



March 2025

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# Structure Design Manual

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ILLINOIS STATE TOLL HIGHWAY AUTHORITY

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# INTRODUCTION

## **Structure Design Manual**

The Structure Design Manual provides guidance on the Illinois Tollway standards for designing new and replacement structures. The manual's content provides a detailed listing of criteria, guidelines, policies and procedures to be followed throughout the design process. The intent of this manual is to guide the design criteria of bridges, culverts, retaining walls, sign structures and noise abatement walls.

The Structure Design Manual, dated March 2025, replaces the Structure Design Manual issued March 2024.

### Major Revision Highlights

<b>Section 1.0: Introduction</b>	
<a href="#">Article 1.4</a>	Removed magnitude and application of vehicular collision force.
<b>Section 2.0: Structure Inspection and Conditions Reports</b>	
<a href="#">Article 2.5.1</a>	Corrected net present value equation.
<a href="#">Article 2.5.2</a>	Added number of years for each type of overlay.
<a href="#">Article 2.5.3</a>	Moved article 2.5.3 to Section 26.13
<b>Section 3.0: Type, Size &amp; Location (TS&amp;L) Plans</b>	
<a href="#">Article 3.1</a>	Clarified TS&L requirement for widenings.
<b>Section 5.0: Design Criteria</b>	
<a href="#">Article 5.1</a>	Added Seismic Retrofitting Manual for Highway Structures: Part 1 – Bridges. Publication No. FHWA-HRT-06-032 to the criteria table Added wind load requirements for noise abatement walls
<b>Section 8.0: Construction Staging</b>	
<a href="#">Article 8.2</a>	Revised article 8.2 to clarify requirement for temporary concrete barrier.
<a href="#">Article 8.3</a>	Changed the transverse limits of protective shield to 2' for deck removal and replacement.
<b>Section 10.0: Abutments</b>	
<a href="#">Figure 10.3.7</a>	Added 4" granular subbase.
<a href="#">Figure 10.3.8</a>	Added 4" granular subbase.
<a href="#">Figure 10.3.9</a>	Added 4" granular subbase.
<b>Section 12.0: Structural Steel</b>	
<a href="#">Article 12.2</a>	Changed fracture critical members to NSTM.
<b>Section 13.0: Precast Prestressed Concrete (PPC)</b>	
<a href="#">Article 13.1</a>	Added IDOT ABD 24.4 as a reference for design and detailing of PPC beams.
<b>Section 15.0: Concrete Bridge Decks, Parapets and Barriers</b>	
<a href="#">Figure 15.6.1</a>	Changed caption to indicated longitudinal sealed joint.
<b>Section 16.0: Deck Drainage</b>	
<a href="#">Article 16.2</a>	Clarified that scupper locations need to be coordinated between drainage and structural engineers and added the reference to the relevant article in drainage manual.
<b>Section 22.0: Retaining Walls</b>	
<a href="#">Article 22.14</a>	Changed "Buried moment slabs shall be considered..." to "Buried moment slabs shall be used...". Updated the text for use of exposed and buried moment slab.
<a href="#">Figure 22.14.3</a>	Updated buried moment slab vertical dimension to clarify the minimum thickness. Added a note to clarify gutter slope.
<b>Section 26.0: Rehabilitation and Repair</b>	
<a href="#">Article 26.13</a>	Moved article 2.5.3 to Section 26.13

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## SECTION 1.0 INTRODUCTION

### 1.1 Purpose and Use

This manual is prepared to aid the Designer in the design of new and replacement bridges (both highway and pedestrian), culverts, retaining walls, sign structures and noise abatement walls as well as reconstruction and rehabilitation of existing structures. The manual covers current design criteria, submittal requirements, and plan preparation details. The latest edition of the Illinois Department of Transportation Bridge Manual shall be used for design criteria not covered by this manual, subject to the Illinois Tollway's concurrence or approval.

### 1.2 Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ABC	Accelerated Bridge Construction
ABD	All Bridge Designers
ACEC-IL	American Council of Engineering Companies of Illinois
ACI	American Concrete Institute
AD/AB	Alternate Design/Alternate Bid
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARBTA	American Road and Transportation Builders Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWS	American Welding Society
BBS	Bureau of Bridges and Structures
B/C	Benefit to Cost Ratio
BCR	Bridge Condition Report
BDE	Bureau of Design and Environment
BLCC	Bridge Life Cycle Comparison
BMPR	Bureau of Materials and Physical Research
BWA	Barrier Warrant Analysis
CADD	Computer Aided Design and Drafting
CFA	Continuous Flight Auger
CFR	Code of Federal Regulations
CFRP	Carbon Fiber Reinforced Polymer
CIP	Cast in Place
CL	Centerline
CM	Construction Manager
CM/GC	Construction Manager General Contractor
CMP	Corrugated Metal Pipe
CORS	Continuously Operating Reference Station
CQP	Contractor's Quality Plan
CRS	Condition Rating System
CSD	Contact Sensitive Design

CSI	Construction Specification Institute
CSS	Context Sensitive Solutions
CVN	Charpy V-Notch
DB	Design Build
DBE	Disadvantaged Business Enterprise
DCM	Design Corridor Manager
DHV	Design Hourly Volume
DMS	Dynamic Message Sign
DMT	Decision Matrix Tool
DSE	Design Section Engineer
DUR	Design Upon Request
EB	Eastbound
EDC	Every Day Counts
ESIP	Existing Structure Information Package
ESL	Equivalent Static Load
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FRP	Fiber Reinforced Polymer
GBSP	Guide Bridge Special Provision
GEC	General Engineering Consultant
HEC	Hydraulic Engineering Circular
HLMR	High Load Multi-Rotational
HMA	Hot-Mix Asphalt
HPC	High Performance Concrete
IBTTA	International Bridge, Tunnel and Turnpike Association
I/D	Incentive/Disincentive
IDOT	Illinois Department of Transportation
IGA	Intergovernmental Agreement
INVEST	Infrastructure Voluntary Evaluation Sustainability Tool
IRTBA	Illinois Road and Transportation Builders Association
ISTHA	Illinois State Toll Highway Authority
ITS	Intelligent Transportation System
JULIE	Joint Utility Locating Information Excavators
LCCA	Life Cycle Cost Analysis
LF	Linear Feet
LFD	Load Factor Design
LRFD	Load and Resistance Factor Design
MASH	Manual for Assessing Safety Hardware
MOT	Maintenance of Traffic
MP	Mile Post
MPR	Master Plan Report
MSE	Mechanically Stabilized Earth
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NAW	Noise Abatement Wall
NB	Northbound
NBIS	National Bridge Inspection Standards
NCHRP	National Cooperative Highway Research Program
NCR	Nonconformance Report
NFPA	National Fire Protection Association
NTP	Notice to Proceed
NTR	Notch Toughness Requirements

PBES	Prefabricated Bridge Elements and Systems
PC	Point of Curvature
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PCI	Precast/Prestressed Concrete Institute
PIN	Property Identification Number
PJF	Preformed Joint Filler
PM	Project Manager
PMO	Program Management Office
PPC	Precast Prestressed Concrete
PT	Post-Tensioned
PTI	Post-Tensioning Institute
PVC	Polyvinyl Chloride
PVI	Point of Vertical Intersection
QA	Quality Assurance
QC	Quality Control
RCP	Reinforced Concrete Pipe
ROW	Right of Way
RSL	Remaining Service Life
RTRP	Reinforced Thermosetting Resin Pipe
SAR	Structure Assessment Report
SB	Southbound
SET	Superelevation Transition
SF	Square Foot/Feet
SGR	Structure Geotechnical Report
SP	Specifications/Special Provisions
SPMT	Self-Propelled Modular Transport
SRM	System Redundant Member
SSPC	Society for Protective Coatings
SUE	Subsurface Utility Engineering
SUR	Survey Upon Request
SY	Square Yard
TCB	Temporary Concrete Barrier
TEC	Traffic Engineer Consultant to the Illinois Tollway
TIN	Triangular Irregular Network
TL	Test Level
TOC	Traffic Operations Center
TRB	Transportation Research Board
TS&L	Type, Size and Location
TSRS	Temporary Soil Retention System
UHPC	Ultra-High-Performance Concrete
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WB	Westbound
WBPM	Web-Based Program Management System
WZSL	Work Zone Speed Limits

### 1.3 Definitions

This article contains definitions of frequently used terms as well as definitions with special or specific meanings as it applies to Illinois Tollway work. Other Articles define infrequently used or technical terms particular to that Article. Whenever in this Manual the following proper nouns are used, their intent and meaning, both singular and plural thereof, shall be as follows:

**Bridge Reconstruction:** Complete replacement of the bridge superstructure and may include work on the substructure and foundation.

**Bridge Rehabilitation:** Repair or replacement work on one or more of the major and/or minor components of a bridge may include deck replacement, superstructure widening or substructure widening.

**Bridge Replacement:** Complete replacement of the entire bridge.

**Crossroad Bridge:** Bridge crossing over the Illinois Tollway, where the roadway crossing over the Illinois Tollway is governed by another agency.

Additional definitions can be found in the Illinois Tollway Design Section Engineer (DSE) Manual.

#### **NOTE**

This manual follows the traditional definitions for **shall**, **should** and **may**. **Shall** is used to mean something that is required or mandatory, while **should** is used to mean something that is recommended, but not mandatory and **may** is used to mean something that is optional and carries no requirement or recommendation.

### 1.4 LRFD and LFD Bridge and Structure Design

The design of all new and replacement structures shall be in accordance with the latest edition of the *AASHTO LRFD Bridge Design Specifications* except as modified by the following Illinois Department of Transportation (IDOT) Manuals: Bridge, Culvert, Drainage, Geotechnical and Sign Structures, or as amended herein by the Illinois Tollway Structure Design Manual. The most current IDOT manuals related to structural policy, documents and procedures are available on the Internet web pages at <http://www.idot.illinois.gov/>.

Navigation to technical manuals begins with “Doing Business” then “Procurements”.

The *AASHTO LRFD Bridge Design Specifications* was not completely adopted by IDOT. Several parts were modified or subjected to interpretation by IDOT. The following examples are representative of some of the changes made by IDOT:

- Portions of Live Load Distribution for bridges have been simplified and/or not adopted (IDOT Bridge Manual Section 3.1.12).
- When to apply lateral stresses for steel beam design has been interpreted (IDOT Bridge Manual Section 3.3.5).
- Moment Redistribution in LRFD and LFD is not allowed (IDOT Bridge Manual Section 3.3.6).
- Seismic design is according to LRFD with some interpretations, but the IDOT Bridge Manual clarifies options in LRFD to use for Illinois (IDOT Bridge Manual Sections 3.7, 3.10 and 3.15).



- Vehicle collision design forces and the approach to design have been interpreted by IDOT Bridge Manual Section 3.9.3.7.
- The resistance factor to use for pile design has been interpreted (IDOT Bridge Manual Section 3.10).
- The loading to use for Constructability Checks in LRFD (and LFD) has been clearly specified and interpreted (IDOT Bridge Manual Section 3.3.26).

## SECTION 2.0 STRUCTURE INSPECTION AND CONDITION REPORTS

### 2.1 Inspection and Testing

Inspection of existing bridges, culverts, and retaining walls shall be conducted in accordance with the latest, *Federal Highway Administration (FHWA) Bridge Inspector's Reference Manual* and its supplement *Inspection of Fracture Critical Bridge Members*, and the *AASHTO Manual for Bridge Evaluation* and in accordance with IDOT's Structural Services Manual and Structure Information and Procedure Manual. Underwater inspections and evaluations when required shall be conducted according to the latest *FHWA Manual for Underwater Inspection of Bridges*.

The field inspections of Illinois Tollway bridges and structures shall follow the guidelines of the IDOT Bridge Condition Report Procedures and Practices as well as Section 3 of the latest IDOT Structural Services Manual. In addition, the field inspection shall be led in the field by an IDOT approved Bridge Inspection Team Leader. For structures requiring a Bridge Condition Report (BCR) or an Abbreviated Bridge Condition Report, the field inspection will generally require more effort than the requirements for a typical Routine Inspection and Element Level Inspection. Designers shall conduct field inspections with the appropriate equipment (such as ladders, aerial lift trucks, lighting, etc.) as well as traffic control and any permits such as railroad right-of-entry.

The Designer shall compare their findings to those of the latest Illinois Tollway Structure Inspection Field Report. Any discrepancies in ratings shall be explained and justified in the Designer's Structure Inspection Report. Defects in the structure or approach roadway which are or may become hazardous to the public or railroads shall be reported immediately to the Illinois Tollway.

### 2.2 Preparation of Structure Condition Reports

Structure condition reports shall be submitted during the master planning or pre-concept phase. Reports shall follow the guidelines of the latest IDOT Bridge Condition Report Procedures and Practices. Existing structures to be abandoned and/or removed or completely replaced shall not be inspected or require a condition report. Only those structures which are to be rehabilitated, reconstructed or widened shall require both in-depth inspections and condition reports.

If a Technical Memorandum is requested by the Illinois Tollway in lieu of a Structure Condition Report, the Technical Memorandum shall include at a minimum:

- Inspection Dates
- Physical Description of the Structure
- Structure Condition Data
- Recommended Scope of Work
- Photos
- Cost Estimate

Designers shall request input from the Illinois Tollway Project Manager and General Engineering Consultant regarding if any known repair items exist in the Illinois Tollway's asset management system (Cartegraph OMS).

Retaining walls and noise abatement walls shall not be inspected nor require a condition report, unless the existing wall(s), or portions thereof, are to be incorporated into the proposed project. In which case, an inspection shall be performed, and a condition report prepared for each wall or section to be utilized in conjunction with the project.

Before any element of a structure and/or its foundations can be considered for reuse in replacing, reconstructing or rehabilitating an existing structure, it shall be evaluated and analyzed in accordance with Section III of IDOT's Bridge Condition Report Procedures and Practices. The results of these evaluation and analysis shall be summarized and included in the Structure Condition Report for each structure where reuse is being considered. The backup data and calculations for each summary shall not be submitted for review unless requested by the Illinois Tollway.

If a new structure, replacement structure or complete reconstruction of the existing deck or superstructure is recommended in the Structure Condition Report, the DSE shall evaluate options for Accelerated Bridge Construction in accordance with Article 27.3.1.

The checklist included in Appendix C is provided as an aid to the designer when completing the Bridge Condition Report (BCR). The checklist of items provided is for guidance and is not all inclusive. The designer and checker shall supplement this checklist with additional material appropriate for the specific project in order to ensure quality submittal.

## 2.3 Hydraulic Analysis

All new structures and existing structures to be replaced, reconstructed, widened or extended which are over or conveying waterways shall require a hydraulic analysis to determine if the resulting waterway opening meets current Illinois Tollway standards and Illinois Department of Natural Resources Office of Water Resources permit requirements.

The results of the analysis shall be summarized in a Waterway Information Table which shall be included in the Hydraulic Report for each structure. The report shall also include any recommendations for improving the waterway opening or channel alignment at each structure.

## 2.4 Scour Analysis

All new structures and existing structures to be replaced, reconstructed or widened which are over waterways, shall require a scour analysis to determine if the resulting or proposed opening will increase the flow and potentially undermine the adjacent structure foundations. The scour analysis shall be performed in accordance with the latest edition of FHWA Publication, Hydraulic Engineering Circular No. 18 (HEC-18) "Evaluating Scour at Bridges". The latest editions of FHWA Publications HEC-20 "Stream Stability at Highway Structures" and HEC-23 "Bridge Scour and Stream Instability Countermeasures" shall be used as a guidance for identifying stream instability problem at highway stream crossings and for countermeasures to mitigate potential scour damage.

Results of the analysis shall be summarized in a Design Scour Elevation Table and the scour critical analysis coding as directed below, and shall be included in the Hydraulic Report, Structure Condition Report and the TS&L plans.

Provide the following information as defined in the *Illinois Highway Information System, Structure Information and Procedure Manual*:

- Scour Critical Evaluation (Item 113)

- Scour Critical Analysis Date (Item 113A)
- Scour Critical Evaluation Method (Item 113B)
- Scour Critical Analysis by Name (Item 113C)
- Scour Critical Remark (Item 113D)
- Channel & Channel Protection Condition (Item 61)
- Waterway Adequacy Appraisal (Item 71)
- Pier Navigation Protection (Item 111)

The Scour Critical Evaluation (Item 113) rating shall be in accordance with IDOT Bridge Manual Section 2.3.6.3. However, on all Illinois Tollway facilities, the Q500 flood shall be used for the check scour elevation and for the design of all new countermeasures and extensions of existing countermeasures.

For Item 113B - Scour Critical Evaluation Method, all foundation types rating shall be A - Analytical method.

The report shall also include any recommendations to mitigate or prevent scour at each structure.

## 2.5 Life Cycle Cost Analysis

Life Cycle Cost Analysis (LCCA) is required for all replacement versus rehabilitation decisions. LCCA shall be performed in accordance with procedures outlined in Publication No. FHWA-SA-98-079, NCHRP Report 483 Bridge Life-Cycle Cost Analysis.

### 2.5.1 General Guidelines

- No inflation (i.e., constant dollars) shall be used. Inflation is included in the real discount rate calculation, provided.
- A real discount rate of 2.9% shall be used.
- If the DSE is asked to calculate a real discount rate, the following equation shall be used:
  - $i = (1+i_b)(1+q)/(1+f)$
- Where:
  - $i$  = Real discount rate
  - $i_b$  = Illinois Tollway Bond Rate
  - $q$  = Anticipated Illinois Tollway Revenue Increase
  - $f$  = Anticipated Rate of Illinois Tollway Construction Cost Inflation
- The following equation may be used to calculate the Net Present Value (NPV):
  - $NPV = (\text{Component Activity Cost}) \times 1/(1+i)^n$
- Where:
  - $i$  = Real discount rate
  - $n$  = Year of expenditure
- The analysis period shall be 100 years.
- The design life of a new bridge, culvert or retaining wall element shall be 100 years, unless fatigue dictates a shorter life.
- The design life of existing superstructure and substructure is 75 years.
- The remaining service life of existing bridge, culvert or retaining wall elements shall be based on age and condition.

- The design life of new and existing bridge decks with epoxy coated reinforcement are 50 years. The design life of new bridge decks with stainless steel reinforcement is 100 years.
- Two scenarios shall be compared.
  - Repair
  - Replacement
- If the total cost of repair is less than or equal to 10% of the total cost of a new structure, then an LCCA is not necessary and repair shall be recommended.
- If the total cost of repair is greater than or equal to 80% of the total cost of a new structure, then an LCCA is not necessary and replacement shall be recommended.
- Deck repair/replacement decisions shall be based on the Deck Repair vs. Replacement Assessment Table and associated requirements in IDOT's Bridge Condition Report Procedures and Practices Manual. An LCCA is not required to justify a deck replacement.
- Once deck replacement is determined to be the minimum scope of work, a LCCA is required to determine if it is more economical to replace only the deck, replace the entire superstructure or replace the entire bridge.
- If deck repairs are recommended and the structure has an older superstructure and/or substructure, an LCCA is required to determine if it is more economical to repair the structure, replace the superstructure or replace the entire bridge.
- Unit prices, quantities shall be established by the Designer and reviewed by the Illinois Tollway.
- Intervals of repairs and recommended maintenance cycles shall be in accordance with IDOT Bridge Preservation Guide, Latest Edition, except as shown in Article 2.5.2.
- The effects of salt contamination on deterioration from open or expansion joints, adjacent roadways, etc. shall be considered.
- Additional expenses due to related and necessary activities such as maintenance of traffic, removal, temporary support or movement, adjacent removal and replacement, new dimensions, etc. shall be included.
- The functionality and strength of the existing structural members shall be considered.
- The salvage value shall be calculated as the percentage of the design life remaining at the end of the analysis period multiplied by the total cost of the last full structure replacement.

### 2.5.2 Maintenance and Repair Cycles

- Deck, Joints and Approaches (See Figure 2.5.1)
  - Bridge Deck with Epoxy Coated Reinforcement
    1. Seal the deck and parapets every 5 years
    2. Joints are repaired every 10 years and replaced every 25 years
    3. Overlay is placed every:
      - 10 years for Thin Polymer Overlay (TPO)
      - 25 years for Latex Modified Concrete Overlay (LMC)
      - 12 to 15 years for Asphalt Overlay
    4. Deck and approaches are reconstructed every 50 years



- Bridge Deck with Stainless Steel Reinforcement
  1. Seal the deck every 5 years, starting at year 25
  2. Joints are repaired every 10 years and replaced every 25 years
  3. Overlay is placed at age 75
  4. Deck and approaches are reconstructed every 100 years
- Superstructure
  - Concrete Girders
    1. Repair beam end at joints and areas within the splash zone every 25 years
  - Steel Girders
    1. At deck joints, girder ends are repaired when the joint above is replaced
    2. Spot painting of coated steel elements every 10 years
    3. Zone painting of coated steel element every 25 years
    4. Full painting of coated steel elements every 50 years
  - Bearings
    1. Repair/replace below joints when joints above are replaced
- Substructure
  - Repair below joints beginning at age 25 and every 25 years following
  - Repair in de-icing zones beginning at age 50 and every 25 years following
  - Concrete Sealer is assumed to be applied:
    1. To the entire substructure element under a joint or within 12' of the edge or shoulder for a new or widened bridge every 5 years.

|

BRIDGE DECK LIFE CYCLE MAINTENANCE - EPOXY COATED								
ITEM	YEAR 15	YEAR 25	YEAR 40	YEAR 50				
* BRIDGE DECK REPLACEMENT	0%	0%	0%	100%				
* BRIDGE DECK REPAIR, FULL DEPTH	0%	5%	1%	0%				
* BRIDGE DECK REPAIR, PARTIAL DEPTH	0%	10%	2%	0%				
* OVERLAY PLACEMENT	0%	100%	0%	0%				
* OVERLAY REPAIR	0%	0%	5%	0%				
* BRIDGE DECK GROOVING	0%	100%	0%	100%				
** BRIDGE EXPANSION JOINT STRIP SEAL	5%	100%	5%	100%				
** BRIDGE EXPANSION JOINT MODULAR JOINT	15%	100%	15%	100%				
* REPAIR APPROACH SLAB	2%	10%	2%	100%				

BRIDGE DECK LIFE CYCLE MAINTENANCE - STAINLESS STEEL								
ITEM	YEAR 15	YEAR 25	YEAR 40	YEAR 50	YEAR 60	YEAR 75	YEAR 85	YEAR 100
* BRIDGE DECK REPLACEMENT	0%	0%	0%	0%	0%	0%	0%	100%
* BRIDGE DECK REPAIR, FULL DEPTH	0%	0%	0%	0%	0%	5%	1%	0%
* BRIDGE DECK REPAIR, PARTIAL DEPTH	0%	0%	0%	0%	0%	10%	2%	0%
* OVERLAY PLACEMENT	0%	0%	0%	0%	0%	100%	0%	0%
* OVERLAY REPAIR	0%	0%	0%	0%	0%	0%	0%	0%
* BRIDGE DECK GROOVING	0%	0%	0%	0%	0%	100%	0%	100%
** BRIDGE EXPANSION JOINT STRIP SEAL	5%	100%	5%	100%	5%	100%	5%	100%
** BRIDGE EXPANSION JOINT MODULAR JOINT	15%	100%	15%	100%	15%	100%	15%	100%
* REPAIR APPROACH SLAB	2%	0%	2%	0%	2%	100%	2%	100%

SUPERSTRUCTURE LIFE CYCLE MAINTENANCE								
ITEM	YEAR 15	YEAR 25	YEAR 40	YEAR 50	YEAR 60	YEAR 75	YEAR 85	YEAR 100
*× STEEL BEAM REPLACEMENT	0%	0%	0%	0%	0%	0%	0%	100%
*× PPC BEAM REPLACEMENT	0%	0%	0%	0%	0%	0%	0%	100%
*** MISC. STEEL GIRDER REPAIRS	0%	2%	0%	10%	0%	15%	2%	0%
* STEEL PAINT	2%	5%	10%	100%	2%	5%	10%	0%
* FIBER WRAP FOR PPC I-GIRDER	0%	1%	1%	2%	1%	2%	1%	0%
* FORMED CONCRETE REPAIR - BEAM	0%	1%	1%	2%	1%	2%	1%	0%
*××× JACK AND REMOVE EXISTING BEARING	0%	25%	5%	100%	0%	25%	5%	0%
*** BEARINGS - EXPANSION	0%	25%	5%	100%	0%	25%	5%	100%
*** BEARINGS - FIXED	0%	25%	5%	100%	0%	25%	5%	100%

SUBSTRUCTURE LIFE CYCLE MAINTENANCE								
ITEM	YEAR 15	YEAR 25	YEAR 40	YEAR 50	YEAR 60	YEAR 75	YEAR 85	YEAR 100
* FORMED CONCRETE REPAIR	0%	3%	0%	6%	6%	10%	10%	0%
* LOW PRESSURE EPOXY INJECTION	0%	3%	3%	6%	6%	10%	10%	0%
* SLOPE REPAIR	0%	5%	10%	25%	5%	25%	10%	0%

× PERCENTAGE IS BASED ON TOTAL AREA OR SURFACE AREA OF THE ELEMENT  
 ×× PERCENTAGE IS BASED ON TOTAL LENGTH OF THE ELEMENT  
 ××× PERCENTAGE IS BASED ON TOTAL QUANTITY OF THE ELEMENT  
 ×××× PERCENTAGE IS BASED ON TOTAL TONNAGE OF THE ELEMENT

Figure 2.5.1: Bridge Life Cycle Maintenance

## SECTION 3.0 TYPE, SIZE & LOCATION (TS&L) PLANS

### 3.1 General

The TS&L Plans form the basis for preparation of Construction Contract Plans. TS&L plans shall be submitted with the 30% design submittal. TS&L Plans are required for new or replacement structures, superstructure and substructure widenings, and superstructure replacements. Structures identified for rehabilitation and/or redecking shall not require TS&L Plans. TS&L Plans for Illinois Tollway structures shall not require completion of a Structure Report Bureau of Bridges and Structures (BBS) Form 153, a Preliminary Bridge Design and Hydraulic Report (Form BLR 10210) or a Plan Development Outline. TS&L Plans for those structures that are either fully or partially funded and/or maintained by IDOT shall follow all guidelines and requirements of Section 2.0 of the latest IDOT Bridge Manual. Prior to submittal of any TS&L Plans, the Plans shall be checked for compliance with Section 2.3.13 of the latest IDOT Bridge Manual.

### 3.2 Bridge Type Study

A Bridge Type Study is the process by which the most appropriate structure type for a given location is determined. A Bridge Type Study considers the structure types feasible for the site parameters or environmental commitments, provides the reasoning for eliminating or developing particular alternatives, including cost estimates for all alternatives considered, and finally explains the rationale for the selection of the structure type chosen.

A Level 3 Barrier Warrant Analysis (including a Benefit/Cost Analysis) shall also be performed according to the requirements of the latest Illinois Tollway Traffic Barrier Guidelines in order to determine abutment type and location and span configuration for all bridges over the Illinois Tollway. This procedure shall also be followed in determining culvert lengths, except the level of Barrier Warrant Analysis shall be according to the Illinois Tollway Traffic Barrier Guidelines. All Barrier Warrant Analyses shall be submitted and reviewed by the Illinois Tollway prior to submission of TS&L Plans.

The Bridge Type Study is a part of the planning process which justifies the TS&L Plan. All new, reconstructed and replacement bridges require a Bridge Type Study which shall be submitted to the Illinois Tollway for review and acceptance before preparation of the TS&L Plan can commence. Such a study would provide additional written treatments concerning economic evaluations (including LCCA) for the viable alternatives, span length versus pier height studies for the approaches, pier type structural and aesthetic studies, main and approach span structure type aesthetic studies, and architectural presentations of the alternative systems presented in the study. The report shall also document unusual design procedures, deviations from or variations of AASHTO Specifications to be used, special materials or details proposed, or tests anticipated.

Beam selection criteria shall be in accordance with the *IDOT Bureau of Design and Environment Manual* and Sections 12 and 13. All Illinois Tollway bridges shall be designed in accordance with requirements of Article 1.4.

The DSE shall evaluate Accelerated Bridge Construction in accordance with Section 27.0. If required by Article 27.3.1, the DSE shall complete the ABC Bridge Life Cycle Comparison (BLCC) Tool and incorporate the recommended bridge alternatives into the Bridge Type Study and perform a cost comparison to make a final recommendation.

### 3.3 Structure Report

Structure Reports are not required to construct, reconstruct, widen or extend Illinois Tollway mainline or ramp structures. However, if the Illinois Tollway is planning on constructing, reconstructing, widening or extending a structure that is jointly maintained by the Illinois Tollway, IDOT or a local agency, the Designer is required to complete the appropriate Structure Report as noted above and submit it with the TS&L Plan package for IDOT's review and approval.

### 3.4 Hydraulic Information

TS&L Plans for all new structures and existing structures to be extended, reconstructed, replaced or widened which span over or convey waterways shall require a Waterway Information Table, a Design Scour Elevation Table, if required, and the scour critical analysis coding as described in Article 2.4 of this Manual.

### 3.5 Structural Geotechnical Report

TS&L Plans for all new structures and existing structures to be extended, reconstructed, replaced or widened shall require subsurface investigations and Structure Geotechnical Report (SGR) in accordance with the Illinois Tollway Geotechnical Manual. The Designer along with the Geotechnical Engineer shall develop a subsurface exploration program for each structure. Subsurface investigations shall begin only after the proposed program has been reviewed and approved by the Illinois Tollway for its conformance to the minimum requirements as set forth within the Geotechnical Manual. The subsurface exploration and analyses shall be in accordance with the latest Geotechnical Manual. The data from the exploration program shall be analyzed and the resulting recommendations shall be documented in the SGR in accordance with the Illinois Tollway Geotechnical Manual. SGRs shall be submitted with the Concept Design Report.

## SECTION 4.0 CONTEXT SENSITIVITY AND AESTHETICS

### 4.1 Introduction

Context Sensitive Solutions (CSS) is an interdisciplinary process, embraced by the Illinois Tollway that seeks effective, multimodal transportation results by working with stakeholders to develop, build and maintain cost-effective transportation facilities which are appropriate to and reflect the project's surroundings. When implementation of the CSS process has been initiated for a particular project, the DSE is expected to coordinate potential enhancements during the appropriate phase of planning and design. When a formal CSS process is not implemented, the DSE shall consider context of the site as an integral part of the functional and aesthetic design development.

### 4.2 Bridges

All bridges make an aesthetic impression on the surroundings and the DSE shall consider and control the impact early in the design phase. The main aesthetic of a bridge is primarily a product of the structural members themselves. The structure form and shape, through the use of proper materials, dimensional relationships and proportions shall be used to emphasize the lightness, slenderness and horizontal continuity, allowing the bridge structure to produce the primary aesthetic on its own. Supplemental details such as texture and color can be important but are ordinarily considered secondary or complementary enhancements to the structural shape. Ornamentation shall not be added or shall be kept to a minimum and used only with special requirements for structures of significance.

Detailing and placement for appurtenances such as drain pipes, conduits, utilities, fencing, rails, signage and lighting shall be coordinated for visual compatibility and design consistency. Drain pipes and other conduit systems shall employ simple details and be located as visually unobtrusive as possible and preferably not visible to passing motorist.

The standard treatment for a bridge and its overpass and underpass area is the use of a basic utilitarian highway bridge, essential erosion control and seeding in landscape areas, and routine Illinois Tollway signage identifying the crossroad. Upgrade treatments for a bridge and the overpass or underpass area where a response to the significance of the crossroad, physical context, or community has been determined, may include the addition and aesthetic enhancements of architectural elements, landscape treatments and signage components. Throughout design, the DSE shall orchestrate all primary aesthetic structural elements and details for efficiency and economy to minimize cost and to achieve an attractive bridge. The DSE shall recommend options for aesthetic enhancements, consistent with discussion herein, that may be presented by the Illinois Tollway to agencies having jurisdiction of roadways crossing under Illinois Tollway bridges.

### 4.3 Walls

Due to the potential size, quantity and location, walls including noise abatement walls and retaining walls are often highly visible components within the Illinois Tollway corridors. The vertical and horizontal alignment, material type, textures and color become important elements of consideration. The primary wall aesthetic theme is to create a natural appearance that blends with the surrounding environment. Walls shall be designed as visual assets from the prospective views of motorists and adjoining communities. The DSE shall develop all wall types together with

surrounding structural and non-structural elements to create a visual relationship to one another and provide a harmonious aesthetic throughout the corridor. Typical formliner aesthetics of retaining walls and both front and back surfaces of noise walls shall have a pattern as specified in the special provisions. Front face of crashworthy retaining walls shall have a smooth surface measuring 44" from top of grade for the attachment of roadway delineators. The 44" smooth surface shall not be stained, however, shall be sealed. A matte finish concrete stain shall be provided and applied with sealer as required. The base stain color of the formliner aesthetic pattern on walls shall match Sherwin-Williams 7633, Taupe Tone 248-C4 (#ADA090 Hex Color Code). The surface stain/paint of support columns or posts of noise walls shall match the color and finish of concrete panels.

## SECTION 5.0 DESIGN CRITERIA

### 5.1 Structural Design Criteria

The following criteria shall be used for the design of structures on the Illinois Tollway. The applicable information shall be shown on the contract plans as discussed in Article 6.3.4. Items indicated in [ ] and bold are notes to the designer to include the latest date for plan presentation.

BRIDGES – New, Reconstruction and Replacement		
Design Specifications	AASHTO LRFD Bridge Design Specifications (except as modified by IDOT and Illinois Tollway Structure Design Manual)	[Latest edition and interims]
	Illinois Tollway Structure Design Manual	[Latest edition]
	IDOT Bridge Manual	[Latest edition]
	Illinois Tollway Geotechnical Manual	[Latest edition]
	IDOT All Bridge Designers Memorandums	(when applicable)
	AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges	[Latest edition, pedestrian bridges]
Design Loads	Live Load: (New or Replacement Illinois Tollway Structures & Ramps)	HL-93 and IL-120
	Live Load: Other Structures and Superstructure Replacement on Illinois Tollway Mainline Structures & Ramps	HL-93
	Future Wearing Surface	50 psf
	Pedestrian Live Load	90 psf
	Vehicle Load (Pedestrian Bridges Only)	H5 (Deck width 7ft – 10ft)
		H10 (Deck width > 10ft)
STRUCTURES – Rehabilitation and Widening (Including Bridges, Retaining walls and NAWs)		
Design Specifications	For Existing ASD or LFD Designs: AASHTO Standards Specifications for Highway Bridges	17 <sup>th</sup> Edition
	For Existing LRFD Designs: AASHTO LRFD Bridge Design Specifications (except as modified by IDOT and Illinois Tollway Structure Design Manual)	[Latest edition]
	Illinois Tollway Structure Design Manual	[Latest edition]
	IDOT Bridge Manual	[Latest edition]
	IDOT Structural Services Manual	[Latest edition]
	Seismic Retrofitting Manual for Highway Structures: Part 1 – Bridges. Publication No. FHWA-HRT-06-032	For rehabilitation only
	Illinois Tollway Geotechnical Manual	[Latest edition]
	IDOT All Bridge Designers Memorandums	(when applicable)
	AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges	[Latest edition, pedestrian bridges]



Design Loads	<i>For Existing ASD or LFD Designs:</i> Live Load: All Structures	HS-20
	<i>For Existing LRFD Designs:</i> Live Load: All Structures	HL-93
	Future Wearing Surface	Match existing design
<b>BRIDGES – Design Stresses</b>		
Reinforced Concrete	$f'_c$ = Compressive Strength (IDOT Class Class SI) Substructure	3,500 psi
	$f'_c$ = Compressive Strength (IDOT Class BS) Parapets and Barriers	4,000 psi (Design)
	$f'_c$ = Compressive Strength (Class HP) Bridge Decks and Diaphragms, and Bridge Approach, Transition Approach and Transition Approach Shoulder Slabs.	4,000 psi (Design)
Precast Concrete	$f'_c$ = Compressive Strength (IDOT Class PC) Prefabricated Bridge Elements and Systems or (Performance Mix) Precast Concrete Approach Slabs	5,000 psi (Design)
Reinforcement	$f_y$ = Yield Strength (Conventional Reinforcement)	60,000 psi
	$f_s$ = Tension (Grade 60) (ASD Design)	24,000 psi
	$f_y$ = Yield Strength (Stainless Steel Reinforcement)	60,000 psi
Prestressed Concrete (LRFD)	$f'_c$ =Compressive Strength	6,000 psi (min.) 8,500 psi (max.)
	$f'_{ci}$ = Release Compressive Strength (as required, but less than $f'_c$ )	4,000 psi (min.) 6,500 psi (max.)
	Compression before losses	$0.65 f'_{ci}$
	Compression after losses (Service I)	Case (a): $0.60\phi_w f'_c$ ; $\phi_w = 1$ for IDOT members Case (b): $0.45 f'_c$
	Tension after losses (Service III)	$0.19\sqrt{f'_c}$ (max) $\leq$ 0.6ksi
	Tension before losses	$0.24\sqrt{f'_c}$
	Fatigue: Compression after losses	$0.40f'_c$
	Fatigue: Tension after losses limit for determination of cracked vs. uncracked	Uncracked $\leq 0.095\sqrt{f'_c}$
Prestressing Strands	0.5 inch diameter low relaxation 0.6 inch diameter low relaxation	0.153 in <sup>2</sup> 0.217 in <sup>2</sup>
	$f_{pu}$ = ultimate strength	270,000 psi
	$f_{pbt}$ = initial tension	202,300 psi = $0.75 f_{pu}$

	$f_s$ = allowable final tension	183,600 psi (0.5 or 0.6 inch nominal diameter strands)
Structural Steel	$f_y$ = yield strength	50 ksi (Typ.)
<b>BRIDGES – Deflection</b>		
Bridges Carrying Mainline Illinois Tollway Routes or Ramps	<i>For LRFD designs:</i>	Span Length/800 (if sidewalk present, Span Length/1000)
	Live Load deflections shall be the larger of: 1. Max deflection resulting from IL-120, HL-93 truck or HL-93 Tandem alone. 2. Max deflection resulting from design lane load plus the max deflection resulting from 25% of the IL-120, HL-93 truck or HL-93 Tandem trucks.	
	<i>For LFD or ASD designs:</i> HS-20 Live Load	
Pedestrian Bridges	Pedestrian Live Load and horizontal deflection due to wind	Span Length/360
Other Bridges	Same as above, except requirements for IL-120 Live load do not need to be met.	
<b>BRIDGES</b>		
Seismic Design	Seismic Performance Zone (SPZ)	Zone 1 (LRFD)
	Seismic Performance Category (SPC)	Category A (LFD)
	Bedrock Acceleration Coefficient (A) (LFD)	Site-specific based on existing soil type. Review SGR for additional information.
	Design Spectral Acceleration at 1.0 sec (S <sub>dl</sub> )	
	Design Spectral Acceleration at 0.2 sec (S <sub>ds</sub> )	
	Site Coefficient (S) (LFD)	
	Soil Site Class (LRFD)	
<b>BOX CULVERTS</b>		
Design Specifications	AASHTO LRFD Bridge Design Specifications	<b>[Latest edition and interims]</b>
	Illinois Tollway Structure Design Manual	<b>[Latest edition]</b>
	Illinois Tollway Geotechnical Manual	<b>[Latest edition]</b>
	IDOT Bridge Manual	<b>[Latest edition]</b>
	IDOT Culvert Manual	<b>[Latest edition]</b>
	Strength Methods (Load Factor Design)	Service Load Design Method for modifications or extensions of existing foundations

BOX CULVERTS – Design Loads		
Dead Loads	Concrete	150 pcf
	Earth (vertical)	120 pcf
Live Load	HL-93 Loading (and IL-120 Illinois Tollway Structures and Ramps)	
Earth Pressure (equivalent fluid pressures)	Height of Fill (above roof)	See below
	Height of Barrel	60 pcf
	Live load surcharge shall be applied to culverts in accordance with Article 3.11.6.4 of the AASHTO LRFD Bridge Design Specifications and latest version of the IDOT Culvert Manual.	
BOX CULVERTS – Design Stresses		
Reinforced Concrete	$f_c$ = Compressive Strength (IDOT Class SI)	3,500 psi
Precast Concrete	$f_c$ = Compressive Strength	5,000 psi
Reinforcement	$f_y$ = Yield Strength	60,000 psi
	$f_s$ = Tension (Grade 60) (ASD)	24,000 psi
Welded Wire Reinforcement	$f_y$ = Yield Strength	60,000 psi
RETAINING WALLS		
Design Specifications	AASHTO LRFD Bridge Design Specifications, as modified by IDOT Bridge Manual	<b>[Latest edition and interims]</b>
	Illinois Tollway Structure Design Manual	<b>[Latest edition]</b>
	Illinois Tollway Geotechnical Manual	<b>[Latest edition]</b>
	IDOT Bridge Manual	<b>[Latest edition]</b>
RETAINING WALLS – Design Loads		
Dead Loads	Concrete	150 pcf
	Earth	120 pcf
Live Loads	Walls adjacent to roadways	Live load surcharge equivalent to 2 feet of earth.
	When a parapet or railing is constructed integrally with the top of the wall.	Barrier shall be designed to transfer impact loads to top of wall.
* Impact Loads	Overturning & Sliding (Static)	23 kips over 8 feet at top of parapet (44" parapet) or 106 kips over 10 feet at 52 inches (72" barrier)

	Strength (Dynamic)	124 kips over 8 feet at top of parapet (44" parapet) or 260 kips over 10 feet at 52 inches (72" barrier)
Earth Pressure	The formula to compute lateral earth pressure is by Coulomb's equation for the resultant parallel to the backfill slope.	Based on soil data from borings accounting for water level and long-term drained conditions for passive resistance.
* Load distribution to be taken as 1:1 at point of impact using 8ft or 10ft as applicable.		
<b>RETAINING WALLS – Design Stresses</b>		
Reinforced Concrete	$f'_c$ = Compressive Strength (Class HP) Moment Slabs	4,000 psi (Design)
	$f'_c$ = Compressive Strength (IDOT Class BS) Moment Slab Parapets and Barriers	4,000 psi (Design)
	$f'_c$ = Compressive Strength (IDOT Class SI) All other retaining wall concrete	3,500 psi
Reinforcement	$f_y$ = Yield Strength	60,000 psi
	$f_s$ = Tension (Grade 60) (ASD)	24,000 psi
Soldier Piles	$f_y$ = Yield Strength	36,000 psi
Timber Lagging	Fb= Extreme Fiber Bending	1,000 psi
<b>NOISE ABATEMENT WALLS</b>		
Design Specifications	AASHTO LRFD Bridge Design Specifications, Chapter 15	<b>[Latest edition and interims]</b>
	Illinois Tollway Structure Design Manual	<b>[Latest edition]</b>
	Illinois Tollway Geotechnical Manual	<b>[Latest edition]</b>
<b>NOISE ABATEMENT WALLS – Design Loads</b>		
Dead Load	Concrete	150 pcf
	Steel	490 pcf
	Earth	120 pcf
Live Loads	Walls adjacent to roadways	Live load surcharge equivalent to 2 feet of earth.
Wind Loads	Structure Mounted NAW	50 psf (strength III) 15 psf (service I)
	Ground Mounted NAW	35 psf (strength III) 15 psf (service I)
Seismic Loads	AASHTO LRFD Bridge Design Specifications latest edition and interims	See Seismic Design requirements for bridges above
Vehicle Impact Loads	Structure Mounted and Crashworthy Walls	See Article 23.2.2

Deflection	Maximum Allowable Panel Deflection	Structure Mounted: L/180 Ground Mounted: L/240
	Maximum Allowable Post Deflection	H/360
<b>NOISE ABATEMENT WALLS – Design Stresses</b>		
Reinforced Concrete	$f'_c$ = Compressive Strength (IDOT Class PC) Non-Prestressed Panel	5,000 psi (Design)
	$f'_c$ = Compressive Strength (IDOT Class SI) Foundation	3,500 psi (Design)
Reinforcement	$f_y$ = Yield Strength	60,000 psi
Steel Post	$f_y$ = Yield Strength	50,000 psi
<b>NOISE ABATEMENT WALLS – Other Requirements</b>		
<p>The design height is determined by the DSE in conjunction with the noise mitigation study for each area.</p> <p>If NAW is to resist lateral earth pressure due to unequal ground lines, the requirement shall be shown on the Plans. The maximum grade differential shall be 3'-6" for non-crashworthy walls and 3'-0" for crashworthy walls.</p> <p>Crashworthy NAWs shall be identified as such on the plans for NAWs located within the clear zone. NAWs outside the clear zone need not be designed for vehicle impact load.</p>		
<b>OVERHEAD SIGN SUPPORTS</b>		
Design Specifications	2015 AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminares, and Traffic Signals (except as modified by IDOT Sign Structures Manual and Illinois Tollway Structure Design Manual)	First Edition with all interims
	IDOT Sign Structures Manual	<b>[Latest edition]</b>
	Illinois Tollway Standard Drawings	<b>[Latest edition]</b>
	Illinois Tollway Base Sheets	<b>[Latest edition]</b>
Design Loads	Dead Load: (LRFD Method)	Self-weight
	Wind Load: (LRFD Method)	Per "Loading" requirements on Illinois Tollway Standard F Drawings and Base Sheets
	Walkway Load	250 plf
	Ice Load	3 psf
	Fall Protection Anchorage	5 kip per person

## 5.2 Design Minimum Vertical Clearances

The following table lists the minimum vertical clearance requirements for all vehicular bridges and railroad bridges over and on the Illinois Tollway. The minimum vertical clearance shall be available over the traveled way, any usable shoulder, and usable median or measured from the top of the rail for clearances above current and future railroad tracks. Early coordination is required to ensure that these minimum vertical clearances are acceptable for all railroad bridges and underpasses and agencies with crossroad bridges over the Illinois Tollway.

Bridge Over Illinois Tollway	Type of Work	Vertical Clearance
Illinois Tollway Single Interstate Routes (1)	New Bridge or Reconstructing Bridge	16'-5"
	Widening or Rehabilitating Existing Bridge	16'-0"
Other Illinois Tollway Routes (2)	New Bridge or Reconstructing Bridge	16'-5" (desirable)
		15'-5" (minimum)
	Widening or Rehabilitating Existing Bridge	15'-5" (desirable)
		Existing Vertical Clearance (minimum)
Illinois Tollway Bridge Over	Type of Work	Vertical Clearance
All Routes	New Bridge or Reconstructing Bridge	As per IDOT BDE Manual Figure 33-5.A
		14'-9" (minimum)
	Rehabilitating or Widening Existing Bridge	As per IDOT BDE Manual Figure 33-5.A
		Existing Vertical Clearance (minimum)

\*16'-5" allows for an ultimate 16'-0" clearance after a 5" overlay is constructed.

\*\*15'-5" allows for an ultimate 15'-0" clearance after a 5" overlay is constructed.

(1) The following segments of the Illinois Tollway are considered Single Interstate Routes (Military Defense Route):

- Tri-State: All sections shared with I-80
- Tri-State: North of Jane Addams Memorial
- Jane Addams Memorial: West of Tri-State
- Reagan Memorial: West of Veterans Memorial
- Veterans Memorial: All sections

(2) The following segments of the Illinois Tollway are considered Other Illinois Tollway Routes:

- Tri-State: North of I-80 and south of Jane Addams Memorial
- Edens Spur: All Sections
- Jane Addams Memorial: East of Tri-State
- Reagan Memorial: East of Veterans Memorial

- Elgin O'Hare: All sections
- West O'Hare Access: All sections

In addition to the above, vertical clearances shall comply with requirements of the latest IDOT Traffic Manual. For widening or rehabilitation of existing bridges, if the clearance is less than 14'-6", the clearance shall be posted on a rectangular "Low Clearance" sign mounted to the structure over the highway. If the clearance is less than 14'-0", the clearance shall also be posted on a "Low Clearance" sign in advance of the structure over the highway, as a supplement to the sign mounted to the structure.

The following minimum vertical clearances includes a future 5" overlay, where applicable, and shall be used for all other structures:

- Pedestrian overpass structures – 17'-5"
- Overhead sign structures
  - Static signs, Dynamic Message Signs (DMS), Lane Control Signs – 17'-5"
- Mainline and Ramp Plaza Canopies – 17'-5"
- I-PASS overhead equipment truss structures – 18'-0"
- Structures over railroads – 23'-0" between top of rail and low structure measured at or within 9'-0" each side of center of outside tracks or as mandated by the operating railroad. On widening structures, not less than the existing, unless written approval is obtained from the railroad. Any clearance less than 21'-6" shall require Interstate Commerce Commission approval. The Design Section Engineer shall review operating railroad design criteria as applicable prior to commencing with design.
- Stream crossings – Minimum 2'-0" measured between design natural high-water elevation (50-year) with backwater effect and low structure. The low structure elevation of the bridge deck shall also be set at or above the peak flood water surface elevation (100-year) and the highest recorded or observed flood elevation at the bridge location, if available. Use whichever criterion produces the highest low structure.

### 5.3 Design Horizontal Clearances

Edge of pavement to the nearest face of existing or proposed piers on the Illinois Tollway System shall comply with Roadway Design Criteria Manual.

The horizontal clearance from the edge of traveled way to the closest face of shoulder piers or abutments shall be established by a Level 3 Barrier Warrant Analysis prepared by the Design Section Engineer and reviewed by the Illinois Tollway. The minimum distance from edge of traveled way to face of pier, abutment or MSE wall for new construction shall be 10-foot for single lane traffic in each direction to allow for maintenance and inspection of substructure elements or as defined in the Illinois Tollway Roadway Design Criteria Manual Article 2.6.3, whichever is greater. Refer to Article 3.2 for additional guidance.

The preferred design for a bridge crossing over the Illinois Tollway is a two-span continuous structure without shoulder piers and with sloped walls to provide an "open feel".

In the case of an abutment constructed on an embankment, the toe portion of the sloped wall shall be graded to a maximum slope of 1:4 (V:H) unless shielded by barrier or guardrail. The desired limit (Grade Break Point) of the 1:4 slope should be determined by a Barrier Warrant Analysis as previously described. The remainder of the sloped wall shall be graded to a maximum of 1:2 (V:H). The entire sloped wall shall be paved. See Article 10.7.



## 5.4 Deck Width

For structures carrying mainline, ramp or C-D roadways, the minimum bridge deck width shall match the approach or departure roadway, which includes pavement lane widths, roadway shoulder widths and gutter widths. To accommodate drainage and any adjacent roadway gutter, the minimum shoulder width shall be as per the table below. In cases where the approach and departure widths are different, the larger bridge shoulder dimension shall be used.

Shoulder widths on curved bridges shall be increased as necessary to provide required stopping sight distances.

### MINIMUM MAINLINE, RAMP OR C-D BRIDGE SHOULDER WIDTH

When concrete barrier is present either upstream or downstream of the bridge parapet.	Roadway shoulder width plus 2'-0"
When no concrete barrier is present either upstream or downstream of the bridge parapet.	Roadway shoulder width plus 1'-0"

## 5.5 Minimum Number of Beam Lines

The Illinois Tollway preference is to support all of the mainline and directional ramp bridges on a minimum of six lines of beams or girders unless the ramp traffic can be detoured for the duration of construction and/ or reconstruction.

## 5.6 Dead Loads

The deck dead loads used for interior beams shall include the calculated fillets expected and the deck width center to center of the beam spacing. The deck dead loads used for exterior beams shall include the weight of the deck soffit wedge, the deck width from the outside of the overhang to half the beam spacing, an allowance for the 3½" of deck provided for slip formed parapet if slip forming is not specifically excluded and the expected fillet.

Dead loads from parapets, luminaires, medians, sidewalks, sign structures and other ancillary fixtures shall be distributed based on engineering judgement, and shall not be distributed equally to all beams. Future wearing surface dead loads may be equally distributed to all beams at the designer's discretion.

Structures with unusual features, such as curved alignments, large skews, very wide beam spacing, flared beam lines, noise abatement walls and large overhangs require more precise methods of analysis.

## 5.7 Field Survey

### 5.7.1 General

Prior to the beginning of the conceptual or TS&L designs, a field survey shall be completed and shall include, but shall not be limited to, the items as outlined herein. A stationing system shall be established and all topography within the site which is relevant to the proposed work shall be collected utilizing one of the networks of Continuously Operating Reference Stations (CORS) coordinated by the National Geodetic Survey. Illinois Tollway CORS stations are located at the following Maintenance and or Plaza facilities:

Station Name	Station I.D. Number
ALSIP	TM01
GURNEE	TM04
SCHAUMBURG	TM05
BELVIDERE	TM06
ROCKFORD	TM07
NAPERVILLE	TM08
DEKALB	TM11
DIXON	TM12
BOLINGBROOK	TP89

A permanent Benchmark for each structure shall be established and all elevations taken for the structure shall be tied to this Benchmark.

#### 5.7.2 Existing Barrier and Parapet Modifications

On existing barriers and parapets that are proposed for modification, the joint locations shall be field verified before designing the new longitudinal reinforcement bars.

#### 5.7.3 Bearings

A condition survey shall be made of the existing bearings to verify the recommendations made in the Bridge Condition Report. On bearings proposed for replacement, measurements between the bottom of the beam and the top of the bearing seat shall be taken at all four corners of existing bearings to determine if shims are required.

#### 5.7.4 Bridge Deck Widening

On bridges that are to be widened, the following data shall be obtained or verified:

- Elevations along the bottom of the beam adjacent to the widening and elevations at the top of the deck at the same points.
- Verification of the locations of existing stiffeners and/or diaphragm connections on steel beams adjacent to the widening.
- Verification of existing beam lengths adjacent to the widening.
- Verification of substructure skew angles.
- Top of seat elevations at each abutment and pier adjacent to the proposed widening.

## 5.8 Construction

If the designer's construction scenario requires a special method of work or restriction to the way the Contractor builds the structure, it shall be defined in the contract documents.

An example would be:

- Precast Beams: The precast beams have been designed to accommodate loads arising from normal hoisting, storage and transportation. Specifically:
  - The lifting apparatus used to pick the beams shall distribute loads evenly between all the lifting points shown. Furthermore, load distributing slings and pins with the same radius as that shown for lifting loops on the drawings shall be used every time the beams are hoisted including movement in the precast yard.
  - Beams shall be supported within a distance equal to 1 1/2 times the depth of the beam from each end of the beam during storage and transportation.
  - Beams shall be stored with webs vertical.
  - Beams shall be transported on roads and bridges conforming to AASHTO standards with regard to smoothness and maximum superelevation.

If the Contractor wishes to use methods of hoisting, storage and transportation that are different from the parameters listed above, a detailed proposal shall be presented with detailed shop drawings and structural calculations sealed by the Contractor's Illinois licensed Structural Engineer. No extra payment shall be considered for changes required to conform to the Contractor's proposed method of work. No work is to proceed without the explicit approval of the Engineer.

The Contractor remains responsible to provide the expert knowledge and necessary care to ensure the delivery and final disposition of the beams in a condition required by the specifications.

## 5.9 Railroad Crossings

Right of entry, insurance and railroad safety training are required when inspecting and working on railroad right of way.

Information as required by the operating railroad shall be listed on the drawings. At a minimum, the following information shall be provided on the drawings and within the contract documents for railroad bridges and bridge structures over railroads:

Information	Comments
Design Specifications: Grade Separation Manual (Railroad Specific) AREMA (Latest Release) Illinois Tollway Structure Design Manual	Used for design of all railroad bridges.
Loading: Cooper E-80 or Railroad Specific	Used for design of railroad bridges. AREMA and Railroad Specific Grade Separation Manuals shall be used.
Horizontal and vertical clearance diagram	Based on the latest AREMA or Railroad guidelines.

Information	Comments
Existing and proposed vertical clearance measured from top of rail to the bottom of lowest beam	For new structures: minimum = 23'-0" For existing structures: not less than existing nor less than 21'-6"
Horizontal dimensions between the center line existing tracks and face of substructure elements	This information is critical for the Contractor to establish work limits, including stock piling of material and storage of construction equipment.
Temporary soil retention systems that support railroad surcharge	These systems shall be designed by the Designer's Illinois licensed Structural Engineer and submitted to the Illinois Tollway and the Railroad during preliminary plan submittal stage.
Railroad flagging requirements	Coordinate with Railroads to determine railroad flagging requirements for the contract. A contract allowance is to be included in the contract for railroad flagging that will be performed by the Railroad during construction and invoiced through the construction contract. Allowance special provisions for railroad flagging are available from the Illinois Tollway.
Specific railroad requirements	The Illinois Tollway requires the Designer to include the specific railroad requirements in the special provisions. Such requirements are specific to each railroad but may include contact persons, insurance requirements, flagging requirements, operational restrictions, right-of-entry agreement requirements, railroad safety training, etc.
Number, type and time of trains passing over/under the proposed structure each day	This information is critical for the Contractor to develop an appropriate work plan.
Railroad Milepost Number	Obtained from the railroad.

## 5.10 Fire Protection Requirements

1. The purpose of these requirements is to establish the minimum provisions necessary to provide protection against loss of life and property from fire.
2. Engineering analysis:
  - a. For any bridge, regardless of length, a fire engineering analysis shall be performed in accordance with National Fire Protection Association (NFPA) 502 Standard for Road Tunnels, Bridges and Other Limited Access Highways Chapter 4.3.1.
  - b. The analysis shall consider fire risk for events above and below the structure, including but not limited to those events outlined in NFPA 502 Annex A.6.3.2.
  - c. The analysis shall consider the consequences of structural collapse and/or major damage in terms of life safety and impact (interruption) to the affected roadway network. Where a major disruption to the road network could occur, the Illinois Tollway will determine acceptability of this impact.
  - d. For bridges, less than 1000-foot in length, where an unacceptable risk to life or property is identified, fire protection measures shall be included in accordance with NFPA 502 Chapter 6 to an extent sufficient to mitigate the risk. The fire protection

measures are subject to approval by the Illinois Tollway. For guidance, an unacceptable risk is defined as HIGH risk level, as evaluated by the risk procedures outlined in Appendix B – Fire Risk Assessment for Structures.

- e. For bridges, regardless of length, a fire risk assessment, covering the requirements in a, b, c and d above is required per the approach provided in Appendix B – Fire Risk Assessment for Structures. For each bridge, a Preliminary Risk Analysis (PRA), at minimum, shall be performed, followed by a Simplified Risk Analysis (SRA) and Detailed Risk Analysis (DRA), as necessary. For bridges for which DRA is performed, and risk is determined to be at a HIGH level, mitigation efforts and countermeasures to reduce risk shall be identified, with the solutions undergoing reassessment of risk, using the process outlined in Appendix B – Fire Risk Assessment for Structures, starting with SRA. Active countermeasures (possibly including passive fire protection), maintenance, and surveillance plans shall be identified and communicated with and agreed to by the Illinois Tollway Authority. The assessment methodology presented in Appendix B – Fire Risk Assessment for Structures shall be used unless other analysis methodology is approved by the Illinois Tollway.
  - f. The fire risk level determined from the set of risk assessments outlined by the procedures in Appendix B – Fire Risk Assessment for Structures are applicable if operating conditions and assumptions made remain unchanged. Regular reassessments are required, especially after significant structural or operational change of work is performed for the bridge. For bridges that are new, especially where assumptions were needed for metrics where insufficient information was available for the initial risk assessment, a reassessment of risk shall be conducted more frequently until realistic metrics to inform a full risk scoring can be obtained. An example metric where little information will be available for a new bridge is accident frequency. Frequency of risk assessment shall correspond with the intervals for a bridge's inspection as informed by Federal Highway Administration (FHWA) guidance, Risk-Based Interval Determination for Routine Bridge Inspections available at <https://www.fhwa.dot.gov/bridge/nbis/180608.pdf>). The data obtained from the bridge inspections shall serve as inputs for the risk assessment. The Illinois Tollway (or assigned delegate) is responsible for conducting inspections and any revisit of the risk assessment.
3. Design requirements
- a. All bridge structures greater than or equal to 1000-foot in length shall, at a minimum, be designed with fire protection elements in accordance with NFPA 502 Chapter 6.
  - b. At a minimum, where fire protection measures are required, the following provisions shall be considered in accordance with NFPA 502:
    - Protection of structural elements
    - Incident detection
    - Standpipe and fire hydrants
    - Portable fire extinguishers
    - Drainage
    - Hazardous locations
    - Control of hazardous materials

- c. Fire protection analyses and solutions shall be reviewed by and are subject to approval from the Illinois Tollway.
  - d. Control of hazardous materials shall be applied to prevent fires occurring and assure that the bridge is not exposed to a fire scenario beyond the design basis. Measures to control hazardous materials shall include the following:
    - Management of vehicular traffic on, under and next to the bridge structure with consideration of regulated and unregulated cargos (including but not limited to gasoline tankers) in accordance with NFPA 502 Chapter 14.
    - Management of and possible prohibition of the short and/or long-term storage of combustible materials on, under or next to the bridge.
    - A hazard assessment, including identification of control measures where identified hazards pose an unacceptable consequence in terms of property damage or life safety. Hazard assessment shall consider hazards including but not limited to security events (i.e., deliberate actions to damage the structure), parking on or under the bridge, construction activities and implications of short-term material storage during a construction project at or near the facility.
    - Documentation and communication of the control measures and hazard assessment (items i through iii above) in a format suitable to the Illinois Tollway and/or agency responsible for operations, to ensure that the control measures are routinely and continuously implemented, updated and maintained during the operational life of the structure.
4. Incident response
- a. Incident response plans shall be developed, in accordance with requirements of the Illinois Tollway, the local fire protection district and NFPA 502 Chapter 13.

## 5.11 Design Truck

For New or Replacement Projects on Illinois Tollway structures and ramps, the Design Truck in the *AASHTO LRFD Bridge Design Specifications* Article 3.6.1.2.2 shall be replaced with the “IL-120” Design Truck as shown in Figure 5.11.1. This truck shall be applied in accordance with AASHTO LRFD Article 3.6.1.3 and is referred to as the “IL-120 loading”. The “IL-120 loading” shall include the IL-120 Design Truck and the Design Lane Load as specified in AASHTO LRFD Article 3.6.1.2.4. The bridge design shall also meet the design requirements for the HL-93 loading. The Design Tandem remains as given in AASHTO LRFD Article 3.6.1.2.3. The structural design shall be based on the maximum force effects resulting from the IL-120 loading, the HL-93 loading and the Design Tandem.

The IL-120 Design Truck shall not be used for fatigue design. All requirements of AASHTO LRFD Article 3.6.1.4 shall apply.

Load factors and combinations shall be according to AASHTO LRFD Article 3.4.

The Inventory and Operating Load Ratings for the HL-93 shall be shown on the General Plan and Elevation sheet. Refer to Article 6.3.12.

The IL-120 Design Truck Diagram (Figure 5.11.1) shall be shown in the plan set. Refer to Article 6.3.4.

Design loads for decks and deck systems shall be in accordance with AASHTO LRFD Article 3.6.1.3.3, using the design truck given in AASHTO LRFD Article 3.6.1.2.2 or the design tandem given in AASHTO LRFD Article 3.6.1.2.3.

For live load deflection evaluation of structures carrying mainline Illinois Tollway routes or ramps, the deflection shall be taken as the larger of:

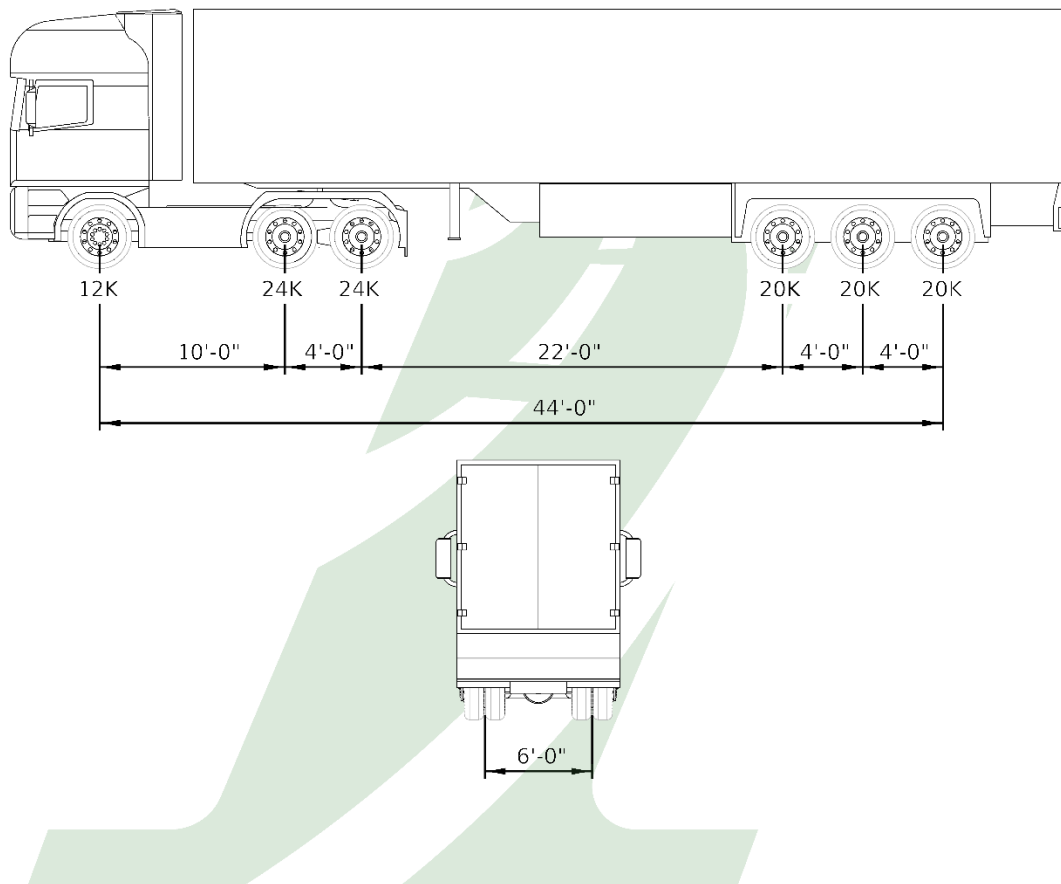
- The maximum deflection resulting from the IL-120 truck, HL-93 truck, or HL-93 Tandem alone, or
- The deflection resulting from the design lane load plus the maximum deflection resulting from 25 percent of the IL-120 truck, HL-93 truck, or the HL-93 Tandem.

Superstructure replacement projects on Illinois Tollway mainline and ramp bridges and new, replacement and superstructure replacement projects on crossroad bridges over the Illinois Tollway shall meet the requirements shown above, except checks for IL-120 live load are not required.

## 5.12 Seismic Design of Bridges

Illinois Tollway structures shall be designed to meet the minimum requirements for AASHTO Seismic Performance Zone 1 (LRFD) or Category A (LFD) with a low probability of being exceeded during the normal life expectancy for a bridge. Bridges and their components that are designed to resist Zone 1 (Category A) forces and constructed in accordance with the design details contained in the latest IDOT Bridge Manual should not experience total collapse but may sustain repairable damage due to seismically induced ground shaking.





**Figure 5.11.1: IL-120 Design Truck**

## SECTION 6.0 PLAN PREPARATION

### 6.1 CADD Standards

Plan presentation shall be in accordance with the Illinois Tollway CADD Standards Manual.

### 6.2 Plan Sheet Organization

Each bridge, culvert and retaining wall shall consist of a set of sequentially numbered plan sheets. Plan sheets shall be organized in such a manner as to facilitate construction. Shown below are plan sheet lists for several types of structures.

#### 6.2.1 Bridges

1. General Plan and Elevation
2. General Notes, Index of Sheets and Total Bill of Material
3. Construction Staging
4. Substructure Layout, Temporary Retention and Slope Paving Details
5. Limits and Details of Temporary Soil Retention System
6. Pile Driving and/or Drilled Shaft Installation Records
7. Abutment Details
8. Pier Details
9. Framing Details
10. Bearing and Anchor Rod Details
11. Superstructure Elevations
12. Superstructure Details
13. Expansion Joint Details
14. Drainage Details
15. Approach Slab Details
16. Boring Logs

#### 6.2.2 Culverts

1. General Plan and Elevation
2. General Notes, Index of Sheets and Total Bill of Material
3. Construction Staging (if required)
4. Foundation Layout and Details (if required)
5. Limits of Temporary Soil Retention Systems (if required)
6. Barrel Details
7. Head and Wing Wall Details
8. Approach Slab Details (if required)
9. Boring Logs

#### 6.2.3 Conventional Concrete Retaining Walls

1. General Plan and Elevation
2. General Notes, Index of Sheets and Total Bill of Material

3. Construction Staging (if required)
4. Substructure Layout and Limits of Temporary Soil Retention System (if required)
5. Existing Pile Driving and/or Drilled Shaft Installation Records (if available)
6. Plans and Elevations Details
7. Sections and Details
8. Rebar Lists and Bending Diagrams
9. Drainage Details
10. Boring Logs and Plan Locations

#### **6.2.4 Performance Based Retaining Walls**

Plans included in Contract Documents shall include the following for each wall:

1. General Plan and Elevation
2. General Notes, Index of Sheets and Bill of Material
3. Construction Staging and MOT (as required)
4. Proposed Elevations of Top and Bottom of the Wall, Finished Ground Lines at the Back and Front Face of the Wall and Existing Surface Profile
5. Existing Pile Driving and/or Drilled Shaft Installation Records (if available)
6. Cross Sections of all Significantly Different Sections
7. Drainage Details
8. Location of utility or drainage interferences, all ancillary structures such as, light standards, overhead sign structures, drainage openings and noise abatement walls. Location of all appurtenances behind, in front of, under, over, mounted upon, or passing through the wall
9. Boring Logs and Plan Locations
10. Subsurface Data Profile Plot

For Performance Based Retaining Walls, the DSE shall review Working Drawings to ensure they are in accordance with the Plan Sheet requirements.

#### **6.2.5 Noise Abatement Walls (Non-Precast)**

Plans included in Contract Documents shall include the following for each ground mounted or structure mounted noise abatement wall:

1. General Plan and Elevation per Article 23.3.1
2. General Notes, Index of Sheets and Bill of Material
3. Construction Staging and MOT (as required)
4. Substructure Layout (Ground Mounted)
5. Plan and Elevation Details
6. Typical Sections and Details
7. Boring Logs and Plan Locations (Ground Mounted)

### 6.2.6 Precast Concrete Noise Abatement Walls

Plans included in Contract Documents shall include the following for each ground mounted or structure mounted noise abatement wall:

1. Reference to Illinois Tollway Standard Drawings (as applicable)
2. General Plan and Elevation per Article 23.3.1
3. Illinois Tollway Base Sheets (as applicable)
4. Construction Staging and MOT (as required)
5. Boring Logs and Plan Locations (Ground Mounted)

## 6.3 General Plan and Elevation

### 6.3.1 Plan and Elevation Views

The plan and elevation views for each bridge shall include at a minimum the following information:

- Horizontal and vertical alignments for roadways, waterways and facilities
- Skew angles
- Bridge and approach roadway widths
- Minimum vertical and horizontal clearances
- Stations and elevations at the centerline of each pier and back of and centerline of bearing of each abutment
- Span lengths and numbers
- Type and depth of spans, i.e., 72-inch PPC I-beam or 48-inch Steel Plate Girder, etc.
- Location, size, and type of expansion joints
- Location of fixed and expansion bearings, deck drainage, signing and lighting
- Guardrail anchorage and terminal type
- Approach slab lengths
- Limits and type of slope paving
- Bottom of footing elevations and foundation type including pile or drilled shaft size, length and capacity
- Location of borings
- Location of all existing and proposed utilities (overhead and buried) and storm sewers in the vicinity of the bridge
- Waterway Information Table and Scour Elevation Table (if required)
- Illinois Tollway and IDOT Structure Number

Station equations shall not be located between the backs of abutments.

### 6.3.2 Benchmark

Include location and description of the benchmark in the upper left-hand corner of the General Plan and Elevation Sheet.

### 6.3.3 Structure Description

- Structure Reconstruction or Rehabilitation – Include a description of the existing structure and list of Major Items of Work as well as the required maintenance of traffic (MOT).
- Structure Widening – Include a description of the existing structure and required MOT.

- Structure Replacement – Include a description of the existing and proposed structure as well as the required MOT.
- New Structure – Include a description of the proposed structure and MOT if required.
- Salvage – For the removal of existing structures, reconstruction and rehabilitation, indicate if any items of the existing bridge will be removed and incorporated into a future Illinois Tollway contract or for future Illinois Tollway use. If no portion of the structure will be removed for reuse in a future contract, indicate “No Salvage.”

#### 6.3.4 Design Criteria

Design criteria are listed in Article 5.1. The design criteria shown on the plans shall include the following:

- Design Specifications
- Construction Specifications
  - Illinois Department of Transportation Guide Bridge Special Provisions (GBSPs)
  - Illinois Tollway Supplemental Specifications to the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction **[Use latest edition]**
  - Illinois Department of Transportation Supplemental Specifications and Recurring Special Provisions **[Use latest edition]**
  - Illinois Department of Transportation Standard Specifications for Road and Bridge Construction **[Use latest edition]**

Items indicated in [ ] and bold are notes to the designer to include the latest date and edition for plan presentation.

- Design Live and Future Wearing Surface Loads
- Design Stresses
- Live Load Deflection Criteria
- Seismic Criteria
- IL-120 Design Truck Diagram

#### 6.3.5 Horizontally Curved Alignments

For bridges on horizontally curved alignments, provide a "Horizontal Offset Sketch" as shown in Figure 6.3.5.1. The sketch shall establish a local tangent at a stationing point along the horizontal curve.

Distances along the local tangent and offsets from the local tangent shall be shown for the centerline of each pier and abutment.

#### 6.3.6 Profile Sketches

Provide "Profile Grade" sketches for the structure, roadways, waterways and facilities crossed by the bridge. Indicate location and limits of the bridge on the appropriate Profile Grade Sketch. For examples of "Profile Grade" sketches, see Figures 6.3.6.1 and 6.3.6.2.

#### 6.3.7 Superelevation Transitions

Superelevation Transitions (SETs) shall not be located on bridges or approach slabs. A Design Deviation is required if a SET occurs within the limits of the bridge or approach slab. If a SET

must be located on a bridge or approach slab, its limits shall be indicated on the General Plan and the appropriate vertical Profile Sketch. The SET diagrams and details shown in the structural and roadway portions of the plans shall also be referenced on the General Plan and Elevation sheet. See Article 15.3 for specific requirements of bridge and approach cross slopes.

### **6.3.8 Location Sketch**

Provide a "Location Sketch" containing the following information in the lower right-hand corner of the sheet. For an example of a "Location Sketch" see Figure 6.3.8.1.

- Range, Township, Principle Meridian and Section Numbers
- North Arrow
- Location of Structure(s)
- Four Township Numbers
- Significant Landmarks

### **6.3.9 Key Map**

Provide a "Key Map" in plans for contracts that has more than one structures containing following information:

- Location and limits of all existing noise abatement walls, retaining walls, and bridges.
- Location and limits of all proposed/new noise abatement wall, retaining walls, and bridges.

### **6.3.10 Highway Classification**

For grade separations, provide the following information for the Route over and under the proposed structure(s): Route Identification, Class, DHV (existing and future), ADT (existing and future), ADTT (existing and future truck traffic) and Design Speed.

### **6.3.11 Railroad Information**

For railroad crossings, provide the number, type and time of trains passing over/under the proposed structure each day. In addition, all structures on or over railways shall be located by the Railroad Mile Post (MP) number.

### **6.3.12 Waterway Information**

For waterway crossings, provide a waterway information table in accordance with Section 1-303.02 of the latest IDOT Drainage Manual and the scour critical analysis coding as described in Article 2.4 of this Manual. Refer to Figure 6.3.11.1 for an example.

### **6.3.13 Structure Rating**

Load rating shall be performed in accordance with the latest edition of IDOT Structural Services Manual applicable sections, unless noted otherwise in this manual. In general, policies and guidelines stated in the Structural Design Manual for bridge design are also applicable for load ratings.

The Inventory and Operating Rating for each new, reconstructed or widened structure shall be calculated by the Designer and shown on the General Plan and Elevation Sheet. The load rating shall include future wearing surface when evaluating original superstructure design. Other load

ratings shall only include the wearing surfaces currently in place or that will be constructed when evaluating a proposed overlay. A load rating is required when a new feature is added to a bridge that increases or redistributes the existing permanent loads on a bridge. Common examples of this are the addition of a new or modified wearing surface, barrier extension or modification, or the attachment of new utilities to a bridge.

The Designer shall also complete and submit the "Illinois Tollway Bridge Superstructure Rating Form" shown in Figure 6.3.12.1 to the Illinois Tollway for their review and comment. The "Bridge Superstructure Rating Form" is required to be submitted for all Illinois Tollway mainline bridges and cross road bridges with the pre-final and final submittals. The "Bridge Superstructure Rating Form" may be downloaded from the Illinois Tollway's internet site at [www.illinoistollway.com](http://www.illinoistollway.com), under Doing Business, Construction & Engineering, Consultant Resources, Manuals, Bridges & Structures.

Load ratings of bridges should be completed, when possible, using AASHTOWare Bridge Rating™ (BrR) software in order to be compatible with the Illinois Transportation Automated Permits (ITAP) system and other software used by IDOT and the Illinois Tollway.

#### **6.3.14 Structural Engineer Seal**

The General Plan and Elevation sheet for each structure shall include a structural seal of a licensed Structural Engineer in the State of Illinois with signature and expiration date.

### **6.4 Total Bill of Material**

A coded "Summary of Quantities" for individual Pay Items and a "Total Bill of Material" shall be shown in the plans for each structure. The "Total Bill of Material" shall be divided into Superstructure, Substructure, Total and Record Quantities and shall be placed on the first or second sheet of the structure plans. Summary of Quantities shall be provided for all Pay Items included in the structure contract on appropriate plan sheets. The total of all of the individual Summary of Quantities shall equal the total shown in the Total Bill of Material.



## 6.5 Abbreviations

Provide a list of all abbreviations and their meanings which will be used on the drawings. A list of some typical abbreviations is shown below.

P.G.L.	PROFILE GRADE LINE
N.B.L.	NORTH BOUND LANES
S.B.L.	SOUTH BOUND LANES
S. ABUT.	SOUTH ABUTMENT
N. ABUT.	NORTH ABUTMENT
E.F.	EACH FACE
F.F.	FRONT FACE
B.F.	BACK FACE
I.F.	INSIDE FACE
O.F.	OUTSIDE FACE
P.J.F.	PREFORMED JOINT FILLER
P.J.S.	PREFORMED JOINT SEALER
BK/	BACK OF
B/	BOTTOM OF
T/	TOP OF
PROP.	PROPOSED
EXIST.	EXISTING

## 6.6 Index of Sheets

Provide an Index of Sheets for each bridge. The index shall list all of the sheet numbers and titles that are part of the bridge plans. The titles in the index shall exactly match the individual sheet titles.

## 6.7 Concrete Reinforcement Detailing

Separate Reinforcement Bar Schedules shall be prepared for each element of the structure and shown along with bending diagrams of each bent bar on the appropriate plan sheet. See Figure 6.7.1 for the Reinforcement Bar List format.

When detailing lengths of reinforcement bars, consideration shall be given to transportation and handling and, where extremely long lengths are contemplated, to availability and special orders.

When the location of bar splices is arbitrary, as in the case of the longitudinal reinforcement of deck slabs on beams and girders, the preferred maximum lengths are as follows:

- #6 bars and up: 36'-0"
- #4 & #5 bars: 30'-0"

Bars shall be detailed to the closest inch of length and the weight of reinforcement bars shown in the Bill of Material shall be to the nearest ten (10) pounds.

To provide uniformity on all structure plans, bar designations used shall be as follows:

- a – Deck Slab (Transverse)
- b – Deck Slab, Sidewalk and Median (Longitudinal)

c	–	Sidewalk and Median (Transverse)
d	–	Barrier Rail (Curb/Parapets)(Vertical)/Dowels (any location except Footing to Wall)
e	–	Barrier Rail (Curb and Parapets) (Longitudinal)
g	–	PPC or CIPC Beams
h	–	Substructure and Walls (Horizontal)
m	–	Diaphragm for PPC I-Beams (Horizontal)
n	–	Footing to Wall (Dowels)
p	–	Pile Caps and Pier Caps (Longitudinal)
s	–	Stirrup and Tie Bars
t	–	Footing (Transverse)
u	–	Ends of Pier Caps, Pile Caps and Crash Walls
v	–	Substructure and Walls (Vertical)
w	–	Footing (Longitudinal)
x	–	Deck Slab – Longitudinal Deck Cantilevers at Expansion Joints

In no case shall the same designation be used for reinforcement bars of a different size, length and shape when they are employed in other elements of the structure.

## 6.8 Beam Numbering

All beam lines shall have a unique beam number. For complete replacement bridges, beams and girders shall be numbered from left to right when looking in the direction of increasing station. When new beams are added to an existing structure, the existing beams shall not be renumbered. The new beams shall be numbered with a suffix consecutively, such as Beam 1A, 1B, 8A, 8B, etc.

## 6.9 Design Concept Submittal (30%)

The Concept 30% plans shall include a TS&L for new or replacement structures, widenings and superstructure replacements. Requirements shall be per Section 3, Type, Size & Location (TS&L) Plans. Structure Report, hydraulic information and Structural Geotechnical Report shall be included as applicable with the 30% Plans. Existing bridges, culverts and retaining walls shall include a structure condition report per Section 2, Structure Inspection and Condition Reports as part of the concept submittal. Fire Risk Assessment memo shall also be included as per Article 5.10.

The checklist included in Appendix C is provided as an aid to the designer when completing the TS&L. The checklist of items provided is for guidance and is not all inclusive. The designer and checker shall supplement this checklist with additional material appropriate for the specific project in order to ensure quality submittal.

## 6.10 Preliminary Plan Submittal (60%)

The Preliminary 60% plans form the basis of establishing final geometry and dimensions of the structure. The objective of the Preliminary Design Phase (60%) is to incorporate comments from the Conceptual Design Phase (30%), and to demonstrate that the plans are being developed into the Pre-Final Design Phase (95%).

The following items shall be included in the 60% submittal:

- Address and incorporate all comments from TS&L (30%) submittal.

- Plan sheets, details and views shall be included to ensure the sheet index and layout of sheets has been established per Illinois Tollway guidelines.
- Major geometry, dimensions, foundation layout, and elevations shall be set.
- Structural details shall be established and developed (rebar detailing and quantities may not be finalized).
- Appropriate structural Illinois Tollway Standards shall be listed in the Contract Documents.
- Appropriate Illinois Tollway Base Sheets shall be incorporated as plan details into the Contract Plans (the Base Sheets may not be finalized).
- A complete list of pay items and special provisions shall be included.

### **6.11 Pre-Final Plan Submittal (95%)**

The Pre-Final 95% plans shall include the revised plans and special provisions, addressing all preliminary plan comments. All geometry, rebar detailing, quantities and base sheets shall be finalized. All new, reconstructed or widened structures shall include the inventory and operating rating on the General Plan and Elevation Sheet, as well as the “Bridge Superstructure Rating Form” per Article 6.3.12. Models shall also be included and submitted through the SRF process on E-builder.

### **6.12 Final Plan Submittal (100%)**

The Final 100% plans shall include the revised plans and special provisions, addressing all Pre-Final plan comments. Plans shall be signed and sealed by a Structural Engineer. A final “Bridge Superstructure Rating Form” and updated model shall be included, if applicable, per Article 6.3.12. Final design calculations indexed and stamped by a Structural Engineer registered in Illinois shall also be submitted.

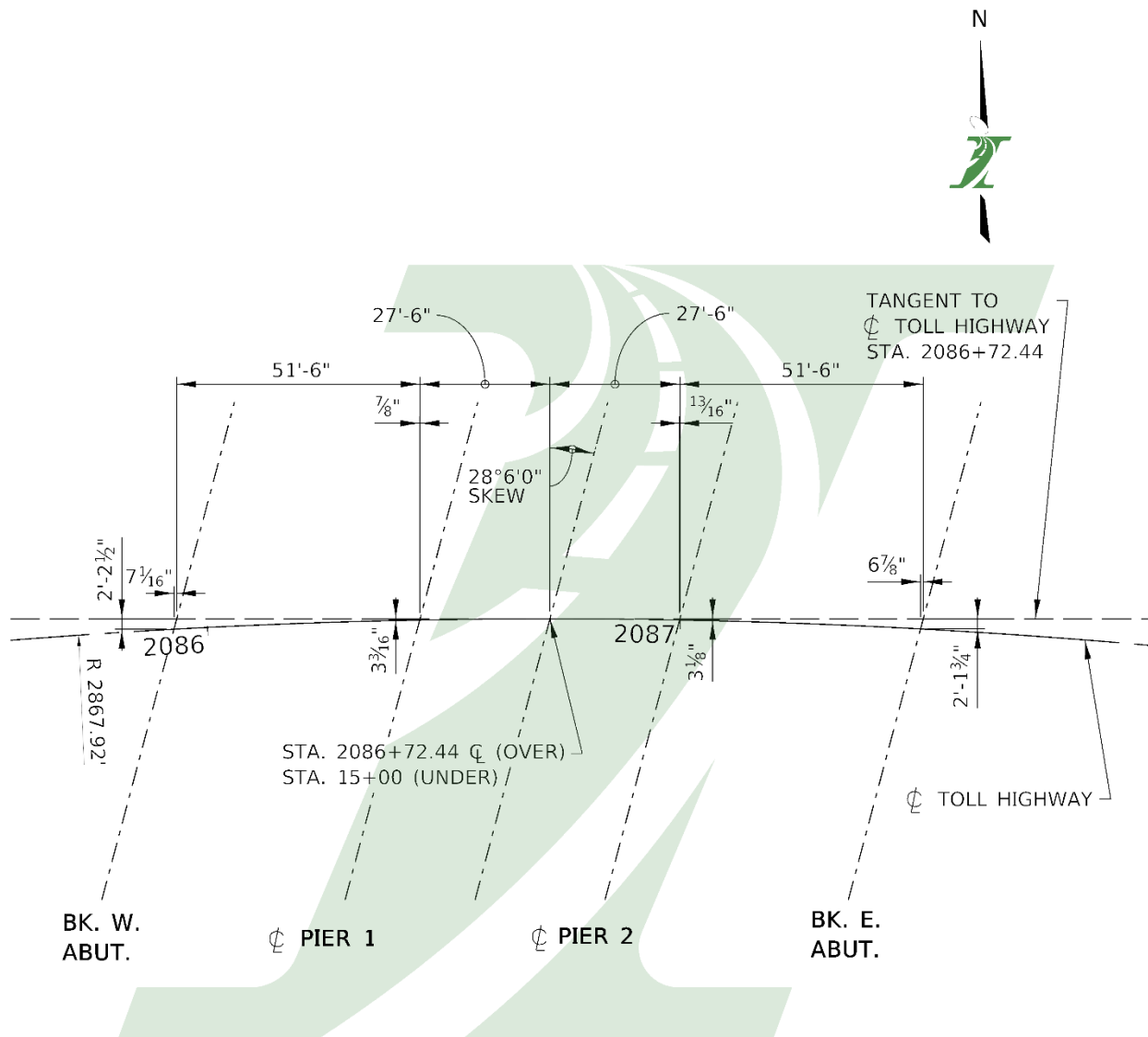
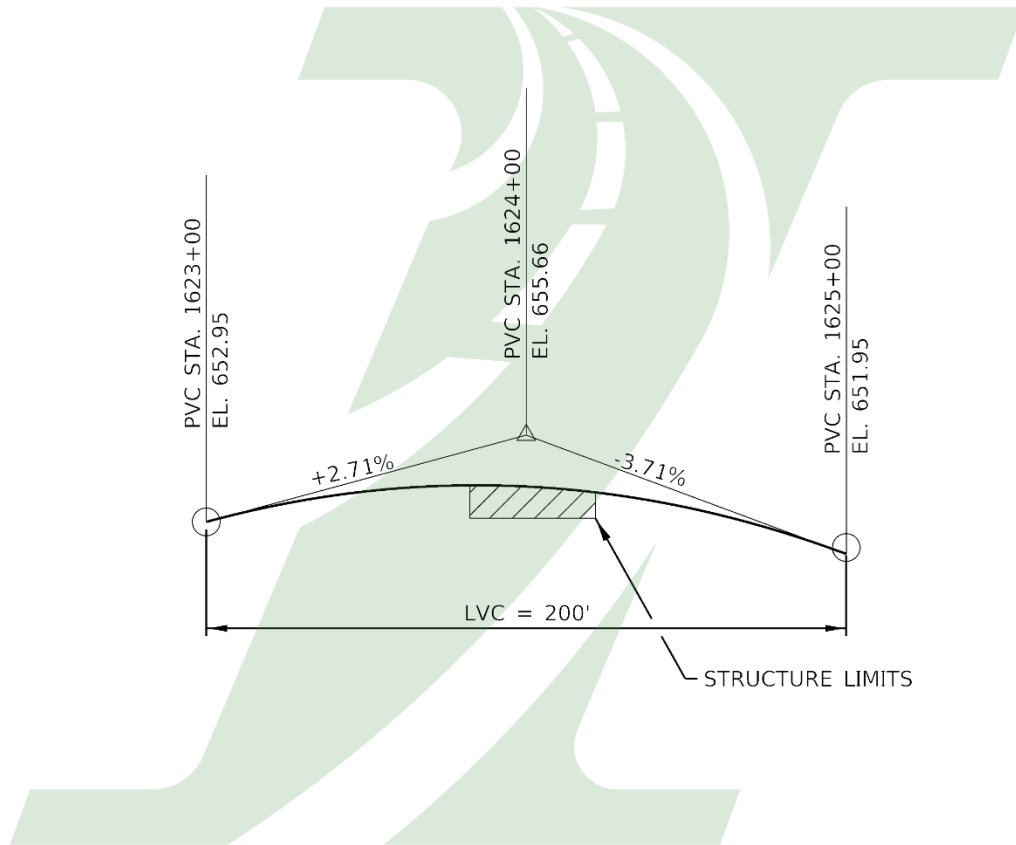
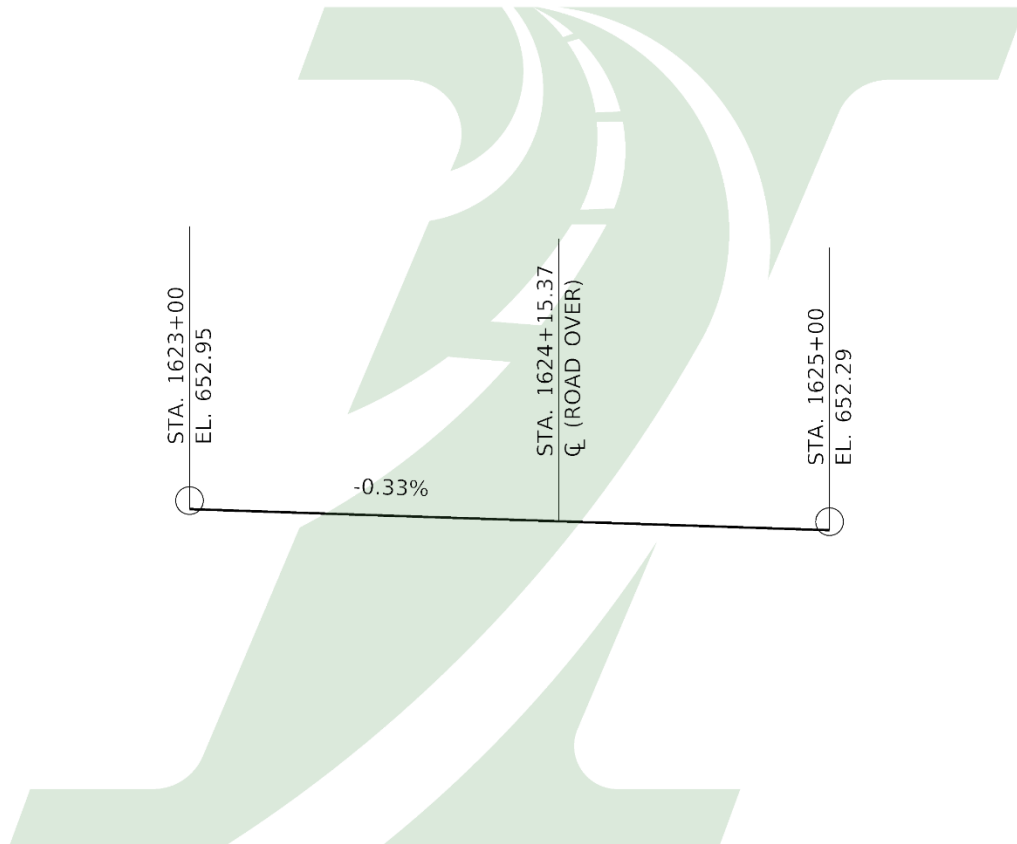


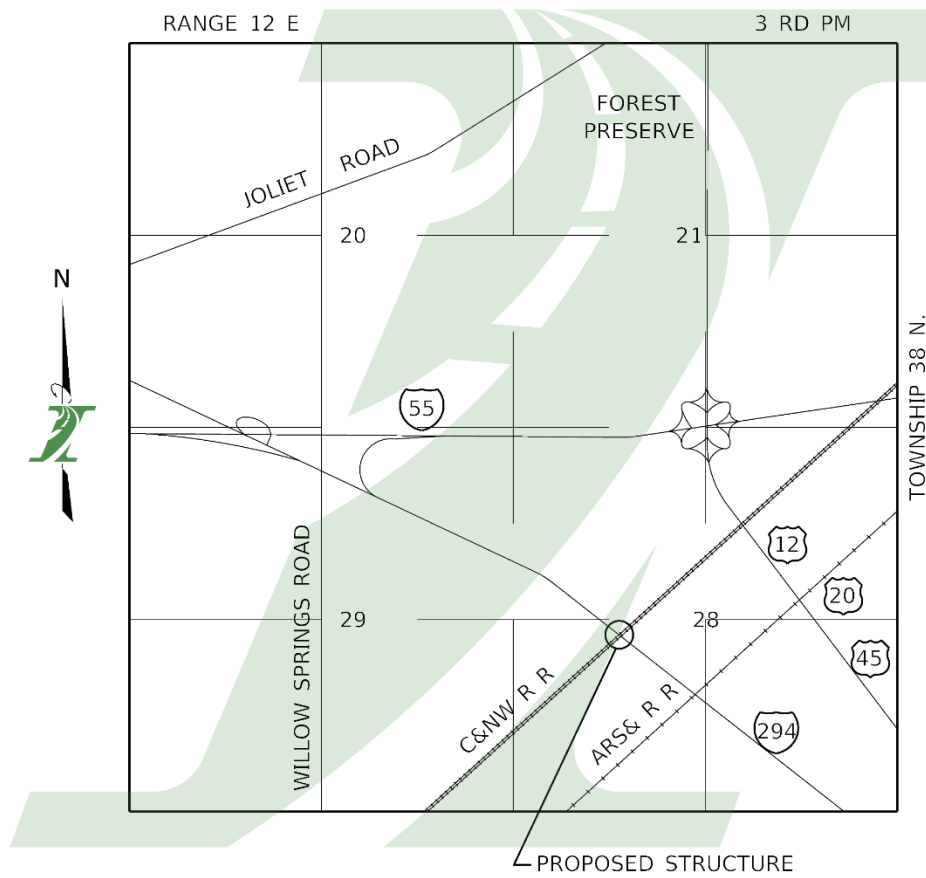
Figure 6.3.5.1: Offset Sketch



**Figure 6.3.6.1: Profile Grade (Over) Existing or Proposed**



**Figure 6.3.6.2: Profile Grade (Under) Existing or Proposed**



**Figure 6.3.8.1: Location Sketch**


DESIGN SCOUR ELEVATION (FT.)			
	W. ABUT	PIER	E. ABUT
Q100			
Q500			
DESIGN			
CHECK			

ILLINOIS HIGHWAY INFORMATION SYSTEM NBI CODING	
SCOUR CRITICAL EVALUATION (ITEM 113)	
SCOUR CRITICAL ANALYSIS DATE (ITEM 113A)	
SCOUR CRITICAL EVALUATION METHOD (ITEM 113B)	
SCOUR CRITICAL ANALYSIS BY NAME (ITEM 113C)	
SCOUR CRITICAL EVALUATION METHOD (ITEM 113B)	
SCOUR CRITICAL REMARK (ITEM 113D)	
CHANNEL AND CHANNEL PROTECTION CONDITION (ITEM 61)	
WATERWAY ADEQUACY APPRAISAL (ITEM 71)	
PIER NAVIGATION PROTECTION (ITEM 111)	

**Figure 6.3.11.1: Design Scour Elevation Table**



	<b>Bridge Superstructure Rating Form</b>	Contract No.: <input style="width: 80%;" type="text"/> Construction Yr.: <input style="width: 80%;" type="text"/>	<input type="checkbox"/> Prefinal <input type="checkbox"/> Final																																																																			
The Inventory and Operating ratings for each new, reconstructed, modified or widened structure shall be calculated by the DSE and shown on the General Plan and Elevation sheet. The DSE shall fill out the following information, to be submitted with the Prefinal Submittal package and updated and resubmitted with the Final Submittal package.																																																																						
<b>Inventory Data</b> Tollway Bridge No.: <input style="width: 100%;" type="text"/> IDOT Bridge No.: <input style="width: 100%;" type="text"/> Tollway Milepost: <input style="width: 100%;" type="text"/> Feature Over: <input style="width: 100%;" type="text"/> Feature Under: <input style="width: 100%;" type="text"/>		Rating Methodology: <input type="checkbox"/> LFR <input type="checkbox"/> LRFR <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 33%;">Superstructure Rating</th> <th style="width: 33%;">Inventory</th> <th style="width: 33%;">Operating</th> </tr> <tr> <td>Strength (LFR or LRFR)</td> <td>Flexure:</td> <td><input style="width: 100%;" type="text"/></td> </tr> <tr> <td></td> <td>Shear:</td> <td><input style="width: 100%;" type="text"/></td> </tr> <tr> <td>Service (LRFR Only)</td> <td>Flexure:</td> <td><input style="width: 100%;" type="text"/></td> </tr> <tr> <td></td> <td>Shear:</td> <td><input style="width: 100%;" type="text"/></td> </tr> </table>		Superstructure Rating	Inventory	Operating	Strength (LFR or LRFR)	Flexure:	<input style="width: 100%;" type="text"/>		Shear:	<input style="width: 100%;" type="text"/>	Service (LRFR Only)	Flexure:	<input style="width: 100%;" type="text"/>		Shear:	<input style="width: 100%;" type="text"/>																																																				
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Form Date: March 2022

Figure 6.3.12.1: Bridge Superstructure Rating Form

REINFORCEMENT BAR LIST				
BAR	No.	SIZE	LENGTH	SHAPE
d51(E)	28	#5	4'-3"	
e50(E)	18	#5	13'-3"	
h51(E)	6	#5	5'-5"	
h52(E)	24	#5	3'-9"	
h53(E)	24	#5	8'-6"	
h61(E)	24	#5	2'-0"	
h62(E)	34	#5	3'-8"	
h51(E)	20	#6	7'-3"	
h52(E)	54	#6	5'-4"	
v51(E)	18	#5	4'-8"	
v52(E)	18	#5	4'-6"	
v53(E)	18	#5	2'-6"	
s51(E)	18	#5	4'-0"	
s52(E)	18	#5	1'-3"	
s52(E)	18	#5	6'-11"	
t51(E)	50	#6	5'-8"	
t52(E)	24	#6	10'-5"	
t53(E)	24	#6	2'-8"	
BILL OF MATERIAL				
DESCRIPTION			UNIT	QUANTITY

Figure 6.7.1: Reinforcement Bar List and Bill of Materials

## SECTION 7.0 GENERAL NOTES

### 7.1 Structural General Notes

The following general plan notes, in addition to those from Section 3.1.3 of the latest IDOT Bridge Manual, shall be included in the Contract Plans as applicable.

Items indicated in [ ] and bold are notes to the designer and shall be filled in or removed in the plans as applicable.

#### 7.1.1 Cast-In-Place Concrete

All exposed concrete edges shall have a  $\frac{3}{4}$ " x 45° chamfer, except where shown otherwise. Chamfer on vertical edges shall be continued a minimum of one foot below finished ground level.

#### 7.1.2 Reinforcement Bars

1. Reinforcement bars, including epoxy-coated reinforcement bars, shall conform to the requirements of AASHTO M-31 (ASTM A706), Grade 60, deformed bars.
2. Reinforcement bars designated "(E)" shall be epoxy coated.
3. Reinforcement bar bending details shall be in accordance with the latest "Manual of Standard Practice for Detailing Reinforced Concrete Structures", ACI 315.
4. Reinforcement bar bending dimensions are out to out.
5. Bars noted thus, 3x2-#5 indicates 3 lines of bars with 2 lengths of bars per line.
6. Cover from the face of concrete to face of reinforcement bars shall be 3" for surfaces formed against earth and 2" for all other surfaces unless otherwise shown.
7. Bridge seat reinforcement shall be carefully placed as detailed in the plans to avoid interference with drilling holes for anchor rods. The beams shall be erected in final position prior to drilling holes for anchor rods. **[See Articles 10.9 and 11.9 for details to be shown in the plans for the detailing of the reinforcement to miss anchor rods.]**
8. The number of ties as specified shall be doubled for lap splices at the stage construction line of concrete bridge decks when traffic is allowed on the first completed stage during the pouring of the second stage.
9. Slopewalls shall be reinforced with welded wire reinforcement, 6" x 6" - W4.0 x W4.0, weighing 58 pounds per 100 square feet.
10. The cost of PJF, welded wire reinforcement and the thickened portion of the slope wall and associated reinforcement bars are included in the cost of "Slope Wall 4 inch". **[If used, add incidental items to Special Provision 110].**

#### 7.1.3 Structural Steel

1. All bearing and side retainer anchor rods shall be set before permanently bolting diaphragms or cross frames over supports.
2. All side retainers shall be installed and bolted down prior to forming and pouring the deck slab.
3. Web plates shall be furnished in available mill lengths and widths with a minimum number of web splices. Location of splices shall be subject to the approval of the Designer and shall be a minimum of 1'-0" from stiffeners or flange splices.

4. Bearing stiffeners and ends of beams shall be perpendicular to flange. **[For all rolled beam bridges and plate girder bridges with grades of 3% or less and skews of 20 degrees or less]**
5. Bearing stiffeners at abutments shall be vertical and ends of beams shall be vertical. Bearing stiffeners at piers shall be perpendicular to flange. **[For plate girder bridges with grades greater than 3% or skews greater than 20 degrees]**
6. The calculated deflections of the primary beams using steel dead load fit shall be used to detail diaphragms, cross frames and lateral bracing connections, and to erect structural steel such that the beams will be plumb within a tolerance of +/- 1/8 inch per vertical foot throughout. **[See Section 12.5.3 for exceptions]**
7. Painting of new structural steel shall be accomplished in accordance with Section 506 of the Standard Specifications except field-applying intermediate or final coats of paint on new steel shall not be allowed.
8. Load carrying components – including tension flanges, webs and splice plates – designated “CVN” shall conform to the AASHTO Impact Testing Requirement, Zone 2. **[This note shall be included on sheets detailing structural steel main members.]**
9. The deck pouring sequence shown on the plans has been used to design the required beam camber and to determine the “Theoretical Grade Elevations Adjusted for Dead Load Deflection” used in the calculation of fillet heights, “t”. Requests for changes to the plan pouring sequence shall be submitted in writing (prior to ordering of steel, prior to the start of building forms for the deck concrete) **[Choose applicable phrase]**. Modifications, either to the camber diagrams or the “Theoretical Grade Elevations Adjusted for Dead Load Deflection”, resulting from changes to the plan pouring sequence shall be the responsibility of the Contractor. All required plans shall be submitted with the request and shall be sealed by an Illinois Licensed Structural Engineer.
10. Heat curving of horizontally curved steel rolled beam or welded I-Girder is not permitted. **[When the provisions of Article 11.4.12.2.2 of the AASHTO LRFD Bridge Construction Specifications regarding cross-sectional limits and radius limitations on heat curving are not met.]**
11. The members herein are designated as System Redundant Members and shall be fabricated according to the provisions of Clause 12 specified in the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code. **[When System Redundant Members are present, draw a box around all System Redundant Members on the plans and tag with this note]**

#### 7.1.4 Construction

1. Plan dimensions and details relative to existing structure have been taken from existing plans and are subject to nominal construction variations. It shall be the Contractor's responsibility to verify such dimensions and details in the field and make necessary approved adjustments prior to construction or ordering of materials. Such variations shall not be cause for additional compensation for a change in the scope of work; however, the Contractor shall be paid for the quantity actually furnished at the unit price for the work.
2. Contractor shall not scale dimensions from the Contract Plans for construction purposes. Scales shown are for information only.
3. No construction joints except those shown on the plans shall be allowed unless approved by the Engineer.
4. The Contractor may request copies of existing construction plans that are currently on file with the Illinois Tollway. The request shall be in writing with the understanding that any

reproduction cost will be at the Contractor's expense at no additional cost to the Illinois Tollway.

5. No concrete cutting shall be permitted until the cutting limits have been outlined by the Contractor and approved by the Engineer.
6. It shall be the Contractor's responsibility to verify the location of all utilities prior to starting construction. Contact J.U.L.I.E., 800-892-0123.
7. It shall be the Contractor's responsibility to verify the location of all fiber optic utilities prior to starting construction. The Contractor shall initiate the location process for the fiber optic cable by completing a "Request Illinois Tollway Utilities Locate" form filled in online at the Illinois Tollway website under "Doing Business" at least four (4) business days prior to starting any underground operations, excavations or digging of any type in the general area of the fiber optic cable."
8. The Contractor shall use care when excavating around existing foundations. Any damage to the existing structure and/or supporting foundation shall be repaired or replaced at the Contractor's expense at no additional cost to the Illinois Tollway.
9. Existing reinforcement which is to be incorporated into the new construction shall be blast cleaned to gray metal, straightened (without heating), and cut to fit. Cost of which shall be included with "Concrete Removal." **[If used, add incidental items to Special Provision 110.]**
10. The protective shield system shall extend a minimum of 10' beyond the indicated limits of repair shown in the plans or 5' beyond the actual limits of partial or full depth repair as identified in the field, whichever is greater.
11. Temporary soil retention systems, sheeting, bracing or cofferdams shall be constructed at the locations shown on the plans and/or as required for the excavation to protect the adjacent areas from settling or falling into the excavated areas.
12. Concrete sealer shall be applied to the surfaces of all new pier (s) and abutment seats, including backwalls located below roadway expansion joints. Sealer shall also be applied to all exposed surfaces of new piers in the median or piers, abutments and wingwalls that are adjacent to the roadway. **[Modify note for site specific locations].**
13. Concrete Sealer shall be applied to the surfaces of all existing pier (s) and abutment seats, including backwalls located below roadway expansion joints. Sealer shall also be applied to all exposed surfaces of existing piers in the median or piers, abutments and wingwalls that are adjacent to the roadway. Existing surfaces shall be power washed in accordance with the applicable portions of Section 592 of the Standard Specifications for Road and Bridge Construction. **[Modify note for site specific locations].**
14. After the beams (girders) are set, all elevations for determining fillet heights shall be taken at one time.
15. Prior to placing the new concrete for the deck, all loose rust, loose mill scale, loose paint and all other foreign material shall be removed from the embedded portions of steel flanges. The removal shall be accomplished in accordance with the requirements of the SSPC Surface Preparation Specifications SP7 for Brush-Off Blast Cleaning. Cost shall be included with "Concrete Removal." **[Use for bridge rehabilitation projects where the full-depth removal of existing concrete deck is specified, and where cleaning and painting of existing structural steel is not specified as an item of work. If used, add incidental items to Special Provision 110.]**
16. Upon completion of each structure, the Contractor shall measure the resulting horizontal and vertical clearances and submit them to the Engineer for review and inclusion in the As Built plans (Record Drawings).
17. The embankment configuration shown shall be the minimum that must be placed and compacted prior to construction of the abutments and bridge approach slabs.

18. The boring logs represent point information. Presentation of this information in no way implies that subsurface conditions are the same at locations other than the exact location of the boring.
19. Whenever any material is deposited into a drainage system or drainage structures, the deposited material shall be removed at the close of each working day. At the conclusion of construction operations, all drainage systems and structures shall be free from dirt and debris deposited during the various construction operations.
20. All PPC beams may be shipped to the job and erected as soon as the beam reaches the specified strength.
21. For structures made continuous for the design of live loads or single span bridges greater than 100 feet long, a minimum period of 45 days between casting of the beam and placing of the concrete deck shall be provided. **[Only used for structures made continuous for live load or single span bridges greater than 100 feet long.]**
22. The beams may be placed on bearings upon delivery, but the bearings may be required to be reset, as per direction of the Engineer, after the 45<sup>th</sup> calendar day after beam casting. The casting of the deck and continuity diaphragm shall not occur prior to this timeframe. The cost of repositioning of the beams on the bearings or resetting of bearings shall be included in the contract unit price for **[Insert beam pay item designation. If used, add incidental items to Special Provision 110.] [Only used when specifying concrete beams 100 feet or longer supported on bearing assemblies]**
23. The fabricator, the Contractor and the beam transportation company shall provide adequate bracing and support for the PPC beams during handling, transporting, storing and erecting.
24. The Contractor shall submit calculations for lateral stability during shipping, handling, and erection to the Engineer for approval prior to shipping. The calculations shall be sealed and signed by an Illinois licensed Structural Engineer. **[See Article 13.3.] [Only used when specifying concrete beams 120 feet or longer]**
25. Contractor shall measure the initial camber (at release) and measure final camber (at erection). The measured values shall be shown on the shop drawings and shall be compared to the values shown in the contract documents and allowable tolerance. The contractor shall verify girder camber to ensure deck plan thickness and minimum fillet are maintained. Camber values within the tolerance limits but differ from contract plan values shall be reported to the Engineer for approval.
26. Horizontal design loads for retaining walls with moment slabs shall include the provisions of the AASHTO LRFD Bridge Design Specifications, Article 11.10.10.2 and Test Level 5 (TL-5 for standard height traffic railing) of 1.15 kips per foot and (TL-5 for 72" tall traffic railing) of 2.4 kips per foot applied at the top of fill supporting the Moment Slab.
27. The MSE Wall supplier is alerted to the anticipated [ \_ ] inches of settlement from Stations [ \_ ] to [ \_ ] and shall take appropriate measures to accommodate this settlement in the wall design. **[Use when 2 or more inches of settlement are expected.]**

## 7.2 Supplemental General Notes

The following general plan notes may be included in the Contract Plans as applicable, with appropriate modifications.

### 7.2.1 Demolition Plan

1. The Contractor shall submit a demolition plan utilizing the Illinois Tollway Web-based Program Management System (WBPM) to the Construction Manager for review and

acceptance, detailing the proposed methods of demolition and the amount, location(s) and type(s) of equipment to be used. With the exception of removal of single box culverts, for work adjacent to or over an active roadway, railroad or navigable waterway, the demolition plan shall include an assessment of the structure's condition and an evaluation of the structure's strength and stability during demolition and shall be signed and sealed by an Illinois Licensed Structural Engineer.

### 7.2.2 Erection Plan

#### [Include for both Steel and Precast Prestressed Concrete Beams]

1. The Contractor shall retain the services of an Illinois Licensed Structural Engineer, experienced in the analysis and preparation of complex bridge erection plans, as defined by IDOT prequalification guidelines, for the completion of a project-specific erection plan. The Structural Engineer shall sign and seal the erection plan, drawings, and calculations for the proposed erection of the **[structural steel or precast prestressed concrete beams]**.
2. Following the placement of each stable segment and prior to the placement of adjacent or continuing segments the Contractor shall survey the horizontal and vertical position of each beam at the center line of all splices and center line of all bearings. The recorded stations and elevations shall be compared to the contract plans and/or the erection plan and significant deviations from the plans shall be reported to the Engineer. **[Complex bridges only.]**
3. The erection plan shall be complete in detail for all phases, stages, and conditions anticipated during erection. The erection plan shall include structural calculations and supporting documentation necessary to completely describe and document the means, methods, temporary support positions, and loads necessary to safely erect the structural steel in conformance with the contract documents and as outlined herein. The erection plans shall address and account for all items pertinent to the steel erection including items such as sequencing, falsework, geometric control, temporary shoring and/or bracing, beam stability, crane positioning and movement, means of access, pick points, beam shape, permissible deformations and roll, interim/final plumbness, cross frame/diaphragm placement and connections, bolting and anchor bolt installation, sequences and procedures, and blocking and anchoring of bearings. The Contractor shall be responsible for the stability of the partially erected steel structure during all phases of the steel erection.
4. The erection plans and procedures shall be submitted utilizing the Illinois Tollway Web-based Program Management System (WBPM) to the Construction Manager for review and acceptance prior to starting the work. Review, acceptance and/or comments by the Engineer shall not be construed to guarantee the safety or final acceptability of the work or compliance with all applicable specifications, codes, or contract requirements, and shall neither relieve the Contractor of the responsibility and liability to comply with these requirements, nor create liability for the Illinois Tollway. Significant changes to the erection plan in the field shall be approved by the Erection Engineer and accepted by the Engineer.

### 7.2.3 Structural Assessment Reports for Contractor's Means and Methods

[Used on a case-by-case basis when an existing bridge is to be removed or rehabilitated based on the following (per discussions and agreement with the Tollway PM): If Structural Assessment Reports (SARs) are deemed required for the removal of existing structures, portions thereof, new construction or for construction utilizing existing components, then use Notes 1 and 2. Use Note



3 when there is deterioration of the existing structure resulting in a reduced load carrying capacity. Use Note 4 when a SAR is not required for miscellaneous repairs such as joint replacement, partial deck repairs, or bearing replacement]

1. A Structural Engineer, licensed in the State of Illinois, shall prepare and submit Structure Assessment Reports (SARs) for the proposed work associated with removing, modifying or reconstructing existing structures or portions thereof. Unless noted otherwise, a SAR shall be required when the Contractor's means and methods apply loads to the structure or change its structural behavior. A SAR shall be submitted to the Engineer for review and acceptance prior to starting the work, in accordance with the latest IDOT Guide Bridge Special Provision, "Structural Assessment Reports for Contractor's Means and Methods" prior to beginning the work covered by that SAR. Separate portions of the work may be covered by separate SARs which may be submitted at different times or as dictated by the Contractor's schedule.
2. An Existing Structure Information Package (ESIP) will be provided by the Illinois Tollway to the Contractor upon request. This package will typically include existing or "As Built" plans, and the latest National Bridge Inspection Standards (NBIS) inspection report. The availability of structural information from the Illinois Tollway is solely for the convenience and information of the Contractor and shall not relieve the Contractor of the duty to make, and the risk of making, examinations and investigations as required to assess conditions affecting the work. Any data furnished in the ESIP is for information only and does not constitute a part of the Contract. The Illinois Tollway makes no representation or warranty, express or implied, as to the information conveyed or as to any interpretations made from the data.
3. 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 (ESIP) is available upon request as noted in Note 2.
4. The Contractor shall submit written verification, prior to the start of the activity, to the Engineer stating that applied loads on the structure due to construction activities will not exceed 10 tons of total combined weight of equipment and stockpiled materials at any one time. This Structural Assessment Report (SAR) exemption shall not relieve the Contractor from the responsibility of properly applying loads to the structure.

### 7.3 Additional Notes Included in the Plans

[See Articles in () for application.]

1. Hard driving may be encountered during the sheet piling installation. The Contractor shall provide the appropriate driving equipment for the soil conditions indicated on the boring logs. (9.5)
2. A cantilever sheet piling design does not appear feasible and additional members or other retention system may be necessary. The information shown for TSRS is estimated. It is the Contractor's responsibility to provide a design and details for each TSRS, complete with calculations and drawings, signed and sealed by an Illinois Licensed Structural Engineer, for the Engineer's review and acceptance before starting work. (9.4)
3. If the Contractor chooses to alter the temporary cantilevered sheet piling design requirements shown on the plans, a design submittal including plan details and calculations will be required for review and acceptance by the Engineer.



4. The information shown for cofferdams is estimated. It is the Contractor's responsibility to provide a design and details for each cofferdam, complete with calculations and drawings, signed and sealed by an Illinois Licensed Structural Engineer, for the Engineer's review and acceptance before starting work. (9.6)
5. Pile membrane sleeve shall not be used with integral abutment bridges. **[Use with integral bridges.]** (10.3).
6. **[Name, version, and release date]** was used for the analysis of the structure. (12.1 & 13.1)
7. For drilled shaft in rock, maximum payment for the rock socket shall be the plan minimum unless otherwise directed by the Engineer. (10.4.2)
8. The fabricator, the Contractor and the beam transportation company shall provide adequate bracing and support for the PPC beams during handling, transporting, storing and erecting to ensure the safety of the personnel associated with the construction of the project. (13.3)
9. All stainless-steel hardware for drainage systems shall be coated with antiseize compound. (16.2)
10. Drain pipe for Bridge Drainage System, including all piping, fittings, and splash blocks shown, shall be as specified in the latest IDOT GBSP for Drainage System, except as modified herein. Drain pipe may be Polyvinyl Chloride (PVC) Pipe, Reinforced Fiberglass Pipe or Galvanized Steel Pipe. Support brackets, inserts and bolts shall be stainless steel. (16.3)
11. Polyvinyl Chloride (PVC) Pipe and fittings shall be 8" diameter schedule 80 meeting the requirements of ASTM D1785 (F441), D2464 and D2467 colored to match the adjacent beam and/or column as approved by the Engineer. (16.3.1 & 16.5)
12. Reinforced Fiberglass Pipe and fittings shall be 8" diameter, meeting the requirements of ASTM D2996 RTRP with a 30,000-psi minimum short-time rupture strength hoop tensile stress. The exterior surfaces of fiberglass pipe and fittings shall be pigmented in accordance with the pipe manufacturer's recommendations or cleaned, given a prewash in accordance with MIL - P - 15328 and top coated with an epoxy-based coating recommended for outdoor applications by the prewash manufacturer. Final color shall be submitted to the Engineer for approval. (16.3.2 & 16.5)
13. The exterior surfaces of aluminum tubes shall be cleaned and given a wash coat pretreatment in accordance with SSPC - SP1 and SSPC - Paint 27. The pretreated surfaces shall be painted with an adhesion bonding primer and top coat per the system recommended by the pretreatment manufacturer for painting aluminum surfaces in an exterior environment. (16.5)
14. A minimum of 6 feet of the barrel shall be poured monolithically with horizontal cantilever wingwalls. (21.1.2)
15. All Culvert concrete shall be Class Sl. (21.2)
16. Non-Metallic water seal used in wingwall shall extend from the top of footing to within 6 inches of top of the headwall. (21.2)

## SECTION 8.0 CONSTRUCTION STAGING

### 8.1 General

The plans shall clearly identify and show all stages of construction, both superstructure and substructure details, required to replace, widen or reconstruct each structure, while simultaneously maintaining traffic in one or both directions. For an example of a Construction Staging Plan, see Figure 8.1.1. Construction stage lines shall be shown and located in all plan views and cross sections. The Designer shall verify that the structure and adjacent roadway staging match. Stage lines shall be located along a lane line wherever possible, and at a distance greater than  $\frac{1}{4}$  of the beam spacing from the centerline of any beam (within the middle half of the beam spacing). If stage lines cannot be located along a lane line, they shall be located within the center third of the lane. Designer shall highlight location of tight work conditions where typical construction methods may not be possible. Pay items for structural removal shall be per bridge.

### 8.2 Temporary Concrete Barriers

The Construction Staging Plans shall also show the location of all temporary concrete barriers for each stage of construction where barriers are required. The minimum distance between a free-standing temporary concrete barrier and the edge of the bridge deck and/or bridge approach slab shall be 3'-6". The temporary concrete barrier can only be anchored to the existing deck and/or slabs when they are proposed to be removed in the subsequent stages of the project. If the temporary concrete barrier is allowed to be anchored, the minimum distance from the back of the temporary concrete barrier to the edge of the slab shall be 10".

### 8.3 Protective Shield System

A drawing or drawings shall be included in the bridge plans to define the limits of a protective shield system when it is required. The quantity of protective shield system to be installed shall be stated within the Plans. Removal of protective shield system shall not be measured for payment. The cost of designing, furnishing, erecting, maintaining, and removing temporary protective shields at the locations and limits shown in plans shall be in accordance with the Special Provisions Protective Shield System and shall apply to new construction, widening, removal, replacement, deck repairs and scarification. The Contractor is responsible for the convenience and safety of the public during demolition, erection, and construction of each element of the structure in accordance with Article 107.09 of the latest Illinois Tollway Supplemental Specifications.

A protective shield system shall be required under the superstructure or at the lower level of the superstructure whenever equipment, falling objects or material may cause damage to existing aerial wire lines, railroads, streets, highways, regulatory waterways, vehicular or waterway traffic or injury to pedestrians, bicyclist or individuals traveling in trains, vehicles or water craft.

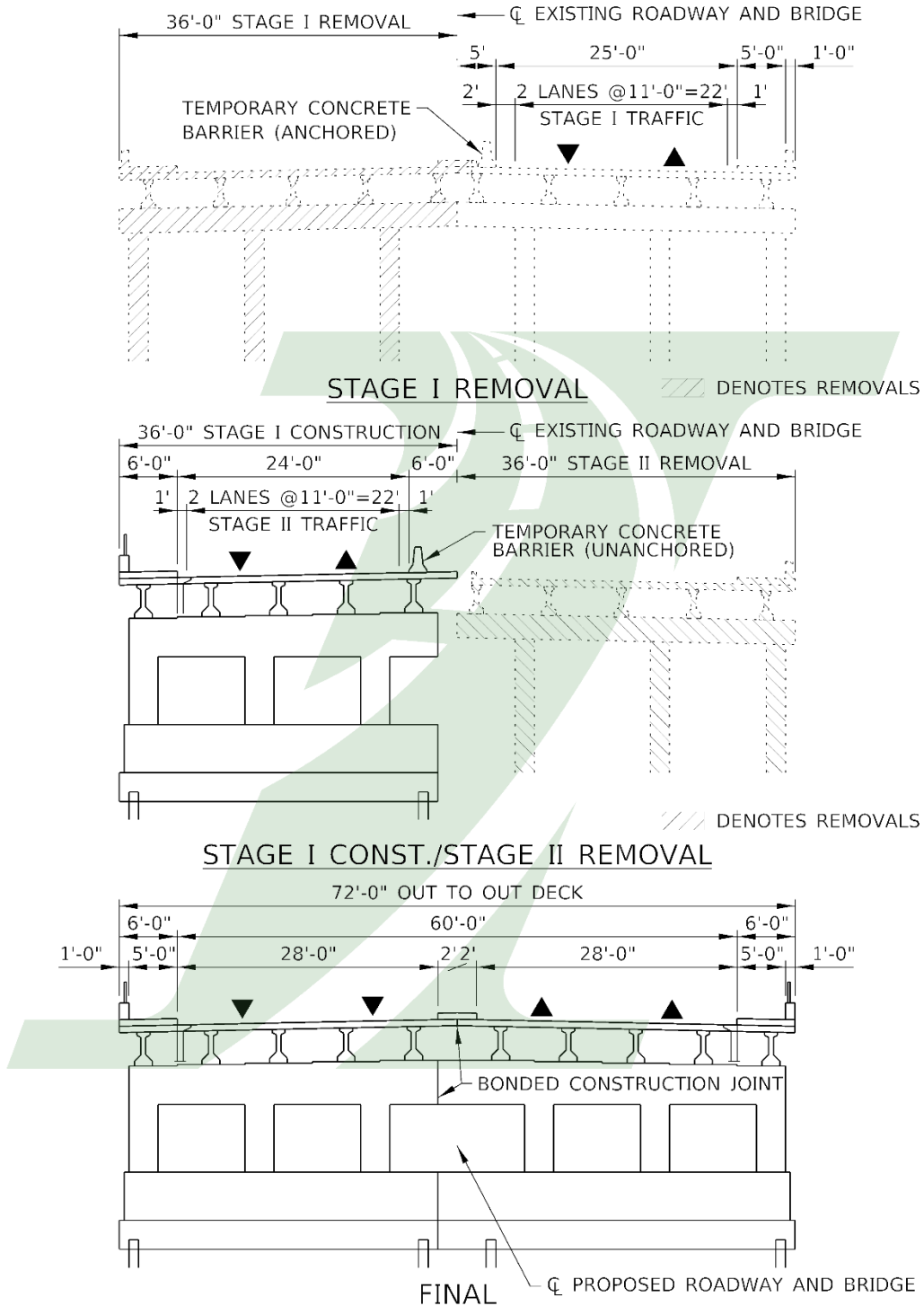
The limits of the protective shield system for bridge projects limited to full and partial depth deck patching shall be set considering the area of the deck to be improved. The protective shield system shall extend a minimum of 10' beyond the indicated limits of repair shown in the plans or 5' beyond the actual limits of partial or full depth repair as identified in the field, whichever is greater.

The lateral limits of the protective shield system are shown in the following table:

Case	Construction or Reconstruction	Transverse Limits of Protective Shield System
1	New construction	Out-to-out width + 2' from outside of each new parapet
2	Deck and superstructure widening	Existing fascia beam to outside of new parapet + 2'
3	Deck removal and replacement	Out-to-out width + 2' from outside of each existing parapet
4	Deck replacement and widening	Out-to-out width + 2' from outside of each new parapet
5	Deck repair and patching	10' outside of expected repair limits above traffic
6	Deck scarification	Out-to-out width above traffic

#### 8.4 Temporary Shoring

The staging plans shall also indicate the location of all temporary shoring including the applied loads required to support portions of the new or existing structure during each stage of construction. The Contractor is responsible for designing, detailing, erecting, maintaining and removing the temporary shoring utilizing the information shown in the proposed and/or existing plans for their particular method of construction.



**Figure 8.1.1: Construction Staging Plan**

## SECTION 9.0 SUBSTRUCTURE AND SHEET PILING LAYOUTS

### 9.1 Substructure Layout

The basic geometry for the location of the substructure shall be clearly shown on the plans. All elements of the substructure shall be referenced to the same single longitudinal reference line. For an example of a substructure location plan on tangent alignment, see Figure 9.1.1. For an example of a substructure layout on curved alignment, see Figures 3.1.8-2 and 3.1.8-3 of the latest IDOT Bridge Manual.

### 9.2 Pile Numbering

On any structure, proposed to be supported on piling, a "Pile Driving Record" table shall be included with the substructure layout or on a separate plan sheet. The "Pile Location" and "Pile Number" column shall be completed during design leaving some additional rows for field changes during construction. The pile numbering system will be used to identify the individual pile and its location in the substructure and "Pile Driving Record". For an example of the pile numbering system and driving record, see Figure 9.1.1 and Figure 9.2.1, respectively. This data is for record purposes and shall be filled in by the Engineer during pile driving.

### 9.3 Drilled Shaft Numbering

On any structure proposed to be supported by drilled shafts, a "Drilled Shaft Installation Record" table shall be included with the substructure layout or on a separate plan sheet. The "Shaft Mark" column shall be completed during design leaving some additional rows for field changes during construction. The drilled shaft numbering system will be used to identify the individual drilled shaft and its location in the substructure and "Drilled Shaft Installation Record". For an example of the drilled shaft installation record, see Figure 9.3.1. This data is for record purposes and shall be filled in by the Engineer during drilled shaft construction.

### 9.4 Temporary Soil Retention Systems

The location and limits of the Temporary Soil Retention System(s) (TSRS) shall be shown and identified on the substructure location plan and/or separate plan sheets in accordance with Section 3.13 of the latest IDOT Bridge Manual. The Designer shall specify the use of TSRS wherever a cantilever sheet pile design is not feasible and additional members or other retention system may be necessary. Cofferdams shall be used to construct elements of the substructure underwater.

The following note shall appear on the substructure location plan when TSRS is shown on the plans:

“A cantilever sheet piling design does not appear feasible and additional members or other retention system may be necessary. The information shown for TSRS is estimated. It is the Contractor's responsibility to provide a design and details for each TSRS, complete with calculations and drawings, signed and sealed by an Illinois Licensed Structural Engineer, for the Engineer's review and acceptance before starting work.”

### 9.5 Temporary and Permanent Sheet Piling

The location and limits of all temporary and permanent sheet piling shall be clearly shown and identified on the substructure location plan and/or separate plan sheets in accordance with Section 3.13.1 of the latest IDOT Bridge Manual. The cut off elevation for any part that is to remain

in place shall also be shown. When cantilevered sheet pile is not sufficient, a temporary soil retention system should be specified by the designer.

Temporary sheet piling shall be designed by the engineer responsible for the Contract plans.

The inside face of the temporary sheeting shall be offset 2'-0" from the proposed footing; while the inside face of any permanent sheeting shall be located along the edge of the footing.

The following note shall be added to the plans if a cantilever sheet piling design is shown on the plans:

"If the Contractor chooses to alter the temporary cantilevered sheet piling design requirements shown on the plans, a design submittal including plan details and calculations will be required for review and acceptance by the Engineer."

The following note shall be added to the plans if a stiff or dense soil layer is present which may require jetting and/or a larger hammer to penetrate:

"Hard driving may be encountered during the sheet piling installation. The Contractor shall provide the appropriate driving equipment for the soil conditions indicated on the boring logs."

## 9.6 Cofferdams

Cofferdams shall be used to construct all elements of the substructure which are located in water, with exceptions noted in Section 3.13.3 of the latest IDOT Bridge Manual. When shallow water is present; i.e., less than 2 feet, other methods of dewatering that allow the Contractor maximum flexibility during construction may be considered.

The location and limits of all cofferdams shall be clearly shown and identified on the substructure location plan. The top and bottom elevations of the cofferdam shall also be shown, as well as the cutoff elevation for any part that is to remain-in-place. The inside face of the cofferdam shall be offset 1'-0" from the proposed footing. The cofferdam and seal coat shall be designed in accordance with Section 3.13.3 of the latest IDOT Bridge Manual.

The following note shall appear on the substructure location plan when cofferdams are required:

"The information shown for cofferdams is estimated. It is the Contractor's responsibility to provide a design and details for each cofferdam, complete with calculations and drawings, signed and sealed by an Illinois Licensed Structural Engineer, for the Engineer's review and acceptance before starting work."

## 9.7 Temporary Sheeting and Bracing for Railroads

Excavations adjacent to active railroad tracks or substructure elements supporting railway operations shall be protected by temporary sheeting and bracing system designed and detailed in the Contract Plans. The system shall be designed in accordance with the latest Grade Separation Manual (Railroad Specific), AREMA, AASHTO and IDOT Specifications.

## 9.8 Structural Sub Drains

The location and limits of structural sub drains behind abutments and wingwalls including invert elevations, slopes, and outfalls shall be shown on the substructure location plan.

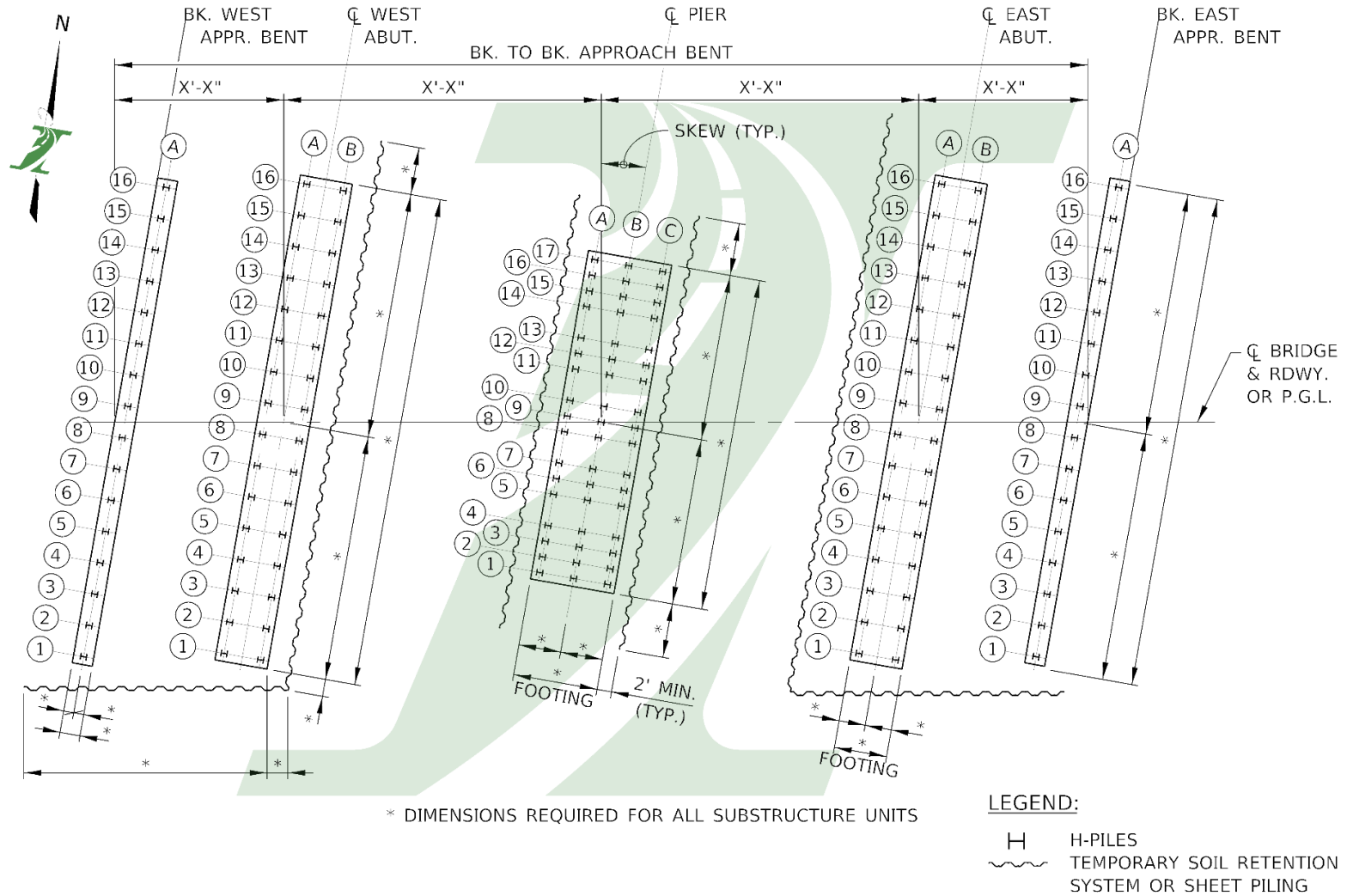


Figure 9.1.1 Substructure Location Plan

### PILE DRIVING RECORD

Date Pile Driven: \_\_\_\_\_  
(Month Year)

Type & Size Pile Used: \_\_\_\_\_

Pile Driving Equipment Used: \_\_\_\_\_ Energy Rating: \_\_\_\_\_

Hammer Used: Type \_\_\_\_\_ Stroke \_\_\_\_\_ Weight \_\_\_\_\_

Formula Used To Calculate Capacity: \_\_\_\_\_

Pile Driving Contractor: \_\_\_\_\_ CM: \_\_\_\_\_

Pile Location	Pile Number	Ground Surface Elevation	Cut-off Elevation	Penetrated Length, ft.	Driving Data For The Final 5 Ft. - Blows							Capacity Tons	Remarks
					5' to 4'	4' to 3'	3' to 2'	2' to 1'	1' to 0'	12" to 6" *	6" to 0" *		

NOTE: \*For piles driven to refusal, blow count for the last foot shall be recorded in 6 inches increments.  
Pile damage, obstruction, pile rejection, test piles etc. shall be recorded in Remarks column.

**Figure 9.2.1 Pile Driving Record**



### DRILLED SHAFT INSTALLATION RECORD

Shaft Mark	Shaft Dia., Ft.	Bell Dia., Ft.	Bottom Elevation	Soil				Ratio of Depth to Diameter	Field Bearing Pressure ksf*	Temporary Casing Used Length, Ft.	Remarks
				Description		Qu=Unconfined Compressive Strength, tsf	Moisture Content %				
				Around Bell	At Bottom of Shaft						

\*Field bearing pressure shall be calculated based on unconfined compressive strength and ratio of depth to diameter of bell. The field bearing pressure shall be 1.5 times  $Q_u$  if the ratio of the depth of the drilled shaft measured from the top of the shaft to the bottom of the bell (or bottom of shaft if no bell is present) to the diameter of the bell (or shaft if no bell is present) is equal to or greater than 4.0. If the depth to diameter ratio is less than 4.0, the Engineer should contact the Tollway.

**Figure 9.3.1 Drilled Shaft Installation Record**

## SECTION 10.0 ABUTMENTS

### 10.1 General

Abutments shall be designed in accordance with the latest AASHTO Specifications as noted in Article 1.4 of this manual and latest IDOT Bridge Manual, except as herein modified.

### 10.2 Design

The friction force caused by an expansion bearing sliding on its bearing plate or deforming on the supporting substructure element shall be included in the design of the substructure. These forces are determined by multiplying the coefficient of friction by the total dead load reactions on the bearing. For steel on steel, a coefficient of 0.30 shall be used and for teflon on teflon, a coefficient of 0.10 shall be used.

For elastomeric bearings, the force required to deform the elastomeric pad shall not be less than 44 pounds per square inch of bearing area for Type I bearings or 0.07 times the dead load reaction for Types II and III bearings.

An allowance for additional eccentricity shall be considered in all abutment designs. For structures with total lengths of greater than 400 feet, each non-integral abutment shall be designed with an allowance for additional eccentricity of 3 inches. An allowance for additional eccentricity shall not reduce the required design capacity.

In addition to a Barrier Warrant Analysis performed in accordance with the Illinois Tollway Traffic Barrier Guideline, abutments located within the clear zone shall be investigated for collision as per AASHTO LRFD 3.6.5.

Substructure components that are backed by soil (e.g., most abutments) are considered to have adequate structural resistance to bridge collapse due to vehicular impacts and are not required to be designed for the vehicular impact load. However, when MSE walls, within the clear zone, are in front of pile support abutments, the MSE wall shall be designed for TL-4 impact loads (per AASHTO LRFD Article A13.2). Walls adjacent to the abutment (wingwalls or closure walls) that are within the clear zone shall be designed for TL-4 impact loads or protected by a minimum TL-4 barrier.

### 10.3 Abutment Types

Integral or semi-integral abutments shall be utilized whenever possible for new grade separation structures and stream and railroad crossings. High wall abutments may be considered where integral and semi-integral abutments are not feasible.

For bridges over the Illinois Tollway mainline, the preferred abutment type is open abutment with slopewalls and no shielding.

- Integral abutments shall be used with steel beams and girders, cast-in-place concrete slabs, or precast, pre-tensioned concrete beams. Beams shall be composite with the cast-in-place concrete deck. The superstructure shall be designed and constructed as a continuous unit between abutments. New integral abutments shall be designed and detailed in accordance with the IDOT Bridge Manual Section 3.8.3. See Figures 10.3.1 through 10.3.3 and 10.3.9 for additional details.
- Semi-integral abutments shall be utilized where soil conditions require the use of two or more rows of piles to support the proposed loadings. Regardless, the superstructure shall

be designed and constructed as a continuous unit between the abutments. The semi-integral concept may also be utilized to eliminate expansion joints at existing stub abutments. However, the existing backwall and part of the approach slab will need to be reconstructed. The existing superstructure may also need to be made composite and continuous between the modified abutments, if it is not already. New semi-integral abutments shall be designed and detailed in accordance with the IDOT Bridge Manual Section 3.8.4. See Figures 10.3.3 through 10.3.5 and 10.3.8 for details.

- Stub abutments with expansion joints shall be utilized where the existing soil condition and proposed loading (reactions) would require two or more rows of piles for support. They shall also be used when the proposed span length and/or skew angles exceed the maximums specified for integral and semi-integral abutments. See Figures 10.3.6 and 10.3.7 for details.
- Combinations of retaining walls and pile supported integral, semi-integral and stub abutments shall be utilized in lieu of highwall or vaulted abutments to reduce span lengths and increase vertical clearance or eliminate the need for shoulder piers and short end spans. See Figures 10.3.7 and 10.3.10 for details of a pile supported stub abutment with MSE walls. See Figure 10.3.8 for details of a pile supported semi-integral abutment with MSE walls. See Figure 10.3.9 for details of a pile supported integral abutment with MSE walls. MSE walls shall not wrap around directly under the approach slab barrier when integral or semi-integral abutments are used except it can be acceptable when the MSE wall is offset to allow movement of the approach slab.
- Conventional cast-in-place concrete highwall abutments founded on spread footings or piles shall not be utilized to support new or replacement structures unless specifically authorized by the Illinois Tollway. Only existing structures which are to be widened and are currently supported by conventional highwall abutments shall utilize the same design to extend the existing abutments and construct new wingwalls. If feasible, a 4 ft minimum shelf or flat area should be provided at the face of the abutment.
- Vaulted abutments, either sand filled or void, founded on spread footings or piles shall not be utilized to support new or replacement structures unless specifically authorized by the Illinois Tollway. Only existing structures which are to be widened and are currently supported by vaulted abutments shall utilize the same design to extend the existing abutments and construct new curtain walls.

## 10.4 Foundations

### 10.4.1 Piles

Piles for foundations shall be designed in accordance with the Section 3.10 of the latest IDOT Bridge Manual.

Abutment piles shall avoid relying on the lateral load carrying capacity of the piles and shall be designed to carry all horizontal loads with the batter component of the pile. The lateral load capacity of soil may be considered when the required batter exceeds 4" in 12". However, the resulting long-term deflection of the pile shall be calculated and accounted for in sizing the joint. Piles used in integral abutments shall be placed in a single row. Pile selection shall be based on IDOT's Integral Abutment Pile Selection Design Guide and Integral Abutment Feasibility Analysis.

For integral abutments with MSE walls, pile membrane sleeves are not allowed. For semi-integral or stub abutments with MSE walls: As determined by the Geotechnical Engineer, if the downdrag on the piles from the reinforced soil mass plus the downdrag from soils below the mass can be incorporated into the pile design, pile casing or any other pile sleeve membrane treatment may not be needed. If pile membrane treatment as determined by the Geotechnical Engineer may be

utilized, then Figures 10.3.7 and 10.3.8 shall be revised to include a note indicating that “Pile membrane sleeves are permitted in lieu of pile casing.”

Consideration shall be given to conflicts with existing buried and overhead utilities or other obstructions when designing pile layouts.

The following information shall be included on Abutment sheets when piles are used:

#### PILE DATA

PILE TYPE AND SIZE:

NOMINAL REQUIRED BEARING:

FACTORED OR ALLOWABLE RESISTANCE AVAILABLE:

ESTIMATED PILE LENGTH:

NUMBER OF PILES REQUIRED: \_\_\_\_\_ plus \_\_\_\_\_ test pile(s)

#### LEGEND

DENOTING THE FOLLOWING:

EXISTING PILES

EXISTING BATTERED PILES

PROPOSED PILES

PROPOSED BATTERED PILES

TEST PILES

#### **10.4.2 Drilled Shafts**

Drilled shafts shall be designed in accordance with Section 3.10 of the latest IDOT Bridge Manual.

### **10.5 Widening Existing Abutments**

In general, abutments shall be widened in kind, especially those which can be viewed by the traveling public. At locations not exposed to the traveling public, such as structures over railroads or streams, other types of designs may be considered. The final selection shall be based on serviceability and economics.

Foundations for widened abutments widened to the outside shall be the same type as the existing. However, construction procedures and type of construction shall be considered when placing new foundations adjacent to existing so as not to reduce the load carrying capacity or cause settlement of existing foundations. Existing borings and new borings (if required) shall also be considered in the final selection. Abutment widenings shall be designed to carry any longitudinal or transverse forces passed through the bearings from the superstructure. Abutments widened to the outside shall be tied to the existing with dowel bars drilled into the existing concrete.

Abutments for structures widened to the inside forming a median closure shall be separated along the centerline of the Illinois Tollway with a preformed joint filler and a 6-inch non-metallic water seal. Abutments widened to the inside shall be tied to the existing with dowel bars drilled into the existing concrete.

### **10.6 Bridge Seats**

The bridge seats shall be constructed in steps poured monolithically with the abutment. The minimum step shall be  $\frac{3}{4}$  inches. Metal shims shall be provided for each bearing where a step is

less than  $\frac{3}{4}$  inches. The elevation and height of each step shall be shown on the plans. Steps shall be reinforced when one or more of the preceding steps are equal to or exceed 4 inches; see Figure 10.6.1. In all cases, the bridge seats between the bearings shall be sloped  $\frac{1}{4}$  inch to drain. The bearing seat shall meet the minimum support length requirements specified in the AASHTO Seismic Design Section for Seismic Performance Zone 1 (LRFD) or Category A (LFD).

Concrete sealer shall be applied to the exposed surfaces of all backwalls, bridge seats and bearing pedestals that are located under expansion or rotation joints between the deck and backwall.

## 10.7 Slope Paving

### 10.7.1 New Bridges - Grade Separation Structures

Grade separation structures shall have 4-inch thick reinforced concrete slopewalls, as shown in Illinois Tollway Base Sheet M-BRG-525. The 2" vertical dimension of the lip shown in Section A-A shall be increased to 4" for structures with skews of  $10^\circ$  or greater and drainage elements that outlet onto the slopewall.

### 10.7.2 New Bridges - Stream Crossings

Stream crossings shall have 6-inch thick reinforced concrete slopewalls, as shown in the latest IDOT Bridge Manual, or stone riprap slopewalls, as shown in Illinois Tollway Base Sheet M-BRG-525. For reinforced concrete slopewalls, the 2" vertical dimension of the lip shown in Section A-A shall be increased to 4" for structures with skews of  $10^\circ$  or greater and drainage elements that outlet onto the slopewall.

### 10.7.3 New Bridges - Railroad Crossings

Railroad crossings shall have 6-inch-thick bituminous coated aggregate slope paving, as shown in Illinois Tollway Base Sheet M-BRG-525.

### 10.7.4 Existing Bridges

Bridge abutment slopes on existing bridges to be rehabilitated shall be repaired and restored to the original design configuration. Slopes on bridges to be widened shall be protected with the same design as the existing bridge. Slopes which do not have any slope protection shall be covered with 6 inches of aggregate slope paving unless there are floor drains in the deck above; in which case, they shall be paved with a 4-inch thick reinforced concrete slopewall.

### 10.7.5 New Bridges - Side Slopes

Embankment cones shall consist of maximum side slopes 1:2.5 (V:H) with a transition slope wrapping around the abutment to the slopewall. See Figure 10.7.5.

## 10.8 Wing Walls

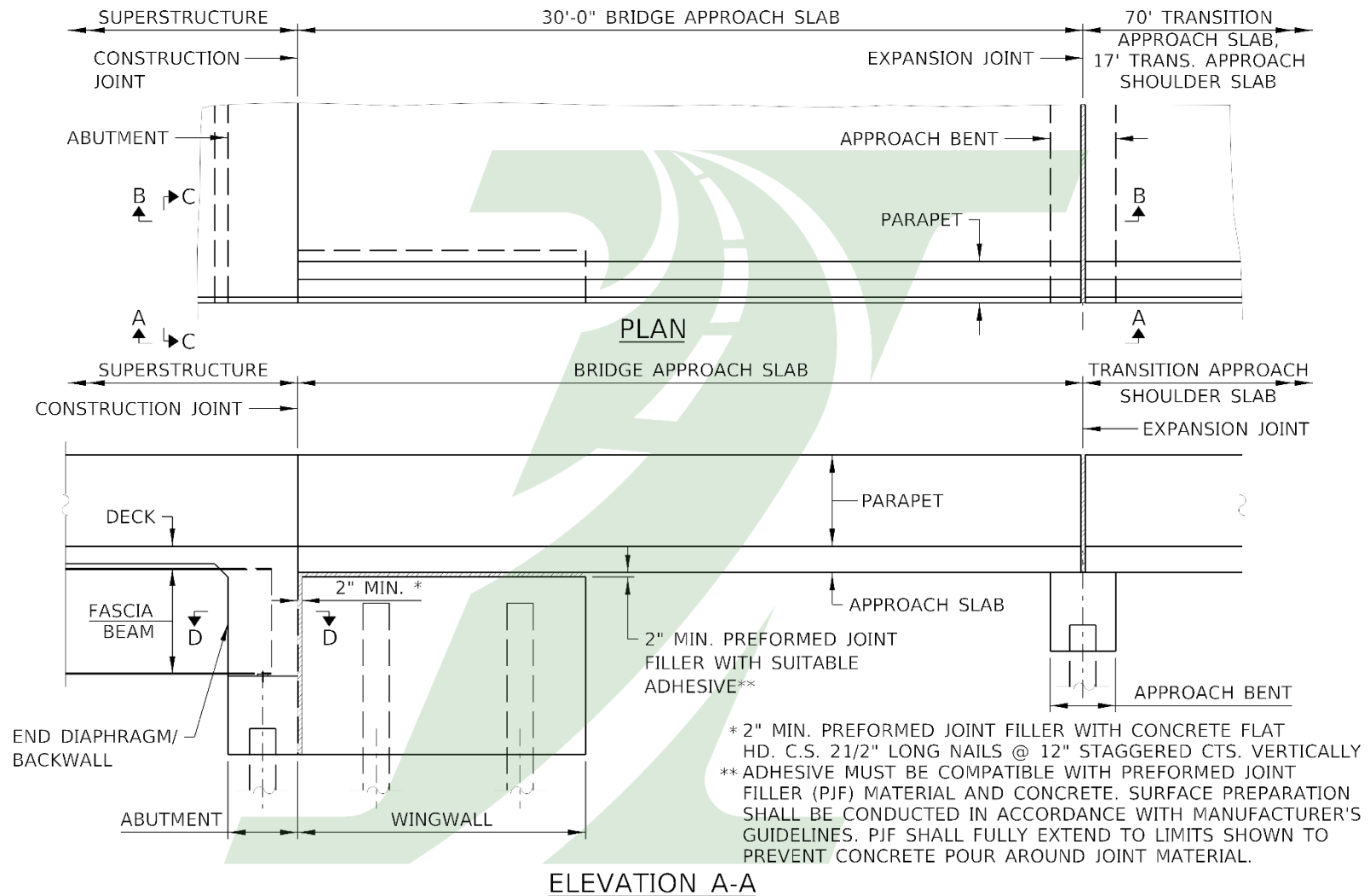
The traffic face of the shoulder parapet shall be carried the full length of each wing wall, vaulted span or approach slab. The sloping curb portion of the barrier shall not be battered to a vertical face or clipped at the leaving or entering end of the barrier. See Standard Drawings C9, C10 and C11 for the required end treatment of a barrier or parapet mounted on a wing wall, vaulted span or approach slab. "Dog-ear" style wing walls that are parallel to the centerline of abutment may also be considered for structures with integral abutments. See the latest IDOT integral abutment base sheets for details.

## 10.9 Abutment Cap Reinforcement

A detail scaled drawing of the reinforcement and the holes drilled for the bearing anchor rods shall be provided in the plans, see Figure 10.9.1. The detail drawing shall include all reinforcement that may interfere with the drilling operation, the reinforcement spacing and the clearances of the reinforcement to the edge of the cap and the future holes.

## 10.10 Concrete Shoulder Barrier Transition

A Concrete Shoulder Barrier Transition shall be used upstream of a high wall abutment or MSE wall abutment when adjacent to the shoulder, even if the shoulder width is not transitioning.



**Figure 10.3.1.1: Integral Abutments and Wingwall Details**

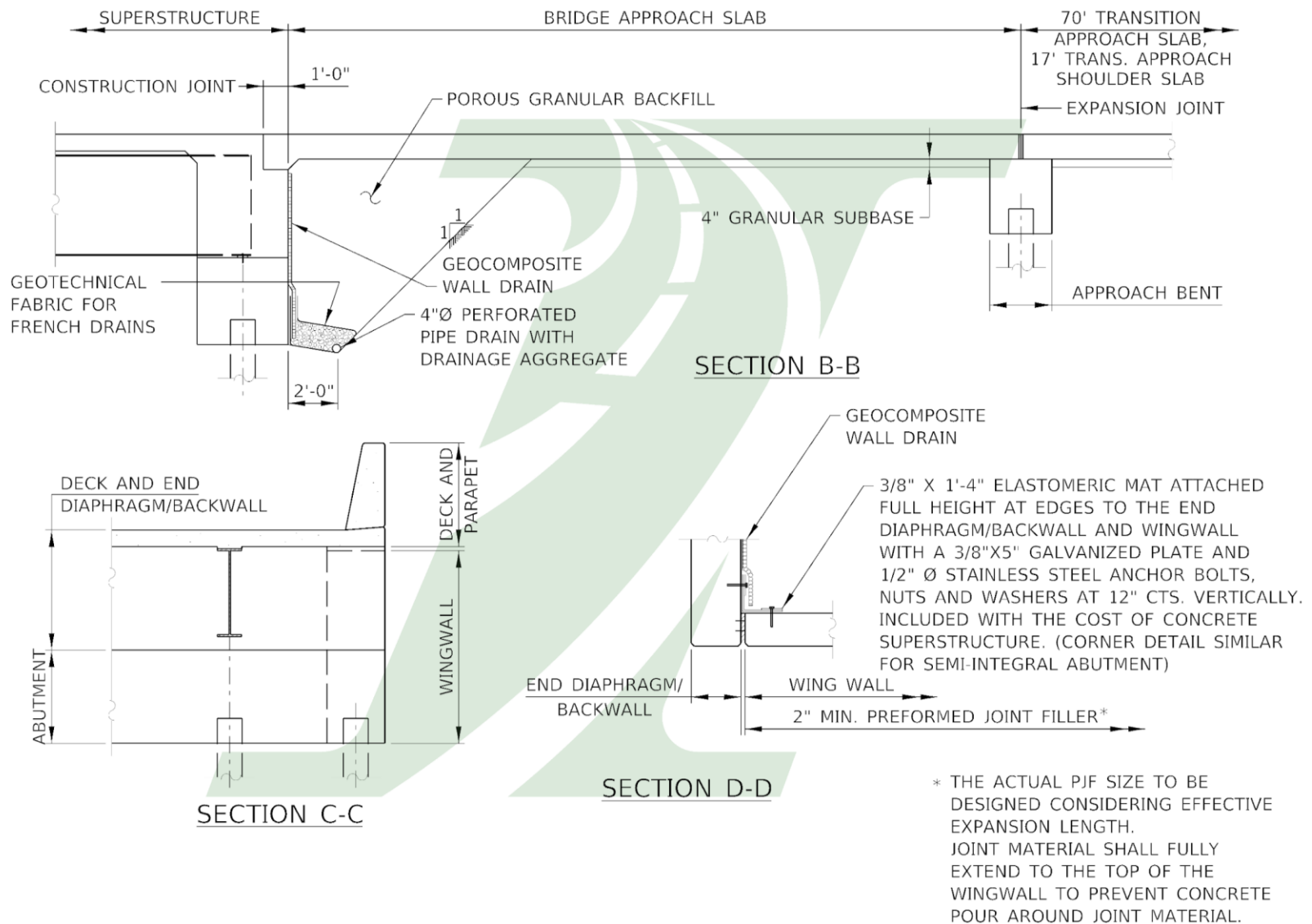
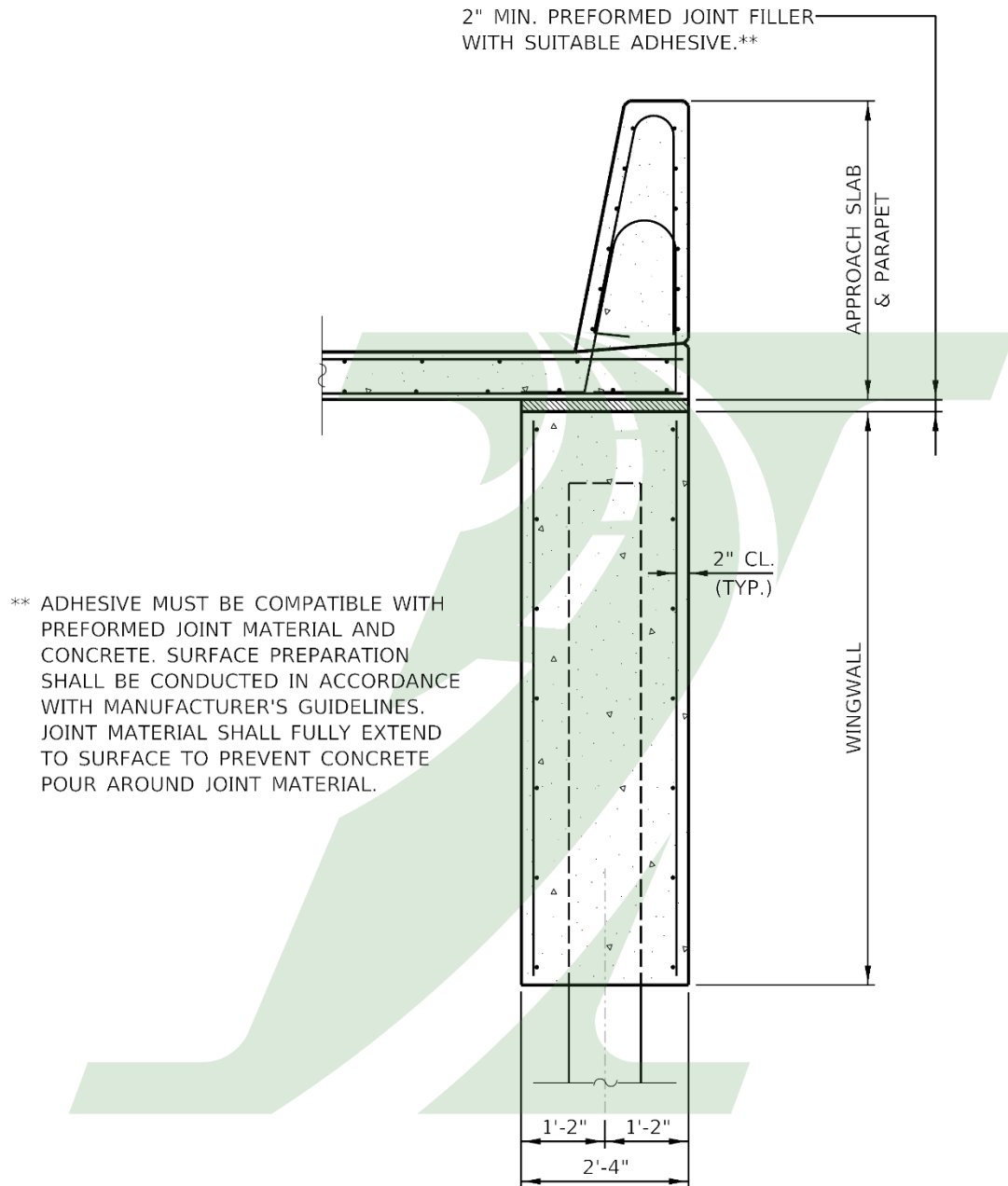


Figure 10.3.2: Integral Abutment Details



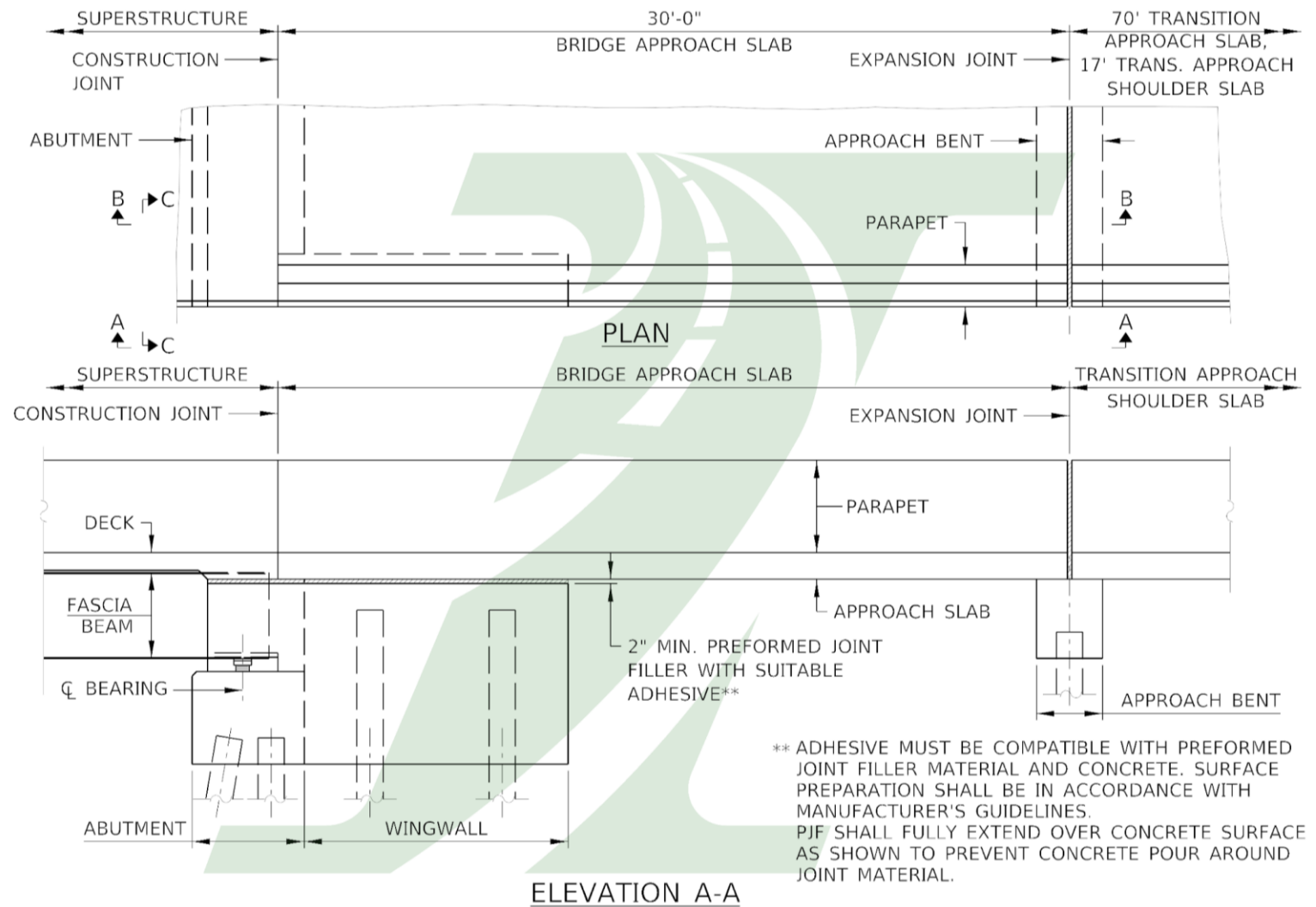


TYPICAL SECTION THRU WINGWALL

NOTE:

PILE SPACING SHALL BE 4'-0" MIN. TO 8'-0" MAXIMUM

**Figure 10.3.3: Integral or Semi-Integral Abutment - Wingwall Detail**



**Figure 10.3.4: Semi-Integral Abutment and Wingwall Details**

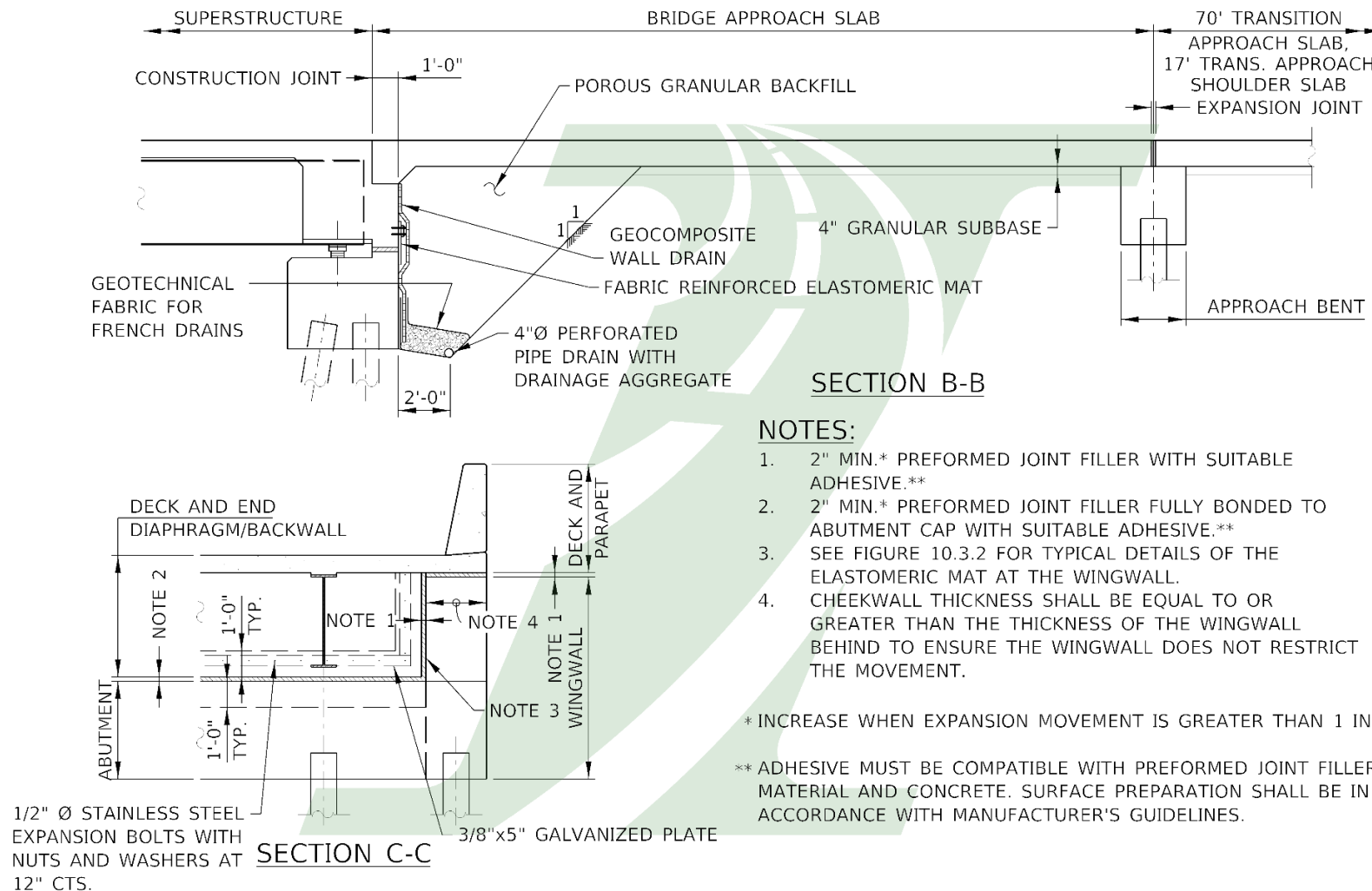
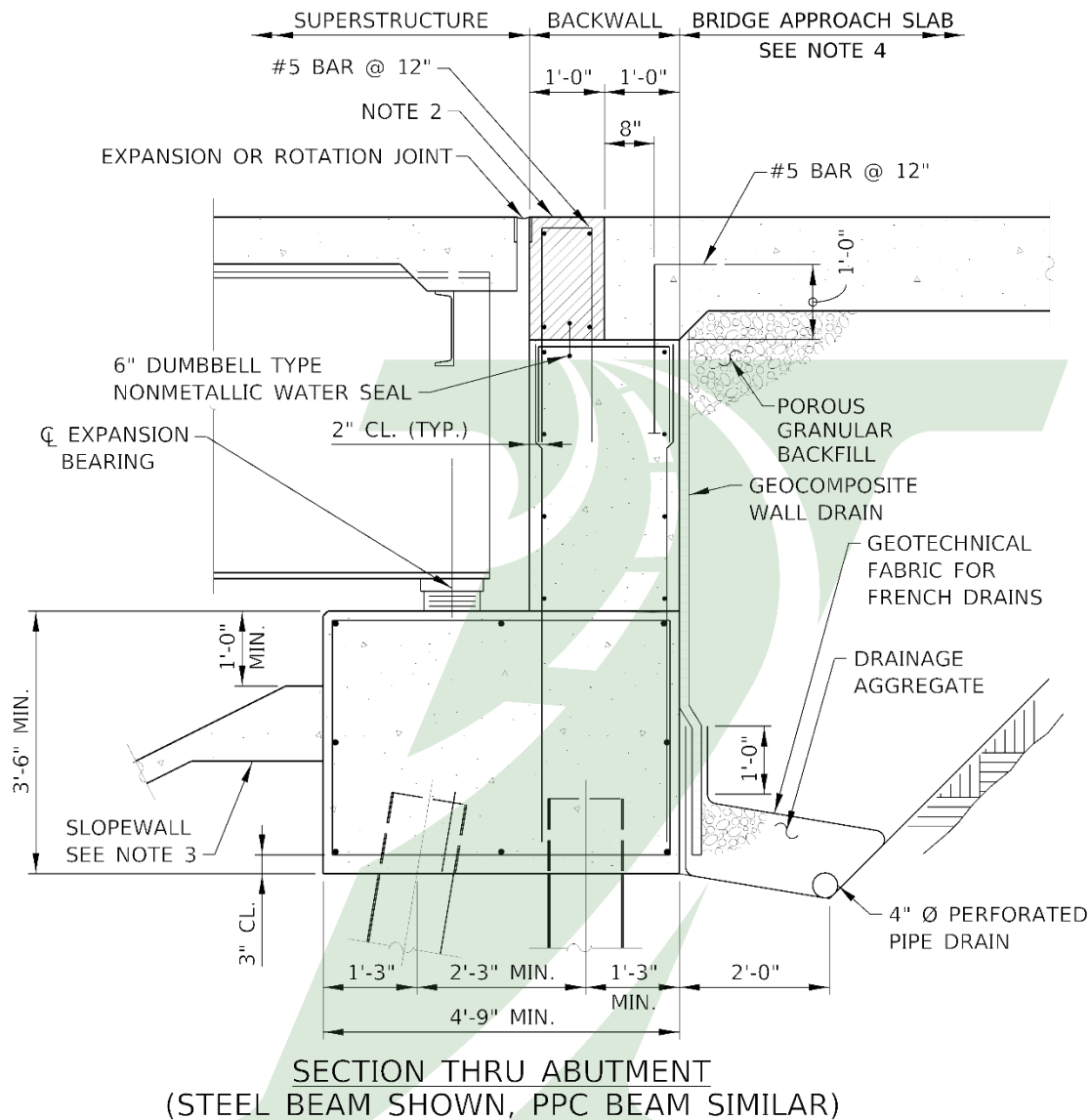
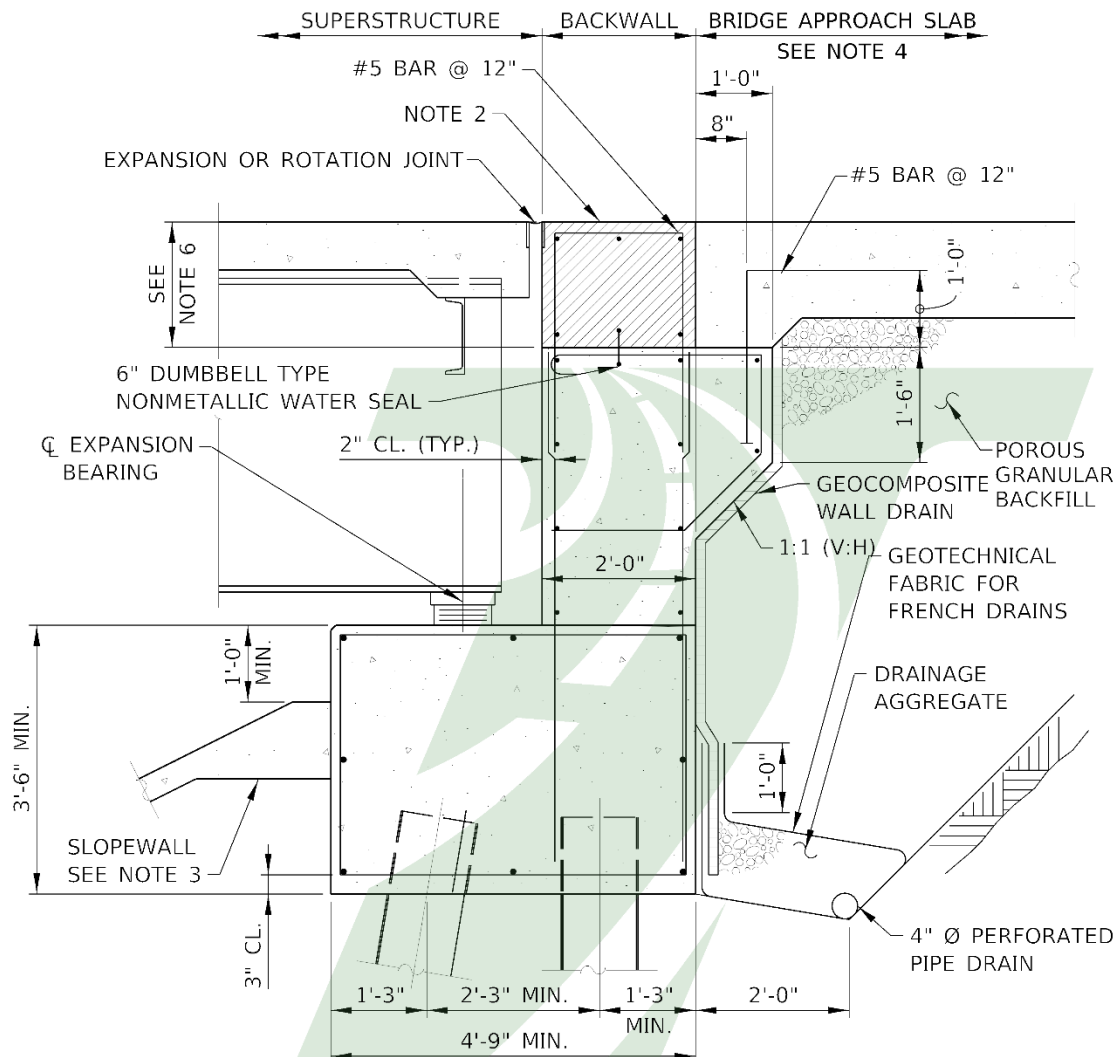


Figure 10.3.5: Semi-Integral Abutment Details

**NOTES:**

1. DIMENSIONS AT RT. L'S EXCEPT AS NOTED.
2. HATCHED AREA TO BE POURED AFTER SUPERSTRUCTURE FALSE WORK HAS BEEN REMOVED. QUANTITY OF CONCRETE INCLUDED WITH HIGH PERFORMANCE CONCRETE SUPERSTRUCTURE.
3. FOR SLOPEWALL DETAILS, SEE TOLLWAY BASE SHEET M-BRG-525.
4. FOR BRIDGE APPROACH SLAB DETAILS SEE TOLLWAY BASE SHEETS M-RDY-408 AND M-RDY-409.
5. COST OF NON METALLIC WATERSEAL INCLUDED IN CONCRETE STRUCTURES PAY ITEM.

**Figure 10.3.6: Stub Abutment Details**

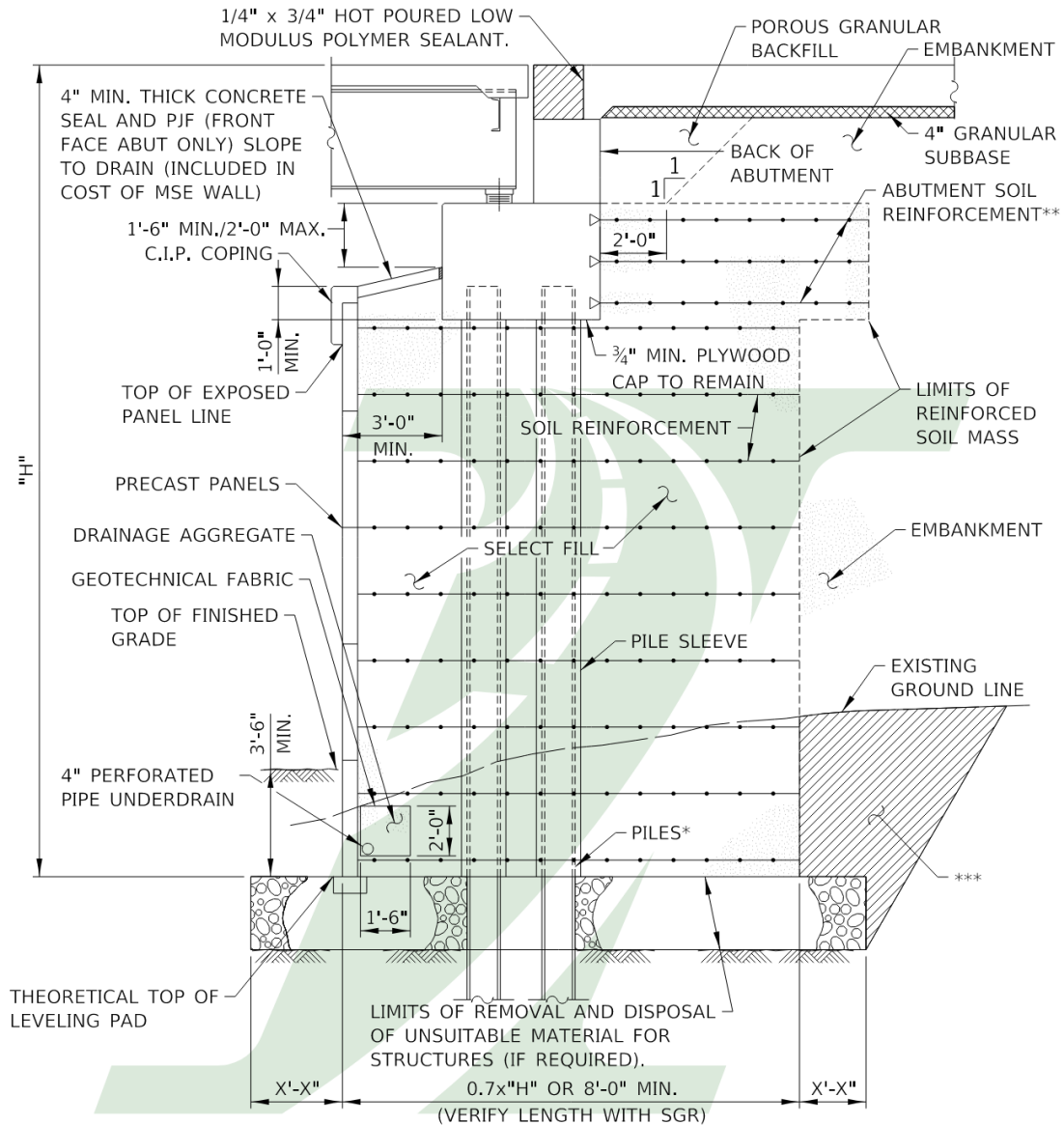


SECTION THRU ABUTMENT  
(STEEL BEAM SHOWN, PPC BEAM SIMILAR)

**NOTES:**

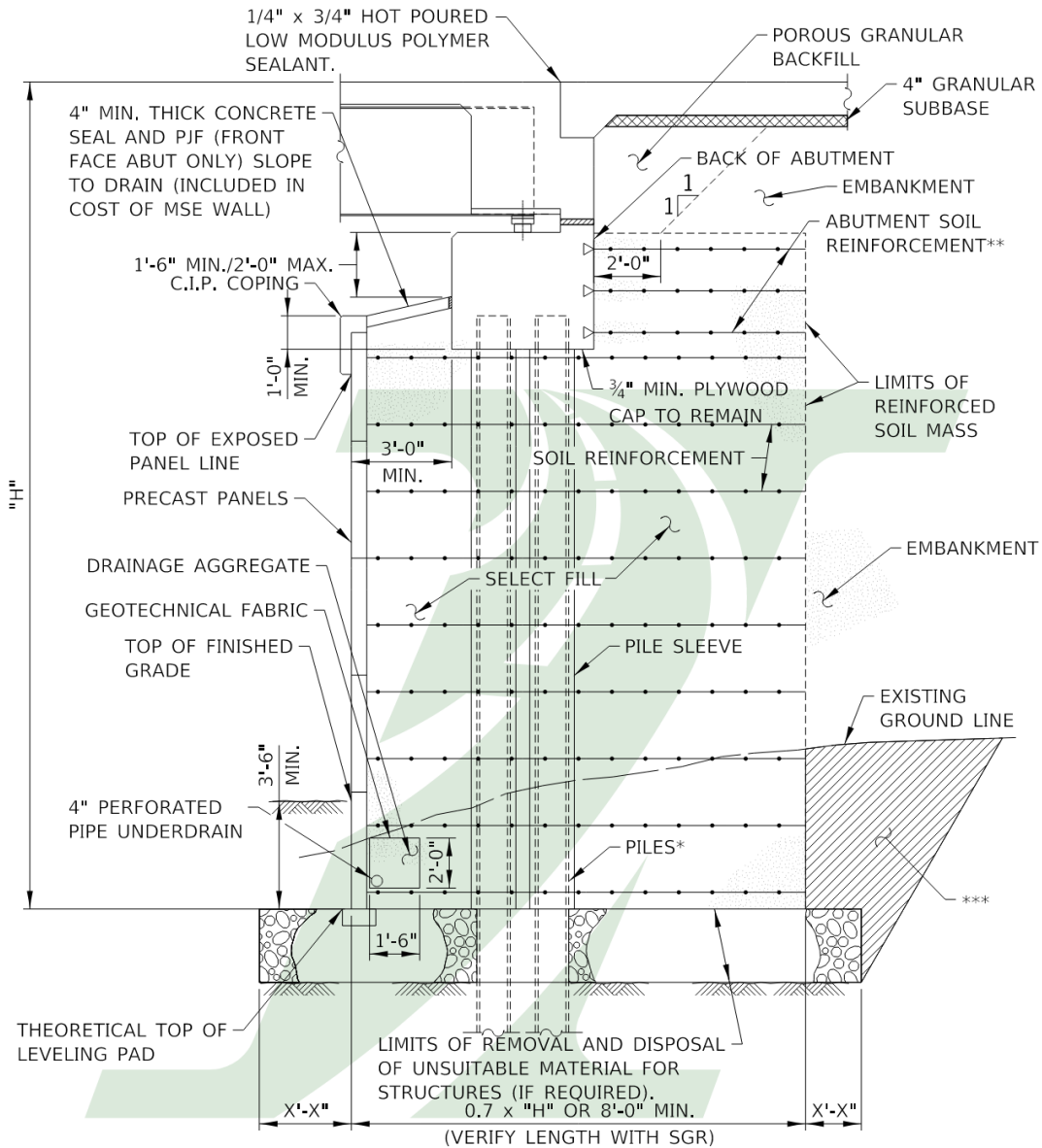
1. DIMENSIONS AT RT. L'S EXCEPT AS NOTED.
2. HATCHED AREA TO BE POURED AFTER SUPERSTRUCTURE FALSE WORK HAS BEEN REMOVED. QUANTITY OF CONCRETE INCLUDED WITH HIGH PERFORMANCE CONCRETE SUPERSTRUCTURE.
3. FOR SLOPEWALL DETAILS, SEE TOLLWAY BASE SHEET M-BRG-525.
4. FOR BRIDGE APPROACH SLAB DETAILS SEE TOLLWAY BASE SHEETS M-RDY-408 AND M-RDY-409.
5. COST OF NON METALLIC WATERSEAL INCLUDED IN CONCRETE STRUCTURES PAY ITEM.
6. 1'-6" MIN. TO BE DETAILED BY DESIGNER BASED ON EXPANSION JOINT SIZE.

**Figure 10.3.6A: Stub Abutment Details with Modular Joint**



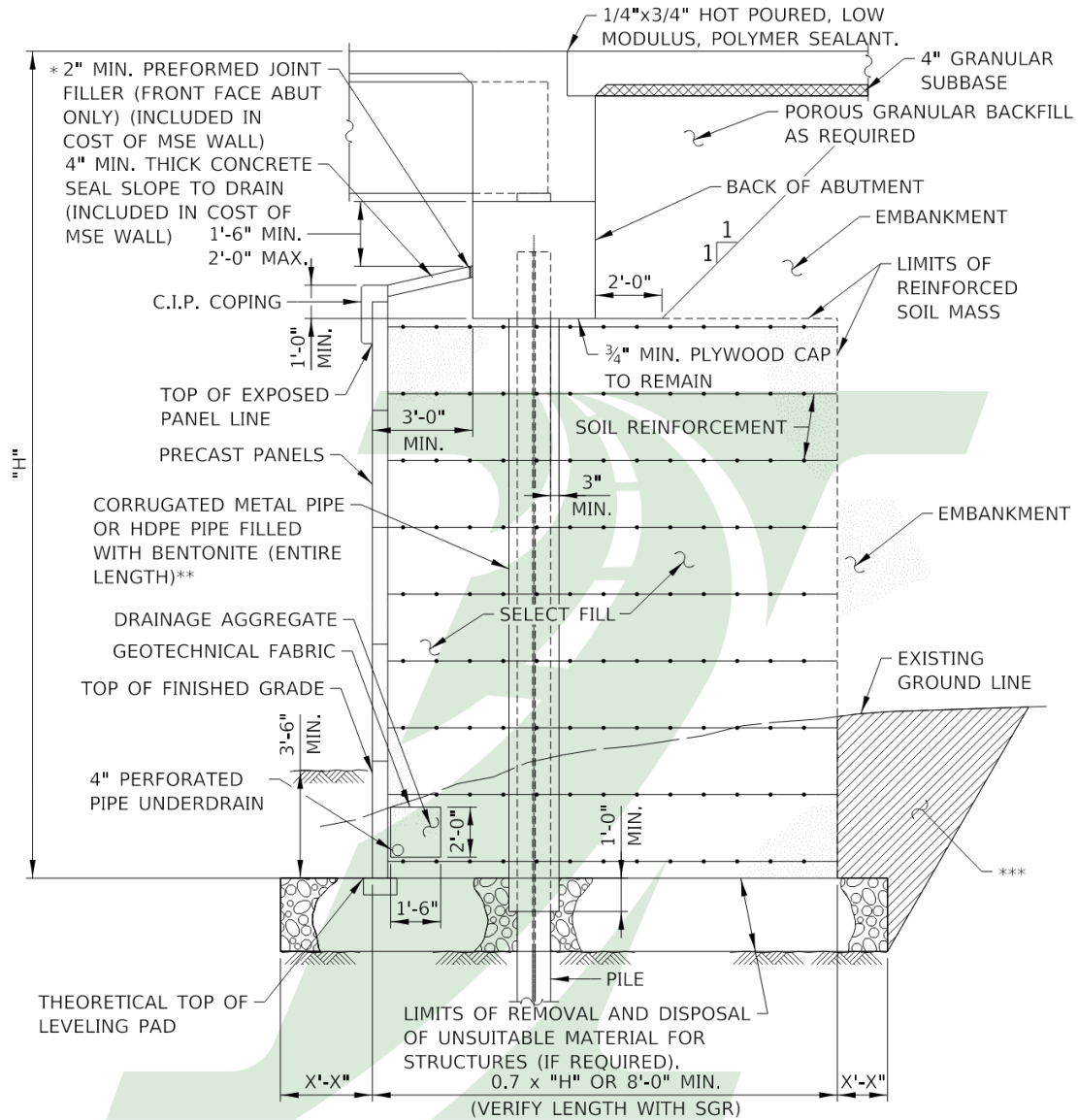
- \* SLEEVE EACH PILE FROM BOTTOM OF PROPOSED ABUTMENT TO TOP OF LEVELING PAD BEFORE PLACING AND COMPACTING THE SELECT FILL. FILL THE ANNULAR SPACE BETWEEN THE PILE AND SLEEVE WITH CLEAN SAND. WORK SHALL BE INCLUDED WITH PILE CASING.
- \*\* THE MSE WALL SUPPLIER SHALL DESIGN THE ABUTMENT SOIL REINFORCEMENT TO RESIST A HORIZONTAL FORCE OF \_\_\_\_\_ KIPS/FT OF ABUTMENT. SELECT FILL AND ABUTMENT SOIL REINFORCEMENT TO THE LIMITS SHOWN SHALL BE INCLUDED IN THE COST OF MSE WALL.
- \*\*\* OVEREXCAVATION BEYOND STRUCTURE EXCAVATION AND BEYOND THE REMOVAL OF UNSUITABLE MATERIAL. THIS AREA NOT MEASURED FOR PAYMENT. BACKFILL OVEREXCAVATION WITH SAME MATERIAL USED FOR SELECT FILL USED IN MSE WALL.

**Figure 10.3.7: MSE Wall Section at Stub Abutment**



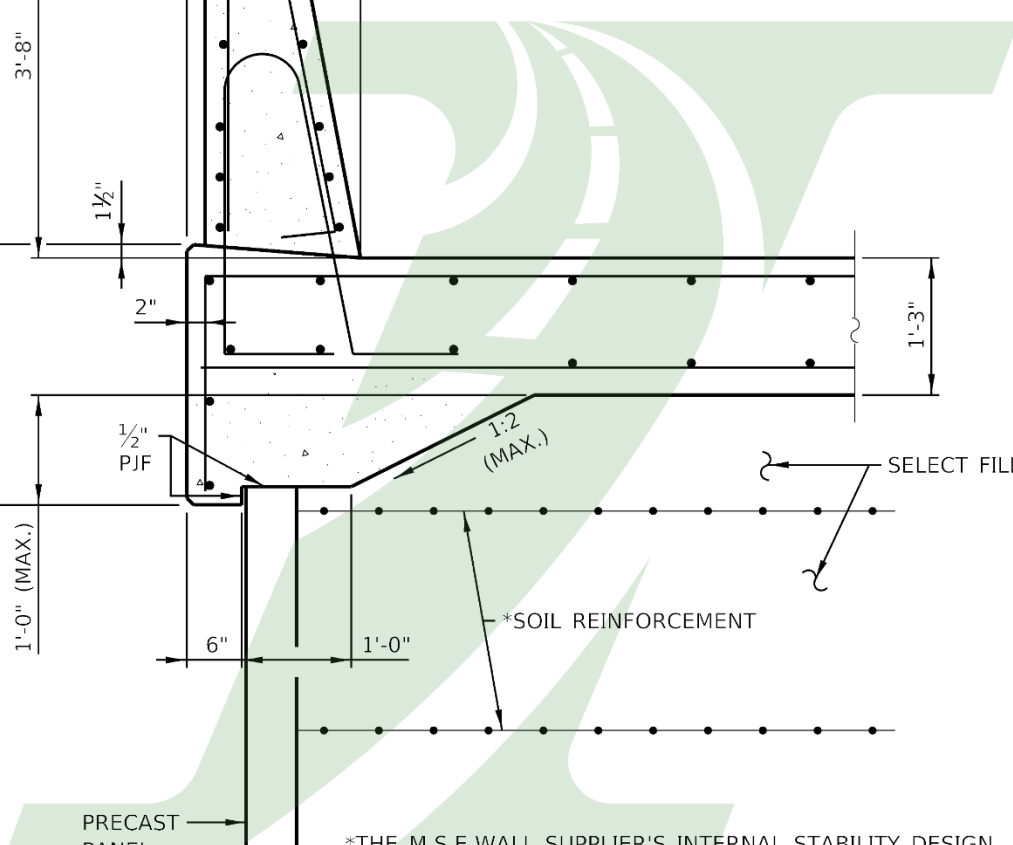
- \* SLEEVE EACH PILE FROM BOTTOM OF PROPOSED ABUTMENT TO TOP OF LEVELING PAD BEFORE PLACING AND COMPACTING THE SELECT FILL. FILL THE ANNULAR SPACE BETWEEN THE PILE AND SLEEVE WITH CLEAN SAND. WORK SHALL BE INCLUDED WITH PILE CASING.
- \*\* THE MSE WALL SUPPLIER SHALL DESIGN THE ABUTMENT SOIL REINFORCEMENT TO RESIST A HORIZONTAL FORCE OF \_\_\_\_\_ KIPS/FT OF ABUTMENT. SELECT FILL AND ABUTMENT SOIL REINFORCEMENT TO THE LIMITS SHOWN SHALL BE INCLUDED IN THE COST OF MSE WALL.
- \*\*\* OVEREXCAVATION BEYOND STRUCTURE EXCAVATION AND BEYOND THE REMOVAL OF UNSUITABLE MATERIAL. THIS AREA NOT MEASURED FOR PAYMENT. BACKFILL OVEREXCAVATION WITH SAME MATERIAL USED FOR SELECT FILL USED IN MSE WALL.

**Figure 10.3.8: MSE Wall Section at Semi-Integral Abutment**

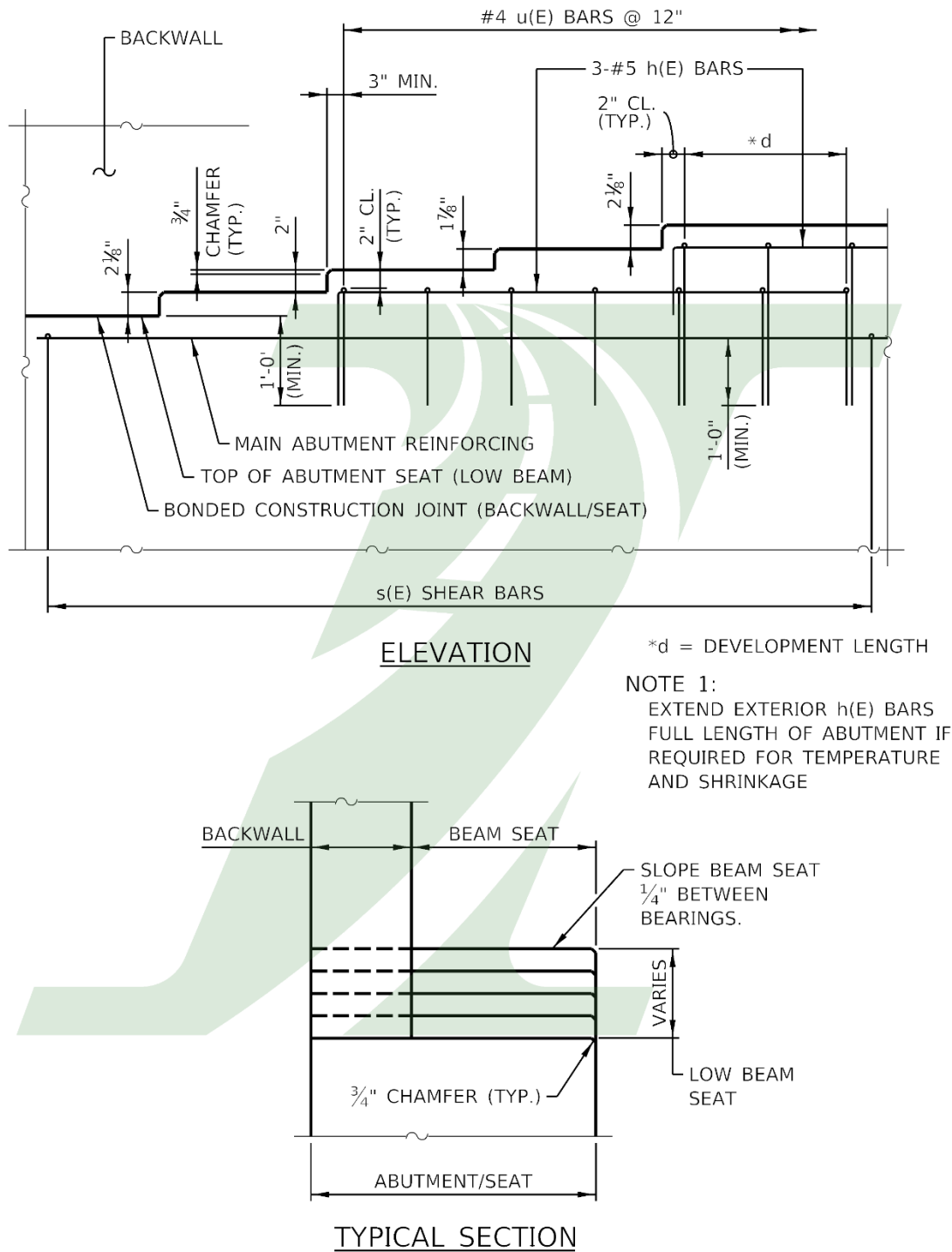


**Figure 10.3.9: MSE Wall Section at Integral Abutment**

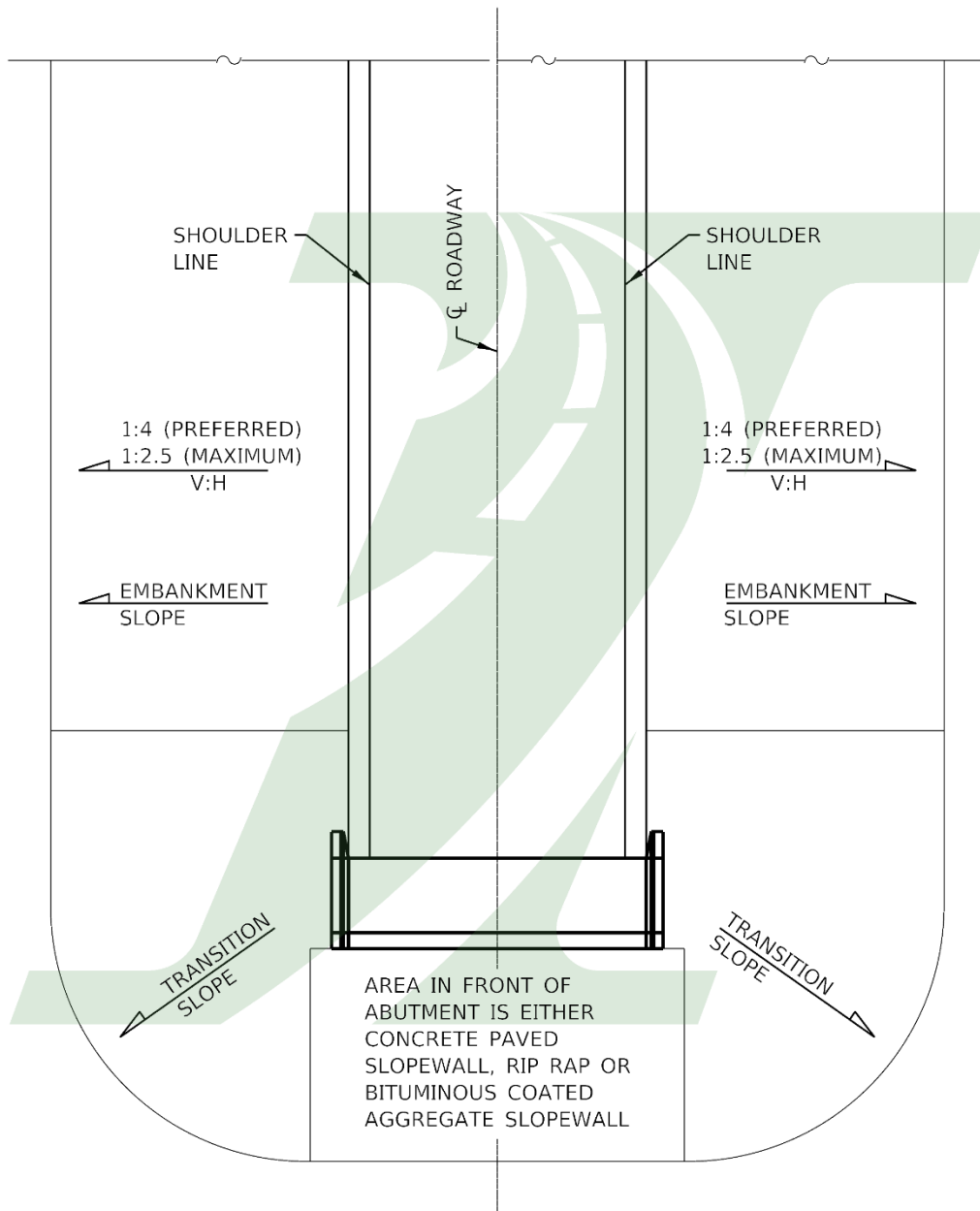




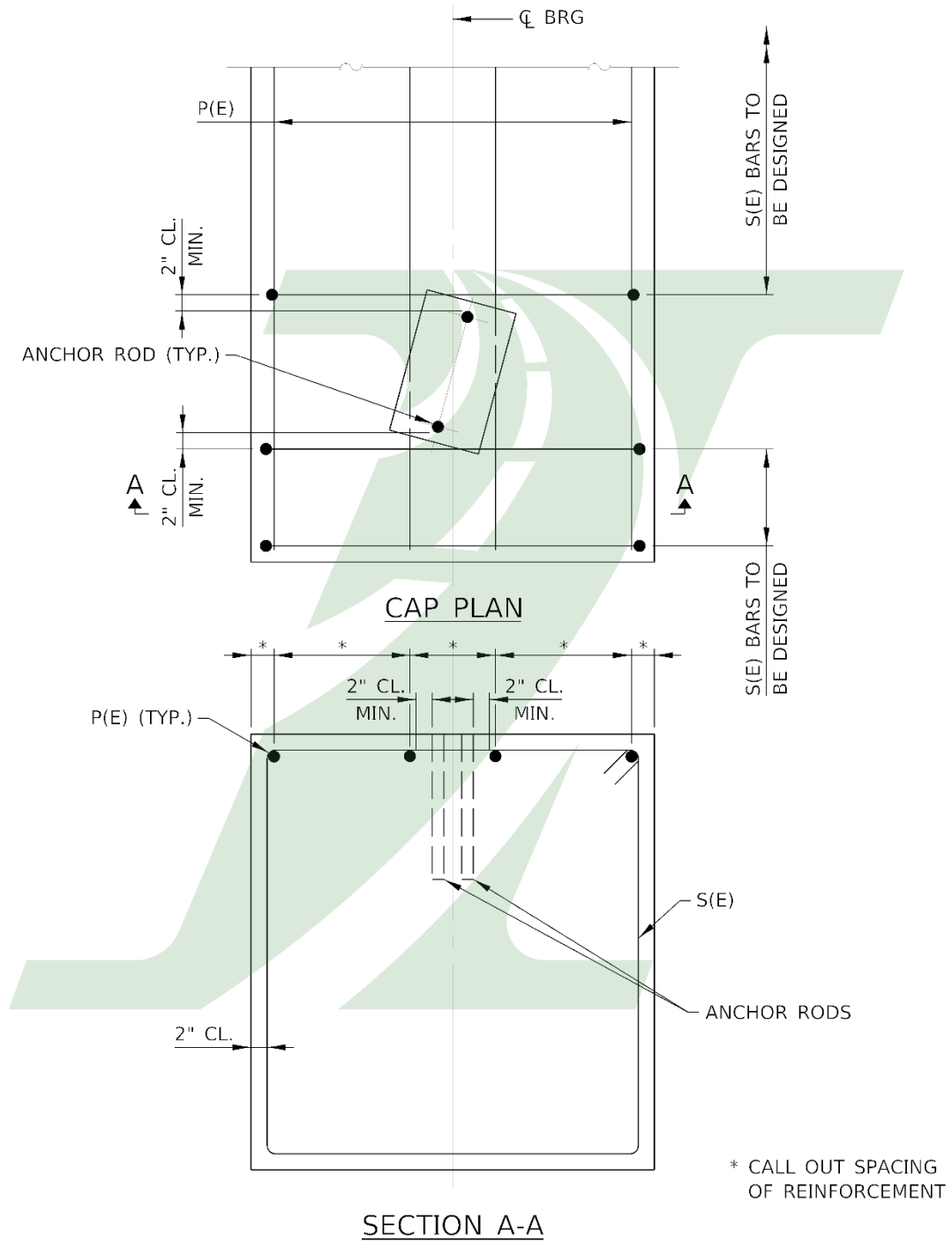
**Figure 10.3.10: Section Through Bridge Approach Slab at MSE Wingwall**



**Figure 10.6.1: Bridge Seat Details**



**Figure 10.7.5: Embankment Cones**



**Figure 10.9.1: Anchor Rod Location**

## SECTION 11.0 PIERS

### 11.1 General

Piers shall be designed in accordance with the latest AASHTO Specifications and Section 3.9 of the latest IDOT Bridge Manual, except as herein modified.

Multi-column pier shapes, as shown in Figure 11.3.1.1 (except single column hammerhead) and Figure 11.3.1.2, are the most commonly used pier types for grade separation structures. The use of square or round columns is appropriate; however, the standard application of square columns is preferred whenever practical to provide system consistency. A typical 3" offset between the face of column and the face of the pier cap and crash wall is desirable.

Piers under deck joints, in medians or within 12 feet of the outer edge of shoulder shall have all exposed surface areas treated with a concrete sealer. For cases involving structure widening, the existing concrete substructure shall be power washed, and both the new and existing surfaces treated with a concrete sealer.

### 11.2 Design

The friction force caused by an expansion bearing sliding on its bearing plates or deforming on the supporting substructure element shall be included in the design of the structure. These forces are determined by multiplying the coefficient of friction by the total dead load reactions on the bearing. Coefficients of 0.30 for steel on steel and 0.10 for Teflon on Teflon shall be used.

For elastomeric bearings, the force required to deform the elastomeric pad shall not be less than 44 pounds per square inch of bearing area for Type I bearings or 0.07 times the dead load reaction for Types II and III bearings.

The fixed pier(s) design shall include the "net" frictional force from expansion bearings on adjacent piers.

An allowance for additional eccentricity shall be considered in all pier designs. For structures with total lengths of greater than 400 feet, each pier shall be designed with an allowance for additional eccentricity of 3 inches. An allowance for additional eccentricity shall not reduce the required design capacity.

The bearing seat shall meet the minimum support length requirements specified in the AASHTO Seismic Design Section for Seismic Performance Zone 1 (LRFD) or Category A (LFD).

### 11.3 Pier Types

#### 11.3.1 Grade Separation

Grade separation piers should be proportioned in accordance with the dimensions as shown on Figures 11.3.1.1 through 11.3.1.8. Care shall be used in applying these criteria on piers with heights greater than 20'-0" measured from the top of crash wall. The minimum cap and crash wall width for grade separation piers shall be 6" (3" offset each side) greater than the minimum column width of 2'-6", unless the bearings require a larger seat area. In this case, the width of the cap may be increased by up to 12" (6" offset each side) desired maximum.

Grade separation piers used with integral abutments may be supported by a single row of piles, provided the capacity of the piles is not exceeded and the number of spans on either side of the

pier are equal and their total lengths are approximately the same ( $\pm 5\%$ ). Otherwise, a larger footing with multiple rows of piles shall be used. See Figure 11.3.1.8 for details of an integral pier.

### 11.3.2 Stream Crossing

Stream crossing piers shall be a solid wall with vertical faces and rounded ends. The minimum width shall be a constant 2'-6" from top to bottom. If a greater width is required for the bearing seats, a wider cap shall be utilized to maintain a constant 2'-6" pier width. Details of a fixed or expansion pier, supported by a pile footing are shown on Figure 11.3.2.1. Expansion piers may also be supported by a single line of encased piles or drilled shafts as shown on Figure 11.3.2.2.

### 11.3.3 Railroad Crossings

Railroad crossings shall utilize grade separation type piers unless the horizontal clearance to the centerline of the nearest track is less than 25'-0", in which case they shall be modified with crash walls meeting the requirements of the latest edition of AREMA. and the railroad. See Figure 11.3.3.1 for details.

## 11.4 Widening Existing Piers

In general, existing piers shall be widened in-kind, especially those which can be viewed by the traveling public, except Article 11.6 shall be followed. At locations not exposed to the traveling public, such as structures over railroads or streams, other designs may be considered. The final selection shall be based on serviceability and economy.

Pier widenings shall be designed to carry all forces which pass through the bearings. All pier widenings shall be tied to the existing cap, column and footing areas with dowel bars drilled into the existing concrete. Minimum depth embedment of dowels in existing concrete shall be 12 inches for vertical bars and the development length for horizontal bars. Maximum spacing shall be 18 inches.

Foundations for widened piers shall be the same type as the existing structure. Existing borings and new borings (if required) shall also be considered. Construction and installation procedures shall be considered when placing new foundations adjacent to existing so as not to reduce the load carrying capacity or cause settlement of existing foundations.

Special attention shall be given to the widening of existing piers that consist of 3-foot diameter hollow precast columns without footings. The extensions shall be designed using 3-foot diameter columns supported on pile foundations.

Generally, piers at dual crossings which are to be widened each side of the centerline of median shall be separated along the centerline with an open joint or preformed joint filler, except for their footings, which shall be constructed without an expansion joint. If a construction joint in the footing is needed, the longitudinal reinforcement shall cross the joint to maintain continuity.

Pier caps with rounded ends shall be attached to the new work as shown in Figure 11.4.1. Pier walls with rounded ends shall be attached to the new work as shown in Figure 11.4.2.

## 11.5 Integral Concrete Pier Caps

An integral pier cap is a pier cap that is incorporated either entirely or largely within the depth of the superstructure. The cap can be constructed of either concrete or steel. For steel superstructures, the longitudinal beams are typically run continuous through the cap. When the

superstructure is constructed of prestressed concrete, a pier segment may run continuous through the cap or the ends of beams may be cast into the integral cap. When the beams are not continuous through the cap, a positive connection is made between the cap and the beams with post-tensioning.

Integral pier caps may be utilized to: Improve vertical clearances, simplify framing, eliminate bearings, improve aesthetics and reduce the mass of the structure which reduces the seismic design forces.

The beams shall be supported on falsework while the caps are constructed. The top surface of the cap is intentionally roughened. Stirrups are extended from the top surface of the cap to provide a positive connection to the deck. After tensioning of cap tendons, the falsework supporting the beams and cap are removed. The deck concrete is then placed according to the deck pouring sequence shown in the plans.

A post-tensioning tendon shall be placed in each corner of the cap along with one or more draped tendons. Strand tendons shall be used rather than bars for simplicity of construction and to allow more flexibility in the tendon profile.

After placement and hardening of the cap concrete but before the deck is cast, tendons shall be tensioned from one end according to a specified sequence. Tendons are then grouted to provide corrosion protection and to provide bond between the strands and the structure.

## **11.6 Pier Protection Requirements**

### **11.6.1 New or Widened Piers**

When shielding is required based on a Level 2 or Level 3 Barrier Warrant Analysis, a crash wall that extends a minimum of 5'-0" above the ground and a minimum 3'-0" width shall be provided. When a crash wall is provided in accordance with AASHTO LRFD Article 3.6.5.1, the substructure is considered to have adequate structural resistance to bridge collapse due to vehicle impact loads. Thus, no separate design for collision load is necessary. The top of crash wall shall be level along the length of the pier.

### **11.6.2 Existing Piers to Remain**

When shielding is required based on a Level 2 or Level 3 Barrier Warrant Analysis, or the face of the pier is within the clear zone:

Existing piers that do not require new walls or columns shall be modified in accordance with Base Sheets M-BRG-507 and M-BRG-508 and herein. Existing crash walls shall be modified to meet the dimension and reinforcement details shown in these Base Sheets. Alternatively, if the crash wall meets the minimum 3-foot width requirement and the 6" offset from the face of the column, the crash wall may be built up to meet the height requirements, provided the top reinforcement matches the existing and dowels are designed to adequately transfer the load. Modifications shall be designed for Test Level 5 (TL-5) Crash Load as specified in Article A13.2 of the AASHTO LRFD Bridge Design Specifications. Additional dead load to the pier foundation shall be analyzed. A concrete shoulder barrier transition shall be used upstream of the crash wall, even if the shoulder width is not transitioning. The barrier height and shape shall transition as shown on Illinois Tollway Standard Drawing C4.

A concrete barrier designed to meet TL-5 impact loading shall be used to shield bridge piers when it is not feasible to comply with the above requirements. See Illinois Tollway Standards C15, C16 and C17 for details.

## 11.7 Pier Columns

If pier columns are over 20 feet high, a bonded construction joint or joints shall be detailed at approximately mid-height or third points.

## 11.8 Foundations

### 11.8.1 Spread Footings

The minimum width of any spread footing under an expansion pier shall be one-fourth the distance from the top of the pier to the bottom of the footing. If the spread footing is founded on rock, this ratio may be reduced to one-fifth of the pier height and keyed a minimum of 6 inches into sound rock. The maximum applied and allowable bearing pressure for each pier foundation shall be shown on the appropriate plan sheet.

Any construction joints allowed in pier footings shall be bonded construction joints with continuous reinforcement.

### 11.8.2 Piles

Piles foundations shall be designed in accordance with Section 3.10 of the latest IDOT Bridge Manual.

The spacing between the outside rows of piles in a pile supported footing shall be minimum one-fifth of the pier height, but no greater than 8-foot.

The following information shall be included in the plans for each pier foundation supported by Piles:

#### PILE DATA

PILE TYPE AND SIZE

NOMINAL REQUIRED BEARING:

FACTORED OR ALLOWABLE RESISTANCE AVAILABLE:

ESTIMATED PILE LENGTH:

NUMBER OF PILES REQUIRED: \_\_\_\_\_ plus \_\_\_\_\_ test pile(s)

#### LEGEND

DENOTING THE FOLLOWING:

EXISTING PILES

PROPOSED PILES

PROPOSED BATTERED PILES

TEST PILES

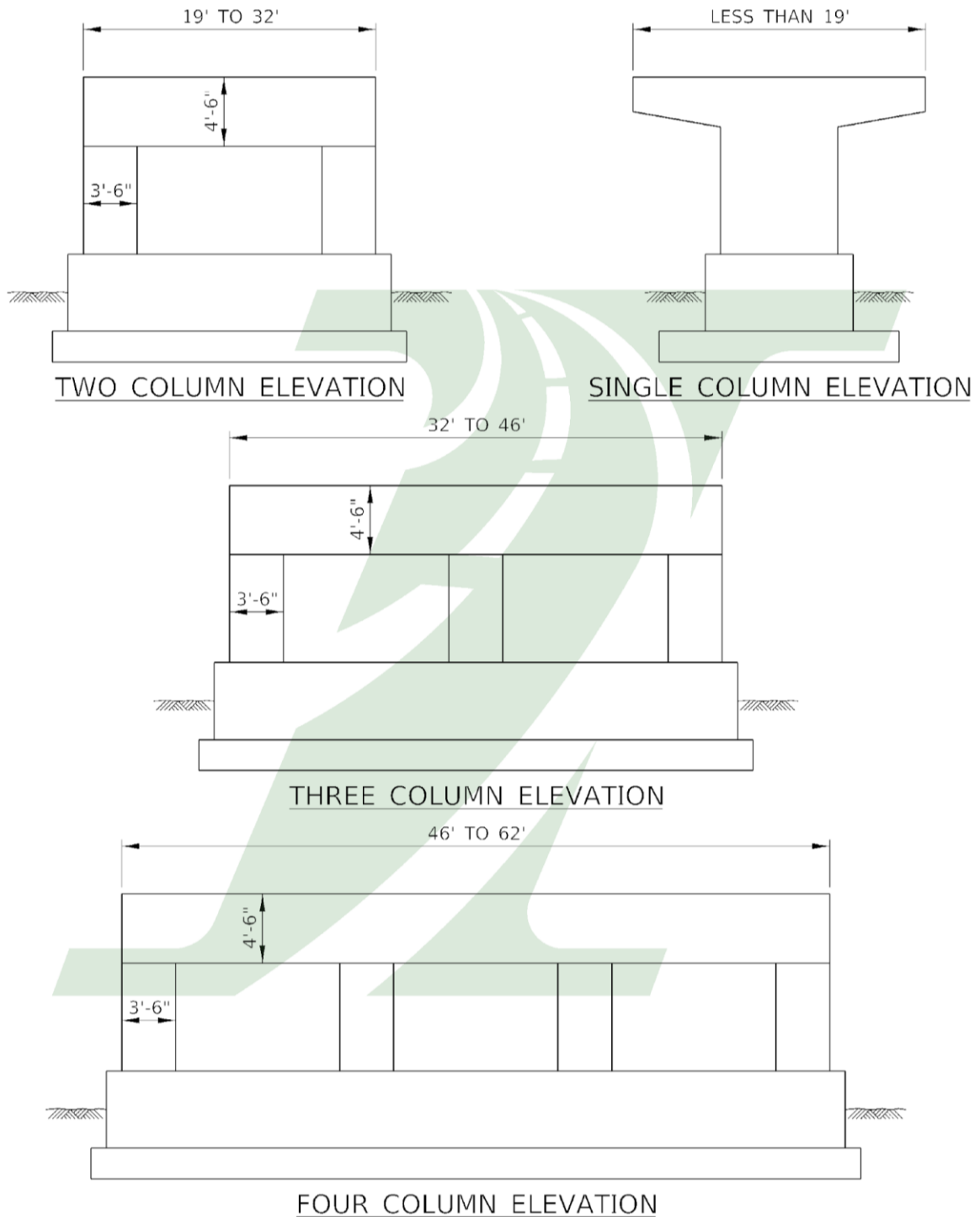
### 11.8.3 Drilled Shafts

Drilled shafts shall be designed and detailed in accordance with Section 3.10 of the latest IDOT Bridge Manual.

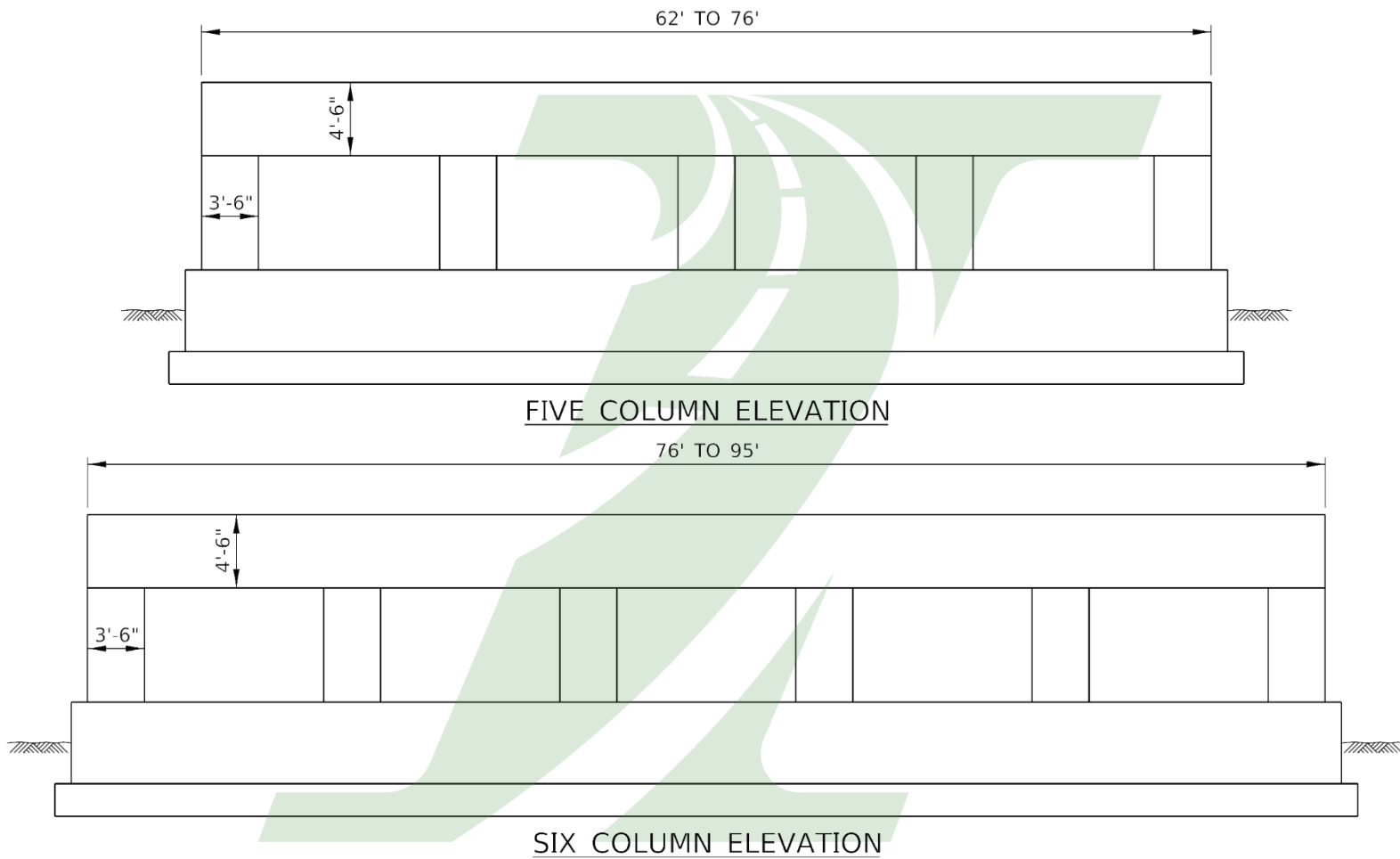


## 11.9 Pier Cap Reinforcement

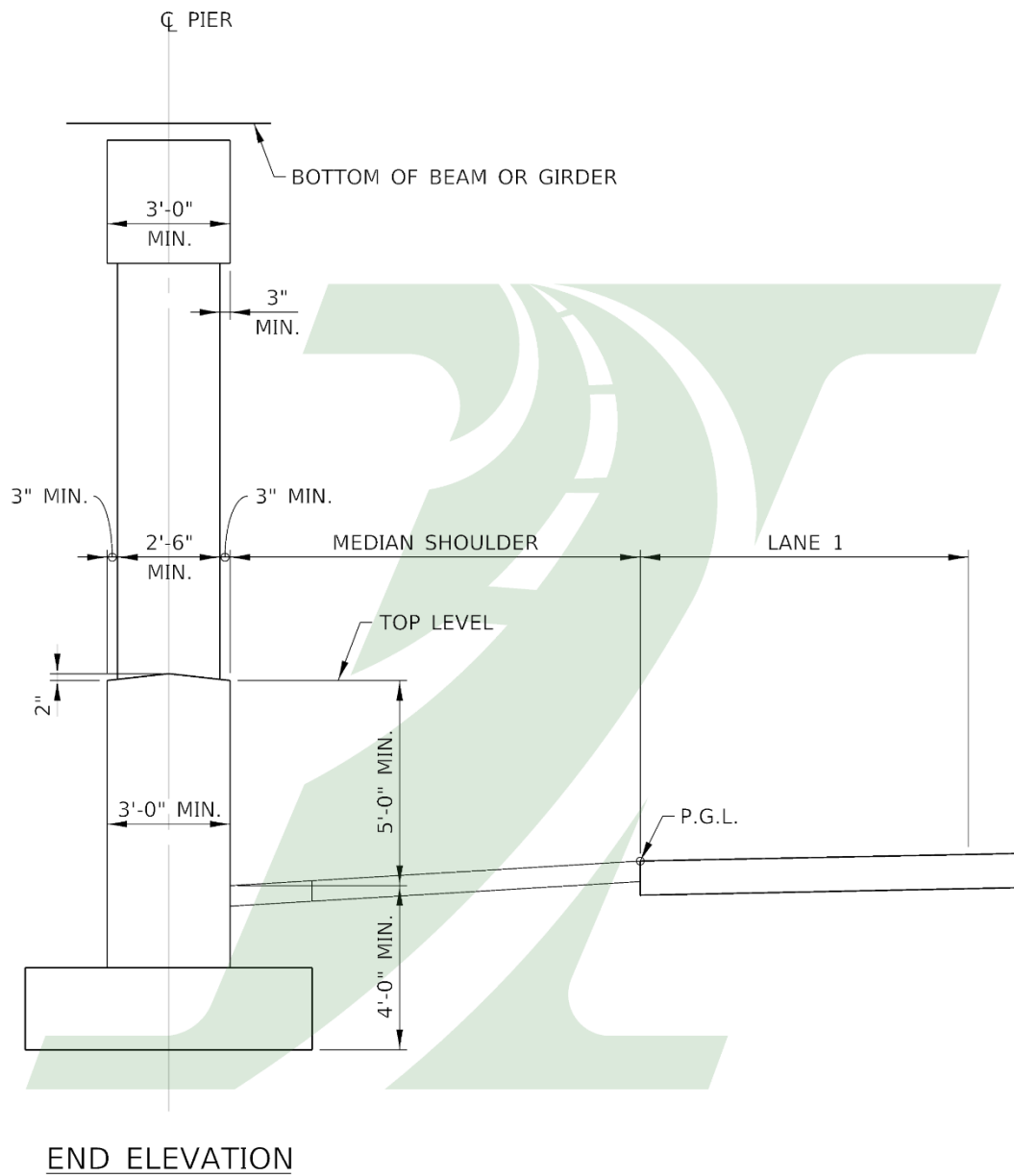
A detail scaled drawing of the reinforcement and the holes drilled for the bearing anchor rods at expansion bearings and anchor bolts at fixed piers shall be provided in the plans, as shown in Figure 11.9.1. The detail drawing shall include all reinforcement that may interfere with the drilling operation, the reinforcement spacing and the clearances of the reinforcement to the edge of the cap and the future holes.



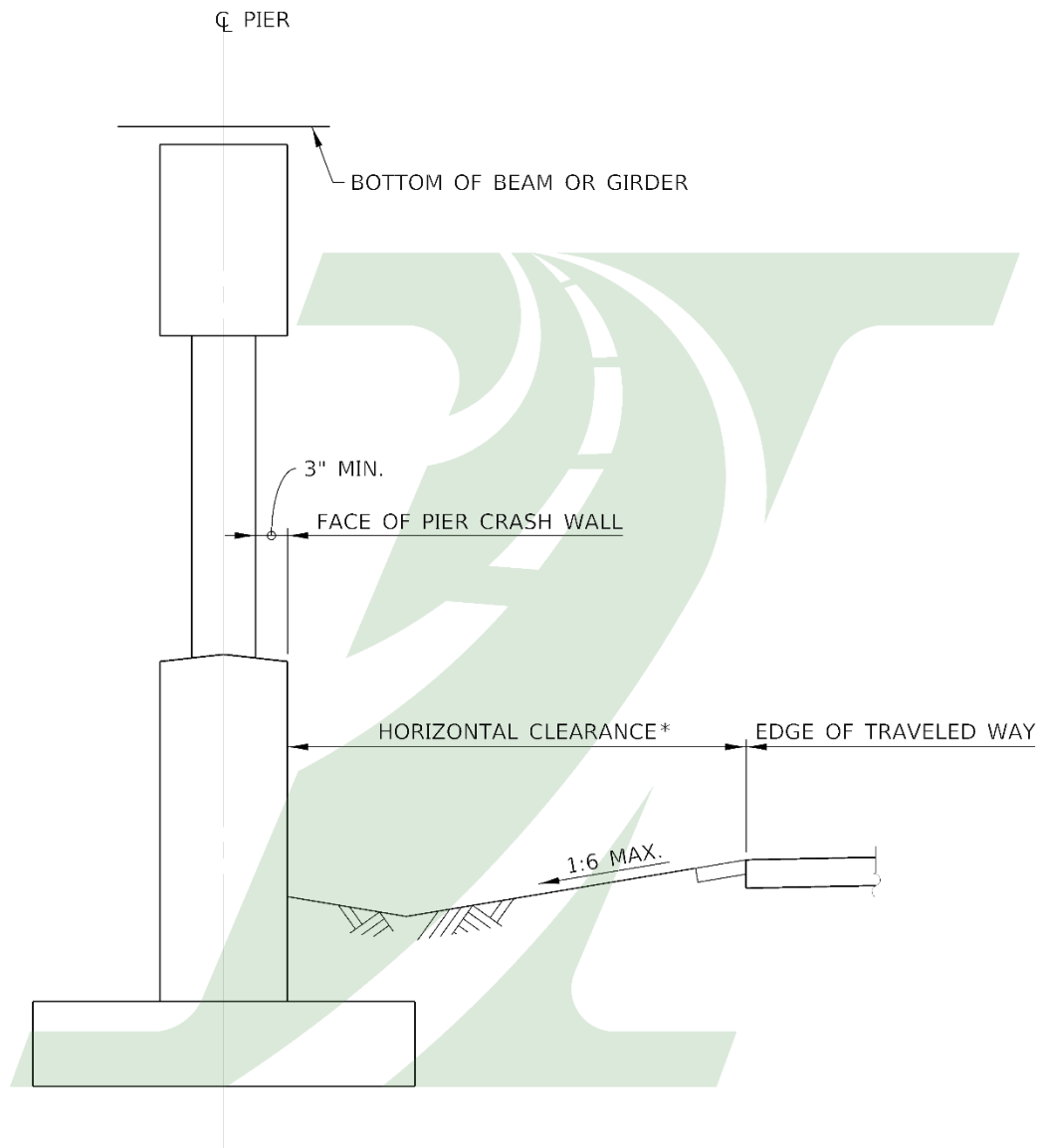
**Figure 11.3.1.1: Grade Separation Piers**



**Figure 11.3.1.2: Grade Separation Piers**



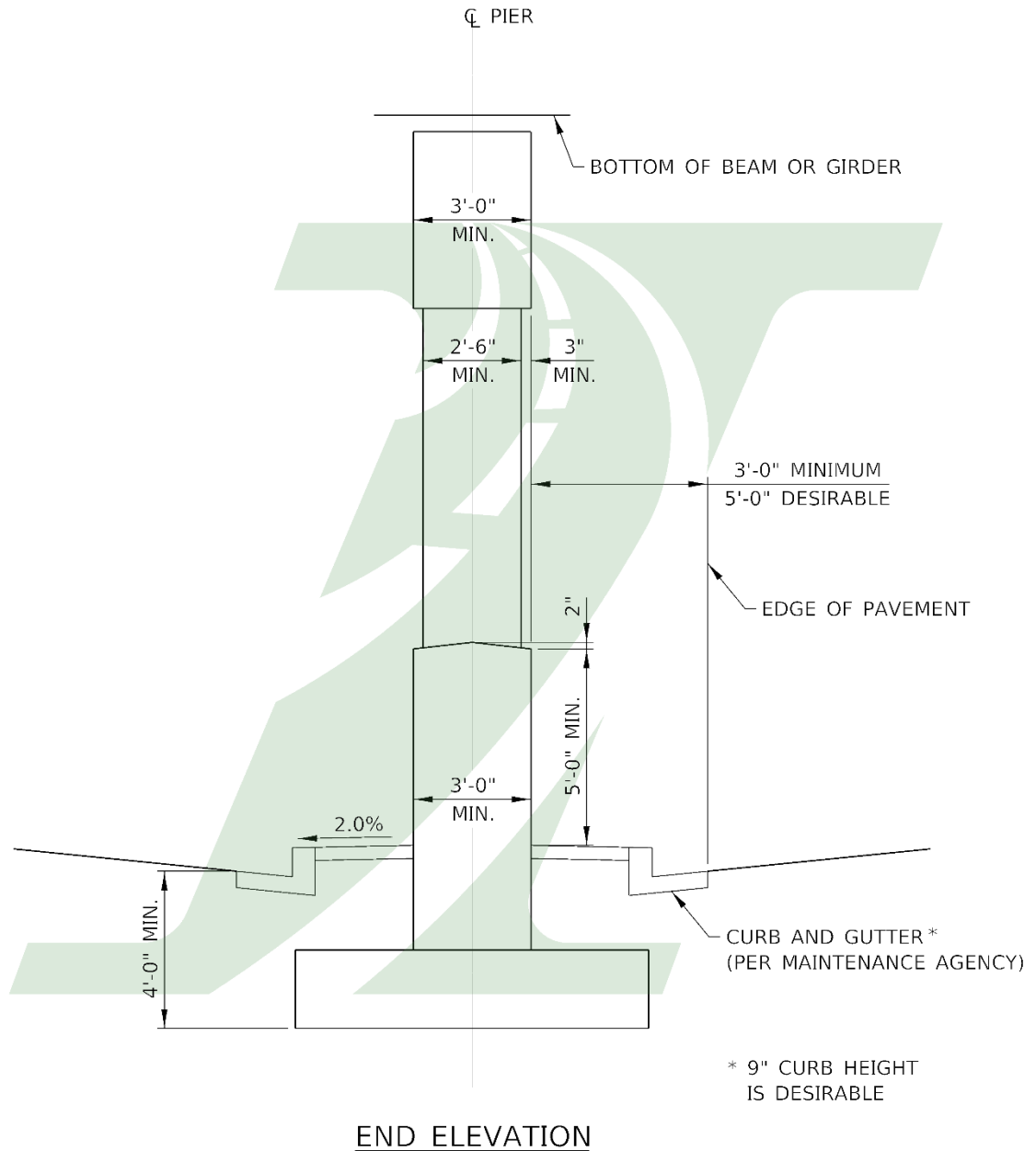
**Figure 11.3.1.3: Median Pier for Structure over Tollway**



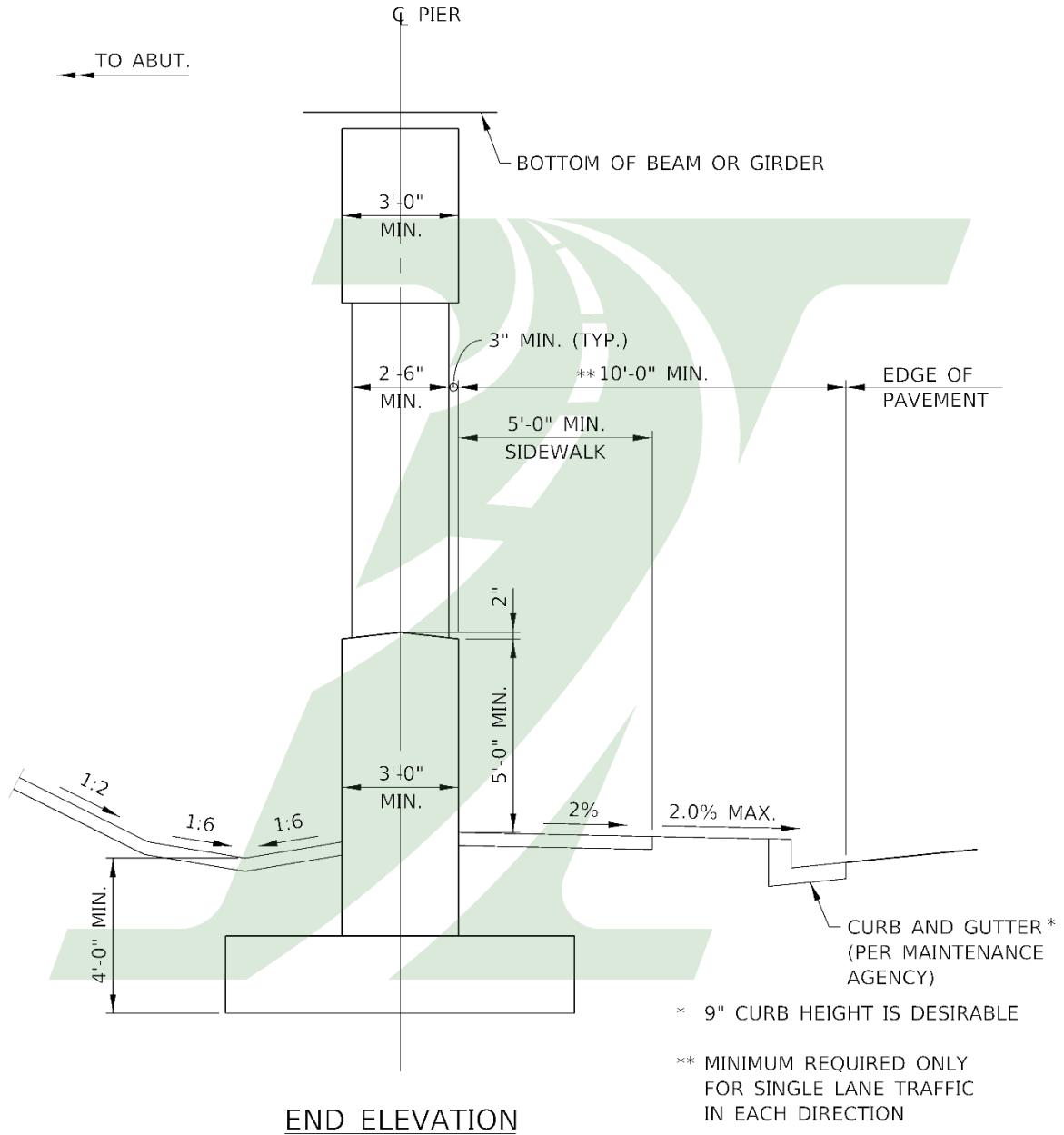
### END ELEVATION

\* SEE ARTICLE 5.3 FOR MINIMUM HORIZONTAL CLEARANCE REQUIREMENTS

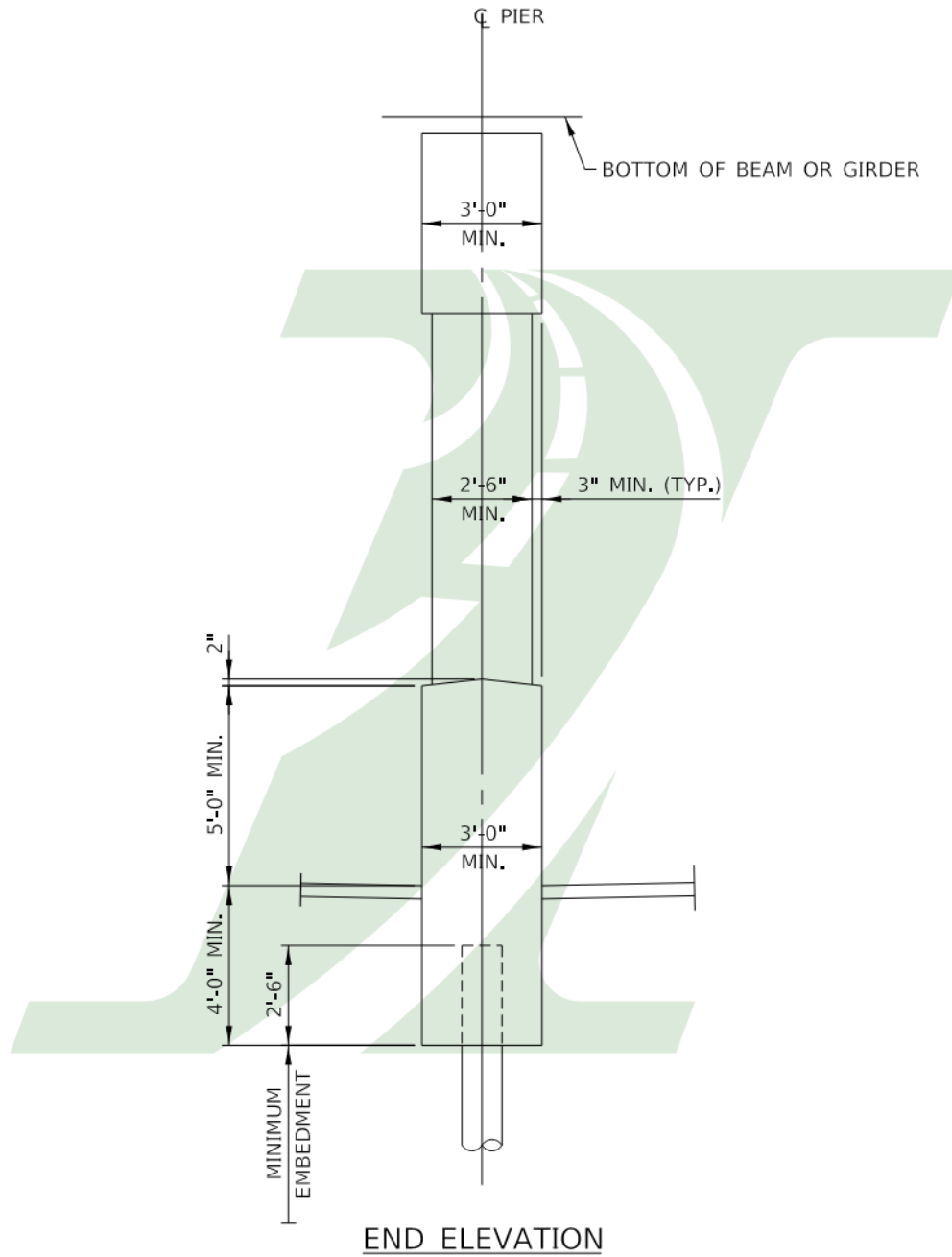
**Figure 11.3.1.4: Shoulder Pier for Structure over Tollway**



**Figure 11.3.1.6 Median Pier for Tollway Structure over Local Road**

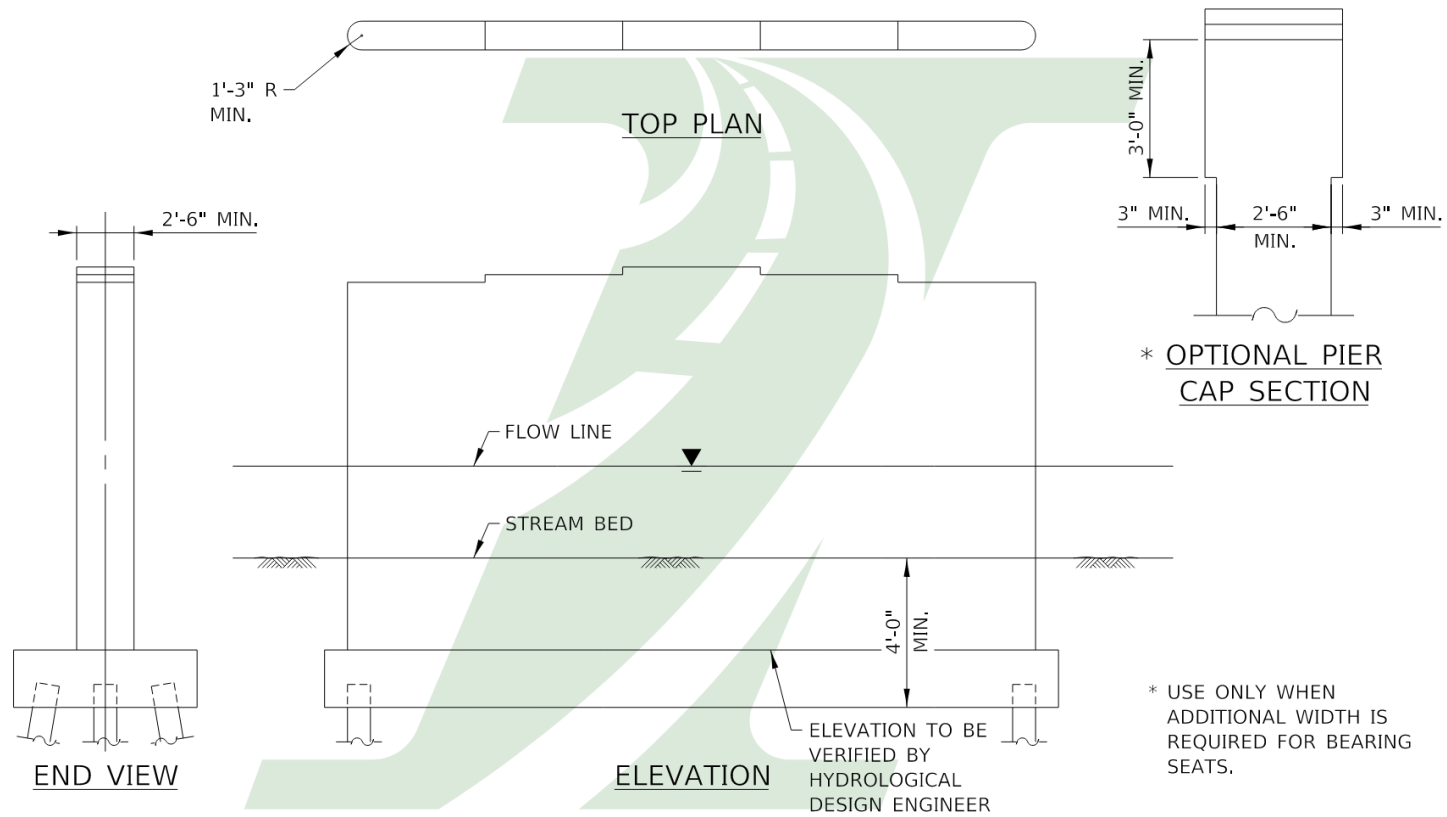


**Figure 11.3.1.7: Shoulder Pier for Tollway Structure over Local Road**

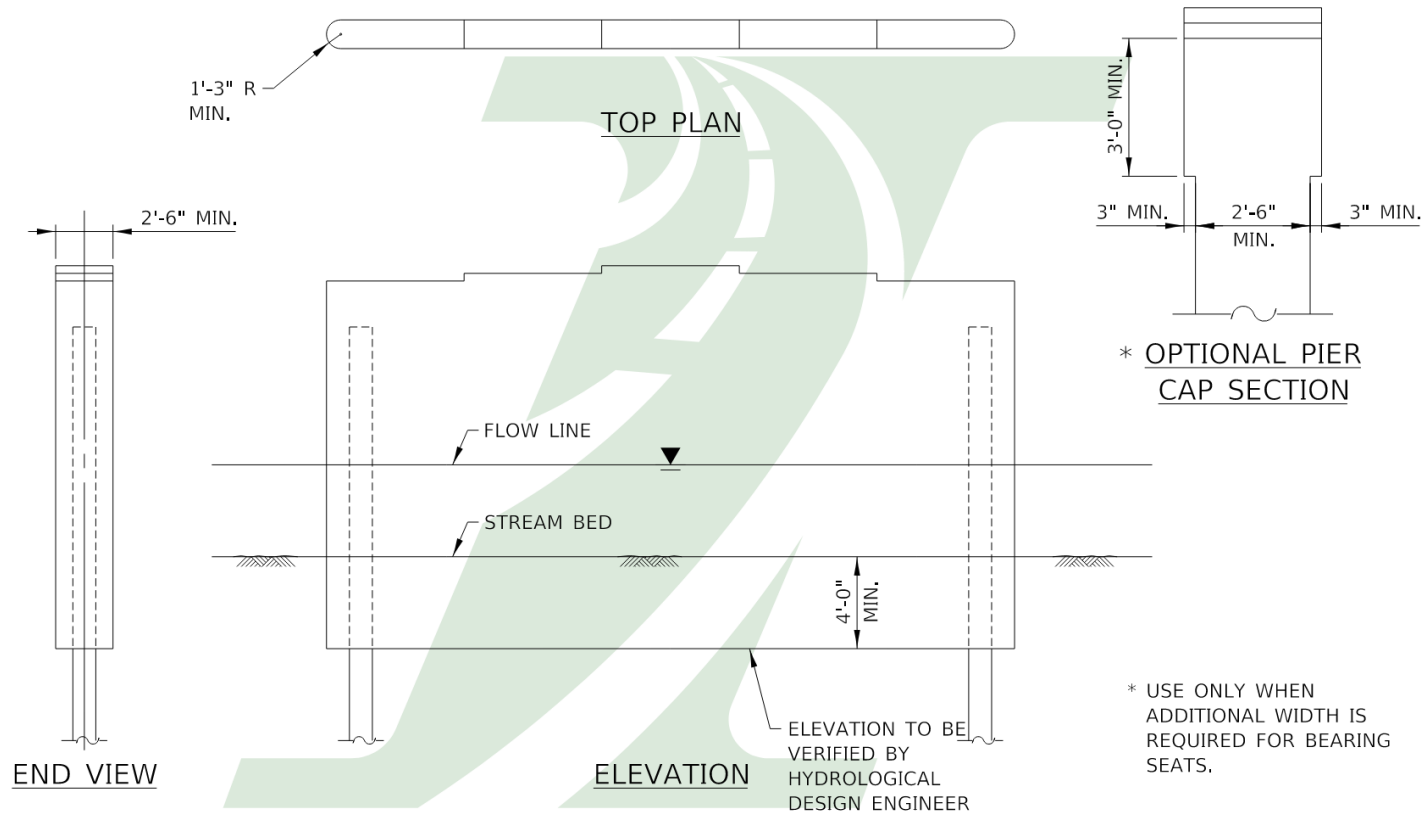


**Figure 11.3.1.8: Grade Separation Pier Detail for use with Integral Abutment Bridge**

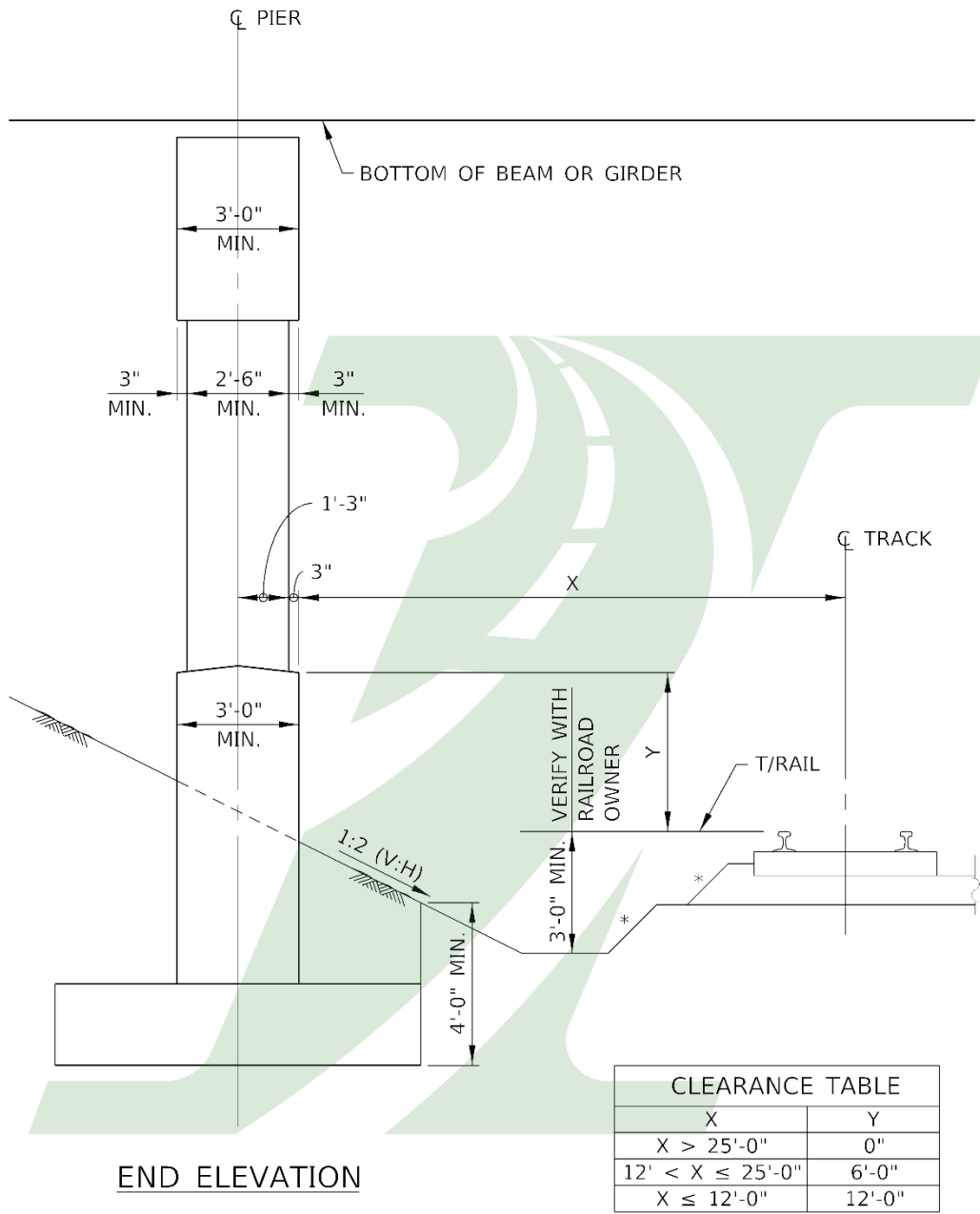




**Figure 11.3.2.1: Stream Crossing Fixed or Expansion Pier**

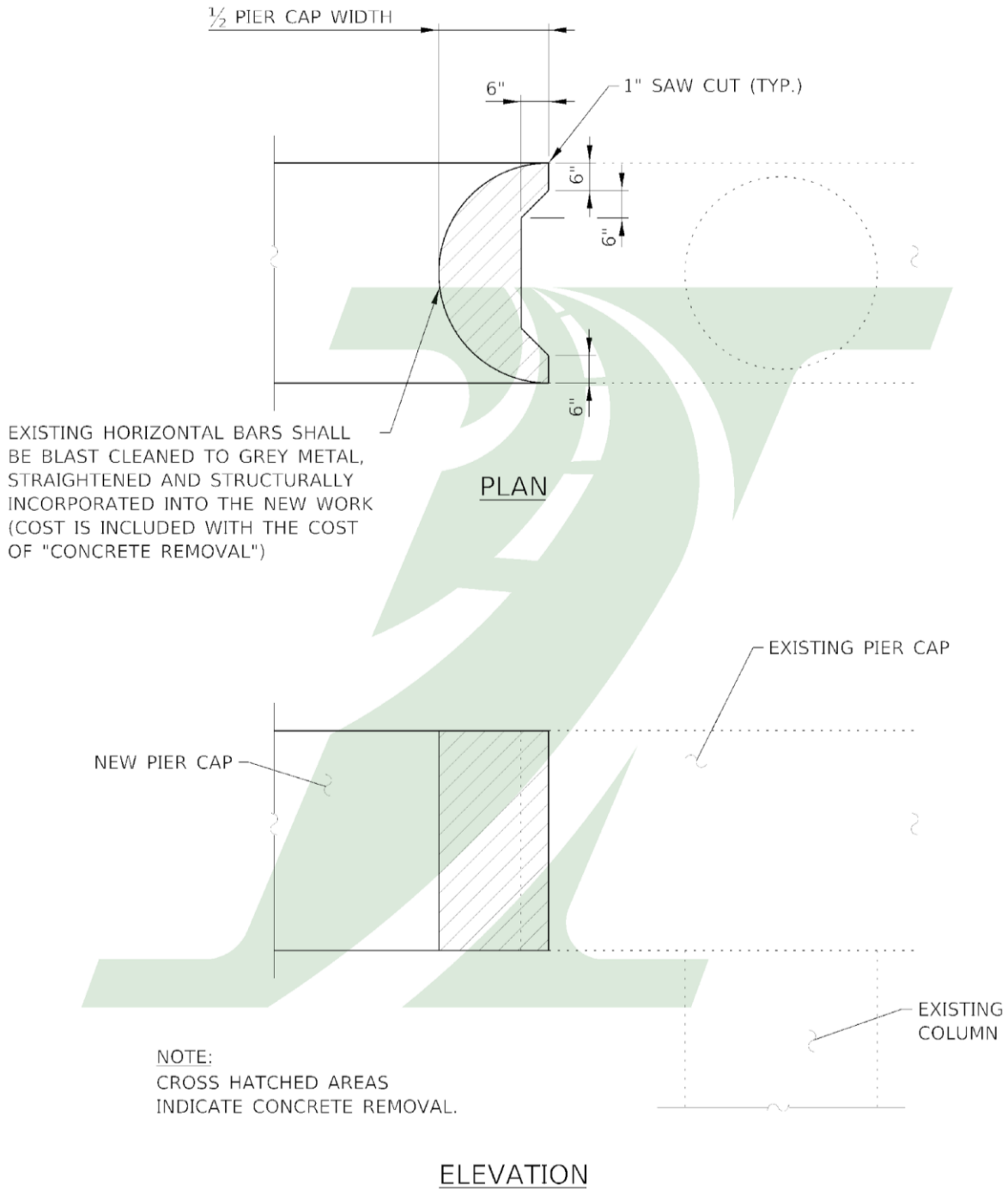


**Figure 11.3.2.2: Stream Crossing Expansion Pier – Encased Pile Type**

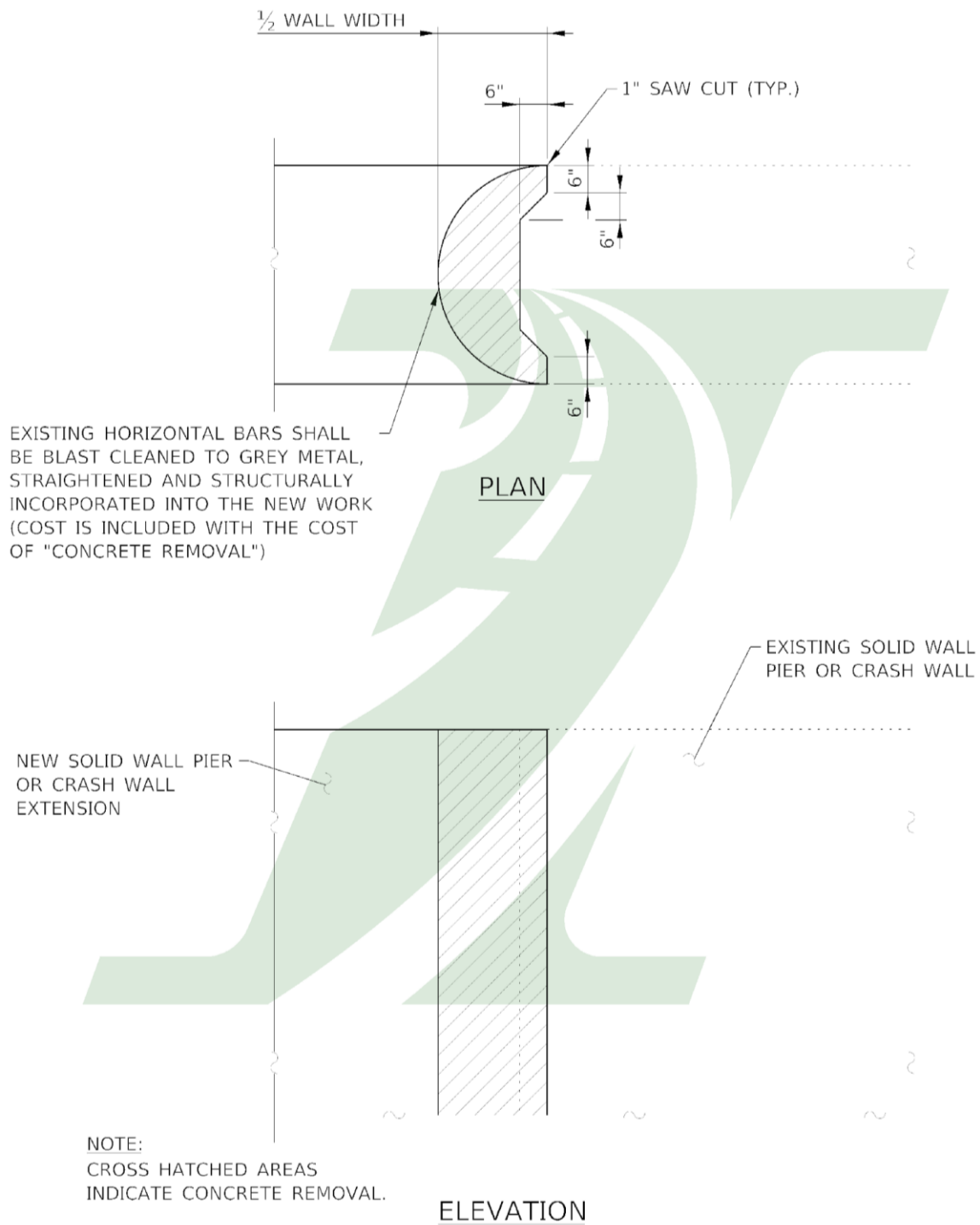


\* OBTAIN APPROPRIATE SLOPE FROM THE RAILROAD

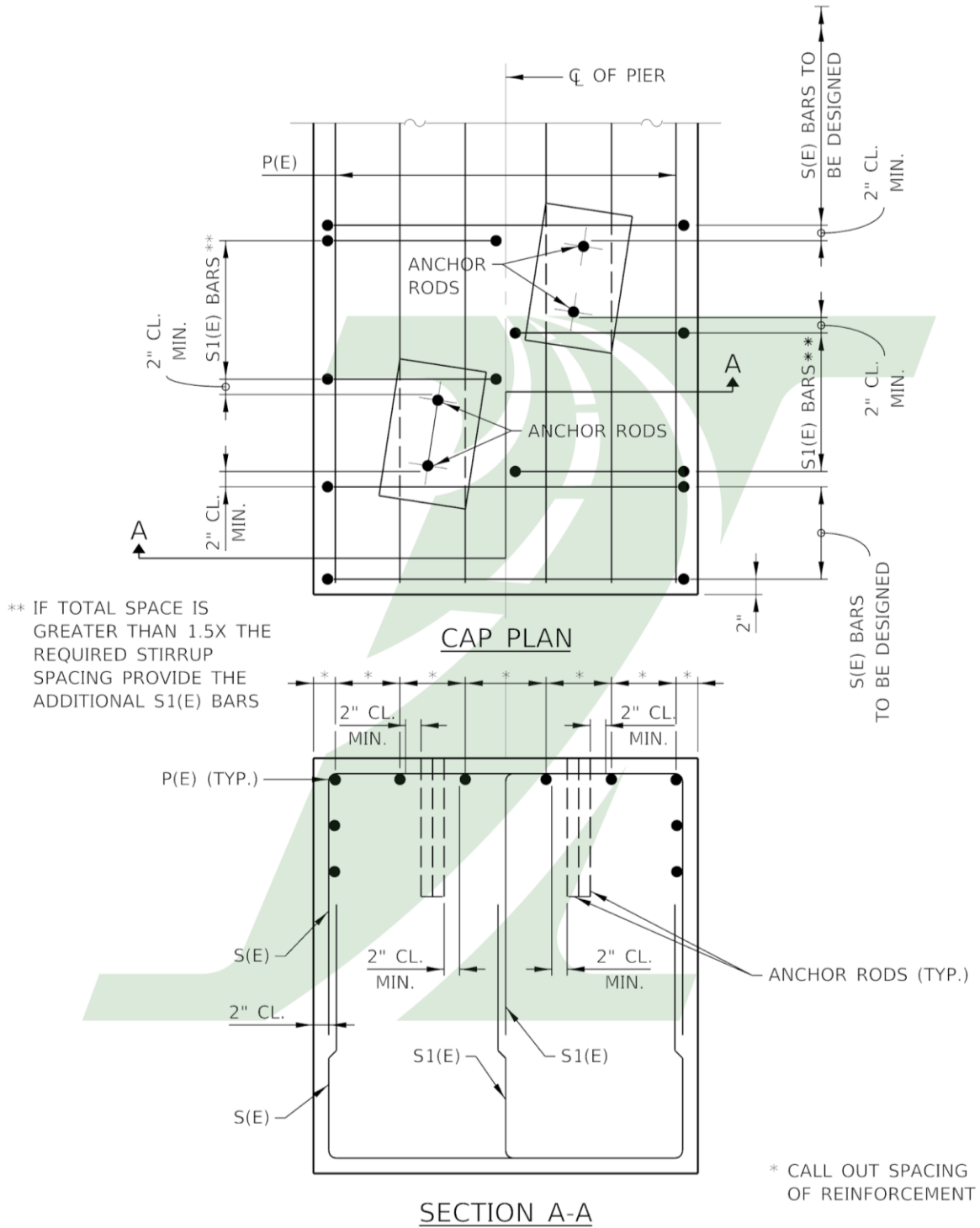
**Figure 11.3.1: Railroad Crossing Pier**



**Figure 11.4.1: Widening Existing Pier Cap**



**Figure 11.4.2: Widening Existing Pier Wall**



**Figure 11.9.1: Anchor Road Location**

## SECTION 12.0 STRUCTURAL STEEL

### 12.1 General

The design and detailing of steel superstructures shall be in accordance with the appropriate AASHTO Specifications and the provisions of Section 3.3 of the IDOT Bridge Manual, except as herein modified. The name, version, and release date of software used shall be indicated as a general note in the plans.

### 12.2 Design

Structural steel shall be AASHTO M270 Grade 50 (ASTM A709) unless otherwise noted. Grade 70 steel may be used in areas of high stress, if this will result in a more economical solution.

All horizontally curved structures not considered essentially straight and/or structures with skews greater than 45 deg. shall be designed and/or checked using three-dimensional analysis. If either type of structure is to be constructed in stages, the beams in each stage shall be checked using three-dimensional analysis for stability, and bending, shear and torsion stresses. For these conditions, the Designer shall consider using a closer spacing (15'- 20') for cross frames or diaphragms and the use of bottom lateral bracing.

Generally, all shop connections shall be welded. All field connections shall be made with  $\frac{7}{8}$ -inch diameter zinc-coated, high-strength bolts per AASHTO M164 (ASTM A325), and shall be designed as friction type connections. Type 3 high-strength bolts may be considered when weathering steel is used.

In order to minimize fillet heights on steel structures, the beam or plate girder slopes shall be changed at the splices to conform to the general configuration of the bottom of the formed deck slab.

Plate girders shall be cambered for dead load deflection and vertical curve geometry except where the resulting camber would be less than one inch.

Welded plate girder flange transitions shall be limited to twice the thickness of the thinner plate. Top of beam or girder web elevations at the center line of each splice and/or bearing shall be shown on the framing plan.

Non-redundant steel tension members (NSTM) and structurally redundant members (SRM) shall be identified in the plans.

Load carrying components – including tension flanges, webs and splice plates – shall be designated “CVN” on the plans and shall conform to the AASHTO Impact Testing Requirement, Zone 2.

### 12.3 Intermediate Vertical Stiffeners

Intermediate vertical stiffeners shall be a minimum of  $\frac{7}{16}$  inch thick and shall be welded to the web with a  $\frac{1}{4}$ -inch minimum continuous fillet weld. The distance between the end of the stiffeners and the near edge of the web-to-tension-flange fillet weld shall be no more than six times or less than four times the web thickness.

For plate girders with web depths equal to or smaller than 54 inches, it is preferable not to utilize intermediate stiffeners. For plate girders with web depths larger than 54 inches, the web thickness may be increased to a maximum  $\frac{5}{8}$  inch to eliminate or limit the vertical stiffeners to only one or two locations per span beyond those provided for cross frame attachments. The minimum web thickness of a plate girder shall be  $\frac{7}{16}$  inch.

## 12.4 Bearing Stiffeners

Bearing stiffeners need not be welded to either flange of rolled beams or plate girders, except as hereafter indicated. They shall be finished to bear on the bearing end and have a tight fit at the other end.

On all skewed plate girders or rolled beams with skews 45 deg. and larger and on all horizontally curved beams and plate girders, the bearing stiffeners shall be welded to both flanges where these stiffeners are used as connecting plates for cross frames or diaphragms. Welding to the flanges shall be done with fillet welds on both sides of stiffeners. The length of the fillet weld at the mill to bear end shall be the width of the stiffener minus  $\frac{1}{2}$  inch ( $\frac{1}{4}$  inch at each end). The length of the fillet weld at the other end shall be the full width of stiffener. The bearing stiffener plates at the junction of the flanges and the web shall be clipped  $1\frac{1}{2}$  inch horizontally and a minimum of 3 inch vertically for rolled beams, or four times the web thickness plus the size of web-to-flange fillet weld for plate girders.

## 12.5 Superstructure Diaphragms

### 12.5.1 End Diaphragms and Cross Frames at Expansion Joints

End diaphragms at expansion joints located over piers and/or abutments shall consist of a thickened slab supported on an end diaphragm or cross frame as shown in the latest IDOT Bridge Manual.

### 12.5.2 Diaphragms and Cross Frames at Expansion Bearings

Steel diaphragms and cross frames at expansion piers or abutments shall be designed to allow for jacking on the diaphragm or cross frame for resetting, repair or replacement of expansion bearings. If jacking cannot be performed on the end diaphragms, then provisions shall be made in the design of the beam seats to allow jacking from directly under the beam. The jacking loads and their locations shall be shown on the drawings. The jacking loads shall be broken down into dead and live load components, so the Contractor has the option of jacking with or without the live load on the structure.

### 12.5.3 Diaphragms and Cross Frames at Intermediate Points

The connecting plates for the cross frames and diaphragms located near the support within a distance equal to twice the girder depth shall be welded to both flanges. This requirement shall also apply to the cross frames and diaphragms in all other areas for skewed and horizontally curved plate girders only. In these cases, flange stress shall be investigated for fatigue under Category C.

Cross frames for curved plate girders or girders that are straight or with skews less than 20 degrees shall be oriented in a straight line, and perpendicular to the fascia girders.

Cross frames for horizontally curved plate girders and girders with skews more than 20 degrees shall be designed and detailed with top and bottom chord members. Design and detailing of these



cross frames should be as per Article 6 of the latest AASHTO LRFD Bridge Design Specifications and/or the AASHTO/NSBA “Guidelines for Design for Constructability” 2016. Fit condition for which the cross-frames or diaphragms are to be detailed shall be stated in the contract documents. Steel dead load fit is recommended for most cases with the exception of horizontally curved I-Girder bridges with  $(L/R)_{MAX} \geq 0.2$  in which L is the span length, bearing to bearing along the centerline of the bridge and R is the radius of the centerline of the bridge cross-section. For this case a no-load fit is recommended unless the additive locked-in force effects are considered. For non-skewed girders, the connecting plates for the cross frames and diaphragms, in all areas other than the areas near the supports, shall be welded to the compression flange and undercut at the tension flange. The distance between the near edge of the web-to-tension-flange weld and the end of the connecting plate shall be six times the web thickness. Special consideration shall be given to the connections between floor beams and the main girder for two-girder system bridges to prevent fatigue cracking in the webs.

#### 12.5.4 Diaphragms and Cross Frames Design Details

The calculated deflections of the primary beams under steel self-weight shall be used to detail diaphragms, cross frames and lateral bracing connections, and to erect structural steel such that the beams will be plumb within a tolerance of  $\pm 1/8$  inch per vertical foot throughout. This requirement shall be added as a note to the General Notes.

### 12.6 Table of Moments and Shears

To provide ready information for any future analysis of a structure and to provide the reviewing agencies with a basis for checking of the design, all detailed bridge plans shall include, as a part of said plans, a Table of Moments and Shears. Refer to the latest IDOT Bridge Manual Section 3.1.12 for suggested table layouts. Bridges utilizing a 72" barrier with noise abatement wall shall include the distribution used for the exterior beams and typical interior beams as addition information included within the plans.

### 12.7 Painting of Structural Steel

Painting of steel beams shall be performed in accordance with the applicable IDOT GBSPs and IDOT Bridge Manual Section 2.3.6.1. Desirable color for inside fascia of exterior girders and all other inside girder surfaces shall be high gloss finish and color shall match Sherwin-Williams 7017, Dorian Gray 244-C3 (#ACA79E Hex Color Code). Outside fascia girders shall be high gloss finish and color shall match Sherwin-Williams 7061, Night Owl 237-C6 (#63655F Hex Color Code). If existing steel bridge structure contains outside fascia girder finish colors that are different than gray or green, then the Designer shall match this existing color as closely as possible. An example color on the Illinois Tollway system other than gray or green is the brown tone (Munsell 2.5YR 3/4) that is specific to the Elgin O'Hare corridor. Shop Painting is used exclusively for new structural steel, field painting of intermediate and finish coats is not allowed.

### 12.8 Weathering Steel

Weathering steel may be considered for Illinois Tollway structures over railroads and waterways. Weathering steel shall not be allowed for steel structures less than 8ft above the average streamflow elevation for stream crossing/running water or 10ft above normal pool elevations of stagnant water they cross. Locations where weathering steel cannot remain dry, such as near an expansion joint, shall be painted or metalized. Illinois Tollway approval is required during preliminary stages of design.

## 12.9 Metallizing Beam Ends

Beam ends under expansion joint shall consider metallizing in accordance with IDOT Bridge Manual Section 2.3.6.1. When metallized beam ends are used, applicable general notes from IDOT Bridge Manual Section 3.1.3 shall be included.

## SECTION 13.0 PRECAST PRESTRESSED CONCRETE (PPC)

### 13.1 General

The design and detailing of PPC I-Beams and Bulb-T beams shall be in accordance with the latest AASHTO LRFD Bridge Design Specification, Section 3.4 of the latest IDOT Bridge Manual, and IDOT ABD 24.4 except as herein modified. The name, version, and release date of software used shall be indicated as a general note in the plans.

### 13.2 Design

All IDOT I-Beams, Bulb-T beams and IL-Beams may be used on the Illinois Tollway. Other beam types may be considered but shall require a design deviation. The details in the Illinois Tollway Base Sheet M-BRG-517 shall be provided for all PPC beam structures.

The behavior of a skewed bridge is different than that of a square one. The differences are largely proportional to the skew angle. Structures with skews greater than 45 deg. shall be designed and/or checked using three-dimensional analysis to obtain a better assessment of skewed structure.

The prestressing strands used in PPC beam designs shall be either 0.5" or 0.6" diameter, low relaxation strands with areas of 0.153 or 0.217 square inches, respectively.

In the design of continuous composite PPC structures, the superimposed dead load, live load and impact stresses shall be computed on the basis of full continuity at the interior supports.

Strand debonding may be considered to reduce the stresses developed at beam ends. The locations of debonded strands shall adhere to the restrictions listed in the IDOT Bridge Manual Section 3.4.3, the IDOT Manual for Fabrication of Precast Prestressed Products 2020 with latest addendums and Article 5.9.4.3.3 of the latest Interims to the AASHTO LRFD Bridge Design Specifications.

The final compressive stress in the bottom flange of the PPC beams at piers for continuous designs shall be calculated at the strand load transfer point (assumed to be at the strand transfer length from the end of the beam) and the edge of bearing pad or diaphragm.

Vertical stirrups are required at the ends of all prestressed beams to resist 6% of the total initial prestressing force at 18 ksi located within a distance of  $\frac{1}{4}$  of the beam depth from the end of the beam. For 63-inch and 72-inch beams, the minimum stirrup reinforcement shall be 5 pairs of #6 bars.

#### 13.2.1 IDOT Beams

There are 4 I-Beams in 36, 42, 48 and 54 inches and 2 Bulb T-Beams in 63 and 72 inches. The 28-day concrete compressive strength for these prestressed beams shall be 6,000 psi and may be increased to a maximum of 7,000 psi. The higher strength, above 6,000 psi, shall be used only when economical. Concrete strengths at strand release shall be a minimum of 4,000 psi and a maximum of 5,200 psi. See IDOT Bridge Manual Section 3.4 and latest IDOT base sheets for details.

### 13.2.2 IDOT IL-Beams

There are 13 IL-Beams which come in 27, 36, 45, 54, 63, 72, 81 and 90 inches. These beams may be selected for use on Illinois Tollway bridges. See IDOT Bridge Manual Section 3.4 and latest IDOT base sheets for details.

### 13.2.3 PPC U-Beams

U-Beams may be considered for bridge sites that require longer spans, curved alignments, reduced number of girders and piers, aesthetic appearance, fast fabrication and easy maintenance. Shipping and picking weights, transportation route, temporary supports, and other site-specific constraints are some important considerations when using U-Beams. Post-tensioned Spliced U-Beams can be a viable option compared to segmental construction. No specialty contractor, fabricator or equipment is required, fewer splices are needed, they provide better redundancy with multiple webs, and standard girder shapes and non-integral decks can be used. The design and detailing of PPC U-Beams shall be in accordance with the latest AASHTO LRFD Bridge Design Specifications. Both Pre-tensioned and Post-tensioned PPC U-Beams are allowed on the Illinois Tollway System. Three Pre-tensioned (48-inch, 60-inch or 72-inch depths) and Two Post-tensioned Spliced (72-inch or 84-inch) sections can be used.

Refer to Illinois Tollway Special Provisions for Design and Erection of U-Beams, Addendum to Manual for Fabrication of Precast Prestressed Concrete Products and Illinois Tollway Base Sheets M-BRG-522, M-BRG-523 and M-BRG-524 for details.

## 13.3 Details

At all piers supporting continuous spans for beams other than IL-Beams, a minimum of two #8 bars for I-Beams and three #8 bars for Bulb-T beams shall be added to the bottom flange, projecting beyond the beam end in accordance with the details shown in Section 3.4 of the latest IDOT Bridge Manual and base sheets. For IL-Beams, minimum prestressing strands shall extend beyond the beam end at piers per IDOT Bridge Manual Section 3.4.9. See the latest IDOT and Illinois Tollway Base Sheets.

When beams exceed 100 feet in length, the Designer shall verify that a precaster, certified by the Precast/Prestressed Concrete Institute (PCI) will be capable of fabricating and transporting the beams to the bridge site within the project schedule.

When beams are used for spans in excess of 120 feet, calculations shall be provided for the lateral stability of the beams during shipping, handling, and erection and shall be submitted to the Engineer for approval. The calculations shall be sealed and signed by an Illinois Licensed Structural Engineer.

## 13.4 Table of Moments and Shears

To provide ready information for any future analysis of a structure and to provide the reviewing agencies with a basis for checking of the design, all detailed bridge plans shall include a Table of Moments and Shears. See Section 3.1.12 and Figure 3.1.12.2-3 of latest IDOT Bridge Manual for an example of a moment and shear table for PPC I-Beams. Bridges utilizing a 72" barrier with noise abatement wall shall include the distribution used for the exterior beams and typical interior beams as addition information included within the plans.

## 13.5 Superstructure Diaphragms

### 13.5.1 Abutment (End) Diaphragms

End Diaphragms at expansion abutments shall consist of a thickened deck slab as shown on the latest IDOT Base Sheets.

End Diaphragms at integral abutments shall be as shown on the latest IDOT Base Sheets.

### 13.5.2 Pier Diaphragms

Fixed piers shall be attached to the superstructure by full-depth diaphragms using the details shown in the latest IDOT Base Sheets. Expansion piers shall be separated from the superstructure by partial depth diaphragms and expansion bearings as shown in the latest IDOT Base Sheets.

Double expansion piers shall be separated from the superstructure by thickening the deck slab on each side of the joint as shown in the latest IDOT Base Sheet.

The design of diaphragms at expansion joints shall include provisions to allow jacking on the diaphragms to lift the beam ends for resetting, repair or replacement of bearings. If jacking cannot be done on the end diaphragms, provisions shall be made in the design of the beam seat to allow jacking from directly under the beam. The jacking loads and their locations shall be shown on the drawings. The jacking loads shall be broken down into dead and live load components so the Contractor has the option of jacking with or without the live load on the structure.

## 13.6 Handling, Storage and Transportation of Beams

All handling, storage and transportation of PPC Beams shall be in accordance with the latest version of the IDOT Manual for Fabrication of Precast Prestressed Concrete Products, Section 3.6, except as herein modified. All designers shall include these provisions in the contract documents.

All PPC I-Beams, Bulb T-Beams, and IL-Beams may ship to the job site once the specified strength has been attained. In addition, "G6" hook bars are provided at the beam ends made continuous over piers using a cast-in-place concrete diaphragm. These requirements are intended to mitigate the loss of contact between the bottom flange of the beams and the diaphragm over the pier as well as other design and construction problems caused by beam creep, shrinkage, shortening and camber.

For PPC Beams on multi-span, continuous structures (beams with G6 bars), the casting of the deck and continuity diaphragm shall not occur prior to 45 calendar days after casting of the youngest beam. At structures with beams exceeding 100 feet in length and supported on bearing assemblies, the beams may be placed on bearings upon delivery, but the bearings shall be reset after the 45<sup>th</sup> calendar day after beam casting. Repositioning of the beams on the bearings or resetting of bearings after the 45<sup>th</sup> calendar day shall be at the Contractor's expense at no additional cost to the Illinois Tollway.

## 13.7 Spliced Girders

### 13.7.1 Introduction

A Spliced Girder is precast prestressed or post-tensioned concrete, fabricated in several long girder segments that are assembled into a single girder in the final bridge structure. Spliced Precast Girders are either conventional Bulb-T or PPC U-Beam shapes that are extended to the 160 to 300-foot span range. Spliced girders have been used to extend spans and/or reduce construction depth.

Spliced girders use constant depth or haunched sections, or a combination of the two, to achieve the spans necessary to satisfy design requirements.

While considering this bridge type in the Bridge Type Study prior to TS&L preparation, designers shall survey fabricators to determine if there is capability to fabricate the beams effectively with regard to cost and that the beams can be shipped to the project site.

### 13.7.2 Design

The design shall include evaluation of the time dependent effects of creep, shrinkage and relaxation on moments, shears and deflections and the effects of sequential construction steps. The method of construction assumed for the design shall be shown in the contract documents. All supports required prior to the splicing of the girder shall be shown on the contract documents, including elevations and reactions. The stage of construction during which the temporary supports are removed shall also be shown on the contract documents. Spliced girders shall not be considered as segmental construction for the purpose of design.

The design shall meet the requirements of the latest AASHTO LRFD Bridge Design Specifications. Other sources of design assistance are:

- The latest edition of the Precast/Prestressed Concrete Institute (PCI) Bridge Manual
- The latest edition of the Post-Tensioning Institute Post-Tensioning Manual
- The latest Florida Department of Transportation (FDOT) Specifications for the Design and Construction of Spliced I-Girder Bridges
- National Cooperative Highway Research Program (NCHRP) Report 517, "Extending Span Ranges of Precast Prestressed Concrete Girders"

### 13.7.3 Splices and Splice Locations

Splices shall meet both serviceability and strength requirements.

### 13.7.4 Pretension Strand Size and Strength

Strands shall not have an area greater than 0.217 square inches, which corresponds to a 0.6-inch diameter and ultimate strength of 270 ksi.

### 13.7.5 Tendon Layout

The vertical alignment of post-tensioning tendons, if provided, shall be kept as simple as possible. The ducts shall be centered in the web.

### **13.7.6 Camber and Geometry Control**

Vertical alignment control is achieved by chording the individual segments between splices and supports as required to compensate for short- and long-term deflections and to achieve the required vertical geometry. Fillets shall vary, and minimum fillets shall be provided as for standard girder structures. All minimum fillet requirements shall be met along the entire width of the top flange of the girder, not only at centerline. The Designer must take into consideration cross slope effect on the fillet variance. Fillet weights shall be accounted for in design. The camber and deflection diagram shown in base sheet M-BRG-517 shall be shown on the plans. Initial camber shall also be included.

### **13.7.7 Creep Redistributions of Forces and Moments**

Creep is the continued shortening of concrete members subjected to permanent compressive forces starting with the application of the prestress load and continuing for up to 30 years after. These effects shall be accounted for in the design.

### **13.7.8 Elastic Shortening Losses**

These losses occur when prestressing and post-tensioning forces compress and thus shorten the concrete member and consequently decrease the forces in them. These losses shall be accounted for in the calculation of prestressing forces. However, the reverse occurs as well and the increase in prestressing forces because of these gains shall also be accounted for.

### **13.7.9 Live Load Deflections**

Live load deflections shall be according to Article 5.1.

### **13.7.10 Diaphragms**

Permanent concrete diaphragms shall be provided at abutments, piers and splices. Temporary steel diaphragms shall be provided for stability of the beams during construction

## SECTION 14.0 BEARINGS

### 14.1 General

Bearings shall be designed and detailed in accordance with Section 3.7 of the latest IDOT Bridge Manual except as amended herein. Only High Load Multi-Rotational (HLMR), elastomeric, low profile steel rocker bearings (fixed) and rocker plates are acceptable types. Sliding plate bearings shall not be used.

Elastomeric bearings are generally used with precast prestressed concrete (PPC) beam and steel beam or girder spans having moderate load and movement requirements. Elastomeric bearing assemblies are divided into three types according to the expansion lengths which they will accommodate.

Low profile rocker bearings shall be used as fixed bearings to support PPC beams at fixed piers or fixed abutments with joints and in single span structures with semi-integral abutments. See the latest IDOT Base Sheets and IDOT Bridge Manual Figure 3.7.1.2-3.

Only fabric or unreinforced elastomeric pads shall be used to support PPC beams at integral abutments.

Low profile rocker bearings shall be used as fixed bearings in combination with elastomeric Types I, II and III expansion bearings to support steel spans. See Figure 3.7.1.2-1 in the latest IDOT Bridge Manual for details.

Rocker plates shall be used to support steel beams or girders at integral abutments. See Figure 3.7.1.2-2 in the latest IDOT Bridge Manual for details.

Only HLMR bearings shall be used to support concrete (segmental or CIP box girders) or steel structures on curved alignments. They may also be used for concrete or steel structures on tangent alignments with high dead load reactions and skew angles and expansion lengths greater than 40° and 450 ft., respectively.

On steel bridge widening projects where the new deck is structurally tied to the existing deck and the extended substructure is discontinuous, the bearings for the new beams or girders resting on the discontinuous portion of the substructure shall be of the HLMR bearing type.

A detail showing the centerline of the bearing over the centerline of the substructure unit and the orientation of the bearing for erection temperatures above and below 50 degrees Fahrenheit shall be provided on the plans.

### 14.2 Design

Elastomeric and low-profile steel rocker bearings including anchor bolts and pintels shall be designed and detailed in accordance with Section 3.7 of the latest IDOT Bridge Manual. HLMR bearings shall be designed and detailed by the Designer in accordance with Section 3.7.5 of the latest IDOT Bridge Manual. Inverted Pot Bearings shall not be used.



### 14.2.1 Elastomeric Bearings

When designing elastomeric bearings, the procedures described and detailed in the IDOT Bridge Manual shall be used. The AASHTO Method B procedure is cost prohibitive for typical Illinois Tollway bridges given the lengthier design procedure and the extensive testing required to verify this bearing design. The current testing requirements in the IDOT Standard Specifications are not sufficient to ensure an acceptable bearing designed by AASHTO Method B.

Pintels and sole plates bonded to elastomeric bearings shall be Type 304 stainless steel conforming to the requirements of ASTM A666 when under an expansion joint. Pintels and sole plates bonded to elastomeric bearings not under an expansion joint shall be galvanized in accordance with AASHTO M232 (ASTM A153) and AASHTO M111 (ASTM A123) respectively. Bearing plates and shear studs embedded in PPC beams shall conform to the requirements of AASHTO M270 (Grade 36) and Article 1006.32 of the latest IDOT Standard Specifications. The shear studs shall be hot dipped galvanized after fabrication, in accordance with AASHTO M232 (ASTM A153).

Masonry and side retainer plates or equivalent rolled shapes shall conform to the requirements of AASHTO M270 (Grade 36). Side retainers and masonry plates shall be hot dipped galvanized after fabrication in accordance with AASHTO M111 (ASTM A123) and anchors per AASHTO M232 (ASTM A153).

### 14.2.2 Low Profile Steel Rocker Bearings (Fixed Only)

Pintels, plates and rolled shapes shall conform to the requirements of AASHTO M270 (Grade 50). Rocker bearings including sole plates and masonry plates shall be hot dipped galvanized after fabrication in accordance with AASHTO M111 (ASTM A123). All bolts and washers shall be hot dipped galvanized after fabrication in accordance with AASHTO M232 (ASTM A153).

### 14.2.3 High Load Multi-Rotational Bearings

All bearing plates and rolled shapes shall conform to the requirements of AASHTO M270 (Grade 50). Prior to shipment, the exposed edges and other exposed portions of the structural steel bearing plates shall be cleaned and painted in accordance with Section 506 of the IDOT Standard Specifications. Painting shall be with the paint specified for shop painting of structural steel. During cleaning and painting, the stainless steel, TFE sheet and neoprene shall be protected from abrasion and paint.

It is the designer's responsibility to also verify the HLMR bearing dimensions and geometry with producers who are approved by IDOT to provide bearings. The overall bearing height and plate thicknesses stated on the Contract Plans shall be chosen such that more than one producer is capable of bidding on the project. Design and detailing shall be per the latest IDOT Base Sheets and Section 3.7.5 of the latest IDOT Bridge Manual.

## SECTION 15.0 CONCRETE BRIDGE DECKS, PARAPETS AND BARRIERS

### 15.1 New and Replacement Decks

Cast-in-place reinforced concrete decks supported on beams or girders shall be designed in accordance with the latest AASHTO LRFD Bridge Design Specifications, Section 3.2 of the latest IDOT Bridge Manual except as herein modified. The slab thickness shall be 8 inches for new and replacement bridges. Deck width requirements shall be in accordance with Article 5.4.

On bridge replacement or full deck replacement projects for mainline bridges and flyover ramps under the Illinois Tollway jurisdiction that provide direct access to the Illinois Tollway, concrete type shall be determined in accordance with the following policy:

- HP Concrete,  $f'_c=4,000$  psi min. shall be used for bridge decks and diaphragms.
- IDOT Class BS Concrete,  $f'_c=4,000$  psi min. shall be used for bridge parapets and barriers.

Smoothness and grinding criteria shall be considered for new concrete decks, slabs, or new concrete overlays. Mainline bridges and ramps shall have longitudinal grooving when bridge lengths are greater than 150ft and ADT greater than 10,000 and shall follow the criteria set forth in IDOT Bridge Manual Section 2.3.7.8. Mainline bridges may consider using longitudinal grooving, regardless of bridge length or ADT, and shall be considered on a case-by-case basis.

Cross Road Bridge deck thickness, deck geometry and material property will depend on the Inter-Governmental Agreement (IGA). The above specified conditions shall be used if ownership of the bridge deck is under Illinois Tollway's jurisdiction.

### 15.2 Existing Deck Widening and Repairs

For widenings, partial replacements or repairs of existing decks, the deck thickness shall match the existing deck thickness. The top reinforcement bars in the new deck portion shall be placed at the same level as the existing deck bars. The proposed deck widenings shall be designed using the design specifications used for the existing deck in accordance with Section 3.2 of the latest IDOT Bridge Manual. Full bar lap splice shall be provided between the old and new reinforcement bars at the longitudinal construction joint. When the length of the existing reinforcement projecting beyond the construction joint is insufficient to develop a full lap splice, the mechanical splice detail shown in Figure 15.2.1 shall be included in the plans.

When overlaying an existing bridge deck, scuppers shall be adjusted to match the new top of overlay elevations.

Partial depth deck removal and replacement is considered to retain original design capacities. Thus, in both the longitudinal and transverse direction the new concrete patch is considered to act compositely with the remaining deck and no reduction in deck live load capacity is considered. Additionally, an increase in wearing surface thickness above the original thickness of the deck is not considered to increase capacity in either the transverse or longitudinal direction. In the longitudinal direction the live load capacity of supporting members shall be reduced by the dead load from the additional overlay thickness.

## 15.3 Cross Slopes

### 15.3.1 Tangent Sections

#### 15.3.1.1 New, Replacement and Widened Decks

The cross slopes of new, replacement and widened decks shall match that of the approach roadway and/or shoulders. A Design Deviation is required for cross slopes not matching the approach roadway and shoulders.

#### 15.3.1.2 Overlays

For bridges on tangent sections, the cross slopes of the proposed bridge deck overlay, shall match the existing cross slopes; however, the capacity of the existing beams or girders shall be checked. For bridges carrying Illinois Tollway traffic that do not have adequate capacity to carry the IL-120 Design Truck at Inventory Level and for other bridges that do not have adequate capacity to carry the AASHTO Design Loading at Operating Level, the following criteria shall be followed:

- For longitudinal grades of 0.3% or less, the minimum cross slope required shall be 1.5% for all lanes.
- For longitudinal grades between 0.3% and 1%, a minimum cross slope of 1% for each lane immediately adjacent to the crown line is acceptable, although not desirable. A minimum cross slope of 1.5% is still required for all other lanes.
- For longitudinal grades greater than 1%, a minimum cross slope of 1% is acceptable for all lanes, although 1.5% is desirable.
- Maximum cross slope for traveled lanes shall be 2.5% and for shoulders shall be 4%.

These criteria apply only to bridge deck overlays and their purpose is to minimize the overlay thickness, while providing a reasonably smooth surface with adequate ability to drain for the safety as well as the comfort of the traveling public. The transition to these cross slopes shall be completed on the roadway, transition slab and roadway shoulder, not on the bridge deck or approach slab.

### 15.3.2 Superelevated Sections

Superelevation Transitions shall not be located on bridges and approach slabs. See Article 6.3.7.

#### 15.3.2.1 New and Replacement Decks

When a superelevated horizontal curve is located within the limits of a bridge and its approach slabs, the bridge deck and approaches shall be sloped at a constant rate. The approach slab and bridge deck shall be planar. The transition in the approach shoulder break shall occur in the transition slab and roadway shoulders at no greater than a 0.5% relative gradient.

#### 15.3.2.2 Deck Widening and Overlays

For bridges on superelevated sections, the minimum cross slope required for deck sections shall equal the original design superelevation rate unless the deck is to be replaced.

The procedure for Preparing Profile Worksheets for Bridge Deck Overlays and approach pavement profile transitions is detailed in Article 18.2. See Article 15.3.1.2 for additional requirements for overlays.

## 15.4 Reinforcement Bars

The top and bottom longitudinal and transverse bars shall not be lapped at the same locations in the deck, except at staged construction joints. Transverse bars shall be lapped at the locations shown in Figure 15.4.1.

On PPC structures made continuous for live load and superimposed dead loads, the additional longitudinal reinforcement bars over the piers shall be designed and checked for fatigue in accordance with the latest AASHTO Specifications and IDOT Bridge Manual. These are the only deck reinforcement bars that need to be checked for fatigue. The additional longitudinal reinforcement shall be placed in the top and bottom of the deck between the #5 bars over the piers for the full width of the superstructure including portions of the deck under parapets, sidewalks, raised medians and median barriers.

Two minimum bar lengths are required for these additional bars; the shorter bars shall be 80% or less of the longer bar. This staggering of bars will help minimize transverse cracking at bar terminations.

Unless otherwise directed by the Illinois Tollway, the top and bottom mat of reinforcement in the bridge deck, all the reinforcement in concrete bridge barriers, diaphragms and substructure elements located directly below an expansion joint (i.e., pier caps, abutment backwall and abutment caps) shall be designed using stainless steel reinforcement providing a design life of 100 years for the following types of bridges:

- Bridges with superstructure types that prohibit deck replacement
- Any individual bridge with a construction cost exceeding \$25 million
- Bridges over navigable waterways or protected wetlands sensitive to environmental impact from construction activity
- Bridges located over railroads where access and right of way restrictions exist.

Specifications for stainless steel reinforcement are available from the Illinois Tollway. Standard bar laps and development lengths for uncoated black reinforcement bars shall be used for stainless steel reinforcement.

For structures not noted above, life cycle cost analysis (LCCA) is required with the use of stainless-steel reinforcement subjected to the approval of the Illinois Tollway. Stainless steel reinforcement bars are limited in use to bridge decks, parapet walls and beam end diaphragms. The rest of the structure shall use epoxy coated rebar. Stainless steel reinforcement bars shall not be considered for cross road bridge structures.

## 15.5 Parapets and Barriers

### 15.5.1 Parapets and Barriers on Structures

The 44" Constant-Slope shoulder and median barrier sections shall be used on all new, reconstructed or rehabilitated structures (deck replacement or superstructure widening) carrying Illinois Tollway mainline and ramp traffic. Cross roads and all other structures shall be per jurisdictional agency's requirements. If the jurisdictional agency has no requirements, 44" Constant-Slope shoulder and median barrier sections shall be used. For barriers where Noise Abatement Wall is attached to structure refer to Articles 22.14, 23.2.2 and 23.5.1.

For bridge overlays, a minimum barrier height of 42" shall be maintained for all Illinois Tollway bridges. If the overlay results in a barrier height less than 42" high, the barrier shall be extended,

a minimum of 4", to provide a height of no less than 42". Adequacy of the existing parapets and decks shall be checked for AASHTO TL-4 impact loading unless originally designed for TL-5 then it should be checked for TL-5. Inadequate parapets and decks shall require rehabilitation/replacement.

For cross road bridges with overlay, the minimum barrier height shall be 36" for TL-4 or 42" for TL-5. If the overlay results in a barrier height less than 36" (TL-4) or 42" (TL-5), the barrier shall be extended, a minimum of 4", to provide a height of no less than 36" (TL-4) or 42" (TL-5). Adequacy of the existing parapets and decks shall be checked for AASHTO TL-4 or TL-5 impact loading. Inadequate parapets and decks shall require rehabilitation/replacement.

The tops of back-to-back median barriers shall be constructed as shown in Figure 15.5.1.2 for the 44" Constant-Slope Median Barrier for differences in vertical elevations of the individual decks at the centerline of the Illinois Tollway. Also, see Figure 15.5.1.1 for 44" Constant-Slope Median Barrier Details when there is no elevation difference.

When a raised median curb is required on structure, the shape of the curb face, the height and the overall width are to match those of the approach roadway.

Reinforcement for parapets and barriers on new, reconstructed or rehabilitated (deck replacement or superstructure widening) structures carrying Illinois Tollway traffic or over Illinois Tollway traffic shall meet the requirements of the AASHTO LRFD Bridge Design Specifications for TL-5 vehicle impact loading. These details shall be used for all 44" barrier walls and parapets mounted on moment slabs, approach slabs and bridge decks carrying Illinois Tollway traffic. Impact loading requirements for bridges not carrying or over Illinois Tollway traffic shall be coordinated with the agency responsible for the roadway.

The following revisions shall replace the provisions of IDOT Bridge Manual Figure 3.2.4-5.

- The 8" spacing of the #5 front face vertical reinforcement bars shall be reduced to 7".

The Designer shall also verify the bridge slab and approach slab capacity at the junction with the parapet and barrier wall.

Although these design details are governed by end impact, at parapet ends and joints, these revisions apply to the full length of the 44" parapet and barrier wall. See Figure 15.5.1.3. 1/8" aluminum parapet joints required at piers, abutments and other locations specified in the latest edition of the IDOT Bridge Manual shall be detailed according to Figure 15.5.1.4. Provide 1/2" interior joints at 14-foot minimum to 20-foot maximum for the 44" parapet as shown in Figure 15.5.1.4. Sawed interior joints shall only be used for the 44" parapet when slipforming is allowed.

### 15.5.2 Structure Mounted Noise Abatement Wall Barrier

Structure mounted noise abatement walls attached to barriers shall use the 72" barrier detailed in Figure 15.5.1.5. Loading is based on NCHRP Report 22-20(2). The following criteria shall be used:

Design Loads for TL-5 Barrier	
Rail Height, H (in.)	72
$F_t$ Transverse (kips)	260
$F_L$ Longitudinal (kips)	75
$F_v$ Vertical (kips)	80
$L_L$ and $L_t$ (ft)	10
$L_v$ (ft)	40
$H_e$ (in)	52
$F_s$ (kips)	106
$W_{min}$ (ft)	12

Where terms are defined as follows:

- H = Rail Height (72")
- $F_t$  = Transverse force assumed to be acting at distance  $H_e$
- $F_L$  = Longitudinal friction force along the barrier
- $F_v$  = Vertical force of vehicle laying on top of the barrier
- $L_t$  = Longitudinal length of distribution of impact force  $F_t$
- $L_L$  = Longitudinal length of distribution of friction force  $F_L$
- $L_v$  = Longitudinal distribution of vertical force  $F_v$  on top of the barrier
- $H_e$  = Height of impact force applied to the barrier above pavement
- $F_s$  = Equivalent static load
- $W_{min}$  = Minimum width of the moment slab

Reinforcement located within 15ft of a full height joint shall use #6 d1 and d2 bars. Minimum spacing of full height joints shall be 11'-3" for end region reinforcing, otherwise the barrier shall be designed as a cantilever section. Interior regions, not located near a full height joint, may use #5 d1 and d2 bars. Minimum spacing between joints using interior region reinforcing shall be 22ft but not exceed 30ft. Intermediate joints, which do not extend the full height, shall be detailed as shown in Figure 15.5.1.8. Expansion joints shall not be located within 6 feet from centerline of a light pole, and interior joints 4'-9". Noise abatement wall posts shall be located in accordance with Figure 15.5.1.6.

### 15.5.3 Roadside Barriers

All rigid roadside barriers, 54" or less in height, adjacent to an Illinois Tollway roadway and not located on a structure (bridge or retaining wall) shall be designed to meet the AASHTO LRFD Bridge Design Specifications for TL-4 impact loading, or TL-5 loading as described herein. Rigid roadside barriers used to shield drop-offs and, when necessary (structurally independent barrier), to protect bridge elements which support the bridge superstructure (such as an existing bridge pier), shall be designed to meet the AASHTO LRFD Bridge Design Specifications for TL-5 impact loading. Bridge wing walls, retaining walls, MSE walls in front of pile supported abutments and noise abatement walls are considered elements which do not support the bridge superstructure and therefore do not require a TL-5 barrier, however, may require a barrier as part of a barrier



warrant analysis. See Illinois Tollway Standard Drawing C3 for TL-4 barrier and C15, C16 and C17 for TL-5 barriers. Note that the minimum installation length for single face Reinforced Concrete Barrier is 25' for TL-4 barriers and 40' for TL-5 barriers. If a shorter installation or different configuration is needed, the Designer shall design the barrier for appropriate impact loading by varying the footing size and/or the reinforcement. The same design methodology shall be used as outlined in Article 22.14. The magnitude of Equivalent Static Force used to check for sliding and overturning shall be 10 kips for TL-4 and 23 kips for TL-5.

The details shown in Illinois Tollway Standard Drawing C3, C15, C16 and C17 can be used with or without fill material behind the barrier. The use of single face barrier wall along a shoulder taper shall be as shown in the Illinois Tollway Traffic Barrier Guidelines.

## 15.6 Longitudinal Joints

When the distance between the fascia girders exceeds 90 feet, the deck shall be split with an open joint. The joint may be located in parapet sections or in a raised median. Joints in a raised median curb shall be sealed using a 1-3/4-inch preformed joint seal. The open joint is not required if the deck is staged and the total width of the staged pours is less than or equal to 120 feet.

The Illinois Tollway prefers not to utilize open or sealed longitudinal joints unless they are located along the center line of the main line between the median barriers on each side of the joint. Details of a sealed joint are shown on Figure 15.6.1.

Longitudinal construction joints between the edges of shoulders shall not be used unless they fall on a lane line and are located at a distance greater than  $\frac{1}{4}$  of the beam spacing from the centerline of any beam (within the middle half of the beam spacing).

## 15.7 Bridge Mounted Lighting

The Designer shall identify the location and size of all embedded conduits, expansion fittings and junction boxes on the structural drawings and reference the roadway electrical drawings for details.

Shoulder and median mounted light pole details for the 44" Constant-Slope barrier are shown in Figures 15.7.1 through 15.7.7. Details for the 72" barrier are shown in Figure 15.7.8.

## 15.8 Slipform Parapet

Slipforming may be used to construct the parapets shown in plans. Slipforming shall be done in accordance with the latest IDOT Guide Bridge Special Provision #61, Base Sheet SFP 39-44 and Section 3.2.4.2 of the latest IDOT Bridge Manual. If one of the conditions from Section 3.2.4.2 which would exclude slipforming is met, a note shall be added to the plans indicating that slipforming of the parapet is not permitted. Slipforming is not allowed for the 72" barrier.

## 15.9 Deck Pouring Sequence

A deck pouring sequence shall be provided in the Contract plans for all new and existing steel superstructures on curved alignments and those with continuous or simple span lengths of 150 feet or greater. The same shall be provided for tangent steel superstructures with a skew angle greater than 40 degrees, regardless of the type of span or length. In addition, the concrete for the bridge deck shall be placed parallel to the skew when it is greater than 40 degrees.

Special care shall be taken when construction staging reduces the width of the pour in relation to span length and/or the number of beams or girders to three or less. In the initial stage, the superstructure framing shall be checked for stability and out of plane displacements and rotation.

Required pouring sequences shall consider the impacts to the project schedule and the design project schedule shall include the time required to comply with the required pouring sequences shown on the plans. Wherever possible the number of required pours shall be minimized to allow the Contractor to complete deck pours in a minimal amount of time and avoid waiting 72 hours between pours. The numbering of the pouring sequence sections shall be duplicated whenever possible rather than using separate numbers for each segment. For example, all positive moment pours could be one (1) and all negative pours could be two (2). Reasonable production rates in the bridge area for deck pours shall be considered.

See Article 7.1.3 for the note to be included in the plans.

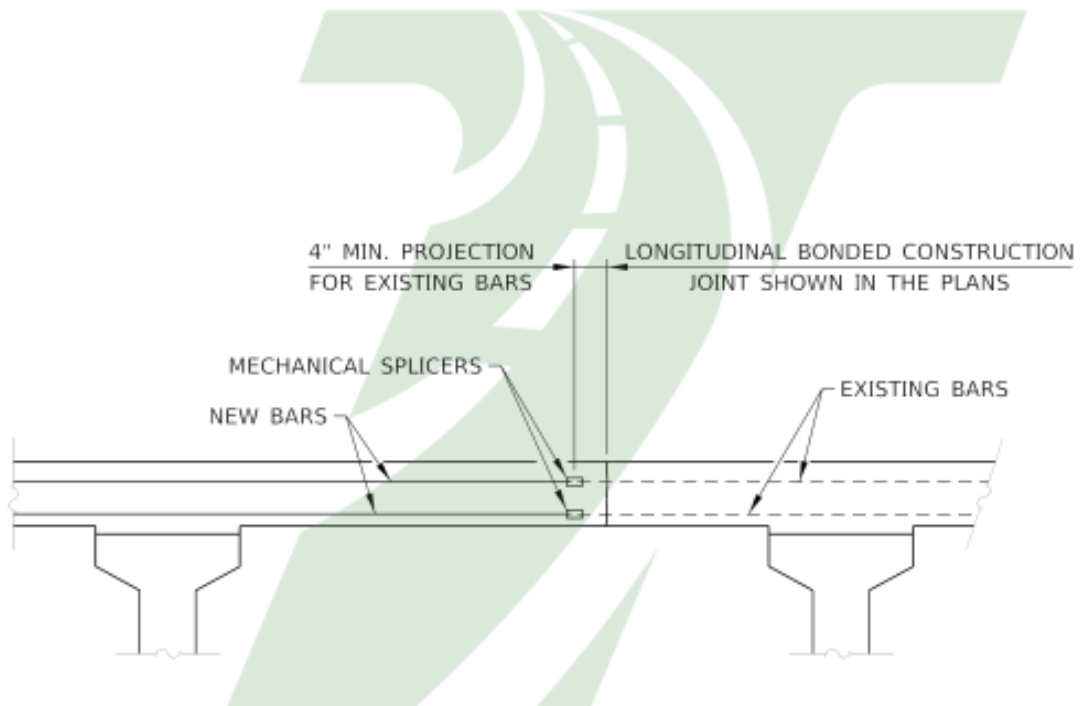
### **15.10 Closure Pour**

On stage constructed bridges where the differential deflection between adjacent stages is 2" or greater, and it is not feasible or economical to use a deeper or stiffer beam or girder section, a closure pour shall be considered. Closure pours will be considered by the Illinois Tollway on a case-by-case basis.

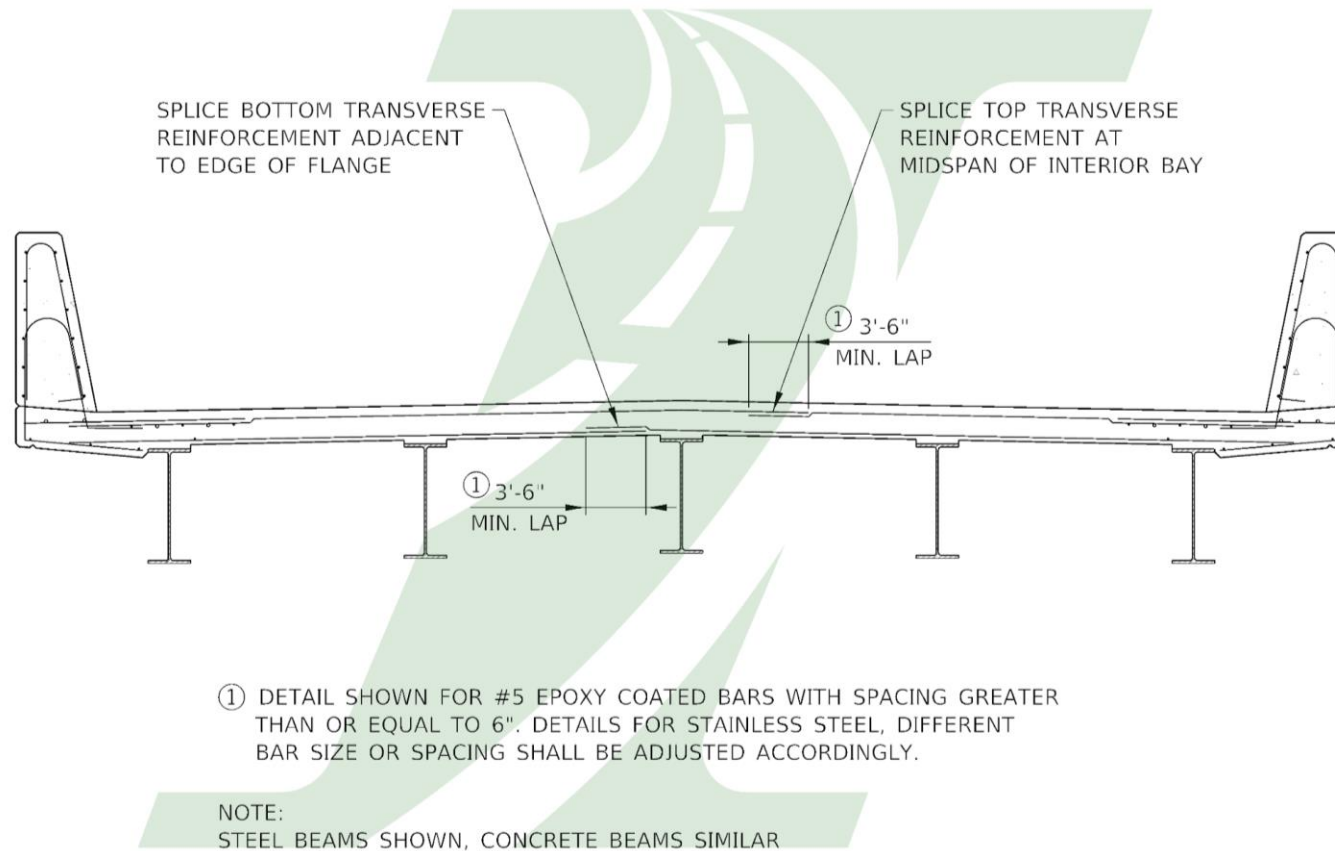
### **15.11 Bridge Deck Overhang**

Bridge deck overhang for 72 in barrier with structure mounted noise abatement wall shall be limited as shown in Figure 15.5.1.5. Minimum deck thickness at the exterior beam shall be 11.5 in. Additional #8 bars shall be used in the overhang for all locations within 15ft of a full height joint in the barrier. These bars may be reduced to #7 bars provided the area of steel for top transverse bars in the deck are a minimum 1.15 sq. in. for maximum overhang limits or 0.86 sq. in. for a minimum overhang limit. Similarly, #6 bars may be used provided the top transverse bars in the deck are a minimum 1.5 sq. in. for maximum overhang limits or 1.23 sq. in. for a minimum overhang limit. All interior regions, not located near a full height joint, may use #6 bar.

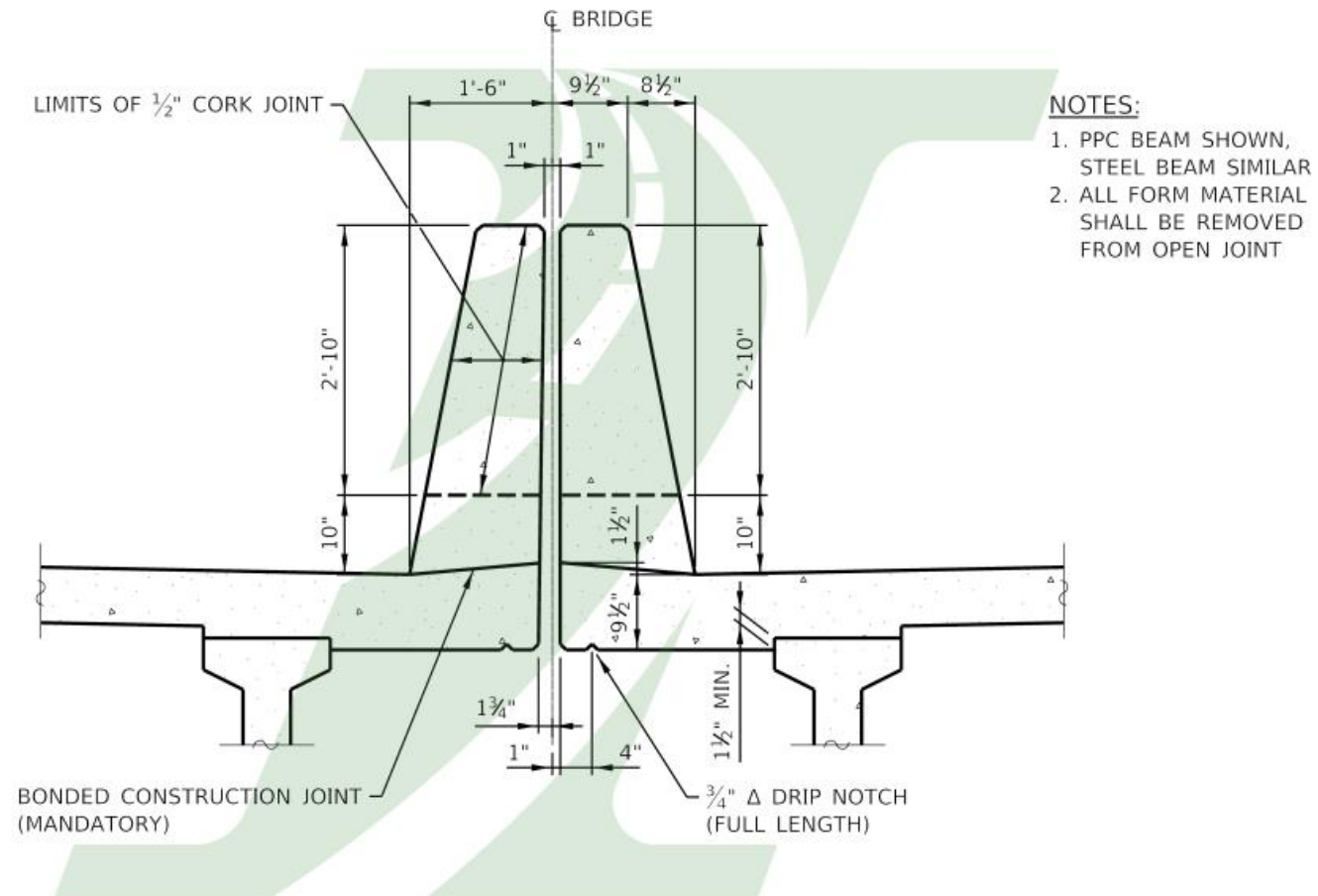




**Figure 15.2.1: Mechanical Splice Detail**



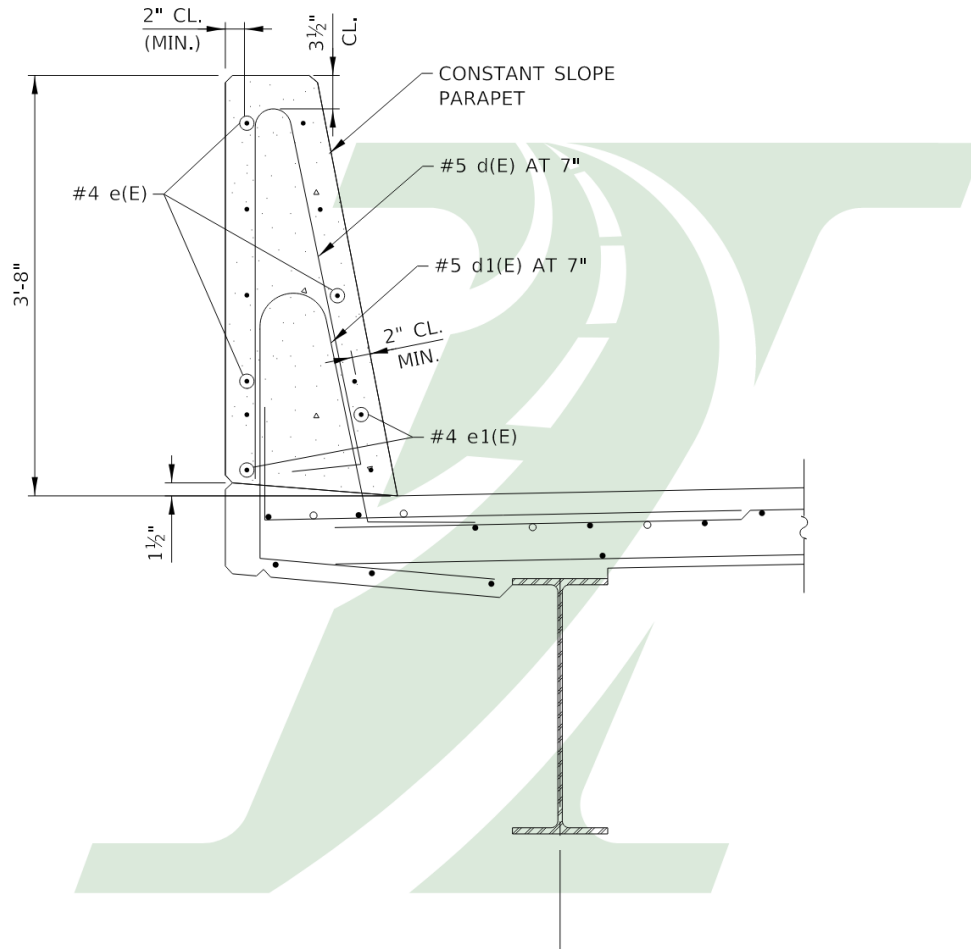
**Figure 15.4.1: Reinforcement Splice Detail**



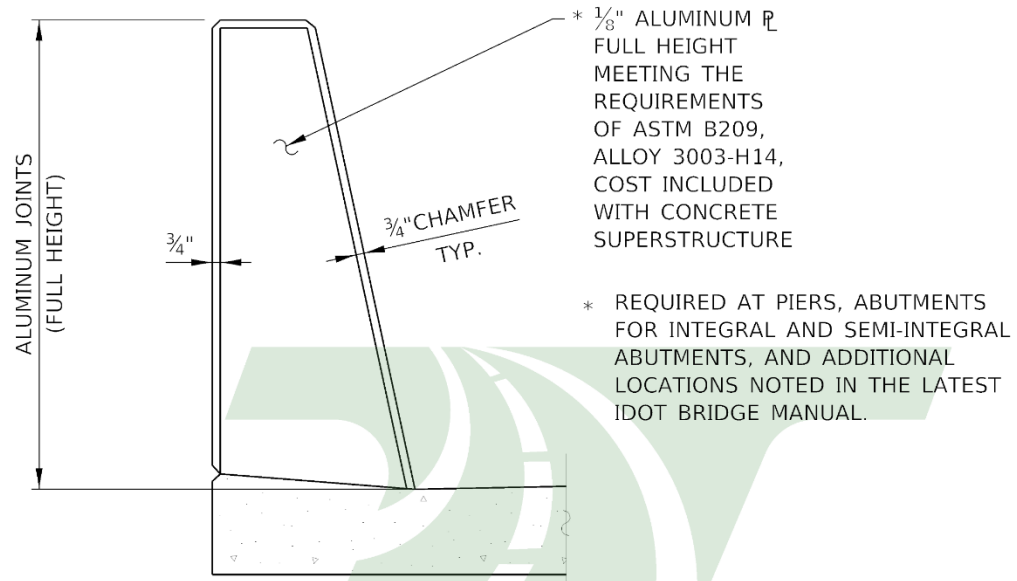
**CONSTANT SLOPE MEDIAN BARRIER DETAILS**  
(NO ELEVATION DIFFERENCE)

**Figure 15.5.1.1: Constant Slope Median Barrier Details – No Elevation Difference**

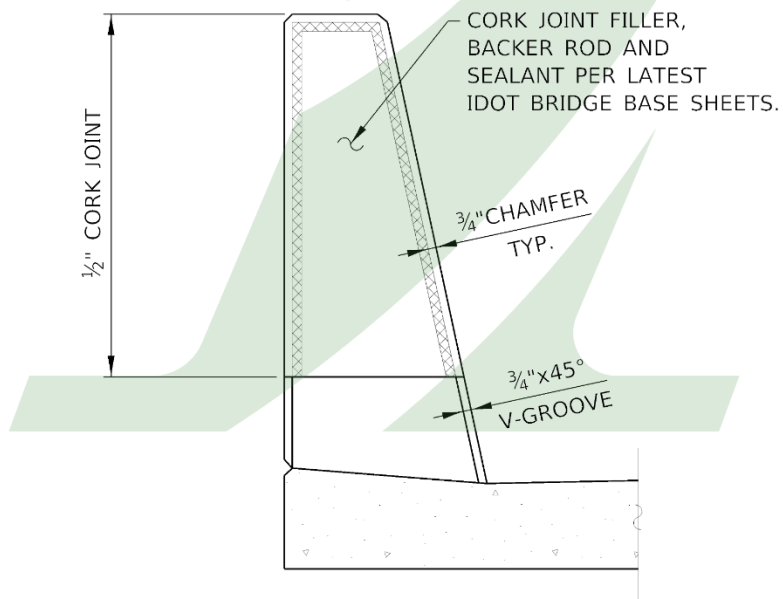




**Figure 15.5.1.3: Parapet Reinforcement**

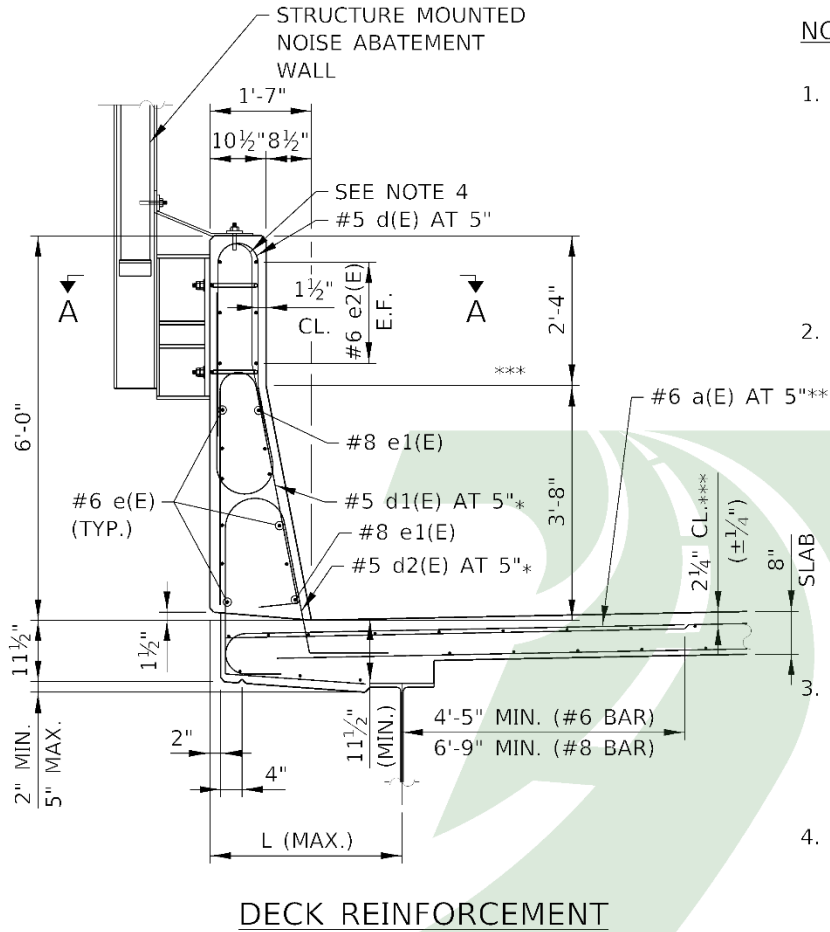


ALUMINUM JOINT DETAIL



PARTIAL HEIGHT JOINT DETAIL

**Figure 15.5.1.4: Parapet Joint Details**



#### NOTES:

1. TYPICAL DETAIL SHOWN IS FOR INTERIOR SECTIONS LOCATED MORE THAN 15FT FROM EXPANSION JOINTS. FOR END REGIONS MAKE MODIFICATIONS AS INDICATED HEREIN.
2. DETAILS IN THIS FIGURE ARE APPLICABLE WHERE NOISE ABATEMENT WALL IS WARRANTED FOR NEW STRUCTURES AND BRIDGE RECONSTRUCTION. DETAILS SHALL BE CONSIDERED FOR DECK REPLACEMENT OR SUPERSTRUCTURE WIDENING ON A CASE BY CASE BASIS WHERE FEASIBLE.
3. FOR FLANGE SIZES LESS THAN 20", LIMIT THE ADJACENT BEAM SPACE TO TWICE THE OVERHANG LENGTH.
4. USE 7 - d3(E) BARS AT POST CONNECTION ONLY. SEE FIGURE 15.5.1.6 FOR SECTION A-A AT NOISE ABATEMENT WALL CONNECTION.

\* WITHIN 15 FOOT OF A FULL HEIGHT JOINT USE #6 AT 5" SPACING.  
 \*\* WITHIN 15 FOOT OF A FULL HEIGHT JOINT USE #8 AT 5" SPACING.  
 BAR SIZE MAY BE REDUCED, SEE ARTICLE 15.11.  
 \*\*\* INCREASE TO 2 1/2" FOR SMOOTHNESS GRINDING.

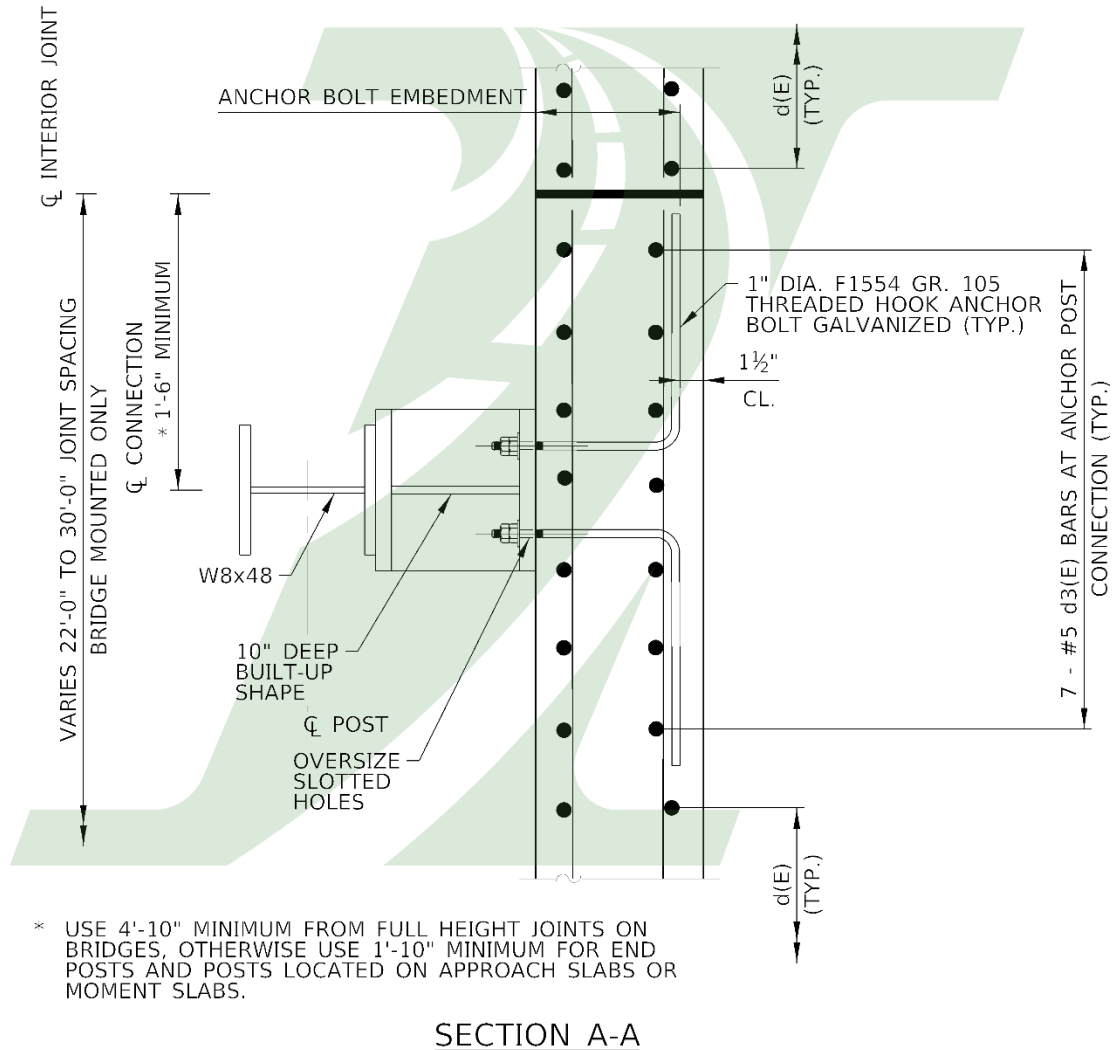
STEEL BEAMS	
FLANGE WIDTH "W"	OVERHANG 'L'
W < 18"	2'-11"
18" ≤ W < 24"	3'-4"
24" ≤ W < 30"	3'-6"
30" ≤ W < 36"	3'-7"
36" OR WIDER	3'-8"

PRECAST CONCRETE BEAMS	
FLANGE WIDTH "W"	OVERHANG 'L'
W < 16"	2'-11"
16" ≤ W < 20"	3'-5"
20" ≤ W < 24"	3'-6"
24" OR WIDER	3'-8"

**Figure 15.5.1.5: Structure Mounted Noise Abatement Wall on Bridge**

**NOTE:**

REFER TO ILLINOIS TOLLWAY STANDARD DRAWINGS G12 AND G13 FOR STRUCTURE MOUNTED NOISE ABATEMENT DETAILS.



**Figure 15.5.1.6: Noise Abatement Wall Connection Plan**



NOTE:  
 MINIMUM BEND RADIUS OUT-TO-OUT OF  
 a(E) BARS SHALL BE 3" FOR #6 BAR  
 AND 4" FOR #8 BAR

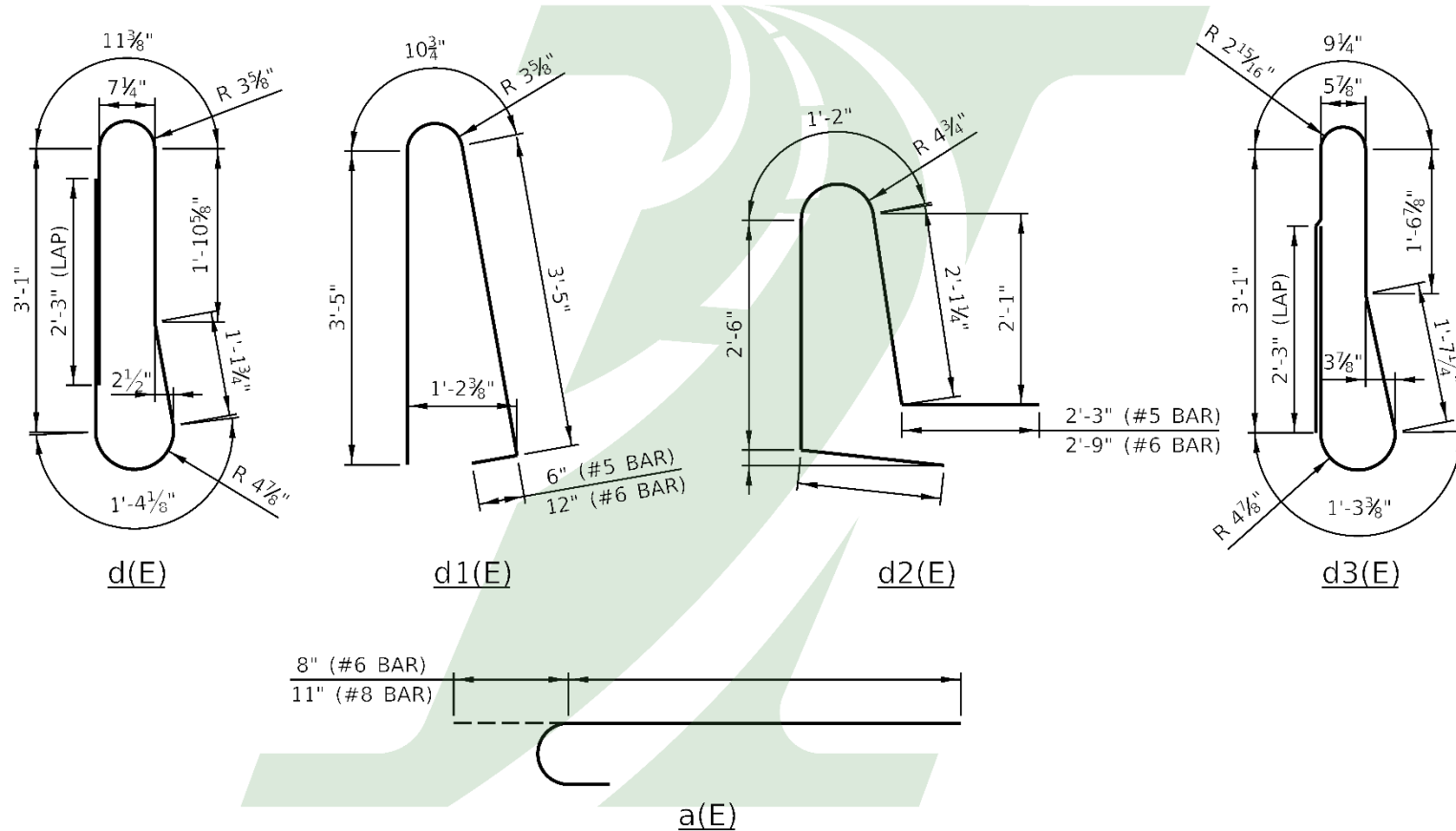
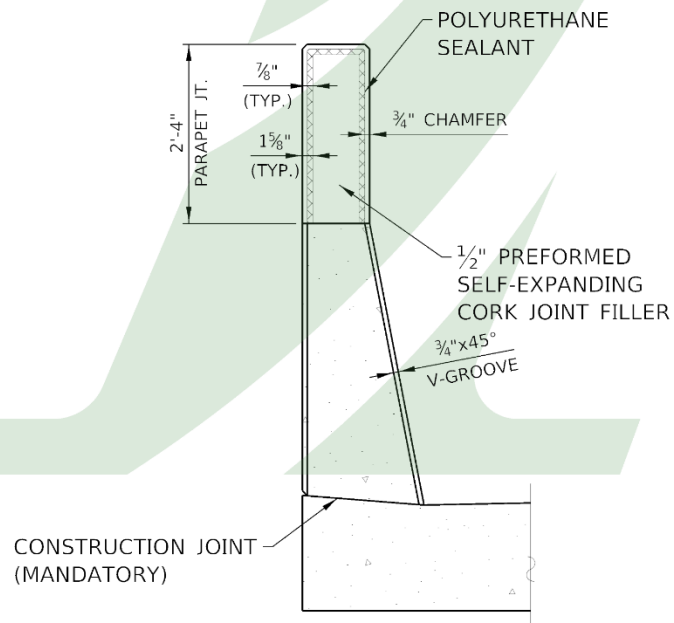
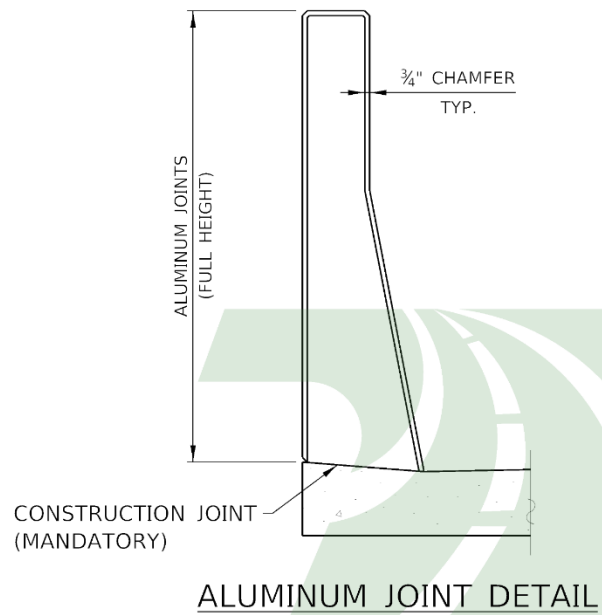
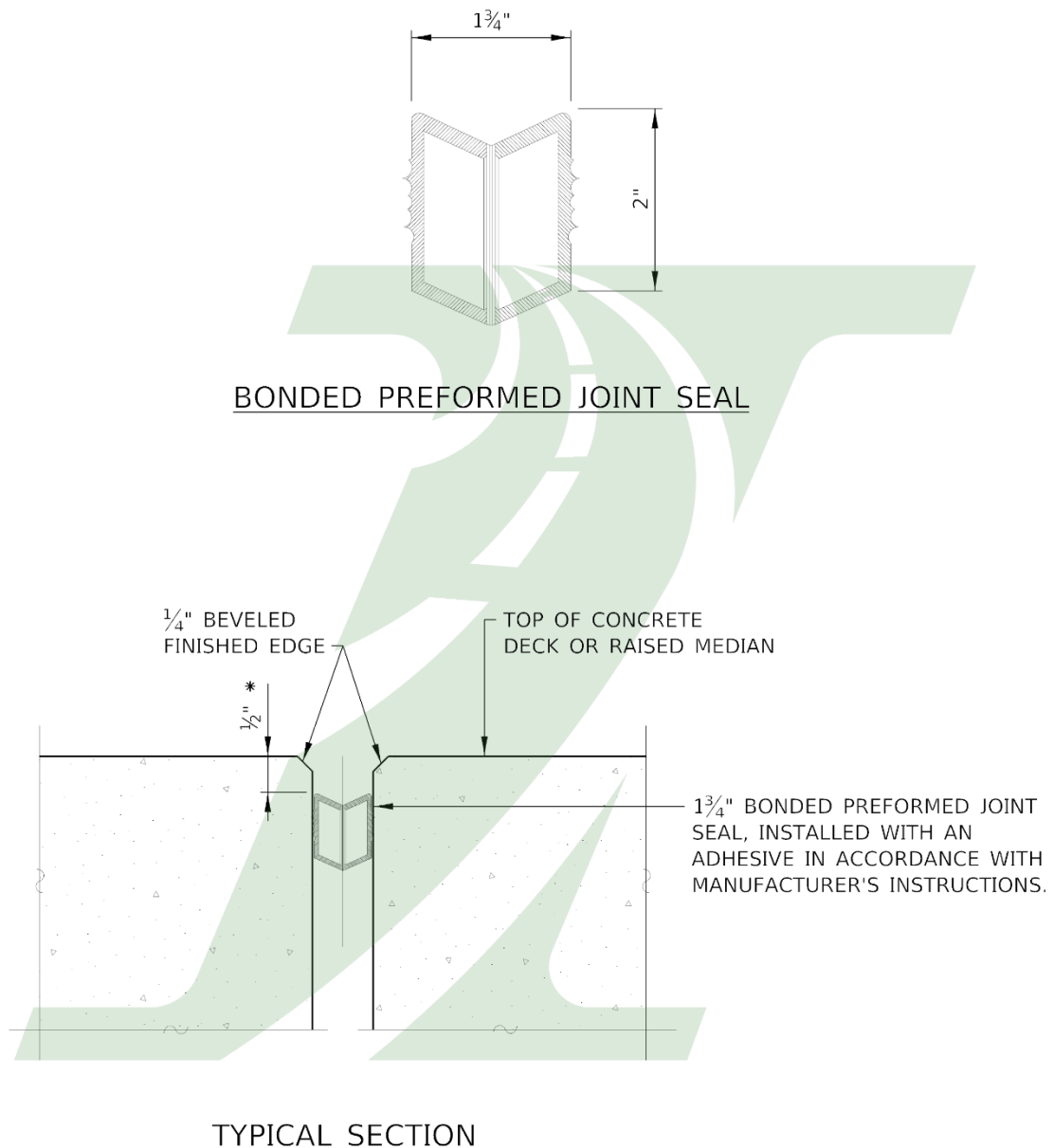


Figure 15.5.1.7: Deck Reinforcement Details

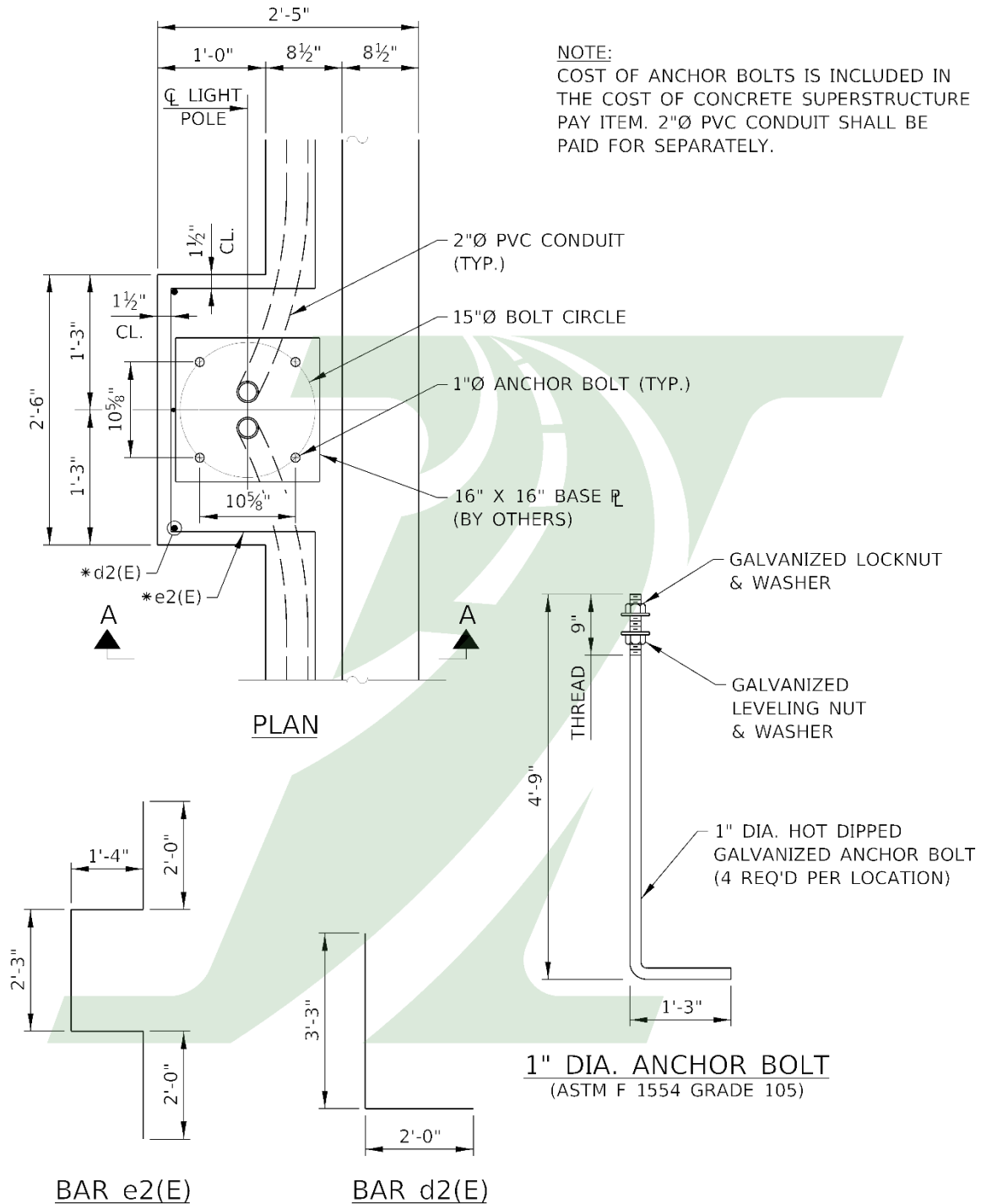


**Figure 15.5.1.8: Barrier Joint Details**



\* INCREASE TO  $\frac{3}{4}$ " FOR SMOOTHNESS GRINDING

**Figure 15.6.1: Bonded Preformed Joint Seal for Longitudinal Sealed Joint**

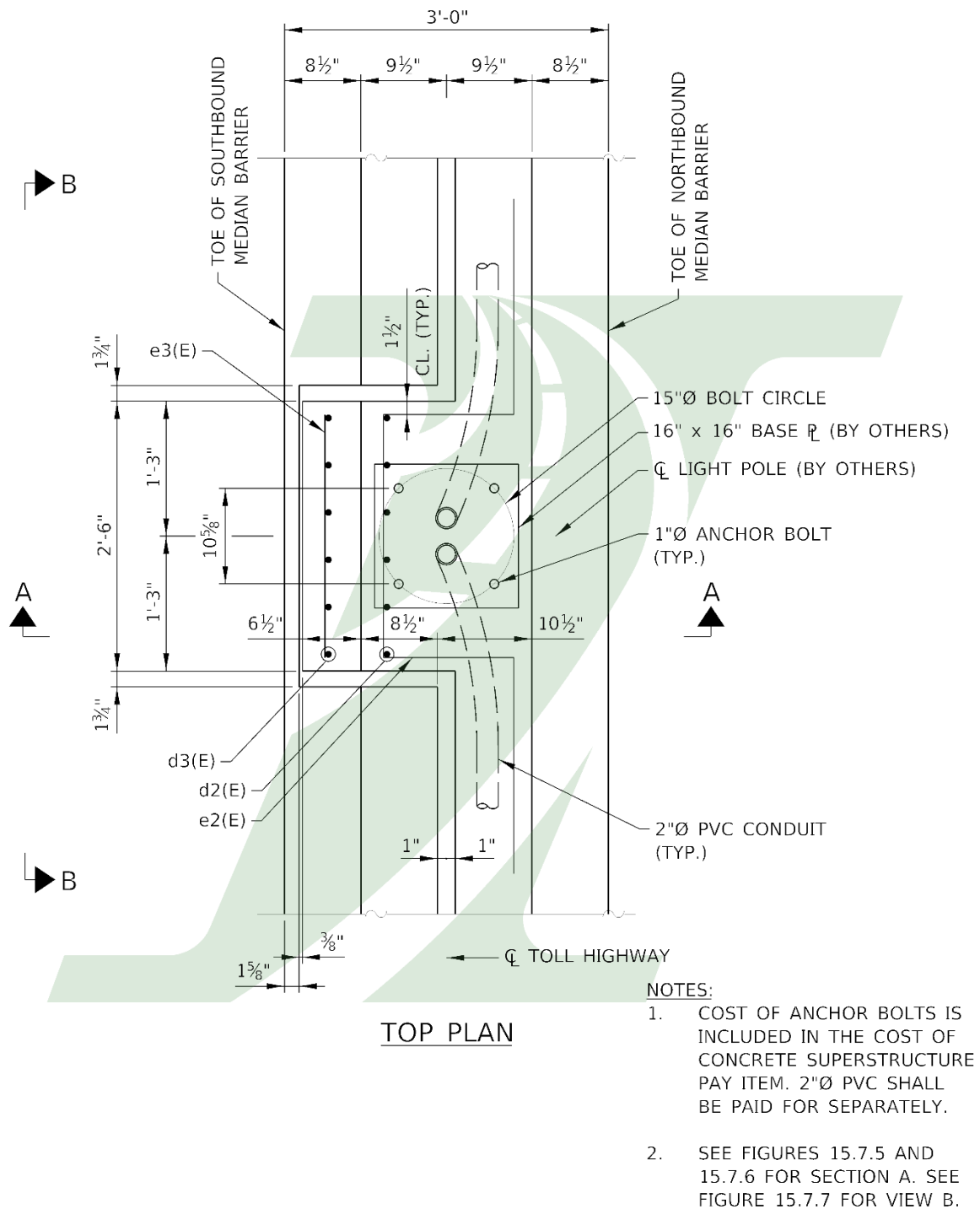


\* SEE FIGURE 15.7.2 FOR SIZE AND NUMBER OF BARS REQUIRED

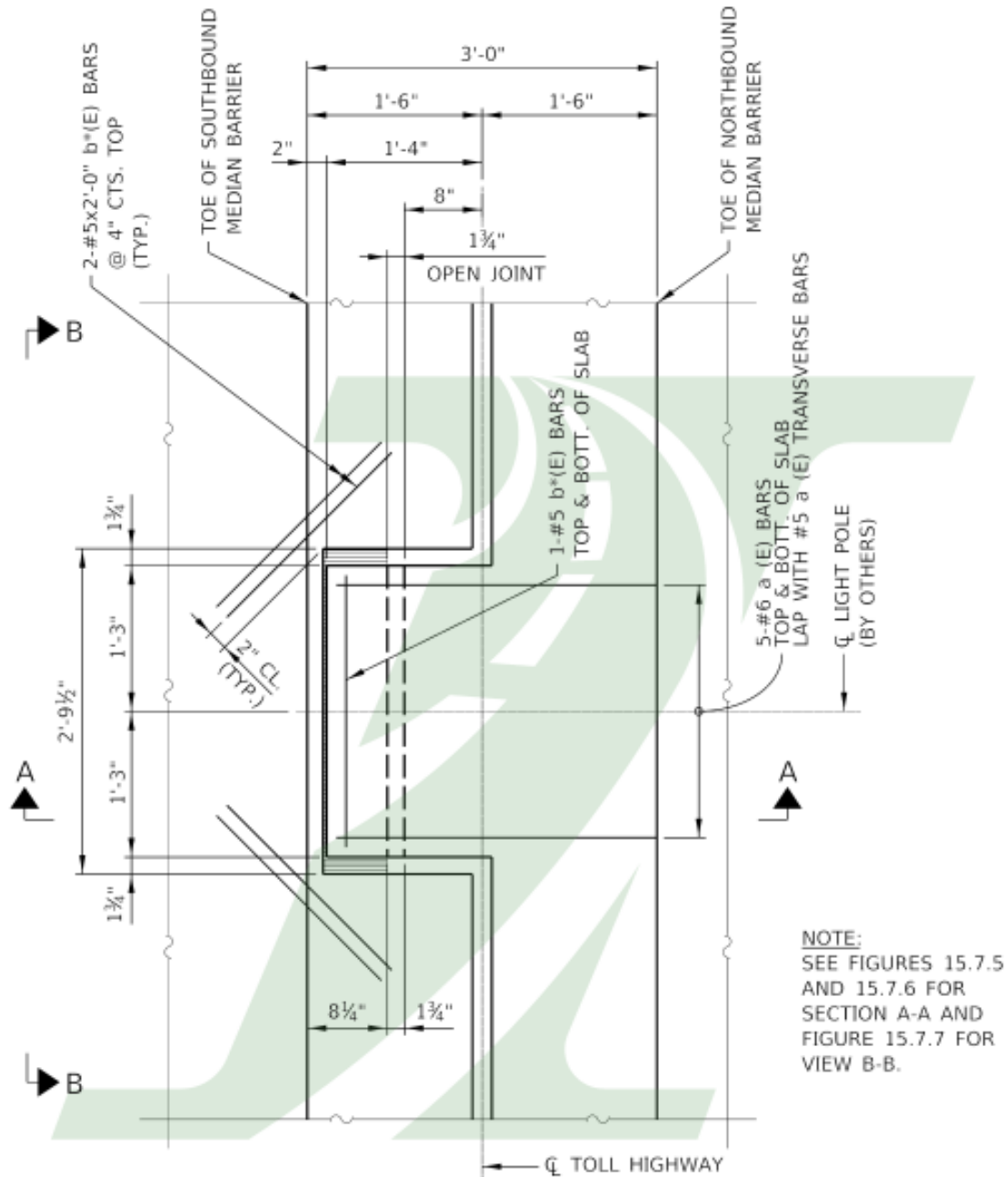
**Figure 15.7.1: Shoulder Mounted Light Pole Details for Constant Slope Barrier**



- Figure 15.7.2: Shoulder Mounted Light Pole Details for Constant Slope Barrier**



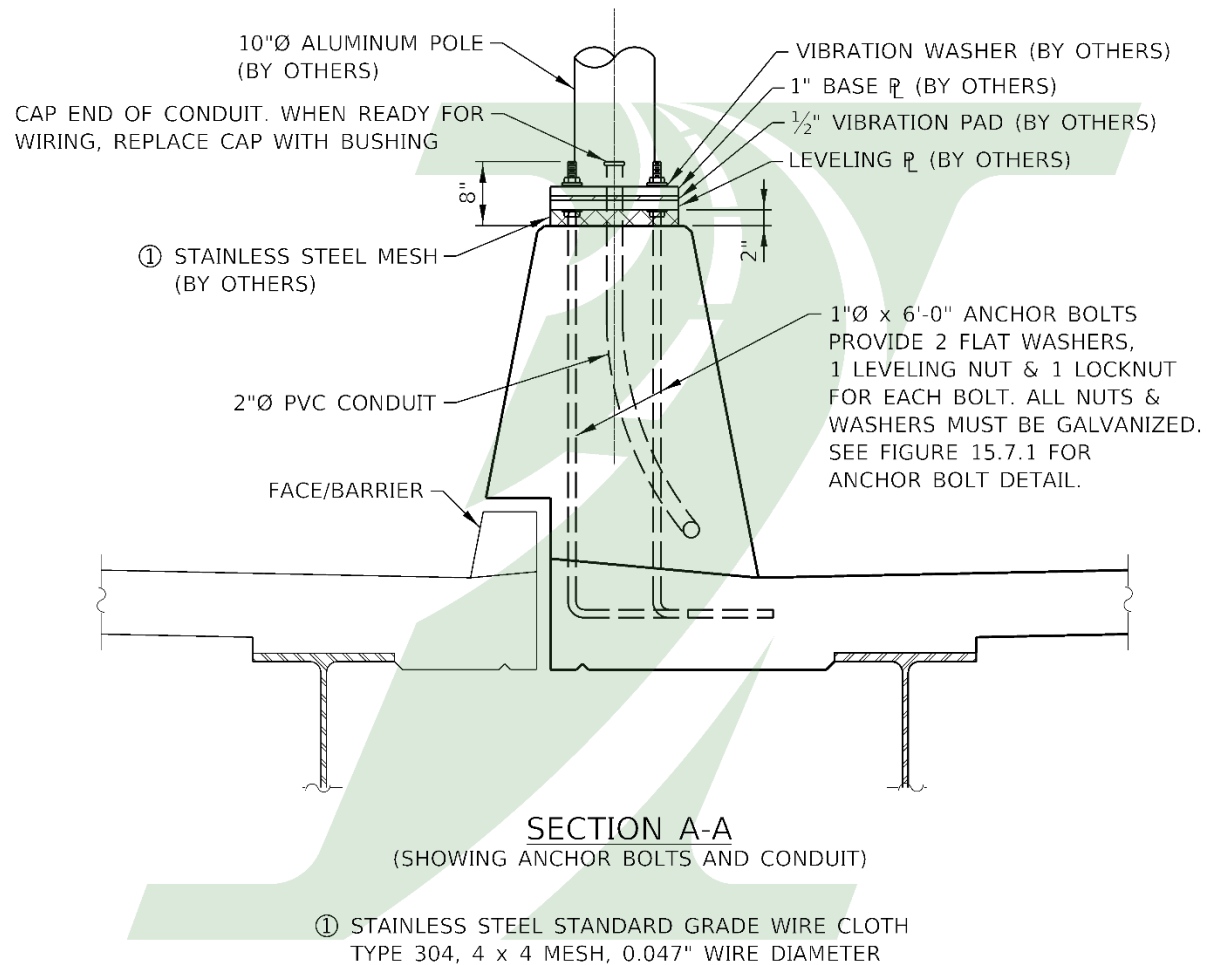
**Figure 15.7.3: Median Mounted Light Pole Details for Constant Slope Barrier**



### BOTTOM PLAN

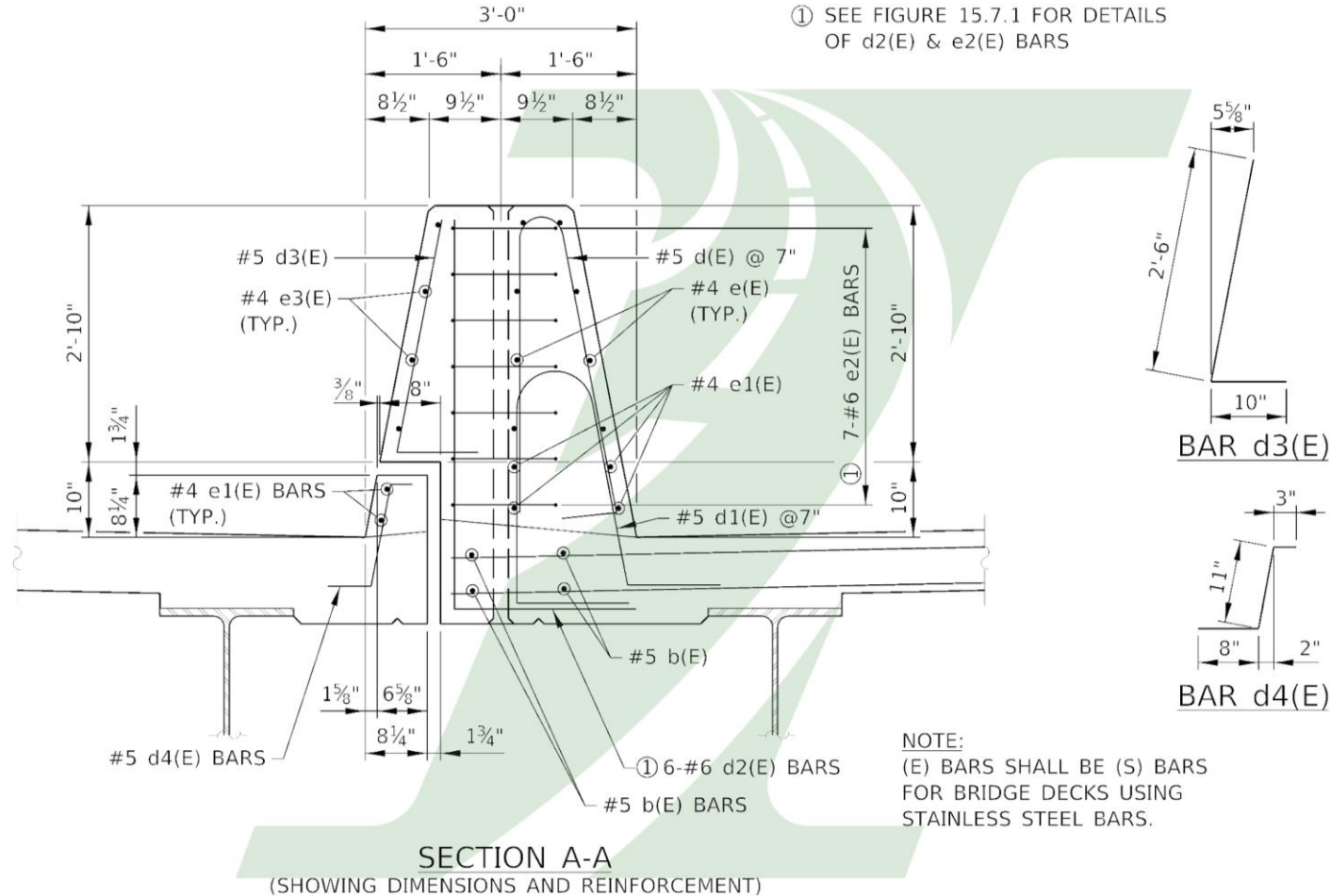
(SHOWING ADDITIONAL REINF. IN DECK AT LIGHT POLE LOCATIONS)

**Figure 15.7.4: Median Mounted Light Pole Details for Constant Slope Barrier**

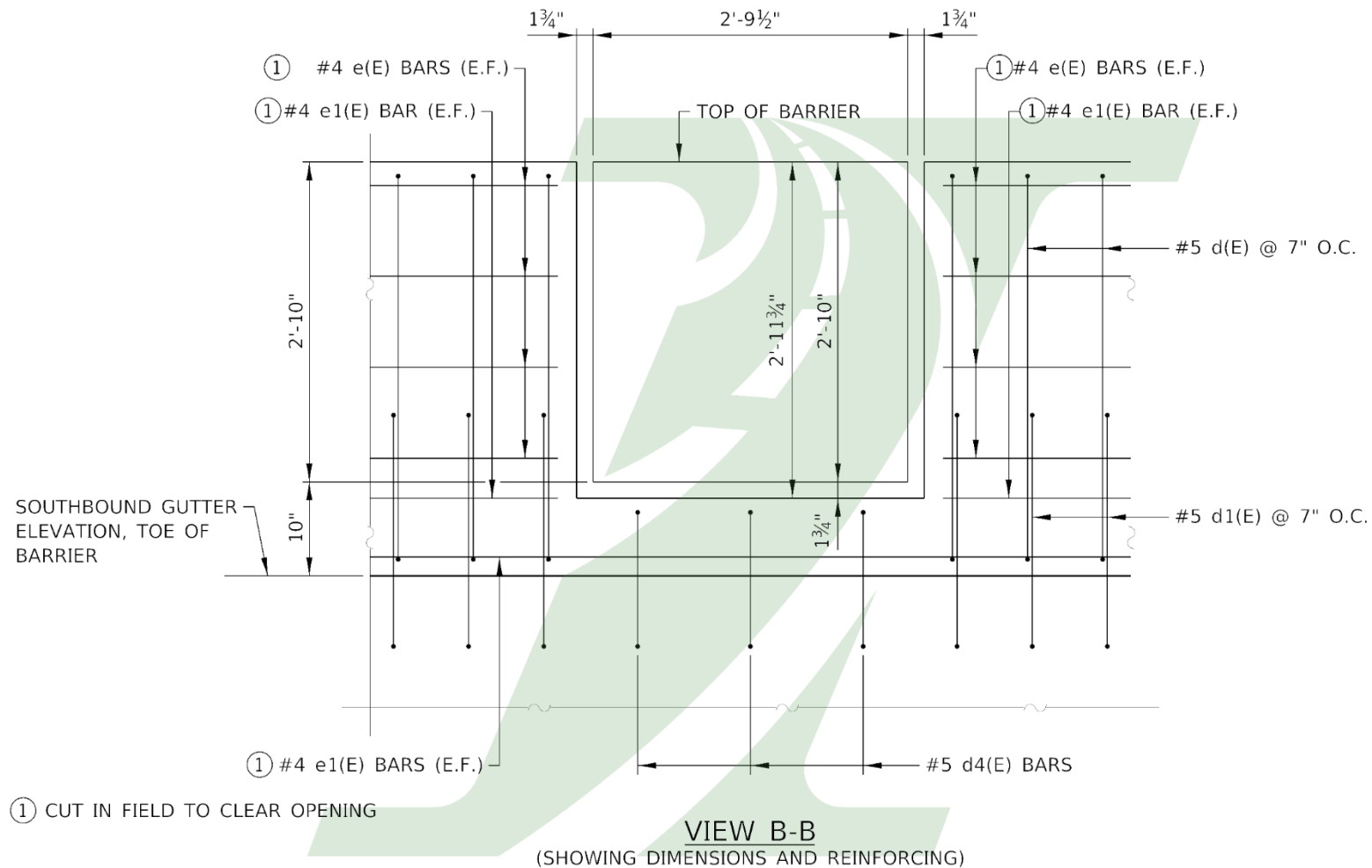


**Figure 15.7.5: Median Mounted Light Details for Constant Slope Barrier**

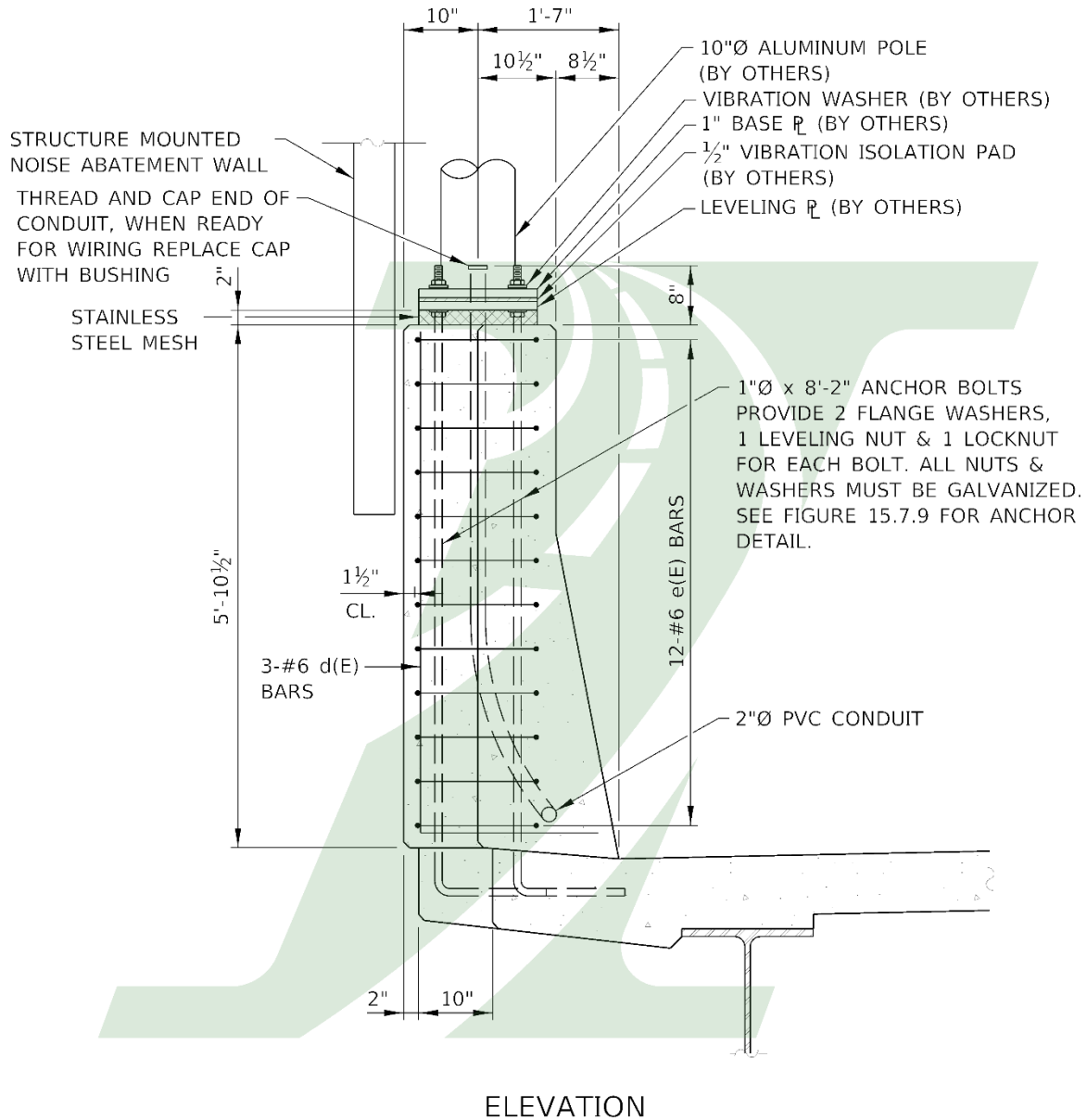




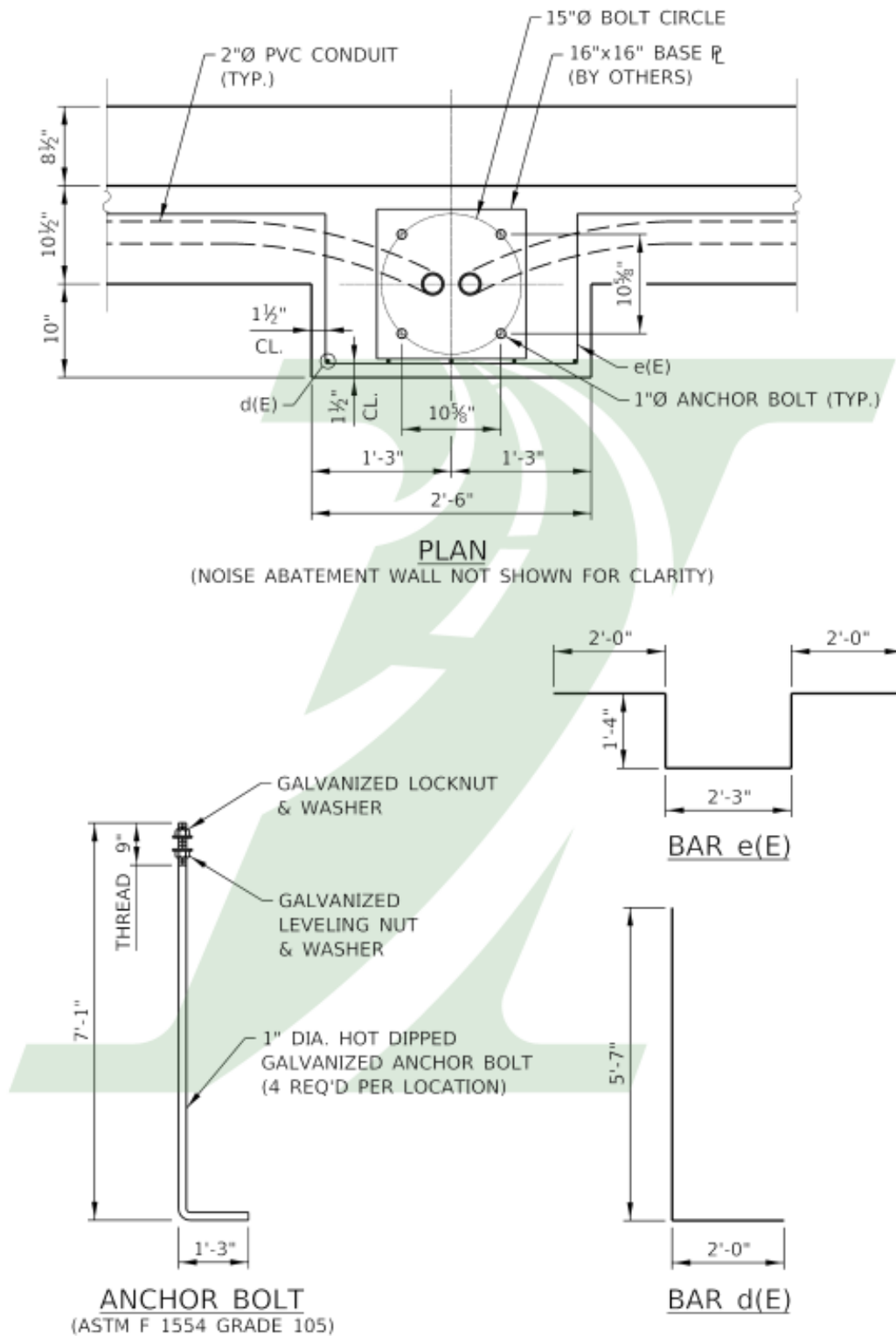
**Figure 15.7.6: Median Mounted Light Pole Details for Constant Slope Barrier**



**Figure 15.7.7: Median Mounted Light Pole Details for Constant Slope**



**Figure 15.7.8: Light Pole Details for 6 ft. Barrier**



**Figure 15.7.9: Light Pole Details for 6 ft. Barrier**

## SECTION 16.0 DECK DRAINAGE

Bridge deck drainage shall be designed and detailed in accordance with the applicable portions of Chapters 7 and 8 of the latest IDOT Drainage Manual, Section 3.2.9 of the latest IDOT Bridge Manual, and Section 9.4 and Table 9.3 of the Illinois Tollway Drainage Manual, except as amended herein.

### 16.1 Deck Drains

When floor drains are required, they shall be uniformly spaced along the gutter line on one or both sides of the bridge deck as indicated in the drainage study. In no case shall the discharge from floor drains be collected in a closed drainage system and piped down and/or off the bridge. The free fall method of discharge shall be permitted except over areas noted herein.

Floor drains may be angled if required to clear the beam or girder flange. Preference shall be given first to the use of 6-inch diameter reinforced fiberglass pipe or aluminum tube. If insufficient space exists between face-of-curb and the girder for a 6-inch diameter drain, consideration shall be given to the use of the 4" x 12" tube. Reinforced fiberglass pipe shall meet the requirements of Article 16.3.2. Aluminum shall be either an extrusion or welded plates meeting the requirements of ASTM B221, Alloy 6061-T6 or ASTM B209, Alloy 6061-T6.

Floor drains shall be omitted from sections of the decks where the discharge would fall on underlying roadways, bikeways, walkways, railroads, aggregate slope paving or unprotected earthen embankments, and other developed or highly erodible areas. Where free fall is not permitted scuppers and a closed drainage system as described below is used. Floor drains shall be located a minimum of 1/2 of the drop height from the face of any abutment or pier. The drop height is defined as the vertical distance between the bottom of the drain pipe and the top of the surface below. Drains shall be located a minimum of 4' clear of all diaphragms and on the upstream side of bridge deck expansion joints. Drain pipes shall extend a minimum of 6" below the bottom of adjacent superstructure members.

### 16.2 Drainage Scuppers

The IDOT DS-11, DS-12 or DS-12M10 Drainage Scuppers should be used whenever possible. The DS-33 scupper shall not be used except when the DS-11, DS-12 or DS-12M10 scuppers conflict with the beam location. The use of scuppers, other than the aforementioned types, need prior approval from the Illinois Tollway. Drainage from scuppers may be collected in a closed drainage system and piped off the bridge or allowed to free fall to the ground except in the areas noted herein.

Scupper frames and grates shall be gray cast iron meeting the requirements of AASHTO M105, Class 35B and AASHTO M306. Stainless steel hold down bolts as specified in the Standard Specifications Article 1006.29(d) shall be used to secure the grates to the frames.

Structural steel weldments of equal sections and of the same configuration may be used in lieu of the gray cast iron frame. Fillet or full penetration welds shall be used for the weldments. Structural steel weldments shall not be used in lieu of the cast iron grates. Structural steel shall meet the requirements of AASHTO M270, Grade 50. Structural steel frames shall be galvanized according to AASHTO M111. The Contractor shall submit shop drawings of all structural steel weldments to the Engineer for review and acceptance prior to ordering any material or starting the work.

The height at the spigot end of the scupper shall be increased from 7-1/4 inches to 12 inches to allow the flange connection to be made below the deck slab. The connection shall be made with stainless steel bolts, nuts and washers as specified in the Standard Specifications Article 1006.29(d). The following note shall be added to the list of General Notes.

“All stainless-steel hardware for drainage systems shall be coated with antiseize compound.”

The structural and drainage engineers shall coordinate the location of scuppers to ensure a proper outlet is provided for the bridge deck runoff. Freefall type scuppers shall be omitted from sections where the discharge would fall on underlying roadways, bikeways, walkways, railroads, aggregate slope paving, unprotected embankments and other developed or highly erodible areas. Scuppers with free fall discharge shall be located a minimum of 1/2 of the drop height from the face of any element of the substructure. The drop height is defined as the vertical distance between the bottom of the spigot and the top of the surface below. Scuppers shall be located clear of all diaphragms and on the upstream side of bridge deck expansion joints, whenever possible. Refer to the Illinois Tollway *Drainage Design Manual* Article 9.4 for additional information.

### 16.3 Drain Pipe

Wherever freefall discharge is not feasible, the drainage shall be collected and piped to the ground or lower roadway. Drain pipes shall not be placed on the traffic face of crash walls. Scuppers shall be located directly above downspouts attached to the substructure. Midspan locations that would result in complex, lengthy drain piping shall be avoided wherever possible. Clean outs are required at 50-foot to 75-foot maximum intervals and should be placed over shoulders. Where horizontal (collection) piping is required, horizontal runs shall be 8 inch in diameter. Vertical (downspouts) piping shall also be 8 inches in diameter. Figures 16.3.1 and 16.3.2 illustrate typical drainage system details. Drainage piping and fittings shall be polyvinyl chloride (PVC), reinforced fiberglass or galvanized steel. Cast iron pipe and fittings shall not be used.

#### 16.3.1 Polyvinyl Chloride Pipe

Polyvinyl Chloride (PVC) pipe and fittings shall be 8" diameter schedule 80 meeting the requirements of ASTM D1785 (F441), D2464 and D2467, colored in accordance with Article 16.5. These requirements shall be added as a note to the list of General Notes.

#### 16.3.2 Reinforced Fiberglass Pipe

Reinforced Fiberglass pipe and fittings shall be 8" diameter and meet the requirements of ASTM D2996 RTRP with a 30,000-psi minimum short-time rupture strength hoop tensile stress, pigmented or painted in accordance with Article 16.5. These requirements shall be added as a note to the list of General Notes.

#### 16.3.3 Galvanized Steel Pipe

Seamless and welded pipe and fittings shall be 8" diameter, extra strong, galvanized steel pipe, meeting the requirements of ASTM A53.

### 16.4 Pipe Supports

Pipe hangers shall be provided for all horizontal (collection) drainpipes at each fitting, cleanout, or change in direction and at intermediate points not more than 5'-0" on centers. Collection pipe hangers shall have an allowable load capacity of not less than 500 lbs. and shall be designed so

as not to apply excessive compressive stress to the pipe. See Figures 16.4.1 and 16.4.2 for pipe hanger details. Steel straps, bars and plates shall meet the requirements of AASHTO M270, Grade 36 or 50.

Pipe supports shall be provided for all vertical (downspout) drainpipes at points not more than 12'-0" on centers. See Figures 16.4.3 through 16.4.6 for drainpipe support details. Structural steel shapes shall meet the requirement of AASHTO M270, Grade 36.

All pipe hangers, inserts, bolts, nuts and washers shall be stainless steel. Stainless steel bolts, and washers shall to the Standard Specifications Article 1006.29(d).

## **16.5 Painting**

All exposed surfaces of floor drains, hangers, brackets and piping located on the exterior side of painted fascia beams and/or visible to the motoring public shall be painted or supplied in the appropriate color except stainless steel and galvanized shall not be painted. The color of the final coat shall match that of the adjacent beam and/or column; past colors for touch-up work may be Munsell number 7.5G 4/8 Interstate Green and/or Munsell number 5B 7/1 Gray for existing green or gray steel beam colors. Sherwin-Williams 7061, Night Owl 237-C6 (#63655F Hex Color Code) for steel fascia girders and Sherwin-Williams 7017, Dorian Gray 244-C3 (#ACA79E Hex Color Code) color for inside steel girders shall be used when entire steel girders will be re-painted or new structures are constructed. The color of the final coat for attachment to exterior fascia girders shall match that of exterior fascia; typically, Sherwin-Williams 7061, Night Owl 237-C6 (#63655F Hex Color Code). Final color shall be submitted to the Engineer for approval.

### **16.5.1 Aluminum Tube**

The exterior surfaces shall be cleaned and given a wash coat pretreatment in accordance with SSPC - SP1 and SSPC - Paint 27. The pretreated surfaces shall be painted with an adhesion bonding primer and topcoat per the system recommended by the pretreatment manufacturer for painting aluminum surfaces in an exterior environment. These requirements shall be added as a note to the list of General Notes.

### **16.5.2 Polyvinyl Chloride Pipe**

The PVC pipe and fittings shall be colored to match the adjacent beam and/or column.

### **16.5.3 Reinforced Fiberglass Pipe**

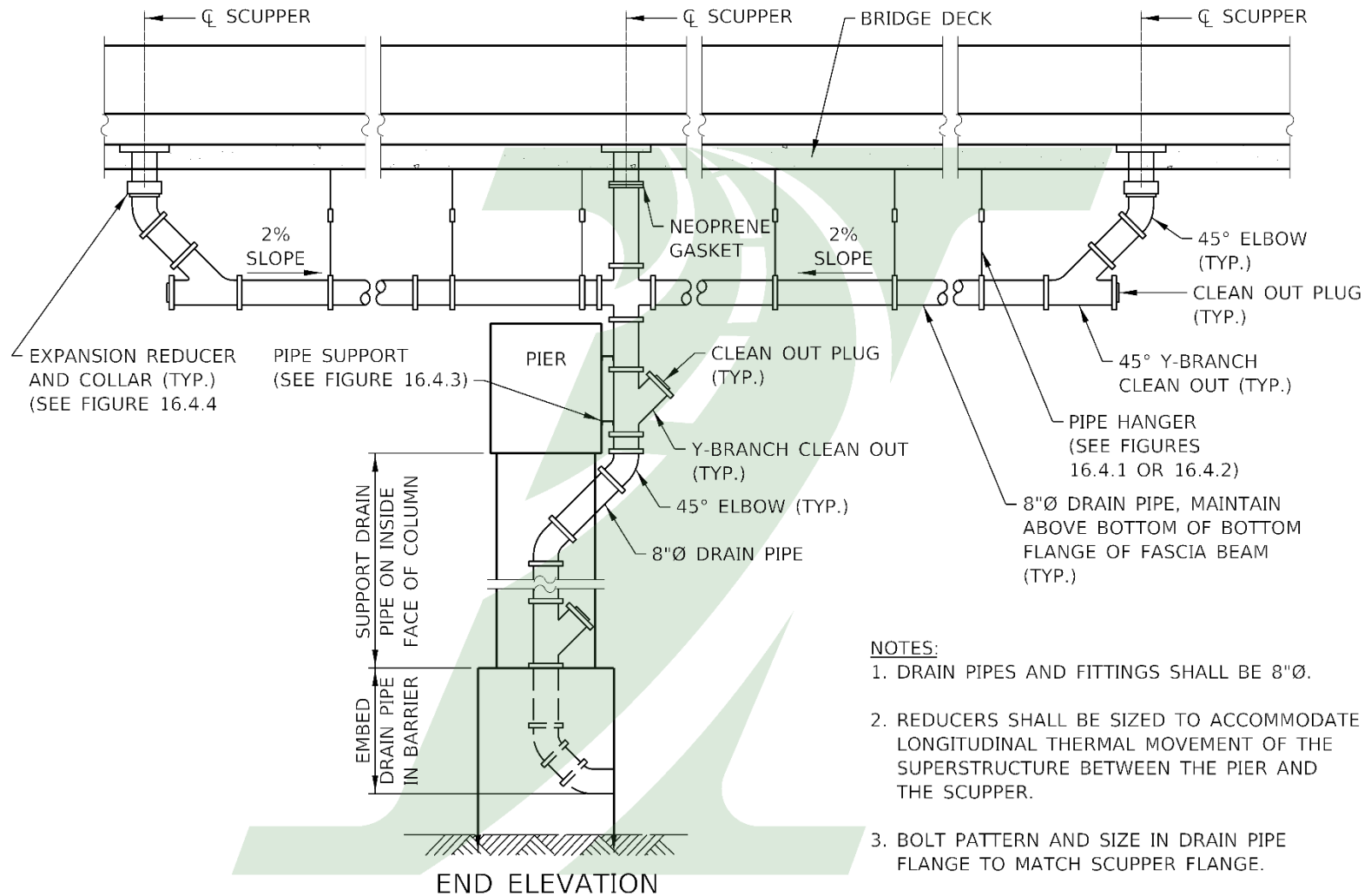
The exterior surfaces of fiberglass pipe and fittings shall be pigmented in accordance with the pipe manufacturer's recommendations or cleaned, given a prewash in accordance with MIL - P - 15328 and top coated with an epoxy-based coating recommended for outdoor applications by the prewash manufacturer.

### **16.5.4 Galvanized Steel Pipe**

Galvanized Steel Pipe shall not be painted.

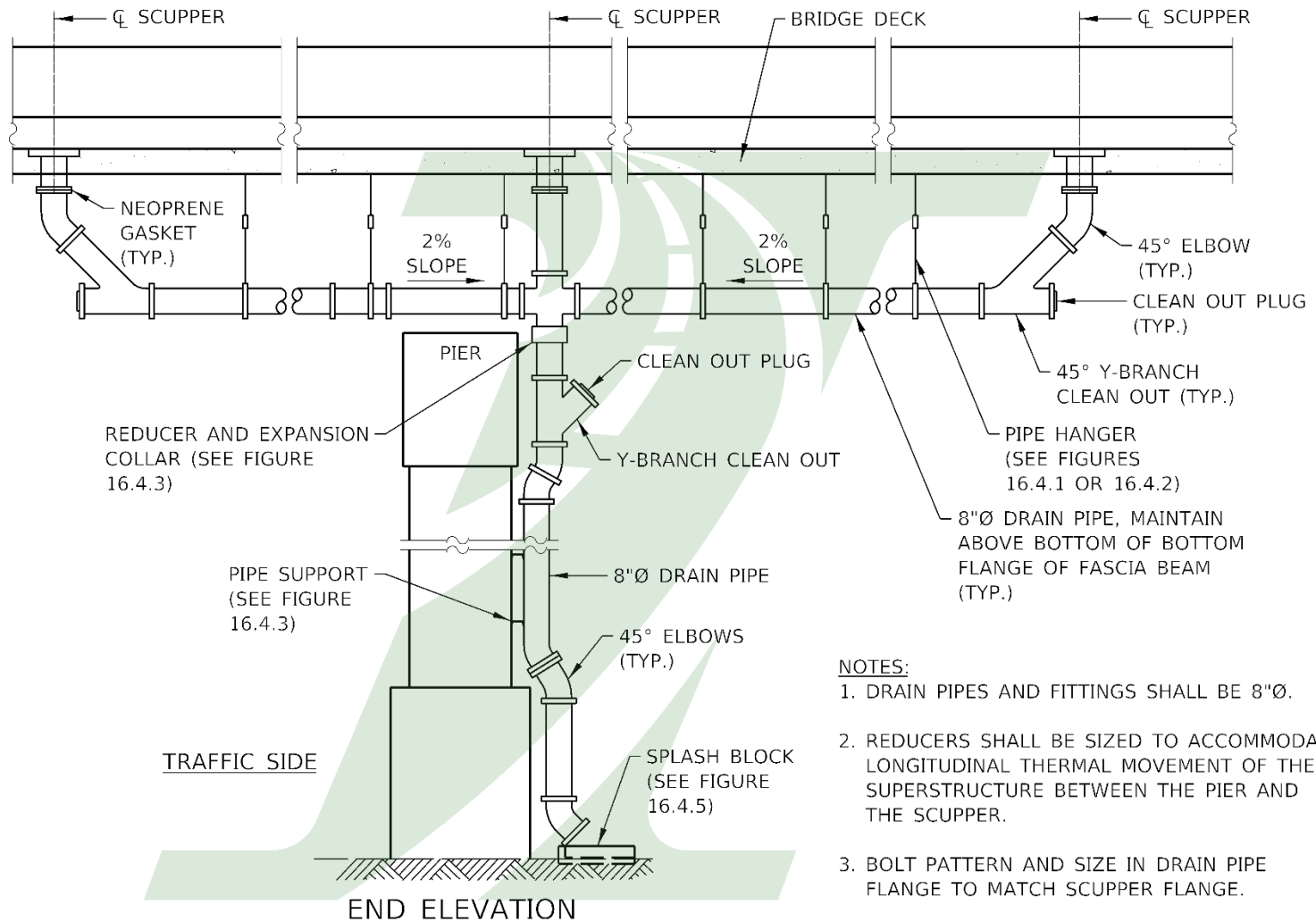
### **16.5.5 Pipe Supports**

The exposed surfaces of galvanized pipe supports shall not be painted.

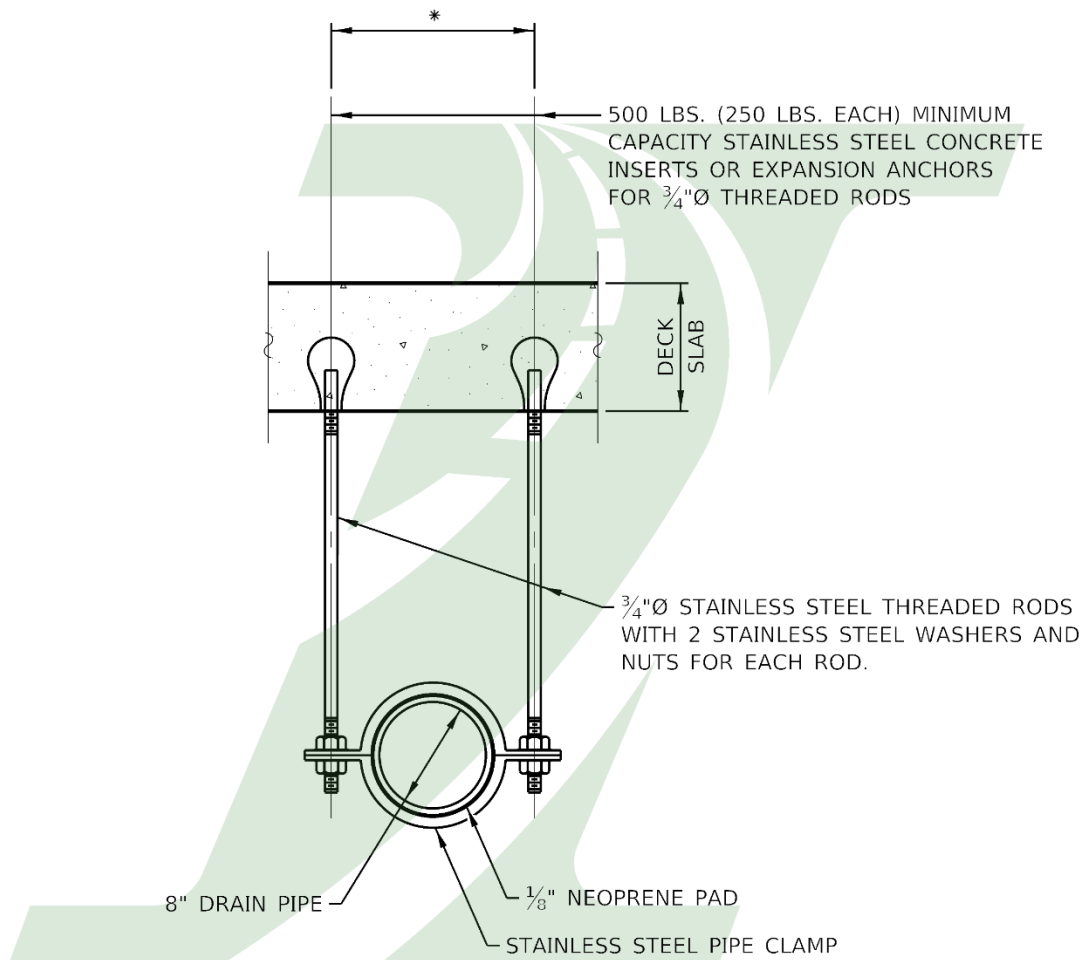


**Figure 16.3.1: Typical Drainage System Details for Median/Fixed Piers**

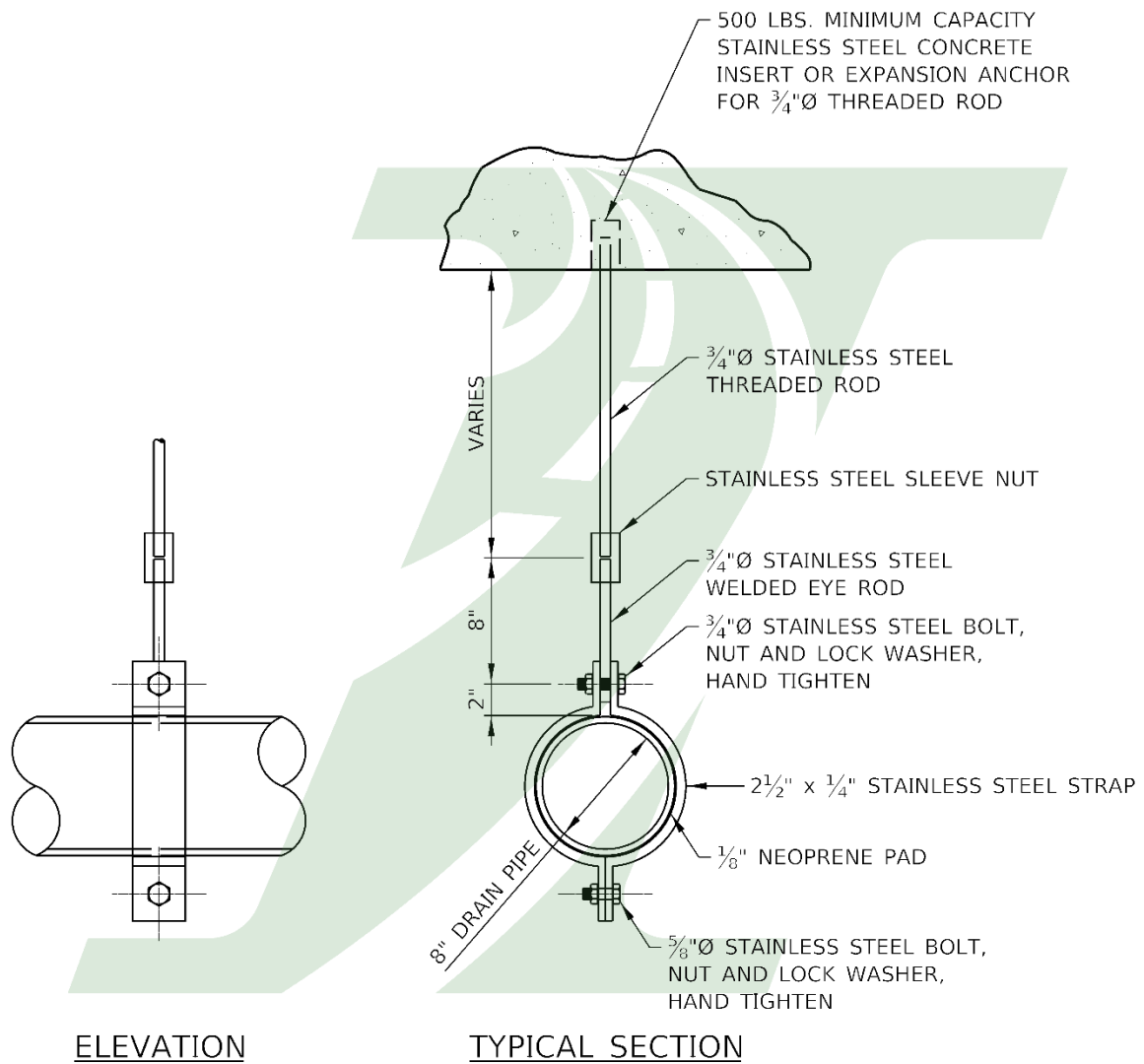




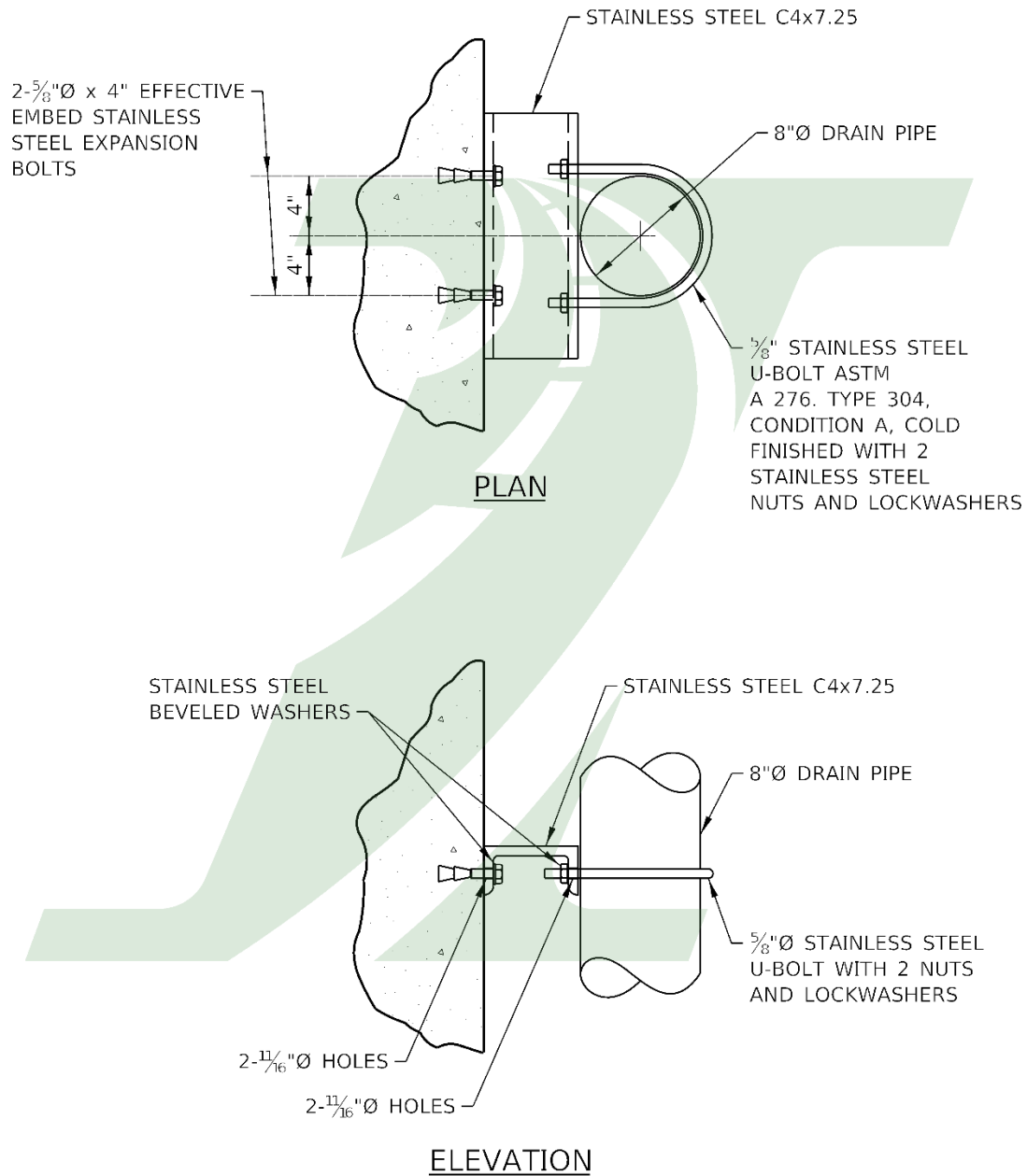
**Figure 16.3.2: Typical Drainage System Details for Shoulder/Expansion Piers**



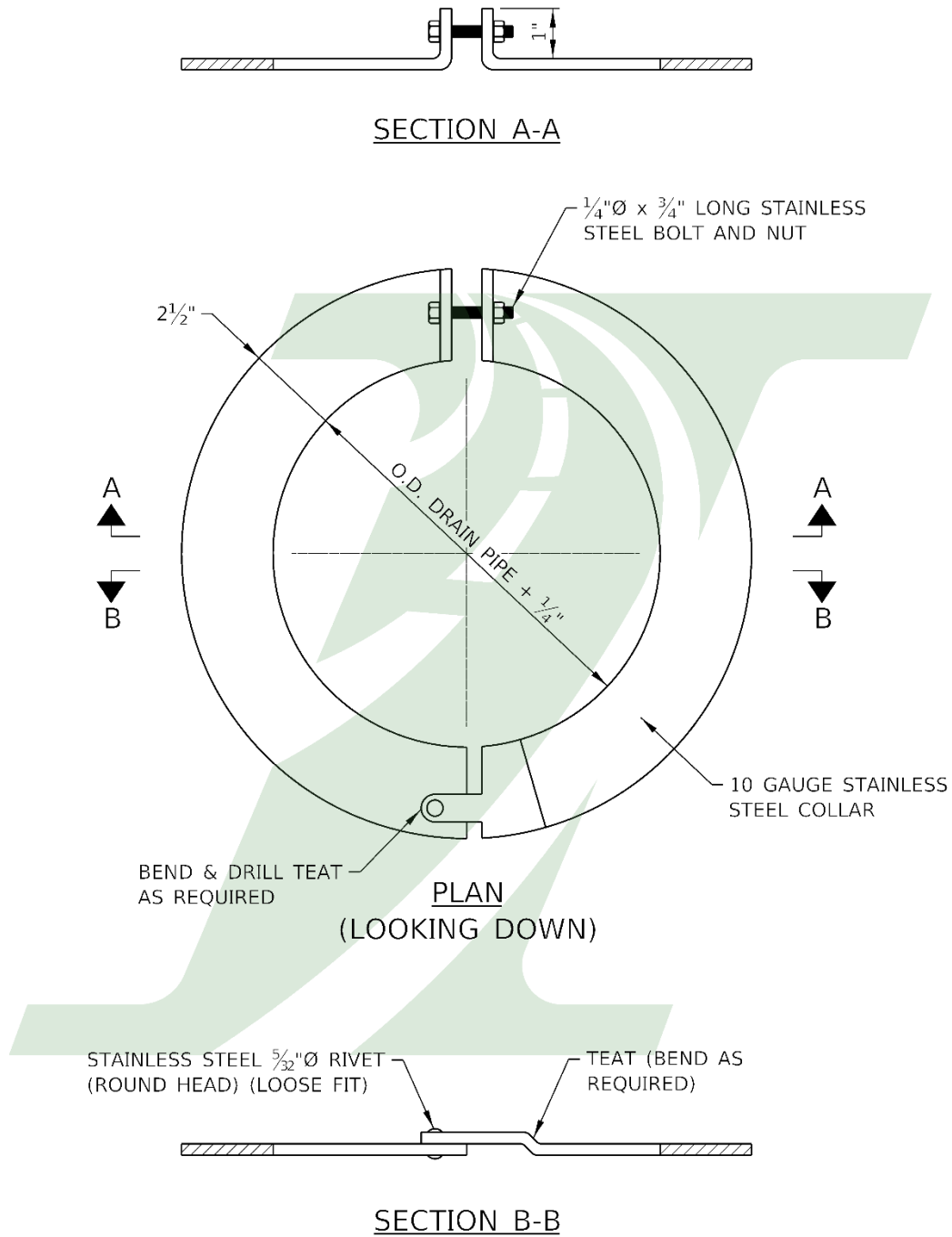
**Figure 16.4.1: Collector Pipe Hanger Details**



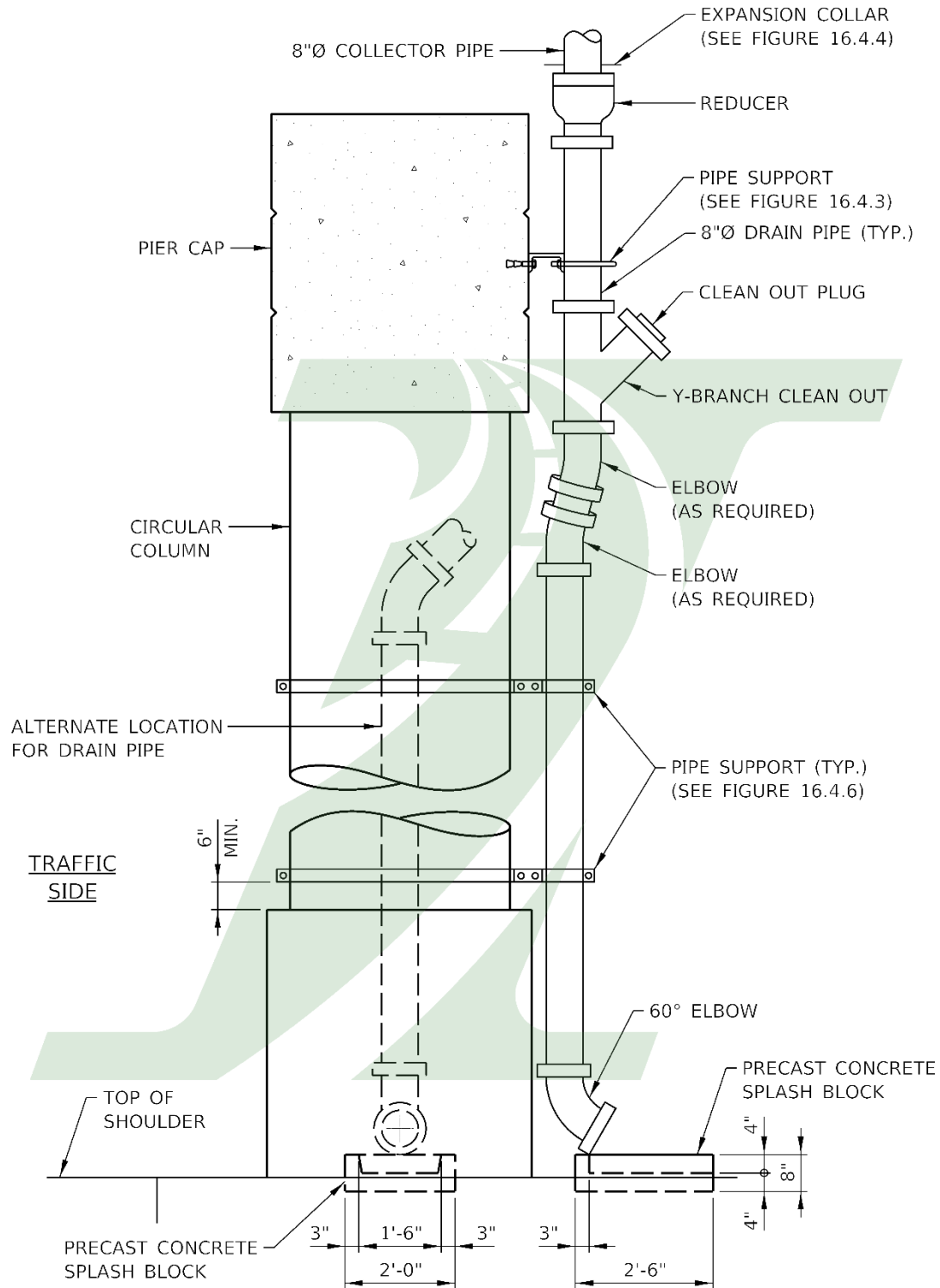
**Figure 16.4.2: Alternate Collector Pipe Hanger Details**



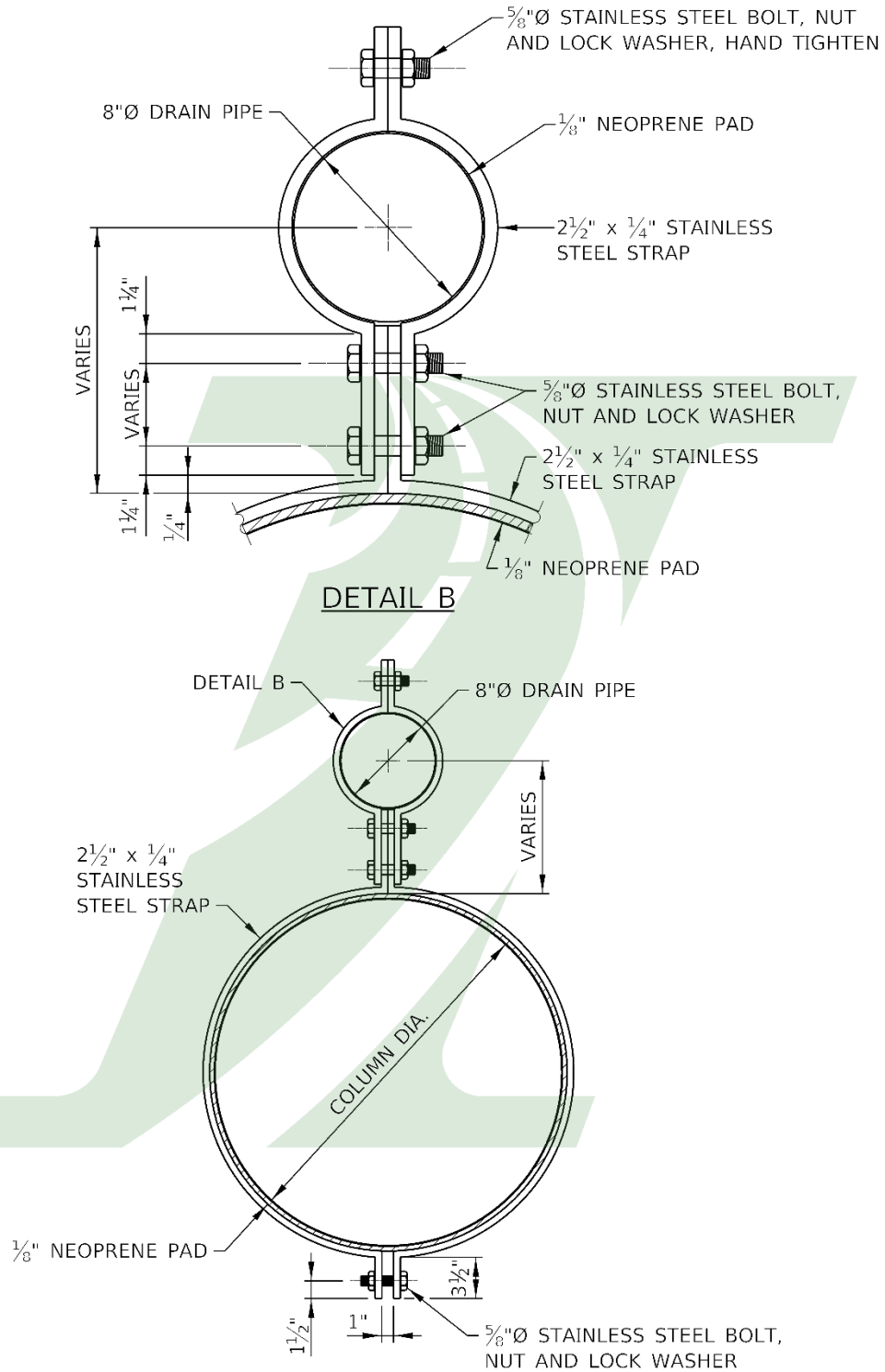
**Figure 16.4.3: Vertical Drain Pipe Support Details**



**Figure 16.4.4 Expansion Collar Details**



**Figure 16.4.5: Vertical Drain Pipe Details for Circular Columns**



**Figure 16.4.6: Drain Pipe Support Details**

## SECTION 17.0 BRIDGE DECK EXPANSION JOINTS

### 17.1 General

All bridge deck expansion and fixed (rotational) joints shall be sealed to prevent water from penetrating to the bridge elements below the deck surface. Both expansion and fixed (rotational) joints shall be designed and detailed in accordance with Section 3.6 of the latest IDOT Bridge Manual except as herein amended. Integral and semi-integral abutments shall be utilized wherever possible to eliminate the need for expansion joints at these locations. See Section 10.0 for parameters pertaining to the use of these types of abutments.

Expansion and fixed joints installed on bridges with 10-degree skews or greater shall be modified to intersect the barrier or curb line at 90 degrees. This change in direction shall occur 6 inches from the back face of curb or front face of parapet (see Base Sheets M-BRG-500 and M-BRG-501).

Joint seals on bridge decks and between bridge decks and bridge approach slabs shall be one continuous piece for the full length of the joint. Splicing of the gland is not allowed. Spliced glands may be considered at joints between transition approach slabs and approach pavement.

### 17.2 New or Replacement Bridge Decks

Only Strip Seals and Modular Joints shall be utilized to seal expansion or fixed (rotation) joints in new or replacement decks. Unbonded Preformed Joint Seals, Neoprene, Bituminous, Poured Silicone and steel Finger Plates shall not be used. Only Strip Seals and Modular Expansion Joints currently on the latest IDOT Pre-Qualified products list shall be considered for use by the Illinois Tollway.

#### 17.2.1 Strip Seals

Strip Seals shall be used to seal the deck joints of all new or replacement structures located on tangent alignments where the skew angle(s) are 60 degrees or less and the expansion length is not greater than 305'. They may also be used for structures on curved alignment provided the skew angles(s) are 40 degrees or less and the expansion length is equal to or less than 305', measured along the center or baseline. The Illinois Tollway will consider the use of greater expansion lengths on a case-by-case basis. See Base Sheets M-BRG-500, M-BRG-501 and M-BRG-502 for details.

#### 17.2.2 Modular Joints

Modular Joints shall be used to seal expansion joints of structures on tangent or curved alignment exceeding the strip seal limits specified above, provided skew angles are 60 degrees or less and the expansion length does not exceed 800 feet. See latest IDOT Base Sheets for modular joint details.

### 17.3 Existing Bridge Deck Widening

Structures that are to be widened on one or both sides shall utilize the same type of joint that is currently installed in the existing deck, provided it is in good condition. If the existing joint is not in good condition, or it is no longer manufactured, it shall be replaced and the deck reconstructed to utilize a Strip Seal or Modular Expansion Joint. Existing Preformed Joint Seals or Poured Silicone Joints shall be completely removed and replaced.



## 17.4 Existing Bridge Deck Repair and Rehabilitation

When a deck is only being repaired and/or resurfaced and isolated sections of the existing joint are in poor condition, they shall be reconstructed or repaired in-kind, provided the total length of repairs does not exceed 40% of the original length. Regardless of the repair length, the existing seal or gland shall be completely replaced.

Whenever the total length of repairs will exceed 40% of the original, or the entire joint is in poor condition, the existing joint shall be completely reconstructed as per current standards available at the time of design.

When reconstructing expansion joints on existing bridges with skews greater than 10 degrees, the joints shall be modified, when feasible, so that they intersect the face of the parapet or curb at a 90-degree angle. This modification typically consists of removing a short section of the existing parapet and relocating the parapet joint so that the modified expansion joint intersects it at a 90-degree angle.

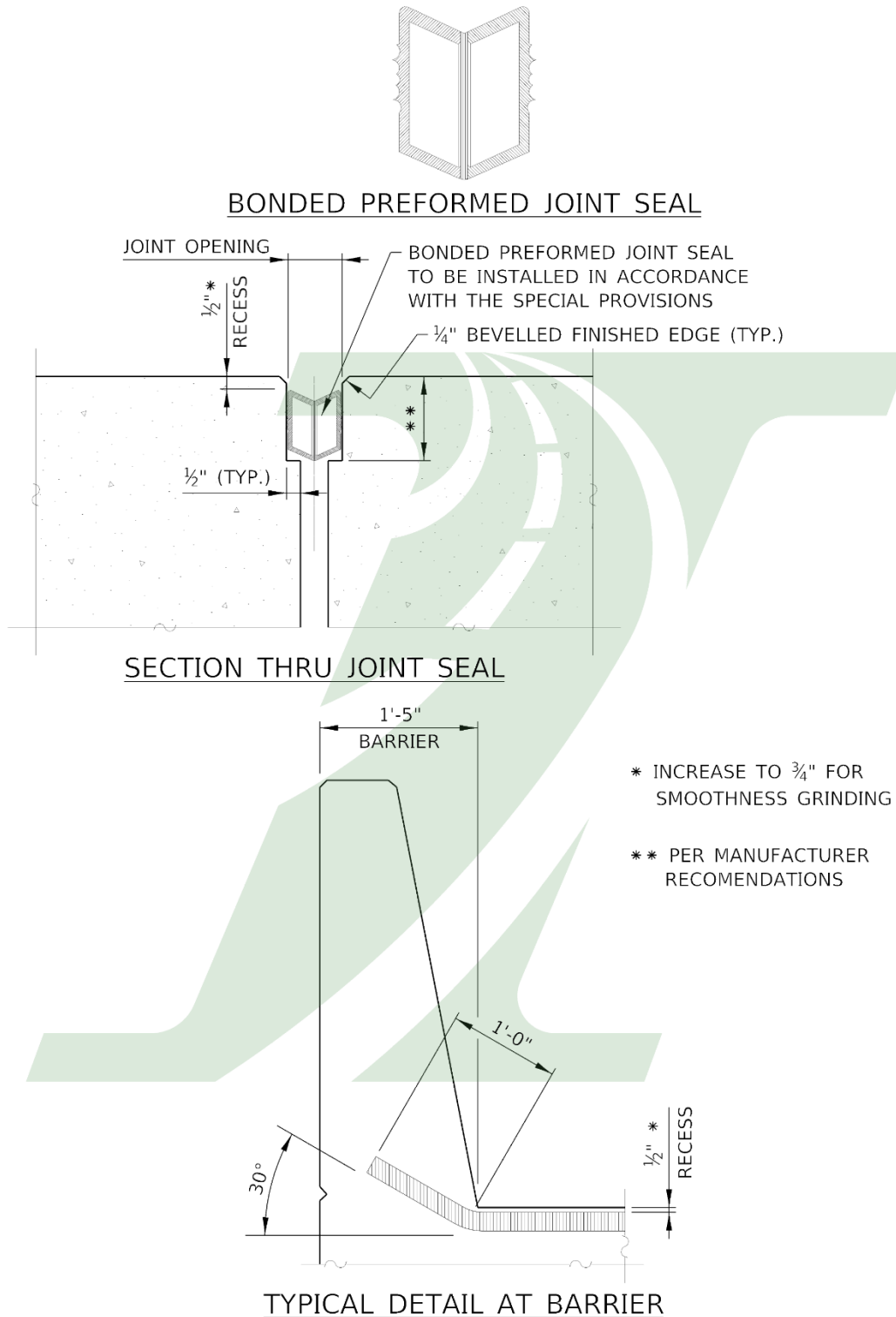
## 17.5 Approach Slabs

Bonded Preformed Joint Seals, preformed pre-compressed, silicone coated, self-expanding sealant system which are fully adhered to both faces of the open joint shall be utilized to construct the expansion joints between the approach and transition slabs and the transition slab and roadway pavement as detailed in the Base Sheets M-RDY-408 and M-RDY-409.

Joint armor is not required or allowed. See Base Sheets M-RDY-408 and M-RDY-409 and Figure 17.5.1 for details.

## 17.6 Fabrication

All structural steel for expansion joints shall be hot dipped galvanized after fabrication in accordance with AASHTO M232 (ASTM A153).



**Figure 17.5.1: Bonded Preformed Joint Detail**

## SECTION 18.0 DECK ELEVATIONS

### 18.1 New Bridges

A table showing top of deck slab elevations along the centerline of each longitudinal beam or girder, stage construction joint, break in cross slope, and profile grade line shall be included in the bridge plans for all structures with steel or concrete stringers. This table is usually in the form of a computer output reduced in tabular form on individual plan sheets.

In addition, top of bridge approach slab, transition approach slab, and transition approach shoulder slab elevations along each longitudinal profile grade line, break in cross slope, stage construction joint, edge of pavement or shoulder shall also be provided on separate individual plan sheet(s) after the deck elevation sheet(s).

Where the stringer lies below a curb, sidewalk or median section, the elevations shall be given for a theoretical top of slab, which would be the projection of the cross slope from the roadway template to the centerline of stringer.

The increments for elevations along centerline of each web shall be 10 feet with any odd increment not greater than 15 feet or less than 5 feet placed at the end of a span. A new series of 10-foot increments shall begin in each respective span along the structure. In all cases, the increments shall progress in the direction of the stationing on the bridge for the full length of the structure. The theoretical top of slab elevations at these increment points shall be adjusted for dead load deflection and grinding, when applicable, and tabulated in a separate column, which will become the finished elevations for construction of the deck slab. Bridges with smoothness and grinding shall follow Section 2.3.7.8 of the IDOT Bridge Manual with theoretical grade elevations adjusted for dead load deflection and grinding.

Actual dead load deflection diagrams (due to weight of concrete deck and all superimposed dead loads except future wearing surface) shall be shown on the top of the slab elevations indicating deflection ordinates at the quarter points and midpoint of all stringers of each span. However, if the variance in deflection between the exterior and interior stringers is one-eighth inch or less, one dead load deflection diagram shall be sufficient for all stringers. Dead load deflection diagrams shall be qualified with the following note:

"The above deflections are not for use in the field if the Engineer is working from the Theoretical Grade Elevations Adjusted for Dead Load Deflection and Grinding."

If the superstructure will be constructed in stages, any superimposed dead loads (noise abatement walls, parapets, sidewalks and medians) applied during the initial stage shall be distributed based on engineering judgement. These initial superimposed dead loads shall not be considered in the deflection calculations for stringers erected in subsequent stages.

### 18.2 Existing Bridge Deck Overlays

The procedure described below shall be used in the preparation of profile worksheets for bridge deck overlays and approach pavement profile transitions.

Profiles shall be prepared for each edge of pavement and crown line. Where there is an auxiliary lane on the deck, a profile for the edge of the auxiliary lane shall also be prepared. The profiles shall have a longitudinal scale of at least 1-inch equals 50 feet, and a vertical scale of at least 1

inch equals 1 foot, although a vertical scale of 1 inch equals ½ foot will facilitate reading elevations from the profiles.

1. Plot existing overlay surface elevations and existing concrete deck elevations at 20-foot centers on roadway and 10-foot centers on deck.
2. Using 1-1/4-inch minimum concrete cover over the existing concrete high points and applying the cross-slope criteria as defined in Article 15.3, fit smooth curvilinear profiles following as close as possible the general direction and configuration of the original profile grade. Where scuppers are involved, cross sections shall be drawn to verify that the scuppers will not present a problem.
3. After the tentative profiles are sketched out, the cross slope shall be checked again for compliance with the criteria. More than one trial and error run may be required to achieve the best fit set of profiles for each individual deck. Profile lines shall not follow theoretical grades and parabolic curves unless such grades and curbs happen to give the best fit for a particular location.
4. The deck profiles shall be transitioned back to the existing or proposed approach roadway elevation within 100 feet to 200 feet from each end of the bridge deck. The transition shall be long enough and end at the most convenient point as to provide a continuous smooth profile, without breaks, dips or bumps.
5. Upon review and acceptance by the Illinois Tollway, the profile worksheets shall be finalized with all lines neatly drawn and identified. It is intended that these worksheets will be used by the Engineer during construction.
6. The elevations for the overlay surface contour plans or screed elevations may be scaled directly from the profiles developed from the field survey.

## SECTION 19.0 BRIDGE APPROACH AND TRANSITION APPROACH SLABS

### 19.1 General

Bridge approach slabs and transition approach slabs shall be included with the plans for each new and widened bridge. Mainline or ramp bridges carrying Illinois Tollway traffic shall be provided with approach and transition slabs including shoulders at each abutment. The bridge approach (30 ft.) and transition approach slabs (70 ft.) shall be 100 feet long as detailed in the latest Illinois Tollway Base Sheets M-RDY-408, M-RDY-409 and M-RDY-410.

For curved structures, the joints between the bridge deck and bridge approach slab (non-integral) and between the bridge approach slab and transition approach slab shall be parallel to the bridge centerline of bearing. The 30-foot length shall be measured along a line tangent at the centerline of bearing. The joint between the transition approach slab and roadway pavement may be made radial to the roadway baseline.

Transition approach shoulder slabs shall be used on integral and semi-integral structures when asphalt shoulders are adjacent to the concrete approach slab to provide a full concrete bond for the bonded preformed joint seal. They are not required on non-integral structures or if a moment slab or concrete shoulder is adjacent to the approach slab, however they may be utilized at high skewers where the standard roadway barrier base conflicts with the approach bent.

Bridges carrying traffic other than that of the Illinois Tollway shall also be provided with approach pavement at each end of the structure. The approach pavement shall be 30 feet long as detailed in the latest IDOT Base Sheets.

Existing approach slabs and shoulders shall be widened, where required, in kind. The new expansion joints at the roadway end of the approach slab shall match the existing joints unless they are in poor condition, in which case the existing joint shall be reconstructed as part of the approach slab widening.

On bridge replacement or approach slab replacement projects for the mainline bridges and flyover ramps under the Illinois Tollway jurisdiction that provide direct access to the Illinois Tollway, concrete type shall be determined in accordance with Article 5.1.

### 19.2 Approach Slabs for Illinois Tollway Bridges

#### 19.2.1 Integral and Semi-Integral Abutments

The first 30 feet of the approach slab is designed as a one-way structural slab simply supported on a 12-inch-wide seat at the end diaphragm and an approach slab bent at the other end. The next 70 feet of approach slab is a reinforced concrete slab on grade, used as a transition between the one-way slab and the roadway pavement.

Cast-in-place bridge approach slabs shall be anchored to the end diaphragm as shown in the IDOT Bridge Manual Figures 3.8.3-3, 3.8.3-4, 3.8.4-3 and 3.8.4-4. The other end shall be separated from the transition approach slab with an expansion joint located over the approach slab pile bent as shown in Illinois Tollway Base Sheets M-RDY-408 and M-RDY-409. UHPC headers may be considered, with prior approval of the Illinois Tollway, as shown in Figures 19.2.1.1 and 19.2.1.2.

For Integral and semi-integral abutment bridges with a distance from the back of abutment to the centroid of stiffness greater than 130 feet, precast concrete bridge approach slabs shall be considered and detailed in accordance with the Illinois Tollway Base Sheet M-RDY-410.

### **19.2.2 Vaulted Abutments**

The first 30 feet of the approach slab is designed as a one-way slab, simply supported on a 6-inch seat at the abutment end bent and the approach slab bent at the other end. Bridge approach slabs for vaulted abutment bridges shall be detailed in accordance with IDOT base sheets for Vaulted Abutment Approach Spans. The next 70 feet of approach slab is a reinforced concrete slab on grade, used as a transition between the one-way structural approach slab and the approach roadway pavement and shall be detailed in accordance with the Illinois Tollway Base Sheets M-RDY-408 and M-RDY-409 for non-integral bridges.

### **19.2.3 Pile Bent/Stub Abutments**

The first 30 feet of approach slab is designed as a one-way structural slab, simply supported on a 12-inch seat at the abutment and an approach slab bent at the other end. The next 70 feet of approach slab is a reinforced concrete slab on grade, used as a transition between the one-way structural approach slab and the roadway pavement.

The one-way slab shall be anchored to the abutment per Figure 10.3.6. The joints between the abutment and the one-way slab and the one-way slab and the transition approach slabs shall be constructed without any expansion material. The top of these joints shall be tooled or sawed and sealed with hot poured low modulus polymer sealant as shown in Base Sheets M-RDY-408 and M-RDY-409.

## **19.3 Approach Slabs for IDOT, County, Township or Municipal Structures**

### **19.3.1 Integral and Semi-Integral Abutments**

The approach slab shall be detailed and anchored to the abutment in accordance with the Sections 3.8.3 and 3.8.4 of the latest IDOT Bridge Manual.

### **19.3.2 Vaulted Abutments**

The approach slab shall be detailed and anchored to the approach bent and span per IDOT Highway Standard 420401 and Section 3.8.9 of the latest IDOT Bridge Manual.

### **19.3.3 Pile Bent/Stub Abutments**

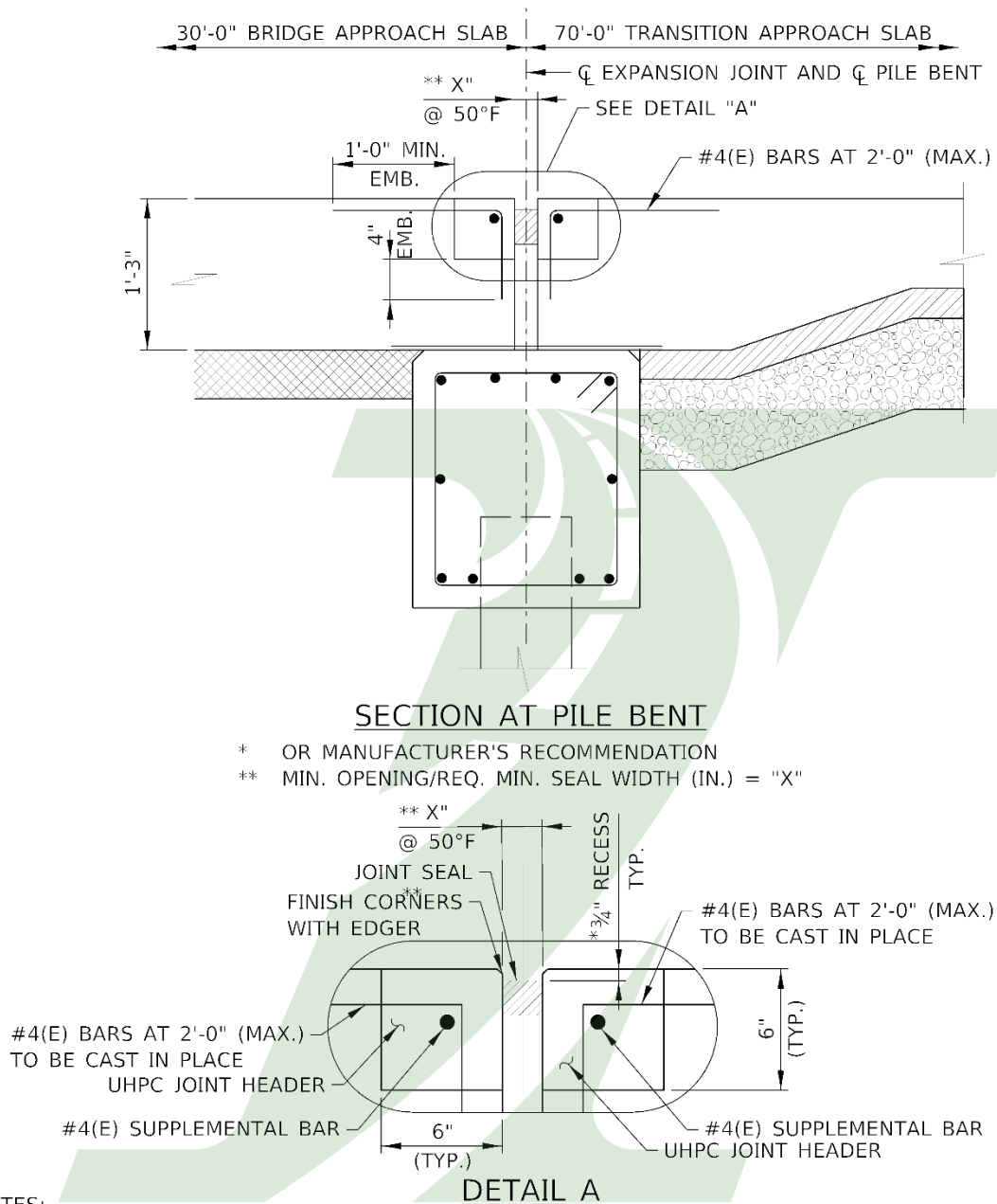
The approach slab shall be detailed and anchored to the abutment per IDOT Highway Standard 420401 and Section 3.8.5 of the latest IDOT Bridge Manual.

## **19.4 Approach Pile Bent**

All approach bents shall be supported by piles in accordance with Base Sheets M-RDY-408 and M-RDY-409. The approach pile bent details shall be included in the structural plans.

The piles shall be designed to support the longitudinally reinforced approach slab similarly to a typical bridge structure. The installation of piles shall be divided into furnishing, driving and test

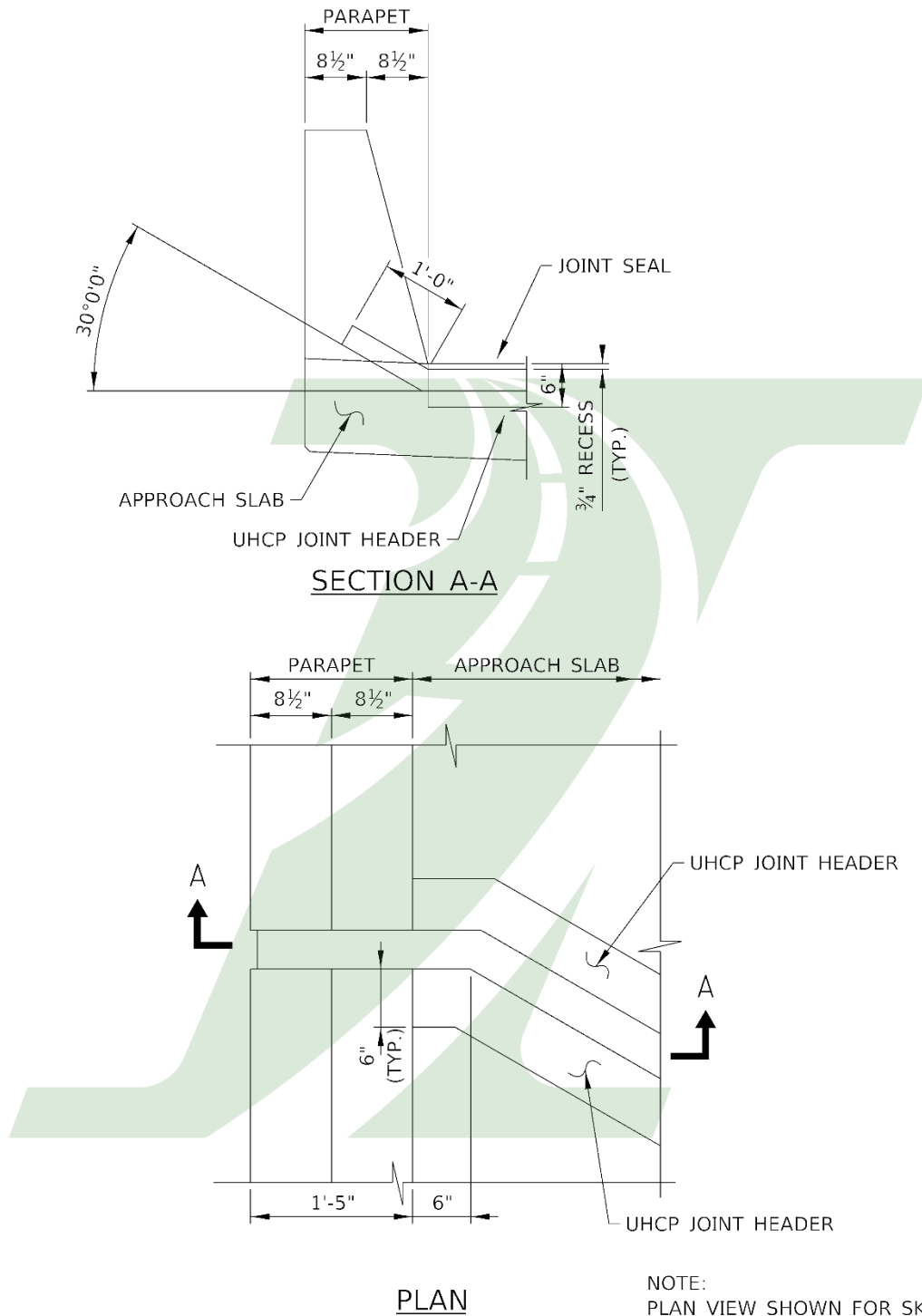
pile pay items. Concrete, reinforcement and piles in the approach pile cap shall not be included in the cost of "Bridge Approach Slab" or "Transition Approach Slab."



NOTES:

1. APPROACH AND TRANSITION APPROACH SLAB REINFORCEMENT NOT SHOWN FOR CLARITY.
2. THE JOINT OPENINGS SHALL BE ADJUSTED IN ACCORDANCE WITH THE FIELD ENGINEER'S INSTRUCTIONS.
3. THE CONTRACTOR SHALL SUPPLY A JOINT SEAL WITH AN UNCOMPRESSED WIDTH EQUAL TO OR GREATER THAN THE DIMENSION NOTED AS "MIN. SEAL WIDTH". THE SEAL SUPPLIED SHALL NOT EXCEED THE MANUFACTURERS COMPRESSION LIMITS AT THE "MINIMUM OPENING" NOTED "X".
4. THE HEADER REINFORCEMENT SHALL HAVE A 2" MINIMUM COVER.
5. SEE FIGURE 19.2.1.2 FOR ADDITIONAL SECTIONS.
6. UHCP HEADERS SHALL BE CONSTRUCTED AND PAY FOR PER THE ILLINOIS TOLLWAY SPECIAL PROVISION "ULTRA-HIGH PERFORMANCE CONCRETE JOINT HEADERS."

**Figure 19.2.1.1: Approach Slab Bonded Preformed Joint with UHPC Header**



**Figure 19.2.1.2: Approach Slab Bonded Preformed Joint Sections**





## SECTION 21.0 CULVERTS

### 21.1 General

Culverts shall be designed in accordance with the latest AASHTO LRFD Bridge Design Specifications and IDOT Culvert Manual, except as herein modified.

Box culverts may be single or multi-cell box, three-sided box or three-sided arch sections constructed of cast-in-place or precast concrete. Culverts are most commonly used to carry water under roadways, but they are also used for pedestrian/bicycle underpasses. The minimum size for a pedestrian/bicycle underpass is 10 feet high by 10 feet wide. Typical sections for the most frequently used box culverts are shown in Figure 21.1.1.

For culverts over waterways, a type study shall be performed in accordance with the Illinois Tollway Drainage Design Manual Article 8.1 to ensure that the type selected is in accordance with United States Army Corps of Engineers permits.

Corrugated metal arch or box culverts are not permitted for new or replacement structures. Existing CMP pipes shall be replaced during any reconstruction/rubblization projects.

Hydraulic and geometric requirements of the site shall determine the area and maximum height of the culvert. Once the maximum height and required area are determined, the selection of the type of culvert, its construction and number of cells is determined by economics and site conditions. Barrel lengths are computed to the nearest 6 inch.

The designer shall determine the end of the barrel based on a barrier warrant analysis (see Article 3.2). For multi-cell culverts, the cell widths shall be kept equal.

Wingwalls shall be designed according to the IDOT Culvert Manual. Horizontal Cantilever Wingwalls shall be used for wingwall lengths less than or equal to 16 feet. If longer walls are required, T-Type or L-Type Vertical Cantilever Wingwalls shall be used for lengths of up to 30 feet. Reinforced concrete aprons between the wingwalls and safety end treatments shall be placed at both ends of the culvert. The barrel section of a culvert used for a pedestrian/bicycle under pass shall be covered with a waterproof membrane system for buried structures and geocomposite wall drain, in accordance with Section 581 and 591 respectively of the latest IDOT Standard Specifications and IDOT ABD Memorandum 19.2.

#### 21.1.1 Cast-In-Place Concrete Culverts

All designs shall be in accordance with the latest version and interims of the AASHTO LRFD Bridge Design Specifications and the latest edition of the IDOT Culvert Manual.

All reinforcement bars for cast-in-place concrete box culverts shall be epoxy coated.

#### 21.1.2 Precast Concrete Culverts

Precast concrete culverts are used where labor and materials are not readily available, and when the duplication and installation of identical precast culvert sections would be more economical than cast-in-place construction. Precast concrete culverts are not suitable in areas where the supporting soils are susceptible to excessive or differential settlements, unless they are supported by a reinforced concrete slab or strip footing founded on piles or if settlement can be reduced by providing subgrade improvement.

A minimum of 6 feet of the barrel shall be poured monolithically with horizontal cantilever wingwalls.

## 21.2 Plan Preparation

Plan sheets for culverts shall contain the following information:

### 21.2.1 General Plan and Elevation

The general plan and elevation sheet shall include the following information:

- Roadway alignment data, both horizontal and vertical
- Roadway and embankment slopes
- Station and elevation at the centerline of the culvert, showing locations of the joints, if any
- Culvert and wingwall lengths, dimensions and reinforcement bar details
- Barrel invert elevations
- Slope and direction of flow
- Section thru barrel showing all concrete dimensions and reinforcement bar details
- Headwall dimensions and reinforcement bar details
- General Notes
- Index of Sheets
- Bill of Material
- Location of borings
- Design Specifications
- Construction Specifications
- Design Stresses

### 21.2.2 Design Criteria

- The latest version and interims of the AASHTO LRFD Bridge Design Specifications
- IDOT All Bridge Designers (ABD) Memorandum 19.2 dated March 5, 2019 and ABD 21.1 dated July 23, 2021
- The latest IDOT Standard Specifications for Road and Bridge Construction and all subsequent Supplemental Specifications
- The latest Illinois Tollway Supplemental Specifications to the IDOT Standard Specifications for Road and Bridge Construction

### 21.2.3 Bill of Material

Regardless of the placement of a coded “Summary of Quantities” on any other plan sheet, there shall be a “Total Bill of Material” shown in the plans for each box culvert.

### 21.2.4 Construction Staging

If the culvert is to be constructed in stages, the plans shall clearly identify and show all stages of construction. Construction staging lines shall be shown on all views. The staging plans shall also include the location and details of the temporary concrete barriers and Temporary Construction Works, if required. The temporary construction details shall show removal and placement of the temporary construction during staged construction to properly retain the existing earth as well as the proposed fill built above the proposed culvert in the prior stage.

### 21.2.5 Concrete Reinforcement Details

A Bar List shall be prepared for each culvert and shown along with bending diagrams of each bent bar on the appropriate plan sheet. See Figure 6.7.1 for the Bar List format.

In no case shall the same designation be used for reinforcement bars of a different size, length and shape when they are employed in other culverts. When detailing lengths of reinforcement bars, consideration shall be given to transportation and handling and, where extremely long lengths are contemplated, to availability and special orders.

All sizes of bars are readily available in lengths up to 60 feet. However, sizes #3, #4, and #5 of more than 40 feet tend to bend in handling and shall be avoided.

Bars shall be detailed to the nearest inch of length and the weight of reinforcement bars shown in the Bill of Material shall be to the nearest ten (10) pounds.

To provide uniformity on all culvert plans, bar designations used shall be as follows:

- a – Top Slab (Transverse)
- b – Top Slab (Longitudinal)
- h – Barrel Walls and/or Wing Walls (Horizontal)
- n – Footing to Wall (Dowels)
- s – Stirrups
- t – Bottom Slab and /or Footing (Transverse)
- v – Barrel Walls and/or Wing Walls (Vertical)
- w – Bottom Slab and/or Footing (Longitudinal)

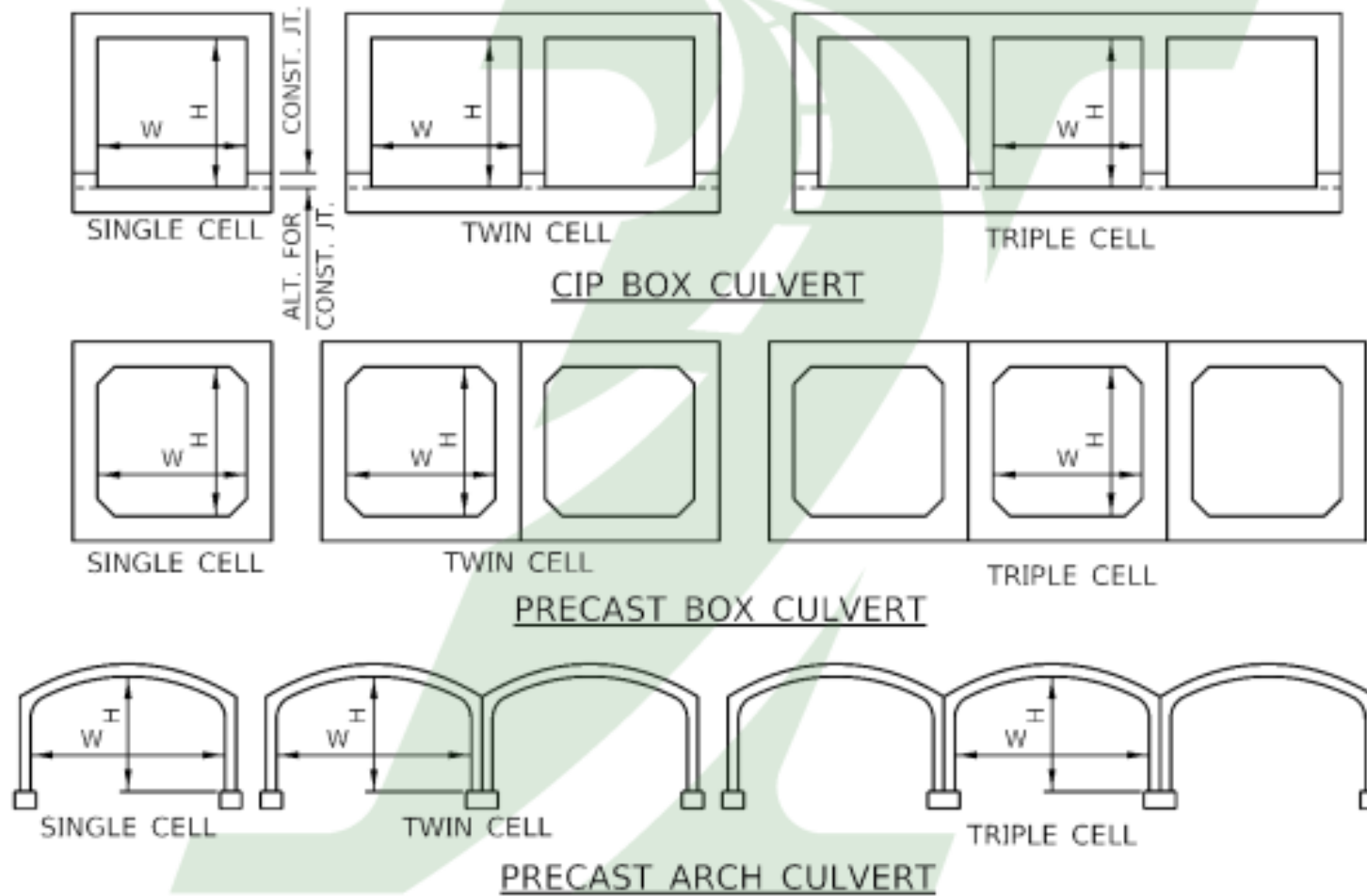


Figure 21.1.1: Culvert Details

## SECTION 22.0 RETAINING WALLS

Retaining walls shall be designed in accordance with Section 11 of the latest AASHTO LRFD Bridge Design Specifications and the Illinois Tollway Geotechnical Manual.

### 22.1 Wall Types

Retaining wall structures are used to hold back soil or loose material where an abrupt change in ground elevation occurs. There are several types of retaining wall structures. Depending on the application, certain wall types are more advantageous than others.

- The Designer shall generalize the site as being either a fill wall location or a cut wall location.
- A fill wall location is characterized by a substantial increase in the ground elevation behind the wall. Fill walls are also appropriate when excavation for the wall can be made without: disruption to traffic lanes that will not be replaced, the need for temporary soil retention or excessively steep or unsafe cut slopes.
- A cut wall location is characterized by a reduction in the ground elevation in front of the wall with minimal or no increase in ground elevation behind the wall.

Fill Walls	Cut Walls
Cast-in-Place T-shaped or L-Shaped	Soldier Piles
Mechanically Stabilized Earth	Sheet Pile
Precast Modular	Soil Nails
Gabion	Tangent Drilled Shafts

- The Designer shall also evaluate a performance-based wall as a feasible wall type. The cost/benefit of a performance-based wall versus a designed wall shall be considered in the selection process. If a performance-based wall is determined to be the most cost-effective retaining wall system, the Designer shall consider permits, Contractor accessibility, right-of-way, schedule, utilities, interactions between pay items and Contractor designed elements, and MOT, as well as coordination with adjacent walls, sections, or stages and shall develop requirements for the interface in the contract requirements.

### 22.2 Retaining Wall Selection Process

For discussion of the retaining wall selection process, refer to Sections 2.3.5.5 and 2.3.12 in the IDOT Bridge Manual.

The Designer shall submit a feasibility study to the Illinois Tollway prior to preparation of TS&L plans. The purpose of the feasibility study is to select the most cost-effective retaining system for advancement to the TS&L Phase. As part of the feasibility study, the Designer shall investigate a “no wall” option. This option may often require additional right-of-way, earth work and/or relocation of existing utilities and existing structures. If the “no wall” option is not feasible, the Designer shall study a combination of slopes and wall types to minimize the wall length and height, while remaining aesthetically acceptable and cost effective.

The entirety of the retaining wall shall be constructed within the Illinois Tollway right-of-way. The constructability of the retaining wall shall be considered in the selection, including that construction operations do not encroach on private property.

If a performance-based retaining wall is recommended, any alternate retaining wall types not allowed shall be stated in the construction contract specifications.

The feasibility study shall include the following items:

1. Introduction – Discussion of the project and location of the retaining wall.
2. Reason for Retaining Wall – Discussion of the improvement, including impact on adjacent property or structures.
3. Retaining Wall Criteria – Design loads, allowable soil pressures, site constraints and design requirements for the retaining wall.
4. Retaining Wall Description – Discussion of the location, geometry and other physical features of the retaining wall.
5. Structural Alternates – Description and cost estimate for each of the wall types investigated including “No Wall” option.
6. Discussion and Recommendation – Summary of findings for each of the wall types along with a recommendation of which alternate to advance to the TS&L Phase.

The feasibility study shall also include the following exhibits:

- Proposed alignment and roadway plan
- Proposed roadway cross sections
- Preliminary general plan and elevation sketch
- Retaining wall typical sections
- Retaining wall cost estimates
- Boring location map
- Boring logs

## 22.3 Plan Preparation

### 22.3.1 Plan Sheet Organization

Each retaining wall shall consist of a set of sequentially numbered plan sheets. Plan sheets shall be organized in such a manner as to facilitate construction. The first sheet shall be a plan and elevation view of the entire wall showing its alignment including stations and offsets to each end of the wall and intermediate control points. The location of all lighting, signing, fencing, drainage structures and utilities located under, on, or adjacent to or passing through the wall shall be shown. Also, all design criteria shall be listed.

The TS&L and final plans shall include a true wall section(s) which shows wall offsets to base line(s) and R.O.W.

The second sheet shall contain an index of sheets, general notes, abbreviations, total bill of material, typical wall section and drainage details.

Subsequent sheets shall completely detail and dimension each succeeding section of the retaining wall in plan and elevation views. Wall sections and details shall be included on each sheet. See Figures 22.3.1.1 through 22.3.1.7 for retaining wall details.

Each retaining wall plan set shall include pile driving record tables and boring log sheets for the data that pertains to the retaining wall. The bottom of footing elevation shall be shown on the appropriate boring log and identified as “Bottom of Retaining Wall Footing.”

### 22.3.2 Naming Convention

Retaining walls shall be identified on the plans using the following format:

Illinois Tollway Milepost Wall Type, Direction (Ramp)

TOLLWAY:

EW = Reagan Memorial Tollway (I-88)  
 NS = Veterans Memorial Tollway (I-355)  
 NW = Jane Addams Memorial Tollway (I-90)  
 TS = Tri-State Tollway (I-294 & I-294/I-80)  
 TN = Tri-State Tollway (I-94)  
 ES = Edens Spur (I-94)  
 EO = Elgin-O'Hare Tollway (IL 390)  
 WA = West O'Hare Access (I-490)

MILEPOST:

Two-decimal lowest wall milepost to the tenth or hundredth if a  $\frac{1}{4}$  mile post (i.e., 14.75)

WALL TYPE:

R = Retaining Wall

DIRECTION:

EB, SB, WB, NB - Inventory direction of the mainline roadway

RAMP:

(R) = if lowest milepost is along ramp (omitted if not along ramp)

EXAMPLE:

TS38.40R,NB(R) for a retaining wall located along the Tri-State Tollway (I-294) northbound at milepost 38.4 on a ramp

If two walls of the same type have identical starting mileposts, the inventory milepost of one of the walls shall be shifted by one hundredth of a mile to create unique names. A new wall designation shall be used when the wall type changes. For median retaining walls, designation shall omit the direction.

## 22.4 Wall Design Criteria

### 22.4.1 Design Specifications

See Article 5.1.

### 22.4.2 Design Loads

- Dead Loads
  - See Article 5.1.



- Live Loads
  - See Article 5.1.
- Earth Pressure
  - See Article 5.1. The formula to compute lateral earth pressure is Coulomb's equation for the resultant parallel to the backfill slope. The maximum angle of internal friction for granular material shall be  $= 30$  deg.
  - The formula to compute lateral earth pressure for sloping backfill assumes the mass of earth behind the wall extending to the point of intersection of the two planes (slope plane and failure plane of soil). In many cases the sloping backfill ends at a certain height above the wall where a roadway is intersected. The formula gives conservative results for this case. See Figure 22.4.2.1 for details
- Wind Loads
  - A wind load on the parapet and/or noise abatement wall shall be applied to the exposed surface area in any direction.
- Seismic Loads
  - In accordance with Article 3.10 of the AASHTO LRFD Bridge Design Specifications.
- Vehicular Collision Loads
  - See Article 10.2 for walls shielding a bridge component. When a retaining wall is within the clear zone, it shall be designed for TL-4 impact loading or shielded with a TL-4 concrete barrier (see Standard C3). Additional guidance may be found in the Traffic Barrier Guidelines Articles 3.8 and 5.7.10 .

### 22.4.3 Design Stresses

See Article 5.1.

### 22.4.4 Wall Layout

Slopes in front of all wall types shall not be continued into or away from the wall. A flat area shall be provided in front of the wall for maintenance and to ensure adequate frost line clearance. A 4-foot desirable width and a 2-foot minimum width shall be used for this flat area.

## 22.5 Cast-in-Place T-Shaped or L-Shaped Walls

Cast-in-place T-shaped and L-shaped walls shall be designed in accordance with Sections 3.10 and 3.11 of the latest IDOT Bridge Manual except as amended herein.

### 22.5.1 Description

In general, the Illinois Tollway utilizes cantilever T-shaped retaining walls in fill locations up to a height of 25 feet. For details of a T-shaped wall see Figures 22.5.1.1 thru 22.5.1.3. Counterforted I-walls and/or I-shaped walls may also be used for special cases.

Typically, a T-shaped wall is more economical than an L-shaped wall. L-shaped walls are utilized only in cases where the face of the wall is located adjacent to or right on the ROW, property line or obstruction. When used, consideration shall be given to constructability and future access to the face of wall. A permanent easement shall be acquired when the face of wall is 4 feet or less from the ROW line.

### 22.5.2 Stem

The minimum thickness at the top of the stem is 12 inches. For stems requiring thickness greater than 12 inches at the base, batter is provided on the back face of the stem (the face in contact

with the earth) in increments of  $\frac{1}{4}$  inch per foot up to a maximum of  $\frac{3}{4}$  inch per foot. The batter shall be held constant for the entire length or section of the retaining wall where it is required.

The stem shall be designed to accommodate crash Test Level 5 (TL-5) loading. See the latest AASHTO LRFD Table A.13.2-1 for loading details. The stem shall have sufficient resistance to force the yield line failure pattern to remain within the parapet and shall be designed for the full dynamic load.

Drainage behind the stem shall consist of a geocomposite wall drain and porous granular backfill, consistent with Section 3.11.2.3 of the IDOT Bridge Manual, except as modified herein. The geocomposite wall drain shall be continuous. Refer to Figures 22.3.1.2 and 22.5.1.1 for illustration.

### 22.5.3 Footing

The bottom of footing shall be set below the frost penetration depth, which is generally 4 feet below the top of finished grade. The minimum spread footing thickness shall not be less than 18 inches or the stem thickness at the base plus 3 inches.

For pile supported footings, the minimum thickness shall be 2'-6" and the piles shall be embedded 12 inches. The front row(s) shall be battered if the piles' lateral resistance to sliding is not adequate. The maximum pile spacing shall be as specified in Section 3.10 of the IDOT Bridge Manual. For walls with pile footings it is usually more economical to use the minimum width of footing where feasible rather than to increase the footing width to reduce the number of piles.

If the top of finished ground is sloped along the face of wall, a stepped footing shall be considered. For details of stepped footings and minimum thickness requirements, see Figures 22.5.3.1 and 22.5.3.2.

The footing shall be designed to accommodate crash Test Level 5 (TL-5) loading. See the latest AASHTO LRFD Table A.13.2-1 for loading details. Guidance on the magnitude of force applied to the footing is limited; however, a reduction in energy will occur as the yield line develops within the parapet and forces are transferred through the stem. The footing and piles shall be designed for the equivalent static load of 23 kips applied over 8 feet at the top of the 44" parapet or 106 kips applied over 10 feet at 52 inch above pavement for the 72" barrier.

### 22.5.4 Stability

The eccentricity limits for spread footings on soil or rock shall be according to AASHTO LRFD 11.6.3.3.

Resistance factors for bearing and sliding shall be according to AASHTO LRFD Table 10.5.5.2.2-1.

Factors resisting sliding for spread footings:

- Friction Between Soil and Concrete
  - Friction resistance shall be according to Section 10 of the latest AASHTO LRFD Bridge Design Specifications.
- Shear Keys for Spread Footings on Soil

- The shear key shall be located in line with the front face of the stem except under severe loading conditions. The width and depth of the shear key shall be 1'-0" minimum. The shear key shall be placed against undisturbed material.
- The total resistance to sliding shall be based on the soil strength in front of the shear key and adhesion between the footing and soil behind the key.
- Shear Keys for Spread Footings on Rock
  - The width of the key shall be 1'-0" minimum. The footing shall be keyed a minimum depth of 6" into the rock.
- Pile Footings
  - The maximum slope to be used for determining the horizontal resistance of a battered pile shall be 3 inches horizontal per foot vertical.
  - The lateral resistance of battered or vertical piles, in addition to horizontal component of battered piles, shall be as specified in the Structure Geotechnical Report.

## 22.6 Flexible Retaining Walls

Flexible retaining walls include: Mechanically Stabilized Earth (MSE), Precast Modular, Soldier Pile, Sheet Pile, Soil Nail and Gabion.

Walls shall be located a minimum of 10'-0" inside of the Illinois Tollway's Right of Way.

The required design life for all elements of retaining wall structures is 75 years except for walls in front of bridge abutments which require a design life of 100 years.

Provide full height expansion joints in the moment slab, gutter and parapet every 90 feet. The expansion joints shall be detailed as shown in Figure 22.14.1. Parapet joint spacing and details shall be per Article 15.5.1 for the 44" parapet and Article 15.5.2 for the 72" barrier. Joint spacings in the parapet, moment slab and retaining wall should be aligned.

Design loads for retaining walls with moment slabs shall include the provisions of the AASHTO LRFD Bridge Design Specifications, Article 11.10.10.2 and Test Level 5 (TL-5). In order to achieve TL-5 crash force protection, all designers shall increase the specified horizontal load applied to the top of the soil mass from 0.5 kip per foot, developed for TL-4, to 1.15 kips per foot (for TL-5) and 2.4 kips per foot (for 72" TL-5). The magnitude of the force was determined by multiplying the ratio of the TL-5 or 72" TL-5 crash force (124 kips or 260 kips) over the TL-4 crash force (54 kips) by 0.5 kip per foot.

When structural steel is in contact with the ground, the effects of corrosion shall be included in the design. The specification and accommodation for the length of the corrosion are the responsibility of the Designer with approval of the Illinois Tollway. Paint used shall be specified by the Designer and shall be consistent with Section 506 of IDOT Standard Specifications. The IDOT Bridge Manual also references concrete encasement and use of additional sacrificial steel section. Paint or concrete in exposed conditions shall generally extend to 3 feet beyond expected exposure line including the fully exposed length. Section 506 of the Standard Specifications for paint shall be used in corrosive soils with or without exposure. If protection is not specified for exposed or corrosive conditions, additional steel section shall be supplied to compensate for losses due to corrosion.

### 22.6.1 Mechanically Stabilized Earth (MSE) Retaining Walls

Generally, MSE walls shall only be utilized for fill locations or where part of the existing side-slope or fore-slope can be removed without compromising the stability of the embankment. MSE walls

shall not be utilized where a Temporary Earth Retention System would be required to construct the reinforced wall mass except in special cases.

The Designer shall be responsible for the analysis of settlement, bearing capacity and overall slope stability for MSE retaining walls and shall coordinate with the Geotechnical Engineer during the Concept (30%) Design Phase.

#### **22.6.1.1 Location**

MSE walls are not allowed at water crossings or adjacent to water where hydraulic draw down within the wall limits is possible.

#### **22.6.1.2 Plans and Specifications**

The Contractor shall be provided with plans showing a line diagram envelope (Elevation View) of the proposed wall location, grades, and dimensions. Specifications shall be furnished covering the work requirements for design, construction plans, materials procurement, and wall construction. The prequalified retaining wall supplier selected by the Contractor shall submit a complete set of design calculations, detailed plans, and explanatory notes for the designer's review and acceptance prior to ordering any material. The design shall be in accordance with the latest AASHTO LRFD Bridge Design Specifications and the special provisions.

When Performance Based MSE Walls are used, the Designer shall define limits of all pay items that could vary based on the MSE Wall proprietary design, such as but not limited to, Structure Excavation limits.

The designer shall prepare plan sheets containing the following information:

- Site plan with boring locations
- Wall plan with stations and offsets
- Top of wall elevations (located at the top of exposed panel line)
- Top of ground elevations at front and back face of wall
- Safety-parapet railing, or fence requirements
- Special coping requirements
- Utility accommodations
- Drainage requirements
- All special design features
- Subsurface information (the proprietary wall companies shall be informed of all geotechnical stability and settlement concerns)
- Wall surface textures
- Wall design criteria
- Bearing requirements
- Minimum footing depth (generally 4'-0", which is considered to be the frost penetration depth)
- Theoretical Top of Levelling Pad
- Payment limits of Structure Excavation

### **22.7 Precast Modular Walls**

Block retaining walls shall be designed in accordance with the applicable parts of Section 3.11.1 of the IDOT Bridge Manual and the latest LRFD AASHTO Bridge Design Specifications except as amended herein.

When specifying a proprietary block retaining wall, the special provisions shall state that the wall shall be built according to the manufacturer's specifications. The manufacturer's specifications generally need to be supplemented. Material specifications for backfill, leveling pad, drainage systems, fill for hollow blocks, geotextile fabrics or any other special requirements shall be clearly stated in the special provisions.

Modular block retaining walls shall be designed and sealed by the manufacturer's Illinois Licensed Structural Engineer. Soil reinforcement shall be either galvanized or coated steel or polypropylene or polyester geogrids. In the absence of more accurate data, design loads on the wall shall be based on a non-cohesive material with an angle of internal friction of 34 deg. The minimum size of the concrete leveling pad shall be 6 inches deep by 12 inches wide. All steel components of a system shall be hot dipped galvanized in accordance with the AASHTO M111 (ASTM A123).

## **22.8 Soldier Pile Retaining Walls**

Soldier pile walls shall be designed in accordance with Section 3.11.3 of the latest IDOT Bridge Manual and the latest AASHTO LRFD Bridge Design Specifications except as amended herein. Timber lagging is not permitted as a facing material for permanent soldier pile walls.

## **22.9 Permanent Sheet Pile Retaining Walls**

Permanent sheet pile retaining walls shall be designed in accordance with Section 3.11.4 of the latest IDOT Bridge Manual.

## **22.10 Soil Nailed and Other Specialized Wall Systems**

Soil nailed and other specialized wall systems shall be designed in accordance with Section 3.11.6 of the latest IDOT Bridge Manual.

## **22.11 Temporary Soil Retention Systems**

Temporary soil retention systems, including temporary sheet piling, wire-faced MSE walls, braced excavations and other temporary construction works shall be designed in accordance with Section 3.13 of the latest IDOT Bridge Manual.

## **22.12 Snow Storage Area**

The need for and design of the snow storage area shall be according to the latest version of the Illinois Tollway Roadway Design Criteria Article 2.6.7. Figure 22.12.1 Structure Mounted Noise Abatement Wall on Moment Slab with notes included provide the configuration and design of the barrier for attached noise abatement wall on a moment slab including snow storage as per the notes when needed.

## **22.13 Parapet Shape**

The Illinois Tollway uses 44" Constant-Slope parapet shapes for retaining walls. Parapet shall be designed to accommodate crash Test Level 5 (TL-5). See the latest AASHTO LRFD Table A.13.2-1 for loading details.

The Constant-Slope parapet integral with the retaining wall shall extend 6" below finished grade. See Figure 22.5.1.3 as an example.

## **22.14 Moment Slab on Retaining Wall Design Guides**

A moment slab includes both the horizontal slab and the 44" Constant-Slope vertical parapet that is attached to the slab. Design loads for strength that include flexure, shear and torsion are applied

in accordance with the AASHTO LRFD Bridge Design Specifications, Section 13, Table A13.2, Test Level 5 (TL-5). Design loads for global stability including sliding and overturning shall follow recommendations of NCHRP 663 for standard height barrier and NCHRP 22-20(2) for 72" barrier. Prior to this change, walls and moment slabs were designed in accordance with AASHTO Standard Specifications Load Factor Design (LFD) methodology.

Exposed moment slabs shall be used for a rigid pavement shoulder. Figures 22.14.2 and 22.12.1 illustrates typical reinforcement bar details for an exposed moment slab. Buried moment slabs shall be used for a flexible pavement shoulder. Figure 22.14.3 shows cast-in-place buried moment slab with integrated concrete gutter. Details for buried moment slab with noise abatement wall are shown in Figure 22.14.7. Other cases may include when a TL-5 barrier is required but site limitations require an L-shape section or a smaller width of slab is preferred over the exposed moment slab details.

Material to be placed beneath the moment slab shall match the adjacent lane base material. This material shall have a total minimum thickness of 6 inches for porous granular subbase and 9 inches for subgrade aggregate. This layer is to be detailed on the plans.

Concrete for moment slabs under the Illinois Tollway jurisdiction shall be placed in accordance with the following policy:

- HP Concrete,  $f'c=4,000$  psi min. shall be used for moment slabs.
- IDOT Class BS Concrete,  $f'c=4,000$  psi min. shall be applied on moment slab parapets and barriers.
- IDOT Class SI Concrete,  $f'c=3,500$  psi min. shall be used for the slab of buried moment slabs.

**Structural Capacity** – The structural capacity of the parapet and concrete moment slab shall be designed using dynamic TL-5 loads in accordance with Sections 5 and 13 of the AASHTO LRFD Bridge Design Specifications for the 44" parapet and in accordance with Article 15.5.2 for the 72" barrier.

**Global Stability** – Sliding and overturning stability of the moment slab shall be based on an Equivalent Static Load (ESL) applied to the top of the traffic parapet. For TL-5 parapet systems, the ESL shall be 23 kips for 44" parapet and 106 kips for 72" barrier.

**Rigid Body Definition** – Moment slabs that have a minimum width of 4'-0" measured from the point of rotation to the heel of the slab and a minimum average depth of 10" are assumed to provide rigid body behavior up to a length of 60' for end parapet and interior parapet impacts. Rigid body behavior may be increased from 60' to a maximum of 120' if the torsional rigidity constant of the moment slab is proportionately increased and the reinforcement bars are designed to resist combined shear, moment, and torsion from impulse loads.

**Sliding of the Moment Slab** – The factored static resistance to sliding ( $\phi P$ ) of the parapet-moment slab system along its base shall satisfy the following condition (See Figure 22.14.1).

- $\phi P \geq \gamma L_s$
- $L_s$  = equivalent static load TL-5 (23 kips for Standard height barrier) or (106 kips for 72" barrier)
- $\phi$  = resistance factor (1.0 for Standard height barrier) [AASHTO LRFD Article 10.5.5.3—Other Extreme Limit States] or (0.8 for 72" barrier) [AASHTO LRFD Table 10.5.5.2.2-1]
- $\gamma$  = load factor (1.2 for Standard height barrier) or (1.0 for 72" barrier)



- $P$  = static resistance (kips)
- $P$  shall be calculated as:
- $P = W \tan \phi_r$
- $W$  = weight of the monolithic section of parapet and moment slab between joints or assumed length of rigid body behavior, whichever is less, plus any material laying on top of the moment slab
- $\phi_r$  = friction angle of the soil on the moment slab interface ( $^\circ$ )

If the soil/moment slab interface is rough (e.g., cast in place),  $\phi_r$  is equal to the friction angle of the soil  $\phi_s$ . If the soil/moment slab interface is smooth (e.g., precast),  $\tan \phi_r$  shall be reduced accordingly to  $0.8 \tan \phi_s$ .

**Overtuning of the Moment Slab** – The factored static moment resistance ( $\phi M$ ) of the parapet/moment slab system to over-turning shall satisfy the following condition (See Figure 22.14.1).

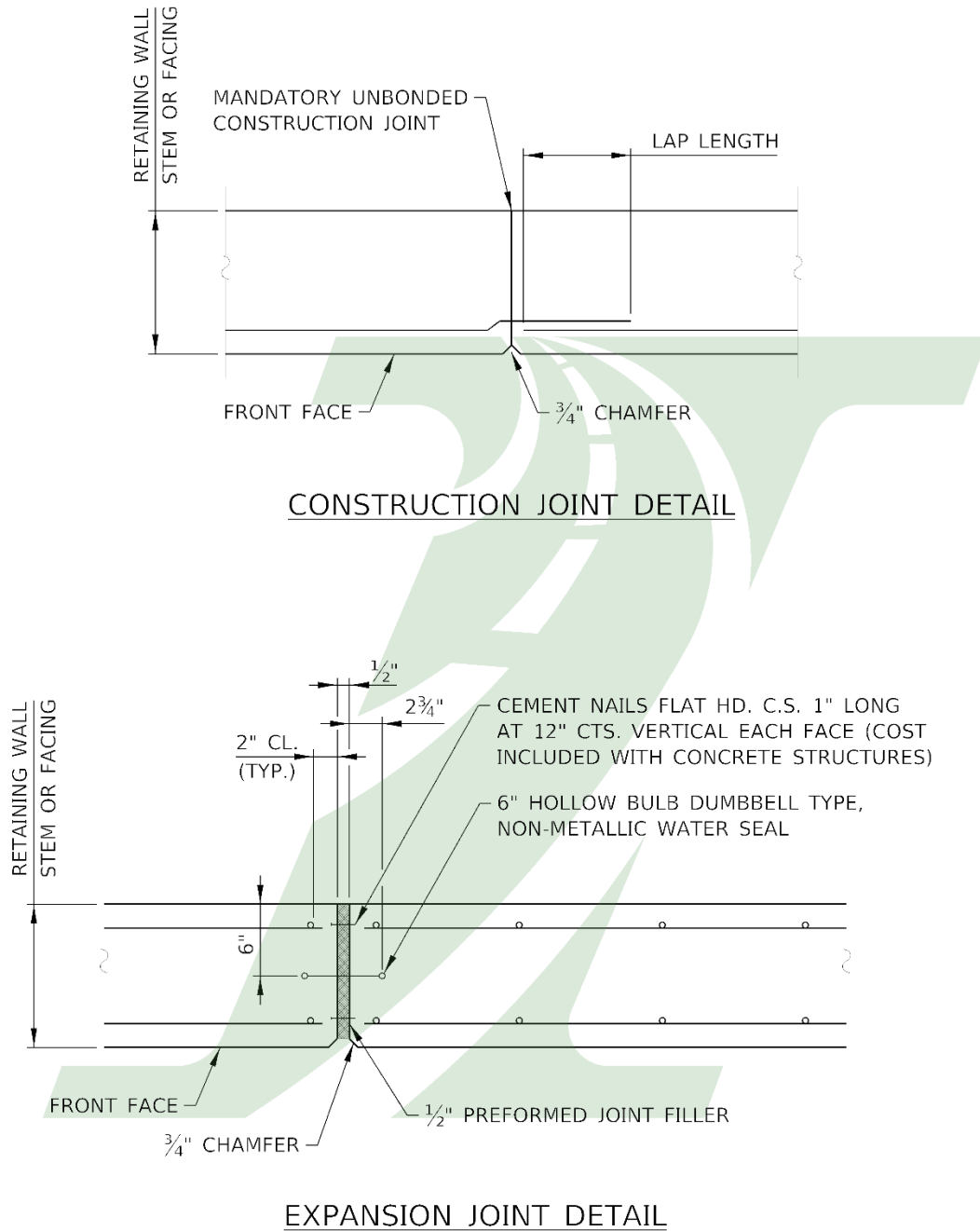
- $\phi M \geq \gamma L_s h_a$
- $A$  = point of rotation, where the toe of the moment slab makes contact with compacted backfill adjacent to the fascia wall
- $L_w$  = width of moment slab
- $L_s$  = equivalent static load TL-5 (23 kips for Standard height barrier) or (106 kips for 72" barrier)
- $\phi$  = resistance factor (0.5 for Standard height barrier) [Supersedes AASHTO LRFD Article 10.5.5.3.3—Other Extreme Limit States and NCHRP Report 663] or (0.8 for 72" barrier)
- $\gamma$  = load factor (1.2 for Standard height barrier) or (1.0 for 72" barrier)
- $h_a$  = moment arm taken as the vertical distance from the point of impact due to the dynamic force (top of the parapet) to the point of rotation  $A$
- $M$  = static moment resistance (kips-ft)
- $M$  shall be calculated as:
- $M = W (L_a)$
- $W$  = weight of the monolithic section of parapet and moment slab between joints or assumed length of rigid body behavior, whichever is less, plus any material laying on top of the moment slab
- $L_a$  = horizontal distance from the center of gravity of the weight  $W$  to point of rotation  $A$

The moment contribution due to any coupling between adjacent moment slabs, shear strength of the overburden soil, or friction which may exist between the backside of the moment slab and the surrounding soil shall be neglected.

Figures 22.14.2 and 22.12.1 illustrates typical reinforcement bar details for a moment slab. Figures 22.14.3 and 22.14.7 illustrates typical reinforcement bar details for a buried moment slab.

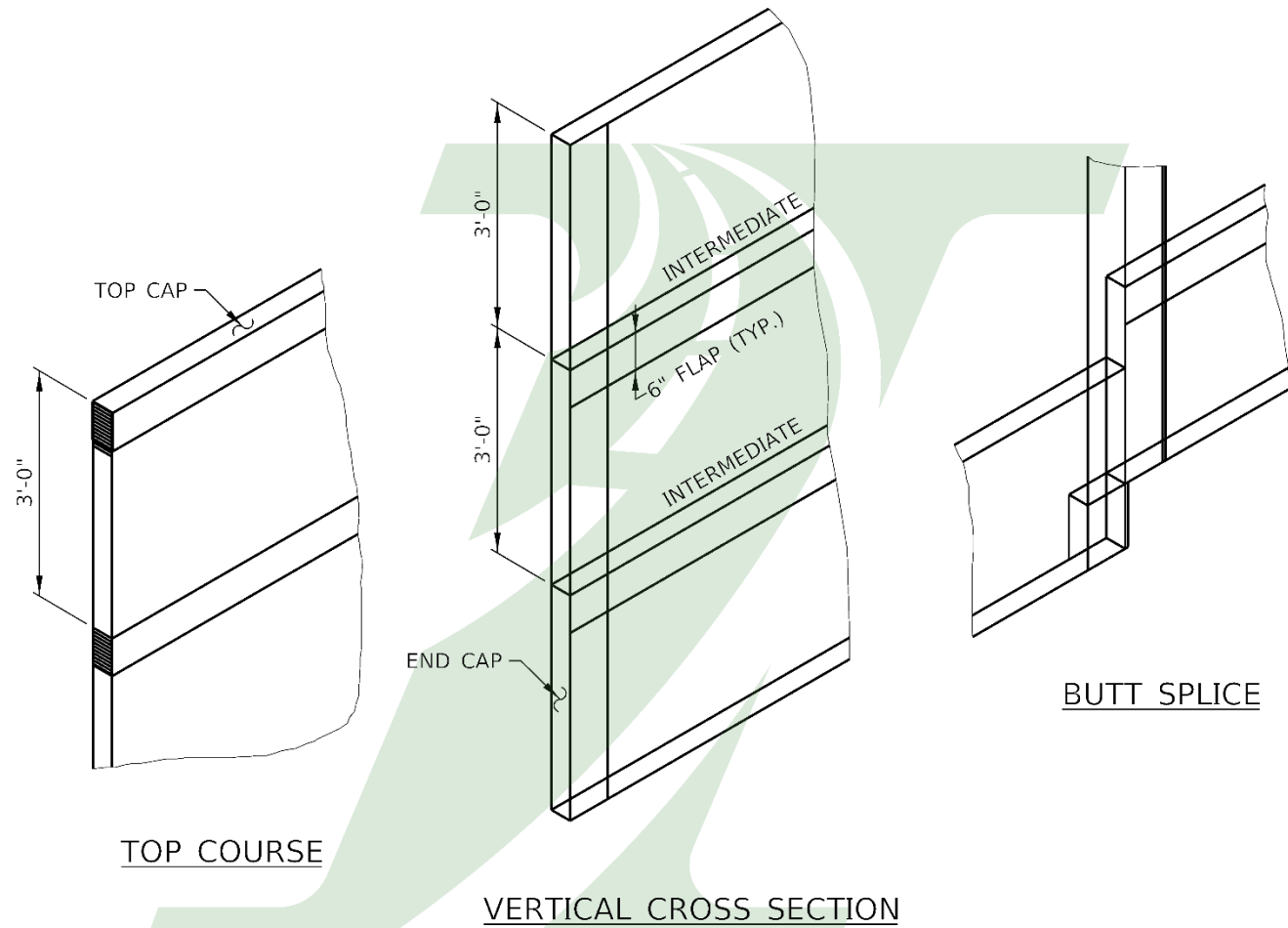
## 22.15 Safety Fencing

Safety fencing shall be considered when a parapet is not required based on an Illinois Tollway barrier warrant analysis. For walls without parapets and exposed heights greater than 4 feet, a railing and/or fencing shall be provided. Where a retaining wall continues under a bridge, the need for a safety fence shall be evaluated on a case-by-case basis. See Figure 22.5.1.1 for details.

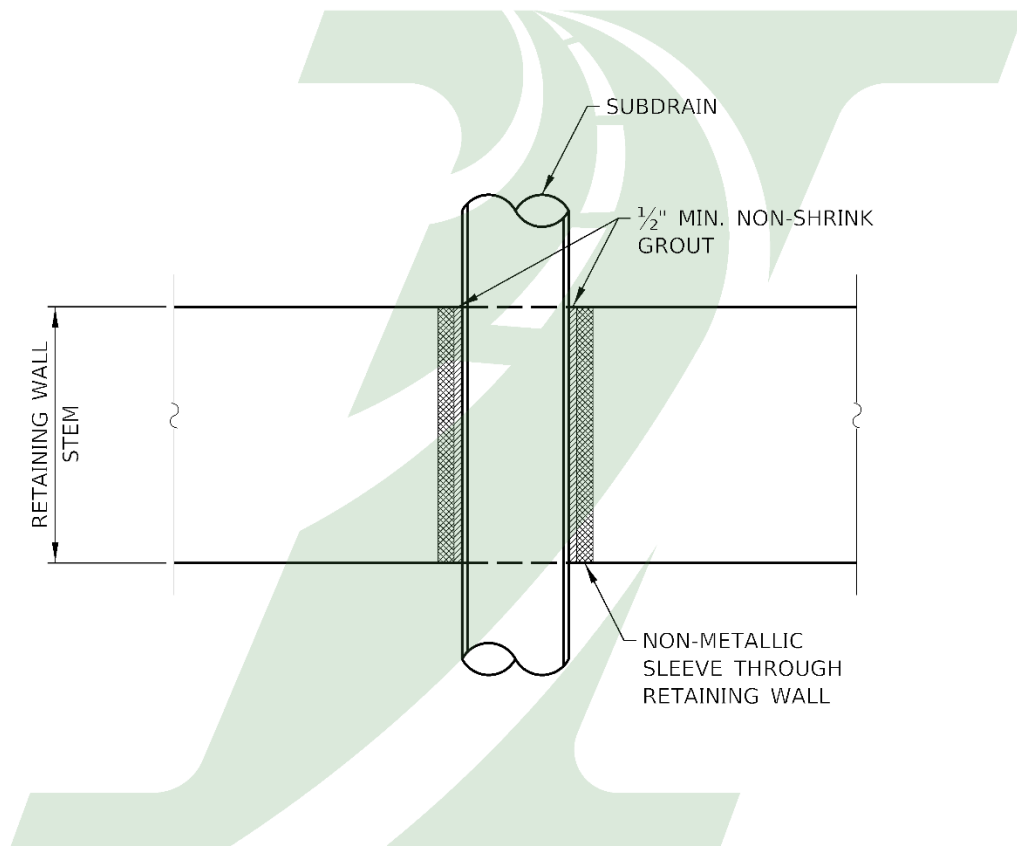


**Figure 22.3.1.1: Retaining Wall Joint Details**

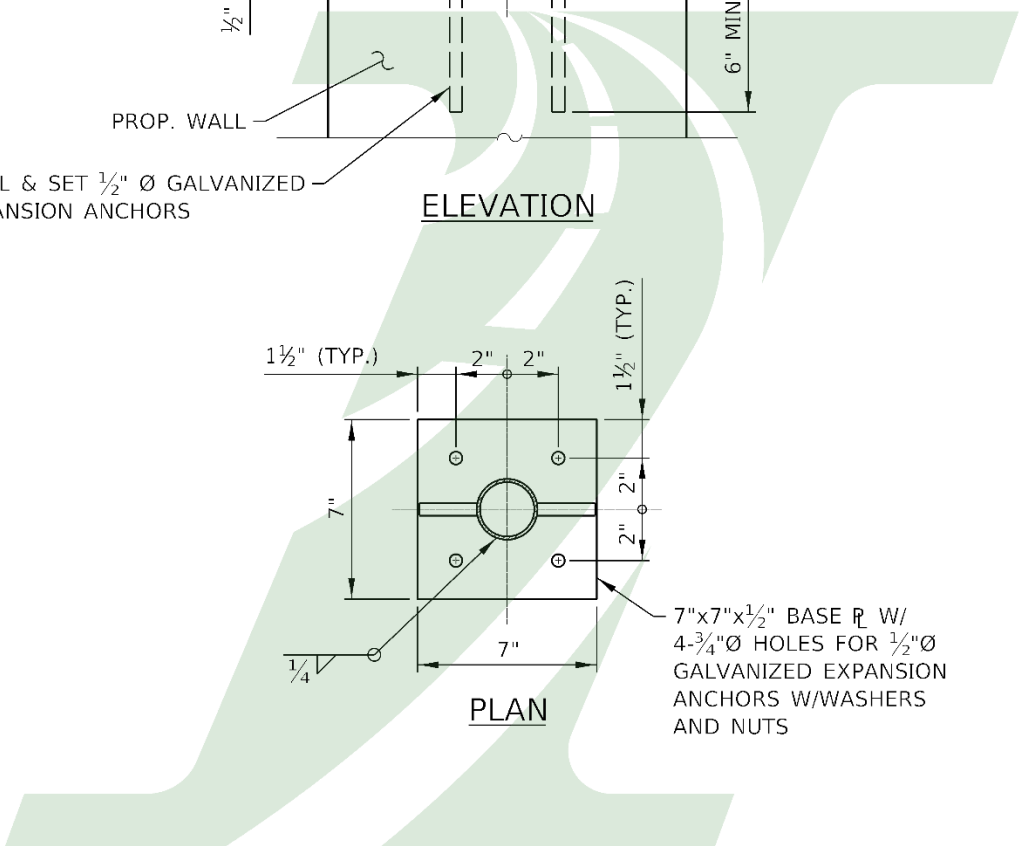




**Figure 22.3.1.2: Geocomposite Wall Drain Details**

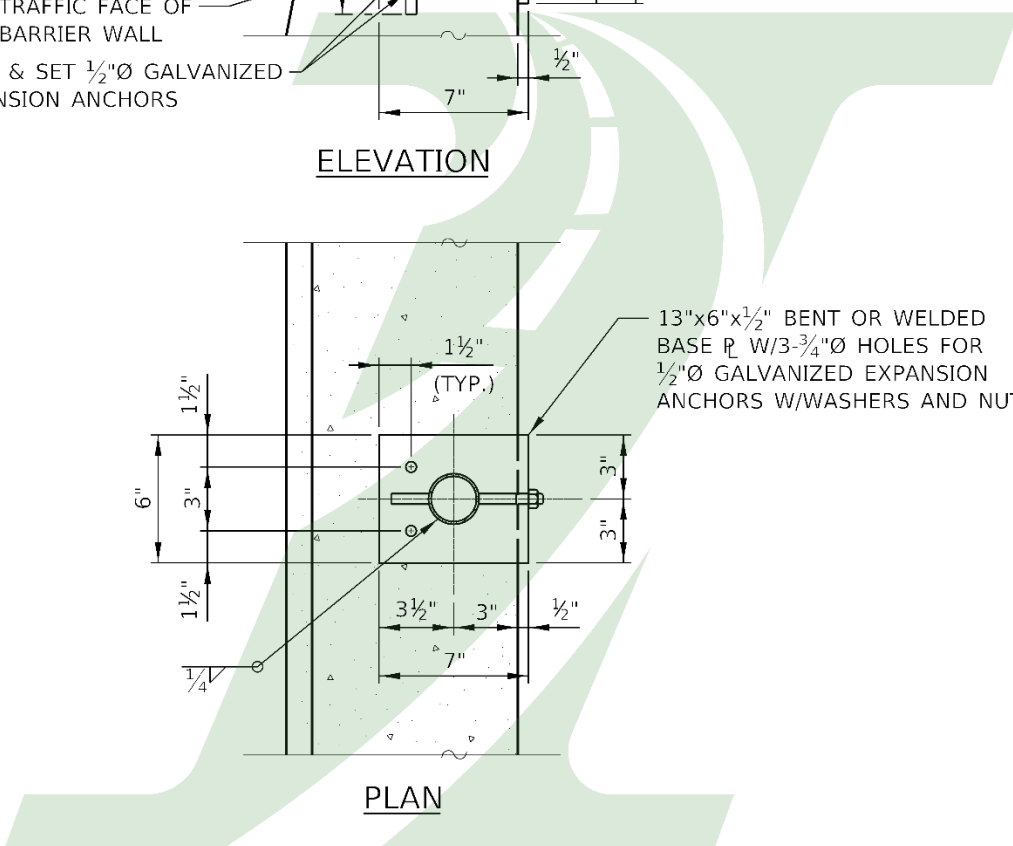


**Figure 22.3.1.3: Subdrain Thru Retaining Wall Details**



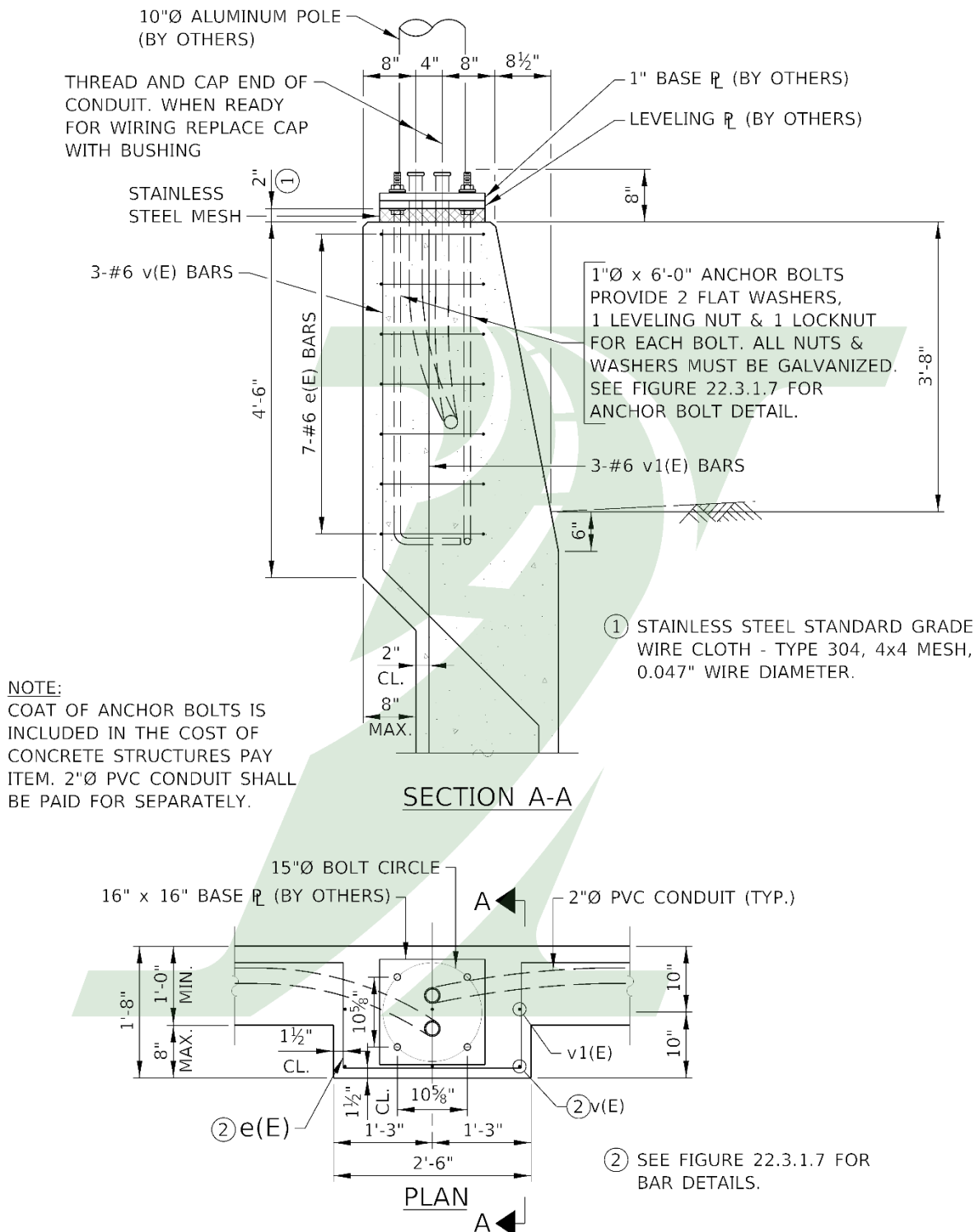
1. BASE PLATES, STIFFENERS AND EXPANSION ANCHORS FOR MOUNTING FENCE ON RETAINING WALLS SHALL BE INCLUDED IN THE COST OF CHAIN LINK FENCE.
2. IF NECESSARY THE SIZE OF THE BASE PLATE AND LOCATION OF THE EXPANSION ANCHORS MAY BE ADJUSTED TO MISS THE WALL REINFORCEMENT.
3. BASE PLATES AND STIFFENERS SHALL BE FABRICATED FROM MATERIAL MEETING THE REQUIREMENTS OF AASHTO M270 GRADE 36.
4. BASE PLATES, STIFFENERS AND POSTS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AASHTO.

**Figure 22.3.1.4: Detail for Mounting Fence Post on Concrete Retaining Wall**

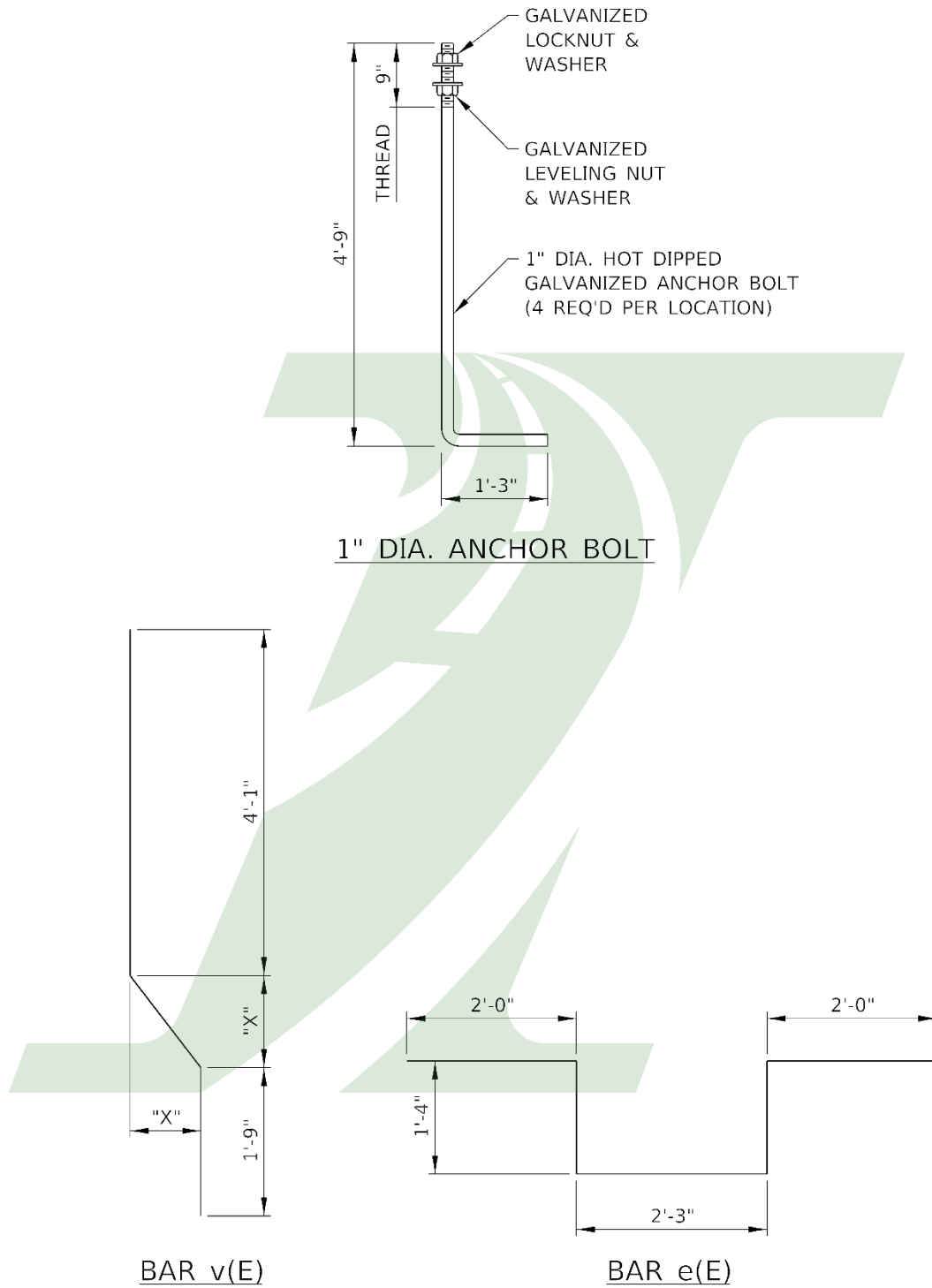


1. BASE PLATES, STIFFENERS AND EXPANSION ANCHORS FOR MOUNTING FENCE ON RETAINING WALL SHALL BE INCLUDED IN THE COST OF CHAIN LINK FENCE.
2. IF NECESSARY THE SIZE OF THE BASE PLATE AND LOCATION OF THE EXPANSION ANCHORS MAY BE ADJUSTED TO MISS THE WALL REINFORCEMENT.
3. BASE AND STIFFENERS SHALL BE FABRICATED FROM MATERIAL MEETING THE REQUIREMENTS OF AASHTO M270 GRADE 36.
4. BASE PLATES, STIFFENERS AND POSTS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AASHTO.

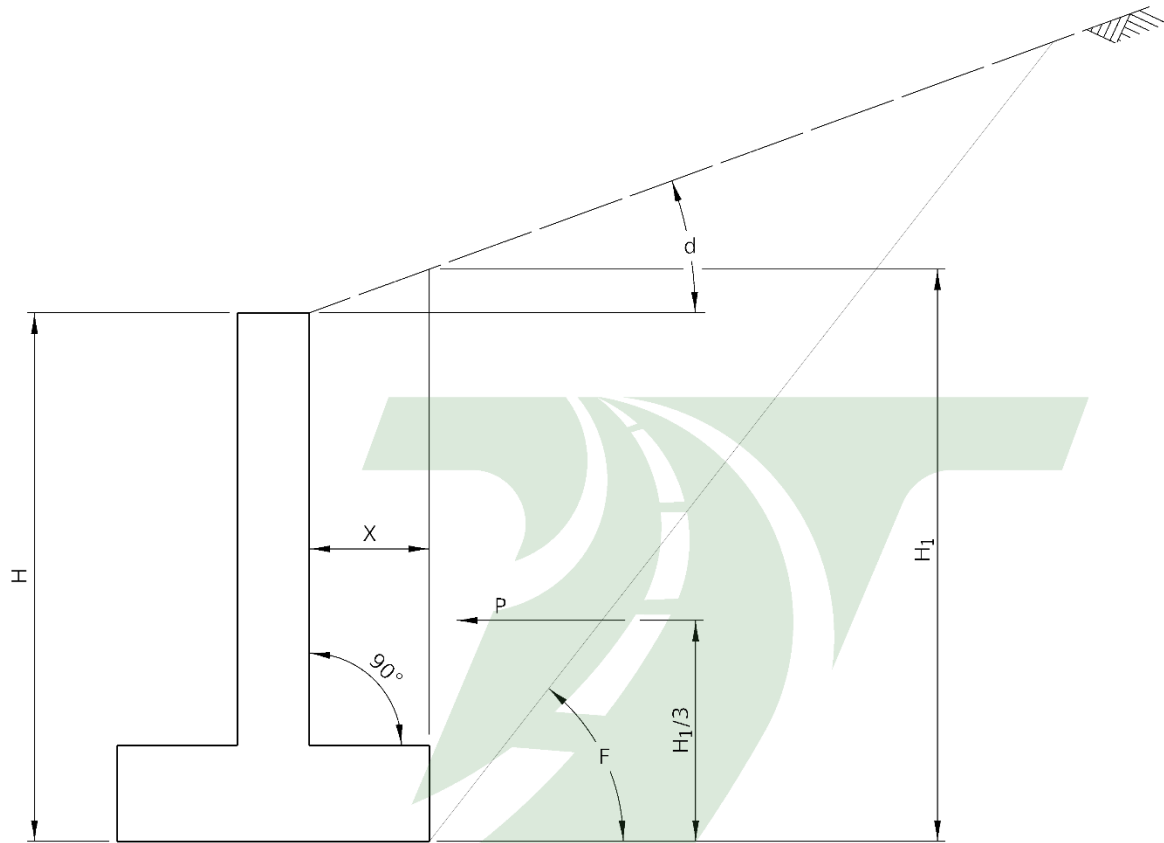
**Figure 22.3.1.5: Details for Mounting Fence Post on Concrete Barrier Wall**



**Figure 22.3.1.6: Light Standard on Retaining Wall Details**



**Figure 22.3.1.7: Light Standard on Retaining Wall Details**



$$P = \frac{WH_1^2}{2} \cos d \left( \frac{\cos d - \sqrt{\cos^2 d - \cos^2 F}}{\cos d + \sqrt{\cos^2 d - \cos^2 F}} \right)$$

WHERE P = TOTAL ACTIVE EARTH PRESSURE, KIPS PER FOOT OF WALL LENGTH.

H<sub>1</sub> = TOTAL WALL DEPTH AS SHOWN IN SKETCH, FEET.

F = ANGLE OF INTERNAL FRICTION OF SOIL, DEGREES.

d = ANGLE OF SLOPE OF BACKFILL, DEGREES.

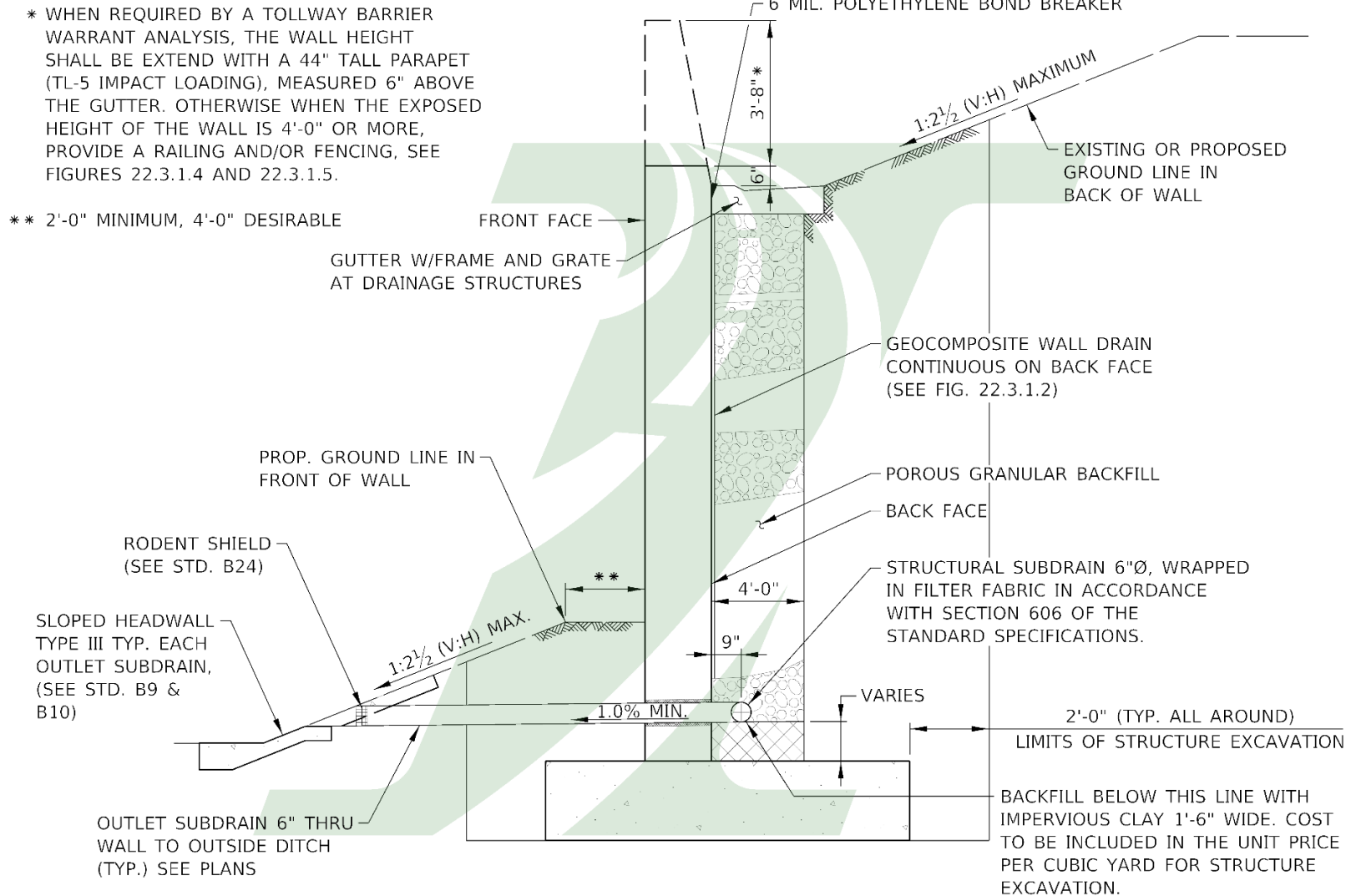
W = UNIT WEIGHT OF SOIL, KIPS PER CUBIC FOOT.

RANKINE OR COULOMB FORMULA FOR ACTIVE EARTH PRESSURE

EXAMPLE FOR F = 30° AND d = 0°.

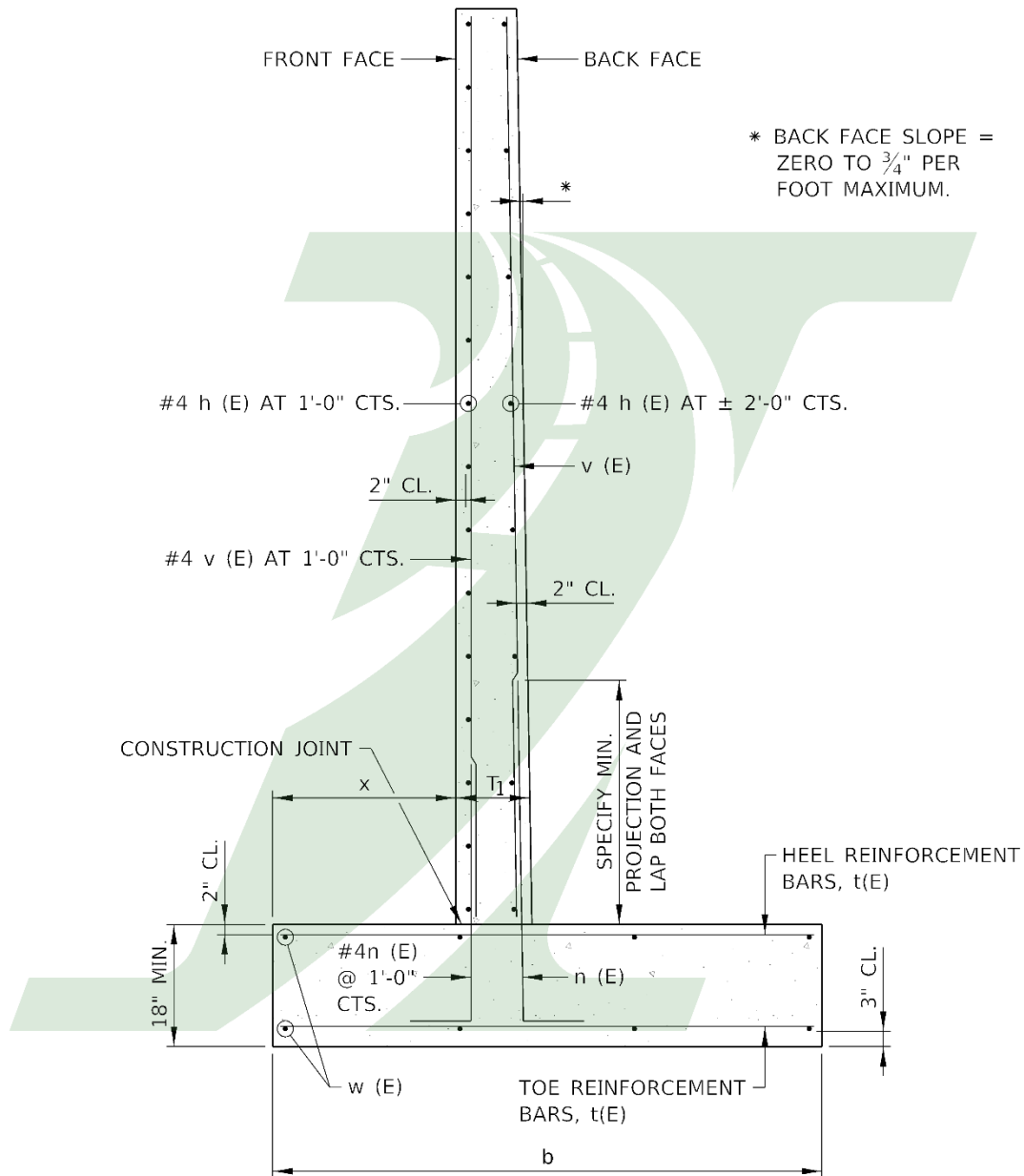
$$P = \frac{WH_1^2}{2} \left( \frac{1 - \sqrt{1 - 0.86603^2}}{1 + \sqrt{1 - 0.86603^2}} \right) = \frac{WH_1^2 (0.333)}{2} = \frac{H_1^2 (0.04)}{2}$$

**Figure 22.4.2.1: Design Loads**

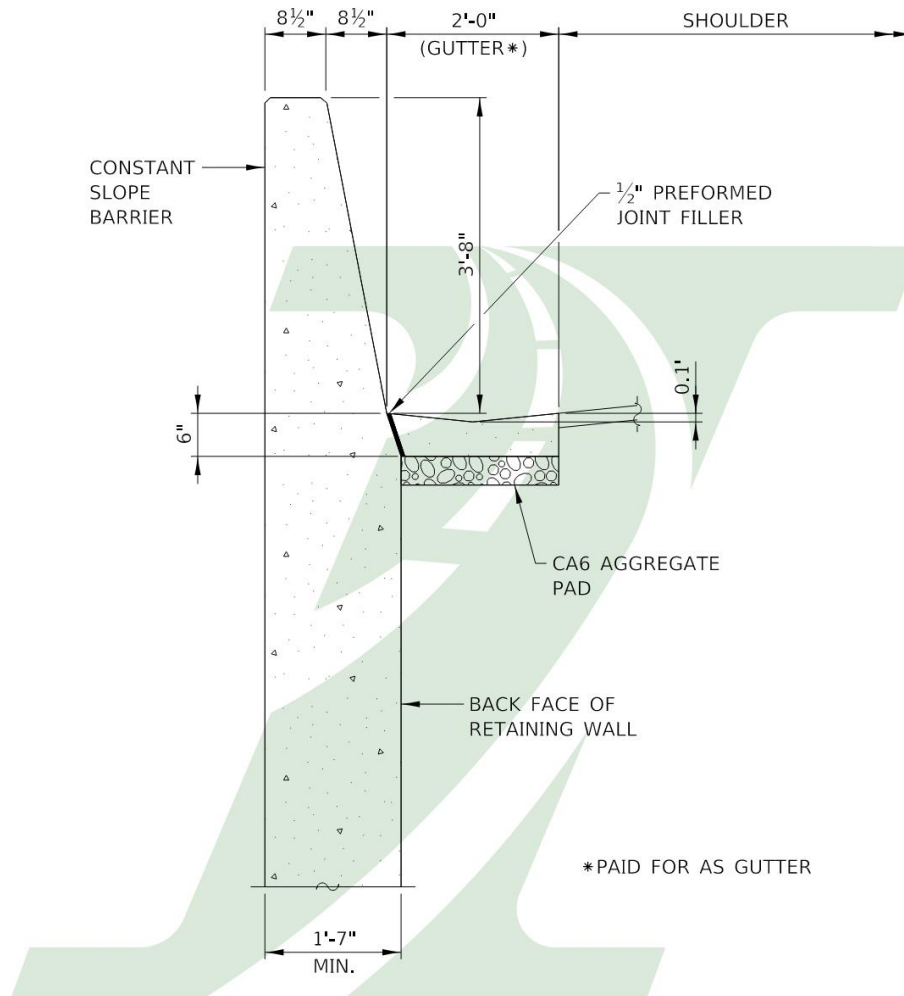


**Figure 22.5.1.1: Typical Section Thru Retaining Wall**

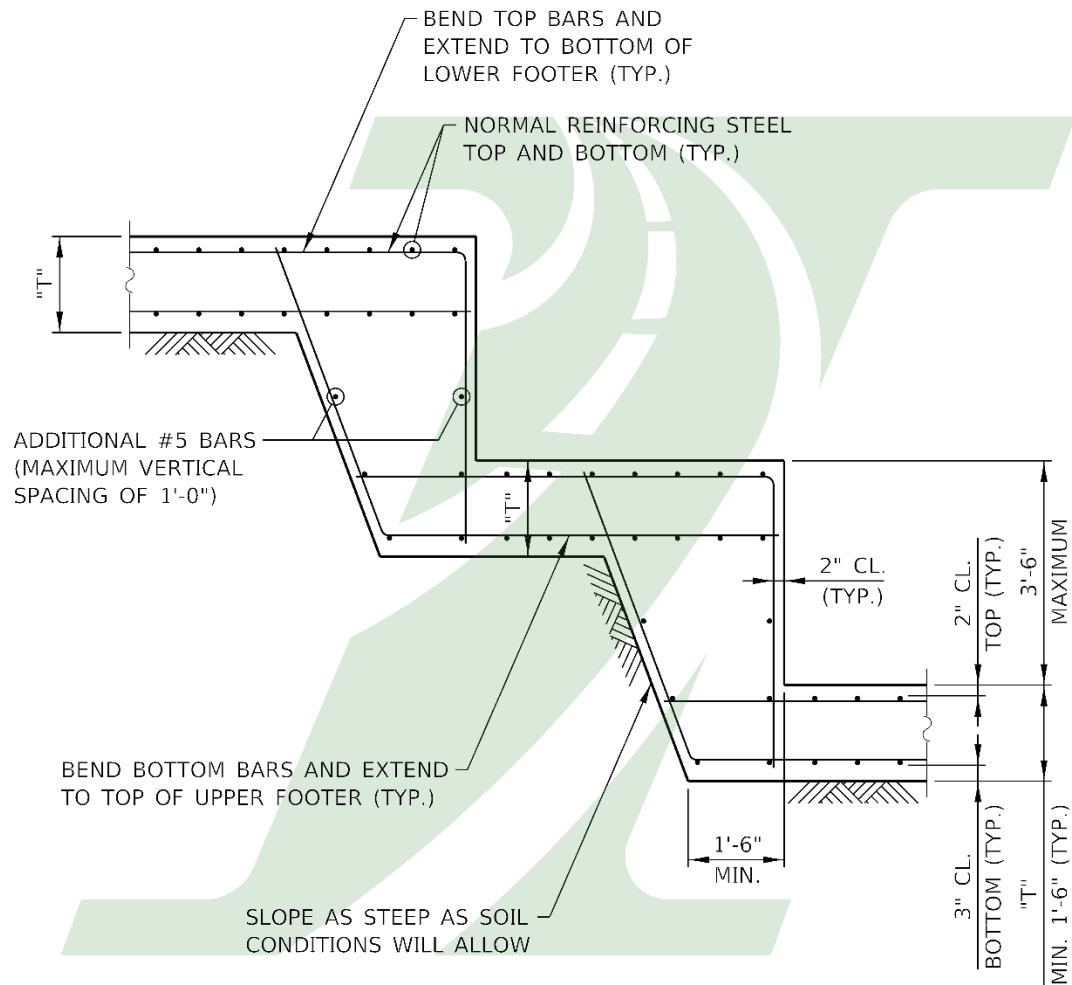




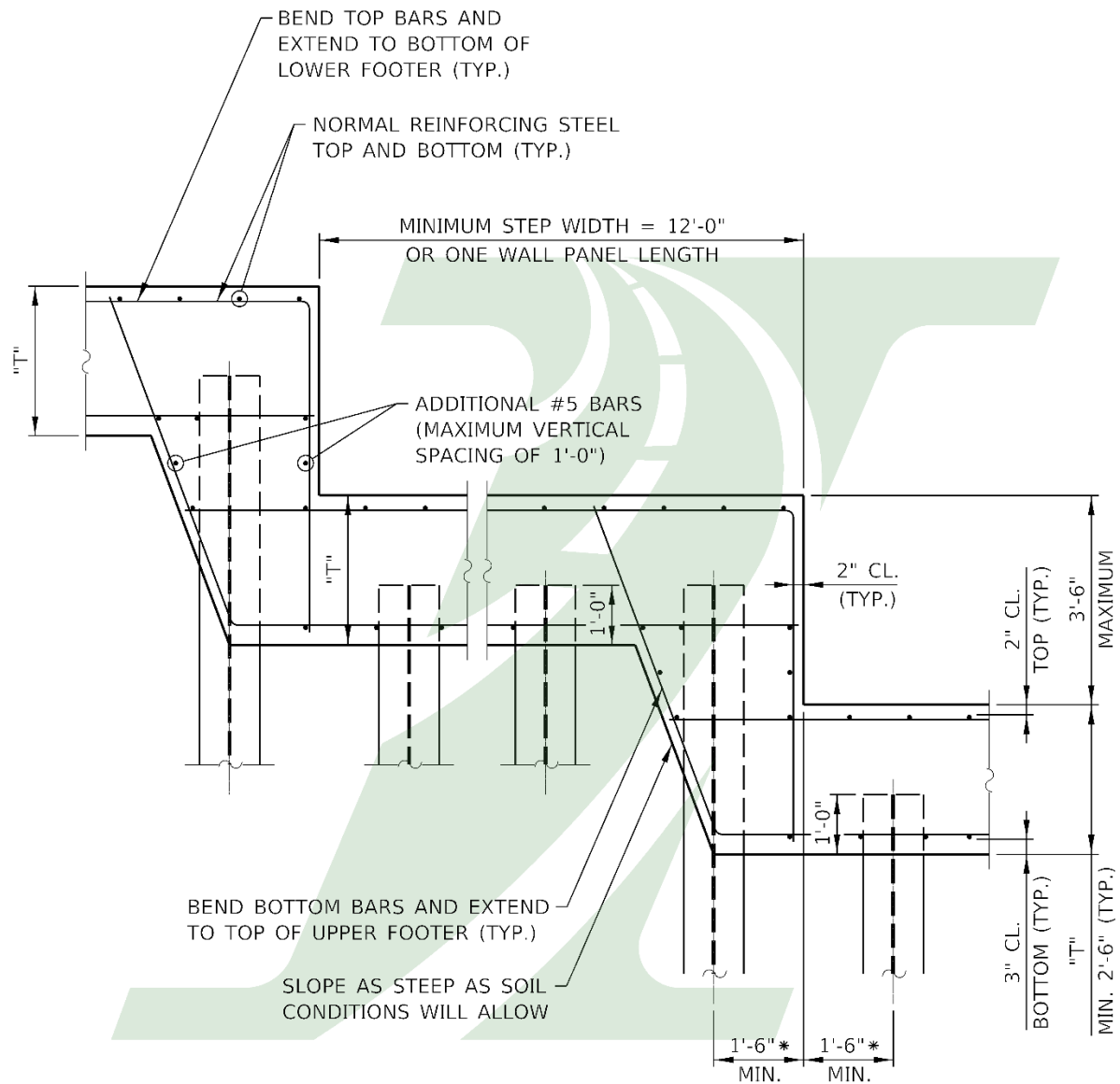
**Figure 22.5.1.2: Typical Cantilever Retaining Wall Reinforcement Bar Details**



**Figure 22.5.3.1: Cantilever Retaining Wall Details with Integral Constant Slope Barrier**



**Figure 22.5.3.1: Stepped Footing Details**



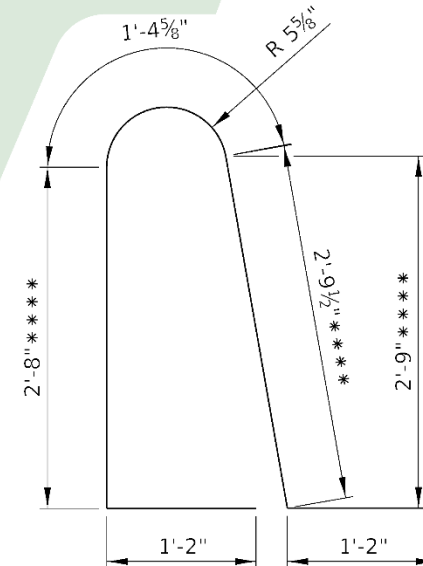
\* TO CENTER LINE OF PILE AND  
END OF LOWER FOOTING

**Figure 22.5.3.2: Stepped Footing Details with Piles**



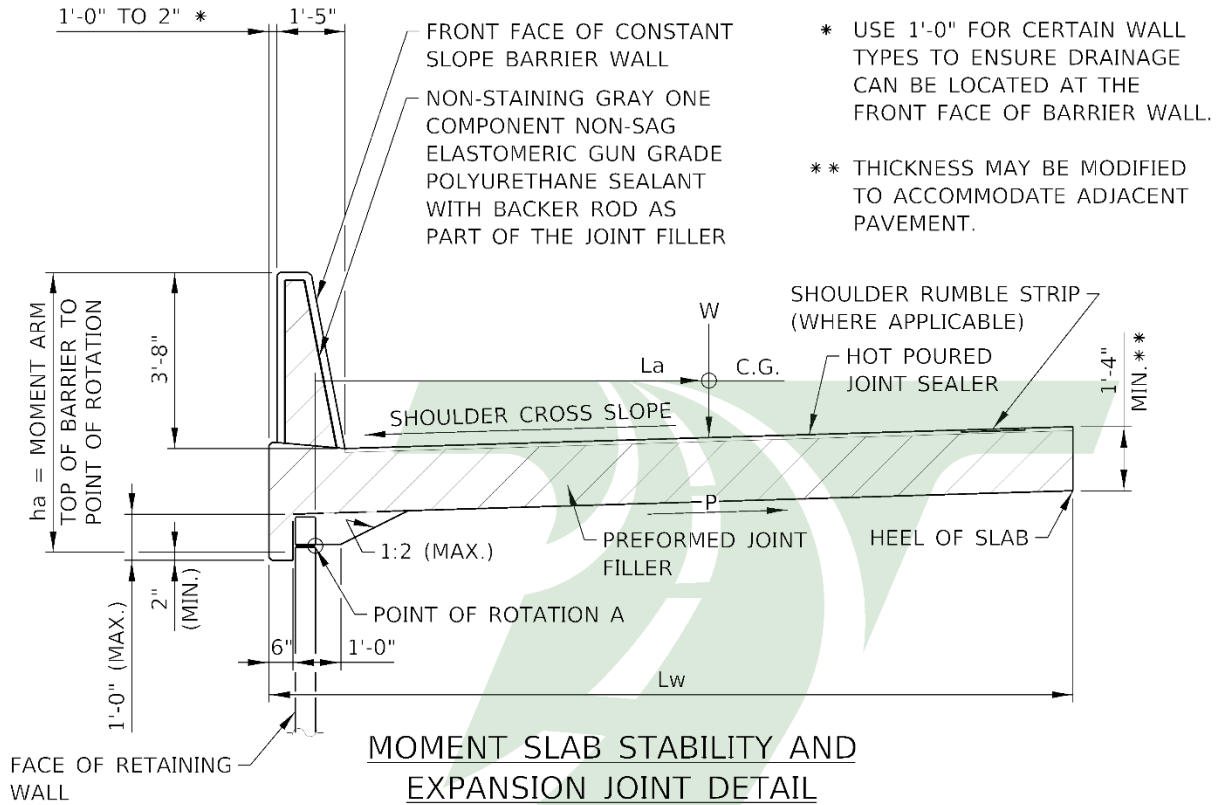
## NOTES:

1. TYPICAL DETAIL SHOWN IS FOR INTERIOR SECTIONS LOCATED MORE THAN 15FT FROM EXPANSION JOINTS. FOR END REGIONS MAKE MODIFICATIONS AS INDICATED HEREIN.
2. THE M.S.E. WALL SUPPLIER SHALL CONSIDER INTERNAL AND EXTERNAL STABILITY DESIGN ACCOUNTING FOR THE MOMENT SLAB'S BEARING PRESSURE SURCHARGE OF 1.0 KSF AND HORIZONTAL SLIDING FORCE OF 2.4 KIPS/FT OF WALL.
3. MINIMUM LENGTH OF MOMENT SLAB SHALL BE 60'-0" BETWEEN EXPANSION JOINTS FOR THIS CONFIGURATION.
4. FOR DETAILS FOR MOMENT SLAB STABILITY AND EXPANSION JOINT SEE FIGURE 22.14.1. OTHER ROADWAY DETAILS INCLUDING PIPE UNDERDRAIN, SUBGRADE AGGREGATE, STABILIZED SUBBASE AND PPC PAVEMENT ARE NOT SHOWN FOR CLARITY. SEE FIGURE 22.14.2 FOR ADDITIONAL DETAILS NOT SHOWN.
5. 16'-0" MOMENT SLAB WIDTH WITH 5'-0" OF SNOW STORAGE IS DESIRABLE TO ACCOMMODATE SNOW STORAGE. SNOW STORAGE LESS THAN 4FT WILL REQUIRE A DESIGN DEVIATION.
6. SEE FIGURE 22.14.1 FOR EXPANSION JOINT DETAIL.
7. SEE ROADWAY DESIGN CRITERIA, ARTICLE 2.6.7, FOR SNOW STORAGE REQUIREMENTS.
8. SEE FIGURE 15.5.1.7 FOR d(E), d1(E) AND d3(E) BAR DETAILS.

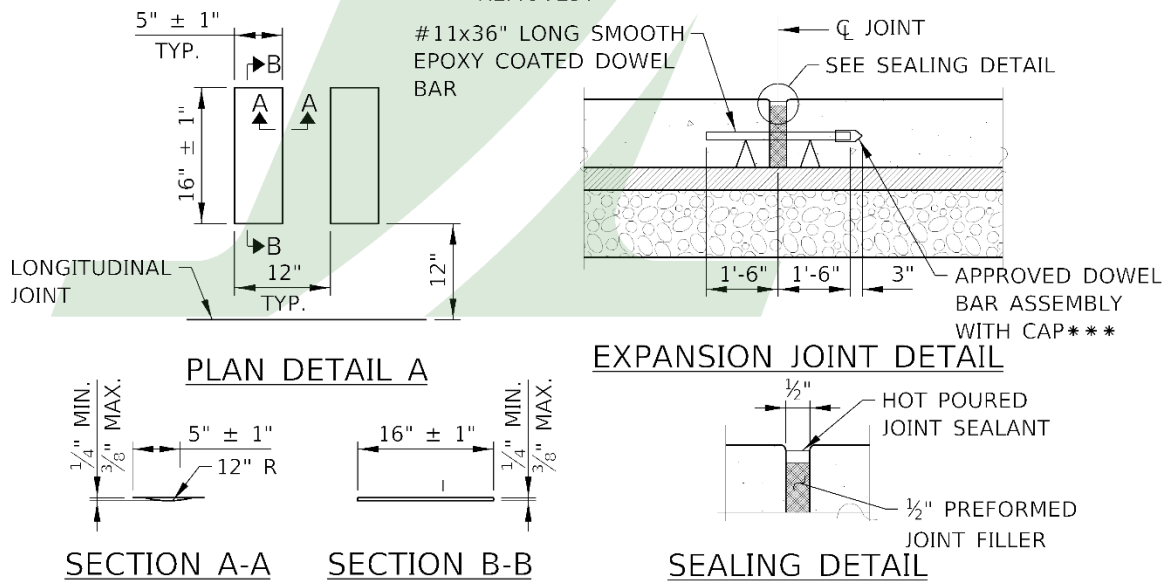


d2(E)

**Figure 22.12.2: Moment Slab Notes and Reinforcement Details for 6 ft. Parapet**



\*\*\* EXPANSION CAPS SHALL BE INSTALLED ON THE EXPOSED END OF EACH DOWEL BAR ONCE THE HEADER HAS BEEN REMOVED.



**Figure 22.14.1: Moment Slab Joint and Shoulder Rumble Strip Details**

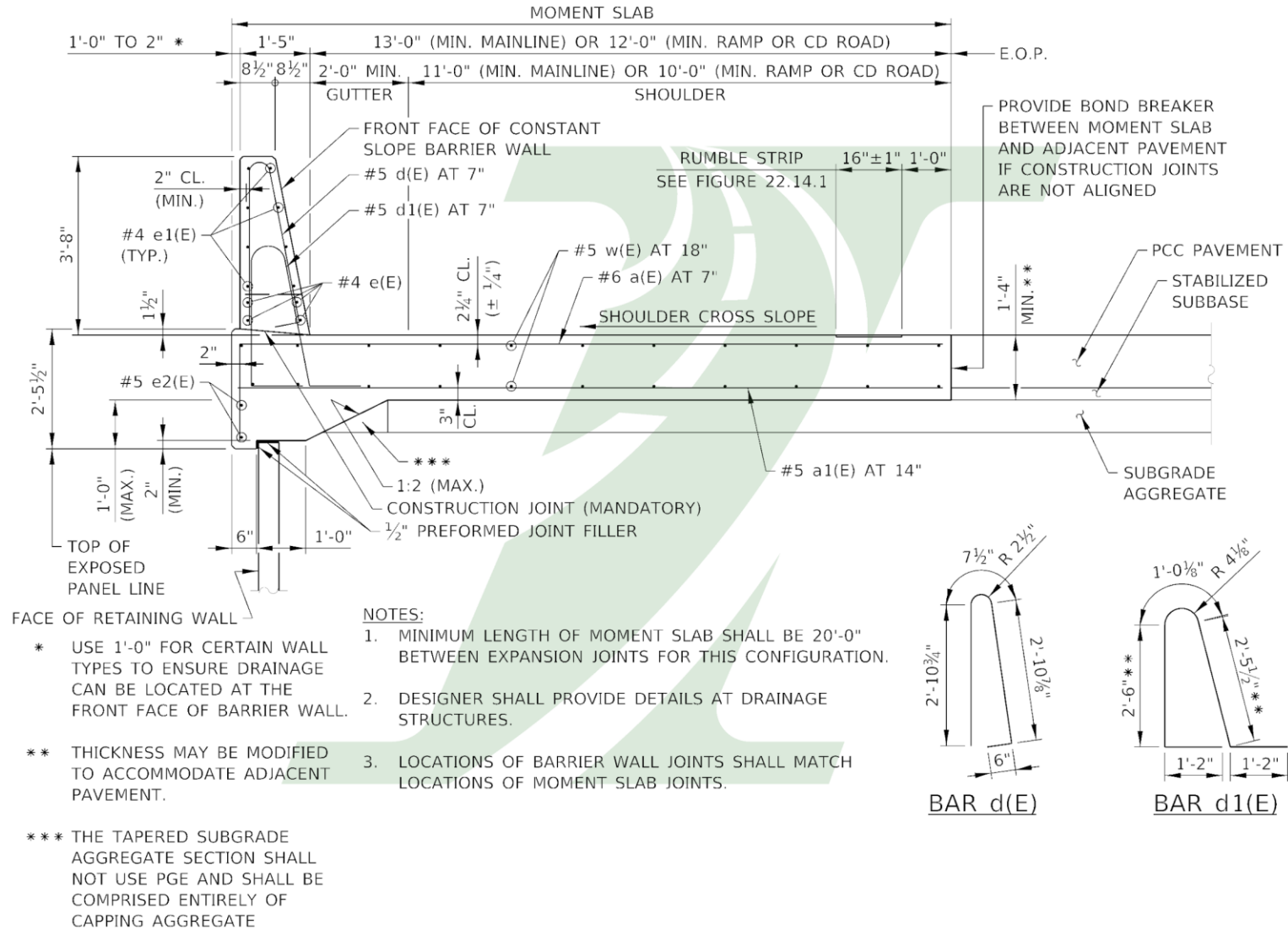
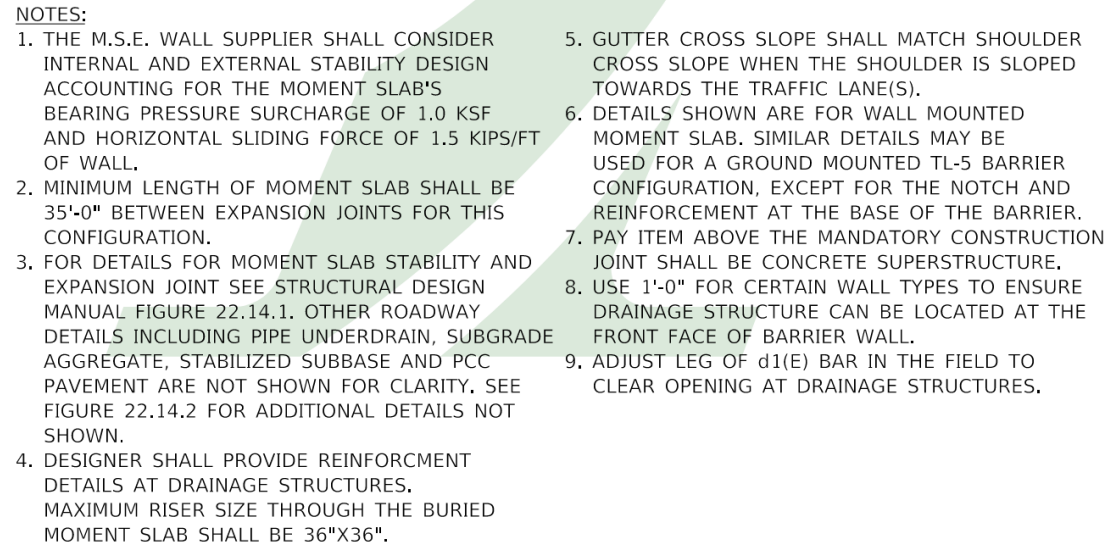


Figure 22.14.2: Moment Slab Reinforcement





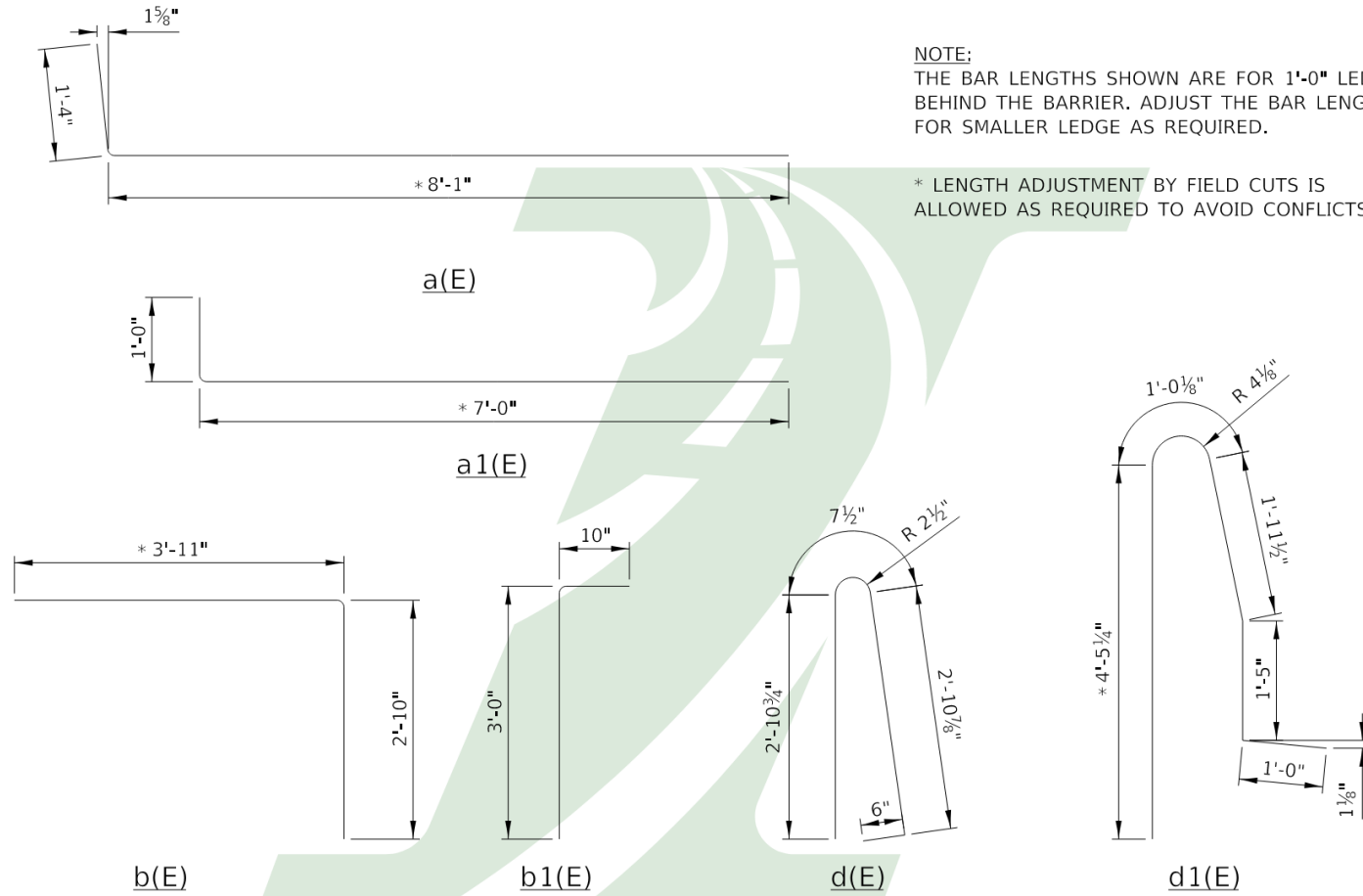
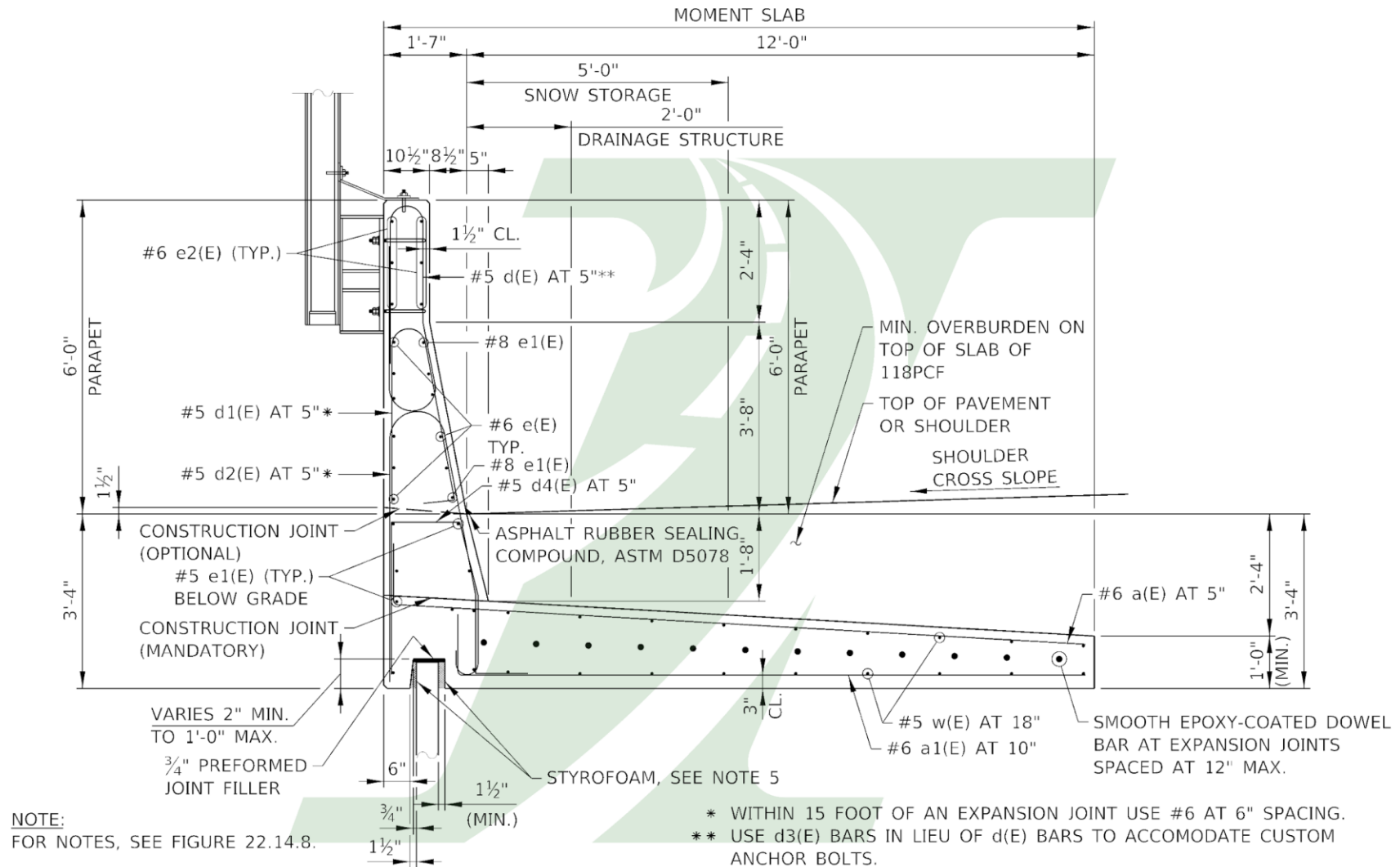


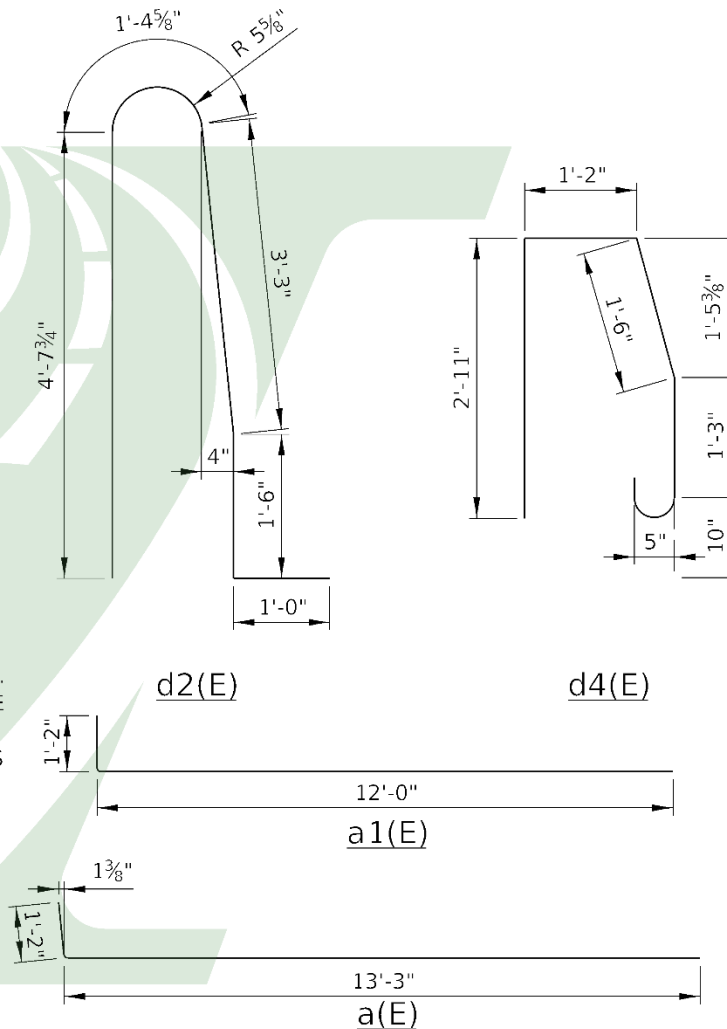
Figure 22.14.4: Buried Moment Slab with Gutter Reinforcement Details



**Figure 22.14.7: Buried Moment Slab W/Structure Mounted NAW**

NOTES:

1. TYPICAL DETAIL SHOWN IS FOR INTERIOR SECTIONS LOCATED MORE THAN 15'-0" FROM EXPANSION JOINTS. FOR END REGIONS MAKE MODIFICATIONS AS INDICATED HEREIN.
2. PROVIDE DOWELS AT EXPANSION JOINTS. USE SAME JOINT AS PROVIDED IN PAVEMENT. EMBED BARS 18" INTO THE MOMENT SLAB.
3. THE M.S.E. WALL SUPPLIER SHALL CONSIDER INTERNAL AND EXTERNAL STABILITY DESIGN ACCOUNTING FOR THE MOMENT SLAB'S BEARING PRESSURE SURCHARGE OF 1.0 KSF AND HORIZONTAL SLIDING FORCE OF 2.4 KIPS/FT OF WALL.
4. MINIMUM LENGTH OF MOMENT SLAB SHALL BE 60'-0" BETWEEN EXPANSION JOINTS FOR THIS CONFIGURATION.
5. GLUE STYROFOAM TO PANEL WITH WATERPROOF ADHESIVE AS REQUIRED TO KEEP STYROFOAM IN PLACE DURING PLACEMENT OF C.I.P. CONCRETE.
6. FOR DETAILS FOR MOMENT SLAB STABILITY AND EXPANSION JOINT SEE ILLINOIS TOLLWAY STRUCTURE DESIGN MANUAL FIGURE 22.14.1. OTHER ROADWAY DETAILS INCLUDING PIPE UNDERDRAIN, SUBGRADE AGGREGATE, STABILIZED SUBBASE AND PPC PAVEMENT ARE NOT SHOWN FOR CLARITY. SEE FIGURE 22.14.2 FOR ADDITIONAL DETAILS NOT SHOWN.
7. DETAILS SHOWN ARE FOR WALL MOUNTED MOMENT SLAB. SIMILAR DETAILS MAY BE USED FOR A GROUND MOUNTED TL-5 BARRIER CONFIGURATION, EXCEPT FOR THE NOTCH AND REINFORCEMENT AT THE BASE OF THE BARRIER.
8. FOR EXPANSION JOINT DETAIL, SEE FIGURE 22.14.1.



**Figure 22.14.8: Buried Moment Slab W/Structure Mounted NAW Notes and Bar Details**

## SECTION 23.0 NOISE ABATEMENT WALLS & RAILROAD BRIDGE FENCING

### 23.1 General

Noise abatement walls shall be designed in accordance with the latest AASHTO Guide Specifications for Structural Design of Sound Barriers and Interims, AASHTO LRFD Bridge Design Specifications, Sections 13 and 15 at Test Level 4 (TL-4) as applicable and as amended herein. Structure Mounted Sound Barrier Systems shall utilize a 72" barrier per Article 15.5.2 with applicable design loads per Article 23.2.2.

The noise abatement wall shall be designed to attenuate the sounds generated by highway traffic and achieve a minimum noise reduction of 5 decibels.

Panels shall be embedded a minimum 1'-0" below grade. In the case of a wall with unbalance soil loads a minimum embedded of 6-inches may be used. The noise abatement wall material shall be manufactured from fire retardant material that meets State and local requirements. Structure mounted or ground mounted noise abatement wall types shall be one of the following:

- Precast Concrete – The precast concrete noise abatement wall shall consist of either separate panels, or posts and panels spanning between vertical posts. The precast concrete panels of the noise abatement shall be conventionally reinforced. The posts of the noise abatement wall shall be constructed of galvanized, structural steel.
- Alternate Material Noise Abatement Wall – This system allows the Contractor to bid an alternate material noise abatement wall system that meets the requirements stated in this section and as accepted by the Illinois Tollway.
  - Concrete Masonry – This system consists of a noise abatement wall constructed of manufactured masonry block units. Masonry block walls shall be hand-laid. The posts of the noise abatement wall may be constructed of precast concrete, galvanized steel encased in masonry, or masonry block pilasters. If precast concrete posts are chosen, the posts may be conventionally reinforced, pre-stressed, post-tensioned, or any combination thereof. Concrete Masonry panels shall not be used as bridge or retaining wall mounted noise abatement walls.
  - Brick Masonry – This system consists of a sound barrier constructed of manufactured brick masonry units. Brick masonry walls shall be hand laid. The brick masonry noise abatement wall shall consist of either separate panels, or posts and panels spanning between vertical posts. The posts of the noise abatement wall may be constructed of precast concrete, galvanized steel, or brick masonry pilasters. If precast concrete posts are chosen, the posts may be conventionally reinforced, pre-stressed, post-tensioned, or any combination thereof. Brick masonry panels shall not be used for bridge or retaining wall mounted or crashworthy ground mounted noise abatement walls.
  - Composite – The composite noise abatement walls shall be a composite plastic extruded material. The composite noise abatement wall shall consist of separate panels, or posts and panels spanning between vertical posts. The posts of the composite noise abatement wall may be constructed of composite material, precast concrete or galvanized steel. If precast concrete is chosen, the posts may be conventionally reinforced, pre-stressed, post-tensioned, or any combination thereof.

- Wood – This system consists of a domestic or Canadian wood sound barrier constructed of treated wood posts, vertically oriented wood panels of tongue and groove construction, and a wood cap board to protect end grain.

If a performance-based noise abatement wall is recommended, subject to the approval of the Illinois Tollway, any alternate noise abatement wall types not allowed shall be stated in the construction contract specifications.

Wooden noise abatement wall shall be designed for a minimum service life of 25 years; precast concrete and alternate material noise abatement walls shall be designed for a minimum service life of 50 years. The design shall be based on the consideration of the potential long-term effects of weathering, corrosion, spray from de-icing chemicals, and other potentially deleterious environmental factors on each of the material components comprising the noise abatement wall.

### **23.1.1 Expansion and Contraction Devices**

The noise abatement wall shall be designed with consideration of the movements in the wall due to temperature changes, dead loads and wind loads. Locations and spacing of expansion devices shall be as designed and detailed following Illinois Tollway Base Sheet M-BRG-530.

### **23.1.2 Stabilizers**

Permanent stabilizers are required between posts and panels to maintain the vertical positions of the panel while resisting the lateral loading primarily due to wind and vehicle impact. The stabilizers shall be spaced at intervals not to exceed 4 feet and shall have a minimum height of 4 inches.

## **23.2 Design Criteria**

### **23.2.1 Design Specifications**

See Article 5.1.

### **23.2.2 Design Loads**

All Loading and Geometric requirements as specified in the latest edition of the AASHTO LRFD Bridge Design Specifications and Interims shall be satisfied.

- Dead Load
  - For bridge and retaining wall mounted noise abatement walls, the panel dead weight shall be based on the actual geometry of the panel.
  - The dead load shall consist of the weight of all the component materials making up the noise abatement wall. For structure-mounted noise abatement walls, the point of action of the weight of the individual components shall be their respective centers of gravity.
- Wind Loads
  - The minimum design wind load for structure-mounted noise abatement walls shall be 35 psf (LFD) or 50 psf (LRFD Strength III). For ground-mounted noise abatement walls, the minimum design wind load shall be 25 psf (LFD) or 35 psf (LRFD Strength III). For Service I load condition, a minimum design load of 15 psf shall be used. Other load combinations shall be per the latest AASHTO LRFD Section 3.8.
  - Design horizontal wind pressures shall account for the direction of wind, height, and elevation of the wall, topography and gust factors. The noise abatement wall shall be designed to withstand wind pressure, applied perpendicular to the wall and

- separately in each direction. Load shall be applied at a distance equal to 0.55 times the noise abatement wall height as defined in AASHTO LRFD Section 3.8.1.2.4.
- The maximum allowable panel deflection for wind loads shall be no more than the panel length (L) divided by 240 ( $L/240$ ) for ground-mounted panels and panel length (L) divided by 180 ( $L/180$ ) for structure-mounted panels, where L is the length between panel supports. The vertical posts shall have a maximum deflection of ( $H/360$ ), where H is the height of the post above the foundation or anchors.
  - Seismic Loads
    - In accordance with Article 3.10 of the AASHTO LRFD Bridge Design Specifications.
  - Vehicle Impact Loads
    - Crashworthy walls shall be specifically identified in the plans and shall meet the “Application of AASHTO LRFD Specifications to Design of Sound Barriers” and the AASHTO LRFD Bridge Design Specifications.
    - The following crash test levels shall be used to determine vehicle impact loads applied to noise abatement walls located within the clear zone or otherwise requiring shielding as determined by a barrier warrant analysis:
      - Structure Mounted: See Figure 23.3.4.1 for Structure Mounted Noise Abatement Wall on Bridge and Figure 23.3.4.2 for Structure Mounted Noise Abatement Wall on Moment Slab. Noise abatement wall shall be designed to resist a collision force of 4.0 kips applied at the highest point up to 14.0 feet above the surface of the pavement in front of the traffic railing.
  - Ground Mounted
    - Shielded: TL-4, applied in accordance with AASHTO LRFD Article 15.8.4 – Cases 1 through 4. The collision forces shall be applied as a line load with a length equal 3.5 feet and distributed over the panel height but not exceeding 5.5 feet. For the post, shafts and connections, the design collision force shall be the full specified collision force applied at the point of application as specified. Distributed of the collision forces for other than concrete panel material shall be based on engineering analysis.
      - In addition, for all shielded noise abatement walls, noise abatement wall components with a setback less than 4.0 foot behind a barrier shall be designed to resist a collision force of 4.0 kips applied at the highest point up to 14.0 feet above the surface of the pavement in front of the traffic railing. This load shall be checked independently from the impact loads specified in the AASHTO LRFD Bridge Design Specifications.
    - Unshielded: TL-4, applied in accordance with AASHTO LRFD Article 15.8.4 – Case 1. The collision forces shall be applied as a line load with a length equal 3.5 feet and distributed over the panel height but not exceeding 5.5 feet. For the post, shafts and connections, the design collision force shall be the full specified collision force applied at the point of application as specified. Distributed of the collision forces for other than concrete panel material shall be based on engineering analysis.
      - In addition, all unshielded noise abatement walls shall be designed to resist a collision force of 4.0 kips applied at the highest point up to 14.0 feet above the surface of the pavement in front of the traffic railing. This load shall be checked independently from the impact loads specified in the AASHTO LRFD Bridge Design Specifications.



The following crash test levels shall be used to determine vehicle impact loads applied to noise abatement walls located outside the clear zone as identified in a barrier warrant analysis:

- Structure Mounted
  - Shielded: TL-4, applied in accordance with AASHTO LRFD Article 15.8.4 – Cases 1 through 4
  - Unshielded: TL-4, applied in accordance with AASHTO LRFD Article 15.8.4 – Case 1
- Ground Mounted
  - Not applicable
- Unbalanced Soil Loads
  - If a noise abatement wall is to account for lateral earth pressure due to unequal ground lines, that requirement shall be shown in the plans. The maximum grade differential shall be 3'-6" for non-crashworthy walls and 3'-0" for crashworthy walls.
- Foundations
  - Foundations for crashworthy Noise Abatement Walls shall consider impact loads. Drilled shaft foundations may be designed for an ultimate strength per the requirements as set forth in IDOT All Geotechnical Manual User Memo 11.1: Light Tower, Traffic Signal, Sign Structure Foundation Design using load combinations for Strength, Service and Extreme Event Limit States. For Service Limit States, an overload factor of 2.0 and under-capacity factor of 0.7 shall be used and a minimum factor of safety of 2.86 shall be achieved. For the Strength and Extreme Event Limit States, an overload factor of 1.0 and under-capacity factor of 1.0 shall be used and a minimum factor of safety of 1.0 shall be achieved. Alternatively, drilled shaft foundations may be designed using procedures in accordance with the latest edition of AASHTO LRFD. Service Limit States shall be used for the horizontal deflection of the post.

### 23.2.3 Design Height

The design height shall be determined by the designer in conjunction with the noise mitigation study for each location. The top of the wall shall be level.

### 23.2.4 Stresses

Allowable design stresses for individual materials comprising the different wall types are covered in the Special Provision for Noise Abatement Wall. For additional design stresses, see Article 5.1.

## 23.3 Plan Preparation

### 23.3.1 General

Refer to Illinois Tollway Standards G and Base Sheets M-BRG-529 and M-BRG-532. Each noise abatement wall shall consist of a set of sequentially numbered plan sheets. The first sheet shall be a general plan and elevation and follow the criteria in Article 6.3. The Designer shall indicate the location of all required noise abatement walls on the appropriate roadway and structure plans. Sufficient information shall be shown on the plans and cross sections so that the manufacturer can design and detail the noise abatement wall to accommodate each: ground-to-structure transition, overlap, obstruction and utility or drainage interference. The Designer shall locate the beginning and end of the noise abatement wall including overlaps and directional changes by



station and offset on the appropriate roadway, drainage and lighting plans including cross sections. See Figure 23.3.1.1 for typical details.

An elevation view of each noise abatement wall shall be included in the plans. Each elevation shall show top of noise abatement wall and proposed grade. The location of transitions, overlaps, obstructions, utility or drainage interferences and changes in noise abatement wall height shall also be shown. Changes in noise abatement wall height shall be accomplished using increments no larger than 2 feet and no smaller than 1 foot. The top of wall shall remain horizontal between steps. For an elevation view example, see Figures 23.3.1.2 and 23.3.1.3. The top of the wall shall remain above the Acoustical Profile Line. Plans shall show all appurtenances behind, in front of, under, over, mounted upon, or passing through the noise abatement wall, such as drainage structures, fire hydrant access, highway signage, emergency access or utilities.

### 23.3.2 Naming Convention

Noise abatement walls shall be identified on the plans using the following format:

Illinois Tollway Milepost Wall Type, Direction (Ramp)

TOLLWAY:

EW = Reagan Memorial Tollway (I-88)  
 NS = Veterans Memorial Tollway (I-355)  
 NW = Jane Addams Memorial Tollway (I-90)  
 TS = Tri-State Tollway (I-294 & I-294/I-80)  
 TN = Tri-State Tollway (I-94)  
 ES = Edens Spur (I-94)  
 EO = Elgin-O'Hare Tollway (IL 390)  
 WA = West O'Hare Access (I-490)

MILEPOST:

Two-decimal lowest wall milepost to the tenth or hundredth if a ¼ mile post (i.e., 14.75)

WALL TYPE:

N = Noise Abatement Wall

DIRECTION:

EB, SB, WB, NB - Inventory direction of the mainline roadway

RAMP:

(R) = if lowest milepost is along ramp (omitted if not along ramp)

EXAMPLE:

TS38.40N,NB(R) for a noise abatement wall located along the Tri-State Tollway (I-294) northbound at milepost 38.4 on a ramp

If two walls of the same type have identical starting mileposts, the inventory milepost of one of the walls shall be shifted by one hundredth of a mile to create unique names.

### 23.3.3 Ground Mounted Noise Abatement Wall

For all Ground Mounted Noise Abatement Walls, a Level-3 Barrier Warrant Analysis shall be performed to determine the wall location with the highest benefit/cost ratio. Variations in noise abatement wall height based on the location of the wall shall be included in the benefit/cost analysis. The traffic face of the noise abatement wall shall be placed outside the clear zone, unless the wall is crashworthy or shielded by a TL-4 (min.) concrete barrier. Plans shall indicate whether the wall is crashworthy or non-crashworthy. Refer to the Illinois Tollway Traffic Barrier Guidelines and Base Sheets M-DRN-607 and M-DRN-608 for grading at face of wall. Grading behind the wall shall be 4-ft desirable or 2-ft minimum flat area for maintenance and inspection purposes. See Illinois Tollway Drainage Manual Article 9.6.4 for drainage requirements.

Standard details have been developed for both crashworthy and non-crashworthy noise abatement walls. See Illinois Tollway Standards G15 and G16 for non-crashworthy and crashworthy details respectively. Section 23.3.3.1 provides guidelines for using the standards. See Illinois Tollway Base Sheet M-BRG-532 for example cover sheet and schedules to be included in the contract plans.

A 5-foot minimum clearance between the proposed R.O.W. line and the centerline of the noise abatement wall shall be maintained. No utilities shall be located between the noise abatement wall and the proposed R.O.W. line.

Overlapped sections of noise abatement walls shall be separated by a minimum of 9 feet to provide access to the area behind the walls when vehicular access is required. A section of the wall shall be overlapped for a minimum length of four times the separation or gap distance. See Figure 23.3.3.1 for a typical plan. Overlaps shall also be located at ground to structure transitions unless alternative access is already provided. See Illinois Tollway Standard G16 for details.

Foundations for Ground Mounted Noise Abatement Walls: The bottom of any foundation shall be a minimum of 4 feet below finished grade, unless solid competent rock strata is encountered. If a drilled foundation is used, it shall be a minimum of 6 feet below finished grade line or two times the shaft diameter, whichever is greater, unless solid competent rock strata is encountered.

Structure borings shall be taken at each end of the noise abatement wall and every 100 feet thereafter along the proposed alignment. The boring locations shall be shown on the roadway noise abatement wall plans and the resulting logs shall be plotted on sheets and included in the plans.

#### 23.3.3.1 Guidelines for Using Standards G15 and G16

Guidelines provided in this section are not meant to cover all possible soil conditions and are not meant to replace engineering judgment.

1. If cohesive soil conditions are indicated in the entirety of the nearest boring log, use the standards for the cohesive material case as follows:
  - a. Calculate the average Unconfined Compressive Strength ( $Q_u$ ) as the minimum of the following:
    - i. The average of the  $Q_u$  values within the embedment depth.
    - ii. The average of the  $Q_u$  values in the upper 50% of the embedment depth.

- iii. The average of the  $Q_u$  values in the lower 50% of the embedment depth.
  - b. If the computed average  $Q_u$  value meets or exceeds the minimum value of 1.25 tsf, use the corresponding table in standards for foundation details (see Standard G15 Sheet 1 of 3) to establish minimum embedment depths.
  - c. If the computed average  $Q_u$  value is less than 1.25-tsf, this standard shall not be used to establish minimum embedment depths, and site- / wall-specific analyses and computations shall be undertaken to establish the required embedment depths.
- 2. If cohesionless soil conditions are indicated in the entirety of the nearest boring log, use the standard for the granular material case as follows:
  - a. Calculate the average friction angle ( $\phi$ ) as the minimum of the following:
    - i. The average of the friction angles within the embedment depth.
    - ii. The average of the friction angles in the upper 50% of the embedment depth.
    - iii. The average of the friction angles in the lower 50% of the embedment depth.
  - b. If the computed average friction angle meets or exceeds the minimum value 30-degrees, use the corresponding table in standards (see Standard G15, Sheet 1 of 3) to establish minimum embedment depths.
  - c. If the computed average friction angle is less than 30-degrees, this standard shall not be used to establish minimum embedment depths, and site- / wall-specific analyses and computations shall be undertaken to establish the required embedment depths.
  - d. The standards for cohesionless soils only apply to cohesionless soils with less than 12% fines (soils classified as GW, GP, SW, and SP in accordance with ASTM D 2487). Fines are defined as the fraction of particles finer than 0.075-mm, as defined in the size limits table in Figure 5.5.5.1-1 of the IDOT Geotechnical Manual and in accordance with ASTM D 2487. Fines content shall be determined primarily from lab test results, as presented in associated SGRs, and secondarily from soil descriptions and classifications in the boring logs.
- 3. If a mixed combination of cohesionless and cohesive soil conditions are indicated in the nearest boring log, this standard shall only apply in situations where all cohesive soils meet the minimum  $Q_u$  value of 1.25-tsf and all cohesionless soils meet the minimum friction angle of 30-degrees. If both of these minimum design conditions are met, the minimum embedment depth shall be computed as follows:
  - a. Determine minimum embedment depth based on assumption that entire profile is cohesive (using method in Item 1).
  - b. Determine embedment depth based on assumption that entire profile is cohesionless (using method in Item 2).
  - c. Use greater embedment depth value computed under steps 3.a and 3.b.
- 4. If soil conditions are indicated that are outside of the minimum design values, as specified in this standard, for cohesive (i.e.,  $Q_u \geq 1.25$ -tsf) and/or cohesionless (i.e., friction angle  $\geq 30$ -degrees) soils, this standard shall not be used to establish minimum embedment depths, and site- / wall-specific analyses and computations shall be undertaken to establish the required embedment depths.
- 5. If rock is anticipated, encountered, or found within the embedment depth, this standard shall not be used to establish minimum embedment depths, and site- / wall-specific analyses and computations shall be undertaken to establish the required embedment depths.

### 23.3.4 Structure Mounted Noise Abatement Wall

Noise abatement walls on retaining walls and bridges shall be designed for the specific site conditions. See Figure 23.3.4.1 for structure mounted noise abatement wall on a bridge and Figure 23.3.4.2 for structure mounted noise abatement wall on moment slab. New Illinois Tollway Standards have been developed as G12 for systemwide use. Standards G13 and G14 have been developed to accommodate aesthetics and bump-outs on the Central Tri-State and shall only be used as approved by the Illinois Tollway. See Illinois Tollway Base Sheet M-BRG-529 and M-BRG-531 for example cover sheet and schedules to be included in the contract plans for systemwide and Central Tri-State respectively.

## 23.4 Specifications

When directed by the Illinois Tollway, The Designer should modify the available Tollway issued special provision for noise abatement wall based on the proposed wall location and site conditions. Consideration should be given to the type of noise walls across from or adjacent to existing noise walls which are not impacted. This would include color, type of posts, post spacing, foundation type, panel type and any aesthetics enhancements.

## 23.5 Railroad Bridge Fence for New Illinois Tollway Structures over Railroad

The Illinois Tollway crosses several railroads that have specific guidelines and drawings for fencing requirements. The Designer shall coordinate with the railroads regarding the need for fencing as early in the design stage as possible.

### 23.5.1 Waivers

The placement of fencing on top of the bridge parapet is not desirable because of traffic safety concerns and inspection access limitations. The Designer shall propose the following waivers to the railroad prior to initiating modifications to the standard bridge rail:

#### Waiver Alternative I

Request a waiver from the Railroad's standards to provide a 44" high Constant-Slope parapet according to the Illinois Tollway's Structure Design Manual. A waiver should be warranted since the Illinois Tollway does not allow pedestrian traffic or sidewalks on the Illinois Tollway system. Also, the Illinois Tollway provides an 11-foot to 12-foot shoulder between the edge of traveled way and bridge parapet to minimize the likelihood of objects being thrown onto railroad property. The 44" high Constant-Slope parapet meets criteria for a Test Level 5, according to the AASHTO LRFD Bridge Design Specifications, which satisfies freeway and large truck requirements.

#### Waiver Alternative II

Should Alternative I be found unacceptable by the railway, the Designer shall propose that a 72" barrier wall be provided to control the amount of snow and debris falling onto the track. This will provide for "splash boards" being provided on structures where switching or other frequent railroad activities are performed. Parapets that are 6.0 feet above the surface of the pavement shall meet the requirements of Article 15.5.2.

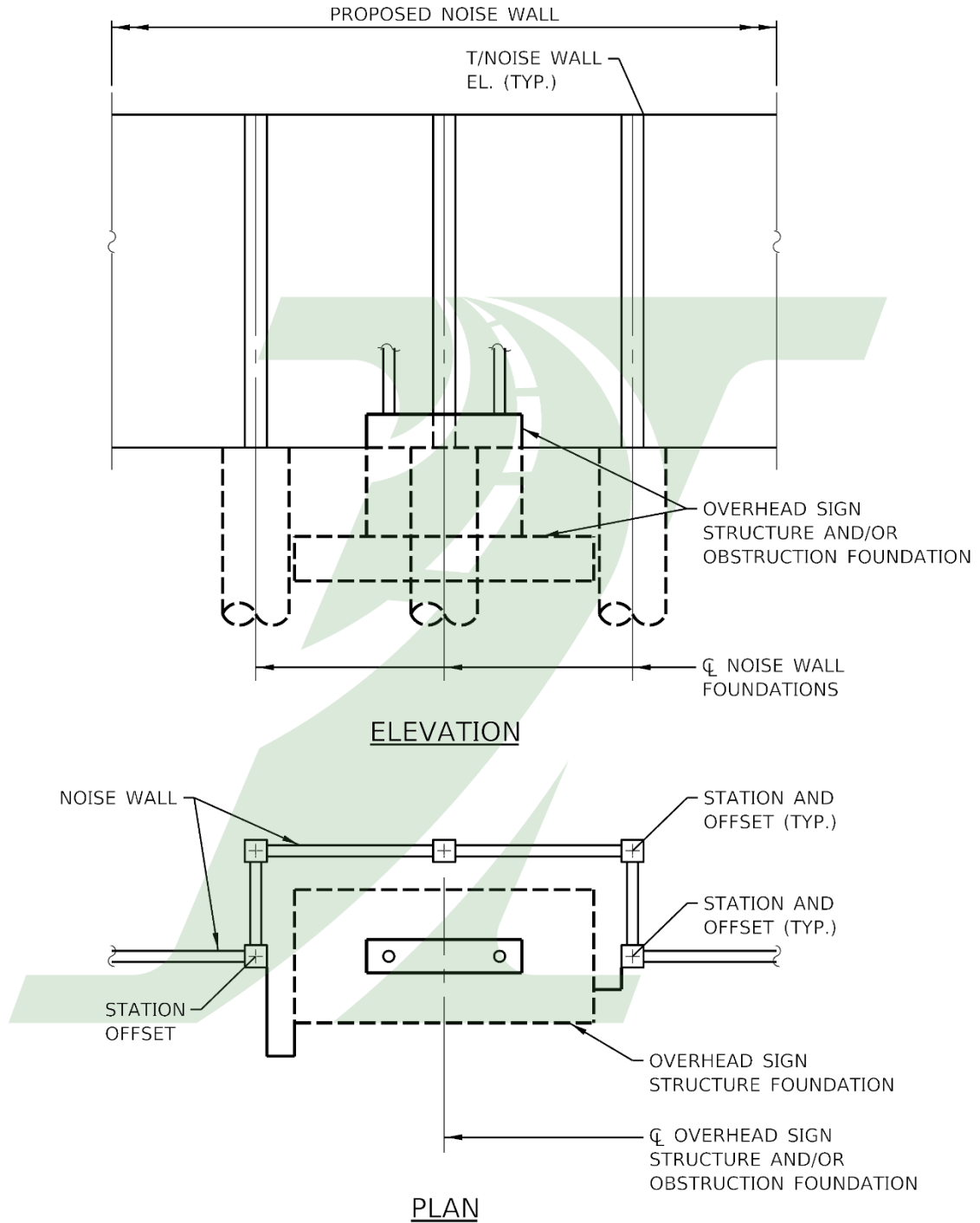
### 23.5.2 Fence Installation

Where a requirement for fencing on mainline structures has not been waived by the railroad, details for the fence shall be developed in accordance with Illinois Tollway Base Sheets M-BRG-521.

Fencing with parapet shall be provided on both sides of all overhead structures crossing Railroad right-of-way. It shall be designed to prevent climbing and provide positive means of protecting the Railroad facility and the safety of Railroad employees below from objects released from the bridge deck above.

The limits of the fencing with parapet shall extend to the limits of the Railroad Right-of-Way or a minimum of 25 feet beyond the centerline of the outermost existing track, future track or access road, whichever is greater. All parallel overhead structures that have a gap of 2 feet or more shall be protected with fencing. Structures with a gap of 2 feet or less shall either have the gap covered or be fenced on both sides.

The minimum combined height of a parapet with curved fencing shall be 8 feet or with straight fencing shall be 10 feet. On sidewalk or trail facilities the top of the fencing shall be curved to discourage climbing. A minimum 8-foot vertical clearance shall be provided for the full clear width of the trail or sidewalk. To prevent surface water from draining onto the Railroad Right-of-Way, a one-foot parapet is required. Fencing is also requested by the railroads on top of parapet on overhead structures without sidewalks or trails.



**Figure 23.3.1.1: Typical Obstruction Details**

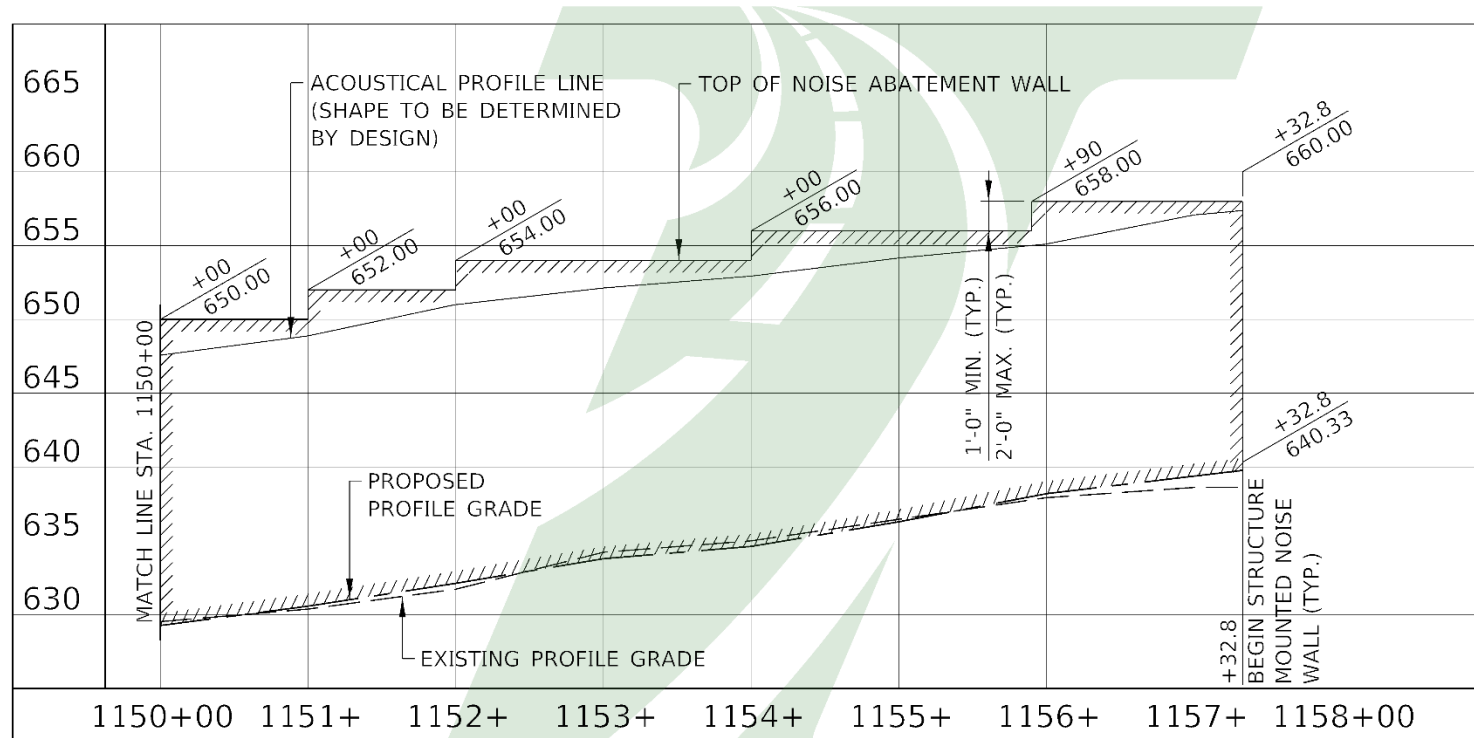
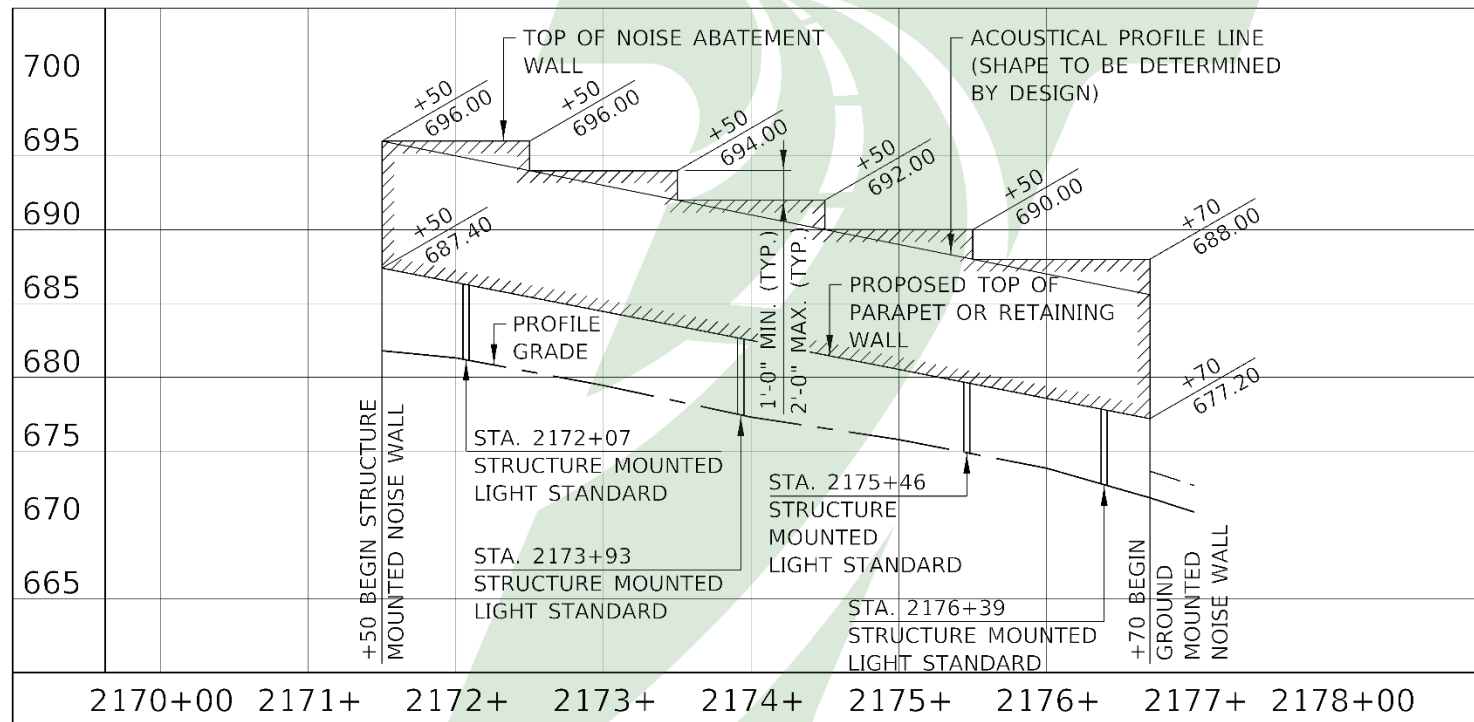
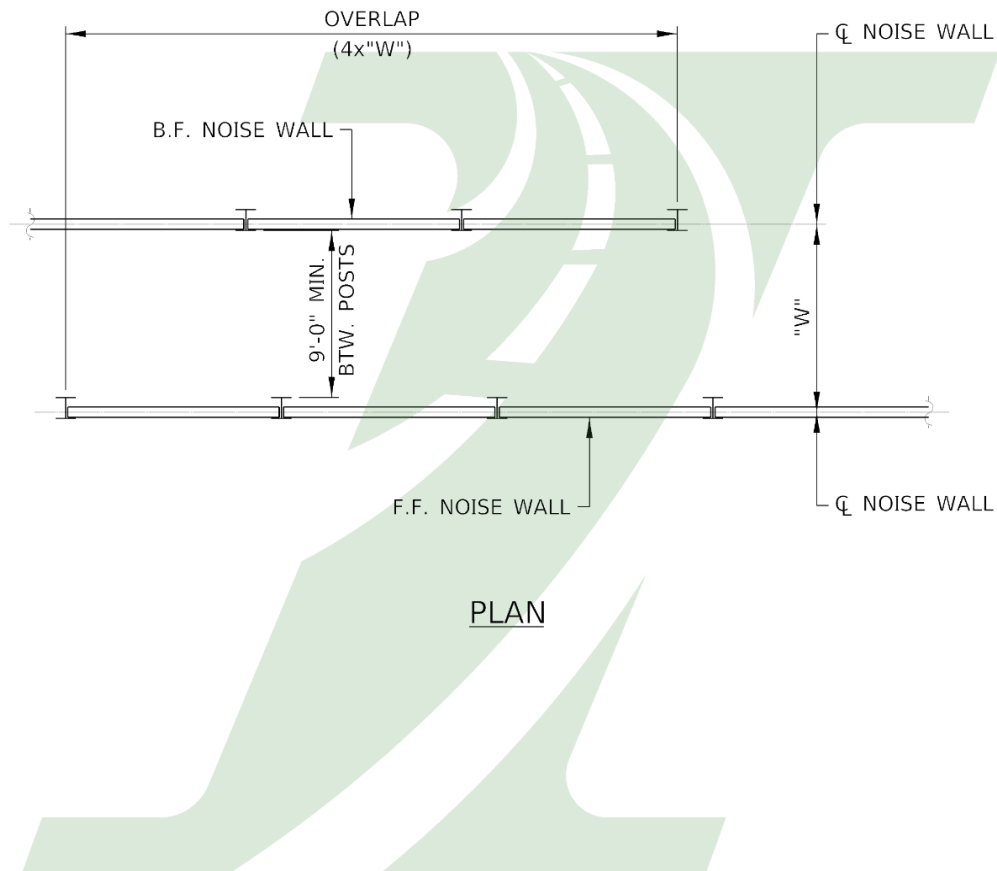


Figure 23.3.1.2: Ground Mounted Noise Abatement Wall Elevation

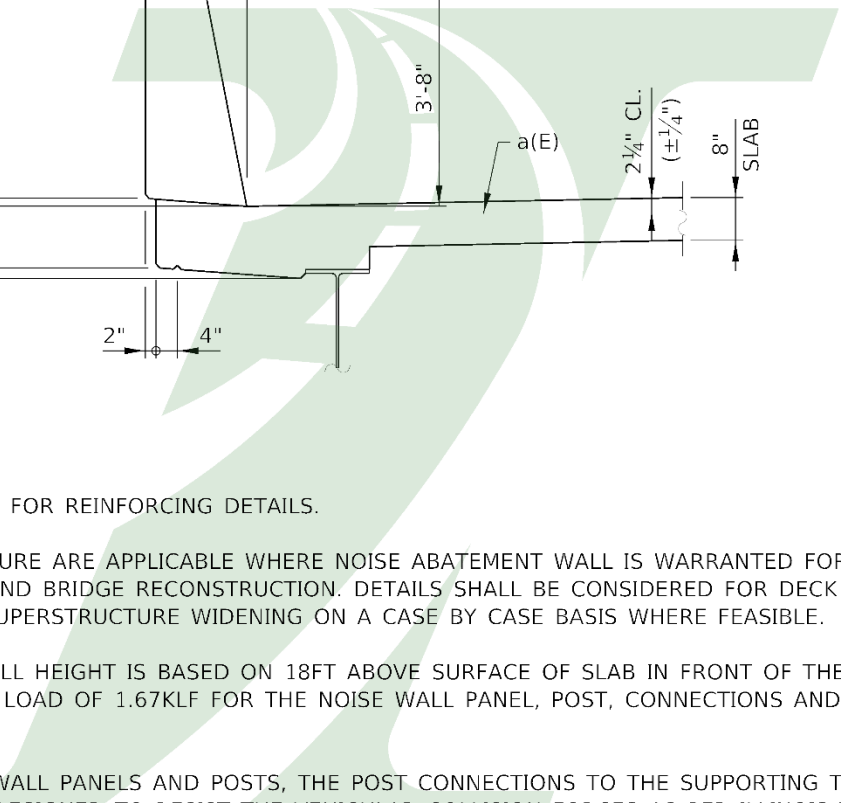


**Figure 23.3.1.3: Structure Mounted Noise Abatement Wall Elevation**





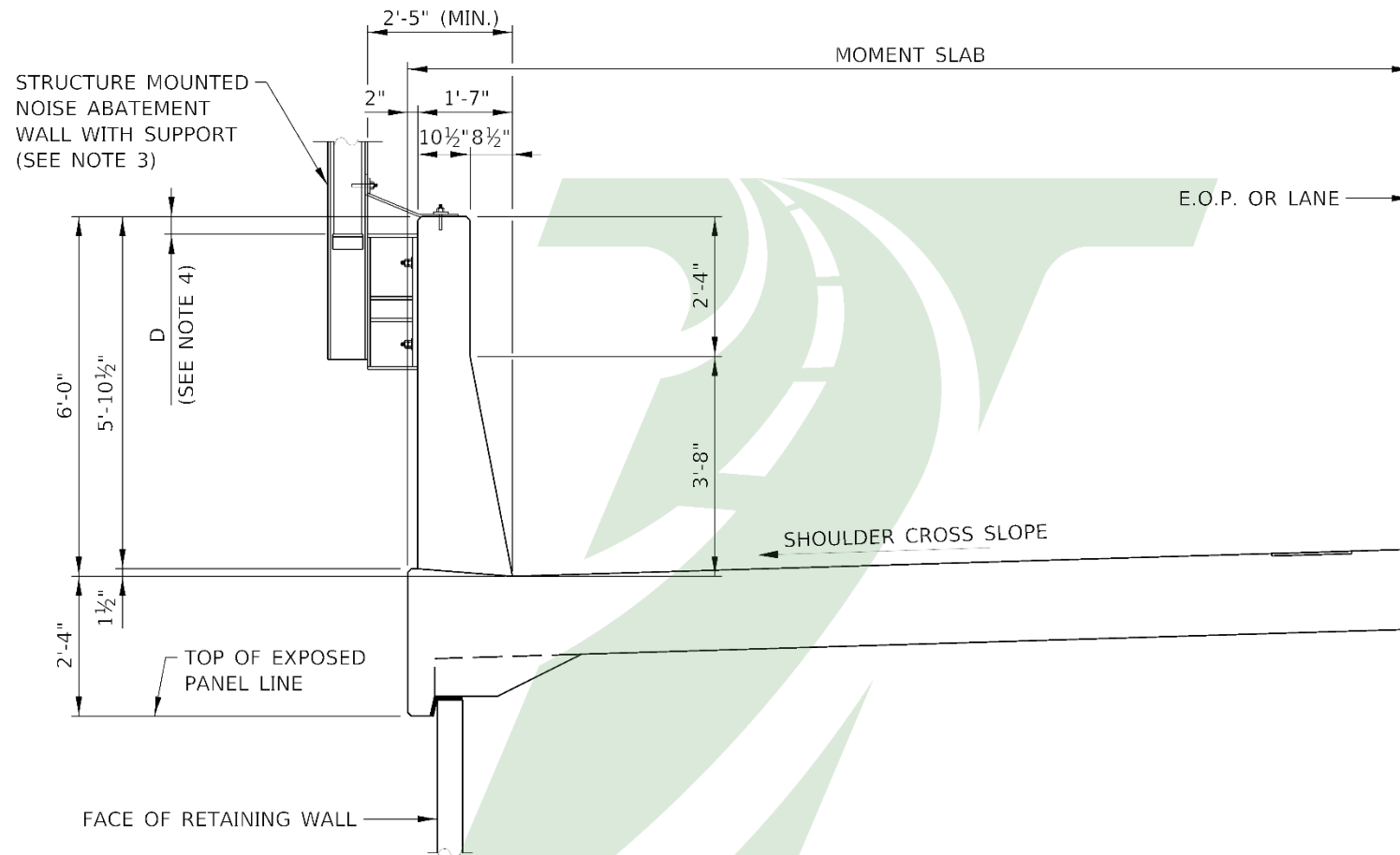
**Figure 23.3.3.1: Noise Wall Overlap Details (For Ground Mounted)**



1. SEE FIGURE 15.5.1.5 FOR REINFORCING DETAILS.

3. MAXIMUM NOISE WALL HEIGHT IS BASED ON 18FT ABOVE SURFACE OF SLAB IN FRONT OF THE BARRIER AND DEAD LOAD OF 1.67KLF FOR THE NOISE WALL PANEL, POST, CONNECTIONS AND SUPPORT.
4. FOR NON-PRECAST WALL PANELS AND POSTS, THE POST CONNECTIONS TO THE SUPPORTING TRAFFIC BARRIER SHALL BE DESIGNED TO RESIST THE VEHICULAR COLLISION FORCES AS PER ILLINOIS TOLLWAY STRUCTURAL DESIGN MANUAL SECTION 23.2.2. CONTINUOUS CORBELS SHALL NOT BE ALLOWED.
5. OVERLAP 'D' SHALL BE 4:1 RATIO OF THE GAP BETWEEN THE NAW AND THE BACK OF THE BARRIER. OTHERS MEANS OF FILLING THE GAP AND ELIMINATE OVERLAP MAY BE USED, SUBJECT TO APPROVAL BY THE ILLINOIS TOLLWAY. SEE ILLINOIS TOLLWAY STANDARD G12 FOR NOISE BLOCKING DETAIL FOR PRECAST CONCRETE NOISE ABATEMENT WALLS.
6. CENTER OF POST SHALL BE LOCATED A MINIMUM OF 3'-7" FROM CENTERLINE OF LIGHTPOLES, AND DESIRABLE DISTANCE OF 4'-7".

**Figure 23.3.4.1: Structure Mounted Noise Abatement Wall on Bridge**

**NOTE:**

SEE FIGURE 22.12.1 FOR MOMENT SLAB REINFORCING. SEE FIGURE 23.3.4.1 FOR ADDITIONAL NOTES.

**TYPICAL SECTION****Figure 23.3.4.2: Structure Mounted NAW on Moment Slab with Snow Storage**

## SECTION 24.0 OVERHEAD SIGN STRUCTURES

### 24.1 Design Specifications

- 2015 AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 1st Edition and all interims.
- Latest IDOT Sign Structures Manual.
- Latest Illinois Tollway Standard Drawings.
- Latest Illinois Tollway Base Sheets, M-OHS-720 thru -730.
- Existing overhead sign structures shall be analyzed using the design methodology of the original design. The Load Resistance Factor Design (LRFD) Method shall be used to design or analyze all new span, butterfly, monotube or cantilever type, overhead sign structures not covered by Section F of the latest Illinois Tollway Standards Drawings (non-standard sign structures).

### 24.2 Sign Structure Type Selection

Sound engineering judgment is required in the selection of the appropriate sign structure type following the parameters described in the Manual on Uniform Traffic Control Devices (MUTCD). The sign size and location are chiefly governed by the location of the traffic lanes.

Economy shall also be considered. Consideration shall be given to utilizing a structure mounted sign if within a reasonable distance of the MUTCD stipulated distance. When several sign locations are included in a single contract, utilizing groups of sign structures of the same length shall be considered. When evaluating Span Type versus Cantilever, Cantilever Type shall be considered approximately 4 times as expensive per foot length as the Span Type.

### 24.3 Overhead Sign Structure Clearance

Overhead sign structures for static signs without sign lighting (span and cantilever) shall be designed to provide 26'-5" from the high point of the roadway beneath the sign structure to the centerline of the truss, which includes an allowance for 9' from the centerline of the truss to the bottom of an 18' tall sign panel, regardless of the size of the panel required for that particular location. This will usually provide extra clearance when constructed and allow for either lighting or a larger panel to be added in the future. Taller panels can be accommodated provided that the overall maximum sign area is not exceeded and the vertical sign panel supports are checked for adequacy.

Sign structures that require lighting, such as those approaching a toll plaza, shall be designed with a minimum 17'-5" vertical clearance to the bottom of the 2' luminaires and with the sign panel(s) sized to accommodate the legend required for that particular location. For structures with multiple signs, the sign with the largest vertical dimension shall be used to determine the structure height. The height from the high point of the roadway beneath the sign structure to the centerline of the truss shall not be less than 26'-5".

Overhead sign structures for Dynamic Message Signs (DMS) shall be designed to provide 22'-5" from the high point of the roadway beneath the sign structure to the centerline of a cantilever, butterfly or span type sign structure that is intended only for installation of DMS. This includes an allowance for 5' from the centerline of the truss to the bottom of a 10' tall DMS, regardless of the size of the DMS required for that particular location.

## 24.4 Span Type (Aluminum)

Aluminum Span Type Sign Structures shall be selected and detailed in accordance with Standard F1 of the latest Illinois Tollway Standard Drawings. Illinois Tollway Base Sheet M-OHS-720 shall be used in combination with Standard F1. Aluminum Span Type structures can span from 80 to 150 feet and shall support static sign panels only. A Barrier Warrant Analysis shall be completed in accordance with Article 5.7.6 of the Illinois Tollway Traffic Barrier Guidelines.

The Illinois Tollway's sign structure-span type is an aluminum trichord truss supported by steel pipe columns, while IDOT's sign structure-span types are aluminum and steel box, four chord span system.

The steel pipe column support has been designed to accommodate maximum heights as shown in the table on Sheet 1 of Standard F1.

Illinois Tollway Standard F1 includes the foundations for the Span Type Sign Structures. The foundations include details as follows:

- The shoulder foundation consists of a grade beam (3'-6" width x 18'-0" length) supported on two 3'-0" diameter drilled shafts for all size truss spans. Foundation detail establishes a standard size grade beam for all span truss sizes. This feature simplifies the Traffic Barrier Warrant analysis by having a fixed dimension for any size truss span type structure.
- The median foundations consist of a grade beam design and details to match the 7'-0" wide concrete barrier base, supported on two 3'-0" diameter drilled shafts.
- The foundations accommodate the maximum column support heights shown on Sheet 1. In addition, the foundation can accommodate an increase in the depth of the grade beam by up to 2'-0", if additional sign structure height is required.

## 24.5 Cantilever Type

Cantilever Type Sign Structures shall be selected and detailed in accordance with Standard F4 of the latest Illinois Tollway Standard Drawings. Illinois Tollway Base Sheet M-OHS-721 shall be used in combination with Standard F4. Cantilever Type structures can span from 20 to 50 feet, and shall support either static sign panels or 1 Type 2W DMS Walk-in. A combination of static signs and DMS units is not permitted. A Barrier Warrant Analysis shall be completed in accordance with Article 5.7.6 of the Illinois Tollway Traffic Barrier Guidelines.

The Cantilever Type Sign Structure standard drawings incorporate a concrete and steel post column support system. This detailing enables the maximum steel post to have a 24" diameter with a nominal wall thickness of 1" for cantilever design spans up to 50 feet in length. Also provided are alternate steel grades for the steel support post; API 5L, Grade B, X42 or X52, ASTM 106, Grade B or C and ASTM A53, Type E or S, Grade B.

## 24.6 Monotube Type

Monotube Type Sign Structures shall be selected and detailed in accordance with Standards F13, F15 or F16 of the latest Illinois Tollway Standard Drawings. Illinois Tollway Base Sheets M-OHS-722, M-OHS-723, M-OHS-725, M-OHS-726 and M-OHS-727 shall be used in combination with Standards F13, F15 or F16. See the latest Illinois Tollway Standard Drawings for span limits and mounting details. Signs that do not meet the requirements shown on the standard drawings are not permitted.

These structures are located at mainline and ramp toll plazas and are used to support electronic toll collection equipment. The foundations have been designed for both single and double face barrier walls, supported by individual drilled shaft foundations of 3'-6" diameter minimum.

## 24.7 Butterfly Type

Butterfly Type Sign Structures shall be selected and detailed in accordance with Standard F14 of the latest Illinois Tollway Standard Drawings. Illinois Tollway Base Sheet M-OHS-724 shall be used in combination with Standard F14. Butterfly lengths up to 40 feet are permitted. Each face of a Butterfly Type structure may support either static signs or 1 Type 2 DMS. A combination of static sign panels and DMS units on the same face is not permitted. A Barrier Warrant Analysis shall be completed in accordance with Article 5.7.6 of the Illinois Tollway Traffic Barrier Guidelines.

The Overhead Sign Structure-Butterfly Type shall be selected and detailed in accordance with Standard F14 of the latest Illinois Tollway Standard Drawings. Details have been developed for median and shoulder applications. These structures are intended to support dynamic message signs.

## 24.8 Bridge Mounted Sign Structures

Bridge Mounted Sign Structures shall be designed and detailed in accordance with the latest IDOT Sign Structures Manual and Illinois Tollway Base Sheets M-BRG-503 and M-BRG-504.

In cases where the depth of the fascia beam is shallow and/or the profile grade approaches 5%, the location of the horizontal wide flange member between the web of fascia beam and the back of the sign support may vary vertically in order to maintain the luminaire supports in a level position (see Base Sheets M-BRG-503 and M-BRG-504). Alternatively, the location of the horizontal leg of luminaire support could also be varied to keep the luminaire supports level (see Figure 24.8.1).

## 24.9 Span Type (Steel)

Steel Span Type Sign Structures shall be selected and detailed in accordance with Standard F17 of the latest Illinois Tollway Standard Drawings. Illinois Tollway Base Sheet M-OHS-728 shall be used in combination with Standard F17. Steel Span Type structures can span up to 160 feet and shall support 1 Type 1 DMS only. Static sign panels are not permitted. A Barrier Warrant Analysis shall be completed in accordance with Article 5.7.6 of the Illinois Tollway Traffic Barrier Guidelines.

## 24.10 ITS Gantry Frame (Steel)

Steel ITS Gantry Frame Sign Structures shall be selected and detailed in accordance with the latest Illinois Tollway Base Sheets M-OHS-729 and M-OHS-730. See the latest Illinois Tollway Base Sheets for span limits and mounting details. Signs that do not meet the requirements shown on the base sheets are not permitted. A Barrier Warrant Analysis shall be completed in accordance with Article 5.7.6 of the Illinois Tollway Traffic Barrier Guidelines.

## 24.11 Overhead Sign Structures with End Cantilever(s)

Span Type, overhead sign structures required to cantilever or overhang the supports at one or both ends shall utilize a standard IDOT (box) truss, support legs and foundations. The selected truss shall be analyzed for the proposed end conditions and loads. The truss member sizes may be modified, if necessary, to accommodate the proposed overhang(s) and sign(s). The Designer shall modify and complete required information in the latest IDOT base sheets for the selected overhead truss, supports and foundations for inclusion in the Contract plans.

## 24.12 Non-Standard Sign Structures

Sign structures that do not fall within the criteria of the latest Illinois Tollway Standard Drawings and/or the latest IDOT Sign Structures Manual shall be designed in accordance with the latest AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

The Designer shall notify the Illinois Tollway in writing prior to beginning the design of a non-standard sign structure.

## 24.13 Naming Convention

Overhead sign structures shall be identified on the plans using the following format:

Illinois Tollway Milepost Structure Type, Direction (Ramp)

TOLLWAY:

EW = Reagan Memorial Tollway (I-88)  
 NS = Veterans Memorial Tollway (I-355)  
 NW = Jane Addams Memorial Tollway (I-90)  
 TS = Tri-State Tollway (I-294 & I-294/I-80)  
 TN = Tri-State Tollway (I-94)  
 ES = Edens Spur (I-94)  
 EO = Elgin-O'Hare Tollway (IL 390)\  
 WA = West O'Hare Access (I-490)

MILEPOST:

Two-decimal milepost to the tenth or hundredth if a ¼ mile post (i.e., 14.75)

SIGN TYPE:

B = Bridge Mounted  
 C = Cantilever and Butterfly Type Trusses  
 M = Monotube and ITS Gantry  
 T = Span Type Trusses

DIRECTION:

EB, SB, WB, NB - Inventory direction of the mainline roadway

RAMP:

(R) = sign is over a ramp (omitted if not along ramp)

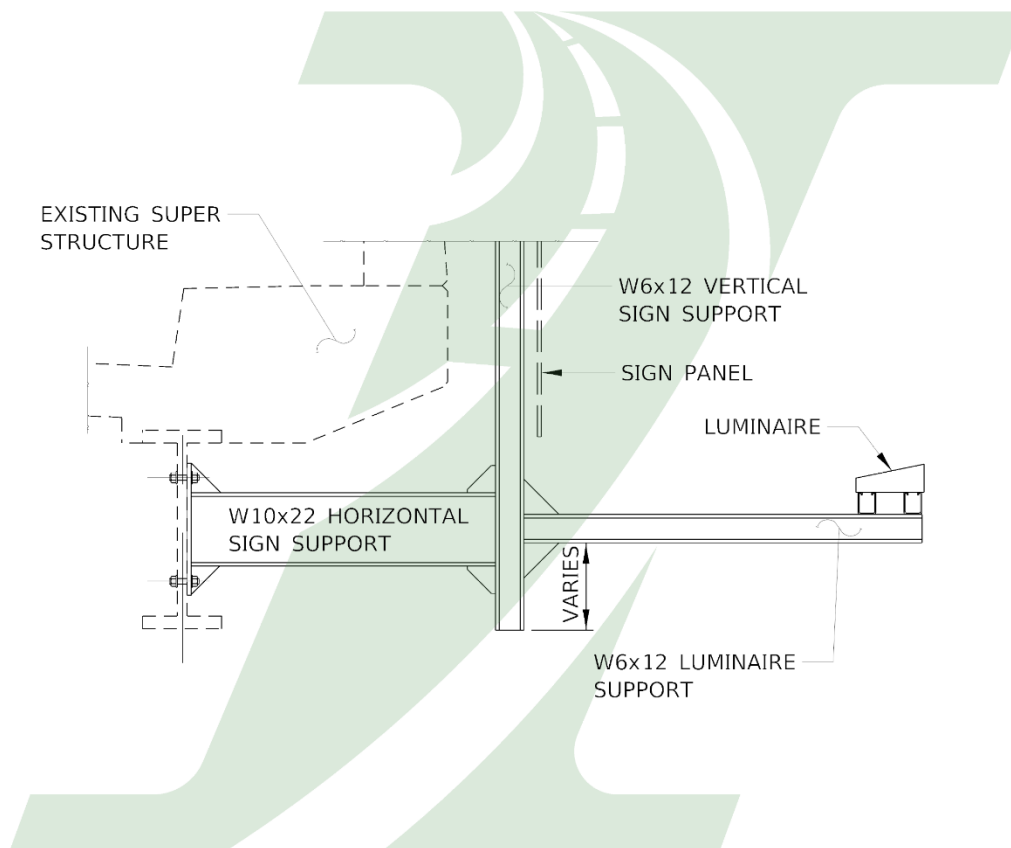
EXAMPLE:

TS38.40T,NB(R) for a span type truss located along the Tri-State Tollway (I-294) northbound at milepost 38.40 on a ramp

## 24.14 Foundations for Overhead Sign Structures

The foundation details shown in the Illinois Tollway Sign Structure Standard Drawings (Section F) and the ITS Gantry Base Sheets M-OHS-729 and M-OHS-730 are designed and detailed based on the common cohesive soil conditions (silty or sandy clay) with an average unconfined compressive strength ( $Q_u$ ) > 1.25 Tons/sq. ft.

The Design Section Engineer (DSE) shall conduct a subsurface investigation at each overhead sign structure foundation to determine the actual soil conditions. Should the investigation reveal soil properties less than average unconfined compressive strength ( $Q_u$ ) = 1.25 Tons/sq. ft. or indicate the presence of rock, the DSE shall design and detail the drilled shaft foundations to meet the actual site conditions and modify the Illinois Tollway Sign Structure Standard Drawings and Base Sheets accordingly. The sign structure shall not be supported on bridge parapets.



**Figure 24.8.1: Alternate Bridge Mounted Sign and Luminaire Support Details**



## SECTION 25.0 SHOP DRAWINGS

### 25.1 General

Shop drawings are detailed fabrication and erection plans prepared by the fabricator, supplier or Contractor which are interpreted from the engineering drawings in the Contract plans. Working drawings are required whenever it is necessary for the Contractor to design, construct or erect temporary structures, design and construct some permanent structures or other performance-based items as outlined in Section 105.04 of the Illinois Tollway Supplemental Specifications. The Contractor shall submit a demolition plan and/or erection plan to the Engineer and Designer when required. When contracted, the Designer shall be responsible for reviewing the drawings for compliance with the design plans and project specifications only. Additionally, demolition plans shall be in accordance with Article 7.2.1 and the latest Illinois Tollway GBSP for Demolition of Structures and erection plans shall be in accordance with Article 7.2.2 and the latest GBSP for Erection of Structures.

It is the responsibility of the Engineer to ascertain that the fabricator is supplying the items specified, while it is the Contractor's responsibility to verify that all items are per contract plan and specifications and fabricated to the correct dimensions. See Article 105.04 of the latest Illinois Tollway Supplemental Specifications and latest Illinois Tollway Construction Manager's Manual. Approved shop drawings shall be archived with the as-built plans for each project.

### 25.2 Required Shop Drawings

For shop drawings and working drawings see the latest Illinois Tollway Supplemental Specifications Article 105.04.

#### 25.2.1 Structural Steel and Expansion Joints

At a minimum the following information shall be reviewed:

- Framing plan, showing general layout of the steel beams, cross frames, location of field splices and marking scheme for identifying members.
- The number, size and geometry of all members.
- The details of all splices, showing the number, size and type of bolts, hole diameters, the type, size and length of all welds and a section showing the size of all splice materials.
- The details of all field connections, showing number, size and type of bolts, hole diameters, and the locations where reaming is required.
- The number, size and spacing of shear developers. The use of shop welded shear developers is acceptable for embedded bearing plates and expansion joints.
- Verify ordinates and geometry at abutments, field splices and interior at piers.
- The amount and location of camber and the permissible tolerances.
- Material specifications (AASHTO and/or ASTM designation) of the steel to be fabricated and any testing requirements.
- The steel surface preparation and the type of shop and/or field coating to be applied.
- All notes that appear on the design plans shall be reflected on the shop drawings.
- Structural steel weights (shop bills) shall be checked.
- Blocking and lifting diagrams.
- Check plate bending radiuses

### 25.2.2 Prestressed Concrete

At a minimum the following information shall be reviewed:

- Erection diagram, showing the general layout of the concrete elements.
- The number and size of all members.
- The number, size and type of prestressing strands or rods, and the forces in these prestressing elements.
- Bearing details showing size, type, and materials.
- The location and the details of lifting devices and of support points, if the beam does not rest on its bearings while being transported.
- The location and type of any inserts required for attachments.
- The layout of the casting bed to be used for casting the prestressed beams.
- The location of hold-down devices for any draped strands.
- The location and length of any bond-breaker.
- The details and type of the reinforcement bars.
- All notes that appear on the design plans shall be reflected on the shop drawings.

### 25.2.3 Bearings

At a minimum the following information shall be reviewed:

- Location diagram, showing the general layout of the structure and the locations of the bearings.
- The number, size and types of all bearings.
- The details of the bearings, showing all materials, dimensions and welding.
- The steel surface preparation and shop coating details.
- Notes listing the material specifications for all parts of the bearings, and the design and specifications used for the design of the bearings.

## 25.3 Miscellaneous Items

Shop Drawings for the following items need not be submitted for review unless specified or special (non-standard) details are proposed for routine items:

- Fabric Reinforced Elastomeric Mats and/or steel anchor plates for the back of Integral Abutments
  - The fabricator shall furnish installation and detail drawings to the Contractor and Engineer for field verification of locations and dimensions. These drawings shall be included in the project record. Shop fabrication inspection is not required, and the Engineer's final acceptance may be based on proper fit and an overall visual inspection of the finished product. The material supplier is responsible for submitting samples to the BMPR for lot testing.
- Bridge Railing & Drainage Systems
  - Steel Bridge Rail, Aluminum Bridge Rail, Pedestrian/Bicycle Railing, Pre-Fabricated Inspection Platforms, Scuppers, Drain Piping, Navigation Lights and Mounting Hardware.
  - The fabricator shall furnish installation and detail drawings to the Contractor and Engineer for field verification of locations and dimensions. These drawings shall be included in the project record. Shop fabrication inspection is not required, and the Engineer's final acceptance may be based on proper fit and an overall visual inspection of the finished product.
  - Standard design base sheet notes require permanent tubular steel bridge traffic rail and rail posts to have Charpy V-Notch (CVN) toughness values certified by

test. Test results, along with mill certification documentation, are to be submitted to the Engineer. CVN testing is not normally required for bicycle/pedestrian railing. All steel for railing, bolts, anchor bolts and posts shall be domestic. Any paint used shall be accepted by the IDOT Bureau of Materials and Physical Research (BMPR). Current requirements of the BMPR concerning aluminum rail and posts shall be satisfied.

- Bridge Joint Seal System (Bonded Preformed Joint Seals) or Strip Seals
  - These joints may be prefabricated in convenient lengths, allowing subsequent shop or field cutting to meet project requirements. Since details will be generic, no project-specific review is required. An installation scheme shall be provided by the fabricator to the Contractor and Engineer.

## SECTION 26.0 REHABILITATION AND REPAIR

### 26.1 General

When extensive repairs to a structural member appear necessary, to the extent that the structural capacity of the member during construction may be in doubt, provisions shall be made to temporarily support the member during construction. This also applies to concrete member repairs, whether it is pneumatically applied mortar or formed concrete repairs. The location of proposed temporary supports shall be indicated on the plans.

Refer to the latest edition of the “Structural Services Manual” by the IDOT Bureau of Bridges and Structures. The manual contains information and guidelines for the types of repairs most often required to adequately maintain typical bridge structures during the service life. The Designer and/or Contractor are encouraged to use guidelines provided in the above referenced manual in preparing final repair details associated with the rehabilitation project.

The most common types of repairs/rehabilitation tasks associated with Illinois Tollway projects are listed below, refer to the applicable sections from the above referenced manual.

- Bridge Deck Overlay
- Expansion Joint Replacement
- Bridge Rails and Parapets
- Bearing Replacement
- Impact Repairs – Steel Beams
- Impact Repairs – Concrete Beams
- Steel Superstructure Repairs
- Concrete Superstructure Repairs
- Substructure Repairs

### 26.2 Precast Concrete Repairs

Even though a higher quality of standards is maintained in a plant-cast prestressed concrete environment, damages or defects can still occur in such products. Examples include voids and cracks in concrete and improperly placed or damaged reinforcement and hardware. These products fall into one of the three following categories:

- Products that can be accepted without repair
- Products that can be accepted with repair
- Products that must be rejected

Refer to “Manual for the Evaluation and Repair of Precast, Prestressed Concrete Bridge Products” published by PCI. The Manual also addresses evaluation and repair for damage caused by imperfections or damage occurring during production, handling, transportation and erection. This Manual serves as a resource and a base for developing repair options. The designer and/or Fabricator is required to prepare repair procedures and details using guidelines provided in the above referenced manual while applying sound engineering judgment. The repair procedures and details shall be submitted to the Illinois Tollway for review and approval.

In addition to the types of damage discussed above and the normal deterioration due to aging, collisions between over-height vehicles and bridges are becoming more commonplace and can be catastrophic. Collision damage, however, is generally far from catastrophic although sound repair techniques are critical if additional damage (typically related to corrosion) is to be mitigated.

A comprehensive study was recently completed by NCHRP to develop criteria to evaluate whether to repair or to replace a prestressed concrete girder damaged by a vehicular impact, identify the gaps in the available information and practices related to repair of collision damage of prestressed girders and prepare a recommended practice report guide. Results of the study are presented in the NCHRP 20-07/Task 307 report, entitled “Updated Research for Collision Damage and Repair of Prestressed Concrete Beams”, dated May 2012.

The primary deliverable of the NCHRP 20-07/Task 307 report is the *Guide to Recommended Practice for the Repair of Impact-Damaged Prestressed Concrete Bridge Girders*, which is included in Appendix A of the report. The *Guide* serves to update the 1985 NCHRP Report 280: *Guidelines for Evaluation and Repair of Prestressed Concrete Bridge Members*, which remains a primary reference for this topic.

Nine repair techniques are described in the Guide of the NCHRP 20-07/Task 307 report; four are generally recommended as being practical for repairing impact damaged prestressed concrete girders: externally bonded carbon fiber reinforced polymer (EBCFRP); externally bonded post-tensioned CFRP (bPT-CFRP); post-tensioned steel (PT-steel); and internal strand splicing. In addition, external repairs in combination with strand splicing are discussed. The Designer is required to prepare repair procedures and details using guidelines provided in the NCHRP 20-07/Task 307 reference, while applying sound engineering judgment. The repair procedures and details shall be submitted to the Illinois Tollway for review and approval.

### 26.3 Aluminum Sign Truss Repairs

Refer to Figures 26.3.1 through 26.3.4 regarding suggested details for repairing existing aluminum sign trusses. These details are to be used as guidelines in preparing repair plans for sign trusses. Figure 26.3.5 provides guidelines for installing damping devices for existing aluminum trusses and Figure 26.3.6 includes details for installing tie offs on existing sign structures to meet OSHA requirements.

### 26.4 Approach Slab Resurfacing and Repairs

When resurfacing an existing approach slab, the surface of new overlay shall be string lined to provide a smooth transition from the ends of bridge to the existing road.

Before resurfacing, the spalled areas of existing approach slabs shall be repaired with partial-depth concrete patches and completely deteriorated areas shall be repaired with full-depth patches. Top reinforcement bars exposed in repair areas that show a 50% loss of section due to corrosion or that were damaged during concrete removal shall be supplemented with additional bars equal to the area of the original deteriorated or damaged bar(s) (see Figure 26.4.1). Bottom reinforcement bars exposed in repair areas that show a 20% loss of section due to corrosion or that were damaged during concrete removal shall be supplemented with additional bars equal to the area of the original deteriorated or damaged bar(s).

Existing reinforcement bars that have been cut or damaged by the Contractor shall be provided with supplemental bars at no additional cost to the Illinois Tollway. Otherwise, supplemental bars shall be paid for as “Reinforcement Bars” or “Reinforcement Bars, Epoxy Coated”.

Those areas of approach slabs showing settlement at the abutment backwall shall be removed and replaced in accordance with the details shown in Figure 26.4.2. Existing preformed filler joints at the bridge end of approach slabs shall be replaced wherever possible with the detail shown in Figure 26.4.3 and at the transition approach slab as shown in Figure 26.4.4.

Wherever an expansion joint between the approach and transition approach slab is being replaced, a transition approach shoulder slab shall be installed unless one is already in place or moment slab is present. The joint shall extend the full width of the approach slab.

## 26.5 Aggregate Slope Paving Repairs

See Figure 26.5.1 for suggested details for repairing eroded or damaged slope paving.

## 26.6 Metal Culvert Temporary Repairs

See Figures 26.6.1 through 26.6.4 for suggested details to temporarily repair metal arch or half round culverts until they can be programmed for replacement or lining.

## 26.7 Bearing Repairs

Frequently, existing rocker bearings are found to be tilted and in need of adjustment. The magnitude of the adjustment is determined by comparing the measured horizontal displacement of the rocker with the theoretical displacement for similar temperature conditions. No adjustment is necessary unless the measured displacement exceeds the theoretical by  $\frac{3}{4}$  inch or more. Adjustment is usually made by repositioning the sole plate; however, if a bearing stiffener is present, the stiffener shall remain within the middle third of the repositioned sole plate.

## 26.8 Fiber Reinforced Polymer Repairs

Fiber Reinforced Polymer (FRP) shall be considered as a cost-effective solution to increase structural capacity for various bridge elements.

The following guidelines are proposed:

- FRP shall be considered by the Designer as one of the available repair methods for restoring structural capacity of PPC Beams and other reinforced concrete structural members. For guidance regarding selection of repair techniques including FRP, refer to the NCHRP 20-07/Task 307 report, entitled “Updated Research for Collision Damage and Repair of Prestressed Concrete Beams”, dated May 2012. Also, refer to “ACI 440.2R-08 Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures” for design guidance.
- FRP shall be installed as the final external layer of any PPC Beam or outside face of parapet patching that is located over shoulders, traffic lanes or railroad tracks. The use of FRP over patch areas in locations other than over shoulders, traffic lanes and/or railroad tracks is not recommended.
- Beam ends shall not be considered for repairs with FRP. In this situation, beam encasement is the preferred option.
- FRP shall not be used in conjunction with patching of bridge deck underside.

## 26.9 Deck Drains

Repair plans for major maintenance projects on deck surface of a structure such as overlay projects shall contain details to provide for elimination of existing deck drains, or adjustment of existing deck drains to direct drainage away from the main load-carrying member of the superstructure and substructure units.

## 26.10 Deck Underside and Concrete Diaphragms

Deck underside and concrete diaphragms where shallow spalls occur, that are less than 3" maximum depth and analysis shows that the missing concrete does not affect the strength of the

member, missing concrete may not need to be replaced. However, all exposed reinforcement bars shall be cleaned and coated with epoxy to prevent deterioration.

Where concrete spalling on cast-in-place concrete diaphragms, is 3" or greater depth, diaphragms shall be repaired with formed concrete repair. A 1/8" tar-paper bond breaker shall be placed between the beam web and the adjacent repair.

Deck underside defects which affect structural capacity shall be addressed with full depth patches. Partial depth patching of bridge deck underside is not allowed.

## 26.11 Expansion Joints

Figure 26.4.4 includes typical details for expansion joint replacement and reconstruction at approach and transition approach pavement. Additionally, bonded preformed joint repairs may utilize UHPC headers as shown and approved by the Illinois Tollway. For bridge joint replacement and reconstruction, details from the latest edition of IDOT's Structural Services Manual shall be followed. When inspecting existing joints, measurements shall be taken of the opening and air temperature recorded. The following note shall be included with the plans:

Measurements taken of opening at time of inspection was \_\_\_\_" at \_\_\_\_°F.

When reconstructing the joint header, consideration shall be given to MOT constraints and long-term durability. When joint repairs or reconstruction result from instances other than normal wear, the designer shall investigate the cause and verify adequacy of existing joint (size and type) for the anticipated movement and reconstruct with appropriately sized joint when necessary.

## 26.12 Slope Wall Modification

When resurfacing an existing roadway adjacent to an existing concrete slope wall, portion of the concrete slope wall shall be removed and reconstructed to match the elevation of the overlay as per Figure 26.12.1.

## 26.13 Overlays Selection

Proactive deck protection is the best way to preserve the life of any concrete bridge deck or slab. Deck protection systems include a variety of methods that prevent water and chlorides from reaching the reinforcing steel in bridge decks to slow or stop corrosion of the steel. Appendix C of the AASHTO Guide to Preservation of Highway Bridge Decks, First Edition January 2023 provides guidance on the selection of the preservation treatments for bridge decks with various treatments and in various conditions. Benefits of the treatments are computed based on the difference between present value normalized cost of service for a treated deck and the present value normalized cost of a deck without treatment. Positive benefit indicates that deck service with treatment is lower cost compared to deck service without treatment.

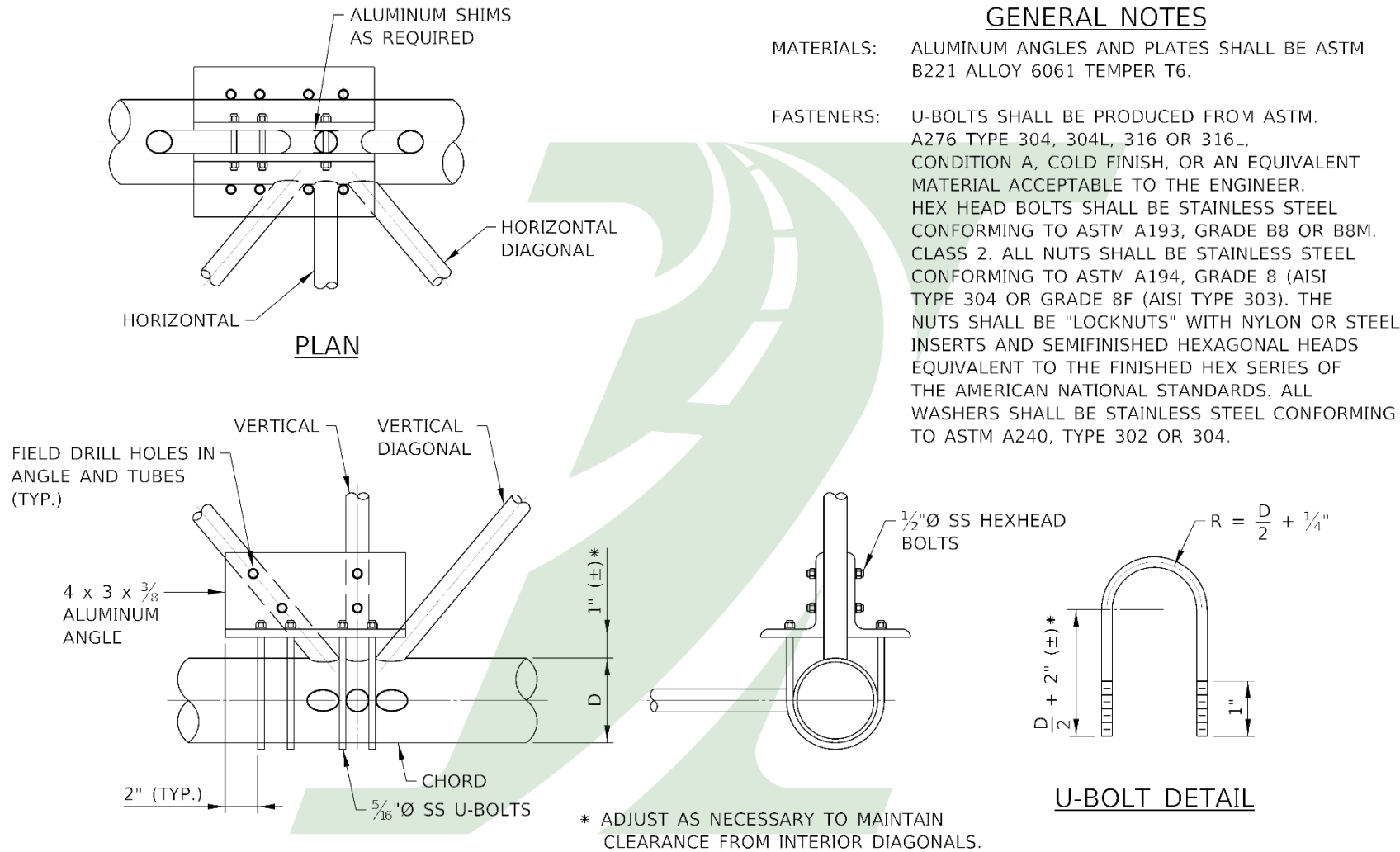
The selection of the type of overlay shall be in accordance with AASHTO Guide to Preservation of Highway Bridge Decks, First Edition January 2023 with the following exception:

- Values for discount rate, age of treatment, frequency of treatment, type of treatment shall be per the Illinois Tollway Structures Design Manual (SDM) and as follows:
  - Expected life:
    - Thin Polymer Overlay (TPO): 10 years
    - Latex Modified Concrete Overlay (LMC): 25 years
    - Asphalt Overlay: 12 to 15 years

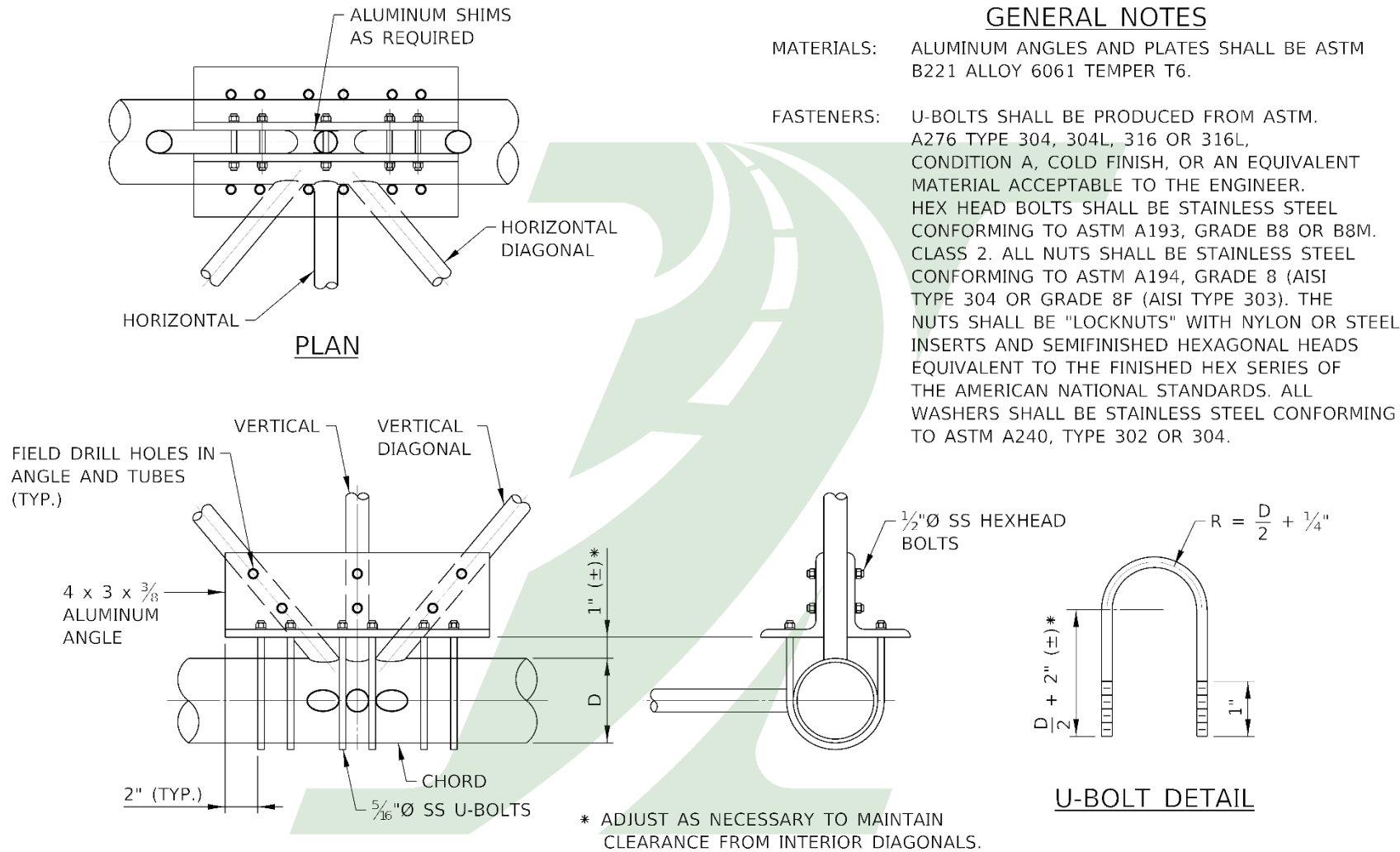


- Deck Condition (Based National Bridge Inspection Standard (NBIS) Condition Rating):
  - Thin Polymer Overlay (TPO): Good condition, spalls less than 0.25 inch, or active cracks <0.04 inch.
  - Latex Modified Concrete Overlay (LMC): Good or fair condition, spalls with depth not greater than the concrete cover of the top mat of rebars (T1 Spalls), or spalls with depth not greater than half the thickness of the deck. T1 spalls are filled with overlay when LMC overlay is applied.
  - Asphalt Overlay: Good condition or fair condition provided repairs to the deck are done before placing overlay.
- TPO shall not be used on bridge deck with ADT  $\geq 10,000$

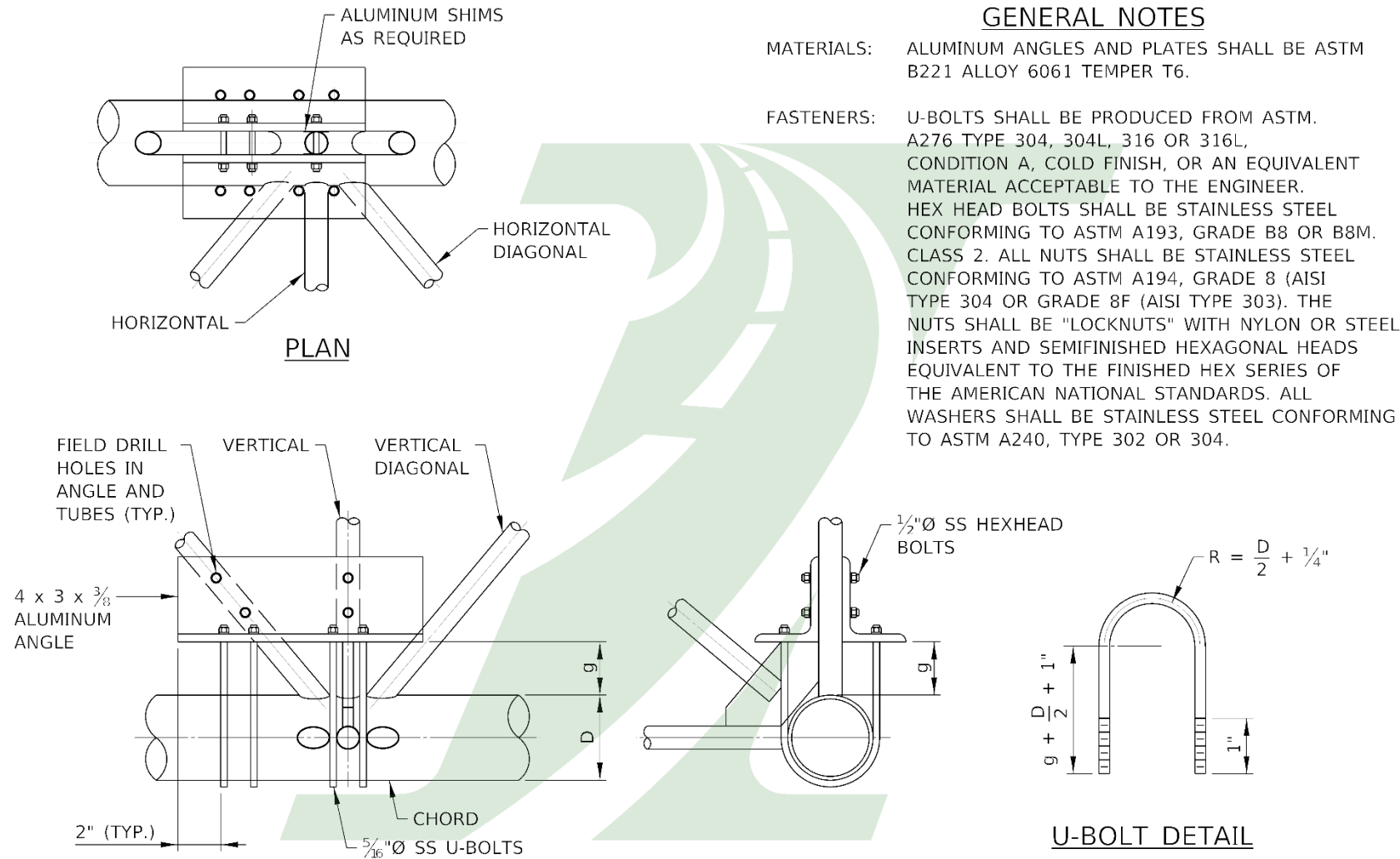


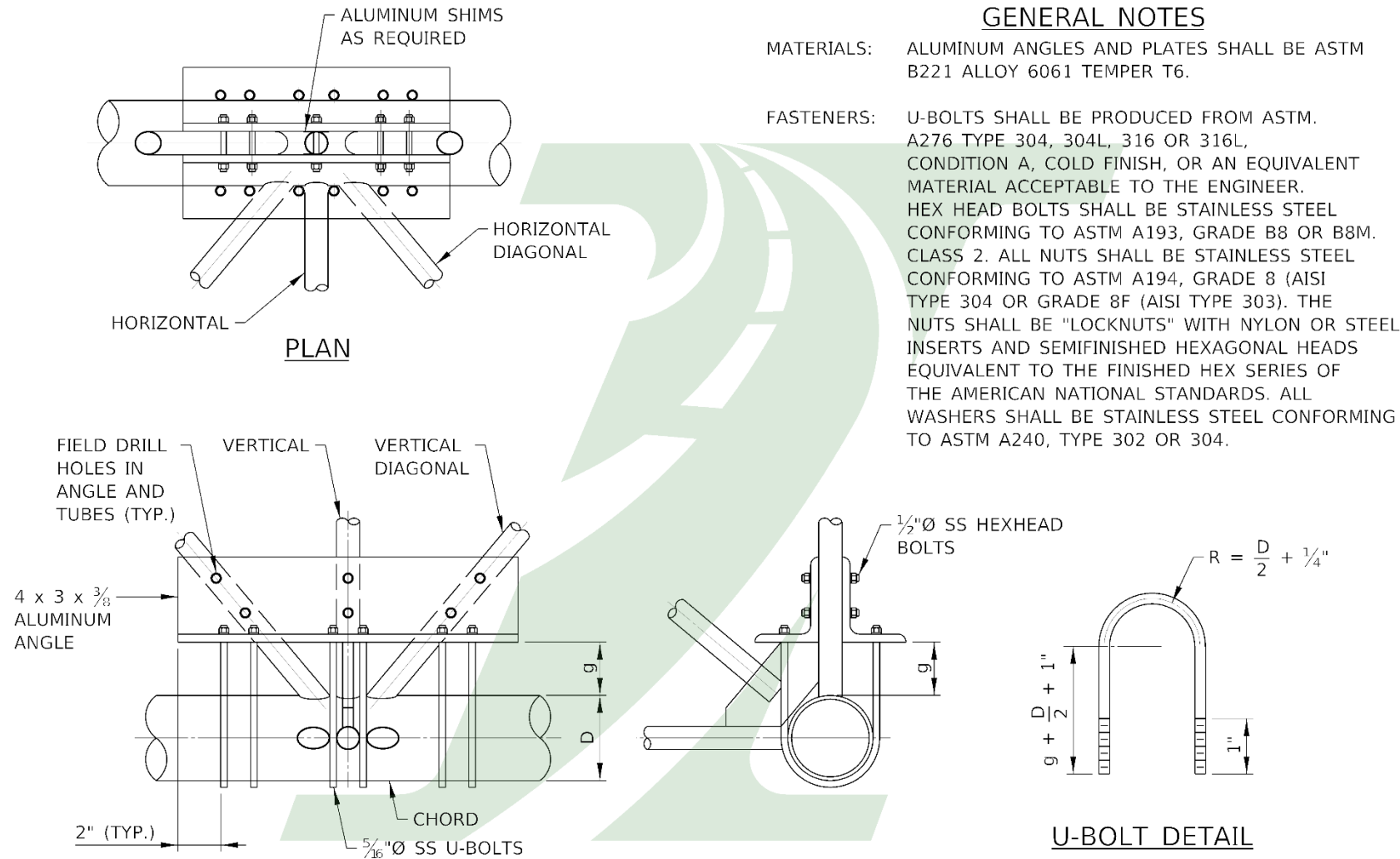


**Figure 26.3.1: Single Vertical Diagonal Repair Without Gusset**



**Figure 26.3.2: Double Vertical Diagonal Repair without Gusset**





**Figure 26.3.4: Double Vertical Diagonal Repair with Gusset**

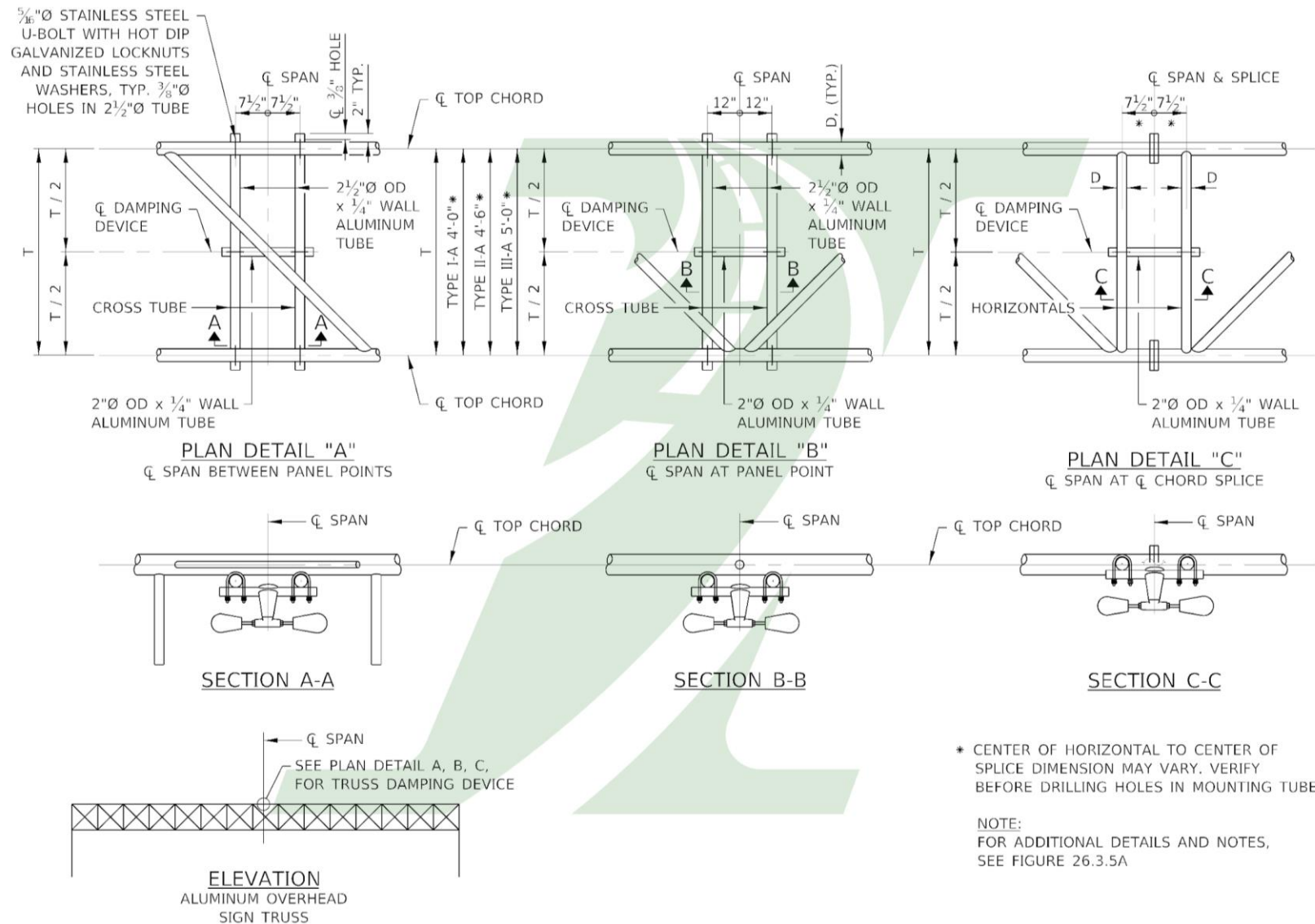
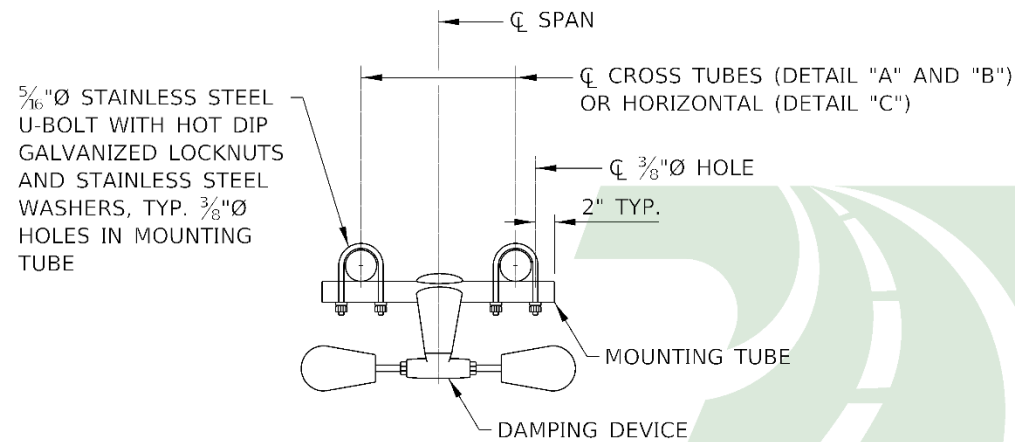


Figure 26.3.5: Damping Devices

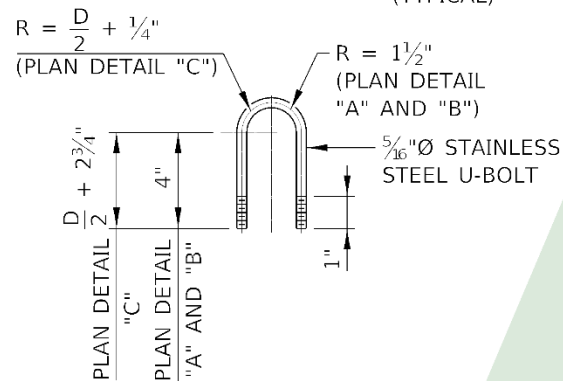


**TRUSS DAMPING  
DEVICE CONNECTION DETAIL**  
(TYPICAL)

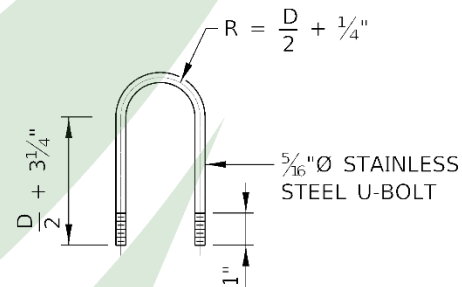
**NOTES:**

**DAMPER:** ONE DAMPER PER TRUSS.  
(31 LBS. STOCKBRIDGE-TYPE  
ALUMINUM) COST INCLUDED IN  
OVERHEAD SIGN STRUCTURE.

**MATERIALS:** ALUMINUM TUBES SHALL BE ASTM  
B221 ALLOY 6061 TEMPER T6.  
COST INCLUDED IN OVERHEAD  
SIGN STRUCTURE.

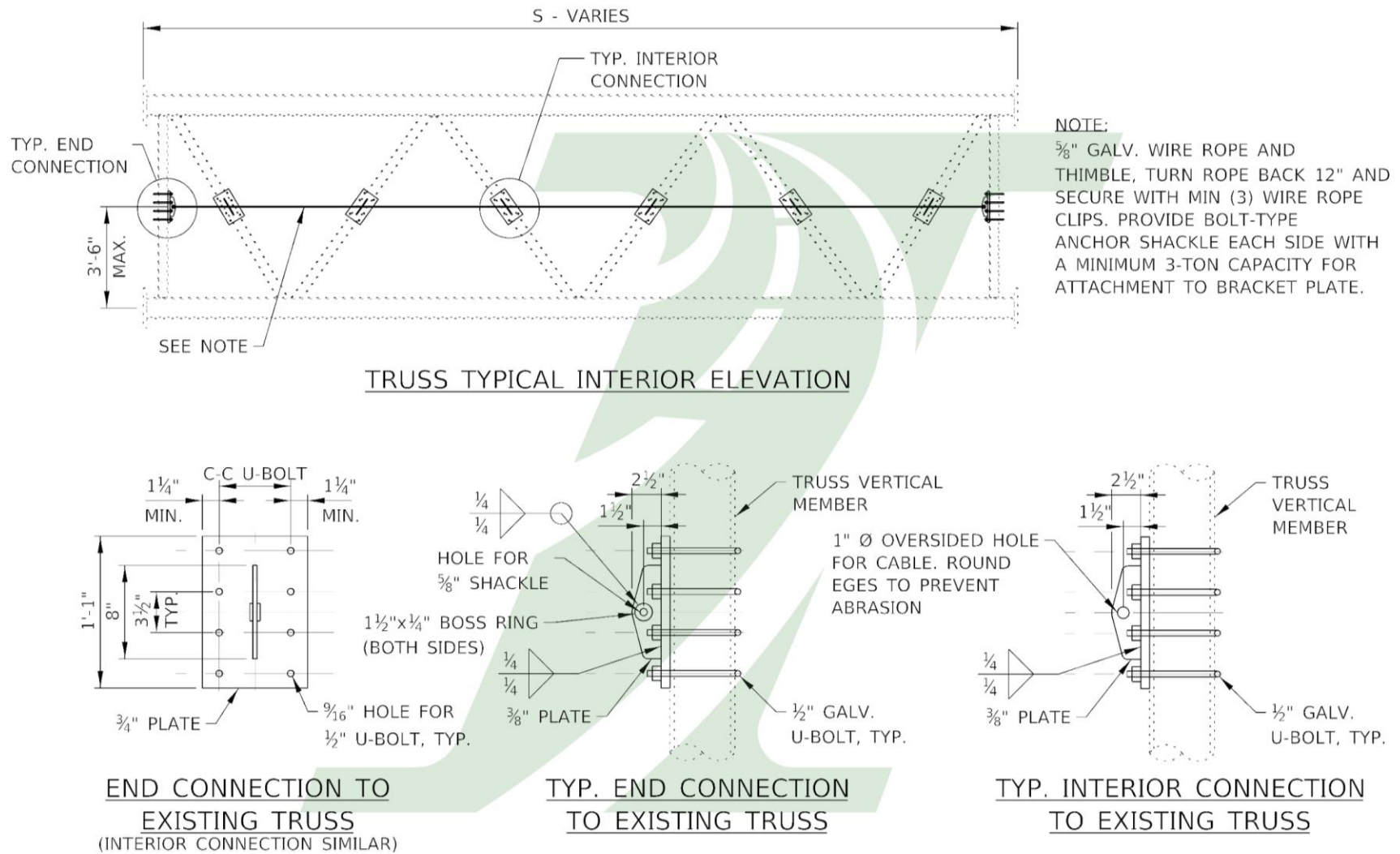


**DAMPING DEVICE MOUNTING  
TUBE U-BOLT DETAIL**  
(TYPICAL)

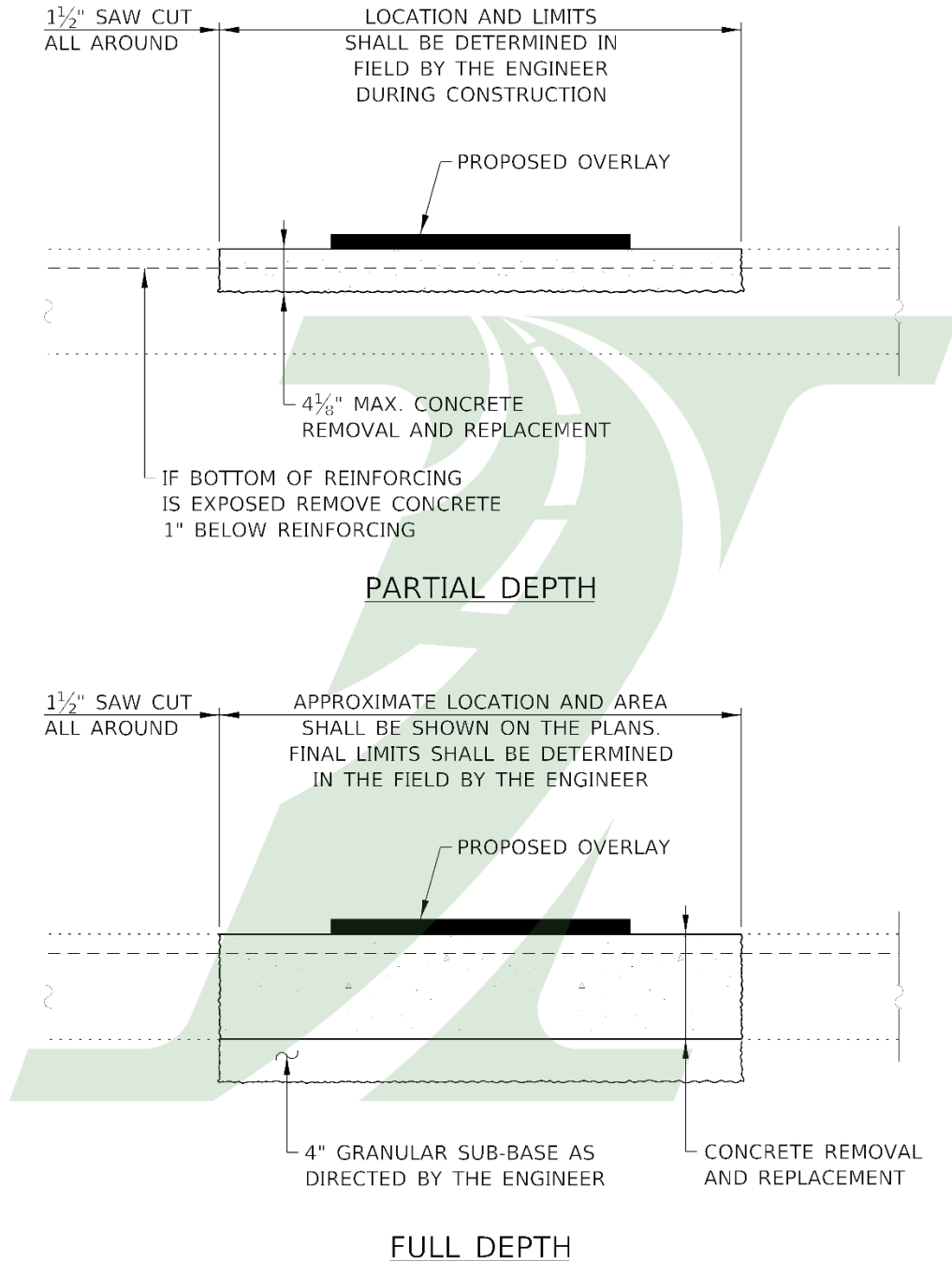


**TOP CHORD TO CROSS TUBE  
U-BOLT DETAIL**  
(TYPICAL - DETAIL "A" AND "B")

**Figure 26.3.5A: Damping Devices**

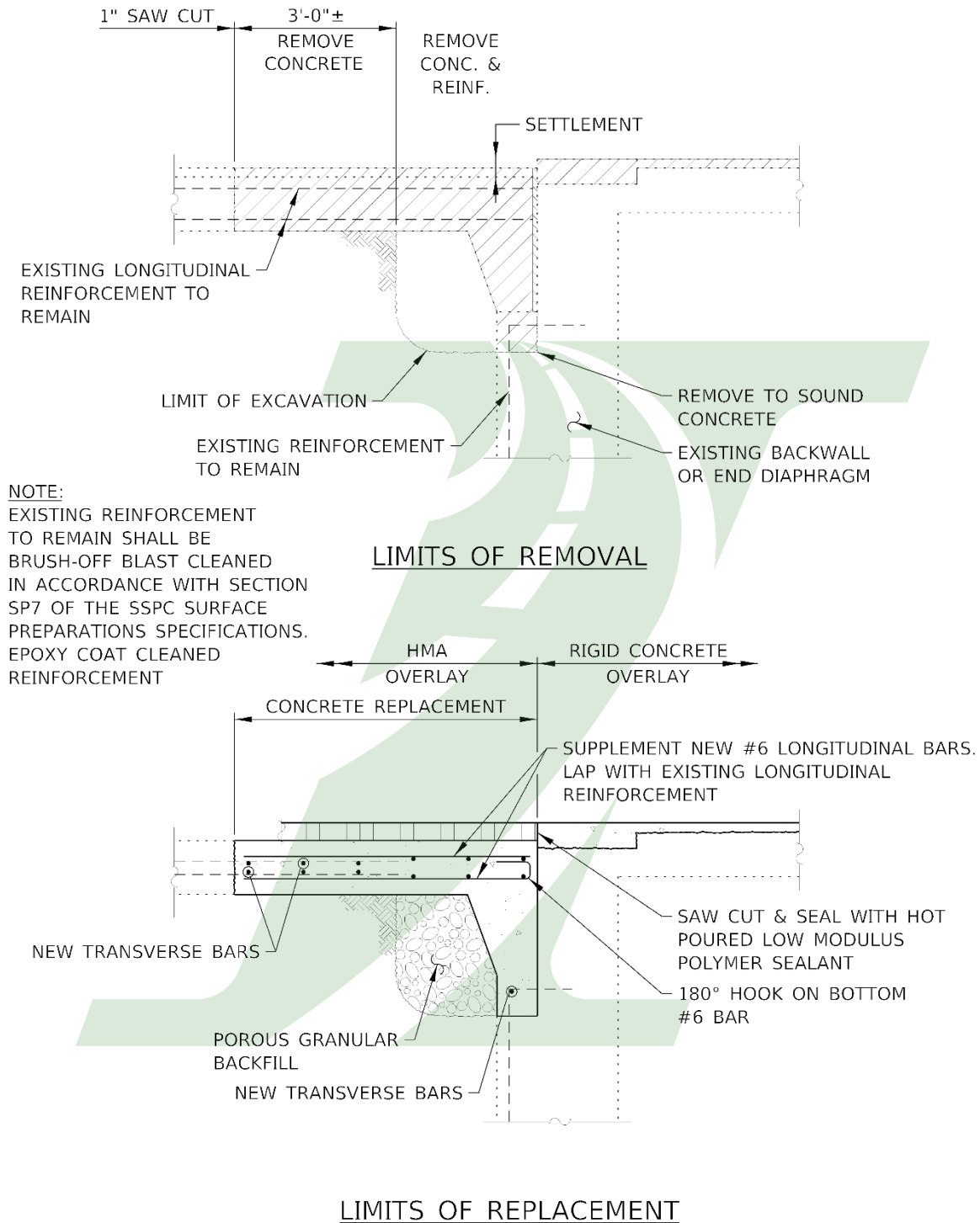


**Figure 26.3.6: OSHA Tie offs for Existing Structure**

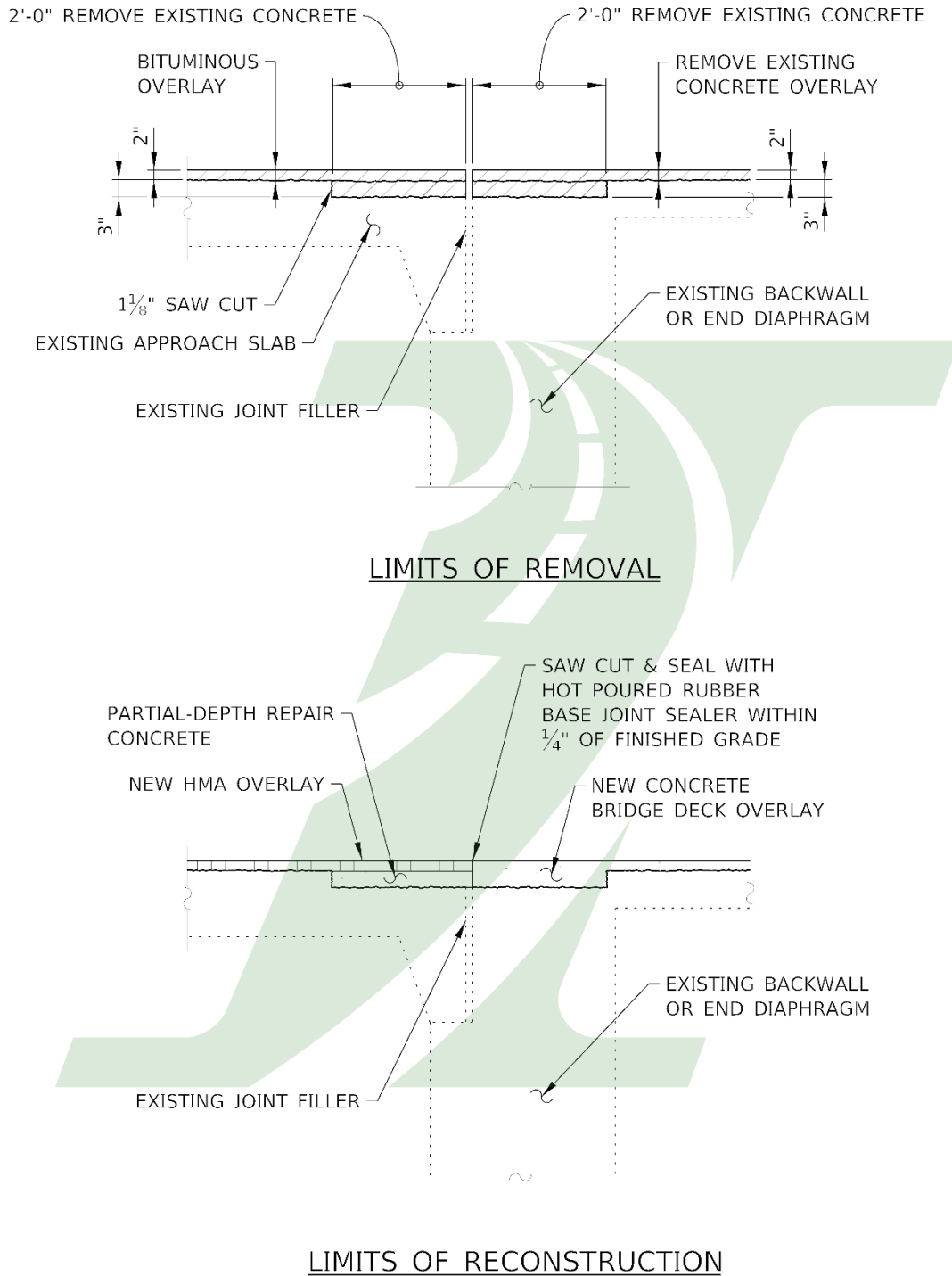


**Figure 26.4.1: Approach Slab Repair Details**

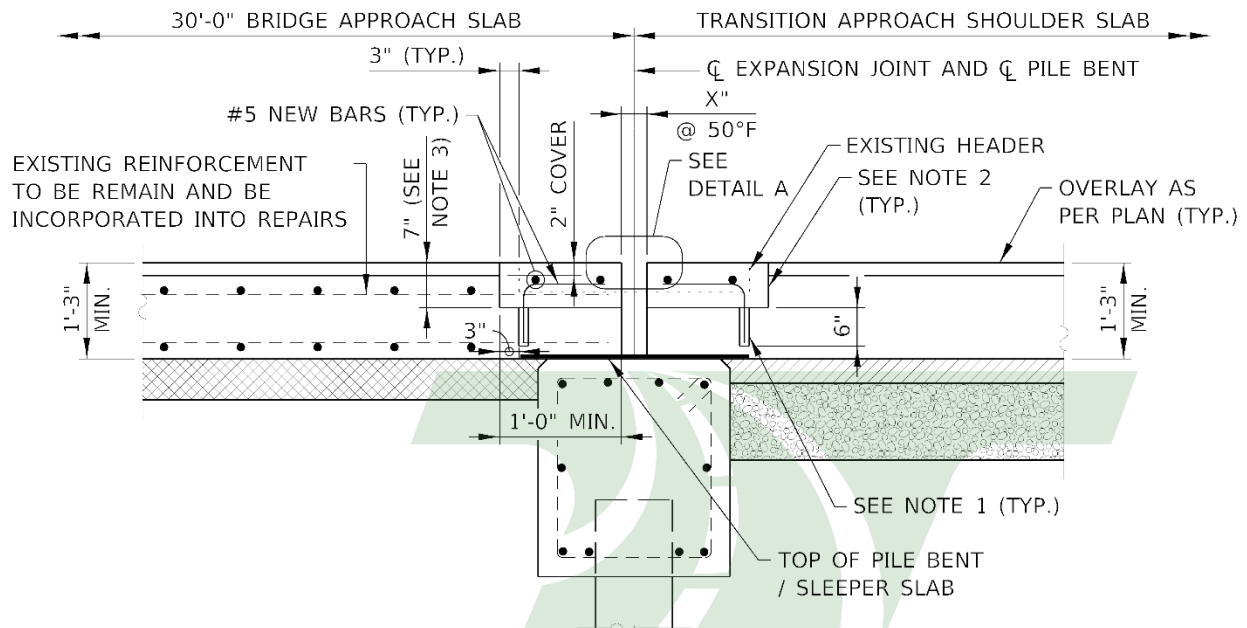




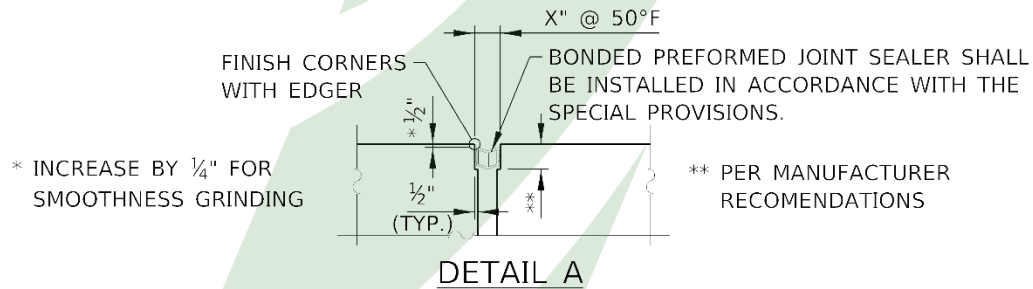
**Figure 26.4.2: Approach Slab Removal and Replacement at Abutment**



**Figure 26.4.3: Approach Slab Joint Reconstructed at Abutment**



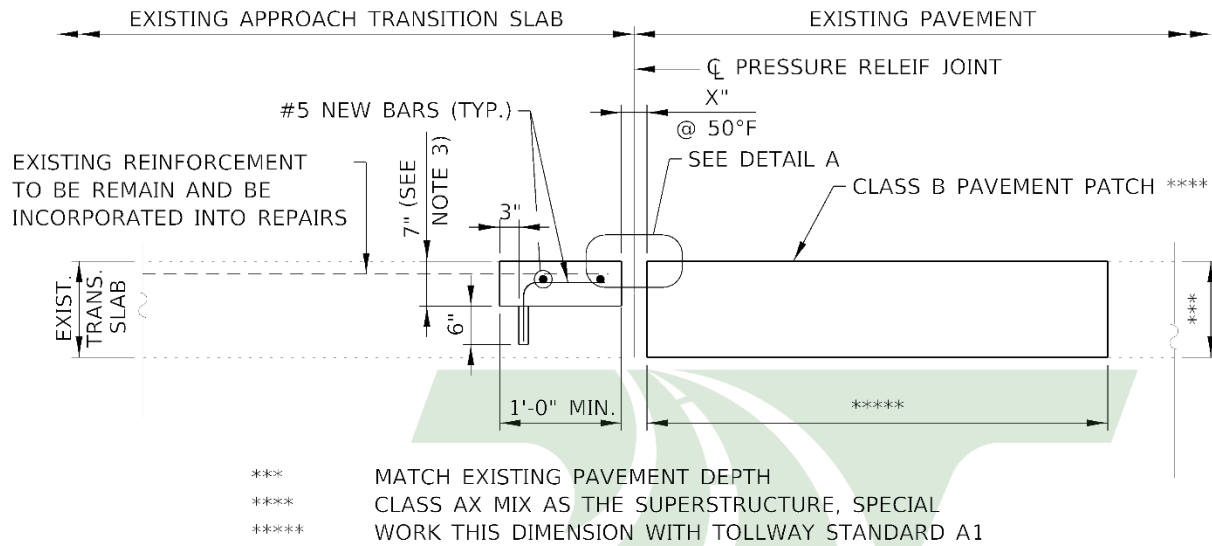
**SECTION**  
**PARTIAL DEPTH JOINT REPAIR BETWEEN**  
**APPROACH - TRANSITION APPROACH**



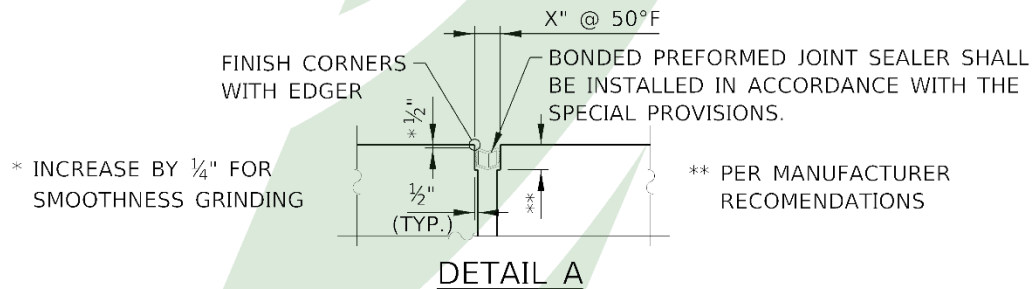
**NOTES:**

1. INSTALL DOWELS AT SIZE, SPACING AND EMBEDMENT AS INDICATED ON DRAWINGS. DRILLING METHOD TO BE USED ROTARY-HAMMER, DRILL 1 1/2" HOLE AND FILL WITH NON-SHRINK INJECTION MORTAR PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. CONCRETE SHALL BE DRY DURING DOWEL INSTALLATION. MECHANICALLY ROUGHEN SURFACE OF EXISTING CONCRETE.
2. COORDINATION WITH THE TOLLWAY IS REQUIRED REGARDING THE CONCRETE HEADER MATERIAL/MIX AND THE ASSOCIATED SPECIAL PROVISIONS FOR THE WORK.
3. REPAIR DEPTH SHALL NOT BE LESS THAN 7". USE FULL DEPTH REPAIR FOR REPAIR DEEPER THAN 7".

**Figure 26.4.4: Approach Slab Joint**



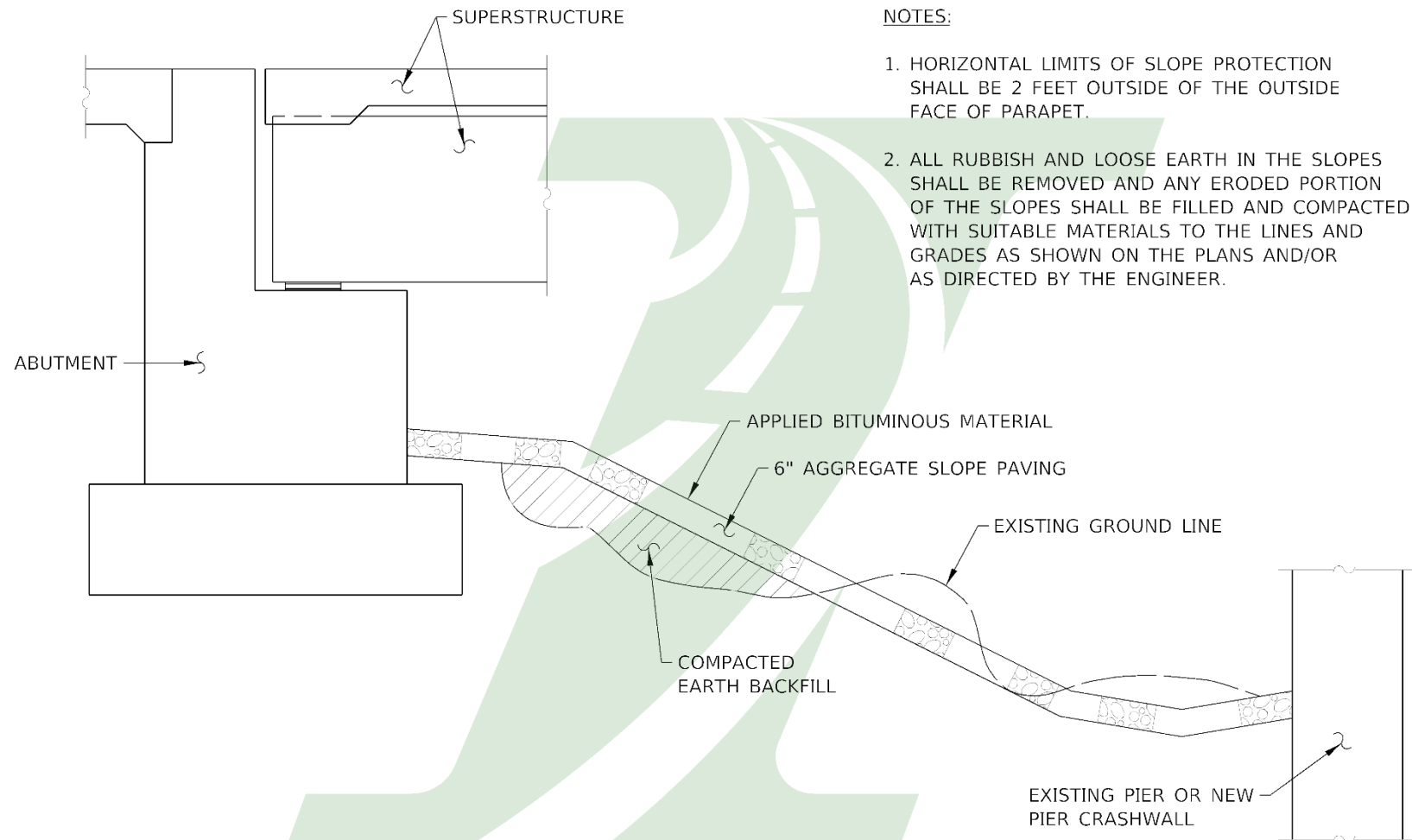
### SECTION PARTIAL DEPTH JOINT REPAIR BETWEEN TRANSITION APPROACH - PAVEMENT



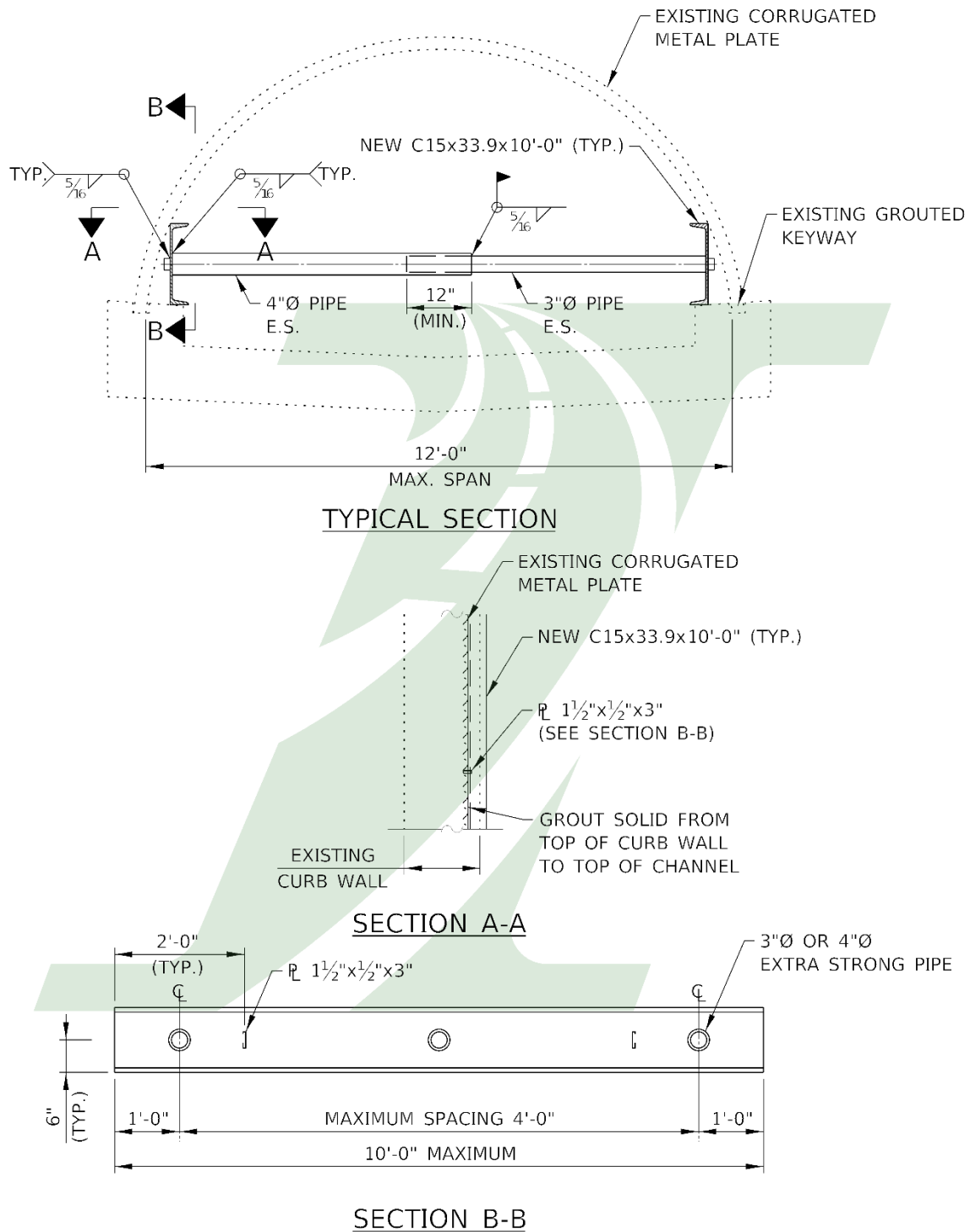
#### NOTES:

1. INSTALL DOWELS AT SIZE, SPACING AND EMBEDMENT AS INDICATED ON DRAWINGS. DRILLING METHOD TO BE USED ROTARY-HAMMER, DRILL  $1\frac{1}{2}$ " HOLE AND FILL WITH NON-SHRINK INJECTION MORTAR PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. CONCRETE SHALL BE DRY DURING DOWEL INSTALLATION. MECHANICALLY ROUGHEN SURFACE OF EXISTING CONCRETE.
2. COORDINATION WITH THE TOLLWAY IS REQUIRED REGARDING THE CONCRETE HEADER MATERIAL/MIX AND THE ASSOCIATED SPECIAL PROVISIONS FOR THE WORK.
3. REPAIR DEPTH SHALL NOT BE LESS THAN 7". USE FULL DEPTH REPAIR FOR REPAIR DEEPER THAN 7".

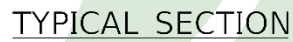
**Figure 26.4.5: Transition and Pavement Joint**



**Figure 26.5.1: Existing Aggregate Slope Paving Repair Details**



**Figure 26.6.1: Temporary Bracing Details**



## Figure

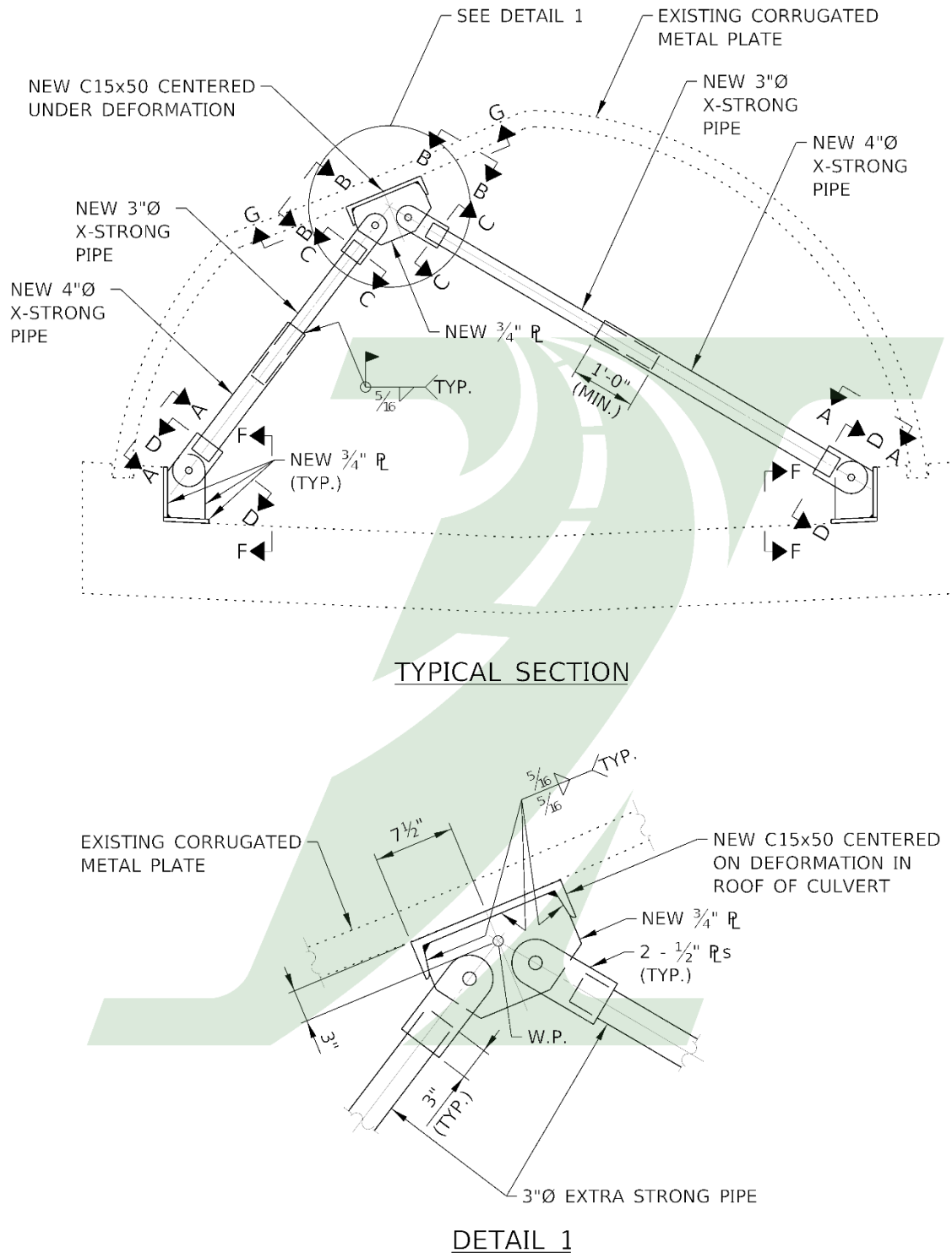
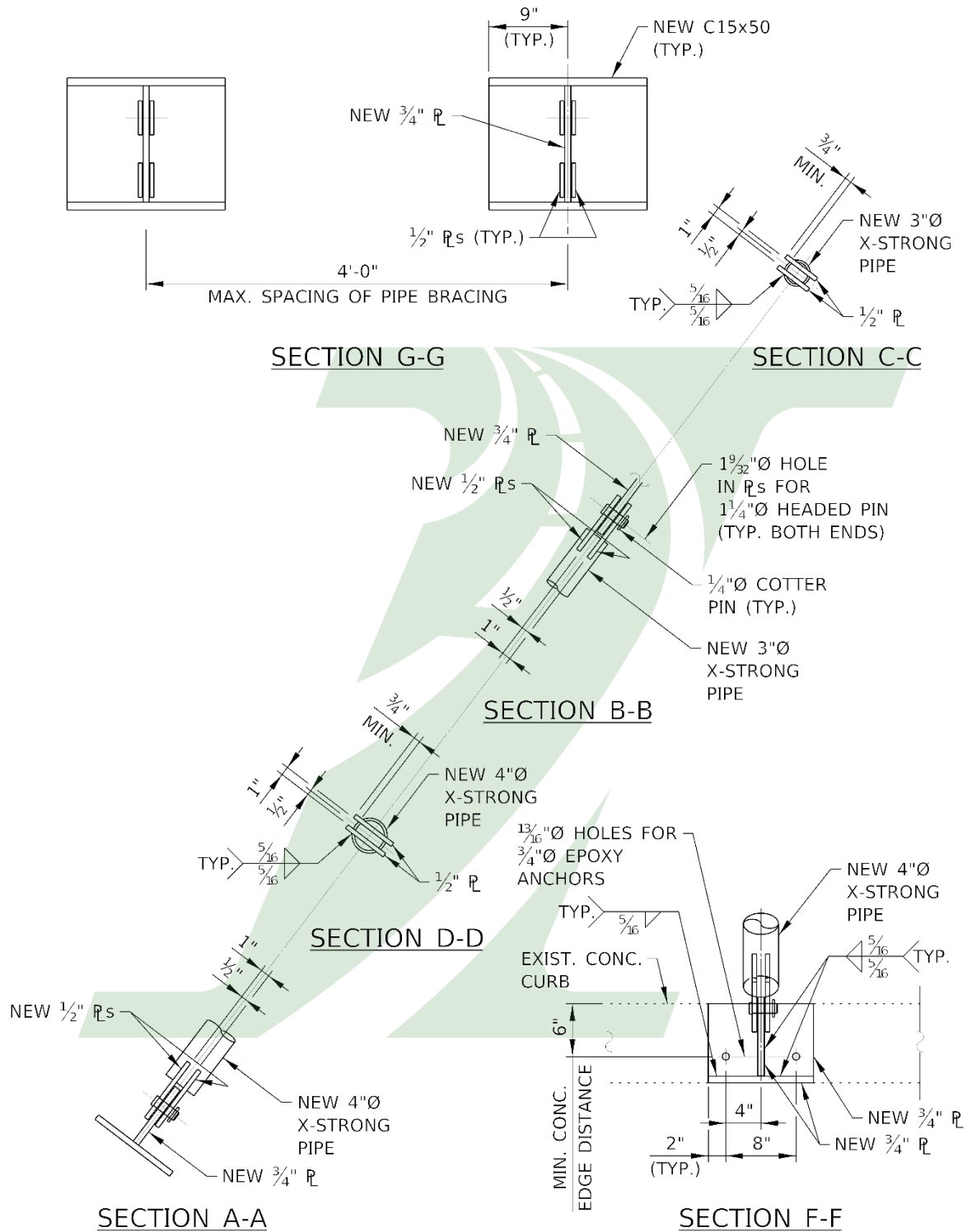
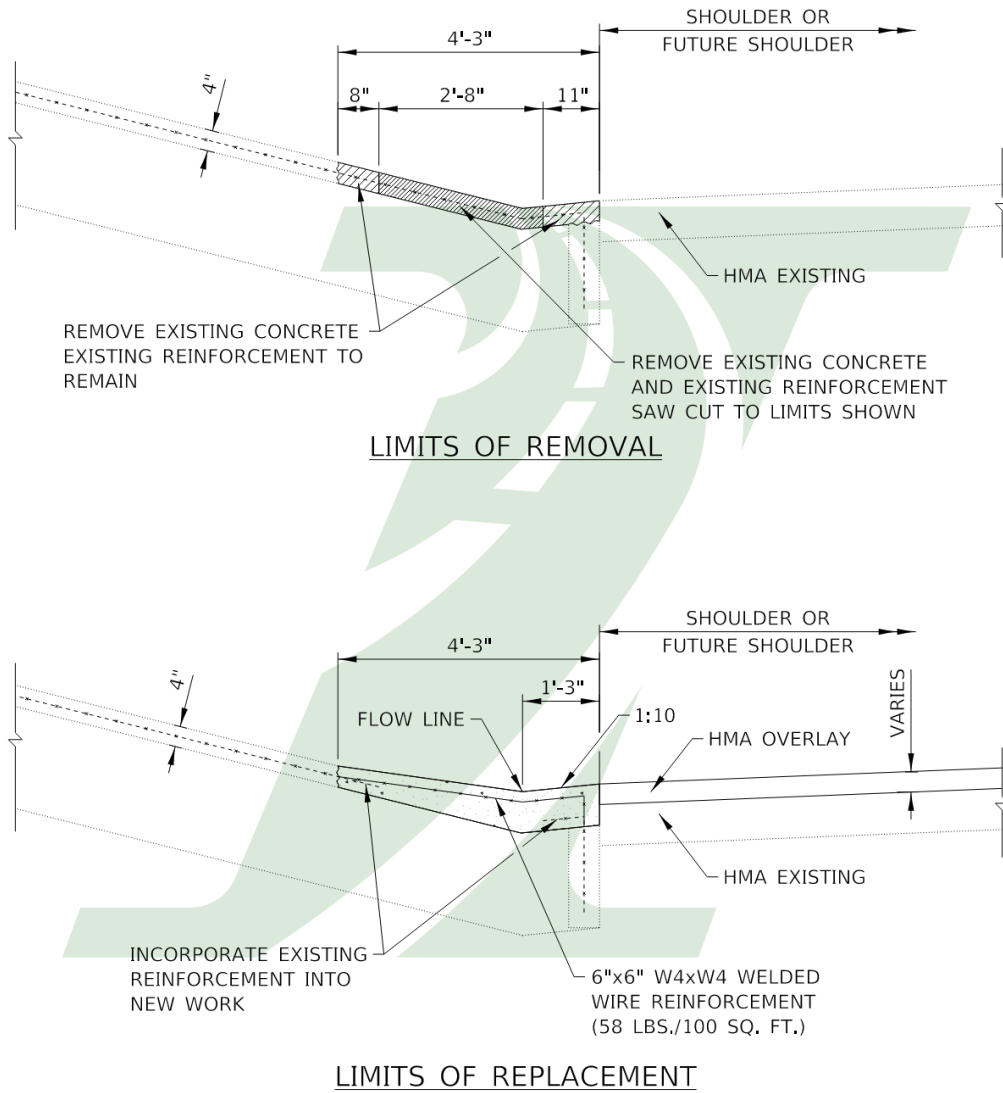


Figure 26.6.3: Temporary Bracing Details





**Figure 26.6.4: Temporary Bracing Details**



**Figure 26.12.1: Slope Wall Modification for Overlay**

## SECTION 27.0 ACCELERATED BRIDGE CONSTRUCTION

### 27.1 Introduction

The purpose of the Accelerated Bridge Construction (ABC) section is to provide tools to be used by the DSE to evaluate the use of ABC on a project during the design phase development. These tools provide a consistent approach for evaluating, designing and constructing all projects utilizing ABC technologies.

This section is in the beginning stages of development and will continue to evolve in the future as ABC methodologies progress and adoption is instituted by the Illinois Tollway.

#### 27.1.1 ABC Overview

ABC is defined as bridge construction technologies that use innovative planning, design, materials or construction methods in a manner to specifically reduce the onsite construction time and mobility impacts that occur when building or replacing bridges.

The most common technologies used in ABC applications are expediting the construction of bridges by using Prefabricated Bridge Elements and Systems (PBES) and the use of bridge movement and installation methods. In addition, there are ABC technologies that deal with materials, connections, foundations and the contractual aspects of project delivery. The combination of one or more of these ABC techniques has the potential to:

- Enhance the quality of the project
- Accelerate Project Delivery
- Encourage Innovation
- Increase the safety of the traveling public and workers
- Decrease user impacts
- Minimize the duration of maintenance of traffic
- Reduce project costs

Because of the potential economic and safety impacts, minimizing traffic disruptions is a goal that should be elevated to a higher priority when planning bridge related construction projects.

#### 27.1.2 Illinois Tollway ABC Initiative

The Illinois Tollway is committed to providing its customers the best overall experience when using its system and is continually exploring opportunities to leverage innovations in the delivery of its construction projects. The application of ABC is consistent with the Illinois Tollway's desire to reduce user impacts during construction while maintaining a high-quality product.

The Illinois Tollway initiative is to provide DSEs with a basic understanding of the different ABC technologies and project delivery methods available, help guide project specific evaluation and encourage the use of alternate bridge design and construction to meet project goals.

Standard tools have been developed to aid the DSE in evaluating ABC technologies for each project. These tools, called the Decision Framework for ABC, include the **ABC Decision Matrix Tool (DMT)** and the **ABC Bridge Life Cycle Comparison (BLCC) Tool**. These tools define a

comprehensive list of variables that need to be considered by the DSE during the design phase development.

With ABC being a new technology, there will be a learning curve for all involved. Learning from other agencies who have implemented ABC successfully, engaging and collaborating with national ABC experts and adopting best practices will help minimize the initial learning curve. ABC is a growing trend within the industry and the Illinois Tollway will continue to collaborate with the industry to advance the state of practice with respect to ABC technologies by encouraging the involvement of local consultants, contractors, and suppliers to help further develop a policy that will continue to improve the delivery of bridge projects along the Illinois Tollway system.

## 27.2 Illinois Tollway ABC Committee

An Illinois Tollway ABC Committee has been established to identify ABC strategies, review current best practices, make recommendations and continue to develop the Illinois Tollway ABC policy. The committee consists of representatives from multiple disciplines within the Illinois Tollway, PMO and GEC as well as representatives from within the industry and is chaired by an Illinois Tollway Deputy Chief.

## 27.3 Decision Framework for ABC

This article defines the ABC decision making process during the design phase development. The Decision Framework for ABC helps the DSE “think” through and execute the design process and consists of two steps – completing the ABC DMT to determine if ABC technologies should be evaluated for a given bridge and performing an ABC BLCC (if required) to compare and eliminate different ABC technologies to make a final recommendation.

An example to aid DSEs in using the ABC DMT and ABC BLCC Tool is available for download from the Illinois Tollway’s internet site at [www.illinoistollway.com](http://www.illinoistollway.com), under Construction & Engineering, Consultant Resources, Manuals, Bridges & Structures. The example shows a step-by-step procedure to evaluate a structure for ABC, explains logical steps and provides explanations for the assumptions used to fill in the variable inputs in the tools.

### 27.3.1 ABC Decision Matrix Tool (DMT)

The ABC DMT is a framework to help DSEs determine if ABC technologies shall be evaluated for a particular bridge. The ABC DMT shall be used during the Master Plan or Pre-Conceptual Phase. The tool is a spreadsheet that may be downloaded from the Illinois Tollway’s internet site at [www.illinoistollway.com](http://www.illinoistollway.com), under Construction & Engineering, Consultant Resources, Manuals, Bridges & Structures.

All new bridges or existing bridges to be replaced or reconstructed shall require an ABC DMT to be completed. Rehabilitation, retaining walls and culvert structures do not need to evaluate the use of ABC. An ABC DMT shall be completed for each individual bridge under consideration. For dual structures that have similar geometry, only one ABC DMT shall be required.

The ABC DMT is a qualitative assessment of the impact ABC technologies may have on a project when compared to conventional construction and does not identify specific ABC technologies that may be used. Because this is a qualitative process that requires engineering judgment, there is an acknowledged level of subjectivity to the tool.

The tool requires the user to assign a score for input variables based on specific scoring criteria and constraint descriptions that have been established to compare ABC to conventional

construction. A description of each input variable and basic guidance for the specific scoring criteria are provided in Figures 27.3.1.1, 27.3.1.2 and 27.3.1.3. The user shall fill in the scores and other requested information in only the yellow highlighted cells in the spreadsheet. See Figure 27.3.1.4. The assigned weights, scoring criteria and formulas shall not be changed without prior approval from the Illinois Tollway. The scores are a function of the bridge location and shall be filled in for an individual bridge.

The ABC DMT automatically calculates an ABC Rating Score based on the input by the user. See Figure 27.3.1.5. The user shall then use the ABC Rating Score – Decision Flow Chart to work toward a recommendation. See Figure 27.3.1.6. If an ABC Rating score of 30 or less is recorded, Conventional Bridge Construction is the most logical choice to evaluate further. The threshold of 30 is intended to capture any bridge receiving a score of 5 in the most heavily weighted variable, Traffic Impact. If an ABC Rating score of 60 or more is recorded, Accelerated Bridge Construction is the most logical choice to evaluate further. The threshold of 60 is intended to capture any bridge receiving a score of 5 in all three of the most heavily weighted variables, Average Daily Traffic, Traffic Impact, and Maintenance of Traffic. For ABC Rating scores between 30 and 60, the user shall consider additional factors prior to making a final decision on ABC. These factors include project delivery and schedule, traffic volumes, site conditions, project risk and structure geometry. See Figure 27.3.1.6.

Prior to making a final recommendation, the DSE shall take a look at the project from a global perspective and determine if ABC technologies provide a benefit with all the project-specific information considered. If the project contains multiple structures within a corridor, the DCM and DSE shall take into consideration the overall corridor project delivery and MOT schemes.

The completed ABC DMT, any supporting material and a summary stating the recommendation from the DSE shall be included in the Master Plan Study or a technical memorandum (if a Master Plan Study is not required). The Master Plan Study or technical memorandum shall provide justification for the recommendation including the major factors affecting the ABC DMT Rating Scores and if ABC technologies provide a benefit with all the project-specific information considered. See article 27.3.3 for a complete list of design phase project deliverables.

If the final recommendation is to evaluate ABC further, the DSE shall use the ABC BLCC Tool to help compare potential ABC and conventional construction technologies that meet project specific goals.

### **27.3.2 ABC Bridge Life Cycle Comparison (BLCC) Tool**

The ABC BLCC Tool is a framework to help DSEs compare potential ABC technologies for a given project and help eliminate the ABC technologies that may not be perceived as the most economical. The tool is a spreadsheet that may be downloaded from the Illinois Tollway's internet site at [www.illinoistollway.com](http://www.illinoistollway.com), under Construction & Engineering, Consultant Resources, Manuals, Bridges & Structures and shall be used during the Concept Phase.

All ABC DMT results that recommend ABC to be evaluated further shall require an ABC BLCC Tool to be completed. If conventional bridge construction was recommended to be evaluated further, then the ABC BLCC Tool is not applicable and no further Decision Framework analysis is required.

The ABC BLCC Tool is a qualitative analysis used to evaluate the long-term economic efficiency between bridge alternatives including conventional construction and various ABC technologies

and does not calculate actual life cycle costs. In addition, the tool does not capture impacts due to service disruptions including traveler delay and revenue impacts. Final recommended bridge alternatives may require additional analysis to determine service disruptions if requested by the Illinois Tollway.

Because this is a qualitative process that requires engineering judgment, there is an acknowledged level of subjectivity to the tool. The tool makes assumptions about costs and service life. If the DSE determines that cost breakdowns or service life information for a given project is different than the tool's assumptions, the input scores may be adjusted accordingly by the user.

The tool requires the user to assign a score for multiple input variables in three major categories: Initial Costs (IC), Traffic Impact Costs (TIC), and Maintenance Costs (MC). Initial Costs are intended to capture the direct costs associated with construction, Traffic Impact Costs are intended to capture the indirect costs associated with traffic impact, and Maintenance Costs are intended to capture routine maintenance and future replacement costs. Each input variable is based on specific scoring criteria and constraint descriptions that have been established to help identify lower long-term costs. Higher input variable scores represent the potential for lower costs for the bridge alternative being considered. A description of each input variable and basic guidance for the specific scoring criteria are provided in Figures 27.3.2.1, 27.3.2.2, and 27.3.2.3. The user shall input the scores and other requested information in only the yellow highlighted cells in the spreadsheet. See Figures 27.3.2.4, 27.3.2.5 and 27.3.2.6. The assigned weights, scoring criteria and formulas shall not be changed without prior approval from the Illinois Tollway. The scores are a function of the bridge location, material, equipment, maintenance of traffic and future maintenance, and shall be filled in for an individual bridge.

The ABC BLCC Tool automatically calculates individual Rating Scores in each of the three major categories and a Total ABC BLCC Rating Score based on the input by the user. See Figure 27.3.2.7. A higher Total ABC BLCC Rating Score represents a more economical choice when compared to other bridge alternatives. Bridge alternatives may consist of individual ABC technologies or a combination of ABC technologies and at a minimum shall be compared to a conventional construction, bridge alternative with no upper limit on the number of bridge alternatives allowed. The number of bridge alternatives shall be based on engineering judgment, site constraints, and project goals. The user of the tool may elect to add additional bridge alternatives to the ABC BLCC Tool to accurately compare all bridge alternatives. A separate ABC BLCC score shall be calculated for each bridge alternative investigated by creating additional tabs in the spreadsheet.

For cross road bridges with an Inter-Governmental Agreement (IGA), the bridge alternatives shall be coordinated with the local agency to ensure the selected ABC technologies are permitted.

The Individual and Total ABC BLCC Rating Scores obtained for each bridge alternative shall then manually be entered into the summary tab of the spreadsheet. See Figure 27.3.2.8. The summary provides a visual comparison of individual and overall scores of each bridge alternative considered. Based on the summary of the ABC BLCC analysis, the DSE shall identify the applicable ABC or conventional construction technologies that best fit the project specific goals. It is suggested that multiple bridge alternatives be carried forward to be able to develop costs and determine a final recommendation. The user of the tool may elect to add additional bridge alternatives to the comparison summary. The DSE shall again take evaluate the project from a global perspective and determine if the bridge alternatives with the higher scores provide a benefit with all the project-specific information considered prior to making a final recommendation.

The completed ABC BLCC Tool for all bridge alternatives, supporting material and summary stating the recommendations from the DSE shall be incorporated into the Bridge Type Study. The Bridge Type Study shall include a cost summary comparison for the recommended bridge alternatives in accordance with Article 3.2 to determine a final recommendation. Additional analysis may be required to determine a final recommendation at the request of the Illinois Tollway. The final recommendation shall be incorporated into the Type, Size and Location (TS&L) Plans in accordance with Section 3.0. See article 27.3.3 for a complete list of design phase project deliverables.

### **27.3.3 ABC Design Phase Project Deliverables**

The following is the list of each Design Phase Project Deliverable required for ABC:

#### Master Planning or Pre-Conceptual Phase

1. The DSE shall develop the Structure Condition Report and Life Cycle Cost Analysis in accordance with Section 2.0.
  - a. The goal of the Structure Condition Report and Life Cycle Cost Analysis is to determine rehabilitation versus replacement.
2. If a new structure, replacement or reconstruction is recommended in the Structure Condition Report, the DSE shall complete the ABC DMT in accordance with Article 27.3.1.
3. The DSE shall incorporate the completed ABC DMT, any supporting material and a summary stating the ABC recommendation into the Master Plan Study or technical memorandum (if a Master Plan Study is not required).

#### Conceptual Design Phase (30%)

1. If required by the ABC DMT, the DSE shall complete the ABC BLCC Tool in accordance with Article 27.3.2.
2. The DSE shall incorporate the recommended bridge alternatives from the ABC BLCC tool into the Bridge Type Study and perform a cost comparison in accordance with Article 3.2. The DSE shall make a final recommendation.
3. Additional analysis at the request of the Illinois Tollway may be required to make a final recommendation.
4. The final recommendation shall be incorporated into the Type, Size and Location (TS&L) Plans in accordance with Section 3.0.

#### Preliminary (60%), Pre-Final (95%), and Final Design Phases (100%)

The DSE shall refine and implement the final recommendation into the Construction Documents.

## **27.4 ABC Technologies**

This article defines the different ABC technologies commonly used in the industry and discusses general guidance associated with each technology. This article is not intended to be all inclusive and is provided for general guidance and to encourage the DSE to evaluate alternate bridge design and construction. It is the responsibility of the DSE to determine the types of ABC technologies during the Decision Framework for ABC that best represent the most viable options for the project based on engineering judgment, site constraints, and project goals. It is important to emphasize that the application of ABC design and construction should not reduce the durability



of the structure or increase the maintenance costs over the life of the structure when compared to bridges built conventionally in accordance with current standards.

#### **27.4.1 Prefabricated Bridge Elements and Systems (PBES)**

Prefabricated Bridge Elements and Systems (PBES) are structural components of a bridge that are fabricated before arriving at the job site and then rapidly assembled. PBES can be fabricated on-site if ROW is available. An entire bridge may be composed of prefabricated elements, or individual bridge elements may be combined with other ABC technologies.

The DSE shall consider PBES during the Decision Framework for ABC. PBES are cost effective when repetitive and simple details are used, the number of connections is minimized, and the system provides tolerances to allow for fit-up inconsistencies. The main advantage to PBES is the reduction in time at the project site for concrete forming, installation of rebar, and concrete placement since PBES are constructed in prefabrication plants or at Illinois Tollway approved on-site casting yards.

PBES elements shall be sized so that they are able to be moved from where they are fabricated to where they are installed. A staging area with adequate space and clearances to place the prefabricated elements is required.

The most commonly used PBES on ABC Projects are as follows:

- Precast Concrete Bridge Approach Slabs
- Precast Concrete Deck Panels
- Precast Concrete Pier Caps
- Precast Concrete Pier Columns
- Precast Concrete Abutments
- Precast Concrete Foundations
- Precast Concrete Wingwalls/ Retaining Walls
- Precast Concrete Parapets
- Prefabricated Superstructure Systems
- Prefabricated Superstructure/Substructure Systems
- Prefabricated Total Bridge Systems

Constructability and erection procedures shall be thoroughly investigated prior to consideration of PBES. The DSE shall evaluate the most appropriate and feasible PBES for the bridge based on site constraints, construction procedures, cost and impacts to traffic. For example, the use of precast deck panels may not be cost effective with the use of large wide top flange Bulb-T's due to large joints between panels and the extensive use of Ultra High Performance Concrete. Precast concrete pier caps and columns may not be cost effective if sufficient head room is not available to place the elements.

For all Prefabricated Bridge Elements and Systems, shop drawings will be required in accordance with Section 25.0.

The TRB SHRP2 R04 Accelerated Bridge Construction Research Project has generated a "Tool Kit" document that contains sample calculations, details, and specifications for projects ranging from deck work to complete superstructure and substructure replacement with precast concrete elements.



### 27.4.2 ABC Materials

During the Decision Framework for ABC, the DSE shall consider material choices carefully for implementation on the Illinois Tollway system as service life and durability are important factors for each project. The DSE shall use caution in selecting material types not typically used on Illinois Tollway projects. Coordination with Illinois Tollway Materials is required to select the appropriate materials, pay items, special provisions and construction procedures.

The most common ABC Material being utilized is Ultra High Performance Concrete (UHPC). UHPC is a composite material that allows high compressive strengths of 14 ksi in relatively short time periods with ultimate strengths of 20-25 ksi. It consists of fiber reinforcement in densely packed concrete and exhibits high ductility and durability. It has been widely used in field-cast connections between precast elements.

UHPC allows for shorter reinforcement development lengths, potential increased durability in severe exposure environments, and potential longer service life if designed and installed properly. The FHWA has published a report “Ultra-High Performance Concrete: A State-of-the-Art Report for the Bridge Community” that provides more specific information and design considerations for UHPC.

Section 15.0 shall also apply to all structures utilizing ABC technologies in which the Illinois Tollway utilizes High Performance Concrete (HPC) Mix Designs and considers stainless steel reinforcement bars in the deck in order to extend the service life of the bridge superstructures by reducing cracking and inhibiting corrosion induced failures. The Illinois Tollway’s objective with current standards for cast-in-place bridges is to obtain a bridge deck service life of at least 50 years and a 75 year or longer service life for bridge decks with HPC and stainless steel reinforcement combined. Similar objectives shall be applied to all structures no matter what ABC technology is used except as noted below:

- Precast Modular Concrete Superstructure Elements
  - HPC Mix Design with more emphasis on crack control shall be utilized in order to inhibit chloride penetrations.
- Prestressed Precast Modular Concrete Superstructure Elements
  - HPC Mix Design with more emphasis on crack control shall be required.

### 27.4.3 ABC Connections

The DSE shall consider the type of connections and detailing requirements during the Decision Framework for ABC to help limit durability issues. It is important to simplify the details of these connections both for ease and quickness of construction and to reduce the risk of different elements not fitting together.

The most common ABC connections used on ABC Projects are as follows:

- Grouted Splice Couplers
- Concrete Closure Joints
- Traditional Post-Tensioning
- Grouted Post-Tensioning
- Welded Connections
- Bolted Connections

The FHWA has published a manual entitled “Connection Details for Prefabricated Bridge Elements and Systems” that provides more specific information about the many different types of prefabricated element connections.

#### **27.4.4 Installation Methods**

This article defines the available ABC technologies for expediting construction using bridge movement and installation methods. The benefit of these installation methods provides contractors with increased speed in removing and installing bridges. The DSE may consider these installation methods during the Decision Framework for ABC.

The most common ABC installation methods used on ABC projects are as follows:

- Lateral Sliding
- Self-Propelled Modular Transporter (SPMT)
- Longitudinal Launches
- Crane Based Projects

For all ABC installation methods, an erection plan shall be required in accordance with the Illinois Tollway Special Provisions.

It should be noted that installation methods are considered Contractor’s means and methods. Contracting Provisions shall be established and discussed with the Illinois Tollway to determine how the project will be bid and packaged.

##### **27.4.4.1 Lateral Sliding**

Lateral Bridge slide-ins consist of building the proposed structure on temporary supports adjacent to an existing bridge, removing the old bridge and transporting the new bridge onto the substructure by sliding or rolling over bearings. In locations where sufficient space exists adjacent to the existing bridge and the site has limited profile changes and limited geometric constraints, bridge slide-in may prove to be a viable option. Lateral sliding is typically used on single span structures. The DSE shall use caution in evaluating lateral slide-ins for a multi-span structure. Several factors shall be considered in the design of these bridge installation methods:

- Lateral slide-in is most effective when ADT under the bridge is low and over the bridge is high.
- A staging area parallel to the structure is required to build the superstructure on temporary supports.
- The superstructure may be pushed transversely onto the new substructure using a hydraulic ram or pulled with winches.
- The lateral slide may utilize roller bearings or a smooth low friction surface.
- Adequate vertical clearance is required under the existing structure.
- Lateral slide-in shall not be used on bridges with high skews.
- The number of spans and length of the bridge are key factors.
- The superstructure stresses, deflections and drift tolerances during the move shall be considered.
- Concrete and steel girder bridges may both be used in lateral slide-ins.
- Abutment selection shall be evaluated to allow the opportunity to jack the bridge superstructure and mount the various sliding systems.
- Loading and stresses of the abutment seat and end diaphragm shall be considered during the move.

- The structure tie-in with the roadway shall be considered.

The FHWA has published a manual “Slide-In Bridge Construction Implementation Guide” that provides more specific information and design considerations.

#### **27.4.4.2 Self-Propelled Modular Transporter (SPMT)**

SPMT is a motorized vehicle with a combination of multi-axle platforms that are remotely controlled through a computer system capable of transporting very large or heavy loads. The use of SPMT is ideal for carrying large structures, such as bridges from offsite locations, lifting them into their final position, and exiting the site within a very short period of time. In locations where high traffic volumes exist, the structure is over a railroad or navigable waterway, or the project site has overhead constraints, SPMT may prove to be a viable option.

Several factors shall be considered in the design of these bridge installation methods:

- SPMTs are most effective when ADT is high under or over the bridge.
- A staging area with adequate space to build the bridge on a temporary structure is required.
- The travel path from the staging area to the final location shall have sufficient clearance, proper grades and the appropriate bearing capacity to support the heavy construction loads.
- A geotechnical investigation shall be conducted for the proposed staging and travel path to determine if the soils can support the SPMT loads.
- Concrete and steel girder bridges may both be used with SPMTs.
- The design of the superstructure shall consider the SPMT loads during placement, movement and lifting.
- Support conditions shall be checked when the structure is placed on the SPMT.
- Pick points shall be identified in the plans and checked for out of plane forces.
- Deflections and twist of the superstructure shall be analyzed with respect to the stroke of the SPMT.
- Deflections and twist of the superstructure shall be continuously monitored and controlled during the bridge move.
- The deck and parapet shall be analyzed for potential stress reversal conditions encountered during the move since any negative moment over the pick points has the potential to cause cracking.

The FHWA has published a manual “Use of Self-Propelled Modular Transporters to Remove and Replace Bridges” that provides more specific information and design considerations.

#### **27.4.4.3 Longitudinal Launches**

Longitudinal launching consists of erecting the bridge superstructure in a launching pit and pushing the unit out over the substructure. The most common launches are used in segmental construction. Longitudinal launching is ideal for bridges over areas that are inaccessible by crane such as deep valleys, roadways with a high ADT or heavily travelled waterways.

Several factors shall be considered in the design of these bridge installation methods:

- Longitudinal bridge launching is effective when ADT under the bridge is high and over the bridge is low.

- A staging area behind the abutments is required to build the superstructure on temporary supports.
- The superstructure may be pushed longitudinally out over the spans using a sliding or rolling system.
- Concrete and steel girder bridges may both be used in longitudinal launches.
- Curved structures can utilize longitudinal launches.

This installation method is more complex than lateral slides. Launching systems usually pertain to specialty bridge types (long multi-span type bridges) which are not as common on the Illinois Tollway system.

More information on longitudinal launching can be found in an NCHRP report entitled “Bridge Construction Practices using Incremental Launching”.

#### **27.4.4.4 Crane Based Projects**

Crane based projects consist of using large capacity cranes to lift partial or completed bridge structures into place. These types of cranes are most effective when the structure is over a roadway, railroad or navigable waterway and an accessible staging area is available. Foundation conditions within the staging area must be able to support the heavy loads.

Conventional cranes that are used for erection of beams and girders can be used for installation of PBES such as deck panels; however, it is fairly common for heavy lifting cranes to be used in conjunction with PBES.

Gantry cranes are a type of crane built on top of a gantry used to straddle a construction site. These types of cranes are most effective for long viaduct structures, when there is limited access or inaccessible areas under the structure for conventional or heavy lifting cranes and can be used for both demolition and erection procedures.

Installation methods are predominantly determined by the Contractor; designers shall carefully evaluate the constructability of the design, develop suggested construction and installation plan details and prepare project special provisions for incorporation into the contract documents.

When planning to use cranes to place a bridge, consider the following:

- Required crane size
- Potential crane locations
- Required reach to place sections
- Weight of sections placed
- Lifting Points and lifting devices
- Stresses at lifting points
- Connection details
- Location of overhead and underground utilities
- Method of delivery
- Location of delivery
- Sequence of construction
- Limits of Right-of-Way

### 27.4.5 Accelerated Foundation Construction Methods

Accelerated foundation construction consists of construction methods that reduce the time for foundation installation. The most common foundation installation methods used on ABC projects are as follows:

- Continuous Flight Auger (CFA) Piles
  - Method of constructing deep foundations that combines augering, injecting concrete and inserting reinforcement into wet concrete into one continuous process.
- Rapid Embankment Construction
  - Use of lightweight Expanded Polystyrene (EPS) Geofoam blocks to reduce long-term settlement.

Additional means of construction such as advance foundation construction or use of low-boy drilling equipment that allow bridge construction activities to occur without impacting traffic shall also be considered. However, these methods shall not be considered ABC methods and scored in the Decision Framework for ABC.

The FHWA has published a Geotechnical Engineering Circular No. 8 titled “Design and Construction of Continuous Flight Auger Piles” that provides more specific information and design considerations. In addition, more information can be found at the FHWA website.

## 27.5 ABC Project Delivery Methods

The ABC technologies listed in Article 27.4 are ways to accelerate on-site bridge construction. ABC project delivery and innovative contracting are ways to accelerate bridge construction during the planning stage. These methods can reduce time required to plan, design and bid the project. Two common innovate contracting methods for ABC are Design Build (DB) which combines the design and construction into one contract and Construction Manager General Contractor (CM/GC) which includes the owner as part of the design team and selects bids based on qualifications. Based on current legislation, both of these methods usually are not allowed on Illinois Tollway projects.

To accelerate bridge construction during the planning stage, contracting provisions may be incorporated into the project delivery method given the right conditions, application, and support. The DSE shall consider these contracting provisions and provide recommendations during the planning process. The recommendations will be reviewed by the Illinois Tollway and approved on a project-by-project basis. The most commonly used contracting provisions on ABC projects are as follows:

- Best Value Selection
  - Technical evaluation of contractor proposal and bid price which are combined to determine “best value.”
- A+B and A+B+C Bidding
  - Assigns value to base bid price and time component of construction and low bid is combination of value components.
- Incentive/Disincentive (I/D) Clauses

- Contract provisions that are used to financially compensate or penalize the contractor for time spent on the construction of a project. This clause is not part of Liquidated Damages.
- Lane Rentals
  - The contractor is charged for the amount of time that a lane is out of service during construction and the charge may vary by time or day of the week. The bid includes a base bid for construction and a secondary bid for lane rental and a best value selection is made.
- Advanced Contracts
  - Consists of expedited contracts in advance of the construction contract for fabrication of structural elements, procurement of specialized equipment or material or to minimize traffic impacts.
- Alternate Design/Alternate Bid (AD/AB)
  - Contractor is permitted to bid an alternate concept when contract provisions allow for a specified project benefit.

## 27.6 ABC References

The following is a brief summary of key references, publications and websites that can be used as resources for Accelerated Bridge Construction.

### KEY REFERENCES

- FHWA through their initiatives, Every Day Counts (EDC) and Highways for LIFE has been promoting, supporting, and advancing ABC efforts nationwide.
- The ABC University Transportation Center (ABC-UTC) supports research and initiatives to provide the transportation industry with the tools needed to effectively and economically utilize the principles of ABC. ABC-UTC has assembled a group of experienced and knowledgeable bridge academics and engineers to engage the industry and support the use of ABC.
- AASHTO Innovation Initiative supports and champions the implementation of ABC technologies that yield significant economic or qualitative benefits to the users.

### PUBLICATIONS


- FHWA, "PBES Cost Study: Accelerated Bridge Construction Success Stories", 2006
- FHWA-HFL, Publication No. HIF-12-013, "Accelerated Bridge Construction – Experience in Design, Fabrication and Erection of Prefabricated Bridge Elements and Systems – Final Manual", November 1, 2011.
- TRB-SHRP2, Publication No. S2-R04-RR-2, "Innovative Bridge Designs for Rapid Renewal, ABC Toolkit", 2013.
- FHWA-HFL, Publication No. FHWA-IF-09-010, "Connection Details for Prefabricated Bridge Elements and Systems", March 30, 2009.
- FHWA, Publication No. FHWA-HRT-13-060, "Ultra-High Performance Concrete: A State-of-the-Art Report for the Bridge Community", June 2013.
- FHWA, Project #F-ST99 (232), "Slide-In Bridge Construction Implementation Guide", November 2013.
- FHWA, Manual on Use of Self-Propelled Modular Transporters to Remove and Replace Bridges, June 2007.

- NCHRP Project 20-07, Task 229, “Bridge Construction Practices Using Incremental Launching”, December 2007.
- Proceedings of the 1st International ABC Conference in Miami, FL December, 2014.
- Proceedings of the 2nd International ABC Conference in Miami, FL, December, 2015.
- FHWA Geotechnical Engineering Circular (GEC) No. 8 “Design and Construction of Continuous Flight Auger Piles”, April 2007.

#### WEBSITES


- ABC University Transportation Center (ABC-UTC) at Florida International University. <http://www.abc-utc.fiu.edu/>
- Transportation Research Board (TRB) ABC Subcommittee under TRB AFF10 General Structure Committee. <http://www.trbaff103.com/>
- Federal Highway Administration (FHWA) Accelerated Bridge Construction website: <http://www.fhwa.dot.gov/bridge/abc/>
- FHWA Every Day Counts (EDC) <http://www.fhwa.dot.gov/everydaycounts/>
- Strategic Highway Research Program (SHRP 2) Innovative Bridge Designs for Rapid Renewal, Project R04, website <http://www.fhwa.dot.gov/goshrp2/>
- AASHTO Innovation Initiative website <http://aii.transportation.org>.
- FHWA’s Slide-In: Bridge Lateral Move In Technology website: <http://www.slideinbridgeconstruction.com/>




<p><b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b></p>  <p><b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - DECISION MATRIX TOOL (DMT)</b>  <b>CONSTRAINT DESCRIPTION TABLE</b></p>	
Constraint	Description
Average Daily Traffic	This accounts for the volume of traffic crossing the bridge construction site. The total combined construction year traffic over and under the structure shall be used. Higher ADT values will support the use of ABC methods.
Traffic Impact	This accounts for the possibility of service disruptions (including traveler delay and cost incurred by the Illinois Tollway due to drivers diverting to non-toll routes) that would result from lane closures during bridge construction activities by calculating a severity index for a given bridge location. The latest edition of the Illinois Tollway Lane Closure Guide was used to assess the possible severity of service disruptions based on lane closures for time of day, peak versus off-peak closures, and weekend, nightly or weekly closures. The results are summarized in the severity index tab of this spreadsheet. The user shall use the severity index tab to score this variable by finding the specific bridge location based on interstate, direction and milepost. The severity index tab has pull down charts that can be easily sorted. The user shall use the weekly severity index unless there are specific project restrictions that would indicate otherwise. Higher severity index scores will support the use of ABC.
Maintenance of Traffic	This accounts for the safety of workers and travelers, and the amount of time and cost of staging during the construction process. "Short duration" shall be defined as a duration of 3 months or less, "normal duration" shall be defined as a duration between 3 and 9 months, and "long duration" shall be defined as a duration of 9 months or greater. "Simple MOT scheme" shall be defined as construction with 2 stages or less. "Multiple staging" shall be defined as construction with more than 2 stages. Longer duration and higher cost staging will support the use of ABC methods.
Economic Impact	This accounts for the negative economic impact on local businesses and limited access for customers and employees at a given site caused by construction activities. Construction sites serving larger populations with higher business impacts will support the use of ABC methods.

**Figure 27.3.1.1: Accelerated Bridge Construction Description Table 1**



<p><b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b></p>  <p><b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - DECISION MATRIX TOOL (DMT)</b>  <b>CONSTRAINT DESCRIPTION TABLE</b></p>	
Constraint	Description
Bridge Classification	This accounts for bridges that are along evacuation/military routes or provide primary access to emergency facilities. These descriptions match the operational classifications given in Articles 1.3.5 and 3.10.5 of the latest AASHTO LRFD Bridge Design Specifications. Bridge Classification shall be based on the factor relating to operational classification. Essential and critical bridge classifications will support the use of ABC.
Railroad/Waterway Impact	This accounts for how railroad traffic or waterways may be affected by construction activities. Impacts to railroads that may require longer temporary track closures or flaggers shall receive high values. Structures that may require work in waterways, particularly waterways that carry commercial boat traffic, shall also receive high values. The volume of rail or waterway traffic shall also be considered when assigning this value. Consideration shall also be given to the capacity of channels and railroad tracks to support and allow Self-Propelled Modular Transporters (SPMT's) and Lateral Bridge Slides (LBS). Structures that affect multiple railroad tracks and/or waterways with commercial boat traffic will support the use of ABC.
Environmental Impact	This accounts for impacts to the environment during construction activities. These impacts can include impacts to streams and lakes, presence of endangered or protected species and potential for contaminated soils which could delay the construction schedule. Projects can also be limited by noise, wetlands, air quality, natural resources, land use or extreme weather which could also limit the allowable construction windows. Structures with significant environmental impacts will support the use of ABC.
Economy of Scale	This accounts for the potential cost savings on a project caused by the use of repetitive elements and operations. The total number of bridge spans for each structure shall be used. Structures with high potential for economies of scale will support the use of ABC.


**Figure 27.3.1.2: Accelerated Bridge Construction Description Table 2**

<p><b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b></p>  <p><b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - DECISION MATRIX TOOL (DMT)</b>  <b>CONSTRAINT DESCRIPTION TABLE</b></p>	
Constraint	Description
Use of Typical Details	This accounts for the level of simplicity of details that can be used for a given bridge. A more symmetric and simpler structure can use more standard details and minimize errors in the field. Examples of "simple" are structures that are straight, have parallel substructure elements, bridge skews 10 degrees or less, etc. Examples of "some complexity" are structures with varying deck width, curved structures, bridge skews from 11 to 29 degrees etc. Examples of "complex" are structures with severe skew (bridge skews 30 degrees or greater), substructure elements not parallel, a unique framing plan, etc. Structures that can utilize more typical details will support the use of ABC.
Accessibility	This accounts for the area available to the Contractor to accommodate prefabricated bridge elements or bridge movement methods near the construction site. Sites that are congested and do not have open areas for fabrication, transportation and installation shall receive low values. Examples of "plenty of ROW available" are structures near interchanges with large infield areas. Examples of "some ROW available" are structures that have available areas along the approach roadways. Examples of "no ROW available" can consist of structures near railroad or waterways. Structures with high levels of accessibility will support the use of ABC.

**Figure 27.3.1.3: Accelerated Bridge Construction Description Table 3**

<b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b> <b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - DECISION MATRIX TOOL (DMT)</b>			
Prepared By	XX	Prepared On	xx/xx/xxxx
Checked By	XX	Checked On	xx/xx/xxxx
Bridge No.	XXXXXX	Mile Post	xx.xx
Location	xxxxxxx		
ABC Rating Procedure			December 2016
Note to User: Refer to Structure Design Manual Article 27.3.1 for general guidance on using this tool.			
<b>Average Daily Traffic</b> (Combined over and under)	<input type="text"/>	0 No traffic during construction 1 Less than 20,000 2 20,000 to 50,000 3 50,001 to 100,000 4 100,001 to 150,000 5 More than 150,000	
<b>Traffic Impact</b> (Based on Severity Index)	<input type="text"/>	0 Least severe traffic impact 1 More severe traffic impact than 0 2 More severe traffic impact than 1 3 More severe traffic impact than 2 4 More severe traffic impact than 3 5 Most severe traffic impact	
<b>Maintenance of Traffic</b>	<input type="text"/>	0 No Impact 1 Short duration with simple MOT 2 Short duration with multiple staging 3 Normal duration 4 Long duration with simple MOT 5 Long duration with multiple staging	
<b>Economic Impact</b>	<input type="text"/>	0 Low business impact 3 Medium business impact 5 High business impact	
<b>Bridge Classification</b>	<input type="text"/>	0 Typical bridge 3 Essential bridge 5 Critical bridge	
<b>Railroad/Waterway Impact</b>	<input type="text"/>	0 No railroad or minor railroad spur or no waterway 3 One mainline railroad track or waterway 5 Multiple mainline railroad tracks or waterway with commercial traffic	
<b>Environmental Impact</b>	<input type="text"/>	0 No Impact 1 Minimum Impact 3 Medium Impact 5 Maximum Impact	
<b>Economy of Scale</b> (Total number of spans)	<input type="text"/>	0 1 span 1 2 or 3 spans 3 4 or 5 spans 5 More than 5 spans	
<b>Use of Typical Details</b>	<input type="text"/>	0 Complex or unsymmetrical geometry 3 Some complexity 5 Simple, symmetrical geometry	
<b>Accessibility</b>	<input type="text"/>	0 Unfavorable site with no ROW available 3 Favorable site with some ROW available 5 Favorable site with plenty of ROW available	

Figure 27.3.1.4: Accelerated Bridge Construction Decision Matrix Tool 1

THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY					
ACCELERATED BRIDGE CONSTRUCTION (ABC) - DECISION MATRIX TOOL (DMT)					
Prepared By	XX	Prepared On	xx/xx/xxxx		
Checked By	XX	Checked On	xx/xx/xxxx		
Bridge No.	XXXXXX	Mile Post	XX.XX		
Location	XXXXXX				
ABC Rating Procedure				December 2016	
<p>Note to User: Refer to Structure Design Manual Article 27.3.1 for general guidance on using this tool.</p> <p>Note: Do not adjust weight factors without prior approval from the Illinois Tollway.</p>					
ABC RATING SCORE: VARIABLES AND WEIGHTS					
Variable	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	0	10	0	5	50
Traffic Impact	0	15	0	5	75
Maintenance of Traffic	0	10	0	5	50
Economic Impact	0	5	0	5	25
Bridge Classification	0	3	0	5	15
Railroad/Waterway Impact	0	5	0	5	25
Environmental Impact	0	3	0	5	15
Economy of Scale	0	3	0	5	15
Use of Typical Details	0	3	0	5	15
Accessibility	0	5	0	5	25
Total Score			0	Max. Score	310
ABC Rating Score:			0		
<p>ABC Rating Score = [(Total Score)/(Max. Score)]*100</p>					

**Figure 27.3.1.5: Accelerated Bridge Construction Decision Matrix Tool 2**

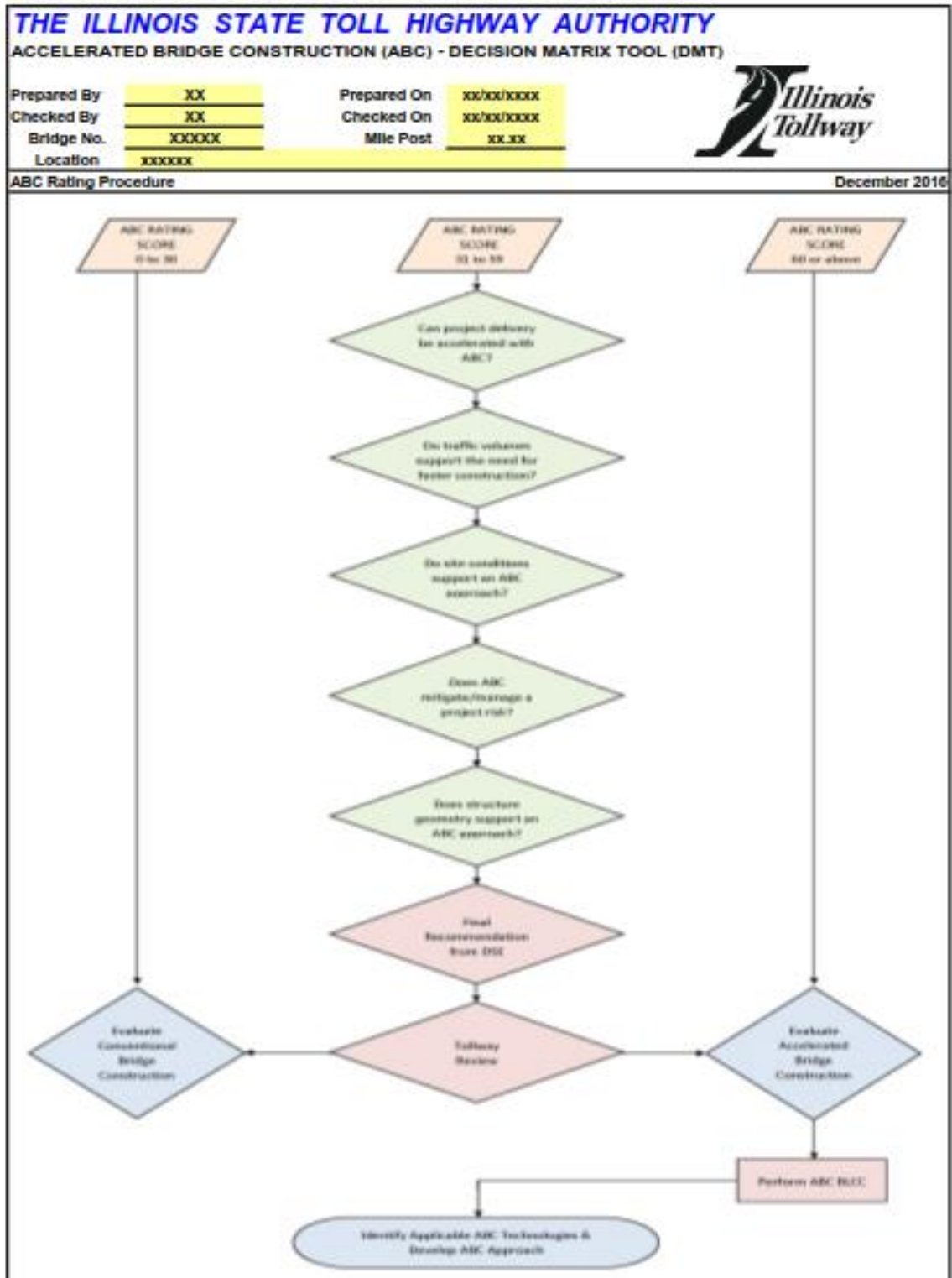


Figure 27.3.1.4: Accelerated Bridge Construction Decision Matrix Tool 3





THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY	
	
ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL	
CONSTRAINT DESCRIPTION TABLE	
INITIAL COSTS (IC)	
Constraint	Description
Total Labor	This accounts for both on-site and off-site labor costs during the duration of the construction project. This constraint shall include time for items specifically on the bridge construction site and time for items constructed "near-site" (such as items constructed at a site adjacent to the bridge and moved into place via slide-ins or SPMT's). Projects that require longer construction periods will generally lead to higher labor costs and will have lower scores in this category.
Deck Material	This accounts for the material cost of the deck portion of the construction project. Cast-in-place concrete decks are assumed to have a higher initial cost due to the need to construct and strip forms and place concrete on-site and will have lower scores in this category. If cost breakdowns for a given project suggest otherwise, the BLCC scores can be adjusted accordingly.
Superstructure Material	This accounts for the material cost of the superstructure portion of the construction project. A precast concrete or steel superstructure is assumed to have the the cheapest initial cost and will have higher scores in this category. If cost breakdowns for a given project suggest otherwise, the BLCC scores can be adjusted accordingly.
Substructure Material	This accounts for the material cost of the substructure portion of the construction project. Precast concrete substructures are assumed to have the cheapest initial cost and will have higher scores in this category. If cost breakdowns for a given project suggest otherwise, the BLCC scores can be adjusted accordingly.
Equipment	This accounts for the equipment cost of the construction project. Conventional equipment that is used for normal concrete and/or steel construction will be considered the most beneficial. As the equipment required becomes more complex and expensive, the scores in this category will decrease. The need for specialized equipment, such as that required for Heavy Lifting or Gantry Cranes, Self-Propelled Modular Transports and Slide-Ins, shall result in lower scores in this category.
Agency Costs	This accounts for the additional costs incurred by the Illinois Tollway as an agency during the construction project. "Normal agency coordination" shall defined for conventional construction methods which present the least likelihood for agency costs during construction and will receive the highest scores in this category. Construction projects that use methods that are less familiar to the agency and contracting community present a higher likelihood for more agency involvement and coordination and will receive lower scores in this category.
Right-of-Way	This accounts for the Right-of-Way aquisition costs required for the bridge construction only. Smaller areas of required Right-of-Way acquisition shall receive higher scores in this category. Scores shall be increased at the descretion of the User if large areas of temporary easement are required. ROW acquisition required for roadway construction (alignment shift, widening etc) should not be included in this variable.
Environmental Impact Costs	This accounts for the cost to mitigate environmental impacts during construction activities and for items requiring permitting that could delay the construction schedule. The environmental impacts can include impacts to streams and lakes, presence of endangered or protected species and potential for contaminated soils. Projects can also be impacted by noise, wetlands, air quality, natural resources, land use or extreme weather which could incur cost or limit the allowable construction windows. The maximum impact of a particular type shall govern the overall score.

Figure 27.3.2.1: ABC Bridge Life Cycle Comparison Tool 1

<p><b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b></p>  <p><b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL</b></p> <p><b>CONSTRAINT DESCRIPTION TABLE</b></p>	
TRAFFIC IMPACT COSTS (TIC)	
Constraint	Description
Maintenance of Traffic Costs	This accounts for the safety of workers and travelers, and the amount of time and cost of staging during the construction process. "Short duration" shall be defined as a duration of 3 months or less, "normal duration" shall be defined as a duration between 3 and 9 months, and "extended duration" shall be defined as a duration of 9 months or greater. "Simple MOT scheme" shall be defined as construction with 2 stages or less. "Multiple Staging" shall be defined as construction with more than 2 stages. More complex, higher duration MOT will cost more and shall receive lower scores.
Economic Impacts	This accounts for the negative economic impacts on local businesses and limited access for customer and employee traffic at a given site caused by construction activities. A bridge alternative affecting larger population with more business impacts will receive a lower score.
Railroad/Waterway Impacts	This accounts for the impact to railroad or waterway traffic and users due to construction activities. Bridge alternatives requiring longer track closures or work in waterways, particularly navigable waterways, shall receive a low score. "Short duration" shall be defined as a duration of 1 week or less, "normal duration" shall be defined as a duration between 1 week and 3 months, and "extended duration" shall be defined as a duration of 3 months or greater.

**Figure 27.3.2.2: ABC Bridge Life Cycle Comparison Tool 2**


THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY	
	
ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL CONSTRAINT DESCRIPTION TABLE	
MAINTENANCE COSTS (MC)	
Constraint	Description
Maintenance / Rehabilitation Life Cycle Costs	This accounts for the cost of routine maintenance, repair and rehabilitation to the structure. It is assumed that precast elements have a longer life cycle than CIP elements and would require less frequent repairs than CIP elements. The more precast element types utilized, the longer the service life and less frequent repair cycle. Refer to Structure Design Manual article 27.4.1 for precast element types to consider. Precast concrete beams should not be considered as a precast element for this variable. If multiple of the same type of precast elements are utilized such as precast pier columns, the scoring shall be based on one precast element type used. Scores shall be increased at the discretion of the User if precast deck panels are used since the deck condition typically controls the frequency of repair.
Cost of Repair	This accounts for the cost to repair different components of the bridge. The cost should be based on the quantity, material, labor and time to perform the repair and not the frequency or cycle of repair. It is assumed that precast deck panels will cost more to repair than CIP decks, since the entire panel will most likely be replaced, requiring fabrication, shipping, etc. It is assumed that steel girders will cost more to repair than precast beams since steel girders require more repair over time. It is assumed that precast substructure elements will cost more to repair than CIP substructure since PBES may require additional joints and grout ports. Therefore, if the bridge alternative under consideration utilizes any of these items, it would cost more to repair than if not utilizing.
Total Replacement Costs	This accounts for the cost for total replacement of the structure. New Illinois Tollway structures have a 100 year service life and the decision to replace the structure is based on the condition/age of the girder/beams and substructure. The deck condition/age does not factor into the decision to completely replace the structure. The structure can be easily re-decked. The scoring criteria is based on PBES elements having a longer life cycle than CIP elements. However, the service life will be determined by the worst condition of either the girders/beams or substructure. The assumption is that utilizing both precast beams and precast substructure will extend the service life of the bridge. If only one precast element is used, the corresponding non-precast element will control the service life of the structure.
Future TIC for Routine Maintenance	This accounts for the cost associated with future routine maintenance of the structure. This item covers all the constraints listed in the Traffic Impact Costs (TIC). The worst condition of the TIC variables (MOT duration or complexity of staging, economical, railroad, waterway, or vulnerability impacts) impacted during future routine maintenance shall govern the scoring.
Future TIC for Rehabilitation and Replacement	This accounts for the cost associated with future rehabilitation or replacement of the structure. This item covers all the constraints listed in the Traffic Impact Costs (TIC). The worst condition of the TIC variables (MOT duration or complexity of staging, economical, railroad, waterway, or vulnerability impacts) impacted during future rehabilitation or replacement shall govern the scoring.
Joint Durability	This accounts for the maintenance cost required to repair joints on the structure. PBES elements tend to require additional joints which may create durability issues. Durability issues could lead to lower service life for the structure.
Unforeseen Performance	This accounts for cost associated with maintenance for unforeseen performance of PBES elements. PBES elements could offer a greater risk for maintenance compared to CIP or conventional components since historical data or performance data is not readily available for these elements. In addition, the PBES elements have not been widely used on the Illinois Tollway; therefore, Contractors have limited experience with this type of construction. Precast concrete beams shall not be considered a PBES for this scoring.
Salvage Value	This accounts for the salvage value of the superstructure. Steel girders are more easily recycled than Precast Concrete Beams.

Figure 27.3.2.3: ABC Bridge Life Cycle Comparison Tool 3



THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY			
ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL			
Prepared By	XX	Prepared On	xx/xx/xxxx
Checked By	XX	Checked On	xx/xx/xxxx
Bridge No.	XXXXXX	Mile Post	xx.xx
Location	xxxxxx		
ABC BLCC Tool			December 2016

Note to User: Refer to Structure Design Manual Article 27.3.2 for general guidance on using this tool.

**INDIVIDUAL ABC BLCC RATING SCORE INPUT**
**INITIAL COSTS (IC)**

<b>Total Labor</b> (On-Site and Off-Site)	<input style="width: 100px; height: 20px;" type="text"/>	1	Estimated construction time >= 15 months
		2	13 months <= Estimated construction time < 15 months
		3	5 months <= Estimated construction time < 13 months
		4	3 months <= Estimated construction time < 5 months
		5	Estimated construction time < 3 months
<b>Deck Material</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Deck type is cast-in-place concrete
		2	Deck type is precast concrete panels
<b>Superstructure Material</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Superstructure type is cast-in-place concrete
		2	Superstructure type is precast concrete or steel
<b>Substructure Material</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Substructure type is cast-in-place concrete
		2	Substructure type is precast concrete
<b>Equipment</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Self-Propelled Modular Transport equipment required
		2	Bridge Slide-In equipment required
		3	Specialty Crane Based equipment required
		4	Prefabricated Bridge Element System or Longitudinal Launch required
		5	Typical cast-in-place concrete/steel construction equipment required
<b>Agency Costs</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Extensive agency coordination
		2	Moderate agency coordination
		3	Normal agency coordination
<b>Right-of-Way</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Required R.O.W. acquisition > 1 acre
		2	0.5 acres < Required R.O.W. acquisition <= 1 acre
		3	0.25 acres < Required R.O.W. acquisition <= 0.5 acres
		4	0 acres < Required R.O.W. acquisition <= 0.25 acres
		5	Required R.O.W. acquisition = 0 acres
<b>Environmental Impact Costs</b>	<input style="width: 100px; height: 20px;" type="text"/>	1	Maximum Impact
		2	Medium Impact
		3	Minimum Impact
		4	No Impact

**Figure 27.3.2.4: ABC Bridge Life Cycle Comparison Tool 4**

<b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b> <b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL</b>			
Prepared By	XX	Prepared On	XX/XX/XXXX
Checked By	XX	Checked On	XX/XX/XXXX
Bridge No.	XXXXXX	Mile Post	XX.XX
Location	XXXXXX		
ABC BLCC Tool			December 2016
Note to User: Refer to Structure Design Manual Article 27.3.2 for general guidance on using this tool.			
<b>INDIVIDUAL ABC BLCC RATING SCORE INPUT</b>			
<b>TRAFFIC IMPACT COSTS (TIC)</b>			
Maintenance of Traffic Costs	<input style="width: 100px; height: 20px;" type="text"/>	1	Extended duration with multiple staging
		2	Extended duration with simple MOT
		3	Normal duration
		4	Short duration with multiple staging
		5	Short duration with simple MOT
Economic Impacts	<input style="width: 100px; height: 20px;" type="text"/>	1	High business impact
		2	Medium business impact
		3	Low business impact
Railroad/ Waterway Impacts	<input style="width: 100px; height: 20px;" type="text"/>	1	Complete closure
		2	Extended duration, disruption or closure
		3	Normal duration, disruption or closure
		4	Short duration, disruption or closure
		5	No disruption or closure of Railroads/Waterways
<div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <b>Note:</b>            Service disruptions (including traveler delay and revenue impacts) are not directly included in the ABC BLCC Tool. Additional analysis required if requested by the Illinois Tollway.         </div>			

**Figure 27.3.2.5: ABC Bridge Life Cycle Comparison Tool 5**

<b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b> <b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL</b>			
Prepared By	XX	Prepared On	XX/XX/XXXX
Checked By	XX	Checked On	XX/XX/XXXX
Bridge No.	XXXXXX	Mile Post	XX.XX
Location	XXXXXX		
ABC BLCC Tool			December 2016




Note to User: Refer to Structure Design Manual Article 27.3.2 for general guidance on using this tool.

INDIVIDUAL ABC BLCC RATING SCORE INPUT

MAINTENANCE COSTS (MC)

<b>Maintenance / Rehabilitation Life Cycle Costs</b> (Frequency)	<input style="width: 100%;" type="text"/>	1 2 3 4	If No Precast element types are used (Highest Repair Frequency) If One Precast element type is used If Two Precast element types are used If Three or more Precast element types are used (Lowest Repair Frequency)
<b>Cost of Repair</b> (Material, Labor and Time)	<input style="width: 100%;" type="text"/>	1 2 3 4	If Three of the Listed Materials are used (Most Expensive Cost) If Two of the Listed Materials are used If One of the Listed Materials are used If None of the Listed Materials are used (Cheapest Cost)
			<b>Note:</b> Listed Material: Precast Deck Panels, Steel Girders, PBES Substructure.
<b>Total Replacement Costs</b> (Estimated Service Life)	<input style="width: 100%;" type="text"/>	1 2	If only super is precast or if only sub is precast or neither Precast Beams and Precast Substructure
			<b>Note:</b> The decision to replace structure is based on superstructure and substructure condition. Excludes deck.
<b>Future TIC for Routine Maintenance</b>	<input style="width: 100%;" type="text"/>	1 2 3 4	Weekday Peak shift or Extended MOT Duration or Major Impact Weekend or night time closure or Medium MOT Duration or Medium Impact Off peak closure or Shorter MOT Duration or Minimal Impact No Closure or Shortest MOT Duration or No Impact
<b>Future TIC for Rehabilitation and Replacement</b>	<input style="width: 100%;" type="text"/>	1 2 3 4	Weekday Peak shift or Extended MOT Duration or Major Impact Weekend or night time closure or Medium MOT Duration or Medium Impact Off peak closure or Shorter MOT Duration or Minimal Impact No Closure or Shortest MOT Duration or No Impact
<b>Joint Durability</b>	<input style="width: 100%;" type="text"/>	1 2 3	Additional Joints between precast elements Typical Jointed Bridge Jointless Bridge
<b>Unforeseen Performance</b> (Risk)	<input style="width: 100%;" type="text"/>	1 2 3	High (More than one PBES element) Medium (Single PBES element) None or Low (Conventional Construction material)
<b>Salvage Value</b>	<input style="width: 100%;" type="text"/>	1 2	Precast Concrete Beam Steel Girders

**Figure 27.3.2.6: ABC Bridge Life Cycle Comparison Tool 6**

<b>THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY</b>					
<b>ACCELERATED BRIDGE CONSTRUCTION (ABC) - BRIDGE LIFE CYCLE COMPARISON (BLCC) TOOL</b>					
Prepared By	XX	Prepared On	XX/XX/XXXX		
Checked By	XX	Checked On	XX/XX/XXXX		
Bridge No.	XXXXXX	Mile Post	XX.XX		
Location	XXXXXX				
ABC BLCC Tool					December 2016

Note to User: Refer to Structure Design Manual Article 27.3.2 for general guidance on using this tool.

**INDIVIDUAL ABC BLCC RATING SCORE INPUT**

Note: Do not adjust weight factors without prior approval from the Illinois Tollway.

Individual ABC BLCC Rating Score = (Total Score)/(Max. Score)\*100

Total ABC BLCC Rating Score = 0.33(IC) + 0.34(TIC) + 0.33(MC)

INITIAL COSTS (IC)					
Variable	Score	Weight Factor	Adjusted Score	Maximum Score	Max Adjusted Score
Total Labor	0	10	0	5	50
Deck Material	0	10	0	2	20
Superstructure Material	0	10	0	2	20
Substructure Material	0	10	0	2	20
Equipment	0	10	0	5	50
Agency Costs	0	5	0	3	15
Right-of-Way	0	5	0	5	25
Environmental Impact Costs	0	3	0	4	12
<b>Total Score</b>			<b>0</b>		<b>212</b>

IC ABC BLCC Rating Score: 0 (33% of Total Score)

TRAFFIC IMPACT COSTS (TIC)					
Variable	Score	Weight Factor	Adjusted Score	Maximum Score	Max Adjusted Score
Maintenance of Traffic Costs	0	10	0	5	50
Economic Impacts	0	5	0	3	15
Railroad/Waterway Impacts	0	5	0	5	25
<b>Total Score</b>			<b>0</b>		<b>90</b>

TIC ABC BLCC Rating Score: 0 (34% of Total Score)

MAINTENANCE COSTS (MC)					
Variable	Score	Weight Factor	Adjusted Score	Maximum Score	Max Adjusted Score
Maintenance / Rehabilitation Life Cycle Costs	0	10	0	4	40
Cost of Repair	0	10	0	4	40
Total Replacement Costs	0	10	0	2	20
Future TIC for Routine Maintenance	0	5	0	4	20
Future TIC for Rehabilitation and Replacement	0	3	0	4	12
Joint Durability	0	5	0	3	15
Unforeseen Performance	0	3	0	3	9
Salvage Value	0	3	0	2	6
<b>Total Score</b>			<b>0</b>		<b>162</b>

MC ABC BLCC Rating Score: 0 (33% of Total Score)

**TOTAL ABC BLCC Rating Score: 0**

**Figure 27.3.2.7: ABC Bridge Life Cycle Comparison Tool 7**