necessary to wait until Support has completed its review of final quantities to send the Contractor the final quantities. If the review finds quantity adjustments need to be made, the Resident will generate an authorization to correct the quantity, and Support sends the Contractor a Final Quantity Adjustment Letter or Revised Quantity Approval Sheets.

1. The Contractor has 21 calendar days from receipt of certified mail to either agree to final quantities or respond in writing indicating the quantities that are in disagreement. Failure to do so will be considered acceptance of the final quantities.
2. Performance requirements, [Form SBE 2115: DBE Payment Agreement](#), for each DBE Subcontractor (if applicable) and a [Form BC 2115: Subcontractor Payment Agreement](#), for non-DBE Subcontractors (if applicable). Time frames for submittal to Support depend on the Contractor and Subcontractor. Another option is for Support to send this request for submittal to the Contractor with the “Final Inspection Letter” (see I.D.).
 - a. Performance Requirements – Closeout cannot occur until warranty inspections are performed as directed in the *Standard Specifications*. This can delay closeout by several months.

- b. Form SBE 2115 and Form BC 2115 – Submitted within one month after Final Quantity Approval Sheets have been agreed to and submitted; this may require intervention by the District EEO Liaison.
- B. The Form SBE 2115 is attached to the DBE/WBE Final Documentation Form ([Form SBE 2028](#)) and submitted to the Bureau of Small Business Enterprises (SBE) in the Office of Business and Workforce Diversity. SBE will respond to the District, and this entire information becomes part of the final documentation submitted to CBC.
- C. Copies of the Final Quantity Approval Sheets are retained with the other Support final documents and given to Support Documentation and Support Material Certification personnel for the review process.
- D. Support will supervise and control the status of all document submittals on a daily basis. Once final quantities are agreed to, Support orders from BCM screen 41 a hard copy of “RE Pay Estimate Report,” to prepare for submittal to CBC with other final paperwork upon District closeout date.
- E. If the above guidelines are not met, non-compliance notifications may be sent to the Contractor by Support, and the Construction Engineer is copied. The Construction Engineer will intervene if warranted. All time frames can be extended to allow for mitigating circumstances.

IV. SUPPORT DOCUMENTATION REVIEW AND TIME FRAMES

- A. A contract records check-in sheet is completed by the Resident and submitted with the contract records. The check-in sheet is a fairly comprehensive visual aid for the documentation personnel to quickly locate certain items. It also aids the Resident to ensure that all documents are present.
 - 1. When records are submitted, the documentation reviewer checks the EEO monthly and payroll weekly log-in sheets for compliance. This check may also be completed by the District EEO Liaison or the Resident. If any required submittals are not logged-in, notification letters are generated, signed and sent to the Contractor. The District EEO Liaison and non-compliant Sub(s) are cc'd on the letter. A more comprehensive review of these items will occur when the actual documentation review process begins.
- B. The documentation reviewer starts the review process within 3 weeks after contract records are submitted. The documentation reviewer must have Final Quantity Approval Sheets to check accuracy of Quantity Book pay item quantities (see III.B.).
 - 1. Target times for initial review completion is 1 day to 3 weeks depending on the number of pay items, the dollar amount of the contract and the volume of documents.
 - 2. [Form BC 111: Checklist for Engineer's Final Payment Estimate](#) is started. Items 1-6, 10, 11, 19, 24, 26-28 are completed by the documentation reviewer with the Resident supporting if necessary. Form BC 111 is retained in a file on the S drive so that it can

- be accessed and completed by other Support personnel as the conclusion of closeout nears.
- C. Documentation personnel complete the review process and Resident is notified.
 - 1. Resident has 10 days to complete all contract documentation deficiencies.
 - D. Documentation reviewer checks to ensure that all deficiencies have been corrected.
 - 1. If corrections are not complete, Resident has 2 days to complete.
 - 2. Documentation reviewer completes review within 2 days, distributes and retains findings.
 - E. If the above guidelines are not met, non-compliance notifications may be sent by Support to the Contractor or Resident, and the Construction Engineer is copied. The Construction Engineer will intervene if warranted. All time frames can be extended to allow for mitigating circumstances.

V. SUPPORT MATERIAL CERTIFICATION REVIEW AND TIME FRAMES

This process time can be significantly decreased and, therefore, contract closeout time decreased, if the Resident strictly adheres to the discussion in Section 109.07-1(e), which presents items that must never be submitted on a progress pay estimate.

- A. Material certifications should be in compliance when contract records are submitted. Resident will have submitted contract records (job boxes) within 30 days of the 100% [Form BC 239: Weekly Report of Resident](#) submittal.
- B. Materials certification reviewer starts process within 1 month after Final Quantity Approval Sheets are received (see III.B.).
- C. Material certification reviewer completes review within 2 weeks and generates a "Shortage Letter" that is sent to Resident and copied to Contractor.
- D. Resident and material certification personnel work with Contractor, Subcontractors, suppliers and producers to resolve outstanding material certification issues. Material certification personnel work with other Districts to generate out-of-District material assignments and with District materials personnel for approvals. Target time frame for resolution is 1 month.
- E. Material certification reviewer conducts a final review and completes process within 1 week.
- F. An alternative option is, when the contract is 85% complete, a preliminary list of material certification deficiencies is compiled and sent to the Resident and Contractor. This provides all entities with another opportunity to reconcile deficiencies before contract records are submitted for review. The process will then follow A. through E.

G. If the above guidelines are not met, non-compliance notifications may be sent by Support to the Contractor or Resident, and the Construction Engineer is copied. The Construction Engineer will intervene if warranted. All time frames can be extended to allow for mitigating circumstances.

VI. SUPPORT PREPARES FINAL DOCUMENTS FOR SUBMITTAL TO CBC AND CONTRACT CLOSE-OUT IS COMPLETE

Support personnel obtain all documents necessary for closeout by the time the material certification review has been completed. Once the material certification review is complete, the close-out and final documents submittal to CBC occurs within 1 day.

VII. DATABASE

Support personnel should manage and track all documents necessary through a database that was created in part considering monitoring requirements. The database should also generate various status sheets, reports, letters, etc., that aid in the administration and monitoring of all phases of the closeout processes for all District contracts.

VIII. CONTRACTOR

The Contractor is also responsible for ensuring that projects are closed in a timely manner as described above. This includes the timely submission of all required documentation. The Resident should never pay for work for which there is not adequate documentation to support the quantity paid. Partial payment is discussed in Section 109.07. Failure to timely submit the required documentation, including that necessary to close a project, may result in a finding of non-responsibility on the part of the Contractor, resulting in the revocation of its prequalification.

109.09 CONTRACT CLAIMS

109.09-1 Claims Avoidance

109.09-1(a) General

The best mechanism for avoiding claims is to take an open and professional approach to claims avoidance by equitable adjustments for changes. Emphasizing field staff responsibilities for identifying and reporting potential change issues provides the “early warning” needed to avoid potential conflicts and disputes over change issues as they arise.

To avoid construction Contractor claims effectively, the following guidelines are recommended:

- Emphasize documentation and document controls to all project staff.
- Detailed Project Diaries; include phone conversations (written follow up) and any discussions.

- Good organization of all project records and claims documentation helps to retrieve these documents if necessary, at a later date, sometimes years later.
- Follow the conditions of the contract. By not following the conditions of the contract, the Contractor may later argue that the Department set a precedent contrary to the contract by neglecting to administer and enforce the requirements.
- Issue non-conformance notifications as required. If the Contractor is not following the contract, let them know clearly what the issue is and the required action and do this timely and in writing.
- Hold progress meetings with the Contractor frequently (at least weekly) to discuss issues, schedules, etc. Issue the meeting minutes as part of the project record.
- Do not allow issues to be ignored and become possibly inflammatory issues at the end of the project. Bring closure to all issues as soon as possible and try not to defer issues for resolution later.
- Track labor, equipment and materials for disputed items of work.

109.09-1(b) Resident's Responsibilities

Management at the project site can play an important role in minimizing problems and avoiding disputes. Following are some tools for accomplishing this:

- Ensure that the good practice guidelines as listed in the "Construction Inspector's Checklist for Contract Administration" and Section A of the IDOT Documentation of Contract Quantities are met.
- Review and discuss the project schedule with the Contractor.
- Recognize unreasonable or inaccurate schedules and define this to the Contractor, in writing, and require an updated schedule.

A photo/video history is a good means of recording progress, equipment in use and conditions.

109.09-2 Claims Review

This Section provides the Residents, Construction Field Engineers/Area Supervisors and District Construction Engineers with a uniform set of guidelines that may be used as a reference in addressing claims made by Contractors on construction projects. Knowledge of the examples included, plus familiarity with the contract documents, will assist engineers when analyzing contract claims. Proper analysis of contract claims will preclude recommendations of settlements that exceed Department policies or may establish potentially costly precedents.

The Department's philosophy in addressing construction contract claims is predicated on the concept of equitable treatment for the Contractor and the Department as owner. Several

questions should be addressed before making recommendations or decisions on claim settlements:

1. Has the Contractor been damaged?

If the Contractor has not suffered a documented financial loss or delay resulting from circumstances or events related to the contract, compensation is generally not granted.

2. Is the amount of the damage claim fair?

The Contractor may not be awarded settlements that exceed documented actual expenses. Assumed loss of profits or pro rata overhead costs are generally not recognized. Once entitlement is recognized, real costs that are not precluded by contract terms may be considered.

3. Is the payment excluded under the contract terms?

The requirements set forth in the contract documents may exclude entitlement for excusable delays and/or compensable damages resulting from compliance with the provisions of the contract. Claims are generally not considered where excluded by “no damage” terms in the contract.

4. Has the Contractor been asked to assume an unfair risk?

Occasionally, “no damage” or exculpatory terms may be considered when the adverse or damaging conditions exceed those contemplated by the contract. It is prudent to consider what was contemplated by the contract when analyzing this type of claim.

5. Would settlement establish an undesirable precedent?

Claims practices and procedures are based to a large extent on precedents established by past settlements. In analyzing claims, the impact a settlement may have in setting a precedent for future claims must be recognized in reaching a recommendation. The risk of establishing a damaging precedent is greatly increased when commitments are made prior to claims settlement.

109.09-3 Types of Costs

The following are examples of costs that are typically claimed by Contractors together with the Department’s position on whether such costs are compensable and, if so, to what extent. Entitlement must be established before any costs are considered compensable:

1. Idled Equipment. Equipment required for a work operation that is idled and cannot be used on other work due to a compensable delay caused by the Department.

This is an identifiable cost and the hours claimed for reimbursement for the idled equipment must be documented by the Resident for future reference. Payment for idled equipment will be made in accordance with Article 109.04(b)(4). The Contractor has an obligation to minimize idled equipment expenses to the extent practical. Payment for

removing the equipment from the project should be considered if it is more economical than keeping it idled on the jobsite.

2. Idled Personnel. The labor force required for a work operation that is idled and cannot be used on other work due to a compensable delay caused by the Department.

This is a compensable cost which should be paid for in accordance with Articles 109.04(b)(1) and (2), without additives, for the time between the start of delay and the minimum remaining hours in the work shift required by the prevailing practice in the area.

Salaried employees of the Contractor who are idled may be paid for the duration of the delay depending on the nature of their occupation. For example, an idled paving superintendent and plant operator would be eligible for compensation.

General superintendents, mechanics, and bookkeepers would not be paid unless all progress on the contract is delayed. Payment will be considered only for those hours solely attributable to the contract for which complete documentation is provided.

3. Increased Wage Rates and Material Costs. Added costs that a Contractor incurs when a compensable delay causes work, which otherwise would have been completed, to be performed after labor and material costs have increased.

Such costs are compensable only to the extent that the delay actually impacted the work operation. For example, a Contractor's paving operation is delayed for two weeks due to an act of the Department. During the two-week period, only seven working days are available because of rain. One week after resuming work, the Contractor is required to pay increased wage rates due to a new collective bargaining agreement. The Contractor is entitled to compensation for the difference in wage rates for those workers included in the paving operation for a period of seven days only — not the entire remaining paving operation.

4. Jobsite Overhead. Includes the cost of items such as salaried personnel, rental of office space, lease of plant and storage sites, telephones and utilities.

If a compensable delay affects a controlling item or the entire project such that the Contractor is required to remain at the project site for a longer duration, jobsite overhead may be considered to be compensable.

Each item of the jobsite overhead must be reviewed independently rather than accepting a daily or percentage rate. The cost of utilities will generally be directly related to the duration of use. However, rental or lease arrangements may be on a monthly, semi-annual or annual basis and not be affected by the delay. Salaried personnel who were compensated as "idled personnel" should not be included in jobsite overhead.

5. Loss of Efficiency. A reduction in labor or equipment productivity due to an act or omission of the Department. Such reductions in productivity must be documented to be compensable.

When a Contractor is delayed and is required to deviate from the progress schedule, the Contractor may claim that the work efficiency “built into” the schedule is lost, resulting in added costs. Similarly, when the Department decides to pay the premium portion of overtime rather than granting an extension of time, it may be claimed that work productivity declines due to the sustained work hours also resulting in added costs. Such added costs may be determined in accordance with the Department’s policy on acceleration. See Section 108.03.

6. Loss of Use of Money or Interest. A cost that reflects the time value of money.

If a Contractor incurs “out of pocket” costs, it may claim that he was unable to invest funds equal to those costs in the marketplace or conversely was required to pay interest on money borrowed to meet those costs for the period from when the costs were incurred until the claim is settled.

Whether such claims have merit is a moot point. The Court of Claims has never awarded interest because there is no basis in the Mechanic’s Lien Act for levying interest against the State. Such claims are therefore non-compensable.

7. Loss of Anticipated Profit. Profit is the excess of returns over expenditures on a business venture.

The amount of profit that a Contractor realizes on a project is dependent upon the profit factor included in the bid to remain competitive, actual productivity compared to planned productivity, weather, strikes, increased material costs, etc.

If a Contractor is required to perform added work beyond the original scope of the contract, such work is paid for on the basis of contract bid prices, agreed prices or force account, each of which provides for a profit factor.

If a Contractor incurs out of pocket costs in performing the original scope of work and is compensated for those costs, then the margin of profit on the original scope of work has not been diminished.

No allowance will be made for any loss of anticipated profit.

8. Preparation of Claims. A cost incurred by a Contractor in preparing and submitting a claim for additional compensation or time.

If a Contractor desires to pursue additional compensation or time, it should bear the cost of establishing entitlement and documenting associated costs. The Department also incurs costs as part of the claims settlement process in the form of review time, meetings, preparation of correspondence and, in some instances, attorney and consultant fees.

Costs for preparing claims are not considered compensable.

109.09-4 Processing

Claims for additional compensation that are supported by the Region Engineer must be submitted to the Central Bureau of Construction together with the District's supportive recommendation as to entitlement. The recommendation of the local agency should also be submitted for claims on FAS and FAUS contracts awarded by the Department.

If the District and Central Bureau of Construction agree that entitlement has been established, the District will review the Contractor's records in accordance with the above guidelines and refer to Article 109.09 to verify the amount of entitlement due the Contractor.

The District will then submit a supportive recommendation as to the amount of the proposed settlement to the Central Bureau of Construction.

Requests for extensions of time will be reviewed in accordance with Article 108.08 of the *Standard Specifications* and Section 108.08 of the *Construction Manual*.

DIVISION 200

Earthwork, Landscaping, and Erosion Control

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
DIVISION 201 EARTHWORK, LANDSCAPING, AND EROSION CONTROL	201-1
SECTION 201. CLEARING, TREE REMOVAL AND PROTECTION, CARE AND REPAIR OF EXISTING PLANT MATERIAL	201-1
201.01 DESCRIPTION	201-1
201.04 TREE REMOVAL	201-2
201.05 PROTECTION OF EXISTING PLANT MATERIAL.....	201-3
201.09 DISPOSAL OF MATERIALS	201-3
SECTION 202. EARTH AND ROCK EXCAVATION	201-3
202.01 DESCRIPTION	201-3
202.03 REMOVAL AND DISPOSAL OF SURPLUS, UNSTABLE, UNSUITABLE AND ORGANIC WASTE	201-3
202.03-1 Definitions	201-3
202.03-2 Unstable or Unsuitable Material.....	201-4
202.03-3 Contaminated Soil	201-5
202.03-4 Open Burning.....	201-5
202.03-5 Excess Materials.....	201-5
202.04 CLASSIFICATION.....	201-5
202.05 DRAINAGE.....	201-6
202.07 METHOD OF MEASUREMENT	201-6
SECTION 203. CHANNEL EXCAVATION	201-6
203.03 CLEARING, TREE REMOVAL, AND PROTECTION OF EXISTING PLANT MATERIAL.....	201-7
203.05 METHOD OF MEASUREMENT	201-7
204.01 DESCRIPTION.....	201-7
204.02 BORROW PITS.....	201-8
204.06 SETTLEMENT PLATFORMS.....	201-8
SECTION 205. EMBANKMENT	201-9

205.04	PLACING MATERIAL.....	201-9
205.06	COMPACTION.....	201-10
205.06-1	Disking.....	201-10
205.06-2	Moisture Content.....	201-10
205.06-3	Density Requirements.....	201-11
205.06-4	Compaction Around Culverts, Bridges and Retaining Walls.....	201-11
205.06-5	Equations.....	201-11
SECTION 208.	TRENCH BACKFILL.....	201-20
208.03	METHOD OF MEASUREMENT.....	201-20
211.03	FURNISHING AND EXCAVATING TOPSOIL.....	201-20
211.04	PLACING TOPSOIL AND COMPOST.....	201-21
SECTION 212.	FINAL SHAPING, TRIMMING, AND FINISHING.....	201-22
212.01	DESCRIPTION.....	201-22
212.02	GRADING SECTIONS.....	201-22
SECTION 250.	SEEDING.....	201-23
250.03	EQUIPMENT.....	201-23
250.05	SEED BED PREPARATION.....	201-24
SECTION 251.	MULCH.....	201-25
251.01	DESCRIPTION.....	201-25
SECTION 280.	TEMPORARY EROSION AND SEDIMENT CONTROL.....	201-26
280.01	DESCRIPTION.....	201-27
280.01-1	Background.....	201-27
280.01-2	Policy.....	201-28
280.01-3	Procedures for ILR10 Permit.....	201-28
280.01-4	Procedures for ILR40 (MS4 - Municipal Separate Stormwater Sewer System) Permit.....	201-32
280.04	TEMPORARY EROSION CONTROL SYSTEMS.....	201-34
SECTION 282.	FILTER FABRIC.....	201-35
SECTION 284.	GABIONS AND SLOPE MATTRESS.....	201-36

LIST OF FIGURES

Figure	Page
Figure 200-1 — TREE WELL.....	201-2
Figure 200-2 — CHANNEL EXCAVATION.....	201-7
Figure 200-3 — SETTLEMENT PLATFORM.....	201-9
Figure 200-4 — EXAMPLE MOISTURE DENSITY CURVE FOR SOIL	201-12
Figure 200-5 — EMBANKMENT DENSITY REQUIREMENTS	201-13
Figure 200-7 — MOTOR GRADER	201-22
Figure 200-8 — FOUR WHEEL DRIVE TRACTOR WITH TWO SCRAPERS	201-22
Figure 200-9 — SEEDING EQUIPMENT (Cultipacker).....	201-23
Figure 200-10 — SEEDING EQUIPMENT (Mechanical Broadcast Seeder)	201-23
Figure 200-11 — SEEDING EQUIPMENT (Slit Seeder).....	201-23
Figure 200-12 — DITCH PREPARED FOR SEEDING	201-24
Figure 200-13 — MULCHING OPERATIONS (Mechanical Stabilizer Discs).....	201-25
Figure 200-14 — BLOWING STRAW MULCH	201-25
Figure 200-15 — RANGE LAND GRASS DRILL.....	201-26
Figure 200-16 — EROSION CONTROL FORMS.....	201-28
Figure 200-16 — EROSION CONTROL FORMS Continued	201-29
Figure 200-17 — GEOTECHNICAL DITCH CHECKS.....	201-34
Figure 200-18 —AGGREGATE DITCH CHECK.....	201-35
Figure 200-19 — FILTER FABRIC INSTALLATION	201-35
Figure 200-20 — MATTRESS INSTALLATIONS	201-36

Division 201

EARTHWORK, LANDSCAPING, AND EROSION CONTROL

Prior to the beginning of earth disturbing operations, it is important to familiarize yourself with the earthwork schedule shown in the plans, storm water pollution prevention plan, erosion and sediment control plan, and regulated soil contract special provisions as applicable. It is important to become familiar with any permits (e.g., 404 permit) applicable to the earth disturbing activities. It is important to check the commitment file and determine if there are any special right-of-way agreements that will restrict the Contractor's operation. Such agreements may include saving or removing certain trees, hedges or plantings, the moving or disposition of particular buildings, fences, walls, other structures or objects, or protection of features within the right-of-way. It is important to ensure actual existing grade/cross-sectional data necessary for determining final excavation pay quantities has been captured. It is also important to ensure all contractor borrow, use, and waste sites have been approved by the Department prior to their use.

A Storm Water Pollution Prevention Plan (SWPPP), [Form BDE 2342](#), may need to be developed or adjusted to accommodate the Contractor's operations (e.g. at Contractor furnished borrow, use and waste sites) and [Form WPC 623](#), Notice of Intent, may need to be submitted to the Illinois Environmental Protection Agency (IEPA) to comply with Illinois laws. At the preconstruction conference, a jobsite inspection should be scheduled with the Contractor. An erosion control plan indicating the erosion control measures to be implemented should be included in the plans. If not, one must be developed from a jobsite inspection with the Contractor.

Any plans to preserve natural points of interest that may be incorporated into the project for the convenience and comfort of the public can be reviewed at this time. Some erosion control measures, especially perimeter barriers and those protecting sensitive areas or special items, must be installed before construction activities disturb existing ground conditions. Other measures will be installed as the work progresses.

The "[Construction Inspector's Checklist for Earth Excavation and Embankment](#)" addresses many of the items in Division 200.

SECTION 201. CLEARING, TREE REMOVAL AND PROTECTION, CARE AND REPAIR OF EXISTING PLANT MATERIAL

201.01 DESCRIPTION

Normally, clearing is the first phase of construction involving new construction and/or reconstruction type projects. Observe the Contractor's operations to ensure the following:

- During the clearing operations, limit the activity of the Contractor to an area within the construction limits as much as possible. The intent is to preserve as much vegetation outside these limits as possible.

- Do not allow the removal of any vegetation unless required for construction. This is part of the environmental commitment to avoid and minimize construction impacts.
- In general, ensure that the clearing operation is consistent with the National Pollutant Discharge Elimination System (NPDES) requirements with respect to:
 - + Minimizing the amount of soil exposed during construction
 - + Minimizing disturbance to steep slopes
 - + Preserving topsoil if feasible

Other Articles within the *Standard Specifications* may have a significant impact on the clearing operation, including:

- 280 of the *Standard Specifications* and of this *Manual* for erosion/sediment control and stream protection.
- Section 107 of the *Standard Specifications* and of this *Manual* for protection or discovery of archeological findings and hazardous materials.

201.04 TREE REMOVAL

Study the limits of the cut and fill slopes on the cross sections to determine which trees may be saved. Review the design files for right-of-way agreements that may require certain trees to be saved (see Figure 200-1 for an example tree well used to save trees). Identify each tree to be saved by a method acceptable to the Department and the Contractor. The District Landscape Architect should be contacted for advice on tree related questions.

Figure 200-1 — TREE WELL



201.05 PROTECTION OF EXISTING PLANT MATERIAL

Department policy is to preserve as many existing plantings as possible. If any plantings designated to be saved are damaged by the Contractor, the plants shall be repaired or replaced at the Contractor's expense. Review the commitments to determine plant material (e.g. trees) to be saved and discuss these requirements at the preconstruction conference. Fencing or other appropriate protective barriers shall be placed around trees or other sensitive areas, as noted in the plans, prior to beginning construction activities.

It may be possible to accommodate haul roads and staging areas through additional clearing or to replace the trees and shrubs at the Contractor's expense. However, do not permit Contractors to remove trees and shrubs outside of designated clearing areas for haul roads or staging areas without the review and approval of the District Landscape Architect. Also, contact the District Landscape Architect for questions regarding plant removal involving utility relocations.

201.09 DISPOSAL OF MATERIALS

Refer to Article 202.03 of the *Standard Specifications* before disposing of waste materials. Article 107.22 requires the Contractor to designate all borrow, use, and/or waste sites for approval by the Engineer prior to their use. See IDOT *BDE Manual* Figure 27-2A for a list of required site documentation and reviews.

SECTION 202. EARTH AND ROCK EXCAVATION**202.01 DESCRIPTION**

Rock encountered in cut sections will require special attention. When rock is encountered at unexpected elevations, consider modifying the typical cross section and profile grades to minimize the excavation. Consult with your supervisor prior to adjusting the cross section when rock is encountered, or variances are discovered in the plan elevations. When modifying typical cross sections, safety, drainage, maintenance, and construction costs must be considered. Rock must be excavated to a minimum depth of 3 inches (75 mm) below the elevation of the proposed subgrade within the limits of the roadbed.

202.03 REMOVAL AND DISPOSAL OF SURPLUS, UNSTABLE, UNSUITABLE AND ORGANIC WASTE**202.03-1 DEFINITIONS**

1. Unsuitable Material. Any material that does not meet the specifications for embankments (e.g., large rocks, broken concrete, asphalt, mineral deposits, muck) and cannot be worked or manipulated to become re-usable (i.e. cannot be rendered suitable or suitable for restricted use) must be disposed of.
2. Unstable Material. Material that can be worked or manipulated to become re-usable (i.e. material be rendered suitable or suitable for restricted use).

3. **Re-Usable Material.** Any material that is suitable for use (or suitable for use in restricted locations). This includes soils that are initially unstable but are able to be rendered suitable or suitable for restricted use (e.g. through disking and drying). This material may be re-used on the project (or another project subject to necessary use and waste approvals). For example, aggregates from detour roads to be removed can be salvaged and incorporated into the new roadway if the material can meet the Specification requirements. Other examples include rock that has been blasted, excavated soil, asphalt millings, etc.

202.03-2 UNSTABLE OR UNSUITABLE MATERIAL

202.03-2(a) General

Commonly, the limits of unsuitable material encountered during excavation cannot be precisely determined prior to construction. The depth to which excavation should extend when removing unsuitable materials must be determined on the job. Notify the District geotechnical engineer to provide guidance when determining the depth this material should be excavated and the type of backfill to be used.

Some soils encountered are unstable and, therefore, unsuitable when in their in-situ state because of excessive moisture, but many of these soils will respond to drainage or mechanical manipulation to reduce moisture, thus improving the soil and rendering it usable.

See the IDOT [Subgrade Stability Manual](#) for more details.

202.03-2(b) Geotechnical Solutions

Over-excavation can lead to additional problems with unstable soils that require a bridging (or “thickening”) solution to stabilize the subgrade area. Geotechnical solutions other than over-excavation should be considered. The first step should be an attempt to render the soils stable/suitable (e.g. through disking and drying). Consult with the District geotechnical engineer to discuss alternatives when unstable soils are encountered.

202.03-2(c) Disposal

Article 107.22 requires that the Contractor designate all waste sites for approval by the Engineer prior to their use. See BDE Manual Figure 27-2A for a list of required site documentation and reviews. This approval is important because the Department may be liable, even after removal from Department property, for violations of environmental statutes, archaeological and zoning requirements, etc.

When a Contractor proposes to dispose of surplus excavated material from one department awarded contract to a different department awarded contract, it may be feasible to document and evaluate the contractor’s request as a “previously approved” waste site in accordance with the BDE Manual Section 27-2.03(c)2. This feasibility is dependent upon the District Environmental Coordinator verifying that the receiving contract has been previously cleared and that the clearance is valid. The feasibility is also dependent upon approval from each contract’s resident.

If approval is granted to dispose of surplus excavated material from one department awarded contract to a different department awarded contract, it is important to verify that any such materials disposed of go to that contract's construction limits as approved.

202.03-3 CONTAMINATED SOIL

If an unexpected regulated substance is encountered (e.g., petroleum-based products, paint material, pesticides, asbestos, herbicides, acids), cease excavation at the affected location immediately (and notify your supervisor and District Environmental Coordinator). The Contractor shall follow the guidelines as set forth by the IEPA for the regulated substance removal and/or disposal. See Article 107.19 and Section 669 of the *Standard Specifications* for removal and disposal of regulated substances.

202.03-4 OPEN BURNING

Ensure that the Department has an active Open Burning Permit from the IEPA . (The Central Bureau of Construction is responsible for obtaining this permit annually and providing a copy of it to the Districts). If the Contractor proposes to deviate from the conditions of the permit, the Contractor shall secure a specific permit for any open burning on the contract.

202.03-5 EXCESS MATERIALS

Excess material may be placed along the side of an embankment to flatten slopes with the Resident's approval. However, any increase in the roadway "footprint" may affect the NPDES permit and may require a modification.

Care must be taken to minimize embankment erosion when excess material is used to flatten the embankment slopes; never make the slope steeper. Where possible, flattening should be made along the original embankment so that proper compaction is obtained. Loose material should not be dumped on the slopes of embankments.

202.04 CLASSIFICATION

Note that the "classification" for rock excavation, earth excavation and channel excavation is not for "soil" classification but, rather, for determining the correct pay item. Section 2.2.4 of the IDOT [*Geotechnical Manual*](#) discusses soil classification. The following will assist in determining the appropriate pay item classification for excavated material:

- Earth is regarded as a natural aggregate of mineral grains, with or without organic constituents that can be separated by gentle mechanical means such as agitation in water. If the Contractor can dig through the material with normal equipment, it is earth excavation.
- Rock is considered to be a natural aggregate of mineral grains connected by strong and permanent cohesive forces (e.g., bedrock, sandstone). Rock is defined as bedded deposits and conglomerate deposits exhibiting the physical characteristics and difficulty of rock removal as determined by the Engineer. When encountered, rock cannot be drilled with earth augers and/or underreaming tools configured to be effective in the soils

indicated in the contract documents, and requires the use of special rock augers, core barrels, air tools, blasting or other methods of excavation.

- Channel excavation applies to construction of new stream channels and in widening, deepening, or straightening existing stream channels (excluding roadside ditches).

202.05 DRAINAGE

See Section 280 for erosion and sediment control information. The location and condition of existing drainage lines (e.g. field tiles) should be documented on as-built plans as this information may be valuable for future reference. Drainage outlet elevations must be considered when establishing the flow line of culverts and ditches. Typically, it is necessary to replace all field tile lines that extend across the roadway and are within the limits of construction. An exception is if the existing tile is clearly not functioning nor needed. Inspection wells can be dug over the tiles near the right-of-way line, to investigate if the tile is functioning. If a field tile will be replaced, use a pipe conforming to the requirements for storm sewers. The tile lines will need to be located and the Resident notified before authorizing any replacement work. See Section 611 of the *Standard Specifications* and this *Manual* for more discussion on field tiles.

202.07 METHOD OF MEASUREMENT

1. Surplus or Deficiency of Excavation. The project shall be constructed to the lines and grades shown on the plans. However, if either too much or an insufficient material is encountered on the contract, check the cross section as shown by the plans with the cross sections of the pavement before selecting a corrective action plan.
2. Excavation Beyond Plan Limits. The *Standard Specifications* require that any material excavated beyond the limits of the required slopes, or excavated material used for purposes other than those designated, shall not be measured for payment. Do not allow the Contractor to make cuts wider and ditches deeper than called for on the plans unless the additional material is required and is approved by the Resident.
3. Pre-Grade Sections. Verify the plan cross sections prior to grading operations. Cross sections will be taken at all even stations, at points where there is a transition from cut to fill or vice versa, and where there is an abrupt change in the original ground line. When grading is completed, survey cross sections again at the same stations to complete the data for computation of quantities. During finishing operations, the Resident must require strict conformance with the 2-in. (50-mm) tolerance contained in Article 212.02.

Previously graded sections must be re-cross sectioned before they are paved.

SECTION 203. CHANNEL EXCAVATION

Channel Excavation is excavation used to improve the alignment or carrying capacity of a stream channel and is excavated as may be required to allow placing riprap. Channel excavation is usually done utilizing bulldozers, excavators and draglines. Channel Excavation does not include the excavation of the roadway ditches. See Figure 200-2.

Figure 200-2 — CHANNEL EXCAVATION**203.03 CLEARING, TREE REMOVAL, AND PROTECTION OF EXISTING PLANT MATERIAL**

Prior to starting any excavation involving waters of the United States, check the Section 404 Permits to determine the extent of work permissible under the conditions of the permit. See Section 107.23-2 of this *Manual* for additional information on Section 404 Permits.

203.05 METHOD OF MEASUREMENT

Measured quantities require cross sections before starting work and upon completion of the work. If the channel excavation is of sufficient length, segments of the work should be cross sectioned upon completion. This will avoid discrepancies in the quantity of cubic yards (cubic meters) removed due to changes that might occur during heavy rains or high water.

SECTION 204. BORROW AND FURNISHED EXCAVATION**204.01 DESCRIPTION**

Borrow Excavation is obtained from outside the right-of-way limits, and the volume is measured at the point of excavation. Furnished Excavation is obtained from approved locations (on or off the right-of-way), and the volume is measured or calculated at the point of placement. Both Borrow and Furnished Excavation sources require Department approval. This approval includes verifying the source material is suitable and the source is clear of biological and cultural resource impacts.

204.02 BORROW PITS

Article 107.22 requires that the Contractor designate all borrow sites for approval by the Engineer prior to their use. (In this context, a borrow site includes any source of items paid as borrow excavation or furnished excavation, as well as any source of excavated materials not paid for separately but included in the costs of other items of work.) See IDOT BDE Manual Figure 27-2A for a list of required site documentation and reviews.

The Contractor shall not disturb the borrow pit area, other than the minimum necessary to obtain samples, until clearance has been received.

When a Contractor proposes to supply excavated material for one department awarded contract from a different department awarded contract, it may be feasible to document and evaluate the contractor's request as a "previously approved" borrow site in accordance with the BDE Manual Section 27-2.03(c)2. This feasibility is dependent upon the District Environmental Coordinator verifying that the source contract has been previously cleared and that the clearance is valid.

If approval is granted to supply excavated material for one department awarded contract from a different department awarded contract, it is important to verify that any such materials supplied come from within that contract's construction limits as approved.

204.06 SETTLEMENT PLATFORMS

Settlement platforms provide a simple method of determining the amount of settlement caused by placing embankment. Settlement will occur almost every time a load is placed on underlying soil, whether it is the natural ground surface or a thoroughly compacted embankment. If the soil settles more than anticipated, though, it can cause instability in a foundation, cracking of a pavement surface or damage to a bridge or other structure.

A settlement platform consists of a 1/8-inch-thick, four foot square steel plate, 3/4 inch diameter four foot long steel riser pipes and 2 1/2" diameter steel casing pipes (see Figure 200-3). The plate is placed at the natural ground surface (prior to placing embankment), the elevation of the plate is recorded, the first four foot long riser pipe is attached to the plate, and the first four foot long casing pipe is placed over the riser pipe. Additional four-foot-long riser pipes and casing pipes are installed, as necessary, as embankment construction progresses. Underlying soil settlement is determined by recording the top tip of the final riser pipe elevation and then subtracting the length of added riser pipes from the final riser pipe tip elevation to determine the plate elevation after settlement. The initial plate elevation minus the plate elevation after settlement is the amount of settlement that has occurred at that point in time.

The Contractor is responsible for furnishing, installing, and maintaining the settlement platforms.

Figure 200-3 — SETTLEMENT PLATFORM

When settlement platforms are required on the project, observe the following:

- Ensure that the settlement platforms are level before any embankment material is placed on the platforms. Settlement platforms that are not level can result in inaccurate settlement readings.
- Ensure that the pipes are vertical at all times.
- Ensure that the Contractor extends the pipes as required. The tip of the grade pipe shall at no time extend more than 4 1/2 ft (1.4 m) above the embankment grade or less than 6 in. (150 mm) below the embankment grade.
- Note any damage that occurs to the settlement platforms and ensure that the Contractor repairs or replaces all damaged platforms.

SECTION 205. EMBANKMENT

205.04 PLACING MATERIAL

If the embankment freezes during delays in the Contractor's operation, remove all frozen material from the embankment prior to resumption of the earth placing operation. The frozen material may be bladed over the slopes or placed in areas designated by the Resident until the material can be

reincorporated into the work after it has thawed. Any stockpiling should be protected in accordance with Section 280.

For large rocks, boulders and broken concrete, the fill must be deep enough to accommodate this material and the material must be distributed as widely as possible. The material shall be placed in specified lifts and distributed to permit the compaction of earth around and between the various pieces, filling all voids.

Designers utilize a shrinkage factor when computing the quantity of furnished (or borrow) excavation anticipated to be necessary to build an embankment. A shrinkage factor (expressed as a percentage) accounts for volume differentials resulting from the effects of compaction. This percentage can vary greatly, depending on the character of the soil and the height of the embankment. District Offices have tabulations of shrinkage factors that address the soil conditions commonly encountered in the District. The shrinkage factor for Furnished Excavation will be taken as 25% unless otherwise shown on the contract plans.

Erosion and sediment control measures must keep pace with the construction of the embankment. Areas should be final graded and seeded at the earliest possible date, and all necessary maintenance regularly performed on the perimeter and other control measures as outlined in Section 280.

205.06 COMPACTION

205.06-1 DISKING

Note that the use of a disk is required on all material with the exception of sand or gravel. The function of the disk is primarily to mix the material, assist in the distribution of moisture and pulverize the soil. Disking must penetrate through the entire depth of the currently placed embankment lift to be effective.

205.06-2 MOISTURE CONTENT

Moisture plays an important role in successful compaction. When the proper amount of moisture is uniformly distributed through the embankment layer, little difficulty will be encountered in obtaining proper compaction, provided that the thickness of the layer does not exceed the capabilities of the disk and compaction equipment. Without the proper moisture content, the density required by the *Standard Specifications* may not be secured even though the embankment is subjected to additional compaction. When the moisture content of the material exceeds its optimum moisture content, to the extent that the required density cannot be obtained, allow the material to dry out before additional material is placed. Alternatively, the wet material may be incorporated with drier material provided that satisfactory results are obtained.

Several light applications of water are more desirable than one heavy application. The frequent light application will allow better moisture percolation through the soils and provide less opportunity for the soil to become rutted and muddy. Care must be taken when adding water to a layer of soil to avoid overlapping or to allow gaps between successive passes of the water wagon. The water wagon/truck driver should work progressively from one side of the fill across to the other side to avoid wet or dry streaks in the embankment.

See Figure 200-4 for an example of a moisture density curve for soil.

205.06-3 DENSITY REQUIREMENTS

All density tests shall meet at least the minimum requirements of Article 205.06. If tests do not meet the minimum requirements, additional compaction efforts shall be applied to bring the density up to the minimum *Standard Specification* requirements. No additional earth placement shall be permitted until the questionable areas are re-tested and approved by the Department. See Figure 200-5.

Sometimes, the first two or three layers placed over acceptable but soft material cannot be compacted to as high a density as the succeeding layers. The firmness of the underlying layer will affect the compaction of any succeeding layer, so this must be recognized, and proper adjustments made so that densities obtained in material above soft areas will be acceptable.

205.06-4 COMPACTION AROUND CULVERTS, BRIDGES AND RETAINING WALLS

The method of placing embankment material around or behind structures may result in excessive pressure or settlement. To protect against displacement or undue settlement, material placed adjacent to structures must be properly compacted at a moisture content not in excess of 110% of optimum. Inspect the placement and compaction of material in places inaccessible to the roller method of compaction. The Contractor shall place sufficient, properly compacted embankment over pipe culverts before crossing with earth moving equipment to prevent damage. See section 542.04-8 in this manual for additional information.

205.06-5 EQUATIONS

$$\text{Shrinkage Factor (SF)} = \frac{\text{bank volume} - \text{compacted volume}}{\text{bank volume}} = 1 - \frac{\text{compacted volume}}{\text{bank volume}}$$

Where:

Bank volume = pre-excavation volume of applicable in-situ soil

Compacted volume = volume of applicable excavated in-situ soil after placement and compaction

Unless otherwise stated in the contract, use SF = 0.25 when calculating furnished excavation quantity.

Figure 200-4 — EXAMPLE MOISTURE DENSITY CURVE FOR SOIL

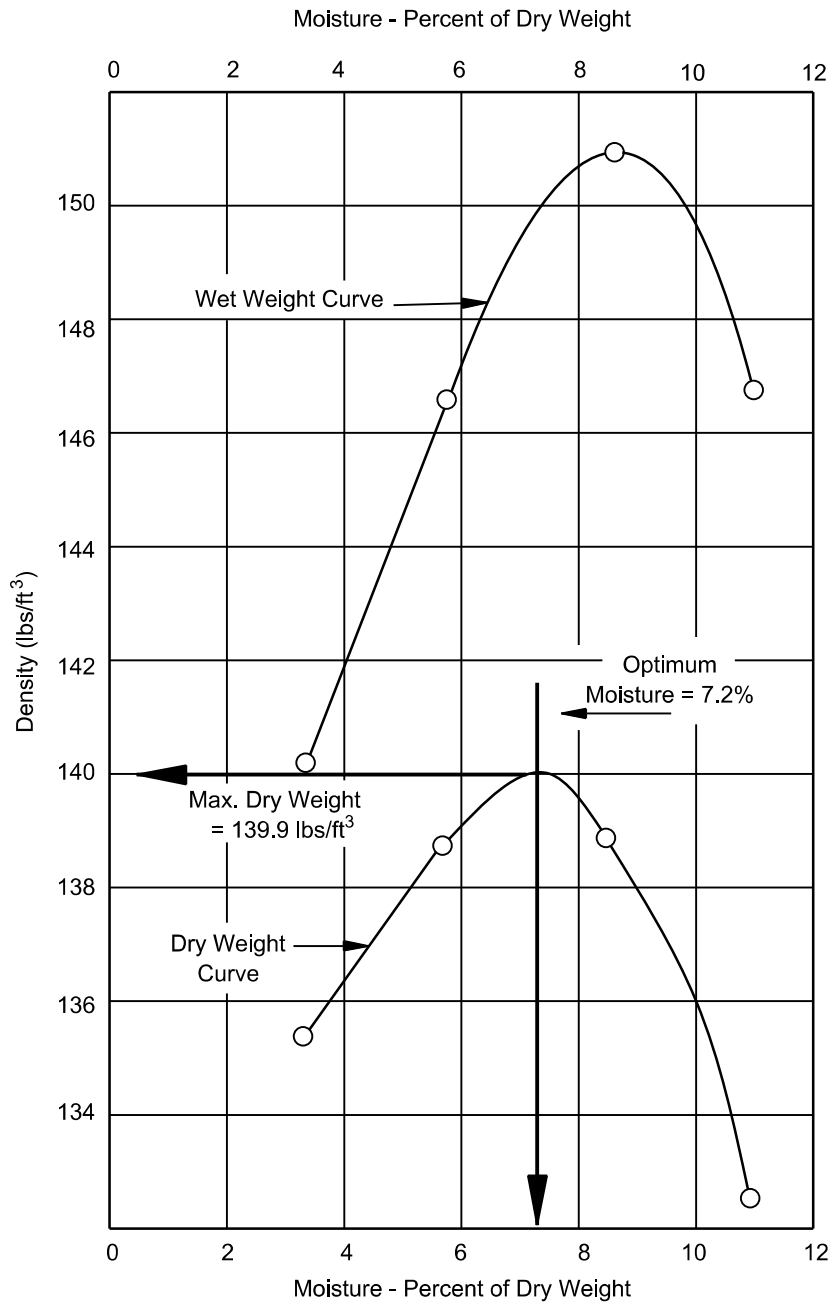
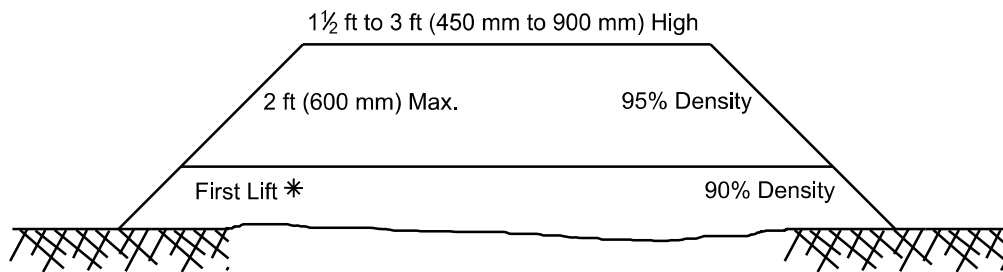
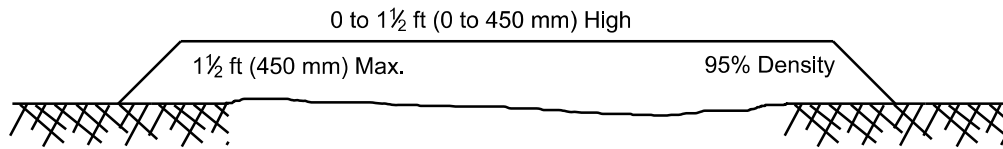
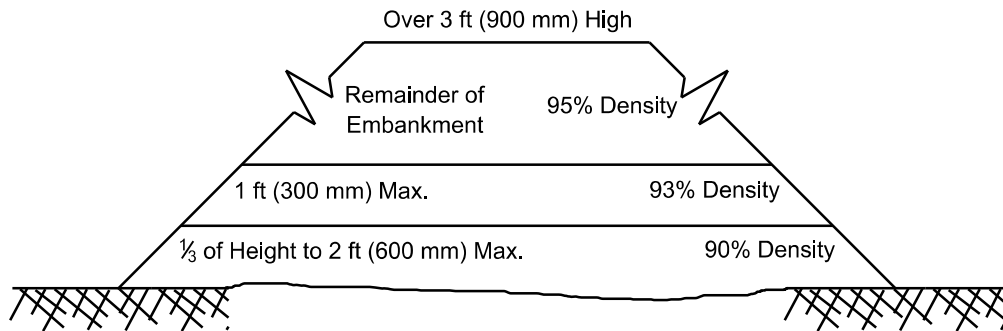


Figure 200-5 — EMBANKMENT DENSITY REQUIREMENTS



* A lift is considered as 8 in. (200 mm) of loose soil before compaction.



Suitable Excavation is defined to be all Earth Excavation, Rock Excavation and all other on-site excavation that is suitable to be used as embankment for the contract. The quantity of embankment that will result from the Suitable Excavation is calculated as:

$$\text{Excavation to be used as Embankment} = \text{Suitable Excavation} \times (1 - SF)$$

If the quantity of excavation to be used as embankment is less than the embankment quantity required, the designer should have used one of the following equations to establish plan quantity for furnished excavation or borrow excavation:

$$\text{Furnished Excavation} = \text{Embankment} - [(\text{Suitable Excavation}) \times (1 - SF)]$$

or

$$\text{Borrow Excavation} = \frac{\text{Embankment} - [(\text{Suitable Excavation}) \times (1 - SF_{\text{project site}})]}{1 - SF_{\text{borrow site}}}$$

(where SF , $SF_{\text{project site}}$, and $SF_{\text{borrow site}}$ are typically assumed to be 0.25)

The designer should have shown all areas of suitable material on an earthwork schedule in the plans. If any area anticipated to contain suitable material as shown on the earthwork schedule cannot actually be used and the project utilizes the furnished excavation pay item, the quantities of suitable excavation and furnished excavation must be adjusted. If the designer did not show an area of suitable material on the earthwork schedule in the plans, the area is considered surplus suitable material and the quantities of suitable excavation and furnished excavation is not adjusted. (On projects using Borrow Excavation, this is not required because borrow excavation is measured in its original position by taking cross sections before the borrow excavation work is started and again after it has been completed.)

205.06-6 Examples

205.06-6(a) Example 1:

Find: The quantity of borrow excavation anticipated to be need based on the following earthwork schedule.

Given:

Earthwork Schedule shown in contract plans

1 Location	2 Earth Excavation	3 Earth Excavation Adjusted for Shrinkage	4 Embankment	5 Earthwork Balance Waste (+) or Shortage (-)
	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard
Sta. 100+00 to 105+00	500	375	100	+275
Sta. 105+00 to 110+00	400	300	100	+200
Sta. 110+00 to 115+00	500	375	200	+175
Side Road A	200	150	300	-150
Total	1600	1200	700	+500

Columns 1, 2 & 4: Location and Quantities from plan cross sections

Column 2: Earth Excavation equates to "cuts"

Column 3: Quantity of Earth Excavation (cut) Adjusted for a Shrinkage Factor of 25%

Column 4: Embankment equates to "fills"

Column 5: Earthwork Balance, Shortage (-) equates to quantity of fill (embankment) needed (Furnished or Borrow Excavation)

Earthwork Balance, Waste (+) = Surplus quantity of earth excavation (cut) to be wasted

Solution: Because the Earth Excavation quantity is greater than embankment needed, only the Earth Excavation pay item is needed/anticipated. No quantity is anticipated for Borrow Excavation. (I.e. based on this earthwork schedule you should not expect to see the borrow excavation pay item in the contract plans.)

Note if there is not an agreement to plan quantity for the earthwork items (between the Contractor and the Department), actual existing cross sections must be taken prior to beginning excavation. After all excavation and embankment is completed, final cross sections must be taken to determine the pay quantities for each applicable pay item.

205.06-6(a) Example 1A:

Continuing with example 1: After completing the before and after cross section measurements the following volumes were calculated.

Earthwork worksheet for as-built measurements

Location	Earth Excavation	Earth Excavation Adjusted for Shrinkage	Embankment	Earthwork Balance Waste (+) or Shortage (-)
	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard
Sta. 100+00 to 105+00	550		100	
Sta. 105+00 to 110+00	375		100	
Sta. 110+00 to 115+00	550		200	
Side Road A	225		375	
Total	1700	1275	775	+500*

*Estimated volume of waste disposed of, this is not used for any pay calculations.

Find:

- Q1) Was an additional pay item for borrow excavation needed?
- Q2) What is the earth excavation pay quantity if there was no agreement to plan quantity?
- Q3) What is the earth excavation pay quantity if there was an agreement to plan quantity?

Solution:

- A1) *The as-built earth excavation quantity is equal to 1700 cubic yards. Embankments were fattened to minimize haul off of surplus material. Even with the fattened embankments there were 500 cubic yards of waste. Thus, no additional pay item was needed for borrow excavation.*
- A2) *Pay EARTH EXCAVATION = 1,700 cubic yards (if no agreement to plan quantity)*
- A3) *Pay EARTH EXCAVATION = 1600 cubic yards (if agreed to plan quantity; see plan earthwork schedule in example 1)*

205.06-6(b) Example 2:

Based on the earthwork schedule shown in the plans, a contract included and estimate quantity for Furnished Excavation equal to 575 cubic yards and an estimated quantity for Earth Excavation equal to 500 cubic yards. The specified shrinkage factor equals 0.25.

Find:

- Q) What is the actual furnished excavation pay quantity and earth excavation pay quantity based on as-built measurements when there is no agreement to plan quantity?

Given:

Earthwork Schedule shown in contract plans

Location	Earth Excavation	Earth Excavation Adjusted for Shrinkage	Embankment	Earthwork Balance Waste (+) or Shortage (-)
	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard
Sta. 320+00 to 325+00	100	75	275	-200
Sta. 325+00 to 330+00	200	150	125	+25
Sta. 330+00 to 335+00	150	112.5	300	-187.5
Side Road X	50	37.5	250	-212.5
Total	500	375	950	-575

Earthwork worksheet for as-built measurements

Location	Earth Excavation	Earth Excavation Adjusted for Shrinkage	Embankment	Earthwork Balance Waste (+) or Shortage (-)
	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard
Sta. 320+00 to 325+00	130		275	
Sta. 325+00 to 330+00	230		125	
Sta. 330+00 to 335+00	180		300	
Side Road X	75		275	
Total	615	461.2	975	-513.8

Solution: The actual pay quantity for furnished excavation, when there is no agreement to plan quantity, equals:

$$\text{Furnished Excavation} = 975 \text{ cubic yards} - [(615 \text{ cubic yards}) \times (1 - 0.25)] = 513.8 \text{ cubic yards}$$

EARTH EXCAVATION = 615 cubic yards

FURNISHED EXCAVATION = 513.8 cubic yards

205.06-6(b) Example 2A:

Based on the plan earthwork schedules shown in example 2, the contract included an estimated quantity for borrow excavation equal to 767 cubic yards and an estimated quantity for Earth Excavation equal to 500 cubic yards. The specified shrinkage factor equals 0.25.

(Note: The Borrow Excavation design quantity was calculated by taking the (Earthwork Shortage) and dividing it by (1 – The anticipated shrinkage factor at a borrow site) $(575 / (1-0.25) = 767)$. For an actual project the anticipated borrow excavation should be shown in a separate column in the earthwork schedule.)

Find: The actual borrow excavation pay quantity based on as-built measurements

Solution: *An agreement to plan quantity is not allowed for Borrow Excavation. Borrow Excavation is measured at the borrow site. After the contractor chooses the borrow site and gets all of the required Department approvals, actual existing cross sections must be taken (by the Department) at the borrow site prior to beginning excavation. After the contractor has obtained the required excavation from the borrow site actual final cross sections must be taken (by the Department). The actual pay quantity is determined using these before and after cross sections. It is anticipated the pay quantity for borrow excavation will be reasonably close to 685 cubic yards $(975 - 461.2) / (1-0.25)$. However, borrow site measurements are needed to determine the actual pay quantity.*

205.06-6(c) Example 3:

Based on the earthwork schedule shown in the plans, a contract included and estimate quantity for Furnished Excavation equal to 304 cubic yards and an estimated quantity for Earth Excavation equal to 571 cubic yards. The specified shrinkage factor equals 0.25.

Find: The actual pay quantities for Furnished Excavation and Earth Excavation based on as-built conditions. (There is no agreement to plan quantities.)

Given:

Earthwork Schedule shown in contract plans

Location	Earth Excavation	Earth Excavation Adjusted for Shrinkage	Embankment	Suitable material from Storm Sewer Excavation adjusted for shrinkage	Earthwork Balance Waste (+) or Shortage (-)
	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard
Sta. 320+00 to 325+00	121	91	400	75	-234
Sta. 325+00 to 330+00	220	165	325	55	-105
Sta. 330+00 to 335+00	175	131	275	88	-56
Side Road Z	55	41	75	125	+91
Total	571	428	1075	343	-304

Earthwork worksheet for as-built measurements

Location	Earth Excavation	Earth Excavation Adjusted for Shrinkage	Embankment	Suitable material from Storm Sewer Excavation adjusted for shrinkage	Earthwork Balance Waste (+) or Shortage (-)
	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard	Cubic Yard
Sta. 320+00 to 325+00	121		400	75	
Sta. 325+00 to 330+00	220		325	55	
Sta. 330+00 to 335+00	175		275	88	
Side Road Z	83		75	125	
Total	599	449.2	1075	343	*

*An estimated 300 cubic yards of surplus suitable material from locations not included on the plan earthwork schedule were obtained from within the project limits.

No material was brought to the project. I.e. all need material was obtained from within the limits of the project

Solution:

Although calculations based on the as-built earth excavation, as-built embankment, 0.25 shrinkage factor, and scheduled suitable material from storm sewer excavation indicate an approximate 283 cubic yard shortage is expected. Other suitable material was obtained from within the project site. Thus, no additional material was actually brought to the jobsite. However, only other suitable excavation shown in the plan earthwork schedule is used in the furnished excavation pay quantity calculation.

The actual pay quantity for furnished excavation, when there is no agreement to plan quantity, equals:

$$\text{Furnished Excavation} = 1075 \text{ cubic yards} - [(599 \text{ cubic yards}) \times (1 - 0.25)] - 343 \text{ cubic yards} = 282.8 \text{ cubic yards}$$

$$\text{EARTH EXCAVATION} = 599 \text{ cubic yards}$$

$$\text{FURNISHED EXCAVATION} = 282.8 \text{ cubic yards}$$

SECTION 208. TRENCH BACKFILL

208.03 METHOD OF MEASUREMENT

If the trench has been excavated wider than the maximum width permitted by the *Standard Specifications*, the backfill material required for the excess excavation will not be measured for payment. The Contractor shall backfill this excess excavation with the same backfill material used for the pay portion of the trench. As an aid in computing the quantity of Trench Backfill for storm sewers, refer to the Trench Backfill Tables for Concrete Pipes in the IDOT [Documentation of Contract Quantities](#). If the material excavated from the trench is suitable fine or coarse aggregate it shall be used for backfilling, and it is not measured for payment as Trench Backfill.

SECTION 211. TOPSOIL AND COMPOST

211.03 FURNISHING AND EXCAVATING TOPSOIL

Do not assume that the top of the soil within the right-of-way is always suitable for topsoil. Topsoil will be specified on the plans if required. The purpose of topsoil is to provide a covering over the slopes that will support vegetation or protect a more erodible material. Review the contract documents prior to starting excavation to determine the areas for topsoil removal. Stockpiles of

topsoil must also be treated in accordance with the Department's erosion and sediment control policy.

211.04 PLACING TOPSOIL AND COMPOST

In addition to raking and breaking of clods on the existing surface, to prevent slippage and to provide adequate bond on slopes, it is necessary to scarify the area preferably at right angles to the slope.

The time of placement of topsoil should be as close as possible to the time of seeding operations. This is to avoid the crusting over or eroding of the topsoil.

SECTION 212. FINAL SHAPING, TRIMMING, AND FINISHING

212.01 DESCRIPTION

Different types of surfacing require different operations regarding shaping and trimming. Most of the operations are mentioned in the *Standard Specifications*, and others may be listed in the Special Provisions. Where the contract calls for surfacing on a pre-graded section, the shaping of backslopes is not required unless it is covered in the Special Provisions or if the original slopes are disturbed.

212.02 GRADING SECTIONS

See Figures 200-7 and 200-8 for examples of equipment used for grading.

Figure 200-6 — MOTOR GRADER



Figure 200-7 — FOUR WHEEL DRIVE TRACTOR WITH TWO SCRAPERS



SECTION 250. SEEDING**250.03 EQUIPMENT**

See Figures 200-9, 200-10 and 200-11.

Figure 200-8 — SEEDING EQUIPMENT (Cultipacker)



Figure 200-9 — SEEDING EQUIPMENT (Mechanical Broadcast Seeder)



Figure 200-10 — SEEDING EQUIPMENT (Slit Seeder)



250.05 SEED BED PREPARATION

See Figure 200-12.

Figure 200-11 — DITCH PREPARED FOR SEEDING



SECTION 251. MULCH

251.01 DESCRIPTION

See Figures 200-13, 200-14 and 200-15.

Figure 200-12 — MULCHING OPERATIONS (Mechanical Stabilizer Discs)



Figure 200-13 — BLOWING STRAW MULCH



Figure 200-14 — RANGE LAND GRASS DRILL

SECTION 280. TEMPORARY EROSION AND SEDIMENT CONTROL

The Department is committed to protecting waterways in and adjacent to our project limits from the effects of erosion and sedimentation that may occur during construction. This commitment is documented in policies and procedures which are discussed in this section.

The following principles guide the Department's overall approach to erosion and sediment control:

- Soil disturbance should be kept at a minimum and remain within the construction limits.
- When appropriate to protect sensitive resources, use staged construction operations to minimize the amount of area exposed at any given time.
- Divert "clear" water flowing through the construction site away from disturbed areas.
- Intercept and contain sediment close to its source.
- Contain all project-related sediment on the project site.
- Construct erosion and sediment controls as quickly as practical.
- Pay for all properly installed work required for proper erosion and sediment control; and ensure it is maintained in effective operating condition.

280.01 DESCRIPTION

While Article 280.01 focuses on work to construct, maintain, remove, and dispose of temporary erosion control systems, there are several procedures the Resident must complete prior to implementing Section 280.

280.01-1 BACKGROUND

For projects disturbing 1 or more acres (0.4 hectares), an ILR10 General National Pollutant Discharge Elimination (NPDES) permit for Storm Water Discharges from Construction Site Activities is required by the Illinois Environmental Protection Agency (IEPA) to comply with Section 402 of the Clean Water Act of 1972. Compliance begins in the Design phase and ends when the Construction phase is completed.

The Department complies with the ILR10 permit by utilizing the following:

- [Form BDE 2342 Storm Water Pollution Prevention Plan \(SWPPP\)](#) and [Form BDE 2342A Contractor Certification Statement](#);
- Erosion and Sediment Control Plan (ESCP);
- Requirements discussed Section 280 of the Standard Specifications for Road and Bridge Construction;
- [Form BC 2259: Storm Water Prevention Plan Erosion Control Inspection Report](#);
- Standard 2800001-07 Temporary Erosion Control Systems; and
- Project Plan commitments (when applicable)

Additional guidance can be found in the following other manuals:

- Illinois BDE Manual;
- Illinois Drainage Manual; and
- Erosion and Sediment Control Filed Guide for Construction Inspection

Note: As required by Section 107.23, for situations not addressed by the above, it is still the Resident's responsibility to ensure the Contractor implements measures to prevent sediment from leaving the project site into waterbodies in or adjacent to the project site. In addition, the lack of pay items does not relieve the Resident of responsibility for erosion and sediment control. When sufficient pay items are not included, the Resident can pay for necessary measures in accordance with Article 109.04

280.01-2 POLICY

Typically, projects that involve no land disturbing or earth moving activities can be exempt from erosion and sediment control measures. Examples of earth moving activities include, but is not limited to, clearing or grubbing, excavation, stockpiling of topsoil, soil covering waste sites, borrow site excavations, construction of embankment, etc.)

Projects that involve only isolated excavation for the installation of lighting, signing, traffic signals, guardrail or woody plant materials may also be exempt from erosion and sediment control measures. Typically, these projects disturb less than one or more acres. However, if there are multiple project sites under that same contract that require an acre or more of land disturbance, compliance with the ILR10 permit is required.

280.01-3 PROCEDURES FOR ILR10 PERMIT

The following forms are utilized to satisfy the ILR10 NPDES Permit. Additional information regarding each is discussed after the figure.

Figure 200-16 — EROSION CONTROL FORMS

FORM	RESPONSIBILITY	WHEN	WHERE TO SEND
Storm Water Pollution Prevention Plan (SWPPP) (Form BDE 2342))	Designer (Phase II consultant)/Resident	During Design/ Construction	IEPA as part of Notice of Intent (NOI) Project Erosion Control File
Contractor Certification Statement (Form BDE 2342A)	Contractor and all Subcontractors involved in Erosion Control	At Preconstruction Meeting	Project Erosion Control File
Notice of Intent (NOI)	Supervising Field Engineer	Before construction begins (IEPA has 30 days to review prior to land disturbing activities)	IEPA Post at Jobsite Project Erosion Control File
NPDES/Erosion Control Inspection Report (Form BC 2259)	Resident/Inspector	Weekly and after more than 0.5 in. rainfall or 6 in. snowfall throughout the full duration of the project (including Winter shutdown)	Project Erosion Control File Copy to Contractor
Incidence of Non-Compliance (ION) (Form WPC 624)	Resident	Within 5 days of incident	IEPA Copy to Contractor Copy to Project Erosion Control File

Figure 200-16 — EROSION CONTROL FORMS Continued

FORM	RESPONSIBILITY	WHEN	WHERE TO SEND
Notice of Termination (NOT) (Form WPC 621)	Supervising Field Engineer	When all permanent erosion control measures are in place and functioning properly and 70% vegetative cover is established for the entire project site	IEPA Copy to Project Erosion Control File

BDE 2342 STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

Prior to the start of construction, the Resident must familiarize themselves with the SWPPP and the ESCP. (Section 41-4 of the BDE Manual discusses the preparation of SWPPP.) After reviewing the SWPPP, the Resident should take special note of the following:

- The locations of sensitive resources such as wetlands, floodplains, and/or threatened or endangered species;
- Potentially erosive areas;
- 303(d) listed (i.e. classified as impaired by the IEPA) waterways, especially those impaired by Total Suspended Solids (TSS), Turbidity, or Siltation;
- Waterways with a Total Maximum Daily Load (TMDL) for sediment, TSS, turbidity or siltation in the project area;
- Pollutants of concern;
- Proper use of best management practices (BMPs); and
- Installation of any permanent stormwater management practices.

At the preconstruction meeting, for projects requiring an ILR10 permit, the Resident must:

- Ensure the Contractor and subcontractor have complied with section G. Contractor Required Submittals of the BDE 2342 (SWPPP).
- Have the Contractor and all subcontractors complete and sign BDE 2342A Contractor Certification Statement

NOTICE OF INTENT (NOI)

The Supervising Field Engineer/Area Supervisor shall submit the Notice of Intent (NOI) to the IEPA as soon as possible after contract execution in one of the following manners:

- File electronically with digital signature at the following website address: <http://dataservices.epa.illinois.gov/SWConstructionPermit/bowLogIn.aspx>

Note: Registration specific to the permittee is required in order to file electronically.

- Submit complete signed NOI and SWPPP to the following email address: epa.constilr10swppp@illinois.gov. and send by registered or certified mail, return receipt requested, to IEPA at the address below:

Illinois Environmental Protection Agency
Division of Water Pollution Control, Mail Code #15 Attention: Permit Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

Note: NOIs that are hand delivered shall be delivered to and receipted for by an authorized person employed in the Permit Section of the Agency's Division of Water Pollution Control.

As stated in the ILR10, The IEPA has 30 days to review the NOI prior to the start of construction. Starting construction before the 30-day review period is a violation of the permit.

The Resident may need to adapt the SWPPP to accommodate the Contractor's intended sequence of construction operations and any anticipated non-storm water discharges. Such modifications should be documented in the SWPPP.

PRECONSTRUCTION MEETING:

At the preconstruction meeting, the Resident should discuss the following with Contractor:

- The plan's BMPs for erosion and sediment control
- The sequence of construction operations
- Any project-specific concerns or problem areas
- Arrangements for a field review of erosion and sediment control aspects
- Construction site management measures (i.e. good housekeeping)

As previously indicated, for projects requiring an ILR10 permit, the Resident must:

- Ensure the Contractor and subcontractor have complied with section G. Contractor Required Submittals of the BDE 2342 (SWPPP).

- Have the Contractor and all subcontractors complete and sign BDE 2342A Contractor Certification Statement

The Resident shall reflect this discussion in the preconstruction conference minutes.

FIELD REVIEW:

The Resident should conduct a field review with the prime Contractor and any Subcontractors. The purpose of the field review is to determine the timing and placement of erosion and sediment control BMPs before earthwork begins and as earthwork progresses. Additional field reviews will be required as work progresses. The Resident should record the date of each field review, including the subjects discussed during the field review and the names and position titles of the individuals in attendance in the diary.

If the Resident determines that erosion and sediment control BMPs are different from those in the plans and are not covered by contract pay items, consult the project Designer or Consultants (if applicable) to ensure that any alterations will comply with permit requirements.

EROSION AND SEDIMENT CONTROL FILE:

The Resident must maintain a project erosion and sediment control file. At a minimum, the file should contain:

- The SWPPP ([Form BDE 2342](#)) and signed Contractor's Certification Statement ([Form BDE 2342A](#))
- The Erosion and Sediment Control Plan (ESCP)
- Field review documentation
- A copy of, Notice of Intent (NOI) ([Form WPC 623](#) when used)
- A copy of each Incident of Non-compliance (ION) ([Form WPC 624](#), when applicable)
- A copy of each [Form BC 2259](#): Storm Water Pollution Prevention Plan Erosion Control Inspection Report

The Resident shall make the erosion and sediment control plan information available for inspection by regulatory agencies or the public upon request.

The Contractor shall complete permanent erosion control measures as soon as practical after the completion of grading. Temporary measures shall be installed and maintained until permanent measures are established. Temporary seeding may be applied by a variety of methods as provided in the *Standard Specifications* or contract Special Provisions. The level of required site grading and seed coverage is dependent on the specific pay item(s) involved. The intent is to provide quick coverage to exposed areas to prevent erosion problems before they occur.

SITE INSPECTION(S):

As required by the ILR10, all disturbed areas, Best Management Practices (BMPs), vehicle entrance/exit locations, and any other areas subject to erosion shall be inspected at least once every seven days and within 24 hours of the end of each 0.5-in. or greater rainfall or equivalent snowfall (6.0 in.). The findings of these inspections shall be documented using [Form BC 2259: Storm Water Pollution Prevention Plan Erosion Control Inspection Report](#). By copy of the Form, the Contractor shall be directed to perform any repairs, maintenance or implementation of additional measures determined necessary. The date(s) of corrective action taken by the Contractor in response to the inspection report must be noted on the Form.

See the IDOT [Erosion and Sediment Control Field Guide for Construction Inspection](#) for additional guidance on inspecting BMPs.

INCIDENCES OF NONCOMPLIANCE (ION):

In general, erosion and sediment control non-compliance may be related to sediment discharges, erosion and sediment control failures, and inadequate or improperly installed or maintained BMPs. Potential non-compliance on the Department's projects must be reported regardless of who holds the permit. Potential non-compliance should be documented immediately with photographs, correspondence and/or in the Project Diary.

DEFICIENCY DEDUCTION:

See Section 105.03-2 Erosion and Sediment Control

NOTICE OF TERMINATION:

When all permanent erosion control measures are in place and functioning properly and 70% vegetative cover is established for the entire project site, the Supervising Field Engineer/Area Supervisor will complete and submit to IEPA a Notice of Termination (NOT), [Form WPC 621](#). Generally, this Form will be processed as a part of the final documentation for closing out the project.

280.01-4 PROCEDURES FOR ILR40 (MS4 - MUNICIPAL SEPARATE STORMWATER SEWER SYSTEM) PERMIT

In addition to the ILR10 permit, the Department is required to obtain coverage for the ILR40 permit. This coverage is maintained by the Bureau of Design and Environment and requires the Department (or any ILR40 permit holder) to follow six minimum control measures. The measures are:

1. Public education and outreach on storm water impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site storm water runoff control
5. Post- construction storm water management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

Of the six control measures listed above, only the last three (numbers four, five, and six), require Resident involvement. These controls are discussed in more detail below.

CONSTRUCTION SITE STORM WATER RUNOFF CONTROL:

This minimum control measure is met through the implementation of temporary erosion and sediment control practices. The ILR40 permit requirements essentially match what is required by the IRL10. The IEPA made the decision to require the Department to obtain both permits (ILR40 and ILR10) due to the presence of roadside ditches; which in their view function like a separate storm water drainage system as used in some municipalities.

POST- CONSTRUCTION STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

The implementation of this minimum control measure is not common. In addition to being a requirement of the ILR40 permit, it is also a requirement of the ILR10 permit. It is also discussed in the SWPPP. However, there is no hard requirement for this control measure.

Currently designed vegetated ditches by default include the infiltration capacity to meet this measure which in the permits is described as “required to maximum extent practicable.” The focus of this control measure is to control the volume and velocity of storm water runoff coming off impervious surfaces, which for the Department are our roadways.

When deemed necessary these BMPs will be implemented through Special Provisions. Examples of these BMPs and closest guidance include:

- Infiltration trenches (similar to a French Drain as described in Section 601 of the Standard Specifications)
- Permanent sediment basins (similar to Sediment Traps and Basins described in Section 41-304 of the BDE Manual)
- bioswales (Section 41-2.04 of the BDE Manual and Bioretention facility in the Illinois Urban Manual)

POLLUTION PREVENTION/GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

The principles behind this minimum control measure are to keep potential pollutants from leaving the project site, control of chemicals and waste, and controlling spills. The following addresses these concerns.

- Section 105.03 Conformity with Contract;
- Article 107.36 Dust Control;
- Section 41-3.06 Entrance/Exit Control of the BDE Manual

280.04 TEMPORARY EROSION CONTROL SYSTEMS

The maintenance of temporary ditch checks is not paid for unless a rain event exceeds the Q_{25} storm event.

Aggregate ditch checks (See Section 41-3.03(a) of the BDE Manual) are not recommended for slopes greater than 20%. When steeper than 20%, stabilize channels and drain to a sediment control basin (See Section 41-3.04 of the IDOT BDE Manual).

See Figures 200-17 and 200-18 for a temporary ditch check.

Figure 200-17 — GEOTECHNICAL DITCH CHECKS



Figure 200-158 —AGGREGATE DITCH CHECK



SECTION 282. FILTER FABRIC

See Figure 200-19.

Figure 200-19 — FILTER FABRIC INSTALLATION



SECTION 284. GABIONS AND SLOPE MATTRESS

See Figure 200-20.

Figure 200-20 — MATTRESS INSTALLATIONS

(Gabions)



(Slope Mattress)



DIVISION 300

Subgrades, Subbases, and Base Courses

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 300. DEFINITIONS	301-1
SECTION 301. SUBGRADE PREPARATION	301-3
301.02 EQUIPMENT	301-3
301.04 SUBGRADE COMPACTION AND STABILITY	301-3
301.04-1 General.....	301-3
301.04-2 Expansive/Compressible Soils	301-5
301.04-3 Stability	301-5
301.04-4 Cut Sections	301-7
301.06 AGGREGATE SURFACE COURSE, TYPE B	301-7
301.07 HOT MIX ASPHALT (HMA) BASE COURSE AND PAVEMENT (FULL-DEPTH) AND PORTLAND CEMENT CONCRETE BASE COURSE AND PAVEMENT.....	301-7
301.09 DRAINAGE.....	301-10
SECTION 302. SOIL MODIFICATION.....	301-10
302.01 DESCRIPTION.....	301-10
302.02 MATERIALS.....	301-11
302.04 GENERAL.....	301-11
302.06 PREPARATION OF SUBGRADE.....	301-11
302.09 COMPACTION.....	301-11
302.10 FINISHING AND CURING.....	301-12
302.11 SUBRADE STABILITY.....	301-12
SECTION 310. LIME STABILIZED SOIL MIXTURE.....	301-12
310.07 APPLICATION OF LIME.....	301-12
310.08 MIXING.....	301-13
310.09 COMPACTION.....	301-13
SECTION 311. GRANULAR SUBBASE.....	301-14

311.01 DESCRIPTION.....	301-14
311.03 EQUIPMENT.....	301-14
311.05 PLACING AND COMPACTING SUBBASE MATERIALS.....	301-14
311.07 TOLERANCE IN THICKNESS.....	301-15
SECTION 312. STABILIZED SUBBASE.....	301-15
312.01 DESCRIPTION.....	301-15
312.02 GENERAL.....	301-15
312.14 TOLERANCE IN THICKNESS.....	301-15
SECTION 351. AGGREGATE BASE COURSE.....	301-17
351.01 DESCRIPTION.....	301-17
351.02 MATERIALS.....	301-17
351.03 EQUIPMENT.....	301-17
351.05 BASE COURSE.....	301-17
351.05-1 General.....	301-17
351.05-2 Type A.....	301-17
351.05-3 Type B.....	301-18
351.06 TOLERANCE IN THICKNESS.....	301-18
SECTION 352. SOIL-CEMENT BASE COURSE.....	301-18
352.01 DESCRIPTION.....	301-18
352.09 DRY MIXING.....	301-18
352.10 MOIST MIXING.....	301-19
352.11 COMPACTION AND FINISHING.....	301-19
352.13 PROTECTION AND COVER.....	301-19
SECTION 353. PORTLAND CEMENT CONCRETE BASE COURSE.....	301-19
353.03 EQUIPMENT.....	301-19
353.11 SURFACE TEST.....	301-19
353.12 TOLERANCE IN THICKNESS.....	301-20
SECTION 354. PORTLAND CEMENT CONCRETE BASE COURSE WIDENING.....	301-20
354.04 GENERAL.....	301-20
354.05 SUBGRADE.....	301-20

354.06 CONSTRUCTING WITHOUT FORMS..... 301-20
354.07 CONSTRUCTING WITH FORMS 301-20
354.09 TOLERANCE IN THICKNESS 301-20

SECTION 356. HOT-MIX ASPHALT BASE COURSE WIDENING 301-20
356.05 SUBGRADE 301-20
356.06 PLACING..... 301-21
356.08 TOLERANCE IN THICKNESS 301-21

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
Figure 300-1	— TYPICAL HMA PAVEMENT STRUCTURE.....	301-2
Figure 300-2	— TYPICAL PCC PAVEMENT STRUCTURE	301-2
Figure 300-3	— BELT TRIMMER (Rough Trimming of Earth Subgrade).....	301-3
Figure 300-4	— SHEEPFOOT ROLLER ON SUBGRADE	301-4
Figure 300-5	— STEEL WHEEL ROLLER ROLLING SUBGRADE	301-4
Figure 300-6	— NUCLEAR DENSITY GAUGE	301-5
Figure 300-7	— SELF LOADING PADDLE WHEEL SCRAPER.....	301-6
Figure 300-8	— FIELD BOOK FOR FINISHED GRADE.....	301-8
Figure 300-9	— WATER TRUCK WATERING SUBGRADE (Prior to Trimming).....	301-9
Figure 300-10	— SUBGRADE MACHINE (Final Trimming of Earth Subgrade)	301-9
Figure 300-11	— CHECKING GRADE BEHIND TRIMMER	301-10
Figure 300-12	— SCARIFYING LIME TREATED SOIL.....	301-12
Figure 300-13	— MIXING LIME WITH SOIL WITH A ROTARY SPEED MIXER.....	301-13
Figure 300-14	— SHEEPSFOOT ROLLER COMPACTING LIME TREATED SOIL.....	301-13
Figure 300-15	— EXAMPLE MOISTURE DENSITY CURVE FOR AGGREGATE.....	301-16

Division 301

SUBGRADES, SUBBASES, AND BASE COURSES

SECTION 300. DEFINITIONS

1. Base Course. The layer, or layers, of specified or selected material (e.g., HMA binder, Cement Aggregate Mixture (CAM II)) of designed thickness placed on a subbase or a subgrade to support the surface course.
2. Composite Pavement. A pavement structure having an HMA surface overlaying a PCC slab of relatively high bending resistance that serves as the principal load distributing layer. The PCC slab may be either a newly constructed base course or an existing rigid or composite pavement that is to be resurfaced.
3. Flexible Pavement. An HMA pavement structure which maintains intimate contact with and distributes loads to the subgrade which depends upon aggregate interlock, particle friction, and cohesion for stability.
4. Improved Subgrade. A subgrade that has been modified with lime, by-product lime, cement, or other approved material or, alternatively, has been removed and replaced with aggregate.
5. Pavement Structure. The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed. See Figures 300-1 and 300-2 for typical examples.
6. Rigid Pavement. A pavement structure whose surface and principal load distributing component is a PCC slab of relatively high bending resistance (e.g., JPCP, CRCP, JRCP).
7. Roadbed. The portion of a highway within the side slopes that is graded and prepared as a foundation for the pavement structure and shoulders.
8. Stabilized Subbase. Same as subbase but constructed of an aggregate mixture containing a binder material such as cement, bituminous material or some type of fly ash. Common types include Cement Aggregate Mixture (CAM II).
9. Subbase. The layer, or layers, of specified or selected material (e.g., HMA, CAM II) of designed thickness that is placed on the subgrade to support the base course or, in the case of rigid pavements, the PCC slab.
10. Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.
11. Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion,

and the disintegrating effects of climate. The top layer is sometimes called the “wearing course.”

Figure 301-1 — TYPICAL HMA PAVEMENT STRUCTURE

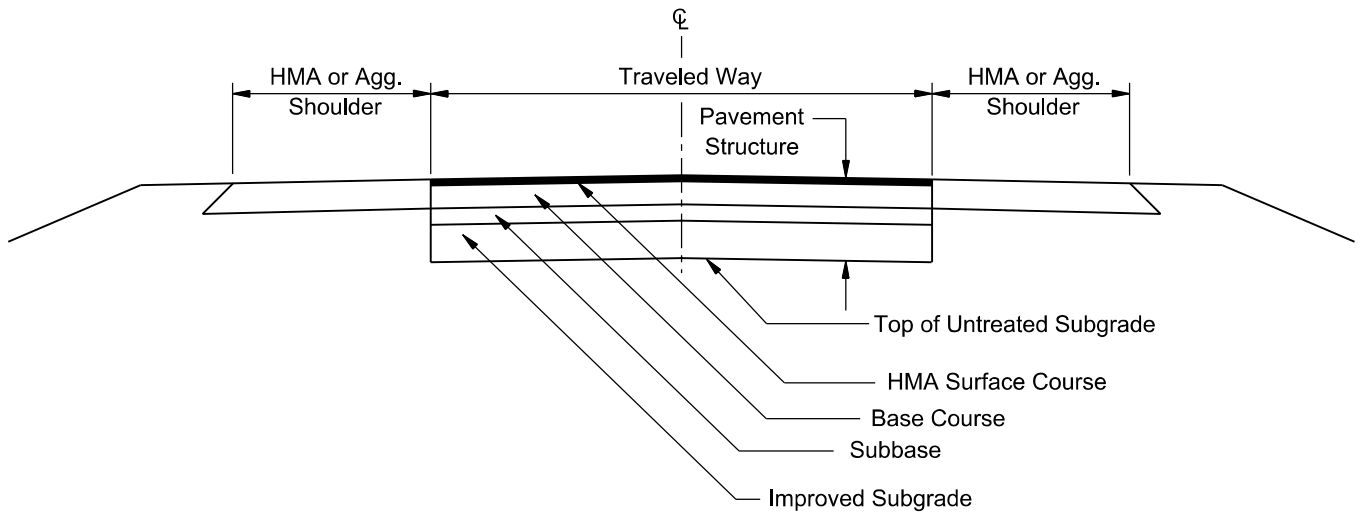
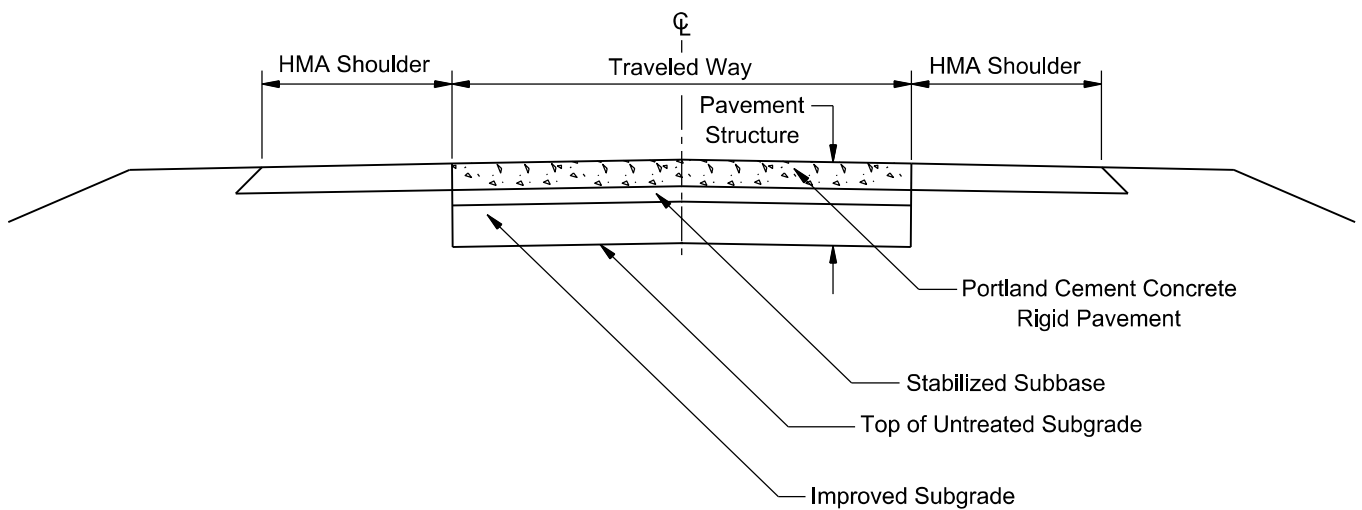


Figure 301-2 — TYPICAL PCC PAVEMENT STRUCTURE



SECTION 301. SUBGRADE PREPARATION

301.02 EQUIPMENT

Figure 300-3 illustrates typical equipment used for rough trimming of the subgrade.

Figure 301-3 — BELT TRIMMER (Rough Trimming of Earth Subgrade)



301.04 SUBGRADE COMPACTION AND STABILITY

301.04-1 General

Subgrades may be divided into two categories:

- The subgrade constructed on an embankment
- The subgrade constructed in a cut section or very near the existing ground surface

Subgrades are typically composed of different materials and may expand or swell at different rates causing humps in the completed road; therefore, scarifying, blending with a proper construction disc, and recompaction are required for such subgrades.

See Figures 300-4 and 300-5.

Figure 301-4 — SHEEPFOOT ROLLER ON SUBGRADE



Figure 301-5 — STEEL WHEEL ROLLER ROLLING SUBGRADE



Construct the final finish of the subgrade in accordance with the requirements for the type of pavement structure specified. Ensure that the subgrade is stable to prevent rutting and shoving during construction, to provide support for the placement and compaction of paving lifts, and to limit pavement resilient deflections and rutting of the subgrade during the service life of the pavement. To ensure adequate stability, the required minimum levels of strength and stiffness must be achieved in the subgrade soil to a depth determined by both construction traffic and pavement design requirements.

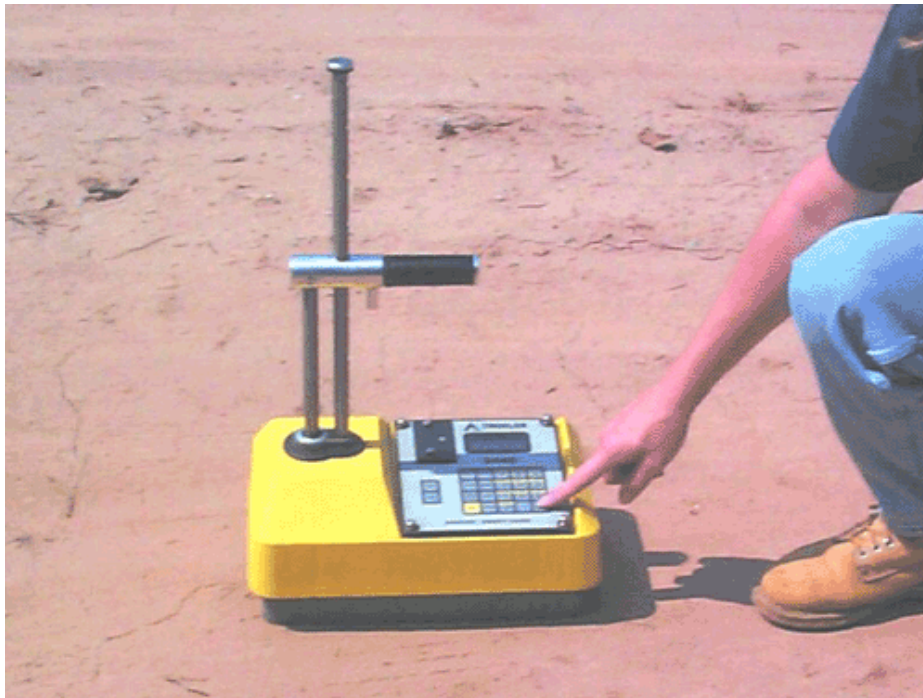
301.04-2 Expansive/Compressible Soils

Alternating layers of expansive and granular soils require mixing and compaction to provide uniformity, or the expansive material may need to be removed and replaced with adequate soils. Hard materials may exist in the midst of acceptable, but with more compressible, material. Because the compressible material will consolidate with time, bumps may occur in the pavement. When these harder materials are encountered, it may be advisable to excavate and backfill with uniform material. If consolidation then occurs, it will happen more uniformly as a unit. If needed, consult the District geotechnical engineer for advice.

301.04-3 Stability

The stability of an earth subgrade is critical for the construction of subsequent pavement lifts and the future performance of the pavement structure. Inspect and evaluate the entire subgrade for stability prior to placement of the subbase or base course. See the [PPG](#) for performing density tests. See Figure 300-6 for a nuclear density gauge.

Figure 301-6 — NUCLEAR DENSITY GAUGE



The stability of the subgrade can easily be evaluated by inspecting the amount of deflection and/or rutting that takes place by proof rolling the subgrade. The objective of proof rolling is to

identify soft or yielding material in embankment construction (fill soils), finished subgrade and/or unbound base layers. Self-loading paddle wheel scrapers are usually used for this purpose. See Figure 300-7. A uniform axle load provides consistency for the Inspector to observe any movement in the subgrade. The Inspector can suggest that the Contractor provide pneumatic tire equipment loaded to a specified axle load. The BMPR [Subgrade Stability Manual](#) provides requirements for subgrade stability and outlines the following remedial procedures for unstable subgrades:

- Soil modification
- Remove and replace with gravel material
- Aggregate on top of modified subgrade
- Use of geosynthetic material
- Moisture control

It is not always apparent which remedial procedure should be used for a particular situation. The Resident should contact the District geotechnical engineer for any subgrade stability problems to be evaluated and make the appropriate recommendations for corrective action.

Figure 301-7 — SELF LOADING PADDLE WHEEL SCRAPER



Before placement of the subbase or base course material, the Inspector must verify that the roadbed or subgrade surface is:

- Compacted to the required density.
- Not rutted, soft, pumping or showing signs of excessive moisture

- Not frozen
- Meets the plan grade and cross section

301.04-4 Cut Sections

A stable subgrade can be constructed by controlling moisture and density for an embankment. However, the stability of a subgrade in a cut or very near the existing ground surface is greatly affected by the insitu soil conditions. Most subgrade problems occur in cut sections; therefore, devote special attention to these areas. Cut sections are prime candidates for soil/cement or lime stabilization treatments. All of these should be evaluated for stability and remedial action (e.g., lime stabilization); contact the District geotechnical engineer and the IDOT Subgrade Stability Manual for assistance.

Examine an exposed cut section as soon as possible to determine whether conditions in the exposed cut are the same as indicated in the preliminary soil survey. Because even the most thorough soil survey provides information only at point locations, often separated by considerable distances, careful examination of the roadway will assist in locating problem foundation materials or faulty drainage conditions that must be corrected. Corrective action may be required for foundation materials that are exceedingly weak, those that appear to be much weaker than originally thought, and materials that differ significantly from adjacent material with respect to frost susceptibility. If the inspection reveals excessive seepage into the cut, problems of instability, often including frost action, may result in future rapid deterioration of the pavement and/or slopes unless special corrective measures are taken.

301.06 AGGREGATE SURFACE COURSE, TYPE B

Although no rolling is required, the provisions of Article 301.03 apply, and the subgrade must be approved by the Resident before the surface material is placed.

301.07 HOT MIX ASPHALT (HMA) BASE COURSE AND PAVEMENT (FULL-DEPTH) AND PORTLAND CEMENT CONCRETE BASE COURSE AND PAVEMENT

The subgrade shall be compacted with a pneumatic-tired roller, three-wheel roller or tandem roller. In small street returns and tapers, hand tamping may be necessary due to the limited space. Close inspection is important where mechanical equipment is not used. The following applies:

1. Preparing Subgrade Ahead. When the subgrade operation gets too close to the paving operation, there is a tendency to overlook certain details in the subgrade preparation in an effort to get ahead. This may result in poor workmanship or neglect of important features of the work. Therefore, the preparation of the subgrade shall be ahead of the paving operation by one day's paving production rate.
2. Moisture Content. When pavement or base courses are to be constructed, the subgrade shall be in a moist condition to prevent moisture from being drawn from the concrete. It may become necessary to re-wet the subgrade by sprinkling.

3. Checking Subgrade Machine. The cutting blades on the subgrade machine should be checked and set to cut the subgrade to the required depth and crown. It is the responsibility of the Contractor to set the equipment to obtain the required crown and thickness and to keep it properly adjusted.
4. Subgrade or Subbase Finished Grade. All finished subgrades or subbases shall be checked for crown and proper elevation prior to starting paving. This is normally done with a stringline stretched transversely between paving stakes and measured from the string to the finished grade. The measurements at the centerline and each edge of pavement are noted in a field book. See Figure 300-8. Other methods, such as taking (shooting) actual elevations at the centerline and each edge of pavement, can be employed. Electronically controlled subgrade machines (Figures 300-3 and 300-10) are used for final trimming prior to slipform paving.

Figure 301-8 — FIELD BOOK FOR FINISHED GRADE

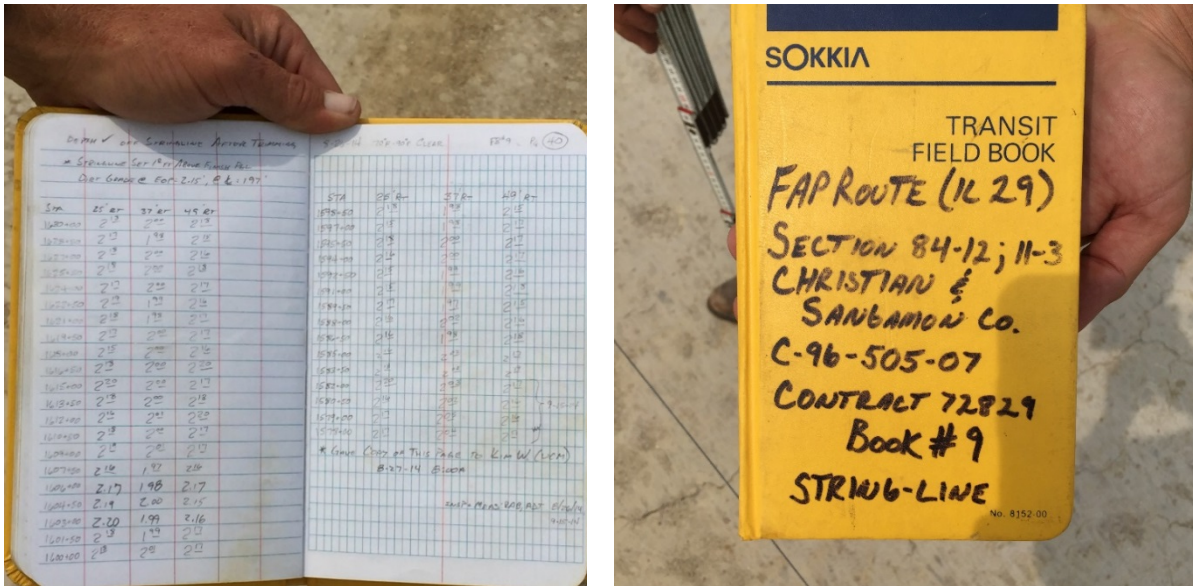


Figure 301-9 — WATER TRUCK WATERING SUBGRADE (Prior to Trimming)



Figure 301-10 — SUBGRADE MACHINE (Final Trimming of Earth Subgrade)



Figure 301-11 — CHECKING GRADE BEHIND TRIMMER

301.09 DRAINAGE

A stable subgrade is essential and can be secured only if adequate attention is given to surface drainage. Water pockets create soft or spongy spots in the subgrade or make the subgrade muddy or otherwise unfit to receive the surfacing material. The Contractor shall make provisions for surface drainage.

SECTION 302. SOIL MODIFICATION

302.01 DESCRIPTION

Soil modification is the physical and chemical alteration of soils to enhance their physical and engineering properties. The most important issue when considering soil modification is subgrade investigation and sampling of the soils to determine the best additive for the mixing operation. Soil modification has an economic value by accelerating construction times and reducing materials to be imported/exported from the job site.

Soil modification is used to prepare a working platform for construction equipment in conjunction with the mechanistic pavement design for the subsequent pavement structure. The Inspector should also consult the [Construction Inspector's Checklist for Soil Modification](#).

See Section 310 for a discussion specifically on lime stabilization of soils.

302.02 MATERIALS

The Department uses the following additives for soil modification:

- Lime (mostly used)
- Cement
- Fly ash

If lime is used as an additive, be aware of the hazards of lime. Dry lime should not be used in windy, open field conditions and should not come into contact with skin or be inhaled. See Section 107.28-3 of this *Manual* for information on Safety Data Sheets (SDS).

302.04 GENERAL

Uniformity is critical to soil modification treated base construction. Lack of uniformity will result in substandard material immediately under the pavement, which can deteriorate and eventually fail under traffic loading. Compaction must meet specified requirements and be uniform over the full width and length of the treated base.

302.06 PREPARATION OF SUBGRADE

Prior to soil modification, the soil should be prepared to approximate final grade. This will ensure a uniform thickness of stabilization following final trimming. Normally, the subgrade will expand (rise) slightly, up to +0.10 ft after soil modification.

The Contractor will maintain the subgrade to meet the moisture density and stability requirements prior to the treated base being placed. Dry and loose subgrades require rework to meet the requirements of Article 301.04 of the *Standard Specifications*.

302.09 COMPACTION

In a typical compaction operation, rolling generally follows immediately behind the mixing and shaping operation. The purpose is to compress aggregate particles together into a dense mass by expelling air and reducing voids. Good construction practice is to begin rolling along the edge and proceed toward the centerline, except on superelevated curves where rolling generally proceeds from the lower to the upper side. In particular, observe compaction along the edge, where compaction is often the most difficult to achieve and is the most susceptible to segregation.

Once the treated base has hardened, it is difficult for the Contractor to correct surface deficiencies without completely ripping out the top layer of the compacted base. The Contractor is responsible for checking the lift thickness, grade and cross section while the base material is in a loose or lightly compacted condition.

302.10 FINISHING AND CURING

Require the Contractor to correct any areas that are not within tolerance. Watch for severe rutting, equipment imprints, roller marks and loose or segregated material. “Severe rutting” is approximately ½ in. or more. See Article 301.04 for density.

The surface of the treated base must be maintained to prevent moisture loss after shaping and compacting so that curing can proceed correctly. The curing must be maintained, and no traffic should be allowed on the base throughout the specified curing period. Article 302.10 of the *Standard Specifications* stipulates the minimum air temperature for curing the treated base.

302.11 SUBGRADE STABILITY

Refer to the BMPR [Subgrade Stability Manual](#).

SECTION 310. LIME STABILIZED SOIL MIXTURE

As a subbase layer, the lime treated soil is a part of the pavement structure and, thus, must provide permanent improvement to the treated soil. Use lime moisture-density curves for determining compaction and density of finished lime stabilized subgrades.

310.07 APPLICATION OF LIME

See Figure 300-12.

Figure 301-12 — SCARIFYING LIME TREATED SOIL



310.08 MIXING

See Figure 300-13.

Figure 301-13 — MIXING LIME WITH SOIL WITH A ROTARY SPEED MIXER



310.09 COMPACTION

See Figure 300-14.

Figure 301-14 — SHEEPSFOOT ROLLER COMPACTING LIME TREATED SOIL



SECTION 311. GRANULAR SUBBASE

311.01 DESCRIPTION

Granular subbase is placed on a prepared earth subgrade to support a pavement structure. It must meet the requirements of Article 1004.04 in the *Standard Specifications*.

311.03 EQUIPMENT

The Inspector should observe the operation to ensure that segregation of the aggregate is avoided.

Although not specifically listed in Article 311.03 of the *Standard Specifications*, the Contractor may at his/her option elect to use a spreading and finishing machine (Paver) as specified in Article 1102.03 to place the granular subbase.

311.05 PLACING AND COMPACTING SUBBASE MATERIALS

During placement, monitor the operation for obvious signs of soft areas. Soft areas in the subgrade must be repaired before the aggregate material has been placed. If areas of pumping or yielding are observed in the wheel path of hauling and other construction equipment, the Contractor shall repair the area.

The aggregate material should be properly spread after hauling to ensure the application of the correct thickness per volume or weight per station to achieve the specified thickness. One suggested method of checking in the field is for the Inspector to observe the distance a truck load is spread to ensure that the correct volume is being applied to the correct depth. Prepare a spreadsheet that contains a tabulation per station of the distance a volumetric quantity is spread for the thickness of lift required. Then, as placing operations progress, the volume actually placed can be compared to the placed volumes from the Contractor. Significant variations warrant investigation.

Each lift of granular subbase must be properly compacted to the correct depth; otherwise, soft spots, lack of durability and an improper pavement foundation may result. During inspection, consider the following guidelines:

- Inspect and test random sections for lift thickness.
- Observe the watering and compaction operation to ensure that a uniformly dense lift is being produced.
- Record the station and lift of material being hauled, placed and spread during the day. Account for irregularities such as corrections to soft areas and material rejections.

The compacted thickness of any lift of granular subbase must not exceed 4 in. (100 mm). If tests show that the required density can be obtained, the compacted thickness may be increased to 8 in. (205 mm).

The Contractor is responsible for constructing the section to the lines and grades required by the contract. The Resident or Inspector will perform the grade checks when notification is provided of the completed section. As needed, the Contractor may reshape, lightly scarify, or trim and finish roll the surface material to comply with the lines, grades and typical sections in the construction plans.

Water should be added at the plant until optimum moisture content is obtained. If already placed on the subgrade, water should be added with a water truck and re-compacted as necessary. Allow the aggregate to dry out completely before placing additional lifts of granular subbase. Avoid placing wet granular subbase material in areas that cannot drain. This can cause instability when the moisture in the aggregate cannot escape. Cut weep holes to allow for drainage if unavoidable. If placing in trench-like subgrade, cut weep holes to allow for drainage. See Figure 300-15 for an example of a moisture density curve with typical moisture content range. Consult the District geotechnical engineer for any issues with moisture density.

311.07 TOLERANCE IN THICKNESS

The Inspector should consult the Thickness Determination Schedule contained in the IDOT [Documentation of Contract Quantities](#).

SECTION 312. STABILIZED SUBBASE

312.01 DESCRIPTION

This work consists of furnishing, placing and compacting an HMA stabilized subbase on a Cement Aggregate Mixture (CAM II) on a prepared subgrade.

312.02 GENERAL

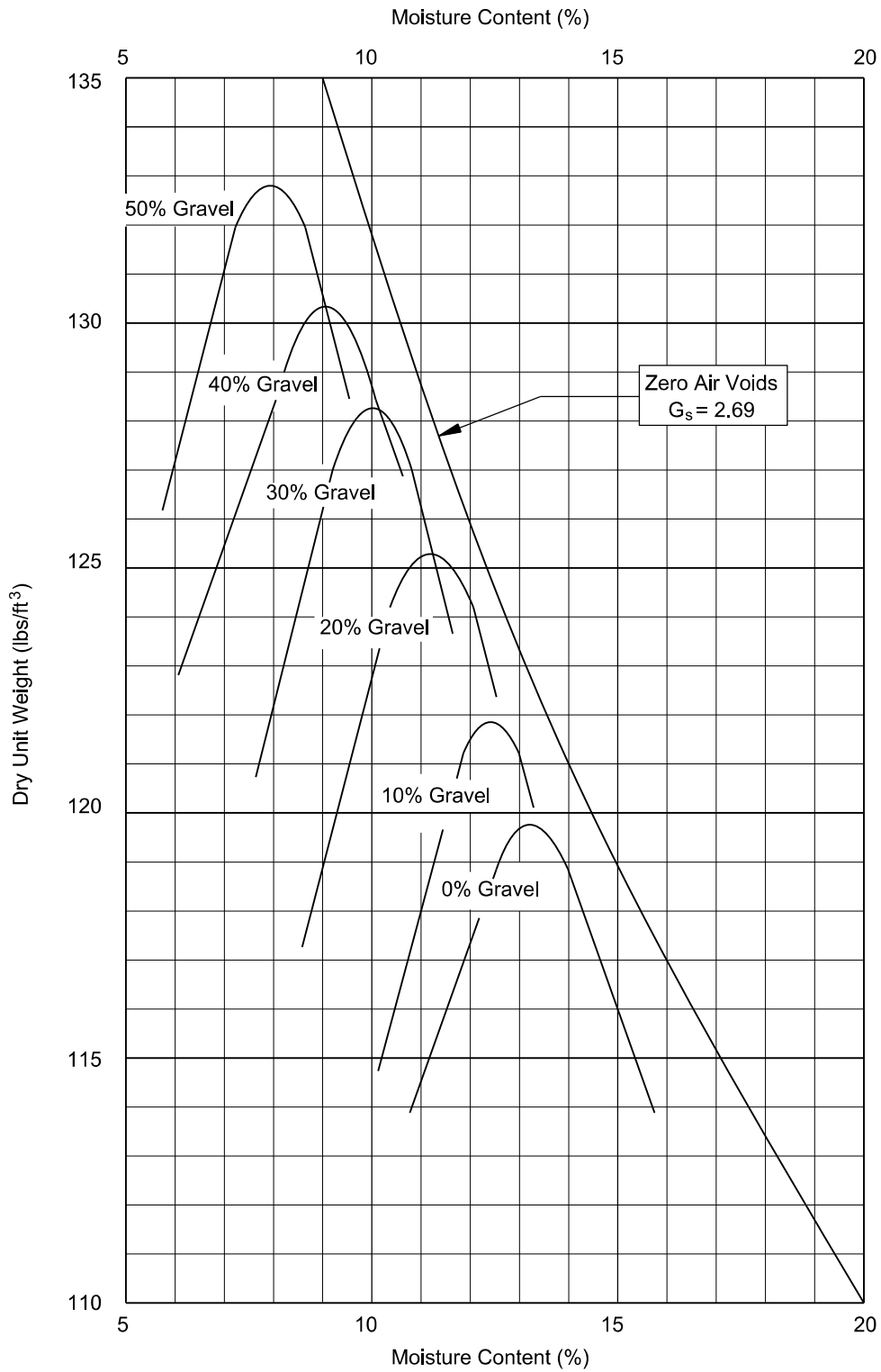
No stabilized subbase should be constructed that cannot be surfaced during the current construction season, because stabilized subbases and the respective subgrades tend to deteriorate when left exposed to the elements over the winter months.

Refer to the [Construction Inspector's Checklist for Stabilized Subbase](#).

312.14 TOLERANCE IN THICKNESS

The Inspector should consult the Thickness Determination Schedule contained in the IDOT Documentation of Contract Quantities.

Figure 301-15 — EXAMPLE MOISTURE DENSITY CURVE FOR AGGREGATE



SECTION 351. AGGREGATE BASE COURSE

351.01 DESCRIPTION

Aggregate base course is generally used as a foundation for flexible surfaces. Ensure that the crown and superelevation have been constructed as shown on the plans.

351.02 MATERIALS

Inspect the aggregate as it is delivered and placed. Ensure that there are no foreign substances (e.g., chunks of wood, weeds, (especially) clay balls, lumps of dirt) and that the material has been inspected and approved. If there are any doubts on the quality of the material that is being delivered or if segregation is quite prominent, consult your supervisor.

351.03 EQUIPMENT

Although not specifically listed in Article 351.03 of the *Standard Specifications*, the Contractor may at its option elect to use a spreading and finishing machine (Paver) as specified in Article 1102.03 to place the aggregate base course.

351.05 BASE COURSE

351.05-1 General

The Contractor should begin the aggregate placing operations with lifts that will not be greater than 4 in. (100 mm) when compacted. Generally, a loose measurement of about 6 in. (150 mm) will result in a compacted thickness of 4 in. (100 mm). If tests show that the specified density is obtained, the compacted thickness may be increased to 8 in. (200 mm). The spreader must be capable of placing the aggregate the full width of one lane and to the desired thickness for one lift. Do not permit the aggregate to be deposited in excessive thicknesses in one lane with the top half of the material then bladed to the adjacent lane.

Article 351.05 requires a minimum of blading and manipulation. If blading and manipulation is necessary to achieve proper crown, ensure that there is sufficient moisture present in the material to prevent segregation.

351.05-2 Type A

Visit the plant and inspect the mixing operation. Ensure that the water and aggregate are being mixed to provide a uniformly moist product. Material that is either too dry or too wet will not compact well when rolled.

It is possible to obtain density (but not stability) at a moisture content higher or lower than optimum. Identify the appropriate ranges from optimum moisture. If the material was deposited on the subgrade or prior lift of base, and the desired density was not obtained, the aggregate can be aerated or watered down in place to obtain required density of 100 percent. This is only for those isolated cases when material was inadvertently placed in too wet or too dry condition.

The roller should follow as closely behind the spreader as possible. If the base is pumping, cracking or showing other signs of failure, determine the magnitude of the failure. It may be easily corrected.

It is extremely important to allow previously placed lifts of aggregate base to cure or dry out before placing additional lifts. Placing multiple lifts of aggregate base without allowing proper cure time for the lower lifts can cause severe pumping and lead to much longer cure times and delay the paving schedule for the surface course.

Water should be added at the plant until optimum moisture content is obtained. If already placed on the subgrade, water should be added with a water truck and re-compacted as necessary. Allow the aggregate to dry out completely before placing additional lifts of granular base course. Avoid placing wet granular subbase material in areas that cannot drain. This can cause instability when the moisture in the aggregate cannot escape. Cut weep holes to allow for drainage if unavoidable. See Section 311.05 for additional information on moisture-density curves with typical moisture content range.

351.05-3 Type B

Water for Type B base course may be added after the aggregate has been placed on the grade. It will be more difficult to obtain uniform moisture content by this method than by the pug mill method. Close inspection throughout the operation will help provide the desired product.

There is no numerical density requirement for Type B base course. Compaction is to the satisfaction of the Resident.

351.06 TOLERANCE IN THICKNESS

Refer to the Thickness Determination Schedule contained in the IDOT Documentation of Contract Quantities for thickness determination policies.

SECTION 352. SOIL-CEMENT BASE COURSE

352.01 DESCRIPTION

The soil-cement base course is generally used as a foundation for a bituminous surface. The construction of a soil-cement base course consists of processing soil, cement and water either mixed in place on the roadbed or by a traveling mixing plant.

352.09 DRY MIXING

When using multiple base mixing equipment, the soil and cement should be satisfactorily mixed prior to the addition of water. Once the dry mixing process has started, all operations through the compaction of the mixture should be continuous without interruption.

352.10 MOIST MIXING

Consider the following for moist mixing:

1. With Equipment Other Than a Traveling Mix Plant. Processing the soil-cement mixture with a multiple pass mixer may require the addition of water in several increments to provide the optimum moisture required for mixing and compaction. Article 352.10 provides the range of moisture content for various soils used in the soil-cement mixture and should be followed to obtain a satisfactory result.
2. With a Traveling Mix Plant. A traveling mixing plant is designed so that the addition of water and the mixing of soil, cement and water are obtained in one pass of the equipment. If proper mixing is not obtained in one pass, have the Contractor reduce the forward speed of the machine to improve the mixing.

352.11 COMPACTION AND FINISHING

Compaction of the soil-cement mixture is a continuation of the moisture mixing operation and should be conducted uninterrupted after moist mixing is completed. It is important that the edges of the soil-cement base course be compacted in addition to the remaining portions of the base course to prevent failures along the edges.

352.13 PROTECTION AND COVER

The soil-cement base course is provided with a protective cover of bituminous material to protect against loss of moisture or abrasion by traffic during the 7-day curing period. Any damage to the protective coat by construction equipment or other traffic must be corrected by the Contractor.

If the air temperature is expected to reach the freezing point during the curing period, cover the base with straw to protect against freezing.

SECTION 353. PORTLAND CEMENT CONCRETE BASE COURSE

353.03 EQUIPMENT

Prior to starting the placing of any concrete, ensure that the required equipment is available and in good working condition. Check the plan cross section of the pavement to ensure that it can be obtained. The finishing machine should be carefully checked to ensure that the screed is adjustable and will alternate in and out of superelevation accurately and provide the desired pavement slope at all times. The subgrade ahead of the paver should be checked by stringline or other methods to ensure that the proper thickness of the pavement will be obtained.

353.11 SURFACE TEST

Portland cement concrete base course is usually overlaid with a bituminous material. To obtain reasonable control of the quantities specified for the bituminous material and a satisfactory finish, place the concrete base course to the plan grade.

Use a 16-ft straightedge (bump buggy) to check the smoothness of the surface. Perform periodic inspection to ensure that there are no bumps greater than $\frac{3}{8}$ in. If there are deficiencies in the base course, instruct the Contractor to correct the base course.

353.12 TOLERANCE IN THICKNESS

See Section 407.10(b) for coring requirements.

Refer to the Thickness Determination Schedule contained in the IDOT Documentation of Contract Quantities, PCC Base Courses, for thickness determination policies.

SECTION 354. PORTLAND CEMENT CONCRETE BASE COURSE WIDENING

354.04 GENERAL

During excavation, ensure that the Contractor avoids damaging the existing edge of pavement. Inspect the existing edge of pavement to ensure that the edge is clean of all loose material before rolling and checking of the subgrade for the required thickness.

354.05 SUBGRADE

After the subgrade has been excavated, check with a stringline to ensure that the specified thickness can be obtained. The subgrade should not be disturbed during the paving operation.

354.06 CONSTRUCTING WITHOUT FORMS

It is important that the consistency of the concrete be as uniform as possible so that the edges will not slump with the movement of the equipment.

354.07 CONSTRUCTING WITH FORMS

Prior to placing the paving forms, check the grades to ensure that the proper slope of the base course widening is being attained. The form line should be smooth, and the forms inspected before the concrete is placed.

354.09 TOLERANCE IN THICKNESS

See Section 353.12 for tolerance in thickness.

SECTION 356. HOT-MIX ASPHALT BASE COURSE WIDENING

356.05 SUBGRADE

Prior to placing any hot-mix asphalt, the subgrade should be rolled and compacted, and the widening depth checked with a stringline or template to verify that the depth has been obtained.

356.06 PLACING

Inspect the existing edge of pavement to ensure that the edge is clean of all loose material before rolling and inspect the subgrade for the required thickness. Keep traffic off the new widening until the HMA base course has cooled sufficiently to support traffic.

356.08 TOLERANCE IN THICKNESS

See Section 353.12 for tolerance in thickness.

DIVISION 400

Surface Courses, Pavements, Rehabilitation, and Shoulders

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 400. DEFINITIONS	400-1
SECTION 402. AGGREGATE SURFACE COURSE	400-2
402.05 TYPE A REQUIREMENTS.....	400-2
402.07 TYPE B REQUIREMENTS.....	400-2
SECTION 403. BITUMINOUS SURFACE TREATMENT (CLASS A-1, A-2, A-3).....	400-2
403.10 APPLICATION OF BITUMINOUS MATERIAL	400-2
403.12 COVER COAT.....	400-3
403.13 SEAL COAT	400-3
SECTION 406. HOT-MIX ASPHALT BINDER AND SURFACE COURSE.....	400-5
406.01 DESCRIPTION.....	400-5
406.01-1 General.....	400-5
406.02 MATERIALS	400-5
406.02-1 Bituminous Materials	400-5
406.03 EQUIPMENT	400-5
406.03-1 General.....	400-5
406.03-2 Pavers	400-7
406.03-3 Rollers	400-9
406.03-4 Trucks.....	400-10
406.04 KEEPING ROAD OPEN TO TRAFFIC.....	400-10
406.05 PREPARATION, TACKING OR PRIMING, AND LEVELING OF BRICK, CONCRETE, HMA OR AGGREGATE BASES	400-11
406.06 PLACING.....	400-11
406.06-1 General.....	400-11
406.06-2 Pre-Paving Procedures/Planning	400-12
406.06-3 Common Construction Problems.....	400-13
406.06-4 Paving Inspector's Guidelines	400-13

406.06-5	Layout of Pavement	400-14
406.06-6	Spreading and Finishing.....	400-14
406.06-7	Transverse Joints	400-15
406.07	COMPACTION	400-15
406.07-1	General.....	400-15
406.07-3	Frequency Control.....	400-17
406.07-4	Rollers	400-17
406.07-5	Density Tests.....	400-18
406.11	SURFACE TESTS.....	400-19
406.14	BASIS OF PAYMENT	400-19
406.14-1	General (Tack Coat).....	400-19
406.14-2	Payment Procedures.....	400-20
406.14-3	Example to Calculate Residual Amount of Asphalt from an Emulsion	400-21
406.14-4	Example to Calculate Residual Amount of Asphalt from a Cut Back	400-21
SECTION 407.	HOT-MIX ASPHALT PAVEMENT (FULL DEPTH)	400-22
407.01	DESCRIPTION.....	400-22
407.05	SUBGRADE	400-22
407.06	PLACING.....	400-23
407.08	HAULING ON THE PARTIALLY COMPLETED FULL-DEPTH PAVEMENT	400-23
407.09	SURFACE TESTS.....	400-23
407.10	TOLERANCE IN THICKNESS	400-28
407.10-1	General.....	400-28
407.10-2	Coring Operations	400-28
407.10-3	Right of Discovery	400-28
407.10-4	For Pay Items Cored in Accordance with Article 407.10(a).....	400-29
407.10-5	For Pay Items Cored in Accordance with Article 407.10(b).....	400-32
SECTION 408.	INCIDENTAL HOT-MIX ASPHALT SURFACING.....	400-34
408.01	DESCRIPTION.....	400-34
SECTION 420.	PORTLAND CEMENT CONCRETE PAVEMENT.....	400-35
420.01	DESCRIPTION.....	400-35
420.01-1	Pre-Paving Conference	400-35

420.01-2	Introducing the Department’s Inspection Crew.....	400-36
420.01-3	Documentation	400-36
420.02	MATERIALS	400-37
420.03	EQUIPMENT	400-37
420.04	PREPARATION OF SUBGRADE OR SUBBASE	400-37
420.05	JOINTS.....	400-38
420.05-1	Purpose	400-38
420.05-2	Issues	400-38
420.05-3	Contractor Responsibilities.....	400-38
420.05-4	Timing of Sawing	400-39
420.05-5	Dowel Bar Assemblies	400-39
420.05-6	Tie Bars	400-42
420.07	PLACING (STATIONARY SIDE FORMS).....	400-42
420.07-1	General.....	400-42
420.07-2	Hot Weather Concreting	400-43
420.07-3	Protection in Case of Rain.....	400-43
420.09	STRIKE OFF, CONSOLIDATION, FINISHING, LONGITUDINAL FLOATING, STRAIGHTEDGING, EDGING AND FINAL FINISH	400-44
420.09-1	Finishing Concrete	400-44
420.09-2	Tining.....	400-46
420.09-3	Curing.....	400-47
420.10	SURFACE TESTS.....	400-48
420.12	SEALING JOINTS	400-48
420.14	SLIP FORM METHOD	400-48
420.14-1	General.....	400-48
420.14-2	Equipment	400-48
420.14-3	Pavement Subbase	400-50
420.14-4	Finishing	400-51
420.14-5	Edge Slump.....	400-51

420.15	TOLERANCE IN THICKNESS	400-51
SECTION 421. CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT.....		400-51
421.01	DESCRIPTION.....	400-51
421.03	EQUIPMENT	400-51
421.04	GENERAL	400-52
SECTION 424. PORTLAND CEMENT CONCRETE SIDEWALK.....		400-53
424.01	DESCRIPTION.....	400-53
SECTION 440. REMOVAL OF EXISTING PAVEMENT AND APPURTENANCES		400-54
440.01	DESCRIPTION.....	400-54
440.02	EQUIPMENT	400-54
SECTION 442. PAVEMENT PATCHING		400-55
442.01	DESCRIPTION.....	400-55
442.01-1	Process	400-55
442.01-2	Types.....	400-55
442.09	OPENING PATCHES TO TRAFFIC.....	400-55

LIST OF FIGURES

Figure	Page
Figure 400-1 — PUGMILL	400-2
Figure 400-2 — DISTRIBUTOR TRUCK APPLYING PRIME COAT	400-3
Figure 400-3 — SPREADING AGGREGATE.....	400-4
Figure 400-4 — ROLLING COVER COAT AGGREGATE WITH RUBBER-TIRED ROLLERS	400-4
Figure 400-5 — ANTI-SEGREGATION DEVICES	400-6
Figure 400-6 — PAVING TRAIN WITH MATERIAL TRANSFER DEVICE	400-6
Figure 400-7 — PAVING TRAIN WITH MATERIAL TRANSFER DEVICE	400-7
Figure 400-8 — BITUMINOUS PAVER SCHEMATIC.....	400-8
Figure 400-9 — CEDAR RAPIDS PAVER	400-9
Figure 400-10 — VIBRATORY ROLLER	400-10
Figure 400-11 — APPLYING BITUMINOUS TACK COAT ON A MILLED SURFACE.....	400-11
Figure 400-12 — DENSITY TESTING WITH A NUCLEAR GAUGE.....	400-18
Figure 400-13 — 16-FT STRAIGHTEDGE.....	400-19
Figure 400-14 — CORING HMA PAVEMENT AT A RANDOM LOCATION	400-30
Figure 400-15 — 2-IN. DIAMETER CORE BEING MEASURED IN A CORE MEASURING DEVICE	400-31
Figure 400-16 — CONCRETE BATCH PLANT.....	400-37
Figure 400-17 — DOWEL BASKET ASSEMBLIES ON CAM II STABILIZED SUBBASE. Error! Bookmark not defined.	
Figure 400-18 — DOWEL BASKET ASSEMBLIES, PINNED SAND PLATE	Error! Bookmark not defined.
Figure 400-19 — DOWEL BASKET ASSEMBLIES ON AGGREGATE SUBBASE	Error! Bookmark not defined.
Figure 400-20 — CONCRETE PAVER WITH DOWEL BAR INSERTER (DBI).....	400-41
Figure 400-21 — CONCRETE FINISHING MACHINE RIDING ON SIDE FORMS	400-42
Figure 400-22 — TEXTURING MACHINE WITH ROLLED UP TARP IN CASE OF RAIN.....	400-44
Figure 400-23 — MECHANICAL FLOATING	400-45
Figure 400-24 — TUBE FLOATING	400-45
Figure 400-25 — FINISHING PCC CONCRETE PAVEMENT.....	400-46
Figure 400-26 — TINING PCC PAVEMENT WITH RANDOM SPACING.....	400-46
Figure 400-27 — MEMBRANE CURING FOR SLIPFORM PAVEMENT	400-47
Figure 400-28 — SLIP FORM PAVER WITH DBI ATTACHMENT	400-49
Figure 400-29 — CONCRETE PAVER WITH TIE BAR INSERTER.....	400-49
Figure 400-30 — UNDERSIDE OF CONCRETE PAVER	400-50
Figure 400-31 — CRCP PAVING.....	400-52
Figure 400-32 — ACCESSIBILITY-COMPLIANT CURB RAMP	400-53
Figure 400-33 — MILLING OPERATIONS.....	400-54
Figure 400-34 — CLASS A PATCHING	400-56
Figure 400-35 — CLASS B PATCHING.....	400-56
Figure 400-36 — CLASS C PATCHING.....	400-57
Figure 400-37 — CLASS D PATCHING.....	400-57

Division 400

SURFACE COURSES, PAVEMENTS, REHABILITATION AND SHOULDERS

SECTION 400. DEFINITIONS

1. Method of Acceptance. Refers to the means of determining whether material supplied is in compliance with specifications. See Section 200.05 of the [Project Procedures Guide \(PPG\)](#).
2. Quality Control/Quality Assurance (QC/QA) Programs. Materials sampling and acceptance testing programs that allow Contractor QC sampling and testing in conjunction with the Department's QA and independent assurance sampling and testing.
3. Quality Control (QC). Materials sampling and testing performed as process control to ensure specification compliance. Performed a) by the Contractor, producer or consultant under QC/QA programs, and b) by the Inspector under non-QC/QA programs. The Contractor is responsible for quality control (QC). The Contractor's QC procedures are intended to produce materials meeting specification requirements and to identify and correct deficient materials before they are permanently incorporated into the work.
4. Quality Assurance (QA). Materials sampling and testing performed by the Inspector that validates the quality of the product and verifies the producer's Quality Control process. Sometimes, Contractors rely upon the Department's quality assurance (QA) test results as their own QC before making any changes to their own operations. However, the Department's QA process should not be considered a substitute for the Contractor's QC procedures.
5. Performance-Related Specifications. Specifications that use quantified quality characteristics and Life Cycle Cost (LCC) relationships that are correlated to product performance.
6. Pay for Performance (PFP). Consistent with Performance-Related Specifications. PFP principles include:
 - Simple statistical measures to determine the amount of product within specific limits
 - Uses Percent within Limits (PWL) approach to adjust pay to Contractors based on compliance with specifications
 - Samples are secured and tested by owner
7. Percent Within Limits (PWL). The percentage of material within the quality limits for a given quality characteristic.

8. Quality Control for Performance (QCP). Used where there are insufficient test results to accurately characterize product through PFP and have to rely upon the Contractor QC.
9. Quality Characteristic. The characteristics that are evaluated by the Department for payment using PWL. The quality characteristics for a typical project are field Voids in the Mineral Aggregate (VMA), voids and density.
10. Quality Level Analysis (QLA). QLA is a statistical procedure for estimating the amount of product within specification limits.

SECTION 402. AGGREGATE SURFACE COURSE

402.05 TYPE A REQUIREMENTS

Aggregate Surface Course Type A is a coarse aggregate (see Article 1004.04) that has been mixed with water in a pugmill (see Figure 400-1). See Section 351.05-2 for more discussion.

Figure 400-1 — PUGMILL



402.07 TYPE B REQUIREMENTS

Aggregate Surface Course Type B is a coarse aggregate (Article 1004.04) that has not been mixed with water in a pugmill. See Section 351.05-3 for more discussion.

SECTION 403. BITUMINOUS SURFACE TREATMENT (CLASS A-1, A-2, A-3)

403.10 APPLICATION OF BITUMINOUS MATERIAL

Hand spraying bituminous material will be permitted in inaccessible areas (e.g., narrow driveways, mail box turnouts, sidewalks). Hand spraying is more difficult to control than pressure spraying from the distributor and the material can be overrun. Precautions should be

taken prior to starting the application of the bituminous material to ensure that the equipment is functioning properly and will give uniform distribution. Unless the roadway is closed to traffic, the bituminous material should be immediately blotted with prime coat aggregate. This will prevent

pick up of the material by traffic and permit the curing of the prime coat. Excess aggregate in gutters and driveways should be removed prior to placing the surface course.

The most common method used is a tanker distributor to apply bituminous material with a tandem spreader truck for the prime coat. See Figure 400-2.

Figure 400-2 — DISTRIBUTOR TRUCK APPLYING PRIME COAT



403.12 COVER COAT

403.13 SEAL COAT

A cover coat and seal coat are important for embedment of the aggregate into the bituminous material. The aggregate must be spread and rolled immediately following the bituminous application. Check the aggregate spreader to ensure that it is operating properly.

See Figures 400-3 and 400-4.

Figure 400-3 — SPREADING AGGREGATE



Figure 400-4 — ROLLING COVER COAT AGGREGATE WITH RUBBER-TIRED ROLLERS



SECTION 406. HOT-MIX ASPHALT BINDER AND SURFACE COURSE

406.01 DESCRIPTION

406.01-1 General

A Hot-Mix Asphalt (HMA) should be stable, dense and durable. The following documents contain additional information pertaining to HMA:

- [Construction Inspector's Checklist for HMA Binder and Surface Course](#)
- [Construction Inspector's Checklist for HMA Pavement \(Full Depth\)](#)
- [Construction Inspector's Checklist for HMA Shoulders](#)
- Section 109.01-3 – Weight Checks
- Appendix A, Construction Memorandum No. 22 – Procedures for Applying the Bituminous Materials Cost Adjustment
- Appendix A, Construction Memorandum No. 40 – Rubblizing PCC Pavement and Placing a Bituminous Concrete Overlay

406.02 MATERIALS

406.02-1 Bituminous Materials

The Resident should consider the following issues with respect to bituminous material for HMA:

- Plant reports should be reviewed to ensure that the HMA conforms to the contract documents.
- The compaction temperature requirements vary between a QC/QA, QCP and PFP specification. The HMA should be checked for conformance to the correct specification.

406.03 EQUIPMENT

The Contractor is responsible for ensuring that the paving equipment meets all requirements. The following discussion provides guidelines for the inspection of equipment.

406.03-1 General

Each piece of the Contractor's equipment should be observed for condition, power and obvious defects. Deficiencies in the condition of various pieces of equipment, if discovered and corrected before paving starts, will help in avoiding delays caused by equipment malfunction later.

Figures 400-5, 400-6 and 400-7 present representative examples of HMA paving equipment.

Figure 400-5 — ANTI-SEGREGATION DEVICES

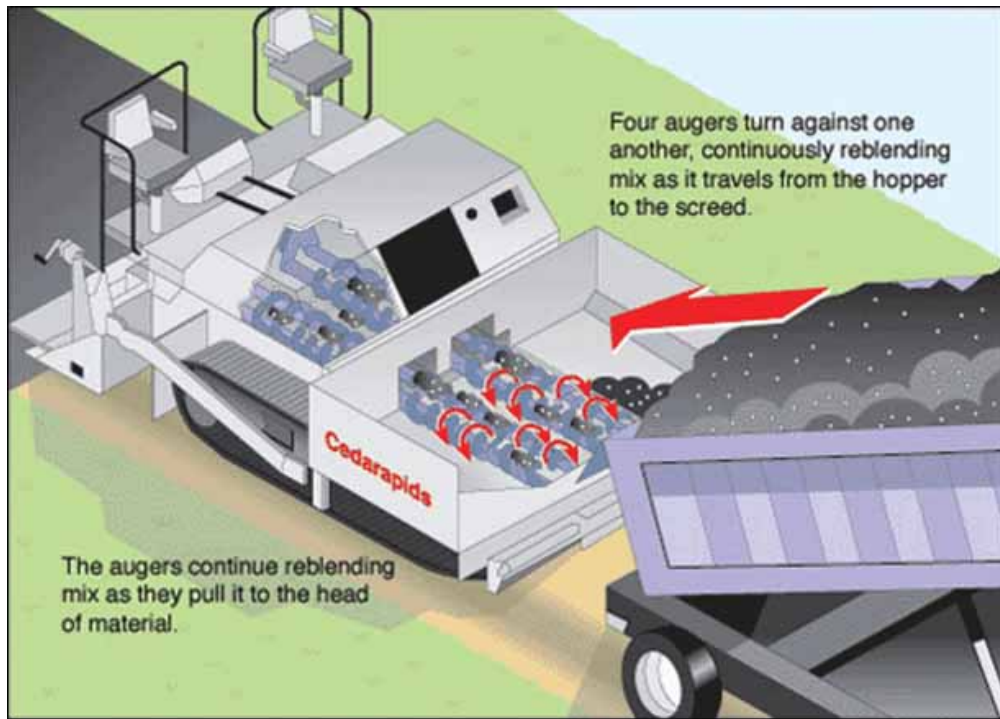


Figure 400-6 — PAVING TRAIN WITH MATERIAL TRANSFER DEVICE



Figure 400-7 — PAVING TRAIN WITH MATERIAL TRANSFER DEVICE

406.03-2 Pavers

The details of the various adjustments to be made on each type of paver are shown in the specific manufacturer's handbook. The Inspector should become familiar with the mechanical features on the type of paver being used so that an appraisal of the condition and adjustment of the machine may be made. The Department does not maintain a qualified list of equipment. It is the Resident's responsibility to ensure that the equipment meets the specifications and is in good working order.

A paving machine with loose controls will cause jerky or erratic operation of the screeds, tracks, etc. In general, paving machines should have approximately 1/16 in. to 1/8 in. (1.5 mm to 3 mm) more crown in the leading edge of the screed than in the trailing edge. This will increase the ironing action and decrease the tendency for the screed to drag the material.

Most pavers need to be started with manual screed controls. Manual control is transferred to automatic control only after the attack angle of the screed has been stabilized at the desired operating speed. It is common practice to start and end the spreading operation at a slow speed, because it may be necessary to use manual control when approaching the terminal point. Refer to Article 1102.03 for spreading and finishing machine requirements.

Other items of importance to check:

- Screed plates are checked for excessive wear, proper crown and tilt adjustment
- Screed heater is operating properly
- Screed extensions are in the same true plane and made flush with the screed bottom
- Surface of the screed plates is true and in good condition
- Screed vibrators are checked to ensure that they operate and function
- Auger extensions are added when screed is extended beyond 1 in. on each side
- Anti-segregation equipment (each manufacturer has a check sheet showing what should be on the paver) 1102.03

See Figures 400-8 and 400-9.

Figure 400-8 — BITUMINOUS PAVER SCHEMATIC

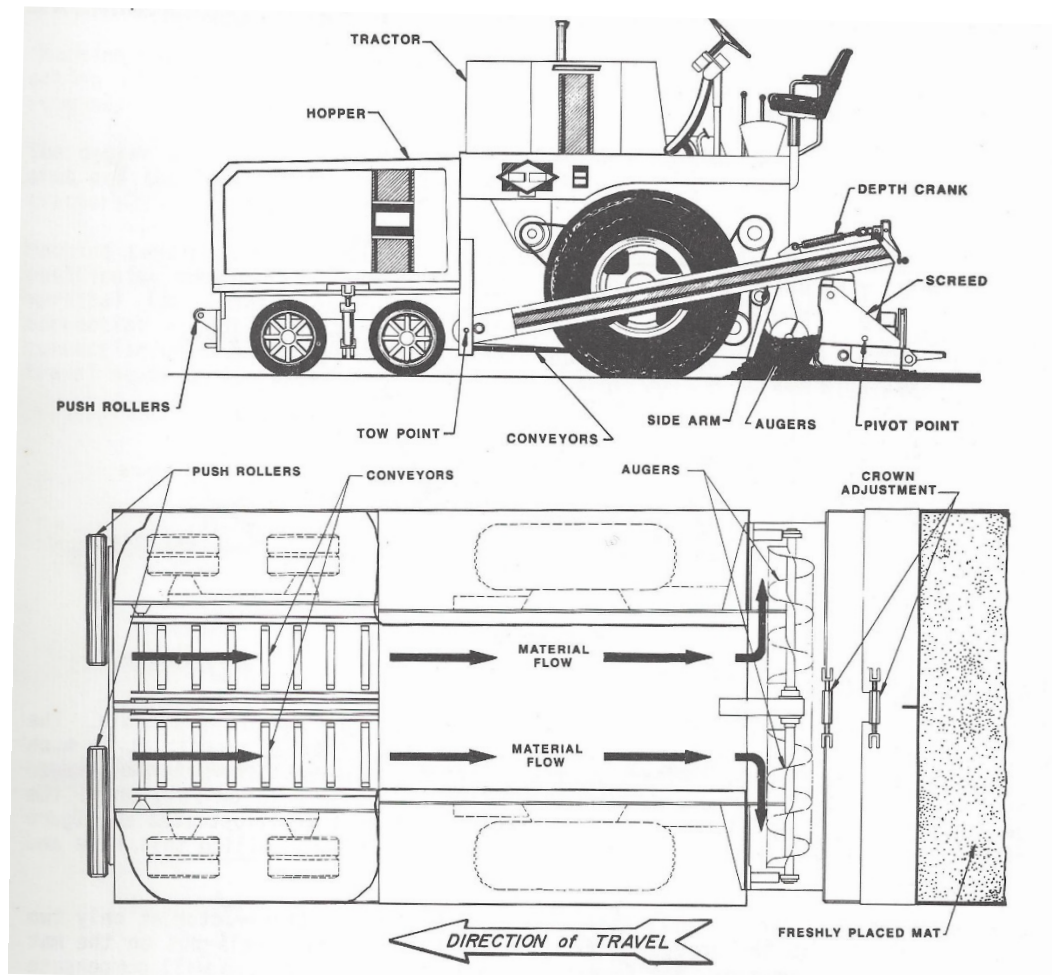


Figure 400-9 — CEDAR RAPIDS PAVER**406.03-3 Rollers**

Refer to Article 1101.01 and see Figure 400-10. Other items of importance to check include:

- Are drums on steel wheel rollers smooth and free of flat spots, ridges or grooves?
- Are pneumatic-tired rollers equipped with smooth tires of equal size, same ply and equally inflated to the proper pressure?
- Are vibratory rollers operated at speeds that do not leave a “chatter” (i.e., corrugations or “washboard” effect) in the rolled surface? Is the vibratory mechanism completely shut off when the roller is stopped or is about to stop? Breakdown or intermediate rollers should not be allowed to sit idle on a hot surface for extended periods (which will create “divots” in the mat that will not roll out).
- Are amplitude and frequency adjustments on vibratory rollers properly set?
- Are all rollers able to start, stop and reverse smoothly?
- Are all rollers equipped with cleaning devices?
- Do water sprinklers for drums on steel wheel rollers operate properly?

Figure 400-10 — VIBRATORY ROLLER



406.03-4 Trucks

The Contractor should provide a sufficient number of hauling vehicles to ensure a continuous paving operation. The truck beds should be sprayed with a light coating of a qualified (release) agent that will prevent the asphalt from adhering to the truck bed. The use of diesel fuel, gasoline or other oil that may cut the asphalt is not permitted.

Tarp should be rolled back prior to dumping, so that the Inspector can see the load before placement. Take the temperature on the HMA after placement, not in the truck before dumping.

406.04 KEEPING ROAD OPEN TO TRAFFIC

Unless specified in the contract, maintain one-way traffic during the tacking and placing of the HMA course. Traffic control to handle the one-way traffic is required by the contract and shall be in place prior to moving the equipment onto the pavement to start operations.

Discuss the Traffic Control Plan (TCP) at the pre-construction conference; see Section 701 for a detailed discussion. Due to the relatively fast movement of paving operations, most of the traffic hazards are concentrated around the paving area.

406.05 PREPARATION, TACKING OR PRIMING, AND LEVELING OF BRICK, CONCRETE, HMA OR AGGREGATE BASES

On two-lane highways open to traffic, only one lane shall be primed at a time, and the adjacent lane shall not be tacked until tack on the first lane has cured or fine aggregate has been applied so that it will not pick up under traffic. The pavement should be cleaned with a mechanical sweeper before applying the bituminous tack coat. De-bonding of the subsequent layer can result if the prepared surface does not remain clean. See Figure 400-11 for tack application.

Figure 400-11 — APPLYING BITUMINOUS TACK COAT ON A MILLED SURFACE



406.06 PLACING

406.06-1 General

If the paving operation sequence is not set forth in the contract, the Contractor should discuss a proposed sequence of paving operations with the Resident. Review first day start-up procedures, which may vary depending upon location and mix. Check with the Contractor on the paving sequence to ensure that the construction equipment on the project is of the number, size and condition required by the *Standard Specifications*.

Prior to paving operations, the HMA overlay type to be placed should be checked. If the surface is a base or subbase, a tack coat (when required) shall be applied and thoroughly cured. Correct grade and cross section on the surface should be checked. All depressions or pavement distresses should be repaired to provide a firm and unyielding paving base. If a leveling course is to be applied, the existing surface should be checked, and the roughest areas marked for proper application of the leveling binder. These actions will:

- Provide for a firm, unyielding base and a uniform thickness
- Reduce the chances for future potholes
- Avoid differential deflection
- Ensure that the proper roadway crown is provided before the HMA overlay

406.06-2 Pre-Paving Procedures/Planning

The day prior to the HMA laydown, a meeting should be held with the Supervising Field Engineer, Resident and Contractor to discuss the procedures, guidelines and equipment to be used and to ensure that the rollers meet contract requirements.

If the test strip evaluation indicates that changes need to be made in the mix, another test strip may be required. If the evaluation shows the mix to be satisfactory, the roller pattern will then be established.

Less compactive effort is not a solution to too much density. A mix with excess density potential, as identified by a growth curve, should not be used. Data associated with development of the growth curve should be clearly documented.

The following items should be evaluated before any HMA paving project begins:

- Tonnage
- Those HMA properties that significantly impact the pavement's service life:
 - + temperature variation
 - + segregation
 - + compaction
 - + stability
- Joints
- Traffic control
- Basic laydown practices

Before paving operations begin, the following should be discussed with the Contractor:

- How the plant and paving operations will be conducted?
- How the work will be sequenced?
- How quality control will be performed?
- What are the lines of authority?
- What equipment will be used?
- What contingency plans are in place for equipment failures?
- How the test results will be reported to the Contractor?
- Who will be responsible for each type of test?
- How roadway grades will be controlled?
- Any areas of the project that require special treatment?
- How random sample times and locations will be established?
- How cold joints will be constructed?
- How weather conditions will impact paving operations?
- How traffic control will be addressed (e.g., short-term pavement marking, signing)?

406.06-3 Common Construction Problems

Some common difficulties encountered that can be traced to improper paving operation or incorrect machine adjustment are:

- A wavy surface with short, choppy waves can be caused by poorly adjusted tracks or drive chains, the truck driver setting the brakes too tight if dumping directly into the paver's hopper or an excessive rate of travel by the paving machine.
- A wavy surface with long waves can be caused by allowing the screed to settle by continual stopping and starting of the paving machine while waiting for the next load of mix to arrive, excessive variation in the quantity of mix carried in the auger box ahead of the screed, rolling too early, rolling too fast or over-controlling the screed. Ideally, the paver should remain in motion at all times while the mix is being placed.
- Mix with an open surface can be caused by improper adjustment of the screed, rough or worn screed plate, or too fast a rate of travel of the paving machine.
- A varying surface texture may be caused by insufficient mixing, over-mixing, overheating of the mix, segregation of the mix or a worn or damaged screed plate.
- Bleeding patches on the surface can be caused by too much asphalt, asphalt not uniformly mixed or excessive moisture in the mix. Excessive moisture in the mix is also apparent when small bubbles appear on the coarse rocks in the mix, the mix slumps in the truck beds, or bubbles or blisters appear immediately behind the paver.
- Irregular rough spots in the pavement can be caused by rollers standing on the fresh surface, abrupt reversing of the roller, trucks backing into the paver or poor workmanship at transverse joints.

All such observations, conditions, issues, etc., should be documented.

406.06-4 Paving Inspector's Guidelines

The following list presents good practices that the Contractor should follow and that the Inspector should observe:

- Each piece of equipment intended for use on the work should be in good repair and proper adjustment. See Section 406.03 for more discussion.
- Ensure that provisions for traffic control are well organized and that traffic control is functioning properly with the correct signs and sign sizes in their proper position.
- Check if the paver guidelines for maintaining proper horizontal control for has been set properly.
- Has soundness of the base material ahead of paver been inspected?

- Check the longitudinal and transverse joints for smoothness and appearance. Also, check to see that longitudinal joints do not fall in wheel paths, unless otherwise approved.
- Make frequent checks of the material temperature.
- Inspect the mat behind the paver for signs of a non-uniform mixture.
- Observe the rolling operation to be sure that the sequence is correct for existing conditions, the proper rolling methods are being used, and the rollers are being operated within a reasonable speed range. Check the mat for the correct thickness and that proper adjustments are being made.
- Make frequent yield checks and keep records of truckloads used each day. The yield should be checked on a routine basis as stipulated in the IDOT [Documentation of Contract Quantities Guide](#). Then check with the plant Inspector concerning the daily totals and reconcile the quantities as soon as practical.

All such observations, conditions, issues, etc., should be documented.

406.06-5 Layout of Pavement

Before paving, the Inspector should check the following:

- Existing pavement conditions
- Existing cross slope
- Lengths, widths, etc.

406.06-6 Spreading and Finishing

Reference: Article 406.06(e)

406.06-6(a) General

The bituminous mixture is spread and finished by a self-propelled paver. In irregular areas, the mixture may be spread and finished by hand.

To achieve these results, the base, mixture, surface texture, rolling operation and paved surface must be continuously checked. The finished surface should be checked for crown and smoothness by using a carpenter's level and string line.

As the trucks arrive with the mixture, each ticket should be reviewed and checked, and each truck should be inspected for leaking fluids that could contaminate the mat. Each truck load of mixture should be inspected for uniformity.

As the paver proceeds, the grade or thickness control device shall be adjusted to give the thickness required by the plans. Because continuity of paving operations is essential to securing a quality pavement surface, the optimum paver speed is controlled by the coordination of roller capabilities and plant production, within specification limits. By inspecting the surface texture

behind the machine, and checking the surface with a straightedge, a malfunction in the paver operation or segregation of mixture may be detected.

406.06-6(b) Paver Movement

Continuous paver movement is essential to a smooth riding surface. Paver movement must be coordinated with both roller speed and plant production. Frequent start-stop operation of the paver should not be permitted.

When the paver is trying to keep up with waiting truckloads of material, it is difficult to cover the mat with the established roller pattern. Usually, the faster the paver runs, the lower the mat density will be behind the paver with a given rolling pattern/speed. Therefore, if a paver is permitted to run faster, additional compactive effort will be needed to achieve density and usually requires an additional vibratory roller.

406.06-7 Transverse Joints

Reference: Article 406.06(g)(1)

A butt joint (Article 406.08) is a transverse joint of a permanent nature. A temporary transverse joint can be opened to traffic with the appropriate ramp taper. A paper joint is a temporary transverse joint used between successive days of paving.

Many methods are used by Contractors to construct transverse joints. Transverse joints are built by cutting back on the HMA just placed to where the course is exposed to its full depth, or by the use of a wooden header. However, a wooden header should be checked with a straightedge before the joint is completed. Wooden headers used in low stability mixes can shove ahead during rolling operations. If shoving does occur, the mat thickness will be too thin, and the material must be trimmed as though no wooden header was used.

Temporary transverse joints are usually constructed by hand. The most common method is to end the paving lift with a paper joint that is cut vertically. Cover the vertical face with roofing paper, and place HMA over it to form a ramp at the required ratio on roadways under traffic, as well as at bridge ends. The next day, the material over the roofing paper is removed to expose the vertical face, and the area is cleaned and tacked before paving resumes.

406.07 COMPACTION

406.07-1 General

Adequate compaction is vital to the success of HMA pavements. Good compaction can often offset some of the other deficiencies and lead to a long-lasting durable pavement. HMA pavements are designed to achieve a critical range of effective voids in the mix when compacted as specified. Too much or too little compaction can be harmful to the long-term performance of the pavement.

The effective use of vibratory rollers for compaction of HMA depends on the following major factors:

- Lift thickness
- Roller and paver speeds
- Total applied force (sum of static and dynamic)
- Frequency
- Amplitude
- Condition of equipment

To obtain optimum results of density and smoothness requires an understanding of the interaction of the above factors. For example, an improper balance of amplitude and frequency can result in a marginal density and/or a rough surface.

The total applied force is the sum of the dynamic force and the static weight force. The formula for dynamic force is:

$$\frac{wrf^2}{35235}$$

Where:

- w = weight of eccentric
- r = radius of weight
- f = velocity of frequency of eccentric

406.07-2 Compaction Problems

If the specified compaction requirements cannot be met, this may be due to one or both of the following reasons:

- The mix is stiff and difficult to compact.
- The mix is tender and can be over-rolled before compaction is attained.

Several other factors may affect how well a plant mix is compacted. The following may influence the ability to compact a lift:

- Air temperature and wind speed
- Temperature of the mix and underlying pavement during the compaction process
- Lift thickness
- High stability/low flow mixture
- A very fine-graded mix or one with well-rounded fine aggregate
- Type and number of compaction equipment, including ballasted weight
- Sequence and timing of compaction equipment
- Operation of equipment including:

- + speed (should be operated within the manufacturer's recommended speeds)
- + tire pressures on pneumatic rollers
- + frequency and amplitude on vibratory rollers

- Inconsistent compaction effort (constant stopping/starting of the laydown machine results in some areas receiving greater rolling than others and inconsistencies in temperature during rolling)

- Plant production rate

The Inspector should document these issues. Regardless of the underlying reason(s), inadequate plant mix pavement compaction is the Contractor's responsibility, and the Resident must enforce the specifications.

406.07-3 Frequency Control

The frequency vibration is controlled by engine speed not roller speed. Manufacturers show frequency as a function of engine rpm, which is normally shown on the rpm dial. A vibrating reed tachometer should be available from the Contractor or the Resident to measure the operating frequency of the roller.

406.07-4 Rollers

Reference: Articles 406.07(a) and (b)

The following discussion relates to recommended methods to attain proper compaction. This is the Contractor's responsibility. It is provided to the Inspector for informational purposes.

Rolling should start as soon as possible after the material has been spread by the paver. During rolling, the roller drums should be kept moist with only enough water to avoid picking up the material. Rollers should move at a slow but uniform speed with the drive wheel nearest the paver. Rollers should be capable of being reversed without backlash. If rolling causes displacement of the material, the affected areas should be loosened at once and restored to the original grade with loose material before being recompact. Heavy equipment including rollers should not be permitted to stand on the finished surface before it has thoroughly cooled.

Establish roller patterns during start-up operations on all HMA mixtures. A pattern of rolling that will provide the most uniform coverage of the lane being paved should be used. Rollers are produced in varying widths, and no one pattern applies to all of them. For this reason, the best rolling pattern for each roller being used should be determined to obtain the most uniform compaction across the lane.

The breakdown roller should be kept reasonably close to the paver. When HMA shoulders are placed simultaneously with the adjacent lane, compaction on both the pavement and shoulder must be considered when establishing the rolling pattern. An additional roller may be required on the shoulder to obtain density at the paver's operating speed.

A pass of the roller is defined as one trip of the roller in one direction over any one spot. One roller pass does not necessarily cover the whole width of the mat. When establishing a rolling pattern, there must be an odd number of passes and usually cannot be one. Three, five, seven and sometimes nine roller passes are typical during the paving operation. Additional rollers may be required to achieve the desired density with the number of passes required determined from the test strip and paver speed.

Vibratory roller speed and the frequency of vibration must be matched to prevent transverse ridges that result from widely spaced impacts. A vibratory roller operated at excessive speeds, producing impacts less than 10 blows per ft. (30 blows per m), results in a rough, choppy surface.

Maximum vibratory roller speed can be calculated using the following formula:

$$\text{Max. Roller Speed} = \text{ft./min (m/min)} = \frac{\text{VPM}}{10 \text{ impacts / ft (30 impacts / m)}}$$

Where:

VPM = Vibrations per minute (measured in field by reed tachometer)

406.07-5 Density Tests

Reference: Article 406.07(c)

Over densification is one major cause of HMA problems. Mixtures that are over compacted will likely result in channeling and flushing under traffic. A nuclear density device can provide a quick indication of mix problems. See Figure 400-12 for density testing with a nuclear gauge. The proper density for a given mixture is dependent on the mix type used. These are listed in Section 1030 of the *Standard Specifications*.

Figure 400-12 — DENSITY TESTING WITH A NUCLEAR GAUGE



406.11 SURFACE TESTS

The Department uses a bump buggy or straightedge to check the surface smoothness of most new pavement overlays (the smoothness specifications should be checked for your contract to determine what smoothness check applies). See Figure 400-13.

Figure 400-13 — 16-FT STRAIGHTEDGE



406.14 BASIS OF PAYMENT

406.14-1 General (Tack Coat)

To accurately pay for tack coat material placed on the pavement surface, the quantity measured for payment will be the actual residual amount of asphalt applied. The volume of the cutback or emulsion used, and any water added will not be the amount that is measured for payment. The residual amount of asphalt in the emulsion or cutback will be used for payment.

A test procedure has been developed to physically check the residual amount of asphalt applied to the pavement surface. For projects that contain at least 2000 tons (1815 metric tons) of HMA, the Inspector shall determine the residual amount of asphalt placed using the test procedure titled, "Determination of Residual Asphalt in Prime and Tack Coat Materials," which is Appendix B24 in the BMPR [Manual of Test Procedures for Materials](#). If a copy of the *Manual* is not available in the Resident's field office, a copy of the test procedure can be obtained from the BMPR or IDOT's website.

The test shall be performed at least once per project for each type of surface being tacked for which at least 2000 tons (1815 metric tons) of HMA will be placed, preferably on the first day tack coat is placed on a given surface. More tests may be performed at the Resident's discretion. The Contractor may proceed with paving as soon as the tack fully breaks and before the test results are provided. However, test results should be obtained as quickly as possible.

This test is not intended to be the sole criteria used for acceptance of the work, but it is a tool for the Resident to evaluate the Contractor's performance. The residual rate of material placed will be calculated as described below based on truck weights.

If the test results and/or quantity calculations indicate that the residual amount of tack on the surface to be paved does not meet the specified amount, the tack may be considered unacceptable. However, research has shown that tack coat applied with a tolerance of plus or minus 0.01 lb./sq. ft. is adequate. Recognizing that precisely meeting the specified rate can be difficult, engineering judgment should be used to consider if unacceptable work performed is adequate to leave in place. In accordance with Article 105.03, the Department reserves the right to accept work that is in close conformity with the contract by a contract modification. The construction supervisor and BMPR should be consulted on how to address the situation. The Contractor shall make appropriate adjustments for further applications so that the correct amount of material is placed. Payment will be made by weight as described in Section 406.14-2.

406.14-2 Payment Procedures

The Inspector will need to know the following to properly calculate the amount of material for payment:

- The total weight of the material applied (This weight includes any additional water added to the emulsion). The actual percentage of residual asphalt in the emulsion or cutback as produced
- The amount of water added to the emulsion

The pressure distributor shall be weighed before and after placement of the tack coat to determine the net amount of material placed. Any scale of adequate size and displaying a current Department of Agriculture sticker will be sufficient to perform the weighing.

The actual percentage of residual asphalt in the emulsion or cutback, as produced, will be indicated on the producer's Bill of Lading or attached Certificate of Analysis from the BMPR. The amount of additional water (if any) added to an emulsion will also be indicated on the Bill of Lading.

The amount of water added is necessary to calculate the percent of emulsion in the diluted emulsion mix. The Bill of Lading will show the amount of water that was added to a tanker of the emulsion from which the pressure distributor is loading out. For example, a pressure distributor may only have two tons of a diluted emulsion mix in its tank, but the tanker it loads out from will have much more. The amounts of emulsion and water on the Bill of Lading may far exceed the quantity delivered in a pressure distributor. Information provided in this fashion is appropriate because only the percentages of water and emulsion are necessary to calculate quantities for payment. Payment is based on weighing the amount of diluted emulsion placed from the pressure distributor.

Using the percentage of residual asphalt for the material used, the quantity of residual asphalt placed can then be calculated as shown in the following two examples.

406.14-3 Example to Calculate Residual Amount of Asphalt from an Emulsion

Known: Material used is an emulsion.

Percent of residual asphalt in the emulsion = 57% (from the producer's Bill of Lading or attached Certificate of Analysis)

Weight of pressure distributor before application of material = 35,000 lb.

Weight of pressure distributor after application of material = 28,000 lb.

Amount of water added (from Bill of Lading) = 2208 lb. added to a tanker containing 8300 lb. of the emulsion

Calculate the amount of residual asphalt for payment:

Net weight of material:

$$35,000 - 28,000 = 7000 \text{ lbs.}$$

Percentage of emulsion in the pressure distributor:

$$8300 \text{ lb.} + 2208 \text{ lb.} = 10,508 \text{ lb. (total weight of diluted emulsion mix)}$$

$$8300 \text{ lb.} / 10,508 \text{ lb.} = 79\% \text{ (amount of emulsion in the pressure distributor)}$$

Percent residual asphalt for payment:

$$7000 \text{ lb.} \times 0.79 = 5530 \text{ lb. of emulsion}$$

$$5530 \text{ lb.} \times 0.57 = 3152 \text{ lb. of residual asphalt}$$

3152 lb. represents the weight of actual residual asphalt that can be paid as Tack Coat

The provisions for maximum payment will apply to this quantity. For example, assume that the quantity ordered by the Resident for tack coat is 3100 lb. (based on the area to be tacked and the appropriate residual rate):

$$\text{Maximum payment} = 3100 \text{ lb.} \times 1.05 = 3255 \text{ lb.}$$

Therefore, all 3152 lb. of residual asphalt placed can be paid for.

406.14-4 Example to Calculate Residual Amount of Asphalt from a Cut Back

Known: Material used is a cutback.

Percent of residual asphalt in the cutback = 60% (from the Bill of Lading or attached Certificate of Analysis)

Weight of pressure distributor before application of material = 35,000 lb.

Weight of pressure distributor after application of material = 29,750 lb.

Calculate the amount of residual asphalt for payment.

Net weight of material:

$$35,000 - 29,750 = 5250 \text{ lb.}$$

Percent residual asphalt for payment:

$$5250 \text{ lb.} \times 0.60 = 3150 \text{ lb.}$$

3150 lb. represents the weight of actual residual asphalt that can be paid as Tack Coat

The provisions for maximum payment will apply to this quantity. For example, assume that the quantity ordered by the Resident for tack coat is 3100 lb. (based on the area to be tacked and the appropriate residual rate):

$$\text{Maximum payment} = 3100 \times 1.05 = 3255 \text{ lb.}$$

The Method of Measurement for Bituminous Materials (Tack Coat) is located in Article 1032.02. The Article states that a weight ticket for each truck load shall be furnished to the Inspector. The truck referred to in this Article is the pressure distributor that is required to place the material. Tack to the project is in a large semi tanker, a tank at the Contractor's yard or from a tank at the producer's facility. Weight tickets are not needed for materials contained in these tanks. Only material that is delivered to the project in a pressure distributor requires weight tickets.

SECTION 407. HOT-MIX ASPHALT PAVEMENT (FULL DEPTH)

407.01 DESCRIPTION

The specifications for the construction of HMA (full depth) are essentially the same as that for the construction of binder and surface courses (see Section 406). The difference for a full-depth pavement is the construction of the pavement in multiple lifts with a maximum thickness for each lift.

Review the [Construction Inspector's Checklist for HMA Pavement \(Full Depth\)](#).

407.05 SUBGRADE

Check the subgrade to ensure that it is at the proper grade and cross section. The riding quality of the new pavement will depend largely on the smoothness of the grade on which it is placed. Check the grade on subgrades by stringline from grade stakes or level shots. Many problems with thin pavements and/or rough riding pavement are due to poor grade control.

Section 301 of the *Standard Specifications* and this *Manual* discusses pavement subgrade preparation, and Division 300 addresses pavement subbase and base courses. Each successive operation from preparing the subgrade to placing, compacting and trimming the aggregate base

courses must be closely controlled. Deficiencies that occur in any foundation course are transmitted to the succeeding layers of work. Therefore, the Inspector should carefully re-inspect the subgrade and base before paving operations begin.

Soft or segregated areas of the surface where the pavement is to be placed must be corrected or replaced. Surface smoothness should be within the specification tolerance. The roadway must be shaped to the proper crown or superelevation.

Reshaping of the aggregate surface may be necessary prior to treatment of the aggregate because of imperfections caused by traffic or resulting from the Contractor's operation. The Resident, Inspector and Contractor should discuss how damaged areas will be identified and repaired before paving begins. It is important to have a contingency plan in place to not unduly hold up the paving operation.

407.06 PLACING

See Section 406.06 of this *Manual* for placing full depth HMA.

407.08 HAULING ON THE PARTIALLY COMPLETED FULL-DEPTH PAVEMENT

The first lift placed for the full-depth pavement is not designed to withstand the loading of a truck, whether empty or fully loaded with HMA other materials. The staging of the work may require that the trucks drive on the initial lift and subsequent intermediate lifts of pavement to deliver the asphalt. Hauling on the partially completed pavement must be strictly limited to that allowed by specification to avoid damage to the underlying lifts of pavement.

407.09 SURFACE TESTS

407.09-1 General

Surface testing of pavements for smoothness is required to verify the contract pavement smoothness requirements have been met. Pavement smoothness that meets (or exceeds) the contract requirements ensures an appropriate level of comfort for the traveling public.

Pavement smoothness also provides other benefits as follows:

- Increased pavement service life by decreasing dynamic loading which will cause damage to the pavement.
- Safer roads because of improved vehicle control which reduces accidents.
- Reduced vehicle fuel consumption.
- Lower vehicle maintenance costs.
- Measuring initial pavement smoothness and conducting additional measurements over time, allows the Department to monitor when future maintenance and rehabilitation work is required.

407.09-2 Equipment

Per Standard Specifications Article 1101.10, three types of pavement surface test equipment are currently allowed. This equipment includes the California Profilograph, inertial profilers, and a 16-foot straightedge.

Historically, the Department has required the California Profilograph be used for profile testing. However, in recent years inertial profilers have been added as an allowable device and have become the tool of choice. The California Profilograph will be phased out with implementation of the International Roughness Index (IRI) because it cannot measure that index. Refer to 407.09-4 for additional information.

An inertial profiler is equipped with laser sensors, accelerometers, and computer equipment to measure the pavement surface. High-speed inertial profilers mounted on vans, trucks, cars, etc., enable data collection at posted speeds without the need for a lane closure. Light-weight inertial profilers mounted to golf carts, all-terrain vehicles, etc., operate at slower speeds and require a lane closure when collecting data. With proper calibration, both types of inertial profilers will provide accurate measurements.

All Districts and the Bureau of Research have high-speed inertial profilers. The Bureau of Research also has a light-weight inertial profiler. This equipment should be used when conducting Department quality assurance smoothness testing.

Prior to the contractor conducting testing, the Contractor shall provide the Engineer with a copy of the approval letter and recorded settings issued by the Bureau of Research for the Profile Equipment Verification (PEV) Program. The Resident is required to verify the Contractor uses the approved settings for their testing. The Bureau of Research should be contacted if there is a question concerning the Contractor's equipment or the PEV Program.

407.09-3 Test Sections

Standard Specifications Article 407.09(a) defines High-Speed Mainline Pavement, Low-Speed Mainline Pavement, and Miscellaneous Pavement. Pavement smoothness testing with a profile testing device (and smoothness assessments) are limited to High-Speed Mainline Pavement and Low-Speed Mainline Pavement. Pavement smoothness testing of miscellaneous pavements is conducted with a 16 ft. straightedge. Smoothness assessments are not applied to miscellaneous pavements.

What constitutes either a high or low speed pavement sections are readily determined? Determining what constitutes a miscellaneous pavement section requires some judgement, especially in the category of "other miscellaneous pavement surfaces".

When determining "other miscellaneous pavement surfaces", per the Standard Specifications, the Engineer should consider if conditions beyond the contractor's control preclude the achievement of smoothness levels typically achievable with mainline pavement construction. Examples of pavement segments that should be considered for classification as miscellaneous pavements include, but are not limited to:

- Consideration should be given to classify pavement which (by contract) must be constructed in multiple short segments, typically defined as segments 100 feet or less in length, as miscellaneous pavement when the pavement would otherwise be considered high-speed mainline or low-speed mainline pavement. (This situation commonly occurs

when construction gaps are needed to maintain access to adjacent property or business owners.)

- Consideration should be given to classify pavement constructed within 50 feet of manholes, utility structures or other appurtenances, where the manholes, utility structures or other appurtenances are located in a testing “wheel path”, as miscellaneous pavement when the pavement would otherwise be considered high-speed mainline or low-speed mainline pavement.
- A turn lane should typically be considered miscellaneous pavement (because of the turning movement and reduced speed in the turn lane).

407.09-4 Profile Index (PI), Lots/Sublots, and International Roughness Index (IRI)

The Profile Index (PI) is a common statistical measurement of smoothness for pavements. For measurement purposes, each pavement lane is divided into lots and sublots. The two-wheel paths are tested in each subplot and averaged into a single value. To determine the PI for a section of pavement, the height of all bumps is measured in inches and divided by the length of the segment in miles (segments cannot exceed 0.1 mile). The resultant unit of measurement is in./mile. Depending on the result of the PI value, the Contractor may have to perform corrective work. In addition, depending on the result of the PI value, the Contractor may receive a payment incentive or disincentive for each subplot.

The Department is in the process of switching from the PI to the International Roughness Index (IRI) for measuring smoothness. The IRI is a computer-based algorithm that is being adopted by State DOTs nationwide. The IRI is based on a standardized vehicle configuration and incorporates vehicle dynamics. The IRI is intended to measure ride quality, which is how the motorist perceives the road being traveled on. If the IRI is specified on a project, the test procedures for collecting smoothness data in this Manual are the same as for the PI. During the data processing, the data is simply evaluated using the IRI algorithm rather than the PI algorithm.

407.09-5 Testing

The finished surface of the pavement shall be tested by the Contractor for smoothness within three days of paving. The recommended practice is to test in the direction of paving. However, repeated testing in the opposite direction has resulted in no significant difference in test results. Testing with a profile testing device is required for high-speed mainline and low-speed mainline pavements. (Testing with a 16 ft straightedge is required for miscellaneous pavements.) Testing shall be performed in the presence of the Engineer. The observation of Contractor quality control (QC) testing is required because the Contractor test results are used to determine the need for corrective work (as well as smoothness assessments when applicable).

Quality assurance (QA) testing (of mainline pavements) to verify the Contractor test results is required, by federal requirements, to allow project acceptance using the Contractor’s test results. In addition, Department QA testing and all other contract requirements for the pavement shall be satisfied before any incentive or disincentive payment is issued to the Contractor. When the Department QA testing is performed, the air temperature should be within

20 °F (11.1 °C) of the temperature at which the Contractor performed QC testing. This is very important for jointed concrete pavements because of pavement curling at the edge of the joint, but not as critical for other types of pavement. QA testing is accomplished by the District, or by an Independent Consultant hired by the District. A minimum 20% or 2 sublots for each lane of pavement, whichever is greater, should be tested by the District. For the start of the project, QA testing is recommended to be performed as soon as possible. Thereafter, QA testing within 30 days of Contractor QC testing is recommended. For the 30-day time period, previous testing indicates the pavement will become slightly smoother with traffic on it for a small period of time before it will become rougher.

The results from the District QA test will be compared to the applicable results from the Contractor's QC test. The QA test segment Average PI must be within 15 percent of the applicable Contractor's QC test result (for the QC test results to be considered acceptable). When Contractor and District test results do not compare, the following list may be used to help ascertain the reason for the difference in test results.

- Was a different line on the road profiled?
- Was a different starting location used?
- Were the sublots tested by each device split at different stations?
- Were both devices properly calibrated?
- Has a profiler part, such as a sensor, failed but has not been detected?
- On jointed concrete pavements, was the 20 °F (11.1 °C) tolerance of the temperature difference at the time of testing maintained?
- For high speed profilers, was the device operated below the minimum specified speed limit for the profiler?
- Was heavy braking or acceleration applied during the testing process?

If none of the above issues occurred and differences are greater than the 15 percent between the QC and QA test results, the District should request the Bureau of Research to perform QA smoothness testing on the entire project with the Bureau of Research's inertial profiler. After obtaining, validating, and comparing the Bureau of Research's QA test results with the Contractor's QC test results, if the Contractor QC test results are not within 15 percent of the Bureau of Research's QA test results, the Central Bureau of Construction should be contacted for resolution.

Once the Resident has verified the Contractor's test results are acceptable, the Contractor's test results may be used to determine project acceptance and smoothness assessments. Form BC 2448B is used by the Resident to calculate the smoothness assessments and is kept in the project files. (A copy is also sent to the Bureau of Research at DOT.BR.Smoothness.Testing@illinois.gov as discussed below.)

407.09-6 Contractor Test Information Submittal

Once Contractor quality control testing is completed for placement or correction of pavement, a profile trace and BC 2448A form shall be submitted to the Resident within two working days.

The profile trace is a diagram of the road profile along the wheel path. The information required on the profile trace is specified in Article 407.09(a).

For the BC 2448A form, bump locations should be listed by station for each track (wheel path). Multiple copies of the form shall be used, if necessary, to report all data. A bump is an elevation difference in excess of 0.30 in. (8 mm) from the specified profile.

Form BC 2448A is submitted to the Bureau of Research by the Resident after it has been reviewed and accepted. The original is kept in the project files, and a copy is emailed to the Bureau of Research at DOT.BR.Smoothness.Testing@illinois.gov.

407.09-7 Corrective Work by Grinding

All bumps in excess of 0.30 in. (8 mm) and sublots with an unacceptable Average PI shall be located and corrected by the Contractor. Corrective work for pavement smoothness is accomplished by surface grinding or by removal and replacement of the pavement. For surface grinding, the device shall be a self-propelled machine with multiple diamond blades and shall have a minimum effective head width of 3 ft (0.9 m). The Contractor is not allowed to perform corrective grinding as a way to increase pay. In the case where a section of pavement has been removed and replaced, the Contractor will be paid based on the PI measured after replacement.

During corrective work, if there are two adjacent bumps close to each other which essentially involve a dip or low area in an otherwise flat pavement, grinding is to be started from the low area to cut its way out of each bump. This is performed in both directions to reduce the abruptness of the low area. Grinding from the level plane is normally not effective for improving smoothness involving dips.

The Resident is advised that free engineering software is available to analyze profiles and develop an optimized grinding strategy. ProVAL (Profile Viewing and Analysis) is the software product which is available at <https://www.roadprofile.com/>.

Upon completion of the corrective work, the surface must be checked by reprofiling the ground areas. It is only necessary to reprofile those areas in the vicinity of grinding to determine the bumps have been corrected, since the surface profile outside the bumps areas may have changed slightly over time. Reprofiling of an entire subplot will only be required when the Contractor grinds a subplot with an Average Profile Index that exceeded the specified maximum.

Where corrective grinding has been deferred over the winter period, it is expected that additional roughness for sublots or greater deviations for bumps will occur. If this situation occurs, it is recommended to reprofile the road before corrective grinding is performed. In regard to smoothness assessments, the Resident will use the test results from the previous construction season.

The Resident is advised that grinding detracts from the appearance of a completed pavement. Care should be exercised to avoid correction of minor irregularities where grinding will remove only a thin layer of surface material and provide little real improvement in smoothness.

407.10 TOLERANCE IN THICKNESS

Pavement shall be constructed to full plan thickness. Pavement placed to a varying thickness could indicate poor workmanship by the Contractor. The Tolerance in Thickness Specification is designed to encourage the Contractor to employ the quality control required to construct the pavement to the proper thickness with minimal variation.

Avoid a thin pavement in superelevation transition areas.

The following discussion applies to all contracts that require coring to confirm the thickness of pavements, base courses, base course widening and shoulder items that are paid on a sq. yd. (sq m) basis.

407.10-1 General

Only those pay items containing at least 1000 contiguous sq. yd. (840 sq. m), not paid by the ton, are required to be cored. In addition, temporary pavement, temporary base course, temporary widening and variable width pavements do not require coring. The Department will have a representative present while the Contractor is coring the various pavement pay items. Core locations will be determined using one of the methods described below.

Coring performed under these provisions does not relieve construction staff of the need to make necessary progress depth checks for measurement. Coring is included in the cost of the various items to be cored and, consequently, must be treated as any other work effort required by a specification if the Contractor or Department seeks to alter these requirements.

407.10-2 Coring Operations

The Contractor and the Department's representative shall witness the entire coring operation including the measurement of each core. Each core shall be measured immediately upon removal from the core bit in a measuring device supplied by the Resident. See Figure 400-14. The core location and lengths shall be recorded on the Pavement Coring Worksheet. The Department and the Contractor shall sign the Pavement Coring Worksheet, attesting to the accuracy of location and lengths of the cores. Upon concurrence of length, the core samples may be discarded. If an agreement on the core measurement is not reached, the core will be placed in a container supplied by the Department, sealed, labeled and stored by the District Bureau of Implementation/Construction. The core length determined by the Department will be used in the calculation for payment and or remedial action.

Cores are to be measured to the nearest 0.05 in. (1 mm). When the coring operation produces a core that is not measurable, a replacement core is to be cut within 1 ft. (0.5 m) of the target location.

407.10-3 Right of Discovery

If the random core selection process does not accurately represent the true conditions of the work, the Resident shall order additional cores. The Resident will provide a written explanation to the Contractor for requiring additional cores. Right of Discovery cores are used to define areas where deficient pavement is believed to exist. Deficient pavement is pavement less than 90 percent of

the plan thickness. If a Right of Discovery core is measured to be at least 90 percent of the plan thickness, the Contractor is to be compensated for the cost of cutting the additional core. If the core is measured to be less than 90 percent of the plan thickness, additional cores are required to determine the limits of deficient pavement. The Contractor is not to receive payment for either the initial core measuring less than 90 percent of plan thickness or additional cores required to define the limits of the deficient area.

Right of Discovery cores are not to be used for any incentive or disincentive calculations. Right of Discovery is not the same as additional cores required to determine the extent of thin pavement.

407.10-4 For Pay Items Cored in Accordance with Article 407.10(a)

In addition to the above general requirements, individual areas less than 500 ft (150 m) in length will not require verification coring.

407.10-4(a) Determination of Lots and Sublots

The Resident/Technician will determine the locations of lots and sublots using as-built plan sheets. The first step is to identify all items to be cored under Article 407.10(a). Each pavement pay item is treated separately when determining the applicability of coring in accordance with Article 407.10 and subsequently determining the size and limits of the lots. For example, short sections of high early strength (HES) pavement should not be included in lots of otherwise similar pavement types. Because of the nature of HES pavements, it is uncommon to require coring.

When deciding if an area of pavement is contiguous, it must touch the same pavement pay item, either longitudinally or transversely. A single lane of pavement 750 ft. (230 m) long by 12 ft. (3.6 m) wide is 1000 contiguous sq. yd. (840 sq. m) of pavement. Two lanes of pavement touching transversely, each 375 ft. (115 m) long by 12 ft. (3.6 m) wide, is also 1000 sq. yd. (840 sq. m) but, however, does not meet the 500-lineal ft. (150 m) requirement and does not require coring under this provision.

The lanes do not need to have been constructed within the same stage for the pay item area to be contiguous. Those areas not subject to coring per Article 407.10(a) should then be evaluated to determine if they should be cored in accordance with the requirements of Article 407.10(b). Determine the number of lots that are required to be cored for each pay item.

Divide the pay item into approximately equal lots not more than 5000 ft. (1500 m) long. Short lengths of pavements less than 5000 ft. (1500 m) that otherwise meet the requirements for coring (i.e., ramps, side streets, turn lanes at least 500 ft (150 m)) shall be grouped together.

To determine the number of lots, divide the total length of the pay item by 5000 ft. (1500 m). The number of lots is equal to this quotient rounded to the next whole number, unless it is already a whole number.

If more than one lot is required for any pay item, all lots for that pay item are to be approximately of equal length. For example, if 5380 ft. (1640 m) of a pay item were constructed on a project, two lots are required. Those two lots should each be 2690 ft. (820 m) long. One lot of 5000 ft

(1500 m) and a second lot of 380 ft. (115 m) is not acceptable and will not provide a statistical equivalence when the lots are later evaluated for final pay factor.

If the pay item includes more than one lot, the area represented by the first lot shall extend from the beginning of the pay item and running in that lane to the end of the pay item or lot. If the entire distance represented by the lot is not covered before the end of the project, the remainder of the lot shall be continued in an adjacent lane until the full length of the lot is covered. To minimize confusion, it is encouraged to always work using increasing stations. Subsequent lots shall then be made up beginning at the end of the previous lot and proceeding as described above. The width of a lot will be the width from the pavement edge to the adjacent lane line, from one lane line to the next or between pavement edges for single lane pavements.

Each lot must then be subdivided into 10 sublots of equal length. The statistical analysis is not correct if less than 10 equal sublots are cored for each lot. The width of each subplot equals the width of the lot. Although all sublots do not need to be cored at the same time, all 10 sublots must be cored before any analysis of the lot can be conducted.

407.10-4(b) Determination of Core Locations

District personnel (other than staff directly assigned to the contract) will determine a random core location for each subplot by multiplying a randomly generated number less than 1 by the length of the subplot. The core location is found by measuring this distance from the beginning of the lot. See Figure 400-14 for coring HMA pavement.

Figure 400-14 — CORING HMA PAVEMENT AT A RANDOM LOCATION



The core locations are to be forwarded to and provided by the Resident or designee.

407.10-4(c) Coring

The Contractor shall proceed to cut the cores at the locations directed by the Resident. If a random core is located within a drainage structure box out, pavement stripe or feature other than smoothness corrective measure, which will prevent securing a representative core of the subplot

that is measurable, the Resident should adjust the location of the core to one of close proximity but missing the obstruction. During the coring operations, if a core is measured to be less than 90 percent of the plan thickness, the Contractor may decide to take three additional cores in accordance with Article 407.10(c).

These cores will be averaged with the first core and an average core value calculated. This average core value is only used to determine if the subplot is deficient and is used only for the purpose of remedial action treatment for the subplot. The original core length must be used in the lot analysis for determination of incentive or disincentive payment for the lot. The three additional core locations must be randomly located in the subplot. The Resident may use any random number generator available to determine the locations of the three additional cores.

407.10-4(d) Core Analysis and Remedial Action

After the completion of the coring operation, the Resident will analyze all core measurements. See Figure 400-15. The Contractor shall address any deficient sublots or deficient lots of pavement with the District. The coring operations shall be repeated for those previously deficient sublots that were corrected.

**Figure 400-15 — 2-IN. DIAMETER CORE BEING MEASURED
IN A CORE MEASURING DEVICE**



407.10-4(e) Incentive and Disincentive Determinations

After addressing all deficiencies, the Resident will calculate a separate pay factor for each lot. When determining incentives or disincentives, only those pavement areas included in lots will be included in the incentive or disincentive payments. For example, short sections of pavements, side roads less than 500 ft (150 m) long and tapers and other areas not included in lots will not be included in the TOTPAVT (= Area of Pavement Subject to Coring) factor used to determine incentive or disincentive payments. It will be very rare that the entire quantity of pavement placed will be subject to either an incentive payment or disincentive.

All pay factors for each separate pavement pay item will be averaged together to determine an average pay factor for the pay item. A copy of these results and the calculation of the pay factor(s) is to be provided to the Contractor with the original retained in the contract files. This pay factor will be in addition to any other pay factors incurred for this particular project. Using the final quantity of pavement placed and subject to coring, the District shall submit an authorization establishing an incentive/disincentive unit price calculated for each pay item and in accordance with Construction Memorandum No. 4 in Appendix A.

407.10-4(f) Authorizing the Incentive/Disincentive Payment

The Resident should determine what correct XXX incentive or disincentive pay item number to be used from Construction Memorandum No. 4 in Appendix A. The quantity is the total area subject to coring; the unit price is the average of the pay factor, not to exceed 0.02 (2 percent) times the contract unit price for the pay item.

407.10-5 For Pay Items Cored in Accordance with Article 407.10(b)

In addition to the general requirements, individual areas less than 500 ft (150 m) in length for pavement, base course, 1000 ft (300 m) for widening and 2500 ft (760 m) for shoulder items will not require verification coring. If the contiguous length of the item to be cored is not evenly divisible by 500 (2500 for shoulder items), prior to determining the random core locations, the Resident will determine the beginning station of the first unit. Subsequent units, if needed, will run continuously from the preceding unit.

407.10-5(a) Prior to Coring

After determining which pay items and areas will be cored by this method, the District should generate chart(s) showing pay items to be cored, the required thickness of those items and the locations of all required cores. It is preferred that coring of base courses will be accomplished prior to placement of the cover layers. If this is not possible, the plan overlay thickness in the area(s) to be cored is also required and will be subtracted from the measured thickness to determine the thickness of the item.

407.10-5(b) Procedure for Determining Random Core Locations

The District, using staff other than that directly assigned to the contract, will determine where to cut the cores using the following procedure:

1. Determine the continuous lengths of items required to be cored by the appropriate specification.
2. Divide the pavement, base course and base course widening pay items into 500 ft (150-m) units. Divide shoulders into 2500 ft. (760 m) units. If the pavement has already been partitioned into 500 ft. (150 m) units for other testing requirements (e.g., smoothness), the same unit delineations may be used. If the length of a continuous strip of the item to be cored is not evenly divisible by 500 (2500 for shoulders), only the 500 ft (150 m) long areas need to be cored. The start of the first unit to be cored is to be selected by the Resident and can be located at any distance from the beginning or end of the continuous strip of

the item to be cored up to the length of the remainder of the unit. For example, a continuous strip of pavement 2400 ft. (730 m) long requires coring. Dividing by 500, 4 units are calculated with 400 ft. (122 m) of pavement left over. The Resident may start the location of the first unit up to 400 ft. (122 m) from the beginning of the location to be cored.

The four units then run continuously. Should the Resident choose to start the first unit 125 ft. (40 m) from the beginning, the four units still run continuously, leaving an area 275 ft. (85 m) at the end of the strip. The location of the start of the first unit is to be determined prior to generating the random number or starting coring.

3. Generate a random number less than 1.00 for each unit.
4. Cut one 2-in. (50-mm) diameter core at the location represented by the random number multiplied by the length of the unit. Measure and record the length of the core, along with its station and offset. The Resident should immediately determine the need for additional cores.

407.10-5(c) Determining the Need for Additional Cores

If cores indicate the unit is 10 percent or less deficient, no further cores or delineation of the unit is allowed. If a core indicates the unit is more than 10 percent deficient, the Contractor may elect to take additional cores at stations selected by the Contractor until a core is encountered that measures 10 percent or less deficient. Additional cores required to delineate areas more than 10 percent deficient are not the same as Right of Discovery cores and will be used to delineate areas more than 10 percent deficient and determine a deficiency deduction for areas of a unit to remain in place. The Resident will determine a representative transverse location for the core. The entire area between the first cores encountered 10 percent or less deficient on either side of the core more than 10 percent deficient will be considered unacceptable and removed and replaced.

In lieu of cutting additional cores in the unit, the Contractor may elect to remove and replace the entire unit. Areas requiring removal and replacement will be re-evaluated in accordance with this policy.

For pavement, base course and base course widening pay items, if only a portion of the unit is removed, the remaining portions of the unit will be subject to the deficiency deduction. The deficiency deduction for area(s) on each side of any area removed and replaced will be determined in accordance with the chart in Article 407.10(b)(6). The construction area subject to the deficiency deduction is the entire area left in place; however, if two separate areas are left in place based on two non-deficient cores on either side of the deficient core, separate deficiency deduction evaluations for the two areas are required. The two cores will not be averaged to determine an average deduction for the area to remain in place.

For shoulder pay items, the first cores measuring at least 90 percent of plan thickness determine the limits of shoulder removal. Areas outside the limits of removal are considered acceptable.

407.10-5(d) Determining the Pavement Thickness Deficiency Deduction

Shoulder items less than 10 percent deficient are acceptable and no deduction is required. Other units 2 percent or less deficient require no deficiency deduction. If a core indicates that the unit is more than 2 percent, but 10 percent or less deficient, a thickness deficiency deduction is required. The unit price for the deficient area is to be established by multiplying the contract unit price for the deficient item by the percent deduction found in the chart in Article 407.10(b)(6) corresponding to the percent the unit is deficient. Each unit is treated separately. The Resident is not to average the units together to determine an average deduction.

407.10-5(e) Authorizing the Deduction

The entire area of the deficient unit and the calculated pavement deficiency deduction will be used to authorize the contract adjustment for the deficient area. The Resident should choose the correct XXX number and pay item description for the pavement type from Appendix A, Construction Memorandum No. 4. The units are the same as the pay item units for the deficient item. The quantity is the entire area represented by the deficient unit. If an area of a unit was removed and replaced, the area will be retested and evaluated. The unit price is calculated per the preceding instructions and the amount will be submitted as a negative addition. It is possible that up to five pavement thickness deficiency pay items may be required for each pavement, base course, widening and shoulder pay item subject to coring.

If the District determines that an area for which a core more than 10 percent deficient was measured is allowed to remain in place, no payment will be made for that area, and a deduction equal to two times the cost of the thin item will be deducted from the compensation due the Contractor. This should be done by authorizing a deficiency deduction for the area to remain in place with a unit price equal to two times the contract unit price (CUP) (200 percent) of the pay item.

SECTION 408. INCIDENTAL HOT-MIX ASPHALT SURFACING

408.01 DESCRIPTION

Incidental HMA surfacing items are miscellaneous pavements such as:

- Driveways
- Side roads
- Alleys
- Commercial entrances
- Detour roads

SECTION 420. PORTLAND CEMENT CONCRETE PAVEMENT

420.01 DESCRIPTION

The construction of concrete pavement is a highly mechanized operation requiring a thorough knowledge of equipment, methods, materials and their proportioning. The discussion in Section 420 is also relevant to continuously reinforced concrete (CRC) pavement. The Inspector should review:

- The [Construction Inspector's Checklist for Portland Cement Concrete Pavement](#)
- The [Construction Inspector's Checklist for Continuously Reinforced PCC Pavement](#)
- Check Sheet #30 "Special Provision for Preventive Maintenance – Micro-Surfacing"
- Check Sheet #31 "Special Provision for Preventive Maintenance – Slurry Seal"

420.01-1 Pre-Paving Conference

Concrete paving is a high-volume operation in which delays are very costly. Before the start of paving operations, the Resident may hold a Pre-Paving Conference with the Contractor's supervisory personnel and the Department inspection staff to discuss the following:

- Review the concrete mix design and specifications (be sure it is the correct one) and material sources
- How the plant and paving operations will be conducted (i.e., the paving plan).
- Review the Quality Control plan.
- How the work will be sequenced (i.e., scheduling).
- How quality control will be performed.
- What are the lines of authority?
- What equipment will be used.
- What contingency plans are in place for equipment failures?
- How the test results will be reported to the Contractor.
- Who will be responsible for each type of test?
- Review the staking plan and how roadway grades will be controlled.
- Any areas of the project that require special treatment.
- How random sample times and locations will be established.
- How joints will be constructed.
- How weather conditions impact paving operations.

- How traffic control will be addressed.

The importance of a Pre-Paving Conference with the Contractor cannot be over emphasized. In effect, the Department and the Contractor are constructing the pavement on paper. This should be the forum where the two parties discuss problems and expectations for the Contractor's paving operation.

420.01-2 Introducing the Department's Inspection Crew

The Pre-Paving Conference should also serve as an introduction of the key personnel on both sides. It is important to highlight the duties and responsibilities of each member and to establish the lines of authority on various issues. Clearly describe the expectations, assignment and schedule for each inspection role. Emphasize to the Contractor those aspects of the paving job that the Department Inspectors will be observing closely:

- Dowel bar placement and alignment
- Aggregate and cement proportioning
- Proper aggregate gradation
- Absolute control of the water content of the mix
- Prevention of segregation in the concrete
- Adequate number and proper spacing of finishing equipment to handle production
- Properly trained equipment operators and finishers
- Proper curing
- Proper sawing and jointing
- Timing of saw cutting

The Resident has flexibility in assigning Inspectors to each of these operations. The goal is to ensure that each operation is adequately inspected so that the Contractor is complying properly with the contract documents. Establish an issue escalation procedure that can be used by both the Inspectors and the Contractor.

Paving operations run the smoothest when decisions are made at the lowest possible level and Inspectors are empowered to make those decisions. Their effectiveness as decision makers depends largely on how clearly the Resident has communicated this principle.

420.01-3 Documentation

The following items should be periodically checked and documented:

- Thickness
- Concrete air content
- Concrete temperature
- Concrete slump (slump cone)
- Edge slump (slip form paving)
- Vibrator frequency
- Cure application rate (include method of measurement used to determine rate)
- Rebar placement/alignment
- Air temperature

- Concrete delivery times
- Dowel bar placement method
- Tie bar placement method
- Timing of saw cutting
- Weather changes during pour

420.02 MATERIALS

The Resident should consult the BMPR *Project Procedures Guide* for material inspection requirements for all paving materials including concrete, reinforcing steel, dowel bar assemblies, curing compound, joint fillers, sealers and other miscellaneous materials.

420.03 EQUIPMENT

The equipment should be checked before any concrete work is initiated. The manufacturer's specifications should be checked for compliance with mechanical condition and capacity, and to ensure that all necessary equipment is on the job and available for use. Plant production, paver capacity and the number of hauling units should match to allow uniform placement speed. Any issues with the equipment should be documented. See Figure 400-16.

Figure 400-16 — CONCRETE BATCH PLANT



420.04 PREPARATION OF SUBGRADE OR SUBBASE

The first requirement of a successful concrete pavement is a well-prepared, stable subgrade. Review the Construction Inspector's Checklist for stabilized subbase. Soft and yielding areas that are observed should be repaired by the Contractor prior to concrete paving. The paver track should be level and stable to maintain a consistent pavement without stopping and correcting the subgrade in front of the tracks. For slip form paving, the width of the stabilized subbase should be constructed 6 in. wider than the outside-to-outside width of the paver tracks. See Article 420.14(a).

The subbase should be inspected for visible indication of surface defects before allowing placement of the concrete pavement. Keeping the subbase or subgrade moist is important because a dry subbase will pull moisture from the fresh concrete. This causes the same shrinkage problems as does rapid surface moisture loss.

Division 300 of the *Standard Specifications* and this *Manual* discuss pavement subgrade preparation and pavement subbase courses. Each successive operation, from preparing the subgrade to placing and compacting the subbase courses, must be closely controlled. Deficiencies that occur in any foundation course are transmitted to the succeeding layers of work. Therefore, the subgrade and subbase should be re-inspected before paving operations begin.

Check the subgrade or subbase to ensure that it is at the proper grade and cross section.

420.05 JOINTS

See [Pavement Joint Standard 420001-09](#) for construction details.

420.05-1 Purpose

Joints control cracking and expansion of concrete slabs, which allow the concrete to release the buildup of internal stresses. The performance of concrete pavement depends significantly upon satisfactory performance of the joints. Most concrete pavement failures can be attributed to failures at the joint, not to inadequate structural capacity. Pavement distresses that may result from joint failure include faulting, pumping, spalling, corner breaks (D-cracking), blow-ups and mid-panel cracking.

420.05-2 Issues

Some of the important issues related to joints are:

- Transverse construction joints are placed at the end of a run or whenever operations will be interrupted for more than one hour.
- When two or more lanes are placed concurrently, the tie bars in the longitudinal joint may be placed automatically by the paving machine. Tie bars should be placed while the concrete is still plastic.
- When concrete curb and gutter are poured concurrently with the concrete roadway, the joint placement in the curb and gutter should match those in the roadway.

420.05-3 Contractor Responsibilities

Joint location is determined by the designer. Joint details should be thoroughly discussed prior to the start of work, preferably as part of the Pre-Paving Conference (see Section 420.01-1). The items to review should include the following:

- The Contractor's responsibility for timely and proper sawing of joints.
- The spacing of construction joints. Placement of joints around openings and other appurtenances (e.g., manholes) in the pavement.
- Proper matching of transverse weakened plane joints with adjacent lanes.

420.05-4 Timing of Sawing

The Contractor is responsible for determining the timing for sawing. However, the Inspector should examine the sawing operation to ensure that the timing is proper.

The Contractor should be discouraged from attempting to perform the sawing by a predetermined schedule because changing temperatures, humidity and wind speed may alter the optimum time for sawing. If a crack should open up at a joint where sawing is being performed, the sawing at the joint should stop. Otherwise, there could be two cracks, which could cause spalling of the concrete between the cracks.

Initial contraction joints, because of their function to relieve early drying-shrinkage stresses, must be cut as soon as the concrete has hardened enough to support the saw equipment. Clean, neat saw cuts generally indicate that the sawing is late in the process. Some minor raveling is an indicator that the timing of the sawing is correct. Excessive raveling at the top edges of the saw cut and washing of mortar from the faces of the cut under the action of the saw indicates that the cut is being made too early.

If the sawing operation is not able to progress at a satisfactory pace with the concrete setting, this will be evident from early cracking in the initial set. In most cases, this situation can be addressed by sawing every other or every third joint and then immediately sawing the skipped joints.

420.05-5 Dowel Bar Assemblies

Dowel bar (or basket) assemblies are typically required for transverse joints. They are placed ahead of the paving operation to transfer the load between the slab segments after the joint is sawed. See Figures 400-17, 400-18 and 400-19. Dowel assemblies must be laid out and marked such that the exact centerline of the assembly can be re-established for sawing. Review the dowel bar details in the plans.

Figure 400-17 — DOWEL BASKET ASSEMBLIES ON CAM II STABILIZED SUBBASE

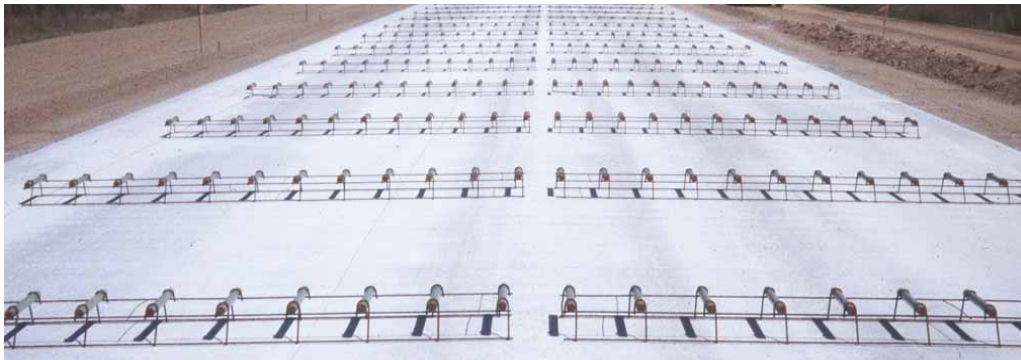


Figure 400-19 — DOWEL BASKET ASSEMBLIES, PINNED SAND PLATE

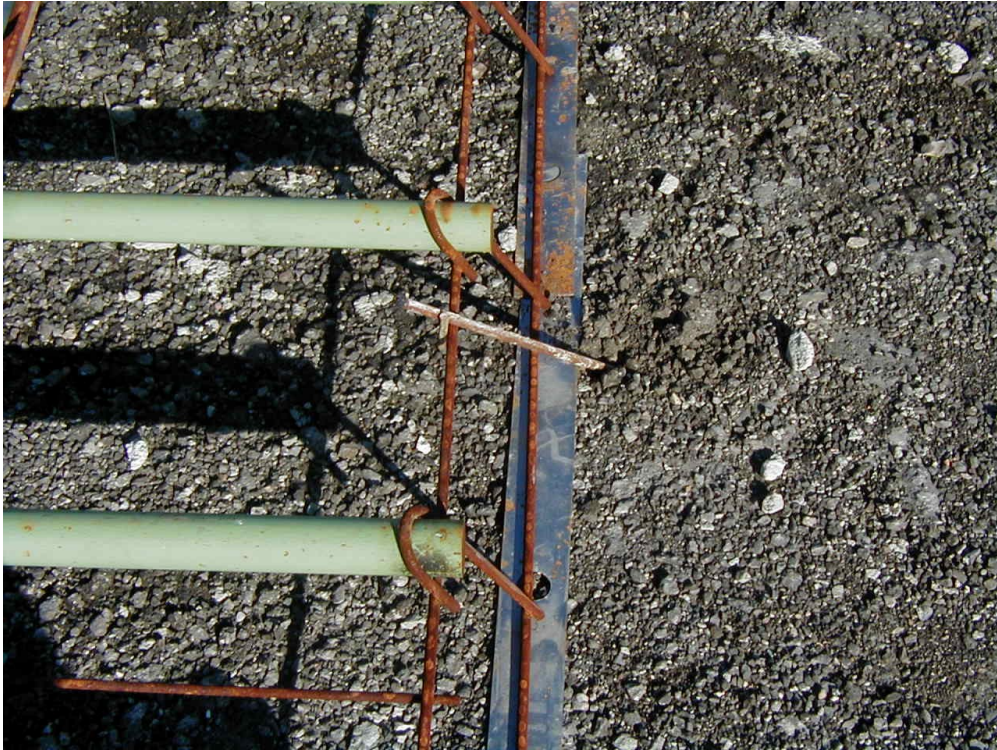


Figure 400-18 — DOWEL BASKET ASSEMBLIES ON AGGREGATE SUBBASE



Watch for any movement in the dowel bar baskets as the paver moves over the dowel bars and vibrates the concrete pavement. Dowel bars placed at a skew to the longitudinal joint are detrimental to the overall structural integrity of the pavement. In addition, dowel bars must never be placed perpendicular to a skewed transverse joint. Proper pinning of the dowel bars should be discussed in the Pre-Paving Conference. The Inspector should notify the Contractor immediately if the dowel bars are rotating or collapsed and are not in the proper locations as required.

The Contractor may choose to use a mechanical device or dowel bar inserter (DBI). See Figure 400-20. The following guidelines may be useful:

- The pavement should be placed and consolidated to full depth prior to insertion of the dowel bars.
- Dowel bars should be inserted into the plastic concrete ahead of the finishing beam or screed.
- The installing device should consolidate the concrete so that no voids exist around the dowel bars.
- Dowel bars should be located within 1 in. of the planned transverse and depth locations.
- Dowel bars should be placed within 2 in. of the planned longitudinal locations.

Figure 400-20 — CONCRETE PAVER WITH DOWEL BAR INSERTER (DBI)



- Dowel bars should be parallel to the pavement surface and centerline within a tolerance of ½ in. per bar length.
- Forward movement of the finishing beam or screed should not be interrupted by insertion of the dowel bars.
- A positive method of marking transverse joint locations should be provided.

Dowel bar location tolerances should be randomly checked. Deviance from the tolerance could result in suspension of paving operations until the problem is corrected. Significant and/or multiple deviances from dowel bar location tolerances may result in removal of the affected concrete section(s) at the Contractor's expense.

For a video on the use of DBIs, see [GOMACO IDBI Dowel Bar Inserter Attachment For GOMACO Concrete Slipform Pavers](#).

420.05-6 Tie Bars

Tie bars are located along longitudinal joints. Their function is to prevent slab separation.

420.07 PLACING (STATIONARY SIDE FORMS)

420.07-1 General

In this method, stationary side forms are placed in advance of the paving operation. Mechanical spreaders ride the forms and spread the concrete with either an auger or plow. The blade travels back and forth between the forms, whereas the screw movement is rotational, either forward or reverse. See Figure 400-21. The elevation of the plow or auger may be adjusted and set to properly distribute concrete.

Figure 400-21 — CONCRETE FINISHING MACHINE RIDING ON SIDE FORMS



The screed is located behind the plow or auger. The purpose of the screed is to strike off and partially consolidate the concrete. The elevation of the screed is usually set somewhat higher than the desired finished elevation so that after consolidation the surface will have the correct elevation. A controlled excess of fresh mix should be kept ahead of the spreader to avoid starving the strike-off screed.

To compensate for superelevation or cross slope, the elevation of the screed is adjusted. When these adjustments are anticipated and made in small increments, the finished surface will be free from abrupt changes.

Proper elevation and cross slope for the screeds of the finisher are determined through the use of a straightedge laid across the pavement and side forms after the final pass. The surface of the fresh concrete should be above the plane of the side forms by an amount sufficient to provide for slump and subsidence during finishing, which varies with different mixes. Experience with the mix in use will indicate the most satisfactory settings.

420.07-2 Hot Weather Concreting

When hot, dry and windy conditions prevail, it may become necessary to prevent rapid surface drying, rapid temperature changes and undesirable high temperatures in the concrete during the early stages of hardening. These conditions may remove moisture from the pavement surface faster than it can be replaced by normal bleeding causing plastic shrinkage cracks to form. Adequate labor should be available to apply a mist of water to the plastic concrete under these conditions. The Contractor may take the following actions:

- It may be desirable to cool the mixing water and aggregate stockpiles to lower the temperature of the concrete.
- The application or placement of curing materials immediately upon completion of finishing becomes extremely important.
- It may be necessary to use wet burlap for the first 24 hours.

If the concrete temperature approaches 90 degrees, notify your supervisor and the Contractor. Also, contact the proportioning engineer and/or QC Manager. Plastic concrete with a temperature up to 96 degrees is allowed by the Specifications. See Article 1020.14(a).

420.07-3 Protection in Case of Rain

Figure 400-22 presents an example of a texturing machine with a rolled-up sheathing that may be used in case of rain.

Figure 400-22 — TEXTURING MACHINE WITH ROLLED UP TARP IN CASE OF RAIN



420.09 STRIKE OFF, CONSOLIDATION, FINISHING, LONGITUDINAL FLOATING, STRAIGHTEDGING, EDGING AND FINAL FINISH

420.09-1 Finishing Concrete

Bumps and other deviations remaining in the surface after spreading and screeding must be cut and floated out as early as possible while the concrete is still very plastic and workable. Floating:

- Eliminates high and low spots
- Reduces ridges in the concrete
- Embeds large aggregate particles immediately after strike-off

Initial passes of float finishers should follow immediately after the finisher and should be performed as rapidly as possible. Manipulation of the surface of the concrete during the period of greatest bleeding, if there is free water present, should be held to a minimum. Floating or screeding the surface in the presence of excess water produces low-strength surface mortar of inferior abrasion resistance and durability.

Water should only be added during float finishing to maintain proper moisture for adequate curing and only in the form of a mist. Adding water to make more grout for floating is not permitted. Generally, the difficulty in floating is caused by too much delay in the finishing operation, and the finish floating should be performed earlier. See Article 1103.13 for finishing equipment requirements.

See Figures 400-23, 400-24 and 400-25.

Figure 400-23 — MECHANICAL FLOATING



Figure 400-24 — TUBE FLOATING



Figure 400-25 — FINISHING PCC CONCRETE PAVEMENT



420.09-2 Tining

The intent of tining is to obtain a series of grooves that are cut into the surface and spaced far enough apart to ensure a strong wall between the grooves. See Article 420.09e (1). For facilities with a posted speed limit of 55 mph or higher, the tining device shall be operated at a 1:6 skew across the pavement. The most important facet of tining is timing. The grooves should be formed while the concrete is still plastic, but before tearing or raveling result from tining. The Contractor should ensure that the tines are all in place, evenly spaced and free from build-up of hardened concrete. The depth of the grooves should also be checked. If the grooves are too shallow, they do not last long enough and do not provide the drainage necessary to prevent hydroplaning. If they are too deep, the surface is weakened and wears excessively. See Figure 400-26.

Figure 400-26 — TINING PCC PAVEMENT WITH RANDOM SPACING



420.09-3 Curing**420.09-3(a) General**

The purpose of curing is to seal off the surface to retain moisture that is needed for hydration and to reduce drying stress. Loss of moisture, particularly at the surface, will result in weak concrete that will be subject to shrinkage cracking with reduced durability.

After finishing operations have been completed and as soon as surface marring will not occur, the entire width of the pavement should be cured. Timing of the application of curing material is extremely important and must be performed prior to the time the surface dries out to avoid shrinkage cracks.

420.09-3(b) Membrane Curing Compound

The membrane method consists of spraying the entire surface of the freshly placed concrete pavement, including the edges, with a liquid membrane curing compound. See Figure 400-27. This application of compound must be sprayed by equipment capable of applying a smooth, even-textured coat. Ensure that all exposed surfaces and edges receive an application of the curing compound applied at the rate specified.

The rate of application of curing compound should be checked by calculating the area of pavement to be covered versus the amount of cure used. This amount should then be compared to the required application rate.

Figure 400-27 — MEMBRANE CURING FOR SLIPFORM PAVEMENT



If the curing membrane is being applied during wind, shielding (a burlap drape) should be provided to prevent loss and avoid bare spots on the surface. It is important that the concrete retains all of the needed moisture for the chemical reaction of hydration and to avoid shrinkage cracks. The requirements for membrane curing equipment are discussed in Article 1101.09.

420.10 SURFACE TESTS

Refer to Article 407.09.

420.10-1 Protective Coat after Grinding

Protective coat, applied prior to grinding, shall be reapplied to the ground area of the portland cement concrete pavement at no additional cost to the Department. If the concrete pavement not otherwise requiring protective coat undergoes corrective grinding performed after November 1, protective coat is not required as a result of the grinding.

420.12 SEALING JOINTS

Longitudinal joints are sealed with hot-poured joint sealer. Transverse joints are not sealed, because they are typically narrow and because unsealed transverse joints reduce vehicular noise.

420.14 SLIP FORM METHOD

420.14-1 General

The slip form method of concrete paving involves spreading, consolidating and finishing concrete pavement with a self-propelled machine on which short sections of side forms are attached. The machine operates on a previously prepared base of sufficient width to fully accommodate the tracks and is located properly to allow adequate lateral clearance for the machine to pass any fixed objects unimpeded.

The function of the slip form paver is to receive freshly mixed concrete, spread it to the required width and thickness, consolidate it by vibration, screed or float it to the proper cross section and profile, and final finish all in one operation.

Slip form machines must be stable to prevent deviation from line and grade. The form faces must be in good condition to minimize dragging and displacement of the concrete. The slip form must be long enough to provide support until the concrete edge can stand behind the trailing form end.

See Figures 400-28, 400-29 and 400-30.

420.14-2 Equipment

Although the Contractor is responsible for the condition and operation of the paving equipment, Inspectors should be familiar with the equipment being utilized. See Article 1103.12 for slip form equipment requirements. The Contractor must ensure that the equipment is assembled according to the manufacturer's recommendations and is operated accordingly. Key requirements to ensure proper assembly and preparation include:

- Ensure that the main pan is flat from side to side. Check it with a straight edge or string line. Several adjustments may be necessary.

Figure 400-28 — SLIP FORM PAVER WITH DBI ATTACHMENT

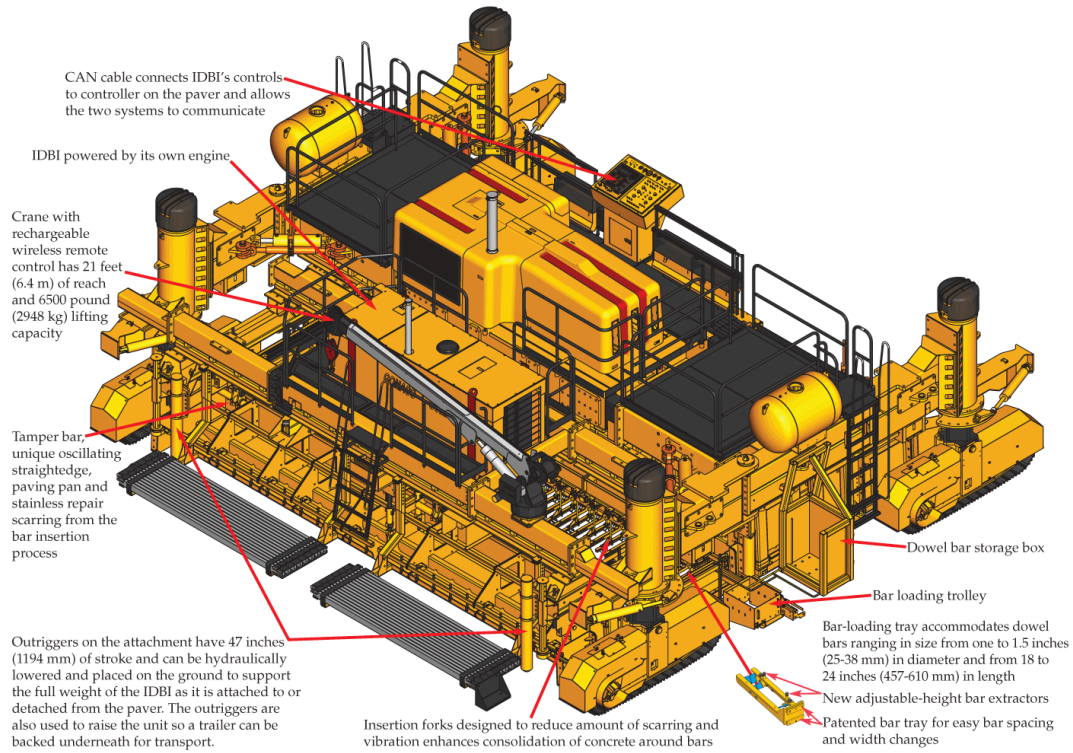
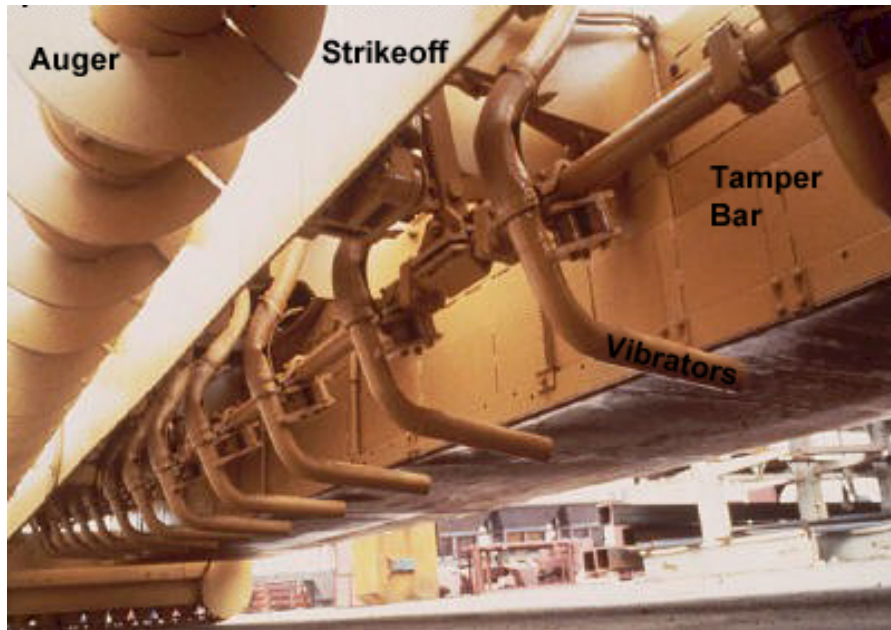


Figure 400-29 — CONCRETE PAVER WITH TIE BAR INSERTER

Figure 400-30 — UNDERSIDE OF CONCRETE PAVER



- The tamper bars should be adjusted so that they are in the lowest position, with the bottom of the tamper bar even with the bottom of the main pan. The tamper bar is located just in front of the pan on a slipform paver. It oscillates in a vertical direction to “tamp” the concrete as it moves under the paving pan. The tamper bar performs several functions. It is part of an extrusion process and helps “tamp” the large aggregates below the surface of the paving pan so that none of the large aggregates are dragged as the concrete moves through the paver. See Figure 400-30.
- Adjust vibrators up or down so that the tip of the vibrator is centered in the thickness of the concrete pavement. If placing over steel mesh or dowels, it may be necessary to position the vibrators above center.

420.14-3 Pavement Subbase

The subbase material must be checked for thickness, line and grade. Once the subbase material is approved and paving has started, it is important to continually check the thickness of the pavement behind the slip form paver and the edge slump while the pavement is being placed.

Because of the absence of side forms from which control of elevation for the surface of both pavement and subbase could be taken, accuracy and uniformity of profile and cross section of the subbase surface are more critical with respect to thickness of pavement and quantity of concrete.

Also, the subbase for slip form pavements is frequently used as a trafficway for the Contractor and other vehicles and equipment. Consequently, risk of damage to the subbase and the importance of checking for damage immediately before concreting is more pronounced. Furthermore, use of the pavement subbase by delivery equipment results in the accumulation of dust and other contaminants. This condition must be corrected before placing concrete.

See the [Construction Inspector's Checklist for Stabilized Subbase](#).

420.14-4 Finishing

The final finish on slip formed pavement is generally accomplished by a concrete finisher float or mechanical longitudinal float. This equipment essentially acts as a straightedge to remove surface irregularities and as a float to seal the surface. The application of water when using this machine should be in the form of a fog or mist and shall be the minimum necessary to secure a satisfactory finish.

420.14-5 Edge Slump

Edge slump can be controlled by using a uniform mix with consistent slump and proper adjustment of the edge plates on the slip form paver. If excessive edge slump, more than that permitted by the *Standard Specifications* is evident, either wood planks or metal forms should be placed against the pavement immediately and the pavement brought to the proper grade.

One of the earliest and best indicators of the quality of a concrete paving operation is the variation in edge slump. Excessive edge slump causes bumps and water to pond over the longitudinal joints; both reduce the long-term durability of the pavement. Continual fixing and finishing of the edge should be avoided.

The Contractor should always have a sufficient number of form sections on hand to immediately repair slumping edges when using the slip form method.

420.15 TOLERANCE IN THICKNESS

It is undesirable to have either a thin pavement or thick pavement because the ratio of steel to concrete is correspondingly increased or decreased depending on the pavement thickness. Special care must be exercised in superelevation transition areas to avoid thin pavement. Refer to Section 407.10 for more guidance.

SECTION 421. CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

421.01 DESCRIPTION

CRCP is a Portland Cement Concrete (PCC) pavement that has continuous longitudinal steel reinforcement and no intermediate transverse expansion or contraction joints. The pavement is allowed to crack in a random transverse cracking pattern and the cracks are held tightly together by the continuous steel reinforcement. See Section 420 for PCC paving information.

421.03 EQUIPMENT

See Figure 400-31 for a belt placer receiving concrete followed by slip form paver followed by texturing and curing machine.

Figure 400-31 — CRCP PAVING



421.04 GENERAL

Refer to the BMPR [Project Procedures Guide](#) for types and frequencies of tests. Review the contract documents in advance to determine the locations of joints, tie bars, wide flange beam terminal joints or lug end anchorages and superelevations. These locations must be adequately staked or marked. The wide flange beams at the pavement ends and structures are constructed in advance of the paving operations, and the slip form paver then paves through the wide flange beams.

Do not permit the Contractor to use bricks or other similar material under the reinforcing steel.

Use split header boards on continuously reinforced pavement so that the reinforcing steel may be extended past the header board at the proper elevation. The pavement standards in the contract documents require additional reinforcing bars at each header. There is a minimum distance from the laps of the steel where a header may be placed. A portable vibrator for vibrating the concrete should be used adjacent to header board at the end of the day's paving and also at the start of the following day's paving. The internal vibrators on the slip form paver will not cover this area. Failures on continuously reinforced pavement are usually the result of improper consolidation at the header boards or improper placement of the reinforcement. Excess mortar carried by the paver should not be placed in the pavement but should be discarded. All concrete protruding between the header boards should be chipped off flush with the pavement face prior to the next pour.

SECTION 424. PORTLAND CEMENT CONCRETE SIDEWALK

424.01 DESCRIPTION

The IDOT accessibility field guide includes checklists that are developed to verify compliance with all applicable laws and regulations in the State of Illinois, including the 2011 *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way* (PROWAG), Illinois Accessibility Code (IAC) and IDOT standards. The field guide includes checklists for accessibility requirements and defines applicable terms.

Crosswalks require detectable warnings in the form of truncated domes where the sidewalk/curb ramp meets the curb or pavement. The Contractor must supply written certification from the manufacturer that the truncated domes meet the accessibility requirements and a written manufacturer's five-year warranty.

The accessibility requirements are required by law and must be implemented on roadway improvement projects. If there are issues relating to implementing the requirements, contact the Resident. See Figure 400-32.

Figure 400-32 — ACCESSIBILITY-COMPLIANT CURB RAMP



SECTION 440. REMOVAL OF EXISTING PAVEMENT AND APPURTENANCES

440.01 DESCRIPTION

Cold milling is the controlled removal of the surface of the existing pavement to the desired depth, with specially designed milling equipment to restore the pavement surface to the specified grade and cross slope. Cold milling is used to remove part of the existing pavement layers. The amount of material removed can also be varied to meet project-specific requirements.

440.02 EQUIPMENT

Cold milling machines are available in a variety of sizes from small milling machines for localized milling around manholes and valves, to high-capacity machines capable of milling up to 16 ft. (4.9 m) wide and over 12 in. (300 mm) deep in one pass. See Figure 400-33 and Article 1101.16 for milling machine requirements.

The speed of the milling machine should be such that the milled and planed surface is not torn, gouged, shoved or otherwise injured by the milling operation. For surface texture requirements, see Checksheet #13.

To increase maneuverability, the cold planer can be operated with front steering, rear steering and/or all-track steering. This permits easy maneuvering of the cold milling machines, which allows them to mill around the tight radius turns found at roadway intersections.

With front loading milling machines, the only lane that needs to be closed to traffic is the lane that is being milled.

Figure 400-33 — MILLING OPERATIONS



SECTION 442. PAVEMENT PATCHING**442.01 DESCRIPTION****442.01-1 Process**

During the design phase, a patching survey is performed with an estimated patching quantity. A significant amount of time can elapse between the initial patching survey and construction phases, during which time additional distresses may appear.

The Resident should review the plans for patching quantities and perform an initial field review identifying pavement distresses that need attention. During the field review, the Resident should prepare a list of proposed patches located by station and summarized by type and class. If the quantity of patching is larger than the plan quantity, the Resident should notify the District Field Engineer for guidance and direction.

See Chapter 53 “Pavement Rehabilitation” of the IDOT [BDE Manual](#) for a thorough discussion on pavement distresses, field testing and pavement rehabilitation methods. See the [Construction Inspector’s Checklist for Pavement Patching](#).

442.01-2 Types

The Department uses the following types of pavement patching classifications:

1. Class A Patches. Pavement removal and continuously reinforced concrete replacement (see Figure 400-34)
2. Class B Patches. Pavement removal and jointed concrete replacement using dowels (see Figure 400-35)
3. Class C Patches. Pavement removal and portland cement concrete replacement (see Figure 400-36)
4. Class D Patches. Pavement removal and bituminous concrete replacement (see Figure 400-37)
5. Pavement Patching. Contractor’s option of Class C or Class D

442.09 OPENING PATCHES TO TRAFFIC

To Be Prepared in the Future

Figure 400-34 — CLASS A PATCHING

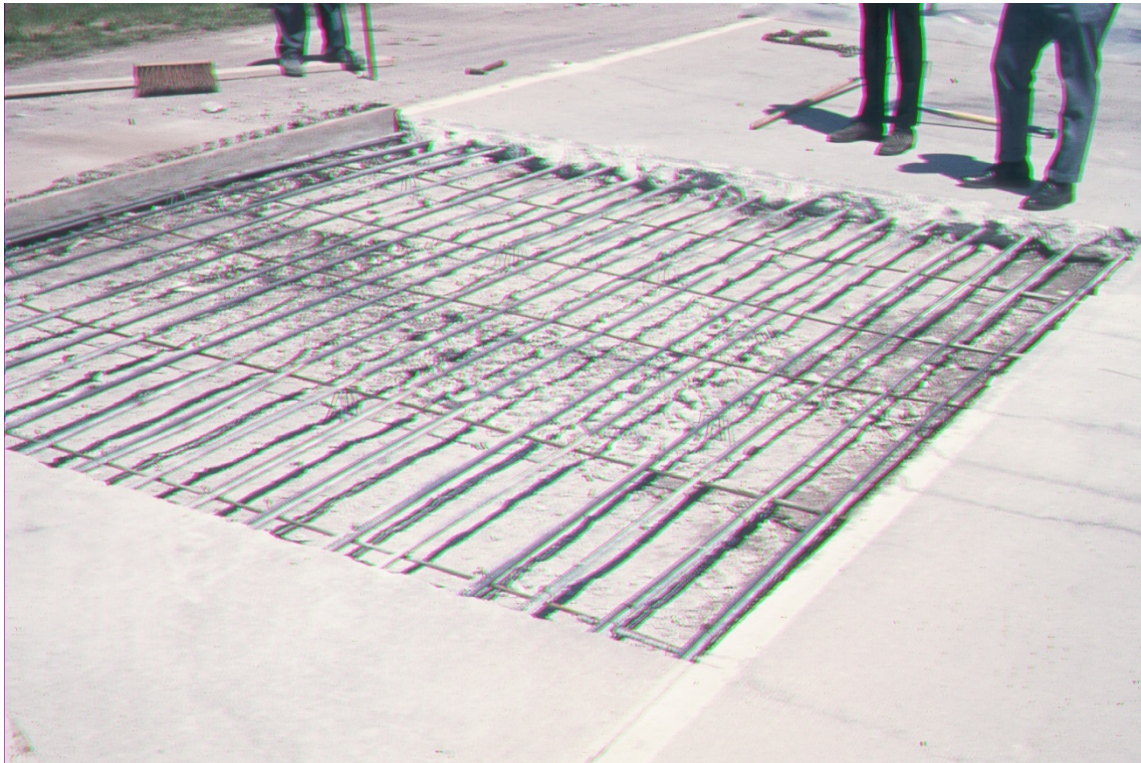


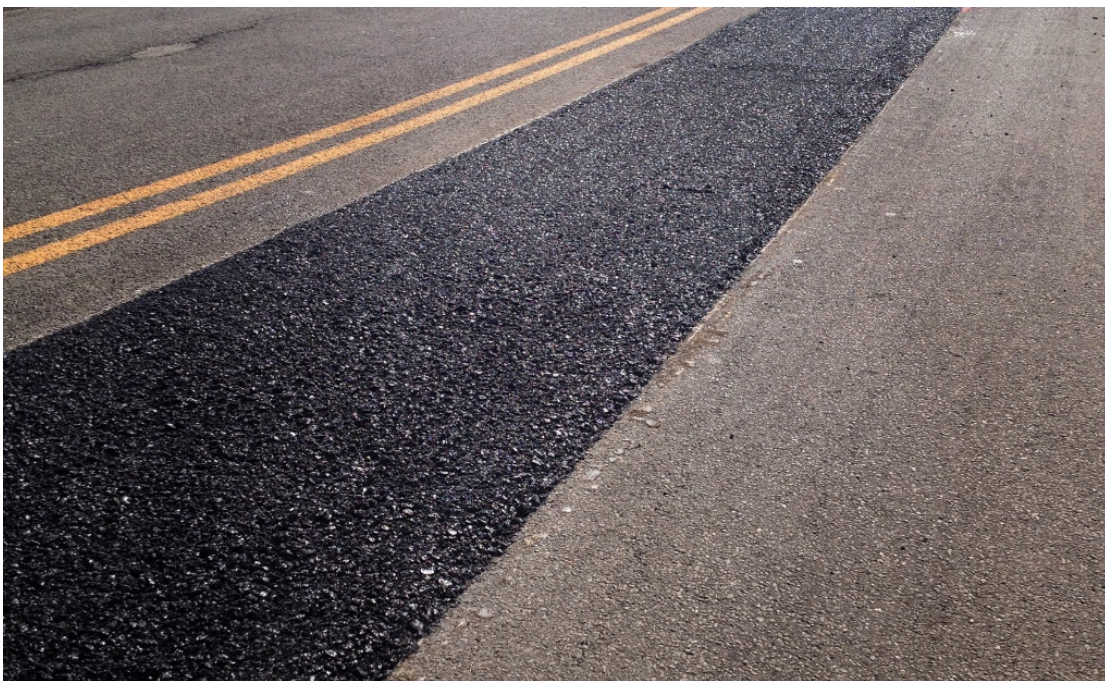
Figure 400-35 — CLASS B PATCHING



Figure 400-36 — CLASS C PATCHING



Figure 400-37 — CLASS D PATCHING



DIVISION 500

Structures

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
LIST OF FIGURES.....	500-VIII
Division 501 STRUCTURES	500-1
SECTION 500. GENERAL	500-1
500.01 DEFINITIONS.....	500-1
500.02 RESOURCES.....	500-5
SECTION 501. REMOVAL OF EXISTING STRUCTURES.....	500-6
501.04, 501.05 COMPLETE AND PARTIAL REMOVAL OF STRUCTURES	500-6
SECTION 502. EXCAVATION FOR STRUCTURES	500-7
502.03 GENERAL.....	500-7
502.03-1 General.....	500-7
502.03-2 Soil Boring Logs	500-7
502.03-3 Wet Excavations.....	500-8
502.03-4 Piles.....	500-9
502.06 COFFERDAMS	500-9
502.06-1 Description	500-9
502.06-2 Unsealed Cofferdams.....	500-9
502.06-4 Foundation Seal (Dewatering the Cofferdam).....	500-10
502.06-5 Cofferdam Safety	500-11
502.08 PUMPING.....	500-11
502.09 INSPECTION	500-12
502.10 BACKFILLING.....	500-12
502.12 METHOD OF MEASUREMENT.....	500-12
SECTION 503. CONCRETE STRUCTURES	500-12
503.05 FALSEWORK.....	500-13

503.05-1	Plans	500-13
503.05-4	Dead Load Deflection	500-13
503.05-5	Falsework Compression and Settlement.....	500-13
503.06	FORMS	500-14
503.06-1	General.....	500-14
503.06-2	Fluid Pressure	500-15
503.06-3	Tightness.....	500-15
503.06-4	Footings.....	500-15
503.06-5	Alignment and Bracing	500-15
503.06-6	Molding (Chamfer).....	500-16
503.06-7	Fillet Calculations	500-16
503.07	PLACING AND CONSOLIDATING	500-18
503.07-1	Inspection Timing	500-18
503.07-2	Placement Rate/Consolidation	500-18
503.07-3	Pumping Bridge Deck Concrete	500-18
503.08	DEPOSITING CONCRETE UNDERWATER	500-19
503.09	CONSTRUCTION JOINTS.....	500-20
503.09-1	Description	500-20
503.09-2	Installation	500-20
503.09-3	Preferred Location of Emergency Joints	500-20
503.13	FOUNDATIONS AND FOOTINGS.....	500-22
503.13-1	General.....	500-22
503.13-2	Spread Footings	500-22
503.14	SEAL COATS IN COFFERDAMS	500-23
503.14-1	General.....	500-23
503.14-2	Seals (Tremie Concrete)	500-24
503.14-3	Seals (Pumping Concrete)	500-24
503.15	SURFACE FINISH	500-24

503.16	CONCRETE SUPERSTRUCTURES	500-24
503.16-1	Bridge Deck Pre-Pour Meeting.....	500-24
503.16-2	Sequential Deck Pours	500-25
503.16-3	Form Grade Check.....	500-26
503.16-4	Reinforcement Bars.....	500-26
503.16-5	Deck Finishing Machines	500-27
503.16-6	Finishing Operations	500-29
503.16-7	Surface Smoothness	500-29
503.16-8	Slipform Parapet.....	500-29
SECTION 504.	PRECAST CONCRETE STRUCTURES	500-30
504.01	DESCRIPTION.....	500-30
504.06	PRECAST, PRESTRESSED CONCRETE MEMBERS	500-30
504.06-1	Damage Inspection	500-30
504.06-6	Erection Plan	500-31
504.06-7	Precast, Prestressed Concrete, Deck Beams	500-32
504.06-8	Stage Construction of Deck Beams.....	500-33
SECTION 505.	STEEL STRUCTURES	500-33
505.01	DESCRIPTION.....	500-33
505.01-1	Composite Steel Welded Plate Girders	500-33
505.01-2	Rolled Girders	500-34
505.02	MATERIALS	500-34
505.04	FABRICATION	500-35
505.04-1	Field Installation and Inspection of High Strength Fasteners for Slip Critical Connections	500-35
505.04-2	Procedure for Installation and Tightening of High Strength Fasteners – Turn-of-Nut Method.....	500-45
505.04-3	Procedure for Installation and Tightening of High Strength Fasteners – Alternet Design Fasteners (Twist Off Bolts).....	500-47
505.04-4	Procedure for Installation and Tightening of High Strength Fasteners – Lockpin and Collar (Huckbolts, etc.).....	500-49
505.04-5	Procedure for Verification and Installation of High Strength Bolts with Direct Tension Indicators (DTIs).....	500-51
505.04-6	General Procedure for Inspection of High Strength Fasteners Installation .	500-54

505.07	MARKING AND SHIPPING	500-57
505.08	ERECTION.....	500-57
505.08-1	General.....	500-57
505.08-2	Pre-Erection	500-57
505.08-3	Erection Plan	500-57
505.08-4	Assembly.....	500-58
505.08-5	Erection Checklist.....	500-59
505.08-6	Handling and Storing Materials	500-59
505.08-7	Falsework	500-59
505.08-8	Long Span Bridges.....	500-59
505.08-9	Bearings and Anchorage (Correction for Temperature)	500-61
505.08-10	Anchor Bolt Holes.....	500-63
505.08-11	Field Bolting.....	500-63
SECTION 506. CLEANING AND PAINTING NEW STEEL STRUCTURES.....		500-67
506.02	MATERIALS	500-67
506.02-1	General.....	500-67
506.02-2	Weathering Steel.....	500-67
506.10	FIELD CLEANING AND PAINTING NEW STRUCTURES	500-68
506.10-1	Protection	500-68
506.10-2	Surface Preparation	500-68
506.10-3	Painting	500-68
506.10-4	Inspection Guidelines	500-69
SECTION 508. REINFORCEMENT BARS		500-69
508.05	PLACING AND SECURING	500-69
508.05-1	General.....	500-69
508.05-2	Rebar Cover and Clearance.....	500-70
508.05-3	Epoxy-Coated Reinforcement	500-70
508.06	SPLICING.....	500-71
508.06-1	Lap Splices.....	500-71
508.06-2	Bar Splicer Assemblies	500-71

508.06-3	Mechanical Splicers	500-71
508.06-4	Reinforcing Steel Inspection.....	500-72
SECTION 509. METAL RAILINGS		500-73
509.02	MATERIALS.....	500-73
509.04	SHOP DRAWINGS	500-73
509.05	STEEL RAILINGS	500-74
509.05-1	Rail Alignment	500-74
509.05-2	Bolt Holes in Field	500-74
SECTION 512. PILING		500-74
512.01	DESCRIPTION.....	500-74
512.02	MATERIALS.....	500-74
512.02-1	General.....	500-74
512.02-2	Pile Inspection	500-74
512.07	WELDING (SPLICES).....	500-75
512.08	STORAGE AND HANDLING OF PILES	500-75
512.08-1	Precast and Precast, Prestressed Concrete Piles.....	500-75
512.08-2	Steel Piles	500-75
512.09	PREPARATION FOR DRIVING	500-75
512.09-1	General.....	500-75
512.09-2	Inspector's Preparation	500-76
512.09-3	Excavation/Embankment.....	500-78
512.09-4	Pile Driving Hammer	500-78
512.09-5	Location and Alignment.....	500-78
512.09-6	Nominal Driven Bearing	500-79
512.09-7	Pile Tip Elevation.....	500-79
512.10	DRIVING EQUIPMENT	500-79
512.10-1	Evaluation of Pile Driving Equipment	500-79
512.10-2	Pile Driving Equipment	500-80
512.10-3	Hammer Energy Requirements	500-81
512.10-4	Loss Due to Impact	500-82
512.10-5	Steel H-Piles Driven to Hard Rock	500-83
512.11	PENETRATION OF PILES.....	500-83

512.11-1	Records of Penetration.....	500-83
512.11-2	Excess Penetration	500-84
512.13	CUTOFFS	500-84
512.14	DETERMINATION OF NOMINAL DRIVEN BEARING	500-84
512.14-1	Formulas	500-84
512.14-2	Wave Equation	500-84
512.14-3	Load Tests.....	500-84
512.15	TEST PILES.....	500-84
SECTION 515. NAME PLATES		500-85
SECTION 516. DRILLED SHAFTS		500-85
SECTION 520. BRIDGE EXPANSION JOINTS.....		500-85
520.01	DESCRIPTION.....	500-85
520.04	JOINT OPENING	500-86
SECTION 542. PIPE CULVERTS		500-86
542.02	MATERIALS	500-86
542.02-1	General.....	500-86
542.02-2	Corrugated Steel Pipe	500-86
542.02-3	Reinforced Concrete Pipe (RCP)	500-87
542.04	METHOD I CONSTRUCTION.....	500-87
542.04-1	Description	500-87
542.04-2	Planning Before Installation.....	500-88
542.04-3	Preliminary Pipe Staking	500-88
542.04-4	Staking Inspection	500-89
542.04-5	Installation and Assembly Considerations.....	500-89
542.04-6	Reinforced Concrete Pipe	500-91
542.04-7	Backfill Considerations	500-92
542.04-8	Pavement Restoration.....	500-93
542.05	METHOD II CONSTRUCTION.....	500-94

542.06	METHOD III CONSTRUCTION.....	500-94
SECTION 550.	STORM SEWERS	500-94
550.04	EXCAVATION AND FOUNDATION.....	500-94
550.04-1	Excavation Hazards	500-94
550.04-2	Definitions.....	500-95
550.04-3	Safety	500-95
SECTION 562.	WATER SERVICE LINE.....	500-96
562.01	DESCRIPTION.....	500-96
562.03	GENERAL	500-96
SECTION 582.	HOT-MIX ASPHALT SURFACING ON BRIDGE DECKS	500-96
SECTION 584.	GROUTING OF ANCHOR RODS AND BARS	500-96
SECTION 593.	CONTROLLED LOW-STRENGTH MATERIAL, BACKFILL	500-96
Appendix 500.A	OVERHANG FORMING EXAMPLE.....	500-97

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 500-1 — ELASTOMERIC BEARING TYPE 2.....	500-1
Figure 500-2 — DS12 M10 SCUPPER.....	500-3
Figure 500-3 — SHEAR STUDS OVER STEEL BEAM/FORMS FOR FILLETS	500-4
Figure 500-4 — SKEW DEFINITION	500-4
Figure 500-6 — CONCRETE FILLET	500-17
Figure 500-7 — BID-WELL DECK FINISHING MACHINE	500-28
Figure 500-8 — TYPICAL DETAIL – STEEL WELDED PLATE GIRDER	500-34
Figure 500-9 — TENSION CALIBRATING DEVICE.....	500-41
Figure 500-10 — INSTALLATION OF HIGH STRENGTH BOLTS WITH DTIs	500-53
Figure 500-11 — DISPLACEMENT OF ENDS OPPOSITE FROM SPLICES	500-64
Figure 500-12 — OBTAINING DESIRED DESIGN POSITIVE FILLETS.....	500-65
Figure 500-13 — UNDESIRABLE POSITIVE AND NEGATIVE FILLETS	500-66
Figure 500-15 — SAXIMETER	500-78
Figure 500-17 — INSTALLATION OF REINFORCED CONCRETE PIPE SECTIONS	500-92
Figure 500-18 — EXCAVATION/TRENCHES	Error! Bookmark not defined.
Figure 500-19 — REQUIRED SLOPE FOR TYPE C SOIL	Error! Bookmark not defined.

Division 500 STRUCTURES

SECTION 500. GENERAL

500.01 DEFINITIONS

1. **Abutment.** A substructure unit that supports the ends of a superstructure. Common abutment types built in Illinois include three primary categories — open, closed and vaulted. Historically, open abutments have also been referred to as pile bent or spill through. Vaulted abutments are of two types — fill and unfilled. The open category includes integral, semi-integral and stub abutments.
2. **Beam.** A horizontal structure member supporting vertical loads by resisting bending. The term beam applies to a steel rolled beam, a W-shape steel beam and a precast, prestressed beam.
3. **Bearings.** A device at the ends of beams that is placed on top of a pier or abutment. The ends of the beam rest on the bearing. See Figure 500-1.
4. **Bent.** Part of a bridge substructure. A rigid frame commonly made of reinforced concrete or steel that supports a vertical load and is placed transverse to the length of a structure. Bents are commonly used to support beams and girders. An end bent is the supporting frame forming part of an abutment.

Figure 500-1 — ELASTOMERIC BEARING TYPE 2

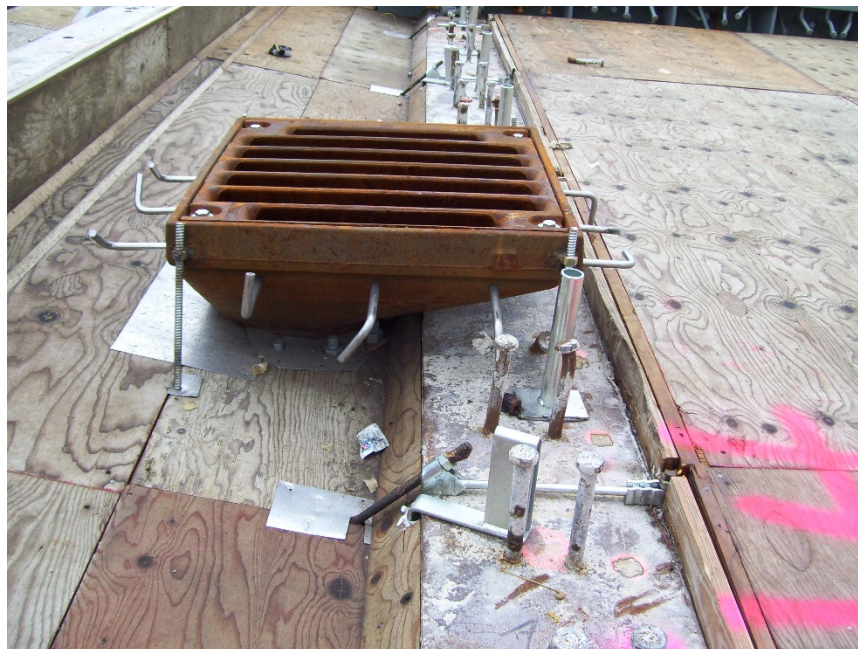


Each vertical member of a bent may be called a column, pier or pile. The horizontal member resting on top of the columns is a bent cap.

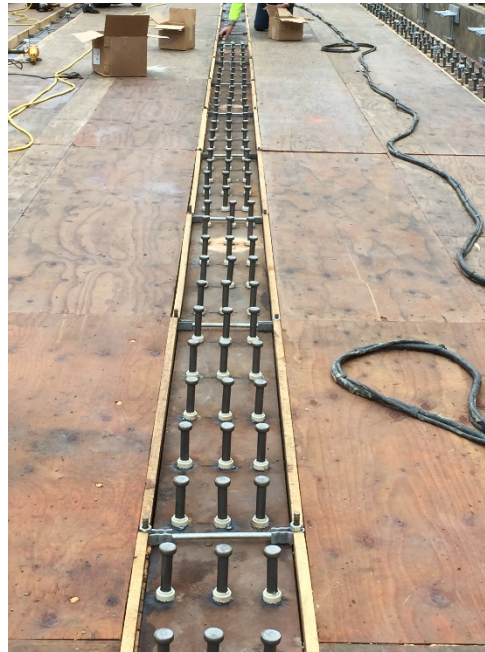
5. Bulkhead Construction Joint. The edge of a construction joint is created using a bulkhead. Bulkheads can be made of various materials, from plastic to steel to preformed concrete.
6. Camber. A positive, upward curve built into a beam or girder that compensates for some of the vertical load and anticipated deflection.
7. Cofferdams. Cofferdams are reasonably watertight enclosures surrounding excavations to be used for placing concrete or other required construction.
8. Column. In architecture and structural engineering, a structural element that transmits, through compression, the weight of the structure above to other structural elements below. In other words, a column is a compression member.
9. Diaphragm. Bracing that spans between the main beams or girders of a bridge and assists in the distribution of loads.
10. Drilled Shafts. A reinforced circular foundation that is constructed by placing fluid concrete in a drilled (excavated) hole.
11. Falsework. The temporary construction used to support the permanent structure until it becomes self-supporting.
12. Filletts (Concrete). That bottom portion of a concrete bridge deck directly over the top flange of supporting steel beams that provides for extra thickness to counter the effects of dead load deflection of the beams or girders.
13. Filletts (Welding). A weld of approximately triangular cross section joining two surfaces, approximately at right angles to each other. The symbol for a fillet weld is in the shape of a triangle.
14. Footings. The enlarged lower portion of the substructure that rests directly on the soil, bedrock or piles; usually below grade and not visible. A footing is sometimes referred to as a foundation.
15. Forms. Temporary structures or molds made of wood or metal, used when placing concrete to ensure that it is shaped to its desired final form.
16. Formwork. A temporary structure or mold used to retain the plastic or fluid concrete in its designated shape until it hardens. In some applications, formwork may be integral with, and so also perform as, falsework.
17. Girder. A horizontal structure member supporting vertical loads by resisting bending. The term girder applies to fabricated welded steel plates and to built-up precast concrete girders.
18. Mechanically Stabilized Earth (MSE) Wall. A three-dimensional stabilized mass of compacted soil, soil reinforcement and wall facing elements that essentially behaves as a rigid body to resist earth pressure and other applied loadings by its own weight.

19. Pier. Intermediate vertical elements that support the superstructure. Three primary categories of piers are built in Illinois — footing supported piers (on piles, drilled shafts or spread footings); individually encased pile or drilled shaft bents; and solid wall encased pile or drilled shaft bents. Footing supported piers include multiple round and trapezoidal column bents with cap beams and crashwalls, solid walls and hammerheads. Pile types, which can be individually encased or encased in a solid wall, include H-pile and metal shell.
20. Pile. A long column driven deep into the ground to form part of a foundation or substructure.
21. Pile Bents. A row of driven or placed piles with a pile cap to hold them in their correct positions.
22. Pile Cap. Reinforced concrete placed over piling to support the superstructure.
23. Pile Shoe/Conical Tip. A pointed or rounded device on the foot of a pile to protect the pile for hard driving conditions.
24. Scuppers. A drainage structure used on bridge decks to transport water from the deck to the underneath side of the structure. See Figure 500-2.

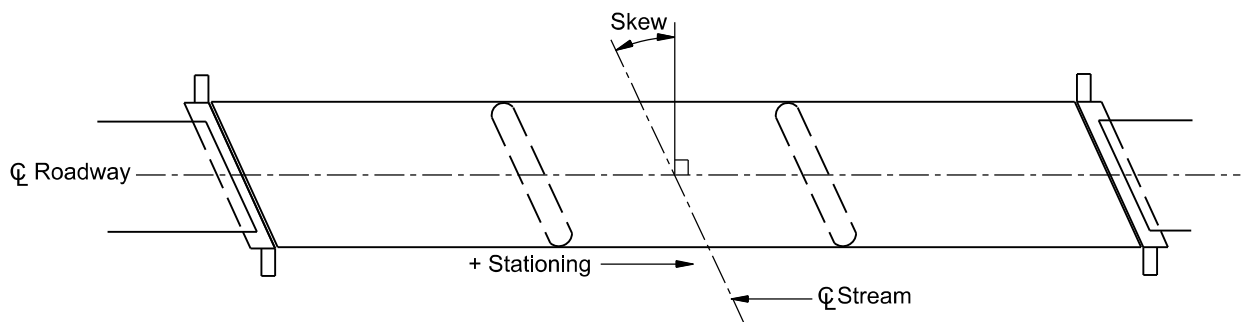
Figure 500-2 — DS12 M10 SCUPPER



25. Shear Studs. A short, unthreaded bolt that transfers shear stress between metal and concrete in composite structural members in which the stud is welded to the metal component. See Figure 500-3.

Figure 500-3 — SHEAR STUDS OVER STEEL BEAM/FORMS FOR FILLETS

26. **Shoring.** A temporary support (e.g., sheet piling) that is used during the repair or original construction of structures and in excavations. Shoring is also used to support the forms for cast-in-place concrete slabs, beams and girders in reinforced concrete structures.
27. **Skew.** The difference between the alignment of an intermediate or end support and a line square to the longitudinal axis of the bridge. The angle between a line normal to the bridge reference chord and the cross-road or waterway centerline. See Figure 500-4.

Figure 500-4 — SKEW DEFINITION

28. Soldier Piles. Soldier piles are constructed of wide flange, steel H-sections evenly spaced and are installed prior to excavation. As the excavation proceeds, horizontal timber sheeting (lagging) is inserted behind the H-pile flanges.
29. Spread Footing. A reinforced or unreinforced concrete structure placed on undisturbed soil.
30. Stringers. A beam aligned with the length of a span that supports the deck.
31. Wingwall. Concrete structures that are adjacent to both ends of an abutment and act as retaining walls to retain the earth fill beneath the bridge approach.
32. Self-Supporting Concrete Component. Self-supporting concrete components are concrete structural members whose self-weight and immediate subsequent loads are required to be supported by the member itself in bending (flexure) or tension. Self-supporting components generally require falsework or formwork to also act as falsework.

500.02 RESOURCES

The following is a selected list of the more important construction-related publications relevant to Division 500 items:

- [Construction Inspector's Checklists](#):
 - + Bridge Superstructures (Section 503)
 - + Concrete Structures other than Bridge Decks (Section 503)
 - + Piling (Section 512)
 - + Pipe Culverts (Section 542)
 - + Storm Sewers (Section 550)
 - + Drilled Shafts (Section 516)
- Illinois Highway Information System, [Structure Information and Procedure Manual \(ISIS Manual\)](#), IDOT
- [Manual for Fabrication of Precast Prestressed Concrete Products](#), IDOT
- [Drilled Shaft Foundation Construction Inspection](#), S32, *Class Reference Guide*, Specific Task Training Program, IDOT
- [Culvert Manual](#), IDOT
- [Geotechnical Manual](#), IDOT
- [Pile Foundation Construction Inspection](#), S19, *Class Reference Guide*, Specific Task Training Program, IDOT
- [Highway Standards](#), IDOT
- [Bridge Manual](#), Bureau of Bridges and Structures, IDOT

- *Documentation of Contract Quantities*, IDOT
- *Standard Specifications for Water and Sewer Main Construction in Illinois*, Illinois Society of Professional Engineers, Illinois Municipal League

Structural Services Manual, IDOT

SECTION 501. REMOVAL OF EXISTING STRUCTURES

501.04, 501.05 COMPLETE AND PARTIAL REMOVAL OF STRUCTURES

Caution should be taken when the plans require removal of existing structures or portions of existing structures. Reinforced concrete structures may require additional shoring if portions of the superstructure are to be removed. The Contractor shall follow the Demolition Plan, if applicable.

Extreme caution should be exercised when blasting to prevent damage to underground utilities or other public and private property. Thoroughly discuss the removal plans with the Contractor and supervisor. If materials are to be removed and disposed of away from the site, the work should be done in accordance with Article 202.03 and District policy.

Structural steel that is to remain must be protected from jackhammer notches and gouges as well as from concrete saw cuts. This type of damage results in stress concentrations that could result in fatigue cracking or failure of a member.

Damage to structural steel can be minimized or eliminated if the Contractor places proper emphasis on controlling the deck removal process. The deck removal process should not result in any damage to the structural steel. However, should damage occur, the following guidelines will assist field personnel in assuring that proper corrective action is taken. These guidelines are not intended to be a convenient method by which the Contractor can compensate for negligence in the deck removal process, but rather as a last resort when unavoidable damage has occurred.

The Contractor will be required to hire a Structural Engineer to provide repair procedures and details for all damage done during the removal operation. No repair shall be undertaken without the recommendations of the Bureau of Bridges and Structures and the concurrence of the Bureau of Construction.

Damage that appears insignificant may be major. Damage to the top flange in the negative moment area (steel in tension) on continuous beams or girders is a major concern. Any gouge, notch or depression greater than 1/16 in. (2 mm) deep shall be subject to review by the Bureau of Bridges and Structures. Typical repair procedures require the gouge to be ground smooth with a minimum slope of 1:3 (V:H). All final striations due to grinding shall be parallel to the longitudinal axis of the beam. To ensure that small micro-cracks are not generated during the grinding process, extreme pressure cannot be applied to the grinding tool to speed up the grinding operation. After grinding is completed, the area shall be checked with the dye penetrant or magnetic particle testing procedure. The term "smooth" is defined as American Standards Institute roughness value 250.

Gouges deeper than 1/4 in. (10 mm) may require specialized repair such as controlled welding accompanied by ultrasound testing, bolted flange plates over the gouge, or other procedures deemed necessary to restore the integrity of the structural steel member.

Unless there is a pre-existing condition, the Contractor will be responsible for all damage resulting from the deck removal operation and all cost associated with the corrective work required. Determination of whether or not there is a pre-existing condition will require special diligence on the part of the Inspector during the deck removal process.

SECTION 502. EXCAVATION FOR STRUCTURES

See the [Construction Inspector's Checklist for Concrete Structures Other than Bridge Decks](#) for additional direction and information.

502.03 GENERAL

502.03-1 General

Structure excavation may begin at natural ground surface or from some designated point in an embankment or cut slope. The area in the vicinity of the bridge must be graded to the limits designated in the contract documents before structure excavation is staked and begun.

It is essential that spread footings be placed on undisturbed material. Before reaching plan grade, teeth should be removed from buckets to prevent disturbing material below the footing. If foundation material is disturbed or over excavated, the Contractor will be required to correct this at their expense.

If the bottom of the excavation is unsuitable or unstable, use crushed stone or gravel to provide stability and a working platform for construction of the footing or foundation of the structure. Increasing the thickness of the concrete structure to more than specified in the contract documents will not be allowed unless directed otherwise by the Resident.

Moisture can alter the soil bearing capacity. It is necessary to protect dry-land foundation excavations from precipitation and run-off. They must also be backfilled as soon as possible.

Article 502.03, Paragraph 4, states the following:

After the Engineer has made the determination that the material qualifies as rock excavation, the Contractor may use any method, approved by the Engineer, to remove the rock.

Methods include blasting, rock bits, pneumatic drills, jackhammers and rock saws, depending on the nature of the work. Equipment should meet EPA and noise regulations if working in an urban environment.

502.03-2 Soil Boring Logs

The geotechnical engineer is generally responsible for:

- Soil borings and geotechnical design during the design phase of the project

- At the request of the Resident, visiting the project site during construction to examine the foundation soils after excavation
- Determining any necessary adjustments to the foundation based on actual field conditions

The designer prepares the plans based on information obtained from a limited number of soil borings made at the site. Section 5.2.5 of the IDOT *Geotechnical Manual* discusses boring logs for structure foundations as prepared by the geotechnical engineer (see Figure 5.3 in the *Geotechnical Manual*). The logs will be documented in the Geotechnical Report (see Chapter 5 of the *Geotechnical Manual*). However, it is not uncommon for conditions to vary from those shown in the plans. This may result in encountering rock or other hard supporting material at a different elevation than shown in the plans. If during excavation for the spread footing or pile driving, the site conditions do not seem to match those shown in the plans, contact the Field Engineer/Area Supervisor. This must be done promptly to minimize expensive delays which may result from a foundation redesign.

A basic understanding of soil boring log information to assist in the inspection of foundations is important. Each soil boring log generally contains the following information:

Soil and rock types and conditions can change within a few feet of the soil boring. The information shown on the boring log only represents the conditions found in that boring at the time the boring was performed. In addition, water levels found at the time of boring can, and many times do, vary considerably from water levels found at the time of construction. Foundation construction is one of the frequent sources for Contractor claims. Many of these claims are based on alleged variations from boring log information in the contract documents. It is vital to maintain comprehensive records of native materials encountered during foundation work.

See Article 104.03 of the *Standard Specifications* and Section 104.03 of this *Manual* for more information.

502.03-3 Wet Excavations

Very often excavations will extend below ground water levels. This requires the excavation to be dewatered before the foundation can be placed. Open excavations and cofferdams (see Article 502.06) are two methods employed for wet excavations. Environmental constraints often preclude the open excavation method in or near streams.

Various problems develop in open excavations. The most common is that it cannot be properly dewatered. The volume of water entering through the exposed area can exceed available pumping capacity. The addition of a cofferdam may be considered; consult the Field Engineer/Area Supervisor.

See Section 503.08 for a discussion on depositing concrete underwater.

502.03-4 Piles

When piles are driven, the displaced material usually causes a swelling in the surface of the footing excavation. To keep the bottom of the footing at plan elevation, either this displaced material must be removed after the piles are driven, or the original excavation must be carried enough below plan grade to allow for the swelling.

502.06 COFFERDAMS**502.06-1 Description**

As described in the *Standard Specifications*, cofferdams are reasonably “watertight enclosures surrounding excavations” to be used for “placing concrete or other required construction.” (See Figure 500-5 for a cofferdam schematic.) The required construction includes the excavation and construction of structure foundations below the design or prevailing water elevation. These enclosures normally consist of sheet piling driven around the perimeter of the excavation with or without one or more “rings” or wales placed at specified elevations within the sheet pile enclosure. The wales are often needed, together with a concrete seal coat, to provide structural stability for the cofferdam when it is dewatered. The cofferdam must be built in accordance with the plans and/or drawings submitted by the Contractor and approved by the Engineer before construction is started. Bracing and other supports cannot extend into the substructure concrete without written approval of the Engineer.

A cofferdam is considered a confined space. The Contractor shall provide adequate means for inspection of the work.

Cofferdams are a tool of the Contractor and the details are largely their choice. The Department’s interest is from the perspective of safety for Inspectors who must enter the cofferdam and that the cofferdam must protect the portions of permanent work enclosed. For this reason, Article 502.06 requires that the Contractor submit drawings and design calculations of the proposed method before construction is started. The drawings are submitted to the Resident and forwarded to the Bureau of Bridges and Structures for review and comment.

502.06-2 Unsealed Cofferdams

In this type, the water is removed without sealing the bottom. One problem that often develops is piping or bottom blow-in when the cofferdam is pumped. It is caused by the difference in water pressure between the inside and outside of the cofferdam. Contractor design submittals will address this and provide tip elevation of the sheet pile.

Rocks and boulders sometimes prevent the sheets from being driven a sufficient distance below the footing to prevent blow-in. An attempt to dewater will often be made anyway. This is the Contractor’s decision to make; however, the Department has a vital concern particularly for a spread footing. Excessive pressure and upward movement of water through the bottom can destroy the bearing capacity of the soil.

In all cases involving spread footings, a depth check of the water should be taken before any pumping is done. This may require the use of a long piece of rebar. Pumping should be halted immediately if any large boils of water and/or fines are seen. Seek assistance from BBS if

necessary. The Contractor is responsible for any measures required to correct loss of sufficient bearing capacity to support the foundation. Bottom blow-in is not as critical structurally where piles are driven.

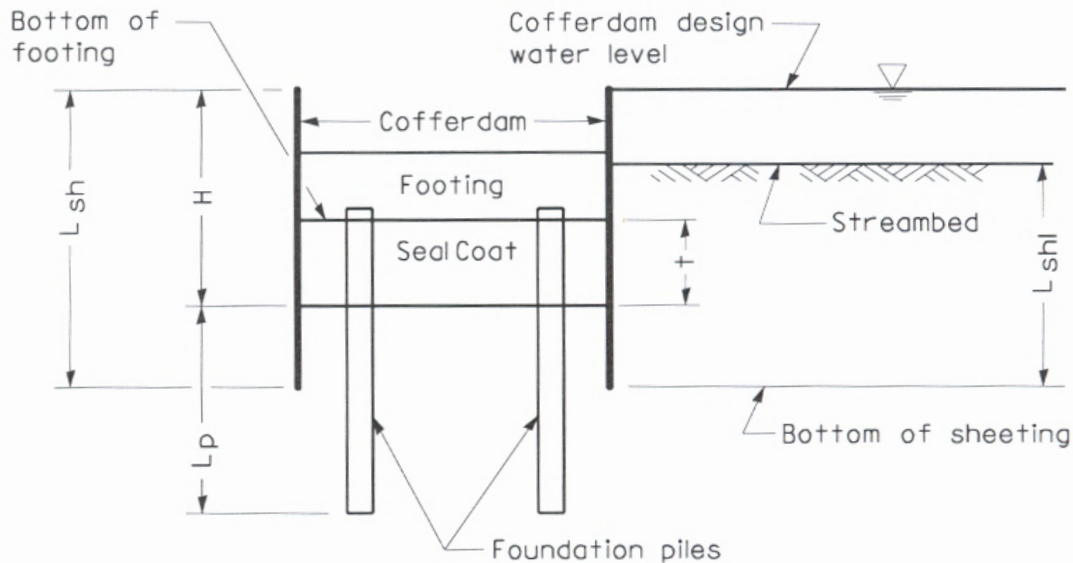
502.06-4 Foundation Seal (Dewatering the Cofferdam)

The purpose of the concrete seal is to permit dewatering of a cofferdam and to maintain the cofferdam in a stable state with respect to boiling and/or buoyancy problems during the dewatering period. Concrete seal coats are designed for a specific water elevation on the outside of the cofferdam. Typically, a seal coat will be shown on the plans.

There are border line cases, however, where there is doubt as to whether a seal is necessary. If it appears probable that the cofferdam can be dewatered without a seal, none will be shown on the plans. In such cases, the success of the Contractor in pouring the footing without a seal coat will depend largely on the penetration of the steel piling and on the Contractor's pumping capacity.

Ordinarily, the sheet piling must be long enough to go well below footing elevation. Even with a satisfactory cofferdam, lack of pumping capacity may prevent successful dewatering. It is not practicable to set a fixed limit for minimum requirements because of the variable conditions encountered but, when the plans do not include a seal coat, the Contractor should use such methods and employ such equipment as necessary to do the work according to the plans. In some places, well points have been very successful and should be tried if other methods fail. Only after the Contractor has met full requirements under the contract and has been unable to dewater the cofferdam, will the Department consider authorizing a seal coat. Seal coat design parameters may be obtained from the Bureau of Bridges and Structures.

The manner of placing the concrete, the use of tremies, etc., are discussed in Article 503.14 of the *Standard Specifications* and Section 503.14 of this *Manual*.

Figure 500-5 — SCHEMATIC OF TYPICAL COFFERDAM**502.06-5 Cofferdam Safety**

Cofferdams are subject to large loads. They are a temporary structure and may not be designed with the same robustness as a permanent structure. This makes it necessary to use caution when entering or working in a cofferdam.

Department personnel must carefully inspect any cofferdam before entering. Enter cofferdams only to perform required inspections. Carefully observe the condition of the bracing. The cofferdam must not be entered if there is any excessive bending, buckling or other sign of distress in the bracing system. Pay particular attention to wood bracing because it is more subject to sudden failure than steel. Adequate means of rapid exit must be in place.

502.08 PUMPING

Sufficient pumping shall be used to maintain a dry footing. To prevent cement loss, water must not be permitted to flow over or in contact with the fresh concrete. The sump from which water is pumped shall be outside of the footing form. The location of the sump and the procedure in pouring the concrete shall be arranged so that any water entering either within or outside of the form will flow to the sump without washing cement out of the concrete until set.

Article 502.08, Paragraph 1, states the following:

Pumping from the interior of a foundation enclosure shall be done in a manner approved by the Engineer.

The discharge must be controlled and directed to a location that meets the NPDES requirements.

502.09 INSPECTION

Regardless of whether piles are used or not, concrete shall never be placed directly on mud. The Contractor is required to notify the Engineer when an excavation is completed and ready for placing the footing. Check the elevation of the bottom of the excavation and its condition. If it is soft and muddy, the bottom must be covered with a 3 in. (75 mm) layer of gravel, crushed stone or other suitable material at the Contractor's expense. The Contractor's method of handling water should also be considered, so that water will not be permitted to flow over or through the concrete as it is being placed.

502.10 BACKFILLING

Backfilling as discussed in Article 502.10 includes not only the backfill up to the original ground line but also the embankment material that is placed on one or both sides of the structure and immediately adjacent to the structure above the original ground line. The backfill includes that part of the approach fill which lies next to the structure.

Too much emphasis cannot be made on the importance of properly constructed backfills. This work requires careful inspection and requires the constant presence of the Inspector during the entire operation. Emphasize compacting the areas next to the structure and areas that cannot be reached with motorized equipment. Backfill material shall be suitable for placing the material in back of closed abutments or walls.

When specified, weep holes shall be placed so that the outlet on the front face is above the completed fill. The *Standard Specifications* are clear in regard to this requirement and the Contractor shall use such methods as will result in the required amount of this material properly placed. Be careful that dirt is not intermixed with the coarser material, interrupting the flow of water before it reaches the weep holes. When the 2 ft (600 mm) cube of gravel or crushed stone is used, 800 lbs. (360 kg), the bottom of the cube should be placed 2 in. (50 mm) below the weep hole. This will make allowance for the dirt that may become mixed with the bottom gravel in cube and will avoid making a reservoir for the water immediately below the weep hole. When the backfill material is an impervious clay, gravel or crushed stone cubes may not be sufficient. In this case, consult your supervisor for a possible alternative. It is not intended that weep holes should be placed in the wings of small culverts, because the area is so small that no appreciable hydrostatic pressure can be built up behind them. Weep holes must be cleared of all obstructions as the fill is placed, and that they remain clear after the fill is completed.

Failure of the weep holes to work properly may result in thoroughly saturating the earth back of the abutment, thus producing stresses beyond those for which the structure is designed.

502.12 METHOD OF MEASUREMENT

Before excavation is started for classified excavation pay items, the Inspector must take cross sections or other appropriate measurements of the existing ground elevation to calculate the quantity of each class of excavation actually performed. The *Standard Specifications* provide the maximum dimensions allowed for calculation of the maximum pay item quantity. Any excavation made outside of the limiting dimensions is not paid for.

SECTION 503. CONCRETE STRUCTURES

Use the following to inspect Section 503 items for additional direction and information:

- [Construction Inspector's Checklist for Bridge Superstructures](#)
- [Construction Inspector's Checklist for Concrete Structures Other Than Bridge Decks](#)

503.05 FALSEWORK

503.05-1 Plans

The Resident submits the Contractor's detailed plans for falsework to the Bureau of Bridges and Structures for review and approval.

503.05-4 Dead Load Deflection

The appearance of the completed structure depends to a large extent on the lines obtained, especially along the outer edges of the superstructure and the top of the handrail. The attainment of good lines depends largely on the care and accuracy with which the falsework and forms are constructed.

The plans will show the profile grade line throughout the length of the structure and the theoretical dead load deflection. The dead load deflection shown on the plans is computed to include not only the immediate deflection that will take place when the falsework is removed but an allowance for long term deflection due to future wearing surfaces placed on the deck.

With the exception of the handrail, the elevation to which the forms should be built is the plan elevation adjusted for dead load deflection shown on the plans plus an allowance for compression and settlement of falsework.

503.05-5 Falsework Compression and Settlement

This settlement may be due to:

- Compression of timbers that are too light
- Settlement of the bents supporting the form work
- Oblique cuts on the tops of piles supporting caps
- Use of small softwood shims that crush or compress under the superimposed load

The estimated compression within the falsework will vary considerably with the use of different materials, spacing, number and type of joints and other factors, and will be based on previous data and experience. The dead load deflection shown on the plans should be added to the amount estimated for falsework compression, and the result used for setting the falsework:

1. Superimposed Loads. The question of placing equipment or materials on a bridge before the falsework is removed has been frequently raised. The *Standard Specifications* prohibit the placement of superimposed loads, either dead or live, prior to the removal of falsework. The reason is the possibility of damaging the concrete, or of destroying the bond between the concrete and the steel, even though the falsework is in place.
2. Backfill and Embankment. If the superstructure is to be built before the backfilling and placing of the embankment, ensure that the expansion devices are free to move when

the backfilling and embankment are started. Although the falsework may still be in place, ensure that any restraints against abutments, bents and piers are cut off so that the superstructures can move freely.

3. Sidewalks and Handrails. Handrails or sidewalks separated from the floor slab by a construction joint should not be poured until after the falsework has been removed. Otherwise, the deflection of the span may set up detrimental stresses or distort the vertical alignment.

503.06 FORMS

503.06-1 General

Self-supporting concrete components are concrete structural members whose self-weight and immediate subsequent loads are required to be supported by the member itself in bending (flexure) or tension. Portions of these components are not fully supported by the ground or other members and, thus, must have their own internal structural capacity to stand without potentially overstressing, cracking or failure of the member. Self-supporting components generally require falsework or the formwork to also act as falsework.

Examples of self-supporting substructure components include:

- Pier caps on columns
- Cantilevered pier caps
- Hammerhead pier caps
- Rigid frame piers
- Beams
- Other members that are primarily in bending (flexure) or tension under their self-weight

Examples of components that are not self-supporting include:

- Pier footings, abutment footings and abutment caps poured on grade
- Pier or abutment walls
- Pier or abutment caps on solid walls with no cantilevered ends
- Pier columns
- Other components that are entirely supported by the ground or another member

Class BS concrete components (Article 503.16(a)) – Riding Surfaces of Superstructures include bridge decks, bridge slabs, CIP RC beams and bridge approach slabs. These members are considered self-supporting components.

Class BS concrete components (Article 503.16(b)) – Concrete Superstructures Other Than Decks include concrete parapets, barriers, railings, curbs, medians, sidewalks and other members not poured monolithically with the deck. These members are considered not self-supporting components.

Appendix 500.A presents an overhang forming example on an outside beam with a maximum fillet of 2 in. See the Construction Inspector's Checklist for Bridge Superstructures and Construction Inspector's Checklist for Concrete Structures Other Than Bridge Decks for

direction and information. The following discusses additional information regarding form inspection.

503.06-2 Fluid Pressure

The horizontal fluid pressure against forms on walls, columns, piers, etc., is very high. Slower placement allows the bottom concrete to settle and partially set before the top section is placed. This lowers the horizontal pressure near the bottom forms. Check with the Contractor regarding the maximum pour rate that the forms are designed to handle.

For self-consolidating concrete, form heights of 10 ft or greater require the Contractor to directly monitor the fluid pressure on the forms according to ITP SCC-10.

503.06-3 Tightness

The individual dressed lumber or sections of plywood composing the forms should be drawn up against each other and be mortar tight. Take special care with all floor forms because the mortar in the concrete next to the cracks may leak through. Although wood forms have been built mortar tight, if they are allowed to stand in the sun for several days before the concrete is poured, the wood forms may shrink and cracks up to ¼ in. (6 mm) may develop. When mortar is lost in this way, the face of the concrete immediately behind the crack will be more porous.

503.06-4 Footings

Where the excavation for footings is in rock, footing forms are not required but the concrete may be placed directly against the rock that is excavated to the footing line. The Resident may permit the Contractor to omit the forms if all of the following conditions are met:

- The excavation is not rock but is in material that is firm enough to be excavated to the neat line (plan dimension) of the footing.
- The excavation will stay in place.
- Pumping is not required.

In this decision, the Resident should be guided by his/her judgment on the result that will be obtained. If the sides of the excavation can be cut to form the edges of the footing and will not crumble or break off until the concrete is poured, the sides will furnish good lateral support for the footing. Payment will be limited to the neat line quantities with no extra compensation for any additional concrete used unless authorized in writing by the Resident.

503.06-5 Alignment and Bracing

Where practicable, the alignment of all forms should be checked with a transit. A waler should always be placed at the top of abutments, piers and wing walls, and the forms shall be well braced. Forms shall not be braced in a way that will interfere with required deflections or expansion and contraction resulting from changes in temperature. All forms should be rechecked during placement and realigned or otherwise adjusted if necessary.

503.06-6 Molding (Chamfer)

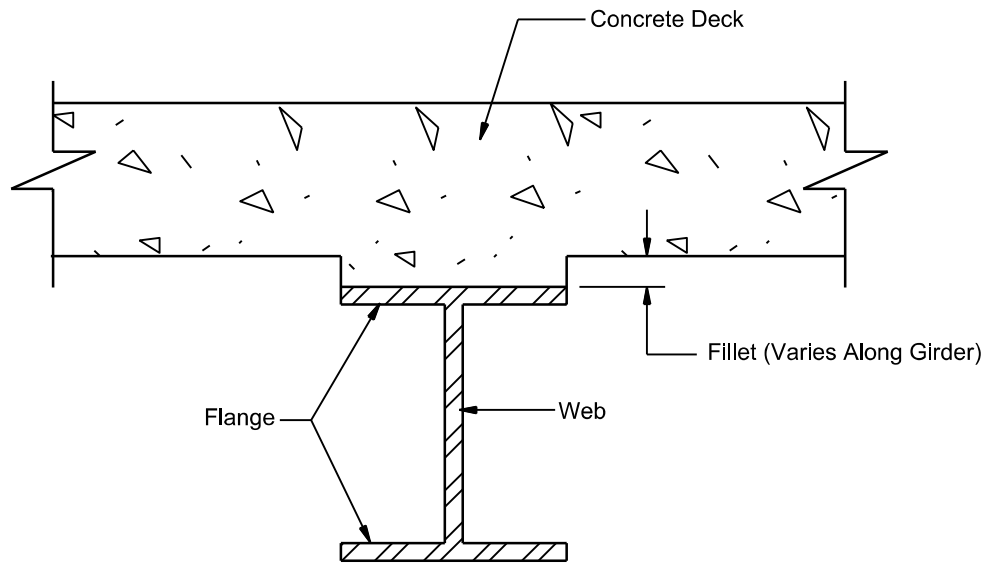
Molding should be used at all sharp corners. The molding should have a uniform size and a smooth face. Molding that has not been planed to uniform dimensions will produce unsightly lines on the finished concrete.

503.06-7 Fillet Calculations

Fillets are extra thick portions of the concrete bridge deck directly over the supporting beams or girders that counter the effect of dead load deflection. See Figure 500-6 for an illustration and example calculations.

To determine the fillet thickness after all structural steel has been erected and before any formwork has begun, elevations of the top flanges are taken at locations shown on the plans. These elevations subtracted from the theoretical grade elevations adjusted for dead load deflection given in the plans, minus the concrete slab thickness, equals the fillet heights above the top flange of beam or girder. Also, see the Construction Inspector's Checklist for Bridge Superstructures for additional direction and information.

Figure 500-6 — CONCRETE FILLET



Fillet Calculation Example

Location	Station	Theo Grade Elevation Adjusted for Dead Load Deflection *	Top Flange Beam Elevation **	Deck Thickness	Fillet
Centerline Bearing North Abut.	332+50.37	602.96	602.11	0.667'	0.18'
A	332+60.37	602.98	602.08	0.667'	0.23'
B	332+70.37	602.99	602.07	0.667'	0.25'
C	332+80.37	602.99	602.08	0.667'	0.24'
D	332+90.37	602.98	602.08	0.667'	0.23'
E	333+00.37	602.97	602.06	0.667'	0.24'
Centerline Bearing North Pier	333+02.62	602.96	602.05	0.667'	0.24'
F	333+12.62	602.96	602.02	0.667'	0.27'
G	333+22.62	602.96	602.03	0.667'	0.26'
H	333+32.62	602.96	602.06	0.667'	0.23'
I	333+42.62	602.96	602.09	0.667'	0.20'
J	333+52.62	602.96	602.11	0.667'	0.18'
Centerline Bearing South Pier	333+55.62	602.96	602.11	0.667'	0.18'
K	333+65.62	602.98	602.12	0.667'	0.19'
L	333+75.62	602.99	602.12	0.667'	0.20'
M	333+85.62	602.99	602.14	0.667'	0.18'
N	333+95.62	602.98	602.14	0.667'	0.17'
O	334+05.62	602.97	602.16	0.667'	0.14'
Centerline Bearing South Abut.	334+07.87	602.96	602.17	0.667'	0.12'

* Given in plans

** Elevations shot on top flange of beams/girders

503.07 PLACING AND CONSOLIDATING

503.07-1 Inspection Timing

Adequate time is needed to inspect structural concrete forms, falsework and steel reinforcement prior to concrete placement. This amount of time will vary from just a few minutes for a concrete catch basin to a few hours for a large bridge deck. The pour schedules, steel placement activities, steel and formwork inspection requirements, and traffic and safety issues should be discussed with the Contractor.

503.07-2 Placement Rate/Consolidation

The rate of placement of the concrete will determine the number of vibrators required. No rigid rule applies for the amount of vibrating necessary; it will vary with different mixes, with the amount of reinforcement present, and the complexity or simplicity of the form work. After a little experience, the Resident can judge if the concrete has settled into place and the reinforcement properly bonded. Failure to vibrate the entire area uniformly may result in porous areas. This will require considerable attention to obtain satisfactory results. The frequency of the vibrator may be measured with a tachometer.

To determine adequate consolidation with the use of a hand vibrator, it is useful to listen to the vibrator. When the vibrator is inserted in the concrete, the frequency will normally decrease, then increase until a constant frequency is reached. To determine adequate consolidation using visual inspection, a thin film of mortar should appear on top, and no more large air bubbles should appear at the surface.

The *Standard Specifications* require a minimum rate of delivery of concrete to the forms. This is especially important when ready-mixed concrete is used. Ensure that the Contractor has made satisfactory arrangements for continuous delivery before a concrete pour is started.

503.07-3 Pumping Bridge Deck Concrete

This Section provides guidelines for the placement of bridge deck concrete with concrete pumps. Also, see the [Construction Inspector's Checklist for Bridge Superstructures](#) and the [Level I Training Manual](#) for additional direction and information.

503.07-3(a) **Plant and Proportioning**

The *Standard Specifications* require mix water to be added at the concrete plant. If continuous adjustments in water are required at the jobsite, the proportioning technician shall be notified so that appropriate adjustments can be made at the plant.

503.07-3(b) **Placement**

A prepour conference should be held with the Contractor, concrete supplier and materials personnel to discuss proportioning, delivery and method of placement; see the [Construction Inspector's Checklist for Bridge Superstructures](#) for additional direction and information.

When a horizontal pump line is used, a protective cover shall be placed under each joint to prevent spillage of concrete onto the reinforcement bars and deck forms when the sections of the pump line are removed during placement. The protective covering also serves to protect the epoxy coating.

When reviewing configurations used by the Contractor, remember that the purpose is to prevent segregation of the mix, minimize concrete air loss, and reduce the potential for damage to the epoxy coated reinforcement. The concrete should look like tooth paste as it comes out of the tube.

Water shall not be added to the pump hopper. If water is added to remove a line blockage, the concrete shall be wasted.

503.07-3(c) Tests

Testing is performed on the deck according to the BMPR [Manual of Test Procedures for Materials](#). The slump may be adjusted at the jobsite when required to improve workability of the concrete mix provided that the maximum water/cement ratio, per Article 1020.04, is not exceeded. If continuous adjustments are required, the proportioning technician shall be notified so that the appropriate adjustments can be made at the plant.

Air tests shall be taken for each load. A correction factor shall be established to allow for a loss of air content during transport. The first three truck loads delivered shall be tested, before and after pumping, to establish the correction factor. Once the correction is determined, it shall be rechecked after an additional 50 cu. yd. (40 cubic meters) is pumped. This shall continue throughout the pour. If the re-check indicates that the correction factor has changed, a minimum of two truckloads are required to re-establish the correction factor. The correction factor shall also be re-established when significant changes in temperature, distance, pump arrangement or other factors have occurred. If the correction factor is greater than 3.0 percent, the Contractor shall take corrective action to reduce the loss of air content during transport by the pump.

Reference the [Level I Training Manual](#) for additional direction and information.

503.08 DEPOSITING CONCRETE UNDERWATER

The bottom of a wet excavation should be large enough so that a sump can be provided, and water can be channeled away from the foundation area. Often a few inches of water will remain in the footing area. It is permissible to place concrete in up to 3 in. or 4 in. (75 mm or 100 mm) of still water provided certain precautions are taken. Carefully examine the footing area for any "sand boils." These indicate water percolating up through the underlying soil. If concrete is placed over them, the sand boils will extend themselves up through the fresh concrete and weaken the footing. Plastic sheeting could be placed under the concrete to seal these off. Concrete should be placed beginning at the point furthest from the sump and proceed toward it. After the initial concrete is placed, all succeeding loads must be placed on top of concrete rather than in the water. Concrete should be placed as close to full depth at one time as possible. Dewatering must continue until all concrete has taken its initial set.

Water percolating up through the bottom of a wet excavation can also reduce or destroy the bearing capacity of soil. This is a problem particularly when dewatering unsealed cofferdams but can be encountered in deeper open excavations. Soundings should be taken before and after dewatering if this is expected to be a problem. Pumping a hole down and allowing it to fill several times can have an adverse effect on foundation materials and should not be permitted.

Once the footing has been placed and is set, the pump intakes should be raised as far as possible above the bottom of footing. This will reduce the possibility of washing fine material out from under the footing and causing settlement.

503.09 CONSTRUCTION JOINTS

503.09-1 Description

A construction joint is a provisional joint used primarily to terminate a concrete pour at a predetermined location. Some structures are sufficiently large that it is not possible or desirable to pour them all at once. The construction joint is intended to provide a temporary means of ending a concrete pour while still providing structural continuity (that is adequate load transfer across the joint).

503.09-2 Installation

The installation of construction joints is generally straightforward. A form serves as a bulkhead where the pour is terminated. The joint is then cleaned with either sand or water blasting (if more than eight hours old) and the next pour is continued.

Correct concrete placement procedures should be checked. Special attention should be given to smoothness across the joint when placed in a bridge deck or other riding surface (this will require a large amount of straight edging and careful screeding and re-screeding by the Contractor).

503.09-3 Preferred Location of Emergency Joints

Construction joints at locations other than those provided for on the plans should be avoided in the superstructure of any bridge. However, because of occasional breakdown of equipment, or sudden storms, emergency construction joints are sometimes necessary. When it is necessary to provide construction joints because of a large amount of concrete, the Bureau of Bridges and Structures will show construction joints on the plans.

503.09-3(a) General

Emergency procedures, including potential header locations, should be discussed at the pre-pour meeting as indicated in the Construction Inspector's Checklist for Bridge Superstructures.

Where possible, emergency headers should be located away from areas of maximum negative bending of continuous beams, where subsequent concrete pours will induce further rotation and negative bending in the deck — potentially resulting in cracking of the deck. These negative bending areas are typically near intermediate piers of continuous beam structures.

The guidance provided below, and the availability of on-call BBS consultation, should provide field personnel with the resources to advise the Contractor.

503.09-3(b) Simple Spans

1. Vertical Construction Joints in Slab Bridges. A longitudinal joint may be placed on the centerline of the roadway. A transverse joint may be placed parallel to the supports as near to the third point of the span as practicable, but preferably not within the middle third of the span.
2. Vertical Construction Joints in Reinforced Concrete Girder, Plate Girder or I-Beam Spans. Longitudinal joints in the slab should be made parallel to the centerline of the roadway as near the third point of the slab span between beams, as practicable, but preferably not within the middle third of the span. Transverse joints through reinforced concrete girders should be made as for simple slab spans. Transverse joints through concrete slabs carried on steel girders or beams may be made on any line parallel to the main reinforcement.

503.09-3(c) Continuous Spans (Concrete Slab, Girder and I-Beam Spans)

1. Longitudinal joints should be made parallel to the centerline of the roadway. For slabs on girders or beams, the longitudinal joint may be placed as given above for simple spans.
2. For continuous slab or reinforced concrete girder spans, transverse joints should be placed parallel to the supports and preferably at the points of dead load contraflexure, but they may be placed between these points and the third points of that portion of the span between points of dead load contraflexure.
3. For continuous steel girder or beam spans, transverse joints in the slab should be placed parallel to the transverse bars and preferably at the points of dead load contraflexure. These points are usually near the quarter points of the spans and at the splices. If necessary, they can be located in span segments between the points of contraflexure that are not over interior piers. The District Office should be contacted for concurrence of the location of emergency joints when feasible.
4. For end spans, one point of contraflexure shall be considered to be at the free end.

503.09-3(d) Rigid Frame Structures

Vertical construction joints should be placed in accordance with the instructions for continuous slab concrete girder bridges.

503.09-3(e) Other Permissible Locations

The above discussion refers only to the preferred location of emergency construction joints. Construction joints are permissible at other locations on the superstructure if it is necessary to make them in cases of real emergency. However, they should be avoided. As an example, the preferred location of an emergency construction joint in the superstructure of a simple slab

bridge should be at some location outside of the middle third of the span. However, if the concrete had been placed to approximately the center of the span and the mixer should break down, it would be permissible to place a joint at or near the center of the span and at right angles to the main reinforcement, and it would not be necessary to remove any of the concrete already placed to make the joint outside of the middle third. Sound judgment must be used when making an emergency construction joint. If the Contractor desires to make a construction joint that is not an emergency, consult the Field Supervisor/Area Engineer before granting permission to make such a joint.

503.09-3(f) Bonded Construction Joints

Bonded joints are used where shear transfer or water tightness are needed. Construction joints will be shown on the plans. See the Construction Inspector's Checklist for Bridge Superstructures for additional direction and information.

In making a bonded construction joint, the objective is to obtain as good a bond as possible between the concrete being placed and that already in place. A good bond will provide for transmission of some stress across the joint and will prevent any infiltration of water into the joint.

503.13 FOUNDATIONS AND FOOTINGS

503.13-1 General

See Section 512 for piling. See Section 516 for drilled shafts.

503.13-2 Spread Footings

503.13-2(a) General

Spread footings generally consist of a reinforced concrete mat to distribute or spread the load of the structure over the foundation soil. The size of the footing determines the soil pressure load per square foot (square meter) that is transmitted to the soil. The designer sizes the footing to prevent excessive soil pressures and determines this load primarily from geotechnical analyses.

Structures on spread footings are more susceptible to settling than those on piling if not constructed properly. This requires certain precautions in constructing spread footings. The footing must be placed on undisturbed soil or engineered fill material. The soil below the bottom of the footing must not be disturbed or over-excavated. The Contractor will be responsible for correcting any disturbance or over-excavation of material below plan elevation.

503.13-2(b) Inspection of Spread Footing Construction

Spread footing inspection consists of logging the material observed during the excavation and performing applicable tests at the bottom of the excavation. In a dry open excavation, the type of material can be observed at the sides of the excavation.

Footings should be excavated nearly to grade and should be in the condition expected during concrete placement; i.e., if the footing is to be pumped and placed in the dry, then it should be pumped and nearly dry when sounded.

When unsuitable material or problems are encountered, the general rule to follow is to carry the excavation to near plan elevation, sound it and contact the geotechnical engineer, who will advise the Inspector of what further action is needed. Do not require the excavation to be carried below plan elevation until notified to do so.

503.14 SEAL COATS IN COFFERDAMS

503.14-1 General

The placing of concrete under water is usually done in the construction of seal coats for bridge foundations. When the interior framing of the cofferdam divides the area into bays, it is necessary to hoist the tremie out of the water when changing from one bay to another. Concrete should be placed as far as possible in one bay before moving the tremie to adjacent bays to prevent forming mud or sand pockets. The outlet end of the tremie must be equipped with a gate, which must be tightly closed when being moved. The tremie must be moved about within the bay as needed to obtain the minimum seal thickness at all points.

Two major concerns to remember in constructing seal coats under water are to:

- Prevent washing the cement out of the concrete by mixing it with the water
- Avoid enclosing pockets of mud pushed up from the bottom into the mass of concrete

To prevent washing out of the concrete, the bottom end of the tremie should always be in the concrete when concrete is being discharged, and care should be taken to avoid spilling concrete into the water when filling the tremie.

Placing should be started at one end of the cofferdam and should proceed continuously for full depth so that any loose mud on the bottom will be pushed ahead of the mass of concrete and up over the concrete at the end of the pour.

The level of the concrete surface should be checked frequently, and the water level should be compared with a fixed mark set in advance, because the water level often rises due to displacement by the concrete. Be sure that the seal has at least the required thickness at all points, checking in particular at the corners of the cofferdam and around the piles. Use the delivery tickets to check the weight of the total volume placed. Ten percent excess cement should be added to the mix design to allow for loss under water. The slump should be large enough to permit the concrete to flow evenly.

In a sealed cofferdam, a concrete plug is placed in the bottom to seal it off. If no piling is used, the water pressure at the bottom is offset by the weight of the seal.

Piling helps resist the water pressure on the bottom of a seal; therefore, it is usually considerably thinner than for a plain seal.

The concrete in a seal must develop sufficient strength to resist the water pressure before a cofferdam is dewatered. Strength development is slow in concrete cured in cold water.

Cofferdam seals are usually placed under water. The *Standard Specifications* require seals to be placed with a tremie (Article 503.08) or a properly equipped concrete pump.

It is not permissible to pump a cofferdam down partway while placing a seal. This could cause a water flow from the bottom up through the seal and reduce its strength. In addition, the cofferdam should have a port so the water level inside and out are nearly the same.

503.14-2 Seals (Tremie Concrete)

Initially, the tremie is sealed and lowered to the bottom. The tremie tube is to be kept filled with concrete at least up to the bottom of the hopper at all times. The tremie is raised slightly until concrete begins to flow. The rate of flow is regulated by raising or lowering. The discharge end must always be embedded in concrete; otherwise, the seal will be broken, and water will enter the tube. If this happens, the Contractor should stop concrete placement immediately.

503.14-3 Seals (Pumping Concrete)

Placing cofferdam seals with a concrete pump is somewhat different because the flow is maintained by pressure rather than by gravity. It is still necessary to seal the end and to keep it buried in concrete. Concrete is maintained in the pump hopper at all times to prevent formation of air pockets in the line. The Contractor must take any measures necessary to prevent the pump discharge line from jumping out of the concrete mass during the pumping operation.

503.15 SURFACE FINISH

The rubbed finish required under Article 503.15(b) will only be required when specified by the plans or Special Provisions. See the Construction Inspector's Checklist for Concrete Structures Other than Bridge Decks for additional direction and information.

All other exposed concrete will be given a normal finish. The amount of work that the Contractor will need to do to obtain a satisfactory job will be determined by the condition of the forms used and the manner in which the concrete is placed. The Contractor should know that good forms and extra care in construction and tying the forms can result in reduced costs in obtaining a satisfactory normal finish. The placing of concrete in the forms should be accomplished to permit mortar to work against the forms to produce a smooth finish free of honeycomb and with a minimum of water and air pockets. Discoloration of the concrete between successive panels may require additional work to obtain a uniform color.

503.16 CONCRETE SUPERSTRUCTURES

See the Construction Inspector's for Bridge Superstructures for additional direction and information on inspection guidance.

503.16-1 Bridge Deck Pre-Pour Meeting

The Resident should hold a Bridge Deck Pre-Pour meeting with the Contractor before any bridge deck pours. See the Construction Inspector's Checklist for Bridge Superstructures for

additional direction and information. The intent is for the Contractor to describe how the deck concrete will be placed, consolidated, finished, textured and cured. Bridge deck pours are difficult and expensive to stop once they get started. The meeting will ensure that both the Contractor's and Department's field personnel have a clear understanding of how the deck will be poured and what inspection procedures will be followed. The time to have discussions about good construction practices and specification enforcement is in a meeting room, not on top of the bridge.

503.16-2 Sequential Deck Pours

Sequential deck pours are included in bridge plans to reduce stresses and minimize the potential for cracking the concrete deck. On some structures, the pour sequence is intended to place much of the concrete for the superstructure in the midspan areas before placing concrete over the piers. The placement sequence allows the reinforcing steel over the piers to move as the bridge deflects from the weight of the concrete. If the concrete over the piers is poured first, the rebar will lock into place as soon as the concrete hardens. When the midspan areas are poured, the concrete over the piers could crack as the concrete tries to restrain the rebar from moving.

The deck pour sequence is also intended to control dead load deflections. A load placed anywhere in a continuous span affects deflection in all spans to some extent. The sequence of placing loads must be controlled if final deflections will be as planned. The location, length and sequence of each pour shown is calculated to produce the plan final deflection. In some cases, the plans will show a pour direction as well as length and sequence.

A proposal by a Contractor to either change the pouring sequence shown in the plans or to add a pouring sequence (e.g., add longitudinal or transverse construction joints not shown in the plans) is not permitted without approval from the Bureau of Bridges and Structures.

Contractors should be advised that any proposal to either change the pouring sequence or to add a pouring sequence should be submitted at an early date to permit adequate review time. Contractor deck pouring sequence proposals shall address issues relating to the proposed rate of placement including:

- Haul times and concrete supply rates
- Equipment and crew requirements
- Minimum placement rates
- Anticipated concrete set times
- Contingency plans

Proposals shall also address potential deflections (including uplift conditions at supports) due to the proposed pouring sequence. This may require an analysis by an Illinois licensed structural engineer.

Pouring sequences that require the use of retarders, or combinations of admixtures, to delay normal concrete set times for the purpose of extending or altering the deck pour sequence will not be allowed. When a retarder is used, its function is to counter the rapid setting caused by high temperatures to maintain the normal concrete set time.

When a sequential deck pour is made, at least 72 hours shall have elapsed since the previous section was placed, and its concrete strength shall have attained a minimum flexural strength of 650 psi (4500 kPa) or a minimum compressive strength of 3500 psi (2400 kPa). This includes sections separated by longitudinal and transverse joints. Extra test beams or cylinders, in addition to those required by the BMPR [Project Procedures Guide](#) or contract QC/QA special provisions, shall be made and tested for the minimum required strength. The extra test beams or cylinders shall be made and field cured according to the Illinois Modified AASHTO T 23 test method, which is maintained in the BMPR [Manual of Test Procedures for Materials](#). A note should be included on the bridge plans with the above minimum time and strength requirements. On continuous structures, simultaneous pours will be allowed if permitted by the pouring sequence shown in the plans.

503.16-3 Form Grade Check

The Contractor must notify the Resident when a bridge deck is ready for inspection with the self-propelled mechanical finishing machine, commonly called the Bid-Well, or a vibrating screed when permitted. The concrete deck finishing machine requires a detailed setup to ensure that the design depth of concrete and clearances are maintained during the pour. A dry run is made by the Contractor with the Inspector. See the [Construction Inspector's Checklist for Bridge Superstructures](#) for additional direction and information. Adjustments are to be made by the Contractor during the dry run for grade and depth. It is the Contractor's responsibility to adjust the paving machine to the designed depths and grades shown on the plans.

Check the form grades by shooting elevations with a surveyor's level or from the machine during the dry run. Detect excessive overhang deflection by positioning the roller or float over a tenth point and measuring from the top of the beam. Detect incorrect interior bay form adjustments by measuring from the forms to the roller. This should equal the slab thickness.

The grade of the deck forms controls the position of the reinforcing steel. Obtaining the proper concrete cover over the top mat requires close adjustment of forms to the proper grade. Inadequate cover can be a major factor in premature deck deterioration. The calculated elevations must take into account the anticipated dead load deflections given in the plans.

503.16-4 Reinforcement Bars

Section 508 discusses reinforcement bars in general. See the [Construction Inspector's Checklist for Bridge Superstructures](#) for additional direction and information. The location of reinforcing bars within a slab is critical. Bars located below their plan location are not fully effective in carrying stress. Premature deterioration can result if bars are located too close to the surface.

The height of the bar supports determines the location of the bar within the slab. Check bar supports for height as soon as they arrive on the project.

Inspect bar placing operations periodically to check bar size, spacing, tie interval, support height and clearance. These intermittent inspections can eliminate costly corrective work after bars are all tied in place.

Perform a final inspection after all bars are in place. This includes checking bar sizes, counting bars, checking spacing and ties, checking clearances from forms and condition of bars.

503.16-5 Deck Finishing Machines

503.16-5(a) Equipment

The work of setting up, adjusting and operating the finishing machine (either a Bid-Well or Gomaco) is solely the Contractor's responsibility. Inspectors should not make any adjustments or attempt to direct this work. However, close inspection is required to ensure that the machine is properly adjusted to produce an acceptable deck slab. An understanding of the main features of operation and adjustment of these machines is necessary to make this inspection.

The machines consist of a frame, which is supported at two points on each side of the deck. These supports consist of adjustable legs to which wheels are attached. These wheels travel along a rail. The adjustments at these points control the height of the framework above the screed rail. Raising or lowering the two leading legs or the two trailing legs will change the slope of the mechanical strike off device without changing the deck slab thickness. Raising or lowering all four legs will change the deck slab thickness throughout. Raising or lowering two legs on one side will make a change in thickness tapering from that side to the other.

The strike-off portion of the machine is suspended from a carriage. This carriage is mounted on wheels that travel on rails attached to the framework. The carriage rails are adjustable to provide the proper cross section. The framework of the machine also has adjustments to provide for crown. The strike-off portion of the machine can be adjusted to operate parallel to centerline of roadway when the framework is on a skew.

Note that placing the strike-off portion at a skew to the carriage requires alteration in the usual procedure for adjusting the carriage rails at the apex of a crown. It is necessary to make trial-and-error adjustments of the apex portion of the carriage rails using a properly set expansion angle or bulkhead as a guide. See Figure 500-7.

Figure 500-7 — BID-WELL DECK FINISHING MACHINE**503.16-5(b) Operation**

The following are possible trouble areas that may be observed during operation of the deck finishing machine.

The mechanical strike off device should be in contact with the concrete surface for nearly the full length. The mechanical strike off device should be set to have a slight roll of concrete ahead of it during each cutting pass. If the trailing edge is too low, a ridge or groove will be left in the slab surface. The same problems may be encountered on float-type machines. One method of correction is to raise or lower the trailing portion of the framework with the adjustment at the machine support wheels. If the adjustment is confined to the trailing wheels only, there will be no change in the grade or deck thickness.

The rate of advance along the deck is also a factor in proper finishing. Single rotating cylinder-type machines cut only on one direction of carriage travel. The leading edge of the rotating cylinder must be rotating up and out of the concrete. Occasionally, extra concrete is placed in the path of the mechanical strike off device to fill a low spot.

The roll of concrete in front of the mechanical strike off device consists of mortar. This is left on the sides of the deck towards which the cutting pass takes place. This material should be raked ahead and distributed over the unfinished concrete ahead of the screed or removed and wasted.

The augers on the machines are designed to cutoff most of any excess concrete and move it ahead. The amount they can move is limited and, if overloaded, have a tendency to pull the

strike-off down. It is necessary to have sufficient personnel available to rake away excess concrete or to add concrete to provide the proper depth in front of the auger.

The screed pipes should be continually checked for unusual deflection, cleanliness and proper support. Concrete, electric cords, tools, etc., on the pipes can produce high spots and cause the machine to jump the track. It is necessary to clean the pipes off just ahead of the machine where they are supported on the girders and covered with concrete during placement.

503.16-6 Finishing Operations

Machine finishing operations are discussed in the Construction Inspector's Checklist for Bridge Superstructures for additional direction and information. For example, most machines cannot finish the area next to the curbs, so hand work is necessary. The finishers must check this area with a straightedge both transversely and longitudinally so it will drain properly. A certain amount of hand finishing at the edges must be done.

Addition of water to aid finishing always weakens the surface and reduces durability. It is, however, sometimes necessary to add water to finish satisfactorily. Water needs to be applied in the form of a fog or mist. Water is not to be applied as a stream from a hose, thrown on with a brush or be allowed to drip.

503.16-7 Surface Smoothness

Straightedge for surface smoothness should be performed as soon as possible after the water curing has ended. The Contractor should complete any grinding/repair work before the required deck grooving (i.e., saw cutting).

Small, localized imperfections such as wrinkle marks caused by curing material or finishing ridges would not be detrimental to the ride and would not be considered as unacceptable in terms of the smoothness tolerance. However, damage to the surface such as gouges, footprints or marks left by soaker hoses or the finishing operation may be determined to be unacceptable under requirements listed in the contract documents.

The deck must be given a final complete check after all corrections have been made. Attention should be given to areas along the curbs to ensure proper drainage.

When the Guide Bridge Special Provision (GBSP) No. 59 "Diamond Grinding and Surface Testing Bridge Sections" is incorporated in a project, refer to Article 407.09-5 for quality assurance testing and acceptance of Contractor test results. The quality assurance testing indicated in 407.09-5 should be increased from 20% to 100%.

503.16-8 Slipform Parapet

The Contractor is allowed to slipform the bridge parapet, unless explicitly prohibited in the contract documents.

SECTION 504. PRECAST CONCRETE STRUCTURES

504.01 DESCRIPTION

There are two methods for prestressing concrete — pretensioning and post-tensioning.

Pretensioning involves running steel strands along the length of the member to be Prestressed. The strands are initially tensioned to a predetermined stress. This causes the strands to stretch. The concrete is poured all around the strands. When released, the strands inside the concrete member attempt to relax and shorten; however, there is now concrete bonded to the strands. As the strands shorten, they push the concrete together inducing a compressive stress into the member.

Post-tensioning involves running steel, plastic or aluminum ducts through the concrete members. Special anchors are placed at each end of the member. The concrete is poured around the ducts and the anchors and steel strands are run through the ducts. Once the concrete has reached the design release strength, the strands are pulled at one end while anchored at the other, which causes the ends of the concrete member to push toward each other. This induces compressive stresses along the entire length of the concrete member. Grout is then injected into the ducts and concrete poured around the ends of the anchors. Once the grout cures, the strand is bonded within the concrete member similar to pretensioning.

504.06 PRECAST, PRESTRESSED CONCRETE MEMBERS

504.06-1 Damage Inspection

See the Construction Inspector's Checklist for Bridge Superstructures for additional direction and information.

Precast, prestressed concrete (PPC) products are inspected at the production facility using a quality control/quality assurance (QC/QA) program described in the Department's [Manual for Fabrication of Precast Prestressed Concrete Products](#). This program does not require a Department QA Inspector to be present or directly involved with every aspect of the product fabrication process. As a minimum, a Department QA Inspector will examine the finished product for cracks and conduct a brief visual inspection. The brief visual inspection shall consist of examining the product for placement of reinforcement or other hardware protruding from the product, overall dimensions, sweep, camber, chips, spalls or anything out of the ordinary.

The *Manual for Fabrication of Precast Prestressed Concrete Products* is referenced by the *Standard Specifications* and is a contract document. Per the *Manual*, products are to be stamped ILL OK by the Department QA Inspector to release them for shipment. Per the *Manual*, the ILL OK stamp is evidence of the validation of the producer's quality control activities by the Inspector's quality assurance activities. The ILL OK stamp is also evidence of materials inspection per the *Project Procedures Guide*.

After an ILL OK stamp is applied, there is potential for product damage during loading at the plant, during transportation and during handling at the jobsite. Thus, it is important that all products be evaluated at the jobsite by Department personnel. The following summarizes the minimum jobsite evaluation that should be performed.

Minor plant repairs that did not warrant an unacceptable product finding may be noticed in the field. Minor repairs frequently involve a small chip, spall or cracks. Contact the Department's QA Plant Inspector at the production facility if any concerns with a plant repair are identified at the jobsite.

504.06-6 Erection Plan

The contract documents may include an Erection Plan Sheet(s) for prestressed, precast concrete girders. The extent of details on the Sheet(s) depends on the project complexity, the amount of skew, etc.

The Contractor must approve, sign and submit the Erection Plan (if required by the contract documents). In some cases, a Pre-Erection Meeting between the Department and the Contractor will be held. The Resident must submit the Plan to the Bureau of Bridges and Structures for review and comment. If falsework is required, falsework drawings must conform to and be submitted in accordance with Article 503.05.

The Erection Plan should provide the following details of the erection process:

- Falsework, struts, bracing, tie cables and other devices, material properties and specifications for temporary works, bolt torque requirements prior to releasing girders from the cranes (if required), connection details and attachments to other structure components or objects
- Procedure and sequence of operations, including a detailed schedule with completion times for work items
- Minimum load chart lift capacity, outrigger size and reactions for each crane
- Calculated loads and girder weights, lift points, lifting devices, spreaders and angle of lifting cables
- Girder stresses at critical points along the girder length during progressive stages of erection, investigated to ensure that the structural integrity and stability of the girders is maintained. Stresses at lift points induced as a result of lifting shall be investigated and adequate bracing provided as indicated by the analysis
- Locations of cranes, trucks delivering girders, and the location of cranes and outriggers relative to other structures (e.g., retaining walls, wingwalls, utilities)
- Drawings, notes, catalog data showing the manufacturer's recommendations, and calculations clearly showing the details, assumptions and dimensions
- Contingency plans detailing what measures the Contractor will take in case of inclement weather (forecast or actual), equipment failure, delivery interruption, and slower than planned production

The Contractor should temporarily anchor and brace the primary members such as beams and girders as they are erected to preclude detrimental movement in any direction, and to prevent overturning and buckling. The Contractor must design struts, bracing, tie cables and other devices used for temporary restraint to resist all loads imposed during each stage of construction.

504.06-7 Precast, Prestressed Concrete, Deck Beams

The design of a precast, prestressed concrete deck beam is predicated on the fact that several beams placed and grouted together will act as one unit. Two important items must be carefully checked prior to erecting any precast deck beams:

1. Check the precast deck beams keyways to ensure that there is no oil, grease or other foreign materials in the keyways. Cleaning, if necessary, shall be done by sandblasting the keyway areas between the top of beam and the bottom edge of keyway.
2. Check the bearing seats to ensure that they are level in all directions. If they are not level, the bearing seats should be ground level. Shim pads may be used as required by the plans.

The erection of beams shall not begin until the bearing seats are level and the keyways are clean. Erecting must start at the expansion joints and the beams set from the joint so that the minimum expansion width is obtained. The beams may need to be shifted or interchanged to obtain the best fit.

After the beams are properly placed, an approved non-shrink grout shall be used for grouting dowels at fixed ends of the deck beams. The hole depth drilled for the dowel bars should be checked and documented. A 24-hour curing period is required for the dowels before keyway grout is placed. Retainer clips must also be in place at the expansion end of beams prior to placing keyway grout. Once the beams have all been set and are ready for the keyways to be grouted, ensure that the grouting is performed in accordance with the *Standard Specifications*. Only approved non-shrink grout shall be used in the keyways. The manufacturer's directions for mixing and application of the grout must be followed with one exception. No coarse aggregate including pea gravel is to be added to the grout. The minimum grout temperature at time of placement shall be 50°F (10°C):

1. The bottom of the precast beam and bearing pad should be checked to ensure that the beam is properly seated on the bearing. By either grinding the bearing seats and/or using shim pads or inserting stainless steel shim plates as called for on the plans, the bearing pad should be leveled to provide 100% bearing contact.
2. If openings due to casting of the beams are evident below the keyways, caulking or a strip of compressible material should be inserted between the beams below the bottom of the keyway. The compressible material must be placed continuously and below the lowest point of the keyway (wood is not considered to be compressible material).
3. Prior to the grouting of the keyways, the keyway surfaces must be soaked with water for a minimum of one hour. This can be done by placing wet burlap in the keyway slot. The

wet burlap should be removed from one keyway at a time. As the grout is placed and finished the wet burlap that was previously in the keyway can then be placed over the completed keyway as the work progresses. This will prevent the grout from drying before the curing is started.

504.06-8 Stage Construction of Deck Beams

On bridges where stage construction is specified, ensure that the keyway clamps are installed as detailed on the plans. Check the Special Provisions for Stage Construction PPC Deck Beams for additional requirements. The procedure for grouting the keyway is similar to the discussion in Section 504.06-7; however, the clamping rods must be properly tightened and have adequate water-soluble lubrication in the keyway area to allow easy removal of the rods after the grout is cured and the holes are properly filled. Traffic in the staged lanes shall be kept as far away as possible until the grout in the stage construction keyway is cured.

Equipment must not be allowed on the beams during the grouting and curing period.

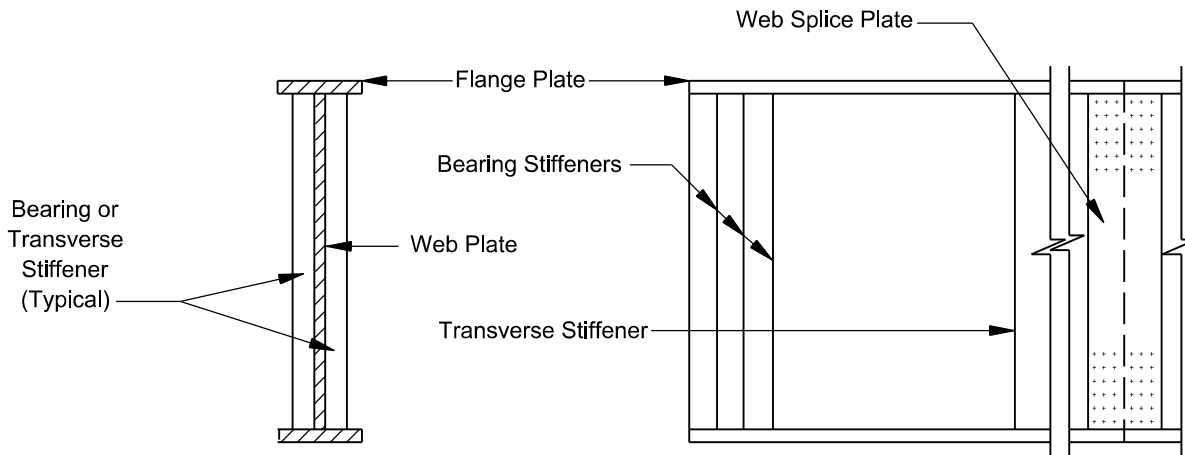
SECTION 505. STEEL STRUCTURES

505.01 DESCRIPTION

505.01-1 Composite Steel Welded Plate Girders

The Department typically uses plate girder superstructures to address longer spans difficult geometrics (e.g., horizontal curves) or limited vertical clearances (e.g., for passage of ice and debris). Figure 500-8 illustrates a typical detail.

The steel plate girders are designed to optimize weight savings and fabrication and erection costs. Top flanges of plate girders are typically thinner than their bottom flanges. The flange sections vary in thickness along the length of the bridge and reduce material cost, thus offsetting increased fabrication costs of welded flange transitions. The most economical location for a flange transition is commonly at a field splice. Field splice plate designs vary depending upon bridge design geometry for their intended location(s) on the girder (i.e., web and or flange(s)). Typically, the bridge designer varies only flange thicknesses, not widths, within a field section.

Figure 500-8 — TYPICAL DETAIL – STEEL WELDED PLATE GIRDER

To avoid buckling, diaphragms provide the stability for the compression flange. Diaphragm designs also vary depending upon bridge design geometry and are used to provide stability and to transfer loads between girders.

505.01-2 Rolled Girders

Factory-rolled steel girders use symmetrical, as-rolled, cross sections with equal-dimensioned top and bottom flanges and relatively thick webs. Thus, the bridge design does not optimize the cross sections for weight savings but, at times on short spans, proves cost effective due to reduced fabrication and erection costs. The relatively thick webs may reduce the number of web stiffeners required.

505.02 MATERIALS

See the PPG and the Construction Inspector's Checklist for Bridge Superstructures for field inspection of materials delivered to the jobsite for additional direction and information.

Upon arrival at the construction site, the Inspector will examine the documents from the Plant Inspector to ensure the delivery of the correct item and to assess the condition of the product before shipment. The Inspector performs a visual inspection upon delivery to ensure that the structural steel members have not been damaged in transit or during handling. The Contractor is responsible for any damage resulting during shipping, storage or handling of all steel members.

During fabrication, the Plant Inspector ensures identification of all steel members to indicate their acceptance. All steel members, plates, bolts, nuts, washers and other hardware should be inspected for:

- Shipping documents that accurately identify the quantities, shapes and type of steel shipped
- Certificates that are complete and descriptive of the materials supplied including grade identification, test results and the applicable lot or heat number

- The appropriate markings that show the type and grade of steel used
- Compliance with key dimensional requirements (e.g., thickness, length, width, diameter, section shape)

Final material acceptance is made in the field. The Contractor will be notified of any deficiencies found in the field. The Contractor must submit in writing the proposed repair procedure for approval by the Resident.

505.04 FABRICATION

505.04-1 Field Installation and Inspection of High Strength Fasteners for Slip Critical Connections

Article 505.04(f)(2) requires that the installation, tightening and inspection of all high strength bolted connections conform to the latest issue of the *Specifications for Structural Joints Using High-Strength Bolts* for slip-critical connections as issued by the Research Council on Structural Connection Joints of the Engineering Foundation. This specification is quite lengthy, and many parts are not pertinent to highway bridges. Therefore, this Section summarizes for the Field Inspector the requirements for both the installation and inspection of high strength fasteners. All bridge connections are slip critical connections.

505.04-1(a) Handling and Storage of Fasteners

Fasteners shall be protected from dirt and moisture at the jobsite. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be removed from protected storage. The fasteners not used shall be returned to protected storage at the end of the shift. Do not allow cleaning of the lubricant from the fasteners that is present in as-delivered condition. The fasteners for slip critical connections must be cleaned of accumulated rust or dirt resulting from jobsite conditions, relubricated and have a rotational capacity test performed prior to installation.

505.04-1(b) Lubrication

During the tightening of galvanized high strength bolts A325M/(A325/), increased friction occurs due to the galling of the galvanizing on the threads or face of the turned element (nut or bolt head) and the washer. This galling can cause seizing or binding of the bolt. This increased friction can result in out-of-specification bolt tension. Dry or rusty black bolts and nuts will also result in bolt tension not meeting the specifications.

It is essential that bolts and nuts be properly lubricated at the time of installation. It is not difficult to determine if the bolts and nuts are properly lubricated. Black bolts must be oily to the touch. For galvanized fasteners, the nuts must be lubricated with lubricant that is clean and dry to the touch and must contain a visible dye for easy identification. Check lubrication of the bolt, washer and nut combinations prior to job start up, using the rotational capacity test (see Section 505.04-1(d)). During installation, if improper lubrication is suspected and/or lubricant is added, the assembly shall be retested for rotational capacity.

The following lubricants have been used successfully in the field, although other lubricants may be available that will work:

- A milky looking liquid lubricant called Safety Film 616 manufactured by Chem-Trend, Inc., Howell, Michigan 48843 or Jon Cote 639 is very easy to use and requires little time to apply. Mix two parts water to one-part lubricant in a plastic spray bottle and spray on threads and washer face just before nuts are installed. The lubricant is water soluble and cleans up easy.
- A stick wax called Chem-Trend 140 (formerly Johnson's 140 stick wax) and also manufactured by Chem-Trend, Inc., will work well but requires some clean up afterwards.

Lubricant not only aids in obtaining proper bolt tension but also increases the bolting production rate for the Contractor, which more than pays for the application of the lubricant.

505.04-1(c) Stripping

Stripping is thread failure of either the nut or bolt threads. Galvanized nuts are over tapped to allow for the thickness of galvanizing. Galvanized bolts therefore strip more readily than black bolts. The amount of overtapping allowed is dependent upon the strength of the nut and bolt. Stripping of the threads occurs when the strength of thread area engaged in the nut is not sufficient to develop the force generated in the bolt.

Often nuts and bolts are made by different manufacturers and shipped to the fabricator/distributor. The only way to know that one lot of nuts will properly assemble and fit with another lot of bolts is to test the bolt-nut combination for stripping. This is done with a rotational capacity test.

505.04-1(d) Rotational Capacity Test

Article 505.04(f)(3) requires that rotational capacity tests be performed according to AASHTO M164M. Bolts, nuts and washers are often made by different manufacturers at different locations and are not fitted as an assembly until they arrive at the fabricator/distributor. Therefore, inadequate combinations of variables (e.g., ductility, out-of-tolerance overtapping of nuts, zinc thickness (galvanized bolts), thread depth, lubrication) can cause inadequate tension in the bolted connection and bolt failure.

The rotational capacity test checks all components as a complete assembly to ensure:

- Ductility
- Adequate thread shear area to prevent stripping
- Adequate lubrication

FHWA now requires rotational capacity tests to be performed at the source where the nuts, bolts and washers are combined to form an assembly. This source (fabricator/distributor/manufacturer) is where the rotational capacity lot numbers are assigned. Rotational capacity tests must also be performed at the jobsite.

Jobsite rotational capacity tests shall be performed on all black or galvanized bolt, nut and washer assemblies of the same rotational capacity lot number as received from the manufacturer and/or distributor. The frequency of testing shall be two assemblies per each rotational capacity lot. Jobsite rotational tests shall be performed in accordance with the procedure in Section 504.04-1(f) and the results documented on [Form BC 2320](#).

505.04-1(e) Field Verification Testing

Before installing any fastener on the structure, each member of the tightening crew and the Engineer must be familiar with the tightening procedure. To accomplish this, the specification requires that three assemblies of each diameter and length be tested in the tension calibrating device.

This verification testing demonstrates that the Contractor's chosen tightening procedure will provide the minimum required tension in the fastener assembly and that each crew member understands and can properly apply the correct snug tightening and final tightening procedure:

1. Snug Tight. The specifications define snug tight as the condition when all plies of the joint are in firm contact. This normally occurs at a tension of approximately 10 kips. With all plies in firm contact, the final tightening procedure produces the desired tension in the fastener. Crew members should demonstrate that their snug tightening procedure produces approximately 10 kips of tension but does not produce more than 50% of the required final tension. Snug tight tensions above 50% of the final tension could result in the fasteners failing when final tightening is applied.
2. Final Tightening. Correct final tightening can only be applied to assemblies that have been properly snug tightened. Final tightening, whether measured by the rotation of the nut, the shearing off of a part of the fastener or the collapse of nodes on a washer, is only correct if it results in at least the required minimum tension in the fastener. In most instances, the amount of rotation of the nut from snug tight, the shearing off of a part of the fastener or the collapse of nodes to a certain thickness will produce tensions in the assemblies above the minimum specified. However, the only way to ensure this is through verification testing. If the Contractor's procedure or the assembly does not produce the minimum tension, then the procedure must be revised until it results in the specified tension or the assemblies must be rejected. Although the specifications do not directly address the maximum tension in fasteners, the minimum required tension is

approximately 70% of the tension strength of the fastener. Therefore, it is important to realize that tension values considerably above the minimum tension should be avoided.

After the Contractor's tightening procedure has been shown to produce the specified tension in the fasteners, the Inspector must observe the tightening procedure used on the structure to verify that it is the same procedure demonstrated. If the Engineer is satisfied that the procedure used on the structure is the same as shown in the verification testing, they can be assured that the required tension is present in the installed fasteners, and the visual and minimum inspection requirements for each type of assembly discussed elsewhere in this Section is the only inspection needed.

505.04-1(f) Procedure for Performing Rotational Capacity Test

Equipment Required

1. Calibrated bolt tension measuring device of the size required for bolts to be tested. Mark off a vertical line and lines $\frac{1}{3}$ of a turn, 120° ; and $\frac{2}{3}$ of a turn, 240° from vertical in a clockwise direction on the face plate of the calibrator.
2. Calibrated dial type torque wrench.
3. Spacers and/or washers with the hole size no larger than $\frac{1}{16}$ in. greater than the bolt to be tested.
4. Steel section to mount bolt calibrator. Flange of girder or cross frame accessible from the ground is satisfactory.

Procedure

1. Install the nut on the bolt and measure the stick out of bolt when 3 to 5 full threads of the bolt are located between the bearing face of the nut and the bolt head. Measure the bolt length; the distance from the end of the threaded shank to the underside of the bolt head.
2. Install the bolt into the tension calibrator and install the required number of shim plates and/or washer (one washer under the nut must always be used) to produce the thread stick out measured in Step 1.
3. Tighten the bolt using a hand wrench to the snug tensions listed below (Tolerance – 0 kips, + 2 kips). These are 10% of the table under Item #5.

Bolt Dia. (in.)	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$
Snug Tension (kips)	1	2	3	4	5	6	7	9	10

4. Match mark the nut to the vertical stripe on the face plate of the bolt calibrator.

5. Using the calibrated manual torque wrench, tighten the bolt to at least the tension listed below and record the torque required to reach the tension and the value of the bolt tension. The torque must be measured with the nut in motion.

Bolt Dia. (in.)	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$
Tension (kips)	12	19	28	39	51	56	71	85	103

6. Further tighten the bolt to the rotation listed below. The rotation is measured from the initial marking in Step 4. Record the bolt tension. Assemblies that fail prior to this rotation either by stripping or fracture fail the test.

Bolt Length (measured in Step 1)	4 × bolt dia. or less	Greater than 4, but no more than 8 × bolt dia.	Greater than 8 × bolt diameter
Required Rotation	$\frac{2}{3}$	1	$1\frac{1}{3}$

7. After the required rotation, the bolt tension measured in Step 6 must equal or exceed the values shown in the table below. Assemblies that do not meet this tension have failed the test.

Bolt Dia. (in.)	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$
Tension (kips)	14	22	32	45	59	64	82	98	118

8. Loosen and remove the nut. Examine the threads on the nut and bolt. There should be no signs of thread shear failure, stripping or torsional failure of the bolt. Assemblies that have evidence of stripping have failed the test.
9. Calculate and record the value of $0.25 \times$ the tension (pounds = kips \times 1000) measured in Step 5 \times the bolt diameter in feet. The torque measured and recorded in Step 5 must be equal to or less than this calculated value. Assemblies with torque values exceeding this calculated value have failed the test. This calculated torque value should not be exceeded at any point in Step 5 or the assembly has failed the test. The following table can be used for $\frac{3}{4}$ in. and $\frac{7}{8}$ in. bolts.

Rotational Capacity Test/Maximum Torque

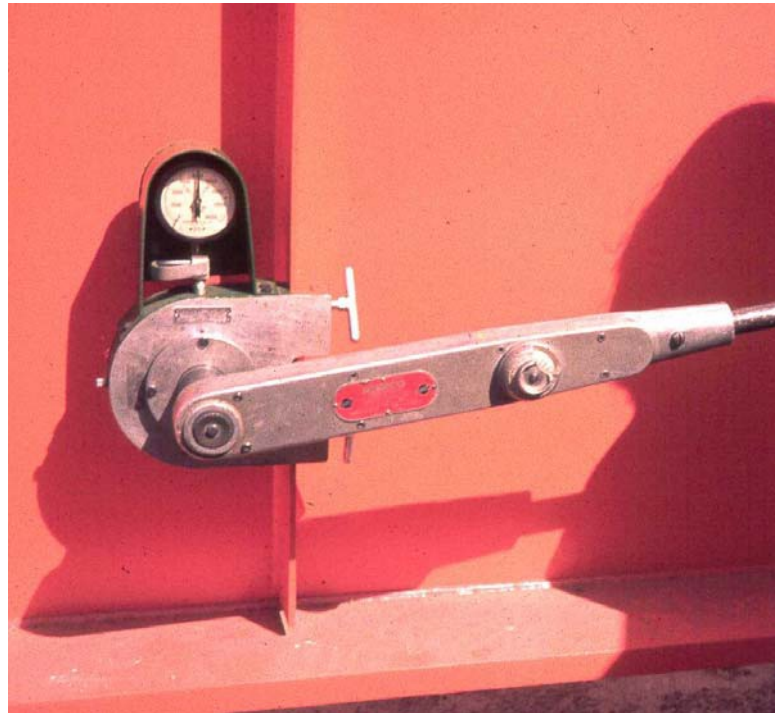
$\frac{3}{4}$ in. Bolt		$\frac{7}{8}$ in. Bolt	
Tension (kips)	Torque (ft-lbs.)	Tension (kips)	Torque (ft-lbs.)
28	437	39	711
29	453	40	729
30	469	41	747
31	484	42	766
32	500	43	784
33	516	44	802
34	531	45	820
35	547	46	839
36	562	47	857
37	578	48	875
38	594	49	893
39	609	50	911
40	625	51	930
		52	948
		53	966
		54	984
		55	1003
		56	1021

505.04-1(g) Tension Calibrating Devices

Currently, there is no known economical means for determining the tension in an installed bolt. However, the tension calibrator is a hydraulic load cell that measures bolt tension created by tightening a bolt in the device. See Figure 500-9.

As the bolt or nut is turned, the internal bolt tension or clamping force is transmitted through hydraulic fluid to a pressure gauge that indicates bolt tension directly in pounds, provided that the device is properly calibrated.

This device is an economical and valuable tool that shall be readily available whenever high-strength bolts will be installed. Although each element of a fastener assembly may conform to the minimum requirements of their separate material specifications, their compatibility in an assembly or the need for lubrication can only be assured by testing of the assembly. Hence, such devices are important for confirming the complete fastened assembly as it will be used with the method of tightening to ensure the suitability of bolts and nuts, including lubrication, and the adequacy of impact wrenches and/or air pressure to provide the specified bolt tension.

Figure 500-9 — TENSION CALIBRATING DEVICE

Testing before the start of fastener installation will identify potential sources of problems including, but not necessarily limited to:

- The need for lubrication to prevent failure of bolts by combined high torque with tension
- Under-strength assemblies due to improper marking or heat treatment or quality control of fasteners
- Excessive overtapping of galvanized nuts
- Improper use of selected installation method by the bolting crews
- Improper or unreliable inspection technique by the Inspectors

These devices are essential for testing fasteners other than AASHTO M164 (ASTM A325M (A325)) or AASHTO M253 (ASTM A490M (A490)) bolts and direct tension indicators. They are also essential for ensuring the proper installation method by the bolting crews. Hydraulic tension calibrating devices capable of indicating bolt tension undergo a slight deformation under load. Hence, the nut rotation corresponding to a given tension reading may be somewhat larger than it would be if the same bolt were tightened against a solid steel member. Stated differently, the reading of the calibrating device tends to underestimate the tension that a given rotation of the turned element would induce in a bolt in an actual joint. Therefore, calibration is at 105% of the minimum required bolt tension.

505.04-1(h) Connections and Snug Tight

With any tightening method, it is important to install the fasteners in all holes of the connection and tighten them to an intermediate level of tension generally corresponding to snug tight to compact the joint. If individual fasteners are installed and tightened in a single continuous operation, fasteners that are tightened first will be subsequently relaxed by the tightening of the adjacent fasteners. The total of the forces in all fasteners will be reduced, which will reduce the slip capacity of the entire connection. Even after being fully tightened, some thick sections with uneven surfaces may not be in contact over the entire faying surface.

This is not detrimental to the performance of the joint. If the specified bolt tension is present in all fasteners of the completed connection, the clamping force equal to the total of the tensions in all fasteners will be transferred at the locations that are in contact and be fully effective in resisting slip through friction.

With all methods, tightening should begin at the most rigidly fixed or stiffest point and progress toward the free edges, both in the initial snugging up and in the final tightening.

505.04-1(i) Field Material Inspection**Bolts, Nuts, Washers, Twist-Off Bolts**

The *Standard Specifications* require the following certifications from the mill, the manufacturer and/or distributor:

(Note: The structural steel fabricator could also be the distributor.)

- Mill Test Report (MTR)
- Manufacturer Certified Test Report (MCTR)
- Distributor Certified Test Report (DCTR)

The information needed on the certification is outlined in the *Standard Specifications*.

Before shipment, the source that combines the nuts, bolts and washers into assemblies (manufacturer/supplier) is required to conduct rotational capacity tests on assemblies of known accepted production lots of bolts, nuts and washers. A rotational lot number is assigned to each assembly representing the bolts, nuts and washers that passed the rotational capacity test. Only the bolts, nuts and washers from the same rotational capacity lot can be used together. Bolts, nuts and washers from a different rotational capacity lot cannot be intermixed.

The bolts, nuts and washers from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked (on the container, not only the lid) with the rotational-capacity lot number so that identification will be possible at any stage before and during installation.

When containers arrive on the jobsite, the MTR, MCTR/DCTR shall be provided by the Contractor. In addition, the containers must have an ILL OK stamp or a letter from the Bureau of Materials approving the respective lots of bolts, nuts and washers.

No bolt, nut or washer shall be permitted to be used in the structure unless the MTR, MCTR/DCTR certifications are received, the material has been approved by the Bureau of Materials and the jobsite rotational-capacity tests have passed. If the material does not have an ILL OK stamp or an approval letter from the Bureau of Materials, a minimum sample from each production lot consisting of five bolts of each diameter and length, three nuts of each size and three washers of each size shall be sampled and sent to the Bureau of Materials for testing.

Lockpin and Collar (Huckbolts, etc.)

The MTR and MCTR/DCTR requirements for lockpin and collar fasteners are the same as for bolts, nuts and washers except that rotational-capacity tests are not required.

Lockpin and collars can be accepted in the field if the following requirements are met:

1. Mechanical galvanizing shall be measured and shall be between 1/16 in. to 1/4 in. (2 mm to 6 mm) in thickness. Hot dipped galvanized lockpin and collars are not permitted.
2. From each production lot, three lockpins and collars of each diameter and length shall be tested in a tension measuring device. Each lockpin shall clamp at no less than 105% of the minimum required tension or the lot shall be rejected.
3. The manufacturer has the option to ask the Bureau of Materials to test the lockpins and collars before they are shipped to the jobsite. If the containers arrive at the jobsite with an ILL OK stamp, the Bureau of Materials has sampled and approved the lockpins and collars. In this case, the galvanizing thickness check as per Item 1 will not be required. However, the field tension testing as per Item 2 will be required.

505.04-1(j) Installation Method

Regardless of the fastener type or method of tightening used, the following general provisions apply:

1. The Engineer shall check the marking, surface condition and storage of bolts, nuts and washers, alternate design fasteners and the faying surfaces of joints for compliance with the specification requirements.
2. When faying surfaces of slip critical joints (all bridge joints are slip critical) are specified to be painted in the field, the Engineer shall ensure that the coating has cured for the minimum time recommended by the paint manufacturer.
3. The Engineer must verify that all bolt tension measuring devices and torque wrenches have been calibrated within the last year and that test certificates are available. The bolt tension measuring device must be capable of accepting the shortest bolts on the contract (Skidmore-Wilhelm, Model MS or equivalent).
4. The Engineer shall witness all rotational capacity tests performed at the fastener installation site to ensure that the tests are properly conducted at the required frequency and that the test results are in compliance with the specifications. Lockpin and collar fasteners (Huckbolts) require no rotational capacity test.

- 4.1 The rotational capacity test shall be performed as outlined on two representative bolt, nut and washer assemblies per rotational capacity lot.
- 4.2 Fasteners not passing the rotational capacity test shall be rejected. If lack of lubricant appears to be a problem, the entire rotational capacity lot of nuts/bolts can be relubricated with an approved lubricant and the rotational capacity test rerun. Select two of the relubricated assemblies as per paragraph 4.1 and perform the rotational capacity test. If the assembly passes the rotational capacity test, the rotational capacity lot they represent can be accepted.
5. The Engineer shall witness all turn-of-nut verification testing, tension verification testing of all fasteners and direct tension indicator (DTI) calibration required by the specification requirements to ensure that the tests are properly conducted at the required frequency.
6. The Engineer will ensure that each member of the bolting crew(s) is familiar with the procedural requirements for the tightening method selected by the Contractor. Each bolting crew member must understand the procedure for snug tightening the joint and fasteners and should have demonstrated this knowledge by tightening a fastener in a bolt tension calibrator.
7. Material within the bolt grip will be steel with no compressible material.
8. Slope of surface shall not exceed 20:1 (V:H). Correct with hardened beveled washers.
9. All surfaces shall be free of loose scale dirt or other foreign material.
10. Uncoated joints shall have no paint, including overspray, in the connection area.
11. All fastener components shall be properly lubricated and protected from contamination, dirt and moisture.
12. Hardened washers may be required for standard holes or special washers may be required for oversize or slotted holes. See the *Standard Specifications*. Hardened washers are required to be used under the turned element.

505.04-1(k) Turn-of-Nut Method

Consistency and reliability using turn-of-the-nut method is dependent upon ensuring that the joint is well compacted and that all bolts are uniformly tight to a snug tight condition before application of the final required partial turn. Under-tightened bolts will result if this procedure is not followed. Reliability is also dependent upon ensuring that the applied turn is relative between the bolt and nut; thus, the element opposite the turned end should be prevented from rotating while the required degree of turn is applied to the turned end. Reliability and inspectability of the method may be improved by having the outer face of the nut match-marked to the protruding end of the bolt after the joint has been snug tightened but before final tightening. Such marks shall be applied by the wrench operator using crayon or a dab of paint. Such marks in their relatively displaced position after tightening will afford the Inspector a means for noting that the rotation that was applied.

Problems with turn-of-nut tightening have been encountered with galvanized bolts. Jobsite tests in the tension indicating device has demonstrated that the lubricant reduced the coefficient of friction between the bolt and nut to the degree that “the full effort of a man using an ordinary spud wrench” to snug tighten the joint actually induced the full required tension. Also, because the nuts could be turned by application of lower torque than normally expected with non-galvanized bolts, they were erroneously judged to be improperly tightened by the Inspector. Research confirms that lubricated galvanized bolts may require only one-half as much torque to induce the specified tension. For other problems with galvanized bolts, the absence of lubrication or lack of proper overtapping caused seizing of the nut and bolt threads, which resulted in twist failure of the bolt at low or no tension. For such situations, use a tension indicating device and the fasteners being installed may be helpful in establishing either the need for lubrication or alternative criteria for snug tight.

505.04-2 Procedure for Installation and Tightening of High Strength Fasteners – Turn-of-Nut Method

2.0 Tension Verification Testing

- 2.1 Equipment required – calibrated bolt tension measuring device, spacers and/or washers with proper hole size. Rigid mounting for bolt tension calibrator. Air impact wrenches that will be used to install fasteners in the structure.
- 2.2 Select at least three bolt, nut and washer (when required) assemblies of each diameter, length and grade to be used in the work.
- 2.3 Install and tighten each assembly in the bolt tension measuring device using the “snug tightening” procedure that will be used to snug tight the fasteners in the work. “Snug tight” is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Ensure that the proposed “snug tightening” procedures do not produce more than 50% of required fastener tension as specified in the table below. If so, revise the snug tightening procedure because bolt stress may be near the bolt failure range when tightened. Too much lubrication can cause this problem.

REQUIRED FASTENER TENSION (Kips)

Bolt Dia. (in)	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
M164 (A325)	13	20	29	41	54	59	75	89	108
M253 (A490)	16	25	37	51	67	84	107	127	155

- 2.4 Following snug tightening, mark nut or drive socket to a reference point on bolt tension calibrator and further tighten to the rotation shown below:

Bolt Length	4 × bolt dia. or less	Greater than 4 but no more than 8 × bolt dia.	Greater than 8 × bolt dia.

Required Rotation	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{2}{3}$
-------------------	---------------	---------------	---------------

2.5 At this rotation, the minimum bolt tension shall be as follows:

Bolt Dia. (in)	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$
M164 (A325)	13	20	29	41	54	59	75	89	108
M253 (A490)	16	25	37	51	67	84	107	127	155

3.0 **Snug Tightening Procedure**

- 3.1 Bolts shall be installed in all holes of the connection and brought up to a “snug tight” condition.
- 3.2 “Snug tight” is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. The snug tightening procedure used in the work shall be the same snug tightening procedure used when conducting the TURN-OF-NUT VERIFICATION TEST in Step 2.3.
- 3.3 Snug tightening shall progress systematically from the most rigid part of the connection to the free edges. Start the pattern near the end of each member being spliced at the center of the pattern and work toward all edges of the splice plate.
- 3.4 Following this initial snug tightening, all bolts in the joint shall be again systematically tightened as necessary, using a similar pattern until all bolts are simultaneously snug tight and the connection is fully compacted.

4.0 Final Turn-of-Nut Tightening

- 4.1 Following this snug tightening operation, all bolts in the connection shall be match-marked so that the subsequent relative rotation between the bolt and the nut can be inspected. All bolts shall then be tightened by the applicable amount of rotation as determined in Step 2.5.
- 4.2 During the tightening operation, there shall be no rotation of the part not turned by the wrench.
- 4.3 Tightening shall progress systematically from the most rigid part of the joint to its free edges. Start the pattern near the end of each member being spliced at the center of the pattern and work toward all edges of the splice plate.
- 4.4 When it is impractical to turn the nut, tightening may be done by turning the bolt with a washer under the bolt head while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

505.04-2(a) Twist Off Bolt Method

The following shall apply when high-strength bolts with mechanical properties equivalent to AASHTO M164 (ASTM A325M (A325)) or AASHTO M253 (ASTM A490M (A490)) but with different geometry that is intended to provide automatic control of installed bolt tension are used. The bolts currently being used involve a splined end extending beyond the threaded portion of the bolt that is gripped by a specially designed wrench chuck that provides a means for turning the nut relative to the bolt. Although such bolts are subject to many of the variables affecting torque/tension relationship, they are produced and shipped by the manufacturers as a nut-bolt assembly under good quality control, which should minimize some of the negative aspects of the torque-controlled process.

Although these alternate design fasteners have been demonstrated to consistently provide tension in the fastener meeting the specifications in the controlled tests in tension indicating devices, this type of fastener may be misused and provide results as unreliable as those with other methods. They must be used in the as-delivered, clean, lubricated condition. The requirements of this Specification and the installation requirements of the manufacturer's specification must be adhered to.

505.04-3 Procedure for Installation and Tightening of High Strength Fasteners – Alternate Design Fasteners (Twist Off Bolts)

2.0 Tension Verification Testing

- 2.1 Equipment required:
 - 2.1.1 Calibrated bolt tension measuring device.
 - 2.1.2 Spacers and/or washers with proper hole size to adjust bolt length in tension measuring device.

- 2.1.3 Rigid mounting for bolt tension calibrator.
- 2.1.4 Wrenches that will be used to install fasteners in the structure.
- 2.1.5 Adequate supply of hex head HS bolts, nuts and washers.
- 2.2 Testing Frequency — As a minimum, three fastener assemblies shall be checked from each fastener length, diameter and grade. The testing should be done immediately before start of installation of the fasteners in the work. Fasteners should be retested when any significant difference is noted in the surface condition or level of lubrication of the fastener threads, nuts or washers.
- 2.2.1 Select three fastener assemblies from each diameter, length and grade.
- 2.2.2 Install each fastener assembly into the tension measuring device and install sufficient spacers and/or washers so that at least three but no more than five full threads are exposed between the nut face and the underside of the bolt head. The fastener manufacturer's installation procedure shall be followed for installation of bolts in the calibration device and in all connections.
- 2.2.3 Tighten each assembly using the "snug tightening" procedure that will be used to snug tight the fasteners in the work. "Snug tight" is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Ensure that the proposed snug tightening procedure does not produce more than 50% of required fastener tension as specified in the table below. If so, revise snug tightening procedure.

REQUIRED FASTENER TENSION (Kips)

Bolt Dia. (in)	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
M164 (A325)	12	19	28	39	51	56	71	85	103
M253 (A490)	15	24	35	49	64	80	102	121	148

- 2.2.4 Following the manufacturer's fastener procedure, further tighten each of the three assemblies until the final twist-off of the control or indicator element. Each assembly must indicate a minimum tension as shown below or the lot the bolt represents shall be rejected:

Bolt Dia. (in)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
M164 (A325)	13	20	29	41	54	59	75	89	108
M253 (A490)	16	25	37	51	67	84	107	127	155

3.0 **Snug Tightening Procedure**

- 3.1 Fasteners shall be installed in all holes of the connection and brought up to a “snug tight” condition.
- 3.2 “Snug tight” is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. The snug tightening procedure used in the work shall be the same snug tightening procedure used when conducting the Tension Verification Testing in Step 2.2.3.
- 3.3 Snug tightening shall progress systematically from the most rigid part of the connection to the free edges. Start the pattern near the end of each member being spliced at the center of the pattern and work toward all edges of the splice plate.
- 3.4 Following this initial snug tightening, all bolts in the joint shall be again systematically tightened as necessary using a similar pattern until all bolts are simultaneously snug tight and the connection is fully compacted.

4.0 **Final Tightening**

- 4.1 Following the snug tightening operation, all fasteners shall be further tightened until the final twist-off of the control or indicator element. All tightening shall be done using equipment and procedures recommended by the fastener manufacturer.
- 4.2 Tightening shall progress systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening before final twist-off of the control or indicator element of individual fasteners.

505.04-4 **Procedure for Installation and Tightening of High Strength Fasteners – Lockpin and Collar (Huckbolts, etc.)**

2.0 **Tension Verification Testing**

- 2.1 Equipment required: Calibrated tension measuring device. Spacers and/or washers with the proper hole size to adjust fastener length in the tension measuring device. Rigid mounting for tension measuring device. Wrenches that will be used to install fasteners in the structure.
- 2.2 Adequate supply of lockpin and collar fasteners.

- 2.3 Select a representative sample of not less than three fasteners of each diameter, length and lot.
- 2.4 Tighten each assembly using the snug tightening procedure that will be used to snug tight the fasteners in the work. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. Ensure that the proposed snug tightening procedure does not produce more than 50% of the required fastener tension as specified in the table, Step 2.5, below. If so, revise the snug tightening procedure.
- 2.5 Following the manufacturer's procedure, further tighten each representative fastener until the pintail shears and the collar is swaged around the pin. Each fastener shall develop a tension of not less than that in the following table:

Bolt Dia. (in.)	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
M164 (A325)	13	20	29	41	54	59	75	89	108
M253 (A490)	16	25	37	51	67	84	107	127	155

If any fastener does not meet the required minimum tension, the lot it represents shall be rejected.

3.0 **Snug Tightening Procedure**

- 3.1 Fasteners shall be installed in all holes of the connection and brought up to a "snug tight" condition.
- 3.2 "Snug tight" is defined as the tightness that exists when the plies of the joint are in firm contact. The snug tightening procedure used in the work shall be the same snug tightening procedure used when conducting the Tension Verification Testing in Step 2.0.
- 3.3 Snug tightening shall progress systematically from the most rigid part of the connection to the free edges. Start the pattern near the end of each member being spliced at the center of the pattern and work toward all edges of the splice plate.
- 3.4 Following this initial snug tightening, all fasteners in the joint shall be again systematically tightened, as necessary, using a similar pattern until all fasteners are simultaneously snug tight and the connection is fully compacted.

4.0 Final Tightening

- 4.1 Following the snug tightening operation, all fasteners shall be further tightened until the pintail shears and the collar is swaged around the pin. All tightening shall be done using equipment and procedures used when conducting the Tension Verification Testing in Step 2.0.
- 4.2 Tightening shall progress systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the fasteners may require more than a single cycle of systematic partial tightening before final shearing of the pintail.

505.04-5 Procedure for Verification and Installation of High Strength Bolts with Direct Tension Indicators (DTIs)**2.0 Tension Verification Testing**

- 2.1 Equipment required: Calibrated bolt tension measuring device with a special flat insert in place of the normal bolt head holding insert. A special insert is required to allow access to measure DTI gap. Tapered leaf thickness (feeler) gages 0.001 in., 0.005 in. and 0.015 in. Use the same gages to inspect the bolts after installation. Bolts, nuts and standard washers to be used in the work with the DTIs. Test at least three assemblies of each diameter, length and grade of bolts used in the work. Use impact and manual wrenches to tighten bolts. Use the same equipment as used in the work.
- 2.2 Install bolt, DTI, standard washer and nut into the bolt tension indicator using the equipment that will be used in the work. Use another wrench on the bolt head to prevent rotation of the head against the DTI if the DTI is to be used under the unturned element.
- 2.3 Snug the bolt to no more than 50% of the required installation tension using the equipment that will be used in the work. Use another wrench on the bolt head to prevent rotation of the head against the DTI if the DTI is to be used under the unturned element.
- 2.4 Further tighten the bolt to tensions listed below. Use another wrench on the bolt head to prevent rotation of the head against the DTI if the DTI is to be used under the unturned element. If an impact wrench is used, tighten to a load slightly below the required load and use a manual wrench to attain the required tension. The load indicating needle of the bolt calibrator cannot be read accurately when an impact wrench is used.

BOLT TENSION (Kips)

Bolt Dia. (in)	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
M164 (A325)	13	20	29	41	54	59	75	89	108
M253 (A490)	N/A	N/A	37	51	67	84	107	127	N/A

- 2.5 Determine the number of spaces between the protrusions on the DTI that a 0.005 in. (galvanized DTI) or 0.015 in. (plain DTI) feeler gage is refused. If the thickness gage is

refused in more than $\frac{1}{2}$ of the total spaces, the DTI fails the test and the lot is rejected.

- 2.6 The bolt should be further tightened to zero total gap. This is defined as the gap at which a 0.001 in. feeler gage cannot enter any space in the DTI, but a visible gap still exists in at least one space.
- 2.7 Remove the bolt from the calibrator and turn the nut on the threads by hand. The nut should be able to be turned on the complete length of the threads. If so, total zero gap is the minimum allowable gap for the job. If not, repeat the test with a larger minimum gap in Step 2.5. For example, one space will accept a 0.005 in. feeler gage to establish the minimum allowable gap for the job.

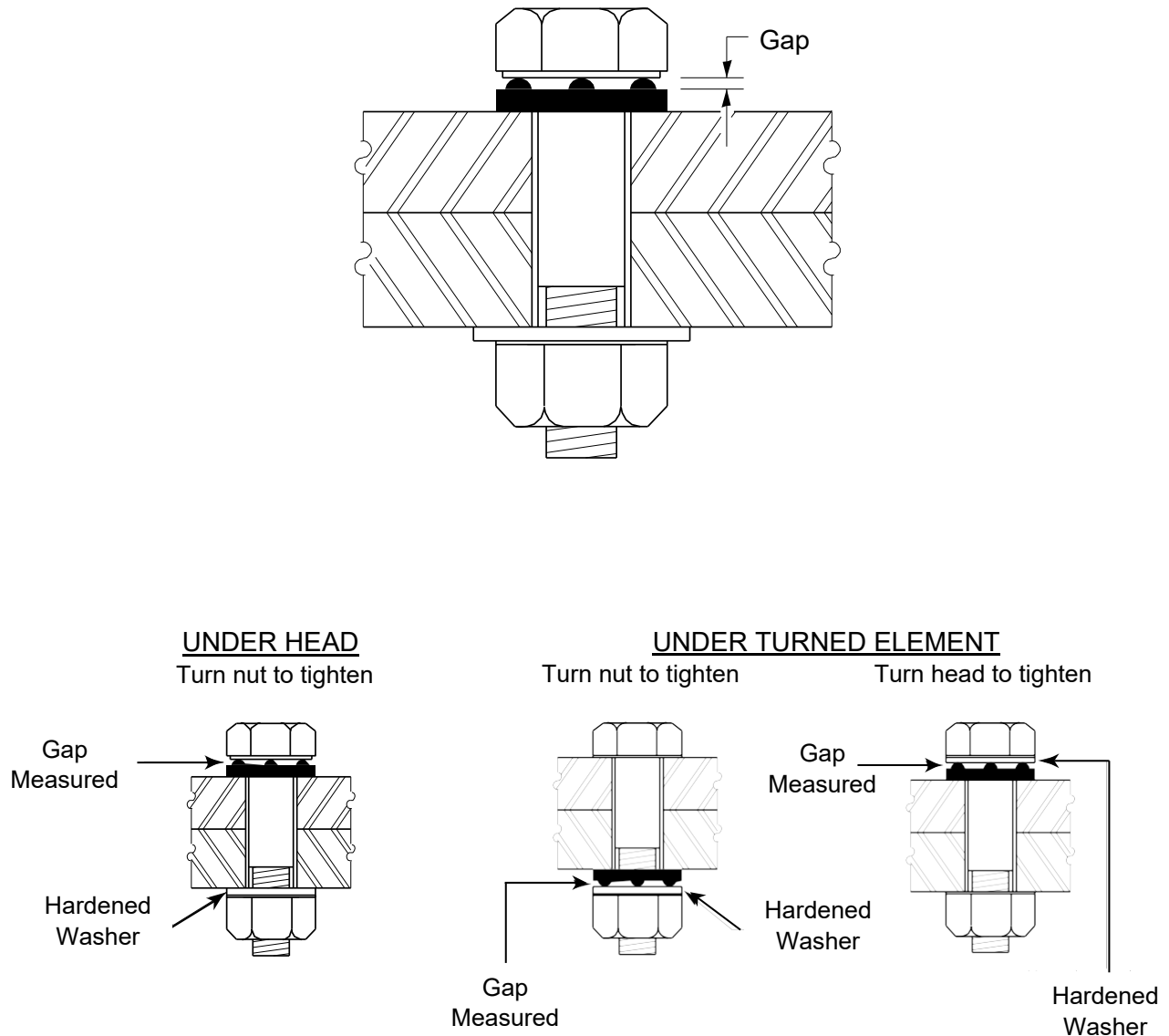
505.04-5(a) Installation

Galvanized high strength A325M (A325) bolts shall always have the galvanized DTI under the bolt head with only the nut being permitted to be turned to tighten the bolt. There is no capability to measure the proper gap of a galvanized DTI when installed under the turned element with a hardened washer.

See the proper installation in Figure 500-10.

3.0 Snug Tightening Procedure

- 3.1 Fasteners shall be installed in all holes of the connection and brought up to a “snug tight” condition.
- 3.2 “Snug tight” is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. The snug tightening procedure used in the work shall be the same snug tightening procedure used when conducting the Tension Verification Testing in Step 2.0.
- 3.3 Snug tightening shall progress systematically from the most rigid part of the connection to the free edges. Start the pattern near the end of each member being spliced at the center of the pattern and work toward all edges of the splice plate.
- 3.4 Following this initial snug tightening, all bolts in the joint shall be again systematically tightened, as necessary, using a similar pattern until all bolts are simultaneously snug tight and the connection is fully compacted.

Figure 500-10 — INSTALLATION OF HIGH STRENGTH BOLTS WITH DTIs

4.0 **Final Tightening**

- 4.1 Following the snug tightening operation, all fasteners shall be further tightened to their final required tension.
- 4.2 Tightening shall progress systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening before final tightening.

505.04-5(b) Inspection of Fastener Installations

The inspection procedures providing the best assurance that bolts are properly installed and tensioned are provided by Inspector observation of the calibration testing of the fasteners, using the selected installation procedure followed by monitoring the work in progress to ensure that the procedure that was demonstrated to provide the specified tension is routinely adhered to. When such a program is followed, no further evidence of proper bolt tension should be required.

505.04-6 General Procedure for Inspection of High Strength Fasteners Installation**2.0 Inspection During Installation**

- 2.1 The Engineer must constantly monitor the surface condition of fasteners to prevent accumulation of dirt or rust and to detect any change in the level of lubrication in the bolt, nut and washer assembly. Lack of lubrication will not affect the installation of lockpin and collar fasteners.
- 2.2 Allow only as many fasteners as are anticipated to be installed and tightened during a work shift to be removed from protective storage. Fasteners not used shall be returned to protected storage at the end of the shift.
- 2.3 At any time during the erection process, if the Engineer suspects there may have been a change in the level of lubrication of the bolt, nut and washer assemblies, they should immediately require the rotational capacity test to be conducted on two assemblies removed from the structure, and all calibration and verification testing.
- 2.4 The Engineer shall monitor the installation of the fasteners in the work to ensure that the selected installation method, as demonstrated in the initial testing to provide the specified tension, is routinely properly applied. This monitoring shall also include verification that all plies of connected material have been drawn together and that the procedure for snug tightening has been followed.

3.0 Field Inspection – Turn-of-Nut Method

In addition to the requirements of Steps 2.1 thru 2.4 above and the requirements of the turn-of-nut procedure, the Engineer shall visually inspect the match marks to ensure that the required rotation has been achieved.

4.0 Field Inspection – Twist Off Bolts

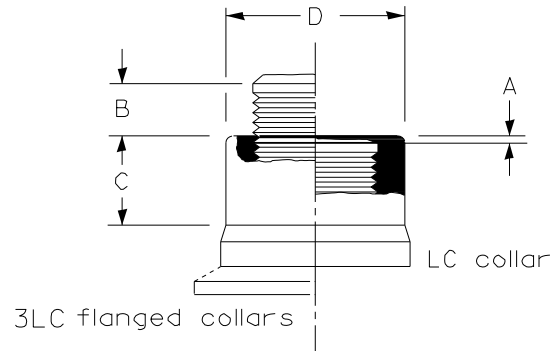
In addition to the requirements of Steps 2.1 thru 2.4 above and the requirements of the procedure for alternate design fasteners, the inspection of completed joints is required. The following inspection procedure shall be used unless a different procedure is specified in the contract documents.

- 4.1 Inspecting torque wrenches will not be required on the completed connections.
- 4.2 Installation inspection shall be performed in the following manner:
- a. If the twist-off bolts are installed and tensioned in a single continuous operation, they will give a misleading indication to the Inspector that the bolts are properly tightened. Therefore, the only way to inspect these fasteners with confidence is to observe the jobsite testing of the fasteners and installation procedure, and then monitor the work while in progress to ensure that the specified procedure is routinely followed.
 - b. Visually check that all spliced ends have been sheared off.
 - c. Tap each bolt with a hammer to ensure that there are no loose bolts.

5.0 Field Inspection – Lockpin and Collar Fasteners (Huckbolt, etc.)

- 5.1 In addition to the requirements of Steps 2.1, 2.2 and 2.4 above, inspection of completed joints shall be used unless a different procedure is specified in the contract documents.
- 5.2 Installation inspection shall be performed in the following manner:
- a. If the fasteners are installed and tensioned in a single continuous operation, they may mislead the Inspector that the bolts are properly tightened. Therefore, the only way to inspect these fasteners with confidence is to observe the jobsite testing of the fasteners and installation procedure and then monitor the work while in progress to ensure that the specified procedure is routinely followed.
 - b. Randomly measure and visually check each installed fastener for compliance with the dimensions in the following table. Remove and replace all fasteners that do not meet the dimensional requirements of the table. (Note: A hardened mechanically galvanized washer may be used under the head of the fastener to increase the grip so that the A and B dimension is within the required tolerance of 1/16 in. or 3/8 in., respectively).

Dia.	Pin Part. No.	Collar Type C	Collar Type	A Max.	B Max	C Min.	D Max.
1/2	C50L(-)(16	LC-2R16G	3LC-2R16G	1/16	3/8	13/32	0.733
5/8	C50L(-)(20	LC-2R20G	3LC-2R20G	1/16	3/8	5/8	0.916
3/4	C50L(-)(24	LC-2R24G	3LC-2R24G	1/16	3/8	21/32	1.110
7/8	C50L(-)(28	LC-2R28G	3LC-2R28G	1/16	3/8	3/4	1.282
1	C50L(-)(32	LC-2R32G	3LC-2R32G	1/16	3/8	7/8	1.465
1 1/8	C50LR-BR36	LC-2R36G		1/16	3/8	29/32	1.646



6.0 **Field Inspection – Direct Tension Indicators (DTIs)**

- 6.1 In addition to the requirements of Steps 2.1 thru 2.4 above, the inspection of completed joints is required. The following inspection procedure shall be used unless a different procedure is specified in the contract documents.
- 6.2 All DTIs in the first two connections of each bolting crew must be checked. No more than 10% of the DTIs in any connection shall have the minimum allowable gap. The Contractor shall remove and replace any bolts that exceed the 10% allowed. No more than 10% of the bolts shall have gaps larger than 0.005 in. for galvanized DTIs or 0.015 in. for plain DTIs. Additional tightening will be required on any bolts that exceed the 10% allowed.
- 6.3 Testing of 100% of the bolts in a connection shall continue until the above requirements are met.
- 6.4 Once the requirements in Step 6.2 are met, a minimum of 20% (but not less than 10 bolts of each splice connection and not less than 1 bolt of each cross frame or diaphragm connection) shall be tested with feeler gages. The remainder of the bolts in a connection shall be visually inspected.
- 6.5 If more than 10% of the bolts tested in Step 6.4 are at the minimum allowable gap or at a gap greater than 0.005 in. (galvanized DTI) or 0.015 in. (plain DTI), the entire connection shall be tested.

The following also apply:

1. **Reuse.** A490M (A490) bolts and galvanized A325M (A325) bolts shall not be reused. Other A325M (A325) bolts may be reused if approved by the Engineer. Retightening previously tightened bolts that may have been loosened by the tightening of adjacent bolts shall not be considered as a reuse.
2. **Oversize and Slotted Holes.** Oversize, short slotted and long slotted holes require hardened washers under both the bolt head and the nut. Refer to the *Specifications for Structural Joints Using High-Strength Bolts* for requirements.

505.07 MARKING AND SHIPPING

When the structural steel is furnished and fabricated under a contract that does not include erection, each bill of lading for each shipment must be inventoried. A complete inventory is required in case any member or fitting is mislaid or lost by the erection contractor. Assign an Inspector to check each piece as it is unloaded.

505.08 ERECTION

505.08-1 General

Erection and final assembly inspection involves ensuring that the Contractor follows the requirements in the erection drawings (if provided) and the contract documents. The fabrication drawings will show how each part of the structure is to be connected together in the field and in what order the parts are to be assembled.

The Contractor must erect and assemble the structure in strict accordance with the contract documents and, specifically, must ensure that no components are bent, over-stressed, cut, punched, drilled or otherwise damaged to expedite the erection procedures.

505.08-2 Pre-Erection

The Resident should hold a pre-erection meeting before the beginning of erection. Steel erection often involves lifting equipment, safety hazards, traffic control.

Before the erection of structural steel begins, the Contractor should locate the centerline of bearings and mark these on all substructure units. See the Construction Inspector's Checklist for Bridge Superstructures for additional direction and information. The bearing areas should be checked to verify that a flat surface will provide uniform contact with the steel at the correct elevation. If the concrete surface that will be in contact with the bearing pad is rough or irregular, the Contractor must grind the concrete pad flat to provide full and uniform bearing.

505.08-3 Erection Plan

The Contractor must submit the Erection Plan. The Resident must submit the Plan to the Bureau of Bridges and Structures for review and comment.

The Erection Plan and procedure must provide complete details of the erection process including:

- Falsework, struts, bracing, tie cables and other devices, material properties and specifications for temporary works, bolt torque requirements prior to releasing girders from the cranes (if required), connection details and attachments to other structure components or objects
- Procedure and sequence of operations, including a detailed schedule with completion times for work items
- Minimum load chart lift capacity, outrigger size and reactions for each crane

- Assumed loads and girder weights, lift points, lifting devices, spreaders and angle of lifting cables
- Locations of cranes, trucks delivering girders, and the location of cranes and outriggers relative to other structures (e.g., retaining walls, wingwalls, utilities)
- Drawings, notes, catalog data showing the manufacturer's recommendations, and calculations clearly showing the details, assumptions and dimensions
- Contingency plans detailing what measures the Contractor will take in case of inclement weather (forecast or actual), equipment failure, delivery interruption and slower than planned production

505.08-4 Assembly

The Contractor should temporarily anchor and brace the primary members such as girders as they are erected to preclude detrimental movement in any direction, and to prevent overturning and buckling.

The following should be checked to ensure that the Contractor performs the work properly:

- During erection, it should be verified that the Contractor placed all members in their proper position in the structure by checking match marks or identification marks on the members with the location shown on the erection drawings.
- Bearing surfaces and metal surfaces in contact with each other must be free of rust, loose mill scale, dirt, oil or grease.
- Any contact surfaces for girder splices or main truss connections that will be connected by high strength bolts must be free of paint or lacquer.
- The steel should fit together with very little strain or distortion. If bolt holes are only slightly out of alignment, usually it is possible to bring the pieces into their proper position with drift pins. However, if the holes fail to line up properly (to the extent that forcing the drift pin through would result in enlargement of the hole or distortion of the metal), the Contractor may re-drill the holes, but only with the approval of the Resident and bridge designer.
- Do not permit field welding of structural members or accessories to structural steel unless specifically allowed in the contract.
- Any fabrication error that cannot be corrected by a slight amount of drifting, drilling or reaming is cause for rejection of the material. Do not permit heavy sledging of the parts to bring them into alignment or making any flame cuts.
- The Bureau of Bridges and Structures must provide approval for any heating of steel members to facilitate bending and installation. Applications of heat to structural steel

must be under rigidly controlled, predetermined conditions that may require different controls for the various members.

505.08-5 Erection Checklist

Use the Construction Inspector's Checklist for Bridge Superstructures.

505.08-6 Handling and Storing Materials

Mishandling of structural steel can result in damage to the paint or to the steel. When the fabrication and erection are performed under separate contracts, the responsibility of the fabricator may terminate when the shipment reaches its destination and the erection contractor assumes responsibility. Therefore, the condition of each individual item must be checked upon arrival and while being unloaded. This will determine whether any abrasion or other damage occurred before delivery. The storage area must be properly drained and safe from high water. Flood waters and mud cause rapid deterioration.

505.08-7 Falsework

The discussion of falsework in Article 503.05 is applicable to Article 505.08. The responsibility for suitable falsework lies entirely with the Contractor.

505.08-8 Long Span Bridges

The discussion in Section 505.08-8 primarily applies to long span bridges. The material stresses the important features of construction practice. Some of these features take on additional importance when the structure involved is a long span bridge. This is because the design involves features not found in relatively simple short span structures. Improper procedure in the field or neglect of certain construction points may lead to serious consequences.

505.08-8(a) Substructures

Substructures are discussed under the sections devoted to the various operations involved:

- Section 501, Removal of Existing Structures
- Section 502, Excavation for Structures
- Section 503, Concrete Structures
- Section 512, Piling

The Resident maintains complete records of the construction of foundations as they are actually built. These should include elevations of the bottom of the footing or seal coat, the nature of the material excavated and, under the foundation, the elevation of the top of the seal coat (if any), the actual alignment, position and elevation of tops of finished piers, etc. Observe any settlement of the piers during construction by taking periodical level readings on horizontal marks scribed on the sides of the piers at convenient elevations.

505.08-8(b) Falsework Bents

The Contractor must keep the structure at the proper line and elevation at all stages of construction and have perfect control of the position of the span at all times. This can be done if steel jacks are used at points of bearing on the falsework. Review Article 503.05 of the *Standard Specifications*.

505.08-8(c) Crookedness of Compression Members

Initial crookedness should not exceed $\frac{1}{8}$ in. (3 mm) plus $1/5000$ of the length of the member, measured center to center at the ends. This concerns shop inspection primarily, but the Resident should be acquainted with the permissible limits.

505.08-8(d) Milling of Compressing Members

Milled surfaces of compression members are assumed to transfer the load in bearing and, therefore, must conform closely to the angles shown on the plans. A deviation from the line of the finished surface, as shown on the plans, by more than an angle of $1/32$ in. in 5 ft (1 mm in 1.92 m) will materially reduce the capacity of the member.

505.08-8(e) Handling of Compression Members

Flanges of wide flanged rolled beams, having a short bend or crook of not more than $1/20$ the outstanding flange, may be straightened on the job or in the shop after heating around the bend to a temperature that glows a deep cherry red. After being heated, members should be annealed but, because this is not practicable in the field, cool off the members as slowly as possible.

505.08-8(f) Top Laterals

High strength bolts for top laterals of compression members should not be tightened until all steel in the trusses is erected. This facilitates aligning the chords properly and avoids overstressing the laterals.

505.08-8(g) Compression Chord Splices

Tighten bolts for main chord splices only after sufficient steel has been placed to ensure that chords may be as close as possible to their final relative positions.

505.08-8(h) Middle Cross Ties at Main Posts

The members connecting the middle of main posts over middle piers to portals should be cut loose at the main posts or be bolted with bolts at least $\frac{3}{8}$ in. (10 mm) smaller in diameter than bolt holes, to allow posts to take an unrestrained position. These connections should be tightened after all other steel has been erected.

505.08-8(i) Closure of Middle Span

Ensure that the Contractor's plan for closing the middle span can be quickly and safely executed and that closure is made at a time when the temperature of the top and bottom chords is approximately equal, unless a provision is made for the difference in temperature. As soon as high strength bolts in final connections are tightened, have the blocking under rollers removed.

505.08-8(j) Floor Slabs

Carefully place floor slabs so that there is little or no overrun in slab thickness, which increases the dead load on the structure appreciably.

505.08-8(k) Information and Reports

The Area Supervisor/Field Engineer should remain in close contact with the Resident on this type of project and be fully informed on all phases of work as it progresses. The Resident should take advantage of the experience of the Area Supervisor/Field Engineer and should discuss all important features of the work. Any special information desired from the Central Office should normally be secured through the Bureau of Construction.

The District should make arrangements to keep the Engineer of Construction constantly informed regarding the more important aspects of the work. The regular weekly report covers progress satisfactorily but is not designed to provide information regarding such items as test piles, seal coats, triangulation and other important details in the normal progress of work. A special report should be made promptly on any feature that does not proceed satisfactorily or if any unusual or unexpected conditions or results are encountered. On structures of this type, there must be close contact among the District, Engineer of Construction and Engineer of Bridges and Structures. The latter two may readily interchange information received from the field but must receive close cooperation from the District.

505.08-9 Bearings and Anchorage (Correction for Temperature)

Correction for temperature should always be considered when setting rollers or rockers. In steel spans, changes in length due to temperature variations is critical. The amount of expansion or contraction allowed in a concrete or steel span is intended to account for the change in length that occurs due to variations in temperature. This amount is independent of any allowance necessary for movement in the substructure. The total expansion or contraction, due to temperature change, is calculated on the basis of a coefficient of expansion of 0.0000067 (0.00001206) per degree F (C) for both steel and concrete. For example, a rise of 8°F (4.44°C) lengthens a 100-ft (30.48-m) span by:

US Customary

$$8 \times 0.0000067 \times 100 \times 12 = 0.0643 \text{ in. (approximately } 1/16 \text{ in.)}$$

Metric

$$4.44 \times 0.00001206 \times 30.48 \times 1000 = 1.63 \text{ mm}$$

Similarly, a drop of 8°F (4.44°C) will shorten the same span a like amount.

The span length shown on the plans is the design length at 50°F (10°C). In setting anchor bolts, bearing plates, bed plates, pedestals, etc., which are in fixed positions with respect to the supporting masonry, it is necessary only to establish the correct span length at 50°F (10°C). This means applying a temperature correction to a steel tape, if one is used. The steel tape used shall be a calibrated tape.

Bearings must be positioned over the bearing lines as shown on the contract plans. This is accomplished at the time of erecting the span by adjusting the expansion bearings a distance determined by the difference between 50°F (10°C) and the existing air temperature. The most desirable time for setting or adjusting bearings is early in the morning. The temperature throughout the entire structure will be more uniform at this time than it will later in the day when the sun is higher, and part of the structure is in shadow. Longer spans have the potential for greater temperatures differentials throughout the structure.

Example 505-1

Suppose that pin rockers will be placed at the expansion of a 180-ft (54.86-m) steel span when the air temperature is 33°F (1°C). The shortening of the span is:

US Customary

$$50^{\circ}\text{F} - 33^{\circ}\text{F} = 17^{\circ}\text{F}$$

$$17 \times 0.0000067 \times 180 \times 12 = 0.246 \text{ in. } (\frac{1}{4} \text{ in.})$$

Metric

$$10^{\circ}\text{C} - 1^{\circ}\text{C} = 9^{\circ}\text{C}$$

$$9 \times 0.00001206 \times 54.86 \times 1000 = 5.92 \text{ mm (6 mm)}$$

Example 505-2

Bearings are to be adjusted under the expansion end of a 60-ft (18.29-m) reinforced concrete girder span when air temperature is 89°F (32°C). The temperature correction is:

US Customary

$$89^{\circ}\text{F} - 50^{\circ}\text{F} = 39^{\circ}\text{F}$$

$$39 \times 0.0000067 \times 60 \times 12 = 0.188 \text{ in. } (3/16 \text{ in.})$$

Metric

$$32^{\circ}\text{C} - 10^{\circ}\text{C} = 22^{\circ}\text{C}$$

$$22 \times 0.00001206 \times 18.29 \times 1000 = 4.85 \text{ mm (5 mm)}$$

505.08-10 Anchor Bolt Holes

In general, the Contractor for the substructure makes no provision for anchor bolts, simply bringing the bearing areas of the abutments, piers or bents to proper elevation; the superstructure Contractor will drill holes for anchor bolts at the proper locations. This is desirable because of variations from theoretical span lengths due to deflection in the abutments from backfill and other causes.

In locating the abutments, the assumed deflection is added to the span length on the plan as explained in the IDOT [Survey Manual](#).

505.08-11 Field Bolting

Bolts in continuous beams and girders shall not be tightened until the entire continuous length is in place on the substructure. Otherwise, excessive negative or positive fillets will result. Bolts shall be tightened in accordance with the ASTM *Specifications for Structural Joints Using High-Strength Bolts*. See Field Installation and Inspection of High Strength Bolts and Fasteners for Slip Critical Connections (Section 505.04) for details.

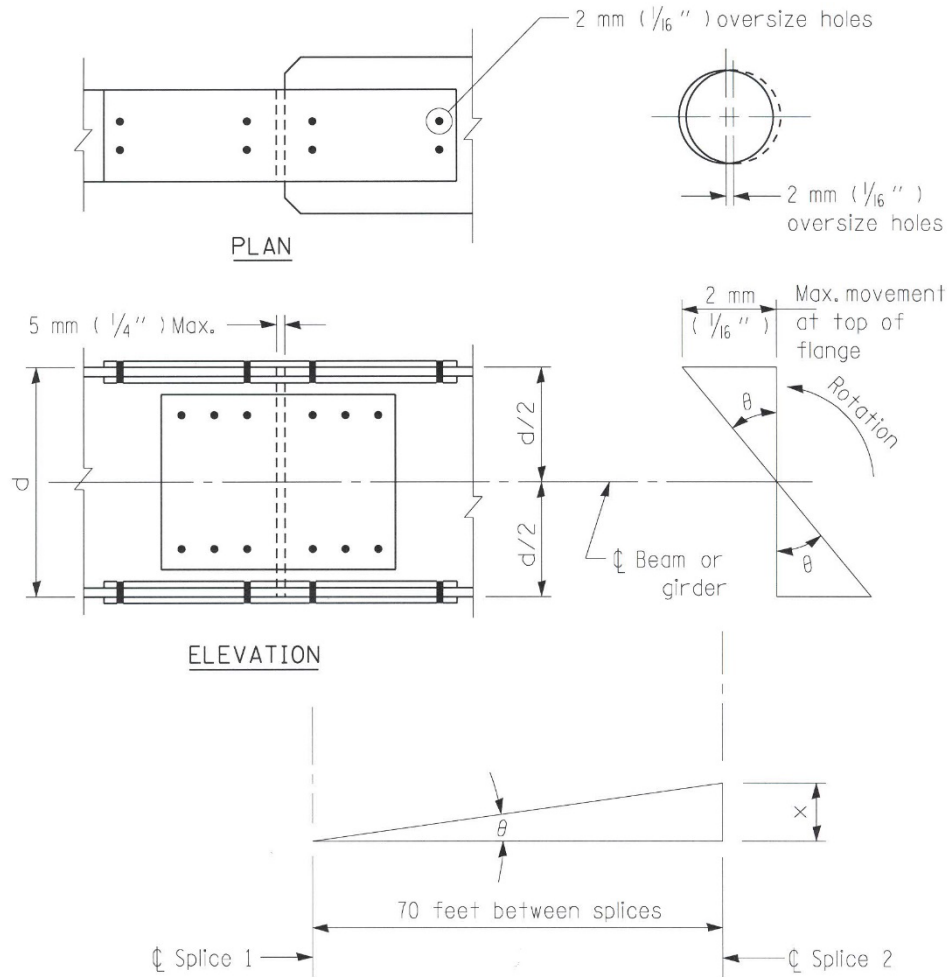
Make certain that all parts of the structure are properly aligned and that the structure is blocked up for the correct camber before tightening the bolts is started. It is possible for a structure to be distorted even though holes are well filled with bolts.

Standard practice in the fabrication of structural steel is to provide 1/16 in. (2 mm) oversize holes for bolts and 1/4 in. (5 mm) maximum spacing between adjoining webs. This allows possible rotation about the centerline of the beam or girder at the splice. The resulting small movement of the splice will cause a larger displacement at the opposite end of the member. The magnitudes of the displacement are illustrated in Figure 500-11.

If the bolts are torqued after the continuous length is in place, the desired result of design positive fillets is obtained. See Figure 500-12.

By torquing the bolts before the entire continuous length is in place, the undesired result of excessive positive and negative fillets will occur. See Figure 500-13.

Figure 500-11 — DISPLACEMENT OF ENDS OPPOSITE FROM SPLICES



d m (in.)	$d/2$ m (in.)	0.8 mm (1/32") Movement	1.6 mm (1/16") Movement
0.61 (24)	.30 (12)	56 (2.19)	111 (4.38)
0.76 (30)	.38 (15)	44 (1.75)	89 (3.5)
0.91 (36)	.46 (18)	37 (1.46)	74 (2.92)
1.07 (42)	.53 (21)	32 (1.25)	64 (2.5)
1.22 (48)	.61 (24)	28 (1.09)	56 (2.19)
1.37 (54)	.69 (27)	25 (0.97)	49 (1.94)
1.52 (60)	.76 (30)	22 (0.87)	44 (1.75)

Figure 500-12 — OBTAINING DESIRED DESIGN POSITIVE FILLETS

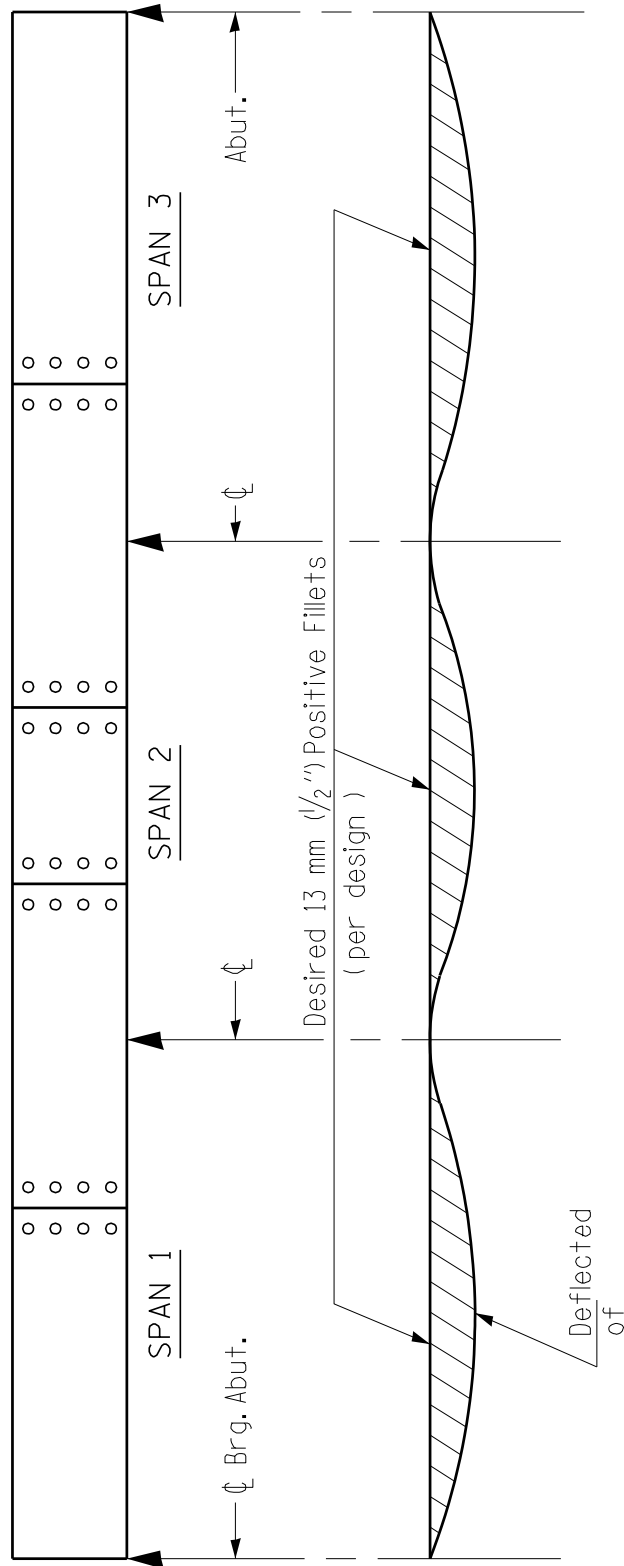
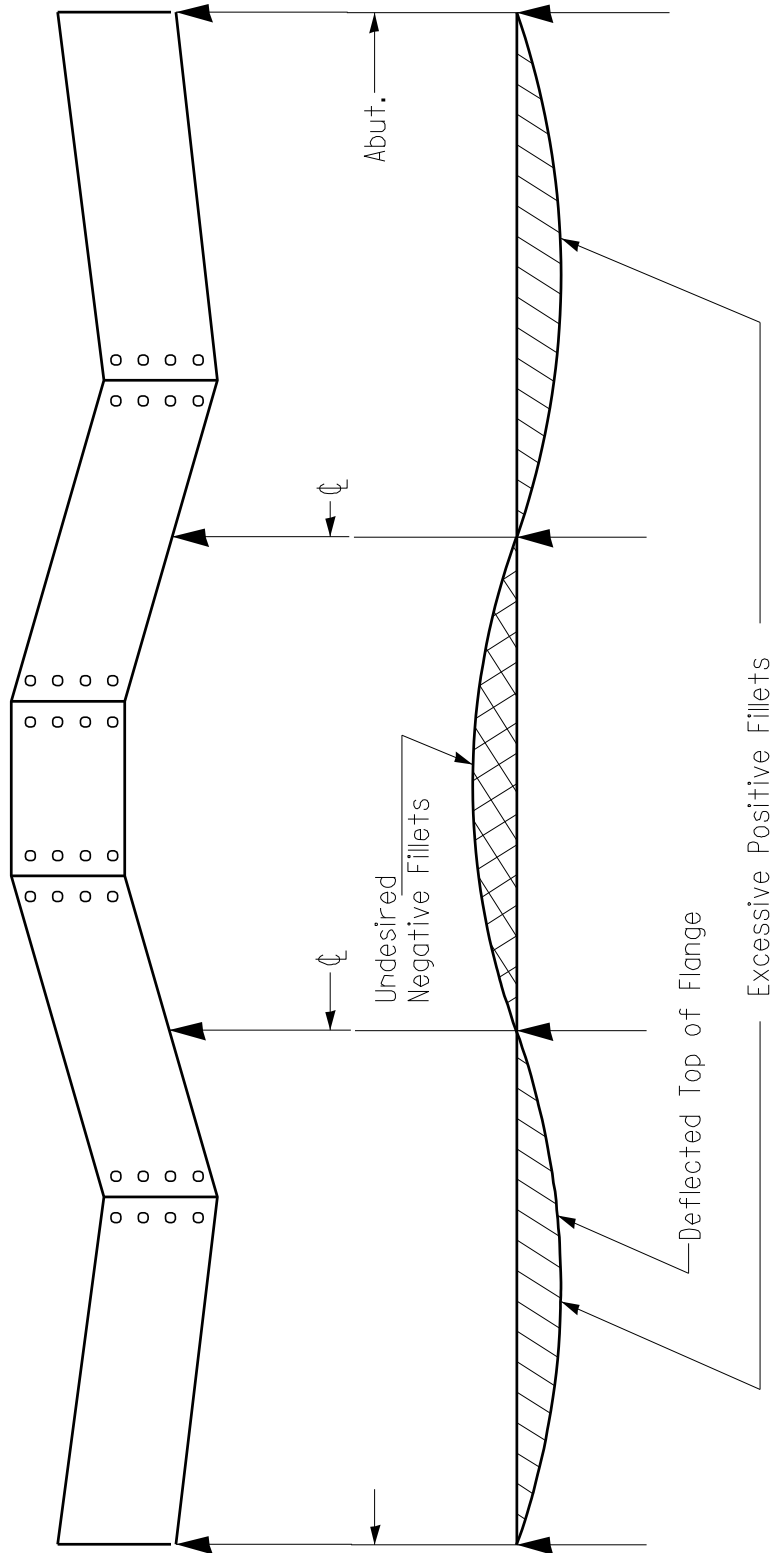


Figure 500-13 — UNDESIRABLE POSITIVE AND NEGATIVE FILLETS



SECTION 506. CLEANING AND PAINTING NEW STEEL STRUCTURES**506.02 MATERIALS****506.02-1 General**

Before starting work, the required submittal of the written description of the coating system and manufacturer's product information should be checked. Any discrepancies from these documents and the actual coating operations should be documented.

Upon arrival at the project site, it should be verified that the primer and paint materials are supplied from an approved lot. See the PPG. The materials used for intermediate and top coats must be supplied by the same manufacturer as the prime coat. Verify that each paint container is plainly marked with the correct paint type, color, number of gallons, lot number, batch number, date of manufacture and the name and address of the manufacturer.

BMPR is responsible for inspecting and accepting fabricated members and shop coats. Visually inspect the structural members upon delivery to ensure proper marking and that no damage has occurred during shipping and handling. Reject damaged materials that cannot be repaired and those materials that are not accompanied with the requisite documentation. Obtain from the Contractor the manufacturer's certifications, application and equipment recommendations and product safety data sheets.

506.02-2 Weathering Steel

Weathering steel will be designated with a "W" in its nomenclature in the contract documents, and it will have a set of specific requirements in the contract. Although weathering steel will not be painted, it must be properly cleaned to ensure that a uniform coat of rust will develop. The last 10 ft. on each side of a joint is typically painted.

506.10 FIELD CLEANING AND PAINTING NEW STRUCTURES**506.10-1 Protection**

Before painting begins, coordinate with the painting Subcontractor on the safety precautions that must be taken around the paint. Personal protective equipment such as goggles and face shields may be needed for some paints. Stains that contain solvents must be used in a well-ventilated area.

Also discuss with the Contractor how adjacent areas will be protected from paint spray and splashes. When painting near traffic, a means of protecting passing vehicles from airborne paint will be required.

506.10-2 Surface Preparation

It is not possible to obtain a good durable paint film that will protect and preserve the metal and also provide an attractive structure unless a thorough job of cleaning and preparation has been done. Imperfections, such as runs or sags in the shop coat, cannot be covered up with the field coats.

The surface should be prepared to meet the manufacturer's recommendations or the contract documents, whichever is more restrictive. Steel is normally cleaned of all dirt, grease, rust and mill scale by profile blasting in the fabricator's shop. Consult with the paint manufacturer's representative if unsure of what an acceptably prepared surface should look like.

After surface preparation, a coat of primer paint is promptly applied. The primer will serve as a rust inhibitor but is easily scarred during handling, transporting and erecting the steel. After the steel has been erected, the areas where the prime coat has been damaged or is otherwise defective should be cleaned and provided another coat of primer.

506.10-3 Painting

Ensure that all inspections of the fabrication have been completed prior to painting. It is good practice for the Contractor to start at the top of the structure and paint down. In this manner, any paint drippings can be removed prior to the application of paint. The paint should be applied so as not to show overlapping joints and so that all metal is covered.

After all necessary spot priming has been done and the primer has dried, the intermediate (first) field coat of paint may be applied. Before painting in the field, the surfaces must be dry. Morning dew and high humidity conditions must be avoided when painting. Wind will not only result in dirt and other undesirable material being blown onto fresh paint, but coverage may be uneven, or paint may be blown onto surfaces that are not intended to be painted.

Areas such as the edges of beams, bolt heads, etc., should be checked for compliance with the minimum thickness requirements in the *Standard Specifications*. These are the areas where the paint film is most likely to be thinnest.

506.10-4 Inspection Guidelines

The following should be emphasized:

1. Obtain and abide by the product safety information (MSS, etc.). Ensure that the necessary personal protective equipment and safety devices are available and being properly used.
2. If paint had not received prior approval, have samples been obtained by the Inspector, submitted to the BMPR and approved prior to use?
3. Has the paint been formulated and mixed in accordance with the *Standard Specifications* and the manufacturer's recommendations?
4. Has the surface to be painted been thoroughly cleaned of rust, loose mill scale, dirt, oil or grease and all foreign substances? Pay particular attention to the areas that must be hand cleaned to prevent surface damage, such as on bearing components and to slip-critical surfaces. Only as much surface should be cleaned in one day as can be painted on that day.
5. Is the metal dry and free of frost; are atmospheric conditions satisfactory?
6. Ensure that the weather conditions meet the manufacturer's recommendations or project contract specifications, whichever is more restrictive, as to surface temperature and dew point/temperature requirements.
7. Are proper precautions taken to protect both vehicular and pedestrian traffic?
8. Is paint being applied in a smooth and uniform manner so that no excess paint will collect at any point? After paint is applied, are there "runs" or "thin" areas? If runs occur, are they sanded out and the area repainted?
9. Has the paint thickness been checked?

SECTION 508. REINFORCEMENT BARS**508.05 PLACING AND SECURING****508.05-1 General**

Reinforcing steel is intended to accept and transfer the various forces of impact, shear and bending that are imposed on the concrete. Clearance from the forms, bar size, lapping details, type of bend specified, method of tying the steel and how the steel is supported are critical. If the bars are not set in the exact positions shown on the plans and then held securely in position while the concrete is being placed, the design allowable loading capability may not be attained. Forms must be oiled before reinforcing steel is placed so that no oil will contact the bars.

For reinforced concrete to work as intended, the reinforcing steel placed in a structure must be:

- The correct grade and type of steel
- The correct size, shape and length
- Placed in its specified location and spaced properly
- The required number of bars at each location
- Tied and spliced together properly
- Clean and has an adequate cover of concrete in all directions

For reinforcement bar tying, there are five types of ties:

- Snap or Single Tie – Used for flat horizontal reinforcement such as in slabs where the force from concrete placement will be minimal.
- Wrap and Snap Tie – Used for vertical reinforcement such as in walls.
- Saddle or “U” Tie – Used for vertical reinforcement such as in walls but is a stronger tie to allow climbing of the reinforcement.
- Wrap and Saddle Tie – Used in horizontal applications for heavy mats to be lifted by a crane or vertical applications where there is considerable strain on the tie.
- Figure Eight Tie – Interchangeable tie with the Wrap and Snap Tie or the Saddle Tie. This tie is good for holding perpendicular bars tightly together to prevent diagonal movement.

508.05-2 Rebar Cover and Clearance

Adequate clearance is needed between reinforcing bars so that all of the concrete mix can completely surround the bar. Where bars are spaced too close together, the following can occur:

- An air void can develop between the bars because there is not enough room for the concrete to flow between the bars. This void severely weakens reinforced concrete locally because there is no concrete bonded to the steel. The void also causes stress concentrations in the surrounding concrete because the concrete must transfer additional stresses that the void cannot.
- The area between the bars is filled only with mortar and is void of coarse aggregate.

508.05-3 Epoxy-Coated Reinforcement

When epoxy-coated steel reinforcement is specified, how the Contractor handles the bars should be observed. Article 508.05 of the *Standard Specifications* specifies how epoxy-coated steel reinforcement must be protected. Scratches, nicks and other marks must be limited. Do not allow the Contractor to mishandle the rebar with the intent of fixing any damage to epoxy coating later.

In addition, epoxy coated reinforcing steel must be covered to prevent ultra-violet (UV) damage. Examine the epoxy coating for damage (i.e., “nicks”) using the evaluation criteria and repair methods in Article 508.05.

508.06 SPLICING

Reinforcing steel is often specified in lengths that are too long for the steel to be delivered and placed as a single piece. The contract documents will designate the types of splices for each location.

508.06-1 Lap Splices

Lap splices are the most common type of splice. A sufficient lap length is needed to adequately transfer loads between the bars. Lap lengths can be longer than specified, but never shorter. Inadequate lap length can cause severe cracking in the concrete around the lap or even catastrophic failure, depending on location.

Reinforced concrete is typically its weakest around the lap splices in the primary reinforcement bars. For this reason, lap splices are placed where the stresses in a reinforced concrete section are the lowest. The Contractor must lap reinforcing steel only as specified. If the Contractor wishes to relocate a lap splice, the designer must approve the location change.

Lap splices can present problems with concrete cover and clearance between bars. Lap splices must have adequate concrete cover for corrosion protection. Ensure that the spacing between adjacent lap splices allows for the adequate flow of concrete between each splice. Sometimes, the lap splices in a group of bars are staggered to reduce congestion at the splice location.

508.06-2 Bar Splicer Assemblies

Bar splicer assemblies are typically used at stage construction joints.

508.06-3 Mechanical Splicers

Mechanical splicers are proprietary splicing mechanisms used to connect reinforcing bars. They are an effective means to reduce rebar congestion in highly reinforced areas for cast-in-place concrete. See Figure 500-14.

The contract documents will indicate if it is acceptable to use mechanical splicers. It is not acceptable to substitute lap splices where mechanical splicers are specified. The Inspector should have available the manufacturer’s recommendations on how to construct mechanical splicers.

Figure 500-14 — MECHANICAL SPLICER

When mechanical reinforcing bar splicers or couplers are allowed, they shall be one of the systems on the current approved list published by the Bureau of Materials. Installation procedures and equipment should be performed in accordance with the manufacturer's instructions. If test samples are fabricated, they shall be with the equipment, technique and conditions representative of the job site.

508.06-4 Reinforcing Steel Inspection

The start of concrete placement operations on any portion of the structure should not be permitted until all steel reinforcement has been checked for conformance with the contract documents. Spot check the following:

- Bar sizes, number of bars per location, and grades
- Concrete cover and bar clearances
- Bar spacing, lengths and ties
- Bar splices
- Height of supports
- Epoxy not scraped off
- Bars free of impurities
- Proper lap lengths for hoops, spirals and straight bars
- Overall length and width
- Stiffness and stability for lifting

This inspection cannot be made in a few minutes and it cannot be properly made until all of the steel is in place. Therefore, the Contractor must allow sufficient time for this check to be made when planning the start of concrete placement. It is good practice to check ties as they proceed across the bridge deck.

SECTION 509. METAL RAILINGS

509.02 MATERIALS

The acceptance of material is accomplished according to the PPG and the receipt of the manufacturer's certifications and mill test reports. The Contractor must provide mill test reports to track heat numbers and to ensure compliance of material grade, origin and chemical and physical properties.

The following provides guidelines for the evaluation of steel bridge rail system components:

1. Galvanization. Check steel rail sections and posts for damage to the galvanization, especially areas where the materials have been stockpiled, and for evidence of being cut or drilled in the field. Require field repairs or replacement based on the extent of the missing coating.
2. Rail Sections. Check for visual defects such as burrs, twists, bends, misaligned holes and uncoated areas. Verify that the sections are of the type, shape, length and curvature required. Require replacement of damaged sections.
3. Steel Posts. Check for visual defects such as bends, twists, uncoated areas, misaligned holes and damaged ends. Verify that the posts are of the proper type and weight for the system to be installed. Check the length, cross-sectional dimensions, hole diameter and template for compliance.
4. Fastener Hardware. Check compliance of fastener type, class, diameter and length. Ensure that the correct fasteners are being supplied with the proper system. Do not permit the cutting of bolts.

509.04 SHOP DRAWINGS

The shop drawings must include, but are not limited to:

- Drawings showing dimensions, steel grade and other pertinent information for rail sections, posts, anchors, bolts and all other hardware required for the installation
- A complete set of installation instructions
- Manufacturer's certification that the system meets the requirements of [NCHRP 350](#) and the AASHTO Manual on Assessing Safety Hardware (MASH) for the intended application of the system

509.05 STEEL RAILINGS

509.05-1 Rail Alignment

The positions of the posts for steel bridge rail are of special importance, because the slots in the beams must be centered on the posts so that the plates may expand and contract without loosening the posts. Rail elements should be assembled to present a smooth, continuous appearance with the top of the rail being in near perfect alignment horizontally and vertically with the roadway. There should be no noticeable sags or humps. The Inspector should ensure that the rail sections are lapped in the direction of travel (i.e., upstream section laps over downstream section).

509.05-2 Bolt Holes in Field

The Department prohibits the use of a cutting torch for making bolt holes. Heat may weaken the metal around the hole so that the bolt head may pull out under the force of impact. Drilling or punching are the only acceptable methods of making bolt holes in the field. The Inspector should ensure that warping of the metal plates does not occur when the Contractor punches the bolt holes.

SECTION 512. PILING

512.01 DESCRIPTION

The following should be reviewed:

- [Construction Inspector's Checklist for Piling](#)
- IDOT "[Pile Foundation Construction Inspection, S19, Class Reference Guide](#)," Specific Task Training Program (STTP)
- IDOT [Project Procedures Guide](#)
- Appendix F from the IDOT *Documentation of Contract Quantities*

512.02 MATERIALS

512.02-1 General

See the PPG for evidence of inspection. A review of the piling documents and a visual inspection of the piles should be performed to ensure that the piling has not been damaged in transit or during handling.

512.02-2 Pile Inspection

See the [STTP Piling Guide](#), the Construction Inspector's Checklist for Piling and the PPG. In addition, the following must be inspected at the job site for all steel piling for:

- Compliance with key dimensional requirements (e.g., thickness, length, width, diameter, section shape);

- The pile labeling (e.g., size, length, grade, weight/foot, heat number) to ensure that it matches the certifications;
- Any bent, deformed or kinked areas on the steel piling; and
- The pile lengths and conical driving points for pipe piling, or cutting shoes for H-piling, for conformance to the contract documents.

512.07 WELDING (SPLICES)

Pile driving Contractors typically order their pile lengths and plan their pile driving sequence to minimize the amount of splicing required. If splicing becomes necessary, it is acceptable to drill “handling holes” for raising and holding the add-on section in position during welding. However, flame cutting of handling holes is not permitted. See the STTP Piling Guide for pile splices and the Construction Inspector’s Checklist for Piling for additional direction and information.

All welders shall produce evidence of prequalification to perform the intended welding. The evidence should be appropriate for both the type of process (e.g., fillet) and weld position (e.g., horizontal, vertical or overhead) to be performed. 512.08 Storage and Handling of Piles

512.08-1 Precast and Precast, Prestressed Concrete Piles

The *Specifications* stress the importance of handling concrete piles with care. Cracks can be caused by indifferent handling. Mishandling can cause cracks that not only may open up under driving but may even spall and “powder” sufficiently to seriously lessen the strength or life of the pile. Shock, vibration or excessive deflection must be avoided. When piles are picked up with adjustable slings, blocking should be used to prevent breaking off corners of the pile. The pick-up points should be plainly marked on all piles before removal from the casting bed, and all lifting shall be done at these points. All piles must be wetted at least six hours before being driven and shall remain moist until driven.

512.08-2 Steel Piles

In loading steel piles at the fabricator’s plant, the webs of each pile must be placed vertical and blocked so that the flanges will not be bent, nor permanent bends caused in the piles by lack of support. The Department’s Inspector at the fabricator’s plant checks the loading into freight cars, but the Inspector at the jobsite must check the piling for damage upon arrival.

512.09 PREPARATION FOR DRIVING

In addition to the following guidance, see the STTP Piling Guide and the Construction Inspector’s Checklist for Piling for additional direction and information.

512.09-1 General

Before the start of pile driving operations, the Resident and/or the pile Inspector must review the plans and *Standard Specifications* and the Construction Inspector’s Checklist for Piling. If anything appears unclear or contradictory between the plans and *Standard Specifications*, the Supervising Engineer should be notified, and the matter resolved before the Contractor starts work. See also the STTP Piling Guide.

512.09-2 Inspector's Preparation

Before pile driving begins, the following preparations should have been conducted. In addition to the following guidance, see the STTP Piling Guide.

512.09-2(a) Safety

Pile driving is a noisy, dangerous activity. See the STTP Piling Guide for safety guidance. In addition, Inspectors must adhere to proper safety and common-sense precautions, including:

- Wear a hard hat, steel-toed boots and a safety vest
- Use ear plugs and/or ear muffs
- Dress for the weather
- Wear clothes that are expendable
- Keep a safe distance from anything that can fall on you

512.09-2(b) Marking the Piles

To keep accurate records on driven piles, the furnished piles should be marked before driving, including:

- Identify which piles and lengths will be driven
- Locate the pile end with the cutting shoe or driving point. This will be the “zero” end
- Mark each pile in 1-ft (300-mm) increments
- Write the cumulative length on each pile every 5 ft. (1.5 m)
- Mark the splice section with continuation numbers after the welded end has been identified
- Mark the pile with its pile number

512.09-2(c) Recording Devices and Tools

The proper tools to inspect the pile driving operation and record the necessary data should be available. These include:

- Measuring tape (dual-unit tapes are useful)
- Level
- Watch
- Soapstone/paint
- Contract documents
- See Production Pile Driving Data ([Form BBS 2184](#))
- Hammer chart (from the Contractor) for additional direction and information
- Saximeter (see Figure 500-15)

The STTP Piling Guide discusses more advanced inspection tools (e.g., Saximeter, Pile Driving Analyzer (PDA)).

This is also an ideal time to set up the field pile driving record book or other means of recording the pile driving data that will be forwarded to the Bureau of Bridges and Structures at the end of the job and to compute the required blow per inch (25 mm) for the hammer that will be used to obtain 110% of plan bearing on the test pile and plan bearing on the vertical and battered pile.

Figure 500-15 — SAXIMETER**512.09-3 Excavation/Embankment**

Before driving the production piles, the excavation or embankment in the immediate area of the piling must be complete. Although the area only has to be within 2 ft. (600 mm) before driving the test pile, the remainder of the preparation must be completed before starting the remaining piles. The plans should be checked again to ensure that any precoring is correctly performed to the depths indicated and check the minimum elevations for the pile tips shown on the plans.

512.09-4 Pile Driving Hammer

The Contractor shall provide the Resident with the make and model of the hammer. The hammer should be checked for compliance with the energy requirements for the nominal required bearing of the pile being driven as required in Article 512.10.

512.09-5 Location and Alignment

Ensure that the bottom of the footing has been excavated to plan grade. A reference must be set in a convenient, yet safe, location to check cut-off elevation. Check pile layout immediately prior to driving. Check pre-bore holes, if required, for proper depth and diameter. The depth when measured with a weighted tape should equal that shown on the plans within a few tenths of a foot.

Check the position of the pile prior to driving. The tip must be at the proper location and in the correct alignment. Check vertical piles for alignment by sighting along a plumb bob string.

Check the alignment periodically and most frequently during the first part of driving while correction is possible. Steel piling should be inspected for damage that may have occurred during driving operations before placing the concrete caps.

The Contractor must have a strategy to keep the piles in alignment and within tolerances. In many cases, the Contractor may use a pile template to assist in proper location and alignment. As needed, the Contractor should be allowed to:

- Brace the pile template
- Drive other (smaller) piles to secure the template
- Move boulders to an out-of-the-way location

Also, see the STTP Piling Guide.

512.09-6 Nominal Driven Bearing

The nominal driven bearing (R_{NDB}) is 10% higher than the actual anticipated load (i.e., the nominal required bearing (R_N)) that will be applied to the pile. This higher value is to account for uncertainty in both the loading and the soil properties.

512.09-7 Pile Tip Elevation

There must be a plan to determine if the pile has been driven to the pile tip elevation, if specified in the contract documents. If the Contractor has not driven the furnished pile length (minus the embedment shown on the plans), the pile tip, may not be at the design tip elevation.

512.10 DRIVING EQUIPMENT

512.10-1 Evaluation of Pile Driving Equipment

The pile-driving equipment should be checked as soon as the Contractor delivers it to the job. The pile driving foreperson should ensure that:

- The Department has approved the equipment; i.e., the equipment meets the requirements of the job
- The leads are sturdy, smooth and straight
- The hammer falls freely in the leads
- The blocks in the driving head of the hammer are not badly worn

Driving can be suspended at any time it is necessary to re-position the pile, to cut-off a deformed head, to align the hammer and leads with the pile, and to brace or guy the leads to properly support the pile. The Contractor must not use excessive force to pull a deeply driven

pile back into position. Driving should be suspended if the hammer is not operating up to specified energy levels during final stages of driving.

Every pile will drive somewhat differently. It is not possible to address every situation that can develop or to write instructions to cover every possible situation. This is why experience and judgment are so important. The best advice is to ask for help if the Inspector encounters an unfamiliar pile-driving situation.

512.10-2 Pile Driving Equipment

See the STTP Piling Guide and the Construction Inspector's Checklist for Piling for additional direction and information. Document the Pile Driving Equipment Data on [Form BBS 136](#).

512.10-2(a) Gravity (Drop) Hammer

A gravity hammer cannot be considered for driving precast piles or piles with a nominal required bearing (R_N) greater than 120 kips (533 kN). In selecting a gravity hammer, the ram weight (mass) must be equal to or exceed the combined weight (mass) of the pile being driven and the drive head. A gravity hammer uses a falling weight. Gravity hammers are guided in their fall by riding in a set of leads. Powered by a hoisting engine having a friction clutch, the drop hammer is raised by an attached hoist line to the desired height. The engine is declutched, allowing the drop hammer to free-fall as the hoist line plays out.

The short-time duration forces exerted directly upon the head of a pile by a gravity hammer would destroy it. The pile head is thus always protected with a pile cap, which the drop hammer strikes. The pile cap rests directly upon the pile head and descends with the pile upon each blow. When the pile has been driven, the cap is attached to the hammer and lifted with the hammer to set upon the next pile.

Remember, no drop can exceed 15 ft (4.6 m), especially with the heavier hammers, because this may injure the pile. A greater penetration per blow with less injury to the pile head will usually be produced with a heavy hammer and a low fall than with a light hammer and a high fall. In either case, the theoretical amount of energy expended may be the same. With a low fall, more blows can be struck in the same time, and there is less chance for the soil to compact around the pile between the blows. Where hard driving is encountered, it may be necessary to reduce the length of the stroke to avoid injury to the pile.

512.10-2(b) Air/Steam Hammers

Consideration must be given to the weight of the pile in determining hammer size for this type hammer. The striking parts of the hammer must be at least one-third of the weight (mass) of the pile and drive cap combined, and in no case less than 1.4 tons (1.3 metric tons).

512.10-2(c) Leads

Ordinarily, the Contractor will use swing leads for driving piles. This is permitted by the *Standard Specifications*, provided that sufficient guy ropes are used to hold the leads steadily in place and the that toe of the leads is set securely in the ground. It is necessary that the leads

be tied rigidly enough to guide and hold the pile in correct position. This is especially important in difficult driving.

512.10-2(d) Caps and Collars

It is advisable to provide extra pile cushions and shock blocks so that they may be quickly replaced when damaged.

512.10-2(e) Followers

Rarely is it necessary to use a follower when driving piles. If the Contractor wants to use a follower, he must receive permission. One pile in each group of 10 must be driven without a follower, and the nominal driven bearing of all piles in the group must be determined from that one pile. The piles driven with the follower should be driven to the penetration found to be required for the pile on which the nominal driven bearing was determined without the follower.

A follower, as the term is used in this Article, is a length of pile, timber or other special material placed on top of the pile to be driven so that the driving can be performed from a higher elevation.

512.10-2(f) Jets

An experienced operator should be able to secure satisfactory alignment of the pile by using only one jet. If this cannot be done, two jets may be necessary.

The pump serving the jet should have plenty of capacity at a moderate pressure. The volume and pressure must be sufficient to erode freely the material adjacent to the pile. The volume of water is more important than pressure, except for penetration of gravel where both volume and pressure are necessary. For jetted piles, the formula for capacity will be applied after the jet is removed and driving is resumed.

512.10-3 Hammer Energy Requirements

In addition to the following guidance, see the STTP Piling Guide and the Construction Inspector's Checklist for Piling for additional direction and information.

512.10-3(a) General

The hammer must meet the energy requirements of the *Standard Specifications*. Regardless of the type of hammer or type of pile, the energy requirement remains the same. The hammer must develop enough energy to drive the pile to a nominal driven bearing (R_{NDB}) equal to or greater than the nominal required bearing (R_N) shown on the plans at a penetration rate of between two and ten blows per inch (blows per 25 mm).

512.10-3(b) Check Procedure

The typical procedure that should be followed to check for hammer compliance and set up charts for nominal driven bearing for use in the field is:

1. The Contractor provides hammer specification sheets for the hammer chosen.
2. Compute the minimum and maximum energies to drive the piles at penetration rates of between 2 and 10 blows per inch.
3. Verify that the hammer selected by the Contractor can operate between those rates.
4. Develop a chart showing the relationship between various hammer energies and penetration rate.
5. Drive the piles to the point where the rate of penetration at the energy developed by the hammer equals or exceeds the nominal required bearing shown on the plans.
6. Record the rate of penetration, energy developed by the hammer at bearing and the nominal driven bearing (R_{NDB}) on the record for that pile.

512.10-3(c) Hammer Energy Equations

The formulas to check for this are:

Minimum:

$$E \geq \frac{32.90 R_N}{F_{\text{eff}}} \quad (\text{US Customary})$$

$$E \geq \frac{10.00 R_N}{F_{\text{eff}}} \quad (\text{Metric})$$

Maximum:

$$E \geq \frac{65.80 R_N}{F_{\text{eff}}} \quad (\text{US Customary})$$

$$E \geq \frac{20.00 R_N}{F_{\text{eff}}} \quad (\text{Metric})$$

Where:

R_N = Nominal required bearing in kips (kN)

E = Energy developed by the hammer per blow in ft-lb (J)

F_{eff} = Hammer efficiency factor in Article 512.14 of *Standard Specifications*

Once the hammer is delivered and is being used, check to ensure that the required energy is actually being developed as the pile approaches bearing. The delivered energy of the hammer, regardless of the type selected is critical in determining that the pile has achieved a nominal driven bearing at least as great as the nominal required bearing. Consequently, either the hammer fall or correctly correlated gages must be properly functioning and monitored during the pile driving operation.

512.10-4 Loss Due to Impact

The successful driving of a pile is dependent upon the weight of the ram with respect to the weight of the pile and the velocity of the ram at the moment of impact with the pile. The driving energy of pile hammers is expressed in foot-pounds (joules) of energy per blow. The blow should be struck by a ram possessing, not only sufficient energy to overcome the inertia of the

pile and the frictional and elastic resistance encountered, but also sufficient weight to reduce to a minimum the portion of this energy that is unavoidably dissipated during impact.

A considerable amount of the energy of the blow is lost during the impaction period. The percentage of loss depends primarily upon the ratio of the mass (weight) of the pile to the mass (weight) of the striking parts. To a lesser degree, the pile material is involved. Assuming that the pile material is inelastic (which is not strictly true), this loss of energy is about 50% when the ratio of the pile mass (weight) to ram mass (weight) is unity. As this ratio increases, the loss becomes greater. The magnitude of this loss becomes so serious as the ratio increases that it is important to keep the ratio as low as possible. Some manufacturers do not recommend the use of a hammer having a ram weighing less than one-fourth the mass (weight) of the pile.

In addition to the energy requirements of the hammer, some situations require additional considerations in selecting the hammer.

512.10-5 Steel H-Piles Driven to Hard Rock

When steel H-piles are driven to hard rock, care must be taken to avoid damaging the tip of the pile. If it is observed that the penetration resistance and hammer energy has abruptly increased, the Contractor should reduce the energy developed by the hammer, and the penetration increment can be calculated over a reduced increment (less than 1 in. (25 mm)) when determining the nominal driven bearing to ensure that the pile obtains the nominal required bearing without sustaining damage.

512.11 PENETRATION OF PILES

In addition to the following guidance, see the STTP Piling Guide and the Construction Inspector's Checklist for Piling for additional direction and information.

512.11-1 Records of Penetration

An accurate and complete record should be kept of the penetration and bearing data for all piles driven. This record must include a diagram of the location of piles in each foundation and a tabulation of the initial length, cutoff, length left in place of each pile and heat number of each steel pile. The final pile penetration rate (N_b) in blows per inch (25 mm), blows per minute, make and model of hammer used, energy developed by the hammer and nominal driven bearing must be recorded. Unless shown on the plans, foundation piles shall be driven to a penetration of at least 10 ft (3 m) below bottom of footing and other piles to a penetration of at least 10 ft (3 m) below undisturbed earth.

Complete and send the test and production piling diagrams and data to the District Office when pile driving is completed. Use [Form BBS 757: Test Pile Driving Record](#) and [Form BBS 2184: Production Pile Driving Data](#). See the IDOT *Documentation of Contract Quantities* for examples on completed Forms BBS 757 and 2184 (Section F "Documentation Examples," pp. F-58 to F-60). They will be filed as a part of the permanent record on the job and remain with the Bureau of Bridges and Structures records plus other data for the structure.

It is recommended to calculate the number of blows per inch (25 mm) for several hammer energy levels near the nominal required bearing (R_N) in advance of the pile driving operation.

The nominal driven bearing (R_{NDB}) will then be known as driving progresses and may quickly determine when the pile has reached its required bearing.

By keeping complete records for driving test piles, the length of piles ordered and the driving of production piles, including pile diagrams, all information needed to determine the payment due the Contractor for furnishing and driving piles will be available.

512.11-2 Excess Penetration

When the pile has attained the required penetration and nominal driven bearing, the Contractor is not required to continue driving unless stated in the contract documents.

512.13 CUTOFFS

See the STTP Piling Guide and the Construction Inspector's Checklist for Piling for additional direction and information.

Piling groups are to be cut in a true plane as indicated on the plans. Accepted driven piles must be cut off square, de-burred and de-slugged before the concrete cap is placed. This is usually at right angles to the vertical axis of the pile. Proper cutoff is especially critical. The cap must bear fully on the piling. Record the cut-off length for computation of driven length. Do not allow the Contractor to cut off piles until acceptance is received from the BBS.

512.14 DETERMINATION OF NOMINAL DRIVEN BEARING

512.14-1 Formulas

The *Standard Specifications* (Article 512.14) provide the required formula for determining nominal driven bearing (R_{NDB}) based on the WSDOT equations. See the typical bearing computations for vertical and battered pile in the attached examples.

512.14-2 Wave Equation

A Wave equation analysis is required to determine the nominal driven bearing of more heavily loaded piles. When this analysis is required, the Bureau of Bridges and Structures must be contacted to perform the analysis. See the STTP Piling Guide for more discussion.

512.14-3 Load Tests

Load tests are the most accurate method of determining the ultimate axial resistance or nominal driven bearing of piles. This test is used when the structure is complex or when a large number of foundation piles are required. If a load test is required by the contract documents, discuss the matter thoroughly with the Supervisor. The procedure will be governed by the contract requirements.

512.15 TEST PILES

See the STTP Piling Guide and the Construction Inspector's Checklist for Piling for additional direction and information.

The Department uses test pile information to set the length of production piles so that sufficient load-carrying capacity will be attained. The Contractor must take special measures in driving test piles. The Contractor must excavate the area to the bottom of cap, seal or footing plan grade and perform any specified pre-bore. The equipment used must be the same as will be used for service piles. The Contractor must drive test piles in as continuous an operation as possible.

The location of the test pile will be specified in the plans to be driven in a production location of a designated substructure unit. However, the Engineer may have to select which individual pile location shall be used as the test pile. The test pile location should be as far away from the nearest soil boring location as possible to obtain more comprehensive subsoil data in the area of the structure.

If the Contractor elects to drive the test pile out of the footing area or in a non-permanent location, written permission of the Engineer is required, and the replacement of the production pile in the footing area will not be paid for. Where treated timber piles are specified, test piles not driven in a production location or driven outside the footing area may be untreated piles with the written permission of the Engineer.

In driving a test pile, maintain a complete record of the driving data all the way down and report on [Form BBS 757: Test Pile Driving Record](#). In doing this, the driving may be delayed somewhat, but a test pile is driven to help determine the itemized list of lengths to be furnished by the Contractor. This is also the final check on the accuracy of the subsurface information upon which the estimated lengths of piling shown in the plans was based.

SECTION 515. NAME PLATES

The date on the name plate will be the year the plate is installed.

SECTION 516. DRILLED SHAFTS

See the *Drilled Shaft Foundation Construction Inspection, S32, Class Reference Guide*, Specific Task Training Program, which is provided in Appendix 500.B.

SECTION 520. BRIDGE EXPANSION JOINTS

520.01 DESCRIPTION

Expansion joints may be located between abutments and bridge superstructures; between two sections of a long bridge superstructure; between bridge decks and approach slabs; and between approach slabs and abutments. The expansion joint allows movement between adjacent structures or between different members within a structure. This movement prevents stress build-up due to creep, shrinkage or temperature changes that would seriously crack the structure. They are also designed to keep out water and prevent debris from falling into the joint.

The following inspection checks are important to ensure long-lasting deck joints:

- A long-lasting joint is a smooth joint. Ensure that the steel expansion angles on each side of the joint are correctly recessed so that no bump or dip will occur as vehicles pass over the joint (concrete grinding should be done to improve the smoothness).

- Ensure that the Contractor achieves good consolidation of the concrete under the expansion angles.
- Ensure that bolts in the erection angle are loosened after the concrete has set to allow movement.

520.04 JOINT OPENING

Expansion joints create a small gap between two structures or structural members that allow for movement. The following must be checked:

- The joint is in the correct location and runs the full depth and length required by the contract documents (the joint must completely separate the two structures or structural elements).
- The gap is set at the correct width.
- There are no obstructions or connections between the two structures (rebar, conduit, utility lines or loose concrete) that would interfere with the opening and closing of the joint.

SECTION 542. PIPE CULVERTS

See the [Construction Inspector's Checklist for Pipe Culverts](#) for additional direction and information.

542.02 MATERIALS

542.02-1 General

Upon arrival at the construction site, the documents should be checked to ensure the delivery of the correct item and to assess the condition of the product. A visual inspection should be performed upon delivery to ensure that the pipe sections have not been damaged in transit or during handling. The Contractor should carefully unload, store and handle all pipe sections. Careful handling of coated pipe is necessary to keep coating scars, chips, cracks and repairs to a minimum. In addition to the PPG, the following should be checked:

- Correct diameter and correct material specifications
- Any spalls, dents or chips in each pipe segment
- Cracks both on the interior and exterior of the pipe
- A fabrication date stamped on precast concrete pipe
- Proper documentation for the pipe, gaskets, banding material and hardware
- Damage to polymeric or asphalt coating

542.02-2 Corrugated Steel Pipe

Upon delivery to the project, each pipe section should be checked to ensure that it is stamped with the same heat number and wall thickness that was listed on the inspection report. See the PPG. Compare the size, length of pipe and wall thickness for each location against the contract documents, the pipe list and the manufacturer's shipping list. If discrepancies are found, reject

the pipe. Manufacturers sometimes convert shell thickness to in. (mm) rather than gage. If a pipe is stamped with the gage rather than the thickness, a conversion to thickness will be necessary to check the pipe for acceptance; this conversion table must accompany the mill test reports/certifications.

If minor dents in corrugated metal pipe can be pounded back into shape without damaging the pipes protective coating, the pipe section may be acceptable for use and payment. However, if the coating has been rubbed off or cracked, or if the dent is too large, the pipe will rust easily and must be replaced.

542.02-3 Reinforced Concrete Pipe (RCP)

When precast pipe arrives at the project site, the casting dates from each pipe joint should be obtained, and it should be determined if the supplier is a certified or non-certified plant. See the PPG. If the supplier is a certified plant, it must be verified that the plant was certified at the time of production. If the supplier is a non-certified plant, inform BMPR of the casting dates. BMPR will verify that the precasting plant was inspected and that materials used for the pipe were tested on those casting dates. Pipe that was made during days where the required plant inspection and testing were not performed due to the plant's failure to properly notify the Department is unacceptable and will be rejected.

See the BMPR Policy Memorandum "[Quality Control/Quality Assurance Program for Precast Concrete Products](#)" for additional direction and information.

542.04 METHOD I CONSTRUCTION

542.04-1 Description

Pipe culverts shall be installed by either Method I, Method II or Method III. Unless otherwise specified, pipe culverts (except private entrances) will be installed by Method I. Familiarization with the *Standard Specifications* to understand the different methods of installation is essential. Proper supervision and inspection must be provided for each culvert location to ensure its proper placement.

In the Method I installation, the diameter of the pipe plus the specified width on each side of the pipe is necessary, and strict enforcement of the width of trench should be required at all times. After the trench has been excavated to the proper width and depth, a cushion of not less than 4 in. (100 mm) of fine aggregate shall be placed in the bottom of the trench and compacted for the pipe bedding. Ensure that the fine aggregate cushion is shaped to provide uniform pipe support. When bell or hub pipe is used, a depression should be made to accommodate the bell or hub.

The pipe shall be laid starting at the downstream end and worked toward the upstream end. After the pipe is installed, fine aggregate shall be placed uniformly on both sides of the pipe in uniform 8 in. (200 mm) layers and mechanically compacted except for the ends; 3 ft (1 m) of impervious material should be placed in this area to prevent erosion and water from entering around the pipe.

Close inspection is necessary when starting the backfill to ensure that the haunches under the pipe are properly filled and compacted. Layers of aggregate shall be continued to the midpoint of the pipe. Above the midpoint, select material obtained from within the right-of-way shall be placed in additional uniform 8 in. (200 mm) layers to at least 1 ft (300 mm) above the culvert and compacted. Aggregate may be used above the midpoint at the Contractor's expense. If aggregate is used, 3 ft (1 m) of impervious material must be placed at each end of the culvert.

On Method I fill installation, placing a portion of the embankment before excavating the trench is sometimes required. Ensure that at least the minimum embankment width and height for the pipe size and select material for the fill is obtained. The required density must be obtained in the embankment before the trench is excavated.

542.04-2 Planning Before Installation

Each proposed pipe installation should be carefully reviewed to ensure that the planned location, skew angle and length are proper to meet the configuration of the street or roadway. The skew angle should be checked to ensure that the angle matches the existing channel. If it does not, the designer should be contacted to ensure that the plans are correct. The grade of the channel, both upstream and downstream from the pipe, should be checked to determine the proper elevation for each end of the pipe. The Contractor should recheck the length of each pipe run before installation. Identify any significant changes needed for pipe lengths, grades and/or elevations and discuss these with the designer before installation.

Other factors the Contractor needs to consider before installation include:

- Marking and protection of all existing underground utilities and structures. Contact JULIE.
- OSHA safety requirements for trenching and confined space entry, including preparation of a shoring plan (if required), plus excavation edge protection and safety fence (see Section 208)
- Notification of utility companies affected by trenching and pipe installation, including coordination for possible shutdowns or temporary interruptions
- Securing any necessary local permits
- Locations of benchmarks and other survey monuments

These items should be documented, and any changes or corrective actions taken should be identified.

542.04-3 Preliminary Pipe Staking

If the contract documents require that the Contractor stake the pipes, the Contractor must provide the Resident with a complete set of staking notes before pipe installation. Pipes should be staked, and the staking information clearly shown in the pipe notes and on the stakes so that there will be no miscommunication during installation.

The staked length of a pipe must fit the slope. The location should be discussed with the Contractor if the Department is responsible for the staking. An offset hub is to be set at each end of the culvert centerline and at a sufficient distance beyond the construction limits to prevent their disturbance. A guard stake placed over each hub should show the cut or fill to the invert elevation for metal pipe and invert elevation minus the shell thickness for concrete pipe plus the distance offset from the end of the culvert. Other information relative to the length, type and size of pipe needed for installation may also be shown on the guard stakes.

Location cross sections that are used in the design of drainage installations may not have been taken at the planned station, nor will the planned station always fit the drainage condition.

542.04-4 Staking Inspection

542.04-4(a) Invert Elevation (Flow Line)

The invert elevation (i.e., elevation of the inside bottom of the pipe) is the same as the flow line. This can be easily checked with an optical level. Hubs and guard stakes, offset from the pipe ends, will be marked either cut or fill in relation to the invert elevation or pipe bed elevation. The stakes should always show which elevation the cut or fill is referring to. See Figure 500-16.

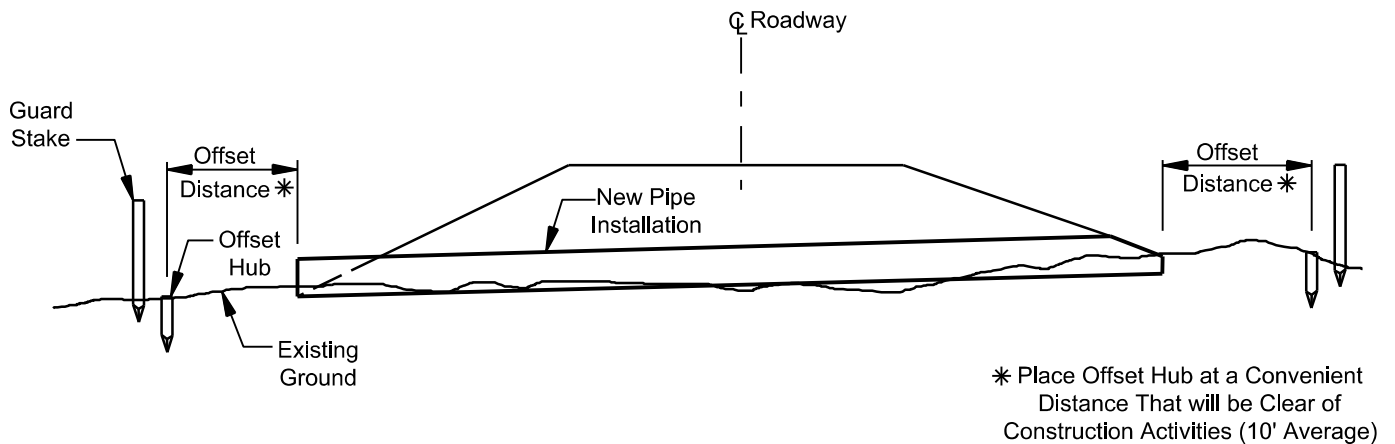
542.04-4(b) Slope (Gradient)

The slope of the culvert is the ratio of its drop-in elevation to its length. For example, if a 200-ft long culvert has an inlet invert elevation of approximately 650 ft. and an outlet invert elevation of 2 ft. less, the slope or gradient would be 2.0 ft. per 200 ft. or 1 ft. per 100 ft., which could also be expressed as a 1% drop, 1% grade or 1% slope. Ordinarily, the most desirable slope is the slope of the channel that the pipe replaces; however, in many cases, this will not be practical, because construction may cause the channel length, invert elevation or both to change.

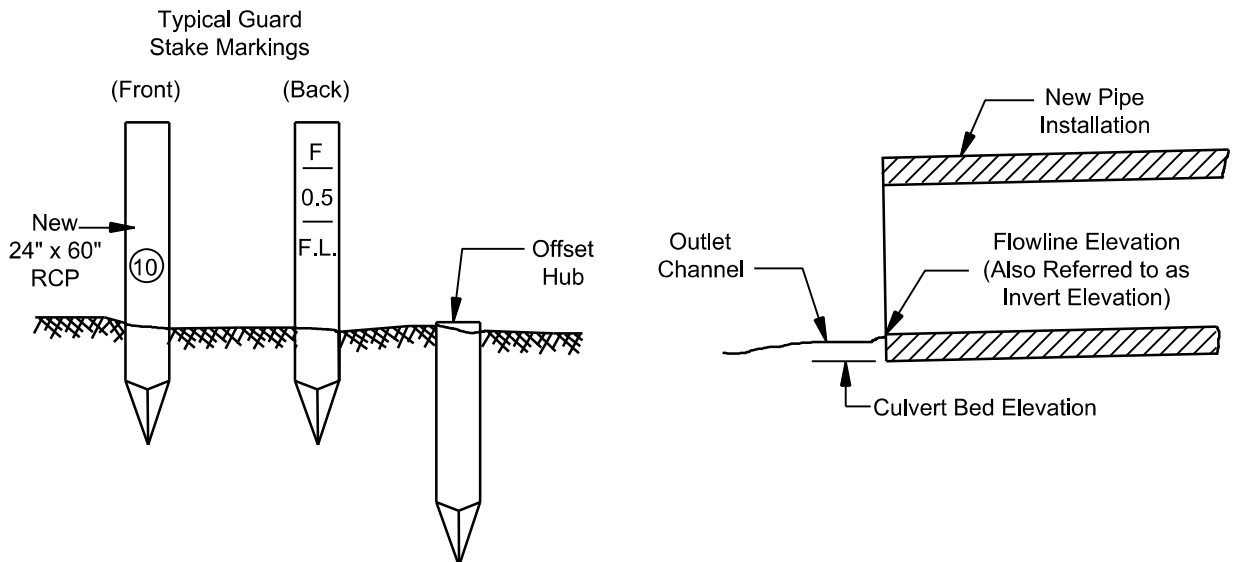
542.04-5 Installation and Assembly Considerations

Unless otherwise permitted, all pipe is laid upgrade. This helps seat each pipe joint because the mating force is applied in a downhill direction. It also helps prevent the joints from pulling apart from accidental movements of the pipe as the installation continues. It is important to ensure that the bell (female) end of the pipe points upstream to reduce the chance of leakage through the pipe joints.

Figure 500-16 — INVERT ELEVATION (FLOW LINE)



Note: Offset hub should be at ground level.
Stakes should also include Station and pipe dimensions.



When existing pipe will be extended, the existing pipe end must be in such condition that the new pipe can be firmly joined. If the existing pipe end is damaged, then the Contractor should remove as much pipe as necessary to ensure a sound joint or pour a collar as shown in the contract plans.

542.04-5 Corrugated Metal Pipe

542.04-5(a) Placement and Alignment

A transit, laser line or string line are usually used to keep the sections aligned properly. Most Contractors also utilize laser levels to maintain grade and alignment.

542.04-5(b) Pipe Section Connections

The hugger type bands used to connect the pipe take advantage of the corrugations on the pipe, with matching corrugations that fit the valleys. Bands of this type will not normally work on pipes with helical corrugations. The ends of these pipes should be pressed with corrugations that match the connecting band. Check to see that the space between the pipe and band is clear of soil, rock or other debris. Tapping the bands with a mallet as the bolts are tightened will help jar the corrugations together for a tight joint.

Article 542.04(e)(3), Paragraph 1, states the following:

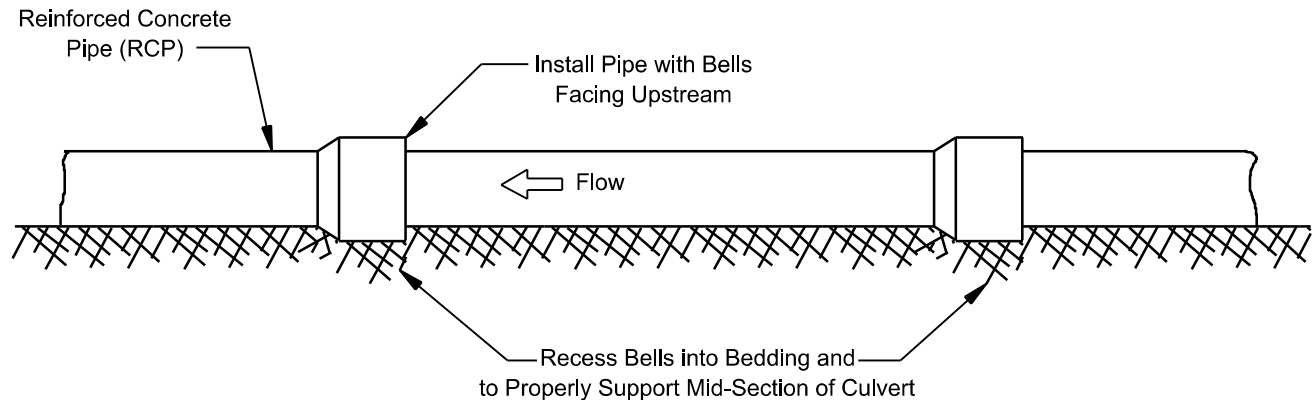
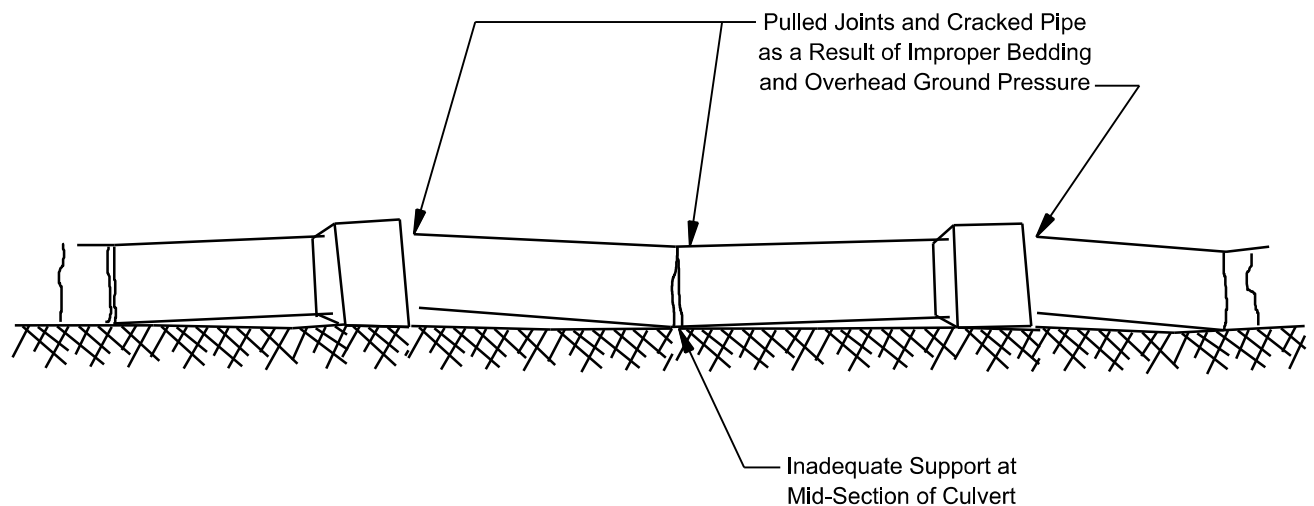
Elongation at the time of installation by the use of vertical struts, wedged or jacked inside the pipe in a manner approved by the Engineer.

When required by the specifications, corrugated metal pipe must be elongated so that it will become circular when a high fill is placed on top. Use rods, turnbuckles, wires, jacks and struts to provide elongation. Strutting or shop elongation is used to provide slight vertical distortion of metal pipe. This improves resistance to vertical loads imposed by embankment. If field strutting is employed, the Inspector should stay well clear during installation and removal of vertical struts. Loading is heavy and operations are dangerous. For this reason, most pipe is now ordered shop elongated.

542.04-6 Reinforced Concrete Pipe

Reinforced concrete pipe is manufactured in relatively short sections of 4 ft to 8 ft (1.2 m to 2.4 m) and, for this reason, positive control of alignment and grade is necessary. The use of a string line, laser or transit for alignment and a level (conventional or laser) for grade will eliminate small errors in placement of individual sections. The small errors tend to propagate and will usually result in a sloppy installation. Each section of pipe should be correctly installed prior to placement of the next section. Forcing a section into alignment during the backfill operation causes poor joints, poor alignment and broken pipe and should not be allowed.

Pipe should be installed with the bell end upstream, with the bells recessed into the bed so that the pipe will lie evenly on the prepared bedding. The pipe should never be used to tamp the bedding into the desired shape. Bells can be broken if the adjoining piece is not inserted straight. See Figure 500-17.

Figure 500-17 — INSTALLATION OF REINFORCED CONCRETE PIPE SECTIONSCorrect InstallationIncorrect Installation**542.04-7 Backfill Considerations****542.04-7(a) Placement of Backfill**

Backfill must be brought up uniformly around the pipe in lifts not to exceed 8 in. (200 mm) of loose thickness for the entire length of the pipe. Unequal backfilling can cause the structure to be pushed out of alignment and subjected to stresses for which the pipe was not designed. Complete the fill over the pipe using the same materials as those used for the backfill, and place and compact in the same manner. Distribute and compact the fill evenly to a depth equal to the height of the entire fill and, in trenches, to the original ground level.

542.04-7(b) Compaction Considerations

Ensure that the Contractor uses reasonable care when tamping the backfill in the haunch area (i.e., the lower 10% on both sides of pipe) so that the alignment and flow line grades are unaffected by the compaction effort. Verify that the backfill is compacted under the pipe haunches on both sides to obtain all the bearing possible. This can be accomplished by hand tamping. Poking a stake under the pipe can check this effectively.

Failure to properly tamp under the haunches can cause lateral movement, excessive stress on the lower 10% of the pipe and water movement alongside rather than through the pipe. Tamping under the haunches is important and is usually done by hand-operated mechanical equipment to obtain compaction. Because of the relatively flat bottom plates, it is impossible to work most mechanical tampers under pipe arches. In such cases, backfill can be compacted by ramming with 2-inch × 4-inch (50-mm × 100-mm) timbers or other device.

542.04-8 Pavement Restoration

The Contractor is responsible for maintaining the integrity of the completed and approved pipe trench areas within the pavement structure until the project receives final acceptance. Some contracts may require that a temporary, plant mix riding surface be placed. Watch for defects in the surface and require the Contractor to correct such damage. As construction continues, loaded heavy equipment usually far exceeds design loading, and many pipe failures are caused by permitting heavy equipment hauling over a pipe without the appropriate amount of cover.

Failures are especially likely to occur on pipe that the Contractor places temporary cover over to permit hauling. In these cases, ensure that the pipe is ramped over on a gradual slope rather than as a large "hump." This protective earth cover should not be "humped" over the structure, because the impact from a loaded, high-speed scraper hitting one of these bumps could severely damage the pipe. The contractor is required to build the embankment at a slope not steeper than 1:6 for the ramp up to the pipe and a level top extending 13 feet on each side of the pipe and finally ramping back down at a slope no steeper than 1:6. The height of the embankment over the pipe to protect it depends on the contractor's equipment and is up to the contractor to determine. The following table is a list of estimated cover heights for pipe protection relative to the weight of wheel load, although not a contract requirement it can be used as a guideline.

Wheel load in Tons*

1	5	10	15	20	25	30	35	40	45	50
---	---	----	----	----	----	----	----	----	----	----

Type	Diameter	Total Cover in Feet										
1 & 4	8" to 108"	1.0	2.0	3.0	4.0	5.0	5.5	6.5	7.5	8.5	9.5	10.5
2 & 3	8" to 108"	2.0	3.0	4.0	5.5	7.0	8.5	10.0	11.5	13.0	14.0	15.0
5 & 6	8" to 72"	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.0	5.5	6.0
	78" to 108"	1.0	1.5	2.0	3.0	3.5	4.0	4.5	5.0	5.0	5.5	6.0
7	8" to 72"	1.0	1.5	2.0	2.5	3.0	3.0	3.5	3.5	4.0	4.0	4.5
	78" to 108"	1.0	1.0	2.0	2.0	3.0	3.0	3.5	3.5	4.0	4.0	4.5

**Retained from 2012 Standard Specifications for Road and Bridge Construction Article 542.04(h).*

If hauling units are making repeated trips over a pipe, be certain that they use the full width of the roadway (i.e., offset or stagger the wheel paths) and do not develop a narrow haul path or ruts. The Contractor is responsible for this work and maintaining their work through to final acceptance. However, it is in the Department's best interest to take an active role and communicate any concerns to the Contractor in these types of situations. Also, document all such situations.

542.05 METHOD II CONSTRUCTION

Method II installations are used for extensions of existing culverts or inaccessible areas where a trench is impractical. The contract documents must indicate when a pipe will be installed by this method.

542.06 METHOD III CONSTRUCTION

The Method III installation is for side road or field entrance culvert installation. Ensure that the pipe lays firmly in the roadway ditch, that the proper backfill is placed around the pipe and that the pipe is not damaged.

SECTION 550. STORM SEWERS

See the [Construction Inspector's Checklist for Storm Sewers](#) for additional direction and information.

550.04 EXCAVATION AND FOUNDATION

550.04-1 Excavation Hazards

Excavations are hazardous because a worker can become engulfed by collapsing soil. See Figure 500-18. One cubic yard of soil can weigh as much as a mid-size pick-up truck. When all this soil surrounds a worker, he or she may not be able to breathe even if not completely engulfed. Some other hazards associated with excavation work include but are not limited to:

- Injury or death from collapse or cave-in
- Working in or around mobile equipment
- Vibration
- Manual material handling
- Working in proximity to traffic
- Various hazards from subsurface installations and overhead lines
- Fall hazards
- Hazardous atmospheric conditions
- Electrical hazards

Figure 500-18 — EXCAVATION/TRENCHES**550.04-2 Definitions**

1. Excavation. Any man-made cut, cavity, trench or depression in an earth surface, formed by earth removal.
2. Trench. A narrow excavation made below the surface of the ground. In general, the depth is greater than the width; the width of a trench (measured at the bottom) is not greater than 15 ft. (4.5 m).
3. Shoring. A structure that is built or put in place to support the sides of an excavation to prevent cave-ins.

550.04-3 Safety

OSHA requires that all excavation and trenches over 5-ft (1.5-m) deep have one of four protective systems:

- Sloping the ground
- Benching the ground
- Shoring the trench with supports such as planking or hydraulic jacks
- Shielding the trench (using a trench box)

See [Subpart P. Excavations](#), of 29 CFR 1926.650, 29 CFR 1926.651, and 29 CFR 1926.652.

Workers should never enter a trench that does not have a protective system installed and inspected by a competent person. Refer to Chapter 12: Excavation and Trenching Safety in the Employee Safety Code Manual for illustrations and information on trench safety.

SECTION 562. WATER SERVICE LINE

562.01 DESCRIPTION

Water lines are included in Department projects for a variety of purposes, including the relocation of municipal water line replacements. The construction or relocation of water service lines may also be specified in the contract for other types of construction, including weigh stations, rest areas and small irrigation systems.

562.03 GENERAL

In addition to the Department contract documents, the installation of metal water service lines may need to meet the requirements in the *Standard Specifications for Water and Sewer Main Construction in Illinois*. The Contractor must coordinate with the local utility company for all work; for example, all existing facilities or underground utilities may not appear in the contract documents.

SECTION 582. HOT-MIX ASPHALT SURFACING ON BRIDGE DECKS

Do not allow the use of vibratory rollers on bridge decks.

SECTION 584. GROUTING OF ANCHOR RODS AND BARS

Hole depths should be documented before the anchor rod is grouted into place.

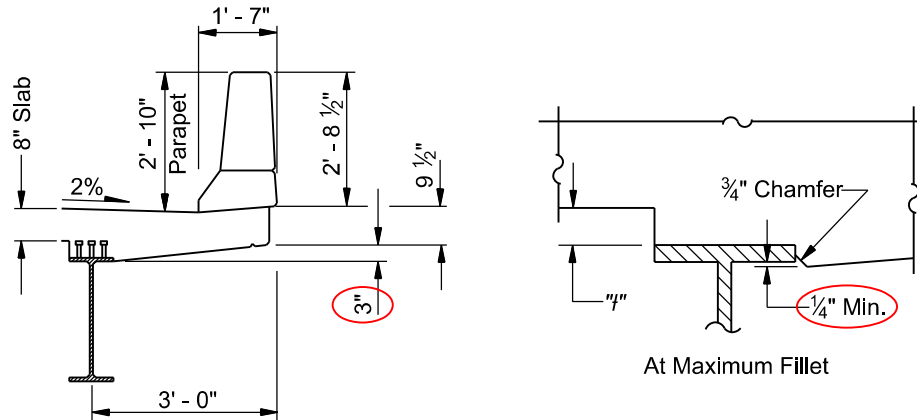
SECTION 593. CONTROLLED LOW-STRENGTH MATERIAL, BACKFILL

Article 593.04, Paragraph 1, states the following:

Other placement methods may be approved by the Engineer if the mix design is appropriate.

These include pumps, wheelbarrows, conveyor belts and buckets.

Appendix 500.A OVERHANG FORMING EXAMPLE



Verify if the 3-in. overhang drop dimension is adequate to hide the top flange by at least $\frac{1}{4}$ in.

Given:

Beam Size = W30 \times 132

Actual Top of Beam Elevation (at point of maximum fillet) = 755.00 ft.

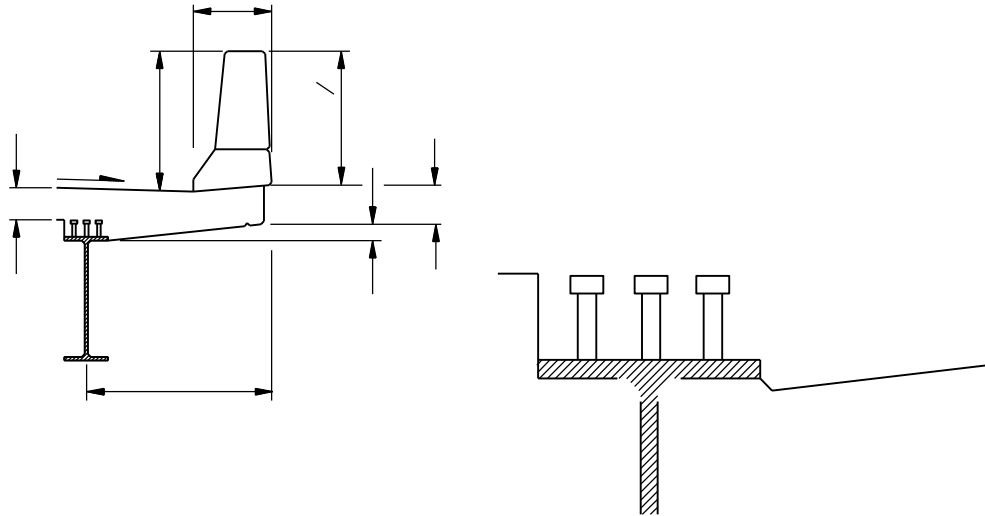
Maximum Fillet Height = 2 in.

Solution:

From *AISC Manual for Steel Construction*:

Top Flange Width = 10 1/2 in.

Top Flange Thickness = 1 in.



Now, we just have to calculate the difference between the bottom of the flange elevation and the bottom of the concrete elevation to verify if the difference equals or exceeds $\frac{1}{4}$ in.

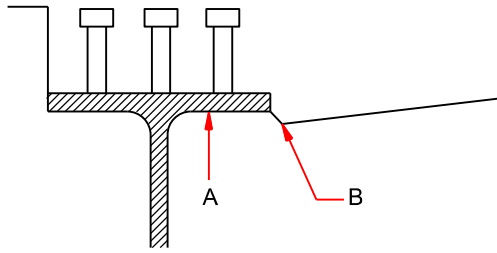
Solution:

At point of maximum fillet:

$$\begin{aligned} \text{Bottom of flange elevation (El. A)} &= 755.00 - (1 \text{ in./12}) \\ &= 754.92 \text{ ft.} \end{aligned}$$

At point of maximum fillet:

Elevation B	=	755.00 ft.	Top of beam elevation
	+	(2.0 in./12)	Maximum fillet
	+	(8 in. /12)	Slab thickness
	-	(36 in. - 19 in.)/12 \times 0.02	Deck cross slope drop
	+	(34 in./12)	Front of parapet height
	-	(32.5 in./12)	Back of parapet height
	-	(9.5 in./12)	Deck fascia dimension
	-	(3 in./12)	Overhang drop dimension
Elevation B	=	754.89 ft.	



Solution:

At point of maximum fillet:

$$\text{Elevation A} - \text{Elevation B} = 754.92 - 754.89 = 0.03 \text{ ft} = 0.36 \text{ in.}$$

Answer:

0.36 in. is greater than 0.25 in.; therefore, the 3-in. overhang drop dimension is adequate.

If the overhang drop dimension would have been slightly inadequate (say, we need the drop dimension to be 4 in. instead of 3 in.), we can make minor adjustments in the field. However, if the dimension is way off, we need to consult with design. For example, if we needed 6 in. instead of 3 in., design may want us to tweak the 9½-in. dimension and/or add some additional reinforcement to ensure that we do not have large thicknesses of unreinforced concrete.

However, we should always be keeping the slope of the overhang constant (for aesthetic purposes).

SPECIFIC TASK TRAINING PROGRAM

**DRILLED SHAFT
FOUNDATION
CONSTRUCTION INSPECTION**

S32

CLASS REFERENCE GUIDE

**Prepared and Published
by
Bureau of Construction**

Instructor: Doug Dirks (217) 782-5283

Training Date: _____

TABLE OF CONTENTS

1	INTRODUCTION TO DRILLED SHAFT INSPECTION	1
1.1	– Role and Responsibilities of the Inspector.....	1
1.2	– Introduction to Drilled Shafts.....	1
1.3	– Plans, Specifications and Reports	3
1.4	– Equipment and Safety.....	5
1.5	– Applicable Specifications and Forms	6
2	SHAFT EXCAVATION TOOLS AND METHODS	8
2.1	– Drill Rigs.....	8
2.2	– Drilling Tools	10
2.2.1	– Earth Drilling Tools	10
2.2.2	– Rock Drilling Tools	12
2.2.3	– Clean Up Tools.....	13
2.3	– Shaft Excavation Methods	13
3	SHAFT EXCAVATION INSPECTION	18
3.1	– Work Plan	18
3.2	– Excavation	18
3.3	– Obstructions and Differing Site Conditions	19
3.4	– Shaft Sizes and Tolerances	20
3.5	– Squeezing, Necking and Cave-Ins.....	20
3.6	– Rock Sockets	21
3.7	– Shaft Acceptance.....	21
3.7.1	– Friction Shafts	21
3.7.2	– End Bearing Shafts in Soil.....	22
3.7.3	– Rock Socket Shafts and Top of Rock Shafts	22
3.5.4	– Bottom Flatness and Cleanliness.....	22
4	REBAR AND CONCRETE INSPECTION AND INSTALLATION	24
4.1	– Rebar	24
4.2	– Concrete	25
4.2.1	– Concrete Mix Design Slump and Slump Retention	25
4.2.2	– Concrete Placement.....	26

5	INSPECTOR'S CHECKLIST AND DOCUMENTATION	31
6	NON-DESTRUCTIVE TESTING AND LOAD TESTING	32
6.1	Non-Destructive Testing	32
6.1.1	Impulse Echo or Impulse Response.....	32
6.1.2	Cross-Hole Sonic Logging.....	33
6.1.3	Gamma-gamma Logging.....	35
6.1.4	Thermal Integrity Profile	36
6.1.5	Non-Destructive Testing Limitations.....	36
6.2	Load Testing	36
6.2.1	Static Load Test	37
6.2.2	Lateral Load Test	37
6.2.3	Bi-Directional Load Test.....	37
6.2.4	High Strain Dynamic Load Testing.....	38
6.2.5	Role of the Inspector	38
7	TROUBLE SHOOTING	39
8	APPENDIX	42
8.1	Additional References.....	42
8.2	Example of Drilled Shaft Pre-Drill Meeting Agenda	43
8.3	Drilled Shaft Straight and Belled Concrete Volume Calculation Tables.....	47
	TABLE OF FIGURES	54

Revised February 2016


1 Introduction to Drilled Shaft Inspection

1.1 – Role and Responsibilities of the Inspector

The role of the inspector is to observe and report on the construction activities at the site. This is especially important for drilled shafts since their construction is more susceptible to defects that result from poor construction techniques. As the inspector, it is your responsibility to confirm that the drilled shaft construction was performed in accordance with the plans and specifications. This task is completed through a combination of observations, recording and testing. The inspector is responsible for recording the means and methods by which a drilled shaft is constructed. In effect, the inspector will create an as-built plan of the foundations at the site. It is also the responsibility of the inspector to measure and record the soil and rock conditions which support the drilled shaft. The drilled shaft inspector is the eyes and ears of the geotechnical and structural engineers who designed the drilled shaft foundations for the project. The inspector has the responsibility to report any deviations from the plans and specifications or deviations from the contractor's approved work plan to their supervisor. The inspector should realize they have the authority and responsibility to observe every aspect of the foundation construction process. The inspector has the authority to not accept work if construction is not being performed in accordance with the plans or specifications.

1.2 – Introduction to Drilled Shafts

A drilled shaft is a foundation element composed of cast-in-place reinforced concrete that is placed into an open drilled excavation. Drilled shaft foundations are specified to address vertical and lateral load capacity concerns resulting from large scour depths, high seismic loadings, potential liquefaction, low soil strengths, and inadequate pile embedment. In general, drilled shafts will have a higher resistance against axial and lateral loads than driven piles. The additional capacity is a result of the size of the drilled shaft. Drilled shaft diameters can range from 1 to 10 feet, and lengths up to 150 feet can be achieved using common drilled shaft construction equipment. Even larger shafts are possible with specialized equipment. An additional benefit of drilled shafts is the less noise, and relatively low vibration levels during construction when compared to driven pile installation.



Drilled Shaft Design – In Soil

- Drilled shafts in soil resist axial loads through friction and end bearing
- Drilled shafts in soil can have a constant diameter or the base can be enlarged by belling to provide additional area

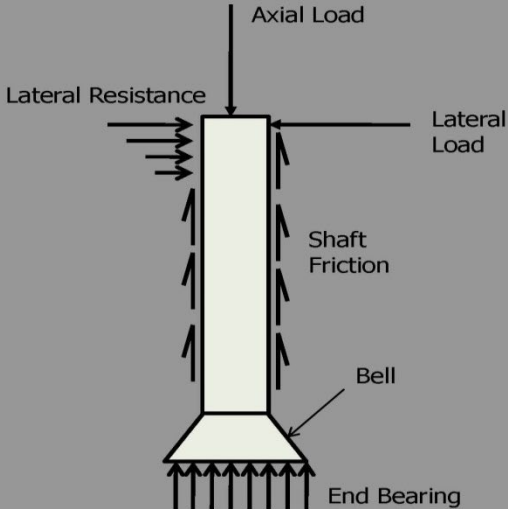



Figure 1 - Drilled Shaft Design - In Soil

Drilled shafts can be constructed in soil or in rock. For drilled shafts in soil, the resistance to load is developed along the perimeter of the shaft through friction and also bearing on the end of the shaft. In certain situations, the capacity of the shaft can be increased by increasing the size of the base of the drilled shaft. Increasing the size of the base is commonly referred to as under-reaming or belling. Bells can be constructed at 45 degree or 60-degree angles. For higher bearing stress applications, a 60-degree bell is required. Bells can be up to three times the diameter of the shaft.



Drilled Shaft Design – In Rock

- Shafts in rock carry load through friction and end bearing
- The majority of the shaft capacity is developed in or on the rock

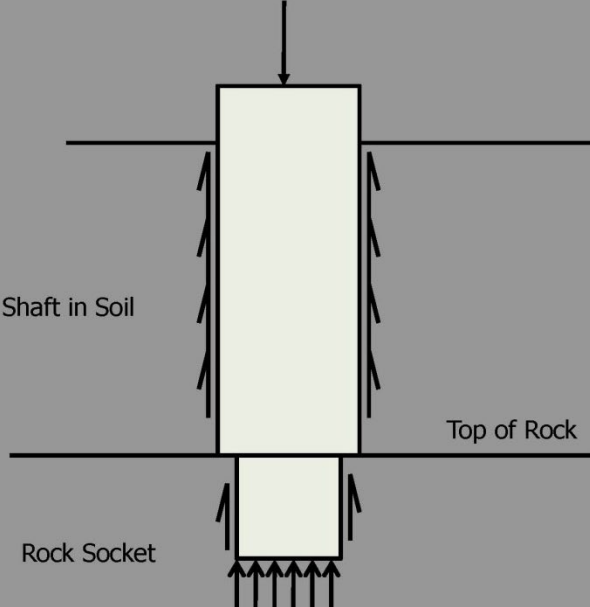


Figure 2 - Drilled Shaft Design - In Rock

Drilled shafts in rock are constructed similarly to drilled shafts in soil. The drilled shaft extends through the overburden soils to the surface of the rock. A rock socket is excavated to a diameter and length necessary to meet the required design. The rock socket will generally be a slightly smaller diameter than the portion of the shaft in the soil. In some cases, no socket will be constructed, and the drilled shaft can bear on the surface of the rock after it has been cleaned. Shafts in rock support load similarly to shafts in soil. Loads are resisted by a combination of friction along the shaft in the soil and the shaft in the rock. End bearing resistance is also developed in the rock. In most cases, the majority of the load will be supported by shaft friction and end bearing in the rock socket and the contribution of the soil above may be ignored.

1.3 – Plans, Specifications and Reports

The construction of drilled shafts is controlled by IDOT plans and specifications. The geotechnical aspects of the drilled shaft design are controlled by the Structure Geotechnical Report.

When preparing for a drilled shaft inspection, the instructor must review the plans before the start of the project. From the plan drawings, important information such as drilled shaft diameters, rock socket diameter, drilled shaft length and rock socket length can be obtained. The plan drawings will also give information related to the type and configuration of reinforcing steel which will be installed.

The specifications provide details regarding the drilled shaft construction process. Before arriving on site, the inspector should be familiar with the specifications. Refer to 1.5 – Applicable Specifications and Forms for applicable specifications to review.

Before arriving on-site, the inspector should also review the Structure Geotechnical Report for the project. The inspector should review the entire report to become familiar with the site conditions. The inspector should pay special attention to the soil conditions section which will provide a general description of the soil conditions at the site. The inspector should also pay special attention to the design recommendations section as this may be the only source for information related to the bearing pressure assumed in the design. Finally, the inspector should pay special attention to the construction considerations section of the report. The construction considerations section may provide valuable information related to the use of temporary or permanent casing for the shafts and provide information on potential drilled shaft construction problems like caving soils and water infiltration.

After reviewing the text of the report, the inspector must carefully review the Soil Boring Log ([Form BBS 137](#)) and Rock Core Log ([Form BBS 138](#)). The logs will be included in the attachments to the Structure Geotechnical Report and should also be included in the plans. Important items to note on the soil boring logs include the soil types and strengths which will be encountered especially at the bearing level. The inspector should also pay close attention to the water levels encountered during drill operations. Two soil types which may be of concern during construction are soft clays and granular soil below the groundwater table.

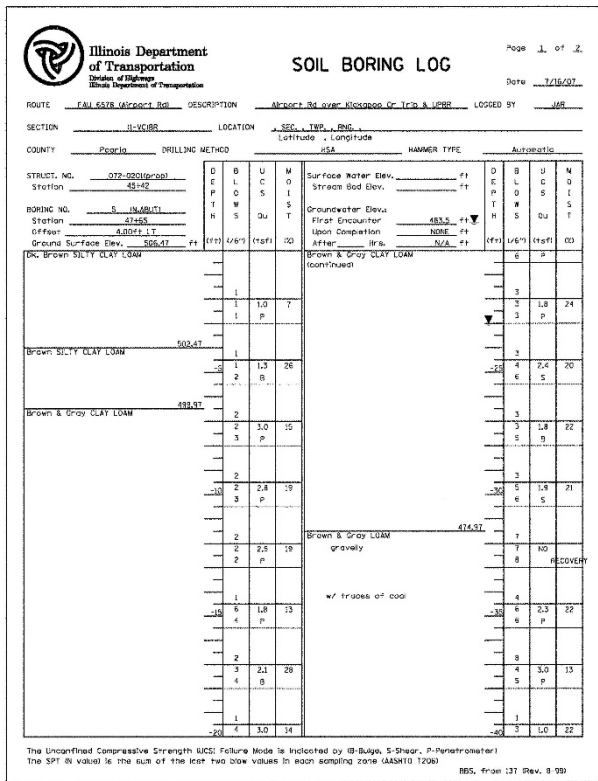


Figure 3 - Soil Boring Log

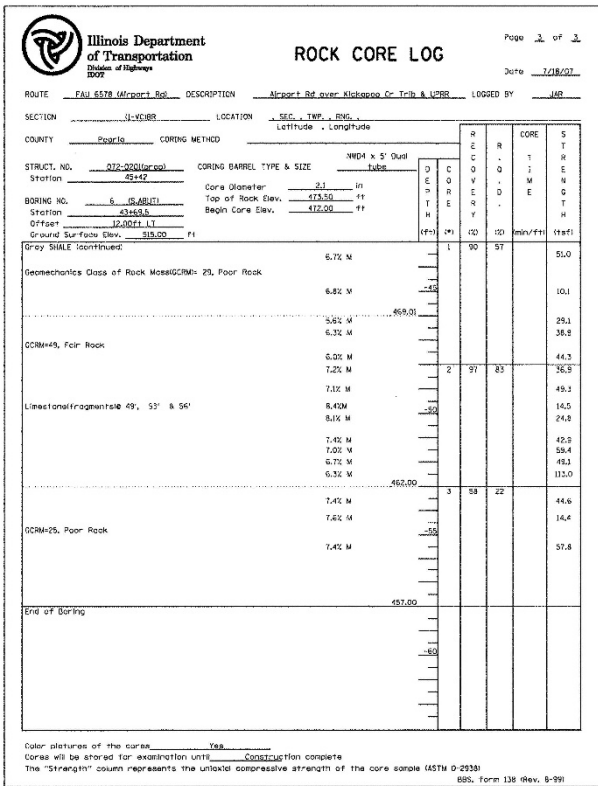


Figure 4 - Rock Core Log

When exploratory soil borings are extended into rock, coring is generally completed to evaluate the type, strength and consistency of the rock. The findings of the rock coring are summarized on rock core logs. The rock core logs will also be included in the attachments to the Structure Geotechnical Report and should be included in the plans as well. When reviewing the rock core logs the

inspector should check which type of rock will be encountered at the site. Two common rock types encountered in Illinois are shale and limestone. Limestone is sometimes referred to as dolomite when the MgO is $\geq 11.0\%$. Shale is a relatively soft rock; it should be excavated relatively easily with rock excavation equipment. Limestone tends to be a much harder rock; excavation in limestone will be a slower process. It is also important to note the Rock Quality Designation (RQD) on the rock core log. The RQD is a measure of the quality of rock that was encountered. RQD is presented as a percentage. It is the percent of the rock core that was collected that consists of solid pieces greater than 4 inches in length. When the RQD is high (greater than 50 percent) the rock will be fairly solid and massive. Low RQD indicates the rock is weathered and fractured.

The rock compressive strengths should also be reviewed. Shale strength may be on the order of 750 psi while limestone or dolomite may exceed 10,000 psi. Fractured rocks with unconfined compressive strengths below 1000 psi may be excavated with rock augers, while hard rocks greater than 3000 psi may require coring. For more information on RQD, refer to 8.1 – Additional References and the IDOT [Geotechnical Manual](#).

1.4 – Equipment and Safety

Job site safety is beyond the scope of this document, but all normal safety procedures for construction sites shall apply. Personal Protective Equipment (PPE) is required on drilled shaft construction sites. Required safety equipment includes hard hat, safety glasses, high visibility vest, steel toed boots, and hearing protection. Gloves may also be required depending on the job site requirements. A life preserver is also required when working around water.

An inspector shall never perform an inspection activity which places them in an unsafe situation. All inspection work will be completed from the ground surface for the drilled shaft. Entry into the excavation is not necessary or recommended for the inspector. Any entry into a drilled shaft will require installation of steel casing, and compliance with Occupational Safety & Health Agency (OSHA) requirements for confined spaces in construction. For confined spaces, air quality testing for such things as oxygen content, flammable gases, and toxic air contaminants are required.

Before drilling begins, utilities within the work area must be located and staked. Also, look for any overhead conflicts. Plenty of headroom is needed when constructing deep drilled shafts because the crane will be lifting the rebar cage or tremie for construction of the drilled shaft.

When drilling next to an underground utility, the contractor should pothole first to locate the utility. During drilling, caving may expose the utility. If this occurs, the inspector should verify that the utility is well supported, if needed, and that the contractor does not entomb it in concrete when the shaft is poured.

With some types of soils, there is the danger of the soil collapsing near the surface as the driller advances the hole. Usually a surface (a.k.a. starter) casing will be placed around the hole to protect workers from cave-ins. The casing may extend above ground (recommended) but is inserted well into the ground. The casing serves as a guide for drilling tools and will help prevent enlargement of the hole at the surface due to tools being in and out of the hole for excavation of the shaft. The surface casing will also prevent soil from falling back into the excavation after it has been cleaned. The inspector is cautioned that it is possible for a starter casing to slide down the shaft if soil sloughing or caving is occurring below the casing.

The inspector is required to follow OSHA regulations for fall protection. When a worker is exposed to vertical drops of more than 6 feet, which is typical for drilled shafts, fall protection is required. Fall protection may include such things a platform with a guardrail, or safety harness and lifeline connected to a fixed object. Thus, the contractor shall take into consideration the inspection activities of the inspector when constructing the drilled shaft.

Another hazard to consider is the open hole when unattended. Safety measures are required to protect the general public. Holes need to be covered with a protective covering, or a fence may need to be erected around the hole.

Additional safety risks peculiar to drilled shaft construction also exist and the inspector must be aware of these. When drilling tools are in and out of the hole, the rig will swivel side to side. Do not stand at the side of a drill rig or behind the operator's cab in a position where the operator cannot see you. Also, when spoil is spun off an auger, flying debris can be a hazard. Large chunks of clay could weigh hundreds of pounds and would break bones if they hit you. An end loader will constantly be working at the side of the rig to remove spoil. Stay out of its way. When approaching the top of the shaft to look into the shaft, be sure that the operator sees you. Also, be careful when a boring tool is being lowered into the shaft. If the tool hits the surface casing, the wings will spring out and if you are standing at the side of the shaft you could be severely injured. Do not stand next to the shaft when tools are being lowered into the hole. When a reinforcement bar cage, casing or tremie pipe are lifted the inspector is advised to stand away and to the side. Anticipate where the object will fall if a cable breaks and be elsewhere.

Since the role of the inspector is to observe and report, some of the most important pieces of equipment for the inspector are the field book, checklist and forms. Refer to 5 Inspector's Checklist and Documentation for more information. Without these tools it will not be possible to document the construction completed at the site. To accurately fill out the forms and field notes, it will be necessary for the inspector to measure the lengths and diameters of the shaft and rebar cage. A 25-foot tape measure is useful to measure diameters and check the rebar. In many cases, the length of the shaft will be longer than 25 feet, so a 100-foot tape measure should also be available for the inspector. Since the shaft will be measured from the surface and in some cases, water may be present in the excavation, it is necessary to provide a weight on the 100-foot tape. A small piece of rebar, a heavy bolt, or a drilling tooth taped to the end of the tape measure is generally sufficient.

For drilled shafts bearing in clayey soils, it is necessary to measure and record the strength of the materials encountered at the base of the excavation. The strength will be measured on auger cuttings recovered from the base of the excavation. An initial check of the unconfined compressive strength of the soil can be performed using a hand penetrometer. Most hand penetrometers can only measure up to an unconfined compressive strength of 4.5 tsf, though some are available that extend to 7 tsf, and some dial gauge penetrometers reach as high as 14 tsf. When high bearing pressures are utilized, a RIMAC unconfined compression testing device may be able to check the unconfined compressive strength of the soil. The inspector should have a calculator to aid in computing the unconfined strength as well as for volume calculations. A camera is useful for documenting field conditions, and a plumb bob is beneficial for checking vertical plumbness.

When inspecting shafts in rock, a rock probe should be utilized. A rock probe consists of a piece of round steel or rebar attached to the end of a cable. The rock probe will be heavier than the weighted tape so that the rock surface can be probed and sounded.

Frequently when inspecting the base of the excavation it can be lit by using a high lumen flashlight or by lowering an explosion proof light. In some instances, the bottom of the drilled shaft can only be inspected by using an explosion proof camera. Frequently for deep holes and belled shafts a camera is lowered to the base of the shaft to evaluate the bottom condition and cleanliness.

1.5 – Applicable Specifications and Forms

The intent of this manual and course is to provide an introduction to the construction and inspection of drilled shafts. Refer to 8.1 – Additional References for more comprehensive information on the proper construction of drilled shafts.

This manual is applicable to the April 1, 2016 Standard Specifications for Road and Bridge Construction. It shall be noted the Drilled Shafts Guide Bridge Special Provision # 86 contains

revisions to Section 516. The inspector should be familiar with the following specifications and forms when constructing drilled shafts.

- IDOT Standard Specifications for Road and Bridge Construction:
 - Section 508 – Reinforcement Bars (Construction Requirements)
 - Section 516 – Drilled Shafts (Construction Requirements)
 - Section 1020 – Portland Cement Concrete (Class DS Requirements)
 - Section 1006.05 – Steel Casing (Material Requirements)
 - Section 1006.10 – Reinforcement Bars (Material and Condition Requirements)

- Bureau of Bridges and Structures (BBS)Forms:
 - [BBS 133](#) – Drilled Shaft Qualifications and Installation Plan
 - [BBS 134](#) – Drilled Shaft Excavation and Inspection Record
 - [BBS 135](#) – Drilled Shaft Concrete Placement Log

2 Shaft Excavation Tools and Methods

2.1 – Drill Rigs

Drill rigs used for construction of drilled shafts come in many types and sizes; however, they all have common components which are used for the drilled shaft excavation process. The power unit is the engine which powers the drilling equipment. In some cases, the power unit can be hydraulically powered off of the main engine for the equipment. In other cases, dedicated engines are provided for the drilling equipment. For large drilling equipment, two engines may be provided. The energy developed by the power unit is transferred to the drilling tools through the Kelly bar. Kelly bars can be round or square in section and are generally composed of multiple telescoping sections to minimize the overhead requirements of the equipment and maximize the drilling depths. The excavation is performed by tools connected to the end of the Kelly bar. Tools can consist of augers, core barrels, hammers or buckets. The type of tool utilized is dependent on the drilling conditions. All the drilling equipment is mounted to a body or carrier. The body can consist of a truck, crawler body or for large drilling equipment an attachment to a crane.

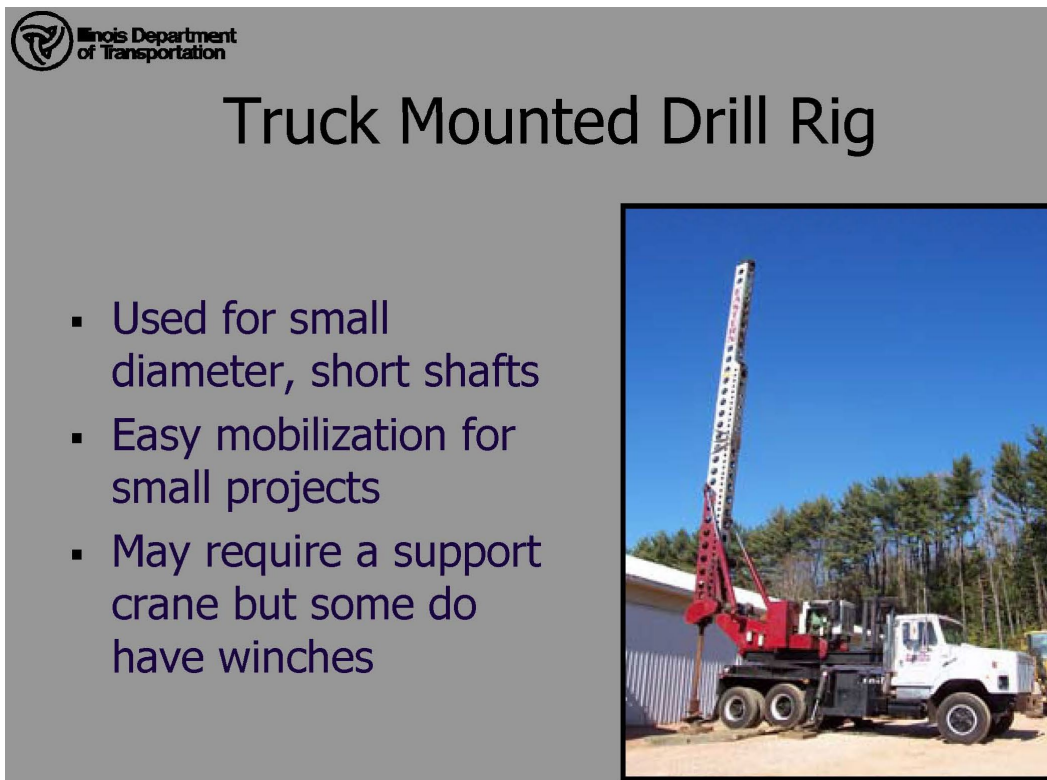



Figure 5 - Truck Mounted Drill Rig

Truck mounted drilling equipment is generally used for small diameter short shafts. The truck carrier provides easy mobilization to sites and moves easily between widely spaced foundation locations. Truck mounted equipment is often self-servicing as winches are generally attached for lifting and placing rebar cages.

 Illinois Department of Transportation

Crawler Body Mounted Drill Rig

- Higher capacity than truck rigs
- Provides highest downward pressure (crowd)
- Better for difficult access conditions due to tracks
- Mobilize to site on flatbed trailer
- Largest rigs equal the torque of crane-mounted rigs





Figure 6 - Crawler Body Mounted Drill Rig

Crawler-body-mounted drill rigs are suited for larger diameter and deeper shafts than truck mounted equipment. The Kelly bar is generally larger diameter and often has more telescoping sections. Crawler mounted equipment is usually capable of providing downward pressure on the drilling tools through hydraulic rams acting on the Kelly bar. This additional pressure often referred to as “crowd”, can be useful when drilling on rock or in hard soils. Another benefit of crawler mounted equipment is the body is track mounted which can be beneficial in difficult site conditions. Service winches are generally attached to crawler mounted equipment, so they can place rebar cages and do other lifting.

 Illinois Department of Transportation

Crane Mounted Drill Rigs

- Largest capacity, for diameter and length
- Crowd pressure limited to Kelly weight
- Highest torque
- Require large foot print to work in
- Mobilize to the site in multiple pieces
- Casing length that can be handled effectively is limited to the clearance below the “bridge”




Figure 7 - Crane Mounted Drill Rigs

The largest piece of drilling equipment available is a crane mounted drill rig. The power unit is attached to the body of the crane by a table. The Kelly bar is then controlled via the boom and cables of the crane. Crane mounted equipment provides the largest amount of torque and can excavate the largest diameter shafts. The crowd of crane mounted equipment is limited to the weight of the Kelly bar and drilling tools. Weighted Kelly bars are available for rock drilling applications. Crane mounted equipment mobilizes to the site in multiple pieces and sections and requires assembly once on site. Service cranes for lifting and setting rebar cages are also required as crane mounted drilling equipment is not equipped with service winches. The size of the drilling equipment along with the requirement for a service crane creates the need for a large working footprint. If the project site is small and congested, crane mounted drilling equipment may not fit on the site.

2.2 – Drilling Tools

The inspector should document the equipment on site and the tools used as well as their condition.

Drilling tools can be lumped into three broad categories including earth drilling tools, rock drilling tools and cleanup tools. The use of earth and rock drilling tools is fairly self-explanatory. Clean up tools are used for final bottom clean up. Earth and rock drilling tools are efficient at removing large amounts of soil or rock; however, they often leave thin layers of sediment and loose soil or rock at the base of the excavation. Earth and rock tools are also incapable of removing any standing water from the base of the excavation. For these final clean up tasks, clean up tools are required.

2.2.1 – Earth Drilling Tools

The most common earth drilling tool is the earth auger. Earth augers are available in single and double flight (cut) varieties. A single flight auger contains a single helix up the stem of the auger. A double flight auger has two helixes up the stem of the auger. Single cut augers only have teeth on one side of the center of the auger stem while double cut augers have two sets of cutting teeth at the base of the auger. Double cut augers are used more frequently for hard drilling and large diameter shafts. The auger shown in the picture is a double flight, double cut auger. The stinger is located below the center of the auger stem to create a pilot hole for the auger and to help prevent the auger from walking along the bottom when drilling in hard soil.

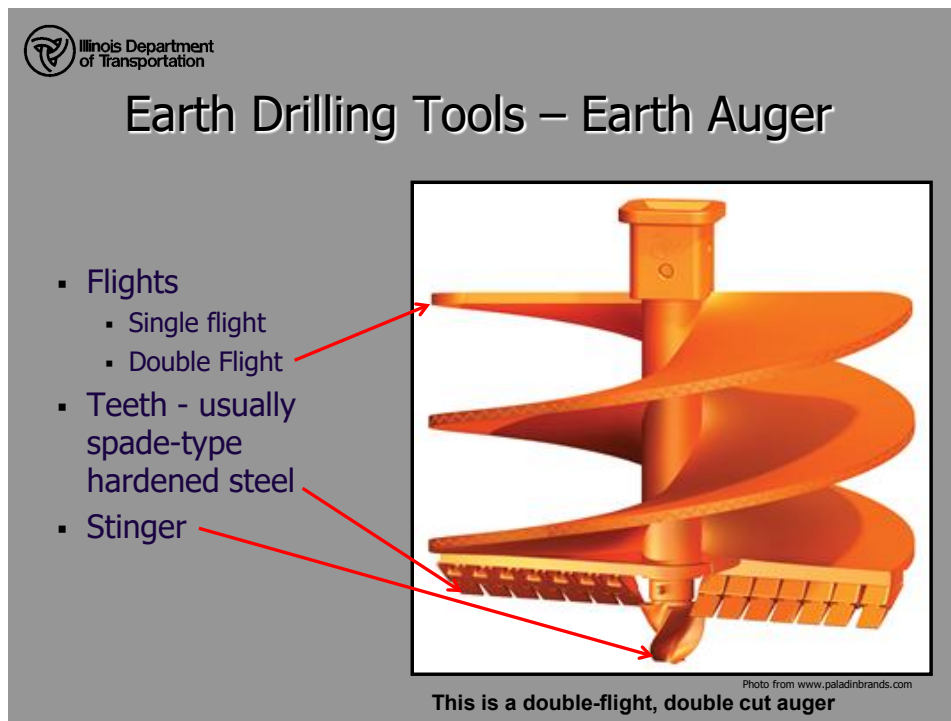



Figure 8 - Earth Drilling Tools - Earth Auger

When creating an enlarged base for a shaft bearing on soil a belling bucket or under-reamer is required. The belling bucket consists of two pieces: the bucket and the wings. The movement of the wings is controlled by the Kelly bar. As the Kelly bar is pushed downward the wings extend out of the bucket creating the enlarged base, when the Kelly bar is pulled up, the wings retract. As the wings cut the bell, the spoil collects in the bucket and is removed when the bucket is pulled out of the shaft. Prior to excavation, the bell size is set by attaching a chain to prevent over-excavation. To ensure the proper bell size is constructed, it is important to measure the travel of the Kelly bar which is required to achieve the design diameter. Alternatively, a marker bar on the side of the belling bucket will indicate how far the wings opened. If no marker bar is available, heavy grease can be placed on the bucket in the wing slot. When the wings open, the grease will be smeared to the maximum opening point and will indicate the size of the bell.

 Illinois Department of Transportation

Shaft Excavation – Belled Shaft

- Belling Bucket
 - Bucket
 - Wings
- Wings controlled by movement of Kelly bar
 - Kelly bar down, wings come out
 - Kelly bar up, wings come in
- Kelly bar travel required to reach design diameter can be measured
- Chains are installed to set maximum bell size
- Bells are often oversized in the field up to 1 ft to compensate for limited cleaning ability




Figure 9 - Shaft Excavation - Belled Shaft

Because, the quality of cleaning is limited with a belling tool, bells are often over-sized 1 foot to provide additional bearing area. Refer to 3.5.4 – Bottom Flatness and Cleanliness for additional information.

2.2.2 – Rock Drilling Tools

Augers can also be used for rock excavations. The primary differences between a rock auger and an earth auger are the teeth and flights. An earth auger will usually have spade-shaped hardened steel teeth. A rock auger will often have carbide-tipped, bullet-shaped or chisel-shaped teeth which are better suited for rock excavation than the spade-shaped teeth generally utilized on an earth auger. Rock auger teeth that are worn need to be replaced. Since rock drilling is harder than excavation in soil, the flights of a rock auger are thicker, heavier and often harder than those on an earth auger and may also be tapered. Rock augers can be used in any rock type but are most efficient in soft rocks such as shale or highly fractured and weathered rocks. Rock augers are also used to grind the surface of harder rock like dolomite when little penetration is required. When large sockets are required in harder rock such as dolomite, specialized equipment such as a core barrel or a downhole hammer are required. A core barrel consists of heavy casing with carbide teeth attached to the bottom, and frequently used for rock with greater than 3,000 psi compressive strength. A core the diameter of the rock socket is created and then the rock remaining in the center is removed with augers or broken up with a drop chisel. A downhole hammer is a hydraulic or pneumatic powered piece of equipment that consists of multiple cutting heads and a hammer. The cutting heads combined with the hammer effect break and crush the rock at the base of the excavation and remove the small rock fragments that remain. Downhole hammers are relatively rare and will only be used on large rock sockets in hard rock with compressive strengths up to 50,000 psi. Downhole hammers are used with reverse circulation or air circulation drilling processes which are unlikely to be encountered on IDOT projects.

For removal of boulders, a downhole hammer can be used but is unlikely. Refer to 3.1 – Obstructions and Differing Site Conditions for more information on equipment to remove boulders.

2.2.3 – Clean Up Tools

The best clean up tool for a dry shaft or shaft with a small amount of water is a clean-out bucket. Clean-out buckets are also commonly referred to as a one-eye bucket or a muck bucket. The clean out bucket has a flat bottom with an opening which is covered by a sliding plate. The bucket is lowered to the bottom of the excavation and rotated in the normal direction to collect any water and loose material off the bottom of the excavation. The bucket is then rotated in the opposite direction which slides the plate across the opening to close the bottom. This will capture soil and water inside. The captured soil will also help seal any gaps, and thus prevent leakage of water. If the bucket leaks water, this is a possible indication the bottom is clean since there is no soil to seal the gaps. Clean-out buckets can also be used to clean the base of excavations filled with water.



Figure 10 - Clean Up Tools

Two other options exist for excavations which are full of water or fluid. The two options are an airlift pump and a downhole pump. These tools are typically only recommended in rock sockets since they can cause excavation and erosion of the side walls or bearing soil if used in a shaft founded in soil. A downhole pump is lowered to the base of the excavation. The pump forces fluid and sediment at the base of the excavation up a hose to the surface. The pump should be lifted and moved around the base of the excavation to help ensure the entire shaft base is cleaned.

An airlift pump is more effective than a downhole pump and works like a giant vacuum. The airlift pump consists of a steel lift pipe 6 to 12 inches in diameter which is lowered to the base of the shaft. Compressed air is blown into the side of the lift pipe near the base of the excavation. The upward movement of the air creates suction in the lift pipe which pulls water and sediment from the base of the excavation up to the surface. The pipe must be lifted and moved around the entire shaft base until no more sediment (only fluid) comes to the surface.

2.3 – Shaft Excavation Methods

The excavation method for drilled shaft construction is dependent on a combination of factors. The following figures from the FHWA Drilled Shaft Tutorial illustrate the most common combinations.

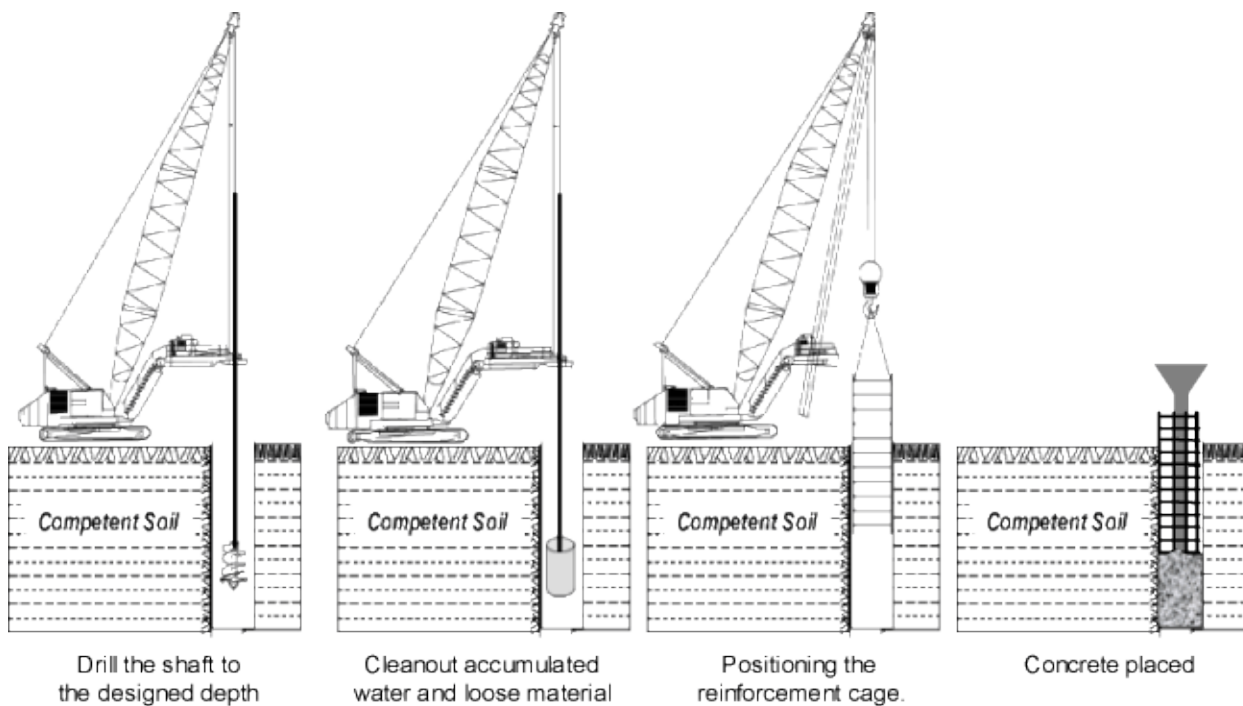


Figure 11 - FHWA Drilled Shaft Tutorial

Dry hole excavations (a.k.a. Dry Method) are the simplest option for drilled shaft construction. Only a surface (a.k.a. starter) casing is utilized if any casing at all. Surface casings protect workers and provide additional benefits. Refer to 1.4 – Equipment and Safety for more information on surface casings. The Dry Method is suited for stiff to hard clayey soils which can stand vertically without sloughing or bulging. This method may also work in cemented sands or rock above the water table. Concrete placement in dry hole excavations is by freefall methods and is discussed in 4.2.2 – Concrete Placement.

Cased excavation methods (a.k.a. Casing Method) can be used for wet or dry hole excavations. Casing is used to prevent caving in unstable soils and can also be used as a groundwater cutoff for intermediate water bearing granular layers. Casing can be temporary or permanent. Temporary casing (a.k.a. Temporary Casing Method) is installed to stabilize the excavation and is typically 6 inches larger than the specified drilled shaft diameter to allow passage of the drilling tools. The temporary casing is removed after placing sufficient concrete in the shaft excavation. Permanent casing becomes a part of the final drilled shaft. Permanent casing is often used adjacent to critical structures or structures supported on shallow footings. The permanent casing reduces the risk of damage to these structures by preventing ground movement caused by the excavation process. Permanent casing may also be used to extend the shaft above the ground surface or the water surface if constructing in a river. Other subsurface conditions may also require permanent casing.

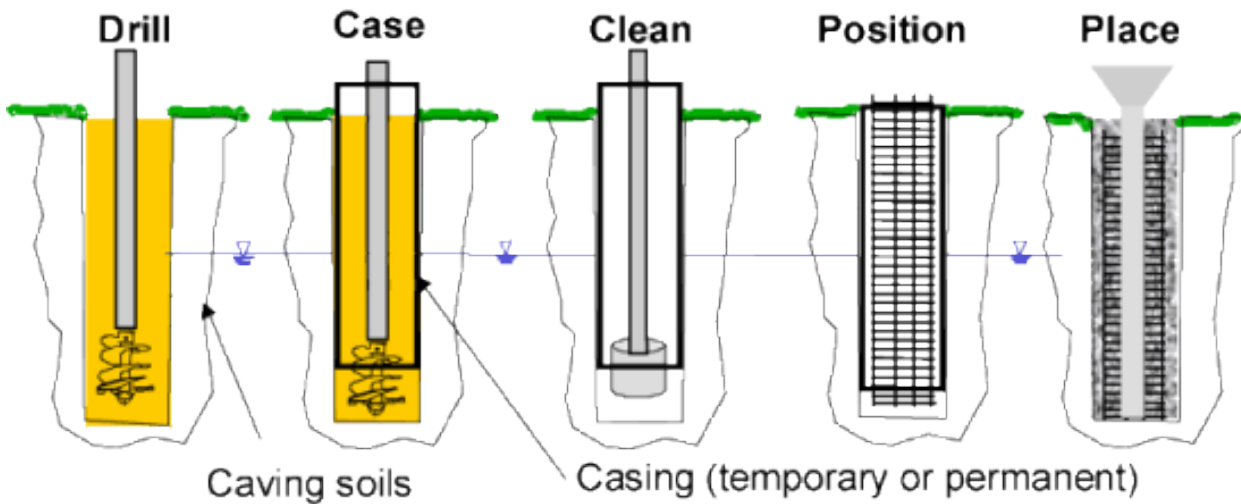


Figure 12 - Cased excavation methods

When temporary casing is used, another reason the diameter of the cased length will be enlarged is to set the casing in the excavation. The temporary casing can also be pushed or twisted into the soil ahead of the excavation. When permanent casing is used, the casing should be twisted into the soil so that it is tight against the excavation. The permanent casing must be a tight fit to provide lateral load transfer.

When temporary casing is used, and the top of the shaft is within an unstable layer, a liner may be installed within the temporary casing. The diameter of the liner is selected to be the design diameter of the shaft. The liner will also be a minimum of 6 inches smaller diameter than the temporary casing it is placed within. A liner is generally thinner steel than permanent steel casing and is usually constructed from corrugated metal pipe. Once the shaft excavation is completed, the corrugated liner is set to the appropriate level and should extend a minimum of 2 feet below the base of the temporary casing. The shaft and liner are then filled with concrete to the design level. The shaft concrete should be allowed to set overnight and the following day the space between the liner and the temporary casing (annulus) is backfilled with a cement-sand grout mixture. The temporary casing can then be removed while the grout is still fluid. Backfilling the annulus with grout and pulling the casing while the grout is fluid helps prevent a gap from developing between the liner and the surrounding soil. This also limits surface settlement which would occur over time if the annulus is left unfilled. Direct contact between the shaft or grout and the surrounding soils is imperative when shafts will support lateral loads.

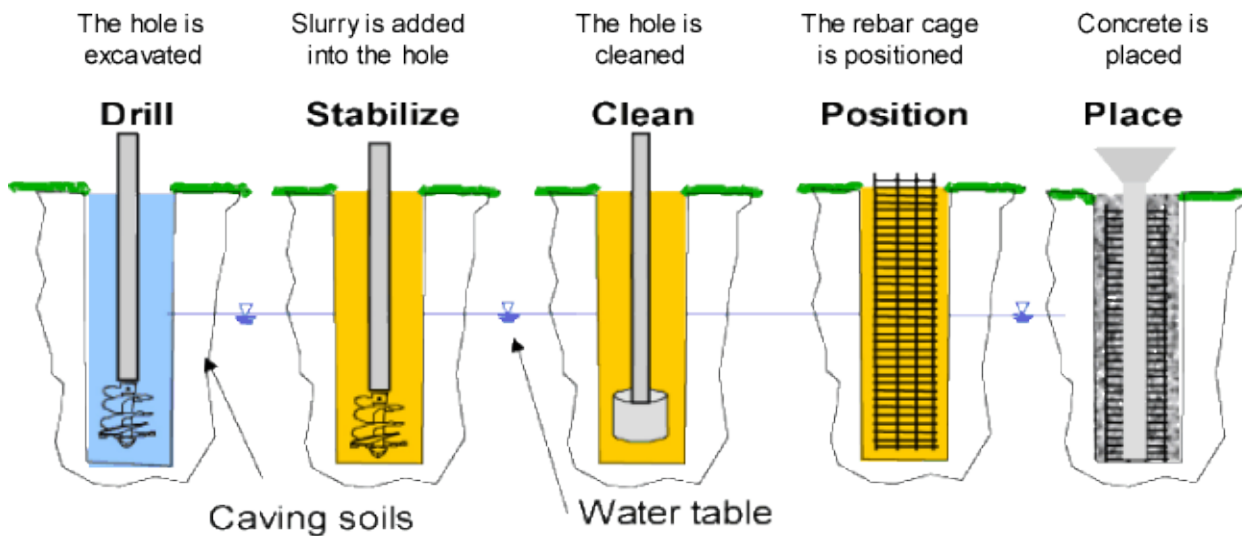


Figure 13 - Slurry Method

The most complicated construction method for drilled shafts for both the contractor and the inspector is wet hole excavations (a.k.a. Wet Method or Slurry Method). For the Slurry Method, construction is being completed in the blind. The fluid in the shaft prevents direct observation of the base and sides of the shaft. Careful construction and detailed inspection are required for successful shaft construction.

The Slurry Method is used when the excavation extends into water bearing granular soils. The shaft excavation progresses to, or slightly above the water bearing layer using either a cased hole or an open hole. The shaft is then flooded with water or slurry mixture. The level of the drilling fluid (water or slurry) in the excavation is maintained above the surrounding groundwater level. By maintaining this higher fluid level, groundwater infiltration into the excavation is prevented. Infiltration into the excavation is undesirable as it can soften and loosen the material at the base and on the side walls of the excavation. The pressure of the drilling fluid acting on the walls of the excavation stabilizes the excavation and limits the material from sloughing or caving into the excavation.

The use of solely water as the drilling fluid is rare and will require a review by the design engineer. The presence of free water against some clayey soils and rocks such as shale can cause the materials to soften. A soft layer along the shaft will reduce the amount of friction that is developed in the shaft and reduce the axial load resistance. To prevent this softening from occurring additives are introduced to the water which will create the slurry mixture. The two most common additives are bentonite clay and polymer.

When a slurry mixture is introduced into a drilled shaft excavation, the slurry will provide stability of the excavated hole by forming a filter cake (a.k.a. mudcake or slurry cake) which effectively acts as a membrane on the walls of the shaft. This membrane requires the slurry head pressure to exceed the fluid pressure resulting from the in-situ formation. Thus, a stable hole will be maintained. For the slurry head pressure to exert this positive pressure on the wall, the slurry has a density higher than the groundwater, and the slurry elevation in the hole is higher than the surrounding groundwater elevation. Refer to 4.2.2 – Concrete Placement for additional information on head pressure.

Polymer is becoming more common in drilling as it is easier to handle and requires less equipment for cleaning and reusing the slurry, than bentonite slurry. One advantage of polymer over bentonite is that sand will settle out of the polymer slurry while sand and silt become suspended in bentonite slurry. It is important to control the sand content of the slurry mixture especially prior to concrete placement. High sand content will affect the quality of the concrete and integrity of the shaft. Slurry

with a high sand content will often be too dense or too viscous to be displaced by the concrete placement operations which can create voids in the shaft. In addition, the high sand content can settle in the concrete and create soil inclusions or contaminate the surface of the concrete during the pour which can affect the compressive strength of the concrete. Over the course of three to four hours, sand will settle out of polymer slurry and can be removed from the base of the excavation using clean up tools. To remove the sand from bentonite slurry, the fluid must be circulated with pumps through screens and a centrifuge (de-sanding unit) to remove the sand particles and then be pumped back into the shaft excavation.

Strict quality control of the drilling fluid is required for water or the slurry mixture. The drilling fluid is tested for density, viscosity, pH, and sand content. The drilling fluid properties should be discussed prior to construction. A discussion of slurry disposal is also required since it is considered a pollutant. The contractor is required by specification to provide a technical representative at the jobsite for a slurry additive, and testing the water or slurry is their responsibility. However, the inspector must record test results and compare to specifications.

The density of the drilling fluid is checked with a mud balance. The viscosity of the drilling fluid is determined by measuring the amount of time required for a quart of drilling fluid to flow through a specially sized (Marsh) funnel. The pH of the drilling fluid is used to determine how acidic or basic the drilling fluid is in the shaft. Digital pH meters or test strips are common methods used to evaluate the pH of the fluid.

The sand content of the drilling fluid is determined by passing a specific volume of drilling fluid through a screen which captures all sand sized and larger particles. The volume of sand retained is then determined using a measuring cylinder. When sampling slurry from a shaft excavation, it is important to sample slurry within 12 inches of the base of the excavation just before the concrete is placed. Specially designed slurry samplers are available for bottom sampling.

If the sand content fails for bentonite slurry, the drilling fluid from the bottom must be circulated through the de-sanding unit and added back into the top of the shaft. Another sand content sample is taken, and the test repeated. If the sand content fails for polymer slurry, wait one to two hours for additional sand to settle out. After the waiting period, the contractor will need to clean the shaft bottom again and the test is repeated.

3 Shaft Excavation Inspection

3.1 – Work Plan

The Contractor is required to submit a Drilled Shaft Qualifications and Installation Plan ([Form BBS 133](#)) at least 28 days prior to drilled shaft construction according to Section 516. Thereafter, a pre-drill meeting is held with the Contractor before construction. The goal of the meeting is to have a clear understanding of the Contractor's plan to construct the drilled shafts. At the same time, the Contractor should have an understanding of how the inspector intends to inspect the shafts and the need to work together. Refer to 8.2 – Example of Drilled Shaft Pre-Drill Meeting Agenda for assistance with developing an agenda.

3.2 – Excavation

When shaft excavation is ready to proceed, it is recommended to notify the District Geotechnical Engineer. The District Geotechnical Engineer can provide assistance with testing of the soil excavation material as discussed in 1.4 – Safety and Equipment. It is also recommended to have the contact information of the design engineer. Once the shaft excavation process begins, it is important for the inspector to record construction as it proceeds. Accurate records are essential if any design changes are required. To accomplish this, the Drilled Shaft Excavation and Inspection Record ([Form BBS 134](#)) is completed. During shaft excavation, the inspector needs to observe and record the soil conditions which are encountered. It is important to compare these conditions to the soil boring logs in the vicinity to confirm that the encountered soil conditions match the conditions that were used to develop the design of the shaft. The drilled shaft Inspector will record the soil type, depth, strength, and any other observations that help identify the soil, and will note any groundwater or caving conditions. If there are significant deviations in soil types, soil stratum depths, soil strengths, or other ground conditions encountered by the driller when compared to the soil boring logs, the inspector is required to notify the design engineer.

It is also important to record the dimensions of the excavation. In cased excavations, the diameter of the shaft may vary with depth. The inspector needs to record the levels at which the casings extend to and the depths and diameters of the casings. If any other changes in diameter occur, such as a rock socket, they must also be recorded.

The length of the shaft in the soil and the rock also needs to be recorded accurately. If the lengths are different than those indicated on the design drawings, the inspector needs to notify the design engineer.

Once the shaft excavation has reached the design depths the inspector needs to confirm that the material at the base of the excavation meets the requirements of the design, the base of the shaft is sufficiently clean, and the shaft meets the specified vertical plumbness. To determine vertical plumbness of the shaft, compare the location of the top of shaft to the bottom of shaft. Take the difference in top and bottom location divided by shaft length to determine percent out of plumb.

The inspector should be aware of the smearing of medium to soft clays on the walls of the excavation. If the contractor is not careful about how these materials are removed, they can adhere to the sides of the excavation and act as a lubricant between the shaft concrete and soils surrounding the shaft. If the inspector suspects that the sides of the shaft have been slickened by auger trimmings, then the contractor should ream the hole until the sides are returned to their original condition. A shaft may also need to be reamed if the sidewall has softened, swelled, or has a buildup of slurry cake.

When excavating while using the Slurry Method, the augers should enter and exit the excavation slowly. Any fast movements may cause turbulence and possibly erode the sides of the excavation.

The inspector should also record any observations that water has softened the soil or rock as discussed in 2.3 – Shaft Excavation Methods.

3.3 – Obstructions and Differing Site Conditions

During the course of the excavation process obstructions may be encountered, and the contractor may be entitled to additional compensation. IDOT specifications define an obstruction as “an unknown isolated object that causes the shaft excavation method to experience a significant decrease in the actual production rate and requires the contractor to core, break up, push aside, or use other means to mitigate the obstruction. Subsurface conditions such as boulders, cobbles, or logs and buried infrastructure such as footings, piling, or abandoned utilities, when shown on the plans, shall not constitute an obstruction”. When an obstruction is encountered, the contractor is to notify the inspector for concurrence that an obstruction has been encountered. Thereafter, the work effort to remove the obstruction is recorded by the inspector, which will allow additional compensation to the contractor. In addition, there is no deduction to the measured shaft length when measuring for payment.

In regard to obstructions, a boulder or cobble is one of the more common since a small diameter boring could easily miss it. Per AASHTO M 146, a boulder is defined as a rock fragment with an average dimension of 12 inches or more, and a cobble has an average dimension between 3 and 12 inches. A boulder or cobble may be removed by a downhole hammer as discussed in 2.2.2 – Rock Drilling Tools, but this is uncommon. Other more common methods include a grab bucket or clamshell, boulder rooter (basically a tapered auger), or a hammergrab. A hammergrab is a percussion tool that both breaks and lifts rock. Hammergrabs are heavy and the jaws are closed when the tool is dropped to break the rock. The jaws are then used to pick up the broken rock. A rock breaker/drop chisel (heavy object to break rock) in combination with a grab bucket or clamshell may be used in lieu of a hammergrab. The disadvantage is the need to make a tool change, whereas a hammergrab can do it in one operation.

A differing site condition is different from an obstruction and may be one of two types. The first type is defined in Article 104.03 as subsurface or latent physical conditions encountered at the site differing materially from those indicated in the contract. One example would be larger rock, such as encountering cobbles and boulders instead of sand in a soil boring strata. Another example would be rock that is harder to drill, such as granite instead of limestone was encountered. For the Contractor to receive additional compensation, the contractor must prove the following:

1. The contract documents must have affirmatively indicated or represented the subsurface or latent physical conditions.
2. The contractor must have acted as a reasonably prudent contractor in interpreting the contract documents.
3. The contractor must have reasonably relied on the indications of the subsurface or latent physical conditions in the contract.
4. The subsurface or latent physical conditions actually encountered within the contract area must have differed materially from the conditions indicated in the same contract area.
5. The actual subsurface conditions or latent physical conditions encountered must have been reasonably unforeseeable.
6. The Contractor’s claimed excess costs must be shown to be solely attributable to the materially different subsurface or latent physical conditions within the contract site.

The second type is defined in Article 104.03 as unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the

work. An example of this would be a hazardous waste deposit. For the Contractor to receive additional compensation, the contractor must prove the following:

1. That it did not know about the condition
2. That it could not have reasonably anticipated the condition after a review of the contract documents, a site inspection, and the contractor's general experience in that area.
3. That the condition was unusual because it varied from the norm in similar construction work.

When a differing site condition is encountered, the compensation for a portion of the measured length of the shaft may be adjusted according to Article 104.02. When a differing site condition occurs, the inspector should notify their supervisor and the design engineer.

3.4 – Shaft Sizes and Tolerances

During construction it is important to record the length and diameter of the shaft. In some cases, the diameter of the shaft may be slightly larger than the diameter indicated on design drawings. When telescoped casing sections or a casing with a liner is installed some portions of the shaft may be larger than the design diameter of the shaft. Oversizing the diameter of the top of the shaft is required so that the base of the shaft meets the minimum design diameter requirements.

The length of the shaft may vary slightly from the design length. Shafts are often designed to bear at or near the top of a hard layer. Slight over excavation is sometimes necessary to meet the required bearing condition. For rock socketed drilled shafts, the constructed length of the rock socket must be at least the length indicated on the design drawings regardless of the overall shaft length.

Section 516 provides the specific requirements regarding construction tolerances and should be reviewed by the inspector.

3.5 – Squeezing, Necking and Cave-Ins

A contractor using the proper size excavation equipment does not necessarily insure that the shaft excavation will be the required diameter. A number of problems can occur during the excavation process that will provide a larger or smaller shaft. In soft cohesive soils, squeezing or necking of the shaft can occur if the shear strength of the soft clay is not sufficient to support the weight of the overburden soils at the free face of the excavation. The weight applied to these low strength soils could cause the clay wall to squeeze into the shaft creating a smaller diameter. Squeeze is more likely to occur the longer a shaft is kept open. To preventing necking, casing or slurry should be extended into the soft layer to provide stability.

A simple formula for predicting clay squeeze relates the clay unconfined strength to the depth of the excavation:

$$Q_u \text{ required (tsf)} \geq H \text{ (ft)} / 50$$

If the measured unconfined compressive strength of a clay sample taken off an auger flight is less than the depth of the shaft divided by 50, there is a risk of squeeze occurring. Clay with a water content that exceeds 30% is also an indicator of potential squeeze problems.

Example: A boring log shows soft clay with an unconfined strength of 0.4 tsf at a depth of 40 ft below grade. The contractor intends to open drill through the material. The water content of the soft clay is 35%. Based on the formula, the necessary unconfined strength to resist squeeze at 40 ft would be 40/50 or 0.8 tsf. The strength shown on the boring log is 0.4 tsf or ½ that predicted for stability. Also, the high-water content

(> 30%) is an indicator of potential squeeze. Thus, squeeze is likely if casing or slurry is not used.

In some soils, typically more granular materials, caving and sloughing of material off the sides of the excavation can occur. Caving of clayey soils can also occur when excavations are left open for long periods of time. The excavation process disturbs the soils on the shaft walls which loosens them. As the auger comes in and out of the excavation, or if groundwater flow is present, these loosened soils will slough off the side of the excavation and fall in.

To identify if necking or caving is occurring it is necessary to pay close attention during excavation especially as the excavation tools are entering and leaving the excavation. If the shaft is experiencing necking the auger will consistently hang up at the same depth. If caving is occurring, materials from the upper parts of the shaft will fall onto the auger, drilling bucket or bell bucket as they enter and leave the excavation. Also, after the tool is out of the hole, the inspector will be able to hear caving soils falling into the base of the excavation.

If necking is occurring, casing should be installed into the excavation to below the level experiencing squeezing. Casing should also be installed when sloughing soils are encountered. The alternative to casing is slurry. If squeezing soils are not supported by casing or slurry, the shaft section could be inadvertently reduced which will lower the capacity of the shaft. If caving occurs during concrete placement, the resulting soil inclusions would represent a major defect and the shaft capacity would be reduced.

3.6 – Rock Sockets

As previously discussed, rock socketed drilled shafts often develop the majority of their capacity in the rock socket. Therefore, it is very important to make sure the rock socket is the proper length and diameter. The rock socket length is measured from the rock surface to the bottom of the rock socket. To accurately determine the socket length, it is necessary to accurately determine the location of the top of rock. Section 516 defines rock as “bedded and conglomerate deposits exhibiting the physical characteristics and difficulty of rock removal”. Essentially, the top of rock surface is defined when the excavation can no longer proceed using conventional earth excavation equipment. When refusal is encountered with an earth auger and rock drilling equipment such as rock augers or coring equipment is required to continue the excavation, rock has been encountered.

When rock is encountered, the elevation of the top of rock should be compared to the elevation rock was encountered at in the nearby soil borings. If the rock is encountered higher than expected the shaft excavation may be resting on shelf rock or a boulder. The inspector should observe that the degree of drilling difficulty does not reduce substantially while drilling the rock socket.

For end bearing drilled shafts on the top of rock, confirmation that the shaft is supported on bedrock and not just a boulder or shelf rock over soil is even more important. The inspector may ask the contractor to use a core barrel to extend a shaft deeper into bedrock when unusual conditions are encountered or when doubt exists.

If the top of rock elevation differs from that shown on the plans by more than 10 percent of the length of the drilled shaft above the rock, the inspector is required to notify the design engineer. Refer to 3.7.3 – Rock Socket Shafts and Top of Rock Shafts for additional information.

3.7 – Shaft Acceptance

3.7.1 – Friction Shafts

The first step in evaluating the acceptance criteria for a shaft is determining if the shaft develops its capacity through skin friction or end bearing. If this cannot be determined from the Structure Geotechnical Report or the plans, the inspector should contact the design engineer. For friction

shafts, it is necessary to evaluate the soil profile over the entire shaft length as explained in 3.2 - Excavation. If the conditions don't match nearby soil borings or if the inspector is unsure about the conditions, contact the design engineer immediately. Be prepared to provide the conditions encountered.

3.7.2 – End Bearing Shafts in Soil

For end bearing shafts in soil two essential items need to be checked. First, the inspector needs to determine if the materials encountered at the base of the excavation are strong enough to support the loads that will be imposed by the shaft. Second, the inspector needs to determine if the soil is the correct material based on the design assumptions. If the shaft bears in sand or silt, it is not possible to test the base material other than confirming that the material type is correct. In clayey soils the unconfined compressive strength of the base material can be estimated by testing the auger cuttings from the bottom of the shaft. A number of tools are available for the testing including hand penetrometers and a RIMAC. The allowable bearing resistance can be approximated as 1.5 times the unconfined compressive strength.

If the bearing soil is not strong enough, contact the design engineer. The design engineer may extend the shaft deeper to find suitable bearing soils, require a larger diameter shaft, or require a larger diameter bell.

3.7.3 – Rock Socket Shafts and Top of Rock Shafts

As previously discussed for shafts bearing in or on rock, the majority of the shaft resistance is developed within or on the rock. The following items are to be checked for rock shafts.

- Confirm the top of rock elevation compares to soil boring and rock core logs as discussed in 3.6 – Rock Sockets.
- Confirm the encountered rock type matches the rock core logs.
- Confirm that there were no voids or weak seams encountered when excavating the rock socket. If voids or weak seams are encountered, contact the design engineer.
- Confirm the bottom is clean. Refer to 3.5.4 – Bottom Cleanliness for additional information.

3.5.4 – Bottom Flatness and Cleanliness

For shafts bearing on soil or rock, specifications require excavation equipment to have a nearly planar bottom. The specifications further state that for shafts bearing on rock the cutting edges of excavation equipment used to create the bottom of shafts in rock shall be normal to the vertical axis of the shaft within a tolerance of 6.25 percent. Thus, when using a rock auger for soft rock, the bottom must be completed with a flat-bottomed auger and a stinger is not allowed. The alternative to the flat-bottomed auger is to allow the rock auger to create a pilot hole with the stinger. A core barrel is then used, and the pilot hole provides some stress relief for final excavation. Bottom flatness is a key factor to facilitate the cleaning of the shaft. Contact the design engineer if there are concerns with the bottom flatness.

For all shafts which are supported partially or entirely supported by end bearing, bottom cleanliness is a critical issue. Loose auger cuttings at the base of the excavation create a compressible layer which is not suitable to support the foundation loads. For open dry shafts, visual inspection of the base of an excavation is often possible. The base of the excavation can be lit when necessary by using a high lumen flashlight or by lowering an explosion proof light to the base of the excavation. For extremely deep excavations or excavations with an enlarged base, an explosion proof camera with a visual depth measurement gauge can be lowered to the base of the excavation for direct observation of the base cleanliness. When direct observation of the base of the excavation is not

possible because of the use of drilling slurry, sounding the base of the excavation with a weighted tape or rock probe is necessary.

The base of the excavation should be sounded at five locations. Check the center of the hole, which is usually the cleanest. Then check the sides of the hole at four locations around the circumference of the shaft. If the weight strikes the bottom and stops immediately, the drilled shaft has little or no sediment and debris. Lifting and dropping the feeling device should produce the same feel everywhere if the bottom is firm, flat and uniform. If there is any doubt, perform additional cleaning of the hole. Refer to Section 516 for the depth of sediment or debris allowed for a drilled shaft terminating in soil or rock.

For shafts bearing on soil, a clean-out bucket should be sufficient. Check that the clean-out bucket has a flat bottom, and also check that the bucket is not riding up and down on a boulder or uneven rock when cleaning the hole. Refer to 2.2.3 – Clean Up Tools for more information on knowing when the hole is clean. For shafts bearing on rock, an airlift pump or downhole pump is frequently required to get the shaft bottom sufficiently clean. Refer to 2.2 – Clean Up Tools for more information on airlift and downhole pumps. For belled shafts on soil, clean the bottom with a bell bucket as best as possible. The remaining spoils can be back-bladed to the bell periphery with a 1-foot over-sized bucket.

4 Rebar and Concrete Inspection and Installation

Once the shaft excavation is completed the role of the inspector is not completed. The inspector also needs to confirm that the concrete and reinforcing steel are placed properly in the drilled shaft and meet the project requirements.

4.1 – Rebar

The contract documents will show the reinforcing steel details for each drilled shaft. Fabrication usually occurs at the project site but can be prefabricated in some cases. When the cages are fabricated at the project site, they are built on the ground giving the inspector ample opportunity to observe the fabrication process. Reinforcing steel (rebar) for drilled shafts is typically tied in a circular cage. The cages consist of vertical reinforcing bars tied together with circular hoop ties or spiral ties. The following items need to be checked when inspecting a rebar cage.

- Check the grade of steel shown on the plans matches the mill certificate.
- Check the rebar number, sizes, spacing, lengths, and clearances match the plans. The vertical spacing for the spiral bar is sometimes referred to as pitch.
- Check the cage diameter matches the plans and the cage length meets field drilled lengths. A sizing hoop (a.k.a. gauge hoop) may be used to aid in the fabrication of the rebar cage with the approval of the design engineer. The gauge hoop is located within the interior of the cage.
- Check proper rebar lap lengths. When mechanical splicers are specified, lap splices are not to be substituted. Lab or mechanical splices should be staggered to prevent an obstruction to concrete flow, and for structural considerations. The inspector should contact the design engineer if there are any questions.
- Refer to Section 508 and Article 1006.10 for additional rebar requirements.

After the inspector has confirmed the rebar cage meets the design requirements, additional considerations related to the installation are required. It is important the rebar is free from mud and debris when placed in the hole. It is also important the cage is lifted and installed properly. The cages should be picked up and moved from multiple lifting points. Cross bracing should be installed within the cage to prevent deformation. In some cases, a lifting cradle (a.k.a. as a strong-back) can be attached to the cage to prevent the cage from deforming.

When the cages are lifted, the inspector must look for any twisting or distortions that may have bent bars. Rebar cages are built horizontally on the ground and then lifted vertically for lowering into the hole. The cages themselves are long, slender and flimsy. The process of lifting a cage to a vertical position can severely distort and bend portions of the rebar cage. High stress concentrations can develop in a drilled shaft when distorted cages are used. Closely examine the rebar cage as it is lowered into the hole. If the inspector notices significant bending or distortion of the bars that affects bar straightness, spiral pitch, bar spacing, or cage shape and diameter, the cage should be lifted from the hole and the bent bars replaced. Once the cage has been lifted and set in place, no visual permanent deformation should be noted. The specified vertical plumbness of the rebar cage is then checked. To determine vertical plumbness of the rebar cage, compare the location of the top of rebar cage to the bottom of rebar cage. Take the difference in top and bottom location divided by cage length to determine percent out of plumb.

Cage centralizers (a.k.a. rolling spacers) are also required for drilled shaft construction. Centralizers ensure that the minimum rebar concrete cover is provided around the perimeter of the cage, and they keep the rebar cage properly aligned in the hole until the concrete is placed.

Centralizers should be round and roll freely around the bars when they are attached to the reinforcement. If they can turn freely as the cage is lowered into the hole, they will minimize the amount of loose material that falls into the hole if the cage hits the side of the excavation. The centralizers should be attached to the hoop or spiral ties so that they roll vertically along the shaft wall. Centralizers are required to be constructed from a non-corrosive material. Two examples are a concrete ring or plastic wheel. The centralizers should be attached at multiple points around the perimeter of the cage, at the maximum vertical spacing, and near the top and bottom of the cage as specified in Section 516.

To prevent rebar corrosion, the design drawings may require concrete cover between the base of the drilled shaft and the rebar cage. Plastic chairs or other devices may be used for this purpose. The devices may also be called clearance boots.

Rebar spacing must be designed to work with the concrete mix design. It is recommended the clear spacing between rebar should not be less than 5 times the nominal maximum aggregate size for concrete placement in a dry shaft, and 8 times the nominal maximum aggregate size for concrete placement underwater. It is also recommended the nominal maximum aggregate size does not exceed two-thirds the clear distance between the reinforcement bar and the permanent casing or shaft wall. Nominal maximum aggregate size is defined as the largest sieve which retains any of the aggregate sample particles. IDOT Class DS concrete mix designs typically use a nominal maximum aggregate size of ½ inch or less.

When non-destructive testing tubes are added to a cage as explained in 6 Non-Destructive Testing and Loading in this manual, they would typically be placed midway between vertical bars. However, if the clear spacing between the tube and bar drops below the recommended spacing, concrete placement problems could occur. If this occurs, contact the design engineer.

One final comment on rebar consists of the term “bundled” bars. The inspector should be familiar with this term. In some cases, two or three vertical bars are placed next to each other to increase the steel percentage, and to maintain appropriate rebar spacing for concrete placement.

4.2 – Concrete

Multiple items need to be checked and monitored for concrete and are discussed in the following sections.

4.2.1 – Concrete Mix Design Slump and Slump Retention

As previously discussed, one crucial issue in the concrete mix design is the acceptable nominal maximum aggregate size for the rebar spacing. Another important issue is maintaining proper slump. According to Article 1020.04, the slump is to be 6 – 8 inches. If concrete is placed to displace drilling fluid (water or slurry), or against temporary casing, the slump shall be 8 – 10 inches at the point of placement. This fluid concrete is required since vibrators are not used to consolidate the concrete around the rebar, and to fill any voids along the wall of the excavation. Filling the voids will enhance the skin friction of the shaft.

Section 516 has additional requirements for slump which involves slump retention. Temporary casing is to be withdrawn before the slump of the concrete drops below 6 inches. The higher slump will make it easier to remove the casing. It will also ensure the concrete will displace any drilling fluid and will flow out and fill any voids behind the casing during the removal process. Another requirement is the slump of all concrete placed shall be a minimum of 6 inches at the end of concrete placement for the Slurry Method. This is required to ensure the initial concrete placed and pushed up and out of the shaft is fluid and will not entrap laitance or sediment in the concrete and thus the shaft itself. In order to know how long the mix will provide a slump of at least 6 inches, a trial batch of the concrete mixture is required for these two situations. A simple method for performing the trial batch is as follows:

- Batch four cubic yards of concrete. It is important to batch at the approximate concrete and air temperatures anticipated in the field.
- Obtain a sample of the concrete by filling up a five-gallon bucket. The remaining concrete is available for use on the project.
- Perform a slump test every 15 minutes until it at least falls below 6 inches. No additional testing is recommended if the slump reaches 4 inches. It is suggested to plot the results with slump on the vertical axis and time on the horizontal axis. This will help to interpolate the time when the slump reaches 6 inches. After the test is completed, the concrete is put back in the bucket.
- During the interim between slump tests, put a lid on the bucket and place the bucket in a wheelbarrow filled with water. The lid will prevent evaporation, and the water should help minimize heat gain between tests. It is also important to keep the bucket in the shade.

For a mix design, slump retention can be maximized by batching the maximum water, using a retarder, and using a long-lasting superplasticizer. Certain retarders known as hydration stabilizers will work a little better to retain slump because the delay in set is a very linear relationship. However, any retarder is acceptable. In regard to a long-lasting superplasticizer, the polycarboxylate type superplasticizer has the longest retention time.

4.2.2 – Concrete Placement

Concrete placement is a critical stage of shaft construction, and the shaft needs to be ready before concrete arrives to facilitate a quality concrete pour. Holes normally are not left open overnight because of the risk of a major collapse. IDOT specifications require concrete placement to begin within 1 hour of shaft cleaning and inspection. As soon as the hole is accepted for cleanliness, the Contractor shall begin to set the rebar cage. This rapid sequence of events will minimize the chance of shaft material sloughing or caving in the hole, which would require it to be cleaned again.

Once concrete placement begins, it is important to record concrete placement as it proceeds. To accomplish this, the Drilled Shaft Concrete Placement Log ([Form BBS 135](#)) is completed. This form provides a log of key information that should be recorded on the job. Any problems encountered while placing the concrete such as movement of rebar cage or loss of concrete slump retention is recorded.

For open dry shafts, concrete can often be placed by free fall. A critical issue with free fall placement is not allowing the concrete to fall through standing water. Free fall placement is allowed if there is a small amount of standing water present in the base of the excavation and water infiltration is low. IDOT specifications require the rate of water infiltration into the shaft to be less than 12 inches per hour, and the depth of water in the shaft excavation to be less than 3 inches at the time of concrete placement. Research has shown that concrete falling through as little as 6 inches of water can reduce the unconfined compressive strength of the concrete by half. If the water depth is more than 3 inches, the Contractor may use a small diameter cleanout bucket, air lift pump, or dewatering pump to remove the water. If the water infiltration rate into the shaft is greater than 12 inches per hour, free fall is prohibited because poor quality concrete may occur despite efforts to dewater the hole immediately before concrete placement.

Another important consideration during free fall placement is placing the concrete down the center of the excavation. Concrete should not hit the side walls of the excavation or the rebar cage as it falls down the excavation. This will segregate the coarse aggregate from the mortar within the concrete mixture. IDOT specifications state that concrete shall not be allowed to fall more than 60 feet for conventional concrete and 30 feet for self-consolidating concrete. If the shaft length is

greater than the allowable free fall height, a drop chute can be used to decrease the free fall height to within allowable limits.

When concrete must be placed in an excavation with more than 3 inches of standing water or the infiltration rate is greater than 12 inches per hour, concrete must be placed by tremie or concrete pump. A tremie or pump is also used for the Slurry Method of construction. The purpose is to prevent intermingling of the concrete with the drilling fluid (water or slurry). Concrete placed by tremie or pump should have a slump at the upper limit of the allowable slump range.

For many shafts, it will not be possible to visually monitor the excavation as the concrete placement continues. This is especially true for concrete placement when displacing drilling fluid. The shaft and top of concrete will be obscured from view for the majority of the pour. To monitor the integrity of the shaft, which should be done for dry or wet shafts, the volume of concrete placed is monitored along with the height of the concrete in the shaft. A theoretical line relating volume to depth is created and compared to the recorded values. Normally a measurement is taken after discharge of each truck, and this information is recorded by the inspector on the front and back of the Drilled Shaft Concrete Placement Log ([Form BBS 135](#)). An explanation for calculating the theoretical line follows:

- For a straight shaft, the total volume is the shaft area times the shaft length. Be careful about units, since concrete is measured in cubic yards. The shaft dimensions are measured in feet, and the calculated cubic feet volume is divided by 27 to get cubic yards.

- The formula is $((\pi r^2) \times (\text{shaft length})) \div 27$.

- Example:

Shaft Diameter = 4.0 feet

Shaft Radius = 4.0 feet \div 2 = 2.0 feet

Shaft Length = 60.0 feet

$\pi = 3.14$

$((3.14 \times 2.0^2) \times (60.0)) \div 27 = 27.9$ cubic yards

- Straight shafts may vary in diameter over the length. For example, the diameter of a rock socket is normally smaller than the shaft. In this case, compute the volume for each segment and add the segments together to get the total volume.
- Note: There is an alternate formula that may be used and is explained in 8.3 – Drilled Shaft and Belled Concrete Volume Calculation Tables.

When comparing the theoretical concrete volume to be placed with the actual concrete volume placed, this is done after discharge of each truck. If the actual amount of concrete placed is larger, this can be an indication there was a void or cavity in the wall of the shaft. If the actual amount of concrete placed is smaller than the theoretical volume, this can be an indication of a void in the shaft. A void may occur from pulling the casing (Refer to 4.2.3 – Removal of Temporary Casing), shaft squeeze or necking because of soft soils, side wall caving or sloughing of the excavation, or the concrete did not flow through the rebar cage due to slump.

At the beginning of tremie or pump placement, the initial concrete flow must be in a manner that will not cause contamination of the concrete with the drilling fluid. IDOT specifications require a “closed” tremie or pump system to be used. For this system, the discharge end will use a steel pipe with a steel or wood flap gate that has gaskets. Another option is a wood plug which may float to

the surface. The wood plug is beveled to hold it in place, or it may be tied to the steel pipe to keep it in place. The wood plug is covered with a sheet of plastic or shall have a gasket. The inspector is advised that aluminum or plastic pipe is not allowed as a substitution for steel pipe. Aluminum will react with the concrete and plastic pipe has been known to break. Steel pipe has the additional advantage of being heavier and will counteract buoyancy.

IDOT specifications do not allow an “open” tremie or pump to be used. A traveling plug (a.k.a. as a pig or rabbit) constructed of polystyrene, closed cell foam, or foam rubber is inserted ahead of the concrete. A similar plug is the go-devil, which is a ball of rolled-up burlap or specially fabricated material. The traveling plug displaces the water inside the tremie pipe or pump line as the concrete falls or is pumped, which will prevent intermingling of water and the concrete. The plug normally floats to the surface once it has exited the discharge end. The disadvantage of the plug is the concern it will compress as it moves against the hydrostatic pressure from the drilling fluid, allowing the concrete to mix with the drilling fluid. Also, a traveling plug is not to be used after the loss of seal, where the discharge end of the tremie or pump becomes separated from the concrete. Once concrete flow is initiated, IDOT specifications require the discharge end to remain embedded in the concrete. If the traveling plug is used to restart concrete placement, it will push out water out of the pipe. This will wash cement and cementitious materials out of the previously placed concrete.

During the initial placement of concrete with a tremie or pump, the discharge end shall be kept within a few inches of the bottom until the discharge end of the tremie or pump is a minimum of 10 feet below the concrete surface. This will ensure there is no breach of the seal created by embedding the end into the concrete. A breach can occur when there is not a sufficient head of concrete when raising the tremie or pump pipe. If the drilling fluid (water or slurry) head pressure is higher, it is possible for the drilling fluid to “back-surge” or enter the discharge end. This will cause the concrete and drilling fluid to intermix. IDOT specifications require a minimum of 10 feet of embedment throughout concrete placement. It is not recommended to have excessive embedment. Excessive embedment into the concrete can cause the reinforcing cage to lift along with the rising column of concrete. The inspector must monitor the embedment of the tremie or pump into the concrete at all times throughout the pour.

As previously discussed in 4.2.1 – Concrete Mix Design Slump and Slump Retention, it is important for all concrete to have a minimum 6 inches of slump at the end of the pour for the Slurry Method. Therefore, for concrete being placed it is recommended to monitor slump loss as explained in 4.2.1.

At the completion of the concrete pour, there will be contaminated concrete at the surface since it was in contact with the drilling fluid. Shaft material such as soil and debris will also be mixed in with the concrete. Even a dry excavation can have contamination because of accumulated bleed water. IDOT specifications require concrete placement to continue until 18 inches of good quality, uncontaminated concrete is expelled at the top of the shaft. The inspector has the option and is encouraged to take a strength sample to ensure the concrete is of acceptable quality after the 18 inches is expelled. The inspector is also reminded that contaminated concrete must be expelled and disposed of in a proper manner.

If at any time the discharge end of the tremie or pump does not remain embedded in the concrete, restart the pour with the previously discussed “closed” system. Since there has been a break in the seal, the concrete may have to be over poured several feet to flush out the contaminated concrete.

4.2.3 – Removal of Temporary Casing

A common technique during drilled shaft construction is the removal of temporary casing during concrete placement. This technique is often referred to as the “pour and pull” method. The method can be used with single temporary casing or multiple, telescoped casings. The temporary casing was installed to retain a squeezing layer, water bearing layer or caving layer. The casing for these

layers cannot be removed until the concrete level is above the layer of concern a sufficient level to maintain the stability of the layer. As the concrete level rises in the shaft and into the casing, the casing is generally broken loose to relieve some of the friction along the side of the shaft. During removal of the casing, the level of concrete in the casing shall be maintained at a level such that the head pressure inside the casing is a minimum of 1.25 times the head pressure outside the casing. The purpose of this head pressure is to prevent breach of the casing and inflow of drilling fluid. The drilling fluid will most likely be mixed with soil. This pressure head will also help fill surface voids in the wall, and compact loose soil material to ensure a tight fit for friction purposes. In no case shall the concrete be less than 5 feet above the bottom of the casing when the casing is broken loose to ensure this tight fit. It is possible for the casing to jump 3 or 4 feet when it is broken loose. An example of inside and outside head pressure when removing casing follows.

- Concrete head is calculated as unit weight of concrete times the depth of concrete in feet within the shaft. Assume the unit weight of concrete is 145 pounds per cubic feet.
- Drilling fluid head (water or slurry) is calculated as drilling fluid unit weight times the depth of drilling fluid in feet within the shaft. Assume the unit weight of drilling fluid (in this case water) is 62.4 pounds per cubic feet.
- Outside head pressure is calculated as unit weight of groundwater times the depth of groundwater in feet, which is measured from the bottom of the casing to the groundwater elevation. Assume the unit weight of groundwater is 62.4 pounds per cubic feet.
- Example:

Assume the depth of concrete inside the casing is 5 feet. The 5 feet is measured up from the bottom of the casing.

Concrete Head Pressure = $145 \times 5 = 725$ pounds per square feet

Assume the depth of drilling fluid inside the casing is 10 feet above the concrete.

Drilling Fluid Head Pressure = $62.4 \times 10 = 624$ pounds per square feet

Total Head Pressure Inside the Casing = $725 + 624 = 1,349$ pounds per square feet

Assume the depth of groundwater measured from the bottom of the casing to the groundwater elevation is 20 feet.

Total Head Pressure Outside the Casing = $62.4 \times 20 = 1,248$ pounds per square feet

Minimum Head Pressure Required Inside the Casing = $1.25 \times 1,248 = 1,560$ pounds per square feet

The actual head pressure inside the casing is inadequate per specifications to begin removal of the casing.

When casing is used, it is important the interior of the casing is free from concrete to facilitate removal. It is also important the inspector measure the depth of concrete before and after the casing is broke loose. If the concrete has risen, this is an indication that soil or drilling fluid has been sucked into the shaft. This could result in necking of the shaft or complete loss of concrete in a section of the shaft. When the casing is pulled, the concrete will normally drop immediately because of voids behind the casing. In addition, it is essential to have a continuous supply of concrete to ensure the head pressure inside the casing exceeds the head pressure outside the casing.

Even with head pressure, it is also essential to have the slump of the concrete at least 6 inches. It is possible that the Contractor will not be able to remove the casing if too much slump is lost. Therefore, it is recommended the inspector select appropriate samples of concrete to monitor slump loss as explained in 4.2.1 – Concrete Mix Design Slump and Slump Retention. By having 6 inches of slump, the concrete will be able to flow and displace drilling fluid, as well as completely fill the excavation. If there is inadequate slump, problems may occur such as arching or lifting of the concrete when the casing is raised. This may then cause a “neck” to form below the casing or possibly lift and twist the rebar cage. The inspector should place a target on the rebar cage and monitor movement with a level at the time when the casing is broken loose.

To pull casing, normally a downward pressure is used to cause movement. Hammering, or vibrating the casing may also be used to facilitate extraction. After the casing is broken loose, concrete placement should then proceed up to or slightly above the design concrete level. Once the final concrete level is achieved, the casing can be removed provided the head pressure in the casing is 1.25 times the head pressure outside the casing. As the casing is removed, continue to check the concrete level. The concrete will fill any voids behind the casing, and thus the level will drop slightly. Therefore, make sure there is a continuous supply of concrete. If the concrete level rises, it would be an indication that soil or drilling fluid outside the casing has collapsed into the concrete forming a defect.

5 Inspector's Checklist and Documentation

IDOT's Bureau of Construction has developed Construction Inspector's Checklists to provide guidance on the required inspection for various categories of work. [The Construction Inspector's Checklist for Drilled Shafts](#) provides a list of items to inspect before, during, and upon completion of work.

In regard to documentation, accurate and timely documentation of the drilled shaft construction process is an essential part of the drilled shaft inspector's job. All forms and documentation should be performed as the work progresses and on a daily basis. All forms for the project must be filled out completely. Use the filed book for inspection of construction tolerances, and to record any additional information.

There is a total of three documents which the inspector is required to complete. The first document to complete is the Drilled Shaft Excavation and Inspection Record ([Form BBS134](#)) which is explained in 3.2 – Excavation. The second document to complete is the front of the Drilled Shaft Concrete Placement Log ([Form BBS 135](#)) which is explained in 4.2.2 – Concrete Placement. The third document to complete is the drilled shaft concrete curve, which is located on the back of Form BBS 135, and is explained in 4.2.2 – Concrete Placement.

6 Non-Destructive Testing and Load Testing

To confirm the quality of construction of drilled shafts, post construction testing can be utilized. Testing can be performed to confirm the integrity of the shaft. Testing can also be performed to determine the capacity of a constructed shaft to confirm the design assumptions which were made.

6.1 – Non-Destructive Testing

Non-destructive testing (NDT) is the general term used for a number of testing techniques which evaluate the condition of the drilled shaft without directly impacting the load carrying ability of the shaft. NDT is utilized to confirm the integrity of the constructed shaft. NDT can be performed on any type of shaft but is most common, and should be required, for shafts where it is anticipated the Slurry Method will be employed. If NDT is used, there are five tests that are available. The most common test used on IDOT projects is cross-hole sonic logging. IDOT has also begun to evaluate thermal integrity profiling on a limited basis for projects.

6.1.1 – Impulse Echo or Impulse Response

Impulse echo and impulse response are two tests for evaluating the length and condition of a drilled shaft. For both testing types, a hammer is used to strike the top of the drilled shaft. An instrument is attached to the top of the drilled shaft which measures the behavior of a wave, induced by the strike of the hammer, traveling through and reflecting off the base of the shaft. In the impulse echo method, an ordinary hammer is used for the testing; in the impulse response method, the hammer is instrumented to measure the force of the strike.

The data from a test generally consists of the initial strike, followed by a reflected wave. For an intact shaft, the reflection will be from the base of the shaft at the soil/concrete interface. If there is a defect in the shaft such as a void or reduction in section, the reflection will occur at the defect. Based on the time required to measure the reflected wave, the depth to the point of reflection can be determined. The following slide presents a schematic of the test setup and some additional information related to the test.

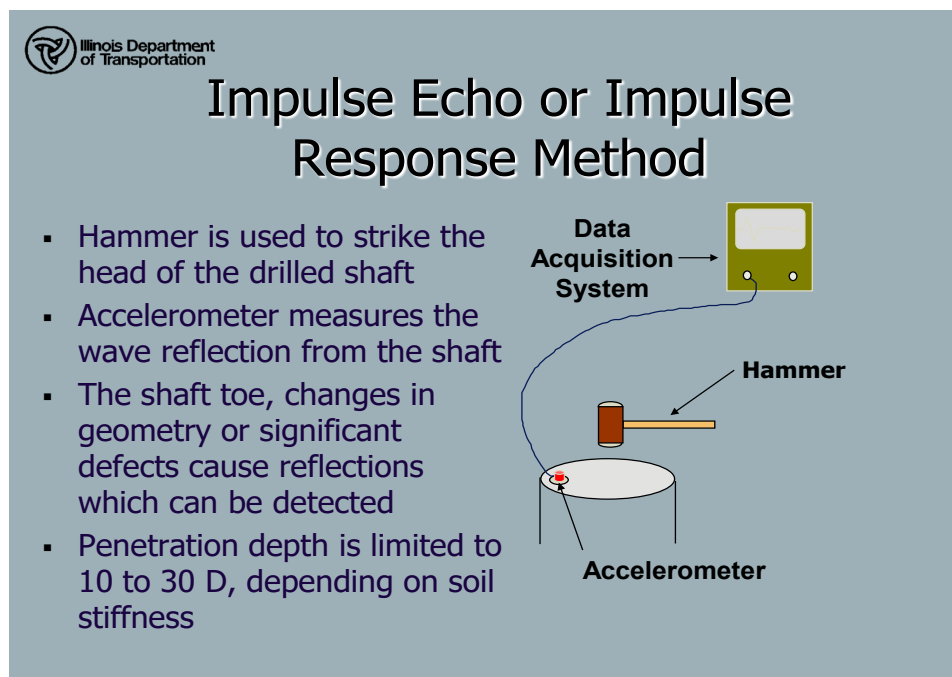



Figure 14 - Impulse Echo or Impulse Response Method

While the inspector does not generally perform the actual testing, there are a few items to be aware of if impulse echo or impulse response will be used on the project.

 Illinois Department of Transportation

Impulse Echo or Impulse Response Method

- **Inspector Issues:**
 - Review test procedures in ASTM D 5882
 - Shaft head must be prepared as shown
 - Large jack hammers should not be used because they can cause micro-cracking of the concrete which may prevent penetration of the signal

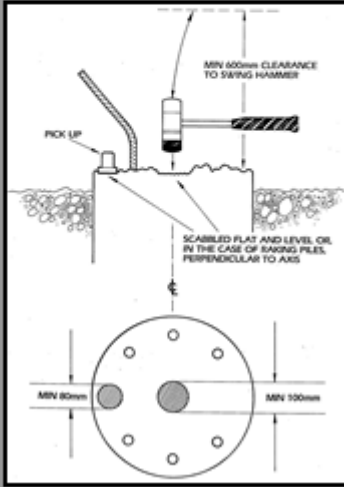


Figure 15 Impulse Echo or Impulse Response Method Inspector Issues

The results of impulse echo and impulse response testing are highly dependent on the size of the shaft and the soil conditions. These testing methods also only provide an estimate of the depth to a defect if one exists, but no information is provided on the type or size of the defect in the shaft. Other testing methods are available which can potential provide more detailed information.

6.1.2 – Cross-Hole Sonic Logging

Cross-hole Sonic Logging (CSL) is a non-destructive test method which can provide more detailed measurements of the shaft integrity and any defects which are encountered in the shaft. A brief description of the testing method follows. It shall be noted that IDOT specifications require steel tubes even though ASTM allows plastic tubes.

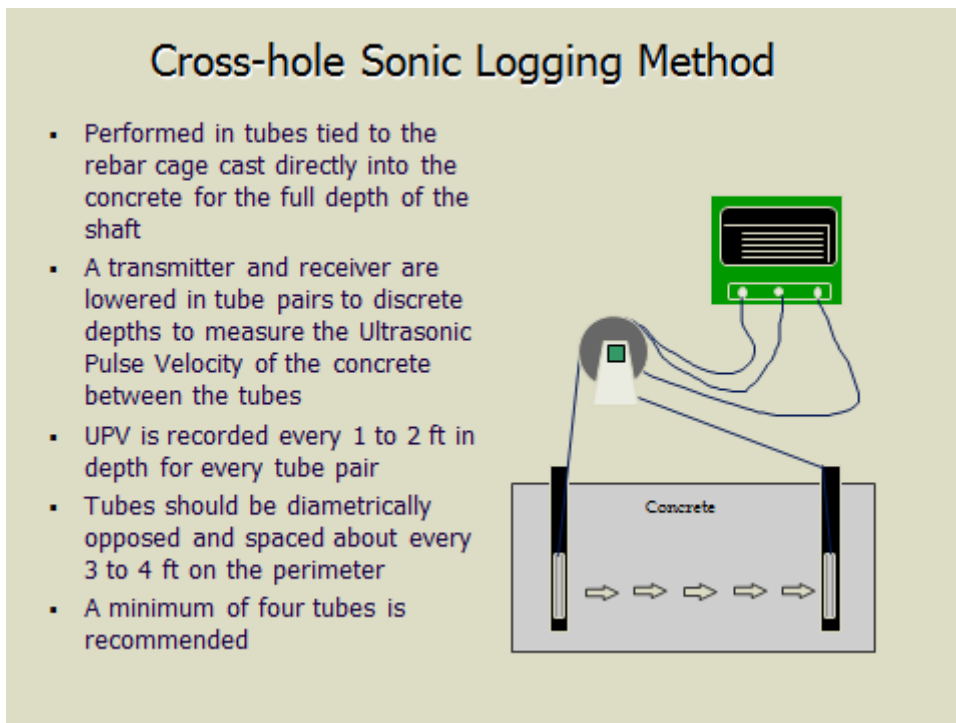


Figure 16 - Cross-hole Sonic Logging Method

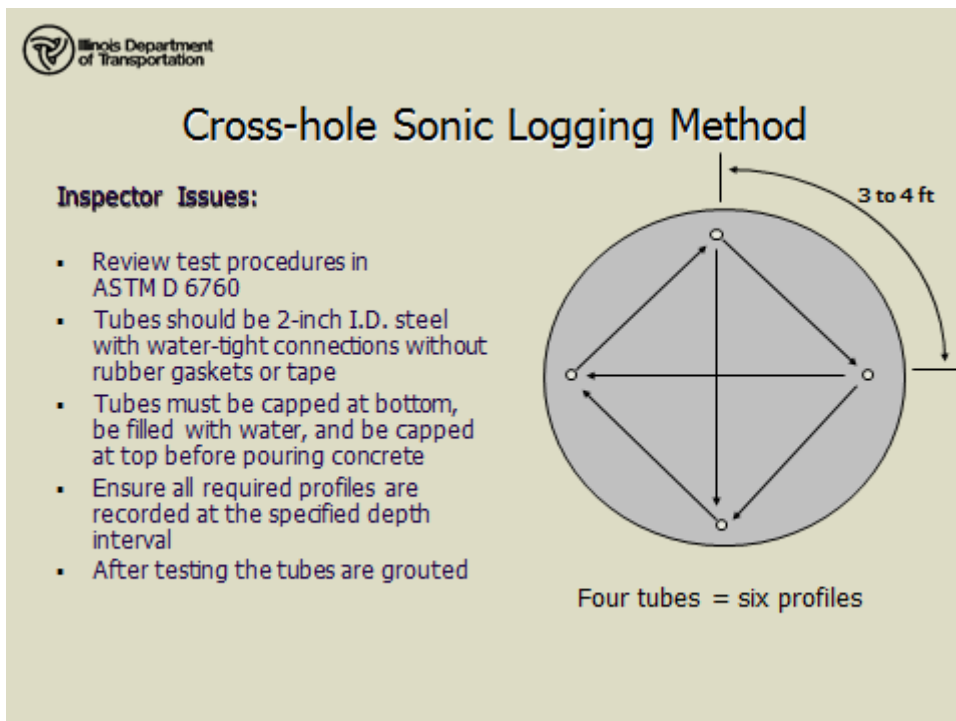


Figure 17 - - Cross-hole Sonic Logging Method Inspector Issues

With the close testing increment along the length of the shaft and the multiple profiles developed across the shaft, more details on the size and the location of possible shaft defects can be determined. Tubes should extend all the way to the base of the shaft so that the bottom condition can also be assessed.

A few key inspection points for cross-hole sonic logging are as follows:

- Steel tubes are required because they provide the best bond to the concrete and shall be installed on the inside of the rebar cage.
- The CSL tubes must be filled with water to ensure the tubes remain at the same temperature as the concrete. Concrete will hydrate and generate heat which will debond the tubes if water is not present. Check the tubes for water no more than one hour after completion of concrete placement.
- It is important the tubes are installed at the proper spacing and maintained in straight alignment for the full length of the shaft. Any deviations will affect the test results.

6.1.3 – Gamma-gamma Logging

Gamma-gamma logging (GGL) is a test which uses a technology similar to a nuclear density gage to measure the density of the concrete surrounding the test location. Low density measurements are an indication that a shaft defect is present. One advantage of this test method is it allows the concrete outside the rebar cage to be evaluated; however, the diameter of the tested zone is limited to only a few inches outside the access tube. Like CSL, gamma-gamma logging is performed inside full length tubes attached to the rebar cage. However, these tubes must be plastic (typically PVC) and not steel. Information on the testing method, and the issues the field inspector should watch for is as follows.

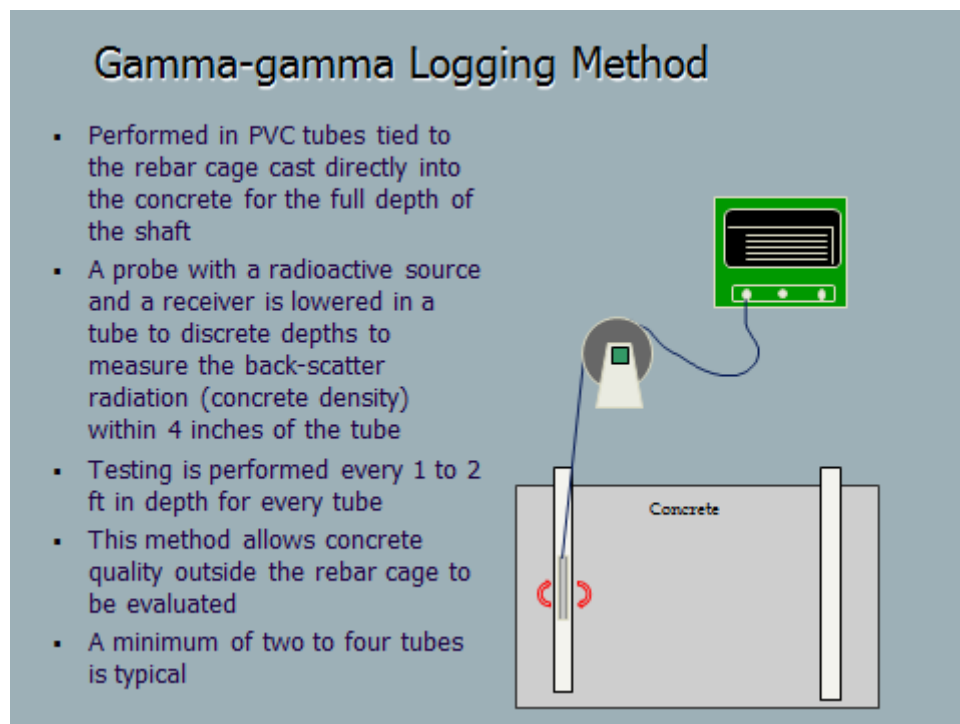


Figure 18 - Gamma-gamma Logging Method

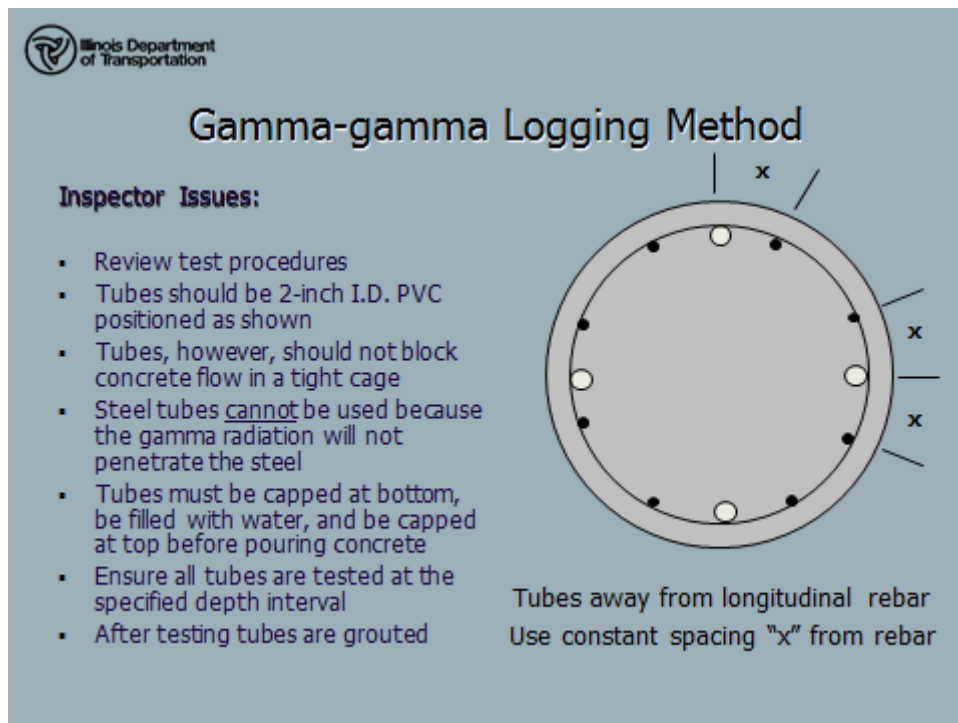


Figure 19 - Gamma-gamma Logging Method Inspector Issues

6.1.4 – Thermal Integrity Profile

Thermal integrity profile (TIP) testing is a recently developed non-destructive test. The test is based on measuring temperature during heat of hydration. If a relatively uniform and symmetrical temperature profile develops during hydration, it can be assumed there are no defects in the shaft.

TIP uses temperature sensors installed along the rebar cage. The temperature sensors record the temperature of the concrete throughout the hydration process. The relative difference in temperature from one side of the rebar cage to the other indicates the position of the rebar cage in the drilled shaft. In addition, low temperatures indicate the presence of soil, water, or aggregate within the drilled shaft.

The advantage of TIP is the ability to detect defects inside and outside the rebar cage. CSL and GGL are limited to the inside of the rebar cage.

6.1.5 – Non-Destructive Testing Limitations

NDT is used to evaluate the condition of the shaft but does not provide a direct measurement of the resistance of the shaft to axial or lateral loads. If the shaft resistance is in question, load testing needs to be performed. Also, when non-destructive testing indicates a defect or possible low strength zone, full length coring along with compressive strength testing of recovered cores will usually be performed to check the concrete and to compare to the NDT results.

It is important to know that NDT is intended to provide additional information on the quality of the drilled shaft constructed, but it can't replace the work of a well-trained inspector.

6.2 – Load Testing

Load testing is a direct measurement of the resistance that a drilled shaft can provide. In some cases, the load testing will be performed on a sacrificial test shaft, so the ultimate load capacity can be determined. In other cases, a production shaft may be used, and the load tests may extend to slightly above the working load applied to the shaft. When a test shaft (sacrificial or production) is

utilized, it is critical that the inspector be present for the construction of that shaft to observe the construction procedures. A test shaft (sacrificial or production) must be constructed using the same procedures as the remaining shafts.

6.2.1 – Static Load Test

The simplest load test method is the static load test. The procedures for static load testing are described in ASTM standards D 1143 and D 3689 for compression and tension loading, respectively. For a static test, the load is applied via hydraulic rams resisted by reaction piles, shafts or anchors, dead weight or a combination of the two. Load increments are applied for a specified time increment and the deflection of the shaft under the load is measured and recorded.

6.2.2 – Lateral Load Test

Lateral load tests are similar to static load tests. The testing procedures are covered in ASTM standard D 3966. The load is again applied to the drilled shaft using hydraulic rams resisted by a reaction shaft, reaction piles, or a deadman cast into the soil.

6.2.3 – Bi-Directional Load Test

Bi-direction load testing, also referred to as Osterberg Cell or O-Cell testing, is a load testing procedure which does not require weights, reaction frames or reaction piles. The O-cell is a hydraulic jack which is cast directly into the shaft concrete, usually below the midpoint of the shaft. When the jack is pressurized it pushes up against the upper portion of the shaft and pushes down against the lower portion. At an intermediate level, the test has the effect of splitting the shaft at the cell location. The jacking forces applied in the cell are resisted by the weight of the shaft and the friction and end bearing resistance of the shaft. The capacity of resistance of a discrete portion of the shaft can be measured by installing cells at multiple levels. The following provides a schematic of a bi-directional load test.

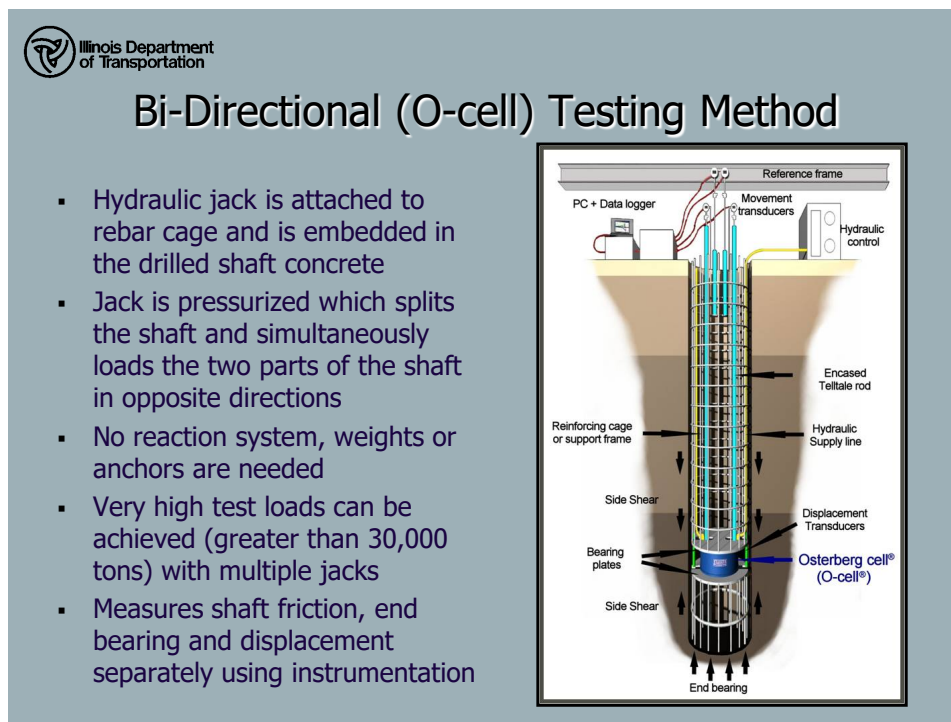


Figure 20 - Bi-Directional Testing Method

6.2.4 – High Strain Dynamic Load Testing

High strain dynamic load testing is similar to the dynamic load testing performed during pile driving. The procedures are presented in ASTM standard D 4945. A large weight is dropped onto the top of the drilled shaft which is instrumented to measure the force imparted by the weight and the displacement of the shaft. Based on these measurements, the load carrying capacity of the drilled shaft can be calculated

6.2.5 – Role of the Inspector

In most cases the drilled shaft inspector will be present, but not be an active participant in the load testing process. The one crucial issue to be aware of is that the construction of the production shafts must follow the procedures used for constructing the test shaft. Other items for an inspector to be aware of are as follows.

- Review ASTM test procedures if available.
- Review specifications, loading schedule, and contractor's procedures.
- Confirm that all required instrumentation is installed.
- Record the load increments, time, and deflections.

7 Trouble Shooting

The following chapter presents some common construction issues which may arise on a drilled shaft project along with the potential cause. This information is reprinted from Table 19-2 in the FHWA publication "Drilled Shafts: Construction Procedures and LFRD Design Methods". Refer to 8.1 – Additional References for the link to this publication.

Problem: Shaft off location or out of plumb.

Cause: Improper set-up or poor alignment while drilling.

Problem: Shaft not based or with insufficient embedment in proper bearing stratum.

Cause: Bearing stratum misidentified or length not properly measured.

Problem: Crack in shaft

Cause: Shaft hit by construction equipment early in curing process.

Problem: Bulge or neck in the shaft.

Cause: Soft ground zones that were not cased.

Problem: Caving of shaft wall

Cause: Improper use of casing or slurry; failure to use weighting agent with slurry; casing not sealed in a stable stratum.

Problem: Reduction in side resistance due to excessive mudcake buildup.

Cause: Failure to agitate slurry or to place concrete in a timely manner.

Problem: Temporary casing cannot be removed

Cause: Crane for handling casing ineffective in squeezing ground; large set-up of soil friction after installing casing; casing wedged in rock or by boulder.

Problem: Horizontal separation or severe necking of shaft.

Cause: Pulling temporary casing with concrete adhering to it.

Problem: Horizontal sand lens in concrete.

Cause: Tremie or pump line pulled out of concrete in wet hole; insufficient head within casing when raising casing.

Problem: Soil intrusion on the side of the shaft.

Cause: Use of telescoping casing where concrete from inner casing spills into annular void behind the outer casing; low concrete slump; reinforcing bars too closely spaced.

Problem: Soft shaft bottom or CSL anomaly at/near bottom of shaft.

Cause: Incomplete bottom cleaning, side sloughing, or sedimentation of cuttings from slurry column.

Problem: Voids outside of cage.

Cause: Low concrete slump, aggregate too large, and/or reinforcing bars too closely spaced

Problem: Concrete defects.

Cause: Tremie pipe joints not watertight; tremie/pump line not at bottom of shaft at start of concrete placement; concrete flow into annular void between temporary and permanent casings; concrete slump inadequate for duration of concrete placement; excessive sediment in slurry.

Problem: Honeycombing, washout of fines or water channels in the concrete

Cause: Concrete placed directly into water; excessive groundwater head; excessive bleed water in concrete mix.

Problem: Folded-in debris.

Cause: Insufficient cleaning of shaft; excessive sand content in slurry.

Problem: Clogged tremie or pump line.

Cause: Concrete with insufficient slump or slump retention; interior of pipe not clean; segregation of concrete aggregates.

Problem: Rebar cage lifted during concrete placement.

Cause: Weight of rebar cage insufficient for rising concrete; tremie/pump line embedded too deep in concrete; rebar cage caught on tremie/pump line; concrete arch between casing/cage.

Problem: Rebar cage settles during concrete placement.

Cause: Missing inadequate number/spacing of rebar cage spacers; insufficient support of cage at bottom of shaft excavation; insufficient cage stiffness.

8 Appendix

8.1 – Additional References

The following additional references provide greater detail and explanation of the construction procedures and inspection requirements for drilled shafts. The inspector is encouraged to review the documents, especially the FHWA documents.

- [Drilled Shaft Inspector Tutorial](#) – Web Based (FHWA – Available online at no cost.)
- [Drilled Shafts: Construction Procedures and LFRD Design Methods](#) (FHWA – May 2010)
- [336.1-01 Specification for the Construction Drilled Piers](#) (American Concrete Institute (ACI))
- [Drilled Shaft Inspector's Manual](#) (ADCS: The International Association of Foundation Drilling, and DFI: Deep Foundations Institute)
- [Geotechnical Manual](#) (IDOT)
- [Bridge Manual](#) (IDOT)

8.2 – Example of Drilled Shaft Pre-Drill Meeting Agenda**DRILLED SHAFT PRE-DRILL MEETING AGENDA**

Date: _____

Time: _____

Contact: _____

1. CONSTRUCTION LAYOUT AND MEASUREMENTS

- a. 3 in. tolerance allowed from plan station and offset for center of shaft
- b. Top of drilled shaft elevation
- c. Will earth or seal coat excavation be necessary prior to start?
- d. What protection will be installed for workers around the excavation?
- e. Required documentation:
 - (1) Recording of soil excavated is required (BBS 134, or field book)
 - (2) Record all visually changing soils (clay, cobbles, rock, sand, silt, etc.)
 - (3) Record all moisture/water changes
 - (4) Record elevation of shaft when slurry was added
 - (5) Record all events throughout the day (weather, number of workers, equipment breakdowns, delays, important conversations, etc.)
- f. Setting top temporary casing
- g. Elevation of casing when fully installed (for use as a measuring point for determining depth)
- h. Survey check of top casing for layout of drilled shaft

2. CASING

- a. Temporary Casing
 - (1) When will temporary casing be installed?
 - (2) Method of removal and action to be taken if casing cannot be removed
- b. Permanent Casing
 - (1) When will permanent casing be installed (prior to, or after drilled shaft excavation)?
 - a. If installed after excavation, non-shrink grout will be required around the casing

- (2) Full length or multiple sections

3. SLURRY

- a. Slurry type (mineral, polymer, water)
- b. Testing of slurry (density, viscosity, pH, sand content)
- c. Minimum level of slurry in excavation
- d. Clean up of slurry during excavation
- e. Method of slurry disposal upon completion

4. SHAFT EXCAVATION

- a. Erosion control should be installed
- b. Method to contain and stock pile dry excavation
- c. Method to contain and stock pile wet excavation
- d. Is non-special waste removal required?

5. OBSTRUCTIONS

- a. Impediments encountered while drilling
 - (1) Section 516
 - a. Contractor must provide notice when obstruction is encountered
 - (2) Paid under Article 109.04
 - (3) Include entire crew and equipment
- b. Check soil borings for types of soil at that elevation
 - (1) Track time until impediment is removed or when plan bottom elevation is reached

6. TOP OF ROCK

- a. Check plan for pay items (drilled shaft in soil, drilled shaft in rock)
- b. Obstructions are different from rock. Obstructions are eventually removed or cut through.
- c. Rock is continual to the bottom of the shaft (drilled shaft in rock)
- d. When the plans call for “drilled shaft in rock”
 - (1) “Non-fractured” rock must be achieved
 - a. “Non-fractured” rock are large pieces of visibly non-rounded rock
 - b. Rounded rock are “cobbles or boulders” that are embedded within soil

- e. Top of rock
 - (1) A determination of top of rock must be made for payment purposes
 - (2) This elevation can be where fractured rock is encountered from a point all the way down the final rock socket
 - (3) This elevation is the divider line between the two pay items (soil, rock)
 - (4) Obtain top of rock elevation prior to drilling with rock drilling equipment

7. DRILLED SHAFT EXCAVATION INSPECTION

- a. A dry hole may be visually inspected
- b. A wet hole may need to be inspected using a weighted tape
- c. A camera may be necessary
- d. Bearing capacity method
- e. Flatness of bottom
- f. Cleaning of bottom

8. ASSEMBLY AND PLACEMENT OF REINFORCEMENT

- a. Depending on length of drilled shaft, a planned splice may be required (lap or mechanical splices)
- b. Rebar cages are assembled prior to excavation (assembly takes time; the cage must be ready when the shaft excavation is ready)
- c. Adjustment of rebar cages due to modified length of excavation
 - (1) Additional rebar will be paid by pay item (in the event of a longer cage)
 - a. 50800105 Reinforcement Bars
 - b. 50800205 Reinforcement Bars, Epoxy Coated
 - (2) Only the reinforcing bars installed will be measured for payment.
- d. Rebar clearance
 - (1) Rebar centralizers are required along the length of the shaft
 - (2) Rebar clearance boots are required at the base of the shaft
- e. Reinforcement bar tolerances
 - (1) 1.5 in. tolerance allowed from plan station and offset for center of cage
 - (2) No more than 1 in. above and 3 in. below plan elevation for top of cage
- f. Method of cage installation and cleaning debris from rebars
- g. Cross-hole sonic logging tubes

- (1) Fill tubes with water after placement of rebar cage
- (2) Seal tubes and cap prior to placement of concrete

9. CONCRETE PLACEMENT

- a. Recording of concrete placement is required (BBS 135, or field book)
- b. Check for correct mix design number
- c. Check for correct air, slump, and temperature
- d. Free fall method of concrete placement (for dry excavation only)
 - (1) Requires DS mix
 - (2) Maximum 60 ft. drop height
 - (3) Cannot impact rebar on the way down
- e. Tremie method of concrete placement
 - (1) Type of tremie (rigid steel pipe, ensure joints are sealed, etc.)
 - (2) Dry method (see requirements for free fall concrete placement above)
 - (3) Wet method
 - a. Tremie must reach to the bottom of the shaft
 - b. Tremie must be sealed before concrete placement begins
 - c. Concrete must remain at least 10 ft. above the discharge end of the tremie throughout the pour
 - d. Disassemble the tremie as concrete is placed
 - e. Pump water/slurry from hole as concrete is placed (if necessary)
 - f. Over-pour the top of the drilled shaft to remove any excess water/slurry in the concrete
 - g. No more than 1 in. above and 3 in. below plan elevation for top of shaft
 - (4) Concrete pump method
 - (5) Protection of the top of the drilled shaft
 - a. Consider weather (precipitation, temperature, etc.)
 - b. Safety for construction personnel
 - c. Fill CSL tubes with water

10. NON-DESTRUCTIVE TESTING

- a. Cross-hole sonic logging testing

- (1) Test must be 3-40 days after placement (minimum 2/3 strength)
- (2) Uncap and test drilled shafts
- (3) Recap tubes
- (4) Review/analyze CSL report
 - a. Acceptable
 1. Cut off tubes to top of drilled shaft
 2. Fill tubes with non-shrink grout from qualified list
 - b. Unacceptable
 1. Require contractor to provide remedial measures
 2. Submit remedy procedures to IDOT BBS
 3. Repair drilled shaft as per approved method
 4. Cut off tubes to top of drilled shaft
 5. Fill tubes with non-shrink grout from qualified list

8.3 – Drilled Shaft Straight and Belled Concrete Volume Calculation Tables



Shaft Volume

- For straight shaft the calculation is pretty simple, shaft area times shaft length equals the volume

$$Area = \frac{3.14}{4} \times (\text{Diameter})^2$$

$$Volume = Area \times \text{Length}$$

- Be careful about units, concrete is usually measured by the cubic yard, you will measure the shaft dimensions in feet
 - Divide the volume you calculate based on the measured dimensions in feet by 27 to get cubic yards

Figure 21 - Shaft Volume



Shaft Volume Calculation

- How about an example?
 - Diameter = 3.5'
 - Length = 35'
 - $\frac{3.14}{4} \times 3.5^2$
 - Area = 9.6 square feet
9.6 x 35
 - Volume = 336.6 cubic feet
 $\frac{336.6}{27}$
 - Volume = 12.5 cubic yards

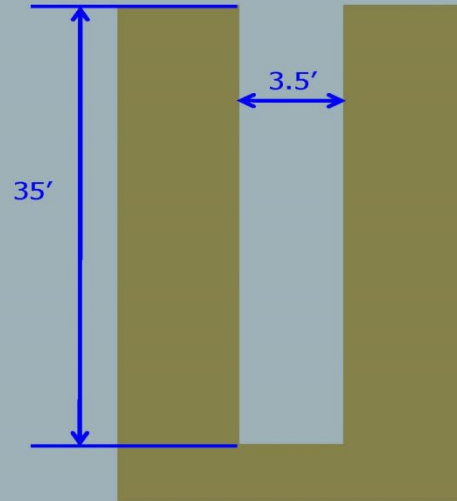


Figure 22 - Shaft Volume Calculation

		STRAIGHT SHAFT VOLUME IN CUBIC YARDS																		
		Shaft Diameter in Inches																		
		12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
Shaft Length in Feet	1	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.9	2.1	2.4	2.6	2.9
	2	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.2	1.5	1.8	2.1	2.5	2.9	3.3	3.7	4.2	4.7	5.3	5.8
	3	0.1	0.2	0.3	0.5	0.8	1.1	1.4	1.8	2.2	2.6	3.1	3.7	4.3	4.9	5.6	6.3	7.1	7.9	8.7
	4	0.1	0.3	0.5	0.7	1.0	1.4	1.9	2.4	2.9	3.5	4.2	4.9	5.7	6.5	7.4	8.4	9.4	10.5	11.6
	5	0.1	0.3	0.6	0.9	1.3	1.8	2.3	2.9	3.6	4.4	5.2	6.1	7.1	8.2	9.3	10.5	11.8	13.1	14.5
	6	0.2	0.4	0.7	1.1	1.6	2.1	2.8	3.5	4.4	5.3	6.3	7.4	8.6	9.8	11.2	12.6	14.1	15.8	17.5
	7	0.2	0.5	0.8	1.3	1.8	2.5	3.3	4.1	5.1	6.2	7.3	8.6	10.0	11.5	13.0	14.7	16.5	18.4	20.4
	8	0.2	0.5	0.9	1.5	2.1	2.9	3.7	4.7	5.8	7.0	8.4	9.8	11.4	13.1	14.9	16.8	18.8	21.0	23.3
	9	0.3	0.6	1.0	1.6	2.4	3.2	4.2	5.3	6.5	7.9	9.4	11.1	12.8	14.7	16.8	18.9	21.2	23.6	26.2
	10	0.3	0.7	1.2	1.8	2.6	3.6	4.7	5.9	7.3	8.8	10.5	12.3	14.3	16.4	18.6	21.0	23.6	26.3	29.1
	11	0.3	0.7	1.3	2.0	2.9	3.9	5.1	6.5	8.0	9.7	11.5	13.5	15.7	18.0	20.5	23.1	25.9	28.9	32.0
	12	0.3	0.8	1.4	2.2	3.1	4.3	5.6	7.1	8.7	10.6	12.6	14.7	17.1	19.6	22.3	25.2	28.3	31.5	34.9
	13	0.4	0.9	1.5	2.4	3.4	4.6	6.1	7.7	9.5	11.4	13.6	16.0	18.5	21.3	24.2	27.3	30.6	34.1	37.8
	14	0.4	0.9	1.6	2.5	3.7	5.0	6.5	8.2	10.2	12.3	14.7	17.2	20.0	22.9	26.1	29.4	33.0	36.8	40.7
	15	0.4	1.0	1.7	2.7	3.9	5.3	7.0	8.8	10.9	13.2	15.7	18.4	21.4	24.5	27.9	31.5	35.3	39.4	43.6
	16	0.5	1.0	1.9	2.9	4.2	5.7	7.4	9.4	11.6	14.1	16.8	19.7	22.8	26.2	29.8	33.6	37.7	42.0	46.5
	17	0.5	1.1	2.0	3.1	4.5	6.1	7.9	10.0	12.4	15.0	17.8	20.9	24.2	27.8	31.6	35.7	40.1	44.6	49.5
	18	0.5	1.2	2.1	3.3	4.7	6.4	8.4	10.6	13.1	15.8	18.8	22.1	25.7	29.5	33.5	37.8	42.4	47.3	52.4
	19	0.6	1.2	2.2	3.5	5.0	6.8	8.8	11.2	13.8	16.7	19.9	23.4	27.1	31.1	35.4	39.9	44.8	49.9	55.3
	20	0.6	1.3	2.3	3.6	5.2	7.1	9.3	11.8	14.5	17.6	20.9	24.6	28.5	32.7	37.2	42.0	47.1	52.5	58.2
	21	0.6	1.4	2.4	3.8	5.5	7.5	9.8	12.4	15.3	18.5	22.0	25.8	29.9	34.4	39.1	44.1	49.5	55.1	61.1
	22	0.6	1.4	2.6	4.0	5.8	7.8	10.2	13.0	16.0	19.4	23.0	27.0	31.4	36.0	41.0	46.2	51.8	57.8	64.0
	23	0.7	1.5	2.7	4.2	6.0	8.2	10.7	13.5	16.7	20.2	24.1	28.3	32.8	37.6	42.8	48.3	54.2	60.4	66.9
	24	0.7	1.6	2.8	4.4	6.3	8.6	11.2	14.1	17.5	21.1	25.1	29.5	34.2	39.3	44.7	50.4	56.5	63.0	69.8
	25	0.7	1.6	2.9	4.5	6.5	8.9	11.6	14.7	18.2	22.0	26.2	30.7	35.6	40.9	46.5	52.5	58.9	65.6	72.7
	26	0.8	1.7	3.0	4.7	6.8	9.3	12.1	15.3	18.9	22.9	27.2	32.0	37.1	42.5	48.4	54.6	61.3	68.3	75.6
	27	0.8	1.8	3.1	4.9	7.1	9.6	12.6	15.9	19.6	23.8	28.3	33.2	38.5	44.2	50.3	56.7	63.6	70.9	78.5
	28	0.8	1.8	3.3	5.1	7.3	10.0	13.0	16.5	20.4	24.6	29.3	34.4	39.9	45.8	52.1	58.8	66.0	73.5	81.4
	29	0.8	1.9	3.4	5.3	7.6	10.3	13.5	17.1	21.1	25.5	30.4	35.6	41.3	47.5	54.0	60.9	68.3	76.1	84.4
	30	0.9	2.0	3.5	5.5	7.9	10.7	14.0	17.7	21.8	26.4	31.4	36.9	42.8	49.1	55.9	63.1	70.7	78.8	87.3
	31	0.9	2.0	3.6	5.6	8.1	11.0	14.4	18.3	22.5	27.3	32.5	38.1	44.2	50.7	57.7	65.2	73.0	81.4	90.2
	32	0.9	2.1	3.7	5.8	8.4	11.4	14.9	18.8	23.3	28.2	33.5	39.3	45.6	52.4	59.6	67.3	75.4	84.0	93.1
	33	1.0	2.2	3.8	6.0	8.6	11.8	15.4	19.4	24.0	29.0	34.6	40.6	47.0	54.0	61.4	69.4	77.8	86.6	96.0
	34	1.0	2.2	4.0	6.2	8.9	12.1	15.8	20.0	24.7	29.9	35.6	41.8	48.5	55.6	63.3	71.5	80.1	89.3	98.9
	35	1.0	2.3	4.1	6.4	9.2	12.5	16.3	20.6	25.5	30.8	36.7	43.0	49.9	57.3	65.2	73.6	82.5	91.9	101.8
	36	1.0	2.4	4.2	6.5	9.4	12.8	16.8	21.2	26.2	31.7	37.7	44.2	51.3	58.9	67.0	75.7	84.8	94.5	104.7
	37	1.1	2.4	4.3	6.7	9.7	13.2	17.2	21.8	26.9	32.6	38.7	45.5	52.7	60.5	68.9	77.8	87.2	97.1	107.6
	38	1.1	2.5	4.4	6.9	9.9	13.5	17.7	22.4	27.6	33.4	39.8	46.7	54.2	62.2	70.7	79.9	89.5	99.8	110.5
	39	1.1	2.6	4.5	7.1	10.2	13.9	18.2	23.0	28.4	34.3	40.8	47.9	55.6	63.8	72.6	82.0	91.9	102.4	113.4
	40	1.2	2.6	4.7	7.3	10.5	14.3	18.6	23.6	29.1	35.2	41.9	49.2	57.0	65.4	74.5	84.1	94.2	105.0	116.4
	41	1.2	2.7	4.8	7.5	10.7	14.6	19.1	24.2	29.8	36.1	42.9	50.4	58.4	67.1	76.3	86.2	96.6	107.6	119.3
	42	1.2	2.7	4.9	7.6	11.0	15.0	19.5	24.7	30.5	37.0	44.0	51.6	59.9	68.7	78.2	88.3	99.0	110.3	122.2
	43	1.3	2.8	5.0	7.8	11.3	15.3	20.0	25.3	31.3	37.8	45.0	52.8	61.3	70.4	80.1	90.4	101.3	112.9	125.1
	44	1.3	2.9	5.1	8.0	11.5	15.7	20.5	25.9	32.0	38.7	46.1	54.1	62.7	72.0	81.9	92.5	103.7	115.5	128.0
	45	1.3	2.9	5.2	8.2	11.8	16.0	20.9	26.5	32.7	39.6	47.1	55.3	64.1	73.6	83.8	94.6	106.0	118.1	130.9
	46	1.3	3.0	5.4	8.4	12.0	16.4	21.4	27.1	33.5	40.5	48.2	56.5	65.6	75.3	85.6	96.7	108.4	120.8	133.8
	47	1.4	3.1	5.5	8.5	12.3	16.7	21.9	27.7	34.2	41.4	49.2	57.8	67.0	76.9	87.5	98.8	110.7	123.4	136.7
	48	1.4	3.1	5.6	8.7	12.6	17.1	22.3	28.3	34.9	42.2	50.3	59.0	68.4	78.5	89.4	100.9	113.1	126.0	139.6
	49	1.4	3.2	5.7	8.9	12.8	17.5	22.8	28.9	35.6	43.1	51.3	60.2	69.8	80.2	91.2	103.0	115.5	128.6	142.5
	50	1.5	3.3	5.8	9.1	13.1	17.8	23.3	29.5	36.4	44.0	52.4	61.5	71.3	81.8	93.1	105.1	117.8	131.3	145.4

Figure 23 - Straight Shaft Volume

		STRAIGHT SHAFT VOLUME IN CUBIC YARDS																		
		Shaft Diameter in Inches																		
		12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
Shaft Length in Feet	51	1.5	3.3	5.9	9.3	13.4	18.2	23.7	30.0	37.1	44.9	53.4	62.7	72.7	83.4	94.9	107.2	120.2	133.9	148.4
	52	1.5	3.4	6.1	9.5	13.6	18.5	24.2	30.6	37.8	45.8	54.5	63.9	74.1	85.1	96.8	109.3	122.5	136.5	151.3
	53	1.5	3.5	6.2	9.6	13.9	18.9	24.7	31.2	38.5	46.6	55.5	65.1	75.5	86.7	98.7	111.4	124.9	139.1	154.2
	54	1.6	3.5	6.3	9.8	14.1	19.2	25.1	31.8	39.3	47.5	56.5	66.4	77.0	88.4	100.5	113.5	127.2	141.8	157.1
	55	1.6	3.6	6.4	10.0	14.4	19.6	25.6	32.4	40.0	48.4	57.6	67.6	78.4	90.0	102.4	115.6	129.6	144.4	160.0
	56	1.6	3.7	6.5	10.2	14.7	20.0	26.1	33.0	40.7	49.3	58.6	68.8	79.8	91.6	104.3	117.7	131.9	147.0	162.9
	57	1.7	3.7	6.6	10.4	14.9	20.3	26.5	33.6	41.5	50.2	59.7	70.1	81.2	93.3	106.1	119.8	134.3	149.6	165.8
	58	1.7	3.8	6.7	10.5	15.2	20.7	27.0	34.2	42.2	51.0	60.7	71.3	82.7	94.9	108.0	121.9	136.7	152.3	168.7
	59	1.7	3.9	6.9	10.7	15.4	21.0	27.5	34.8	42.9	51.9	61.8	72.5	84.1	96.5	109.8	124.0	139.0	154.9	171.6
	60	1.7	3.9	7.0	10.9	15.7	21.4	27.9	35.3	43.6	52.8	62.8	73.7	85.5	98.2	111.7	126.1	141.4	157.5	174.5
	61	1.8	4.0	7.1	11.1	16.0	21.7	28.4	35.9	44.4	53.7	63.9	75.0	86.9	99.8	113.6	128.2	143.7	160.1	177.4
	62	1.8	4.1	7.2	11.3	16.2	22.1	28.9	36.5	45.1	54.6	64.9	76.2	88.4	101.4	115.4	130.3	146.1	162.8	180.4
	63	1.8	4.1	7.3	11.5	16.5	22.4	29.3	37.1	45.8	55.4	66.0	77.4	89.8	103.1	117.3	132.4	148.4	165.4	183.3
	64	1.9	4.2	7.4	11.6	16.8	22.8	29.8	37.7	46.5	56.3	67.0	78.7	91.2	104.7	119.1	134.5	150.8	168.0	186.2
	65	1.9	4.3	7.6	11.8	17.0	23.2	30.3	38.3	47.3	57.2	68.1	79.9	92.6	106.4	121.0	136.6	153.2	170.6	189.1
	66	1.9	4.3	7.7	12.0	17.3	23.5	30.7	38.9	48.0	58.1	69.1	81.1	94.1	108.0	122.9	138.7	155.5	173.3	192.0
	67	1.9	4.4	7.8	12.2	17.5	23.9	31.2	39.5	48.7	59.0	70.2	82.3	95.5	109.6	124.7	140.8	157.9	175.9	194.9
	68	2.0	4.5	7.9	12.4	17.8	24.2	31.6	40.1	49.5	59.8	71.2	83.6	96.9	111.3	126.6	142.9	160.2	178.5	197.8
	69	2.0	4.5	8.0	12.5	18.1	24.6	32.1	40.6	50.2	60.7	72.3	84.8	98.3	112.9	128.5	145.0	162.6	181.1	200.7
	70	2.0	4.6	8.1	12.7	18.3	24.9	32.6	41.2	50.9	61.6	73.3	86.0	99.8	114.5	130.3	147.1	164.9	183.8	203.6
	71	2.1	4.6	8.3	12.9	18.6	25.3	33.0	41.8	51.6	62.5	74.4	87.3	101.2	116.2	132.2	149.2	167.3	186.4	206.5
	72	2.1	4.7	8.4	13.1	18.8	25.7	33.5	42.4	52.4	63.4	75.4	88.5	102.6	117.8	134.0	151.3	169.6	189.0	209.4
	73	2.1	4.8	8.5	13.3	19.1	26.0	34.0	43.0	53.1	64.2	76.4	89.7	104.1	119.4	135.9	153.4	172.0	191.6	212.3
	74	2.2	4.8	8.6	13.5	19.4	26.4	34.4	43.6	53.8	65.1	77.5	90.9	105.5	121.1	137.8	155.5	174.4	194.3	215.3
	75	2.2	4.9	8.7	13.6	19.6	26.7	34.9	44.2	54.5	66.0	78.5	92.2	106.9	122.7	139.6	157.6	176.7	196.9	218.2
	76	2.2	5.0	8.8	13.8	19.9	27.1	35.4	44.8	55.3	66.9	79.6	93.4	108.3	124.4	141.5	159.7	179.1	199.5	221.1
	77	2.2	5.0	9.0	14.0	20.2	27.4	35.8	45.4	56.0	67.8	80.6	94.6	109.8	126.0	143.3	161.8	181.4	202.1	224.0
	78	2.3	5.1	9.1	14.2	20.4	27.8	36.3	45.9	56.7	68.6	81.7	95.9	111.2	127.6	145.2	163.9	183.8	204.8	226.9
	79	2.3	5.2	9.2	14.4	20.7	28.2	36.8	46.5	57.5	69.5	82.7	97.1	112.6	129.3	147.1	166.0	186.1	207.4	229.8
	80	2.3	5.2	9.3	14.5	20.9	28.5	37.2	47.1	58.2	70.4	83.8	98.3	114.0	130.9	148.9	168.1	188.5	210.0	232.7
	81	2.4	5.3	9.4	14.7	21.2	28.9	37.7	47.7	58.9	71.3	84.8	99.5	115.5	132.5	150.8	170.2	190.9	212.6	235.6
	82	2.4	5.4	9.5	14.9	21.5	29.2	38.2	48.3	59.6	72.2	85.9	100.8	116.9	134.2	152.7	172.3	193.2	215.3	238.5
	83	2.4	5.4	9.7	15.1	21.7	29.6	38.6	48.9	60.4	73.0	86.9	102.0	118.3	135.8	154.5	174.4	195.6	217.9	241.4
	84	2.4	5.5	9.8	15.3	22.0	29.9	39.1	49.5	61.1	73.9	88.0	103.2	119.7	137.4	156.4	176.5	197.9	220.5	244.3
	85	2.5	5.6	9.9	15.5	22.3	30.3	39.6	50.1	61.8	74.8	89.0	104.5	121.2	139.1	158.2	178.6	200.3	223.1	247.3
	86	2.5	5.6	10.0	15.6	22.5	30.6	40.0	50.7	62.5	75.7	90.1	105.7	122.6	140.7	160.1	180.7	202.6	225.8	250.2
	87	2.5	5.7	10.1	15.8	22.8	31.0	40.5	51.2	63.3	76.6	91.1	106.9	124.0	142.4	162.0	182.8	205.0	228.4	253.1
	88	2.6	5.8	10.2	16.0	23.0	31.4	41.0	51.8	64.0	77.4	92.2	108.2	125.4	144.0	163.8	184.9	207.3	231.0	256.0
	89	2.6	5.8	10.4	16.2	23.3	31.7	41.4	52.4	64.7	78.3	93.2	109.4	126.9	145.6	165.7	187.0	209.7	233.6	258.9
	90	2.6	5.9	10.5	16.4	23.6	32.1	41.9	53.0	65.4	79.2	94.2	110.6	128.3	147.3	167.6	189.2	212.1	236.3	261.8
	91	2.6	6.0	10.6	16.5	23.8	32.4	42.4	53.6	66.2	80.1	95.3	111.8	129.7	148.9	169.4	191.3	214.4	238.9	264.7
	92	2.7	6.0	10.7	16.7	24.1	32.8	42.8	54.2	66.9	81.0	96.3	113.1	131.1	150.5	171.3	193.4	216.8	241.5	267.6
	93	2.7	6.1	10.8	16.9	24.3	33.1	43.3	54.8	67.6	81.8	97.4	114.3	132.6	152.2	173.1	195.5	219.1	244.1	270.5
	94	2.7	6.2	10.9	17.1	24.6	33.5	43.7	55.4	68.4	82.7	98.4	115.5	134.0	153.8	175.0	197.6	221.5	246.8	273.4
	95	2.8	6.2	11.1	17.3	24.9	33.9	44.2	56.0	69.1	83.6	99.5	116.8	135.4	155.4	176.9	199.7	223.8	249.4	276.3
	96	2.8	6.3	11.2	17.5	25.1	34.2	44.7	56.5	69.8	84.5	100.5	118.0	136.8	157.1	178.7	201.8	226.2	252.0	279.3
	97	2.8	6.3	11.3	17.6	25.4	34.6	45.1	57.1	70.5	85.4	101.6	119.2	138.3	158.7	180.6	203.9	228.6	254.7	282.2
	98	2.9	6.4	11.4	17.8	25.7	34.9	45.6	57.7	71.3	86.2	102.6	120.4	139.7	160.4	182.4	206.0	230.9	257.3	285.1
	99	2.9	6.5	11.5	18.0	25.9	35.3	46.1	58.3	72.0	87.1	103.7	121.7	141.1	162.0	184.3	208.1	233.3	259.9	288.0
	100	2.9	6.5	11.6	18.2	26.2	35.6	46.5	58.9	72.7	88.0	104.7	122.9	142.5	163.6	186.2	210.2	235.6	262.5	290.9

BELL VOLUMES IN CUBIC YARDS, 45 DEGREE BELLS, HEIGHT INCLUDES 6" PAD, VOLUME INCLUDES PAD											
Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)	Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)	Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)
18	24	0.75	0.33	48	54	0.75	1.87	66	72	0.75	
	30	1.00	0.57		60	1.00	2.73		78	1.00	
	36	1.25	0.89		66	1.25	3.75		84	1.25	
	42	1.50	1.33		72	1.50	4.95		90	1.50	
	48	1.75	1.88		78	1.75	6.33		96	1.75	
24	54	2.00	2.56		84	2.00	7.93		102	2.00	
	30	1.00	0.68		90	2.25	9.74		108	2.25	
	36	1.25	1.05		96	2.50	11.79		114	2.50	
	42	1.50	1.53		102	2.75	14.09		120	2.75	
	48	1.75	2.13		108	3.00	16.65		126	3.00	
	54	2.00	2.87		114	3.25	19.50		132	3.25	
	60	2.25	3.77		120	3.50	22.63		138	3.50	
	66	2.50	4.83		126	3.75	26.07		144	3.75	
72	2.75	6.07	132	4.00	29.84	150	4.00				
30	36	1.25	1.23	138	4.25	33.94	156	4.25			
	42	1.50	1.76	144	4.50	38.40	162	4.50			
	48	1.75	2.42	54	60	1.00	2.99	168	4.75		
	54	2.00	3.22		66	1.25	4.09	174	5.00		
	60	2.25	4.18		72	1.50	5.37	180	5.25		
	66	2.50	5.31		78	1.75	6.84	186	5.50		
	72	2.75	6.63		84	2.00	8.53	192	5.75		
	78	3.00	8.15		90	2.25	10.44	198	6.00		
84	3.25	9.88	96		2.50	12.59	72	78	1.00		
90	3.50	11.85	102		2.75	15.00		84	1.25		
36	42	1.50	2.03		108	3.00		17.67	90	1.50	
	48	1.75	2.74		114	3.25		20.63	96	1.75	
	54	2.00	3.61		120	3.50		23.89	102	2.00	
	60	2.25	4.64		126	3.75		27.46	108	2.25	
	66	2.50	5.85		132	4.00		31.35	114	2.50	
	72	2.75	7.24	138	4.25	35.59		120	2.75		
	78	3.00	8.85	144	4.50	40.19		126	3.00		
	84	3.25	10.67	150	4.75	45.15		132	3.25		
	90	3.50	12.73	156	5.00	50.50		138	3.50		
	96	3.75	15.04	162	5.25	56.25		144	3.75		
	102	4.00	17.61	60	66	1.25		4.45	150	4.00	
108	4.25	20.46	72		1.50	5.82	156	4.25			
42	48	1.75	3.10		78	1.75	7.38	162	4.50		
	54	2.00	4.04		84	2.00	9.17	168	4.75		
	60	2.25	5.14		90	2.25	11.18	174	5.00		
	66	2.50	6.43		96	2.50	13.44	180	5.25		
	72	2.75	7.91		102	2.75	15.96	186	5.50		
	78	3.00	9.60		108	3.00	18.75	192	5.75		
	84	3.25	11.52		114	3.25	21.83	198	6.00		
	90	3.50	13.68		120	3.50	25.21	204	6.25		
	96	3.75	16.09		126	3.75	28.91	210	6.50		
	102	4.00	18.78		132	4.00	32.94	216	6.75		
	108	4.25	21.74		138	4.25	37.32				
	114	4.50	25.01	144	4.50	42.06					
	120	4.75	28.58	150	4.75	47.18					
	126	5.00	32.49	156	5.00	52.68					
			162	5.25	58.60						
			168	5.50	64.93						
			174	5.75	71.69						
			180	6.00	78.90						

Figure 24 - Bell Volumes

BELL VOLUMES IN CUBIC YARDS, 60 DEGREE BELLS, HEIGHT INCLUDES 6" PAD, VOLUME INCLUDES PAD											
Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)	Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)	Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)
18	24	0.93	0.39	48	54	0.93	2.26	66	72	0.93	4.12
	30	1.37	0.74		60	1.37	3.60		78	1.37	6.35
	36	1.80	1.23		66	1.80	5.20		84	1.80	8.93
	42	2.23	1.89		72	2.23	7.10		90	2.23	11.88
	48	2.67	2.74		78	2.67	9.32		96	2.67	15.22
	54	3.10	3.81		84	3.10	11.89		102	3.10	18.98
24	30	0.93	0.64		90	3.53	14.82		108	3.53	23.19
	36	1.37	1.14		96	3.96	18.15		114	3.96	27.87
	42	1.80	1.80		102	4.40	21.90		120	4.40	33.05
	48	2.23	2.66		108	4.83	26.09		126	4.83	38.74
	54	2.67	3.73		114	5.26	30.76		132	5.26	44.98
	60	3.10	5.05		120	5.70	35.92		138	5.70	51.80
	66	3.53	6.64	126	6.13	41.60	144		6.13	59.21	
	72	3.96	8.52	132	6.56	47.83	150		6.56	67.24	
30	36	0.93	0.95	138	7.00	54.63	156		7.00	75.91	
	42	1.80	2.08	144	7.43	62.02	162		7.43	85.26	
	48	2.23	3.02	54	60	0.93	2.82		168	7.86	95.31
	54	2.67	4.20		66	1.37	4.43		174	8.29	106.08
	60	3.10	5.62		72	1.80	6.33	180	8.73	117.60	
	66	3.53	7.32		78	2.23	8.56	186	9.16	129.89	
	72	3.96	9.33		84	2.67	11.13	192	9.59	142.97	
	78	4.40	11.66		90	3.10	14.07	198	10.03	156.88	
	84	4.83	14.34		96	3.53	17.40	72	78	0.93	4.86
	90	5.26	17.40		102	3.96	21.15		84	1.37	7.44
36	42	0.93	1.33		108	4.40	25.35		90	1.80	10.39
	48	1.37	2.19		114	4.83	30.02		96	2.23	13.74
	54	1.80	3.28	120	5.26	35.19	102		2.67	17.51	
	60	2.23	4.61	126	5.70	40.87	108		3.10	21.73	
	66	2.67	6.20	132	6.13	47.11	114		3.53	26.41	
	72	3.10	8.09	138	6.56	53.91	120		3.96	31.59	
	78	3.53	10.30	144	7.00	61.31	126		4.40	37.29	
	84	3.96	12.86	150	7.43	69.33	132		4.83	43.54	
	90	4.40	15.78	156	7.86	78.00	138	5.26	50.35		
	96	4.83	19.10	162	8.29	87.34	144	5.70	57.77		
42	102	5.26	22.84	60	66	0.93	3.43	150	6.13	65.80	
	108	5.70	27.03		72	1.80	6.87	156	6.56	74.49	
	48	0.93	1.76		78	2.23	9.25	162	7.00	83.84	
	54	1.80	3.66		84	2.67	11.98	168	7.43	93.89	
	60	2.23	5.10		90	3.10	15.09	174	7.86	104.67	
	66	2.67	6.82		96	3.53	18.60	180	8.29	116.19	
	72	3.10	8.84		102	3.96	22.54	186	8.73	128.48	
	78	3.53	11.19		108	4.40	26.93	192	9.16	141.57	
	84	3.96	13.90		114	4.83	31.80	198	9.59	155.49	
	90	4.40	16.98		120	5.26	37.18	204	10.03	170.25	
48	96	4.83	20.46	126	5.70	43.08	210	10.46	185.89		
	102	5.26	24.37	132	6.13	49.54	216	10.89	202.42		
	108	5.70	28.74	138	6.56	56.58					
	114	6.13	33.58	144	7.00	64.22					
	120	6.56	38.93	150	7.43	72.50					
	126	7.00	44.81	156	7.86	81.43					
				162	8.29	91.04					
				168	8.73	101.35					
				174	9.16	112.40					
				180	9.59	124.20					

Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)	Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)	Shaft Diameter (in)	Bell Diameter (in)	Bell Height (ft)	Bell Volume (cy)
78	84	0.93	5.66	90	96	0.93	7.45	96	102	0.93	8.44
	90	1.37	8.62		102	1.37	11.24		108	1.80	16.32
	96	1.80	11.57		108	1.80	15.46		114	2.23	21.25
	102	2.23	15.75		114	2.23	20.16		120	2.67	26.68
	108	2.67	19.96		120	2.67	25.36		126	3.10	32.63
	114	3.10	24.85		126	3.10	31.07		132	3.53	39.15
	120	3.53	29.84		132	3.53	37.33		138	3.96	46.24
	126	3.96	35.54		138	3.96	44.17		144	4.40	53.94
	132	4.40	41.79		144	4.40	51.59		150	4.83	62.27
	138	4.83	48.62		150	4.83	59.64		156	5.26	71.25
	144	5.26	56.04		156	5.26	68.34		162	5.70	80.91
	150	5.70	64.08		162	5.70	77.71		168	6.13	91.28
	156	6.13	72.76		168	6.13	87.78		174	6.56	102.38
	162	6.56	82.12		174	6.56	98.56		180	7.00	114.24
	168	7.00	92.18		180	7.00	110.10		186	7.43	126.87
	174	7.43	102.96		186	7.43	122.41		192	7.86	140.32
	180	7.86	114.48		192	7.86	135.52		198	8.29	154.59
	186	8.29	126.78		198	8.29	149.45		204	8.73	169.72
	192	8.73	139.88		204	8.73	164.22		210	9.16	185.74
	198	9.16	153.80		210	9.16	179.87		216	9.59	202.66
	204	9.59	168.57		216	9.59	196.42		222	10.03	220.51
	210	10.03	184.21		222	10.03	213.90		228	10.46	239.32
	216	10.46	200.75		228	10.46	232.32		234	10.89	259.11
222	10.89	218.21	234	10.89	251.72	240	11.33	279.91			
228	11.33	236.63	240	11.33	272.12	246	11.76	301.75			
234	11.76	256.01	246	11.76	293.54	252	12.19	324.64			
84	90	0.93	6.53	252	12.19	316.01	258	12.62	348.61		
	96	1.37	9.88	258	12.62	339.55	264	13.06	373.70		
	102	1.80	13.66	264	13.06	364.20	270	13.49	399.91		
	108	2.23	17.89	270	13.49	389.97	276	13.92	427.29		
	114	2.67	22.58				282	14.36	455.85		
	120	3.10	27.77				288	14.79	485.62		
	126	3.53	33.48								
	132	3.96	39.74								
	138	4.40	46.56								
	144	4.83	53.99								
	150	5.26	62.03								
	156	5.70	70.72								
	162	6.13	80.09								
	168	6.56	90.15								
	174	7.00	100.93								
	180	7.43	112.46								
	186	7.86	124.77								
192	8.29	137.87									
198	8.73	151.79									
204	9.16	166.57									
210	9.59	182.21									
216	10.03	198.76									
222	10.46	216.23									
228	10.89	234.65									
234	11.33	254.04									
240	11.76	274.43									

Table of Figures

Figure 1 - Drilled Shaft Design - In Soil.....	2
Figure 2 - Drilled Shaft Design - In Rock	2
Figure 3 - Soil Boring Log	4
Figure 4 - Rock Core Log.....	4
Figure 5 - Truck Mounted Drill Rig	8
Figure 6 - Crawler Body Mounted Drill Rig	9
Figure 7 - Crane Mounted Drill Rigs	9
Figure 8 - Earth Drilling Tools - Earth Auger.....	11
Figure 9 - Shaft Excavation - Belled Shaft.....	12
Figure 10 - Clean Up Tools.....	13
Figure 11 - FHWA Drilled Shaft Tutorial	14
Figure 12 - Cased excavation methods	15
Figure 13 - Slurry Method	16
Figure 14 - Impulse Echo or Impulse Response Method.....	32
Figure 15 Impulse Echo or Impulse Response Method Inspector Issues.....	33
Figure 16 - Cross-hole Sonic Logging Method	34
Figure 17 - - Cross-hole Sonic Logging Method Inspector Issues	34
Figure 18 - Gamma-gamma Logging Method.....	35
Figure 19 - Gamma-gamma Logging Method Inspector Issues.....	36
Figure 20 - Bi-Directional Testing Method	37
Figure 21 - Shaft Volume	47
Figure 22 - Shaft Volume Calculation	48
Figure 23 - Straight Shaft Volume.....	49
Figure 24 - Bell Volumes.....	51

DIVISION 600

Incidental Construction

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 601. PIPE DRAINS, UNDERDRAINS AND FRENCH DRAINS	601-1
601.04 PIPE UNDERDRAIN INSTALLATION.....	601-1
SECTION 602. CATCH BASIN, MANHOLE, INLET, DRAINAGE STRUCTURE AND VALVE VAULT CONSTRUCTION, ADJUSTMENT, AND RECONSTRUCTION	601-1
602.02 MATERIALS.....	601-1
602.03 INLETS/CATCH BASINS.....	601-2
602.03-1 Description	601-2
602.03-2 Frames and Grates	601-2
602.04 MANHOLES.....	601-5
SECTION 606. CONCRETE GUTTER, CURB, MEDIAN AND PAVED DITCHES.....	601-5
606.05 FORMS.....	601-5
606.07 CONCRETE GUTTER, CURB, AND CURB AND GUTTER.....	601-5
606.07-1 Appearance	601-5
606.07-2 Drainage.....	601-5
SECTION 610. SHOULDER INLET WITH CURB	601-6
610.03 INLET BOXES.....	601-6
SECTION 611. TREATMENT OF EXISTING FIELD TILE SYSTEMS.....	601-6
611.01 DESCRIPTION	601-6
611.02 LOCATING EXISTING FIELD TILE	601-6
611.03 EXISTING FIELD TILE INTERCEPTED BY BACKSLOPES	601-6

611.04 FIELD TILE NOT INTERCEPTED BY BACKSLOPES
.....
601-6

611.05 FIELD TILE JUNCTION VAULTS
.....
601-7

SECTION 630. STEEL PLATE BEAM GUARDRAIL 601-7

630.01 DESCRIPTION
.....
601-7

630.02 MATERIALS INSPECTION
.....
601-7

630.03 GENERAL
.....
601-8

630.03-1 Staking and Driving Posts 601-8

630.03-2 Paving 601-8

630.03-3 Rail Alignment 601-8

630.03-4 Bolt Holes in Field 601-8

630.03-5 Utility Considerations
601-9

SECTION 631. TRAFFIC BARRIER TERMINALS 601-9

631.01 DESCRIPTION
.....
601-9

631.02 MATERIALS
.....
601-9

SECTION 664. CHAIN LINK FENCE 601-9

664.03 GENERAL
.....
601-9

664.04 INSTALLING POSTS
.....
601-9

664.07 BRACES
.....
601-10

664.08 FABRIC

.....
601-10

SECTION 665. WOVEN WIRE FENCE..... 601-10

665.03 GENERAL

.....
601-10

SECTION 669. REMOVAL AND DISPOSAL OF REGULATED SUBSTANCES..... 601-10

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 600-1 — CATCH BASIN VS INLET	601-2
Figure 600-2 — TYPICAL FRAME AND GRATE FOR CATCH BASINS	601-3
Figure 600-3 — TYPICAL FRAME AND GRATE FOR INLETS	601-4

Division 601 INCIDENTAL CONSTRUCTION

SECTION 601. PIPE DRAINS, UNDERDRAINS AND FRENCH DRAINS

Portions of the discussion in Section 542 “Pipe Culverts” of this *Manual* also apply to Section 601 (e.g., field inspection of materials that arrive at the construction site).

601.04 PIPE UNDERDRAIN INSTALLATION

The contract documents are intended to provide all necessary details to install the pipe underdrain. However, the following design elements should be investigated for proper installation during construction:

- Outlets are typically provided on the plans at 500-ft (150-m) intervals. However, ensure that outlets are provided at all sag locations; do not provide outlets at crest locations.
- Do not use perforated pipe for underdrain outlets.
- The underdrain can be installed before or after PCC paving. There must be a minimum of 9½ in. of HMA before underdrain can be installed per Article 407.07.
- Do not allow heavy equipment on underdrain outlets. Inspect outlets after the headwall is installed. Be sure that the outlet pipe has a fall to the ditch. Do not outlet the underdrain if the ditch flowline is higher than the underdrain flowline. If not, outlet the underdrain into box or pipe culverts when practical.

SECTION 602. CATCH BASIN, MANHOLE, INLET, DRAINAGE STRUCTURE AND VALVE VAULT CONSTRUCTION, ADJUSTMENT, AND RECONSTRUCTION

The [Construction Inspector’s Checklist for Storm Sewers](#) also addresses Section 602 items.

602.02 MATERIALS

Inspect the materials according to the BMPR Policy Memorandum “[Quality Control/Quality Assurance Program for Precast Concrete Products.](#)”

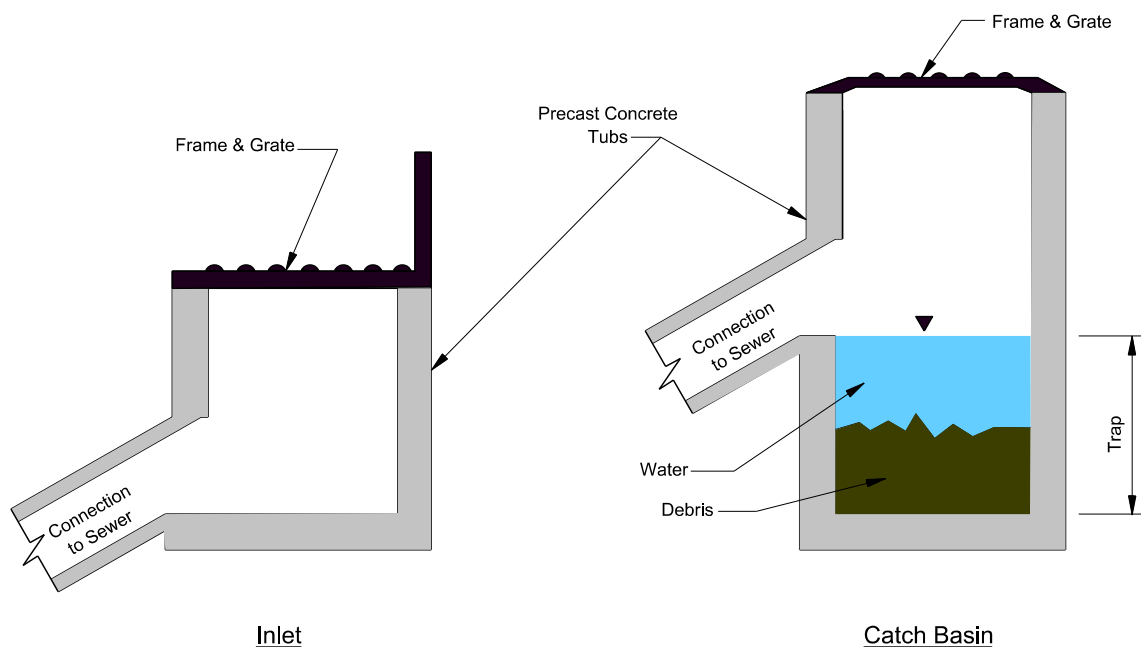
602.03 INLETS/CATCH BASINS

602.03-1 Description

Inlet and catch basin surfaces must meet adjacent sidewalk, curb and gutter, ditch, and pavement surfaces. Station and offset callouts are typically to the center of the structure. Note that the center of the structure is not always the same as the center of the inlet grate.

The primary difference between a precast inlet tub and a precast catch basin tub is that a catch basin has a “trap” or “sump” below the outlet end of the catch basin that allows for cleanout. See Figure 600-1. The trap or sump collects debris that could otherwise build up and block the outlet pipe. A precast inlet tub has an outlet pipe at generally the same elevation as the bottom of the inlet tub. Catch basin sumps require periodic cleaning to be effective and may become an odor and mosquito nuisance if not properly maintained.

Figure 600-1 — CATCH BASIN VS INLET



602.03-2 Frames and Grates

See Figure 600-2 for a typical frame and grate for a catch basin. See Figure 600-3 for a typical frame and grate for inlets.

Figure 600-2 — TYPICAL FRAME AND GRATE FOR CATCH BASINS



Figure 600-3 — TYPICAL FRAME AND GRATE FOR INLETS



602.04 MANHOLES

Manhole station and offset callouts are typically to the center of the manhole structure. The center of the structure and the center of the manhole lid may not be at the same location.

Joints in precast sections are required to be watertight and should be finished smooth and neat on the inside. Manhole lids in the wheel lane should be avoided if practical. If the staking or plans show that the lid is in the lane, contact the designer.

SECTION 606. CONCRETE GUTTER, CURB, MEDIAN AND PAVED DITCHES

606.05 FORMS

Article 1103.05 addresses the forms required. All forms must be checked prior to placing concrete. Joints should be checked for tightness and any difference in elevation on the top of the forms. Variations in alignment on tangents and flat spots in horizontal curves and between control stakes can be detected by sighting down the form line. Sighting down the top of the back-form line will locate variations in elevation between control points if observed from a distance.

606.07 CONCRETE GUTTER, CURB, AND CURB AND GUTTER

606.07-1 Appearance

Ensure that line and grade requirements are met because these items are highly visible to the traveling public. The grade should be checked prior to the pour for the offsets. Sight down the wire line for grade changes that appear incorrect. The top, front face and flow line of curbs should be checked with a straightedge during the finishing operations.

606.07-2 Drainage

Poor curb and gutter construction may result in areas that pond water, resulting in a potential safety hazard. Locations where this frequently occurs are at at-grade intersections, especially in curb radii and connections to existing gutter lines. At inlets in the curb and gutter, slope the gutter pan into the inlet. Ensure that no water can stand near inlets. Do not slope the back of the curb towards the inlet. Line up joints in curb and gutter with joints in PCC pavement. See [Highway Standard 606001](#).

The drainage conditions on any project where curbs will control drainage should be evaluated prior to the start of any grading work, because it may be necessary to make minor alterations in grades or minor changes in elevations of inlets, culverts, etc., to ensure proper drainage. The areas behind curbs and between curbs and the right-of-way line should be checked to ensure that drainage flows to a drainage structure. The drainage characteristics of the roadway section should be inspected during a rain event to observe runoff patterns and problem areas.

SECTION 610. SHOULDER INLET WITH CURB**610.03 INLET BOXES**

The inlet box and pipe drain should be positioned between the proposed approach guardrail posts. Place the grate so that water exiting off the bridge is forced into the inlet and not allowed to run past the inlet and wash the shoulder and fill areas.

SECTION 611. TREATMENT OF EXISTING FIELD TILE SYSTEMS**611.01 DESCRIPTION**

This work consists of maintaining the integrity of all existing field tile drainage systems within the limits of the right-of-way. Special care shall be taken to minimize possible future disputes with adjacent property owners.

611.02 LOCATING EXISTING FIELD TILE

Locate any existing field tiles with an exploration trench within the right-of-way. As a guideline, a continuous exploratory trench can be excavated along one side of the roadway close to the right-of-way. Intermittent trenching can be done along the opposite right-of-way where it is anticipated to intersect with the tile found in the initial trench. An accurate field book should be kept of locations and flow line elevations of all field tiles found during exploration trenching. This information should be plotted on as-built plan sheets for future reference during and after construction of the project.

Even if the existing tile is plugged, repair the tile because it may resume working in the future.

611.03 EXISTING FIELD TILE INTERCEPTED BY BACKSLOPES

Outletting field tile into the ditch is the economically preferred method of treatment. In some instances, however, this can cause continual moisture in the ditch, which promotes unattractive weeds and can make maintenance mowing difficult. The field tile can also drain along the ditch and then outlet onto adjacent private property, often the same property that the field tile is draining. This collects subsurface water and converts it to surface water. Cost effective alternatives to draining the field tiles into the ditch should be evaluated. Consider the following options:

- Adjusting the ditch to not intercept the tile
- Rerouting the tile along the right-of-way to another tile that is not intercepted by the ditch grade
- Rerouting the tile to an outlet into a stream that has a continual flow of water

611.04 FIELD TILE NOT INTERCEPTED BY BACKSLOPES

If there is sufficient cover between the top of the field tile and the ditch grade (typically 2 ft (600 mm) or greater), then the concrete slab protection is not required.

611.05 FIELD TILE JUNCTION VAULTS

In addition to junction vaults, inspection wells (or risers) should be installed for future use to verify the operation of the field tile system. Inspection wells should be placed approximately 2 ft (600 mm) inside the right-of-way lines at all locations where field tile enters or exits the right-of-way. Risers would not be necessary at locations where the field tile is intercepted by the backslopes of ditches because water flow from the terminating headwalls will provide sufficient inspection.

Components used for inspection wells can typically be a T-section, a portion of pipe rising at least 1 ft (300 mm) above the ground line, and a suitable lid or cap. Materials may be the same as those used for the Storm Sewer (Special), except that the material rising above ground must be UV resistant.

SECTION 630. STEEL PLATE BEAM GUARDRAIL

630.01 DESCRIPTION

Steel plate beam guardrail, commonly known as the W-beam system, with strong posts is a semi-rigid system. Blockouts are used to prevent a vehicle from snagging on the posts and to maintain rail alignment during a crash. For W-beam guardrail, the deflection distance is measured from the back of the post to the front face of the object. See Section 38-5 of the IDOT [BDE Manual](#) and the [Highway Standards](#).

630.02 MATERIALS INSPECTION

The acceptance of material is based on a visual inspection and receipt of the manufacturer's certifications and mill test reports. Mill test reports are required to track heat numbers and to ensure compliance of material grade, origin and chemical and physical properties.

The following provides guidelines for the evaluation of guardrail system components:

1. Identification Marks. As required in the PPG, the guardrail must have a commercial label, tag or other marking that indicates product specification compliance and/or approved source/manufacturer.
2. Galvanization. Check steel rail sections and posts for damage to the galvanization, especially areas where the materials have been stockpiled, and for evidence of being cut or drilled in the field. Require field repairs or replacement based on the extent of the missing coating.
3. Guardrail Sections. Check for visual defects such as burrs, twists, bends, misaligned holes and uncoated areas. Verify that the sections are of the type, shape, length and curvature required. Require replacement of damaged sections.
4. Steel Posts. Check for visual defects (e.g., bends, twists, uncoated areas, misaligned holes, damaged ends). Verify that the posts are of the proper type and weight for the system to be installed. Check the length, cross-sectional dimensions, hole diameter and template for compliance.

5. Wood Posts and Blockouts. Check compliance with the hammer mark from the mill. Check that the wood is straight, sound, free from defects, and meets the dimensions specified. Field cuts should be avoided; however, where necessary, ensure that the cut wood is not painted, but treated with an approved preservative material.
6. Fastener Hardware. Check compliance of fastener type, class, diameter and length. Ensure that the correct fasteners are being supplied with the proper system. Cutting of bolts is not permitted.

630.03 GENERAL

630.03-1 Staking and Driving Posts

Guardrail layout staking generally consists of marks on the pavement to locate the longitudinal position of the post together with the offset distance to the post. Stakes or markings for guardrail control are generally adequate if set at 50-ft (15-m) intervals for tangent sections and 25-ft (8-m) intervals on horizontal curves. When staking post locations, locate all drainage structures so that, where practical, the post location can be adjusted to eliminate any conflicts.

The Contractor may elect to drive steel guardrail posts full depth or place them in manually or mechanically dug holes and then drive the final 10 in. (250 mm) to grade. However, the Contractor shall not drive posts through HMA pavement. When posts are placed in manually or mechanically dug holes, the space around posts must be backfilled with moist soils placed in compacted lifts. Ensure that posts are not damaged during installation from hydraulic hammers and that posts are vertical.

630.03-2 Paving

Coordination of the mainline paving and guardrail installation is the Contractor's responsibility. Details must be included in the progress schedule and Traffic Control Plan (TCP). Every effort should be made to have the roadway and shoulders completed before the new guardrail is installed. Placing the guardrail before the roadway or shoulder is placed can affect grades and make rolling the outside edge of the asphalt pavement or shoulder impossible. The paving also provides the guardrail Subcontractor with a stable base to work from.

630.03-3 Rail Alignment

The positions of the posts for steel plate beam guardrail are of special importance, because the slots in the beams must be centered on the posts so that the plates may expand and contract without loosening posts. Rail elements should be assembled to present a smooth, continuous appearance with the top of the rail being in near perfect alignment horizontally and vertically with the roadway. There should be no noticeable sags or humps.

630.03-4 Bolt Holes in Field

The Department prohibits the use of a cutting torch for making bolt holes. Heat may weaken the metal around the hole so that the bolt head may pull out under the force of impact. The only acceptable methods of making bolt holes in the field are drilling or punching.

630.03-5 Utility Considerations

Post installation must not interfere with or damage underground facilities (e.g., lighting, signal cables, underdrains). Such utilities must be located and marked in advance of construction. The Contractor must contact [J.U.L.I.E./Digger](#) to locate underground utilities.

SECTION 631. TRAFFIC BARRIER TERMINALS**631.01 DESCRIPTION**

The Department has adopted several types of traffic barrier terminals for various applications; see Section 38-6.06 of the IDOT [BDE Manual](#) and the [Highway Standards](#).

631.02 MATERIALS

Almost all traffic barrier terminals are proprietary items, and the Qualified Products List identifies the acceptable terminals. When the terminal components are delivered to the construction site, the manufacturer's documentation will include, but is not limited to:

- Detailed shop drawings showing dimensions, steel grade and other pertinent information for rail sections, posts, blockouts, anchors, bolts and all other hardware required for the installation
- A complete set of installation instructions, which is especially important for proprietary terminal sections
- Manufacturer's certification that the system meets requirements of the AASHTO Manual on Assessing Safety Hardware (MASH) for the intended application of the system

SECTION 664. CHAIN LINK FENCE**664.03 GENERAL**

The purpose of chain link fence is to control access onto State right-of-way by correct horizontal and vertical alignment. The bottom of the fence should clear natural ground by a minimum of 1 in. (25 mm) and maximum of 5 in. (125 mm), with 3 in. (75 mm) clearance desirable. Any high points or other obstacles that interfere with the above clearances should be removed. At locations of small natural drainage ditches where it is not practical to conform the fence to the general contour of the ground surface, close the resulting opening below the fence with barbed wire fastened to stakes of such length as required.

664.04 INSTALLING POSTS

To provide for true alignment and the centering of the post in the footing, a stringline or other suitable method of alignment should be used by the Contractor in excavating for the post footings. After the concrete is placed, alignment of posts should be checked by stringline or "eyeball" while the Class SI footing concrete is still in a plastic state. All posts should be plumbed with a suitable carpenter's level and concrete footings trowel finished and sloped away from the post to protect the posts from later corrosion. When digging footing holes, ensure not to disturb

existing right-of-way posts. Although various soils behave differently, 1 ft (300 mm) clearance from the right-of-way post is generally sufficient.

664.07 BRACES

For each brace, there must be a truss rod in the same span to transmit fabric from the brace post back to the terminal post. Position and fasten braces and truss rods to the posts prior to fabric erection.

664.08 FABRIC

Construct fabric on the outside of the fence line with the top of the fence extending 1 in. (25 mm) above the top tension wire. Do not allow fabric contact with the ground. No continuous run of fabric should be installed in excess of 660 ft. (200 m) due to expansion considerations. Every run of fabric must terminate at a terminal (end, corner, gate or pull) post and be properly supported by brace and truss rod.

SECTION 665. WOVEN WIRE FENCE

665.03 GENERAL

The purpose of woven wire fence is to delineate the access control limits of property adjacent to the right-of-way. It is desirable to have the fence built before other construction work has started. This is especially important in rolling terrain, where areas may become inaccessible after cuts are made. At locations where it may not be possible to build the fence on State right-of-way, an easement will be needed before any fence can be built on private property.

The bottom strand of the woven wire should clear the ground by 1 in. (25 mm) with a maximum of 3 in. (75 mm) allowable. Remove any high points or other obstacles that interfere with the above clearances. At locations of small natural drainage ditches, where it is not practical to conform the fence to the general contour of the ground surface, close the opening below the fence with barbed wire fastened to stakes at required lengths. All concrete post encasements should be crowned and sloped to drain. No continuous run of fabric shall be installed in excess of 660 ft (200 m) because of expansion considerations. If wood posts are used, install protective electrical grounds as called for on the plans and Article 665.03.

Review the areas adjacent to culverts and pipes before setting pullposts to prevent washouts and maintenance.

SECTION 669. REMOVAL AND DISPOSAL OF REGULATED SUBSTANCES

669.01 DESCRIPTION

Section 27-3 of Chapter 27 "Environmental Surveys" of the IDOT *BDE Manual* discusses the preconstruction process for regulated substances, aka, special wastes. It is designed to implement and comply with Departmental Policy D&E-11, "Identifying and Responding to Regulated Substances in Highway Project Development, Implementation and Operations." Figures 27-3.A through 27-3.D presents detailed flowcharts describing the environmental assessment process conducted to address the removal and disposal of regulated substances

within the project limits. The outcome of the process is a project-specific Special Provision identifying the location and contract requirements for handling regulated substances. For each location, the Special Provision will provide:

- The station-to-station limits
- The lateral offset to the site of concern
- The site identification (e.g., Mobil Gas Station, PESA Site 1388V-67, 1400 South LaGrange Road)
- The applicable Article within Section 669 that describes how the material shall be handled (e.g., Article 669.05 “Regulated Substances Management and Disposal”)
- An identification of the “contaminants of concern sampling parameters” (e.g., BETX and Arsenic)

In addition, the Special Provision will provide the engineering requirements for any special features needed to remediate the regulated substance. For example, the Special Provision may require the installation of an engineered barrier in storm sewer trenches to limit the exposure and control the migration of chemical contamination from contaminated soil that may be present within the trench excavation.

669.03 PRE-CONSTRUCTION SUBMITTALS AND QUALIFICATIONS

In most cases, the Contractor will hire a qualified environmental firm that meets requirements specified in Article 669.03 to perform monitoring and reporting work. Per Article 669.03, the Contractor must submit Form BDE 2730 “Regulated Substances Pre-Construction Plan” (RSPCP), for review and approval, prior to beginning any excavation in the regulated areas. The Resident shall forward the plan to the District Environmental Studies Unit (DESU) for their review and acceptance recommendation. (Note, BDE 2731 “Regulated Substance Pre-Construction Plan Checklist” is available to facilitate the plan review.)

669.04 REGULATED SUBSTANCES MONITORING

Per Article 669.04 regulated substance monitoring must be conducted during excavation in contract specific areas where regulated substances were identified during the environmental due-diligence process / design phase. The Contractor shall document monitoring activities via Form BDE 2732 “Regulated Substances Monitoring Daily Record” (RSMDR).

Regulated substances monitoring consists of two distinct components, each with their own subset of duties: 1) environmental observation and 2) field screening. Specific duties of the environmental monitor are listed on form BDE 2732.

Field screening and environmental observation are required in contract specific work areas containing materials classified as 669.05(a)(1), 669.05(a)(2), 669.05(a)(3), 669.05(a)(4), 669.05(a)(5), 669.05(a)(6), 669.05(b)(2) and 669.05(d) in the regulated substances special provision..

Field screening is not required in contract specific work areas containing materials classified as 669.05(b)(1) (pH exceedances) or 669.05(c) (manganese and iron exceedances) in the regulated substances special provision. However, environmental observation of these work areas is still required of the contractor during construction activities.

Environmental observation and field screening activities shall be documented on form BDE 2732. One BDE 2732 form shall be completed each day, excavation occurs in applicable work areas, by the qualified personnel conducting the regulated substances monitoring. The forms should be submitted weekly to the Resident for approval. Once the Resident has approved the forms, they will be sent back to the contractor for future inclusion in the Regulated Substances Final Construction Report (form BDE 2733).

It is permissible for the contractor to utilize more than one qualified person on the job to conduct regulated substances monitoring; however, the cost for those personnel shall be included in the contractors bid price per calendar day.

Per Article 107.19, if any unexpected abnormal condition is encountered which may indicate the presence of a regulated substance, including underground storage tanks and railroad ties, work shall be immediately discontinued. The DESU should be contacted promptly for additional guidance. The Central Bureau of Design and Environment will provide additional technical guidance when requested by the DESU. Form BDE 2730A "Regulated Substances Pre-Construction Plan Addendum" shall be used to document the changed condition(s) accordingly.

669.05 REGULATED SUBSTANCES MANAGEMENT AND DISPOSAL

A regulated substances special provision identifies contaminated soil, sediment, and groundwater restrictions for an IDOT project and specifies proper management and disposal of that material during construction. Section 669.05 of the Standard Specifications for Road and Bridge Construction specifically lists the methods for managing and disposing regulated substances encountered during construction. The following table provides guidance regarding soil management and payment issues for work associated with regulated soils (and groundwater):

Specification Article	Guidance
669.05(a)(1)	<p><u>Management:</u> Soil can be used on site or managed and disposed of at a properly permitted landfill as non-special waste.</p> <p>When disposed of at a landfill, the Contractor must provide a signed letter specifying the proposed disposal facility and documentation the landfill is permitted to accept the regulated soil. The Contractor is also responsible for providing the Waste Material Profile and Generator’s Non-Special Waste Certification. (Typically, these documents are prepared by an environmental firm hired by the Contractor). The District is responsible for signing the Generator’s Non-Special Waste Certification (to demonstrate the waste is not a special waste)</p> <p><u>Payment:</u></p>

	<p>Unless otherwise noted in the plans or special provision, when this soil is disposed of at a landfill, both the pay item associated with the excavation and the non-special waste disposal should be paid; when this soil is used on site, only the pay item associated with the excavation should be paid.</p>
669.05(a)(2)	<p><u>Management:</u> Soil can be used on site, disposed of at a clean construction demolition debris (CCDD) or uncontaminated soil fill operation (USFO) within an MSA County, or disposed of on another IDOT contract with the same MSA restriction.</p> <p>When disposed of at a CCDD or USFO, the Contractor must provide a signed letter specifying the proposed disposal facility. The Contractor must also provide documentation the facility is on the IEPA approved CCDD or Solid Waste sites lists or possess the appropriate permit to accept the regulated soil. The District is responsible for providing the Contractor with a completed IEPA LPC 663 form for their use.</p> <p>When disposed of on another IDOT contract with the same MSA restrictions, the Contractor must provide a signed letter specifying the proposed disposal site and provide a copy of the letter in the BDE 2733. The proposal must be approved by the Resident of each contract involved. Final disposition of soil transported to another contract must be documented on BDE 2732.</p> <p><u>Payment:</u> Only the pay item associated with the excavation should be paid (unless otherwise noted in the plans or special provision).</p>
669.05(a)(3)	<p><u>Management:</u> Soil can be used on site, managed and disposed of at a clean construction demolition debris (CCDD) or uncontaminated soil fill operation (USFO) within an MSA County excluding Chicago or excluding the Chicago corporate limits, or disposed of on another IDOT project with the same MSA restrictions.</p> <p>When disposed of at a CCDD or USFO, the Contractor must provide a signed letter specifying the proposed disposal facility. The Contractor must also provide documentation the facility is on the IEPA approved CCDD or Solid Waste sites lists or possess the appropriate permit to accept the regulated soil. The District is responsible for providing the Contractor with a completed IEPA LPC 663 form for their use.</p> <p>When disposed of on another IDOT contract with the same MSA restrictions, the Contractor must provide a signed letter specifying the proposed disposal site and provide a copy of the letter in the BDE 2733. The proposal must be approved by the Resident of each contract involved. Final disposition of soil transported to another contract must be documented on BDE 2732.</p> <p><u>Payment:</u> Only the pay item associated with the excavation should be paid (unless otherwise noted in the plans or special provision).</p>

<p>669.05(a)(4)</p>	<p><u>Management:</u> Soil can be used on site, managed and disposed of at a clean construction demolition debris (CCDD) or uncontaminated soil fill operation (USFO) within an MSA County excluding Chicago, or disposed of on another IDOT project with the same MSA restrictions.</p> <p>When disposed of at a CCDD or USFO, the Contractor must provide a signed letter specifying the proposed disposal facility. The Contractor must also provide documentation the facility is on the IEPA approved CCDD or Solid Waste sites lists or possess the appropriate permit to accept the regulated soil. The District is responsible for providing the Contractor with a completed IEPA LPC 663 form for their use.</p> <p>When disposed of on another IDOT contract with the same MSA restrictions, the Contractor must provide a signed letter specifying the proposed disposal site and provide a copy of the letter in the BDE 2733. The proposal must be approved by the Resident of each contract involved. Final disposition of soil transported to another contract must be documented on BDE 2732.</p> <p><u>Payment:</u> Only the pay item associated with the excavation should be paid (unless otherwise noted in the plans or special provision).</p>
<p>669.05(a)(5)</p>	<p><u>Management:</u> Disturbed soil must be managed and disposed of at a properly permitted landfill as non-special waste. The Contractor must provide a signed letter specifying the proposed disposal facility and documentation the landfill is permitted to accept the regulated soil. The Contractor is also responsible for providing the Waste Material Profile and Generator’s Non-Special Waste Certification. (Typically, these documents are prepared by an environmental firm hired by the Contractor.) The District is responsible for signing the Generator’s Non-Special Waste Certification (to demonstrate the waste is not a special waste).</p> <p><u>Payment:</u> Both the pay item associated with the excavation and the non-special waste disposal should be paid (unless otherwise noted in the plans or special provision).</p>
<p>669.05(a)(6)</p>	<p><u>Management:</u> Disturbed soil must be managed and disposed of at a properly permitted landfill as special waste or hazardous waste (as applicable). The Contractor must provide a signed letter specifying the proposed disposal facility and documentation the landfill is permitted to accept the regulated soil. The Contractor is also responsible for providing the Waste Material Profile and a Uniform Hazardous Waste Manifest. (Typically, these documents are prepared by an environmental firm hired by the Contractor.) The District is responsible for signing the Uniform Hazardous Waste Manifest.</p>

	<p><u>Payment:</u> Both the pay item associated with the excavation and the special waste/hazardous waste disposal should be paid (unless otherwise noted in the plans or special provision).</p>
669.05(b)(1), 669.05(b)(2), And 669.05(c)	<p><u>Management:</u> Soil can be used on site, managed and disposed of offsite according to Article 202.03, or disposed of on another IDOT contract. This soil cannot be disposed of at a CCDD or USFO facility.</p> <p>When disposed of offsite according to Article 202.03, the submittal and approval process shall be according to BDE Manual Chapter 27; Section 27-2.</p> <p>When disposed of on another IDOT contract, the Contractor must provide a signed letter specifying the proposed disposal site and provide a copy of the letter in the BDE 2733. The proposal must be approved by the Resident of each contract involved. Final disposition of soil transported to another contract must be documented on BDE 2732.</p> <p><u>Payment:</u> Only the pay item associated with the excavation should be paid (unless otherwise noted in the plans or special provision).</p>
669.05(d)	<p><u>Management:</u> Groundwater shall be managed and disposed of as a special waste or hazardous waste, as applicable, according to Article 669.05(d). When disposed of offsite, special waste groundwater shall be containerized and delivered to an approved treatment facility. When disposed of in a sanitary sewer or combined sewer, the discharge shall be pre-treated to remove particulates and the discharge shall be approved (in writing) by the local sewer authority.</p> <p><u>Payment:</u> Only the pay item associated with the groundwater disposal should be paid (unless otherwise noted in the plans or special provision).</p>

See also the Construction Inspector's Checklist for Regulated Substances.

669.07 TEMPORARY STAGING

In accordance with section 669.07 of the Standard Specifications for Road and Bridge Construction, soil classified according to Articles 669.05(a)(2), 669.05(b)(1) or 669.05(c) may be temporarily staged, at the Contractor's option, when used for fill within the project construction limits. If circumstances require the contractor to use temporary staging for soil or material other than those specified above, the contractor will request written approval from the Engineer using form BDE 2730.

All temporary staging activities must be documented in the Regulated Substances Monitoring Daily Sheets (form BDE 2732) and in the Regulated Substances Final Construction Report (form BDE 2733).

669.09 REGULATED SUBSTANCES FINAL CONSTRUCTION REPORT

Not later than 90 days after completing all work associated with regulated substances, the Contractor shall submit a "Regulated Substances Final Construction Report (RSFCR)" and associated required attachments to the Engineer using form BDE 2733 for review and approval. The report shall be signed by an Illinois licensed Professional Engineer or Professional Geologist. The Resident will forward the report to the DESU for their review and approval recommendation. (Note: BDE 2734 "Regulated Substance Final Construction Report Checklist" should be used to facilitate the report review.)

669.11 BASIS OF PAYMENT

Monitoring of regulated substances, including completion of form BDE 2732 for each day of work, will be paid for at the contract unit price per calendar day, or fraction thereof, for REGULATED SUBSTANCES MONITORING." If monitoring activities occur for 4 or more hours on a given calendar day, pay 1.0 CALENDAR DAY. If monitoring activities occur for less than 4 hours, pay 0.5 CALENDAR DAY. In no case should there be more than 1.0 calendar day paid on a given calendar day on the same contract. In all cases, payment is also based on the receipt of Form BDE 2732, "Regulated Substances Monitoring Daily Record".

ADDITIONAL RESOURCES AND TRAINING

IDOT's Bureau of Design and Environment (BDE) has prepared web-based training to assist Resident's, Contractor's and others with understanding regulated substances requirements. The web-based training is hosted on the IDOT "Illinois State Learning Management System" (LMS). The LMS may be accessed at <https://ildottraining.org>. The training is titled "*Regulated Substances, Construction Projects and Special Provisions Training Course*".

DIVISION 700

Work Zone

Traffic Control and Protection, Signing, and Pavement Marking

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 701. WORK ZONE TRAFFIC CONTROL AND PROTECTION, SIGNING, AND PAVEMENT TRACKING	701-1
701.01 DESCRIPTION.....	701-1
701.01-1 Importance	701-1
701.01-2 Definitions.....	701-1
701.01-3 Resources	701-1
701.04 GENERAL	701-2
701.04-1 Overview	701-2
701.04-2 Contractor's Responsible Engineer's Responsibilities	701-2
701.04-3 Responsibilities of Department Field Construction Staff	701-3
701.04-4 Pedestrian and Bicyclist Accommodation.....	701-4
701.07 DROP-OFFS	701-5
701.15 TRAFFIC CONTROL DEVICES.....	701-6
701.15-1 Purpose	701-6
701.15-2 Inspection	701-6
SECTION 703. WORK ZONE PAVEMENT MARKING	701-7
SECTION 704. TEMPORARY CONCRETE BARRIER	701-7
SECTION 720. SIGN PANELS AND APPURTENANCES.....	701-8
720.02 MATERIALS	701-8
720.04 INSTALLATION.....	701-8
SECTION 724. REMOVE AND RELOCATE SIGN PANEL AND SIGN PANEL ASSEMBLY	701-8
SECTION 727. SIGN SUPPORT – BREAKAWAY	701-8
SECTION 780. PAVEMENT STRIPING	701-9
780.02 MATERIALS	701-9

780.04	GENERAL	701-9
780.05	THERMOPLASTIC.....	701-9
780.06	PAINT.....	701-11
780.07	PREFORMED PLASTIC	701-11
780.09	EPOXY	701-11

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 700-1 — THERMOPLASTIC APPLICATION TROUBLESHOOTING.....	701-10
Figure 700-2 — PAINT APPLICATION TROUBLESHOOTING.....	701-12
Figure 700-3 — EPOXY APPLICATION TROUBLESHOOTING.....	701-13

Division 701

WORK ZONE TRAFFIC CONTROL AND PROTECTION, SIGNING, AND PAVEMENT MARKING

SECTION 701. WORK ZONE TRAFFIC CONTROL AND PROTECTION, SIGNING, AND PAVEMENT TRACKING

701.01 DESCRIPTION

701.01-1 Importance

Highway construction often disrupts the normal flow of traffic and may pose safety hazards to motorists, bicyclists, pedestrians and workers. Therefore, to mitigate potential operational and safety problems, IDOT requires that a Traffic Control Plan (TCP) be prepared for every construction project to provide for the continuity of movement for all users.

701.01-2 Definitions

1. Traffic Control Plan (TCP). A plan to safely guide traffic through a construction project through the use of traffic control devices and project coordination. The TCP focuses on the mobility and protection of traffic within the construction zone.
2. Transportation Management Plan (TMP). An integrated strategy to manage work zone impacts of a project. The possible components of a TMP are a TCP, TOP, and PIP.
3. Transportation Operations Plan (TOP). A plan that consists of strategies that mitigate work zone impacts through the use of improved transportation operations and management of the transportation system.
4. Public Information Plan (PIP). A plan that consists of strategies to inform those affected road users, including the surrounding community, of the expected impact of a project, of changing conditions and available travel options.

701.01-3 Resources

- Chapter 55 “Work Zone Traffic Control,” IDOT [BDE Manual](#)
- Chapter 13 “Work Zone Transportation Management Plans,” IDOT [BDE Manual](#)
- [Illinois Highway Standards for Traffic Control](#), IDOT
- “[Work Zone Safety and Mobility Rule](#),” IDOT Safety Engineering Policy 3-07
- “[Work Zone Safety and Mobility: Positive Protection of Workers, Drop-Offs and Temporary Concrete Barrier](#),” IDOT Safety Engineering Policy 4-15
- [Traffic Control Field Manual](#), IDOT

- [Illinois Supplement to the National MUTCD](#), IDOT
- [Part 6 “Temporary Traffic Control,” MUTCD](#), FHWA
- [Sign Structures Manual](#), IDOT

701.04 GENERAL

701.04-1 Overview

The Contractor is responsible for providing, erecting, maintaining and removing traffic control signing and devices that are required to protect traffic in accordance with the TCP. Traffic control must be set up before the Contractor is allowed to begin construction.

A revised TCP is required for any revisions in construction staging or operations that affect traffic and shall be approved by the District Operations Engineer, the Central Bureau of Construction and the Program Development Engineer.

701.04-2 Contractor’s Responsible Engineer’s Responsibilities

The Contractor prepares [Form BSPE 725: Traffic Control Authorization Request](#), which identifies the Contractor’s Responsible Engineer. The Resident must have ready access to this individual’s contact information on a 24-hour/7-day per week basis. The Contractor shall use [Form BC 2240: Traffic Control Surveillance Report](#), to document surveillance as required by Article 701.10 of the *Standard Specifications*.

The Contractor’s duties include:

- Maintain the project’s temporary traffic control for compliance with the contract
- Verify that the proper type and number of traffic control devices are located and arranged as presented in the approved TCP for the method of traffic accommodation designated for the active construction phase
- Ensure that the traffic control devices in place are managing the traffic and other highway users appropriately and as intended
- Ensure that warning lights, flashing beacons, portable arrow boards and portable, changeable message signs and other devices are functioning properly and are clearly visible with sufficient battery life
- Ensure the cleaning of traffic control devices as frequently as necessary to preserve visibility, legibility and retroreflectivity
- Ensure that the traffic control surveillance is performed if directed by the Resident

701.04-3 Responsibilities of Department Field Construction Staff**701.04-3(a) General**

On relatively simple construction projects, the Resident will often perform the duties presented in this subsection; however, on large, complex projects where the reviews are continuous and time-consuming, the Resident will usually delegate the duties to a full-time Inspector.

Ensure that the Contractor's Responsible Engineer is present during any Department project meeting that may affect temporary traffic control on the project.

Each District Bureau of Operations includes a Traffic Control Supervisor, who participates in the periodic TCP reviews performed by the Central Bureau of Operations. The Supervisor also independently visits ongoing construction projects to evaluate the work zone traffic control. The District Traffic Control Supervisor periodically inspects traffic control on all projects, completes [Form BSPE 726: Traffic Control Inspection Report](#) and submits the form to the Resident. In addition, the District Field Engineer runs the preconstruction conference. The Traffic Control Supervisor also attends the preconstruction conference and emphasizes the work zone traffic control requirements for each project.

701.04-3(b) Inspection Duties

The Resident is responsible for conducting the following inspections:

1. Frequency (Daytime). Inspection and monitoring of the project is necessary because, as the construction work progresses, conditions affecting traffic control constantly change resulting in the need to adjust traffic control devices. When temporary traffic control devices are in place, the Resident or Inspector shall routinely drive through and document the jobsite at the beginning and end of each workday, when practical. Perform one detailed daytime inspection weekly for projects having hazards in the work zone, barricades on the pavement or barricades on the shoulder. Record the inspections on Form BSPE 726: Traffic Control Inspection Report.
2. Frequency (Nighttime). When temporary traffic control devices are in place, perform routine nighttime inspections at a minimum of two times per month to ensure sign reflectivity, identify light outages and required maintenance of traffic control devices, and confirm clear direction to motorists through the work zones. Record the inspections on Form BSPE 726: Traffic Control Inspection Report. Traffic control devices and pavement markings that are adequate during daytime may be inadequate at night, especially during rain or snow conditions. Retroreflectivity of signs and misleading striping are especially important items to inspect at night.
3. Winter Shutdown. Project work is frequently idle during long holiday weekends and during a winter shutdown. Many circumstances may occur during this time that can affect the efficiency of traffic control devices. For example, signs and barricades can be destroyed by traffic. These deficiencies must be corrected immediately. Scheduling of inspections during holidays and the winter shutdown is the responsibility of the Resident. During periods longer than 21 days when no work is being performed (e.g., winter

shutdown, suspension of work, extraordinary third-party delay, strikes) and temporary traffic control devices are in place, perform inspections at a minimum of two times a week. Also, see Construction Memorandum No. 77 in Appendix A.

4. Adverse Weather. Rain and snow can greatly affect traffic control on a project. Therefore, monitoring during periods of adverse weather is important to ensure as safe a project as practical.
5. Deficiencies. If a deficiency is found during an inspection, notify the Contractor in writing. The Contractor shall notify the Resident when the deficiency has been corrected. The Contractor shall provide evidence of the date and time the deficiency was corrected. If a deficiency is not corrected in accordance with the contract, the traffic control deficiency deduction should be applied.
6. Speed Limit Signs. Check speed limit signing, both temporary and permanent, and ensure that no conflicts exist.

When construction activities are performed outside normal working hours, adjustment will be made as to when the inspections will be performed. The adjustments will correspond to actual field conditions. The frequency of the inspections will remain the same, although they may be performed at times other than previously stated.

These reviews are critical before weekends and/or holiday periods. Routine inspection of traffic control ensures that work zones are safe for both the motoring public and individuals working within the work zone.

701.04-4 Pedestrian and Bicyclist Accommodation

Situations that typically warrant special pedestrian/bicyclist considerations during construction include locations where:

- Sidewalks traverse the work zone
- A designated school route traverses the work zone
- Significant pedestrian/bicyclist activity exists

The contract documents should include all necessary provisions to address pedestrian/bicyclist accommodation during construction. Section 58-1.01(c) of the IDOT *BDE Manual* discusses the IDOT practices and policies with respect to this objective. In addition, Section 55-2.01(d) of the IDOT *BDE Manual* presents several guidelines for pedestrian/bicyclist accommodation through work zones. Also, see Section 424 of this *Manual* for a discussion on accessibility requirements.

The Resident should ensure that the work zone traffic control in the contract documents adequately addresses pedestrian, bicyclist and, as practical, accessibility accommodation. However, the Resident must not override the designer or contract documents. Contact the designer if any changes are being considered.

In addition to the guidance in the IDOT BDE Manual, the Resident may consider the following guidance:

1. Obstructions. Ensure that pedestrian walkways/bicycle paths are free of any obstructions and hazards (e.g., holes, debris, mud, construction equipment, stored materials).
2. Lighting. Consider providing temporary lighting for all walkways that may be used at night, particularly if adjacent walkways are lighted.
3. Hazards. Clearly delineate all hazards (e.g., ditches, trenches, excavations) near or adjacent to walkways.
4. Covering. Walkways under or adjacent to elevated work activities (e.g., bridges, retaining walls) may need to be covered.
5. Pedestrian/Bicyclist Guidance. Emphasize positive guidance to pedestrians. Where pedestrian walkways and bicycle paths cannot be provided, direct pedestrians/bicyclists to a safe location (e.g., the other side of the street).
6. Timing. Stage construction operations so that, if there are two walkways, at least one remains open. The Contractor should schedule the construction so that any temporary removal of sidewalks will occur in the shortest practical time.
7. Closed Sidewalks and Visually Impaired. The desired method to provide information for notification of sidewalk closures to pedestrians with visual impairments is a speech message provided by an audible information device. An audible information device activated by a motion detector is most desirable.
8. Detectable Edging. Detectable edging is required where it is determined that a facility should be accessible to and detectable by pedestrians with visual impairments. The detectable edging should be provided throughout the length of the facility so that it can be followed by pedestrians using long canes. Detectable edging should be provided where sidewalks are closed at intersections and where sidewalks are near excavation areas to prevent entrance into the work area and to direct visually impaired pedestrians in the direction of safest travel.
9. Temporary Sidewalks. Consider providing temporary sidewalks where an existing sidewalk is removed and where:
 - There is a known pedestrian generator (e.g., schools, neighborhood shopping centers)
 - The principal access for pedestrian traffic to a business is via an existing paved surface
 - The new sidewalk will not be constructed prior to a winter shutdown

701.07 DROP-OFFS

In addition to Article 701.07, see Section 55-2.04 of the IDOT BDE Manual and "Work Zone Safety and Mobility: Positive Protection of Workers, Drop-Offs and Temporary Concrete Barrier," IDOT Safety Engineering Policy 4-15.

701.15 TRAFFIC CONTROL DEVICES

701.15-1 Purpose

Physical maintenance of temporary traffic control devices is necessary to retain the legibility and visibility requirement and will ensure the proper functioning of the device. See the IDOT Traffic Control Field Manual. Classifications and color pictures with written descriptions are included for each traffic control device.

Signs that do not apply should be removed or covered. Displaying signs that do not apply causes confusion and lack of respect for other signs. When covering a sign, cover the entire sign face with opaque material. As an example, use the back side of another sign of the same dimensions and attach with sign clips. "Road Construction Ahead" signs should be taken down or covered when all physical work is completed.

701.15-2 Inspection

Functional maintenance of traffic control devices is necessary to determine if the devices are performing satisfactorily, the retroreflectivity is adequate, they are clean, and if they have been moved, damaged or otherwise rendered ineffective. The Resident and/or the District Traffic Control Supervisor should perform the following:

1. On-Site Yard Inspection. Inspection of the devices before placement in the field is necessary to ensure that they are appropriate for the TCP and are in acceptable condition. There must also be sufficient devices to meet the needs of the TCP.
2. Drive-Through Inspection. A drive-through inspection enables the Inspector to see the traffic control devices and perform the maneuvers required by all drivers. Conduct the inspection for all lanes in both directions and at all entry or exit points within the construction zone. Daytime and nighttime inspections are required to ensure that devices are functioning properly, are clean and legible, and are maintaining retro-reflectivity.
3. Stationary Observations. A fixed observation point allows the Traffic Control Inspector to view how drivers are reacting to a particular portion of the work zone. Locations with numerous skid marks and areas with new skid marks may indicate a location where drivers are having problems navigating the work zone.
4. Walk-Up Inspections. Major devices (e.g., crash cushions, portable changeable message boards) require walk-up inspections. Ensure that the assembly and installation of the work zone devices comply with the contract documents and manufacturer's recommendations.
5. Nighttime Inspections. Work zones must appear on the road at night as intended by the project design. Therefore, conduct nighttime inspections for both projects with daytime work and those with nighttime work:
 - a. For projects with daytime work, focus on retro-reflectivity of signs and devices and legibility of signs, and verify that all steady-burn warning lights are working.

- b. For projects with nighttime work, conduct inspections each night. Focus on the issues previously discussed plus the following concerns:
- Flagging stations must be lit from above.
 - Equipment must be lit with balloon lights.

SECTION 703. WORK ZONE PAVEMENT MARKING

The purpose of work zone markings is to channelize traffic and provide delineation for the travel lanes during construction until the permanent pavement markings are applied. Temporary pavement markings “mimic” the permanent pavement markings until the permanent markings are applied. Short term pavement markings are solely to provide positive guidance to drivers for short term traffic patterns.

Pavement marking tape may be applied to areas where the Contractor will modify the traffic pattern but maintain the traffic on an existing pavement or final surface. These markings are removable. Ensure that the tape is clean and pressed down until it completely adheres to the surface. Verify that the Contractor is removing pavement marking tape after permanent markings are applied. Ensure that all conflicting markings are ground off, water blasted or covered with black-out tape.

SECTION 704. TEMPORARY CONCRETE BARRIER

See the “Work Zone Safety and Mobility: Positive Protection of Workers, Drop-Offs and Temporary Concrete Barrier,” IDOT Safety Engineering Policy 4-15, for more information.

Ensure that proper pinning is being done per this policy.

SECTION 720. SIGN PANELS AND APPURTENANCES

720.02 MATERIALS

When signing materials are delivered to the construction site, obtain the manufacturer's certified mill test reports and other documentation as required by the [PPG](#). Also check all sign materials for damage and ensure that they conform to the requirements in the contract documents (e.g., size, number, legends, length of posts).

720.04 INSTALLATION

The Contractor must call [JULIE](#) before the sign post holes are dug. All signs should be checked for obstructions to sign visibility and for compliance for the type, color, size, message, placement, lateral offset, mounting height and orientation. Signs should be checked to ensure that the posts are plumb and that bases meet all breakaway requirements. Do not allow workers to walk on sign faces. Doing so damages the sign's retroreflectivity.

Overlays must be plumb and level and have reflective sheeting that matches the color, shade and type of the existing sheeting material for partial overlays. For full sign overlays, the overlay must match the size of the existing sign so that the entire background is overlaid.

Sign placement must not compromise sight distances at intersections and pedestrian safety and must not violate accessibility requirements (e.g., the effective sidewalk width). The date of the installation label must be attached to the back of new signs.

SECTION 724. REMOVE AND RELOCATE SIGN PANEL AND SIGN PANEL ASSEMBLY

For the removal and relocation of existing signs, consider the following:

- Take pictures before the sign removal.
- Document the stations and offsets for all existing signs that are likely to be moved. Consult the Bureau of Operations to access the Department's sign inventory, which locates signs by mile stations.
- Ensure that all removed signs are stored properly; taken to the nearest IDOT Operations Yard for storage.
- Check the condition of signs before they are reinstalled.

SECTION 727. SIGN SUPPORT – BREAKAWAY

Field personnel may observe adverse field conditions (missed in the design phase) that could compromise the proper function of breakaway sign supports. These include locating supports in

ditches, on steep slopes, in weak soils or within the roadside barrier deflection distance. Contact the designer if problems are observed.

SECTION 780. PAVEMENT STRIPING

780.02 MATERIALS

When pavement marking materials are delivered to the construction site, the Contractor should provide the material inspection documents. Follow the requirements of the PPG.

780.04 GENERAL

Pavement markings should be thought of as a system of binder and retroreflective elements. Correct installation per the specifications is the key to getting the full design life out of the marking. Air and pavement temperature specifications must be followed for the marking binder to bond correctly to the pavement. Application rates are designed as a part of the system to ensure the retroreflective material bonds to the binder correctly. When grooving is specified, the correct depth is critical to pavement marking durability and correct position of the retroreflective material. Refer to the [Documentation of Contract Quantities Guide](#), Section C for additional field inspection information. In addition, District traffic operations staff are available for assistance if needed.

The marking application Contractor shall be approved by the Engineer of Operations to apply thermoplastic, epoxy, modified urethane, and polyurea pavement markings as applicable. This approval consists of a review of the Contractor's equipment and previous contract experience. The approved [Pavement Marking Contractors list](#) is found on the Department's website. (Contractors for paint and preformed plastic pavement markings are not required to be on an approved list.)

780.05 THERMOPLASTIC

Surface preparation is critically important for long-lasting thermoplastic pavement markings. Key inspection items to be checked during thermoplastic striping include:

- Material temperature is within specified range when applied
- Road surface temperature remains above minimum
- Pavement is clean and dry
- Thickness and widths of the stripes
- Correct amount of beads are firmly stuck to the thermoplastic
- Markings are protected from traffic until material sets

Figure 700-1 provides a thermoplastic application troubleshooting guide to remedy problems that may be encountered during thermoplastic marking application.

Figure 701-1 — THERMOPLASTIC APPLICATION TROUBLESHOOTING

Problem	Cause	Effect	Remedy
Applied line appears rough on edges	<ul style="list-style-type: none"> Material not cured 	<ul style="list-style-type: none"> Loss of durability Out of standards 	<ul style="list-style-type: none"> Raise material temperature Increase amount of material Decrease atomizing air pressure (if spray application)
Applied line is wavy with irregular edges	<ul style="list-style-type: none"> Material too hot Application pressure too high Extrusion gate too wide or material flowing past gate Road surface uneven 	<ul style="list-style-type: none"> Poor reflectivity Poor appearance Poor durability 	<ul style="list-style-type: none"> Verify correct material for type of application Adjust material temperature Lower application pressure Adjust application equipment/lower application rate
Line appears discolored, beige or dingy (dull white)	<ul style="list-style-type: none"> Material overheated or reheated too many times 	<ul style="list-style-type: none"> Does not meet color standard Material is brittle - low durability 	<ul style="list-style-type: none"> Discard material
Line appears pitted	<ul style="list-style-type: none"> Trapped moisture Material not cured Trapped air 	<ul style="list-style-type: none"> Poor surface bond - low durability 	<ul style="list-style-type: none"> Stop operation until road dries and/or primer cures Slow application
Line appears lumpy	<ul style="list-style-type: none"> Charred material Unblended material 	<ul style="list-style-type: none"> Low durability 	<ul style="list-style-type: none"> If lumps appear burnt or dark in color, screen material to remove lumps If lumps appear grainy or unmixed, hold material at 420°F until they dissolve
Line appears stretched or pulled	<ul style="list-style-type: none"> Material applied too cold Material applied too fast 	<ul style="list-style-type: none"> Poor surface bond - low durability 	<ul style="list-style-type: none"> Raise temperature Lower speed of application
Line appears scarred or gapped	<ul style="list-style-type: none"> Charred material Dirt or debris on surface 	<ul style="list-style-type: none"> Poor surface bond - low durability 	<ul style="list-style-type: none"> If lumps appear burnt or dark in color, screen material to remove lumps Clean pavement surface
Line appears uneven at beginning or end	<ul style="list-style-type: none"> Applicator not adjusted properly 	<ul style="list-style-type: none"> Poor appearance 	<ul style="list-style-type: none"> Adjust applicator

780.06 PAINT

Figure 700-2 presents a troubleshooting guide to remedy problems that may be encountered during paint application.

780.07 PREFORMED PLASTIC

Preformed pavement markings have a retro-reflective film coating on a backing that is coated with an adhesive capable of adhering to the roadway surface.

Preformed markings are factory or field cut to the specified shape and are applied with a pre-coated adhesive. Typically, the adhesive is of a type to allow the marking to be moved around before final pressure is applied to seal it in place.

The pavement must be non-bleeding, clean, warm and dry.

780.09 EPOXY

Figure 700-3 provides an epoxy application troubleshooting guide to remedy problems that may be encountered during epoxy-marking application.

Figure 701-2 — PAINT APPLICATION TROUBLESHOOTING

Problem	Cause	Effect	Remedy
Uneven Paint Line (spotty)	<ul style="list-style-type: none"> Atomizing air pressure too low Paint tank pressure too low Old paint (viscosity too high) Loose paint gun tip and/or shroud Insufficient heat No shroud 	<ul style="list-style-type: none"> Poor appearance Line has fuzzy edges Slow drying time Paint won't flow smoothly 	<ul style="list-style-type: none"> Increase atomizing air pressure Increase material tank pressure Rotate material stock Secure paint gun tip and/or shroud Increase heat (enough to get paint to flow evenly) Install shroud
Excessive Thickness (middle of line)	<ul style="list-style-type: none"> Paint tank pressure too high Paint gun volume control (if present) open too wide Pump pressure too high Atomizing air pressure off or too low Material buildup in paint gun tip and/or shroud 	<ul style="list-style-type: none"> Buried beads – poor nighttime retroreflectivity Slow drying time – paint tracked by motorists Paint won't cure properly – shortened life 	<ul style="list-style-type: none"> Reduce tank pressure Adjust paint gun Reduce pump pressure Increase atomizing air pressure Clean tip and/or shroud
Excessive Thickness (along one side)	<ul style="list-style-type: none"> Materials buildup in paint gun tip and/or shroud Clogged hole(s) in paint gun atomizing tip 	<ul style="list-style-type: none"> Buried beads – poor initial nighttime retroreflectivity Slow drying time – paint tracked by motorists 	<ul style="list-style-type: none"> Clean paint tip and/or shroud Clear clogged hole(s) in paint atomizing tip
Insufficient Thickness	<ul style="list-style-type: none"> Paint tank pressure too low Paint gun volume control (if present) not open enough Paint pressure too low Applicator speed too low Atomizing pressure too high Material buildup in paint gun tip and/or shroud Materials buildup in paint filter(s) and/or plumbing 	<ul style="list-style-type: none"> Poor line quality and/or shortened life Beads won't adhere and/or poor or not nighttime retroreflectivity 	<ul style="list-style-type: none"> Increase tank pressure Adjust paint gun volume control Increase pump pressure Decrease speed Decrease atomizing air pressure Clean paint gun tip and/or shroud Clean paint filter(s) and/or plumbing
Wide Paint Line	<ul style="list-style-type: none"> Paint gun set too high Tip and/or shroud 	<ul style="list-style-type: none"> Line does not meet standards Line has fuzzy edges 	<ul style="list-style-type: none"> Lower gun Repair or replace tip and/or shroud
Narrow Paint Line	<ul style="list-style-type: none"> Paint gun too low Paint gun tip slot not at 90° angle to paint line Clogged paint gun tip and/or shroud Low air pressure in paint machine tire 	<ul style="list-style-type: none"> Line does not meet standards Not as visible as a full-width line (day or night) 	<ul style="list-style-type: none"> Raise paint gun Reposition paint gun tip Clean paint gun tip and/or shroud Inflate tire

Figure 701-3 — EPOXY APPLICATION TROUBLESHOOTING

Problem	Cause	Effect	Remedy
Heavy centers	<ul style="list-style-type: none"> Inadequate fluid delivery 	<ul style="list-style-type: none"> Tracking Erratic wear patterns “Railroad Tracks” initially 	<ul style="list-style-type: none"> Increase tip size Replace tip
Light centers	<ul style="list-style-type: none"> Inadequate fluid delivery 	<ul style="list-style-type: none"> Tracking from the edges Erratic wear patterns “Railroad tracking” with time 	<ul style="list-style-type: none"> Increase tip size Replace tip
Surging pattern	<ul style="list-style-type: none"> Pulsating fluid delivery 	<ul style="list-style-type: none"> Does not conform to standards Erratic wear pattern 	<ul style="list-style-type: none"> Reduce demand Remove restrictions in supply system Check supply hose for leaks
“Lop-sided” mills	<ul style="list-style-type: none"> Worn tip sides Clogged tips 	<ul style="list-style-type: none"> Erratic wear pattern 	<ul style="list-style-type: none"> Replace tips Clean tips
Line too wide	<ul style="list-style-type: none"> Gun too high Too wide a fan angle on tip 	<ul style="list-style-type: none"> Does not meet standards 	<ul style="list-style-type: none"> Lower gun Adjust tip size if necessary
Applied line too thin	<ul style="list-style-type: none"> Inadequate tip hole Traveling too fast for tip size Change in delivery pressure 	<ul style="list-style-type: none"> Poor durability Does not meet standards 	<ul style="list-style-type: none"> Change tip size Decrease speed of application Verify pressure settings
Applied line too thick	<ul style="list-style-type: none"> Too large a tip size Traveling too slow for tip size Change in delivery pressure 	<ul style="list-style-type: none"> Cure time too long May cause shape problems Poor retroreflectivity 	<ul style="list-style-type: none"> Change tip size Increase speed of application Verify pressure setting
Too much hardener	<ul style="list-style-type: none"> Displacement pumps not properly synchronized 	<ul style="list-style-type: none"> Dark or black lines Takes too long to cure 	<ul style="list-style-type: none"> Adjust pumps
Too little hardener	<ul style="list-style-type: none"> Displacement pumps not properly synchronized 	<ul style="list-style-type: none"> Poor durability 	<ul style="list-style-type: none"> Adjust pumps

DIVISION 800

Electrical

Illinois Department of Transportation

March 31, 2021

THIS PAGE WAS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 801. ELECTRICAL REQUIREMENTS	801-1
801.01 DEFINITION	801-1
801.01-1 Responsibilities	801-1
801.13 TESTING.....	801-3
801.15 ACCEPTANCE.....	801-3
SECTION 804. ELECTRICAL SERVICE INSTALLATION – LIGHTING	801-3
804.01 ELECTRICAL SERVICE CONNECTIONS.....	801-3
804.04 INSTALLATION.....	801-4
SECTION 810. UNDERGROUND RACEWAYS	801-4
810.04 INSTALLATION.....	801-4
SECTION 816. UNIT DUCT.....	801-4
SECTION 821. ROADWAY LUMINAIRES.....	801-4
821.03 GENERAL	801-4
SECTION 825. LIGHTING CONTROLLER.....	801-5
825.03 INSTALLATION.....	801-5
SECTION 830. LIGHT POLES	801-5
SECTION 836. POLE FOUNDATION	801-5
836.03 INSTALLATION.....	801-5
SECTION 838. BREAKAWAY DEVICES	801-6
838.03 INSTALLATION.....	801-6

SECTION 857. TRAFFIC ACTUATED CONTROLLER.....	801-6
857.03 INSTALLATION.....	801-6
857.03-1 General.....	801-6
857.03-2 Controller Cabinets.....	801-6
857.03-3 Traffic Signal Activation and Final Cleanup.....	801-6
SECTION 873. ELECTRIC CABLE.....	801-7
873.03 INSTALLATION.....	801-7
SECTION 875. TRAFFIC SIGNAL POST	801-7
875.03 INSTALLATION.....	801-7
SECTION 886. DETECTOR LOOP	801-7
886.04 INSTALLATION.....	801-7
SECTION 890. TEMPORARY TRAFFIC SIGNAL.....	801-9
890.02 INSTALLATION.....	801-9
890.02-1 General.....	801-9
890.02-2 Applications.....	801-9

Division 801 ELECTRICAL

SECTION 801. ELECTRICAL REQUIREMENTS

801.01 DEFINITION

801.01-1 Responsibilities

This Section briefly summarizes the responsibilities of various IDOT units and outside entities with respect to the construction of electrical work.

801.01-1(a) Central Office Bureau of Operations

The Statewide Traffic Signals Unit is located in the Central Bureau of Operations. The responsibilities of this individual include:

- Reviewing traffic signal plans prepared by the Districts and consultants
- Evaluating and updating policies and provisions in the *Standard Specifications* relating to traffic signals
- Serving as a resource to the Department's field construction staff

801.01-1(b) Central Office Bureau of Design and Environment

The Electrical and Mechanical Unit in the Central BDE is responsible for:

- Design lighting and pump station plans for the Districts.
- Reviewing lighting and pump station plans prepared by the Districts and consultants
- Evaluating and updating policies and provisions in the *Standard Specifications* related to roadway lighting and pump stations
- In Districts 2 - 9, coordinating with the District Lighting Engineer/Technician to:
 - + Serve as a resource to the Department's field construction staff
 - + Test and accept all lighting and pump station items
 - + Perform final inspections in coordination with the District and the Contractor

Note: All projects within District 1 shall be coordinated with the Electrical Section in the Bureau of Traffic Operations in District 1.

801.01-1(c) District Office

Each District includes a Roadway Lighting and Traffic Signal Engineer/Technician, whose responsibilities include:

- On a case-by-case basis, attending the preconstruction conference when the construction project includes lighting, pump station or traffic signal work
- In coordination with the Electrical and Mechanical Unit in the Central BDE:
 - + Serving as a resource to the Department's field construction staff
 - + Testing and accepting all lighting and pump station items
 - + Performing final inspections of roadway lighting and pump stations
- Testing and accepting all traffic signal items
- Performing final inspections of traffic signals
- Phasing and timing permanent traffic signals
- Phasing and timing temporary traffic signals

Note: *In District 1, these duties are performed by the District Bureau of Traffic Operations.*

In addition, the District will be responsible for the design of the traffic signals, preparing final plans and specifications for roadway lighting and preparing the traffic signal detail sheets to be included in the plans. The District also will coordinate with any involved local agency to ensure that the selected roadway lighting and traffic signal equipment can be maintained by that agency. Also, the District will be responsible for preparing any necessary agreements between the State and the local agency for the operation and maintenance of roadway lighting and traffic signals. The District will also prepare any necessary agreements between the State and the utility companies.

801.01-1(d) Department Field Construction Staff

The District Traffic Signal and Roadway Lighting Engineer/Technician will serve as the primary technical resource and advisor to the Resident during the construction of traffic signals, highway lighting and other electrical devices. The Department's field construction staff is primarily responsible for the inspection of the installation, measurement of quantities, and payment for items for electrical systems to ensure compliance with the contract documents.

801.01-1(e) Contractor

The Contractor is responsible for contacting the Utility company for the final connection, when the new service assembly is completed.

801.01-1(f) Local Agency

The District will be responsible for preparing any necessary agreements between the State and the local agency for the operation and maintenance of roadway lighting and traffic signals on a local facility. The Department has the final approval on contracts that are administered by the Department unless it is specifically written otherwise into the contract documents.

801.13 TESTING

Luminaire test reports, when required, shall be sent to the Electrical and Mechanical Unit for approval before the luminaires are shipped to the job site. Testing of roadway lighting shall be performed by the Contractor in the presence of the Resident. Any circuit that does not pass insulation testing shall be diagnosed, reinsulated and retested as necessary to ensure that the megohm readings are to the required levels. All testing must be completed, and the results submitted to and approved by the Electrical and Mechanical Unit before a final inspection will be scheduled. Other supporting documentation to include with the test reports are completed Construction Inspector's Checklist for Roadway Lighting showing compliance with requirements and photographs of major items such as light poles, controllers, and service installations.

Surge arresters can sometimes cause problems with insulation testing. It is sometimes advantageous to remove the surge arresters from the circuit when testing is performed. The voltage impressed on the branch lighting circuit during insulation testing shall be minimized so as not to damage the LED luminaire. 801.15ACCEPTANCE

The Resident shall contact the District Lighting Engineer/Technician to schedule the inspection for acceptance. Determination of acceptance of roadway lighting will be made jointly by the Electrical and Mechanical Unit in the Central BDE and the District Lighting Engineer/Technician. Determination of acceptance of traffic signals is performed by the District Bureau of Operations. For projects in District 1, these functions are performed by the District Bureau of Traffic Operations.

Acceptance of roadway lighting installations will include photometric testing. The Electrical and Mechanical Unit will provide locations for the testing. Points should be painted on the roadway surface as depicted on the plans provided by the Electrical and Mechanical Unit. Horizontal illuminance readings will be taken at each of these points.

SECTION 804. ELECTRICAL SERVICE INSTALLATION – LIGHTING**804.01 ELECTRICAL SERVICE CONNECTIONS**

The Resident and the Contractor will determine when the electrical service connection needs to be ordered. The determination will be made based on the lead time and amount of work necessary by the Utility company and the progress of the construction project.

The Contractor will order the service connection from the Utility company at the appropriate time. The Utility will provide the Utility's construction or connection fees and the new service application/agreement to the Resident.

Unsealed holes in the disconnect enclosures can cause maintenance problems with moisture, insects or rodents getting into the enclosure. Make sure that the enclosure is completely sealed and all holes are addressed.

Enclosures shall be provided with provisions to lock the external handle in both the open and closed position.

Keying of the padlock will be determined by the District or by the Municipality, depending on who will own and maintain the lighting.

804.04 INSTALLATION

For overhead service installations, a downguy and anchor should be installed on service pole according to Articles 804.04, 830.03(c), and 1086.01(a)(1) and the plan details.

SECTION 810. UNDERGROUND RACEWAYS

810.04 INSTALLATION

For cut trenches, backfilling should be done as soon as possible after the installation of the unit duct or conduit to avoid the loss or dispersal of the excavated material by rainfall. Open trenches should not be left open over weekends and should not be initiated if inclement weather is expected. Utility trenches may be sensitive to water/weather and may fail due to water infiltration into the subgrade. Also, a dip at the trench after paving may result. Provide special attention to the compaction of the backfill material.

Installation depth should be a minimum of 2 ft (600 mm) or 2.5 ft (750 mm) whenever possible. Extra depth may be desirable when crossing ditch bottoms, aggregate surfaces (e.g., field entrances/driveways), railroads, where horizontal restrictions require the unit duct or conduit to be installed near the edge of pavement, or any other location where the conductor may be susceptible to accidental damage. A detailed drawing should be made of the exact locations of the installed cables for future reference. Splices inside poles, towers and junction boxes should be made so that the power cables and components can be arranged with none of the conductors touching the interior metal surfaces.

SECTION 816. UNIT DUCT

The Contractor should take care not to kink the unit duct when installing the duct in light pole foundations. This may damage the cable and precludes the possibility of pulling new wire into the unit duct.

SECTION 821. ROADWAY LUMINAIRES

821.03 GENERAL

All factory wire connections and component installations should be checked for tightness and security.

Bridge mounted light poles are subject to higher levels of vibration. Stainless steel set screws are required to prevent the luminaire from vibrating off the pole. Likewise, on high mast light towers stainless steel screws shall be used to permanently secure the luminaires for each tenon on the ring.

SECTION 825. LIGHTING CONTROLLER

825.03 INSTALLATION

The Utility company should be advised of the beginning of work on the lighting system to allow the completion of their work in a timely manner. The control installation should be placed with consideration of possible flood water levels experienced in the past.

The Contractor needs to ensure that the cabinet is supplied with a linkage arm for the door and that the door opens and closes easily.

The as-built plans and branch circuit diagram will be used by maintenance personnel to repair and maintain the lighting system. It is important that they are updated with all circuit revisions made during construction and inserted in the weatherproof pouch inside the lighting control cabinet.

Installation of components on din rail is not acceptable.

SECTION 830. LIGHT POLES

The ground conductor shall be connected to the ground lug in the light pole hand hole. Wrapping the ground around the anchor bolt is not acceptable.

Surge arresters, fuses and fuse holders must be installed in each light pole hand hole.

Washers on top of the light pole base need to be large enough to cover the slotted hole so that it will seal out rodents.

Identification numbers must be installed on each light pole.

SECTION 836. POLE FOUNDATION

836.03 INSTALLATION

Light pole foundations should not be located in ditch bottoms.

Light pole foundations must comply with the AASHTO 4-in. (100-mm) limit per Section 836. The Contractor should grade around the poles or replace the foundations or both to comply with this requirement. After restoring final grade, reseed and mulch as necessary.

Rodents can be a maintenance problem in light poles. Fine aggregate should be installed in screw-in metal foundations and in the raceway entries of concrete foundations to prevent rodents from entering the poles through the foundations.

SECTION 838. BREAKAWAY DEVICES**838.03 INSTALLATION**

Torque nuts shall not be used to mount the pole to the breakaway device. The breakaway device shall be threaded completely onto the foundation anchor bolt.

SECTION 857. TRAFFIC ACTUATED CONTROLLER**857.03 INSTALLATION****857.03-1 General**

The proper installation of traffic signal equipment includes the correct wiring of all equipment, labeling of wiring, furnishing wiring diagrams, signal phase layout and any other incidental work in the contract documents.

857.03-2 Controller Cabinets

The Inspector should use the following inspection guidelines to evaluate the work:

- Was the bottom of the cabinet sealed between the cabinet and foundation with a good quality sealant?
- Verify that the controller cabinet is mounted in compliance with the cabinet orientation detailed on the plan sheet. Check mounting height and orientation with respect to driver and pedestrian approaches and ADA requirements.
- Check the service load center cabinets and service entrance equipment to verify:
 - + Is the completed service assembly acceptable for connection by the Utility company?
 - + Did the Contractor and Inspector meet with the Utility company in the field to verify the exact location of the service run?
- Keys to all the locks should be delivered to the Traffic Operations Engineer.

857.03-3 Traffic Signal Activation and Final Cleanup

The Inspector should use the following inspection guidelines to evaluate the work:

- Has the Inspector coordinated the activation date with the District Traffic Signal Engineer/Technician to set up the timing of the controller and activation?
- Is the roadway striping and signing completed prior to the intended activation?
- Has the Contractor arranged for traffic control for the day of activation?
- Were stop signs removed after the signal was activated?

- Is all touch-up painting completed?
- Was all pavement and sidewalk patching/replacement completed?
- Was salvaged equipment dismantled and stockpiled or delivered?
- Was any salvage equipment that was damaged or destroyed by the Contractor replaced?
- Did the Contractor furnish and deliver to the Resident all manufacturer's warranties, guarantees and materials inspections as required by the [PPG](#)?

SECTION 873. ELECTRIC CABLE

873.03 INSTALLATION

See Section 810.04 for trenches.

SECTION 875. TRAFFIC SIGNAL POST

875.03 INSTALLATION

The Inspector should use the following inspection guidelines to evaluate the work:

- Check the signal hardware package when it is delivered to the project site for conformity with the approved materials list and specifications.
- Has the accuracy of the pole layout for mounting assemblies been checked for correct orientation against the pole schedule?
- Were the mounting bolts properly sized, galvanized and configured per the approved pole drawings for Contractor-furnished poles?
- Are all traffic signal mounting assemblies plumbed and securely assembled with appropriate mounting to achieve clearance to the roadway?
- Are the tunnel visors of the specified length?
- Are any not-in-service signal heads covered?

SECTION 886. DETECTOR LOOP

886.04 INSTALLATION

The Inspector should use the following inspection guidelines to evaluate the work:

- Ensure that loop detectors are installed in the subbase or base material on new roadway construction:
 - + Make sure loop detectors are properly located with respect to centering in each traffic lane and distance into the stop bar area as specified in the contract documents.

-
- + Make sure the specified amount of sand is placed above and below the loop wire.
 - + Check the number of wire turns.
 - Saw cutting loop detectors in HMA:
 - + On new construction with multiple lifts of HMA, the plans may indicate that the detector loops are installed in the binder lift rather than the final surface.
 - + Is the saw cutting straight?
 - + Check saw cut depth to ensure proper depth.
 - + Has the loop detector wire been approved?
 - + Check the number of wire turns.
 - + Were hold-down retainers installed as specified?
 - + Was the approved sealant furnished and applied?
 - + Are the plan loop number with permanent wire marking tags as specified?

SECTION 890. TEMPORARY TRAFFIC SIGNAL

890.02 INSTALLATION

890.02-1 General

Temporary traffic control signals are preferable to flaggers for long-term work activities and work that would require flagging at night. When the Contractor plans on using temporary traffic control signals, ensure that these traffic signals are included in the Contractor's TCP.

890.02-2 Applications

890.02-2(a) Rural Applications

For rural applications, consider the following:

- Use temporary traffic control signals on projects where each end of the controlled section of roadway is visible to both directions of travel. Sight distance is especially important when a temporary signal is used at a bridge in a sag vertical curve.
- Place a temporary stop bar, or temporary painted stop bar, at least 40 ft (12 m) in advance of the temporary signals. Remove the stop bar when the signal is not in operation or is removed.
- Verify that the placement of the STOP HERE ON RED sign does not obscure the signal face. Typically, place the STOP HERE ON RED sign at least 40 ft (12 m) in advance of the signal.
- The District Traffic Signal Engineer/Technician will set the timing for the temporary signal. Monitor traffic queues at the signals and adjust the signal time appropriate to the queues.

890.02-2(b) Urban Applications

In urban areas, consider the following:

- Where temporary traffic signals are used at urban intersections, place the signals as close to the intersection as practical to ensure a clear view of all intersection approaches. If the signal location will not provide traffic with a clear view of all intersection approaches, use flaggers or stop signs.
- Place the temporary stop bar pavement marking in accordance with the MUTCD.
- Consider pedestrian movements at intersections. Typically, temporary signals do not provide control for pedestrians. At high-use pedestrian intersections, a flagger may be more appropriate to control both vehicular and pedestrian movements. Signing an alternative pedestrian route to a nearby intersection may also be appropriate based on the location, work activity and duration.

APPENDIX A

IDOT Construction

Memoranda

Illinois Department of Transportation

March 31, 2021

Appendix A

IDOT CONSTRUCTION MEMORANDA

See <https://idot.illinois.gov/doing-business/procurements/construction-services/contractors-resources/construction-memorandums> for links to current Construction Memorandums.