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Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	24.2
From:	Jayme F. Schiff	
Subject:	Full Depth Precast Bridge Approach Slab	
Date:	March 15, 2024	

Jayme F. Schiff

Due to the propensity of cracks in the concrete wearing surface (CWS) over our current partial depth precast bridge approach slabs, the Department (IDOT) investigated the potential merits of full depth precast bridge approach slabs. Details from the Illinois State Toll Highway Authority (ISTHA) and surrounding states were studied and evaluated for performance, leading to the development and implementation of IDOT's new Full Depth Precast Bridge Approach Slabs.

IDOT primarily sees two types of cracks on precast bridge approach slabs. The first is reflective cracking in the CWS, occurring along joints between approach slab beams. The second type occurs on skewed bridges, where cracks appear in the CWS perpendicular to the backwall across the acute corners of the bridge approach slab.

Additionally, ISTHA performed a crack survey for bridge approach slabs in 2016 with similar crack observations. This survey resulted in the development of full depth precast approach slabs with Ultra-High Performance Concrete (UHPC) shear keys. While relatively new for ISTHA, the full depth slabs with stronger UHPC shear keys appear to have reduced the reflective cracking, and additional reinforcement in the corners of skewed beams have reduced the perpendicular cracks to the backwall.

Summary of Improvements

1. Created full depth precast bridge approach slabs with UHPC connections. This is intended to eliminate the reflective cracking that was observed in the CWS above the partial depth precast bridge approach slabs.
2. Provided transverse reinforcement protruding out of the precast beams and developed them into the connecting full depth UHPC shear keys for continuity.
3. Updated the transverse and top longitudinal reinforcement to be consistent with the policies of the Bridge Manual Section 3.2.11. However, the top transverse reinforcement was placed parallel to the skew and the spacing was reduced to match the bottom transverse reinforcement spacing. This provides better constructability and easier placement of the precast beams. It also eliminates the need for additional reinforcement in the fascia beams under the parapets.
4. Provided additional development utilizing 90° bends in the top longitudinal reinforcement at the abutment end to reduce cracking near the beam ends.

5. Require Bridge Deck Smoothness Grinding for the full depth precast bridge approach slabs and the structure deck. This will remove discrepancies in the precast beam heights and the raised UHPC shear keys and provide a smooth profile grade.

The full depth precast bridge approach slabs, similar to partial depth precast bridge approach slabs, will still maintain an overall length of 30', a finished thickness of 1'-3", and will be applicable on both ends of the bridge when the longest distance from the centroid of stiffness of the structure to the back of integral or semi-integral abutments is greater than 130'. The application of full depth precast bridge approach slabs shall be similar to partial depth Precast Bridge Approach Slabs as described in the Bridge Manual Section 3.2.12.

Design Assumptions

- 2020 AASHTO LRFD Bridge Design Specifications, 9th edition, HL-93 Loading and the design provisions from Section 3.2.11 of the 2023 Bridge Manual
- Transverse reinforcement is placed parallel to the skew.
- f'_c of beam = 5 ksi
- f'_{ci} of beam = 4 ksi
- f'_c of Ultra-High Performance Concrete = 14 ksi minimum
- f'_c of cast-in-place bridge approach footing concrete = 3.5 ksi
- f'_c of cast-in-place parapet concrete = 3.5 ksi
- Estimated concrete beam with reinforcement density = 0.153 kcf
- f_y = 60 ksi
- Approach Slab Design Span Length = 26'-0"
- Designed loading for 44" constant slope concrete TL-5 parapet. Detailed for 39" constant slope concrete TL-4 parapet.
- Minimum Out to Out Parapet Width = 33'-10"
- Slab thickness for design loading = 1'-3¼"
- Slab thickness for capacity = 1'-3"
- Skew Angle ≤ 45°

Special Provision and Guide Bridge Special Provisions (GBSPs):
"Ultra-High Performance Concrete (UHPC) Joints" (Available upon request)
GBSP 59 "Diamond Grinding and Surface Testing Bridge Sections"
GBSP 79 "Bridge Deck Grooving (Longitudinal)"

Details

Beam Layout
A 12' lane is achieved with two standard width interior beams and the connecting shear keys. This standard width was developed to position the longitudinal joints at the center and edge of the lane, away from direct wheel load path. The table below shows the interior beam widths for 12' lanes. Consult with the Bridge Office when using a lane width other than 12'. Shoulder widths vary, therefore exterior beams do not have standard widths.

Beam Width at		
Top	Core	Bottom
5'-4"	5'-2½"	5'-5"

Within the shear key, the minimum required spacing between the reinforcement of adjacent panels shall be 1⅛" to provide adequate clearance for up to ¾" maximum long steel fibers in the UHPC mix. This minimum spacing will also allow room for concrete dimensions and reinforcement placement tolerances.

The maximum out-to-out beam width, including protruding reinforcement, is limited to 8'-6". Wider beam widths require an oversize and/or overweight permit for truck transportation. For bridge layouts requiring smaller or larger interior beam widths, consultation with the Bridge Office is required. The minimum exterior beam core width is 3'-8" at the abutment end and transitions to 2'-9" at the footing end due to the parapet to curb transition.

Beams can be flared in width to accommodate bridge geometry provided the reinforcement follows the spacing guidelines and the shear keys are a constant width.

Exterior Beams

The exterior beams decrease in width halfway through the total slab length to accommodate the parapet to curb transition, an 11" change in width. Additional #4 hooked bars are detailed at the top and bottom of this slab transition to reduce potential cracking.

In cases where the parapet spans the full length of the bridge approach slab, the #4 hooked bars may be omitted due to the elimination of the transition and the beam dimensions shall be adjusted accordingly.

The dowel rod spacing for exterior beams may be adjusted to better fit the beam width. The centerline of the dowel rod closest to the parapet shall be a minimum of 4" away from the inside face of the parapet and a maximum of 1'-1".

Staged Construction

The staged construction line should ideally coincide with the crown of the road. This may be difficult to achieve or impractical, therefore the staged construction line can be placed as necessary and as approved by the Bureau of Bridges and Structures provided the interior panel core width is not less than 3', nor greater than 8'.

Expansion Blockout

The beam ends shall be cast for a strip seal joint with a blockout parallel to the skew as detailed on the base sheets. Straight coil loop inserts and coil rods are used to connect the beams to the blockout. The length of the ¾" diameter coil rod shall be as recommended by the manufacturer. Bridge Manual Figure 2.3.6.1.6-1 sets the Department's policy on maximum expansion length with respect to skew for strip seal joints.

The distance from the centerline of the closest insert to the nearest corner is 3" minimum and 12" maximum. The straight coil loop inserts shall be spaced to miss the studs from the preformed joint strip seal. As the skew increases, designers must verify the edge distance chosen will provide 1½" of cover at the end of the straight coil loop inserts in the beam and in the expansion blockout. When checking the cover of the straight coil loop insert, assume the end of the straight coil loop insert is 7" away from the vertical face of the expansion blockout and is 2" in diameter.

Bridge Deck Smoothness Grinding
The beams require smoothness grinding to meet the final profile grade. Designers should reference Bridge Manual Section 3.2.1.2 for design guidelines.

Implementation

Full Depth Precast Bridge Approach Slabs will be implemented on select projects as coordinated between the Central Office Bureau of Bridges and Structures and the District offices. The Department will monitor their performance with the intention of eventually replacing the partial depth precast bridge approach slabs.

New base sheets have been developed and will be available at the primary IDOT CADD page for selected projects.

The Pay item for this work is Full Depth Precast Bridge Approach Slab, Sq. Ft. and the pay code is X5040101.

Please direct questions and comments to Kevin Riechers, Policy, Standards, and Final Plan Control Unit Chief, by email at dot.bbs.comsuggest@illinois.gov.

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	24.1
From:	Jayme F. Schiff Jayme F. Schiff	
Subject:	IDOT Seismic Manual Update – Planning Requirements	
Date:	January 9, 2024	

All Bridge Designers (ABD) Memorandum 24.1 introduces the Planning section to the Seismic Manual. The planning policies herein shall be applicable to all structures being designed using a displacement-based design approach.

The Department is adopting a displacement-based approach, with performance guidelines. The Planning section provides guidance to bridge planners on performance levels, seismic hazards, and structure type selection for bridges in high seismic zones.

The policy and details herein are subject to review. The Seismic Manual is intended to provide direction and documentation for all forthcoming seismic policy. Bridge planners are encouraged to review the forthcoming policy and forward any questions or comments to the Bureau of Bridges and Structures. Incorporation of comments will occur when future sections are added.

The Department intends to incorporate displacement-based seismic design on bridges with Type, Size, and Location plans approved February 1, 2024 and later. Due to the amount and complexity of required design changes, and the effects these changes may have on preliminary design, this date may be extended on a project-by-project basis.

Please direct questions and comments to Mark Shaffer, Bridge Design Engineer, by telephone at (217) 782-2125 or email at mark.shaffer@illinois.gov.

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	23.3
From:	Jayme F. Schiff	
Subject:	Full Lane Sealant Waterproofing System	
Date:	October 30, 2023	

The Department has developed a waterproofing system to be used as an alternative to the Waterproofing Membrane System specified in Section 581 of the Standard Specifications for Road and Bridge Construction. This system, titled Full Lane Sealant Waterproofing System, creates a cost-effective, high-performance substitution for the traditional waterproofing membrane system for concrete bridge decks. The system uses a combination of highly polymerized asphalt interlayers of Full Lane Sealant (FLS) with dense, high-quality hot-mix asphalt (HMA) to create a waterproofing system that is easier to construct and prevents the ingress of water and deicing chemicals to protect concrete bridge decks from chloride ingress and subsequent spalling and corrosion.

When used, the details for the waterproofing membrane system and HMA overlay should be replaced with the attached detail. The pay items used shall be as follows:

- FULL LANE SEALANT WATERPROOFING SYSTEM, which includes the tack coat, both layers of FLS, and the ¾ in. thick layer of IL-4.75 HMA Binder Course.

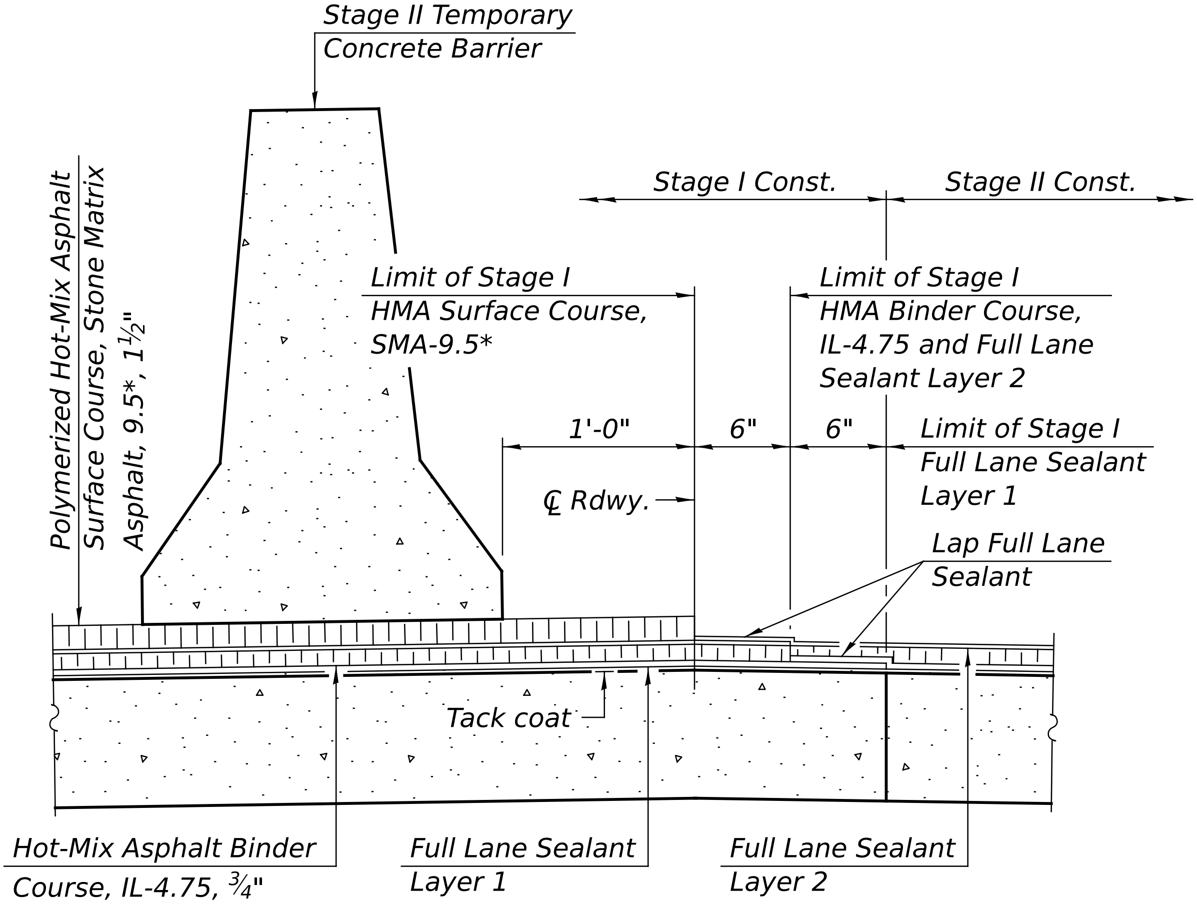
- POLYMERIZED HOT-MIX ASPHALT SURFACE COURSE, STONE MATRIX ASPHALT, 9.5, which includes the 1½ in. thick layer of SMA-9.5 Surface Course.

The minimum thickness of the system is 2.25 inches. When required, additional thickness may be added by increasing the thickness of the HMA Binder layer.

The Bureau of Design and Environment maintains a special provision FULL LANE SEALANT WATERPROOFING SYSTEM, which shall be inserted into contracts containing this system.

This system may be implemented on applicable projects beginning with the January 2024 letting. Please direct questions to Mark Shaffer, Bridge Design Engineer, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

Attachment



WATERPROOFING STAGING

Full Lane Sealant Waterproofing System consists of an initial tack coat to promote bonding, Layer 1 of Full Lane Sealant, a layer of Hot-Mix Asphalt Binder Course, IL-4.75, and Layer 2 of Full Lane Sealant.

** Mix and N-number to be determined in design.*

FULL LANE SEALANT WATERPROOFING SYSTEM

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	23.2
From:	Jayme F. Schiff	
Subject:	Headed Reinforcement	Jayme F. Schiff
Date:	October 30, 2023	

The Department uses threaded, headed reinforcement to develop reinforcement when proper development lengths or hooked bars are geometrically not feasible. Previously, the cost of the headed portion of the reinforcement bar was included with Reinforcement Bars, Epoxy coated as detailed on our base sheets. Without a separate pay item, it was difficult to identify, sample and test the headed reinforcement.

To remedy this, headed reinforcement will be paid for as Reinforcement Bars, Epoxy Coated and the heads will be paid for as Bar Terminators. A Qualified Product List (QPL) has been developed for bar terminators and added to the QPL – Reinforcing Bar Splicer Assemblies, Mechanical Splicers and Bar Terminators. Additionally, Guide Bridge Special Provision (GBSP) #100 (Bar Splicers, Headed Reinforcement) has been modified to include bar terminators. This special provision shall be included on applicable projects. The Superstructure CADD Libraries have been updated as well. Please be aware that all bar terminators, regardless of size, are included in one pay item which will be indicated on the Summary of Quantities and the Total Bill of Material. The total number of bar terminators and the bar size should be identified under each headed reinforcement bar detail.

The policies in this memorandum shall be implemented on applicable projects beginning with the March 8, 2024 letting. Please direct questions to Mark Shaffer, Bridge Design Engineer, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	23.1
From:	Jayme F. Schiff	Jayme F. Schiff
Subject:	Nonredundant Steel Tension Members in Design	
Date:	August 25, 2023	

Bridges with Nonredundant Steel Tension Members (NSTMs) require hands-on inspection by qualified inspectors at an interval defined in the Illinois Department of Transportation (IDOT) *Structural Services Manual* Section 3.4.5 – Fracture Critical Member Inspection Interval. This hands-on inspection often requires additional equipment, such as manlifts and snoopers, and the accompanying lane closures to accommodate said equipment. This results in considerable traffic delays and monetary costs to the motoring public and bridge owners.

To avoid these costs, some members that do not have load path redundancy may be shown to be system redundant or internally redundant, therein removing the NSTM classification and the hands-on inspection requirements. In order to classify a member as redundant, Federal Highway Administration (FHWA) requirements must be met. These requirements are provided in the May 9, 2022, FHWA memorandum titled "Inspection of Nonredundant Steel Tension Members".

The May 9, 2022, FHWA memorandum was written in response to new updates to the National Bridge Inspection Standards (NBIS) in 23 CFR part 650, subpart C (23 CFR 650.C) that became effective June 6, 2022.

To reduce costs associated with NSTM inspections, primary steel tension members without load path redundancy should be designed as system or internally redundant whenever possible. The purpose of this memorandum is to clarify guidelines for the classification of primary steel tension members in accordance with FHWA and NBIS policies.

This memorandum provides guidance on the following:

- Definitions of types of redundancy for steel members
- Classification of member redundancy
- Required submittals and plan details for system redundant, internally redundant, and nonredundant members

The policies in this memorandum apply to newly designed yet to be constructed bridges only.

Definitions of Types of Redundancy for Steel Members

The first update resulting from the latest NBIS is the introduction of the term Nonredundant Steel Tension Member, defined as a primary steel member fully or partially in tension, and without load path redundancy, system redundancy or internal redundancy, whose failure may cause a portion of or the entire bridge to collapse. The term NSTM replaces the term Fracture Critical Member (FCM). The design, fabrication, in-service inspection, and load rating requirements currently in place for FCMs shall apply to NSTMs.

The second update resulting from the latest issuance of the NBIS is the formal recognition of the following sources of redundancy:

Load path redundancy: A redundancy that exists based on the number of primary load-carrying members between points of support, such that fracture of the cross section at one location of a member will not cause a portion of or the entire bridge to collapse.

FHWA considers the primary longitudinal load-carrying members in bridges with three or more primary load-carrying members to be load path redundant members, (e.g., girders in a three-girder system). A redundancy evaluation is not necessary for the determination of load path redundancy, as it is for system redundancy or internal redundancy.

Primary steel tension members that do NOT have load path redundancy are by default considered NSTMs, unless system redundancy or internal redundancy is shown. The list of members that IDOT considers to NOT have load path redundancy can be found in the IDOT *Structural Services Manual* Section 3.3.5.1 as well as in the coding instructions of Item No. 92A1 in the *Illinois Highway Information System Structure Information and Procedure Manual*. Note that the documents referenced are current as of June 2023 and that IDOT is currently working on updates to both of these documents.

System redundancy: A redundancy that exists in a bridge system without load path redundancy, such that fracture of the cross section at one location of a primary member will not cause a portion of or the entire bridge to collapse.

To demonstrate system redundancy it is necessary to evaluate the structure following a hypothetical failure of a primary load carrying member, as the number of primary load carrying members is not sufficient to demonstrate load path redundancy. Therefore, refined structural analysis is typically required to demonstrate system redundancy.

Internal redundancy: A redundancy that exists within a primary member cross-section without load path redundancy, such that fracture of one component will not propagate through the entire member, is discoverable by the applicable inspection procedures, and will not cause a portion of or the entire bridge to collapse.

Internally redundant members are typically built-up sections, where failure of one component in a section will not result in failure of the entire section.

NSTMs are typically classified as such due to the lack of load path redundancy. If a recognized source of redundancy is demonstrated, NSTM classification may be modified and, therefore, NSTM inspection requirements would no longer apply.

IDOT expects that new bridges will be designed with no NSTMs; however, it is understood that in some instances, it is not possible or practical for all primary steel tension members to be load path redundant. For such instances, IDOT considers system redundancy as the preferred source of redundancy to avoid primary steel members to be classified as NSTMs. Internal redundancy is considered as an alternate source to be considered when system redundancy cannot be demonstrated.

Classification of Member Redundancy

According to NBIS Section 650.313(f)(1)(i), a State transportation department may choose to demonstrate a member has system or internal redundancy such that it is not considered a NSTM. Current classification of a NSTM may be modified if a recognized source of redundancy is demonstrated. System redundancy and internal redundancy require analysis supplemental to conventional design. Supplemental analysis shall be based on a nationally recognized method.

The following guide specifications are considered nationally recognized methods for System Redundant Member (SRM) and Internally Redundant Member (IRM) analysis.

<u>Herein referred to as the "SRM Guide Specifications":</u>
AASHTO Guide Specification for Analysis and Identification of Fracture Critical Members and System Redundant Members, First Edition, 2018

<u>Herein referred to as the "IRM Guide Specifications":</u>
AASHTO Guide Specifications for Internal Redundancy of Mechanically-Fastened Built-Up Steel Members, First Edition, 2018 with 2022 Interims

These Guide Specifications establish analytical processes and requirements, loading, and performance criteria that a member classified as a NSTM needs to meet to be re-classified as an SRM or an IRM. For a particular bridge redundancy evaluation, modifications to the approaches outlined in the *IRM Guide Specifications* or *SRM Guide Specifications*, or other alternative nationally recognized methods may be accepted by IDOT at its discretion.

Primary steel members that do not have load path redundancy, in which both system and internal redundancy are demonstrated are considered as SRMs for inspection purposes, (i.e., they are not subject to the inspection requirements of IRMs). It should be noted that designers are not required nor expected to demonstrate both system redundancy and internal redundancy.

There may be cases where members may not be able to be classified as system or internally redundant. In these cases, the members will be required to be classified as NSTMs.

Submittals

The intent to classify members as SRMs, IRMs, or NSTMs should be communicated as early as possible in the planning and design phase and shall be included in the Plan Development Outline (PDO). The PDO shall include identification of the members to be classified as SRMs, IRMs or NSTMs.

Designers shall submit a signed and sealed stand-alone written summary of the redundancy analyses along with the Final Structure Plans for acceptance and records. The summary shall include:

1) Identification of the members subjected to a redundancy analysis.
2) Member designations (i.e., SRM, IRM, NSTM) based on redundancy analysis results.
3) Nationally recognized methods used to evaluate redundancy. Any modifications to the nationally recognized methods shall be described.

4) In-service inspection requirements for those members designated as IRMs or NSTMs, as applicable. Inspection requirements for load path redundant members and system redundant members are only subject to routine inspection requirements. This does not need to be added to the submittal.

The Final Structure Plans shall reflect all details and notes associated with the redundancy analysis in accordance with this memo.

Plan Details

SRMs: Members in new designs that have demonstrated system redundancy through analysis in accordance with the *SRM Guide Specifications* shall be labeled as SRM in applicable design and in-service inspection documents. SRMs are required to be fabricated in accordance with NSTM fabrication requirements. The following notes shall be included in the design plans for newly designed yet to be constructed bridges containing SRMs:

Note	Application
Members designated as “SRM” are System Redundant Members	All SRMs
Members designated as “SRM” shall be fabricated to satisfy the provisions of Clause 12 of the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code.	All SRMs with welds.
Fabricated plate components of members noted as “SRM” shall satisfy the Fracture-Critical Tension Component Impact Test Requirements, zone 2 specified in AASHTO M 270M/M270 (ASTM A709/A709M).	All load-carrying <u>fabricated plate</u> components of SRMs.
Rolled section components of members noted as “SRM” shall satisfy the Non-Fracture-Critical Tension Component Impact Test Requirements, zone 2 specified in AASHTO M 270M/M270 (ASTM A709/A709M).	All load-carrying <u>rolled section</u> components of SRMs.

IRMs: Members in new designs that have demonstrated internal redundancy through analysis in accordance with the *IRM Guide Specifications* shall be labeled as IRMs in applicable design and in-service inspection documents. IRMs are required to be fabricated in accordance with NSTM fabrication requirements. The following notes shall be included in the design plans for newly designed yet to be constructed bridges containing IRMs:

Note	Application
Members designated as “IRM” are Internally Redundant Members	All IRMs
Fabricated plate components of members noted as “IRM” shall satisfy the Fracture-Critical Tension Component Impact Test Requirements, zone 2 specified in AASHTO M 270M/M270 (ASTM A709/A709M).	All load-carrying <u>fabricated plate</u> components of IRMs.
Rolled section components of members noted as “IRM” shall satisfy the Non-Fracture-Critical Tension Component Impact Test Requirements, zone 2 specified in AASHTO M 270M/M270 (ASTM A709/A709M).	All load-carrying <u>rolled section</u> components of IRMs.

NSTMs: Members in new designs that have not been established as system or internally redundant through analysis shall be labeled as NTSMs in applicable design and in-service inspection documents. The following notes shall be included in the design plans for newly designed yet to be constructed bridges containing NTSMs:

Note	Application
Members designated as "NSTM" are Nonredundant Steel Tension Members	All NSTMs
Members noted as "NSTM" shall be fabricated to satisfy the provisions of Clause 12 of the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code	All NSTMs with welds
Fabricated plate and rolled section components of members noted as "NSTM" shall satisfy the Fracture-Critical Tension Component Impact Test Requirements, zone 2 specified in AASHTO M 270M/M270 (ASTM A709/A709M)	All NSTMs

Implementation

The policies in this memorandum shall be implemented on applicable projects with TS&Ls approved after September 1, 2023, and as soon as practical on newly designed yet to be constructed bridges. Please direct questions to Mark Shaffer, Bridge Design Engineer, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

This policy will continue to be reviewed and updated as IDOT identifies NSTMs based on lack of load path redundancy. A policy to declassify NSTM members in existing structures will also be developed for future updates.

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	22.8
From:	Jayme F. Schiff	
Subject:	Modular Expansion Joint Details and Re-Certification	
Date:	December 2, 2022	

Modular and swivel modular expansion joints are theoretically a very useful expansion device for longer structures and currently the only joints readily available to accommodate significant lateral movement. Improvements have been made to the concrete details encasing these joints, intended to prolong the service life and reduce lifecycle costs. This memorandum introduces new bridge details for accommodating modular joint systems and updated policies and Guide Bridge Special Provision No. 18 (GBSP18) applicable for modular joints.

Joint Application

Modular expansion joints are an expansion device option, along with steel finger plate joints, for structures with contributing expansion lengths as shown in the updated Bridge Manual Figure 2.3.6.1.6-1. The joints consist of a series of strip seal glands, held in place by center beams and edge beams studded into deck concrete. Wheel loads are transferred from the center beams to support bars and their bearings. A concrete support ledge or the steel beam and bracing under the support bar bearings is utilized to direct the load into the girder and bearings at the joint.

In addition to allowing for longitudinal expansion, standard modular joints also allow for minimal lateral movement (typically around 3/8" per gland), while swivel modular joints allow for much larger lateral movements. In comparison, steel finger joints allow for 3/8" lateral movement total.

The more complex, multi-directional swivel modular joints have a higher cost and more complex installation procedure. For this reason, swivel modular joints shall only be considered for structures that must remain open to all traffic after seismic events (critical or essential structures), or for other structures as required by the owner. For joints requiring higher lateral movements, consideration shall be given to selecting a larger standard modular joint size in lieu of using a swivel joint. The benefit of reducing any possible normal racking due to temperature movements typically outweighs the small additional cost to increase the joint size.

The joint type (modular, finger plate, or other) shall be specified on the Type, Size, and Location (TSL) plan, but the size of the joint does not need to be shown. The specific joint size and the need for a swivel modular joint will be determined during the design phase.

Additional consideration shall be given to the bearings on structures with lateral movement. In some cases, the expected lateral movement at the expansion bearings is greater than the typical distance between the beam and the side retainer. If this occurs, the retainers should be placed at least the expected lateral movement distance away from the beam flanges.

Contributing Expansion Length and Total Longitudinal Movement
For structures with only one fixed pier, the contributing expansion length for each abutment shall be the length from the joint at the abutment to the centerline of the fixed pier. For structures with multiple fixed piers (typically two) the contributing expansion length shall be the length from the joint at the abutment to the centroid of fixity, typically the middle of the span between the fixed piers. For structures with joints at the piers the expansion length shall be the distance from one joint to the center of fixity.

The total longitudinal movement in inches shall be shown on the contract plans and calculated using the following equation:

$$T = \gamma \alpha L(\Delta t)$$

Where:
T = total longitudinal movement along centerline of roadway (in.)
γ = 1.2 (AASHTO Table 3.4.1-1)
α = 0.0000065/ºF
L = contributing expansion length (in.)
Δt = 140 ºF (-20 ºF to 120 ºF)

The designer shall then choose the joint size based on this calculated movement. The dimension shown for the actual modular joint width is determined by the manufacturer and shall be left as a starred dimension with a note as shown on the figures and base sheets.

The distance between the concrete at right angles, “A” at 50 ºF, shown in Figures 1, 2, 7, and 8 shall be calculated as:

$$A = (T/2)\cos(S) + 3/4"$$

Where:
S = skew angle (degrees), measured from the baseline to a line perpendicular to the centerline of joint

The additional 3/4" is provided to ensure there is no hard contact between the concrete surfaces.

For the purposes of calculating the quantity for the contract plans, the length shall be calculated along the centerline of the joint from out-to-out of the deck.

Structures with larger lateral movement demands requiring swivel modular joints shall also specify the maximum vertical displacements, transverse displacements, and horizontal rotations on the contract plans.

Modular Joint Deck Details
Two types of deck end details have been developed or expanded upon to improve the performance of the modular joints and the deck surrounding them.

<u>Full Depth Deck Blockout</u>: A deck end detail utilizing a full depth deck blockout is shown in Figures 1 thru 6. Full depth deck blockouts allow for easier forming and reinforcement bar placement, greater flexibility to adjust rebar in the field to avoid interferences and provides a larger monolithic cast of concrete around the joint assembly. The joint assembly shall be temporarily supported off of the beam ends until the concrete is placed. If intermittent support is required due to large skews, large beam spacing, or heavy joints

then the joint shall be additionally supported off of the cross frame top chord members. This detail type is applicable for all girder sizes. Longitudinal bar splicers are not required for the full depth blockout detail type.

A blockout and construction joint is preferred according to AASHTO 14.5.5.1. It may be optional if the designer evaluates the pouring sequence and determines that there will be no adverse effects, such as excessive rotations, that will inhibit concrete cover or cause joint misalignment. The blockout and construction joint shall be labeled on the plans as optional, as applicable.

Partial Depth (Ledge) Deck Blockout: A deck end detail utilizing a partial depth blockout and concrete ledge is shown in Figures 7 thru 13. A concrete ledge provides a formed concrete platform to easily place and adjust the joint assembly. While the increased concrete thickness below the support box reduces reinforcement congestion, the ledge requires complicated formwork and reinforcement bar placement in order to prevent modular joint assembly interference. Due to the increased concrete thickness this detail may be more suitable for deeper girder sections but is not recommended for structures with web depths less than 54". The bar splicer/reinforcement detail shown in Figure 13 shall be included on the bar splicer base sheet for plans utilizing this concrete ledge type detail.

Both types of deck end details shall have a minimum clearance of 4¼" above the support box and the full depth blockout shall have a minimum clearance of 6" below the support box.

Modular Joint Beam End Details

Beam ends shall be coped whenever feasible to avoid support box interference and allow the support boxes to have a uniform spacing. Plate girders shall utilize the standard coping details shown in Figures 14 and 15. If the beams are not coped then the modular joint assembly support boxes shall be spaced to miss the beam flanges.

Modular Joint End Cross Frames and Diaphragms

Cross frames are the preferred lateral bracing method for plate girder structures with modular joints. Cross frame details for various skews are shown in Figures 16 thru 20.

The centerline of the diagonal members of the cross frame are not required to intersect the centerline of the top chord, but it should be as close as practical. When the diagonals of the cross frame cannot practically have a minimum angle of 30 degrees (as measured from the bottom chord) due to beam spacing, skew, and/or web/cope depth, an alternate bent plate channel is required as shown in Figure 21. The bent plate channel is not allowed for skews greater than or equal to 45 degrees. Additional analysis is required if the minimum diagonal angle cannot be satisfied for skews over 45 degrees.

For end cross frames and end bent plate diaphragms at stage construction joints, see Figures 22 and 23.

Figures 16 through 23 supersede Figures 14 through 17 from ALL BRIDGE DESIGNERS (ABD) 19.4 memorandum.

Base sheets

Twelve base sheets have been developed that show the minimum amount of information required on the plans for the deck end, beam end, and sliding plate details for the structure. Modular joint details, deck end reinforcement, and beam end/end diaphragm details may be found in the Base Sheets – General, Superstructure – Expansion Steel Beams, and Diaphragms – Expansion Abutment Steel Beams base sheet libraries, respectively.

Guide Bridge Special Provision
GBSP18 (Modular Expansion Joint) has been updated and will be released concurrently with this memorandum. The updates include additional guidance on construction and fabrication requirements, such as:

- Additional weld requirements have been added and tolerances have been developed for various joint dimensions.
- Updated fatigue requirements are clearly specified for different elements of the joint.
- The entire width of the joint shall be designed for the vehicular live load shown on the General Plan & Elevation sheet of the contract plans.
- All non-stainless steel structural elements of the joint assembly shall be hot-dip galvanized.

Recertification
Modular joint suppliers will be required to recertify their joint assemblies within six months of the release of this memorandum and then at least every five years to remain on the List of Prequalified Modular Expansion Joints. Recertification will be required immediately if any changes are made to the materials, or joint details.

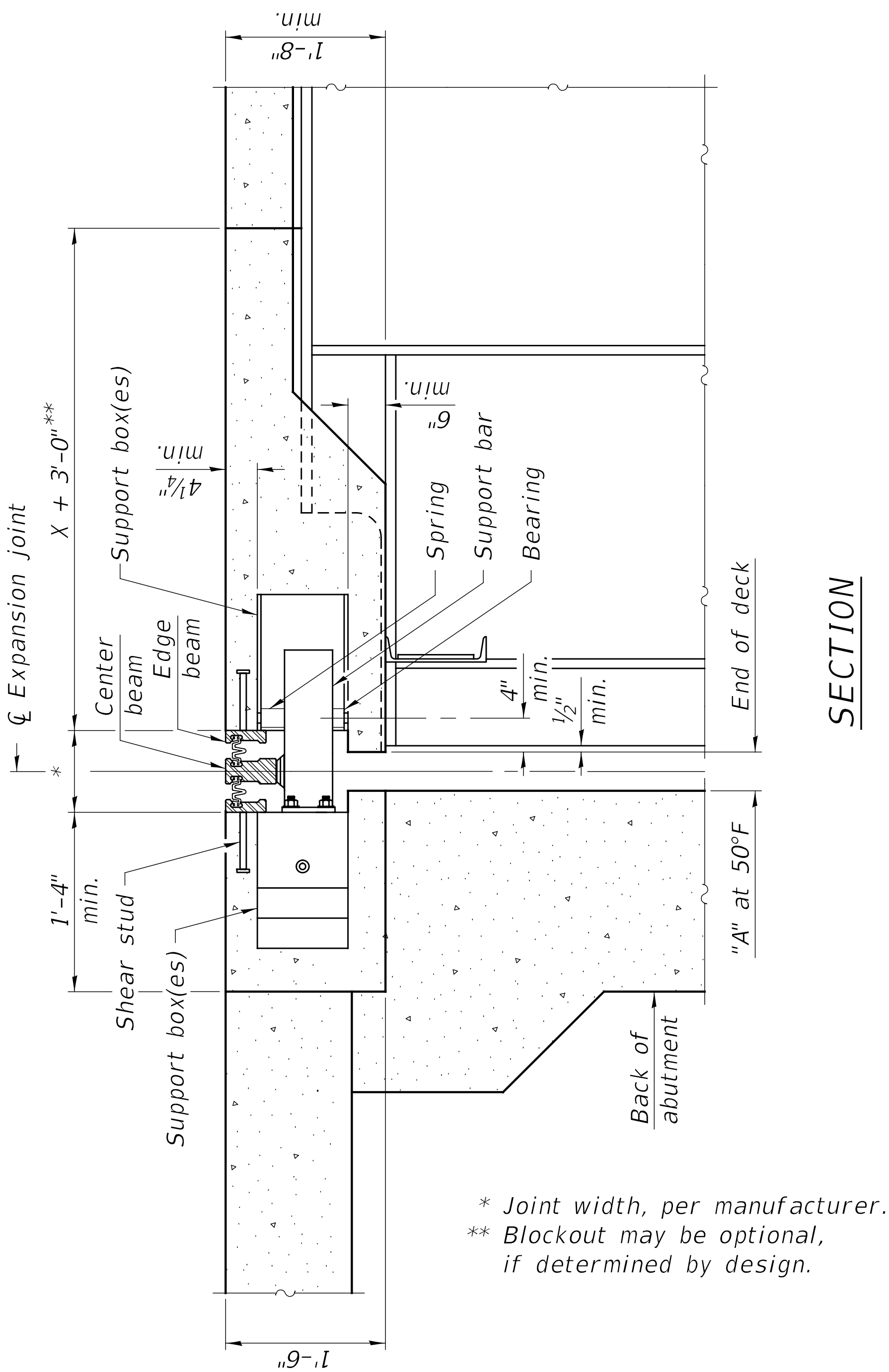
The Recertification section of the Submittal Requirement for Modular Expansion Joints Evaluation and Pre-Qualification has been updated to reflect this new requirement.

Implementation
The revised modular joint base sheets dated 11-1-2022 shall be implemented as soon as practical, on all applicable projects that have not been let. The Modular Expansion Joint Guide Bridge Special Provision No. 18 and the modular expansion joint submittal requirements have been updated. To remain on the prequalified modular expansion joint product list, companies will have six months to submit their re-certification.

The base sheets, updated GBSP18, and certification requirements may be found on IDOT's website at https://idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/index.

Please direct questions to the Policy, Standards, and Specifications Unit by email at dot.bbs.comsuggest@illinois.gov.

Attachments

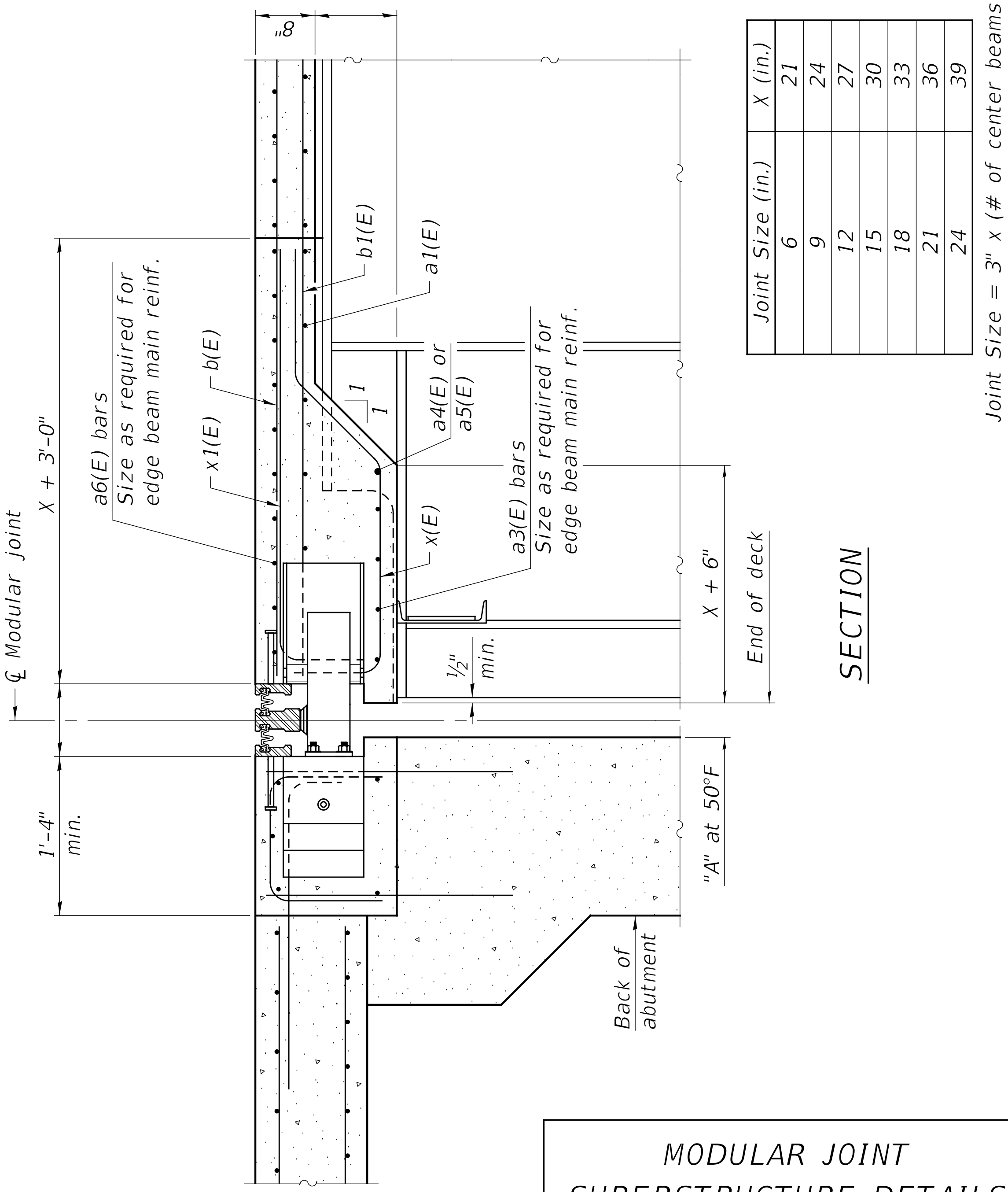


* Joint width, per manufacturer.
** Blockout may be optional,
if determined by design.

Note:
Modular joint shown is a general schematic. See prequalified list of modular joints for all available configurations.

MODULAR JOINT & FULL DEPTH BLOCKOUT DETAILS

Figure 1

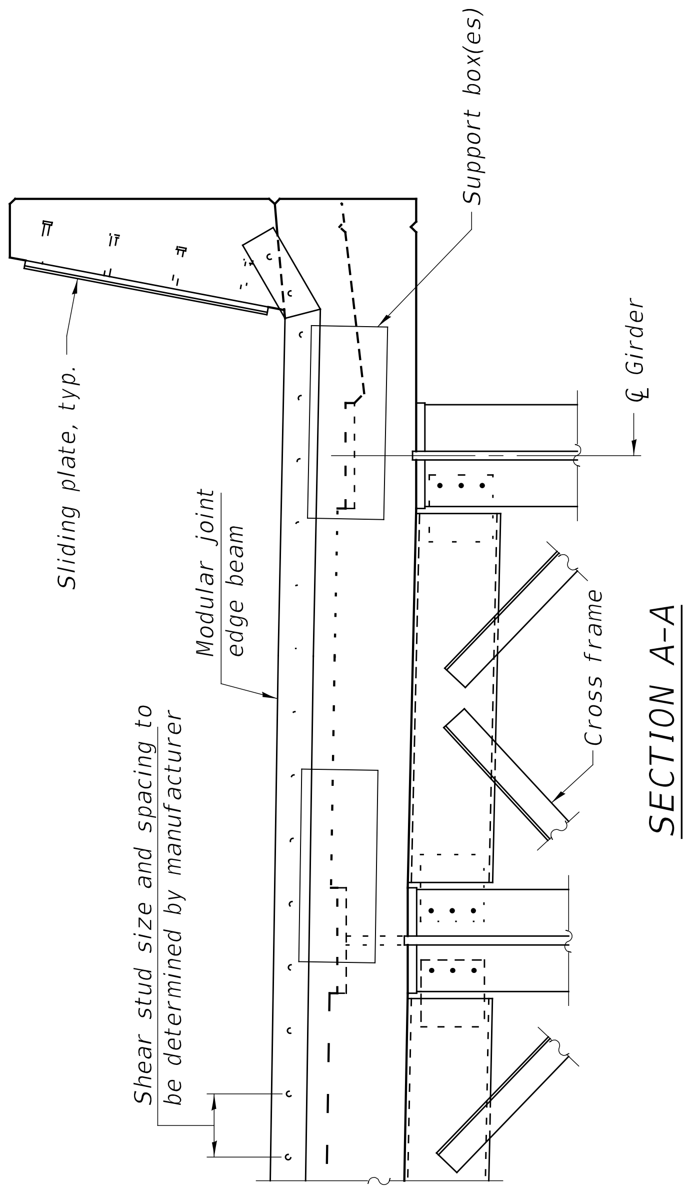


Joint Size (in.)	X (in.)
6	21
9	24
12	27
15	30
18	33
21	36
24	39

Joint Size = 3" x (# of center beams + 1)

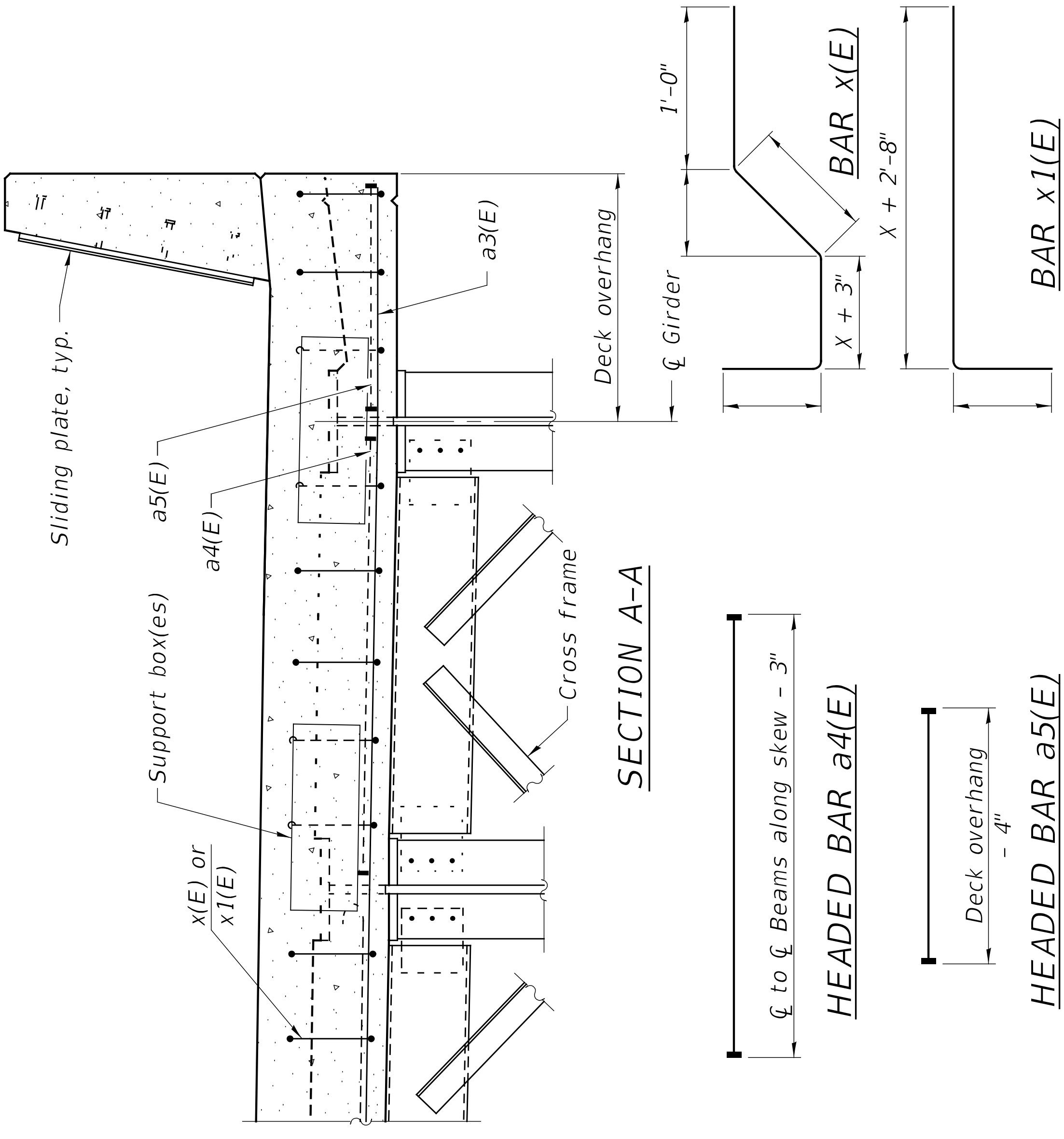
MODULAR JOINT
SUPERSTRUCTURE DETAILS
FOR FULL DEPTH BLOCKOUT

Figure 2



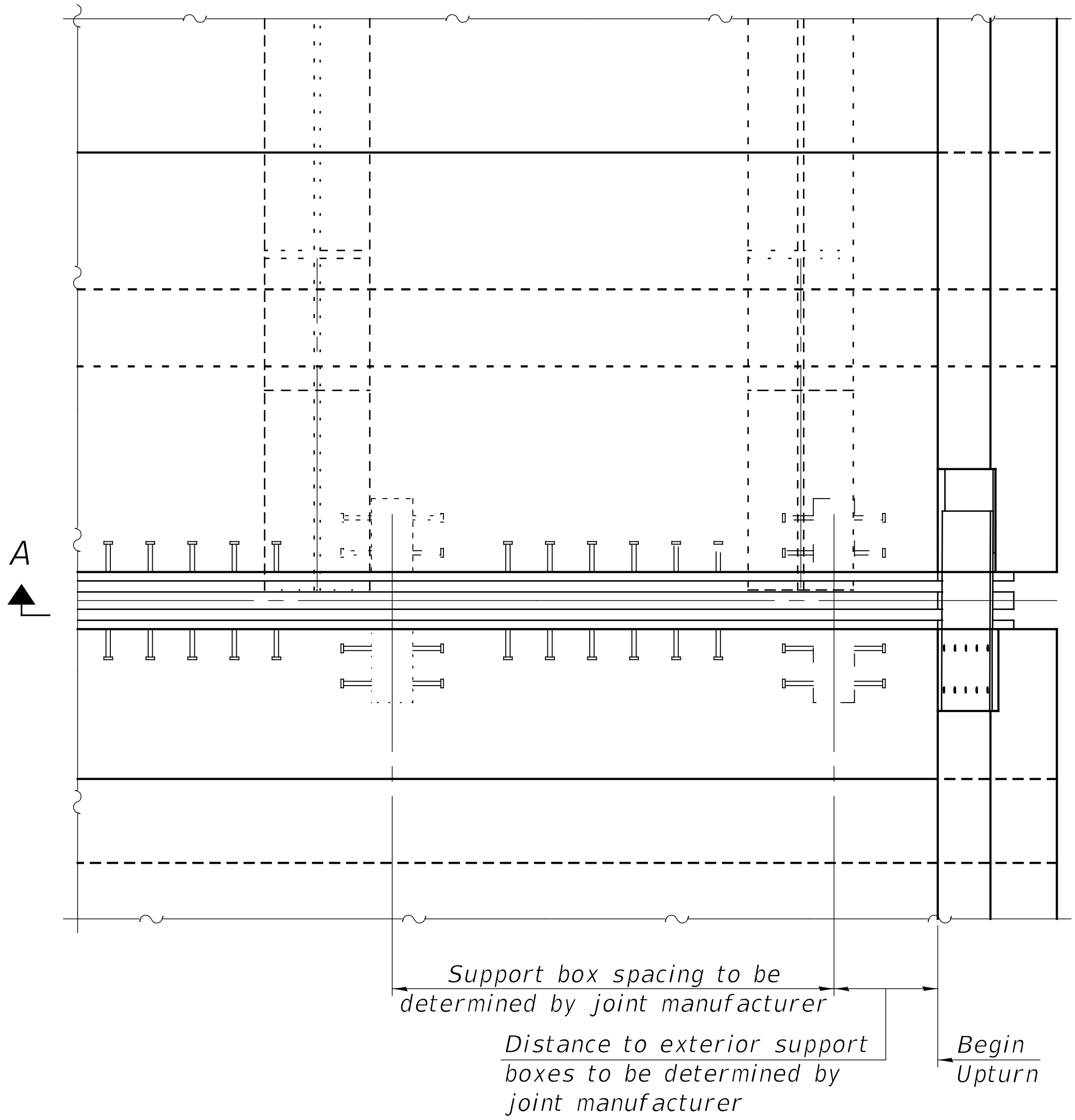
MODULAR JOINT & FULL DEPTH BLOCKOUT DETAILS

Figure 3



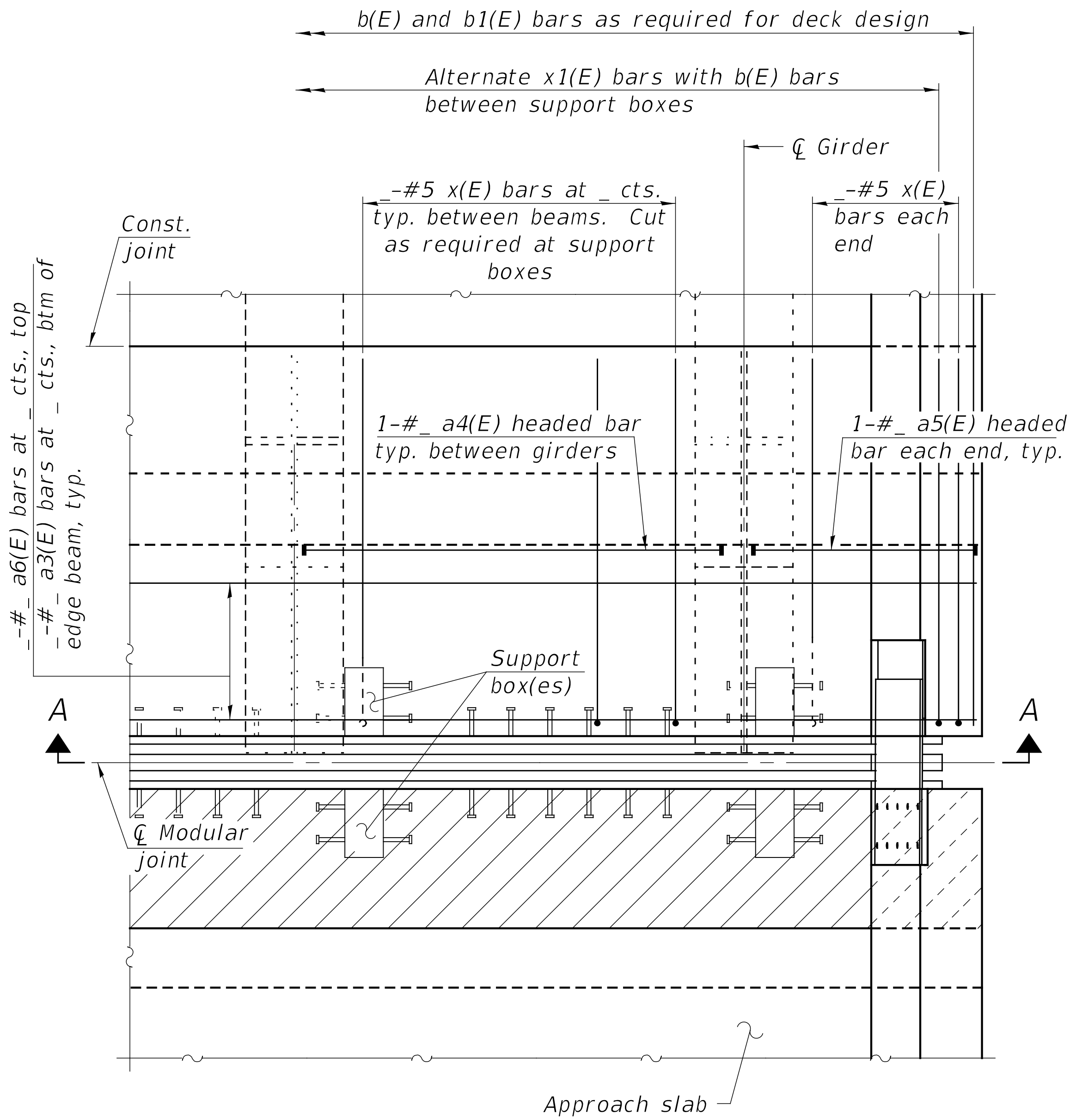
SUPERSTRUCTURE DETAILS FOR FULL DEPTH MODULAR JOINT BLOCKOUT

Figure 4



MODULAR JOINT & FULL DEPTH BLOCKOUT DETAILS

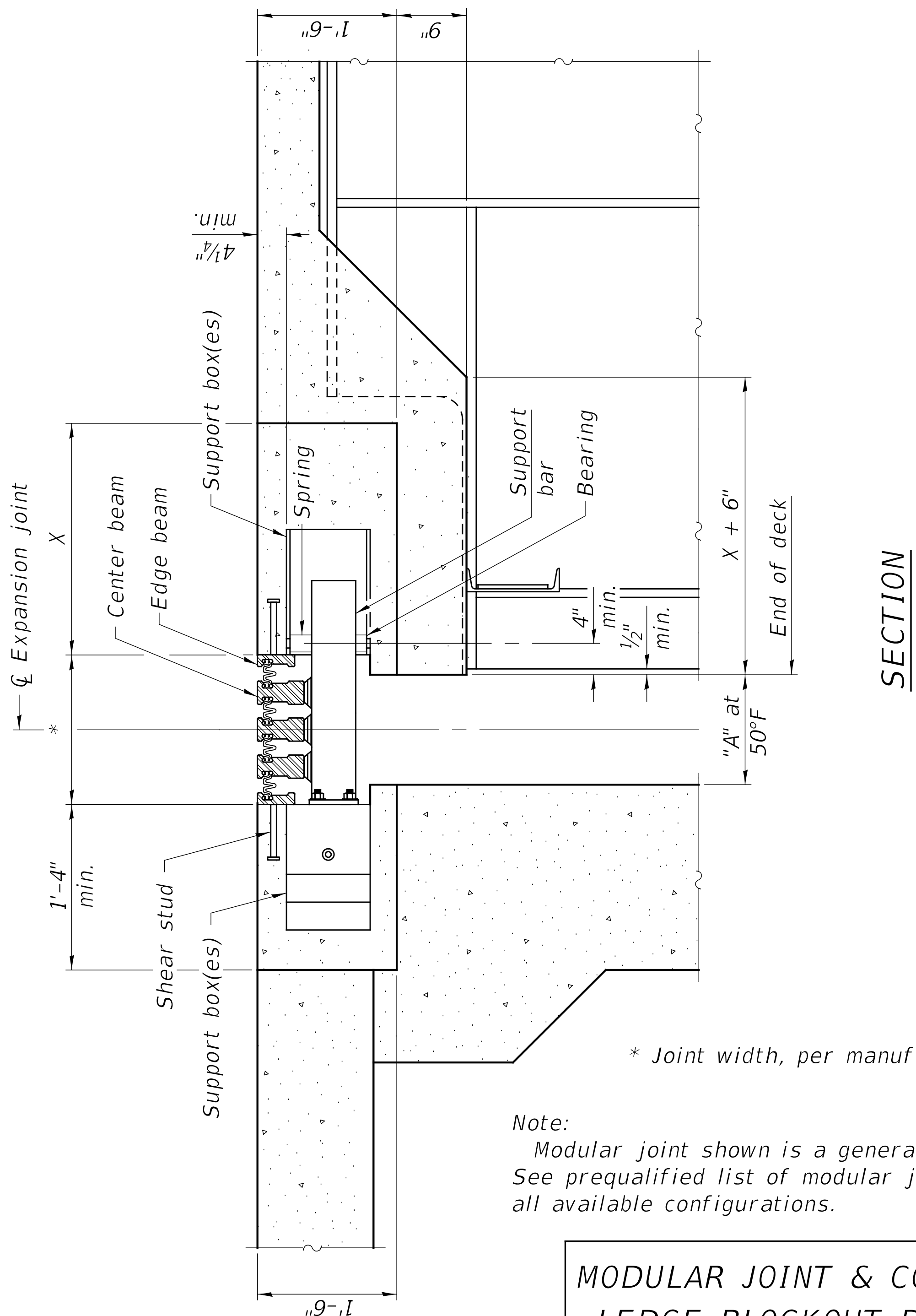
Figure 5



PARTIAL PLAN

SUPERSTRUCTURE DETAILS FOR FULL DEPTH MODULAR JOINT BLOCKOUT

Figure 6

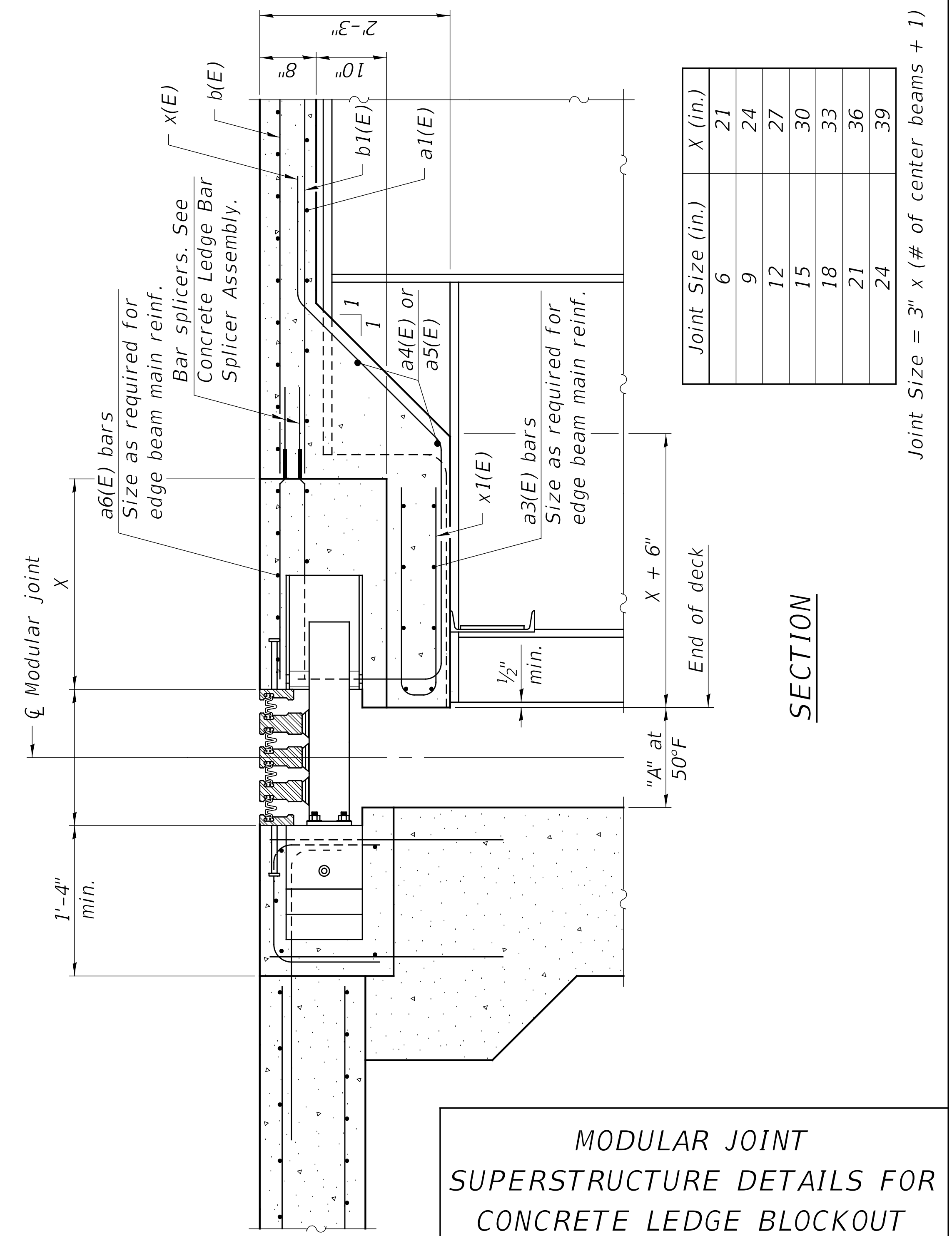


* Joint width, per manufacturer.

Note:
Modular joint shown is a general schematic. See prequalified list of modular joints for all available configurations.

MODULAR JOINT & CONCRETE LEDGE BLOCKOUT DETAILS

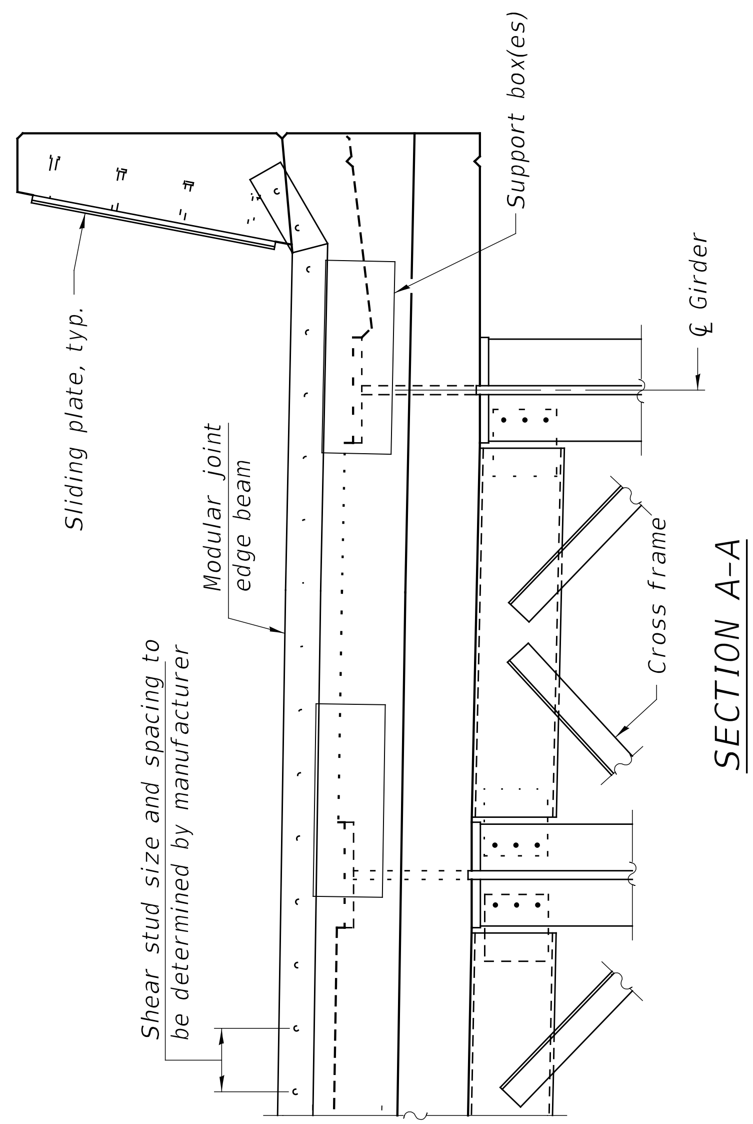
Figure 7



Joint Size (in.)	X (in.)
6	21
9	24
12	27
15	30
18	33
21	36
24	39

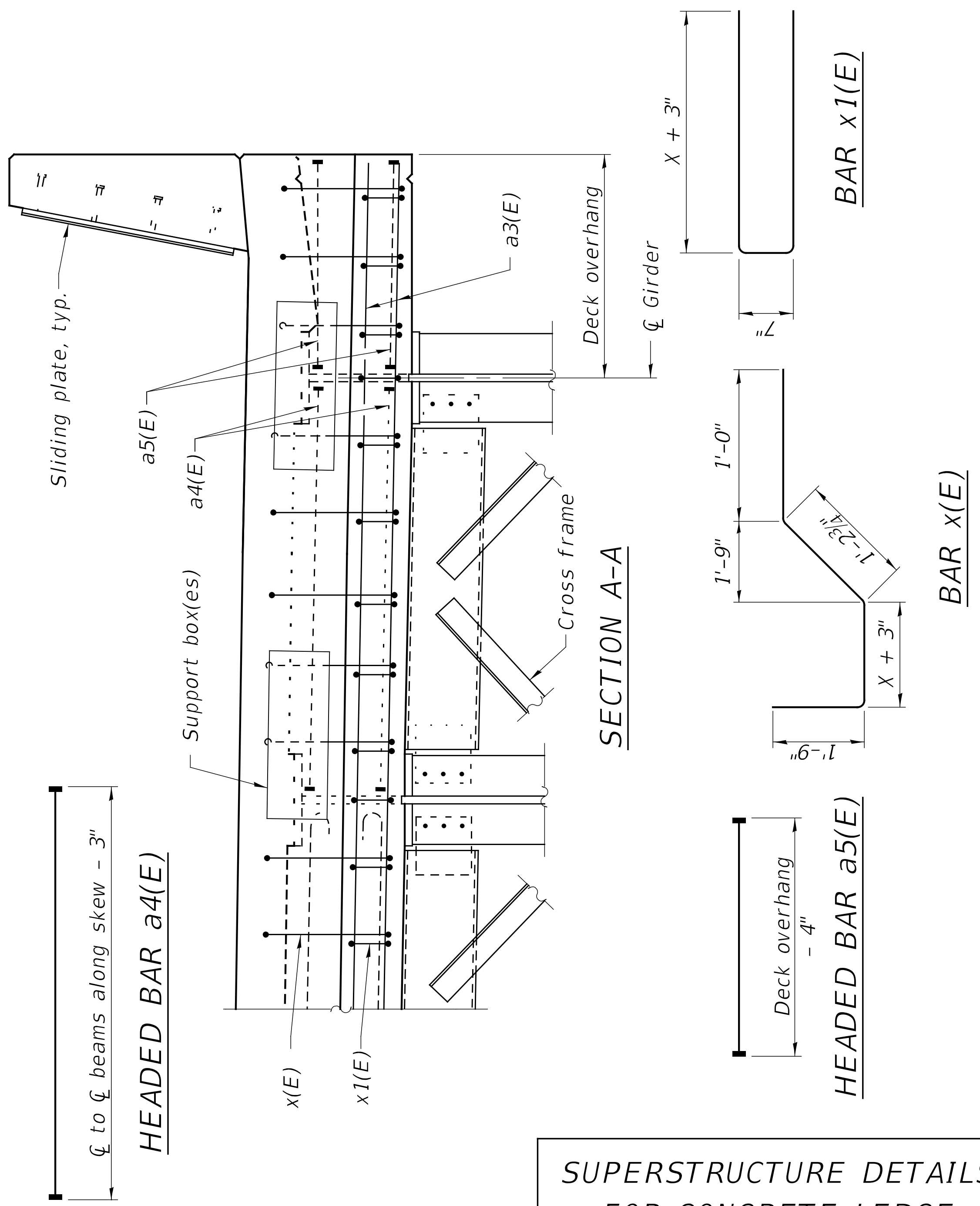
Joint Size = 3" x (# of center beams + 1)

MODULAR JOINT
SUPERSTRUCTURE DETAILS FOR
CONCRETE LEDGE BLOCKOUT



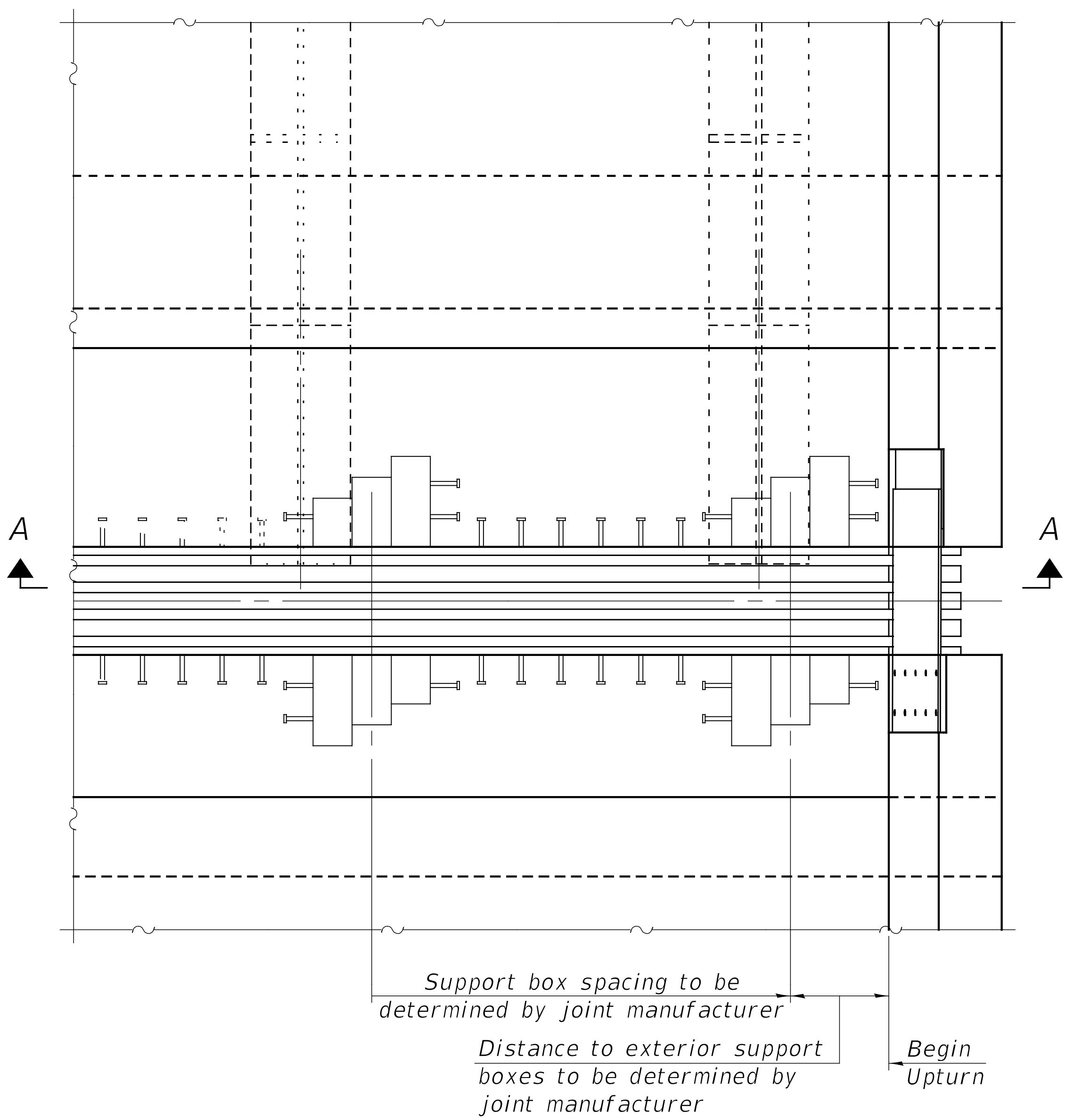
MODULAR JOINT & CONCRETE LEDGE BLOCKOUT DETAILS

Figure 9



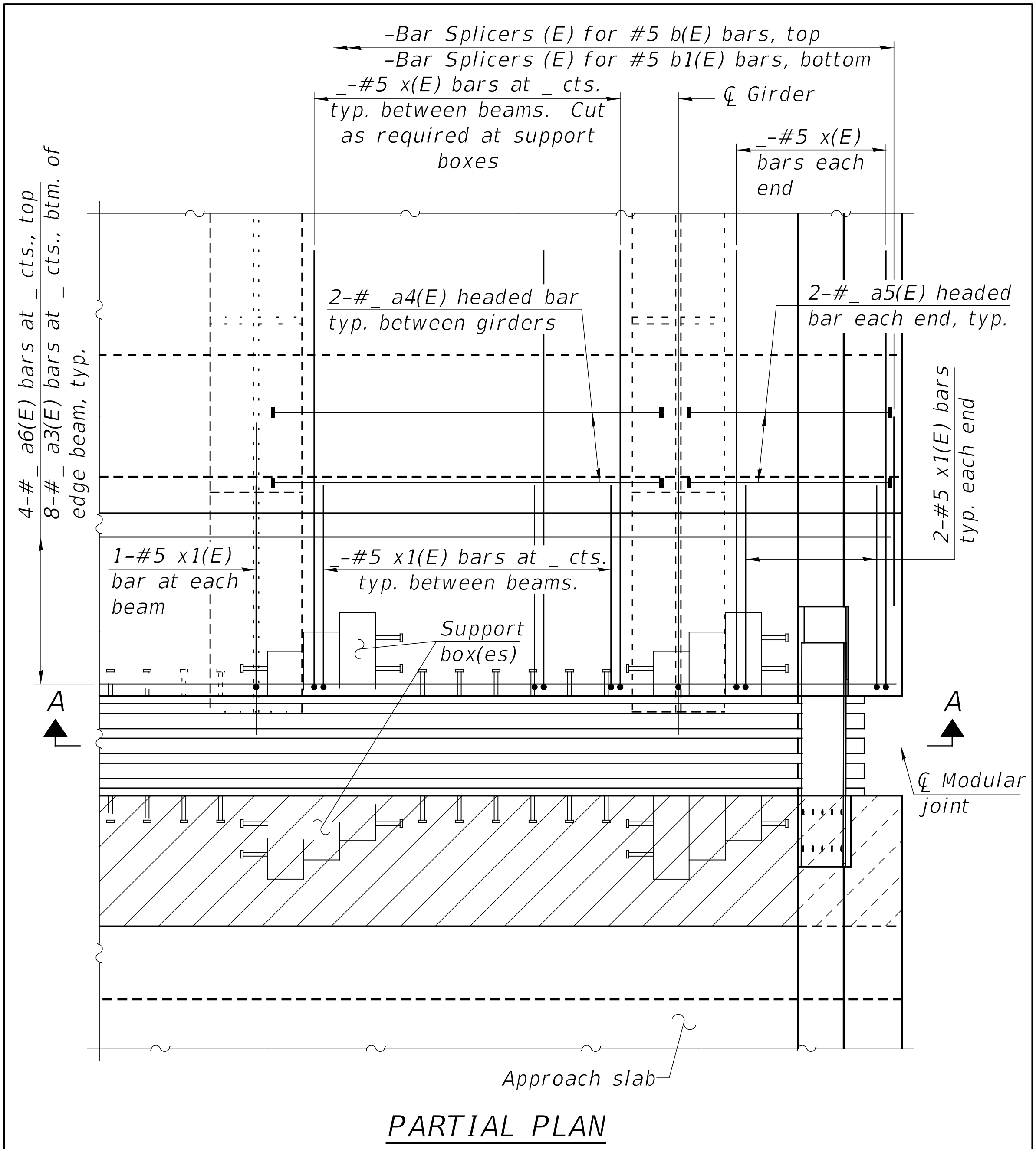
SUPERSTRUCTURE DETAILS
FOR CONCRETE LEDGE
MODULAR JOINT BLOCKOUT

Figure 10



MODULAR JOINT & CONCRETE
LEDGE BLOCKOUT DETAILS

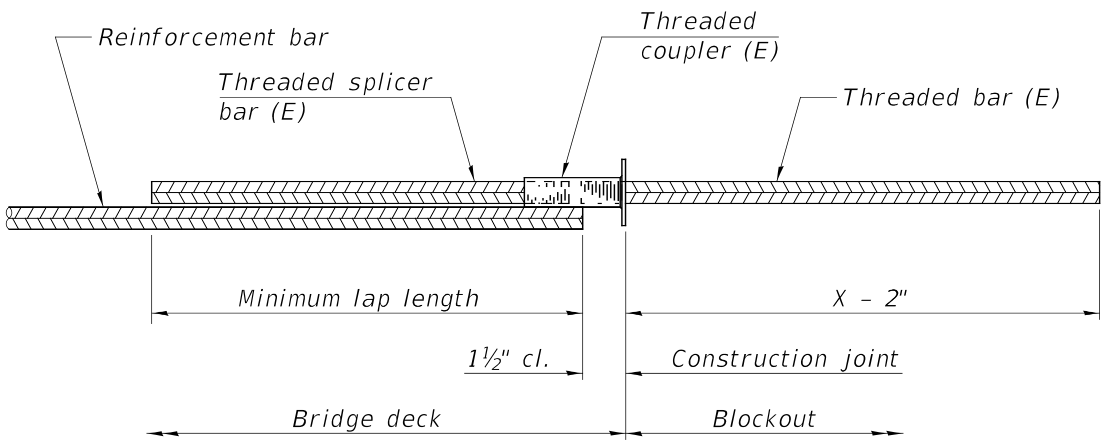
Figure 11



PARTIAL PLAN

SUPERSTRUCTURE DETAILS FOR CONCRETE LEDGE MODULAR JOINT BLOCKOUT

Figure 12



CONCRETE LEDGE BAR SPLICER ASSEMBLY PLAN

(All components shall be provided from one supplier)

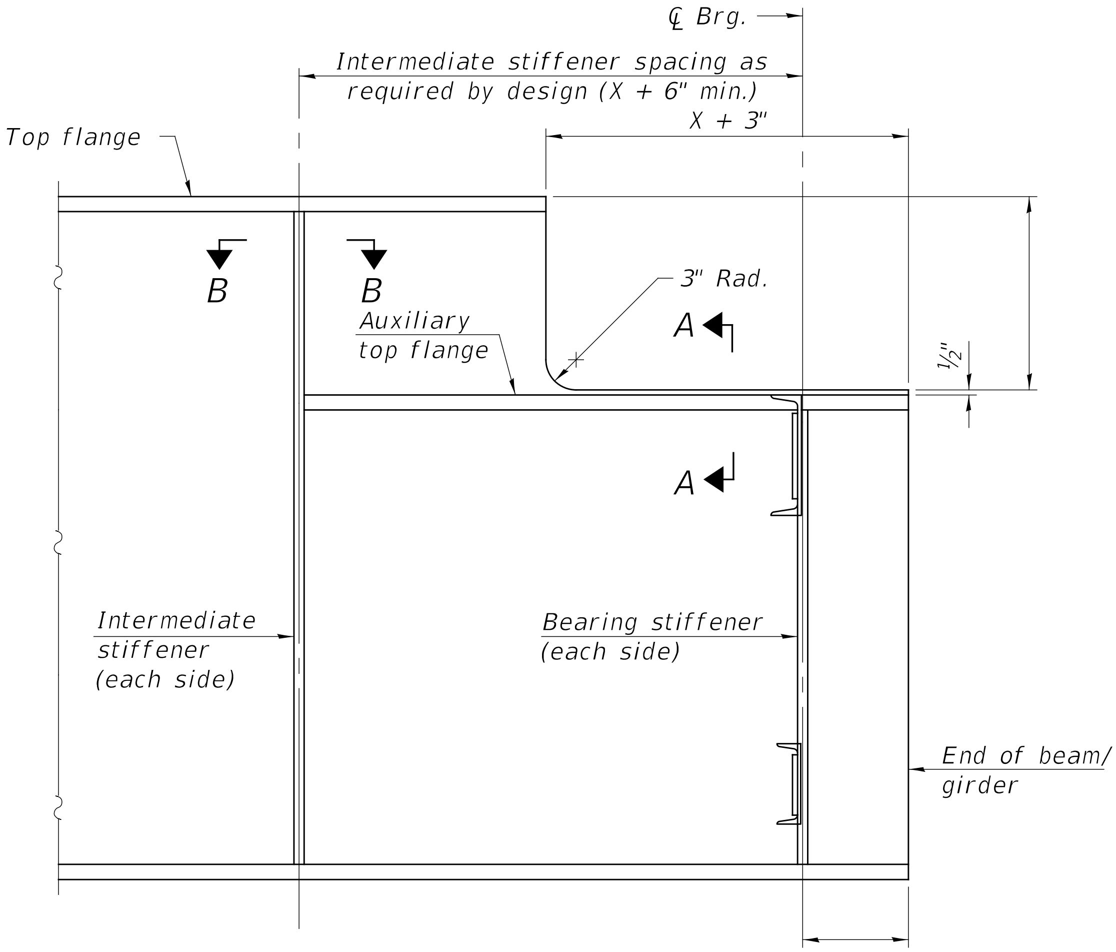
Threaded splicer bar length = min. lap length + 1½" + thread length
Threaded bar length = X – 2" + 1 thread length

Location	Bar size	No. threaded bars req'd	Length
Bridge deck	#5		
Blockout	#5		

Note:
One bar splicer assembly includes a threaded splicer bar, threaded bar, and threaded coupler.

CONCRETE LEDGE BAR SPLICER ASSEMBLY

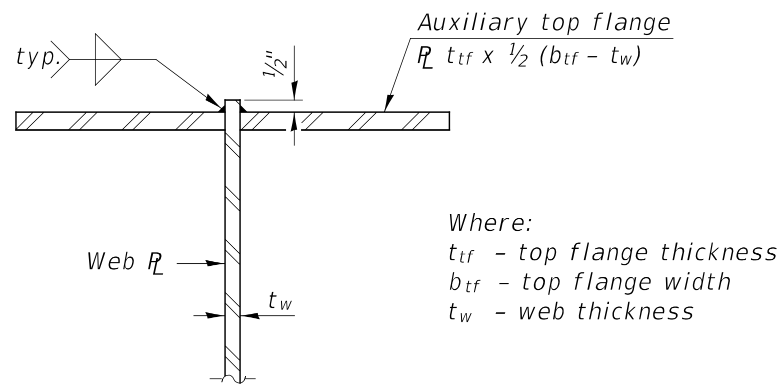
Figure 13



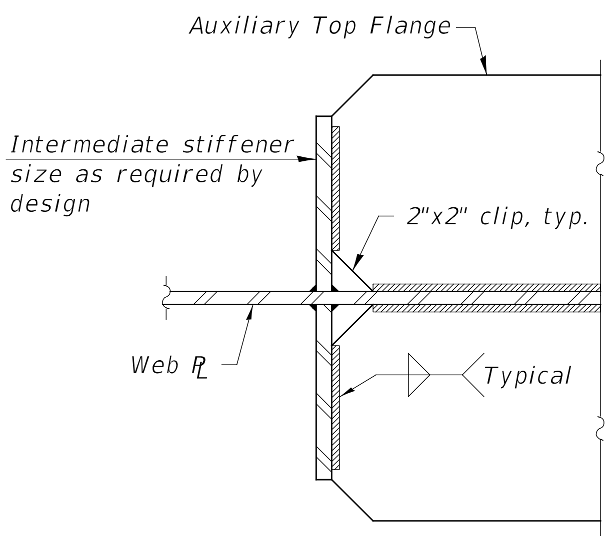
TYPICAL BEAM END

END OF GIRDER DETAILS
FOR MODULAR JOINTS

Figure 14



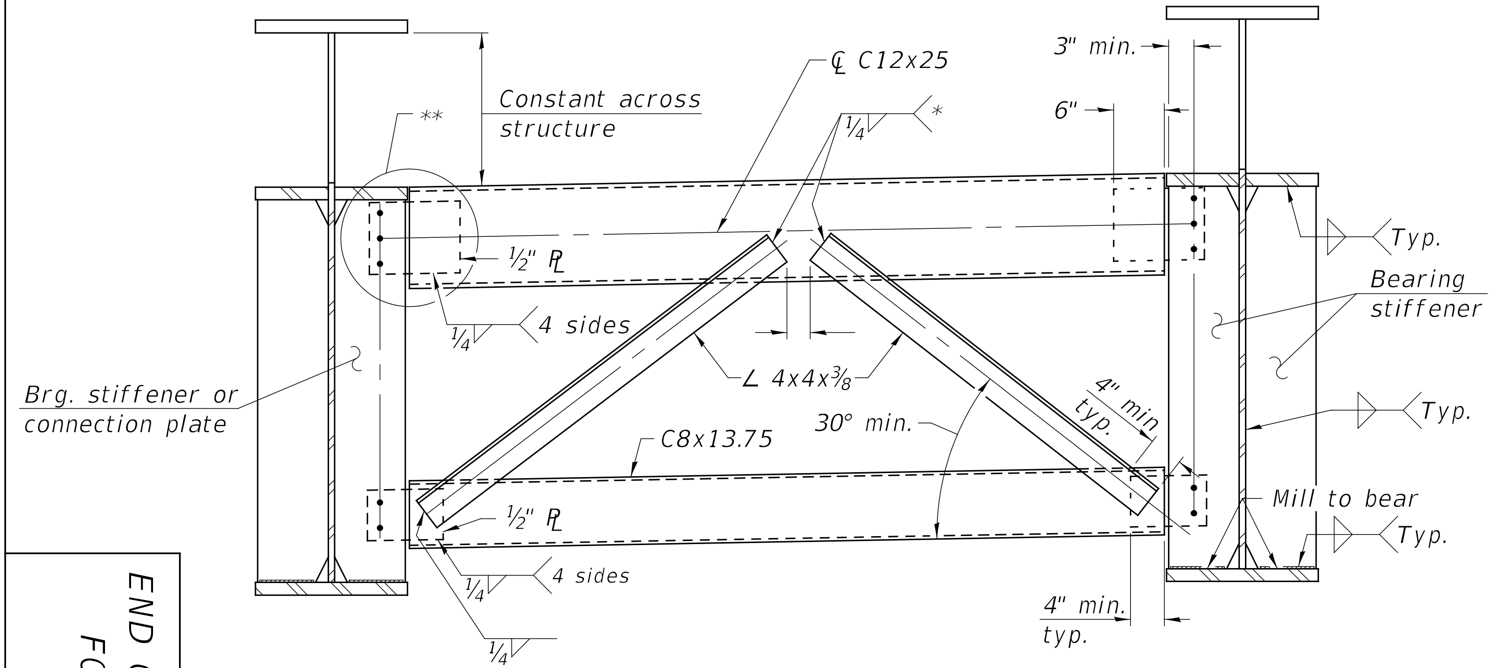
SECTION A–A



SECTION B–B

END OF GIRDER DETAILS
FOR MODULAR JOINTS

Figure 15



TYPICAL END CROSS-FRAME

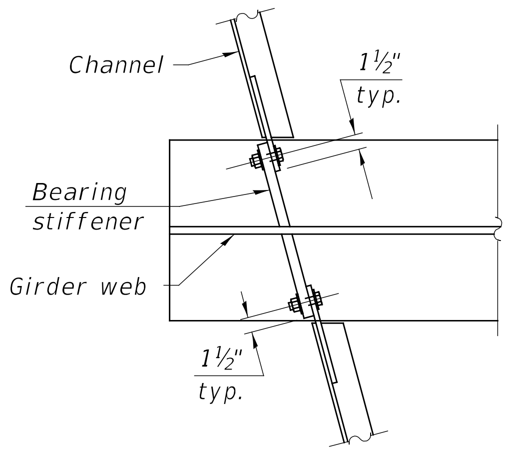
* Weld angles along 3 sides on one face of the channel; however, if cross frames are galvanized, weld all around. Use bolted connections for stage construction, 2 bolts minimum.

** See End Cross Frame Connection Details for Modular Joints.

Notes:
Detail $1\frac{5}{16}$" Ø holes for all $\frac{3}{4}$" Ø bolts ($1\frac{1}{16}$" Ø holes for all $\frac{7}{8}$" Ø bolts only if required by design).
Two hardened washers required for each set of oversized holes.

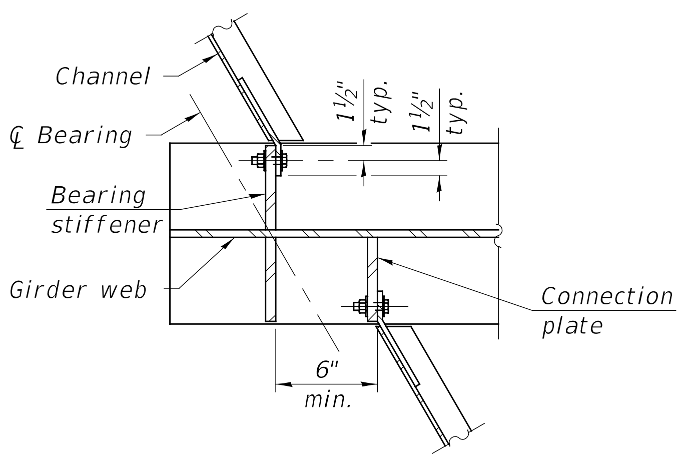
END CROSS FRAME DETAILS
FOR MODULAR JOINTS
(SKEWS < 45°)

Figure 16



CONNECTION DETAIL

(Skews ≤ 20°)

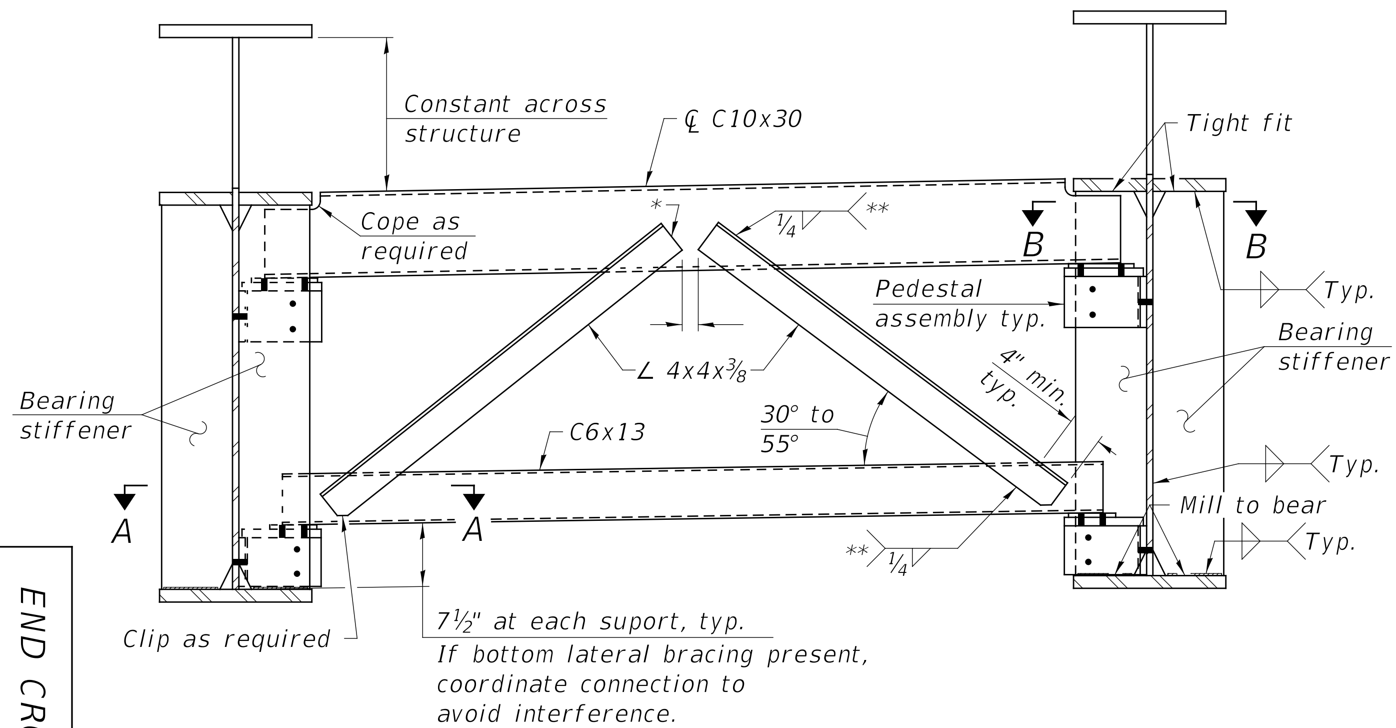


CONNECTION DETAIL

(Skews 20° – 45°)

END CROSS FRAME CONNECTION DETAILS FOR MODULAR JOINTS (SKEWS < 45°)

Figure 17



TYPICAL END CROSS FRAME

Notes:

Detail 15/16" Ø holes for all 3/4" Ø bolts (1 1/16" Ø holes for all 7/8" Ø bolts only if required by design).

Two hardened washers required for each set of oversized holes.

Place cross frame with channel flanges outward from abutment backwall.

* Use a minimum 2 bolt connection for stage construction.

** Weld angles along 3 sides to back face of channel: however, if cross frames are galvanized, weld all-around.

END CROSS FRAME DETAILS FOR MODULAR JOINTS (SKEWS ≥ 45°)

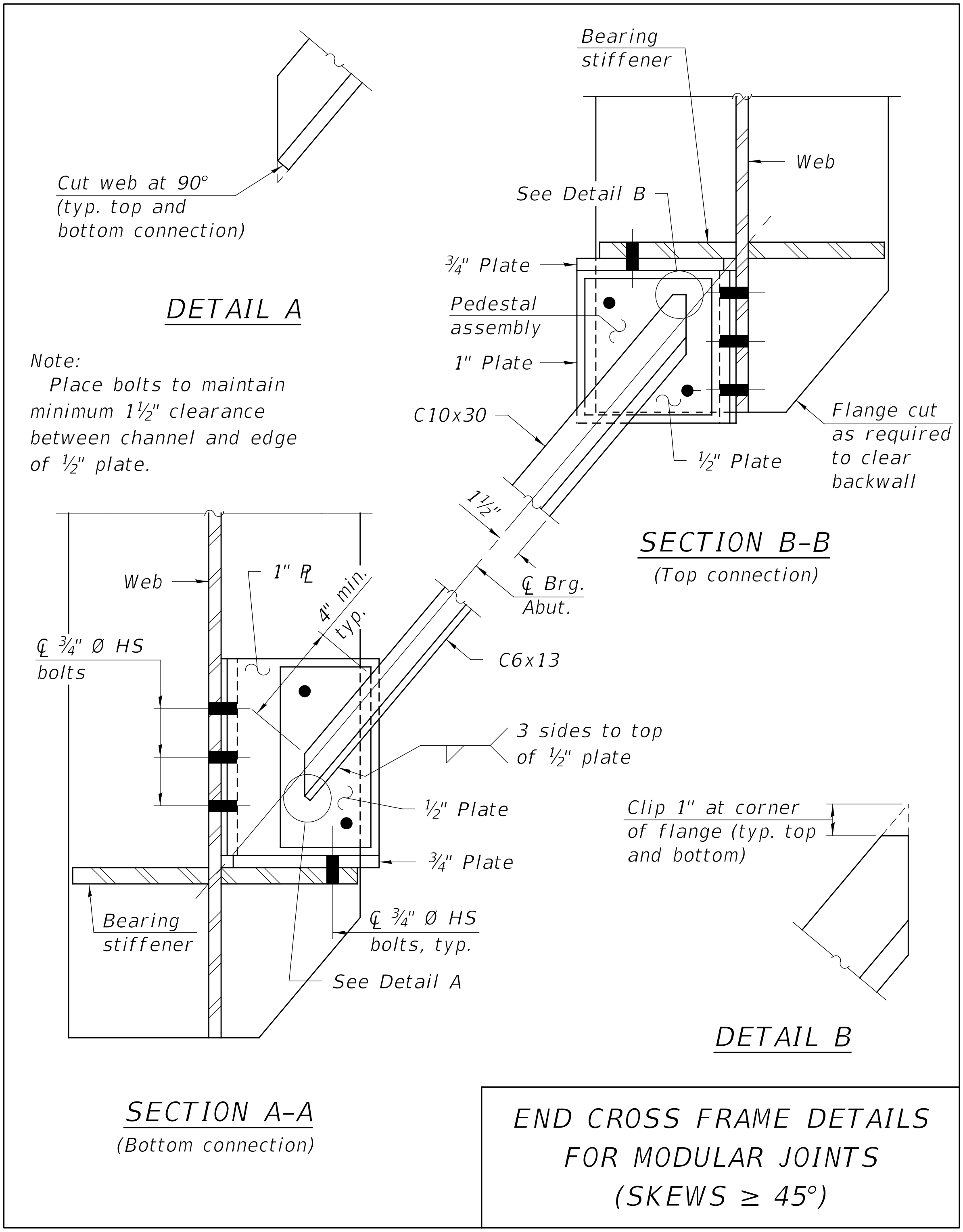
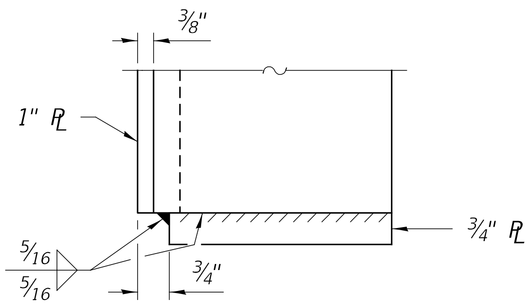
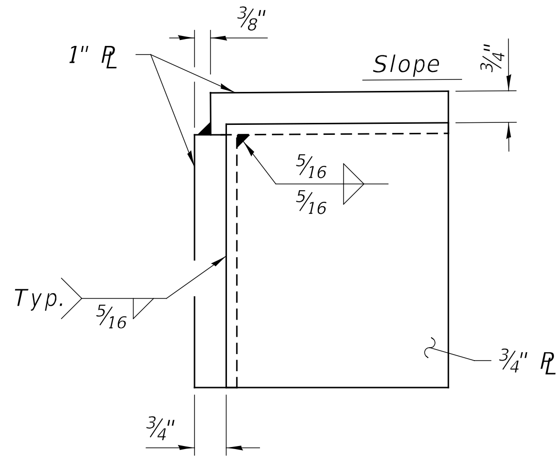

Cut web at 90°
(typ. top and
bottom connection)
DETAIL A
Note:
Place bolts to maintain
minimum 1½" clearance
between channel and edge
of ½" plate.
Bearing
stiffener
Web
See Detail B
¾" Plate
Pedestal
assembly
1" Plate
C10x30
Flange cut
as required
to clear
backwall
½" Plate
1½"
SECTION B-B
(Top connection)
℄ Brg.
Abut.
Web
1" PL
4" min.
typ.
℄ ¾" Ø HS
bolts
C6x13
3 sides to top
of ½" plate
½" Plate
¾" Plate
Clip 1" at corner
of flange (typ. top
and bottom)
Bearing
stiffener
℄ ¾" Ø HS
bolts, typ.
See Detail A
DETAIL B
SECTION A-A
(Bottom connection)
END CROSS FRAME DETAILS
FOR MODULAR JOINTS
(SKEWS ≥ 45°)

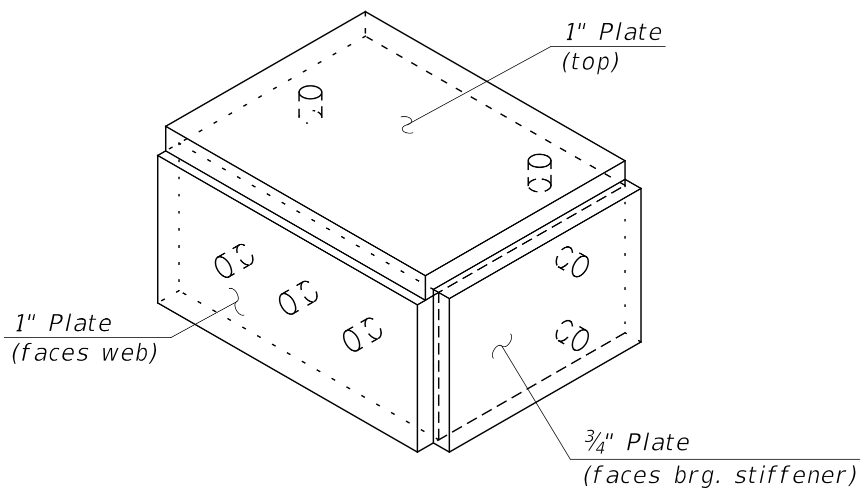
Figure 19



PEDESTAL ASSEMBLY
PARTIAL PLAN

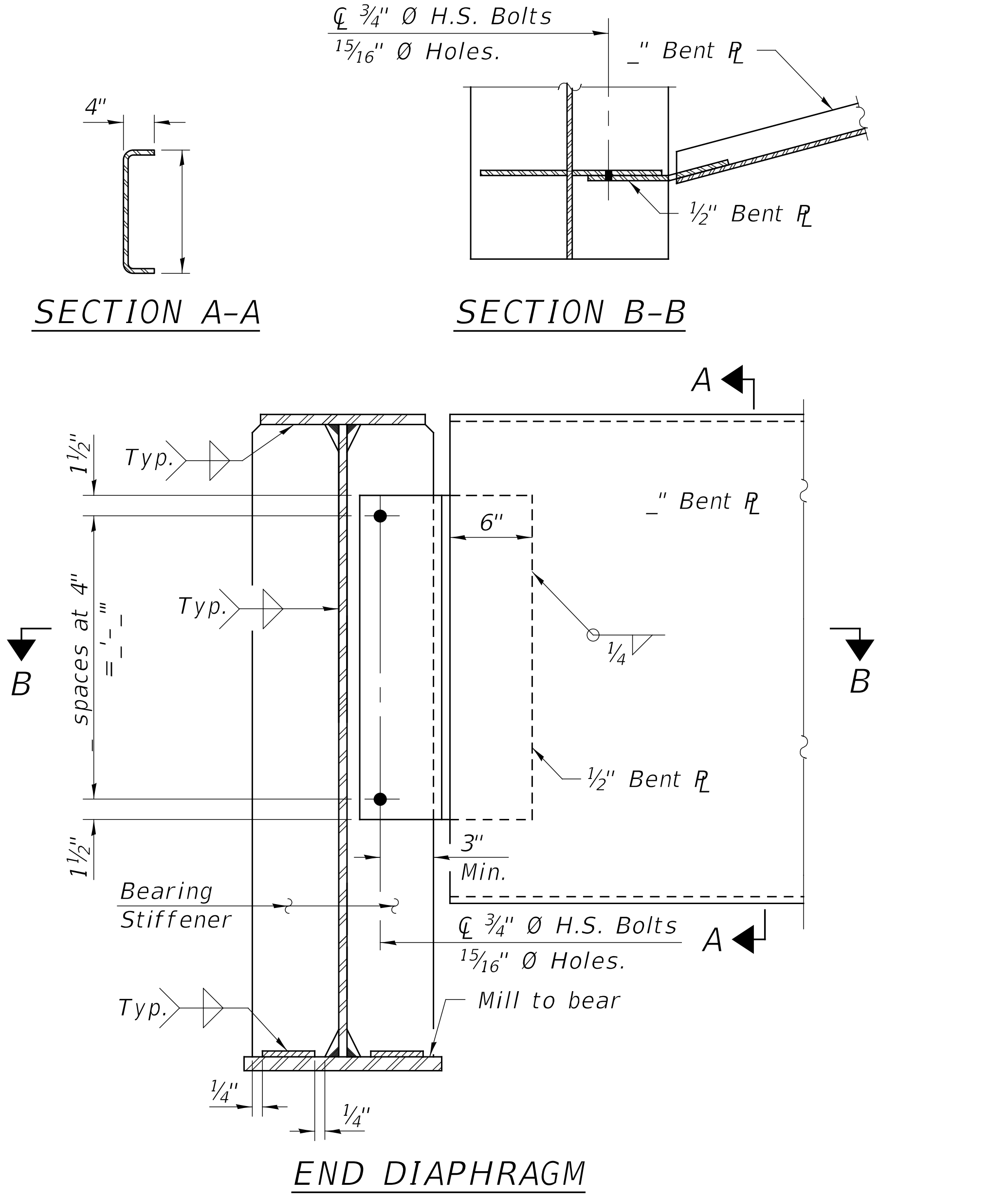


PEDESTAL ASSEMBLY
ELEVATION



PEDESTAL ASSEMBLY
ISOMETRIC VIEW

PEDESTAL ASSEMBLY DETAILS FOR MODULAR JOINT END CROSS FRAME (SKEWS ≥ 45°)



Notes:

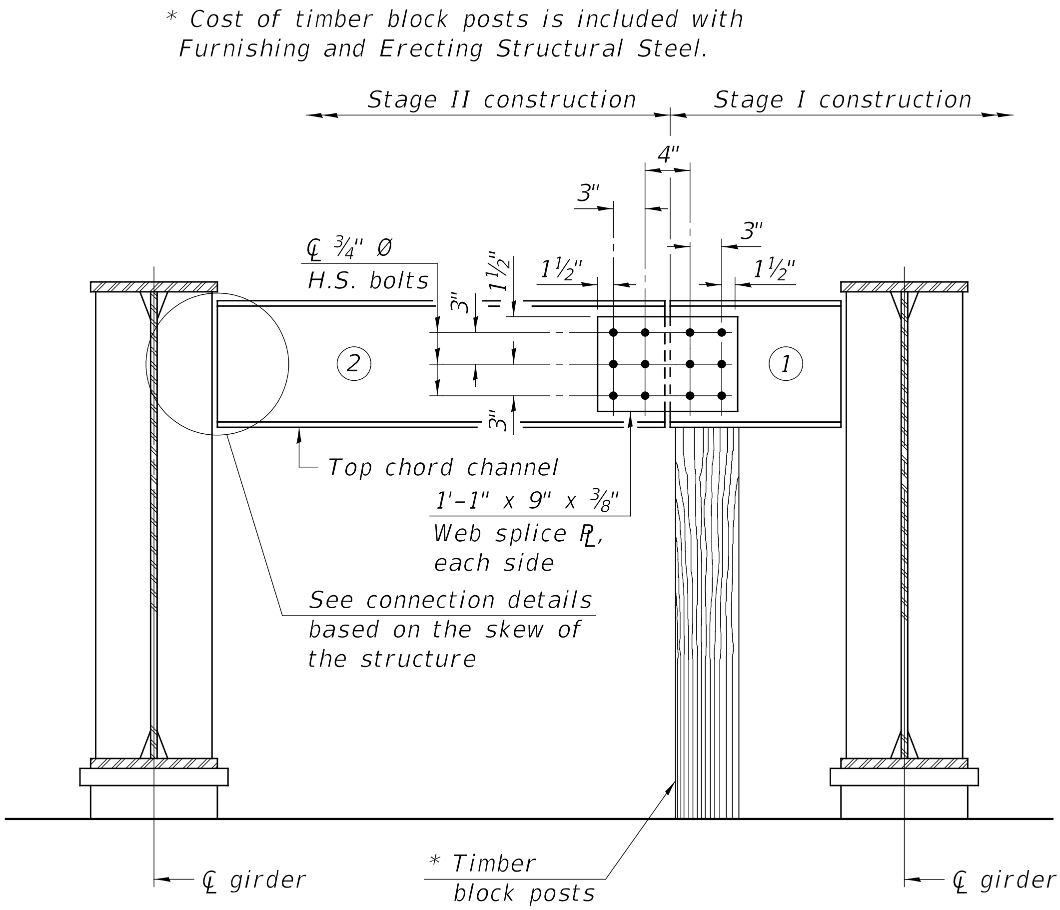
Detail 15⁄16" Ø holes for all ¾" Ø bolts (1 1⁄16" Ø holes for all ⅞" Ø bolts only if required by design).

Two hardened washers required for each set of oversized holes.

Place bent PL diaphragm with flanges outward from abutment backwall.

FINGER PLATE AND MODULAR JOINT END DIAPHRAGM (SKEWS ≤ 45°)

Figure 21



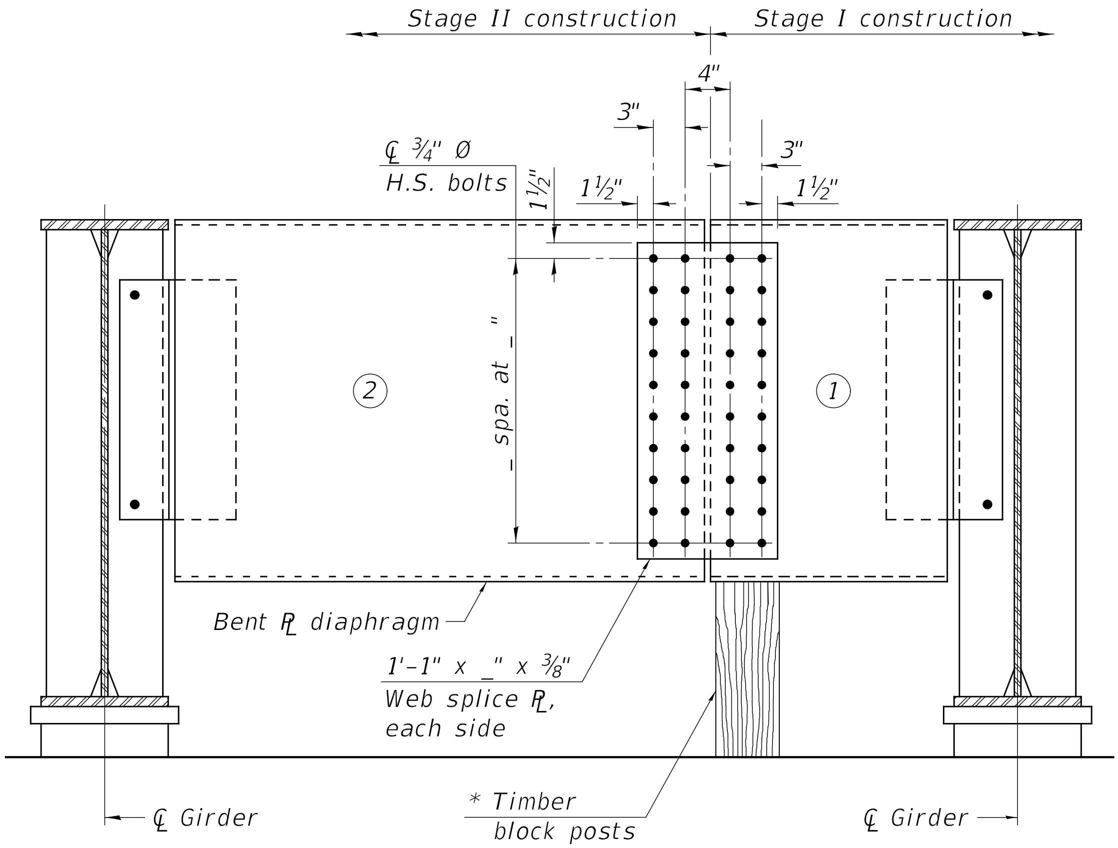
STAGE CONSTRUCTION SEQUENCE

1.) Order top chord in two sections.
2.) Attach section 1 of top chord to girder.
3.) Place timber block posts between section 1 of top chord and abutment bearing section.
4.) Attach section 2 of top chord to both girder and section 1 of top chord during stage II construction with splice plates.
5.) Attach remaining diagonal truss and bottom chord elements of end cross frame.
6.) Remove timber block posts.

END CROSS FRAME
STAGE CONSTRUCTION SEQUENCE

Figure 22

* Cost of timber block posts is included with
Furnishing and Erecting Structural Steel.



STAGE CONSTRUCTION SEQUENCE

1.) Order bent PL in two sections.
2.) Attach section 1 of bent PL to girder.
3.) Place timber block posts between section 1 of bent PL and abutment bearing section.
4.) Attach section 2 of bent PL to both girder and section 1 of bent PL during stage II construction with splice plates.
5.) Remove timber block posts.

END BENT PL DIAPHRAGM
STAGE CONSTRUCTION SEQUENCE

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	22.7
From:	Jayme F. Schiff	Jayme F. Schiff
Subject:	Noise Abatement Walls	
Date:	November 10, 2022	

The following memorandum outlines design, detailing, and submittal procedure requirements for ground-mounted and structure-mounted noise abatement walls.

Reference is made to Chapter 26 of the Bureau of Design and Environment (BDE) Manual and the IDOT Highway Traffic Noise Assessment Manual. The policies in the BDE Manual regarding noise analysis, wall placement location, wall materials, etc., should be examined during Phase I, well in advance of application of the policies in this All Bridge Designers (ABD) memorandum. The intent of this ABD memorandum is to provide guidance on structural plan details, not to circumvent any policies in the Bureau of Design and Environment Manual or the IDOT Highway Traffic Noise Assessment Manual.

Noise abatement wall plans are evaluated by the Bureau of Bridges and Structures in two phases: the Phase II Design contract plan review phase, and the Phase III Construction/Fabrication shop drawing review phase. This ABD memorandum provides guidance for these two phases of plan submittal.

The details and design procedures herein are consistent with precast reinforced concrete noise abatement wall panels with steel posts (ground-mounted or structure-mounted) or concrete posts (ground-mounted only). Other systems and materials are available and should be considered as applicable during the Phase I evaluations for the noise abatement wall.

Noise Abatement Wall Phase II Contract Plan Requirements

Issues involving noise abatement wall design and detailing are more easily resolved during Phase II design contract plan review, prior to letting and bidding. A Phase II submittal of the proposed noise abatement wall plans to the Bureau of Bridges and Structures is therefore required at the pre-final stage prior to letting and bidding, preferably six months in advance of the letting. The Bureau of Bridges and Structures will review the contract plans and special provisions for noise abatement walls that will be state-owned. The local agency owner will review the contract plans and special provisions for noise abatement walls that will be local agency owned.

Illinois Licensed Structural Seal Requirements
Depending upon whether the noise abatement wall is ground-mounted or structure-mounted, and the phase of the contract, the following structural seal requirements apply.

Phase	Plan Type	SE Seal & Signature Required?
Phase II	Ground-Mounted NAW Contract Plans	No
	Structure-Mounted NAW Contract Plans	Yes
Phase III	Ground-Mounted NAW Shop Drawings	Yes
	Structure-Mounted NAW Shop Drawings	Yes

For ground-mounted noise abatement walls, no structural design is provided on the Phase II contract plans. The post, panel, and foundation designs for ground-mounted noise abatement walls are all provided during the Phase III shop drawing submittal. Therefore, an Illinois Licensed Structural Engineer seal and signature are not required for the Phase II contract plans for ground-mounted noise abatement walls but are required for the Phase III shop drawings for ground-mounted noise abatement walls.

For structure-mounted noise abatement walls, the effects of the noise abatement wall on the attached structure (bridge or anchorage slab), are considered part of the structural design of the wall and attached structure. The post sizes and connections shall be verified by the Engineer of Record for the noise abatement wall plans. Therefore, the Phase II contract plans for structure-mounted noise abatement walls require the seal and signature of an Illinois Licensed Structural Engineer.

For structure-mounted noise abatement walls, the Phase III shop drawings contain the structural design of wall elements such as panels, clip angles, etc. Therefore, the Phase III shop drawings for structure-mounted noise abatement walls require the seal and signature of an Illinois Licensed Structural Engineer.

Detail Requirements
The intent of the Phase II contract documents, distributed for letting and bidding, is to ensure:

- adequate data is provided to the Contractor to accurately bid the noise abatement wall pay items, and then construct the noise abatement walls during the construction contract.
- adequate data is provided to the noise abatement wall supplier to design and detail the walls, and to provide shop drawings signed and sealed by an Illinois Licensed Structural Engineer.
- for structure-mounted noise abatement walls, the adequacy of the design details for the noise abatement wall mounted on the bridge or anchorage slab, and the structural adequacy of the bridge or anchorage slab itself.

In order to provide this data to the Contractor and wall supplier, the following details and specifications are required in the contract documents. These are listed using numerical indices below and discussed in more detail thereafter.

1. Design Specifications
2. Design Loading
3. Design Stresses
4. Aesthetic Requirements
5. General Plan and Elevation Views
6. Structural Details
7. Noise Reduction Data
8. Soil Data
9. Name Plate Requirements
10. Pay Items, Methods of Measurement, and Bases of Payment

1. Design Specifications

The most current version of the AASHTO LRFD Bridge Design Specifications shall be shown on the General Plan and Elevation sheet, under *Design Specifications*. This provides a record of the design specifications for future engineers in the event of required wall repairs.

Structural design of noise abatement walls is governed by Section 15 of the AASHTO LRFD Bridge Design Specifications, titled Sound Barriers. Guide Bridge Special Provisions #101 and #102 alert the noise wall supplier that this code shall be used in design.

An example of specifying the design specifications is shown in Figure 1.

2. Design Loading

Design loads shall be shown on the General Plan and Elevation sheet, under *Design Loading*.

Factored loadings shall be taken as 35 psf for Strength III or Strength V wind loading and 15 psf for Service I wind loading. These loads are derived from the wind loading formulas in Chapter 15 of the AASHTO LRFD Bridge Design Specifications, and are based upon Open Country wind exposure and a structure height of 33 ft. Use of the Open Country wind exposure category is sufficiently conservative that these loadings are applicable to noise walls in Urban or Suburban areas with heights far exceeding 33 ft., and recalculation of loads is not required.

For structure-mounted noise abatement walls, unfactored wall dead load shall be taken as 65 pounds per square foot. The unfactored 72 in. concrete barrier dead load is 0.98 kips per linear foot. This loading shall be distributed by the slab over the three beams closest to the noise abatement wall. This additional loading shall be accounted for in the DC loading on the interior beam moment table.

When noise abatement walls are required to resist differential earth loading, maximum active earth pressure and live load surcharge loads shall be shown in the design loading. The maximum retained fill shall be 7 ft. Walls requiring greater than 7 ft. of retained fill are defined as retaining walls and will require additional planning, design, and detailing beyond the scope of this memorandum.

An example of specifying the design loading is shown in Figure 1.

3. Design Stresses

The design stresses for materials shall be included on the General Plan and Elevation sheet, under Design Stresses. This will give the Contractor and wall supplier information on the types of materials required on the project, and their required design strengths.

Minimum required design strengths are provided below.

Field Units:

Drilled Shaft Concrete Foundations:	f'_c	=	4,000 psi
Structural Steel (Grade 36):	F_y	=	36,000 psi
Structural Steel (Grade 50):	F_y	=	50,000 psi
Reinforcement:	f_y	=	60,000 psi

Precast Units:

Precast Concrete:	f'_c	=	4,500 psi
Reinforcement:	f_y	=	60,000 psi
Welded Wire Reinforcement:	f_y	=	65,000 psi

An example of specifying the design stresses is shown in Figure 1.

4. Aesthetic Requirements

Aesthetic requirements, such as color, texture, or form liner patterns, shall be shown in the noise wall structure plans. When form liners are utilized, it is desirable to show a drawing of the required pattern on the contract plans to ensure the aesthetic requirements are clearly conveyed to the Contractor and wall supplier. These requirements may be too detailed to be placed on the General Plan and Elevation sheet and/or may be more appropriate to be placed in other locations in the noise abatement wall plans.

5. General Plan and Elevation Sheets

For ground-mounted noise abatement walls, a General Plan and Elevation sheet for the noise abatement wall plans shall be provided.

For structure-mounted noise abatement walls, on either bridges or anchorage slabs, the wall is considered a separate structure and requires plans independent of the bridge or anchorage slab on which it is mounted. A General Plan and Elevation sheet for the noise abatement wall, independent of the bridge or anchorage slab, shall be provided. Structure-mounted noise abatement walls are not always constructed on the same contract as their supporting structures.

Figures 2 and 3 show Plan and Elevation details for ground-mounted noise abatement walls. Structure-mounted noise abatement wall General Plan and Elevation sheets are similar.

Plan Views
Plan views shall show stations and offsets of the beginning and end of the noise abatement wall, as well as the stations and offsets of any required overlapping wall sections, wall directional changes, adjacent retaining walls or culverts, obstructions, ground modifications such as drainage interference, all overhead and underground utilities, and lighting. The stations and offsets shown in the contract plans and in the shop drawings shall be tied to the project stationing and not to a separate stationing system.

Plan views shall show the station and offset of each boring log included in the plans.

Elevation Views
Elevation views shall show the theoretical top and bottom of noise wall elevations at all necessary locations to ensure the proper shape of the wall is provided.

The theoretical top of wall elevations shown on the contract plans shall meet applicable noise wall height requirements. See Chapter 26 of the Bureau of Design and Environment Manual and the IDOT Highway Traffic Noise Assessment Manual for more information on noise wall height requirements. The noise wall height will be dependent upon the proposed ground surface elevations at the front face of the wall for ground-mounted walls, or the top of slab elevations for structure-mounted walls.

For ground-mounted walls, theoretical bottom of wall elevations shown on the contract plans should be assumed to be eight inches below the proposed ground surface. Theoretical bottom of wall elevations may be decreased as required to accommodate proposed ground conditions such as locations of utilities, earth retention, drainage, etc. The plans shall show both the existing ground elevations and proposed ground profile grade at the face of the wall.

For structure-mounted walls, theoretical bottom-of-wall elevations shown on the plans shall be taken as six inches below the top of parapet elevation. See Figure 4.

For ground-mounted noise abatement walls, the theoretical top and bottom elevations are a minimum envelope to be provided by the supplier. Due to the discrete, stair-stepped nature of the final wall dimensions, the furnished top and bottom wall elevations will vary and exceed the dimensions shown on the plans. For structure-mounted noise abatement walls, the furnished height of the wall should closely match the dimensions shown on the plans such that the loading requirements are not exceeded.

For ground-mounted walls, the maximum post spacing of 20 ft. shall be shown on the elevation view. Exact post locations will be determined by the wall supplier and therefore are not shown on the plans; the intent of the plan view is to aid the supplier in locating available post locations, not to dictate exact post locations. See Figure 3 for an example.

For structure-mounted walls, the exact post locations shall be detailed on both the General Plan and Elevation sheet for the noise abatement wall plans and in the bridge or anchorage slab plans. The maximum post spacing for structure-mounted walls is given in Figure 4.

For ground-mounted walls, when proposed ground surface slopes indicate that ponding at the wall face is a concern, 4 in. diameter weep holes shall be provided at ground level in the bottom panel of the wall at a spacing of 8 ft.

Section Thru Wall
When portions of ground-mounted walls are required to resist soil loading, a section thru the wall showing the maximum height of retained fill shall be provided. The section thru the wall shall show similar granular backfill and pipe underdrain details as a soldier pile retaining wall. See Chapter 3.11 of the Bridge Manual for applicable details. Walls requiring more than 7 ft. of soil retention will require design and detailing beyond the scope of this memorandum.

Details for sections thru walls for structure-mounted walls are given in Figures 4 and 7. Because noise walls require separate plan sheets than the structures they are mounted on, wall details on the bridge or anchorage slab sheets should be marked For Information Only.

Access door or panel locations shall be shown on the elevation view.

6. Structural Details

Figures 4 through 13 show details for structure-mounted noise abatement walls. These details shall be used for noise abatement walls mounted on bridges and anchorage slabs.

Figure 4 shows a standard configuration for a structure-mounted noise abatement wall on a bridge. The wall is mounted to the back of a 72 in. concrete barrier via a post connection bracket. The barrier is mounted on a thickened deck overhang.

The 72 in. concrete barrier for use with structure-mounted noise abatement walls consists of a standard 44 in. constant-slope barrier, with the addition of a vertical 28 in. parapet extension. The vertical extension reduces the rotation of a truck in an impact event, reducing the zone of intrusion of the truck. The vertical extension also reduces salt spray on the face of the noise wall, reducing wall damage due to chloride ingress.

The post connection bracket shape is a steel section that acts as a spacer, placing the front face of the wall 10 in. behind the back face of the 72 in. concrete barrier, further reducing the zone of intrusion of the truck.

When used together, the 72 in. concrete barrier and offset noise wall position the wall such that it is outside the zone of intrusion of the truck. This configuration has been successfully crash-tested, and has been determined to be crashworthy for Test Level 5 criteria for the 2016 Manual for Assessing Safety Hardware.

The deck overhang thickness when a noise abatement wall is used shall be 11.5 in. This additional thickness is required to support the loading from the noise abatement wall and larger parapet. The fillet at the exterior beam section is also thickened such that there is a minimum of 11.5 in. of deck thickness over the exterior beam.

The maximum post spacing for a noise abatement wall mounted on a structure shall be 11 ft. 8 in. The maximum height for a noise abatement wall mounted on a bridge shall be 18 ft. above the deck elevation at the front of the parapet.

Structure-mounted noise abatement wall plans require the CL post locations to be as specified on the bridge or anchorage slab plans. This is to ensure that bridge or anchorage slab reinforcement details are consistent with the anchor rod assemblies and post connection locations on the wall plans. It also ensures that parapet joints are appropriately placed outside the minimum required distance from the CL post to the joint. Post locations for structure-mounted walls cannot be altered by the wall supplier.

Figure 4 also shows a section thru the noise abatement wall anchor rod assembly. This assembly consists of four L-shaped anchor rods, a template plate, and related hardware. More information is given in Figure 12 below.

Figure 5 shows deck overhang and parapet reinforcement details for use with the 72 in. concrete barrier. The reinforcement in the parapet, overhang, and adjacent slab are increased to support the noise abatement wall loading.

Parapet and deck overhang reinforcement used with the 72 in. concrete barrier is increased in “end regions” near full-depth joints and parapet ends. These “end regions” are shown in Figure 5 and are defined as regions within 15 ft. of full-depth joints and parapet ends. Regions outside of this distance are shown as “interior regions” and have lesser reinforcement requirements.

Figure 6 shows dimensions for the standard reinforcement used in the 72 in. concrete barrier and deck overhang.

Figures 7, 8, and 9 show details for noise abatement walls mounted on anchorage slabs. These three figures show similar detail requirements to those required for bridges in Figures 4 through 6.

Figure 10 shows details for aluminum parapet joints and cork parapet joints, for use with the 72 in. concrete barrier.

Figure 11 shows details for an elastomeric debris shield. The intent of this shield is to prevent debris, such as snow and ice, from accumulating between the noise abatement wall and parapet.

Figure 12 shows a plan view of the post, post connection bracket, and parapet section. Dimensions for L-shaped anchor rods are shown in this figure, as well as an anchor rod template plate. The anchor rod template plate is embedded ¼ in. into the back face of the parapet, and maintains the positions of the anchor rods during the pouring of the parapet. The template plate will remain in place after the parapet forms are removed, with the connection bracket mounted on the back face of the template plate.

Figure 12 also shows required distance from posts to parapet joints.

Figure 13 shows post connection bracket details, and concrete connection details for post connection brackets.

Figure 14 shows details for Name Plates and name plate mounting locations.

7. Noise Reduction Data

A noise reduction data table shall be shown on the plans. The noise abatement wall supplier is required to meet noise reduction requirements. An example noise reduction table is found below, with instructions on how to fill in the blanks of the table.

Noise Wall Structure Number	Face	From Sta.	To Sta.	Noise Reduction Coefficient	Comments
	front face			Select Value	
	back face			Select Value	

Noise Reduction Data Table

Noise Wall Structure Number:
A noise wall structure number will be issued by the Department and shall be provided in the table. For structure-mounted noise abatement walls, the noise wall structure number is independent of the bridge structure number. The noise wall structure number will have the format CCC-N####, where CCC is the county number, N is an indicator that it is a noise abatement wall, and #### is a four-digit index.

Face:
The intent of this column is to differentiate between the two faces of the wall. Because the two faces may require different treatments, it is important to differentiate between the two such that the contractor does not install a panel in the incorrect orientation.

The terms “front face” and “back face” are used as examples for this memorandum. The designer is encouraged to use as descriptive a term as possible to clarify to the

Contractor the correct installation orientation. Examples include “interstate face,” “frontage road face,” “residential face,” or use of actual roadway names such as “I-55 face”.

From and To Stations:
The noise reduction coefficients may change over the length of the wall. The intent of these columns is to show stations where these changes occur. Additional rows may be added as necessary.

Noise Reduction Coefficient:
The Noise Reduction Coefficient is a measure of how much noise is absorbed by absorptive noise walls. There are three options for this column: Reflective, Absorptive- 0.8 min., and Absorptive- 0.65 min. Instruction is given in BDE Manual Chapter 26 and IDOT Highway Traffic Noise Assessment Manual as to the applicability of each option.

Comments:
Any additional comments may be entered into this column.

8. Soil Data

For ground-mounted noise abatement walls, approximate locations of each boring log included in the contract plans shall be shown in the plan view. Boring logs should be taken every 200 ft., or as close as feasible given issues such as terrain, utilities, right-of-way, etc. All boring logs shall be included in the contract plans. The wall designer will use the data in the boring logs to design the wall foundations. Conservative soil data assumptions are included in the Guide Bridge Special Provisions to ensure that the wall foundations may still be designed should boring logs be omitted or incomplete.

9. Name Plate Details

Name plates shall be provided for all noise abatement walls. Name plate location requirements and lettering details are provided in Figure 14.

10. Pay Items, Methods of Measurement, and Special Provisions

Anchor bolts used for the anchorage assembly for structure-mounted walls shall be paid for as NOISE ABATEMENT WALL ANCHOR ROD ASSEMBLY, with units of Each. This pay item is furnished with the parapet on which the noise abatement wall is mounted. Therefore, it shall be shown on the plans for the bridge or anchorage slab on which the wall is mounted. This pay item shall not be shown on the noise abatement wall plans. Each anchor rod assembly will consist of the four anchor rods, template plate, and associated hardware.

For ground-mounted noise abatement walls, the pay item NOISE ABATEMENT WALL, GROUND MOUNTED shall be used, with units of Sq. Ft. As specified in the special provision, this pay item includes the panels, posts, foundations, connections, and any other items associated with the wall.

For structure-mounted noise abatement walls, the pay item NOISE ABATEMENT WALL, STRUCTURE MOUNTED shall be used, with units of Sq. Ft. As specified in the special provision, this pay item includes the panels, posts, connections, debris shield, and any other items associated with the wall, with the exception of the anchor rod assemblies. This pay item shall be shown on the wall plans only. The bridge or anchorage slab plans shall not show these items. This is to avoid unintentionally doubling the quantities, and to allow for noise walls to be placed on separate contracts, independent of the contract containing the bridge or anchorage slab construction.

Name plates will be paid for at the contract unit cost per each for NAME PLATES.

Methods of measurement for these pay items are found in the applicable Guide Bridge Special Provision.

Three Guide Bridge Special Provisions (GBSP) are available online and shall be inserted into contracts as applicable. These are:

- Noise Abatement Wall, Ground Mounted (GBSP #101)
- Noise Abatement Wall, Structure Mounted (GBSP #102)
- Noise Abatement Wall Anchor Rod Assembly (GBSP #103)

Noise Abatement Wall Phase III Shop Drawing Requirements

The Phase III shop drawings submittal include the site-specific wall design calculations, details, working drawings, and fabrication shop drawings for the proposed noise abatement wall. The structural design includes required post sizes and locations, wall panel designs, baseplate designs, concrete shaft and shaft reinforcement details, steel connections, etc. The Bureau of Bridges and Structures or local agency owner will review the shop drawings submittal for structural and geotechnical adequacy, conformance with code requirements, and additional contract requirements.

Phase III shop drawings shall be sealed and signed by an Illinois Licensed Structural Engineer.

Other Wall Types

Noise abatement walls typically consist of precast reinforced concrete panels, with either steel or precast concrete posts. However, other wall types, such as acrylic and vinyl, have also been utilized by the Department for some applications. While use of these wall types is allowed, the standard details and special provisions outlined in this memorandum are not applicable. Selection of alternate noise wall types is performed during Phase I wall selection. For more information on these wall types, contact the Bureau of Bridges and Structures or the Bureau of Design and Environment.

Implementation

The policies in this memorandum shall be implemented, as soon as practical, on all applicable projects that have not been let.

CAD cells for many of the figures below will be made available on the Details-Design cell library at https://idot.illinois.gov/Assets/uploads/files/Doing-Business/Specialty-Lists/Highways/Bridges/Cell-Libraries/Bridge/Details-Design.pdf.

Guide Bridge Special Provisions for Noise Abatement Wall, Ground-Mounted and Noise Abatement Wall, Structure-Mounted and Noise Abatement Wall Anchor Rod Assembly will be made available on the IDOT website at https://idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/guide-bridge-special-provisions.

For more information, please contact Mark Shaffer, Bridge Design Engineer, by telephone at (217) 782-2125 or email at mark.shaffer@illinois.gov.

Attachments

ABD22.7-20221110

DESIGN SPECIFICATIONS

AASHTO LRFD Bridge Design Specifications, ___ Edition

DESIGN STRESSES

FIELD UNITS

f'c = 4,000 psi
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (Struct. Steel, M270 Grade 50, posts)
fy = 36,000 psi (Struct. Steel, M270 Grade 36, all other structural steel)

PRECAST UNITS

f'c = 4,500 psi
fy = 60,000 psi (Reinforcement)
fy = 65,000 psi (Welded Wire Reinforcement)

DESIGN LOADS

Strength III or V Wind: 35 psf
Service I Wind: 15 psf

NOISE ABATEMENT WALL SPECIFICATIONS, STRESSES, AND LOADS

Figure 1 (ABD 22.7)

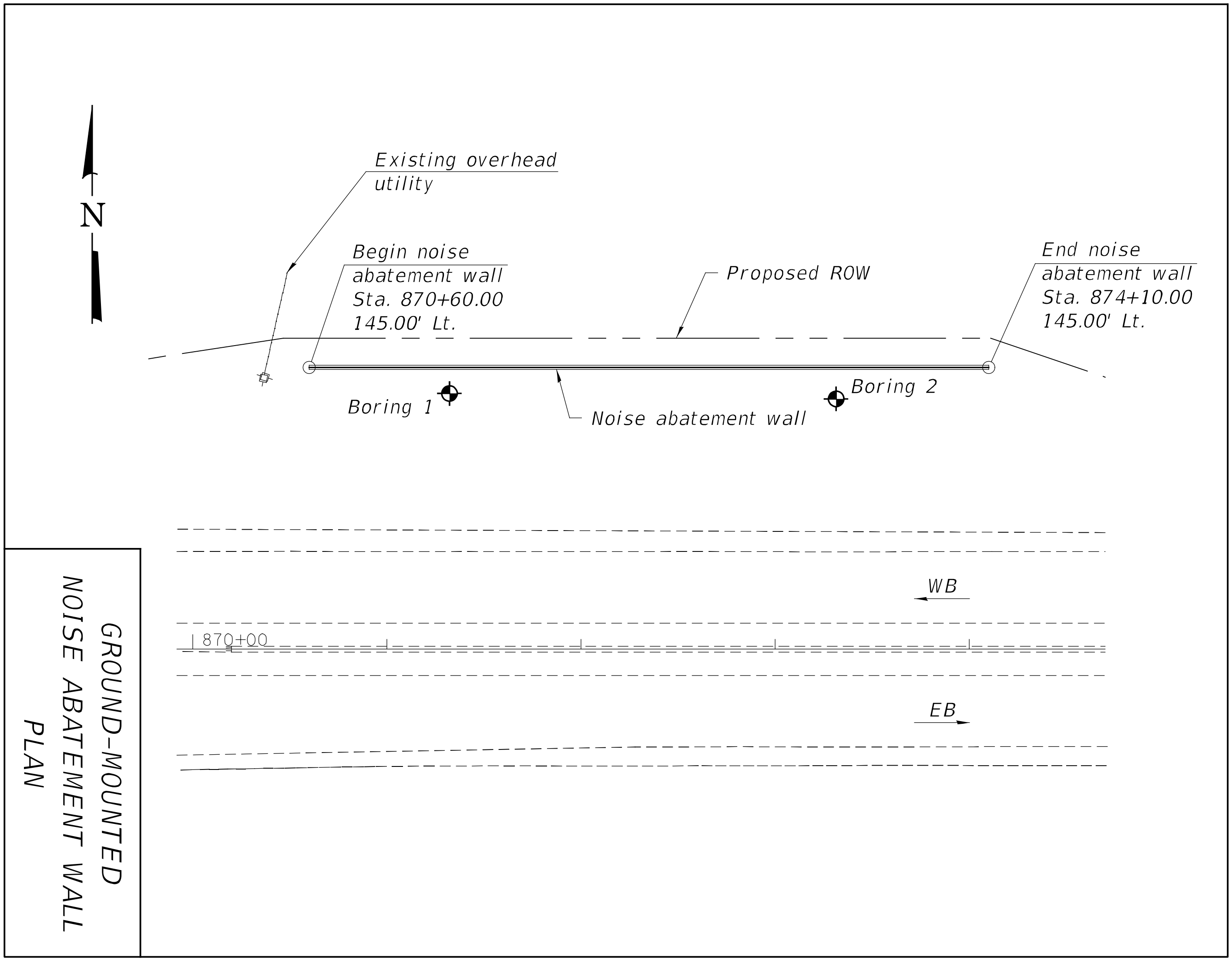


Figure 2 (ABD 22.7)

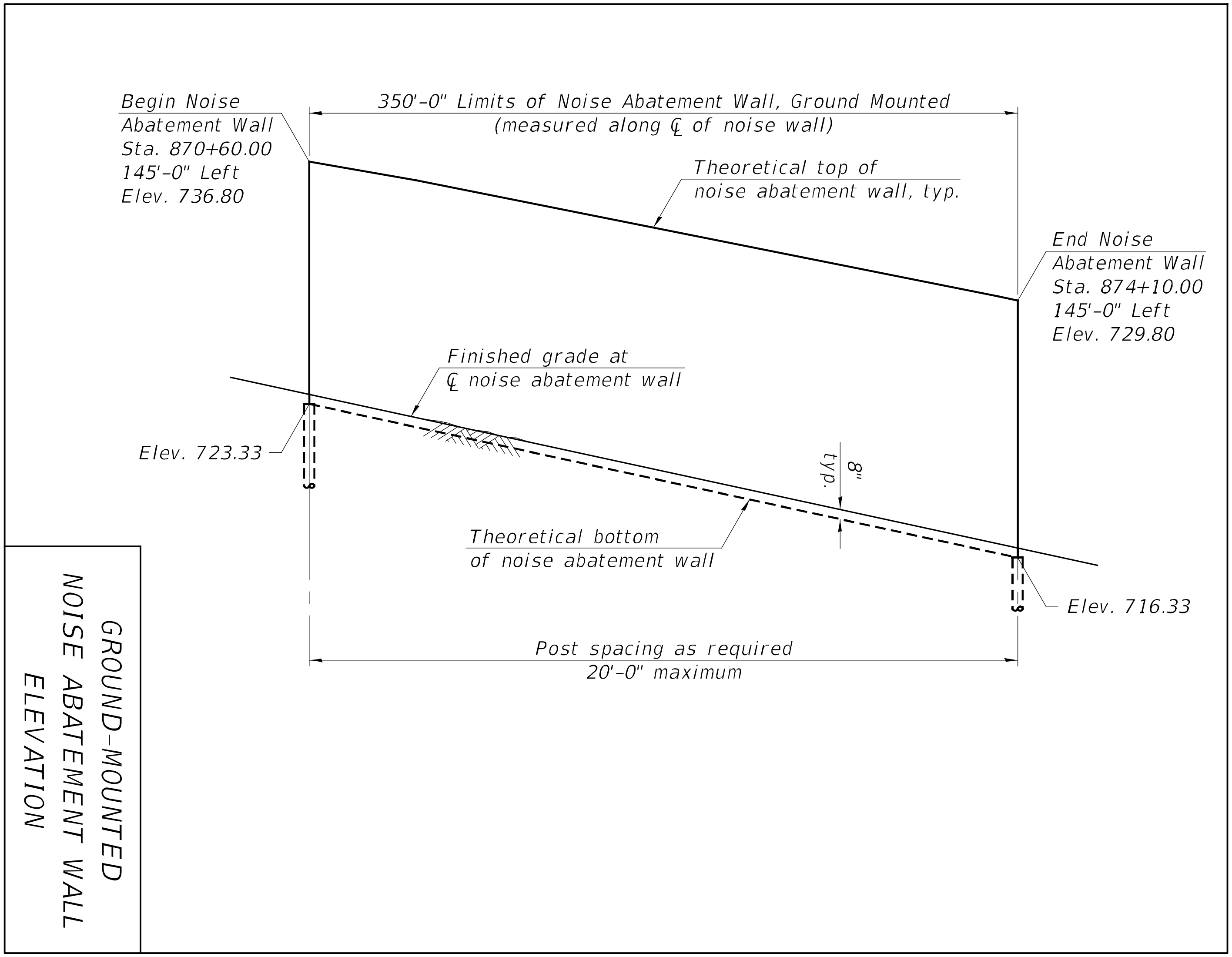
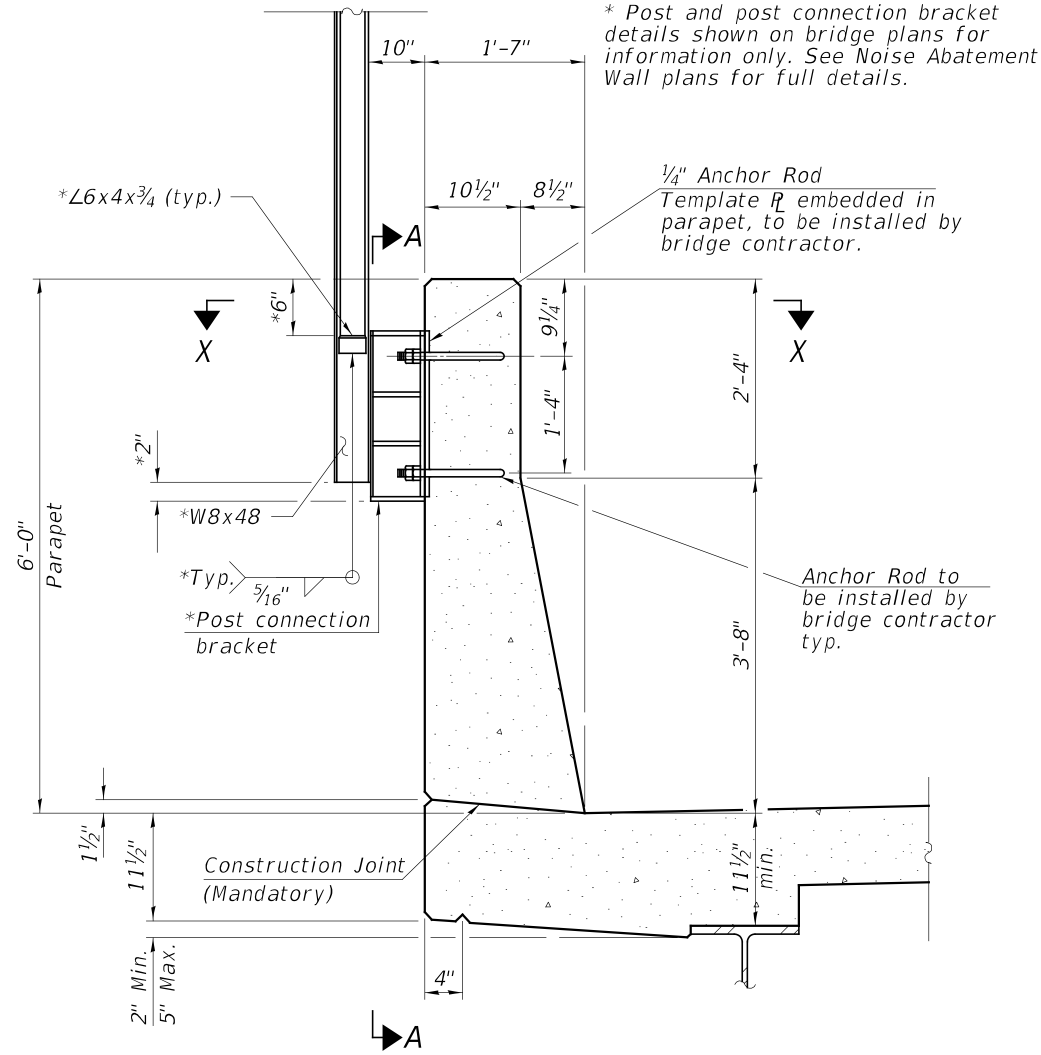


Figure 3 (ABD 22.7)

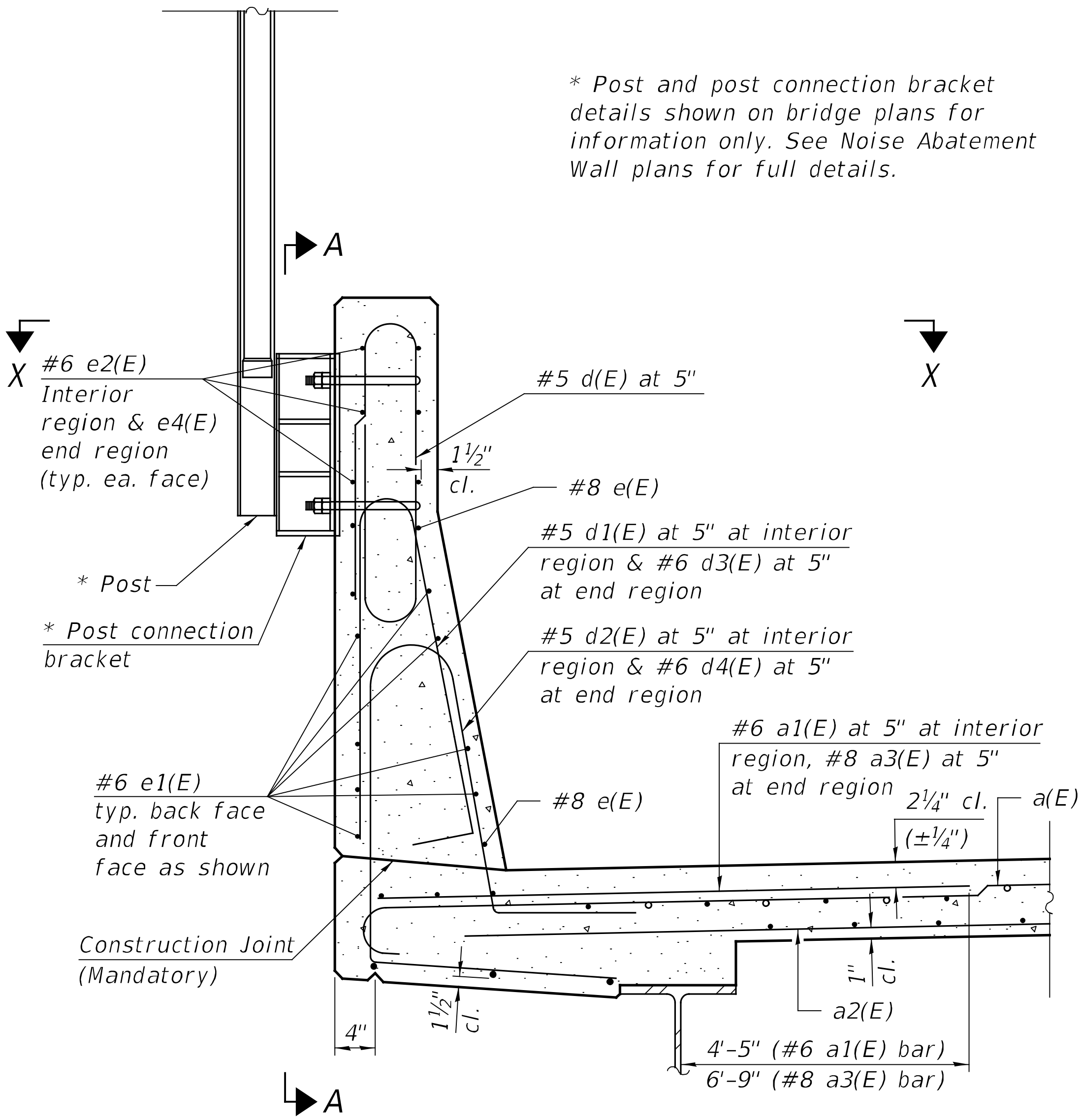


Notes:

1. Steel post maximum spacing is 11 ft. 8 in.
2. Maximum wall height is 18'-0", measured from the top of deck elevation at the front face of the parapet.
3. Slipforming of the parapet is not allowed.
4. For Section X–X, See Figure 12.
   For Section A–A, See Figure 13.
5. Cost of four anchor rods, template plate, and associated hardware included in the unit cost for one each of Noise Abatement Wall Anchor Rod Assembly

NOISE ABATEMENT WALL STRUCTURE MOUNTED ON BRIDGE CONFIGURATION

Figure 4 (ABD 22.7)



Notes:

1. End regions are areas within 15' of full height aluminum joints or ends of parapet. All other areas are interior regions.

NOISE ABATEMENT WALL STRUCTURE MOUNTED ON BRIDGE DECK AND PARAPET REINFORCEMENT

Figure 5 (ABD 22.7)

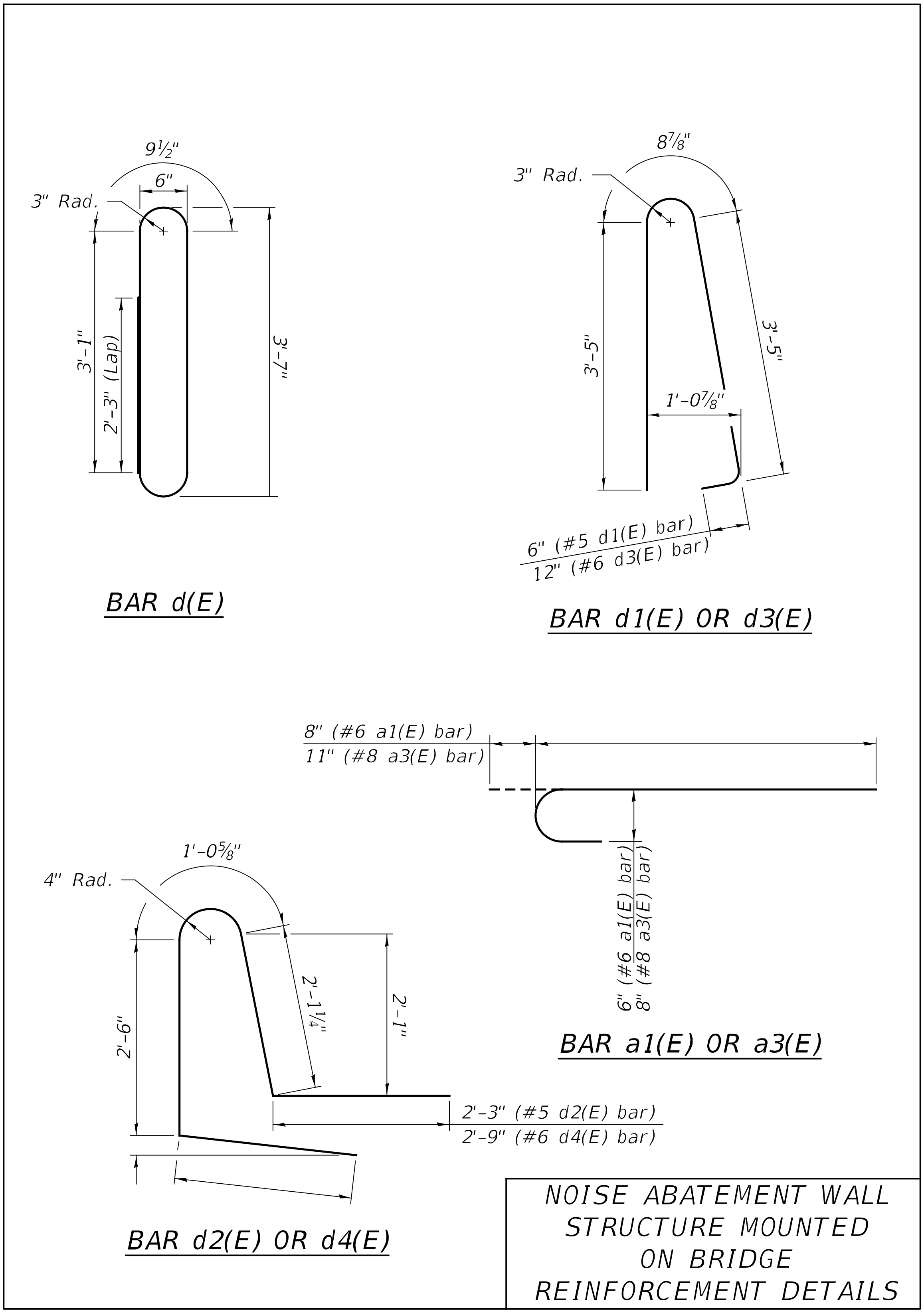


Figure 6 (ABD 22.7)

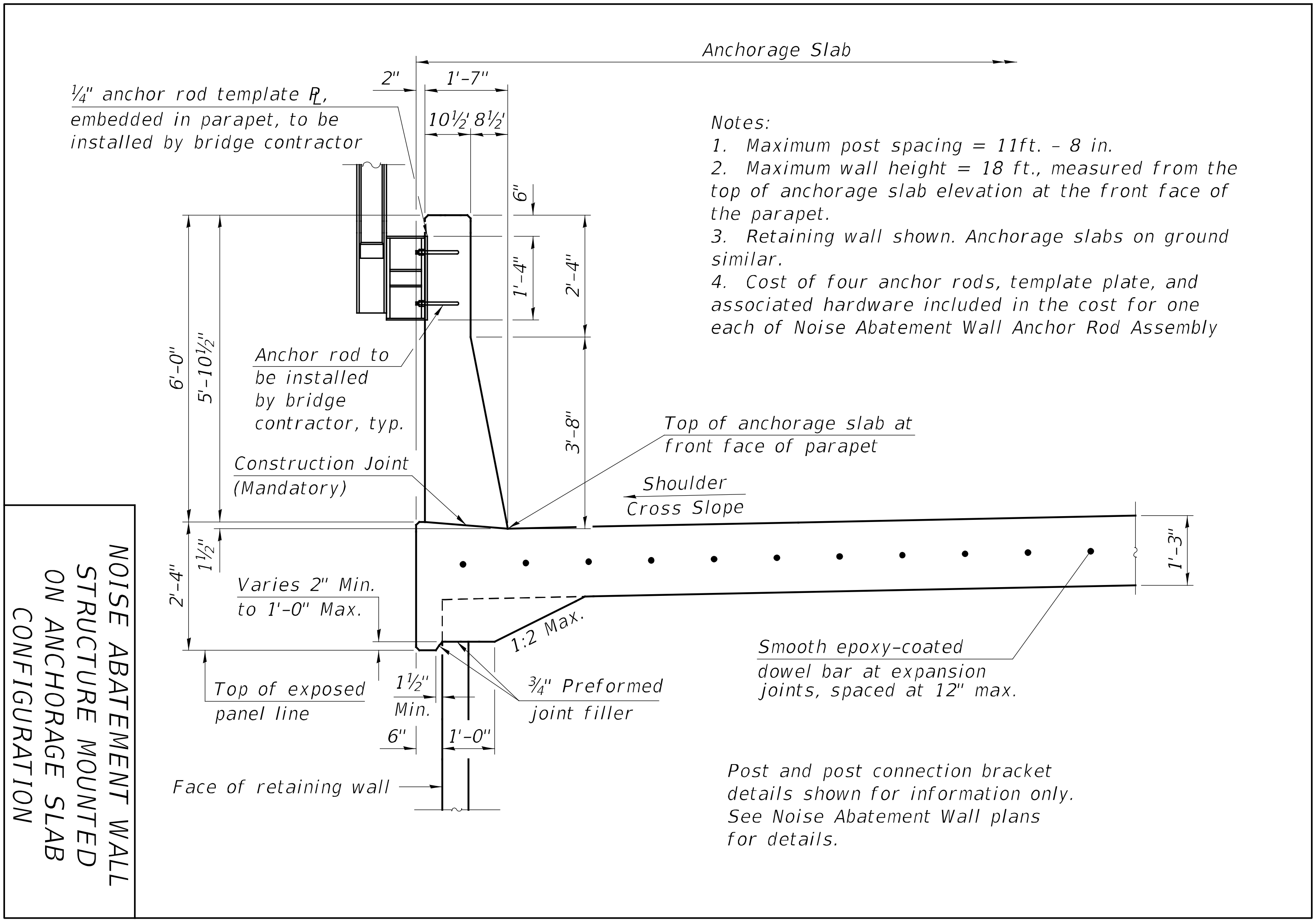


Figure 7 (ABD 22.7)

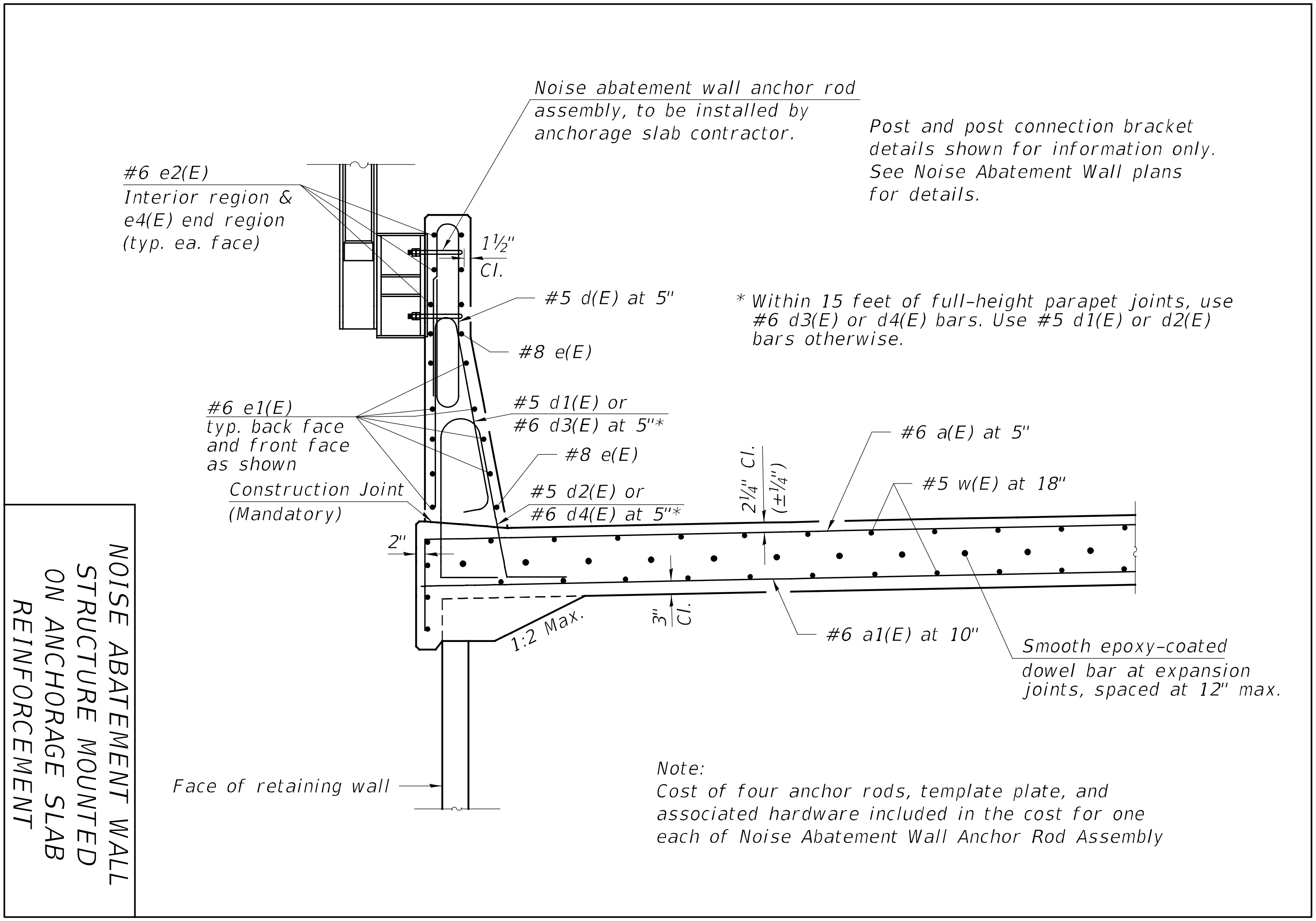


Figure 8 (ABD 22.7)

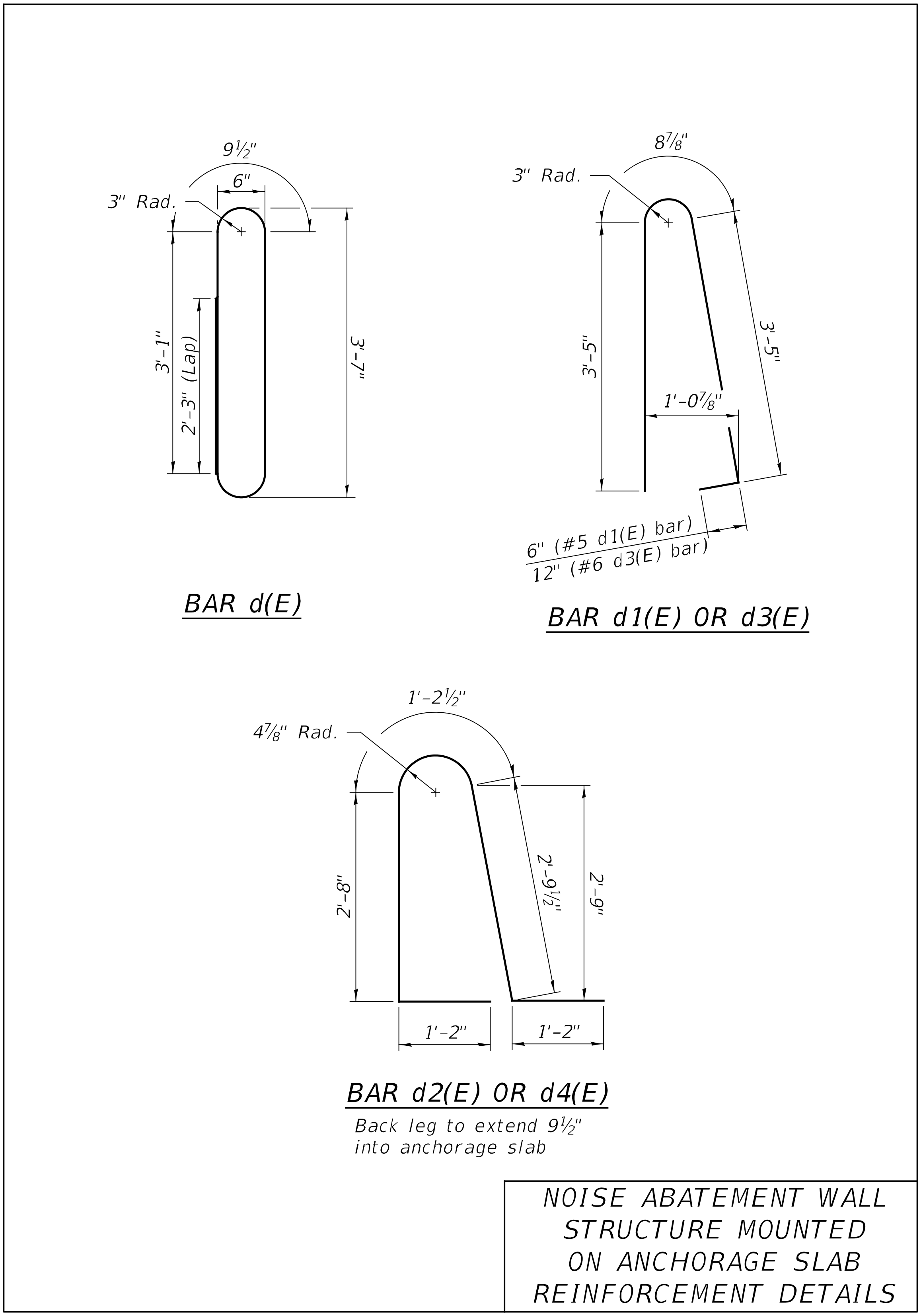
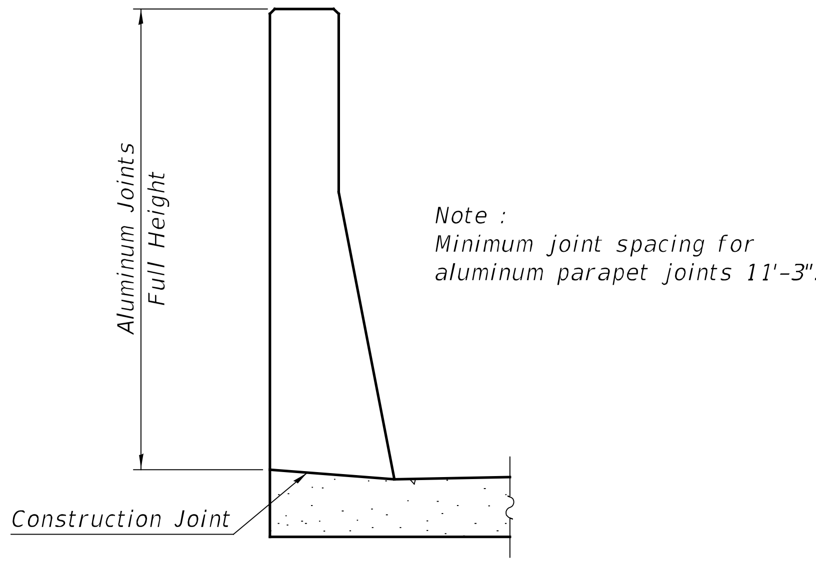
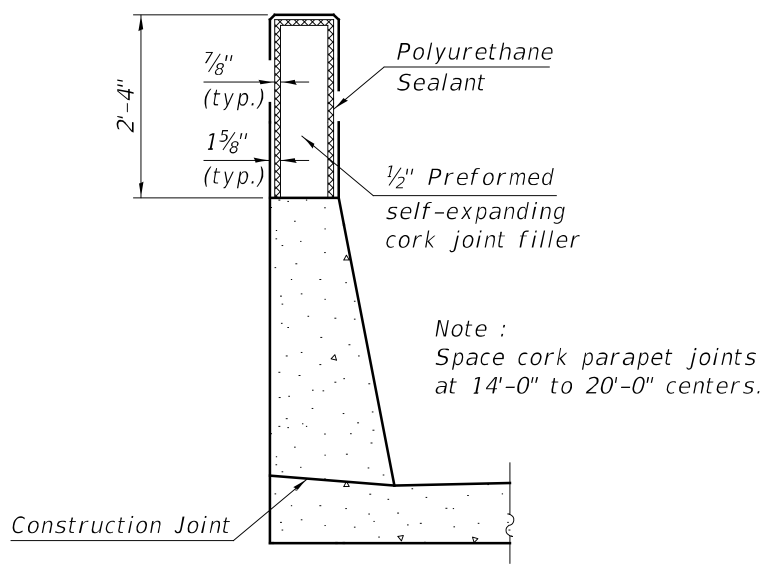


Figure 9 (ABD 22.7)



ALUMINUM PARAPET JOINT DETAILS



CORK PARAPET JOINT DETAILS

Notes:

1. The 1/8" aluminum sheet shall be ASTM B 209 alloy 3303-H14 and coated to minimize reaction with wet concrete. Cost included with Concrete Superstructure.

2. The polyurethane sealent shall be according to Article 1050.04 of the Std. Spec. and the color shall be gray.

NOISE ABATEMENT WALL
STRUCTURE MOUNTED
PARAPET JOINT DETAIL

Figure 10 (ABD 22.7)

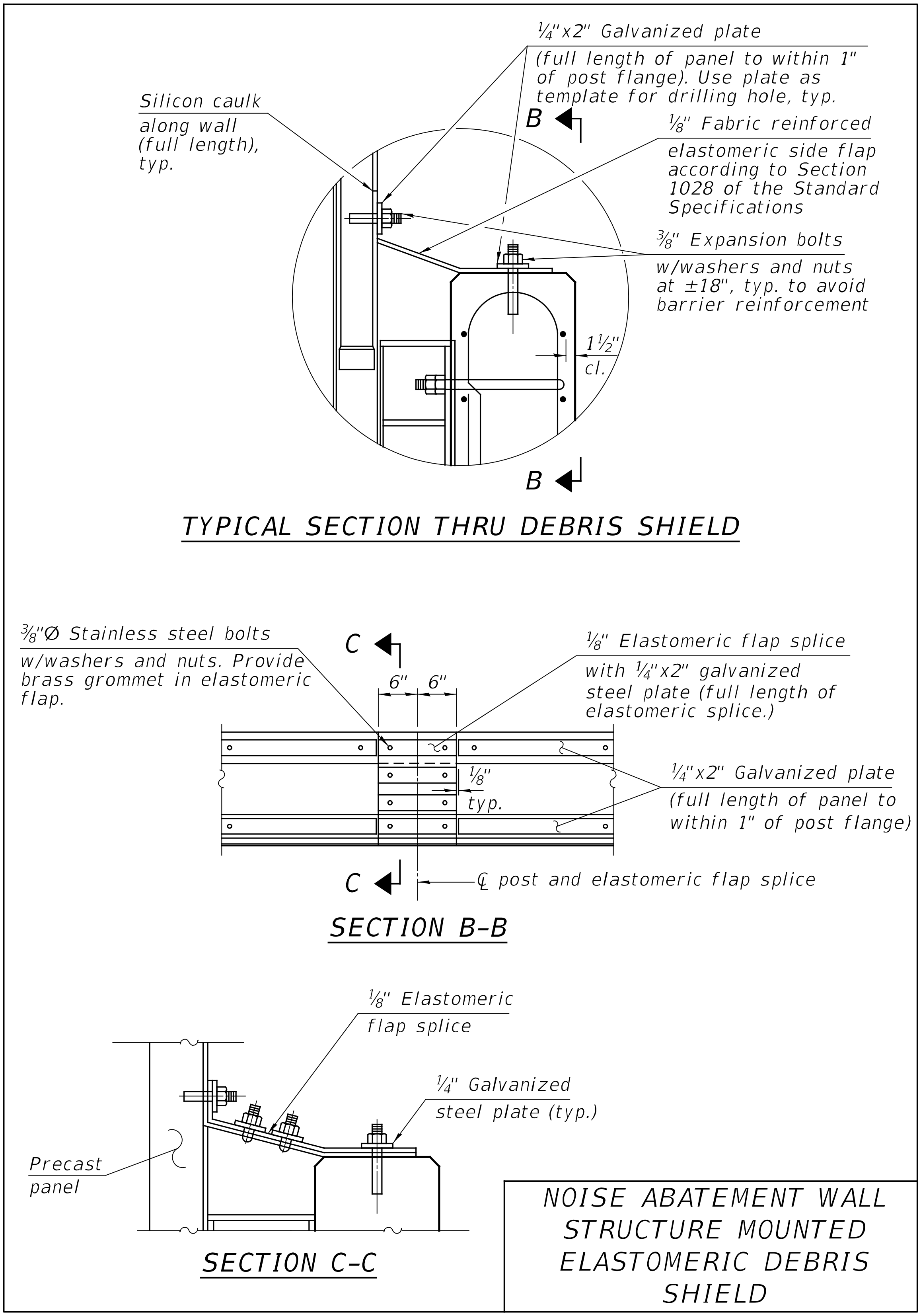


Figure 11 (ABD 22.7)

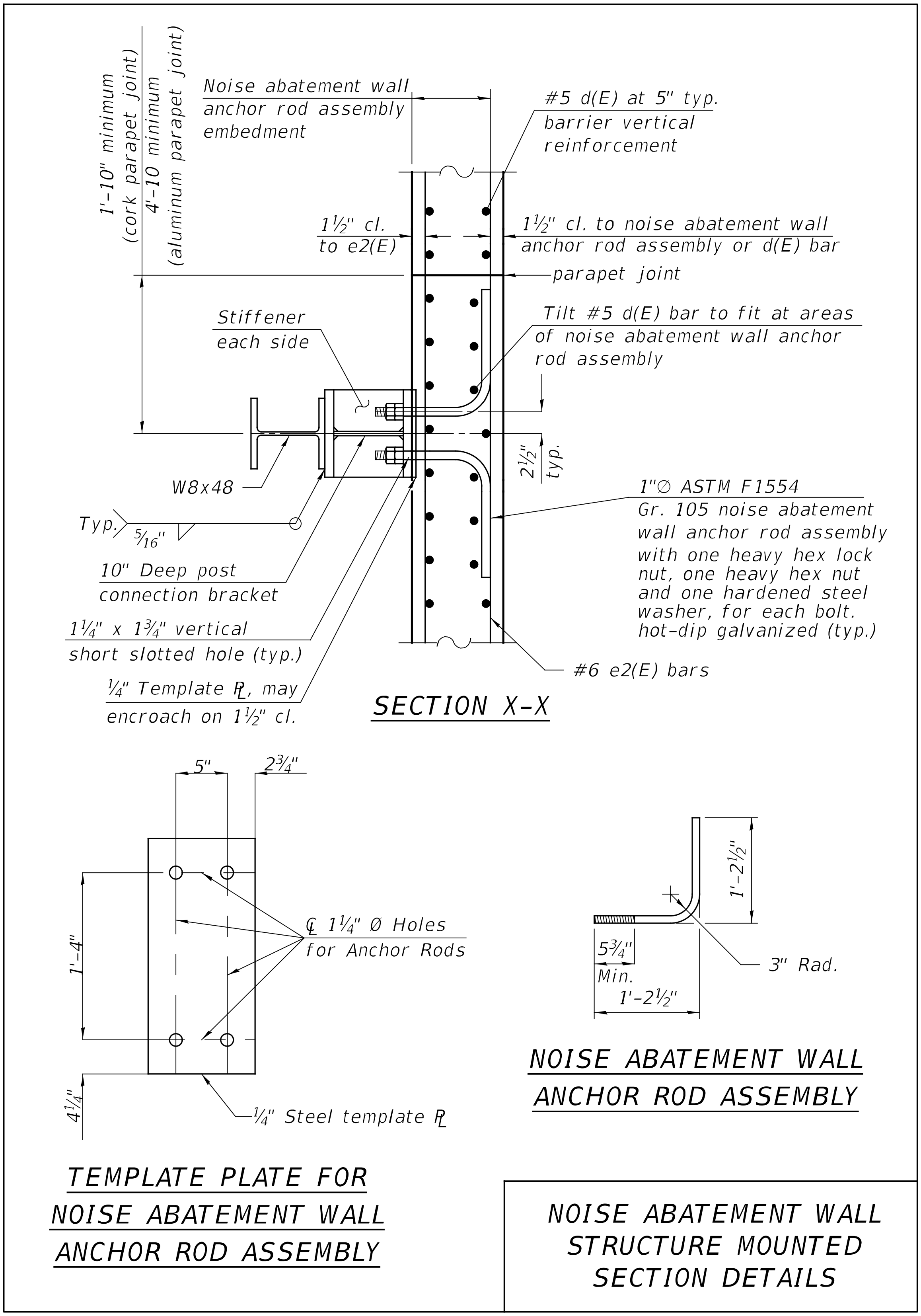
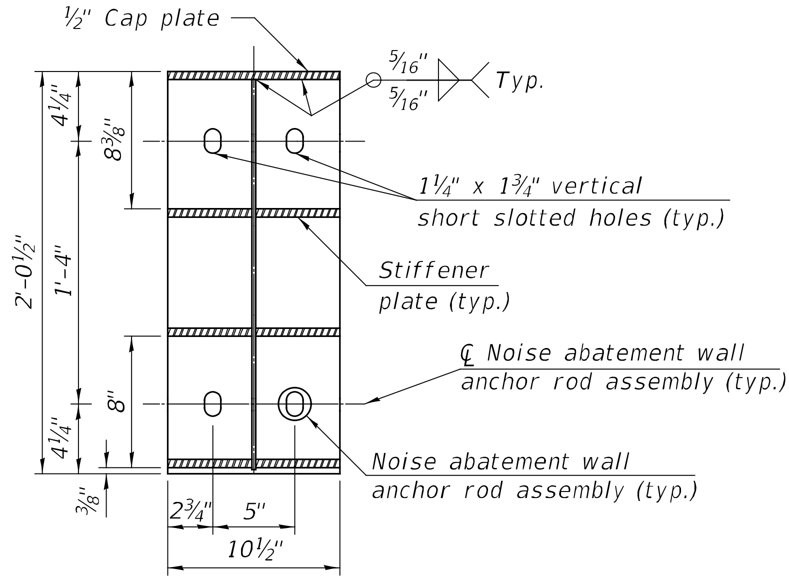
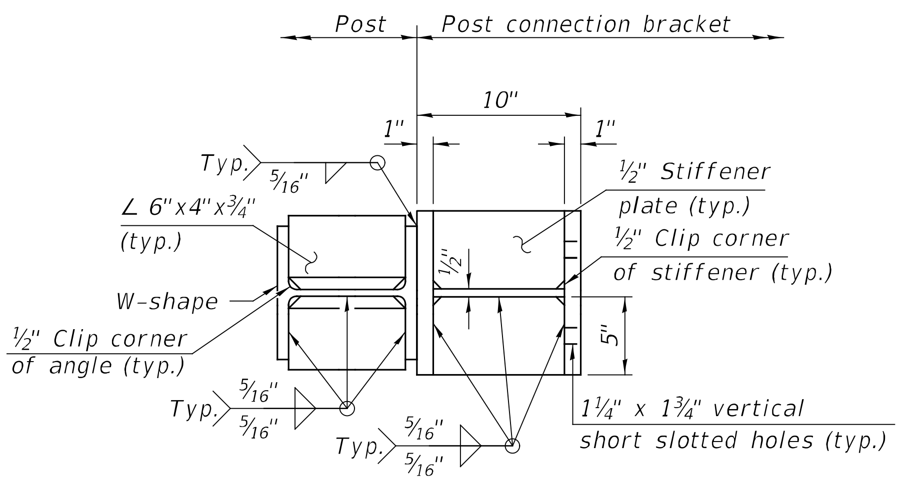


Figure 12 (ABD 22.7)



SECTION A-A

(Showing post connection bracket)



SECTION THRU POST AND
POST CONNECTION BRACKET

(Template ℞ not shown for clarity)

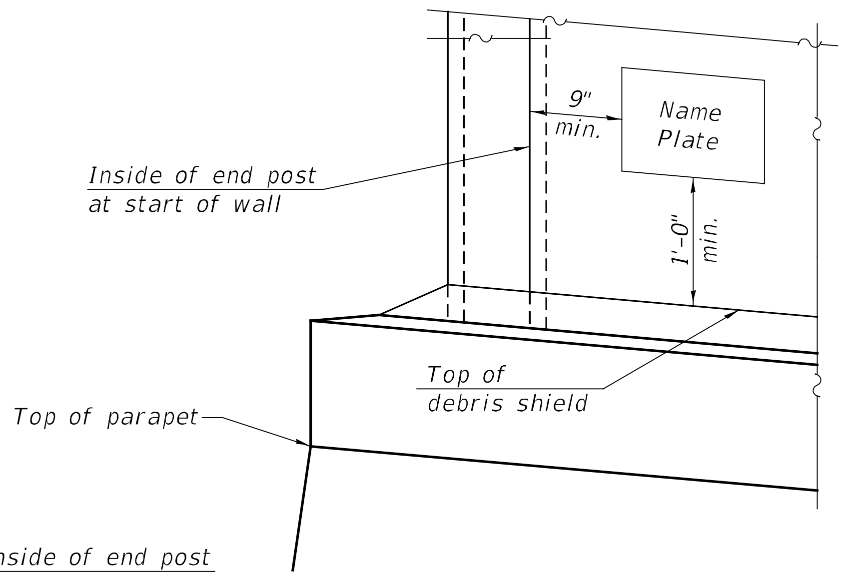
NOISE ABATEMENT WALL
STRUCTURE MOUNTED
SECTION DETAILS

Figure 13 (ABD 22.7)

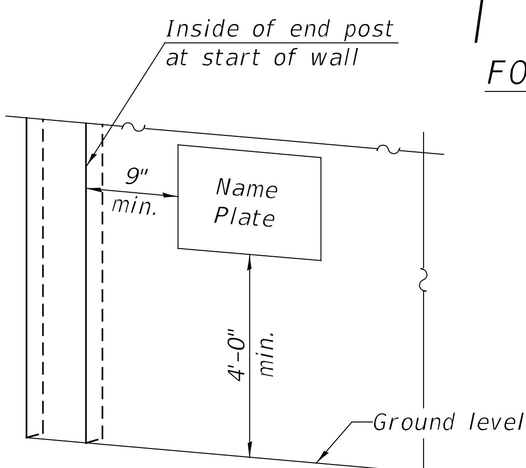
NOISE ABATEMENT WALL
BUILT (YEAR) BY
STATE OF ILLINOIS
(ROUTE NO. OR LOCAL AGENCY STREET NAME)
(SECTION NO.)
FROM STA. (STA. NO.) TO STA. (STA. NO.)
STRUCTURE NO. (STR. NO.)

NAME PLATE

Items in parentheses to be added by designer.
Refer all Name Plates to Highway Standard 515001.



FOR NOISE ABATEMENT WALL, STRUCTURE MOUNTED



FOR NOISE ABATEMENT WALL, GROUND MOUNTED

NAME PLATES
FOR NOISE
ABATEMENT WALLS

Figure 14 (ABD 22.7)

Illinois Department of Transportation
Memorandum

To: ALL BRIDGE DESIGNERS 22.6

From: Jayme F. Schiff

Subject: IDOT Seismic Manual Update — Plan Detail Requirements

Date: October 7, 2022

This memorandum introduces the Plan Detail Requirements section to the Seismic Manual. The details herein shall be applicable to all structures being designed using a displacement-based design approach.

One goal of the Seismic Manual is to house details required for a displacement-based design approach in a separate document from those required for a force-based design approach. The details herein have been derived from the Guide Specifications for LRFD Bridge Seismic Design, are specific to a displacement-based approach, and therefore should not be used for bridges designed using a force-based approach without prior approval from the Bureau of Bridges and Structures. Examples of details that would be approved include support length requirements and abutment backfill details, as these details are not specific to one design paradigm.

The Department intends to incorporate displacement-based seismic design on bridges with Type, Size, and Location plans approved September 1, 2023, and later. Due to the amount and complexity of required design changes, and the effects these changes may have on preliminary design, this date may be extended on a project-by-project basis.

The Seismic Manual is found in the "Design" tab, under Specific Scope of Services on the primary IDOT-Bureau of Bridges and Structures website at https://idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/index#Bridges.

The policy and details herein are subject to review. The Seismic Manual is intended to provide direction and documentation for all forthcoming seismic policy. Bridge designers are encouraged to review the forthcoming policy and forward any questions or comments to Mark Shaffer, Policy, Standards, and Final Plan Control Unit Chief, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov. Incorporation of comments will occur when future sections are added.

MDS/kktABD22.6-20221007

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	22.5
From:	Jayme F. Schiff	
Subject:	Railing Library Update	
Date:	September 30, 2022	

Jayme F. Schiff

In the Fall of 2021, the Department issued several new and updated bridge railings to comply with the 2016 AASHTO Manual for Assessing Safety Hardware (MASH). MASH testing and evaluations have continued, and this memorandum summarizes the latest status of select railings in our Railing CADD Cell Library. Please note that railings which have been removed and archived may still be requested for projects if a suitable MASH Test Level railing is not available and when approved by the Bureau of Bridges and Structures.

R-23A (Type S-1): This railing has been removed and archived. It is geometrically and structurally deficient for MASH Test Level 1. The R-34 (Type SM) is MASH Test Level 2 and is suggested as a suitable alternative.

R-24A (Type T-1): This railing has been removed and archived. The curb component and connection are not recommended. The MASH Test Level 2, R-34CWSC (Type SM) railing is a similar side mounted railing with curb and is suggested as a suitable alternative.

R-25 Steel Railing (Temporary): This railing has been removed and archived. It is very similar to the Type S-1 railing except it is top mounted. Therefore, it is considered geometrically and structurally deficient for any MASH Test Level requirements. Past usage data indicates that this railing is only used for rare, staged construction projects where there is not adequate space for a temporary concrete barrier and drilling into the concrete deck is allowed.

Should a project require a top-mounted temporary steel railing, details for the TxDOT T631 Bridge Railing are available at https://www.roadwayspecialties.com/pdf/rlstd038-18.pdf and the crash test report is available at https://www.roadsidepooledfund.org/longitudinal-barrier/txdot-t631-bridge-rail-2/. The TxDOT T631 Bridge Railing is crash tested to a MASH level 3. Due to the low usage of the R-25 railing, the Department is not currently maintaining standard details for this railing type. If it is shown that there is sufficient demand for this railing type, the Department will create and maintain standard details.

R-26 (Type TP-1): This railing has been removed and archived. The railing is mounted on an open sidewalk and has deficient geometry. The R-28 (Bridge Fence Railing) and R-32 (Bridge Fence Railing, Curved) are suitable alternative railings on an open sidewalk.

R-28 (Bridge Fence Railing): This railing has been updated. An expansion splice was added for the handrail to provide a continuous railing per ADA requirements and details were updated through discussions with fabricators. Similar railings are currently being evaluated for MASH. The Department anticipates that a MASH Test Level designation will be provided next year, but until then this railing may continue to be used on applicable projects.

R-29 (Bicycle Railing and Parapet Railing): The parapet railing was recently successfully crash tested for MASH Test Level 4 subject to the new modifications at the expansion splice. Drafting and related details were also updated. The bicycle railing has remained similar. It does not require a MASH evaluation since it is behind the combination parapet and parapet railing.

R-30 (Type WT): This railing has been removed and archived. It is geometrically and structurally deficient for MASH. The R-34HMAWS (Type SM) is a similar side mounted railing for HMA wearing surfaces. It is MASH Test Level 2 and is suggested as a suitable alternative.

R-31 (Type 2399): This railing has been removed and archived. It has been replaced with R-42 (Type CO-10) which is MASH Test Level 4.

R-32 (Bridge Fence Railing, Curved): This railing has been updated similar to R-28 and the Department anticipates a MASH Test Level designation will be provided next year. Until then, this railing may continue to be used on applicable projects.

R-33 (Bicycle Railing, Curved and Parapet Railing): This railing has been updated similarly to R-29. The parapet railing satisfies MASH Test Level 4. Drafting and related details were also updated. The railing “Bicycle Railing, Curved” has remained similar. It does not require a MASH evaluation since it is behind the combination parapet and parapet railing.

R-39 (Bicycle Railing, Parapet): This railing has been removed and archived. The MASH Test Level 4 parapet railing as detailed on the R-29 and R-33 railings has replaced this railing for both new and existing conditions when required.

Implementation
The revised Railing CADD Cell Library base sheets dated 9-1-2022 shall be effective for all applicable projects with Type, Size and Location (TSL) plans approved after September 1, 2022 and may also be implemented for projects currently under design as determined by the District. Please direct questions to Mark Shaffer of the Policy, Standards and Final Plan Control Unit Chief, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

KLR/kktABD22.5-20220930

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	22.4
From:	Jayme F. Schiff	Jayme F. Schiff
Subject:	Seismic Manual Announcement	
Date:	September 2, 2022	

The AASHTO LRFD Bridge Design Specifications currently include a seismic design method known as force-based design. In accordance with these specifications, seismic structural design and detailing policies in the Bridge Manual utilize this method of design. A second design method known as displacement-based design is currently found in the AASHTO Guide Specifications for LRFD Seismic Bridge Design.

Displacement-based design is the only method currently being modified by AASHTO and is expected to replace force-based design in forthcoming AASHTO updates. Displacement-based design is required to be used when other documents such as the AASHTO Guidelines for Performance-Based Seismic Design and AASHTO Guide Specifications for Seismic Isolation Design are used. Therefore, it is prudent for the Department to begin utilizing this method of design.

In anticipation of displacement-based design becoming the preferred method of seismic design used in Illinois, IDOT has begun developing new seismic design and detailing criteria for this method. The seismic design and detailing criteria required for displacement-based design have many differences when compared to the criteria used in force-based design. Because of the large number of differences, and the need for clarity and separation of the two design methodologies, IDOT has chosen to adopt future seismic design and detailing policy into a separate document, known as the Seismic Manual. Use of a separate document to keep seismic design policy will also allow this manual to be updated on a regular basis. These updates will be accompanied with All Bridge Designers Memoranda.

The Seismic Manual will not be populated all at once, but rather will be constructed via a series of All Bridge Designers Memoranda.

This manual will contain most forthcoming seismic policies. Some policies, such as liquefaction analysis, or evaluation of existing structures during Bridge Condition Reports, are more appropriately placed in the manuals associated with their use (e.g. Geotechnical Manual). References to these manuals will be made in the Seismic Manual.

The following is a preliminary outline of the Seismic Manual:

1. Introduction
2. Engineering Design Parameters
3. Design Hazards
4. Planning Structure Types
5. Analysis Procedures
6. Modeling Assumptions
7. Design Requirements
8. Plan Detail Requirements
9. Retrofitting of Existing Bridges
10. Design Guide

The IDOT Bridge Manual will contain all policy regarding force-based design until such time that it is determined that it is no longer required to be maintained.

The Department intends to incorporate displacement-based design on bridges with Type, Size, and Location plans approved September 1, 2023 and later. Due to the amount and complexity of required design changes, and the effects these changes may have on preliminary design, this date may be extended on a project-by-project basis. Type, Size, and Location plans will state which document the designer will be required to use (AASHTO LRFD Bridge Design Specifications for force-based design, AASHTO Guide Specifications for LRFD Seismic Bridge Design for displacement-based design).

Please direct questions to Mark Shaffer, Policy, Standards, and Final Plan Control Unit Chief, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

MDS/kktABD22.4-20220826

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS 22.3 (REV)
From:	Jayme F. Schiff
Subject:	High Load Multi-Rotational Pot and Disc Bearing Base Sheets
Date:	August 26, 2022 (Revised December 12, 2023)

The Prequalified Structural System List for High Load Multi-Rotational (HLMR) bearings currently includes two different types: pot and disc bearings. Owners and designers have often questioned when each type should be used, and the differences in detailing requirements between the two. To better clarify HLMR bearing policy and improve plan consistency, IDOT has developed base sheets for each bearing type. This memorandum introduces base sheets for fixed, guided expansion, and non-guided expansion pot and disc bearing types.

HLMR bearings support high loads and are able to rotate in any direction. They typically are necessary for long span or unique structures. They are suited for bearing designs beyond the limitations of the standard elastomeric bearings shown in the Bridge Manual. If a curved bridge is equivalently straight or bearing locations on curved bridges will result in lateral movements not exceeding the movement capacity of standard elastomeric bearings, then standard elastomeric bearings may be used. For curved bridges that are not equivalently straight or when the elastomeric bearing movement capacity is exceeded, HLMR bearings shall be required for structures designed for curvature.

HLMR Bearing Type and Class

The HLMR Bearing types (Pot or Disc) can be divided into one of three classes based on its expansion requirements. The three classes of HLMR bearings are: Fixed, Guided expansion, and Non-Guided expansion. Fixed and guided expansion HLMR bearings are analogous to fixed bearings and elastomeric bearings with side retainers and are used in similar scenarios. A non-guided expansion HLMR bearing is similar to an elastomeric bearing without a side retainer and is applicable in cases where both longitudinal and lateral displacements are required to be accommodated, such as very wide structures, some curved structures, or structures with large lateral seismic displacements.

The details shown herein are readily available from suppliers on the Qualified Producer List (QPL). The base sheet details have been thoroughly vetted and should result in better serviceability than alternate details. Because of unknown availability and potential serviceability issues, alternate bearing types such as inverted bearings or center-guided bearings are not allowed.

Figures 1, 2, 3, and 4 present an illustrative example of typical plan details for a fixed, guided expansion, and non-guided expansion pot bearing, respectively.

Figures 5, 6, and 7 present an illustrative example of typical plan details for a fixed, guided expansion, and non-guided expansion disc bearing, respectively.

Figures 1 through 7 shall replace Bridge Manual Section 3.7.5 HLMR bearing figures 3.7.5-1 and 3.7.5-2.

Base sheets for each bearing type and class are now available.

HLMR Bearing Dimensions

The dimensions used for pot bearings are:

D = Base Cylinder Diameter, inch
L_b = Masonry Plate Length, inch
L_p = Transverse Piston Diameter, inch
L_t = Sole Plate Length, inch
T_b = Masonry Plate Thickness, inch
T_h = Bearing Assembly Total Height, inch
T_t = Sole Plate Thickness, inch
W_b = Masonry Plate Width, inch
W_t = Sole Plate Width, inch

The dimensions used for disc bearings are:

D_d = Disc Diameter, inch
D_{db} = Bottom Disc Plate Diameter, inch
D_{dt} = Top Disc Plate Diameter, inch
L_d = Transverse length of the top disc plate for fixed bearings or disc diameter for expansion bearings, inch
T_b = Masonry Plate Thickness, inch
T_h = Bearing Assembly Total Height, inch
T_t = Sole Plate Thickness, inch
W_b = Masonry Plate Width, inch
W_t = Sole Plate Width, inch

Dimensions L_p and L_d will equal the diameter value for either the piston or top disc plate, respectively. The “L” nomenclature dimensions are meant to be analogous to the L_e dimension shown in Bridge Manual Figure 3.7.4-21.

HLMR Bearing Selection

The HLMR bearing and its components will be designed by the bearing manufacturer to meet the project specific requirements provided in the Design Data table on the plans and the AASHTO LRFD Bridge Design Specifications. The bridge designer shall contact the bearing manufacturer when selecting the bearing size to meet the design requirements.

Pot bearings shall be shown on the plans for vertical load capacities less than 300 kips and disc bearings shall be shown on the plans for vertical load capacities equal to and greater than 300 kips. However, if pot and disc bearings are required on the same structure, it is recommended to detail disc bearings at the pot bearing locations for economy. Elastomeric bearings may be used in addition to HLMR bearings on the same structure provided the same bearing type is used across the same substructure unit.

HLMR Bearing Design

Manufacturer literature for the Department's Prequalified List for HLMR Bearing manufacturers may be found on the IDOT web site at Prequalified Structural Systems under Find Your List. This list also states which manufacturers are pre-approved for pot bearings, disc bearings, or both.

The bridge designer shall calculate the Service I Factored Vertical Reaction to determine the type of HLMR bearing – pot or disc – to use. The bridge designer shall calculate the Maximum Strength or Extreme Event Lateral Reaction. The bridge designer shall determine rotations and movement using AASHTO 14.4.2.2 and the current AASHTO / NSBA Steel Bridge Collaboration "Steel Bridge Bearing Design and Detailing Guidelines".

For each bearing size, type, and class on a bridge, the bridge designer shall evaluate bearing manufacturer literature from the Prequalified List to determine the appropriate bearing depth, and pot and piston outside diameter (pot bearings) or disc diameter and disc plate diameters (disc bearings). These dimensions shall be chosen based upon the Service I Factored Vertical Reaction shown in the Design Data table shown on the plans.

Article C14.6.1 of the AASHTO LRFD Bridge Design Specifications states that bearings loaded to less than 20 percent of their vertical capacity require special design. This occurs when the ratio of dead loads to live loads is very small. Therefore, when choosing a bearing size, bridge designers shall verify that the Unfactored Dead Load Vertical Reaction is not less than 20 percent of the Service I Factored Vertical Reaction:

$$\frac{\text{Unfactored Dead Load Vertical Reaction}}{\text{Service I Factored Vertical Reaction}} > 0.2$$

The bridge designer shall also verify that there is not any uplift at the bearing location due to Service I Factored Live Loads:

$$\text{Service I Factored Vertical Reaction} > 0$$

If either of these conditions are encountered and cannot be avoided by choosing a different bearing size, the bridge designer shall provide a vertical restraint at the bearing location to prevent uplift. These vertical restraints are typically in the form of horizontal tabs or clamps extending from the Masonry Plate over the top of the bottom flange. Bearing suppliers are aware of this issue and have their own supplier-specific and bearing-specific details. Therefore, details for vertical restraints are not included on the base sheets. Vertical restraints shall be shown on the plans when required.

The bridge designer shall determine required dimensions of the Sole Plate and Masonry Plate for the plate dimensions and loads assumed in design. The bridge designer shall detail the bevel slope of the Sole Plate, if required. See "Sole and Masonry Plate Dimensions" of this memorandum for more information.

The bridge designer should evaluate as many manufacturers' bearing literature as feasible and choose the bearing with the largest bearing height for the type and vertical capacity required. The overall bearing height and plate thicknesses stated on the contract plans shall be chosen such that more than one manufacturer is capable of bidding on the project.

The design of HLMR bearing components will be the responsibility of the bearing manufacturer in accordance with AASHTO based on the parameters outlined below.

The bearing will be designed by the supplier for the exact parameters specified in the Design Data table. The load value specified in the pay item name is an approximate vertical load capacity that is used for letting and bidding purposes only. See "Plan Presentation" and "Completing the Bill of Material" sections of this memorandum.

The Maximum Strength or Extreme Event Lateral Reaction will be used by the bearing manufacturer to design required bearing components such as guide bars, pot thicknesses, etc. Due to this, details provided by the bearing manufacturer such as Sole and Masonry Plate dimensions may be slightly larger to account for the additional lateral loads. These slightly larger details should not be expected to be so large that the Sole and Masonry Plate thicknesses determined by the bridge designer will be inadequate. The bearing manufacturer may refine the dimensions of the Sole Plate and Masonry Plate when designing the bearing.

Upon receipt of the shop drawings, the bridge designer shall verify the Sole and Masonry Plate thicknesses shown on the shop drawings. The supplier has the option of recessing various elements, such as pistons and pots, into the Sole and Masonry Plates. When this occurs, the minimum plate thicknesses shall be verified against the thickness of the plate in the location of the recess.

The bearing plate lengths, widths, and thicknesses prescribed by this memorandum are intended to be used as guidance for achieving a similar bearing in cost and overall depth by all suppliers. It also assists the designer in determining the seat elevation and construction gap necessary for the bearing. However, the lengths and widths of the bearing plates actually provided by the supplier may vary substantially from those shown on the contract plans. These variances, used in conjunction with the plate thickness formulas prescribed by this memorandum, may result in substantial variances in plate thicknesses. When checking shop drawings for HLMR bearings, plate lengths and widths provided on shop drawings may vary, but plate thicknesses thinner by more than 25% of those shown on the contract plans should be returned with a comment requesting verification.

The bridge designer shall be responsible for the design of the threaded studs of the Sole Plate to flange connection and anchor bolts.

Sole and Masonry Plate Dimensions

Masonry Plate dimensions assume a 2 inch minimum edge distance for anchor bolts. This is based upon the minimum edge distance for a 1 ½ inch diameter anchor bolt according to Table 6.13.2.6.6-1 of the AASHTO LRFD Bridge Design Specifications. If a different anchor bolt size / edge distance is used, the equations below for L_b shall be modified for the given edge distance. For Masonry Plates with anchor bolts with diameters greater than 1 ½ inch, the edge distance shall be increased according to the minimum edge distance requirements found in the AASHTO specification.

In the plate dimension equations below, 2 inches is allowed between the edge of Sole Plate and the line of anchor bolts in the Masonry Plate. If a different spacing is used, the equations below for L_b shall be modified for the given spacing between the Sole Plate and the line of anchor bolts.

The calculations for L_t, W_t, L_b and W_b are minimum dimensions. The dimensions may be adjusted if other factors dictate.

Plate thicknesses Tt and Tb shall be determined according to top and bottom bearing plate equations found on Bridge Manual Figure 3.7.4-21.

Fixed Pot Bearings: The dimensions of the Sole Plate on a fixed pot bearing (Figure 1) shall be:

$$L_t = D + 2\left(\frac{1}{2}\text{ in.}\right)$$

$$W_t = D + 2\left(\frac{1}{2}\text{ in.}\right) + 1\text{ in.}$$

The dimensions of the Masonry Plate on a fixed pot bearing (Figure 1) shall be:

$$L_b = L_t + 2(2\text{ in.}) + 2(2\text{ in.})$$

$$W_b = D + 2\left(1\frac{1}{4}\text{ in.}\right)$$

Guided Expansion Pot Bearings: The dimensions of the Sole Plate on a guided expansion pot bearing (Figure 2 and 3) shall be:

$$L_t = D + 2\left(\frac{1}{2}\text{ in.}\right) + 2\left(\frac{1}{16}\text{ in.}\right) + 2\left(1\frac{3}{4}\text{ in.}\right) + 2(1\text{ in.})$$

$$W_t = L_t + 1\text{ in.}$$

The dimensions of the Masonry Plate on a guided expansion pot bearing (Figure 2 and 3) shall be:

$$L_b = L_t + 2(2\text{ in.}) + 2(2\text{ in.})$$

$$W_b = D + 2\left(1\frac{1}{4}\text{ in.}\right)$$

Non-Guided Expansion Pot Bearings: The dimensions of the Sole Plate on a non-guided expansion pot bearing (Figure 4) shall be:

$$L_t = D + 2\left(\frac{1}{2}\text{ in.}\right) + 2\left(1\frac{1}{2}\text{ in.}\right)$$

$$W_t = L_t + 1\text{ in.}$$

The dimensions of the Masonry Plate on a non-guided expansion pot bearing (Figure 4) shall be:

$$L_b = L_t + 2(2\text{ in.}) + 2(2\text{ in.})$$
$$W_b = D + 2\left(1\frac{1}{4}\text{ in.}\right)$$

For pot bearings, to determine Sole Plate thickness, T_t, the transverse dimension of the pot, dimension L_p, shall be substituted for the variable L_e.

To determine Masonry Plate thickness, T_b, the outside diameter of the base cylinder, dimension D, shall be substituted for the variable L_e.

<u>Fixed Disc Bearings</u>: The dimensions of the Sole Plate on a fixed disc bearing (Figure 5) shall be:

$$L_t = D_{dt} + 2\left(1\frac{1}{2}\text{ in.}\right)$$
$$W_t = D_{dt} + 2\left(1\frac{1}{2}\text{ in.}\right) + 1\text{ in.}$$

The dimensions of the Masonry Plate on a fixed disc bearing (Figure 5) shall be:

$$L_b = L_t + 2(2\text{ in.}) + 2(2\text{ in.})$$
$$W_b = D_{db} + 2(1\text{ in.})$$

To determine T_t, the diameter of the top disc plate, dimension D_{dt}, shall be substituted for the variable L_e.

To determine Masonry Plate thickness, T_b, the diameter of the bottom disc plate, dimension D_{db}, shall be substituted for the variable L_e.

<u>Guided Expansion Disc Bearings</u>: The dimensions of the Sole Plate on a guided expansion disc bearing (Figure 6) shall be:

$$L_t = D_{dt} + 2\left(\frac{1}{16}\text{ in.}\right) + 2\left(1\frac{3}{4}\text{ in.}\right) + 2(1\text{ in.})$$
$$W_t = L_t + 1\text{ in.}$$

The dimensions of the Masonry Plate on a guided expansion disc bearing (Figure 6) shall be:

$$L_b = L_t + 2(2\text{ in.}) + 2(2\text{ in.})$$
$$W_b = D_{db} + 2(1\text{ in.})$$

To determine Sole Plate thickness, T_t, the diameter of the disc, dimension D_d, shall be substituted for the variable L_e.

To determine Masonry Plate thickness, $T_{b,}$ the diameter of the bottom disc plate, dimension D_{db}, shall be substituted for the variable L_e.

<u>Non-Guided Expansion Disc Bearings</u>: The dimensions of the Sole Plate on a non-guided expansion disc bearing (Figure 7) shall be:

$$L_t = D_{dt} + 2\left(1\frac{1}{2}\text{ in.}\right)$$
$$W_t = L_t + 1\text{ in.}$$

The dimensions of the Masonry Plate on a non-guided expansion disc bearing (Figure 7) shall be:

$$L_b = L_t + 2(2\text{ in.}) + 2(2\text{ in.})$$
$$W_b = D_{db} + 2(1\text{ in.})$$

To determine Sole Plate thickness, T_t, the diameter of the disc, dimension D_d, shall be substituted for the variable L_e.

To determine Masonry Plate thickness, $T_{b,}$ the diameter of the bottom disc plate, dimension D_{db}, shall be substituted for the variable L_e. If a bottom disc plate is not used, the diameter of the disc, dimension D_d shall be substituted for the variable L_e.

The bridge designer shall combine the design thicknesses for Sole and Masonry Plates with the maximum height of bearing components from manufacturers' literature to calculate the total bearing height, T_h. Shim plates and ⅛ inch leveling pad are not included in total bearing height.

Flange Connection Design

The bridge designer shall design the Sole Plate to flange connection for the Maximum Strength or Extreme Event Lateral Reaction. The bridge designer shall determine the number of stud bolts for the connection between the Sole Plate and bottom flange. A minimum of four stud bolts shall be used. Additional stud bolts may be added as required by design.

Anchor Bolt Design

Anchor bolts for HLMR bearings shall be designed according to Section 3.7.3 of the Bridge Manual. A minimum of four anchor bolts shall be used. Additional anchor bolts may be added as required by design.

Plan Presentation

The bridge designer shall use the applicable base sheet for the bearing type and class selected. A separate base sheet shall be used for each bearing type and class. The bridge designer shall provide the bearing height, T_h and the Sole and Masonry Plate dimensions L_t, L_b, W_b, T_t, and T_b. When bearings of the same type and class, but with different loads, are required on the same bridge, the base sheet may be modified to account for the different bearing dimensions and loads on the same sheet.

The bridge designer shall specify the diameter, grade and number of anchor bolts on the plans.

The bridge designer shall specify the diameter and number of stud bolts for the Sole Plate to flange connection on the plans.

The bridge designer shall provide the required reactions, vertical and lateral loads, thermal movements and rotations to complete the Design Data table on the base sheet.

Completing the Bill of Material

The bridge designer shall complete the Bill of Material for each bearing, type and loads shown on the base sheet. The pay items will be for the type and class of bearing, bearing load capacity and anchor bolt required. Pay items will be available for the type and class of bearing and load capacity specified. The load capacities will be available in 100 kip increments up to 1000 kips. The load increment will increase in 250 kip increments thereafter. Please contact the Department if a bearing's load capacity pay item is not available, and a pay item will be created.

When determining pay items, the bridge designer shall round up the Service I Factored Vertical Reaction to the next largest 100 kips increment available (for bearings with Service I Factored Vertical Reaction up to and including 1000 kips) or next largest 250 kips increment available (for bearings with Service I Factored Vertical Reaction exceeding 1000 kips) to choose an approximate bearing capacity for the pay item. The pay item will be HIGH LOAD MULTI-ROTATIONAL BEARING of the type, class and designated vertical capacity.

The ANCHOR BOLT pay item shall be for the diameter required.

Available HLMR bearing and anchor bolt pay items may be found on the IDOT web site at Letting Specific Items under Coded Pay Items.

Guide Bridge Special Provision (GBSP)

The Department's GBSP #13 for HLMR bearings describes material, fabrication, installation, and testing requirements for all types of HLMR bearings.

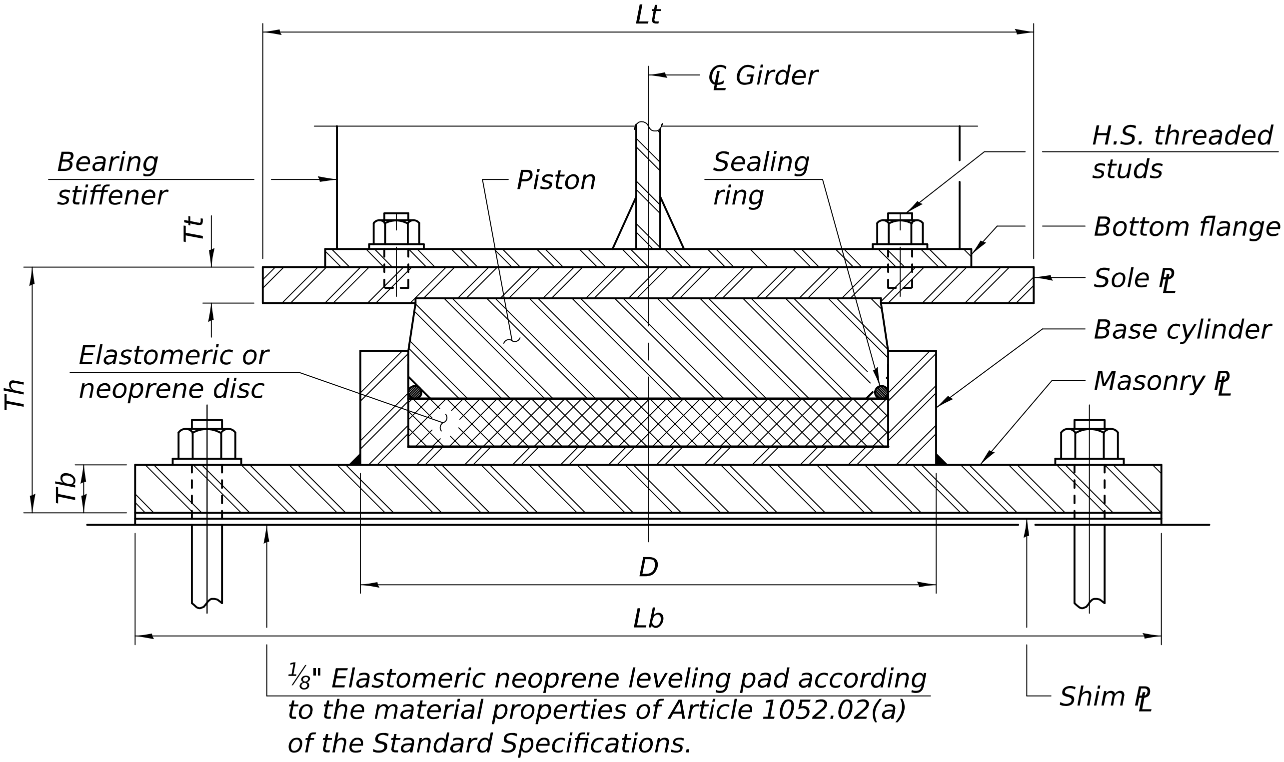
Implementation

The HLMR bearing base sheets dated 5-15-2023 shall be implemented, as soon as practical, on all applicable projects that have not been let. The base sheets are located in the Bearings-Steel Beams CADD cell library.

Please direct questions to Mark Shaffer, Policy, Standards, and Final Plan Control Unit Chief, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

Attachment

KLR/CME/kktABD22.3REV-20231212



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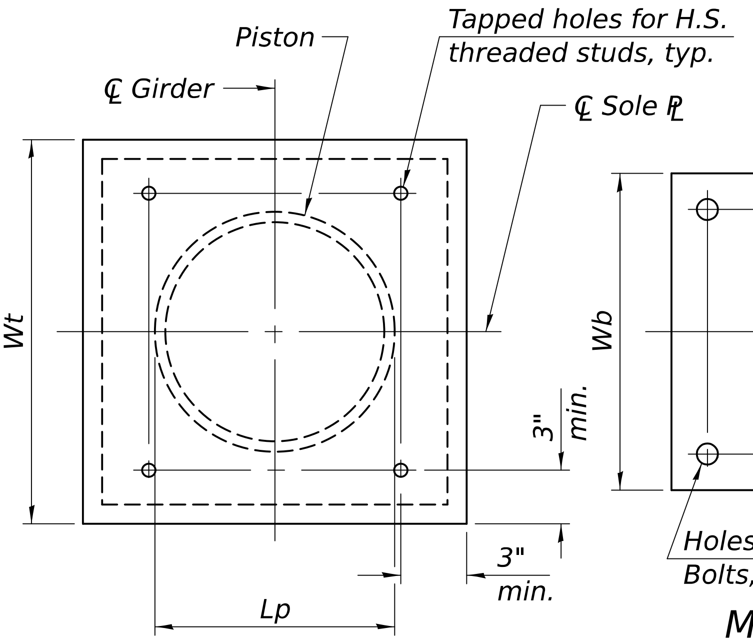
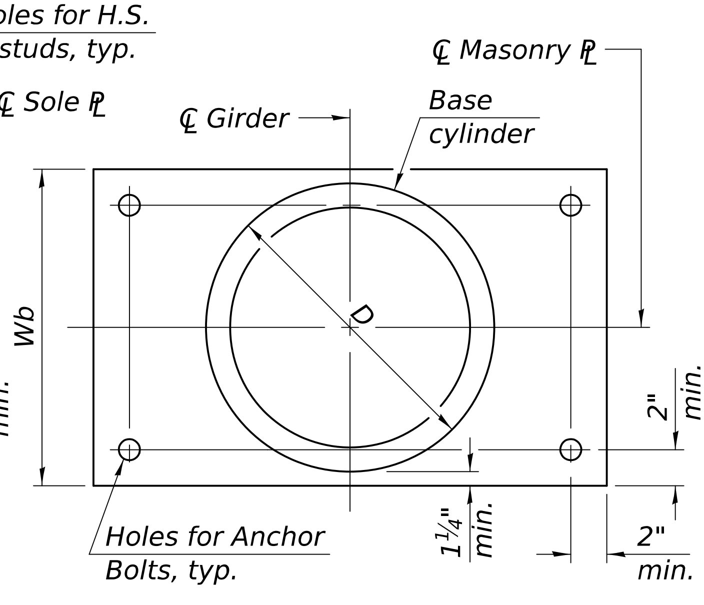
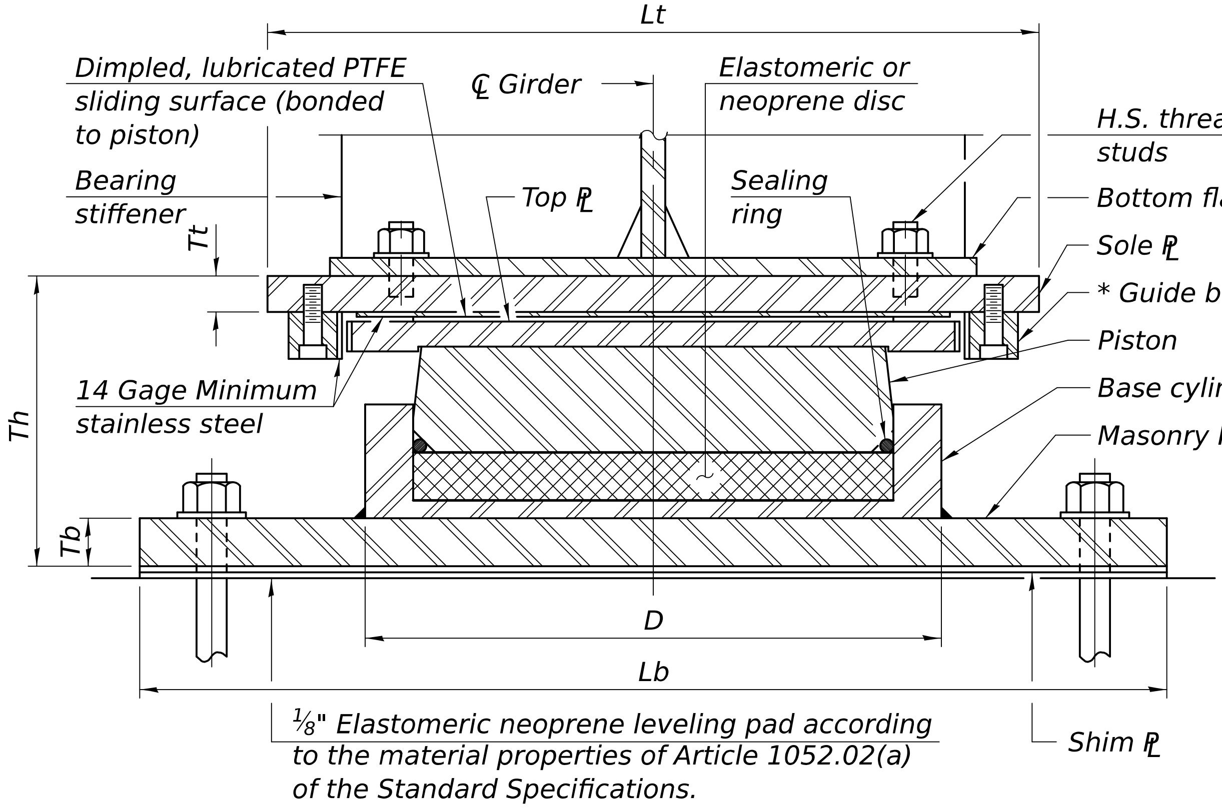




SOLE PLATE AND PISTON PLAN

MASONRY PLATE AND BASE CYLINDER PLAN

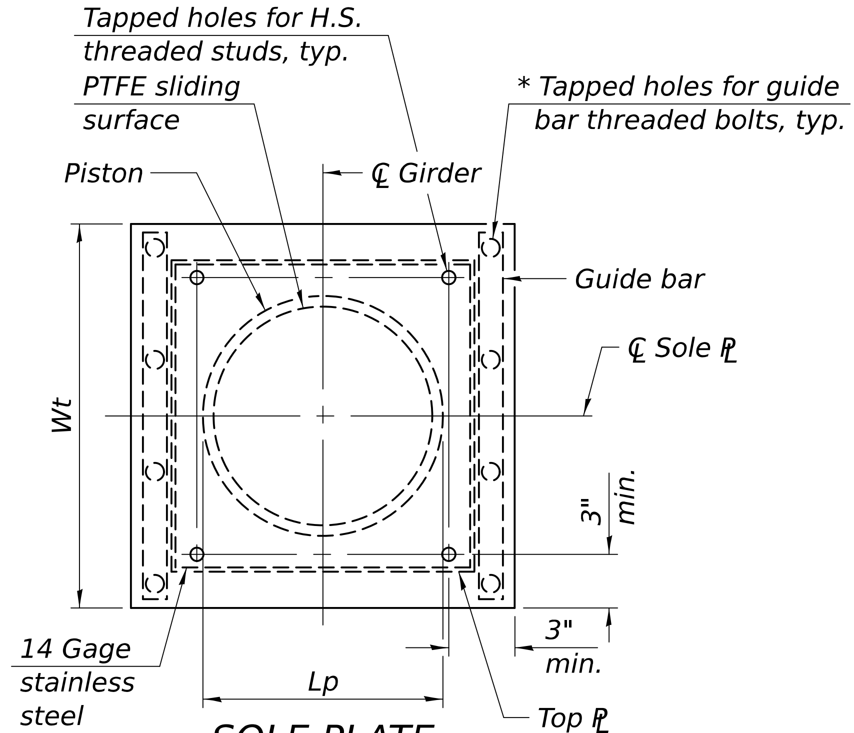
FIXED HLMR
POT BEARINGS



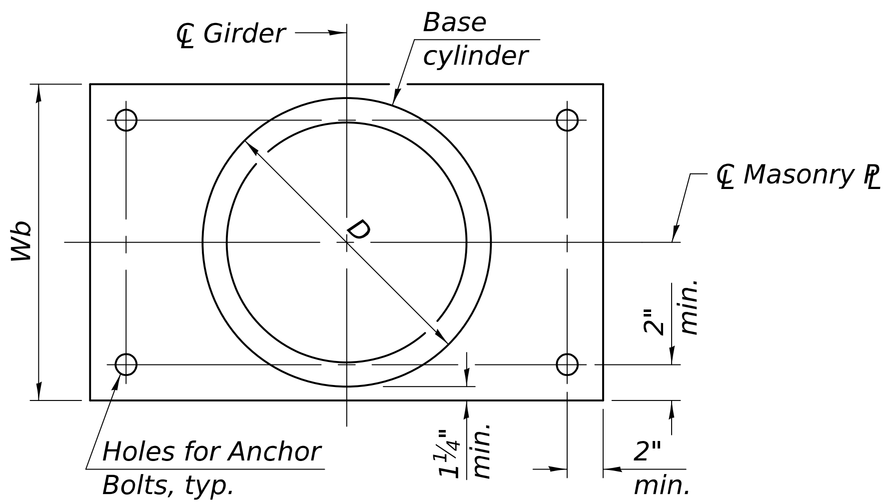
SECTION THRU BEARING

* As alternates to the bolted connection shown, the guide bars may be connected to the top bearing plate by groove welds or the guide bars and top bearing plate may be fabricated as a single piece.

GUIDED EXPANSION
HLMR POT BEARINGS



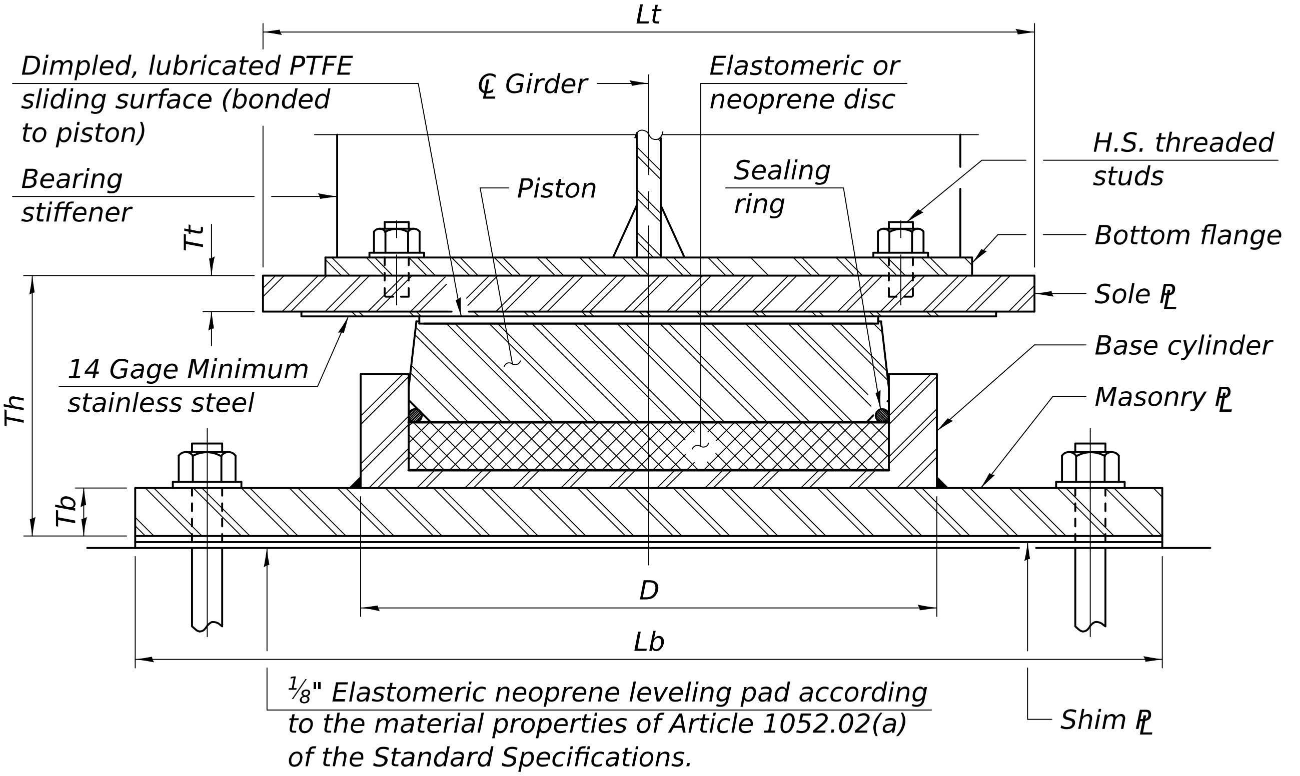
SOLE PLATE
AND PISTON PLAN



MASONRY PLATE AND
BASE CYLINDER PLAN

* As alternates to the bolted connection shown, the guide bars may be connected to the top bearing plate by groove welds or the guide bars and top bearing plate may be fabricated as a single piece.

GUIDED EXPANSION
HLMR POT BEARINGS



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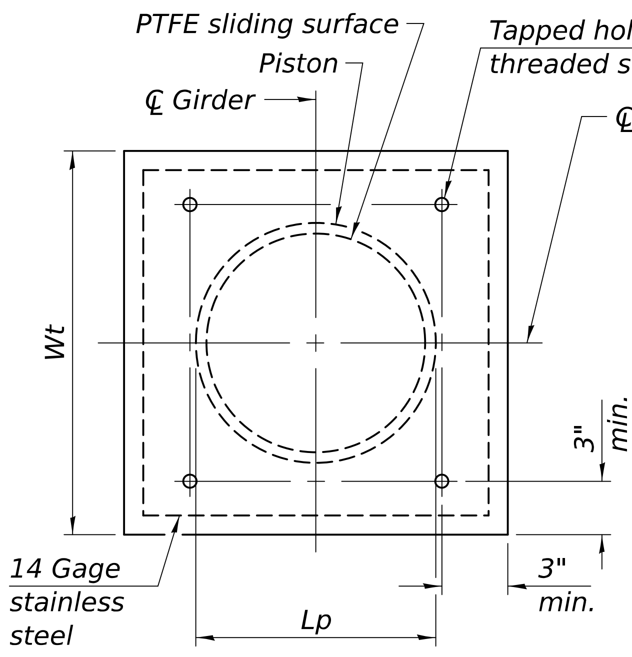
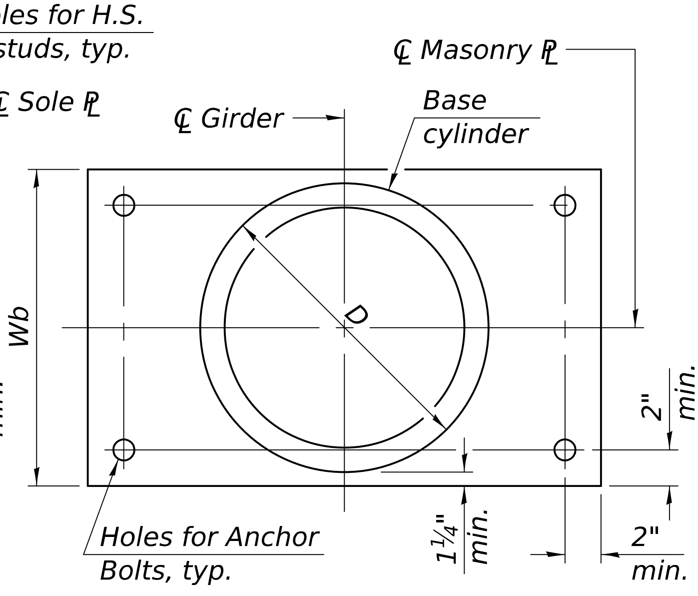
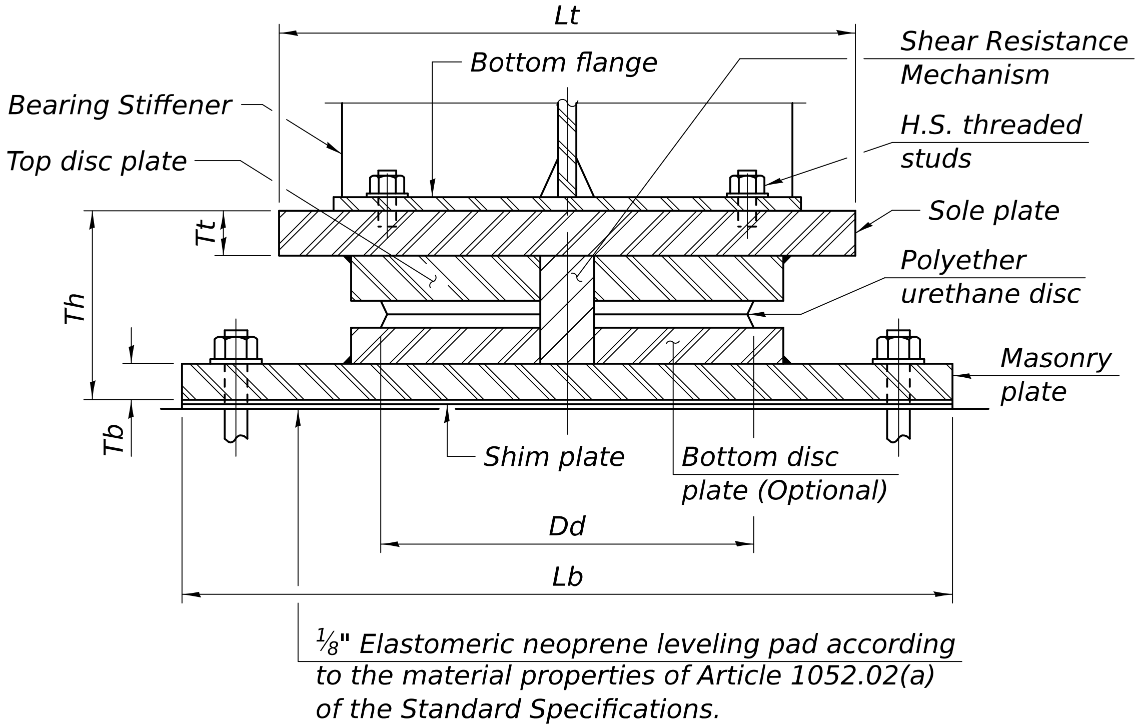


SOLE PLATE AND PISTON PLAN



MASONRY PLATE AND BASE CYLINDER PLAN

NON-GUIDED EXPANSION HLMR POT BEARINGS



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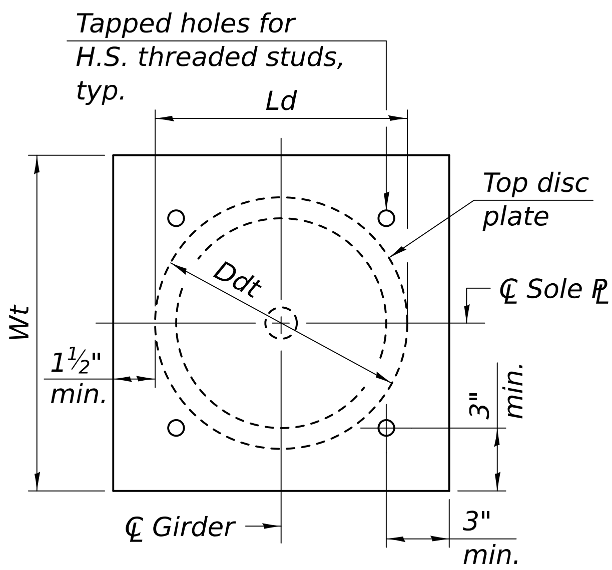
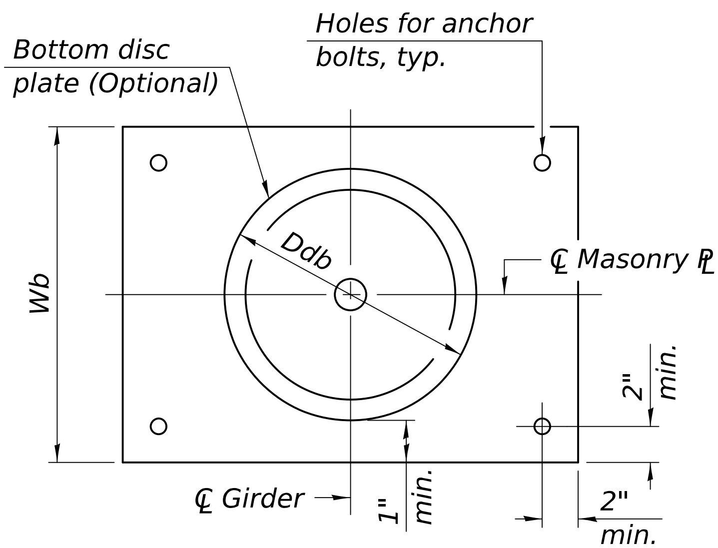
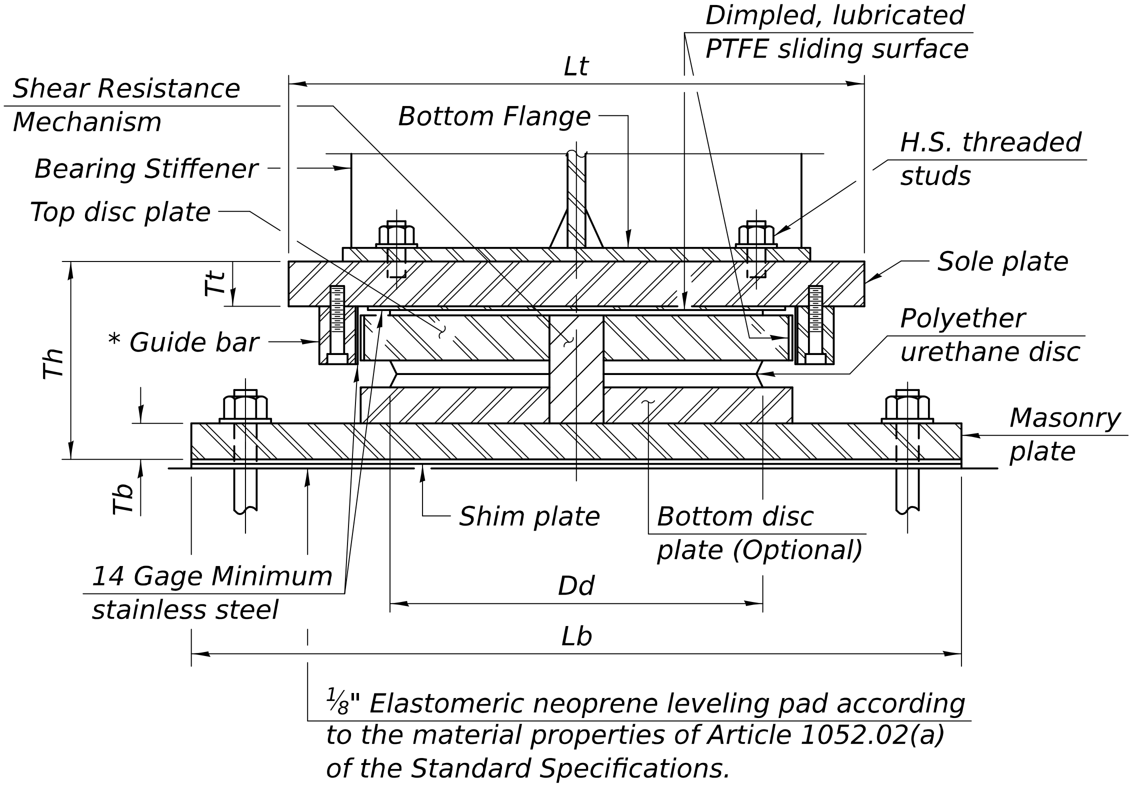


SOLE PLATE AND TOP DISC PLATE PLAN



MASONRY PLATE AND BOTTOM DISC PLATE PLAN

FIXED HLMR
DISC BEARINGS



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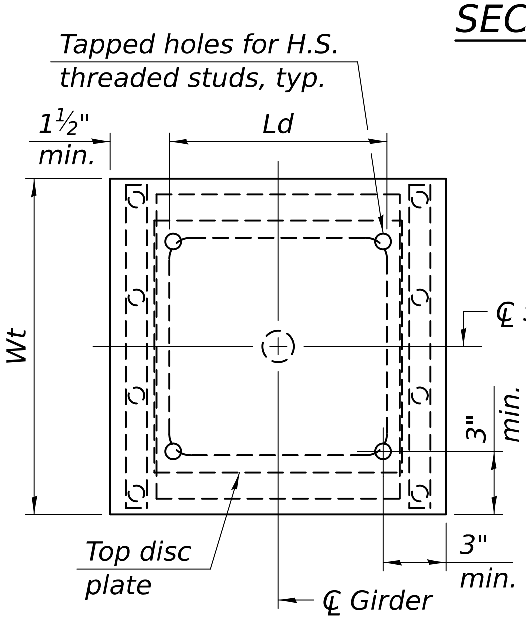
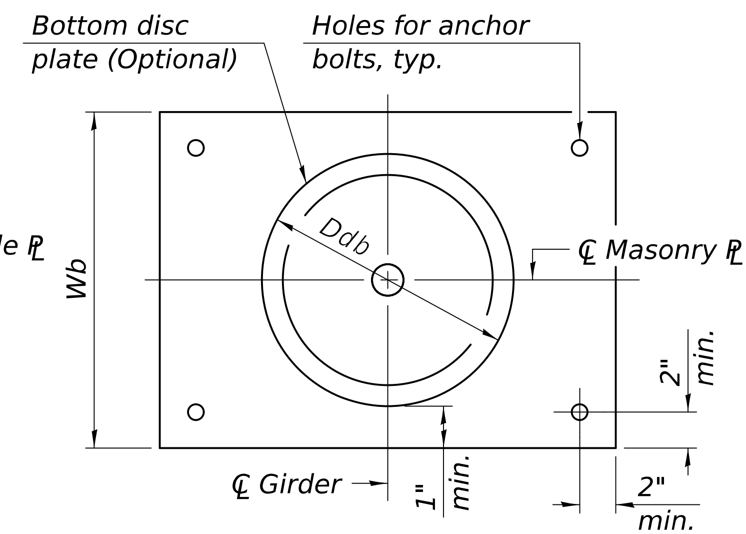


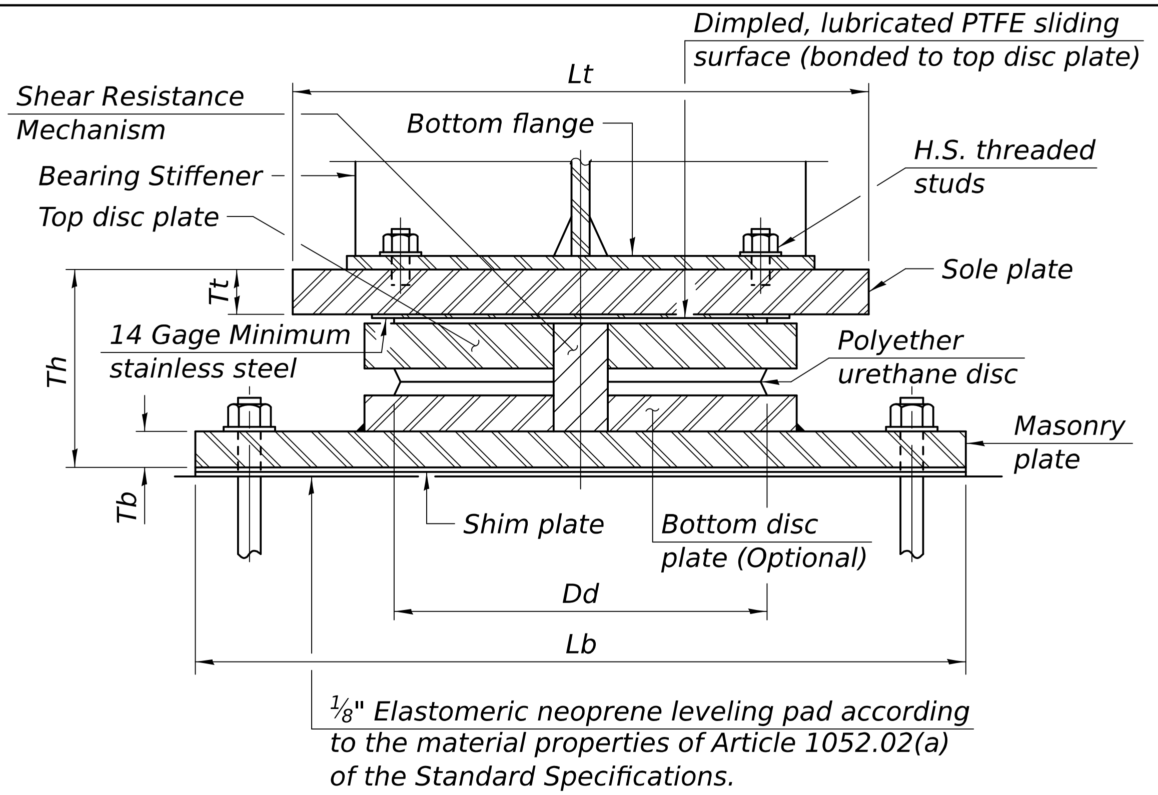


SOLE PLATE AND TOP DISC PLATE PLAN

MASONRY PLATE AND BOTTOM DISC PLATE PLAN

* As alternates to the bolted connection shown, the guide bars may be connected to the top bearing plate by groove welds or the guide bars and top bearing plate may be fabricated as a single piece.

GUIDED EXPANSION HLMR DISC BEARINGS



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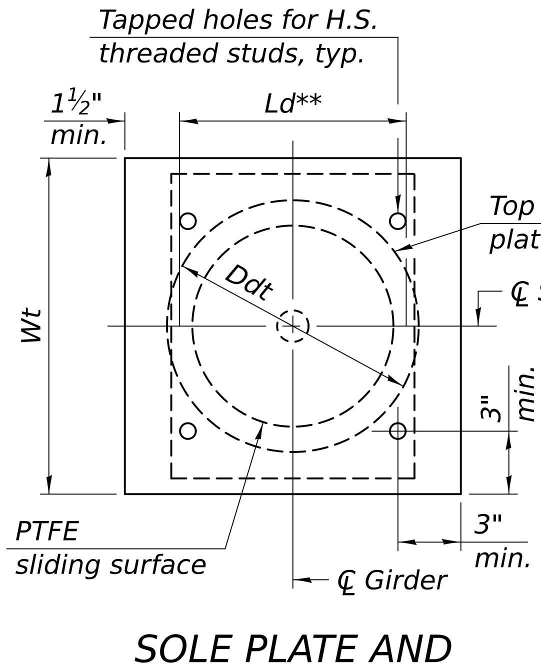
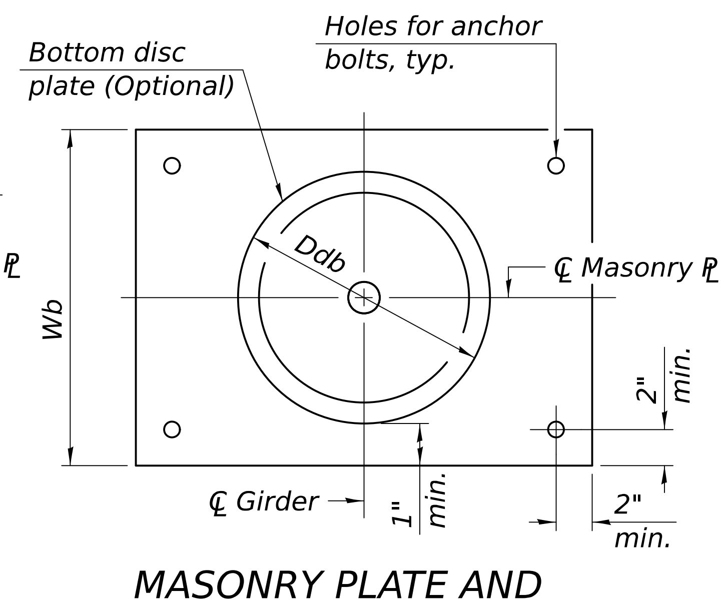


SOLE PLATE AND TOP DISC PLATE PLAN



MASONRY PLATE AND BOTTOM DISC PLATE PLAN

**Ld = Dd, disc not shown for clarity

NON-GUIDED EXPANSION HLMR DISC BEARINGS

Figure 7

Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	22.2
From:	Jayme F. Schiff	Jayme F. Schiff
Subject:	Pipe Liners	
Date:	March 31, 2022	

When pipe culverts and storm sewers become deteriorated, one option to prolong their service life is the addition of an interior pipe liner. These pipe liners are designed to withstand all loads that the host pipe withstands, essentially being a fully designed pipe independent of the host pipe. This memorandum contains an overview of the Illinois Department of Transportation's (IDOT) pipe liner policy and introduces three new Guide Bridge Special Provisions.

IDOT does not prefer one type of pipe liner over another; however, the parameters for each liner type may make one type preferable over another for a particular project. The intent of this memorandum is to increase awareness of different types of pipe liners available for use on IDOT projects and their applicability, design requirements, and Contract requirements.

IDOT currently utilizes four different technologies for pipe liners. They are as follows:

- Insertion Liner
- Folded/Formed PVC Liner
- Cured-In-Place Pipe Liner
- Spray-Applied Pipe Liner

A brief description, applicability parameters and required contract documents are given below for each of these four types of pipe liners.

Insertion Liner

Description: Insertion lining consists of a new smaller pipe, inserted into a deteriorated larger host pipe, with the annular space between the two pipes grouted. Specifications for insertion liner are found in Section 543 of the Standard Specifications for Road and Bridge Construction.

Insertion liner also may be used to line box culvert or pipe arch sections, given that the following requirements are met.

Allowable Diameters: The restrictions on diameter for an insertion liner are the same as those for a new pipe and are dependent upon pipe type and fill depth. Designers should consult the applicable design tables in Section 542 or Section 550 of the Standard Specifications for Road and Bridge Construction when determining applicable pipe diameters for a specific project.

<u>Hydraulic Opening:</u> As per Article 543.02 of the Standard Specifications for Road and Bridge Construction, the minimum hydraulic opening of insertion liner pipe shall be as follows:

Diameter of Existing Pipe/Culvert	Percent of the Cross-Sectional Opening of the Existing Pipe/Culvert
< 5 ft	72 %
5 ft - 10 ft	82 %
> 10 ft	90 %

Designers should consider these reductions in hydraulic opening when determining pipe liner type and diameter. If the resulting reduction in hydraulic opening does not meet the hydraulic requirements of the culvert, designers should consider use of a different liner type.

Unlike other liner types, which become difficult to design for pipes that have "ovalled" due to deterioration, there is no limit on the amount of host pipe deflection that would preclude the use of insertion liner pipe.

<u>Segment Length:</u> There is no restriction on total length of pipe to be lined with insertion liners, as individual segments are spliced together to create one continuous liner. As per Section 543 of the Standard Specifications, no more than three joints are allowed per 50 ft. Segment length will depend on the amount of area provided for jacking operations.

Liners cannot easily accommodate bends; insertion liner should be used for straight segments of pipe only.

<u>Site Conditions:</u> Insertion liner may be installed in wet or dry conditions. Water diversion is not required.

Insertion liners require a jacking pit adjacent to the existing culvert to be lined. The jacking pit should be able to accommodate a segment length of 20 ft, plus extra length for jacking equipment. Designers should evaluate the width of right-of-way available when determining pipe liner type, as small widths of right-of-way may preclude the use of insertion liner.

<u>Structural Design:</u> Pipe design charts are found in Section 542 of the Standard Specifications for Road and Bridge Construction. Storm sewer design charts are found in Section 550 of the Standard Specifications for Road and Bridge Construction. When these charts are used, there are no further design calculations, and there is not a requirement for an Illinois Licensed Structural Engineer.

<u>Required Contract Documents:</u> Plan and Profile sheets should show all information that would be required for a new pipe culvert or storm sewer. In order for the contractor to properly order an insertion liner, host pipe information such as diameter, fill, etc. are required to be placed in the contract documents. Section 543 of the Standard Specifications for Road and Bridge Construction contains all required specifications for the contract. There are no additional special provisions required.

Folded/Formed PVC Liner

Description: Folded/Formed Poly-Vinyl Chloride (PVC) liners consist of a flexible PVC pipe that appears on the jobsite “folded,” or in a flattened shape, with the appearance of a deflated balloon. It is then pulled through the host pipe with a winch, inflated until it conforms with the shape of the host pipe (i.e., “formed”). It is then steam cured and hardened. The final result is a PVC liner that conforms to the contours of the existing pipe.

Allowable Diameters: Standard Folded/Formed PVC Liner diameters of 4 in., 6 in., 9 in., 12 in., 18 in., 24 in., and 30 in. are found in ASTM F1504. A second ASTM standard, F1871, has diameters of 4 in., 6 in., 8 in., 9 in., 10 in., 12 in., 15 in., and 18 in. Either standard may be used. As stated in the Guide Bridge Special Provision “Folded/Formed PVC Liner,” host pipes not meeting these exact diameters may also be used, given that the supplier certifies that the diameter used meets the requirements of ASTM F1504 or ASTM F1871. Host pipes with diameters exceeding 30 in. shall not be lined with Folded/Formed PVC Liner.

Host pipes that have ovalled more than 12.5% (e.g., 3.75 in. of deflection on a 30 in. diameter pipe) may require additional structural calculations due to the applicability of the design formulas in the applicable ASTM documents. If this level of deterioration is found, the designer should consider a different liner type that is capable of accommodating this level of deterioration, or complete replacement of the existing pipe.

Hydraulic Opening: Diameter of lined pipe is typically between 0.5 in. and 1.5 in. smaller than that of host pipe diameter.

Segment Length: Folded/Formed PVC Liner segment length is dependent upon host pipe diameter. Host pipes with diameters 15 in. or less may have Folded/Formed PVC Liner segment lengths exceeding 900 ft. Host pipes with diameters of 30 in. have a Folded/Formed PVC Liner segment length limit of 325 ft. Exact segment length limits may be obtained from supplier literature.

Folded/Formed PVC Liners can accommodate bends in host pipes.

Site Conditions: Dry conditions and water diversion are required. Water diversion may be removed after PVC is cured, which is typically on the same day as installation.

Folded/Formed PVC Liners are inserted, formed, and cured from truck-mounted equipment. Jacking pits and additional right-of-way are not required. Temporary lane closures may be required to facilitate the truck-mounted equipment; relevant traffic control standards shall be included in the plans.

Structural Design: Folded/Formed PVC liners are designed using the procedure in ASTM F1867, Appendix X1. Design calculations shall be sealed by an Illinois Licensed Structural Engineer.

Required Contract Documents: Plan and profile sheets should show host pipe diameter and fill height. For pipes that have ovalled due to deterioration, both the maximum and minimum diameters of the pipe should be shown. This information may be difficult to obtain due to pipe location and diameter, and therefore may be omitted from the plans. Soil class around pipe should be provided; however, due to unknown backfill used in the initial pipe installation, this information may not be attainable. In the event of omitted diameter or soil type data, the structural engineer will make conservative assumptions based on the data provided. Host pipes that have ovalled more than 10% may require a higher level of analysis than the prescribed procedure in the applicable ASTM standard.

Guide Bridge Special Provision Folded/Formed PVC Liner shall be included in the contract documents.

Cured-In-Place Pipe Liner

Description: Cured-In-Place Pipe Liner consists of a flexible resin-impregnated polypropylene. This material appears on the jobsite in a deflated shape. It is then inserted into a deteriorated pipe, inflated until it conforms with the shape of the host pipe, and the resin is then cured using heated water, steam, or UV light. When cured, the resin hardens, creating a liner for the existing pipe.

Allowable Diameters: There are no restrictions on maximum or minimum host pipe diameter, but Cured-in-Place Pipe Liners may become prohibitively expensive when used to line pipes of larger diameters. The preferred maximum diameter to ensure cost-effectiveness is 36 in.

Host pipes that have ovalled more than 10% (e.g., 3 in. of deflection on a 30 in. diameter pipe) may require additional structural calculations due to the applicability of the design formulas in the applicable ASTM documents. If this level of deterioration is found, the designer should consider a different liner type that is capable of accommodating this level of deterioration, or complete replacement of the existing pipe.

Hydraulic Opening: Diameter of lined pipe is typically less than 1 in. smaller than that of host pipe diameter.

Segment Length: Cured-In-Place Pipe Liner segment lengths between 300 ft. and 500 ft. are typical. Segment lengths exceeding 1000 ft. are possible, but may be difficult to install.

Cured-In-Place Pipe Liners can accommodate bends in host pipes.

Site Conditions: Dry conditions and water diversion are required. Water diversion may be removed after Cured-In-Place Pipe Liner is cured, which is typically on the same day as installation.

Cured-In-Place Pipe Liners are inserted, formed, and cured from truck-mounted equipment. Jacking pits and additional right-of-way are not required. Temporary lane or road closures may be required to facilitate the truck-mounted equipment; include relevant traffic control standards in the plans.

Structural Design: Cured-In-Place Pipe Liners shall be designed using the procedure in ASTM F1216, F1743, or F2019, depending upon Cured-In-Place Pipe

Liner type. Design calculations shall be sealed by an Illinois Licensed Structural Engineer. Host pipes that have ovalled more than 10% may require a higher level of analysis than the prescribed procedure in the applicable ASTM standard.

Required Contract Documents: Plan and Profile sheets should show host pipe diameter and fill height. For pipes that have ovalled due to deterioration, both the maximum and minimum diameters of the pipe should be shown. This information may be difficult to obtain due to pipe location and diameter, and therefore may be omitted from the plans. Soil class around pipe should be provided; however, due to unknown backfill used in the initial pipe installation, this information may not be attainable. In the event of omitted diameter or soil type data, the structural engineer will make conservative assumptions based on the data provided.

The Guide Bridge Special Provision Cured-In-Place Pipe Liner shall be included in the contract documents.

Spray-Applied Pipe Liner

Description: Spray-Applied Pipe Liners consist of a geopolymer concrete that is sprayed onto the inside surface of the host pipe, creating a liner similar to shotcrete. The application is performed via a machine that is pulled through the host pipe. This machine has a spinning nozzle that sprays the geopolymer concrete. Larger pipes may be installed with trained technicians using a hand nozzle applicator.

Allowable Diameters: Due to the possibility that manual application may be required for areas of application, host pipes of diameters 36 in. and larger are preferred. Host pipes of 30 in. diameter are allowed, but installation of the Spray-Applied Pipe Liner may be difficult due to the size of the equipment, and possibility of a manual operator, required for installation.

Host pipes that have ovalled more than 12% (e.g., 3.6 in. of deflection on a 30 in. diameter pipe) may require additional structural calculations due to the applicability of the design formulas in the design methodology document. If this level of deterioration is found, the designer should consider a different liner type that is capable of accommodating this level of deterioration, or complete replacement of the existing pipe.

Hydraulic Opening: Diameter of lined pipe is typically between 1 in. and 4 in. smaller than that of host pipe diameter.

Segment Length: Spray-Applied Pipe Liners may be applied continuously, with no limitations on segment length. When multiple days of application are required, segment lengths are spliced together, creating one continuous liner.

Tight bends in host pipes may be accommodated, but will require manual application at the bend location.

Site Conditions: Dry conditions and water diversion are required. Water diversion may be removed after Spray-Applied Pipe Liner is cured, which is typically the same day as installation.

Structural Design: Spray-Applied Pipe Liners may be designed using methodology in industry literature such as the document Testing and Modeling Analysis of

Geopolymer Pipe-lining Technology for Sewer & Stormwater Rehabilitation (approved by Water Resources Council). The methodology in this document was based on experiments on pipes with a maximum ovality of 12%. Design calculations shall be sealed by an Illinois Licensed Structural Engineer.

Required Contract Documents: Plan and Profile sheets shall show host pipe diameter and fill height. For pipes that have ovalled due to deterioration, both the maximum and minimum diameters of the pipe should be shown. This information may be difficult to obtain due to pipe location and diameter, and therefore may be omitted from the plans. Soil class around pipe should be provided; however, due to unknown backfill used in the initial pipe installation, this information may not be attainable. In the event of omitted data, the structural engineer will make conservative assumptions based on the data provided.

The Guide Bridge Special Provision Spray-Applied Pipe Liner shall be included in the contract documents.

Implementation

Three new Guide Bridge Special Provisions (GBSPs) have been released for use of pipe liners: Folded/Formed PVC Liner (#97), Cured-In-Place Pipe Liner (#98), and Spray-Applied Pipe Liner (#99). The GBSP for Folded/Formed PVC Liner replaces Recurring Special Provision #16. These GBSPs may be found on the IDOT website at Guide Bridge Special Provisions.

Please direct questions to Mark Shaffer, Policies, Standards and Final Plan Control Unit Chief, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

MDS/kktABD22.2-20220331

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	21.1
From:	D. Carl Puzey	
Subject:	Porous Granular Embankment Requirements for Precast Concrete Box Culverts	
Date:	July 23, 2021	

This memorandum serves to update portions of ALL BRIDGE DESIGNERS (ABD) memorandum 11.3 (Rev.) regarding the requirements of Porous Granular Embankment (PGE) for precast concrete box culvert design and installation.

Highlights of Updates

1. Removal of PGE requirements from top of all precast concrete box culverts.
2. Clarification of PGE limits on sides and bottoms of all precast concrete box culverts.
3. Summary of proper specification and usage of related Bureau of Design and Environment (BDE) Special Provisions.
4. Updated Base Sheets SCB-GPE, DCB-GPE, and TCB-GPE.

History and Revised Policy

<u>Removal of PGE Requirements from Top of All Precast Concrete Box Culverts</u>

In 2012, a minimum of 6” of PGE was required on the top of precast concrete box culverts to satisfy the live load design distribution requirements of ASTM C 1577. IDOT implemented this requirement through BDE special provision 80294 (“Concrete Box Culverts with Skews ≤ 30 Degrees Regardless of Design Fill and Skews > 30 Degrees with Design Fills > 5 Feet,” Effective 4/1/2012). ASTM C 1577 was later revised to remove this PGE requirement on top of the precast box culverts. In response, IDOT removed this requirement in a 4/1/2014 update to BDE special provision 80294. The revised special provision was then incorporated into the Standard Specifications in Articles 540.04 and 540.06. Please discontinue the use of BDE special provision 80294 as PGE is no longer required on the top of precast concrete box culverts.

However, IDOT does still require a 6” minimum cover between the top of the precast box culvert and the bottom of a flexible pavement structure to facilitate shear transfer across precast concrete box culvert joints. The cover requirement is independent of the former load distribution requirements from ASTM C 1577. This cover does not need to be PGE, and can be any acceptable roadway embankment material. **See Figure 1**.

IDOT does not require a 6” minimum cover between the top of precast concrete box culverts and the bottom of a rigid pavement structure. The rigid pavement itself is considered adequate to provide shear transfer across the precast concrete box culvert joints. When rigid pavement is placed directly on top of precast concrete box culverts, the waterproofing requirements for the culverts are not applicable.

ABD 11.3 (Rev.) also references active BDE special provision 80293 (“Concrete Box Culverts with Skews > 30 Degrees and Design Fills ≤ 5 Feet,” Effective 4/15/2016). This special provision shall continue to be used for applicable projects and has already been revised to accommodate the latest ASTM C1577 revisions. With this special provision application, 6” of fill between the top of the precast box culvert and bottom of the flexible pavement structure is required, but, similarly to above, the fill is not required to be PGE.

Clarification of PGE Limits on Sides and Bottoms of All Precast Concrete Box Culverts

As per ASTM C 1577, PGE is required, regardless of the size of the box or the depth of the fill, on the sides of precast box culverts from the top of the top slab to the bottom of the bottom slab. The precast box culvert general plan and elevation base sheets (SCB-GPE, DCB-GPE, and TCB-GPE; revised herein as part of this Memo) describe a required vertical 2-foot strip of PGE on both sides of the precast box culvert. Districts have reported that it is difficult to construct and properly compact this column of PGE while constructing and compacting the adjacent remainder of the required excavation with backfill. Therefore, for precast boxes and end sections:

- An additional cross-section detail on the revised base sheets has been added to clarify these side dimensions of PGE for the purposes of payment only.

- The notes on the base sheets have been revised to include PGE for the required excavation on both sides of the precast box and end section(s) from the top of the top slab to the bottom of the bottom slab.

- This volume of PGE shall be measured and paid for at the contract unit price for the Porous Granular Embankment pay item, which is listed on the Bill of Materials on the base sheet.

- Drainage on the sides shall continue to be detailed as specified in Art. 502.10 of the Supplemental Specifications.

PGE is additionally required under precast concrete box culverts as described in Section 540.06 of the Standard Specifications. This volume of PGE will not be measured/paid for separately but shall be considered included in the cost of the precast concrete box culvert.

See Figure 1 for details.

Summary of Proper Specification and Usage of Related BDE Special Provisions

BDE special provision 80294 (“Concrete Box Culverts with Skews ≤ 30 Degrees Regardless of Design Fill and Skews > 30 Degrees with Design Fills > 5 Feet,” Effective 4/1/2012) has been revised and incorporated into Articles 540.04 and 540.06 of the Standard Specifications for Road and Bridge Construction. Discontinue the use of this special provision.

BDE special provision 80293 ("Concrete Box Culverts with Skews > 30 Degrees and Design Fills ≤ 5 Feet,") is still applicable and available on the IDOT website.

Updated Base Sheets SCB-GPE, DCB-GPE, and TCB-GPE

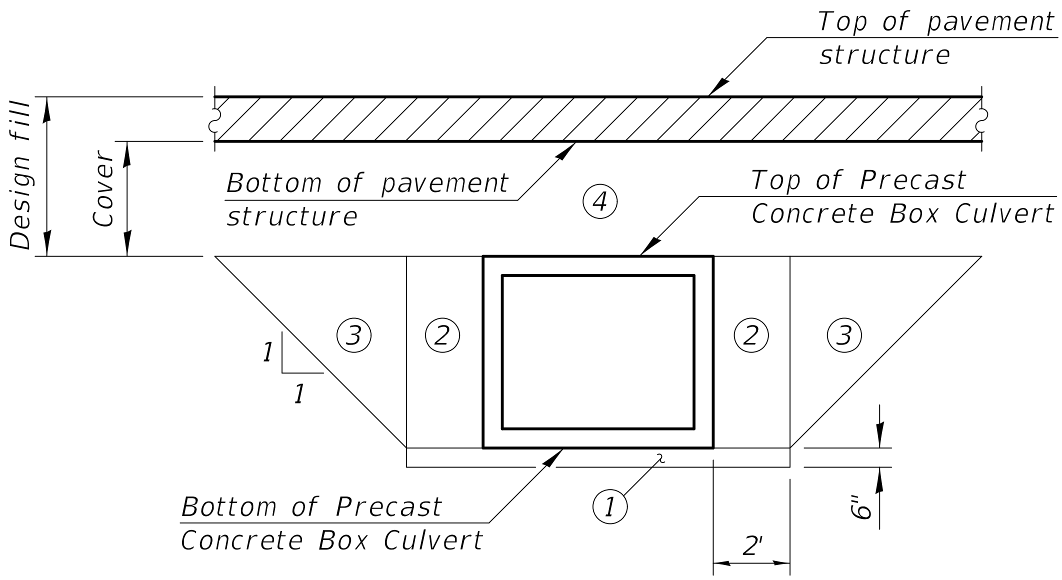
Revised General Plan and Elevation base sheets for single, double, and triple precast concrete box culverts will soon be available on the IDOT website and are available upon request from Mark Shaffer if required sooner. These base sheets include revised notes and figures to clarify the policies above.

Implementation

The revised base sheets will soon be available on the IDOT website and shall be implemented, as soon as practical, on all applicable projects that have not been let. Please direct questions to Mark Shaffer, Policies, Standards and Final Plan Control Unit Chief, by telephone at (217) 785-2914 or email at mark.shaffer@illinois.gov.

Attachment

KLR/kktABD21.1-20210723



BACKFILL COMPONENTS OF PRECAST CULVERT CROSS SECTION

1 - 6" PGE as described in Sect. 540. Included in cost of Precast Concrete Box Culvert.

2 - Select backfill (PGE) required. This provides for uniform load distribution and is consistent with the requirements of ASTM C 1577. See IDOT Culvert base sheets. This PGE is not described in Sect. 540 and is paid for at the cost per cubic yard for Porous Granular Embankment.

3 - Select backfill (PGE) required. To facilitate the compaction requirements for the PGE in area 2, this area is also required to be compacted PGE. This area will be paid for at the cost per cubic yard for Porous Granular Embankment.

4 - Minimum 6" cover under flexible pavement structure to provide better shear transfer across the precast joints. This cover is not required to be PGE. See roadway plans for quantity and basis of payment.

PRECAST CONCRETE BOX CULVERT BACKFILL

Figure 1

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	20.X
From:	D. Carl Puzey	D. Carl Puzey
Subject:	AASHTO LRFD Specification	
Date:	May 12, 2020	

The American Association of State Highway and Transportation Officials (AASHTO) have published the following publication:

2020 AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 9th Edition

Looseleaf: LRFDBDS-9
PDF Download Single User: LRFDBDS-9-UL
PDF Download 5 Users: LRFDBDS-9-IP5
PDF Download 10 Users: LRFDBDS-9-IP10
PDF Download 25 Users: LRFDBDS-9-IP25
Hardcopy and PDF Download Single User: LRFDBDS-9-PUL

You can order this, and all AASHTO publications, by calling 1-800-231-3475 or visiting the online bookstore at https://store.transportation.org/.

This publication shall be applicable to all design plans prepared from TS&L plans approved on or after July 1, 2020.

Please direct questions regarding interpretation to DOT.BBS.COMSUGGEST@illinois.gov.

KLR/MDS/ABD20.X-20200512

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	19.7
From:	D. Carl Puzey *D. Carl Puzey*	
Subject:	Cleaning and Painting Existing Steel Structures	
Date:	August 1, 2019	

ALL BRIDGE DESIGNERS (ABD) Memorandum 19.7 details the latest policies for cleaning and painting existing steel structures and the special provisions related to this work. It also gives direction in the creation of paint-only contracts and general paint information and terminology. ABD Memorandum 19.7 supersedes the applicable portions of the previously issued ABD Memorandum 10.1. The remainder of ABD Memorandum 10.1 addressing coating strategies for new structures is addressed in ABD Memorandum 19.6.

Bridge painting serves two purposes: aesthetic treatment and corrosion protection. To choose a bridge paint system that is functional, durable, and aesthetically pleasing, the following information must be determined:

- Required areas to be cleaned
- Required type of cleaning
- Appropriate paint system
- Desired color

These decisions should be coordinated with the District Bridge Maintenance Engineer and/or the District Paint Technician, or the Owner for Local Public Agency (LPA) structures. Once these aspects have been determined, a cost estimate can be calculated, the appropriate pay items and notes can be chosen, and plans can be generated.

This memorandum contains two sections. In the first, the cleaning and painting strategies are outlined, and guidance is given to the designer to aid in the choosing of the correct strategy. In the second, plan-specific items such as pay items, General Notes, and plan details are discussed.

Determining the cleaning and painting strategy for existing structures

1) *Determination of Areas to be Cleaned and Painted*

Two strategies may be employed for cleaning and painting existing structural steel. The structure may be zone cleaned and painted, which involves painting only the beam ends and/or fascia girders, or it may be fully cleaned and painted. Whether the structure is zone cleaned and painted or fully cleaned and painted is dependent upon the quality of the existing paint coating and the difference of cost of each option.

Zone cleaning and painting addresses specific problem areas of the bridge and involves removing the coating to bare metal in those areas only. The rest of the structure coating remains intact. Zone cleaning and painting typically has a higher cost per square foot compared to full cleaning and painting because of fixed mobilization costs and lower productivity per square foot. However, the total project cost is usually lower because the total square footage to be painted is much less than cleaning and repainting the entire structure. Typically, the problem areas of the bridge consist of beam ends under joints. Fascia girders are often repainted for aesthetic purposes.

The following are general rules for determining cleaning and painting areas:

- For typical slab-on-beam structures, areas near deck joints will typically be cleaned and painted a minimum of five feet on each side of the joint. The distance may be increased to the extent of evidence of corrosion outside of this area.

- Aesthetic painting of fascia girders is required when determined necessary by the District Bridge Maintenance Engineer and/or the District Bridge Paint Technician.

- Zone painting of trusses, arches, bascules, or other complex structures should be evaluated on a case by case basis to determine the best painting strategy. Typically, as a minimum, the splash zone (bottom chord to 12 feet above the bridge deck surface) and the areas near the deck joints should be cleaned and painted. Trusses are typically repainted in combination with a rehabilitation contract. The Bureau of Bridges and Structures should be consulted for concurrence on the scope of work.

- A bridge should be fully cleaned and painted when damage to the existing paint system is widespread.

Estimates of square foot costs can vary greatly depending upon location and amount of painting required. The Bureau of Bridges and Structures maintains average square foot costs for cleaning and painting that are available upon request.

2) *Cleaning Method Requirements*

Illinois commonly uses two types of cleaning. These cleaning types are defined by the Society for Protective Coatings (SSPC) and are as follows: Near White Blast Cleaning (SSPC SP-10), and Commercial Grade Power Tool Cleaning (SSPC SP-15).

Near White Blast Cleaning (SSPC SP-10) involves the use of an abrasive blast to remove all existing paint, rust and mill scale from the area to be cleaned. It requires a complex containment system that includes dust collection but reduces the chance of delamination of the new paint system since the new paint system is being applied to clean, bare steel. Near White Blast Cleaning (SSPC SP-10) should be used for zone painting near joints, for complete coating removal and replacement, and may be specified for fascias in lieu of Commercial Grade Power Tool Cleaning (SSPC SP-15) when desired.

Commercial Grade Power Tool Cleaning (SSPC SP-15) involves the use of power tools to remove all existing paint, rust and mill scale from the area to be cleaned. It typically involves the use of vacuum-shrouded power tools. This system is primarily used when cleaning fascias over traffic or spans over active railroads where rapid removal of the containment system may be required.

These two cleaning methods may be used in conjunction with each other on projects. For example, in a grade separation with zone painting of bridge joints and fascia beams, the areas under the bridge joints will be cleaned using Near White Blast Cleaning (SSPC SP-10), and the fascia beams will be cleaned using Commercial Grade Power Tool Cleaning (SSPC SP-15). The standard general paint notes found later in this memorandum give preferred configurations of cleaning methods.

3) *Determination of Appropriate Paint System*

A Paint System Selection Flow Chart is provided in Figure 1 to assist the designer in selecting the appropriate paint system. Considerations include matching topcoats of existing steel and anticipated weather conditions. The naming convention used for the paint systems below is primer / intermediate coat / topcoat.

There are three approved systems for painting existing steel cleaned to bare metal:

- Organic Zinc-Rich Primer/Epoxy Intermediate Coat/Urethane Topcoat (OZ/E/U)
- Epoxy Mastic Primer/Epoxy Mastic Intermediate Coat/Acrylic Topcoat (EM/EM/AC)
- Moisture Cured Urethane (MCU)

The OZ/E/U system is the preferred system for repainting steel. The department maintains the other two systems for special cases as noted below. The zinc-rich primer is seen as providing a level of cathodic protection that the other two systems do not provide.

The EM/EM/AC system is the oldest current system used for painting existing steel and is found on many existing structures. It is seen as less durable than the OZ/E/U system because the primer serves only as a barrier coat and offers little corrosion protection once the coating is compromised. This system should only be used when new steel is being added to an existing bridge with an acrylic topcoat. In these cases, it is important to preserve continuity of the topcoat between the new and existing steel.

The MCU system is a three-coat system consisting of an MCU primer, MCU intermediate coat, and an aliphatic topcoat. It was developed for painting structures primarily where the weather conditions are expected to be very humid and/or the temperatures are cool. This system can be cured in very low temperatures (20 degrees Fahrenheit). This system should only be used during times of the year when high humidity is expected, and/or the temperatures are cold on existing steel prepared using Near White Blast Cleaning (SSPC SP-10).

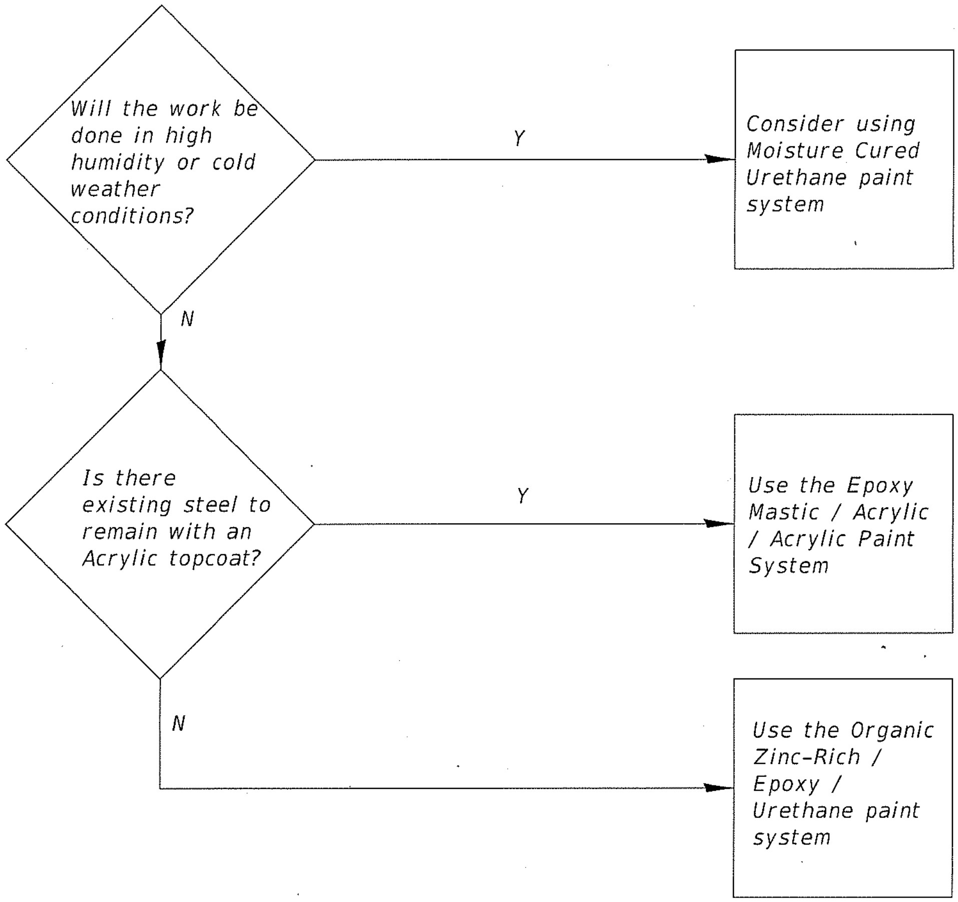


Figure 1

4) *Determination of Bridge Color*

Bridge color is determined via district/owner preference.

IDOT uses four standard colors for bridge fascias. They are:

- Interstate Green (Munsell No. 7.5G 4/8)
- Reddish Brown (Munsell No. 2.5YR 3/4)
- Blue (Munsell No. 10B 3/6)
- Gray (Munsell No. 5B 7/1)

For ease of inspection, all interior surfaces shall be Gray.

5) *Caulking of Connections on Existing Structures*

Caulking of connections (splices, gusset plates, etc.) may be utilized at the request of the District Bridge Maintenance Engineer and/or Bridge Paint Technician, or the Owner's representative for LPA structures. Caulking has been successfully used on truss rehabilitation contracts. It is seen as a viable method of extending the life of coatings in locations where corrosion is known to have occurred.

6) *Cleaning and Painting Existing Steel Structures in Conjunction with Bridge Repairs*

Structures with a reduced load capacity due to section loss will require cover plates to restore strength to the damaged areas. This is typically provided in a steel repair contract. Paint-only contracts should not include items such as plating that are not germane to cleaning and painting existing steel. Painting on bridge repair contracts should utilize the same policies as those used in a paint-only contract.

7) *Cleaning and Painting of Existing Weathering Steel Structures*

Cleaning and painting of existing weathering steel has been successfully accomplished utilizing the standard details, pay items, and special provisions. There are no separate details, pay items, or special provisions required for cleaning and painting an existing weathering steel bridge.

Required Pay Items, Special Provisions, General Notes, and Plan Details

1) *Required Pay Items*

Three main pay items are used when painting an existing bridge: one for cleaning and painting, one for containment and disposal of residues, and one for a warranty. For projects including bridge repairs, cleaning and painting new steel or contact surfaces between new and existing steel is included with the furnishing and erecting pay items and not paid for using paint pay items.

Cleaning and painting of existing structural steel shall be paid for as CLEANING AND PAINTING STEEL BRIDGE, at the location specified. The number of locations corresponds with the number of bridges on the contract. Dual structures require two pay items, one for each bridge, even though they technically are in the same location.

If the existing structure paint system contains lead, the pay item CONTAINMENT AND DISPOSAL OF LEAD PAINT CLEANING RESIDUES, at the location specified, shall be used. If the existing structure does not contain lead, the pay item CONTAINMENT AND DISPOSAL OF NON-LEAD PAINTING RESIDUES, at the location specified, shall be used. The Master Structure Report from Structure Information Management System (SIMS) will show if the existing structure coating contains lead for State-owned structures. In general, structures erected prior to 1986 are coated with lead paint. Multiple bridges may be covered by one containment pay item with no individual location specified.

A two-year painting warranty may be used on projects for cleaning and painting of existing structures, with or without lead paint. The warranty may only be used when full removal and replacement of the existing coating is specified. Use of this warranty requires the pay item BRIDGE CLEANING AND PAINTING WARRANTY, at the location specified. There should be only one bridge per warranty pay item.

When caulking of structures is required, a separate pay item is not used, and the item is paid for via Section 109.04 of the Standard Specifications for Road and Bridge Construction.

2) *Required Special Provisions*

The following Guide Bridge Special Provisions (GBSPs) are used when applicable:

- GBSP21: Cleaning and Painting Contact Surface Areas of Existing Steel Structures
- GBSP25: Cleaning and Painting Existing Steel Structures
- GBSP26: Containment and Disposal of Lead Paint Cleaning Residues
- GBSP60: Containment and Disposal of Non-Lead Paint Cleaning Residues
- GBSP94: Warranty for Cleaning and Painting Steel Structures

The following Bureau of Design & Environment (BDE) special provision is used when applicable:

- Moisture Cured Urethane Paint System

3) *Required General Notes*

The following General Notes shall be placed on plans for contracts involving bridge painting.

When painting existing steel structures:

Cleaning and painting of the existing structural steel shall be as specified in the special provision for "Cleaning and Painting Existing Steel Structures". All beams, bearings and other structural steel within (*) ft (measured along the beam) of either side of deck joints shall be cleaned per Near White Blast Cleaning (SSPC- SP10). The exterior surfaces and bottom of the bottom flange of the fascia beams shall be cleaned per Commercial Grade Power Tool Cleaning (SSPC- SP15).

The designated areas cleaned per Near White Blast Cleaning (SSPC- SP10) and per Commercial Grade Power Tool Cleaning (SSPC- SP15) shall be painted according to the requirements of (**). The color of the final finish coat for all interior steel surfaces shall be Gray, Munsell No 5B 7/1. The color of the final finish coat for the exterior and bottom flange of the fascia beams shall be (***).

*5 ft. minimum or as required to repair damaged coatings

**See flowchart for correct paint system

***See "Determining Bridge Color" above. The Munsell Numbers are required to be added to the General Notes.

On large projects with spans greater than 200 feet, truss bridges, or moveable bridges, containment systems are required to be analyzed and sealed by an Illinois Licensed Structural Engineer. This requirement is found in the special provisions above. For these cases, the following note shall be added to the General Notes:

The Contractor shall submit calculations and details demonstrating the structural integrity of the bridge is maintained under the additional imposed loads of the containment system. See special provisions.

Air monitors are required for all structures with lead abatement that have sensitive receptors within 1000 feet or five times the bridge height. One air monitor may be required for each cardinal direction, for a maximum of four. Sensitive receptors are defined as schools, homes, businesses, livestock, etc. For example, if at one end of the bridge there are two homes, one 500 ft. away, one 1200 ft. away, and one school 700 ft. away from the bridge, two monitors would be required, one in the direction of the home 500 ft. away and one in the direction of the school. The special provisions give detailed instructions as to the exact placement of the monitors, and the plans only need to state the number required. Vehicular traffic is considered transient and not exposed for a long enough period to be considered a sensitive receptor. When air monitors are required, the following note shall be added to the General Notes:

A minimum of (*) air monitor(s) will be required to monitor abrasive blasting operations at this site. See special provision for "Containment and Disposal of Lead Paint Cleaning Residues."

*Number as determined by Department Policy.

For structures that do not contain lead, the containment requirements are reduced because the containment is only to abate nuisance dust instead of lead residues. For these structures, the following note is required:

Containment of cleaning residue is required to control nuisance dust. See special provisions.

For all paint contracts, IDOT requires SSPC QP1 Certification. For all contracts that involve lead abatement, IDOT requires SSPC QP2 Certification in addition to SSPC QP1. These requirements are listed in the special provisions, but the following General Note is typically added to restate them:

SSPC QP1 (and SSPC QP2) Certification is required for this Contract.

Some Districts have district-specific notes involving overspray, bridge washing, cleanup, re-seeding, etc. These notes are intended to address specific issues noted by District Paint Technicians. These notes should be added as required.

4) *Required Plan Details*

For contracts containing cleaning and painting of existing steel, all details of the steel to be painted shall be shown on the plans. This includes a framing plan, beam details, diaphragm details, bearing details, and anything else necessary for the contractor to be able to accurately determine a bid. A General Plan and Elevation of the structure to be painted shall also be added to inform the Contractor of work conditions.

Because there are numerous details, and each contract is different, listing all the required details would be tedious and unhelpful. Rather, a checklist is provided as an attachment to this memorandum. This checklist may be used by designers to determine if all the correct details have been added to the Contract plans.

Implementation

If you have questions or specific situations that need to be addressed, please contact the Paint Technician for the District involved and/or Mark Shaffer of the Bureau of Bridges and Structures at (217) 785-2914 or Mark.Shaffer@illinois.gov.

Checklist for Bridge Painting Contracts:

1. Are the required General Notes stated above included in the contract?

2. Has the existing structure's paint coating been verified with data in SIMS?

3. Are applicable district-specific notes included? Verify the need for district-specific notes with the District Paint Technicians.

4. Are the existing (For Information Only) plans legible? Sometimes existing plans do not scan well. If there is an issue with obtaining legible, current plans, contact the Bureau of Bridges and Structures.

5. Are the correct bridges shown on the plans? This is typically only a concern in contracts with large interchanges where there are many structures in close proximity.

6. Is a General Plan and Elevation sheet included for each structure to be painted in the contract?

7. Do the plans account for widening or other additions to the original steel square footage?

8. Does the framing plan show the lengths of the members? Sometimes the framing plan is populated with letters (e.g. "Segment L1, L2, etc."), which then require another chart (sheet) to be added to put the lengths of these members in the contract plans.

9. Do the plans show the framing plan and not the top of slab elevations plan? The two sheets are often very similar-looking.

10. Are the diaphragm and cross-frame sizes shown? Diaphragms and cross-frames can account for a large amount of square footage in larger structures.

11. Do the plans account for recent bearing replacements? There may be access issues if old rocker bearings have been replaced with steel extensions, and the Contractors should know this prior to bid.

12. Do the special provisions correspond with the plan notes? Often, special provisions are copied from old contracts and contain incorrect structure numbers, paint areas, etc. Are all structures in the contract shown in the special provisions?

13. Are the correct pay items shown in the Summary of Quantities? Section 506 pay items are for painting new steel structures.

14. Is a warranty only used when the entire structure is painted?

15. Does the required contractor certification shown on the plans match the special provisions?

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	19.2
From:	D. Carl Puzey D. Carl Puzey	
Subject:	Membrane Waterproofing System for Buried Structures	
Date:	March 5, 2019	

To adequately waterproof a buried structure, IDOT requires a self-adhering membrane sheet with film, a geocomposite drainage sheet (i.e. geocomposite wall drain), and ancillary materials to attach these components. Previous versions of the Membrane Waterproofing System for Buried Structures Guide Bridge Special Provision (GBSP 81) contained Physical Property tables for these components, which were not consistent with products known to be effective in the field. Moreover, the geocomposite wall drain was a hidden cost not obvious to designers and contractors.

In order to simplify testing requirements and make pay items more consistent with those used on bridges, the pay item Membrane Waterproofing System for Buried Structures is being split into two pay items: Membrane Waterproofing System for Buried Structures and Geocomposite Wall Drain. The Guide Bridge Special Provision has been updated to simplify the Physical Property table for the membrane sheet and remove the references to the geocomposite drainage sheet. The Geocomposite Wall Drain specifications are found in Section 591 of the Standard Specifications.

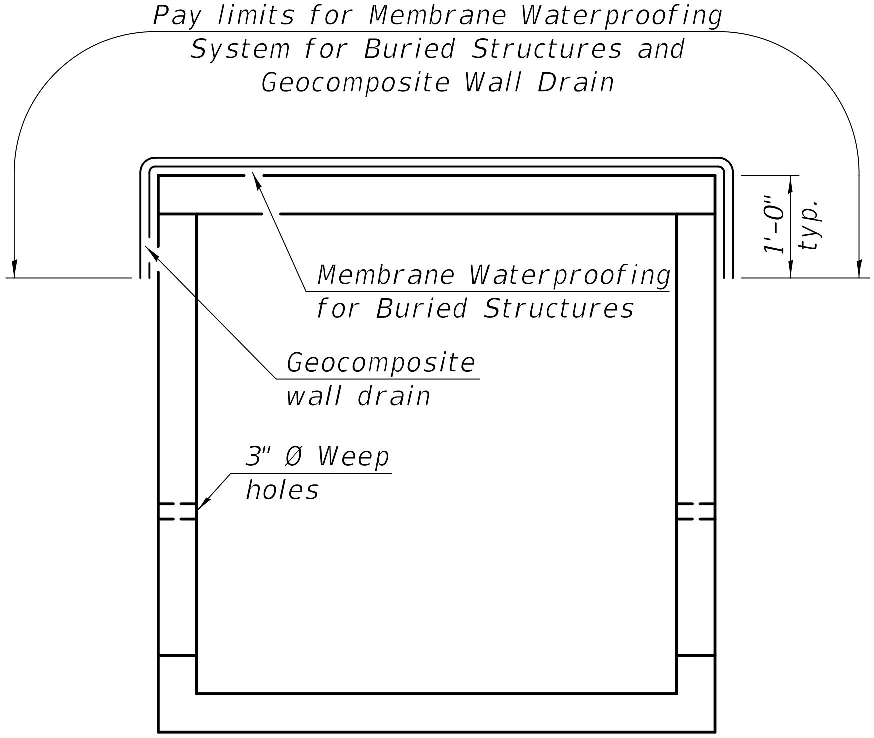
The attached figures show revised pay limits, with the Geocomposite Wall Drain and Membrane Waterproofing for Buried Structures shown as separate pay items.

The details specified in this memorandum shall be effective for projects beginning with the April 26, 2019 letting. The Bureau of Bridges and Structures will coordinate with design consultants and district offices to make necessary revisions.

Please direct questions to Mark Shaffer in the Policies, Standards, and Specifications Unit at (217) 785-2914.

Attachments

MDS/kktABD19.2-20190305

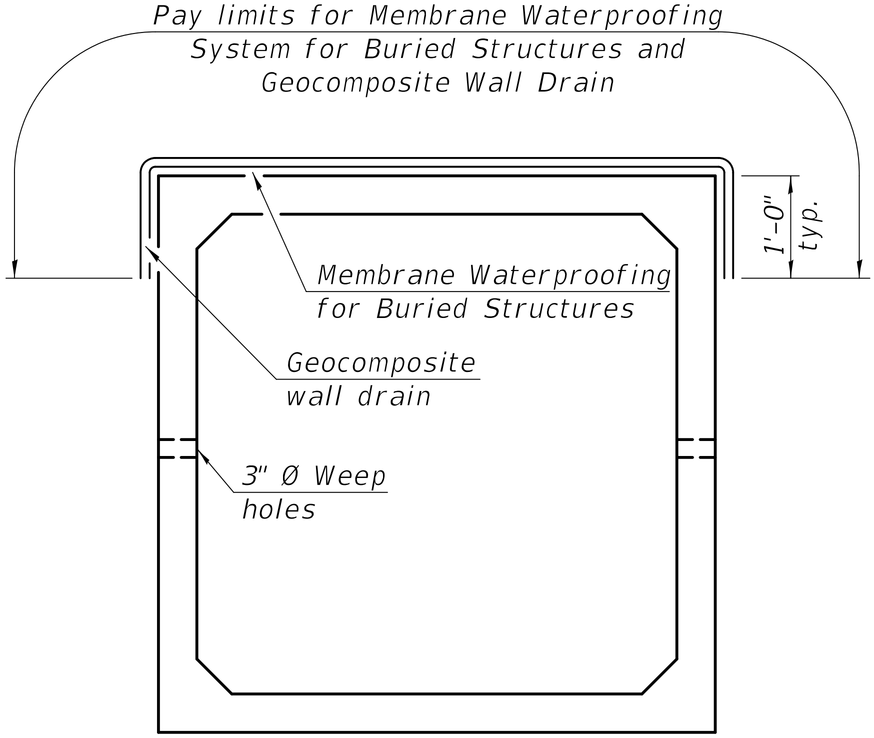


CAST-IN-PLACE CONCRETE BOX CULVERT

Fill Height ≤ 3 ft.
For Fill Heights > 3 ft., Omit Membrane Waterproofing for Buried Structures and Geocomposite Wall Drain.

Note:
Geocomposite Wall Drain shall be according to Section 591 of the Standard Specifications, except that concrete nails shall not be used in areas where it overlaps Membrane Waterproofing System for Buried Structures.

MEMBRANE WATERPROOFING SYSTEM FOR CAST-IN-PLACE CULVERTS

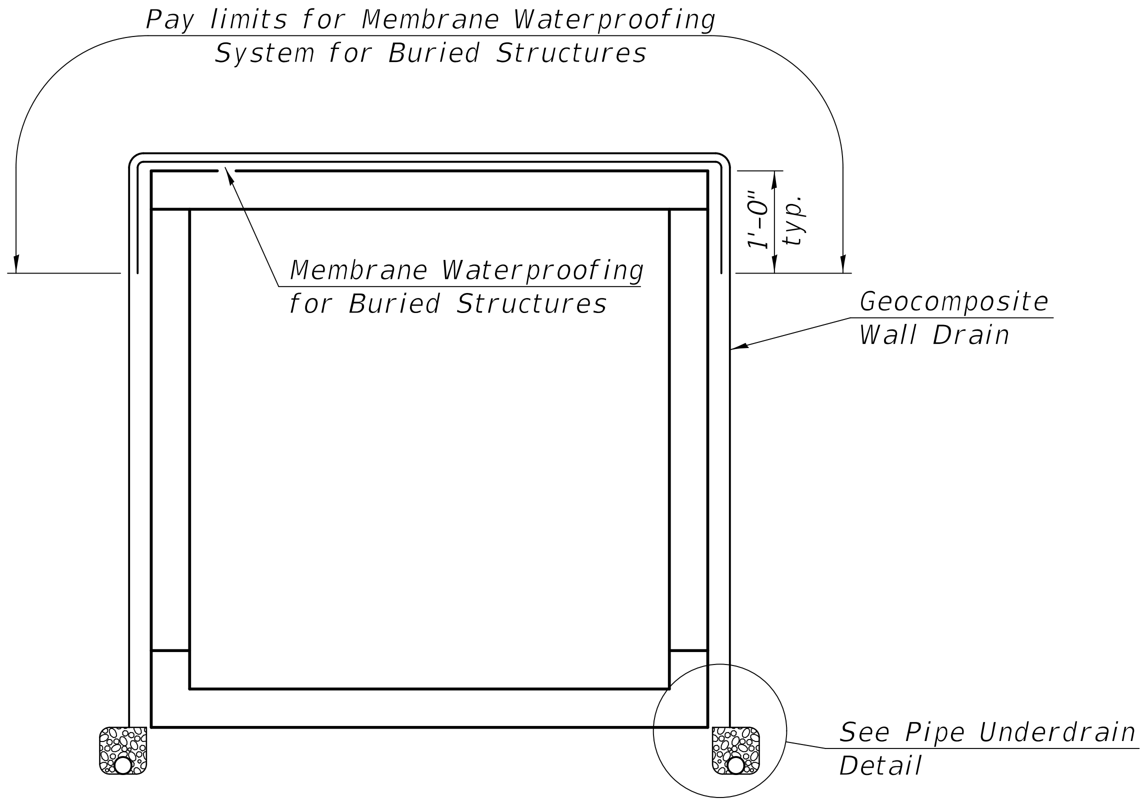


PRECAST CONCRETE BOX CULVERT

Fill Height ≤ 3 ft.
For fill heights > 3 ft., omit Membrane Waterproofing System for Buried Structures and Geocomposite Wall Drain.

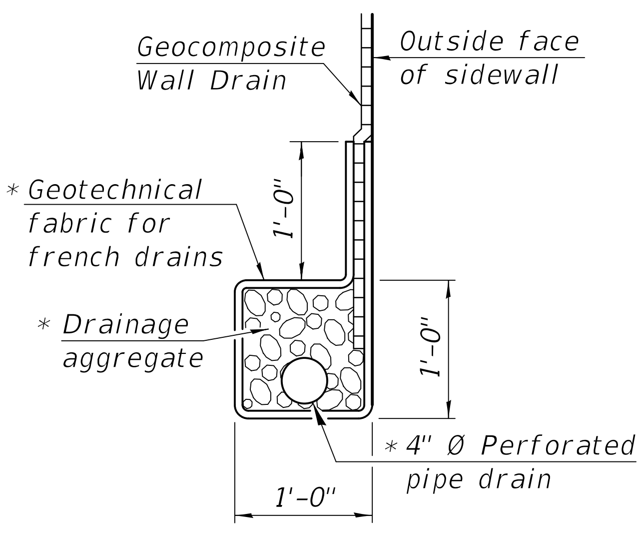
Note:
Geocomposite Wall Drain shall be according to Section 591 of the Standard Specifications, except that concrete nails shall not be used in areas where it overlaps Membrane Waterproofing System for Buried Structures.

MEMBRANE WATERPROOFING SYSTEM FOR PRECAST CULVERTS



CAST-IN-PLACE CONCRETE BOX CULVERT

Pedestrian tunnel (All fill heights)



PIPE UNDERDRAIN DETAIL

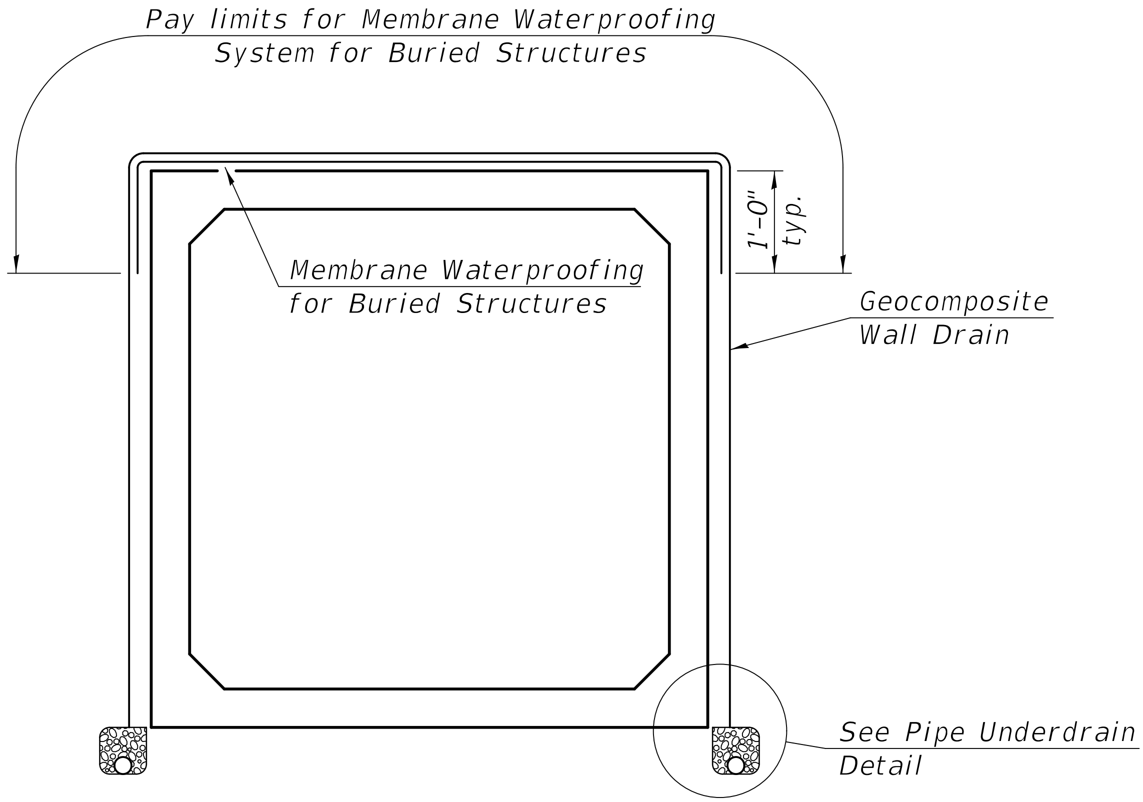
Note:

The pay limits for Geocomposite Wall Drain are along the perimeter of the top and side walls.

Geocomposite Wall Drain shall be according to Section 591 of the Standard Specifications, except that concrete nails shall not be used in areas where it overlaps Membrane Waterproofing System for Buried Structures.

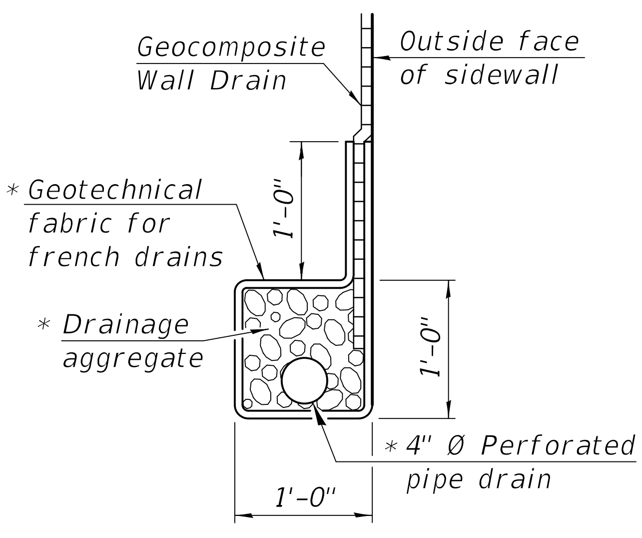
* Cost included with Pipe Underdrains for Structures 4". All drainage components shall extend to 2'-0" from the end of each wingwall, except an outlet pipe shall extend until interesecting with side slopes. The pipes shall drain into concrete headwalls. See Highway Standard 601101.

MEMBRANE WATERPROOFING SYSTEM FOR CAST-IN-PLACE CULVERTS



PRECAST CONCRETE BOX CULVERT

Pedestrian tunnel (All fill heights)



PIPE UNDERDRAIN DETAIL

Note:

The pay limits for Geocomposite Wall Drain are along the perimeter of the top and side walls.

Geocomposite Wall Drain shall be according to Section 591 of the Standard Specifications, except that concrete nails shall not be used in areas where it overlaps Membrane Waterproofing System for Buried Structures.

* Cost included with Pipe Underdrains for Structures 4". All drainage components shall extend to 2'-0" from the end of each wingwall, except an outlet pipe shall extend until interesecting with side slopes. The pipes shall drain into concrete headwalls. See Highway Standard 601101.

MEMBRANE WATERPROOFING SYSTEM FOR PRECAST CULVERTS

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	15.5
From:	D. Carl Puzey	D. Carl Puzey
Subject:	Revised Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges	
Date:	October 6, 2015	

Based on the research findings of the National Cooperative Highway Research Program (NCHRP) Report 12-84 along with the Transportation Research Board (TRB) Report w197, the American Association of State Highway and Transportation Officials (AASHTO) has updated the Manual for Bridge Evaluation (MBE) with the 2014 and 2015 Interims. These MBE Interims also incorporated and superseded the Federal Highway Administration (FHWA) Publication No. FHWA-IF-09-014 titled "*Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges*" dated February 2009. Based on these changes, the Department found it necessary to supersede our original ABD Memo 10.2, "*Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges*".

To assist with determining gusset plate capacities and ratings, the Department has updated the attached guidelines. These guidelines are intended to be used with the 2014 and 2015 MBE Interims. Updates to this guidance will be revisited and updated if required due to future releases of the MBE.

All Department staff and consultants who are load rating trusses with gusset plates shall use the most recent version of the MBE along with the attached guidelines for determining the capacities and ratings of gusset plates for structure ratings initiated after the date of this memorandum. Currently, the Department does not see a need to update previous gusset plate ratings solely due to these updates. However, more favorable ratings may be attainable using these updates.

Further guidance regarding load rating implementation for Local Public Agency (LPA) maintained trusses with gusset plates will be forthcoming in the near future.

Questions regarding these documents may be directed to Carl Puzey at (217) 782-2124.

Attachment

DCP/kktABD15.5gussetplates-20151006

Guidelines for Rating Gusset Plates

Introduction

Gusset plate ratings have been included in the 2014 Interim and 2015 Interim of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Evaluation (MBE). Therefore, bridge owners should check the capacity and load rating of gusset plates on steel truss bridges as part of the load rating calculations.

This guideline is intended for use with the 2014 and 2015 Interims of the MBE. Updates to this guidance will be revisited and updated if required due to future releases of the MBE.

FHWA Resources

The previous Federal Highway Administration (FHWA) document *"Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges"* (Publication Number FHWA-IF-09-014) has been incorporated into and superseded by the 2014 Interims of the MBE and is no longer a current gusset plate rating document. The research results from the FHWA National Cooperative Highway Research Program (NCHRP) Project 12-84 along with Transportation Research Board (TRB) Report w197, as well as reference to the Illinois Department of Transportation (IDOT) sponsored "*Gusset Plate Evaluation Guide*", have also been incorporated into the 2014 and 2015 Interims of the MBE.

IDOT Bureau of Bridges and Structures (BBS) Gusset Plate Rating Guidelines

The BBS has developed these guidelines for rating gusset plates for Illinois. These recommendations shall take precedence over the current MBE if in conflict.

Rating Method

Currently the main load rating method for the BBS is Load Factor Rating (LFR). Rating methods other than LFR are allowed but should be brought to the attention of the owner.

Refined Analysis Ratings

Where results of a load rating analysis produce substandard controlling ratings, a more refined analysis should be performed consistent with the 2014 and 2015 Interims of the MBE. If using a refined rating analysis method, it should be brought to the attention of the owner.

The "*Gusset Plate Evaluation Guide*" prepared by Wiss, Janney, Elstner Associates, Inc. (WJE) for the Department provides examples to assist raters with the refined analysis of gusset plates. This guide is available at the IDOT website at the following link (http://www.idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/index under the "Bridges & Structures" tab and "Ratings" tab). Other refined analysis approaches, including the Truncated Whitmore Section method, are also acceptable.

Dead Load Forces

The BBS recommends using 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 per the MBE.

Live Load Forces

Live load forces may be determined by using the maximum envelope forces or by the concurrent forces. The maximum envelope forces should be used for the individual member rating checks. However, using the maximum envelope forces for the overall gusset plate shear checks may be un-conservative. Therefore, the BBS recommends using the controlling concurrent forces for the overall gusset plate shear rating checks.

Both maximum enveloped forces and concurrent forces can be attained using the AASHTOWare Bridge Design and Rating (BrDR) software (formerly Virtis software).

Effective Length Factor, K

For the effective length factor, K, the BBS recommends using K = 0.5 (MBE L6B.2.6.4) for all typical cases when evaluating the column model for gusset plates. If a rater uses a K factor other than 0.5, it should be brought to the attention of the owner.

Shear Reduction Factor, Ω

For the Shear Reduction Factor, Ω, the BBS recommends Ω = 0.88 (MBE L6B.2.6.3) be used for typical cases. The Shear Reduction Factor, Ω, can vary from 0.74 to 1.00. Therefore, it is possible that a more refined analysis of this factor may provide more favorable results. Thus, if the rater uses an Omega Factor other than Ω = 0.88, it should be brought to the attention of the owner

Slip Critical Considerations

Slip critical connections do not need to be considered for the gusset plate rating.

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. Sometimes 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).

Currently, the BBS recommends 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 plate(s) on one side carrying 50% of the load, the maximum redistribution would result in the gusset plate(s) on the one (strong) side carrying a maximum of 65% of the total load and the gusset plate(s) on the other (weak) side carrying a minimum of 35% of the total load. If this load redistribution technique is utilized, it should be brought to the attention of the owner.

Please also see the section below on Section Loss.

Capacity Reduction Factor

The previous capacity reduction factor of the 2009 FHWA Guidance is now included in the LRFD system factor within the current MBE. This factor has been removed for the LFR gusset plate ratings in the current MBE.

Section Loss

Rating of the gusset plates for section loss shall be based on the current MBE (see MBE Article 6A.6.5). However, where the MBE procedures produce a rating that controls the overall structure rating, a more refined analysis is recommended. Procedures for the refined section loss calculations are outlined in the "*Gusset Plate Evaluation Guide*". If this refined section loss method is utilized, it should be brought to the attention of the owner.

If there is no recorded corrosion of the gusset plates, the splice plates or the fasteners, raters need not consider section loss. If there is recorded corrosion of the gusset plates, splice plates and/or fasteners, raters should reduce the areas and capacities of the affected members to account for the greater of:

- The actual section loss based on the detailed measurements (from the inspection records).
- 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 should be verified (see Load Distribution between Gusset Plates above).

Partial Shear Planes

The 2014 MBE Interims added a new Partial Shear Plane check for gusset plates. Based on research conducted on behalf of the Department, the Partial Shear Plane checks within the 2014 MBE Interims may be overly conservative in some incidences. Therefore, if the rating of a Partial Shear Plane is controlling the rating of the structure, the BBS recommends that a more refined analysis be performed to possibly improve the overall structure rating.

7/23/21 Note: Special PGE requirements detailed in this memo for design of live load distribution is no longer required; however, see ABD 21.1 for PGE requirements on the sides of precast boxes and pay limits.

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	11.3 (REV)
From:	D. Carl Puzey D. Carl Puzey	
Subject:	LRFD Design Requirements for Precast and Cast-In-Place Concrete Box Culverts	
Date:	November 2, 2011 (Revised January 27, 2012)	

The Department is beginning implementation of AASHTO Load and Resistance Factor Design (LRFD) for buried structures, which includes culverts, pipes and three sided structures. This memorandum addresses concrete box culverts.

PRECAST CONCRETE BOX CULVERTS

Effective with the 2012 Standard Specifications for Road and Bridge Construction and beginning with the January 20, 2012 letting, all precast concrete box culverts and precast extensions of existing culverts shall utilize LRFD by applying the standard designs of ASTM C 1577. Precast box configurations and loadings not addressed in ASTM C 1577 may be designed utilizing LRFD with the latest version of the BOXCAR program, provided similar slab and wall thicknesses of the nearest standard geometric configurations from ASTM C 1577 are used. These non-standard precast box culvert sections shall have the design shown on the contract plans, similar to a cast-in-place box, and shall be sealed by an Illinois Licensed Structural Engineer. The following table is a list of standard precast box configurations that may be found in ASTM C 1577. Standard configurations are encouraged for new culvert designs. If the closest standard configuration is too tall for a specific application, consider setting the box invert deeper or utilizing more culvert barrels of a shallower configuration before using a non-standard configuration.

Standard Precast Concrete Box Culvert Configurations (Span x Rise - ft.)				
3 x 2	6 x 3	8 x 4	9 x 9	11 x 6
3 x 3	6 x 4	8 x 5		11 x 8
	6 x 5	8 x 6	10 x 5	11 x 10
4 x 2	6 x 6	8 x 7	10 x 6	11 x 11
4 x 3		8 x 8	10 x 7	
4 x 4	7 x 4		10 x 8	12 x 4
	7 x 5	9 x 5	10 x 9	12 x 6
5 x 3	7 x 6	9 x 6	10 x 10	12 x 8
5 x 4	7 x 7	9 x 7		12 x 10
5 x 5		9 x 8	11 x 4	12 x 12

It is important to note there are a few design limitations associated with ASTM C 1577. First, the design tables are adequate for skews up through 30 degrees and also for larger skews when the design fill is greater than 5 feet. Skews larger than 30 degrees with design fills less than or equal to 5 feet shall be handled with design tables that IDOT will provide through a (BDE) special provision entitled

7/23/21 Note: Special PGE requirements detailed in this memo for design of live load distribution is no longer required; however, see ABD 21.1 for PGE requirements on the sides of precast boxes and pay limits.

"CONCRETE BOX CULVERTS WITH SKEWS > 30 DEGREES AND DESIGN FILLS ≤ 5 FEET (BDE)" prior to the January letting. Designs from this special provision or ASTM C 1577 do not require a seal by an Illinois Licensed Structural Engineer. This policy is summarized in the following chart.

Skew*	Design Fill	Specification
≤ 30	All Fills	ASTM C 1577
> 30	> 5 ft	ASTM C 1577
> 30	≤ 5 ft'	IDOT Special Provision

*The skew is the angle between a perpendicular line to the box culvert and the centerline of the roadway.

Second, the design tables of ASTM C 1577 are based on a live load distribution of 1.15 in both directions through design fills ≥ 2 feet. To achieve this distribution, Porous Granular Embankment (PGE) backfill is required for all boxes meeting either of the following two conditions:

- Depth of fill ≥ 2 ft. and ≤ 8 ft.
- Depth of fill ≤ span of largest box in configuration

The limits and quantities of the PGE necessary for the box installation shall be shown and included in the roadway plans.

Design fills less than 2 feet shall satisfy the requirements of AASHTO LRFD Article 4.6.2.10. The Department recommends PGE or a continuation of the roadway sub base up to the 2 feet of fill. Note that for Case 1, parallel to the span, the LLDF shall then be 1.15.

Roadway Plan Presentation

Over the years, many Districts have developed their own unique contract plan details for precast box culverts, some by repeating portions of the AASHTO details and tables and others by developing their own notes, tables and details. This transition from Load Factor Design (LFD) to LRFD design is a good opportunity to unify and promote consistent details throughout the State. Therefore, in lieu of the various past practices, we are recommending the following:

1. Each culvert shall be identified on the plan/profile sheets of roadway plans with the following information:

   ASTM C 1577; Station; Size; Skew; Design Fill

   Fabricators will be instructed in the Bureau of Materials and Physical Research (BMPR) policy memorandum "Quality Control/ Quality Assurance Program for Precast Concrete Products" to identify each precast box culvert section in the same way for easy identification and location in the field. Additionally, the policy memorandum requires fabricators to include their producer mark and the date of manufacture on each precast box culvert section.

7/23/21 Note: Special PGE requirements detailed in this memo for design of live load distribution is no longer required; however, see ABD 21.1 for PGE requirements on the sides of precast boxes and pay limits.

2. Each set of applicable roadway plans shall have a Culvert Schedule including the following minimum information. The designer shall determine the design fill heights, and shall note whether PGE backfill is required.

Precast Box Culvert Schedule (ASTM C 1577)					
Station	Size (Span x Height)	Skew*	Design Fill (ft.)		PGE backfill required
			Edge of shldr. (minimum)	Maximum	

*Skews > 30° with design fills ≤ 5 ft. require a special design. See BDE Special Provision "CONCRETE BOX CULVERTS WITH SKEWS > 30 DEGREES AND DESIGN FILLS ≤ 5 FEET (BDE)". The skew is the angle between a perpendicular line to the box culvert and the centerline of the roadway.

3. The roadway plans shall clearly illustrate the intended limits, pay item and quantity of the PGE necessary for the box installation.

CAST-IN-PLACE (CIP) BOX CULVERTS

In order to allow some time for plan preparation, all CIP concrete box culverts and CIP extensions of existing culverts, beginning with the June 15, 2012 letting and beyond shall utilize LRFD according to the latest version and interims of the AASHTO LRFD Bridge Design Specifications. The Department anticipates issuing Standardized Design Tables of single span box culverts for the Culvert Manual. Until these tables become available, all CIP simple span box culverts, on the June 15, 2012 letting and beyond, will require a design sealed by an Illinois Licensed Structural Engineer. All multi-span CIP boxes will continue to require a design sealed by an Illinois Licensed Structural Engineer similar to our current policy.

Design Preferences

The same live load distribution of 1.15, as previously discussed for precast concrete box culverts, shall also be used for CIP boxes. As such, PGE will also be required for the same ranges of design fill.

CIP concrete box culverts shall be designed for the perpendicular span between the culvert walls. The main flexure reinforcement is therefore also placed at right angles to the wall. On skewed structures, the skewed areas near staged construction lines or end sections shall preferably be addressed with an edge beam design satisfying Article 4.6.2.1.4 of the AASHTO LRFD Bridge Design Specifications. However, there are circumstances where it may be more advantageous to place the flexure reinforcement along the skew rather than perpendicular to the walls. Examples may be culverts with short lengths, staged construction and large skew or shallow fills where an edge beam design requiring more slab depth may interfere with the roadway sub base. In these cases, the perpendicular span shall be used to design the slab thickness and the steel area.

7/23/21 Note: Special PGE requirements detailed in this memo for design of live load distribution is no longer required; however, see ABD 21.1 for PGE requirements on the sides of precast boxes and pay limits.

- The steel area shall then be increased by the multiplication of $\sec^2\theta$ and the resulting area of steel placed along the skew. The skew, θ, is defined as the angle between a perpendicular line to the box culvert and the centerline of the roadway. Additionally, Article 5.5.4.2.1 of the AASHTO LRFD Bridge Design Specifications shall be satisfied such that the slab remains "tension controlled".

IMPLEMENTATION

In summary, all precast concrete box culverts and precast extensions of existing culverts, beginning with the January 20, 2012 letting, shall utilize LRFD by applying the standard designs of ASTM C 1577 and all CIP concrete box culverts and CIP extensions of existing culverts on the June 15, 2012 letting and beyond shall utilize LRFD according to the latest version and interims of the AASHTO LRFD Bridge Design Specifications.

Due to these time frames, it is possible to have a few scenarios that will require additional action. First, a LFD designed CIP box culvert may appear on some of the early 2012 lettings. If there is not a note stating otherwise on the plans, the contractor may still have the option to substitute a precast box culvert as permitted by Article 540.04 of the Standard Specifications. In these cases, a precast box culvert built according to ASTM C 1577 may be substituted provided the design requirements previously described are satisfied. To ensure all potential additional costs, such as PGE, are covered by the contract for this scenario, a BDE special provision of either "CONCRETE BOX CULVERTS WITH SKEWS ≤ 30 DEGREES REGARDLESS OF DESIGN FILL AND SKEWS > 30 DEGREES WITH DESIGN FILLS > 5 FEET (BDE)" or "CONCRETE BOX CULVERTS WITH SKEWS > 30 DEGREES AND DESIGN FILLS ≤ 5 FEET (BDE)" shall be inserted into each applicable contract document.

Second, the contract plans may originally have detailed a precast concrete box based on the old AASHTO M 259 or M 273 (LFD design) but the equivalent standard ASTM C 1577 (LRFD designed) precast concrete box culvert may require PGE, depending on the design fill. To ensure all potential additional costs, such as PGE, are covered by the contract for this scenario, the appropriate BDE special provision as mentioned in the previous paragraph, shall be inserted into each applicable contract document.

The Bureau of Bridges and Structures will coordinate with the Bureau of Design and Environment to insure contracts with culverts, let before June 15, 2012, have the appropriate special provisions inserted. If there are any questions regarding these policies please contact Gary Kowalski at (217) 785-2914.

KLR/kktABD11.3LRFDrevised-20111102

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS
From:	Ralph E. Anderson Ralph E. Anderson
Subject:	AASHTO Manual for Bridge Evaluation
Date:	April 3, 2009

The American Association of State Highway and Transportation Officials has published the following publication:

Manual for Bridge Evaluation

Item Code: MBE-1 (Print), MBE-1-UL (Online)

You can order this, and all AASHTO publications, by calling 1-800-231-3475 or visiting the online bookstore, https://bookstore.transportation.org

Effective immediately, this publication replaces the *AASHTO Manual for Condition Evaluation of Bridges* and the *AASHTO Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*. It is applicable to the performance of bridge evaluation, including inspection, material and load testing and load rating of bridges.

TAA/kktABDaashtomanualBridgeevaluation-20090126

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	09.1
From:	Ralph E. Anderson	Ralph E. Anderson
Subject:	Guidelines for Structural Assessment Reports for Contractor's Means and Methods	
Date:	March 9, 2009	

This memorandum provides guidance to engineers regarding the Guide Bridge Special Provision for Structural Assessment Reports for Contractor's Means and Methods (GBSP 67). This special provision will initially be applicable for pilot projects selected by the Department beginning with the June 12, 2009 letting. For future lettings, appropriate projects may be selected by the Department and the Phase II engineers will be notified that GBSP 67 is applicable.

After the I-35W Bridge in Minnesota collapsed, the Federal Highway Administration issued Technical Advisory T5140.28, which charged state transportation agencies with ensuring that construction loading and stockpiled materials placed on structures do not overload its members.

In response to this advisory, the Department has developed GBSP 67, which requires the contractor to submit Structural Assessment Report(s) (SARs) to the engineer for approval. The SARs shall demonstrate that the structural demands of the applied loads due to the contractor's means and methods will not exceed the available capacity of the structure at the time the loads are applied. GBSP 67 is intended to replace the special provision for Demolition Plans for Removal of Existing Structures (GBSP 63) and to supplement the special provisions for erection of curved or complex steel structures.

For state owned bridges, the SARs shall be submitted by the contractor to the Resident Engineer and forwarded to the Bureau of Bridges and Structures (BBS), Attn: Design Section Chief, for review and approval. These submittals will be processed in the same manner as other construction–related submittals to BBS. BBS will respond to the District. For local agency owned bridges, the SARs shall be submitted to the owner's Resident Engineer. SARs for local agency projects will not be reviewed by BBS.

To assist in determining the available capacity for the SARs, each project with an existing structure will have an Existing Structure Information Package (ESIP) available to the contractor at the time the contractor obtains the plans and proposal prior to bidding. This package will typically include existing or "As-Built" plans and the latest National Bridge Inspection Standards (NBIS) inspection report. For state owned bridges, the District will be responsible for providing this package. After award, requests by the contractor for additional information shall be accompanied by justification. The District may ask the Phase II consultant engineer to prepare the ESIP. For local agency owned bridges, the owner will be responsible for providing this information to the contractor if the information is requested.

RESPONSIBILITIES

To assist in addressing the requirements of the SAR special provision, the responsibilities of the Phase II engineer, the contractor and the contractor's structural engineer are noted below.

Responsibilities of the Phase II Engineer:

- For all projects on state owned bridges:

    - Verify with BBS whether a note is required on the contract plans stating that a consultant pre-qualification category other than "Highway Bridges-Typical" will be required for preparation of the SARs. If a note is required, BBS will identify which pre-qualification category should be specified in the plan note shown below.

- For projects with an existing structure:

    - Review the existing and/or "As-Built" plans, the latest NBIS inspection report, shop plans and other reports such as the Bridge Condition Report (BCR), Structure Geotechnical Report (SGR) or Hydraulic Report that were not completed by that Phase II engineer.

    - Determine whether any notes should be provided on the contract plans advising the contractor there is structure deterioration. In addition to the General Note shown below, other advisory notes may be shown. These notes can be very helpful to the contractor and other field personnel. (For example, "Beam 1 is severely deteriorated and the Contractor is advised to put no loads on it.")

- Consider whether the condition of the existing structure will require the contractor to work under some restrictions. (For example, if the existing structure is so deteriorated that the contractor will not be able to bring a crane on the structure and will need to work from the stream, then making arrangements to acquire a permit to work in the water may be appropriate.)

- Obtain the current ratings or rating factors (Inventory and Operating) and any live load restrictions that are on file for the existing structure and show them on the plans. These ratings or rating factors are measures of the live load carrying capacity.

● <u>Information to be shown on the contract plans (for state owned bridges), on a case-by-case basis (per discussion with BBS), for some complicated projects:</u>

- Add the following note to the General Notes of the structure plans:

  "The Contractor shall retain the services of an engineering firm, prequalified in the IDOT consultant selection category of Highway Bridges (Advanced Typical / Complex), for preparation of the Structural Assessment Report(s). Contractor's pre-approval shall not be applicable for this project. See Special Provision."

● <u>Additional information to be shown on the contract plans when there is an existing structure. (Structures that are allowed to carry legal loads only are not considered to have a live load restriction for the purposes of GBSP 67. Structures with signs stating "40 Tons Gross, 10 Tons Axle" indicate that only legal loads are allowed.):</u>

- For existing structures designed by the AASHTO Standard Specifications for Highway Bridges, add the following note to the General Notes of the structure plans:

  "<u>Current Ratings on File for Existing Structure</u>
  Inventory: HS__
  Operating: HS__
  Live Load Restrictions: __ ["Yes (_____)" (Provide a value in tons)
  "No"]

  Inventory and Operating Ratings and Live Load Restrictions are provided for information only. Inventory and Operating Ratings are based on HS loading and configuration. Live Load Restrictions are based on Illinois legal loads and configurations. The Ratings and Live Load Restrictions are not necessarily representative of capacities to support the Contractor's equipment."

- For existing structures designed by the AASHTO LRFD Bridge Design Specifications, add the following note to the General Notes of the structure plans:

  "Current Rating Factors on File for Existing Structure
  Inventory: RF__
  Operating: RF__
  Live Load Restrictions: __ ["Yes (_____)" (Provide a value in tons)
  "No"]

  Inventory and Operating Rating Factors and Live Load Restrictions are provided for information only. Inventory and Operating Rating Factors are based on HL-93 loading and configuration. Live Load Restrictions are based on Illinois legal loads and configurations. The Rating Factors and Live Load Restrictions are not necessarily representative of capacities to support the Contractor's equipment."

- The following note shall be added to the General Notes of the structure plans when the Phase II engineer has determined there is deterioration of the existing structure resulting in a reduced load carrying capacity:

  "The Contractor is advised that the existing structure contains members that are in a deteriorated condition with reduced load carrying capacity. It is the Contractor's responsibility to account for the condition of the existing structure when developing construction procedures for the complete or partial removal, or replacement of the structure. An Existing Structure Information Package is available upon request as noted in the special provisions."

Responsibilities of the Contractor:

- Determine the intended means and methods of construction.

- Provide for SARs preparation by an Illinois licensed Structural Engineer. As noted in GBSP 67, the contractor shall be pre-approved to prepare SARs or shall retain a pre-qualified engineering firm to prepare SARs. For some complicated projects, pre-approved contractors may not be allowed to prepare the SARs and the contractor shall retain a pre-qualified engineering firm. On projects where these restrictions apply, there will be a note on the plans indicating this and also stating the required pre-qualification category for the engineering firm.

- Submit the SARs to the Resident Engineer along with evidence of pre-approval/pre-qualification as noted in GBSP 67.

● Upon approval of the SARs, implement measures necessary to ensure that the approved SARs are followed. (For example, if a crane will only be allowed to travel long certain beam lines, markings could be made on the deck to designate those lines.)

Responsibilities of the Contractor's Structural Engineer:

● For projects with an existing structure, review the ESIP information and any additional information provided to the contractor. Field verification of the current condition of the structure may be required.

● Verify that the structural demands of the applied loads due to the contractor's means and methods will not exceed the available capacity of the structure at the time the loads are applied. For existing structural components, the existing condition shall be considered. The appropriate load distributions according to AASHTO shall be used.

● Provide sealed SARs that clearly show the work covered (including allowed and/or restricted load locations), calculations of the available capacity, calculations of the load effects, any assumptions made, and comparison of the largest load effect and the available capacity. Separate portions of the work may be covered by separate SARs which may be submitted at different times.

GUIDELINES FOR THE PREPARATION OF SARS

To reduce the number of items to be analyzed and reviewed and the number of submittals, the structural engineer may wish to develop maximum load effect envelopes. These may provide the greatest amount of flexibility to the contractor. To produce a maximum load effect envelope, calculate the greatest possible effects on the structure based on several alternative construction plans or alternative loading patterns using the contractor's means and methods. Then determine the available capacity at the controlling locations. The SAR is only required to demonstrate that the maximum effect due to loading will be less than the available capacity at that location. Lists of the activities covered by the envelope and/or restrictions to the contractor's means and methods should be shown in the SAR. This will allow the contractor a wider range of options in the field. It will also inform the contractor's personnel that this wider range of options is acceptable according to the approved SAR. (For example, consider a bridge where a portion of the existing deck has been removed. Although there may be only one concrete truck on the structure at times and two concrete trucks on the structure at other times, the SARs would only need to verify that there is adequate capacity during the worst of these conditions. The intermediate, lesser load cases would not need to be shown.)

Since contractors may need to make revisions to their intended procedures due to weather, availability of equipment and personnel, etc., SARs that have been well thought-out and include the load effects of possible alternate means and methods will greatly assist the contractor in meeting critical path schedules and minimize the need for revised SARs submittals. (For example, a contractor may wish to remove an existing superstructure by placing removal equipment on the banks of a stream below. However, if the stream floods, the contractor may want to place the removal equipment on the existing structure. If the submitted SARs have already evaluated this condition and demonstrated that the maximum effects caused by this applied load will be less than the available capacity at all locations, then the contractor may switch from the original plan to the new plan without submitting a new SAR.)

If the contractor wants to change a load or load pattern, a SAR resubmittal will only be required when the change results in a greater load effect at a controlling location as determined by the contractor's structural engineer. The contractor's structural engineer shall provide written verification for the contractor to submit to the Engineer indicating that the specified revised loads do not result in an increased load effect.

After structures, or portions thereof, are closed to traffic and prior to removal of any portion of the existing structure, the contractor may move vehicles across the existing structure without a SAR provided the vehicles satisfy the requirements of Section 15-111 of the Illinois Vehicle Code or the FHWA document "Bridge Formula Weights" under the conditions noted in GBSP 67.

To meet the requirement in GBSP 67 that the contractor shall be responsible for following the approved SARs, lists of acceptable loadings at various stages should be well defined in the SARs to assist the contractor's personnel in ensuring that the approved SARs are followed. Clear and easy-to-follow summaries in the SARs of allowed/restricted movements, loads, conditions, etc., will permit the contractor's personnel to more readily recognize when an anticipated activity will not be in accordance with the approved SARs and to stop the activity until an approved SAR covering the activity is obtained. These summaries should be stated in language that will be understood by all personnel who are attempting to follow the SAR or who are attempting to ensure the SAR is followed.

Since there may be deterioration on an existing structure, the location of the controlling available capacity may not be obvious for each loading pattern.

An existing structure is likely to be posted for live load restrictions when the operating rating is less than HS20 or the operating rating factor is less than 1.0. For structures which are posted for live load restrictions, a SAR will always be needed for any applied construction loads and neither SAR exemption noted in GBSP 67 will be allowed (i.e., the SAR exemption for loads under 10 tons nor the SAR exemption for vehicles meeting the Section 15-111 of the Illinois Vehicle Code (see reference in GBSP 67)). The “Live Load Restrictions” line in the General Notes will show a “Yes” (with a value in parentheses, e.g., 15 Tons) for structures that are considered to have a live load restriction for the purposes of GBSP 67.

As noted in GBSP 67, the effects of the applied loads cannot exceed given capacity levels which are dependent on the type of work being done. For new construction and for portions of the existing structure that are to be reused, the specified available capacity is at the Inventory level, which is the design load level for normal service. For portions of the structure that are being removed, the specified available capacity is at the Operating level, which is the maximum permissible load level for occasional use. See the AASHTO Manual for Bridge Evaluation (MBE) for further information on determining the available capacity at each of these levels. Structures designed by the AASHTO Standard Specifications for Highway Bridges may utilize any of the methods shown in the MBE (Working Stress, Load Factor or Load and Resistance Factor). Structures designed by the AASHTO LRFD Bridge Design Specifications shall utilize the Load and Resistance Factor method shown in the MBE.

Firms involved in the development of the contract plans or firms which are performing project management and/or SAR review on that structure will not be eligible to develop a SAR for that project.

Please contact the Design Section Chief of the Bureau of Bridges and Structures with any questions.

GMK/ktALLBRIDGEDESIGNERS09.1-20090306

Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	08.4
From:	Ralph E. Anderson Ralph E. Anderson	
Subject:	Drainage Manual Modification \ Pipe Culverts & Storm Sewers	
Date:	November 7, 2008	

This memorandum complements BDE Procedure Memorandum Number 65-08 Pipe Culverts and Storm Sewers. BDE PM 65-08 modifies Section 40-3.07 of the BDE Manual by revising the limitations that govern allowable pipe types for culverts and storm sewers. Per PM 65-08, the new procedures are applicable to all roadways beginning with the April 24, 2009 letting.

The revisions impact two chapters within the IDOT Drainage Manual; Chapter 6 Culvert Hydraulics and Chapter 8 Storm Sewers. Modify the chapters according to the information and direction included here:

Chapter 6, Section 6-002 Kind and Size of Culvert

Within the 3rd sentence of 6-002, **Delete:** "6 inches of cover measured from the top of the pipe to the bottom of the subbase". **Replace with:** "12 inches of cover from the top of the pipe to the top of the subgrade".

Replace Figure 6-002 with this table:

PIPE CULVERT CLASSES

Conditions	Pipe Culvert Class	Minimum Diameter
Entrances, regardless of ADT; and Roadways with ADT < 4,000	D	15"
Roadways with 4000 ≤ ADT < 10,000	C	18"
Roadways with ADT ≥ 10,000	A	24"

The Class and Material listings that immediately follow Figure 6-002 were compiled before 2004 and are consequently incomplete. Refer to Article 542.03 of the Standard Specifications for Road and Bridge Construction for the current listing.

Chapter 6, Section 6-003 Types of Culverts

Delete: Additional types of culverts will be discussed in this chapter, though not in great detail. More comprehensive information on the use of these products may be obtained from the manufacturer.

Insert: This chapter focuses on concrete and metal pipe materials. However, the list of allowable pipe types shown in Section 542 of the Standard Specifications for Road and Bridge Construction has expanded over recent years, allowing flexible pipe to be utilized in a wider range of conditions. For a given culvert installation, the calculations of headwater and outlet velocity follow the same procedures provided in 6-100 Hydraulic Analysis, regardless of pipe or material type. The procedures are taken directly from the FHWA publication entitled HDS5, Hydraulic Design of Highway Culverts. For the concrete and metal pipe types listed here, the nomographs, tables and charts required for headwater calculations are included at the end of this chapter. For allowable pipe types not listed here- such as plastic pipe- please refer to HDS5 for the analogous information. To automate culvert hydraulic analysis for any allowable pipe material or shape, refer to the software titles recommended in this manual's Chapter 14 Computer Programs.

Chapter 6, Section 6-100 Hydraulic Analyses

Insert at the end of the 1st paragraph: The culvert designer should recognize that Section 40-3.07 of the BDE Manual allows the contractor to bid the most cost effective material type for pipe culverts, choosing among the allowable types for the pipe class and diameter specified in the contract plans. To accommodate the contractor's selection, the designer has to anticipate the contractor may choose ANY of the allowable material types for the specified class of culvert. It follows that in order to ensure the as-built installation satisfies design constraints on headwater and outlet velocity, design calculations should utilize an appropriately conservative Manning roughness n- value from the list of allowable materials within the given class of pipes. The correct approach is dependent on the controlling design flow condition. To satisfy headwater constraints in outlet control flow conditions, design calculations should employ the highest Manning roughness (n-value) for the pipe types within the specified class. Utilize a range of 0.010 to 0.013 (concrete) for Class A and 0.027 to 0.028 (corrugated metal) for Class C and Class D, noting that n-value varies by pipe diameter for corrugated metal. (See Figure 6-805b.) Analogously, to ensure outlet velocity limits or constraints are satisfied for pipe culverts operating under inlet control flow conditions, design calculations should employ the lowest available Manning roughness among the material types within the specified class. Utilize 0.010 to 0.013 (concrete) for Class A and 0.009 to 0.011 (PVC) for Class C and Class D. Given this direction, the designer should also anticipate the potential impact of material selection when the estimated design headwaters are on the cusp of inlet and outlet control.

Chapter 8, Section 8-009.06 Type of Materials

Insert after the 1st sentence: The storm sewer designer should recognize that Section 40-3.07 of the BDE Manual allows the contractor to bid the most cost effective material type for pipe storm drains, choosing among the allowable types for the pipe class and diameter specified in the contract plans. To accommodate the contractor's selection, the designer has to anticipate the contractor may choose ANY of the allowable material types for the specified n-value from the list of allowable materials within the given class of pipes. For both Class A and B, utilize concrete with roughness ranging from 0.013 to 0.016. In addition to accounting for rougher pipe in this manner, the designer also needs to consider any adverse affects on design features due to the implementation of a smoother, thinner pipe than the concrete pipe assumed in hydraulic design calculations.

Delete: The three criteria currently listed as the basis for selecting an acceptable storm sewer material type. Replace with this table:

STORM SEWER CLASSES

Conditions	Storm Sewer Class
Roadways with ADT < 1,500 or pipe location is > 12 ft (3.6 m) from the edge of the traveled way	B
Roadways with ADT ≥ 1,500 and pipe location is ≤ 12 ft. (3.6 m) from the edge of the traveled way	A

Chapter 8, Section 8-009.07 Cover

Delete: The 6th sentence of this section: "However, in no case should a cover depth less than 0.5 ft below the subbase be used."

Insert: "For all cases, the minimum cover depth from top of the pipe to top of the subgrade is 12 inches".

Chapter 8 does not provide a list of the available material types within the two respective classes of storm sewer materials. See Article 550.03 of the Standard Specifications for Road and Bridge Construction for the Class A and Class B listings.

These modifications will be incorporated into the Drainage Manual in a future update. The Drainage Manual is posted with other Bureau of Bridges and Structures technical manuals at: http://www.dot.il.gov/bridges/brmanuals.html. Questions can be directed to Matt O'Connor of our Hydraulics Unit at 217-785-2917 or matthew.oconnor@illinois.gov.

MO'C/kktABDdrainagemanualmodification08.4-20081107
cc: Bureau of Design and Environment / Attn: Tara Elston

Illinois Department of Transportation

Memorandum

To: ALL BRIDGE DESIGNERS

From: Ralph E. Anderson Ralph E. Anderson

Subject: Metric Manuals

Date: March 19, 2007

Effective today, all Metric manuals produced by the Bridge Office as well as ABD memo 97.3 (Metric Guidelines) will be archived. The Department discontinued metric units on new designs effective April 1, 1999 and consequently the metric manuals have not been updated to reflect the latest English details and policies. Most metric projects have been let by now but there are still occasionally a few projects. If you have a metric project and are still in need of design policies and details, please contact the Bridge Office.

KLR/bb28775

Illinois Department of Transportation
Memorandum

To: ALL BRIDGE DESIGNERS 06.1

From: Ralph E. Anderson Ralph E. Anderson

Subject: Structural Concrete Repair

Date: March 16, 2006

The policies of this memorandum were developed from the recommendations of an FHWA/IDOT process review for structural concrete repair and input from the Industry. A new Guide Bridge Special Provision (GBSP #53) entitled "Structural Repair of Concrete" was developed and shall replace the previous GBSP #1 "Formed Concrete Repair" and GBSP #3 "High Performance Shotcrete". Additionally, the following two new pay items were developed: Structural Repair of Concrete ≤ 5 inches and Structural Repair of Concrete > 5 inches. Some of the significant improvements include:

1. Tightened and clarified material requirements.

2. Tightened curing and quality control for shotcrete.

3. Updated shotcrete specifications per industry guide specifications.

4. Unified removal and surface preparation requirements for both formed concrete and shotcrete methods.

5. Repair method determined by the contractor and according to the four rules listed in the specification.

Temporary shoring and cribbing should be considered and accounted for with the appropriate pay item when one of the following three conditions is anticipated during structural concrete repair:

1. Concrete removal may exceed 6 inches in depth or ¼ the cross section of a structural member.

2. More than half of the vertical column reinforcement may be exposed at a given cross section.

3. More than 6 consecutive rebar may be exposed.

The type of repair described in the new GBSP #53, "Structural Repair of Concrete" is not intended for repair of prestressed concrete members.

The new GBSP 53 may be found on the IDOT web site. Designers are encouraged to implement this new special provision on all applicable projects which have not been let; however, all applicable projects beginning with the August 4, 2006 letting shall utilize this special provision.

GMK/jp1860