GENERAL GUIDELINES FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES

RC-0506-04STR

November 15, 2018 REV. 1.1

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

METROLINX GENERAL GUIDELINES FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES

METROLINX

RC-0506-04STR

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Nov 15, 2018 REV. 1.1

PREFACE

This is the third edition of the METROLINX General Guidelines for Design of Railway Bridges and Structures. It is adapted from CN Engineering Guidelines for Design of Railway Structures as per the agreement between METROLINX and CN on March 28, 2013. In accordance with the agreement, METROLINX is authorized to affix the name of METROLINX to the CN Standards, shall remove all references to CN and update / modify the standards to METROLINX Standards.

The purpose of METROLINX General Guidelines for Design of Railway Bridges and Structures is to ensure that METROLINX owned and operated infrastructure is designed, constructed and maintained utilizing safe, cost effective, durable and efficient methods to meet project delivery timelines, and on-time operational performance goals. Construction Contract Documents, where more restrictive, shall supersede design guideline requirements.

A consistent approach in the application of METROLINX General Guidelines for Design of Railway Bridges and Structures will reduce disputes during the design and construction phases of a project, enhance the long term safety, reliability and extend the useful service life of the infrastructure.

The updates to the third edition of the METROLINX General Guidelines for Design of Railway Bridges and Structures include revisions to the following; the structural steel material standards, types of superstructure, mechanically stabilized embankments, design and construction of reinforced concrete box culverts.

Note

The METROLINX Guidelines for Design of Railway Bridges and Structures is intended for use by suitably qualified professionals. It is not a substitute for coordination and compliance with all applicable local codes, standards, manuals, and approvals for fire protection, life safety and security measures that are part of the planning, design and implementation of a railway.

Suggestions for revisions and improvement

Suggestions for revision or improvement can be sent to the Senior Manager of Track and Structures, Rail Corridor Infrastructure. Please include a description of the proposed change, background of the application and any other useful rationale or justification. Please include your name, company affiliation (if applicable), email address and phone number.

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PART 1

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART 1 - GENERAL REQUIREMENTS FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES

PURPOSE AND SCOPE

The purpose of these guidelines is to modify and supplement the applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, 2017 and to present METROLINX design guidelines, standard requirements and general details for railway bridges and structures. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

1. DESIGN DRAWINGS

    1.1. Standard size of drawings is 559 mm X 864 mm (22 in x 34 in) METROLINX Title Block, in accordance with the design requirements manual (CI-0705).

    1.2. The complete set of design drawings shall be detailed with all relevant information necessary to complete construction, such as material specifications and general construction notes.

    1.3. All drawings shall be electronically signed and sealed by a Professional Engineer registered in the Province of Ontario, Canada. The complete set of signed and sealed drawings shall be submitted to METROLINX in two different formats – ADOBE ACROBAT "PDF" and AUTOCAD "DWG" format.

    1.4. Signed and sealed drawings that are to be submitted in hardcopy format are to be an approved photographic reproduction.

    1.5. All METROLINX Bridges and Structures project drawings shall have the subdivisions and mileage shown in the title block.

    1.6. All METROLINX Bridges and Structures Project drawings shall be reviewed by Rail Corridor Infrastructure-Bridges & Structures.

2. SUBMISSION OF DOCUMENTS UPON COMPLETION OF PROJECT

    2.1. Upon the completion of the project, a complete set of as-built drawings, specifications and design calculations must be submitted to Rail Corridor Infrastructure-Bridges & Structures, as required by the Rail Corridor Infrastructure-Bridges & Structures Handover Protocol (RC-0503-1).

    2.2. The documents shall be emailed or posted on the FTP site to the attention of:

Manager of Bridges and Structures
Rail Corridor Infrastructure
METROLINX

2.3. As-built design plans and specifications shall be submitted in electronic form. Electronic form for drawings shall be submitted in two different formats - ADOBE ACROBAT "PDF" and AUTOCAD "DWG". The specifications shall be in MICROSOFT WORD "DOC" format.

3. WALKWAYS & INSPECTION CATWALKS

3.1. Walkways shall be provided on both sides of the bridge, unless otherwise approved by the Rail Corridor Infrastructure Senior Manager Track and Structures.

3.2. Railings on these walkways shall be clear of METROLINX standard clearances (see METROLINX standard drawing K1U-10.1 Appendix A).

3.3. Refuge bays are required at maximum 45.7 m (150 ft) intervals, staggered on both sides of the bridge. The omission of refuge bays shall be subject to the approval of the Rail Corridor Infrastructure Senior Manager Track and Structures.

3.4. Catwalks to facilitate inspection shall be installed inside a steel Deck Plate Girder (DPG) span. Inspection catwalks shall be 610 mm (2 ft) wide and shall be located so as to maximize ease of inspection and access to structural members.

3.5. Grab bars to facilitate inspection shall be provided on steel Deck Plate Girder (DPG) spans.

3.6. The support bracket for the steel walkway and refuge bays on both sides of the bridge shall be cut from a rolled structural steel section, rather than welded steel plates.

4. DECK DRAINAGE

4.1. The minimum longitudinal grade of bridge span shall be 0.5%.

4.2. All concrete decks shall have a minimum transverse crossfall of 1%.

4.3. Drainage pipes are not allowed to discharge onto bridge seats, roadways and walkways below.

4.4. Horizontal drainage pipes shall be embedded in the ballast adjacent to the concrete and steel curbs, on either side of each track. The drainage pipes shall consist of perforated corrugated galvanized metal pipes surrounded with a geotextile filter material. The pipes shall drain to the abutments and be connected to the vertical drainage system behind the abutment walls. Where there is an approach slab, the pipes shall drain in accordance with Appendix A – Standard Drawing C15.

4.5. Prefabricated drainage sheets with geotextile filter material shall be placed against the back face of the abutment stem.

5. VERTICAL CLEARANCES

5.1. Vertical clearance for vehicular traffic under the railway bridge shall be a minimum of 5.30 m (17 ft 4-½ in).

5.2. For bridge sites with height constraints, a reduction in the vertical clearance may be allowed only with the written approval from the Rail Corridor Infrastructure Senior Manager Track and Structures.

6. TEMPORARY SHORING (Appendix A - Standard Drawings F1, F2, F3, F4)

6.1. The temporary shoring shall be designed in accordance with The METROLINX Guidelines for Design and Monitoring of Shoring Walls (Part 6 of this Guideline) by the Engineering Consultant or Project Engineer and reviewed by Rail Corridor Infrastructure-Bridges & Structures.

6.2. Detailed drawings shall be complete with all relevant details, material notes, design loads and construction procedures.

7. STEEL GUARD RAILS (Chapter 15 Article 1.2.12)

7.1. Guardrails must be installed at the following locations:

7.1.1. All bridges that have supporting structure extending above the top of the ties;

7.1.2. All bridges that have the underside supporting structure protruding beyond the deck of the bridge;

7.1.3. All bridges that cross major roadways or commercially navigable waterways;

7.1.4. All bridges longer than 30.5 m (100 ft);

7.1.5. All bridges with curves 2 degrees and over.

7.2. For any other situations or locations, the Rail Corridor Infrastructure Senior Manager Track and Structures shall determine the requirements for guard rails. See also GO Transit Track Standards.

8. TYPES OF BRIDGES

8.1. Skewed, continuous, or cantilevered spans will not be permitted unless there is written approval from the Rail Corridor Infrastructure Senior Manager Track and Structures.

8.2. Semi-integral and integral abutment bridges will not be permitted unless there is written approval from the Rail Corridor Infrastructure Senior Manager Track and Structures.

8.3. All new bridges shall be ballast deck bridges.

9. APPROACH SLABS

9.1. All existing bridges with superstructure replacement work and new railway bridges shall have approach slabs.

10. SIGNAL STRUCTURES

10.1. The design of signal structures within Metrolinx ROW shall utilize the more stringent design requirement from the following codes and standards;

1. CAN/CSA-S157/S157.1 Latest Revision – Strength Design in Aluminum,
2. CAN/CSA-S6 Latest Revision – Canadian Highway Bridge Design Code (CHBDC) Annex A3.2,
3. AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals Latest Revision, with Latest Revised Interim for Fatigue.

10.2. The following serviceability limit states (SLS) design criteria shall be used for Signal Structures within Metrolinx ROW;

1. For Gantry Signal Structures, the max allowable deflection shall be the minimum of Span/240 or 200 mm.
2. For cantilevered Signal Structures;
   - A. The max allowable free-end vertical deflection shall be min of 1.5%×arm length or 200 mm.
   - B. The max allowable free-end lateral/horizontal deflection shall be a min of 3%×arm length or 200 mm.

10.3. Column lateral sway cannot be greater than 100 mm.

10.4. All new signal structures to have stainless steel bolts, nuts and washer locking mechanism, such as nylon insert lock nuts.

10.5. For all aluminum structures with stainless steel bolts, nuts, and washers; the stainless steel components shall be applied with an approved dielectric coating to protect against oxidation/corrosion due to contact between electrically dissimilar metals.

11. ELECTRIFICATION REQUIREMENTS

11.1. All METROLINX Bridges and Structures projects shall be evaluated for electrification requirements and shall have a detailed design included in the contract procurements.

11.2. All Bridges and Structures shall be grounded and bonded as per the METROLINX Electrification Standard Drawings and Specifications.

11.3. All Bridges shall be evaluated by METROLINX Electrification to determine whether Overhead Catenary Support (OCS) structures are required on the bridges. If OCS structures are required, the bridge shall be designed to support these structures and associated wire and wind loading from supports integrated with piers, abutments, or superstructure, as directed by METROLINX.

12. DURABILITY

12.1. All new railway structures shall be designed for Cooper E-80 loading plus diesel impact (where applicable), with a service life of 100 years.

--END OF GENERAL REQUIREMENTS FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES--

GUIDELINES FOR DESIGN OF STEEL BRIDGES AND STRUCTURES

PART 2A

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART 2A – GUIDELINES FOR DESIGN OF STEEL BRIDGES AND STRUCTURES

PURPOSE AND SCOPE

These guidelines modify and supplement the applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering 2017, Steel Structures, Chapter 15, Parts1 and 8. These guidelines apply specifically to steel railway bridge spans not exceeding 122 m (400 ft) in length. For spans longer than 122 m (400 ft), these guidelines are still applicable but applied with special provisions as specified by Rail Corridor Infrastructure-Bridges & Structures. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

CHAPTER 15 - PART 1

1. GENERAL REQUIREMENTS (Chapter 15 - Section 1.2)

1.1. MATERIALS (Chapter 15 - Article 1.2.1)

In general and unless approved by Rail Corridor Infrastructure-Bridges & Structures, the type of steel and non-ferrous bearing components shall be as follows:

1.1.1. Structural Steel

Members	**Standards**	
	CSA	**ASTM**
Fracture Critical Members - Main / Beam Girders - Truss Members - Floor Beams Sections - Stringers Sections - Connections of FCM members	G40.20/G40.21 350AT or 350WT Category 5. [Low Temperature Charpy Impact Test – 34 Joules (25 ft-lbs) at -30 °C (-22 °F)]	A709/A709M Grade 50 or 50W Zone 3 or as specified by METROLINX
Non-Fracture Critical Members - End Bearing Stiffeners	G40.20/G40.21 350AT or 350WT Category 3 [Low Temperature Charpy Impact Test – 27 Joules (20 ft-lbs) at -30 °C (-22 °F)]	A709/A709M Grade 50 or 50W Zone 3 or as specified by METROLINX

<table>
<tr><th rowspan="2">Members</th><th colspan="2">Standards</th></tr>
<tr><th>CSA</th><th>ASTM</th></tr>
<tr><td>Non-Fracture Critical Members

/ Secondary Members

- Bracing
- Struts
- Stiffeners (Intermediate and Horizontal)
- Deck Plates
- Knee Braces
- Walkway Brackets
- Columns / Posts
- Jacking Beams (if used solely for jacking and not part of the floor system)
- Gusset Plates
- Deck and Deck Joint Plates
- Diaphragms</td><td>G40.20/G40.21

350A or 350W</td><td>A588, A709/A709M

A572, A36

Grade 50 or 50W</td></tr>
<tr><td>Galvanized Secondary Members

- Handrails – structural sections
- Bearing Plates
- Fiber Optics Brackets
- Handrails – pipe sections</td><td>G40.20/G40.21 300W

G40.20/G40.21 350W Class C</td><td>A572, A36 Grade 50

ASTM A500 Grade C</td></tr>
</table>

1.1.2. High Strength Steels

High strength steels conforming to ASTM A572 – Grades 60 and 65, ASTM A709/A709M – Grades HPS 70W, 100 and 100W and ASTM A852 shall not be used for welded built-up main members of bridges without prior approval of Rail Corridor Infrastructure - Bridges & Structures.

1.1.3. Fracture Critical Members (FCM)

All Fracture Critical members shall be designated on the drawing plans as "FCM". Beam Span's girders are considered as FCM.

1.1.4. Members Other than Fracture Critical

All main load carrying members subject to tensile stresses, other than fracture critical members, subject to meeting notch toughness requirements shall be designated on the plans as "NTR"

1.1.5. Bronze Castings and Rolled Copper-Alloy Bearing and Expansion Plates

Self-lubricating bronze bearing plates shall conform to the requirements of current ASTM specifications, designated B22, Alloy C91300, C91100 or UNS C86300. Alloy C91100 may be used only if the bearing pressure is less than 11.0 MPa (1,600 psi). Self-lubricating rolled copper-alloy bearing plates shall conform to the requirements of current ASTM specifications designated B100, Alloy C51000 or C51100. Material conforming to specification B100 may not be used for plates more than 20 mm (3/4 in) thick or 455 mm (18 in) wide.

To increase service life, low bearing pressures are desirable and the bearing areas should not be reduced to bring the pressures up to the allowable. The plates shall be provided with trepanned or drilled recesses (not grooves), which shall be filled with a lubricating binder. Shellac, tars and asphalts, petroleum solvents or other non-lubricating binders shall not be used. The lubricating area shall comprise approximately 25% of the total area. The coefficient of friction shall not exceed 0.1 at a load of 13.8 MPa (2,000 psi).

1.2. TYPES OF BRIDGES (Chapter 15 - Article 1.2.3)

The preferred types of bridge shall be in accordance with Chapter 15 - Article 1.2.3 except as modified below:

1.2.1. All spans shall be ballasted simple span bridges consisting of Beam Spans (BS), Deck Plate Girder Spans (DPG) or Through Plate Girder Spans (TPG).

1.2.2. Pin connected trusses will not be permitted.

1.2.3. Skewed Through Truss (TT) or Skewed Deck Truss (DT) spans will not be permitted unless there is written approval from the Rail Corridor Infrastructure Senior Manager Track and Structures.

1.2.4. Pony Truss designs are not permitted.

1.3. SPACING OF TRUSSES, GIRDERS AND STRINGERS (Chapter 15 - Article 1.2.4)

The distance between the centers of a two-girder span shall not be less than 2.1m (7 ft).

1.4. DEFLECTION (Chapter 15 - Article 1.2.5)

The computed live load deflections shall not exceed $\frac{L}{750}$ unless otherwise approved by the Rail Corridor Infrastructure Senior Manager Track and Structures.

1.5. CLEARANCES (Chapter 15 - Article 1.2.6)

In general, for new construction, the bridge span layout shall meet METROLINX Clearance Diagram (see METROLINX standard drawing K1U-10.1 Appendix A).

2. LOADS, FORCES AND STRESSES (Chapter 15 - Section 1.3)

2.1. Steel bridges shall be designed for all loads stated in AREMA Chapter 15 except as modified herein.

2.1.1. DEAD LOAD (Chapter 15 - Article 1.3.2)

- The dead load on ballast deck bridges shall be based on a minimum of 405 mm (16 in) of ballast to top of tie plus 305 mm (12 in) of ballast for future track surfacing. For track on a curve, the minimum ballast to the top of tie shall be 405 mm (16 in) at the low end of crossties.
- Regardless of the type of ties proposed, the weight of concrete ties shall be used for calculation of dead load.

2.1.2. LIVE LOAD (Chapter 15 - Article 1.3.3)

Cooper E-80 or Alternate Live Load as shown in Figure 15-1-3 of AREMA manual; whichever produces the greater stresses.

2.1.3. IMPACT LOAD (Chapter 15 - Article 1.3.5)

Percentage of live load for rolling equipment without hammer blow.

3. BASIC ALLOWABLE STRESSES (Chapter 15 - Section 1.4)

3.1. High Strength Bolts (Chapter 15 - Article 1.4.1)

3.1.1. Allowable shear in ASTM A325 bolts shall be 117.2 MPa (17 ksi) except at connections where the bolts may be subject to moment tension; allowable shear is limited to 93.0 MPa (13.5 ksi).

3.1.2. The use of ASTM A490 bolts is not permitted.

3.2. Bearing Pressure on Concrete (Chapter 15 - Article 1.4.4 and Article 5.2.7)

3.2.1. When the strength of existing concrete is unknown or shows signs of deterioration, allowable bearing pressure shall be limited to 4.8 MPa (700 psi).

4. MINIMUM DIMENSIONS OF MATERIAL

4.1. Metal (Chapter 15 - Article 1.5.4)

Minimum thickness except for fillers shall not be less than 10 mm (3/8 in).

4.2. High Strength Bolts (Chapter 15 -Article 1.9.5)

Minimum bolt diameter shall be 22mm (7/8 in).

4.3. Rehabilitation of Existing Bridges

4.3.1. For bridges constructed with imperial fasteners, they shall be rehabilitated with imperial fasteners.

4.3.2. For bridges constructed with metric fasteners, they shall be rehabilitated with metric fasteners.

5. GENERAL RULES - ACCESSIBILITY OF PARTS (Chapter 15 - Article 1.5.5)

5.1. In addition, rolled or built-up sections of beam spans shall preferably have a mean clearance between flanges of 355 mm (14 in).

6. MEMBERS STRESSED PRIMARILY IN BENDING (Chapter 15 - Section 1.7)

6.1. FLANGE SECTIONS (Chapter 15 - Article 1.7.2)

6.1.1. Add the following to Chapter 15 - Article 1.7.2.1.

Cover plates of girders with bolted flanges shall be equal in thickness or shall reduce gradually in thickness on the outer face. No plate shall be thicker than the flange angles. The gross area of cover plates in any flange shall not exceed 70% of the total flange area consisting of cover plates, flange angles directly connected to cover plates, and side plates. The area of any flange element (flange angle, cover plate or side plate) shall not exceed 50% of the total flange.

6.1.2. Chapter 15 - Article 1.7.2.2.b

Welding of cover plates to the top and bottom flanges of the girder is not allowed.

6.2. THICKNESS OF WEB PLATE (Chapter 15 - Article 1.7.3)

The minimum web thickness for Beam Spans, DPGs and TPGs shall not be less than 13 mm (1/2 in).

6.3. FLANGE-TO-WEB CONNECTION OF PLATE GIRDERS (Chapter 15 - Article 1.7.4)

The flange plates of all welded plate girders shall be connected to the web plate with continuous fillet welds except for open deck plate girders whereby the connection shall be continuous, full penetration groove welds.

6.4. MAIN GIRDER FLANGE AND WEB SPLICES (Chapter 15 - Article 1.7.5 and 1.7.6)

6.4.1. Splices shall be avoided whenever possible. Designer and/or steel supplier must have prior written approval from the Rail Corridor Infrastructure Senior Manager Track and Structures to use splices. For spans longer than 18.3 m (60 ft), locations of web and flange splices shall be shown on the design drawings.

6.4.2. The top and bottom flange splices locations shall be staggered in position and shall be shown on the design drawings. Splices shall preferably be located at between 0.2L - 0.3L of span.

6.4.3. The web splice locations shall be staggered in position between left and right girders. Splices shall preferably be located at between 0.35L - 0.45L of span.

6.4.4. The distance apart between flanges and web splices shall be a minimum 0.1L of the span.

6.4.5. Bolted splices in the webs of plate girders shall be designed for the full strength of the web in both shear and bending.

6.5. STIFFENERS AT POINTS OF BEARING (Chapter 15 - Article 1.7.7)

6.5.1. Bearing stiffeners shall be 25 mm (1 in) minimum thickness and shall be connected to the web of the girders with fillet welds and connected to the flanges with full penetration groove welds.

6.5.2. The top and bottom ends of bearing stiffeners shall be welded to the outstanding portion of the flanges with full penetration, double bevel groove welds.

6.6. WEB PLATE STIFFENERS (Chapter 15 - Article 1.7.8)

6.6.1. Intermediate web stiffeners shall be bolted to the plate girder or beam webs with high strength bolts. Welding of the stiffeners is not permitted except at the top end of the stiffener connection to the top flange of the girder.

6.6.2. The top ends of intermediate stiffeners shall be welded with a fillet weld while the bottom shall be milled to bear.

6.7. FLOOR MEMBERS AND FLOORBEAM HANGERS (Chapter 15 - Section 1.8)

6.7.1. END FLOORBEAMS (Chapter 15 - Article 1.8.1)

End floor beams shall be bolted to the end bearing stiffeners.

6.7.2. END CONNECTIONS OF FLOOR MEMBERS (Chapter 15 - Article 1.8.3)

Intermediate floor beams shall be bolted to the web of the girder or stiffener with double connection angles.

6.8. WELDED CONSTRUCTION (Chapter 15 - Section 1.10)

6.8.1. Field welding shall be avoided, if possible. Field welding of Fracture Critical Members (FCM) shall be prohibited. All welding must be done using shielded metal-arc or submerged arc process. All flange-to-web "T-Joint" welds and shop welded splices in flanges or webs shall be performed by an approved continuous automatic feed and travel submerged arc weld process.

6.8.2. Main members subjected to tensile stress shall be welded by the submerged arc welding process.

6.8.3. Electro-slag, gas metal-arc and electro-gas welding processes are not permitted.

6.8.4. Welded attachments to main members will not be permitted except at noncritical locations.

6.8.5. All welding shall be carried out by Operators qualified under the provisions of CSA W47.1 Division 1.

6.9. BRACING (Chapter 15 - Section 1.11)

6.9.1. BRACING OF TOP FLANGES OF THROUGH GIRDERS (Chapter 15 - Article 1.11.1)

Floor beam brackets may be made up of welded plates or cut from rolled sections and shall be bolted to the girder stiffeners and to the floor beams.

6.9.2. LATERAL BRACING (Chapter 15 - Article 1.11.2)

For ballasted deck plate girder and beam spans having four (4) or more girders/beams per track, top and bottom lateral bracing will not be required except for spans more than 21.3 m (70 ft) long, spans on curves greater than 2 degrees or unless otherwise instructed by the Rail Corridor Infrastructure Senior Manager Track and Structures.

6.9.3. CROSS FRAMES AND DIAPHRAGMS FOR DECK SPANS (Chapter 15 - Article 1.11.4)

6.9.3.1. Cross frames shall be spaced not more than 3.6 m (12 ft) apart.

6.9.3.2. Revise sections (f) and (g) of Chapter 15 - Article 1.11.4 by deleting the reference to diaphragms in the first sentence of each.

6.9.4. Longitudinal beams, or deck plate girders where four (4) or more girders are used per track, shall have diaphragms at the ends and intermediate points. To obtain lateral distribution of the load on spans with ballast floors, the intermediate diaphragms shall be placed not more than 2.44 m (8 ft) apart. The diaphragms shall be as deep as the depth of the beam will permit, and be rigidly connected to the web of the beam or girder. If it is so required for adequate transverse load distribution, double angle connections shall be used.

6.9.5. At all end diaphragms; special connection details or access holes must be provided due to space constraints from the backwall.

6.10. TRACTION BRACING

6.10.1. For bridges with transverse floor beam systems such as TPG, TT or DT spans; provide traction bracing to transfer the longitudinal forces to the main girders or trusses.

6.10.2. For spans exceeding 15.2 m (50 ft), the traction bracing shall preferably be located at both ends of the bridge span but final location shall be determined by the configuration and type of the steel spans. For spans shorter than 15.2 m (50 ft), traction bracing shall be installed only at the fixed end of the span.

6.10.3. Traction bracings shall be sized to be the same depth or as close as possible to the member being braced.

6.10.4. The load transfer path for the longitudinal forces shall be determined, and analysis shall be carried out to determine the percentage of the load sharing to the other members of the floor system.

6.10.5. Allowable stresses for members designed for longitudinal forces are permitted to be increased by 25 %.

CHAPTER 15 - PART 8

6.11. WALKWAYS AND HANDRAILS ON BRIDGES – LOADS (Chapter 15 - Article 8.5.3.2)

Walkways and inspection catwalks shall be designed to support a uniformly distributed live load of not less than 4.8 kPa (100 psf).

--END OF GUIDELINES FOR DESIGN OF STEEL BRIDGES AND STRUCTURES--

GUIDELINES FOR FABRICATION OF STEEL BRIDGES AND STRUCTURES

PART 2B

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART 2B - GUIDELINES FOR FABRICATION OF STEEL BRIDGES AND STRUCTURES

PURPOSE AND SCOPE

These guidelines modify and supplement the applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering 2017, Steel Structures, Chapter 15, Part 3, and shall apply to all work pertaining to the fabrication of steel railway bridges. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

CHAPTER 15 - PART 3

1. SHOP DRAWINGS (General)

1.1. The Fabricator's attention is called to the requirements for shop drawings, of the AREMA Manual, Chapter 15, Article 1.1.3, Shop Drawings. Standard size of drawings is 559 mm x 864 mm (22 in x 34 in) with METROLINX Title Block.

1.2. The Fabricator shall furnish complete set(s) of detailed shop drawings as called for in the tender documents; to METROLINX for review prior to starting fabrication. Unchecked drawings shall not be submitted for review. After review of shop drawings, the Fabricator shall supply METROLINX with additional complete set(s) of shop drawings as called for in the tender documents.

1.3. The rejection of or the procedure for the correction of shop drawings will not be considered as cause for delay.

1.4. As-built shop drawings shall be furnished to Rail Corridor Infrastructure-Bridges & Structures at the completion of the contract in electronic format AUTOCAD "DWG" and ADOBE ACROBAT "PDF", to the attention of:

Manager of Bridges and Structures
Rail Corridor Infrastructure
METROLINX

1.5. The correctness and completeness of shop drawings irrespective of any review by METROLINX shall be the responsibility of the Fabricator.

2. MATERIALS (General)

2.1. Mill test reports will be required for all steel plates and rolled sections supplied by the Fabricator.

2.2. Bolts, nuts and washers shall meet the current requirements of ASTM for high strength bolts. Bolts designated A325(M) will be used except where noted otherwise on plans. All bolts, nuts and washers shall be supplied as an assembly from a single source with documentation as to their origin and quality certification. Where fasteners of foreign manufacturer(s) are supplied, local test(s) shall be conducted to verify fasteners comply with specification requirements.

2.3. All high strength connection bolts and nuts may be used only once and must then be discarded and replaced with new.

3. GENERAL (Chapter 15 - Section 3.1)

3.1. Dimensional Tolerances for Structural Members (Chapter 15 - Article 3.1.7)

3.1.1. Deck Spans

The top flanges of all beams and girders supporting a steel plate or timber deck shall not vary by more than 3 mm (1/8 in) from a straight edge placed at any line across two adjacent beams, and by not more than 6 mm (1/4 in) across all beams.

3.1.2. Through Plate Girder Spans

The top flanges of all transverse floor beams supporting a steel plate or timber deck shall be in the same plane.

3.2. Fit of Stiffeners (Chapter 15 - Article 3.1.10)

3.2.1. Bearing Stiffeners

The top and bottom ends shall be welded to the outstanding portion of the flanges with full penetration, double bevel groove weld.

3.2.2. Intermediate Stiffeners

The top ends shall be welded with a fillet weld while the bottom end shall be milled to bear.

4. RIVETED AND BOLTED CONSTRUCTION - PREPARATION OF HOLES FOR FASTENERS (Chapter 15 - Article 3.2.6 and 3.2.7)

4.1. Deck Spans

4.1.1. The beams or girders in each shop-assembled set shall be assembled with the top of the top flanges of adjacent beams in a true horizontal plane to ensure that all floor plates will fit properly. Holes for the diaphragm connections shall be match-marked and drilled.

4.1.2. Holes for field-connections of diaphragms and walkway brackets shall be reamed to size while adjacent girder sets are shop assembled in a true horizontal plane as specified for shop-connected diaphragms, and the field connections match-marked.

4.2. Through Plate Girder Spans

4.2.1. Holes for field connections of floor-beams, floor-beam brackets, and members to which they connect shall be sub-punched or sub-drilled and reamed to size with parts assembled or drilled full size from the solid while assembled as required by the AREMA manual, Chapter 15, Article 3.2.6.

4.2.2. Floor-beams and connection angles shall be assembled in suitable frames and the holes match-marked prior to drilling so that the connection angles will be square with the beam and true to dimensions.

5. WELDED CONSTRUCTION (Chapter 15 - Section 3.3)

5.1. GENERAL (Chapter 15 - Article 3.3.1)

5.1.1. All welding must be done using shielded metal-arc or submerged arc process. All flange-to-web "T-Joint" welds and shop welded splices in flanges or webs shall be by an approved continuous automatic feed and travel submerged arc weld process. Electro-slag, electro-gas and gas metal-arc processes are not permitted.

5.1.2. Preheating is required prior to flame cutting or welding:

Material thickness	Temperature
40 mm (1 ½ in) to 60 mm (2 ⅜ in)	65 °C (150 °F)
> 60 mm (2 ⅜ in)	107 °C (225 °F)

5.2. Welding Procedures

5.2.1. Welding procedures shall be submitted for METROLINX review before commencing any fabrication work.

5.2.2. Welding procedures shall be prepared in accordance with the applicable requirements of CSA Standard W59 and the AREMA Manual except as modified herein.

5.2.3. Welding procedures shall indicate the following information:

- joint preparation
- fit-up
- electrode specification and diameter
- welding position
- flux, polarity and amperage
- number of passes
- preheat and interpass temperatures
- sequence of welding, any procedure changes from one pass to the next in the same weld
- maximum thickness in weldment layer

These requirements apply to each type of weld, pre-qualified or other.

5.2.4. Welding procedures for joining Fracture Critical Members (FCM) which are not pre-qualified shall be qualified by test as outlined in CSA Standard W59.

6. INSPECTION (Chapter 15 - Section 3.5)

6.1. The METROLINX Consultant will carry out shop inspection of the fabrication including non-destructive testing of the welds such as radiographic, ultrasonic or magnetic particle tests and any other tests deemed necessary to complete the inspection. This will be in addition to the Fabricator's Quality Assurance Program.

6.2. The Fabricator shall submit a detailed fabrication schedule in increments of not more than one week. The detailed schedule shall be in clear, concise, bar chart form and shall clearly indicate the fabrication periods and sequence of operations of each item of work in sufficient detail so that the METROLINX Project Manager or the appointed inspector can determine the feasibility of the work schedule and monitor the progress of the work.

Interim reviews of work progress based on the schedule submitted by the Fabricator shall be conducted every 2 weeks by the Fabricator or at a closer interval when requested by the METROLINX Project Manager.

6.3. The Fabricator shall give a two week notice to the METROLINX Project Manager prior to start of shop fabrication, so inspection may be provided. No work in the shop shall be undertaken until the METROLINX Project Manager has been notified.

6.4. The following inspections shall be carried out:

6.4.1. Geometric Control

- Plate and Shape Sizes
- Dimensions
- Alignment
- Tolerances

6.4.2. Quality of Welds

- Visual Examination - 100% of all welds
- Radiograph Test Method - 100% of butt joint groove welds at flange and web splices. For bottom flanges, test to be carried out after heat treatment.
- Ultrasonic Test Method - 100% at flange to bearing stiffeners butt groove weld, 100% of flange to web plate butt groove weld of FCM members, 100% in the tension zone and 10% in the compression zone of flanges and web splices of non-FCM members butt groove welds.
- Magnetic Particle Test Method – 100% of fillet welds for main members and 50% of fillet welds for secondary members.

6.4.3. High Strength Bolts

- Turn of the nut method or by torque wrench - 100% sampling of installed bolts (site installed bolts are not included)

6.4.4. Surface Finishes

- Cleaning
- Galvanizing
- Metalizing

6.4.5. All joints to be radiograph inspected shall be ground flush on both sides, and shall be free of paint, scale and grease. The direction of grinding shall be perpendicular to the length of the weld.

6.4.6. Welds requiring repairs shall be retested after repairs are made. The cost for such repairs and the subsequent retesting shall be at the Fabricator's expense.

--END OF GUIDELINES FOR FABRICATION OF STEEL BRIDGES AND STRUCTURES--

GUIDELINES FOR DESIGN OF CONCRETE BRIDGES AND STRUCTURES

PART 3

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART 3 - GUIDELINES FOR DESIGN OF CONCRETE BRIDGES AND STRUCTURES

PURPOSE AND SCOPE

These guidelines modify and supplement the applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering 2017 Concrete Structures and Foundations, Chapter 8, Parts 1, 2, 3, 4, 5, 16, and 20. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

CHAPTER 8 - PART 1

1. GENERAL

1.1. TYPE OF SUPERSTRUCTURES

For means of maintenance, inspection and replacement purposes, the acceptable types of superstructures are:

1.1.1. Precast and cast-in-place, conventionally reinforced and prestressed concrete simple spans.

1.1.2. Cast-in-place, conventionally reinforced rigid frames.

Subject to approval by the Senior Manager of Track and Structures, other types of superstructures may be considered on a case by case basis. Feasibility studies for the alternate superstructure system demonstrating; evidence of 100 year service life, span replacement within a 55 hour weekend workblock time frame, maintenance requirements and life-cycle cost effectiveness shall be submitted for review.

In general, post-tensioning superstructures are not acceptable due to difficulties created for inspection, maintenance, repair or partial replacement during the structure's service life. Post-tensioned simple span superstructure may be considered if it can be shown that the preferred systems noted above in 1.1.1 to 1.1.2 are not feasible due to span length (e.g. requirement for longer span without the use of temporary intermediate supports (not only to meet aesthetics criteria)); demanding geometry (e.g. complex curve); construction requirements (e.g. disruption to water course or road traffic below); or other unyielding constraints.

Transverse post-tensioning rods used for SVB and/or DVB superstructures are acceptable.

1.2. CLEARANCES

In general, for new construction, the bridge span layout shall meet METROLINX Clearance Diagram (see METROLINX standard drawing K1U-10.1 Appendix A).

1.3. SHOP DRAWINGS

1.3.1. Standard size of drawings is 559 mm x 864 mm (22 in x 34 in) with METROLINX Title Block.

1.3.2. The Fabricator shall furnish complete set(s) of detailed shop drawings or as called for in the tender documents; to METROLINX for review prior to starting fabrication. Unchecked drawings shall not be submitted for review. After review of shop drawings, the Fabricator shall supply METROLINX with additional set(s) of the shop drawings as called for in the tender documents.

1.3.3. The rejection of, or the procedure for the correction of shop drawings will not be considered as cause for delay.

1.3.4. As-built shop drawings shall be furnished to METROLINX at the completion of the contract in electronic format AUTOCAD "DWG" and ADOBE ACROBAT "PDF", to the attention of:

Manager of Bridges and Structures
Rail Corridor Infrastructure
METROLINX

1.3.5. Correctness of shop drawings irrespective of any review by METROLINX shall be the responsibility of the Fabricator.

2. CEMENT – SPECIFICATIONS (Chapter 8 - Article 1.2.2)

2.1. The cement used in the concrete for all grade separations shall be low alkali cement. The Contractor shall obtain and furnish to METROLINX, a statement signed by an officer or chemist of the cement manufacturer, certifying that the cement furnished does not exceed 0.6 percent alkali equivalent, as measured by the percent of sodium oxide plus 0.658 times the percent of potassium oxide.

3. AGGREGATES

3.1. AGGREGATE (Chapter 8 - Article 1.4.)

3.1.1. All aggregates shall be from MTO approved sources (i.e. Quarries, pits, etc.).

3.1.2. Aggregates shall be tested to CAN/CSA and/or ASTM Standard to confirm not susceptible to frost, ASR, ACR, etc.

4. REINFORCEMENT - WELDING (Chapter 8 - Article 1.6.2)

Rebar welding is not allowed.

5. DETAILS OF REINFORCEMENT - PLACING OF REINFORCEMENT – GENERAL (Chapter 8 - Article 1.10.4.1)

The use of epoxy coated reinforcing steel is not allowed. The use of stainless steel for substructure components exposed to de-icing chemicals shall be considered in the design of new structures and structural rehabilitations. Approval shall be sought from the Rail Corridor Infrastructure Manager of Bridges and Structures to incorporate stainless steel into these components.

6. PROPORTIONING

6.1. The quality and proportions of the concrete shall be in accordance with CSA/CAN3-A23.1, latest edition and OPSS.PROV.1350:

6.1.1. Cement shall be "Portland Cement", in accordance with CSA/CAN3-A-5, latest edition.

6.1.2. The exposure class of concrete shall be Class C-1, minimum. More restrictive exposure classes shall be specified where warranted by site conditions, as designed by the METROLINX Consultant.

6.1.3. The only acceptable supplementary cementing material (SCM) is blast furnace slag. The use of blast furnace slag is permitted up to 25 % (max) slag content for Class C-1 concrete mix, as per OPSS.PROV.1350.

6.1.4. Size of coarse aggregate shall be as determined by the METROLINX Consultant and in accordance with Clause 4.3.2.2 of CSA/CAN3-A23.1, latest edition.

6.1.5. Maximum size aggregate shall be 20 mm.

6.1.6. The water/cementing materials ratio shall not exceed 0.40.

6.1.7. Air entrainment shall give a content range of 5 to 8%. All concrete shall be air entrained in accordance with the requirements of its designed exposure class.

6.1.8. Where concrete contains admixture the following requirements shall apply;

Admixture shall be selected from MTO's Designated Sources for Material (DSM) (http://www.mto.gov.on.ca/english/publications/mto-research-library-online-catalogue.shtml) and (http://www.roadauthority.com/mpl/mpl.asp?MPIShortName=MTO+DSM)

- All admixtures included in the same pour shall be compatible with each other.
- All admixtures shall be added in accordance with manufacturer's recommendations.
- All proposed use of admixtures shall be reviewed and authorized for use by the METROLINX Consultant.

6.1.9. Slump at point of discharge shall be as follows;

- For normal concrete mix 75 mm + 25 mm (without superplasticizer).
- For normal concrete mix 150 mm, maximum (after addition of superplasticizer).
- Where propriety mix design is proposed, with a slump exceeding 150 mm, the concrete mix shall be reviewed and its use shall be authorized by the METROLINX Consultant.

6.1.10. The use of calcium chloride is not permitted.

6.1.11. All concrete mix design shall be reviewed and authorized for use by the METROLINX Consultant.

6.2. FIELD TESTS (Chapter 8 - Article 1.12.9)

6.2.1. Modify paragraph (b) to require a minimum of four (4) cylinders be made for each 38 cubic meters (50 cubic yards) or portion thereof for each concrete mix per day.

6.2.2. Modify paragraph (d) to require that air content be checked at least twice for each 38 cubic meters (50 cubic yards) or portion thereof for each concrete mix per day.

6.2.3. A minimum of 2 determinations for slump shall be made for each 38 cubic meters (50 cubic yards) or portion thereof for each concrete mix per day.

7. DEPOSITING CONCRETE (Chapter 8 - Section 1.14)

7.1. Chutes, pipelines or baffles made of aluminum or aluminum alloy components shall not be used.

7.2. The free fall weight during concrete placement shall not exceed 1.2 m, to avoid concrete segregation.

8. CURING – GENERAL (Chapter 8 - Article 1.18.1)

8.1. Concrete shall be protected from freezing, abnormally high temperatures, premature drying and moisture loss.

8.2. All concrete surfaces shall be moist cured for a minimum of 7 consecutive days at a minimum of 10 °C (50 °F) or for a longer period of time to attain 70% of the specified 28 day compressive strength.

8.3. The use of curing compounds is not permitted.

9. REPAIRS AND ANCHORAGE USING REACTIVE RESINS (Chapter 8 - Article 1.23)

9.1. Dowel pull-testing of each lot shall be performed for all dowels installed using an adhesive system.

9.2. Dowels shall be considered to be from the same lot when the following criteria are met;

Dowels have the same:

- adhesive system
- bar diameter
- bar type
- hole diameter
- installation crew
- day of installation
- concrete sub-straight

9.3. For testing each lot, the METROLINX Project Manager will randomly select 5% of the dowels in that lot, or 10 dowels, whichever is greater.

9.4. The METROLINX Consultant will be responsible for performing the pull-tests.

9.5. Acceptance of dowels into concrete will be based on the pull-test loads as required by the METROLINX Consultant.

CHAPTER 8 – PART 2

10. NOTATIONS, DEFINITIONS AND DESIGN LOADS (Chapter 8 - Section 2.2)

10.1. DEAD LOADS (Chapter 8 - Article 2.2.3.b.(1))

10.1.1. The dead load on ballast deck bridges shall be based on a minimum of 405 mm (16 in) of ballast to top of tie plus 305 mm (12 in) of ballast for future track surfacing. For track on a curve, the minimum ballast to the top of tie shall be 405 mm (16 in) at the low end of the crossties.

10.1.2. Regardless of the type of ties proposed, the weight of concrete ties shall be used for calculation of dead load.

10.2. LIVE LOADS (Chapter 8 - Article 2.2.3.c)

10.2.1. Chapter 8 - Article 2.2.3.c.(1)

All railway structures shall be designed for Cooper E80 loading - plus diesel impact, where applicable.

10.2.2. Chapter 8 - Article 2.2.3.c.(3)

Revise this Article to read as follows:

Live load from a single track acting on the top surface of a structure with ballasted deck or under fills shall be assumed to have uniform lateral distribution over a width equal to the length of track tie plus the depth of ballast and fill below the bottom of the tie, plus twice the effective depth of slab; limited, however, by the extent of the structure.

10.3. IMPACT LOAD (Chapter 8 - Article 2.2.3.d.(3))

10.3.1. Impact shall not be used where the live load is allowed to dissipate either by soil or massive concrete. This is usually the case for earth retaining structures such as abutments, retaining wall, shoring walls, shallow foundations and pile foundations with massive cap.

11. MATERIALS – CONCRETE (Chapter 8 - Article 2.3.1)

11.1. Minimum 28 days concrete strength of members shall be as follows:

Element Type:	Strength of concrete MPa (psi)
Precast prestressed elements	50 MPa (7000 psi)
Conventionally reinforced concrete elements	35 MPa (5000 psi)
Conventionally reinforced precast or other minor concrete elements	35 MPa (5000 psi)

11.2. Minimum 24 hour concrete strength at release for prestressed concrete members shall be 35 MPa (5000 psi).

12. MATERIALS – REINFORCEMENT (Chapter 8 - Article 2.3.2)

Rebar welding is not allowed.

13. CONCRETE PROTECTION FOR REINFORCEMENT – MINIMUM CONCRETE COVER (Chapter 8 - Article 2.6.1)

13.1. Delete this Article and substitute the following table:

Exposure Conditions	Minimum Cover
Concrete cast against and permanently exposed to earth	75 mm (3 in)
Concrete not submerged or exposed to earth or de-icing chemicals: • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	 50 mm (2 in) 50 mm (2 in)
Concrete submerged or exposed to earth in nonaggressive environments: • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	 50 mm (2 in) 50 mm (2 in)
Concrete subjected to de-icing chemicals or other aggressive environments: • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	 75 mm (3 in) 75 mm (3 in)
Soffit of slabs over roadways • Principle reinforcing bars	 50 mm (2 in)

13.2. If the above cover cannot practically be attained, it may be reduced as necessary, subject to the acceptance of Rail Corridor Infrastructure-Bridges & Structures, but in no case shall the cover be less than 50 mm

(2 in) for conventionally reinforced concrete or 40 mm (1 ½ in) for precast prestressed concrete members.

13.3. For casting-in-place concrete, the maximum concrete cover shall be 30 mm (1 $^{3}/_{16}$ in) more than the minimum cover provided in section 13.1.

13.4. For precast concrete, the maximum concrete cover shall be 10 mm (3/8") more than the minimum cover provided in section 13.1.

14. SHRINKAGE AND TEMPERATURE REINFORCEMENT (Chapter 8 - Section 2.12)

In the last line, change 455 mm ("18 in") to 305 mm ("12 in").

15. SPLICES OF REINFORCEMENT – WELDED SPLICES AND MECHANICAL CONNECTIONS (Chapter 8 - Section 2.22.2)

Rebar welding is not allowed.

16. ALLOWABLE SERVICE LOAD STRESSES – CONCRETE (Chapter 8 - Article 2.26.1.c)

Delete the last line and substitute the following:

Minimum edge distance on concrete shall be as follows:

Bearing Element	Minimum Edge Distance
Steel plates continuous under two or more rolled beams	150 mm (6 in)
Slab type shoes	230 mm (9 in)
Shoes for truss spans and spans longer than 30.5 m (100 ft)	305 mm (12 in)

CHAPTER 8 – PART 3

17. FIELD CONDITIONS – REINFORCEMENT (Chapter 8 - Article 3.7.2)

If the concrete is placed against a seal coat or against steel sheeting that is to remain in place, the cover shall not be less than 65 mm (2 ½ in).

CHAPTER 8 – PART 4

18. PILE LENGTH DETERMINATION (Chapter 8 - Section 4.3)

Add the following:

Piles supporting concrete foundation caps, pier caps or abutments shall have their tops embedded at least 305 mm (12 in) into the concrete.

19. PILE DRIVING FORMULAS (Chapter 8 - Article 4.3.5)

Add the following:

One of the following criteria must be satisfied for piles to be driven to practical refusal:

19.1. With Pile Dynamics Test

Piles shall be driven to a minimum allowable load capacity 50% greater than the design loading. The required blow counts for the 150% of design loading shall be verified by pile dynamics test.

19.2. Without Pile Dynamics Test

Piles shall be driven to a minimum allowable load capacity 100% greater than the design loading. The required blow counts for the 200% of design loading shall be determined by a qualified Geotechnical Engineer.

<u>CHAPTER 8 – PART 5</u>

20. COMPUTATION OF APPLIED FORCES – LOADS EXCLUSIVE OF EARTH PRESSURE (Chapter 8 - Article 5.3.1.b)

20.1. Delete this Article and substitute the following:

In calculating the surcharge due to track loading, the entire live load shall be assumed to be uniformly distributed as follows:

- Longitudinal - A length of 915 mm (3 ft) plus the depth of ballast and fill under the tie; limited, however, by the axle spacing.
- Lateral - For load from a single track, and for structures at which the nature of the structure does not provide for practical extension of future tracks, the lateral distribution may be made over a width equal to the length of tie plus the depth of ballast and fill under the tie down to the elevation of the section under investigation; limited, however, by the extent of the structure. The lateral distribution of load from multiple tracks shall be as specified for single tracks and further limited so as not to exceed the distance between centers of adjacent tracks. At abutments, the above distribution shall be limited to the abutment shaft only. In no case shall the resulting surcharge be less than 28.7 kPa (600 psf).

20.2. Live load forces resulting from track geometry shall be considered in the design of shoring walls or any other structural elements.

20.3. At-Rest pressure coefficients shall be used for the design of abutments and other permanent earth retaining structures. At-Rest pressure coefficient will be determined by a qualified Geotechnical Engineer but shall not be less than 0.50.

20.3.1. For calculation of soil lateral pressure, the triangular method shall be used.

20.3.2. Delete all references to apparent earth pressure in AREMA Chapter 8- 28.5.4.1, Figure 8-28-1. Apparent earth pressure method will not be allowed.

20.4. The permanent abutment walls, wing walls, or any other structural elements supporting Railway tracks, shall be designed for lateral pressure due to Cooper-E80 surcharge as per AREMA. [i.e. 95.8 kPa (2.00 ksf) – 80 kips axle load, 5 ft spacing between two consecutive axles. The effect of the strip load surcharge calculated with 8 ft tie length can be assessed as described in AREMA, Chapter 8 - Article 20.3.2.2.]

20.5. The lateral pressure to the structural elements, described above, due to train loading shall be computed using Boussinesq formula as described in AREMA, Chapter 8, Article 20.3.2.2.

$$Ps = \frac{2q}{\pi}(\beta + \sin\beta\ sin^2\alpha - \sin\beta\ \ cos^2\alpha)$$

For α, β, see AREMA Figure 8-20-2.

Where:

$$q\ = \frac{80\ kips}{Axel\ spacing(ft) * Tie\ length(ft)}$$

Axel spacing = 5 ft.

Tie length = 8 ft.

- No other alternative method of calculation for estimation of lateral pressure to the structural elements due to train load is allowed.

20.6. Calculated lateral pressure due to train loading shall be applied to the whole entire height of the structural element. No elimination of lateral pressure due to train loading will be allowed (e.g., area above the point of intersection of the METROLINX influence line - one and half feet away from edge of tie with downward slope of two horizontal and one vertical 2H to 1V, and vertical face of structural elements).

20.7. No reduction factor will be allowed to reduce the computed lateral pressure due to train loading based on Boussinesq formula.

20.8. The effect of E80 train loading on all tracks shall be considered for the estimation of the lateral pressure due to train loading, as described in AREMA, Chapter 8 - Article 2.2.3.c(6).

21. DETAILS OF DESIGN AND CONSTRUCTION FOR ABUTMENTS AND RETAINING WALLS – GENERAL Chapter 8 - Article (5.7.1.b)

Revise this Article to read as follows:

The width of the stem of a semi-gravity wall at the level of the top of the footing shall be at least one-fourth of its height for wingwalls and retaining walls, and three-tenths of its height to the base of rail for abutments.

CHAPTER 8 – PART 7

22. MECHANICALLY STABILIZED EMBANKMENT

22.1. Mechanically stabilized earth (MSE) retaining walls are not allowed for embankments carrying railway loads (i.e. if the wall falls within the Metrolinx load influence line of 2H:1V starting at 450mm from the end of tie).

22.2. In lieu of MSE walls, precast T-wall system shall be used for embankments carrying railway loads.

22.3. Any proposed alternative retaining wall system to be used to carry railway loading shall have an engineering study confirming 100 year service life while accommodating ease of inspection and maintenance.

CHAPTER 8 – PART 16

23. DESIGN AND CONSTRUCTION OF REINFORCED CONCRETE BOX CULVERTS

23.1. The dry cast method is not allowed. All precast concrete box culverts shall be air-entrained and wet cast.

23.2. The concrete mix design for box culverts, and all other buried structures adjacent to the culverts shall be Class C-1, unless existing site and/or soil conditions warrant a higher exposure class.

23.3. The concrete mix design for box culverts used for pedestrian tunnel applications, and all other buried structures adjacent to the tunnel shall contain a crystalline waterproofing admixture, by XYPEX (or approved equivalent with regards to performance and aesthetics), as a means for waterproofing the structure. The approved equivalent must meet the following performance criteria;

Property	Test Method	Performance Criteria
Scanning Electron Microscopy		Evidence of Crystal Growth at 500X Magnification treated concrete
Water Permeability	DIN 1048-5 EN 12390-8	99.7% reduction in Perm Co-Efficient [DIN 1048-5 / Unmodified EN 12390-8]
Water Pressure Resistance	USACE-CRD-C48	99.997% reduction in Perm Co-Efficient
Water Vapor Permeability	BS 3177	36% reduction
Autogenous Sealing of Cracks	Costume Method	Up to 0.7 mm
Petroleum Product Penetration	Modified EN 12390-8	90% Reduction – Unleaded Gas 83% Reduction – Diesel Fuel
Sulfate Resistance Testing	CSN 73 1326	Admix Modified Sample with 99% reduction in mass loss vs the control samples after 4 months
Drying Shrinkage	BS 1881-5	23% Reduction
Wetting Expansion	BS 1881-5	32% Reduction
Freeze-Thaw Expansion	BS 5075-2	89% Reduction
Chemical Resistance: Weight loss after 42 days in 5% sulfuric acid	ASTM C267	68% Reduction

CHAPTER 8 – PART 20 AND 25

24. FLEXIBLE SHEET PILE BULKHEADS

SLURRY WALL CONSTRUCTION

Permanent flexible sheet pile walls and permanent slurry walls subjected to railroad surcharge are not allowed.

--END OF GUIDELINES FOR DESIGN OF CONCRETE BRIDGES AND STRUCTURES--

GUIDELINES FOR DESIGN OF BEARINGS

PART 4

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART 4 - GUIDELINES FOR DESIGN OF BEARINGS

PURPOSE AND SCOPE

These guidelines modify and supplement the applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering 2017, Bridge Bearings, Chapter 15, Part 5. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

CHAPTER 15 – PART 5

1. GENERAL REQUIREMENTS (Chapter 15 - Article 5.1.2)

1.1. Elastomeric Bearing Pads

The minimum thickness shall not be less than 13 mm (½ in).

1.2. Bearing Levelling Pads

The minimum thickness shall not be less than 6 mm (¼ in).

Levelling pads shall be laminated fabric rubber, supplied by Fabreeka, or Sorbtex or approved equivalent. Other leveling pads may be considered by Rail Corridor Infrastructure -Bridges & Structures, and shall only be specified with the prior approval of Rail Corridor Infrastructure -Bridges & Structures. The designer shall submit all pertinent documents to Rail Corridor Infrastructure-Bridges & Structures for review.

1.3. All bearings shall have positive mechanical restraint. Adhesive shall not be considered a means of positive mechanical restraint.

2. BEARING SELECTION CRITERIA (Chapter 15 - Article 5.1.5)

This section shall be modified as follows:

2.1. For steel spans

The preferred bearing types are as follows:

2.1.1. Bridge spans of length < 9.1 m (30 ft)

- Elastomeric Bearing
- Sliding Plate Bearing

2.1.2. Bridge spans of length 9.1 m (30 ft) < L < 16.7 m (55 ft)

- Elastomeric Bearing

2.1.3. Bridge spans of length > 16.7 m (55 ft)

- Spherical Bronze Alloy (Through Plate Girders (TPG), Deck Plate Girder (DPG) and skew spans)
- Radial Bronze Alloy, Deck Plate Girder (DPG)

2.2. For concrete spans

The preferred bearings types are as follows:

2.2.1. Bridge spans of length ≤ 8.5 m (28 ft)

- 10 mm (3/8 in) thick rubber pads, supplied by Fabreeka or Sortex, or approved equivalent. Other bearing pads may be considered by Rail Corridor Infrastructure-Bridges & Structures, and shall only be specified with the prior approval of Rail Corridor Infrastructure-Bridges & Structures. The designer shall submit all pertinent documentation to Rail Corridor Infrastructure-Bridges & Structures for review.

2.2.2. Bridge spans of length > 8.5 m (28 ft) to < 14.6 m (48 ft)

- Elastomeric bearings (strip)

2.2.3. Bridge spans of length > 14.6 m (48 ft)

- To be approved by Rail Corridor Infrastructure-Bridges & Structures.

2.3. For details of bearings, see Appendix A - Standard Drawings S15, S16 and S17 for steel spans and C9-1 & C9-2 for concrete spans.

3. BASIC ALLOWABLE STRESSES – BRONZE OR COPPER ALLOY PLATES (Chapter 15 - Article 5.2.3)

Allowable bearing pressure on bronze bearing plates shall be limited to 11.0 MPa (1,600 psi) on the gross area and 13.8 MPa (2,000 psi) on the net area; except for UNS C86300 grade whereby the allowable bearing pressure is 20.7 MPa (3,000 psi).

4. STEEL BEARING COMPONENTS – ANCHOR BOLTS AND RODS (Chapter 15 - Article 5.3.7)

Add the following clauses:

4.1. All anchor bolts shall be hot-dip galvanized.

4.2. Anchor bolts shall meet the requirements of ASTM F1554, or shall be corrosion resistant, low alloy structural steel, conforming to the requirements of ASTM Specification A588 or ASTM A276, Type 410, annealed.

4.3. Anchor bolts shall be grouted with fast setting, low shrinkage grout such as SIKA 212 or equivalent. Other low shrinkage grouts may be considered by Rail Corridor Infrastructure-Bridges & Structures, and shall only be specified with the prior approval of Rail Corridor Infrastructure-Bridges & Structures. The designer shall submit all pertinent documentation to Rail Corridor Infrastructure-Bridges & Structures for review.

--END OF GUIDELINES FOR DESIGN OF BEARINGS--

GUIDELINES FOR DESIGN OF WATERPROOFING AND BALLAST MAT

PART 5

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART 5 - GUIDELINES FOR DESIGN OF WATERPROOFING AND BALLAST MAT

These guidelines modify and supplement the applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering 2017, Waterproofing Chapter 29, Part 1 and 2. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

CHAPTER 29 – PART 1

1. HIGH PERFORMANCE WATERPROOFING SYSTEM

All steel and concrete decks shall be waterproofed. All deck and bridge joints shall be thoroughly sealed against leakage.

The preferred High Performance Waterproofing system shall be the Matacryl System comprised of Matacryl Primer, Matacryl RB Membrane and Matacryl STC Sealer Coat, manufactured by RPM Belgium. In addition, all bridge joints shall utilize Matacryl LM and Matacryl WS (where required), by RPM Belgium. Alternatives may be considered, provided the proposed alternative is equal or better than the specified product.

1.1. General Requirements of High Performance Waterproofing System:

1.1.1. Surface Preparation:

- All surfaces shall be shot, captive blasted or abrasive blast cleaned as per OPSS 929 to attain the required surface profiles specified in the Manufacturer's recommendations.
- Surfaces shall be free of oil, grease, curing compounds, loose particles, rust, mill scale and any other deleterious substance or matter.
- Surface moisture shall be less than 6%.
- The Contractor shall conduct tests for adequate tensile surface strength, in accordance with the Manufacturer's recommendations, at a minimum frequency of three tests per 465 m^2 (5,000 sq. ft.) at locations as directed by the Metrolinx Consultant. In no instance shall tensile surface strength be less than 1.20 MPa. For smaller areas, the frequency shall be dictated by the Metrolinx Consultant. These tests shall be conducted in advance of the application commencing to ensure that surface exhibits sufficient structural integrity. All tests shall be witnessed by the Metrolinx Consultant. The contractor shall undertake the necessary remediation to achieve the minimum tensile surface strength where found to be deficient prior to application of the waterproofing system.

- The conditions required as part of surface preparation shall be maintained for the entire duration of application of the High Performance Waterproofing System.

1.1.2. Priming of Surfaces:

- Substrate temperatures MUST be above the dew point.

- The primer onto substrate shall consist of one or two coats with an overall coverage rate of 0.40 kg per m² (1 gallon to 80-100 sq. ft.) via brush or roller application.

- The primer shall be a one component solvent-free, 100% reactive, acrylic-based, Methyl Methacrylate (MMA) resin requiring only the addition of a catalyst and shall be capable of full cure in 40 minutes at 0°C. The primer shall be equal to or better than RPM Belgium MATACRYL Primer CM (steel and concrete). Properties shall be equal to or better than the following:

Material Properties	Criteria
Percent reactive resin	100%
Cure time @ 0°C (32°F) to 20°C (68°F)	20-45 minutes
Recoat time @ 20°C (68°F)	30-45 minutes
Multi-coat application, solution weld	Yes
Tensile Strength	> 10.3 MPa (1500 psi)

- Quartz Aggregate shall be employed as a broadcast onto the primer if required by the manufacturer.

1.1.3. Waterproofing Membrane:

- The waterproofing membrane shall be a one component solvent free 100% reactive Polyurethane & Methyl Methacrylate blend (PUMA) resin requiring only the addition of a catalyst and be capable of providing chloride ion inhibition, bridging of hairline and shrinkage cracks, and equal to RPM Belgium – Matacryl RB.

- The waterproofing membrane for High Performance Waterproofing System shall meet or exceed the following properties as related to laboratory prepared samples tested at 20°C (68°F) and 24 hour cure where applicable:

Material Properties	Criteria
Percent reactive PUMA resin	100%
Volatile Organic Content (VOC) (ASTM D 2369-07)	< 1%
Tensile Adhesion to Concrete (ASTM C 1583 / 1583 M -04)	> 2.75 MPa (400 psi)
Tensile Adhesion to SSPC-SP 10 Steel (ASTM D 4541-09)	> 6.89 MPa (1000 psi)
Water Absorption (ASTM D 570-98)	< 1.3%
Elongation (ASTM D 638-10)	> 245%
Tensile strength (ASTM D 638-10)	> 8.27 MPa (1200 psi) @ -30°C
Dynamic Crack bridging (ASTM C 1305-08)	> 3mm (120 mils) @ -26°C
Crack bridging (VTT)	> 5 mm (200 mils) @ -30°C
AREMA Ballast Indentation	Approved

- The membrane shall consist of one or more coats with an overall coverage rate of 4.0 kg per m² (1 gallon per 12.5 sq. ft.) via gauge rake and spike rollers or spray equipment. Minimum dry film thickness shall govern over overall coverage rates where dispute of coverage arises. The minimum dry film thickness shall be 3 mm (120 mils) applied in either one or two layers.

- The METROLINX consultant shall determine based on the chosen waterproofing system the parameters for wet film thickness testing required to achieve the prescribed dry film thickness.

1.1.4. Sealer Coat (if required by the Manufacturer):

- The Sealer Coat shall be a one component solvent-free, 100 % reactive, acrylic based Methyl Methacrylate (MMA) resin requiring only the addition of a catalyst and be capable of full cure in less than one hour at 0 °C (32 °F), and equal to RPM Belgium - MATACRYL STC.

- The Sealer Coat shall be applied by roller with an overall coverage rate of 0.80 – 1.00 kg per m² and in accordance with the Manufacturer's recommendations.

- The sealer coat shall be applied to all areas that will remain exposed.

1.1.5. Full System Approvals:

- The waterproofing and crack bridging membrane system must additionally be able to demonstrate testing and approval to the following standards:

Material Properties	Criteria
Water Tightness by Dye Penetration (EOTA TR 003)	Watertight with no discolouration
Water Vapor Permeability (NF EN ISO 7783-2)	μ < 1,638
Resistance to Delamination (EOTA TR 004)	> 1.9 MPa or Concrete Tensile Failure
Resistance to Cracking (EOTA TR 013)	At 1.5 mm crack induction, watertight with zero cracking
Resistance to Fatigue Movement (EOTA TR 008)	watertight with zero cracks or debonding after 500 cycle @ -10 °C
Effects of Low Surface Temperature Dynamic Puncture (EOTA TR 006)	6 mm diam. indenter @ 5.9J impact energy
Effects of High Surface Temperature Static Puncture (EOTA TR 007)	+60 °C with load of 200 N
Shear Strength of Support (NF EN 13653)	> 3.40 MPa

- Where the High Performance Waterproofing System is to be applied to existing concrete, all repairs to cracks and delaminated / deteriorated concrete shall be performed and allowed to cure and dry, prior to High Performance Waterproofing System application.

- Treatment of joints and other details shall be in accordance with the applicable METROLINX standard drawings.

- The METROLINX Consultant, Contractor and waterproofing Subcontractor shall jointly review the deck area(s) to which the completed System has been installed. Any irregularities or other items that do not meet the requirements of the METROLINX Consultant shall be addressed at this time.

2. BALLAST MAT SYSTEM

All new railway bridges and pedestrian tunnel structures shall have a Ballast Mat System.

2.1. General Requirements for Ballast Mat System

The Ballast Mat System shall include the following components:

2.1.1. Ballast Mats:

- The preferred Ballast Mat is the Under Ballast Mat Sylodyn® DN 1019 manufactured by Getzner Inc. Alternatives may be considered, provided the proposed alternative is equal to or better than the specified product.

- The material performance of ballast mats shall fulfil the following minimum characteristic and material requirements:

    - Closed cell foamed polyurethane resilient layer for vibration isolation. Resilient layers constructed from bonded granulated elastomeric particles or other non-closed cell products will not be acceptable.

    - Protection layer consisting of geotextile that is bonded to the resilient layer for the purpose of resisting ballast penetration and enabling thermal fusion bonded joints in ballast mats. Ballast mats that do not feature a bonded protection layer commercially endorsed by the Manufacturer will not be acceptable.

    - Thermal fusion bonded protection layer joining strips over joints in ballast mats of the composition and geometry specified by the Manufacturer. Ballast mats that do not feature thermal fusion bonded geotextile joining strips commercially endorsed by the Manufacturer will not be acceptable.

Material properties	Characteristic data	Test method	Note
Specific static stiffness C_{stat} between 0.02 - 0.10 N/mm² between 0.02 - 0.20 N/mm²	0.100 N/mm³ 0.079 N/mm³	DIN 45673-5:2010-08	Evaluation as a secant stiffness (3rd load cycle)
High frequency dynamic stiffening κ_{dyn2} (20 Hz) at preload 0.03 N/mm² κ_{dyn2} (20 Hz) at preload 0.06 N/mm² κ_{dyn2} (20 Hz) at preload 0.10 N/mm²	1.08 1.15 1.06	DIN 45673-5:2010-08	
Mechanical fatigue resistance	passed	DIN 45673-5:2010-08	TU Munich. Report Nr. 1988
Tensile strength of resilient layer (min)	1.7 N/mm²	DIN 53455	
Water admission in per cent by volume Resilient + protection layer protection layer	10 % 67 %	DIN 45673-5:2010-08	

Note: Tolerances within 20% of the values in the above table will be considered acceptable.

2.1.2. Ballast Mat Adhesive:

- Ballast mat adhesive shall be used to bond ballast mats to the waterproofing membrane. The ballast mat adhesive shall be chemically compatible with the High Performance Waterproofing System and shall develop an adhesive bond between the ballast mat elastomer and the waterproofing membrane that exceeds the tensile strength of the elastomer.

- If the proposed waterproofing system is Matacryl RB or LM, and the proposed Ballast Mat System includes the Getzner Sylodyn® ballast mat, then Matacryl RB shall be used as the ballast mat adhesive.

2.1.3. Ballast Mat Joints:

- Fully bonded joints of the protection layer of the Ballast Mat shall be constructed. Joints shall employ protection layer joining strips thermal fusion bonded over joints in ballast mats of the composition and geometry specified by the Manufacture

2.2. The Consultant, Contractor and waterproofing Subcontractor shall jointly review the deck area(s) to which the completed System has been installed. Any irregularities or other items that do not meet the requirements of the Consultant shall be addressed at this time.

3. REFERENCE STANDARDS

- Standard Drawing No. C16 – Waterproofing & Ballast Mat Details at Joints Between Steel Ballast Pans
- Standard Drawing No. C17 – Waterproofing & Ballast Mat Details at Existing (Sound) Concrete.
- Standard Drawing No. C18 – Waterproofing & Ballast Mat Details at Existing (Poor) Concrete.
- Standard Drawing No. C19 – Waterproofing & Ballast Mat Details at Fixed-Fixed Joints.
- OPSS 929 Construction Specification for abrasive blast cleaning – concrete construction
- AREMA Manual for Railway Engineering – Chapter 8: Concrete Structures and Foundations, Part 29: Waterproofing.

--END OF GUIDELINES FOR DESIGN OF WATERPROOFING & BALLAST MAT--

GUIDELINES FOR SHORING WALL DESIGN AND MONITORING

PART 6

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

PART- 6 - GUIDELINES FOR SHORING WALL DESIGN AND MONITORING

PURPOSE AND SCOPE

These guidelines modify and supplement the applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering 2017, Concrete Structures and Foundations, Chapter 8, Part 28. Where there is a conflict between these guidelines and the AREMA Manual sections, the provisions of these guidelines shall apply and supersede the AREMA sections.

The METROLINX Consultant will be responsible to review the submitted shoring system design and to establish the tolerable deflection limits of the shoring system to be considered in the geotechnical instrumentation monitoring plan.

CHAPTER 8 – PART 28

TEMPORARY STRUCTURES FOR CONSTRUCTION – DESIGN OF SHORING SYSTEMS (Chapter 8 - Section 28.5)

1. DESIGN GUIDELINE AND DESIGN PROCEDURE

1.1. Metrolinx guidelines for design and monitoring of shoring walls shall be used for the design and monitoring of any track protection

1.2. Any deviation from the present guidelines shall be reviewed by Rail Corridor Infrastructure–Bridges & Structures prior to construction.

1.3. The shoring Consultant / Contractor shall design and construct the track protection system to resist the design loads applied on all tracks, in accordance with METROLINX standards and AREMA, indicated on the following METROLINX standard drawings;

- F2, Typical Tied-Back Wall Details Shoring Wall
- F3, Typical Tied-Back Wall Notes
- F4, Design Load Diagrams

1.4. The shoring Consultant / Contractor shall consider all stages of excavation.

1.5. The shoring Consultant / Contractor shall provide for review by METROLINX a copy of;

- signed and sealed detailed design calculations and
- signed and sealed proposed shoring wall drawings.

1.6. The shoring Consultant / Contractor design calculations shall clearly identify the interaction between soil and the track protection system, considering the possible passive reaction of soil in case the soil behind the track protection is mobilized due to the pre-stressing of the tiebacks.

1.7. The shoring Consultant / Contractor design calculations shall clearly identify the allowable design bond capacity, ultimate bond capacity between anchors and soil / rock, and applied safety factors.

1.8. The shoring Consultant / Contractor shall consider that while prestressing the anchors, the prestressing shall not load the soil behind the shoring wall more than its available passive resistance (especially for the top row where the passive wedge resistance is limited).

1.9. The shoring Consultant / Contractor design calculations shall include;

- all assumptions,
- detailed design of all structural members,
- estimated lateral displacement of the track protection system, especially at the location of all tie-backs or supports. The lateral displacement of the proposed track protection system shall be estimated for hydrostatic pressure (if any), soil pressure, lateral pressure from live load due to all tracks considering the worst case,
- all input and output files used for analysis and design of the proposed track protection system, both hard copy and electronic format.

2. DESIGN REQUIREMENTS

2.1. METROLINX acceptable line of influence is as follows;

- from the point starting 450 mm (18 in) away from edge of the tie with downward slope of two (2) horizontal to one (1) vertical [2H to 1V].

2.2. Live load forces resulting from track geometry shall be considered in the design of shoring walls or any other structural elements.

2.3. At-Rest pressure coefficients shall be used for the design of shoring walls supporting METROLINX tracks. At-Rest pressure coefficient is to be determined by a qualified Geotechnical Engineer but shall not be less than 0.50.

2.4. For estimation of soil lateral pressure, the triangular soil pressure method shall be used.

2.5. Delete all references to apparent earth pressure in AREMA Chapter 8 - Article -28.5.4.1, Figure 8-28-1. The use of the apparent earth pressure method is not allowed.

2.6. All vertical excavations deeper than 1.4 m (4.5 ft) must be supported by a shoring wall system. Alternative support system may be required for excavation less than 1.4 m (4.5 ft) in depth, in accordance with Ontario Occupational Health and Safety Act.

2.7. Timber lagging design must take into consideration soil and water conditions as well as train surcharge using the Theory of Elastic Analysis.

2.8. If there is risk of groundwater building up behind a lagged wall, or of washing in of soil particles, mitigation measure to control internal erosion shall be implemented;

- to prevent soil collapse before placement of the timber lagging (during the temporary excavation)
- to relieve water pressure while preventing soil erosion (with use of non-woven geotextile or equivalent method).

2.9. The track protection shall be designed for the surcharge due to the Cooper-E80 loading as per AREMA. [i.e. 95.8 kPa (2.00 ksf) – 80 kips axle load, 5 ft. spacing between two consecutive axles. The effect of the strip train live load surcharge calculated with 8 ft tie length can be computed as described in AREMA, Chapter 8 - Article 20.3.2.2.].

2.10. The estimated lateral pressure to the shoring wall due to train loading shall be computed using Boussinesq formula as described in AREMA, Chapter 8 - Article 20.3.2.2., and in accordance with Metrolinx standard drawing F4.

$$\text{Ps} = \frac{2\,q}{\pi}\left(\beta + \sin\beta\ sin^2\,\alpha - \sin\beta\ \ cos^2\,\alpha\right)$$

For α, β, see AREMA Figure 8-20-2 Pressure Distribution for Strip Load.

Where:

$$q\ = \frac{80\ kips}{Axel\ spacing(ft){*}Tie\ length(ft)}$$

Axel spacing = 5 ft.

Tie length = 8 ft.

- No other alternative method of calculation for estimation of lateral pressure to the structural elements due to train load is allowed.

2.11. No reduction factor will be allowed to reduce the computed lateral pressure due to train loading based on Boussinesq formula.

2.12. The effect of E80 train loading on all tracks shall be considered for the estimation of the lateral pressure due to train loading, as described in AREMA Chapter 8 - Article 2.2.3.c.(6).

2.13. For shoring walls that remain as permanent structures, their design shall comply with all METROLINX design guidelines and applicable codes and standards.

2.14. Shoring walls to remain in place permanently shall be identified in contract documents as permanent retaining walls, not shoring walls.

3. LATERAL DISPLACEMENT OF THE SHORING WALL

3.1. The lateral displacement of the shoring wall shall be limited to maximum of 0.1% of the height of the excavated area.

4. GROUND ANCHOR / TIEBACK DESIGN AND TEST

4.1. The distance between the 1st row of tiebacks and the bottom of the rail and/or elevation of the top of excavation (whichever is closer) shall be maximum 1.5 m (5 ft).

4.2. The distance between two rows of tiebacks shall be maximum 3.0 m (10 ft).

4.3. The distance between the lowest row of tiebacks to the bottom of excavation shall be maximum 3.0 m (10 ft).

4.4. The shoring wall model shall be based on nonzero deflections at the point of intersection of shoring piles and tieback anchors.

4.5. The solid bars and strands are the only two acceptable types of tiebacks that can be used for track protection systems. The hollow bars are not allowed to be used as tiebacks for design and construction of shoring walls.

4.6. The design load on the drawings shall match the calculated design load for each row of tiebacks. This has to be done to ensure that excessive tieback force will not be applied to the shoring wall.

4.7. All permanent tiebacks to have triple corrosion protection.

4.7.1. Triple-corrosion protection tiebacks/tie-rods shall be comprised of three mechanisms of corrosion protection which are:

- plastic sheathing,
- cementitious grout within the annular area between tieback/tie-rod and plastic sheathing, and
- Hot-dip galvanization of the tieback/tie-rod.

4.8. The tieback design shall be in accordance with AREMA Chapter 8, Article 20.5.7.a.(2).

- AREMA requires that the allowable stress of the tie-back be calculated to the ½ tensile yield strength of steel.

4.9. The tieback design load shall be specified on the proposed drawings.

4.10. The track elevation, cross level and alignment shall be surveyed accurately before starting the project and then monitored regularly during the tieback load testing.

4.11. The design of the anchorages shall be in accordance with AREMA Chapter 8, Article 20.5.5.d, "Anchorage should never be proportioned for a safety factor less than 2.0".

4.12. Performance bond test(s) (2.0 times the tieback design load) shall be performed to validate the assumed allowable bond stress between the soil/rock and tieback.

- The duration of the portion of the test - as part of the creep test - while holding the load equal to 2.0 times the tieback design load, shall not be less than 30 minutes.
- Special attention shall be taken for the testing of the top anchors in order to avoid track heave for passive wedge failure.
- The loading of the anchor shall be less than the passive resistance behind the wall (toward the tracks).

4.13. Proof test(s) (1.33 times of the tieback design load) shall be performed to validate the proof of actual overall bond capacity between the soil/rock and tieback.

- The duration of the portion of the test - as part of creep test - while holding the load equal to 1.33 times the tieback design load, shall not be less than 30 minutes.

4.14. The maximum movement of the piles toward the soil - at the location of tiebacks - during the stressing of the tieback shall be limited to 5 mm (0.20 in), (towards the soil). If this recorded movement during the tieback stressing exceeds the maximum allowable movement of 5 mm (0.20 in), towards the soil, track elevation and alignment shall be checked. If track disturbance (movement) is recorded, the tieback stressing shall stop and Rail Corridor Infrastructure-Bridges & Structures shall be notified.

4.15. The minimum bond length of the anchorages shall be 4.6 m (15 ft), see METROLINX Standard Drawing F2.

4.16. The maximum bond length of the anchorages should be 10.0 m (33 ft), unless proper method(s) has (have) been considered and implemented to transfer the load equally along the bonded length of tieback from the tieback to the soil / rock, see METROLINX Standard Drawing F2.

4.17. The minimum distance between two tiebacks shall be approximately 3.5 times the diameter of the anchorage, see METROLINX Standard Drawing F2.

4.18. The distance between the line of potential failure surface and the anchor zone shall be minimum 0.15 times of excavated height, see METROLINX Standard Drawing F2.

5. PROOF TEST AND PERFORMANCE TEST OF GROUND ANCHORS / TIEBACKS

5.1. PROOF TEST

5.1.1. The proof test shall be performed by loading the anchor with the following increments of the design load and measuring the anchor movement at the end of each load increment:

5% initial seating load

25%

50%

75%

100%

133% held for creep test

100%

Adjust to specified transfer (lock-in) load, as indicated on the drawings.

5.1.2. Each increment shall be held for a minimum of 2 minutes except the maximum load (200% of design load) shall be held for a minimum of 30 minutes.

5.1.3. Initial seating load increment will not be included in the calculation of elastic movement of the anchor.

5.1.4. The min number of anchors required for performance tasting of 200 % of the design load shall be the max of 2 anchors or 5 % of the total number of anchors for each wall type (i.e. temporary or permanent). However, additional performance testing of anchors may be required by the geotechnical engineer to confirm soil substrate conditions on site. The METROLINX Project Manager will select the anchors to be tested.

5.2. PERFORMANCE TEST

Performance testing of ground anchors/tiebacks shall be in accordance with OPSS 942.

6. TEST ACCEPTANCE CRITERIA

6.1. The acceptance of anchors will be based on three criteria, as follows:

- The total elastic movement of the anchor head obtained from the proof test shall exceed 80% of the theoretical free length elongation for any test load.
- The minimum acceptable movement (D) shall be computed as follows: D = (0.8 PL/AE)

  Where:

  P= total applied test load minus initial seating load

  L= length from jack to the bottom of the free length specified

  A= cross sectional area of steel tendon

  E= Young's modulus of the steel

- The total elastic movement of the anchor head obtained from the test at the maximum test load shall be less than the theoretical elastic elongation of the tendon length measured from the jack to the centre of the bond length.

6.2. The creep movement between 2 and 30 minutes of loading shall not exceed 1 mm (0.04 in) per log cycle of time or the creep movement between 10 and 60 minutes of loading shall not exceed 2 mm (0.08 in) per log cycle of time.

6.3. Replacement Criterion

- An anchor which fails to meet the test acceptance criteria shall have its design load reduced as directed by the METROLINX Project Manager. In evaluating an individual anchor, consideration will be given to the demonstrated capacity of adjacent soil anchors. All such anchors shall be proof tested and creep tested to confirm their revised design load.

- Tie back anchors which do not have sufficient capacity to meet requirements of the work will be rejected by the METROLINX Project Manager and shall be replaced at no cost to METROLINX.

7. TIMBER LAGGING

7.1. The timber lagging shall be species (S-P-F), beams and stringers, grade No. 1 or better, in accordance with AREMA chapter 7.

7.2. The allowable bending stresses shall be 6.5 MPa (960 psi) (including all modification factors).

7.3. The thickness of lagging for shoring walls shall be as follows;

- For the upper 2 m (6.5 ft) – 150 mm (6 in) minimum
- Below 2 m (6.5 ft) to a depth of 4.5 m (14.8 ft) – 200 mm (8 in) minimum

8. DESIGN AND CONSTRUCTION OF TOE OF THE PILES

8.1. A minimum depth of 1.5 times the width of the pile in soil and a depth of 0.3 m (1 ft) in the rock below excavation, shall not been considered in providing passive lateral support, see AREMA Chapter 8 - Article 28.5.3.2.

8.2. To account for soil frost, a minimum depth equal to 1.2 m (4 ft) or local frost depth, whichever is greater, shall not be considered in providing passive lateral support to the soldier piles.

8.3. For calculation of the depth of embedment, the passive resistance shall include a factor of safety of 1.5 and be reduced by multiplying kp by 0.66, AREMA Chapter 8 - Article 28.5.1.2.

8.4. In general, it is preferable that the minimum embedded length of the pile into soil be 3.05 m (10 ft), and 1.8 m (6 ft) into sound rock.

8.5. No skin friction, acting between the back of the pile and soil from top of the wall to 1.5 m below the bottom of the excavation, shall be considered for the design of the shoring wall.

8.6. No increase of kp shall be applied due to assumed skin friction between the back of the pile and soil.

8.7. It is required to establish vertical loads imposed on the pile from the tieback anchors without using any reduction for skin friction or adhesion from the soil behind the wall, (both between the soil-tieback, and soil-pile).

8.8. The concrete used for the soldier piles shall have a minimum compressive strength of 30 MPa (4,350 psi) below the dredge line (from an elevation of the bottom of the excavation to the bottom elevation of the pile).

9. DRAWINGS

The shoring wall system shall be designed, signed and sealed by a Professional Engineer registered in the Province of Ontario.

9.1. The following items shall be written on the drawings:

- The total amount of force applied to the one-meter width of the shoring wall for the entire excavated height, due to soil lateral pressure (triangular shape) applied to the wall, in kN/m unit.
- The total amount of force applied to the one-meter width of the shoring wall for the entire excavated height, due to hydrostatic pressure or any other load, in kN / (m width of the wall) unit.
- The total amount of force applied to the one-meter width of the shoring wall for the entire excavated height, due to train load, using Boussinesq method as described in AREMA Chapter 8 - Article 20.3.2.2., on each individual track, in kN / (m width of the wall).
- Total lateral force due to E-80 on track #1 = ### kN / (m width of wall).
- Total lateral force due to E-80 on track #2 = ### kN / (m width of wall).
- Total lateral force due to E-80 on track #3 = ### kN / (m width of wall).
- The total design load applied to each individual tie back.
- The tie-back (thread-bars or strands) size, diameter, number of thread-bars / strands, grade, etc.
- The total bonded length of the tie-backs.
- If the tie-back is anchored in rock, the bounded part of the tie-back, shall be started one meter (in the vertical direction) below the actual elevation of rock.
- The total un-bonded length of tie-backs.
- To illustrate bore hole information at the location of drilling and also illustrate inferred subsurface soil stratigraphy on all section and longitudinal profile.

10. SECANT PILE / CAISSON WALLS

10.1. The lean concrete used in filler caissons shall have the minimum compressive strength of 6.0 MPa (870 psi), prior to the commencement of excavation.

10.2. Removal (shaving off) of lean concrete from the filler caissons will not be allowed. Other techniques to eliminate the concrete removal (shaving off) of filler caissons will be allowed, such as,

a) setting back the centre line of the filler caissons axis verses the centerline of king pile axis, or

b) increasing the diameter of the filler caissons,

10.3. If the concrete removal (shaving off) of the front portion of king pile caissons is absolutely necessary, the loss of concrete at the front face of the king piles shall be taken into account during the calculations of the shoring wall. This must be demonstrated in the details and submitted detailed calculation design.

10.4. The concrete used for the king piles shall have a minimum compressive strength of 30 MPa (4350 psi) for the full length of the pile (from an elevation of the tip of pile all the way to the elevation of the top of the pile).

- If the elevation of the top of the pile is higher than the elevation of the bottom of the rail, the 30 MPa (4350 psi) concrete may be terminated at the bottom of rail elevation.

10.5. The maximum spacing between the centerline of king piles shall be limited to 2.0 m (6.5 ft).

10.6. The maximum clear spacing between the concrete portion of the king piles shall be limited to 1.0 m (39 in).

10.7. No skin friction, acting between back of the filler / king pile caisson and soil from the top of the wall to 1.5 m below the bottom of the excavation, shall be considered for the design of the caisson shoring wall.

10.8. The calculation of the vertical loads imposed on the pile from the tieback anchors shall not include any reduction for skin friction or adhesion from the soil behind the wall (both between the soil & tieback, and soil & caisson).

11. MICROPILES AND SOIL NAILS

11.1. Micropiles and soil nails may only be used as part of a shoring system, subject to acceptance by Rail Corridor Infrastructure-Bridges & Structures.

12. SHORING MONITORING

12.1. The shoring wall monitoring plan, which is part of the Geotechnical Instrument Monitoring Plan (GIMP), shall be designed, signed and sealed by a Geotechnical Professional Engineer registered in the Province of Ontario.

12.2. The Contractor shall provide a monitoring procedure to the satisfaction of Rail Corridor Infrastructure-Bridges and Structures. The monitoring shall be carried out during construction of the temporary shoring wall and must be continued up to the removal of the temporary shoring wall.

12.3. The Contractor shall submit the monitoring results to the METROLINX Consultant for review.

12.4. The monitoring plan shall include all tracks and the shoring wall.

12.5. No open excavation shall be left without visual inspection during long periods of time, i.e., holidays, etc.

12.6. The monitoring instrumentation reading interval shall be daily from the first day of shoring wall installation until such time the excavated area is backfilled, or the shoring wall is removed. This duration includes;

- during shoring wall installation,
- during excavation,
- at all times when the excavation is in an open condition, and the shoring wall is under load,
- during all stages of the work and,
- until all the shoring wall is removed or excavated area is backfilled.

12.7. The monitoring plan of the shoring wall shall include a formal procedure for visual inspection, monitoring instrumentation reading, the number of targets and location of the targets at pile locations, as well as all other monitoring instruments / equipment.

12.8. Visual inspection is an important tool for monitoring track(s) and shoring walls. If the track shifts, or deflects, visual inspection will be an effective tool to prevent any track safety related incident.

12.9. Daily visual monitoring of the ground behind the shoring wall shall be performed. If any crack within or up-ward movement of, the soil is/are observed, the following shall be immediately reported to the METROLINX Project Manager;

a) site information, location,

b) width and length of the crack and its/their location(s), and

c) length and height of heave.

12.10. Daily visual and surveyed monitoring of the track(s) behind the shoring wall shall be performed. If any upward, downward or lateral movement of track is/are observed, the following shall be immediately reported to the METROLINX Project Manager;

a) site information, location,

b) location of track(s) movement, and

c) length of the track(s) movement.

12.11. Targets shall be placed on a minimum of one-third of the piles.

12.12. It is required that monitoring targets shall be placed:

a) At the top of the selected pile(s),

b) At the level of all tiebacks on each selected pile(s),

c) At a mid-point between two consecutive levels of tie backs.

12.13. If there is only one row of tieback on the selected pile, it is required to have two targets on the pile, one at the tieback level and the second one at the mid-point between the dredge line and the tieback.

12.14. It is required to monitor the track(s) as well as shoring wall piles.

12.15. For surface monitoring of tracks, the maximum spacing between the targets on each rail of each track shall be 4.0 m (13 ft).

12.16. For filler caisson monitoring, the most important tool for monitoring shoring wall is inclinometers. It is required to install a series of inclinometers equally spaced along each segment of shoring wall. For each wall segment, the total number of inclinometers at filler piles shall be equal to 25 % of total number of king piles. For short walls, less than 15 m in length, a minimum of three (3) inclinometers for the whole length of the shoring wall shall be required.

12.17. All inclinometers shall be installed such that initial readings can be obtained a minimum of one week prior to first drilling for installation of the shoring wall.

12.18. Inclinometer reading interval shall be daily from the first day of shoring wall installation, during shoring wall installation, during structure excavation, and at all times when the excavation is in an open condition and the shoring wall is under load, during all stages of the work and until all the shoring wall is removed.

12.19. The only acceptable location of inclinometer is in the filler caisson, along the centreline of the filler-pile at the back face of shoring wall furthest from the open excavation.

12.20. The location of each inclinometer shall be clearly shown, with respect to filler caissons and the king piles.

12.21. The slope inclinometer(s) must be protected by steel casing at least 300 mm (12 in) above the ground and 1.0 m (39 in) below the ground.

12.22. The threshold of the lateral displacement, 0.1% of the excavated height, must be shown on the required graph(s).

12.23. The monitoring report shall clearly show:

- The actual collected data (date, target #, pile #, northing, easting, elevation, actual lateral and vertical movements, etc.
- A graphical representation of the lateral displacement of targets placed along the selected piles, the unit shall be in milimetre, mm.

12.24. It is required to have one graph for each row of tie-backs, along lthe shoring wall.

13. GROUND AND TRACK MOVEMENT MONITORING

The minimum requirements for the ground movement monitoring of any work in the vicinity of METROLINX Right of Way (ROW) is as follows:

13.1. The ground movement (settlement/ heave) monitoring must be performed by a qualified and competent 'third party'. In-ground monitoring points shall have florescent markers with blunt tops to protect track workers from injury.

13.2. The ground movement (settlement/ heave) monitoring plan, which is part of the Geotechnical Instrument Monitoring Plan (GIMP), shall be stamped, signed and dated by a Geotechnical Professional Engineer registered in the Province of Ontario.

13.3. Rail surface monitoring points shall be installed on the webs of each rail at 4.0 m (13 ft) intervals for at least 12.0 m (40 ft) on either side of the proposed works.

13.4. In-ground monitoring points shall be installed along the tracks at 4.0 m (13 ft) intervals for at least 12.0 m (40 ft) on either side of the proposed works, on both sides (approximately 150 mm (6.0 in) from outside edge of the tie and equally spaced - if more than one track, the points can be installed along the centerline of each track. In-ground rods shall extend 1.2 m below ground surface.

13.5. For casing/utility crossing under tracks, deep in-ground movement monitoring points shall be installed along the alignment of the proposed casing placement / utility within the Right of Way (ROW) (maximum of 4.0 m (13 ft)) intervals and approximately at a depth of 1.0 m (39 in) above the proposed utility alignment).

13.6. For jack-and-bore, HDD, MHDD and tunneling work; monitor tracks with in-ground monitoring instruments and rail surface monitoring points at 2.0 m center to center. In-ground monitoring points shall be installed along the alignments of jack-and-bore, HDD, MHDD and tunnels at 2.0 m centre to centre. The in-ground rods shall extend to a depth of 1.0 m (39 in) above the proposed alignment.

- HDD denotes Horizontal Directional Drilling
- MHDD denotes Micro Horizontal Directional Drilling

13.7. A reference drawing showing location and general arrangement of the ground movement monitoring points is required for review and acceptance.

13.8. The baseline should be established by taking three (3) readings prior to construction, taken on three (3) separate days.

13.9. For monitoring of railway track(s), the 'Alert Levels' with its associated actions to be taken are as follows:

Class of Track	Allowable Limits (mm)		Review Limits (mm)		Alarm Limits (mm)	
	Horiz.	Elev.	Horiz.	Elev.	Horiz.	Elev.
1 / yard 2	0 – 10	0 - 12	10 - 1	12 - 20	>15	>20
3 4 5	0 – 4	0 - 4	4 - 9	4 - 12	>9	>12

- Allowable Limit: Review the available data and provide comments on any potential ground movement concerns and implications to railway operations. The ground movement monitoring reports shall be forwarded to GO Transit / Metrolinx/ their representatives within 24 hours of readings.

- Review Limit: Immediately notify all parties involved. Monitoring frequency shall be increased to determine if any additional ground movement is occurring. Monitoring frequency shall remain increased until there is stabilization of the ground movement. The Contractor shall plan for remedial track works within 7 days. The work may continue.

- Alarm Limit: Immediately notify all parties involved. The work will immediately cease until an assessment of the observed ground movement is conducted and inspected by a qualified and competent Geotechnical Engineer. The Contractor shall arrange for immediate repairs to the track. The findings with a proposed action plan will be reviewed by GO Transit / Metrolinx.

13.10. The METROLINX Project Manager shall be copied on all correspondence regarding the readings taken for ground movement monitoring within 24 hours of readings. The METROLINX Project Manager and the flag person on duty shall be notified immediately if any erratic ground movement is observed. If required, Rail Corridor Infrastructure Track and Structures will request emergency protection, to ensure the safety of rail traffic.

13.11. Ground Movement Visual Monitoring shall be performed a minimum of twice daily (i.e. before morning rush hour trains and prior to afternoon rush hour trains) during construction/boring/tunneling activities and when excavation is in an open condition.

13.12. Track movement monitoring, via surveying of in-ground monitoring points and rail surface monitoring points, shall be performed once a day during construction/boring/tunneling activities and when excavation is in an open condition.

13.13. After work has been completed, a set of readings shall be taken at each ground movement monitoring point for:

- once a day for 14 days,
- then twice weekly for the next 30 days (i.e. month),
- then once monthly for the three months,
- the above frequency may change depending on site condition(s).

14. GENERAL

14.1. Wash-boring (or wet-drilling) method is not allowed to be performed for drilling tie-backs under METROLINX tracks.

14.2. METROLINX does not accept "pile splicing" of any shoring pile. However, if due to the excessive length of piles, and pile splicing is absolutely necessary, pile splices shall be designed to develop the full capacity of the pile.

14.3. All tie backs shall be de-stressed during the backfill.

--END OF GUIDELINES FOR DESIGN AND MONITORING OF SHORING WALLS--

APPENDIX A

STANDARD DRAWINGS

RAIL CORRIDOR INFRASTRUCTURE
METROLINX
Toronto, Ontario

Nov 15, 2018 REV. 1.1

APPENDIX A

STANDARD DRAWINGS – IMPERIAL

Dwg. No.	Rev.	Description
C1i	-	Cancelled
C2i	-	Cast-in-Place Concrete Bridge Deck Details
C3i	-	Cancelled
C4i	-	Cancelled
C5i	-	Cancelled
C6i	-	Refuge Bays
C7i	-	Standard Bar List & Bar Shapes
C9i-1&2	-	Bronze Bearings - Example of an Expansion Bearing for a Concrete Span Bridge (2 Sheets)
C10i	-	Concrete Slab - Joint Details
C11i	-	Cancelled
C12i	-	Cancelled
C15i	-	Railway Bridge Approach Slab
C16i	-	Waterproofing & Ballast Mat Details at Joints between Steel Ballast Pans
C17i	-	Waterproofing & Ballast Mat Details at Existing (Sound) Concrete
C18i	-	Waterproofing & Ballast Mat Details at Existing (Poor) Concrete
C19i	-	Waterproofing & Ballast Mat Details at Fixed-Fixed Bearings
F1i	-	Example of Typical Temporary Shoring Wall
F2i	-	Typical Tied-Back Wall Details, Shoring Wall
F3i	-	Typical Tied-Back Wall Notes, Shoring Wall
F4i	-	Temporary Shoring Wall Design Load Diagrams
K1U-10.1i	-	METROLINX Standard Clearance Diagram for All New Railway Bridges
K1U-10.2i	-	Protection and Minimum Clearances for Overhead Bridges
K1U-10.3i	-	Protection Wall Requirements for Reinforced Earth (or Equiv.) Walls for Overhead Bridges
K1U-10.4i	-	Clearance Diagram Requirements for Prefabricated Tunnels

STANDARD DRAWINGS - IMPERIAL (cont'd)

Dwg. No.	Rev.	Description
S1i	-	Submerged Arc Welded Joints for Flanges, Webs, Stiffeners and Gusset Plates
S2i	-	Stiffeners
S3i	-	Anchor bolt
S4i	-	Floor Beam Connections
S5i	-	Stringer to Floor Beam Connection Open Deck Only
S6i	-	Beam Copes
S7i	-	Lateral Bracing for DPG Spans
S8i	-	Attachment of Deck Plate by Bolting in Shop or Field
S9i	-	Type H-3 Saddle Clip for 38-H-4 Heavy Duty Grating
S10i	-	Attachment of Deck Plate by Bolting in Shop or Field
S12i	-	HP 12 & 14 Pile Splice
S13i	-	Tubular Pile Splice
S14i	-	HP 12 & 14 Pile Splice Detail For Driving Through Template
S15i	-	Standard Bearings for DPG & TPG Steel Spans (Sheet 1)
S16i	-	Standard Bearings for DPG & TPG Steel Spans (Sheet 2)
S17i	-	Steel Trestle - Bearings
S18i	-	Typical Notes for Steel Spans
S19i	-	Template for Pile Driving
S20i	-	Metallizing Area for Beam Spans, DPG & TPG Spans
R7A-80.1i-1&2	-	Corrugated Steel Pipe (CSP) and Structural Plate Corrugated Steel Pipe (SPCSP) Culverts (2 Sheets)
R9A-1.6i-1,2&3	-	Timber Open Deck for Steel Bridges, System "A" (3 Sheets)
R9A-1.7i-1,2&3	-	Timber Open Deck for Steel Bridges, System "B" (3 Sheets)
R1S-1i	-	Standard Instruction for Dating Concrete Structures
TD-05-Li	-	Location for Bridge Name Plate

APPENDIX A

STANDARD DRAWINGS – METRIC

Dwg. No.	Rev.	Description
C1m	-	Cancelled
C2m	-	Cast-in-Place Concrete Bridge Deck Details
C3m	-	Cancelled
C4m	-	Cancelled
C5m	-	Cancelled
C6m	-	Refuge Bays
C7m	-	Standard Bar List & Bar Shapes
C9m-1&2	-	Bronze Bearings - Example of an Expansion Bearing for a Concrete Span Bridge (2 Sheets)
C10m	-	Concrete Slab - Joint Details
C11m	-	Cancelled
C12m	-	Cancelled
C15m	-	Railway Bridge Approach Slab
C16m	-	Waterproofing & Ballast Mat Details at Joint between Steel Ballast Pans
C17m	-	Waterproofing & Ballast Mat Details at Existing (Sound) Concrete
C18m	-	Waterproofing & Ballast Mat Details at Existing (Poor) Concrete
C19m	-	Waterproofing & Ballast Mat Details at Fixed-Fixed Bearings
F1m	-	Example of Typical Temporary Shoring Wall
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F3m	-	Typical Tied-Back Wall Notes, Shoring Wall
F4m	-	Temporary Shoring Wall Design Load Diagrams
K1U-10.1m	-	METROLINX Standard Clearance Diagram for All New Railway Bridges
K1U-10.2m	-	Protection and Minimum Clearances for Overhead Bridges
K1U-10.3m	-	Protection Wall Requirements for Reinforced Earth (or Equiv.) Walls for Overhead Bridges
K1U-10.4m	-	Clearance Diagram Requirements for Prefabricated Tunnels

STANDARD DRAWINGS – METRIC (cont'd)

Dwg. No.	Rev.	Description
S1m	-	Submerged Arc Welded Joints for Flanges, Webs, Stiffeners and Gusset Plates
S2m	-	Stiffeners
S3m	-	Anchor Bolt
S4m	-	Floor Beam Connections
S5m	-	Stringer to Floor Beam Connection Open Deck Only
S6m	-	Beam Copes
S7m	-	Lateral Bracing for DPG Spans
S8m	-	Attachment of Deck Plate by Bolting in Shop or Field
S9m	-	Type H-3 Saddle Clip for 38-H-4 Heavy Duty Grating
S10m	-	Attachment of Deck Plate by Bolting in Shop or Field
S12m	-	HP 310 & 360 Pile Splice
S13m	-	Tubular Pile Splice
S14m	-	HP 310 & 360 Pile Splice Detail For Driving Through Template
S15m	-	Standard Bearings for DPG & TPG Steel Spans (Sheet 1)
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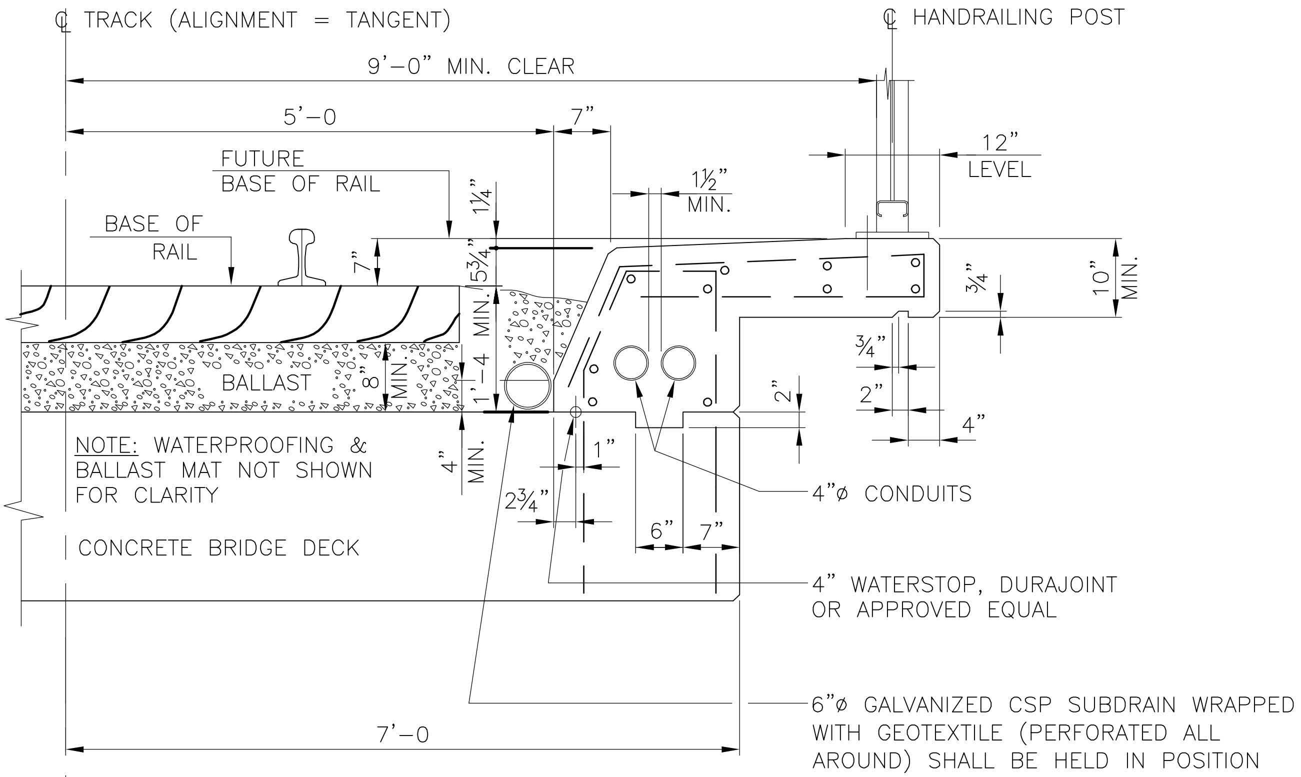
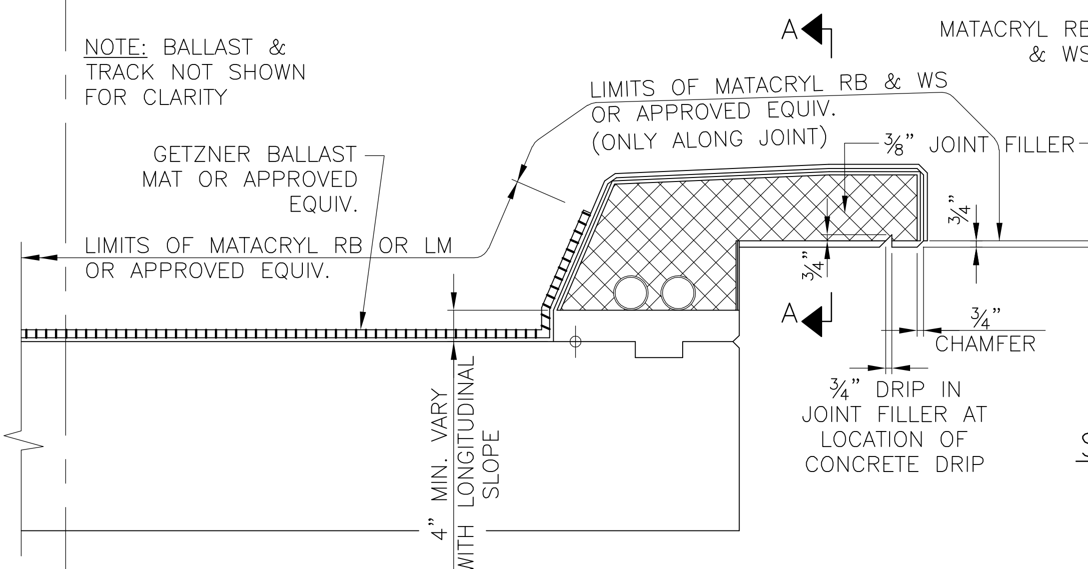
S18m	-	Typical Notes for Steel Spans
S19m	-	Template for Pile Driving
S20m	-	Metallizing Area for Beam Spans, DPG & TPG Spans
R7A-80.2m-1&2	-	Corrugated Steel Pipe (CSP) and Structural Plate Corrugated Steel Pipe (SPCSP) Culverts (2 Sheets)
R1S-1m	-	Standard Instruction for Dating Concrete Structures
TD-05-Lm	-	Location for Bridge Name Plate

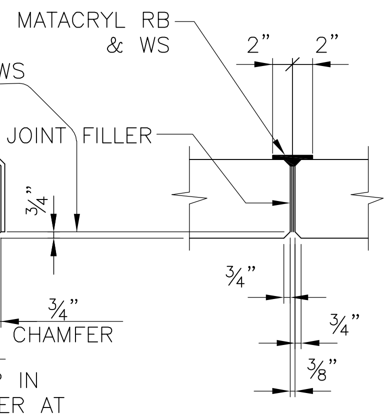
NOTES



PARTIAL DECK SECTION



PARTIAL DECK WITH
WATERPROOFING AT JOINT



SECTION A–A

LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE
WS = WEARING SURFACE

NOTES:

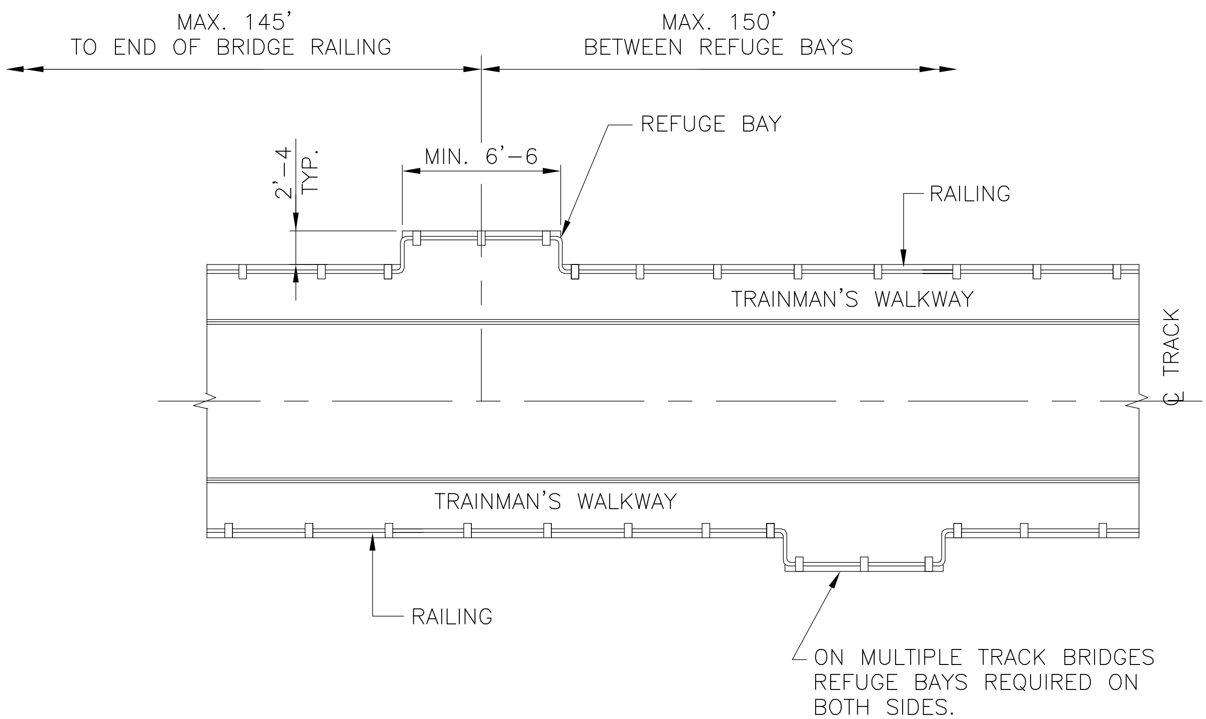
- SPACING OF TRANSVERSE JOINTS IN CURB SHALL NOT EXCEED 11'–6
- LONGITUDINAL SLOPE OF 0.5% MIN.
- FOR TRANSVERSE SLOPE (SEE METROLINX GENERAL GUIDELINES FOR RAILWAY BRIDGES & STRUCTURES)

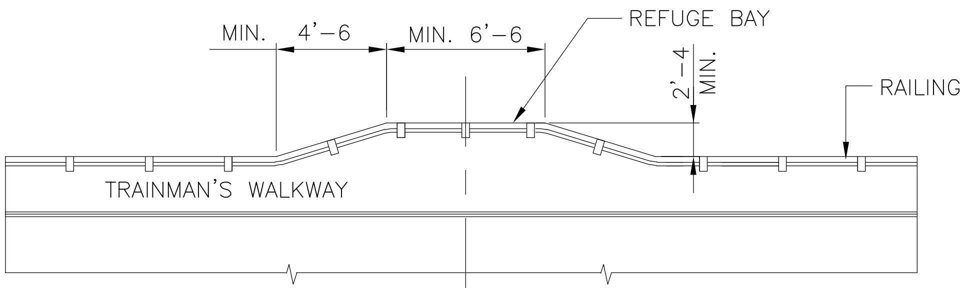
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CAST-IN-PLACE CONCRETE BRIDGE DECK DETAILS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
C2i

–





ALTERNATIVE TYPE OF REFUGE BAY

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**REFUGE BAYS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

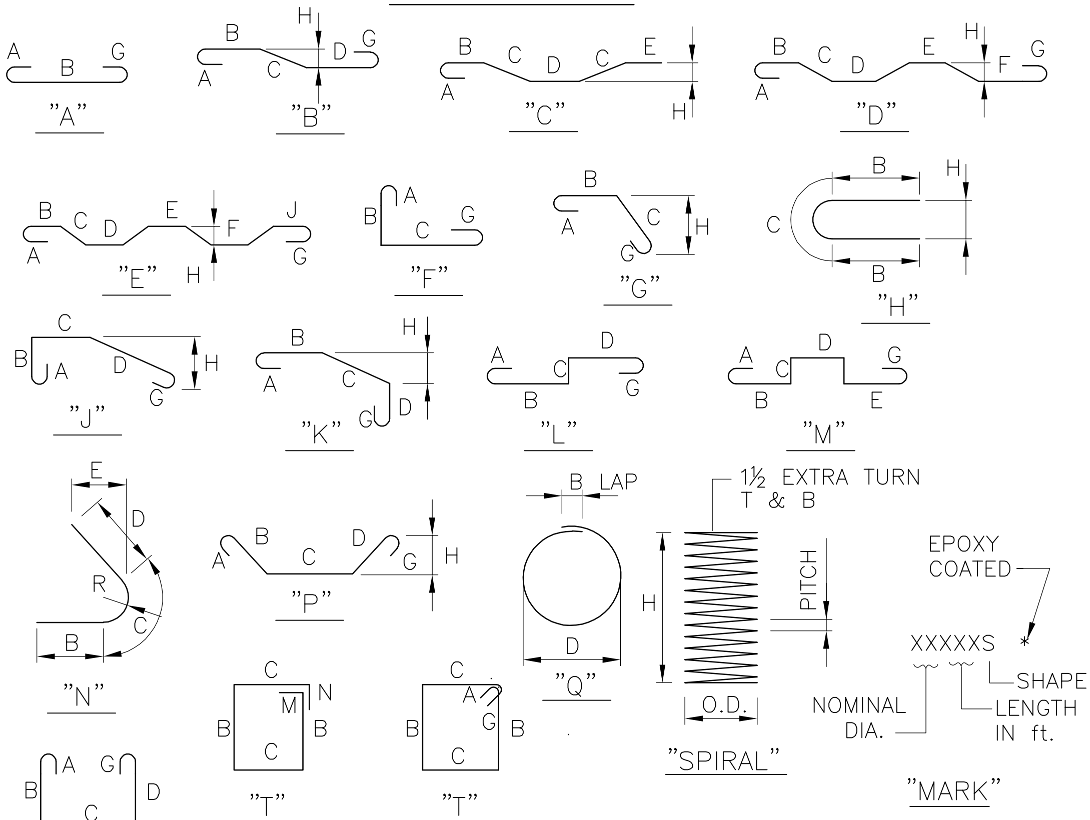
METROLINX

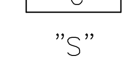
Drawing Number
Dessin Numero
C6i
–

BAR LIST EXAMPLE

QTY.	SIZE	MARK	LENGTH	A	B	C	D	E	F	G	H	R
50	#5	D5001C	16'–0	0'–8	2'–0	0'–11	6'–6	4'–4			0'–8	

BAR SHAPES





NOTE:

- ALL DIMENSIONS ARE OUT TO OUT BARS
- ALL BAR SHAPES CAN ALSO BE WITHOUT HOOKS
- LETTERS "U" "V" ETC. CAN BE USED FOR NON STANDARD SHAPES.

BAR MARK EXAMPLE

D 5 01 C

IDENTIFICATION — SIZE — NUMBER — SHAPE

A – ABUTMENT
B – BENT
F – FOOTING
P – PIER
R – RIGID FRAME
W – WALL
D – DECK
S – SPAN

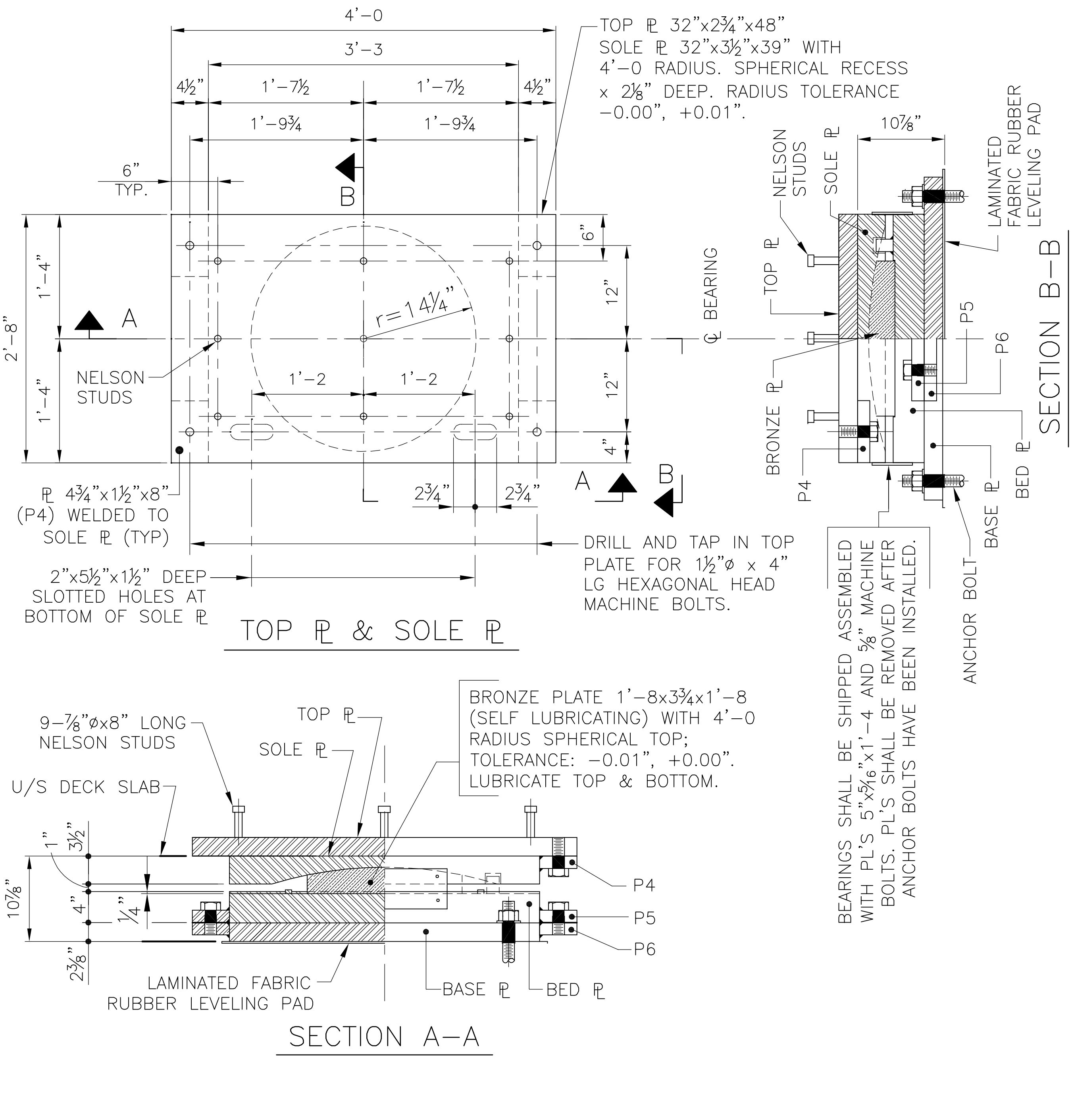
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**STANDARD BAR LIST & BAR SHAPES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero

C7i

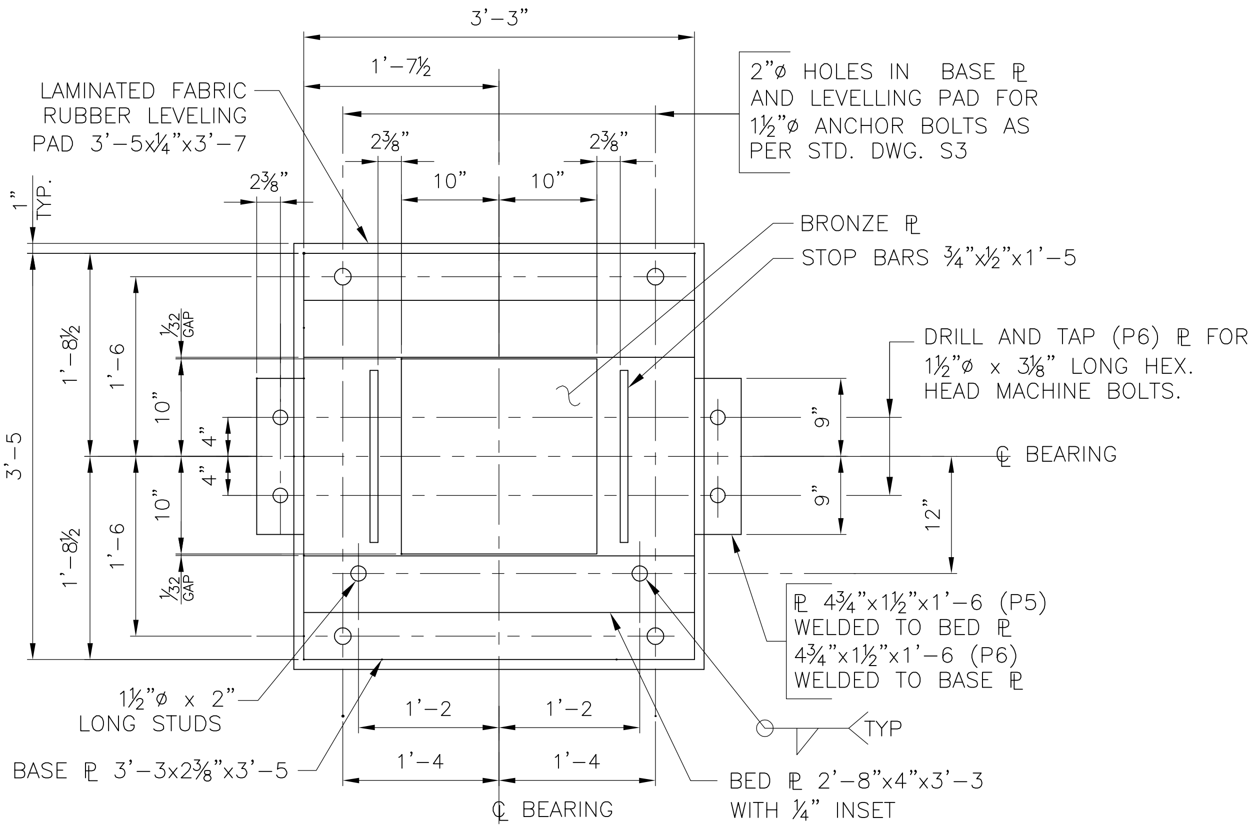
–



Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BRONZE BEARINGS - EXAMPLE OF AN EXPANSION BEARING FOR A CONCRETE SPAN BRIDGE** SHEET 1 OF 2
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **C9i-1** –

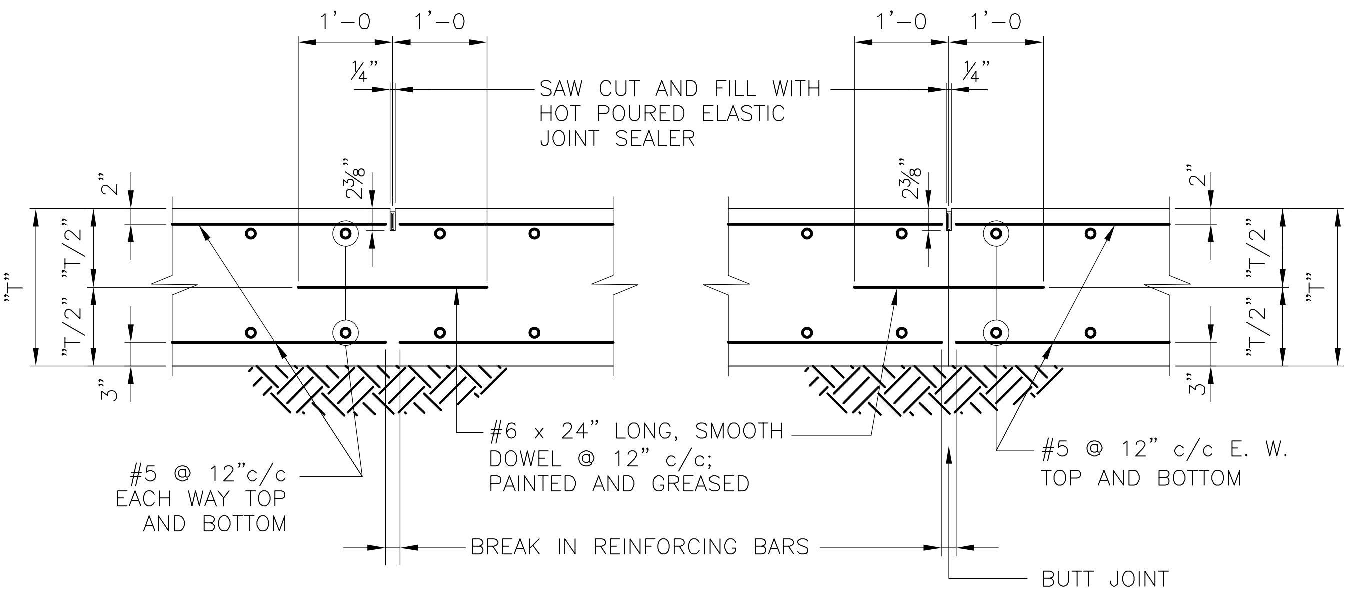


BED ℙ & BASE ℙ

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BRONZE BEARINGS - EXAMPLE OF AN EXPANSION BEARING FOR A CONCRETE SPAN BRIDGE** SHEET 2 OF 2
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **C9i-2** –

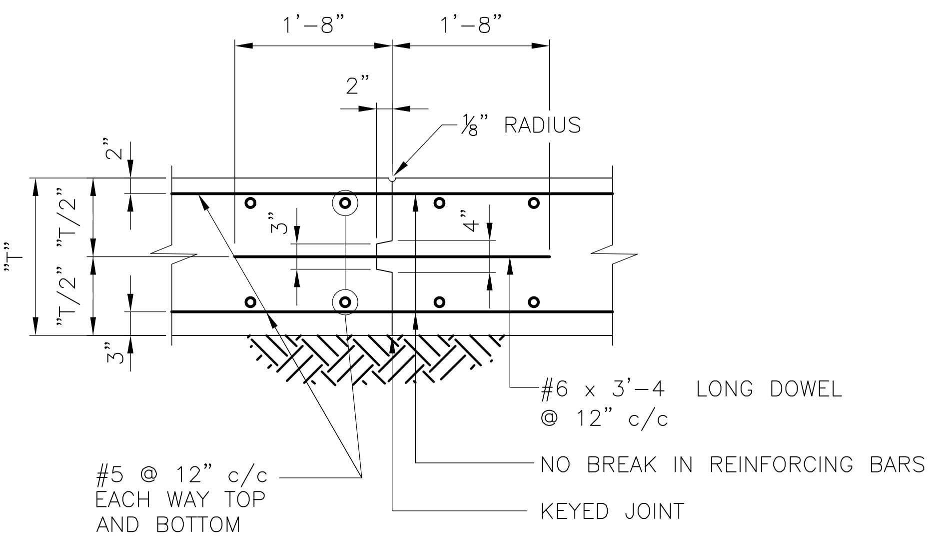


CONTROL JOINT

@ 20'–0 c/c

CONSTRUCTION JOINT

IF IT OCCURS AT CONTROL JOINTS



CONSTRUCTION JOINT

IF IT OCCURS IN MIDDLE THIRD
OF NORMAL JOINT INTERVAL

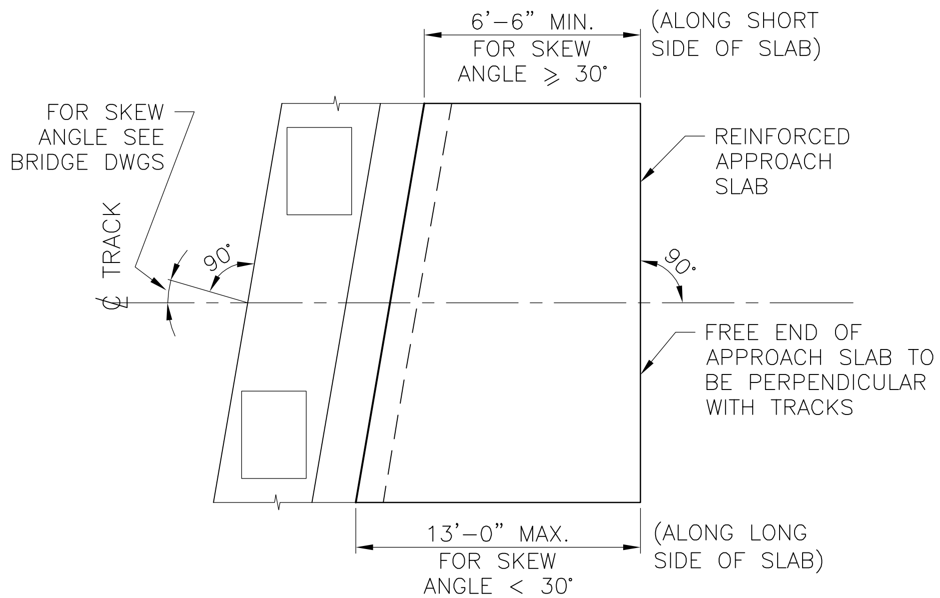
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CONCRETE SLAB - JOINT DETAILS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

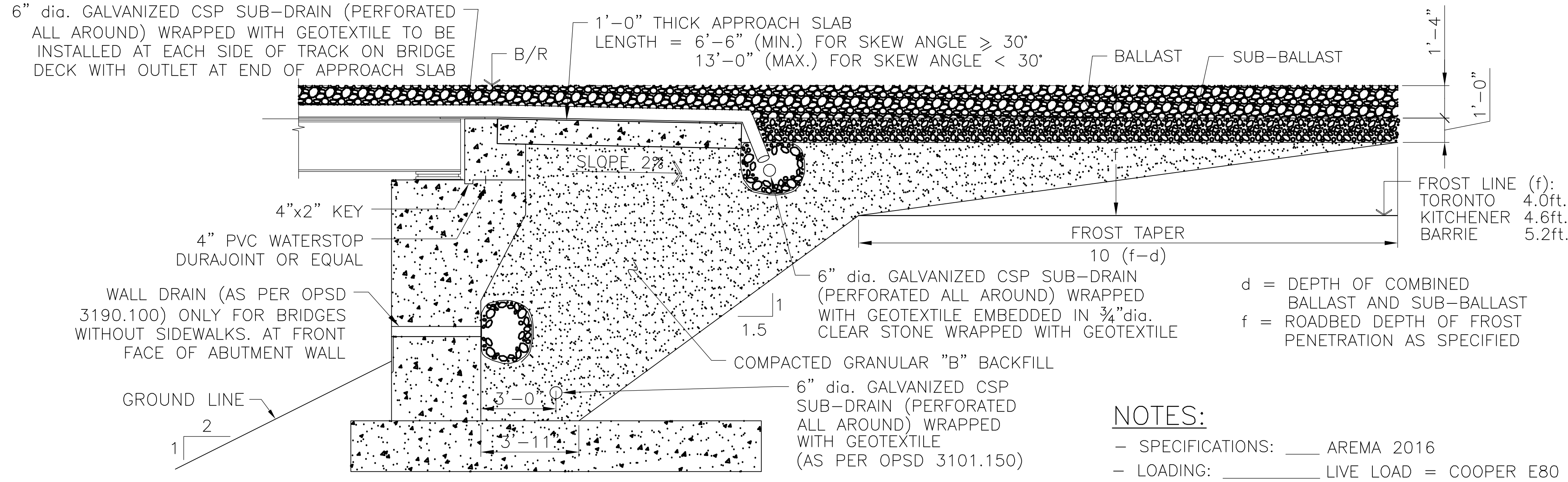
Drawing Number
Dessin Numero

C10i

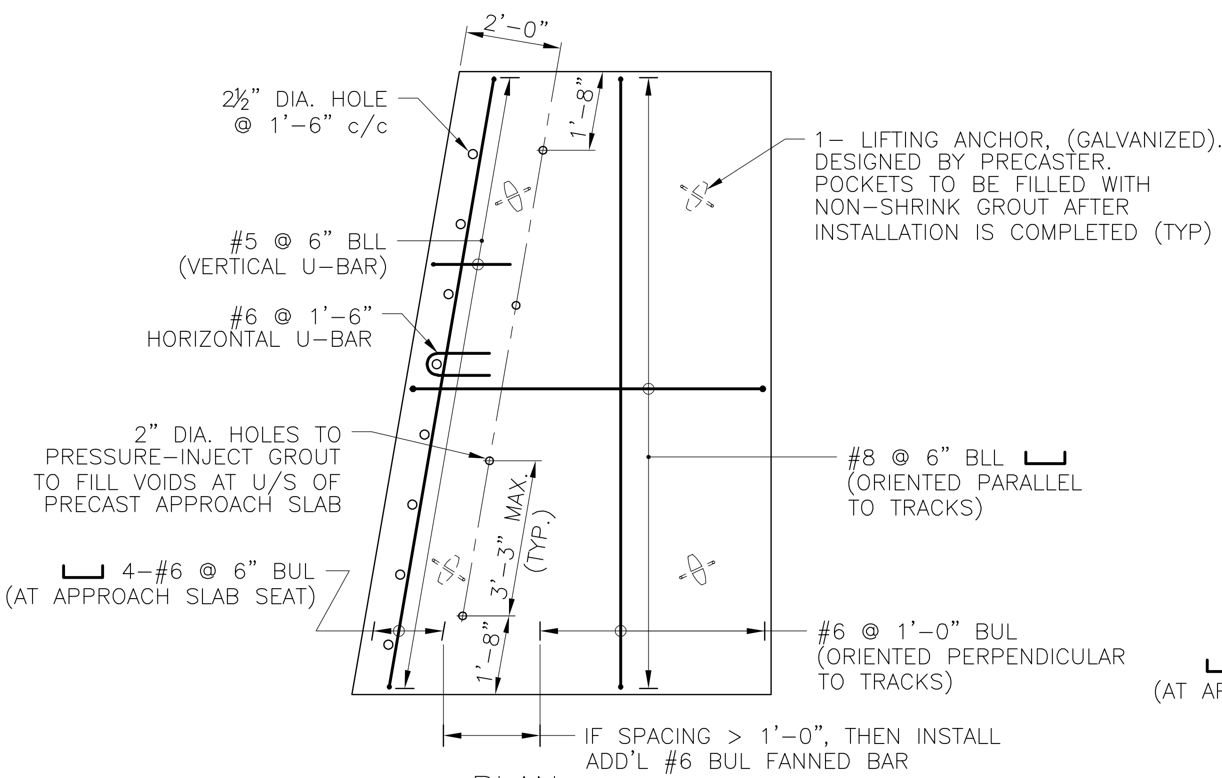
–



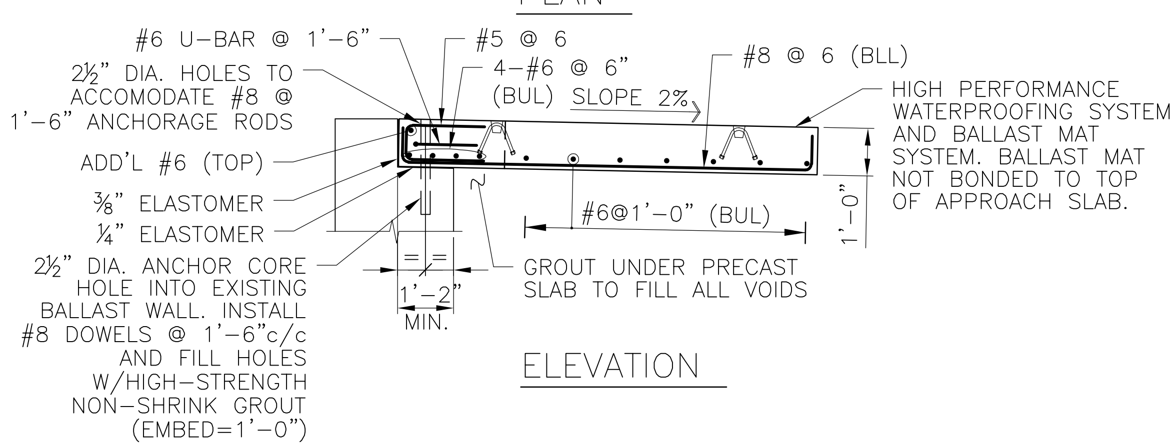
PLAN



MIN. GRANULAR BACKFILL REQUIREMENTS

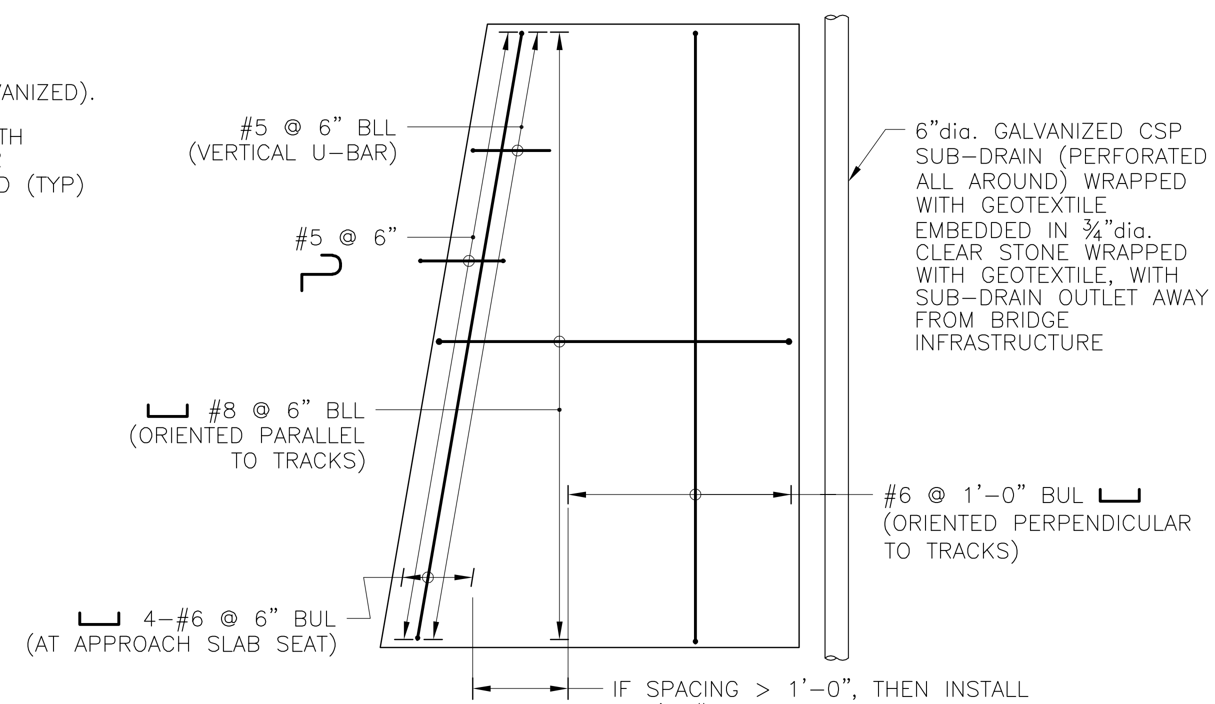


PLAN

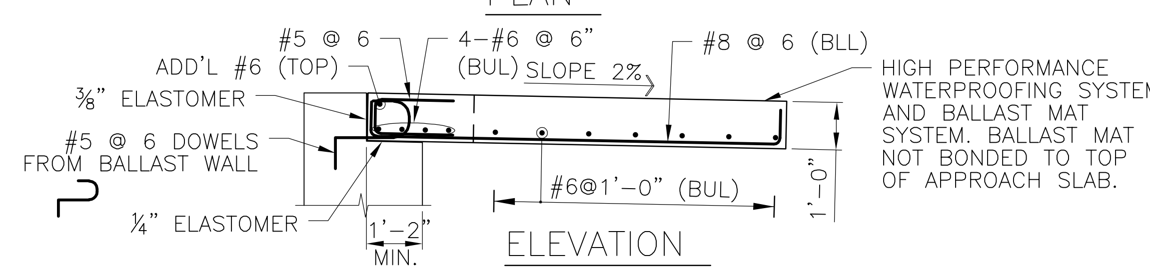


ELEVATION

PRECAST APPROACH SLAB – DETAILS



PLAN



ELEVATION

CAST–IN–PLACE APPROACH SLAB – DETAILS

NOTES:

- SPECIFICATIONS: AREMA 2016
- LOADING: LIVE LOAD = COOPER E80
- CONCRETE: SHALL BE CLASS C–1 5,000PSI @ 28 DAYS
- CONVENTIONAL REINFORCING: SHALL BE NEW BILLET STEEL GRADE 400MPa, MEETING THE REQUIREMENTS OF CSA STANDARD CAN/CSA–G30.18
- GALVANIZING: ASTM A123
- HIGH PERFORMANCE WATERPROOFING SYSTEM: MATACRYL RB, OR APPROVED EQUIVALENT.
- BALLAST MAT SYSTEM: GETZNER SYLODYN DN 1019, OR APPROVED EQUIVALENT.
- ALL EXPOSED CONCRETE EDGES SHALL BE GIVEN ¾x¾ CHAMFERS; ALL DIMENSIONS ARE TO UNCHAMFERED EDGES.
- TOP SURFACE OF APPROACH SLAB SHALL BE WATERPROOFED.
- GROUT SHALL BE SIKA 123 HIGH–STRENGTH NON–SHRINK GROUT OR APPROVED EQUIVALENT.
- MIN. CONCRETE COVER TO REINFORCEMENT:
  - PRECAST: 1½" ±⅜"
  - CAST–IN–PLACE: 2" ±1¼"

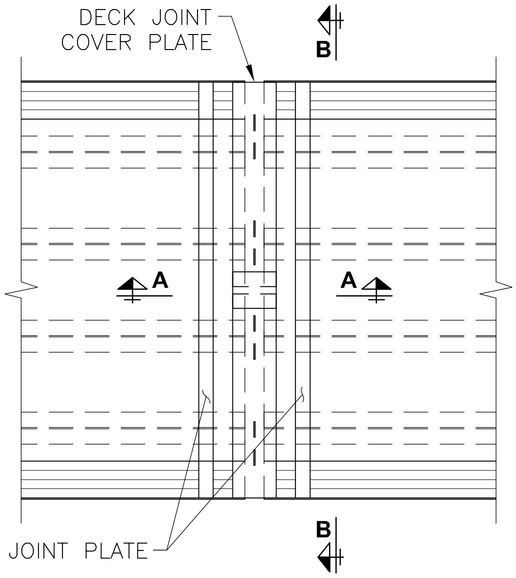
APPLICABLE STANDARD DRAWINGS:

OPSD 3101.150	WALLS – ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD 3190.100	WALLS – RETAINING AND ABUTMENT, WALL DRAIN

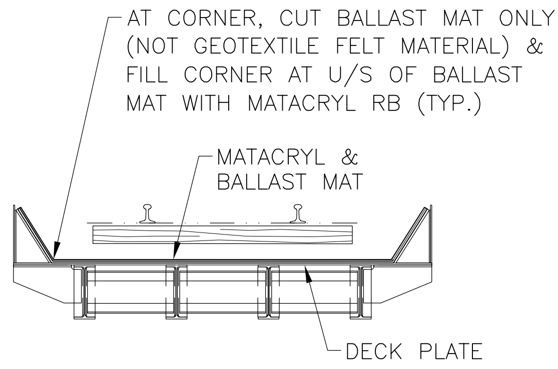
LIST OF ABBREVIATION:

BLL – BOTTOM LOWER LAYER
BUL – BOTTOM UPPER LAYER
ADD'L – ADDITIONAL
TYP – TYPICAL

Drawn: Dessin: T.Z.	Checked: Verification: S.Kh.	RAILWAY BRIDGE APPROACH SLAB
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero C15i

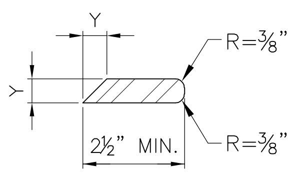


STEEL BALLAST PAN PLAN VIEW

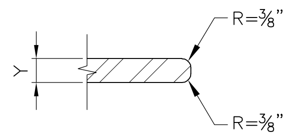


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 1"

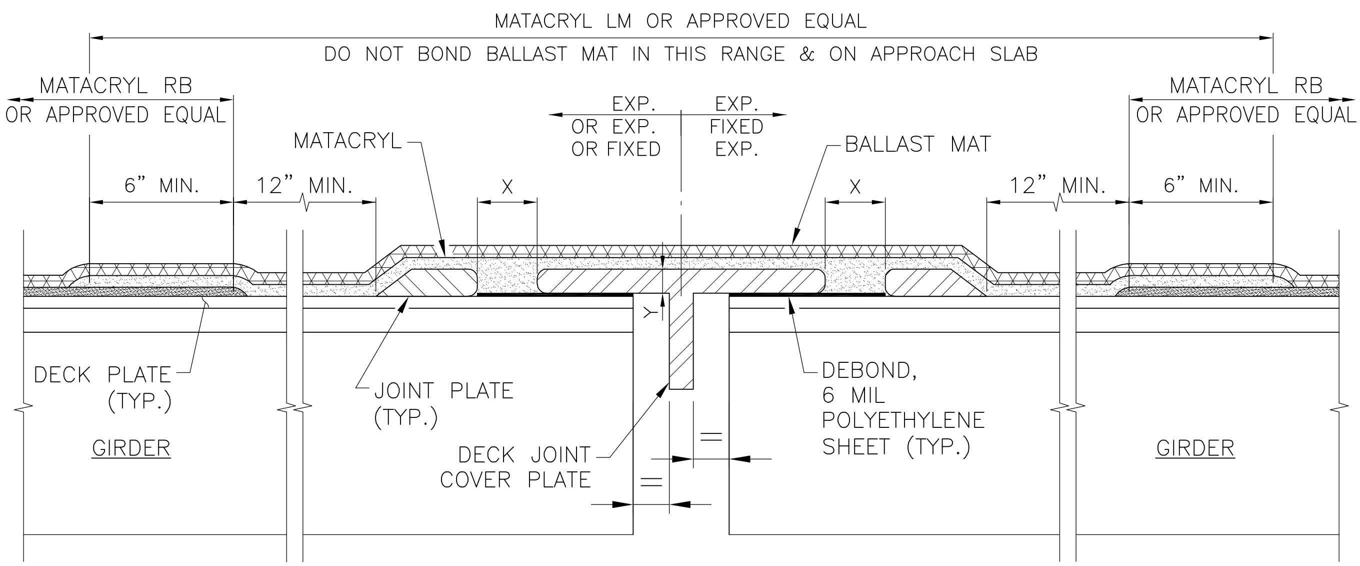


JOINT PLATE DETAIL



DECK JOINT COVER PLATE DETAIL

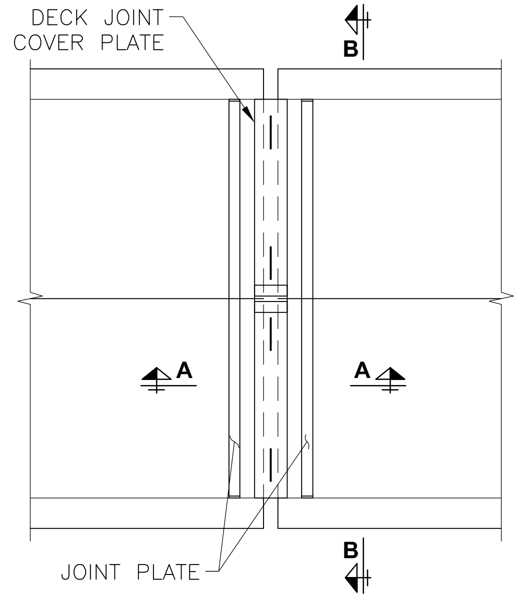
NOTE:
- MIN. COVER PLATE THICKNESS = 1"
- TOP OF COVER PLATE AND TOP OF JOINT PLATE SHALL BE AT THE SAME ELEVATION, ADJUST JOINT PLATE THICKNESS TO SUIT.
- JOINT GAP (X) TO BE SIZED BY THE CONSULTANT.
- JOINT PLATES SHALL BE WELDED OR BOLTED TO THE DECK PLATE. BOLTS, IF USED, SHALL BE COUNTERSUNK.
- NO BALLAST MAT JOINTS WITHIN 2'–6" OF JOINT ℄



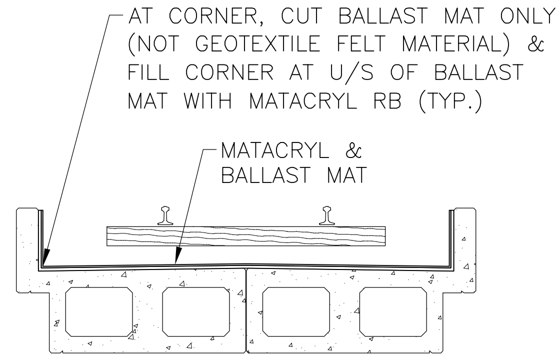
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

SECTION A–A
(SCHEMATIC)

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT JOINTS BETWEEN STEEL BALLAST PANS**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **C16i**	–

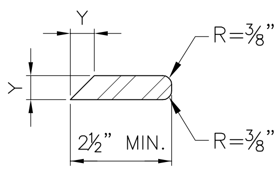


CONCRETE PAN PLAN VIEW

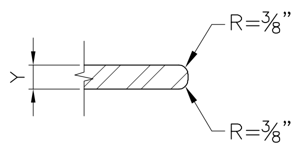


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 1"

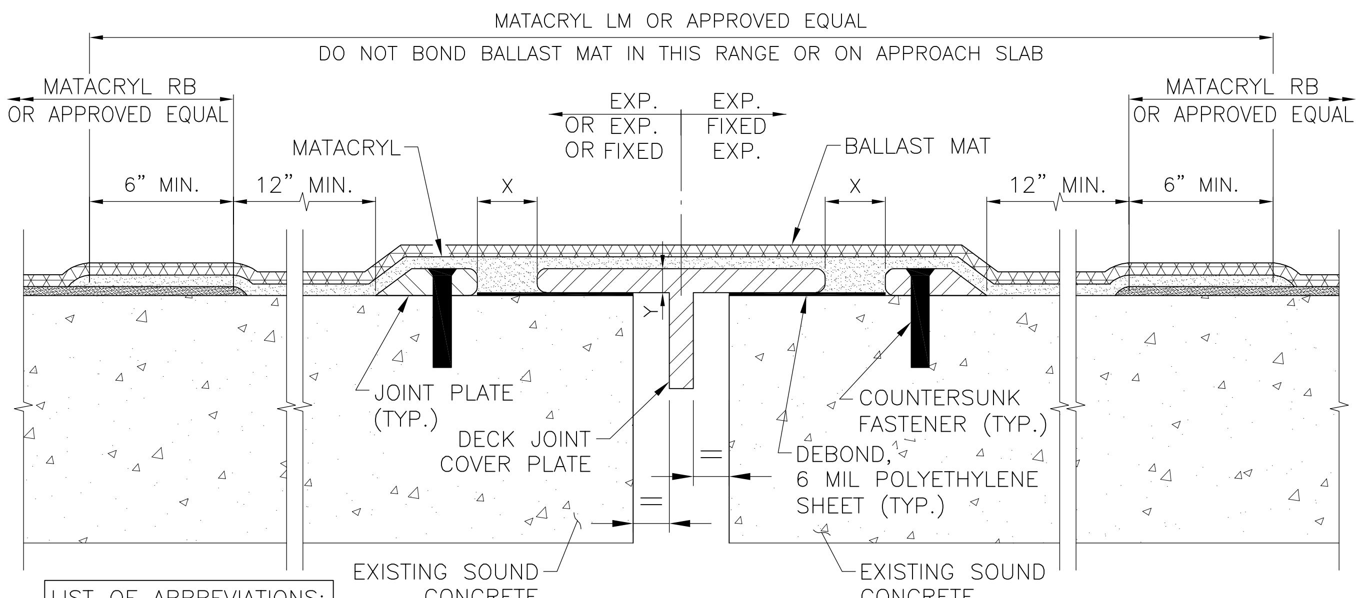


JOINT PLATE DETAIL



DECK JOINT COVER PLATE DETAIL

NOTE:
- MIN. COVER PLATE THICKNESS = 1"
- TOP OF COVER PLATE AND TOP OF JOINT PLATE SHALL BE AT THE SAME ELEVATION, ADJUST JOINT PLATE THICKNESS TO SUIT.
- JOINT GAP (X) TO BE SIZED BY THE CONSULTANT.
- JOINT PLATES SHALL BE BOLTED WITH COUNTERSUNKS TO CONCRETE.
- NO BALLAST MAT JOINTS WITHIN 2'–6" OF JOINT ℄



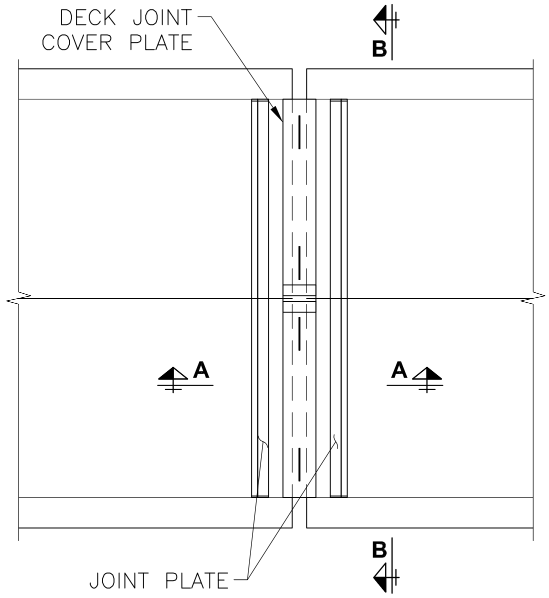
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

SECTION A–A
(SCHEMATIC)

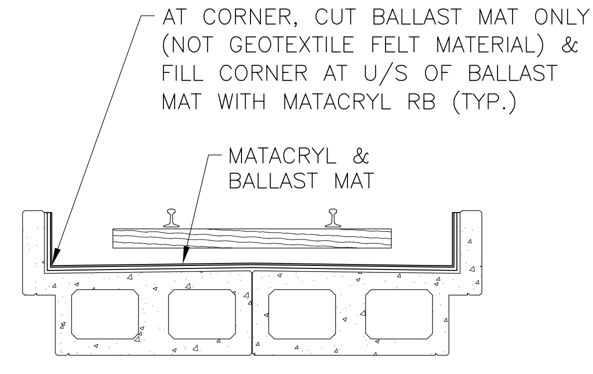
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT NEW OR EXISTING (SOUND) CONCRETE**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
C17i
–

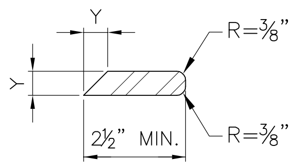


CONCRETE PAN PLAN VIEW

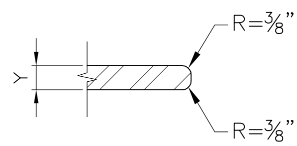


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 1"

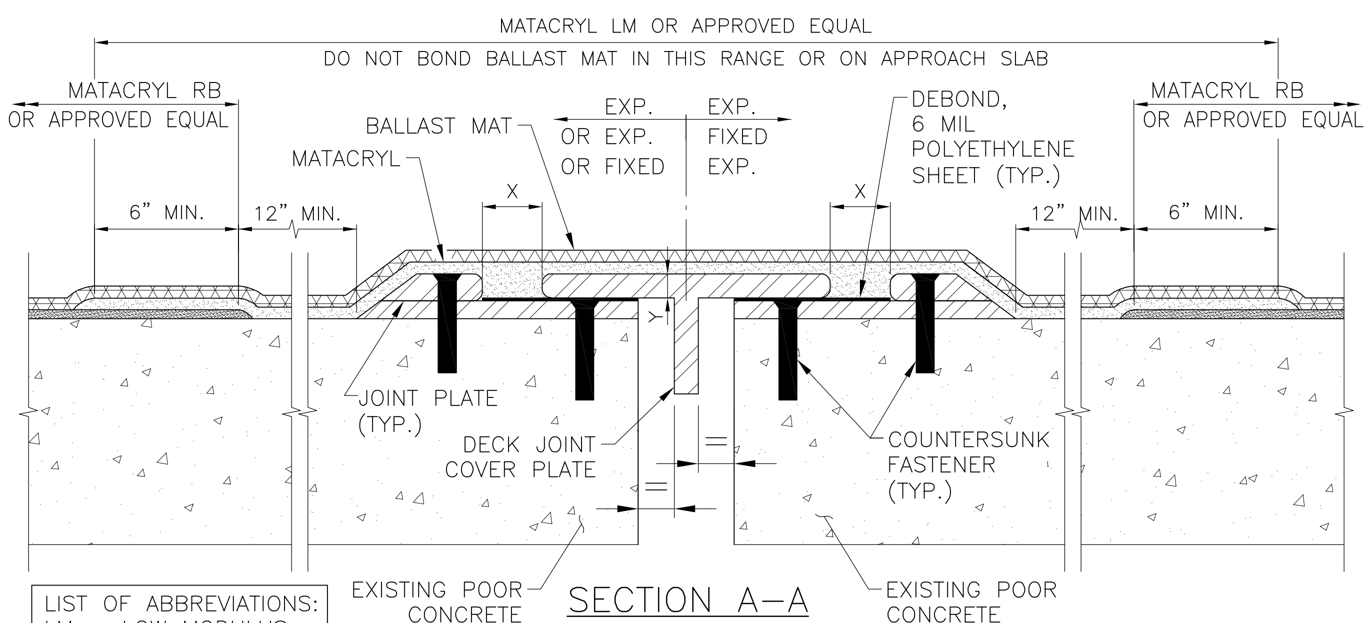


JOINT PLATE DETAIL



DECK JOINT COVER PLATE DETAIL

NOTE:
- MIN. COVER PLATE THICKNESS = 1"
- TOP OF COVER PLATE AND TOP OF JOINT PLATE SHALL BE AT THE SAME ELEVATION, ADJUST JOINT PLATE THICKNESS TO SUIT.
- JOINT GAP (X) TO BE SIZED BY THE CONSULTANT.
- JOINT PLATES SHALL BE BOLTED WITH COUNTERSUNKS TO CONCRETE.
- NO BALLAST MAT JOINTS WITHIN 2'–6" OF JOINT ℄



SECTION A–A
(SCHEMATIC)

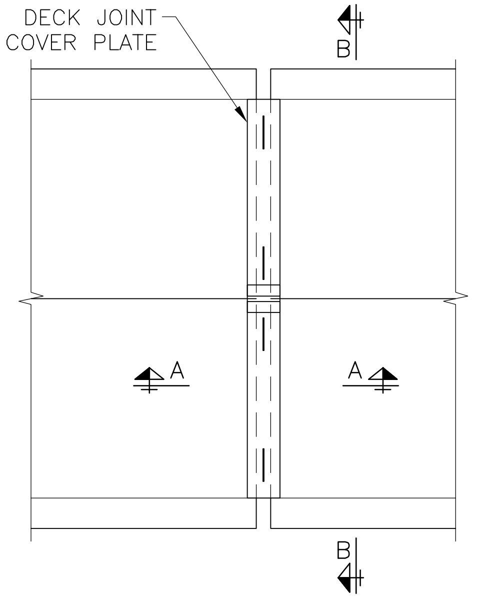
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT EXISTING (POOR) CONCRETE**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

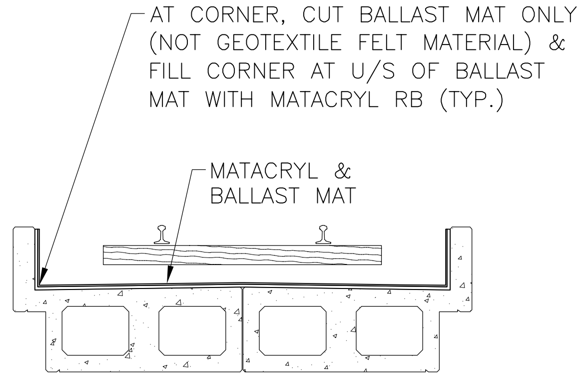
METROLINX

Drawing Number / Dessin Numero: **C18i**

–

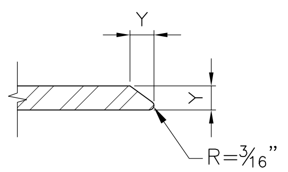


CONCRETE PAN PLAN VIEW



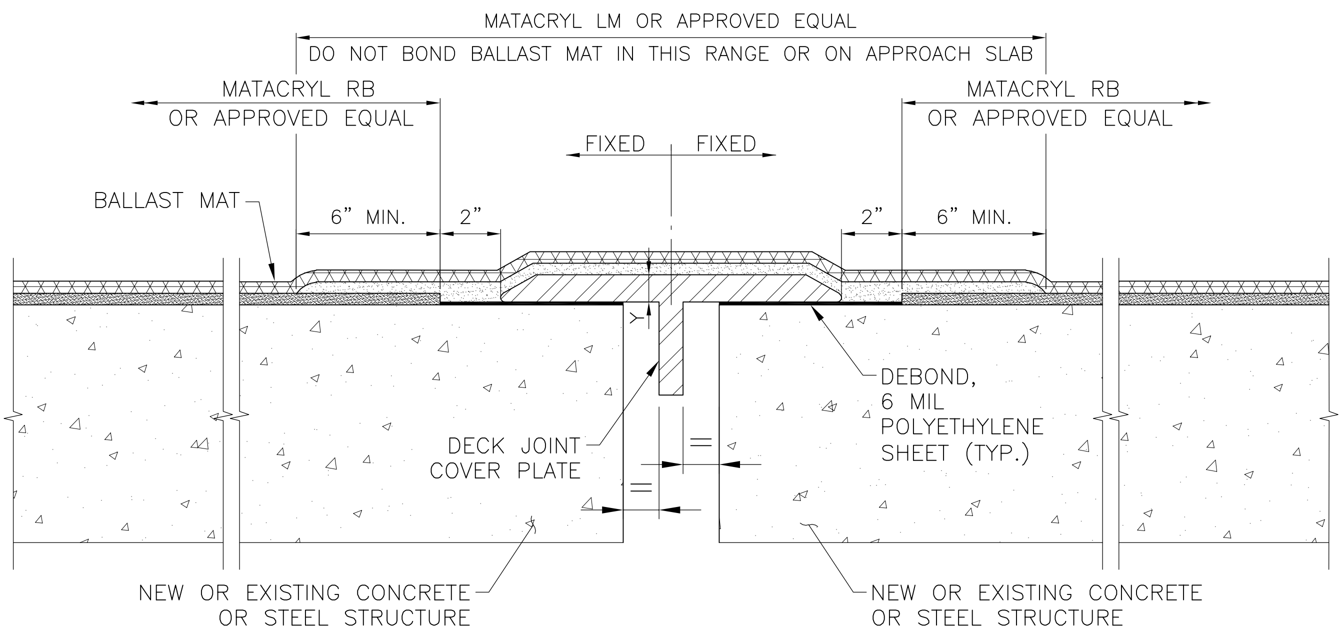
SECTION B–B

LEGEND:
Y ≥ 5/8"



DECK JOINT COVER PLATE DETAIL

NOTE:
- PLATE THICKNESS SIZED BY DESIGNER (MIN. 5/8")
- NO BALLAST MAT JOINTS WITHIN 2'–6" OF JOINT ℄
- DO NOT BOND BALLAST MAT ON APPROACH SLAB
- FOR FIXED–FIXED BEARINGS WHERE EXPECTED LONGITUDINAL MOVEMENT DUE TO SPAN ROTATION ≤1/16"



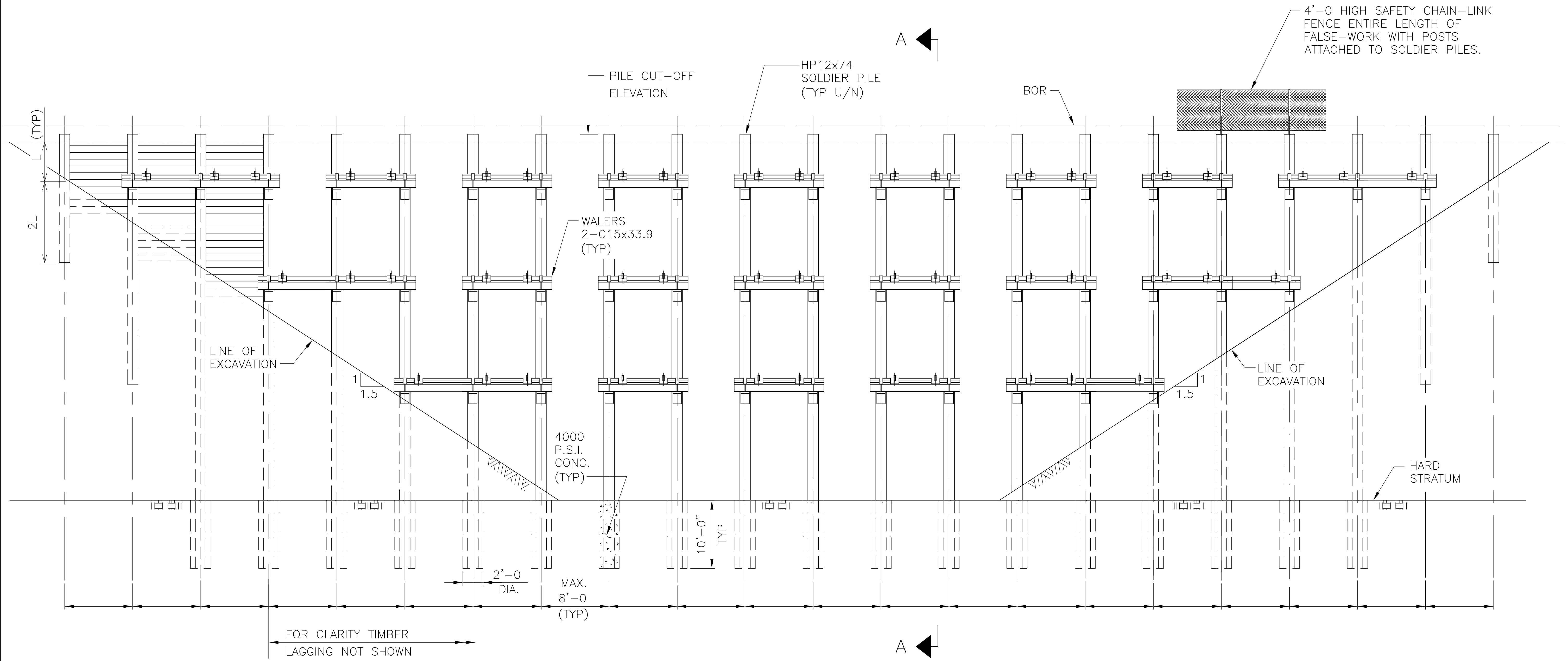
SECTION A–A
(SCHEMATIC)

LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT FIXED-FIXED BEARINGS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
C19i
–



ELEVATION

NOTES:

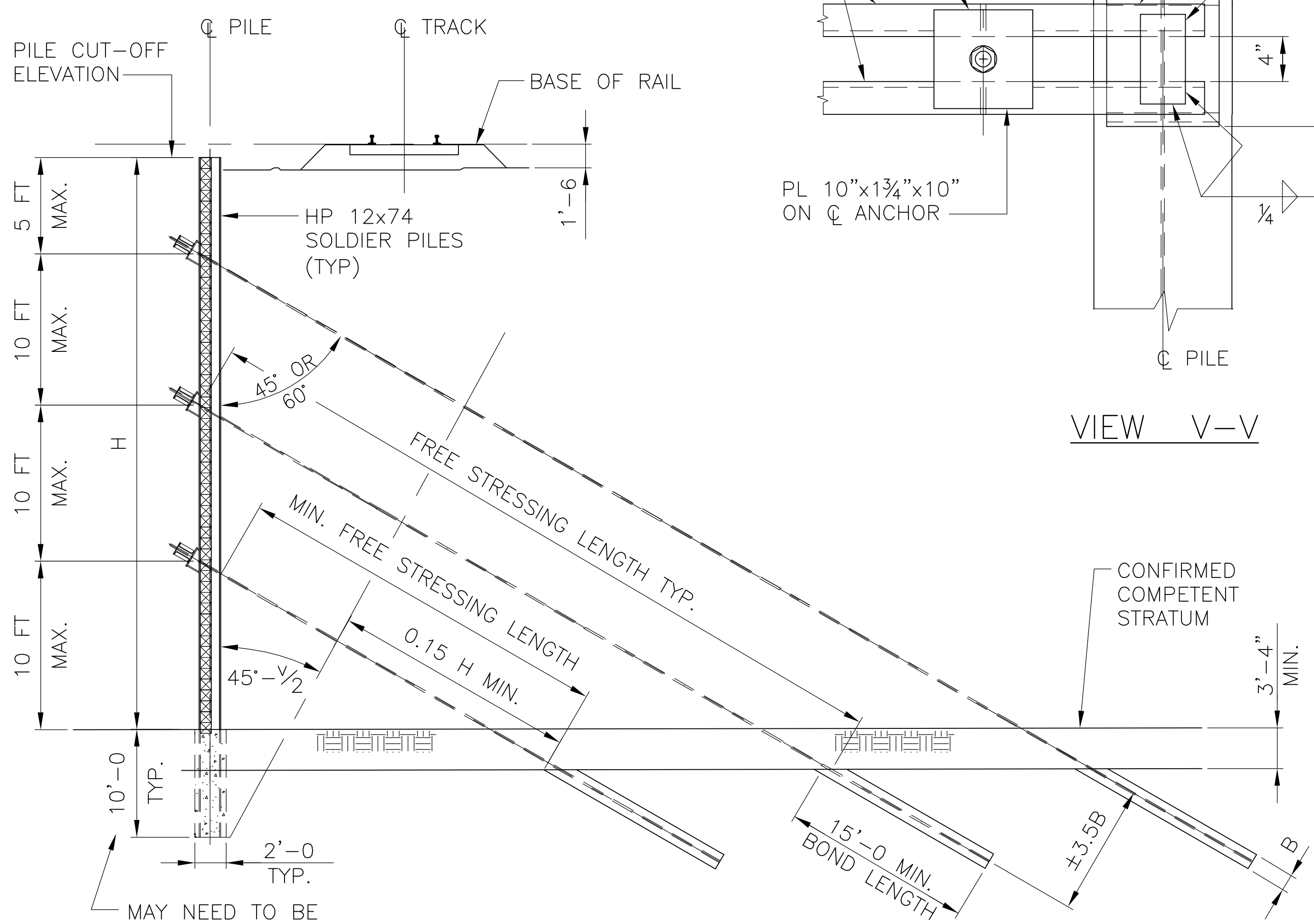
–SOCKET LENGTH MAY VARY ACCORDING TO SOIL TYPE

–SOCKET DIAMETER MAY VARY ACCORDING TO SOLDIER PILE SIZE AND INCLINED ANCHOR LOAD.

–FOR THE UPPER 6'–6 USE 6" LAGGING (MINIMUM) THICKNESS AND BELOW 6'–6 USE 8" (MINIMUM) THICKNESS.

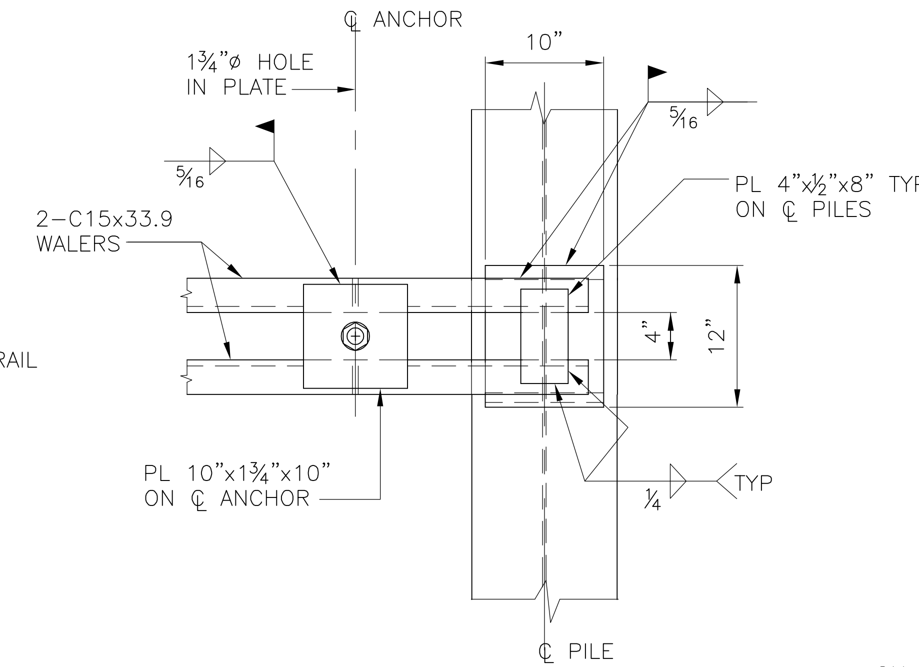
–SEE DWG. F–3 FOR MATERIAL SPECIFICATIONS.

Drawn: Dessin:	J.E.	Checked: Verification:	S.Kh.	**EXAMPLE OF TYPICAL TEMPORARY SHORING WALL**
Scale: Echelle:	NOT TO SCALE	Date:	2017/03/31	
METROLINX				Drawing Number Dessin Numero **F1i** –

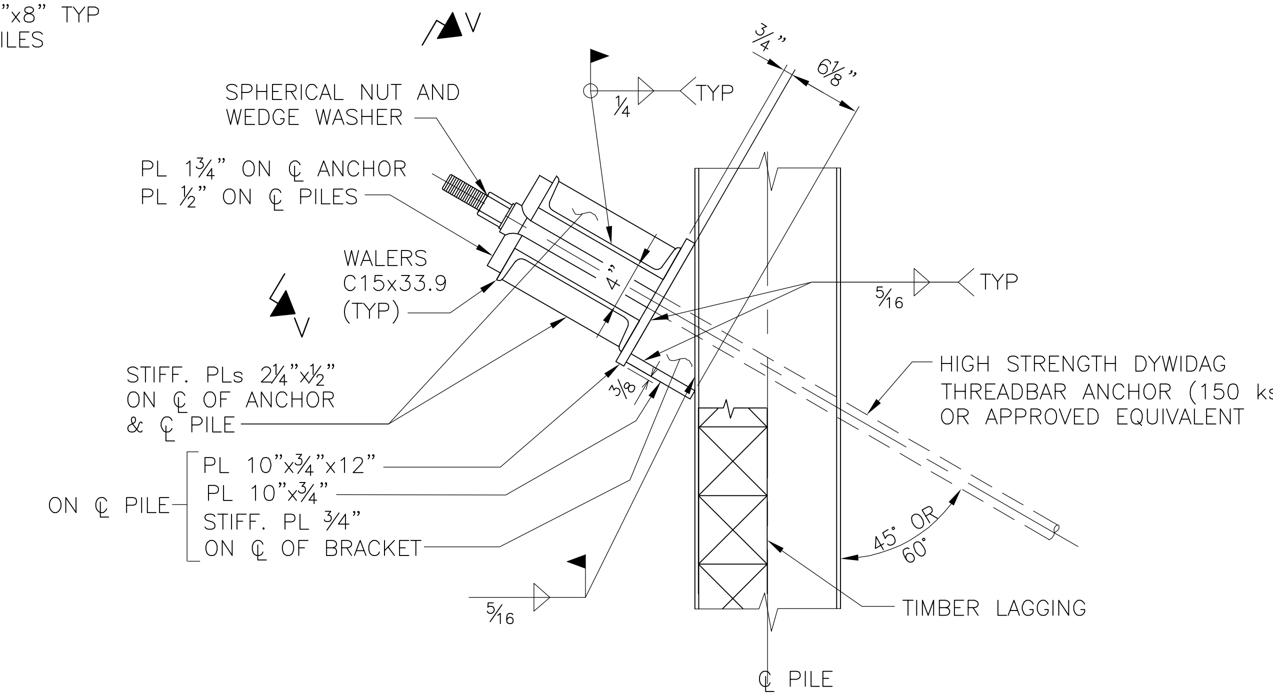


SECTION A–A

SEE DWG. No. F1i



VIEW V–V



TYPICAL ANCHOR DETAIL

NOTES:

- IF ROCK OR COMPETENT STRATUM IS WITHIN REASONABLE DISTANCE (AS SHOWN HERE FOR EXAMPLE), IT IS PREFERABLE TO DESIGN ANCHOR CAPACITY WITHIN THAT ZONE ONLY. (i.e. TRY TO AVOID BOND LENGTH WITHIN TWO DIFFERENT ZONES)
- THE FREE EARTH OR FIXED EARTH METHOD OF ANALYSIS MAY BE USED. HOWEVER, A GEOTECHNICAL ENGINEER SHALL BE CONSULTED AND THE ANALYSIS SUBMITTED TO METROLINX.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPICAL TIED-BACK WALL DETAILS SHORING WALL**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **F2i** –

ESTIMATED QUANTITIES:

PILES HP12x74 ______	lb.
STRUCTURAL STEEL ______	lb.
DYWIDAG ANCHORS ______	ft.
CONCRETE 4000 p.s.i. ______	yd^3
CONCRETE 75 p.s.i. ______	yd^3
LAGGING 4" ______	ft^2
LAGGING 6" ______	ft^2
LAGGING 8" ______	ft^2

NOTES:

-FOR GENERAL NOTES SEE DRAWING NO.

-STRUCTURAL STEEL FOR PILES, WALERS AND BRACKETS SHALL BE GRADE 300W ACCORDING TO CSA CAN3-G40.21-92.

-CONCRETE SHALL BE 4000 P.S.I. IN SOLDIER PILE TOES, AND 4000 P.S.I. WITHIN BOND LENGTH OF TIE-BACK ANCHORS. BENTONITE CONCRETE SHALL BE USED WITHIN FREE STRESSING LENGTH OF ANCHORS. HOLES FOR PILES AT LOCATIONS WITHOUT WALERS SHALL BE FILLED WITH 75 P.S.I. CONCRETE.

-TIE BACK ANCHORS SHALL BE 1½"ø GRADE 150ksi HIGH STRENGTH "DYWIDAG THREADED BAR TO CSA G279-82, AND SHALL HAVE A MINIMUM BOND LENGTH OF 15'-0 INTO SOLID ROCK.

-DESIGN LOAD TO BE SPECIFIED (TYP. APPROXIMATELY 142 Kips/ANCHOR)

-TIMBER LAGGING SHALL BE SPECIES (S-P-F), BEAMS AND STRINGERS GRADE NO.1 OR BETTER , IN ACCORDANCE WITH AREMA 2016 CHAPTER 7. FOR ALLOWABLE BENDING STRESS USE 6.5 MPa (INCLUDING ALL MODIFICATION FACTORS).

-TIMBER LAGGING THICKNESS SHALL BE 6" MIN. FOR UPPER 6'-6" AND 8" MIN. FOR BELOW 6'-6".

-TIEBACK ANCHORS SHALL BE DYWIDAG MULTISTRAND, 0.6" dia., 7-WIRE GREASED AND COATED, LOW-RELAXATION, GRADE 270 ksi STRAND CONFORMING TO CSA G279-82 (ASTM A 416)

-WELDING SHALL BE IN ACCORDANCE WITH CSA CAN3-W59-M1989.

K_o = 0.50 MIN.

K_p = ...

γ_{water} = 9.806 kN/m3

γ_{soil} = ### kN/m3

CONSTRUCTION PROCEDURE FOR SOLDIER PILES, LAGGING AND TIE BACK ANCHORS:

1. DRILL HOLES TO SIZE AND DEPTH SHOWN. INSTALL PILES, ALIGN AND CAST CONCRETE TOES WHERE SHOWN.
2. WHEN CONCRETE IN TOES HAS SET (30MPa), FILL VOID AROUND PILES TO GRADE WITH 0.5MPa MATERIAL.
3. EXCAVATE IN 4'-0" LIFTS AND INSTALL LAGGING. EXCAVATE SOIL FACES NEATLY TO ENSURE A TIGHT FIT FOR LAGGING. WEDGE AT PILE AS NECESSARY, PACK ALL VOIDS BEHIND LAGGING WITH GRANULAR MATERIAL RAMMED INTO PLACE.
4. WHEN EXCAVATION REACHES 12" MAX. BELOW ANCHOR ELEVATION NOTED ,DRILL AND INSTALL ANCHORS.
5. FILL ALL VOIDS AROUND TIEBACKS WITH 3000 PSI CONCRETE GROUT
6. DO NOT FURTHER EXCAVATE BELOW ANCHOR ELEVATIONS UNTIL ALL ANCHORS ARE STRESSED AND LOAD LOCKED IN. ALL ANCHORS SHALL BE PROOF TESTED TO 1.33 TIMES DESIGN LOAD AND IF NO CREEP OCCURS AFTER 30 MINUTES THE LOAD SHALL BE REDUCED TO 1.1 TIMES DESIGN LOADS AND LOCKED IN.
7. A NOMINAL LOAD SHALL BE USED TO STRESS ALL HORIZONTAL ANCHORS IN ORDER TO DRAW OUT ANY SLACK IN THESE ANCHORS.
8. REPEAT OPERATION 3 AND 7 TO THE NEXT STAGE EXCAVATION LEVEL.
9. DO NOT EXCAVATE BELOW TIE-BACK ELEVATIONS UNTIL ALL ANCHORS ARE STRESSED & LOAD LOCKED IN.

-DESIGN LOAD: ### kN FOR ANCHORS # to #

-STRAND SIZE AND NUMBERS: #-0.6" TENDONS, (### kN /anchor)

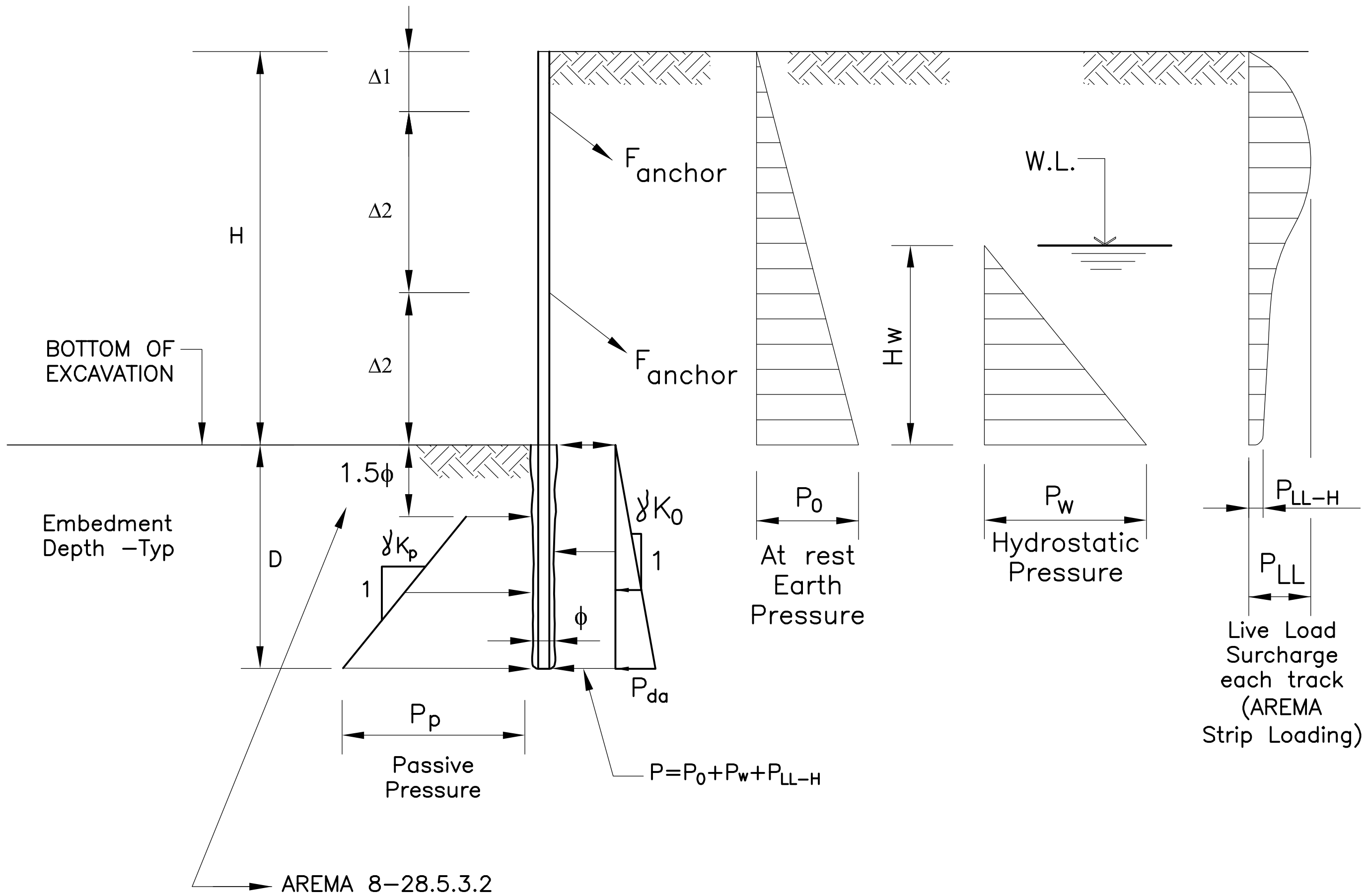
-LOCK-OFF LOAD = 1.10 x DESIGN LOAD

-PROOF LOAD = 1.33 x DESIGN LOAD

-PERFORMANCE BOND LOAD = 2.0 x DESIGN LOAD

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPICAL TIED-BACK WALL NOTES SHORING WALL**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **F3i** –

TRACK PROTECTION SYSTEM DESIGN LOAD DIAGRAMS



WHERE:

- γsoil = 133.68 lb/ft^3
- γw = 62.42 lb/ft^3
- K_0 = 0.50 Minimum
- K_p = 3.0
- ϕ = DIAM. OF SHAFT

AT REST EARTH PRESSURE

$P_0 = K_0 \gamma s\ H$ (kPa)

$P_{da} = K_0 \gamma s\ D$ (kPa)

PASSIVE RESISTANCE

$P_p = K_p \gamma s\ D$ (kPa)

HYDROSTATIC PRESSURE

$Pw = \gamma w\ Hw$ (kPa)

$\Delta 1$ = Maximum 5 ft

$\Delta 2$ = Maximum 10 ft

LIVE LOAD SURCHARGE

–TO BE CALCULATED IN ACCORDANCE WITH AREMA 2016, CHAPTER 8, SECTION 20,3,2,2(a), BOUSINESQ METHOD.

–THE TRACK PROTECTION SHALL BE DESIGNED FOR THE SURCHARGE DUE TO THE COOPER–E80 LOADING AS PER AREMA–2016. (I.E. 95.8 kPa (2.00 ksf) –80 kips AXLE LOAD, 5 FT SPACING BETWEEN TWO CONSECUTIVE AXLES. THE EFFECT OF THE STRIP LOAD SURCHARGE CALCULATED WITH 8 FT TIE LENGTH CAN BE ASSESSED AS DESCRIBED IN AREMA 2016, CHAPTER 8, ARTICLE 20.3.2.2.

–THE EFFECT OF E–80 TRAIN LOADING ON ALL TRACKS SHALL BE CONSIDERED FOR THE ESTIMATION OF THE LATERAL PRESSURE DUE TO TRAIN LOADING, AS DESCRIBED IN AREMA 2016 CHAPTER 8 ARTICLE 2.2.3.C.(6).

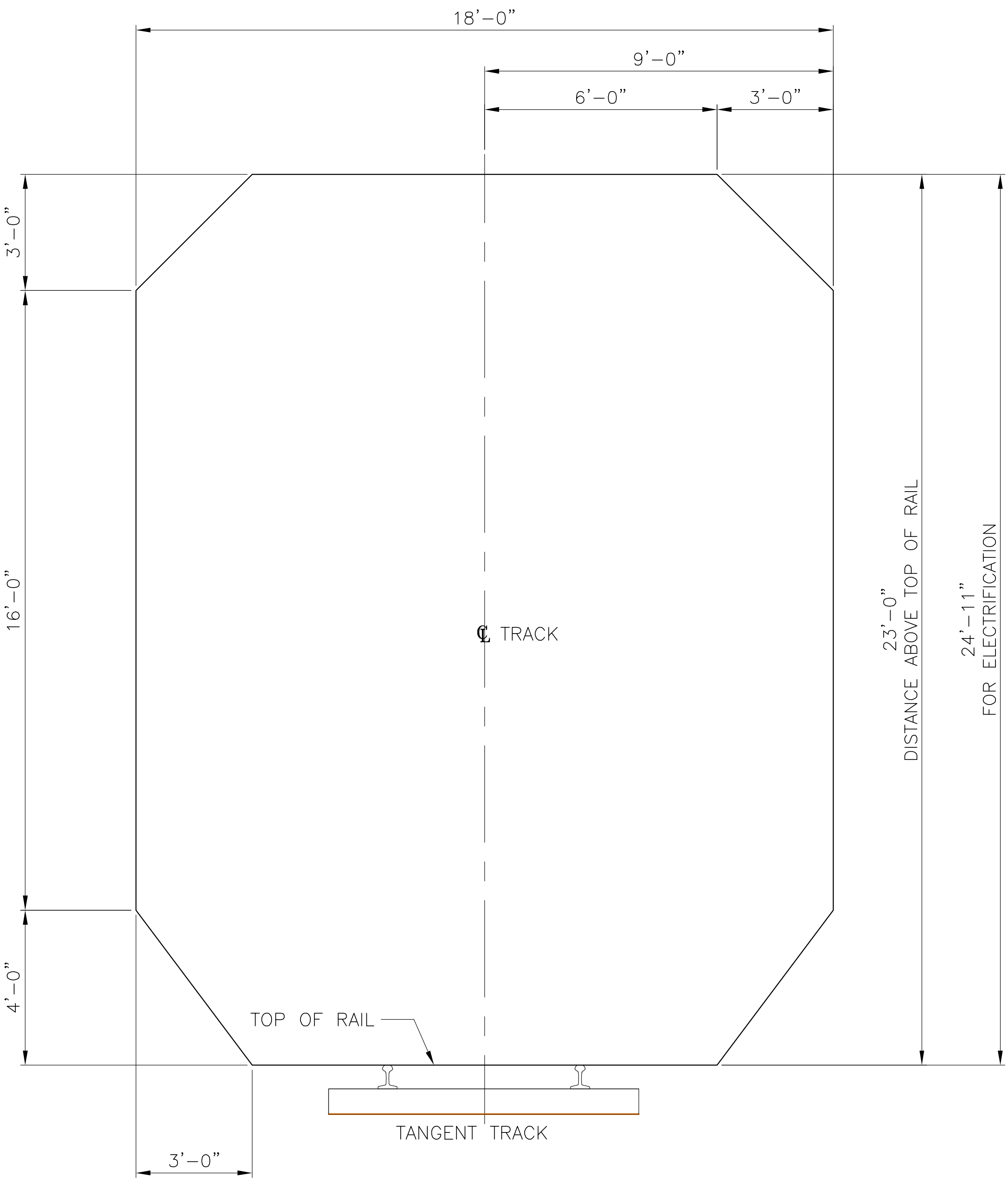
BOUSSINESQ METHOD

–NO REDUCTION FACTOR WILL ALLOWED TO REDUCE COMPUTED LATERAL PRESSURE DUE TO TRAIN LOADING BASED ON BOUSINESQ METHOD.

APPARANT EARTH PRESSURE METHOD

–FOR ESTIMATION OF SOIL LATERAL PRESSURE, TRIANGULAR SOIL PRESSURE METHOD SHALL BE USED. DELETE AREMA 2016 ARTICLE 8_28.5.4.3.C.(3), FIGURE 8–28–1, APPARENT EARTH PRESSURE METHOD IS NOT ALLOWED.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TEMPORARY SHORING WALL DESIGN LOAD DIAGRAMS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **F4i** –



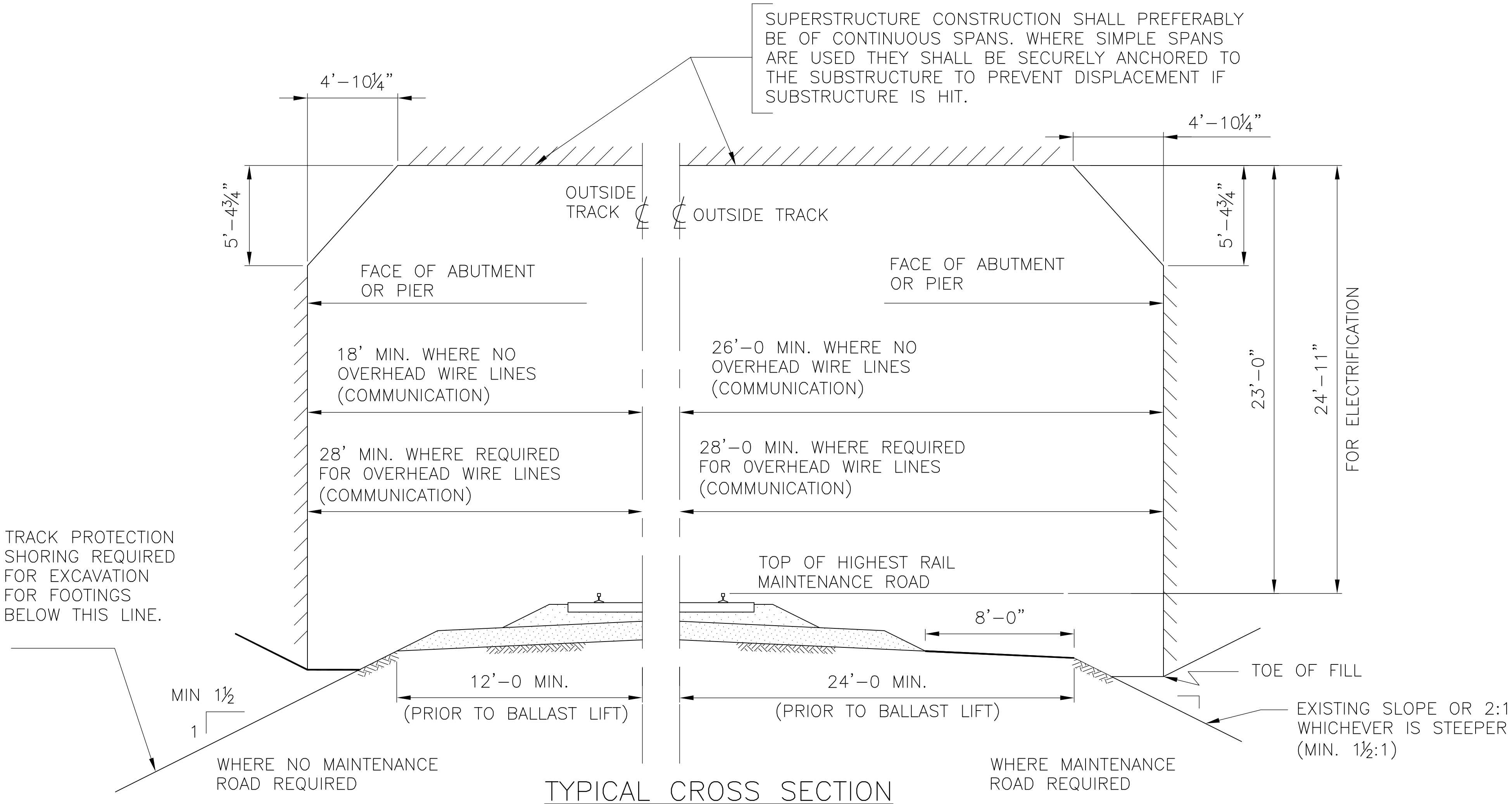
NOTE: SEE ARTICLE 1.2.6a FOR CURVE CORRECTIONS.
AREMA MANUEL FOR RAILWAY ENGINEERING – CHAPTER 15

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**METROLINX STANDARD CLEARANCE DIAGRAM FOR ALL NEW RAILWAY BRIDGES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

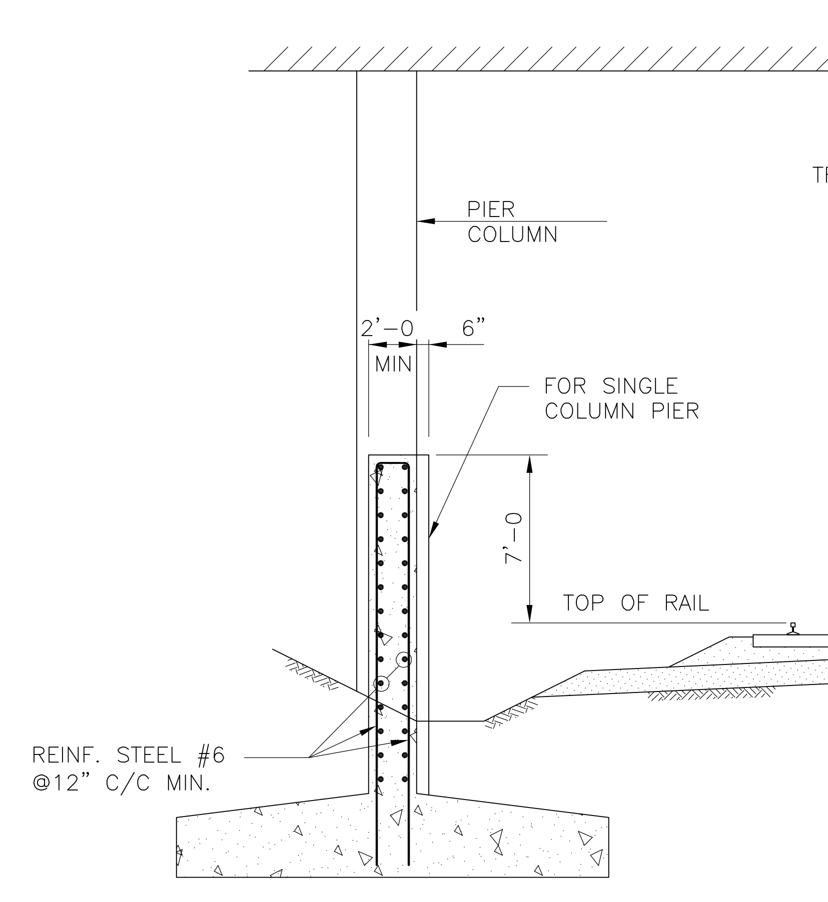
METROLINX

Drawing Number
Dessin Numero

K1U-10.1i –



TYPICAL CROSS SECTION



PROTECTION WALL DETAIL

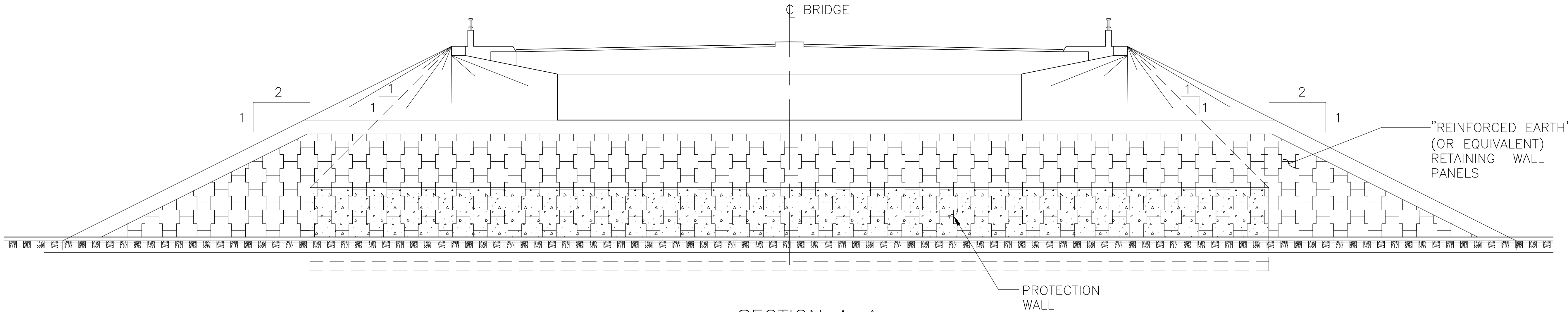
NOTES

- ALL HORIZONTAL DIMENSIONS ARE TO BE TAKEN PERPENDICULAR TO RAILWAY TRACKS.
- ALL VERTICAL DIMENSIONS ARE TO BE TAKEN FROM THE TOP OF RAIL.
- FOR TRACKS ON CURVE, CONSULT SYSTEM ENGINEER – TECHNICAL SERVICES.
- FOR RAILWAY REQUIREMENTS FOR ADDITIONAL FUTURE TRACK PROVISIONS AND FOR THE MINIMUM TEMPORARY CONSTRUCTION CLEARANCES CONSULT RAIL CORRIDORS.
- NO WATER FROM DECK OF STRUCTURE SHALL DRAIN ONTO RAILWAY TRACK BETWEEN TRACK DITCHES.
- NO WATER FROM ROAD APPROACH EMBANKMENT SHALL DRAIN INTO RAILWAY DITCHES WITHOUT PROPER PROTECTION AGAINST EROSION OF SLOPE OR FILLING WITH FINES OF DITCHES.
- APPROACH SLOPES IF ADJACENT TO TRACKS ARE TO BE PAVED OR OTHERWISE PROTECTED FROM EROSION.
- ANY DEVIATION FROM THIS STANDARD MUST RECEIVE PRIOR APPROVAL OF THE SENIOR MANAGER TRACK & STRUCTURES.

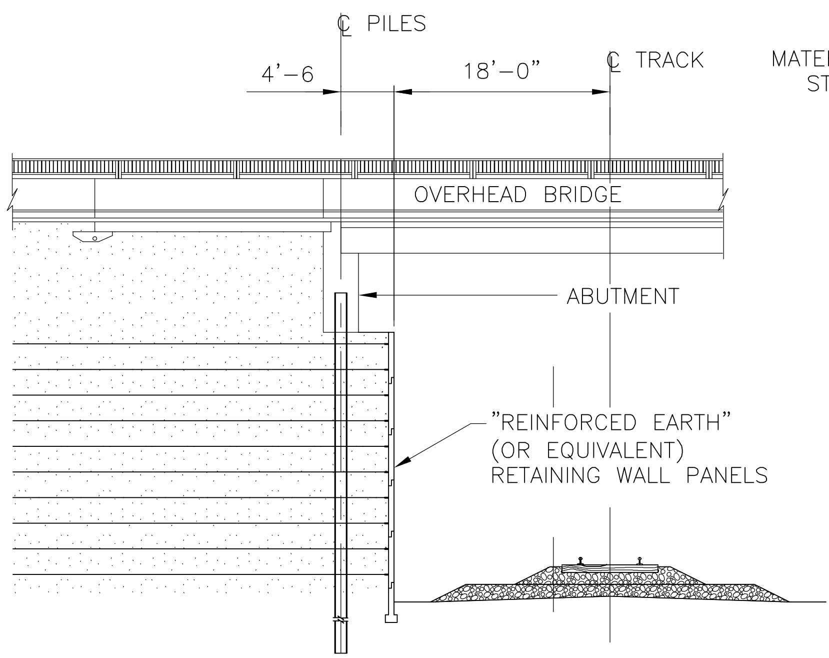
PIER PROTECTION

- PIERS WITHIN 25'–0 OF CENTER LINE OF ADJACENT TRACK SHALL BE OF SOLID HEAVY CONSTRUCTION OR SHALL BE PROTECTED BY REINFORCED CONCRETE PROTECTION WALL EXTENDING 7'–0 ABOVE TOP OF RAIL. WHERE 2 OR MORE COLUMNS COMPOSE A PIER, A PROTECTION WALL AT LEAST 2'–0 THICK SHALL CONNECT THE COLUMNS. WHEN THE PIER CONSISTS OF A SINGLE COLUMN, THE PROTECTION WALL SHALL BE PARALLEL TO THE TRACK, 2'–6 THICK, EXTEND AT LEAST 7'–0 BEYOND BOTH SIDES OF THE COLUMN, END PROJECT 6" BEYOND THE FACE OF THE COLUMN ON THE SIDE ADJACENT TO THE TRACK. PROTECTION WALL SHALL BE ANCHORED TO THE COLUMN AND FOOTINGS WITH ADEQUATE REINFORCING STEEL.
- DESIGN AND LOCATION OF PROTECTION WALLS SHALL BE VERIFIED WITH RAIL CORRIDORS–BRIDGES & STRUCTURES.

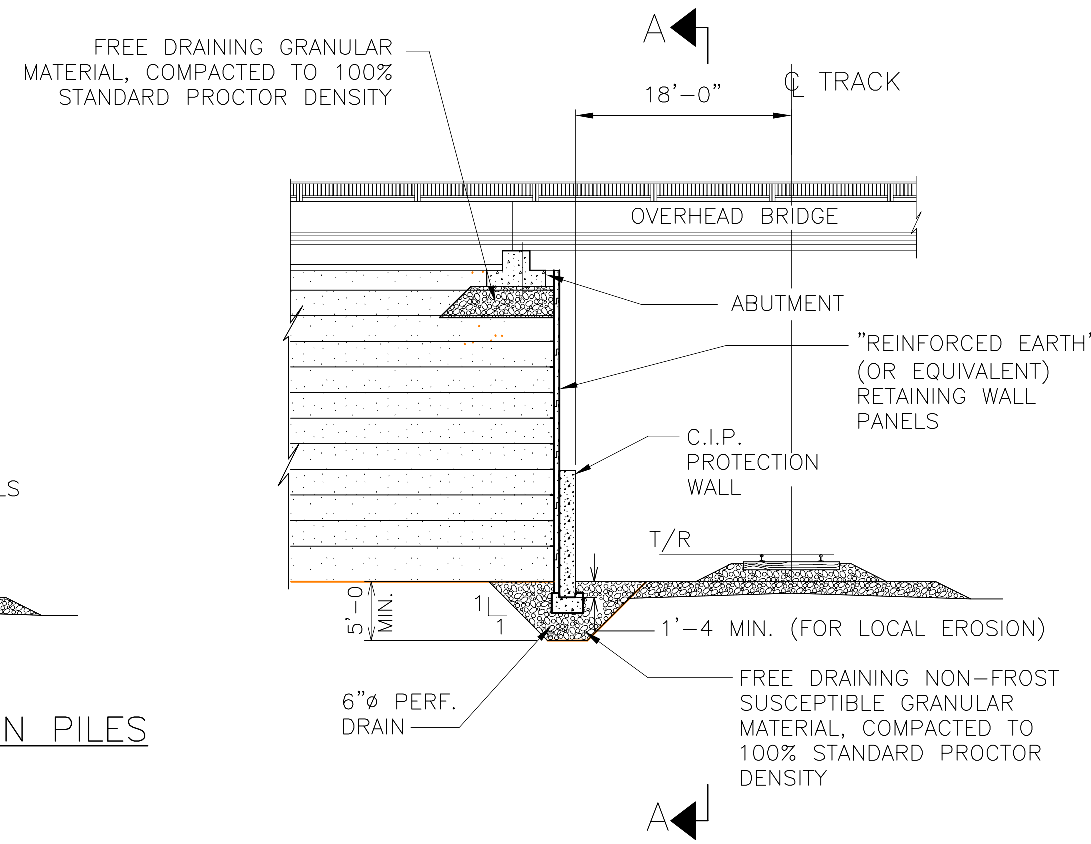
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**PROTECTION AND MINIMUM CLEARANCES FOR OVERHEAD BRIDGES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number / Dessin Numero **K1U-10.2i** –



SECTION A–A



TYPICAL SECTION FOR ABUTMENTS ON PILES

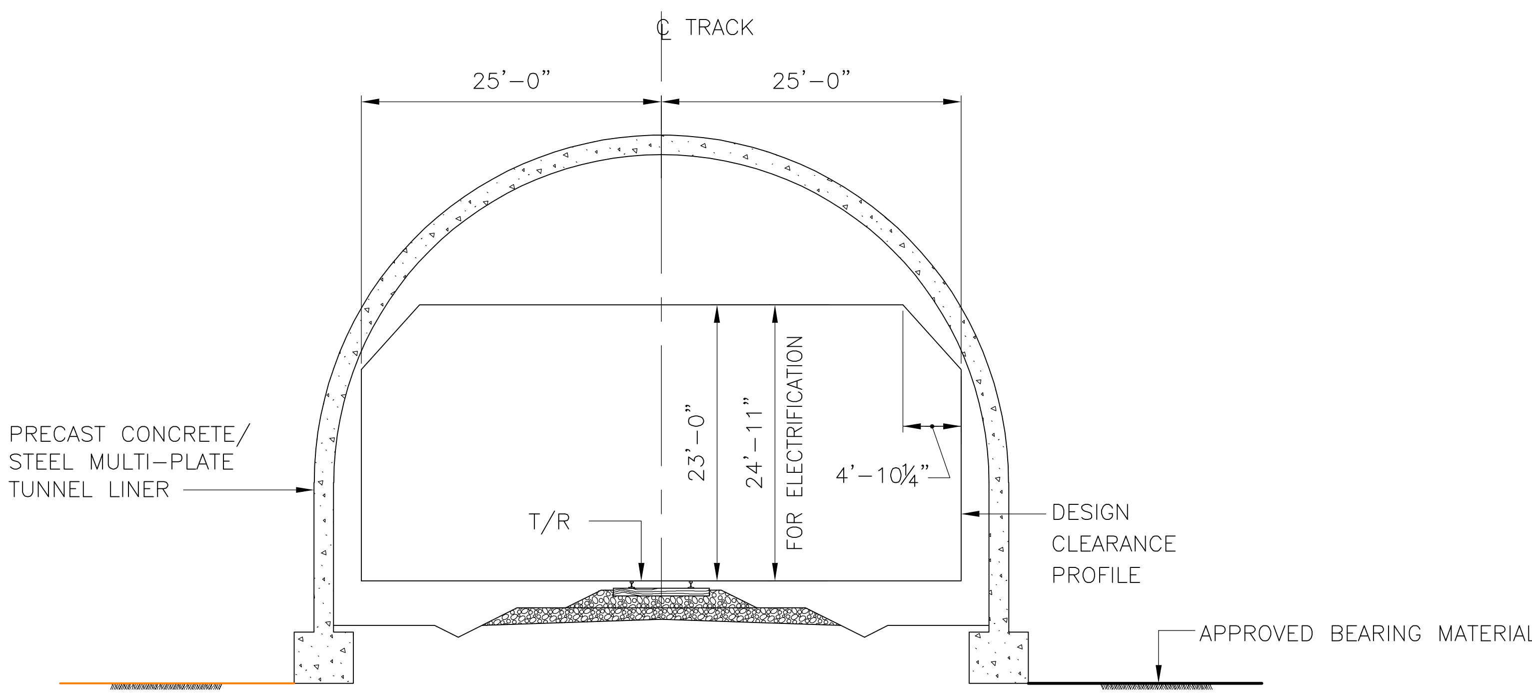


TYPICAL SECTION FOR ABUTMENTS ON GRANULAR BASE

NOTES:

- WHEN "REINFORCED EARTH" WALLS (OR EQUIVALENT) ARE TO BE CONSTRUCTED WITHIN 25'–0 OF THE CENTER LINE OF TRACK, THEY SHALL BE IN ACCORDANCE WITH THE TYPICAL SECTIONS SHOWN ON THIS DRAWING FOR ABUTMENTS ON PILES OR ON A GRANULAR BASE.
- THE PROTECTION WALL SHALL BE PARALLEL TO THE TRACK 2'–6 (MIN.)THICKNESS AND EXTEND 7'–0 ABOVE THE TOP OF RAIL.
- REFER TO DWG. K1U–10.2 FOR NOTES & PROTECTION WALL DETAILS.
- PRIOR TO CASTING OF THE C.I.P. PROTECTION WALL A TEMPORARY FACED REINFORCED EARTH WALL(OR EQUIVALENT) MUST BE CONSTRUCTED TO THE TOP OF THE C.I.P. WALL TO ENSURE THAT THE SOIL REINFORCEMENT HAS BEEN MOBILIZED EQUALLY.
- THE C.I.P. PROTECTION WALL MUST BE POSITIVELY CONNECTED TO THE M.S.E. WALL AND AN ALLOWANCE PROVIDED FOR VERTICAL DRAINAGE BETWEEN THE TWO WALLS.

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**PROTECTION WALL REQUIREMENTS FOR REINFORCED EARTH (OR EQUIV.) WALLS FOR OVERHEAD BRIDGES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number / Dessin Numero **K1U-10.3i** –



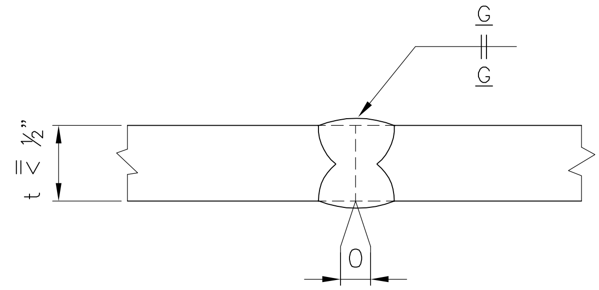
TYPICAL TUNNEL SECTION

NOTE: ONLY AFTER THE PROPOSED CONCEPTUAL DESIGN HAS BEEN APPROVED BY METROLINX CAN THIS FORM OF CONSTRUCTION BE USED

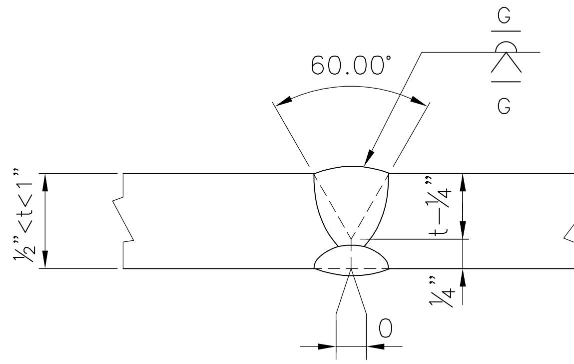
NOTES:

- ANY PROPOSAL MUST BE SUBMITTED TO THE SENIOR MANAGER TRACK & STRUCTURES FOR REVIEW ACCOMPANIED BY COMPLETE DESIGN CALCULATIONS AND GEOTECHNICAL INFORMATION.
- ALL HORIZONTAL DIMENSIONS ARE TO BE TAKEN PERPENDICULAR TO RAILWAY TRACKS.
- ALL VERTICAL DIMENSIONS ARE TO BE TAKEN FROM THE TOP OF RAIL.
- FOR TRACKS ON CURVE, CONSULT RAIL CORRIDORS.
- FOR RAILWAY REQUIREMENTS FOR ADDITIONAL FUTURE TRACK PROVISIONS AND FOR THE MINIMUM TEMPORARY CONSTRUCTION CLEARANCES, CONSULT RAIL CORRIDORS.
- NO WATER FROM DECK OF STRUCTURE SHALL DRAIN ONTO RAILWAY TRACK BETWEEN TRACK DITCHES.
- NO WATER FROM ROAD APPROACH EMBANKMENT SHALL DRAIN INTO RAILWAY DITCHES WITHOUT PROPER PROTECTION AGAINST EROSION OF SLOPE OR FILLING WITH FINES OF DITCHES.
- ANY DEVIATION FROM THIS STANDARD MUST RECEIVE PRIOR ACCEPTANCE OF THE SENIOR MANAGER TRACK & STRUCTURES.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CLEARANCE DIAGRAM REQUIREMENTS FOR PREFABRICATED TUNNELS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **K1U-10.4i** –



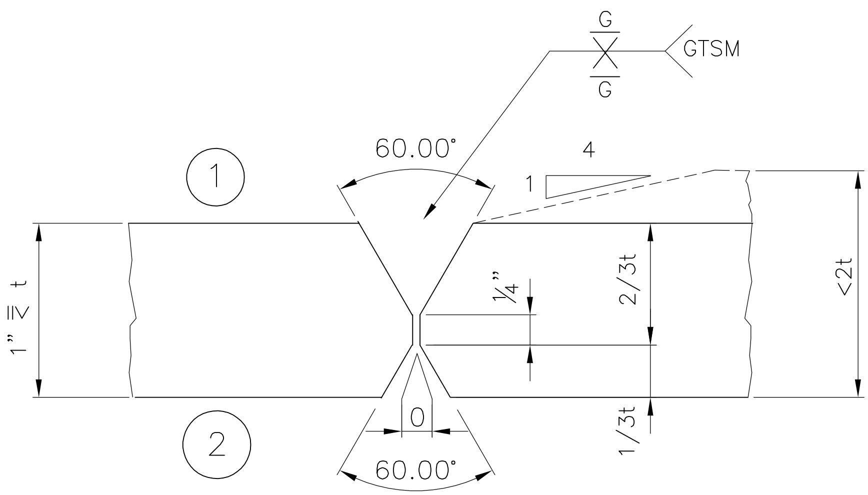
PLATES OF EQUAL THICKNESSES



PLATES OF EQUAL THICKNESSES

NO. OF PASSES WILL VARY WITH THICKNESS

SIDE ② GOUGED OUT TO SOUND METAL AFTER SIDE ① IS WELDED, AND THEN WELD.



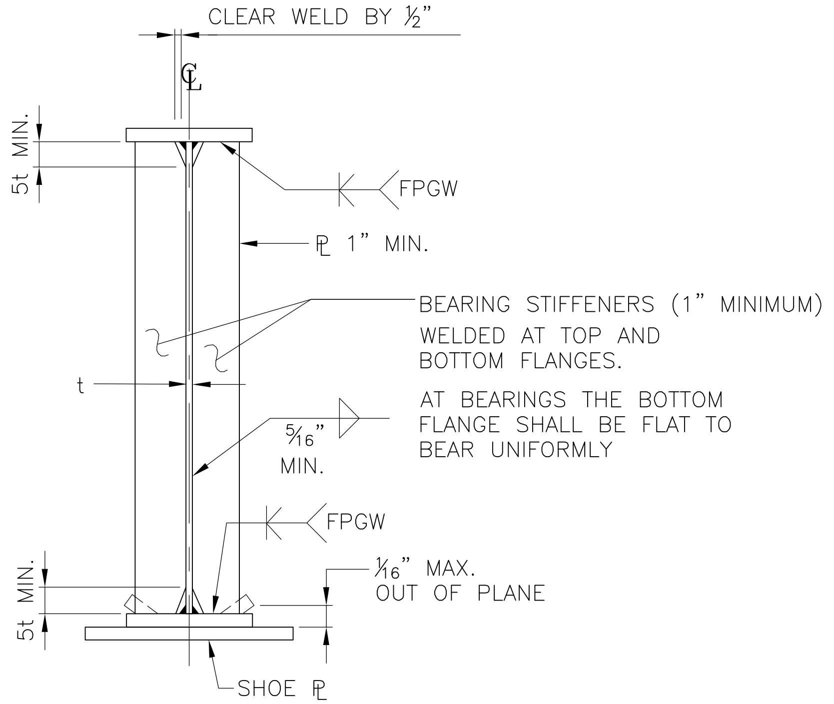
PLATES OF EQUAL OR UNEQUAL THICKNESSES

WELDING SHALL BE PERFORMED IN FLAT POSITION IN ACCORDANCE WITH CSA STANDARD W59. RUN–OFF PLATES SHALL BE USED TO ENSURE SOUND WELDS AND FULL THROAT THICKNESS, AND SHALL BE OF SAME MATERIAL AND GEOMETRY AS FLANGE AT JOINT. AFTER COMPLETION AND COOLING OF WELD, REMOVE RUN–OFF PLATES AND GRIND WELD FLUSH ON ALL SIDES (IN DIRECTION OF STRESSES).

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**SUBMERGED ARC WELDED JOINTS FOR FLANGES WEB, STIFFENERS & GUSSET PLATES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

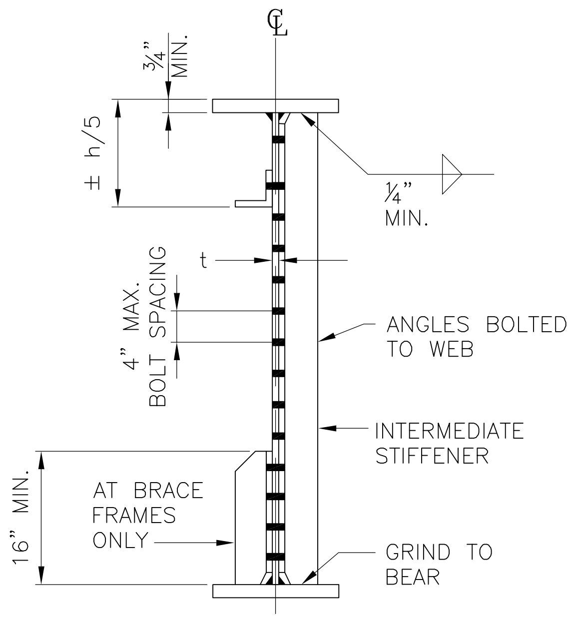
METROLINX

Drawing Number / Dessin Numero
S1i
–



BEARING STIFFENER

NOTE:
FPGW DENOTES FULL PENETRATION GROOVE WELD



INTERMEDIATE STIFFENER

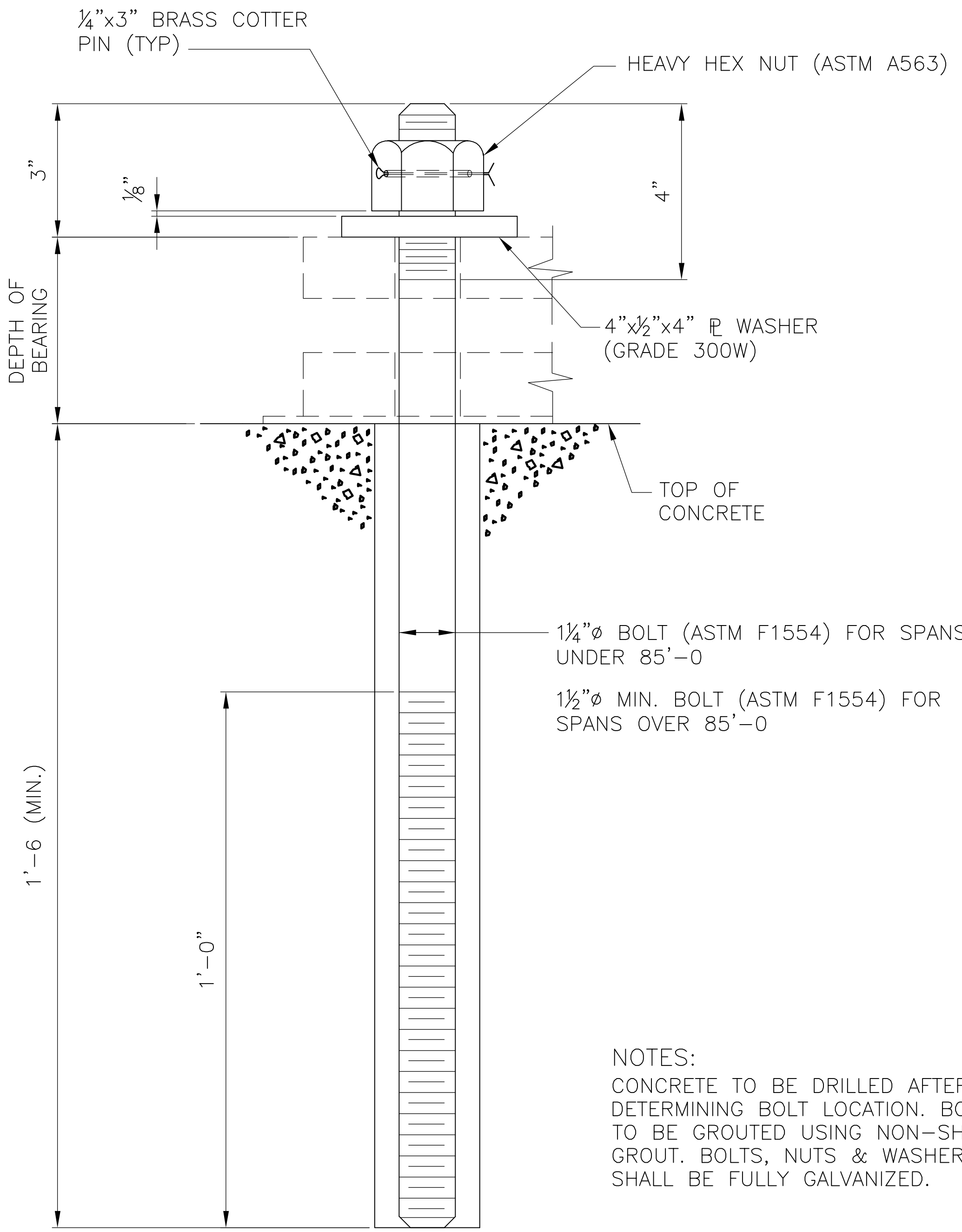
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**STIFFENERS**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero

S2i

–



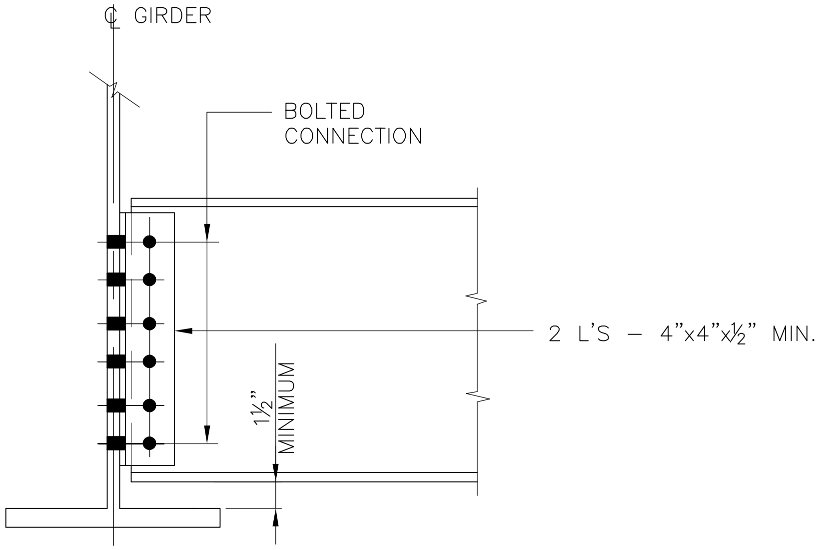
NOTES:
CONCRETE TO BE DRILLED AFTER DETERMINING BOLT LOCATION. BOLTS TO BE GROUTED USING NON-SHRINK GROUT. BOLTS, NUTS & WASHERS SHALL BE FULLY GALVANIZED.

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**ANCHOR BOLT**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

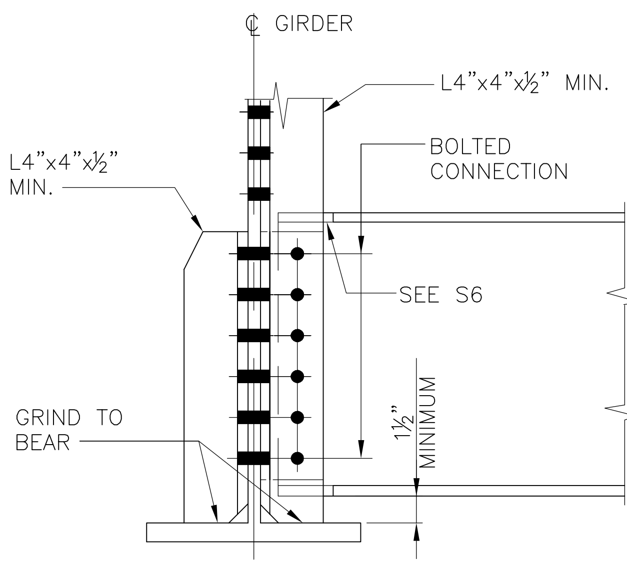
METROLINX

Drawing Number / Dessin Numero: **S3i**

–



FLOOR BEAM TO GIRDER WEB



FLOOR BEAM TO GIRDER STIFFENER

NOTE

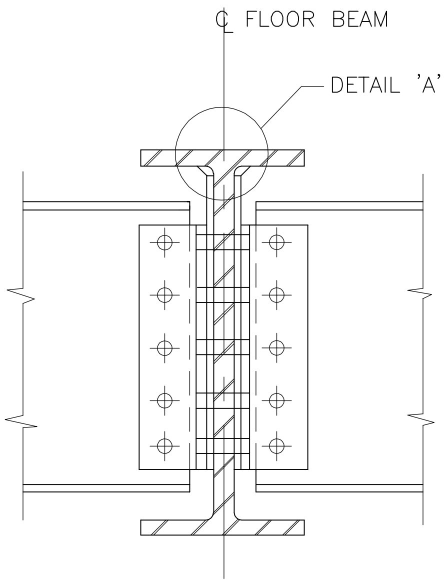
THESE ARE DIAGRAMATIC SKETCHES. THE CONTRACTOR SHALL DESIGN THE CONECTIONS AND SUBMIT FOR RAIL CORRIDORS REVIEW.

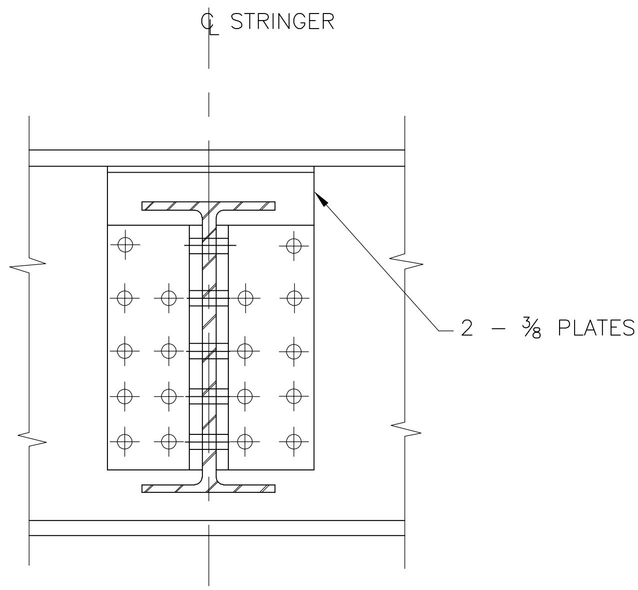
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**FLOOR BEAM CONNECTIONS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

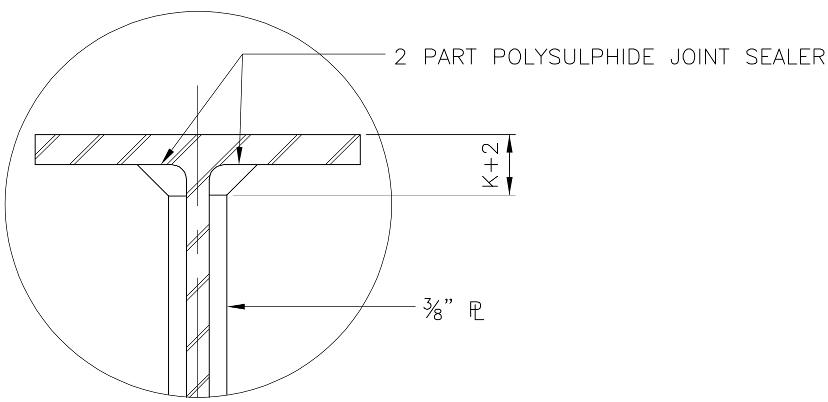
METROLINX

Drawing Number Dessin Numero **S4i**

–







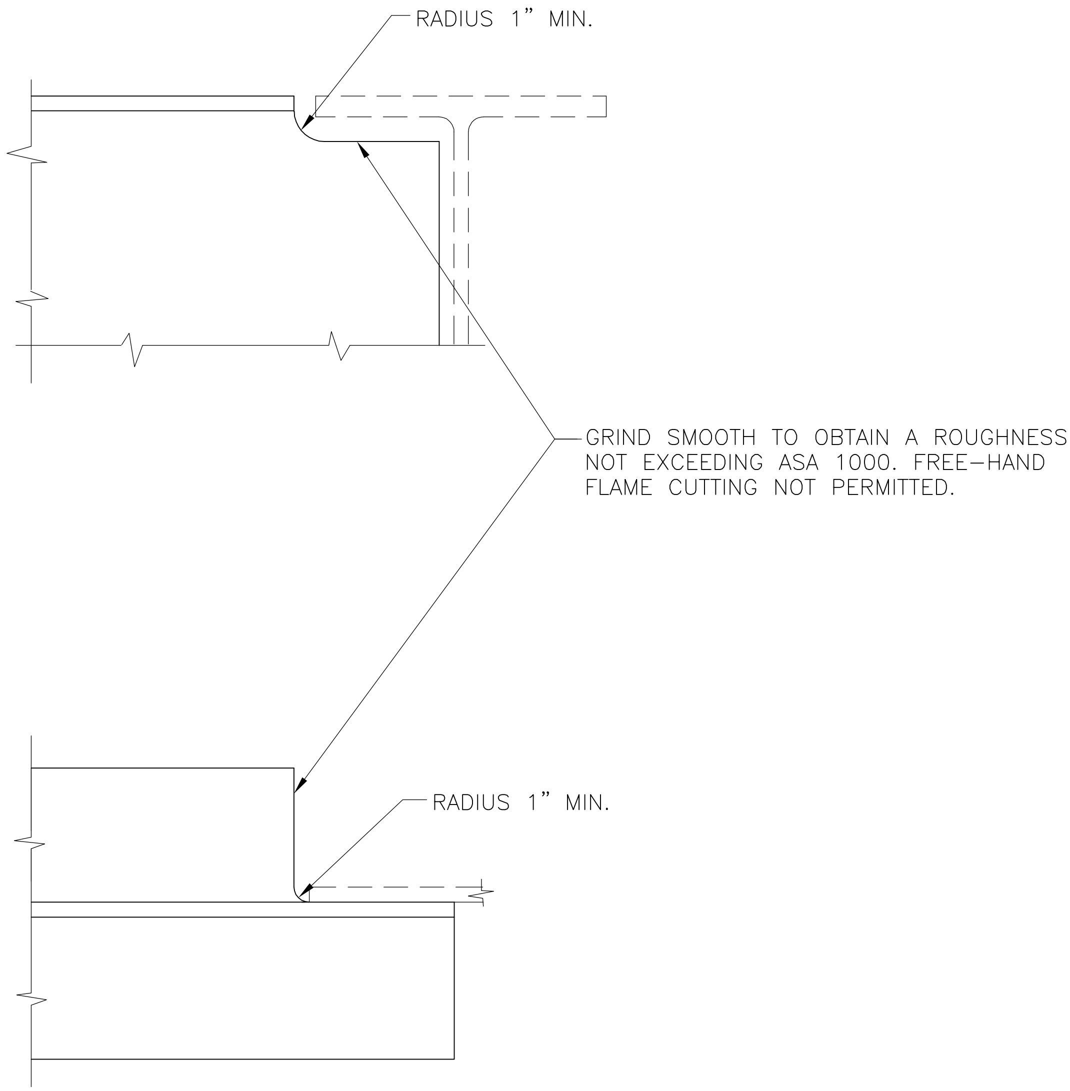
DETAIL 'A'

NOTE:
THESE ARE DIAGRAMATIC SKETCHES. THE CONTRACTOR SHALL DESIGN THE CONNECTION AND SUBMIT FOR RAIL CORRIDORS REVIEW.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STRINGER TO FLOOR BEAM CONNECTION OPEN DECK ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
S5i
–



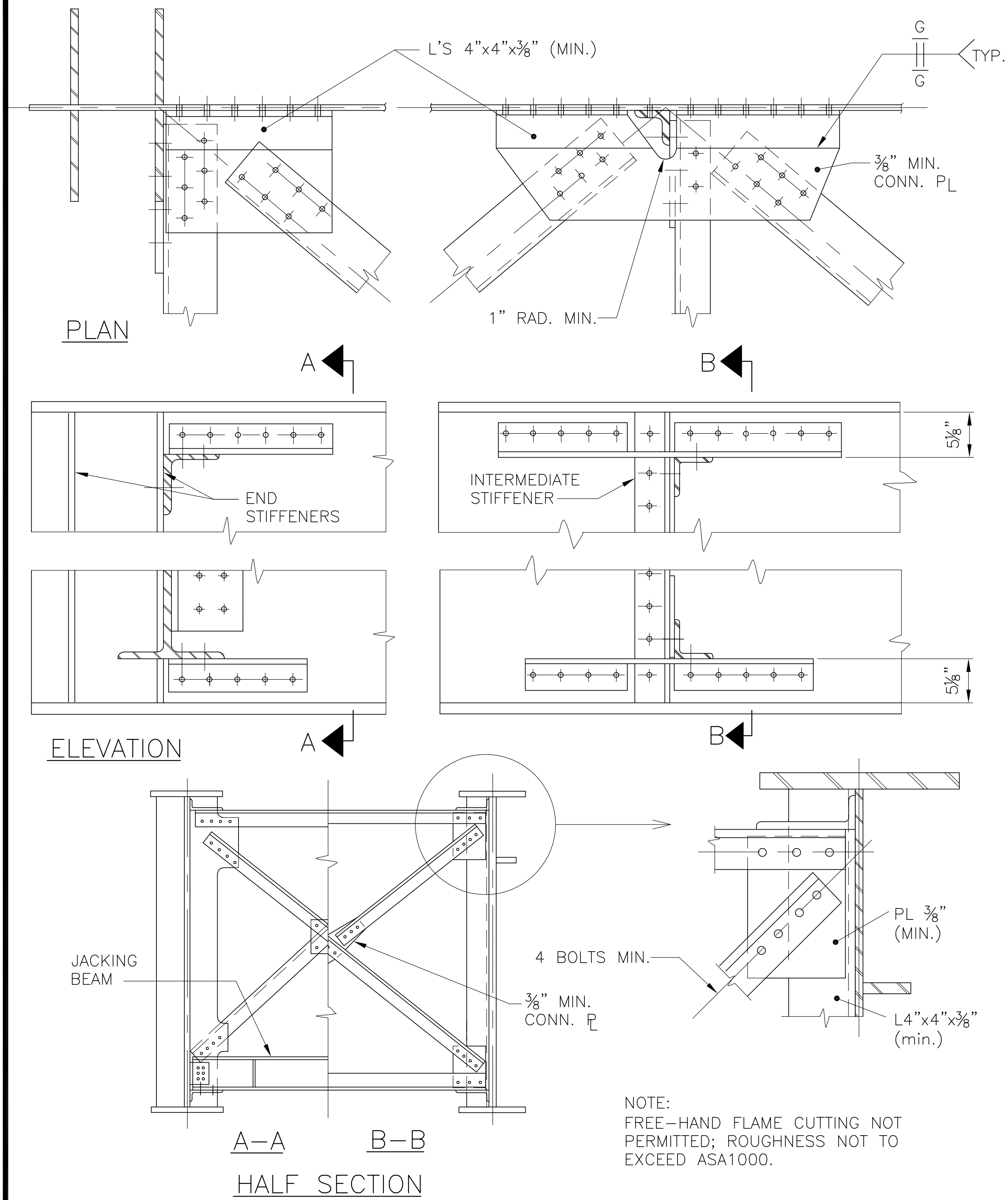
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**BEAM COPES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero

S6i

–



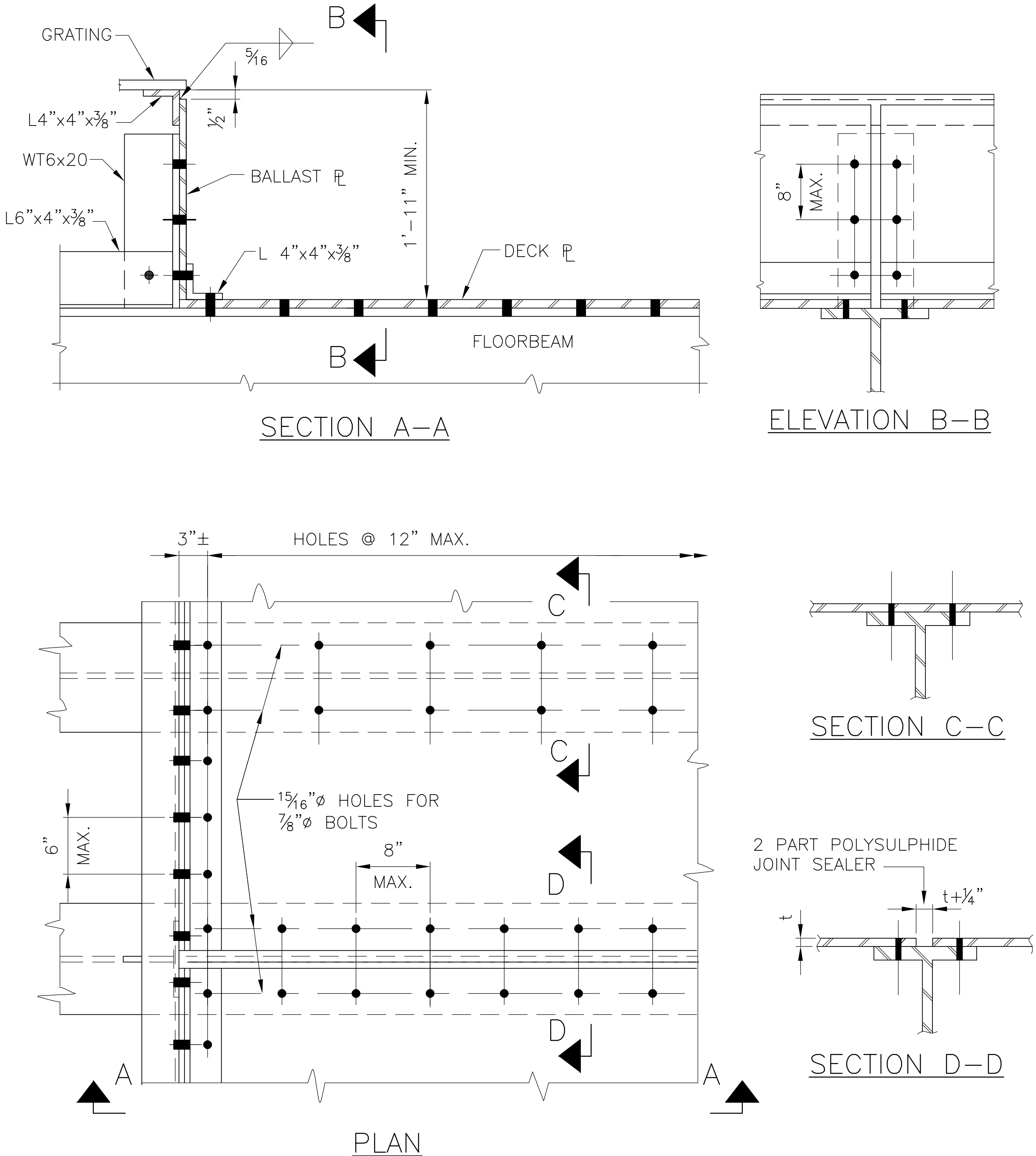
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**LATERAL BRACING FOR DPG SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

S7i

–

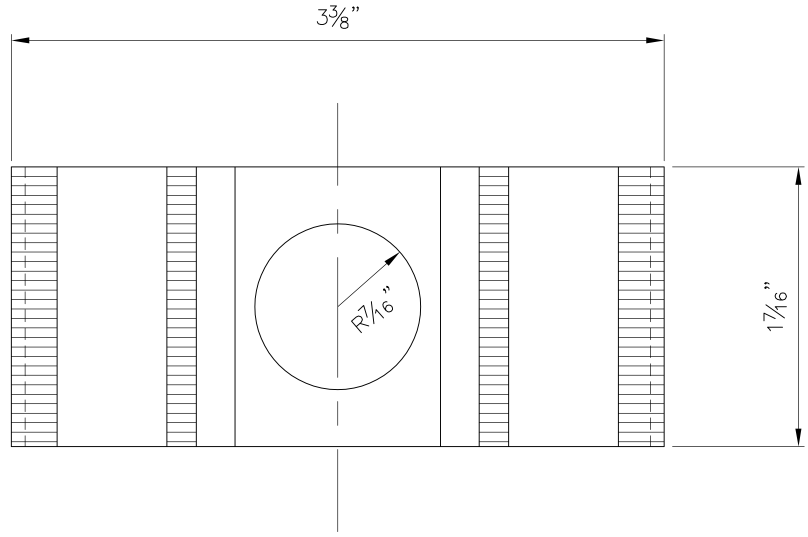


NOTE: USE E 7018 ELECTRODE OR EQUIVALENT FOR WELDS SHOWN.

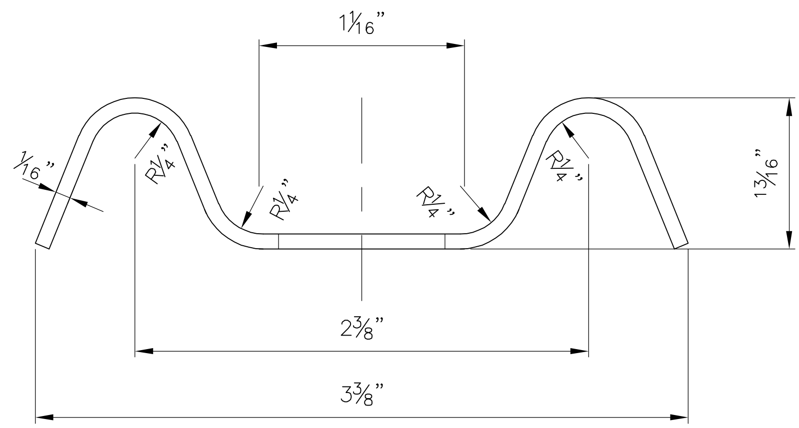
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ATTACHMENT OF DECK PLATE BY BOLTING IN SHOP OR FIELD**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
S8i
–



PLAN



ELEVATION

7/8"ø HOLE FOR USE WITH 3/4"ø BOLT OR LAG SCREW

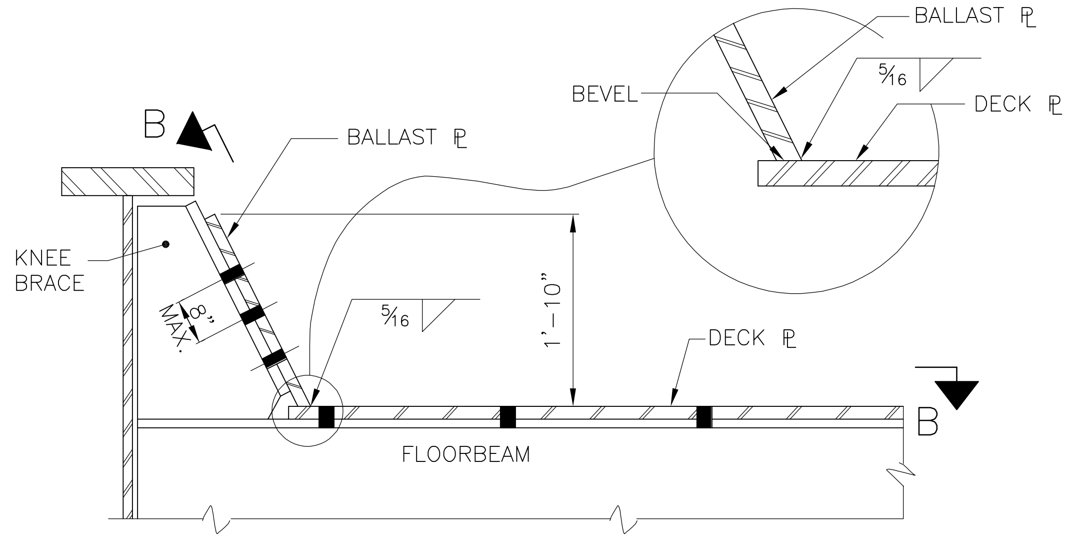
CLIPS AVAILABLE FROM FISHER & LUDLOW OR APPROVED EQUIVALENT

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPE H-3 SADDLE CLIP FOR 38-H-4 HEAVY DUTY GRATING**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

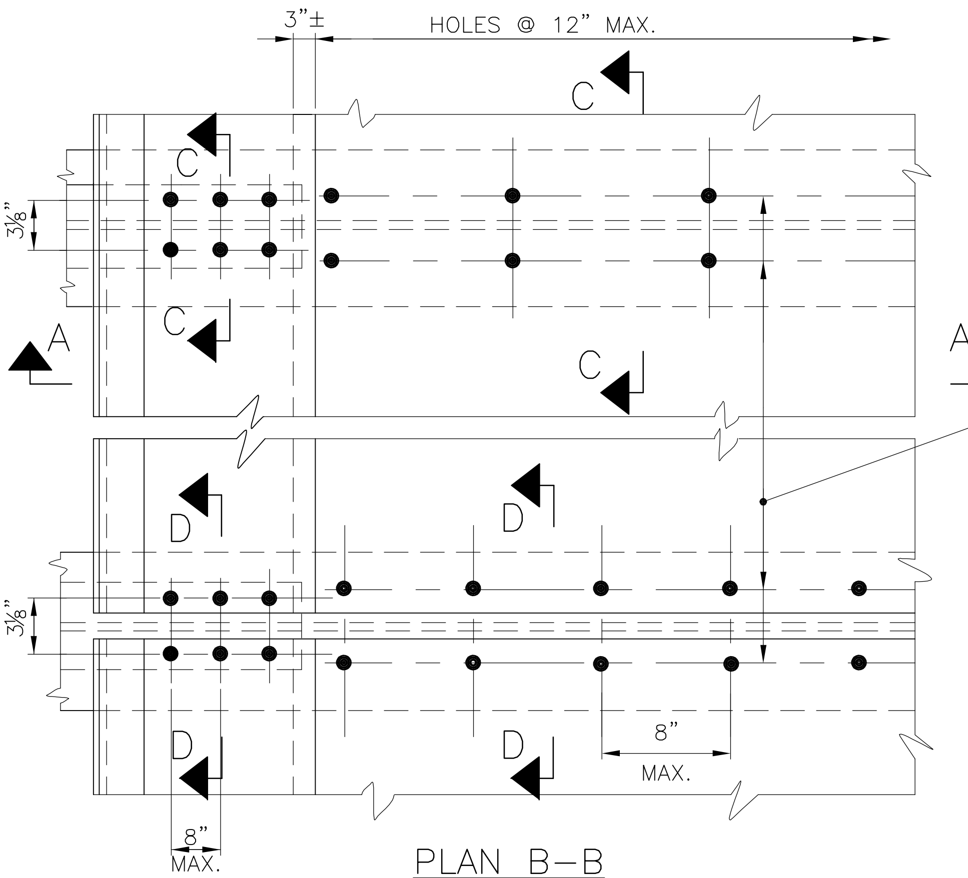
METROLINX

Drawing Number
Dessin Numero
S9i

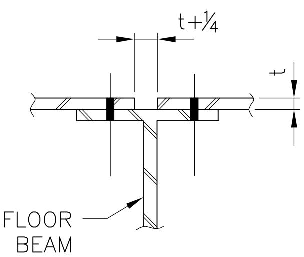
–



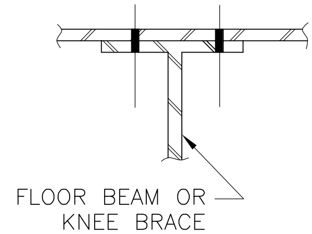
SECTION A–A



PLAN B–B



SECTION D–D



SECTION C–C

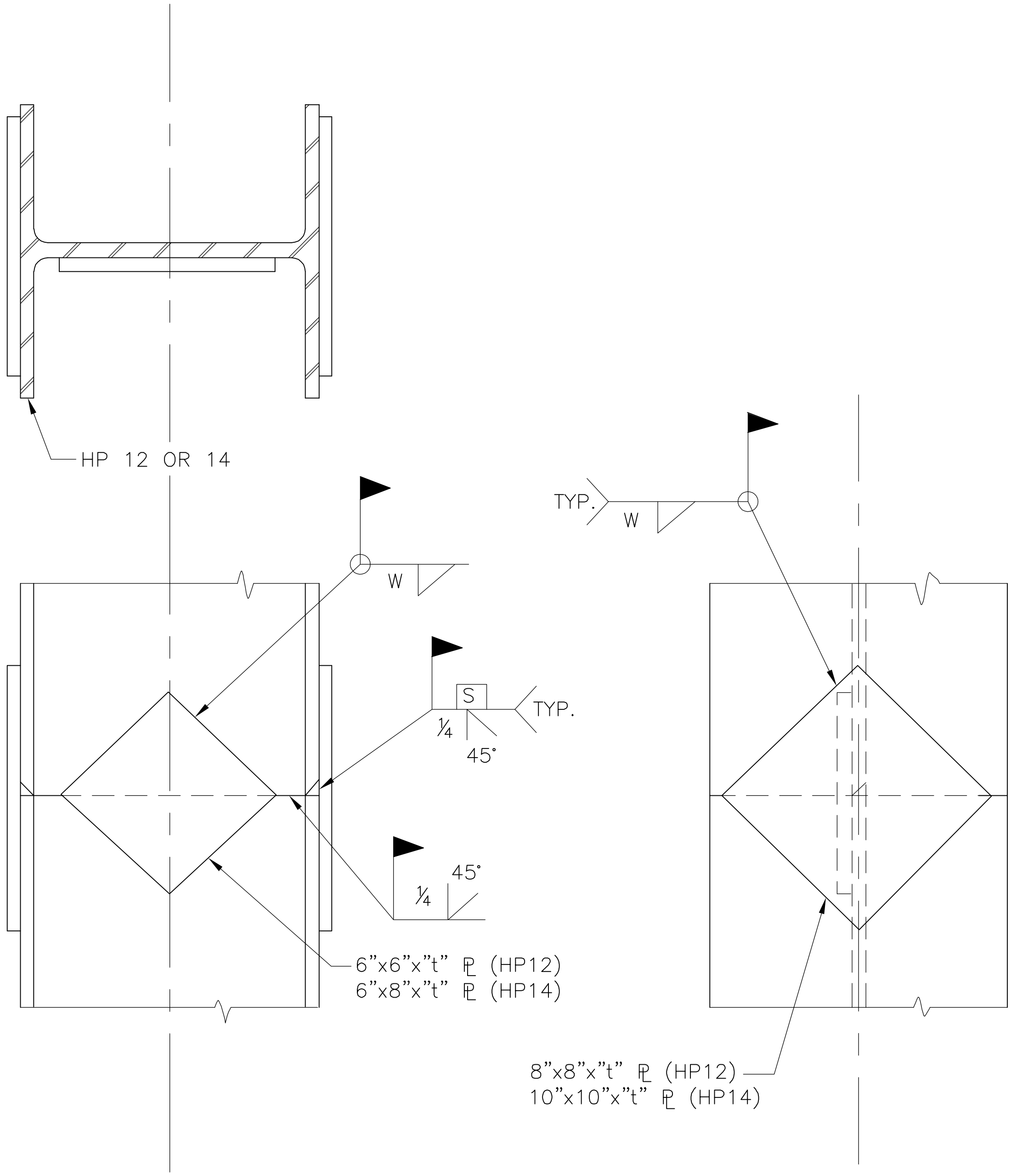
NOTE: USE E 7018 ELECTRODE OR EQUIVALENT FOR WELDS SHOWN.

(FOR SQUARE SPANS 40'–0 & OVER & ALL SKEWED SPANS)

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ATTACHMENT OF DECK PLATE BY BOLTING IN SHOP OR FIELD**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S10i** –

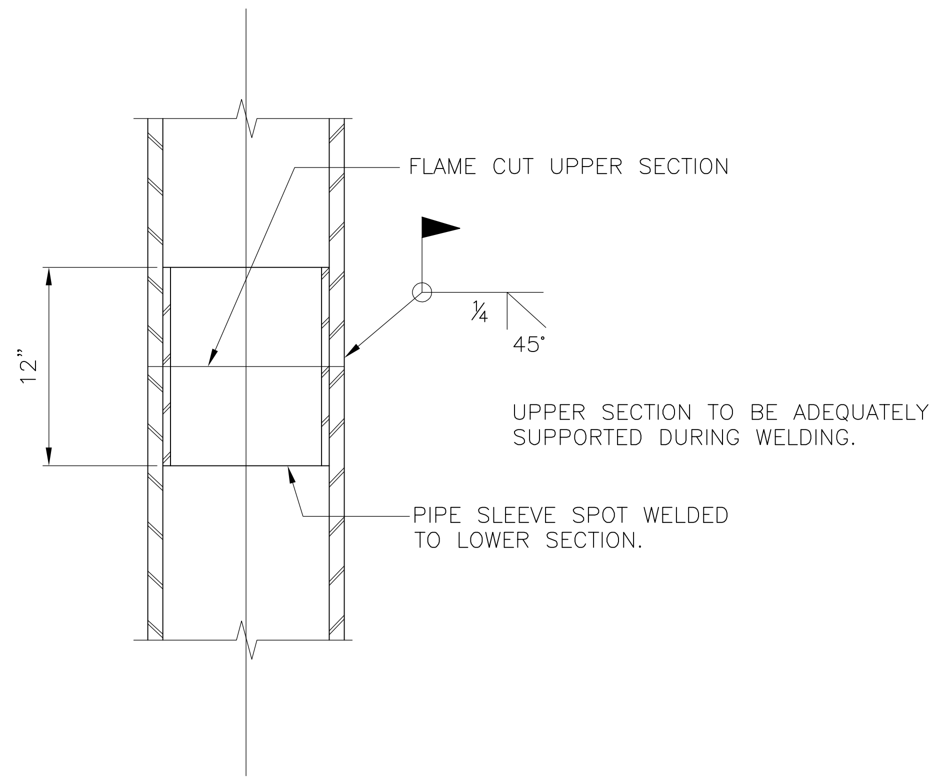


PILE	t	W
HP 12x53	½	5/16
HP 12x74	⅝	⅜
HP 14x73	½	⅜
HP 14x89	⅝	⅜

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**HP 12 & 14 PILE SPLICE** **FOR AXIAL LOAD ONLY**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero: **S12i** –



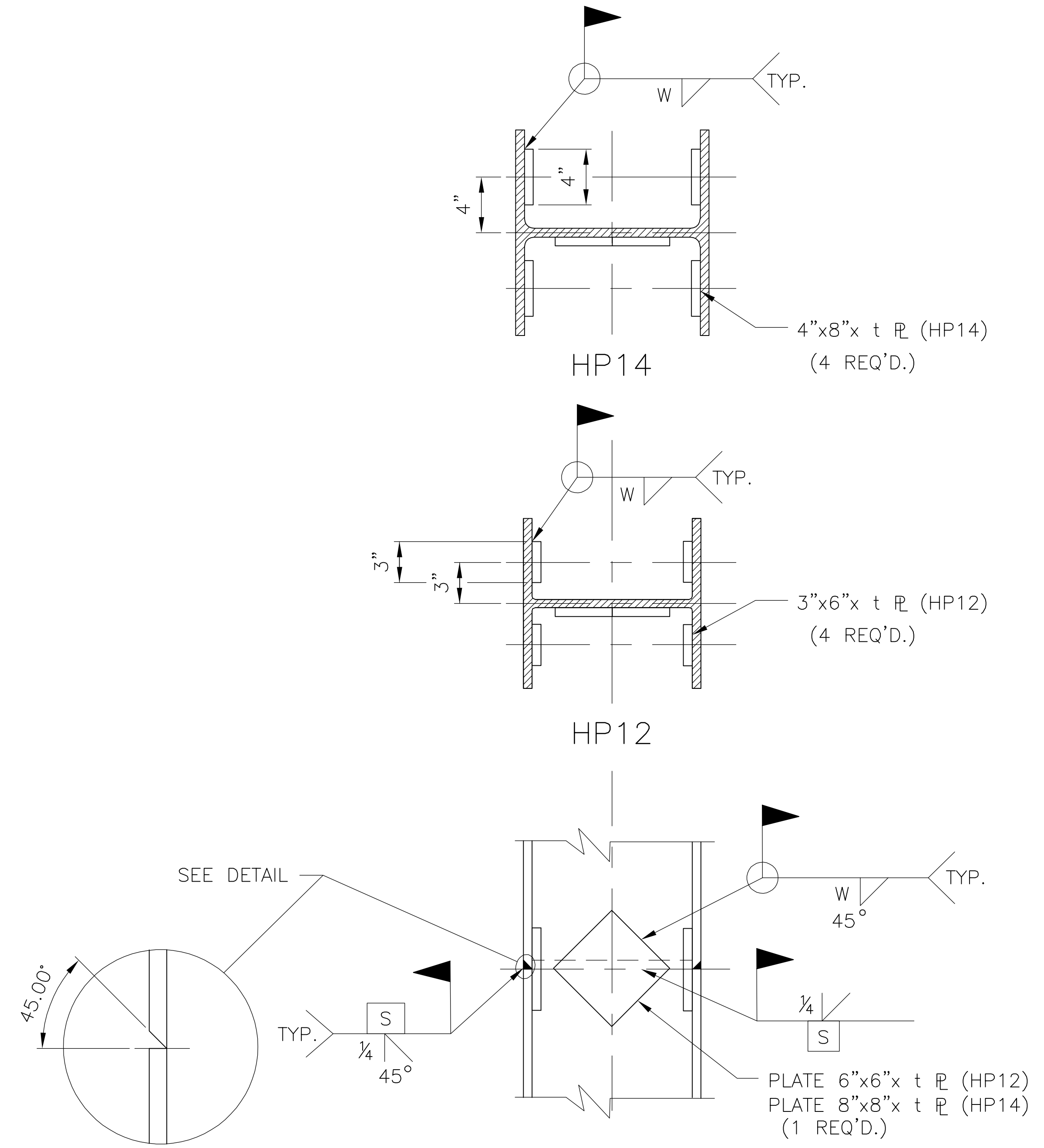
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TUBULAR PILE SPLICE** **FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

S13i

–



USE E48018 ELECTRODES

PILE	t	W
HP 12x53	½	5/16
HP 12x74	5/8	3/8
HP 14x73	½	3/8
HP 14x89	5/8	3/8

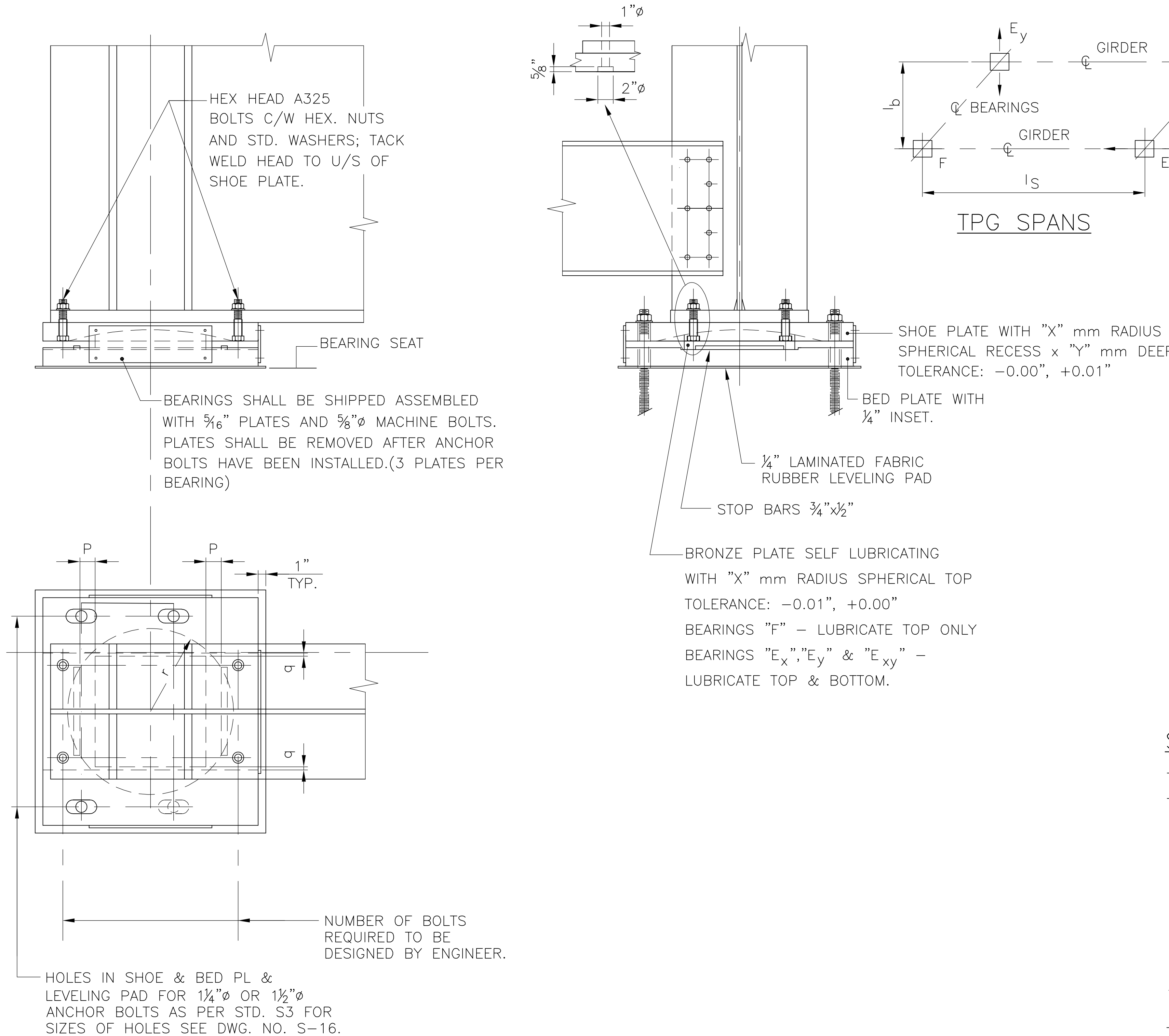
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**HP 12 & 14 PILE SPLICE DETAIL FOR DRIVING THROUGH TEMPLATE FOR AXIAL LOAD ONLY**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

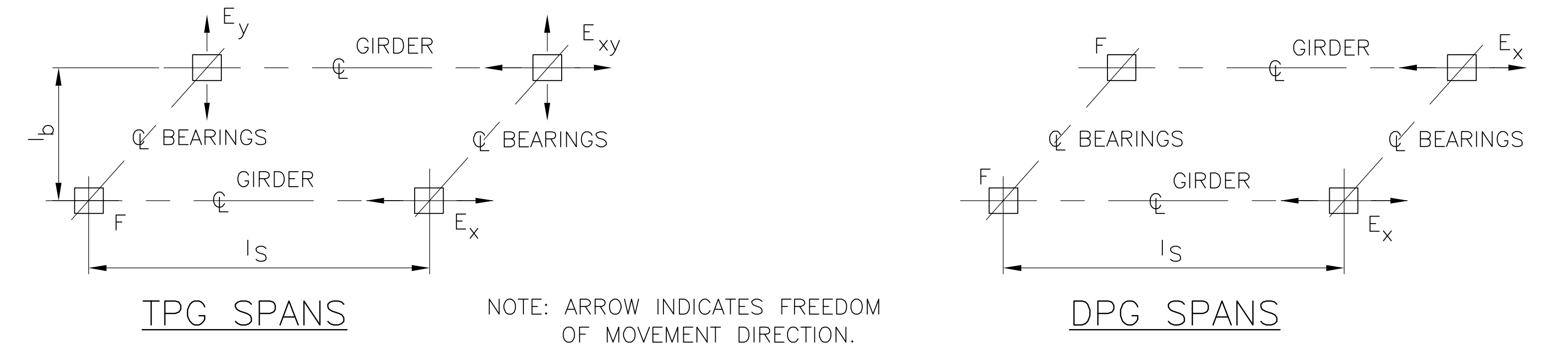
METROLINX

Drawing Number / Dessin Numero

S14i

–





ARRANGEMENT OF BEARINGS

LEGEND

l_b - BEARING C/C

l_s - BRIDGE SPAN

F - FIXED BEARING

E - EPANSION BEARING

BEARING SERVICE LOADS

V_D = ... Kips/BEARING

V_{L+I} = ... "

V_{TOT} = ... "

$H_{MIN} = \frac{V_{TOT}}{10}$ "

STANDARD NOTES:

-DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AREMA MANUAL CHAP. 15.

-MATERIAL SHALL BE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

-STRUCTURAL STEEL:	CSA CAN3-G40.21,
-BRONZE PLATES:	ASTM B22 COPPER ALLOY UNS No. C863000, C91100 or C91300
-BEARING PLATES:	GRADE 300W / ASTM 572 / A36 GRADE 36
-WELDING:	CSA CAN3-W59
-ANCHOR BOLTS:	ASTM F1554
-HS BOLTS	ASTM A325

-ALL HOLES SHALL BE DRILLED OR SUB-PUNCHED AND REAMED.

-ALL NON-SLIDING SURFACES OF BEARINGS SHALL BE ZINC-METALLIZED IN ACCORDANCE WITH CSA G189. ZINC COATING SHALL NOT BE LESS THAN 0.01".

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD BEARINGS FOR DPG & TPG STEEL SPANS (sheet 1)**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **S15i** –

HOLES FOR ANCHOR BOLTS OF DIAMETER "d" :

TPG SPANS

BEARINGS "F" & "E_y"

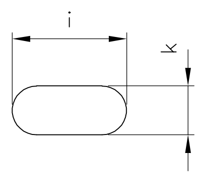
IN SHOE PL:

ROUND HOLES: DIA = d + w (but not less than d + 3/8") where w = greater of w_x and w_y.

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 3/8".

BEARINGS "E_x"& "E_{xy}"



IN SHOE PL:

SLOTTED HOLES i x k

where i = d + 2p

k = d + w_y

(but not less than d + 3/8")

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 3/8".

d = 1¼" FOR SPANS UNDER 80'–0

d = 1½" MIN. FOR SPANS EQUAL TO AND OVER 80'–0.

DPG SPANS

BEARINGS "F"

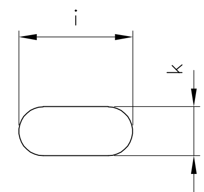
IN SHOE PL:

ROUND HOLES: DIA = d + w_x (but not less than d +3/8")

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 3/8".

BEARINGS "E"



IN SHOE PL:

SLOTTED HOLES i x k

where i = d + 2p

k = d + 3/8"

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 3/8".

MINIMUM REQUIRED CLEARANCES "p" & "q"			
TYPE OF BRIDGE SPAN	TYPE OF BEARING	p	q
DPG	FIXED "F"	1/32"	1/32"
	EXPANSION "E"	SPAN EXP. + w_x	1/32"
TPG	FIXED "F"	1/32"	1/32"
	EXPANSION "E_x"	SPAN EXP. + w_x	1/32"
	EXPANSION "E_y"	1/32"	FL.BEAM EXP.+ w_y
	EXPANSION "E_{xy}"	SPAN EXP. + w_x	FL.BEAM EXP.+ w_y

$w_x = 8R\ \delta_s / l_s$ $\quad$ $w_y = 8R\ \delta_b / l_b$

δ_s = max. deflection of bridge span due to L + I

δ_b = max. deflection of end floor beam due to L + I

R = radius of spherical surface

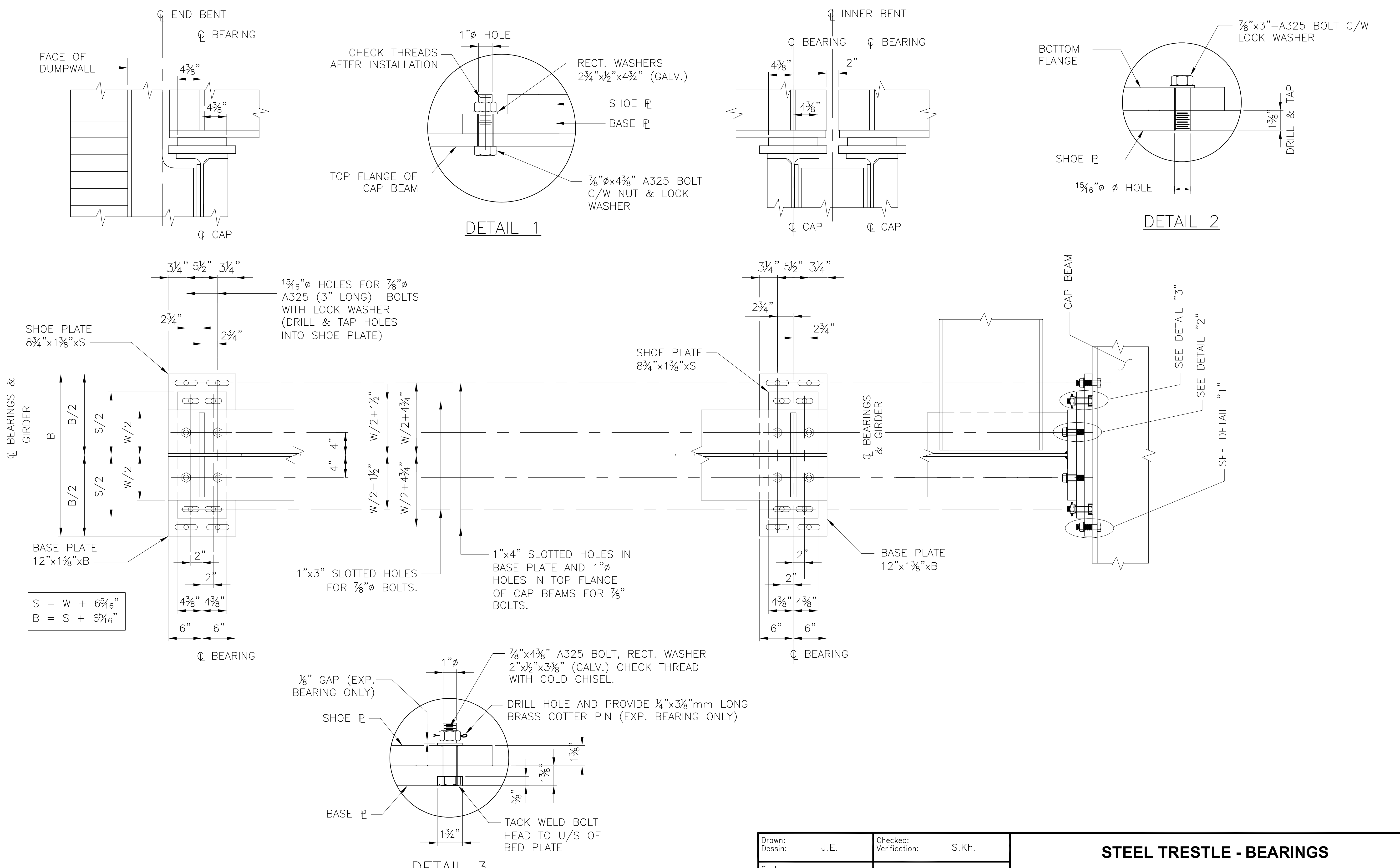
l_s = bridge span length

l_b = distance c. to c. girders

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD BEARINGS FOR DPG & TPG STEEL SPANS (sheet 2)**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S16i** –



Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STEEL TRESTLE - BEARINGS**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **S17i**	–

FLOOR BEAMS SIZE SPAN LENGTH = mm
TOTAL BOTT. FLANGE STRESS = ksi
PERMISS. STRESS = 27.9 ksi
RATIO $\frac{\text{WORKING}}{\text{PERMISS.}}$ =
$\frac{\Delta \text{LL} + \text{I}}{\text{SPAN}} = \frac{1}{\quad}$
$\frac{\text{MAX. STRESS RANGE}}{\text{PERMISS. FATIGUE STRESS}}$ =

TABLE OF STRESSES

SPAN LENGTH C/C BEARINGS

STEEL: SEE NOTES

TOP FLANGE PLATE SIZE AREA = ft^2

WEB PLATE SIZE AREA = ft^2

BOTTOM FLANGE PLATE SIZE AREA = ft^2

Sx−x TOP = ft^3 Ix = ft^4

Sx−x BOT = ft^3

	END REACTION kip	SHEAR STRESS ksi	BENDING MOMENT kipft	BENDING STRESSES BOTT. FLANGE ksi
DEAD LOAD N/m				
LIVE LOAD E90				
IMPACT %				
CENTRIFUGAL FORCE COMPOSITE				
TOTAL GROUP "A"				
ALLOWABLE STRESSES (BENDING & SHEAR)	—	17.75	—	27.9
RATIO OF WORKING STRESS TO ALLOWABLE	—		—	

$$\frac{\Delta \text{LL} + \text{I}}{\text{SPAN}} = \frac{1}{\quad}$$

ALLOWABLE STRESS RANGE FOR FATIGUE CATEGORY "B" FOR N >2,000,000 CYCLES

S_{Rfat} = 16.0 ksi

MAXIMUM DESIGN STRESS RANGE AT BOTTOM FLANGE TO WEB WELD AT MIDSPAN

MPa < S_{Rfat}

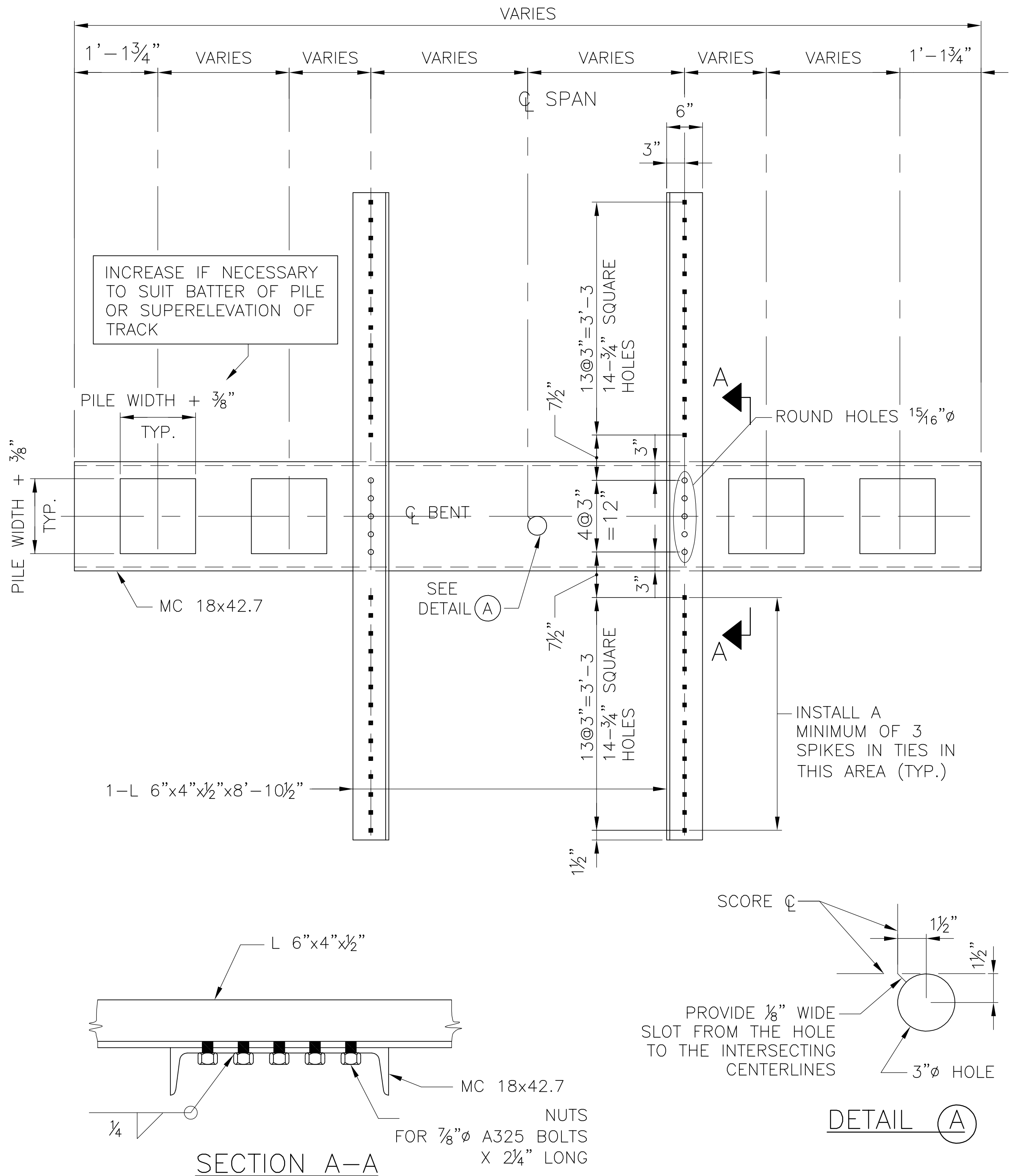
NOTES:

- FOR GENERAL NOTES SEE DRAWING −1.1
- DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AREMA 2016 MANUAL CHAPTER 15
- MATERIAL SHALL BE IN ACCORDANCE WITH THE FOLLOWING SPEC'S.:
  - STRUCTURAL STEEL: SEE PART 2A GUIDELINES FOR DESIGN OF STEEL BRIDGES & STRUCTURES
  - WELDING: C.S.A. CAN3−W59
  - H.S. BOLTS: A.S.T.M. A325, M22, TYPE 3.
- ALL HOLES SHALL BE DRILLED OR SUB−PUNCHED AND REAMED.
- ALL H.S. BOLTS SHALL BE TIGHTENED BY THE TURN−OF−NUT METHOD.
- BOTTOM FLANGES OF GIRDERS OVER BEARINGS SHALL BE TRUE AND SQUARE; MAXIMUM MEASURED DEVIATION AT OUTSIDE EDGE OF BEARING PLATES SHALL NOT EXCEED 1⁄32".
- DEVIATION FROM STRAIGHTNESS OF MAIN GIRDERS SHALL NOT EXCEED ¼".
- DEVIATION RESULTING IN NEGATIVE CAMBER SHALL NOT BE PERMITTED.
- ALL NON−SLIDING SURFACES OF BEARING PLATES SHALL BE ZINC METALLIZED AS PER C.S.A. G189; A.S.T.M. A123 ZINC COATING SHALL NOT BE LESS THAN 0.01".
- THE SPANS SHALL BE SHIPPED ENTIRELY SHOP ASSEMBLED.
- METROLINX STANDARD DRAWINGS ARE REFERENCED TO PROVIDE ADDITIONAL INFORMATION NOT SHOWN ON THIS DRAWING.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	TYPICAL NOTES FOR STEEL SPANS
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S18i** –

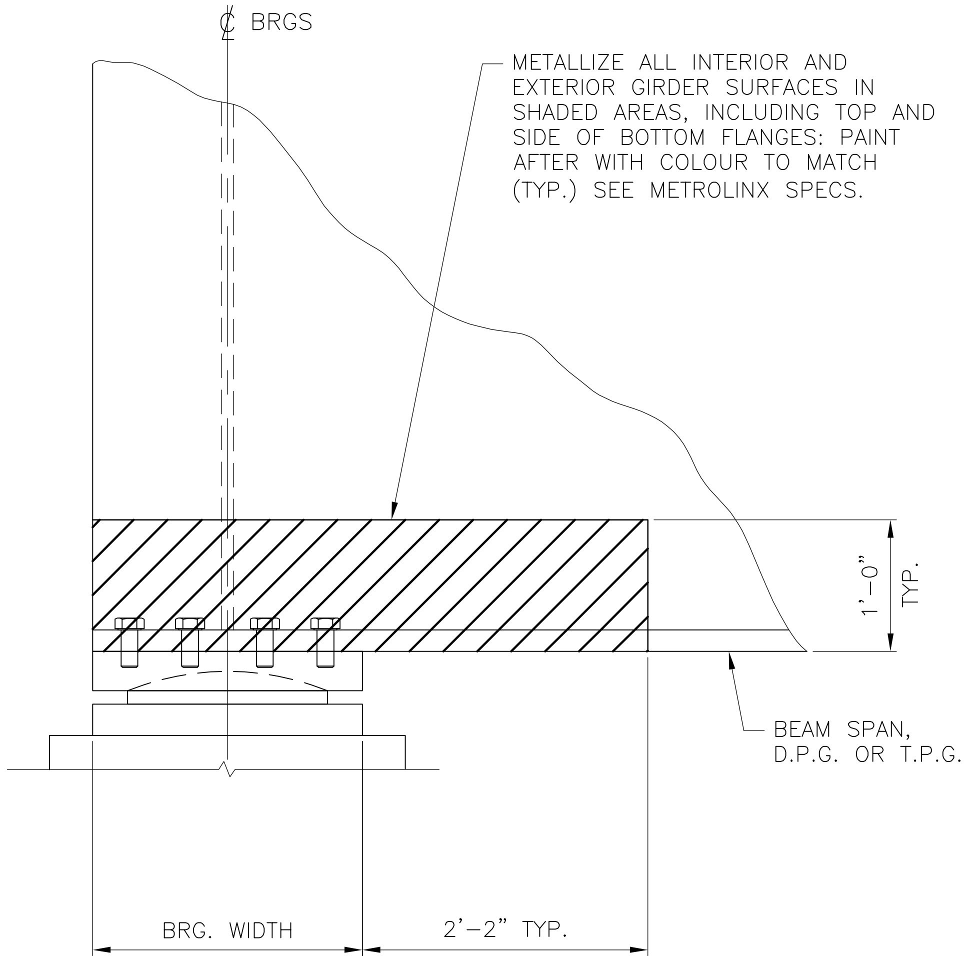


Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31

TEMPLATE FOR PILE DRIVING

METROLINX

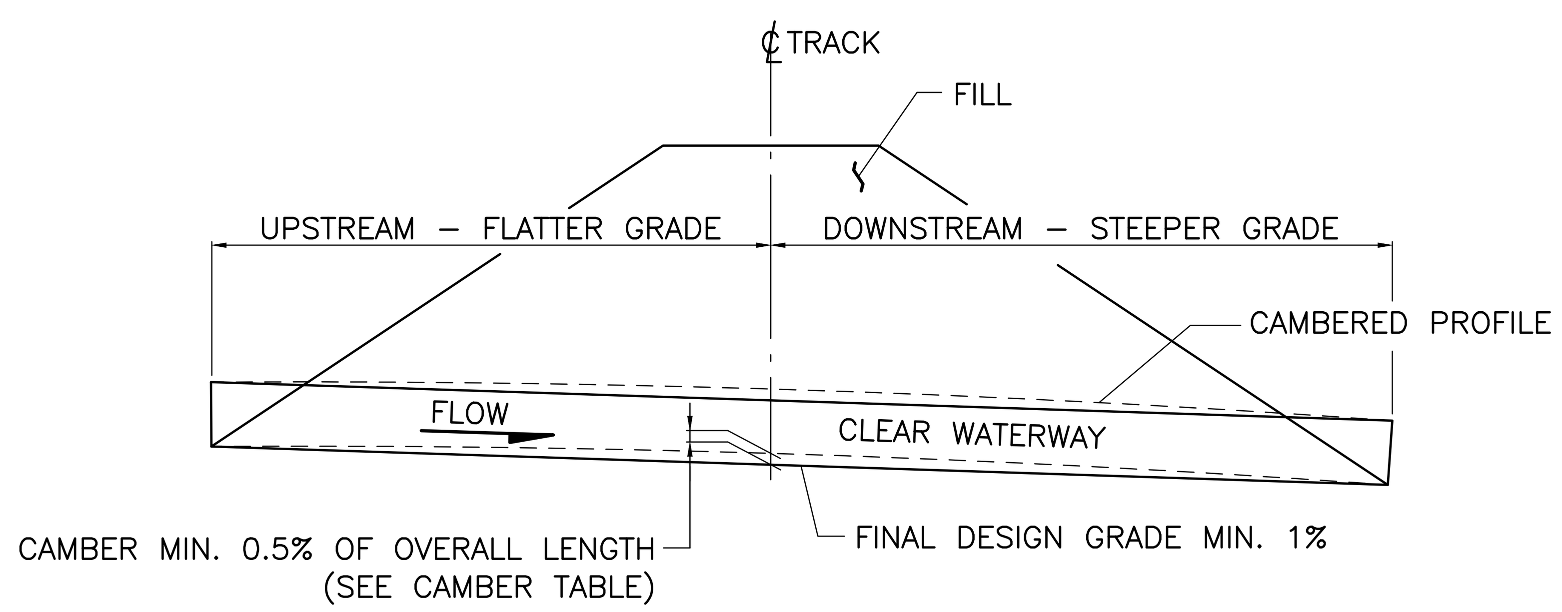
Drawing Number / Dessin Numero: **S19i** –



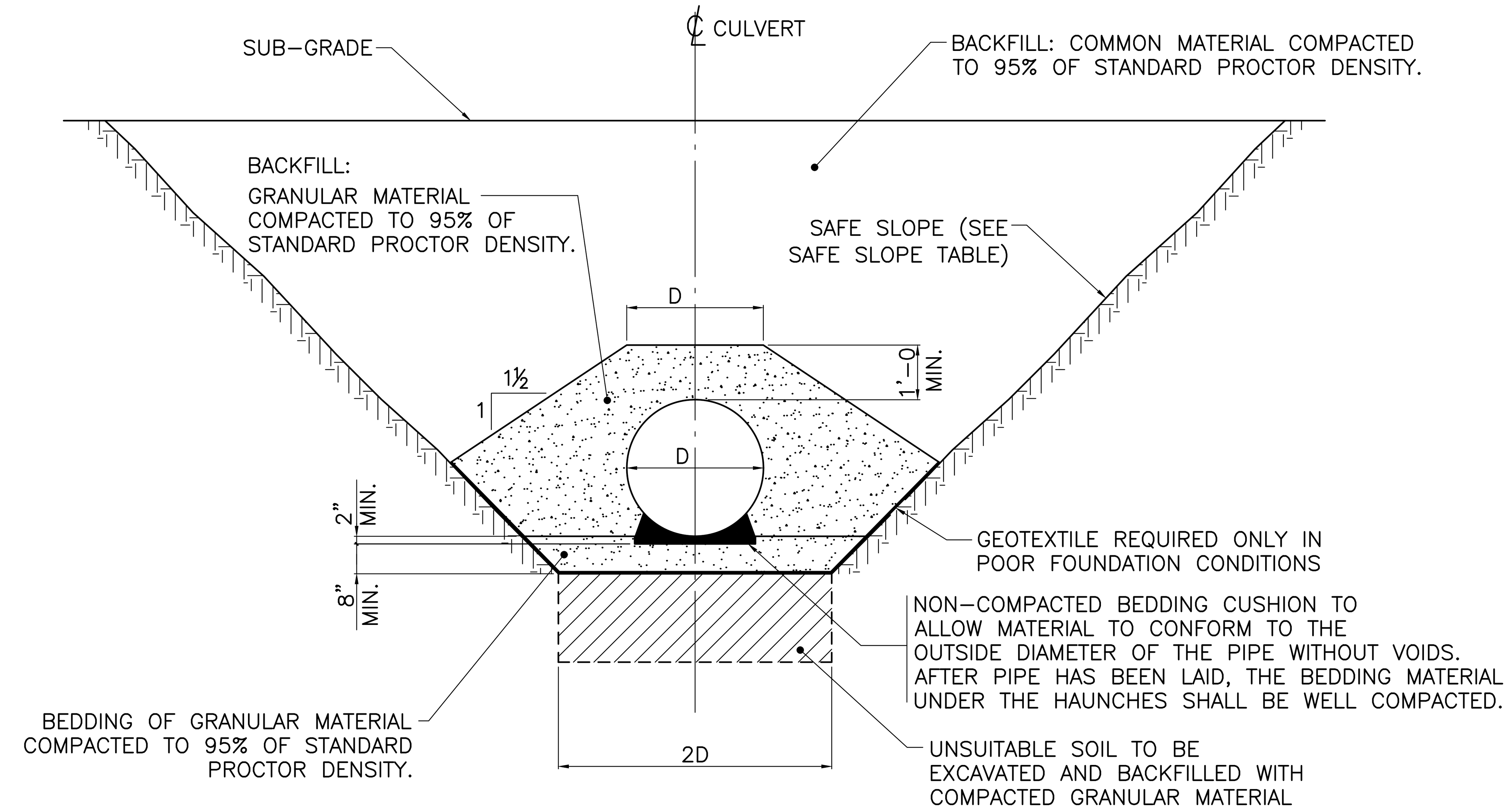
NOTES:

METALLIZING IN ACCORDANCE WITH SSPC–CS 23.00 OR A.S.T.M. B833
ZINC METALLIZING SHALL NOT BE LESS THAN 0.01" THICKNESS

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**METALLIZING AREA FOR BEAM SPANS, DPG & TPG SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **S20i** –

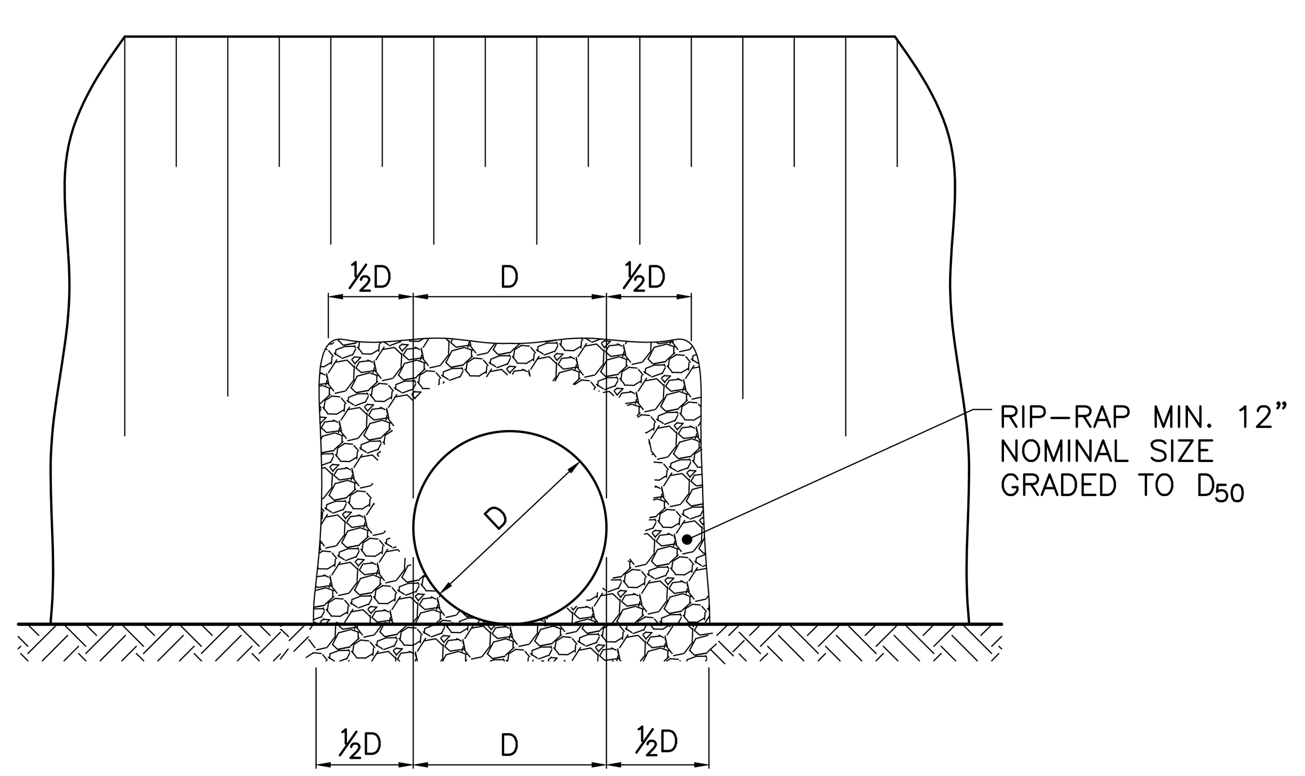


MINIMUM GRADE AND CAMBERING REQUIREMENTS FOR CULVERT INSTALLATION

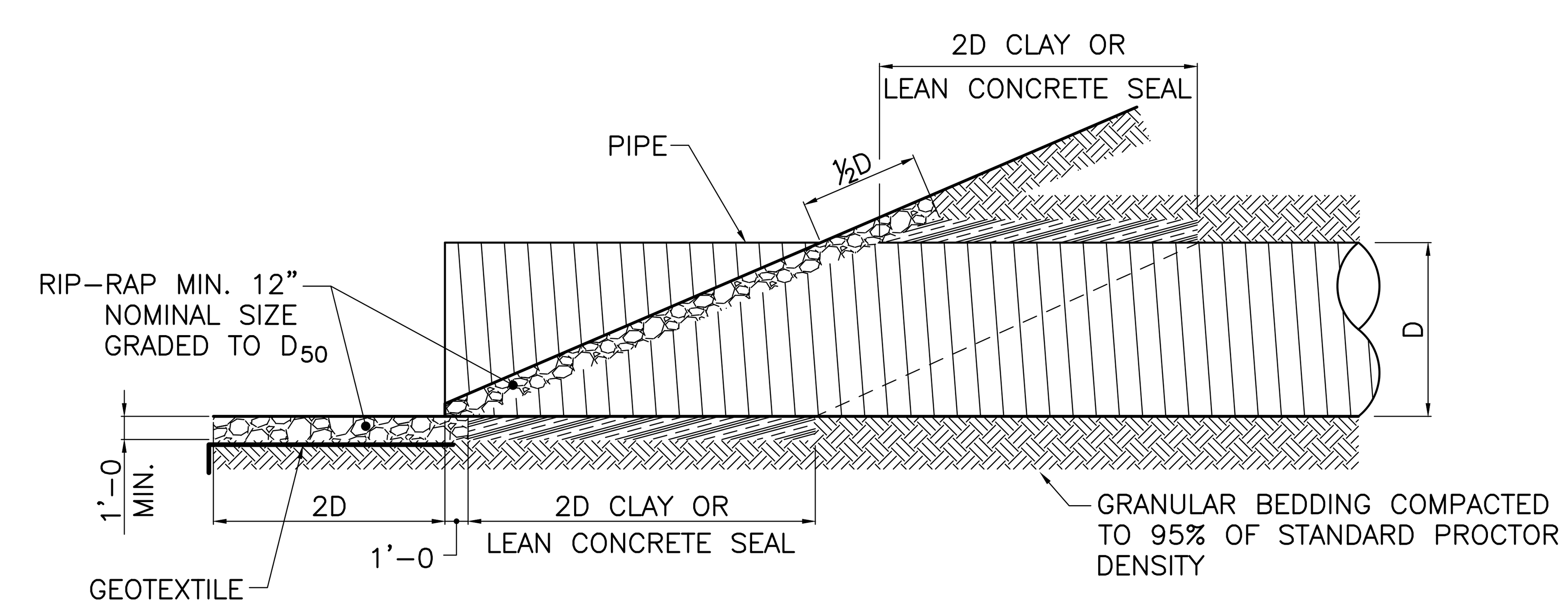


GRANULAR MATERIAL FOR BEDDING AND BACKFILLING TO BE APPROVED BY THE ENGINEER. IN GENERAL, PIT–RUN SAND AND GRAVEL, REASONABLY WELL GRADED FROM MAXIMUM SIZE 4" TO NOT MORE THAN 8% FINER THAN SIEVE No. 200.

MINIMUM GRADE AND CAMBERING REQUIREMENTS FOR CULVERT INSTALLATION



RIP-RAP PROTECTION



INORGANIC CLAY OR LEAN CONCRETE SEAL TO BE PLACED AT BOTH ENDS OF CULVERTS FOR A LENGTH OF TWICE THE DIAMETER (2D). THE CLAY OR LEAN CONCRETE SEAL SHALL EXTEND FROM THE BOTTOM OF THE EXCAVATION TO 12" ABOVE THE CROWN OF THE PIPE AND FOR THE FULL WIDTH OF THE EXCAVATION.

SEEPAGE CUT-OFF DETAIL

GENERAL NOTES:

SCOPE:
CULVERT SIZES IN TABLE 3 AND 4 HAVE BEEN DEVELOPED BASED ON STRENGTH AND DURABILITY REQUIREMENTS FOR NORMAL SITE CULVERT INSTALLATIONS.

DESIGN LOAD: E80 + IMPACT

DURABILITY BASED ON 75 YEAR SERVICE LIFE.

CULVERT DURABILITY:
SITE SPECIFIC DESIGN IS REQUIRED WHERE WATER AND/OR SOIL IS CORROSIVE OR ABRASIVE.
WATER AND/OR IN CLAY, CLAY LOAM, PEAT AND ORGANIC SOILS SHOULD BE TESTED FOR WATER AND SOIL CORROSIVENESS. TESTS TO BE CARRIED OUT ARE RESISITIVITY AND PH TESTING IN ACCORDANCE WITH CALIFORNIA TEST METHOD 6438 AND SHALL BE PERFORMED BY A QUALIFIED MATERIALS TESTING COMPANY.

INSTALLATION:
PIPE SHALL BE INSTALLED IN ACCORDANCE WITH CN ENGINEERING RECOMMENDED METHOD OF INSTALLATION OF CULVERTS RM4402.

FOR MULTIPLE PIPE INSTALLATIONS, THE CLEARANCE BETWEEN CULVERTS SHALL NOT BE LESS THAN ½ THE PIPE DIAMETER, BUT NEED NOT BE GREATER THAN 3 FT UNLESS REQUIRED FOR SPECIFIC CONSTRUCTION COMPACTION METHODS AND EQUIPMENT.

FOR PIPES SIZES GREATER THAN 60", TEMPORARY STRUTTING SPACED AT MAX. 10' SPACING SHALL BE PROVIDED.

FOR VERTICAL FACE CUTS, SHORING TO BE PROVIDED AND SHALL BE ENGINEERED TO SUIT HEIGHT OF EMBANKMENT AND VERTICAL FACES.

COVER:
THE MINIMUM HEIGHT AND MAXIMUM HEIGHT OF COVER FOR VARIOUS CULVERT SIZES AND SPECIFIED WALL THICKNESS ARE GIVEN IN TABLES 3 AND 4.

END TREATMENT:
WHERE REQUIRED TO PREVENT, EROSION, UNDERMINING, DRIFT AND DEBRIS DETENTION AT THE INLET AND/OR OUTLET, OR WHERE REQUIRED TO INCREASE HYDRAULIC CAPACITY, THE ENGINEER SHALL SPECIFY AN APPROPRIATE CULVERT PIPE END TREATMENT. END TREATMENT MAY CONSIST OF SLOPE RIP–RAP, GABIONS, STANDARD STEEL CULVERT APRONS, BEVELLED PIPE ENDS OR CONCRETE HEADWALLS WITH RIP–RAP APRONS.

SPECIFICATIONS:

CULVERTS:
CSP SHALL BE PLAIN GALVANIZED CORRUGATED STEEL PIPE IN ACCORDANCE WITH CSA STANDARD CAN3–G401, AASHTO M–218 OR ASTM A929.

SPCSP SHALL BE PLAIN GALVANIZED STRUCTURAL PLATE PIPE IN ACCORDANCE WITH CSA STANDARD CAN3–G401, AASTHO M–167 OR ASTM A761.

GALVANIZING SHALL BE NOT LESS THAN 0.125 lb/ft^2 OF SURFACE (TOTAL BOTH SIDES)

ALTERNATIVE COATINGS:
ALUMINIZE STEEL TYPE 2 – ASTM A929 AND AASHTO M–274 WITH 0.062 lb/ft^2 COATING WEIGHT.
POLYMER COATING SUCH AS TRENCHCOAT OR EQUIVALENT – ASTM A742 OR AASHTO M–525 WITH 10/10 GRADE FINISH.

GEOTEXTILE FILTER FABRIC:
WHEN IN THE OPINION OF THE ENGINEER, FOUNDATION CONDITIONS ARE CONSIDERED SOFT AND UNSTABLE, WOVEN GEOTEXTILE FILTER FABRIC SHALL BE INSTALLED AT THE BASE OF THE EXCAVATION AND SHALL CONFORM WITH THE FOLLOWING:

- GRAB STRENGTH .... 290 LBS
- ELONGATION (FAILURE) 15%
- PUNCTURE STRENGTH .... 60 LBS
- BURST STRENGTH .... 525 PSI
- TRAPEZOIDAL TEAR .... 105 LBS
- MINIMUM FABRIC LAP TO BE 3'

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SCALE: 1:XXX	FULL SIZE ONLY

CORRUGATED STEEL PIPE (CSP) AND STRUCTURAL PLATE CORRUGATED STEEL PIPE (SPCSP) CULVERTS

CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R7A–80.1i–1		

TABLE 1: CAMBER TABLE

LENGTH (FT)	CAMBER (IN)
20	1.2
30	1.8
40	2.4
50	3.0
60	3.6
70	4.2
80	4.8
90	5.4
100	6.0

TABLE 2: SAFE SLOPE TABLE

TYPE	SOIL CONDITION	SAFE SLOPE
A	HARD, DENSE AND STIFF SOILS WITH A LOW MOISTURE CONTENT	1 HORIZ: 1 VERT
B	MEDIUM DENSITY SOILS WHICH ARE OF LOOSECONSISTENCY, HAVE BEEN PREVIOUSLY EXCAVATED OR EXHIBIT SIGNS OF WATER SEEPAGE	1.5 HORIZ: 1 VERT
C	SOFT, VERY LOOSE, WET AND MUDDY SOILS	3 HORIZ: 1 VERT

THE SAFE SLOPE SHALL BE REDUCED WHEN THE FOLLOWING CONDITIONS OCCUR:

- SIGNS OF DISTRESS APPEAR AT THE FACE OF THE CUT OR AT THE GROUND ADJACENT TO THE OPEN EXCAVATION
- SURCHARGE LOADS FROM STORED MATERIAL OR EQUIPMENT OPERATE AT TOP OF CUT
- HIGH WATER TABLE
- INADEQUATE OR UNCERTAIN SOIL PROPERTIES DATA.

TABLE 3: STEEL ROUND CORRUGATED PIPE (CSP)
MINIMUM AND MAXIMUM HEIGHT OF COVER
ASSUMED NORMAL SITE CONDITION
PH > 6–8, MINIMUM RESISTIVITY > 381000 ohm–in.

CULVERT SIZE ID (IN)	MIN COVER (FT)	MAXIMUM COVER (FT)							
		CORRUGATION PROFILE							
		2⅔ x ½				5 x 1			
		16 ga	14 ga	12 ga	10 ga	14 ga	12 ga	10 ga	8 ga
24	4	20	30	44					
30	4	18	24	36					
36	4	15	18	30	32				
42	4	12	16	25	28				
48	4		24	40		28	50	66	
54	6			30		26	45	58	
60	6					23	40	52	62
66	8					20	36	48	56
72	8					18	34	42	52
78	8					16	30	40	48
84	8						22	36	44
90	8						20	34	40
96	8							30	38

NOTES: MINIMUM SIZE OF CSP CULVERTS TO BE 36 in. DIA.
24 in. AND 30 in. DIA. CSP CULVERTS ARE TO BE USED WHERE EXISTING COVER DOES NOT PERMIT A 36 in. DIA. SIZE CULVERT.
SELECTION OF CULVERTS SHALL BE BASED ON MINIMUM GAUGE FOR ANY GIVEN DIAMETER.
IN POOR GROUND CONDITIONS, IT IS RECOMMENDED THAT RIVETED PIPES BE USED.

TABLE 4: STRUCTURAL PLATE PIPE (MULTI PLATE/SPCSP)
MINIMUM AND MAXIMUM HEIGHT OF COVER
ASSUMED NORMAL SITE CONDITION
PH > 6–8, MINIMUM RESISTIVITY > 381000 ohm–in.

CULVERT SIZE ID (IN)	MIN COVER (FT)	CORRUGATION PROFILE 6 x 2					
		MAXIMUM COVER (FT)					
		12 ga	10 ga	8 ga	7 ga	5 ga	3 ga
84	8	22	36	50	60	74	86
96	8	18	32	44	52	65	78
108	8	16	28	38	46	58	70
120	8		25	35	42	52	62
132	8		22	32	36	46	56
144	8		20	28	34	42	52
156	8			26	32	38	48
168	8			24	28	36	45
180	8				26	34	40

TABLE 5: CULVERTS IN CORROSIVE CONDITIONS

SOIL TYPE	DESCRIPTION	DEGREE OF CORROSIVENESS	UPGRADES	
			WALL THICKNESS	COATINGS
1	SANDY SILT	LOW	NONE	NONE
2	CLAYEY SOIL	MODERATE	INCREASE IN GAUGE	ALUMINIZED/POLYMER/INCREASE GALVANIZING THICKNESS 0.186/0.25 lb/ft^2 (ONLY SPCSP)
3	MARSH AND PEATY SOIL	SEVERE	INCREASE IN GAUGE	ALUMINIZED/POLYMER/INCREASE GALVANIZING THICKNESS 0.25 lb/ft^2 (ONLY SPCSP)

NOTE:

1. RECOMMENDED ALTERNATIVE COATINGS ARE:
   - ALUMINIZED STEEL TYPE 2 IN ACCORDANCE WITH ASTM A929 AND AASHTO M–274 WITH 0.62 lb/ft^2
   - POLYMER COATING SUCH AS TRENCHCOAT OR EQUIVALENT IN ACCORDANCE WITH ASTM A742 AND AASHTO M525 WITH 10/10 FINISH.
2. ABRASION IS A COMBINATION OF STREAM VELOCITY AND BED LOAD. IN GEOGRAPHIC AREAS WHERE HEAVY LOADS OF SAND AND SMALL GRAVEL POSE AN ABRASION PROBLEM, AND FLOW VELOCITY IS HIGH, INCREASE RECOMMENDED THICKNESS BY ONE GAUGE THICKNESS.
3. SELECTION OF UPGRADES OR COMBINATION OF UPGRADES SHALL BE DETERMINED BY THE SEVERITY OF SITE CONDITIONS.

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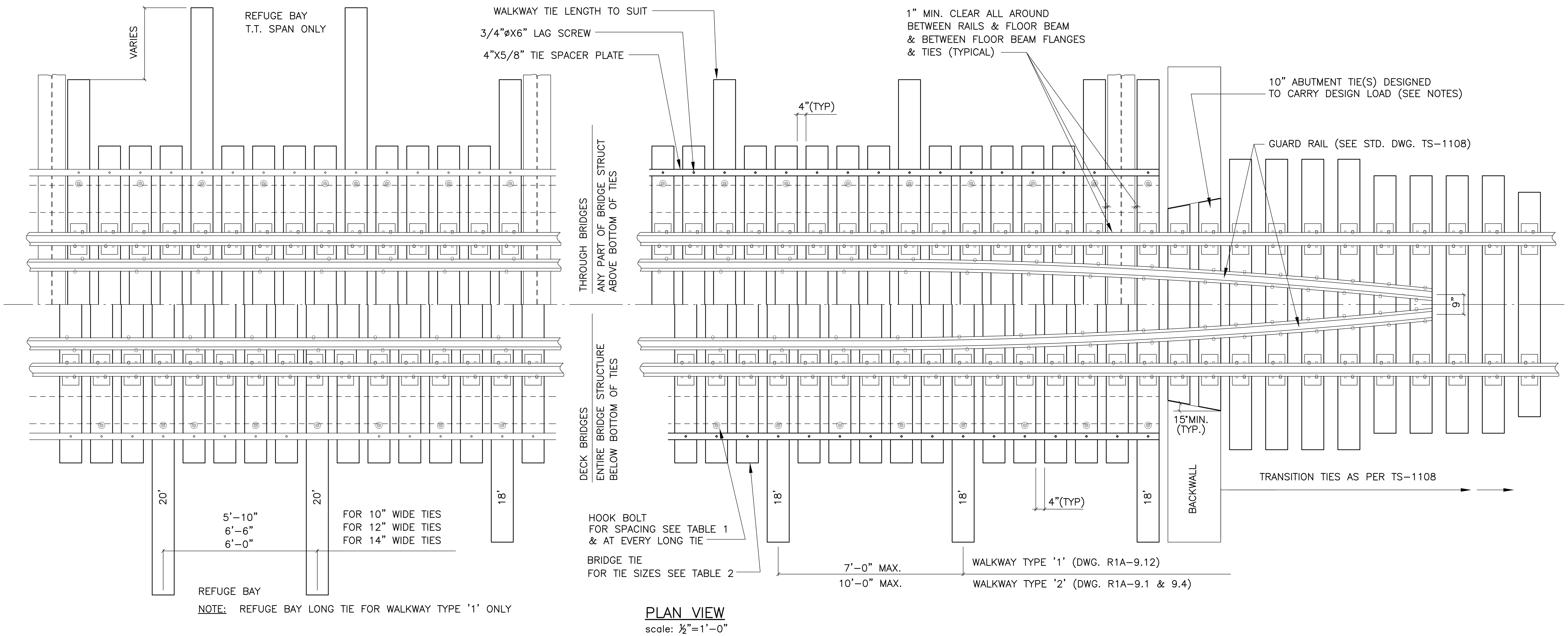
CORRUGATED STEEL PIPE (CSP) AND STRUCTURAL PLATE CORRUGATED STEEL PIPE (SPCSP) CULVERTS

CONTRACT NO. –
DWG. NO. R7A–80.1i–2
REV.
SHEET



PLAN VIEW
scale: ½"=1'-0"

CE DESSIN EST AUSSI DISPONIBLE EN FRANCAIS

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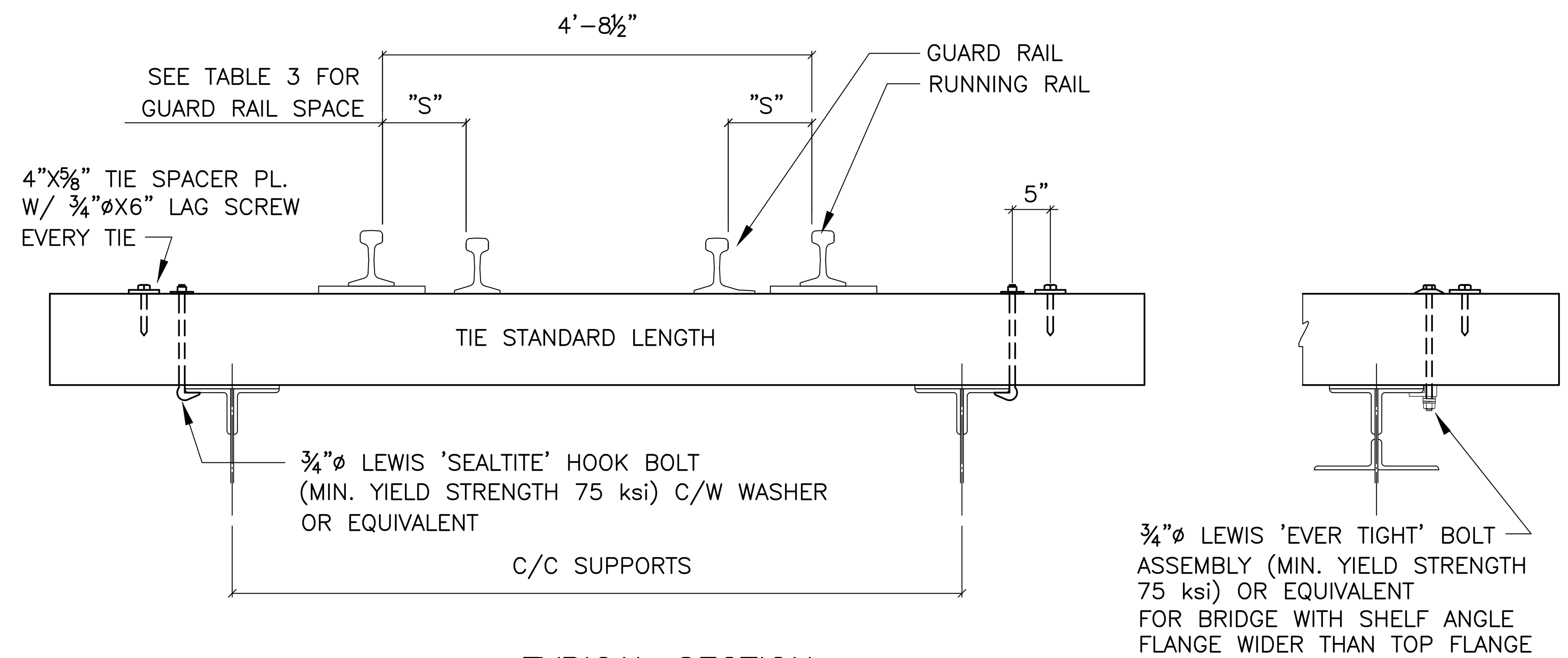
CHECKED BY: YY/MM/DD	APPROVED BY: YY/MM/DD
SCALE: 1:XXX	FULL SIZE ONLY

METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES
SYSTEM "A"

CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A-1.6i-1		



TYPICAL SECTION
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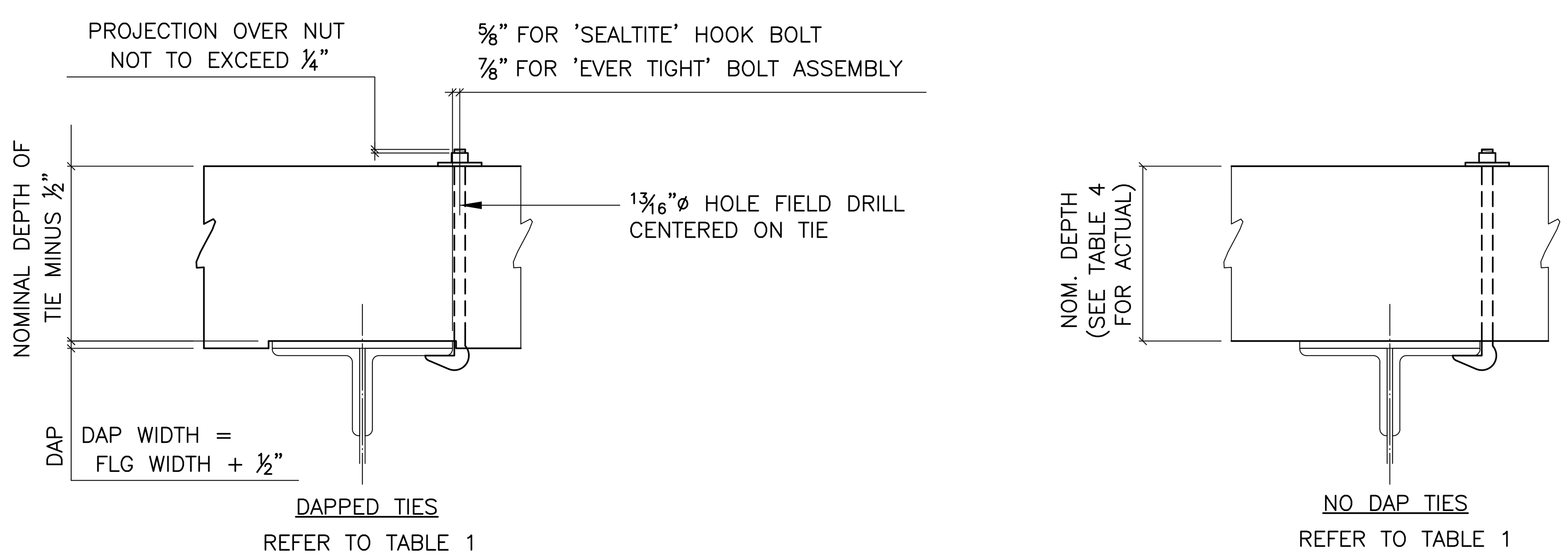

DETAILS AT HOOK BOLT
scale: 1½"=1'–0"

NOTES

- DESIGN LOAD: TWO 90 KIPS AXLES SPACED AT 7 FEET
- ALL TIES EXCEPT THOSE FOR TEMPORARY SERVICE SHALL BE TREATED TIMBER, TREATED TO SPECIFICATION 12–30A
- TIES SHALL BE DOUGLAS FIR NLGA No.1 STRUCTURAL FOR LINES OF LESS THAN 30 MGTM, AND NLGA No.1 CLOSE GRAIN FOR LINES OF 30 MGTM OR MORE
- SOUTHERN YELLOW PINE (DENSE STRUCTURAL GRADE 86 FOR TIES & GRADE 65 FOR GUARD TIMBER) MAY BE USED AS AN ATERNATIVE TIMBER FOR BRIDGES SOUTH OF OHIO RIVER
- ALL FIELD HOLES & CUTS IN TREATED TIMBER SHALL BE TREATED WITH OSMOSE COP–R–PLASTIC WOOD PRESERVING COMPOUND OR OTHER APPROVED PRESERVATION SYSTEM. DAPPING & DRILLING SHALL PREFERABLY BE DONE PRIOR TO TREATING
- TREATED TIMBER SHALL BE STORED, HANDLED & FRAMED IN ACCORDANCE WITH CURRENT C.S.A. O80/AWPA M4 FOR THE HANDLING OF TREATED TIMBER. THE POINT OF PIKES, PEAVIES ETC. MUST NOT BE DRIVEN INTO THE SURFACES OF TREATED TIMBER
- FOR TRACK WITH TRAFFIC GREATER THAN 10 MGTM, RUNNING RAIL SHALL BE 136 LB RAIL. IF EXISTING RAILS ARE LESS THAN 136 LBS, COMPROMISE RAILS OF 19'–6" TO 20' IN LENGTH SHALL BE INSTALLED ON THE APPROACHES
- EACH TIE PLATE EXCEPT FOR MSR TIE PLATE SHALL HAVE A TIE PAD
- GUARD RAILS SHALL BE PLACED ON BRIDGES AS PER SPC 4500. GUARD RAILS SHALL BE ONE SIZE SMALLER THAN THE RUNNING RAIL AND SHALL NOT BE MORE THAN 2" LOWER THAN THE TOP OF RUNNING RAILS
- MAXIMUM OPEN DECK LENGTH WITHOUT FIREBREAK SHALL BE 400 FEET. FIREBREAK SHALL CONSIST OF MINIMUM 12 FEET OF BUNCHED ACZA TREATED TIES (TREATED TO CURRENT C.S.A. O80/AWPA C20) AND STEEL HANDRAIL WHERE APPLICABLE. HARDWARE THRU ACZA TREATED TIES SHALL BE GALVANIZED
- THE REQUIREMENT FOR REFUGE BAY IS TO BE DETERMINED BY REGIONAL ENGINEER

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METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES
SYSTEM "A"

CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A–1.6i–2		

TABLE 1: HOOK BOLT SPACING & DAPPED VS NO DAP TIES

TRACK ALIGNMENT	ANCHORED RAIL		UNANCHORED RAIL		DAPPED/ NO DAP TIES
	SMOOTH TOP FLG	RIVET/BOLT TOP FLG	SMOOTH TOP FLG	RIVET/BOLT TOP FLG	
TANGENT TO < 2"	EVERY 2nd TIE SMOOTH TOP FLG	EVERY 3rd TIE	EVERY 3rd TIE	EVERY 3rd TIE	NO DAP
2" TO 6"	EVERY TIE	EVERY TIE	EVERY 2nd TIE	EVERY 2nd TIE	DAPPED
> 6"	EVERY TIE	EVERY TIE	EVERY TIE	EVERY TIE	DAPPED

TABLE 2: BRIDGE TIE SIZES[1]

C/C SUPPORTS	TIE SIZES WxD (NOMINAL)	LENGTH[2]					C/C TIES
		STANDARD	WALKWAY		REFUGE BAY		
			W/W 1 SIDE[3]	W/W 2 SIDES	W/W 1 SIDE	W/W 2 SIDES	
2'-6" (BEAM/STRG SPAN)	10"X10"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
6'-6"	10"X10"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
7'-0"	10"X10"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
7'-6"	10"X12"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
8'-0"	10"X12"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
8'-6"	12"X12"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	16"
9'-0"	12"X12"	13'-0"	15'-6"	18'-0"	17'-6"	20'-0"	16"
9'-6"	12"X12"	13'-0"	15'-6"	18'-0"	17'-6"	20'-0"	16"
10'-0"	12"X14"	13'-0"	15'-6"	18'-0"	17'-6"	20'-0"	16"
10'-6"	12"X14"	AS REQUIRED					16"
11'-0"	12"X14"	AS REQUIRED					16"
11'-6"	12"X16"	AS REQUIRED					16"
12'-0"	12"X16"	AS REQUIRED					16"
14'-6"	12"X16"	AS REQUIRED					16"
USE THE FOLLOWING ALTERNATIVE TIE SIZES ONLY IF DEPTH OF TIE IS REQUIRED TO MAINTAIN BASE OF RAIL ELEVATION							
8'-6"	10"X14"	12'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
9'-0"	10"X14"	13'-0"	15'-0"	18'-0"	17'-0"	20'-0"	14"
9'-6"	10"X14"	13'-0"	15'-6"	18'-0"	17'-6"	20'-0"	14"
11'-6"	14"X14"	AS REQUIRED					18"
12'-0"	14"X14"	AS REQUIRED					18"
14'-6"	14"X14"	AS REQUIRED					18"

1 THIS TABLE IS APPLICABLE TO BRIDGES ON TANGENT TRACK ONLY. FOR BRIDGES ON CURVE, TIES SHALL BE FRAMED TAPERED TO THE REQUIRED SUPERELEVATION AND DAPPED. MINIMUM DEPTH OF TIE SHALL BE AS SHOWN IN TABLE. LENGTH OF WALKWAY TIES SHALL BE DETERMINED ON A BRIDGE-TO-BRIDGE BASIS

2 TIE LENGTH FOR WALKWAY & REFUGE BAY APPLIES TO DECK BRIDGES ONLY, LENGTH VARIES FOR THROUGH BRIDGES AND SHALL BE DETERMINED ON A BRIDGE-TO-BRIDGE BASIS

3 WALKWAY MAY BE INSTALLED ON ONE SIDE ONLY WHEN ALL OF THE FOLLOWING CONDITIONS ARE MET:
- HEIGHT OF BRIDGE IS LESS THAN 8 FEET
- TRAIN TRAFFIC IS LESS THAN 5 MGTM
- NO SWITCHING OF TRAIN OVER BRIDGE
- ALL REGULATORY REQUIREMENTS ARE MET

TABLE 3: GUARD RAIL SPACE "S"

FOR BRIDGE PLATE	"S"
7½X14 PL. (STOCK 01-24-091)	11"
7¾X16 PL. (STOCK 01-24-858)	11"
BP-2-18-6	11"
BP-3-18-5 & 6	11"
BP-3-22-6	13"
7½X15½ & 7½X16 MSR TP (STOCK 01-24-014 & 015)	11"
7½X18 MSR BP (STOCK 01-24-016)	11"

TABLE 4: SIZES (NOMINAL/ACTUAL)

NOMINAL	ACTUAL
10"	9.75"
12"	11.75"
14"	13.75"
16"	15.75"

TABLE 5: BRIDGE PLATE SYSTEMS

FOR TRAIN TRAFFIC UP TO 10 MGTM

TRACK ALIGNMENT	ANCHORED RAIL (115 LBS)	UNANCHORED RAIL (115 LBS)
TANGENT TO < 2"	7½X14 PL. (STOCK 01-24-091)	7½X14 PL. (STOCK 01-24-091)
2" TO 6"	7½X15½ MSR TP (STOCK 01-24-014)	BP-3-18-5 W/ TOEPLATE
> 6"	7½X15½ MSR TP (STOCK 01-24-014)	BP-3-18-5 W/ TOEPLATE

FOR TRAIN TRAFFIC 10 MGTM TO 40 MGTM

TRACK ALIGNMENT	ANCHORED RAIL (136 LBS)	UNANCHORED RAIL (136 LBS)
TANGENT TO < 2"	7½X16 MSR TP (STOCK 01-24-015) or BP-3-18-6	7¾X16 PL. (STOCK 01-24-858) or BP-2-18-6 or BP-3-22-6 W/ TOEPLATE
2" TO 6"	7½X16 MSR TP (STOCK 01-24-015) & 7½X18 MSR BP (STOCK 01-24-016) EVERY 4th TIE	BP-3-22-6 W/ TOEPLATE
> 6"	7½X18 MSR BP (STOCK 01-24-016)	BP-3-22-6 W/ TOEPLATE & TP19 GAUGE PL. (SPACING TO BE DETERMINED)

FOR TRAIN TRAFFIC > 40 MGTM

TRACK ALIGNMENT	ANCHORED RAIL (136 LBS)	UNANCHORED RAIL (136 LBS)
TANGENT TO < 2"	7½X18 MSR BP (STOCK 01-24-016) or BP-3-22-6	7¾X16 PL. (STOCK 01-24-858) or BP-3-22-6 W/ TOEPLATE
2" TO 6"	7½X18 MSR BP (STOCK 01-24-016)	BP-3-22-6 W/ TOEPLATE
> 6"	7½X18 MSR BP (STOCK 01-24-016)	BP-3-22-6 W/ TOEPLATE & TP19 GAUGE PL. (SPACING TO BE DETERMINED)

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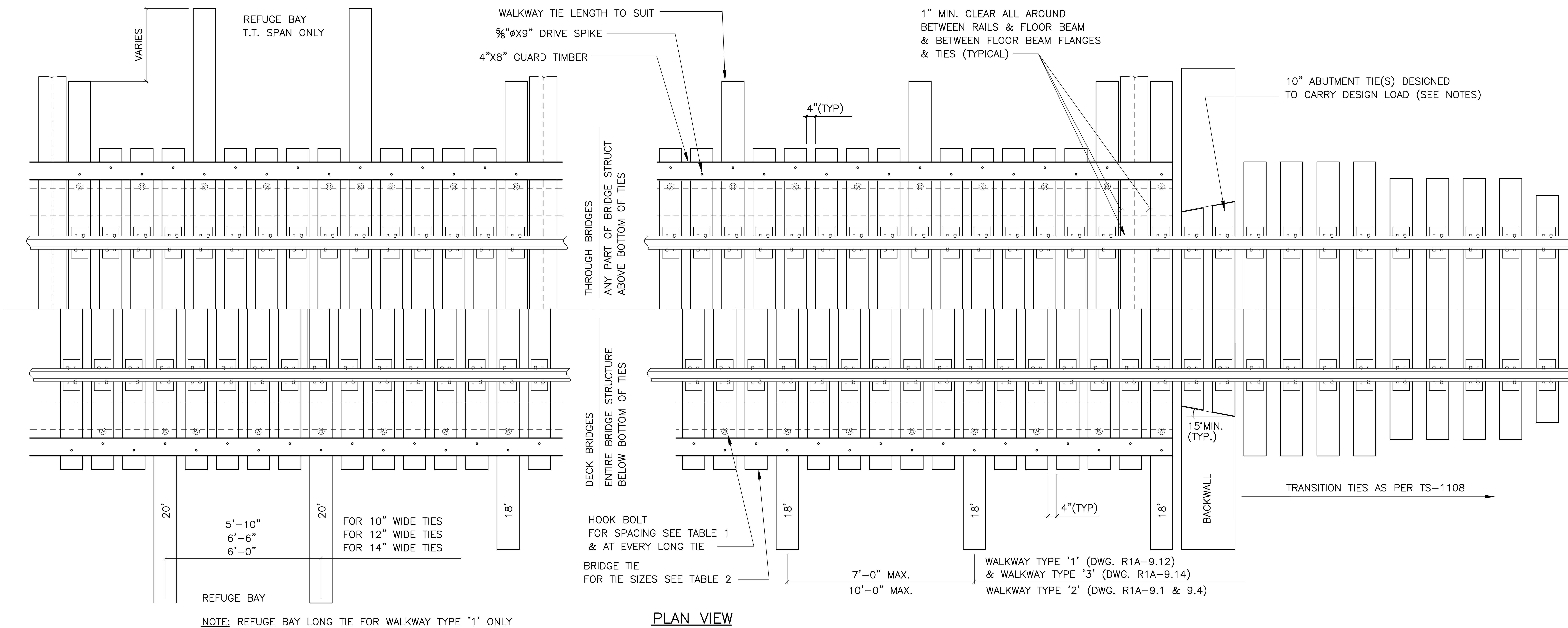
METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES
SYSTEM "A"

CONTRACT NO. - | DWG. NO. R9A-1.6i-3 | REV. | SHEET



PLAN VIEW

scale:½"=1'-0"

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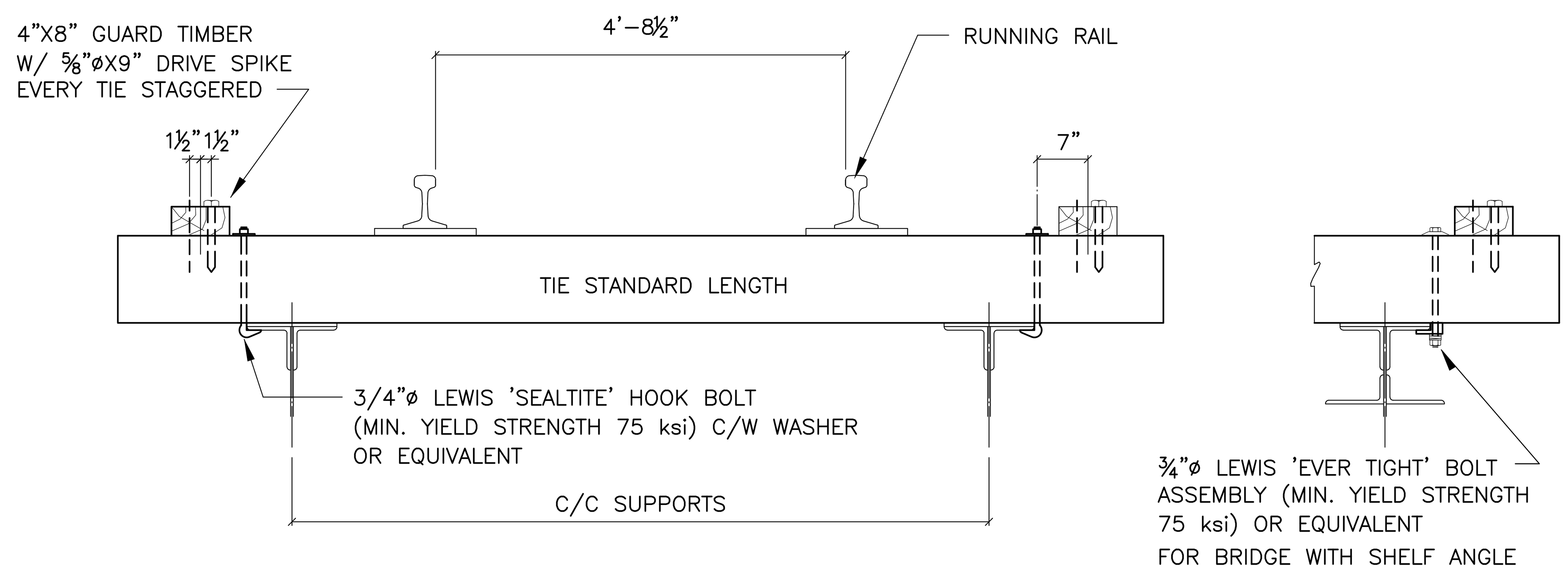
METROLINX

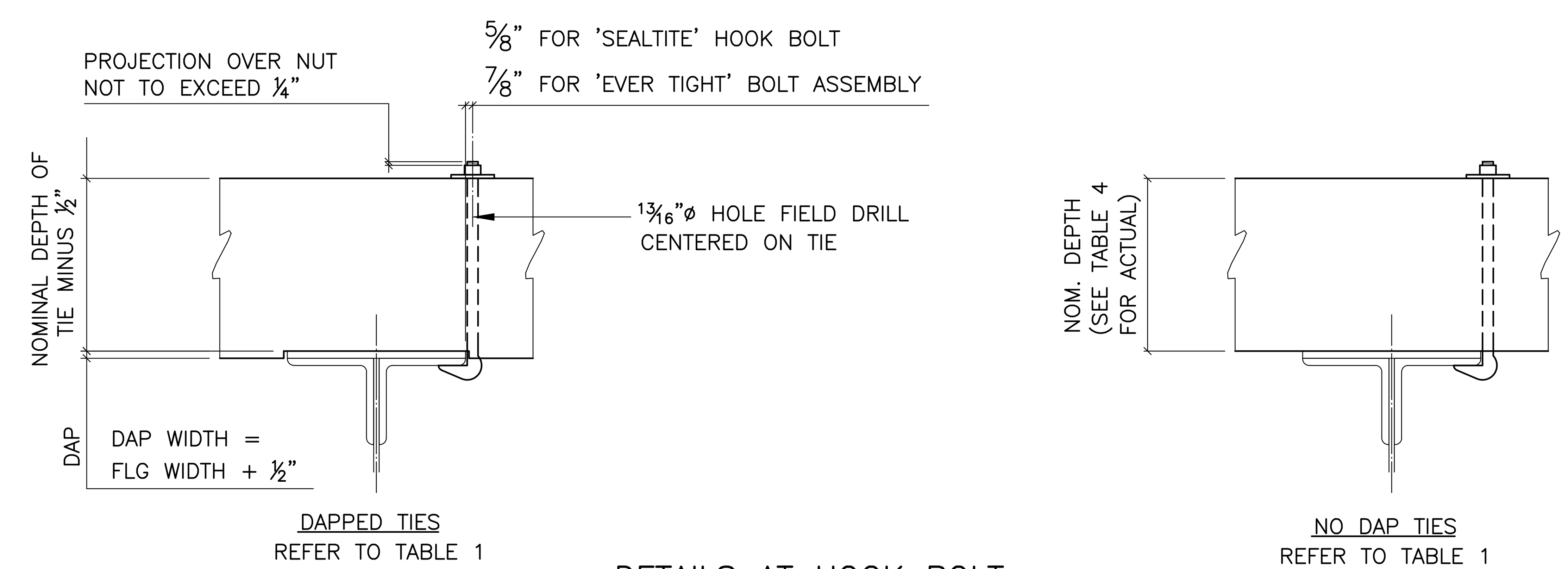
TIMBER OPEN DECK FOR STEEL BRIDGES

SYSTEM "B"

CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A-1.7i-1		



TYPICAL SECTION
scale: ¾"=1'-0"



DETAILS AT HOOK BOLT
scale: 1½"=1'-0"

NOTES

- DESIGN LOAD: TWO 90 KIPS AXLES SPACED AT 7 FEET
- ALL TIES EXCEPT THOSE FOR TEMPORARY SERVICE SHALL BE TREATED TIMBER, TREATED TO SPECIFICATION 12-30A
- TIES SHALL BE DOUGLAS FIR NLGA No.1 STRUCTURAL FOR LINES OF LESS THAN 30 MGTM, AND NLGA No.1 CLOSE GRAIN FOR LINES OF 30 MGTM OR MORE
- SOUTHERN YELLOW PINE (DENSE STRUCTURAL GRADE 86 FOR TIES & GRADE 65 FOR GUARD TIMBER) MAY BE USED AS AN ATERNATIVE TIMBER FOR BRIDGES SOUTH OF OHIO RIVER
- ALL FIELD HOLES & CUTS IN TREATED TIMBER SHALL BE TREATED WITH OSMOSE COP-R-PLASTIC WOOD PRESERVING COMPOUND OR OTHER APPROVED PRESERVATION SYSTEM. DAPPING & DRILLING SHALL PREFERABLY BE DONE PRIOR TO TREATING
- TREATED TIMBER SHALL BE STORED, HANDLED & FRAMED IN ACCORDANCE WITH CURRENT C.S.A. O80/AWPA M4 FOR THE HANDLING OF TREATED TIMBER. THE POINT OF PIKES, PEAVIES ETC. MUST NOT BE DRIVEN INTO THE SURFACES OF TREATED TIMBER
- FOR TRACK WITH TRAFFIC GREATER THAN 10 MGTM, RUNNING RAIL SHALL BE 136 LB RAIL. IF EXISTING RAILS ARE LESS THAN 136 LBS, COMPROMISE RAILS OF 19'-6" TO 20' IN LENGTH SHALL BE INSTALLED ON THE APPROACHES
- EACH TIE PLATE EXCEPT FOR MSR TIE PLATE SHALL HAVE A TIE PAD
- GUARD RAILS SHALL BE PLACED ON BRIDGES AS PER SPC 4500. GUARD RAILS SHALL BE ONE SIZE SMALLER THAN THE RUNNING RAIL AND SHALL NOT BE MORE THAN 2" LOWER THAN THE TOP OF RUNNING RAILS
- MAXIMUM OPEN DECK LENGTH WITHOUT FIREBREAK SHALL BE 400 FEET. FIREBREAK SHALL CONSIST OF MINIMUM 12 FEET OF BUNCHED ACZA TREATED TIES (TREATED TO CURRENT C.S.A. O80/ AWPA C20) AND STEEL HANDRAIL WHERE APPLICABLE. HARDWARE THRU ACZA TREATED TIES SHALL BE GALVANIZED
- THE REQUIREMENT FOR REFUGE BAY IS TO BE DETERMINED BY REGIONAL ENGINEER

CE DESSIN EST AUSSI DISPONIBLE EN FRANCAIS

REFERENCE DRAWINGS		ISSUE			REVISIONS		
DWG NO.	TITLE	NO.	DATE	ISSUED FOR	REV.	DATE	

DRAWN BY: WW YY/MM/DD	DESIGNED BY: YY/MM/DD
CHECKED BY: YY/MM/DD	APPROVED BY: YY/MM/DD
SCALE: 1:XXX	FULL SIZE ONLY

METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES
SYSTEM "B"

CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A-1.7i-2		

TABLE 1: HOOK BOLT SPACING & DAPPED VS NO DAP TIES

TRACK ALIGNMENT	ANCHORED RAIL		UNANCHORED RAIL		DAPPED/ NO DAP TIES
	SMOOTH TOP FLG	RIVET/BOLT TOP FLG	SMOOTH TOP FLG	RIVET/BOLT TOP FLG	
TANGENT TO < 2°	EVERY 2nd TIE SMOOTH TOP FLG	EVERY 3rd TIE	EVERY 3rd TIE	EVERY 3rd TIE	NO DAP
2° TO 6°	EVERY TIE	EVERY TIE	EVERY 2nd TIE	EVERY 2nd TIE	DAPPED
> 6°	EVERY TIE	EVERY TIE	EVERY TIE	EVERY TIE	DAPPED

TABLE 2: BRIDGE TIE SIZES [1]

C/C SUPPORTS	TIE SIZES WxD (NOMINAL)	LENGTH [2]					C/C TIES
		STANDARD	WALKWAY		REFUGE BAY		
			W/W 1 SIDE [3]	W/W 2 SIDES	W/W 1 SIDE	W/W 2 SIDES	
2'–6" (BEAM/STRG SPAN)	10"X10"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
6'–6"	10"X10"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
7'–0"	10"X10"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
7'–6"	10"X12"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
8'–0"	10"X12"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
8'–6"	12"X12"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	16"
9'–0"	12"X12"	13'–0"	15'–6"	18'–0"	17'–6"	20'–0"	16"
9'–6"	12"X12"	13'–0"	15'–6"	18'–0"	17'–6"	20'–0"	16"
10'–0"	12"X14"	13'–0"	15'–6"	18'–0"	17'–6"	20'–0"	16"
10'–6"	12"X14"	AS REQUIRED					16"
11'–0"	12"X14"	AS REQUIRED					16"
11'–6"	12"X16"	AS REQUIRED					16"
12'–0"	12"X16"	AS REQUIRED					16"
14'–6"	12"X16"	AS REQUIRED					16"
USE THE FOLLOWING ALTERNATIVE TIE SIZES ONLY IF DEPTH OF TIE IS REQUIRED TO MAINTAIN BASE OF RAIL ELEVATION							
8'–6"	10"X14"	12'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
9'–0"	10"X14"	13'–0"	15'–0"	18'–0"	17'–0"	20'–0"	14"
9'–6"	10"X14"	13'–0"	15'–6"	18'–0"	17'–6"	20'–0"	14"
11'–6"	14"X14"	AS REQUIRED					18"
12'–0"	14"X14"	AS REQUIRED					18"
14'–6"	14"X14"	AS REQUIRED					18"

[1] THIS TABLE IS APPLICABLE TO BRIDGES ON TANGENT TRACK ONLY. FOR BRIDGES ON CURVE, TIES SHALL BE FRAMED TAPERED TO THE REQUIRED SUPERELEVATION AND DAPPED. MINIMUM DEPTH OF TIE SHALL BE AS SHOWN IN TABLE. LENGTH OF WALKWAY TIES SHALL BE DETERMINED ON A BRIDGE–TO–BRIDGE BASIS

[2] TIE LENGTH FOR WALKWAY & REFUGE BAY APPLIES TO DECK BRIDGES ONLY, LENGTH VARIES FOR THROUGH BRIDGES AND SHALL BE DETERMINED ON A BRIDGE–TO–BRIDGE BASIS

[3] WALKWAY MAY BE INSTALLED ON ONE SIDE ONLY WHEN ALL OF THE FOLLOWING CONDITIONS ARE MET:
- HEIGHT OF BRIDGE IS LESS THAN 8 FEET
- TRAIN TRAFFIC IS LESS THAN 5 MGTM
- NO SWITCHING OF TRAIN OVER BRIDGE
- ALL REGULATORY REQUIREMENTS ARE MET

TABLE 3:

NOT USED

TABLE 4: SIZES (NOMINAL/ACTUAL)

NOMINAL	ACTUAL
10"	9.75"
12"	11.75"
14"	13.75"
16"	15.75"

TABLE 5: BRIDGE PLATE SYSTEMS

FOR TRAIN TRAFFIC UP TO 10 MGTM

TRACK ALIGNMENT	ANCHORED RAIL (115 LBS)	UNANCHORED RAIL (115 LBS)
TANGENT TO < 2°	7½X14 PL. (STOCK 01–24–091)	7½X14 PL. (STOCK 01–24–091)
2° TO 6°	7½X15 1/2 MSR TP (STOCK 01–24–014)	BP–3–18–5 W/ TOEPLATE
> 6°	7½X15 1/2 MSR TP (STOCK 01–24–014)	BP–3–18–5 W/ TOEPLATE

FOR TRAIN TRAFFIC 10 MGTM TO 40 MGTM

TRACK ALIGNMENT	ANCHORED RAIL (136 LBS)	UNANCHORED RAIL (136 LBS)
TANGENT TO < 2°	7½X16 MSR TP (STOCK 01–24–015) or BP–3–18–6	7¾X16 PL. (STOCK 01–24–858) or BP–2–18–6 or BP–3–22–6 W/ TOEPLATE
2° TO 6°	7½X16 MSR TP (STOCK 01–24–015) & 7½X18 MSR BP (STOCK 01–24–016) EVERY 4th TIE	BP–3–22–6 W/ TOEPLATE
> 6°	7½X18 MSR BP (STOCK 01–24–016)	BP–3–22–6 W/ TOEPLATE & TP19 GAUGE PL. (SPACING TO BE DETERMINED)

FOR TRAIN TRAFFIC > 40 MGTM

TRACK ALIGNMENT	ANCHORED RAIL (136 LBS)	UNANCHORED RAIL (136 LBS)
TANGENT TO < 2°	7½X18 MSR BP (STOCK 01–24–016) or BP–3–22–6	7¾X16 PL. (STOCK 01–24–858) or BP–3–22–6 W/ TOEPLATE
2° TO 6°	7½X18 MSR BP (STOCK 01–24–016)	BP–3–22–6 W/ TOEPLATE
> 6°	7½X18 MSR BP (STOCK 01–24–016)	BP–3–22–6 W/ TOEPLATE & TP19 GAUGE PL. (SPACING TO BE DETERMINED)

CE DESSIN EST AUSSI DISPONIBLE EN FRANCAIS

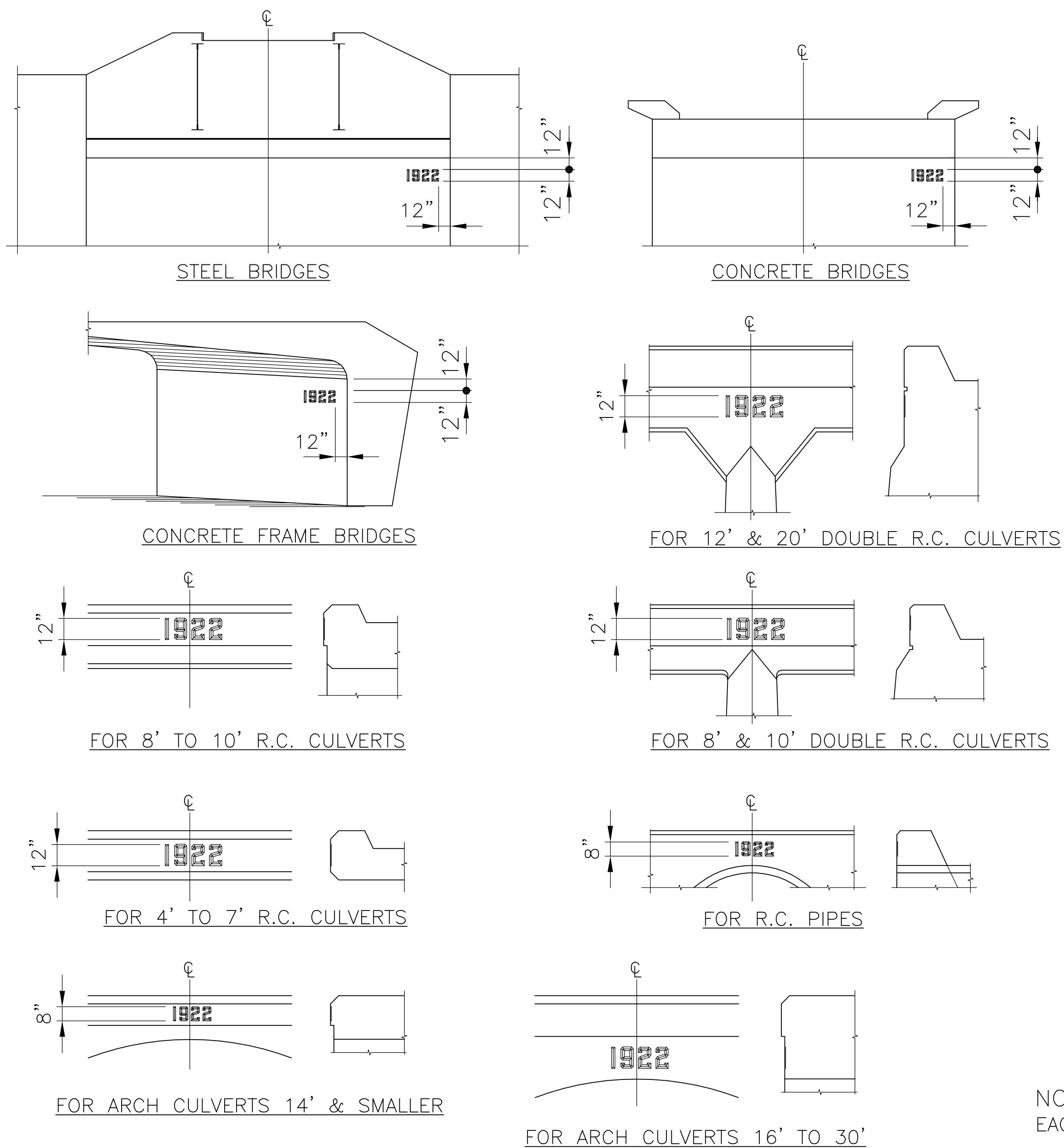
REFERENCE DRAWINGS		ISSUE			REVISIONS		
DWG NO.	TITLE	NO.	DATE	ISSUED FOR	REV.	DATE	

DRAWN BY: WW YY/MM/DD | DESIGNED BY: YY/MM/DD
CHECKED BY: YY/MM/DD | APPROVED BY: YY/MM/DD
SCALE: 1:XXX | FULL SIZE ONLY

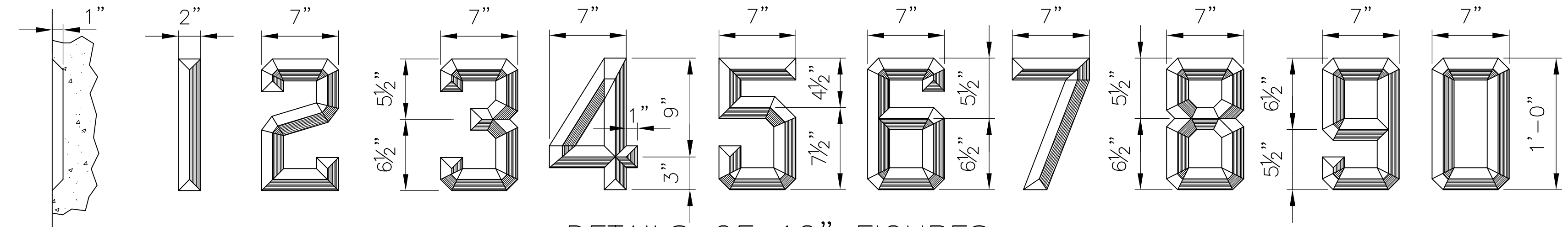
METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES
SYSTEM "B"

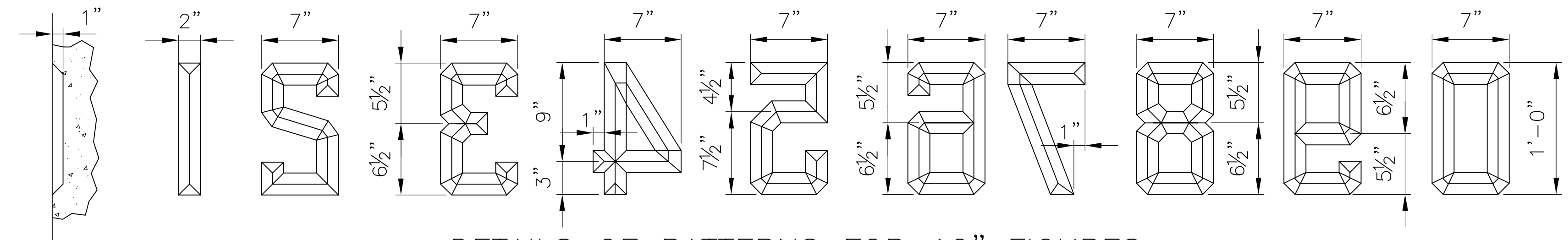
CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A–1.7i–3		



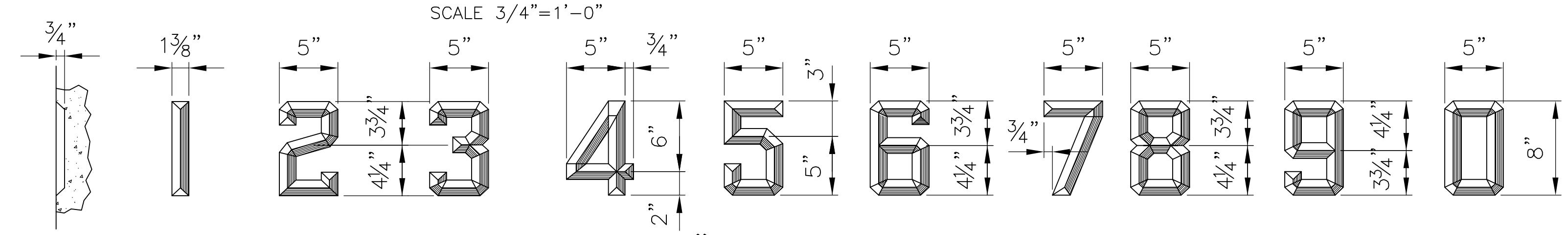
TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON CONCRETE STRUCTURES



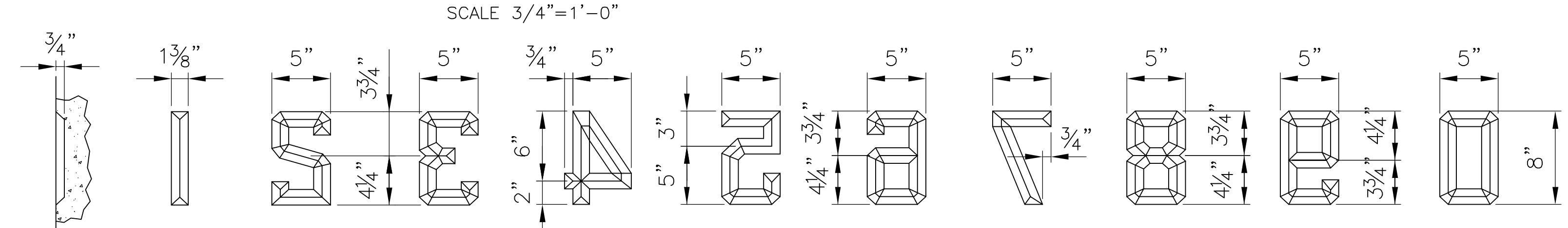
DETAILS OF 12" FIGURES
SCALE 3/4"=1'-0"



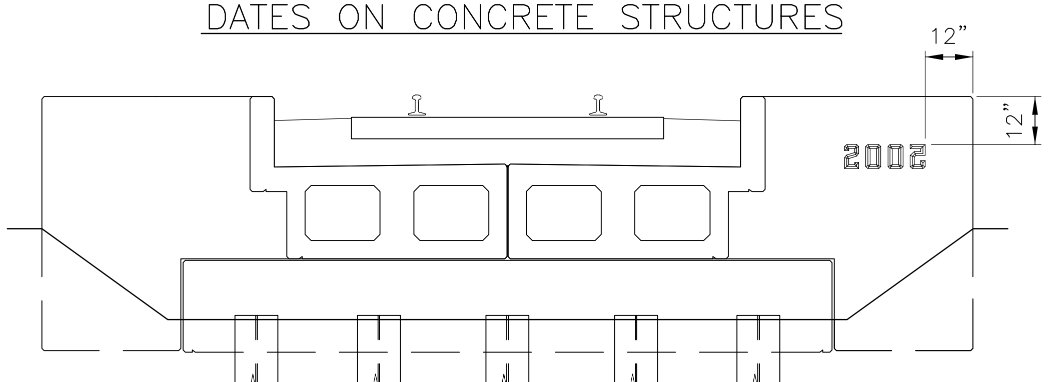
DETAILS OF PATTERNS FOR 12" FIGURES
SCALE 3/4"=1'-0"



DETAILS OF 8" FIGURES
SCALE 3/4"=1'-0"



DETAILS OF PATTERNS FOR 8" FIGURES
SCALE 3/4"=1'-0"



TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON PRECAST BALLAST WALLS

NOTES:

EACH CONCRETE STRUCTURE (OR INDIVIDUAL CONCRETE UNIT OF ANY STRUCTURE) SHALL BE DATED TO SHOW THE YEAR OF CONSTRUCTION.

FIGURES FOR DATES SHALL BE MADE IN ACCORDANCE WITH DETAILS ON THIS PLAN (USING 12" FIGURES WHERE PRACTICABLE) AND DATES SHALL BE PLACED AT LOCATIONS INDICATED IN SKETCHES OR AS NOTED BELOW.

CULVERTS – BOTH ENDS OF STRUCTURE & SYMETRICAL ABOUT CENTRE LINE.

CONCRETE – TRESTLES 5 SPANS OR LESS IN LENGTH, DATE BOTH SIDES OF ONE SLAB AT CENTRE OF TRESTLE.
OVER 5 SPANS IN LENGTH, DATE BOTH SIDES OF SLAB AT EACH END OF TRESTLE.

RETAINING WALLS – WALLS UNDER 100' LONG, DATE ON FACE OF WALL 10' FROM ONE END.
– WALLS OVER 100' LONG, DATE ON FACE OF WALL 10' FROM EACH END.

PIERS – BELOW COPING ON THE CENTRE OF THE FACE TOWARDS THE ZERO MILEAGE OF THE SUB DIVISION – ONLY IF CALLED FOR ON DRAWINGS.

ABUTMENTS – BELOW BRIDGE SEAT, AS SHOWN ON SKETCH.

CONCRETE SLAB AND RIGID FRAME BRIDGES – ON THE ABUTMENT OR LEG OF THE FRAME AS SHOWN.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD INSTRUCTIONS FOR DATING CONCRETE STRUCTURES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **R1S-1i** –

NOTES:

ONE NAME PLATE IS TO BE LOCATED ON EACH SPAN AS FOLLOWS:

DECK PLATE GIRDERS – ON THE OUTSIDE OF THE WEB AT THE NEAR END OF THE RIGHT HAND GIRDER (LOOKING IN THE DIRECTION OF INCREASING MILEAGE).

THROUGH PLATE GIRDERS – ON THE INSIDE OF THE WEB AT THE NEAR END OF THE RIGHT HAND GIRDER (LOOKING IN THE DIRECTION OF INCREASING MILEAGE) WHERE THERE IS ROOM ABOVE BASE OF RAIL LEVEL. OTHERWISE AS FOR DECK PLATE GIRDER.

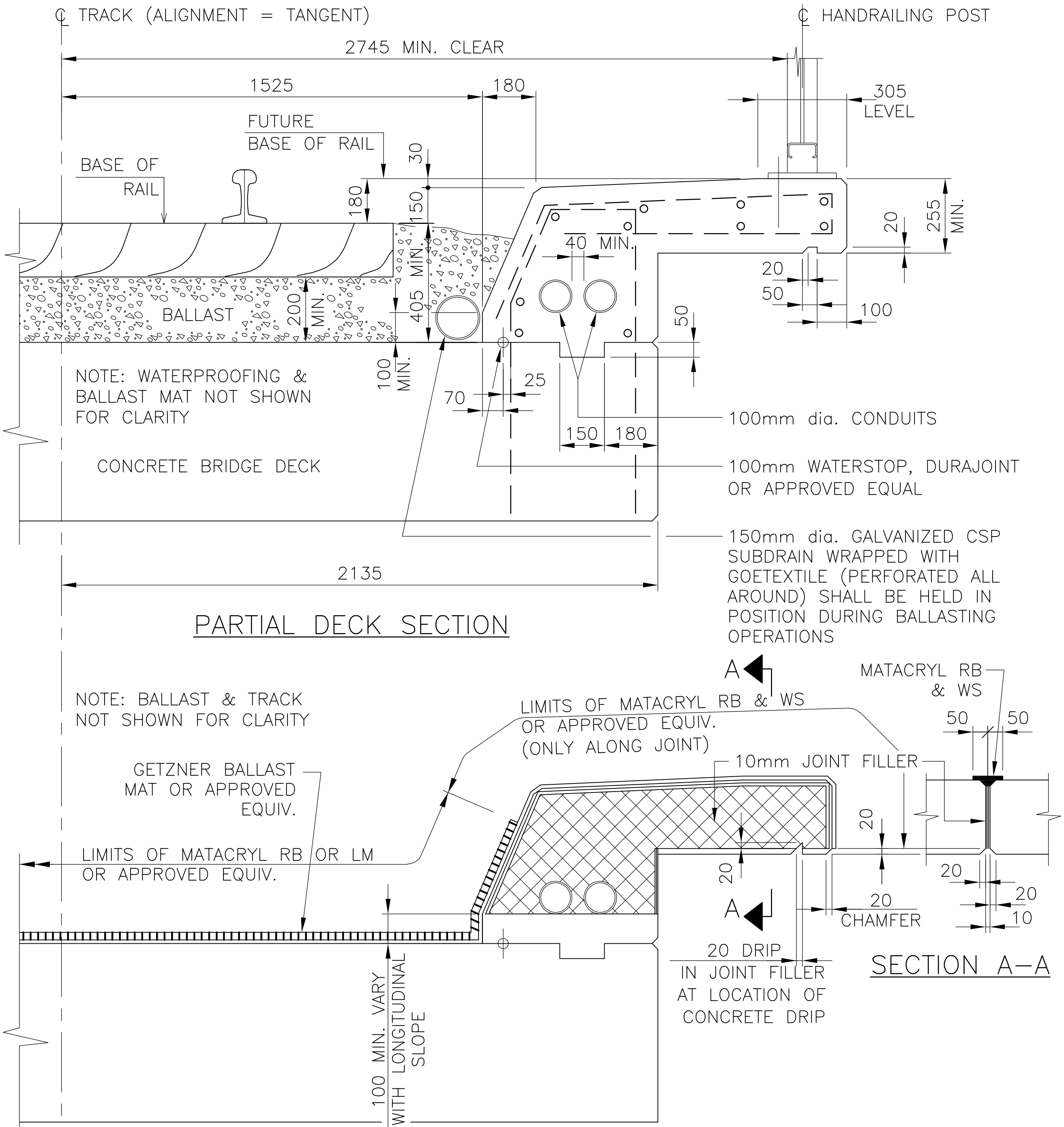
THROUGH TRUSSES – ON THE END POST AT THE NEAR END OF THE RIGHT HAND TRUSS LOOKING IN THE DIRECTION OF INCREASING MILEAGE.

DECK TRUSSES – ON THE OUTSIDE OF THE TOP CHORD OR END POST AT THE NEAR END OF THE RIGHT HAND TRUSS (LOOKING IN THE DIRECTION OF INCREASING MILEAGE).

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**LOCATION FOR BRIDGE NAME PLATE**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero: **TD-05-Li** | –



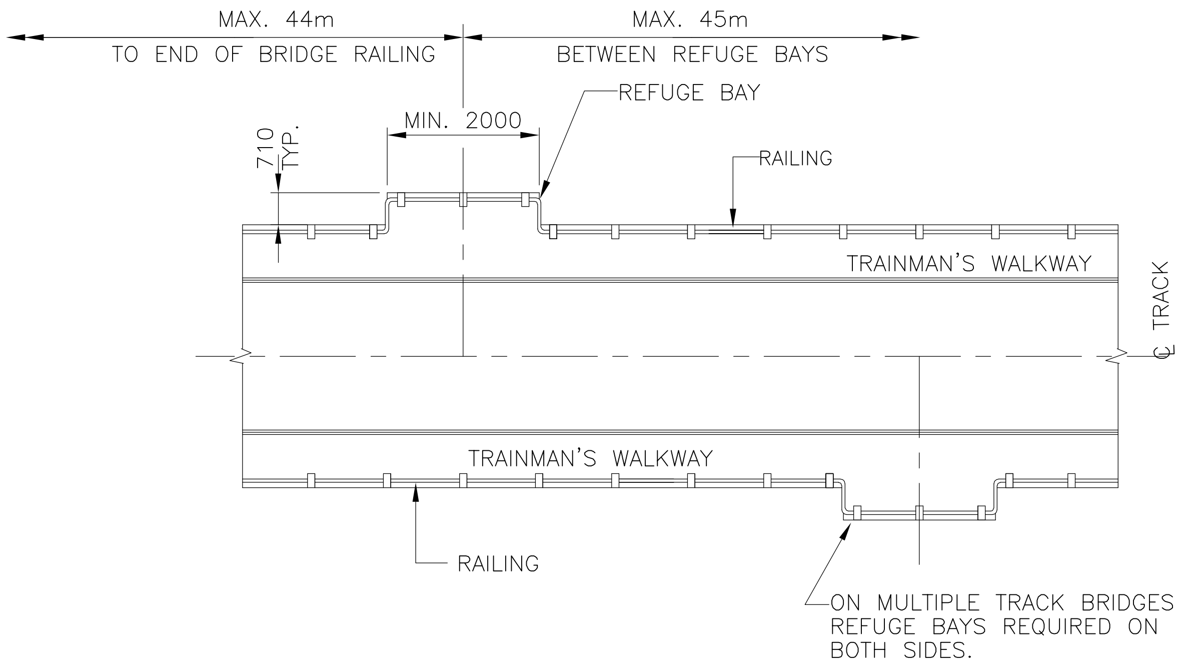
PARTIAL DECK WITH
WATERPROOFING AT JOINT

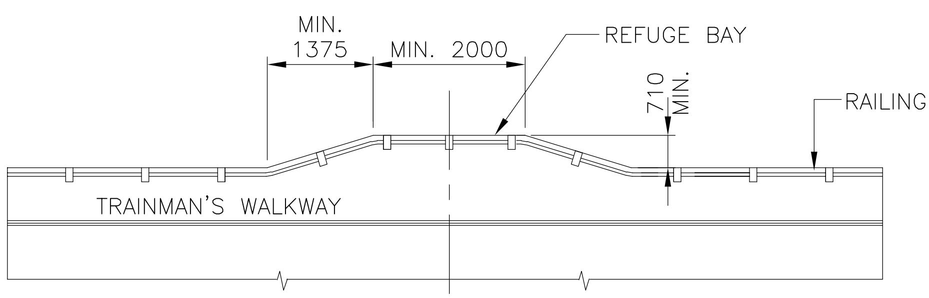
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE
WS = WEARING SURFACE

NOTES:

- SPACING OF TRANSVERSE JOINTS IN CURB SHALL NOT EXCEED 3500mm
- LONGITUDINAL SLOPE OF 0.5% MIN.
- FOR TRANSVERSE SLOPE (SEE METROLINX GENERAL GUIDELINES FOR RAILWAY BRIDGES & STRUCTURES)

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CAST-IN-PLACE CONCRETE BRIDGE DECK DETAILS**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **C2m**	–





ALTERNATIVE TYPE OF REFUGE BAY

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**REFUGE BAYS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

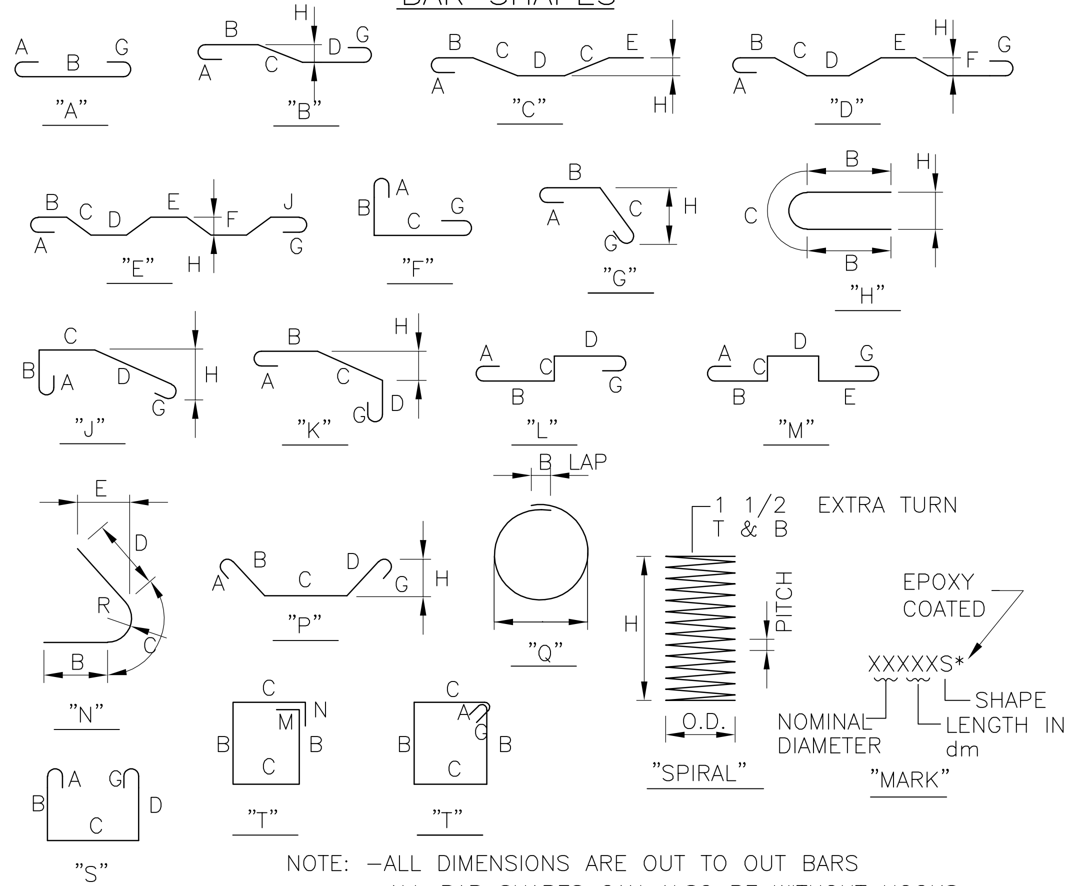
METROLINX

Drawing Number Dessin Numero **C6m** –

BAR LIST EXAMPLE

QTY.	SIZE	MARK	LENGTH	A	B	C	D	E	F	G	H	R
50	20M	D20001C	4915	200	610	280	2000	1340			200	

BAR SHAPES



NOTE: –ALL DIMENSIONS ARE OUT TO OUT BARS
–ALL BAR SHAPES CAN ALSO BE WITHOUT HOOKS
–LETTERS "U" "V" ETC. CAN BE USED FOR NON STANDARD SHAPES.

BAR MARK EXAMPLE

D 5 01 C

IDENTIFICATION — D
SIZE — 5
NUMBER — 01
SHAPE — C

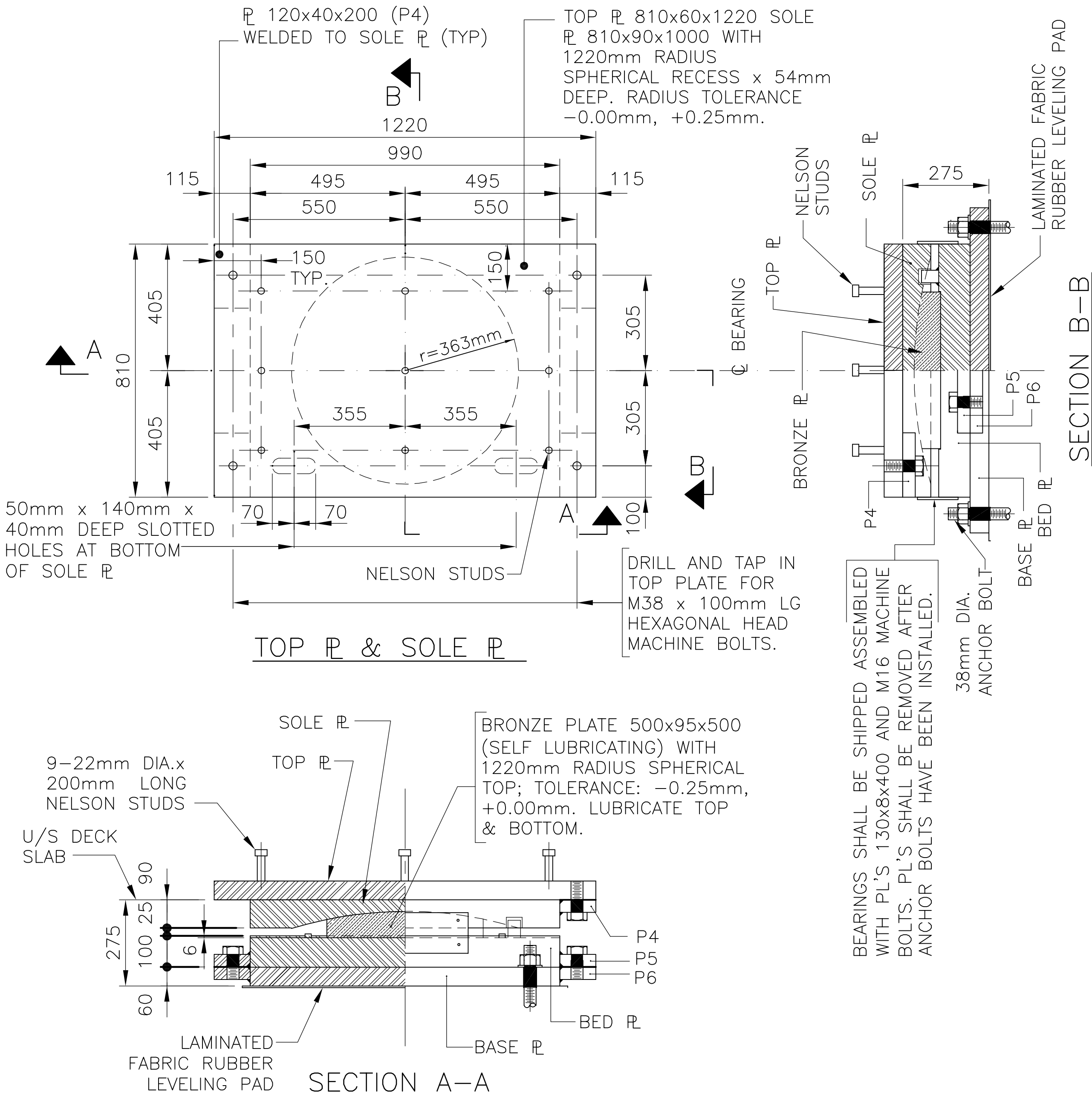
A – ABUTMENT
B – BENT
F – FOOTING
P – PIER
R – RIGID FRAME
W – WALL
D – DECK
S – SPAN

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**STANDARD BAR LIST & BAR SHAPES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero: **C7m**

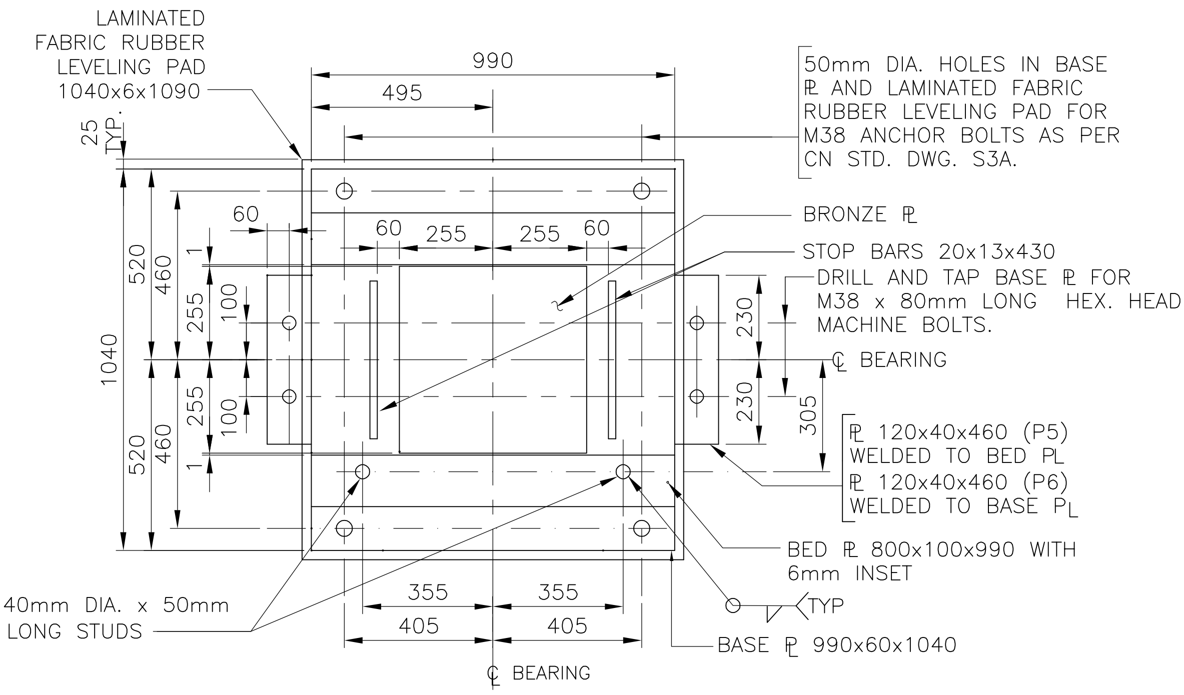
–



Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**BRONZE BEARINGS - EXAMPLE OF AN EXPANSION BEARING FOR A CONCRETE SPAN BRIDGE**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	SHEET 1 OF 2

METROLINX

Drawing Number / Dessin Numero: **C9m-1** –



BED ℙ & BASE ℙ

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31

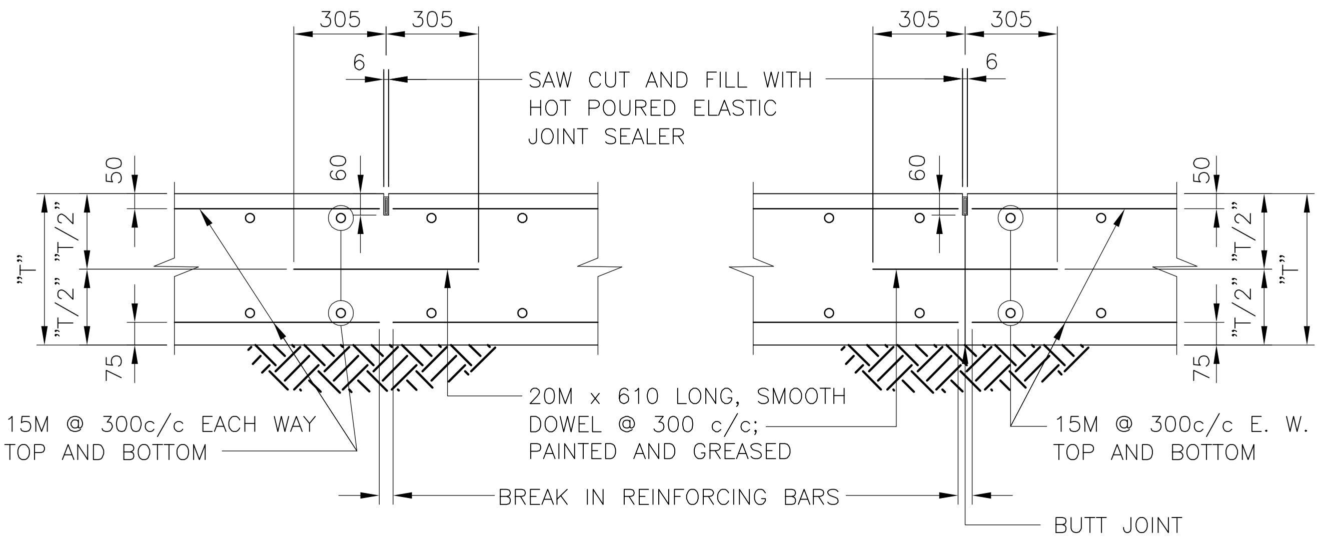
BRONZE BEARINGS - EXAMPLE OF AN EXPANSION BEARING FOR A CONCRETE SPAN BRIDGE

SHEET 2 OF 2

METROLINX

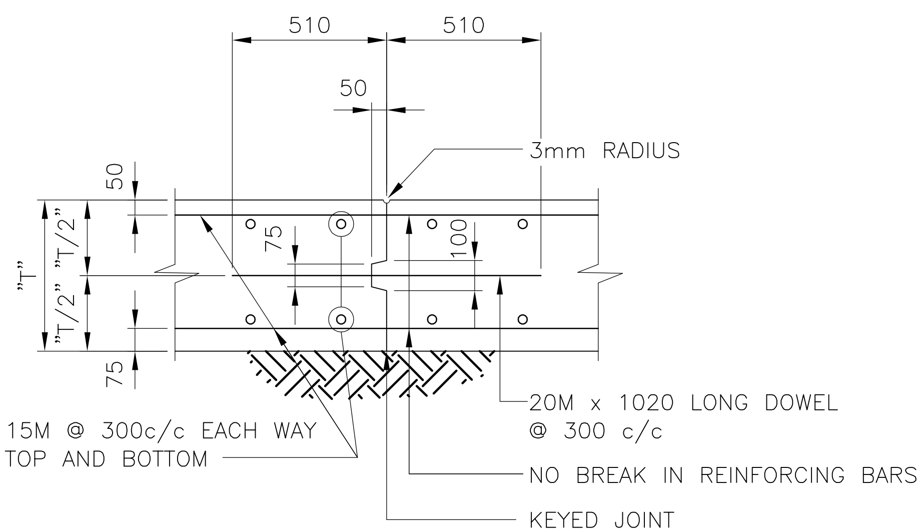
Drawing Number / Dessin Numero: **C9m-2**

–



CONTROL JOINT
@ 6000 c/c

CONSTRUCTION JOINT
IF IT OCCURS AT CONTROL JOINTS

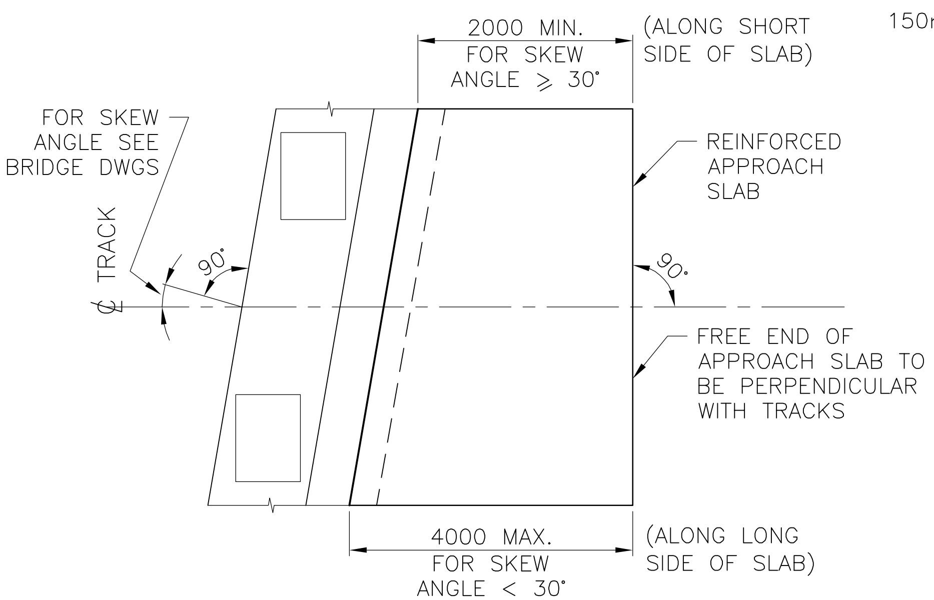


CONSTRUCTION JOINT
IF IT OCCURS IN MIDDLE THIRD
OF NORMAL JOINT INTERVAL

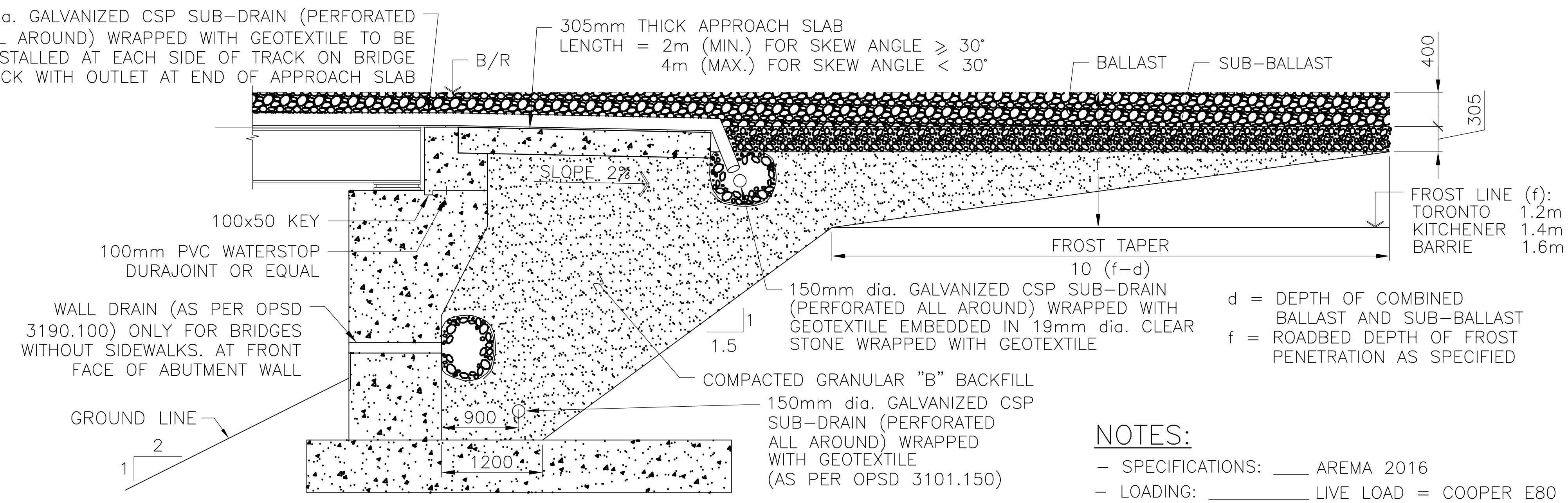
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CONCRETE SLAB - JOINT DETAILS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

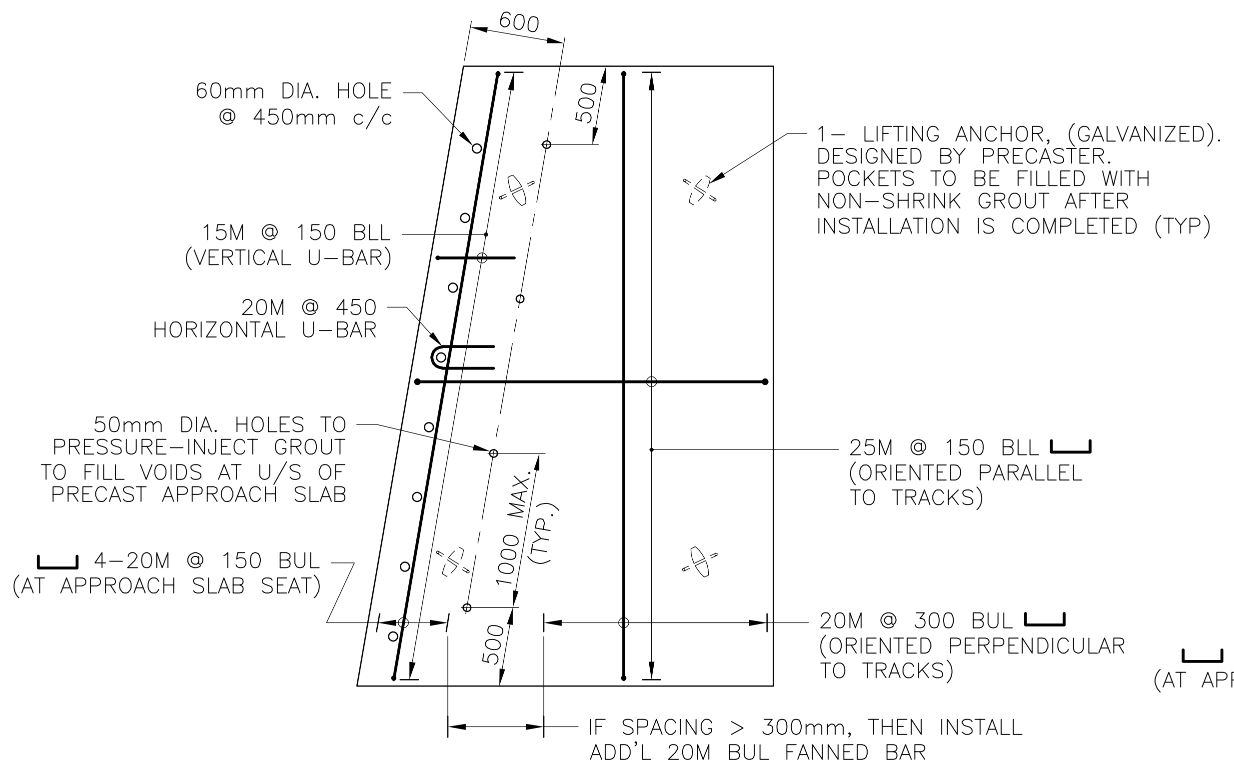
Drawing Number
Dessin Numero
C10m
–



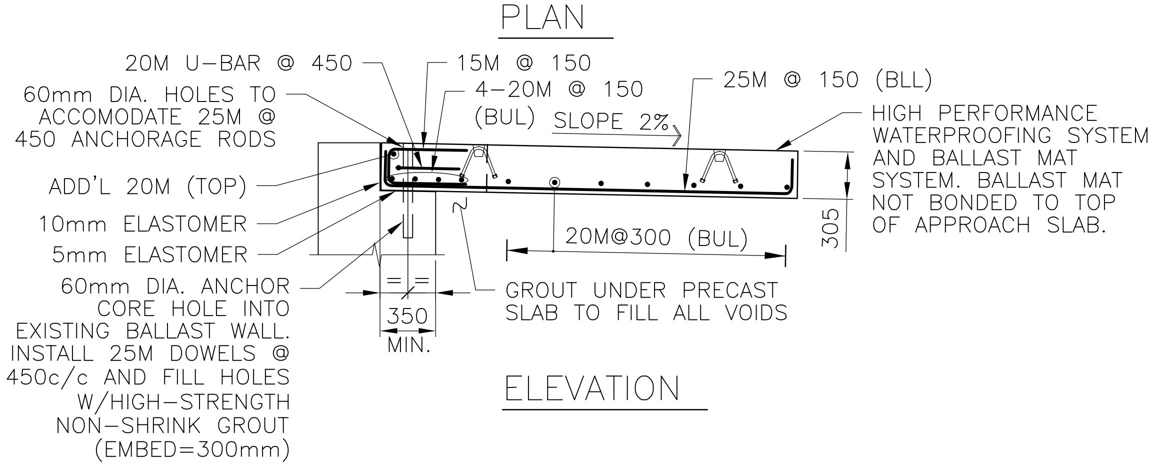
PLAN



MIN. GRANULAR BACKFILL REQUIREMENTS

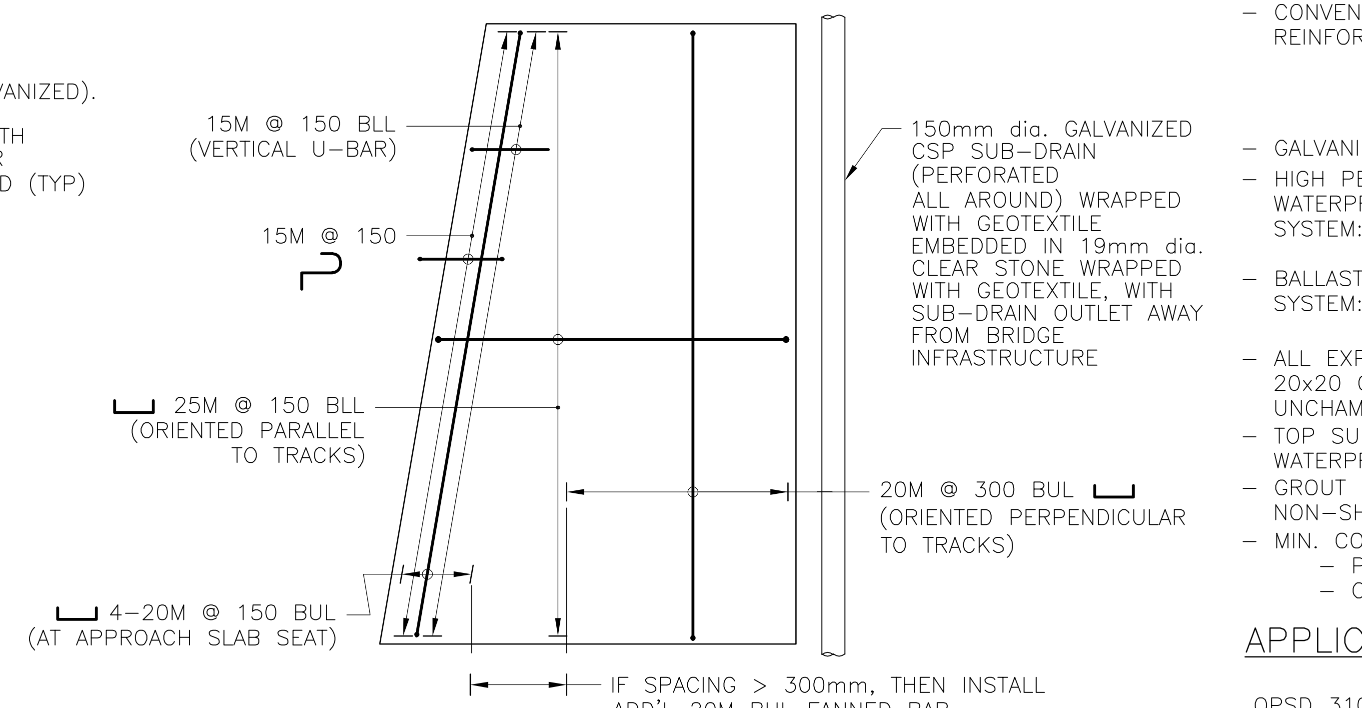


PLAN

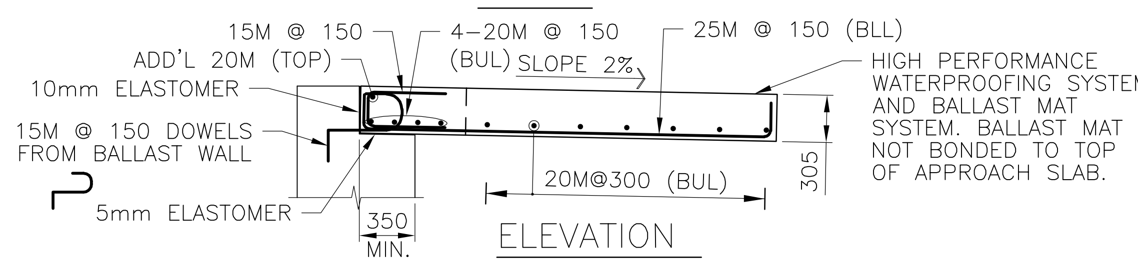


ELEVATION

PRECAST APPROACH SLAB – DETAILS



PLAN



ELEVATION

CAST-IN-PLACE APPROACH SLAB – DETAILS

NOTES:

- SPECIFICATIONS: AREMA 2016
- LOADING: LIVE LOAD = COOPER E80
- CONCRETE: SHALL BE CLASS C-1 5,000PSI @ 28 DAYS
- CONVENTIONAL REINFORCING: SHALL BE NEW BILLET STEEL GRADE 400MPa, MEETING THE REQUIREMENTS OF CSA STANDARD CAN/CSA-G30.18
- GALVANIZING: ASTM A123
- HIGH PERFORMANCE WATERPROOFING SYSTEM: MATACRYL RB, OR APPROVED EQUIVALENT.
- BALLAST MAT SYSTEM: GETZNER SYLODYN DN 1019, OR APPROVED EQUIVALENT.
- ALL EXPOSED CONCRETE EDGES SHALL BE GIVEN 20x20 CHAMFERS; ALL DIMENSIONS ARE TO UNCHAMFERED EDGES.
- TOP SURFACE OF APPROACH SLAB SHALL BE WATERPROOFED.
- GROUT SHALL BE SIKA 123 HIGH-STRENGTH NON-SHRINK GROUT OR APPROVED EQUIVALENT.
- MIN. CONCRETE COVER TO REINFORCEMENT:
  - PRECAST: 40mm ±10mm
  - CAST-IN-PLACE: 50mm ±30mm

APPLICABLE STANDARD DRAWINGS:

OPSD 3101.150	WALLS – ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD 3190.100	WALLS – RETAINING AND ABUTMENT, WALL DRAIN

LIST OF ABBREVIATION:

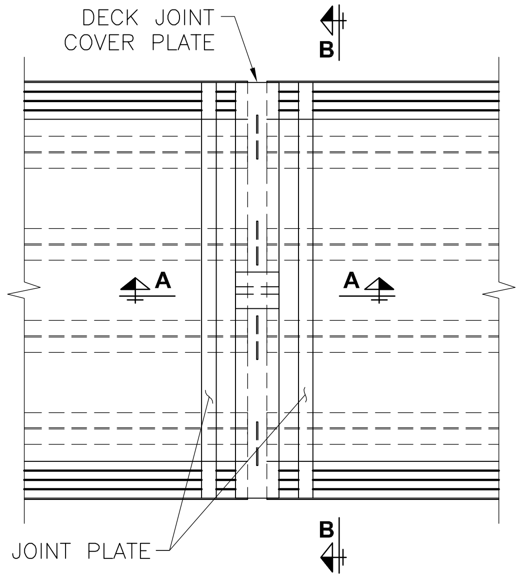
BLL – BOTTOM LOWER LAYER
BUL – BOTTOM UPPER LAYER
ADD'L – ADDITIONAL
TYP – TYPICAL

Drawn: Dessin: T.Z.	Checked: Verification: S.Kh.
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31

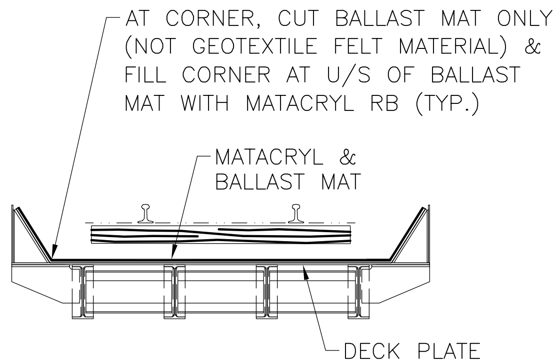
RAILWAY BRIDGE
APPROACH SLAB

METROLINX

Drawing Number Dessin Numero: C15m

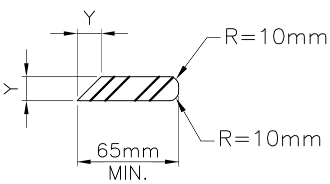


STEEL BALLAST PAN PLAN VIEW

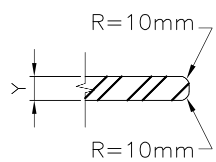


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 25mm

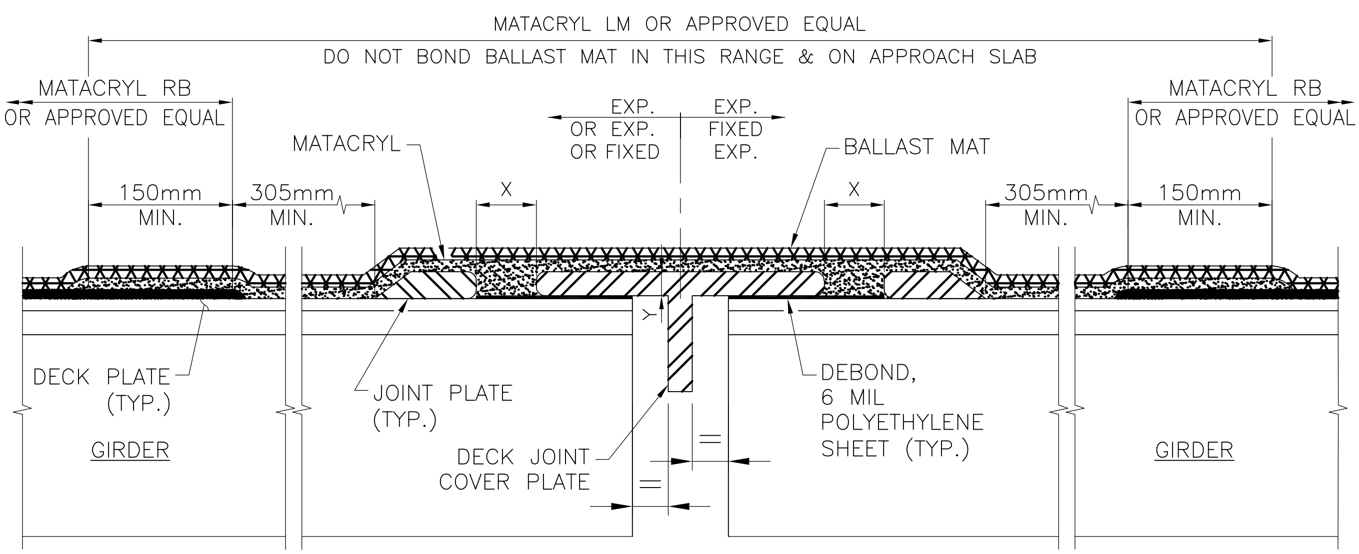


JOINT PLATE DETAIL



DECK JOINT COVER PLATE DETAIL

NOTE:
- MIN. COVER PLATE THICKNESS = 25mm
- TOP OF COVER PLATE AND TOP OF JOINT PLATE SHALL BE AT THE SAME ELEVATION, ADJUST JOINT PLATE THICKNESS TO SUIT.
- JOINT GAP (X) TO BE SIZED BY THE CONSULTANT.
- JOINT PLATES SHALL BE WELDED OR BOLTED TO THE DECK PLATE. BOLTS, IF USED, SHALL BE COUNTERSUNK.
- NO BALLAST MAT JOINTS WITHIN 760mm OF JOINT ℄



LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

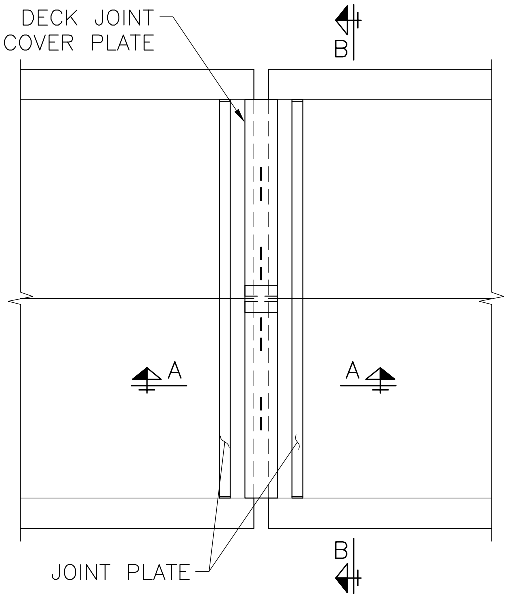
SECTION A–A
(SCHEMATIC)

Drawn: Dessin:	J.E.	Checked: Verification:	S.Kh.
Scale: Echelle:	NOT TO SCALE	Date:	2017/03/31

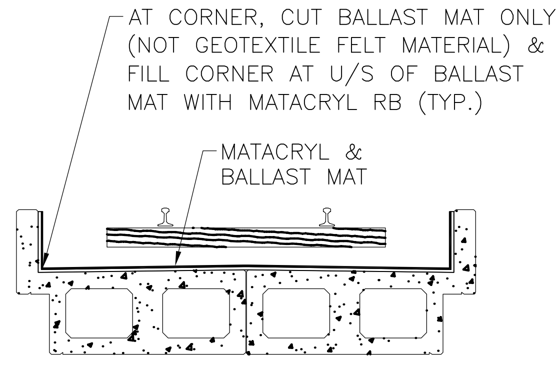
WATERPROOFING & BALLAST MAT DETAILS AT JOINTS BETWEEN STEEL BALLAST PANS

METROLINX

Drawing Number
Dessin Numero
C16m –

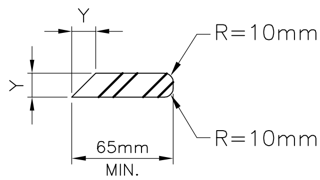


CONCRETE PAN PLAN VIEW

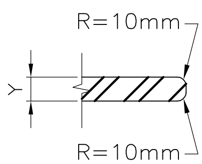


SECTION B–B

LEGEND:	
X	≥ 2Y
Y	≥ 25mm

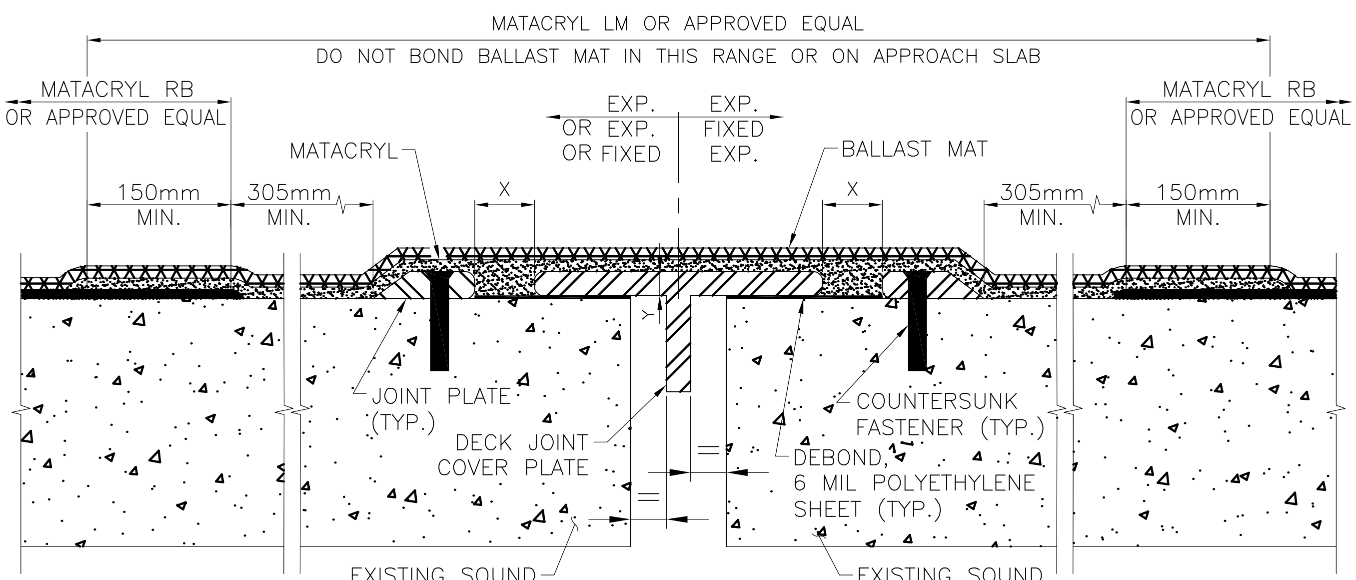


JOINT PLATE DETAIL



DECK JOINT COVER PLATE DETAIL

NOTE:
- MIN. COVER PLATE THICKNESS = 25mm
- TOP OF COVER PLATE AND TOP OF JOINT PLATE SHALL BE AT THE SAME ELEVATION, ADJUST JOINT PLATE THICKNESS TO SUIT.
- JOINT GAP (X) TO BE SIZED BY THE CONSULTANT.
- JOINT PLATES SHALL BE BOLTED WITH COUNTERSUNKS TO CONCRETE.
- NO BALLAST MAT JOINTS WITHIN 760mm OF JOINT ℄



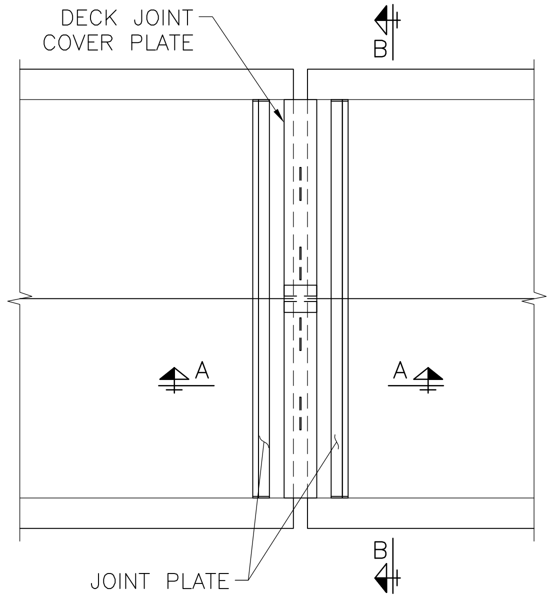
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

SECTION A–A
(SCHEMATIC)

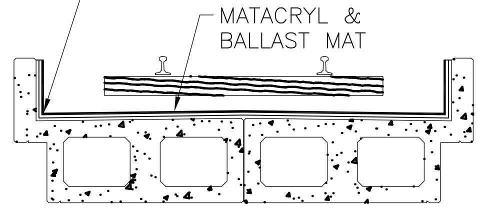
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT NEW OR EXISTING (SOUND) CONCRETE**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
C17m –



CONCRETE PAN PLAN VIEW

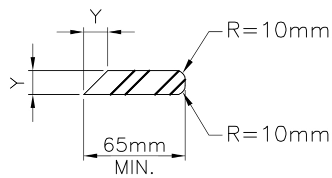


SECTION B–B

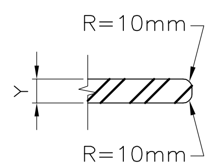
LEGEND:

X ≥ 2Y

Y ≥ 25mm



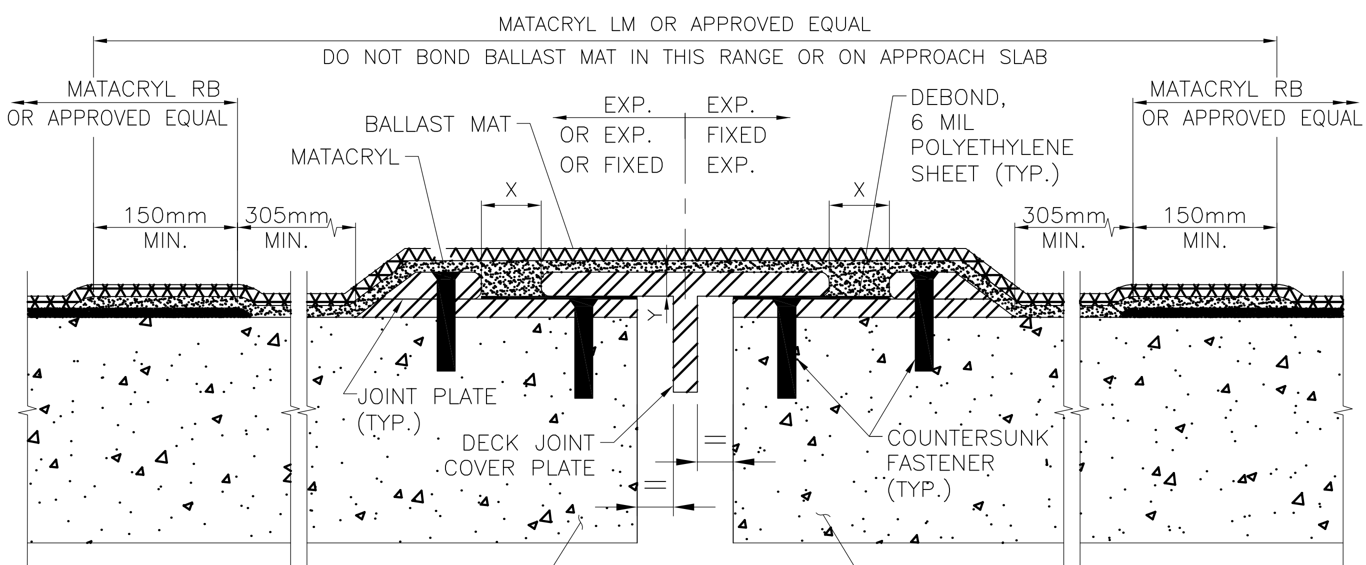
JOINT PLATE DETAIL



DECK JOINT COVER PLATE DETAIL

NOTE:

- MIN. COVER PLATE THICKNESS = 25mm
- TOP OF COVER PLATE AND TOP OF JOINT PLATE SHALL BE AT THE SAME ELEVATION, ADJUST JOINT PLATE THICKNESS TO SUIT.
- JOINT GAP (X) TO BE SIZED BY THE CONSULTANT.
- JOINT PLATES SHALL BE BOLTED WITH COUNTERSUNKS TO CONCRETE.
- NO BALLAST MAT JOINTS WITHIN 760mm OF JOINT ℄



SECTION A–A

(SCHEMATIC)

LIST OF ABBREVIATIONS:

LM = LOW MODULUS

RB = RAILWAY BRIDGE

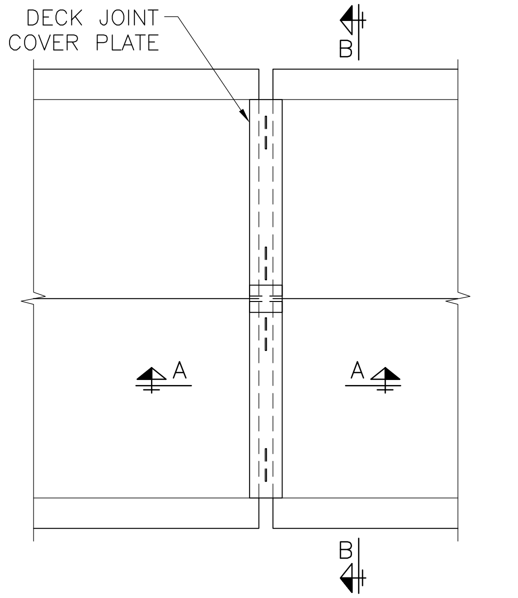
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT EXISTING (POOR) CONCRETE**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

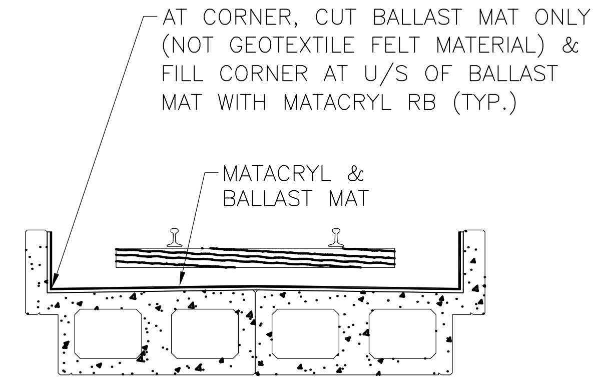
Drawing Number
Dessin Numero

C18m

–

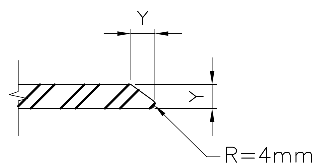


CONCRETE PAN PLAN VIEW



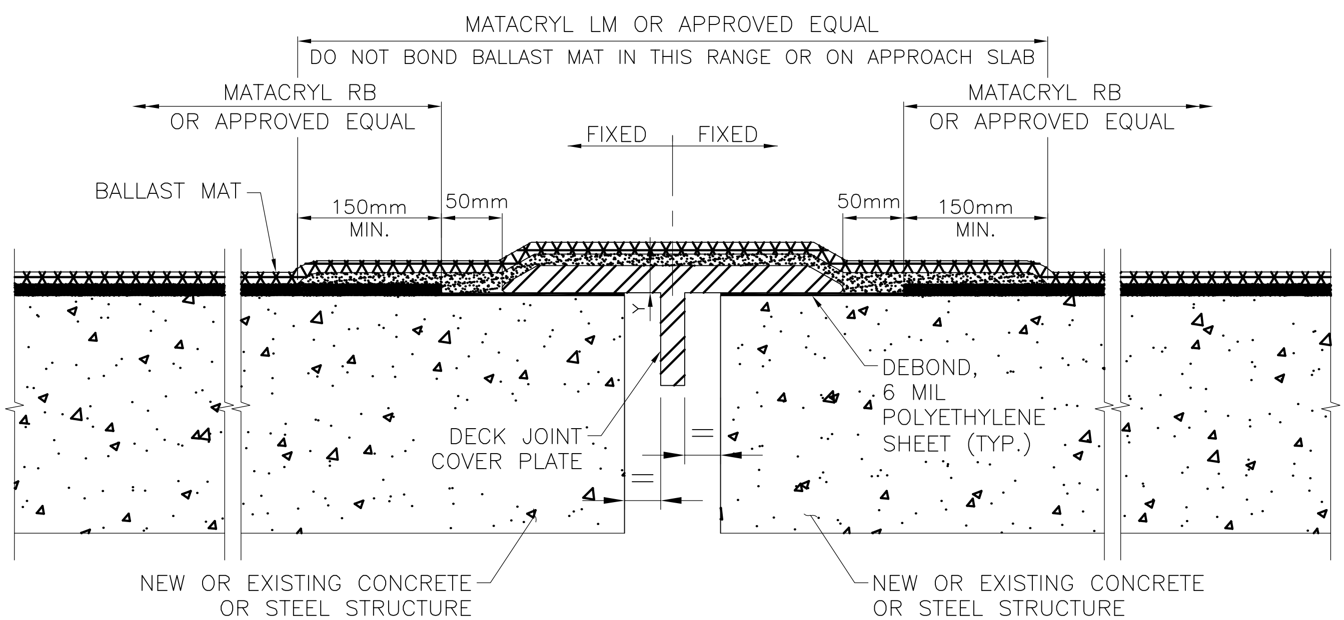
SECTION B–B

LEGEND:
Y ≥ 16mm



DECK JOINT COVER PLATE DETAIL

NOTE:
- PLATE THICKNESS SIZED BY DESIGNER (MIN. 16mm)
- NO BALLAST MAT JOINTS WITHIN 760mm OF JOINT ℄
- DO NOT BOND BALLAST MAT ON APPROACH SLAB
- FOR FIXED–FIXED BEARINGS WHERE EXPECTED LONGITUDINAL MOVEMENT DUE TO SPAN ROTATION ≤ 2mm



SECTION A–A
(SCHEMATIC)

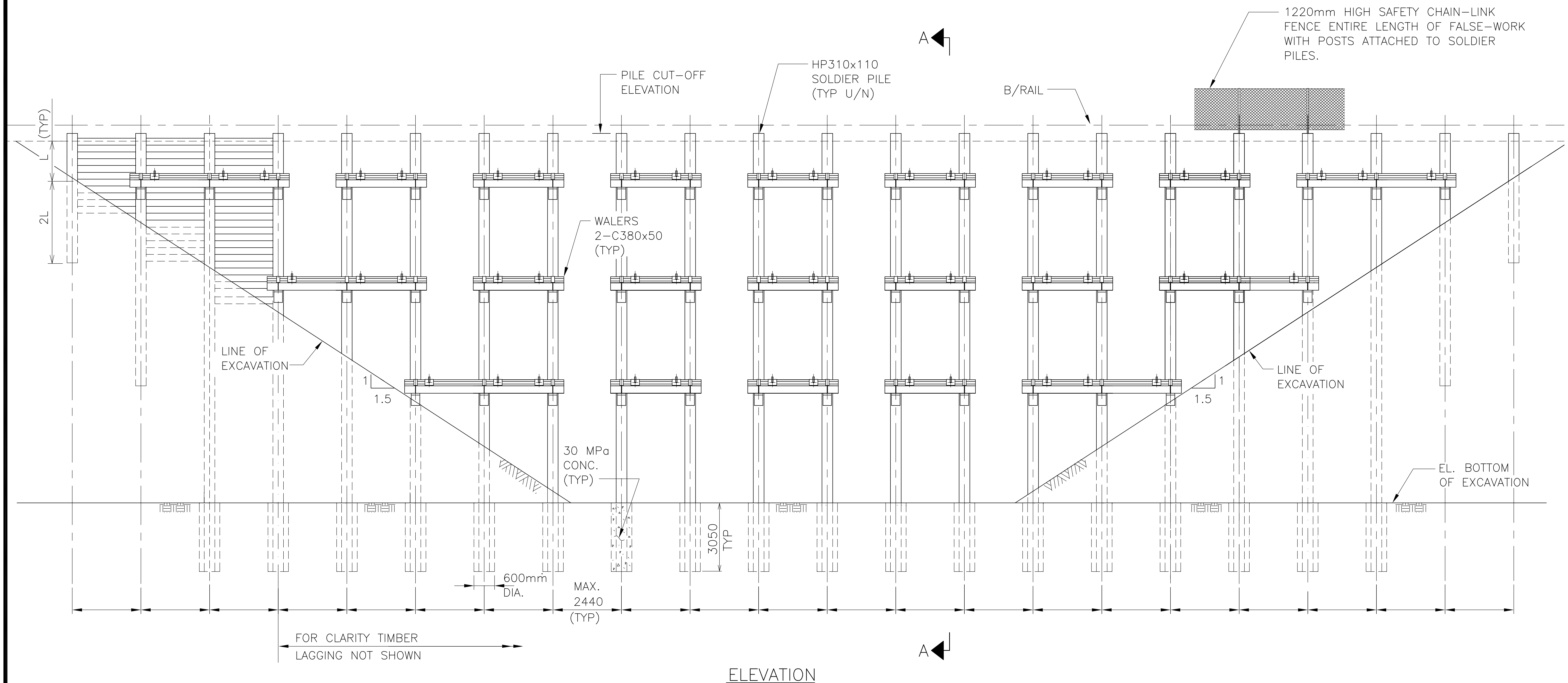
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

Drawn: Dessin:	J.E.	Checked: Verification:	S.Kh.
Scale: Echelle:	NOT TO SCALE	Date:	2017/03/31

WATERPROOFING & BALLAST MAT DETAILS AT FIXED-FIXED BEARINGS

METROLINX

Drawing Number
Dessin Numero
C19m
–

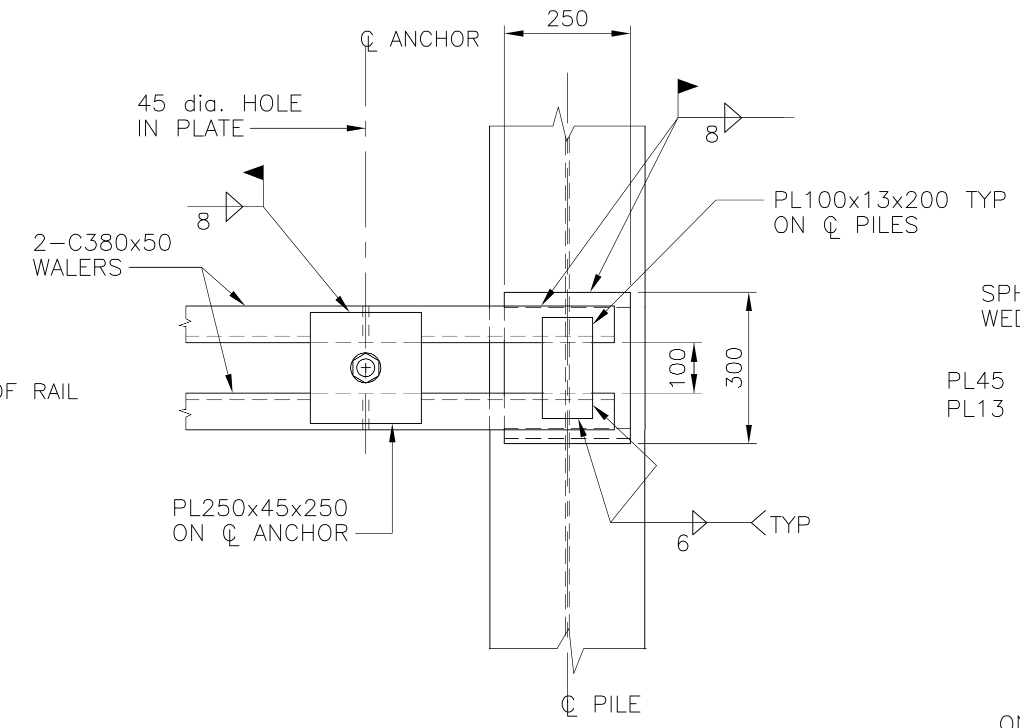


ELEVATION

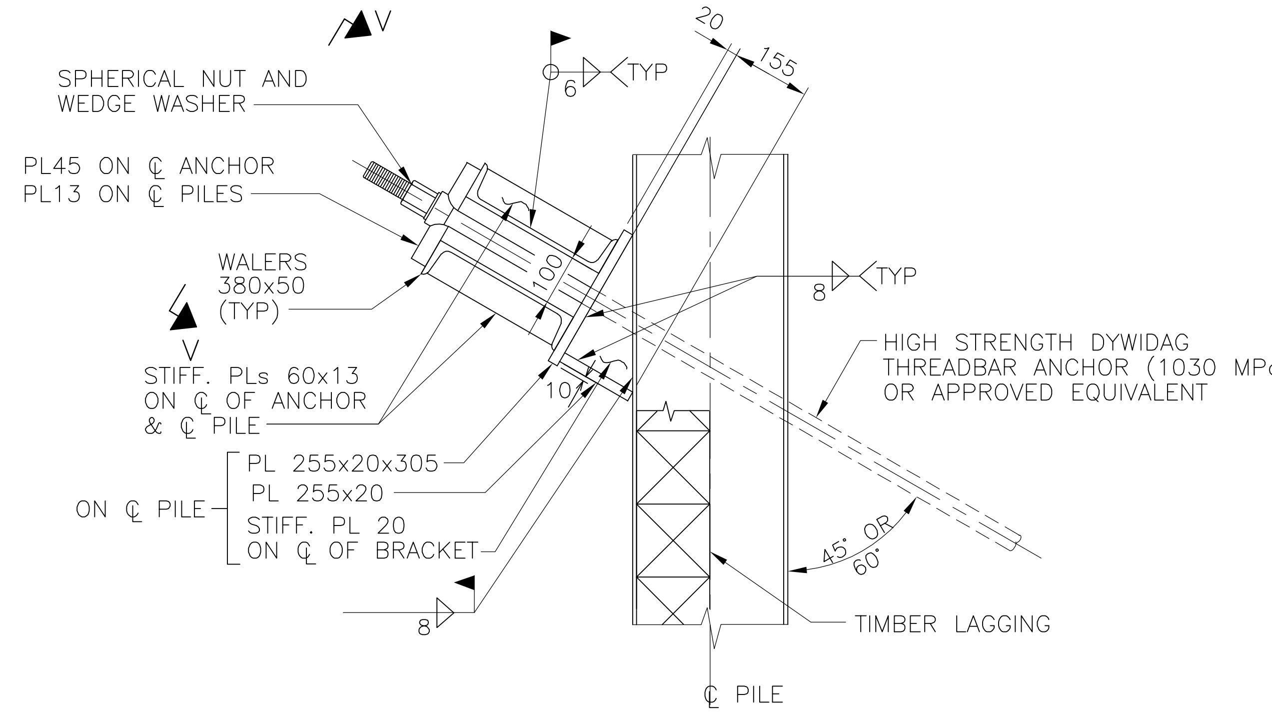
NOTES:

- SOCKET LENGTH MAY VARY ACCORDING TO SOIL TYPE
- SOCKET DIAMETER MAY VARY ACCORDING TO SOLDIER PILE SIZE AND INCLINED ANCHOR LOAD.
- FOR THE UPPER 2000mm USE 150mm LAGGING (MINIMUM) THICKNESS AND BELOW 2000mm USE 200mm (MINIMUM) THICKNESS.
- SEE DWG. F-3 FOR MATERIAL SPECIFICATIONS.

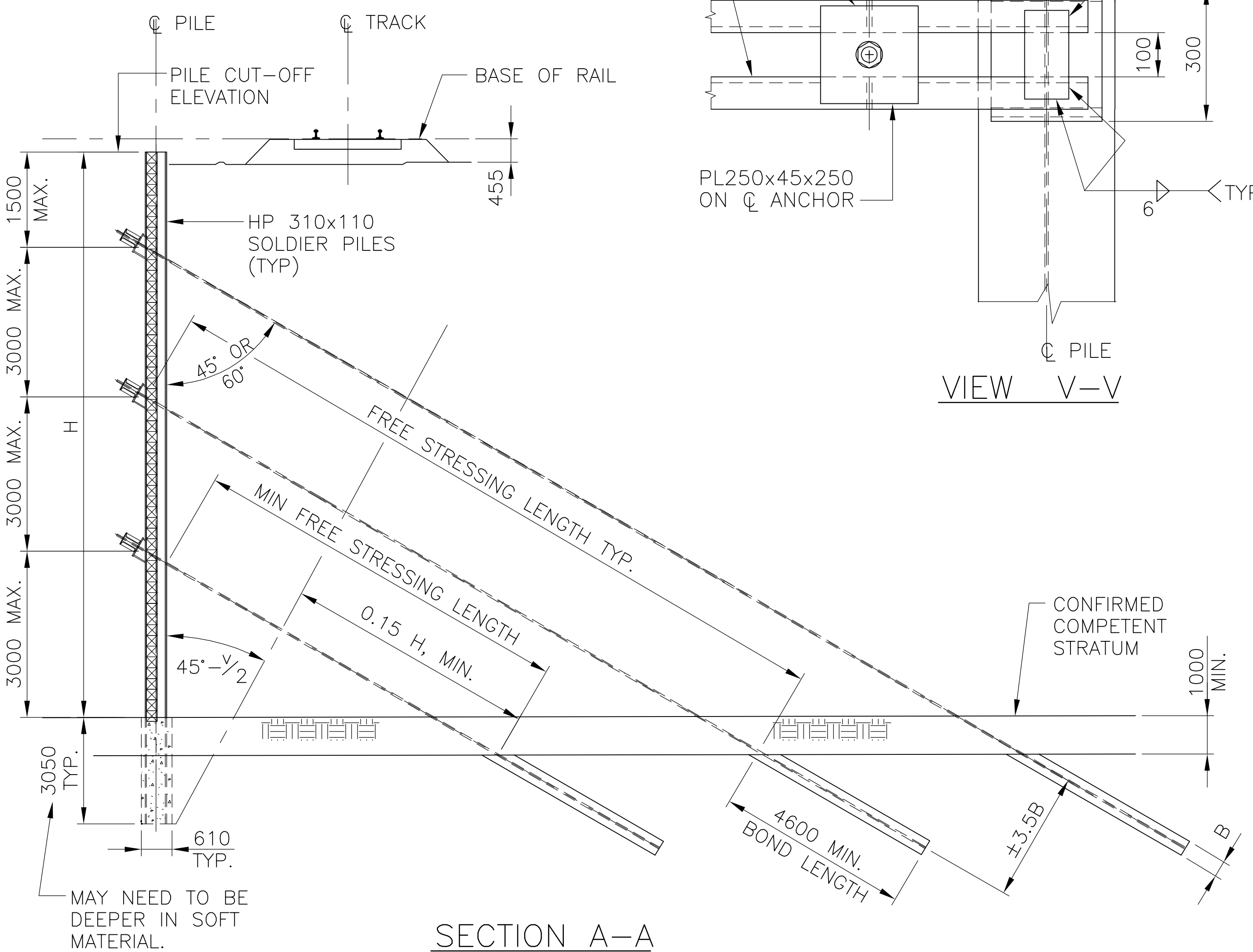
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**EXAMPLE OF TYPICAL TEMPORARY SHORING WALL**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **F1m**	–



VIEW V–V



TYPICAL ANCHOR DETAIL



SECTION A–A

SEE DWG. No. F1m

NOTES:

–IF ROCK OR COMPETENT STRATUM IS WITHIN REASONABLE DISTANCE (AS SHOWN HERE FOR EXAMPLE), IT IS PREFERABLE TO DESIGN ANCHOR CAPACITY WITHIN THAT ZONE ONLY. (i.e. TRY TO AVOID BOND LENGTH WITHIN TWO DIFFERENT ZONES)

–THE FREE EARTH OR FIXED EARTH METHOD OF ANALYSIS MAY BE USED. HOWEVER, A GEOTECHNICAL ENGINEER SHALL BE CONSULTED AND THE ANALYSIS SUBMITTED TO METROLINX.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	TYPICAL TIED-BACK WALL DETAILS SHORING WALL
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero F2m –

ESTIMATED QUANTITIES:

PILES HP310x110	________________	kg
STRUCTURAL STEEL	________________	kg
DYWIDAG ANCHORS	________________	m
CONCRETE 30MPa	________________	m^3
CONCRETE 0.5MPa	________________	m^3
LAGGING 100mm	________________	m^2
LAGGING 150mm	________________	m^2
LAGGING 200mm	________________	m^2

NOTES:

-FOR GENERAL NOTES SEE DRAWING NO.

-STRUCTURAL STEEL FOR PILES, WALERS AND BRACKETS SHALL BE GRADE 300W ACCORDING TO CSA CAN3-G40.21-M92.

-CONCRETE SHALL BE 30 MPa IN SOLDIER PILE TOES, AND 30 MPa WITHIN BOND LENGTH OF TIE-BACK ANCHORS. BENTONITE CONCRETE SHALL BE USED WITHIN FREE STRESSING LENGTH OF ANCHORS. HOLES FOR PILES AT LOCATIONS WITHOUT WALERS SHALL BE FILLED WITH 0.5 MPa CONCRETE.

-TIE BACK ANCHORS SHALL BE 38mmø GRADE 1030 MPa HIGH STRENGTH "DYWIDAG THREADED BAR TO CSA G279-M82, AND SHALL HAVE A MINIMUM BOND LENGTH OF 4575mm INTO SOLID ROCK.

-DESIGN LOAD TO BE SPECIFIED (TYP. APPROXIMATELY 630kN/ANCHOR)

-TIMBER LAGGING SHALL BE SPECIES (S-P-F), BEAMS AND STRINGERS GRADE NO.1 OR BETTER , IN ACCORDANCE WITH AREMA 2016 CHAPTER 7. FOR ALLOWABLE BENDING STRESS USE 6.5 MPa (INCLUDING ALL MODIFICATION FACTORS).

-TIMBER LAGGING THICKNESS SHALL BE 150 mm MIN. FOR UPPER 2000 mm AND 200 mm MIN. FOR BELOW 2000 mm.

-TIEBACK ANCHORS SHALL BE DYWIDAG MULTISTRAND, 0.6" dia., 7-WIRE GREASED AND COATED, LOW-RELAXATION, GRADE 270 ksi STRAND CONFORMING TO CSA G279-82 (ASTM A 416)

-WELDING SHALL BE IN ACCORDANCE WITH CSA CAN3-W59-M1989.

K_o = 0.50 MIN.

K_p = ...

γ_{water} = 9.806 kN/m3

γ_{soil} = ### kN/m3

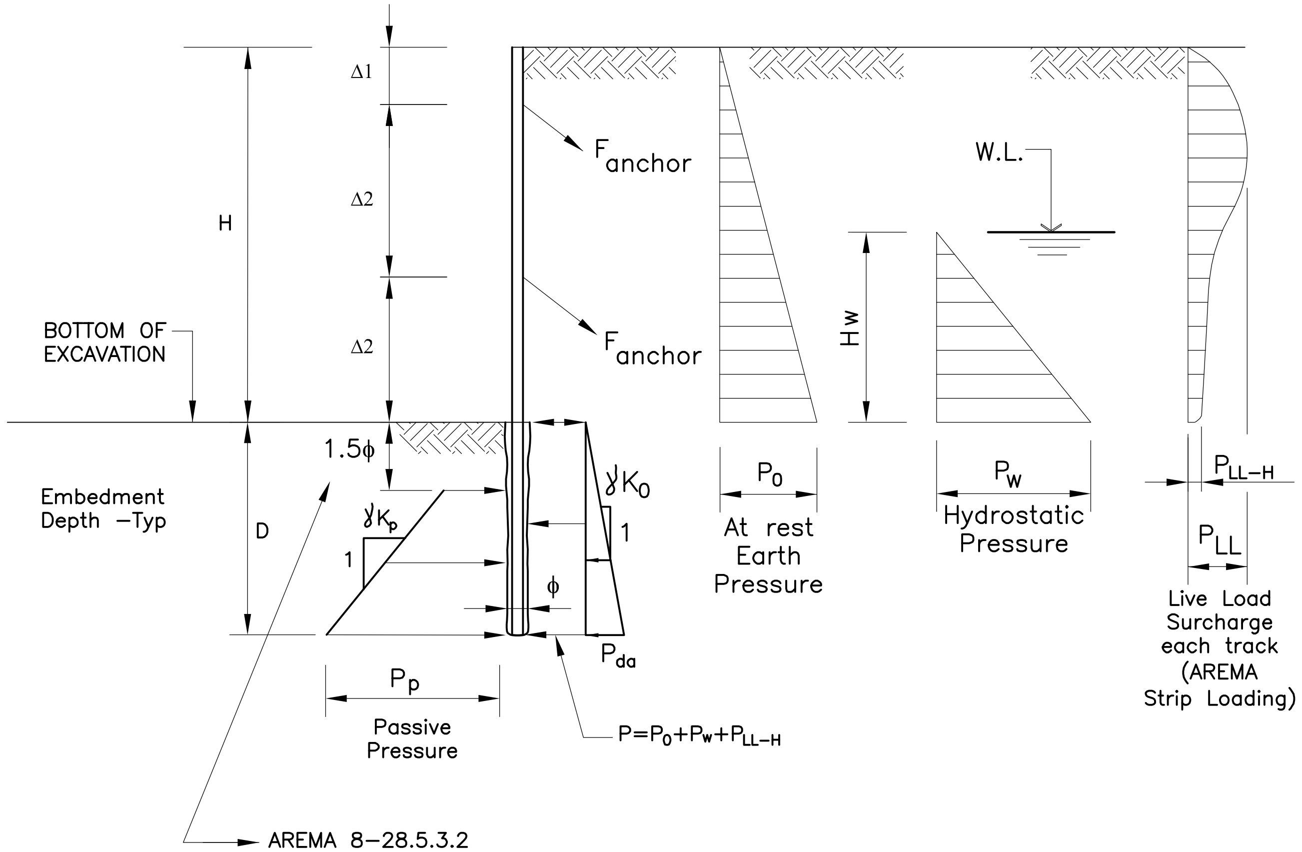
CONSTRUCTION PROCEDURE FOR SOLDIER PILES, LAGGING AND TIE BACK ANCHORS:

1. DRILL HOLES TO SIZE AND DEPTH SHOWN. INSTALL PILES, ALIGN AND CAST CONCRETE TOES WHERE SHOWN.
2. WHEN CONCRETE IN TOES HAS SET (30MPa), FILL VOID AROUND PILES TO GRADE WITH 0.5MPa MATERIAL.
3. EXCAVATE IN 1220mm LIFTS AND INSTALL LAGGING. EXCAVATE SOIL FACES NEATLY TO ENSURE A TIGHT FIT FOR LAGGING. WEDGE AT PILE AS NECESSARY, PACK ALL VOIDS BEHIND LAGGING WITH GRANULAR MATERIAL RAMMED INTO PLACE.
4. WHEN EXCAVATION REACHES 305mm MAX. BELOW ANCHOR ELEVATION NOTED , DRILL AND INSTALL ANCHORS.
5. FILL ALL VOIDS AROUND TIEBACKS WITH 3000 PSI CONCRETE GROUT
6. DO NOT FURTHER EXCAVATE BELOW ANCHOR ELEVATIONS UNTIL ALL ANCHORS ARE STRESSED AND LOAD LOCKED IN. ALL ANCHORS SHALL BE PROOF TESTED TO 1.33 TIMES DESIGN LOAD AND IF NO CREEP OCCURS AFTER 30 MINUTES THE LOAD SHALL BE REDUCED TO 1.1 TIMES DESIGN LOADS AND LOCKED IN.
7. A NOMINAL LOAD SHALL BE USED TO STRESS ALL HORIZONTAL ANCHORS IN ORDER TO DRAW OUT ANY SLACK IN THESE ANCHORS.
8. REPEAT OPERATION 3 AND 7 TO THE NEXT STAGE EXCAVATION LEVEL.
9. DO NOT EXCAVATE BELOW TIE-BACK ELEVATIONS UNTIL ALL ANCHORS ARE STRESSED & LOAD LOCKED IN.

-DESIGN LOAD: ### kN FOR ANCHORS # to #
-STRAND SIZE AND NUMBERS: #-0.6" TENDONS, (### kN /anchor)
-LOCK-OFF LOAD = 1.10 x DESIGN LOAD
-PROOF LOAD = 1.33 x DESIGN LOAD
-PERFORMANCE BOND LOAD = 2.0 x DESIGN LOAD

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPICAL TIED-BACK WALL NOTES SHORING WALL**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **F3m** –

TRACK PROTECTION SYSTEM
DESIGN LOAD DIAGRAMS



WHERE:
γsoil = 21 kN/m3
γw = 9.806 kN/m3
K_0 = 0.50 Minimum
K_p = 3.0
ϕ = DIAM. OF SHAFT

AT REST EARTH PRESSURE

$P_0 = K_0 \gamma s\ H$ (kPa)

$P_{da} = K_0 \gamma s\ D$ (kPa)

PASSIVE RESISTANCE

$P_p = K_p \gamma s\ D$ (kPa)

HYDROSTATIC PRESSURE

$Pw = \gamma w\ Hw$ (kPa)

$\Delta 1$ = Maximum 1.5 m

$\Delta 2$ = Maximum 3.0 m

LIVE LOAD SURCHARGE

–TO BE CALCULATED IN ACCORDANCE WITH AREMA 2016, CHAPTER 8, SECTION 20,3,2,2(a), BOUSINESQ METHOD.

–THE TRACK PROTECTION SHALL BE DESIGNED FOR THE SURCHARGE DUE TO THE COOPER–E80 LOADING AS PER AREMA–2016. (I.E. 95.8 kPa (2.00 ksf) –80 kips AXLE LOAD, 5 FT SPACING BETWEEN TWO CONSECUTIVE AXLES. THE EFFECT OF THE STRIP LOAD SURCHARGE CALCULATED WITH 8 FT TIE LENGTH CAN BE ASSESSED AS DESCRIBED IN AREMA 2016, CHAPTER 8, ARTICLE 20.3.2.2.

–THE EFFECT OF E–80 TRAIN LOADING ON ALL TRACKS SHALL BE CONSIDERED FOR THE ESTIMATION OF THE LATERAL PRESSURE DUE TO TRAIN LOADING, AS DESCRIBED IN AREMA 2016 CHAPTER 8 ARTICLE 2.2.3.C.(6).

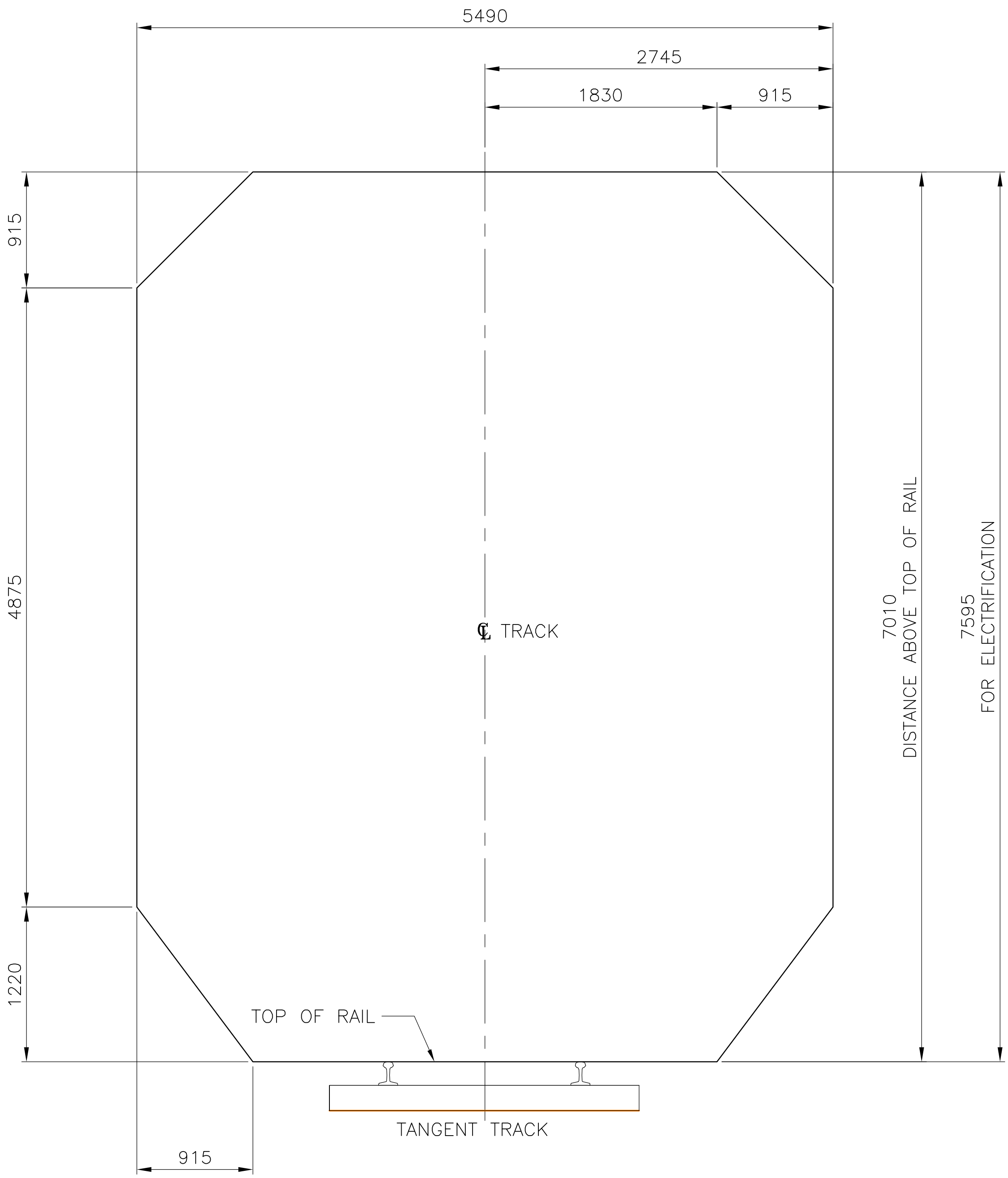
BOUSSINESQ METHOD

–NO REDUCTION FACTOR WILL ALLOWED TO REDUCE COMPUTED LATERAL PRESSURE DUE TO TRAIN LOADING BASED ON BOUSINESQ METHOD.

APPARANT EARTH PRESSURE METHOD

–FOR ESTIMATION OF SOIL LATERAL PRESSURE, TRIANGULAR SOIL PRESSURE METHOD SHALL BE USED. DELETE AREMA 2016 ARTICLE 8_28.5.4.3.C.(3), FIGURE 8–28–1, APPARENT EARTH PRESSURE METHOD IS NOT ALLOWED.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TEMPORARY SHORING WALL DESIGN LOAD DIAGRAMS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **F4m** –

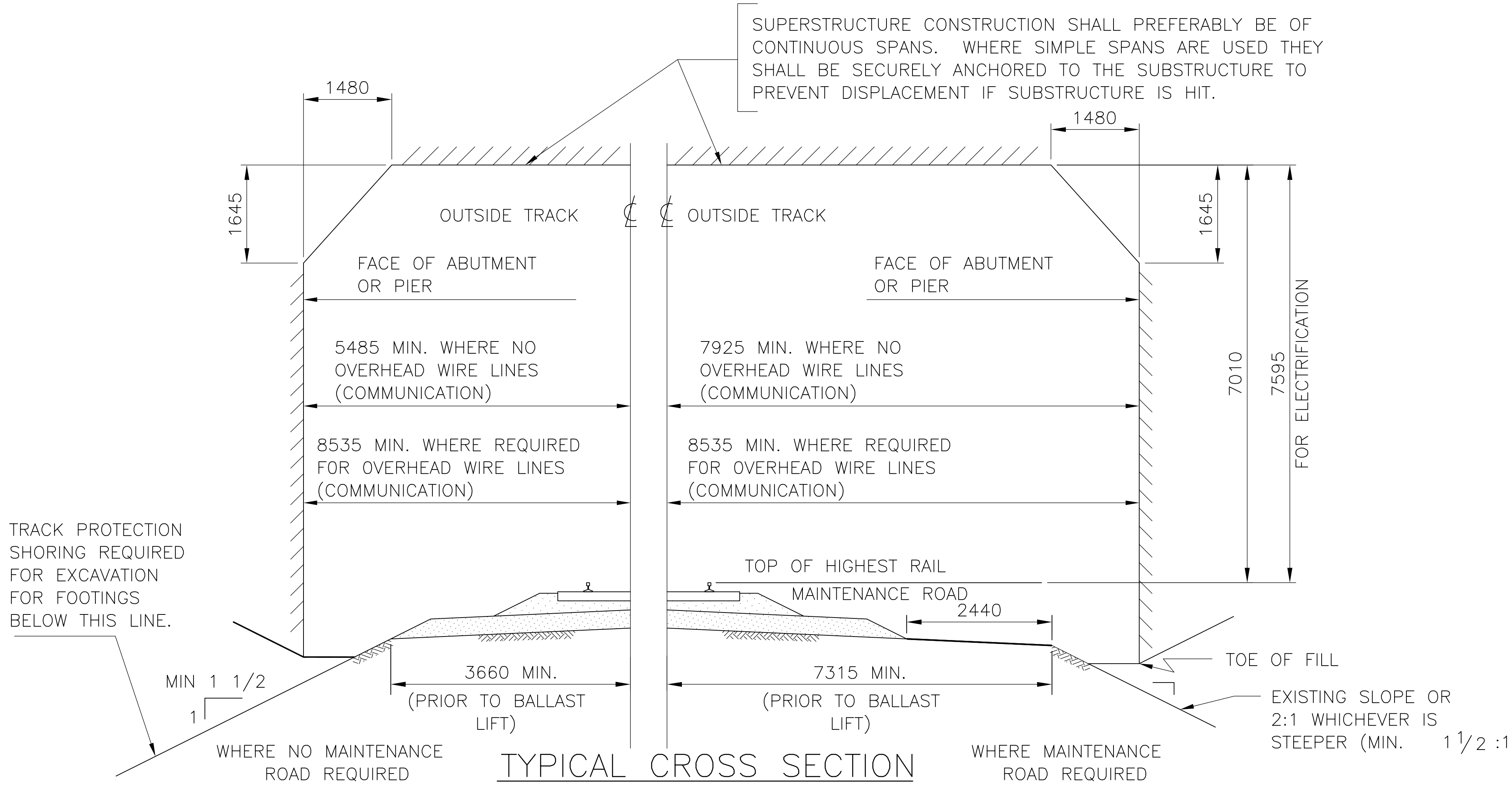


NOTE: SEE ARTICLE 1.2.6a FOR CURVE CORRECTIONS.
AREMA MANUEL FOR RAILWAY ENGINEERING – CHAPTER 15

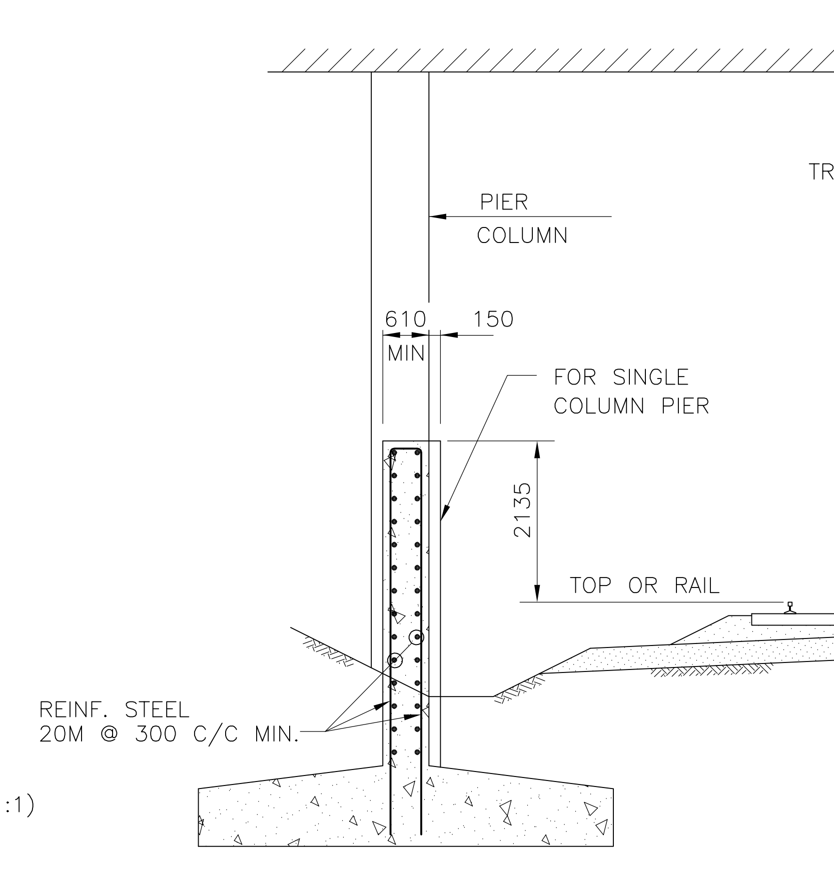
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**METROLINX STANDARD CLEARANCE DIAGRAM FOR ALL NEW RAILWAY BRIDGES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
K1U-10.1m –



TYPICAL CROSS SECTION



PROTECTION WALL DETAIL

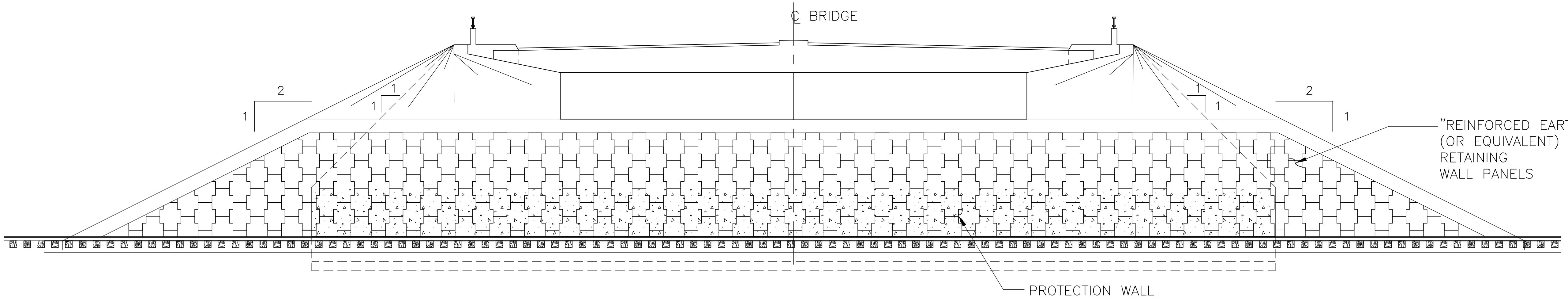
NOTES

- ALL HORIZONTAL DIMENSIONS ARE TO BE TAKEN PERPENDICULAR TO RAILWAY TRACKS.
- ALL VERTICAL DIMENSIONS ARE TO BE TAKEN FROM THE TOP OF RAIL.
- FOR TRACKS ON CURVE, CONSULT SYSTEM ENGINEER – TECHNICAL SERVICES.
- FOR RAILWAY REQUIREMENTS FOR ADDITIONAL FUTURE TRACK PROVISIONS AND FOR THE MINIMUM TEMPORARY CONSTRUCTION CLEARANCES CONSULT RAIL CORRIDORS.
- NO WATER FROM DECK OF STRUCTURE SHALL DRAIN ONTO RAILWAY TRACK BETWEEN TRACK DITCHES.
- NO WATER FROM ROAD APPROACH EMBANKMENT SHALL DRAIN INTO RAILWAY DITCHES WITHOUT PROPER PROTECTION AGAINST EROSION OF SLOPE OR FILLING WITH FINES OF DITCHES.
- APPROACH SLOPES IF ADJACENT TO TRACKS ARE TO BE PAVED OR OTHERWISE PROTECTED FROM EROSION.
- ANY DEVIATION FROM THIS STANDARD MUST RECEIVE PRIOR APPROVAL OF THE SENIOR MANAGER TRACK & STRUCTURES.

PIER PROTECTION

- PIERS WITHIN 7620 OF CENTER LINE OF ADJACENT TRACK SHALL BE OF SOLID HEAVY CONSTRUCTION OR SHALL BE PROTECTED BY REINFORCED CONCRETE PROTECTION WALL EXTENDING 2135 ABOVE TOP OF RAIL. WHERE 2 OR MORE COLUMNS COMPOSE A PIER, A PROTECTION WALL AT LEAST 610 THICK SHALL CONNECT THE COLUMNS. WHEN THE PIER CONSISTS OF A SINGLE COLUMN, THE PROTECTION WALL SHALL BE PARALLEL TO THE TRACK, 760 THICK, EXTEND AT LEAST 2135 BEYOND BOTH SIDES OF THE COLUMN, END PROJECT 150 BEYOND THE FACE OF THE COLUMN ON THE SIDE ADJACENT TO THE TRACK. PROTECTION WALL SHALL BE ANCHORED TO THE COLUMN AND FOOTINGS WITH ADEQUATE REINFORCING STEEL.
- DESIGN AND LOCATION OF PROTECTION WALLS SHALL BE VERIFIED WITH RAIL CORRIDORS–BRIDGES & STRUCTURES.

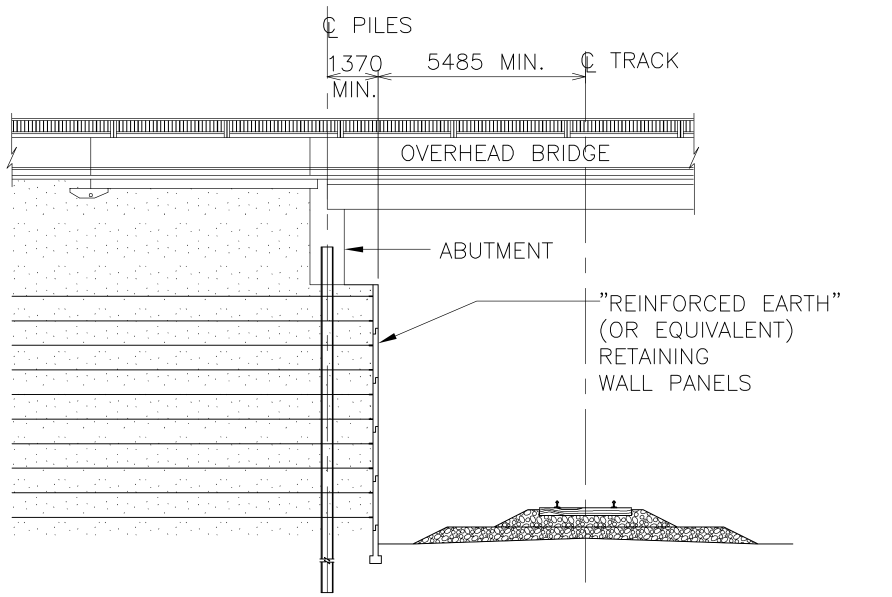
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**PROTECTION AND MINIMUM CLEARANCE FOR OVERHEAD BRIDGES**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number / Dessin Numero **K1U-10.2m** –



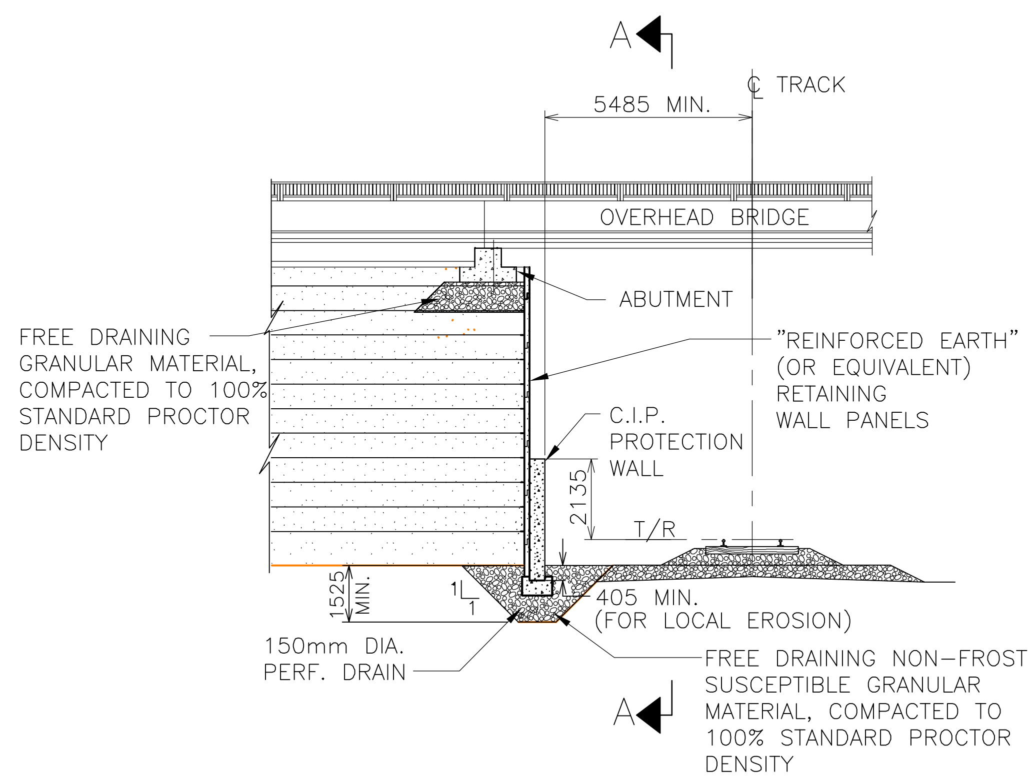
SECTION A–A

NOTES:

- WHEN "REINFORCED EARTH" WALLS (OR EQUIVALENT) ARE TO BE CONSTRUCTED WITHIN 7.62m OF THE CENTER LINE OF TRACK, THEY SHALL BE IN ACCORDANCE WITH THE TYPICAL SECTIONS SHOWN ON THIS DRAWING FOR ABUTMENTS ON PILES OR ON A GRANULAR BASE.
- THE PROTECTION WALL SHALL BE PARALLEL TO THE TRACK 760mm (MIN.)THICKNESS AND EXTEND 2.135m ABOVE THE TOP OF RAIL.
- REFER TO DWG. K1U–10.2 FOR NOTES & PROTECTION WALL DETAILS.
- PRIOR TO CASTING OF THE C.I.P. PROTECTION WALL A TEMPORARY FACED REINFORCED EARTH WALL(OR EQUIVALENT) MUST BE CONSTRUCTED TO THE TOP OF THE C.I.P. WALL TO ENSURE THAT THE SOIL REINFORCEMENT HAS BEEN MOBILIZED EQUALLY.
- THE C.I.P. PROTECTION WALL MUST BE POSITIVELY CONNECTED TO THE M.S.E. WALL AND AN ALLOWANCE PROVIDED FOR VERTICAL DRAINAGE BETWEEN THE TWO WALLS.

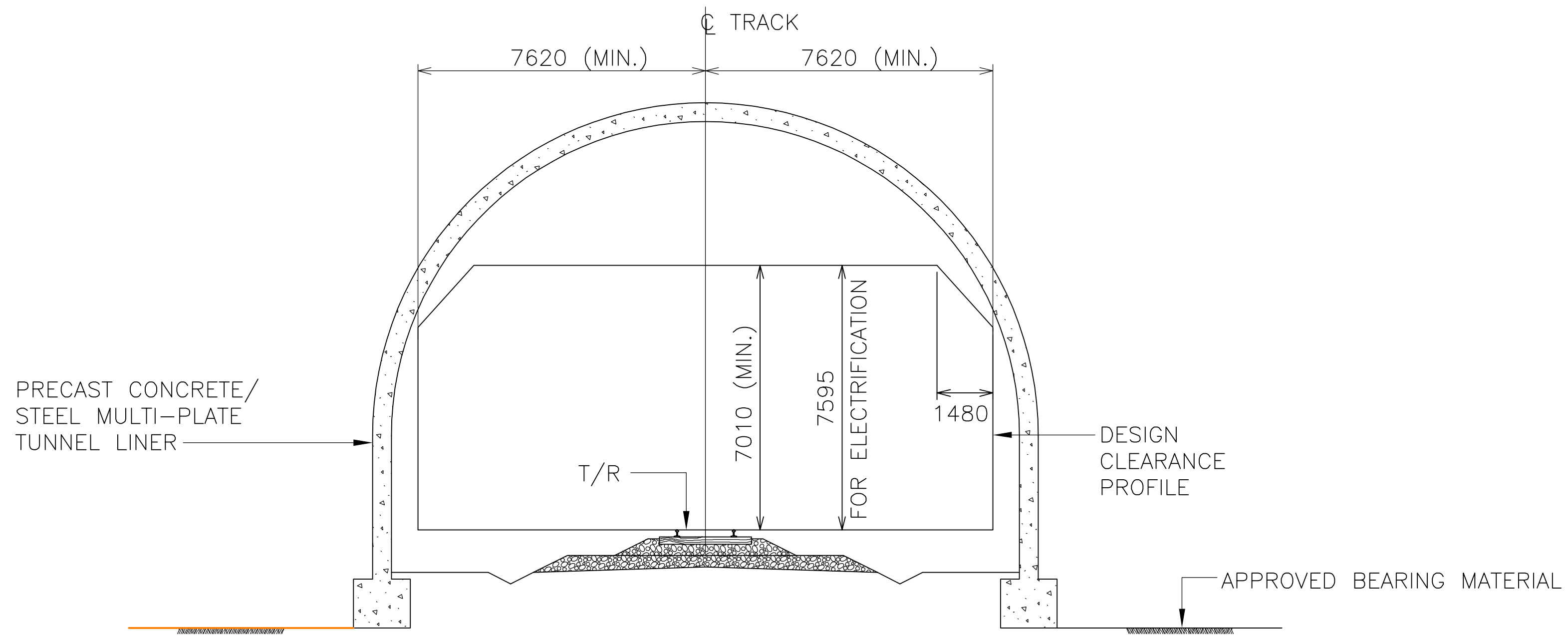


TYPICAL SECTION FOR ABUTMENTS ON PILES



TYPICAL SECTION FOR
ABUTMENTS ON GRANULAR BASE

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**PROTECTION WALL REQUIREMENTS FOR REINFORCED EARTH (OR EQUIV.) WALLS FOR OVERHEAD BRIDGES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **K1U-10.3m** –



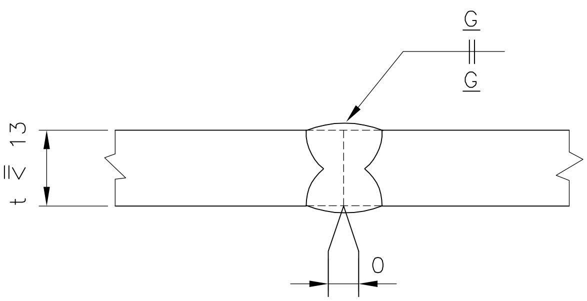
TYPICAL TUNNEL SECTION

NOTE: ONLY AFTER THE PROPOSED CONCEPTUAL DESIGN HAS BEEN APPROVED BY METROLINX CAN THIS FORM OF CONSTRUCTION BE USED

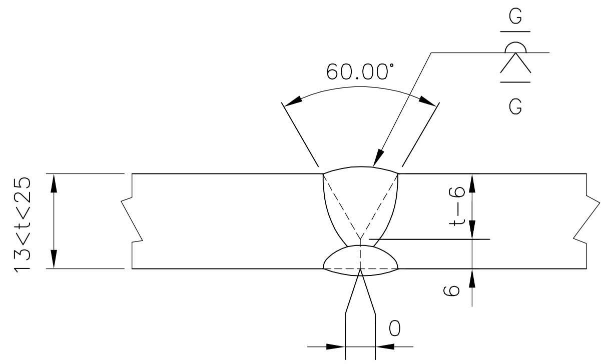
NOTES:

- ANY PROPOSAL MUST BE SUBMITTED TO THE SENIOR MANAGER TRACK & STRUCTURES FOR REVIEW ACCOMPANIED BY COMPLETE DESIGN CALCULATIONS AND GEOTECHNICAL INFORMATION.
- ALL HORIZONTAL DIMENSIONS ARE TO BE TAKEN PERPENDICULAR TO RAILWAY TRACKS.
- ALL VERTICAL DIMENSIONS ARE TO BE TAKEN FROM THE TOP OF RAIL.
- FOR TRACKS ON CURVE, CONSULT RAIL CORRIDORS.
- FOR RAILWAY REQUIREMENTS FOR ADDITIONAL FUTURE TRACK PROVISIONS AND FOR THE MINIMUM TEMPORARY CONSTRUCTION CLEARANCES, CONSULT RAIL CORRIDORS.
- NO WATER FROM DECK OF STRUCTURE SHALL DRAIN ONTO RAILWAY TRACK BETWEEN TRACK DITCHES.
- NO WATER FROM ROAD APPROACH EMBANKMENT SHALL DRAIN INTO RAILWAY DITCHES WITHOUT PROPER PROTECTION AGAINST EROSION OF SLOPE OR FILLING WITH FINES OF DITCHES.
- ANY DEVIATION FROM THIS STANDARD MUST RECEIVE PRIOR ACCEPTANCE OF THE SENIOR MANAGER TRACK & STRUCTURES.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CLEARANCE DIAGRAM REQUIREMENTS FOR PREFABRICATED TUNNELS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **K1U-10.4m** –



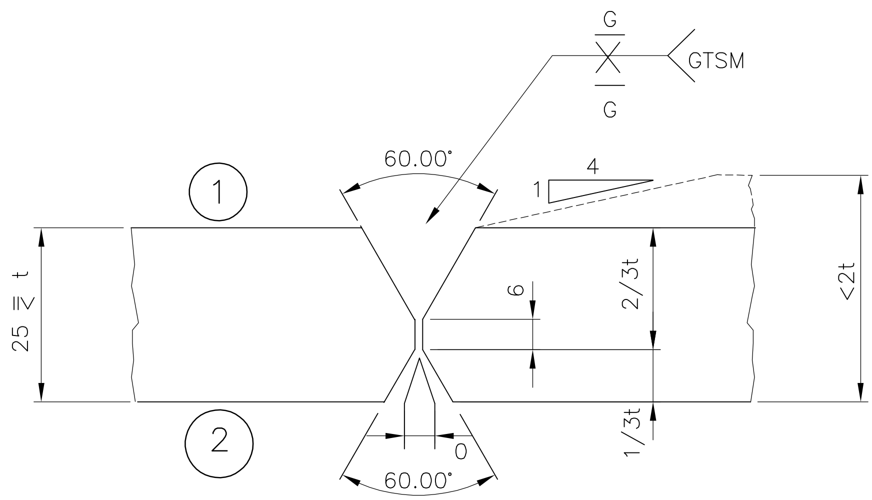
PLATES OF EQUAL THICKNESSES



PLATES OF EQUAL THICKNESSES

NO. OF PASSES
WILL VARY WITH
THICKNESS

SIDE 2 GOUGED OUT TO
SOUND METAL AFTER
SIDE 1 IS WELDED, AND
THEN WELD.

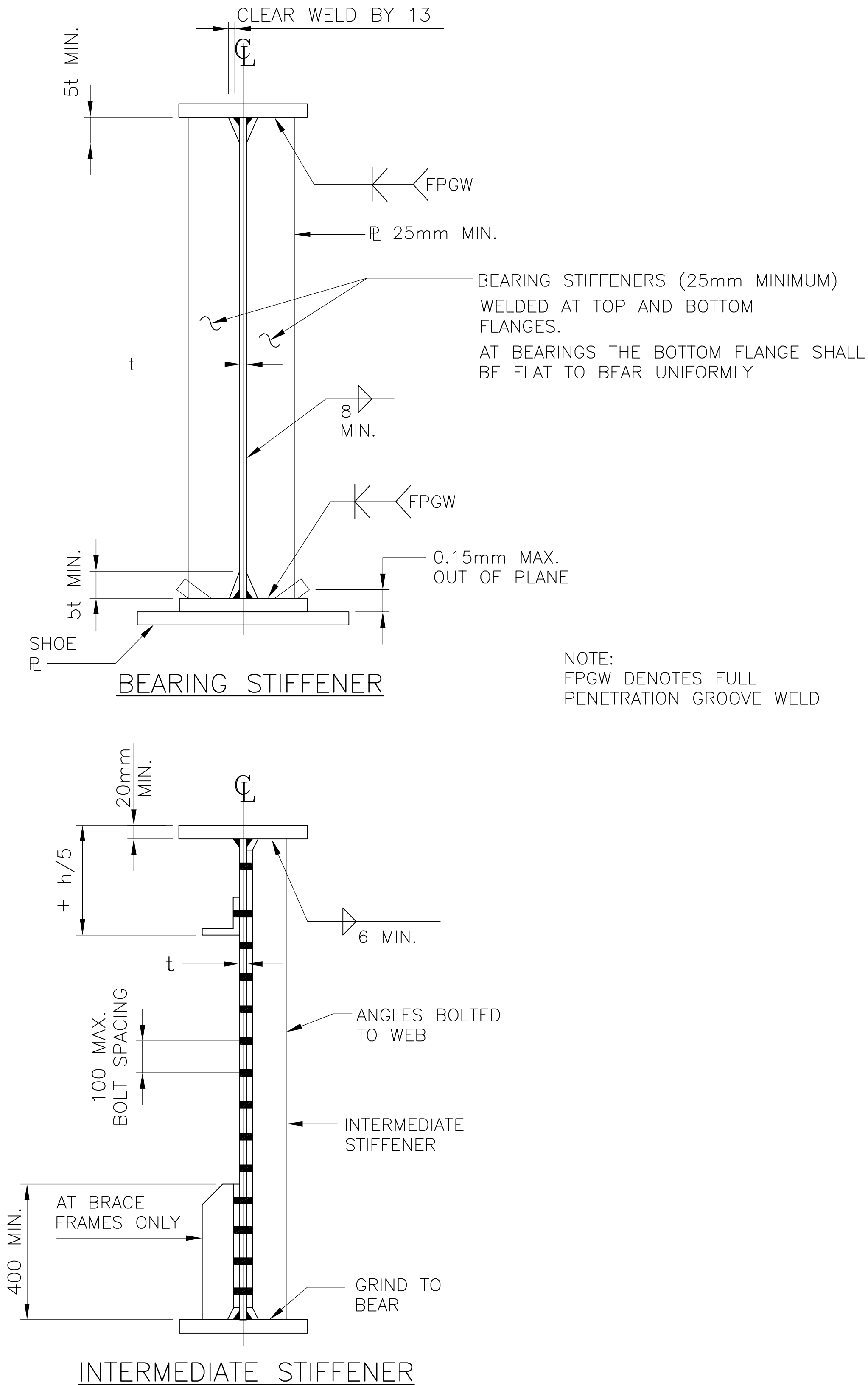


PLATES OF EQUAL OR UNEQUAL THICKNESSES

WELDING SHALL BE PERFORMED IN FLAT POSITION IN ACCORDANCE WITH CSA STANDARD W59. RUN−OFF PLATES SHALL BE USED TO ENSURE SOUND WELDS AND FULL THROAT THICKNESS, AND SHALL BE OF SAME MATERIAL AND GEOMETRY AS FLANGE AT JOINT. AFTER COMPLETION AND COOLING OF WELD, REMOVE RUN−OFF PLATES AND GRIND WELD FLUSH ON ALL SIDES (IN DIRECTION OF STRESSES).

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**SUBMERGED ARC WELDED JOINTS FOR FLANGES WEB, STIFFENERS & GUSSET PLATES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX	Drawing Number Dessin Numero **S1m**	−

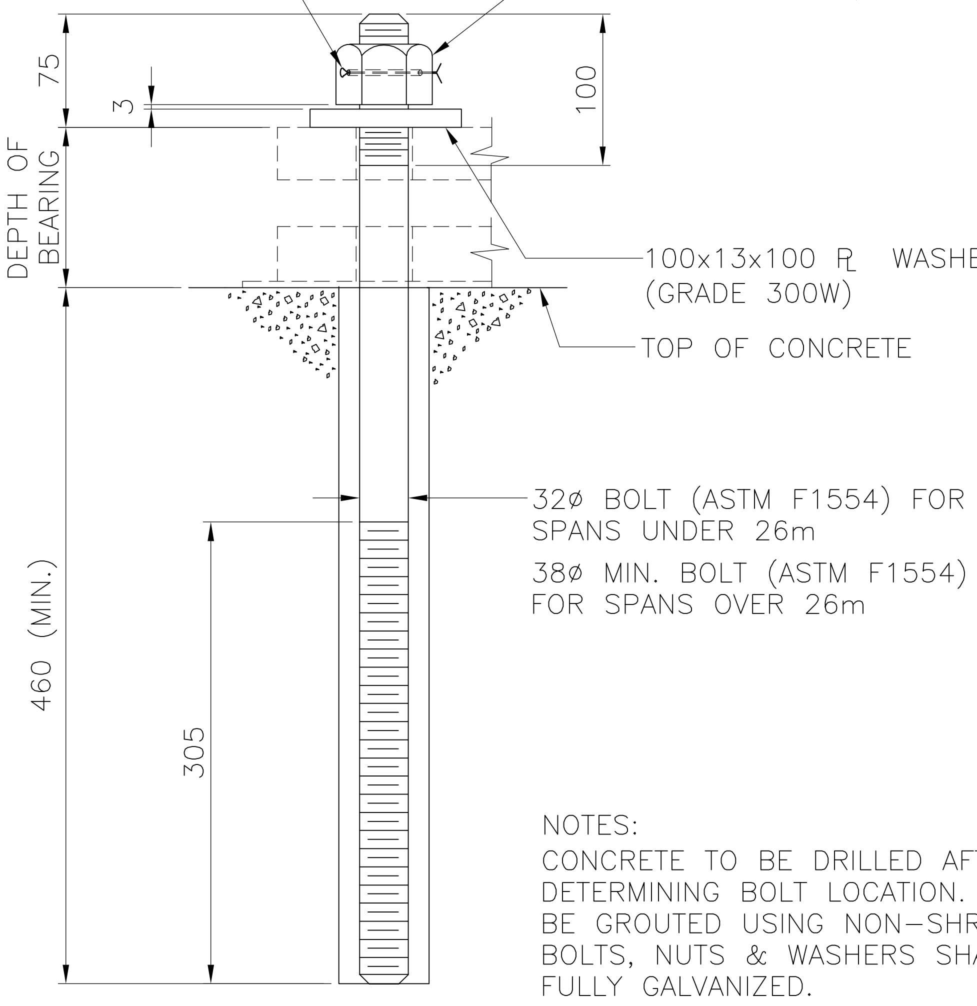


Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STIFFENERS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
S2m

–



NOTES:

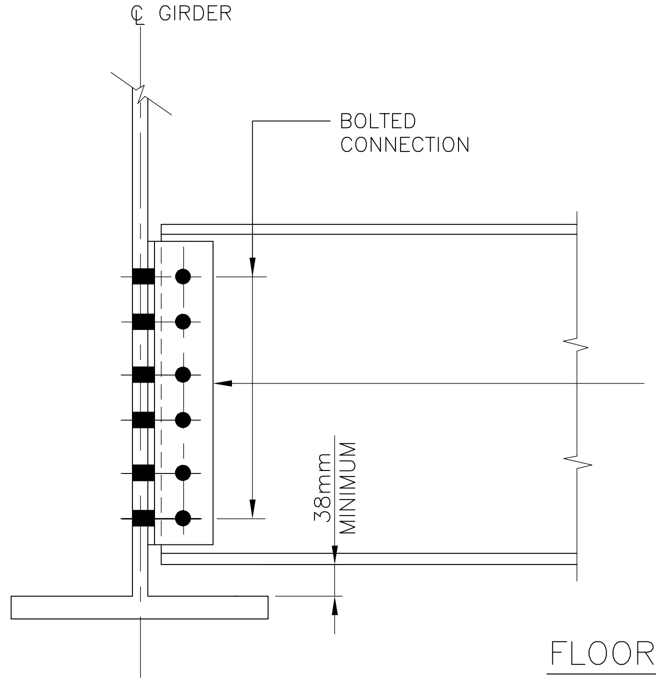
CONCRETE TO BE DRILLED AFTER DETERMINING BOLT LOCATION. BOLTS TO BE GROUTED USING NON-SHRINK GROUT. BOLTS, NUTS & WASHERS SHALL BE FULLY GALVANIZED.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ANCHOR BOLT**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

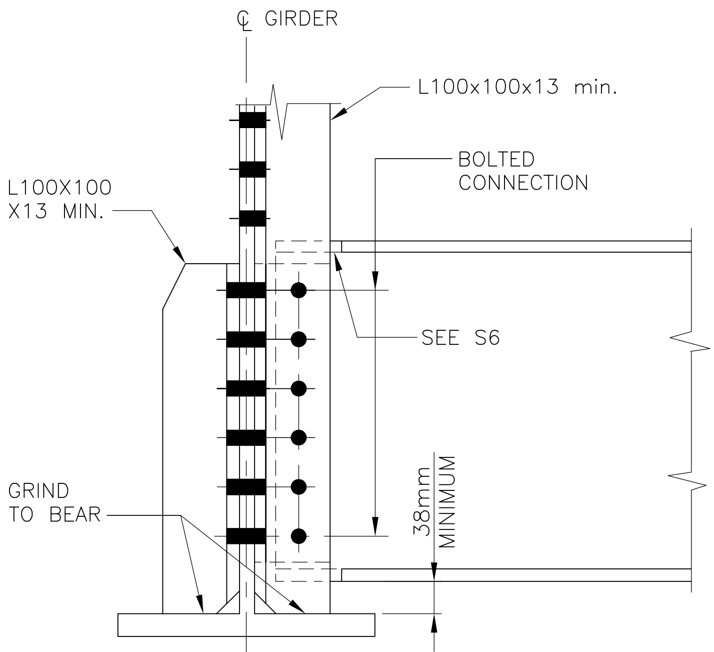
METROLINX

Drawing Number
Dessin Numero
S3m

–



FLOOR BEAM TO GIRDER WEB



FLOOR BEAM TO GIRDER STIFFENER

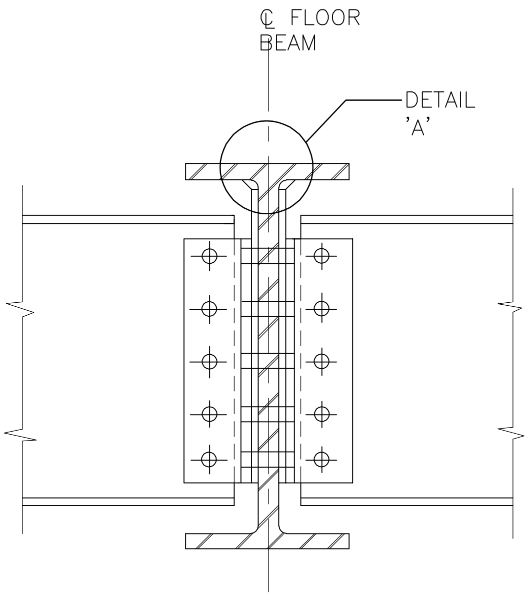
NOTE

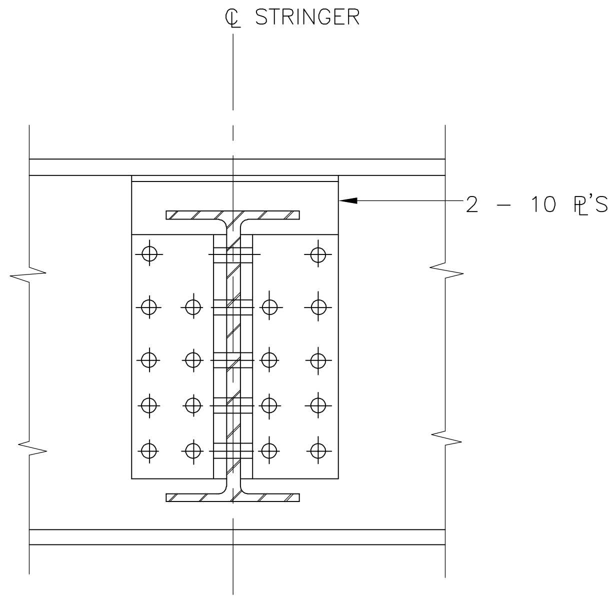
THESE ARE DIAGRAMMATIC SKETCHES. THE CONTRACTOR SHALL DESIGN THE CONNECTIONS AND SUBMIT FOR RAIL CORRIDORS REVIEW.

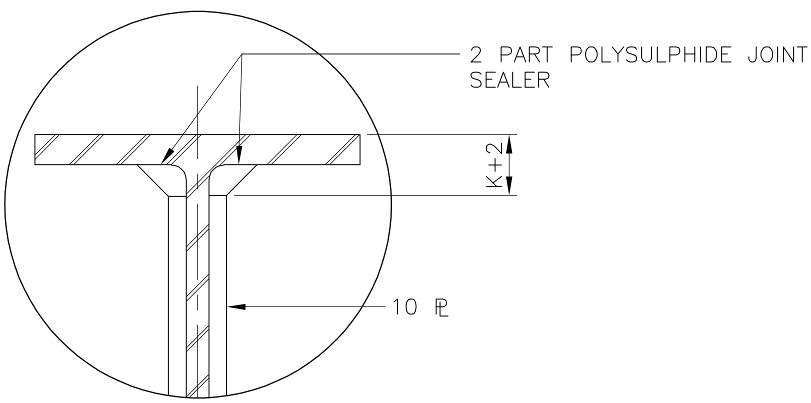
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**FLOOR BEAM CONNECTIONS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S4m** –







DETAIL 'A'

NOTE:

THESE ARE DIAGRAMMATIC SKETCHES. THE CONTRACTOR SHALL DESIGN THE CONNECTION AND SUBMIT FOR RAIL CORRIDORS REVIEW.

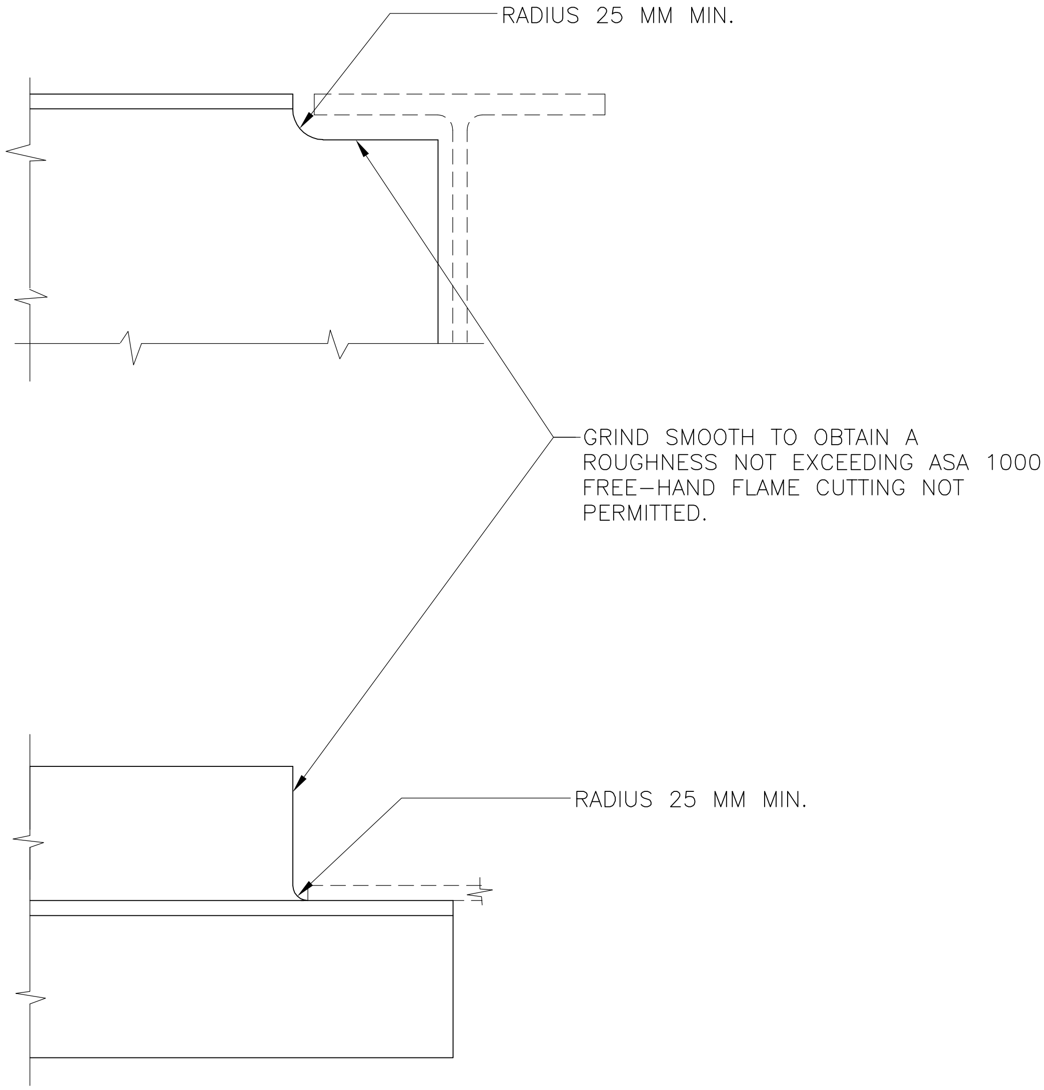
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**STRINGER TO FLOOR BEAM CONNECTION OPEN DECK ONLY**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero

S5m

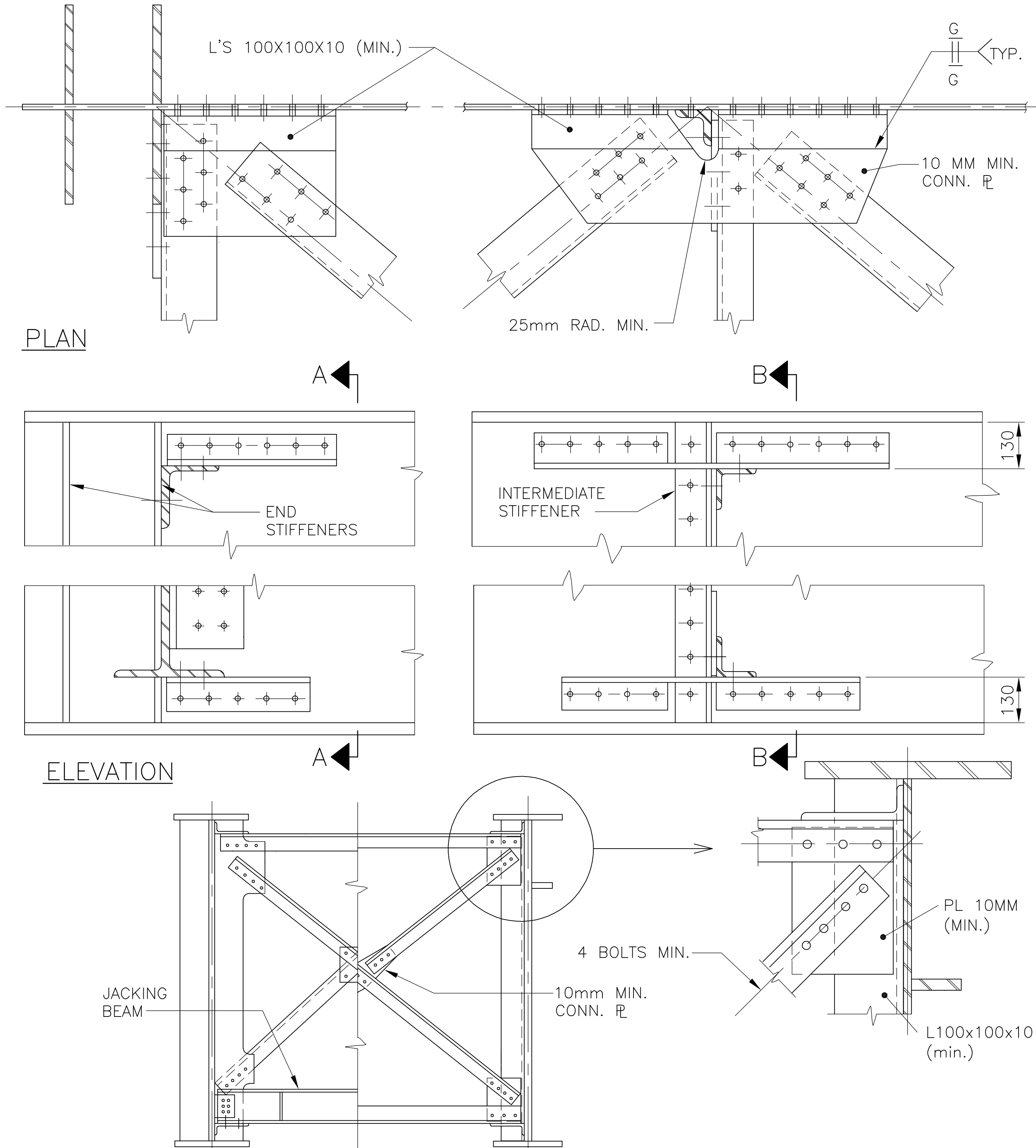
–



Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BEAM COPES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S6m** –



A–A B–B

HALF SECTION

NOTE:
FREE–HAND FLAME CUTTING NOT PERMITTED;
ROUGHNESS NOT TO EXCEED ASA1000.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31

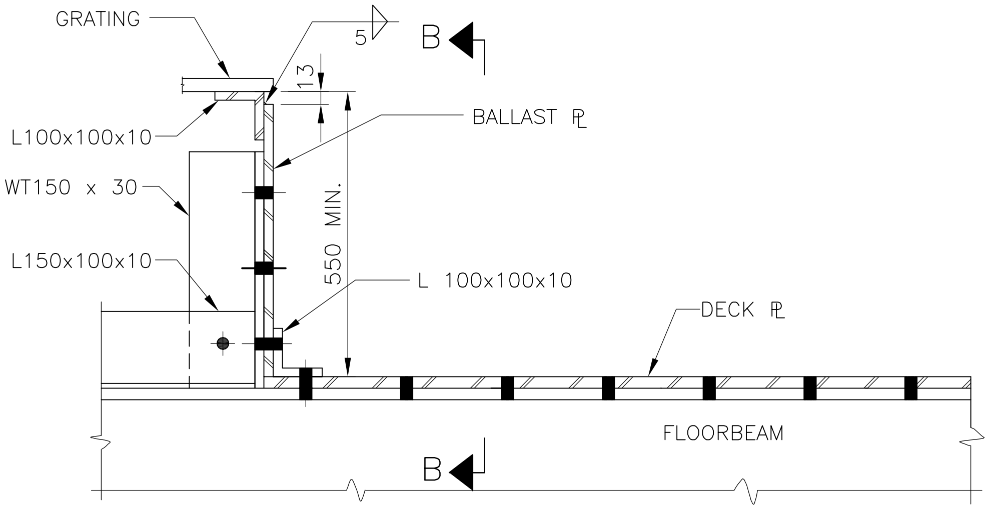
LATERAL BRACING FOR DPG SPANS

METROLINX

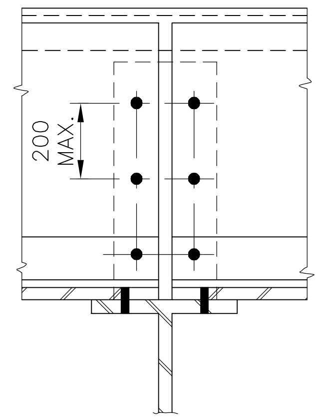
Drawing Number
Dessin Numero

S7m

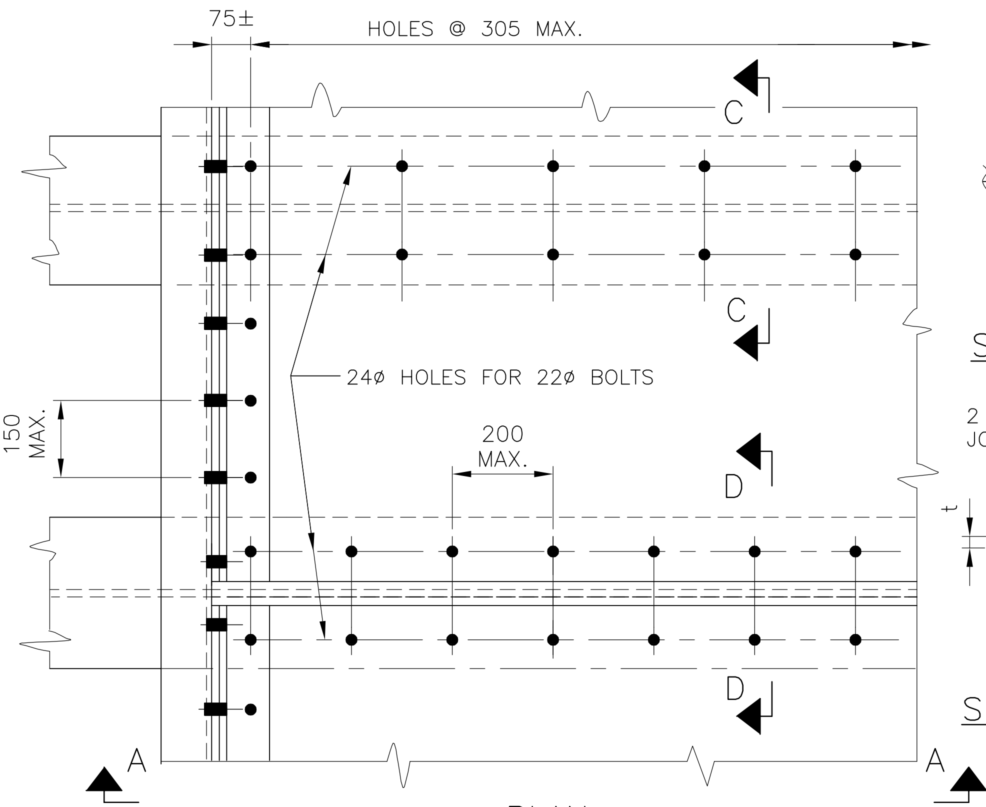
–



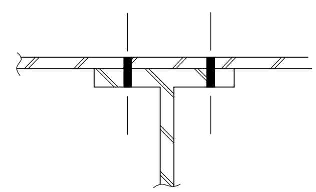
SECTION A–A



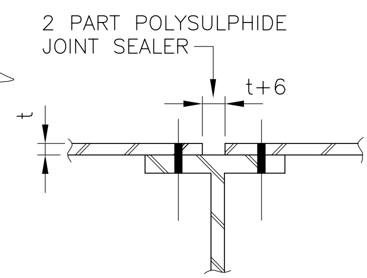
ELEVATION B–B



PLAN



SECTION C–C



SECTION D–D

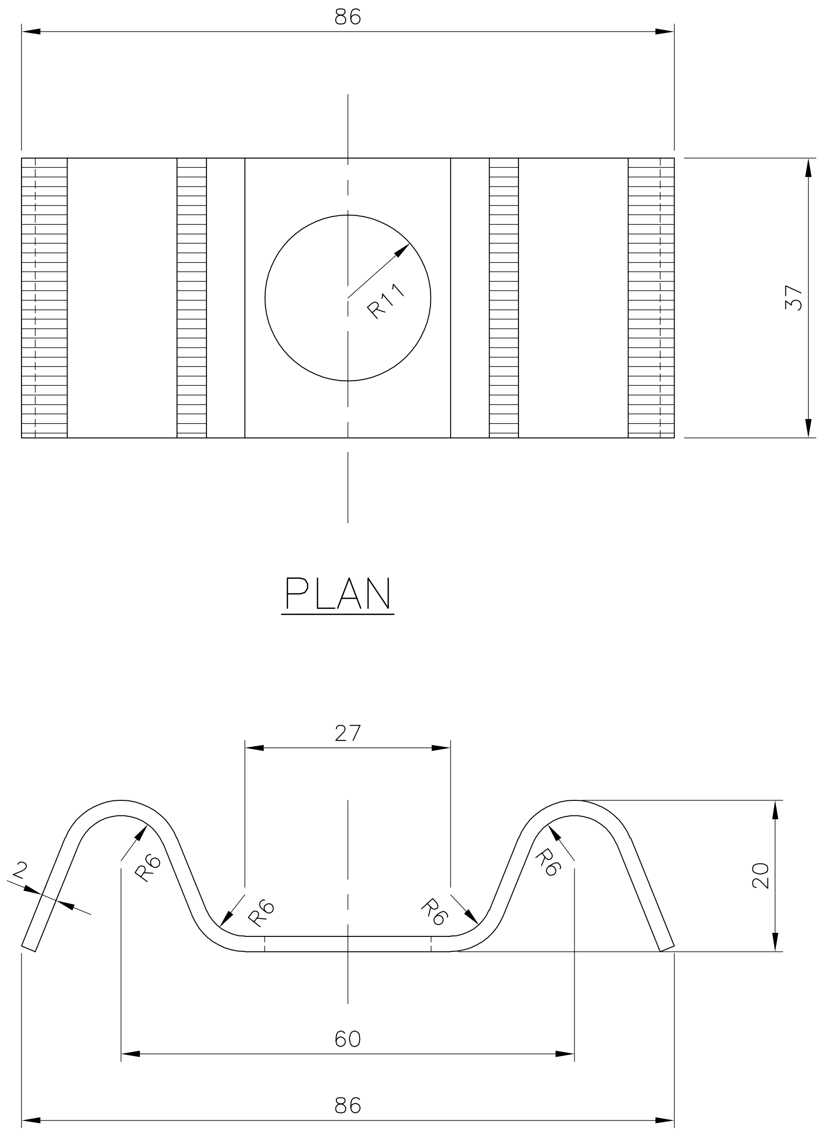
NOTE: USE E 7018 ELECTRODE OR EQUIVALENT FOR WELDS SHOWN.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ATTACHMENT OF DECK PLATE BY BOLTING IN SHOP OR FIELD**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
S8m

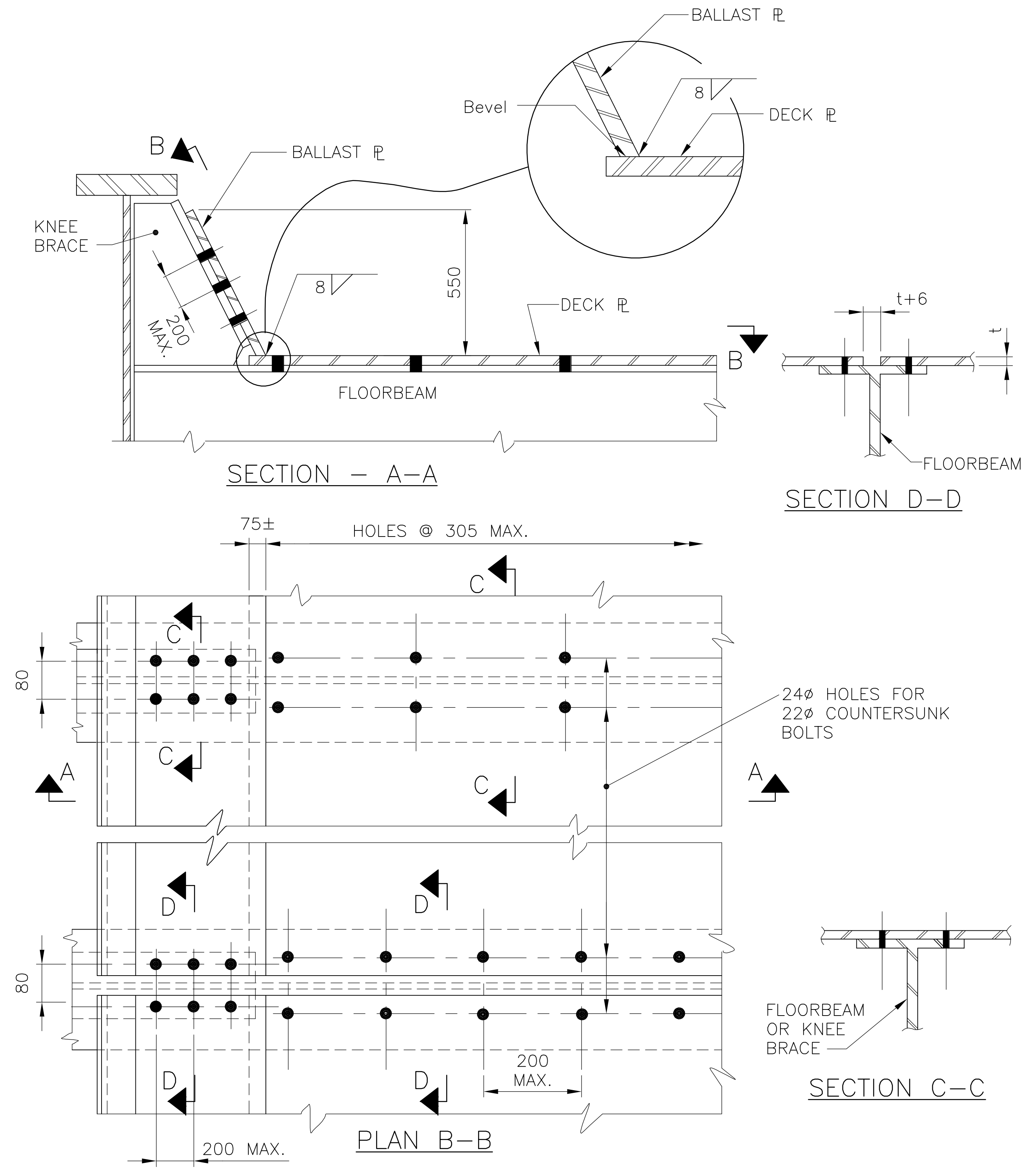
–



22ø HOLE FOR USE WITH 20ø BOLT OR LAG SCREW

CLIPS AVAILABLE FROM FISHER & LUDLOW OR APPROVED EQUIVALENT

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPE H-3 SADDLE CLIP FOR 38-H-4 HEAVY DUTY GRATING**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **S9m** –



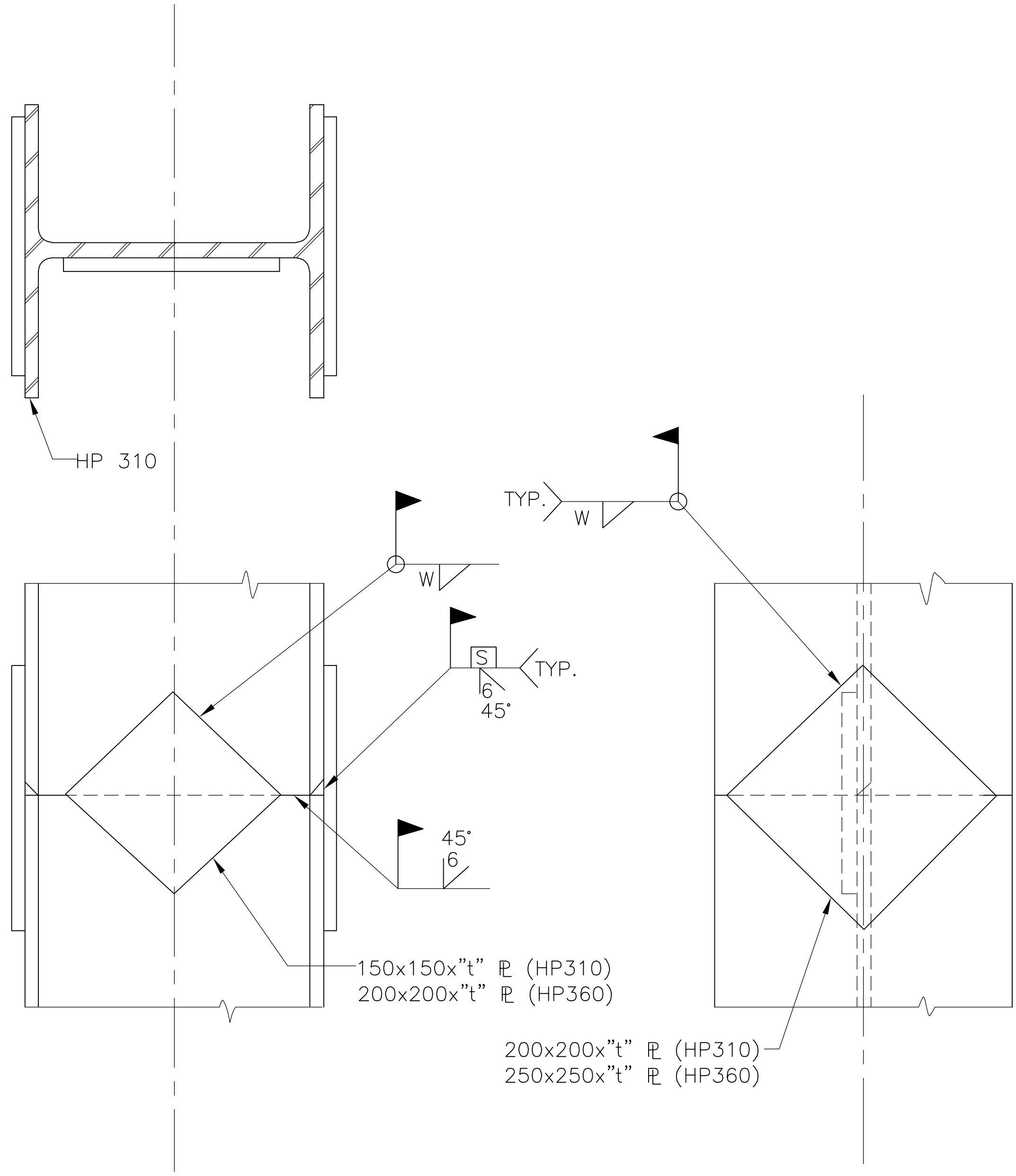
NOTE: USE E 7018 ELECTRODE OR EQUIVALENT FOR WELDS SHOWN.

(FOR SQUARE SPANS 12M & OVER & ALL SKEWED SPANS)

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**ATTACHMENT OF DECK PLATE BY BOLTING IN SHOP OR FIELD**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero: **S10m** –

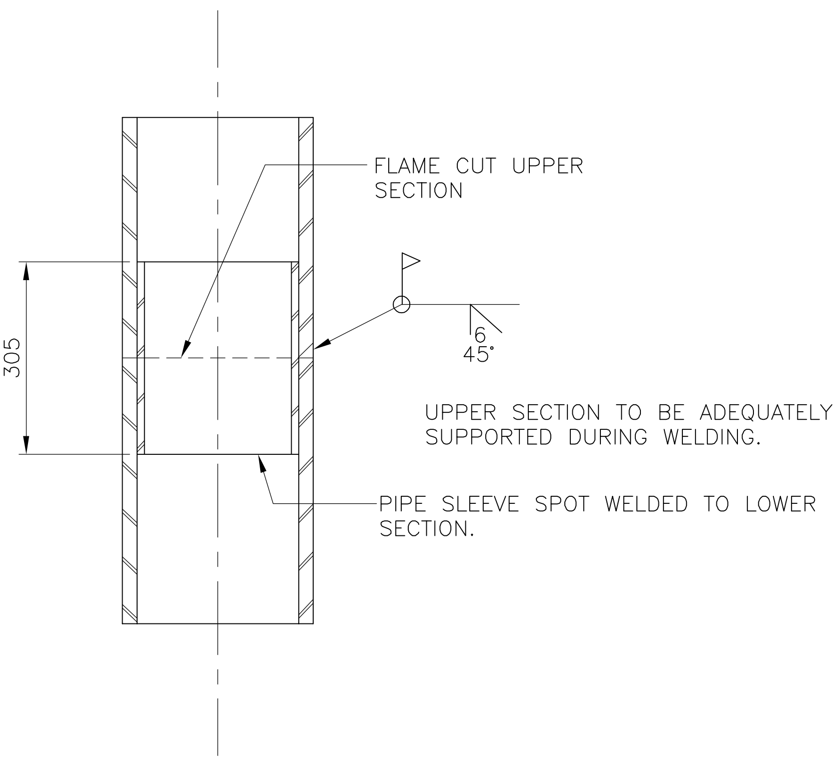


PILE	t	W
HP 310x79	13	8
HP 310x110	16	10
HP 360x108	13	10
HP 360x132	16	10

Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**HP 310 & 360 PILE SPLICE FOR AXIAL LOAD ONLY**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero: **S12m** –

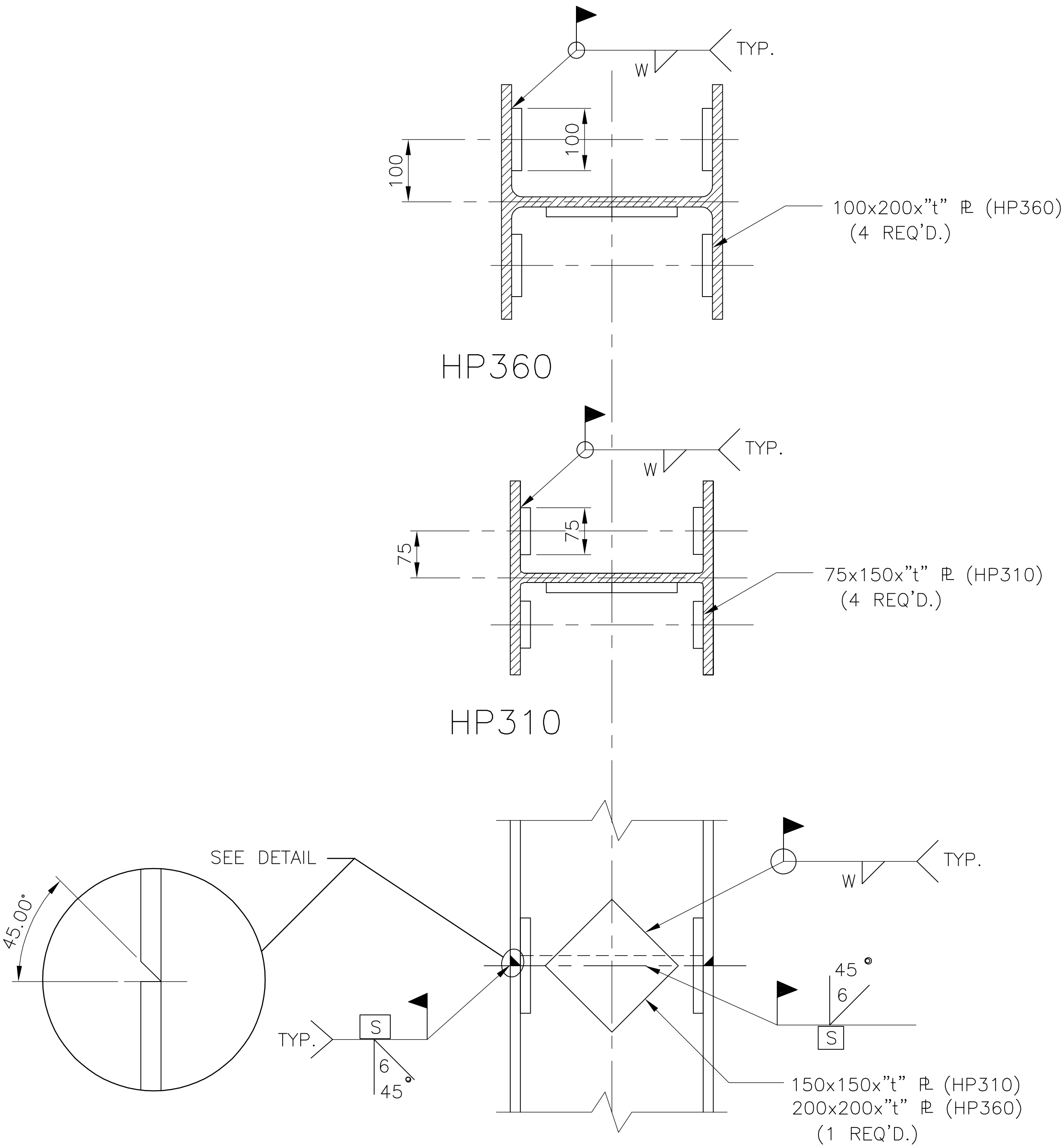


Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TUBULAR PILE SPLICE FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero

S13m –



USE E48018 ELECTRODES

PILE	t	W
HP310x79	13	8
HP310x110	16	10
HP360x108	13	10
HP360x132	16	10

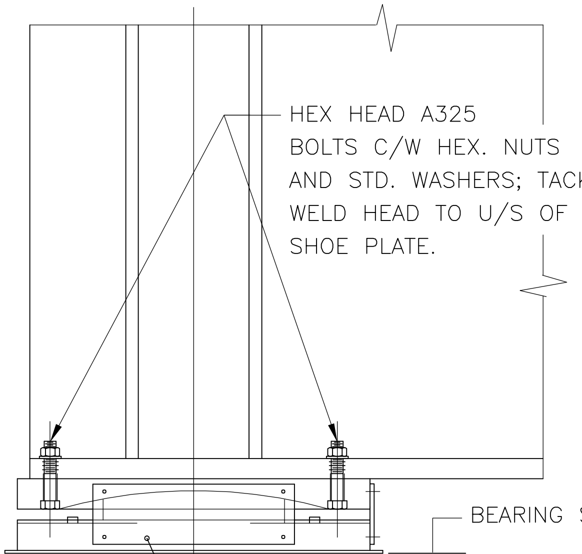
Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31

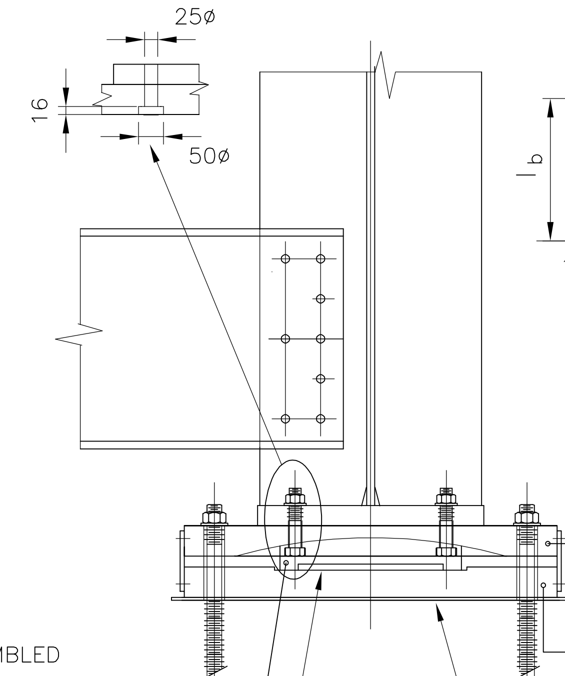
HP 310 & 360 PILE SPLICE DETAIL FOR DRIVING THROUGH TEMPLATE FOR AXIAL LOAD ONLY

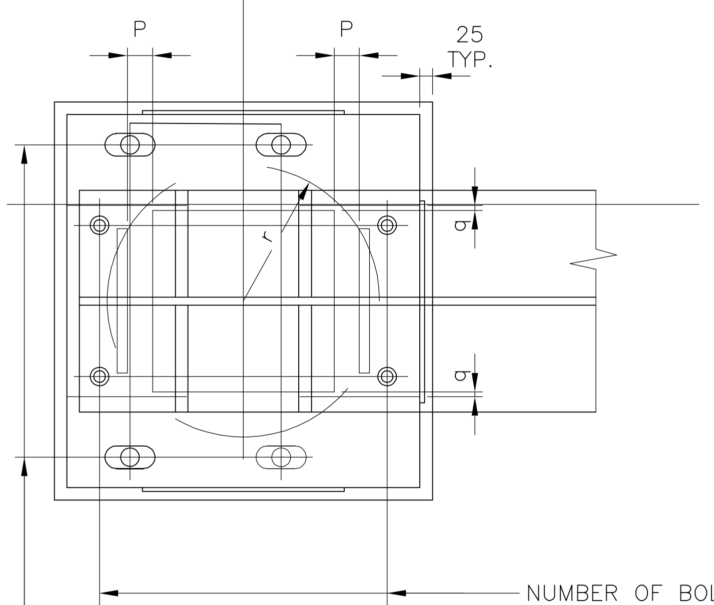
METROLINX

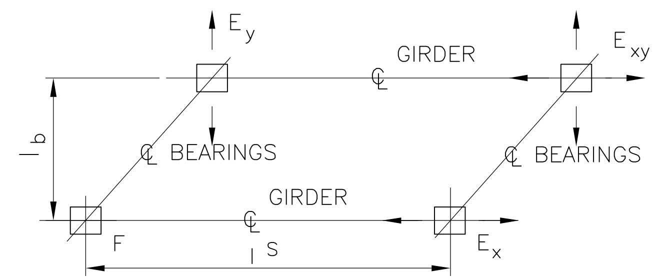
Drawing Number / Dessin Numero

S14m –



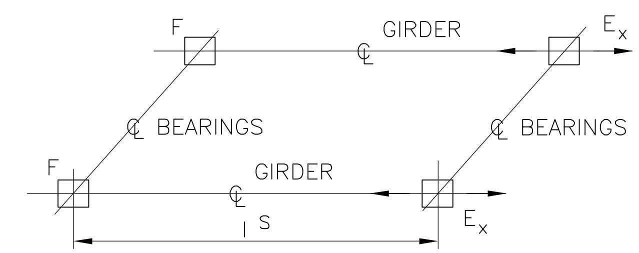






TPG SPANS

NOTE: ARROW INDICATES FREEDOM OF MOVEMENT DIRECTION.



DPG SPANS

ARRANGEMENT OF BEARINGS

LEGEND

l_b − BEARING C/C
l_s − BRIDGE SPAN
F − FIXED BEARING
E − EPANSION BEARING

BEARING SERVICE LOADS

V_D = ... kN/BEARING
V_{L+I} = ... "
V_{TOT} = ... "
H_{MIN} = $\frac{V_{TOT}}{10}$ "

STANDARD NOTES:

−DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AREMA MANUAL CHAP. 15.
−MATERIAL SHALL BE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

−STRUCTURAL STEEL:	CSA CAN3−G40.21, ASTM 572/A36
−BEARING PLATES:	GRADE 300W
−BRONZE PLATES:	ASTM B22 COPPER ALLOY UNS No. C863000, C91100 or C91300
−WELDING:	CSA CAN3−W59
−ANCHOR BOLTS:	ASTM F1554
−HS BOLTS	ASTM A325

−ALL HOLES SHALL BE DRILLED OR SUB−PUNCHED AND REAMED.

−ALL NON−SLIDING SURFACES OF BEARINGS SHALL BE ZINC−METALLIZED IN ACCORDANCE WITH CSA G189. ZINC COATING SHALL NOT BE LESS THAN 0.25mm.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD BEARINGS FOR DPG & TPG STEEL SPANS (sheet 1)**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **S15m** −

HOLES FOR ANCHOR BOLTS OF DIAMETER "d" :

TPG SPANS

BEARINGS "F" & "E_y"

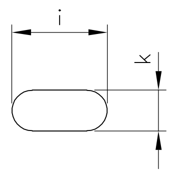
IN SHOE PL:

ROUND HOLES: DIA = d + w (but not less than d + 10mm) where w = greater of w_x and w_y.

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 10mm.

BEARINGS "E_x"& "E_{xy}"



IN SHOE PL:

SLOTTED HOLES i x k

where i = d + 2p

k = d + w_y

(but not less than d + 10mm)

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 10mm.

d = 32mm FOR SPANS UNDER 25m

d = 38mm MIN. FOR SPANS EQUAL TO AND OVER 25m

DPG SPANS

BEARINGS "F"

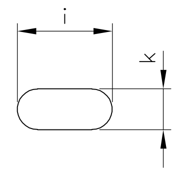
IN SHOE PL:

ROUND HOLES: DIA = d + w_x (but not less than d +10mm)

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 10mm.

BEARINGS "E"



IN SHOE PL:

SLOTTED HOLES i x k

where i = d + 2p

k = d + 10m

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + 10mm.

MINIMUM REQUIRED CLEARANCES "p" & "q"			
TYPE OF BRIDGE SPAN	TYPE OF BEARING	p	q
DPG	FIXED "F" EXPANSION "E"	1 mm SPAN EXP. + w_x	1 mm 1 mm
TPG	FIXED "F" EXPANSION "E_x" EXPANSION "E_y" EXPANSION "E_{xy}"	1 mm SPAN EXP. + w_x 1 mm SPAN EXP. + w_x	1 mm 1 mm FL.BEAM EXP.+ w_y FL.BEAM EXP.+ w_y

$w_x = 8R\, \delta_s / l_s$ $\qquad$ $w_y = 8R\, \delta_b / l_b$

δ_s = max. deflection of bridge span due to L + I

δ_b = max. deflection of end floor beam due to L + I

R = radius of spherical surface

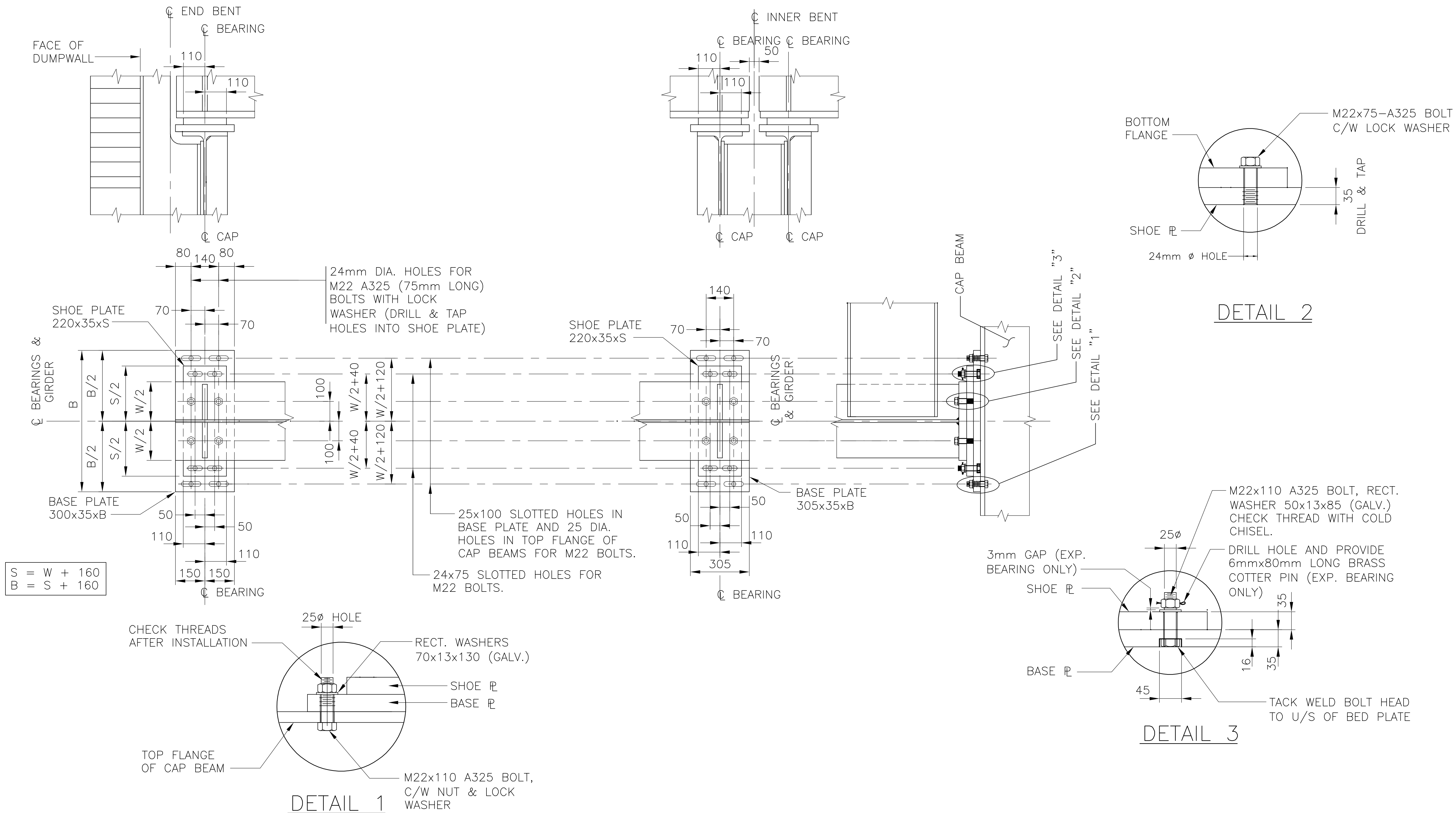
l_s = bridge span length

l_b = distance c. to c. girders

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	STANDARD BEARINGS FOR DPG & TPG STEEL SPANS (sheet 2)
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S16m** –



Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STEEL TRESTLE - BEARINGS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number Dessin Numero **S17m** –

FLOOR BEAMS SIZE
SPAN LENGTH = mm

TOTAL BOTT.
FLANGE STRESS = MPa

PERMISS. STRESS = 192.50MPa

RATIO $\frac{\text{WORKING}}{\text{PERMISS.}} =$

$\frac{\Delta \text{LL} + \text{I}}{\text{SPAN}} = \frac{1}{\quad}$

$\frac{\text{MAX. STRESS RANGE}}{\text{PERMISS. FATIGUE STRESS}} =$

TABLE OF STRESSES

SPAN LENGTH C/C BEARINGS

STEEL: SEE NOTES
TOP FLANGE PLATE SIZE AREA = mm^2
WEB PLATE SIZE AREA = mm^2
BOTTOM FLANGE PLATE SIZE AREA = mm^2
Sx−x TOP = mm^3 Ix = mm^4
Sx−x BOT = mm^3

	END REACTION kN	SHEAR STRESS MPa	BENDING MOMENT kN.m	BENDING STRESSES BOTT. FLANGE MPa
DEAD LOAD N/m				
LIVE LOAD E90				
IMPACT %				
CENTRIFUGAL FORCE COMPOSITE				
TOTAL GROUP "A"				
ALLOWABLE STRESSES (BENDING & SHEAR)	—	122.50	—	192.50
RATIO OF WORKING STRESS TO ALLOWABLE	—		—	

$\frac{\Delta \text{LL} + \text{I}}{\text{SPAN}} = \frac{1}{\quad}$

ALLOWABLE STRESS RANGE FOR FATIGUE CATEGORY "B" FOR N > 2,000,000 CYCLES

$S_{Rfat} = 110.30$ MPa

MAXIMUM DESIGN STRESS RANGE AT BOTTOM FLANGE TO WEB WELD AT MIDSPAN

MPa < S_{Rfat}

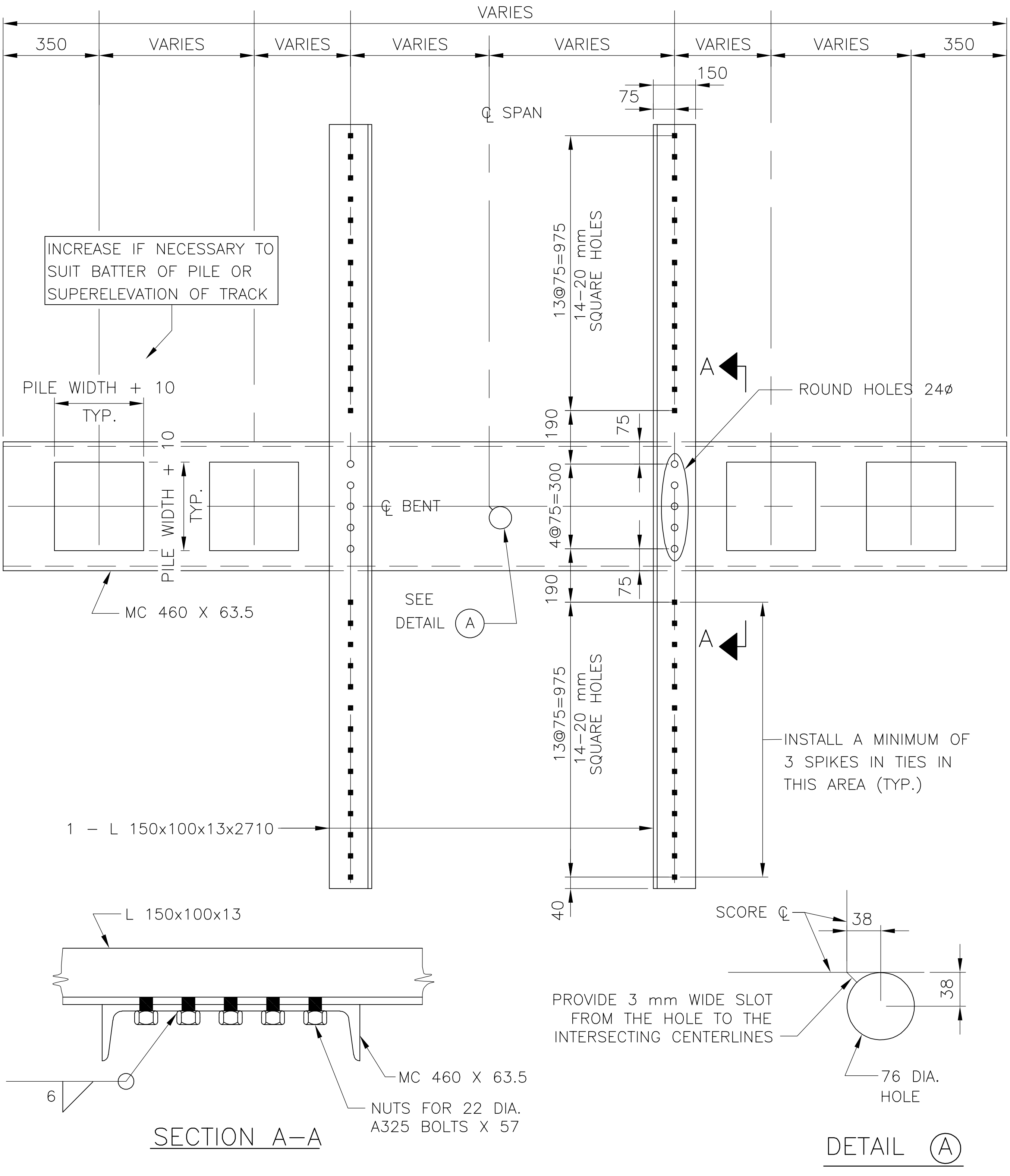
NOTES:

- FOR GENERAL NOTES SEE DRAWING −1.1
- DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AREMA 2016 MANUAL CHAPTER 15
- MATERIAL SHALL BE IN ACCORDANCE WITH THE FOLLOWING SPEC'S.:
  - STRUCTURAL STEEL: SEE PART 2A GUIDELINES FOR DESIGN OF STEEL BRIDGES & STRUCTURES.
  - WELDING: C.S.A. CAN3−W59
  - H.S. BOLTS: A.S.T.M. A325, M22, TYPE 3.
- ALL HOLES SHALL BE DRILLED OR SUB−PUNCHED AND REAMED.
- ALL H.S. BOLTS SHALL BE TIGHTENED BY THE TURN−OF−NUT METHOD.
- BOTTOM FLANGES OF GIRDERS OVER BEARINGS SHALL BE TRUE AND SQUARE; MAXIMUM MEASURED DEVIATION AT OUTSIDE EDGE OF BEARING PLATES SHALL NOT EXCEED 1 mm.
- DEVIATION FROM STRAIGHTNESS OF MAIN GIRDERS SHALL NOT EXCEED 6 mm.
- DEVIATION RESULTING IN NEGATIVE CAMBER SHALL NOT BE PERMITTED.
- ALL NON−SLIDING SURFACES OF BEARING PLATES SHALL BE ZINC METALLIZED AS PER C.S.A. G189; A.S.T.M. A123 ZINC COATING SHALL NOT BE LESS THAN 0.25mm.
- THE SPANS SHALL BE SHIPPED ENTIRELY SHOP ASSEMBLED.
- METROLINX STANDARD DRAWINGS ARE REFERENCED TO PROVIDE ADDITIONAL INFORMATION NOT SHOWN ON THIS DRAWING.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPICAL NOTES FOR STEEL SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

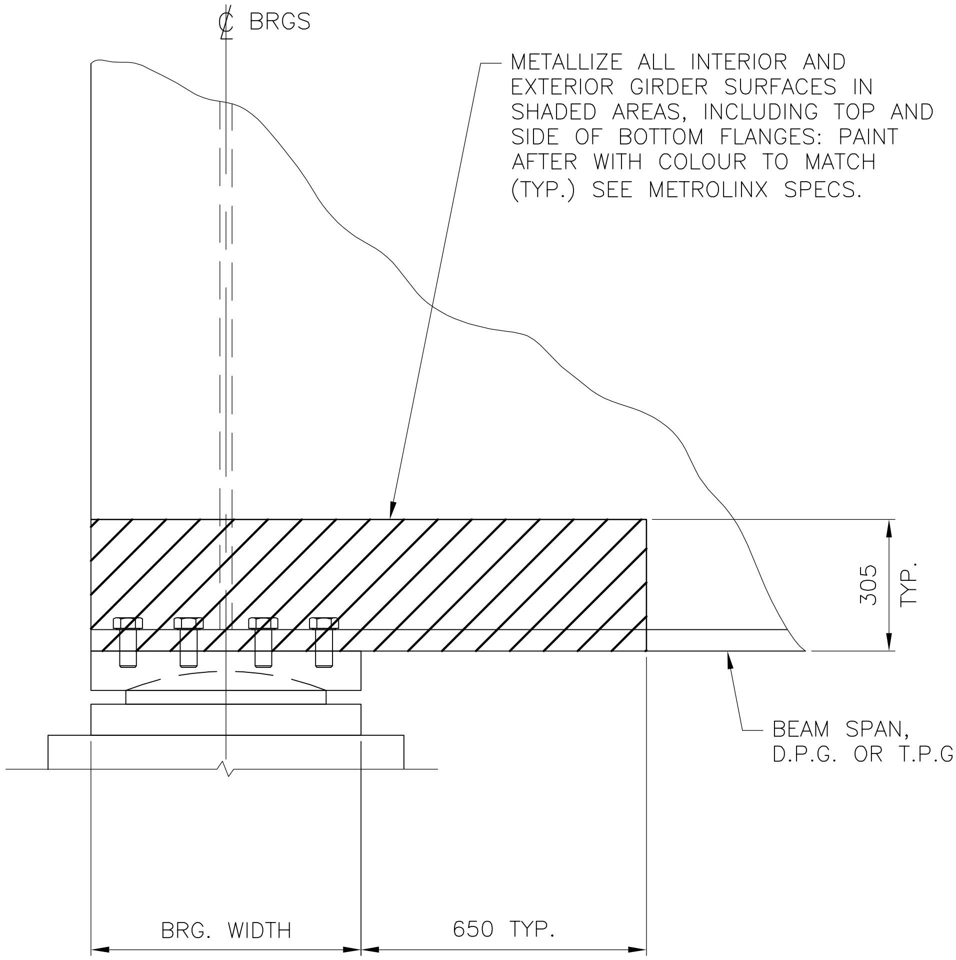
Drawing Number
Dessin Numero
S18m −



Drawn: / Dessin: J.E.	Checked: / Verification: S.Kh.	**TEMPLATE FOR PILE DRIVING**
Scale: / Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number / Dessin Numero: **S19m** –



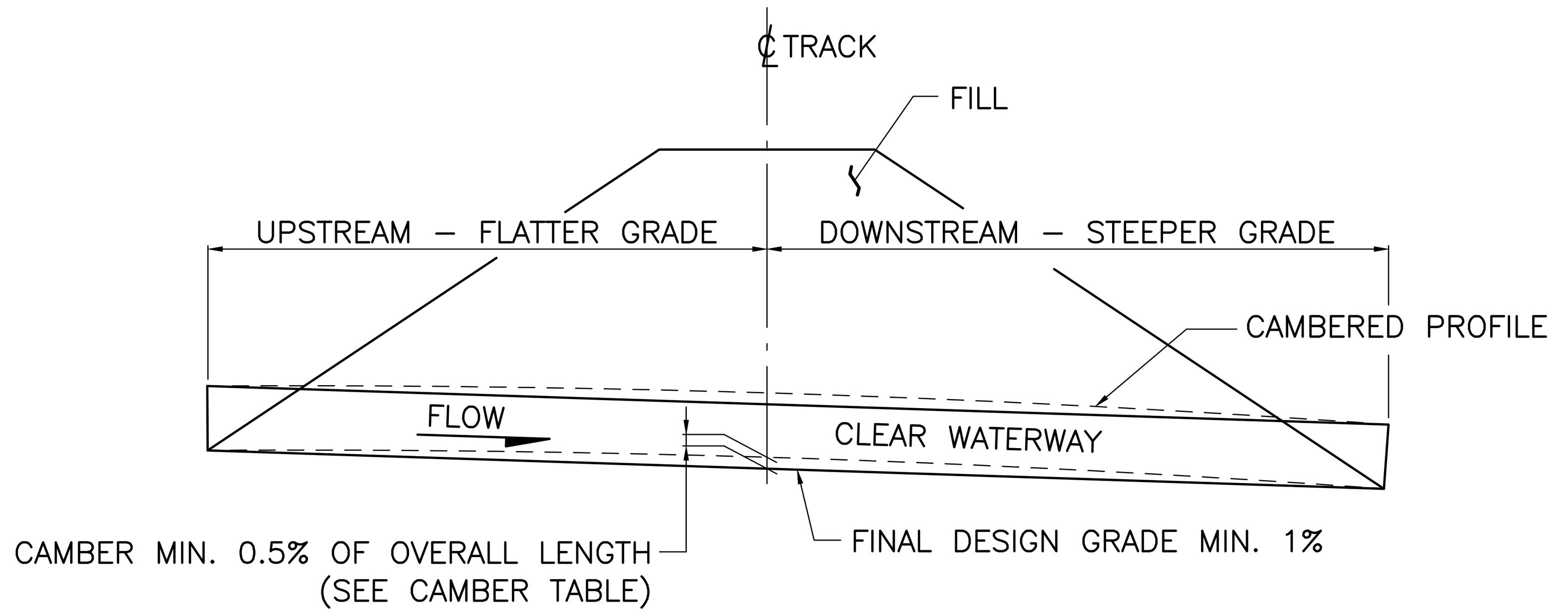
NOTES:

METALLIZING IN ACCORDANCE WITH SSPC-CS 23.00 OR A.S.T.M. B833
ZINC METALLIZING SHALL NOT BE LESS THAN 0.25mm THICKNESS

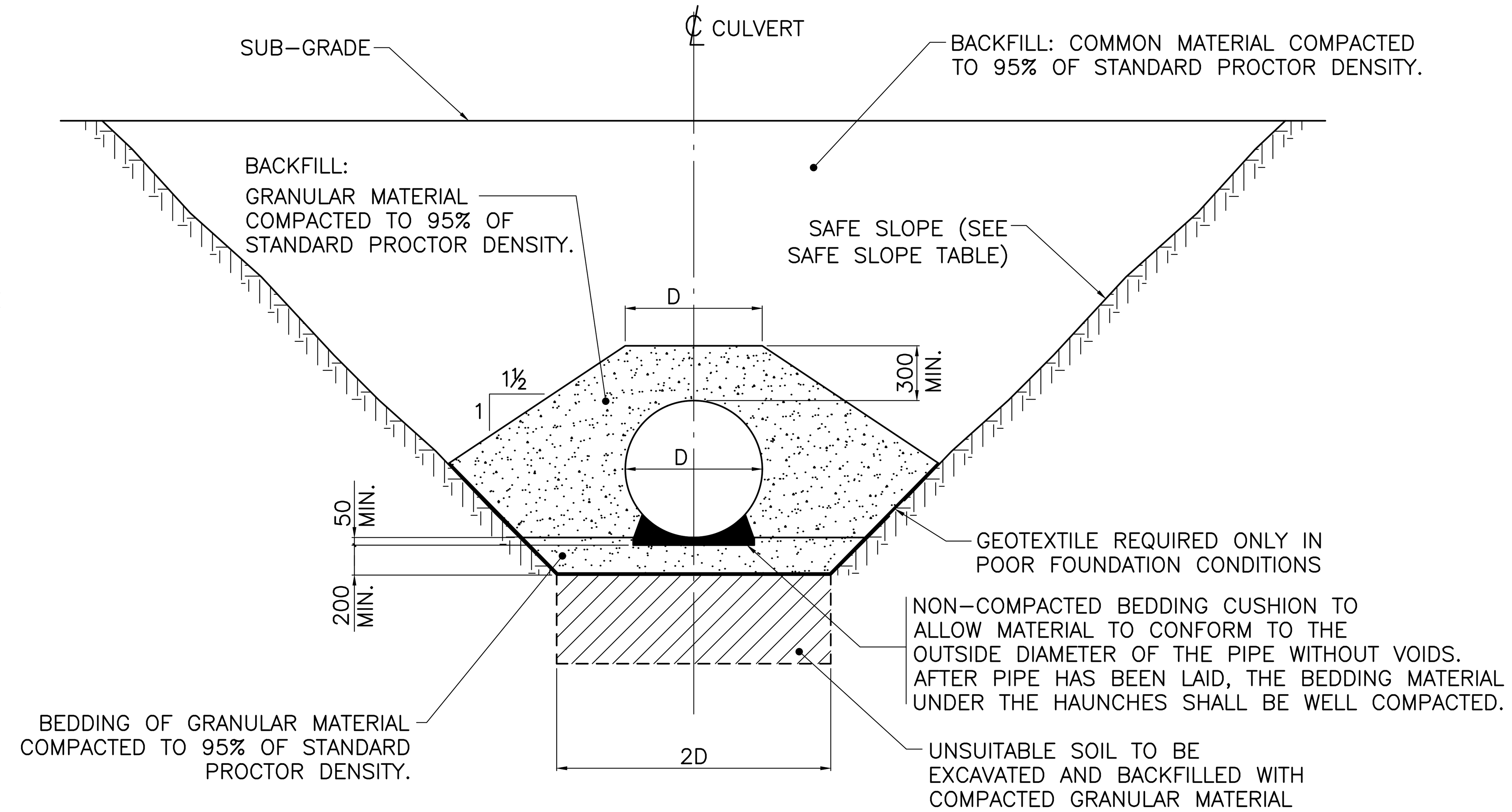
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**METALLIZING AREA FOR BEAM SPANS, DPG & TPG SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
S20m –

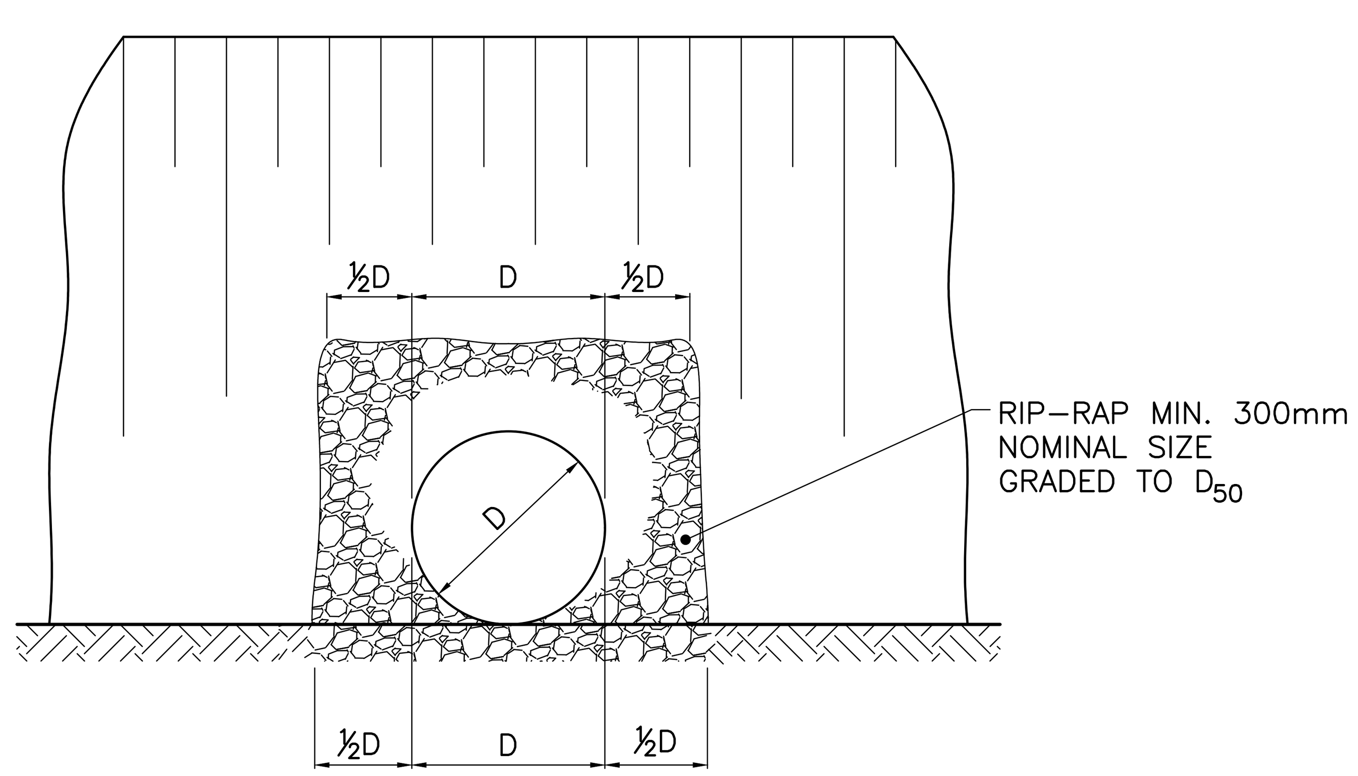


MINIMUM GRADE AND CAMBERING REQUIREMENTS FOR CULVERT INSTALLATION

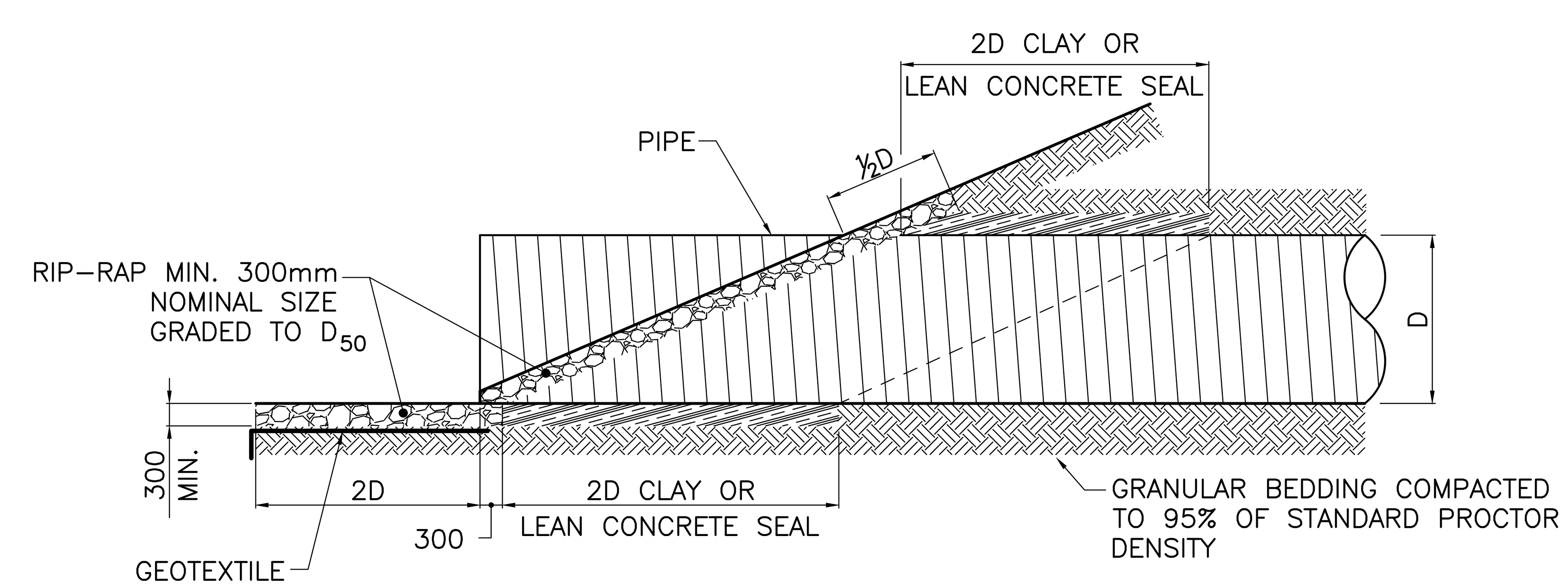


GRANULAR MATERIAL FOR BEDDING AND BACKFILLING TO BE APPROVED BY THE ENGINEER. IN GENERAL, PIT–RUN SAND AND GRAVEL, REASONABLY WELL GRADED FROM MAXIMUM SIZE 100mm TO NOT MORE THAN 8% FINER THAN SIEVE No. 200.

CULVERT INSTALLATION



RIP-RAP PROTECTION



INORGANIC CLAY OR LEAN CONCRETE SEAL TO BE PLACED AT BOTH ENDS OF CULVERTS FOR A LENGTH OF TWICE THE DIAMETER (2D). THE CLAY OR LEAN CONCRETE SEAL SHALL EXTEND FROM THE BOTTOM OF THE EXCAVATION TO 300mm ABOVE THE CROWN OF THE PIPE AND FOR THE FULL WIDTH OF THE EXCAVATION.

SEEPAGE CUT-OFF DETAIL

GENERAL NOTES:

SCOPE:
CULVERT SIZES IN TABLE 3 AND 4 HAVE BEEN DEVELOPED BASED ON STRENGTH AND DURABILITY REQUIREMENTS FOR NORMAL SITE CULVERT INSTALLATIONS.

DESIGN LOAD: E80 + IMPACT

DURABILITY BASED ON 75 YEAR SERVICE LIFE.

CULVERT DURABILITY:
SITE SPECIFIC DESIGN IS REQUIRED WHERE WATER AND/OR SOIL IS CORROSIVE OR ABRASIVE.
WATER AND/OR CLAY, CLAY LOAM, PEAT AND ORGANIC SOILS SHOULD BE TESTED FOR WATER AND SOIL CORROSIVENESS. TESTS TO BE CARRIED OUT ARE RESISITIVITY AND PH TESTING IN ACCORDANCE WITH CALIFORNIA TEST METHOD 6438 AND SHALL BE PERFORMED BY A QUALIFIED MATERIALS TESTING COMPANY.

INSTALLATION:
PIPE SHALL BE INSTALLED IN ACCORDANCE WITH CN ENGINEERING RECOMMENDED METHOD OF INSTALLATION OF CULVERTS RM4402.

FOR MULTIPLE PIPE INSTALLATIONS, THE CLEARANCE BETWEEN CULVERTS SHALL NOT BE LESS THAN ½ THE PIPE DIAMETER, BUT NEED NOT BE GREATER THAN 1.0m UNLESS REQUIRED FOR SPECIFIC CONSTRUCTION COMPACTION METHODS AND EQUIPMENT.

FOR PIPES SIZES GREATER THAN 1.5m, TEMPORARY STRUTTING SPACED AT MAX. 3.0m SPACING SHALL BE PROVIDED.

FOR VERTICAL FACE CUTS, SHORING TO BE PROVIDED AND SHALL BE ENGINEERED TO SUIT HEIGHT OF EMBANKMENT AND VERTICAL FACES.

COVER:
THE MINIMUM HEIGHT AND MAXIMUM HEIGHT OF COVER FOR VARIOUS CULVERT SIZES AND SPECIFIED WALL THICKNESS ARE GIVEN IN TABLES 3 AND 4.

END TREATMENT:
WHERE REQUIRED TO PREVENT, EROSION, UNDERMINING, DRIFT AND DEBRIS DETENTION AT THE INLET AND/OR OUTLET, OR WHERE REQUIRED TO INCREASE HYDRAULIC CAPACITY, THE ENGINEER SHALL SPECIFY AN APPROPRIATE CULVERT PIPE END TREATMENT. END TREATMENT MAY CONSIST OF SLOPE RIP–RAP, GABIONS, STANDARD STEEL CULVERT APRONS, BEVELLED PIPE ENDS OR CONCRETE HEADWALLS WITH RIP–RAP APRONS.

SPECIFICATIONS:

CULVERTS:
CSP SHALL BE PLAIN GALVANIZED CORRUGATED STEEL PIPE IN ACCORDANCE WITH CSA STANDARD CAN3–G401, AASHTO M–218 OR ASTM A929.

SPCSP SHALL BE PLAIN GALVANIZED STRUCTURAL PLATE PIPE IN ACCORDANCE WITH CSA STANDARD CAN3–G401, AASTHO M–167 OR ASTM A761.

GALVANIZING SHALL BE NOT LESS THAN 610 g/m^2 OF SURFACE (TOTAL BOTH SIDES)

ALTERNATIVE COATINGS:
ALUMINIZE STEEL TYPE 2 – ASTM A929 AND AASHTO M–274 WITH 305 g/m^2 COATING WEIGHT.
POLYMER COATING SUCH AS TRENCHCOAT OR EQUIVALENT – ASTM A742 OR AASHTO M–525 WITH 10/10 GRADE FINISH.

GEOTEXTILE FILTER FABRIC:
WHEN IN THE OPINION OF THE ENGINEER, FOUNDATION CONDITIONS ARE CONSIDERED SOFT AND UNSTABLE, WOVEN GEOTEXTILE FILTER FABRIC SHALL BE INSTALLED AT THE BASE OF THE EXCAVATION AND SHALL CONFORM WITH THE FOLLOWING:

- GRAB STRENGTH ______ 1275 N
- ELONGATION (FAILURE) ______ 15%
- PUNCTURE STRENGTH ______ 275 N
- BURST STRENGTH ______ 3.6 MPa
- TRAPEZOIDAL TEAR ______ 475 N
- MINIMUM FABRIC LAP TO BE 1 m

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REFERENCE DRAWINGS		ISSUE			REVISIONS	
DWG NO.	TITLE	NO.	DATE	ISSUED FOR	REV.	DATE

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DESIGNED BY: YY/MM/DD
CHECKED BY: YY/MM/DD
APPROVED BY: YY/MM/DD
SCALE: 1:XXX
FULL SIZE ONLY

METROLINX

CORRUGATED STEEL PIPE (CSP) AND STRUCTURAL PLATE CORRUGATED STEEL PIPE (SPCSP) CULVERTS

CONTRACT NO. –
DWG. NO. R7A–80.1m–1
REV.
SHEET

TABLE 1: CAMBER TABLE

LENGTH (m)	CAMBER (mm)
6.0	30
9.0	45
12.0	60
15.0	75
18.5	90
21.5	105
24.5	120
27.5	135
30.5	150

TABLE 2: SAFE SLOPE TABLE

TYPE	SOIL CONDITION	SAFE SLOPE
A	HARD, DENSE AND STIFF SOILS WITH A LOW MOISTURE CONTENT	1 HORIZ: 1 VERT
B	MEDIUM DENSITY SOILS WHICH ARE OF LOOSECONSISTENCY, HAVE BEEN PREVIOUSLY EXCAVATED OR EXHIBIT SIGNS OF WATER SEEPAGE	1.5 HORIZ: 1 VERT
C	SOFT, VERY LOOSE, WET AND MUDDY SOILS	3 HORIZ: 1 VERT

THE SAFE SLOPE SHALL BE REDUCED WHEN THE FOLLOWING CONDITIONS OCCUR:
- SIGNS OF DISTRESS APPEAR AT THE FACE OF THE CUT OR AT THE GROUND ADJACENT TO THE OPEN EXCAVATION
- SURCHARGE LOADS FROM STORED MATERIAL OR EQUIPMENT OPERATING AT TOP OF CUT
- HIGH WATER TABLE
- INADEQUATE OR UNCERTAIN SOIL PROPERTIES DATA.

TABLE 3: STEEL ROUND CORRUGATED PIPE (CSP)
MINIMUM AND MAXIMUM HEIGHT OF COVER
ASSUMED NORMAL SITE CONDITION
PH > 6–8, MINIMUM RESISTIVITY > 2000 ohm–cm

CULVERT SIZE ID (mm)	MIN COVER (mm)	MAXIMUM COVER (m) CORRUGATION PROFILE								
		68 x 12				125 x 25				
		1.6mm	2.0mm	2.8mm	3.5mm	1.6mm	2.0mm	2.8mm	3.5mm	4.2mm
600	1200	7.0	9.0	14.0	15.0					
700	1200	5.5	7.0	12.0	13.0					
800	1200	5.0	6.5	10.0	11.0					
900	1200	4.0	6.0	9.0	10.0					
1000	1200		5.0	8.0	9.0					
1200	1200			13.0		5.5	8.0	16.0	20.0	23.0
1400	1600			12.0		5.0	7.0	13.0	17.0	20.0
1600	1600					4.0	6.0	11.0	15.0	17.0
1800	2400						5.5	10.0	13.0	15.0
2000	2400						5.0	9.0	12.0	14.0
2200	2400							7.0	10.5	12.0
2400	2400							5.5	10.0	11.0

NOTE: MINIMUM SIZE OF CSP CULVERTS TO BE 900mm DIA.
600mm AND 750mm DIA. CSP CULVERTS ARE TO BE USED WHERE EXISTING COVER DOES NOT PERMIT A 900mm DIA. SIZE CULVERT.
SELECTION OF CULVERTS SHALL BE BASED ON MINIMUM WALL THICKNESS FOR ANY GIVEN DIAMETER.
IN POOR GROUND CONDITIONS, IT IS RECOMMENDED THAT RIVETED PIPES BE USED.

TABLE 4: STRUCTURAL PLATE PIPE (MULTI PLATE/SPCSP)
MINIMUM AND MAXIMUM HEIGHT OF COVER
ASSUMED NORMAL SITE CONDITION
PH > 6–8, MINIMUM RESISTIVITY > 2000 ohm–cm

CULVERT SIZE ID (mm)	MIN COVER (mm)	CORRUGATION PROFILE 152x51 MAXIMUM COVER (m)			
		3mm	4mm	5mm	6mm
2120	2430	7.0	12.0	18.0	26.0
2280	2430	6.0	11.5	17.0	24.0
2430	2430	5.5	11.0	16.0	23.0
2590	2430	5.0	10.0	15.0	21.0
2740	2430		9.5	14.0	20.0
3050	2430		9.0	13.0	18.0
3360	2430		8.0	12.0	16.0
3670	2430		7.0	11.0	15.0
3990	2430			10.0	13.5
4300	2430			9.0	13.0
4610	2430			8.0	12.0

TABLE 5: CULVERTS IN CORROSIVE CONDITIONS

SOIL TYPE	DESCRIPTION	DEGREE OF CORROSIVENESS	UPGRADES	
			WALL THICKNESS	COATINGS
1	SANDY SILT	LOW	NONE	NONE
2	CLAYEY SOIL	MODERATE	INCREASE IN WALL THICK.	ALUMINIZED/POLYMER/INCREASE GALVANIZING THICKNESS 910/1220 g/m^2 (ONLY SPCSP)
3	MARSH AND PEATY SOIL	SEVERE	INCREASE IN WALL THICK.	ALUMINIZED/POLYMER/INCREASE GALVANIZING THICKNESS 1220 g/m^2 (ONLY SPCSP)

NOTES:

1. RECOMMENDED ALTERNATIVE COATINGS ARE:
   - ALUMINIZED STEEL TYPE 2 IN ACCORDANCE WITH ASTM A929 AND AASHTO M–274 WITH 305 g/m^2
   - POLYMER COATING SUCH AS TRENCHCOAT OR EQUIVALENT IN ACCORDANCE WITH ASTM A742 AND AASHTO M525 WITH 10/10 FINISH.
2. ABRASION IS A COMBINATION OF STREAM VELOCITY AND BED LOAD. IN GEOGRAPHIC AREAS WHERE HEAVY LOADS OF SAND AND SMALL GRAVEL POSE AN ABRASION PROBLEM, AND FLOW VELOCITY IS HIGH, INCREASE RECOMMENDED THICKNESS BY ONE SIZE WALL THICKNESS.
3. SELECTION OF UPGRADES OR COMBINATION OF UPGRADES SHALL BE DETERMINED BY THE SEVERITY OF SITE CONDITIONS.

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REFERENCE DRAWINGS		ISSUE			REVISIONS		
DWG NO.	TITLE	NO.	DATE	ISSUED FOR	REV.	DATE	

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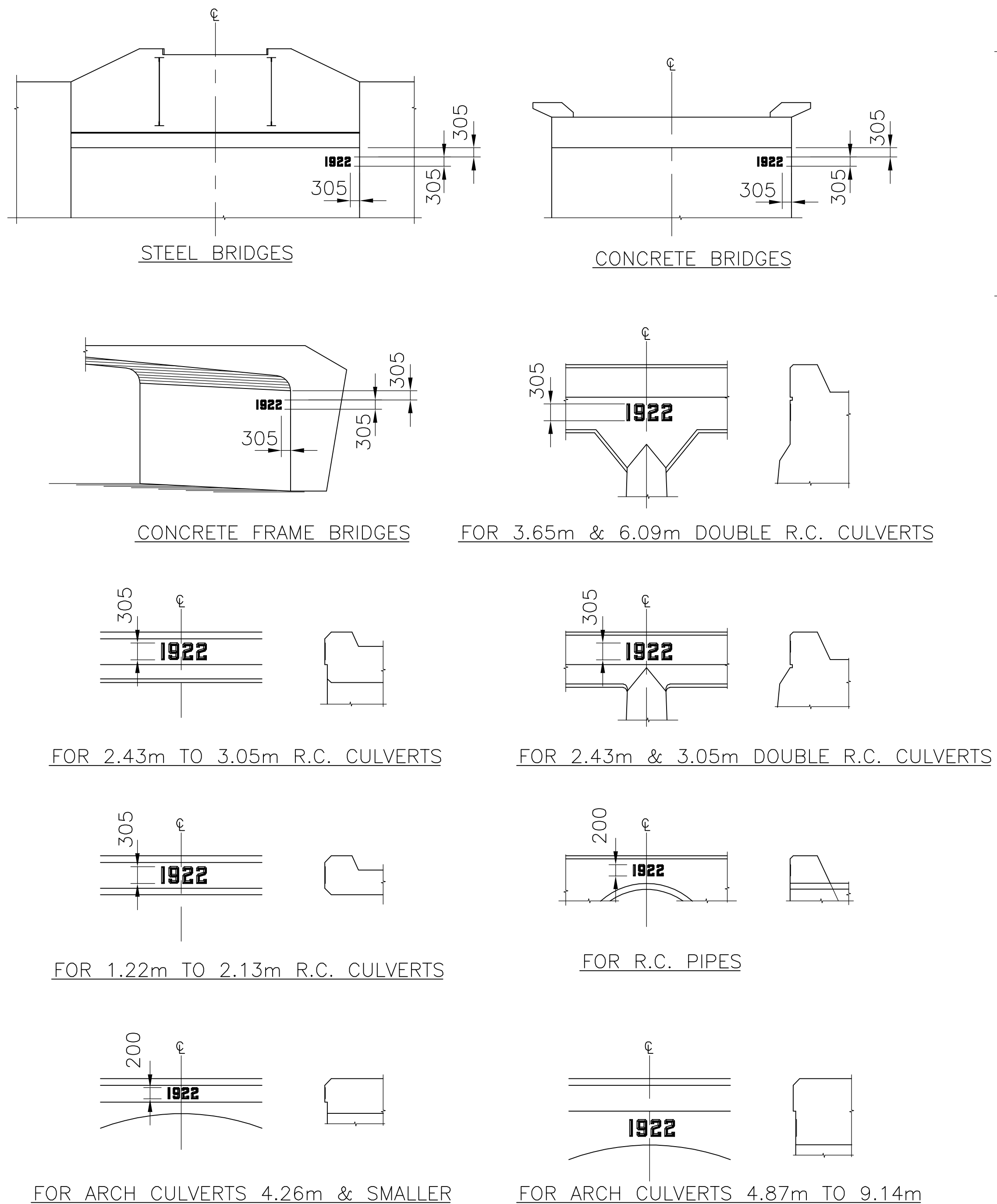
CHECKED BY: YY/MM/DD
APPROVED BY: YY/MM/DD
SCALE: 1:XXX FULL SIZE ONLY

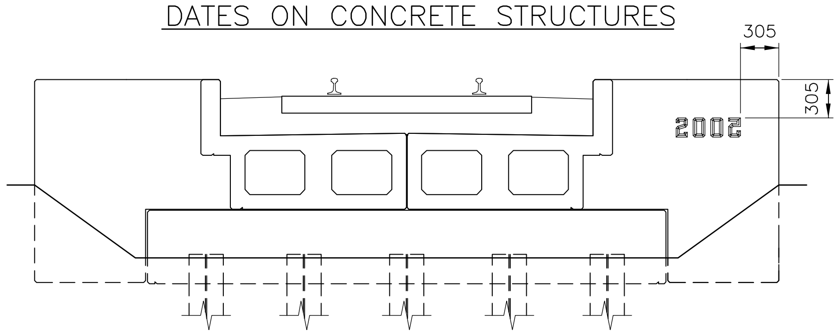
METROLINX

CORRUGATED STEEL PIPE (CSP) AND STRUCTURAL PLATE CORRUGATED STEEL PIPE (SPCSP) CULVERTS

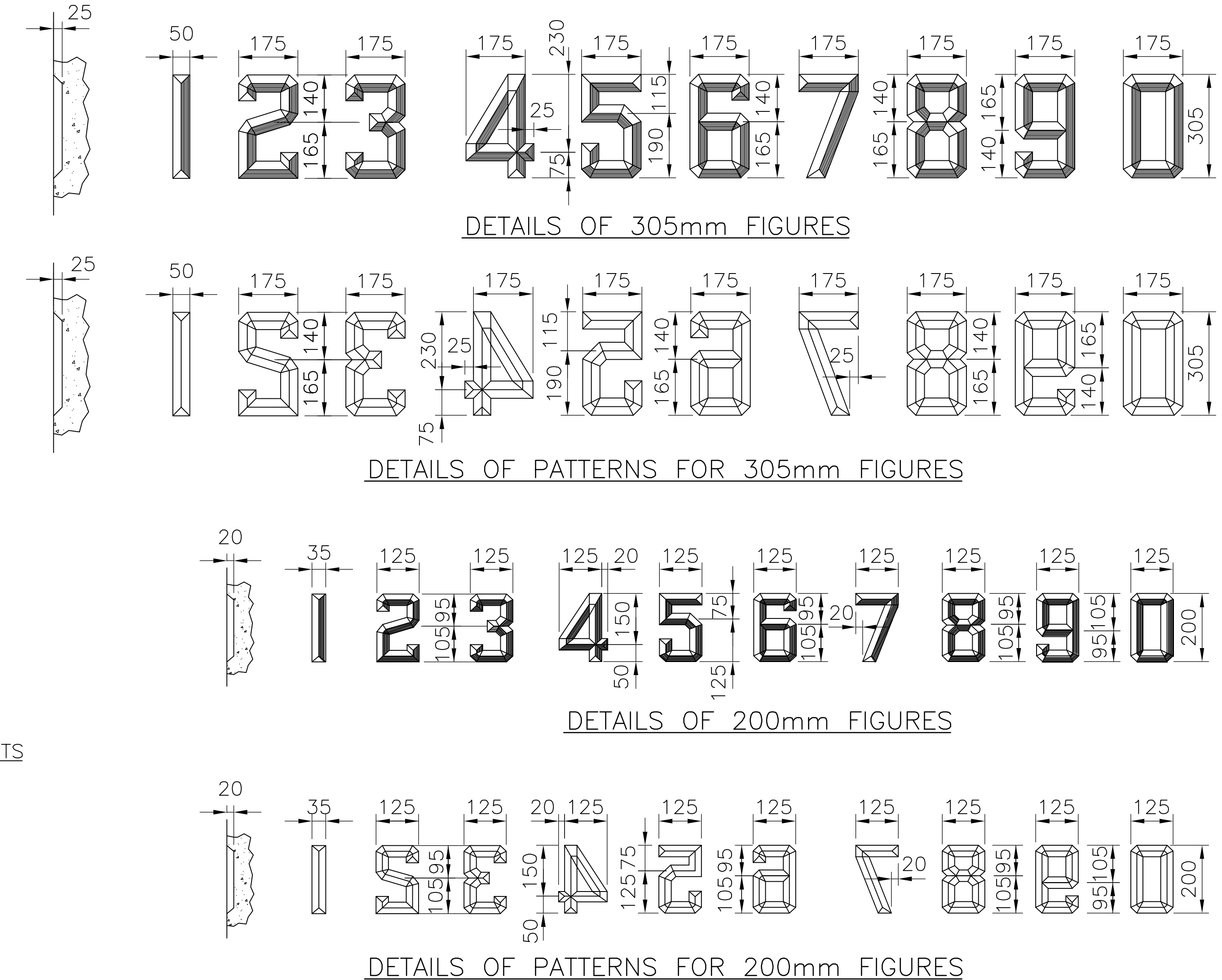
CONTRACT NO. –
DWG. NO. R7A–80.1m–2
REV.
SHEET



TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON CONCRETE STRUCTURES



TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON PRECAST BALLAST WALLS



NOTES:

EACH CONCRETE STRUCTURE (OR INDIVIDUAL CONCRETE UNIT OF ANY STRUCTURE) SHALL BE DATED TO SHOW THE YEAR OF CONSTRUCTION.

FIGURES FOR DATES SHALL BE MADE IN ACCORDANCE WITH DETAILS ON THIS PLAN (USING 305mm FIGURES WHERE PRACTICABLE) AND DATES SHALL BE PLACED AT LOCATIONS INDICATED IN SKETCHES OR AS NOTED BELOW:

CULVERTS – BOTH ENDS OF STRUCTURE & SYMETRICAL ABOUT CENTRE LINE.

CONCRETE – TRESTLES 5 SPANS OR LESS IN LENGTH, DATE BOTH SIDES OF ONE SLAB AT CENTRE OF TRESTLE. OVER 5 SPANS IN LENGTH, DATE BOTH SIDES OF SLAB AT EACH END OF TRESTLE.

RETAINING WALLS – WALLS UNDER 30.5m LONG, DATE ON FACE OF WALL 3.05m FROM ONE END.
– WALLS OVER 30.5m LONG, DATE ON FACE OF WALL 3.05m FROM EACH END.

PIERS – BELOW COPING ON THE CENTRE OF THE FACE TOWARDS THE ZERO MILEAGE OF THE SUB DIVISION – ONLY IF CALLED FOR ON DRAWINGS.

ABUTMENTS – BELOW BRIDGE SEAT, AS SHOWN ON SKETCH.

CONCRETE SLAB AND RIGID FRAME BRIDGES – ON THE ABUTMENT OR LEG OF THE FRAME AS SHOWN.

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD INSTRUCTIONS FOR DATING CONCRETE STRUCTURES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **R1S-1m** –

NOTES:

ONE NAME PLATE IS TO BE LOCATED ON EACH SPAN AS FOLLOWS:

DECK PLATE GIRDERS – ON THE OUTSIDE OF THE WEB AT THE NEAR END OF THE RIGHT HAND GIRDER (LOOKING IN THE DIRECTION OF INCREASING MILEAGE).

THROUGH PLATE GIRDERS – ON THE INSIDE OF THE WEB AT THE NEAR END OF THE RIGHT HAND GIRDER (LOOKING IN THE DIRECTION OF INCREASING MILEAGE) WHERE THERE IS ROOM ABOVE BASE OF RAIL LEVEL. OTHERWISE AS FOR DECK PLATE GIRDER.

THROUGH TRUSSES – ON THE END POST AT THE NEAR END OF THE RIGHT HAND TRUSS LOOKING IN THE DIRECTION OF INCREASING MILEAGE.

DECK TRUSSES – ON THE OUTSIDE OF THE TOP CHORD OR END POST AT THE NEAR END OF THE RIGHT HAND TRUSS (LOOKING IN THE DIRECTION OF INCREASING MILEAGE).

Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**LOCATION FOR BRIDGE NAME PLATE**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	
METROLINX		Drawing Number Dessin Numero **TD-05-Lm** –