

Structural Services Manual - 2017



State of Illinois
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	<p>STRUCTURAL SERVICES MANUAL CHANGE LETTER NO. 17-01</p>
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Section 3 – “Inspection” and Section 4 – “Ratings and Permits” have been updated. Existing policies and procedures in both sections have been expanded and clarified. Section 5 – “Tunnel Inspection” is a new section to the manual.

This Structural Services Manual revision includes several minor and editorial changes throughout the manual and some major changes as well. The following is a brief summary of some of the major changes:

Section 1 – “Introduction”

- Section 1 is now the introduction section to the manual.

Section 2 – “Repairs”

- The previous Section 1 – “Repairs” has been moved to Section 2.

Section 3 – “Bridge Inspection”

- Section has been renamed “Bridge Inspection”.
- Section 3.1.3 “Illinois Bridge Inspection Organization” clarifies the responsibilities of a consultant program manager for a local agency.
- Revised Section 3.2.1 “Reporting Inventory Information” to limit the number of days allowed to submit changes in inventory data.
- Section 3.3.3 “Routine Inspection” added requirement that hardwood blocking be installed when certain conditions are met.
- Section 3.3.5.1 “Identifying Bridges with Fracture Critical Members” has been re-written.
- Section 3.3.12 “Critical Findings” has been re-written to clarify IDOT’s policy for identifying and reporting critical findings.
- Section 3.4.2.1 “Routine Inspection 48-Month Interval Criteria” criteria for the 48-Month Inspection Interval has been revised.

Section 4 – “Load Rating”

- Section has been renamed “Load Rating”.
- Entire Section has been re-written.

Section 5 – “Tunnel Inspection”

- Section has been added to outline IDOT policy for the National Tunnel Inspection Standards.

The Structural Services Manual is now available for download on the IDOT website. **All IDOT approved Team Leaders and Program Managers are required to read and be familiar with Section 3 – “Bridge Inspection”.**



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Engineer of Bridges and Structures

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Document Control and Revision History

The Structural Services Manual is owned by the Illinois Department of Transportation Bureau of Bridges and Structures. The manual is reviewed during use and updated by the Bureau of Bridges and Structures, as necessary.

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Archived versions of this guide are available to examine in the Policy Center.

Electronic copies of this manual are available in Portable Document Format (PDF) and can be downloaded at the website below.

<http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Bridges/Inspection/Structural%20Services%20Manual.pdf>

The official archives of this manual are available for examination by contacting the Department's Records Center at DOT.Records@illinois.gov. The Policy and Research Center Library (DOT.PolicyResearchCenter@illinois.gov) located at 2300 S. Dirksen Parkway, Room 320, Springfield, IL, has reference copies of this manual.

Interim changes are communicated through the Bureau of Bridges and Structures' National Bridge Inventory (NBI) subscription service.

This manual is not distributed in hard copy format. Users of this manual who choose to print a copy are responsible for ensuring use of the most current version.

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Section 1 Introduction

As directed by the Engineer of Bridges & Structures, it is the responsibility of the Engineer of Structural Services to develop, maintain, and administer the policies that govern repair, inspection, and load rating of bridges and tunnels in Illinois. This also applies to bridges and tunnels under the jurisdiction of other agencies when IDOT oversight is required by State Statute. The IDOT *Structural Services Manual* is the vehicle by which these policies are controlled.

1.1 Organization and Functions

The Bureau of Bridges & Structures is a part of the Office of Program Development. The Engineer of Bridges & Structures, as head of the Bureau, is responsible for the planning, developing and maintaining of the State's bridges. The Structural Services Section Chief is responsible for the bridge inspection program for the State of Illinois, structural investigations of existing bridges, the development or review of repair plans, determination of bridge load carrying capacity, establishment of posted weight limits, evaluation of overweight permit vehicle movements, and review and approval of local public agency bridge construction projects.

The Section is comprised of four units: Bridge Investigations and Repair Plans Unit, Bridge Management Unit, Local Bridge Unit and the Structural Ratings and Permits Unit.

1.1.1 Bridge Investigations and Repair Plans Unit

Under the supervision of the Unit Chief, this unit performs field investigations to identify the cause or extent of structural deficiencies, develops repair alternatives, and prepares plans to address deficiencies related to the deterioration of structural members or accidental or manmade damage. Field investigations performed by the unit also include those to evaluate reoccurring deficiencies associated with standard structural detailing practices to identify the elements contributing to the deficiencies and to offer solutions. The unit provides guidance to IDOT personnel, consulting engineers and other agencies engaged in the development of repair or maintenance projects, and this guidance is provided on a project specific basis and through the maintenance and updating of information contained in the Repair Section of the IDOT *Structural Services Manual*, for which the unit is responsible. Repair, maintenance and minor

bridge rehabilitation projects prepared by IDOT personnel or consulting engineers are reviewed by the unit for comment and approval prior to being accepted for advertisement as a contract for letting. The unit also assists IDOT implementation personnel as required to resolve construction issues during the implementation of the projects reviewed or prepared by the unit. In order to comply with Federal Regulations and to ensure that IDOT obtains a proportional share of Federal funds, the unit tracks and assembles bridge construction cost information for submittal to the Federal Highway Administration. For additional information related to unit procedures, the Repair Section of the IDOT *Structural Services Manual* should be referenced.

1.1.2 Bridge Management Unit

Under the supervision of the Unit Chief, this unit is responsible for providing oversight of the bridge and tunnel inspection procedures utilized by IDOT and local public agencies to ensure bridge and tunnel safety as required by the National Bridge Inspection Standards (NBIS) and the National Tunnel Inspection Standards (NTIS) provided in Title 23 of the Code of Federal Regulations. The Unit Chief is the State Program Manager for bridge and tunnel inspections in Illinois and is responsible for setting bridge and tunnel inspection policy. The Unit Chief also ensures that only qualified personnel inspect bridges and tunnels in Illinois. This unit performs quality assurance reviews of agencies to ensure that agency inspection programs meet the standards of the NBIS. These agencies include the Illinois Department of Transportation, the Illinois State Toll Highway Authority, county, municipal and other state government agencies. This unit is responsible for the publication of the IDOT *Structural Services Manual* and development and maintenance of Section 3 and Section 5 of the IDOT *Structural Services Manual* which summarizes the official bridge and tunnel inspection policies for the State of Illinois. The unit is responsible for assisting with IDOT's Asset Management Plan. This unit interacts routinely with FHWA, other units and sections of the Bureau of Bridges & Structures, central offices, District bridge inspection staff, and local public agencies.

1.1.3 Local Bridge Unit

Under the supervision of the Unit Chief, this unit provides administrative and technical expertise to local public agencies concerning local bridge matters and assists the Bureau of Local Roads and Streets during the development of policies and procedures for Local Public Agency (LPA) bridges. LPA bridge rehabilitation and replacement projects utilizing Federal, State or motor fuel tax funds, and other local projects requiring IDOT approval by State Statutes, are reviewed by

the unit during project development to the degree necessary to ensure structural adequacy and compliance with IDOT policies and procedures. As part of the project review, the unit provides coordination with the Department of Natural Resources, using information received from the LPA, to obtain approvals necessary for local bridge projects to proceed to letting. The unit provides services to counties, as required by State Statute, leading to the development of contract plans for bridge construction. Unit personnel conduct field inspections and perform analyses to determine the load carrying capacity of existing bridges in response to LPA requests, or to address changes in bridge conditions routinely reported by LPA inspection personnel. The unit establishes weight limits for LPA bridges to ensure highway safety, and assists agencies in developing repairs to improve the condition of LPA bridges or to avoid the implementation of weight restrictions. LPAs coordinate with the unit, as necessary, to resolve construction issues and to evaluate permit requests for overweight vehicles. The unit, in cooperation with the Bureau of Local Roads and Streets, provides bridge inspection, bridge repair, and structural database training to LPA and consulting engineer personnel. For additional information related to unit procedures, the IDOT *Bureau of Local Roads and Streets Manual* should be referenced.

1.1.4 Structural Ratings and Permits Unit

Under the supervision of the Unit Chief, this unit performs analysis and evaluations to determine the load carrying capacity of new and existing bridges under IDOT jurisdiction, as required by State Statute and Federal Regulations. When necessary, unit personnel perform field inspections of severely damaged or deteriorated bridges to obtain information regarding essential bridge elements for use in evaluating load carrying capacity. When necessary to address existing structural conditions, the unit issues directives to place weight restrictions on existing bridges under IDOT jurisdiction to ensure highway safety. The unit works cooperatively with the other units of the Structural Services Section for identifying repair alternatives to eliminate deficiencies that would otherwise require the implementation of a weight restriction. The Bureau of Operations routinely coordinates the review of overweight permit requests with the unit prior to authorizing the movement of overweight vehicles to ensure that highway infrastructure is not damaged. In order to ensure that bridge load carrying capacities can be determined in an expeditious manner, the unit maintains databases of structural information for use during the evaluation of overweight permit vehicle movements or the effect of damage or deterioration on bridge load carrying capacity. The movement of heavy construction equipment across existing bridges to facilitate construction projects is evaluated by this unit, as well as the

feasibility of placing additional wearing surface on existing bridges located within the limits of roadway resurfacing projects. The unit reviews proposed legislative changes to the Illinois Vehicle Code to determine the effect of the changes on highway system bridges, and provides coordination with other Units and Bureaus for developing comments in regard to anticipated effects. Unit personnel assist the Office of Planning and Programming during the maintenance and updating of the IDOT *Structure Information and Procedure Manual* to ensure compliance with the bridge safety and inventory provisions of the National Bridge Inspection Standards, and represents IDOT in matters pertaining to the maintenance, revision or updating of bridge rating specifications that may be proposed by the American Association of State Highway and Transportation Officials (AASHTO).

Section 2 Repairs

2.1 General

2.1.1 Purpose and Scope

This section has been developed to assist IDOT personnel and consulting engineers during the preparation of bridge repair plans. Serviceability and performance history were considered in the development of the procedures and details presented in this section. The inclusion of specific details in this section for the repair of every type of structural deterioration or damage that may be encountered is not possible. In preparing this section, information has been included for the types of repairs most often required to adequately maintain typical bridge structures during their service life. The details and procedures provided in this section are intended to address routine repair requirements and to provide a foundation to assist in the preparation of unusual repair details.

All structure repair plans for maintenance contracts and Day Labor awards will be subject to the requirements of this section. The Design and Planning Sections of the IDOT *Bridge Manual* should be used as the primary reference when developing plans for bridge rehabilitations and the details and procedures provided in the Repair Section may be used during the final preparation of repair details associated with the rehabilitation project.

2.1.2 General Notes

In addition to the general notes provided in the Design Section of the IDOT *Bridge Manual*, the following general notes should be included in repair plans, when applicable.

NOTE

1. All new fasteners shall be high strength bolts. Holes shall be subpunched or subdrilled 11/16" dia. and reamed in the field to 13/16" dia. for 3/4" dia. bolts, unless otherwise noted. Holes shall be subpunched or subdrilled 13/16" dia. and reamed in the field to 15/16" dia. for 7/8" dia. bolts, unless otherwise noted.
2. The Contractor shall provide support and/or shoring systems for the slab and beam in the area of existing beam removal and at other locations as required in order to maintain the existing deck profile. The support and/or shoring systems shall be approved by the Engineer. Such approval will not relieve the Contractor of responsibility for the safety of the structure.
3. After the new beam is in its final position and/or beam straightening operations have been completed, the Engineer in the field shall check to see that the top flange is tight against the slab. If not, the Contractor shall inject an approved epoxy between the existing concrete deck and the top flange of the beam. Cost to be incidental to "Furnishing and Erecting Structural Steel". See special provision for "Epoxy Injection".

APPLICATION

When new structural steel elements are to be connected to an existing steel member.

When replacing portions of noncomposite beams without removing the existing deck slab.

When replacing or straightening a portion of a noncomposite beam without removing the existing deck slab. (Cost is incidental to "Beam Straightening" if "Furnishing and Erecting Structural Steel" is not used as a pay item.)

NOTE

4. Grind existing nicks, gouges and shallow cracks in the damaged beams as shown by the details included in the plans. Ground surfaces shall be inspected for cracks using magnetic particle testing prior to initiating any beam straightening operations. The cost of grinding and testing is incidental to "Beam Straightening". Any cracks that cannot be removed by grinding approximately 1/4" deep shall be identified and reported to the Bureau of Bridges and Structures for further disposition.
5. Existing structural steel shall only be cleaned and painted as required by the Special Provision "Cleaning and Painting Adjacent Areas of Existing Steel Structures".
6. The Inorganic zinc rich primer / Acrylic / Acrylic Paint System shall be used for shop and field painting of new structural steel except where otherwise noted. The color of the Acrylic finish coat shall be _____, Munsell No. _____. See Special Provision for "Cleaning and Painting New Metal Structures".
7. Any reinforcement bars that are damaged during concrete removal operations shall be repaired or replaced using an approved bar splicer or anchorage system. Cost incidental to "Concrete Removal".

APPLICATION

All beam straightening projects where nicks, gouges or shallow cracks may be present on the damaged beams.

When new structural steel is being provided and attached to existing structural steel as part of a repair project.

When new structural steel is being provided as part of a repair project.

When existing concrete is to be removed and replaced. (This note may be placed adjacent to the detail showing concrete removal.)

2.2 Plan Preparation and Review**2.2.1 Responsibilities**

The responsibility for the preparation of plans, special provisions and estimates for Maintenance Contracts and Day Labor awards rests with the Districts. The plans and special provisions may be prepared by District personnel or by a consulting engineer. Consulting engineers used for

the preparation of repair plans and special provisions should be retained by listing the proposed project in the Professional Services Bulletin.

When repair plans are prepared by District personnel, the Structural Services Section of the Bureau of Bridges & Structures will prepare the details and special provisions necessary for the repair of deteriorated structural elements which will be included in a project. The District should submit a request for the preparation of structural repair details to the Structural Services Section with the following information:

- Structure Number
- Route Number
- Project Section Number
- County Name
- Marked Route
- Feature Crossed
- Inspection Information
- Bridge Description of Proposed Structural Repairs
- Tentative Letting or Award Date
- Contract Number or Day Labor Project Number

Upon completion of the structural repair details, the Structural Services Section will provide the District with a copy of the structural repair detail sheets which will be included with the plans prepared by the District.

When a consulting engineer prepares the repair plans, the consulting engineer is responsible for the preparation of all repair details, including the structural repair details, necessary to complete the project.

2.2.2 Preparation Procedures

Bridge Condition Reports, existing fabrication plans and existing design plans should be consulted prior to commencing repair plan preparation. Plans should be prepared on 24" x 36" sheets. However, 8 1/2" x 11" sheets may be used for the preparation of repair plans for projects which are limited in scope and require relatively few repair details. Repair details and lettering on plan sheets which will be reduced in size for letting or award should be large enough

for legibility after reduction. The plan presentation guidelines provided in the Design Section of the IDOT *Bridge Manual* should also be applied to repair plans.

2.2.3 Review Procedures

All Maintenance Contract and Day Labor plans prepared for the repair or retrofit of existing structures must be submitted to the Bureau of Bridges & Structures for review. The plans should be submitted for review prior to their submittal to the Bureau of Design and Environment for letting or to the Bureau of Operations' Day Labor Section for award. The plans should be submitted to the Bureau of Bridges & Structures sufficiently prior to the anticipated letting or award date to allow adequate time for review and revision of the plans. Review time will vary depending on the size and complexity of the project and on the current workload within the Bureau. Typically, project plans should be submitted for review a minimum of 90 days prior to the scheduled date for submittal of the plans, specifications and estimates (PSE) to the Bureau of Design and Environment for letting. In order for the Bureau of Bridges & Structures to be able to prioritize the review of projects submitted for review, it is important that each submittal for review be accompanied by information stating an anticipated letting or award date.

No bridge related repair plans for Maintenance Contracts or Day Labor awards are exempt from review by the Bureau of Bridges & Structures. All plans, including those for minor operations such as bridge rail and parapet repairs, slopewall repairs, rip rap placement, standard bridge rail installation and in-kind removal and replacement of bituminous surfaces must be submitted for review prior to submittal to the Bureau of Design and Environment or the Bureau of Operations.

Plans prepared by District personnel or consulting engineers for bridge maintenance or repair projects will be reviewed by the Structural Services Section of the Bureau of Bridges & Structures and should be submitted to:

To: Bureau Chief of Bridges & Structures

Attn: Section Chief of Structural Services

Plans prepared by consulting engineers for bridge replacement or rehabilitation projects will be reviewed by the Design Section of the Bureau of Bridges & Structures and should be submitted to:

To: Bureau Chief of Bridges & Structures
Attn: Section Chief of Design

In most situations, maintenance and repair projects may be categorized as those projects for which a Type, Size and Location Plan (TSL) was not prepared. Project plans developed without the initial preparation of a TSL should be submitted to the Structural Services Section. After the submittal of the plans, if the scope of the project is determined to be rehabilitation rather than maintenance or repair, the Structural Services Section will forward the plans to the Design Section for review.

2.3 Inspections

2.3.1 Responsibilities

The District is responsible for the inspections required to produce repair plans prepared by IDOT personnel. The inspections should include the collection of information describing and locating the deterioration or damage. The Bureau of Bridges & Structures will provide assistance to the Districts during inspections, when requested to do so by the District. Assistance by Bureau of Bridges & Structures personnel will be limited to providing guidance to District personnel during the inspection on the collection of data required to adequately determine the extent and nature of the repairs needed. Also, the Bureau of Bridges & Structures may provide the District with inspection equipment and operating personnel when inspection scheduling does not conflict with other Bureau responsibilities.

2.3.2 General Deterioration

The information collected during the inspection of deteriorated structures should include a framing plan and detailed sketches of the affected members. The framing plan should indicate the locations of the deteriorated areas on the structure. The sketches should be dimensioned to show the extent and the location of the deterioration relative to a fixed point of reference, such as the end of the member. An estimate of the maximum amount of section loss should be given and the size and location of any corrosion holes, cracks and areas of section loss in the member should be shown on the sketch. [Figure 2.3-1](#) shows a sample framing plan and sketch documenting the location and extent of structural deterioration. Photographs of all deteriorated locations requiring repairs should also be provided.

During an inspection, particular attention should be given to the structural elements in the area of existing deck drains and expansion joints. Also, personnel inspecting tension members should be alert for the presence of tack welds and plug welds.

When inspecting abutments and piers to determine areas of unsound concrete, an effort should be made to determine the depth of concrete deterioration. The depth of unsound concrete can be determined using a chipping hammer, masonry drill or concrete cores. When the depth of deterioration exceeds 12 inches, or significantly reduces the effective size of the member, a structural evaluation is needed to determine repair requirements. The length and size of all cracks in substructure units should be determined. Although hairline cracks are not repaired, they should be recorded in the inspection sketches and designated as "hairline". An example inspection sketch showing areas of deterioration is shown in [Figure 2.3-2](#).

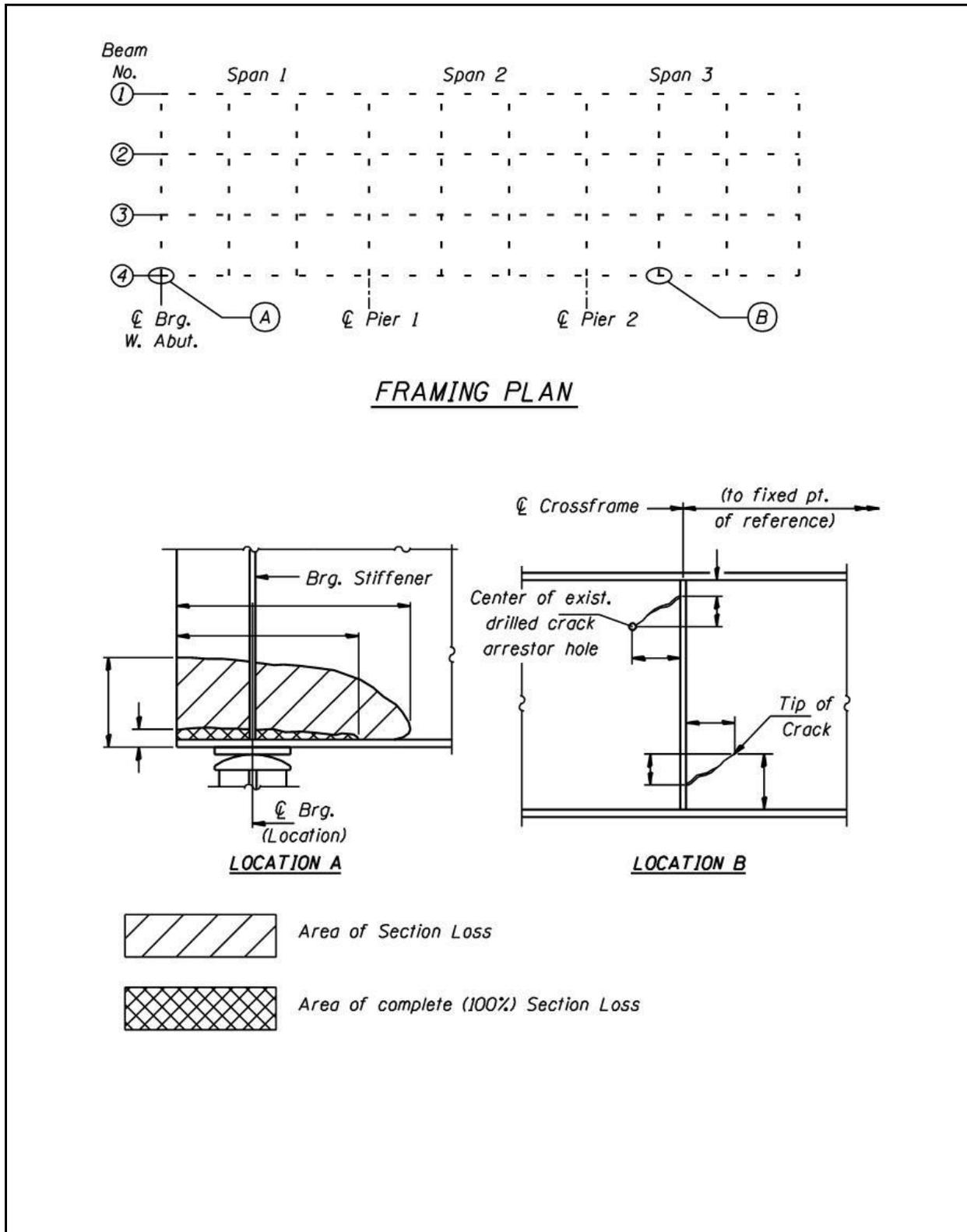


Figure 2.3-1 – Documentation of Structural Steel Deterioration

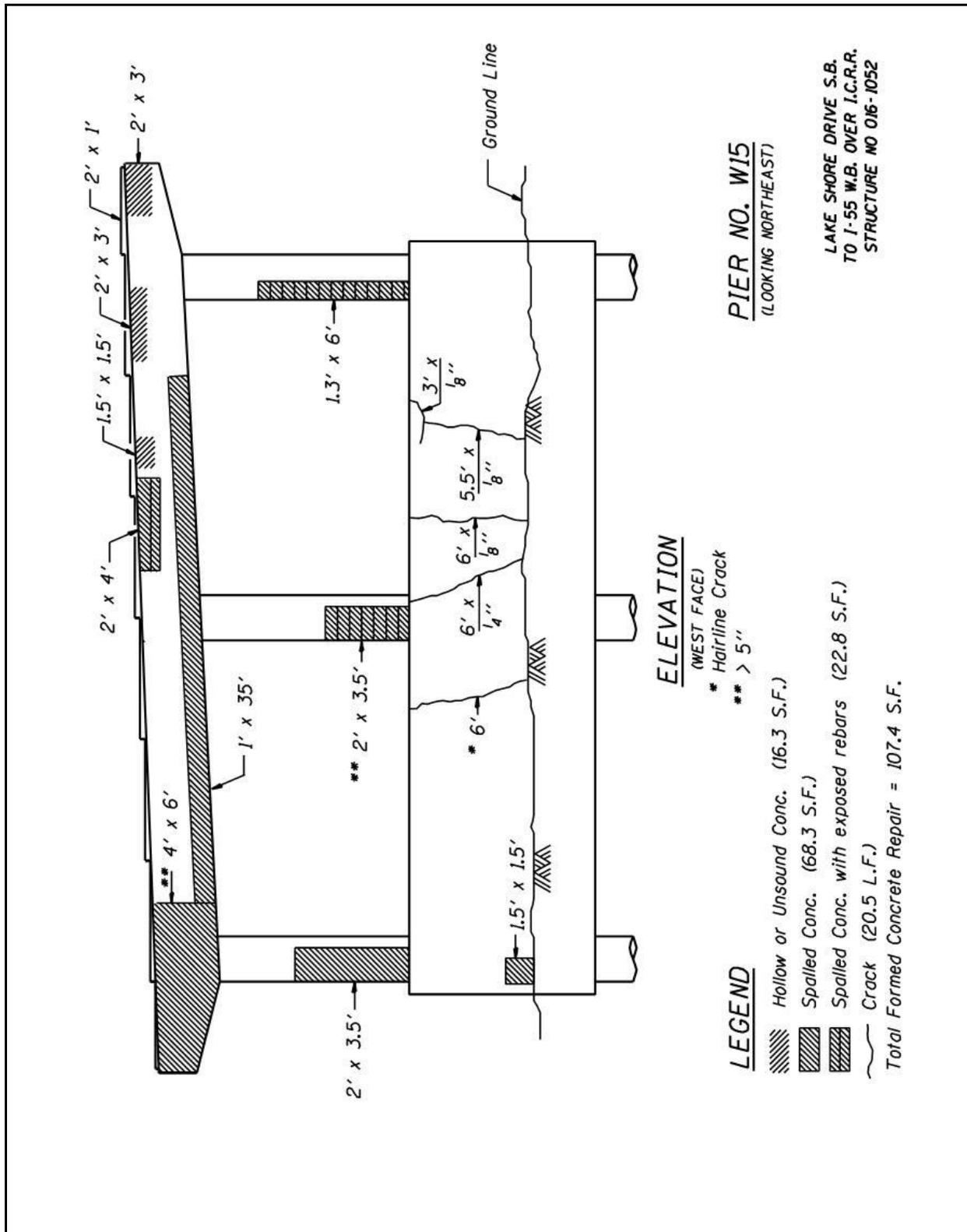


Figure 2.3-2 – Documentation of Pier Deterioration

2.3.3 Impact Damage - Steel Structures

The inspection of steel beams or girders which have been struck by a vehicle is the first procedure necessary in determining whether to repair or replace a damaged beam. Depending on the extent of the damage, the beams may be replaced, straightened or straightened and retrofitted. In many cases the need for beam replacement is obvious, however, a beam may be damaged to a degree where visual observation alone is not sufficient to determine repair or replacement requirements. In order to more accurately determine if a beam can be straightened or must be replaced, measurements of impact deflection must be obtained. The measurements of the damage should be done in accordance with the guidelines presented in the National Cooperative Highway Research Program (NCHRP) Report 271 (Guidelines for Evaluation and Repair of Damaged Steel Bridge Members), with the following exceptions. NCHRP Report 271 indicates that deflection measurements should be obtained for the entire length of the beam where impact deflections have occurred. However, it has been found that it is not necessary to obtain deflection information for the entire deflected length of the beam when determining repair requirements. In order to reduce traffic lane closure time and the length of time inspection crews are exposed to traffic, measurements of vertical and horizontal beam flange deflection should typically be obtained at horizontal intervals of 3-inches for a distance of 2-feet on each side of the point of maximum displacement. This point is usually located at the point of impact where the highest local strains have occurred in the beam. Also, vertical and horizontal flange deflections should be obtained at horizontal intervals of 3-inches for a distance of 4-feet from the center of any deflected beam splice toward the adjacent substructure unit. Horizontal web deflections should also be measured at 2-inch vertical intervals for the depth of the web at the most severely deflected web section and adjacent to a deflected beam splice. Additional measurements of the web deflection should then be taken in a similar manner at a location 3-inches each side of the most severely deflected web section. The deflection measurements of the flange and web described above need not necessarily be the total deflection which has occurred relative to the beam's original position at the points being measured. The deflections being measured at 2 or 3-inch intervals must be measured relative to a common reference plane which is approximately parallel to the original location of the undamaged beam. [Figure 2.3-3](#) illustrates the recording of localized impact deflections for steel beams and girders.

In addition to the localized impact deflection information, an overall description of the extent of damage and existing beam conditions should be provided. This should consist of photographs, sketches and framing plans of the beams and diaphragms showing:

1. the location of impact on the beams which were hit.
2. the extent of impact deflection along each damaged beam referenced to a fixed point on the structure or the point of impact.
3. the location of damaged diaphragms or crossframes and the connecting angles or plates.
4. the location and dimensions of cracked welds and flange or web gouges.
5. the location and extent of damage to the concrete slab or fillet encasing the top flange of the beam.
6. any factors or conditions (such as utilities, clearances or beam deterioration not related to the impact) which must be considered during the preparation of repair plans.

An example framing plan recording impact damage information is shown in [Figure 2.3-4](#). [Figure 2.3-5](#) illustrates the documentation of damage to the concrete fillet encasing the top flange of a noncomposite beam. Also, a cross section of each damaged beam should be provided showing:

1. the maximum horizontal and vertical impact deflection of the beam.
2. the maximum rotation of the flange.

[Figure 2.3-6](#) illustrates the documentation of maximum beam distortion.

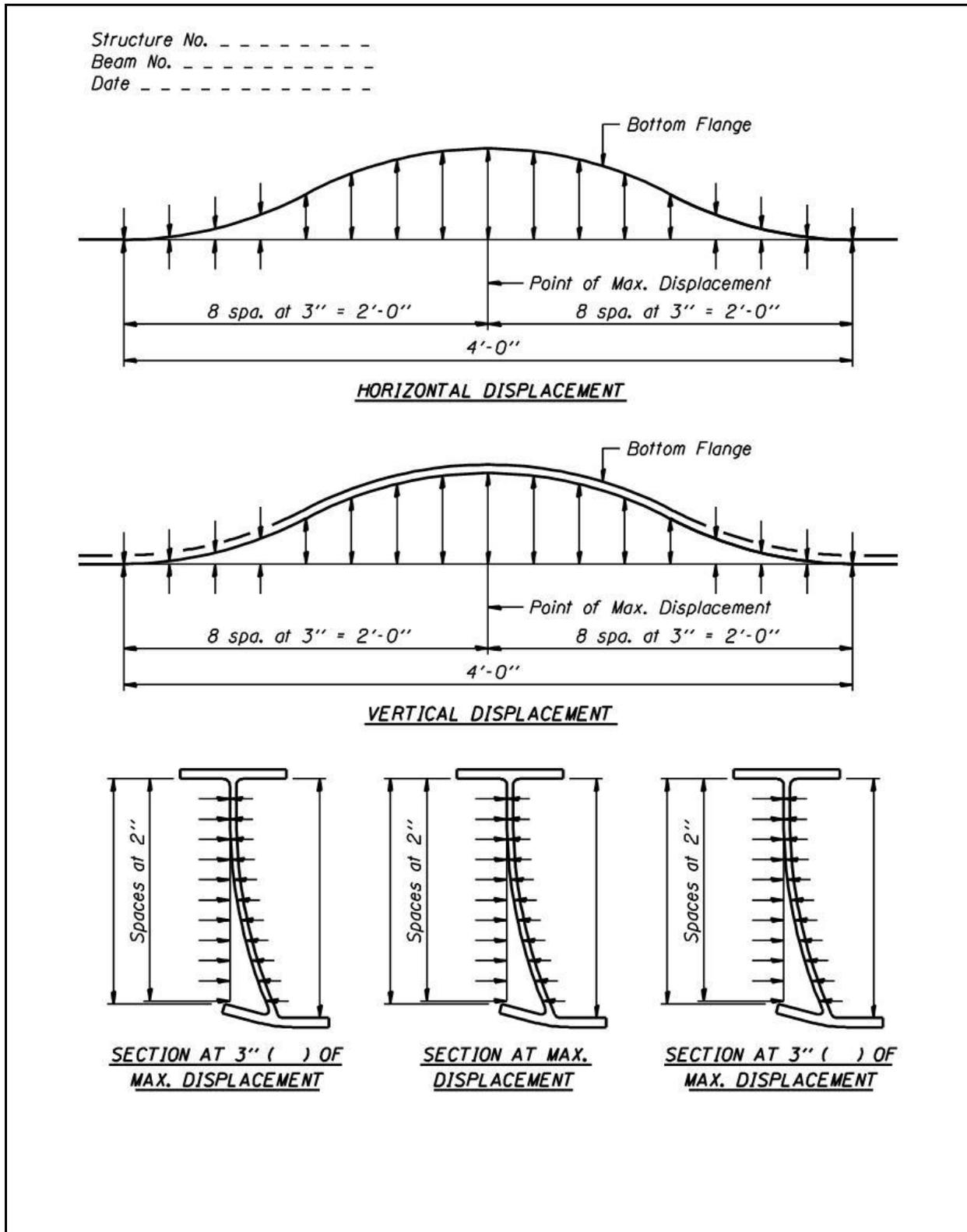


Figure 2.3-3 – Impact Damage Steel Beams

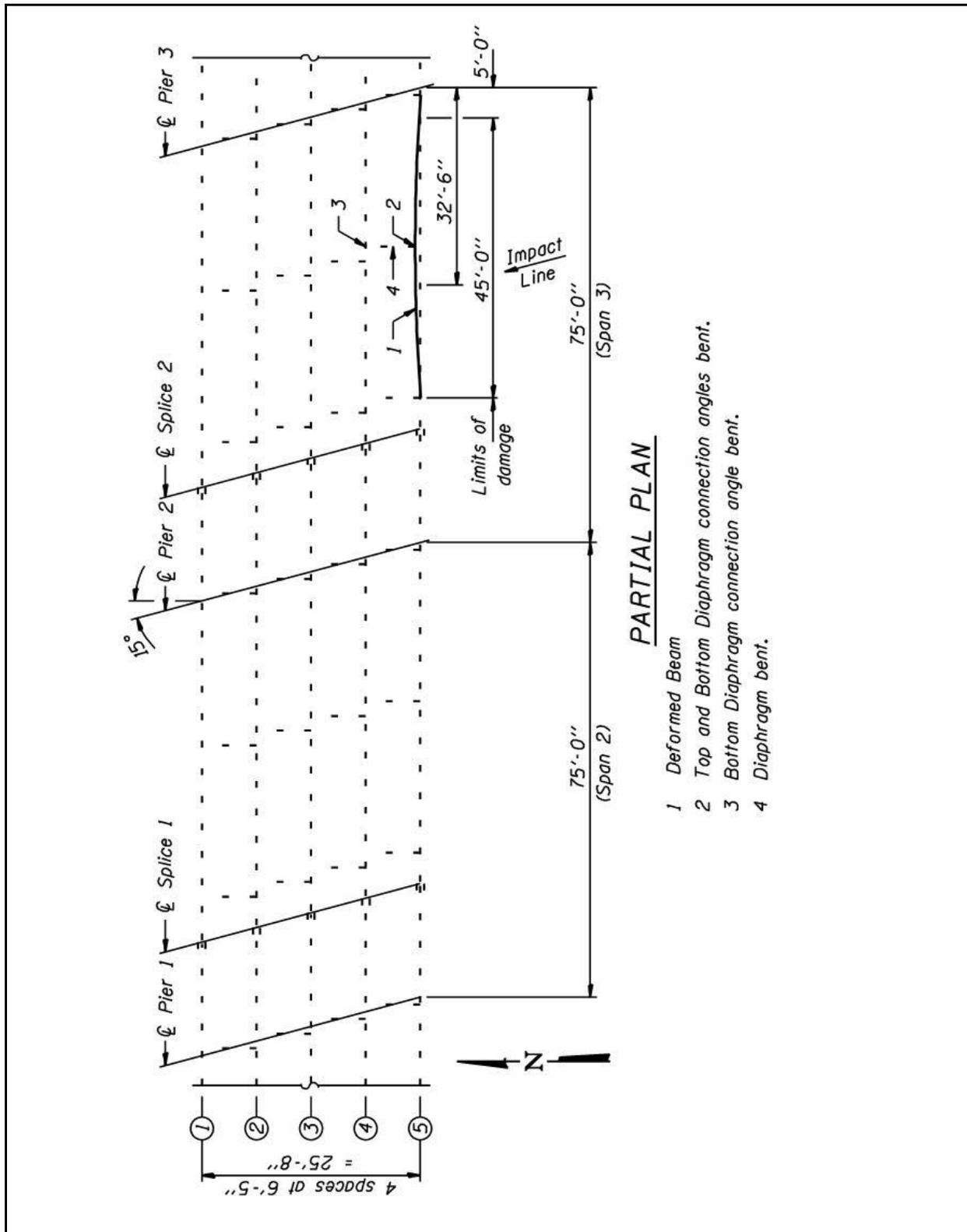


Figure 2.3-4 – Framing Plan Recording Impact Damaged Steel Beams

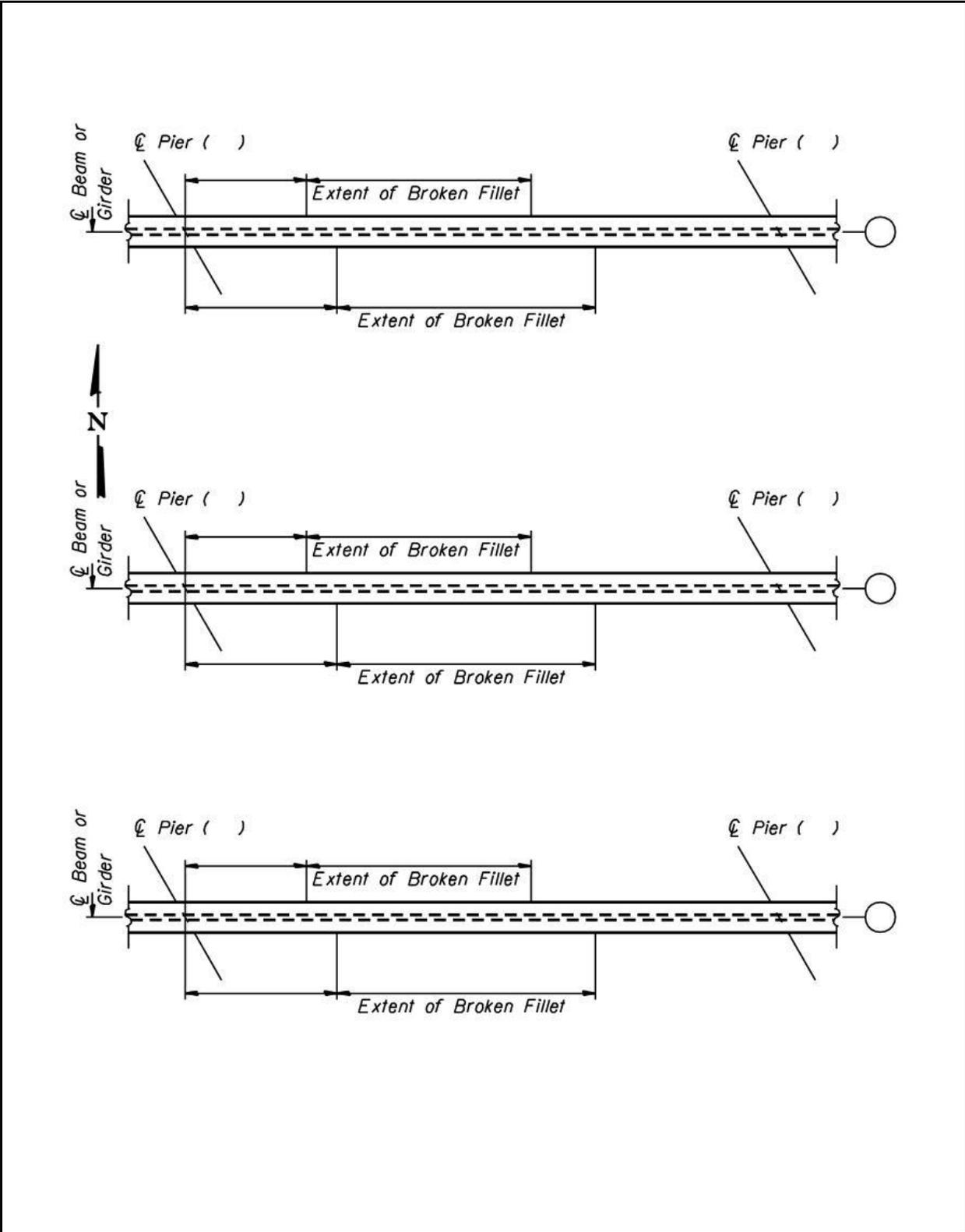


Figure 2.3-5 – Impact Damage Steel Beams Broken Fillets

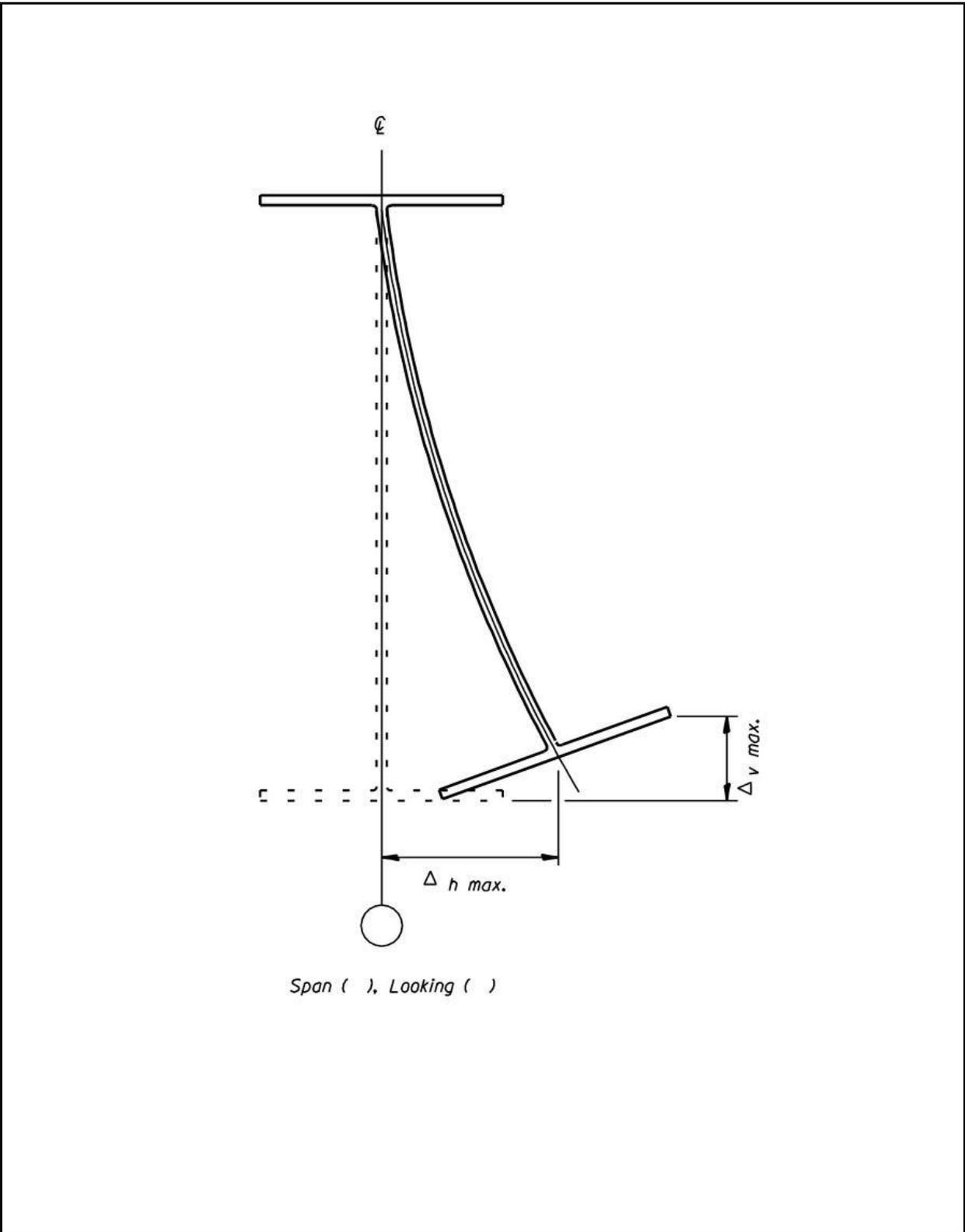


Figure 2.3-6 – Maximum Displacement of Impact Damaged Steel Beam or Girder

2.3.4 Impact Damage - Concrete Structures

The inspection of impact damage to concrete structures should include information locating all cracks and areas of substantial section loss. This usually requires an elevation view of each side of the beam and a view of the bottom of the beam marked to show crack and section loss locations relative to a fixed point of reference as illustrated in [Figure 2.3-7](#). The approximate width of cracks should be provided and the depth, width and length of areas of section loss should be defined. The location of exposed reinforcement bars or prestressing strands should be noted. Information giving the location, size and number of any severed reinforcement bars or prestressing strands should also be provided. Photographs of the damaged areas should be submitted with the inspection information. In addition to the above information, a framing plan showing information such as the point of impact and the location of damage to diaphragms should be included with the inspection data. An example framing plan recording impact damage on a concrete structure is illustrated in [Figure 2.3-8](#).

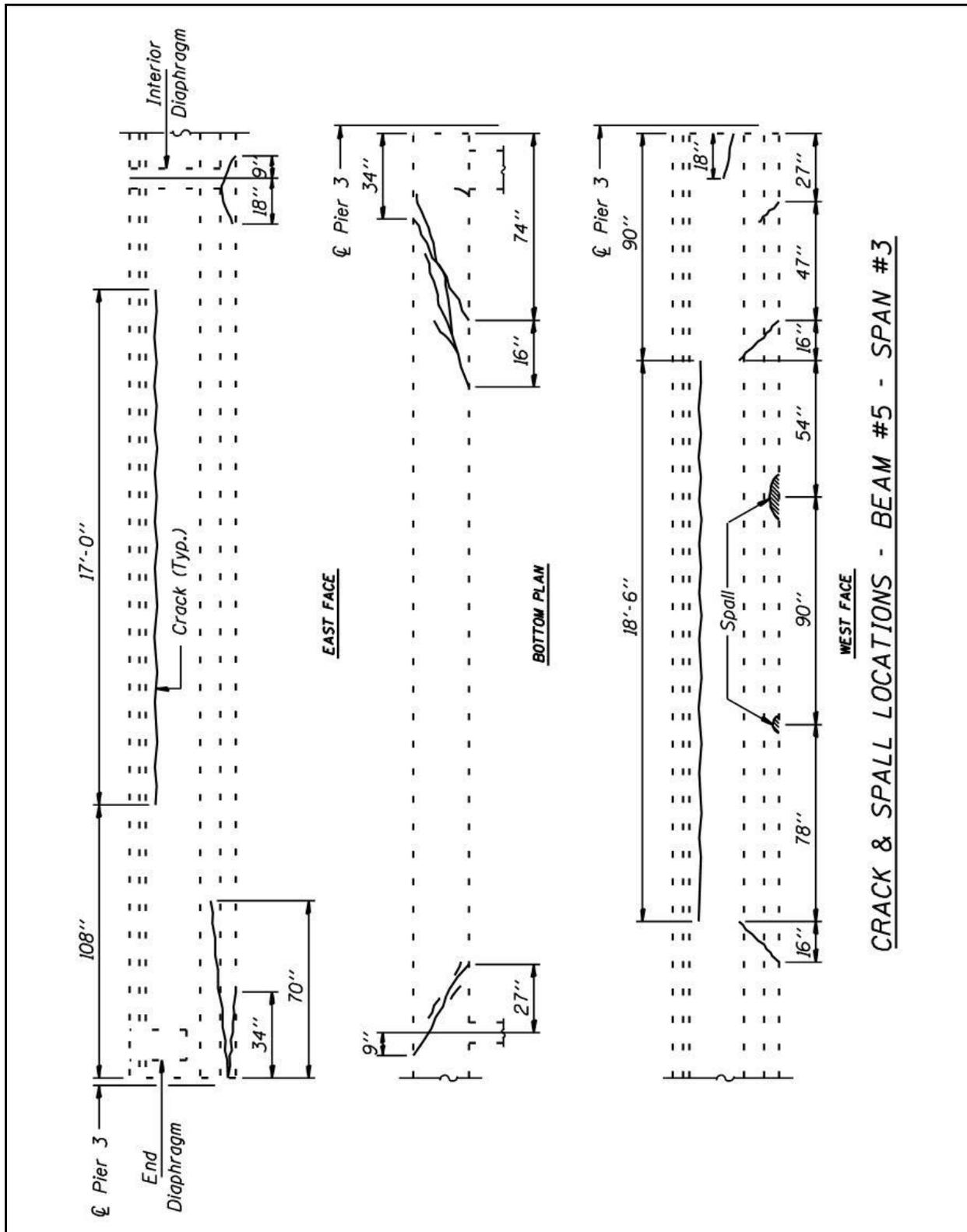


Figure 2.3-7 – Details of Impact Damaged PPC I Beams

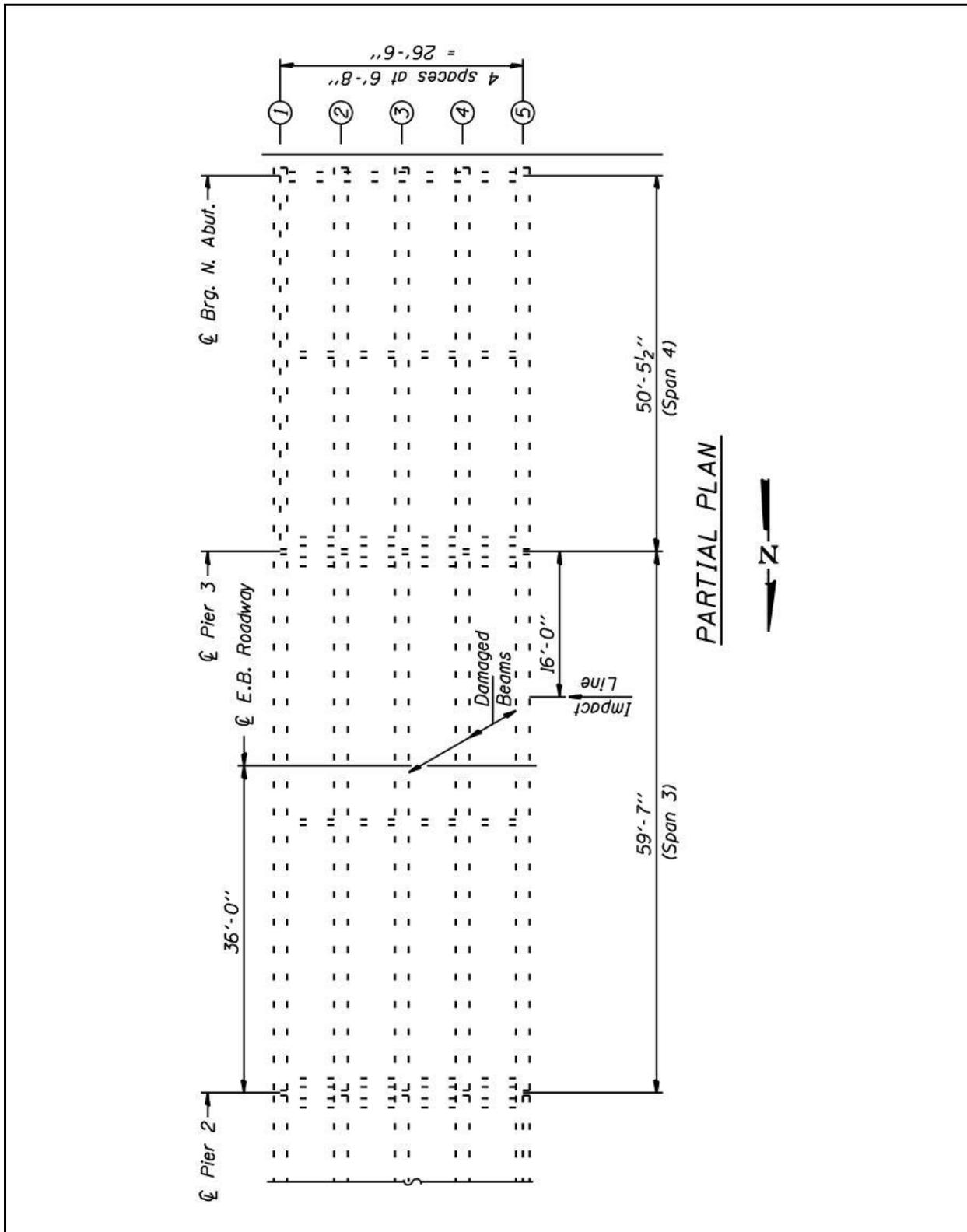


Figure 2.3-8 – Framing Plan of Impact Damaged PPC I Beams

2.3.5 Inspection Photographs

Colored photographs should be taken of all deteriorated or damaged members to be repaired. The photographs submitted with inspection data should be of original quality and permanently attached to 8 1/2" x 11" pages with, depending on the size of the photographs, two or four photographs per page. The date the photographs were taken and the structure number of the bridge should be shown on each page of photographs. The location on the structure where the photograph was taken should be written on the page directly below each photograph (rather than on the back of the photograph) with an indication of the photograph's direction of view (such as "Looking North"). The recommended format for mounting inspection photographs submitted to the Bureau of Bridges & Structures with requests for the preparation of repair plans is illustrated in [Figure 2.3-9](#) and [Figure 2.3-10](#).

2.3.6 Nondestructive Testing

When evidence of cracking in a steel member is found during an inspection, nondestructive testing should be performed to confirm the presence of the crack and to determine the extent of the cracking. The most frequently used forms of nondestructive testing employed during an inspection to identify cracking are dye penetrant testing and magnetic particle testing.

<i>Str. No.:</i> ----- <i>INSPECTION DATE:</i> -----	
<i>3" x 5"</i> <i>PHOTO</i>	<i>DESCRIPTION:</i>

Figure 2.3-9 – Recommended Picture Format for Submittal with Repair Plans Request

2.4 Bridge Deck Overlays

2.4.1 Overlay Types

Bridge deck overlays will typically consist of one of the following alternates:

1. Bituminous concrete with a waterproofing membrane system.
2. Microsilica or latex modified concrete.
3. Reinforced concrete

The type of overlay used for a project is chosen by district personnel based on cost, availability and experience with the overlay types. The IDOT *Guidelines for Bridge Deck Repair Projects*, developed and distributed by the Planning Section of the Bureau of Bridges & Structures, should be used to assist in the planning and design of all bridge deck overlay projects. However, the expansion joint replacement details and longitudinal joint replacement details shown in this Repair Section should take precedence over similar details shown in the IDOT *Guidelines for Bridge Deck Repair Projects*.

2.4.2 Bridge Condition Reports

The Bridge Condition Report for Deck Repairs (BCR-DR) requirements presented in the IDOT *Guidelines for Bridge Deck Repair Projects* apply to all Federal or State Funded projects. Bridge deck overlay projects using only Maintenance Funds do not require the preparation and submittal of a formal BCR-DR. However, District personnel should use the procedures presented in the guidelines for the survey and evaluation of an existing bridge deck when planning an overlay project using Maintenance Funds.

2.4.3 Deck Patching

Prior to the placement of an overlay, a deck survey is necessary to identify areas of the existing deck which require repair before the overlay can be placed. The date of the most recent delamination survey should be shown in the project plans on the sheet showing the deck patching locations or delamination survey plot. When more than one winter is expected to occur between the last delamination survey and the projected date of the commencement of deck patching operations, another delamination survey should be performed prior to the submittal of

repair plans for review. It is preferred that the anticipated partial and full depth deck slab repair areas be shown on a plan view of the deck and included in the plans. When the deck slab repair areas cannot be predicted, then the deck survey data and how it relates to potential partial and full depth deck slab repairs should be shown in the plans. In all cases deck plan views should be shown of adequate size to allow the Engineer to record the location of the actual deck slab repairs on the as-built plans. The plans should include a note instructing the Engineer to record the deck repair areas in order to document as-built conditions for future reference.

Except for locating the anticipated patching areas in a plan view, specific details for partial and full depth patching are not required to be shown in the plans. Instructions for deck patching are included in the special provision for "Deck Slab Repair".

When the existing superstructure consists of a reinforced concrete slab, reinforced concrete deck girder or other type of superstructure where the deck functions as a component of the main load carrying members of the bridge spans, partial and full depth deck patching should be avoided. When partial or full depth patching is necessary on these types of structures, the size, locations and extent of the deck patching must be evaluated to determine if temporary shoring must be placed under portions of the superstructure until the deck patching concrete has obtained the required load carrying capacity.

2.4.4 Effect on Structure

The Bureau of Bridges & Structures should be contacted to evaluate the effect of overlay projects on the overall load carrying capacity of the structure. The load carrying capacity of a structure will be evaluated during the review of the BCR-DR. When a BCR-DR is not required for a project, the Structural Services Section should be contacted to evaluate the effect of the overlay on the structure. This contact for evaluation is also necessary for bridges included with roadway resurfacing projects where the District plans to scarify the existing wearing surface on a bridge deck and/or place a new wearing surface on the bridge.

When a bridge deck overlay project requires the removal of the existing deck concrete over a large area to the level of the existing top reinforcement bars of a reinforced concrete slab bridge, special precautions are necessary to maintain the structural load carrying capacity of the structure. The Bureau of Bridges & Structures should be contacted by District personnel for

assistance in determining what measures should be taken to ensure the structural integrity of reinforced concrete slab bridges when the method of deck removal specifies that the top reinforcement bars are to be exposed or deck patching is required. The measures typically taken will require that:

1. the superstructure be supported from below during the scarification and overlay operations.
2. the full and partial depth slab repairs be completed and cured prior to scarification operations.
3. the existing reinforced concrete slab be scarified and overlaid in segments following a predetermined sequence.

Details associated with the sequential concrete surface removal and overlaying of a reinforced concrete slab bridge are shown in [Figure 2.4-1](#).

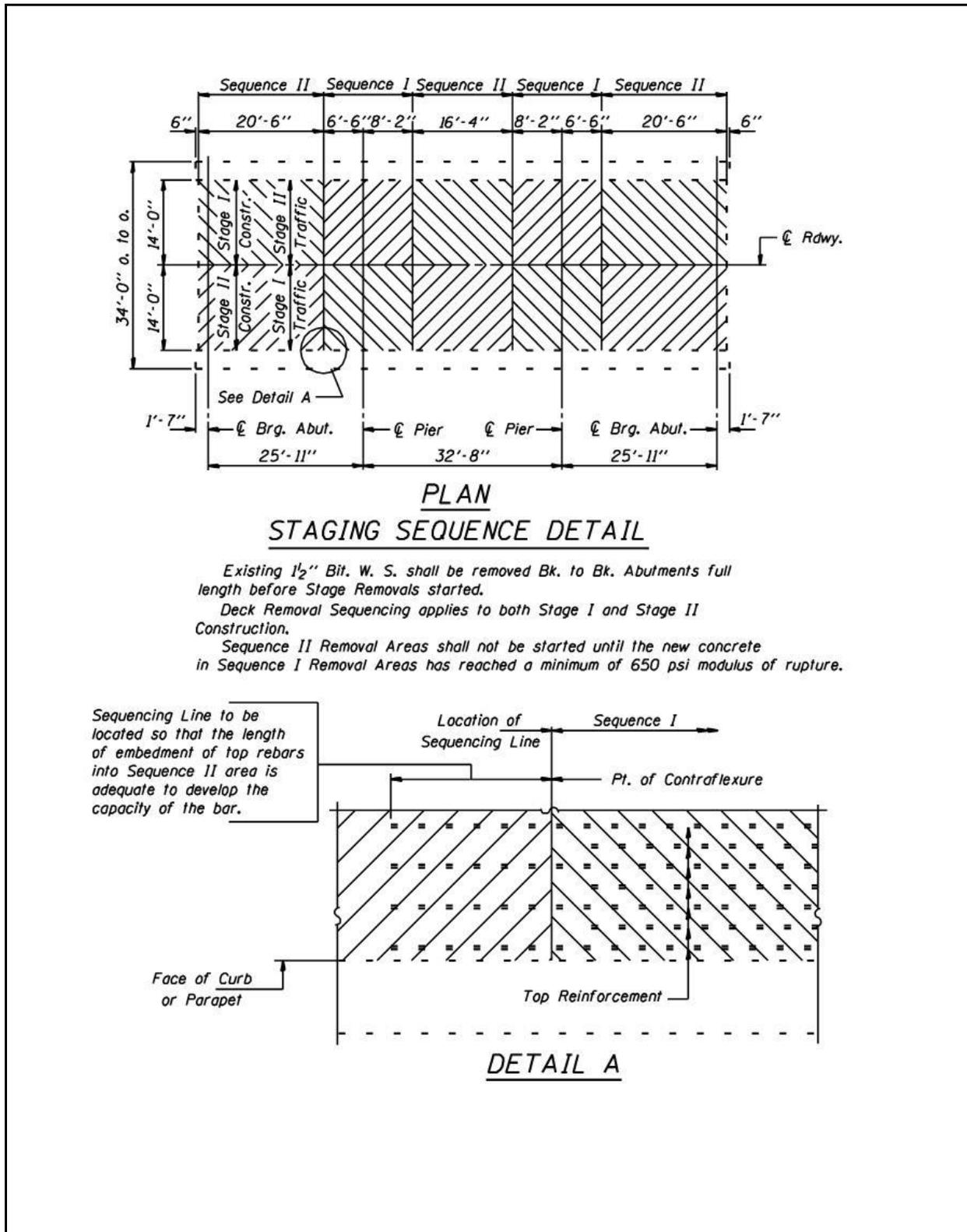


Figure 2.4-1 – Sequential Scarification and Overlaying of a R.C. Slab Bridge

2.4.5 Bituminous Concrete Overlays

A bituminous concrete overlay can be used to replace an existing bituminous concrete wearing surface or to protect an existing bare concrete deck. A waterproofing membrane system is always required when using a bituminous concrete overlay. The minimum thickness of the bituminous overlay to be placed, not including the 1/2 inch waterproofing, should be 1-1/4 inches for a minimum total thickness of 1-3/4 inches. When replacing an existing bituminous concrete overlay, the scarification of the existing overlay should not extend into the existing waterproofing membrane if the waterproofing is to remain in place. If the existing waterproofing system is to be removed and a new waterproofing membrane system applied to the deck, the scarification of existing overlay should not extend into the surface of the concrete deck. Also, an existing bare concrete deck should not be scarified prior to the application of the waterproofing membrane system, but the deck should be cleaned using methods which will not roughen the surface. Waterproofing membrane should always be extended across construction joints in the deck at locations where the deck has been patched or replaced. When removing existing bituminous concrete surfaces and existing waterproofing systems, the existing plans and other records should be consulted to determine if any hazardous materials, such as asbestos, were used. If hazardous materials were used in the existing overlay, containment of the materials during removal and proper disposal will be necessary.

2.4.6 Microsilica, Plasticized Dense, or Latex Concrete Overlays

Microsilica, plasticized dense, and latex concrete should be placed with a minimum thickness of 2-1/4 inches on a roughened or scarified concrete surface. A maximum overlay thickness of 3 1/2 inches may be placed without the inclusion of reinforcement bars or wire mesh. Existing concrete decks, to which microsilica, plasticized dense, or latex concrete is to be applied, should be scarified a minimum of 1/4 inch to remove all waterproofing membrane and to provide a roughened surface. When microsilica, plasticized dense, or latex concrete is used to overlay a precast prestressed concrete deck beam superstructure, the minimum overlay thickness, reinforcement bar requirements and scarification limitations specified for Reinforced Concrete Overlays should be used.

2.4.7 Reinforced Concrete Overlays

Reinforced concrete overlays may be a minimum of 4 inches in thickness. However, a minimum concrete overlay thickness of 5 inches should be used when the additional dead load will not adversely affect the load carrying capacity of the structure. Also, a minimum overlay thickness of 5 inches will facilitate the embedment of rail post anchors in the overlay if necessary. Reinforcement bars or wire mesh providing a minimum cross sectional area equivalent to no. 4 bars at 12 inch centers, in both the longitudinal and transverse directions, should be incorporated in the overlay to prevent and control cracking.

Except when placed on a precast prestressed concrete deck beam or precast concrete bridge slab superstructures, the concrete surface on which the reinforced concrete overlay will be placed should be scarified a minimum of 1/4 inch. All existing wearing surface, waterproofing and foreign material must be removed from the surface receiving the overlay.

2.4.8 Overlaying Precast Superstructures

The top surface of precast prestressed concrete deck beams and precast bridge slabs superstructures should be prepared by scarifying only the wearing surface and removing any waterproofing or foreign material using hand methods and shotblasting. The top surface of the original precast should not be scarified.

The thickness of an overlay on a precast prestressed concrete deck beam superstructure will vary parallel to the centerline of the bridge in order to match the profile grade of the roadway and to account for the camber in the beams. A profile of the overlay should be shown in the plans to clarify the relationship of the overlay thickness to the profile grade and beam camber as illustrated in [Figure 2.4-2](#).

[Figure 2.4-3](#) shows the use of a preformed joint seal at an expansion joint reconstruction with concrete overlay.

In order to control cracks in the area of the overlay located over a fixed pier, a relief joint should be installed in the overlay over the pier. [Figure 2.4-4](#) illustrates the use of a formed joint with sealer to control overlay cracking over a fixed pier. This detail is used with overlay on existing PPC Deck Beams.

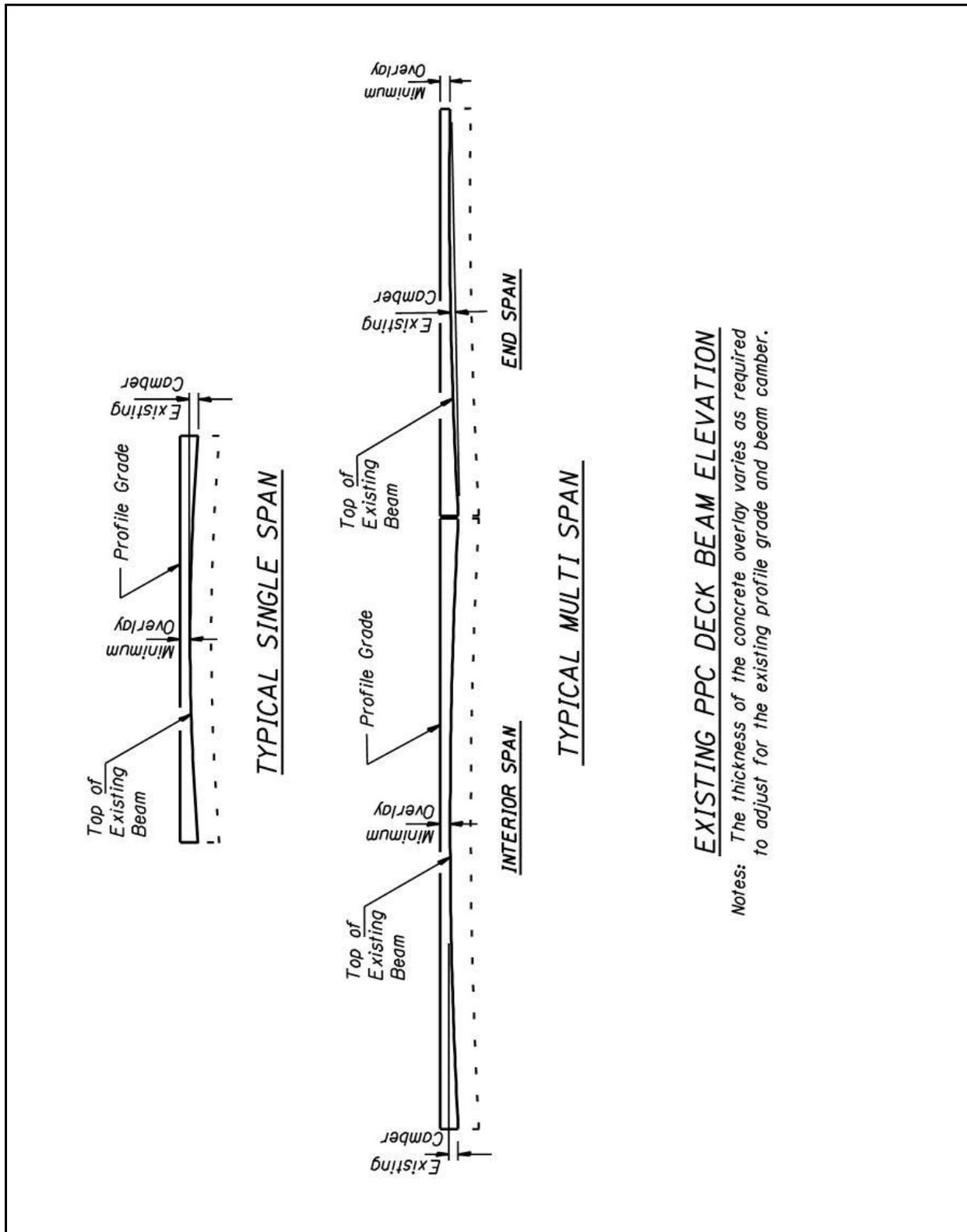


Figure 2.4-2 – Concrete Overlay Profile on PPC Deck Beams

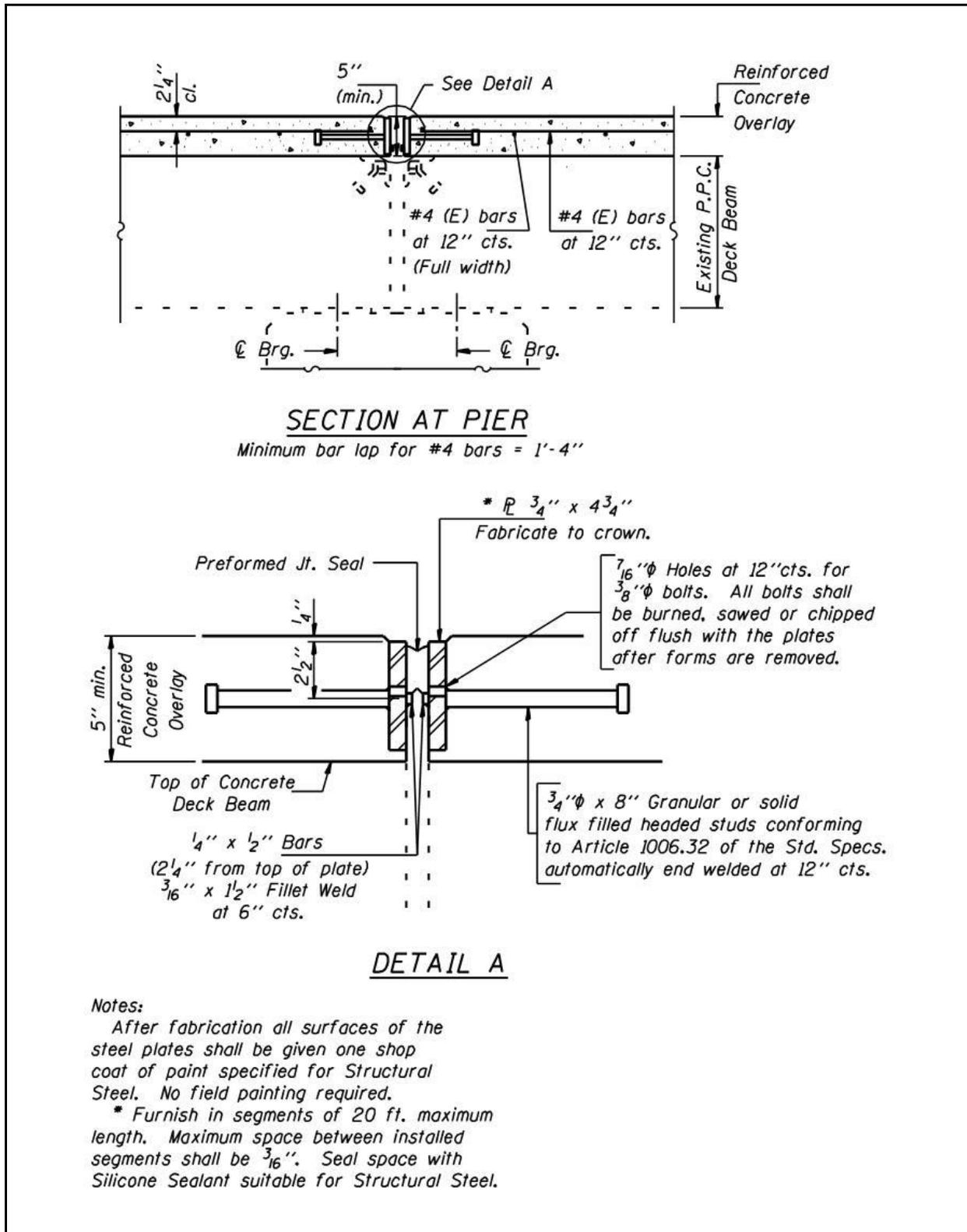


Figure 2.4-3 – PPC Deck Beam Expansion Joint Reconstruction with Concrete Overlay

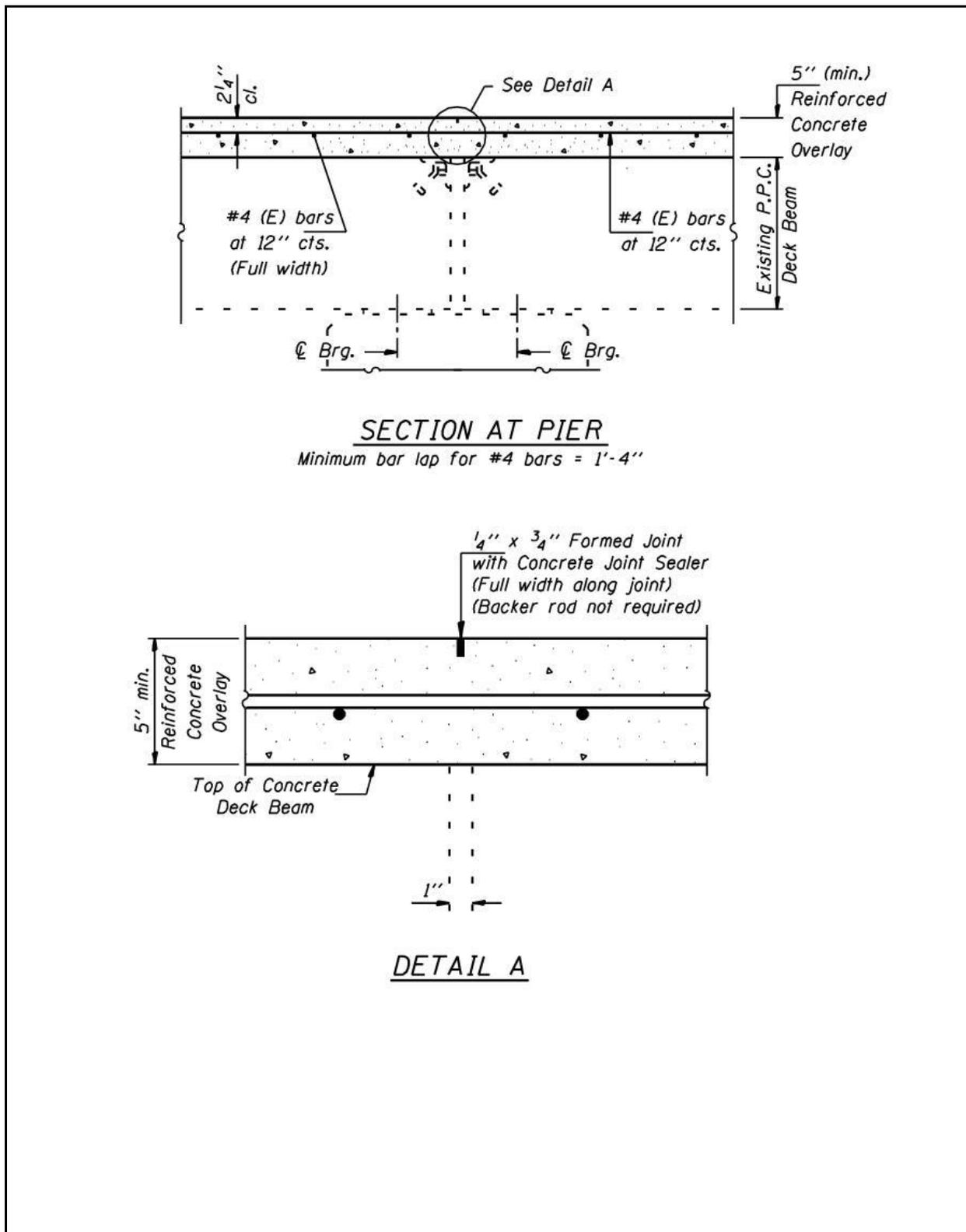


Figure 2.4-4 – PPC Deck Beam Fixed Joint Reconstruction with Concrete Overlay

2.5 Expansion Joint Replacements

2.5.1 General

The replacement of expansion joints is a common maintenance operation necessary to prolong the life of a structure. This operation is usually required due to: the structural failure of the joint, the joint no longer provides protections for the structural elements below against exposure to drainage from the deck; or the joint opening has closed and is restricting the normal expansion of the structure. Before preparing plans to replace closed expansion joints it is necessary to determine the cause of the closure to avoid a recurrence after the new expansion joint is installed. If the cause of the joint closure is not apparent or easily correctable, the Bridge Investigations and Repair Plans Unit of the Structural Services Section of the Bureau of Bridges & Structures should be contacted for assistance.

2.5.2 Joint Type Selection

When replacing an expansion joint, the selection chart provided in the Design Section of the IDOT *Bridge Manual* should be used to select the type and size of the replacement joint. Joint types not shown in the Design Section of the IDOT *Bridge Manual* joint selection chart or which have not been tested and approved for general use by IDOT should not be used unless the Bureau of Bridges & Structures and the Bureau of Materials and Physical Research have concurred in the use of the joint on an experimental basis. A joint type which is not in the IDOT *Bridge Manual*, but is approved as an alternate to the Preformed Joint Sealer and Neoprene expansion joints up to 3 inch width is the Silicone Joint Sealer. [Figure 2.5-1](#) shows the sealer being used with the same plates and studs which are utilized in the Preformed Joint Sealer. An optional, preferred method for the sealer is illustrated in [Figure 2.5-2](#) where a polymer concrete nosing protects the joint edges. Silicone Joint Sealers larger than 3 inch width are considered experimental.

2.5.3 Existing Armoring Steel

The existing steel armoring elements anchored in the ends of the PPC deck beams or cast-in-place decks can often be reused and incorporated into the details for the replacement joint when the concrete in the area of repair is sound and will not be removed. When these existing steel elements are found to be loose, re-anchorage of the steel elements can be achieved by

drilling through the steel element and into the beam, installing epoxy grouted threaded rods and bolting the steel element firmly in position. Also, voids under the existing steel elements can be repaired by injecting epoxy under the steel element in the area of the voids. These procedures are illustrated in [Figure 2.5-3](#) and require the placement of a concrete overlay in the area of the deck adjacent to the armoring elements. When the grade is raised at an expansion joint with existing armoring steel, the steel can be retrofitted as shown in [Figure 2.5-4](#) and [Figure 2.5-5](#). In these details the grade is raised by the thickness of the new bituminous wearing surface or concrete overlay.

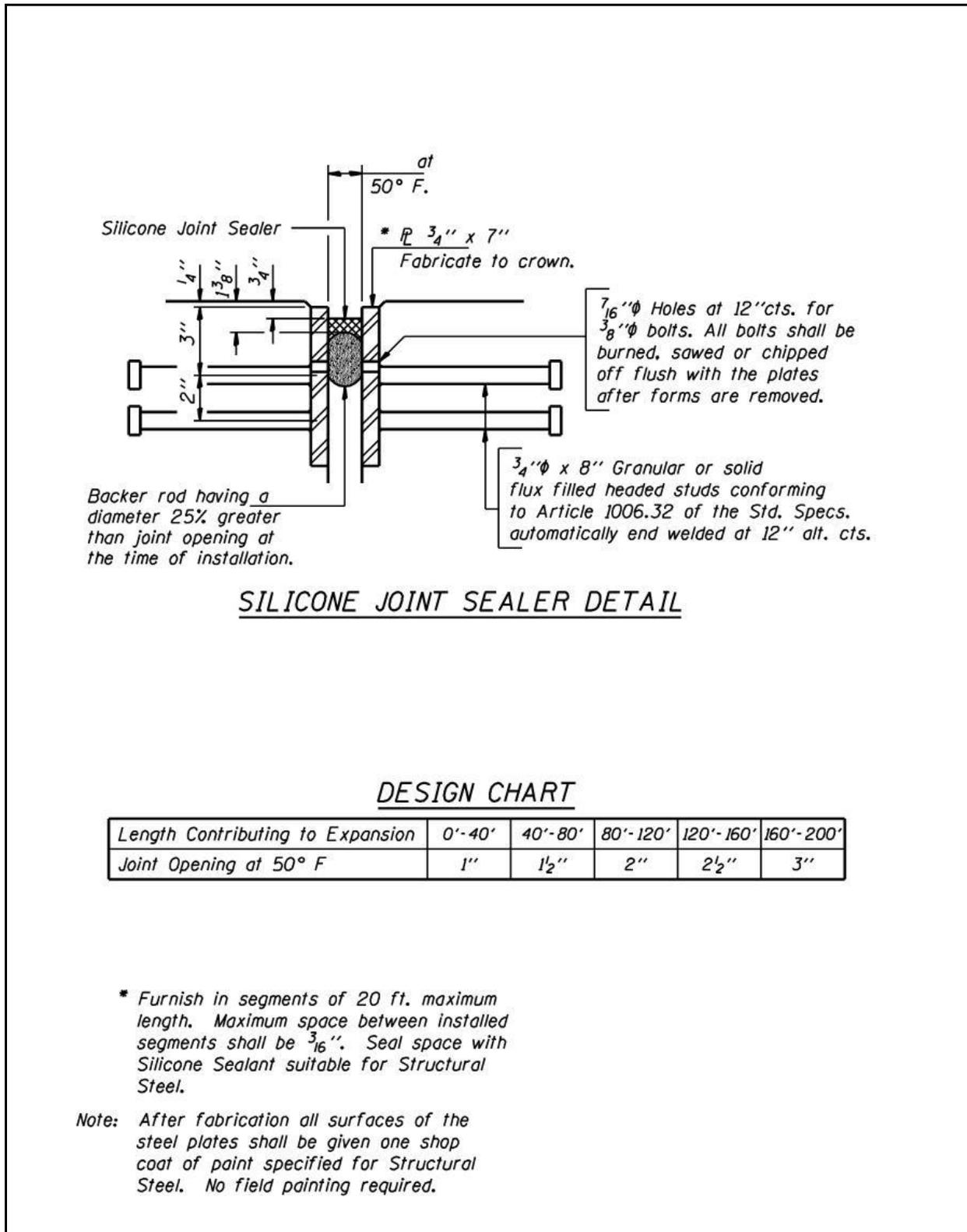
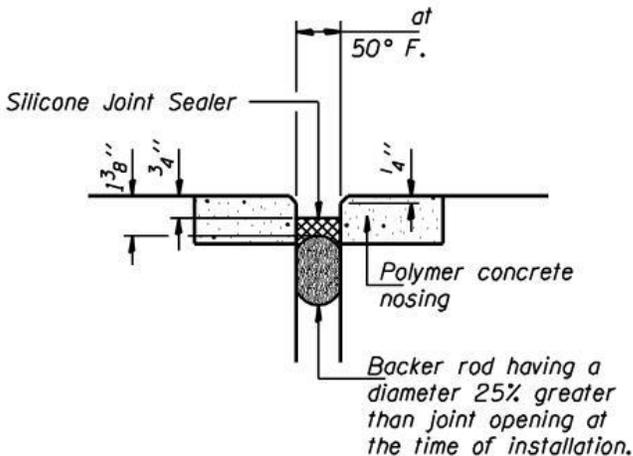


Figure 2.5-1 – Silicone Joint Sealer with Steel Plates



SILICONE JOINT SEALER DETAIL

DESIGN CHART

Length Contributing to Expansion	0'-40'	40'-80'	80'-120'	120'-160'	160'-200'
Joint Opening at 50° F	1"	1 1/2"	2"	2 1/2"	3"

Figure 2.5-2 – Silicone Joint Sealer with Polymer Concrete Nosing

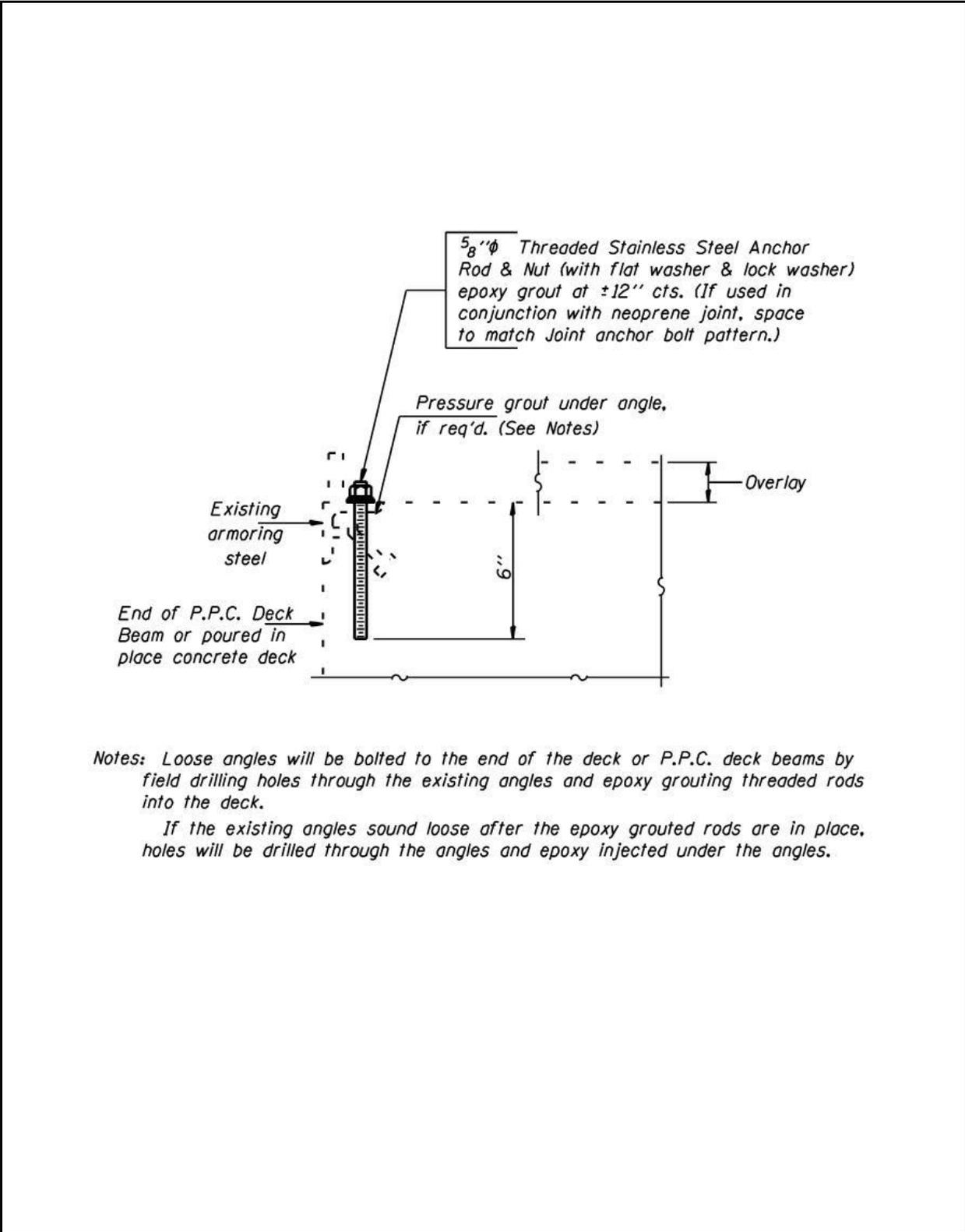


Figure 2.5-3 – Re-Anchoring Existing Loose Expansion Angles

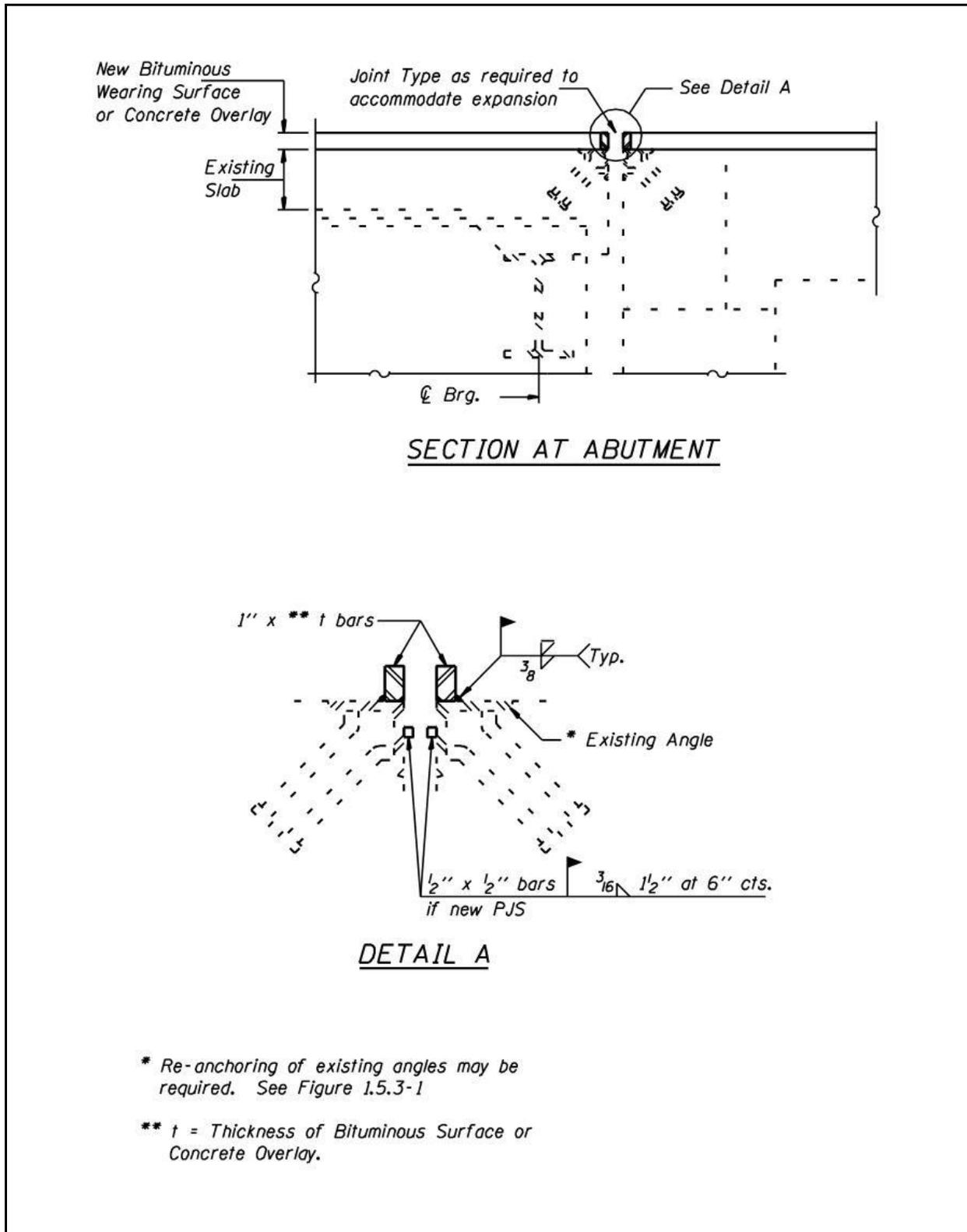


Figure 2.5-4 – Expansion Joint Treatment with Grade Raise and Existing Angles

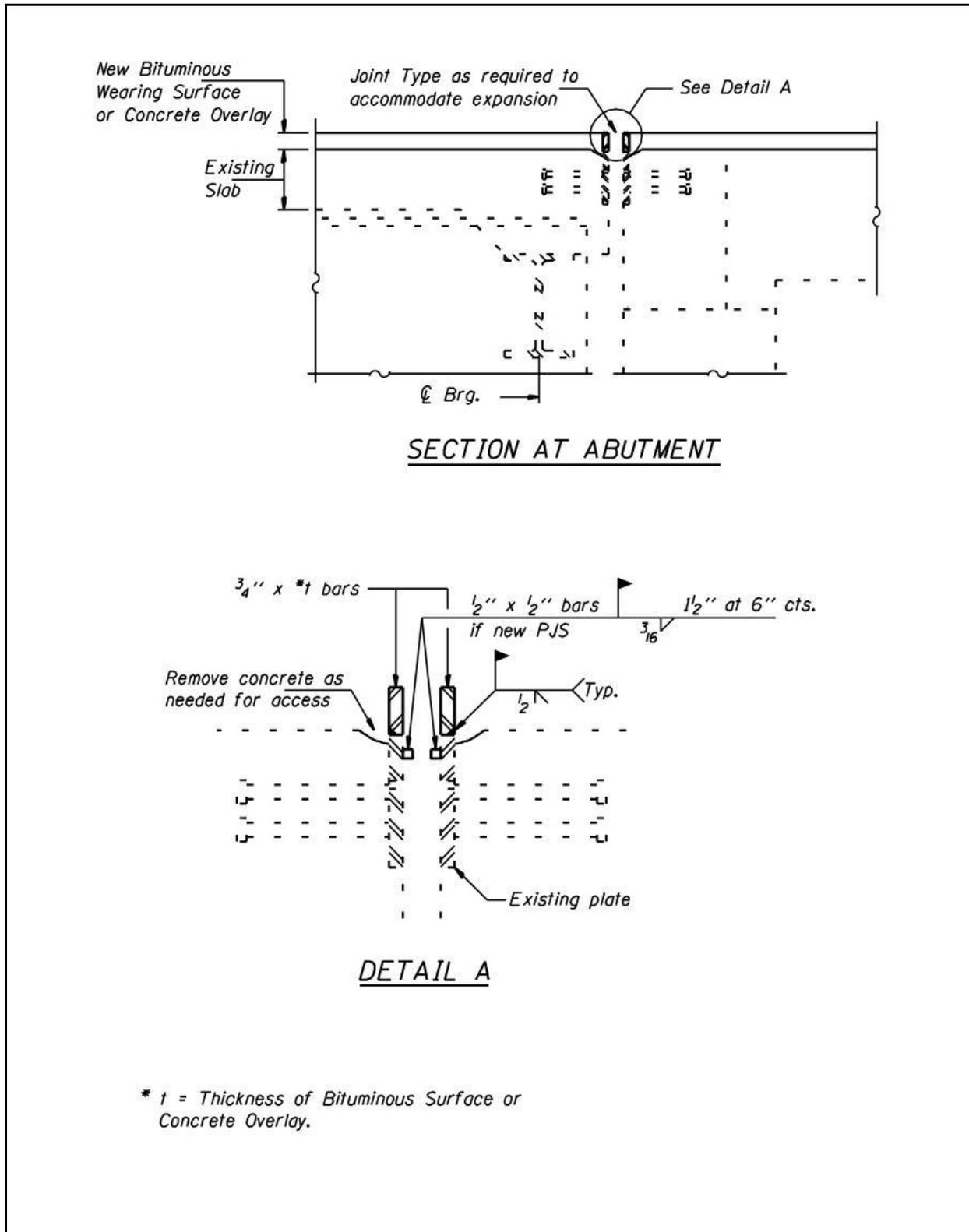


Figure 2.5-5 – Expansion Joint Treatment with Grade Raise and Existing Plates

2.5.4 Concrete Deck on Multi-Beam System

The most common type of expansion joint replacement involves the removal and replacement of a portion of a reinforced concrete deck slab which rests on a multi-beam support system. A minimum 2'-0" of deck slab and parapet removal and replacement is required. The deck slab removal should be sufficient to include the entire thickened (corbel) area of the deck slab in the area of the joint. This will require more than the minimum 2'-0" of deck slab removal and replacement in many situations.

The longitudinal reinforcement bars in the area of slab, curb, sidewalk and parapet removal should remain in place and should be cleaned and incorporated into the new construction. The existing reinforcement bars placed parallel to the end of the deck should be removed and new reinforcement bars should be provided. Also, the existing vertical reinforcement bars in the curb and parapet areas should be removed and replaced.

The details, which should be incorporated in expansion joint replacements for deck slabs on multi-beam systems, are illustrated in [Figure 2.5-6](#) for steel beams and [Figure 2.5-7](#) for PPC I beams.

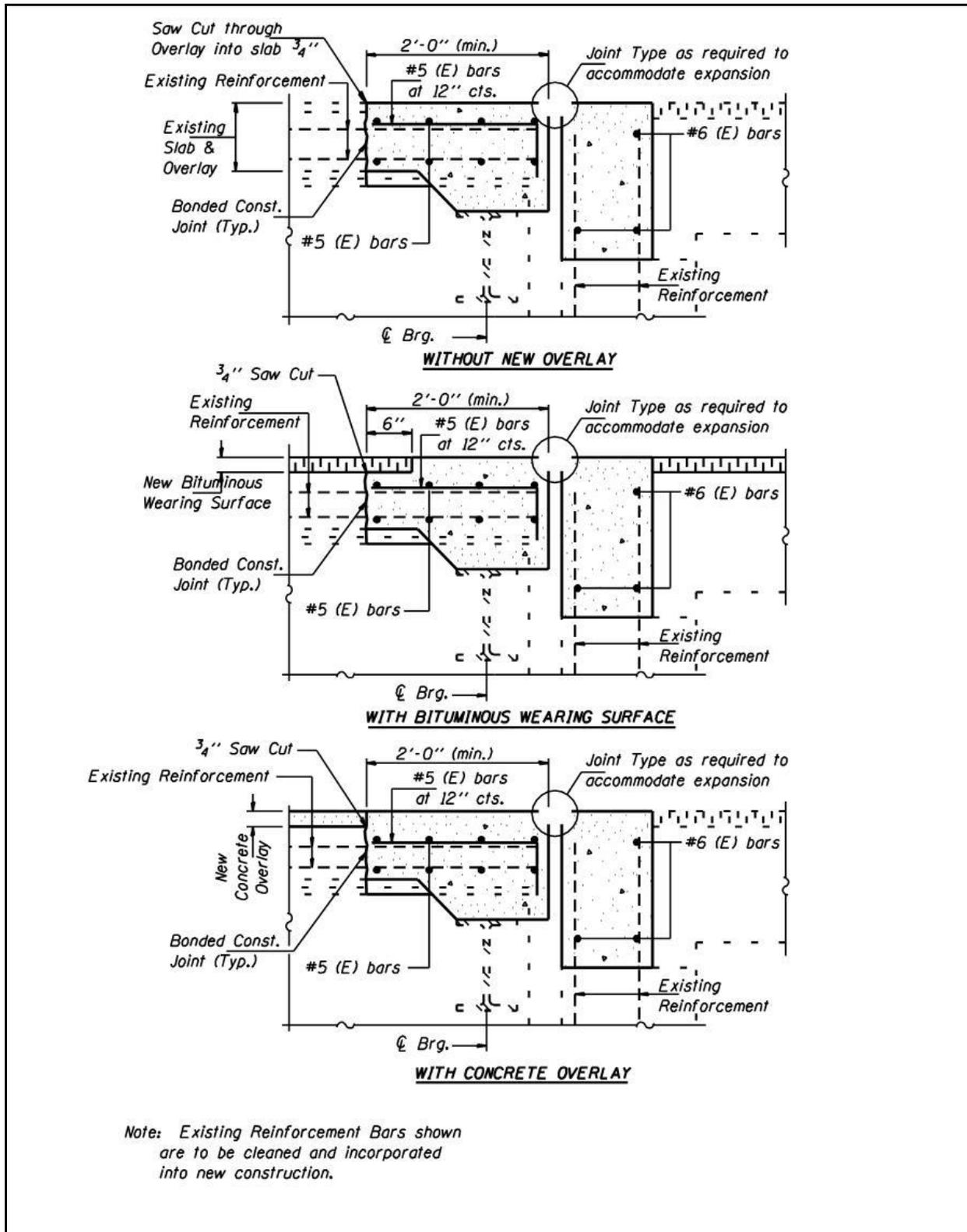


Figure 2.5-6 – Joint Reconstruction for Steel Beams

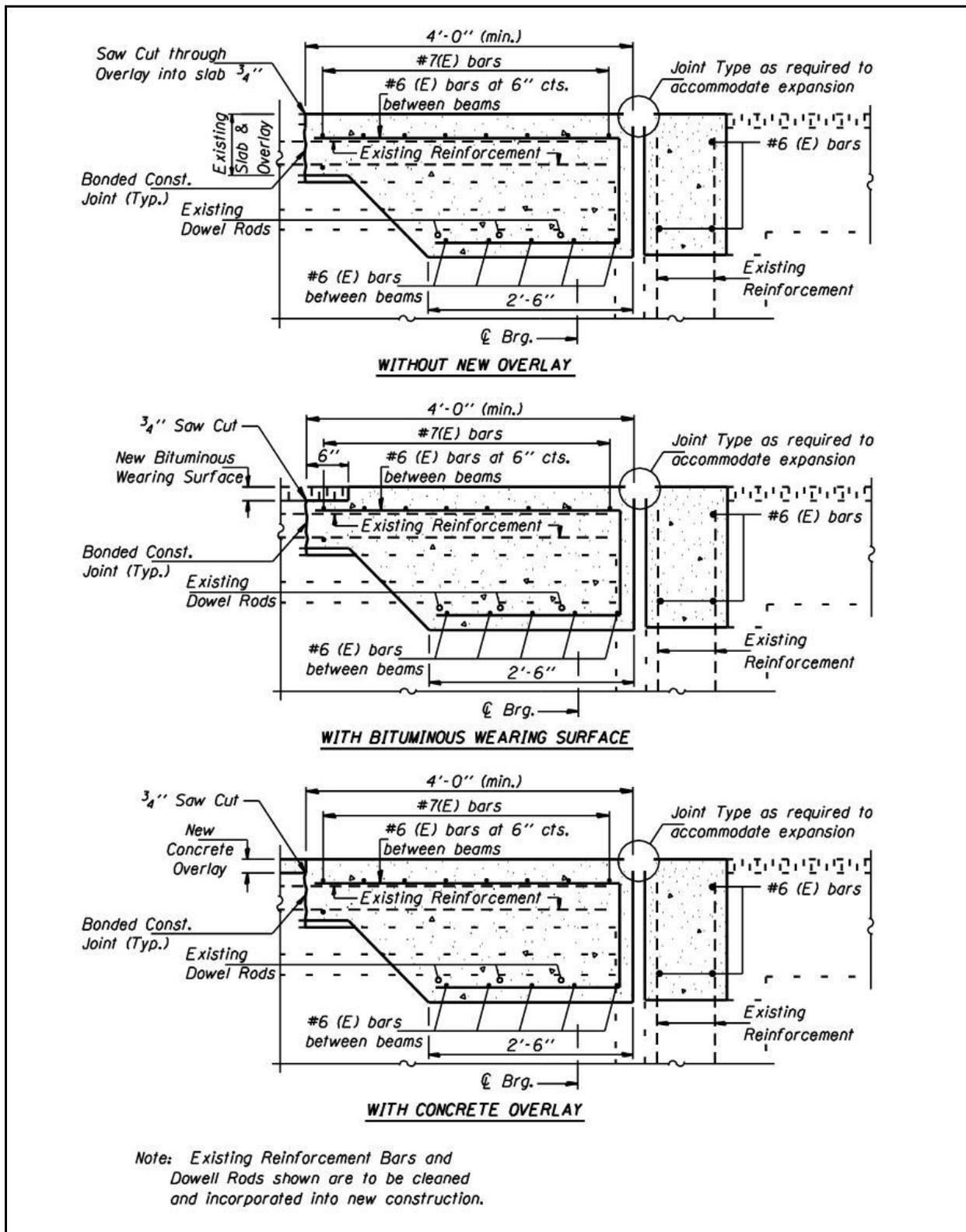


Figure 2.5-7 – Joint Reconstruction for PPC I Beams

2.5.5 Reinforced Concrete Deck Girder

Another type of superstructure often encountered during an expansion joint replacement project is the cast-in-place reinforced concrete deck girder (T-beam). The same slab removal and replacement requirements specified for multi-beam bridges should be used except that the depth of the deck slab removal in the area directly over the girders should be limited to the minimum depth of the deck slab rather than the thickened (corbel) end area of the slab. This difference in concrete removal limits is illustrated in [Figure 2.5-8](#).

The existing reinforcement bars should be incorporated into the new construction or replaced in a manner similar to that specified for deck slabs on multi-beam systems. [Figure 2.5-9](#) and [Figure 2.5-10](#) illustrate detail for expansion joint replacement associated with reinforced concrete deck girders.

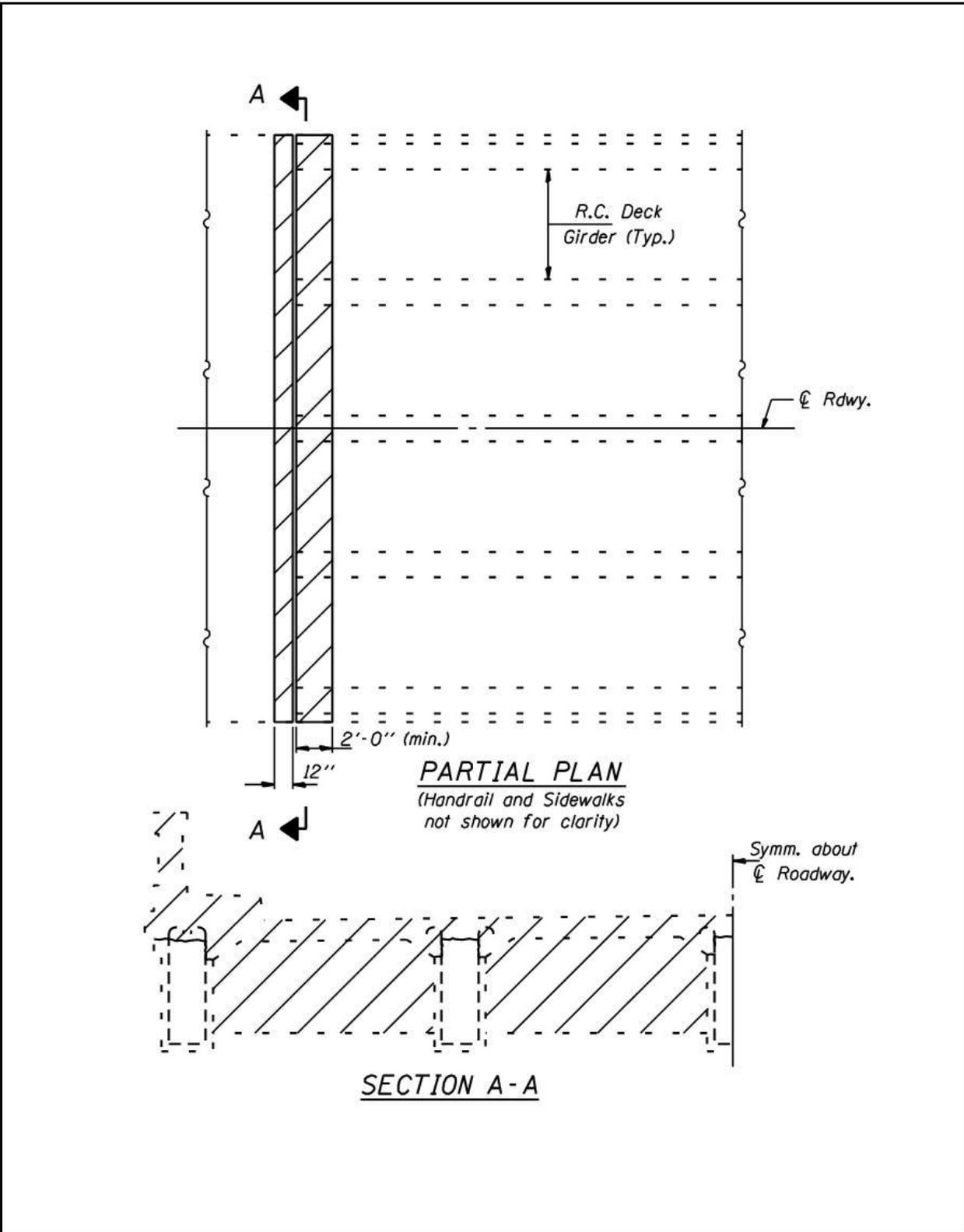


Figure 2.5-8 – R.C. Deck Girder Concrete Removal

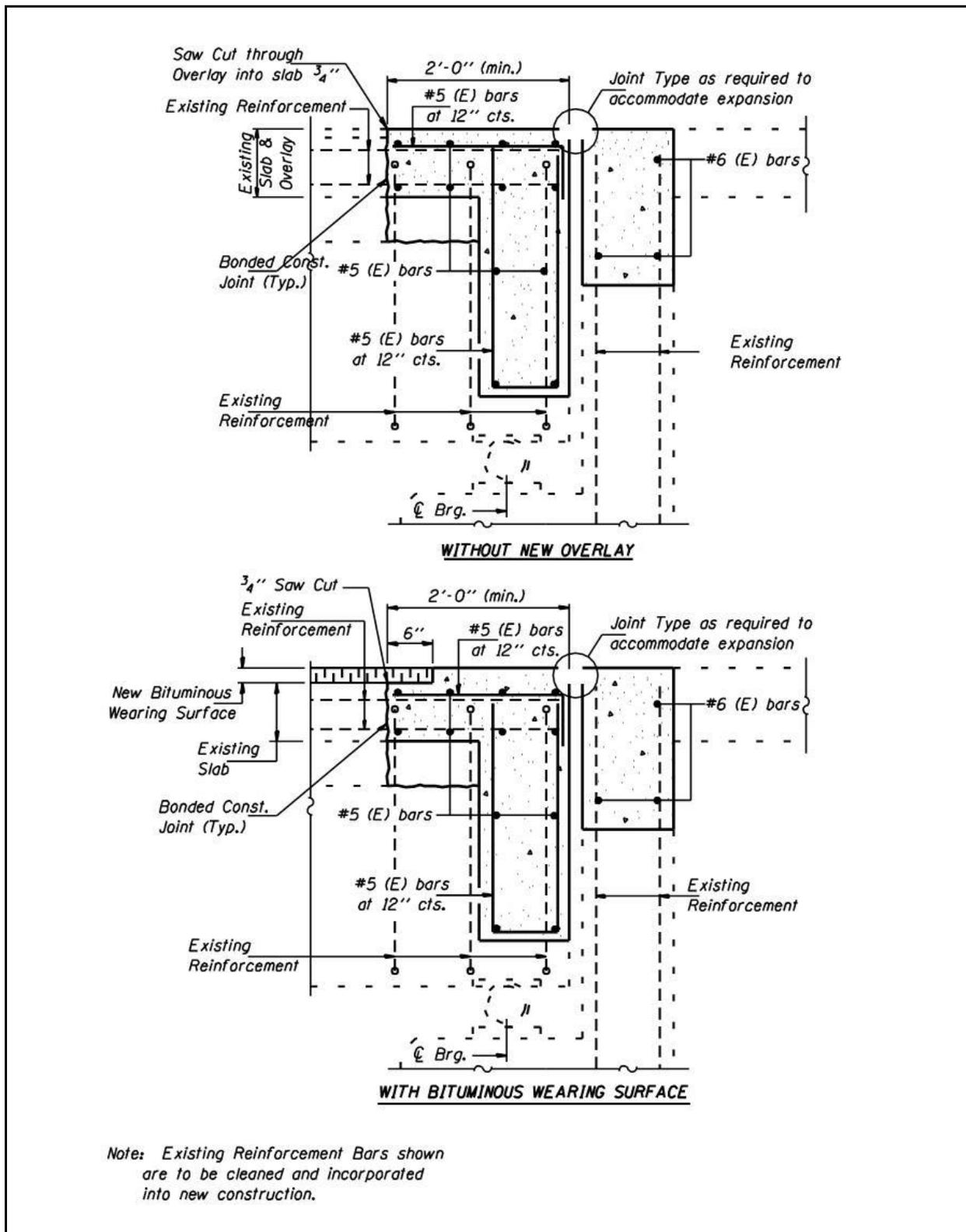


Figure 2.5-9 – R.C. Deck Girder Joint Reconstruction (Full Removal)

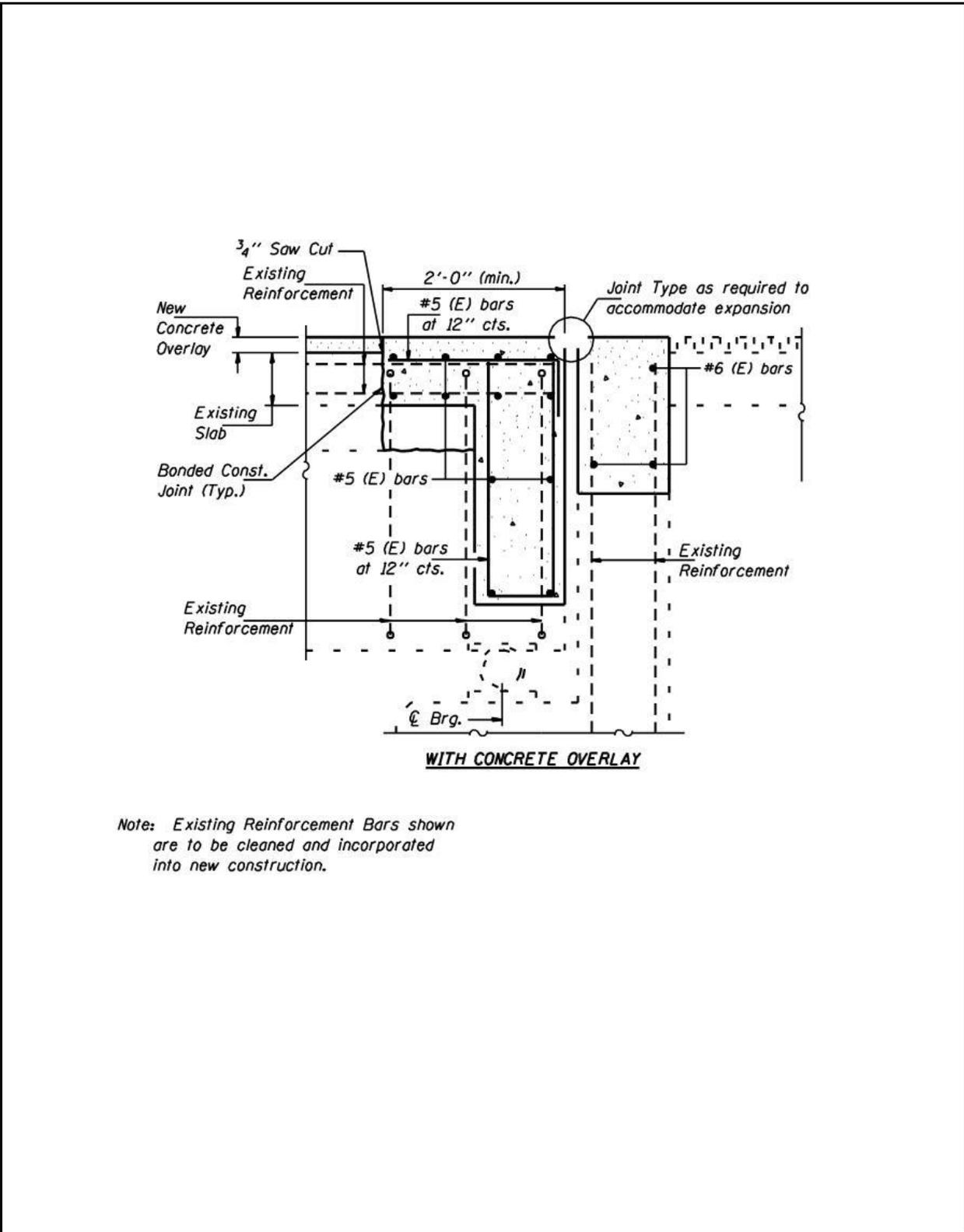


Figure 2.5-10 – R.C. Deck Girder Joint Reconstruction (Full Removal)

2.5.6 Reinforced Concrete Slab

For reinforced concrete slab bridges, the concrete removal, concrete replacement and reinforcement bar requirements given for multi-beam bridges is preferred. In addition, if the ends of the existing longitudinal reinforcement bars in the bottom of the slab are not hooked, new hooked bars should be provided and lapped with the existing unhooked bottom longitudinal reinforcement bars in the area of slab removal and replacement. [Figure 2.5-11](#) shows details for the removal and replacement of the end of a reinforced concrete slab during the replacement of an expansion joint.

Although not preferred, a limited partial-depth removal area in the immediate area of the joint can be utilized if inspection indicates that the slab concrete that will remain in the area of the joint is sound and analysis shows that the reduced end area is structurally adequate to support the structure during the joint replacement operations without need for temporary support. Refer to [Figure 2.5-12](#) for details of partial slab removal and replacement.

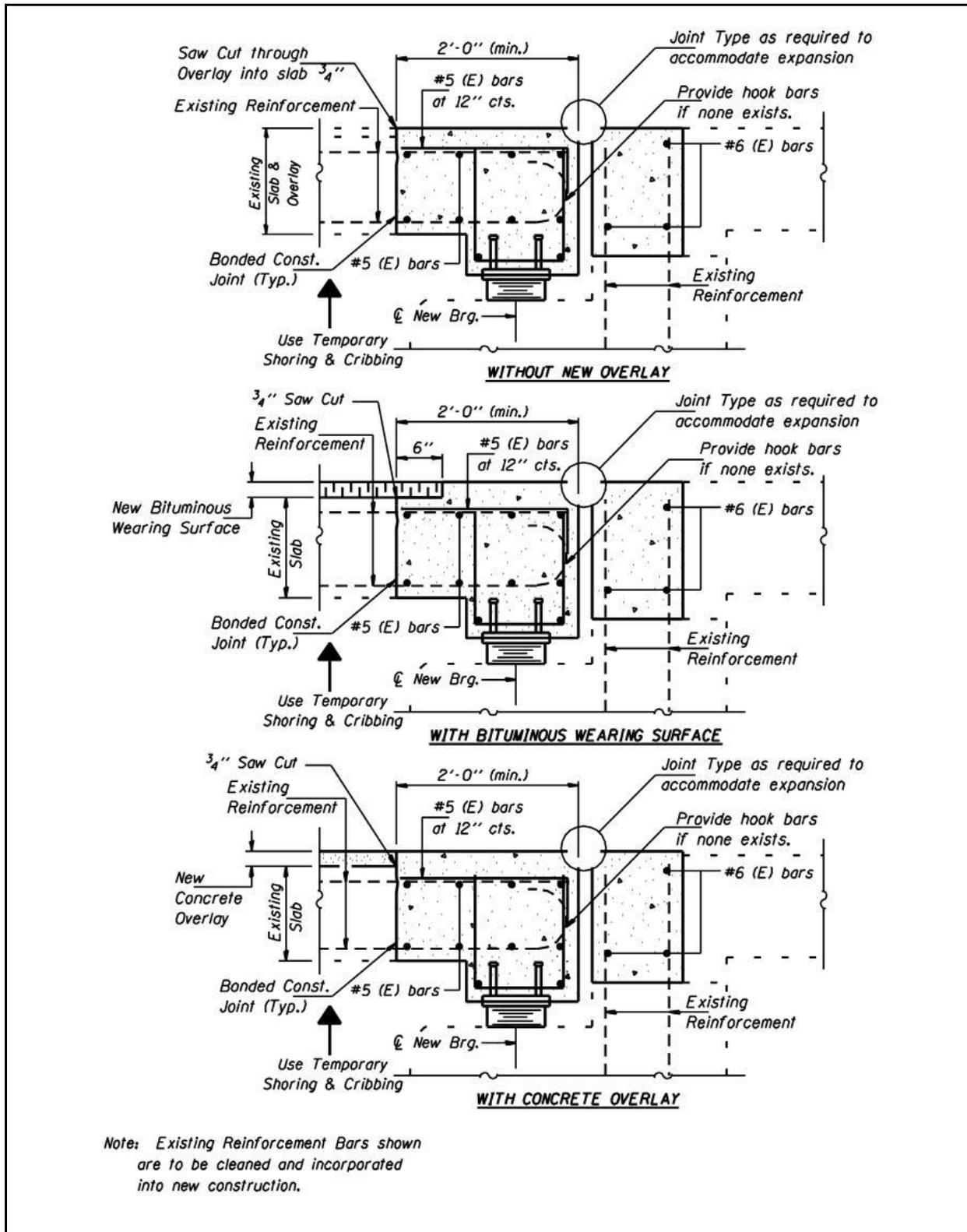


Figure 2.5-11 – Joint Reconstruction for R.C. Slab (Full Removal)

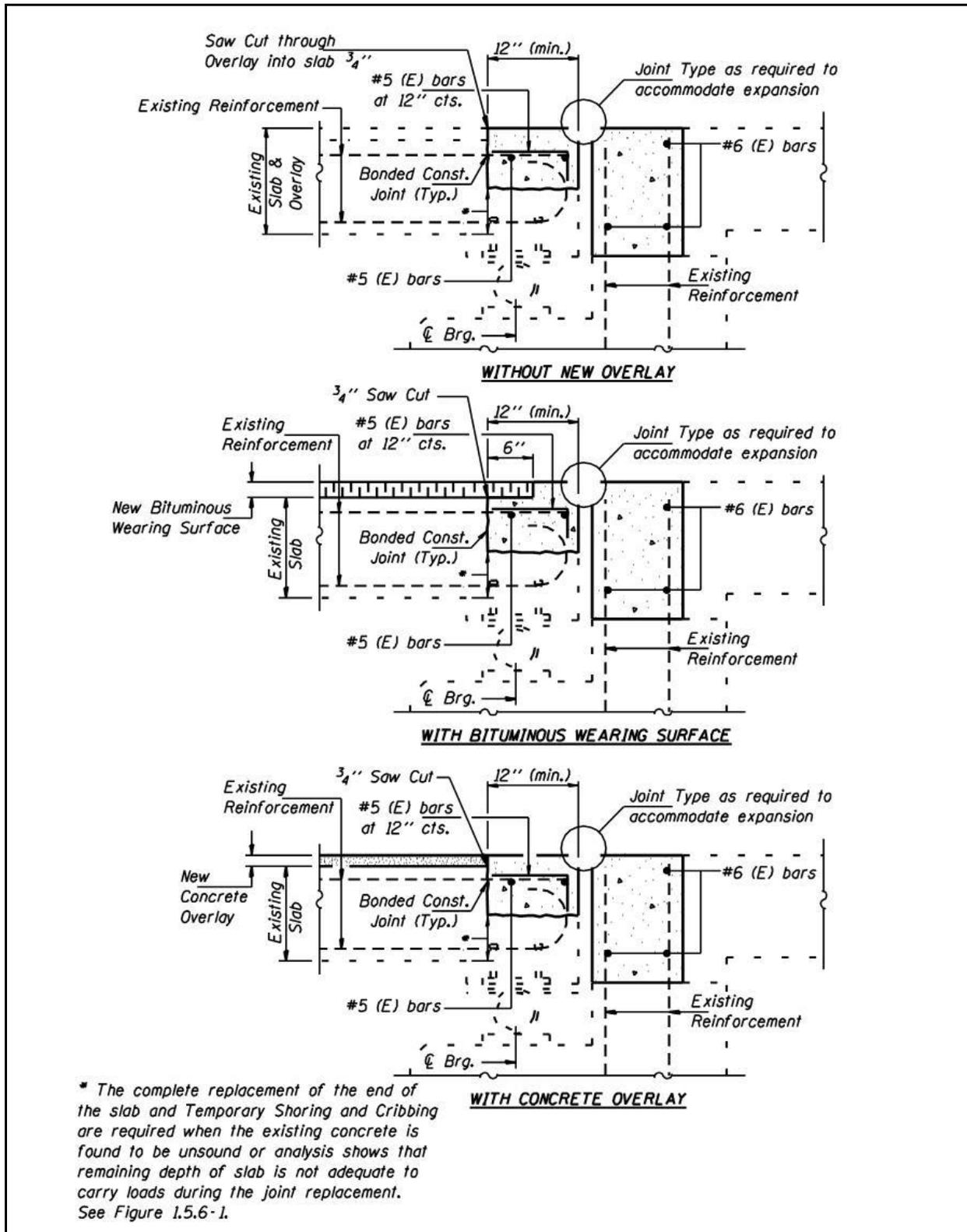


Figure 2.5-12 – Joint Reconstruction for R.C. Slab (Partial Removal)

2.5.7 Precast Prestressed Concrete Deck Beams

When replacing an expansion joint on a PPC deck beam bridge, the existing structure plans should be consulted to determine if the ends of the beams were originally fabricated with 9"x10" blockouts for the placement of cast-in-place concrete in the field during construction. If blockouts were provided, the original cast-in-place can be removed and replaced in conjunction with the expansion joint replacement as shown in [Figure 2.5-13](#). All existing reinforcement bars and anchorage devices within the existing blockout areas of PPC deck beams which extend into the precast concrete beam should be cleaned and incorporated into the new construction. The existing reinforcement bars placed parallel to the expansion joint in the area of the blockout should be removed and replaced with new reinforcement bars. If the existing PPC deck beams were not fabricated with blockouts, concrete removal should be limited in depth to the top layer of the existing reinforcement bars at the ends of the PPC deck beams.

When an existing bituminous concrete overlay is being replaced in-kind, the existing steel armoring elements cast into the beams should be reused as part of the new expansion joint details, as shown in [Figure 2.5-14](#). The details shown in [Figure 2.5-15](#) should be utilized to provide a modified armoring element for small preformed joint sealer type joints, when a new reinforced concrete overlay is placed on PPC deck beams. Occasionally, a neoprene expansion joint must be used in lieu of a preformed joint seal in order to accommodate the geometry encountered at an existing expansion joint.

When installing a neoprene expansion joint on an existing PPC deck beam, shimming is often necessary to place the top of the joint at the proper elevation relative to the roadway surface. This can be accomplished using a polymer concrete as the shimming material as shown in [Figure 2.5-16](#).

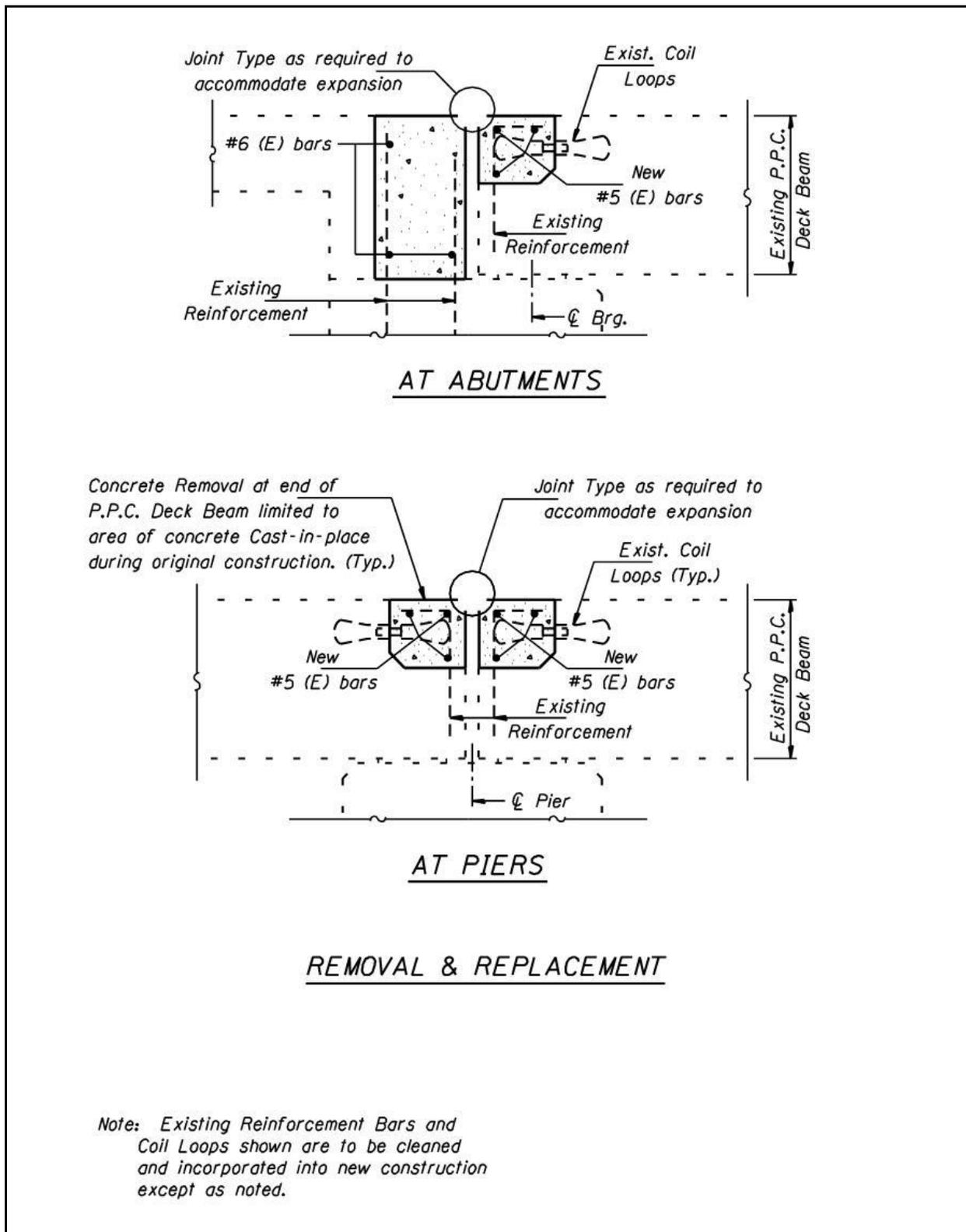


Figure 2.5-13 – PPC Deck Beam Joint Reconstruction (Blockout Removal)

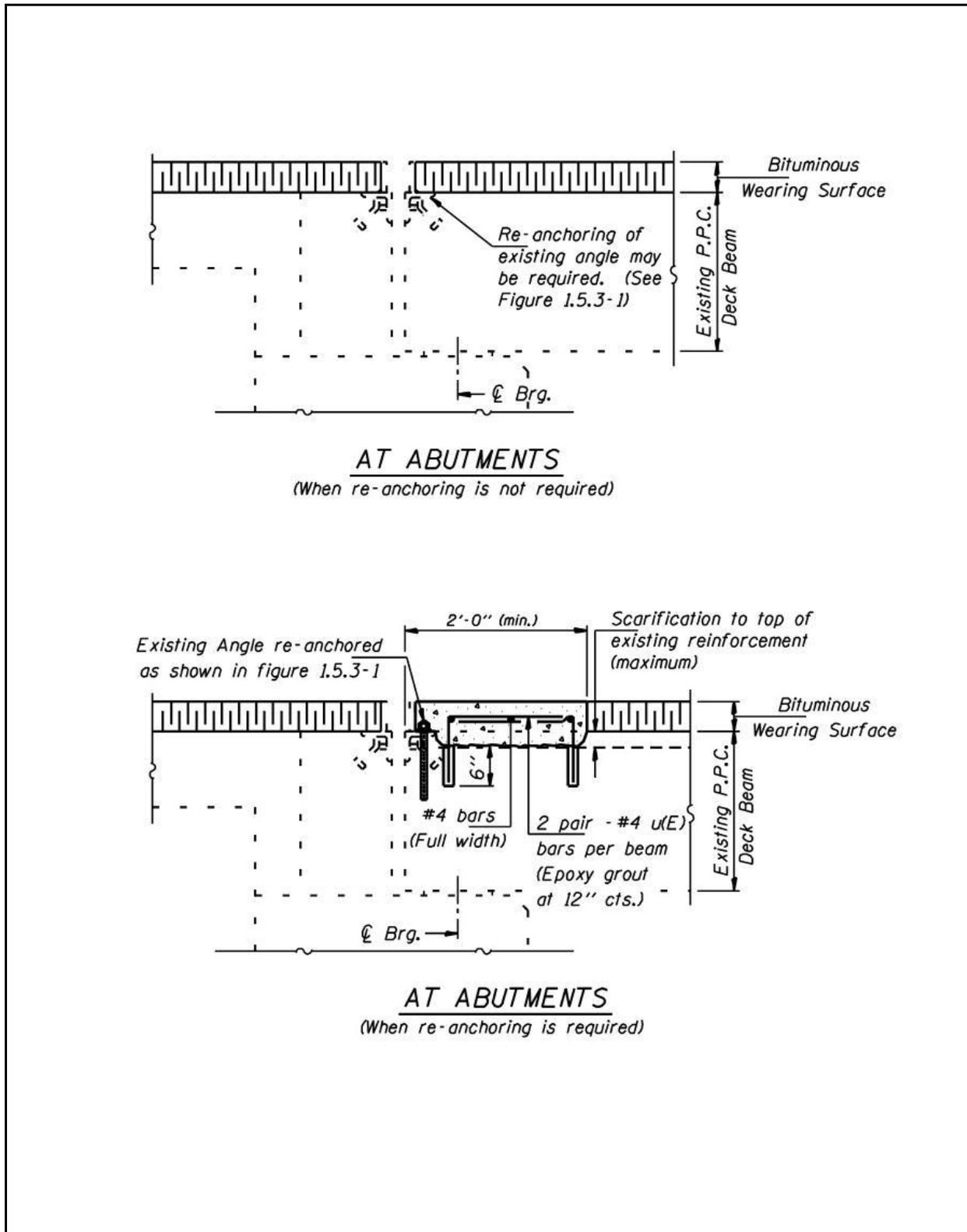


Figure 2.5-14 – PPC Deck Beam Joint Reconstruction

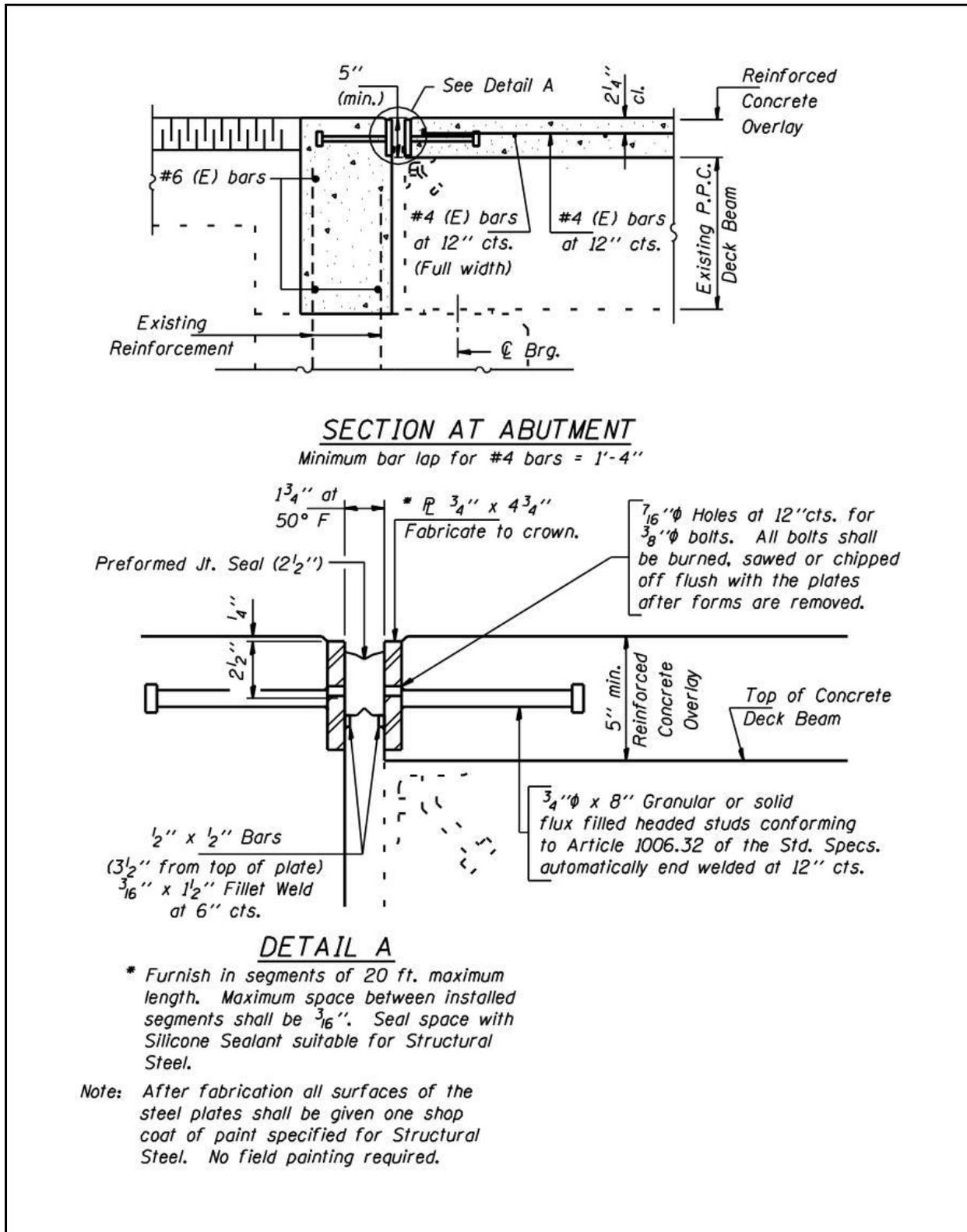


Figure 2.5-15 – PPC Deck Beam Expansion Joint Reconstruction with R.C. Overlay

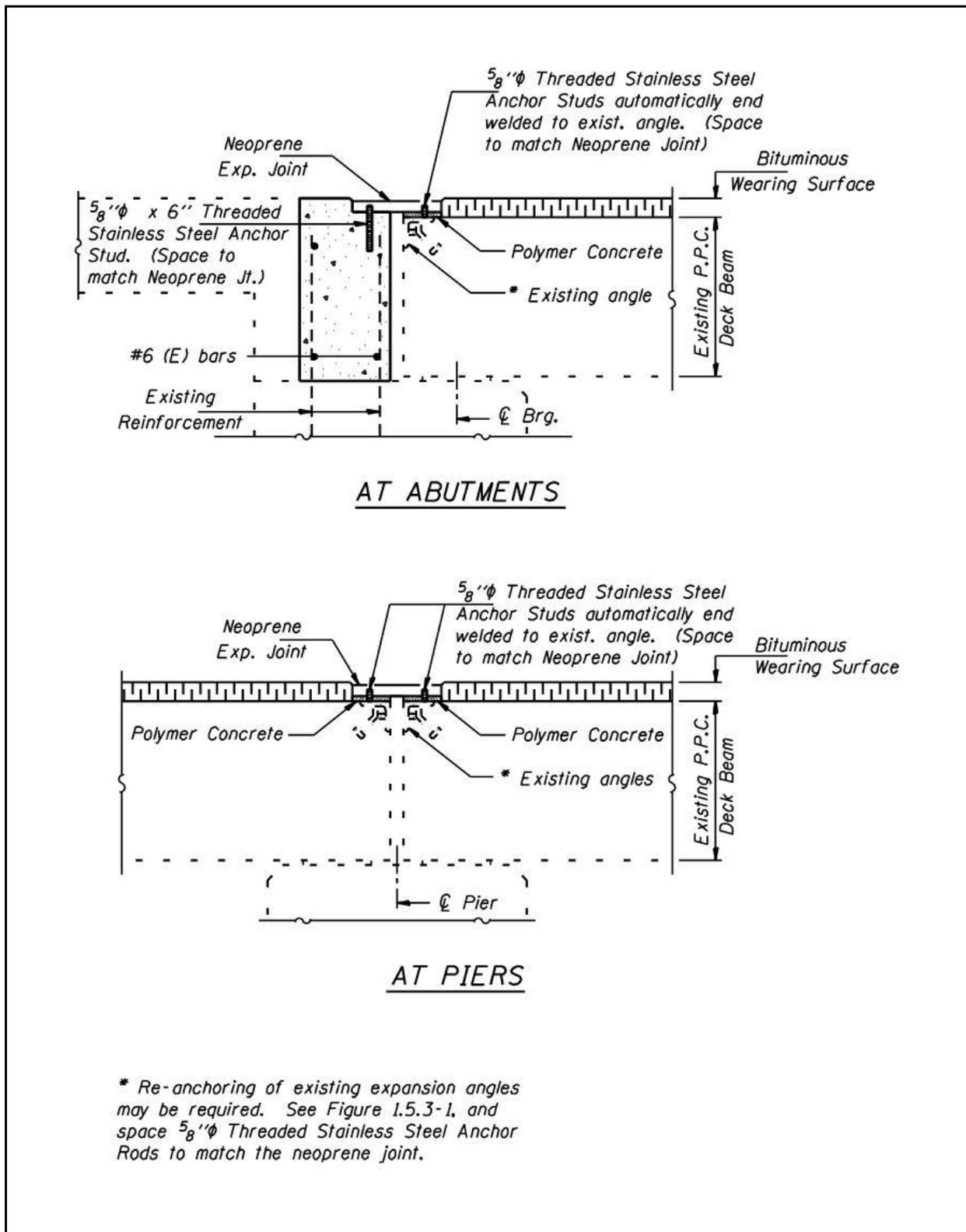


Figure 2.5-16 – PPC Deck Beam Joint Reconstruction (Neoprene)

2.5.8 Concrete Removal Limits and Reinforcement Bar Lapping

Regardless of the type of structure, expansion joint replacements should extend across the entire (out-to-out) width of the structure. The replacement joint should effectively seal the existing curb, sidewalk and parapet in a manner similar to new construction. Bonded construction joints should be provided between the existing concrete slab or beam and the replacement concrete.

An approved bar splicing device or anchorage system should be used to install new longitudinal reinforcement bars in deck slabs, slab bridges or new end block reinforcement in PPC deck beams, when the existing reinforcement bars do not extend a sufficient distance into the new construction or cannot be salvaged. Provisions should also be made for lapping or splicing reinforcement bars which extend across a stage construction joint.

Refer to [Figure 2.5-17](#) for a general illustration of concrete removal limits and reinforcement bar treatment requirements. A similar detail should be included in all repair plans for joint replacements.

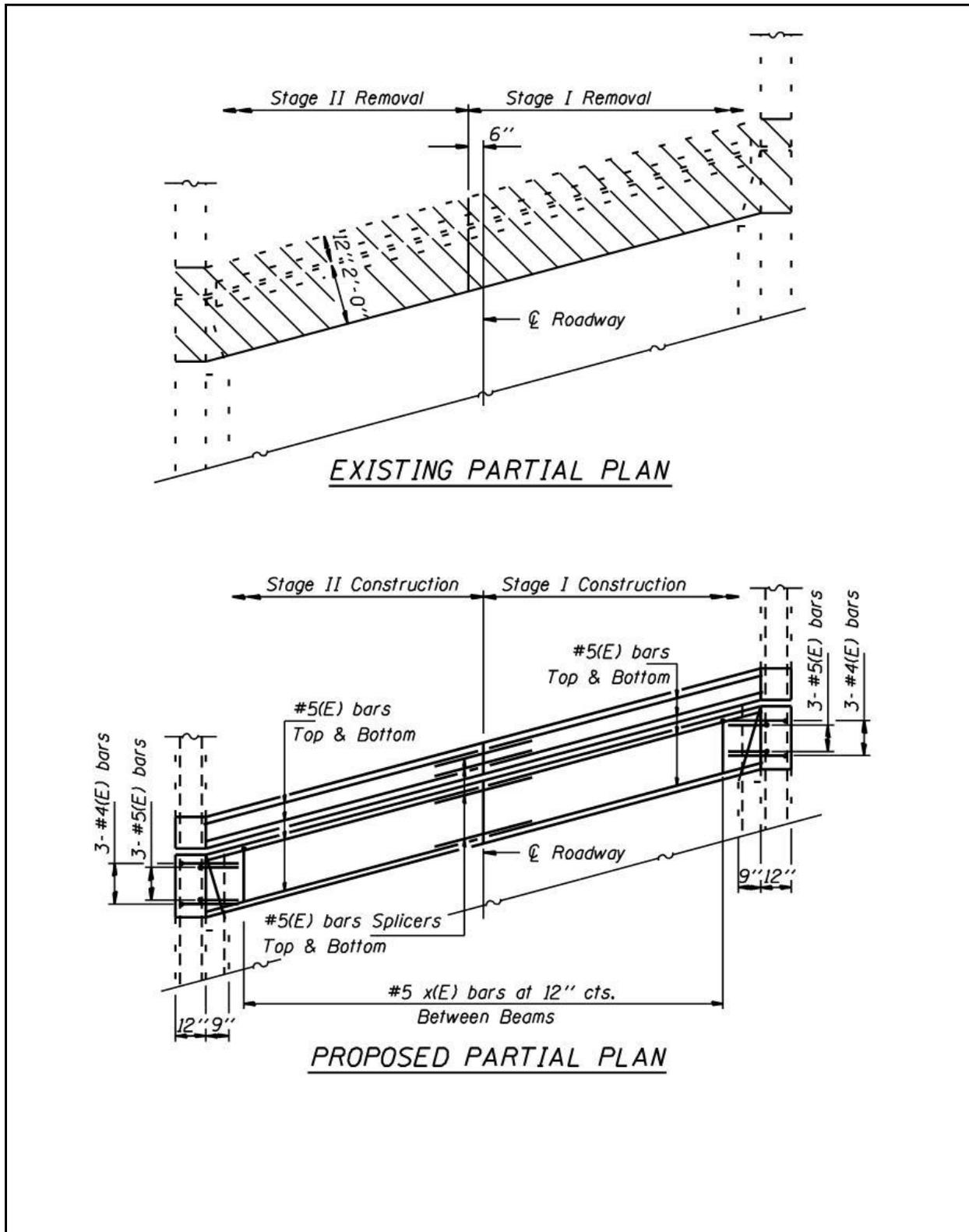


Figure 2.5-17 – Plan of Reconstruction

2.5.9 Steel Finger Plate Joint

When developing plans for the installation of steel finger plate joints, the information shown in the existing design plans and shop plans should be verified. Construction delays can occur when existing diaphragms or beam ends are found at different locations or elevations than those indicated by the existing plans. In order to avoid necessity to refabricate or redesign the joint during construction, the District should provide the engineer designing the joint with field measurements showing the location of the existing diaphragms, beam ends and bearings relative to the proposed joint opening and top of deck. [Figure 2.5-18](#) and [Figure 2.5-19](#) indicate typical dimensions which are critical for the accurate detailing of steel finger joint replacement plans. When the grade is raised at a finger plate expansion joint, the joint can be retrofitted as shown in [Figure 2.5-20](#).

A note should be added to the plans as follows: Tapered shims shall be added under the stools as required by the Engineer to make a smooth finger joint. Cost shall be included in the cost of "Furnishing and Erecting Structural Steel".

Concrete deck removal shall consist of 3'-6" minimum on each side of the centerline of the joint to allow room for the placement of the new finger plate and reinforcement bars.

2.5.10 Existing Neoprene Joint

When raising the grade at a neoprene expansion joint, the joint can be retrofitted as shown in [Figure 2.5-21](#). In these details the grade is raised by the thickness of the new bituminous wearing surface or concrete overlay.

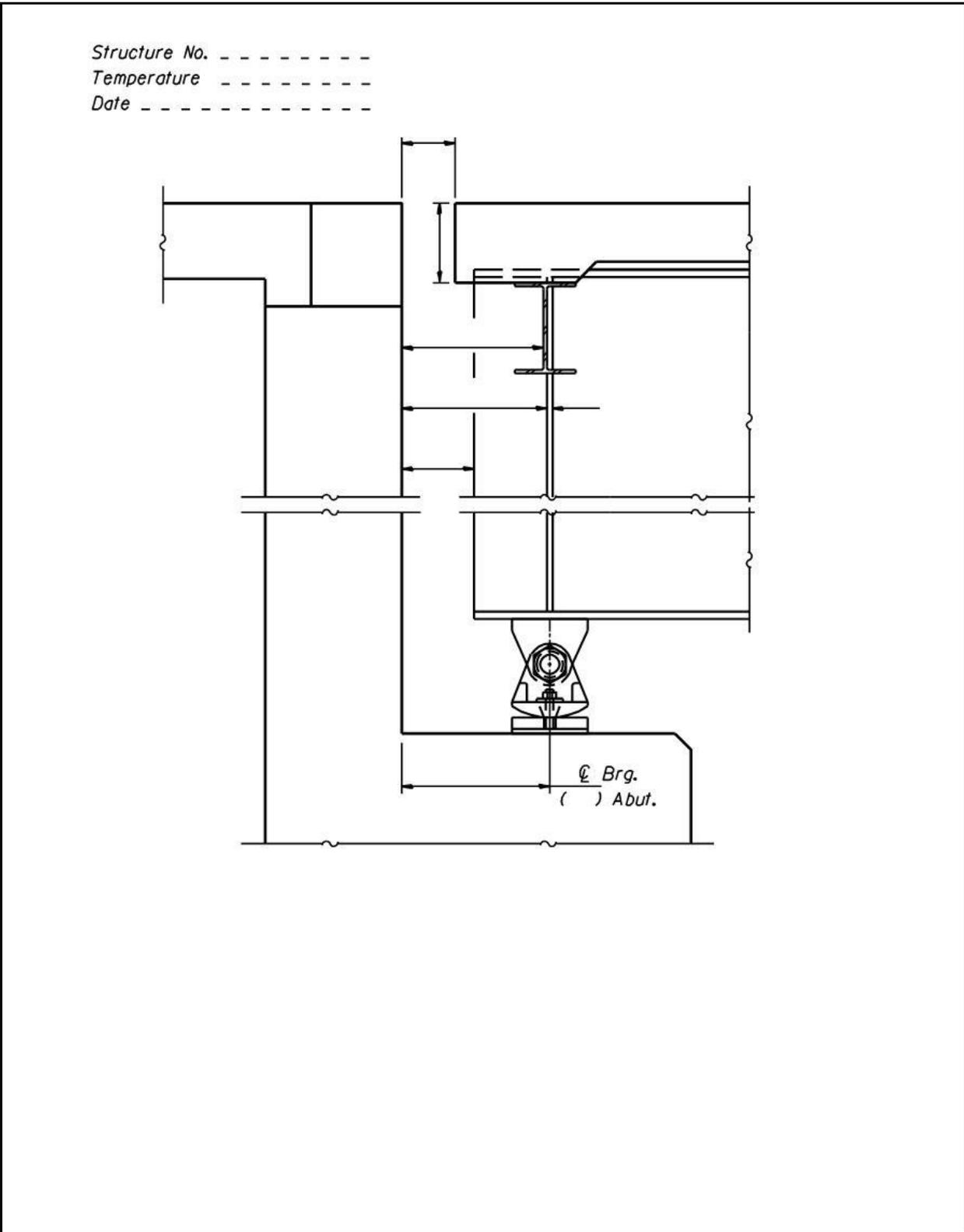


Figure 2.5-18 – Finger Joint Field Dimensions (At Abutment)

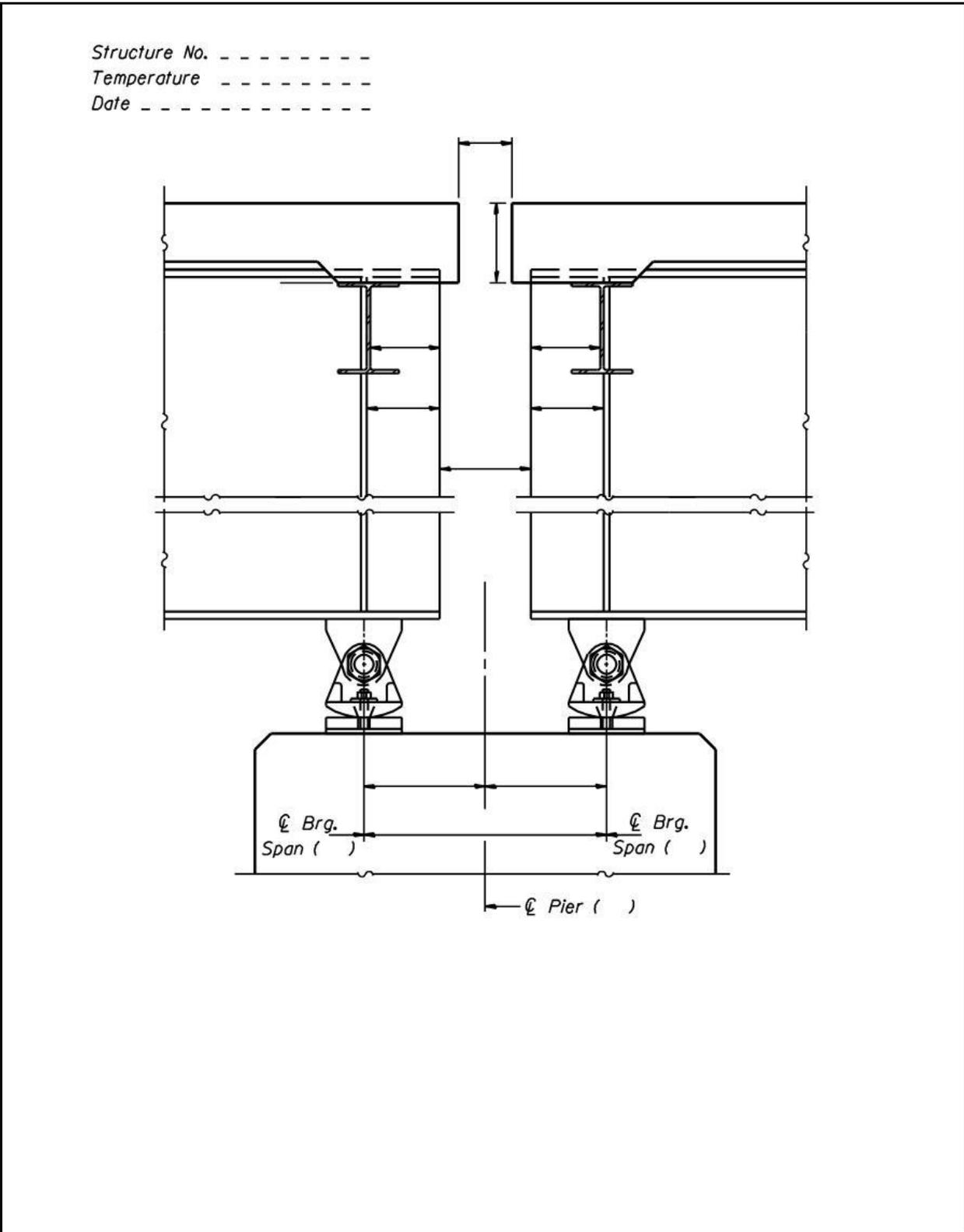


Figure 2.5-19 – Finger Joint Field Dimensions (At Pier)

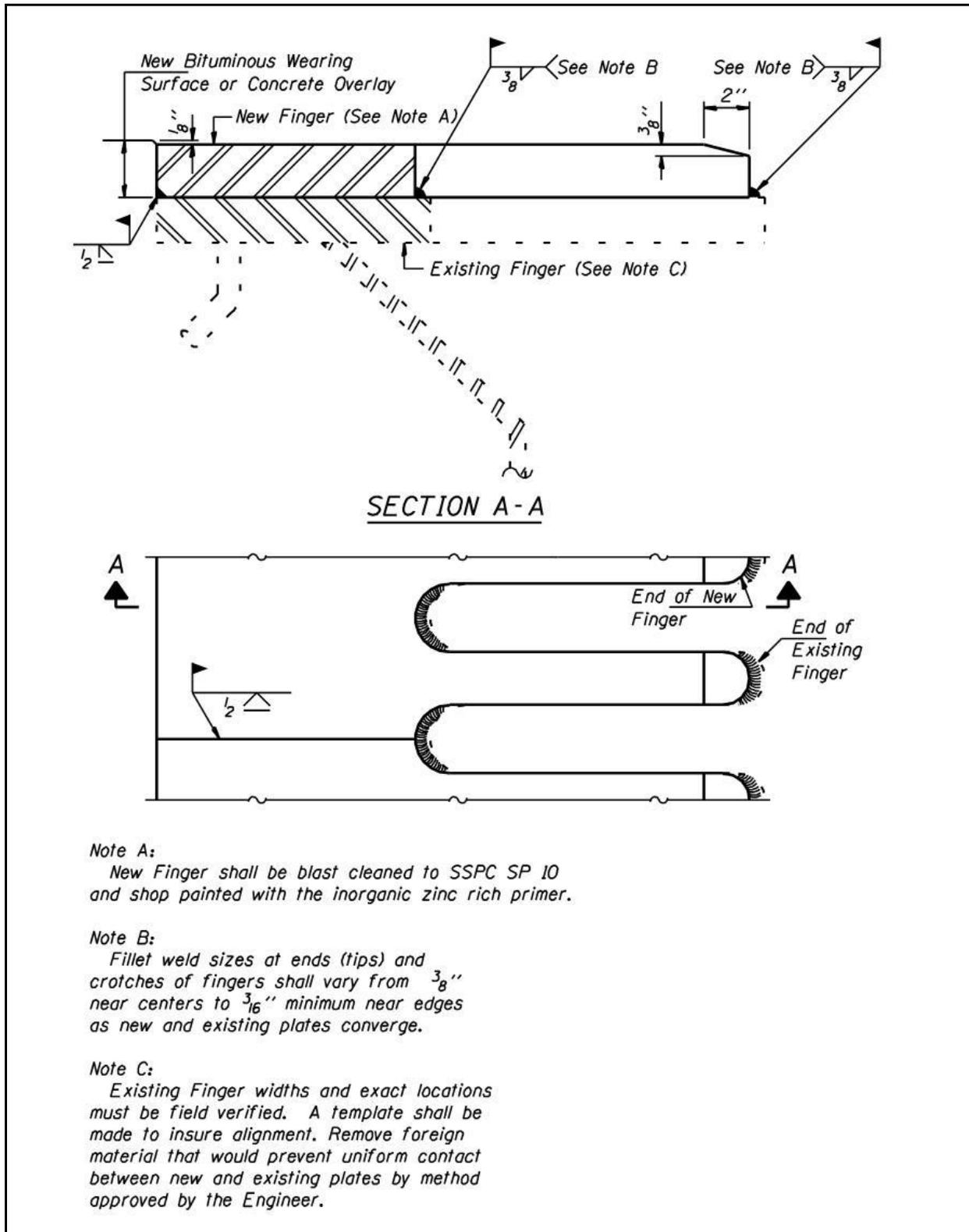


Figure 2.5-20 – Expansion Joint Treatment with Grade Raise and Existing Finger Plates

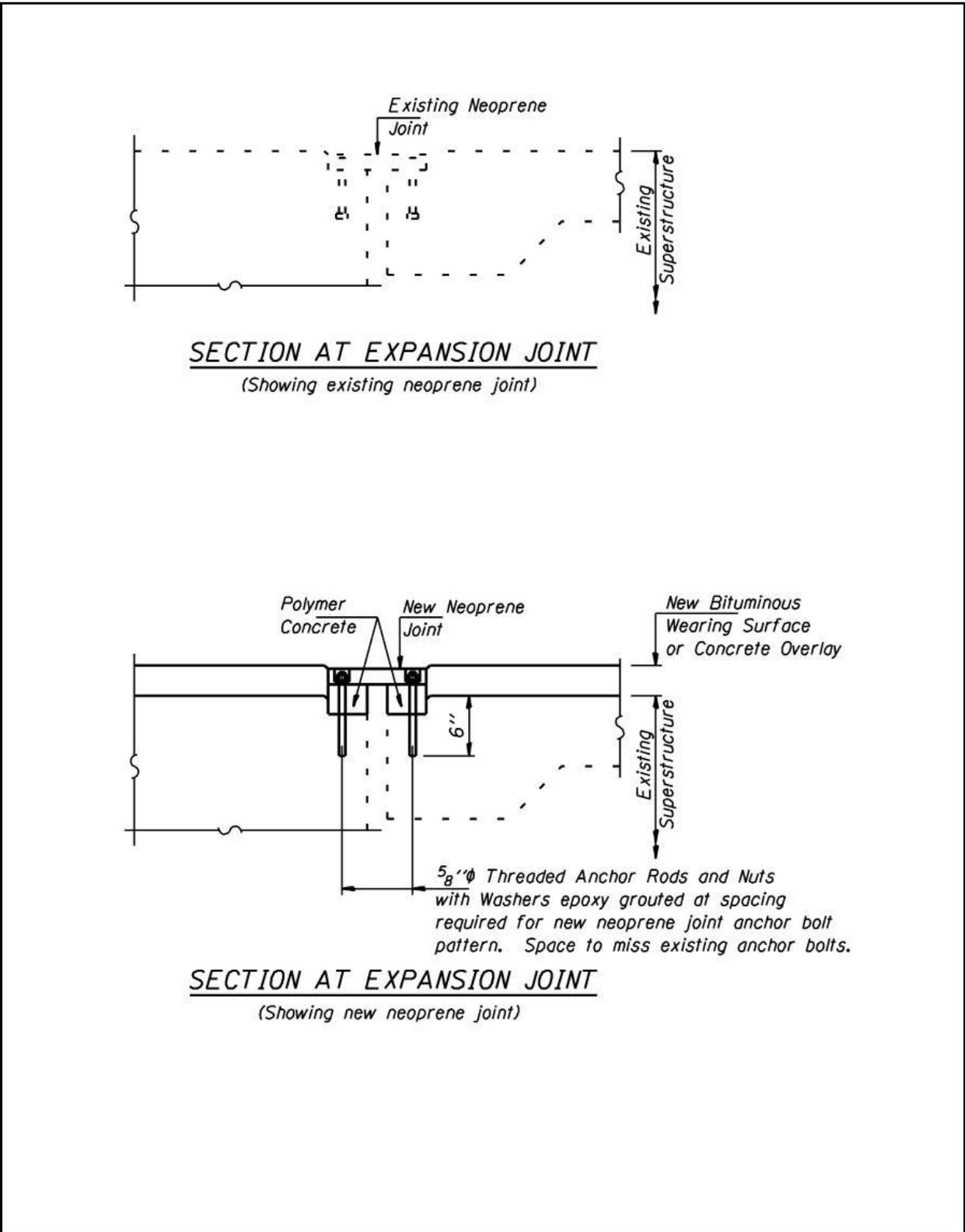


Figure 2.5-21 – Expansion Joint Treatment with Grade Raise and Existing Neoprene

2.6 Longitudinal Joint Closure

2.6.1 General

Maintaining an effective seal against the intrusion of water, chlorides and other contaminants through a leaking longitudinal deck joint is very difficult. The beams or girders supporting the deck are often adversely affected by moisture and deicing agents passing through poorly sealed longitudinal joints. One solution to the problem of a leaking longitudinal joint is the removal of the existing joint seal along with a portion of the adjacent concrete deck and the construction of a new segment of continuous reinforced concrete deck (without a sealed longitudinal joint). This method of eliminating the leaking longitudinal joints can be applied to all concrete superstructures with out-to-out deck width of 90 feet or less. The Bureau of Bridges & Structures should be consulted when considering the closure of an existing longitudinal joint on a superstructure with an out-to-out of deck width greater than 90 feet.

2.6.2 Concrete Removal Limits

The width of the existing deck to be removed will depend on the distance between the beams or girders adjacent to the joint. The width of the removal of the existing concrete deck should be limited so that the deck removal does not extend beyond the centerline of the adjacent beam or girder. When the existing superstructure is a reinforced concrete deck girder, the removal should not extend beyond the stirrup reinforcement bars of the girder adjacent to the existing longitudinal joint. When shear stud connectors are present on the existing beams or girders, the limits of removal should be adjusted so that the remaining and new concrete will adequately encase the shear studs. These requirements are illustrated in [Figure 2.6-1](#). When the existing superstructure is a reinforced concrete slab bridge, removal of the edge beam at the longitudinal joint will require temporary shoring and cribbing at the expansion bents if the slab was supported on bearings.

Bonded construction joints should be specified for the joints between the existing concrete deck and the new construction. When a bituminous concrete surface and waterproofing membrane system will be placed on the deck, the waterproofing membrane should extend a minimum of 6 inches across the construction joint in the deck.

2.6.3 Reinforcement Bar Treatment

The length of existing transverse reinforcement exposed by the deck removal should be checked to determine if it can be lapped with the new transverse reinforcement bars sufficiently to develop the capacity of the reinforcement bar. When deck removal is limited and the transverse reinforcement bars cannot be lapped to develop the full reinforcement bar capacity, the new bottom transverse reinforcement bars should be hooked at each end.

All exposed existing longitudinal reinforcement bars should be removed and replaced. Existing transverse reinforcement bars should remain in place and should be cleaned and incorporated into the new construction. All new reinforcement bars should be epoxy coated. The typical features to be incorporated in a longitudinal joint closure are shown in [Figure 2.6-2](#), [Figure 2.6-3](#), and [Figure 2.6-4](#) for a project without an existing deck overlay, with an existing bituminous concrete overlay and with a proposed overlay respectively. [Figure 2.6-5](#) shows a longitudinal joint closure for a reinforced concrete girder bridge with an overlay.

For a reinforced concrete slab bridge, new longitudinal reinforcement should be added to match the size and spacing of the reinforcement of the existing slab section adjacent to the edge beam being removed. See [Figure 2.6-6](#).

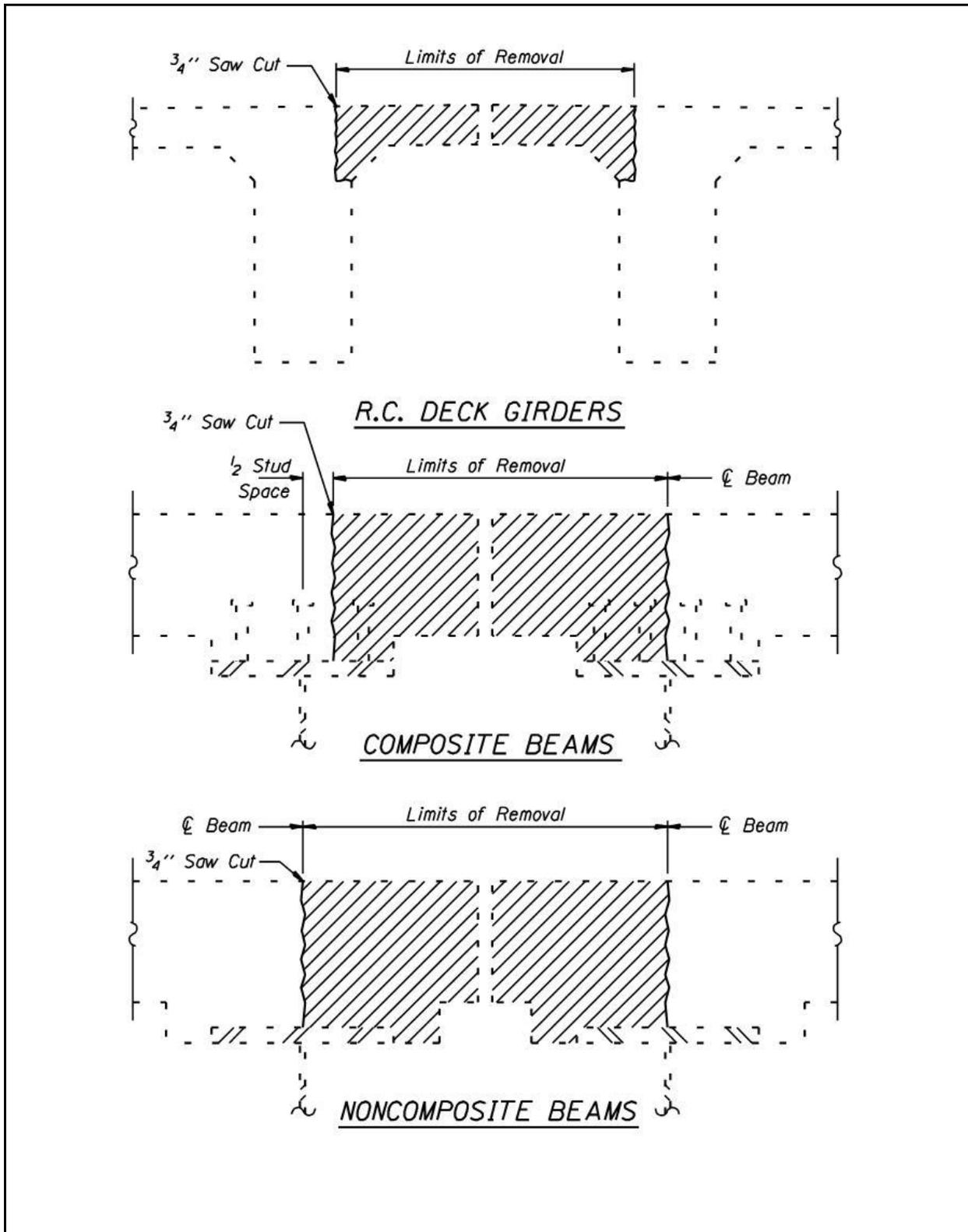


Figure 2.6-1 – Longitudinal Joint Removal Limits

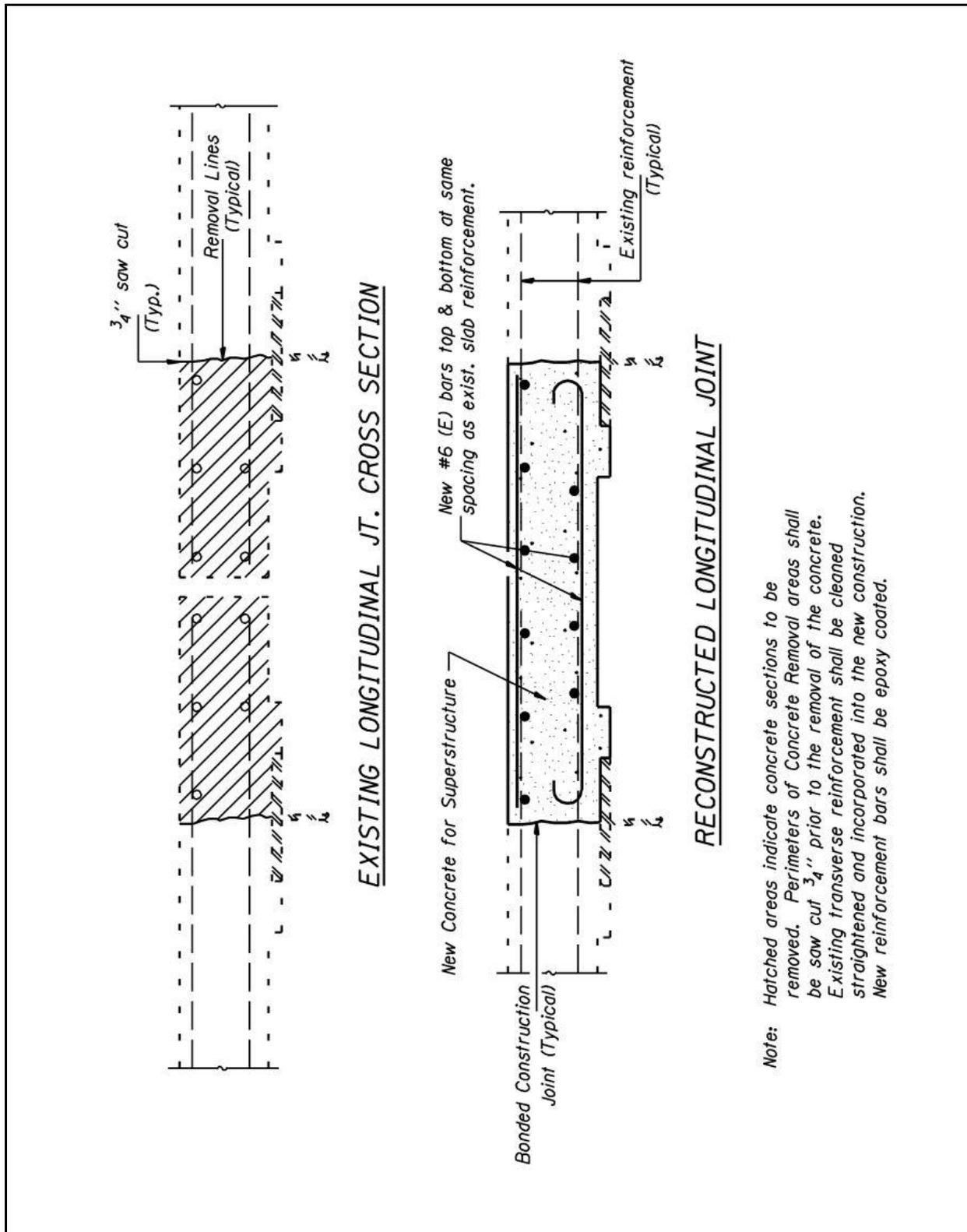


Figure 2.6-2 – Longitudinal Joint Reconstruction Without Overlay

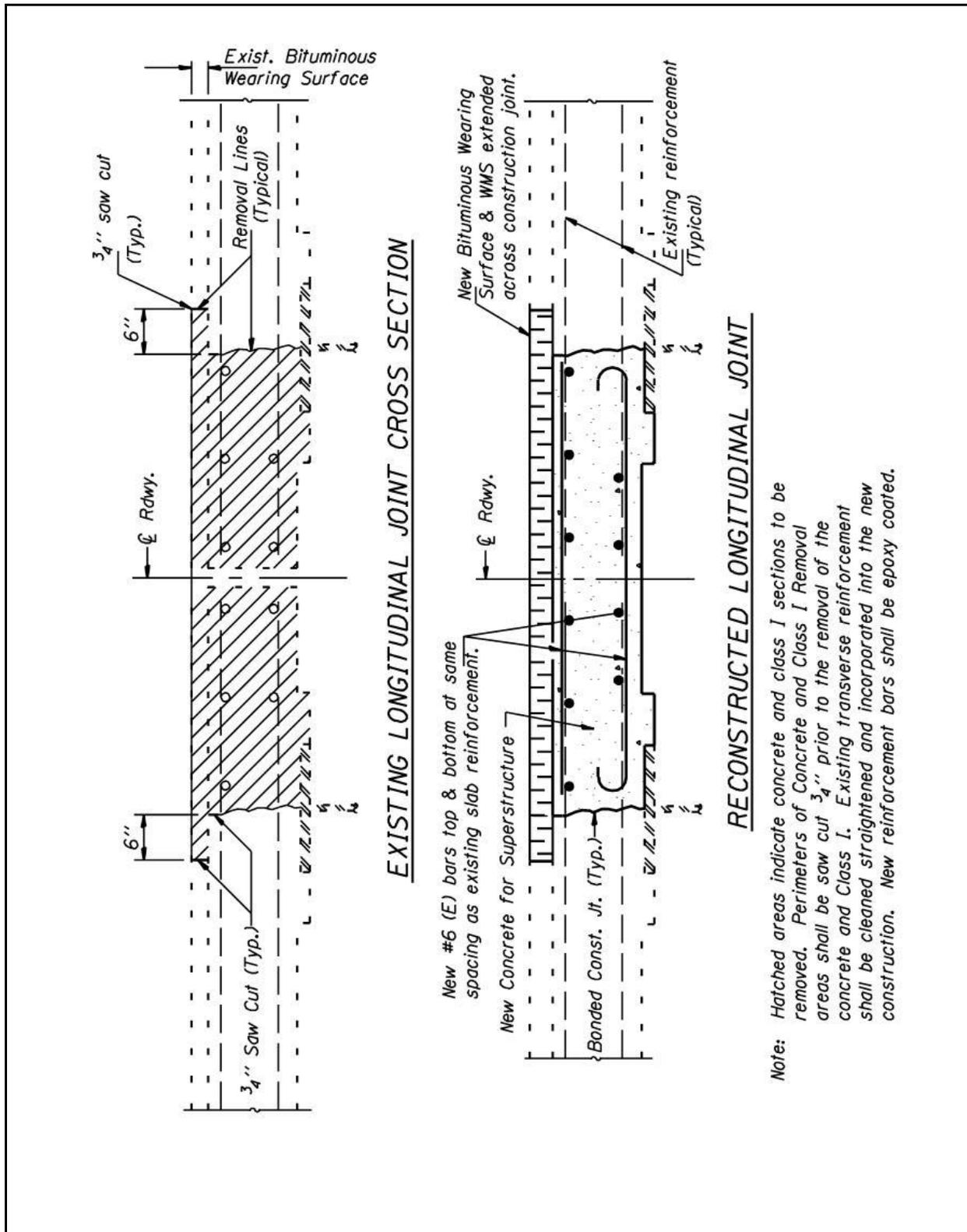


Figure 2.6-3 – Longitudinal Joint Reconstruction with Existing Bituminous Overlay

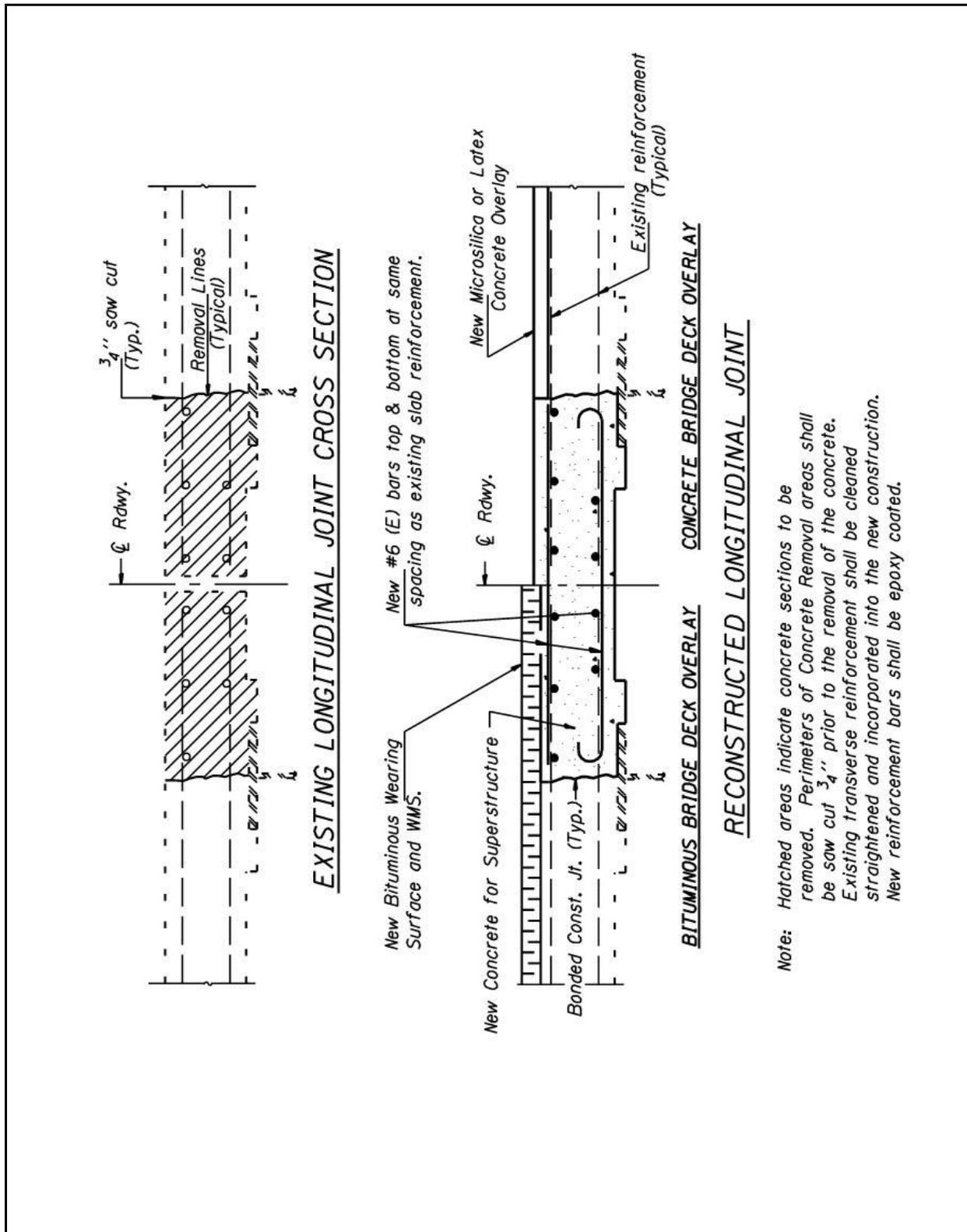


Figure 2.6-4 – Longitudinal Joint Reconstruction with New Overlay

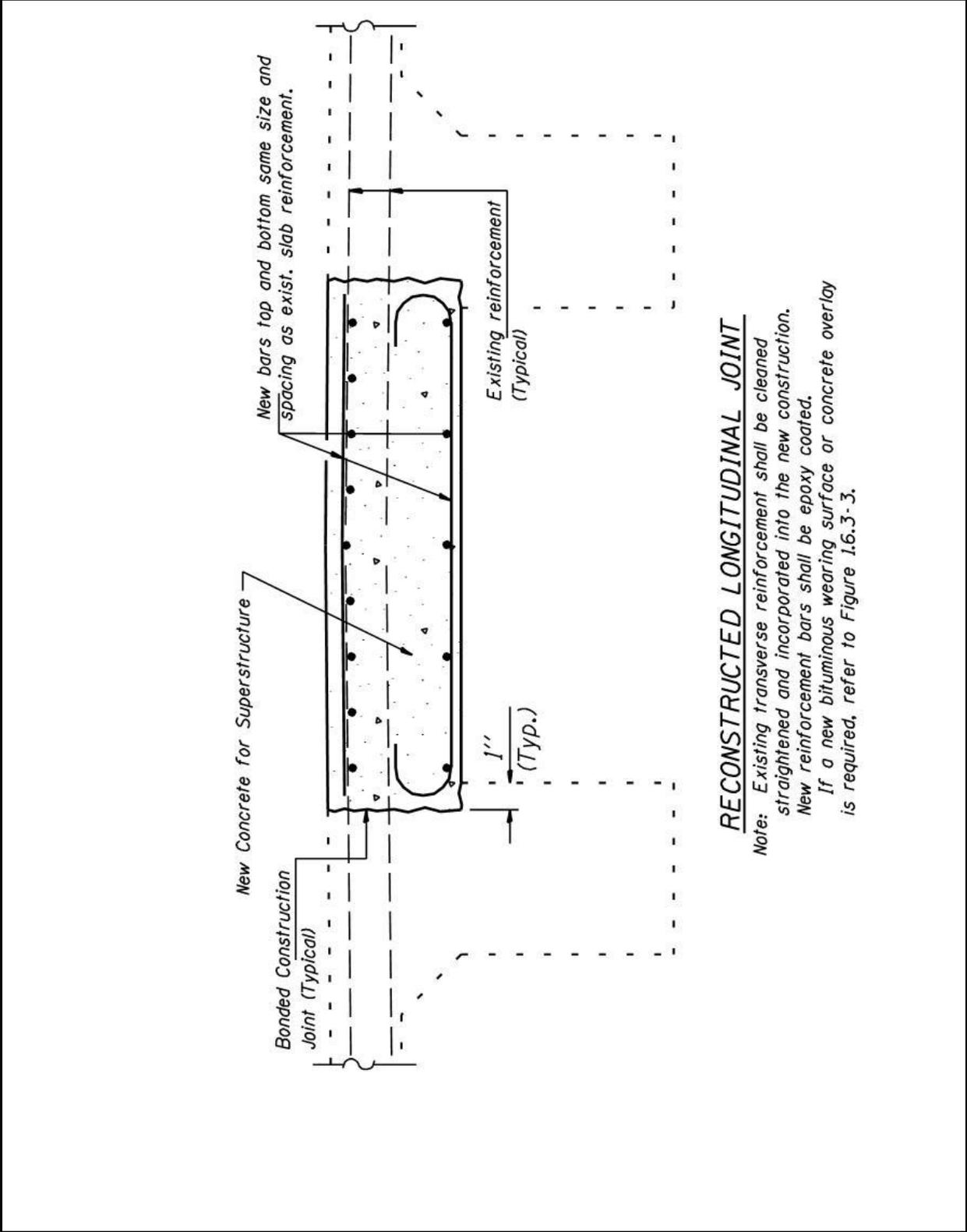


Figure 2.6-5 – Longitudinal Joint Reconstruction with R.C. Deck Girders

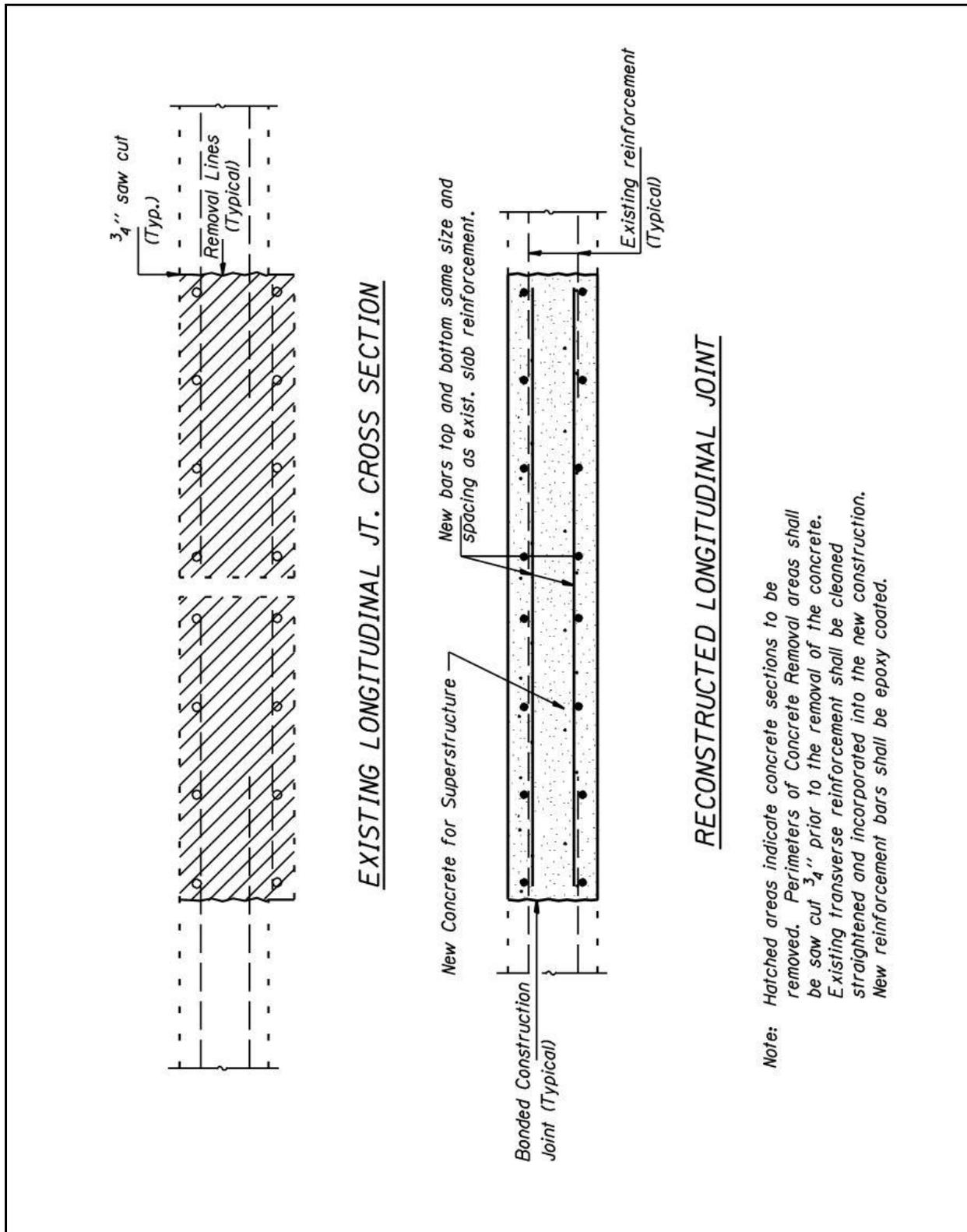


Figure 2.6-6 – Longitudinal Joint Reconstruction with R.C. Slab

2.6.4 Diaphragms / Crossframes

Diaphragms or crossframes should be installed, when not already in place, between existing steel beams or girders adjacent to the existing longitudinal joint being closed, except that end diaphragms and diaphragms directly over interior piers are not required. When the distance between the beams adjacent to the longitudinal joint is 4 feet or less and traffic on the deck will be far enough away from the longitudinal joint so as not to cause excessive differential live load deflection in the beams during the joint reconstruction, the installation of diaphragms is not required. To ensure a minimum amount of live load deflection in beams without diaphragms adjacent to longitudinal joints, traffic should be kept at least three beam spaces away from the beams adjacent to the longitudinal joint during placement and curing of the closure slab.

The diaphragms or crossframes and their connections should be detailed to account for the installation difficulties presented by small beam or girder spacing and dimensional variations for existing members typically encountered. This typically requires that end attachment angles be field bolted to the diaphragm using slotted or oversized holes during installation and that the flanges of the diaphragms be clipped to allow them to be swung into place between the existing beams. Place proposed diaphragms midway between existing diaphragms whenever possible, however locate diaphragms midway between existing splice plates. If a small skew does not permit midway placement, locate the proposed diaphragms approximately one foot from the centerline of one of the existing diaphragms.

2.7 Bridge Rails and Parapets

2.7.1 Project Requirements

Bridge rails and parapets on structures to be repaired using Federal or State Funds should be repaired or retrofitted as required by the IDOT *Guidelines for Bridge Deck Repair Projects*. For structures being repaired using Maintenance Funds, damaged portions of the existing bridge rail or parapet should be repaired and consideration should be given to installing a crash tested replacement rail on structures with bridge rails which do not meet the current geometric or structural requirements for vehicle induced loadings.

All replacement rails on projects to be implemented using Maintenance Funds must be designed to withstand the lateral loads specified in the current edition of the AASHTO *Standard Specifications for Highway Bridges*.

2.7.2 Rail Retrofit on PPC Deck Beams

When a reinforced concrete overlay is placed on a PPC Deck Beam superstructure, the existing bridge rail is often replaced to conform with current bridge rail geometric and structural requirements. A new bridge rail, conforming with current design policies, can be attached to an overlaid PPC Deck Beam superstructure as shown in [Figure 2.7-1](#) or [Figure 2.7-2](#).

2.7.3 Rail Replacement on Trusses

Attaching a new bridge rail to an existing truss is often done to eliminate an existing damaged or structurally deficient bridge rail. Whenever possible, the post spacing of the new bridge rail should be adjacent to avoid attaching the new rail posts to the truss members. General details of the procedure are shown in [Figure 2.7-3](#) and [Figure 2.7-4](#).

2.7.4 Concrete Parapet Extensions

Existing concrete parapets are often reconstructed to meet current design requirements or to eliminate existing aluminum rail elements. This usually involves the removal of existing aluminum rail sections from the top of an existing parapet and the addition of a section of concrete parapet to the top of the existing parapet. The section of parapet added can be cast-in-place or precast as shown in [Figure 2.7-5](#) and [Figure 2.7-6](#) respectively.

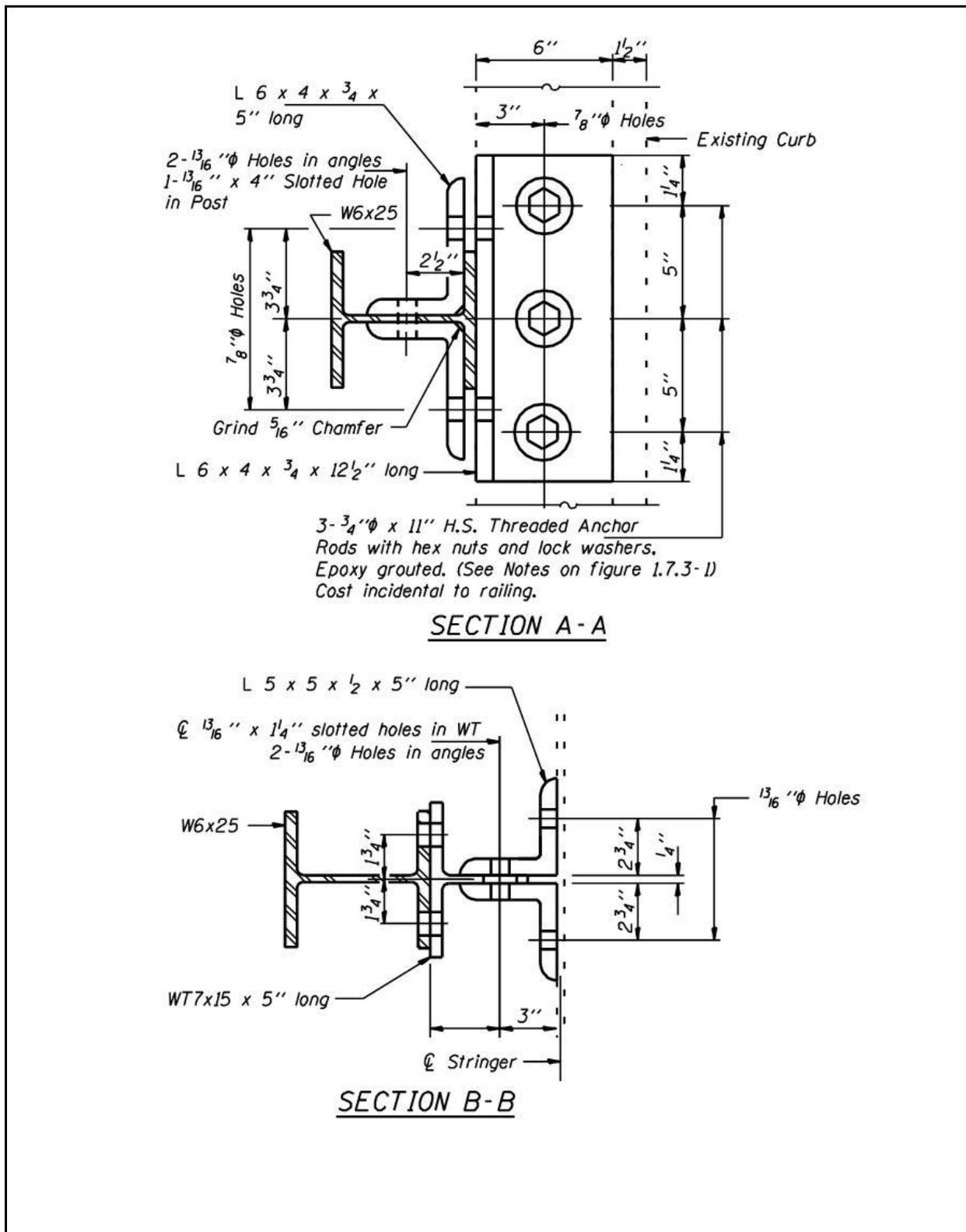


Figure 2.7-4 – Truss Rail Replacement

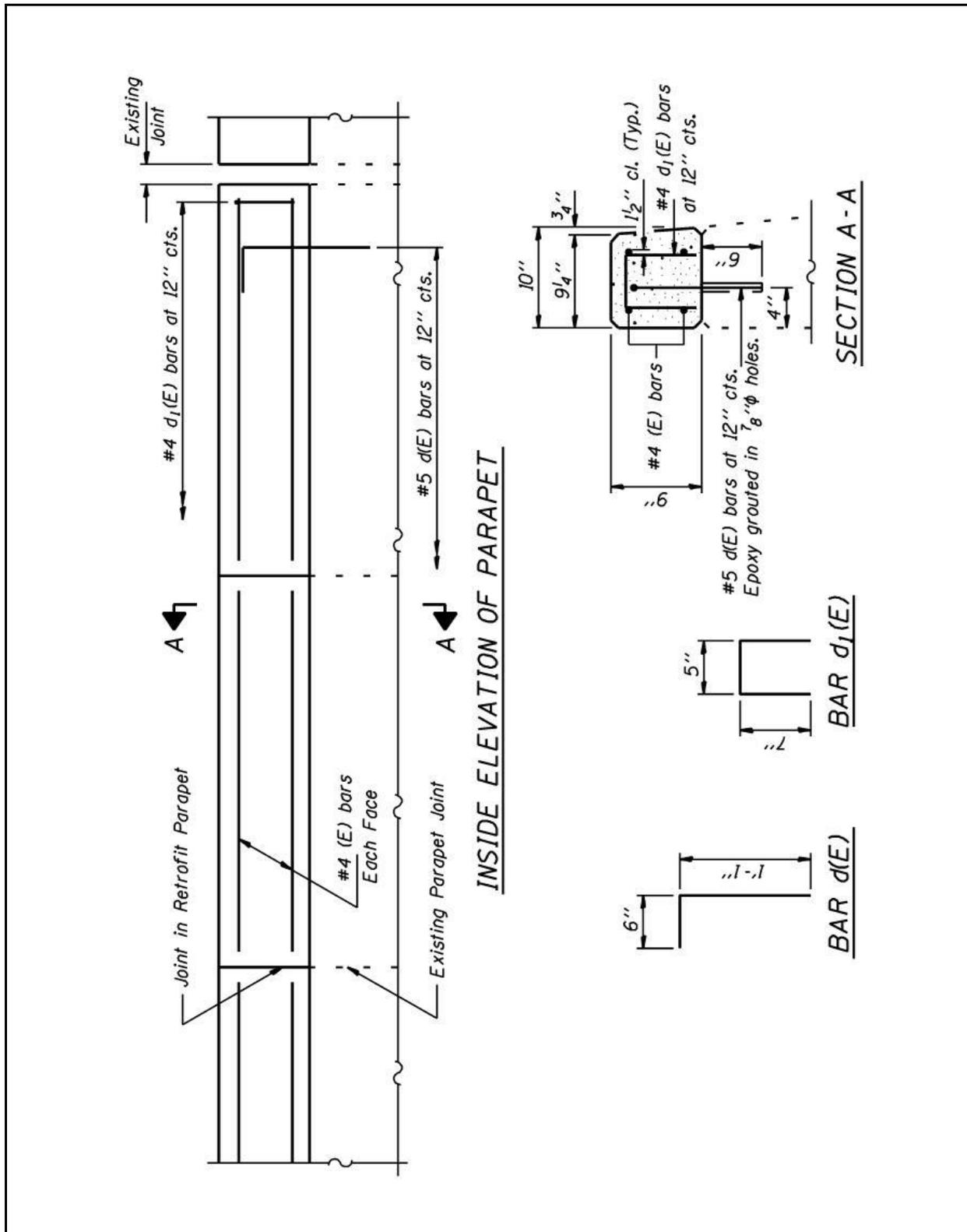


Figure 2.7-5 – Concrete Parapet Extension (Cast in Place)

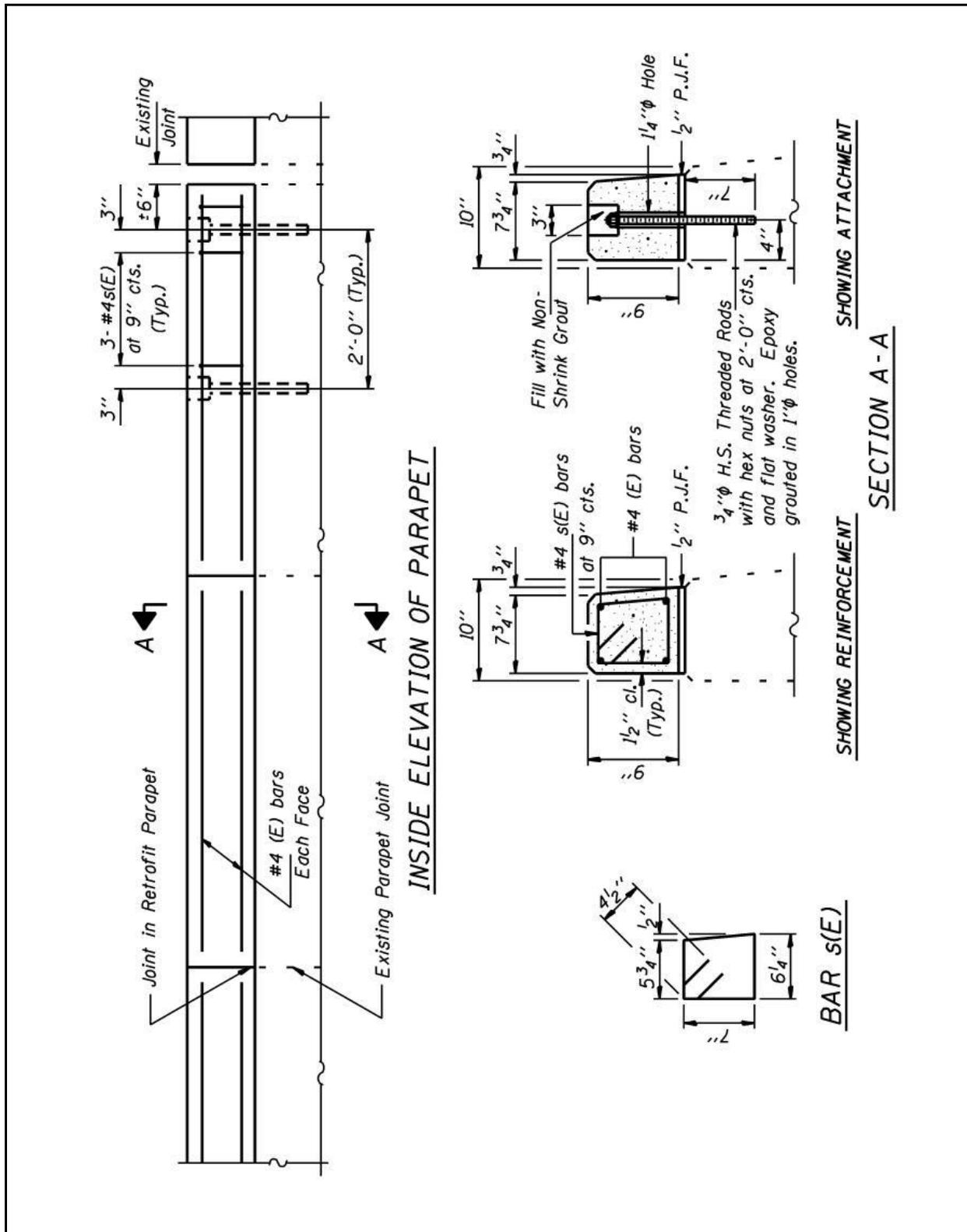


Figure 2.7-6 – Concrete Parapet Extension (Precast)

2.7.5 Parapet Repairs

When repairing a section of parapet damaged by a vehicle impact or natural deterioration, the following procedures should be used:

1. Extend the concrete removal for the repair to an existing parapet joint whenever possible or saw cut the perimeter of the damaged area 3/4 inch deep.
2. Salvage, clean and incorporate all existing vertical reinforcement bars into the new construction.
3. Remove and replace all existing horizontal reinforcement bars in the area of concrete removal when a significant length of the bars has been exposed and there is a probability that the bars will be damaged during the concrete removal operations.
4. Except at existing parapet joints, new horizontal reinforcement bars should be lapped with existing horizontal reinforcement bars sufficiently to develop the strength of the bar and bonded construction joints should be specified for the contact area between the new concrete and the existing parapet.
5. Existing parapet joint spacing and features should be utilized in the repair.

See [Figure 2.7-7](#) for parapet repair details.

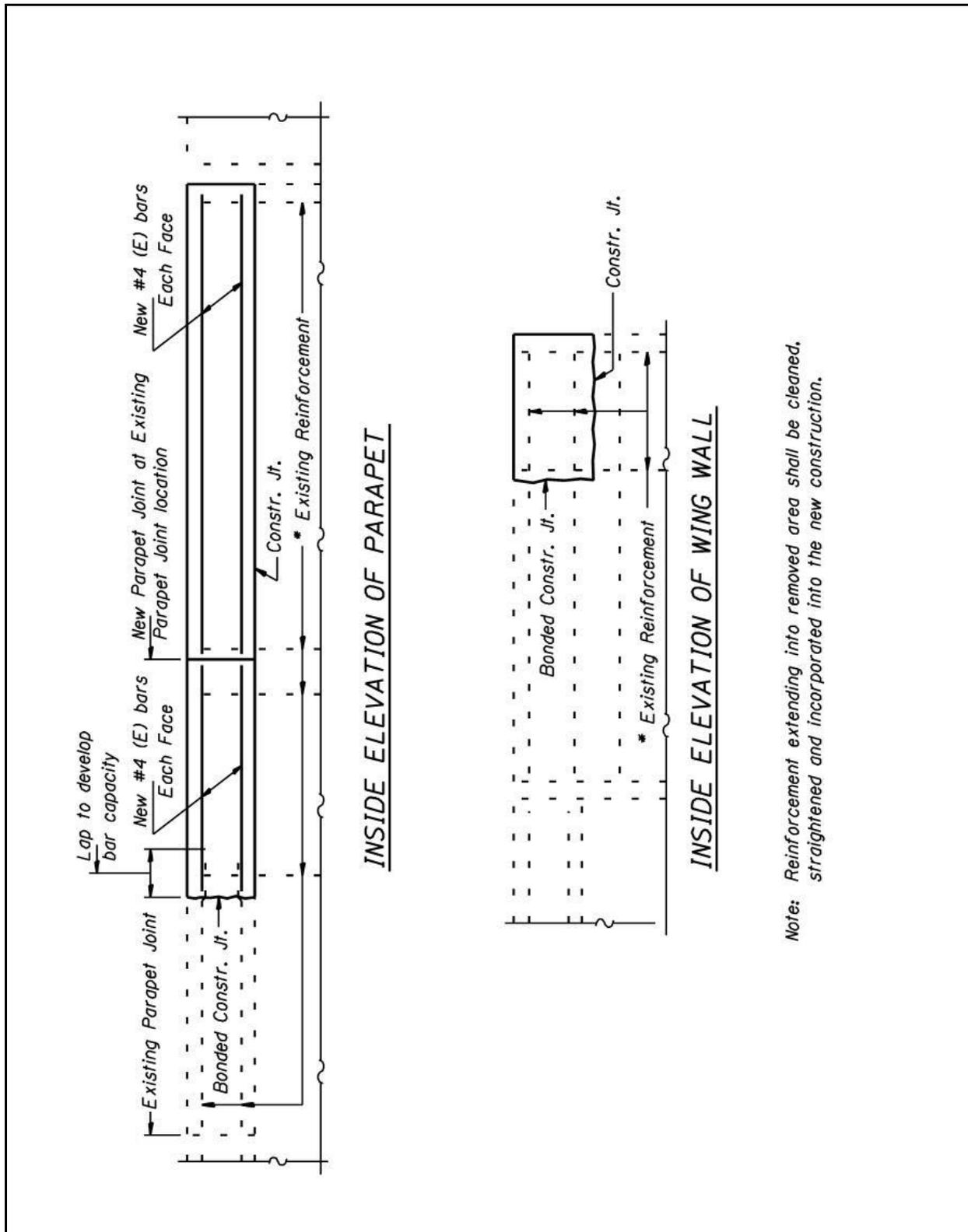


Figure 2.7-7 – Parapet and Wing Wall Repair Details

2.8 Deck Drains

2.8.1 General

Many existing structures were constructed with deck drains which direct drainage in to the main load carrying members of the superstructure or onto the substructure units. Also, the number of deck drains present on many existing structures greatly exceeds the number of drains necessary to adequately control the ponding of water on the deck surface. Repair plans for major maintenance projects on the deck surface of a structure, such as overlay projects, should contain details to provide for the adjustment or elimination of existing deck drains. Also, when the low point of a vertical sag curve is located on the structure and there is no existing drainage scupper at the low point, major deck maintenance projects should provide for the installation of a drainage scupper.

2.8.2 Drain Extensions

When existing deck drains are to remain in place, adjustments must be made to prevent the discharge of deck drainage onto the superstructure. Existing aluminum drains may be extended using bent aluminum sheets as shown in [Figure 2.8-1](#) or an aluminum extrusion as shown in [Figure 2.8-2](#).

When the existing drain consists of a formed opening in the concrete deck, an aluminum drain can be fabricated and attached to the existing deck and beam as shown in [Figure 2.8-3](#). When the existing aluminum drain extends horizontally through the curb, as is often the case with PPC deck beam superstructures, the details shown in [Figure 2.8-4](#) may be utilized to prevent drainage onto the side of the fascia beam.

Deck drains should always be extended to a point at least 3 inches below the bottom of the beam or girder. Drain extensions on bridges where the extensions will be directly visible to the travelling public should be painted to match the color of the fascia beam or girder. The method of painting should be as described for deck drains in the IDOT *Precast Prestressed Concrete Design Manual* and the Design Section of the IDOT *Bridge Manual*.

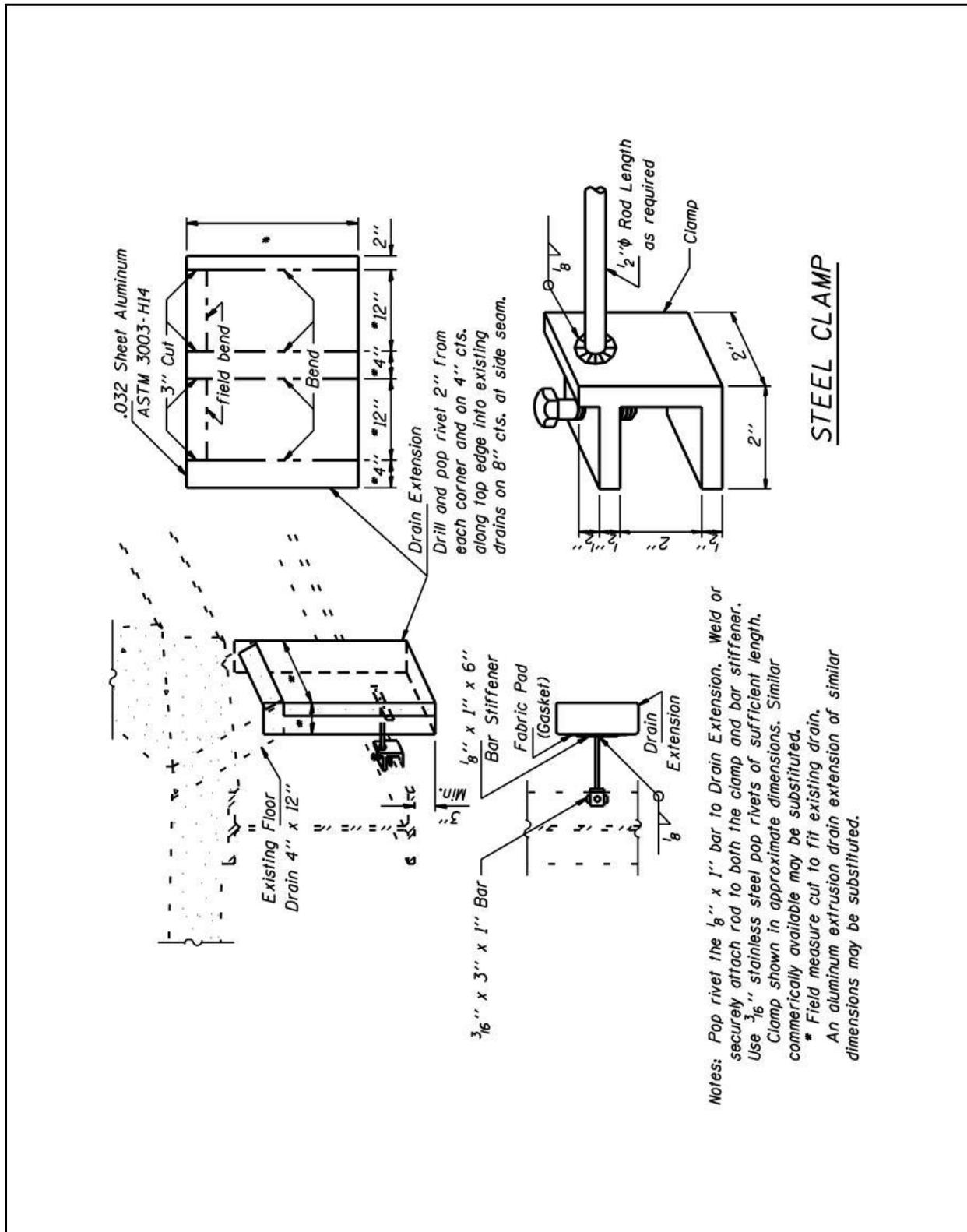


Figure 2.8-1 – Drain Extension Detail

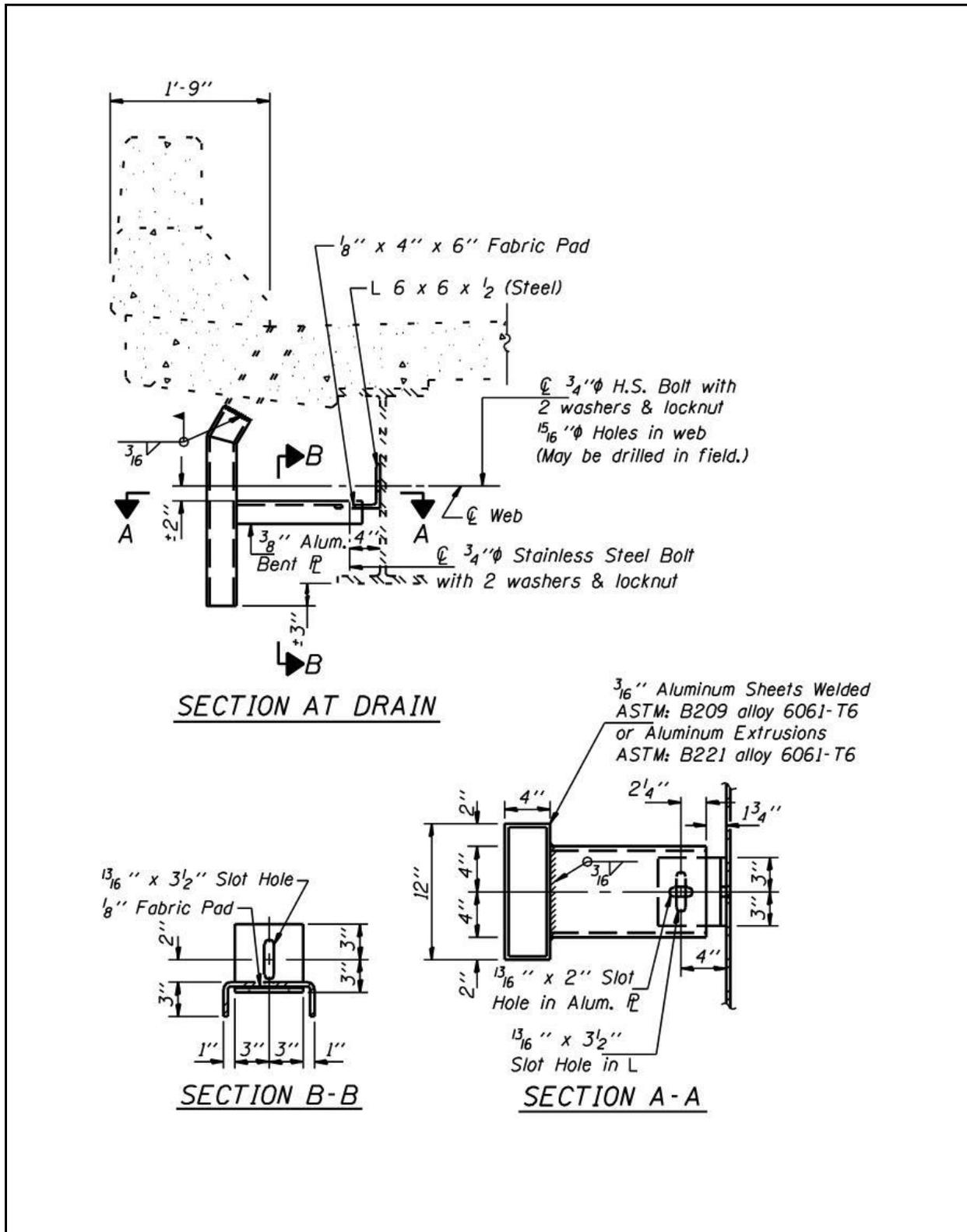


Figure 2.8-2 – Drain Extension Detail

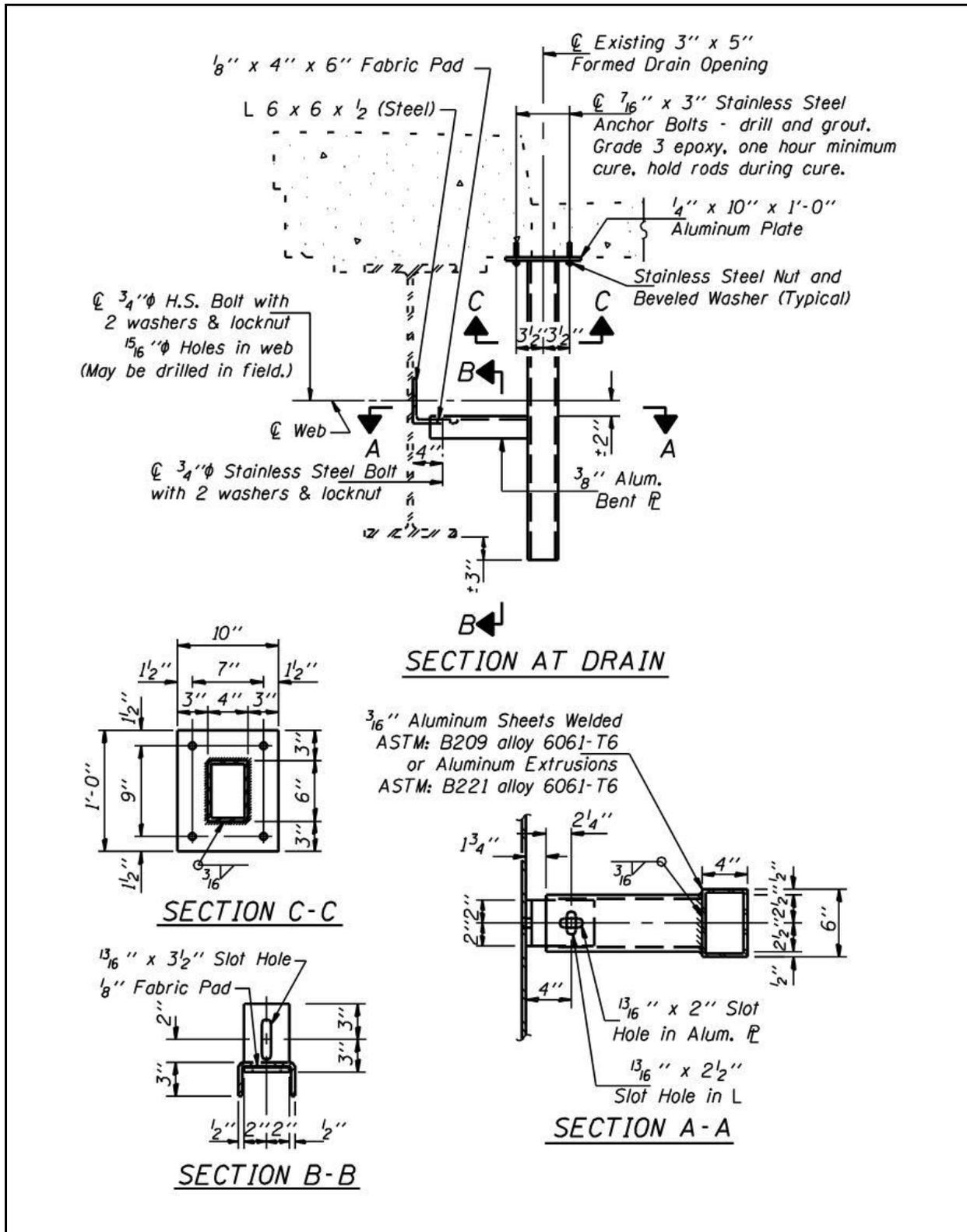


Figure 2.8-3 – Drain Extension Detail

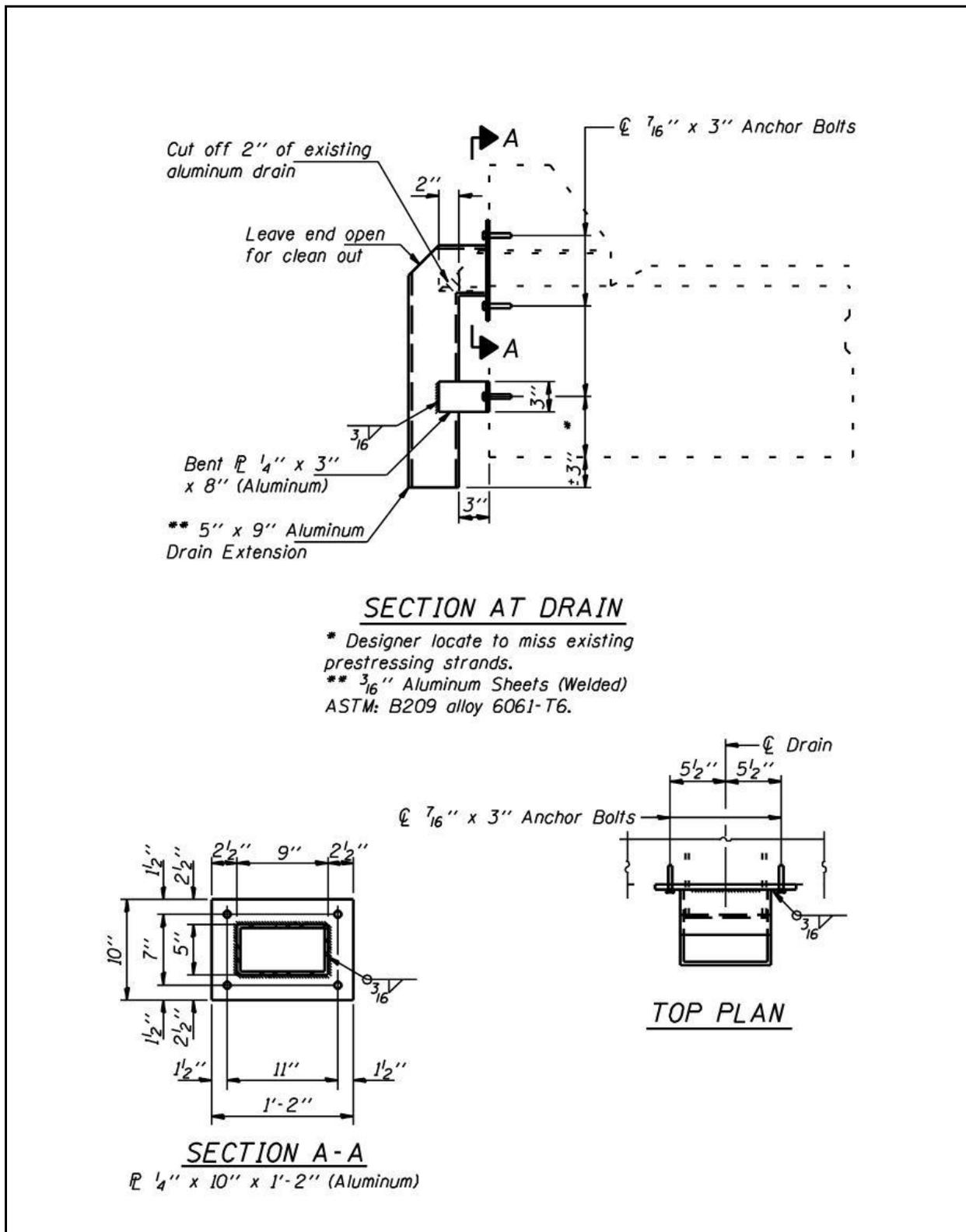


Figure 2.8-4 – Drain Extension Detail

2.8.3 Drain Elimination

Many existing structures were constructed with deck drains at 6 foot centers. The number of drains on these structures greatly exceeds the number of drains required to prevent ponding on the deck. When this situation is encountered, alternate drains may be eliminated to provide a 12 foot drain spacing. Also, existing deck drains located within 10 feet of a substructure unit should be eliminated.

Existing aluminum deck drains, which extend below the deck, can be eliminated by installing a threaded rod through the bottom of the drain and plugging the drain with concrete as shown in [Figure 2.8-5](#). Existing drains consisting of a vertical formed opening in the deck slab should be eliminated by removing and replacing a 1 foot by 2 foot area of the deck as shown in [Figure 2.8-6](#). Formed drain openings extending diagonally through the deck may be eliminated by coating the interior surface of the opening with a bonding agent and plugging the opening with concrete as illustrated in [Figure 2.8-7](#).

The deck concrete adjacent to deck drains is often in an advanced state of deterioration relative to other areas of the deck slab. The condition of the concrete surrounding the drain should be considered when determining if a drain should be eliminated by plugging the existing drain opening or removing and replacing an area of the deck.

2.8.4 Drain Replacement

Rather than extending an existing deck drain, a drain may be completely replaced using the details shown in the Design Section of the IDOT *Bridge Manual*. Installing a new drain will include the removal and replacement of any poor quality concrete in the area of the existing drain. Also, the replacement drain may be of a type which requires less maintenance or is more easily replaced when damaged or stolen.

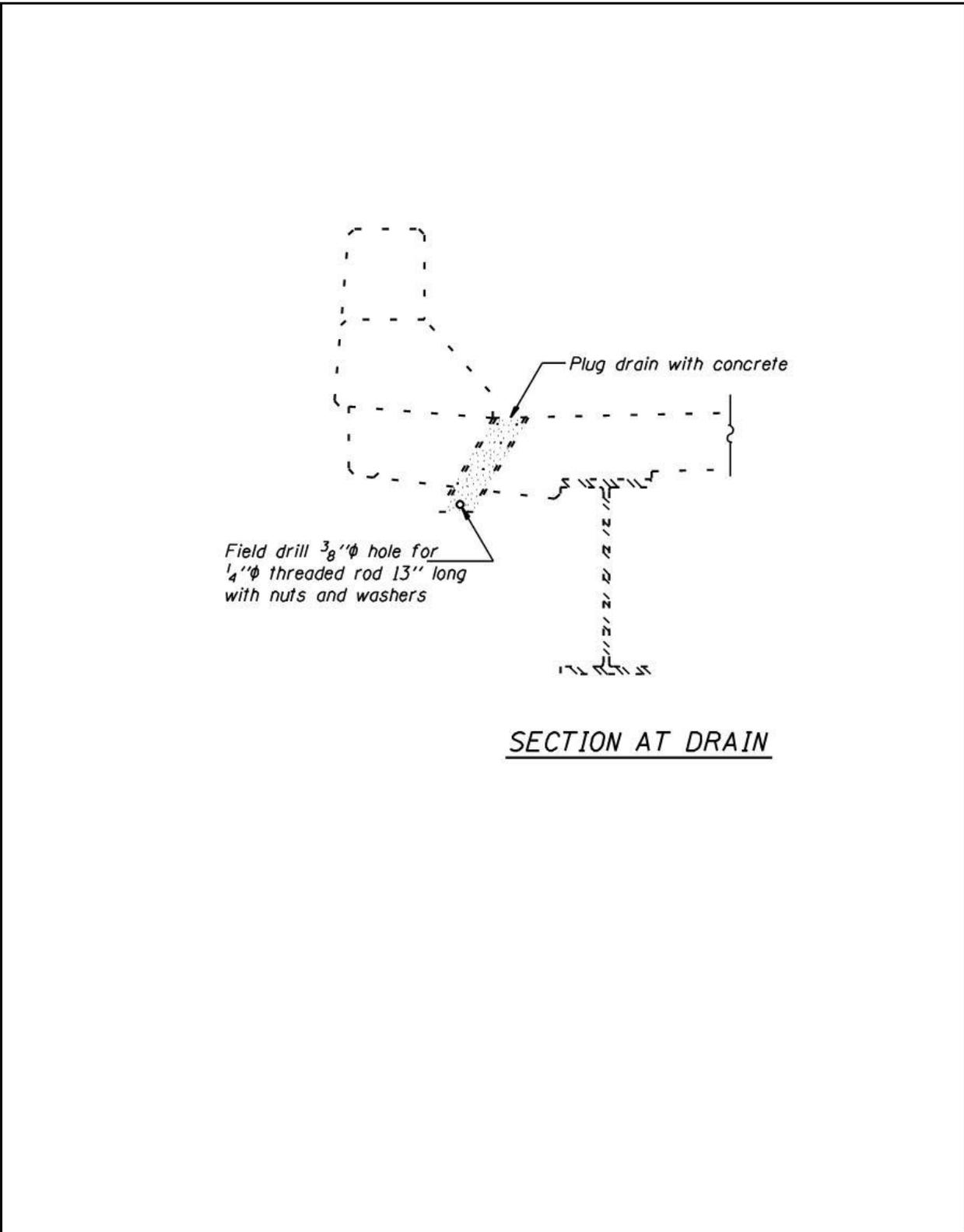


Figure 2.8-5 – Drain Elimination Detail

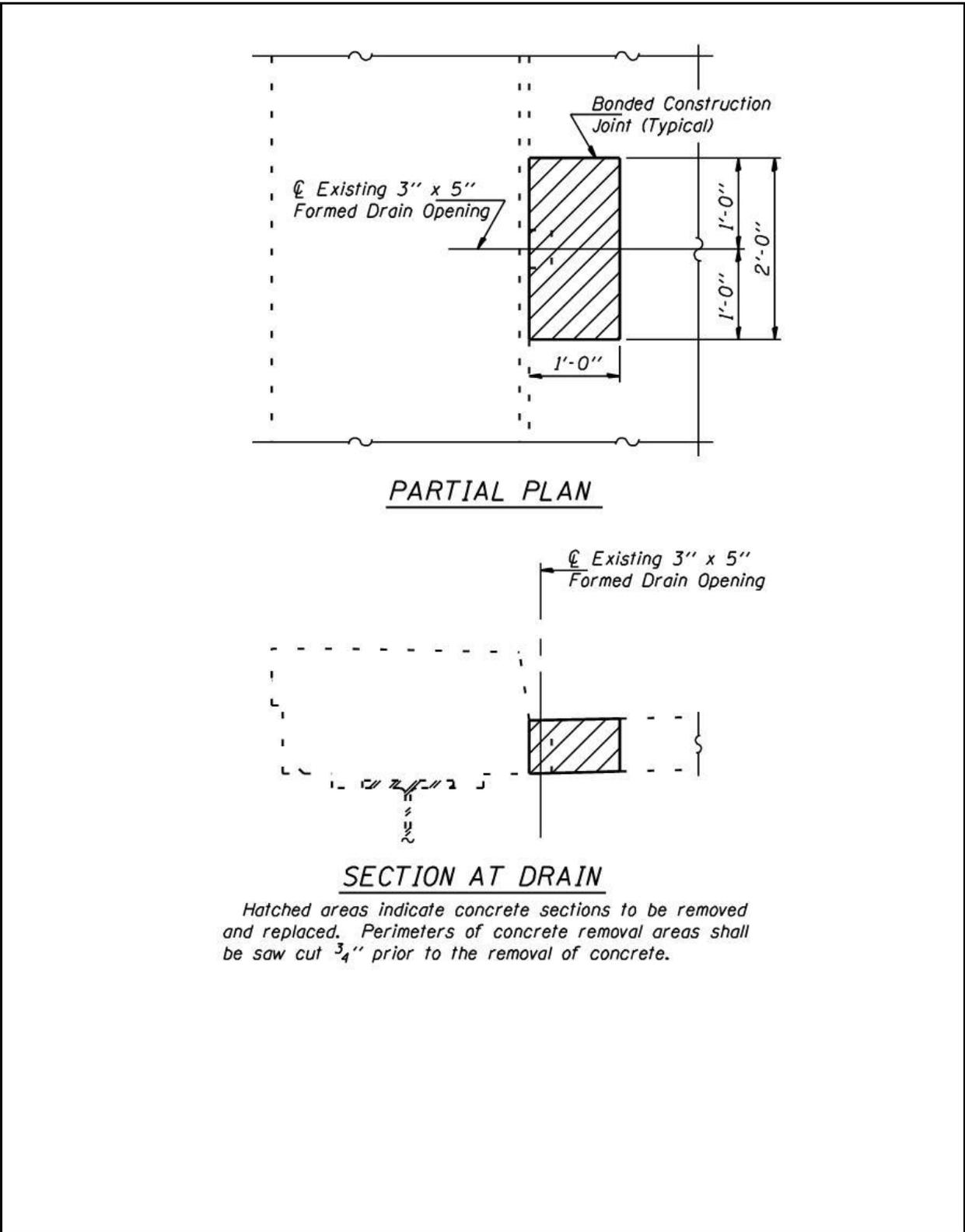


Figure 2.8-6 – Drain Elimination Detail

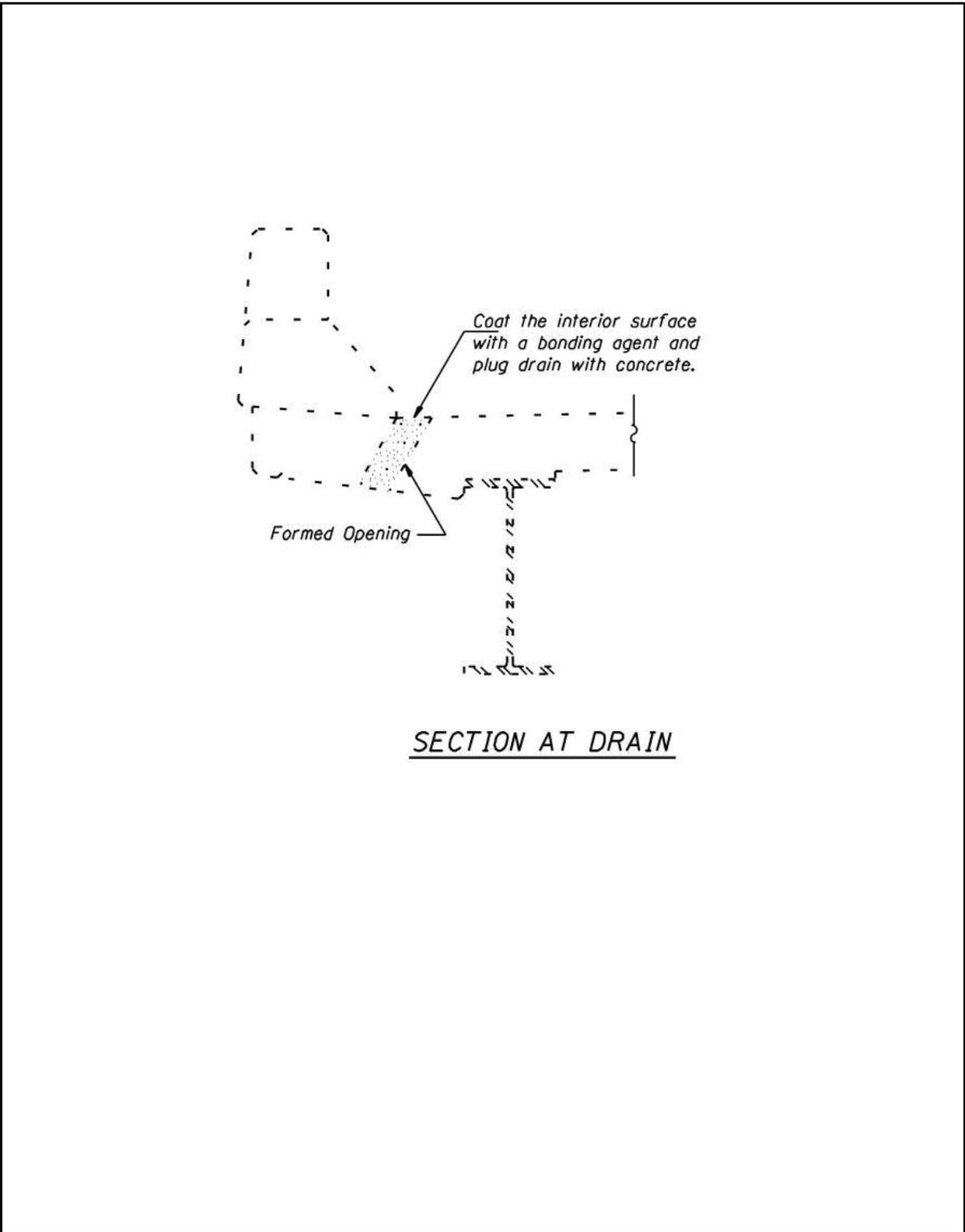


Figure 2.8-7 – Drain Elimination Detail

2.9 Bearing Replacements

2.9.1 Bearing Type Selection

When existing bearings must be replaced, the replacement bearing assemblies shall be designed as specified in the Design Section of the IDOT *Bridge Manual*. Elastomeric bearings should be used when replacing existing expansion bearings except where specific design requirements necessitate the use of an alternate type of bearing. Steel rocker or roller bearings should be used as replacement bearings only when a limited number of bearings are to be replaced on a specific structure and the replacement bearings need to match the behavior of the existing bearings which are to remain in place.

2.9.2 Seismic Requirements

Seismic requirements, including substructure seat width and superstructure restraint, need not be considered for maintenance contracts and Day Labor awards. However, seismic requirements should be considered as specified in the IDOT *Bridge Manual* for structures being rehabilitated or replaced.

2.9.3 Existing Bearing Removal

When removing an existing bearing assembly, the steel plate welded to the bottom flange of an existing beam or girder should be removed. The method of removal used should not damage the bottom flange and should provide for the removal of all existing weld material from the bottom flange. [Figure 2.9-1](#) shows details associated with the removal of an existing bearing assembly.

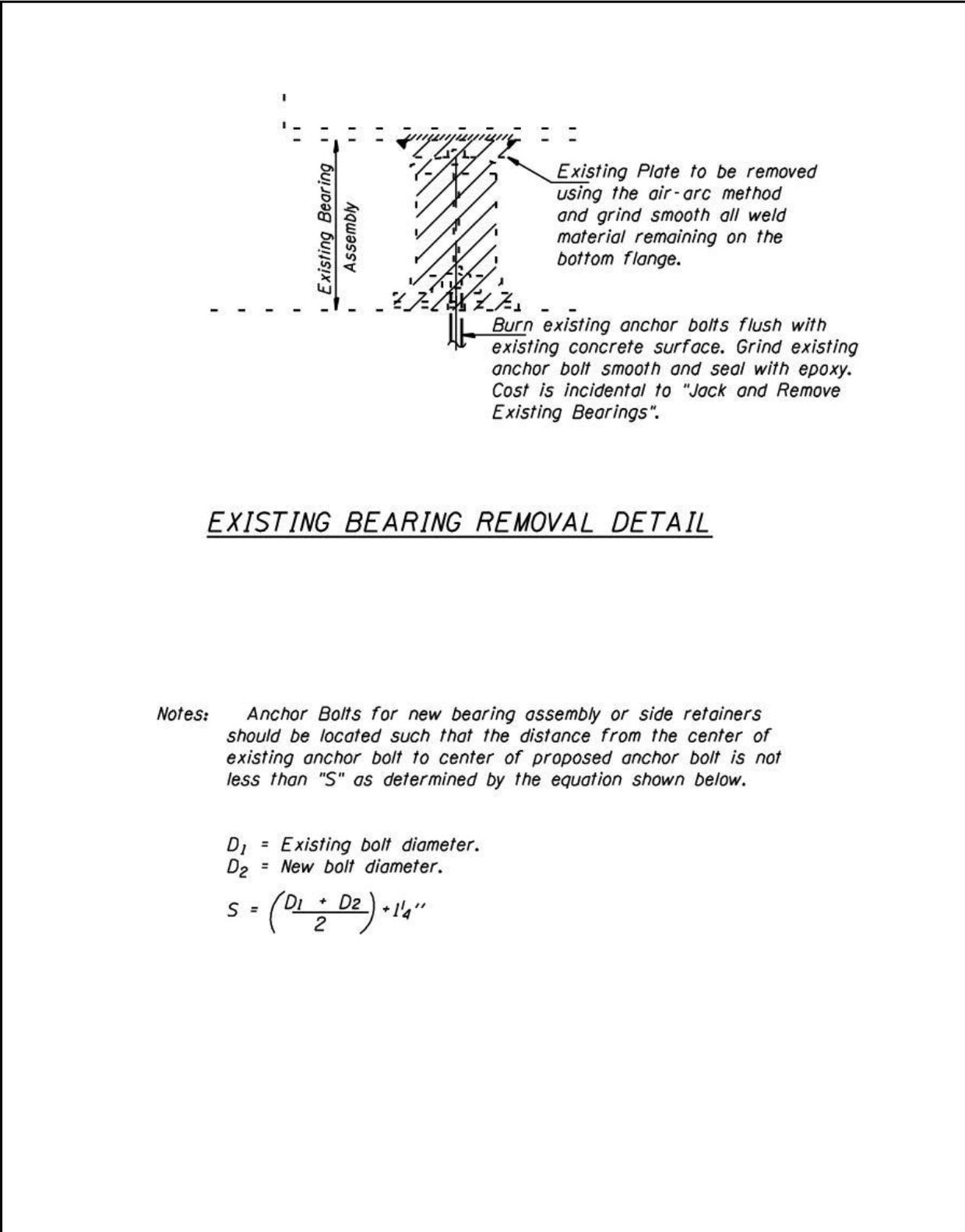


Figure 2.9-1 – Existing Steel Rocker Bearing Removal

2.9.4 Bearing Height Adjustment

When elastomeric bearings are used to replace existing steel bearings, there is routinely a difference in the height of the existing bearing assembly versus the height of the new elastomeric bearing assembly. Differences in bearing assembly height require the addition of a steel extension to the elastomeric bearing assembly or the reconstruction of the substructure bearing seat. These adjustments are necessary to maintain the current profile grade elevations of the superstructure or to adjust the elevation of the superstructure to meet a new profile grade.

The decision to use either a steel extension or a reconstructed bearing seat will depend on the difference between the existing and proposed bearing assembly heights. Generally, steel extensions should be used to adjust the height of the elastomeric bearing assembly for extensions less than or equal to 12 inches in height. When the height of the extension is less than 6 inches, the extension should consist of steel shim plates placed between the elastomeric bearing assembly and the superstructure as shown in [Figure 2.9-2](#). When the required height of the extension is greater than or equal to 6 inches and less than 12 inches, an extension should be fabricated using 1 inch plates as shown in [Figure 2.9-3](#). When 12 inches or more of bearing assembly height adjustment is required, the bearing seat area of the abutment or pier should be reconstructed to provide the proper elevation for the new elastomeric bearing assemblies. [Figure 2.9-4](#) illustrates an acceptable method of constructing a new concrete seat for a replacement bearing assembly.

The guidelines for choosing extension types should be used with some flexibility. Although a concrete extension is preferred for extension heights of 12 inches or more, situations will occur when a fabricated steel extension may be used with a height of 12 inches or greater in order to minimize construction time and traffic disruptions. Also, fabricated steel extensions may be used for a height less than 6 inches when it is physically possible to fabricate and install the steel extension.

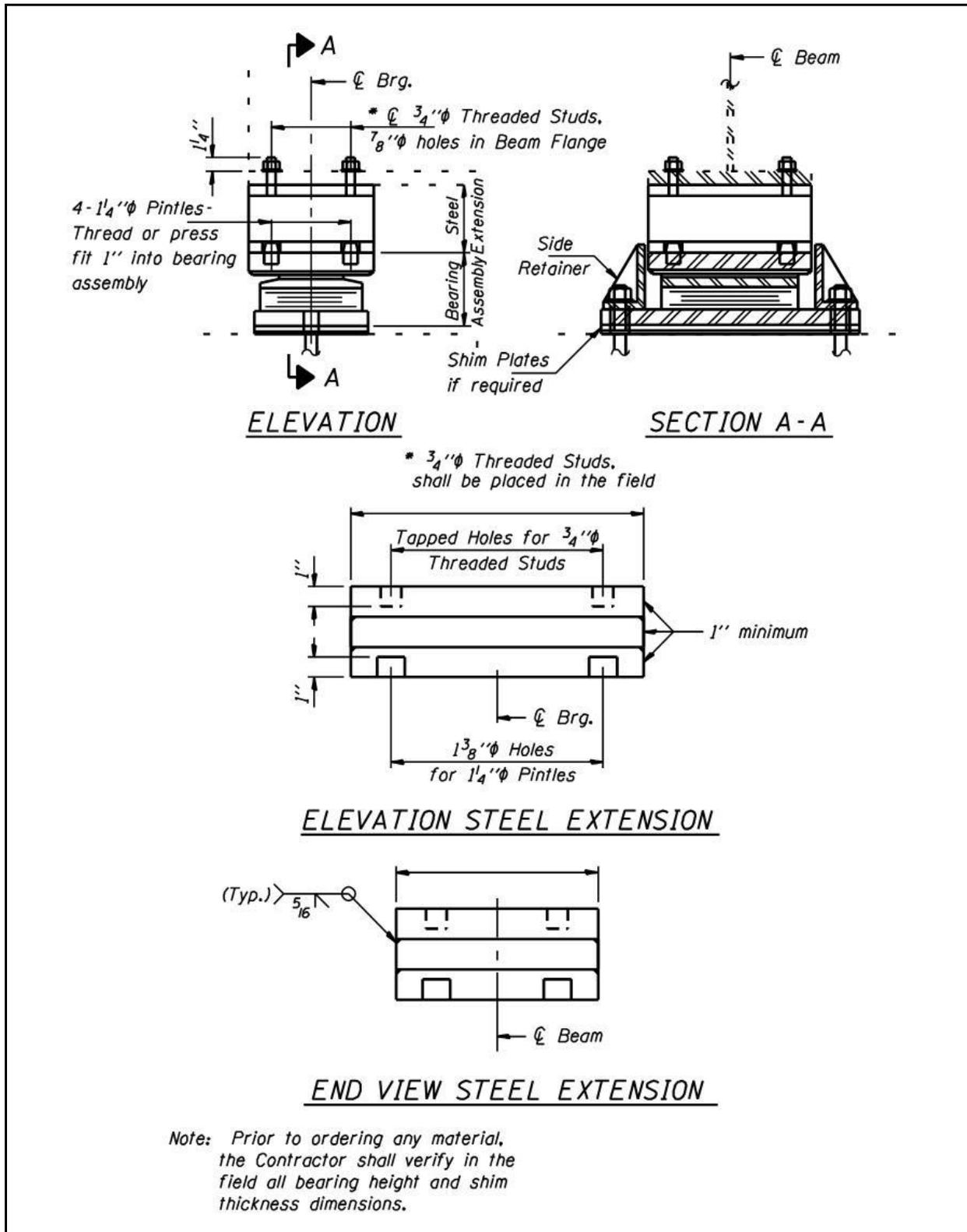


Figure 2.9-2 – Stacked Plate Steel Extension

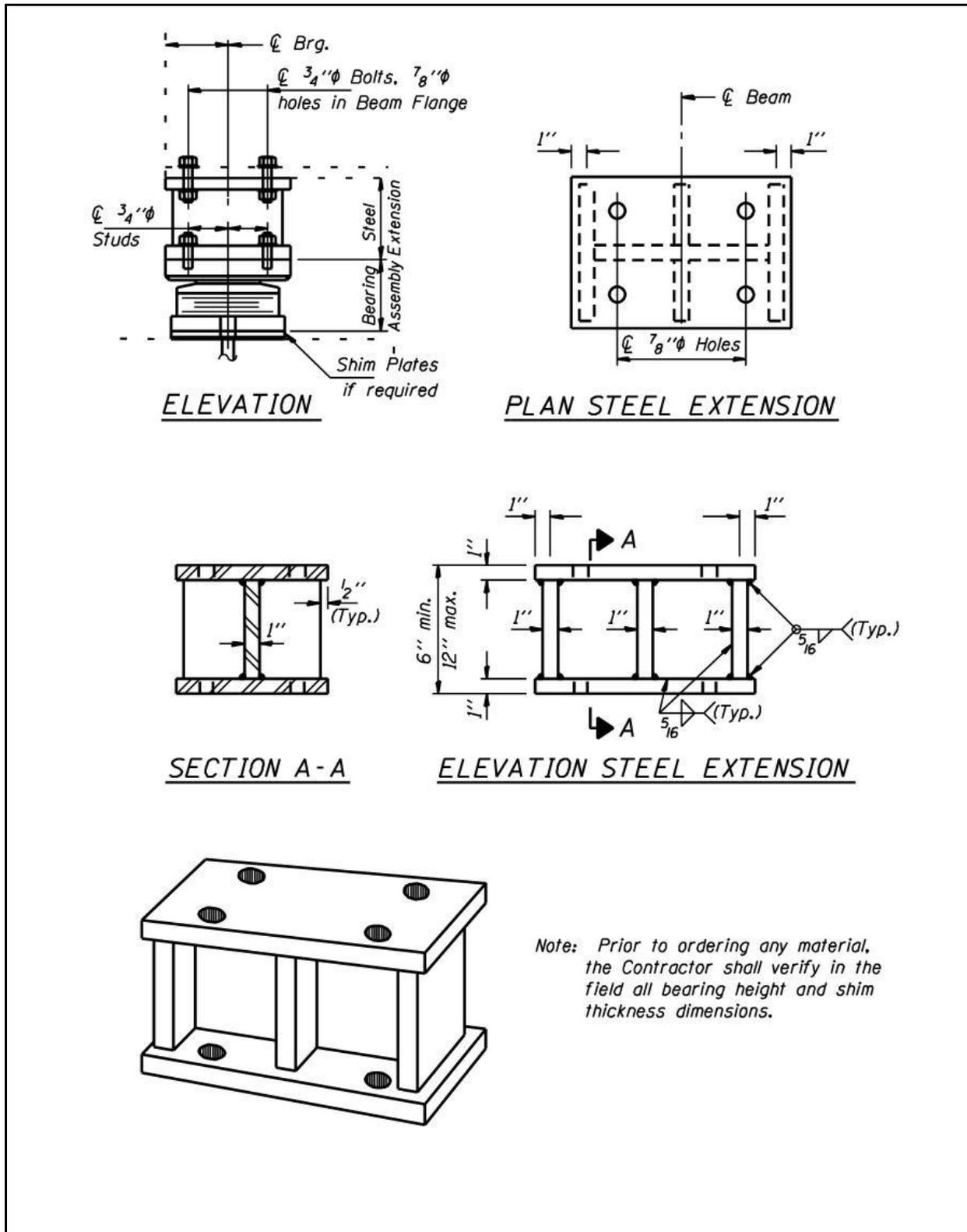


Figure 2.9-3 – Fabricated Steel Extension

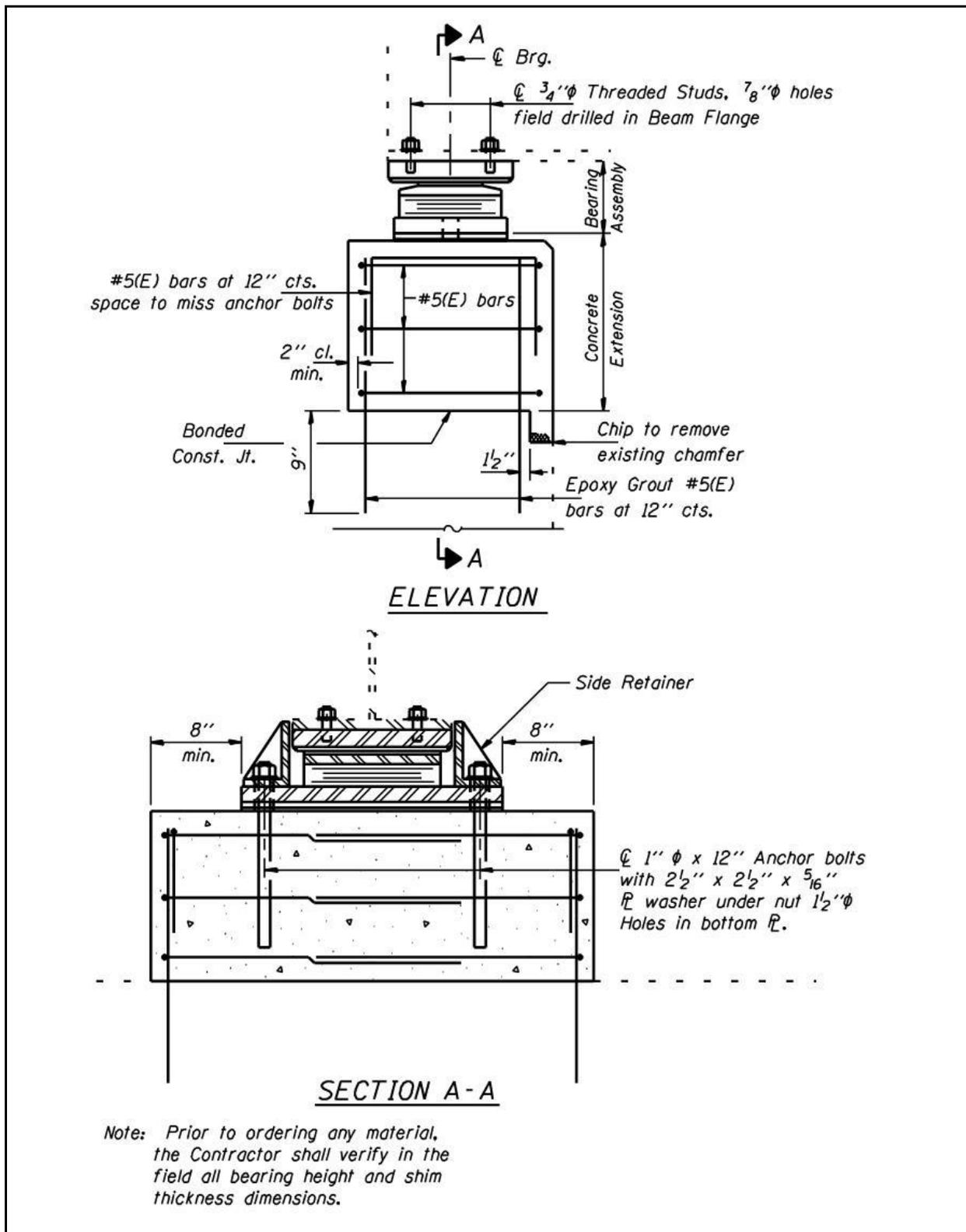


Figure 2.9-4 – Concrete Extension

2.9.5 Reinforced Concrete Slab Bearings

When replacing the bearings under a reinforced concrete slab bridge, preferably the end of the deck should be removed and replaced as described for expansion joint replacement elsewhere in the Repair Section. Although this method, as shown in [Figure 2.9-5](#), will require the slab to be temporarily supported and the employment of stage construction during construction, it will ensure that the new bearings are uniformly loaded.

Bearings may also be replaced under a reinforced concrete slab bridge without completely removing the end of the deck, as shown in [Figure 2.9-6](#). However, this method requires that accurate field measurements of the existing bearing heights be taken to ensure that the replacement bearings are detailed and fabricated to match the heights of the existing bearings. Heights can vary from one existing bearing to the next and failure to match existing bearing assembly heights can result in the replacement bearings being unequally loaded. This method of bearing replacement also requires the new bearing assemblies to be field welded to the existing steel bearing plates usually found embedded in the bottom of the slab. The limited space available between the bottom of the slab and the bearing seat and the condition of the existing plate should be considered to determine if field welding operations can be adequately performed.

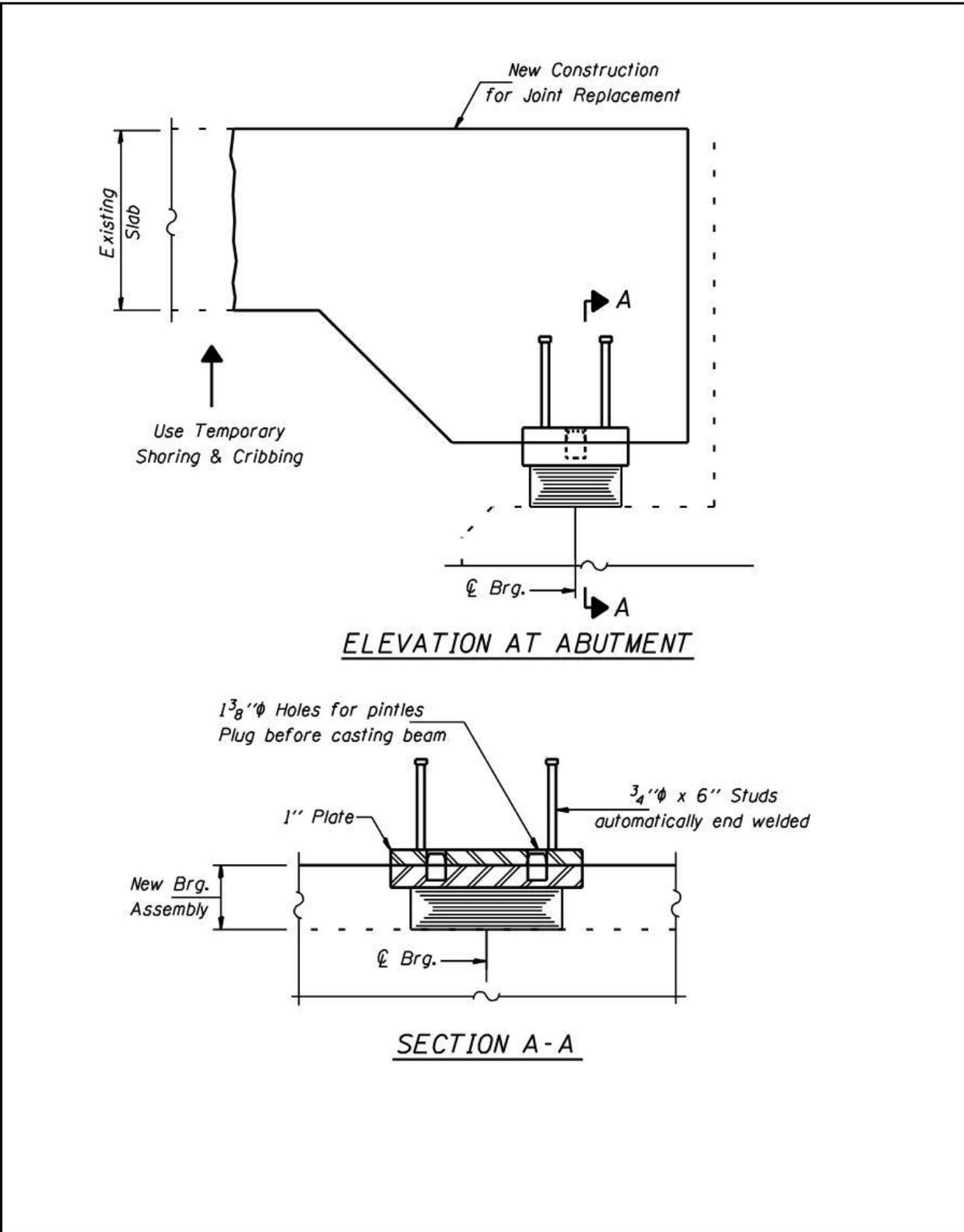


Figure 2.9-5 – Bearing Replacement for R.C. Slabs with Joint Replacement

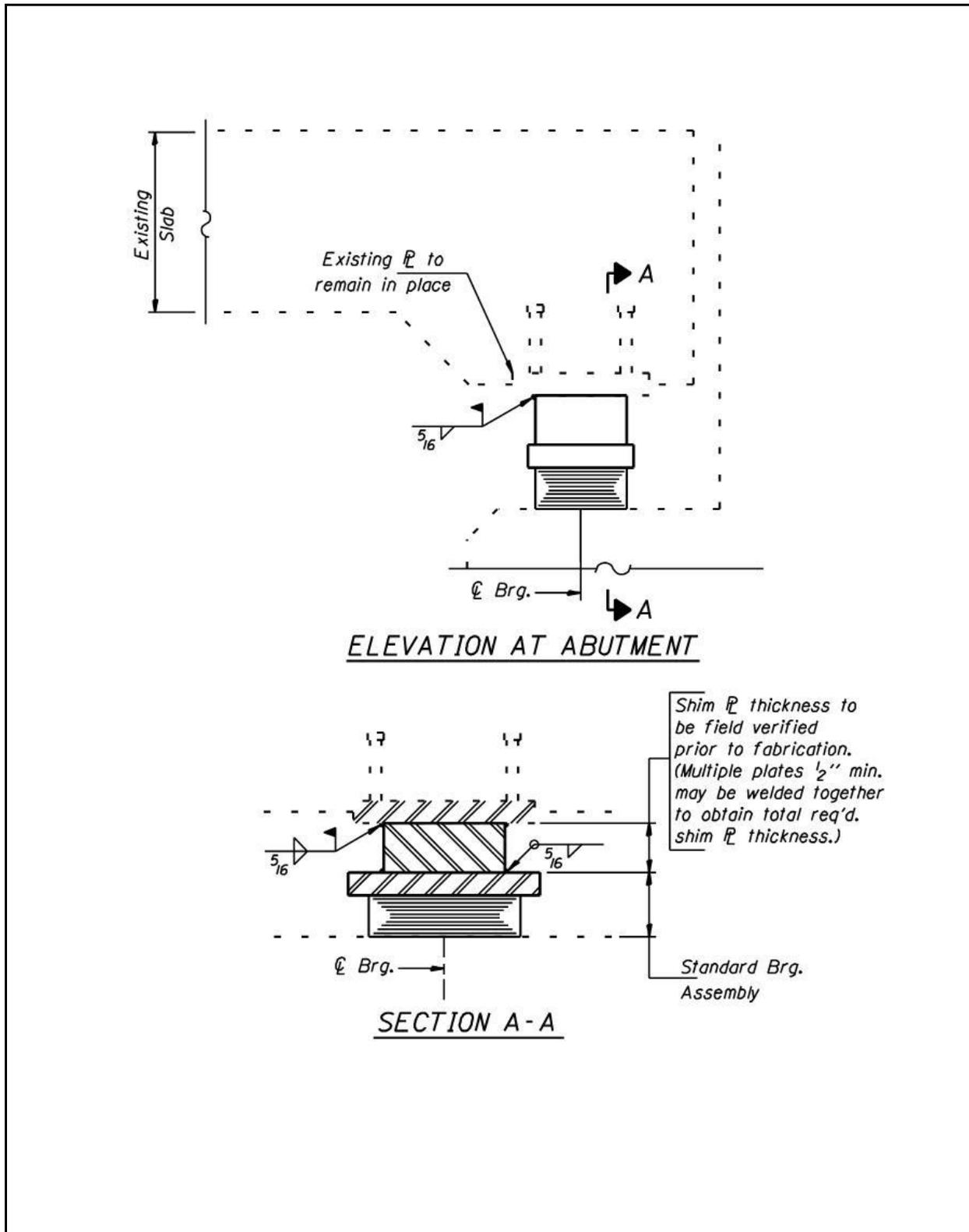


Figure 2.9-6 – Bearing Replacement for Existing R.C. Slabs

2.9.6 Reaction Table

All plans for bearing replacement should contain a table showing the girder or beam reactions for each bearing replacement location (substructure unit). The table should include the Deadload, Liveload, Impact and Total reaction per beam line as shown in the Design Section of the IDOT *Bridge Manual* for an “Interior Girder/Beam Reaction Table”. The Structural Services Section of the Bureau of Bridges & Structures will provide reaction tables when plans are prepared by District personnel.

2.9.7 Top Bearing Plate Adjustment

If a steel rocker expansion bearing is substantially tilted out of position with respect to its proper location for a given temperature, the top bearing plate needs to be adjusted. This consists of removing the top bearing plate by the air-arc method without damaging the bottom flange and grinding smooth all weld material remaining on the bottom flange. Then a new top bearing plate should be placed in the right position depending on the temperature at the time and welded to the bottom flange.

2.9.8 Anchor Bolts

If existing anchor bolts are deteriorated due to corrosion or broken, a new threaded extension rod can be welded on to the existing anchor bolt as shown in [Figure 2.9-7](#). If new anchor bolts are needed, they shall be placed such that the distance between the center of the existing anchor bolt and the center of the new anchor bolt is as shown in [Figure 2.9-1](#).

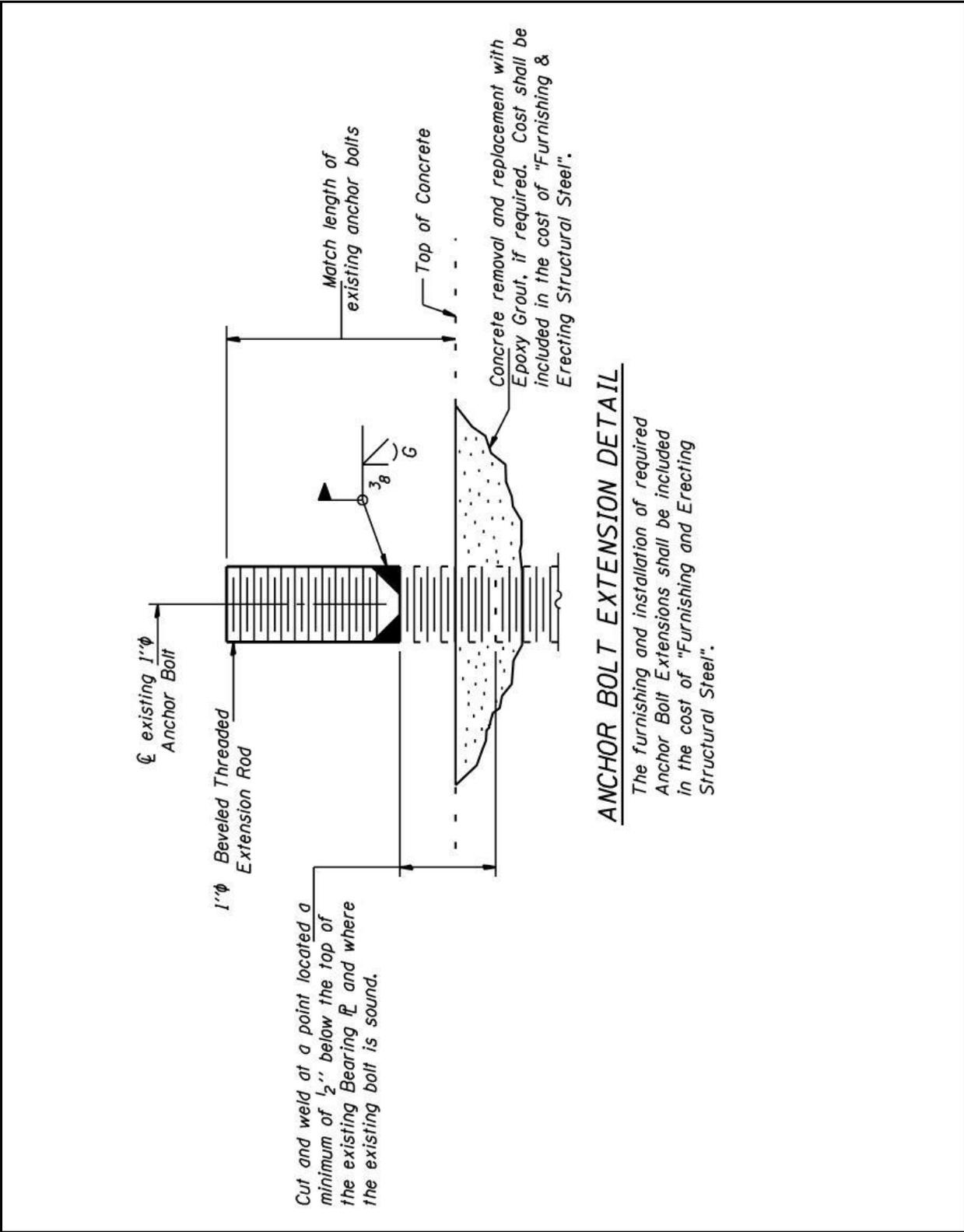


Figure 2.9-7 – Anchor Bolt Extension

2.10 Jacking and Cribbing

2.10.1 General

During bearing replacements or the repair of concrete immediately under bearings, the superstructure must be lifted and temporarily supported. This procedure is generally referred to as Jacking and Cribbing. Specific details for Jacking and Cribbing are not usually shown in the repair plans prepared for maintenance contracts or Day Labor awards. However, pay items and special provisions for jacking, cribbing, and bearing removal should always be included in the repair plans. Specific details for the jacking and cribbing system to be used to implement the planned repairs will be developed by the contractor and submitted to the Bureau of Bridge and Structures for review and approval prior to beginning jacking operations. Design calculations should be included with the jacking and cribbing details submitted for review and approval.

2.10.2 Traffic Staging

The plans or special provisions should require that traffic be redirected during the jacking and cribbing operations so that vehicles will not be located directly over the cribbed areas. Traffic should not be allowed directly over cribbed areas of the superstructure unless there is no reasonable alternate method of routing vehicles and the jacking and cribbing plans contain details which will provide adequate horizontal and vertical stability for the superstructure. Vehicles must not be allowed to travel over uncribbed areas of the structure supported only by hydraulic jacks.

2.10.3 Jacking Synchronization

During the jacking and cribbing operations, the lifting of the structure should be controlled so that the relative elevation between adjacent beams does not vary more than 1/8 inch from their original elevation differential. Also, the relative elevations of a continuous beam at adjacent substructure units should not vary more than 1/4 inch from the original relative elevations. If the entire superstructure is being raised a significant amount to meet new profile grade requirements, a synchronous lifting system should be used to control and equalize individual jack pressures to ensure that the superstructure is lifted uniformly without exceeding the above stated relative elevation differentials. These relative elevation restrictions and system requirements should be included in the plans or special provisions. The relative elevation

restrictions should not be exceeded unless analysis indicates that greater differential elevation variances can be tolerated and will not induce stresses in the superstructure elements which will exceed the original allowable design stresses used for the structure.

2.10.4 Jack Capacities

The jack capacities required for lifting should be based on the maximum expected load present during the lift derived from the reactions shown in the Beam Reaction Table included with the plans. The jack capacity provided should be between 50% and 100% greater than the maximum expected load.

2.10.5 Jack Placement

Unless the diaphragms of the superstructure have been retrofitted or analyzed to carry jacking loads, they should not be used as load carrying members in the jacking and cribbing system. The plans or special provisions should state this restriction when diaphragms are present.

When jacks are placed directly under a beam, the jack should be centered under the web and a steel plate should be placed between the top of the jack and the bottom flange of the beam. When web stiffeners bearing on the bottom flange do not exist directly over the location of the jack under a steel beam, hardwood timbers should be installed tightly between the top and bottom flange to prevent flange rotation. Steel stiffening angles should be attached to the web of the beam when the beam web thickness is not adequate to carry the jacking load. Steel plates should be placed under jacks bearing directly on the existing substructure to distribute the jacking load and prevent damage to the existing concrete.

When lifting the entire superstructure as a unit, jacks should be placed in a manner and in locations that will ensure that the jacks will be equally loaded and the load will be uniformly distributed to the foundation of the jacking system.

2.10.6 Load Distribution

Whenever the jacking system will require that lifting loads be transferred to natural ground, slopewall, roadway shoulder or roadway pavement an adequate distribution of the load should be accomplished using steel beams, timber mats or other means approved by the Engineer. An

aggregate leveling base may also be required below the mats when natural ground is used to support the jacking system.

The following maximum allowable pressures should be used to determine the area of the timber mats supporting jacking systems, unless information is available indicating that higher values may be used:

Supporting Material	Max. Allowable Pressure
Natural ground (unsaturated)	0.5 Tons / Sq. Ft.
Conc. slopewalls & bit. Shoulders	1.0 Tons / Sq. Ft.
Bituminous pavements	2.0 Tons / Sq. Ft.
Concrete pavements	4.0 Tons / Sq. Ft.

Table 2.10-1 – Maximum Allowable Bearing Pressures for Jacking System Support

2.11 Pin and Link Replacement

2.11.1 General

When pins are found to be defective or “frozen”, the pin and link assemblies must be replaced. These assemblies are considered to be fracture critical details for inspection and maintenance purposes, and measures should be taken to immediately correct any deficiencies associated with the pins or link plates.

2.11.2 Pin and Link Replacement

When replacing defective pins, the notes shown in [Figure 2.11-1](#) and the features shown in [Figure 2.11-2](#) and [Figure 2.11-3](#) should be incorporated into the design of the replacement whenever possible. Also, new link plates, designed in accordance with AASHTO specifications, should always be provided when replacing defective pins.

The suspended span must be temporarily supported from below with shoring or from above using a needle beam. General details for temporarily supporting the suspended span using a needle beam are shown in [Figure 2.11-4](#). Specific details for the temporary support system are

typically to be submitted by the contractor for review and approval by the Bureau of Bridges & Structures and are not shown in the plans. However, pay items and special provisions for the temporary support system should be included with the repair plans.

A Reaction Table, similar to that required for bearing replacements, should be included with the pin and link replacement plans.

2.11.3 Pin and Link Elimination

When the major rehabilitation of a structure is planned, the elimination of the pin and link assemblies should be evaluated. The method used to eliminate the assemblies will depend on the characteristics of the individual structures and may include replacing the assemblies with bolted splices and the installation of counterweights at the simply supported ends of spans. This will eliminate a fracture critical detail, susceptible to sudden failure, from the structure and reduce future maintenance inspection requirements.

Note A:

Existing welds shall be inspected for cracks using liquid dye penetrant or magnetic particle testing. Any cracks that are found shall be identified and reported to the Bureau of Bridges and Structures for further disposition. Clean and paint before installing new link plates.

Note B:

Bore diameter for bushing in link plate, existing webs and web reinforcement plates shall correspond to bushing manufacturer's allowable tolerances for proper functioning. Hole diameter may be adjusted to allow use of stock bushings.

Note C:

Inside face of new link plates shall receive first field coat in shop. The primer shall pass the M.E.K. Rub Test before the first field coat is applied.

Note D:

Actual bushing thickness per manufacturer's specifications, $\frac{1}{4}$ " is approximate. Bushings shall be a self lubricating filament wound epoxy matrix backed Duralon Bearing, metal backed Fiber Glide Bearing or equivalent. No primer or grease shall be allowed on bushings. Bushings shall be suitable for dynamic loads of 20,000 psi.

Note E:

Tighten inside nuts to bring all bushings into firm contact, then back off $\frac{1}{4}$ turn and tighten outer nuts.

Note F:

Apply $\frac{3}{8}$ " bead to face of the web reinforcing plates approximately $\frac{1}{2}$ " from bushing immediately before installing new link plates. Place sealant around nuts after installation. Sealant shall be suitable for prolonged exterior exposure without losing flexibility or adhesion to painted steel surfaces. Proposed products shall be subject to Department's acceptance based on documented testing or other evidence.

Note G:

Body of Pin dimension "a" shall be based on measured thickness of captured plates (including paint), plus $\frac{1}{2}$ ".

$$a = 2(tl) + tw + \frac{1}{2}"$$

Note H:

Nominal Pin diameter (diameter tolerances subject to Specifications of Teflon Bushing Manufacturer and shall be approved by the Engineer). Pin shall be ASTM A276, UNS 21800 (Nitronic 60 or equal) (No step at threads) 12 threads per inch. Install prior to new link plates.

Figure 2.11-1 – Pin Replacement Detail Notes

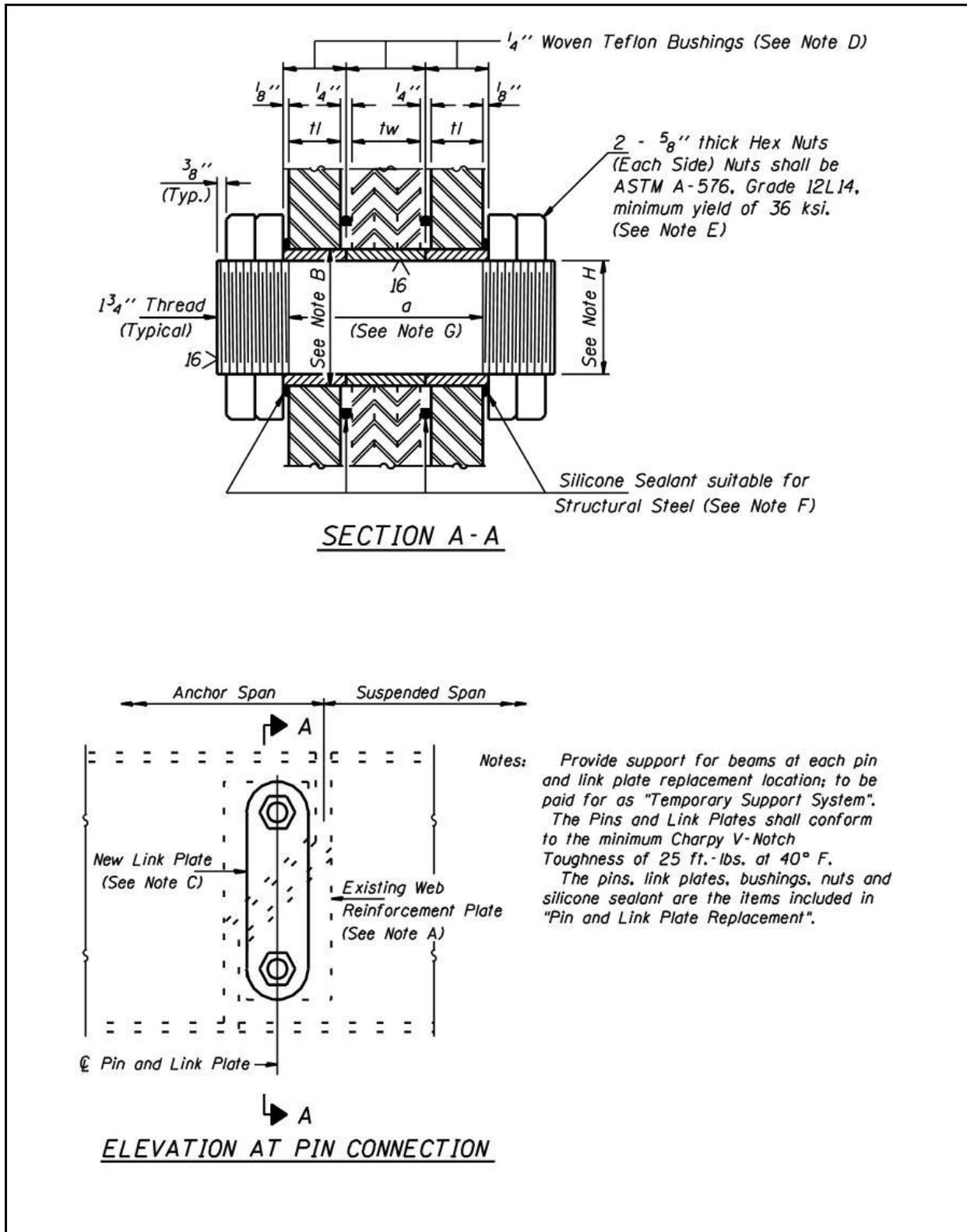
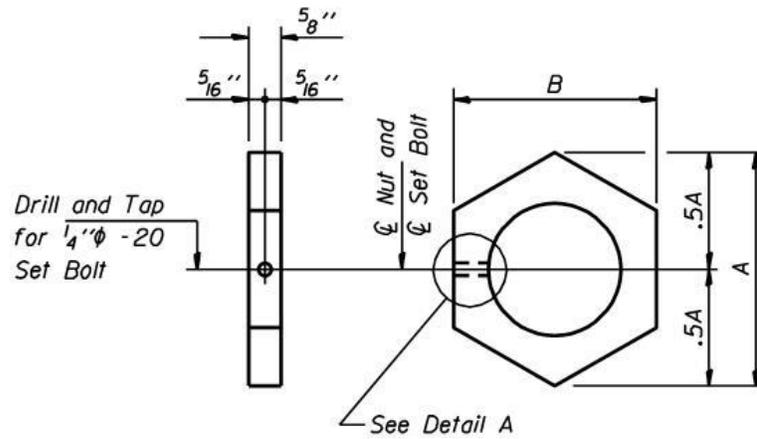
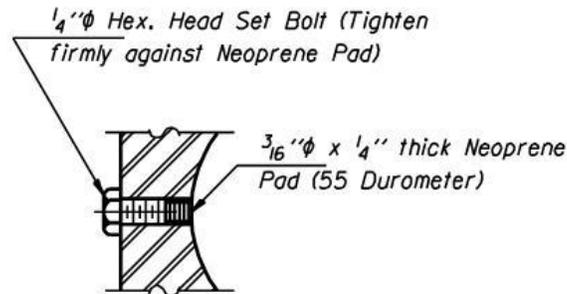


Figure 2.11-2 – Pin Replacement Detail



EXTERIOR NUT DETAIL



DETAIL A

Set Bolts shall conform to the requirements of ASTM A 307 and shall be galvanized according to AASHTO M 232.

Figure 2.11-3 – Set Bolt for Pin and Links

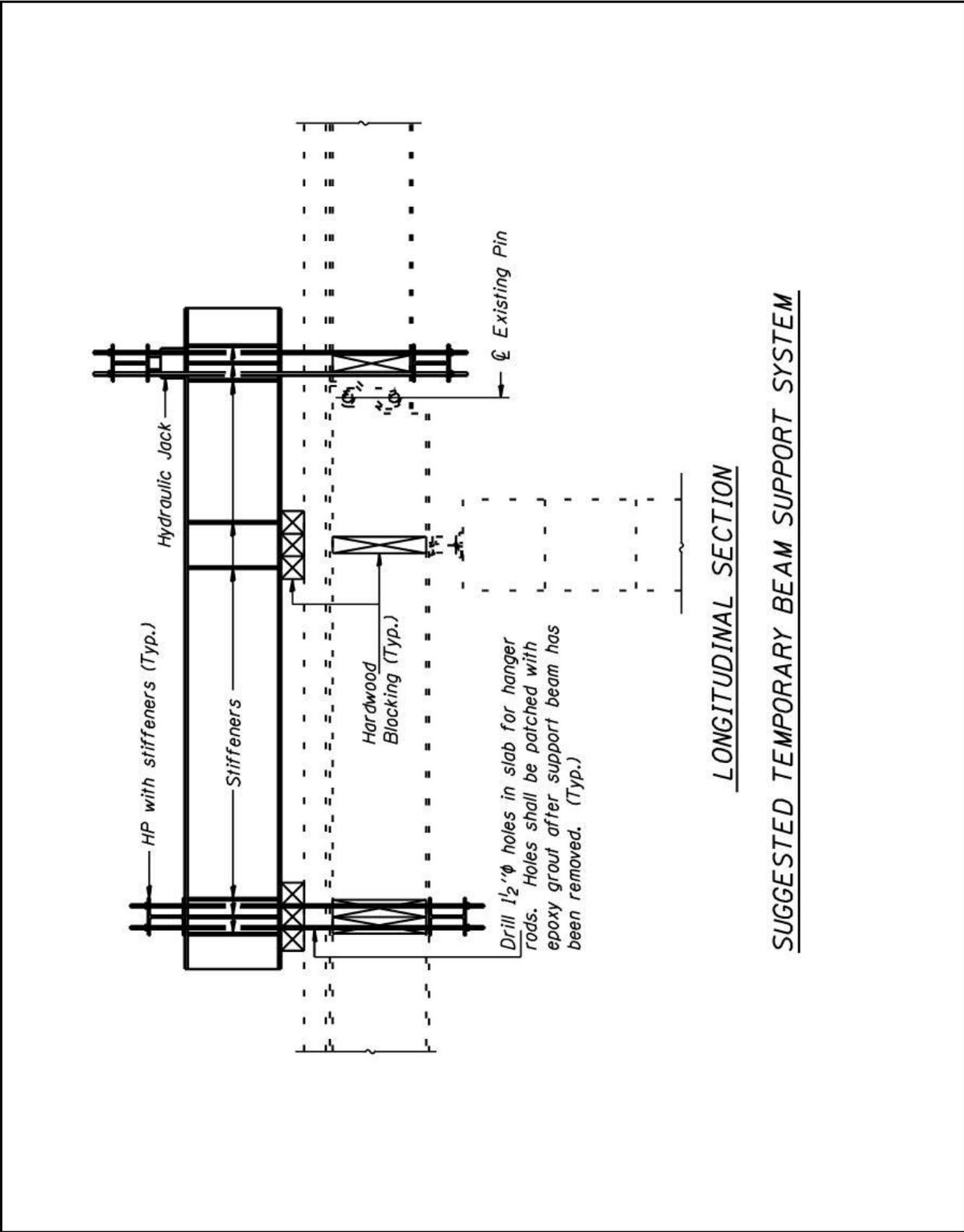


Figure 2.11-4 – Temporary Beam Support Details

2.12 Fatigue

2.12.1 General

“Fatigue” is the general term used to indicate the eventual loss of ductility that may cause cracking in a steel member after repeated loading. The fatigue cracking found in steel structures is generally associated with localized deformations and fabrication operations to which a member has been subjected. Nicks, gouges and cuts present on a member due to vehicle impacts or construction operations can eventually initiate cracking in a member. Tack welds used during construction to ease erection difficulties and unauthorized field welding during maintenance operations can cause fatigue cracking. Fatigue cracks are also frequently found in the area of copes which have been cut with too small a radius or were poorly made.

Fatigue cracks can occur due to in-plane bending or out-of-plane bending. Cracks caused by in-plane bending stresses can occur in any tensile zone of a member. They are usually related to the presence of a weld or surface defect on the member. Fatigue cracks due to in-plane bending stresses can grow quickly and should receive immediate attention. Cracks caused by out-of-plane bending are usually associated with the welded connections of a secondary member to the primary load carrying member. These types of cracks are usually in the web and grow slowly except when located in a tensile zone of the primary member.

A common type of fatigue cracking found in welded plate girders is related to “freezing” of articulated expansion bearings at the simply supported end of the girder. When a pin associated with the bearing “freezes”, rotation of the girder over the bearing is restricted. A crack eventually forms between the bottom flange and the web plate along the flange to web weld.

2.12.2 Pre-repair Procedures

When cracks are found, the Bureau of Bridges & Structures should be immediately contacted. Information should be obtained and submitted describing the location and size of all cracks found so that the current structural adequacy and the procedures necessary to contain or repair the cracks can be determined.

The first step during the inspection of a fatigue crack is to locate the ends of the crack. This can be done by using dye penetrant or magnetic particle testing. Once the ends of the crack are found, 13/16 inch minimum diameter holes should be drilled as shown in [Figure 2.12-1](#) to capture the crack ends to prevent crack growth while repair requirements are being determined or retrofit plans are being prepared. To ensure that the arresting hole captures the end of the crack, the hole should be centered 1/4 inch beyond the apparent crack end. After the arresting holes have been drilled, tests should be performed again to ensure that the drilled holes have captured the crack ends. A high strength bolt with washers should be installed when possible in the arresting hole to provide a compressive force in the area of the crack tip and to minimize distortions in the area of the crack that may encourage further growth of the crack.

2.12.3 Repair Considerations

Cracks located in tensile stress areas of a primary load carrying member should be retrofitted to prevent further growth of the existing cracks and to prevent additional cracks from developing. The retrofit details should restore the load carrying capacity lost when cracking has significantly affected the section properties of the member. [Figure 2.12-2](#) shows details used to repair the end of a stringer where cracking has initiated due to low tensile stress repeatedly occurring in the area of a poorly coped web. Details for the repair of a beam when cracking occurs at the end of a welded coverplate are shown in [Figure 2.12-3](#). A similar detail should be used to retrofit the ends of coverplates during bridge deck replacement projects.

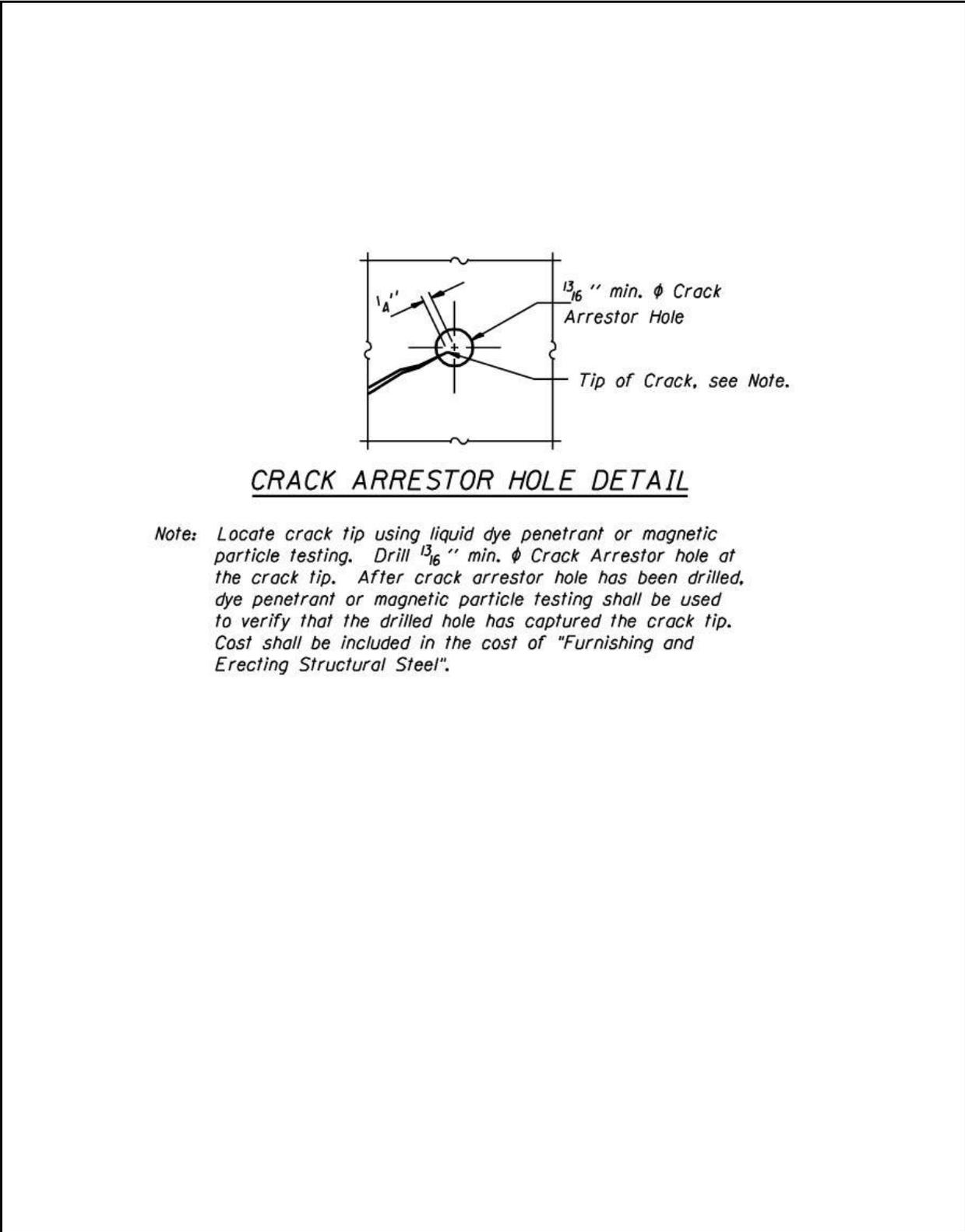


Figure 2.12-1 – Crack Arrestor Hole

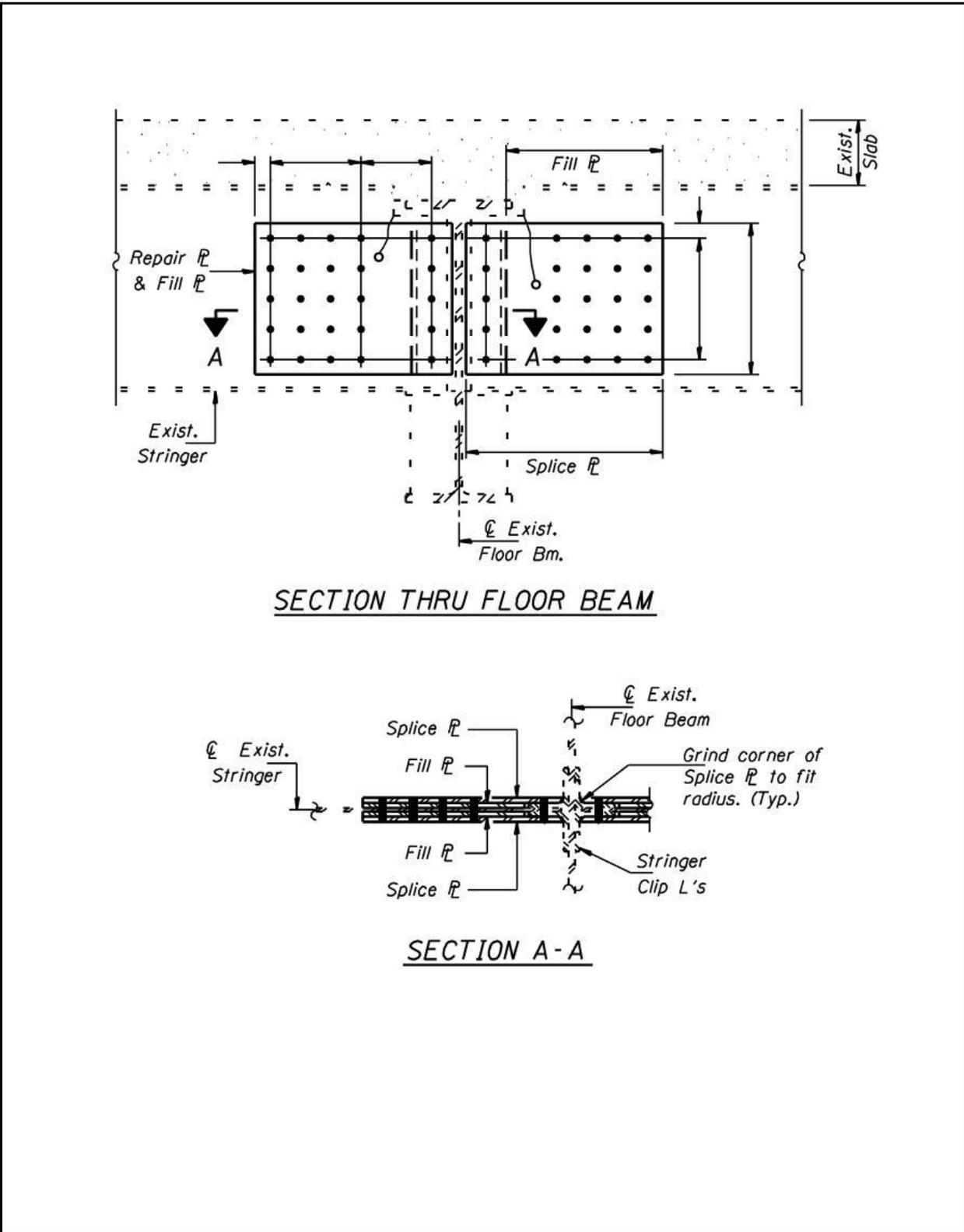


Figure 2.12-2 – End of Stringer Repair Detail

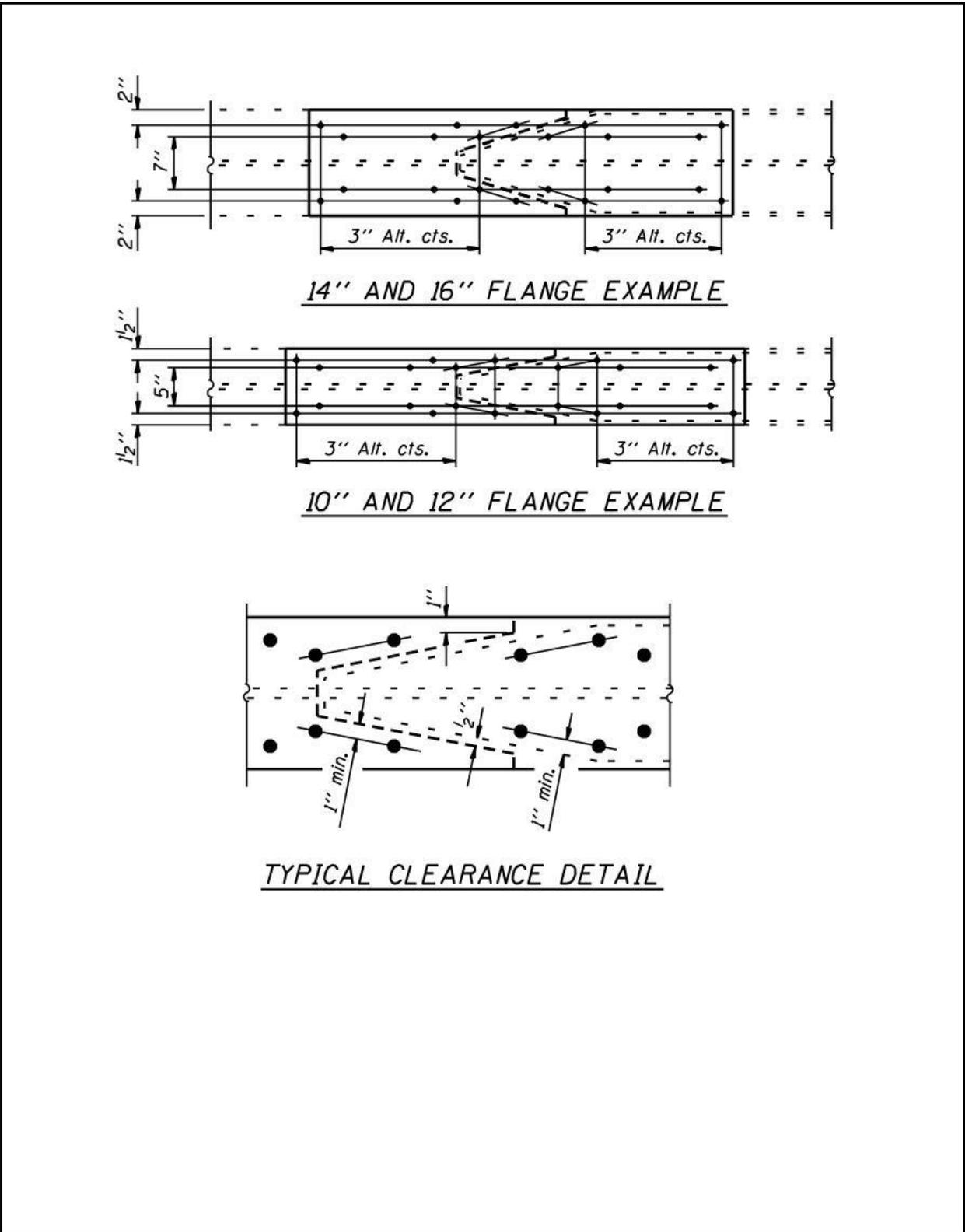


Figure 2.12-3 – Cover Plate Repair Detail

When the cracking is due to out-of-plane bending, the connection of the secondary member to the primary member should be retrofitted to eliminate the cause of the cracking. This is usually achieved by retrofitting the connection details to make the connection more flexible in order to relieve out-of-plane bending stresses, or by retrofitting the connection details to stiffen the connection in order to prevent out-of-plane displacements. Of these two methods, the stiffening of the connection to resist out-of-plane displacement is usually the most effective in arresting and preventing crack growth. [Figure 2.12-4](#) illustrates a method of increasing the flexibility of a floorbeam to girder connection by removing a portion of the connection plate. The resistance of a connection to out-of-plane displacements can be increased as illustrated in [Figure 2.12-5](#) and [Figure 2.12-6](#).

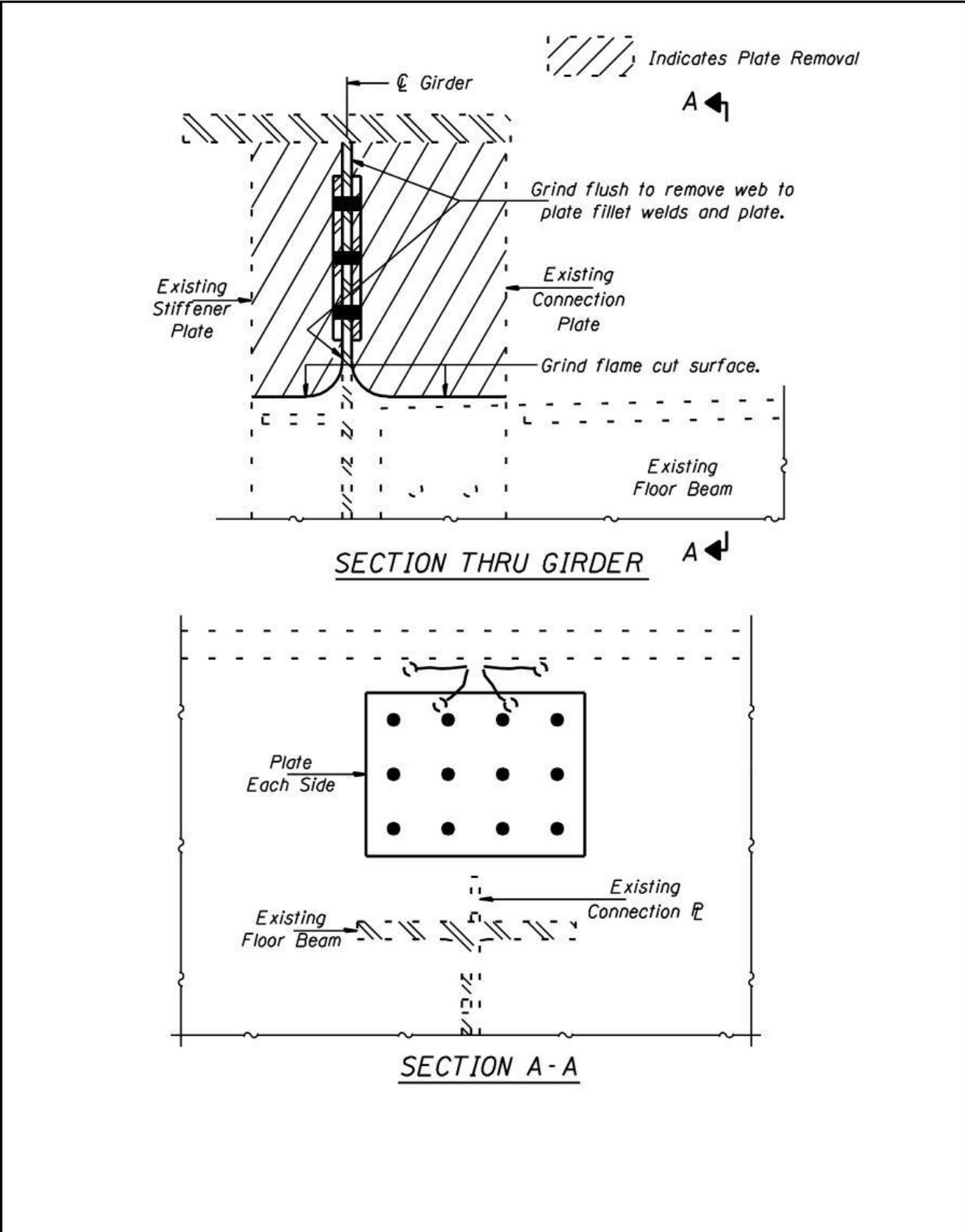


Figure 2.12-4 – Fatigue Repair to Increase Flexibility

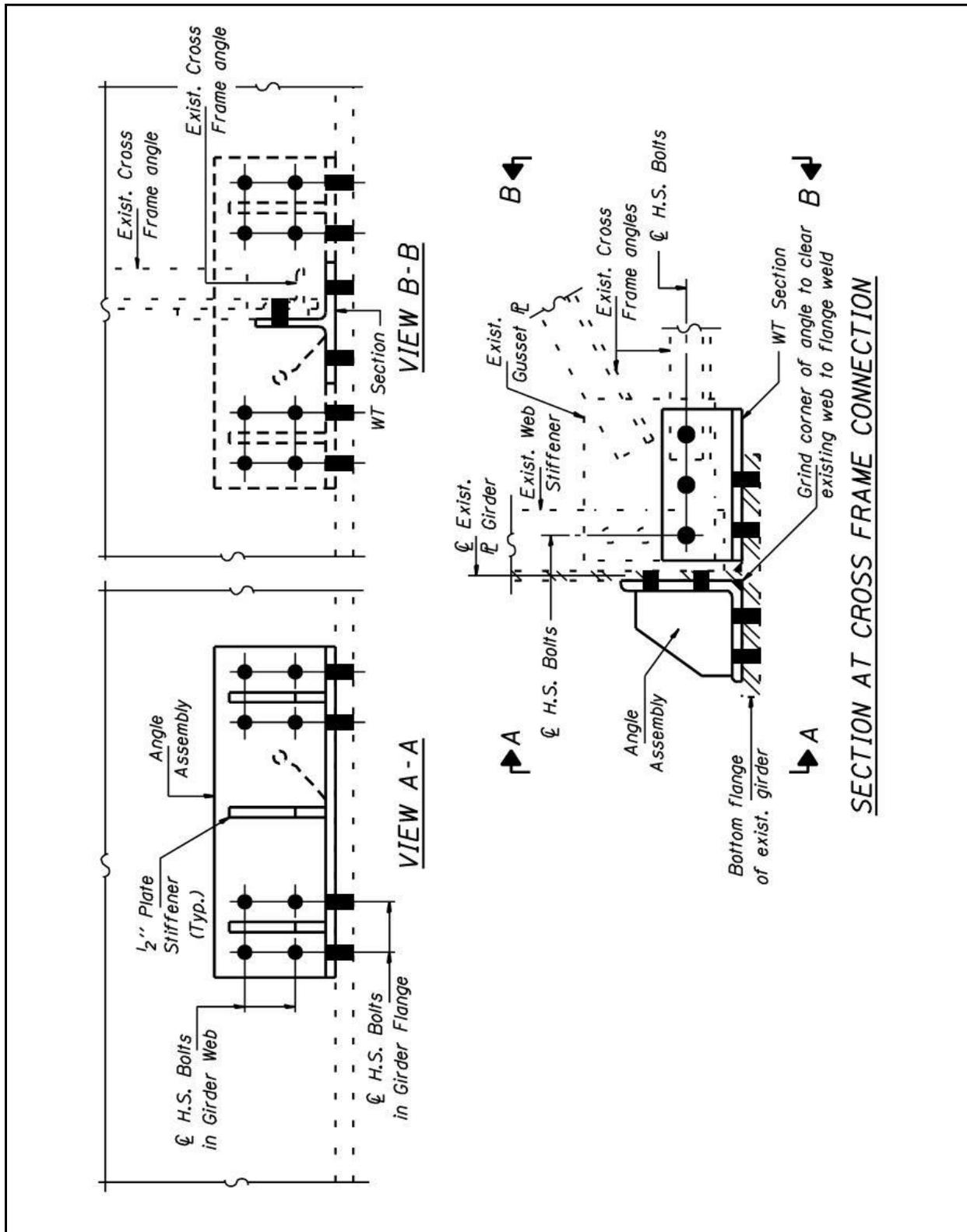


Figure 2.12-5 – Bolted Strengthening Fatigue Repair

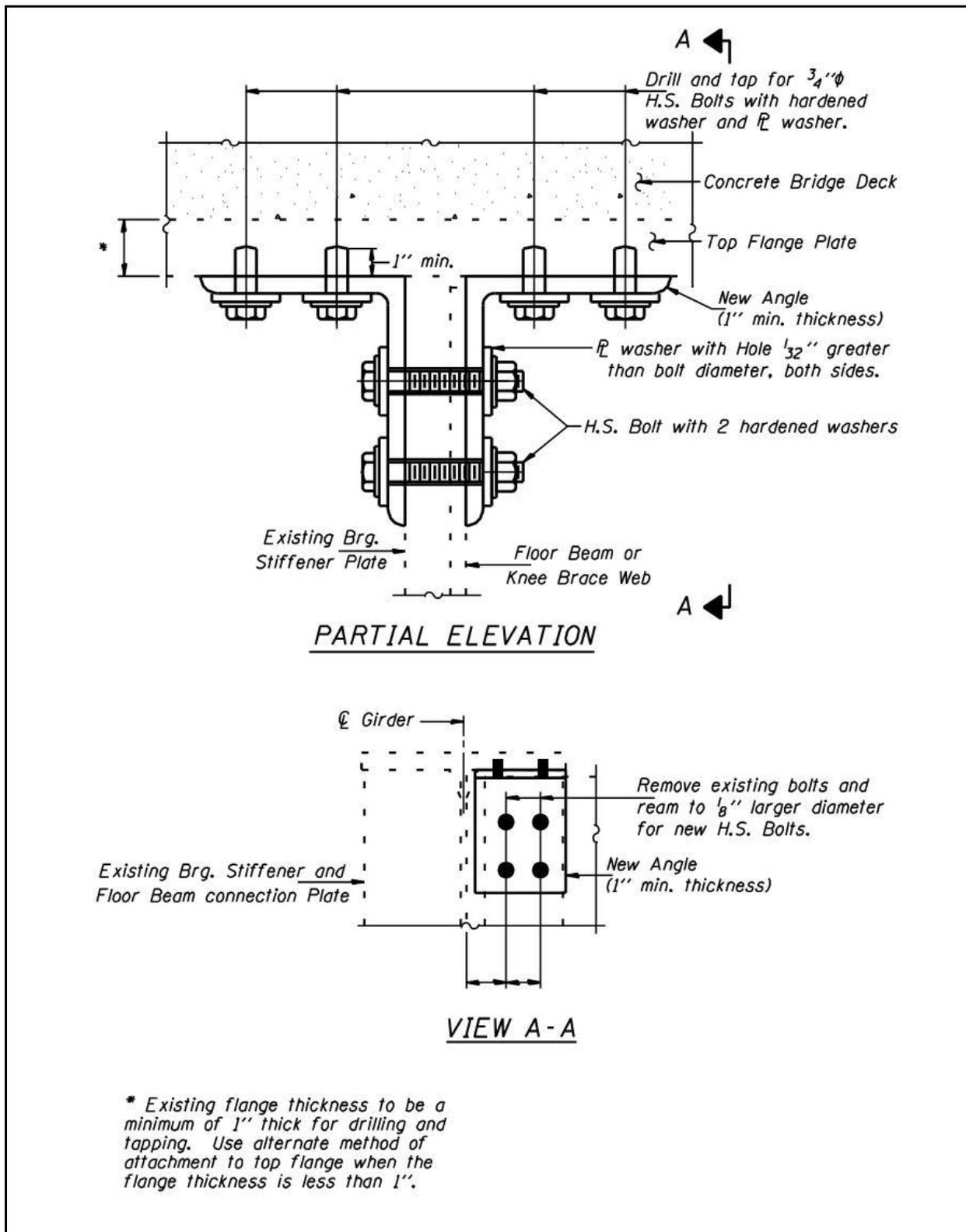


Figure 2.12-6 – Fatigue Repair to Increase Stiffness

To correct the cracks which form in the web near the bottom flange of girder ends located over “frozen” articulated bearings, a portion of the bottom flange and web plate must be repaired as shown in [Figure 2.12-7](#). The defective bearing must also be replaced to prevent cracking from recurring.

Retrofits should be made using bolted details. If welded details are proposed, the stresses in the primary load carrying member at the location to be welded must be considered to determine the effect that welding may have on the fatigue life of the member at that location. Also, if field butt welds are required, they must be tested using nondestructive methods and the method of testing must be specified in the plans.

Tack welds found in the tensile zone areas of a primary load carrying member should be removed by grinding. The grinding should be done parallel to the direction of the primary stress in the member when possible.

When plug welds are found in tensile zone areas, they should be removed by drilling a hole through the plug large enough to remove all of the weld material. If possible, high strength bolts should be installed in the holes drilled to remove the plug welds.

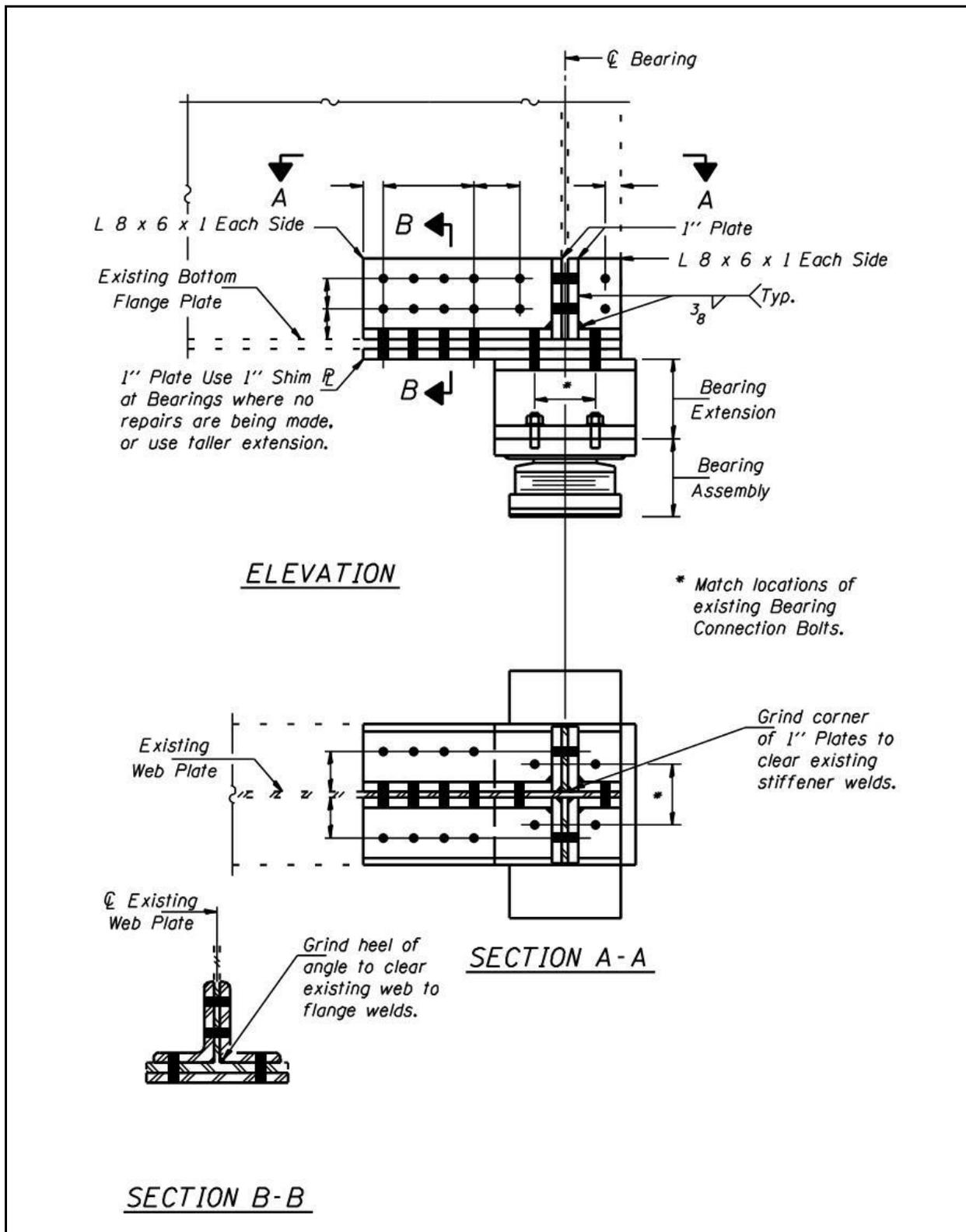


Figure 2.12-7 – Girder End Retrofit

2.13 Impact Repairs - Steel Beams**2.13.1 Determination of Repair Requirements**

Based on the inspection information obtained in accordance with the procedures provided in the Repair Section for the field inspection of impact damaged steel structures, a determination can be made to:

1. Straighten a damaged beam
2. Straighten and strengthen the damaged portion of the beam
3. Replace the damaged portion of the beam

The guidelines presented in the National Cooperative Highway Research Program (NCHRP) Report 271 should be used when determining which of the above actions should be taken to repair an impact damaged steel structure.

The NCHRP Report 271 guidelines for choosing a repair method are based on determining the amount of strain the impact has placed in the steel. The strain induced at any point on the member can be approximated by using the measured impact deflections adjacent to that point to determine a radius of curvature as illustrated in [Figure 2.13-1](#).

Based on the approximate strain, the following NCHRP guidelines should be used to determine the repair requirements for primary tension members:

1. If the strain in the member is equal to or less than the yield point strain of the steel, straightening is not required unless necessary to restore the structure to its original appearance.
2. If the strain in the member is greater than the yield point strain but less than or equal to 15 times the yield point strain, the member can be straightened without strengthening.
3. If the strain in the member is greater than 15 times the yield point strain but less than 5 percent nominal strain, the member can be straightened without strengthening. However, if the damage is located in a highly fatigue susceptible area (lower than category C) the beam should be strengthened by adding material to the beam to provide 50 percent additional cross-sectional beam area in the damaged highly fatigue susceptible area.

4. If the strain in the member is greater than 5 percent nominal strain and straightening is attempted, the beam must be strengthened after straightening to provide additional cross sectional beam area equivalent to the existing beam (100 percent strengthening). Beams with extensive damage exceeding 5 percent nominal strain are typically replaced.

The repair requirement guidelines are illustrated graphically using a stress and strain diagram in [Figure 2.13-2](#). Using approximated impact strains should be considered an aid rather than an exact solution for determining repair requirements. The age of the structure, visibility of the structure to the travelling public, roadway closure requirements during repair operations, plans for future replacement or rehabilitation of the structure and other factors peculiar to each bridge impact situation should be considered when determining the extent of member repairs or replacement required.

The guidelines given for determining repair requirements for primary members in tension or bending are based on the effect of the damage on the serviceability or fatigue life of the member. Compression members are not subject to the same guidelines and may be straightened without strengthening regardless of the impact strain unless fracture has occurred or deformations are too large to allow the member to be adequately straightened.

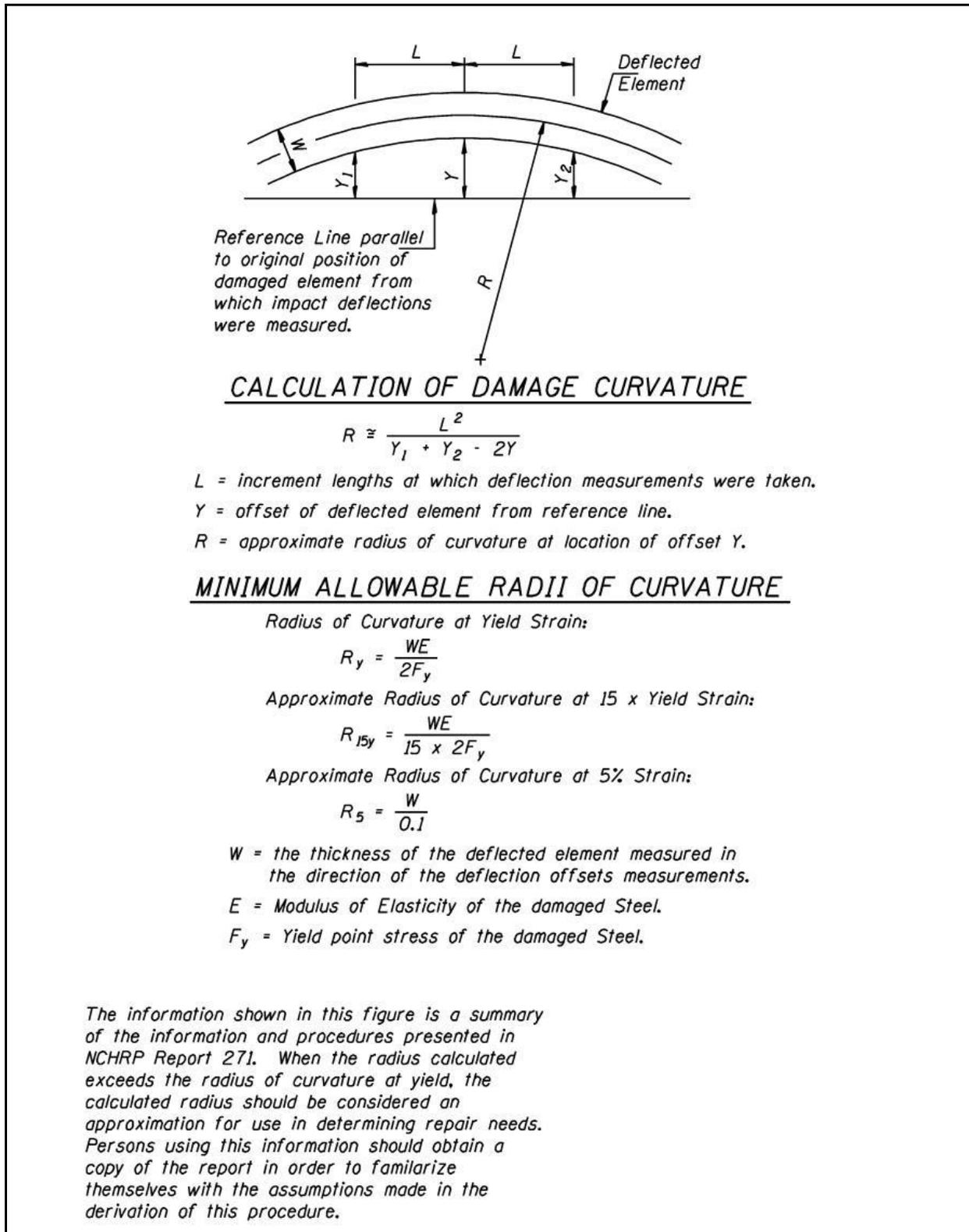


Figure 2.13-1 – Damage Calculations Based on NCHRP 271

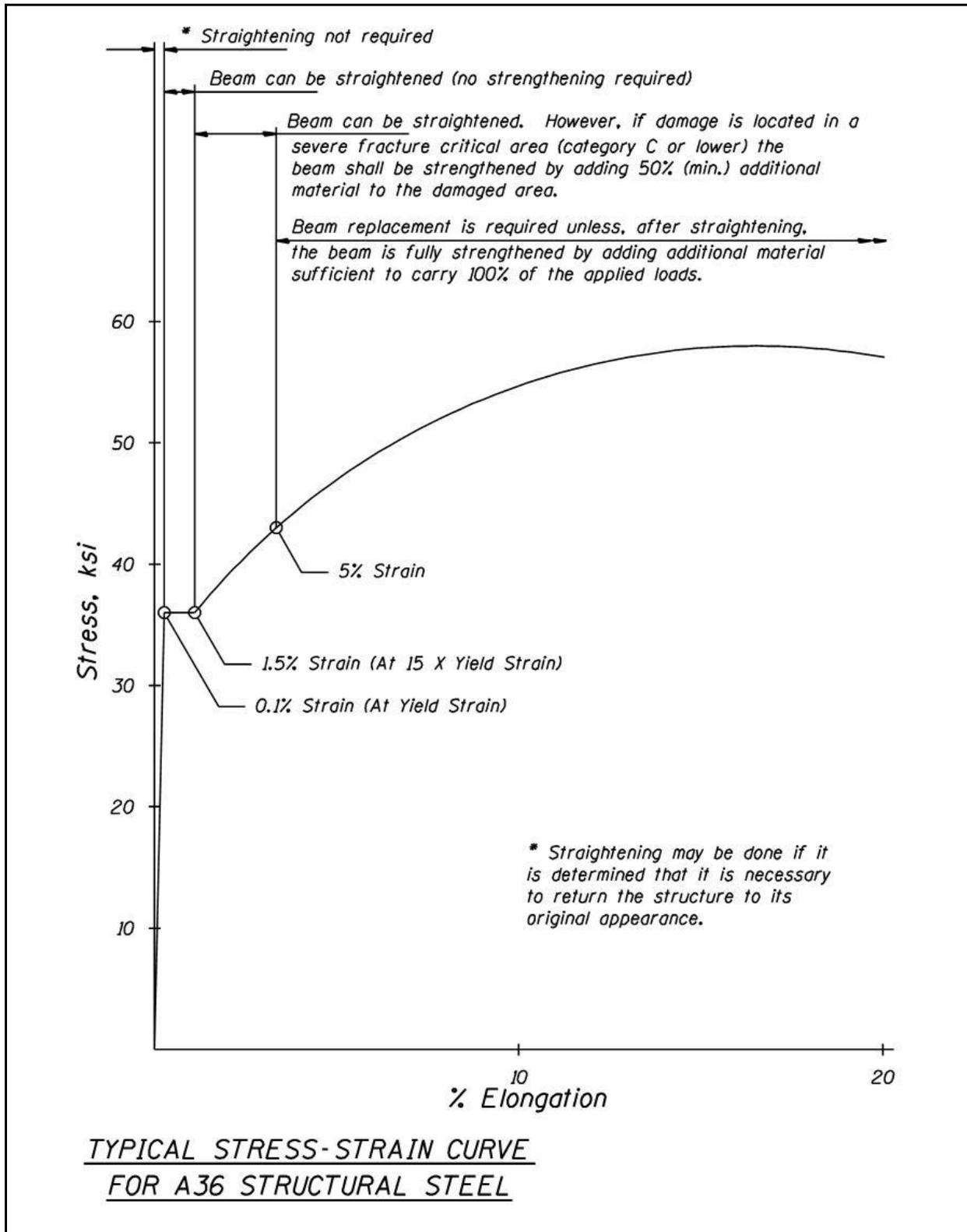


Figure 2.13-2 – General Guidelines Based on NCHRP 271

2.13.2 Beam Straightening and Strengthening

At the present time, IDOT is straightening damaged beams using mechanical methods only. IDOT is currently experimenting with the use of heat to straighten beams. Until the experimental heat straightening projects have been completed and evaluated, damaged beams should only be straightened using mechanical methods.

The mechanical straightening of damaged beams is accomplished using timber bracing, jacks, cables and winches between the beams to push or pull the damaged beam back to its original configuration. Typical details associated with beam straightening are shown in [Figure 2.13-3](#), [Figure 2.13-4](#), and [Figure 2.13-5](#). After straightening, the configuration of the damaged beam should meet the tolerances specified for new fabrication in the current issue of the IDOT *Standard Specifications for Road and Bridge Construction*.

After straightening operations are completed, welded connections in the damaged area must be inspected and welds should be nondestructively tested using magnetic particle or dye penetration testing at locations where visible evidence of damage exists. If cracks are found after straightening, further retrofitting of the member will be necessary.

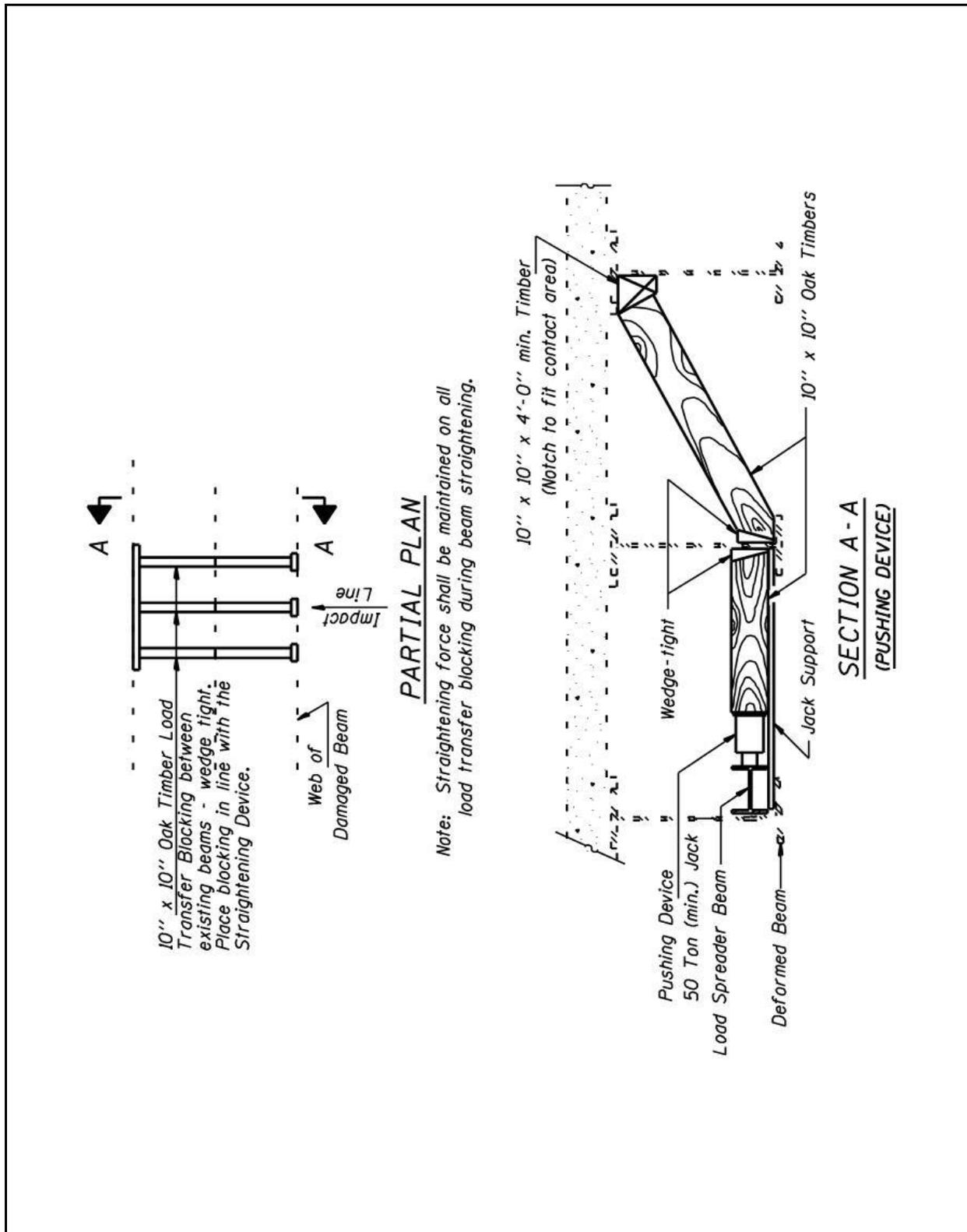


Figure 2.13-3 – Suggested Beam Straightening Methods

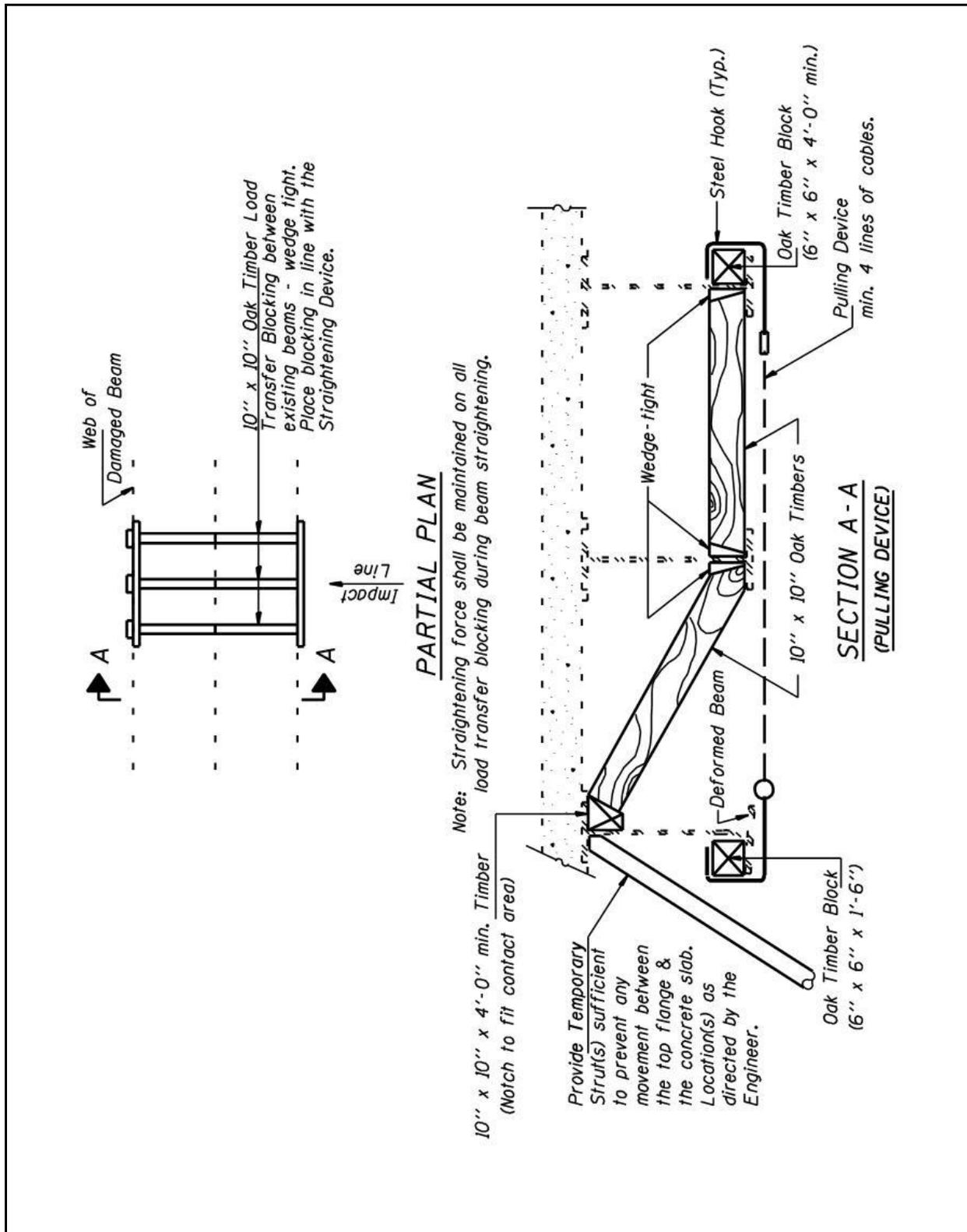


Figure 2.13-4 – Suggested Beam Straightening Methods

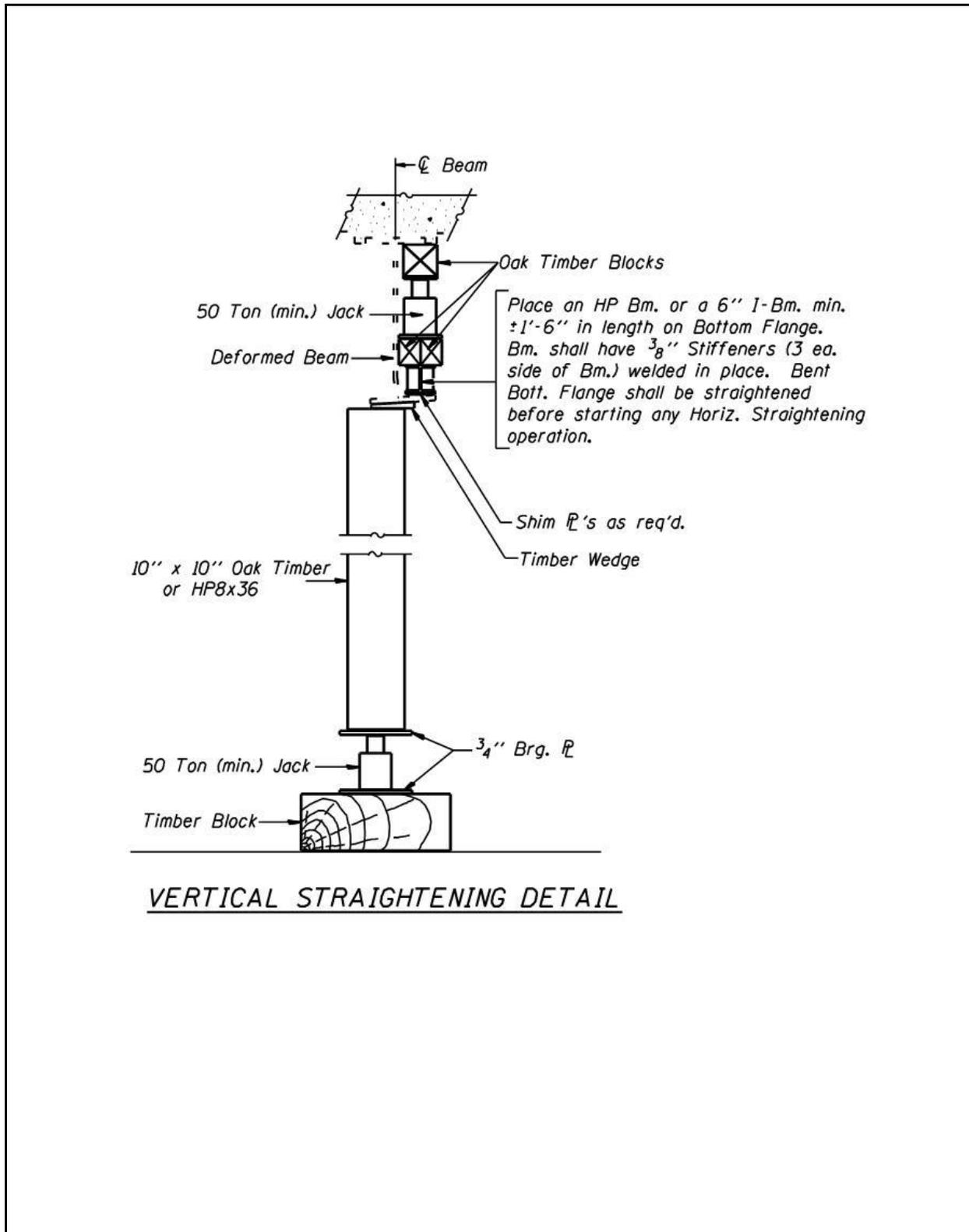


Figure 2.13-5 – Suggested Beam Straightening Methods

When strengthening is necessary after straightening or grinding the damaged area, bolted plates should be used. The plates should be placed continuously through the entire damaged area where the impact strains indicate that strengthening is required, with sufficient bolts to adequately stitch the strengthening plates to the damaged beam. The strengthening plates should extend beyond the above mentioned area for a distance sufficient to install an adequate number of bolts in the flange and/or web to transfer the loads from the strengthening plates to the portion of the beam not requiring strengthening. These requirements are illustrated in [Figure 2.13-6](#).

Gouges caused by the impact should be ground to eliminate sharp or sudden irregularities in the beam surface. Grinding should be done in such a way as to provide a smooth transition with a maximum slope of 3:1 between the damaged and undamaged surfaces as illustrated in [Figure 2.13-7](#). Long or deep gouges should be evaluated to determine if it will be necessary to strengthen the gouged area after grinding. After grinding, the gouged area should be checked for cracks using nondestructive testing methods.

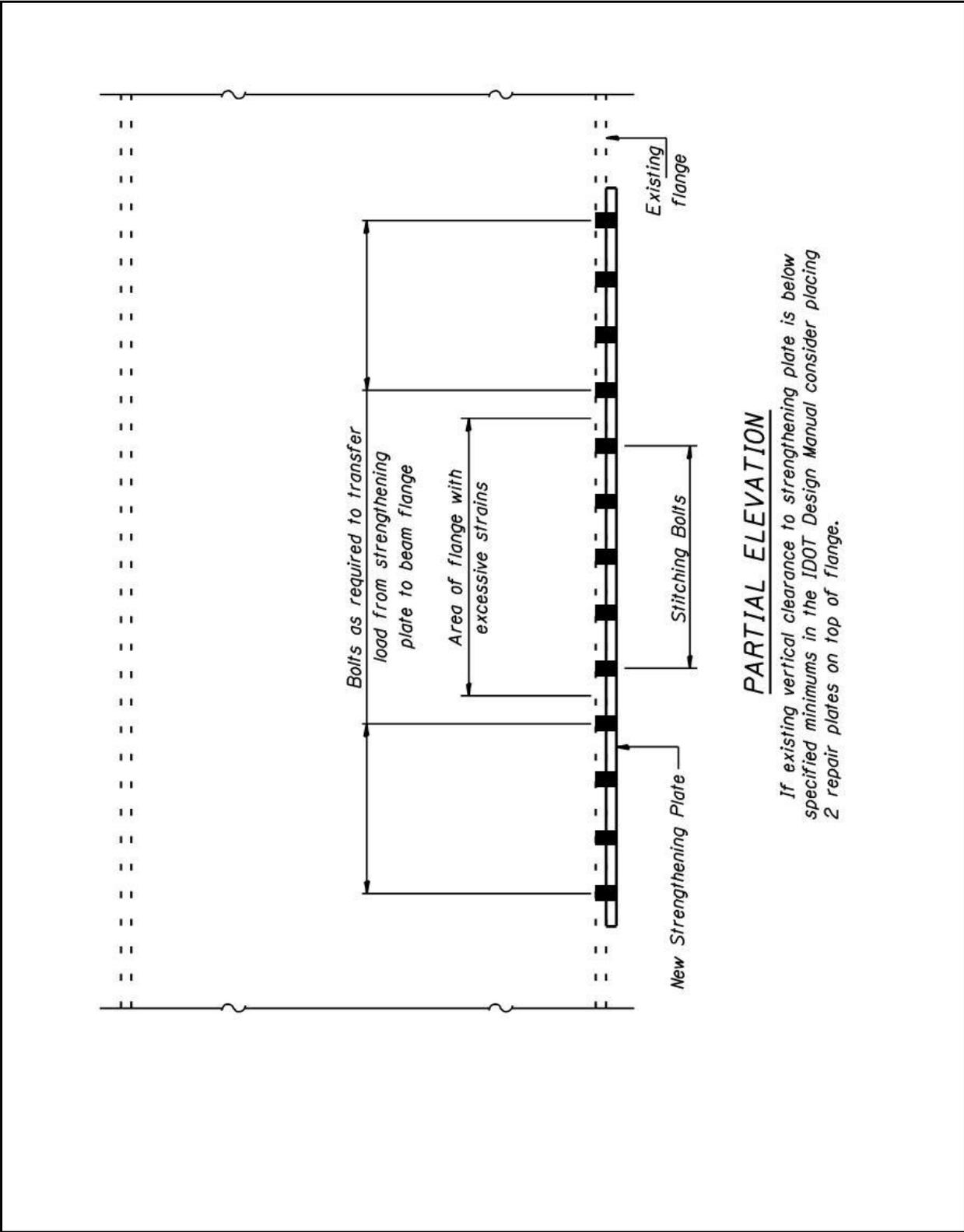


Figure 2.13-6 – Strengthening Details

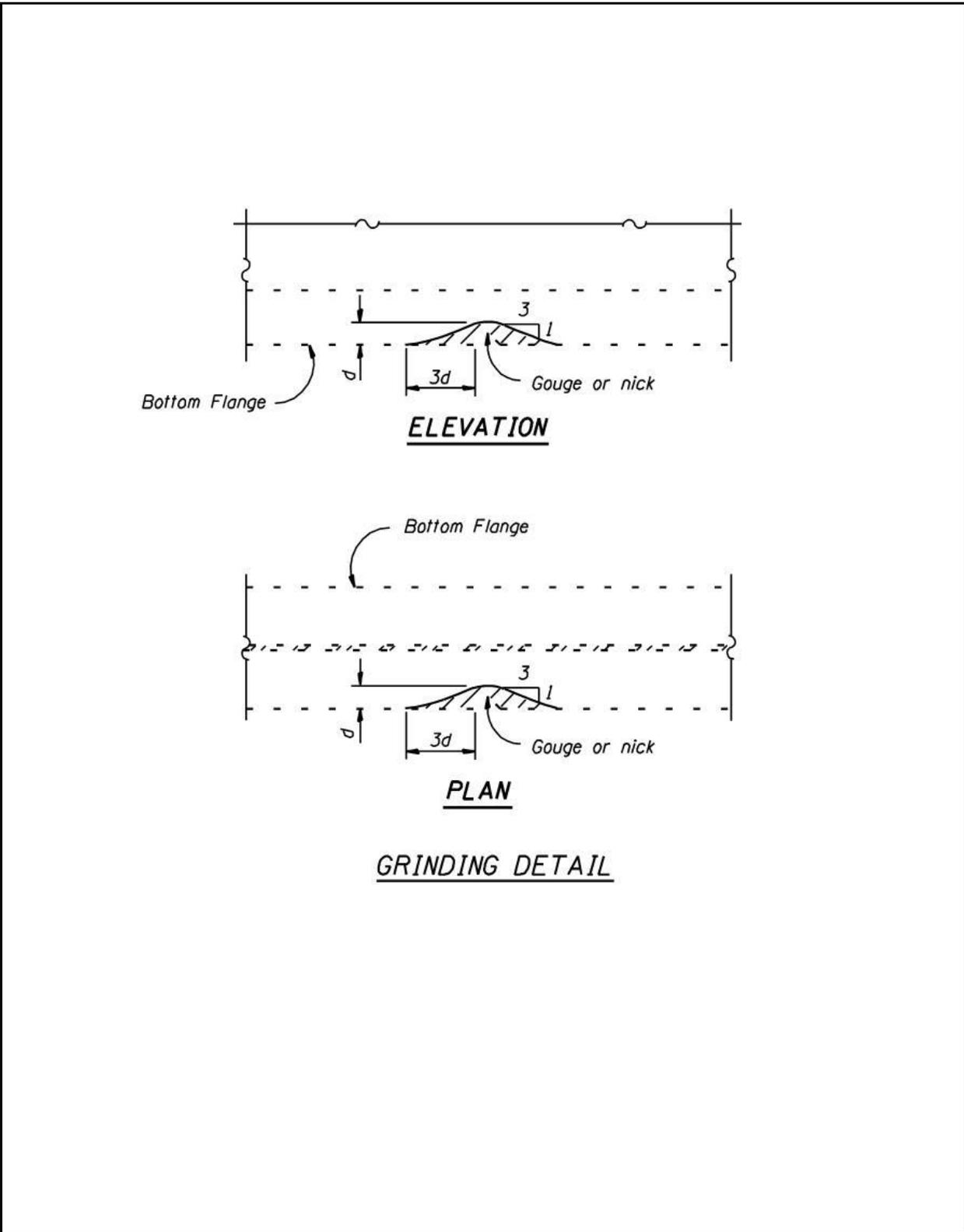


Figure 2.13-7 – Grinding Detail

2.13.3 Beam Replacement

Beam replacements are typically done in the interior span areas of structures between points of dead load contraflexure. Beam splices may be installed at locations where field splices currently exist or at new locations. When an existing splice location is deformed and cannot be straightened for reuse, a new splice can be installed adjacent to the existing splice at a location where the existing beam can be adequately straightened for splicing with the new beam. Occasionally the replacement will extend to a point of simple support. If unavoidable, due to traffic control restraints or other reasons, beam removal and replacement may require a new beam splice at a location where sizable dead load moments occur in addition to the live load moments. The removal and replacement of a portion of the existing deck slab, as shown in [Figure 2.13-8](#), is required at the locations where the top flange of the new and existing beams are to be spliced.

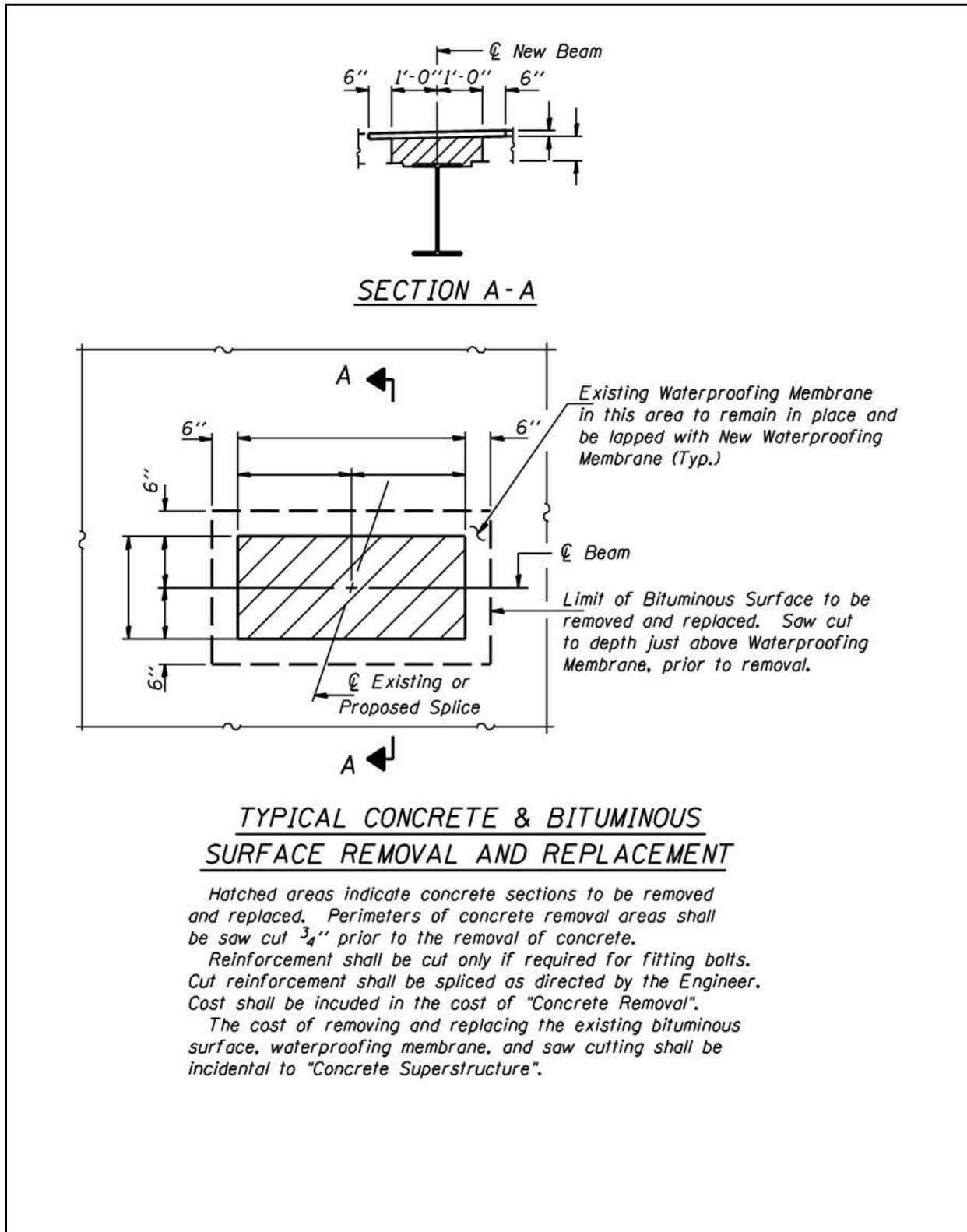


Figure 2.13-8 – Deck Slab Removal for Beam Replacement

Noncomposite beams can be removed and replaced without removing the existing concrete deck slab. However, the deck must be temporarily supported during the replacement of a noncomposite beam. [Figure 2.13-9](#) and [Figure 2.13-10](#) provide details for a method of temporarily supporting a deck slab during the replacement of a damaged noncomposite beam. When inserting a new noncomposite beam into the existing top flange pocket of an existing deck, the edges of the top flange should be ground as shown in [Figure 2.13-11](#) to ease the installation.

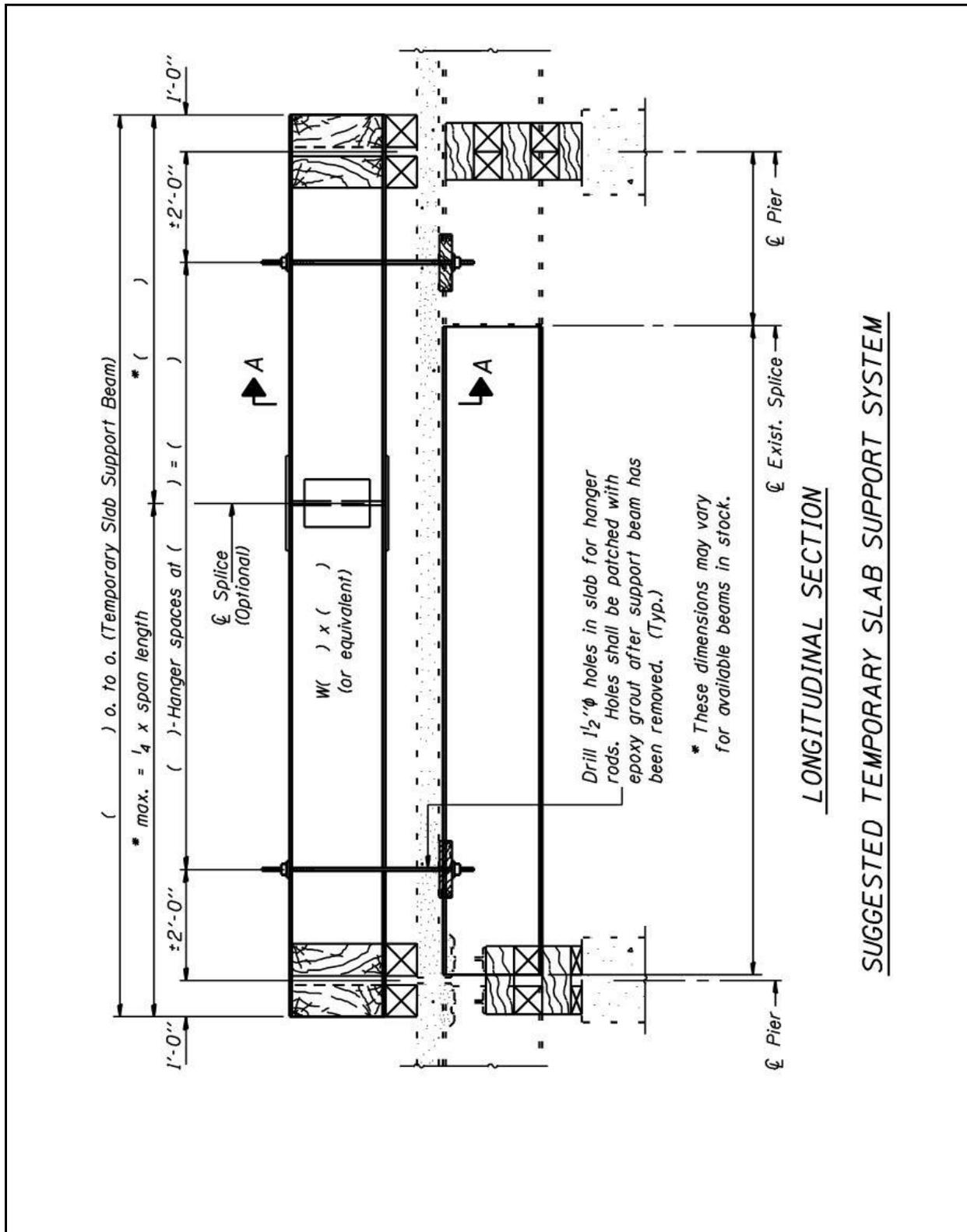


Figure 2.13-9 – Temporary Slab Support Details

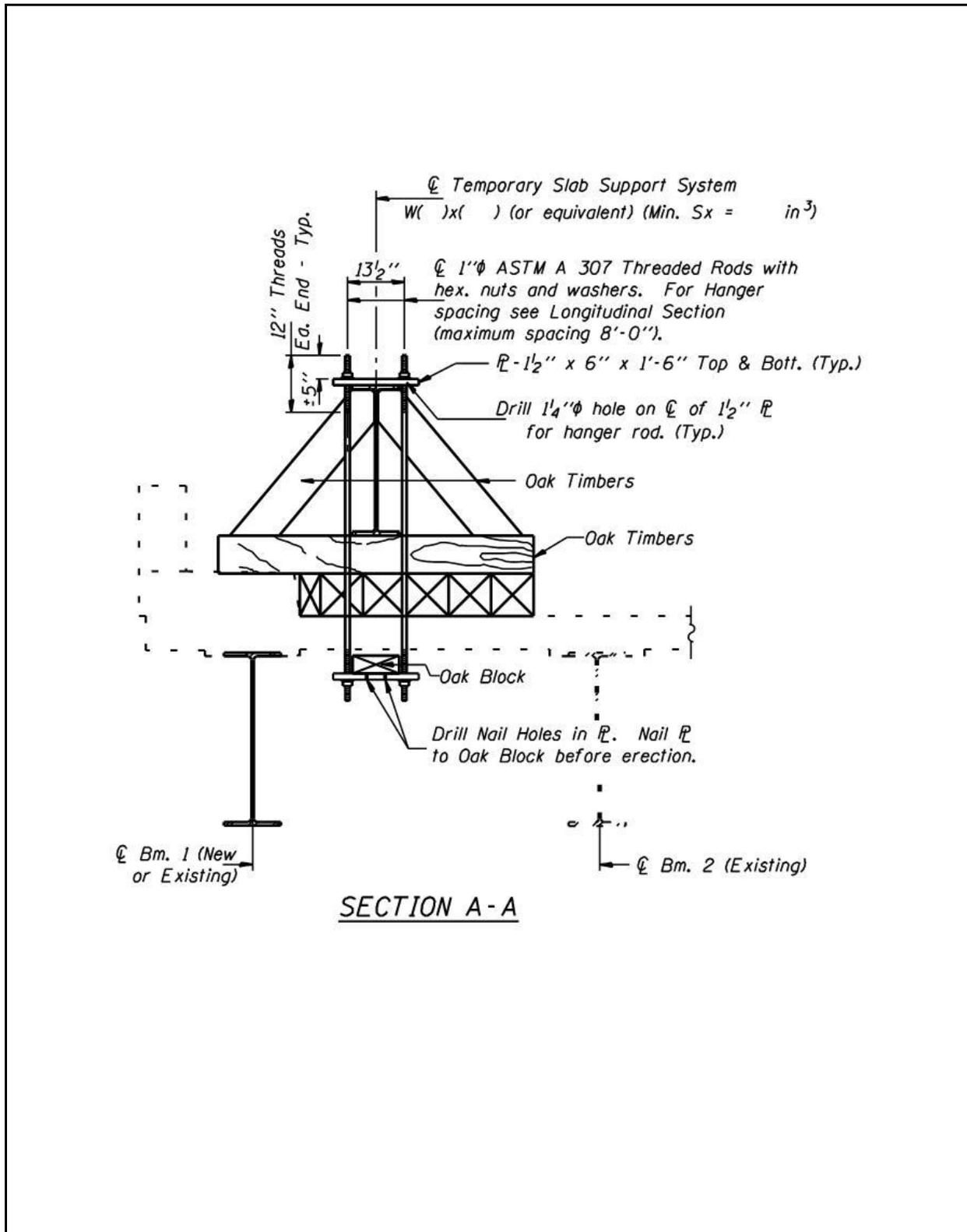
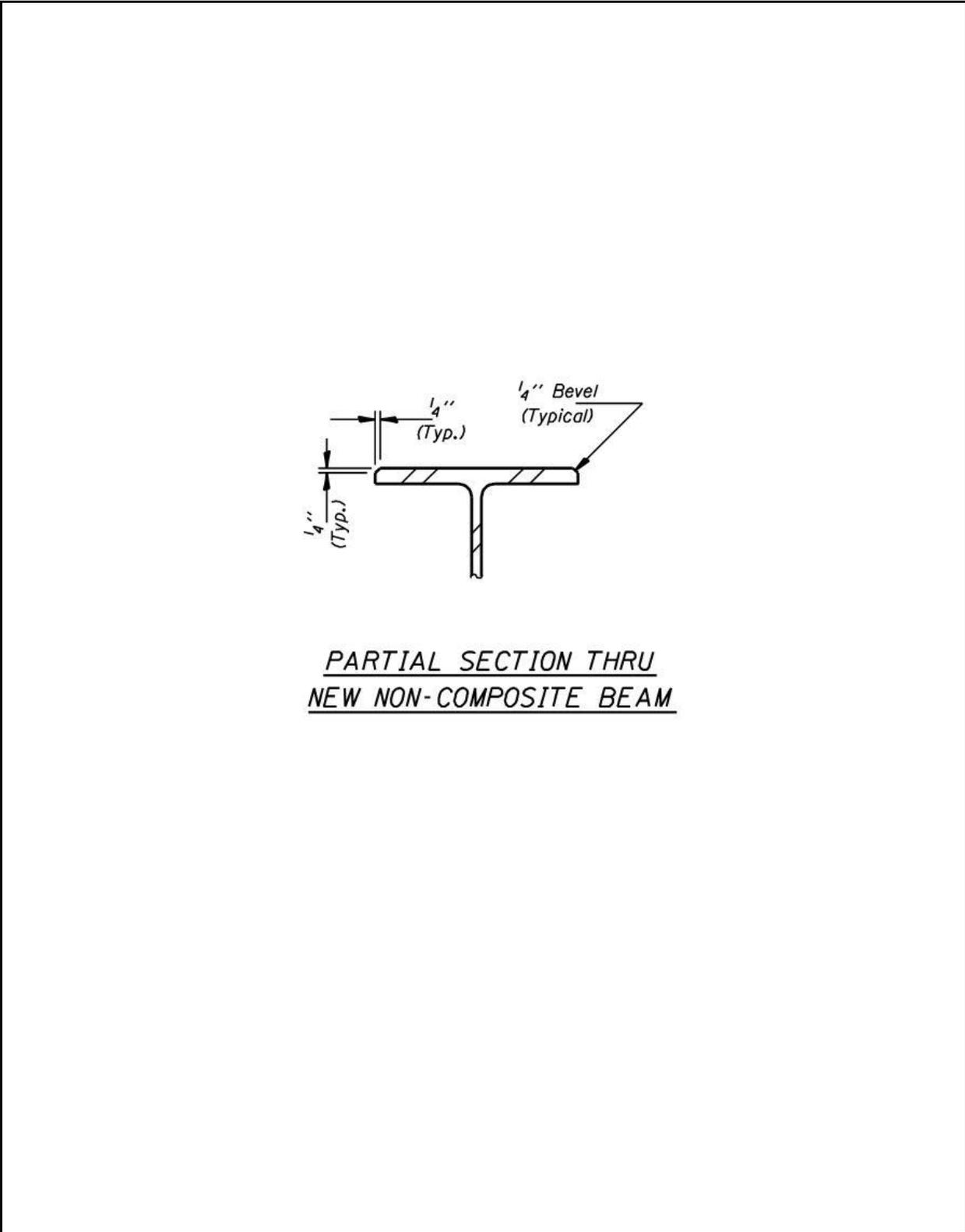


Figure 2.13-10 – Temporary Slab Support Details



PARTIAL SECTION THRU
NEW NON-COMPOSITE BEAM

Figure 2.13-11 – Top Flange Bevel Grind Detail

Removing the existing deck is usually necessary when replacing damaged composite beams. However, if it is not possible to remove the deck for the replacement of the damaged composite beam, the existing top flange can be left in place and a new beam can be field attached to it. The new beam, which is to be attached to the existing beam flange, should be designed as if it were a noncomposite member in order to account for the reduced quality control associated with field welding operations. Although occasionally used to reduce the traffic lane closure time on bridges with very high traffic volumes, this method is discouraged because of the amount of field cutting and welding required. [Figure 2.13-12](#) and [Figure 2.13-13](#) shows the general details for methods which have been used to attach a new beam to an existing composite beam flange which has been left in place.

During beam replacements, temporary shoring and cribbing should be placed under portions of the existing beam which are to remain in place at locations sufficient to maintain the as-built profile of the structure and provide for adjustments during field splicing of the replacement beam. As a minimum, this requires the placement of shoring and cribbing immediately adjacent to the location of the new field splices and, for longer spans, in the spans adjacent to the new field splices.

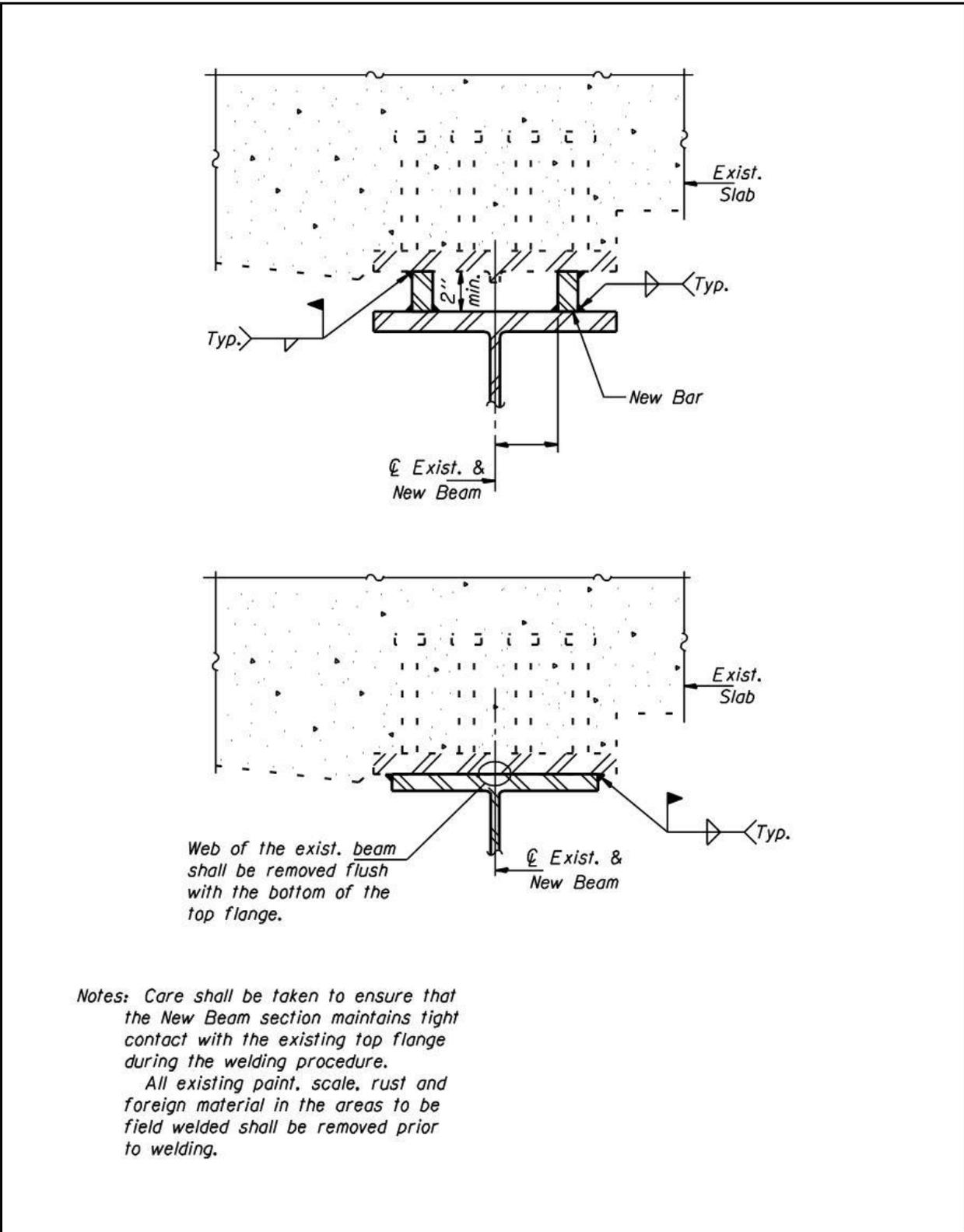


Figure 2.13-12 – Partial Beam Replacement for Composite Beams

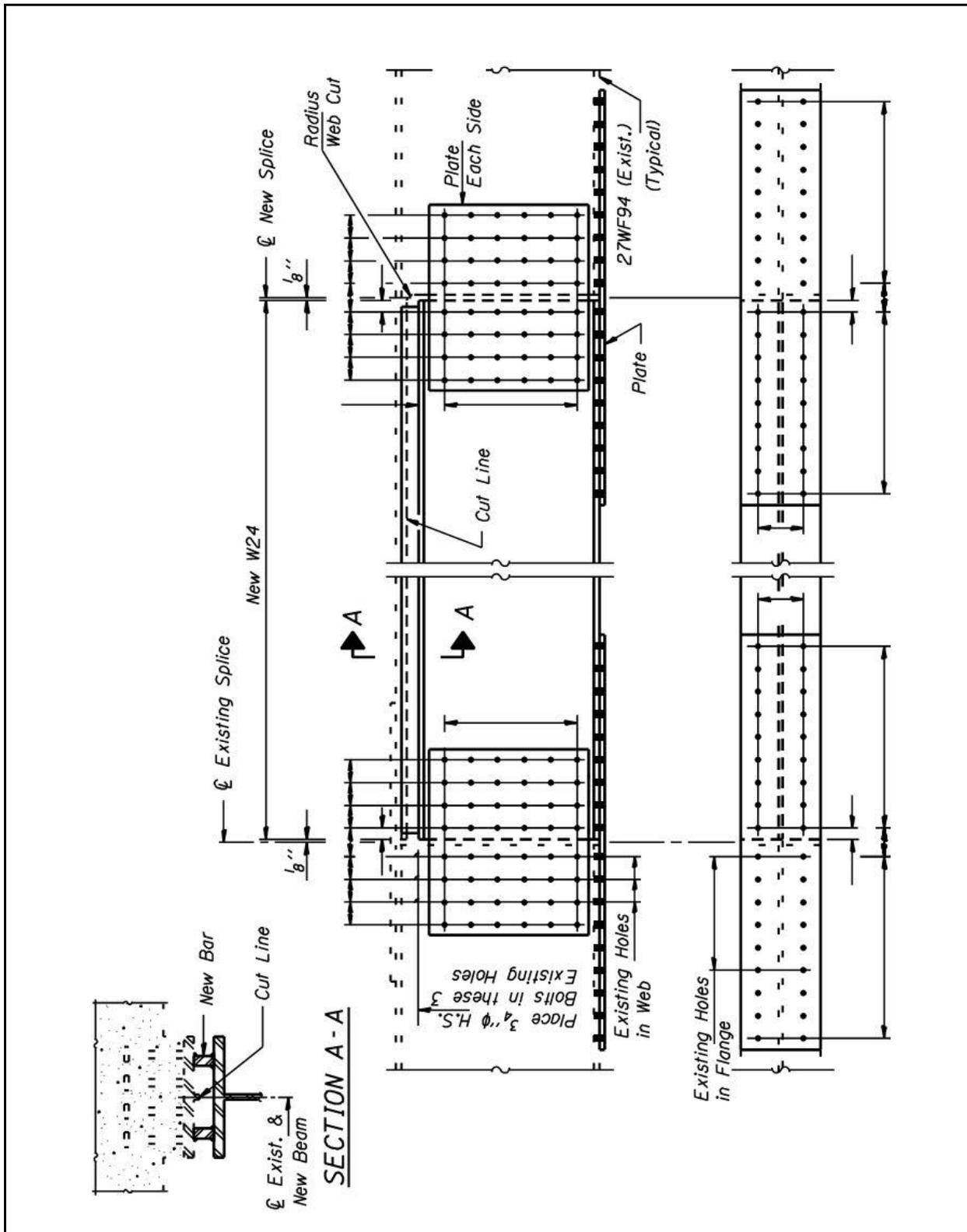


Figure 2.13-13 – Splice for A Composite Beam Partial Replacement

2.13.4 Top Flange to Deck Slab Repairs

After straightening or replacement, the top flange of the beam should be inspected to ensure that it is in solid contact with the deck slab. Any gaps between the top flange of the beam and the deck slab should be injected with epoxy to provide positive contact with the deck slab. Also, damaged or missing concrete fillets encasing the top flange of noncomposite beams should be evaluated to determine the effect of the missing fillets on the strength of the beam's compression flange. Only when substantial lateral movement of the top flange is occurring should top flange restrainers be installed. The restrainers should be located in the area of missing concrete fillets to provide lateral restraint for the compression flange in positive moment areas as shown in [Figure 2.13-14](#).

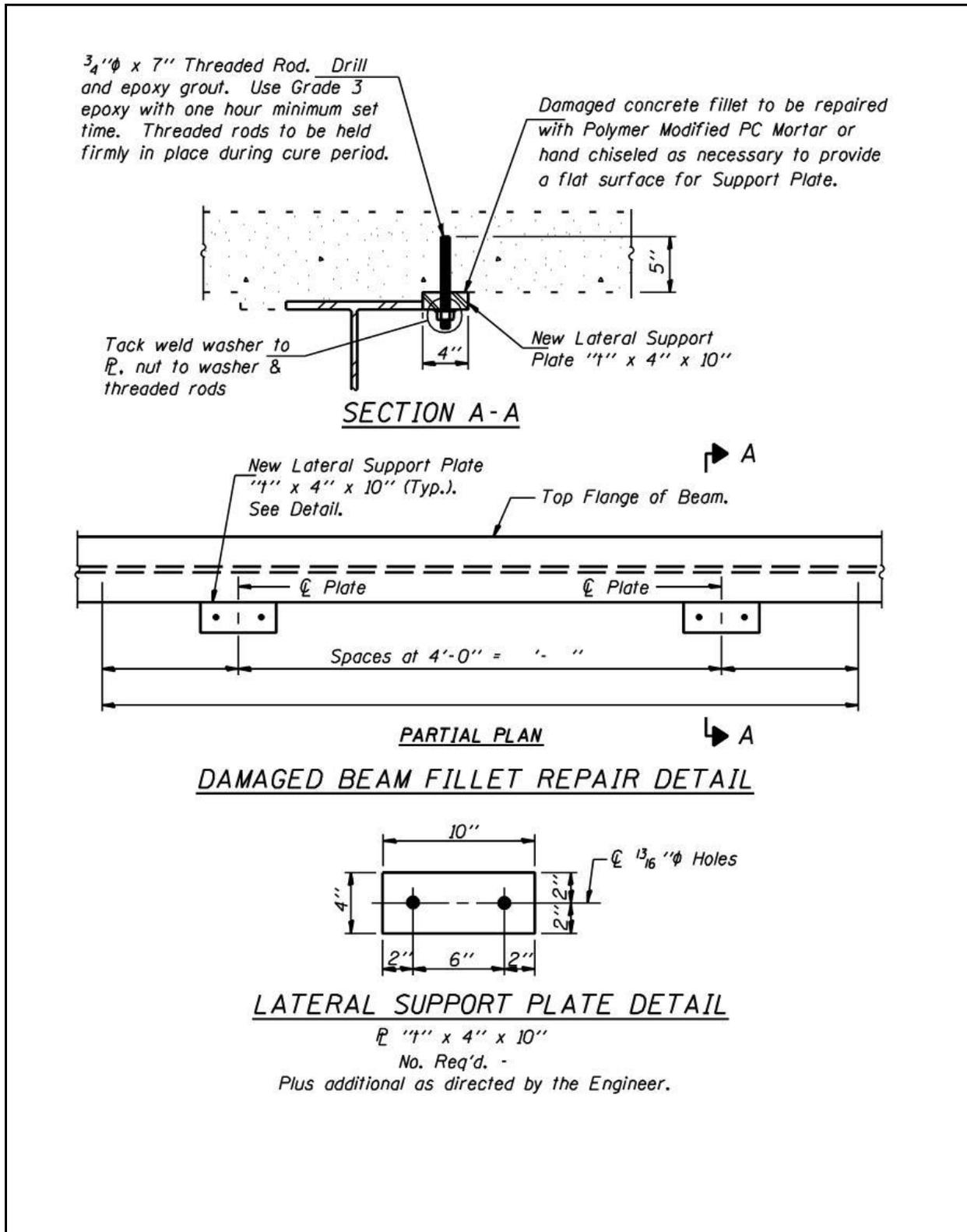


Figure 2.13-14 – Fillet Repairs and Layout of Locations

2.14 Impact Repairs - Concrete Beams*2.14.1 General*

When concrete beams are struck and an area of concrete is removed from the beam by the impact, a decision must be made to repair or replace the member. Often a decision to replace a concrete member is based on the extent of the damage rather than the effect of the missing concrete on the strength of the member. Damage is usually located on the bottom of a member located over traffic. If the missing concrete is to be replaced, measures must be taken to ensure that the concrete patch will be securely anchored in place to protect the strands and cannot eventually loosen and spall off.

2.14.2 Preloading

To ensure that an area of repair concrete will remain in place, anchors should be installed in the existing beam and a preload should be applied to the structure during the repair and curing period. After the repair concrete has cured, the preload should be removed from the structure to effectively place the concrete repair in compression. The preload used should approximate the effect on the member of the passage of a maximum legally loaded vehicle crossing the structure. An analysis is required to determine:

- The existing stresses in the damaged member
- The stresses in the damaged member during preloading
- The stresses in the repaired member after the preloading is removed

If the analysis shows excessive stresses in the member during the necessary repair procedures, the member should be replaced. For the repair of precast prestressed concrete beams, the guidelines given in the National Cooperative Highway Research Program (NCHRP) Report 280 should be used.

The preload used during the repair of the damaged member can consist of loaded vehicles, tacked pig iron, concrete barriers or any load determined to approximate the effect of the maximum legally loaded vehicle on the member (provided the damaged beam is capable of carrying the preload).

2.14.3 Repair Procedures

The concrete patches should be keyed into the existing member by making shallow saw cuts along the perimeter of the proposed patch and removing the damaged concrete in such a way as to provide a square (unfeathered) edge along the perimeter of the replacement concrete. Contact with the existing prestressing strands must not occur during the sawcutting operations. Patching details associated with the repair of a PPC I-beam are shown in [Figure 2.14-1](#).

If the damage is located on an interior beam which is protected from the elements and analysis shows that the missing concrete does not affect the strength of the member, replacement of the missing concrete may not be necessary. However, all exposed reinforcement bars and prestressing strands should be cleaned and coated with epoxy to prevent deterioration.

All cracks in the members should be located and repaired using epoxy injection. Precast prestressed concrete members should be preloaded prior to and during the curing period of the epoxy crack repairs. Again, the effect of the preload on the damaged member should be analyzed prior to its application.

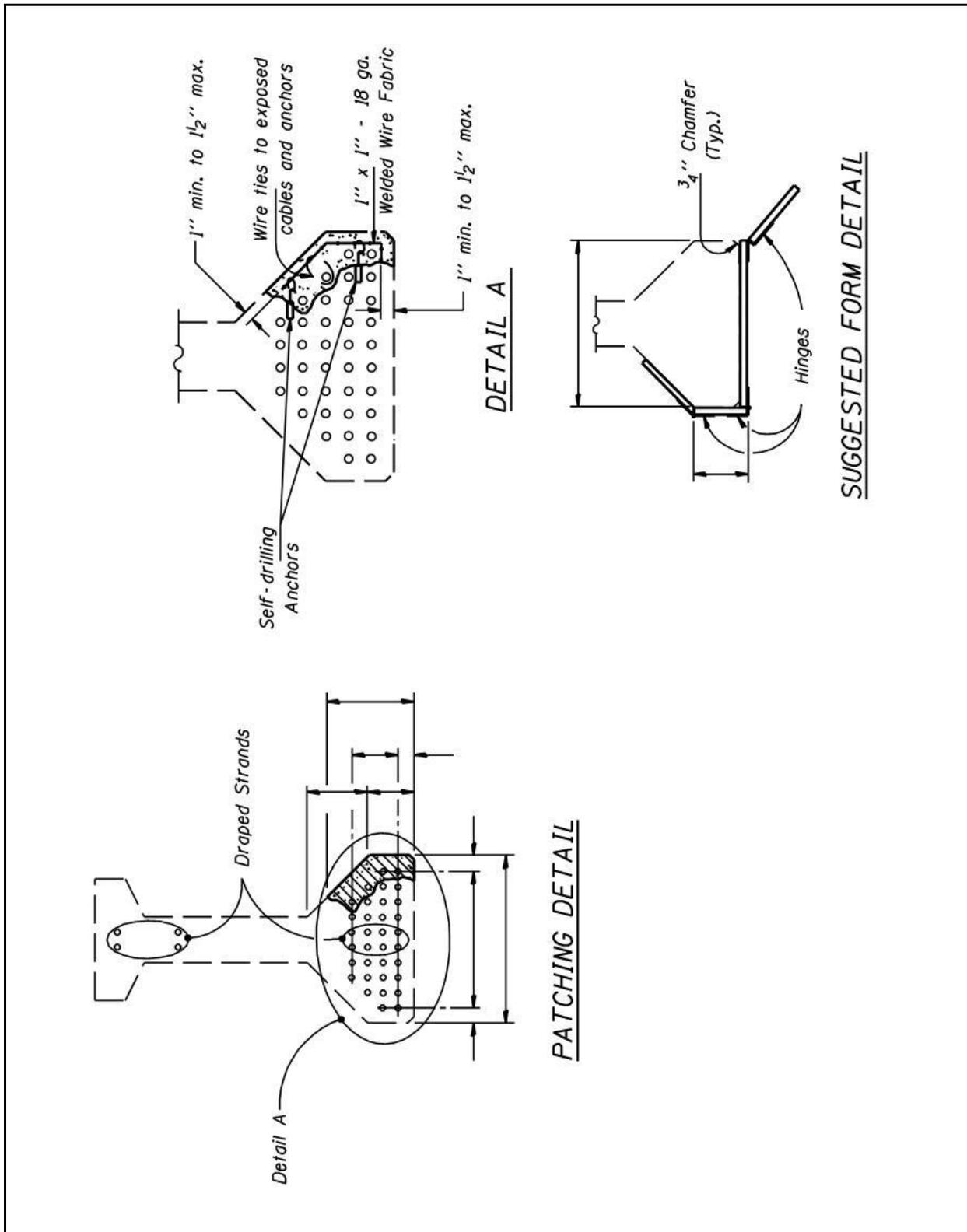


Figure 2.14-1 – PPC I Beam Impact Repair

2.15 Steel Superstructure Repairs

2.15.1 General

The major cause of the deterioration of steel superstructure elements is the exposure of the members to moisture and deicing agents. The types of deterioration most often encountered include:

- Section loss in beams, girders and diaphragms adjacent to unsealed or leaking expansion joints.
- Section loss in the bottom flange and lower web of beams and girders located beneath unextended deck drains.
- Section loss in stringers and floorbeams located near unsealed or defective expansion joints or deck relief joints.
- Section loss in truss members in the splash zone area and in areas prone to the collection of debris.

Although not as common as deterioration from exposure, steel members must occasionally be repaired to correct damage occurring to members during the construction operations associated with rehabilitation projects.

Repairs will often be required for a number of members located adjacent to different expansion joints or deck drains on the same structure. The length or extent of deterioration will vary from member to member and the type of repair required will be identical except for the length or depth dimensions of the repair. Rather than preparing an individual repair detail for each location, the number of repair details used should be minimized whenever possible by using the details developed for the location with greatest extent of deterioration at the locations with less deterioration.

Severely deteriorated or damaged diaphragms should be completely replaced rather than repaired. The cost of the labor involved to repair a defective diaphragm is usually enough to make the complete replacement of the diaphragm the most economical choice. Replacement diaphragms should be detailed to minimize field installation difficulties by bolting the connection angles to the diaphragm and specifying oversized holes.

Locations where complete or severe loss of section has occurred should be repaired even when the load carrying capacity of the member has not been affected. The corrosion holes or areas of severe section loss should be repaired by placing new steel plates on both sides of the deteriorated member to prevent further deterioration. The plates should be a minimum of 3/8 inch in thickness and the spacing of the bolts used to attach the plates should meet the AASHTO requirements for stitching and sealing.

2.15.2 Beam and Girder Repairs

The girder end retrofit shown for the repair of cracks over frozen bearings in the Fatigue chapter of this Section can also be used to repair ends of members which have experienced severe section loss in the area of their bottom flange and lower web. When the deterioration is restricted to the upper area of the web near the attachments to the diaphragms, plates can be added to the web and the diaphragms can be adjusted or replaced if necessary as shown in [Figure 2.15-1](#). When the section loss extends into the lower web and bottom flange area of the member, repair can be made using plates and angles as shown in [Figure 2.15-2](#) and [Figure 2.15-3](#) or channel sections as shown in [Figure 2.15-4](#).

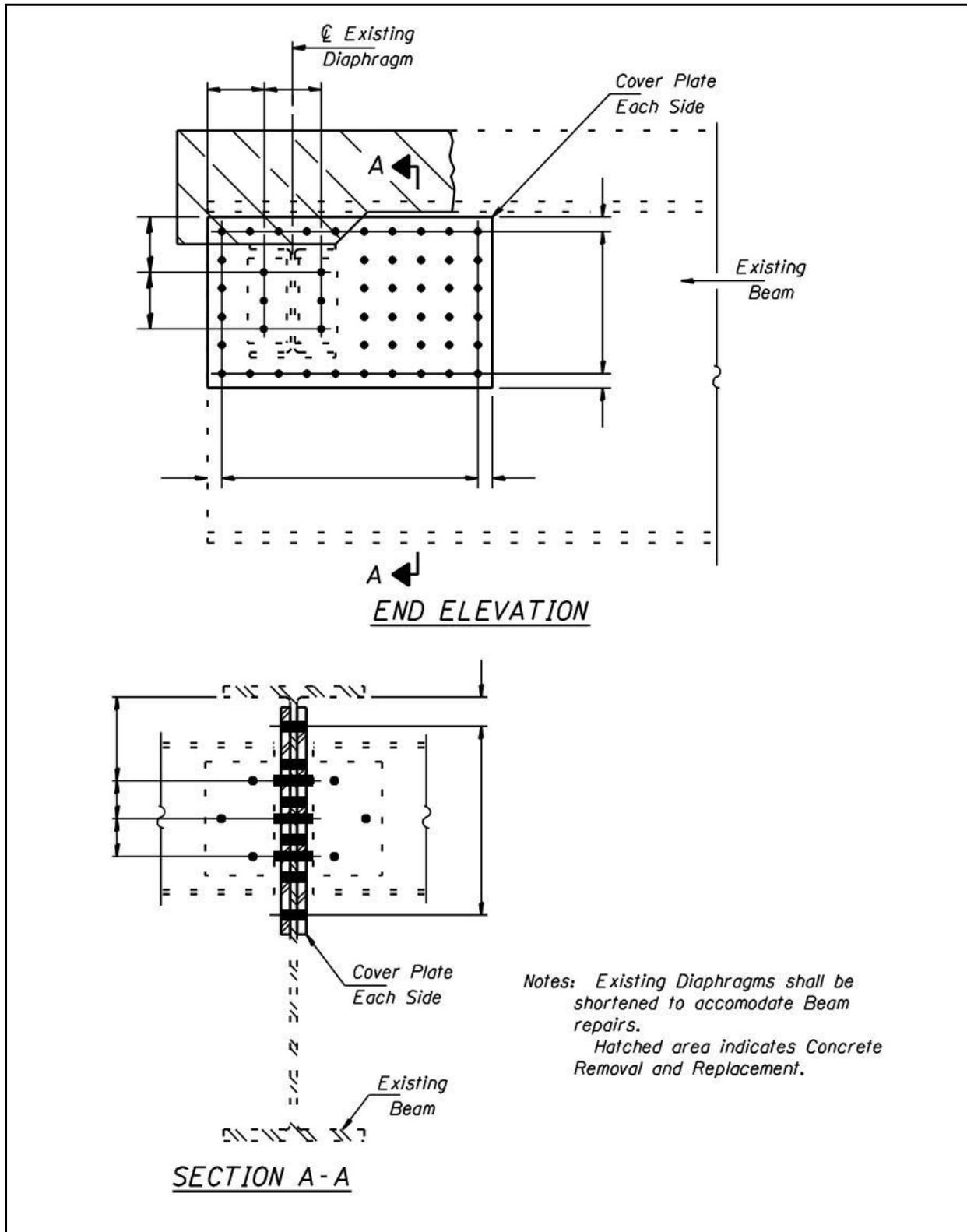


Figure 2.15-1 – End of Beam Repair Detail

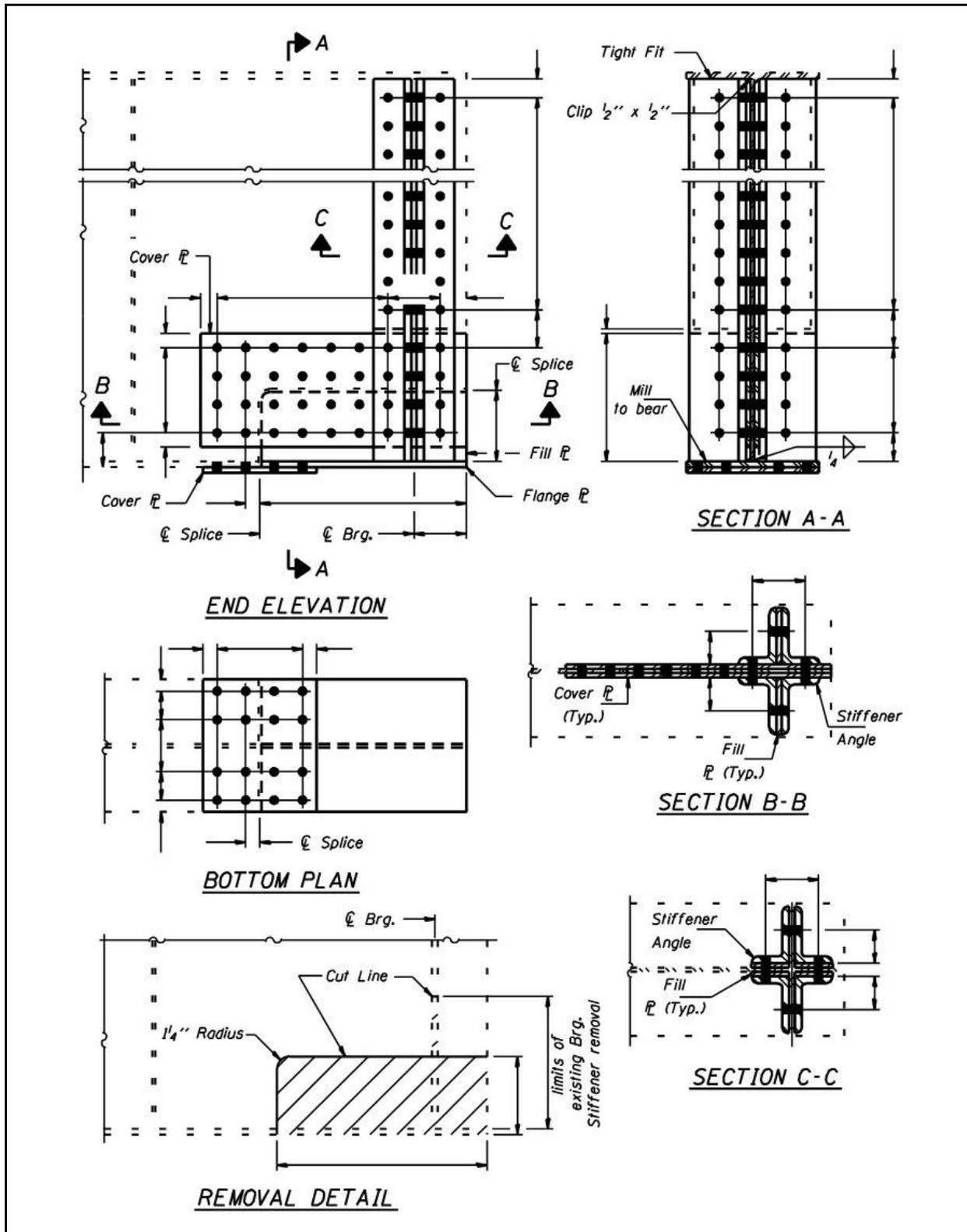


Figure 2.15-2 – Girder End Retrofit

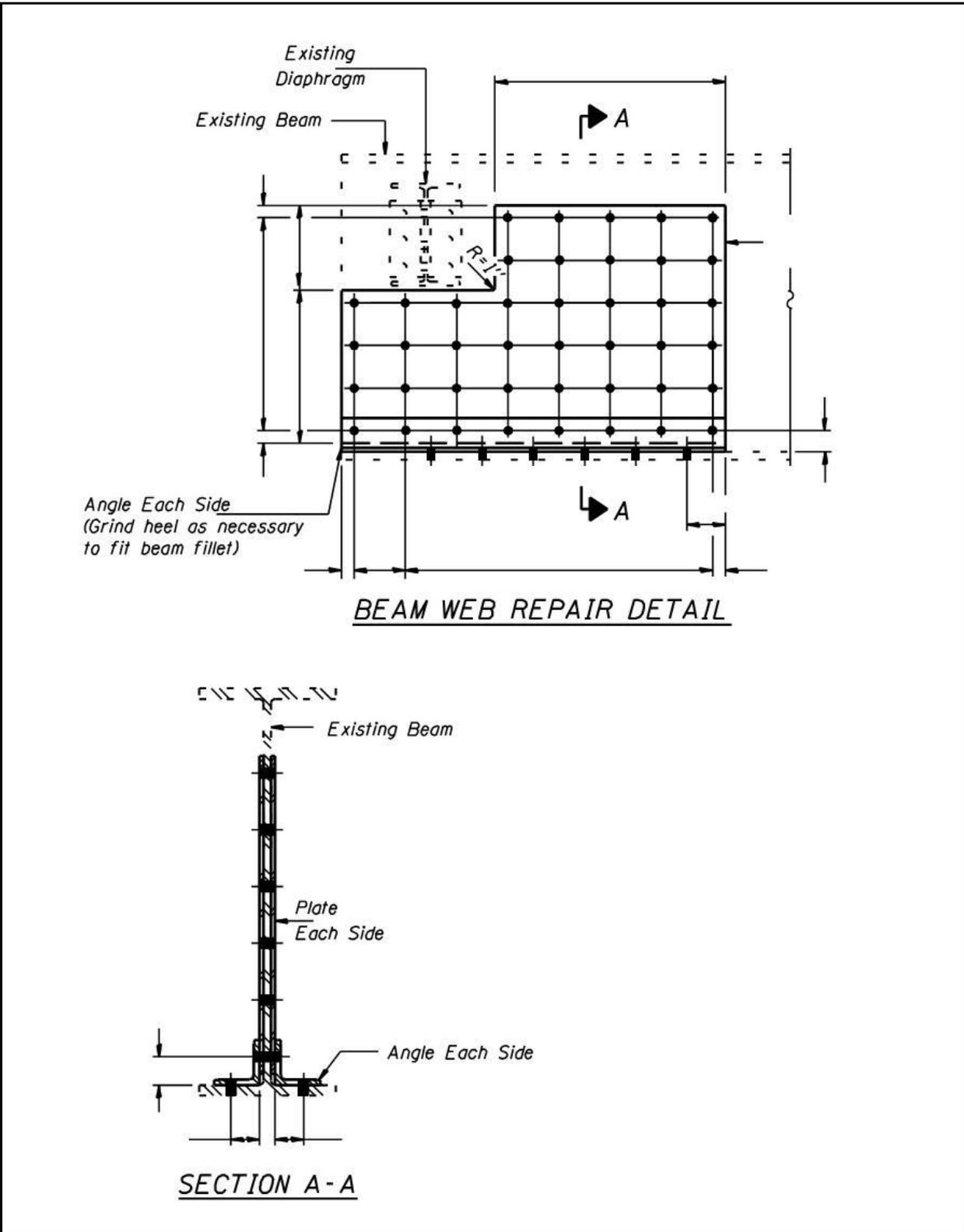


Figure 2.15-3 – End of Beam Repair Detail

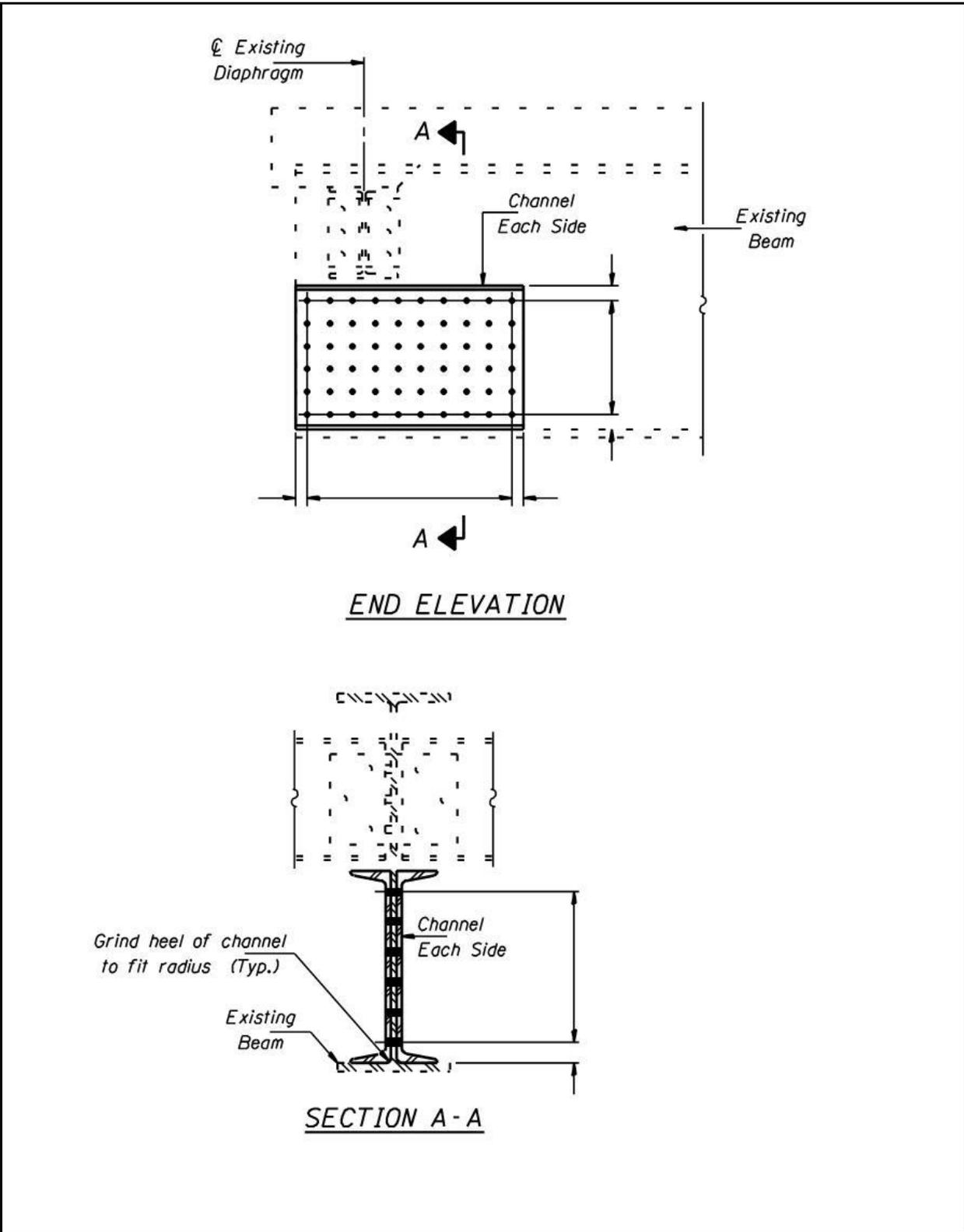


Figure 2.15-4 – End of Beam Repair Detail

The section loss, which occurs in the bottom flange and lower web of a member located beneath a deck drain, should be measured to determine the effect of the section loss on the load carrying capacity of the member. When the deterioration is located on a tension flange, the affected area should be ground parallel to the primary stress in the beam to remove sharp corners and deep rifts in the material. The grinding should be tapered into the undamaged areas at a 3:1 slope similar to that shown elsewhere in this Section for grinding impact gouges on steel beams. When load carrying capacity must be restored, splice plates should be placed across the deteriorated portion of the web and bottom flange, as shown in [Figure 2.15-5](#). Holes in the lower portion of the web should be repaired by placing plates on both sides of the web to prevent further deterioration. Whenever possible, the drains adjacent to the problem area should be eliminated or extended to discharge below the member to prevent recurrence of the deterioration.

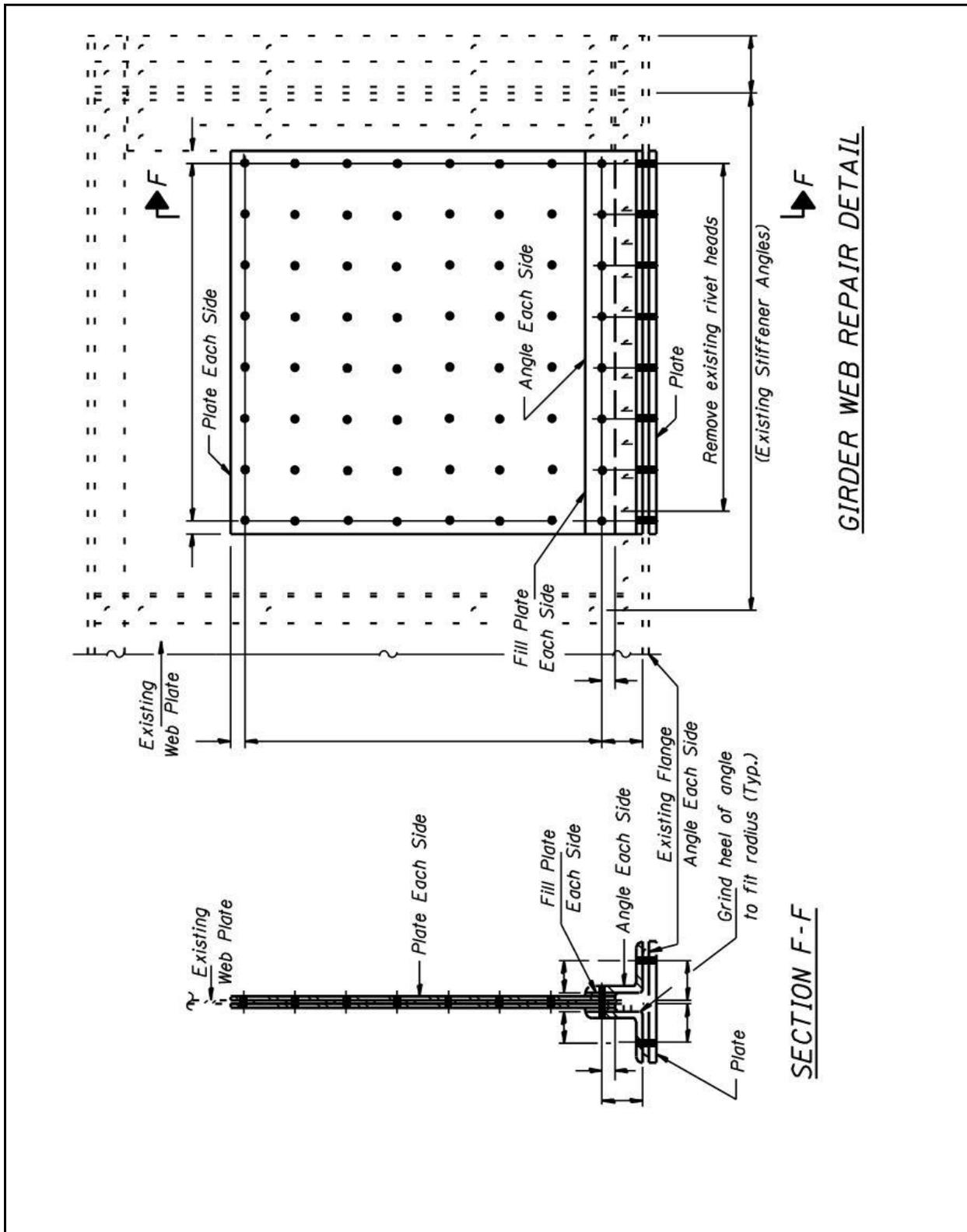


Figure 2.15-5 – Built-Up Floor Beam Repair Detail

2.15.3 Stringer and Floorbeam Repairs

Severe section loss in the ends of stringers at expansion/relief joints can be repaired by attaching a channel section to each side of the stringer as shown in [Figure 2.15-6](#) and [Figure 2.15-7](#). The bottom flanges of the channel sections should be placed tightly against the bottom flange of the deteriorated stringer when the stringer is supported on a seat bracket and is not connected to the floorbeam by web clip angles. Steel plates and angle sections can also be used as shown in [Figure 2.15-8](#) for a “slip type” connection when the deterioration is limited to the lower web area and bottom flange of the existing stringer.

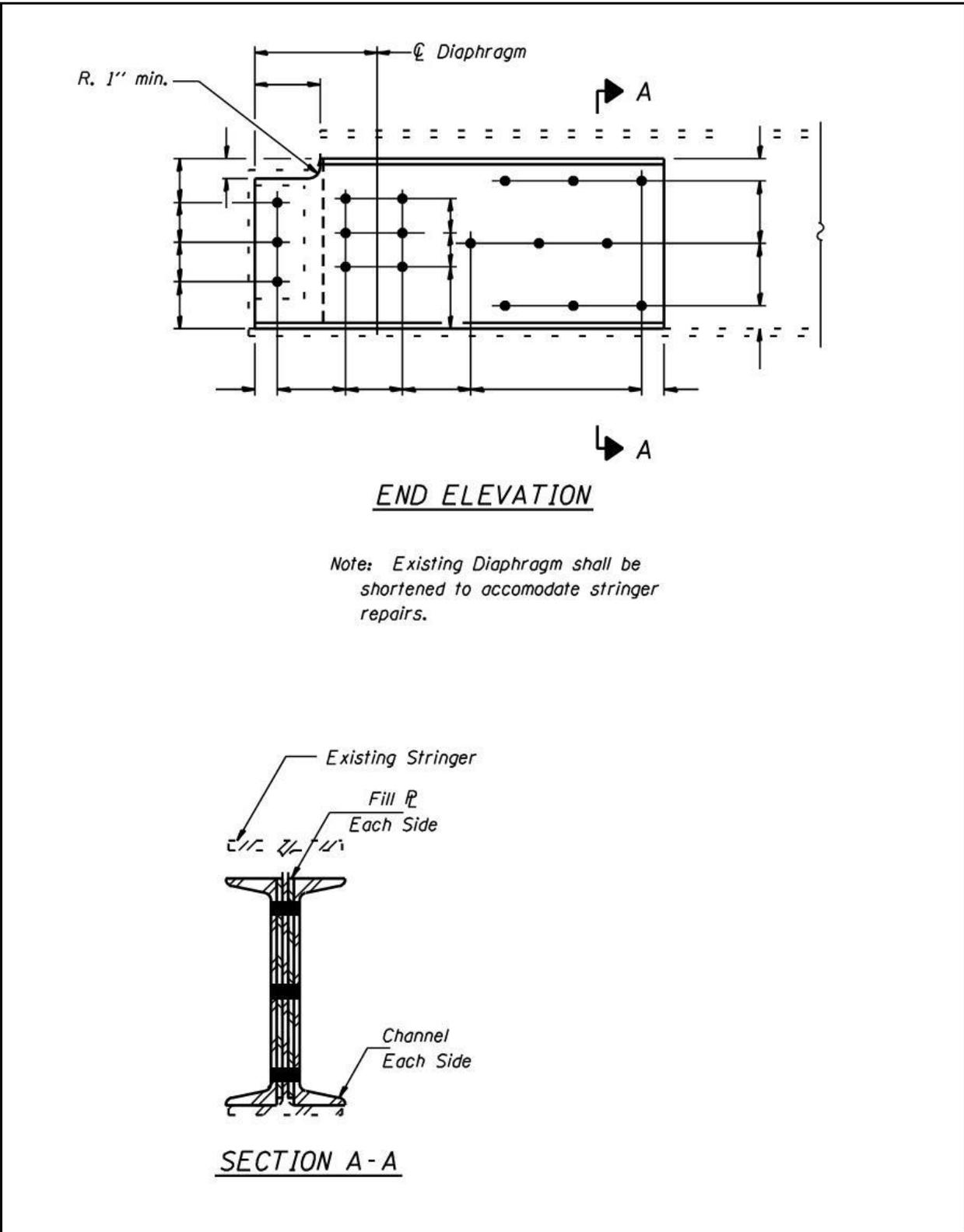
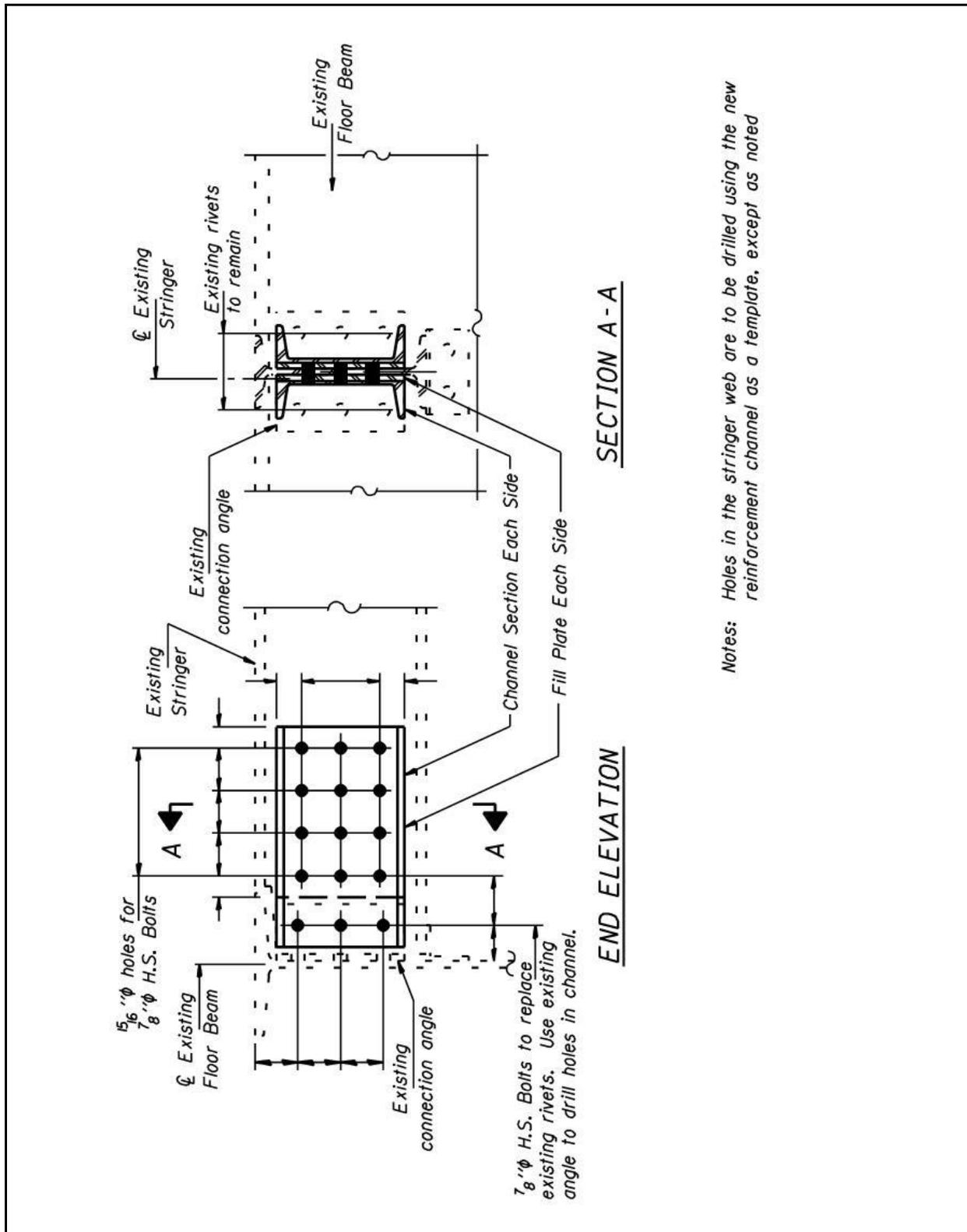


Figure 2.15-6 – End of Stringer Repair Detail



Notes: Holes in the stringer web are to be drilled using the new reinforcement channel as a template, except as noted

Figure 2.15-7 – End of Stringer Repair Detail

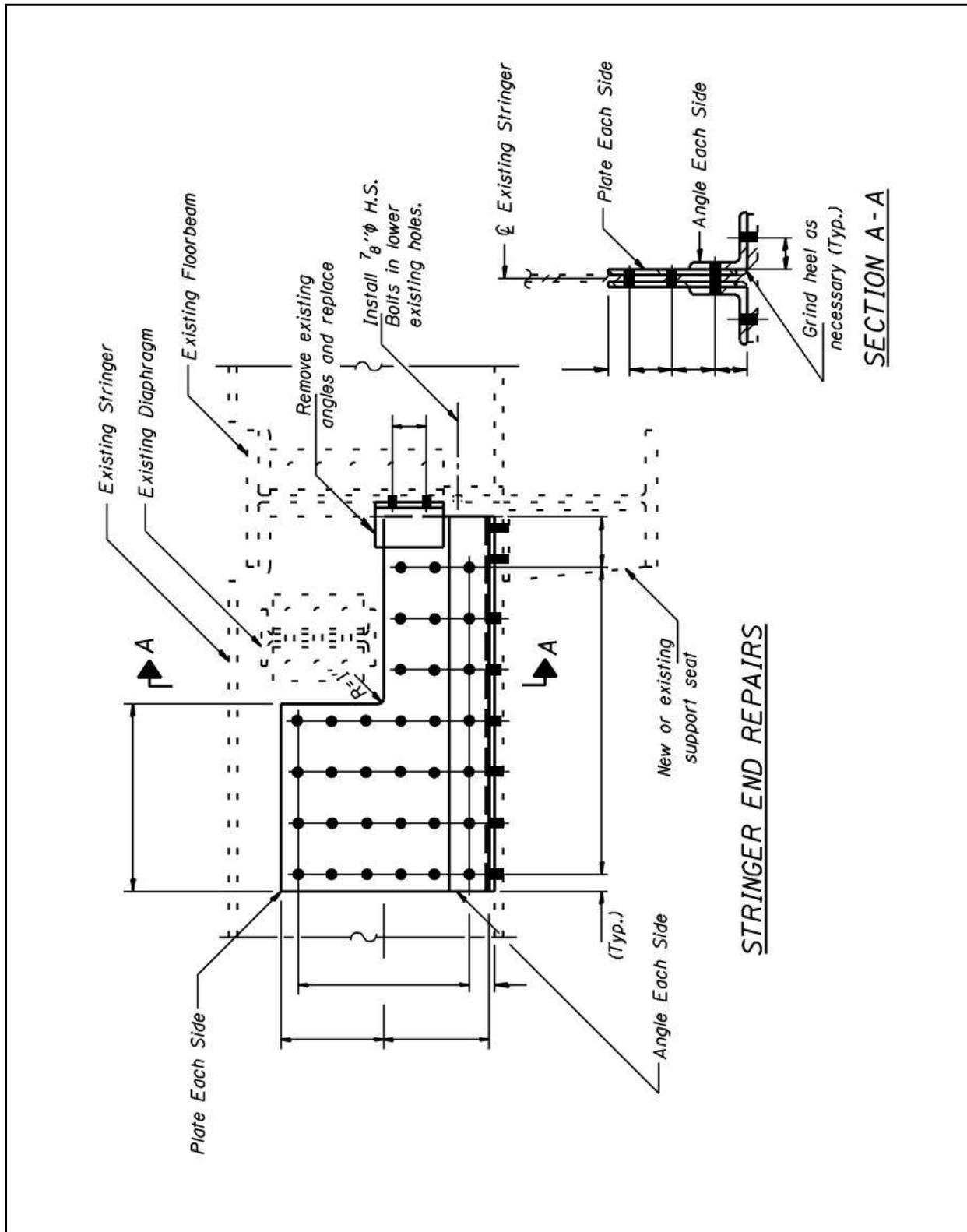


Figure 2.15-8 – Stringer End Repair

Deterioration in the webs and flanges of floorbeams should be repaired in the manner previously described for the repair of beam and girder deterioration adjacent to deck drains. [Figure 2.15-9](#) shows details used for the repair of an existing floorbeam constructed as a built-up section.

Deterioration is commonly found at the locations where the floorbeams are connected to a truss. When the structural capacity of the floorbeam has been affected by excessive section loss in the floorbeam web at the angles connecting the floorbeam to the truss, plates may be placed at the connection to restore the lost capacity as shown in [Figure 2.15-10](#). When cracks develop between the top flange and web of the floorbeam in the area of the floorbeam to truss connection, angles can be installed as shown in [Figure 2.15-11](#).

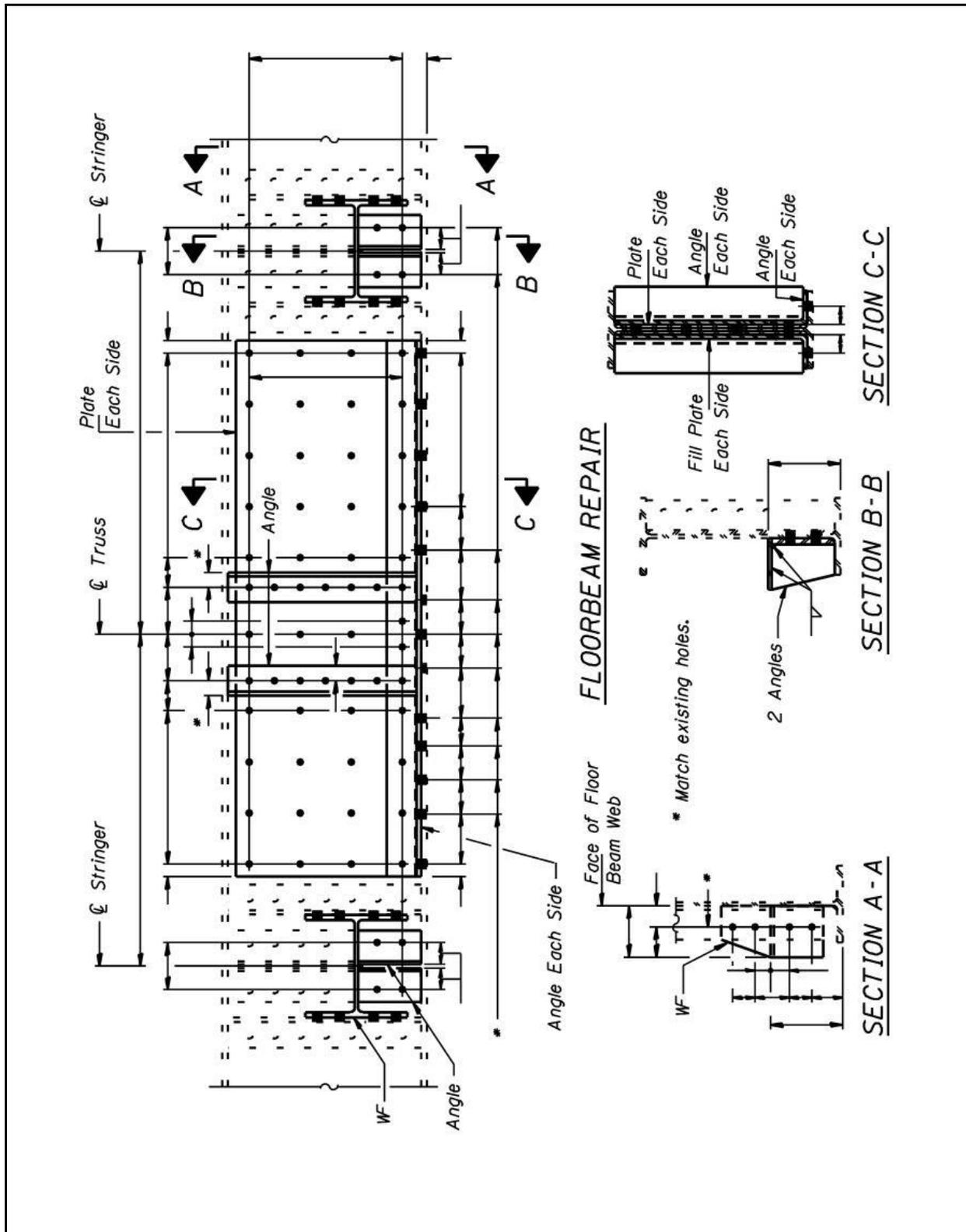


Figure 2.15-9 – Floorbeam Repair

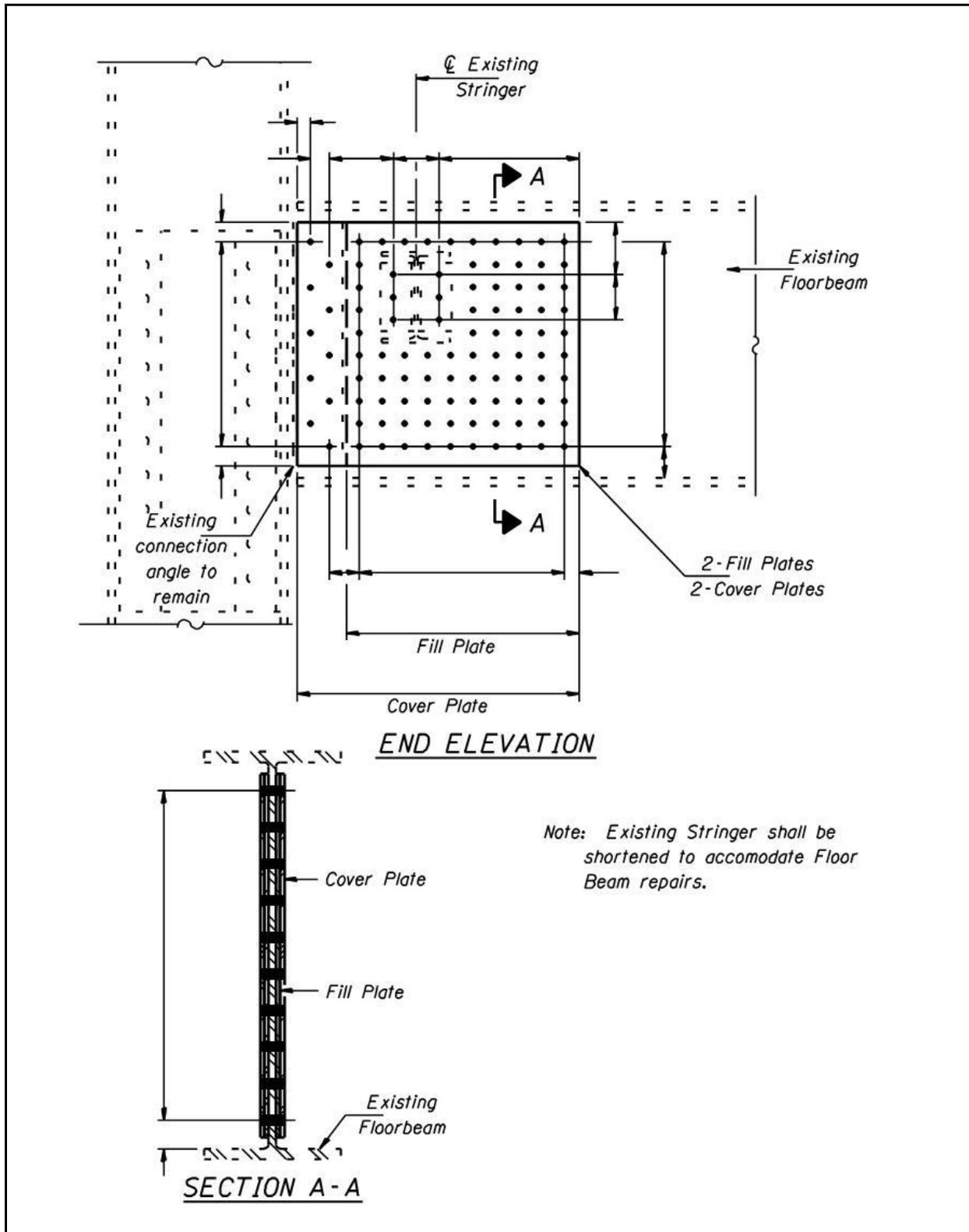


Figure 2.15-10 – Floorbeam Web Repair

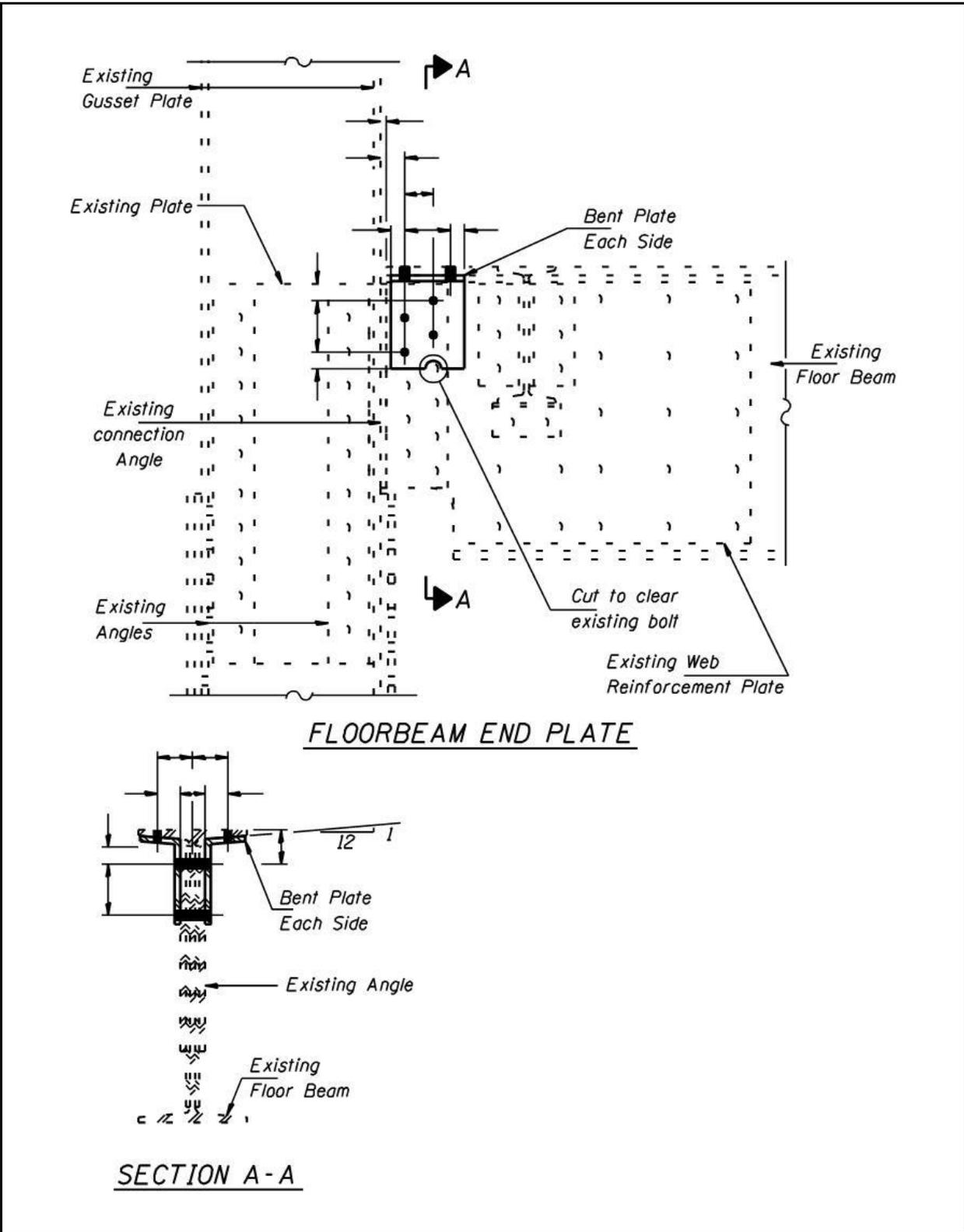


Figure 2.15-11 – Floorbeam Repair

2.15.4 Construction Damage

There are many types of damage which can occur during construction. A new beam or girder can be dropped during erection, a piece of construction equipment can strike a portion of the structure which has already been constructed, or the beams can be damaged by equipment being used to remove an existing concrete deck. Damage due to impacts can be analyzed and repaired as described elsewhere in this Section for impact repairs. This section will deal with the repair of steel beam flanges damaged by deck removal operations.

Plans for projects where portions of the existing deck will be removed should include a note instructing the contractor to mark the top surface of the existing deck to identify the location and limits of the top flanges of the beams prior to the commencement of deck removal operations. When a beam is damaged by deck removal operations, it is the contractor's responsibility to repair the damage at his/her own expense. The contractor will be responsible for retaining a licensed structural engineer (State of Illinois) to analyze the effect of the damage on the structure, to make repair recommendations and to prepare repair details. The structural engineer's analysis, recommendations and repair details will be submitted to the Bureau of Bridges & Structures for review and concurrence prior to the implementation of repair.

When the flange of a beam has been nicked, gouged or cut during the removal of the existing deck, each damaged location must be analyzed to determine the effect of the damage on the load carrying capacity of the structure and on the serviceability of the structure (fatigue life). The damaged area should be ground parallel to the primary stress to remove the defects and to provide a 3:1 taper from the bottom of the defect to the undamaged steel surface. The cross sectional area remaining after grinding operations should be analyzed to determine the maximum stresses and stress range expected to occur at the damaged location if left unrepaired. Damaged locations where the stresses or stress range are determined to be unacceptable, must be strengthened by placing splice plates across the damaged area to return the damaged beam to its original load carrying capacity. The grinding details and the flange strengthening details shown in the Impact Repairs - Steel Beams chapter of this Section can be applied to the repair of nicked, gouged or saw cut flanges.

2.16 Concrete Superstructure Repairs

2.16.1 General

The procedure described elsewhere in this Section, for the repair of impact damage on concrete beams, can also be applied to the repair of beams which have experienced severe long term deterioration. The repair concrete should be securely anchored to the existing beam. Shallow unanchored mortar repairs should be avoided, especially over areas of vehicular or pedestrian traffic. When deterioration has exposed the existing reinforcement bars but does not extend to below the bars, the exposed reinforcement bars can be coated with epoxy in lieu of a thin mortar repair being applied to the deteriorated area to cover the exposed reinforcement.

2.16.2 Beam End Repairs

The repair of deteriorated beam ends is among the most common repair procedures performed during maintenance contracts. When the deterioration extends into the concrete directly over the bearings, the beams must be temporarily supported during the repair operations. The deteriorated concrete areas should then be repaired using formed concrete repairs as described for the repair of substructures elsewhere in this Repair Sections.

2.16.3 PPC Deck Beam Repairs - General

Among the most common repairs necessary for the maintenance of PPC deck beams are:

1. The replacement of the wearing surface
2. The repair of keyways
3. The repair of deteriorated concrete and the protection of exposed reinforcement and strands
4. The adjustment of bearing pads
5. The repair of grouted dowel rod holes
6. The repair of grouted joints at the fixed beam ends

Plans for projects including these repairs, should contain a plan view of the superstructure showing the locations of all keyways, deteriorated beam areas, expansion joints and fixed joints. The locations to be repaired should be identified on the plan view. Special provisions for the

repair procedures listed above can be obtained by contacting the Structural Services Section of the Bureau of Bridges & Structures.

The existing wearing surface may be removed and replaced as described for overlays elsewhere in this Section. The repairs listed above must be included with all overlay projects on PPC deck beams when deterioration is present.

After the wearing surface and waterproofing have been removed from deck beams, any existing unplugged fabrication vent holes in the top of the beams should be located and sealed with epoxy to prevent water from entering the voids cast inside the beams. Also, during the inspection of PPC deck beams, the existing drain holes extending through the bottom of the beams into the voids inside the beam should be probed to ensure that they are not clogged and that water is not accumulating in the voids.

2.16.4 Keyway Repairs

The grouted keyways between the individual beams, which combine to form the bridge superstructure, are essential for the lateral distribution of load during the application of live loads. If the keyways adjacent to a beam are severely deteriorated, that beam must carry a portion of the live load significantly greater than the amount of live load the beam was designed to carry. When this condition exists, the Bureau of Bridges & Structures should be contacted to determine if a load restriction must be placed on the structure until repairs can be made.

Keyways are repaired by removing all deteriorated grout from the keyway and replacing it with an epoxy grout. In areas of the keyway where the existing grout is cracked but otherwise sound, the cracks in the grout should be filled with epoxy. The epoxy grouting and crack sealing should not be done until all PPC deck beam repairs, bearing pad adjustments and dowel rod hole repairs have been completed.

When the edges of the beam forming the keyway have deteriorated to the point where they cannot provide the geometric shape necessary to contain the keyway grout, consideration must be given to beam replacement or the installation of a mechanical keyway device. A device similar to the one shown in the IDOT *Precast Prestressed Concrete Design Manual* for use during the staged construction of a PPC deck beam bridge can be used. The device details should be modified as shown in [Figure 2.16-1](#). When the superstructure is over a roadway or

railroad, the effect of the mechanical devices on vertical clearance must be considered. Also, since the devices will interfere with the placement of waterproofing membrane and may loosen with time, they should only be installed to avoid total beam replacement on structures scheduled for replacement.

When the keyway deterioration is due to the lateral movement of the beams relative to one another, side retainers should be installed adjacent to the fascia beams to prevent further movement. The IDOT *Precast Prestressed Concrete Design Manual* provides details for side retainers which can be installed adjacent to the beams when adequate bearing seat area is available.

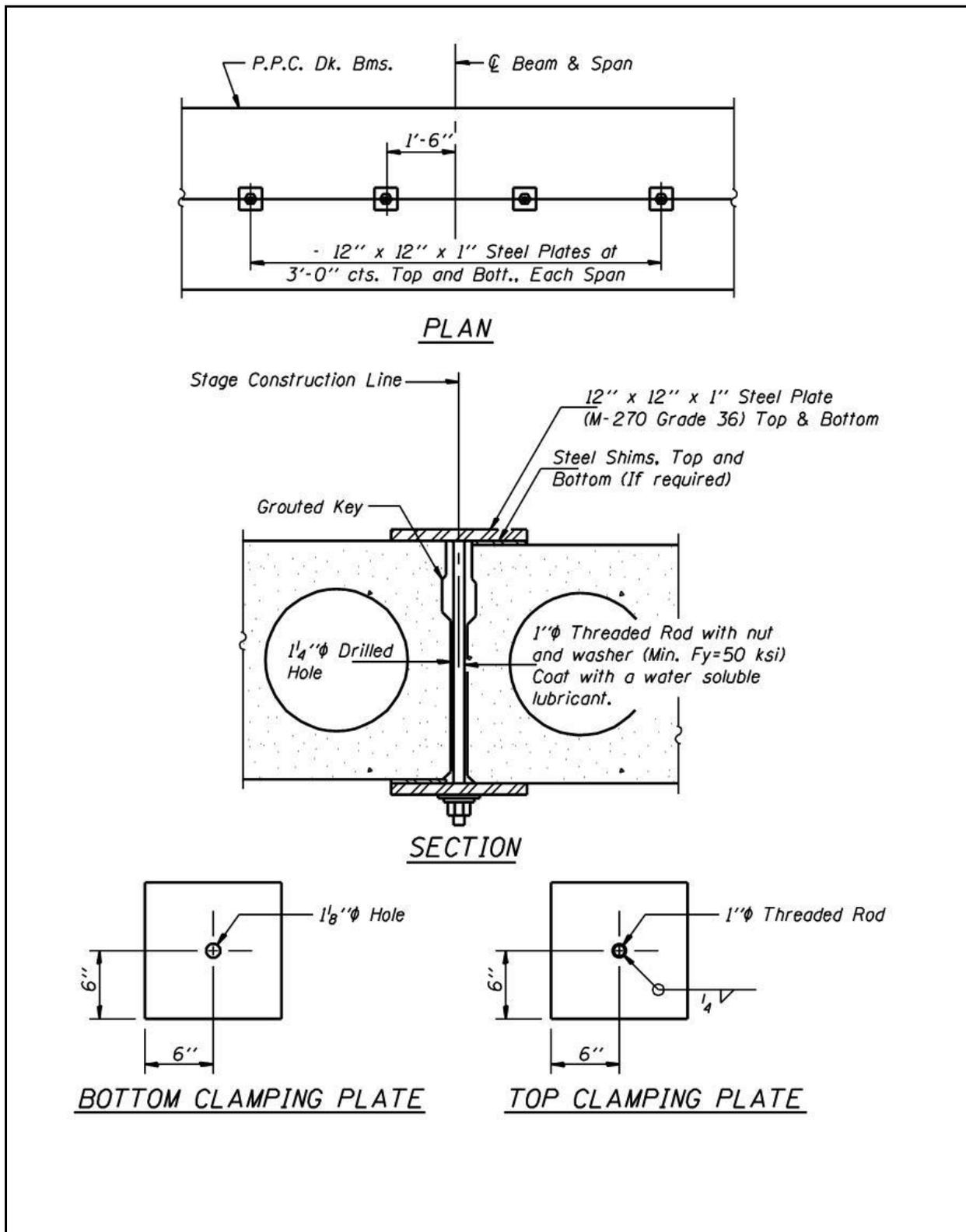


Figure 2.16-1 – Shear Key Clamping Device for PPC Deck Beams

2.16.5 Bearing Pad Adjustment

The bearing pads located under the ends of the PPC deck beams must be inspected to identify areas where uniform bearing of the beams on the pads does not exist. These areas will be prone to rocking when live load is applied to the structure and will contribute to the accelerated deterioration of the keyways between the beams. Uniform bearing should be established by inserting shims under the beam ends where rocking is occurring. At fixed bearings, where the ends of the beams are held in place by dowel rods, uniform bearing can be provided by the placement of epoxy grout between the bottom of the beams and the bearing seat in lieu of furnishing shims.

2.16.6 Dowel Hole and Grout Joint Repairs

Deterioration of the grout in the dowel rod holes and the grout joints at the ends of the beams can occur due to the rocking of poorly supported beam ends or due to the accumulation of moisture under the overlay at the ends of the beams. After the existing overlay has been removed, all deteriorated grout should be removed from the dowel rod holes and grouted joints. Cracks in existing grout to remain in the dowel holes should be sealed with epoxy. Epoxy grout should then be used to replace the removed deteriorated grout.

2.16.7 PPC Deck Beam

PPC deck beams should be repaired as described earlier in the “General” portion of this chapter. When the concrete deterioration extends into the voids inside the deck beams or severed prestressing strands are present, the Bureau of Bridges & Structures should be contacted to determine if a load restriction must be placed on the structure and if the replacement of the beam is necessary.

When a PPC deck beam must be replaced, the replacement beam’s load carrying capacity must not be less than the capacity of the existing beams remaining in place. The number and size of the prestressing strands placed in the replacement beam should provide the required capacity and should conform with current design and fabrication practices. When replacing an interior beam, the width dimension of the replacement beam should be reduced a maximum of 1/2 inch to facilitate the placement of the new beam between the existing beams. Whenever possible, transverse tie assemblies should be reinstalled. A modified tie coupler for use with a beam

replacement is shown in [Figure 2.16-2](#). It is not always possible to reinstall the transverse ties on structures with large skews and staggered tie assemblies. When transverse ties cannot be reinstalled, side retainers should be installed adjacent to the fascia beams at the ends of the beams which are not connected to the substructure with dowel rods and are not tied together by expansion joint steel.

2.16.8 R.C. Deck Girder Replacement

The primary cause of deterioration in R.C. deck girders is exposure to deicing agents. Compounding this situation are the lack of anchorage and the debonding of the existing main tension reinforcement in the bottom of many R.C. deck girders. When deterioration requires that a girder be replaced, the girder can be replaced in-kind or a precast prestressed concrete deck beam can be used as shown in [Figure 2.16-3](#). The use of the precast beam will avoid many of the problems associated with forming and temporarily supporting a cast in place R.C. deck girder.

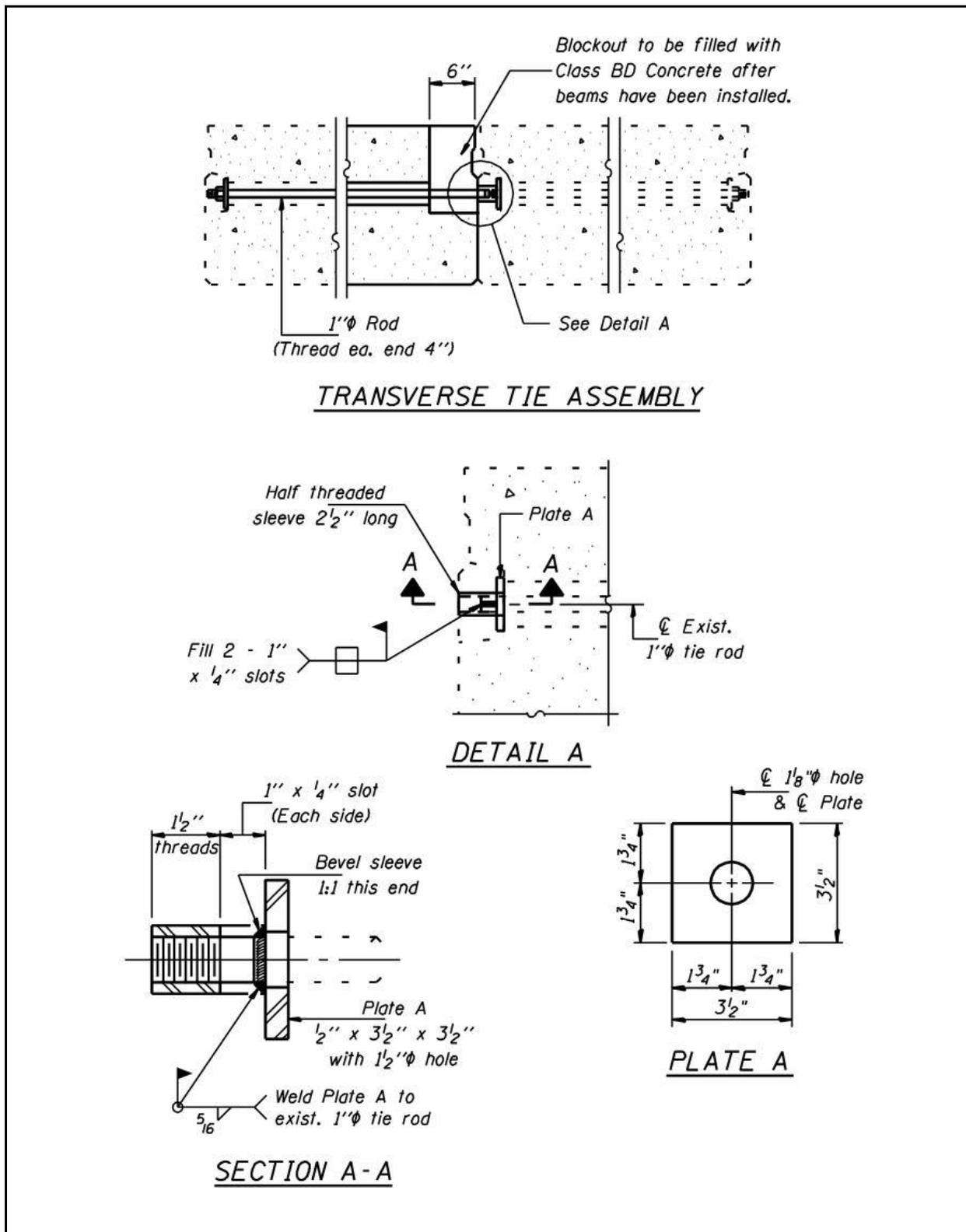


Figure 2.16-2 – Modified Tie Coupler for Transverse Tie Assembly

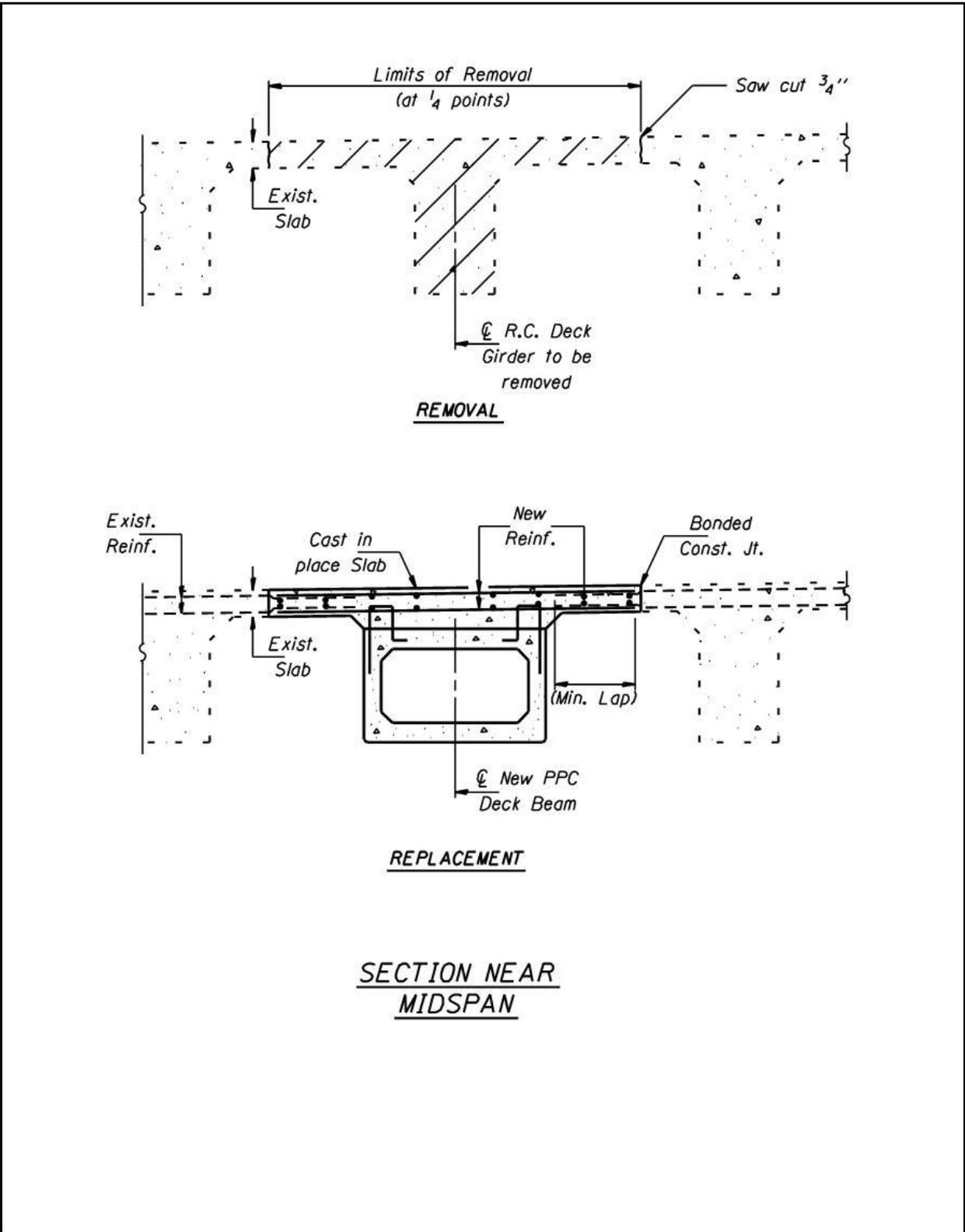


Figure 2.16-3 – R.C. Girder Replacement

2.17 Substructure Repairs*2.17.1 General*

The repair of cracks and areas of deteriorated concrete are the most common types of substructure repairs included in maintenance repair plans. The plans must contain information identifying the locations to be repaired. The information should consist of views of the top, faces and sides of the substructure showing the approximate size and location of all cracks and deteriorated concrete areas as shown in [Figure 2.17-1](#). [Figure 2.17-2](#) shows “Guidelines for the Selection of Substructure Repair Methods”.

When large cracks or extensive areas of deteriorated concrete are present, an investigation should be performed to determine the cause of the cracking or deterioration. The repair plans should include measures to eliminate the cause of the problems. In some cases, the corrective measures required to avoid the recurrence of the deterioration will simply call for the replacement of a leaking expansion joint or the elimination or extension of nearby deck drains.

Maintenance repair plans are occasionally required for the replacement of failed retaining walls and the stabilization of abutment walls. These type of repairs require analysis and investigation to identify the cause of the wall failure or movement in order to develop a solution.

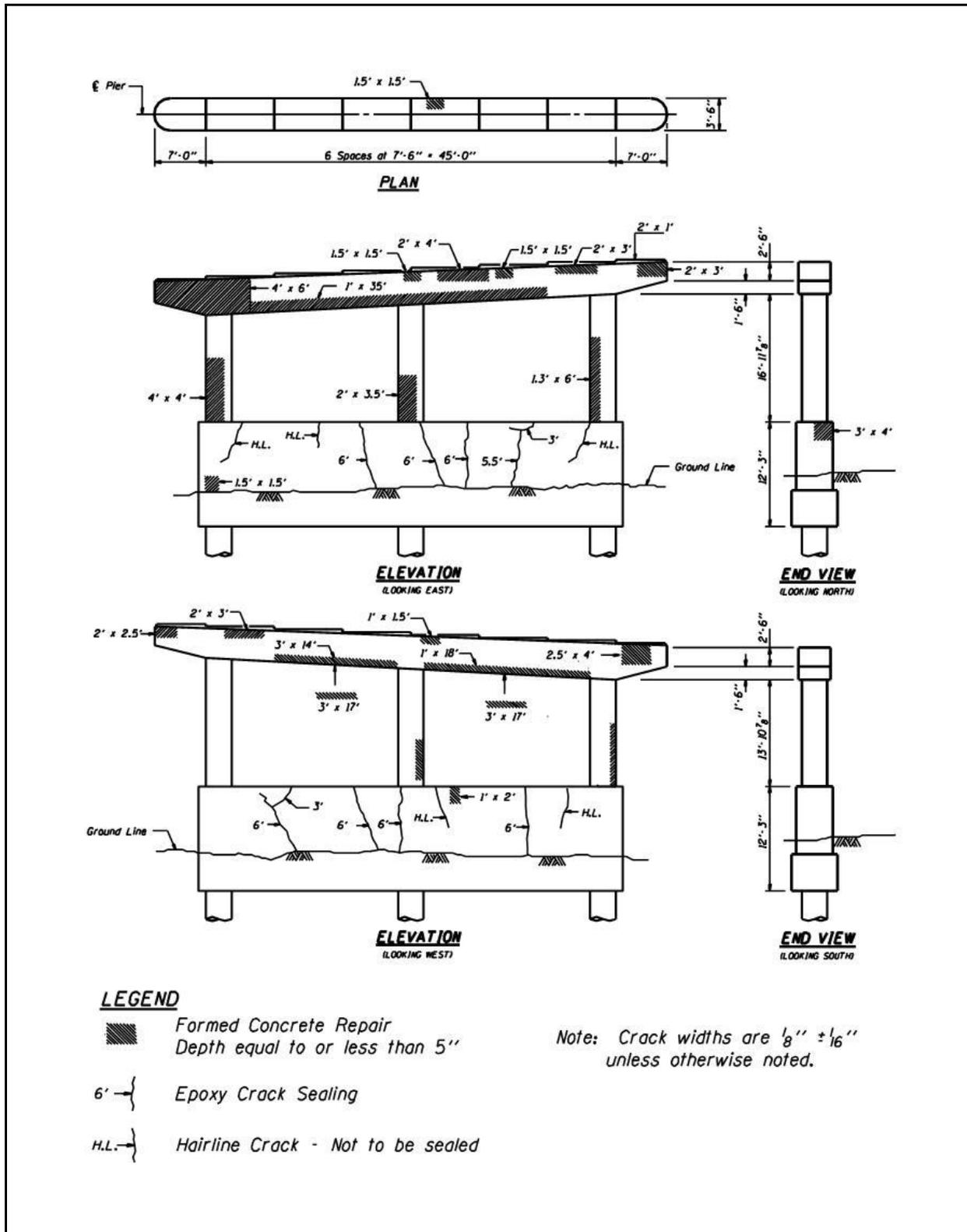


Figure 2.17-1 – Pier Repair Details

Substructure Repair Type	Project Quantity	Repair Location	Limits of Repair	Aesthetic Requirements / Limitations / Other Comments
Formed Concrete Repair (FCR)	Recommended method for 10 ft ² to 100 ft ² . Alternate with high performance shotcrete for ≥ 100 ft ² .	Any location except overhead	Generally <5 in. in depth. If depth >8 in., use anchors. Max. 12 in. removal depth allowed without Bridge Office evaluation.	No restriction for aesthetics. Note: If repair of patch boundaries is necessary, ensure proper placement of repair material to avoid cracking and delamination. Also ensure proper consolidation and curing of FCR to minimize honeycombing, cracking and delamination.
High Performance Shotcrete (HPS)	Alternate to FCR for ≥100 ft ² . Note: HPS should be competitive with FCR for 100 ft ² to 200 ft ² if all repair area is localized. HPS should be competitive regardless of locality of repairs for >200 ft ² .	Horizontal, Vertical and Overhead Can be used in locations that are difficult to form.	Unlimited depth. Follow manufacturer's recommendations for max. lift thickness (4 in. max.).	Acceptable for all areas for aesthetics. Note: Proper curing is extremely important.
Epoxy Mortar Repair	Small Quantities	Use mainly for overhead applications (Consider potential hazard to users under structure).	Shallow: 2 in. max. Follow manufacturer's recommendations	Use only when quick set is necessary. General poor appearance. Try to avoid use where repair is exposed to public. Proper mixing of material is critical.
Polymer Modified Portland Cement Mortar Repair	Recommended for <10 ft ² , but 10 ft ² is not a maximum limit. Can also be specified for other small quantities.	Horizontal, Vertical and Overhead (Consider potential hazard to users under structure).	Intended for very shallow repairs (2 in. max. depth). Can allow deeper repairs with multiple lifts, but use is discouraged.	Acceptable for all areas for aesthetics. Generally favored over epoxy mortar repair unless quick set is required. Note: If deep repairs are required (with multiple lifts), follow manufacturer's recommendations very closely.
Concrete Jacking	Large Quantity (Multiple pier stems)	Generally intended for encapsulation to increase rebar cover (pier stems).	Intended for shallow repairs. Can allow deep repair, but if repair depth >8 in. then repairs should be done prior to encasement (leave rough surface).	Acceptable for all pier locations. Desirable to encase full height of pier column when visible to traffic.
Epoxy Crack Sealing	Any Quantity	Intended for locations on structural elements exposed to water and/or salt intrusion. Generally not intended for non-structural elements (i.e. slope walls, crash walls).	Min. crack width should be more than thickness of a dime (1/16 in.). Crack length should be >24 in. (to allow a min. of 2 zerks or nipples).	Minimize use where there is no expansion joint or other source of water intrusion. Ensure specifications are followed for stoning and grinding, zerk removal, etc. for aesthetics

Figure 2.17-2 – Guidelines for the Selection of Substructure Repair Methods

2.17.2 Crack Sealing

Cracks in concrete substructures, with crack openings less than or equal to 1/2 inch, are repaired by injecting an epoxy crack sealing material into the crack. Cracks located in a wall with voided areas behind the wall cannot be effectively sealed by injecting material into the cracks unless the voided area has been filled with material which will prevent the injected crack sealing material from being forced into the voided area. Hairline cracks need not be sealed but their locations should be noted in the repair plans.

Cracks with openings greater than 1/2 inch should be sealed by removing all loose material along the edges of the crack and then using an expansive cement grout to fill the crack. The presence of large vertical cracks in an unreinforced concrete pier may require the installation of a steel collar as shown in [Figure 2.17-3](#), if a determination is made that the cracks will reinitiate after repairs are made.

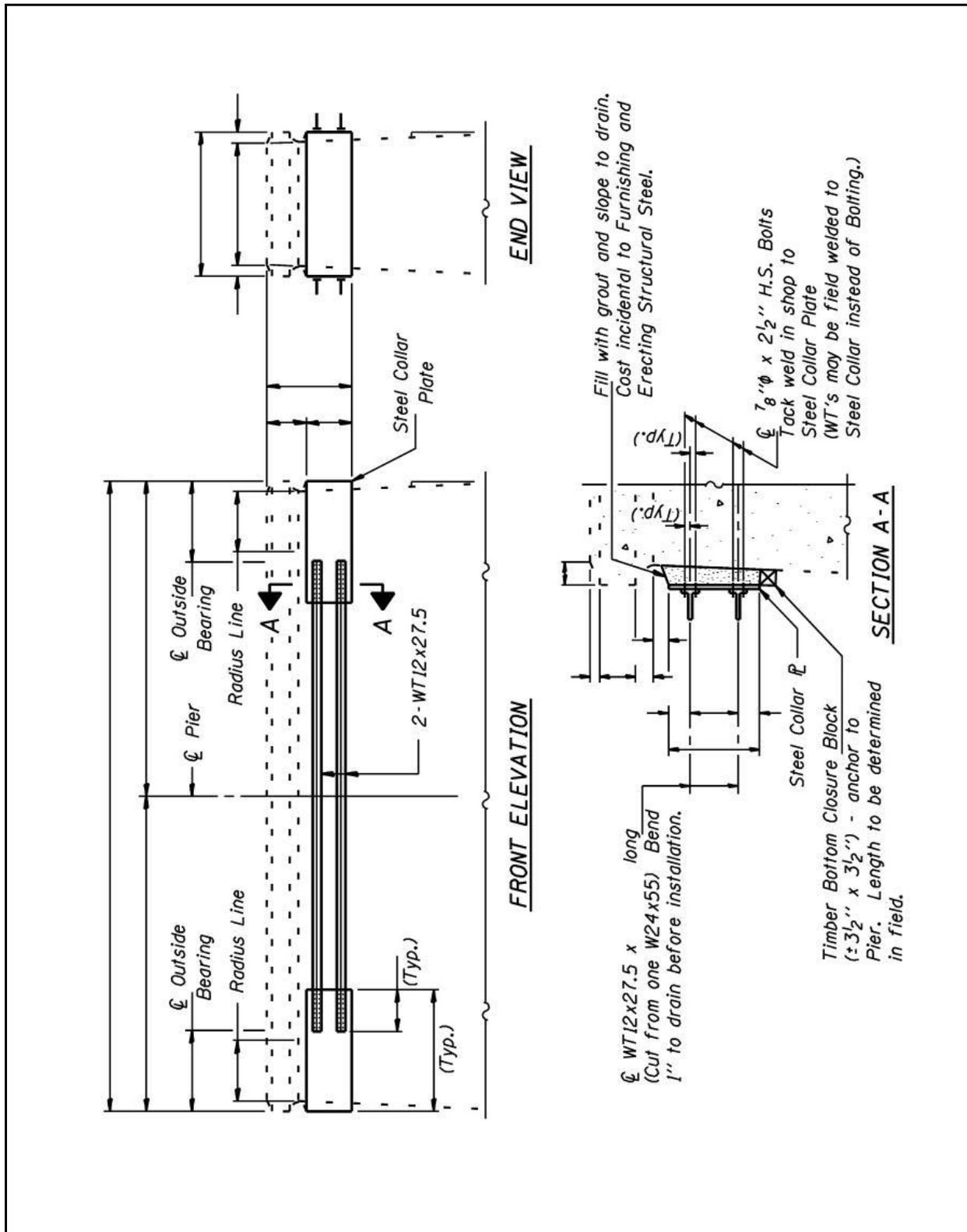


Figure 2.17-3 – Steel Collar Detail

2.17.3 Mortar Repairs

Shallow repairs of deteriorated concrete substructure surfaces can be made using polymer modified Portland cement mortar. This type of repair should be limited to use for repairing concrete surfaces when the depth of the deterioration does not extend below the existing reinforcement bars or to a depth of 2 inches for unreinforced substructure units. The application of mortar repairs to overhead surfaces should be avoided and the repair should not be used on any portion of a structure located directly over vehicular or pedestrian traffic.

2.17.4 Formed Concrete Repairs

Formed concrete repairs can be categorized into the following two types:

1. Formed concrete repairs with depths of repair less than or equal to 5 inches
2. Formed concrete repairs with depths of repair greater than 5 inches but less than 12 inches

Both types of repairs use formed concrete to replace the deteriorated concrete areas.

When making a formed concrete repair, the perimeter of the deteriorated area should be saw cut to a depth of 1 inch after the limits of unsound concrete have been determined. The existing concrete within the saw cut area should be removed to sound concrete and to a depth at least 1 inch below the inside surface of the existing reinforcement bars. The existing reinforcement bars within the repair area must be cleaned and damaged or deteriorated reinforcement bars must be replaced prior to the placement of the repair concrete.

The effect of the concrete removal, required for a formed concrete repair, on the strength of the structure during the repair operations must be considered. When an extensive area of the substructure, such as an entire column face, is to be repaired, the superstructure should be temporarily supported until the concrete repair has cured.

2.17.5 Pneumatically Placed Mortar

High strength pneumatically placed mortar (shotcrete) may be used in lieu of formed concrete repairs. The saw cutting, concrete removal and reinforcement bar repair requirements for formed concrete repairs should also be applied to shotcrete repairs.

2.17.6 Retaining Wall Replacement

The cause of a retaining wall failure should be determined prior to the replacement of the wall. The failure may have been caused by a vehicular impact, a design or construction error, the placement of additional backfill behind the wall, the lack of sufficient drainage of ground water from behind the wall, the undermining of the footing, the slope failure of embankment material behind the wall or the general long term deterioration of the wall. The Bureau of Bridges & Structures should be contacted to investigate the cause of the failure.

When the entire wall, including the footing, has failed, complete replacement is necessary. However, if the footing has not failed and analysis indicates that it can carry the anticipated loadings, the failed wall stem can be removed and a new wall can be attached to the existing footing using epoxy grouted reinforcement bars as shown in [Figure 2.17-4](#).

The water seal in a joint between a replaced section of retaining wall and an adjacent structure should be maintained. When it is not possible to salvage the existing water seal, the details shown in [Figure 2.17-5](#) can be used.

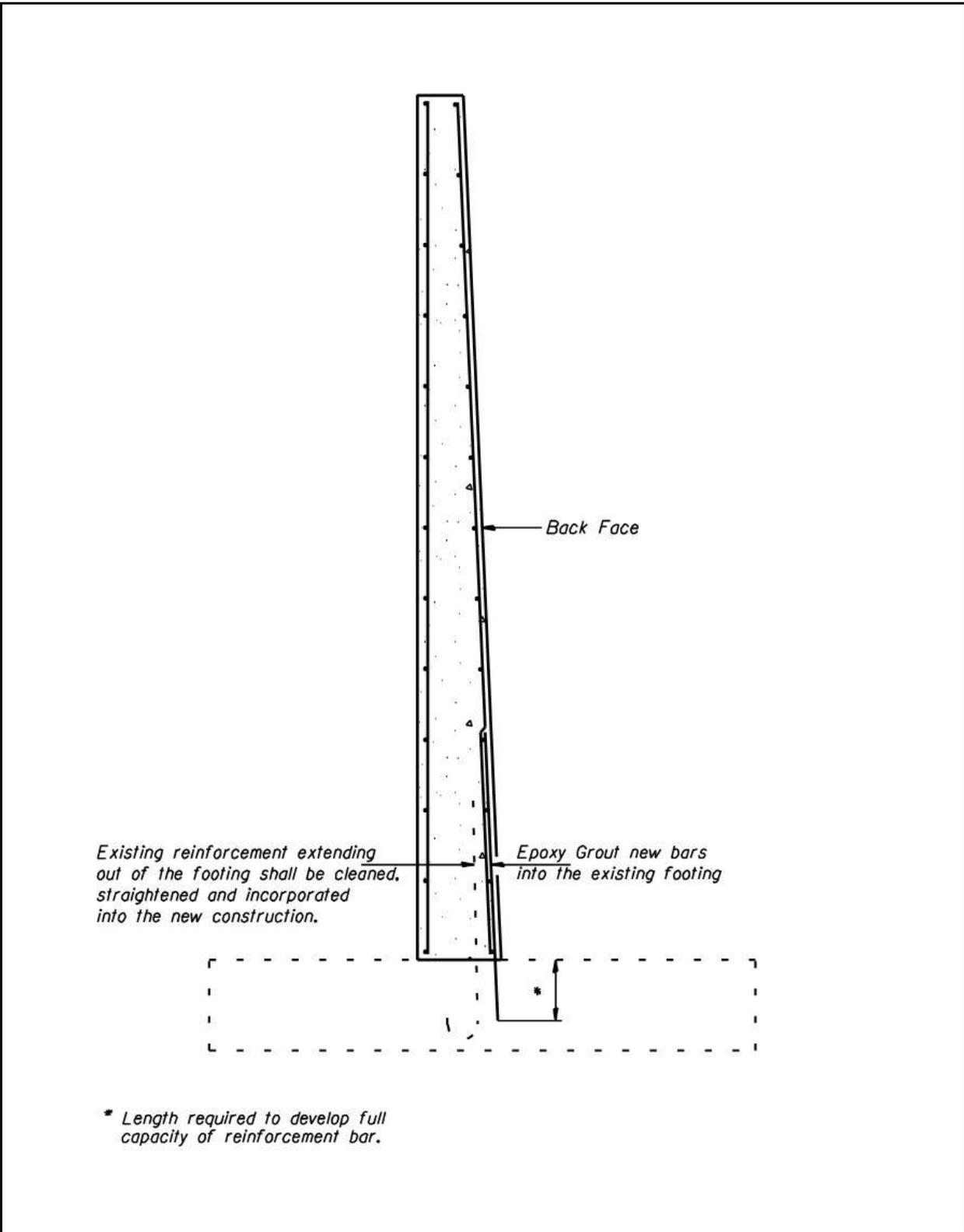


Figure 2.17-4 – Retaining Wall Stem Removal and Replacement

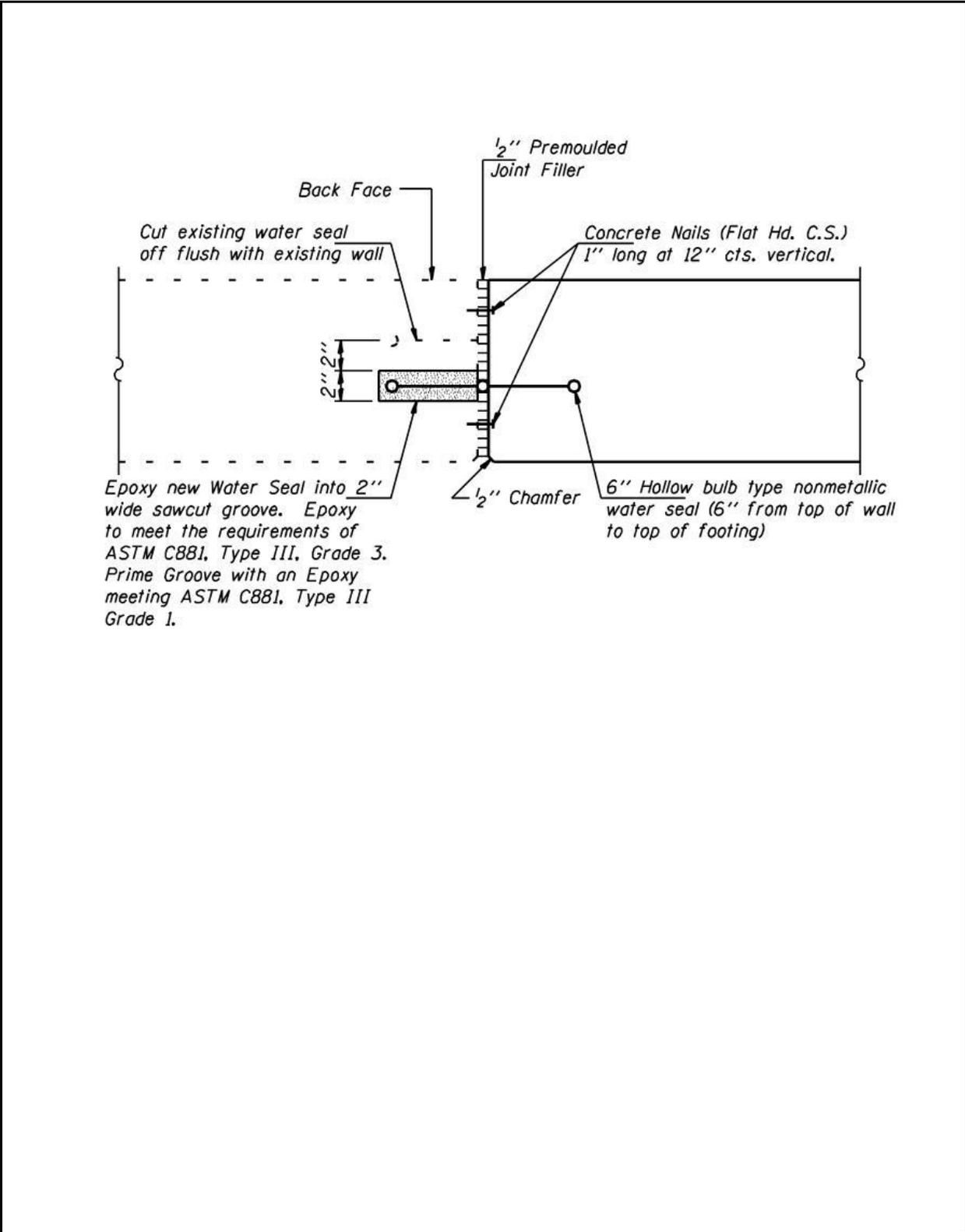


Figure 2.17-5 – Water Seal Replacement Detail

2.17.7 Abutment Wall Movement

When excessive horizontal movement has occurred in the front wall of closed concrete abutments, measures should be taken to determine the cause and to stabilize the movement. Closed concrete abutments are generally designed with:

1. The front wall restrained against movement at both the top of the wall where it meets the superstructure and at the bottom of the wall where it is attached to the footing
2. The front wall acting as a cantilever rigidly attached to the footing and free to deflect at the top of the wall adjacent to the superstructure

Abutment walls designed to be restrained at the top and bottom of the wall should not experience any horizontal deflection at those locations. Occasionally the top restraining element of this type of wall will fail and allow the top of the wall to move. If the wall is determined to be in sound structural condition, except for the loss of top restraint, restraining angles can be attached to the bottom of the superstructure as shown in [Figure 2.17-6](#). If the structural integrity of the wall has been compromised by movement or analysis shows that the wall is structurally deficient, a steel frame work can be installed between the abutments as illustrated in [Figure 2.17-7](#).

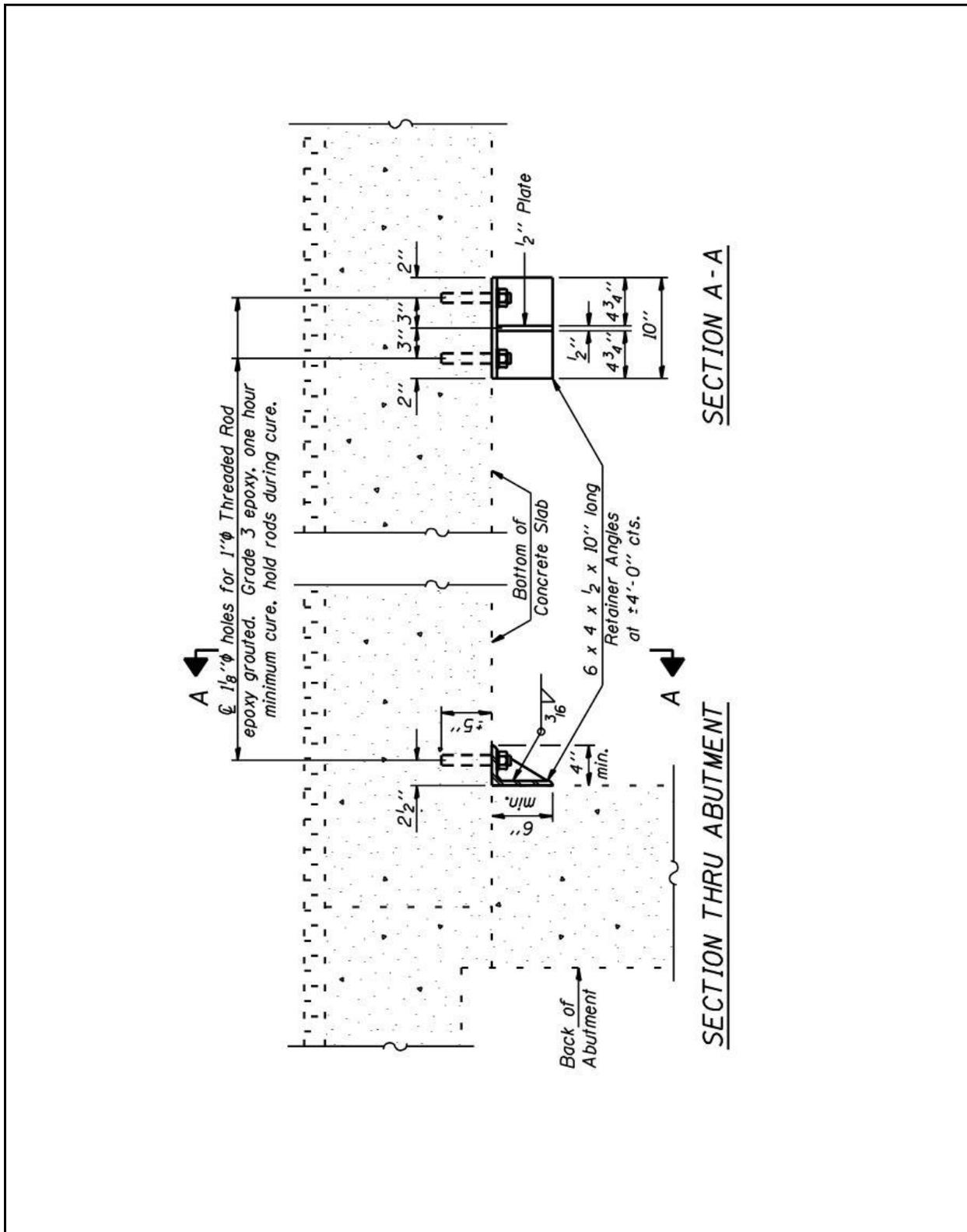


Figure 2.17-6 – Abutment Wall Top Restraining Angle Detail

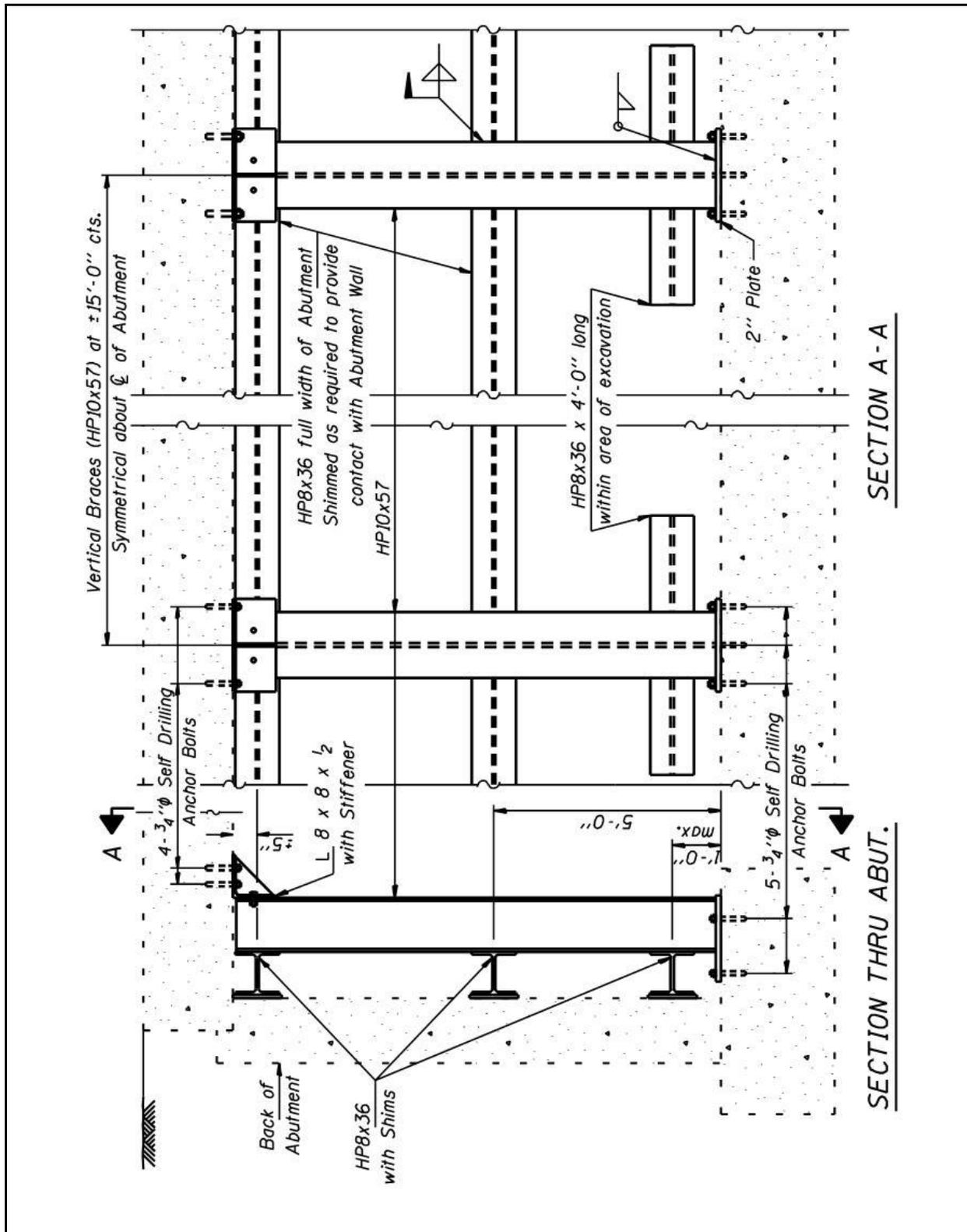


Figure 2.17-7 – Abutment Wall Support Using Steel Framework

Abutment walls designed to act as cantilevers will deflect horizontally after backfill material has been placed behind the wall. Also, cantilevered abutment walls may experience additional horizontal movement when the height of the backfill is significantly increased by raising the roadway profile grade during a rehabilitation of the structure. If the existing abutment wall cannot carry the increased loading without exceeding the design stresses of the reinforcement bars and concrete used for its original construction, excessive horizontal deflections may occur at the top of the wall. The wall can be stabilized by placing additional embankment material in front of the abutment wall as shown in [Figure 2.17-8](#) or by constructing counterforts as shown in [Figure 2.17-9](#). Prior to adopting a method of stabilizing a wall, the effect of the method on the size of the bridge opening and the hydraulic adequacy of the structure must be considered.

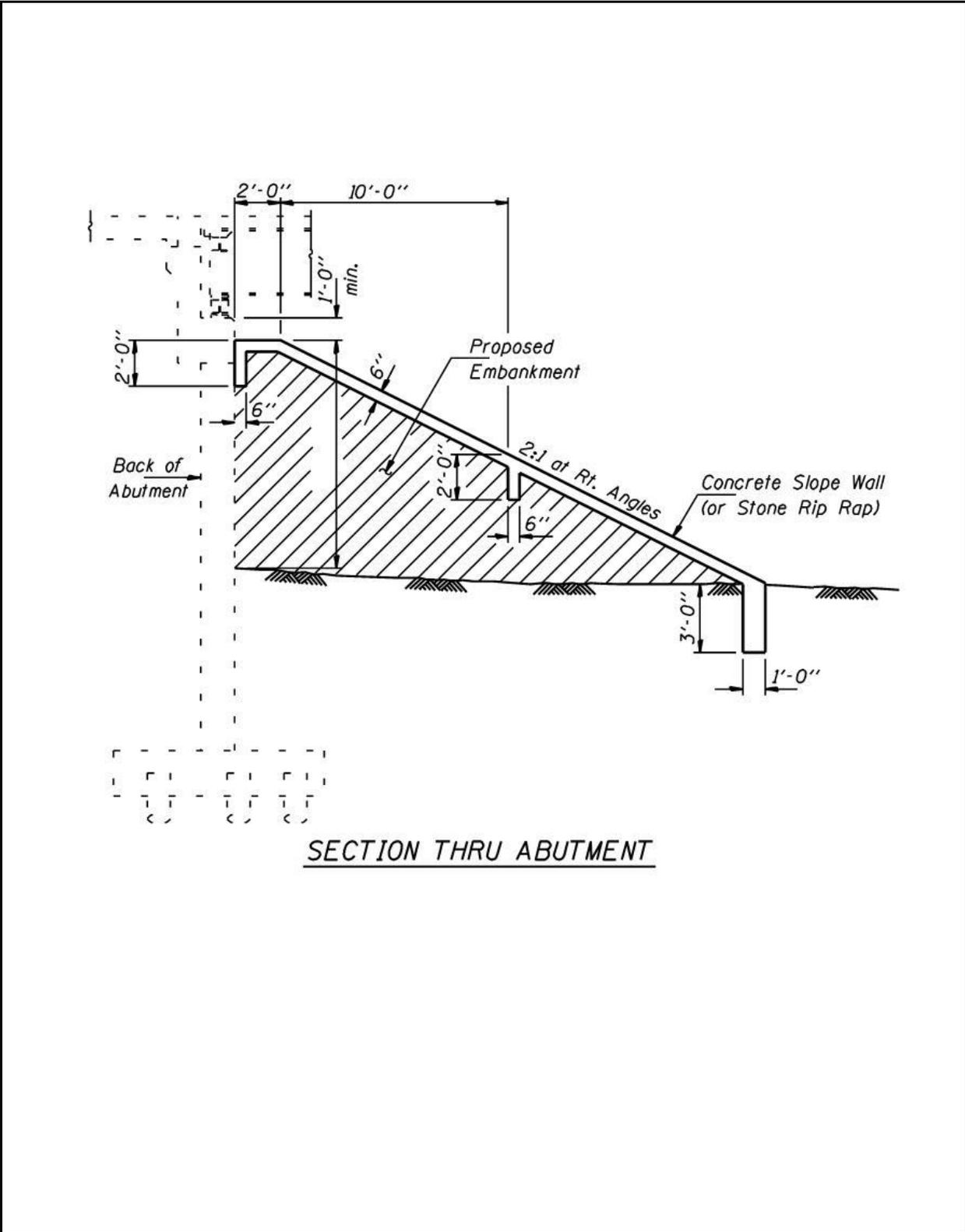


Figure 2.17-8 – Abutment Wall Support Using Embankment

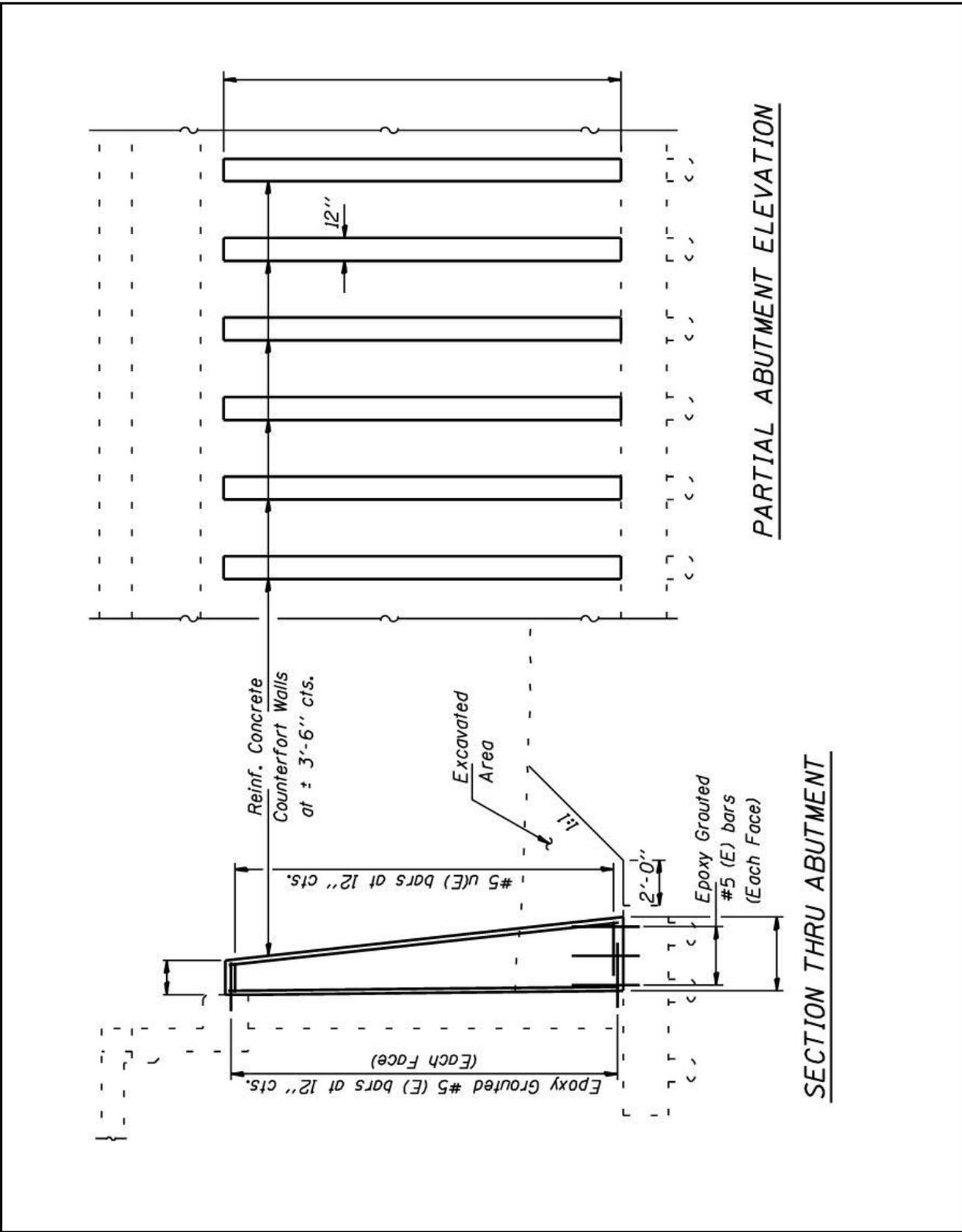


Figure 2.17-9 – Abutment Wall Support Using Counterforts

Section 3 Bridge Inspection

3.1 General

3.1.1 Purpose and Scope

Congress implements highway policy through passage of multi-year authorization bills (The Highway Bill). The Highway Bill establishes the federal statutes that govern, in part, the inspection of the Nation's bridges. The statutes are codified in the United States Code (USC) and grant authority to the US Department of Transportation, Federal Highway Administration (FHWA) to establish and promulgate, or publish, the National Bridge Inspection Standards (NBIS) in the Code of Federal Regulations (CFR) under Title 23, Chapter I, Subchapter G, Part 650, Subpart C included in [Appendix A-1](#).

Inspections of structures located on public roads are necessary to provide adequate safety for the traveling public, ensure compliance with the NBIS, and protect the large investment in Illinois bridges.

To maintain full compliance with the NBIS, the Illinois Department of Transportation (IDOT) must adhere to all policies, procedures, and regulations established by the FHWA. This section of the IDOT *Structural Services Manual* provides documentation of the official bridge inspection policies for the State of Illinois.

The primary purpose of this section is to provide information pertaining to bridge inventory and inspection activities. The information provided in this section summarizes IDOT inspection policies and guidelines for the effective and efficient management of the bridge inspection program. The information provided in regard to inspection types and frequencies is also applicable to structures under the jurisdiction of agencies other than IDOT, where the oversight for inspections is the responsibility of the agency having jurisdiction.

The primary function of the bridge inspections performed in accordance with the NBIS is to ensure that bridges serving roadways in Illinois remain safe for all users of the highway system. The results of the inspections are also used as a tool to assist in determining bridge maintenance and improvement needs. To enhance this capability, IDOT has implemented

element level inspections that provide information which may be used in a Bridge Management System (BMS) complying with federal guidelines. The primary use of the BMS is to identify existing and potential deterioration in individual bridge members, and to predict bridge maintenance and construction programming needs on a system-wide basis.

3.1.2 National Bridge Inspection Standards

Bridge inspections are generally performed and recorded under the requirements of the NBIS. The NBIS contains the federal regulations establishing minimum requirements for inspection organizations, qualifications of personnel, frequency of inspections, inspection procedures, and the preparation and maintenance of a bridge inventory.

The FHWA administers the NBIS under the guidelines outlined in the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (Federal Coding Guide). The information collected, as required by the NBIS, is reported annually to the FHWA. The NBIS applies to all structures defined as highway bridges located on public roads. The following definitions, which have been taken from federal regulations, apply:

Bridge: A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening, measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Public Road: Any road or street under the jurisdiction of and maintained by a public authority and open to public travel.

It should be noted that a Bridge includes both permanent and temporary structures as discussed in [Section 3.12](#) and a Public Road includes transit highways as discussed in [Section 3.13](#).

Although the NBIS requirements are not directly applicable to privately owned bridges, the FHWA strongly encourages private bridge owners to follow the NBIS as the standard for

inspecting their bridges. In those instances, where a privately owned bridge carries or crosses a public road, the FHWA has indicated that public agencies should encourage the private bridge owner to inspect their bridge in accordance with the NBIS or reroute the public road.

In addition to the Federal Coding Guide, several national publications have been developed to assist the states in uniformly complying with the NBIS including but not limited to:

- FHWA *Bridge Inspector's Reference Manual*
- FHWA *Underwater Bridge Inspection*
- FHWA *Evaluating Scour at Bridges*
- AASHTO *The Manual for Bridge Evaluation*
- AASHTO *Manual for Bridge Element Inspection*

NHI courses are another source that help ensure uniform compliance with the NBIS.

3.1.3 Illinois Bridge Inspection Organization

Illinois complies with the NBIS program requirements for inspection and inventory data through the following responsible positions.

State Program Manager: The IDOT Bridge Management Unit Chief within the Bureau of Bridges & Structures providing statewide oversight for all NBIS related activities. The State Program Manager is responsible for inspection policy and to ensure the quality of the NBIS program.

Local Program Manager: The IDOT Local Bridge Unit Chief within the Bureau of Bridges & Structures providing assistance to the State Program Manager for statewide oversight of all NBIS related activities performed by local public agencies or other state agencies.

Central Program Manager: The IDOT Bridge Inspection Group Engineer within the Bureau of Bridges & Structures providing oversight for all NBIS activities related to the In-Depth Inspections performed for designated Major Structures.

District Program Manager: The IDOT District Bridge Maintenance Engineers providing oversight for all NBIS related activities within their designated area of responsibility.

Area Program Manager: The IDOT Area Bridge Inspection Engineers in District 1 providing oversight for all NBIS related activities within their designated area of responsibility.

Agency Program Manager: All local public agencies with jurisdiction of a structure in the National Bridge Inventory (NBI) must designate a Program Manager to ensure compliance with the NBIS, and provide guidance and management of their bridge inventory. Local public agencies may designate in-house staff or a consultant who is an approved Program Manager. The consultant and agency should discuss and clarify the program manager duties such as responding to BridgeWatch alerts, submitting inspection reports to IDOT, maintaining official bridge files, responding to IDOT requests for additional NBIS information, and other NBIS related activities.

The local public agency should complete IDOT Form BBS LAPMD, "Local Agency Program Manager Designation" to designate their Program Manager.

3.1.4 Illinois Structure Information System

The Illinois Structure Information System (ISIS) is the official database containing all Illinois bridge inventory and inspection information. The bridge data stored in ISIS for each structure includes an inventory record, current and previous inspection records, and information related to construction, reconstruction, highway routes, scour evaluations, microfilm, hydraulics, and design.

3.1.5 Structure Information and Procedure Manual

The IDOT *Structure Information and Procedure Manual* (SIP Manual) is the official document describing ISIS, which includes the various data items it contains and coding of each item. This includes the criteria to be used by bridge inspectors when assigning condition ratings and appraisals. Use and knowledge of this manual is essential for all inspectors and other involved in the inventory and inspection of Illinois bridges. The manual is maintained by the IDOT Office of Planning and Programming, Data Management Unit.

3.1.6 Maintenance Management Information System

The Maintenance Management Information System (MMIS) is utilized by the IDOT Bureau of Operations to track various maintenance operations performed on IDOT maintained structures.

3.1.7 Bridge Management System

The Bridge Management System (BMS) contains element level inspection and condition state information. Element Level Inspections provide detailed quantitative condition data for each element of a bridge. This system provides IDOT with an enhanced capability of predicting future bridge programming needs. Guidance for this system and Element Level Inspections is included in the *AASHTO Manual for Bridge Element Inspection* and the *IDOT Bridge Element Inspection Manual*.

3.1.8 Structure Information Management System

The Structure Information Management System (SIMS) provides IDOT personnel with access to information contained in ISIS, Program Planning System (PPS), Bridge Project Tracking (BPT), and the Bridge Management System. SIMS provides those involved in managing bridge inspection programs with a means to easily and quickly access NBIS information and run data queries for individual structures. For bridges under the maintenance jurisdiction of local public agencies, the SIMS-County database file of local bridges for each county may be obtained from IDOT's website.

3.1.9 Bridge Inspection System

The Bridge Inspection System (BIS) is utilized by IDOT bridge inspectors to record the results of bridge inspections in the following databases:

- Illinois Structure Information System, which contains data from the following NBIS related inspections:
 - Routine Inspections
 - Underwater Inspections
 - Fracture Critical Member Inspections
 - Special Inspections

- Bridge Inspection - Structured Query Language (SQL), which contains information regarding:
 - Element Level Inspections
 - Inspector Work Candidates

Using BIS, inspection personnel can download the most recent inspection information onto a laptop computer prior to an upcoming field inspection. The inspector can then utilize the laptop computer during the next field inspection and can input new inspection data during the inspection or at any time prior to returning to the office, subsequent to the field inspection. After returning to the office, the inspector can utilize BIS to directly upload the recently obtained bridge inspection information for eventual inclusion into ISIS, after approval by supervisory personnel.

3.2 Structure Inventory

3.2.1 Reporting Inventory Information

Each bridge involved with a public road, whether carrying or crossing the roadway, must be included in the bridge inventory. In accordance with NBIS, bridges carrying a public roadway must be inspected and reported to FHWA. Bridges that do not carry motor vehicle traffic but cross over a public road, such as pedestrian/bicycle bridges or railroad bridges, must also be included in the bridge inventory. Even though Routine Inspections are not required by NBIS for these structures, they are recommended as a matter of public safety. Inspections for bridges that do not carry public roadways are further addressed in [Section 3.11](#) of this manual. Directions for recording structure inventory information are provided in the IDOT *Structure Information and Procedure Manual* (SIP Manual).

Bridge inventory information, or changes to the bridge that affect the inventory, must be recorded in ISIS for bridges involving state maintained roads, within 90 days of opening to traffic or when necessary. In general, the inventory data is entered by Region/District personnel. Data entry for some items, such as load rating and hydraulics, are the responsibility of the Bureau of Bridges & Structures.

For bridges not directly under IDOT jurisdiction, IDOT policy requires that the Illinois Structure Information System must also be updated within 90 days of the inventory change taking effect.

The agency with jurisdiction of the roadway carried by the bridge is responsible for submitting the revised inventory information to IDOT. If the bridge passes over a public road, but does not carry a public road, the agency with jurisdiction of the roadway under the bridge is responsible for submitting the revised inventory information to IDOT.

3.2.2 Updating Inventory Information

A general review of inventory items should be a part of each Routine Inspection, with any needed corrections promptly reported to appropriate personnel, so that the bridge data in ISIS can be kept as accurate as possible. This general review of inventory information during the Routine Inspection does not necessarily require the inspector to take physical measurements, but should include an effort to identify obvious errors in existing inventory information. The inspector should print a copy of IDOT Form S-114, "Inspector's Inventory Report" or IDOT Form S-107, "Master Structure Report" to refer to during the Routine Inspection, noting any discrepancies or missing information on the form.

3.2.3 The National Bridge Inventory

ISIS data is submitted to FHWA annually. The data becomes part of the National Bridge Inventory (NBI) which is defined by FHWA as:

National Bridge Inventory: The NBI is a collection of information (database) covering over 600,000 of the Nation's bridges located on public roads, including Interstate Highways, U.S. highways, State and County roads, as well as publicly-accessible bridges on Federal lands. It presents a State by State summary analysis of the number, location, and general condition of highway bridges within each State.

3.3 Structure Inspections

3.3.1 General

There are various types of bridge inspections derived directly from the NBIS and other FHWA referenced publications and technical documents as follows:

Initial Inspection: The first inspection of a new bridge or a bridge that has undergone rehabilitation to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.

Routine Inspection: A regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

Underwater Inspection: Inspection of the underwater portion of a bridge substructure and the surrounding channel which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

Fracture Critical Member Inspection: A Hands-On Inspection of a Fracture Critical Member or member components that may include visual and other non-destructive evaluation methods.

Special Inspection: An inspection scheduled at the discretion of the Program Manager or Bureau of Bridges & Structures, used to monitor a particular known or suspected deficiency.

In-Depth Inspection: A close-up inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using Routine Inspection procedures; Hands-On Inspection may be necessary at some locations.

Damage Inspection: An unscheduled inspection performed to assess structural damage resulting from environmental factors or human actions.

Load Rating Inspection: A scheduled inspection performed to investigate damage or deterioration in order to evaluate potential reductions in the live load carrying capacity.

Complex Bridge Inspection: This is an In-Depth Inspection, requiring Hands-On Inspection procedures, to assess the unique or unusual characteristics of the bridge according to a pre-established, written Complex Bridge Inspection Plan.

Element Level Inspection: Inspection of the individual elements of a bridge, each rated for severity and extent of deterioration, assigning quantities of each element in 1 of 4 specific Condition States.

Hands-On Inspection: Inspection within arm's length of the component using visual techniques that may be supplemented by non-destructive testing.

These various inspections are performed at intervals controlled by such things as structural condition, structure type and details, site conditions, load capacity evaluation, and scour critical evaluation. IDOT policy requires that SI&A data must be entered into ISIS within 90 days of inspection for all bridges regardless of jurisdiction. The 90 day rule only applies to data entry and shall not be used to extend the inspection intervals.

NBIS related inspections must be coordinated and performed by qualified personnel as stated in the NBIS requirements. The individuals with overall responsibility for controlling the quality of the NBIS inspection program in a specific area, designated as Program Managers, and the individuals leading field inspection teams, designated as Team Leaders, must meet the qualifications specified in [Section 3.9](#) . An approved Team Leader must be present during Initial, Routine, Underwater, Fracture Critical Member, In-Depth, Damage, Load Rating, and Complex Bridge Inspections.

NBIS requires that all Routine Inspections, Underwater Inspections, Fracture Critical Member Inspections, Special Inspections, In-Depth Inspections, and Complex Bridge Inspections be performed within the inspection interval specified in [Section 3.4](#) . Program Managers must ensure that their NBIS inspections do not become delinquent.

Once a local public agency bridge inspection is completed, the Program Manager is required to use the IDOT Inspection Date Notification website to record the date of the inspection. Information on obtaining access to the website can be found in Local Roads Circular Letter CL2015-18.

All state maintained structures and local public agency structures on the National Highway System require Element Level Inspections as specified in [Section 3.3.11](#).

Inspection procedures vary greatly depending on the characteristics of the bridge, the inspection type, and the extent of bridge deterioration. Detailed inspection procedures including guidance for taking and recording field measurements are provided in FHWA *Bridge Inspector's Reference Manual*, AASHTO *The Manual for Bridge Evaluation*, and in this manual. Inspection procedures are provided for commonly encountered bridge types and elements.

If possible, bridges should be observed during the passage of heavy vehicular loads to assess the presence of excessive vibration, deflection, or noise. If detected, further investigations should be made to determine their cause. Complex bridges require specific inspection procedures that are documented in an inspection plan for each Complex Bridge as specified in [Section 3.3.10](#).

3.3.1.1 Inspection Forms

The applicable IDOT forms must be used to document each bridge inspection. The latest IDOT bridge inspection forms, available on the date of the inspection, shall be used. The form must be signed by both the Team Leader and Program Manager and the original document with “wet” signatures stored in the Bridge File. For situations where the Team Leader and Program Manager are the same person, that person must sign the form in both places.

For situations where the Program Manager and the Team Leader are employed by separate entities, the Program Manager still has ultimate responsibility for the quality of the inspections. The Program Manager may delegate quality control of the Team Leaders work to others but should require documentation of this for quality assurance purposes. This policy is in no way intended to discourage additional QC/QA measures within an inspection program but to clarify ultimate responsibility for that program.

3.3.2 Initial Inspection

New and recently rehabilitated bridges must receive an Initial Inspection.

The bridge owner is responsible for performing the inspection in accordance with NBIS requirements and reporting the information to IDOT, allowing sufficient time for data entry by IDOT. Agencies should coordinate the timing of submittal of inspection data with IDOT. IDOT Form BBS-BIR, “Routine Inspection Report” shall be used to record the Initial Inspection.

Some bridges are built over several years and under different construction contracts. When this is the case, the Initial Inspection shall be performed after the first construction stage of the bridge is opened to traffic. As additional stages are completed, Routine Inspections shall be completed and inventory data updated as necessary. The inspection and revised inventory data must be entered into ISIS within 90 days after opening the new stage to traffic.

The purpose of an Initial Inspection is to verify the safety of a bridge in accordance with the NBIS, provide required inventory information of the as-built structure, and to determine its baseline structural condition.

Documents, including photographs, drawings (design, as-built, and shop), scour analysis, foundation information, hydrologic and hydraulic data, stream cross sections, pile driving records, and field changes shall be included in the Bridge File as applicable. See [Section 3.9.3.4](#) for Bridge File content requirements.

The level of effort required to perform an Initial Inspection will vary according to the structure's type, size, design complexity, and location. An Initial Inspection may include a Hands-On Inspection of main bridge members of the structure to document the baseline conditions.

3.3.3 Routine Inspection

Although commonly used to also determine bridge maintenance and repair needs, the primary focus of the Routine Inspection is public safety. This inspection must be performed for all bridges on public roads with an opening greater than 20 feet, measured face-to-face of abutments along the center line of the roadway. See [Section 3.1.2](#) for the complete NBIS definition of a Bridge. This inspection includes sufficient observations and measurements to determine the physical condition of a bridge in order to accomplish the following functions:

- Verification and updating condition ratings and appraisals assigned to various items pertaining to the physical condition and the functionality of the bridge.
- Identification and documentation of potential problems that may affect bridge safety.
- Correction of inaccuracies in the bridge inventory data. During Routine Inspections, inspectors are encouraged to verify inventory data items. See [Section 3.2.2](#) for updating bridge inventory.

- Determination of need for the Bureau of Bridges & Structures, or an Illinois Licensed Structural Engineer retained by an agency, to evaluate load carrying capacity or repair needs.
- Documentation of maintenance work that may be required.

Inventory and inspection items are coded in accordance with the guidelines provided in the IDOT *Structure Information and Procedure Manual* (SIP Manual). The results will be recorded on the IDOT Form BBS-BIR, "Routine Inspection Report". The BBS-BIR for each Routine Inspection is kept in the official Bridge File at the headquarters of the District or the Agency responsible for inspection.

The Inspector's Appraisals section of the BBS-BIR contains space for comments next to each condition rating item. A concise description of deficiencies must be included for all condition ratings of "5" (Fair) or less and should be included for condition ratings of "6" (Satisfactory). Deficiencies must also be documented with photographs for condition ratings of "4" (Poor) or less.

When the rating for "Superstructure Condition", "Substructure Condition", or "Culvert Condition" (ISIS Items 59, 60, or 62) is judged to warrant a drop to a level of "4" (Poor) or lower, or the rating for "Deck Condition" (ISIS Item 58) drops to "3" (Serious) or less, a subsequent Load Rating Inspection as specified in [Section 3.3.9](#) is required to evaluate load carrying capacity. Such a condition rating is an indication that a main structural member may have deteriorated to a point where its load carrying capacity has been reduced. The Bureau of Bridges & Structures monitors ISIS to determine when condition ratings are lowered to levels requiring a Load Rating Inspection and will schedule an inspection and perform analysis as needed to determine the revised load carrying capacity of the deteriorated structure.

When the rating for "Superstructure Condition" (ISIS Item 59) for steel superstructures drops to a "3" or lower due to section loss of the web at the bearing, the Program Manager responsible for the structure shall ensure hardwood blocking is installed between beam flanges at the identified bearing locations to resist buckling or crushing of the web.

If an inspection reveals that an imminent danger to the travelling public is likely, the inspector should immediately take necessary action to protect the travelling public prior to notifying the Program Manager responsible for the structure and the Bureau of Bridges & Structures.

When the Bureau of Bridges & Structures cannot provide a Load Rating Inspection for an Agency within a reasonable time frame, the responsible Agency will be notified to retain the services of an Illinois Licensed Structural Engineer to evaluate the load carrying capacity of the affected bridge. The Structural Engineer's recommendation must be submitted to the Bureau of Bridges & Structures for concurrence and approval.

3.3.3.1 Routine Inspections - Structures over Waterways

When the water depth at a substructure unit is normally less than 4-feet (typically referred to as "shallow water conditions"), site conditions do not meet the "Basic Submergence Criteria" specified in [Section 3.3.4](#) and an Underwater Inspection is not required.

Condition of substructure units and the surrounding streambed below the waterline are typically determined by wading and probing during the Routine Inspection as required for the proper coding of "Substructure Condition" (ISIS Item 60). If all waterway substructure units of a bridge are located in water that is normally less than 4-feet in depth, an Underwater Inspection is not required and the "Underwater Inspection Interval" (ISIS Item 92B) is left blank.

If site conditions at the bridge indicate that there is a known deficiency or concern at one or more substructure units, the responsible Program Manager must determine how it should be monitored:

- During subsequent Routine Inspections at their normal interval
- By lowering the Routine Inspection Interval
- By initiating a Special Inspection to address each concern
- By closing the structure or limiting traffic

If the Program Manager elects to initiate monitoring with a Special Inspection, the appropriate "Special Inspection Type" (ISIS Item 92C1) and "Special Inspection Interval" (ISIS Item 92C) must be determined for each deficiency or concern and entered in ISIS. See [Figure 3.4-2](#), "Substructure Condition Assessment Method below Waterline" and [Table 3.4-3](#) for options and recommended monitoring intervals.

When Special Inspections are initiated for waterway monitoring, IDOT Form BBS SI-1, "Special Inspection Report" must be completed for each Special Inspection Type. Information obtained

during Special Inspections will be used for the coding of “Substructure Condition” (ISIS Item 60). See [Section 3.3.6.2](#), Special Inspections for Monitoring Substructure and Channel Conditions Below the Waterline.

Channel cross-sections, along the upstream and downstream fascias shall be taken for comparison with Initial Inspection baseline cross-sections at a maximum interval of every 5 years and after significant storm events as documented by an alert from BridgeWatch specified in [Section 3.7.6](#). Additional cross-sections should be taken when conditions indicate significant changes from original construction or previous inspections. An elevation “grid” may be established for tracking local scour around individual substructure units. Whether accomplished during a Routine Inspection or by a Special Inspection, the condition of substructure units below the waterline and the streambed adjacent to those units must be determined to verify that existing conditions do not compromise the safety of the structure. This need for inspection applies to all structures over water, including new bridges that may have been designed to structurally accommodate an established scour depth determined by analysis. [Figure 3.4-2](#) illustrates the use of the various inspection types referred to in this Section.

3.3.4 Underwater Inspection

When water is normally 4-feet or more in depth or the combined depth of mud makes it unsafe to wade in normal chest waders at a substructure unit, site conditions meet the “Basic Submergence Criteria” requiring an Underwater Inspection. Underwater conditions at these substructure units typically cannot be determined by wading and probing, and inspections require the use of a boat, sonar depth finder, or diving to determine existing conditions.

As described in FHWA *Bridge Inspector’s Reference Manual* (BIRM), an Underwater Inspection for all bridges meeting the Basic Submergence Criteria shall include the development of an Underwater Inspection Plan (IDOT Form BBS UIP) for inspecting each substructure unit. The Underwater Inspection Plan shall include the following, as applicable:

- A plan sheet locating each substructure unit that qualifies for an Underwater Inspection
- Inspection records from previous Underwater Inspections
- Initial Inspection baseline stream cross-sections and all subsequent cross-sections taken during past Underwater Inspections
- Detailed inspection procedures to be followed for each substructure unit

- Equipment required to complete the inspection

Procedures for inspecting the substructure units may vary, depending on weather, stream level, or stream current. Inspection history will assist in determining preferred time periods when conditions are usually most conducive for conducting an inspection.

In addition to assessing the condition of the substructure elements, waterway inspections are conducted to create a record of the existing channel conditions adjacent to the bridge. Conditions such as channel opening width, depth at substructure elements, channel cross-sections, water flow velocity, and channel constriction and skew should be noted and compared to previously recorded conditions. To track local scour conditions near substructure units, a streambed elevation “grid” may be established.

Channel cross-sections along the upstream and downstream fascias shall be taken for comparison with Initial Inspection baseline cross-sections and previous inspection data with each Underwater Inspection. Current waterway inspection data should be plotted against previous inspection data in order to identify channel changes. This “tracking” of channel change over time is an important step in ensuring the safety of the bridge. Over time, vertical changes, due to either degradation or aggradation processes, or horizontal alignment changes, due to lateral migration of the channel, could result in foundation undermining, bridge overtopping, or even collapse of the structure.

For bridges that are located in low-flow or no-flow conditions, such as in lakes, ponds, or lagoons, or in controlled pool conditions above locks and dams, the requirement for stream cross-sections may be waived, at the discretion of the responsible Program Manager. Justification for waiving this requirement must be documented in the Underwater Inspection Plan and kept with the Bridge File.

3.3.4.1 Assessing Substructure Conditions Below Waterline

Bridges that have one or more substructure units located in a depth of water meeting the Basic Submergence Criteria are coded in ISIS as requiring an Underwater Inspection by entering an “Underwater Inspection Interval” (ISIS Item 92B) and all “Underwater Inspected Substructure Units” (ISIS Item 93B8) in ISIS. When performing Underwater Inspections, inspectors should be

aware of which units were entered for ISIS Item 93B8 to ensure that their efforts are appropriately directed.

If site conditions at the bridge indicate that there is a known deficiency or concern at one or more substructure units, the responsible Program Manager must determine how it should be monitored or addressed:

- During subsequent Underwater Inspections at their normal interval
- By lowering the Underwater Inspection Interval
- By initiating a Special Inspection to address each concern
- By closing the structure or limiting traffic

The procedures used for determining the need for an Underwater Inspection are the same for new structures, which have been designed for anticipated scour, and older structures, which were designed prior to the development of procedures for estimating scour. [Figure 3.4-2](#) illustrates the use of the various inspection types referred to in this Section.

3.3.4.2 Procedures for Underwater Inspections

A typical Underwater Inspection should evaluate the substructure units and adjacent streambeds areas utilizing procedures considered appropriate by the District/Area Program Manager, the Central Program Manager, or the Agency Program Manager.

Streambed cross-sections shall be obtained during each Underwater Inspection for comparison to initially established baselines and to previous inspection data. Procedures utilized for an Underwater Inspection shall include the following as deemed appropriate for a particular bridge site:

- Visual observation of the channel at, and adjacent to, the substructure units.
- Manual probing of the channel bottom and/or substructure footing at, and adjacent to, the substructure units to identify areas of concern or to establish channel bottom elevations.
- Probing of the substructure walls below the waterline for damage.

- Recording of the channel bottom elevations with depth finding sonar at, and adjacent to, the substructure units, as well as at cross sections just upstream and downstream from the bridge.
- Visual observation of the substructure units to detect possible abnormalities in elevation or attitude.
- Observation of conditions below waterline by certified divers.

When the water depth is too great or site conditions prohibit an inspector from adequately determining the condition of a substructure unit by visual means or probing, a diving inspection will be required.

All procedures used for accomplishing the Underwater Inspection are recorded in ISIS as Item 93B4, "Underwater Inspection Method". As bridge deficiencies are discovered or suspected, more thorough evaluation techniques should be employed. These may include surveying measurements to determine the elevation and attitude of substructure units or obtaining soil borings. The findings of inspections are to be recorded on IDOT Form BBS BIR-UW1, "Bridge Inspection Report Underwater Inspection" and an "Underwater Appraisal Rating" (ISIS Item 93B1) is to be entered in ISIS.

3.3.4.3 Effect of Conditions Below Waterline on Substructure Rating

The findings from Underwater, Routine, and Special Inspections should be taken into account in determining the "Substructure Condition" (ISIS Item 60). Condition of bridge elements below the waterline should be included during the evaluation of the substructure as part of each Routine Inspection. Inspectors should take advantage of low water conditions during Routine Inspections to observe elements below the waterline, especially those elements that would normally receive an Underwater Inspection and are currently accessible due to environmental circumstances. The performance of Underwater Inspections at intervals less than 60 months is encouraged when resources are available and environmental circumstances are favorable.

Only observed or historical scour is considered when determining a "Substructure Condition" (ISIS Item 60). Calculated scour, which is an analytically derived estimate of the depth to which the channel could be eroded during an extreme event, is only considered when determining the coding for "Scour Critical Evaluation" (ISIS Item 113). Scour Critical Evaluation is unrelated to Substructure Condition unless significant scour has actually occurred at the bridge. The

“Substructure Condition” (ISIS Item 60) shall match the “Scour Critical Evaluation” (ISIS Item 113) when the “Scour Critical Evaluation” (ISIS Item 113) is "2" or less.

3.3.4.4 Determining Safe Conditions for Standard Diving Inspections

IDOT policy for safe diving inspections requires that certain field conditions must be met before allowing a dive team to enter the water.

- Diving Inspections shall be scheduled to avoid unsafe waterway conditions. Prior research shall be conducted to evaluate the best time of year to make a dive. Every effort shall be made to schedule Diving Inspections for periods of low flow and/or low water levels when diving inspections can be safely performed in accordance with IDOT Policy and FHWA guidance. Dive Teams shall research the site conditions from the office before traveling to the site to make sure water levels are in a safe condition for diving.
- Upon arrival at the bridge, the site and waterway conditions shall be assessed with a formal Job Hazard Analysis to determine if an Underwater Inspection by a diving team can be safely performed. If the conditions are unsafe for diving, IDOT shall be notified immediately.
- With IDOT approval, Underwater Acoustic Imaging may be performed at unsafe bridge sites to preliminarily evaluate the bridge prior to the NBIS compliance Underwater Inspection Interval date. The approved types of Acoustic Imaging equipment are Sector Scanning Sonar, Mechanical Scanning Sonar, and Multibeam Sonar. “Underwater Inspection Remarks” (ISIS Item 93B2) shall have a comment added stating that Acoustic Imaging was done without diving until diving could be rescheduled due to unsafe diving conditions. The Dive Team shall reschedule the dive as soon as conditions are safe.
- FHWA does not accept sonar evaluations for Underwater Inspections as a substitute for diving, even in situations where the Underwater Inspection cannot be safely performed by divers. However, FHWA recognizes that safety of the diving inspectors and adherence to policies are necessary when conditions are unfavorable. Full documentation of the conditions and reasons why sonar inspection was employed should be included in the Underwater Inspection Report.

Current	Depth	Special Conditions	Unsafe Conditions – Underwater Imaging Procedures to be Used
>4.0 fps	Any Depth	None	Unsafe Conditions
3.0 to 4.0 fps	>30 ft	None	Unsafe Conditions
	Any Depth	Hazardous Debris Present at Dive Site	Unsafe Conditions
	Any Depth	Channel Bottom Unstable	Unsafe Conditions
All flow velocities	>99 ft	None	Unsafe Conditions
	>50 ft	Water Temp < 35 deg. F	Unsafe Conditions

Table 3.3-1 –Unsafe Conditions for Underwater Diving Inspections

3.3.4.4.1 IDOT Expectations for Routine Diving Inspection Team

A typical diving inspection team should include:

- Dive Team Size: 3 or 4 person team including an IDOT approved Team Leader who is also an Illinois Licensed Structural Engineer and will be at the site 100% of the inspection
- Standard dive equipment but not including hot-water suits or a hyperbaric chamber on site
- Commercial scuba or surface-supplied air in accordance with OSHA Dive Standards
- All dive team members are required to be certified divers and have taken NHI “Underwater Bridge Inspection” Course FHWA-NHI-130091 or NHI “Safety Inspection of In-Service Bridges” Course FHWA-NHI-130055
- Appropriate sized boat (typically less than 25 feet in length)

In addition, diving consultants may have their own requirements.

3.3.4.4.2 Procedures for Underwater Diving Inspections

The following procedures should be performed during an underwater diving inspection:

- Determine if safe diving conditions exist at the structure.

- Inspection schedules will be sent to the Bureau of Bridges & Structures and the United States Coast Guard a minimum of two weeks in advance of the inspection.
- IDOT shall inform the Illinois State Police of the inspection.
- Visual and tactile inspection of 100% of the underwater portions of the substructure units.
- Provide measurements of pitting and damage of each substructure unit.
- Provide a complete report with topside photographs, diagrams, and underwater photographs necessary to adequately describe conditions and deficiencies found at the water surface and below, and anything above the waterline that would be hidden from an inspector not diving.
- Reports will include scope of work, description of the structure, method of investigation, existing site conditions, structure conditions with elevation views of units showing damage and streambed elevations, streambed probing information at each unit, streambed elevation grid at 25 ft. intervals out to 50 ft. from each unit, streambed cross-sections at both fascias and at 100 ft. upstream and downstream, IDOT Form BBS BIR-UW1, "Bridge Inspection Report Underwater Inspection" and anything else as required by the Bureau of Bridges & Structures.
- The reports shall be signed and sealed by an Illinois Licensed Structural Engineer.

For local public agency structures, the Agency Program Manager will set the requirements of the Underwater Diving Inspection for each bridge, but they should generally follow the requirements above. The Agency Program Manager is responsible for coordination with the waterway authority and local law enforcement.

3.3.5 Fracture Critical Member Inspections

Federal regulations provide the following definition:

Fracture Critical Member: A steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

Based on the above definition, Fracture Critical Member Inspections are performed on steel bridge tension members and tension components of members whose failure could result in collapse of the bridge or a portion of the bridge. These inspections consist of arm's length investigations of all Fracture Critical Members contained within the structure. The primary

method for detecting cracks in steel members is a Hands-On visual inspection. See BIRM for detailed guidelines for identifying and inspecting Fracture Critical Members.

NBIS requirements specific to bridges containing Fracture Critical Members include:

- Fracture Critical Inspection procedures must identify the locations and include a description of all Fracture Critical Members.
- An inspection frequency must be specified for Fracture Critical Members. The Federal Coding Guide states the maximum frequency between Fracture Critical Member Inspections is 24 months. See [Section 3.4.5](#) for requirements for reduced intervals.
- Procedures for inspection of Fracture Critical Members must be identified prior to the inspection.

As described in AASHTO *The Manual for Bridge Evaluation*, a Fracture Critical Member Inspection should include the development of a plan for inspecting such members. The inspector should be in a position to see at least one side of all Fracture Critical Members, all sides when accessible, and to look along all welds attaching the members. This may require that critical areas be specially cleaned prior to or during the inspection. Additional lighting and magnification may also be required to facilitate the Fracture Critical Member Inspection. Other non-destructive testing procedures may be used at the discretion of the Bridge Owner, Program Manager, or Team Leader. Where the fracture toughness of the steel is not documented, testing may be needed to determine the threat of brittle fracture at low temperatures. Consult with the Bureau of Bridges & Structures before taking samples for testing.

IDOT requires that a Fracture Critical Member Inspection Plan be included in the Bridge File for every fracture critical bridge. A Fracture Critical Member Inspection Plan template is available in [Appendix A-5](#) to aid in the development of the Fracture Critical Member Inspection Plan. It is the responsibility of the District/Area or Agency Program Manager to ensure that the Fracture Critical Member Inspection Plan is developed, included in the Bridge File, and updated as needed.

As part of the development or review of the Fracture Critical Member Inspection Plan the Program Manager shall verify that any active FHWA Technical Advisories that are applicable to the bridge, or its components, are included in the Fracture Critical Member Inspection Plan. All FHWA Technical Advisories are located at the following address:

<https://www.fhwa.dot.gov/reports/techadvs.cfm>

Bridges which are known or suspected to have been fabricated with Grade 100 ksi ASTM A514 Steel (also known by several different proprietary names such as “T1”, “NAXTRA” and others; or may be designated as “Quench and Tempered (Q&T) Steel” or “Heat-Treated Steel” on the plans) require special inspection procedures and considerations. FHWA Technical Advisory 5140.32, *Inspection of Fracture Critical Bridges Fabricated from AASHTO M270 Grade 100 (ASTM A514/A517) Steel*, provides recommendations regarding the inspection and treatment of such structures. This Technical Advisory addresses issues found with welds, particularly butt welds, connecting this type of steel. It does not recommend re-inspection of bridges that have been previously properly inspected and maintained. Rather it recommends a review of the inspection records to ensure that any components fabricated with this type of steel have been regularly and appropriately inspected and that any critical findings identified have been properly addressed. Although IDOT anticipates very few such structures, it is important to identify bridges containing this type of steel and to follow the recommendations of this Technical Advisory.

The following items are required to be included in the Fracture Critical Member Inspection Plan for each bridge:

- Sketches as necessary to identify Fracture Critical Members.
- The Fracture Critical Member Inspection Plan should identify the inspection frequency and procedures to be used. The inspection frequency shall be in accordance with the NBIS and [Section 3.4.5](#).
- Description of inspection procedures for the Fracture Critical Members. Include any specific inspection requirements (specific measurements, NDT, access equipment required, additional lighting and magnification, etc.).

A table listing the Fracture Critical Members, and identifying the Fatigue Sensitive Details (FSDs) for each Fracture Critical Member is recommended. See [Appendix A-6](#) for the table of AASHTO LRFD Fatigue Categories.

When documenting and recording cracks or other deterioration during Fracture Critical Member Inspections, several items of information should be noted:

- The general location of the crack or deterioration with respect to the member should be recorded, as well as the exact location of the member with respect to the entire bridge. Any noticeable lengthening, opening and closing, and visible distortion of the crack when exposed to live load should be documented.
- The members should be labeled in the field using paint or other permanent markings. The ends of all cracks should be marked, and the date should be identified. It is important to compare the new markings with any previous markings, if any, and the inspection team should be sensitive to aesthetics at prominent areas.
- Detailed sketches and photographs of cracking and other deterioration should be provided showing the orientation, length, width, depth and end of crack. A close-up view should be provided, as well as a general view of the member from the same perspective to show context, showing all sides of the deteriorated area.
- The inspection team should document dimensions and details of the member containing the crack. The general condition at the location of the problematic detail should be noted, including corrosion and section loss, dirt and debris, traffic impact and steel type (if available).

For bridges with superstructures containing Fracture Critical elements, the bridge's "Superstructure Condition" (ISIS Item 59) shall not be higher than the "Fracture Critical Appraisal Rating" (ISIS Item 93A1) for the superstructure Fracture Critical Member, though it may be lower.

For bridges with substructures containing Fracture Critical elements, the bridge's "Substructure Condition" (ISIS Item 60) shall not be higher than the "Fracture Critical Appraisal Rating" (ISIS Item 93A1) for the substructure Fracture Critical Member, though it may be lower.

3.3.5.1 Identifying Bridges with Fracture Critical Members

Fracture Critical Members can have either all or part of their cross section in tension. Steel members that are subjected to calculated tension and are not part of a load path redundant system are to be considered Fracture Critical Members.

The FHWA *Bridge Inspector's Reference Manual* (BIRM) defines redundancy as follows:

Load Path Redundancy: Bridge designs that are load path redundant have three or more main load carrying members or load paths between supports. If one member were to fail, load would be redistributed to the other members and bridge failure would not be expected. Bridge designs that are non-redundant have two or fewer main load carrying members or load paths.

Structural Redundancy: Most bridge designs, which provide continuity of load path from span to span, are referred to as structurally redundant. Some continuous span two-girder bridge designs are structurally redundant. In the event of a member failure, loading from that span can be redistributed to the adjacent spans and total bridge failure may not occur.

Internal Redundancy: Internal redundancy is when a bridge member contains several elements which are mechanically fastened together so that multiple load paths are formed. Failure of one member element would not cause total failure of the member.

Only load path redundancy is to be considered when identifying Fracture Critical Members. Note that while the presence of structural redundancy and internal redundancy may reduce the consequence of the failure of a Fracture Critical Member, these types of redundancy are not to be considered when identifying Fracture Critical Members. For a structure to be considered load path redundant it must have three or more primary load carrying members between supports.

The Bureau of Bridges & Structures with the assistance of the applicable Program Manager will identify all bridges requiring a Fracture Critical Member Inspection. The Bureau of Bridges & Structures will enter the necessary information for a bridge to be included in the Fracture Critical Member Inventory in ISIS.

Some common fracture critical bridge types include, but are not limited to, the following:

- One- or two-girder systems (I-girder or box girder)
- Suspension systems with eyebar components
- Steel pier caps and cross girders
- Two-truss systems
- Steel tied arches
- Pin and hanger connections on two- or three-girder systems

- Bascule/Lift bridges with two primary girders or two primary trusses
- Floorbeams are considered fracture critical when their spacing exceeds 15 feet or the floorbeam supports other longitudinal or flared beams, girders, or stringers

See IDOT *Structure Information and Procedure Manual* (SIP Manual) Item 92A1.

3.3.5.2 Common Problematic Details on Fracture Critical Members

It is important to note that problematic details may exist on a variety of bridges, such as steel girder, frame, truss or arch substructure configurations. Problematic details may also exist on substructure components. The following problematic details can lead to cracking:

- Triaxial constraint
- Intersecting welds
- Welded Cover plates
- Suspended spans
- Field welds on patch and splice plates
- Intermittent welds
- Details prone to out-of-plane bending (small web gaps, diaphragm connection plates that are not attached to flanges)
- Improperly installed or spliced back-up bars
- Tack welds and poor quality welds

More information about these problematic details and procedures for their inspection are described in considerable detail in the following documents:

- FHWA *Bridge Inspector's Reference Manual*
- AASHTO *The Manual for Bridge Evaluation*
- Course material from "Fracture Critical Inspection Techniques for Steel Bridges" (FHWA-NHI-130078)

Fatigue-prone details shall be given special attention as part of an arm's length visual inspection during Fracture Critical Member Inspections. The inspection of fatigue-prone details may include non-destructive testing.

Fatigue cracks may occur at stress concentrations, where the rigidity of the member changes. Examples of such locations include connection details, damaged components, material flaws, changes in member cross-section, welds, corrosion-notched sections or a combination of these features.

Common connection details have been identified and have been assigned a fatigue stress category as shown in [Appendix A-6](#). Category E' details generally have the shortest fatigue life and are most prone to fatigue cracking. The susceptibility of the detail to fatigue cracking decreases from Category E' to Category A. Problems associated with these details are often related to weld terminations and weld defects. Tack welds, plug welds, and other welds made in the field are also susceptible to fatigue cracking.

3.3.5.3 Recording Fracture Critical Member Inspections

All Fracture Critical Member Inspections must be reported using IDOT Form BBS-BIR-FC1, "Fracture Critical Member Inspection Report" form. New and rehabilitated fracture critical bridges shall receive an initial Fracture Critical Member Inspection within 90 days of opening to traffic to ensure that no cracks or discontinuities have initiated in any Fracture Critical Member due to faulty fabrication, substandard construction or inappropriate design details.

3.3.5.4 Identifying Misclassified Bridges

Team Leaders are responsible for identifying bridges that have been misclassified as not being fracture critical. Local public agencies should also survey their inventory for any structures having characteristics which previously may have excluded them being reported as fracture critical. If any structures are identified, notify the District/Area Program Manager or Agency Program Manager and the State or Local Program Manager. Inventory information for ISIS Items 92A1, 92A2, and 92A3 should be provided. The IDOT *Structure Information and Procedure Manual* (SIP Manual) should be consulted for additional information on reporting Fracture Critical Members.

3.3.5.5 Gusset Plates – Fracture Critical Member Inspections

Each gusset plate will require Hands-On Inspection and thickness measurements to be taken to document and assess continued growth and expansion of section loss, initiation or growth of

cracks, and development or increase in any plate distortion. The inspection record for each gusset plate must document all significant changes to previously identified areas of concern as well as any new areas identified with each new inspection.

The District/Area or Agency Program Manager shall determine if new inspection findings are significant enough to require structural analysis and load rating. Results of any Hands-On inspection that identifies significant changes to previously documented data should be reviewed by a load rating engineer to determine if a new load rating will be required. The District/Area or Agency Program Manager should consult with the Bureau of Bridges & Structures when determining the need for further analysis.

Copies of the inspection report, including a summary of all field measurements and photos shall be kept in the Bridge File. It is imperative that complete and accurate records are kept to chronicle the initiation and progression of gusset plate deterioration and the steps taken to repair or mitigate those findings.

All repairs, retrofits or member replacements that have been performed since the last Fracture Critical Member Inspection shall be documented in the bridge file. The condition of the work performed and a general assessment of its effectiveness in arresting or mitigating previous damage or deterioration shall be noted.

3.3.5.6 Non-Destructive Testing for Fracture Critical Member Inspections

When visual inspection alone is not sufficient for determining the condition of a Fracture Critical Member, Non-destructive Testing (NDT) may also be performed by qualified personnel to determine the condition of structure elements and components associated with the Fracture Critical Members. Through the use of NDT, an inspector can verify both the presence and extent of a crack or discontinuity. The NDT methods most frequently used in the field by IDOT are D-Meter Thickness Measurement (DM), Dye Penetrant Testing (DT), Magnetic Particle Testing (MT) and Ultrasonic Testing (UT). Inspectors should be trained in the use and limitations of the various methods of NDT. Basic procedures for performing DM, DT, MT and UT are provided in [Section 3.5](#).

3.3.6 Special Inspections

Special Inspections are performed to monitor a specific structural feature, deficiency or condition that must be monitored more frequently than Routine, Underwater, or Fracture Critical Member Inspection Types require. Special Inspections may be initiated by structural damage or deterioration, conditions affecting the stability of the structure, or for other reasons at the discretion of the responsible District or Agency Program Manager or the Bureau of Bridges & Structures. Some examples of concerns that may be cause for a Special Inspection are damage/deterioration to main load carrying members, existing or potential scour, settlement/movement of substructure units or adjacent embankment, and structural details with histories of poor performance. Procedures used during these inspections should be adopted in accordance with the specific deficiency or condition to be monitored.

Special Inspections for local public agency or other non-IDOT State Agency structures are typically initiated by or after consultation with the Local Bridge Unit of the Bureau of Bridges & Structures. Failure to comply with the inspection frequency and/or the established procedure for the required Special Inspection may result in posting, reduced posting, or closure of the bridge.

3.3.6.1 Recording and Performing Special Inspections

The frequency of the Special Inspection shall be recorded in ISIS as the “Special Inspection Interval” (ISIS Item 92C). See IDOT *Structure Information and Procedure Manual* (SIP Manual) “Special Inspection Type” (ISIS Item 92C1) for a list of feature types that can be specified.

The dates when the Special Inspection was initiated and rescinded are recorded in ISIS as the “Special Inspection Determination Date” (ISIS Item 92C6) and the “Special Inspection Close Date” (ISIS Item 92C3) respectively. The Agency that initiated the Special Inspection should be recorded in ISIS as “Special Inspection Initiated By” (ISIS Item 92C4). The Agency responsible for initiating the Special Inspection must determine a time frame for conducting the first Special Inspection by entering the “Special Inspection Inspect By Date” (ISIS Item 92C7). The actual date of the First Special Inspection is recorded as the “Special Inspection Date” (ISIS Item 93C).

In order to record information specific to the “Special Inspection Type” (ISIS Item 92C1) and to provide information relative to the conditions that initiated the need for a Special Inspection, comments should be entered for “Special Inspection Remarks” (ISIS Item 92C5).

The performance of each inspection is recorded by entering the date of the inspection in ISIS for “Special Inspection Date” (ISIS Item 93C) and the results of each inspection are recorded by entering a Condition Type Code in ISIS for “Special Inspection Condition Status” (ISIS Item 93C1). See IDOT *Structure Information and Procedure Manual* (SIP Manual) Item 93C1.

Except when the Special Inspection Condition Status is coded as 2 or 4, the inspector must document the change in condition in ISIS by providing information for “Special Inspection Remarks” (ISIS Item 92C5).

It is imperative that personnel performing Special Inspections compare the conditions noted in the field. The comparison of current conditions to initial conditions determines the proper coding of “Special Inspection Condition Status” (ISIS Item 93C1). When a Special Inspection Condition Status code of “1” or “0” is applicable, the Bureau of Bridges & Structures should be contacted immediately to determine if additional information is required and to discuss measures that must be taken to ensure safety.

The inspection team for the Special Inspection should be established by the Program Manager based on the specific requirements of the Special Inspection. The responsible Program Manager must emphasize to personnel performing the inspections that they are to compare observed conditions to the conditions that initiated the need for the Special Inspection. In some cases, a qualified Team Leader may not be required, provided the inspection team is fully instructed on what specific observations are needed. Personnel performing Special Inspections must be knowledgeable of the conditions that initiated the need for the inspections. The inspectors must understand, based on their observations, decisions will be made relative to the need for follow-up inspections or the need for traffic restrictions. Whenever possible, consecutive Special Inspections should be performed by the same inspection personnel to ensure sufficient site specific knowledge.

Observations made during Special Inspections are recorded as “Special Inspection Remarks” (ISIS Item 93C4). IDOT Form BBS SI-1, “Special Inspection Report” should be utilized by personnel performing Special Inspections. The form must be accepted by means of the signature of an IDOT approved Program Manager. Photographs or other evidence are suggested to validate Special Inspection findings.

3.3.6.2 Special Inspections for Monitoring Conditions Below the Waterline

Special Inspections may be necessary to monitor known, suspected or potential deficiencies of a substructure unit or adjacent channel. The inspections are performed to verify that deficiencies do not exist, or to determine the extent to which previously identified deficiencies are affecting the substructure.

If site conditions at the bridge indicate that there is a known deficiency or concern at one or more substructure units, the responsible Program Manager must determine how it should be monitored:

- During subsequent Routine or Underwater Inspections at their normal interval
- By lowering the Routine or Underwater Inspection Interval
- By initiating a Special Inspection to address each concern
- By closing the structure or limiting traffic

If the Program Manager elects to initiate monitoring with a Special Inspection, the appropriate “Special Inspection Type” (ISIS Item 92C1) and “Special Inspection Interval” (ISIS Item 92C) must be determined for each deficiency or concern and entered in ISIS. See [Figure 3.4-2](#), “Substructure Condition Assessment Method below Waterline” and [Table 3.4-3](#) for options and recommended monitoring intervals.

3.3.6.3 Special Inspections for Pin and Link Assemblies

Pin and link or pin only assemblies in girder/beam bridges that have been retrofitted with the stainless steel pins and Teflon bushings as shown in [Section 2.11](#) shall have a Special Inspection on a maximum interval of 48 months, preferably coinciding with the Routine Inspection. This inspection shall be completed as per [Section 3.6](#). Any defects found in the pins or link plates shall be reported to the Bureau of Bridges & Structures immediately. The link assemblies shall be visually observed to verify they are functioning as intended. The link plates shall be measured as required to verify any section loss or cracks. Any defects found in the pins or link plates shall be reported to the Bureau of Bridges & Structures immediately.

If a defect is found in the pin or a crack is found in a link plate, the inspection interval of the Special Inspection shall be changed as required by the Bureau of Bridges & Structures. If the

assembly appears not to be functioning properly or section loss in the link plates is between 5% and 10% the Special Inspection interval shall be 24 months or less. If the loss is greater than 10% the interval shall not be greater than 12 months, and the Bureau of Bridges & Structures must be notified to perform a structural evaluation.

Pin and link or pin only assemblies in multi-girder/beam bridges that have not been retrofitted as described above shall have a maximum inspection interval of 24 months.

3.3.7 In-Depth Inspections

As described in AASHTO *The Manual for Bridge Evaluation*, an In-Depth Inspection is a close-up, hands-on inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using Routine Inspection procedures. Traffic control and special equipment (such as under-bridge inspection equipment, staging and workboats) should be provided for access and safety, as needed. In addition, personnel with special skills (such as divers and riggers) may be required. Non-destructive field tests and other material tests may be used as needed to fully ascertain the presence and extent of any deficiencies.

Every bridge shall receive an In-Depth Inspection at least once every 4 years for bridges with 12 month inspection intervals; at least once every 6 years for bridges with 24 month inspection intervals; and at least once every 8 years for bridges with 48 month inspection intervals. These In-Depth Inspections need not necessarily require access to all areas of the bridge but should serve to assure the inspector that areas of potential concern have received the proper degree of inspection. Areas under expansion joints (beam ends, end cross frames or diaphragms, bearings, concrete bearing areas), web stiffeners (transverse and horizontal), cross frame connections, lateral bracing connections, fixed bearings, and any other areas of the bridge that are not normally visible during a Routine Inspection should receive special attention.

An In-Depth Inspection can replace a Routine Inspection, be scheduled independently, or be scheduled as a follow-up to a Damage Inspection, Load Rating Inspection, or an Initial Inspection.

An In-Depth Inspection may include a load rating to assess the residual capacity of the members, depending on the extent of deterioration or damage. In addition, a non-destructive load test may be conducted to assist in determining the safe bridge load carrying capacity.

On typical bridges, In-Depth Inspections should include all critical elements of the structure. For large or complex bridges, In-Depth Inspections may be scheduled separately for defined portions of the bridge or for specific groups of elements, connections or details that can be efficiently addressed by the same inspection procedures. If this option is chosen, then each defined bridge segment, each designated group of elements or both should be clearly identified in the Bridge File and each should be assigned a frequency of re-inspection. It is especially important for an In-Depth Inspection that the activities, procedures and findings be completely and carefully documented.

3.3.7.1 Inspection of Major Bridges by the Bureau of Bridges & Structures

The Bureau of Bridges & Structures and qualified consultant teams, under the direction of the Central Program Manager, conduct In-Depth Inspections for designated “Major Structures”. Included are all structures physically maintained by IDOT over the Mississippi, Ohio, Wabash and Illinois Rivers, as well as other designated structures. The inspections of these major structures typically require extensive traffic control and special equipment (i.e. under-bridge inspection equipment, staging and/or work boats).

Each major bridge receives an In-Depth Inspection, and when applicable, each bridge receives a Fracture Critical Member Inspection, an Underwater Inspection, and steam/river cross sections are taken for comparison to previous inspection data. These inspections provide documentation of deficiencies for use in determining the need for immediate repairs or future rehabilitation of the structure. See [Appendix A-8](#) for a listing of these structures.

In addition to the In-Depth Inspections, the Bureau of Bridges & Structures coordinates periodic jointly conducted cursory visual inspections of border bridges with adjacent states to mutually determine maintenance, repair and rehabilitation needs. District Program Managers are encouraged to participate during In-Depth Inspections and should be represented during the mutual border bridge inspections conducted with the adjacent state’s Department of Transportation. The District Program Manager may be called upon to oversee periodic Special Inspections or to monitor special problems related to the Major Structures when specialized equipment is not required.

3.3.8 Damage Inspections

Damage Inspections are performed on an emergency basis to assess a bridge for damage as a result of environmental factors or human actions that results in a sudden change in the structural capacity or stability of a bridge (fire, collision, scour, severe or extensive section loss, steel cracks, etc.). The inspection shall be performed by District staff, Bureau of Bridges & Structures staff, or an Illinois Licensed Structural Engineer who is an IDOT-approved Team Leader or Program Manager.

The scope of a Damage Inspection should be sufficient to determine the need for emergency load restrictions or closure of the bridge to traffic, and to assess the level of effort necessary to repair the damage. The level of effort required for a Damage Inspection may vary significantly, depending upon the extent of the damage. If major damage has occurred, the inspection team must evaluate the damaged members, determine the extent of section loss, take measurements for misalignment of members, and check for any loss of foundation support. It may be desirable to make on-site calculations to establish emergency load restrictions.

Photos, sketches, and detailed description documenting defects that potentially impact the load carrying capacity of the bridge should be transmitted from the field immediately to the Bureau of Bridges & Structures.

Any calculations or analysis performed as a result of a Damage Inspection must be sealed by an Illinois Licensed Structural Engineer and submitted to the Bureau of Bridges & Structures for review and concurrence. A Damage Inspection may be supplemented by a timely Load Rating Inspection to document verification of field measurements and calculations. In addition, a more refined analysis may be warranted to establish or adjust interim load restrictions or required follow-up procedures.

3.3.8.1 Damage Inspections for State Maintained Structures

Damage Inspections are typically conducted by the Bureau of Bridges & Structures for state owned structures. However, the inspection may be performed by District personnel, at the direction of the District/Area Program Manager with guidance from the Bureau of Bridges & Structures, for the measurement and recording of existing conditions. These inspections include measurement of main structural members to obtain detailed documentation of member

size, section loss, structural defects, and member deflections/distortions that may be present. Traffic control and special equipment are often necessary to accomplish these inspections.

The results of these inspections, for state owned structures, are reviewed by the Structural Ratings and Permits Unit in the Bureau of Bridges & Structures, which performs an analysis to determine the load carrying capacity of each inspected structure. After completing the analysis, the Bureau of Bridges & Structures will provide the Region/District with documentation of the inspection and the results of the structural rating. The documentation provided to the Region/District will include field data and photographs, recommended revisions to condition ratings, updated Inventory and Operating Ratings, and recommendations for load restrictions and/or Special Inspections.

3.3.8.2 Damage Inspections for Local Public Agency Structures

For local public agency structures, Damage Inspections are performed by the Local Bridge Unit of the Bureau of Bridges & Structures.

Local public agencies also have the option of employing the services of a qualified Illinois Licensed Structural Engineer to perform Damage Inspections, calculate the load ratings and provide posting recommendations. The Structure Load Rating Summary sheet (Form BBS 2795) shall be include with the Load Rating and submitted to the Bureau of Bridges & Structures for review and approval.

3.3.9 Load Rating Inspections

Load Rating Inspections are performed to confirm and document the variables that affect the safe live load carrying capacity of a bridge. Load Rating Inspection personnel are not required to have any particular qualifications but must be trained to collect and document the information necessary to conduct a quality load rating analysis. Additional information on Load Rating Inspections is included in [Section 4.3.3.1](#).

3.3.9.1 Load Rating Inspections for State Maintained Structures

Load Rating Inspections are typically conducted by the Bureau of Bridges & Structures, Structural Ratings and Permits Unit for state owned structures. The inspections may be

performed by District Personnel, at the direction of the District/Area Program Manager with guidance from the Bureau of Bridges & Structures, for the measurement and recording of existing conditions. These inspections include measurement of main structural members to obtain detailed documentation of member size, section loss, structural defects, and member deflections/distortions that may be present. Traffic control and special equipment are often necessary to accomplish these inspections.

The results of these inspections are reviewed by the Structural Ratings and Permits Unit in the Bureau of Bridges & Structures, which performs an analysis to determine the load carrying capacity of each inspected structure. After completing the analysis, the Bureau of Bridges & Structures will provide the Region/District with documentation of the inspection and the results of the structural rating. The documentation provided to the Region/District will include field data and photographs, recommended revisions to condition ratings, updated Inventory and Operating Ratings, and recommendations for load restrictions and/or Special Inspections.

3.3.9.2 Load Rating Inspections for Local Public Agency Structures

Load Rating Inspections and load capacity calculations are performed by the Local Bridge Unit of the Bureau of Bridges & Structures as resources allow, following the guidelines for the “Bridge Load Carrying Capacity Rerating Program” originally presented in County Engineer/Superintendent of Highway Circular Letter # 96-11. Using the information in ISIS, the Local Bridge Unit monitors condition rating reductions for local public agency bridges and automatically schedules structures for inspections to determine if the load carrying capacity has been adversely affected.

In addition to the structures automatically scheduled for inspection, agencies may request an inspection and rerating of any structure at any time utilizing the “Local Agency Load Rating Request” from (BLR 06510). A copy can be obtained from the Public Partners area of the IDOT website at:

<http://www.idot.illinois.gov/Assets/uploads/files/IDOT-Forms/BLR/BLR%2006510.docx>

When the Bureau of Bridges & Structures cannot provide a Load Rating Inspection for an Agency within a reasonable time frame, the responsible Agency will be notified that they must retain the services of an Illinois Licensed Structural Engineer to perform Load Rating Inspection

and evaluate the load carrying capacity of the affected bridge and provide posting recommendations. IDOT Form BBS 2795, "Structure Load Rating Summary" shall be included with the Load Rating calculations and submitted to the Bureau of Bridges & Structures for review and approval.

3.3.9.3 Gusset Plates - Initial Inspection for Load Rating

The Federal Highway Administration (FHWA) and the Illinois Department of Transportation (IDOT) have published documents providing guidance on the initial inspection and load rating of gusset plates on non-load-path-redundant steel truss bridges. IDOT issued All Bridge Designers (ABD) Memorandum 10.2, dated May 11, 2010, "Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges," which can be viewed at:

<http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Memorandums-&-Letters/Highways/Bridges/ABD-Memos/ABD102.pdf>

This memorandum references FHWA Technical Advisory T5140.29, which strongly encourages bridge owners to check the capacity of gusset plates, and may be found at:

<https://www.fhwa.dot.gov/bridge/t514029.cfm>

The first step in determining the capacity of gusset plates is inspection. Current inspection guidelines provide that all gusset plates joining main load carrying members must have a Hands-On Inspection. This includes compression and tension members, but not connection plates of secondary members. For any structures containing gusset plates that have not been assessed and load rated, IDOT requires performing a Hands-on Inspection of all gusset plates at or before the next Fracture Critical Member Inspection or Routine Inspection.

The full, non-corroded gusset plate thickness, as well as the overall height and width, should be measured for calculation purposes and for comparison to the original design and shop plans. Any areas of section loss should be measured, and the quantity should be calculated and documented.

Severe section loss or any signs of warping or buckling should be documented and immediately reported to the District or Agency Program Manager and the State or Local Program Manager.

When documenting gusset plate section loss, a photo should be taken of both sides of all gusset plates (i.e., typically both sides of both gusset plates (minimum 4 photos) at each panel point location). Photos of the interior face of the gusset plates may be difficult to take and/or may not show the entire interior surface, but they should still be taken.

The thickness of the gusset plate is critical in calculating its load carrying capacity. In most cases, rudimentary methods (tape measure, ruler and straight edge, etc.) of measuring plate thickness do not provide measurements precise enough to accurately quantify section loss. FHWA Technical Advisory T5140.31 recommends use of an ultrasonic thickness meter as the most appropriate method for measuring remaining plate thickness at locations of section loss and the full plate thickness at an uncorroded location, which can be found at:

<https://www.fhwa.dot.gov/bridge/t514031.cfm>

Field measurements should be compared to the original design and shop plans if they are available. Any discrepancies should be documented and brought to the attention of the District or Agency Program Manager. If plans are not available, detailed drawings of the gusset plates should be made depicting the plate size, thickness, and bolt or rivet pattern and spacing. A digital imaging method was developed by the Oregon State University for the Oregon DOT and FHWA to measure gusset plate dimensions and rivet/bolt patterns through photographic records. That system can be found at:

<http://library.state.or.us/repository/2009/200903241458232/index.pdf>

After the field inspection is completed, any structure not originally designed for current legal live loads or whose original dead load has changed, or any structure having gusset plates with section loss, should have a new load rating performed. A new load rating is not required if a previous load rating included the dead load changes or section loss. The capacity of the gusset plates should be determined and included in the load rating. Gusset plate capacities should also be considered when analyzing truss bridges for permit loads. A list of known steel truss structures potentially having gusset plates was sent to the IDOT District Bureaus of Local Roads and Streets for dissemination to local public agencies. This list was not meant to be all inclusive; it only served as a starting point for local public agencies to search their inventory for structures with bolted or riveted gusset plates.

Local public agencies are encouraged to utilize their own resources or consultants to perform the load ratings as necessary. IDOT does not have the resources necessary to perform load ratings for all local public agencies. Note that load ratings must be performed by or under the direct supervision of an Illinois Licensed Structural Engineer and must be signed and sealed by that Structural Engineer.

To assist with determining the load rating of gusset plates, guidelines are presented in FHWA Publication No. FHWA-IF-09014, entitled “*Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges*”.

When completed, local public agencies should submit documentation to IDOT, including detailed inspection reports and load rating computations. Any spreadsheet used for determining gusset plate capacities and any other software input files, such as AASHTOWare Bridge Rating™ (BrR), should also be submitted for use in evaluation of the load rating analysis. If the local public agency is unable to perform the required load rating analysis, in-depth inspection information should be submitted to IDOT in a timely manner. Reduced size (11” x 17”) copies of existing design and shop plans should be provided if available.

3.3.10 Complex Bridge Inspections

The inspection of complex bridges presents many unique challenges for an experienced bridge inspection team. Complex bridges (defined below) represent a major capital investment in the bridge inventory and many times serve as the only major river crossing for many miles. Other complex bridges, typically bascule bridges, are key to efficient traffic flow in major urban areas. Complex bridges must receive a heightened degree of investigation and evaluation to preserve their continued service to the travelling public and protect IDOT’s investment.

IDOT has determined that the following types are defined as Complex and will be inspected under the provisions and policies of this section:

- Suspension
- Cable-Stayed
- Moveable - Bascule, Swing, and Lift

The Nation Bridge Inspection Standards (NBIS) requires the owner of each complex bridge to develop and maintain a detailed Complex Bridge Inspection Plan, specific to each bridge. The plan must be kept in the official Bridge File and be available for the inspection team to consult prior to each inspection.

3.3.10.1 General Complex Bridge Inspection Procedures

A comprehensive Complex Bridge Inspection Plan should provide a detailed outline for conducting all aspects of the inspection process. The following is a brief outline for a detailed plan.

Team Members: The Program Manager should select an experienced inspection team, trained for the specific tasks required for the unique structure. The Team Leader should provide experience and guidance to the remainder of the inspection team. It is preferable that members of the team have previous experience inspecting the subject bridge type and are familiar with any past issues and concerns. The Team Leader should assign specific tasks for each member in order to conduct an efficient and thorough inspection.

Traffic Control: The inspection of a Complex Bridge will typically require an extensive Traffic Control Plan. The Program Manager / Team Leader should coordinate the Complex Bridge Inspection Plan with IDOT or Agency Traffic Operations, Maintenance, and Construction personnel in order to assure that the inspection operation, lane closures, or lane width restrictions do not interfere with other activities in the area. The plan should detail timing and sequence of operations, including lane closure sequences, signage, flagman responsibilities, and coordination with movement of inspection access equipment.

Navigable Waterways: For bridges that cross navigable waterways, the Program Manager or Team Leader should coordinate the Complex Bridge Inspection Plan with the United States Coast Guard.

Access Equipment: A Complex Bridge Inspection will typically require use of a wide variety of access equipment, including under-bridge inspection cranes (snoopers), manlifts, boats, scaffolding, and ladders. The Complex Bridge Inspection Plan should

coordinate availability of equipment and operators for the entire inspection. Access to enclosed areas should be documented, including box girder access doors, tower entrance doors, etc.

Inspection Equipment: A Complex Bridge Inspection will also require an extensive use of inspection tools and equipment in order to complete a thorough inspection of the structure. This could include survey equipment, hammers, scrapers, wire brushes, drills, cameras, sonar depth finders, and NDT equipment.

Documentation: A Complex Bridge Inspection will typically require a greater extent of documentation and should therefore be compiled into an Inspection Report. The report should contain all inspection notes, photos, and findings in an organized narrative. It should contain an overall description of the structure, a table or listing of significant findings, and recommendations for both general maintenance and any needed repairs. The findings should be prioritized by importance and severity. Any defect of a structural member that could potentially affect the load carrying capacity of the structure must be reported immediately to the District/Area Program Manager or Agency Program Manager, and the State Program Manager. See [Section 3.3.12](#) for details and requirements for a Critical Finding.

3.3.10.2 General Inspection Requirements for Suspension Bridges

A suspension bridge is typically comprised of a steel superstructure of beams, girders, and floorbeams supporting a riding surface, all suspended by cables or wires from two large multi-wire cables stretched over high towers and anchored in large concrete structures. The general inspection requirements for a suspension bridge are as follows:

Deck: The deck, including any wearing surface should be inspected for signs of distress using appropriate procedures, such as chain drag, infrared thermography, ground-penetrating radar, etc. Deck elevations should periodically be surveyed and compared to original as-built plans and previous inspection reports for any marked changes. An inspection of the deck drainage system should be included.

Cable: The main cables of a suspension bridge are usually comprised of hundreds of individual wire strands, combined together to form the main cable. The cable is usually

protected from the elements by a system of wire wrapping and a barrier coating of paint. The cables can also be wrapped in special waterproof fabric material. Inspection of the cables is typically restricted to a visual, hands-on procedure, concentrating on identification of any signs of potential problems with the protection system. Any signs of tearing or gouges that could allow intrusion of water should be documented. Areas surrounding the cable bands, areas around tower saddles, and entrances to the anchorages should be inspected thoroughly. The cable inspection should also document the condition of the safety handhold cable and its connections to the main cables.

A schedule shall be documented in the Complex Bridge Inspection Plan and followed for an In-Depth Inspection involving the use of Non-Destructive Evaluation (NDE) techniques and/or intrusive inspection, where a portion of the cable wrapping is removed and the wire strands are wedged apart allowing for both a visual and borescope inspection of individual wires.

Cable Anchorage: Consult the Confined Space Entry Plan before entering the anchorage structure. The inspection should note the overall condition of the anchorage house. The inspector should document the temperature and humidity both inside and outside the anchorage and should also document any sources of water intrusion into the anchorage building. The inspector should carefully inspect the condition of the cables as they pass through the anchorage walls and into the splaying (cable spreading) structure noting any signs of rust or deterioration.

Hangers: Hangers or suspenders should be thoroughly inspected for any signs of wear or fraying. Note any signs of rust, pitting, or section loss of the wires. Connections to the cable, typically at cable bands should be carefully inspected for signs of rust staining or water intrusion. Hanger cable connections to the superstructure, usually through lead filled sockets and mechanically fastened brackets should also be thoroughly inspected for signs of rust, pitting, section loss, or distortion.

Towers: Typically comprised of massive steel legs and bracing members, towers can rise hundreds of feet above the deck surface. A detailed plan for access and inspection of the tower members should be part of the Complex Bridge Inspection Plan. This may require hiring an experienced inspection team, trained in rope and free climbing

techniques in order to gain access to the external components of the tower. A typical suspension bridge tower will have an internal system of ladders or stairs that gain access to the top of the tower. The inspection should include a complete documentation of the condition of all tower members, including the competence of the access ladder or stair structures. Proper operation of the tower aviation lighting and condition of their supports should also be noted.

Miscellaneous: The inspection report should include a complete inspection of the structure's expansion joints, noting the opening and air temperature and any out-of-tolerance movements. Superstructure wind-tongue structures should be inspected, noting any areas of deterioration or section loss, and any defects in the operation of the system. Proper operation of navigation lighting and condition of their supports should also be noted.

3.3.10.3 General Inspection Requirements for Cable-Stayed Bridges

A cable-stayed bridge is typically comprised of a steel or concrete box or girder superstructure supporting a deck structure, all supported by a series of fanned or splayed high strength multi-strand cables, spanning from anchorages near the top of tall concrete or steel towers to the superstructure near deck level. The general inspection requirements for a cable-stayed bridge are as follows:

Deck: The deck of a cable-stayed bridge is typically concrete, either cast in place or comprised of precast concrete panels with a bituminous or concrete overlay wearing surface. In most designs, the deck of a cable-stayed bridge is always in compression. The inspection should note any distressed areas in the deck, including any signs of compressive force damage or any notable transverse cracks that could indicate a loss of deck compression and a potential sag in the superstructure. The deck, including any wearing surface should be inspected for signs of distress using appropriate procedures, such as chain drag, infrared thermography, ground-penetrating radar, etc. A deck survey should be completed periodically to document elevations against original as-built plans and past inspection surveys. The inspection should include an inspection of the deck drainage system.

Cable: A typical cable-stayed bridge cable is comprised of a series of multi-wire, high strength steel strands inside a steel or plastic pipe encasement. The encasement pipe will usually have a secondary protection system such as a fabric wrap and/or paint. The cable protection system should be visually inspected for any signs of distress or areas of possible water intrusion. Areas near cable anchorages in the towers, areas where the cable typically passes through the deck structure, and areas near the connection to the superstructure should be inspected thoroughly. Any cable damping system should be inspected to ensure that it continues to provide proper damping of wind-induced cable vibrations. A schedule shall be developed and followed for an In-Depth Inspection involving the use of Non-Destructive Evaluation (NDE) techniques and/or intrusive inspection of the cables.

Cable Anchorages: If possible, the cable anchorages at the superstructure connections and at the towers should be inspected for signs of moisture intrusion. Signs of trapped water and any leaching should be noted. Anchorage protective end caps can usually be removed for a close inspection of the strand ends and wedge condition.

Tower: Cable-stayed bridge towers are usually massive, hollow, concrete structures. The inspection should include a visual assessment of the outside of the towers, noting any cracks, rust staining, leaching, or significant deterioration. The Confined Space Entry Plan shall be followed before entering the inside of the tower. A system of ladders, stairs, or elevators is available for access to the top of the towers, including access to cable anchorages near the top of the tower. Proper operation of tower aviation lighting and condition of their supports should be noted also. The access door should be inspected for proper security locks.

Miscellaneous: The inspection report should include a complete inspection of the structure's expansion joints, noting the opening and air temperature and any out-of-tolerance movements. Proper operation of navigation lighting and condition of their supports should also be noted.

3.3.10.4 General Inspection Requirements for Movable Bridges

A moveable bridge presents unique challenges. Dynamic loadings are induced into structural members of the bridge as the bridge is operated. Inspectors should observe operation of the

bridge in order to identify any unusual vibrations or noises or irregular movement of the structure. The bridge operators and bridge mechanics should be interviewed to discuss any operational issues identified.

In addition to structural aspects of the bridge, movable bridges owners usually employ bridge mechanics and electricians to oversee the routine inspection, maintenance, and repair to the mechanical and electrical elements of the bridge. These employees are usually responsible for the inspection and maintenance of the power supply, wiring, motors, control panels, trunnions, rack castings, gears, and counterweights. Although the NBIS inspection is the prime responsibility of the Team Leader, he/she should discuss operation of the bridge with the mechanic and electrician. Mechanical / electrical issues can lead to improper operation of the bridge and induce unusual forces into members, potentially causing severe buckling or torsion. The general inspection requirements for a moveable bridge are as follows:

Deck: Most movable bridges have an open steel grid deck system in order to reduce the overall dead load of the span. The steel grid should be inspected for potential member breakage, weld failures, and deterioration of connection details to the steel superstructure. The open grid design allows deicing salts and water to fall directly on the steel superstructure members below the deck.

Superstructure: The superstructure inspection should follow the Complex Bridge Inspection Plan for the bridge.

Mechanical: The inspection of the mechanical systems of the bridge should include any operational reports from the bridge operators, mechanics and electricians. In addition, the inspector should observe the operation of the span, noting any unusual sounds or vibrations. The lift system should periodically be scheduled for a span balancing procedure to ensure efficient and safe operation of the structure.

3.3.11 Element Level Inspections

The primary purpose of an Element Level Inspection is to provide a foundation for a statewide Bridge Management System. These inspections quantify the physical condition of individually identified elements of a structure, such as decks, beams, expansion joints, beam ends,

bearings, piers, abutments, etc. The “condition states” assigned to the elements also indicate the level of action, if any, necessary to bring the element up to a “like new” condition.

The Team Leader for all Element Level Inspections must have successfully completed the IDOT Element Level Bridge Inspection course.

Element Level Inspections are performed on all IDOT maintained structures, on and off the Nation Highway System (NHS). Element Level Inspections are performed on all local public agency structures on the National Highway System. Element Level Inspection data is included in the annual NBIS data submittal to FHWA. Element Level Inspections are typically conducted in conjunction with and at the same interval as the Routine Inspection. Local public agencies are encouraged to extend this requirement to their entire inventories.

IDOT Form BBS-ELI, "Element Level Inspection Report" contains “Comments” fields for all elements inspected during an Element Level Inspection. A concise description of deficiencies shall be included in the comments fields for elements with a Condition State of “3” or greater.

3.3.12 Critical Findings

A Critical Finding is defined as a structural or safety related deficiency that may pose an imminent threat to the safety of the traveling public.

3.3.12.1 Identifying a Potential Critical Finding

Any of the following will be considered a Potential Critical Finding:

- Bridges that sustain damage from vehicle impacts, fire, severe flooding or other natural disaster
- Lowering the “Deck Condition”, “Superstructure Condition”, “Substructure Condition”, or “Culvert Condition” (ISIS Items 58, 59, 60, and 62 respectively) rating to a “2” (Critical) or less
- Lowering “Channel Condition” (ISIS Item 61) rating to a “2” (Critical) or less
- Lowering the code for “Scour Critical Evaluation” (ISIS Item 113) to a “2” or less (See [Section 3.7](#) for assessing Scour Critical Evaluation)

- Lowering the “Fracture Critical Appraisal Rating” (ISIS Item 93A1) to a “2” (Critical) or less
- Any unforeseen event that the inspector considers to be a threat to the safety of the traveling public

When a Potential Critical Finding is identified, the safety of the traveling public must be the initial focus. The Team Leader must take all necessary steps to ensure the structure is secured. If the Team Leader determines that the identified defect may seriously reduce a structure’s load carrying capacity, the Team Leader should isolate the defect from traffic by closing lanes. If the defect is extensive enough that lane closures may be inadequate, the structure should immediately be closed to traffic. Based on the conditions present, a conservative decision to limit traffic or close the structure must be made until further analysis can be performed.

3.3.12.2 Critical Finding Determination

On each occasion that a Potential Critical Finding is identified, information regarding the conditions that contributed to a Potential Critical Finding must be immediately provided by the Team Leader to the responsible District/Area or Agency Program Manager. The responsible Program Manager shall then immediately contact the Bureau of Bridges & Structures as follows:

State Maintained Structures: For all state-maintained structures, the Program Manager shall immediately contact the State Program Manager by phone, email, or other means with photographs and a description of the critical element.

Local Public Agency Maintained Structures: For all locally-maintained structures, the Program Manager shall immediately email the IDOT District Local Bridge Liaison and BBS Local Bridge Unit with photographs and a description of the critical element.

The Program Manager shall provide sufficient, detailed information to allow the Bureau of Bridges & Structures to make an initial determination of the severity of the finding. The Bureau of Bridges & Structures will then work with the Program Manager to determine if there is a need for a Damage Inspection, Load Rating Inspection, follow-up structural analysis, Special Inspection, submission of IDOT Form BBS CF 1, “Critical Finding Report” and to develop a plan of action to mitigate the deficiency.

3.3.12.3 Submitting a Critical Finding Report

If the Bureau of Bridges & Structures determines that the deficiency will require FHWA notification, the Program Manager will be required to submit IDOT Form BBS CF 1, "Critical Finding Report" within 7 days. The Program Manager shall provide in sufficient detail all required information on the form and submit it to the Bureau of Bridges & Structures, retaining a copy for the Bridge File. This shall include basic structure inventory and location information, a description of the deficiency, the immediate steps that were taken to ensure public safety, and a summary of the initial plan of action to mitigate the finding.

If the Bureau of Bridges & Structures determines that submission of a "Critical Finding Report" is not required, the responsible Program Manager shall follow the initial plan of action, unless conditions change or additional deficiencies are subsequently found.

3.3.12.4 Reporting Critical Findings to FHWA

The Bureau of Bridges & Structures will report each Critical Finding to the Illinois Division Office of the FHWA within 24 hours of receiving the "Critical Findings Report". A complete file, containing all pertinent data, will be retained by the Bureau of Bridges & Structures for each Critical Finding.

3.3.13 Inspection of Structures under Construction

When a highway bridge or any portion of a highway bridge is open to public travel, it is to be inspected per the NBIS.

3.3.13.1 New Structures Under Stage Construction

For staged constructed structures, the portion of the structure open to public traffic is to be inspected at regular frequency to ensure its safety. Such safety inspections are to be completed in accordance with the NBIS. The initial NBIS inspection is required once all of the staged construction is complete and the new structure is carrying full traffic.

3.3.13.2 Existing Structure Replaced with New Structure

When an existing structure is being replaced with a new structure on a new alignment, the existing structure is to be inspected per the NBIS as long as it remains in service. The new structure is subject to the NBIS once it is open to traffic.

When an existing structure is replaced with a new structure on the same alignment and under staged construction, the portion of the existing/new structure open to public traffic is to be inspected per the NBIS. The existing structure may be inspected prior to construction to avoid an inspection delinquency.

3.3.13.3 Existing Structure Rehabilitation

For an existing bridge that is closed to public traffic during rehabilitation work, an NBIS inspection is to be completed and SI&A data is to be updated within 90 days of completion of the work (all lanes open to public travel).

For an existing bridge that is open to public traffic during rehabilitation work, regularly scheduled NBIS inspections are to be performed. If an NBIS inspection cannot be conducted due to reasonable circumstances such as a hazardous project site or conditions unfavorable to complete an inspection, then those circumstances should be documented and the inspection is to be rescheduled at the earliest date possible. Once all risks have been mitigated, an NBIS inspection is to be completed and updated SI&A data is to be input within 90 days.

See [Section 3.3.13.2](#) for an existing bridge being rehabilitated under stage construction.

3.3.13.4 Temporary Structures

For a temporary structure being used to carry public traffic while the permanent structure is closed, the temporary structure is to be inspected in accordance with the NBIS. The temporary structure is not required to have its own individual SI&A data in the state's or federal agency's inventory. Generally, the structure being rehabilitated or replaced remains in the inventory and appropriate SI&A data, Items 10, 41, 47, 53, 54, 55, 56, 70, and 103, are to be coded for the temporary structure. Once the permanent structure is complete and open to public traffic, an NBIS inspection is to be completed and updated SI&A data is to be input within 90 days.

3.3.14 Inspection of Closed Structures

NBIS requirements do not extend to structures closed to traffic. However, IDOT policy is to continue to inspect all closed structures.

The following “Bridge Status” (ISIS Item 41) codes in ISIS represent closed structures in the inventory:

Bridge Status	Description
A	Closed, replacement/repairs under contract
B	Closed, replacement/repair anticipated within next 5 years
C	Road Closed, closure not related to condition of the structure
E	Closed, permanent closure due to bridge condition, repair/replacement not anticipated within the next 5 years

Table 3.3-2 – “Bridge Status” (ISIS Item 41) Codes for Closed Structure

For bridges over public/private roadways, navigable waterways, active railroads, and pedestrian/bicycle paths, the inspector must assure safety of the public that may travel below the structure. Any potential or suspected hazards from falling debris should be noted and reported immediately to the District/Area or Agency Program Manager.

For all other bridges closed to traffic, the inspection should be limited to verification of proper signage and closure measures. For structures that may still be used by trespassers, additional fencing may be warranted to prevent access to the bridge. A closed bridge in the inventory may pose undue liability to IDOT or the local public agency. The bridge should be scheduled for demolition if it continues to be a source of concern for collapse or a hazard to the public.

Once a weight restriction or closure has been established for a structure, it cannot be removed or altered without approval from IDOT. Additional information on removing or altering weight restrictions is included in [Section 4.4.5.3](#).

3.4 Inspection Intervals

3.4.1 General

The following sections document IDOT policy for the required frequency of different bridge inspection types. Routine, Fracture Critical, and Underwater inspections shall be completed by the end of the calendar month in which they are due. An exception is for the Special Inspection with an interval of one month or less in which case inspections must be completed by the day it is due.

For rare and unusual circumstances, such as extreme flooding, the Statewide Program Manager through coordination with the FHWA Division Office may preapprove an inspection delay when the situation is expected to cause a delinquency greater than one month. Bridge inspection delay requests shall be sent via email by the Program Manager to:

DOT.BBS.BridgeMgmt@illinois.gov

The email shall document the original inspection due date, the reason for the delay, and an estimated date for inspection completion. A copy of the response approving the delay shall be kept in the bridge file.

3.4.2 Routine Inspection Interval

The Routine Inspection Interval may vary over the life of the structure. After the Initial Inspection, the interval to the first Routine Inspection will be 24 months. The first Routine Inspection can be completed before 24 months, but no sooner than 12 months after the Initial Inspection. After the first Routine Inspection, the interval will remain at 24 months unless the bridge qualifies for a 48-month inspection interval as described in [Section 3.4.2.1](#).

The NBIS recognizes that certain bridges in poor condition should be inspected at lesser intervals, while some bridges in good condition may be inspected at an interval greater than 24 months, up to 48 months. The Federal Highway Administration (FHWA) has approved IDOT's criteria for determining a maximum allowable interval for Routine Inspections. Based on the established criteria, an interval is automatically determined (computer generated) in ISIS for "Routine Inspection Interval" (ISIS Item 91).

The 48-month inspection interval represents an allowable maximum, and in no way precludes inspections at lesser intervals. The responsible Program Manager may allow structures to be inspected at lesser inspection intervals.

3.4.2.1 Routine Inspection 48-Month Interval Criteria

Bridges with “Main Structure Material”, “Main Structure Type”, “Near/Far Approach Span Material”, or “Near/Far Approach Span Type” (ISIS Items 43A, 43B, 44AN/AF, and 44BN/BF, respectively) indicated in the following [Table 3.4-1](#) are not eligible for the 48-month inspection interval extension and must be inspected at a maximum 24-month inspection interval.

ISIS Item 43/44	Structure Material	Structure Type
x03	All	Deck Girder
x08	All	Orthotropic Deck
x09	All	Deck & Truss
x10	All	Thru & Pony Truss
x12	All	Thru Arch
x13	All	Suspension
x14	All	Cable Stayed
x15-x17	All	Movable
x24	All	Thru Girder
x28	All	Segmental Box Girder
x30-x70	All	Specific Truss Types
x00	All	Other
8xx	Masonry	All
9xx	Aluminum, Wrought Iron, Cast Iron	All
0xx	Other or Varied	All
311	Steel	Deck Arch
319	Steel	Culvert

Table 3.4-1 – 48-Month NBIS Inspection Interval Structure Material and Type Exclusions

Note 1: ISIS Items 43 and 44 are three (3) position alphanumeric fields with the first position (43A or 44AN/AF) representing the type of material used and the last two (2) positions (43B or 44BN/BF) representing the type of structure constructed.

Note 2: An “x” in the above table indicates that any alphanumeric character specified for the coding of ISIS Items 43A, 43B, 44AN/AF, or 44BN/BF.

For the structures that are not included in [Table 3.4-1](#), all of the following conditions must be met for the structure’s inspection interval to be assigned as 48-months:

- Structures with a “Deck Condition” (ISIS Item 58) rating of "6" (Satisfactory) or greater and a “Superstructure Condition” and “Substructure Condition” (ISIS Items 59 and 60) rating of "7" (Good) or greater.
- Structures with a “Culvert Condition” (ISIS Item 62) rating of "7" (Good) or greater.

- The structure must be capable of carrying Illinois legal loads at the inventory (design) stress level. (Rating Factor ≥ 0.9 for bridges or ≥ 0.75 for concrete culverts under 2 or more feet of fill.) A structure cannot have a weight limit or “Legal Loads Only” restriction (“Bridge Posting Level” (ISIS Item 70) must be coded “5”).
- “Minimum Vertical Clearance On” (ISIS Items 53A-B) and “Minimum Vertical Highway Underclearance” (ISIS Items 54B1-B2) must be 14'-0" or greater (if applicable).
- The “Length of Longest Span” (ISIS Item 48) must not be greater than 100 feet.
- For new bridges or after reconstruction, major rehabilitation, or major repairs to bridges, after the Initial Inspection, one Routine Inspection must have been performed within the normal 24-month inspection interval, but no sooner than 12 months.
- “Estimated AADT Count” (ISIS Item 29) must be 30,000 or less and Average Daily Truck Traffic [“Estimated AADT Count” (ISIS Item 29) x “Estimated Truck Percentage” (ISIS Item 109)] must be 3,000 or less. Culverts with 2 or more feet of fill (See “Culvert Fill Depth” (ISIS Item 62E)) do not have to meet the AADT and Truck count criteria for a 48-month inspection interval.
- The age of the structure must not exceed 50 years (with reference to “Construction Year” (ISIS Item 27A) where “Construction Type Indicator” (ISIS Item 27) = “O”) unless the structure has been reconstructed within the past 30 years (with reference to “Construction Year” (ISIS Item 27A) where “Construction Type Indicator” (ISIS Item 27) = “R”).
- All structural members are load path redundant; i.e. no truss or two girder type structures, tied arches, cable stayed, suspension, etc. (See “48-Month NBIS Inspection Interval, Structure Material and Type Exclusion” [Table 3.4-1](#)).
- The rating for “Scour Critical Evaluation” (ISIS Item 113) must be “5”, “8”, or “9” or “Blank” (for bridges not over waterways).
- The structure shall not carry an interstate route or interstate ramp or carry any highway over an interstate. The “Functional Classification” (ISIS Item 26) for highway on/under cannot be coded “10”.
- The structure must not be on the Strategic Highway Network (STRAHNET) system as designated by “Special Systems” (ISIS Item 100) coded “4”.
- The structure must not be under the primary maintenance responsibility of a Federal Agency (denoted by “Maintenance Responsibility” (ISIS Item 21) with codes of “5”, “F”, “G”, or “H”).

Bridges with repair histories that indicate a substantial probability of future problems should not be included among the candidates for the 48-month NBIS inspection interval. Such a determination may be made at the discretion of the District Program Manager, the Agency Program Manager, or the Program Managers within the Bureau of Bridges & Structures for any structures that otherwise fall under the eligibility guidelines.

The eligibility of each structure is automatically reviewed by ISIS following any revision of applicable inventory and inspection data. Any formerly eligible structures which no longer meet the inspection interval extension criteria are changed back to a maximum 24-month interval. ISIS will automatically change a 48-month interval to 24-months if the un-reconstructed age of a structure will reach 50 years before its next scheduled inspection or the reconstructed age of a structure will reach 30 years before its next scheduled inspection. Other changes to Inventory items or traffic counts may trigger an immediate change of a 48-month interval to a maximum 24-month interval, causing a structure to become “instantly delinquent”. When this occurs, the bridge should be inspected within 30 days and documented appropriately in the delinquent check box and reason field on the inspection form.

3.4.2.2 Routine Inspection 12-Month Interval Criteria

IDOT maintained bridges with one or more of the following characteristics shall receive a Routine Inspection at 12-month maximum intervals.

- Rating for “Superstructure Condition” (ISIS Item 59), “Substructure Condition” (ISIS Item 60) or “Culvert Condition” (ISIS Item 62) is “4” (Poor) or less.
- Appraisal rating for “Structural Evaluation” (ISIS Item 67) is “3” or less.
- Posted weight limit has been established due to deteriorated condition of the structure where “Bridge Posting Level” (ISIS Item 70) is less than “5” and not equal to “L” (Legal Loads Only structures do not require a 12-month interval).
- Uncommon or unusual designs for which there is little performance history within Illinois, such as Segmental Box Girders, Cable Stayed Superstructures, and Tied Arches. After the Initial Inspection of these bridge types, they shall receive two 12-month inspections before being considered for a normal 24-month inspection cycle. After the first two 12-month inspections are completed, and there is no identified deficiencies or areas of concern, the Program Manager may request, in writing using IDOT Form BBS CBW1, "Complex Bridge 12-Month Waiver Statement", that the inspection interval be changed

to 24-months. This documentation must be signed by the Bureau Chief of Bridges & Structures and kept in the official Bridge File.

Structures not under IDOT jurisdiction are typically evaluated on an individual basis by the Agency Program Manager to determine if a 12-month inspection interval is appropriate based on specific site conditions. However, IDOT may require a 12-month inspection interval for bridges under the jurisdiction of other agencies based on inspections conducted by the Bureau of Bridges & Structures to determine the safe load carrying capacity of structures in accordance with Section 15-317 of the Illinois Vehicle Code.

3.4.2.3 Routine Inspection Interval for Bridges over Waterways

All structures over waterways that do not meet the Basic Submergence Criteria specified in [Section 3.3.4](#) shall have the condition of substructure elements below the waterline and the surrounding streambed assessed at each Routine Inspection. Evaluation of site conditions is required to establish the appropriate Routine Inspection Interval and if Special Inspections will be required to monitor specific areas of concern.

When site conditions indicate a need to monitor substructure elements below the waterline at an interval that is less than the normal Routine Inspection Interval, the Program Manager must determine whether lowering the Routine Inspection Interval or initiating Special Inspections is more appropriate.

When site conditions indicate the need to monitor a portion of the substructure units at an interval less than the Routine Inspection Interval, a Special Inspection should be initiated and an appropriate Special Inspection Interval set for each Special Inspection Type identified. The Routine Inspection Interval can remain unchanged. Special Inspections may be staggered to efficiently monitor the structure by setting the “Special Inspection Interval” (ISIS Item 92C) and “Special Inspection Inspect By Date” (ISIS Item 92C7) to fall between Routine Inspections.

When site conditions indicate the need to monitor a majority of the substructure units or the entire streambed at an interval less than the Routine Inspection Interval, the Routine Inspection Interval may be lowered or the Program Manager may initiate Special Inspections for each Special Inspection Type identified. See [Table 3.4-3](#) for more guidance on monitoring requirements and recommended intervals.

In most cases, the “Routine Inspection Interval” (ISIS Item 91) will be set by policy at 24 months or as modified by [Section 3.4.2.1](#) or [Section 3.4.2.2](#). If Special Inspections are preferred, all the Special Inspection (ISIS Item 92C, 92C1, 92C2, 92C4, 92C6, and 92C7) information must be entered into ISIS.

3.4.3 Underwater Inspection Interval

All bridges requiring Underwater Inspections as specified in [Section 3.3.4](#) shall have an Initial Inspection to establish a baseline for comparison with future inspections. After the Initial Inspection has been performed, the “Underwater Inspection Interval” (ISIS Item 92B) shall be set by the Program Manager. IDOT policy is to use an interval of 60 months unless site conditions indicate a need to monitor elements below the waterline at a shorter interval. Alternately, the Underwater Inspection Interval could be set at 60 months and a Special Inspection could be used to monitor a specific area of concern at a shorter interval.

When site conditions indicate the need to monitor a portion of the substructure units at an interval less than the Underwater Inspection Interval, a Special Inspection should be initiated and an appropriate Special Inspection Interval set for each Special Inspection Type identified. The Underwater Inspection Interval can remain unchanged. Special Inspections may be staggered to efficiently monitor the structure by setting the “Special Inspection Interval” (ISIS Item 92C) and “Special Inspection Inspect By Date” (ISIS Item 92C7) to fall between Underwater Inspections.

When site conditions indicate the need to monitor a majority of the substructure units or the entire streambed at an interval less than the Underwater Inspection Interval, the Underwater Inspection Interval may be lowered or the responsible Program Manager may initiate Special Inspections for each Special Inspection Type identified. See [Section 3.4.4](#) for more guidance on monitoring requirements and recommended intervals.

If Special Inspections are preferred, all the Special Inspection (ISIS Item 92C, 92C1, 92C2, 92C4, 92C6 and 92C7) information must be entered into ISIS.

3.4.4 Substructure and Channel Monitoring Requirements and Options

When site conditions warrant special monitoring, refer to [Figure 3.4-2](#) “Substructure Condition Assessment Method below Waterline” and [Table 3.4-3](#) “Substructure and Channel Monitoring Options” to determine the appropriate inspection type and interval.

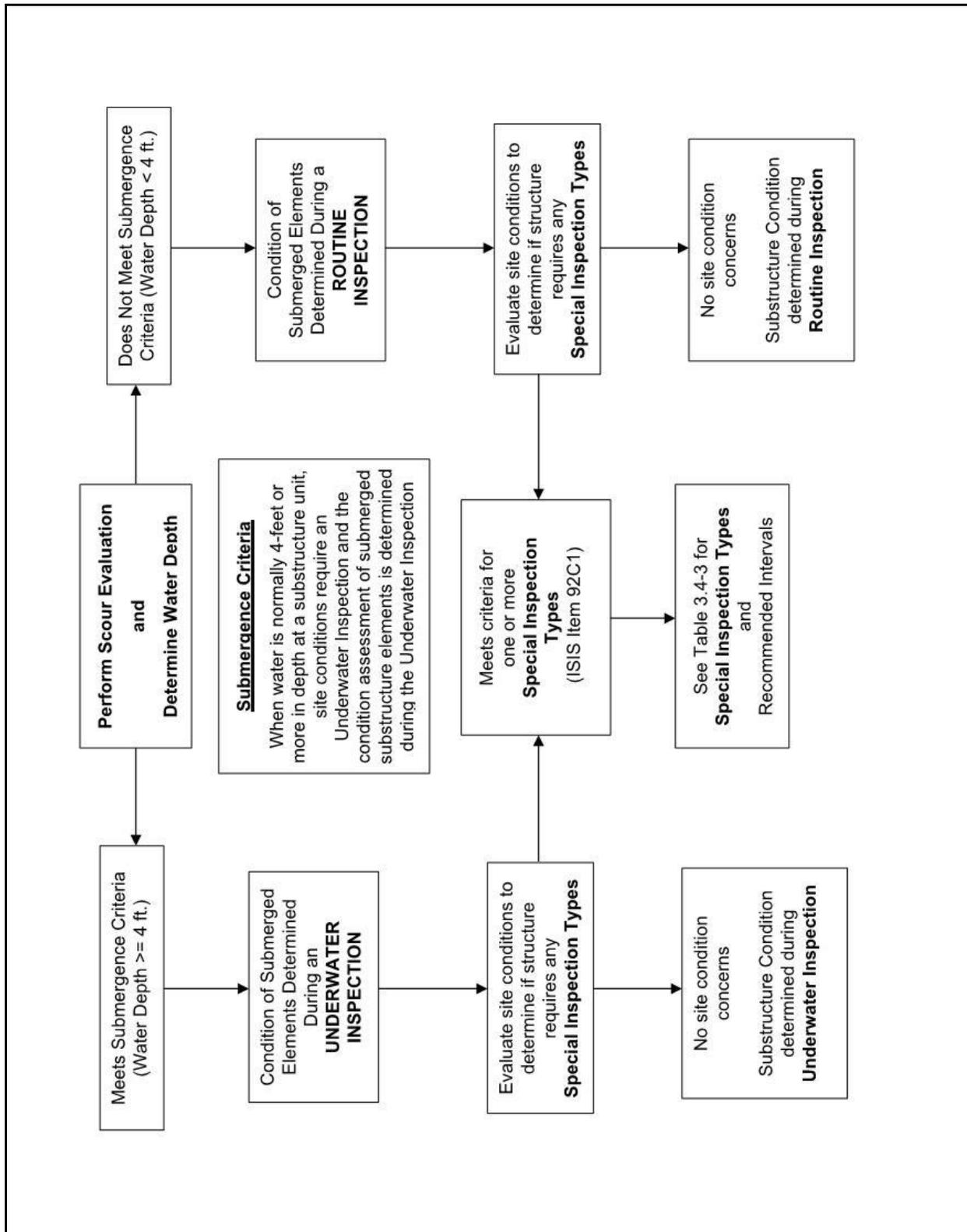


Figure 3.4-2 – Substructure Condition Assessment Method Below Waterline

Description	Underwater Inspection		Routine Inspection	
	Underwater Inspection Interval	Special Inspection Type and Recommended Interval *	Routine Inspection Interval	Special Inspection Type and Recommended Interval *
a) Known debris problem b) Erodible soils c) "Channel Condition" (ISIS Item 61) rating of "4" or less	60 months with Special Inspection or 12 months (max)	"G"	24/48 months with Special Inspection or 12 months (max)	"G"
		"I"		24 month interval (redundant) 12 month Interval (non-redundant)
Substructure supported by Spread Footing foundation not adequately keyed into rock or protected from streambed scour or degradation. A Scour Plan of Action (POA) is required	60 months with Special Inspection or 24 months (redundant) 12 months (non-redundant)	"G"	24/48 months with Special Inspection or 24 months (redundant) 12 months (non-redundant)	"I"
		"K"		See Scour POA
Scour Critical or Scour Susceptible structure as determined by a Scour Critical Evaluation. A Scour Plan of Action (POA) is required	60 months with Special Inspection or As determined by the POA	"K"	24/48 months with Special Inspection or As determined by the POA	"K"
		"L"		See Scour POA
Observed scour at one or more substructure units that has not been mitigated. A Scour Plan of Action (POA) is required	60 months with Special Inspection or As determined by the POA	"L"	24/48 months with Special Inspection or As determined by the POA	"L"
		"M"		"M"
		"N"		"N"
*Program Manager shall determine the required inspection interval(s) appropriate for site conditions				

Table 3.4-3 – Substructure and Channel Monitoring Options

3.4.5 Fracture Critical Member Inspection Interval

The “Fracture Critical Inspection Interval” (ISIS Item 92A) assigned to a structure with Fracture Critical Members should be commensurate with the structural details and condition of the structure and cannot exceed 24 months. Maximum intervals for Fracture Critical Member Inspection are summarized as follows:

- 3 months, and again within 24 months from the date of opening to traffic for all newly constructed or rehabilitated bridges with Fracture Critical Members.
- 12 months for all bridges with a “Fracture Critical Appraisal Rating” (ISIS Item 93A1) coded “4” or less.
- 12 months or less (as specified by the BBS Bridge Management Unit) for bridges with a history of fatigue crack formation or with structural details susceptible to fracture.
- 24 months for bridges other than those included in the previously described categories for Fracture Critical Member Inspection intervals.

3.4.6 Element Level Inspection Interval

All State structures will receive an Element Level Inspection, typically in conjunction with and at the same interval as the Routine Inspection. Structures under the jurisdiction of the Illinois State Toll Highway Authority (ISTHA), local public agencies, or other State Agencies, which are on the NHS, require Element Level Inspections at the same interval as the Routine Inspection interval.

3.5 Non-Destructive Testing

3.5.1 General

Non-Destructive Testing (NDT) is often used during the inspection of steel structures to determine the presence or extent of a defect when visual inspection either suggests the existence of a crack, or is not sufficient to verify the internal integrity of structural elements such as pins. The NDT methods most frequently used in the field by IDOT are:

- D-Meter Thickness Measurement (DM)
- Dye Penetrant Testing (PT)
- Magnetic Particle Testing (MT)

- Ultrasonic Testing (UT)

Personnel inspecting steel structures should be familiar with the use and limitations of the various methods of NDT. The information in this chapter provides only basic guidance in the NDT methods employed by IDOT. To ensure proper application of the testing procedures and interpretation of results, inspection personnel require additional training by certified instructors and extensive hands-on experience.

3.5.2 D-Meter Thickness Measurement (DM)

A D-meter is a hand-held, UT based instrument that is used to measure steel plate thicknesses at discrete locations. Several different models of D-meters are available. Consult the manual for the specific D-meter being used for proper operation. General guidance is presented below:

- Calibrate the D-meter per the manual for the particular model being used. Measure a plate of a known thickness with the D-meter to verify that it is working properly after calibration.
- Refer to the manual for the particular model being used for the maximum plate thickness the D-meter can measure.
- D-meters can only measure the thickness of the ply the transducer is in contact with.
- When measuring remaining section, check the other side of the plate, if accessible, to see if a flat and uniform area is available at the location where the thickness is to be measured.
- Remove loose paint, corrosion and dirt/debris at the location where the thickness is to be measured. Expose a small area of bare steel that is slightly larger than the transducer being used.
- Use couplant between the transducer and the bare steel when taking thickness measurements.
- In addition to recording thickness remaining, be sure to record the nominal thickness at nearby areas of the same plate that do not have section loss for comparison purposes.
- When measurements are complete, clean the bare steel areas of couplant and dirt/debris. Touch up these small areas with a spray “paint + primer” product to protect the area from further deterioration.

3.5.3 Dye Penetrant Testing (PT)

After a visual inspection, PT is often used to verify the existence and extent of cracks open to the surface in welded connections or the base material of steel beams/girders, depending on capillary action to reveal the existence of cracks. The following general procedures are used:

Prepare Surface: Prior to PT, all dirt, grease, oil and moisture, together with loose, heavy or flaking paint, rust and scale must be removed from the area to be tested, exposing bare metal at the suspected defect. Thin, tightly adhered paint or scale and light rust may remain as long as it does not prevent dye from entering a defect. The use of mechanical grinding tools or blasting equipment to prepare the test surface can deform or “smear” base metal, obscuring the crack and severely affecting the accuracy of the test. For this reason, foreign materials (dirt, grease, oil, loose paint, moisture) should be removed using solvents, strippers and nonmetallic scraping tools, followed by compressed air or volatile cleaners, ensuring any potential cracks are “empty” - free of material that would prevent capillary action for absorption of penetrant. Removing rust and scale requires mechanical methods, so scrapers and hand-wire brushing are used to avoid deforming or “smearing” base metal and covering cracks.

Application of Penetrant: After the surface to be tested has been cleaned and thoroughly dried (solvent has evaporated from any defects), a dye penetrant is applied to the surface in the area where a crack may exist. The penetrant is applied by spraying or brushing, depending on the type of dye, available access, and the orientation of the surface. The penetrant must remain on the surface for a specified “dwell time” prior to further actions. The dwell time is based on manufacturer recommendations, and depends on the temperature of the material, relative humidity, geometry or suspected defects (surface opening and internal volume) and the type of material tested (weld, plate, rolled shape, bent plate, sheared edge, etc.).

Excess Penetrant Removal: After sufficient dwell time to allow capillary action to pull the dye into open defects, the remaining penetrant must be removed from the surface. While nearly complete removal of the penetrant on the surface is necessary to prevent false indications, care must be taken not to flush dye out of a crack or other discontinuities within the tested area. This is accomplished by spraying the cleaning agent on a towel and wiping, but not spraying the cleaner directly on the surface. Some

traces of dye may remain on the surface, especially on welds or cut edges with irregular faces, but that should not be mistaken for a subsurface defect.

Application of Developer: After excess penetrant has been removed and the surface has dried, a developer is applied to the surface to extract the dye from any discontinuities. The developer is a “blotting agent” with a higher attraction for the dye than the capillarity holding it in the defect(s). The developer usually dries white, so the red or blue dye absorbed provides a strong color contrast, and the extent and intensity of the stain gives some indication of the volume of the defect. Scratches and nicks holding small amount of dye show as small, non-relevant indications, but significant cracks and porosity will produce large vivid stains. The time necessary for the developer to extract most of the penetrant varies, depending on the type of developer, the geometry of the defect and material temperature. In general, the developing time will be approximately one half of the required dwell time.

Interpretation of Test Results: After the developer has been on the surface a sufficient period of time, a visual inspection is made to interpret any indications within the tested area. Only discontinuities that are open to the surface within the test area will be visible. Proper interpretation requires that the inspector be familiar with the original fabrication of the tested area (assembly, bending, welding procedures) and the types of defects likely to be present (base metal fractures, delaminations, scabs, weld toe or centerline cracks, porosity, roll-over, lack of fusion). Photographs of the defect/test area should be taken for documentation of the test results.

A Dye Penetrate Testing kit typically contains:

- Visible dye penetrant that will be pulled into defects and held by capillary action.
- Cleaning fluid for use in pre-cleaning the test area and removing excess penetrant from the surface being tested.
- Non-aqueous developer that will both extract the dye which penetrated into a discontinuity and also provide a contrasting background color for the dye.
- Wiping towels, brushes and directions for using the kit.

In addition to steel, PT can be used on such materials as aluminum, cast iron, forgings, castings, plastics and ceramics. Although the removal of paint from existing structures can be

problematic, PT is a very effective tool for detecting surface cracks, and can be easily carried and used without a power supply or complex equipment.

3.5.4 Magnetic Particle Testing (MT)

MT, also often called “mag” particle testing, can be used to locate both surface and near surface discontinuities in ferrous steel elements using magnetization techniques and principles. It cannot be used on aluminum or non-ferritic (non-carbon stainless) steels. Two types of MT equipment may be used, the prod or the yoke. The prod, which is often used in steel fabrication shops, has two rounded aluminum contact points that pass an AC or DC electrical current through the test piece, inducing a magnetic field around the current path. (Copper contact points must never be used, since arcing could deposit copper residue.) Bare steel is required at the contact points, and care must be taken to only energize the prod while in firm contact with the test surface or arcing may occur, causing “arc strikes”, which are considered serious defects. The yoke, which is most often used for field inspections, is an electromagnet. This is used so that no electrical current passes into the piece and arcing is avoided. One advantage of MT using a yoke is that it can be performed without removing well adhered paint from the tested surface. However, paint on the surface of the test area can mask very small discontinuities by inhibiting movement of the iron particles, and the thickness of coatings present on the test surface should be 2 mils or less. Yoke legs should be oriented nearly perpendicular to the surface for transfer of the magnetic field, so positioning near inside corners may be difficult. The following general procedures are used by IDOT personnel for performing MT using a yoke:

Prepare Surface: Although cracks filled with contaminants can be detected using MT, efforts should be made to ensure that the tested surface is clean, dry, and free of such contaminants as oil and grease that impede particles from moving toward defects. Heavy, thick, or loose rust and scale, thick or peeling paint and paint runs, and heavy weld spatter prevent good yoke contact and impede particle mobility. Test surfaces can be cleaned using solvent or detergent cleaners, wire brushing, grinding or blasting with sand or grit. If necessary, solvent paint removers can be used to remove excessive paint from the test surface.

Creation of Magnetic Field: A “yoke”, which is essentially a C-shaped electromagnet, is used to create a magnetic field in the test area. Although referred to as “C-shaped”,

most yokes have articulated “legs” and their shape can be varied to make the ends (“feet”) perpendicular to the surface, providing good contact to transfer magnetic flux into the test surface. The yoke is connected to an electrical power source and legs of the yoke are placed in contact with the test surface on either side of the test location. Once the yoke is placed in contact with the test surface and current activated, the magnetic field is established. To verify the yoke is working properly, the lifting requirements of the AASHTO/AWS *D1.5 Bridge Welding Code* included in [Appendix A-7](#) must be met.

Application & Removal of Particles: While the magnetic field is established, a powder of dry, finely divided ferromagnetic material with high magnetic permeability and low magnetic retention, commonly referred to as “iron filings”, is applied to the test area using a squeeze bulb or shaker bottle. The powder is typically orange or red in color to contrast with the test surface. With the magnetic field maintained, excess powder is removed from the test area using dry, low pressure compressed air.

Interpretation of Test Results: Once the excess powder has been removed from the test area, the iron filings that remain should have aligned themselves with any discontinuities present on or near the steel surface within the area tested. If the powder is on top of a flat area, the yoke may be de-energized, and even removed to allow the particle pattern to be picked up on cellophane tape. For vertical or overhead areas, de-energizing will release the particles.

This technique depends on the placement of the yoke relative to the defect’s orientation and size. The magnetic field induced in the steel “flows” between legs of the yoke, and any interruption in the steel “leaks” magnetic flux, which attracts the iron particles. If a crack is parallel to the “flow”, very little leakage occurs. Therefore, the yoke must be placed in two orientations, offset approximately 90°, for each location tested to avoid missing significant defects. This may require realigning the yoke legs. Personnel performing the test must determine if any pattern observed is a defect, a false indication, or a suspected defect requiring additional investigation using another method of NDT. Photographs of the defect/test area should be taken for documentation of the test results.

To perform MT with a yoke, the following material and equipment is required:

- A source of electricity

- An electromagnetic yoke
- Ferromagnetic “powder”
- Dry, low pressure compressed air

When an electrical source is not available, MT can be performed using Permanent Magnets. Permanent magnets are sometimes used for magnetic particle inspection as the source of magnetism. The two primary types of permanent magnets are bar magnets and horseshoe (yoke) magnets. These industrial magnets are usually very strong and may require significant strength to remove them from a piece of metal. However, permanent magnets are sometimes used by divers for inspection in underwater environments or other areas, such as explosive environments, where electromagnets cannot be used. Permanent magnets can also be made small enough to fit into tight areas where electromagnets might not fit.

3.5.5 Ultrasonic Testing (UT)

UT is used by IDOT bridge inspection personnel to ascertain the internal condition of structural elements that cannot be visually or otherwise inspected. Testing pins for the presence of internal cracks is the most common use of UT during bridge inspections. UT must be performed by personnel trained to use the equipment and interpret the test results. Equipment and materials typically used for UT pin inspections are:

- Ultrasonic Test Machine (horizontal and vertical axes can be calibrated)
- 2.25 MHz and 3.5 MHz, ½” diameter, straight beam transducers
- Calibration block (Note: Special IDOT calibration block is used for pins)
- Couplant and clean-up material
- Scrapers and other tools to prepare surface
- Documentation for pins (geometry, material, previous inspection results)
- Record keeping material

3.6 Inspection of Pins, Links, and Hangers

3.6.1 Inspection of Pin & Link Assemblies

3.6.1.1 General

The information provided in this section for the inspection of pin and link assemblies provides an expedient method for evaluating in-place double-pin and link or single-pin moment release joints on multi-beam/girder and 2-girder bridges. Region/District inspectors are trained by IDOT employees previously certified by outside agencies in the use of ultrasonic testing (UT) equipment and evaluation methods. UT and visual inspection (VT) shall be utilized for a Preliminary Pin Inspection (PPI), based on pass-fail criteria related to the detection of defects or discontinuities within the length of the pin. A PPI utilizing UT shall be performed by qualified personnel with adequate training. This procedure, although based on industry practices, is an IDOT method developed to provide basic condition information, and neither intends or purports to identify all irregularities within a pin.

3.6.1.2 Inspector Qualifications

Personnel utilizing UT for the inspection of pins must be adequately trained. IDOT inspectors performing a PPI to detect significant defects/discontinuities are trained by IDOT personnel qualified to the recommend ASNT standards for UT Level II certification. At a minimum, the training provides:

- Familiarization with operating principles of UT.
- Calibration methods, using American Society for Testing Materials/American Society for Nondestructive Testing (ASTM/ASNT) standard UT reference blocks and an IDOT UT reference standard for preliminary pin evaluation.
- Initial VT and subsequent UT scanning methods for various situations and configurations, including assessments and reporting of results.
- IDOT pin scanning methods, result interpretation, testing documentation and recommendations for follow-up inspection or immediate action.
- Potential problems with access and interpretation, and alternative tests or methods.
- Field exercise or classroom mock-up.
- Additional discussion, questions and answers, etc.

The training includes extensive hands-on and interactive participation, encouraging participants to critically examine the methodology and propose modifications and improvements. Upon the successful conclusion of the training, inspectors will be considered qualified to conduct preliminary pin and link inspections. During a PPI, if results indicate the presence of anomalies or are inconclusive, a SPI must be scheduled for additional nondestructive testing (NDT) to be performed by IDOT or outside testing agency employees qualified to appropriate ASNT Level II or III criteria.

3.6.1.3 Link Inspections

All accessible surfaces of link plates shall be visually inspected (VT) for corrosion and paint deterioration, distortion due to misalignment or seizure, and cracking, especially at critical sections near the pins. Any confirmed or suspected cracks shall be immediately reported to the District/Area or Agency Program Manager, so that further NDT may be scheduled or shoring / lane closures may be instituted. Other defects shall be documented for future reference or for directing follow-up NDT.

UT or DM may be used during link inspections to verify remaining material thickness, but their use for crack evaluation and detection in link plates is not common. Magnetic particle inspection (MT) or dye penetrant testing (PT) may also be used to assess possible cracks if the inspector is equipped and trained for their use.

The inspector should attempt to determine if the pins are “frozen” within the girder webs and/or link plates or are free to rotate due to temperature changes or the passage of vehicles across the structure. A continuous layer of paint or corrosion across the interface with no interruption caused by rotation may indicate seizure. Single pins in moment release joints may undergo sufficient motion under live load to disclose the absence of seizure. Dual pins in hanger links usually rotate gradually due to temperature changes and do not show perceptible motion under live load, so seizure is difficult to assess.

3.6.1.4 Pin Inspections

If pins are judged satisfactory, based on the criteria herein, no additional testing is needed. If anomalies or non-conforming pins are found, the District/Area or Agency Program Manager shall arrange for a SPI to provide additional UT evaluation by District, Central Office or outside

agency personnel qualified to at least the standards recommended for an ASNT UT Level II. Based on the results of the SPI, recommendations can be made for replacement or subsequent inspection criteria for suspect pins. If the PPI indicates the actual (or potential) failure of one or more pins, the District/Area or Agency Program Manager, and the State Program Manager shall be notified immediately and lane reductions, traffic restrictions or complete structure closure may be required until further inspections, pin replacement or supplementary supports can be implemented.

An actual or suspected pin failure is a Critical Finding. Once steps have been taken to assure safety of the public, a "Critical Finding Report" must be submitted to the Bureau of Bridges & Structures as specified in [Section 3.3.12](#).

3.6.1.4.1 Preliminary Pin Inspections

The objective of the Preliminary Pin Inspection (PPI) is to verify the absence or detect the presence of significant defects or discontinuities within the length of a pin. To perform a PPI, the following materials and equipment are required:

- Ultrasonic Test Machine (horizontal and vertical axes can be calibrated)
- 2.25 MHz and 3.5 MHz, 1/2" diameter straight beam transducers
- IDOT Test Specimen (See Diagram "A" - [Figure 3.6-1](#))
- Couplant and clean-up material
- Scrapers and other tools to prepare surface
- Documentation on existing pin geometry, material and previous inspection results
- Record keeping material

A method for a Preliminary Pin Inspection is as follows:

- Either transducer may be used. If problems arise in evaluating the far end of long and/or small diameter pins, the 3.5 MHz transducer may be more accurate with its smaller beam spread. The greater beam spread of the 2.25 MHz transducer may be preferred for pins with cotter pin holes near the contact end, and to access areas behind threads or step-down diameter reductions at ends.
- Calibrate the equipment just before beginning work, using the transducer and IDOT test specimen. For pins up to 10" (250 mm) long, adjust the display so horizontal screen

increments represent 1" (25mm). For longer pins, adjust screen increments to represent convenient units (for example: 1 ¼", 1 ½", 2" or 30 mm, 40 mm, 50 mm), while keeping the pin's far end back signal on the screen.

- At the first pin to be tested, verify that no unexpected reflectors (not including threads, cotter pin holes, etc.) are present between the transducer and far end. If any appear, go to another pin until a satisfactory pin is found. Then adjust the gain so the back reflection of the pin's far-end is 50% of the screen height (use this value as the reference level on IDOT Form 2760, "Preliminary Pin and Link Inspection Journal"), and record the transducer and dB reading on the inspection form. For inspection scanning of that pin and all similar pins, increase that gain by 10 dB.
- Distance calibration should be periodically verified by checking the IDOT specimen after each two hours of work, at each new work location ("work location" usually entails all the pins at one deck joint), for significant changes in pin lengths or condition, or if the pin's temperature rises or falls more than about 30°F (20°C), possibly affecting couplant behavior. The IDOT specimen should be at approximately the same temperature as the tested pins.
- Scan one end of each pin, using a circular motion and positioning the transducer so that near-end threads do not degrade the image while evaluating the far end of the pin. Compare results to the pin geometry, so that diameter changes, cotter pin holes or far-end threads are not mistaken for defects. If the "shelf" or "shoulder" (change in diameter of the pin) is more than ¼ inch, scanning should be done from both ends.
- Any "other reflectors", especially in bearing contact areas, producing an image more than 20% screen height at reference level (50% of screen height at end of pin) require also scanning the pin from the opposite end. The results shall be recorded for future reference, indicating the location (distance from each end), gain, signal height and transducer position to maximize the signal for each reflector. The transducer's positions when the defect initially appears and finally disappears (or is minimized) on the screen shall also be noted. "Transducer position" shall be described by its circumferential location, based on a theoretical clock face with 12 at the top of the pin, and radial distance from the center of the pin. For consistency, pins requiring additional inspections shall have the 12 o'clock position center punch marked on both ends near the periphery, and "clockwise" shall be considered independently for each end.
- Scanning from both ends may provide sufficient data to characterize the type, size, orientation and criticality of defects. If any such reflector produces a signal more than 50% of screen height at reference level, or if a pin's far end response is completely lost

while scanning from either end, the results for both ends shall be immediately reported to the District/Area or Agency Program Manager and the State Program Manager. Large internal discontinuities may prevent most of the pulse from reaching the far end or redirect the reflected signal, resulting in loss of far end back reflection.

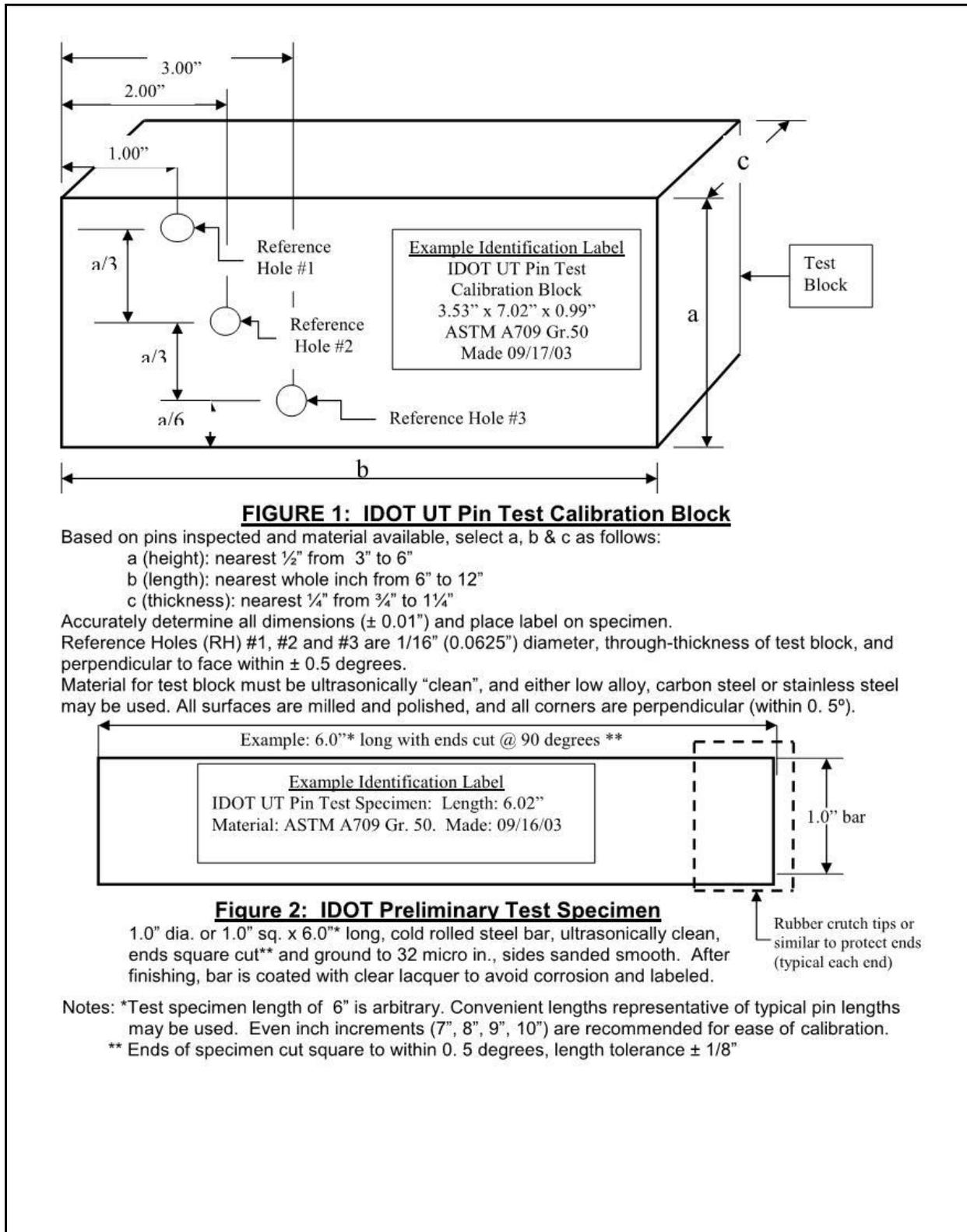


Figure 3.6-1 – Diagram “A” – IDOT Test Block & Specimen

3.6.1.4.2 Supplemental Pin Inspections

The equipment and procedures used to conduct a Supplemental Pin Inspection (SPI) are the same as used for performing the PPI. The SPI is, however, performed by personnel with greater experience and a higher level of training in the use of UT (ASNT Level II or III).

3.6.1.5 Inspection Records

Permanent inspection records shall be maintained for pins and links. Forms for documenting the condition of pins and links during PPI's and SPI's are provided by IDOT Form BBS 2760, "Preliminary Pin and Link Inspection Journal" and IDOT Form BBS 2780, "Supplemental Pin / Link Inspection Journal". Pins and links with no structurally significant anomalies detected by the PPI only require stating "No Defects Noted", along with the item's location, the pin end(s) scanned, and any pertinent remarks to assist future inspections. Note that "location" for pins and links includes span and girder/beam number, distance to nearest identified support, pin location (upper or lower) and link position, such as "east side". Other comments regarding field conditions (paint condition, possible seizure, excessive rust staining, etc.) or recommended maintenance actions must be reported to the District/Area or Agency Program Manager.

A copy of the permanent inspection records for each pin and/or link with reportable anomalies, indicating all pertinent field observations and recommendations for additional investigations, shall accompany the preliminary inspection report submitted to the District/Area or Agency Program Manager. The permanent record documents the initiation and subsequent growth of defects, and will be maintained until the item is replaced. If reported indications are proven to be non-significant or "spurious" (caused by technique or other causes, but not actual internal defects), the record should include possible explanations and verification testing results.

Pins requiring additional investigation (due to a reflector exceeding 20% of screen height during the PPI) shall have the location of all reflectors exceeding 20% of screen height at the reference level documented, as described in item 6 of the "Preliminary Pin Inspection Method" in [Section 3.6.1.4.1](#).

Additional investigation required for links to quantify potential structural problems noted during the PPI may employ UT, MT, PT, DM or radiographic testing (RT), as directed by the District/Area or Agency Program Manager. The additional test results shall be recorded on a

separate form for each link, and the form shall be attached to the link's permanent inspection record for future reference, even if the indications prove to be non-significant or "spurious" (caused by technique or other cases, but not actual internal defects). The record should include possible explanations and verification testing results. Additional information, test reports, photos or other pertinent information shall be attached to the permanent record and stored in the Bridge File.

If paint, rust and/or other foreign material is removed from links, nuts and non-stainless steel pins for VT, MT, UT or PT, bare steel should be protected after the inspection is complete. UT couplant, PT residue and moisture should be removed and then a zinc-rich primer or other owner-approved coating may be spray-applied. For pins that will continue to be inspected on a regular cycle, the exposed ends may be coated with grease.

Copies of each structure's overall evaluation, together with copies of the permanent records for each pin and/or link and additional testing recommended to evaluate anomalies, shall be signed by the Team Leader and forwarded to the District/Area or Agency Program Manager, immediately after the inspection. Reports, including summaries, photos and additional investigations of PPI-revealed deficiencies, along with inspection personnel's suggestions or comments applicable to the particular location and similar installations, should be compiled by the Team Leader and submitted to the District/Area or Agency Program Manager.

Inspector suggestions and comments may include initial and follow-up investigation methods, preventative maintenance actions, inspection documentation, employee safety considerations, and methods to improve inspection efficiency.

3.6.2 Inspection of Cantilever Truss Suspended Span Pins & Hanger Members

3.6.2.1 General

Large, continuous, cantilever trusses typically have suspended simple span trusses in the main span, supported by large steel pins and hanger members. The pins vary in size and diameter, but can reach 30 inches long and 12 inches in diameter. Hangers are typically either built-up members or rolled sections with additional reinforcement plates at the pin locations. The pins and hangers in suspended truss spans are typically considered Fracture Critical Members. See [Section 3.3.5](#) and [Section 3.3.6.3](#) for Fracture Critical Member Inspection requirements.

3.6.2.2 Pin Inspections

In general, although they are much larger and more complex, suspended truss pins and hangers are to be inspected by the same criteria as beam/girder pins and links. A Preliminary Pin Inspection shall be completed at each location. A detailed access and pin preparation plan may be required. Suspended truss pins may have center bore holes with steel threaded rods and end cap plates that must be removed before a PPI can be completed. Consult previous inspection records and procedures or discuss potential limitations of cap or retention plate removal before commencing an inspection. In some instances, test pins, fabricated to the same specifications as the existing pins, may be available for calibration of UT equipment.

As with pin and link inspections, the PPI is a general investigation to verify the absence or detect the presence of significant defects or discontinuities within the length of the pin. If any anomalies or potential defects are detected, they should be immediately reported to the Program Manager and a Supplemental Pin Inspection (SPI) should be scheduled.

Any potential major defect or suspected fracture is considered a Critical Finding and should be reported immediately to the District/Area or Agency Program Manager and the State Program Manager, after taking all necessary procedures to safeguard public safety. IDOT Form BBS CF 1, "Critical Finding Report" must be completed and submitted to the Bureau of Bridges & Structures as soon as possible as specified in [Section 3.3.12](#).

3.6.2.3 Hanger Member Inspections

Suspended truss hangers are typically large vertical members consisting of steel box sections, built-up riveted or bolted plates, angles, or channels, or large rolled beam sections. The area immediately adjacent to the pins is typically reinforced with additional welded or bolted plates or other steel shapes. The entire hanger, also a Fracture Critical Member, must be completely inspected visually. Any suspected cracks, distortions, or other potential defects must be recorded on the appropriate inspection form. Further investigation may require specialized NDT methods by a trained inspector.

3.6.3 Inspection of Pins and Eyebars in Eyebare Trusses

3.6.3.1 General

Eyebare trusses, although no longer used in modern bridge construction, remain in the Illinois bridge inventory and are usually located on low traffic volume rural roadways. Eyebare trusses are typically light, relatively short, simple-span trusses but can reach major bridge lengths and span major waterways.

3.6.3.2 Pin Inspections

Eyebare truss pins and eyebars are to be inspected by the same criteria as beam/girder pins and links. A PPI shall be performed on each pin and the results recorded on the appropriate inspection forms. Eyebare truss pins are considered Fracture Critical Members and must be inspected during each scheduled FCM Inspection. See the recording and reporting requirements in the previous section.

In many instances, excessive pack rust between eyebars at pin locations may have totally seized any movement of the pins. Excessive pack rust should be carefully removed, if possible, without causing any damage to the eyebars. In addition, the inspector should verify that there is sufficient pin length beyond the outside eyebars or that the end caps, retainer nuts, or cotter pins are functioning properly. Excessive pack rust can exert enough force to push eyebars off of their pins in extreme cases.

3.6.3.3 Eyebare Inspections

Eyebars are typically cast, forged, or cut from rolled steel plate material. Most eyebars are rectangular in cross-section that transition to a wider section with an opening to receive a steel pin. The “eyes” in round eyebars are generally flattened by forging. The “eye” can also be formed by creating a loop that is then forged or welded to close the loop. Eyebare members are considered Fracture Critical Members and must be inspected during each scheduled FCM Inspection.

As with links and hangers, the entire length of the eyebare should be visually inspected for any cracks, gouges, section loss, or distortions. Particular attention should be paid to the forged or

formed “eye” areas. Any anomalies or potential defects should be reported immediately to the District/Area or Agency Program Manager. Any major flaws or suspected fractures should be immediately reported to the District/Area or Agency Program Manager and the State Program Manager after taking all necessary procedures to safeguard public safety. IDOT Form BBS CF 1, “Critical Finding Report” must be completed and submitted to the Bureau of Bridges & Structures as soon as possible as specified in [Section 3.3.12](#).

3.7 Bridge Scour and Plans of Action

3.7.1 General

Scour is the leading cause of bridge failures. In 1988, FHWA initiated the National Scour Evaluation Program. The National Bridge Inspection Standards (NBIS) specifies that all bridges over waterways must be evaluated to assess susceptibility to scour and to determine if protection in the form of countermeasures is required to ensure the stability of the structure. NBIS further specifies that the responsible agencies for all bridges determined to be scour critical must prepare and implement a Plan of Action (POA) to monitor known and potential deficiencies in accordance with the POA and to address Critical Findings as specified in [Section 3.3.12](#).

The following definitions are provided within the NBIS:

Scour: Erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges.

Scour Critical Bridge: A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour conditions.

Illinois has completed this program and all waterway structures in the inventory have been assigned a “Scour Critical Evaluation” (ISIS Item 113) rating. A POA has been developed for all bridges determined to be scour critical. A copy of the POA is maintained in each Bridge File. See [Section 3.7.6](#) for monitoring scour critical and scour susceptible bridges.

The National Highway Institute (NHI) offers several training courses related to the evaluation of scour at bridges. See [Appendix A-2](#) for web addresses and reference documents.

3.7.2 New and Rehabilitated Bridges over Waterways

A Scour Evaluation Study, determination of estimated scour depths, and a recommended “Scour Critical Evaluation” (ISIS Item 113) rating are required to be completed during the preliminary planning phase for all new bridges over waterways and all rehabilitation projects that alter existing substructure units in the waterway. For all State bridges, the Bureau of Bridges & Structures must review and approve all Scour Evaluation Studies and must enter the Scour Critical Evaluation Rating into ISIS. For all Local Bridges, the designer must provide the Scour Evaluation Study, estimated scour depths, and “Scour Critical Evaluation” (ISIS Item 113) rating when submitting IDOT Form BLR 10210, “Preliminary Bridge Design and Hydraulics Report”. See the IDOT *Bridge Manual* for design guidance.

3.7.3 Scour Plan of Action (POA)

For every structure identified as a Scour Critical bridge, and for selected structures described as “scour susceptible” in [Section 3.7.4.2](#), a Plan of Action (POA) must be developed.

An outline for a POA and instructions for utilizing the outline are available in IDOT Form BBS 2680, “Scour Critical Bridge Plan of Action (POA)” for structures with a Scour Critical Evaluation Rating of “7” or “4” or less. This outline is applicable to POA preparation for most structures. However, Major River Bridges or other unique structures may require POA documentation beyond that contained in the outline provided.

The scour POA must provide, at a minimum:

- Instructions regarding the type and frequency of inspections required to ensure adequate monitoring of conditions at the bridge site.
- Identification of fixed scour monitoring devices or reference points that have been installed at the site and are to be routinely referenced by inspection personnel.
- Reference data for use by inspection personnel for assessing existing site conditions and evaluating the effect of current conditions on structure stability.
- Guidance to inspection personnel for reporting site deficiencies.
- Guidance to inspection personnel for initiating or recommending bridge closures. The following are examples of when the bridge / roadway shall be closed; other site specific items will be included in the POA.

- Bridges experiencing pressure flow (water touching the superstructure).
- Bridge approach roadways being overtopped.
- Guidance provided to inspection personnel to reopen the roadway.
- Information relative to the type of countermeasure in-place or scheduled for placement at the site to mitigate existing or potential scour problems.

The POA must be maintained with the Bridge File. A copy of the POA must also be available for use during field inspections and updated if necessary based on the conditions observed during each inspection.

Stream cross-sections shall be taken along the upstream and downstream fascia after each major storm event as defined by the “alert” level in BridgeWatch as specified in [Section 3.7.6](#), at a minimum, for structures with a “Scour Critical Evaluation” (ISIS Item 113) rating of “7” or “4” or less, and for all structures with Scour Critical Evaluation rating of “5” that require an Underwater Inspection. Additional cross-sections may be required in the POA.

3.7.4 Scour Evaluation and Stability Assessment of Existing Bridges

Although the theoretical Scour Evaluation process identified Scour Critical bridges in the inventory, any bridge over a waterway has the potential for severe scour. Storm events that produce record flows beyond design levels, large debris piles against one or more substructure units, pressure flow, or other factors that lead to actual scour may occur at any structure. “Scour Critical Evaluation” (ISIS Item 113) rating, assigned to all structures over waterways, are defined by the allowable scour limits. However, once actual scour progresses beyond those limits, the stability of the structure may be threatened.

Any structure that incurs scour at or beyond the limits identified in [Section 3.7.4.1](#), [Section 3.7.4.2](#), or [Section 3.7.4.3](#) may require a new Scour Evaluation Study and a structural stability analysis. The District/Area or Agency Program Manager must contact the Bureau of Bridges & Structures immediately so that a determination can be made. If the Bureau of Bridges & Structures finds that further analysis must be made before the stability of the structure can be determined, precautionary measures may need to be implemented. The District/Area or Agency Program Manager and the State Program Manager will determine the need for precautionary measures on a case-by-case basis. See [Section 3.7.5](#) for conducting a Scour Evaluation Study on existing bridges.

3.7.4.1 Reporting Actual Scour at Scour Critical Bridges

A scour critical bridge is one with abutments and/or pier foundations rated as unstable due to scour potential as determined from a Scour Evaluation Study. The bridge has “Scour Critical Evaluation” (ISIS Item 113) coded “3” or less.

If newly discovered scour damage on any bridge rated Scour Critical meets one of the criteria below, the inspector shall, as soon as possible, notify the District/Area or Agency Program Manager and the Bridge Management Unit (BMU) in the Bureau of Bridges & Structures for further direction. “Scour Critical Evaluation” (ISIS Item 113) should be coded “A” as soon as practical:

- Scour equaling 25% or greater of the as-built overburden above the top of footing occurs during a flood event
- Scour exposing the top of footing or greater than six (6) feet of scour has occurred at a pile bent substructure.

The Bureau of Bridges & Structures tracks scour critical bridges in ISIS using the codes entered for “Scour Critical Evaluation” (ISIS Item 113). When “Scour Critical Evaluation” (ISIS Item 113) is changed to “A”, the Bridge Management Unit must be contacted. See “Scour Evaluation Study for Existing Bridges” in [Section 3.7.5](#).

3.7.4.2 Reporting Actual Scour at Scour Susceptible Bridges

Some structures with “Scour Critical Evaluation” (ISIS Item 113) rated greater than “3” may have scour related concerns that require monitoring, even though they are not considered scour critical bridges. Structures with “Scour Critical Evaluation” (ISIS Item 113) coded “4”, “6”, or “7” are considered to be scour susceptible bridges, and they require the establishment of a POA as well. See [Section 3.7.6](#) for monitoring requirements.

If newly discovered scour damage on any bridge rated Scour Susceptible meet one of the criteria below, the inspector shall, as soon as possible, notify the District/Area or Agency Program Manager and the Bridge Management Unit (BMU) in the Bureau of Bridges & Structures for further direction. “Scour Critical Evaluation” (ISIS Item 113) should be changed to “A” as soon as practical:

- Scour equaling 50% or greater of the as built overburden above the top of footing occurs during a flood event
- Scour exposing the top of footing or greater than six (6) feet of scour has occurred at a pile bent substructure
- The scour countermeasure has been damaged during a flood event

The Bureau of Bridges & Structures tracks scour susceptible bridges in ISIS using the codes entered for “Scour Critical Evaluation” (ISIS Item 113). When “Scour Critical Evaluation” (ISIS Item 113) is changed to “A”, the Bridge Management Unit must be contacted. See “Scour Evaluation Study for Existing Bridges” in [Section 3.7.5](#).

3.7.4.3 Reporting Actual Scour at Non-Scour Critical/Susceptible Bridges

Structures with “Scour Critical Evaluation” (ISIS Item 113) rated “5”, “8”, or “9” may incur scour during a major storm event, even though they are not considered Scour Critical or Scour Susceptible bridges. These bridges can still pose a risk as explained in [Section 3.7.6](#) under “Scour Critical Evaluation Rating coded “8”. Since these bridges were determined to not be Scour Critical or Scour Susceptible, there is no requirement for establishment of a POA.

If newly discovered scour damage on any non-scour critical or non-scour susceptible bridge meets one of the criteria identified in [Section 3.7.4.2](#) the inspector shall, as soon as possible, notify the District/Area or Agency Program Manager and the Bridge Management Unit (BMU) in the Bureau of Bridges & Structures for further direction. “Scour Critical Evaluation” (ISIS Item 113) should be changed to “A” as soon as practical. The Bureau of Bridges & Structures tracks non-scour critical and non-scour susceptible bridges in ISIS using the codes entered for “Scour Critical Evaluation” (ISIS Item 113). When “Scour Critical Evaluation” (ISIS Item 113) is changed to “A”, the Bridge Management Unit shall be contacted. See “Scour Evaluation Study for Existing Bridges” below.

3.7.5 Scour Evaluation Study for Existing Bridges

A Scour Evaluation Study (SES) considers the hydraulic, geotechnical and structural characteristics of the bridge and the site where it is located. When scour has occurred that exceeds estimated or calculated depths, a new Scour Evaluation Study must re-examine those characteristics. The study must determine if additional scour could occur with subsequent

events before mitigation measures are implemented. The study must also determine if the structure is stable for the scour which has occurred as well as for scour from additional storm events. A Scour Evaluation Study is also required for any existing bridge identified as not previously being evaluated for scour.

In order to conduct the new Scour Evaluation Study, the following data is required:

- Information relative to the current event and historic site conditions regarding streambed and channel stability including past observed scour.
- Soil borings or other data indicating the type and properties of the material present at and below the elevation of the streambed.
- Hydraulic data providing information regarding discharge, flow velocities, and backwaters from the current and historic flood events.
- Structural information relative to the type and location of the structure's substructure units.

Coordination between the Bureau of Bridges & Structures and the District / Agency will determine if the study and stability analysis are required and if they will be conducted by the Bureau of Bridges & Structures, District or Agency personnel, or qualified consultants. The completed study and stability analysis must be submitted to the Bureau of Bridges & Structures for review and approval. The Bureau of Bridges & Structures will make the final determination for a new Scour Critical Evaluation Rating and have it entered in ISIS.

If the study determines that the structure is not stable for the depth of scour incurred or potential future scour, the bridge shall be closed, or remain closed until mitigation can be implemented. If the study determines that the structure is still stable for the existing or future scour, the Bureau of Bridges & Structures will determine the required Scour Critical Evaluation Rating and monitoring requirements and have it entered in ISIS.

3.7.6 Bridge Scour Monitoring System

IDOT has established a contract to provide a Bridge Scour Monitoring System, "BridgeWatch", to notify specific State and Local users when threshold rainfall events occur. This system monitors the National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), NEXRAD rainfall accumulation products, and the United States Geological

Survey (USGS) network of stream flow gages to determine when warning and/or alert messages should be sent. A link to the Illinois Department of Transportation BridgeWatch web site is provided in [Appendix A-2](#).

When a warning and/or alert threshold is exceeded, notification is sent via e-mail or text message to cell phone numbers provided by the users. Upon notification, an inspector will assess the current condition of the structure to determine what, if any action should be taken to assure the safety of the traveling public. The inspector will then document the conditions at the site (date, time, water level, bridge condition, debris buildup, approach roadway condition, take pictures, etc.), and enter this information into the BridgeWatch System and/or contact the District/Area or Local Program Manager so they can enter the data. Each District/Area or Agency Program Manager is responsible for determining how their respective inspectors will be notified when a “Warning” and/or “Alert” occurs.

The District/Area or Agency Program Managers are responsible for maintaining their respective users’ and inspectors’ contact information on an ongoing basis in BridgeWatch and Communication Centers or other offices of contact for local public agencies. The District/Area Program Managers will be able to update the contact information directly in BridgeWatch. The Agency Program Managers will need to contact the Bridge Management Unit in the Bureau of Bridges & Structures to add, modify, and delete their contact information.

If changes to the warning and/or alert levels in BridgeWatch are proposed, the State Program Manager must review and approve the proposed modifications.

The user manual for BridgeWatch is included in [Appendix A-9](#) for reference. Utilizing the individual POA prepared for each scour critical or scour susceptible bridge, inspection personnel must monitor the site during each Routine Inspection, Underwater Inspection if applicable, and subsequent to major storm events as follows:

Scour Rating	Storm Event			
	10 Year	25 Year	50 Year	100 Year
4 or Less	Warning	Alert		
5		Warning	Alert	
6	Warning	Alert		
7 or 8			Warning	Alert

Table 3.7-1 – Scour Monitoring Schedule

Scour Critical Evaluation coded “4”: Structures that have “Scour Critical Evaluation” (ISIS Item 113) coded as “4” should be considered scour susceptible, and require a POA that states it will be monitored when a 25 year storm event has occurred.

Scour Critical Evaluation coded “5”: Structures that have “Scour Critical Evaluation” (ISIS Item 113) coded as “5” are not considered scour susceptible, however, some of these State structures will be included in the Scour Monitoring System in order to obtain statewide coverage of rainfall events.

Scour Critical Evaluation coded “6”: All existing bridges over waterways in the inventory have been screened and assigned a Scour Critical Evaluation Rating in ISIS. For all new and replacement structures over waterways, a temporary Scour Critical Evaluation Rating of “6”, indicating that a Scour Evaluation Study has not yet been completed, will automatically be assigned upon establishment of a new Structure Record in ISIS. The Bureau of Bridges & Structures will update “Scour Critical Evaluation” (ISIS Item 113) after review and approval of the Scour Critical Evaluation Study.

Scour Critical Evaluation coded “7”: Structures that have “Scour Critical Evaluation” (ISIS Item 113) coded as “7” are considered scour susceptible and require a POA that states it will be monitored when a 100-year storm event has occurred. Once the adequacy of the installed, properly designed countermeasures has been established by passing two design storm events with little or no damage as documented in the scour monitoring system, the rating for “Scour Critical Evaluation” (ISIS Item 113) can be revised to an “8” and monitoring can be discontinued upon the approval of the State Program Manager in the Bureau of Bridges & Structures.

Scour Critical Evaluation coded “8”: A number of bridges previously had a “Scour Critical Evaluation” (ISIS Item 113) of “3”. A mitigation repair was completed and the

“Scour Critical Evaluation” (ISIS Item 113) was changed to “7”. After a period of time, the “Scour Critical Evaluation” (ISIS Item 113) was allowed to be changed to “8”. However, the scour mitigation repair may not have been designed to current standards or the calculations for those repairs have not been found. These structures, although having a “Scour Critical Evaluation” (ISIS Item 113) of “8”, have been included in the Scour Monitoring System. The bridge may be removed from the Scour Monitoring System once the adequacy of the existing countermeasures has been determined by the Bureau of Bridges & Structures.

Due to the range of conditions that can cause a structure to have a “Scour Critical Evaluation” (ISIS Item 113) of “4” or “5”, the storm event triggering an alert or warning can be modified for site specific conditions upon approval of the State Program Manager.

If a given structure experiences several storm events without producing any scour concerns, the specified storm event triggering a warning/alert can be modified with approval of the State Program Manager.

If users determine BridgeWatch has not adequately estimated the predicted storm event for a given rainfall, the State Program Manager should be contacted to assist in calibrating the system.

Per the schedule from [Table 3.7-1](#) above, Warnings and Alerts will be generated by BridgeWatch, and notification will be sent via e-mail or text messages to cell phone numbers provided by the users. Appropriate personnel will then be notified for a given structure or structures experiencing the storm event. A “Warning” is provided as advance notification of the potential alert, and no immediate action is required. An “Alert” is a notification to users that a scour critical or scour susceptible bridge has passed the specified storm event, and the structure needs to be inspected to determine if the structure has been adversely impacted by the storm event in accordance with the POA.

3.7.7 Updating the Scour Critical Rating

The Bridge Management Unit in the Bureau of Bridges & Structures is responsible for updating the Scour Critical Evaluation Rating (ISIS Item 113), based on reported field data and observations from District and local public agency inspectors.

To raise the Scour Critical Evaluation Rating from a “4” or less will require completion of a new Scour Evaluation Study for review and approval by the Bridge Management Unit in the Bureau of Bridges & Structures.

To raise the Scour Critical Evaluation Rating to “7” to reflect the installation of scour countermeasures, the Bureau of Bridges & Structures must review and approve the countermeasure design and installation.

To raise the Scour Critical Evaluation Rating from a “7” to “8” requires that the installed countermeasure has performed adequately through two design storm events with little to no damage. The Bureau of Bridges & Structures must concur.

When actual scour is observed during any inspection that meets or exceeds the criteria in [Section 3.7.3](#), the District/Area or Agency Program Manager must contact the Bridge Management Unit in the Bureau of Bridges & Structures. “Scour Critical Evaluation” (ISIS Item 113) should be changed to “A”.

3.7.8 Countermeasures

FHWA *Bridge Scour and Stream Instability Countermeasures* (HEC 23 (Vol 1 / Vol 2)) is a recommended source of information for the selection and design of countermeasures to control scour. This publication provides the following definition:

Countermeasures: Measures incorporated into a highway-stream crossing system to monitor, control, inhibit, change, delay, or minimize stream instability and bridge scour problems.

Since monitoring is included within the definition of countermeasures, a properly developed and implemented POA may be considered a countermeasure.

When considering countermeasures and their relevance to the rating assigned for “Scour Critical Evaluation” (ISIS Item 113), consideration must be given to the methods used to select, design or develop the countermeasures. Only countermeasures that were implemented at the site based on established engineering principles that considered site specific conditions can be

considered effective when evaluating scour susceptibility and rating “Scour Critical Evaluation” (ISIS Item 113).

3.8 Inspection Safety

Safety of the inspection team and traveling public is of paramount importance during bridge inspections. All members of the inspection team must be familiar with the safety policies and guidelines set forth by OSHA, the bridge owner, and their employees. The FHWA *Bridge Inspector's Reference Manual* (BIRM) is a good resource for recommended bridge inspection safety precautions.

IDOT safety policies and rules are included in Departmental Order 5-1: Employee Safety Code. Special attention should be given to Part II, Chapter 8. If traffic control is required, Part II, Chapter 1 should be consulted.

3.8.1 General

It is incumbent on each IDOT, local public agency, consultant, and other state agency employee conducting bridge inspections to take every precaution and to follow all standard procedures designed to minimize or avoid placing themselves in undue danger.

IDOT employees are required to read and follow Departmental Order 5-1, “Employee Safety Code”.

Hard copies of the Employee Safety Code are available by contacting the Bureau of Personnel Management, Occupational, Safety and Health Unit.

In general, the Employee Safety Code prescribes the requirements for safety procedures for many typical work place and field operation situations. The manual is not all-inclusive but provides basic safety requirements and directs employees to specific additional resources and training opportunities.

3.8.2 Bridge Inspection Safety

Each employee engaged in Bridge Inspection activities shall have read and be familiar with the Employee Safety Code and have received all required and necessary safety training for their job requirements.

3.8.2.1 Personal Safety

Each employee should be equipped with personal protection equipment including, but not limited to, the following:

- Vest
- Hard Hat
- Bump Cap
- Eye protection
- Ear protection
- Steel-toed footwear
- Personal Floatation Device

3.8.2.2 Worksite Protection and Flagging

The person responsible for traffic control operations must follow the requirements in the IDOT *Supplement to the Work Site Protection Manual*. All IDOT bridge inspectors should be familiar with this manual and be aware of the hazards of working along-side traffic.

3.8.2.3 Fall Protection

Each employee engaged in bridge inspection shall be familiar with all policies, requirements, and equipment as stated in the “Employee Safety Code: Fall Protection Plan for Field Activities”.

3.8.2.4 Confined Space Entry

Certain types of bridges in Illinois require access to confined spaces while conducting NBIS inspections, examples include steel box girders, steel box pier caps, concrete box girders, steel tie girders and arch ribs in tied arch bridges, vaulted abutments, and some buried structures. All

State employees engaged in Confined Space Entry procedures shall be adequately trained in their functional duties prior to any confined space entry.

Each employee engaged in bridge inspection shall be familiar with all policies, requirements, and equipment as stated in the Employee Safety Code: Confined Space Entry Policy.

3.8.3 Non-State Employee Bridge Inspection Personnel

Local public agency employees, other State Agency employees, and consultant personnel engaged in bridge inspections should, in general, be familiar with and follow all OSHA, Department of Labor, or any Federal, State, or Local laws pertinent to bridge inspection activities. Each inspector should consult their agency or company safety policies before conducting any bridge inspection activities.

3.9 Quality Control and Quality Assurance

3.9.1 General

IDOT recognizes that established and documented Quality Control and Quality Assurance (QC/QA) procedures are essential for ensuring that bridge inspections are performed in an appropriate, consistent, and uniform manner by all inspection Program Managers and Team Leaders employed by various agencies having bridge inspection responsibilities throughout the state. Through the application of QC/QA procedures, agencies enhance their ability to obtain accurate inspection information required for determining load capacity and bridge maintenance, repair, rehabilitation and replacement needs. Of utmost importance is the role QC/QA plays for ensuring bridge inspection staff are adequately trained and experienced to readily identify conditions that adversely affect public safety.

The National Bridge Inspection Standards (NBIS) states that agencies must “assure systematic quality control (QC) and quality assurance (QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program”, and that these procedures shall “include periodic field review of inspection teams, periodic bridge inspection refresher training for Program Managers and Team Leaders, and independent review of inspection reports and computations.” In conjunction with these statements regarding QC/QA, the NBIS provides the following definitions:

Quality Control: Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level.

Quality Assurance: The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.

Program Manager: The individual in charge of the program who has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The Program Manager provides overall leadership and is available to inspection Team Leaders to provide guidance.

Team Leader: Individual in charge of an inspection team responsible for planning, preparing, performing and documenting field inspection of the bridge.

3.9.2 Personnel Qualifications

The quality of an agency's bridge inspection program is very much dependent on the performance of the Program Manager in charge of the agency's inspection program, and on the Team Leaders leading the inspection teams that perform the field inspections. These individuals must be qualified to perform their duties. IDOT has established procedures for reviewing, verifying and approving the acceptability of the education, training and experience of an individual to function as a Program Manager or Team Leader. IDOT Form BBS 2610, "Program Manager Qualifications" and IDOT Form BBS 2620, "Team Leader Qualifications" shall be used for documenting the qualifications of Program Managers and Team Leaders.

3.9.2.1 Bridge Inspection Training

Federal regulations require all personnel, including registered (note the term is "licensed" in Illinois) professional or structural engineers, managing bridge inspection programs or directing inspections in the field, to have successfully completed a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course. This requirement is fulfilled by individuals who have successfully completed the "Safety Inspection of In-Service Bridges" course (FHWA-NHI-130055) offered by the National Highway Institute (NHI).

3.9.2.1.1 Training for Underwater Inspections

The NBIS requirement for comprehensive bridge inspection training also extends to divers performing underwater inspections. The NHI Course Number FHWA-NHI-130091, “Underwater Bridge Inspection” course provides an overview of diving operations that will be useful to IDOT and Agency personnel responsible for managing Underwater Inspections. This course also fulfills the NBIS bridge inspection training requirement for all divers conducting Underwater Inspections. The NHI Course Number FHWA-NHI-130055, “Safety Inspection of In-Service Bridges” will also meet the training requirements for divers.

3.9.2.1.2 Fracture Critical Member Inspection Training

Although the training typically provided for personnel performing Routine Inspections provides the basic knowledge needed for performing a Fracture Critical Member (FCM) Inspection, inspectors are highly encouraged to obtain additional training specifically related to the inspection of Fracture Critical Members. The specialized course titled “Fracture Critical Inspection Techniques for Steel Bridges” (FHWA-NHI-130078), which is periodically presented by NHI, is highly recommended for both technical and engineering staff engaged in the inspection and evaluation of Fracture Critical Members.

3.9.2.2 Bridge Inspection Experience

NBIS provides the following definition for bridge inspection experience:

Bridge Inspection Experience: Active participation in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominate amount in bridge inspection, is acceptable.

To provide agencies with guidance and clarification of experience levels that would be adequate to satisfy NBIS requirements, FHWA has provided the following statement in regard to the “desired minimum bridge inspection experience level” for personnel engaged in bridge inspections:

Desired Minimum Bridge Inspection Experience Level: The predominate amount, or more than fifty percent, should come from NBIS bridge safety inspection experience. Other experience in bridge design, bridge maintenance, or bridge construction may be used to provide the additional required experience.

When the experience of personnel does not meet the “Desired Minimum Bridge Inspection Experience Level”, the State Program Manager and others with delegated program manager responsibilities must perform an in-depth evaluation of the individual’s bridge related experience to determine acceptability, as described within [Section 3.9.2.4](#).

3.9.2.3 Program Manager Qualifications

To satisfy IDOT and NBIS qualification requirements to function as a Program Manager in Illinois, an individual must have successfully completed “Safety Inspection of In-Service Bridges” course (FHWA-NHI-130055) and satisfy one of the following:

- Be licensed as a Professional Engineer or Structural Engineer
- Have ten years of Routine Inspection experience

Under the current NBIS rules, all state departments of transportation must designate an individual to function as the State Program Manager to provide overall leadership for bridge inspection. The State Program Manager can delegate program manager responsibilities to qualified individuals, as needed, to ensure compliance with the NBIS rules.

Individuals who have been approved by IDOT to function as Program Managers are also qualified to function as Team Leaders.

3.9.2.4 Team Leader Qualifications

To be accepted to function as a Team Leader, each candidate must have successfully completed “Safety Inspection of In-Service Bridges” course (FHWA-NHI-130055). The qualifications of potential Team Leaders are first reviewed by the District/Area or Agency Program Manager who has oversight responsibility for the structures to be inspected. If the District/Area or Agency Program Manager deems an individual’s qualifications acceptable for functioning as a Team Leader, the District/Area or Agency Program Manager must forward the

documentation of the individual's licensing, training, and experience to the State Program Manager for concurrence. IDOT Form BBS 2620, "Team Leader Qualifications" shall be used for the purpose of documenting and submitting Team Leader qualifications to the State Program Manager for concurrence.

NBIS rules provide qualification requirements for engineers and for technical personnel for use in evaluating an individual's qualifications to function as a Team Leader. See [Sections 3.9.2.4.4](#) for bridge inspection experience requirements.

3.9.2.4.1 Structural and Professional Engineers as Team Leaders

Individuals who are licensed in Illinois as Professional Engineers and have successfully completed an FHWA approved comprehensive bridge inspection training course are qualified to function as Team Leaders with approval by the State Program Manager. Licensing as a Structural Engineer in Illinois is accepted in lieu of licensing as a Professional Engineer.

3.9.2.4.2 Engineering Personnel as Team Leaders

Engineering Personnel are individuals who have received a bachelor's degree or higher in engineering from a program accredited by ABET but are not licensed in Illinois as Professional Engineers. For the purpose of evaluating required experience levels for acceptance as a Team Leader, Engineering Personnel are categorized as follows:

Type 1 - Engineering Personnel: Personnel who have passed the "Fundamental of Engineering" exam, also known as the "Engineer in Training" (EIT) exam.

Type 2 - Engineering Personnel: Personnel who have not passed the "Fundamentals of Engineering" exam, also known as the EIT exam.

The criteria used for the evaluation of experience is presented in [Section 3.9.2.4.4](#).

3.9.2.4.3 Technical Personnel as Team Leaders

For the purpose of evaluating required experience levels for acceptance as a Team Leader, Technical Personnel are categorized as follows:

Type 1 - Technical Personnel: Personnel who have been certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer’s (NSPE) program for National Certification in Engineering Technologies (NCET).

Type 2 - Technical Personnel: Personnel who have an associate’s degree in engineering or engineering technology from a college or university accredited by ABET.

Type 3 - Technical Personnel: Personnel who have not received formal education or training resulting in a bachelor’s degree in engineering, an associate’s degree related to engineering, or a certification as a Level III or IV Bridge Safety Inspector.

The criteria used for the evaluation of experience is presented in [Section 3.9.2.4.4](#).

3.9.2.4.4 Review of Bridge Inspection Experience

Based on the guidelines provided by FHWA, Engineering Personnel or Technical Personnel can function as Team Leaders after the State Program Manager has evaluated their training and experience and determined that they are qualified based on one of the criteria provided. The values, provided in the following table for Bridge Related Experience and Performance of NBIS Inspections, represent the level of experience required to satisfy criteria requirements:

Personnel Type	Bridge Related Experience (years)	Performance of NBIS Inspections (months)
Type 1 - Engineering Personnel with EIT	2	12
Type 2 - Engineering Personnel without EIT	4	24
Type 1 - Technical Personnel - NPSE-NCET certified	0	0
Type 2 - Technical Personnel - Associates Degree	4	24
Type 3 - Technical Personnel	5	30

Table 3.9-1 – Team Leader Bridge Inspection Experience Requirements

Criteria #1: An individual having accumulated at least the shown number of years of bridge related experience over the course of their career through the performance of NBIS bridge inspections, bridge design, bridge maintenance, or bridge construction activities, with more than the shown number of months of the accumulated bridge related experience obtained through the performance of Routine Inspections, meets the

experience requirements to qualify as a Team Leader if the Program Manager has evaluated and approved the potential Team Leader's overall experience as acceptable. Technical Personnel meeting these requirements have the "Desired Minimum Bridge Inspection Experience Level" preferred by FHWA for acceptance as a Team Leader, and in-depth evaluation of the individual's experience by the State Program Manager to verify qualifications is not required. However, the performance of the Team Leader is subject to review by the State Program Manager to ensure the quality of inspections, and that assignments are consistent with the experience of the individual.

Criteria #2: An individual having accumulated at least the shown number of years of bridge related experience over the course of their career through the performance of NBIS bridge inspections, bridge design, bridge maintenance, or bridge construction activities, with more than the shown number of months of the accumulated bridge related experience obtained through the performance of Routine Inspections and other various bridge inspection activities, meets the experience requirements to qualify as a Team Leader, if the Program Manager has evaluated and approved the potential Team Leader's overall experience as acceptable. A portion of the individual's bridge inspection experience must have been acquired through the performance of Routine Inspections, with the remainder of the individual's bridge inspection experience derived from inspections associated with bridge design, bridge construction inspections, and bridge maintenance inspections.

Criteria #3: An individual having less than the shown number of years of bridge related experience accumulated over the course of their career through the performance of NBIS bridge inspections, bridge design, bridge maintenance, or bridge construction activities, with a portion of their accumulated bridge related experience obtained through the performance of Routine Inspections, meets the experience requirements to qualify as a Team Leaders only if both the State Program Manager and FHWA concur that the individual's experience is acceptable. This criterion should only apply to special situations involving highly qualified individuals performing NBIS bridge inspections that require specialized knowledge or training on unusual or complex bridges.

Note that in all cases, a portion of the experience accumulated by Technical Personnel must have been derived from the performance of Routine Inspections in order to be considered

qualified to function as a Team Leader, except as noted in [Table 3.9-1](#) for NSPE-NCET certified inspectors.

3.9.2.5 Program Manager - Element Qualifications

To satisfy IDOT requirements to function as a Program Manager overseeing Element Level inspections in Illinois, an individual must meet all the requirements of [Section 3.9.2.3](#) and successfully complete the IDOT Bridge Element Inspection Class.

3.9.2.6 Team Leader - Element Qualifications

To satisfy IDOT requirements to function as a Team Leader performing Element Level inspections in Illinois, an individual must meet all the requirements of [Section 3.9.2.4](#) and successfully complete the IDOT Bridge Element Inspection Class.

3.9.3 Quality Control

The quality control (QC) procedures established by IDOT are intended to define, monitor, and document the qualifications and performance of personnel engaged in the management of inspection programs, the performance of field inspections, and the load rating of bridges. Factors related to the maintenance of effective QC procedures are:

- Review of bridge inspection reports
- Inspector's performance
- Personnel qualifications
- NBIS bridge inspection reports in the Bridge File
- NBIS data verification
- Bridge inspection refresher training
- Identifying special skills, training or equipment
- Monitoring of inspector's production rates and quality of bridge inspections

3.9.3.1 Review of Bridge Inspection Reports

To ensure the quality of a Team Leader's inspection reports, all reports must be reviewed by the Program Manager prior to the data being entered into ISIS. The depth of review shall be

determined by the Program Manager based on the experience level of the Team Leader as well as the type, age and typical exposure of the bridge. At a minimum, the review should verify that the condition ratings are appropriate and that the documentation meets the requirements of [Section 3.3.3](#).

Program Managers must monitor each inspector's production rates (number of bridges inspected per day) to ensure that each inspection is of high quality and is conducted properly. The Bridge Management Unit also monitors all inspector's production rates and will contact the responsible Program Manager if rates appear excessive.

3.9.3.2 Inspector's Performance

District and Area Program Managers and the Central Program Manager must conduct in-depth reviews of the field procedures of all Team Leaders functioning under their supervision to ensure that inspections are being performed in an appropriate, consistent, and uniform manner.

At least once every 24 months, Program Managers should accompany each Team Leader to observe the performance of NBIS bridge inspections on at least three (3) structures over the course of a 30 day period. Program Managers are required to complete IDOT Form BBS 2790, "Bridge Inspection Procedures Review" for each Team Leader.

The Central Program Manager must accompany each Team Leader to observe the performance of NBIS bridge inspections on at least 10% of structures over a 12 month time period due to the complexity and duration of the major structure inspections.

District and Area Program Managers should choose inspections of different structure types and include a Fracture Critical Member Inspection, when possible, for the purpose of monitoring inspector's performance in a variety of circumstances. The District and Area Program Manager should increase the number of bridge inspections monitored or reduce the period of time between inspection-monitoring as needed to address concerns with Team Leader's performance. If the District and Area Program Manager determines a Team Leader is not capable of functioning at an appropriate level to ensure adequate inspection procedures, the individual should no longer be used as a Team Leader, and the situation must be reported to the State Program Manager for final resolution.

3.9.3.3 Personnel Documentation

The Bridge Management Unit maintains documentation of the qualification approvals and concurrences issued for all Program Managers and Team Leaders employed by IDOT and by other agencies. The Bridge Management Unit also maintains documentation of performance deficiencies reported by Central, District/Area, or Agency Program Managers for resolution.

Central, District/Area, or Agency Program Managers must maintain a file containing documentation of education, professional registrations, training, and certifications received from the State Program Manager for themselves and each Program Manager and Team Leader functioning under their direction.

In addition, the file must contain documentation of Bridge Inspection Performance Reviews performed to monitor the bridge inspection procedures used by the individual. The documentation for all inspection personnel functioning in a District or Agency should be located in a central location and readily accessible by the District/Area or Agency Program Manager.

3.9.3.4 NBIS Bridge Inspection Reports in the Bridge File

A Bridge File is a collection of required and optional information representing a complete history of a bridge. The Bridge File should contain National Bridge Inventory (NBI) data, design plans and specifications, construction records, as-built plans, maintenance and repair records, and all NBIS bridge inspection records.

AASHTO *The Manual for Bridge Evaluation* (MBE) provides the following guidance for the maintenance of a Bridge File:

- Bridge Owners should maintain a complete, accurate, and current record of each bridge under their jurisdiction. Complete information, in good usable form, is vital to the effective management of bridges. Furthermore, such information provides a record that may be important for repair, rehabilitation, or replacement.
- A bridge record contains the cumulative information about an individual bridge. It should provide a full history of the structure, including details of any damage and all strengthening and repairs made to the bridge. The bridge record should report data on

the capacity of the structure, including the computations substantiating reduced load limits, if applicable.

A separate file must be maintained for each structure. The documentation for all bridges in a District or Agency should be located in a central location that is maintained and readily accessible by the Team Leader and the District/Area or Agency Program Manager.

A Bridge File Checklist must be completed and updated, as required, for each bridge and stored with the Bridge File. A copy of the Bridge File Checklist is available on the IDOT website.

It is recognized that it is not practical or necessary to physically store all required items in the file. However, the actual location of each item should be referenced on the Bridge File Checklist. This can include separate file locations, plan stacks, electronic files, databases, and data in document storage systems, where applicable.

3.9.3.5 NBIS Data Verification

3.9.3.5.1 Recognizing Errors, Omissions, or Changes in the Field

When performing field inspections, Team Leaders and accompanying staff should use IDOT Form S-114, "Inspector's Inventory Report" or IDOT Form S-107, "Master Structure Report" to assist them in recognizing any readily apparent errors, omissions, or changes in structure inventory data. Information regarding errors, omissions, and changes should be provided to the District/Area or Agency Program Managers and subsequently forwarded to IDOT staff responsible for the data input of NBIS inventory information in accordance with [Section 3.2.2](#).

For rehabilitated, replaced, and new structures, the "Inventory Data" shown on the first page of the "Master Structure Report" shall be reviewed to verify that it is in agreement with the information provided on the as-built structure plans. For local public agency structures, after the Initial Inspection, the Agency Program Manager shall review the inventory data and forward any errors, omissions, or changes in inventory data to IDOT staff responsible for the data input.

3.9.3.5.2 Resolution of Inspection Errors or Omissions

During the review of inspection reports or the monitoring of field bridge inspection procedures, the Central, District/Area, or Agency Program Manager must note data errors or omissions and provide personnel responsible for their occurrence with directions that will eliminate similar incidents in the future. For minor reporting deficiencies, the initial resolution of the findings may be in the form of verbal instructions by the Program Manager to the Team Leader with a note to the Team Leader's file, if considered necessary by the Program Manager. For major deficiencies, such as those that result in the assignment of inappropriately high condition ratings to deteriorated structures or the omission of data concerning critical structural deficiencies from an inspection report, the Program Manager must provide documentation to the Team Leader's file describing the inspection report deficiency and the measures taken to both correct the inspection deficiency and to prevent the reoccurrence of the inspection deficiency.

If the Team Leader continues to provide inspection reports or to perform field inspections in a manner that does not address a previously noted major deficiency, the Program Manager should no longer utilize the Team Leader for NBIS bridge inspection purposes, and the situation must be reported to the State Program Manager for final resolution.

3.9.3.6 Bridge Inspection Refresher Training

All Program Managers and Team Leaders must receive periodic NBIS bridge inspection refresher training at intervals not to exceed 60 months. However, each Program Manager must evaluate the performance and experience level of each Team Leader performing field inspections within their designated area of responsibility and, if necessary, establish an interval for bridge inspection refresher training that is less than the maximum allowed to maintain inspection quality.

The "Bridge Inspection Refresher Training" (FHWA-NHI-130053) class is available through the NHI and IDOT and is utilized to satisfy NBIS bridge inspection refresher training needs.

IDOT will also provide an Illinois specific "Bridge Inspection Calibration Class" to afford inspection personnel an opportunity to fulfill bridge inspection refresher training requirements. The "Bridge Inspection Calibration Class" only meets the refresher training requirements for the State of Illinois. It is not currently accepted as refresher training in other states by FHWA.

When reviewing Team Leader performance, Program Managers may determine which class is the more appropriate choice for addressing deficiencies noted in a Team Leader's performance.

3.9.3.7 Identifying Special Skills, Training, and Equipment

Inspection teams performing Fracture Critical Member (FCM) Inspections, Underwater Inspections, or Complex Bridge Inspections must have skills, training, and equipment suitable for the inspection being performed. NHI offers various courses that address the above mentioned inspections. Central, District/Area, or Agency Program Managers should utilize these courses for training purposes, as needed, to ensure that personnel are knowledgeable of required inspection methods and procedures for the structures assigned to them for inspection.

Central, District/Area, or Agency Program Managers must ensure that personnel familiar with non-destructive testing methods are available to the inspection team to perform follow-up investigations for visually identified defects, especially those located within an FCM. Bridge inspectors should be trained to identify fatigue-prone details.

Equipment such as man-lifts, safety harnesses, boats, probing poles, sonar-depth-finders, and life vests must be available, as needed to address the type of inspection being performed.

3.9.3.8 Local Bridge Liaison Annual Meeting

The IDOT District Local Bridge Liaisons are one of the main points of contact for local public agency Program Managers. As such, the success of the Illinois NBIS Program relies on these individuals to be confident and dedicated to their mission.

IDOT shall coordinate an annual meeting of the Local Bridge Liaisons to review policy changes, discuss best practices, and encourage networking between Districts.

3.9.4 Quality Assurance

Quality Assurance (QA) measures are required to ensure that established Quality Control (QC) procedures are being followed and are effective for ensuring bridge safety on all public roadways. Quality Assurance reviews of all agencies are performed to assure the quality of bridge inspections and bridge load ratings. The State Program Manager will conduct the Quality

Assurance review. When the State Program Manager is unavailable, the responsibility may be delegated to the Central Program Manager, Local Program Manager, or other Bridge Management staff.

3.9.4.1 Quality Assurance Reviews

IDOT will conduct annual Quality Assurance reviews in one IDOT District and seventeen local public agencies to determine the adequacy and effectiveness of the Quality Control procedures utilized for bridge inspections and load ratings. The intervals between these reviews may be reduced in response to agency personnel changes or to address findings from previous Quality Assurance reviews.

3.9.4.1.1 Office Reviews

Quality Assurance reviews include a review of the office files and procedures used to document inspections, to track personnel performance and qualifications, and to schedule follow-up inspections or repairs to address NBIS bridge inspection findings. The procedures used to establish inspection schedules and to select Team Leaders and inspection personnel will be included in the Quality Assurance review. During the office review, the District/Area or Agency Program Managers and member of their staff included in the review process, will be requested to provide information describing the procedures employed within their designated area of responsibility to ensure bridge safety and compliance with NBIS.

3.9.4.1.2 Field Reviews

Quality Assurance reviews include field observations of at least seven bridges that are within the Agency's jurisdiction. The structures chosen for review should vary in regard to "Main Structure Material" and "Main Structure Type" (ISIS Items 43A and 43B respectively). An effort should be made to include bridges with condition ratings ranging between "6" (Satisfactory) to "3" (Serious) for "Deck Condition", "Superstructure Condition", "Substructure Condition", or "Culvert Condition" (ISIS Items 58, 59, 60, and 62 respectively) and, whenever possible, to include structures with "Scour Critical Evaluation" (ISIS Item 113) coded "3" or less. When possible, the review should also include bridges requiring Underwater, Fracture Critical Member, or Special Inspections, and bridges with unusual or drastic changes in primary condition ratings (greater than plus or minus one rating point).

The District/Area or Agency Program Manager or a suitable substitute must be present during the Quality Assurance field review. Personnel conducting the Quality Assurance field review will refer to the Bridge Files maintained by the District/Area or Agency Program Manager to compare the inspection information contained in the files to the conditions observed during the Quality Assurance field review. IDOT Form S-107, "Master Structure Report" should be obtained for reference by Quality Assurance staff during the field review of each bridge. The Quality Assurance staff should note inventory data errors or omissions as well as observed condition rating related discrepancies. Conditions that could affect load ratings will be noted during the Quality Assurance field review. Follow-up must occur to ensure the noted conditions have been considered in the current load rating.

3.9.4.2 Final Quality Assurance Review Report

A "Final Quality Assurance Review Report" noting commendable practices, review findings, and the measures to be taken to address Quality Control deficiencies will be provided to the reviewed Program Manager. When requested and noted in the "Final Quality Assurance Review Report", the reviewed Program Manager must provide the State Program Manager with documentation verifying that corrective measures described in the report have been implemented.

IDOT will provide FHWA with a copy of every "Final Quality Assurance Review Report".

3.9.4.3 Annual Quality Assurance Review Report

IDOT will assemble an "Annual Quality Assurance Report" summarizing the findings of each agency's Quality Assurance review.

3.10 Coordination with the Illinois State Toll Highway Authority

In order to establish National Bridge Inspection Standards (NBIS) inspection and reporting responsibilities for structures jointly maintained by the Illinois State Toll Highway Authority (ISTHA) and IDOT or a local public agency, guidelines were developed and mutually agreed to in 1966. The guidelines provided in this section have been in effect since January 1, 1997.

3.10.1 Performance of ISTHA Inspections

ISTHA will perform the periodic inspections required by the NBIS to determine the current condition ratings for all jointly maintained bridges. The inspections performed by ISTHA will provide condition ratings for the entire jointly maintained structure but will not provide the joint maintaining agency with detailed inspection information needed to determine the extent and cost of maintenance and repairs. IDOT and ISTHA will perform the inspections necessary to collect in-depth information for determining maintenance and repair needs for the portions of the structure for which they have maintenance responsibility. If ISTHA is unable to completely inspect the jointly maintained structures, upon notice being given by ISTHA, IDOT will perform the inspections necessary to provide condition ratings for these structures.

3.10.2 Interagency Coordination of ISTHA Inspections

Personnel involved with bridge inspection and associated with ISTHA, located at 2700 Ogden Avenue, Downers Grove, Illinois 60515, can be contacted by phone at (630) 241-6800.

ISTHA will provide the joint maintaining agency with inspection scheduling information. The scheduling information will be provided to the joint maintaining agency sufficiently in advance of the scheduled date of inspection to allow the agency the opportunity to accompany ISTHA personnel during the NBIS inspection. The name and telephone number of the ISTHA contact person will be included with the scheduling information provided to ISTHA. The joint maintaining agency will notify the designated ISTHA contact person no later than one week prior to the scheduled date of inspection of its intention to either participate or not participate in the NBIS inspection. ISTHA will notify agencies choosing to participate in the inspection of scheduling changes.

3.10.3 ISTHA Inspection Permit Requirements

In order to obtain the inspection information required to establish maintenance and repair needs, IDOT and local public agency inspectors will require access to ISTHA right-of-way. IDOT and local public agency personnel should obtain an access permit and/or an authorization letter from ISTHA before allowing their personnel to perform inspections within the right-of-way of ISTHA. ISTHA will issue authorization letters to the joint maintaining agencies to allow them access to structures to perform routine inspection operations. The authorization will be in the

form of a letter from the Permit Engineer of ISTHA stating that the jointly maintaining agency is authorized to perform inspection operations for specific structures within ISTHA right-of-way for a designated period of time. For non-routine inspection operations, such as those requiring the temporary closure of traffic lanes, the joint maintaining agency must obtain an access permit from ISTHA. The joint maintaining agency will be required to provide adequate and appropriate traffic control when performing inspections within ISTHA right-of-way. The procedures provided in these guidelines for obtaining concurrence from ISTHA for inspection activities is applicable only when the inspection operations are being performed by personnel employed by IDOT or a county highway department. Consulting engineers, or units of local government other than county highway departments, must contact ISTHA for specific information on the permit requirements for the inspection activities they intend to perform.

3.10.4 Reporting ISTHA Inspection Information

ISTHA will report the NBIS inspection information for jointly maintained structures to IDOT for recording in ISIS. The inspection information will be preferably submitted to IDOT on a monthly basis to ensure that the information is placed in ISIS in a timely manner to avoid inspected bridges being reported as not meeting the periodic NBIS inspection requirement. Inspection information for bridges jointly maintained by ISTHA and IDOT should be submitted to the Region/District Bureau of Operations. Inspection information for structures jointly maintained by ISTHA and a local public agency should be submitted to the District Bureau of Local Roads and Streets, and a copy of the reported inspection should be simultaneously provided to the local public agency. IDOT or local public agency personnel will contact ISTHA to resolve discrepancies noted in the NBIS inspection information submitted to IDOT by ISTHA. NBIS inspection information for structures under the exclusive jurisdiction of ISTHA should be submitted to the Planning Services Section of the Bureau of Urban Program Planning in the Central Office of Planning and Programming.

3.11 Inspection of Non-NBIS Structures

3.11.1 General

The State of Illinois is responsible for establishing policies and procedures to ensure the safety of structures serving the traveling public, including those that are not addressed by federal regulations as provided by the National Bridge Inspection Standards (NBIS). Federal

regulations requiring periodic bridge inspections to ensure safety apply only to structures that 1) carry a public roadway and 2) have an opening greater than 20 feet measured along the center of the roadway. Structures that do not meet either of these conditions are considered to be “Non-NBIS Structures”.

In order to track the existence and condition of Non-NBIS Structures that could significantly affect highway safety, Structure Inventory and Appraisal (SI&A) information is maintained for selected bridges in the Illinois Structure Information System (ISIS). This section provides information related to the selection of Non-NBIS structures that should be included in the ISIS and the inspection of those structures.

3.11.2 Small Bridge Inspection Program

To address the safety of the smaller structures not subject to NBIS requirements, IDOT developed the Small Bridge Inspection Program (SBIP). For the purpose of establishing inspection policies and procedures for this program, the following definition for small bridge has been established by IDOT:

Small Bridge: A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening, measured along the center of the roadway of 6 feet or greater, but not greater than 20 feet, between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening and at least one of the pipes has an inside diameter of 60 inches or greater.

When measuring the opening referenced in the definition of small bridge, the guidelines provided for determining “AASHTO Bridge Length” (ISIS Item 112) in the IDOT *Structure Information and Procedure Manual* (SIP Manual) should be used. [Figure 3.11-1](#) provides guidance for measuring the AASHTO Bridge Length for multiple-pipe culverts.

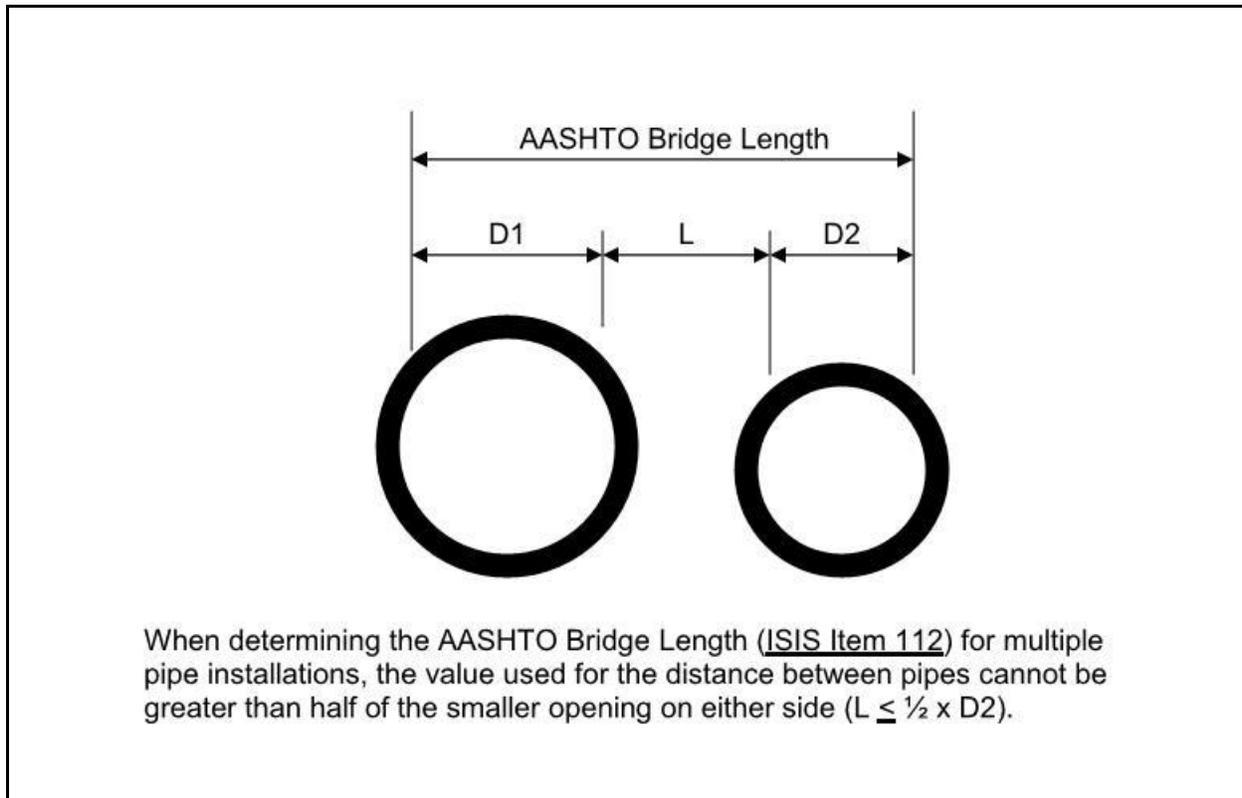


Figure 3.11-1 – Bridge Length for Multi-Pipe Culverts

The SBIP is applicable to all structures under the jurisdiction of IDOT that serve the traveling public. Local public agencies are not required to adopt SBIP for the inspection of structures under their jurisdiction. However, in order to ensure highway safety, local public agencies should perform inspections of the small bridges under their jurisdiction utilizing either SBIP or policies and procedures developed by the agency to specifically address the inspection and safety of the highway system under their jurisdiction.

3.11.2.1 Small Bridge Inventory and Appraisal

All small bridges under the jurisdiction of IDOT must be included in ISIS. The SIP Manual provided by the Office of Planning and Programming should be used for guidance when entering SI&A information. Small bridges must be assigned Structure Numbers (ISIS Item 3 and 8A) using the same format utilized for NBIS bridges.

Although the Region/District may enter all of the information typically required for a bridge to satisfy NBIS requirements, it is not necessary to do so in order to establish a record for a small

bridge in the ISIS. To establish a small bridge record, the following ISIS items are required at a minimum:

Minimum ISIS Items Needed to Issue a Structure Number

- Item 3B (Maintenance County)
- Item 3B1 (Maintenance Township)
- Item 21 (Maintenance Responsibility)
- Item 22A (Reporting Agency)
- Item 41 (Bridge Status)
- Item 42A (Type Service ON)
- Item 42B (Type Service UNDER)
- Item 38 (Navigation Control)

Minimum ISIS Items Needed to Link a Bridge to an Existing Road

- Item 1A (Key Route Type)
- Item 1B (Key Route Number)
- Item 1D (Key Route Appurtenance Type)
- Item 1G (Key Route Station)
- Item 3A (Inventory County)
- Item 12 (Link Indicator)
- Item 28 (Number of Lanes)
- Item 102 (One or Two Way Traffic)

Minimum Items Related to Bridge Characteristics

- Item 6 (Feature Crossed)
- Item 7 (Facility Carried)
- Item 9 (Location Description)
- Item 43A (Main Structure Material)
- Item 43B (Main Structure Type)
- Item 49 (Structure Length)
- Item 62E (Culvert Fill Depth)
- Item 107A (Deck Structure Thickness)

- Item 108D (Total Deck Thickness)
- Item 112 (AASHTO Bridge Length)

Minimum Items Related to Inspection

- Item 58 (Deck Condition)
- Item 59 (Superstructure Condition)
- Item 60 (Substructure Condition)
- Item 61 (Channel & Channel Protection Condition)
- Item 62 (Culvert Condition)
- Item 91 (Inspection Interval)

Load Rating Codes (to be entered by the Bureau of Bridges & Structures)

- Item 63 (Method Used to Determine Operating Rating)
- Item 64B1 (Operating Rating)
- Item 65 (Method Used To Determine Inventory Rating)
- Item 66B1 (Inventory Rating)
- Item 66C (Last Rating Date)
- Item 70 (Bridge Posting Level)
- Item 70A1 (Allowable Single Unit Weight Limit - Tons)
- Item 70A2 (Posted Single Unit Vehicle Weight Limit)
- Item 70B1 (Allowable Combination Vehicle Type 3S-1 Weight Limit)
- Item 70B2 (Posted Combination Vehicle Type 3S-1 Weight Limit)
- Item 70C1 (Allowable Combination Vehicle Type 3S-2 Weight Limit)
- Item 70C2 (Posted Combination Vehicle Type 3S-2 Weight Limit)
- Item 70D1 (Allowable One Truck At A Time (OTAT) Indicator)
- Item 70D2 (Posted One Truck At A Time)

Records related to bridge design plans or as-built plans must be maintained for small bridges. The Bureau of Bridges & Structures maintains an archive of bridge plans, which includes small bridges. The Bureau of Bridges & Structures routinely updates the archive by obtaining plan information prior to the award of contract for the construction of new bridges. However, when a small bridge is constructed as part of a roadway project, rather than as a stand-alone bridge contract, the Bureau of Bridges & Structures relies on the Regions/Districts to identify the small

bridges included in the roadway contract. Regions/Districts must review the contract plans for roadway projects to identify structures that satisfy the definition of small bridge, and information regarding the small bridges must be forwarded to the Bureau of Bridges & Structures for inclusion in their bridge plan archives.

3.11.2.2 Routine Inspections for Small Bridges

In order to ensure highway safety, Routine Inspections must be performed for small bridges. Since many of the small bridges can be classified as culverts, which are buried structures that are somewhat protected from direct contact with traffic and other destructive elements, extended inspection intervals are appropriate for many small bridges that are in good or better condition. Small bridges that cannot be classified as culverts should have inspection intervals consistent with those applicable to larger structures. Inspection intervals for small bridges must not exceed the maximum "Routine Inspection Interval" (ISIS Item 91) provided in this section.

For the purpose of determining inspection intervals for small bridges, a "Buried Structure" is defined as follows:

Buried Structure: A culvert having 2-feet or more of fill, which includes pavement material, base material, and sub-grade, over the highest element of the culvert located within the traveled way and shoulders of the roadway.

"MAIN STRUCTURE TYPE" (ISIS ITEM 43B) CODED "19" or "91" AND "CULVERT FILL DEPTH" (ISIS ITEM 62E) IS 2-FEET OR GREATER	
Condition Rating Assigned to "Culvert Condition" (ISIS Item 62)	Maximum Inspection Interval (months)
"7", "8" or "9" (Good or Better)	72
"5" or "6" (Fair or Satisfactory)	48
"4" (Poor)	24
"3" (Serious)	12
"2" (Critical)	12 or less (See Note 1)
"1" or "0"	Bridge Closed

Table 3.11-2 – Routine Inspection Interval for Buried Structures

Note 1: A maximum Inspection Interval will be determined on a case by case basis after a Load Rating Inspection and analysis has been performed. A Special Inspection may also be required at intervals less than the Maximum Inspection Interval.

"MAIN STRUCTURE TYPE" (ISIS ITEM 43B) NOT CODED "19" or "91" OR "MAIN STRUCTURE TYPE" (ISIS ITEM 43B) CODED "19" or "91" AND "CULVERT FILL DEPTH" (ISIS ITEM 62E) IS LESS THAN 2-FEET	
Lowest Condition Rating Assigned to "Superstructure Condition" (ISIS Item 59) "Substructure Condition" (ISIS Item 60) or "Culvert Condition" (ISIS Item 62)	Maximum Inspection Interval (months)
"5", "6", "7", "8" or "9" (Fair or Better)	48
"4" (Poor)	24
"3" (Serious)	12
"2" (Critical)	12 or less (See Note 1)
"1" or "0"	Bridge Closed

Table 3.11-3 – Routine Inspection Interval for Non-Buried Structures

Note 1: A maximum Inspection Interval will be determined on a case by case basis after a Load Rating Inspection and analysis has been performed. A special Inspection may also be required at intervals less than the Maximum Inspection Interval.

3.11.3 Ancillary Structures

There are many structures serving public highways that are smaller than NBIS bridges and small bridges, as described in the following definition for Ancillary Structures:

Ancillary Structure: A structure, including supports, erected over a depression or an obstruction, such as water, or highway, and having a passageway for carrying traffic or other moving loads, and having an opening, measured along the center of the roadway to be less than 6 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Although statewide policies and procedures for the inspection of Ancillary Structures are not established, IDOT and local public agencies are responsible for the maintenance of the Ancillary Structure under their respective jurisdictions. The policies and procedures employed for addressing Ancillary Structure issues must adequately address highway safety, and each Region/District and local public agency must evaluate how to apply available resources to the task of inspecting, maintaining, repairing, and replacing Ancillary Structures within its jurisdiction.

3.11.4 Structures Not Carrying Public Roadways

It is not uncommon for a structure that does not carry a public roadway to be located over a highway carrying traffic. Prime examples of these types of structures are bridges that carry a railroad or a bicycle/pedestrian trail over a public highway. Since these bridges do not carry public roadways, the NBIS rules are not directly applicable. However, all bridges crossing public roadways must be included in the ISIS to document the vertical and horizontal clearances provided for vehicles passing under the bridge. The tracking of overhead Non-NBIS Structures:

- Assists the jurisdictional agency with monitoring clearances for the movement of Oversize Vehicles and the planning of highway improvement projects
- Satisfies the Federal Highway Administration (FHWA) requirement that vertical and horizontal clearance be included in the ISIS for all bridges crossing the National Highway System (NHS). Information identifying NHS routes is available on the FHWA web site at:

http://www.fhwa.dot.gov/planning/national_highway_system

Although Routine Inspections are not required by federal regulations for Non-NBIS Structures, the agency or entity with ownership of the structure is responsible for ensuring the safety of the

bridge, and this responsibility for safety extends to the protection of traffic traveling under the structure. The following guidance is provided in regards to addressing Non-NBIS Structures crossing over public roadways:

Overhead Structure and Roadway Owned by Same Agency: If IDOT, another state agency, or a local public agency has 1) the jurisdictional responsibility for a public roadway; and 2) the jurisdictional responsibility for a Non-NBIS Structure passing over that roadway, the agency should treat the bridge in the same manner as a structure subject to NBIS regulations. This would entail applying the policies and procedures presented in the IDOT *Structure Information and Procedure Manual* (SIP Manual) to ensure that inventory information is included in the ISIS. Routine Inspections shall be performed at the same interval provided in [Table 3.11-3](#).

The inspection should follow typical NBIS policies for a Routine Inspection except that it may be limited to accessible areas of the structure for a visual assessment. Unless there is a visually apparent concern, a Hands-On Inspection will not typically be required.

IDOT, as well as several other agencies, owns and maintains a number of railroad structures that carry private rail traffic over highways. Inspection of these structures will require contact with the rail company or companies that operate on that line and approval obtained prior to entering their right-of-way. Railroad flagmen may be required by the rail company before inspection of the structure can be performed.

Overhead Structure and Roadway Owned by Different Entities: The Entity with ownership of a Non-NBIS Structure is responsible for establishing policies and procedures that ensure the safety of the structure and that of the persons crossing on and under the bridge. If, during the course of normal operations, IDOT, another state agency, or a local public agency with responsibility for a public roadway passing under a Non-NBIS Structure owned by another entity should note hazardous conditions, the entity with ownership of the structure should be immediately notified of the conditions posing the hazard. The agency with jurisdiction of the roadway should take actions necessary to protect traffic passing under the bridge until the owner of the overhead structure has taken corrective actions.

Overhead Structure Over Non-Public Roadway: If a situation should be presented, such that IDOT or other state agency is the jurisdictional agency for a Non-NBIS Structure, which crosses over a traveled way that is not a public roadway and is under the jurisdiction of another entity, inventory information should be documented and inspections should be conducted as described above for “Overhead Structure and Roadway Owned by Same Agency”.

3.12 Temporary Bridges

The NBIS does not distinguish between permanent and temporary bridges and both are consequently subject to NBIS requirements. The FHWA does recognize that it is not practical to meet all NBIS requirements for bridges that are in service for a very short timeframe. The following are IDOT policies for temporary bridges:

Temporary Bridges that will be open 90 days or more: These bridges are required to follow the same procedures as permanent bridges and will be part of IDOT’s annual National Bridge Inventory data submission to the FHWA. An Initial Inspection must be performed along with Routine Inspections, Underwater Inspections, and Fracture Critical Member Inspections as applicable. If the bridge is Scour Critical, a Scour POA must also be completed for the bridge and any inspections required by the POA must be completed accordingly. The bridge shall be assigned a structure number and all inventory and inspection data must be entered into ISIS. When the bridge is taken out of service, the “Bridge Status” (ISIS Item No. 41) shall be changed to “D” and the structure number cannot be reused.

Temporary Bridges that will be open for less than 90 day: These bridges are only required to have a Routine Inspection completed and documented by a qualified Team Leader prior to the opening of the bridge to ensure the safety of the traveling public. The bridge will not be assigned a structure number and inventory and inspection data will not be entered into ISIS.

3.13 Transit Highways

The FHWA has clarified that the NBIS and National Tunnel Inspection Standards (NTIS) are applicable to highways dedicated to publicly accessible transit vehicles, usually buses carrying

the general public. As such, agencies with jurisdiction over these bridges are subject to the policies set forth in this manual as well as the IDOT *Structure Information and Procedure Manual* (SIP Manual) and AASHTO *The Manual for Bridge Evaluation*.

Section 4 Load Rating

4.1 Supporting Information

4.1.1 Definitions and Terminology

The following is a list of definitions and terminology used throughout this section.

- AASHTO - American Association of State Highway and Transportation Officials
- AASHTO Legal Loads - Legal Loads provided by the AASHTO *The Manual for Bridge Evaluation*.
- ABD Memorandum - IDOT All Bridge Designers Memorandum
- Allowable GVW - The product of the operating rating factor for a given rating vehicle multiplied by the vehicle's GVW.
- ASD - Allowable Stress Design
- ASR - Allowable Stress Rating
- BBS - IDOT, Bureau of Bridges & Structures
- FHWA - Federal Highway Administration, U.S. Department of Transportation
- GVW - Gross Vehicle Weight
- IDOT - Illinois Department of Transportation
- Illinois Statutory Load - The maximum legal load for each vehicle configuration permitted by the Illinois Vehicle Code.
- Inventory Rating - A load carrying capacity rating indicative of the permissible live load to which an existing structure may be routinely subjected for an indefinite period of time for the load configuration used in the rating. The inventory rating is comparable to a level of stress or a level of reliability used for the design of a structure for determining the proportions of main load carrying members.
- ISIS - Illinois Structure Information System
- ISTHA - Illinois State Toll Highway Authority
- ITAP - Illinois Transportation Automated Permit
- LBU - BBS, Local Bridge Unit
- Legal Load - The maximum legal load for each vehicle configuration permitted by State Statutes and Code of Federal Regulations.
- LFD - Load Factor Design

- LFR - Load Factor Rating
- LLDF - Live Load Distribution Factor
- Load Effect - The response (axial force, shear force, bending moment, torque) in a member or an element due to loading on a bridge.
- Load Posting - Signing a bridge for weight restrictions.
- Load Rating - The determination of the safe load capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection.
- LPA - Local Public Agency - includes counties, townships, road districts, municipalities, park districts, forest preserve districts, and conservation districts.
- LRFD - Load and Resistance Factor Design
- LRFR - Load and Resistance Factor Rating
- LRI - Load Rating Inspection
- NBI - National Bridge Inventory - The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards.
- Operating Rating - A load carrying capacity rating indicative of the maximum permissible live load to which the structure may be subjected for the load configuration used in the rating. The operating rating is representative of the maximum load effect that can occasionally be tolerated by a structure without causing appreciable damage. Allowing a structure to be routinely subjected in an unlimited fashion to load effects at the operating level may shorten the life of the structure.
- OTAT - One Truck at a Time
- Owner - Agency having jurisdiction over the bridge.
- Permit Load - A vehicle that exceeds the configuration and gross weight limits established by the Illinois Vehicle Code for unrestricted access to public highways.
- PPC - Precast Prestressed Concrete
- Public Road - Any road or street under the jurisdiction of and maintained by a public authority and open to public travel.
- QA - Quality Assurance
- QC - Quality Control
- Rating Factor - Ratio of reserve capacity to the transient load effects applied to a structural member as further described in [Section 4.3.2](#).
- Routine Permit - A limited continuous operation permit issued by a bridge owner which allows a permit load of a given configuration within specified gross and axle weight limits unlimited bridge crossings over a period of time on specific routes, not to exceed one year.

- Safe Load Capacity - A live load that can safely utilize a bridge.
- SHV - Specialized Hauling Vehicle - Short wheelbase multi-axle trucks used in construction, waste management, bulk cargo, and commodity hauling industries.
- SLRS - Structure Load Rating Summary
- Special Construction Load - Equipment or stockpiled material which has the potential to exceed the safe load capacity of the bridge.
- Special Permit - A permit issued by a bridge owner which allows a permit load of a specific configuration, axle weights, and gross weight a limited number of specified bridge crossings.
- Transient Load - Load that occurs over a short time and will not remain on the bridge indefinitely. Vehicular live loads and their secondary effects, including dynamic load allowance, are transient loads.

4.1.2 Resources

The following is a list of resources referenced throughout this section:

- AASHTO *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges*
- AASHTO *LRFD Bridge Design Specifications* (AASHTO LRFD Specifications) - Edition currently adopted by IDOT
- AASHTO *The Manual for Bridge Evaluation* (AASHTO MBE) - Edition currently adopted by IDOT
- AASHTO *Standard Specifications for Highway Bridges, 17th Edition, 2002* (AASHTO Standard Specifications)
- American Wood Council *National Design Specifications for Wood Construction* (NDS) - Edition currently adopted by IDOT
- Code of Federal Regulations (CFR)
- FHWA *Culvert Inspection Manual - FHWA-IP-86-2*
- FHWA *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD)
- FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (Federal Coding Guide)
- IDOT *Bridge Manual*
- IDOT *Bureau of Design and Environment Manual* (BDE Manual)
- IDOT *Bureau of Local Roads and Streets Manual* (BLRS Manual)
- IDOT *Culvert Manual*

- IDOT *Oversize and Overweight Permit Movements on State Highways*
- IDOT *Structure Information and Procedure Manual* (SIP Manual)
- Illinois Compiled Statutes (ILCS)
- Illinois Highway Code - 605 ILCS 5
- *Illinois Supplement to the National Manual on Uniform Traffic Control Devices* (IMUTCD)
- Illinois Vehicle Code - 625 ILCS 5
- National Bridge Inspection Standards (NBIS) - 23 CFR 650(C)
- Structural Engineering Practice Act (SE Act) - 225 ILCS 340

4.1.3 Purpose and Goals

The purpose of this section is to supplement the AASHTO MBE with IDOT policies, procedures, and guidelines for load rating bridges. The goals of load rating bridges are to ensure public safety, prevent structural damage, and assist in the evaluation of programming needs. By determining the safe load capacity of bridges, agencies are able to:

- Comply with federal regulations and state statutes
- Evaluate the as-built condition of a bridge
- Evaluate the effects of bridge damage and deterioration
- Establish appropriate bridge weight restrictions
- Evaluate the movement of vehicles that do not conform to the Illinois Vehicle Code
- Evaluate the feasibility of proposed structural modifications

4.1.4 Load Rating Regulations

4.1.4.1 Federal Regulations

Federal regulations governing load ratings are included in the Code of Federal Regulations (CFR) under the NBIS. The NBIS requires all bridges on public roads be load rated and posted in accordance with the AASHTO MBE.

The NBIS also requires each agency prepare and maintain an inventory of all bridges subject to the NBIS, which includes load rating and load posting data. IDOT maintains this inventory in a database referred to as the Illinois Structure Information System (ISIS). ISIS data is annually provided to the FHWA for updating the NBI.

4.1.4.2 State Statutes

State statutes governing load ratings in Illinois are included in the Illinois Compiled Statutes (ILCS) under the Illinois Vehicle Code, the Illinois Highway Code, and the Structural Engineering Practice Act of 1989 (SE Act).

The Illinois Vehicle Code and Illinois Highway Code assign responsibility to IDOT for the load rating and load posting of bridges on state and LPA highways, without regard to highway jurisdiction or bridge ownership. For bridges on tollways, load ratings and load postings are the responsibility of the bridge owner, but coordination with IDOT is still required.

The Illinois Vehicle Code defines the size and weight limitations of vehicles allowed to have unrestricted access to Illinois highways. The Illinois Vehicle Code grants authority to highway and bridge owners to issue permits to vehicles exceeding these limitations.

The SE Act requires the individual with overall responsibility for the load rating inspection, load rating analysis, and load posting recommendations to be licensed in the State of Illinois as a Structural Engineer.

4.1.5 Structures Requiring Load Ratings

Load ratings are required for all structures on public roads meeting the NBIS definition of a bridge, regardless of jurisdiction.

To provide an increased level of safety, IDOT has developed the Small Bridge Inspection Program. Under these provisions, a load rating is required for all structures under IDOT jurisdiction with a clear span length of six feet or greater. Although these provisions are only required for structures under IDOT jurisdiction, other agencies are encouraged to take measures to inventory and assess the safe load capacity of smaller structures not covered by the NBIS. Additional information on the program can be found in [Section 3.11.2](#).

4.1.6 Load Rating Software

Load ratings of bridges on state and LPA highways, regardless of jurisdiction, should be completed, when possible, using AASHTOWare Bridge Rating™ (BrR) software in order to be

compatible with the ITAP system and other software used by IDOT. If a load rating cannot be performed using AASHTOWare BrR, the BBS must be contacted to determine an acceptable alternative.

4.2 Quality Control and Quality Assurance

Quality Control (QC) and Quality Assurance (QA) are established procedures used to ensure load ratings are accurate and comprehensively evaluate the safe load capacity of bridges.

QC procedures must ensure:

- Load ratings are certified by an Illinois Licensed Structural Engineer.
- Load ratings are completed using an independent load rater and reviewer.
- Staff performing and checking the load ratings are appropriately qualified.
- Records are maintained documenting the load rating calculations, assumptions made, specifications used, and identify the staff performing the load rating.

QA procedures must ensure:

- All established QC procedures have been followed.
- Load rating conclusions are reasonable given the bridge type and condition.
- The load rating has been certified and documented using the appropriate IDOT forms.

4.2.1 Staff Qualifications

Load rating QC/QA procedures require contributions from an independent load rater and reviewer. The Engineer of Record must act as either the load rater or reviewer and must be an Illinois Licensed Structural Engineer. Both of these individuals must be familiar with standard load rating procedures, IDOT policies regarding load ratings, and the requirements of the AASHTO MBE.

The load rater is the individual directly responsible for the analysis and calculations required to determine the safe load capacity of the bridge. The actions of the load rater contribute to the QC of the load rating.

The reviewer is the individual providing oversight and ensuring the QC procedures were followed during the load rating. The reviewer is also responsible for ensuring the load rating conclusions are reasonable given the bridge type and condition. The reviewer must be an Illinois Licensed Structural Engineer unless the load rater acts as the Engineer of Record, in which case it is acceptable for the reviewer to be an Illinois Licensed Professional Engineer. The actions of the reviewer contribute to the QA of the load rating.

The Engineer of Record is the Illinois Licensed Structural Engineer who seals the load rating. In accordance with the SE Act, the load rating must be prepared by or under the structural engineer's supervision.

4.2.2 Documentation and Deliverables

The primary documentation of a load rating is IDOT Form BBS 2795, "Structure Load Rating Summary" (SLRS). The purpose of the SLRS is to provide documentation a load rating was performed, with a brief summary of its findings. The SLRS must be sealed by an Illinois Licensed Structural Engineer. The original SLRS shall be kept by the BBS in the load rating file. Regardless of the bridge owner or highway system carried by the bridge, a SLRS must be submitted to IDOT for every load rating performed.

When load ratings of bridges on state and LPA highways (excluding bridges owned by border states and federal agencies) are not completed by IDOT, the SLRS, load rating calculations, AASHTOWare BrR and/or other applicable software files, as-built bridge plans, and shop drawings, when applicable, shall be submitted to the BBS. Documentation of IDOT's concurrence with the load rating will be returned to the owner for inclusion in the bridge file. IDOT will update ISIS based on information on the SLRS.

For tollway bridge load ratings, a SLRS, sealed by an Illinois Licensed Structural Engineer, must be submitted to the BBS. IDOT concurrence is not required and the SLRS will serve as documentation a load rating was completed and the basis for updating ISIS.

4.3 General Requirements

Load ratings shall be completed using US Customary Units regardless of the units used in the original bridge plans. See [Appendix A-11](#) for IDOT reinforcement bar conversion standards.

4.3.1 Evaluation Methods

The AASHTO MBE provides both analytical and empirical methods for load rating bridges. The analytical methods include:

- Allowable Stress Rating (ASR)
- Load Factor Rating (LFR)
- Load and Resistance Factor Rating (LRFR)

The empirical methods include:

- Load ratings based on load testing
- Approximate load ratings based on rational criteria

Load ratings shall be completed using analytical methods when possible. Empirical methods should only be used when no plans are available for reinforced concrete bridges or masonry bridges, load testing has been performed, or an analytical load rating results in a less severe restriction than preferred given the condition of the structure. The BBS must concur with the use of empirical methods.

The evaluation method used depends on several factors including:

- Member(s) or bridge type being evaluated
- AASHTO specification used to design the bridge initially
- Bridge material type
- Availability of original design and rehabilitation plans and specifications

If existing plans cannot be located, the BBS shall be contacted for guidance on the load rating. Historic IDOT manuals, standards, and manufacturer's details may be used to augment empirical evaluations. A load rating inspection may be needed to verify the required measurements prior to these aids being used.

4.3.2 Rating Factors

A rating factor is a numerical representation of a bridge’s capacity to safely carry a specific transient load having a defined magnitude and dimensional configuration. The general load rating equation for an individual load carrying member can be expressed as:

$$RF = \frac{(C - DL)}{(LL + IM)}$$

Where:

RF = Rating Factor

C = Capacity of load carrying member

DL = Load effect of all permanent loads

LL = Load effect of transient load

IM = Impact or dynamic load allowance, when applicable

An inventory load rating is comparable to a level of stress or reliability used during the design of a bridge to determine the proportions of load carrying members. An operating load rating is representative of the maximum load effect that can occasionally be tolerated by a bridge without causing appreciable damage. The specific ASR, LFR, and LRFR rating factors at inventory and operating levels are as follows:

ASR:

$$RF_{INV} = \frac{(C_{INV} - DL)}{(LL + IM)}$$

$$RF_{OPR} = \frac{(C_{OPR} - DL)}{(LL + IM)}$$

LFR:

$$RF_{INV} = \frac{(C - 1.3 \cdot DL)}{2.17 \cdot (LL + IM)}$$

$$RF_{OPR} = \frac{(C - 1.3 \cdot DL)}{1.3 \cdot (LL + IM)}$$

LRFR:

$$RF_{INV} = \frac{(C - \gamma_{DC}DC - \gamma_{DW}DW \pm P)}{\gamma_{LL(INV)}(LL + IM)}$$

$$RF_{OPR} = \frac{(C - \gamma_{DC}DC - \gamma_{DW}DW \pm P)}{\gamma_{LL(OPR)}(LL + IM)}$$

Where:

- C_{INV} = Allowable capacity of load carrying member - inventory level
- C_{OPR} = Allowable capacity of load carrying member - operating level
- DC = Dead load effect due to structural components and attachments
- DW = Dead load effect due to wearing surface and utilities
- P = Permanent loads other than dead loads such as locked in force effects from the construction process
- γ_{DC} = LRFR load factor for structural components and attachments
- γ_{DW} = LRFR load factor for wearing surface and utilities
- $\gamma_{LL(INV)}$ = LRFR load factor for live load - inventory level
- $\gamma_{LL(OPR)}$ = LRFR load factor for live load - operating level

See AASHTO MBE for more detailed information on calculating rating factors.

In order to determine a bridge's rating factor for a specific transient load, a rating factor must be calculated for each load effect of each load carrying member in the bridge. The smallest of these factors is the bridge's rating factor for that specific transient load, and the corresponding load carrying member is the controlling member. This process is repeated for several different transient loads. Bridges are limited to maximum inventory and operating rating factors of 2.74 as a practical limit. Per the Federal Coding Guide, a rating factor of 2.75 shall only be used when the bridge is subject to insignificant live load, such as culverts under large fill depths.

4.3.3 Rating Factor Variables

Accurately defining the variables necessary to calculate rating factors is essential for completing a quality load rating. This information can be obtained from sources including but not limited to:

- Original design and rehabilitation plans and specifications
- As-built plans and shop drawings
- Construction records
- Load rating inspection documentation
- Routine Inspection reports
- Special Inspection reports

4.3.3.1 Load Rating Inspection

Before a load rating is started, the load rating team reviews existing documentation and determines if a Load Rating Inspection (LRI) is necessary. This inspection may be performed by the load rating team or delegated to a separate inspection team. At a minimum, the LRI must:

- Confirm the condition and dimensions of the primary load carrying members
- Confirm the bridge geometric dimensions
- Confirm the presence, magnitude, and location of permanent loads with particular attention paid to utilities, attachments, and thickness of wearing surface
- Document any deterioration or repairs made to primary load carrying members

If necessary, the load rating team will discuss specific information to be collected or verified and how the information is to be documented. [Section 2.3](#) contains information on recommended procedures for documenting LRI findings.

Additional information on LRIs can be found in [Section 3.3.9](#).

4.3.3.2 Load Carrying Member Properties

Section and material properties of load carrying members are required to calculate the capacities of individual members and to determine load effects throughout the bridge.

4.3.3.2.1 Section Properties

Section properties are typically calculated using dimensions given in existing plans when available. Information taken from existing plans and the condition of the load carrying members may need to be field verified. If load carrying members are damaged or deteriorated, the section properties shall be modified accordingly. Unsound material is excluded from section property calculations.

If existing plans are not available, an LRI may be required to determine the section properties. Although devices are available for estimating the location and size of reinforcement bars, IDOT has not found these to be sufficiently reliable and has not adopted this technology for determining the section properties of reinforced concrete members. If section properties cannot be calculated or estimated with reasonable confidence, empirical methods may be used.

4.3.3.2.2 Material Properties

Material properties are based on information provided in the existing plans and specifications when available. If existing plans are not available, the historic material properties presented in [Appendix A-11](#) shall be used.

It is reasonable to expect the original material properties of sound structural steel or iron have not changed. However, the strength of some sound materials, such as concrete or timber, may have changed over time. Material testing may justify using higher or lower strengths than originally expected.

4.3.4 Load Carrying Member Policies and Guidelines

Experience with load rating different types of load carrying members has led IDOT to develop various policies and guidelines, which are included in the following sections. The policies recognize it is not necessary to load rate every load carrying member on a bridge. However, it is the responsibility of the load rater to review the bridge's structural system and make the final determination if a load carrying member can be safely excluded from a load rating.

In general, policies and guidelines stated in the IDOT *Bridge Manual* for bridge design are also applicable for load ratings.

4.3.4.1 Decks

4.3.4.1.1 Concrete and Metal Decks

Concrete decks and metal decks supported by primary load carrying members typically do not need to be load rated. A deteriorated concrete deck or metal deck is usually a maintenance issue that requires patching or shielding to protect areas below the deck.

When concrete decks and metal decks are not maintained and have deteriorated to the point where weight restrictions need to be considered, the BBS shall be contacted for guidance.

The following are IDOT policies regarding concrete and metal deck load ratings:

Concrete Cracks: When a concrete deck is load rated, the Crack Control Parameter (ASR and LFR) and Exposure Factor (LRFR) are typically 130 k/in and 0.75, respectively, for the top reinforcement in the deck based on severe exposure condition.

Decks with Overlays: When a deck is load rated, the structural thickness of the deck is the thickness remaining after scarification. The overlay thickness shall not be included when calculating the section properties of the deck unless it meets the requirements given in [Section 4.3.4.2](#) for Concrete Deck-Slabs with Concrete Overlays. The weight of the overlay shall be accounted for accordingly.

4.3.4.1.2 Timber Decks

Timber plank decks supported by primary load carrying members must be included in a load rating.

Special attention is given to:

- Deteriorated timber planks
- Decks without running boards
- Decks with narrow running boards (Running boards are not expected to distribute wheel loads unless they are a minimum width of 2'-6" for each wheel path)

The following are IDOT policies regarding timber deck load ratings:

Load Rating Guidelines: Timber deck load ratings follow the procedures in the USDA Forest Service *Timber Bridges Design, Construction, Inspection, and Maintenance*.

Wheel Load Distribution: The distribution of wheel loads shall be determined based on loading and effective tire width. BBS practice is to distribute the wheel load to a single deck plank, except where running boards are present. When running boards are present, the wheel load is distributed vertically through the running boards at a 45° angle.

4.3.4.2 Superstructures

The following are IDOT policies regarding superstructure load rating:

Concrete Deck-Slabs with Concrete Overlays: When a superstructure with a scarified deck-slab and hard concrete overlay is judged to act composite with the original deck, the actual scarified deck and overlay thicknesses will be used as tributary for dead loads. The deck structural thickness will be the original, pre-scarification structural thickness.

A concrete overlay considered to act composite with the original deck-slab is expected to have the following characteristics:

- Scarification was performed with hydro-scarification. This is the case for scarification on state highway system bridges since 2003 inclusive. Prior to 2003, hydro-scarification would be indicated as a separate pay item on the overlay plans.
- The concrete overlay is in good condition, including physical structure and adherence to the original slab.

Future Wearing Surface: Future wearing surface is only included when evaluating the original superstructure design. Other load ratings only include the wearing surfaces currently in place or that will be constructed when evaluating a proposed overlay project.

Vehicle Lanes/Live Load Distribution: When performing load ratings, the number of traffic lanes to be loaded, and the transverse placement of wheel lines, shall be in conformance with the current AASHTO Standard Specifications or AASHTO LRFD Specifications and the following:

- Roadway widths from 18 to 24 feet shall have two traffic lanes, each equal to one half the roadway width.
- Roadway widths less than 18 feet shall have one traffic lane only.
- Timber decks with running boards shall have one traffic lane for every pair of running boards.

However, the following alternatives may be used with approval from the BBS:

- When lane striping is present: The number of traffic lanes and transverse placement of wheel lines may be determined by placing truck loads only within the striped lanes. When load rating a structure based on the existing striped lanes, the transverse positioning of the truck shall include placing the wheel load anywhere within the lane, including on the lane stripe.
- When lane striping is not present: If ADT is less than 2000 and ADTT is less than 400, one traffic lane may be used.
- The BBS does not allow these alternatives for the Design Vehicle.

The exterior beam LLDF shall be computed using the Lever Rule exclusively for the purposes of load ratings.

Exterior and Interior Beams: Both the exterior and interior beams of multi-beam superstructures shall be evaluated in a load rating. However, if the analysis results in the exterior beam governing and a restriction is required, the analysis can be refined by limiting the application of the vehicular live load(s) to the actual striped lanes. In some cases, the exterior beam can be neglected or omitted from the load rating. Examples of this would be physical traffic control devices installed to deter traffic or an approach roadway width that is less than the width of the bridge roadway.

4.3.4.2.1 Cast-in-Place Concrete Superstructures

Cast-in-place concrete is used in a variety of superstructure systems. The stringers, beams, and girders in these superstructure systems are primary load carrying members and shall be evaluated in the load rating.

Concrete bridges constructed after the early 1940's generally used air entrainment in the concrete mix to improve the long-term freeze/thaw durability of the bridge. Bridges constructed prior to this date did not use air entraining agents and generally can exhibit significant concrete deterioration due to internal damage caused by freeze/thaw cycles. Cores were taken on many state owned concrete bridges built prior to the 1940's. The BBS should be contacted to verify if core reports and strengths are available.

4.3.4.2.2 Precast Concrete Superstructures

Precast concrete beams are commonly referred to as "Channel Beams", "Nelsen Beams", "Midwest Beams", or "Precast Concrete Bridge Slabs". They are primary load carrying members and shall be evaluated in the load rating.

IDOT uses the same policies regarding live load distribution factors for precast concrete superstructure load ratings as precast prestressed concrete box beams given in [Section 4.3.4.2.4](#).

4.3.4.2.3 Precast Prestressed Concrete Superstructures

Precast prestressed concrete (PPC) is used in a variety of superstructure systems. These systems are primary load carrying members and shall be evaluated in the load rating. When present, diaphragms between the beams are included in the analysis model but are typically not evaluated in the load rating.

The following are IDOT policies regarding PPC superstructure load ratings:

Beam Deterioration: Policies for load rating PPC box beams given in [Section 4.3.4.2.4](#) are also applicable to other PPC superstructures. Deterioration in PPC box beams is more prevalent due to the tendency for shear key leakage. PPC superstructures can

also be exposed to deicing agents, especially below deck drains, scuppers, and leaking expansion joints.

Shear: The 1994 & 2003 IDOT *Precast Prestressed Concrete Design Manual* directed engineers to neglect prestressing force effects when designing shear reinforcement in the negative moment region of continuous spans. Although not allowed by design, many beams were fabricated with non-conforming shear stirrup spacing, which were then reanalyzed using prestressing force effects to justify use in construction. For all precast prestressed concrete beams, IDOT load rating policy uses the contribution of prestressing force effects, even if neglected in the original design. In addition, the method for design of shear reinforcement presented in the 1979 Interim AASHTO *Standard Specifications for Highway Bridges* is not allowed for load rating.

4.3.4.2.4 Precast Prestressed Concrete Box Beams (Deck Beams)

PPC box beams (deck beams) are primary load carrying members and shall be included in the load rating.

Special attention is given to:

- Areas of delaminated concrete
- Areas of inadequate concrete cover
- Areas of longitudinal cracking
- Areas of transverse cracking
- Areas with spalls, exposed stirrups, or exposed prestressing strands
- Performance of grouted shear keys between beams

The following are IDOT policies regarding PPC box beam load ratings:

Beam Deterioration: Some PPC box beams have exhibited rapid deterioration rates. IDOT sponsored the University of Illinois at Urbana-Champaign to research this issue. The main finding of the research was once corrosion has initiated within a prestressing strand, the rate of corrosion is sufficient to expect the strand has lost the ability to carry load. In addition, if a strand is in the vicinity of corroding conventional reinforcement (stirrups, welded wire fabric, etc.), that strand is expected to be corroded as well.

IDOT developed guidelines for estimating strand loss in PPC box beams. These guidelines are documented in the IDOT *Guidelines for Estimating Strand Loss in PPC Deck Beam Bridges*, which is included in [Appendix A-10](#).

Live Load Distribution Factors: For LFR, there are two primary methods used to calculate LLDF's for PPC box beams in Illinois: AASHTO *Standard Specifications for Highway Bridges 13th Edition* (AASHTO 1983) and *17th Edition* (AASHTO 2002). AASHTO 2002 is similar to current design practice and is generally more conservative for wider bridges (greater than or equal to 30 feet), while AASHTO 1983 is more conservative for narrower bridges (less than 30 feet). Thus, the preference is to use AASHTO 2002 for state bridges and AASHTO 1983 for LPA bridges as described below:

- For state owned bridges being evaluated using LFR, the LLDF shall be calculated using AASHTO 2002, Section 3.23.4.
- For LPA bridges being evaluated using LFR, the LLDF shall be calculated using AASHTO 1983, Section 3.23.4. AASHTO 2002 shall only be used if specified on the existing bridge plans.

4.3.4.2.5 Steel Superstructures

Steel is used in a variety of superstructure systems. The stringers, beams, girders, floorbeams, diaphragms, and crossframes on curved bridges are primary load carrying members and shall be evaluated in the load rating. Diaphragms and crossframes on straight bridges are included in the analysis model but are typically not evaluated in the load rating.

Special attention is given to:

- Fracture critical members
- Members with noted section loss

The following are IDOT policies regarding steel superstructure load ratings:

Plastic Capacity: The use of plastic capacity in steel members is not allowed when existing plans cannot be located or for steels with F_y greater than 70ksi. The use of

plastic capacity is not allowed when load rating LPA bridges without approval from the LBU.

Moment Redistribution: Moment redistribution in continuous steel members shall not be used.

Beam Splices: Steel beam splices are typically not evaluated in the load rating.

Bearing Stiffeners: Bearing stiffeners are included in the analysis model but are typically not evaluated in the load rating.

Fatigue and Serviceability: Load ratings of steel members generally do not evaluate fatigue, overload, and live load deflections.

Cover Plates: The length used for analysis of cover plates is shorter than the actual end-to-end cover plate length. The Theoretical End of Cover Plate location is reduced 1.5 times the full width of the cover plate as shown in [Figure 4.3-1](#).

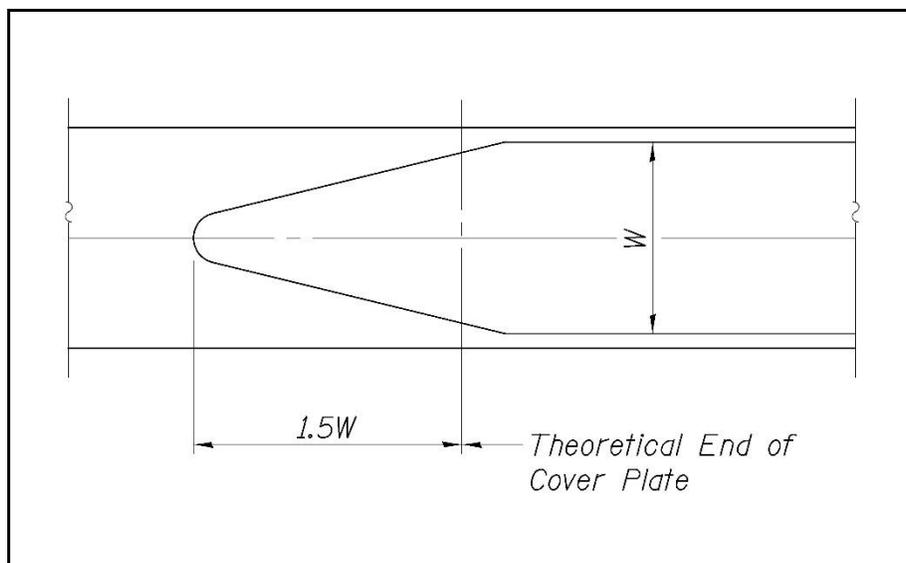


Figure 4.3-1 – Theoretical End of Cover Plate

Section Loss: When the steel superstructure condition rating drops due to section loss caused by corrosion, the IDOT SIP Manual allows the condition rating to be raised back to the previous rating if:

- Design load rating inventory rating factor is greater than or equal to 1.00 (considering section loss)
- Corroded area is cleaned and painted

This may only be done with the approval of the BBS.

4.3.4.2.6 Trusses

Unless a structural analysis has identified a specific truss member as a non-load carrying member, all elements of steel trusses (including gusset plates and other connection elements) are considered primary load carrying members and shall be evaluated in the load rating. Tension members and floor beams of steel trusses are fracture critical members and may be given special attention.

The following are IDOT policies regarding steel truss load ratings:

Rating Method: Currently the main load rating method is LFR. Rating methods other than LFR are only allowed with approval from the BBS.

Dead Load Forces: IDOT uses a minimum dead load factor of 0.90 when the dead load acts to reduce the overall loading (i.e. the dead load and live load are acting in opposite directions). The maximum dead load factors shall be as defined in the AASHTO MBE.

Live Load Force Effects: Live load force effects may be determined by either the maximum envelope method or concurrent force method. The maximum envelope method should be used for the individual member rating checks. However, using the maximum envelope method for the overall gusset plate shear rating checks may be unconservative and the concurrent force method should therefore be used.

Both maximum enveloped force effects and concurrent force effects can be attained using the AASHTOWare BrR software.

Additional policies specific to gusset plates:

Shear Reduction Factor, Ω : For the shear reduction factor, Ω , the BBS recommends using $\Omega = 0.88$ for typical cases. This factor can vary from 0.74 to 1.00 and a more refined analysis may provide more favorable results. The BBS must approve the use of a factor other than 0.88.

Slip Critical Connections: Slip critical considerations need not be considered in the gusset plate load rating.

Partial Shear Planes: Based on research conducted on behalf of IDOT, the partial shear plane checks within the 2014 AASHTO MBE Interims may be overly conservative in some instances. Therefore, if partial shear plane checks control a load rating, a more refined analysis shall be performed.

Load Distribution between Gusset Plates: There are typically two gusset plates at each panel point node location; an inside gusset plate and an outside gusset plate. In some instances, there are multiple gusset plates on each side. Generally, half the loads shall be distributed to the inside gusset plate(s) and half to the outside gusset plate(s). However, for gusset plates with resulting substandard load ratings, load redistribution between inside and outside gusset plates at a given node may be based on the remaining capacity of each gusset plate(s).

The BBS uses a maximum redistribution of 30% of the load carried by the gusset plate(s) on one side of the member to the gusset plate(s) on the other side of the member. Under the design assumption of the gusset plates(s) on one side carrying 50% of the load, the maximum redistribution would result in the gusset plate(s) on the stronger side carrying a maximum of 65% of the total load and the gusset plate(s) on the weaker side carrying a minimum of 35% of the total load. If other load redistribution techniques are used, it must be with the approval of the BBS.

Section Loss: Load rating of the gusset plates for section loss shall be based on the AASHTO MBE procedures. However, when the AASHTO MBE procedures conclude the gusset plate is the controlling member, a more refined analysis is used. Procedures for the refined section loss calculations are outlined in the IDOT *Gusset Plate Evaluation Guide* (see "Refined Analysis Load Ratings" policy). If this refined section loss method is utilized, it must be done with approval from the BBS.

If there is no recorded corrosion of the gusset plates, splice plates, or fasteners, the load rating need not consider section loss. If there is recorded corrosion of the gusset plates, splice plates, and/or the fasteners, the load rating shall reduce the areas and capacities of the affected members to account for the greater of:

- The actual section loss based on the detailed measurements
- An assumed minimum section loss of 10%

If the member section loss is not proportional between the inside plate(s) and the outside plate(s), the load distribution between the plates must be verified (see “Load Distribution between Gusset Plates” policy).

Refined Analysis Load Ratings: The *Gusset Plate Evaluation Guide* prepared for IDOT by Wiss, Janney, Elstner Associates, Inc. provides examples to assist load raters with the refined analysis of gusset plates. This guide is available on the IDOT website under the “Bridges & Structures” and “Ratings” tabs:

<http://www.idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/index>

Other refined analysis approaches, including the Truncated Whitmore Section method, are also acceptable.

4.3.4.2.7 Cables and Hangers

Cables and hangers, along with their anchorage and end connections, are structural elements typically found in suspension and tied arch bridges. They are primary load carrying members and shall be evaluated in the load rating. Unless designed to provide load path redundancy, these are fracture critical members and may be given special attention.

4.3.4.2.8 Pin and Link Connections

Pin and link plates as part of a pin and link connection are primary load carrying members and shall be evaluated in the load rating.

4.3.4.2.9 Arches

Arches utilize various types of material and construction techniques. The arch is a primary load carrying member and shall be evaluated in the load rating.

Although some arches may not be considered a culvert, the FHWA *Culvert Inspection Manual* provides information relating the observed field conditions of arches to structural deficiencies. This information can be useful in identifying conditions indicative of reduced load carrying capacity.

4.3.4.2.10 Precast Concrete Three-Sided Structures

Precast concrete three-sided structures are produced under several different proprietary names. They are primary load carrying members and shall be evaluated in the load rating. The initial load rating is typically provided by the manufacturer. In order to effectively evaluate these members, future load ratings must utilize software programs that take into account the soil structure interaction.

4.3.4.3 Substructures

Substructures are generally excluded from the load rating. However, the condition and configuration must be reviewed to confirm the primary load carrying members of the substructure can be safely excluded from the load rating.

4.3.4.3.1 Abutment and Pier Caps

Abutment and pier caps can be made of steel, concrete, or timber. These are primary load carrying members and shall be evaluated in the load rating when the following conditions are observed:

- Pile deterioration affecting the ability to adequately support the cap
- Deteriorated areas of timber caps (identified by sounding or coring)
- Deteriorated areas of concrete cap with exposed reinforcement bars
- Concrete caps with flexure or diagonal shear cracks (width greater than 0.012 inches)
- Steel caps determined to be fracture critical members

- Deteriorated areas of steel caps with measurable section loss
- Loss of bearing area

4.3.4.3.2 Cantilever Abutment and Pier Caps

Cantilever abutment and pier caps are typically made of reinforced concrete. These are primary load carrying members and shall be evaluated in the load rating when the following conditions are observed:

- Exposed tension or shear reinforcement
- Flexure or diagonal shear cracks (width greater than 0.012 inches)
- Loss of bearing area

4.3.4.3.3 Piles

Typical pile types in Illinois include timber, precast concrete, metal shell, and steel H-piles. When piles are not exposed, they are excluded from the load rating. When piles are exposed, they shall be evaluated in the load rating when the following conditions are observed:

- Scour has exposed the pile(s) under a footing
- Section loss due to damage or deterioration

Deterioration of timber piles is a major factor in the load posting and closure of LPA bridges.

4.3.4.3.4 Scour

Scour is the leading cause of bridge failure. The loss of material supporting the bridge foundation can affect the stability of the bridge as well as the safe load capacity of the foundation. The effects of scour must be accounted for in the load rating.

4.3.4.4 Culverts

Individual elements of a culvert barrel are the primary load carrying members and shall be evaluated in the load rating. Wingwalls and headwalls are not evaluated in the load rating.

4.3.4.4.1 Concrete Box Culverts/Rigid Frames

Reinforced concrete box culverts can be cast-in-place or precast. The top slab and sidewalls are the primary load carrying members and shall be evaluated in the load rating. Bottom slabs are typically excluded from the load rating. If existing plans cannot be located, the load rating shall be based on empirical methods. Empirical methods may also be used to evaluate culverts with 2.0 feet or more of fill depth, even when existing plans are available.

The following are IDOT policies regarding reinforced concrete box culvert load ratings:

Barrel Walls: When the top slab is simply supported, the exterior and interior walls are typically excluded from the load rating. If the condition rating of the culvert is “4” (Poor) or less and the walls have horizontal cracks or show signs of distortion, the load rating of the culvert should be based on the lower of:

- Rational evaluation method ([Table 4.4-5](#))
- Analytical top slab load rating

For rigid frames (i.e. moment connection between slab and wall) the walls shall be evaluated in the load rating regardless of condition.

Negative Moment Reinforcement: If the existing plans of a multi-cell box culvert do not detail negative moment reinforcement and if a construction joint is detailed directly over the interior wall(s), the culvert shall be evaluated as multiple single cells.

Fill Heights: Load ratings shall consider both maximum and minimum fill heights, within the travel way, as shown on existing plans or as measured in the field.

Shear: Shear shall be evaluated for the top slab.

4.3.4.4.2 Concrete Pipe Culverts

Regardless of the shape of the concrete pipe culvert, the pipe walls are the primary load carrying members and must be evaluated in the load rating. These load ratings are typically based on empirical methods.

4.3.4.4.3 Metal Pipe Culverts

The corrugated metal walls are the primary load carrying members in a metal pipe culvert and shall be evaluated in the load rating. The National Corrugated Steel Pipe Association (NCSPA) *Design Data Sheet No. 19: Load Rating and Structural Evaluation of In-Service, Corrugated Steel Structures* and the AASHTO Standard Specifications are the basis for load rating of metal pipe culverts.

The deflected shape of the culvert, distress at the joints of adjoining plates, and section loss must be included in the load rating. Both minimum and maximum fill depths must be considered. Impact shall be included for fill heights less than 3 feet. Rating factors can be controlled by either the structural capacity of the metal walls or the minimum cover.

4.3.4.4.4 Masonry Culverts

Masonry culverts are typically box-shaped or arch-shaped. The sides of boxes, arches, and arch supports are the primary load carrying members and shall be evaluated in the load rating.

4.4 Design and Legal Load Ratings

A design load rating is the evaluation of a bridge's safe load capacity relative to the design live load defined as HS20 (ASR or LFR) or HL93 (LRFR). This evaluation is completed at both the inventory and operating levels. Regardless of what load or specification the original bridge was designed to, the design load rating shall be based on the HS20 or HL93 vehicle to provide a consistent basis of comparison across the nation.

A legal load rating is the evaluation of a bridge's safe load capacity relative to the Illinois Statutory Loads defined in the Illinois Vehicle Code. The purpose of a legal load rating is to determine if a weight restriction, to either Legal Loads Only or below legal loads, is required.

4.4.1 Assignment of Responsibility

IDOT's responsibility for load ratings is granted by 625 ILCS 5/15-317.

4.4.1.1 State Bridges

State bridges are those under the jurisdiction of IDOT, and include structures covered by the IDOT Small Bridge Inspection Program.

Design and legal load ratings for state bridges are typically completed by IDOT staff. When load ratings are completed by consulting engineers, IDOT must concur with the load rating and any subsequent weight restrictions.

4.4.1.2 Local Public Agency Bridges

Local Public Agency (LPA) bridges include those under the jurisdiction of counties, townships, road districts, municipalities, park districts, forest preserve districts, and conservation districts.

Design and legal load ratings for all new construction, rehabilitations, and other work affecting the safe load capacity of a LPA bridge must be completed by the LPA or their designated representative.

IDOT typically assists LPAs in completing design and legal load ratings for damaged or deteriorated bridges. The LBU monitors bridge condition ratings in ISIS and automatically schedules a load rating for bridges meeting the requirements of [Section 4.4.2.2.2](#). LPAs may also request load rating assistance from IDOT by submitting IDOT Form BLRS 06510, "Local Agency Load Rating Request". If a rapid response is critical, the LBU shall be contacted directly to notify them of the situation.

Due to limited resources, IDOT is typically not able to assist LPAs with load rating major bridges requiring under bridge inspection equipment or man-lifts to inspect, or bridges serving high traffic volume roadways requiring traffic control to safely inspect. In these cases, the load rating must be completed by the LPA or their designated representative.

IDOT must concur with load ratings completed by LPAs or their designated representative and any subsequent weight restrictions. Maintaining documentation of IDOT concurrence with weight restrictions is especially important for effective enforcement of load postings.

4.4.1.3 Other Bridges

Other bridges include those which are not under IDOT or LPA jurisdiction. Border state bridges are those with maintenance responsibility assigned to the adjacent state. These bridges may or may not carry state or LPA highways.

Design and legal load ratings for bridges not under IDOT or LPA jurisdiction must be completed by the bridge owner or their designated representative. Except for bridges owned by border states or federal agencies, IDOT must concur with the load rating and any subsequent weight restrictions if the bridge serves a state or LPA highway. Maintaining documentation of IDOT concurrence with weight restrictions is especially important for effective enforcement of load postings. Load ratings and weight restrictions for bridges not serving state or LPA highways do not require IDOT concurrence.

Regardless of the owner or the highway system, all load ratings and any weight restrictions must be submitted to IDOT for inclusion in ISIS.

4.4.2 Load Rating Frequency

4.4.2.1 Initial Load Rating

All new bridges and new structures in the NBI or covered by the IDOT Small Bridge Inspection Program require an initial analytical load rating. For practical reasons, the initial load rating is typically performed as part of the design process. The variables used in the initial load rating must then be verified with the as-built bridge. If variations are noted affecting the safe load capacity of the bridge, a new load rating must be completed, documented, submitted to the BBS if applicable, and ISIS information updated.

4.4.2.2 Revised Load Ratings

When the safe load capacity of a bridge has changed, a load rating must be completed, documented, submitted to the BBS if applicable, and ISIS information updated.

4.4.2.2.1 Modified Permanent Loads

A load rating is required when a new feature is added to a bridge that increases or redistributes the existing permanent loads on a bridge. Common examples of this are the addition of a new or modified wearing surface or the attachment of new utilities to a bridge.

When a project proposes to modify existing permanent loads, a preliminary evaluation should be completed early in the project development phase to determine the project's effects on the safe load capacity of the bridge. The preliminary evaluation findings may affect the project's scope of work. After construction, the as-built improvements must be reviewed to verify the variables used in the preliminary evaluation are accurate. A final load rating must be completed, documented, submitted to the BBS if applicable, and ISIS information updated.

Existing permanent loads on a bridge are sometimes unintentionally modified as part of routine roadway maintenance. A typical example is when an oil and chip treatment is placed on a roadway and the bridge is not omitted. When this happens, the existing load rating must be reviewed to determine if the modifications warrant a new load rating.

Load ratings must be performed and submitted to the BBS for concurrence for resurfacing projects down to a zero-inch increase in surface thickness to verify the safe load capacity of the bridge. The condition of the bridge must be considered.

4.4.2.2.2 Structural Deterioration

IDOT policies for load rating deteriorated bridges are as follows:

- Perform load rating when "Deck Condition" (ISIS Item 58) rating drops to "3" or less, and for subsequent drops in the condition rating.
- Perform load rating when "Superstructure Condition" (ISIS Item 59), "Substructure Condition" (ISIS Item 60), or "Culvert Condition" (ISIS Item 62) rating drops to "4" or less, and for subsequent drops in the condition rating.
- After an initial load rating due to deterioration, continue load rating at an interval determined by the BBS based on bridge type and anticipated deterioration rate. This interval shall not exceed 10 years.

Although IDOT has established procedures to automatically initiate load ratings based on condition ratings, the BBS must be contacted immediately if an inspection finds a condition that may significantly affect a bridge's safe load capacity.

4.4.2.2.3 Structural Damage

When structural damage is identified, a preliminary evaluation may be required to determine the effect of the damage on a bridge's safe load capacity. The preliminary evaluation will help determine a scope of work to repair the damage and identify temporary measures to be implemented until the repairs are completed.

After repairs are made, photographs and/or construction plans of the as-built improvements must be submitted to the BBS to verify the variables used in the preliminary evaluation are still accurate. A final load rating must be completed, documented, submitted to the BBS if applicable, and ISIS information updated.

4.4.2.2.4 Bridge Rehabilitation

A new load rating is required when a bridge is rehabilitated. Depending on the scope of work, a rehabilitation could include changes to permanent loads, capacity of load carrying members, or allowable travel way.

When a project proposes to rehabilitate a bridge, a preliminary evaluation should be completed early in the project development phase to determine the project's effect on the bridge's safe load capacity. This preliminary evaluation is critical in defining the project's scope of work. After construction, the as-built improvements must be reviewed to verify the variables used in the preliminary evaluation are accurate and the load rating shall be updated as required. A final load rating must be documented, submitted to the BBS if applicable, and ISIS information updated.

Funding for some rehabilitation projects is contingent on reestablishing a minimum level of the bridge's safe load capacity. Therefore, it is imperative to have IDOT concurrence with the project scope and preliminary evaluation before proceeding with a rehabilitation project.

4.4.2.2.5 Temporary Measures

Temporary measures can be utilized to keep a bridge in service until permanent measures can be installed. These measures may involve temporarily increasing a load carrying member's capacity, providing alternative load paths within the bridge, or altering the allowable travel way. A special inspection shall be assigned while temporary measures are in place.

A preliminary evaluation should be completed to ensure the proposed temporary measures adequately restore the bridge's safe load capacity. After implementation, the as-built improvements shall be reviewed to verify that the variables used in the preliminary evaluation are accurate and the load rating shall be updated as required. A final load rating must be documented, submitted to the BBS if applicable, and ISIS information updated.

When evaluating temporary measures, a design load rating and legal load rating are performed to assess different conditions. The design load rating ignores the contribution of temporary measures and provides the inventory and operating rating factors for updating ISIS. The legal load rating includes the contribution of temporary measures and determines if the bridge requires weight restrictions with the temporary measures in place.

Temporary measures in place more than five years shall be considered a permanent part of the bridge. The load ratings after this point shall consider the temporary measures as permanent measures, except when timber is used. When timber is used as a temporary measure, any positive contribution of the timber shall be ignored after five years. Thus, the load rating will ignore any bracing, stability, or transfer of load previously assumed.

4.4.3 Evaluation Methods

The analytical method to use for design and legal load ratings depends on the AASHTO specification used to design the original bridge. IDOT policies for this are given in [Table 4.4-1](#) and [Table 4.4-2](#).

Original Design Specifications	Acceptable Rating Method
Allowable Stress Design (ASD)	Load Factor Rating (LFR)
	Load & Resistance Factor Rating (LRFR)
	Allowable Stress Rating (ASR) (See Note 1)
Load Factor Design (LFD)	Load Factor Rating (LFR)
	Load & Resistance Factor Rating (LRFR)
Load & Resistance Factor Design (LRFD)	Load & Resistance Factor Rating (LRFR)

Table 4.4-1 – Rating Method for Existing Bridges

Note 1: ASR can only be used for timber and/or masonry bridges. Non-NHS bridges with design and legal load ratings using ASR completed prior to 1994 are allowed to remain in ISIS.

Construction Type	Design Specification	Acceptable Rating Method
New	LFD	LFR
	LRFD	LRFR
Rehabilitation	LFD	LFR
	LRFD	LRFR

Table 4.4-2 – Rating Method for New or Rehabilitated Bridges

IDOT policy regarding acceptable analytical rating methods is based on a FHWA Policy Memorandum “Bridge Load Ratings for the National Bridge Inventory” dated November 5, 1993 and the subsequent follow-up memoranda dated December 22, 1993 and October 30, 2006 which may be found at:

<https://www.fhwa.dot.gov/legsregs/directives/policy>

4.4.3.1 ASR and LFR Methods

Design and legal load ratings based on the ASR and LFR methods shall follow the provisions in the AASHTO MBE and AASHTO Standard Specifications.

4.4.3.2 LRFR Method

Design and legal load ratings based on the LRFR method shall follow the provisions in the AASHTO MBE and AASHTO LRFD Specifications except as modified herein.

IDOT provides the following condition and system factors for use with design and legal load ratings:

Structural Condition of Members	ϕ_c
Good or Satisfactory	1.00
Fair	0.95
Poor	0.85

Table 4.4-3 – Condition Factor: ϕ_c

Superstructure Type	ϕ_s
Welded Members in Two-Girder/Truss/ Arch Bridges	0.85
Riveted Members in Two-Girder/Truss/Arch Bridges	0.90
Multiple Eyebar Members in Truss Bridges	0.90
Three-Girder Bridges with Girder Spacing \leq 6 ft	0.85
Four-Girder Bridges with Girder Spacing \leq 4 ft	0.95
All Other Girder Bridges and Slab Bridges	1.00
Floorbeams with Spacing > 12 ft and Noncontinuous Stringers	0.85
Redundant Stringer Subsystems between Floorbeams	1.00

Table 4.4-4 – System Factor ϕ_s for Flexural and Axial Effects

The system factors in [Table 4.4-4](#) shall only be applied when checking flexural and axial effects at the strength limit state of typical spans and geometries. A constant value of $\phi_s = 1.0$ shall be applied when checking shear at the strength limit state or when evaluating flexure and shear of timber members.

4.4.3.3 Rational Evaluation Method

When the use of empirical methods is justified and approved by IDOT, the design and legal load rating can be assigned using the rational evaluation method. This method is based on the premise that the inventory rating, operating rating, and load posting are proportional to each other and can be assigned based on condition ratings.

Using this methodology, [Table 4.4-5](#) gives **suggested** rating factors and load postings for a given superstructure, substructure, or culvert condition rating:

Condition Rating	LFR Design Load Rating Factors		Load Postings (Tons)		
	Inventory	Operating	Single Unit	3 or 4 Axle Combinations	5 or More Axle Combinations
<u>Good to Excellent</u> - No signs of structural deterioration or distress.	1.00	1.66	No Posting Required		
<u>Fair</u> - Initial evidence of structural deterioration or distress. (No restrictions required)	0.75	1.25	No Posting Required		
<u>Poor</u> - Some structural deterioration or distress. (Legal Loads Only restriction)	0.60	1.00	No Posting Required		
<u>Serious</u> - Advanced structural deterioration or distress evident. (Load posting required) (See Note 1)	0.39	0.65	15	20	25
	0.21	0.35	8	12	14
<u>Critical</u> - Severe structural deterioration or distress evident.	0.13	0.22	5		

Table 4.4-5 – Rational Evaluation Method Rating Factors and Load Postings

Note 1: The upper and lower values related to the seriousness of the deterioration or distress (i.e. is it closer to Poor (upper) or Critical (lower)). The load rater may alternatively require a single load posting based on the Single Unit load posting. Weight restrictions on township roads are typically single load postings.

When using this method, the “Inventory Load Rating Method” (ISIS Item 65) shall be coded as “0” (Field evaluation and documented engineering judgment).

4.4.3.4 Load Testing Method

Design and legal load ratings based on load testing shall follow the provisions of the AASHTO MBE.

4.4.4 Transient Loads

Transient loads may include pedestrian loading if there is expectation of high pedestrian usage. A reduced pedestrian loading may be appropriate.

4.4.4.1 Design Load Rating

The transient load used for a design load rating following either the ASR or LFR evaluation method is the HS20 loading defined in the AASHTO Standard Specifications. The transient load used for a design load rating following the LRFR evaluation method is the HL93 loading defined in the AASHTO LRFD Specifications. For all three evaluation methods, the appropriate impact load must also be included.

4.4.4.2 Legal Load Rating

The transient loads used for a legal load rating, regardless of the evaluation method, are the Illinois Posting Vehicles shown in [Figure 4.4-6](#) and [Figure 4.4-7](#). The Illinois Posting Vehicles are notional loads, not actual vehicles. This means they produce load effects enveloping the load effects produced by the AASHTO Legal Loads and the Illinois Statutory Loads. This includes the Specialized Hauling Vehicles (SHVs) defined in the AASHTO MBE.

For span lengths greater than 200 feet, the transient load used for a legal load rating shall consist of a truck train, spaced 30 feet apart head to tail, using each of the Illinois Posting Vehicles with a single IL-PC4-41 truck in the adjacent lane or lanes. The IL-PD6-40 is a train configuration itself, thus, does not require additional spacing at 30 feet.

When placing a different vehicle in adjacent lanes is not practical due to analysis software limitations, additional truck trains may conservatively be used in place of the IL-PC4-41 truck.

The appropriate impact load must also be included.

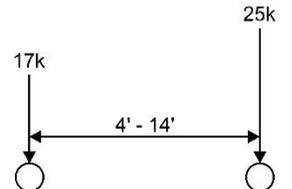
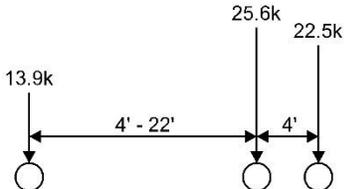
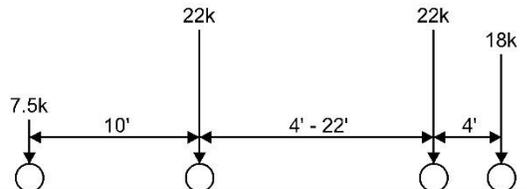
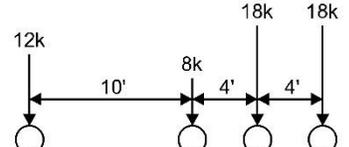
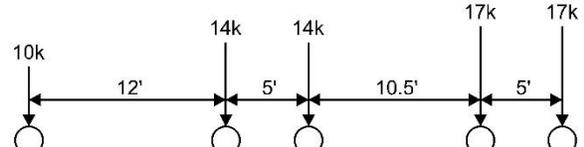
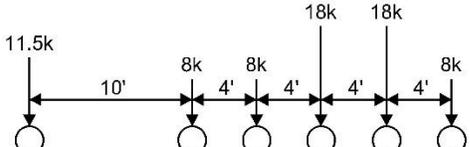
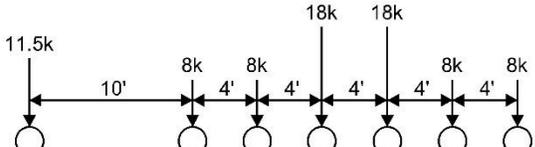
Vehicle Configuration	Name & GVW
	<p>IL-PS2-21 GVW = 21 Tons</p>
	<p>IL-PS3-31 GVW = 31 Tons</p>
	<p>IL-PS4-34.75 GVW = 34.75 Tons</p>
	<p>IL-PS4-28 GVW = 28 Tons</p>
	<p>IL-PS5-36 GVW = 36 Tons</p>
	<p>IL-PS6-35.75 GVW = 35.75 Tons</p>
	<p>IL-PS7-39.75 GVW = 39.75 Tons</p>

Figure 4.4-6 – Illinois Posting Vehicles (Single Unit Vehicles)

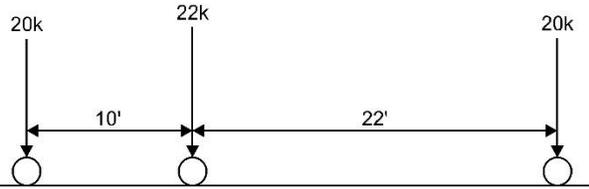
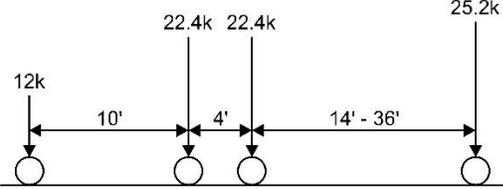
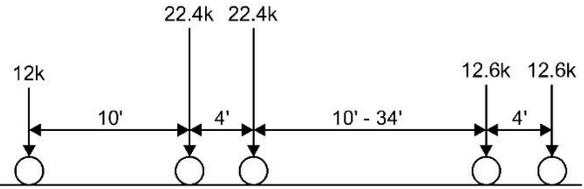
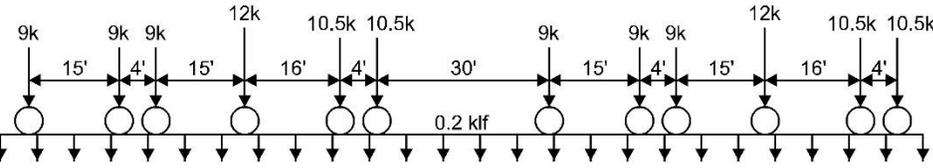
Vehicle Configuration	Name & GVW
	<p>IL-PC3-31 GVW = 31 Tons</p>
	<p>IL-PC4-41 GVW = 41 Tons</p>
	<p>IL-PC5-41 GVW = 41 Tons</p>
	<p>IL-PD6-40 GVW = 40 Tons</p>

Figure 4.4-7 – Illinois Posting Vehicles (Combination Unit Vehicles)

4.4.4.3 Routine Permit Load Rating

As part of a legal load rating, a routine permit load rating must be completed to evaluate the Illinois Routine Permit Vehicles included in Section 4.5.3.1. This is used to determine if a bridge requires a restriction to Legal Loads Only status.

4.4.5 Weight Restrictions

Load ratings can be determined at both the inventory and operating levels, which represent a range of safe load capacities for the bridge. IDOT policy is to require bridge weight restrictions based on the operating level. The BBS must be contacted for concurrence when the load rater feels a situation may warrant more conservative weight restrictions.

4.4.5.1 Implementing Weight Restrictions

After calculating a rating factor for each of the Illinois Posting and Routine Permit Vehicles, the load rater will choose one of the following courses of action for the bridge:

- No weight restriction
- Restrict to Illinois Statutory Loads (Legal Loads Only)
- Restrict below Illinois Statutory Loads (Load Posting)
- Close the bridge

When choosing a course of action, the load rater should consider the enforceability of the weight restrictions. If there is concern significant disregard of the load posting will occur, the load rater may recommend closure of the bridge in the interest of public safety.

Occasionally, emergency situations will require a bridge owner to use judgment and temporarily load post or close a damaged or deteriorated bridge until an inspection and load rating can be completed by the appropriate personnel. These emergency load postings or closures may have limited legal enforceability, but owners are encouraged to implement and maintain such measures for the safety of the traveling public. While these temporary measures may be implemented immediately, the BBS must be notified as soon as practical for concurrence with their continued use.

4.4.5.1.1 No Weight Restrictions

When operating rating factors are greater than or equal to 1.00 for **ALL** Illinois Posting and Routine Permit Vehicles, the bridge can safely carry all legal loads and all routine permit vehicles. However, if weight restrictions are not required but the operating rating factor from the design load rating is less than 1.00, the SLRS must include commentary documenting the findings of the analysis. This is typically done by identifying the posting vehicle and the controlling operating rating factor.

4.4.5.1.2 Weight Restricted to Illinois Statutory Loads (Legal Loads Only)

When operating rating factors are greater than or equal to 1.00 for **ALL** Illinois Posting Vehicles but less than 1.00 for **ANY** Illinois Routine Permit Vehicle, the bridge can safely carry all legal

loads but not all routine permit vehicles. Thus, the bridge must be restricted to Legal Loads Only. If an agency allows routine permit vehicles to travel on roadways under its jurisdiction, Legal Loads Only bridges should be posted using the appropriate signage per the MUTCD and IMUTCD.

4.4.5.1.3 Weight Restricted Below Illinois Statutory Loads (Load Posting)

When operating rating factors are less than 1.00 for **ANY** Illinois Posting Vehicle, the bridge cannot safely carry all legal load configurations and the bridge must be load posted unless temporary measures are used to mitigate the load posting. The use of temporary measures must be documented on the SLRS.

The allowable weight limits that are used to load post bridges are based on the allowable GVW. The allowable GVW is determined by multiplying the operating rating factor for a given Illinois Posting Vehicle by the vehicle’s GVW.

The Illinois Posting Vehicles are divided into three posting groups as shown in [Table 4.4-8](#). A maximum allowable GVW limit is determined for each posting group.

Posting Group	Illinois Posting Vehicles
Single Unit	IL PS2-21
	IL-PS3-31
	IL-PS4-28
	IL-PS4-34.75
	IL-PS5-36
	IL-PS6-35.75
	IL-PS7-39.75
Combination Unit - 3 or 4 Axles	IL-PC3-31
	IL-PC4-41
Combination Unit - 5 or More Axles	IL-PC5-41
	IL-PD6-40

Table 4.4-8 – Combination Posting Method Groups

The maximum allowable GVW limits for each posting group is determined as follows:

Single Unit: Determine the allowable GVW for all Illinois Posting Vehicles in the “Single Unit” posting group with an operating rating factor less than 1.00. The maximum allowable GVW for the “Single Unit” posting group is the smallest of these values.

Combination Unit - 3 or 4 Axles: Determine the allowable GVW for all Illinois Posting Vehicles in the “Combination Unit – 3 or 4 Axles” posting group with an operating rating factor less than 1.00. The maximum allowable GVW for the “Combination Unit – 3 or 4” posting group is the smallest of these values.

Combination Unit - 5 or More Axles: Determine the allowable GVW for all Illinois Posting Vehicles in the “Combination Unit – 5 or More Axles” posting group with an operating rating factor less than 1.00. The maximum allowable GVW for the “Combination Unit – 5 or More Axles” posting group is the smallest of these values.

Consideration must be given to practical limitations when determining allowable weight limits. The minimum “Combination Unit - 3 or 4 Axle” load posting is 12 Tons and the minimum “Combination Unit - 5 or More Axle” load posting is 14 Tons. The AASHTO MBE requires a bridge to have a minimum allowable weight limit of 3 Tons in order to remain open. However, IDOT policy more conservatively limits this to 10 Tons on the state system and generally 5 Tons on the LPA system.

A load posting may restrict the number of heavy vehicles allowed to simultaneously use a bridge. This restriction is referred to as a “One Truck at a Time” (OTAT) load posting. IDOT discourages OTAT load postings and restricts its use to bridges carrying roadways with low traffic volumes and adequate sight distance for opposing vehicles to easily identify one another and reduce speed.

After a weight restriction has been determined, ISIS must be updated accordingly.

4.4.5.2 Posted Weight Restriction Signage

When the decision is made to implement a load posting or closure, it is the responsibility of the agency with jurisdiction of the roadway carried by the bridge to erect the necessary signage and barricades as soon as possible.

To ensure violations of the weight restrictions can be successfully enforced, the signage must comply with the MUTCD and IMUTCD. The provisions in the IMUTCD shall supersede the MUTCD when in conflict. In addition, owners of state or LPA highways must have

documentation of IDOT concurrence with the weight restriction and the posted weight limits must match the allowable weight limits given in that documentation.

The agency with roadway jurisdiction must notify appropriate school districts, emergency service providers, and other affected agencies of the weight restrictions as appropriate. School buses and emergency vehicles are not exempt from posted weight limits.

The agency with roadway jurisdiction must monitor signage and barricades for repair or replacement needs. The frequency of monitoring should be appropriate for the classification of the roadway carried by the bridge. Although IDOT standard procedures require routine NBIS safety inspections to review signage and barricades in the vicinity of the bridge, additional inspections should be performed more often when reasonable.

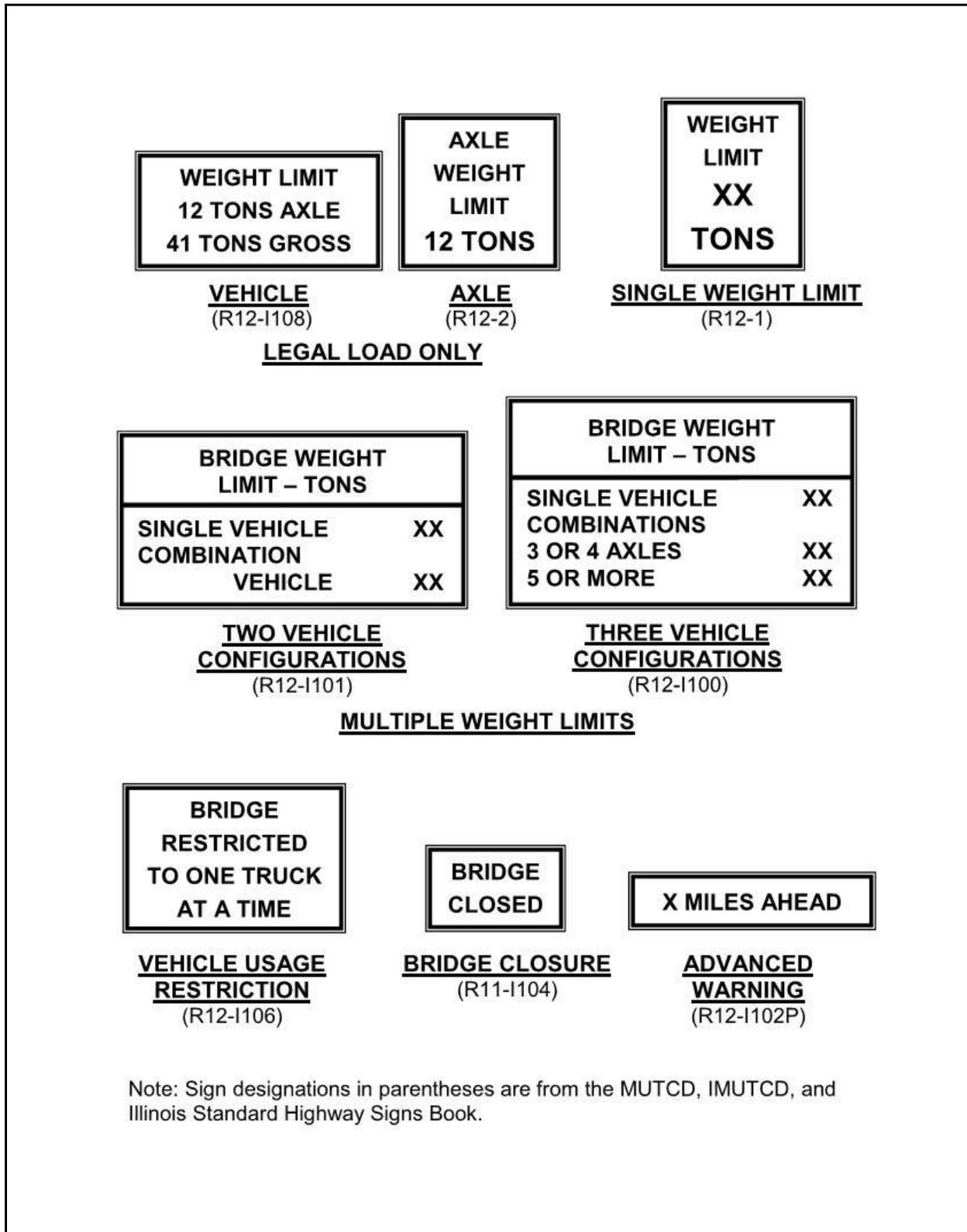


Figure 4.4-9 – Typical Load Posting Signs

4.4.5.3 Removing and Altering Weight Restrictions

Once a weight restriction has been established for a bridge, it cannot be removed or altered without approval from IDOT. Modifying weight restrictions requires rehabilitation of the bridge or the installation of temporary measures. The load rating procedures for these courses of action are included in [Section 4.4.2.2.4](#) and [Section 4.4.2.2.5](#), respectively.

IDOT must approve the installed improvements, final load rating, and proposed modified weight restrictions before the current weight restrictions can be removed or altered.

4.5 Overweight Permit Load Rating

The purpose of this section is to provide policies, procedures, and guidelines for completing overweight permit load ratings in Illinois. General information on issuing overweight permits is included for context purposes only. The detailed policies and procedures governing the issuing of overweight permits by an agency should be documented by the bridge owner.

An overweight permit load rating is the evaluation of a bridge's safe load capacity relative to a specific permit load. The load rating results are used to determine if an overweight permit may be issued for the permit load to cross the bridge.

The two types of permits are a routine permit and a special permit. Routine permit vehicles may mix in the traffic stream and move at normal speeds without any movement restrictions but may be restricted to specific routes. Special permit vehicles are usually heavier and have more restrictions than routine permit vehicles. Each of these permit types has unique permit load rating requirements.

An overweight permit cannot be issued to cross posted or otherwise restricted bridges.

4.5.1 Assignment of Responsibility

The Illinois Vehicle Code assigns the responsibility of issuing permits to the highway owner. When a bridge and the highway it carries are under separate jurisdiction, a permit must also be obtained from the bridge owner. A separate permit must be obtained from each individual highway and bridge owner along every route the permit load plans to utilize.

Information governing IDOT's issuance of permits is included in a document titled "Oversize and Overweight Permit Movements on State Highways". For IDOT owned highways and bridges, the IDOT Bureau of Operations processes the permit load applications and the BBS completes the required overweight permit load ratings.

Non-IDOT bridge owners are responsible for processing the applications for permit loads to cross their bridges. Each agency should have policies and procedures in place to ensure that permit load applications are properly evaluated. Overweight permits must be performed with the oversight of an Illinois Licensed Structural Engineer.

4.5.2 Evaluation Methods

Overweight permit load ratings should follow the LFR method unless the bridge material or type precludes its use. ASR is used to evaluate timber and masonry load carrying members. LRFR is used on a selective basis when a less conservative yet reliable load rating is required.

4.5.3 Evaluation of Routine Permits

A routine permit application evaluation requires a routine permit load rating comparing the safe load capacity of each bridge along a proposed permitted route relative to the Illinois Routine Permit Vehicles. This load rating is completed as part of the design and legal load rating process described in [Section 4.4](#).

Routine permit applications are evaluated by comparing the proposed permit load to the Illinois Routine Permit Vehicles. In order to issue a permit, the proposed permit load must have an axle configuration similar to one of the Illinois Routine Permit Vehicles and axle weights equal to or less than those of that vehicle.

4.5.3.1 Illinois Routine Permit Vehicle Configurations

The transient loads used for a routine permit load rating, regardless of the evaluation method, are the Illinois Routine Permit Vehicles shown in [Figure 4.5-1](#). The Illinois Routine Permit Vehicles are notional loads, not actual vehicles. This means they produce load effects enveloping the load effects produced by limited continuous operation overweight permits allowed by the ILCS.

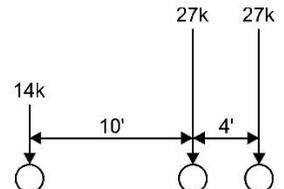
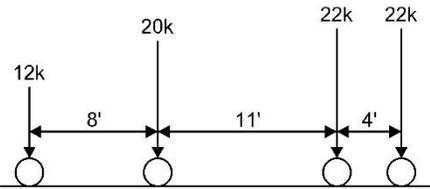
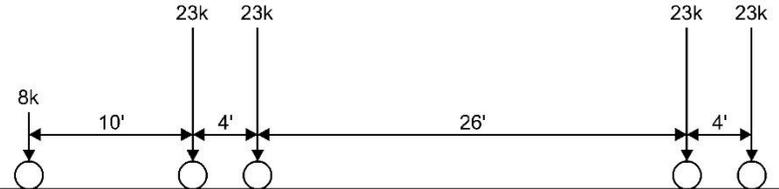
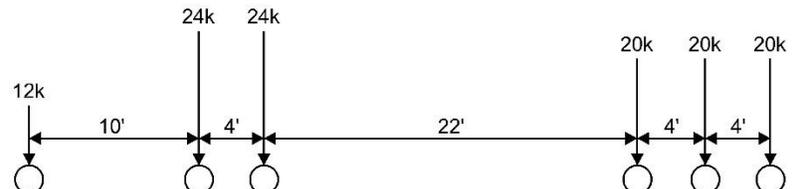
Vehicle Configuration	Name & GVW
	<p>IL-RS3-34 GVW = 34 Tons</p>
	<p>IL-RS4-38 GVW = 38 Tons</p>
	<p>IL-RC5-50 GVW = 50 Tons</p>
	<p>IL-RC6-60 GVW = 60 Tons</p>

Figure 4.5-1 – Illinois Routine Permit Vehicles

4.5.4 Evaluation of Special Permits

A special permit application evaluation requires a special permit load rating comparing the safe load capacity of each bridge along a proposed permitted route relative to the proposed permit load. In order to issue a permit, the load rating must result in an operating rating factor greater than or equal to 1.00 for that load.

The need to complete a load rating inspection is left to the discretion of the load rating team. This determination is typically based on the size of the permit load, the condition of the bridge, availability of as-built plans, inspection sketches and photographs, and whether a load rating inspection was completed for previous load ratings.

4.5.4.1 Transient Load Configurations

The proposed permit load is the transient load configuration used to evaluate a special permit. In order to complete a load rating, the following vehicle information must be provided:

- Gross Vehicle Weight
- Number of axles (utilized to carry the gross vehicle weight)
- Weight on each axle (steering axle to trailing axle)
- Axle spacing (distance center to center of axles)
- Non-standard gauge information (distance center to center of wheels along the width of vehicle, standard gauge = 6 feet)

The load rating of more complex permit loads may also require the configuration of the individual wheel loads on each axle.

4.5.4.2 Permit Restrictions

When a load rating follows standard procedures and determines a bridge does not have the safe load capacity required to issue a permit, special restrictions may be placed on the permit loads movement reducing the load effects on load carrying members. The load rating may be evaluated again with a restriction or a combination of restrictions in place. If the safe load capacity of the bridge is then sufficient, the permit may be issued with specific restrictions.

Some permits may require a police escort or other means of supervision to ensure compliance with permit restrictions.

4.5.4.2.1 One Lane Loaded

When a permit restriction specifies one lane loaded, the live load distribution factors given in either the AASHTO Standard Specifications or the AASHTO LRFD Specifications can be adjusted accordingly. This permit restriction is commonly specified as, "One lane loaded, at least 300' between nearest vehicle."

4.5.4.2.2 Load Position

A permit restriction may specify a permit load place its axles in a specific position relative to load carrying members. This may include specifying the permit load straddle the longitudinal centerline of the bridge or use methods such as crabbing (i.e. staggering front and rear axles in separate lanes) to distribute the load over more beam lines. Coordination with law enforcement may be required.

4.5.4.2.3 Reduced Impact Loading

A permit restriction may specify a permit load reduce speed to limit the effects of impact. It is generally acceptable to eliminate the effects of impact from a load rating when the permit load speed is 5 mph or less. It is generally acceptable to reduce the effects of impact to 10% for speeds up to 45 mph when there is a smooth riding surface at the approaches, along the bridge deck, and at expansion joints.

4.5.4.3 Temporary Measures

When a load rating determines a bridge does not have the safe load capacity required to issue a permit, the permit applicant may choose to investigate the use of temporary measures. Temporary measures may include systems that spread the load to additional superstructure members, provide alternative load paths for the structural system, strengthen existing load carrying members, or span partially or completely over the existing bridge.

The development and use of temporary measures are the responsibility of the permit applicant. An Illinois Licensed Structural Engineer must prepare and seal the plans and specifications for the proposed measures. The owner must approve the temporary measures before they are implemented and a permit must be issued.

4.6 Construction Load Rating

A construction load rating is the evaluation of a bridge's safe load capacity relative to a specific special construction load along with other transient loads that may be allowed to access the bridge simultaneously. The load rating results are used to determine if a special construction load can be approved to access the bridge.

Approving special construction loads is the responsibility of the bridge owner.

4.6.1 Project Development Phase

Milling/Scarification: Although pavement milling/scarification reduces the overall dead load, it may also reduce the overall capacity of the bridge. The capacity of concrete slab bridges and composite decks on beams or stringers must be reduced to account for the loss of structural thickness caused by milling/scarification. Precast prestressed concrete box beams (deck beams) should not be milled due to the potential for damaging the beams.

Overlay: In general, overlays only increase dead load and do not provide benefit to the capacity of the bridge. However, an increase in capacity may be considered if criteria set forth for Concrete Deck-Slabs with Concrete Overlays in [Section 4.3.4.2](#) is followed.

Material Transfer Device: A Material Transfer Device (MTD) is used on hot-mix asphalt paving projects to aid in transferring material from the trucks to the paver. The axle spacing and weights are typically significantly higher than legal loads. For this reason, bridges within the paving contract limits must be evaluated for an MTD. A typical empty MTD configuration is Axle 1 = 38,500 pounds, Axle 2 = 40,500 pounds, spaced 14'-4". For more information see IDOT All Regional Engineers memo; "Special Provision for Material Transfer Devices".

BCR, TSL, and Final Plans: The Engineer of Record shall evaluate whether the existing bridge or any portion of the existing bridge planned for reuse is structurally adequate. It is the engineer's responsibility to notify the owner if the condition of the existing bridge warrants interim repairs, select member replacement, structural support, load restrictions, or bridge closure. For more information see IDOT All Deputy Directors of Highways memo, "Consultant Plan Responsibility for Existing Bridges" included in [Appendix A-12](#).

4.6.2 Project Implementation Phase

Demolition Plan: The contractor shall submit a demolition plan to the owner for approval, including the proposed methods of demolition and the location(s) and type(s) of equipment to be used for the removal of existing bridge structures or bridge decks (except for box culverts), when such work will be adjacent to or over an active roadway, railroad, or waterway designated on the plans as "Public Waters". The demolition plan shall include an assessment of the bridge

condition and an evaluation of the capacity and stability of the bridge during demolition. The plan shall be sealed by an Illinois Licensed Structural Engineer.

Special Construction Loads: The configuration and magnitude of a special construction load relies on the contractor's means and methods. The contractor is responsible for completing a load rating to ensure the bridge can safely support the anticipated loads.

For IDOT projects, the contractor must follow the procedures of IDOT Construction Memorandum No. 06-39, "Transportation or Operation of Heavy Equipment on Pavement or Bridges Within the Contract Limits" and the IDOT *Standard Specifications for Road and Bridge Construction* for obtaining permission for special construction loads within the limits of the construction section. IDOT Construction Memorandum No. 06-39 provides a means for the contractor to submit some common special construction loads for the BBS to complete the load rating. The contractor must allow IDOT a minimum of ten working days to complete the load rating. For other special construction loads specific to a contractor's means and methods, the contractor must retain the services of an Illinois Licensed Structural Engineer to complete the load ratings. The contractor must submit the sealed load ratings along with supporting calculations to IDOT for review and approval.

For non-IDOT projects, the contractor must follow the policies and procedures of the bridge owner for obtaining permission for special construction loads within the limits of the construction section. Construction load ratings must be completed and sealed by an Illinois Licensed Structural Engineer. When a special construction load is unusual compared to those typically employed during project implementation, the Engineer of Record for the bridge being constructed should be given the opportunity to review and comment on the evaluation.

Outside of the construction section, the contractor must obtain a special permit from the highway owner.

Structural Assessment Reports: Structural Assessment Reports (SARs) are required on a contract-by-contract basis when Guide Bridge Special Provision 67, "Structural Assessment Reports for Contractor's Means and Methods" is included with the contract. Two primary criteria are as follows:

1. For any portion of the bridge that is not reused, the effects of the applied loads shall not exceed their capacity at operating level.
2. For any portion of the bridge that is reused, the effects of the applied loads shall not exceed their capacity at inventory level.

4.6.3 Evaluation Methods

Construction load ratings may utilize the ASR, LFR, or LRFR evaluation method. No preference is placed on any method.

IDOT construction load ratings follow the LFR method unless the bridge material or type precludes its use. ASR is used to load rate timber and masonry load carrying members. LRFR is used on a selective basis when a less conservative yet reliable load rating is required.

Section 5 Tunnel Inspection

5.1 General

The highway bill Moving Ahead for Progress in the 21st Century Act (MAP-21) required the Federal Highway Administration (FHWA) to establish national standards for tunnel inspections. The National Tunnel Inspection Standards (NTIS) (23 CFR 650 Subpart E – National Tunnel Inspection Standards) contains the regulatory requirements for the tunnel inventory and inspection program.

A tunnel is defined as: “an enclosed roadway for motor vehicle traffic with vehicle access limited to portals, regardless of type of structure or method of construction, that requires, based on the owner’s determination, special design considerations to include lighting, ventilations, fire protection systems, and emergency egress capacity. The term “tunnel” does not include bridges or culverts inspected under the National Bridge Inspection Standards (23 CFR 650 Subpart C – National Bridge Inspection Standards).”

The FHWA administers the NTIS under the guidelines outlined in the FHWA *Specifications for the National Tunnel Inventory (SNTI)* and the FHWA *Tunnel Operations, Maintenance, Inspection and Evaluation Manual (TOMIE)*. The inventory and inspection information collected, as required by the NTIS, is reported to the FHWA and recorded in the National Tunnel Inventory (NTI).

The SNTI contains information on conducting inspections and for submitting the inventory and inspection data to the FHWA. The TOMIE provides uniform and consistent guidance on the operation, maintenance, inspection and evaluation of tunnels.

The NTIS, SNTI, TOMIE, and NTI were developed to ensure that tunnels continue to provide safe, reliable, and efficient levels of service for the traveling public.

To maintain full compliance with the NTIS, the Illinois Department of Transportation (IDOT) must adhere to all policies, procedures, and regulations established by the FHWA. The IDOT Bridge Management Unit Chief within the Bureau of Bridges and Structures will act as the State Program

Manager overseeing the NTIS Program for all tunnels in the state regardless of the jurisdiction the tunnel is located in.

Section 6 Reserved

Section 7 Appendix

A-1 Code of Federal Regulations 23 CFR 650 (C) – NBIS

Code of Federal Regulations (CFR)

Title 23: Highways

PART 650—BRIDGES, STRUCTURES, AND HYDRAULICS

Subpart C—National Bridge Inspection Standards

Contents

§ 650.301	Purpose.
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§ 650.305	Definitions.
§ 650.307	Bridge inspection organization.
§ 650.309	Qualifications of personnel.
§ 650.311	Inspection frequency.
§ 650.313	Inspection procedures.
§ 650.315	Inventory.
§ 650.317	Reference manuals.

SOURCE: 69 FR 74436, Dec. 14, 2004, unless otherwise noted.

§ 650.301 Purpose.

This subpart sets the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151.

§ 650.303 Applicability.

The National Bridge Inspection Standards (NBIS) in this subpart apply to all structures defined as highway bridges located on all public roads.

§ 650.305 Definitions.

Terms used in this subpart are defined as follows:

American Association of State Highway and Transportation Officials (AASHTO) Manual. "The Manual for Bridge Evaluation," First Edition, 2008, published by the American Association of State Highway and Transportation Officials (incorporated by reference, see § 650.317).

Bridge. A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge inspection experience. Active participation in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominant amount in bridge inspection, is acceptable.

Bridge inspection refresher training. The National Highway Institute “Bridge Inspection Refresher Training Course”¹ or other State, local, or federally developed instruction aimed to improve quality of inspections, introduce new techniques, and maintain the consistency of the inspection program.

¹ The National Highway Institute training may be found at the following URL: <http://www.nhi.fhwa.dot.gov/>

Bridge Inspector's Reference Manual (BIRM). A comprehensive FHWA manual on programs, procedures and techniques for inspecting and evaluating a variety of in-service highway bridges. This manual may be purchased from the U.S. Government Printing Office, Washington, DC 20402 and from National Technical Information Service, Springfield, Virginia 22161, and is available at the following URL: <http://www.fhwa.dot.gov/bridge/bripub.htm>.

Complex bridge. Movable, suspension, cable stayed, and other bridges with unusual characteristics.

Comprehensive bridge inspection training. Training that covers all aspects of bridge inspection and enables inspectors to relate conditions observed on a bridge to established criteria (see the Bridge Inspector's Reference Manual for the recommended material to be covered in a comprehensive training course).

Critical finding. A structural or safety related deficiency that requires immediate follow-up inspection or action.

Damage inspection. This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

Fracture critical member (FCM). A steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

Fracture critical member inspection. A hands-on inspection of a fracture critical member or member components that may include visual and other nondestructive evaluation.

Hands-on. Inspection within arm's length of the component. Inspection uses visual techniques that may be supplemented by nondestructive testing.

Highway. The term “highway” is defined in 23 U.S.C. 101(a)(11).

In-depth inspection. A close-up, inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations.

Initial inspection. The first inspection of a bridge as it becomes a part of the bridge file to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.

Legal load. The maximum legal load for each vehicle configuration permitted by law for the State in which the bridge is located.

Load rating. The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection.

National Institute for Certification in Engineering Technologies (NICET). The NICET provides nationally applicable voluntary certification programs covering several broad engineering technology fields and a number of specialized subfields. For information on the NICET program certification contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314-2794.

Operating rating. The maximum permissible live load to which the structure may be subjected for the load configuration used in the rating.

Professional engineer (PE). An individual, who has fulfilled education and experience requirements and passed rigorous exams that, under State licensure laws, permits them to offer engineering services directly to the public. Engineering licensure laws vary from State to State, but, in general, to become a PE an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam, gain four years of experience working under a PE, and pass the Principles of Practice of Engineering exam.

Program manager. The individual in charge of the program, that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance.

Public road. The term “public road” is defined in 23 U.S.C. 101(a)(27).

Quality assurance (QA). The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.

Quality control (QC). Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level.

Routine inspection. Regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

Routine permit load. A live load, which has a gross weight, axle weight or distance between axles not conforming with State statutes for legally configured vehicles, authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis.

Scour. Erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges.

Scour critical bridge. A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

Special inspection. An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency.

State transportation department. The term "State transportation department" is defined in 23 U.S.C. 101(a)(34).

Team leader. Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.

Underwater diver bridge inspection training. Training that covers all aspects of underwater bridge inspection and enables inspectors to relate the conditions of underwater bridge elements to established criteria (see the Bridge Inspector's Reference Manual section on underwater inspection for the recommended material to be covered in an underwater diver bridge inspection training course).

Underwater inspection. Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

[69 FR 74436, Dec. 14, 2004, as amended at 74 FR 68379, Dec. 24, 2009]

§ 650.307 Bridge inspection organization.

(a) Each State transportation department must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the State's boundaries, except for bridges that are owned by Federal agencies.

(b) Federal agencies must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the respective agency responsibility or jurisdiction.

(c) Each State transportation department or Federal agency must include a bridge inspection organization that is responsible for the following:

(1) Statewide or Federal agency wide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.

(2) Bridge inspections, reports, load ratings and other requirements of these standards.

(d) Functions identified in paragraphs (c)(1) and (2) of this section may be delegated, but such delegation does not relieve the State transportation department or Federal agency of any of its responsibilities under this subpart.

(e) The State transportation department or Federal agency bridge inspection organization must have a program manager with the qualifications defined in § 650.309(a), who has been delegated responsibility for paragraphs (c)(1) and (2) of this section.

§ 650.309 Qualifications of personnel.

(a) A program manager must, at a minimum:

(1) Be a registered professional engineer, or have ten years bridge inspection experience; and

(2) Successfully complete a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course.

(b) There are five ways to qualify as a team leader. A team leader must, at a minimum:

(1) Have the qualifications specified in paragraph (a) of this section; or

(2) Have five years bridge inspection experience and have successfully completed an FHWA approved comprehensive bridge inspection training course; or

(3) Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET) and have successfully completed an FHWA approved comprehensive bridge inspection training course, or

(4) Have all of the following:

(i) A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;

(ii) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;

(iii) Two years of bridge inspection experience; and

(iv) Successfully completed an FHWA approved comprehensive bridge inspection training course, or

(5) Have all of the following:

(i) An associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;

(ii) Four years of bridge inspection experience; and

(iii) Successfully completed an FHWA approved comprehensive bridge inspection training course.

(c) The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.

(d) An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course.

§ 650.311 Inspection frequency.

(a) *Routine inspections.* (1) Inspect each bridge at regular intervals not to exceed twenty-four months.

(2) Certain bridges require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these bridges are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(3) Certain bridges may be inspected at greater than twenty-four month intervals, not to exceed forty-eight-months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(b) *Underwater inspections.* (1) Inspect underwater structural elements at regular intervals not to exceed sixty months.

(2) Certain underwater structural elements require inspection at less than sixty-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as construction material, environment, age, scour characteristics, condition rating from past inspections and known deficiencies.

(3) Certain underwater structural elements may be inspected at greater than sixty-month intervals, not to exceed seventy-two months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(c) *Fracture critical member (FCM) inspections.* (1) Inspect FCMs at intervals not to exceed twenty-four months.

(2) Certain FCMs require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(d) Damage, in-depth, and special inspections. Establish criteria to determine the level and frequency of these inspections.

§ 650.313 Inspection procedures.

(a) Inspect each bridge in accordance with the inspection procedures in the AASHTO Manual (incorporated by reference, see § 650.317).

(b) Provide at least one team leader, who meets the minimum qualifications stated in § 650.309, at the bridge at all times during each initial, routine, in-depth, fracture critical member and underwater inspection.

(c) Rate each bridge as to its safe load-carrying capacity in accordance with the AASHTO Manual (incorporated by reference, see § 650.317). Post or restrict the bridge in accordance with the AASHTO Manual or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor.

(d) Prepare bridge files as described in the AASHTO Manual (incorporated by reference, see § 650.317). Maintain reports on the results of bridge inspections together with notations of any action taken to address the findings of such inspections. Maintain relevant maintenance and inspection data to allow assessment of current bridge condition. Record the findings and results of bridge inspections on standard State or Federal agency forms.

(e) Identify bridges with FCMs, bridges requiring underwater inspection, and bridges that are scour critical.

(1) Bridges with fracture critical members. In the inspection records, identify the location of FCMs and describe the FCM inspection frequency and procedures. Inspect FCMs according to these procedures.

(2) Bridges requiring underwater inspections. Identify the location of underwater elements and include a description of the underwater elements, the inspection frequency and the procedures in the inspection records for each bridge requiring underwater inspection. Inspect those elements requiring underwater inspections according to these procedures.

(3) Bridges that are scour critical. Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan.

(f) *Complex bridges*. Identify specialized inspection procedures, and additional inspector training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures.

(g) *Quality control and quality assurance*. Assure systematic quality control (QC) and quality assurance (QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, periodic

bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations.

(h) *Follow-up on critical findings.* Establish a statewide or Federal agency wide procedure to assure that critical findings are addressed in a timely manner. Periodically notify the FHWA of the actions taken to resolve or monitor critical findings.

§ 650.315 Inventory.

(a) Each State or Federal agency must prepare and maintain an inventory of all bridges subject to the NBIS. Certain Structure Inventory and Appraisal (SI&A) data must be collected and retained by the State or Federal agency for collection by the FHWA as requested. A tabulation of this data is contained in the SI&A sheet distributed by the FHWA as part of the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges," (December 1995) together with subsequent interim changes or the most recent version. Report the data using FHWA established procedures as outlined in the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges."

(b) For routine, in-depth, fracture critical member, underwater, damage and special inspections enter the SI&A data into the State or Federal agency inventory within 90 days of the date of inspection for State or Federal agency bridges and within 180 days of the date of inspection for all other bridges.

(c) For existing bridge modifications that alter previously recorded data and for new bridges, enter the SI&A data into the State or Federal agency inventory within 90 days after the completion of the work for State or Federal agency bridges and within 180 days after the completion of the work for all other bridges.

(d) For changes in load restriction or closure status, enter the SI&A data into the State or Federal agency inventory within 90 days after the change in status of the structure for State or Federal agency bridges and within 180 days after the change in status of the structure for all other bridges.

§ 650.317 Reference manuals.

(a) The materials listed in this subpart are incorporated by reference in the corresponding sections noted. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval, and notice of any change in these documents will be published in the FEDERAL REGISTER. The materials are available for purchase at the address listed below, and are available for inspection at the National Archives and Records Administration (NARA). These materials may also be reviewed at the Department of Transportation Library, 1200 New Jersey Avenue, SE., Washington, DC 20590, (202) 366-0761. For information on the availability of these materials at NARA call (202) 741-6030, or go to the following URL:

http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.htm . In the event there is a conflict between the standards in this subpart and any of these materials, the standards in this subpart will apply.

(b) The following materials are available for purchase from the American Association of State Highway and Transportation Officials, Suite 249, 444 N. Capitol Street, NW., Washington, DC 20001, (202) 624-5800. The materials may also be ordered via the AASHTO bookstore located at the following URL: <http://www.transportation.org> .

(1) The Manual for Bridge Evaluation, First Edition, 2008, AASHTO, incorporation by reference approved for §§ 650.305 and 650.313.

(2) [Reserved]

[74 FR 68379, Dec. 24, 2009]

A-2 Web Resources

Government Offices

US Department of Transportation (USDOT)

<https://www.transportation.gov>

Federal Highway Administration (FHWA)

<https://www.fhwa.dot.gov>

Occupational Safety and Health Administration (OSHA)

<http://www.osha.gov/oskdir/il.html>

United States Coast Guard (USCG)

<http://www.uscg.mil>

United States Corps of Engineers (USCOE)

St Louis District

<http://www.mvs.usace.army.mil>

Rock Island District

<http://www.mvr.usace.army.mil>

Chicago District

<http://www.lrc.usace.army.mil>

State of Illinois

<https://www2.illinois.gov>

Illinois Department of Transportation (IDOT)

<http://www.idot.illinois.gov>

Illinois Department of Natural Resources (IDNR)

<http://www.dnr.illinois.gov>

Illinois Department of Labor (IDOL)

<https://www.illinois.gov/idol>

Illinois Department of Financial & Professional Regulation (IDFPR)

<http://www.idfpr.com>

Illinois State Police (ISP)

<http://www.isp.state.il.us>

Illinois State Toll Highway Authority (ISTHA)

<https://www.illinoistollway.com>

Chicago Department of Transportation (CDOT)

<http://www.cityofchicago.org/city/en/depts/cdot.html>

Associations, Institutes, and Societies

American Association of State Highway Transportation Officials (AASHTO)

<http://www.transportation.org>

National Highway Institute (NHI)

<https://www.nhi.fhwa.dot.gov>

National Society of Professional Engineer's (NSPE)

<http://www.nspe.org>

Illinois Association of County Engineers (IACE)

<http://www.iaceng.org>

Illinois Municipal League (IML)

<http://www.iml.org>

Illinois Society of Professional Engineers (ISPE)

<http://www.illinoisengineer.com>

Structural Engineers Association of Illinois (SEAOI)

<http://www.seaoi.org>

Accreditation Board of Engineering and Technology (ABET)

<http://www.abet.org>

American Society of Nondestructive Testing (ASNT)

<https://www.asnt.org>

American Society for Testing Materials (ASTM)

<http://www.astm.org>

National Institute for Certification in Engineering Technologies (NICET)

<http://www.nicet.org>

Publications, Regulations, and Training

AASHTO – Bookstore

<https://bookstore.transportation.org>

FHWA – Bridges & Structures

<https://www.fhwa.dot.gov/bridge>

FHWA – Memorandums

<https://www.fhwa.dot.gov/legregs/directives/policy>

FHWA – National Bridge Inspection Standards (NBIS)

<https://www.fhwa.dot.gov/bridge/nbis.cfm>

FHWA – Technical Advisories

<https://www.fhwa.dot.gov/reports/techadvs.cfm>

NHI – Store & Course Catalog

<https://www.nhi.fhwa.dot.gov/store>

IDOT – Consultant Resources

<http://www.idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources>

IDOT –Resources

<http://www.idot.illinois.gov/home/resources/resources>

IDOT – BridgeWatch

<https://ildot.bridgewatch.us/main/admin-login.html>

[Requires authorized User Log-In]

Oregon DOT / FHWA – Digital Image Rectification Tool for Metrification of Gusset Plate Connections in Steel Truss Bridges

<http://library.state.or.us/repository/2009/200903241458232/index.pdf>

A-3 Definitions

AASHTO - American Association of State Highway and Transportation Officials, name changed from AASHO (American Association of State Highway Officials) in 1973

American Association of State Highway and Transportation Officials (AASHTO) Manual - “The Manual for Bridge Evaluation,” published by the American Association of State Highway and Transportation Officials (incorporated by reference into 23 CFR 650)

abutment - part of bridge substructure at either end of bridge which transfers loads from superstructure to foundation and provides lateral support for the approach roadway embankment

ADT - Average Daily Traffic

ADTT - Average Daily Truck Traffic

aggradation - progressive raising of a streambed by deposition of sediment

anchorage - the complete assemblage of members and parts, embedded in concrete, rock or other fixed material, designed to hold a portion of a structure in correct position

anchor bolt - a metal rod or bar commonly threaded and fitted with a nut and washer at one end only, used to secure in a fixed position upon the substructure the bearings of a bridge, the base of a column, a pedestal, shoe, or other member of a structure

anchor span - the span that counterbalances and holds in equilibrium the cantilevered portion of an adjacent span; also called the back span; see CANTILEVER BEAM, GIRDER, or TRUSS

appraisal rating - a judgment of a bridge component's adequacy in comparison to current standards

approach - the part of the roadway immediately before and after the bridge structure

approach pavement - an approach which has a cross section that is either the same as or slightly wider than the bridge deck width

approach slab - a reinforced concrete slab placed on the approach embankment adjacent to and usually resting upon the abutment back wall; the function of the approach slab is to carry wheel loads on the approaches directly to the abutment, thereby transitioning any approach roadway misalignment due to approach embankment settlement

appurtenance - an element that contributes to the general functionality of the bridge site (e.g., lighting, signing)

apron - a form of scour (erosion) protection consisting of timber, concrete, riprap, paving, or other construction material placed adjacent to abutments and piers to prevent undermining

arch - a curved structure element primarily in compression that transfers vertical loads through inclined reactions to its end supports

arch rib - the main support element used in open spandrel arch construction; also known as arch ring

armor - a secondary steel member installed to protect a vulnerable part of another member, e.g., steel angles placed over the edges of a joint; also scour protection such as rip rap

as-built plans - plans made after the construction of a project, showing all field changes to the final design plans (i.e. showing how the bridge was actually built)

ASTM - American Society for Testing and Materials

axle load - the load borne by one axle of a traffic vehicle, a movable bridge, or other motive equipment or device and transmitted through a wheel or wheels

B

backfill - material, usually soil or coarse aggregate, used to fill the unoccupied portion of a substructure excavation such as behind an abutment stem and backwall

backstay - cable or chain attached at the top of a tower and extending to and secured upon the anchorage to resist overturning stresses exerted upon the tower by a suspended span

backwall - the topmost portion of an abutment above the elevation of the bridge seat, functioning primarily as a retaining wall with a live load surcharge; it may serve also as a support for the extreme end of the bridge deck and the approach slab

backwater - the back up of water in a stream due to a downstream obstruction or constriction

bank - sloped sides of a waterway channel or approach roadway, short for embankment

bascule bridge - a bridge over a waterway with one or two leaves which rotate from a horizontal to a near-vertical position, providing unlimited overhead clearance

base metal - the surface metal of a steel element to be incorporated in a welded joint; also known as structure metal, parent metal

base plate - steel plate, whether cast, rolled or forged, connected to a column, bearing or other member to transmit and distribute its load to the substructure

batten plate - a plate with two or more fasteners at each end used in lieu of lacing to tie together the shapes comprising a built-up member

batter - the inclination of a surface in relation to a horizontal or a vertical plane; commonly designated on bridge detail plans as a ratio (e.g., 1:3, H:V); see RAKE

battered pile - a pile driven in an inclined position to resist horizontal forces as well as vertical forces

bay - the area of a bridge floor system between adjacent multi-beams or between adjacent floor beams

beam - a linear structural member designed to span from one support to another and support vertical loads

bearing - a support element transferring loads from superstructure to substructure while permitting limited movement capability

bearing capacity - the load per unit area which a structural material, rock, or soil can safely carry

bearing failure - crushing of material under extreme compressive load

bearing pile - a pile which provides support through the tip (or lower end) of the pile

bearing plate - a steel plate, which transfers loads from the superstructure to the substructure

bearing pressure - the bearing load divided by the area to which it is applied

bearing seat - a prepared horizontal surface at or near the top of a substructure unit upon which the bearings are placed

bearing stiffener - a vertical web stiffener at the bearing location

bearing stress - see BEARING PRESSURE

bedding - the soil or backfill material used to support pipe culverts

bedrock - the undisturbed rock layer below the surface soil

bench mark - an established reference point with known elevation and coordinates, used to document dimensions, elevations or position movement

bending moment - the internal force within a beam resulting from transverse loading

bent - a substructure unit made up of two or more column or column-like members connected at their top-most ends by a cap, strut, or other member holding them in their correct positions

berm - the line that defines the location where the top surface of an approach embankment or causeway is intersected by the surface of the side slope

bituminous concrete - a mixture of aggregate and liquid asphalt or bitumen, which is compacted into a dense mass

blanket - a streambed protection against scour placed adjacent to abutments and piers

BMS - Bridge Management System

bolster - a block-like member used to support a bearing on top of a pier cap or abutment bridge seat; see PEDESTAL

bond - in reinforced concrete, the grip of the concrete on the reinforcing bars, which prevents slippage of the bars relative to the concrete mass

bond stress - a term commonly applied in reinforced concrete construction to the stress developed by a force tending to produce movement or slippage at the interface between the concrete and the reinforcement bars

bowstring truss - a general term applied to a truss of any type having a polygonal arrangement of its top chord members conforming to or nearly conforming to the arrangement required for a parabolic truss; a truss with a curved top chord

box beam - a hollow structural beam with a square, rectangular, or trapezoidal cross-section that supports vertical loads and provides torsional rigidity

box culvert - a culvert of rectangular or square cross-section

box girder - a hollow, rectangular or trapezoidal shaped girder, a primary member along the longitudinal axis of the bridge, which provides good torsional rigidity

bracing - a system of secondary members that maintains the geometric configuration of primary members

bracket - a projecting support fixed upon two intersecting members to strengthen and provide rigidity to the connection

breastwall - the portion of an abutment between the wings and beneath the bridge seat; the breast wall supports the superstructure loads, and retains the approach fill; see STEM

bridge - a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening

bridge deficiency - a defect in a bridge component or member that makes the bridge less capable or less desirable for use

bridge inspection experience - active participation in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominant amount in bridge inspection, is acceptable.

bridge inspection refresher training - the National Highway Institute “Bridge Inspection Refresher Training Course” or other State, local, or federally developed instruction aimed to improve quality of inspections, introduce new techniques, and maintain the consistency of the inspection program.

Bridge Inspector's Reference Manual (BIRM) - a comprehensive FHWA manual on programs, procedures and techniques for inspecting and evaluating a variety of in-service highway bridges.

bridge pad - the raised, leveled area upon which the pedestal, masonry plate or other corresponding element of the superstructure bears on the substructure; also called bridge seat bearing area

bridge seat - the top surface of an abutment or pier upon which the superstructure span is placed and supported; for an abutment it is the surface forming the support for the superstructure and from which the backwall rises; for a pier it is the entire top surface

bridge site - the position or location of a bridge and its surrounding area

bridging - a carpentry term applied to the cross-bracing fastened between timber beams to increase the rigidity of the floor construction, limit differential deflection and minimize the effects of impact and vibration

brittle fracture - the failure of a steel member occurring without warning, prior to plastic deformation

brush curb - a narrow curb, 9 inches or less in width, which prevents a vehicle from brushing against the railing or parapet

buckle - to fail by an inelastic change in alignment (deflection) as a result of compression in axial loaded members

built-up member - a column or beam composed of plates and angles or other structural shapes united by bolting, riveting or welding to enhance section properties

bulb t-girder - a t-shaped concrete girder with a bulb shape at the bottom of the girder cross section

bulkhead - a retaining wall-like structure commonly composed of driven sheet piles or a barrier of wooden timbers or reinforced concrete members

buoyancy - upward pressure exerted by the fluid in which an object is immersed

butt joint - a joint between two pieces of metal that have been connected in the same plane

buttress - a bracket-like wall, of full or partial height, projecting from another wall; the buttress strengthens and stiffens the wall against overturning forces; all parts of a buttress act in compression

buttressed wall - a retaining wall designed with projecting buttresses to provide strength and stability

butt weld - a weld joining two plates or shapes end to end; also splice weld

C

cable - a tension member comprised of numerous individual steel wires or strands twisted and wrapped in such a fashion to form a rope of steel; see SUSPENSION BRIDGE

cable band - a steel casting with clamp bolts which fixes a floor system suspender cable to the catenary cable of a suspension bridge

cable-stayed bridge - a bridge in which the superstructure is directly supported by cables, or stays, passing over or attached to towers located at the main piers

caisson - a rectangular or cylindrical chamber for keeping water or soft ground from flowing into an excavation

camber - the slightly arched or convex curvature provided in beams to compensate for dead load deflection; in general, a structure built with perfectly straight lines appears slightly sagged

cantilever - a structural member that has a free end projecting beyond a support; length of span overhanging the support

cantilever abutment - an abutment that resists lateral earth pressure through the opposing cantilever action of a vertical stem and horizontal footing

cantilever bridge - a general term applying to a bridge having a superstructure incorporating cantilever design

cantilever span - a superstructure span composed of two cantilever arms, or of a suspended span supported by one or two cantilever arms

cap - the topmost portion of a pier or a pile bent serving to distribute the loads upon the columns or piles and to hold them in their proper relative positions; see PIER CAP, PILE CAP

cap beam - the top member in a bent that ties together the supporting members

capstone - the topmost stone of a masonry pillar, column or other structure requiring the use of a single capping element

carbon steel - steel (iron with dissolved carbon) owing its properties principally to its carbon content; ordinary, unalloyed steel

cast-in-place (C.I.P.) - the act of placing and curing concrete within formwork to construct a concrete element in its final position

cast iron - relatively pure iron, smelted from iron ore, containing 1.8 to 4.5% free carbon and cast to shape

catch basin - a receptacle, commonly box shaped and fitted with a grilled inlet and a pipe outlet drain, designed to collect the rainwater and floating debris from the roadway surface and retain the solid material so that it may be periodically removed

catenary - the curve obtained by suspending a uniformly loaded rope or cable between two points

cathode - the negatively charged pole of a corrosion cell that accepts electrons and does not corrode

cathodic protection - a means of preventing metal from corroding by making it a cathode through the use of impressed direct current or by attaching a sacrificial anode

catwalk - a narrow walkway for access to some part of a structure **causeway** - an elevated roadway crossing a body of water

cement mortar - a mixture of sand and cement with enough water to make it plastic

cement paste - the plastic combination of cement and water that supplies the cementing action in concrete

centerline of bearings - a horizontal line that passes through the centers of the bearings, used in abutment/pier layout and beam erection

center of gravity - the point at which the entire mass of a body acts; the balancing point of an object

centroid - that point about which the static moment of all the elements of area is equal to zero

chain drag - a chain or a series of short medium weight chains attached to a T-shaped handle; used as a preliminary technique for sounding a large deck area for delamination

chamfer - an angled edge or corner, typically formed in concrete

channel - a waterway connecting two bodies of water or containing moving water; a rolled steel member having a C-shaped cross section

channel profile - a longitudinal section of a channel along its centerline

check - a crack in wood occurring parallel with the grain and through the rings of annual growth

chloride - an ingredient in deicing agents that can damage concrete and steel bridge elements

chord - a generally horizontal member of a truss

circular arch - an arch in which the intrados surface has a constant radius

clearance - the unobstructed vertical or horizontal space provided between two objects

clear headroom - the vertical clearance beneath a bridge structure available for navigational use

clear span - the unobstructed space or distance between support elements of a bridge or bridge member

clip angle - see CONNECTION ANGLE

closed spandrel arch - a stone, brick or reinforced concrete arch span having spandrel walls to retain the spandrel fill or to support either entirely or in part the floor system of the structure when the spandrel is not filled

coarse aggregate - aggregate that stays on a sieve of 5 mm (1/4") square opening

coating - a material that provides a continuous film over a surface in order to protect or seal it; a film formed by the material

coefficient of thermal expansion - the unit change in dimension produced in a material by a change of one degree in temperature

cofferdam - a temporary dam-like structure constructed around an excavation to exclude water; see SHEET PILE COFFERDAM

column - a general term applying to a vertical member resisting compressive stresses and having, in general, a considerable length in comparison with its transverse dimensions

column bent - a bent shaped pier that uses columns incorporated with a cap beam

compaction - the process by which a sufficient amount of energy (compressive pressure) is applied to soil or other material to increase its density

complex bridge - movable, suspension, cable stayed, tied arch, concrete segmental, and other bridges with unusual characteristics (Illinois definition)

component - a general term reserved to define a bridge deck, superstructure or substructure

composite action - the contribution of a concrete deck to the moment resisting capacity of the superstructure beam when the superstructure beams are not the same material as the deck

composite construction - a method of construction whereby a cast-in-place concrete deck is mechanically attached to superstructure members by shear connectors

comprehensive bridge inspection training - training that covers all aspects of bridge inspection and enables inspectors to relate conditions observed on a bridge to established criteria (see the Bridge Inspector's Reference Manual for the recommended material to be covered in a comprehensive training course).

compression - a type of stress involving pressing together; tends to shorten a member; opposite of tension

compression failure - buckling, crushing, or collapse caused by compression stress

compression flange - the part of a beam that is compressed due to a bending moment

compression seal joint - a joint consisting of a neoprene elastic seal squeezed into the joint opening

concentrated load - a force applied over a small contact area; also known as point load

concrete - a stone-like mass made from a mixture of aggregates and cementing material, which is moldable prior to hardening; see BITUMINOUS CONCRETE and PORTLAND CEMENT CONCRETE

concrete beam - a structural member of reinforced concrete designed to carry bending loads

concrete pile - a pile constructed of reinforced concrete either precast and driven into the ground or cast-in-place in a hole bored into the ground

concrete tee team - "T" shaped section of reinforced concrete; cast-in-place monolithic deck and beam system

condition rating - a judgment of a bridge component condition in comparison to its original as-built condition

connection angle - a piece of angle serving to connect two elements of a member or two members of a structure; also known as clip angle

consolidation - the time dependent change in volume of a soil mass under compressive load caused by water slowly escaping from the pores or voids of the soil

construction joint - a pair of adjacent surfaces in reinforced concrete where two pours have met, reinforcement steel extends through this joint

continuous beam - a general term applied to a beam that spans uninterrupted over one or more intermediate supports

continuous bridge - a bridge designed to extend without joints over one or more interior supports

continuous footing - a common footing that is underneath a wall, or columns

continuous span - spans designed to extend without joints over one or more intermediate supports

continuous truss - a truss without hinges having its chord and web members arranged to continue uninterrupted over one or more intermediate points of support

continuous weld - a weld extending throughout the entire length of a connection

contraction - the thermal action of the shrinking of an object when cooled; opposite of expansion

coping - a course of stone laid with a projection beyond the general surface of the masonry below it and forming the topmost portion of a wall; a course of stone capping the curved or V-shaped extremity of a pier, providing a transition to the pier head proper, when so used it is commonly termed the "starling coping", "nose coping," the "cutwater coping" or the "pier extension coping"

corbel - a piece constructed to project from the surface of a wall, column or other portion of a structure to serve as a support for another member

core - a cylindrical sample of concrete or timber removed from a bridge component for the purpose of destructive testing to determine the condition of the component

corrosion - the general disintegration of metal through oxidation

corrugated - an element with alternating ridges and valleys

counter - a truss web member that undergoes stress reversal and resists only live load tension; see WEB MEMBERS

counterfort - a bracket-like wall connecting a retaining wall stem to its footing on the side of the retained material to stabilize the wall against overturning; a counterfort, as opposed to a buttress, acts entirely in tension

counterfort abutment - an abutment that develops resistance to bending moment in the stem by use of counterforts. This permits the breast wall to be designed as a horizontal beam or slab spanning between counterforts, rather than as a vertical cantilever slab

counterfort wall - a retaining wall designed with projecting counterforts to provide strength and stability

counterweight - a weight which is used to balance the weight of a movable member; in bridge applications counterweights are used to balance a movable span so that it rotates or lifts with minimum resistance. Also sometimes used in continuous structures to prevent uplift

couplant - a viscous fluid material used with ultrasonic gages to enhance transmission of sound waves

couple - two forces that are equal in magnitude, opposite in direction, and parallel with respect to each other

coupon - a sample of steel taken from an element in order to test material properties

cover - the clear thickness of concrete between a reinforcing bar and the surface of the concrete; the depth of backfill over the top of a pipe or culvert

covered bridge - an indefinite term applied to a wooden bridge having its roadway protected by a roof and enclosing sides

cover plate - a plate used in conjunction with a flange or other structural shapes to increase flange section properties in a beam, column, or similar member

crack - a break without complete separation of parts; a fissure

cracking (reflection) - visible cracks in an overlay indicating cracks in the concrete underneath

crack initiation - the beginning of a crack usually at some microscopic defect

crack propagation - the growth of a crack due to energy supplied by repeated stress cycles

creep - an inelastic deformation that occurs under a constant load, below the yield point, and increases with time

creosote - an oily liquid obtained by the distillation of coal or wood tar and used as a wood preservative

crib - a structure consisting of a foundation grillage combined with a superimposed framework providing compartments or coffer which are filled with gravel, concrete or other material satisfactory for supporting the structure to be placed thereon

cribbing - a construction consisting of wooden, metal or reinforced concrete units so assembled as to form an open cellular-like structure for supporting a superimposed load or for resisting horizontal or overturning forces acting against it.

cribwork - large timber cells that are submerged full of concrete to make an underwater foundation

critical finding - a structural or safety related deficiency that requires immediate follow-up inspection or action

cross - transverse bracings between two main longitudinal members; see DIAPHRAGM, BRACING

cross frame - steel elements placed in "X" shaped patterns to act as stiffeners between the main carrying superstructure members

cross girders - transverse girders, supported by bearings, which support longitudinal beams or girders

cross-section - the shape of an object cut transversely to its length

cross-sectional area - the area of a cross-section

crow - the highest point of the transverse cross section of a roadway, pipe or arch; also known as soffit or vertex

crow of roadway - the vertical dimension describing the total amount the surface is convexed or raised from gutter to centerline; this is sometimes termed the cross fall or cross slope of roadway

culvert - a drainage structure beneath an embankment (e.g., corrugated metal pipe, concrete box culvert)

curb - a low barrier at the side limit of the roadway used to guide the movement of vehicles

curb inlet - see SCUPPER

curtain wall - a term commonly applied to a thin wall between main columns designed to withstand only secondary loads. Also the wall portion of a buttress or counterfort abutment that spans between the buttresses or counterforts

curvature - the degree of curving of a line or surface

curved girder - a girder that is curved in the horizontal plane in order to adjust to the horizontal alignment of the bridge

cutoff wall - vertical wall at the end of an apron or slab to prevent scour undermining

cutwater - a sharp-edged structure, facing the water channel current, built around a bridge pier to protect it from the flow of water and debris in the water

cyclic stress - stress that varies with the passage of live loads; see STRESS RANGE

D

damage inspection - this is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions

dead load - a static load due to the weight of the structure itself

debris - material including floating wood, trash, suspended sediment or bed load moved by a flowing stream

deck - that portion of a bridge which provides direct support for vehicular and pedestrian traffic, supported by a superstructure

deck arch - an arch bridge with the deck above the top of the arch

deck bridge - a bridge in which the supporting members are all beneath the roadway

decking - bridge flooring installed in panels, e.g., timber planks

deck joint - a gap allowing for rotation or horizontal movement between two spans or an approach and a span

deficiency - see BRIDGE DEFICIENCY

deflection - elastic movement of a structural member under a load

deformation - distortion of a loaded structural member; may be elastic or inelastic

deformed bars - concrete reinforcement consisting of steel bars with projections or indentations (deformations) to increase the mechanical bond between the steel and concrete

degradation - general progressive lowering of a stream channel by scour

delamination - surface separation of concrete into layers; separation of glue laminated timber plies

design load - the force for which a structure is designed; the most severe combination of loads

deterioration - decline in quality over a period of time due to chemical or physical degradation

diagonal - a sloping structural member of a truss or bracing system

diagonal stay - a cable support in a suspension bridge extending diagonally from the tower to the roadway to add stiffness to the structure and diminish the deformations and undulations resulting from traffic service

diagonal tension - the tensile force due to horizontal and vertical shear in a beam

diaphragm - a transverse member placed within a member or superstructure system to distribute stresses and improves strength and rigidity; see BRACING

diaphragm wall - a wall built transversely to the longitudinal centerline of a spandrel arch serving to tie together and reinforce the spandrel walls, together with providing a support for the floor system in conjunction with the spandrel walls; also known as cross wall

differential settlement - uneven settlement of individual or independent elements of a substructure; tilting in the longitudinal or transverse direction due to deformation or loss of foundation material

dike - an earthen embankment constructed to retain or redirect water; when used in conjunction with a bridge, it prevents stream erosion and localized scour and/or so directs the stream current such that debris does not accumulate; see SPUR

discharge - the volume of fluid per unit of time flowing along a pipe or channel

displacement induced stress - stresses caused by differential deflection of adjacent parts

distributed load - a load uniformly applied along the length of an element or component of a bridge

ditch - a trough-like excavation made to collect water

diver - a specially trained individual who inspects the underwater portion of a bridge substructure and the surrounding channel

dolphin - a group of piles driven close together or a caisson placed to protect portions of a bridge exposed to possible damage by collision with river or marine traffic

dowel - a length of bar embedded in two parts of a structure to hold the parts in place and to transfer stress

drainage - a system designed to remove water from a structure

drainage area - an area in which surface run-off collects and from which it is carried by a drainage system; also known as catchment area

drain hole - hole in a box shaped member or a wall to provide means for the exit of accumulated water or other liquid; also known as drip hole; see WEEP HOLE

drain pipes - pipes that carry storm water

drawbridge - a general term applied to a bridge over a navigable body of water having a movable superstructure span of any type

drift bolt - a short length of metal bar used to connect and hold in position wooden members placed in contact; similar to a dowel

drift pin - tapered steel rod used by ironworkers to align bolt holes

drip notch - a recess cast on the underside of an overhang that prevents water from following the concrete surface onto the supporting beams

drop inlet - a type of inlet structure that conveys the water from a higher elevation to a lower outlet elevation smoothly without a free fall at the discharge

duct - the hollow space where a prestressing tendon is placed in a post-tensioned prestressed concrete girder

ductile - capable of being molded or shaped without breaking; plastic

ductile fracture - a fracture characterized by plastic deformation

ductility - the ability to withstand non-elastic deformation without rupture

dummy member - truss member that carries no primary loads; may be included for bracing or for appearance

E

E - modulus of elasticity of a material; Young's modulus; the stiffness of a material

efflorescence - a deposit on concrete or brick caused by crystallization of carbonates brought to the surface by moisture in the masonry or concrete

elastic - capable of sustaining deformation without permanent loss of shape

elastic deformation - non-permanent deformation; when the stress is removed, the material returns to its original shape

elasticity - the property whereby a material changes its shape under the action of loads but recovers its original shape when the loads are removed

elastomer - a natural or synthetic rubber-like material

elastomeric pad - a synthetic rubber pad used in bearings that compresses under loads and accommodates horizontal movement by deforming

electrolyte - a medium of air, soil, or liquid carrying ionic current between two metal surfaces, the anode and the cathode

electrolytic cell - a device for producing electrolysis consisting of the electrolyte and the electrodes

electrolytic corrosion - corrosion of a metal associated with the flow of electric current in an electrolyte

elevation view - a drawing of the side view of a structure

elliptic arch - an arch in which the intrados surface is a full half of the surface of an elliptical cylinder; this terminology is sometimes incorrectly applied to a multicentered arch

elongation - the elastic or plastic extension of a member

embankment - a mound of earth constructed above the natural ground surface to carry a road or to prevent water from passing beyond desirable limits; also known as bank

end block - in a prestressed concrete I-beam, the widened beam web at the end to provide adequate anchorage bearing for the post tensioning steel and to resist high shear stresses; similarly, the solid end diaphragm of a box beam

end post - the end compression member of a truss, either vertical or inclined in position and extending from top chord to bottom chord

end section - a concrete or steel appurtenance attached to the end of a culvert for the purpose of hydraulic efficiency, embankment retention or anchorage

end span - a span adjacent to an abutment

epoxy - a synthetic resin which cures or hardens by chemical reaction between components which are mixed together shortly before use

epoxy coated reinforcement - reinforcement steel coated with epoxy; used to prevent corrosion

equilibrium - in statics, the condition in which the forces acting upon a body are such that no external effect (or movement) is produced

equivalent uniform load - a load having a constant intensity per unit of its length producing an effect equal to that of a live load consisting of vehicle axle or wheel concentrations spaced at varying distances

erosion - wearing away of soil by flowing water not associated with a channel; see SCOUR

expansion - an increase in size or volume

expansion bearing - a bearing designed to permit longitudinal or lateral movements resulting from temperature changes and superimposed loads with minimal transmission of horizontal force to the substructure; see BEARING

expansion dam - the part of an expansion joint serving as an end form for the placing of concrete at a joint; also applied to the expansion joint device itself; see EXPANSION JOINT

expansion joint - a joint designed to permit expansion and contraction movements produced by temperature changes, loadings or other forces

expansion rocker - a bearing device at the expansion end of a beam or truss that allows the longitudinal movements resulting from temperature changes and superimposed loads through a tilting motion

expansion roller - a cylinder so mounted that by revolution it facilitates expansion, contraction or other movements resulting from temperature changes, loadings or other forces

expansion shoe - expansion bearing, generally of all metal construction

exterior girder - an outermost girder supporting the bridge floor

eyebars - a member consisting of a rectangular bar with enlarged forged ends having holes for engaging connecting pins

F

failure - a condition at which a structure reaches a limit state such as cracking or deflection where it is no longer able to perform its usual function; collapse; fracture

falsework - a temporary wooden or metal framework built to support the weight of a structure during the period of its construction and until it becomes self-supporting

fascia - an outside, covering member designed on the basis of architectural effect rather than strength and rigidity, although its function may involve both

fascia girder - an exposed outermost girder of a span sometimes treated architecturally or otherwise to provide an attractive appearance

fatigue - the tendency of a member to fail at a stress below the yield point when subjected to repetitive loading

fatigue crack - any crack caused by repeated cyclic loading at a stress below the yield point

fatigue damage - member damage (crack formation) due to cyclic loading

fatigue life - the length of service of a member subject to fatigue, based on the number of cycles it can undergo

fender - a structure that acts as a buffer to protect the portions of a bridge exposed to floating debris and water-borne traffic from collision damage; sometimes called an ice guard in regions with ice floes

fender pier - a pier-like structure which performs the same service as a fender but is generally more substantially built; see GUARD PIER

field coat - a coat of paint applied after the structure is assembled and its joints completely connected; quite commonly a part of the field erection procedure; field painting

fill - material, usually earth, used to change the surface contour of an area, or to construct an embankment

filler - a piece used primarily to fill a space beneath a batten, splice plate, gusset, connection angle, stiffener or other element; also known as filler plate

filler metal - metal prepared in wire, rod, electrode or other form to be fused with the structure metal in the formation of a weld

filler plate - see FILLER

fillet - a curved portion forming a junction of two surfaces that would otherwise intersect at an angle

fillet weld - a weld of triangular or fillet shaped cross-section between two pieces at right angles

fine aggregate - sand or grit for concrete or mortar that passes a No. 4 sieve (4.75 mm)

finger dam - expansion joint in which the opening is spanned by meshing steel fingers or teeth

fish belly - a term applied to a girder or a truss having its bottom flange or its bottom chord constructed either haunched or bow-shaped with the convexity downward; see LENTICULAR TRUSS

fixed beam - a beam with a fixed end

fixed bearing - a bearing that allows only rotational movement; see BEARING

fixed bridge - a bridge having constant position, i.e., without provision for movement to create increased navigation clearance

fixed end - movement is restrained

fixed span - a superstructure span having its position practically immovable, as compared to a movable span

fixed support - a support that will allow rotation only, no longitudinal movement

flange - the (usually) horizontal parts of a rolled I-shaped beam or of a built-up girder extending transversely across the top and bottom of the web

flange angle - an angle used to form a flange element of a built-up girder, column, strut or similar member

floating bridge - see PONTOON BRIDGE

floating foundation - used to describe a soil-supported raft or mat foundation with low bearing pressures; sometimes applied to a "foundation raft" or "foundation grillage"

flood frequency - the average time interval in years in which a flow of a given magnitude will recur

flood plain - area adjacent to a stream or river subject to flooding

floor - see DECK

floorbeam - a primary horizontal member located transversely to the general bridge alignment

floor system - the complete framework of members supporting the bridge deck and the traffic loading

flow capacity - maximum flow rate that a channel, conduit, or culvert structure is hydraulically capable of carrying

flux - a material that protects the weld from oxidation during the fusion process

footbridge - a bridge designed and constructed to provide means of traverse for pedestrian traffic only; also known as pedestrian bridge

footing - the enlarged, lower portion of a substructure, which distributes the structure load either to the earth or to supporting piles; the most common footing is the concrete slab; footer is a colloquial term for footing

foot wall - see TOE WALL

force - an influence that tends to accelerate a body or to change its movement

forms - the molds that hold concrete in place while it is hardening; also known as form work, shuttering; see LAGGING, STAY-IN-PLACE FORMS

form work - see FORMS

foundation - the supporting material upon which the substructure portion of a bridge is placed

foundation excavation - the excavation made to accommodate a footing for a structure; also known as foundation pit

foundation failure - failure of a foundation by differential settlement or by shear failure of the soil

foundation grillage - a construction consisting of steel, timber, or concrete members placed in layers; each layer is perpendicular to those above and below it and the members within a layer are generally parallel, producing a crib or grid-like effect. Grillage are usually placed under very heavy concentrated loads

foundation load - the load resulting from traffic, superstructure, substructure, approach embankment, approach causeway, or other incidental load increment imposed upon a given foundation area

foundation pile - see PILE

foundation pit - see FOUNDATION EXCAVATION

foundation seal - a mass of concrete placed underwater within a cofferdam for the base portion of structure to close or seal the cofferdam against incoming water; see TREMIE

fracture - see BRITTLE FRACTURE

fracture critical member (FCM) - a steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse

fracture critical member inspection - a hands-on inspection of a fracture critical member or member components that may include visual and other nondestructive evaluation

frame - a structure which transmits bending moments from the horizontal beam member through rigid joints to vertical or inclined supporting members

framing - the arrangement and connection of the component members of a bridge superstructure

free end - movement is not restrained

friction pile - a pile that provides support through friction resistance between the pile and the surrounding earth along the lateral surface of the pile

friction roller - a roller placed between members intended to facilitate change in their relative positions by reducing the frictional resistance to translation movement

frost heave - the upward movement of, or force exerted by, soil due to freezing of retained moisture

frost line - the depth to which soil may be frozen

functionally obsolete – a bridge that has deck geometry, load carrying capacity, clearance or approach roadway alignment that no longer meets the criteria for the system of which the bridge is a part

G

gabion - rock filled wire baskets used to retain earth and provide erosion control

galvanic action - electrical current between two unlike metals

galvanize - to coat with zinc

gauge - the distance between parallel lines of rails, rivet holes, etc.; a measure of thickness of sheet metal or wire; also known as gage

geometry - shape or form; relationship between lines or points

girder - a horizontal flexural member that is the main or primary support for a structure; any large beam, especially if built up

girder bridge - a bridge whose superstructure consists of two or more girders supporting a separate floor system as differentiated from a multi-beam bridge or a slab bridge

girder span - a span in which the major longitudinal supporting members are girders

glue laminated - a member created by gluing together two or more pieces of lumber

grade - the fall or rise per unit horizontal length; see GRADIENT

grade crossing - a term applicable to an intersection of two highways, two railroads or a railroad and a highway at a common grade or elevation; now commonly accepted as meaning the last of these combinations

grade intersection - the location where two roadway slopes meet in profile; to provide a smooth transition from one to the other they are connected by a vertical curve and the resulting profile is a sag or a crest

grade separation - roadways crossing each other at different elevations; see OVERPASS, UNDERPASS

gradient - the rate of inclination of the roadway and/or sidewalk surface(s) from the horizontal, applying to a bridge and its approaches; it is commonly expressed as a percentage relation (ratio) of horizontal to vertical dimensions

gravity abutment - a thick abutment that resists horizontal earth pressure through its own dead weight

gravity wall - a retaining wall that is prevented from overturning or sliding by its own dead weight

grid flooring - a steel floor system comprising a lattice pattern that may or may not be filled with concrete

grillage - assembly of parallel beams, usually steel or concrete, placed side by side, often in layers with alternating directions; see FOUNDATION GRILLAGE

groin - a wall built out from a river bank to check scour

grout - mortar having a sufficient water content to render it free-flowing, used for filling (grouting) the joints in masonry, for fixing anchor bolts and for filling cored spaces; usually a thin mix of cement, water and sometimes sand or admixtures

grouting - the process of filling in voids with grout

guard pier - a pier-like structure built to protect a swing span in its open position from collision with passing vessels or water-borne debris; may be equipped with a rest pier upon which the swing span in its open position may be latched; see FENDER PIER

guardrail - a safety feature element intended to redirect an errant vehicle

guide rail - see GUARDRAIL

gunite - the process of blowing Portland cement mortar or concrete onto a surface using compressed air

gusset plate - a plate that connects the members of a structure and holds them in correct position at a joint

gutter - a paved ditch; area adjacent to a roadway curb used for drainage

guy - a cable member used to anchor a structure in a desired position

H

H Loading - a combination of loads used to represent a two-axle truck developed by AASHTO

hairline cracks - very narrow cracks that form in the surface of concrete due to tension caused by loading

hammerhead pier - a pier with a single cylindrical or rectangular shaft and a relatively long, transverse cap; also known as a tee pier or cantilever pier

hand hole - hole provided in component plate of built-up box section to permit access to the interior for construction and maintenance purposes

hand rail - commonly applies only to sidewalk railing presenting a latticed, barred, balustered or other open web construction

hands-on - inspection within arm's length of the component. Inspection uses visual techniques that may be supplemented by nondestructive testing

hands-on access - close enough to the member or component so that it can be touched with the hands and inspected visually

hanger - a tension member serving to suspend an attached member; allows for expansion between a cantilevered and suspended span

haunch - an increase in the depth of a member usually at points of support; the outside areas of a pipe between the spring line and the bottom of the pipe

haunched girder - a horizontal beam whose cross sectional depth varies along its length

H-beam - a rolled steel member having an H-shaped cross-section (flange width equals beam depth) commonly used for piling; also H-pile

head - a measure of water pressure expressed in terms of an equivalent weight or pressure exerted by a column of water; the height of the equivalent column of water is the head

head loss - the loss of energy between two points along the path of a flowing fluid due to fluid friction; reported in feet of head

headwall - a concrete structure at the ends of a culvert to retain the embankment slopes, anchor the culvert, and prevent undercutting

headwater - the source or the upstream waters of a stream

heat treatment - any of a number of various operations involving controlled heating and cooling that are used to impart specific properties to metals; examples are tempering, quenching, and annealing

heave - the upward motion of soil caused by outside forces such as excavation, pile driving, moisture or soil expansion; see FROST HEAVE

heel - the portion of a footing behind the stem

helical - having the form of a spiral

high carbon steel - carbon steel containing 0.5 to 1.5% dissolved carbon

highway - the term 'highway' includes:

- A) a road, street, and parkway;
- B) a right-of-way, bridge, railroad-highway crossing, tunnel, drainage structure, sign, guardrail, and protective structure, in connection with a highway; and
- C) a portion of any interstate or international bridge or tunnel and the approaches thereto, the cost of which is assumed by a State transportation department, including such facilities as may be required by the United States Customs and Immigration Services in connection with the operation of an international bridge or tunnel

hinge - a point in a structure at which a member is free to rotate

hinged joint - a joint constructed with a pin, cylinder segment, spherical segment or other device permitting rotational movement

honeycomb - an area in concrete where mortar has separated and left spaces between the coarse aggregate, usually caused by improper vibration during concrete construction

horizontal alignment - a roadway's centerline or baseline alignment in the horizontal plane

horizontal curve - a roadway baseline or centerline alignment defined by a radius in the horizontal plane

Howe truss - a truss of the parallel chord type with a web system composed of vertical (tension) rods at the panel points with an X pattern of diagonals

HS Loading - a combination of loads developed by AASHTO used to represent a truck and trailer

hybrid girder - a girder whose flanges and web are made from steel of different grades

hydraulics - the mechanics of fluids

hydrology - study of the accumulation and flow of water from watershed areas

I

I-beam - a structural member with a cross-sectional shape similar to the capital letter "I"

ice guard - see FENDER

Illinois Licensed Professional Engineer – see **PROFESSIONAL ENGINEER (PE)**

Illinois Licensed Structural Engineer – see **STRUCTURAL ENGINEER (SE)**

impact - A factor that describes the effect on live load due to dynamic and vibratory effects of a moving load; in bridge design, a load based on a percentage of live load to include dynamic and vibratory effects; in fracture mechanics, a rapidly applied load, such as a collision or explosion

incomplete fusion - a weld flaw where the weld metal has not combined metallurgically with the base metal

in-depth inspection - a close-up, inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations

indeterminate stress - stress in a structural member which cannot be calculated directly; it is computed by the iterative application of mathematical equations, usually with an electronic computer; indeterminate stresses arise in continuous span and frame type structures

individual column footing - footing supporting one column

inelastic compression - compression beyond the yield point

initial inspection - the first inspection of a bridge as it becomes a part of the bridge file to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.

inlet - an opening in the floor of a bridge leading to a drain; roadway drainage structure which collects surface water and transfers it to pipes

inspection frequency - the frequency with which the bridge is inspected -- normally every two years

integral abutment - an abutment cast monolithically with the end diaphragm of the deck; such abutments usually encase the ends of the deck beams and are pile supported

integral deck - a deck which is monolithic with the superstructure; concrete tee beam bridges have integral decks

interior girder - any girder between exterior or fascia girders

interior span - a span of which both supports are intermediate substructure units

intermittent weld – a noncontinuous weld commonly composed of a series of short welds separated by spaces of equal length

inventory item - data contained in the structure file pertaining to bridge identification, structure type and material, age and service, geometric data, navigational data, classification, load rating and posting, proposed improvements, and inspections

inventory rating - the capacity of a bridge to withstand loads under normal service conditions based on 55% of yield strength

invert elevation - the bottom or lowest point of the internal surface of the transverse cross section of a pipe or culvert

isotropic - having the same material properties in all directions, e.g., steel

J

jacking - the lifting of elements using a type of jack (e.g., hydraulic), sometimes acts as a temporary support system

jack stringer - the outermost stringer supporting the bridge floor in a panel or bay

jacket - a protective shell surrounding a pile made of fabric, concrete or other material

jersey barrier - a concrete barrier with sloping front face that was developed by the New Jersey Department of Transportation

joint - in masonry, the space between individual stones or bricks; in concrete, a division in continuity of the concrete; in a truss, point at which members of a truss are joined

K

keeper plate - a plate, which is connected to a sole plate, designed to prohibit a beam from becoming dislodged from the bearing

key - a raised portion of concrete on one face of a joint that fits into a depression on the adjacent face

king-post - the vertical member in a "king-post" type truss; also known as king rod

king-post truss - two triangular panels with a common center vertical; the simplest of triangular system trusses

kip - a kilo pound (1000 lb.); convenient unit for structural calculations

knee brace - a short member engaging at its ends two other members that are joined to form a right angle or a near-right angle to strengthen and stiffen the connecting joint

knee wall - a return of the abutment backwall at its ends to enclose the bridge seat on three of its sides; also called cheek wall

knife edge - a condition in which corrosion of a steel member has caused a sharp edge

knuckle - an appliance forming a part of the anchorage of a suspension bridge main suspension member permitting movement of the anchorage chain

K-truss - a truss having a web system wherein the diagonal members intersect the vertical members at or near the mid-height; the assembly in each panel forms a letter "K"

L

L-abutment - a cantilever abutment with the stem flush with the toe of the footing, forming an "L" in cross section

laced column - a riveted, steel built-up column of usually four angles or two channels tied together laterally with lacing

lacing - small flat plates, usually with one rivet at each end, used to tie individual sections of built up members; see LATTICE

lagging - horizontal members spanning between piles to form a wall; forms used to produce curved surfaces; see FORMS

lamellar tear - incipient cracking parallel to the face of a steel member

laminated timber - timber planks glued together face to face to form a larger member; see GLUE LAMINATED

lane loading - a design loading which represents a line of trucks crossing over a bridge

lap joint - a joint between two members in which the end of one member overlaps the end of the other

lateral - a member placed approximately perpendicular to a primary member

lateral bracing - the bracing assemblage engaging a member perpendicular to the plane of the member; intended to resist transverse movement and deformation; also keeps primary parallel elements in truss bridges and girder bridges aligned; see BRACING

lattice - a crisscross assemblage of diagonal bars, channels, or angles on a truss; also known as latticing, lacing

lattice truss - in general, a truss having its web members inclined but more commonly the term is applied to a truss having two or more web systems composed entirely of diagonal members at any interval and crossing each other without reference to vertical members

leaching - the action of removing substances from a material by passing water through it

leaf - the movable portion of a bascule bridge that forms the span of the structure

legal load - the maximum legal load for each vehicle configuration permitted by law for the State in which the bridge is located

lenticular truss - a truss having parabolic top and bottom chords curved in opposite directions with their ends meeting at a common joint; also known as a fish belly truss

levee - an embankment built to prevent flooding of low-lying land

leveling course - a layer of bituminous concrete placed to smooth an irregular surface

light-weight concrete - concrete of less than standard unit weight; may be no-fines concrete, aerated concrete, or concrete made with lightweight aggregate

link - a hanger plate in a pin and hanger assembly whose shape is similar to an eyebar, e.g., the head (at the pinhole) is wider than the shank

link and roller - a movable bridge element consisting of a hinged strut-like link fitted with a roller at its bottom end, supported upon a shoe plate or pedestal and operated by a thrust strut serving to force it into a vertical position and to withdraw it therefrom; when installed at each outermost end of the girders or the trusses of a swing span their major function is to lift them to an extent that their camber or droop will be removed and the arms rendered free to act as simple spans; when the links are withdrawn to an inclined position fixed by the operating mechanism the span is free to be moved to an open position

live load - a temporary dynamic load such as vehicular traffic that is applied to a structure; also accompanied by vibration or movement affecting its intensity

load - a force carried by a structure component

load factor design - a design method used by AASHTO, based on limit states of material and arbitrarily increased loads

load indicating washer - a washer with small projections on one side, which compress as the bolt is tightened; gives a direct indication of the bolt tension that has been achieved

load rating - the determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection

load and resistance factor design (LRFD) - design method used by AASHTO, based on limit states of material with increased loads and reduced member capacity based on statistical probabilities

local buckling - localized buckling of a beam's plate element, can lead to failure of member

longitudinal bracing - bracing that runs lengthwise with a bridge and provides resistance against longitudinal movement and deformation of transverse members

loss of prestress - loss of prestressing force due to a variety of factors, including shrinkage and creep of the concrete, creep of the prestressing tendons, and loss of bond

lower chord - the bottom horizontal member of a truss

luminaire - a lighting fixture

M

main beam - a horizontal structural member which supports the span and bears directly on a column or wall

maintenance - basic repairs performed on a facility to keep it at an adequate level of service

maintenance and protection of traffic - the management of vehicular and pedestrian traffic through a construction zone to ensure the safety of the public and the construction workforce; MPT; TRAFFIC PROTECTION

marine borers - mollusks and crustaceans that live in water and destroy wood by digesting it

masonry - that portion of a structure composed of stone, brick or concrete block placed in courses and usually cemented with mortar

masonry cement - Portland cement and lime used to make mortar for masonry construction

masonry plate - a steel plate placed on the substructure to support a superstructure bearing and to distribute the load to the masonry beneath

mattress - a flexible scour protection blanket composed of interconnected timber, gabions, or concrete units.

meander - a twisting, winding action from side to side; characterizes the serpentine curvature of a narrow, slow flowing stream in a wide flood plain

median - separation between opposing lanes of highway traffic; also known as median strip

member - an individual angle, beam, plate, or built component piece intended ultimately to become an integral part of an assembled frame or structure

metal corrosion - oxidation of metal by electro-galvanic action involving an electrolyte (moisture), an anode (the metallic surface where oxidation occurs), a cathode (the metallic surface that accepts electrons and does not corrode), and a conductor (the metal piece itself)

midspan - a reference point half-way between the supports of a beam or span

military loading - a loading pattern used to simulate heavy military vehicles passing over a bridge

mill scale - dense iron oxide on iron or steel that forms on the surface of metal that has been forged or hot worked

modular joint - a bridge joint designed to handle large movements consisting of an assembly of several strip or compression seals

moisture content - the amount of water in a material expressed as a percent by weight **moment** - the couple effect of forces about a given point; see BENDING MOMENT **monolithic** - forming a single mass without joints

mortar - a paste of Portland cement, sand, and water laid between bricks, stones or blocks

movable bridge - a bridge having one or more spans capable of being raised, turned, lifted, or slid from its normal service location to provide a clear navigation passage; see BASCULE BRIDGE, VERTICAL LIFT BRIDGE, PONTOON BRIDGE, RETRACTILE DRAW BRIDGE, ROLLING LIFT BRIDGE, and SWING BRIDGE

movable span - a general term applied to a superstructure span designed to be swung, lifted or otherwise moved longitudinally, horizontally or vertically, usually to provide increased navigational clearance

moving load - a live load which is moving, for example, vehicular traffic

MPT - see MAINTENANCE AND PROTECTION OF TRAFFIC

MSE - mechanically stabilized earth; see REINFORCED EARTH

N

nail laminated - a laminated member produced by nailing two or more pieces of timber together face to face

NBIS - National Bridge Inspection Standards, first established in 1971 to set national policy regarding bridge inspection frequency, inspector qualifications, report formats, and inspection and rating procedures

NCHRP - National Cooperative Highway Research Program

NICET - National Institute for Certification in Engineering Technologies, the NICET provides nationally applicable voluntary certification programs covering several broad engineering technology fields and a number of specialized subfields. For information on the NICET program certification contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314-2794.

NDE - nondestructive evaluation

NDT - nondestructive testing; any testing method of checking structural quality of materials that does not damage them

necking - the elongation and contraction in area that occurs when a ductile material is stressed

negative bending - bending of a member that causes tension in the surface adjacent to the load, e.g., moment at interior supports of a span or at the joints of a frame

negative moment - bending moment in a member such that tension stresses are produced in the top portions of the member; typically occurs in continuous beams and spans over the intermediate supports

neoprene - a synthetic rubber-like material used in expansion joints and elastomeric bearings

neutral axis - the internal axis of a member in bending along which the strain is zero; on one side of the neutral axis the fibers are in tension, on the other side the fibers are in compression

nose - a projection acting as a cut water on the upstream end of a pier; see STARLING

notch effect - stress concentration caused by an abrupt discontinuity or change in section

O

offset - a horizontal distance measured at right angles to a survey line to locate a point off the line

on center - a description of a typical dimension between the centers of the objects being measured

open spandrel arch - a bridge that has open spaces between the deck and the arch members allowing "open" visibility through the bridge

open spandrel ribbed arch - a structure in which two or more comparatively narrow arch rings, called ribs, function in the place of an arch barrel; the ribs are rigidly secured in position by arch rib struts located at intervals along the length of the arch; the arch ribs carry a column type open spandrel construction which supports the floor system and its loads

operating rating - the capacity of a bridge to withstand loads based on 75% of yield strength; the maximum permissible live load to which the structure may be subjected for the load configuration used in the rating

operator's house - the building containing control devices required for opening and closing a movable bridge span

orthotropic - having different properties in two or more directions at right angles to each other (e.g., wood); see ANISOTROPY

outlet - in hydraulics, the discharge end of drains, sewers, or culverts

out-of-plane distortion - distortion of a member in a plane other than that which the member was designed to resist

overlay - see WEARING SURFACE

overload - a weight greater than the structure is designed to carry

overpass - bridge over a roadway or railroad

overturning - tipping over; rotational movement

oxidation - the chemical breakdown of a substance due to its reaction with oxygen from the air

oxidized steel - rust

pack - a steel plate inserted between two others to fill a gap and fit them tightly together; also known as packing; fill; filler plate

pack rust - rust forming between adjacent steel surfaces in contact which tends to force the surfaces apart due to the increase in material volume

paddleboard - striped, paddle-shaped signs or boards placed on the roadside in front of a narrow bridge as a warning of reduced roadway width

panel - the portion of a truss span between adjacent points of intersection of web and chord members

panel point - the point of intersection of primary web and chord members of a truss

parabolic arch - an arch in which the intrados surface is a segment of a symmetrical parabolic surface (suited to concrete arches)

parabolic truss - a polygonal truss having its top chord and end post vertices coincident with the arc of a parabola, its bottom chord straight and its web system either triangular or quadrangular; also known as a parabolic arched truss

parapet - a low wall along the outmost edge of the roadway of a bridge to protect vehicles and pedestrians

pedestal - concrete or built-up metal member constructed on top of a bridge seat for the purpose of providing a specific bearing seat elevation

pedestal pier - one or more piers built in block-like form that may be connected by an integrally built web between them; when composed of a single, wide block-like form, it is called a wall or solid pier

pedestrian bridge - see FOOT BRIDGE

penetration - when applied to creosoted lumber, the depth to which the surface wood is permeated by the creosote oil; when applied to pile driving; the depth a pile tip is driven into the ground

physical testing - the testing of bridge members in the field or laboratory

pier - a substructure unit that supports the spans of a multi-span superstructure at an intermediate location between its abutments

pier cap - the topmost horizontal portion of a pier that distributes loads from the superstructure to the vertical pier elements

pile - a shaft-like linear member which carries loads to underlying rock or soil strata

pile bent - a row of driven or placed piles extending above the ground surface supporting a pile cap; see BENT

pile bridge - a bridge carried on piles or pile bents

pile cap - a slab or beam which acts to secure the piles in position laterally and provides a bridge seat to receive and distribute superstructure loads

pile foundation - a foundation supported by piles in sufficient number and to a depth adequate to develop the bearing resistance required to support the substructure load

pile pier - see PILE BENT

piling - collective term applied to group of piles in a construction; see PILE, SHEET PILES

pin - a cylindrical bar used to connect elements of a structure

pin-connected truss - a general term applied to a truss of any type having its chord and web members connected at each panel point by a single pin

pin and hanger - a hinged connection detail designed to allow for expansion and rotation between a cantilevered and suspended span at a point between supports.

pin joint - a joint in a truss or other frame in which the members are assembled upon a single cylindrical pin

pin packing - arrangement of truss members on a pin at a pinned joint

pin plate - a plate rigidly attached upon the end of a member to develop the desired bearing upon a pin or pin-like bearing, and secure additional strength and rigidity in the member; doubler plate

pintle - a relatively small steel pin engaging the rocker of an expansion bearing, in a sole plate or masonry plate, thereby preventing sliding of the rocker

pipe - a hollow cylinder used for the conveyance of water, gas, steam etc.

pipng - removal of fine particles from within a soil mass by flowing water

plain concrete - concrete with no structural reinforcement except, possibly, light steel to reduce shrinkage and temperature cracking

plan and profile - a drawing that shows both the roadway plan view and profile view in the same scale; see PLAN VIEW, PROFILE

plan view - drawing that represents the top view of the road or a structure

plastic deformation - permanent deformation of material beyond the elastic range

plate - a flat sheet of metal which is relatively thick; see SHEET STEEL

plate girder - a large I-shaped beam composed of a solid web plate with flange plates attached to the web plate by flange angles or fillet welds

plug weld - a weld joining two members produced by depositing weld metal within holes cut through one or more of the members; also known as slot weld

pneumatic caisson - an underwater caisson in which the working chamber is kept free of water by compressed air at a pressure nearly equal to the water pressure outside it

pointing - the compacting of the mortar into the outermost portion of a joint and the troweling of its exposed surface to secure water tightness or desired architectural effect; replacing deteriorated mortar

ponding - accumulation of water

pontoon bridge - a bridge supported by floating on pontoons moored to the riverbed; a portion may be removable to facilitate navigation

pony truss - a through truss without top chord lateral bracing

pop-out - conical fragment broken out of a concrete surface by pressure from reactive aggregate particles

portable bridge - a bridge that may be readily erected for a temporary communication-transport service and disassembled and reassembled at another location

portal - the clear unobstructed space of a through truss bridge forming the entrance to the structure

portal bracing - a system of sway bracing placed in the plane of the end posts of the trusses

Portland cement - a fine dry powder made by grinding limestone clinker made by heating limestone in a kiln; this material reacts chemically with water to produce a solid mass

Portland cement concrete - a mixture of aggregate, Portland cement, water, and usually chemical admixtures

positive moment - a force applied over a distance that causes compression in the top fiber of a beam and tension in the bottom fiber

post - a member resisting compressive stresses, located vertical to the bottom chord of a truss and common to two truss panels; sometimes used synonymously for vertical; see COLUMN

posting - a limiting dimension, speed, or loading indicating larger dimensions, higher speeds, or greater loads cannot be safely taken by the bridge

post-stressing - see POSTTENSIONING

posttensioning - a method of prestressing concrete in which the tendons are stressed after the concrete has been cast and hardens

pot bearing - a bearing type that allows for multi-dimensional rotation by using a piston supported on an elastomer contained on a cylinder ("pot"), or spherical bearing element

pot holes - irregular shaped, disintegrated areas of bridge deck or roadway pavement caused by the failure of the surface material

Pratt truss - a truss with parallel chords and a web system composed of vertical posts with diagonal ties inclined outward and upward from the bottom chord panel points toward the ends of the truss; also known as N-truss

precast concrete - concrete members that are cast and cured before being placed into their final positions on a construction site

prestressed concrete - concrete with strands, tendons, or bars that are stressed before the live load is applied

prestressing - applying forces to a structure to deform it in such a way that it will withstand its working loads more effectively; see POSTTENSIONING, PRETENSIONING

pretensioning - a method of prestressing concrete in which the strands are stressed before the concrete is placed; strands are released after the concrete has hardened, inducing internal compression into the concrete

primary member - a member designed to resist flexure and distribute primary live loads and dead loads

priming coat - the first coat of paint applied to the metal or other material of a bridge; also known as base coat, or primer

probing - investigating the location and condition of submerged foundation material using a rod or shaft of appropriate length; checking the surface condition of a timber member for decay using a pointed tool, e.g., an ice pick

Professional Engineer (PE) - an individual, who has fulfilled education and experience requirements and passed rigorous exams that, under State licensure laws, permits them to offer engineering services directly to the public. Engineering licensure laws vary from State to State, but, in general, to become a PE an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam, gain four years of experience working under a PE, and pass the Principles of Practice of Engineering exam

profile - a section cut vertically along the center line of a roadway or waterway to show the original and final ground levels

program manager - the individual in charge of the program, who has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance

protective system - a system used to protect bridges from environmental forces that cause steel and concrete to deteriorate and timber to decay, typically a coating system

PS&E - Plans, Specifications, and Estimate; the final submission of the designers to the owner

public road. - the term "public road" means any road or street under the jurisdiction of and maintained by a public authority and open to public travel

punching shear - shear stress in a slab due to the application of a concentrated load

Q

quality assurance (QA) - the use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program

quality control (QC) - procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level

queen-post truss - a parallel chord type of truss having three panels with the top chord occupying only the length of the center panel

R

railing - a fence-like construction built at the outermost edge of the roadway or the sidewalk portion of a bridge to protect pedestrians and vehicles; see HANDRAIL

rake - an angle of inclination of a surface in relation to a vertical plane; also known as batter

ramp - an inclined traffic-way leading from one elevation to another

range of stress - the algebraic difference between the minimum and maximum stresses in a member

raveling - the consistent loss of aggregate from a pavement resulting in a poor riding surface

reaction - the resistance of a support to a load

rebar - see REINFORCING BAR

redundancy - the quality of a bridge that enables it to perform its design function in a damaged state.

redundant member - a member in a bridge which renders it a statically indeterminate structure; the structure would be stable without the redundant member whose primary purpose is to reduce the stresses carried by the determinate structure

rehabilitation - significant repair work to a structure

reinforced concrete - concrete with steel reinforcing bars embedded in it to supply increased tensile strength and durability

reinforced concrete pipe - pipe manufactured of concrete reinforced with steel bars or welded wire fabric

Reinforced Earth - proprietary retaining structure made of earth and steel strips connected to concrete facing; the steel strips are embedded in backfill and interlock with the facing; see MSE

reinforcement - rods or mesh embedded in concrete to strengthen it

reinforcing bar - a steel bar, plain or with a deformed surface, which bonds to the concrete and supplies tensile strength to the concrete

relaxation - a decrease in stress caused by creep

residual stress - a stress that is trapped in a member after it is formed into its final shape

resistivity of soil - an electrical measurement in ohm-cm that estimates the corrosion activity potential of a given soil

resurfacing - a layer of wearing surface material that is put over the approach or deck surface in order to create a more uniform riding surface

Retained Earth - proprietary retaining structure made of weld wire fabric strips connected to concrete facing; see MSE

retaining wall - a structure designed to restrain and hold back a mass of earth

rib - curved structural member supporting a curved shape or panel

rigger - an individual who erects and maintains scaffolding or other access equipment such as that used for bridge inspection

rigid frame - a structural frame in which bending moment is transferred between horizontal and vertical or inclined members by joints

rigid frame bridge - a bridge with moment resisting joints between the horizontal portion of the superstructure and vertical or inclined legs

rigid frame pier - a pier with two or more columns and a horizontal beam on top constructed monolithically to act like a frame

rip-rap - stones, blocks of concrete or other objects placed upon river and stream beds and banks, lake, tidal or other shores to prevent scour by water flow or wave action

rivet - a one-piece metal fastener held in place by forged heads at each end

riveted joint - a joint in which the assembled members are fastened by rivets

roadway - the portion of the road intended for the use of vehicular traffic

roadway shoulder - drivable area immediately adjoining the traveled roadway

rocker bearing - a bridge support that accommodates expansion and contraction of the superstructure through a tilting action

rocker bent - a bent hinged or otherwise articulated at one or both ends to provide the longitudinal movements resulting from temperature changes and superimposed loads

rolled shape - forms of rolled steel having "I", "H", "C", "Z" or other cross sectional shapes

rolled-steel section - any hot-rolled steel section including wide flange shapes, channels, angles, etc.

roller - a steel cylinder intended to provide longitudinal movements by rolling contact

roller bearing - a single roller or a group of rollers so installed as to permit longitudinal movement of a structure

roller nest - a group of steel cylinders used to facilitate the longitudinal movements resulting from temperature changes and superimposed loads

rolling lift bridge - a bridge of bascule type devised to roll backward and forward upon supporting girders when operated through an "open and closed" cycle

routine inspection - regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

routine permit load - a live load, which has a gross weight, axle weight or distance between axles not conforming to State statutes for legally configured vehicles, authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis.

runoff - the quantity of precipitation that flows from a catchment area past a given point over a certain period

S

sacrificial anode - the anode in a cathodic protection system

sacrificial coating - a coating over the base material to provide protection to the base material; examples include galvanizing on steel and aluclading on aluminum

sacrificial protection - see CATHODIC PROTECTION

sacrificial thickness - additional material thickness provided for extra service life of a member in an aggressive environment

saddle - a member located upon the topmost portion of the tower of a suspension bridge which acts as a bearing surface for the catenary cable passing over it

safe load - the maximum load that a structure can support with an appropriate factor of safety

safety belt - a belt worn in conjunction with a safety line to prevent falling a long distance when working at heights; no longer acceptable as fall protection under OSHA rules

safety curb - a curb between 9 inches and 24 inches wide serving as a limited use refuge or walkway for pedestrians crossing a bridge

safety factor - the difference between the ultimate strength of a member and the maximum load it is expected to carry

safety harness - harness with shoulder, leg, and waist straps of approved OSHA design used as personal fall protection in conjunction with appropriate lanyards and tie off devices

sag - to sink or bend downward due to weight or pressure

scaling - the gradual disintegration of a concrete surface due to the failure of the cement paste caused by chemical attack or freeze/thaw cycles

scour - removal of a streambed or bank area by stream flow; erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges

scour critical bridge - a bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

scour protection - protection of submerged material by steel sheet piling, rip rap, concrete lining, or combination thereof

scuba - self-contained underwater breathing apparatus; a portable breathing device for free swimming divers

scupper - an opening in the deck of a bridge to provide means for water accumulated upon the roadway surface to drain

seam weld - a weld joining the edges of two members placed in contact; in general, it is not a stress-carrying weld

seat - a base on which an object or member is placed

seat angle - a piece of angle attached to the side of a member to provide support for a connecting member either temporarily during its erection or permanently; also known as a shelf angle

secondary member - a member that does not carry calculated live loads; bracing members

section loss - loss of a member's cross sectional area usually by corrosion or decay

section view - an internal representation of a structure element as if a slice was made through the element

seepage - the slow movement of water through a material

segmental - constructed of individual pieces or segments which are collectively joined to form the whole

segmental arch - a circular arch in which the intrados is less than a semi-circle

segregation - in concrete construction, the separation of large aggregate from the paste during placement

seismic - a term referring to earthquakes (e.g., seismic forces)

service load design - AASHTO's description for Working Stress Design

settlement - the movement of substructure elements due to changes in the soil properties

shear - the load acting across a beam near its support

shear connectors - devices that extend from the top flange of a beam and are embedded in the above concrete slab, forcing the beam and the concrete to act as a single unit

shear spiral - a coil-shaped component welded to the top flange of a beam, as a shear connector

shear stress - the shear force per unit of cross-sectional area; also referred to as diagonal tensile stress

shear stud - a type of shear connector in the form of a rod with a head that is attached to a beam with an automatic stud-welding gun

sheet pile cofferdam - a wall-like barrier composed of driven piling constructed to surround the area to be occupied by a structure and permit dewatering of the enclosure so that the excavation may be performed in the open air

sheet piles - flattened Z-shaped interlocking piles driven into the ground to keep earth or water out of an excavation or to protect an embankment

sheet piling - a general or collective term used to describe a number of sheet piles installed to form a crib, cofferdam, bulkhead, etc.; also known as sheeting

sheet steel - steel in the form of a relatively thin sheet or plate; for flat rolled steel, specific thicknesses vs. widths are classified by AISI as bar, strip, sheet or plate

shelf angle - see SEAT ANGLE

shim - a thin plate inserted between two elements to fix their relative position and to transmit bearing stress

shoe - a steel or iron member, usually a casting or weldment, beneath the superstructure bearing that transmits and distributes loads to the substructure bearing area

shop - a factory or workshop

shop drawings - detailed drawings developed from the more general design drawings used in the manufacture or fabrication of bridge components

shoring - a strut or prop placed against or beneath a structure to restrain movement; temporary soil retaining structure

shoulder abutment - a cantilever abutment extending from the grade line of the road below to that of the road overhead, usually set just off the shoulder; see FULL HEIGHT ABUTMENT

shoulder area - see ROADWAY SHOULDER

shrinkage - a reduction in volume caused by moisture loss in concrete or timber while drying

sidewalk - the portion of the bridge floor area serving pedestrian traffic only

sidewalk bracket - frame attached to and projecting from the outside of a girder to serve as a support for the sidewalk stringers, floor and railing or parapet

sight distance - the length of roadway ahead that is easily visible to the driver; required sight distances are defined by AASHTO's "A Policy on Geometric Design of Highways and Streets"

silt - very finely divided siliceous or other hard rock material removed from its mother rock through erosive action rather than chemical decomposition

simple span - beam or truss with two unrestrained supports near its ends

S-I-P forms - see STAY-IN-PLACE FORMS, FORMS

skew angle - the angle produced when the longitudinal members of a bridge are not perpendicular to the substructure; the skew angle is the acute angle between the alignment of the bridge and a line perpendicular to the centerline of the substructure units

slab - a wide beam, usually of reinforced concrete, which supports load by flexure

slab bridge - a bridge having a superstructure composed of a reinforced concrete slab constructed either as a single unit or as a series of narrow slabs placed parallel with the roadway alignment and spanning the space between the supporting substructure units

slide - movement on a slope because of an increase in load or a removal of support at the toe; also known as landslide

slip form - to form concrete by advancing a mold

slope - the inclination of a surface expressed as a ratio of one unit of rise or fall for so many horizontal units

slope protection - a thin surfacing of stone, concrete or other material deposited upon a sloped surface to prevent its disintegration by rain, wind or other erosive action; also known as slope pavement

slot weld - see PLUG WELD

slump - a measurement taken to determine the stiffness of concrete; the measurement is the loss in height after a cone-shaped mold is lifted

soffit - underside of a bridge deck; also see INTRADOS

soldier beam - a steel pile driven into the earth with its projecting butt end used as a cantilever beam

soldier pile wall - a series of soldier beams supporting horizontal lagging to retain an excavated surface; commonly used in limited right-of-way applications

soil interaction structure - a subsurface structure that incorporates both the strength properties of a flexible structure and the support properties of the soil surrounding the structure

sole plate - a plate attached to the bottom flange of a beam that distributes the reaction of the bearing to the beam

solid sawn beam – a section of tree cut to the desired size at a saw mill

sounding - determining the depth of water by an echo-sounder or lead line; tapping a surface to detect delaminations (concrete) or decay (timber)

spall - depression in concrete caused by a separation of a portion of the surface concrete, revealing a fracture parallel with or slightly inclined to the surface

span - the distance between the supports of a beam; the distance between the faces of the substructure elements; the complete superstructure of a single span bridge or a corresponding integral unit of a multiple span structure; see CLEAR SPAN

spandrel - the space bounded by the arch extrados and the horizontal member above it

spandrel column - a column constructed on the rib of an arch span and serving as a support for the deck construction of an open spandrel arch; see OPEN SPANDREL ARCH

spandrel fill - the fill material placed within the spandrel space of a closed spandrel arch

spandrel tie - a wall or a beam-like member connecting the spandrel walls of an arch and securing them against bulging and other deformation; in stone masonry arches the spandrel tie walls served to some extent as counterforts

spandrel wall - a wall built on the extrados of an arch filling the space below the deck; see TIE WALLS

special inspection - an inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency

specifications - a detailed description of requirements, materials, tolerances, etc., for construction which are not shown on the drawings; also known as specs

spider - inspection access equipment consisting of a bucket or basket which moves vertically on wire rope, driven by an electric or compressed air motor

spillway - a channel used to carry water away from the top of a slope to an adjoining outlet

splice - a structural joint between members to extend their effective length

spread footing - a foundation, usually a reinforced concrete slab, which distributes load to the earth or rock below the structure

spring line - the horizontal line along the face of an abutment or pier at which the intrados of an arch begins

spur - a projecting jetty-like construction placed adjacent to an abutment or embankment to prevent scour

stage - inspection access equipment consisting of a flat platform supported by horizontal wire-rope cables; the stage is then slid along the cables to the desired position; a stage is typically 20 inches wide, with a variety of lengths available

staged construction - construction performed in phases, usually to permit the flow of traffic through the site

statics - the study of forces and bodies at rest

station - 100 feet (U.S. customary); 100 meters (metric)

stationing - a system of measuring distance along a baseline

stay-in-place forms - a corrugated metal sheet for forming deck concrete that will remain in place after the concrete has set; the forms do not contribute to deck structural capacity after the deck has cured; see FORMS, S.I.P FORMS

stay plate - a tie plate or diagonal brace to prevent movement

steel - an alloy of iron, carbon, and various other elements

stem - the vertical wall portion of an abutment retaining wall, or solid pier; see BREASTWALL

stiffener - a small member attached to another member to transfer stress and to prevent buckling

stiffening girder - a girder incorporated in a suspension bridge to distribute the traffic loads uniformly among the suspenders and reduce local deflections

stiffening truss - a truss incorporated in a suspension bridge to distribute the traffic loads uniformly among the suspenders and reduce local deflections

stirrup - U-shaped bar used as a connection device in timber and metal bridges; U-shaped bar placed in concrete to resist diagonal tension (shear) stresses

stone masonry - the portion of a structure composed of stone, generally placed in courses with mortar

straight abutment - an abutment whose stem and wings are in the same plane or whose stem is included within a length of retaining wall

strain - the change in length of a body produced by the application of external forces, measured in units of length; this is the proportional relation of the amount of change in length divided by the original length

strand - a number of wires grouped together usually by twisting

strengthening - adding to the capacity of a structural member **stress** - the force acting across a unit area in a solid material

stress concentration - local increases in stress caused by a sudden change of cross section in a member

stress range - the variation in stress at a point with the passage of live load, from initial dead load value to the maximum additional live load value and back

stress raiser - a detail that causes stress concentration

stress reversal - change of stress type from tension (+) to compression (-) or vice versa

stress sheet - a drawing showing all computed stresses resulting from the application of a system of loads together with the design composition of the individual members resulting from the application of assumed unit stresses for the material to be used in the structure

stress-laminated timber – consists of multiple planks mechanically clamped together to perform as one unit

stringer - a longitudinal beam spanning between transverse floorbeams and supporting a bridge deck

strip seal joint - a joint using a relatively thin neoprene seal fitted into the joint opening

structural analysis - engineering computation to determine the carrying capacity of a structure

Structural Engineer (SE) - an individual, who has fulfilled education and experience requirements and passed rigorous exams that, under Illinois State licensure laws, permits them to offer engineering services directly to the public. To become an SE an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam, gain four years of experience working under an SE, and pass the Structural Engineering exam

structural member - an individual piece, such as a beam or strut, which is an integral part of a structure

structural redundancy - the ability of an interior continuous span to resist total collapse by cantilever action in the event of a fracture

structural shapes - the various types of rolled iron and steel having flat, round, angle, channel, "I", "H", "Z" and other cross-sectional shapes adapted to heavy construction

structural stability - the ability of a structure to maintain its normal configuration, not collapse or tip in any way, under existing and expected loads

structural tee - a tee-shaped rolled member formed by cutting a wide flange longitudinally along the centerline of web

structurally deficient – bridges where 1) significant load carrying elements are found to be in poor or worse condition due to deterioration and/or damage or, 2) the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing intolerable traffic interruptions

structure - something, such as a bridge, that is designed and built to sustain a load

strut - a member acting to resist axial compressive stress; usually a secondary member

stub abutment - an abutment within the topmost portion of an embankment or slope having a relatively small vertical height and usually pile supported; stub abutments may also be founded on spread footings

sub-panel - a truss panel divided into two parts by an intermediate web member, generally a sub-diagonal or a hanger

substructure - the abutments and piers built to support the span of a bridge superstructure

superelevation - the difference in elevation between the inside and outside edges of a roadway in a horizontal curve; required to counteract the effects of centrifugal force

superimposed dead load - dead load that is applied to a compositely designed bridge after the concrete deck has cured; for example, the weight of parapets or railings placed after the concrete deck has cured

superstructure - the entire portion of a bridge structure that primarily receives and supports traffic loads and in turn transfers these loads to the bridge substructure

surface corrosion - rust that has not yet caused measurable section loss

suspended span - a simple span supported from the free ends of cantilevers

suspender - a vertical wire cable, metal rod, or bar connecting the catenary cable of a suspension bridge or an arch rib to the bridge floor system, transferring loads from the deck to the main members

suspension bridge - a bridge in which the floor system is supported by catenary cables that are supported upon towers and are anchored at their extreme ends

suspension cable - a catenary cable which is one of the main members upon which the floor system of a suspension bridge is supported; a cable spanning between towers

swale - a drainage ditch with moderately sloping sides

sway anchorage - a guy, stay cable or chain attached to the floor system of a suspension bridge and anchored upon an abutment or pier to increase the resistance of the suspension span to lateral movement; also known as sway cable

sway bracing - diagonal brace located at the top of a through truss, transverse to the truss and usually in a vertical plane, to resist transverse horizontal forces

sway frame - a complete panel or frame of sway bracing

swing span bridge - a movable bridge in which the span rotates in a horizontal plane on a pivot pier, to permit passage of marine traffic

T

tack welds - small welds used to hold member elements in place during fabrication or erection

tail water - water ponded below the outlet of a waterway, thereby reducing the amount of flow through the waterway; see HEADWATER

team leader - individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge

tee beam - a rolled steel section shaped like a "T"; reinforced concrete beam shaped like the letter "T"

temperature steel - reinforcement in a concrete member to prevent cracks due to stresses caused by temperature changes

temporary bridge - a structure built for emergency or interim use, intended to be removed in a relatively short time

tendon - a prestressing cable, strand, or bar

tensile force - a force caused by pulling at the ends of a member; see TENSION

tensile strength - the maximum tensile stress at which a material fails

tension - stress that tends to pull apart material

thermal movement - contraction and expansion of a structure due to a change in temperature

three-hinged arch - an arch that is hinged at each support and at the crown

through arch - an arch bridge in which the deck passes between the arches

through girder bridge - normally a two-girder bridge where the deck is between the supporting girders

tie - a member carrying tension

tie plate - relatively short, flat member carrying tension forces across a transverse member; for example, the plate connecting a floor beam cantilever to the main floor beam on the opposite side of a longitudinal girder; see STAY PLATE

tie rod - a rod-like member in a frame functioning to transmit tensile stress; also known as tie bar

tie walls - one of the walls built at intervals above an arch ring connecting and supporting the spandrel walls; any wall designed to serve as a restraining member to prevent bulging and distortion of two other walls connected thereby; see DIAPHRAGM WALL

timber - wood suitable for construction purposes

toe - the front portion of a footing from the intersection of the front face of the wall or abutment to the front edge of the footing; the line where the side slope of an embankment meets the existing ground

toe of slope - the location defined by the intersection of the embankment with the surface existing at a lower elevation; also known as toe

toe wall - a relatively low retaining wall placed near the "toe-of-slope" location of an embankment to protect against scour or to prevent the accumulation of stream debris; also known as footwall

ton - a unit of weight equal to 2,000 pounds

torsion - twisting about the longitudinal axis of a member

torsional rigidity - a beam's capacity to resist a twisting force along the longitudinal axis

tower - a pier or frame supporting the catenary cables of a suspension bridge

traffic control - modification of normal traffic patterns by signs, cones, flagmen, etc.

transducer - a device that converts one form of energy into another form, usually electrical into mechanical or the reverse; the part of ultrasonic testing device which transmits and receives sound waves

transverse bracing - the bracing assemblage engaging the columns of bents and towers in planes transverse to the bridge alignment that resists the transverse forces tending to produce lateral movement and deformation of the columns

transverse girder - see CROSS GIRDER

travel way - the roadway

trestle - a bridge structure consisting of spans supported on braced towers or frame bents

truck loading - a combination of loads used to simulate a single truck passing over a bridge

truss - a jointed structure made up of individual members primarily carrying axial loads arranged and connected in triangular panels

truss bridge - a bridge having a pair of trusses for a superstructure

trussed beam - a beam stiffened to reduce its deflection by a steel tie-rod that is held at a short distance from the beam by struts

truss panel - see PANEL

tubular sections - structural steel tubes, rectangular, square or circular; also known as hollow sections

tubular truss - a truss whose chords and struts are composed of pipes or cylindrical tubes

turnbuckle - a long, cylindrical, internally threaded nut with opposite hand threads at either end used to connect the elements of adjustable rod and bar members

two-hinged arch - a rigid frame that may be arch-shaped or rectangular with hinges at both supports

U

ultimate strength - the highest stress that a material can withstand before breaking

ultrasonic thickness gage - an instrument used to measure the thickness of a steel element using a probe which emits and receives sound waves

ultrasonic testing - nondestructive testing of a material's integrity using sound waves

underpass - the lowermost feature of a grade separated crossing; see OVERPASS

underwater diver bridge inspection training - training that covers all aspects of underwater bridge inspection and enables inspectors to relate the conditions of underwater bridge elements to established criteria (see the Bridge Inspector's Reference Manual section on underwater inspection for the recommended material to be covered in an underwater diver bridge inspection training course).

underwater inspection - inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

uniform load - a load of constant magnitude along the length of a member

unit stress - the force per unit of surface or cross-sectional area

uplift - a negative reaction or a force tending to lift a beam, truss, pile, or any other bridge element upwards

upper chord - the top longitudinal member of a truss

V

vaulted abutment - an abutment in which the space between wings, abutment stem, approach slab, and footings is hollow.

vertical - describes the axis of a bridge perpendicular to the underpass surface

vertical alignment - a roadway's centerline or baseline alignment in the vertical plane

vertical clearance - the distance between the structure and the underpass

vertical curve - a sag or crest in the profile of a roadway, usually in the form of a parabola, to transition between grades

vertical lift bridge - a bridge in which the span moves up and down while remaining parallel to the roadway

viaduct - a series of spans carried on piers at short intervals

vibration - the act of vibrating concrete to compact it

Vierendeel truss - a truss with only chords and verticals joined with rigid connections designed to transfer moment

voided slab - a precast concrete deck unit cast with cylindrical voids to reduce dead load

voids - an empty or unfilled space in concrete

W

wale, waler - horizontal bracing running along the inside walls of a sheeted pit or cofferdam

Warren truss - a triangular truss consisting of sloping members between the top and bottom chords and no verticals; members form the letter W

water/cement ratio - the weight of water divided by the weight of Portland cement in concrete; this ratio is a major factor in the strength of concrete

waterproofing membrane - an impervious layer placed between the wearing surface and the concrete deck, used to protect the deck from water and corrosive chemicals that could damage it

waterway opening - the available width for the passage of water beneath a bridge

wearing surface - the topmost layer of material applied upon a roadway to receive the traffic loads and to resist the resulting disintegrating action; also known as wearing course

web - the portion of a beam located between and connected to the flanges; the stem of a dumbbell type pier

web crippling - damage caused by high compressive stresses resulting from concentrated loads

web members - the intermediate members of a truss, not including the end posts, usually vertical or inclined

web plate - the plate forming the web element of a plate girder, built-up beam or column

web stiffener - a small member welded to a beam web to prevent buckling of the web

weep hole - a hole in a concrete retaining wall to provide drainage of the water in the retained soil

weld - a joint between pieces of metal at faces that have been made plastic and caused to flow together by heat or pressure

weldability - the degree to which steel can be welded without using special techniques, such as pre-heating

welded bridge structure - a structure whose metal elements are connected by welds

welded joint - a joint in which the assembled elements and members are connected by welds

welding - the process of making a welded joint

weld layer - a single thickness of weld metal composed of beads (runs) laid in contact to form a pad weld or a portion of a weld made up of superimposed beads

weld metal - fused filler metal added to the fused structure metal to produce a welded joint or a weld layer

weld penetration - the depth beneath the original surface to which the structure metal has been fused in the making of a fusion weld; see PENETRATION

weld sequence - the order of succession required for making the welds of a built-up piece or the joints of a structure, to minimize distortion and residual stresses

weld toe - particularly in a fillet weld, the thin end of the taper furthest from the center of the weld cross section

wheel load - the load carried by and transmitted to the supporting structure by one wheel of a traffic vehicle, a movable bridge, or other motive equipment or device; see AXLE LOAD

weep hole - a hole in a concrete element (abutment backwall or retaining wall) used to drain water from behind the element; any small hole installed for drainage

Whipple truss - a double-intersecting through Pratt truss where the diagonals extend across two panels

wide flange - a rolled I-shaped member having flange plates of rectangular cross section, differentiated from an S-beam (American Standard) in that the flanges are not tapered

wind bracing - the bracing systems that function to resist the stresses induced by wind forces

wind lock - a lateral restraining device found on steel girder and truss bridges

wingwall - the retaining wall extension of an abutment intended to restrain and hold in place the side slope material of an approach roadway embankment

wire rope - steel cable of multiple strands which are composed of steel wires twisted together

X Y Z

X-ray testing - nondestructive testing technique used for detecting internal flaws by passing X-rays through a material to film or other detector

A-4 Acronyms

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway Transportation Officials
ABD	All Bridge Designers
ABET	Accreditation Board of Engineering and Technology
ASNT	American Society of Nondestructive Testing
ASTM	American Society for Testing Materials
AWS	American Welding Society
BBS	Bureau of Bridges & Structures
BIRM	Bridge Inspector's Reference Manual
BIS	Bridge Inspection System
BLRS	Bureau of Local Roads and Streets
BMS	Bridge Management System
BMU	Bridge Management Unit
BPT	Bridge Project Tracking
BSAP	Bridge Scour Assessment Procedure
CFR	Code of Federal Regulations
DM	D-Meter Thickness Measurement
DT	Dye Penetrant Testing
EIT	Engineer In Training
FCM	Fracture Critical Member
FHWA	Federal Highway Administration
HEC	Hydraulic Engineering Circular
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
IRIS	Illinois Roadway Information System
ISIS	Illinois Structure Information System
ISTHA	Illinois State Toll Highway Authority
LRFD	Load Resistance Factor Design

MBE	The Manual for Bridge Evaluation
MMIS	Maintenance Management Information System
MT	Magnetic Particle Testing
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NCET	National Certification in Engineering Technologies
NDE	Non-destructive Evaluation
NDT	Non-destructive Testing
NEXRAD	Next Generation Radar
NHI	National Highway Institute
NHS	National Highway System
NOAA	National Oceanic and Atmospheric Administration
NSPE	National Society of Professional Engineers
NWS	National Weather Service
OSHA	Occupational Safety and Health Administration
POA	Plan of Action
PPI	Preliminary Pin Inspection
PPS	Program Planning System
PT	Post-tensioned Tendons
QA	Quality Assurance
QC	Quality Control
QC/QA	Quality Control and Quality Assurance
RT	Radiographic Testing
SBIP	Small Bridge Inspection Program
SES	Scour Evaluation Study
SI&A	Structure Inventory and Appraisal
SIMS	Structure Information Management System
SIP	Structure Information and Procedure
SPI	Supplemental Pin Inspection
SQL	Structured Query Language

STRAHNET	Strategic Highway Network
USC	United States Code
USDOT	United States Department of Transportation
USGS	United States Geological Survey
UT	Ultrasonic Testing
VT	Visual Testing

A-5 FCM Inspection Plan Template

MLK Approach Bridge over I-55/70 W.B., Missouri Avenue and Railroads

East St. Louis, IL

Structure No. 082-6003

June 27, 2012

Fracture Critical Member Inspection Plan



Prepared for
Illinois Department of Transportation

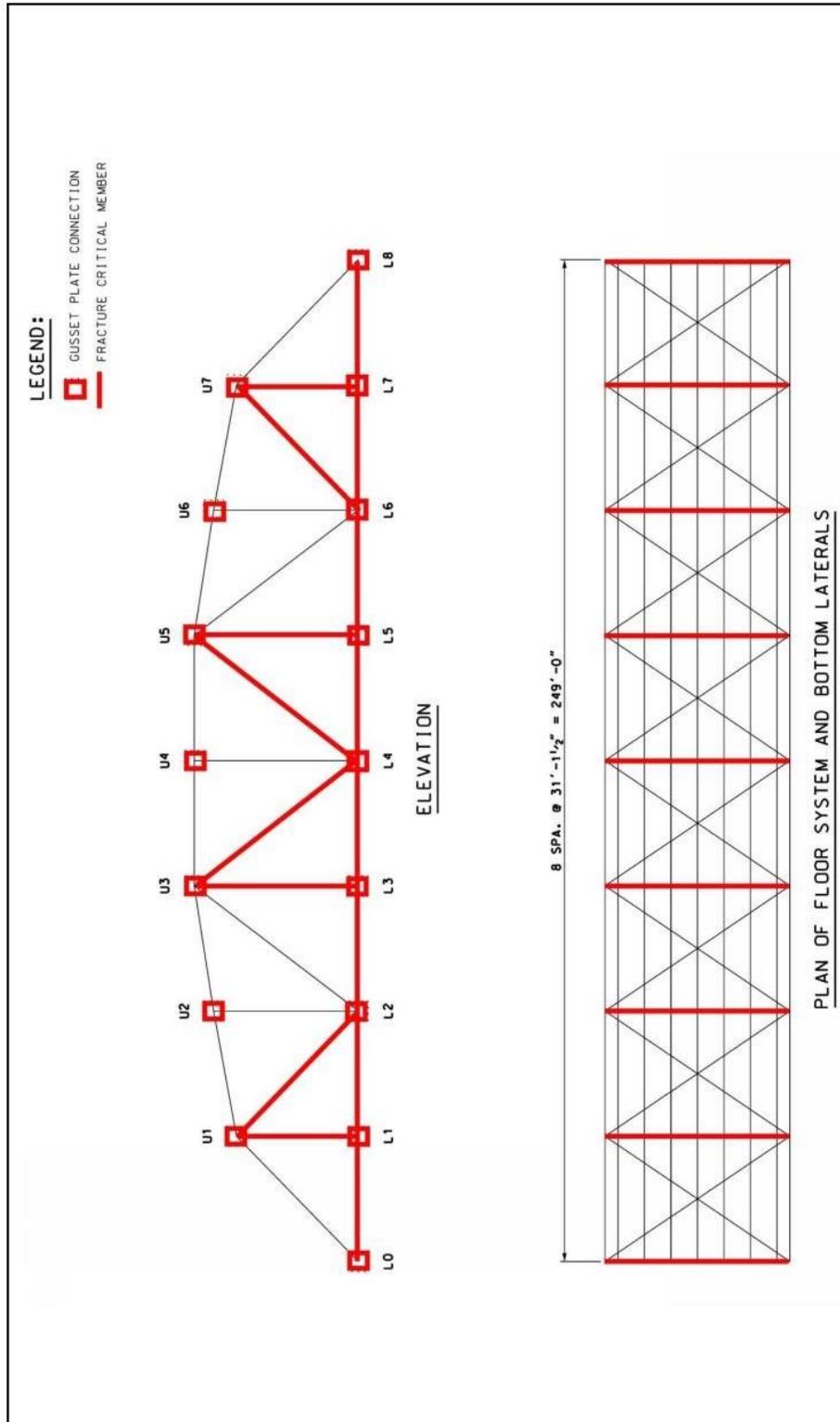
Team Leader: <<insert name here>>

INSTRUCTIONS: (DELETE THIS BOX) Replace the photo and update the text on this sheet.

Last Revision: 5/25/2012

St. Clair County, Illinois
 MLK Approach Bridge over I-55/70 W.B., Missouri Avenue and Railroads
 SN 082-6003

FRACTURE CRITICAL INSPECTION PLAN



INSTRUCTIONS: (DELETE THIS BOX) Replace this sketch with a sketch for the subject bridge. Floorbeams spaced >15' are considered fracture critical.

Last Revision: 5/25/2012

FRACTURE CRITICAL INSPECTION PLAN

St. Clair County, Illinois
 MLK Approach Bridge over I-55/70 W.B., Missouri Avenue and Railroads
 SN 082-6003

Fracture Critical Member		Fracture Critical Member Inventory			Inspection Procedures for FCMs	
Span	Member	Description	Fatigue Detail Description	Member Detail		AASHTO Fatigue Category
38	L0-L1, L1-L2, L2-L3, L3-L4, L4-L5, L5-L6, L6-L7, L7-L8	Truss Bottom Chord	Built-up steel member	Net section of steel member and riveted connection	D	Inspect entire length of the members, including the riveted connections. Special Feature Inspection: Not Required
38	U1-L1, U7-L7	Truss Verticals	Wide flange steel member	Net section of steel member and riveted connection	D	Inspect entire length of the members, including the riveted connections. Special Feature Inspection: Not Required
38	U1-L2, L2-U3, U3-L4, L4-U5, U5-L6, L6-U7	Truss Diagonals	Built-up steel member	Net section of steel member and riveted connection	D	Inspect entire length of the members, including the riveted connections. Special Feature Inspection: Not Required
38	FB0, FB1, FB2, FB3, FB4, FB5, FB6, FB7	Floorbeams	Wide flange steel member	Tension flange of floorbeam and connection to truss	A	Inspect the tension flanges and the floorbeam hangers. Special Feature Inspection: Not Required
38	Panel Points: U1 thru U7, L0 thru L8	Gusset Plates	Steel plate	Gusset plate and net section of rivets in connection	D	Inspect all gusset plates for section loss, buckling, rust pack, and integrity of rivets. Special Feature Inspection: Not Required

INSTRUCTIONS: (DELETE THIS BOX) List each of the fracture critical members, grouping them as appropriate. Expand table as necessary.

Last Revision: 5/25/2012

St. Clair County, Illinois
MLK Approach Bridge over I-55/70 W.B., Missouri Avenue and Railroads
SN 082-6003

FRACTURE CRITICAL INSPECTION PLAN

<p>Fracture Critical Inspection Scope and Frequency</p>	<p>Perform Fracture Critical Member Inspection with each Routine Inspection at a maximum interval of 24 months. Hands-on inspection of all FCM's is required with emphasis on tension members and fatigue sensitive details. All previously noted defects shall be verified and recorded to determine if the defect has changed over time.</p>
<p>FCM Inspection Procedures</p>	<ol style="list-style-type: none"> 1. Modify this Fracture Critical Member Inspection Plan as member conditions or inspection requirements change. Add a line at the top of the Revision History row at the bottom of this table to describe the revision(s). Place a copy of the revised Fracture Critical Member Inspection Plan in the bridge file. 2. Report Critical Inspection Findings to the Team Leader on site immediately. If Team Leader concurs that a particular defect is a Critical Inspection Finding contact <<enter District/Agency Program Manager name, phone number and e-mail address here>> immediately. Refer to the <i>Structural Services Manual Section 3.3.10</i> for guidance on what constitutes a Critical Inspection Finding. 3. Hands-on inspection required on all surfaces of all FCMs including base metal, welds, bolts and rivets. 4. Hands-on inspection required on all surfaces of any connections to FCMs including base metal, welds, bolts and rivets in the vicinity of any connections. 5. Clean FCMs as required to expose the area to be inspected. Clean dirt/debris using a broom, shovel, or heavy duty vacuum. Clean corrosion product in order to determine what the remaining section is. Report excessive/hazardous debris accumulation to XXXX XXXXX at XXX XXX XXXX so that the bridge can be scheduled for washing. 6. Measure section remaining with a calibrated ultrasonic thickness gauge. In order to improve accuracy of plate thicknesses by this method, clean a 1/2" diameter area of paint and corrosion product using a wire brush or a "flapper" type sanding disc to expose bare steel at the location where thickness is to be measured. After taking the measurement, clean the area of dirt/dust/couplant and paint the bare metal using a spray paint "paint+primer" type product to prevent additional corrosion. Be sure to note the nominal thickness of the plate from an area close by that has no section loss. 7. When taking photos of small defects take a close-up photo and a wider angle photo from the same perspective for context. 8. Losses in FCMs representing less than 3% of the design section property are not required to be recorded. Take pictures of these types of defects for the "Paint" item in the Defect Table. 9. Losses in FCMs representing greater than 3% of the design section property are required to be recorded in the Defect Table and on a sketch with enough detail to inform live load rating calculations. 10. Cracks shall be documented through the use of photos and sketches. By visual inspection, mark the visible end of the crack with a permanent marker or paint pen and date the mark. Cracks in critical areas should be recommended for follow up NDT. Report all cracks to the Team Leader on site for immediate evaluation. If a crack is encountered on a particular detail that is repeated throughout the bridge the Team Leader shall notify all of the inspection teams to inspect for similar defects at these details. 11. A gusset report is on file for this bridge. Gusset plates shall be compared to the latest gusset plate report. Any changed conditions observed in the field shall be noted.

St. Clair County, Illinois
 MLK Approach Bridge over I-55/70 W.B., Missouri Avenue and Railroads
 SN 082-6003

Last Revision: 5/25/2012

FRACTURE CRITICAL INSPECTION PLAN

	12. For all of the required reporting, use the latest versions of the forms.
NDT	1. UT inspection of XX pins required.
Access	<ol style="list-style-type: none"> 1. Access to upper portions of truss members by man-lift with a minimum 40' reach. Man-lift shall not be used over live traffic lanes and two separate lane closures with be required. 2. Access to floor system components by underbridge inspection unit. A unit with a 50' horizontal reach will allow access to the entire width of the structure from one side of the bridge. 3. Note that aerial power lines run along the south face of the bridge approximately 20 feet from the truss.
Traffic Control	<ol style="list-style-type: none"> 1. Inspection and traffic control activities only allowed between 10am and 3pm due to high traffic volumes. 2. Maintain a single lane of traffic at all times. 3. Two-lane bridge requires flaggers. 4. Posted speed limit = 50 MPH. 5. Use latest IDOT Highway Standard 701xxx-xx 6. Notify District Bridge maintenance Engineer at XXX.XXX.XXXX for closure approval.
Revision History	<ol style="list-style-type: none"> 1. Modified 5/25/2012 by Tom Inspector, IDOT: added inspection and traffic control hour restrictions 2. Created 5/16/2010 by Joe Inspector, Inspection Consultant, Inc.

A-6 AASHTO Fatigue Categories

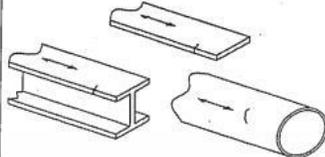
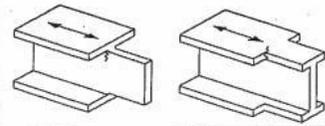
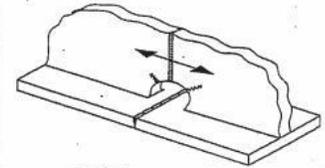
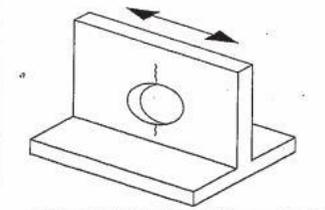
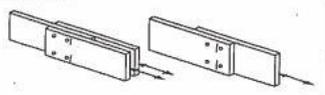
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SECTION 6: STEEL STRUCTURES

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deck plate details and 4350 for all other details, based on Category C. Thus, finite life design may produce more economical designs on lower-volume roadways.

Table 6.6.1.2.3-1—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta F)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 1—Plain Material away from Any Welding					
1.1 Base metal, except noncoated weathering steel, with rolled or cleaned surfaces. Flame-cut edges with surface roughness value of 1,000 μ -in. or less, but without re-entrant corners.	A	250×10^8	24	Away from all welds or structural connections	
1.2 Noncoated weathering steel base metal with rolled or cleaned surfaces designed and detailed in accordance with FHWA (1989). Flame-cut edges with surface roughness value of 1,000 μ -in. or less, but without re-entrant corners.	B	120×10^8	16	Away from all welds or structural connections	
1.3 Member with re-entrant corners at copes, cuts, block-outs or other geometrical discontinuities made to the requirements of AASHTO/AWS D1.5, except weld access holes.	C	44×10^8	10	At any external edge	
1.4 Rolled cross sections with weld access holes made to the requirements of AASHTO/AWS D1.5, Article 3.2.4.	C	44×10^8	10	In the base metal at the re-entrant corner of the weld access hole	
1.5 Open holes in members (Brown et al., 2007).	D	22×10^8	7	In the net section originating at the side of the hole	
Section 2—Connected Material in Mechanically Fastened Joints					
2.1 Base metal at the gross section of high-strength bolted joints designed as slip-critical connections with pretensioned high-strength bolts installed in holes drilled full size or subpunched and reamed to size—e.g., bolted flange and web splices and bolted stiffeners. (Note: see Condition 2.3 for bolt holes punched full size; see Condition 2.5 for bolted angle or tee section member connections to gusset or connection plates.)	B	120×10^8	16	Through the gross section near the hole	

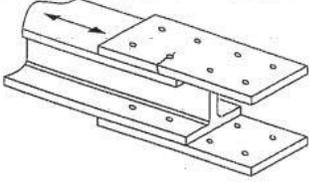
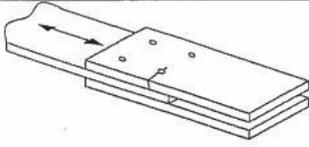
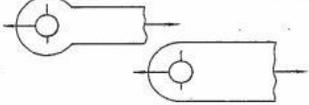
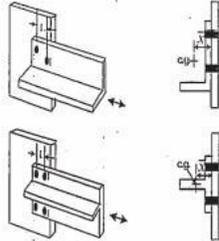
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AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta F)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 2—Connected Material in Mechanically Fastened Joints (continued)					
2.2 Base metal at the net section of high-strength bolted joints designed as bearing-type connections but fabricated and installed to all requirements for slip-critical connections with pretensioned high-strength bolts installed in holes drilled full size or subpunched and reamed to size. (Note: see Condition 2.3 for bolt holes punched full size; see Condition 2.5 for bolted angle or tee section member connections to gusset or connection plates.)	B	120×10^6	16	In the net section originating at the side of the hole	
2.3 Base metal at the net section of all bolted connections in hot dipped galvanized members (Huhn and Vallinat, 2004); base metal at the appropriate section defined in Condition 2.1 or 2.2, as applicable, of high-strength bolted joints with pretensioned bolts installed in holes punched full size (Brown et al., 2007); and base metal at the net section of other mechanically fastened joints, except for eyebars and pin plates, e.g., joints using ASTM A307 bolts or non-pretensioned high-strength bolts. (Note: see Condition 2.5 for bolted angle or tee section member connections to gusset or connection plates).	D	22×10^6	7	In the net section originating at the side of the hole or through the gross section near the hole, as applicable	
2.4 Base metal at the net section of eybar heads or pin plates (Note: for base metal in the shank of eyebars or through the gross section of pin plates, see Condition 1.1 or 1.2, as applicable.)	E	11×10^6	4.5	In the net section originating at the side of the hole	
2.5 Base metal in angle or tee section members connected to a gusset or connection plate with high-strength bolted slip-critical connections. The fatigue stress range shall be calculated on the effective net area of the member, $A_e = UA_g$, in which $U = (1 - \bar{x}/L)$ and where A_g is the gross area of the member. \bar{x} is the distance from the centroid of the member to the surface of the gusset or connection plate and L is the out-to-out distance between the bolts in the connection parallel to the line of force. The effect of the moment due to the eccentricities in the connection shall be ignored in computing the stress range (McDonald and Frank, 2009).	See applicable Category above	See applicable Constant above	See applicable Threshold above	Through the gross section near the hole, or in the net section originating at the side of the hole, as applicable	

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SECTION 6: STEEL STRUCTURES

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Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta F)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
<p>2.5 (continued) The fatigue category shall be taken as that specified for Condition 2.1. For all other types of bolted connections, replace A_g with the net area of the member, A_n, in computing the effective net area according to the preceding equation and use the appropriate fatigue category for that connection type specified for Condition 2.2 or 2.3, as applicable.</p>					
<p>Section 3—Welded Joints Joining Components of Built-Up Members</p>					
<p>3.1 Base metal and weld metal in members without attachments built up of plates or shapes connected by continuous longitudinal complete joint penetration groove welds back-gouged and welded from the second side, or by continuous fillet welds parallel to the direction of applied stress.</p>	B	120×10^8	16	From surface or internal discontinuities in the weld away from the end of the weld	
<p>3.2 Base metal and weld metal in members without attachments built up of plates or shapes connected by continuous longitudinal complete joint penetration groove welds with backing bars not removed, or by continuous partial joint penetration groove welds parallel to the direction of applied stress.</p>	B'	61×10^8	12	From surface or internal discontinuities in the weld, including weld attaching backing bars	
<p>3.3 Base metal and weld metal at the termination of longitudinal welds at weld access holes made to the requirements of AASHTO/AWS D1.5, Article 3.2.4 in built-up members. (Note: does not include the flange butt splice).</p>	D	22×10^8	7	From the weld termination into the web or flange	
<p>3.4 Base metal and weld metal in partial length welded cover plates connected by continuous fillet welds parallel to the direction of applied stress.</p>	B	120×10^8	16	From surface or internal discontinuities in the weld away from the end of the weld	

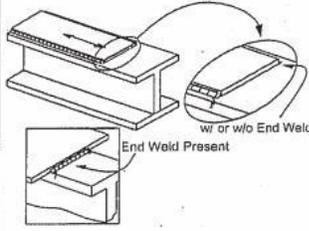
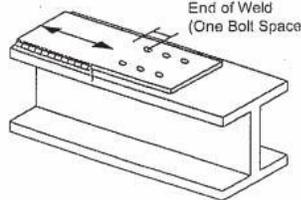
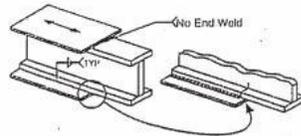
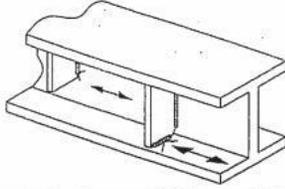
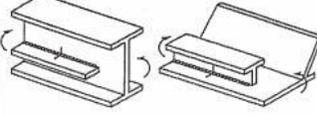
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AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta f)_T$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 3—Welded Joints Joining Components of Built-Up Members (continued)					
3.5 Base metal at the termination of partial length welded cover plates having square or tapered ends that are narrower than the flange, with or without welds across the ends, or cover plates that are wider than the flange with welds across the ends: Flange thickness ≤ 0.8 in. Flange thickness > 0.8 in.	E E'	11×10^8 3.9×10^8	4.5 2.6	In the flange at the toe of the end weld or in the flange at the termination of the longitudinal weld or in the edge of the flange with wide cover plates	
3.6 Base metal at the termination of partial length welded cover plates with slip-critical bolted end connections satisfying the requirements of Article 6.10.12.2.3.	B	120×10^8	16	In the flange at the termination of the longitudinal weld	
3.7 Base metal at the termination of partial length welded cover plates that are wider than the flange and without welds across the ends.	E'	3.9×10^8	2.6	In the edge of the flange at the end of the cover plate weld	
Section 4—Welded Stiffener Connections					
4.1 Base metal at the toe of transverse stiffener-to-flange fillet welds and transverse stiffener-to-web fillet welds. (Note: includes similar welds on bearing stiffeners and connection plates).	C'	44×10^8	12	Initiating from the geometrical discontinuity at the toe of the fillet weld extending into the base metal	
4.2 Base metal and weld metal in longitudinal web or longitudinal box-flange stiffeners connected by continuous fillet welds parallel to the direction of applied stress.	B	120×10^8	16	From the surface or internal discontinuities in the weld away from the end of the weld	

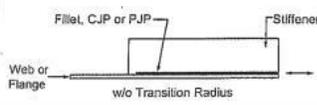
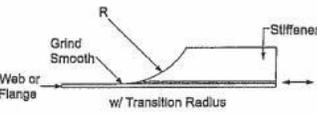
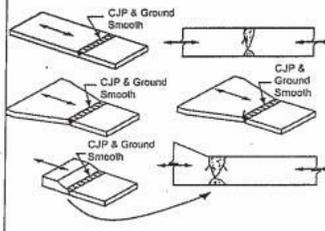
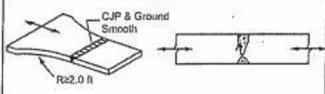
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SECTION 6: STEEL STRUCTURES

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Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta\sigma)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 4—Welded Stiffener Connections (continued)					
<p>4.3 Base metal at the termination of longitudinal stiffener-to-web or longitudinal stiffener-to-box flange welds:</p> <p>With the stiffener attached by fillet welds and with no transition radius provided at the termination:</p> <p>Stiffener thickness < 1.0 in.</p> <p>Stiffener thickness ≥ 1.0 in.</p>				<p>In the primary member at the end of the weld at the weld toe</p> 	
	E	11×10^8	4.5		
<p>With the stiffener attached by welds and with a transition radius R provided at the termination with the weld termination ground smooth:</p> <p>$R \geq 24$ in.</p> <p>24 in. > $R \geq 6$ in.</p> <p>6 in. > $R \geq 2$ in.</p> <p>2 in. > R</p>	E'	3.9×10^8	2.6	<p>In the primary member near the point of tangency of the radius</p> 	
	B	120×10^8	16		
	C	44×10^8	10		
	D	22×10^8	7		
	E	11×10^8	4.5		
Section 5—Welded Joints Transverse to the Direction of Primary Stress					
<p>5.1 Base metal and weld metal in or adjacent to complete joint penetration groove welded butt splices, with weld soundness established by NDT and with welds ground smooth and flush parallel to the direction of stress. Transitions in thickness or width shall be made on a slope no greater than 1:2.5 (see also Figure 6.13.6.2-1).</p> <p>$F_y < 100$ ksi</p> <p>$F_y \geq 100$ ksi</p>				<p>From internal discontinuities in the filler metal or along the fusion boundary or at the start of the transition</p> 	
	B	120×10^8	16		
<p>5.2 Base metal and weld metal in or adjacent to complete joint penetration groove welded butt splices, with weld soundness established by NDT and with welds ground parallel to the direction of stress at transitions in width made on a radius of not less than 2 ft with the point of tangency at the end of the groove weld (see also Figure 6.13.6.2-1).</p>	B'	61×10^8	12	<p>From internal discontinuities in the filler metal or discontinuities along the fusion boundary</p> 	
	B	120×10^8	16		

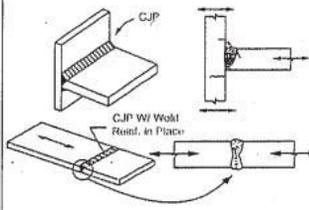
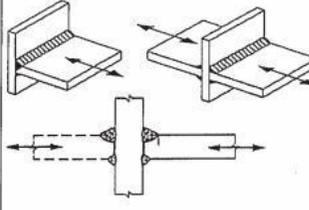
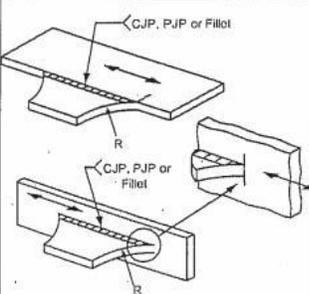
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AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta f)_{TH}$ ksi	Potential Crack Initiation Point	Illustrative Examples
5.3 Base metal and weld metal in or adjacent to the toe of complete joint penetration groove welded T or corner joints, or in complete joint penetration groove welded butt splices, with or without transitions in thickness having slopes no greater than 1:2.5 when weld reinforcement is not removed. (Note: cracking in the flange of the "I" may occur due to out-of-plane bending stresses induced by the stem).	C	44×10^8	10	From the surface discontinuity at the toe of the weld extending into the base metal or along the fusion boundary	
5.4 Base metal and weld metal at details where loaded discontinuous plate elements are connected with a pair of fillet welds or partial joint penetration groove welds on opposite sides of the plate normal to the direction of primary stress.	C as adjusted in Eq. 6.6.1.2.5-4	44×10^8	10	Initiating from the geometrical discontinuity at the toe of the weld extending into the base metal or initiating at the weld root subject to tension extending up and then out through the weld	
Section 6—Transversely Loaded Welded Attachments					
6.1 Base metal in a longitudinally loaded component at a transversely loaded detail (e.g. a lateral connection plate) attached by a weld parallel to the direction of primary stress and incorporating a transition radius R with the weld termination ground smooth.				Near point of tangency of the radius at the edge of the longitudinally loaded component or at the toe of the weld at the weld termination if not ground smooth	
$R \geq 24$ in.	B	120×10^8	16		
24 in. $> R \geq 6$ in.	C	44×10^8	10		
6 in. $> R \geq 2$ in.	D	22×10^8	7		
2 in. $> R$	E	11×10^8	4.5		
For any transition radius with the weld termination not ground smooth (Note: Condition 6.2, 6.3 or 6.4, as applicable, shall also be checked.)	E	11×10^8	4.5		

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Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta f)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 6—Transversely Loaded Welded Attachments (continued)					
<p>6.2 Base metal in a transversely loaded detail (e.g. a lateral connection plate) attached to a longitudinally loaded component of equal thickness by a complete joint penetration groove weld parallel to the direction of primary stress and incorporating a transition radius R, with weld soundness established by NDT and with the weld termination ground smooth:</p> <p>With the weld reinforcement removed:</p> <p>$R \geq 24$ in.</p> <p>24 in. $> R \geq 6$ in.</p> <p>6 in. $> R \geq 2$ in.</p> <p>2 in. $> R$</p> <p>With the weld reinforcement not removed:</p> <p>$R \geq 24$ in.</p> <p>24 in. $> R \geq 6$ in.</p> <p>6 in. $> R \geq 2$ in.</p> <p>2 in. $> R$</p> <p>(Note: Condition 6.1 shall also be checked.)</p>	<p>B</p> <p>C</p> <p>D</p> <p>E</p> <p>C</p> <p>C</p> <p>D</p> <p>E</p>	<p>120×10^8</p> <p>44×10^8</p> <p>22×10^8</p> <p>11×10^8</p> <p>44×10^8</p> <p>44×10^8</p> <p>22×10^8</p> <p>11×10^8</p>	<p>-16</p> <p>10</p> <p>7</p> <p>4.5</p> <p>10</p> <p>10</p> <p>7</p> <p>4.5</p>	<p>Near points of tangency of the radius or in the weld or at the fusion boundary of the longitudinally loaded component or the transversely loaded attachment</p> <p>At the toe of the weld either along the edge of the longitudinally loaded component or the transversely loaded attachment</p>	<p>The diagram shows two sets of weld details. The top set shows a groove weld with a transition radius R and thickness t. The left side shows the weld with reinforcement removed, and the right side shows it with reinforcement not removed. Labels include CJP and R. The bottom set shows a similar detail with labels t_1 and t_2.</p>
<p>6.3 Base metal in a transversely loaded detail (e.g. a lateral connection plate) attached to a longitudinally loaded component of unequal thickness by a complete joint penetration groove weld parallel to the direction of primary stress and incorporating a weld transition radius R, with weld soundness established by NDT and with the weld termination ground smooth:</p> <p>With the weld reinforcement removed:</p> <p>$R \geq 2$ in.</p> <p>$R < 2$ in.</p> <p>For any weld transition radius with the weld reinforcement not removed (Note: Condition 6.1 shall also be checked.)</p>	<p>D</p> <p>E</p> <p>E</p>	<p>22×10^8</p> <p>11×10^8</p> <p>11×10^8</p>	<p>7</p> <p>4.5</p> <p>4.5</p>	<p>At the toe of the weld along the edge of the thinner plate</p> <p>In the weld termination of small radius weld transitions</p> <p>At the toe of the weld along the edge of the thinner plate</p>	<p>The diagram shows two sets of weld details. The top set shows a groove weld with a transition radius R and thicknesses t_1 and t_2. The left side shows the weld with reinforcement removed, and the right side shows it with reinforcement not removed. Labels include CJP and R. The bottom set shows a similar detail with labels t_1 and t_2.</p>

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AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ²)	Threshold $(\Delta\sigma)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 6—Transversely Loaded Welded Attachments (continued)					
6.4 Base metal in a transversely loaded detail (e.g. a lateral connection plate) attached to a longitudinally loaded component by a fillet weld or a partial joint penetration groove weld, with the weld parallel to the direction of primary stress (Note: Condition 6.1 shall also be checked.)	See Condition 5.4				
Section 7—Longitudinally Loaded Welded Attachments					
7.1 Base metal in a longitudinally loaded component at a detail with a length L in the direction of the primary stress and a thickness t attached by groove or fillet welds parallel or transverse to the direction of primary stress where the detail incorporates no transition radius: $L < 2$ in. 2 in. $\leq L \leq 12t$ or 4 in. $L > 12t$ or 4 in. $t < 1.0$ in. $t \geq 1.0$ in. (Note: see Condition 7.2 for welded angle or tee section member connections to gusset or connection plates.)	C D E E'	44×10^8 22×10^8 11×10^8 3.9×10^8	10 7 4.5 2.6	In the primary member at the end of the weld at the weld toe	
7.2 Base metal in angle or tee section members connected to a gusset or connection plate by longitudinal fillet welds along both sides of the connected element of the member cross-section. The fatigue stress range shall be calculated on the effective net area of the member, $A_e = UA_g$, in which $U = (1 - \bar{x}/L)$ and where A_g is the gross area of the member. \bar{x} is the distance from the centroid of the member to the surface of the gusset or connection plate and L is the maximum length of the longitudinal welds. The effect of the moment due to the eccentricities in the connection shall be ignored in computing the stress range (McDonald and Frank, 2009).	E	11×10^8	4.5	Toe of fillet welds in connected element	

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SECTION 6: STEEL STRUCTURES

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Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ⁻¹)	Threshold $(\Delta f)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 8—Miscellaneous					
8.1 Rib to Deck Weld—One-sided 80% (70% min) penetration weld with root gap ≤ 0.02 in. prior to welding Allowable Design Level 1, 2, or 3	C	44×10^8	10	See Figure	
8.2 Rib Splice (Welded)—Single groove butt weld with permanent backing bar left in place. Weld gap $>$ rib wall thickness Allowable Design Level 1, 2, or 3	D	22×10^8	7	See Figure	
8.3 Rib Splice (Bolted)—Base metal at gross section of high strength slip critical connection Allowable Design Level 1, 2, or 3	B	120×10^8	16	See Figure	
8.4 Deck Plate Splice (in Plane)—Transverse or Longitudinal single groove butt splice with permanent backing bar left in place Allowable Design Level 1, 2, or 3	D	22×10^8	7	See Figure	
8.5 Rib to FB Weld (Rib)—Rib wall at rib to FB weld (fillet or CJP) Allowable Design Level 1, 2, or 3	C	44×10^8	10	See Figure	

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AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

Description	Category	Constant A (ksi ³)	Threshold $(\Delta f)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
8.6 Rib to FB Weld (FB Web)—FB web at rib to FB weld (fillet, PJP, or CJP) Allowable Design Level 1 or 3	C (see Note 1)	44×10^8	10	See Figure	
8.7 FB Cutout—Base metal at edge with "smooth" flame cut finish as per AWS D1.5 Allowable Design Level 1 or 3	A	250×10^8	24	See Figure	
8.8 Rib Wall at Cutout—Rib wall at rib to FB weld (fillet, PJP, or CJP) Allowable Design Level 1 or 3	C	44×10^8	10	See Figure	
8.9 Rib to Deck Plate at FB Allowable Design Level 1 or 3	C	44×10^8	10	See Figure	
Note 1: Where stresses are dominated by in-plane component at fillet or PJP welds, Eq. 6.6.1.2.5-4 shall be considered. In this case, Δf should be calculated at the mid-thickness and the extrapolation procedure as per Article 9.8.3.4.3 need not be applied.					
Section 9—Miscellaneous					
9.1 Base metal at stud-type shear connectors attached by fillet or automatic stud welding Allowable Design Level 1 or 3		44×10^8	10	At the toe of the weld in the base metal	

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SECTION 6: STEEL STRUCTURES

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Table 6.6.1.2.3-1 (continued)—Detail Categories for Load-Induced Fatigue

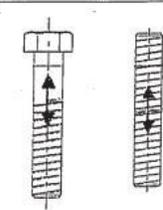
Description	Category	Constant A (ksi ³)	Threshold $(\Delta F)_m$ ksi	Potential Crack Initiation Point	Illustrative Examples
Section 9—Miscellaneous (continued)					
9.2 Nonpretensioned high-strength bolts, common bolts, threaded anchor rods, and hanger rods with cut, ground, or rolled threads. Use the stress range acting on the tensile stress area due to live load plus prying action when applicable.				At the root of the threads extending into the tensile stress area	
(Fatigue II) Finite Life	E'	3.9×10^8	N/A		
(Fatigue I) Infinite Life	D	N/A	7		

Table 6.6.1.2.3-2—75-yr $(ADTT)_{SL}$ Equivalent to Infinite Life

Detail Category	75-yr $(ADTT)_{SL}$ Equivalent to Infinite Life (trucks per day)
A	530
B	860
B'	1035
C	1290
C'	745
D	1875
E	3530
E'	6485

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AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

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A-7 AASHTO/AWS D1.5 Bridge Welding Code Section 6.7.6.2

AASHTO/AWS D1.5 Bridge Welding Code 2010, with 2011 and 2012 Interims

Lifting requirements for verification of proper current using the yoke method

6.7.6.2 The yoke method shall be performed in conformance with ASTM E 709, and the standard of acceptance shall be in conformance with 6.26.

(1) Testing by the yoke method shall be performed using half-wave rectified DC or AC DC, DC Pulsed, or AC.

(2) Electromagnetic yokes shall have lifting forces conforming to the following requirements:

Yoke Pole Leg Spacing (YPS), mm [in]		
Current Type	50 ≤ YPS < 100 [2 ≤ YPS < 4]	100 ≤ YPS < 150 [4 ≤ YPS ≤ 6]
AC	45 N [10 lb]	45 N [10 lb]
Half-Wave Rectified DC or DC Pulsed	135 N [30 lb]	225 N [50 lb]

A-8 IDOT Major Structures

Major Structures

In-depth Inspections by the Bureau of Bridges & Structures

District	Structure Number	Bridge Name	Feature Carried	Feature Crossed
1	099-0008	Smith	I-55 SB	Des Plaines R.
1	099-0009	Smith	I-55 NB	Des Plaines R.
1	099-0056	Des Plaines	I-80 EB	Des Plaines R.
1	099-0057	Des Plaines	I-80 WB	Des Plaines R.
2	008-6000	Savanna-Sabula	US 52	Mississippi R.
2	081-0011	LeClaire	I-80	Mississippi R.
2	081-0106	Rock Island	I-280	Mississippi R.
2	081-9905	Centennial	US 67	Mississippi R.
2	098-6003	Gateway	US 30	Mississippi R.
3	032-0099	Morris	IL 47	Illinois R.
3	050-0237	Shippingsport	IL 351	Illinois R.
3	050-0246	Seneca	IL 170	Illinois R.
3	050-0079	Peru	IL 251	Illinois R.
3	050-0088	Utica	IL 178	Illinois R.
3	050-0180	Veterans Memorial/Ottawa	IL 23 & 71	Illinois R.
3	050-0191	A. Lincoln Memorial	I-39, US 51	Illinois R.
3	050-0219	Marseilles	CH 15	Illinois R.
3	078-0001	Hennepin	I-180	Illinois R.
3	078-0006	Spring Valley	IL 89	Illinois R.
4	062-0003	Lacon	IL 17	Illinois R.
4	062-0036	Henry	IL 18	Illinois R.
4	063-0002	Scott Lucas/Havana	US 136	Illinois R.
4	090-0001	Murray Baker	I-74	Illinois R.
4	090-0030	Cedar Street	IL 8, 29 & 116	Illinois R.
4	090-0070	McCluggage (old)	US 24 & 150 EB	Illinois R.
4	090-0108	Shade-Lohmann	I-474 EB	Illinois R.
4	090-0109	Shade-Lohmann	I-474 WB	Illinois R.
4	090-0114	John T. McNaughton/Pekin	IL 9	Illinois R.
4	090-0115	McCluggage (new)	US 24 & 150 WB	Illinois R.
4	090-0122	Bob Michel	Franklin Street	Illinois R.

District	Structure Number	Bridge Name	Feature Carried	Feature Crossed
6	001-0019	Quincy Memorial	US 24 EB	Mississippi R.
6	001-0068	Quincy Bayview	US 24 WB	Mississippi R.
6	009-0001	Beardstown	US 67 & IL 100	Illinois R.
6	034-0062	Keokuk-Hamilton	US 136	Mississippi R.
6	069-0016	Meredosia	IL 104	Illinois R.
6	075-0122	Valley City Eagle	I-72 EB	Illinois R.
6	075-0123	Valley City Eagle	I-72 WB	Illinois R.
6	086-0001	Florence	IL 100 & 106	Illinois R.
7	058-0120	William B. Sands Memorial	IL 121	N&W Railroad
7	093-0021	Mt. Carmel	IL 15	Wabash R.
8	031-0001	Joe Page	IL 100	Illinois R.
8	060-0035	Chain of Rocks	I-270	Mississippi R.
8	060-0345	Chain of Rocks Canal	I-270 EB & WB	Chain of Rocks Canal
8	060-0255	Clark	US 67	Mississippi R.
8	060-6002	McKinley	Salisbury Street	Mississippi R.
8	082-6001	Martin Luther King Memorial	M. L. King Mem.	Mississippi R.
9	002-0005	Old Cairo	US 60 & 62	Mississippi R.
9	002-0022	New Cairo	I-57	Mississippi R.
9	064-0035	Metropolis-Paducah	I-24	Ohio R.
9	097-0003	Grayville	I-64 EB	Wabash R.
9	097-0004	Grayville	I-64 WB	Wabash R.

A-9 BridgeWatch User Manual



Overview:

BridgeWatch® is a real-time, web-based, bridge monitoring software application developed by USEngineering Solutions to afford transportation officials and asset managers an early warning of hazards to their bridge infrastructure. BridgeWatch collects real-time data from sources such as the NWS, NOAA, NRCS, and USGS to compare against client-specified thresholds and will send alert notifications if any thresholds are exceeded. Alert notifications are distributed immediately via electronic mediums (email/sms/fax, etc.) and clients can login to BridgeWatch for a command-and-control view of their data, infrastructure, geography, and alert specifics to respond according to their Plans of Action (POAs).

Interface:

BridgeWatch offers an intuitive interface for users to view and interact with information. The interface consists of:

- 1) **Watch List:** The Watch List displays structures experiencing alert conditions. Users can select structures from the list to view alert details.
- 2) **Geography Filter:** Users can interact with the Geo-Spatial Display to view general areas and structures in each area utilizing the series of drop-down menus.
- 3) **Search Tool:** The Search Tool enables users to query for structures, gages, or user profiles.
- 4) **Data Sources:** The Data Sources buttons enable users to select information about structures, users, and official real-time meteorological, hydrologic and seismologic sources.
- 5) **Informational Display:** The Informational Display is used to publish detailed information about individual structures, profiles, or gages. Detailed information is displayed in a tabular format for ease of user interaction.
- 6) **Geo-Spatial Display:** The Geo-Spatial Display allows users to interact with static geographic boundaries such as towns, counties, political boundaries, watersheds, basins-of-influence, or any other user defined areas. Dynamic data sets such as real-time meteorological, hydrologic and seismologic overlays can also be displayed.
- 7) **Admin Interface:** Users who have administrative privileges are able to access the system's Admin Interface. This interface is partitioned into three categories: Management, Notification, and Simulation. Within each respective category, users can manage profiles, create reports, and access archived data. Users can also simulate training alerts and broadcast real-time messages to others.

Interface:

BridgeWatch | Illinois Department of Transportation

admin | logout | help | dispatch status: ON

1 Watch List
There are currently no active events.
Refresh List

2 Geography
Back to State Level
Select a District
Select a County
Select a HUC

3 Search
Submit

4 Data Sources

5

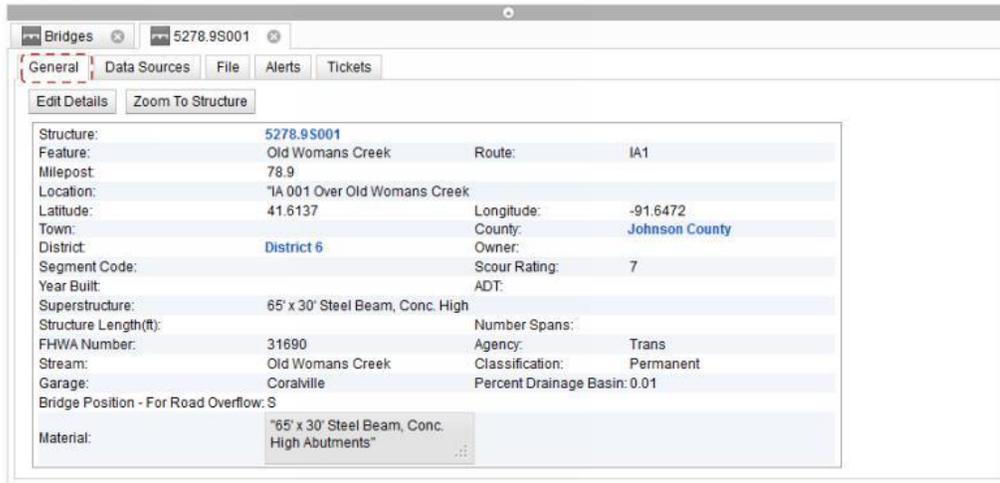
Bridge Number	Town	County	District	Latitude	Longitude	Feature	Location
0010002		Adams County	District 6	40.1451	-91.0665		
0010003		Adams County	District 6	40.1361	-91.0795		
0010014		Adams County	District 6	39.8797	-91.3993		
0010045		Adams County	District 6	39.8400	-91.3600		
0010043		Adams County	District 6	40.0074	-91.2770		
0010068		Adams County	District 6	39.9357	-91.4150		
0010070		Adams County	District 6	40.1390	-91.2201		
0013622		Adams County	District 6	40.1762	-91.3220		
0013382		Adams County	District 6	40.1183	-91.3967		
0020010		Alexander County	District 9	37.2406	-89.4437		
0020030		Alexander County	District 9	37.1224	-89.2746		

Data Tabs:

Data becomes visible through a series of detail screens in tabular format once a user selects a structure via the Geo-Spatial Display, Geography Filter, Search Tool, Structures, or Navigation Data Source buttons. Options will also appear to allow for zooming to the specifics of each structure and for displaying basins-of-influence.

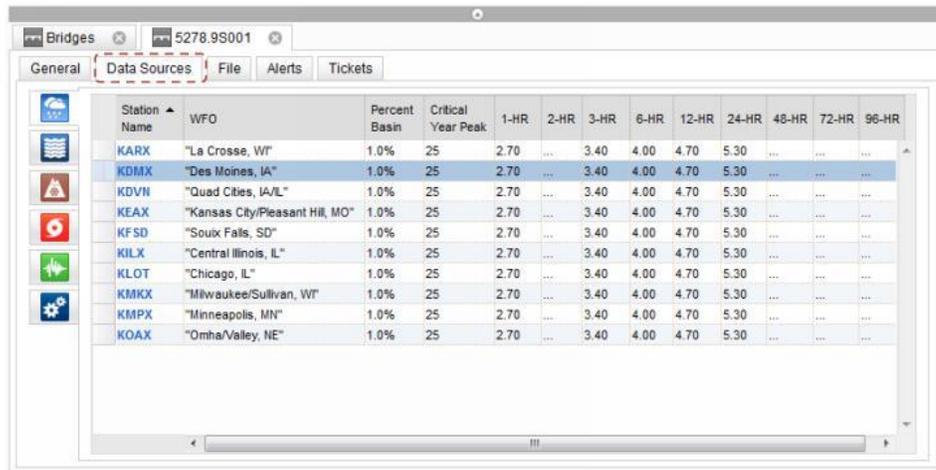
A structure detail screen consists of a series of five tabs (General, Data Sources, File, Alerts and Tickets). Below is an example of the “General” tab highlighting database information for a particular bridge.

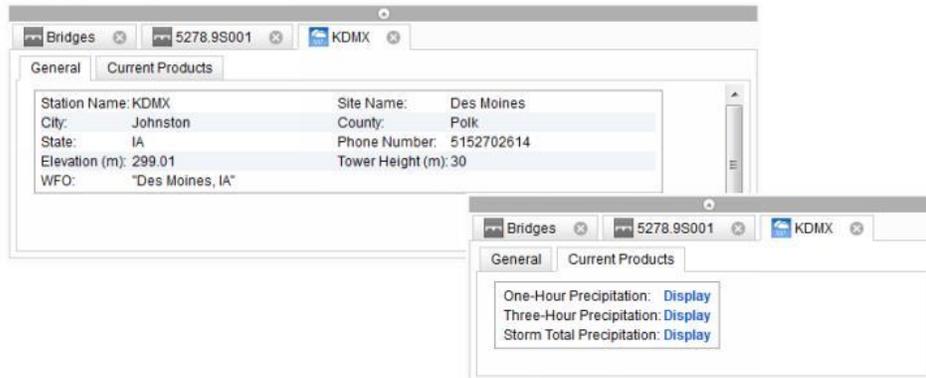
General Tab:



The "Data Sources" tab allows the user to display USGS gages and NOAA/NWS NEXRAD stations that are associated with the selected structure. Users can access sub-tabs and select data sources to obtain real-time information and thresholds related to that structure. For example, once a USGS gage is selected, users can view current hydrographs for discharge and height measurements, view peak discharge values, and display the list of structures that have been related to the gage.

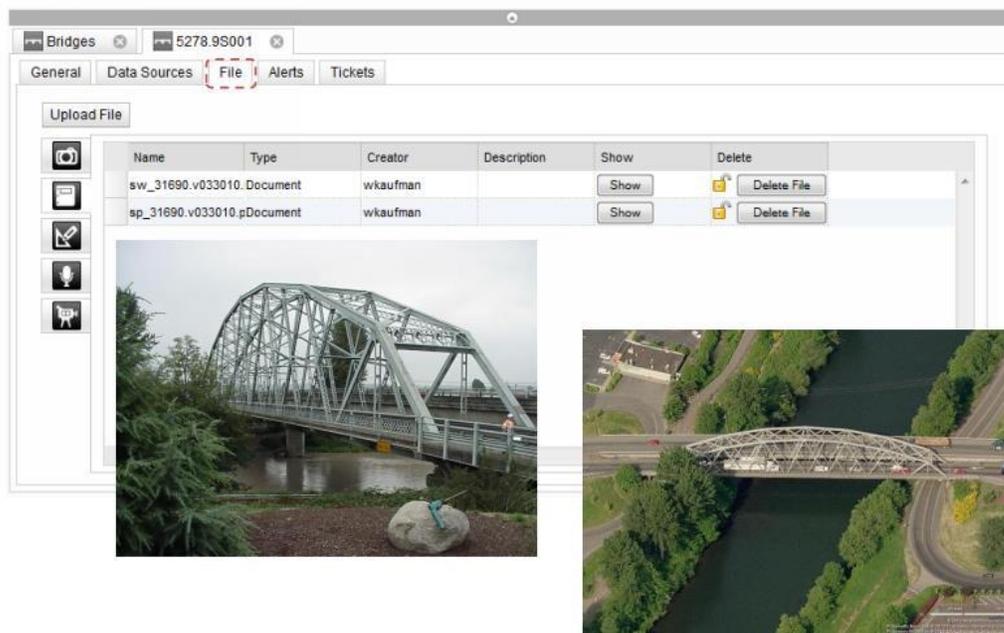
Data Sources Tab:





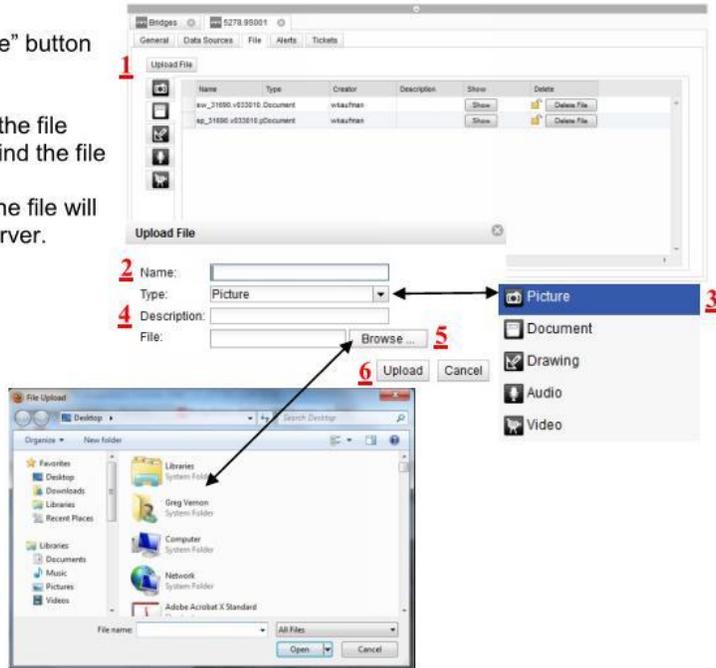
Tabs also delineate data where documents, alerts, tickets, and even navigational information can be viewed, stored, and updated. Users can select the "File" tab to access sub-tabs containing Images, Inspection Reports, Plans of Action (POAs), Site Plans, and any other supported files. Each document can be viewed within the informational display area by clicking on the "Show" button.

File Tab:



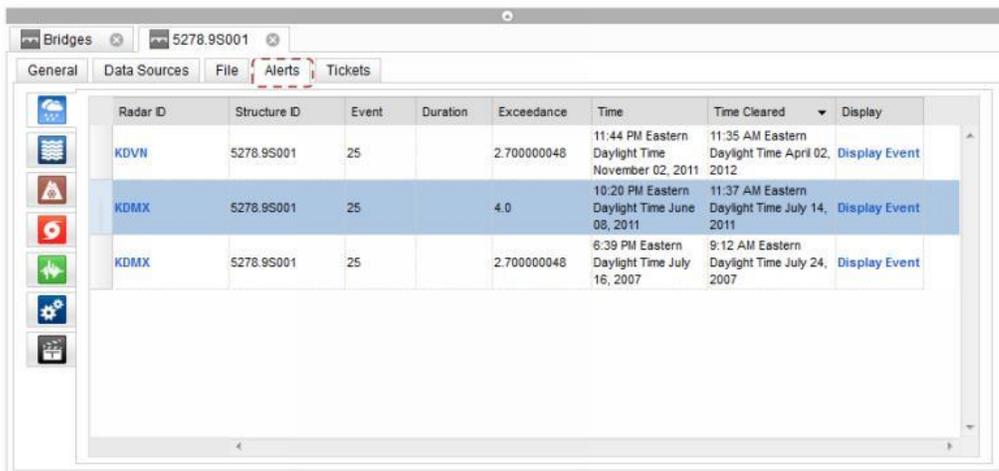
To add files to data tabs:

- 1) Select the "Upload File" button
- 2) Name the file
- 3) Select "Type"
- 4) Give a Description of the file
- 5) Select "Browse" and find the file to upload
- 6) Select "Upload" and the file will be uploaded to the server.



Alerts are documented and stored in the "Alerts" tab when an alert is triggered. Users can view alert history for radars, gages, devices, and simulations. Users can also overlay radar alerts on the Geo-spatial Display. An active alert will be represented in the Geo-Spatial Display with a red bridge icon.

Alerts Tab:



BridgeWatch | Iowa Department of Transportation admin | logout | help | dispatch status: ON

▼ Watch List
There are currently no active events.
[Refresh List](#)

▼ Geography
Back to State Level
Select a District:
Select a County:
Select a Town:
Select a HUC:

▼ Search
Submit

▼ Data Sources

KDMX Storm Total Wed Jun 08 22:23:04 CDT 2011

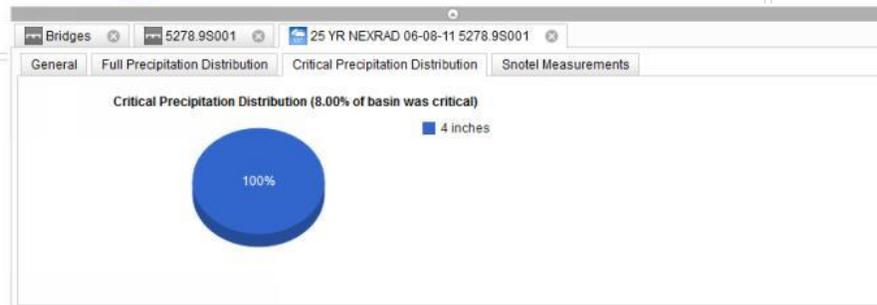
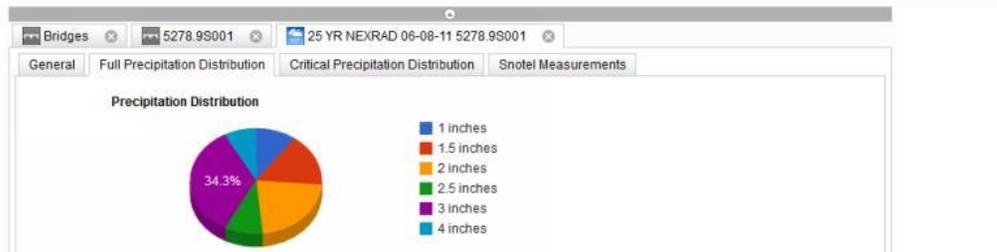
Hide Nexrad Hybrid Map

Map data ©2012 Google Imagery ©2012 TerraMetrics - Terms of Use Report a map error

Bridges 5278.9S001 25 YR NEXRAD 06-08-11 5278.9S001

General Full Precipitation Distribution Critical Precipitation Distribution Snotel Measurements

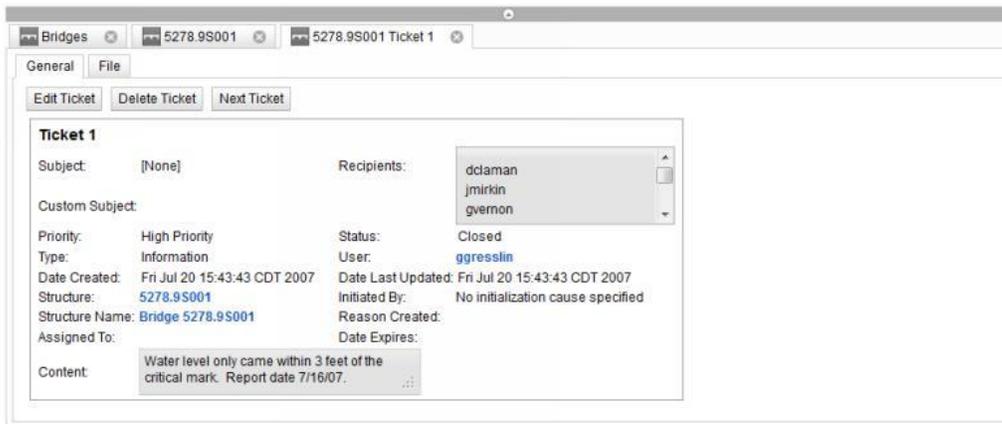
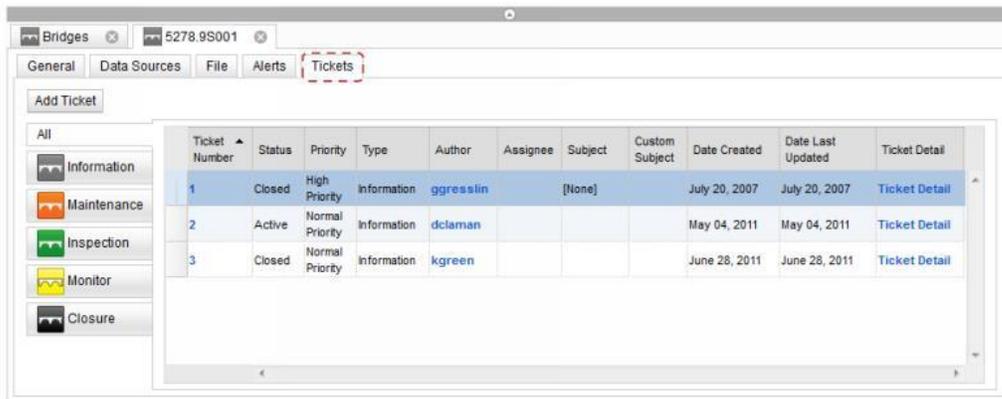
Event:	25	Structure:	5278.9S001
NEXRAD Station:	KDMX	SNOTEL Gage:	
Value:	4.0	Status:	Finished
Duration:	Six Hour		
Time Caused:	Wed Jun 08 2011 22:20:31 GMT-1		
Time Cleared:	Thu Jul 14 2011 11:37:20 GMT-0		
NEXRAD Product Display:		SNOTEL Contribution:	0.0



The "Tickets" tab allows users to document the condition and status of structures. Users initiate tickets by choosing one of five types: Information, Maintenance, Inspection, Monitor, or Closure. Once the type of ticket has been selected, the user fills out the ticket, adds an attachment, and can even select other users to whom the ticket will be distributed. Once submitted, the ticket is considered to be open and will be represented on the map with a color-coded status to enable users to quickly identify the progression to their Plan of Action (POA). A ticket will remain open until the author of the ticket or an administrator closes it.



Tickets Tab:



Data Sources:

The Data Sources window has several selectable buttons with logical icons representing their respective data source. Users can choose the respective data source layer to overlay on the Geo-Spatial Display by selecting the corresponding button.



The **Structure** button allows the user to view all of the structures and query a bridge by primary identification number, county, and region.



The **User** button enables users to display a list of other users and their contact information. By clicking on a username hyperlink, the profile belonging to that username appears with the username, assigned area, contacts and subscriptions. Users have the ability to edit their individual profile through the interface.



The **Navigation** button provides users with an easy way to navigate between sites and addresses. The display allows users to select their starting point, destination, and whether they want to view the directions within the system, on Google Maps or Bing Maps. Directions are generated once the "Get Directions" button has been selected.



The **NEXRAD** button enables users to perform a real-time meteorological review. Users can select local NWS radar sites and one of the three precipitation products to overlay. These products are the one hour, three hour, and storm total accumulated precipitation estimates.



Users can perform a real-time hydrologic review using USGS streamflow data. When the **USGS** button is selected, users are able to view gages and structures within hydrologic units or query gage sites for the current discharge and height measurements.



The **NWS Warnings** button enables users to view active system-aggregated NWS products such as Flash Flood (FFW) and Flood Warnings (FLW).



NRCS snow data is available when users select the **SNOTEL** button. Users can interact and query SNOTEL sites to review precipitation, accumulated precipitation, snow-to-water equivalency, and temperature.



The **SLOSH** button allows users to overlay NOAA storm surge data over coastlines. Probabilistic storm surge for impending tropical systems can also be displayed.



The **Seismic** button enables users to view seismic data from USGS and visualize energy propagation within the Geo-Spatial Display.



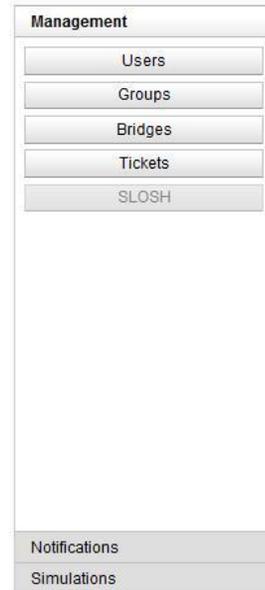
The **Devices** button enables users to view monitoring instruments that are specific to the client.

Admin Interface:

Users with administrative privileges are able to utilize advanced features for managing and querying data through the Admin Interface. This interface is partitioned into three categories: Management, Notification, and Simulation. Within each respective category, users can manage profiles, create reports, and access archived data. Users can also simulate training alerts and broadcast real-time messages to others.

Management:

Management provides administrators with the capability to add new users, edit existing profiles, or delete individuals. Administrators can use this feature to easily update contact information and alerts subscriptions.



Notification:



The majority of the Notification group contains all active and archived alerts that are processed by BridgeWatch. Notification also offers interactive features such as messaging.

“Active Alerts” provides administrators the ability to view all NEXRAD, USGS, NWS Warnings, or Simulated Events. With this function, administrators can simultaneously view, document, and close individual or multiple structure alerts.

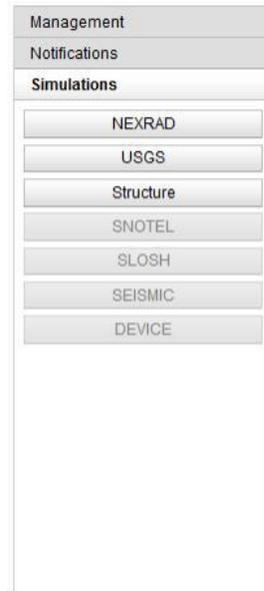
The “Archived Alerts” provides administrators the ability to view all inactive NEXRAD, USGS, and NWS Warnings and display a history of all alerts that have occurred over the life of the system. Data is displayed in tabular format and can be exported to an Excel® file with a single click.

“Messaging” allows an administrator to quickly distribute information to other users. Administrators can quickly select individual or multiple users, the form of contact (email, sms, fax,

etc.) and submit for instant delivery.

Simulation:

The Simulation “NEXRAD,” “USGS,” and “Structure” buttons are selected when a user wants to conduct training sessions. Administrators can create a simulated NEXRAD, USGS, or Structure event to test the effectiveness of current Plans of Action (POAs), inspection team response, and/or visualize influence of data source-driven events.



A-10 Guidelines for Estimating Strand Loss in PPC Deck Beam Bridges

Prestressed strands incorporated in the PPC Deck Beams shall be disregarded during analysis for load carrying capacity based on the following observed conditions:

LONGITUDINAL CRACKS

1. Cracks observed in the middle area of the beam underside, with or without rust stains or other discoloration of the concrete adjacent to the cracks:
Disregard all strands from all rows of strands that may be located adjacent to the cracks.
2. Cracks observed along the edges of the beam underside, with or without rust stains or other discoloration of the concrete adjacent to the cracks:
Disregard at least the strands located adjacent to the edge of the beam in the bottom row of strands. When the crack is extensive in length and its location varies in distance from the beam edge, disregard additional interior strands from all rows of strands that may be intersected by the crack.
3. Two longitudinal cracks observed crossing or meeting:
Disregard all strands in all rows of strands located between the cracks and one strand from all rows of strands located adjacent to the outer edge of the cracks.

Note: The intent is to disregard all strands that could intersect the crack and be exposed to air and moisture.

DETERIORATION

1. Exposed strands observed with sound concrete adjacent to and above the exposed strands:
Disregard exposed strands only.
2. Exposed strands observed with unsound concrete adjacent to and above the exposed strands:
Disregard exposed strands and all strands located in rows above and immediately adjacent to the area of unsound concrete.

3. Exposed reinforcement bars observed (#3 or #4 stirrups typically extending less than 1-foot in from the sides of the beam):
Disregard the strands located in the lower row directly above the exposed stirrups. If the concrete is found to be unsound adjacent to the exposed reinforcement bars, disregard all strands in all rows located above the area of unsound concrete.
4. Exposed wire mesh or full width reinforcement stirrup bars observed on bottom of beam:
Judge whether or not the wire mesh or reinforcement bars are in contact with the strands.
 - If in contact, disregard all strands in the lower row directly above the exposed wire mesh or stirrups.
 - If not in contact but the concrete adjacent to the exposed wire mesh or stirrups is found to be unsound, disregard all strands located above the area of unsound concrete.
 - If not in contact and concrete adjacent to the exposed wire mesh or stirrups is sound, do not disregard strands during analysis.
5. Areas of delaminated concrete observed:
Remove all delaminated concrete to determine the depth of concrete deterioration.
 - If reinforcement stirrup bars, wire mesh or strands are exposed, treat as in “1” through “4” above.
 - If no reinforcement, mesh or strands are exposed but there are indications that the exposed concrete is unsound within the affected area, disregard all strands located in the rows of strands above the area.
 - If no reinforcement, mesh or strands are exposed in the affected area and concrete in the area is found to be sound, do not disregard strands in analysis.
6. Wet or stained areas observed on bottom or side of beams:
Closely inspect the wet or stained area to determine the soundness of the concrete.
 - If close inspection indicates that concrete is unsound or delaminated, treat as in “5” above.
 - If close inspection confirms that the concrete is sound, do not disregard strands in analysis.

Note: Wet and/or rust stained areas should be watched closely. These areas will be the next areas to experience significant deterioration.

A-11 Historic Load Rating Information

Reinforcement Bar Conversions

When converting reinforcement bars from metric to English units, the following table shall be used:

Metric Bar	English Substitution
10	3
13	4
15	5
16	5
19	6
20	(See Note 1)
22	7
25	8
29	9
30	(See Note 1)
32	10
35	(See Note 1)
36	11

Table A-11-1 – Reinforcement Bar Metric to English Conversion

Note 1: Use the previous English bar size at a spacing that equates to the same area of steel per foot as the metric bar size and spacing.

Material Properties

IDOT has compiled a list of material properties based on the historic use of materials in the state. Unless records are available to indicate otherwise, the following material properties shall be used:

Year of Construction	Minimum Yield Strength, F_y (ksi)	Allowable Stress Rating	
		Inventory (0.55 F_y) (ksi)	Operating & Posting (0.75 F_y) (ksi)
Before 1905	26.0	14.3	19.5
1905 - 1929	30.0	16.5	22.5
1930 - 1961	33.0	18.1	24.7
After 1961	36.0	20.0	27.0

Table A-11-2 – Structural Steel Material Properties

Year of Construction	Minimum Yield Strength, f_y (ksi)	Allowable Stress Rating	
		Inventory (ksi)	Operating & Posting (ksi)
Before 1905	26.0	14.3	19.5
1905 - 1920	32.0	17.6	24.0
1921 - 1944	33.0	18.1	24.7
1945 - 1979	40.0	20.0	28.0
After 1979	60.0	24.0	36.0

Table A-11-3 – Reinforcing Steel Material Properties

Year of Construction	Tensile Strength, f_{pu} – LRFD f'_s – Std. Spec's (ksi)
Before 1963	228.0
1963 - 1976	248.0
After 1976	270.0

Table A-11-4 – Prestressing Strand Material Properties

	Year of Construction	Compressive Strength, f_c (f_c) (ksi)
Cast in Place Concrete	Before 1930	3.0 (1.2)
	1930 to date	3.5 (1.4)
Precast Concrete	All years	4.5 (1.8)
Precast Prestressed Concrete	All years	5.0 (2.0)

Table A-11-5 – Concrete Material Properties

	Member Type	Allowable Inventory Stresses Normal Load Duration (See Note 2) (ksi)	
		Bending	Shear
Members subject to bending and shear, dry service conditions	Stringer, Floor Beam, Pile Cap	$F_b = 1.15$	$F_y = 0.155$
Members subject to axial loading	Truss Member	Compression $F_c =$ (See Note 1)	Tension $F_t =$ (See Note 1)
Members subject to axial compression and bending, wet service conditions	Piling	Compression $F_c = 1.25$	Bending $F_b = 1.95$

Table A-11-6 – Timber Material Properties

Note 1: Truss member elements are very dependent on member sizes. Stresses shall be the lesser of the Select Structural values found in the NDS for Douglas Fir-Larch, Red Oak, or Southern Pine.

Note 2: Operating/Posting allowable stress is typically 133% of the inventory allowable stress, except for timber piles, which is 116.5% of the inventory allowable stress. This is to account for the eccentric loading at piers, and to a lesser extent at abutments, induced by the simple span configurations of many LPA bridges.

Condition	Allowable Bending Stresses, F_b Normal Load Duration & Dry Service Conditions	
	Inventory (ksi)	Operating & Posting (ksi)
Good	1.650	2.195
Fair	1.485	1.975
Poor	1.320	1.755

Table A-11-7 – Timber Deck Material Properties

The AASHTO MBE shall be referenced for material properties not included in these tables.

A-12 Consultant Plan Responsibility For Existing Bridges



Illinois Department of Transportation

Memorandum

To: ALL DEPUTY DIRECTORS OF HIGHWAYS
From: Milton R. Sees By: Ralph E. Anderson
Subject: Consultant Plan Responsibility For Existing Bridges
Date: February 23, 2007 *Ralph E. Anderson*

This memorandum supersedes the September 14, 2006 memorandum titled "Consultant Responsibility For Existing Bridges From Plan Development Through Construction" to All Deputy Directors from Milton R. Sees by Ralph E. Anderson.

This memorandum provides clarification of plan responsibility for consultants during the development of bridge plans including Bridge Condition Reports (BCR), Type, Size, and Location plans (TS&L), and Final Plans.

The following details the extent of the consultant's plan responsibility based on the scoping decisions made in the development of plans upon execution of their contract with the Department.

Bridge Condition Report

- Upon notice to proceed, the consultant shall conduct a field inspection of the subject bridge and prepare a Bridge Condition Report as detailed in the Bridge Manual and the "Bridge Condition Report Procedures and Practices" document dated July 26, 2004.
- The consultant shall review the current load rating prepared by the Department, or others, update based on the results of the bridge inspection, and submit their findings to the Department.
- The consultant shall evaluate whether the existing structure or any portion of the existing structure is suitable for reuse.
- The consultant shall evaluate if stage construction is geometrically feasible for any proposed replacement or rehabilitation scenario.
- If the District has established the Letting/Construction schedule for this project, the consultant shall prepare their final BCR recommendations taking into account that entire construction period. If staging is considered, the consultant shall evaluate the existing condition of the structure and provide an estimate of future deterioration for the duration of the construction schedule. If any portion of the existing structure is estimated to be inadequate for staging, the consultant shall make recommendations for structural repair or replacement of the affected members, recommend load restrictions during staging, or recommend full closure with traffic detours as part of the BCR submittal.

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- If a Letting/Construction schedule has not been established, the consultant shall prepare BCR recommendations based on the timeframe negotiated in their contract. If the Letting/Construction schedule is delayed beyond that established timeframe, the structural responsibility for the BCR will transfer back to the Department. The District may choose to close their contract with the consultant after acceptance of the BCR. Once a new Letting/Construction schedule is established by the Department, a consultant will be selected to evaluate the BCR, including scope, integrity of the existing structure, and feasibility of stage construction before preparation of the TS&L begins.
- The Department is responsible for monitoring the condition and safety of in-service bridges. Based on direction from the Department, the Consultant may be asked to provide monitoring inspections during BCR development as negotiated with the Department. If the consultant conducts a monitoring inspection, and determines that the condition of the existing bridge warrants interim repairs, selected member replacement, structural support, load restrictions, or bridge closure, they shall make recommendations to the Department in a timely manner.

Type, Size, and Location Plan

- Upon notice to proceed, the consultant shall review the existing BCR (whether prepared by the Department, a separate consultant, or themselves). Based on negotiations with the Department, a follow-up inspection may be required. The consultant shall then make any necessary modifications to the BCR and then assume responsibility for the report.
- The consultant shall prepare the TS&L as detailed in the Bridge Manual.
- If the District has established the Letting/Construction schedule for this project, the consultant shall estimate if their final TS&L will be valid for the duration of that construction period. If staging is considered, the consultant shall evaluate the existing condition of the structure and provide an estimate of future deterioration for the duration of the construction schedule. If any portion of the existing structure is estimated to be inadequate for staging, the consultant shall make recommendations for structural repair or replacement of the affected members, recommend load restrictions during staging, or recommend full closure with traffic detours as part of the TS&L submittal.
- If a Letting/Construction schedule has not been established, the consultant shall prepare the TS&L based on the timeframe negotiated in their contract. If the Letting/Construction schedule is delayed beyond that established time frame, the structural responsibility for the TS&L will transfer back to the Department. The District may choose to close their contract with the consultant after acceptance of the TS&L. Once a new Letting/Construction schedule is established by the Department, a consultant will be selected to evaluate the BCR and TS&L, including scope, integrity of the existing structure, and feasibility of stage construction before preparation of Final Plans begins.

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- The Department is responsible for monitoring the condition and safety of in-service bridges. Based on direction from the Department, the Consultant may be asked to provide monitoring inspections during TS&L development as negotiated with the Department. If the consultant conducts a monitoring inspection, and determines that the condition of the existing bridge warrants interim repairs, selected member replacement, structural support, load restrictions, or bridge closure, they shall make recommendations to the Department in a timely manner.

Final Plans

- Upon notice to proceed, the consultant shall review the existing BCR and TS&L (whether prepared by the Department, a separate consultant, or themselves). Based on negotiations with the Department, a follow-up inspection may be required. The consultant shall then make any necessary modifications to the BCR and TS&L and then assume responsibility for them.
- The consultant shall prepare and submit final, sealed plans to the Department based on the approved TS&L.
- During plan development, the consultant shall evaluate if the existing structure and any portion of the existing structure used for staging will be structurally adequate for the given construction schedule.
- If the District has established the Letting/Construction schedule for this project, the consultant shall estimate if their Final Plans will be valid for the duration of the construction period. If staging is considered, the consultant shall evaluate the existing condition of the structure and provide an estimate of future deterioration for the duration of the construction schedule. If any portion of the existing structure is estimated to be inadequate for staging, the consultant shall make recommendations for structural repair or replacement of the affected members, recommend load restrictions during staging, or recommend full closure with traffic detours as part of the Final Plan submittal.
- If a Letting/Construction schedule has not been established, the consultant shall prepare Final Plans based on the timeframe negotiated in their contract. If the Letting/Construction is delayed beyond that established timeframe, the structural responsibility for the Final Plans will transfer back to the Department. The District may choose to close their contract with the consultant after acceptance of the Final Plans. Once a new Letting/Construction schedule is established by the Department, a consultant will be selected to evaluate the BCR, TS&L, and Final Plans, including scope, integrity of the existing structure, and feasibility of stage construction before any updates to the Final Plans begins.
- The Department is responsible for monitoring the condition and safety of in-service bridges. Based on direction from the Department, the Consultant may be asked to provide monitoring inspections during Final Plan development as negotiated with the Department. If the consultant conducts a monitoring inspection, and determines that the condition of the existing bridge warrants interim repairs, selected member

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replacement, structural support, load restrictions, or bridge closure, they shall make recommendations to the Department in a timely manner.

The District shall provide existing inspection data to the consultant. Any subsequent inspection data resulting from new inspections performed by the District, the Central Bridge Office, or other consultants, shall be forwarded to the consultant in a timely manner.

The Department shall provide a anticipated scope of work for the project based on current inspection reports, analysis data, and the established letting schedule. The consultant shall provide all necessary documentation, including new inspection results and structural analysis computations for any recommended change to the anticipated scope of work.

The District may provide access equipment and/or traffic control to facilitate the consultant field inspections or they may require the consultant to contract separately for these items.

Nothing contained in the above discussion shall relieve the awarded contractor of their responsibilities as detailed in Section 107 of the Standard Specifications.

The Consultant may be retained during construction for consultation, shop drawing review or field services as defined per their contract scope.

The Bureau of Bridges and Structures will continue to review consultant BCR, TSL, and Final Plans for approval.

1. This policy will be effective immediately for projects scheduled for the August 3, 2007 Letting or later, that involve the repair or replacement of existing PPC Deck Beams. This may require additional manhours for consultants currently under contract, in order for them to assess the current condition of the existing deck beams and to make recommendations for repair, replacement, temporary supports, posting, or closure as necessary.
2. For all other projects, regardless of existing bridge type, this policy will be effective with selection on PTB 143 – Selection on March 28, 2007.

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