Illinois Department of Transportation

Memorandum

To:	Regional Engineers and Central Bureau Chiefs
From:	Steve Travia, Director of Highways Project Implementation
Subject:	Revision of Safety Engineering Policy Memorandum 4-15 – Safety Engineering Policy 4-21
Date:	November 8th, 2021

Attached is the revised Safety Engineering Policy Memorandum Safety 4-21. This version supersedes Safety Engineering Policy Memorandum 4-15 and shall be effective January 1, 2022.

The changes to the policy are summarized below:

1. Table 1 outlining requirements for accommodating drop off between traveled lanes was reformatted to mirror changes to the Standard Specification with Road and bridge Construction Adopted January 1, 2022.

2. Figure 4 outlining limits for pinning requirements was edited to fix errata.

These changes will not affect plan preparation or change previous requirements outlined under Safety Engineering Policy Memorandum 4-15.

Apart from the changes outlined above, all guidance and requirements outlined under the Safety Policy Memorandum 4-15 and transmittal memorandum dated March 1st, 2015 remain effective.

For questions regarding this policy, please contact Juan David Pava at (217) 557-7229 or Juan.pava@illinois.gov.

Illinois Department of Transportation
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Safety Engineering Policy Memorandum

Safety 4-21

Work Zone Safety and Mobility Supplemental Policy- Moving Ahead for Progress in the 21st Century Act (MAP-21) and Subpart K to Title 23 CFR Part 630: Positive Protection of Workers, Drop-offs and Temporary Concrete Barrier (TCB)

Effective December 4, 2008
Revised November 8, 2021

Overview

Based on MAP-21, the Federal Highway Administration (FHWA) is instructed to update Subpart K to 23 CFR Part 630 to supplement existing regulations that govern work zone safety and mobility in highway and street work zones. This includes conditions for appropriate use of positive protection between workers and motorized traffic, and installation and maintenance of temporary traffic control devices during construction, as well as utility and maintenance operations. These regulations are intended to decrease the likelihood of fatalities and injuries to road users and workers exposed to motorized traffic. Illinois Department of Transportation (IDOT) has already been in substantial compliance with many of the provisions of the supplemental regulations. Design guidance for roadside safety issues including work zone safety is the responsibility of the Bureau of Safety Programs and Engineering (BSPE) and this policy will ensure full compliance with updated regulations by addressing more key areas of work zone safety. This policy supersedes Safety 4-08 and Safety 4-15. Exceptions to this policy shall be reviewed and approved by the BSPE.

Purpose and Implementation

Safety Policy 4-08 was revised to provide detailed guidance on mitigating drop-offs and the appropriate use and installation of temporary concrete barrier (TCB). The stated planning, design, and construction guidance shall be used in future project development and implementation for any state projects, or local Federal-aid highway projects let after July 1, 2015 and shall be included as part of the required project Transportation Management Plan (TMP).

Projects let prior to July 1, 2015, with the exception of bridge deck and approach slab locations, that have the back of unpinned TCB installed less than 24 in. from a drop-off shall have a risk assessment performed using this policy and BSPE Spreadsheet for Guidance on Pinning TCB (Guidance on Pinning). The risk assessment, including the district's reasoning and justification for its proposed course of action, shall be submitted by the district's Bureau of Construction (BoC) to the BSPE for review and approval.

Safety Policy 4-15 was revised to address errata and provide consistency with other contract documents.

Guidance for Use of Positive Protective Devices

Introduction

There are many instances where workers are working on the pavement adjacent to traffic lanes and are only separated from traffic by channelizing devices. In accordance with 23 CFR 630.1106 and 630.1108, the management of work zone impacts shall include the consideration and management of highway worker safety on Federal-aid highway projects and the use of positive protective devices. This policy establishes requirements and provides guidance for addressing worker and motorist safety by providing positive protective devices to limit the exposure and risk from motorized traffic in order to decrease the likelihood of fatalities or injuries to workers and prevent the intrusion of motorized traffic into the work zone on all Interstate, National Highway System, and other highways under State jurisdiction.

Definitions and Notes

The following definitions and notes shall apply to this policy:

2L2W. A two-lane/two-way (2L2W) is an undivided roadway with one continuous through lane in each direction. Bidirectional left turn lanes are not counted as through lanes. A “three lane” roadway with a bidirectional left turn lane is considered a 2L2W for the purposes of this guidance.

4L2W. A four-lane/two-way (4L2W) is an undivided multilane roadway with two continuous through lanes in each direction. Bidirectional left turn lanes are not counted as through lanes. A “five lane” roadway with a bidirectional left turn lane is considered a 4L2W for the purposes of this guidance.

Anchor Pin. An anchor pin is a “Connecting and Anchor Pin” as shown on Highway Standard 704001 when used for anchoring TCB, or for pinning TCB.

Anchoring TCB. A TCB is “anchored” if the connecting pins are installed in the connecting loops joining adjacent TCBs and (in order of preference):

1. All six anchor pins are installed in the 1 ¼ in. diameter holes on both the first and last segments of a run or,

2. When the installation of anchor pins is not feasible or desirable, then the layout of TCB in Figure 2 or Figure 3, as applicable, may be used in lieu of providing anchor pins. Note that these layouts work for the approaching traffic direction, but access to the work area is limited if they are also applied on the other end of the TCB installation. For bridge projects, it will often be possible to extend the TCB beyond the limits of a bridge and its approach slabs to a suitable location for placing anchor pins, or application of Figure 3. or

3. Site-specific structural details provided by the Bureau of Bridges and Structures (BBS) and approved by the BSPE are applied, or

4. A water-filled, non-redirective impact attenuator is used. This device must be accepted by FHWA under National Cooperative Research Program Report 350 (NCHRP 350) or the Manual for Assessing Safety Hardware (MASH) and approved by IDOT for use without anchor pins in the end segment of TCB. In using this anchoring method, it is necessary to design for the fact that impacting vehicles may travel 100 ft beyond and behind the impact attenuator, and that FHWA cautions that this application should only be used where high speed impacts are unlikely. Impacts at higher speed than 45 mph should be considered as high speed.

Back of TCB. The back of TCB is the back edge of the contact of the TCB with the supporting road, shoulder, or other surface.

Connecting Pin. A connecting pin is a "Connecting and Anchor Pin" as shown on Highway Standard 704001, when used to connect adjacent segments of TCB.

Deflection. Deflection is the distance that a barrier system moves laterally when impacted by a vehicle. For design purposes, this is usually related to the most severe impact in the applicable crash testing.

Drop-off. A drop-off is defined as an elevation difference between adjacent traveled lanes, between a traveled lane and an adjacent shoulder, between a lane or shoulder and other lower surface (such as an excavation), or between the surface of a bridge deck and an exposed grid of reinforcement bar supported along its perimeter by structural concrete. Pavement patching is not considered a drop-off condition, except when individual patching holes are left open in excess of 24 hours.

Long Duration Stationary Operation. A long duration stationary operation is defined as a stationary operation in place for two weeks or more.

Locations With No Means of Escape from Motorized Traffic. Locations with no means of escape from motorized traffic are defined based on engineering judgment (e.g., tunnels, bridges, bridge painting, narrow medians, etc.).

Mobile Operations. Mobile Operations are defined as work that moves intermittently or continuously, (at approximately 1 mph, a walking pace, or greater).

Motorized Traffic. Motorized traffic means the motorized traveling public, but does not include motorized construction or maintenance vehicles or equipment within the work zone.

Multilane Roadway. A roadway with two or more continuous through lanes of traffic in at least one direction. A multilane roadway may or may not include a median.

Pinning. A TCB is "pinned" if each anchor pin is installed in the 1 ¼ in diameter hole of the barrier, along the traffic side only, and the connecting pins are installed in the connecting loops joining adjacent TCB's (Highway Standard 704001). On a bridge

deck or approach slab, a TCB is "pinned" if its movement is restrained by application of details provided by the Bureau of Bridges and Structures (BBS), generally using short pins into an existing deck or a restraining plate and blocking at the edge of a new deck. See BBS Base Sheet R-27, "Temporary Concrete Barrier for Stage Construction":

http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Bridges/CADD/Bridge-Cell-Libraries/Superstructure.pdf

Positive Protective Devices. Positive protection devices means the devices that contain and/or redirect errant vehicles and meet the crashworthiness evaluation criteria contained in NCHRP Report 350 or MASH. This can include approved Temporary Longitudinal Traffic Barriers (TLTB) or truck/trailer mounted attenuators (TMA).

Risk Assessment. A risk assessment is the appraisal and comparison of expected losses and costs associated with an action. Specific to this policy, risk assessment relates to the decision of whether or not to provide pinning for TCB at locations other than bridge decks or approach slabs, or locations where engineering judgment identifies similar risks. The risk assessment and discussion of the reasoning and justification for the proposed course of action regarding pinning shall be included in the required project TMP. Bridge decks and approach slabs are excluded from risk assessment.

For development of the TMP and Traffic Control Plan (TCP) documents in Phase I, or Phase II, a risk assessment is applicable when the back of the TCB is located from 12 in. to 24 in. (inclusive) from the edge of a drop-off. (See Figure 4).

For projects let prior to July 1, 2015, a risk assessment shall be applied to TCB installations when the back of the TCB is located from zero to 24 in. (inclusive) from the edge of a drop-off.

Risk Assessment includes estimation of the number of additional TCB failures expected as a result of not pinning. This estimation should be done using the latest version of the spreadsheet given in the "Guidance on Pinning TCB" on the BSPE website:

http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Safety-Engineering/SpreadsheetForGuidanceOnPinningTCBrev8_7_2014.xlsx

Factors considered by the spreadsheet are the safety performance of proposed or existing unpinned TCB, duration and length of TCB, deflection distance, ADT, percentage of single unit and multiple unit trucks, and others. See Figure 1 for an example of the spreadsheet. The user weighs this information against other job-specific factors, such as crash history, worker exposure, project scheduling, and cost to support and document a decision regarding pinning of the TCB.

Stationary Operations. Stationary operations are defined as work that occupies a location for more than one hour. In these cases the work would require a lane closure in accordance with an appropriate Highway Standard.

Temporary Longitudinal Traffic Barrier. TLTB means the Illinois F-shape TCB, a device listed by IDOT as approved for use under the specification for MOVABLE TRAFFIC BARRIER, or other temporary longitudinal traffic barrier accepted by FHWA under NCHRP 350 or MASH and approved by IDOT BSPE for use in lieu of TCB or MOVABLE TRAFFIC BARRIER**.**

Transition. Where it is necessary to have both pinned and unpinned (freestanding) lengths of TCB in a continuous installation, a transition of the pin pattern is necessary.

Traversable Drop-off. A traversable drop-off applies for Table 2 (Condition II) The traversable drop-off connects the two elevations using a slope of 1V:3H or flatter that is firm and unyielding under traffic. Where the slope of the traversable drop-off is steeper than 1V:4H, the width of the slope may not be considered towards satisfying the construction clear zone. If the slope of the traversable drop-off is steeper than 1V:4H, then during non-working hours the construction clear zone must be provided beyond the toe of the slope. Providing a traversable drop-off does not relieve any requirement for worker protection.

Work Zone Safety Management. Work zone safety management means the entire range of traffic management and control and highway safety strategies and devices used to avoid crashes in work zones that can lead to worker and road user injuries and fatalities, including positive protective devices, exposure control measures and other traffic control measures.

SPREADSHEET FOR GUIDANCE ON PINNING TCB
LOCATIONS WITH NORMAL POSTED SPEED LIMIT OF 55 MPH OR 65 MPH
OR OTHER FREEWAY LOCATIONS
THIS IS NOT TO BE USED FOR BRIDGE DECKS OR SIMILAR LOCATIONS

Data entry	
Calculated value	
Primary Consideration	
Supporting Consideration	
Data entry warning	MESSAGE

Route
Contract
Project Phase: Phase III

Safety Performance to Date of Existing Unpinned TCB (PHASE III ONLY)	Input/Output		Recommendations and Remarks
Has the TCB installation been hit, knocking any TCB unit into the drop off?	Yes		
If "Yes", how many times?	1	Integer	RECOMMEND RETROFIT PINNING
Has the TCB installation been hit, knocking any TCB unit into the drop off and resulting in injury to anyone?	Yes		
If "Yes", how many times?	0	Integer	

Predicted Safety Performance			
How long has the TCB installation been in place? (PHASE III ONLY.)	30	Weeks	
How much longer must the TCB installation be used?	30	Weeks	
How long is the TCB installation?	5	Miles (Nearest 0.1)	
What is the total 2 way AADT on the highway?	35000	(Nearest 5000)	
What percentage of the traffic is passenger vehicles, PV? (Cars, pickups, minivans, SUVs)	60	0 to 100	
What is the offset from the back of the TCB to the drop off?	1.5	Nearest 0.5 ft.	
Projected additional, excess TCB failures if not pinned.	0.47	Predicted excess TCB failures from present to completion.	
Actual TCB failures	1		THRESHOLD GREATER THAN 'PREDICTED IF PINNED'

Other Site Considerations			
What is the percentage of Multiple Unit trucks in the AADT?	35	Nearest percent	LARGE TRUCK VOLUME SUPPORTS RETROFIT PINNING
What is the percentage of Single Unit (SU) trucks in the AADT?	5	Nearest percent	
What is the general alignment along the TCB installation?	Some curves, up to 2 degrees.		
What is the terrain along the installation?	Flat		
Does the TCB installation length include any entrance ramps?	No		
Does the TCB installation length include any exit ramps?	No		

Definition: Rolling Terrain: The natural slopes consistently rise above and fall below the roadway gradeline and, occasionally, steep grades present some restriction to the desirable horizontal and vertical alignment. In general, rolling terrain generates steeper grades causing trucks to reduce speeds below those of passenger cars.

Definition: Rugged Terrain: Longitudinal and transverse changes in elevation are abrupt, and benching and side hill excavation are usually required to provide the desirable horizontal and vertical alignment. Rugged terrain aggravates the performance of trucks relative to passenger cars and results in some trucks operating at crawl speeds.

Dated:	3/13/2014	
Updated:	5/2/2014	Corrected calculation bug. Corrected formulae and conditional formatting for some of the supporting considerations.
	6/25/2014	Changed cell formatting for legibility in black and white printing.
	8/7/2014	Account for application in Phase I, Phase II or Other.
	1/9/2015	Corrected reference to project phases. Added checking for data appropriate to project phases.

Instructions | GUIDANCE ON TCB PINNING

FIGURE 1

EXAMPLE: SPREADSHEET FOR GUIDANCE ON PINNING TCB

Use of Positive Protective Devices

Positive protective devices must be considered in work zone situations that place workers at increased risk from motorized traffic, and where positive protective devices offer the highest potential for increased safety for workers and road users. For local roads with Average Daily Traffic (ADT) of less than or equal to 400, barricades may be used in lieu of positive protection based on engineering judgment. The following describes conditions where work is conducted under traffic and positive protection is required:

Mobile Operations

- Multilane highways

  A mobile operation may be accomplished using a stationary standard lane closure as shown in the Highway Standards, the Work Site Protection Manual for IDOT Employees, or superseding publications, where the lane is closed using signing, arrow boards and channelizing devices. Establishing the lane closure shall employ TMAs as shown on the Highway Standards or other applicable references.

  If such a stationary standard lane closure is not used, then positive protective devices such as TMAs shall be used to close the lane in advance of the workers. The use of additional signing would be dependent upon the normal posted speed limit, duration, and the length of the work and shall be in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

- 2L2W highways

  Mobile operations on two lane highways will require the use of a positive protective device such as a TMA in advance of the work.

TMAs are acceptable for limited daily work hours consistent with the Work Site Protection Manual for IDOT Employees, or superseding publications.

Stationary Operations

The conditions below will require positive protective devices.

Locations with no means of escape from motorized traffic:

-Multilane highways will require positive protection. When this condition lasts for more than 24 hours, or requires multiple days/nights setups exceeding a cumulative 24 hours to complete, it will require the use of TLTBs.

-2L2W highways will require positive protection. When this condition lasts for more than four days per stage it will require the use of TLTBs.

Long duration, stationary locations, with high speed and workers near a traffic lane:

-TLTBs will be required for stationary operations where the normal posted speed limit is 45 mph or greater, the duration of the stationary operation is two weeks or more, and workers are present within one lane width of the open traffic lane. EXCEPT when the project is outside of an urbanized area and the annual average daily traffic load is less than 100 vehicles per hour. (AADT/24 is less than 100)

Positive protective devices must be used in accordance with the Highway Standards, MUTCD, manufacturers' requirements and NCHRP 350 or MASH, and technical guidance in this policy. Their use provides greater protection for workers than normal channelizing devices; however, workers should be aware of the limitations of positive protective devices.

For emergency situations and traffic incidents, apply the guidance in the Work Site Protection Manual for IDOT Employees or superseding publication.

When developing the TMP, designers should take emergency situations into consideration. Gaps in the TCB to allow for emergency responder access should be considered and TCB ends shielded as appropriate.

Design Policy to Minimize Drop-off Exposure

Drop-offs along highways present exposure to risk for highway users, especially vulnerable users such as motorcyclists. Exposure can be minimized by reducing speed, increasing lateral distance to the drop-off, providing a notched wedge joint or traversable drop-off, or providing TLTB.

The following tables provide policy for accommodating drop-offs in applicable cases (*i.e.* preparation of plans, Construction sites or Operations work sites, sites with changing field conditions, and others.)

Table 1, Condition I

Table 1 - Drop-offs Between Traffic Lanes [1/]				
Normal Posted Speed	Drop-off Type	Drop-off Depth, in. (mm)	Physical Treatment	Additional Signage
≥ 45 mph	Lift of HMA	> 1 (25) to 2 (51)	n/a	UNEVEN [6/] LANES Signs
		> 2 (50) to 4 (100)	Notched wedge [3/] longitudinal joint	UNEVEN [6/] LANES Signs
	Milled Edge or Vertical Edge	> 1 (25) to 1.5 (38)	n/a	UNEVEN [6/] LANES Signs
		> 1.5 (38) to 4 (100)	Temporary wedge or [3/] tapered edge, 1:3 min.	UNEVEN [6/] LANES Signs
	All	> 4 (100) to 12 (300) [2/]	Lane closure with [4/] channelizing devices	n/a
		> 12 (300)	Lane closure with temp. [5/] longitudinal traffic barrier	n/a
< 45 mph	Lift of HMA	> 1.5 (38) to 2.5 (64)	n/a	UNEVEN [6/] LANES Signs
		> 2.5 (64) to 4 (100)	Notched wedge [3/] longitudinal joint	UNEVEN [6/] LANES Signs
	Milled Edge or Vertical Edge	> 1.5 (38) to 4 (100)	Temporary wedge or [3/] tapered edge, 1:3 min.	UNEVEN [6/] LANES Signs
	All	> 4 (100) to 12 (300) [2/]	Lane closure with [4/] channelizing devices	n/a
		> 12 (300)	Lane closure with temp. [5/] longitudinal traffic barrier	n/a

1/ Excludes pavement patching if backfilled within 24 hours.

2/ The exposure to drop-offs in this range shall be limited to a length of 0.5 miles (0.8 km) and a duration of 48 hours. Exceeding this length or duration shall require the use of a temporary longitudinal traffic barrier in lieu of channelizing devices.

3/ Or same physical treatment and additional signage as "> 4 (100) to 12 (300)".

4/ The channelizing devices shall be placed at the same level as the open lane or in the drop-off to preserve the width of the open lane as directed by the Engineer. When placed in the drop-off, the reflective area of the channelizing devices shall be raised to the elevation above the open lane as required by Highway Standard 701901.

5/ The temporary longitudinal traffic barrier (TLTB) shall be placed at the same level as the open lane. A TLTB is a temporary concrete barrier or movable traffic barrier.

6/ The "UNEVEN LANES" (W8-11) signs shall be spaced at 2 mile (3 km) intervals on freeways and expressways; 1-mile (1600 m) intervals on rural highways; and as directed by the Engineer on urban roadways.

Table 2, Condition II

Drop-off Near the Edge of Traveled Way

Existing Road Type	Normal Posted Speed Limit, NPSL (mph)	Drop-off Depth, D (in.)	TCB is Warranted(2)	Use of TCB may be warranted, based on traffic exposure.(2)	Maximum Allowable Total Traffic (Both Directions)Without TCB (3)
2L2W	Up to 35	12 ≤ D ≤ 18		Yes(1)	3.02
2L2W	Up to 35	18 < D ≤ 24		Yes(1)	2.39
2L2W	Up to 35	24 < D ≤ 36		Yes(1)	2.08
2L2W	Up to 35	D > 36	Yes(1)		
2L2W	35<NPSL≤45	12 ≤ D ≤ 18		Yes(1)	1.42
2L2W	35<NPSL≤40	18 < D ≤ 24		Yes(1)	1.12
2L2W	> 45	D > 12	Yes(1)		
4L2W	Up to 35	12 ≤ D ≤ 18		Yes(1)	9.31
4L2W	Up to 35	18 < D ≤ 24		Yes(1)	7.30
4L2W	Up to 35	24 < D ≤ 36		Yes(1)	6.25
4L2W	Up to 35	> 36	Yes(1)		
4L2W	35<NPSL≤45	12 ≤ D ≤ 18		Yes(1)	3.43
4L2W	35<NPSL≤40	18 < D ≤ 24		Yes(1)	2.94
4L2W	> 45	D ≥ 12	Yes(1)		
All	>45	D < 12	No (2)		
All	>45	D ≥ 12	Yes		

Locations where the drop-off is located within 8 ft. of the edge of the nearest open traffic lane. For drop-off locations beyond 8 ft. of the edge of the nearest open traffic lane, but within the construction clear zone, base the decision and design upon an engineering study.

Channelizing devices and temporary barrier are to be placed at same level as traveling lane or shoulder profile.

Where TCB is not used, channelizing devices may be placed at the drop-off elevation to preserve lane width. The reflective area and warning light (if required) shall be raised to the elevation above traveling lane or shoulder profile as required by Highway Standard 701901.

This guidance includes consideration of analysis by the Roadside Safety Analysis Program, Version 3.0.1, and is based on use of Illinois F-Shape TCB. Other TLTB approved for use by IDOT may be used in lieu of TCB where space is available for its design deflection, and where it is considered economically justified.

(1) For urban/suburban locations, the designer should consider access needs and sight distance in making a final decision to use TCB.

(2) However, see above sections for long duration stationary operations on high speed roads with workers, and for worker protection where there is no means of escape.

(3) The product of Average Daily Traffic and duration, in calendar days, divided by 1,000,000 (ADT x Calendar Days/1,000,000). This is per each time that the TCB is installed or relocated.

Guidance for Pinning and Anchoring TCB

Background

FHWA requires that roadside hardware used on the National Highway System (NHS), including work zones, meet crash testing criteria of NCHRP 350 or MASH. IDOT applies these criteria and, for consistency, applies them to all roadways under State jurisdiction. Further, the AASHTO Roadside Design Guide (4th Edition, 2011) is the major reference used for further technical guidance on selection, location, and installation of roadside safety hardware and other roadside safety issues. This policy is intended to provide compliance as well as design flexibility.

In the early 2000's, several states crash tested TCB using NCHRP 350 criteria and received FHWA approval for its use. Illinois reviewed the various approved barriers and received FHWA concurrence (July 3, 2002 FHWA Memorandum) to use the Illinois F-Shape TCB (Highway Standard 704001).

The Illinois F-Shape TCB utilizes the shape and reinforcing from the approved Midwest TCB, and the pin and loop connection similar to the Oregon barrier. Deflection testing per NCHRP 350 of the Midwest TCB was 45 in., while the Oregon TCB reported 30 in. deflection. The approved Illinois F-Shape TCB was not crash tested; however, based upon the deflections of the two barriers of which the Illinois F-Shape TCB is comprised, IDOT adopted an estimated deflection of 42 in. for its F-Shape TCB. These deflections are based upon movement of the TCB on a clear paved surface in the same plane during the crash test; therefore, it is important that the area behind the TCB is kept in similar conditions as the crash testing.

Based on the AASHTO Roadside Design Guide and the guidance provided therein of acceptable field performance, the BBS method of pinning TCB utilizing BBS Base Sheet R-27 is acceptable until a MASH design that does not negatively impact the structural integrity of the bridge deck has been designed and approved by FHWA.

In 2003, Midwest Roadside Safety Facility (MwRSF) at the University of Nebraska – Lincoln performed computer modeling of the Midwest TCB to evaluate and better predict deflection criteria. In summary, the study stated that in critical situations where barrier falling off the edge would lead to catastrophic results (as on bridge decks), the full 45 in. deflection distance (for the Midwest TCB they were evaluating) should be used to assure that the center of gravity of the TCB would not cross the edge of the bridge deck. For all other non-critical situations, the study recommended reduced crash criteria based upon containing 85% of impacting vehicles.

IDOT has studied the relationships between various impact conditions for design vehicles, considered the items and research noted above, reviewed fatal and severe injury crashes involving TCB in work zones, and developed the Spreadsheet for Guidance on Pinning TCB, and minimum requirements to guide the decision of where and when to pin TCB.

Anchoring

In an effort to mitigate pocketing of impacts near the end of a run of TCB, the first and last segments of a TCB run are anchored with all six anchor pins and the connecting pins are installed in the connecting loops between adjacent TCB's Pins in accordance with Highway Standard 704001, Article 704.04 of the latest version of the Standard Specifications for Road and Bridge Construction, and BDE Special Provision, TEMPORARY CONCRETE BARRIER (BDE). When use of anchor pins is not feasible or desirable at one or both ends of the TCB (e.g. new pavement, bridge approach slabs, or bridge decks), the anchoring alternatives shown in Figure 2 or Figure 3 may be used. In no case shall holes for anchor pins be placed in bridge decks or approach slabs without the concurrence of the BSPE and the BBS. Subject to the conditions and cautions included in the definition of anchoring, specific water-filled, non-redirective impact attenuators accepted by FHWA and approved by IDOT may be used with TCB and no anchor pins. See the definition of anchoring for more information and for the order of preference of these anchoring methods.

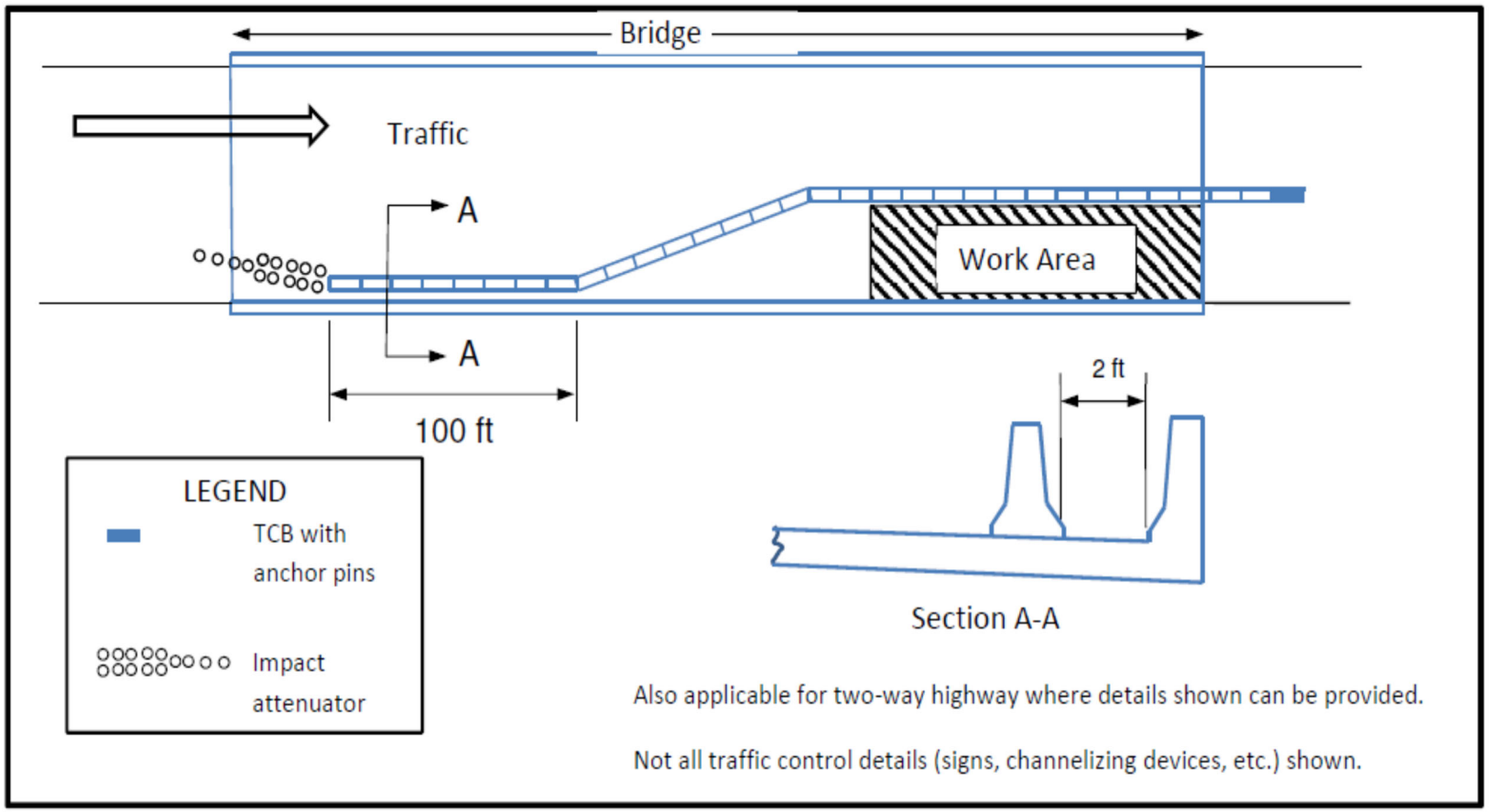


FIGURE 2

ALTERNATE LAYOUT OF TCB FOR ANCHORING ADJACENT TO CONCRETE BRIDGE PARAPET OR CONCRETE MEDIAN BARRIER

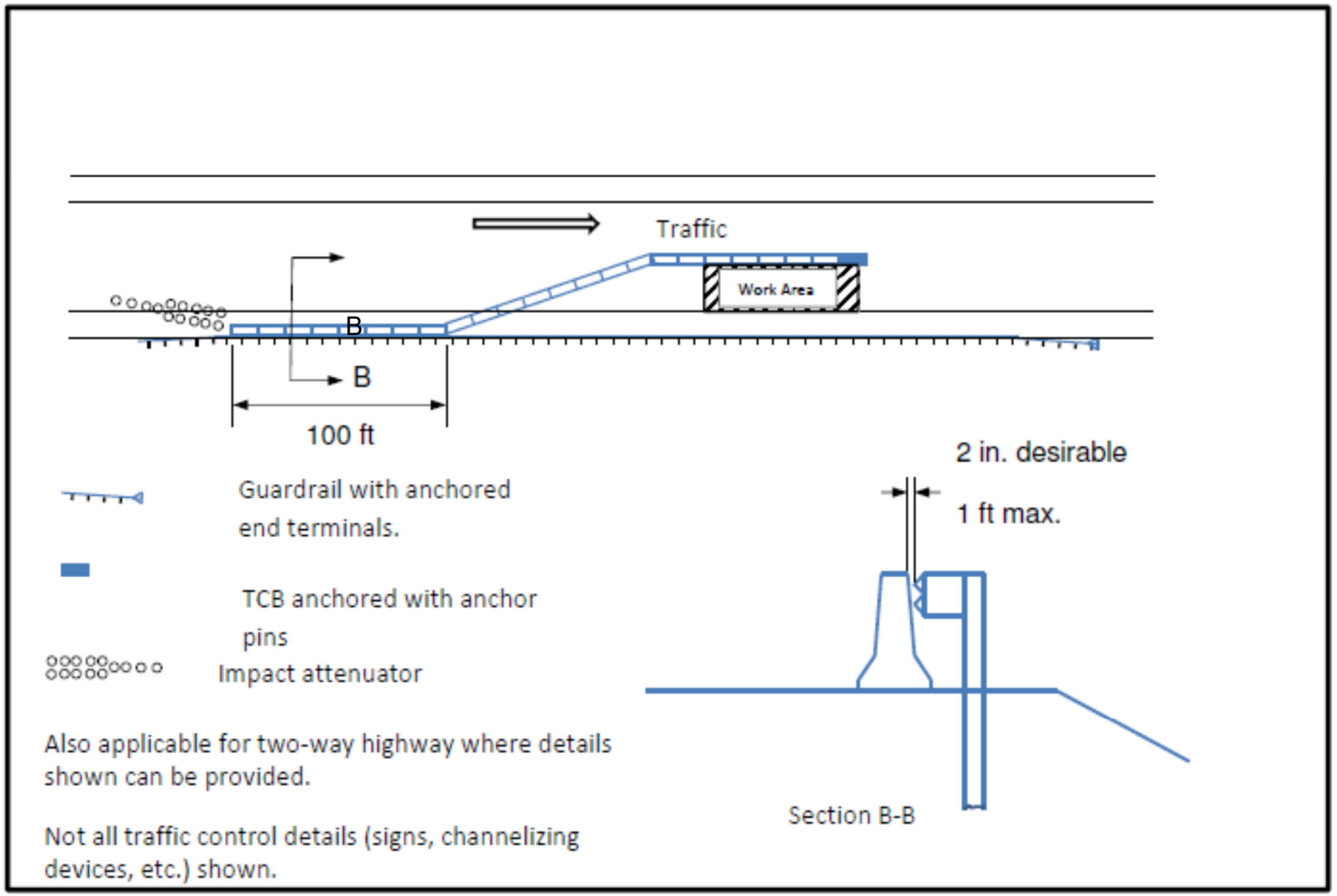


FIGURE 3

ALTERNATE LAYOUT OF TCB FOR ANCHORING ADJACENT TO STEEL PLATE BEAM GUARDRAIL

Pinning

Once the need for the use of TCB is determined, TCB shall be pinned when:

- Placed such that the distance from the back of the TCB to the edge of an uncompleted bridge deck or approach slab is less than 37 in. The 6 in. safety margin is based on consideration of sliding friction and overturning forces.

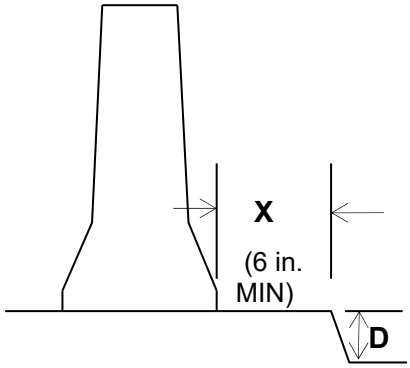
  (Deflection + 6 in. safety margin – ½ width of TCB = 42 in. + 6 in. – 11 in. = 37 in.)

  This also applies for other locations where engineering judgment identifies risks similar to those at the edge of bridge decks (large vertical dimension, presence of traffic, or other risks to persons or property below.)
- Any fixed object exists within a rectangle 24 in. behind the base of a TCB, and within 78 in. above the bottom elevation of the TCB.
- Any drop-off of more than 2 in. is located from 6 in. and 12 in. (inclusive) from the back of the TCB.
- A drop-off is located from 12 to 24 in. (inclusive) from the back of the TCB, a risk assessment using the Spreadsheet for Guidance on Pinning indicates that pinning is recommended, and the recommendation is judged to be practical and economically justified. The spreadsheet can be accessed at:

  http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Safety-Engineering/SpreadsheetForGuidanceOnPinningTCBrev8_7_2014.xlsx.

Additional criteria for pinning are found in Figure 4. Once it has been determined that pinning of TCB is required, the BDE Special Provision, TEMPORARY CONCRETE BARRIER (BDE) shall be incorporated into the plan documents.

"Illinois F-Shape" TCB (Highway Standard 704001)



D (Drop-off)	**X** (Distance Behind TCB)				
	X < 6 in.	6 in. ≤ X < 12 in.	12 in. ≤ X < 24 in.	24 in. ≤ X < 37 in.	37 in. ≤ X
> 2 in., except as below	Not Allowed	Pinned	Subject to Results of Risk Assessment	Not Pinned	Not Pinned
Edge of Bridge Deck, Approach Slab or similar	Not Allowed	Pinned	Pinned	Pinned	Not Pinned

FIGURE 4

Transitions

Transitions shall be installed where pinned TCB connects to freestanding TCB. Going from pinned to freestanding TCB's:

- for the first TCB segment beyond the pinned portion, anchor pins shall be installed in the first and last hole of the traffic side;
- for the next TCB segment, an anchor pin shall be installed in the middle hole of the traffic side, and;
- the next TCB segment(s) may then be freestanding.

Minimum Pavement for Pinning TCB

As shown in the development of pinned tie-down systems on asphalt road surfaces by the Midwest Roadside Safety Facility (MwRSF) at the University of Nebraska, Lincoln, a two in. thickness of compacted (Hot Mix Asphalt) HMA provides a suitable bearing surface for the TCB and provides adequate resistance for the pins. The soil or other material below the minimum 2 in. HMA is considered adequate as long as it allows compaction of the HMA and results in a uniform surface for placement of the TCB and pins. Existing sound HMA pavements, shoulders, or bases that are 2 in. or more in thickness are also adequate for pinning TCB.

Tapers and Median Crossovers

Where the TCB alignment tapers toward the traveled way, or where a TCB installation is used to separate and shift traffic at a median crossover, it is not desirable to use the TCB in a pinned configuration. Design of these areas should provide at least 37 in. and desirably more, clear paved area behind the TCB for deflection.

Separation of Opposing Traffic

Where TCB separates opposing directions of parallel traffic, the design deflection is 24 in., and this may be accommodated in the roadway in most conditions. If the roadway width in one direction is less than 12 feet, this deflection may not be accommodated, and an engineering study should determine whether to provide additional paved width, pinning of TCB, use of other TLTB, or use of channelizing devices.

Exceptions from Pinning Due to Field Conditions

If, due to field conditions, pinning is not fully compliant with the contract requirements for PINNING TEMPORARY CONCRETE BARRIER then the reasons and locations where pinning is not fully achieved shall be documented by the Resident Engineer in the project diary.

Minimizing Pinning and Worker Exposure – An Example

It is desirable to minimize pinning by design to maintain safety performance and save costs, time, and worker exposure. The following example illustrates how staging details can be coordinated with pinning requirements to minimize worker exposure and need for pinning of TCB on new pavement. This is just one of the possible examples.

Remove Median Shoulder and Replace with Temporary Pavement Step 1A and Step 1B (Figures 5-STEP 1A and STEP 1B). The steps shown in these two figures illustrate construction of temporary pavement to mitigate pinning into new pavement structure in Step 3 (Figure 7), and show how TCB can be installed while working only in a closed lane. To avoid pinning altogether, the temporary pavement would have to be wider.

Remove and Replace Driving Lane Step 2 (Figure 6). This step allows for clearance of paving equipment, sufficient construction width to avoid pinning in Step 3 (Figure 7), and use of the temporary pavement to accommodate traffic.

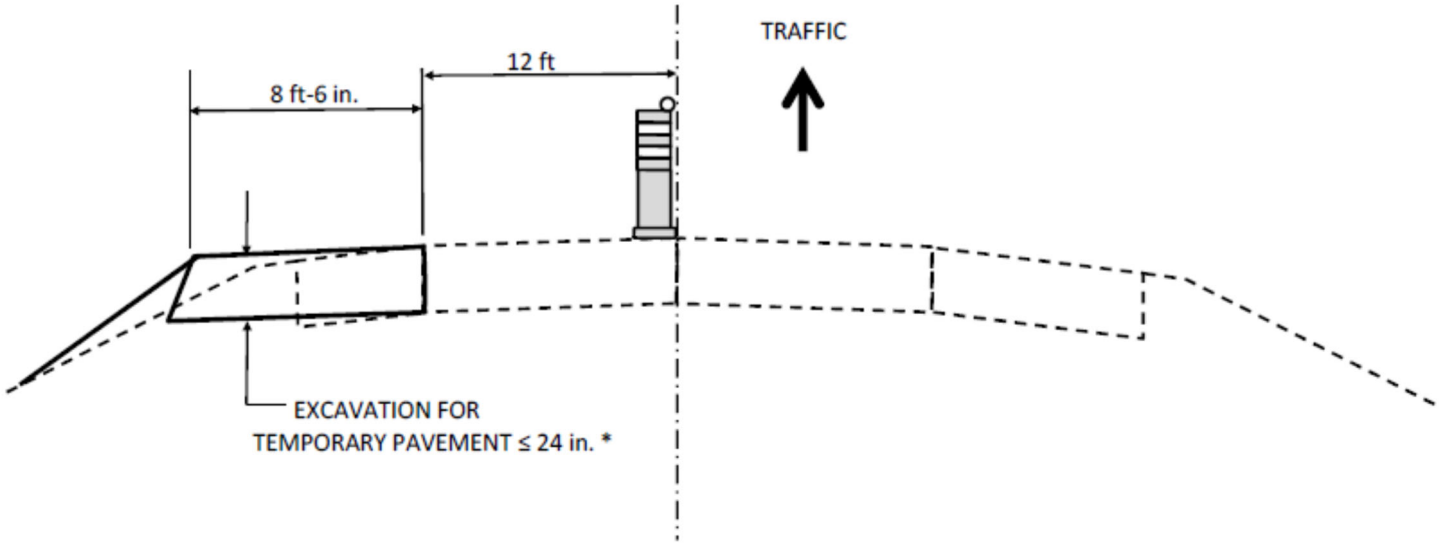
Remove and Replace Passing Lane Step 3 (Figure 7). This step shows construction of the remaining pavement with unpinned TCB used on the new pavement.

Other Designs. Contact the Bureau of Safety Engineering for guidance on any locations where the above guidance may not be applicable.

PAVEMENT REPLACEMENT

STEP 1A

REMOVE AND REPLACE MEDIAN SHOULDER WITH TEMPORARY PAVEMENT



*If > 24 in. use Temporary Concrete Barrier (TCB) in lieu of drums.

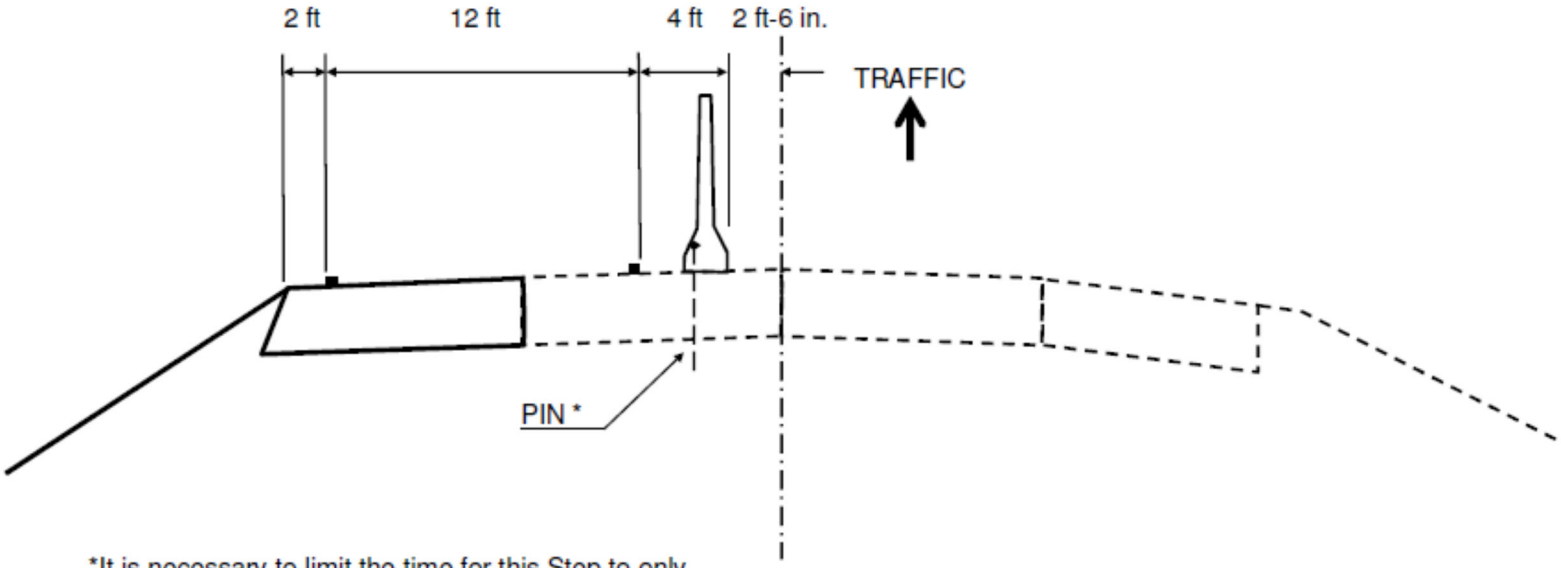
NO SCALE

FIGURE 5-STEP 1A

PAVEMENT REPLACEMENT

STEP 1B

PLACE TEMPORARY CONCRETE BARRIER FOR STEP 2 *



*It is necessary to limit the time for this Step to only that required for installation of the TCB. The TCB is pinned on the side opposite traffic during this installation step, and this condition must be limited to the minimum traffic exposure.

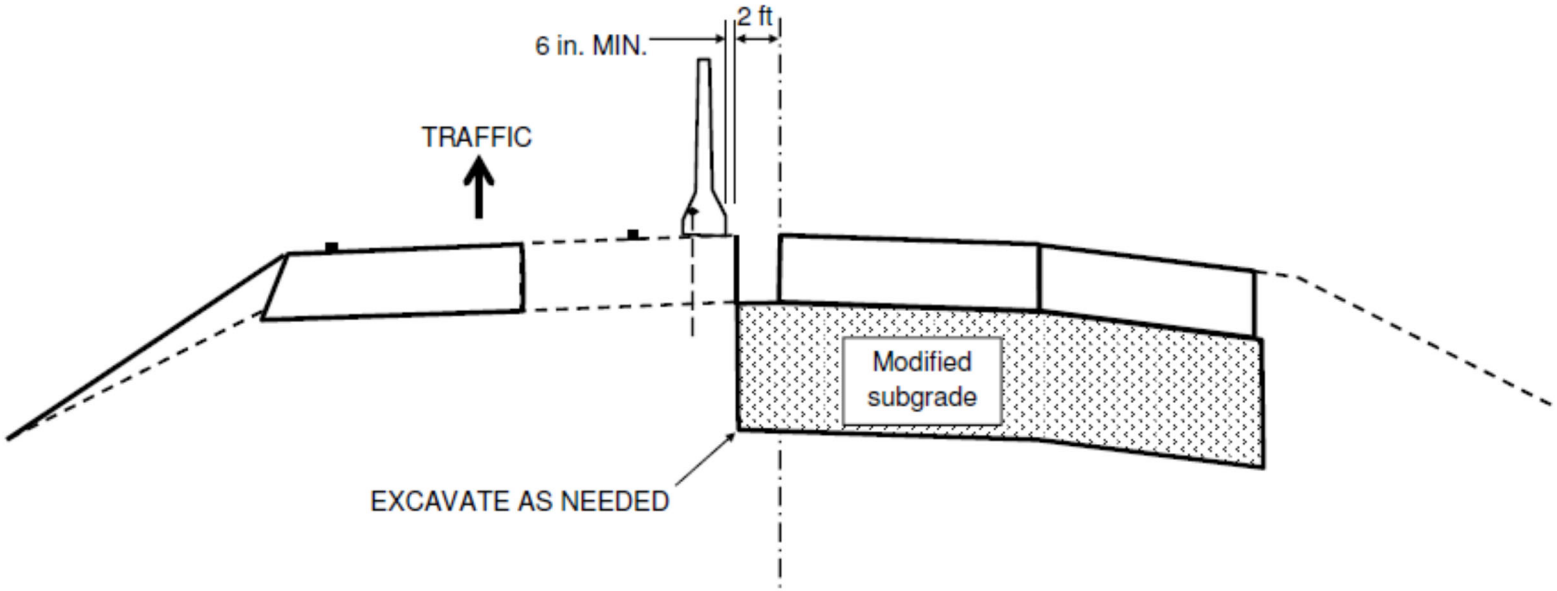
NO SCALE

FIGURE 5-STEP 1B

PAVEMENT REPLACEMENT

STEP 2

REMOVE AND REPLACE PAVEMENT AND SHOULDER FOR DRIVING LANE



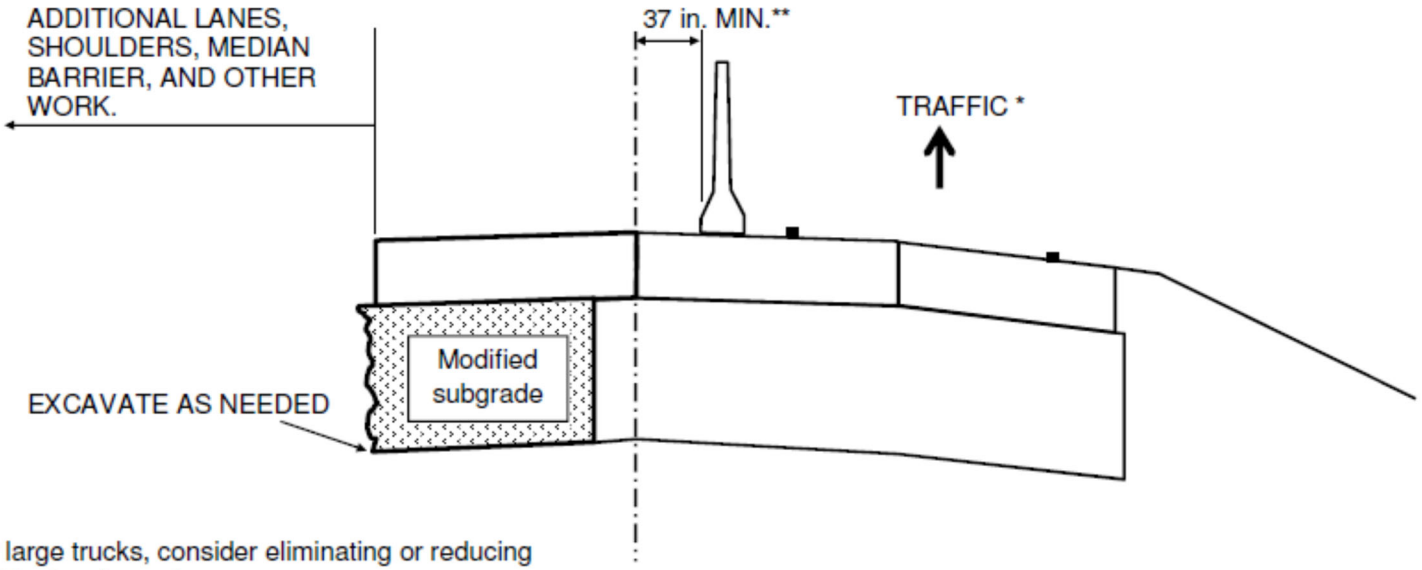
NO SCALE

FIGURE 6-STEP 2

PAVEMENT RECONSTRUCTION

STEP 3

REMOVE AND REPLACE PASSING LANE AND OTHER ELEMENTS



* For large trucks, consider eliminating or reducing shoulder breakover in curves.

** No pinning required as long as this dimension is 37 in. or more.

NO SCALE

FIGURE 7-STEP