METROLINX

General Guidelines for Design of Railway Bridges and Structures

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METROLINX GENERAL GUIDELINES FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES

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METROLINX

an Agency of the Government of Ontario

PREFACE

This is the fourth edition of the METROLINX General Guidelines for Design of Railway Bridges and Structures. The updates in the fourth edition include additions of or revisions to the following topics; culverts, geotechnical requirements, railway abutments and retaining walls, types of superstructures, mechanically stabilized embankments, concrete mix designs, reinforced concrete box structures, waterproofing and ballast mats, retaining structure design, and monitoring. This revision also incorporates Bulletin #001 Monitoring Requirements for Trenchless and Grouting Works. Bulletin #002 regarding shoring work outside Metrolinx-owned rail corridor remains effective and should continue to be used by projects where conditions are met as set out in this Bulletin.

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 METROLINX General Guidelines for Design of Railway Bridges and Structures modifies, supplements and/or supersedes applicable sections of the American Railway Engineering and Maintenance of Way Association (AREMA) Manual. Where the Metrolinx General Guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. This document presents 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.

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, Bridges & Structures, Engineering & Asset Management – Civil 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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GENERAL REQUIREMENTS FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES

PART 1

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

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

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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. All drawings shall be prepared in accordance with Metrolinx DRM-CI-0705, Tab 7.

1.2. 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).

1.3. 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.

1.4. 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 ADOBE ACROBAT "PDF" format. CADD files shall be provided for all drawings with all associated references and plotting CTB files in accordance with the Metrolinx CADD/BIM Standards Manual.

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

1.6. All contract, construction and record drawings for bridges shall bear the seal of two Professional Engineers, licensed to Practice in the province of Ontario.

1.7. All METROLINX bridges and structures drawings shall have the subdivisions and mileage shown in the title block.

1.8. All works which impact Metrolinx bridges and structures shall be provided to Engineering & Asset Management (E&AM)- Bridges & Structures for review.

1.9. Where Metrolinx Standard Drawings (Appendix A) are used, they shall be included in the contract drawings, completed, or modified as required, and sealed by the Professional Engineer.

1.10. The design load for all components shall be represented on the plans.

2. SHOP DRAWINGS

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

2.2. 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.

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

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

Senior Manager, Bridges and Structures
Engineering & Asset Management
METROLINX

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

3. SUBMISSION OF DOCUMENTS UPON COMPLETION OF PROJECT

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

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

Senior Manager, Bridges and Structures
Engineering & Asset Management
METROLINX

3.3. 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 CADD format (See Metrolinx CADD/BIM Standards Manual). The specifications shall be in MICROSOFT WORD "DOC" format.

4. WALKWAYS & INSPECTION CATWALKS

4.1. Walkways shall be provided on both sides of the bridge, unless otherwise approved by the Senior Manager Bridges and Structures, E&AM.

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

4.3. Refuge bays are required on all new deck, spans and bridges (see METROLINX standard drawing C6 Appendix A) at maximum 30.48m (100ft) spacing on both sides of the bridge. The omission of refuge bays shall be subject to the approval of the Senior Manager Bridges and Structures, E&AM.

4.4. 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.

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

4.6. 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. Support brackets connections shall be made up of minimum 4 bolts.

4.7. All walkways shall have kick plate assemblies comprised of an L or C section with a minimum thickness of 6 mm (1/4") and extend a minimum of 150 mm (6") above the walking surface. Flat bar material shall not be used.

4.8. Walkway gratings shall have a maximum gap of 13 mm (1/2"). All gaps or voids between bridge elements that poses a risk of ballast falling below the railway structure shall be limited to 13 mm (1/2") maximum.

4.9. Where insufficient clearance exists between TPG girders to accommodate a walkway, walkways may be provided on the exterior of the girders complete with suitable transitions to bridge approaches.

5. DECK DRAINAGE

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

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

5.3. Drainage pipes are not permitted to discharge onto bridge seats, roadways, and walkways below.

5.4. Where through-deck drains are used and are intended to discharge to the area below the bridge, the flow from such drains shall be conveyed by suitably sized drainpipes to a minimum of 100 mm below the bottom flange of the bridge girders. Sizing of pipes and pipe supports shall accommodate both anticipated flow and anticipated ice accretion to maintain flow during winter months without obstruction.

5.5. Horizontal drainage pipes shall be embedded in the ballast adjacent to the concrete and steel curbs and on both sides of each track. The drainage pipes shall consist of perforated corrugated galvanized metal pipes surrounded with a geotextile filter material. Pipes shall be restrained from raising during ballasting and track surfacing. 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.

5.6. Prefabricated drainage sheets with geotextile filter material shall be placed against the back face of the abutment stems, wingwalls and retaining walls.

6. CLEARANCES FOR RAILWAY BRIDGES

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

7. VERTICAL CLEARANCES

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

7.2. For bridge sites with height constraints, a reduction in the vertical clearance may be allowed only with the written approval from the Senior Manager, Bridges and Structures-E&AM. If the required vertical clearance cannot be achieved due to site constraints, then a crash beam shall be provided to protect the bridge superstructure from vehicle impact.

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

8.1. 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 E&AM - Bridges & Structures.

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

9. STEEL GUARD RAILS (AREMA Chapter 15 Article 1.2.12)

9.1. Guardrails must be installed at the following locations:

a) All bridges that have supporting structure extending above the top of the ties;

b) All bridges that have the superstructure elements protruding beyond the deck of the bridge;

c) All bridges that cross roadways or commercially navigable waterways;

d) All bridges longer than 30.5 m (100 ft);

e) All bridges with curves 2 degrees and over.

9.2. For any other situations or locations, the Senior Manager Bridges and Structures E&AM shall determine the requirements for guard rails. See also GO Transit Track Standards.

10. TYPES OF BRIDGES

10.1. Skewed, continuous, or cantilevered spans will not be permitted unless there is written approval from the Senior Manager Bridges and Structures, E&AM.

10.2. Semi-integral and integral abutment bridges will not be permitted unless there is written approval from the Senior Manager Bridges and Structures, E&AM.

10.3. All new bridges shall be ballasted deck bridges. Where existing conditions permit, span replacements of existing bridges shall be converted to ballasted deck bridges.

11. APPROACH SLABS

11.1. Approach slabs shall be installed on;

a) New railway bridges,

b) Existing bridges with superstructure replacement work,

c) Bridges where the track and ballast are removed from the structure, and

d) Buried slabs, pedestrian tunnels or other structures with a ballast depth less than 800 mm below bottom of tie.

11.2. The cross-sectional geometry of the approach slabs shall match with the cross-sectional geometry at the end of the bridge deck (i.e. curbs, transverse crossfall, etc.), in order to achieve continuity of the deck joint cover plates, joint waterproofing, ballast mat, longitudinal deck subdrains, etc. The approach slab curbs shall extend to the end of the approach slab to ensure that all surface runoff is directed away from the abutments of the bridge structure.

12. SIGNAL STRUCTURES

12.1. The design of signal structures within Metrolinx ROW shall follow GO Transit Signals & Communications Standards – Overhead Signal Structures Specification 34 42 04 and the standards referenced therein.

13. ELECTRIFICATION REQUIREMENTS

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

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

13.3. All electrification infrastructure, such as Overhead Catenary Support (OCS) structures, shall be supported on separate foundations adjacent to the bridge. They shall not be supported on the bridge structure.

13.4. If the electrification infrastructure cannot be supported on separate foundations due to proven site conditions, then the bridge shall be evaluated by METROLINX Electrification to determine whether Overhead Catenary Support (OCS) structures are required on the bridges. If OCS structures are required, they shall only be supported on the substructure elements of the bridge. The bridge shall be designed to support these structures and associated wire and wind loading from the supports integrated with the bridge substructure elements, as directed by METROLINX. Prior to installation of electrification infrastructure on the bridge substructure; rehabilitation, repairs and/or strengthening shall be carried out on the bridge elements.

14. CULVERTS

14.1. All culverts shall meet the following geometric and orientation/layout requirements;

14.1.1. Culvert crossings under tracks shall have 900mm minimum diameter. Where existing cover does not permit a 900mm diameter culvert, 750mm or 600mm diameter culverts may be considered with approval from E&AM–Bridges & Structures;

14.1.2. All culverts shall cross under the tracks at 90^{o} with respect to the tracks. Skewed culvert crossings shall be avoided.

14.2. Corrugated steel pipe (CSP) culverts shall meet the following requirements;

14.2.1. CSP culverts shall be installed such that no joints or couplers are located under the tracks (i.e. within the zone bounded by a line projecting downward at 2H to 1V from edge of railway ties);

14.2.2. In multi-track territories, CSP culverts shall be installed such that there are no joints or couplers installed under the tracks, as defined in Section 12.2.1;

14.2.3. Further to Section 12.2.2, if joints or couplers under railway tracks cannot be avoided due to fabrication, transportation or site constraints, then the number of joints shall be minimized and located directly under the centerline of a railway track. Culvert joints or couplers shall not be located between railway tracks to avoid differential loading on both sides of the joint, resulting in potential opening of the joints over time;

14.2.4. For CSP culverts, the minimum coupler length shall be 610 mm (2 ft).

14.2.5. All couplers shall have the same or greater thickness as the culvert pipes that they are connecting.

14.3. Spiral welded steel pipes:

14.3.1. Spiral welded steel pipes that function as structural pipes at shallow depths shall be evaluated to determine the minimum steel thickness required for structural performance. Once this minimum thickness has been determined, a suitable additional thickness for corrosion loss shall be added to the minimum steel thickness to determine the total required wall thickness of the pipe. In no instance shall the thickness for corrosion loss be less than 0.25".

14.3.2. Joints on Spiral welded pipes shall be fully welded.

14.4. HDPE pipes:

14.4.1. The use of HDPE shall not be permitted for open ended culvert structures. The use of HDPE is acceptable for culvert liners.

14.5. Culverts shall be hydraulicly sized to meet stormwater flow and erosion threshold requirements.

14.5.1. Where necessary, riprap, adequately sized riverstone, and/or bioengineering materials should be used at the inlet and outlets of culverts to prevent erosion of the watercourse.

14.5.2. Culverts must tie into existing upstream and downstream thalweg of the watercourse.

14.5.3. Where applicable, environmental design should include provisions to encourage and protect fish passage, Species at Risk, and meet requirements as outlined in Toronto and Region Conservation Authorities' Crossing Guideline for Valley and Stream Corridors (latest) or other applicable guideline by the local Conservation Authority.

15. GEOTECHNICAL

15.1. A Global Stability analysis shall be executed as part of the Engineer's analysis, per the GO Track Standards Appendix W, for all excavations greater than 3.65m (12 ft.) in length and/or depth or as otherwise deemed necessary by the Geotechnical Engineer.

15.2. Any excavation or tunneling work located within the zone of 2H to 1V from a railway bridge foundation system or within 5 m from the substructure shall require a geotechnical investigation to provide shoring design requirements and tunneling recommendations. The substructure components shall be monitored in accordance with Part 6 of these Guidelines.

15.3. A Professional Geotechnical Engineer shall provide recommendations regarding requirements for shoring based on excavation depth, distance between excavation and railway tracks, soil conditions on site, and impact to track safety and operations.

15.4. Any temporary or permanent retaining structure falling within or intersecting the METROLINX Load Influence Line, as defined in 15.4.1, shall be designed for lateral live load pressure due to Cooper E-80 train surcharge loading, as per AREMA. The calculated pressure due to train live load shall be applied to the full height of the structural element. No elimination of lateral pressure due to train loading will be allowed.

15.4.1. METROLINX Load Influence Line is a theoretical line starting at 450 mm (18 in) from edge of tie with downward slope of 2H to 1V.

15.5. For all retaining/shoring structures that fall within the METROLINX Load Influence Line, as defined in 15.4.1, a monitoring system shall be required for the railway tracks and the retaining/shoring system, as per Part 6 of these Guidelines.

15.6. Any buried voided structure, such as culverts, sewers, sub-drains (greater than 200mm), manholes, etc., falling within or intersecting the METROLINX Load Influence Line, as defined in 15.4.1, shall be designed for railway loading.

15.7. At locations where additional track(s) are to be constructed and/or track(s) shifts are to be carried out, all new and existing buried structures

shall be confirmed by the Railway Bridge Engineer to be structurally adequate to carry all railway loads.

15.8. All unshored excavations shall follow the requirements of the GO Transit Track Standards (GTTS).

16. INSPECTION REQUIREMENTS

16.1. To facilitate inspection and maintenance efforts of all bridges and structure assets and elements, the following requirements shall be met;

16.1.1. Provide 610 mm (2 ft) minimum clearance between existing superstructure of railway bridges and new Metrolinx bridge superstructure (railway, vehicular or pedestrian);

16.1.2. Provide 3000 mm minimum clearance between existing superstructure of railway bridges and new third-party bridge superstructure (railway, vehicular or pedestrian);

16.1.3. Provide 1HOR:1VERT line of clearance projecting from the top of existing railway bridge superstructure to the underside edge of the proposed adjacent bridge superstructure;

16.1.4. Provide 1HOR:1VERT line of clearance projecting from top of existing railway bridge superstructure to underside edge of proposed conduit duct bank running along and adjacent to existing railway bridge;

16.1.5. Provide adequate clearances to accommodate inspection, maintenance, repair, removal and replacement of all bridge elements, such as, but not limited to: bridge bearings, anchorage assemblies, end diaphragms, end bracings, etc.

16.1.6. Architectural features shall not impede inspection access.

17. RAILWAY ABUTMENTS AND RETAINING WALLS

17.1. All abutments carrying railway loading shall be monolithic cast-in-place concrete and shall be exposed to accommodate inspection and maintenance. Precast, MSE or Tied-back abutments are not permitted unless otherwise approved by E&AM – Bridges & Structures.

17.2. Secant pile wall retaining structures shall be designed to anticipate drainage/seepage through the wall. The design of the secant wall shall consist of;

17.2.1. Miradrain system (or approved equivalent) installed on the face of the secant pile wall with the permeable face towards the wall,

17.2.2. Spray foam insulation system (or approved equivalent) installed on the entire exposed face of the secant pile wall. The insulation

layer shall have a minimum thickness of 50 mm (2 in) on the face of the wall, with a minimum thickness of 100 mm (4 in) at the vertical joints (i.e. at the king pile to filler pile interface) of the secant pile wall. The R-value of the insulation shall be determined by the Designer based on site location and geographical frost zone.

17.2.3. Perforated subdrain with geotextile sock embedded in clear stone, which is wrapped with geotextile fabric, shall be buried along the front face of the wall and adequately frost-protected. The subdrain shall be 200 mm (min) diameter and designed to accommodate the drainage and seepage from behind and in front of the wall. The subdrain shall outlet into a drainage system to avoid potential flooding in front of the wall.

17.2.4. The lateral displacement of secant walls used as railway abutments and railway supporting retaining wall shall be less than 0.1% of the height of the excavated area. For permanent railway supporting retaining walls less than or equal to 2m in height, the lateral displacement shall be less than 0.15% height of the excavated area. This clause does not apply to conventional railway supporting retaining walls.

18. CRASH WALLS

18.1. Crash walls shall be provided for the protection of structures located within 7.62m (25 ft) from the centreline of tracks, that poses a risk of catastrophic collapse in a derailment event, such as, but not limited to;

a) Piers/Columns supporting overhead structures crossing over the tracks,

b) Support system of elevated structures oriented parallel and adjacent to the tracks,

c) Building structures adjacent to the tracks.

18.2. Crash walls for the protection of structures listed in Section 17.1 that are located within 3.6m (12 ft) from the centreline of tracks shall be designed in accordance with AREMA.

18.3. Piers/Columns supporting a structure that requires crash protection due to its proximity to the tracks shall extend to the foundation level and be embedded in the crash wall. Piers/columns supported on and terminating at the top of the crash wall are not acceptable.

19. DURABILITY

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

19.2. All new railway culverts shall be designed for Cooper E-80 loading plus diesel impact (where applicable), with a service life of 75 years.

20. HYDROLOGY

20.1. All new culverts and bridges shall account for climate change through an increase of 25% to the peak flow and be designed for the 100-year return period storm event + 25%.

20.2. For flooding assessments, the worst case of the peak flow from the 100-year storm + 25% and the Regional Storm shall be utilized. Consideration should also be given to downstream flood risks.

20.3. For the extension or modification of existing culverts, the criteria in this section shall be applied to the extended or modified structures.

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

GUIDELINES FOR DESIGN OF STEEL BRIDGES AND STRUCTURES

PART 2A

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

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

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, Steel Structures, Chapter 15, Parts 1 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 shall be applied with special provisions as specified by E&AM -Bridges & Structures. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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 (AREMA Chapter 15 - Section 1.2)

    1.1. MATERIALS (AREMA Chapter 15 - Article 1.2.1)

    In general and unless approved by E&AM -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 Beam Sections - Stringer Sections - Gusset Plates for Truss Structures - Connections of FCM members	G40.20/G40.21 350AT (for new bridges, span replacement or repair of existing bridges) 350WT(for the repair of Non-Type AT bridges only) 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 (for new bridges, span replacement or repair of existing bridges) 350WT (for the repair of Non-Type AT bridges only) 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
Non-Fracture Critical Members (Unless evaluated otherwise) / 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	G40.20/G40.21 350A (for new bridges, span replacement or repair of existing weathering steel bridges) 350W (for the repair of Non-Type A bridges only / bridges not constructed from weathering steel)	A588, A709/A709M A572, A36 Grade 50 or 50W

Members	Standards	
	CSA	ASTM
Galvanized Secondary Members - Handrails – structural sections - Bearing Plates - Fiber Optics Brackets - Handrails – pipe sections	G40.20/G40.21 300W G40.20/G40.21 350W Class C	A572, A36 Grade 50 ASTM A500 Grade C

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 or Fracture Critical Elements of bridges without prior approval of E&AM -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. Redundancy

With the exception of Fracture Critical Members, redundancy shall be included in the design of any element where failure of the element will result in an immediately unsafe condition. All connections shall include a minimum of 3 bolts.

1.1.5. 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".

1.1.6. Materials Sourced from Outside of North America

Materials sourced from outside of North America shall have a total maximum boron content below 0.0008%.

1.1.7. 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 (AREMA Chapter 15 - Article 1.2.3)

The acceptable 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 Senior Manager Bridges and Structures, E&AM.

1.2.4. Pony Truss designs are not permitted.

1.3. SPACING OF TRUSSES, GIRDERS AND STRINGERS (AREMA 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 Senior Manager Bridges and Structures, E&AM.

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 (AREMA 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 (AREMA Chapter 15 - Article 1.3.2)

a) The dead load on ballasted 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.

b) 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 (AREMA 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 (AREMA Chapter 15 - Article 1.3.5)

Percentage of live load for rolling equipment without hammer blow.

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

3.1. High Strength Bolts (AREMA 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.

3.1.3. Where historic reference is made to ASTM A325 and A490, reference is now made to ASTM F3125 with ASTM A325 & A490 as grades under this specification.

3.2. Bearing Pressure on Concrete (AREMA 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 (AREMA 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 (AREMA 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 (AREMA Chapter 15 - Article 1.5.5)

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

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

6.1. FLANGE SECTIONS (AREMA Chapter 15 - Article 1.7.2)

6.1.1. Add the following to AREMA 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. AREMA 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 (AREMA 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 (AREMA 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 (AREMA 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 Senior Manager of Bridges 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 (AREMA 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 (AREMA 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 (AREMA Chapter 15 - Section 1.8)

6.7.1. END FLOORBEAMS (AREMA 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 (AREMA 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 (AREMA 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 welded splices in flanges or webs shall be performed in the shop 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.

6.8.6. The use of a rolled section over a welded section is preferred in instances where a section can be cut from a rolled section.

6.9. BRACING (AREMA Chapter 15 - Section 1.11)

6.9.1. BRACING OF TOP FLANGES OF THROUGH GIRDERS (AREMA 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 (AREMA 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 Senior Manager Bridges and Structures, E&AM.

6.9.3. CROSS FRAMES AND DIAPHRAGMS FOR DECK SPANS (AREMA 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 AREMA 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 %.

6.11. WALKWAYS AND HANDRAILS ON BRIDGES – LOADS (AREMA 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--

METROLINX

GUIDELINES FOR FABRICATION OF STEEL BRIDGES AND STRUCTURES

PART 2B

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

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

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, Steel Structures, Chapter 15, Part 3, and shall apply to all work pertaining to the fabrication of steel railway bridges. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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. MATERIALS (General)

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

   1.2. 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.

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

2. GENERAL (AREMA Chapter 15 - Section 3.1)

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

      2.1.1. 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.

      2.1.2. 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.

   2.2. Fit of Stiffeners (AREMA Chapter 15 - Article 3.1.10)

2.2.1. Bearing Stiffeners

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

2.2.2. Intermediate Stiffeners

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

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

3.1. Deck Spans

3.1.1. 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.

3.1.2. 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.

3.2. Through Plate Girder Spans

3.2.1. 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.

3.2.2. 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.

4. WELDED CONSTRUCTION (AREMA Chapter 15 - Section 3.3)

4.1. GENERAL (AREMA Chapter 15 - Article 3.3.1)

4.1.1. 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.

4.1.2. 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)

4.2. Welding Procedures

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

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

4.2.3. 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.

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

5. INSPECTION (AREMA Chapter 15 - Section 3.5)

5.1. 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.

5.2. 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.

5.3. 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.

5.4. The following inspections shall be carried out:

5.4.1. Geometric Control

- Plate and Shape Sizes
- Dimensions
- Alignment
- Tolerances

5.4.2. 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% of all web and flange splices of FCM and non-FCM members.
- Magnetic Particle Test Method – 100% of fillet welds for main members and 50% of fillet welds for secondary members.

5.4.3. High Strength Bolts

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

5.4.4. Surface Finishes

- Cleaning
- Galvanizing
- Metalizing

5.4.5. 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.

5.4.6. 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

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

PART 3 - GUIDELINES FOR DESIGN OF CONCRETE BRIDGES AND STRUCTURES

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, Concrete Structures and Foundations, Chapter 8, Parts 1, 2, 3, 4, 5, 16, and 20. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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. GENERAL

1.1. TYPE OF SUPERSTRUCTURES (AREMA Chapter 8 – Part 1)

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.

Transverse post-tensioning rods used for Single-Voided Box (SVB) and/or Double-Voided Box (DVB) superstructures are acceptable.

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

2.1. Sourced non-reactive fine and coarse aggregates shall be listed in the concrete mix design and approved on the latest revision of MTO Structural Concrete Aggregate Source List (CASL).

2.2. Cement, Supplementary Cementing Materials and Chemical Admixtures type and source shall be identified on the concrete mix design and only those listed on the MTO Designated Sources of Material (DSM) shall be used. The supplier shall provide a declaration that all chemical admixtures are used at dosages exceeding the minimum dosages shown on the DSM for that product. For clarity, letter of compatibility declaration is only required if admixture sources are from different suppliers, as per OPSS.PROV 1350.04.02.01.05. The conveyance of this information is consistent with an MTO Form A (PH-CC-433A) submission.

2.3. An independent third party testing company shall provide QA aggregate sampling and testing of production stockpiled aggregate at the concrete plant consistent with the requirements and testing frequency of OPSS.PROV 1002.08.

2.4. Consistent with OPSS.PROV 1002.05.04, the combined coarse and fine aggregate used in a concrete mix shall have a total of less than 0.001%

by mass of lime (CaO) or periclase (MgO); a total of less than 1.0% by mass of gypsum, anhydrite or other sulphate minerals; no steel slag or glass; and a total of less than 1.0% by mass of sulphur. Petrographic analysis aggregate test reports shall be provided to Contracting Authority to confirm compliance.

2.5. As per OPSS.PROV 1350.04.02.01.05, all required supporting test data and certificates shall be less than 12 months old at the time the concrete mix design is submitted. Current annual test results shall be provided to Contracting Authority to confirm compliance.

2.6. Documents related to aggregate testing/analysis along with an accompanying letter (signed and dated) from the Concrete Batch Plant's Materials Engineer confirming there are no aggregate-related deterioration concerns and that all aggregates used in the concrete mix designs for the project are from MTO-approved sources.

2.7. Where the conditions of 2.1 through 2.6 cannot be met, low alkali cement may be used as an alternative. 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 (AREMA Chapter 8 - Article 1.4.)

3.1.1. All aggregates shall be from MTO approved sources.

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 (AREMA Chapter 8 - Article 1.6.2)

Rebar welding is not allowed.

5. DETAILS OF REINFORCEMENT - PLACING OF REINFORCEMENT – GENERAL (AREMA 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 used in the design of new structures and structural rehabilitations. Stainless steel reinforcement shall be used in areas of all bridge components where their surface is within the roadway splash zone as follows;

- Abutment, Walkways and Retaining Walls: located within 7 m horizontally (measured from the edge of the nearest travelled roadway lane) and 5 m vertically above the roadway.

- Piers, Columns and Pier Caps: located within 10 m horizontally (measured from the edge of the nearest travelled roadway lane) and 5 m vertically above the roadway.

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 use of Supplementary Cementing Materials (combination of blast furnace slag and/or silica fume only) permitted up to 25% (max) of the total cementing materials content by mass for Class C-1 concrete mix, as per OPSS.PROV.1350. The use of Fly Ash is not permitted.

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% for 14-20 mm maximum coarse aggregate size, and 6 to 9% for 10 mm max. 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;

a) 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)

b) All admixtures included in the same pour shall be compatible with each other.

c) All admixtures shall be added in accordance with manufacturer's recommendations.

d) 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;

a) For normal concrete mix 75 mm + 25 mm (without superplasticizer).

b) For normal concrete mix 150 mm, maximum (after addition of superplasticizer).

c) Where proprietary 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 (AREMA 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 (AREMA 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.

7.3. Discharge of concrete to be complete within 1.5 hours (90 minutes) after the introduction of the mixing water to the cement and aggregates, except when the air temperature exceeds 28 degrees and the concrete temperature exceeds 25 degrees, the concrete shall be discharged within 1 hour after the introduction of the mixing water.

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

8.1. Concrete shall be maintained between 10 °C and 70°C, prevented from premature drying and moisture loss. Temperature control plans shall be submitted in accordance with OPSS.PROV 904.

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 (AREMA 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;

9.2.1. Dowels have the same:

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

9.2.2. A lot shall not be larger than 300 dowels.

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. Dowels shall be installed in accordance with OPSS.MUNI 904.

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

AREMA CHAPTER 8 – PART 2

10. NOTATIONS, DEFINITIONS AND DESIGN LOADS (AREMA 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 (AREMA Chapter 8 - Article 2.2.3.c)

10.2.1. AREMA 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. AREMA 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 (AREMA 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 (AREMA 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 (AREMA Chapter 8 - Article 2.3.2)

12.1. To accommodate an inner and outer reinforcement mat, all railway bridge concrete elements shall have a minimum thickness of 300 mm.

12.2. Rebar shall be 400W.

12.3. Rebar welding is not allowed.

12.4. With exception to surficial concrete patch repairs and refacing, the minimum reinforcement bar shall be 15 mm, for railway structures.

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

13.1. Delete this Article and substitute the following table:

Exposure Conditions	Minimum Clear Cover
Precast or cast-in-place concrete cast against or permanently exposed to fill material (ballast, granular, soil, etc.)	75 mm (3 in)
Precast or cast-in-place concrete not submerged or exposed to earth or de-icing chemicals: • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	50 mm (2 in)
Precast or cast-in-place concrete submerged or exposed to earth in nonaggressive environments: • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	65 mm (2.5 in)
Concrete subjected to de-icing chemicals or other aggressive environments: • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	75 mm (3 in)
Soffit of slabs over roadways • Principle reinforcing bars • Stirrups elsewhere, ties and spirals	50 mm (2 in)

13.2. The Engineer shall set the nominal cover including tolerances to meet the minimum clear cover requirements in the table in 13.1.

13.3. If the above cover cannot practically be attained, due to existing condition constraints, it may be reduced as necessary, subject to the acceptance of E&AM - 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.

13.4. For cast-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.

13.5. For precast concrete, the maximum concrete cover shall be 20 mm (3/4") more than the minimum cover provided in section 13.1.

14. SHRINKAGE AND TEMPERATURE REINFORCEMENT (AREMA 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 (AREMA Chapter 8 - Section 2.22.2)

Rebar welding is not allowed.

16. ALLOWABLE SERVICE LOAD STRESSES – CONCRETE (AREMA 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)

AREMA CHAPTER 8 – PART 3

17. FIELD CONDITIONS – REINFORCEMENT (AREMA 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).

AREMA CHAPTER 8 – PART 4

18. PILE LENGTH DETERMINATION (AREMA 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 (AREMA 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.

AREMA CHAPTER 8 – PART 5

20. COMPUTATION OF APPLIED FORCES – LOADS EXCLUSIVE OF EARTH PRESSURE (AREMA 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:

a) Longitudinal - A length of 915 mm (3 ft) plus the depth of ballast and fill under the tie; limited, however, by the axle spacing.

b) 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 or temporary 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 entire height of the structural element if any portion of the structural element intersects the Metrolinx Influence Line. No elimination of lateral pressure due to train loading will be allowed (e.g., area above the point of intersection of the METROLINX Load Influence Line and vertical face of structural elements).

20.6.1. METROLINX Load Influence Line is defined as a theoretical line taken from one and half feet (450 mm) away from edge of tie with downward slope of two horizontal and one vertical 2H to 1V.

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 (AREMA 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 (1/4) of its height for wingwalls and retaining walls, and three-tenths (3/10) of its height to the base of rail for abutments.

AREMA CHAPTER 8 – PART 7

22. MECHANICALLY STABILIZED EMBANKMENT

22.1. Mechanically stabilized earth (MSE) retaining walls are not permitted for embankments carrying railway loads.

22.2. In lieu of MSE walls, precast T-wall system can be used for embankments carrying railway loads and shall meet 100 year service life.

AREMA 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 structures 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. All precast concrete box structures shall be mechanically connected by the following, but not limited to, post-tensioning rods, steel angles or steel straps.

23.4. The concrete mix design for box structures used for pedestrian tunnel or roadway underpass applications, and all other buried structures adjacent to the tunnel shall contain a crystalline waterproofing admixture added within the concrete mix, by XYPEX (or approved equivalent with regards to performance and aesthetics), as a means for providing additional waterproofing of the concrete 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 in 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	Costum 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

23.5. In addition to the use of XYPEX as identified in 23.4, an intact 100% waterproof external membrane shall also be provided.

23.6. In addition to the use of XYPEX (or approved equivalent), all buried cast-in-place box structures used for pedestrian tunnel or roadway underpass applications, and all other buried structures adjacent to and extending from the pedestrian tunnel, shall have an external waterproofing system. External waterproofing shall be applied to the walls of the box structure and the top of the top slab of the box structure and extend onto the walls of the buried structure up to 300 mm (1 ft) below the wall-to-top slab construction joint. Blind side waterproofing shall be applied to the bottom of the bottom slab.

23.7. For Precast box structures, the joints between each precast unit shall be watertight by providing at least three (3) means of leak protection by using three (3) layers of hydrophilic waterstops. The acceptable hydrophylic waterstop system shall require lapped ends per the manufacturers recommendations.

23.8. All joints between cast-in-place and Precast box structures shall be watertight and have at least three (3) layers of internal watertight leak protection including one layer of PVC waterstop.

23.9. All joints in below grade cast-in-place concrete walls and slabs of pedestrian and underpass roadway/railway structures shall be watertight and have at least three (3) layers of internal watertight leak protection including one layer of PVC waterstop.

23.10. All cast in place and precast pedestrian tunnels and associated underground structures shall be constructed with continuous curtain drains over top of the roof slab and covering the full height of walls. Curtain drains shall lap over top of subdrains adjacent to the base slab elevation of the structure. Subdrains shall be constructed with a minimum of 300 mm of clear stone on all edges, the perimeter of which shall be wrapped in geotextile fabric. Subdrains shall be a minimum of 150 mm in diameter and shall be perforated; without filter socks. Provisions to clean subdrains shall be made at either end of the subdrain by way of appropriately detailed cleanouts accessible from ground level; the location of which shall be clearly marked and shown on the record drawings. Subdrains shall terminate at a suitable gravity drainage system or a mechanical pumping system, capable of maintaining the ground water elevation external to the structure at or below the top of the interior walking surface of the tunnel. The requirement for of such a drainage system as described above shall be in addition to the waterproofing requirements described elsewhere in this section.

23.11. Reinforcing steel for cast in place and precast pedestrian tunnels and associated underground structures shall be detailed to limit shrinkage cracks to a width not exceeding 0.25 mm. Such detailing shall additionally consider the differential shrinkage that is encountered at cold joints between floor slabs, walls and roof slabs.

23.12. A waterproofing report including expected service life shall be provided for review and acceptance by METROLINX Bridges and Structures.

AREMA 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

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

PART 4 - GUIDELINES FOR DESIGN OF BEARINGS

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, Bridge Bearings, Chapter 15, Part 5. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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.

AREMA CHAPTER 15 – PART 5

1. GENERAL REQUIREMENTS (AREMA Chapter 15 - Article 5.1.2)

   1.1. Elastomeric Bearing Pads

   The minimum thickness shall not be less than 13 mm (½ in). The use of trapezoidal shaped elastomeric bearings shall be prohibited.

   For steel structures where elastomeric bearings are proposed, they shall include a steel bed plate and steel shoe plate.

   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 E&AM - Bridges & Structures and shall only be specified with the prior approval of E&AM - Bridges & Structures. The designer shall submit all pertinent documents to E&AM - 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 (AREMA Chapter 15 - Article 5.1.5)

   This section shall be modified as follows:

   2.1. Steel Spans

   The allowable 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

2.2. Concrete Spans

The allowable 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, fabric reinforced elastomeric pads approved by Metrolinx. Other bearing pads may be considered by E&AM-Bridges & Structures, and shall only be specified with the prior approval of E&AM-Bridges & Structures. The designer shall submit all pertinent documentation to E&AM -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 E&AM-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 (AREMA 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 bronze whereby the allowable bearing pressure is 20.7 MPa (3,000 psi).

4. STEEL BEARING COMPONENTS – ANCHOR BOLTS AND RODS (AREMA 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 E&AM-Bridges & Structures, and shall only be specified with the prior approval of Corridor Maintenance-Bridges & Structures. The designer shall submit all pertinent documentation to E&AM-Bridges & Structures for review.

--END OF GUIDELINES FOR DESIGN OF BEARINGS--

GUIDELINES FOR DESIGN OF WATERPROOFING AND BALLAST MAT

PART 5

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

PART 5 - GUIDELINES FOR DESIGN OF WATERPROOFING AND BALLAST MAT

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, Waterproofing Chapter 29, Part 1 and 2. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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.

AREMA CHAPTER 8 – PART 29

1. GENERAL

1.1. For the specification regarding the waterproofing of the bridge deck, curbs, walkways and joints, refer to Specification Section 07112 – High-Performance Waterproofing System.

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

1.3. The High-Performance Waterproofing System shall meet the performance requirements specified herein and be approved by Metrolinx. All bridge joints shall conform to the most current edition of applicable Metrolinx Standard drawings and be supplied by the same manufacturer of the High-Performance waterproofing system. The products that comprise the Waterproofing System have been specified, and this specification developed, to establish the performance criteria for the High-Performance Waterproofing System to be employed as specified elsewhere in the Contract Documents.

1.4. In the event the Contractor wishes to propose an alternate product, it shall be the Contractor's responsibility to conclusively demonstrate, to the complete satisfaction of the Consultant, that the proposed alternate is equal to or better than the products specified herein. The High-Performance Waterproofing System shall be comprised of a complete system, consisting of products supplied by a single manufacturer. The use of a product or system on past projects shall not constitute proof of acceptance or equivalence on subsequent future projects.

2. HIGH-PERFORMANCE WATERPROOFING SYSTEM

2.1. High-Performance Waterproofing Membrane

2.1.1. General: Provide a fast cure, high build polymer system that prevents the passage of water and complies with the physical property requirements specified herein. Compliance shall be demonstrated by third party testing meeting the requirements of Section 3.9 in this document. Use materials specified below.

2.1.2. Primer: Single or multi-component polymer primer with the material properties shown in Table 1.

i. Variation in substrate porosity and roughness may influence coverage rates. Additional coats may be needed based on primer absorption.

ii. Consult the Manufacturer for recommended primer selection and coverage rates based on expected site and environmental conditions.

iii. If primer is not used, the performance of the waterproofing membranes shall meet or exceed the required criteria of the respective membranes.

Table 1: Primer

Physical Properties	**Test Method**	**Criteria**
Mixing Ratio		Per Manufacturer
Adhesion to Concrete	ASTM D7234	2 MPa minimum
Adhesion to Steel	ASTM D4541	3 MPa minimum

2.1.3. Base Waterproofing Membrane: 100% solid, rapid curing elastomer with the material properties shown in Table 2.

Table 2: Base Waterproofing Membrane

Physical Properties	Test Method	Criteria
Mixing Ratio		Per Manufacturer
Solid Content		100%
Return to Service[1] 0°C (32°F) – 20°C (68°F)		1 Hour Maximum
Shore Hardness	ASTM D2240	40D, Minimum
Adhesion to Concrete[3]	ASTM D7234	2 MPa, Minimum[2]
Adhesion to Steel[3]	ASTM D4541	3 MPa, Minimum
Tensile Strength at Break	ASTM D638/D412	13.8 MPa Minimum
Elongation at Break	ASTM D638/D412	150% Minimum
Tear Strength (Die C)	ASTM D624	50 kN/m Minimum
Low Temperature Crack Bridging (⅛" @ -15˚F, 3.175 mm @ -26˚C)	ASTM C1305	Pass @ 40 Cycles
Extensibility after Heat Aging (6.4 mm, ¼" expansion)	ASTM C1522	Pass
North American Ballast Impact Test	9.2 – 28.1 kips @ 2,000,000 Cycles	Pass
Resistance to Penetration [Modified per AREMA Ch. 8 Part 29.10.3.3]	ASTM D1883	Pass

[1] Return to Service – The time required by the manufacturer for the applied membrane to reach sufficient set after which work can be carried out by other trades.
[2] For coatings on concrete surfaces, substrate failure is the preferred mode of failure. Low values in this failure mode indicate a deficiency in the concrete. For additional commentary, see ASTM D7234, Appendix X1.
[3] Interlayer adhesion to exceed adhesion to substrate.

2.2. High-Performance Expansion Joint

2.2.1. General: The High-Performance Expansion Joint is designed to be used in conjunction with the High-Performance Waterproofing Membrane. All bridges joints shall conform to the most current edition of applicable Metrolinx Standard Drawings. All materials specified shall be supplied or approved and recommended by the Manufacturer.

2.2.2. The base and flexible waterproofing membranes shall be of different colours to differentiate the membranes during on-site application.

2.2.3. Flexible Waterproofing Membrane: A 100% solid elastomeric membrane with the material properties shown in Table 3.

Table 3: Flexible Waterproofing Membrane

Physical Properties	Test Method	Criteria
Mixing Ratio		Per Manufacturer
Solid Content		100%
Return to Service[1] 0°C (32°F) – 20°C (68°F)		1 Hour Maximum
Shore Hardness	ASTM D2240	55A, Minimum
Adhesion to Concrete	ASTM D7234	2 MPa, Minimum[2]
Adhesion to Steel	ASTM D4541	3 MPa, Minimum
Tensile Strength at Break	ASTM D638/D412	7.0 MPa Minimum
Elongation at Break	ASTM D638/D412	600% Minimum
300% Modulus	ASTM D638/D412	4 MPa, Maximum
Tear Strength (Die C)	ASTM D624	30 kN/m Minimum

[1] Return to Service – The time required by the manufacturer for the applied membrane to reach sufficient set after which work can be carried out by other trades.

[2] For coatings on concrete surfaces, substrate failure is the preferred mode of failure. Low values in this failure mode indicate a deficiency in the concrete. For additional commentary, see ASTM D7234, Appendix X1.

2.2.4. Pre-Molded, Trough-Type Expansion Joint: Molded, prefabricated, trough-type elastomeric expansion joint system with the material properties shown in Table 4. The Manufacturer shall supply the pre-molded, trough-type expansion joints based on the Consultant's design and guarantee the supplied joints are compatible with all relevant component of the High-Performance Waterproofing System.

Table 4: Pre-Molded, Trough-Type Expansion Joint

Physical Properties	Test Method	Criteria
Operating Temperature Range		-40˚C to 150˚C
Movement Capability (of nominal joint size)		± 50%
Tensile Strength	ASTM D638	10 MPa, minimum
Elongation	ASTM D638	150% minimum

2.2.5. The Consultant shall select joint trough depth based on the median joint width and the expected maximum movement in contraction and expansion. Table 5 can be used to inform the selection. It is recommended centering tab depth be a minimum of 50mm, but based on joint size selection. Additional consultation with the joint manufacturer may be required, especially for joints of varying elevations, or of unique geometries.

Table 5: Prefabricated Trough-Type Joint Selection

Joint Width Opening	Trough-Type Expansion Joint Lengths	Steel Cover Plate Centering Tab Depth
50mm	100mm x 100mm "V"	50mm
75mm	100mm x 100mm "V"	50mm
100mm	125mm x 125mm "V"	75mm
125mm	150mm x 150mm "V"	75mm
150mm	175mm x 175mm "V"	75mm
175mm	200mm x 200mm "V"	100mm
A mm	(A+25)mm x (A+25)mm "V"	100mm

Values in Table 5 are to be used as a guide to assist in the preliminary design of the Prefabricated Trough-Type Joint. The Consultant shall coordinate with the Waterproofing Manufacturer to finalize Prefabricated Trough-Type Joint design for each bridge joint, which is based on the designed joint width at construction and maximum expected in-service joint width.

2.2.6. Joint Adhesive: 100% solids, slow-setting elastomer with the material properties shown in Table 6.

Table 6: Joint Adhesive

Physical Properties	Test Method	Criteria
Solids Content		100%
Tensile Strength	ASTM D638/D412	7 MPa, minimum
Elongation	ASTM D638/D412	150% minimum

2.2.7. Expandable Elastomeric Foam Filler: Solvent-free, closed cell, elastomeric, pourable foam with properties in Table 7.

Table 7: Expandable Elastomeric Foam

Physical Properties	Criteria
VOC	0
Expansion	400%
Cell Structure	Closed cell

2.2.8. Aliphatic Lock Coat: Color stable coating for use on exposed waterproofing systems intended for foot traffic with the material properties shown in Table 8 and Non-Skid Broadcast Media.

Table 8: Aliphatic Lock Coat

Physical Properties	Test Method	Criteria
Mixing Ratio		Per Manufacturer
Solid Content		75%
Shore Hardness	ASTM D2240	50D, Minimum
Adhesion to Concrete	ASTM D7234	2 MPa, Minimum[1]
Adhesion to Steel	ASTM D4541	3 MPa, Minimum
Tensile Strength at Break	ASTM D638	20 MPa Minimum
Elongation at Break	ASTM D638	2.5% Minimum
Tear Strength (Die C)	ASTM D624	1,130 N-cm Minimum
Taber Abrasion (CS17, 1000 revolutions, 1000 g)	ASTM D4060	100 mg loss, Maximum

[1] For coatings on concrete surfaces, substrate failure is the preferred mode of failure. Low values in this failure mode indicate a deficiency in the concrete. For additional commentary, see ASTM D7234, Appendix X1.

2.2.9. Ancillary Products: Additional materials that are called out in the joint design. These products are not required to be manufactured or supplied by the Manufacturer. If they are not manufactured or supplied by the Manufacturer, the products shall be approved and recommended by the Manufacturer.

i. Ethylene-vinyl acetate (EVA) foam of the size and shape called out in the project drawings with a minimum density of 60 kg/m^3

ii. A polyethylene sheet with a maximum nominal thickness of 0.5 mm (20 mils). Only adhere the outer edges of the sheet to the top of deck, as outlined in the joint detail.

iii. An Ultra High Molecular Weight (UHMW) Polyethylene Tape of the width specified in the project drawing with an adhesive backing and a maximum film thickness of 2 mm.

iv. Non-Skid Broadcast Media – Furnish a basalt, granite, or calcined bauxite aggregate as recommended by the manufacturer, to provide a non-slip surface, with an angular shape and a Mohs hardness of at least 6.

3. BALLAST MAT SYSTEM

3.1. General

3.1.1. For further details regarding the ballast mat system, see Specification Section 07113 – Ballast Mat System.

3.1.2. Ballast mat systems shall be used on the following;

- All new railway bridges,
- Rehabilitated bridge decks where the ballast will be removed, and
- Top face of roof slabs of pedestrian tunnels or concrete culverts with less than 1.0m fill between underside of tie and top of structure.

3.1.3. The Ballast mat system on bridge decks shall be fully bonded with an adhesive system that is acceptable by the Ballast Mat and Waterproofing manufacturers.

3.1.4. The ballast mat system on top of the pedestrian tunnel structures shall be fully bonded along the edges of the mat and spot-adhered on the interior portion of the ballast mats.

3.2. Requirements for Ballast Mat System

The Ballast Mat System shall include the following components:

3.2.1. Ballast Mats:

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

i. 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.

ii. 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.

iii. 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.

3.2.2. Ballast Mat Adhesive:

i. Ballast mat adhesive shall be used to bond ballast mats to the waterproofing membrane. The ballast mat adhesive shall be chemically compatible with the ballast mat and 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.

ii. The compatibility of the adhesive shall be confirmed with, and deemed acceptable by, the Waterproofing and ballast mat manufacturers, prior to its application.

3.2.3. 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

3.3. 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.

4. REFERENCE STANDARDS

- Standard Drawing No. C20 – Typical High Performance Expansion Joint.
- 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 RETAINING STRUCTURE DESIGN AND MONITORING

PART 6

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

PART- 6 - GUIDELINES FOR RETAINING STRUCTURE DESIGN AND MONITORING

PURPOSE AND SCOPE

The purpose of these guidelines is to modify, supplement and/or supersede applicable sections of the American Railway and Maintenance of Way Association (AREMA) Railway Engineering Manual, Concrete Structures and Foundations, Chapter 8, Part 28. Where the guidelines do not modify, supplement and/or supersede the AREMA manual, the provisions of the AREMA manual shall apply. 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. The Contractor's Engineer and Geotechnical Engineer shall establish the tolerable deflection limits of the shoring system to be considered in the geotechnical instrumentation monitoring plan such that there will be no impact to track safety and rail operations.

This section is applicable to shoring walls and permanent retaining structures. For shoring walls that will remain in place as permanent structures, their design shall comply with all METROLINX design guidelines and applicable codes and standards. The permanent shoring walls shall be identified in the contract documents as permanent retaining walls and shall meet all requirements of AREMA and these Guidelines for permanent retaining structures.

AREMA CHAPTER 8 – PART 28

TEMPORARY STRUCTURES FOR CONSTRUCTION – DESIGN OF SHORING SYSTEMS (AREMA 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 system.

1.2. Any deviation from the present guidelines shall be reviewed by E&AM–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 Design Engineer and Shoring 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;

a) all assumptions,

b) detailed design of all structural members,

c) 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,

d) 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 Load Influence Line 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. The lateral earth pressure, calculated according to Section 2.11, shall be applied over the full height of the structural element if any portion of the element intersects the METROLINX Load Influence Line.

2.3. Shoring systems must provide continual support of the tracks at all stages of construction. No construction of shoring within the Zone of Influence is permitted under railway operations on the track it is supporting.

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

2.5. 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.

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

2.7. 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.

2.8. 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.

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

2.10. 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;

a) to prevent soil collapse before placement of the timber lagging (during the temporary excavation),

b) to relieve water pressure while preventing soil erosion (with use of non-woven geotextile or equivalent method).

2.11. 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.].

2.12. 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.

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

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.

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

2.14. The effect of Cooper-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).

2.15. For temporary shoring walls where it is contemplated but unknown whether the wall will remain as a permanent retaining structure, the requirements for the design of a permanent wall shall be followed.

3. LATERAL DISPLACEMENT OF THE SHORING WALL

3.1. The total cumulative lateral displacement of permanent and temporary shoring walls or retaining structures shall be limited to maximum of 0.1% of the height of the excavated area. For temporary shoring walls less than or equal to 3m in height, the total cumulative lateral displacement of the shoring walls or retaining structures shall be limited to maximum of 0.15% 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 retaining structures.

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 shall have triple corrosion protection.

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

1) plastic sheathing,

2) cementitious grout within the annular area between tieback/tie-rod and plastic sheathing, and

3) 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/pre-production 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.

a) 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.

b) Special attention shall be taken for the testing of the top anchors in order to avoid track heave for passive wedge failure.

c) 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 E&AM-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 methods approved by the geotechnical engineer 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/PRE-PRODUCTION TEST OF GROUND ANCHORS / TIEBACKS

5.1. GENERAL

5.1.1. Prior to the start of shoring or retaining structure work, the contractor shall submit a Ground Anchor Test Plan for any soil or rock anchors (tiebacks, tiedowns, soil nails etc.) which identifies anchors designated for testing and outlines the testing program and acceptance criteria in accordance with these Guidelines.

5.2. PROOF TEST

5.2.1. 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.

5.2.2. Each increment shall be held for a minimum of 2 minutes except the maximum load (133% of design load) shall be held for a minimum of 30 minutes.

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

5.3. PERFORMANCE/PRE-PRODUCTION TEST

5.3.1. Performance/Pre-production testing of ground anchors/tiebacks shall be in accordance with OPSS 942, except as modified in this section.

5.3.1.1. 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.

5.3.1.2. The minimum number of anchors required for performance/pre-production testing 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/pre-production 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.

6. TEST ACCEPTANCE CRITERIA (PROOF AND PERFORMANCE/PRE-PRODUCTION TESTING)

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

a) 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.

b) 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

c) 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

a) 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.

b) 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 the following safety factors;

8.3.1. A factor of safety of 1.5 shall be applied for temporary construction by multiplying kp by 0.66, AREMA Chapter 8 - Article 28.5.1.2.

8.3.2. A factor of safety of 2.0 shall be applied for permanent construction by multiplying kp by 0.5, AREMA Chapter 8 – Article 20.5.1.

8.4. The minimum embedded length of the pile into soil shall be 3.05 m (10 ft), and 1.8 m (6 ft) into sound rock unless specified otherwise in the geotechnical report.

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:

a) 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.

b) 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.

c) 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).

d) Total lateral force due to E-80 on track #1 = ### kN / (m width of wall).

e) Total lateral force due to E-80 on track #2 = ### kN / (m width of wall).

f) Total lateral force due to E-80 on track #3 = ### kN / (m width of wall).

g) The total design load applied to each individual tie back.

h) The tie-back (thread-bars or strands) size, diameter, number of thread-bars / strands, grade, etc.

i) The total bonded length of the tie-backs.

j) If the tie-back is anchored in rock, the bonded part of the tie-back, shall be started one meter (in the vertical direction) below the actual elevation of rock.

k) The total un-bonded length of tie-backs.

l) 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. Permanent Secant Pile wall designs shall demonstrate 100-year service life and provide adequate drainage behind and in front of the wall.

10.2. 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.

10.3. 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

10.4. 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.

10.5. The concrete used for the king piles shall have a minimum compressive strength of 30 MPa (4,350 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 (4,350 psi) concrete may be terminated at the bottom of rail elevation.

10.6. The maximum spacing between the centerline of king piles shall be limited to 1.6 times the king pile diameter to a maximum of 2.0 m (6.5 ft).

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

10.8. 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.

10.9. 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 temporary shoring system, subject to acceptance by E&AM-Bridges & Structures.

12. GROUND AND RETAINING WALL MONITORING

12.1. Monitoring for all temporary and permanent shoring/retaining structures shall meet the requirements of this section (Part 6, Section 12).

12.2. 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.

12.3. The Contractor shall provide a monitoring procedure to the satisfaction of E&AM-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.

12.4. The Contractor shall submit the monitoring results to the METROLINX Consultant for review. The reports shall be submitted weekly (min). Updates shall be provided daily unless otherwise instructed by Metrolinx.

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

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

12.7. The monitoring instrumentation reading interval shall be daily (including weekends and holidays) 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;

a) during shoring wall installation,

b) during excavation,

c) at all times when the excavation is in an open condition, and the shoring wall is under load,

d) during all stages of the work and,

e) until all the shoring wall is removed or excavated area is backfilled.

12.8. 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.

12.9. 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.

12.10. Visual monitoring (minimum twice daily for each day of the week) of the ground behind the shoring wall shall be performed. If any crack within or up-ward movement of, the soil is/are observed, a qualified Geotechnical Engineer shall visit the site to perform an inspection and 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.

12.11. Visual and surveyed monitoring of the track(s) (in accordance with section 13) 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.

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

12.13. 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 (and/or struts) on each selected pile(s),

c) At a mid-point between two consecutive levels of tie backs (and/or struts),

d) At the mid-point between the lowest tie-back (and/or strut) and excavation elevation.

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

12.15. 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.

12.16. 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.

12.17. 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.

12.18. 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.

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

12.20. 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.

12.21. Required graph(s) shall include review and alert threshold limits.

12.22. The monitoring report shall clearly show:

a) The actual collected data (date, target #, pile #, northing, easting, elevation, actual lateral and vertical movements, etc.)

b) A graphical representation of the lateral displacement of targets placed along the selected piles, the unit shall be in milimetre, mm.

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

13. GROUND, TRACK AND STRUCTURE MOVEMENT MONITORING

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

13.1. Monitoring of movements of ground (settlement/ heave), for tracks, shoring and existing structures (including bridges) 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 monitoring plan for movements of ground (settlement/ heave), tracks, shoring and existing structures (including bridges), 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, pipe ramming, HDD, MHDD and tunneling work; monitor tracks with in-ground monitoring instruments and rail surface monitoring points at 4.0 m (max) center to center. Deep in-ground monitoring points shall be installed along the alignments of jack-and-bore, HDD, MHDD and tunnels at 4.0 m (max) centre to centre. The in-ground rods shall extend to a depth of 1.0 m (39 in) above the proposed alignment. Track support forces shall be on standby to address any track settlement issues.

a) HDD denotes Horizontal Directional Drilling (or Horizontal Auger Drilling)

b) MHDD denotes Micro Horizontal Directional Drilling (or Microtunneling)

13.7. The monitoring points for bridge substructures (abutment, pier, wingwall, etc.) shall consist of surface monitoring points (installed at the top and bottom of substructure elements with intermediate monitoring points spaced at 3m max intervals both vertically and horizontally), and any other monitoring instrumentation deemed necessary by the Geotechnical Engineer to adequately monitor the bridge structure based on their subsurface investigation.

13.8. A reference drawing showing location and general arrangement of the ground movement monitoring points is required for review and acceptance by METROLINX or METROLINX representative.

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

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

Railway Tracks

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

Bridge Substructure

Class of Track	Allowable Limits (mm)		Review Limits (mm)		Alarm Limits (mm)	
	Horiz.	Elev.	Horiz.	Elev.	Horiz.	Elev.
Any	0 to <2	0 to <2	2 to <3	2 to <3	3	3

a) In the absence of any analysis to the contrary, the above deflection/displacement criteria shall apply.

b) In all cases where work is planned, the Consultant shall undertake an analysis of the structure to determine structure specific deflection/displacement criteria.

c) Notwithstanding the bridge substructure deflection/displacement criteria, the criteria for railway track deflection/displacement shall apply.

d) 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.

e) 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.

f) 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. No construction work shall take place until instructed by a qualified and competent Geotechnical Engineer and Metrolinx or Metrolinx representative subsequent to the following conditions being satisfied:

- The cause of ground movement has been identified;
- A corrective / preventive plan is established and adopted;
- Any corrective and / or preventive measure deemed necessary is implemented;

13.11. 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, Metrolinx Track and Structures will request emergency protection, to ensure the safety of rail traffic.

13.12. Visual monitoring for movements of ground, tracks, shoring and existing structures 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.

13.13. Survey monitoring for movements of ground, tracks, shoring and existing structures shall be performed once a day during construction, boring, tunneling activities and when excavation is in an open condition.

13.14. Continuous monitoring (i.e. visual and/or survey and/or remote monitoring, based on Geotechnical Engineer's recommendations) for

movements of ground, tracks, shoring and existing structures shall be performed during construction, boring, tunneling, grouting and other activities that may have a potential risk in impacting track safety and rail operations;

13.14.1. If there is any grouting operation being carried out to fill buried voided structures under or adjacent to railway tracks (ie. grouting of tunnels or other buried structures, grouting annular void between existing culvert and new liner insert, grouting under approach slabs, etc.) such that the work may result in potential build-up of fluid pressures during the grouting operation, then the following shall be exercised;

a) Engineer shall assess the work to be carried out and establish grouting pressures that will not impact ground, tracks or existing structures,

b) There shall be continuous monitoring of all infrastructure (i.e. ground, tracks or existing structures). If the monitoring program reveals that there is movement of any infrastructure, grout rising above ground or any other issues that may impact any infrastructure, then all work shall cease, and the Geotechnical Engineer shall provide recommendations to mitigate the issues.

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

a) once a day for 14 days,
b) then twice weekly for the next 30 days (i.e. month),
c) then once monthly for the three months,
d) 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

ENGINEERING & ASSET MANAGEMENT
METROLINX
Toronto, Ontario

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	-	Cancelled
C17i	-	Cancelled
C18i	-	Cancelled
C19i	-	Cancelled
C20i	-	Typical High Performance Expansion Joint
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	-	Cancelled
C17m	-	Cancelled
C18m	-	Cancelled
C19m	-	Cancelled
C20m	-	Typical High Performance Expansion Joint
F1m	-	Example of Typical Temporary Shoring Wall
F2m	-	Typical Tied-Back Wall Details, Shoring Wall
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
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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
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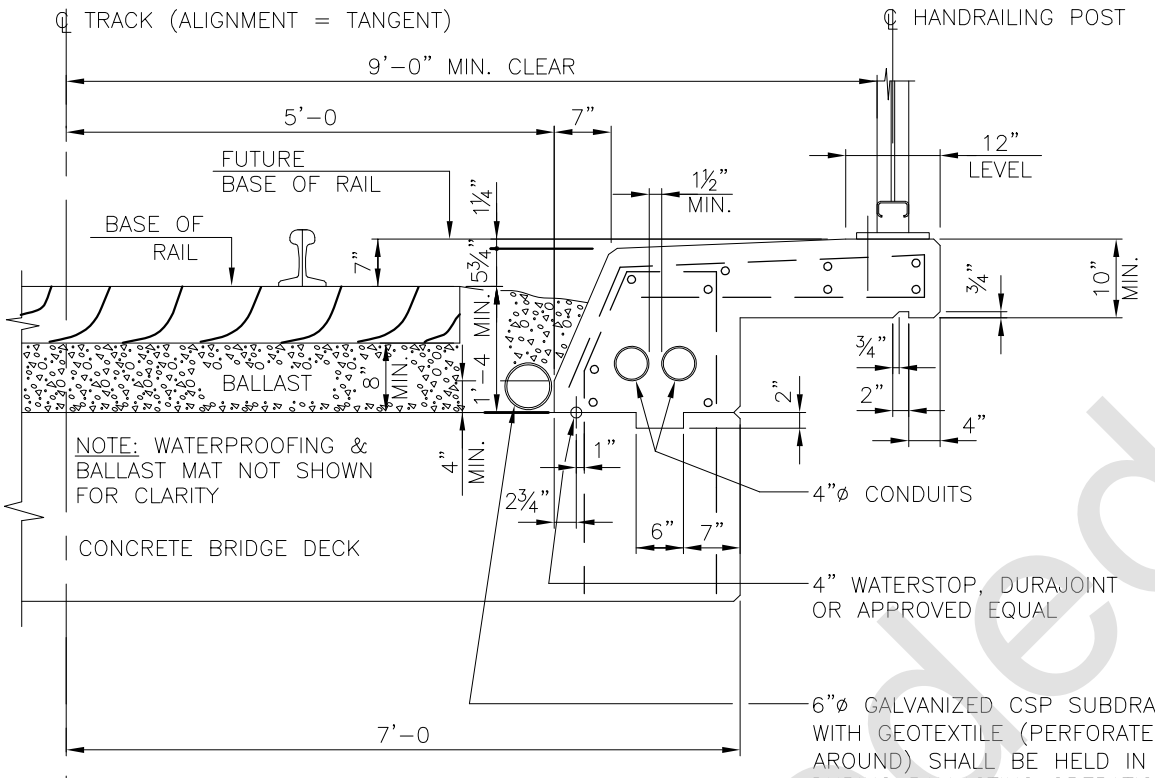
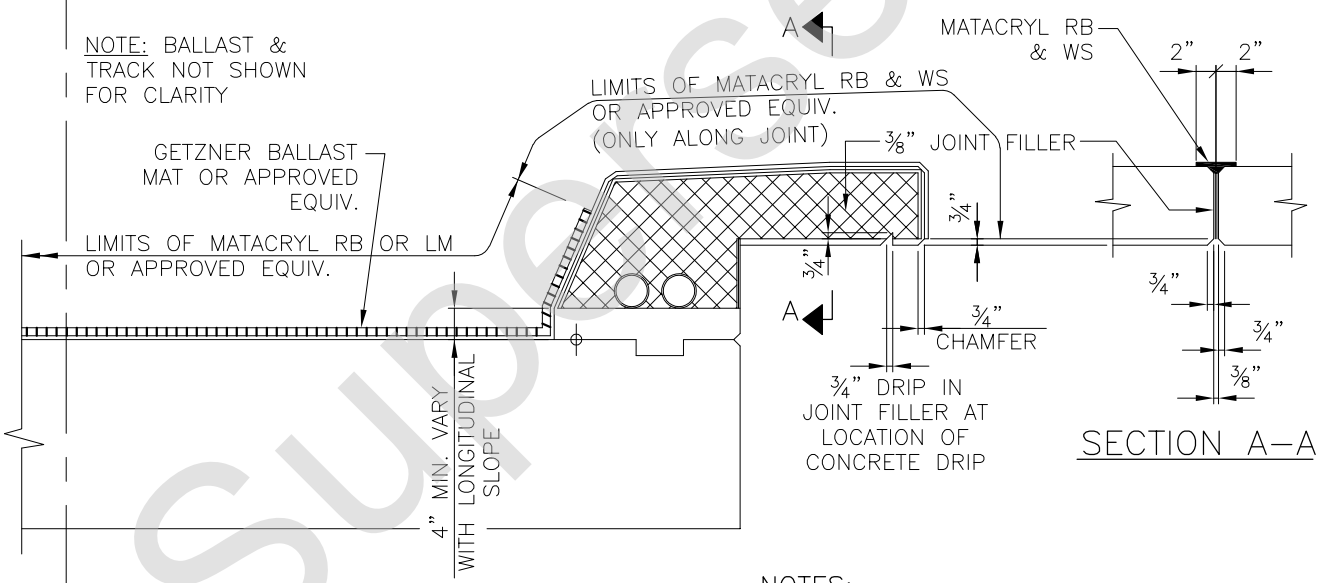
R7A-80.2m-1&2	-	Corrugated Steel Pipe (CSP) and Structural Plate Corrugated Steel Pipe (SPCSP) Culverts (2 Sheets)
R1S-1m	-	Standard Instruction for Dating Concrete Structures
TD-05-Lm	-	Location for Bridge Name Plate

NOTES



PARTIAL DECK SECTION



SECTION A–A

PARTIAL DECK WITH WATERPROOFING AT JOINT

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

NOTES:

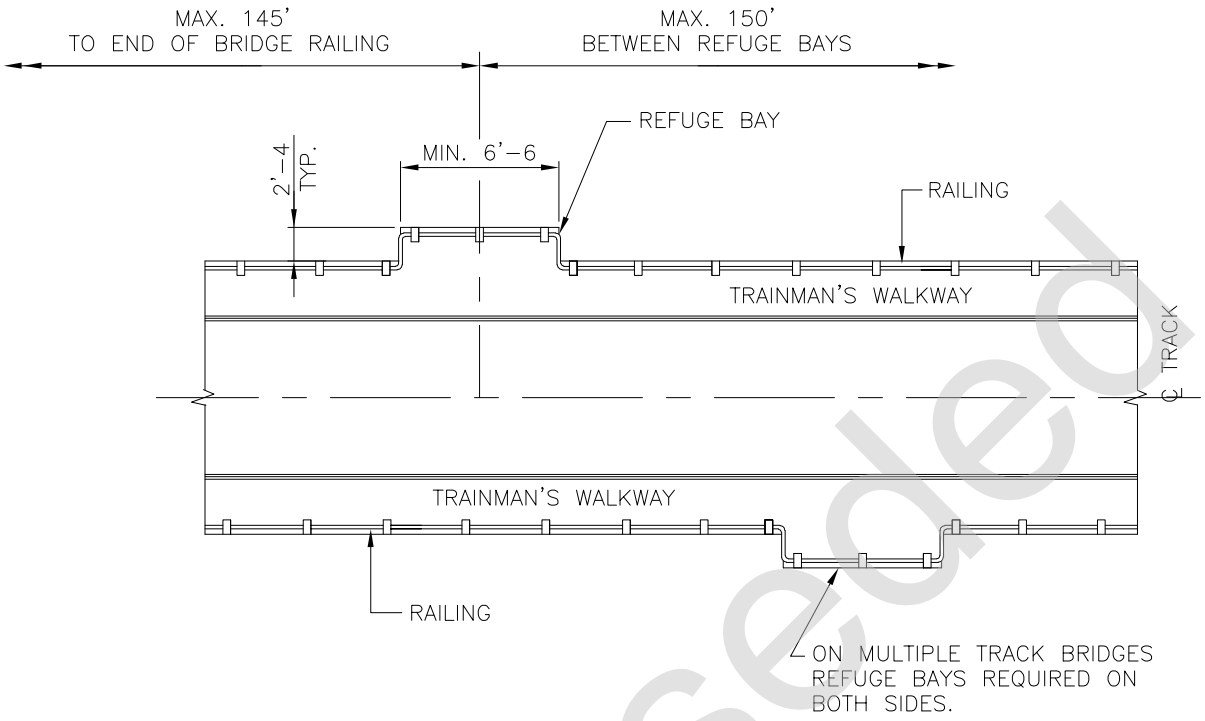
- SPACING OF TRANSVERSE JOINTS IN CURB SHALL NOT EXCEED 11'–6
- LONGITUDINAL SLOPE OF 0.5% MIN.
- FOR TRANSVERSE SLOPE (SEE METROLINX GENERAL GUIDELINES FOR RAILWAY BRIDGES & STRUCTURES)

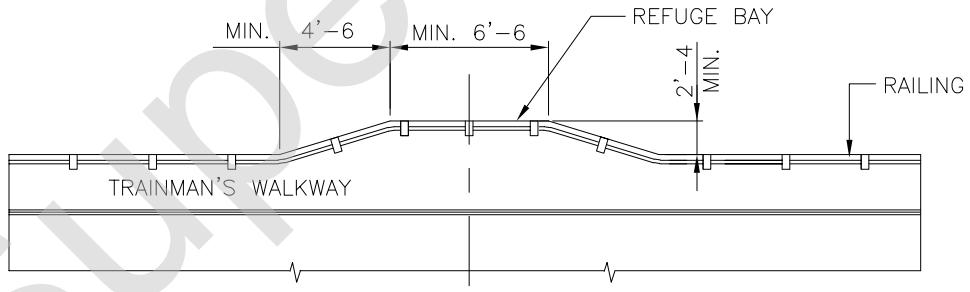
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CAST-IN-PLACE CONCRETE BRIDGE DECK DETAILS**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

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

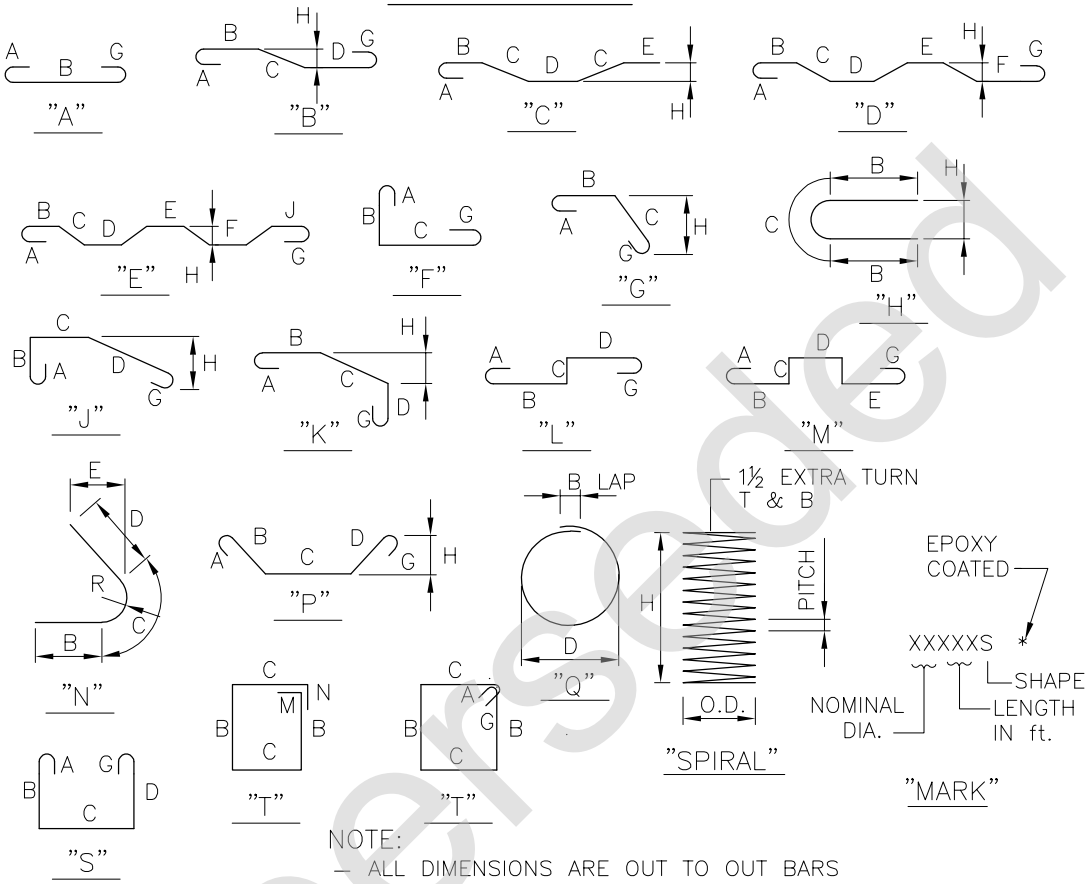
C6i

-

BAR LIST EXAMPLE

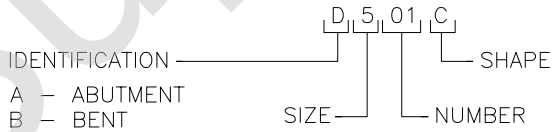
QTY.	SIZE	MARK	LENGTH	A	B	C	D	E	F	G	H	R
50	#5	D5001C	16'–0	0'–8	2'–0	0'–11	6'–6	4'–4			0'–8	

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



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

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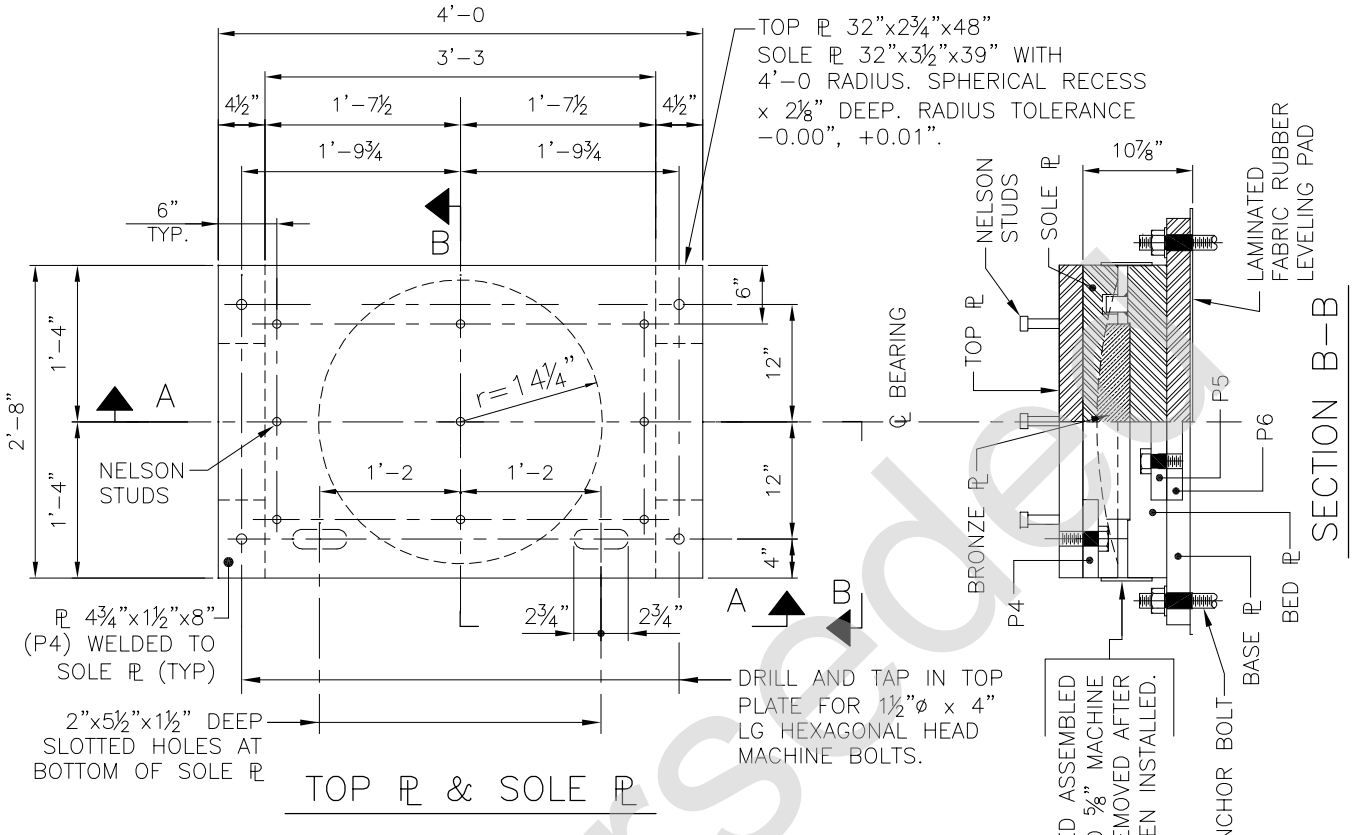
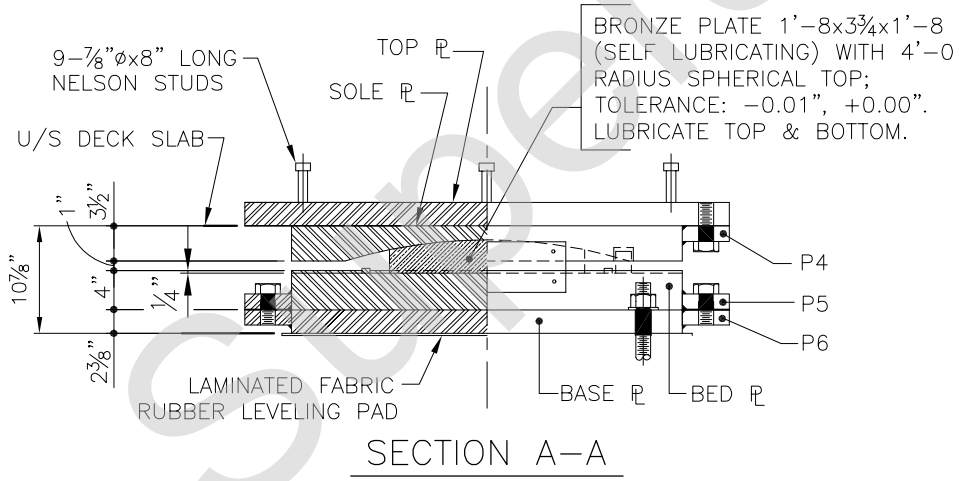
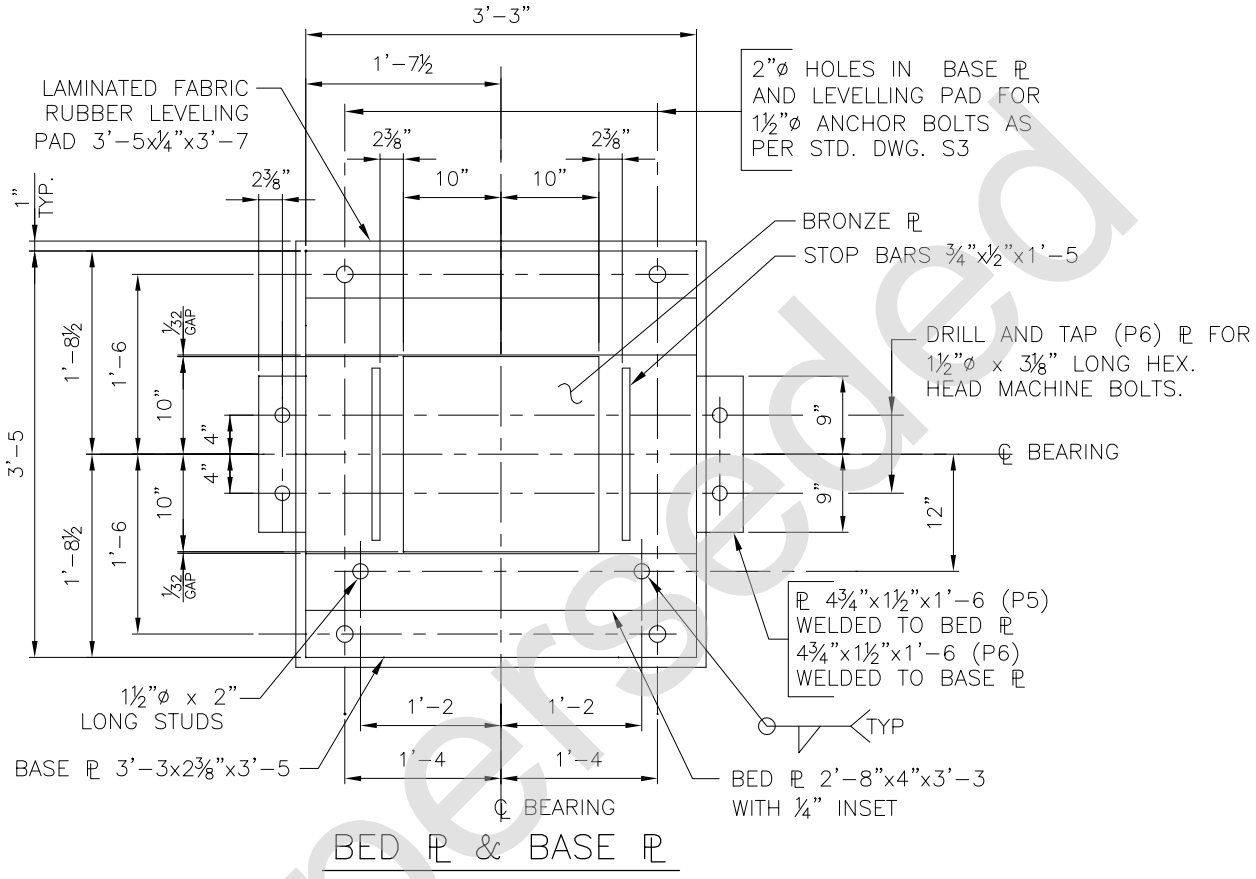




Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BRONZE BEARINGS - EXAMPLE OF AN EXPANSION BEARING FOR A CONCRETE SPAN BRIDGE** SHEET 1 OF 2	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero
C9i-1

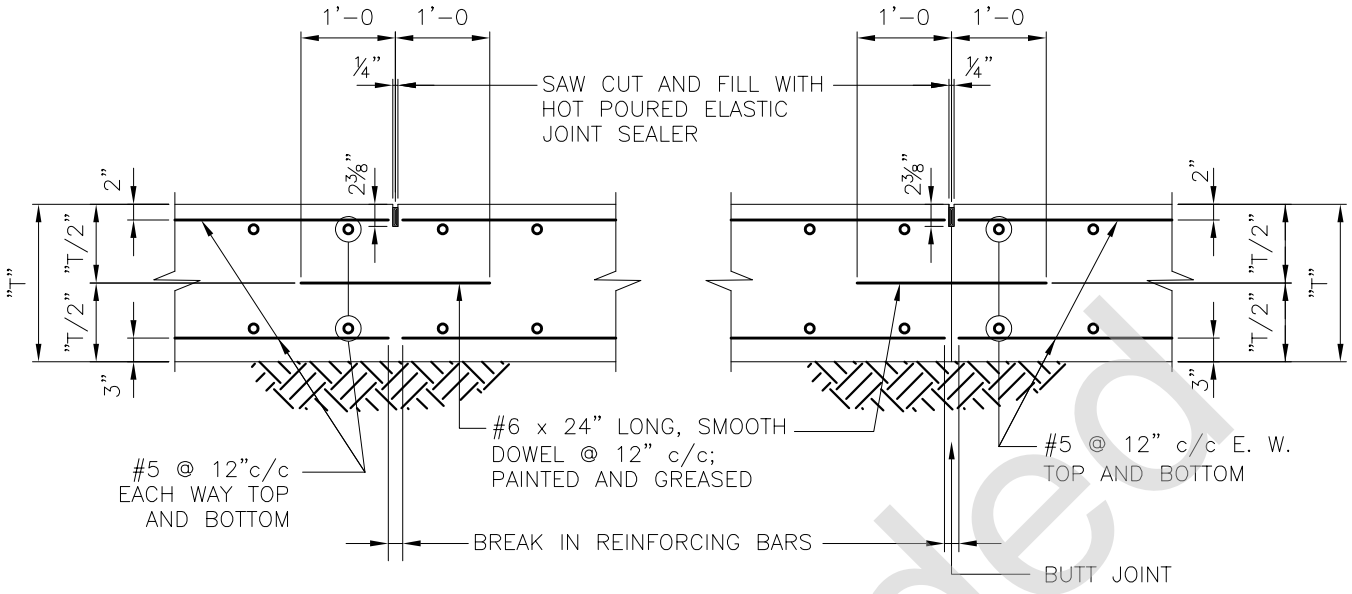


BED ℄ & BASE ℄

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		

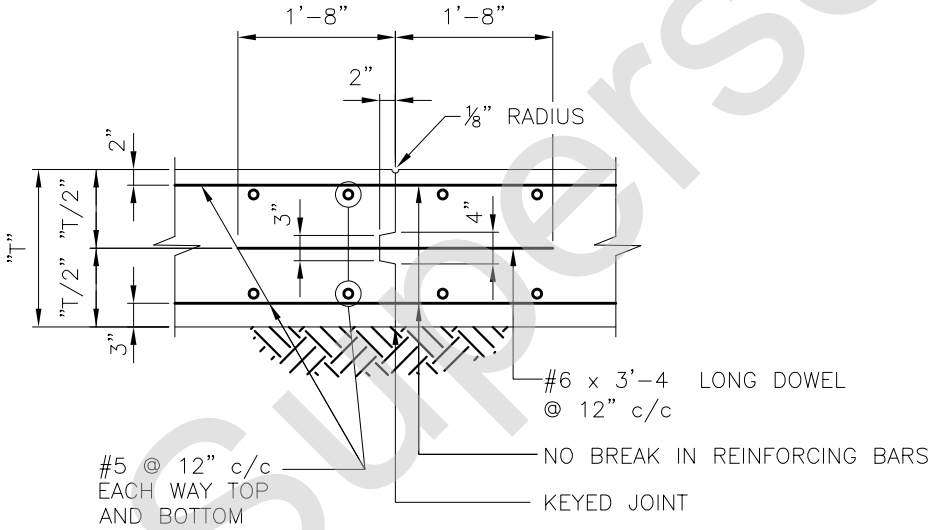
METROLINX

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

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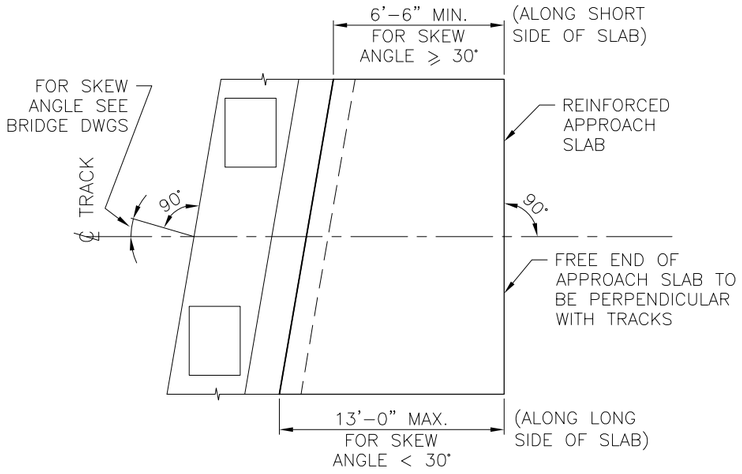
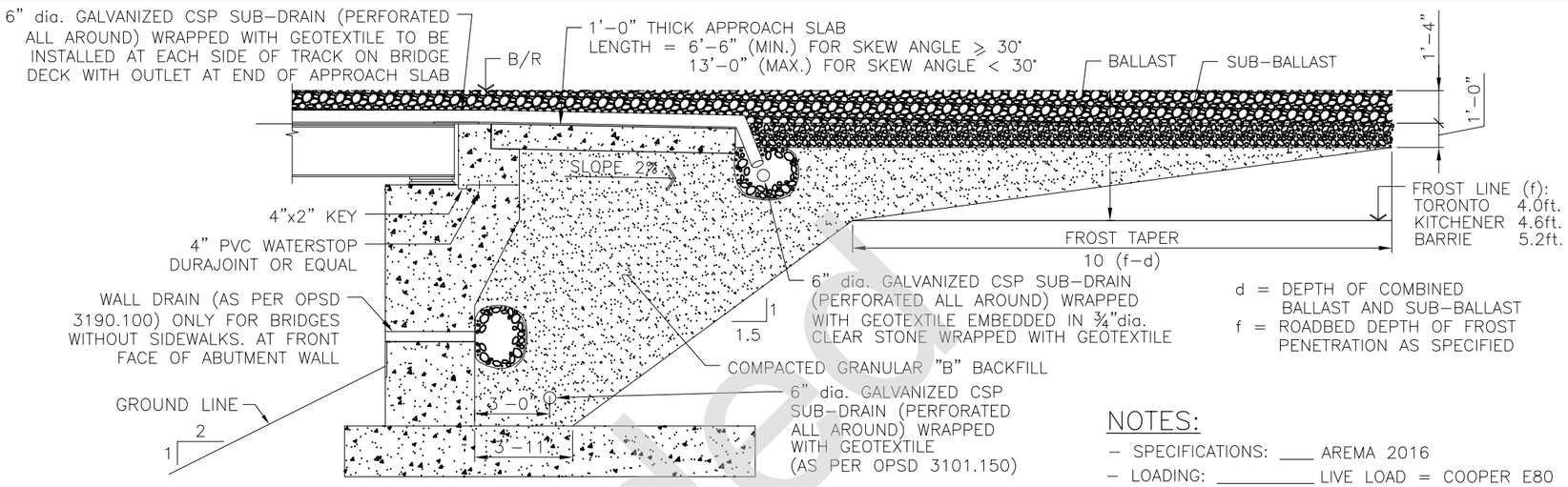
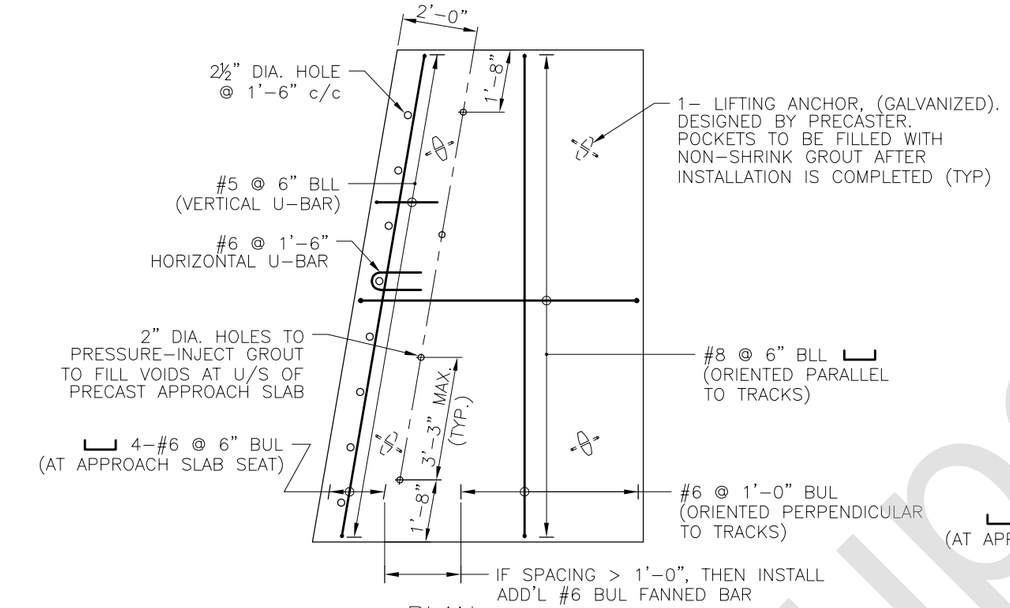


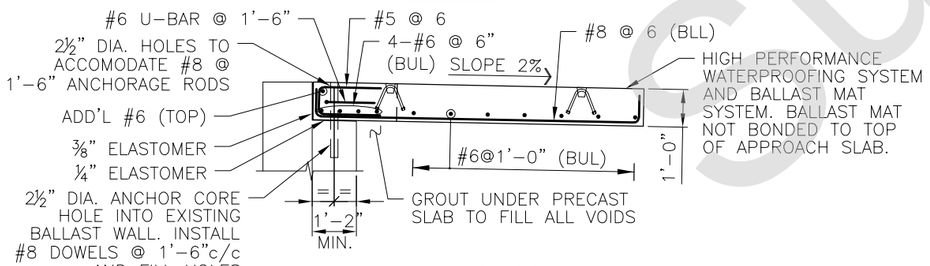
PLAN



MIN. GRANULAR BACKFILL REQUIREMENTS

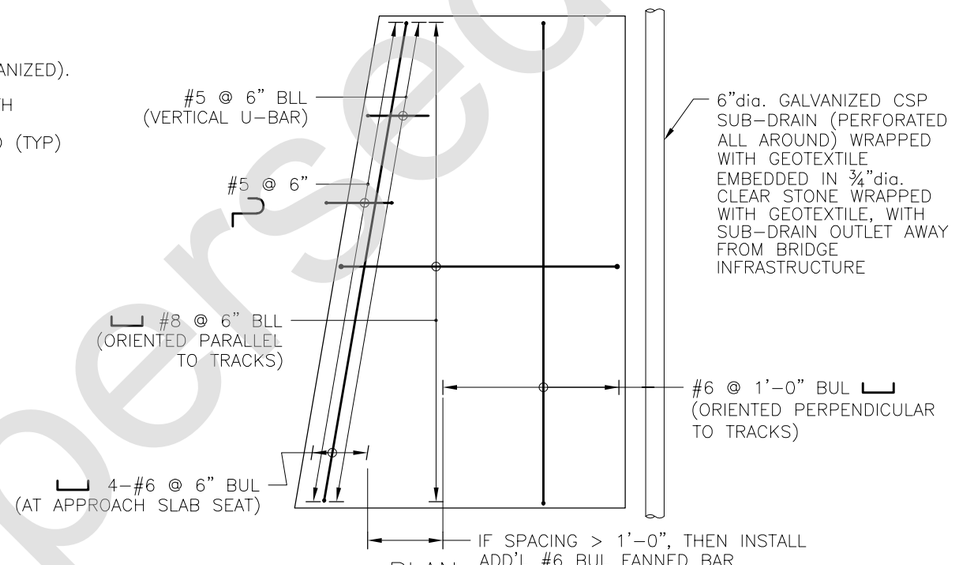


PLAN

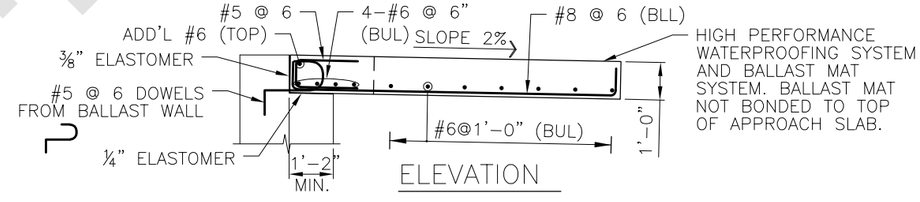


ELEVATION

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:

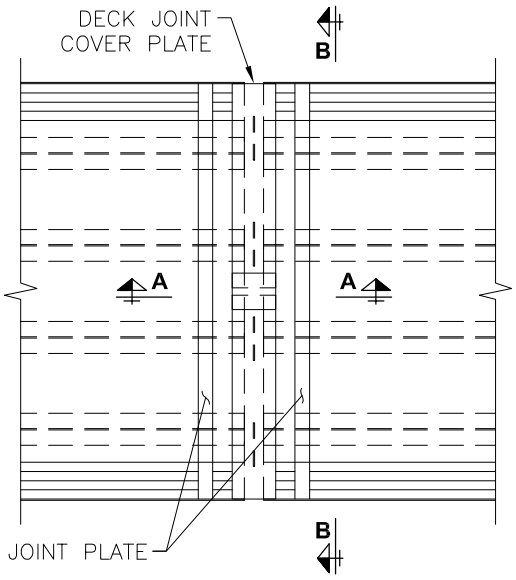
BLL – BOTTOM LOWER LAYER
BUL – BOTTOM UPPER LAYER
ADD'L – ADDITIONAL
TYP – TYPICAL

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

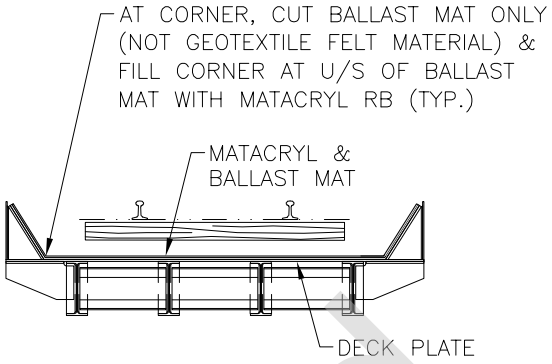
RAILWAY BRIDGE
APPROACH SLAB

METROLINX

Drawing Number
Dessin Numero
C15i

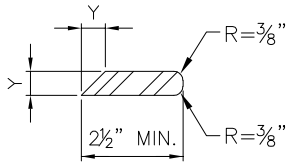


STEEL BALLAST PAN PLAN VIEW

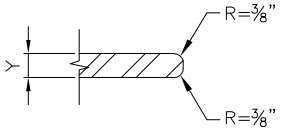


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 1"

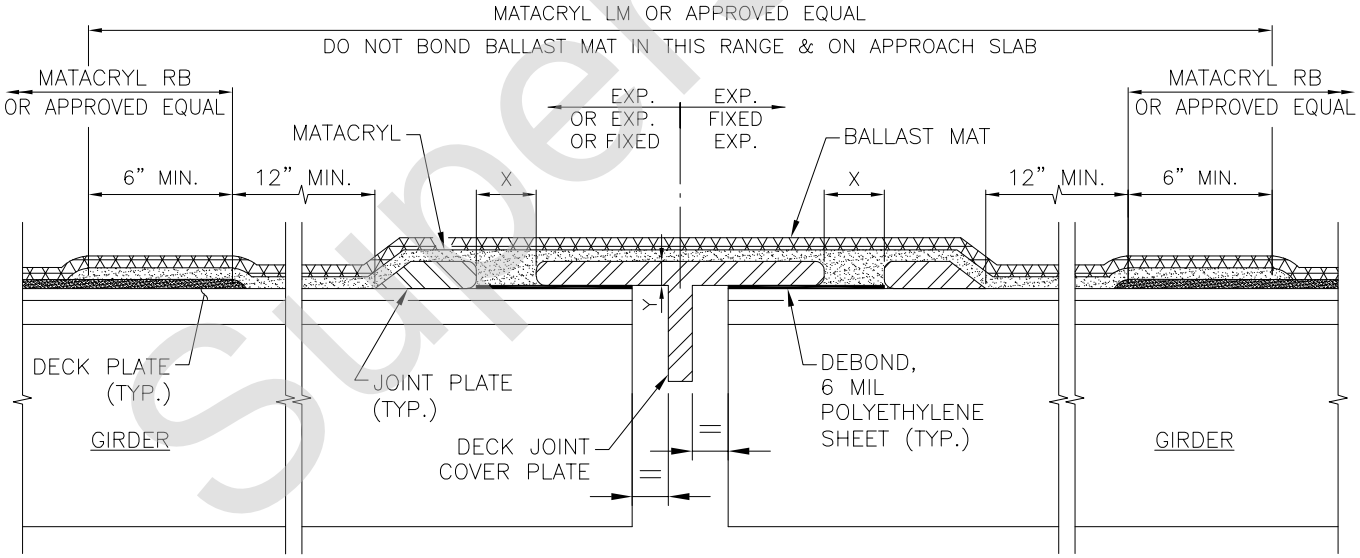


JOINT PLATE DETAIL



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 ℄



SECTION A–A
(SCHEMATIC)

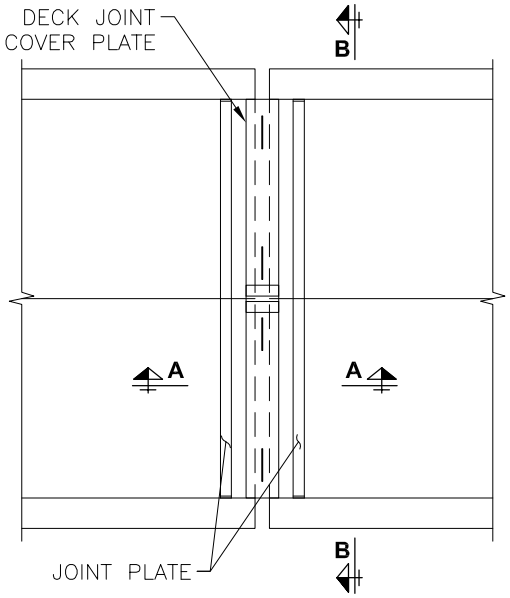
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

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

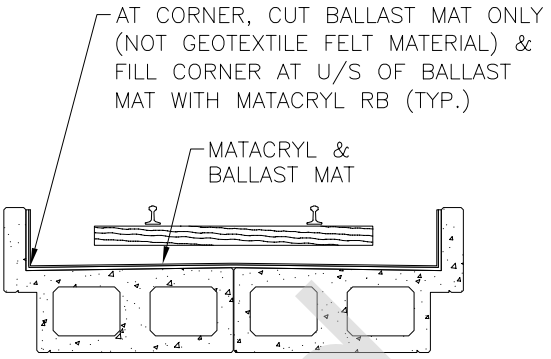
METROLINX

Drawing Number
Dessin Numero
C16i

–

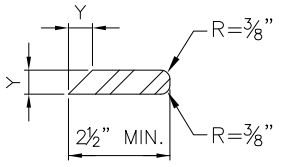


CONCRETE PAN PLAN VIEW

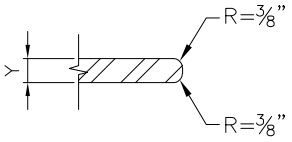


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 1"

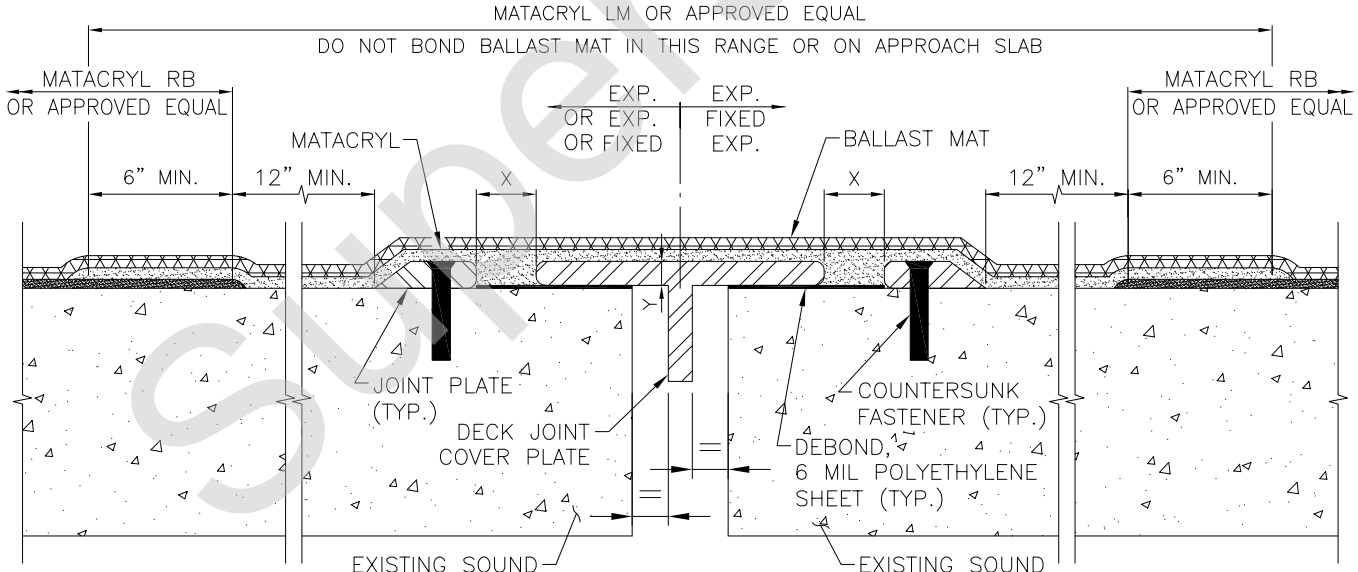


JOINT PLATE DETAIL



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 ℄



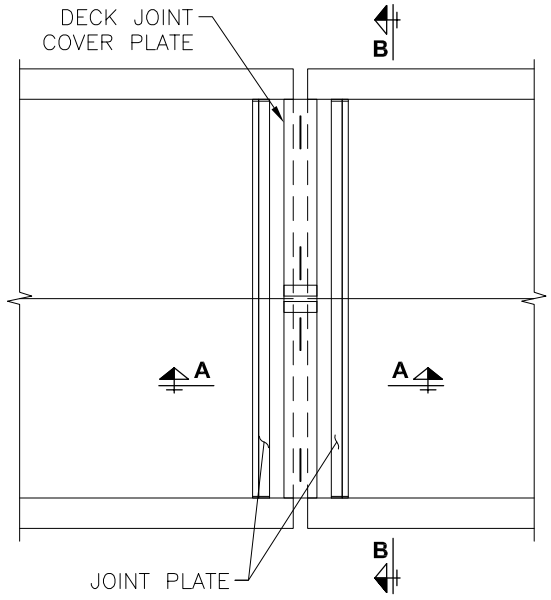
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

SECTION A–A
(SCHEMATIC)

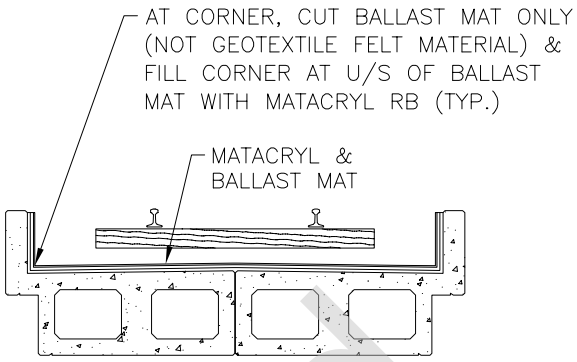
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT NEW OR EXISTING (SOUND) CONCRETE**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero
C17i

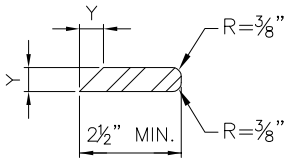


CONCRETE PAN PLAN VIEW

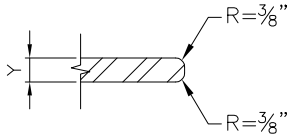


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 1"

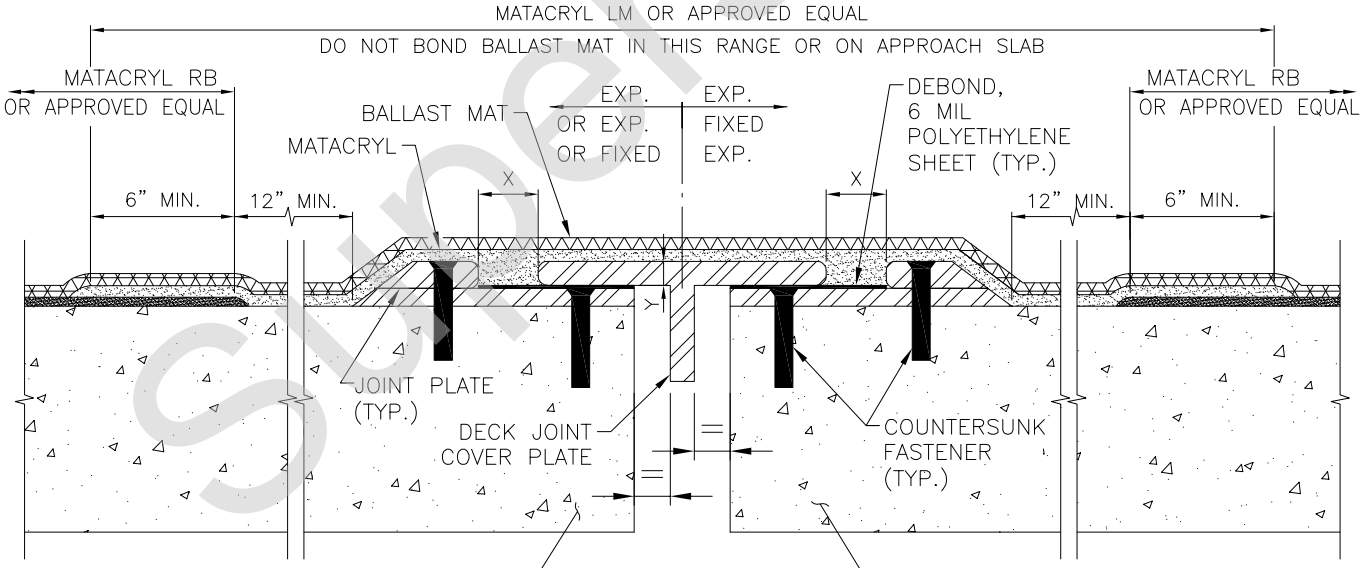


JOINT PLATE DETAIL



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 ℄



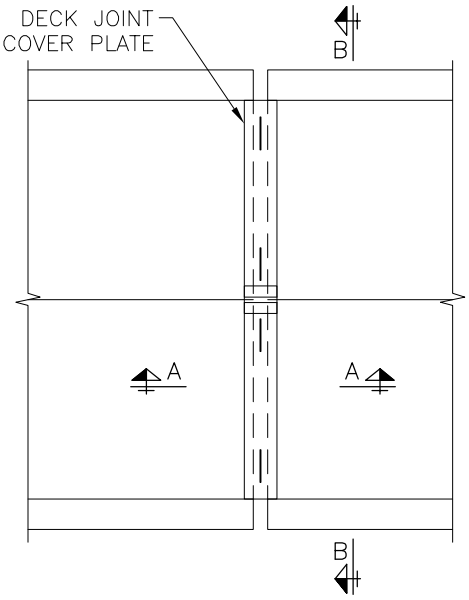
SECTION A–A
(SCHEMATIC)

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

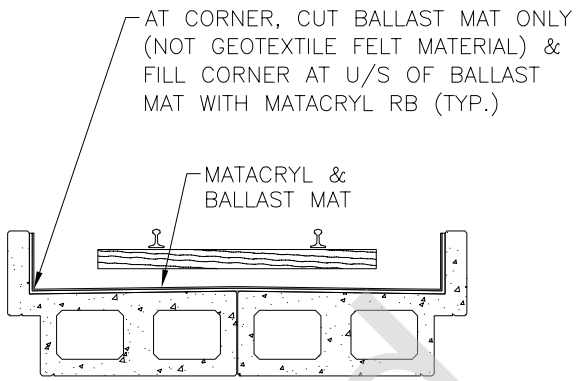
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT EXISTING (POOR) CONCRETE**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero
C18i

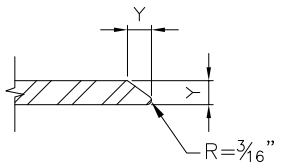


CONCRETE PAN PLAN VIEW



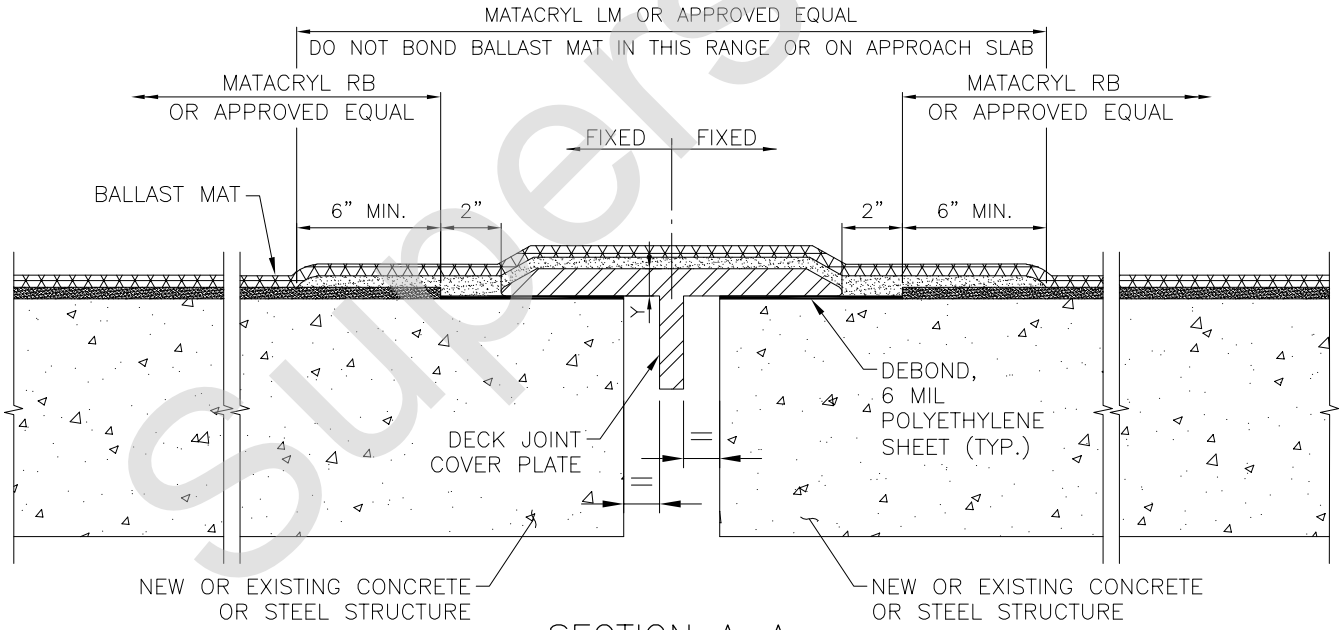
SECTION B–B

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)

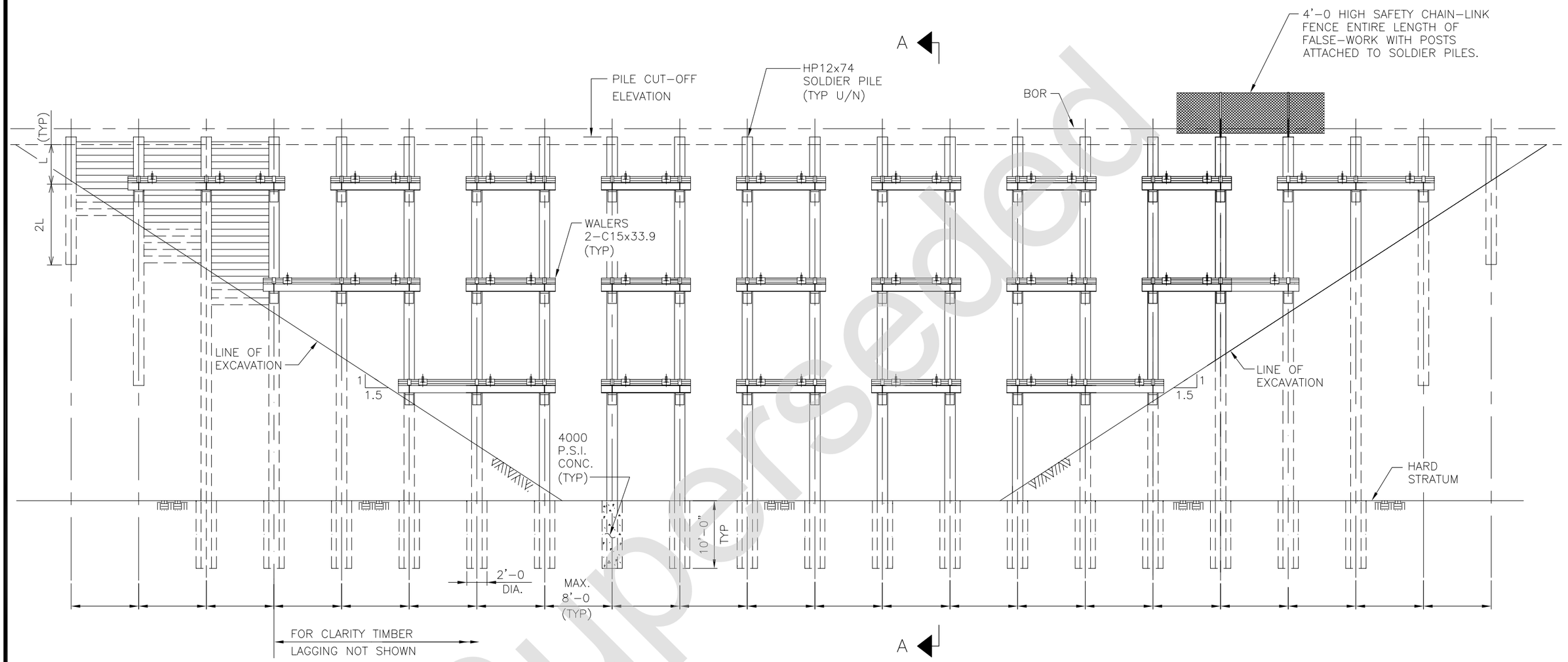
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

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:

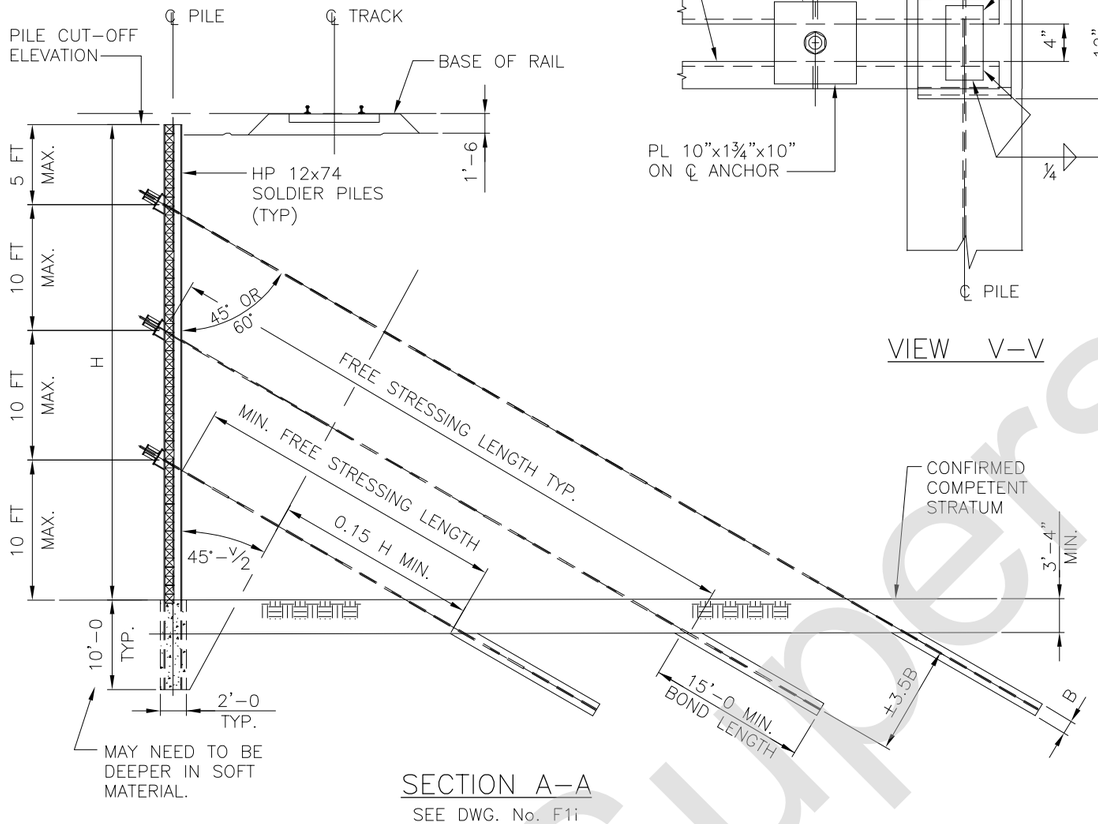
–SOCKET LENGTH MAY VARY ACCORDING TO SOIL TYPE

–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.

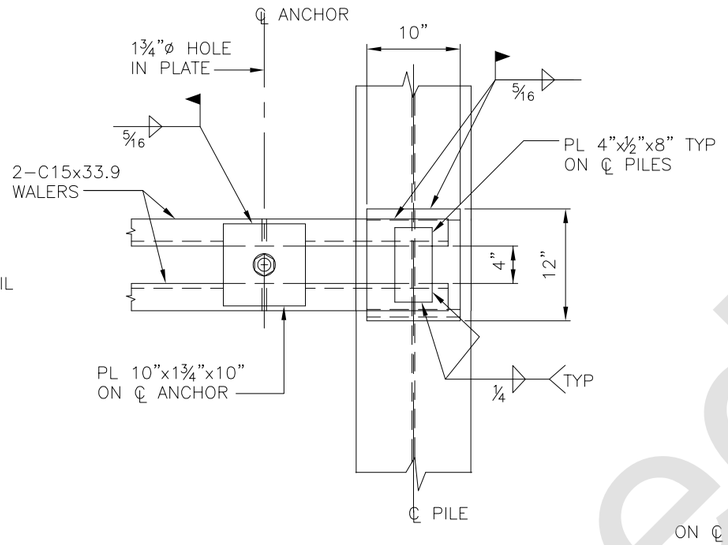
–SEE DWG. F–3 FOR MATERIAL SPECIFICATIONS.

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**	–

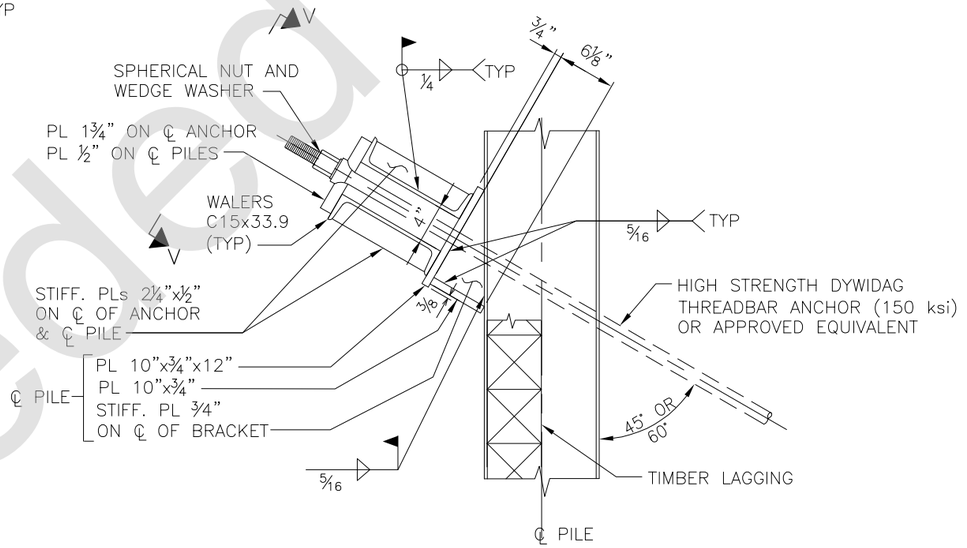


SECTION A–A

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)

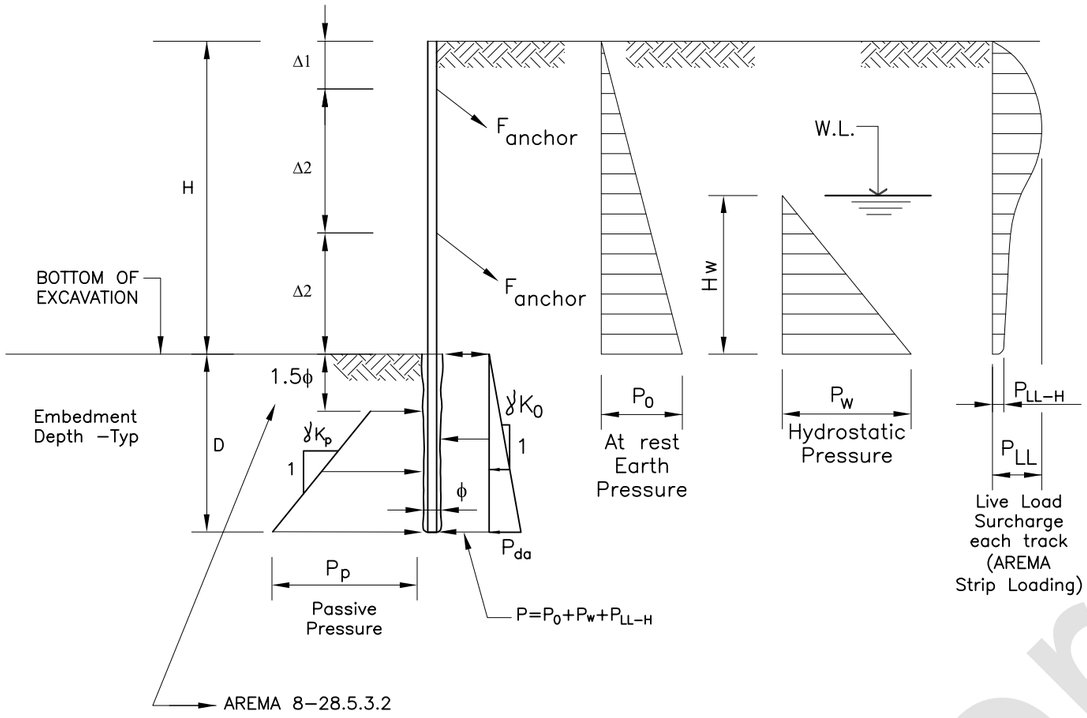
–LOCK–OFF LOAD = 1.10 x DESIGN LOAD

–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:
- γ_{soil} = 133.68 lb/ft^3
- γ_w = 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).

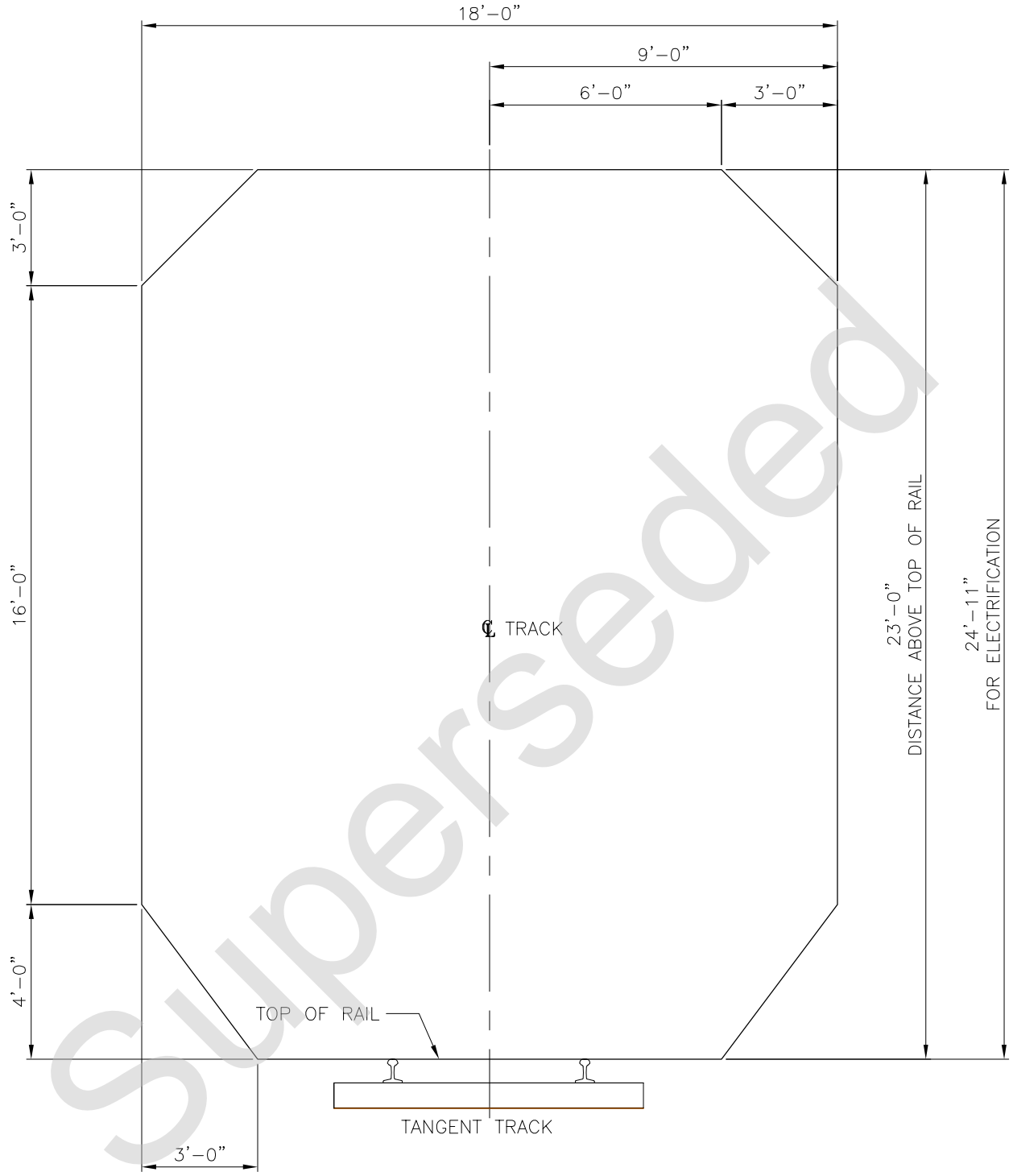
BOUSSINESQ METHOD

–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**



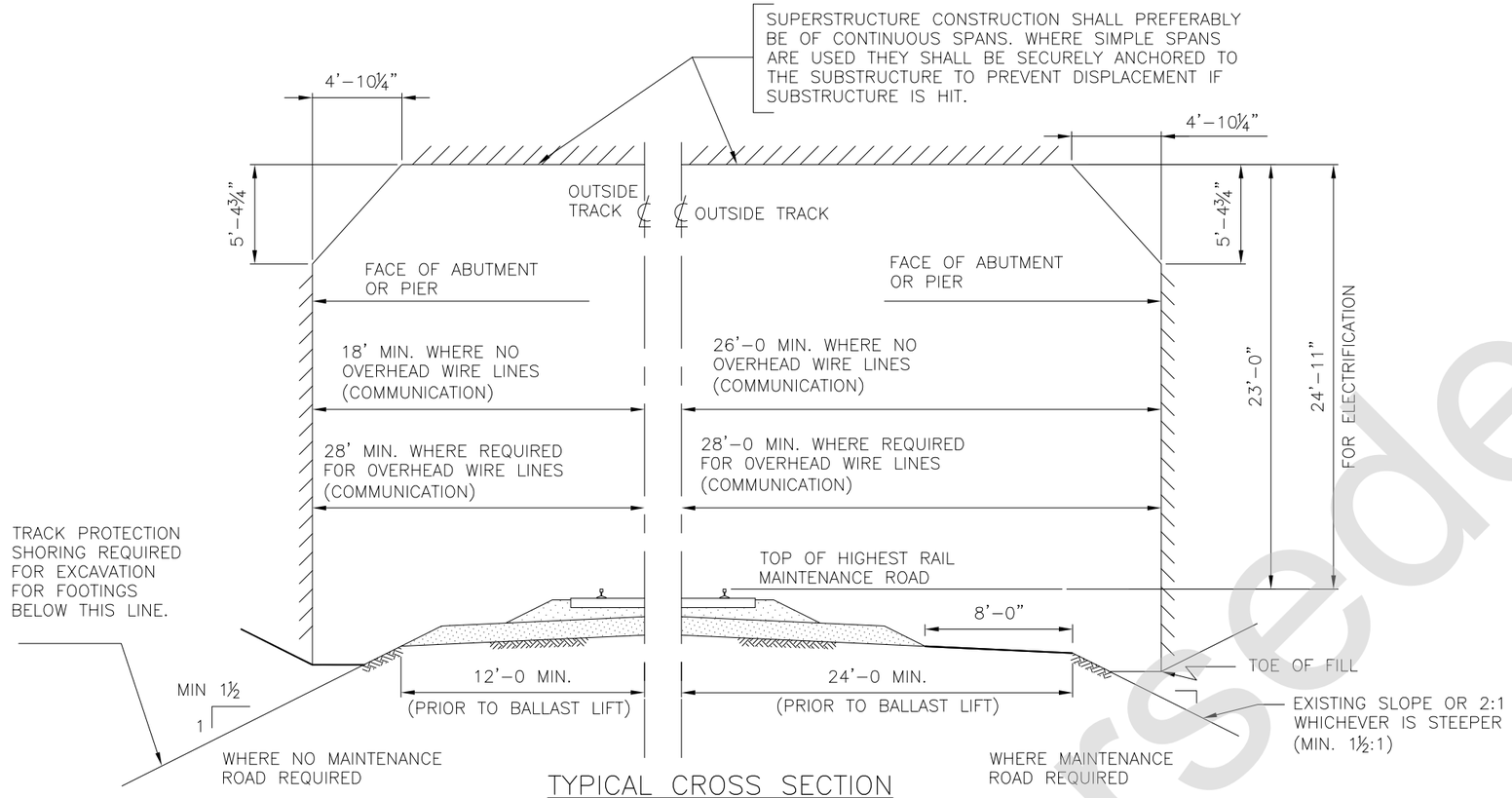
NOTE: SEE ARTICLE 1.2.6a FOR CURVE CORRECTIONS.
AREMA MANUEL FOR RAILWAY ENGINEERING – CHAPTER 15

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	

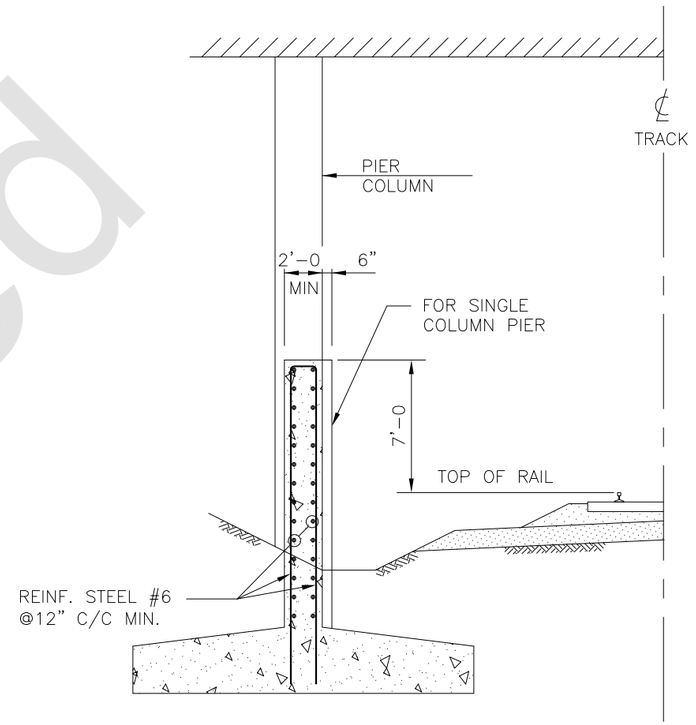
METROLINX

Drawing Number
Dessin Numero

K1U-10.1i –



TYPICAL CROSS SECTION



PROTECTION WALL DETAIL

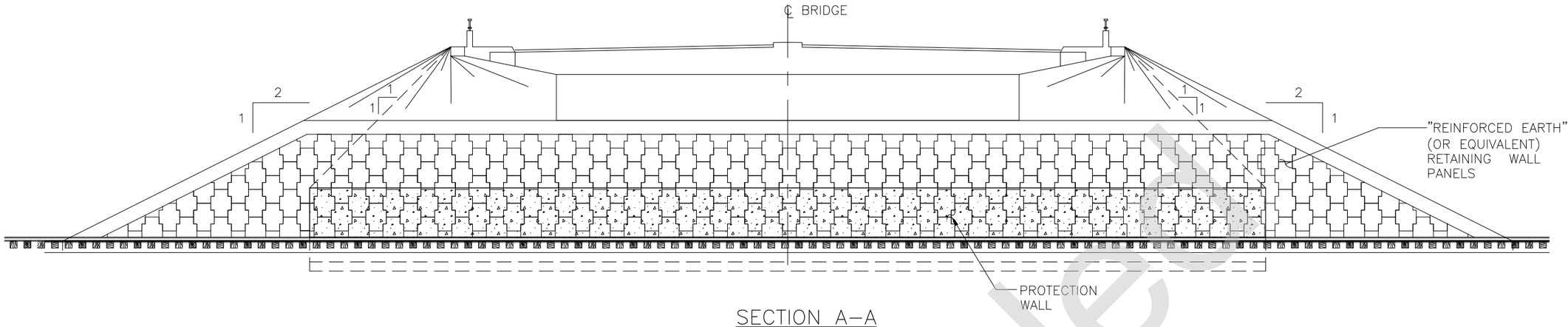
NOTES

- 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.

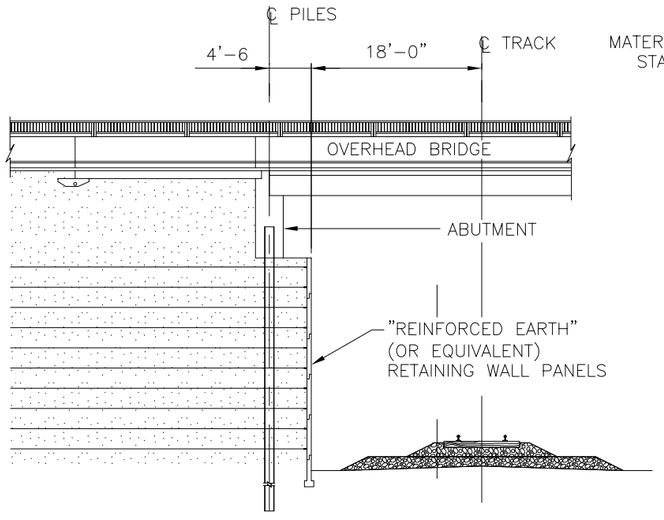
PIER PROTECTION

- 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.

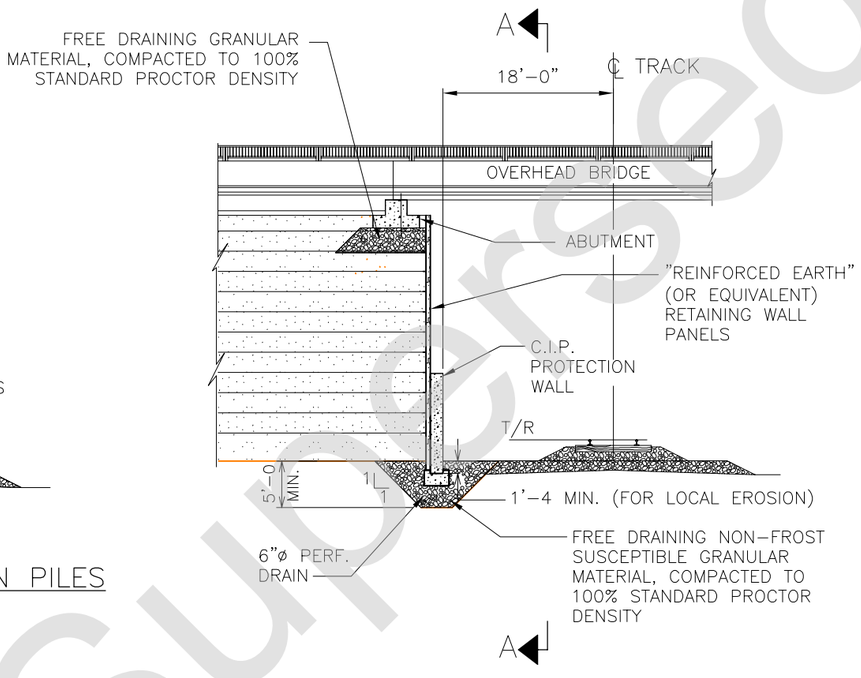
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**PROTECTION AND MINIMUM CLEARANCES FOR OVERHEAD BRIDGES**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero	**K1U-10.2i** –



SECTION A–A



TYPICAL SECTION FOR ABUTMENTS ON PILES

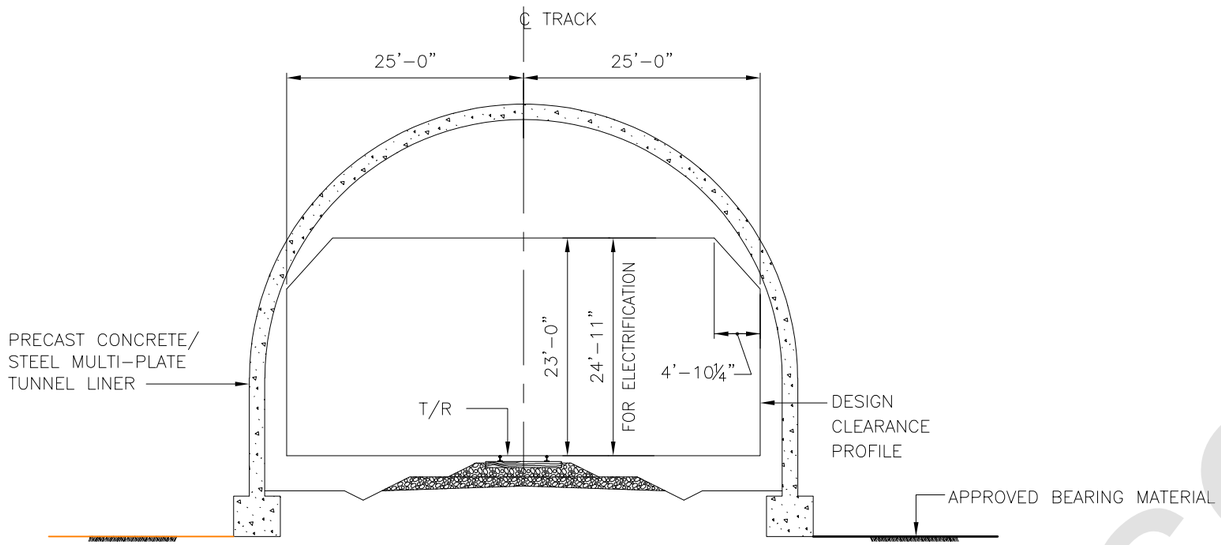


TYPICAL SECTION FOR ABUTMENTS ON GRANULAR BASE

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** –



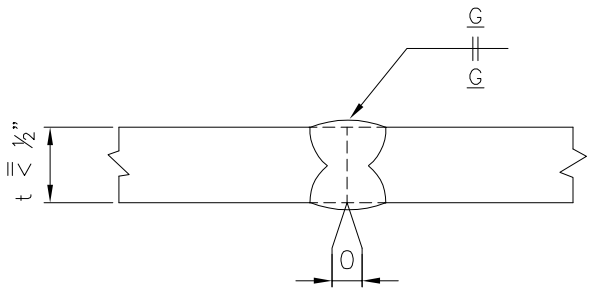
TYPICAL TUNNEL SECTION

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

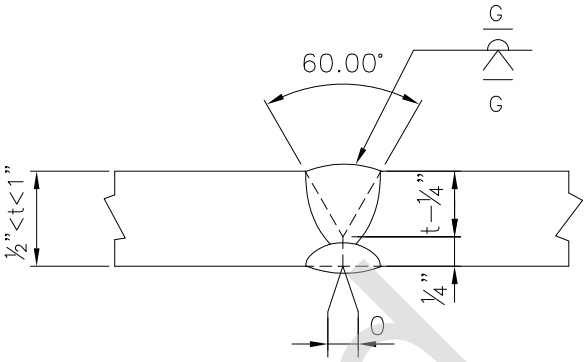
NOTES:

- 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**	–



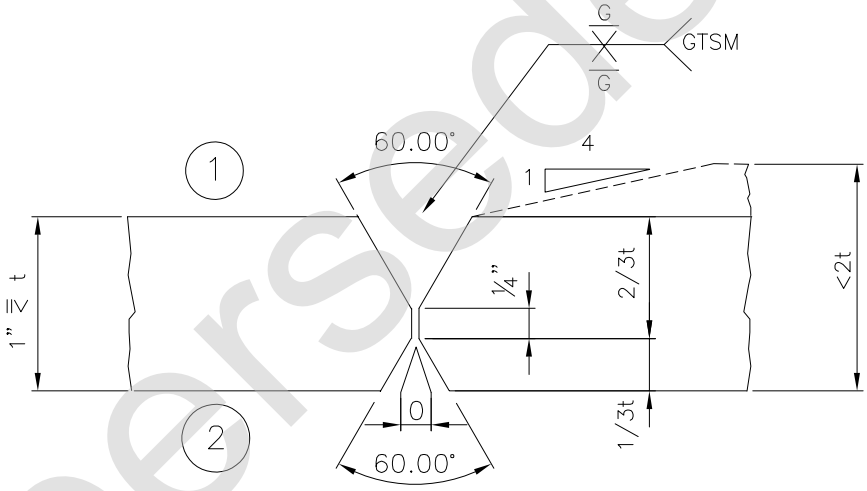
PLATES OF EQUAL THICKNESSES



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

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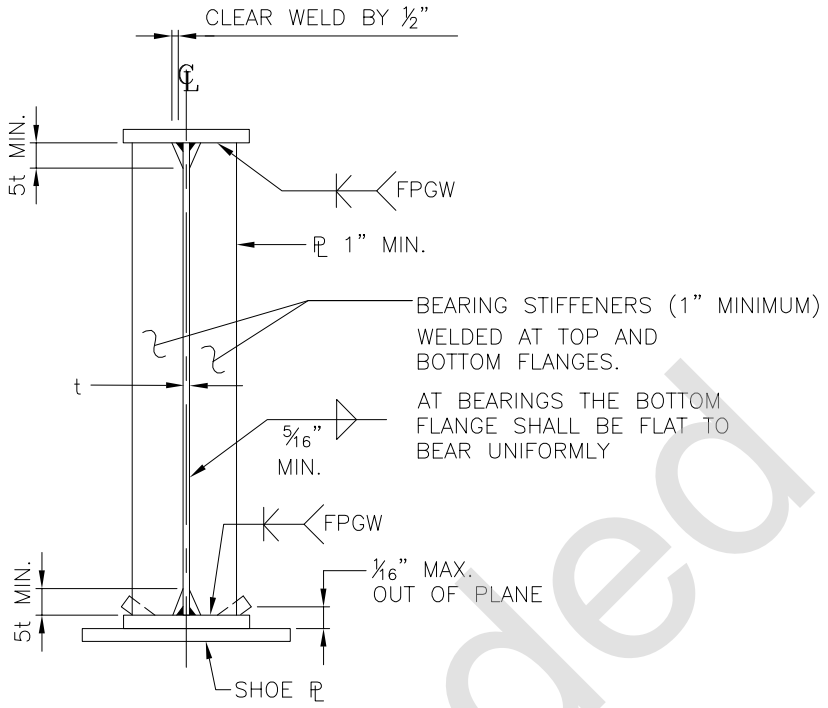
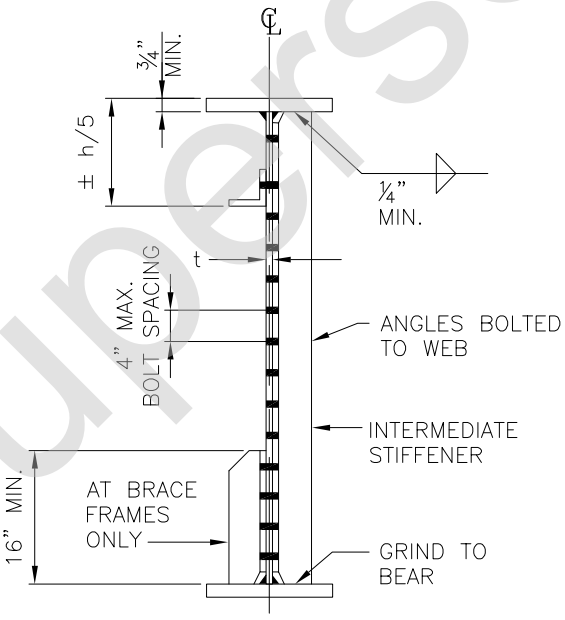


BEARING STIFFENER

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

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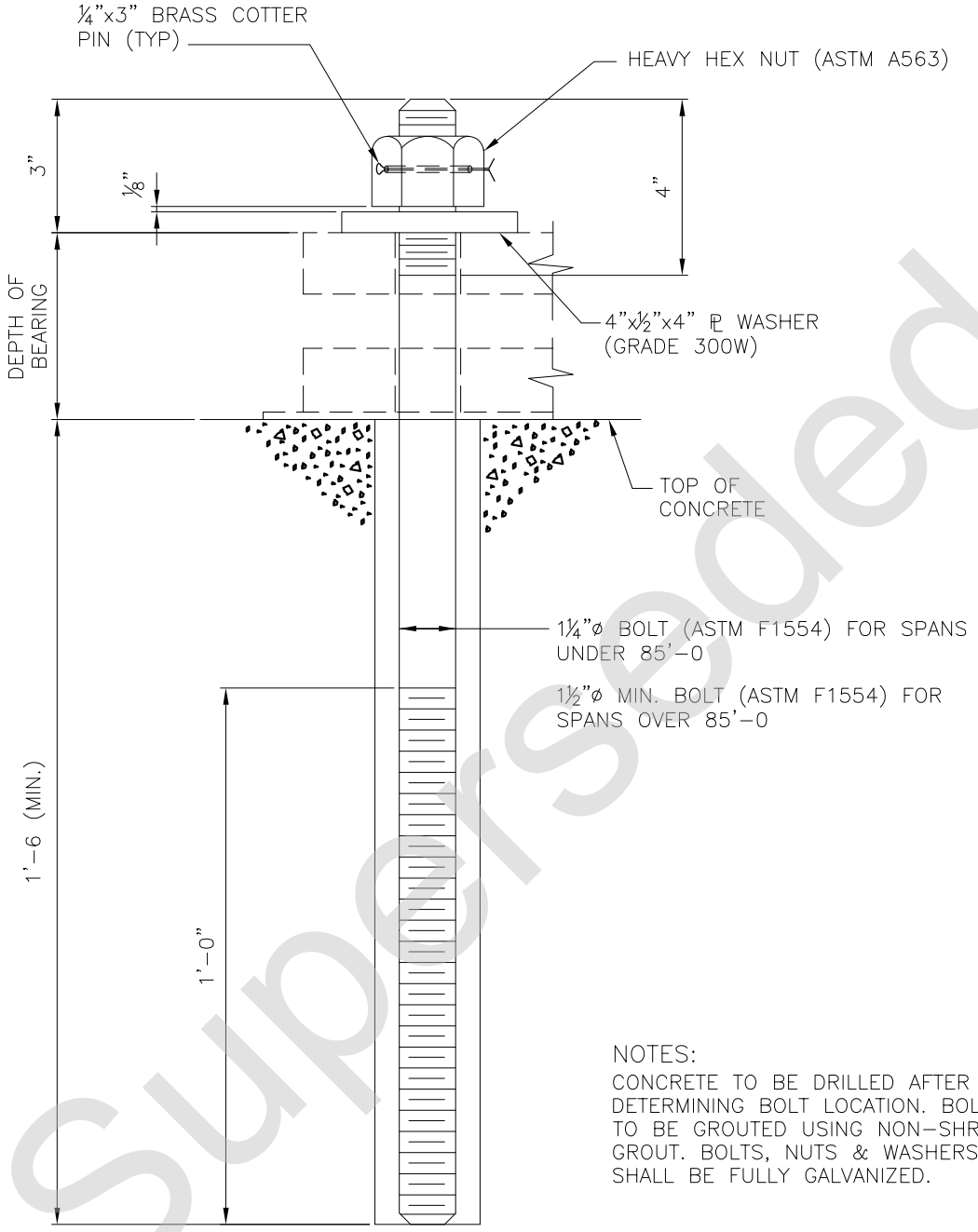

NOTES:

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

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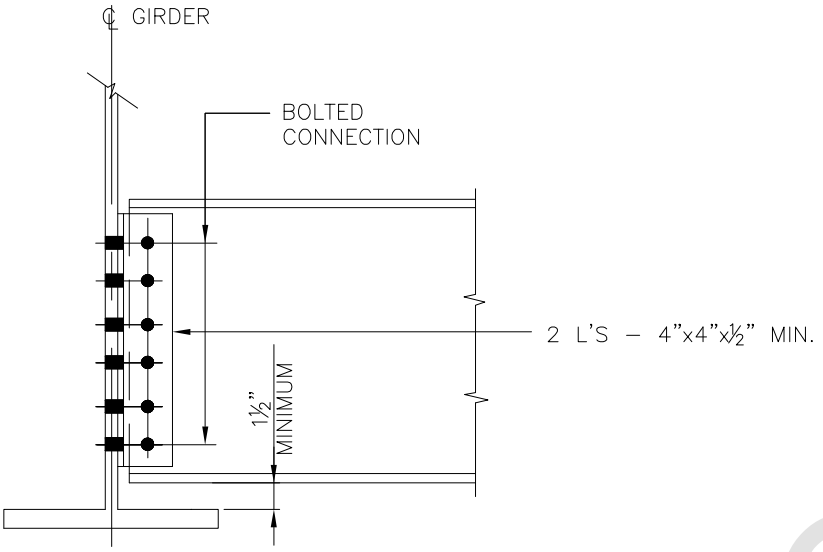
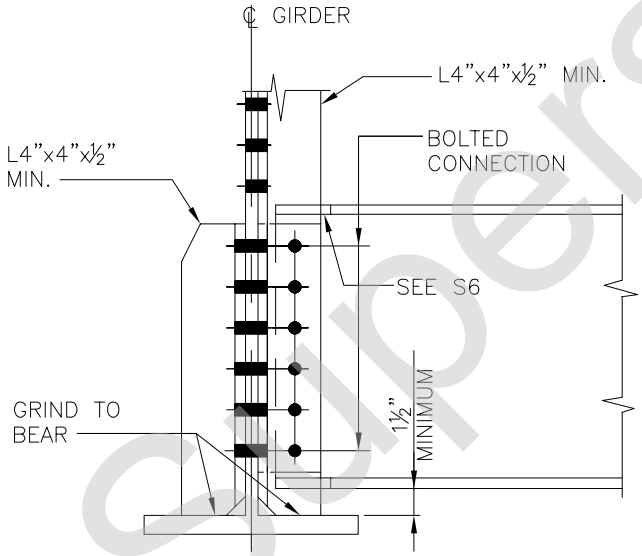


FLOOR BEAM TO GIRDER WEB



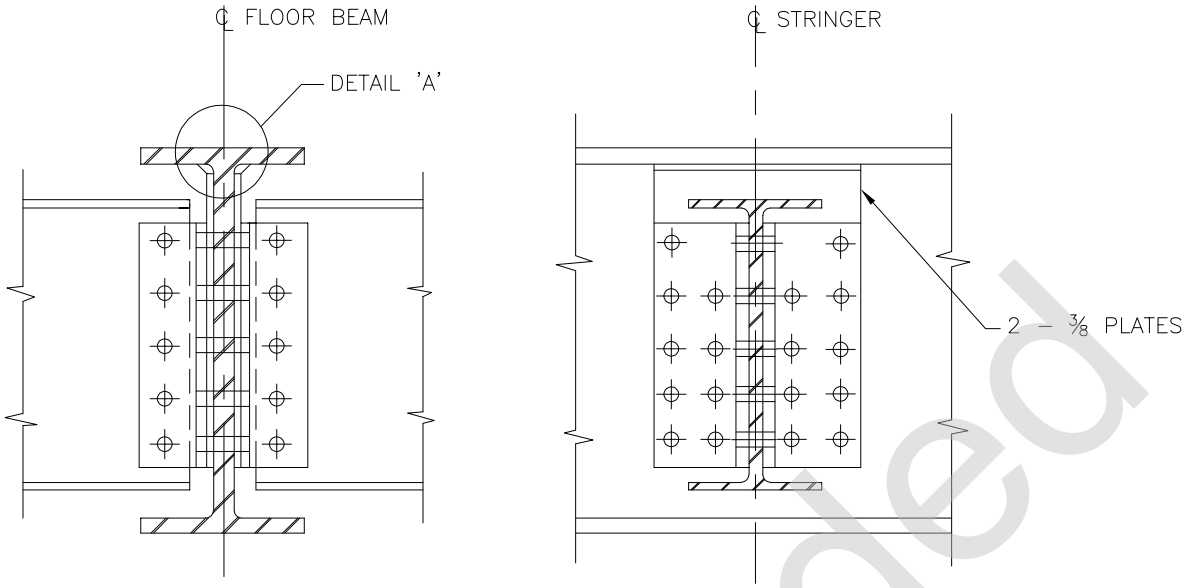
NOTE
THESE ARE DIAGRAMATIC SKETCHES. THE CONTRACTOR SHALL DESIGN THE CONECTIONS AND SUBMIT FOR RAIL CORRIDORS REVIEW.

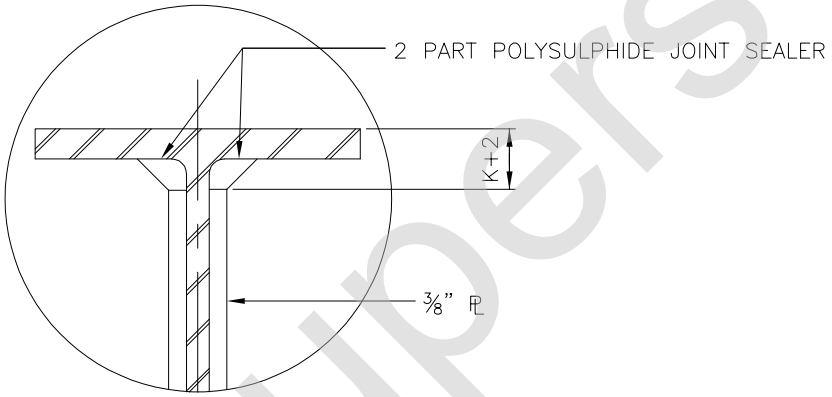
FLOOR BEAM TO GIRDER STIFFENER

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

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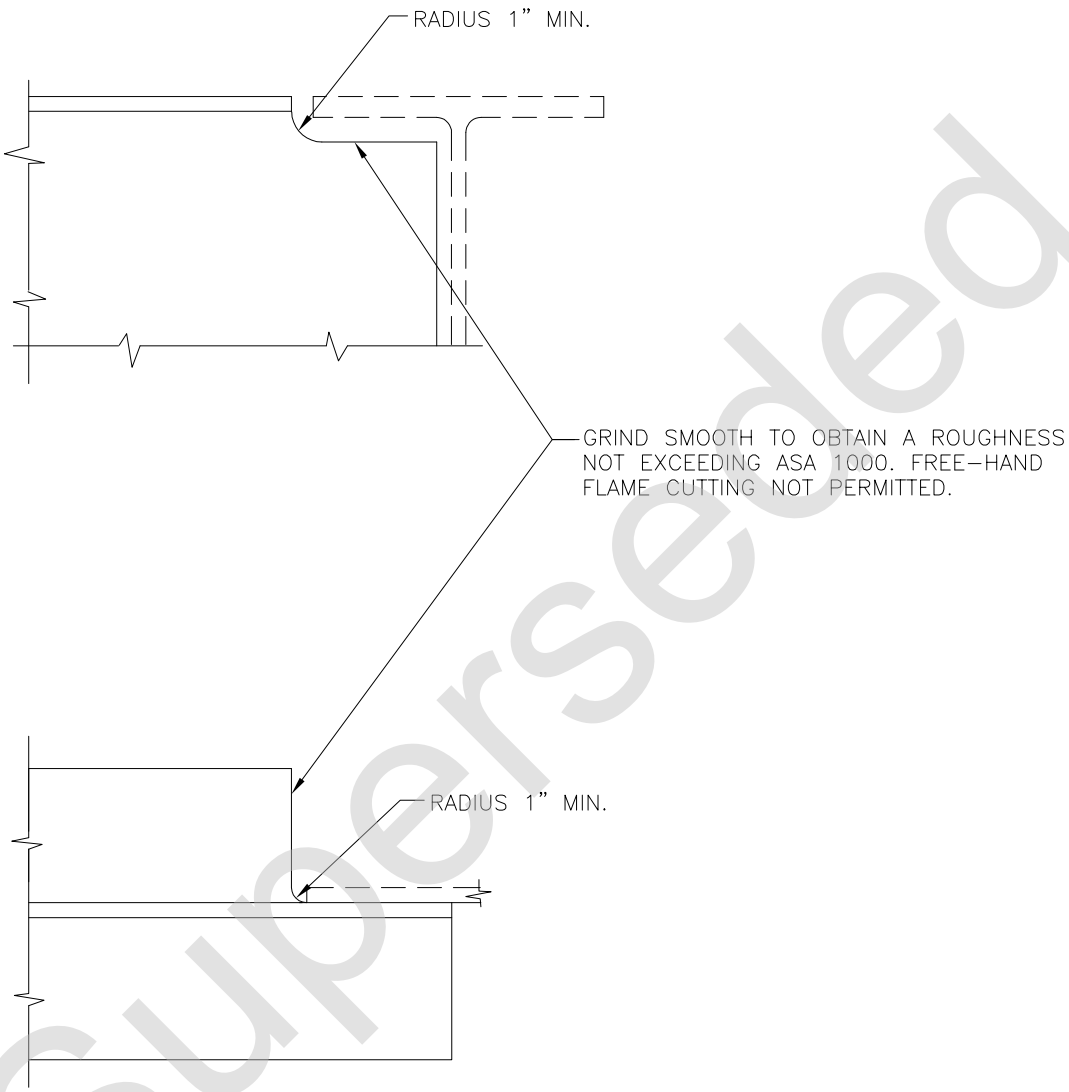


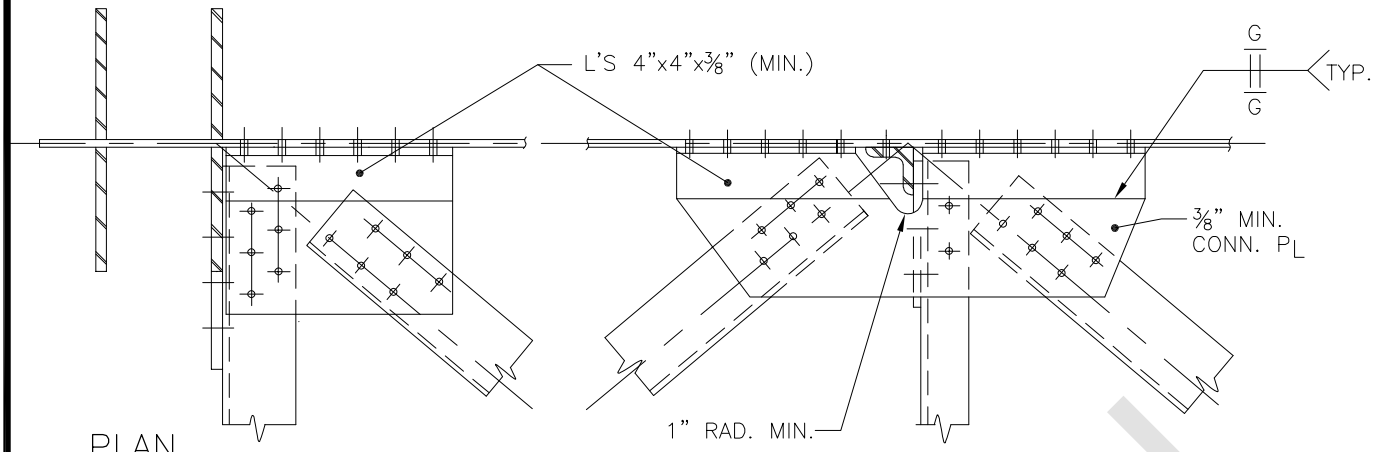
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BEAM COPES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

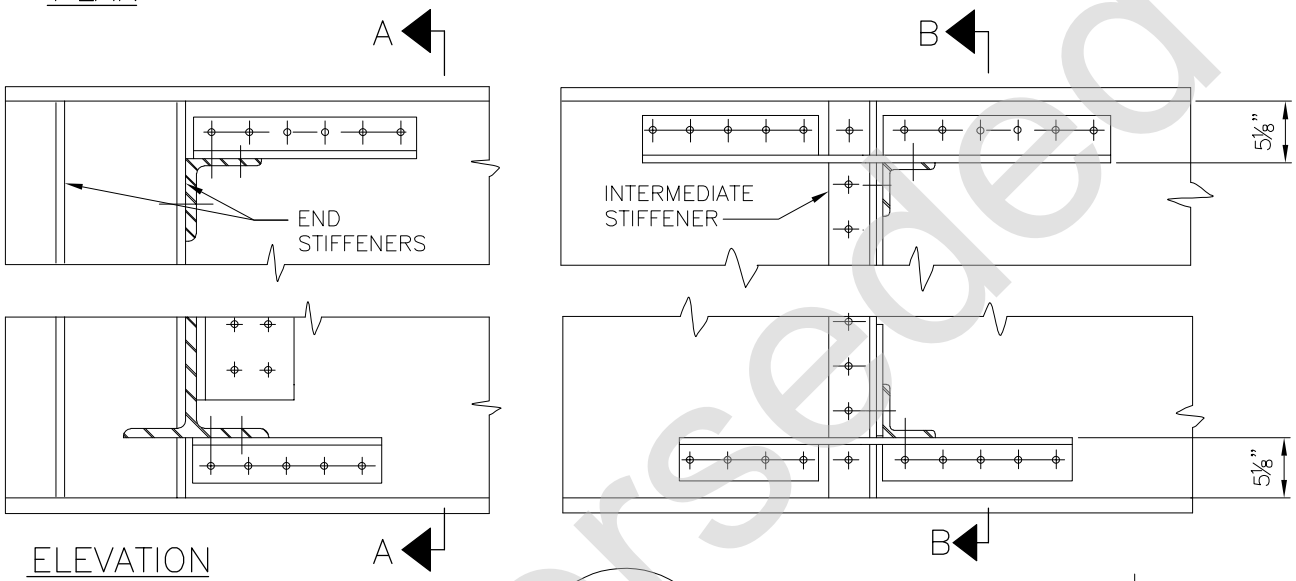
Drawing Number
Dessin Numero

S6i

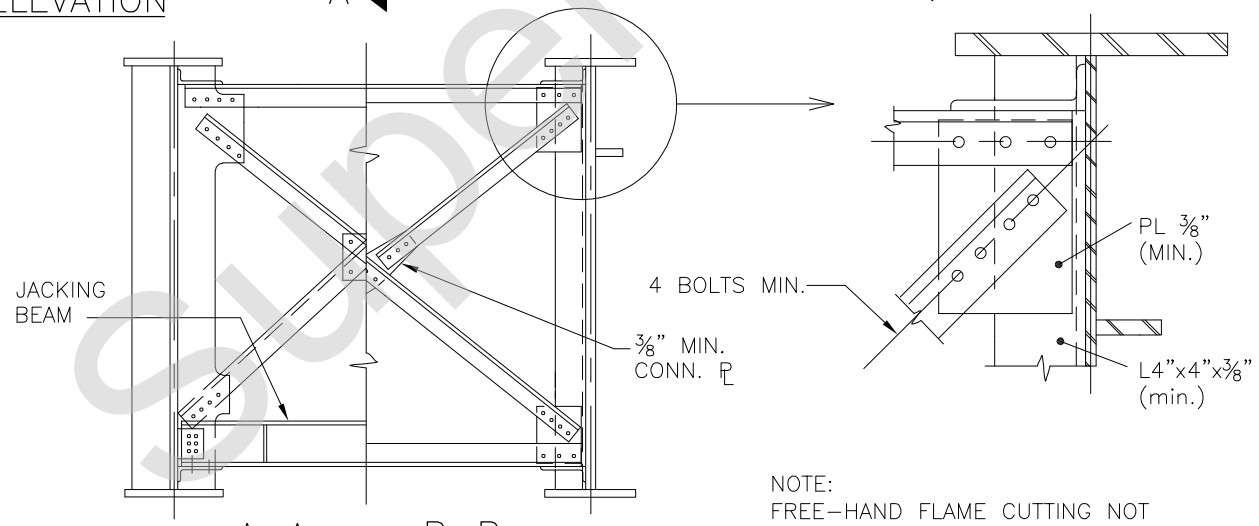
-



PLAN



ELEVATION



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.	**LATERAL BRACING FOR DPG SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

S7i

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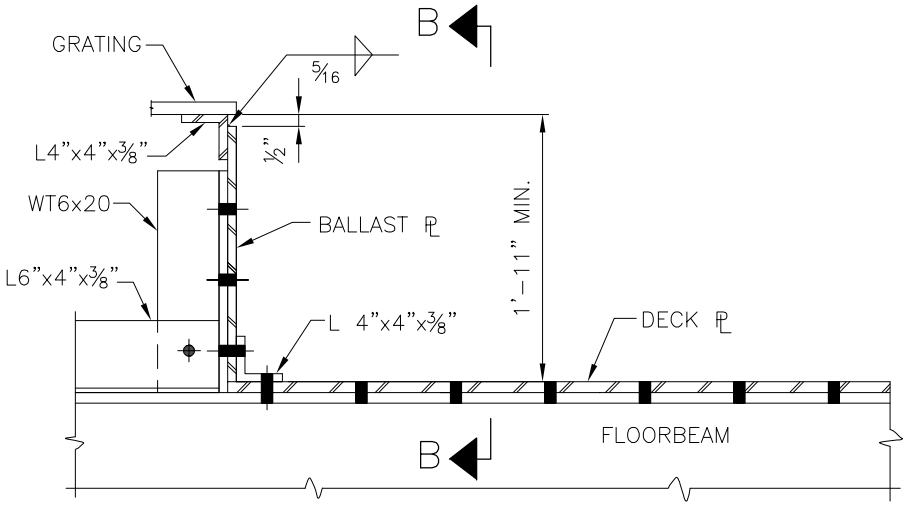
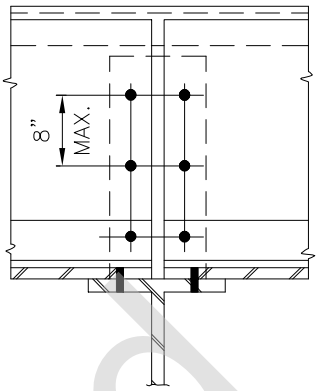
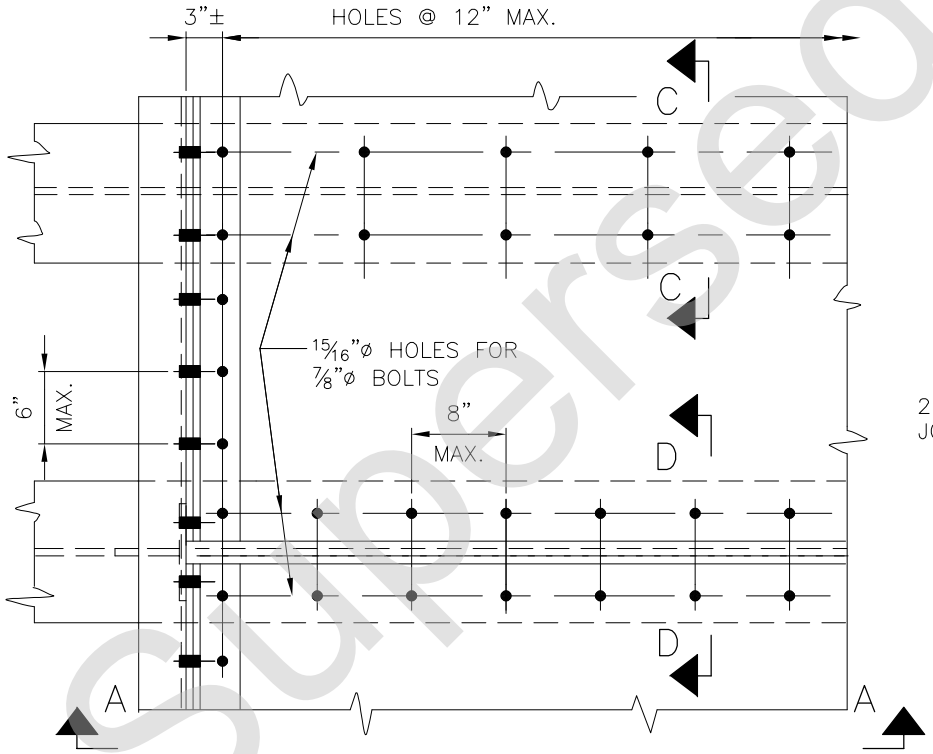


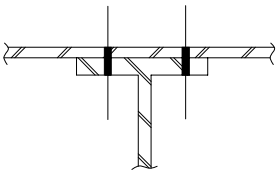
SECTION A–A



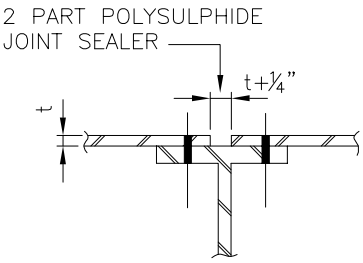
ELEVATION B–B



PLAN



SECTION C–C



SECTION D–D

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

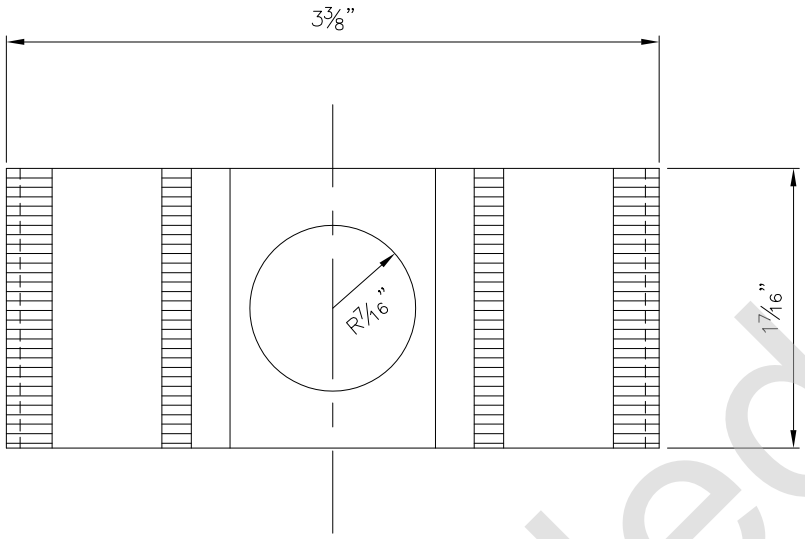
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ATTACHMENT OF DECK PLATE BY BOLTING IN SHOP OR FIELD**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

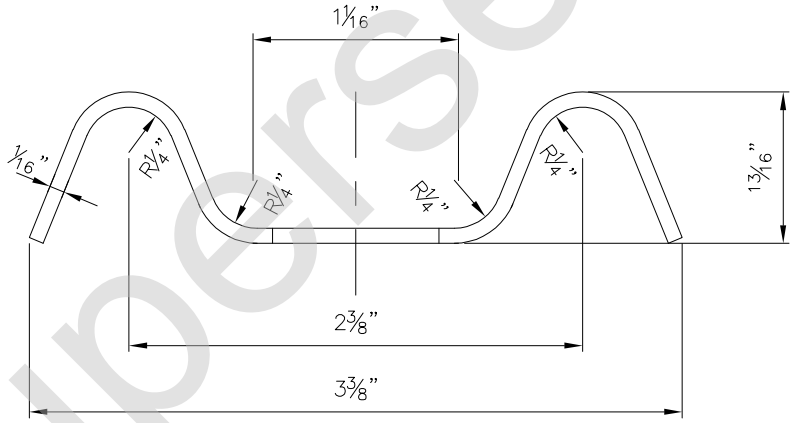
Drawing Number
Dessin Numero

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

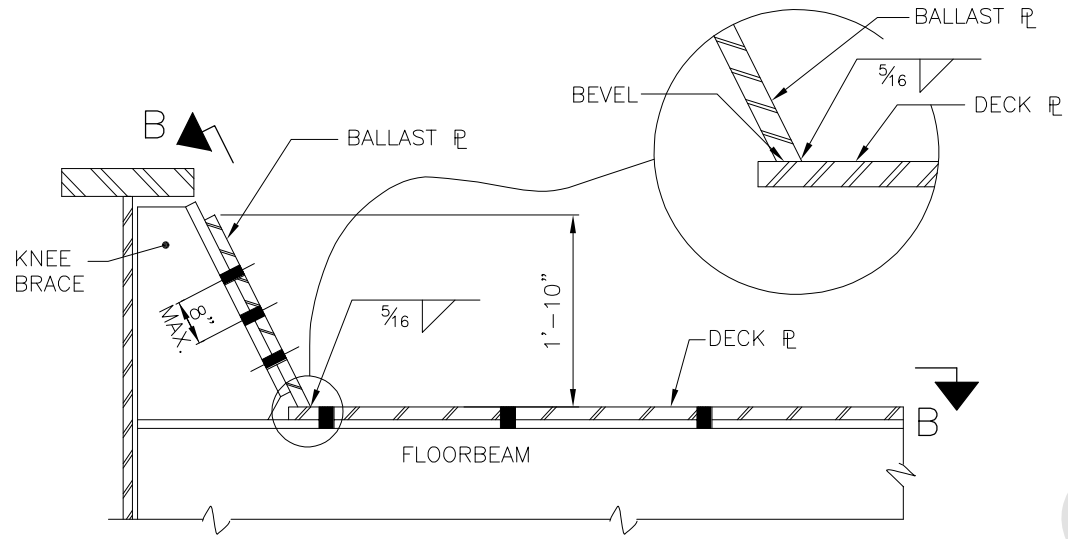
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPE H-3 SADDLE CLIP FOR 38-H-4 HEAVY DUTY GRATING**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

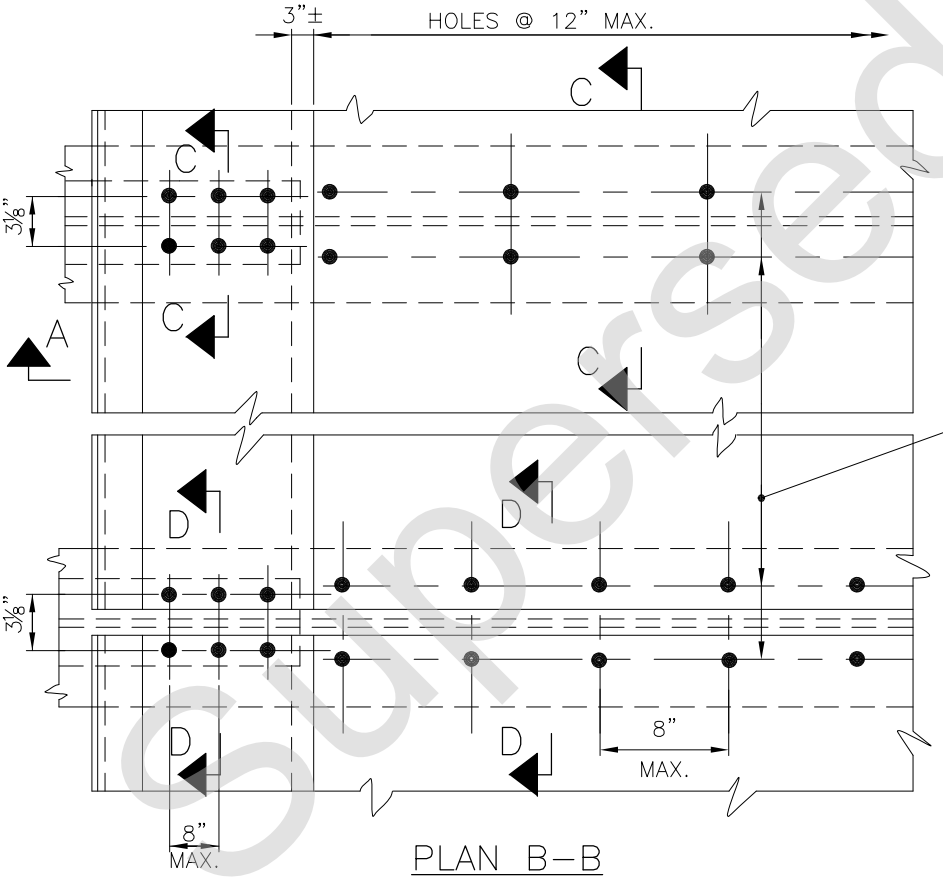
Drawing Number
Dessin Numero

S9i

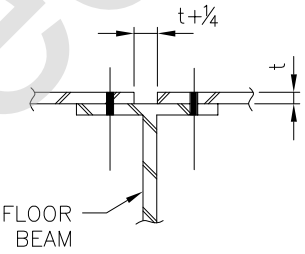
–



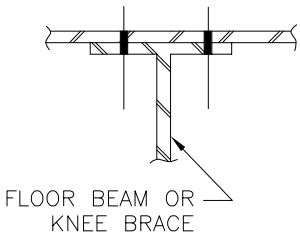
SECTION A–A



PLAN B–B



SECTION D–D



SECTION C–C

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

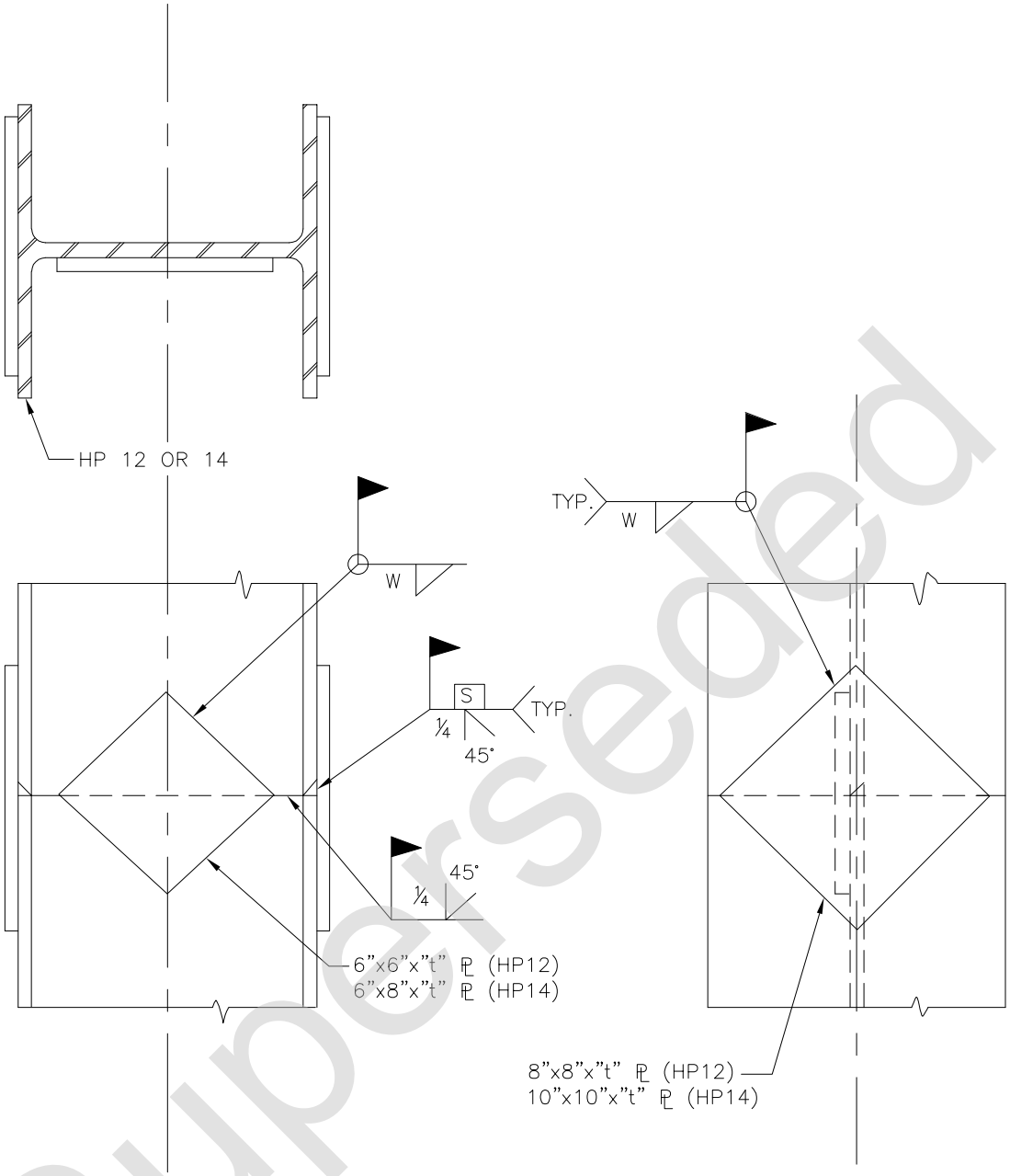
(FOR SQUARE SPANS 40'–0 & OVER & ALL SKEWED SPANS)

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	5/8	3/8
HP 14x73	½	3/8
HP 14x89	5/8	3/8

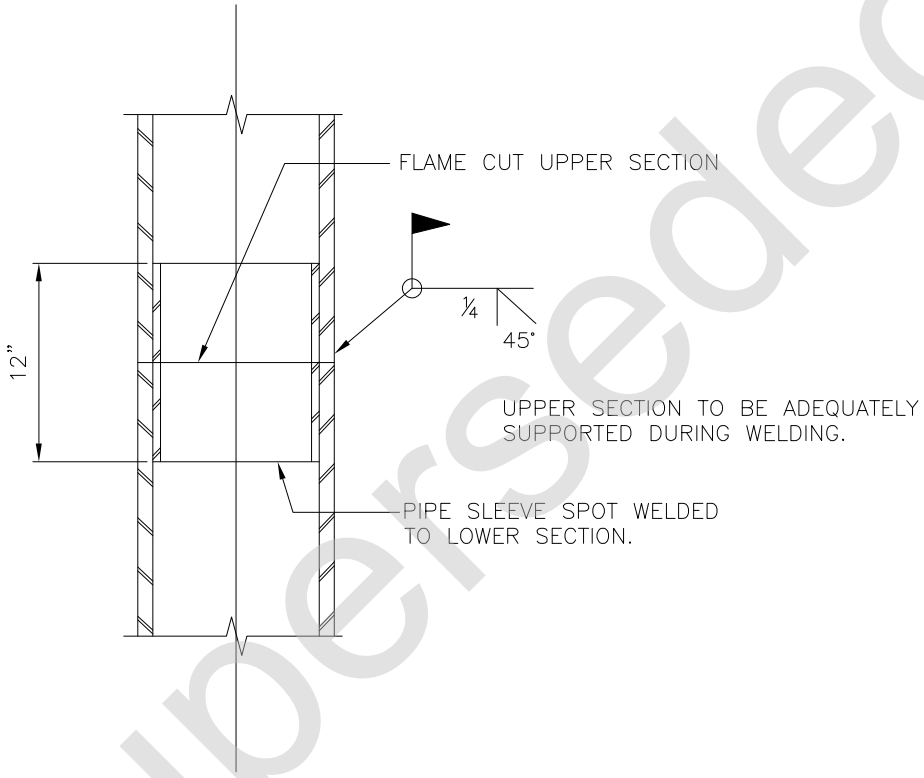
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**HP 12 & 14 PILE SPLICE FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

S12i

–



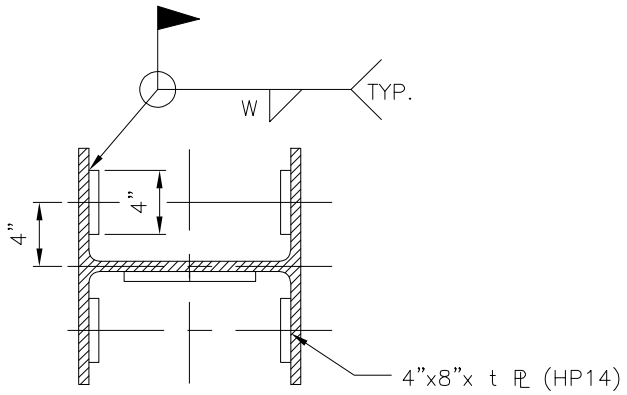
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TUBULAR PILE SPLICE FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

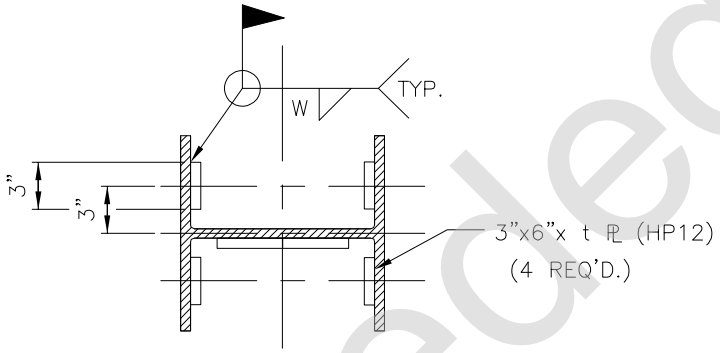
Drawing Number
Dessin Numero

S13i

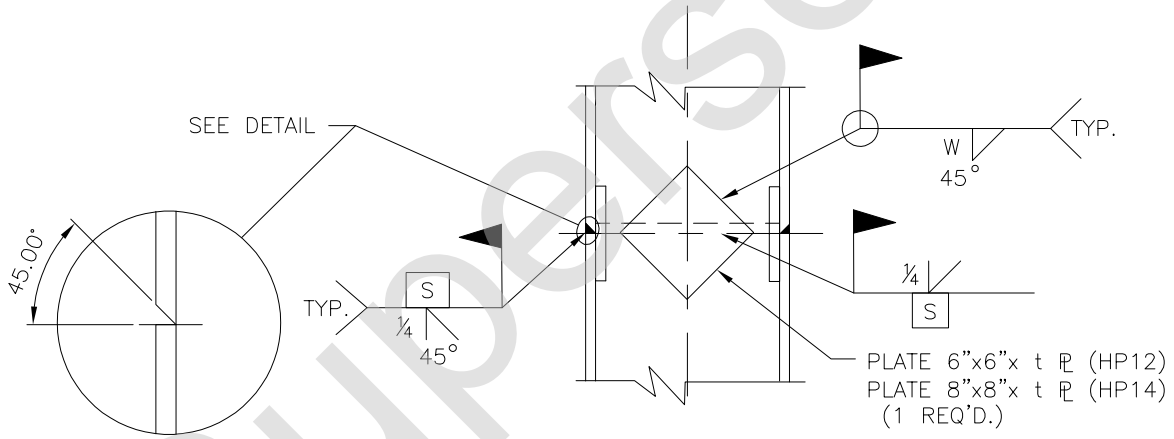
–



HP14



HP12



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

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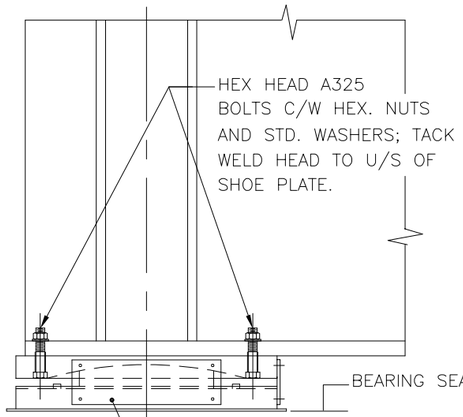
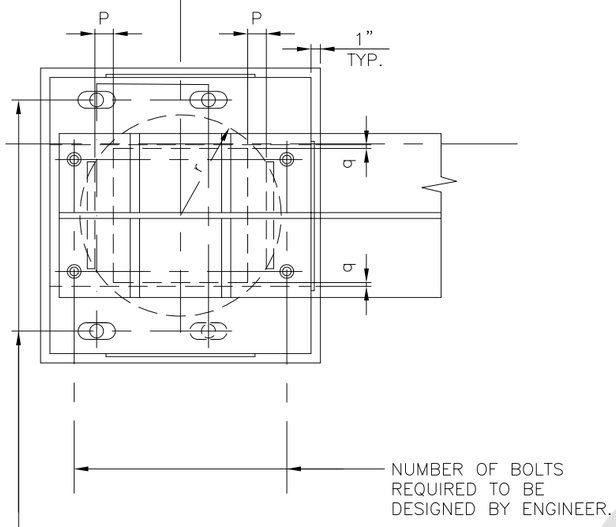
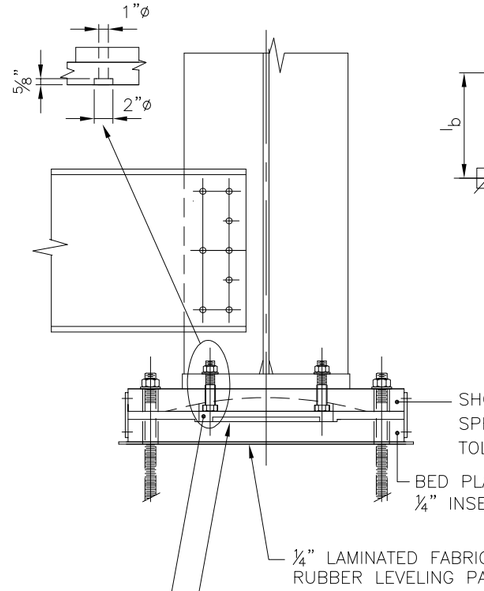
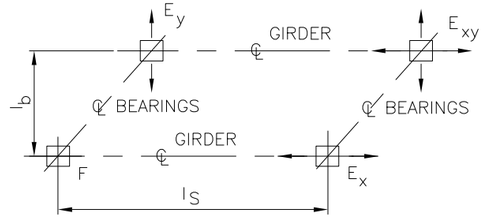


BEARINGS SHALL BE SHIPPED ASSEMBLED WITH 5⁄16" PLATES AND 5⁄8"ø MACHINE BOLTS. PLATES SHALL BE REMOVED AFTER ANCHOR BOLTS HAVE BEEN INSTALLED.(3 PLATES PER BEARING)

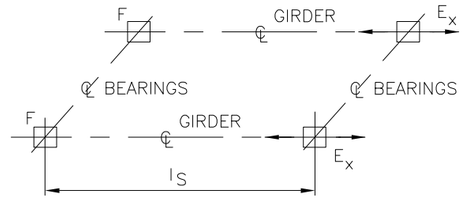






TPG SPANS

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 = ... 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"

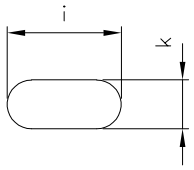
IN SHOE PL:

ROUND HOLES: DIA = d + w (but not less than d + ⅜") where w = greater of w_x and w_y.

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + ⅜".

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 + ⅜")

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + ⅜".

d = 1¼" FOR SPANS UNDER 80'–0

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

DPG SPANS

BEARINGS "F"

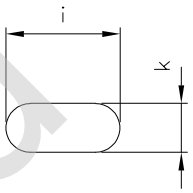
IN SHOE PL:

ROUND HOLES: DIA = d + w_x (but not less than d +⅜")

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + ⅜".

BEARINGS "E"



IN SHOE PL:

SLOTTED HOLES i x k

where i = d + 2p

k = d + ⅜"

IN BED PL & LEVELING PAD:

ROUND HOLES: DIA = d + ⅜".

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

$w_x = 8R\ \delta_{s/l_s}$ $\qquad$ $w_y = 8R\ \delta_{b/l_b}$

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

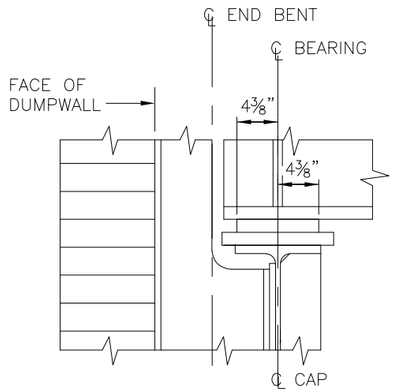
δ_b = max. deflection of end floor beam due to L + I

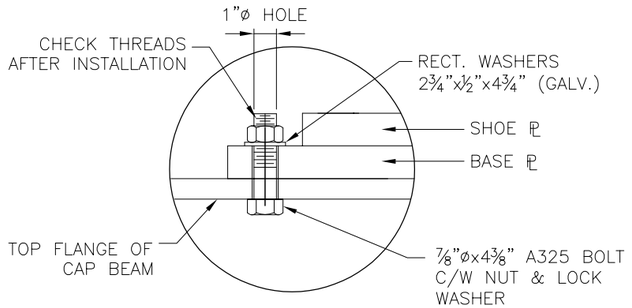
R = radius of spherical surface

l_s = bridge span length

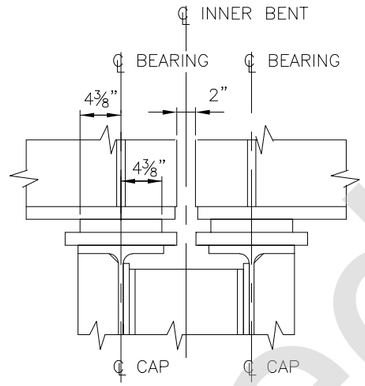
l_b = distance c. to c. girders

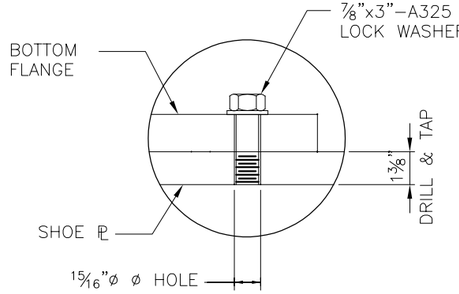
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD BEARINGS FOR DPG & TPG STEEL SPANS (sheet 2)**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **S16i**	–



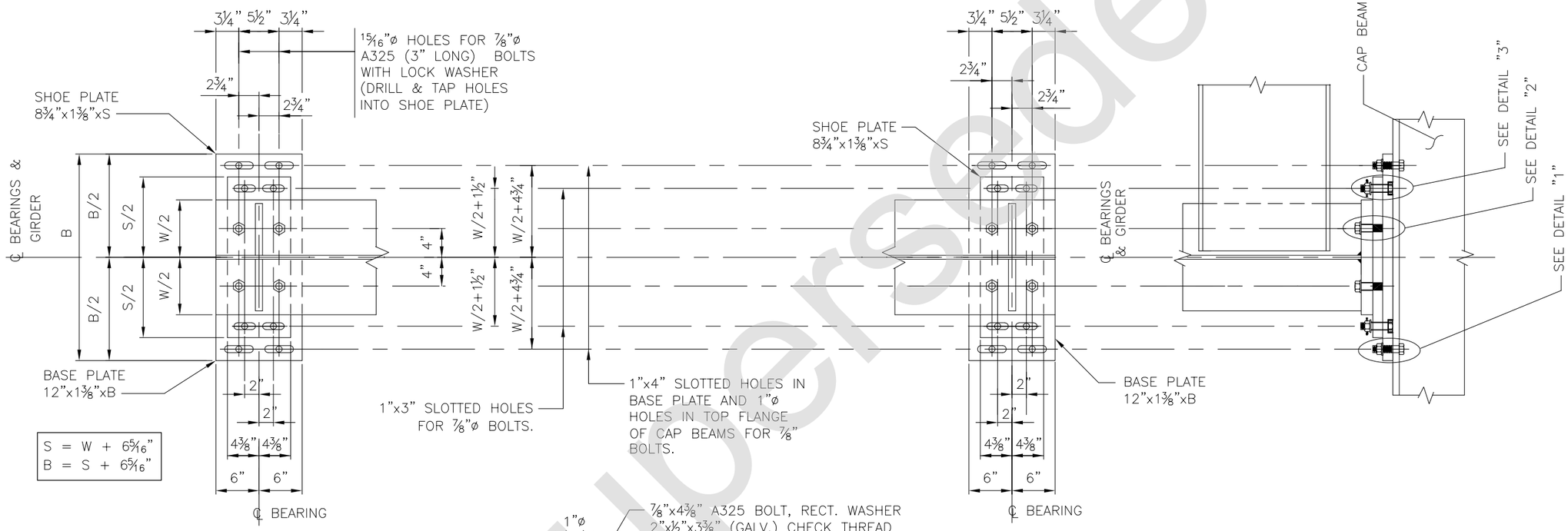


DETAIL 1

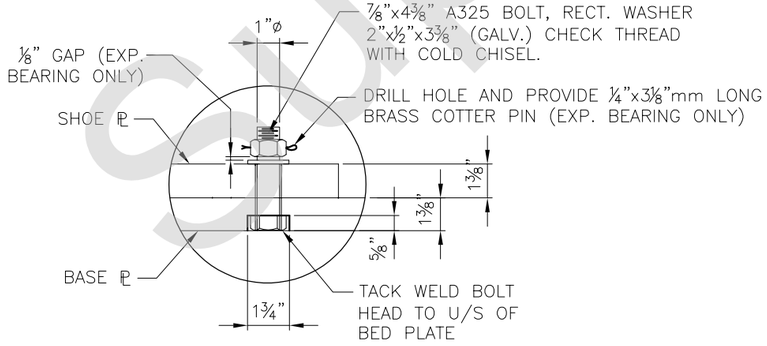




DETAIL 2



S = W + 6 5⁄16"
B = S + 6 5⁄16"



DETAIL 3

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 $\frac{\text{WORKING}}{\text{PERMISS.}} =$

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

$\frac{\text{MAX. STRESS RANGE}}{\text{PERMISS. FATIGUE STRESS}} =$

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	—		—	

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

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:

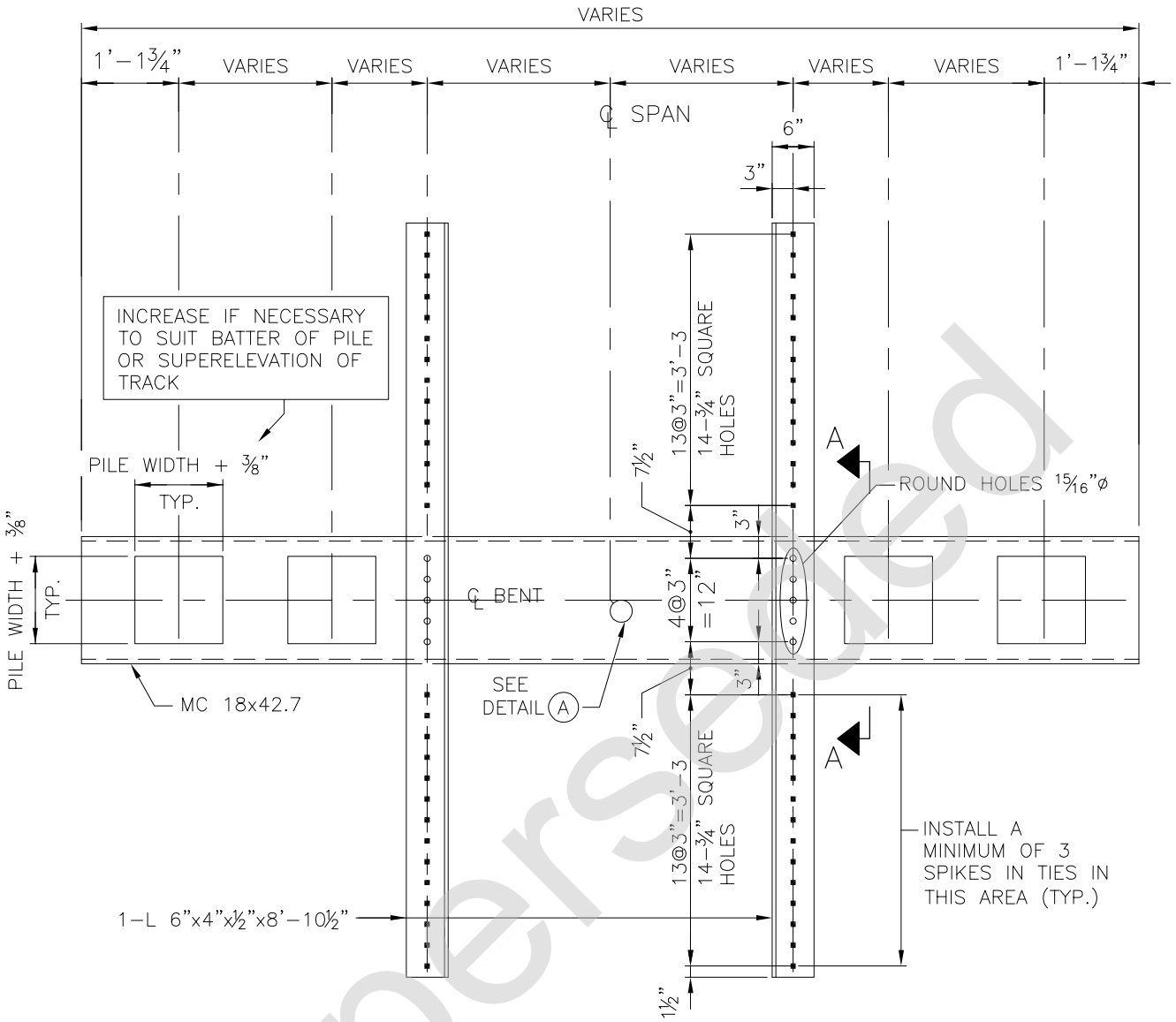
- FOR GENERAL NOTES SEE DRAWING –1.1
- DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AREMA 2016 MANUAL CHAPTER 15
- MATERIAL SHALL BE IN ACCORDANCE WITH THE FOLLOWING SPEC'S.:
  - STRUCTURAL STEEL: SEE PART 2A GUIDELINES FOR DESIGN OF STEEL BRIDGES & STRUCTURES
  - WELDING: C.S.A. CAN3–W59
  - H.S. 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 1/4".
- 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.

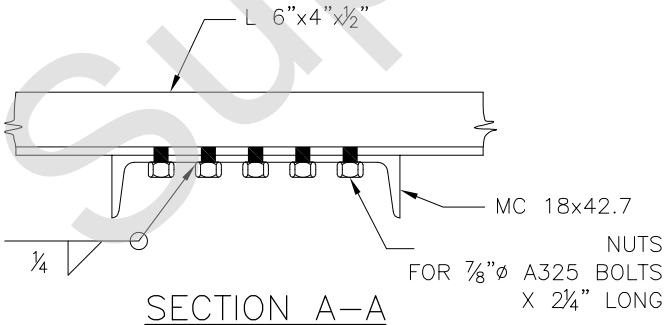
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPICAL NOTES FOR STEEL SPANS**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

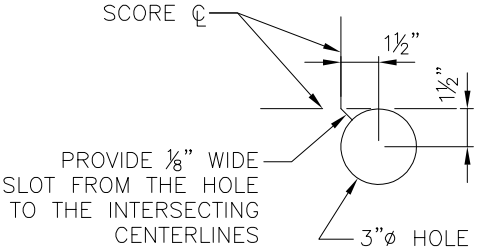
Drawing Number
Dessin Numero
S18i

–





SECTION A–A



DETAIL (A)

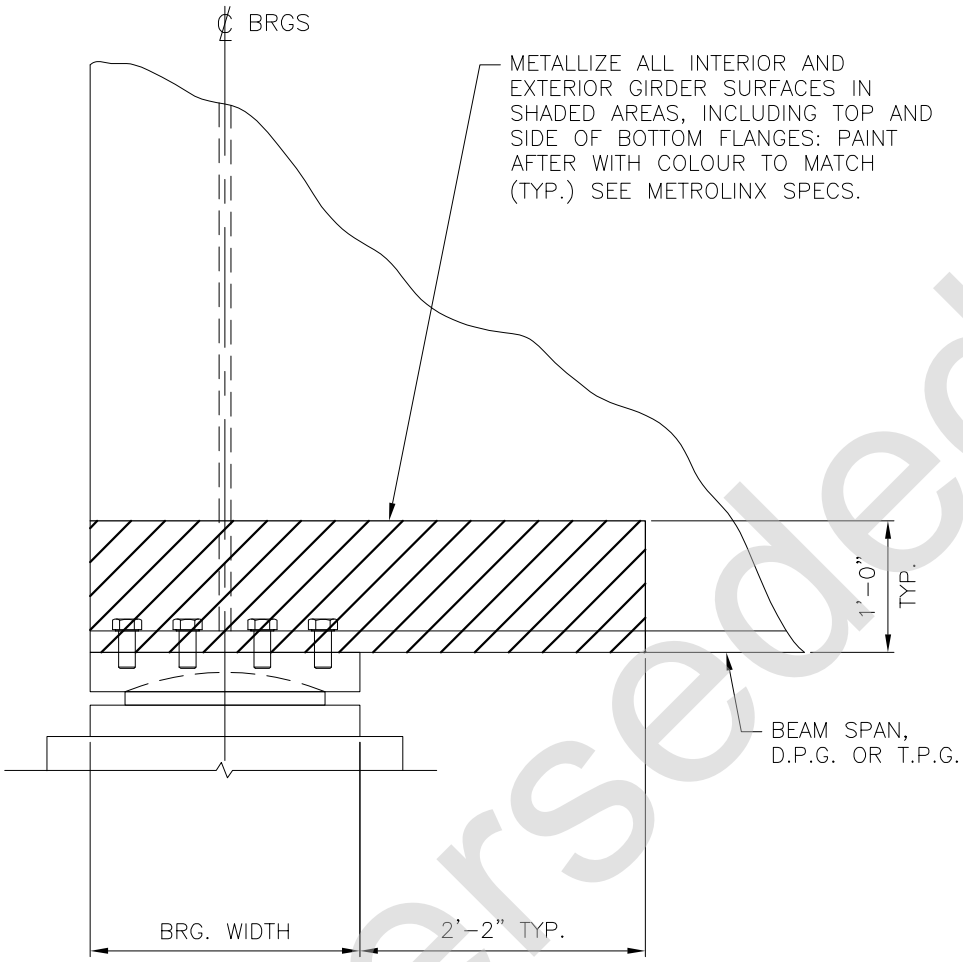
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TEMPLATE FOR PILE DRIVING**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero

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

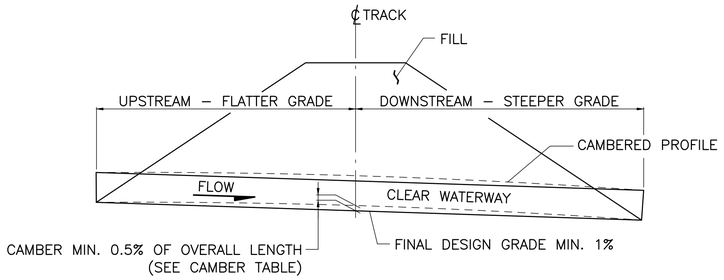
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**METALLIZING AREA FOR BEAM SPANS, DPG & TPG SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

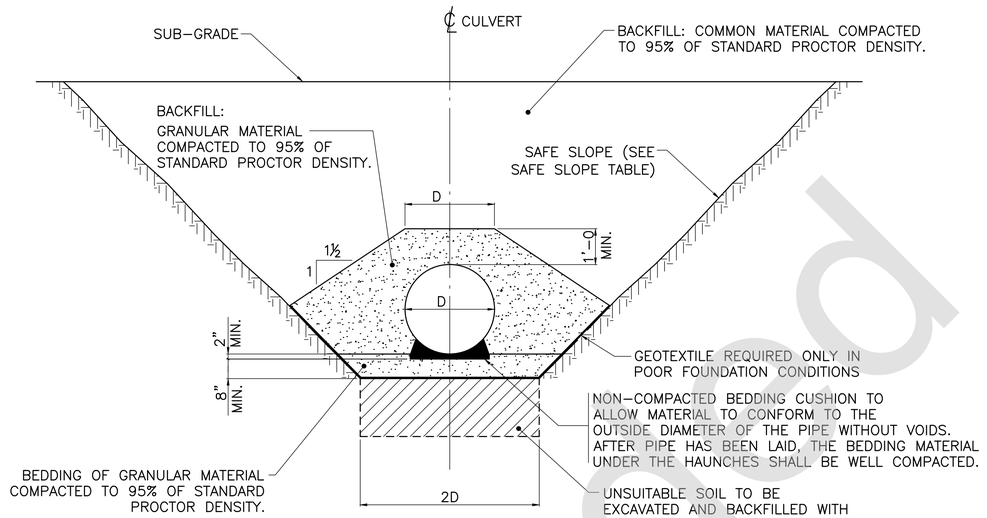
Drawing Number
Dessin Numero

S20i

-

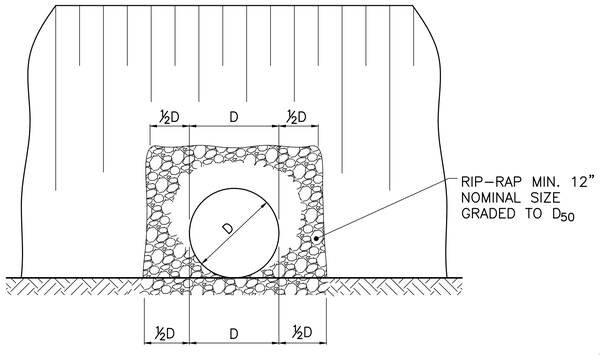


MINIMUM GRADE AND CAMBERING REQUIREMENTS FOR CULVERT INSTALLATION

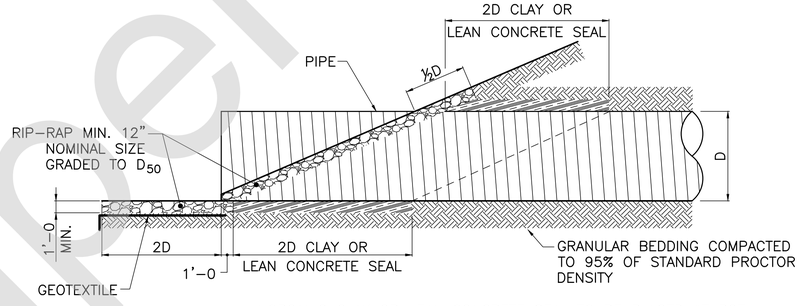


GRANULAR MATERIAL FOR BEDDING AND BACKFILLING TO BE APPROVED BY THE ENGINEER. IN GENERAL, PIT–RUN SAND AND GRAVEL, REASONABLY WELL GRADED FROM MAXIMUM SIZE 4" TO NOT MORE THAN 8% FINER THAN SIEVE No. 200.

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'

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

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.

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

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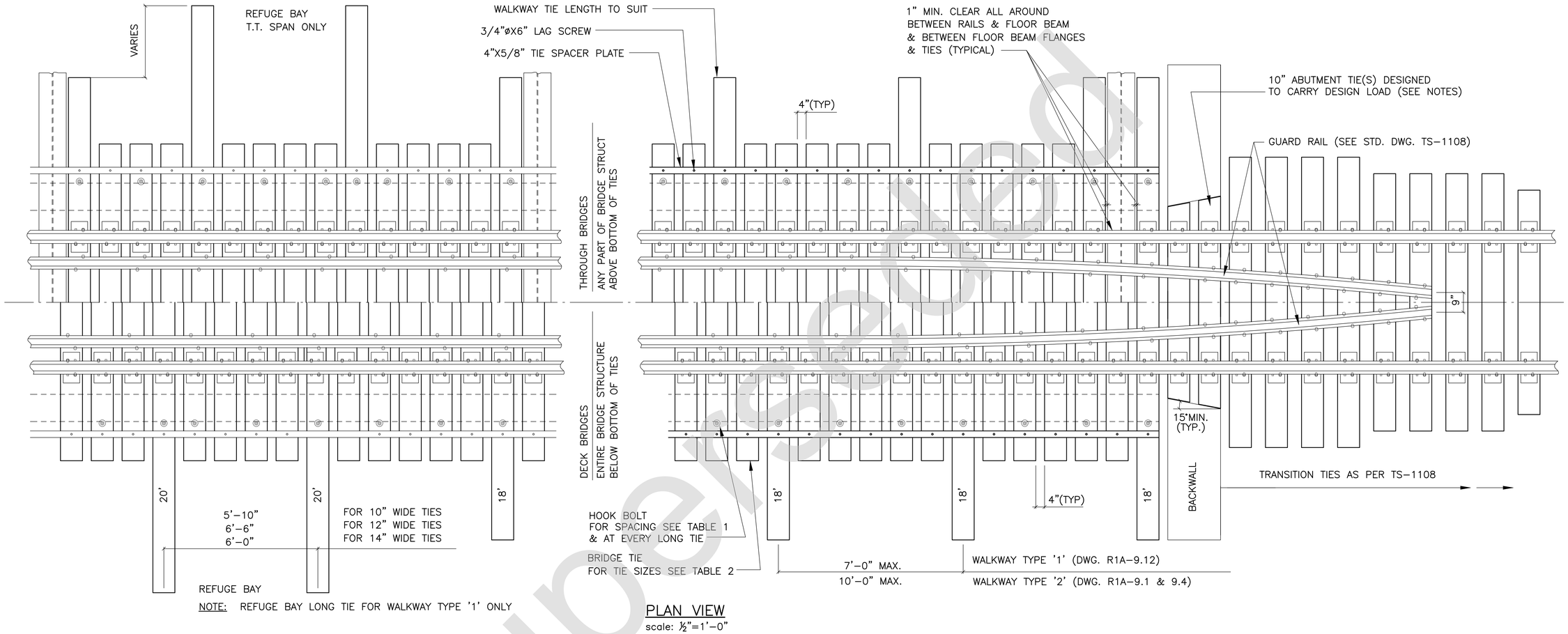
SCALE: 1:XXX FULL SIZE ONLY	

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

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



PLAN VIEW
scale: ½"=1'-0"

CE DESSIN EST AUSSI DISPONIBLE EN FRANCAIS

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

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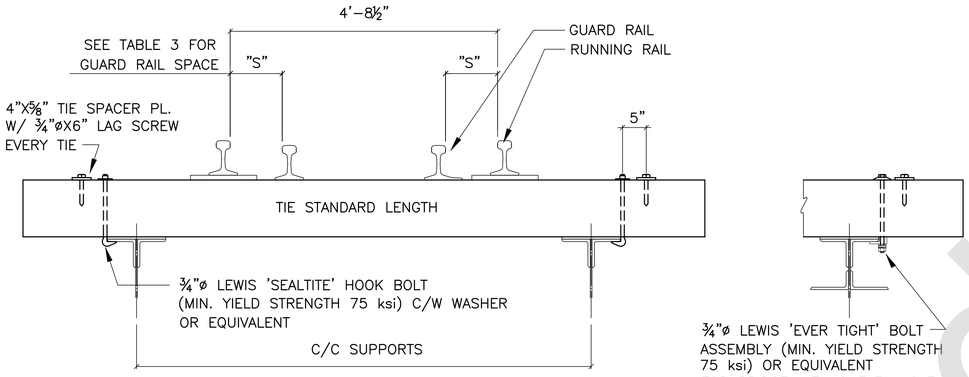
SCALE: 1:XXX	FULL SIZE ONLY

METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES
SYSTEM "A"

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

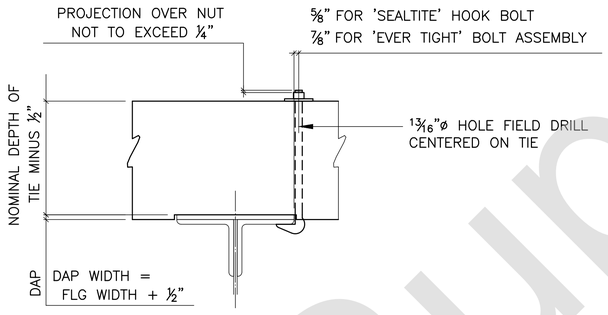


TYPICAL SECTION

scale: ¾"=1'–0"

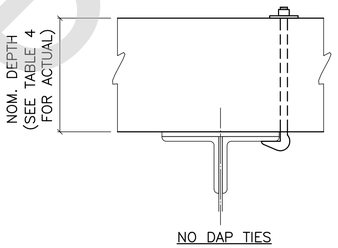
NOTES

- 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. 080/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. 080/ 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



DAPPED TIES

REFER TO TABLE 1



NO DAP TIES

REFER TO TABLE 1

DETAILS AT HOOK BOLT

scale: 1½"=1'–0"

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

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SCALE: 1:XXX	FULL SIZE ONLY

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)

CE DESSIN EST AUSSI DISPONIBLE EN FRANCAIS

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

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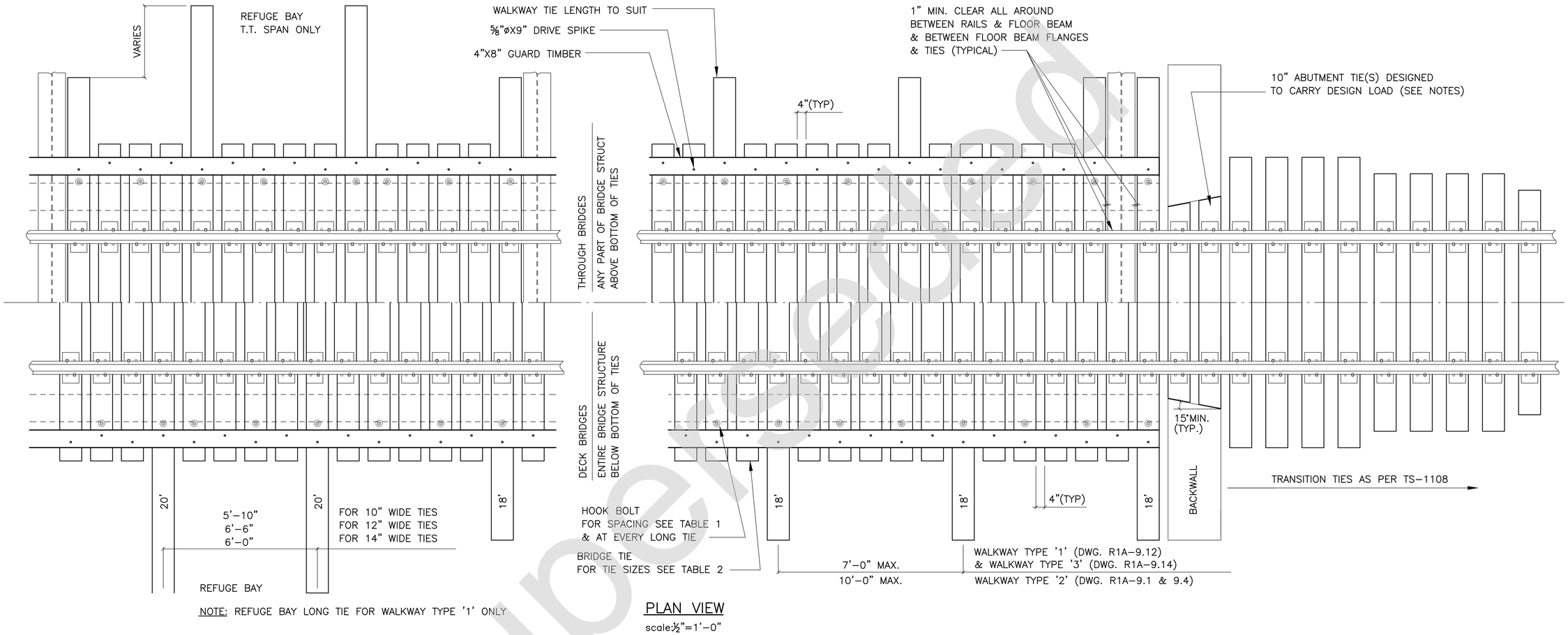
SCALE: 1:XXX	FULL SIZE ONLY

METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES

SYSTEM "A"

CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A–1.6i–3		



NOTE: REFUGE BAY LONG TIE FOR WALKWAY TYPE '1' ONLY

PLAN VIEW

scale ½"=1'-0"

CE DESSIN EST AUSSI DISPONIBLE EN FRANCAIS

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

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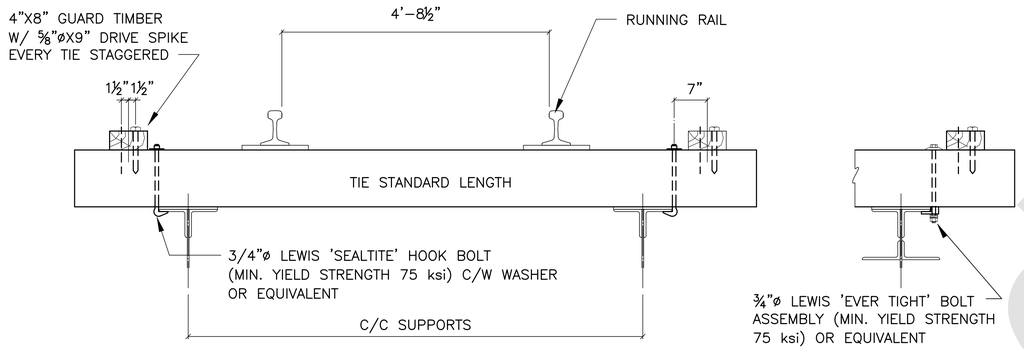
SCALE: 1:XXX	FULL SIZE ONLY

METROLINX

TIMBER OPEN DECK FOR STEEL BRIDGES

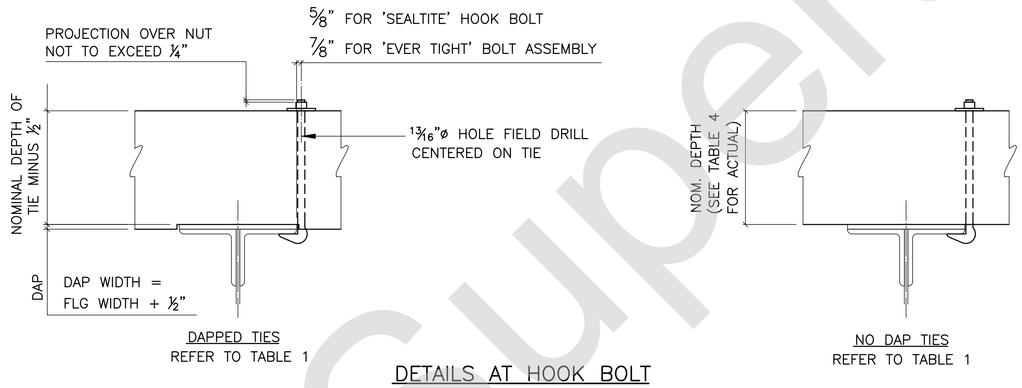
SYSTEM "B"

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

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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:

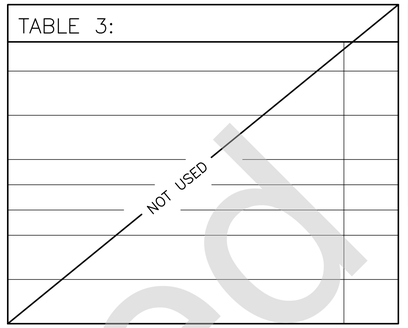

TABLE 4: SIZES (NOMINAL/ACTUAL)

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		
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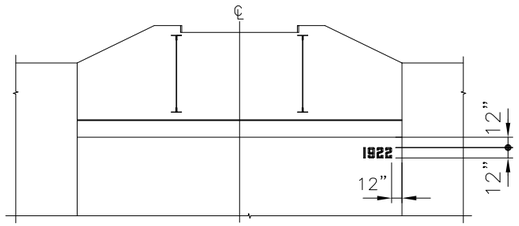
SCALE: 1:XXX	FULL SIZE ONLY

METROLINX

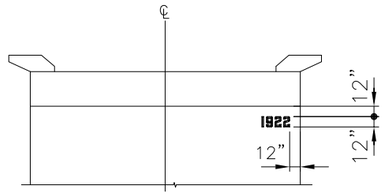
TIMBER OPEN DECK FOR STEEL BRIDGES

SYSTEM "B"

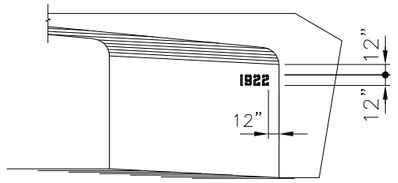
CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R9A–1.7i–3		



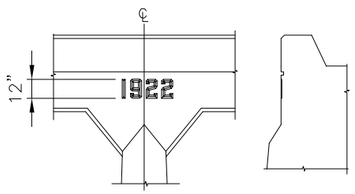
STEEL BRIDGES



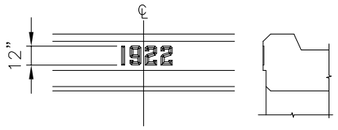
CONCRETE BRIDGES



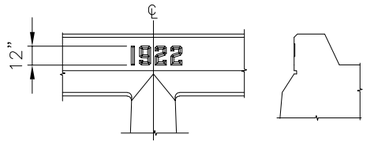
CONCRETE FRAME BRIDGES



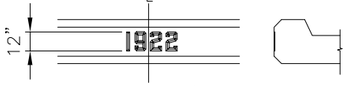
FOR 12' & 20' DOUBLE R.C. CULVERTS



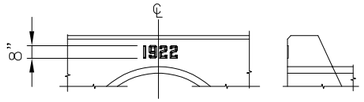
FOR 8' TO 10' R.C. CULVERTS



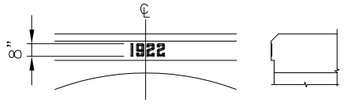
FOR 8' & 10' DOUBLE R.C. CULVERTS



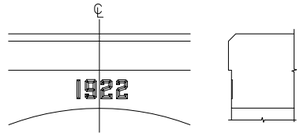
FOR 4' TO 7' R.C. CULVERTS



FOR R.C. PIPES

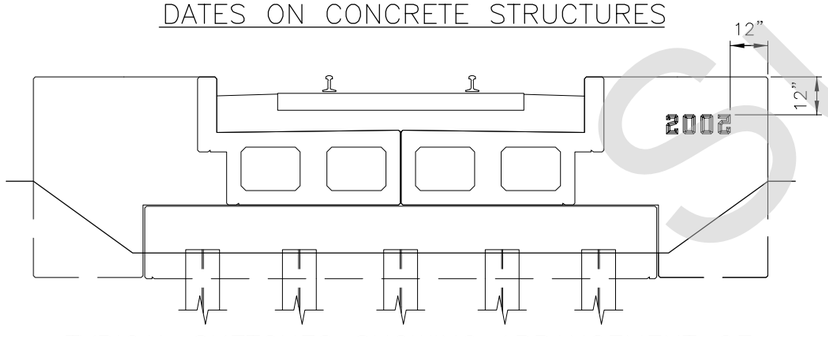


FOR ARCH CULVERTS 14' & SMALLER

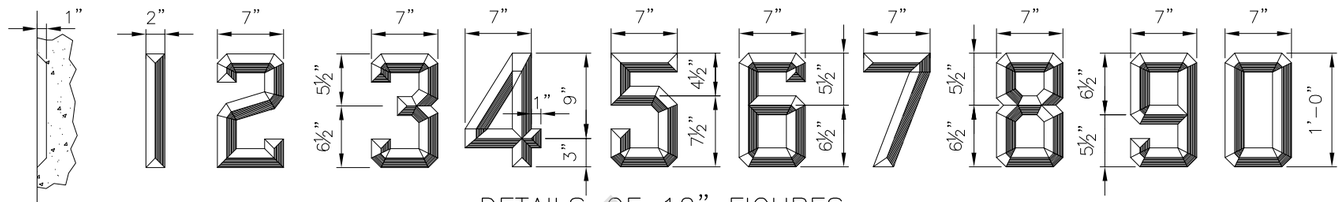


FOR ARCH CULVERTS 16' TO 30'

TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON CONCRETE STRUCTURES

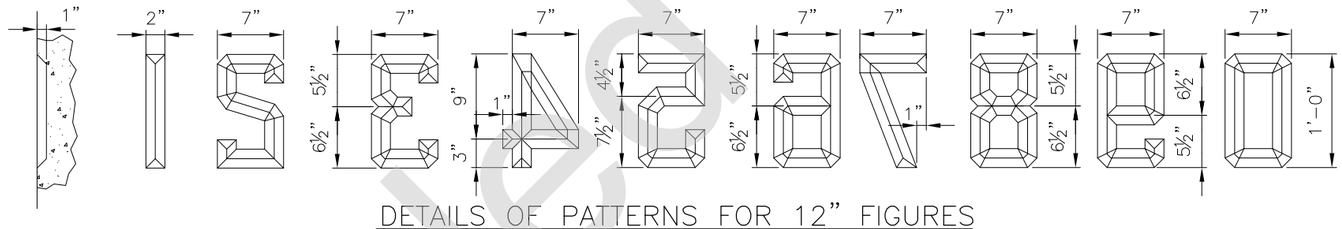


TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON PRECAST BALLAST WALLS



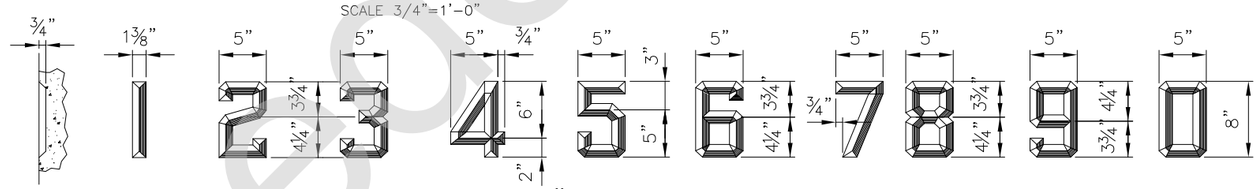
DETAILS OF 12" FIGURES

SCALE 3/4"=1'–0"



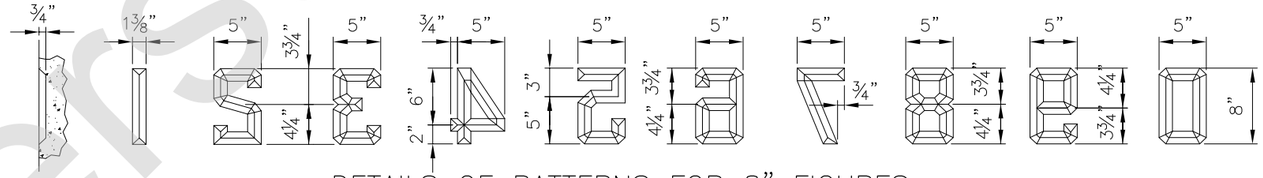
DETAILS OF PATTERNS FOR 12" FIGURES

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"

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.

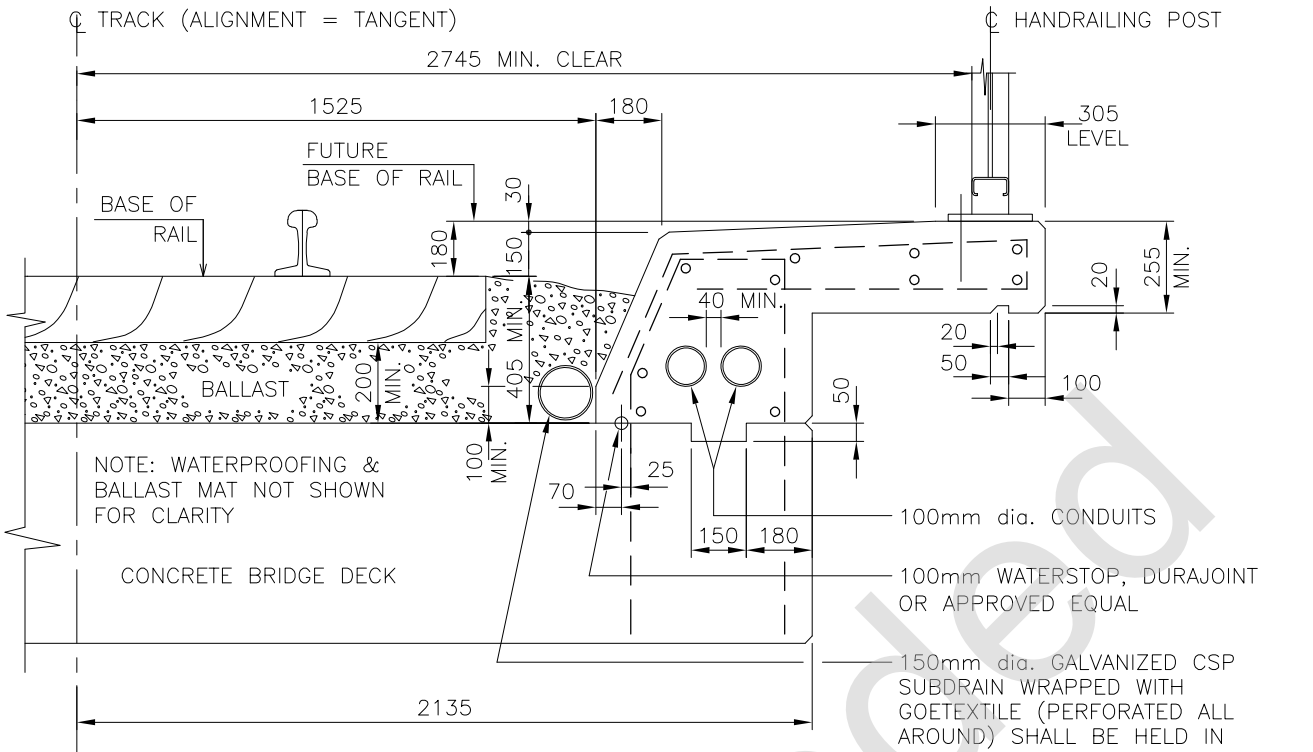
DECK TRUSSES – ON THE OUTSIDE OF THE TOP CHORD OR END POST AT THE NEAR END OF THE RIGHT HAND TRUSS (LOOKING IN THE DIRECTION OF INCREASING MILEAGE).

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

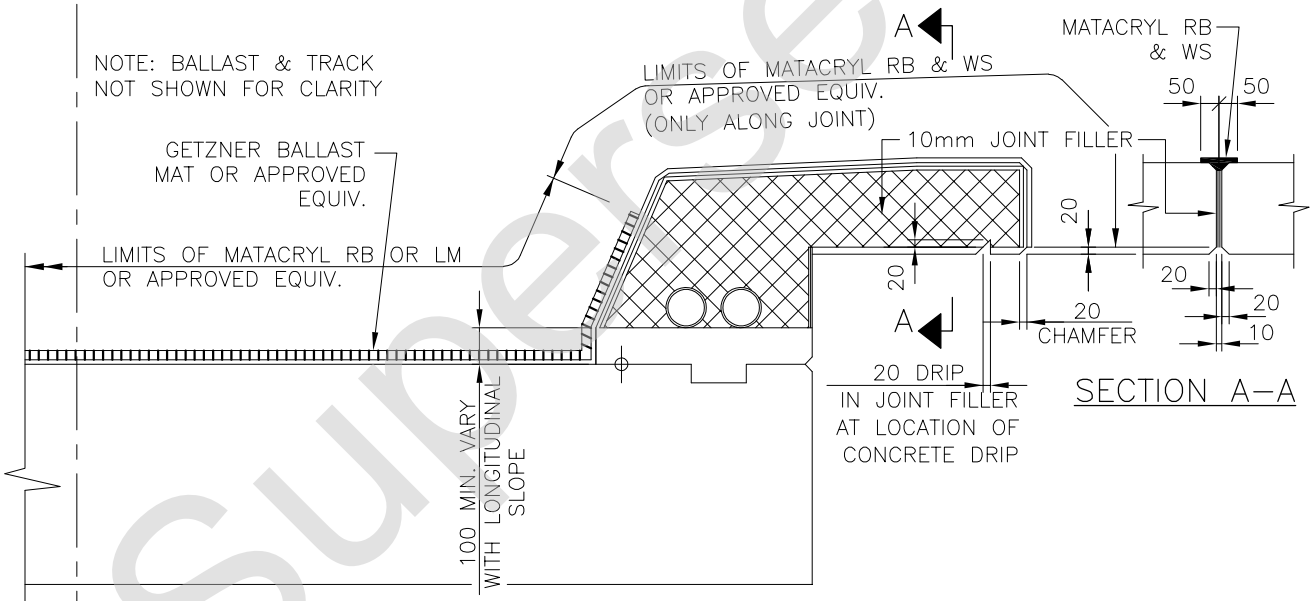
METROLINX

Drawing Number
Dessin Numero

TD-05-Li –



PARTIAL DECK SECTION



SECTION A–A

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.
Scale: Echelle:	NOT TO SCALE	Date:	2017/03/31

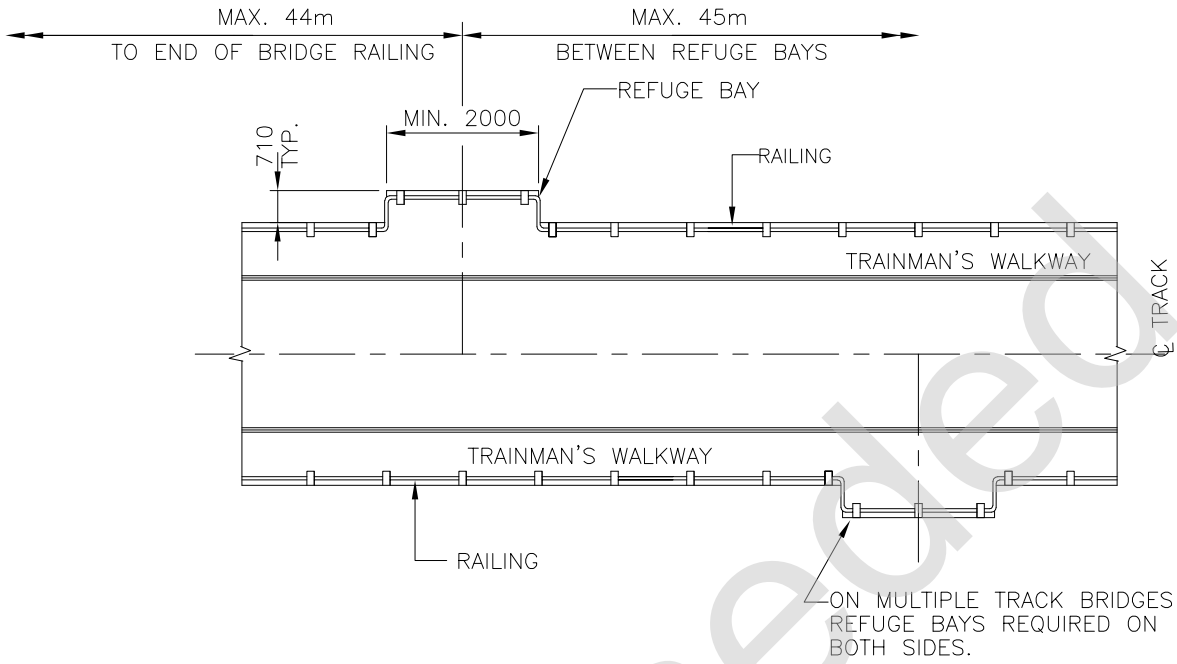
CAST-IN-PLACE CONCRETE BRIDGE DECK DETAILS

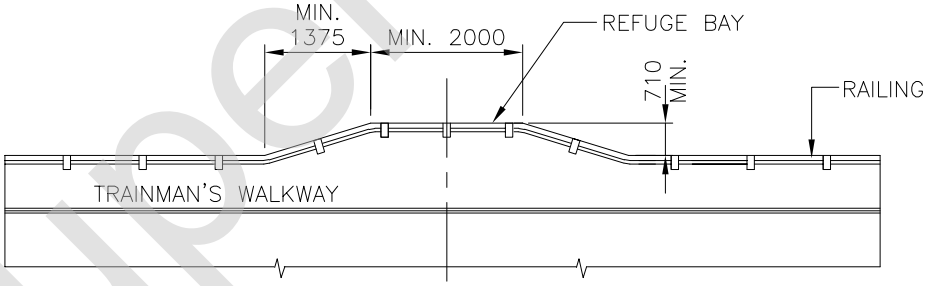
METROLINX

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

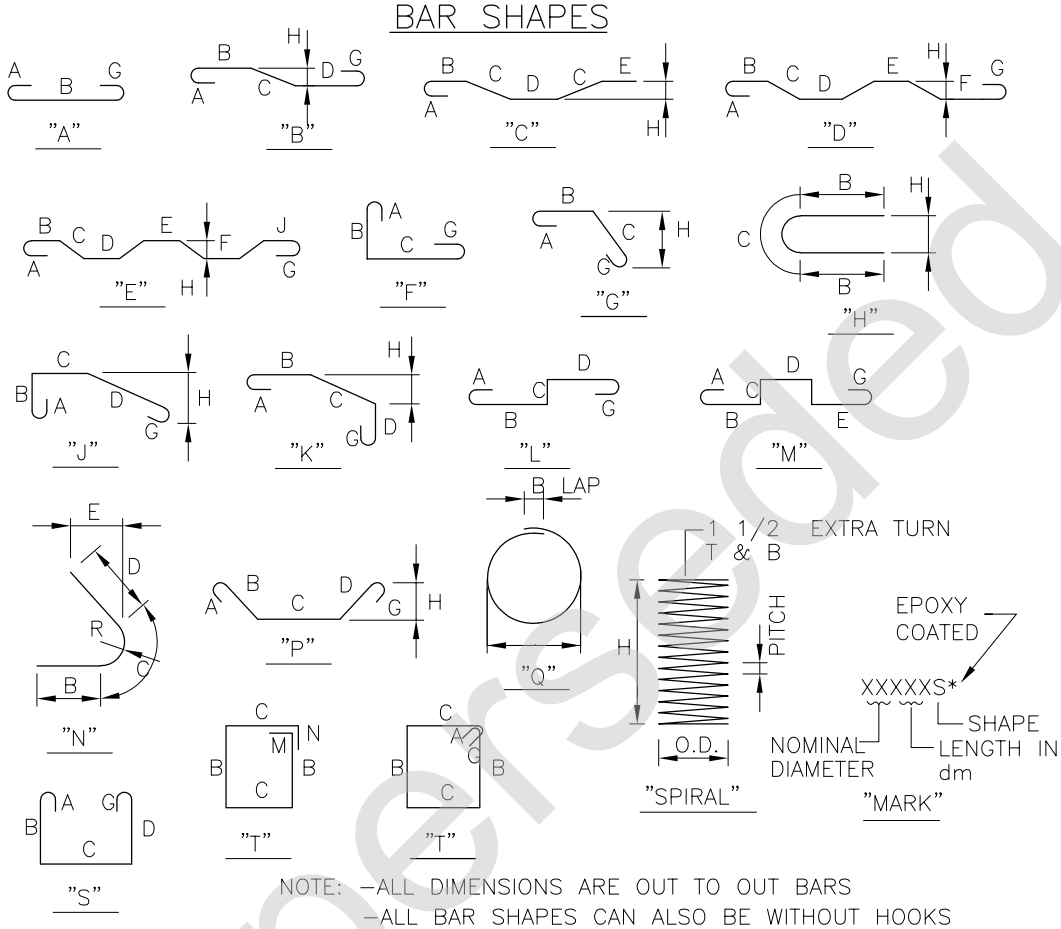
C6m

–

BAR LIST EXAMPLE

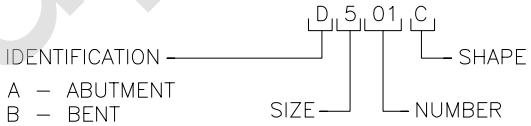
QTY.	SIZE	MARK	LENGTH	A	B	C	D	E	F	G	H	R
50	20M	D20001C	4915	200	610	280	2000	1340			200	

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



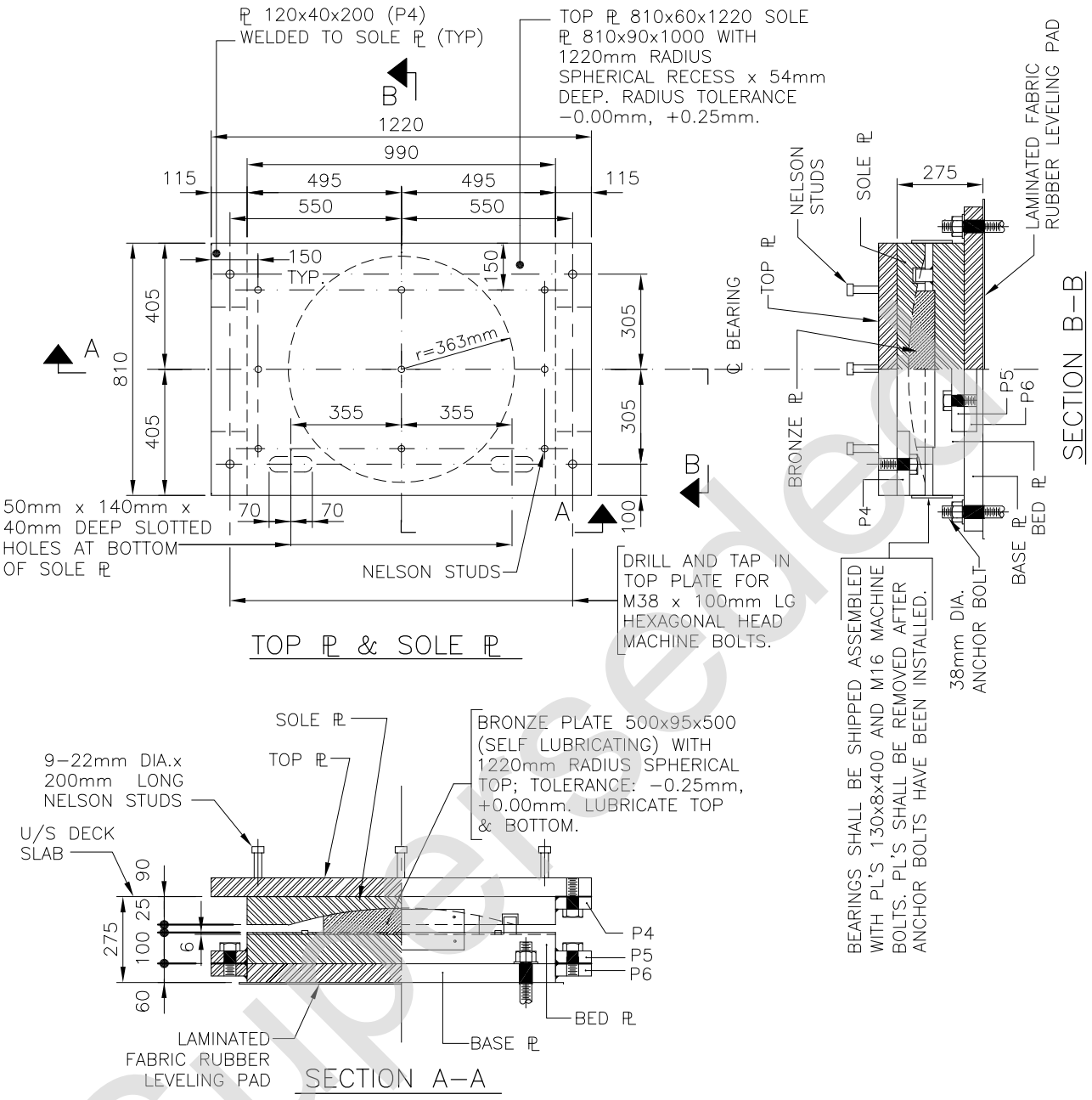
A – ABUTMENT
B – BENT
F – FOOTING
P – PIER
R – RIGID FRAME
W – WALL
D – DECK
S – SPAN

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

–



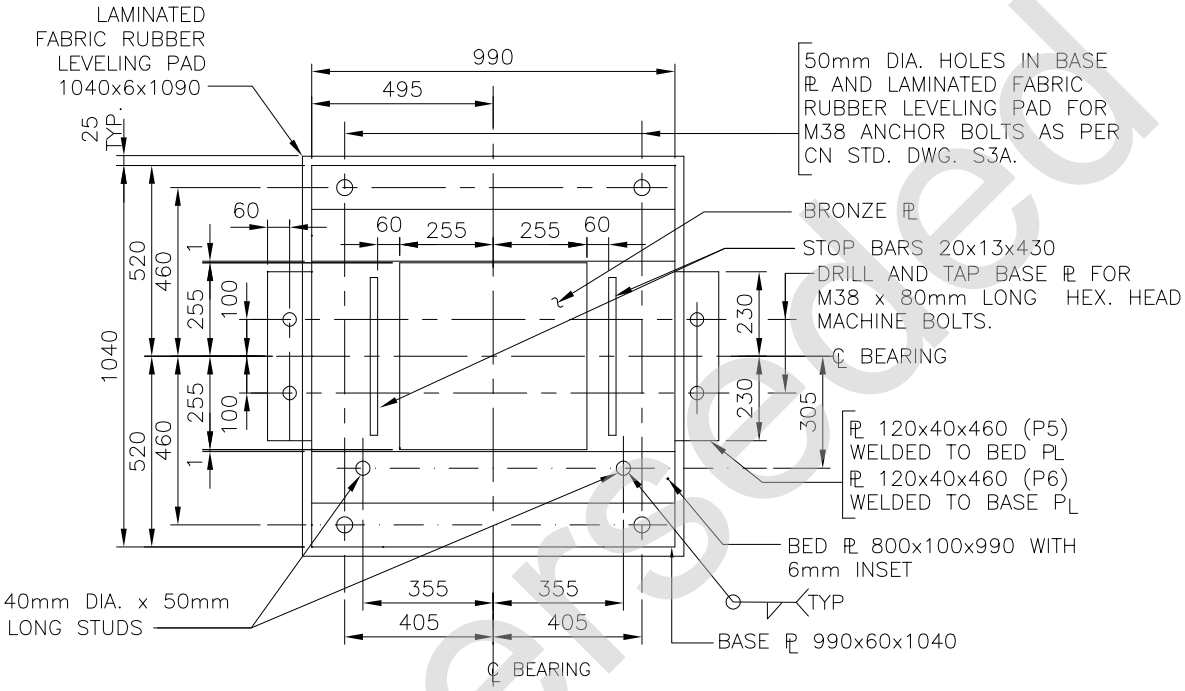
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BRONZE BEARINGS - EXAMPLE OF AN EXPANSION BEARING FOR A CONCRETE SPAN BRIDGE**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	SHEET 1 OF 2	

METROLINX

Drawing Number
Dessin Numero

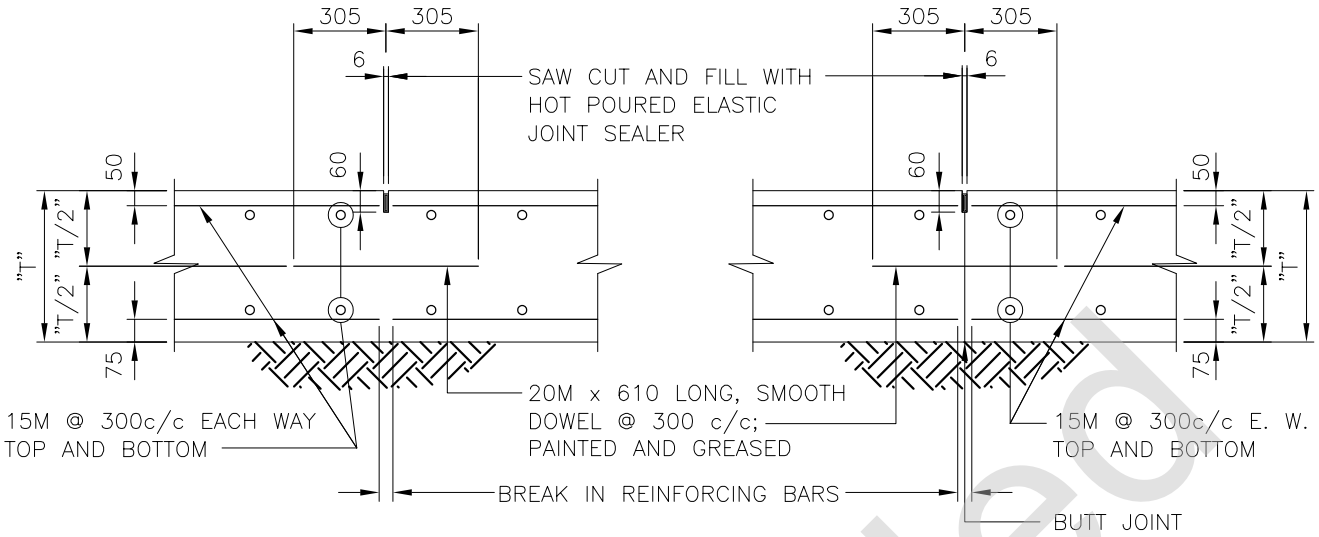
C9m-1

–



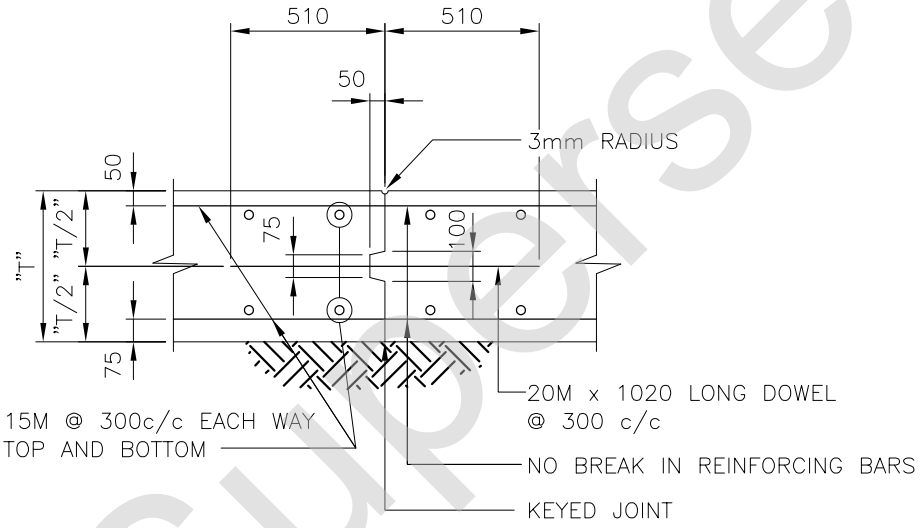
BED ℄ & BASE ℄

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 **C9m-2**



CONTROL JOINT
@ 6000 c/c

CONSTRUCTION JOINT
IF IT OCCURS AT CONTROL JOINTS

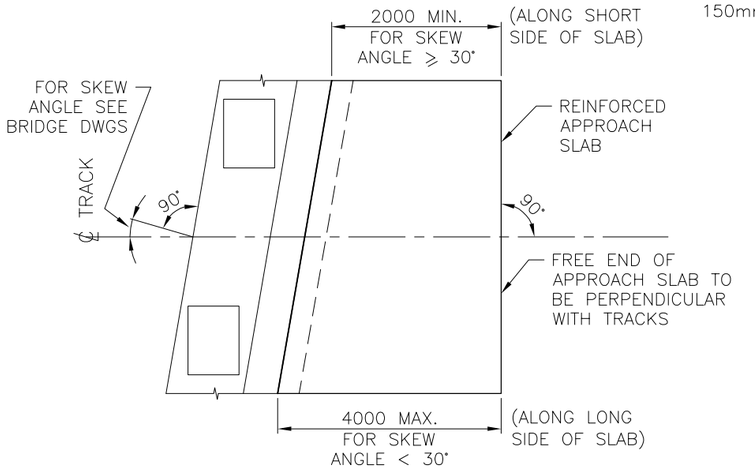


CONSTRUCTION JOINT
IF IT OCCURS IN MIDDLE THIRD
OF NORMAL JOINT INTERVAL

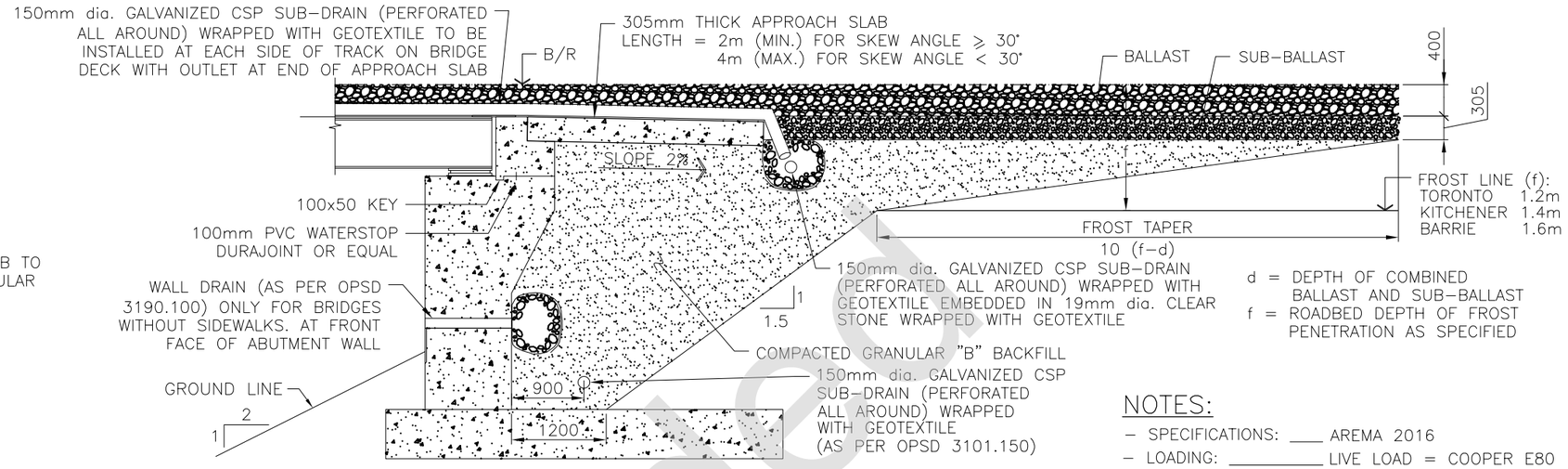
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**CONCRETE SLAB - JOINT DETAILS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero
C10m
–



PLAN



MIN. GRANULAR BACKFILL REQUIREMENTS

NOTES:

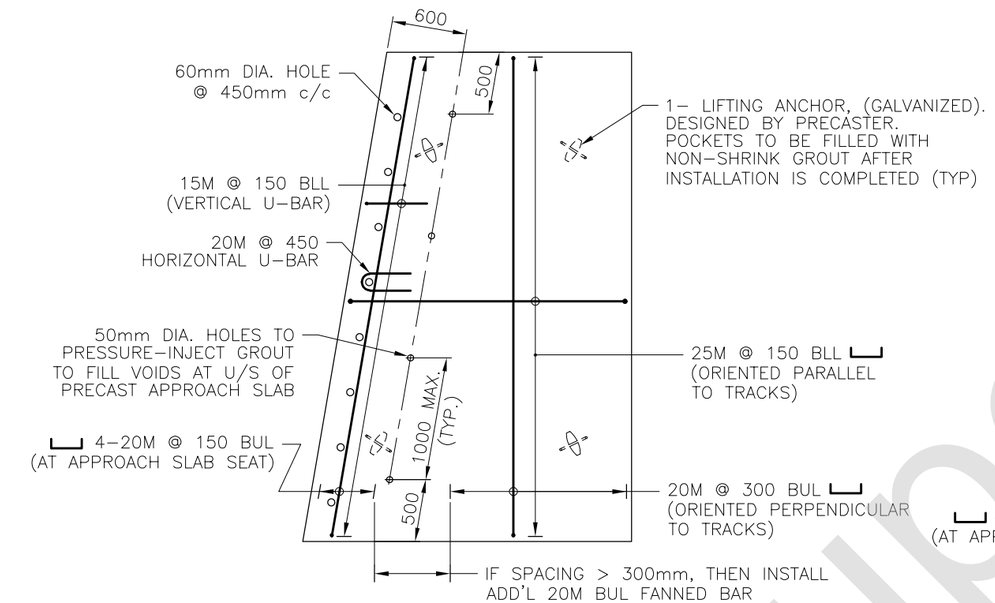
- SPECIFICATIONS: ____ AREMA 2016
- LOADING: _____ LIVE LOAD = COOPER E80
- CONCRETE: _____ SHALL BE CLASS C-1 5,000PSI @ 28 DAYS
- CONVENTIONAL REINFORCING: _____ SHALL BE NEW BILLET STEEL GRADE 400MPa, MEETING THE REQUIREMENTS OF CSA STANDARD CAN/CSA-G30.18
- GALVANIZING: _____ ASTM A123
- HIGH PERFORMANCE 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:

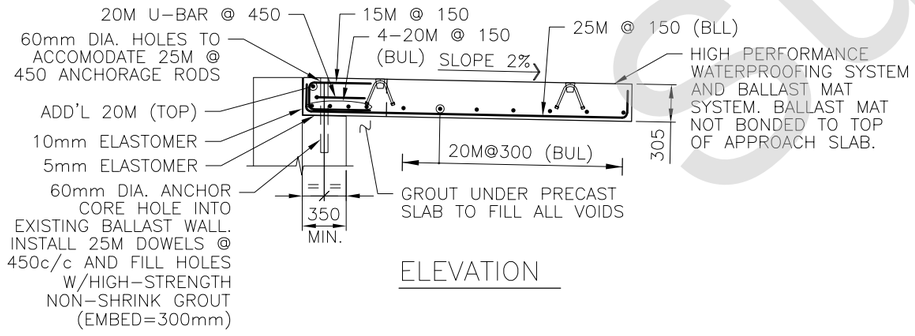
OPSD 3101.150	WALLS – ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD 3190.100	WALLS – RETAINING AND ABUTMENT, WALL DRAIN

LIST OF ABBREVIATION:

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

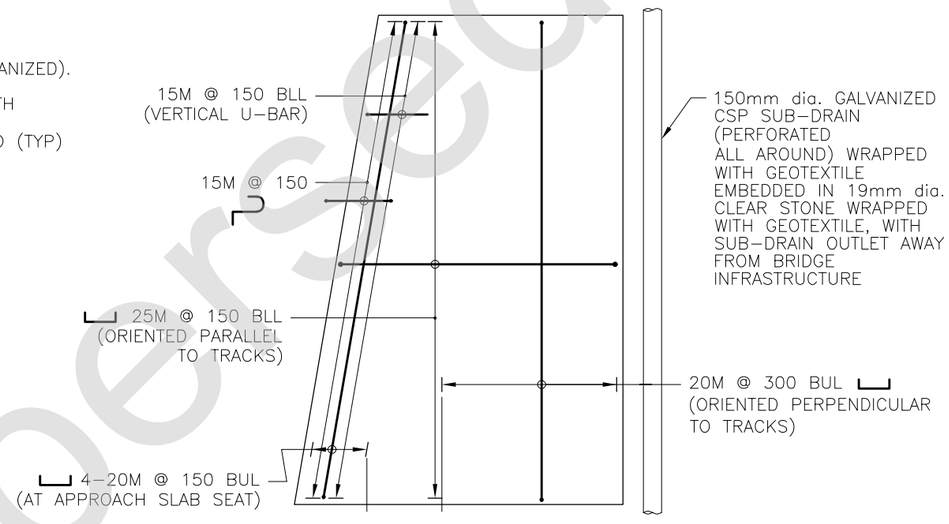


PLAN

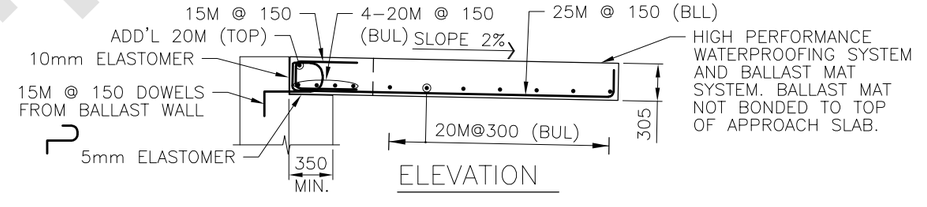


ELEVATION

PRECAST APPROACH SLAB – DETAILS



PLAN



ELEVATION

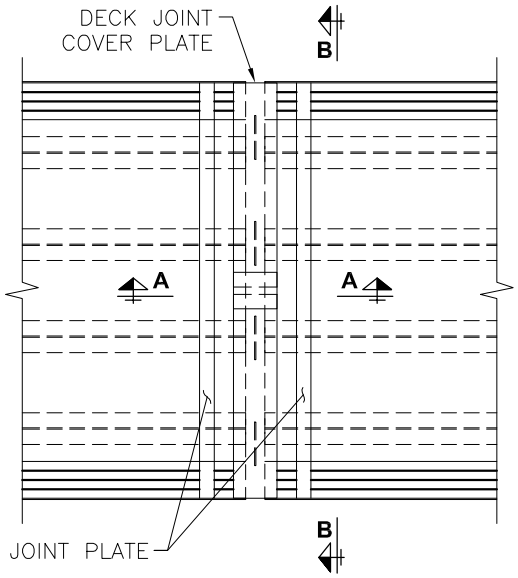
CAST-IN-PLACE APPROACH SLAB – DETAILS

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

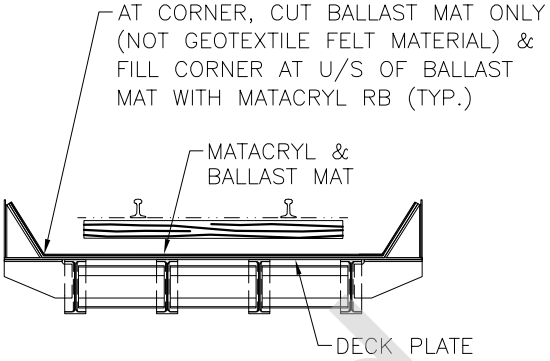
RAILWAY BRIDGE
APPROACH SLAB

METROLINX

Drawing Number
Dessin Numero
C15m

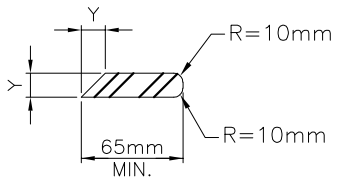


STEEL BALLAST PAN PLAN VIEW

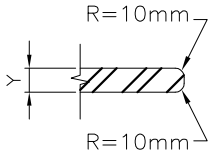


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 25mm

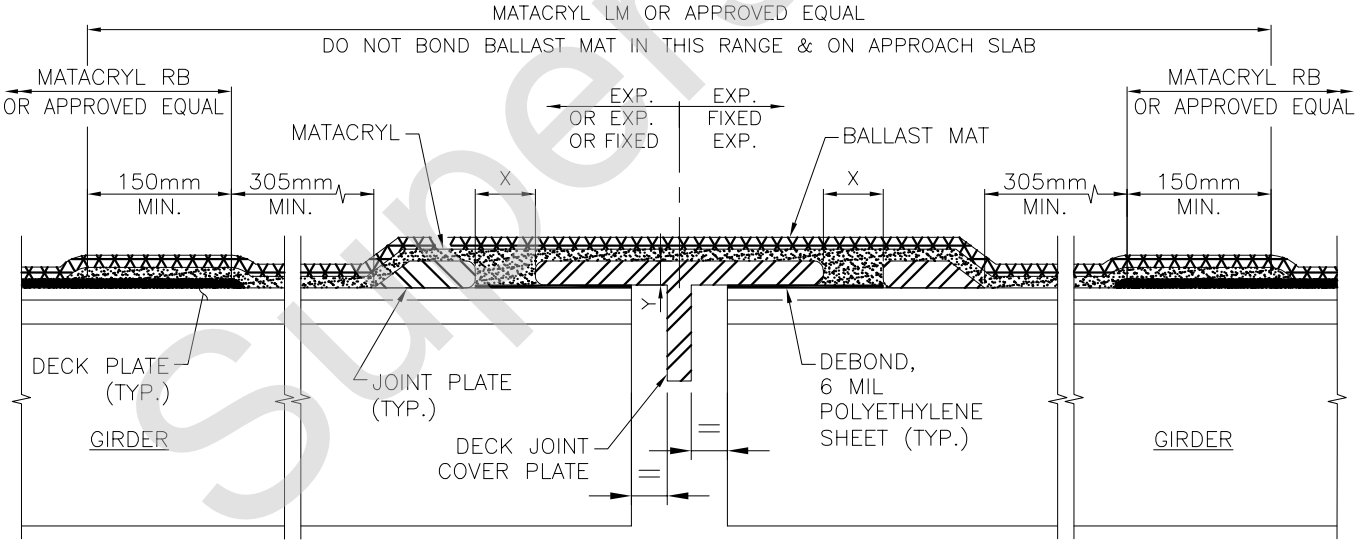


JOINT PLATE DETAIL



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 ℄



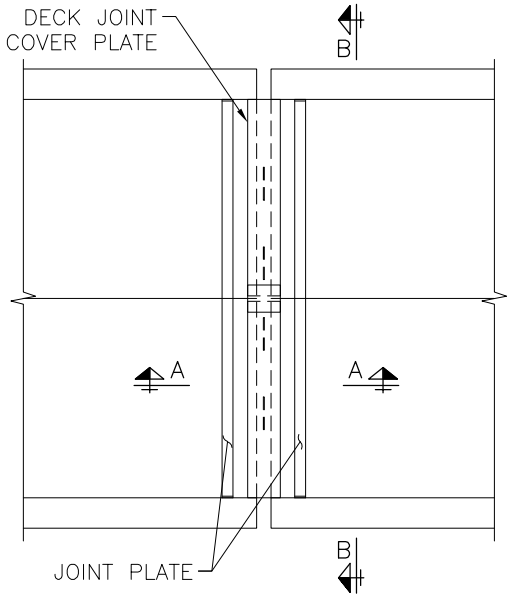
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

SECTION A–A
(SCHEMATIC)

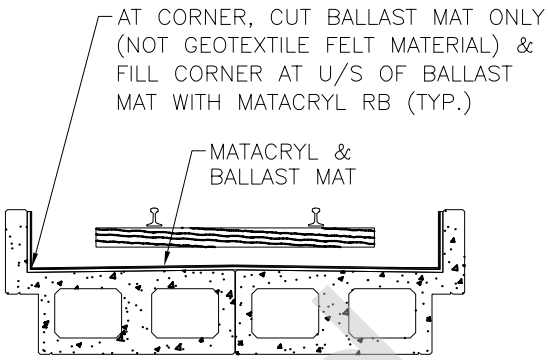
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT JOINTS BETWEEN STEEL BALLAST PANS**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero
C16m –

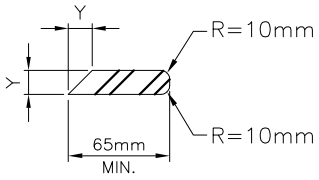


CONCRETE PAN PLAN VIEW

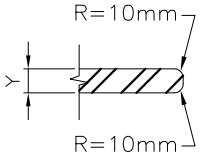


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 25mm

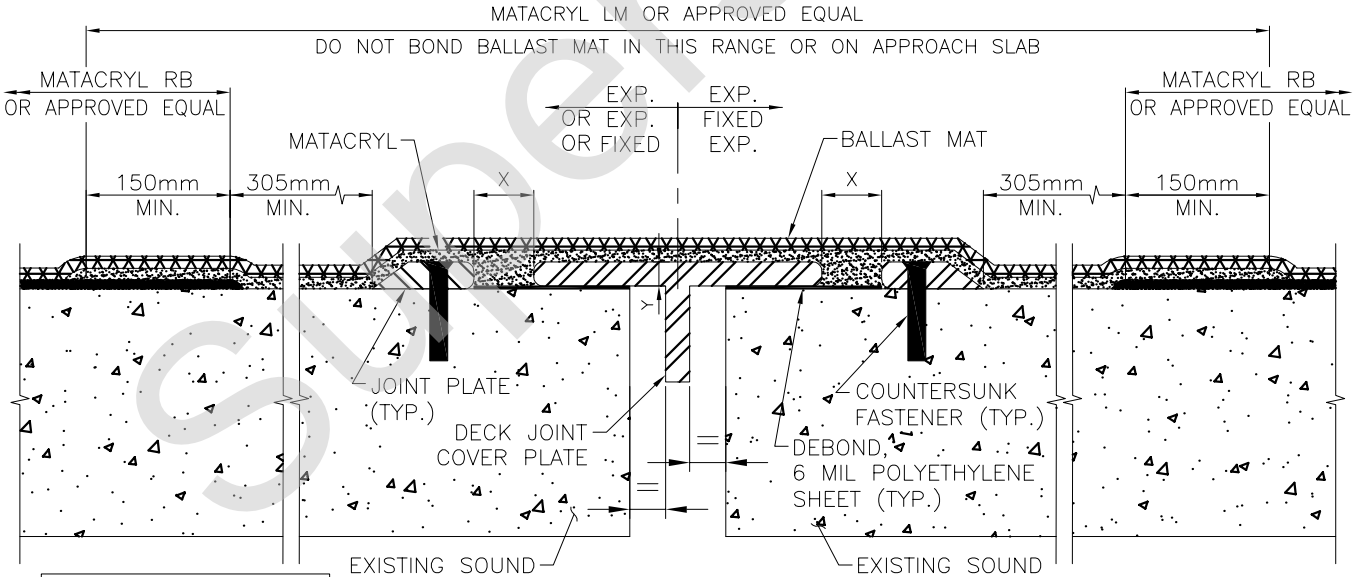


JOINT PLATE DETAIL



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 ℄



SECTION A–A
(SCHEMATIC)

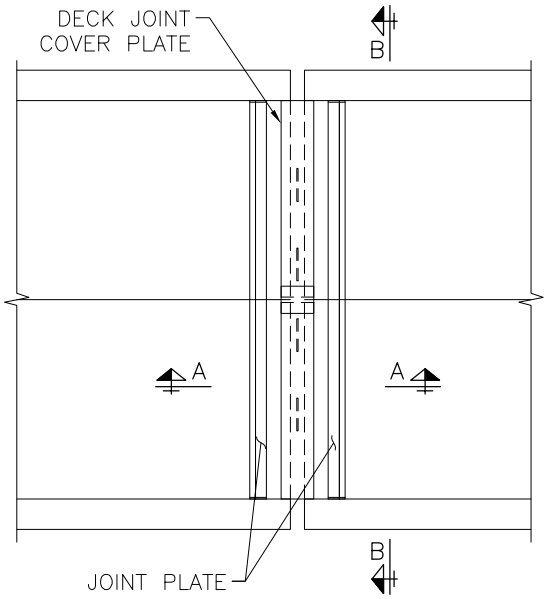
LIST OF ABBREVIATIONS:
LM = LOW MODULUS
RB = RAILWAY BRIDGE

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

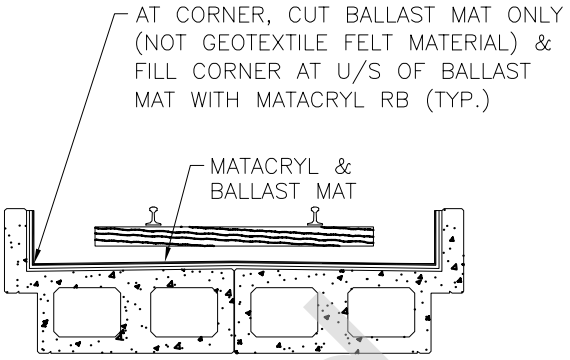
METROLINX

Drawing Number
Dessin Numero
C17m

–

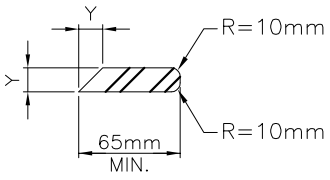


CONCRETE PAN PLAN VIEW

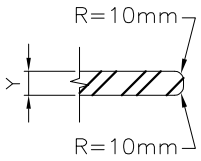


SECTION B–B

LEGEND:
X ≥ 2Y
Y ≥ 25mm

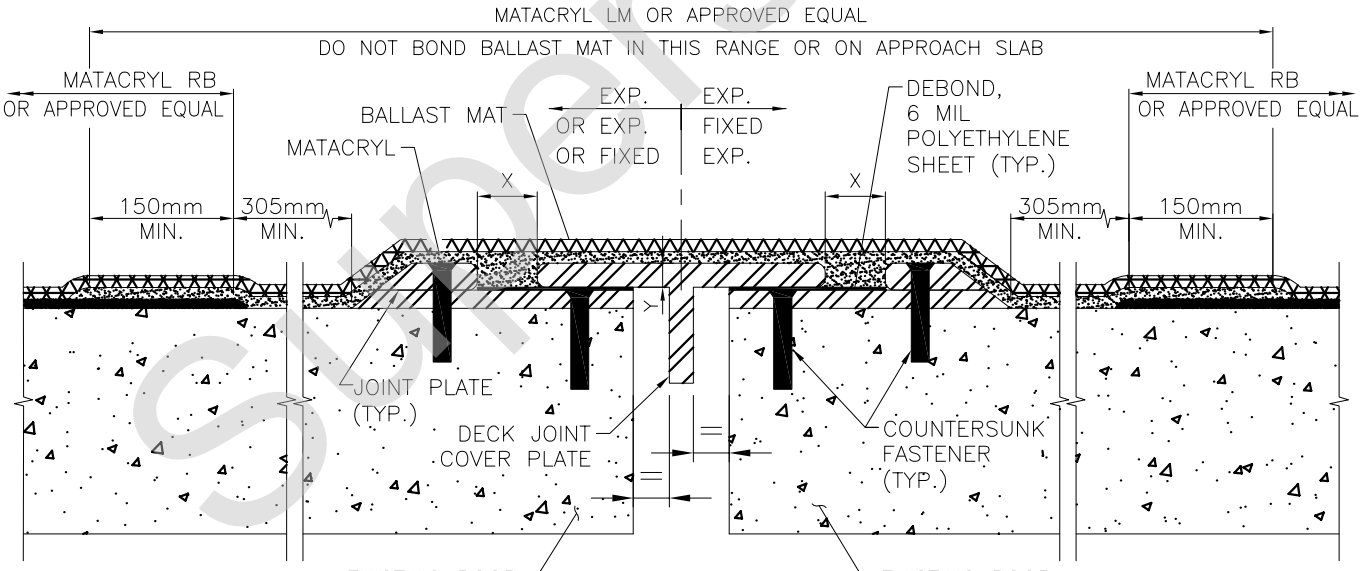


JOINT PLATE DETAIL



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 ℄



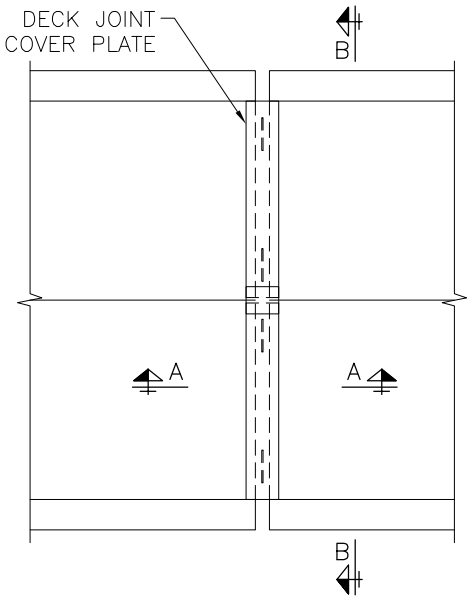
SECTION A–A
(SCHEMATIC)

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

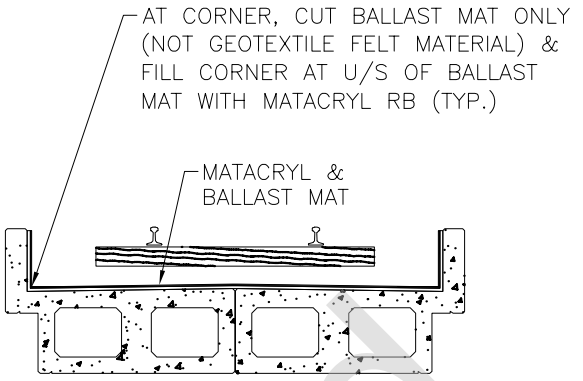
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**WATERPROOFING & BALLAST MAT DETAILS AT EXISTING (POOR) CONCRETE**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero
C18m
–

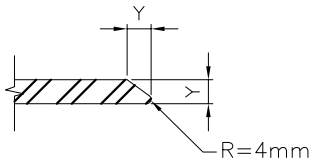


CONCRETE PAN PLAN VIEW



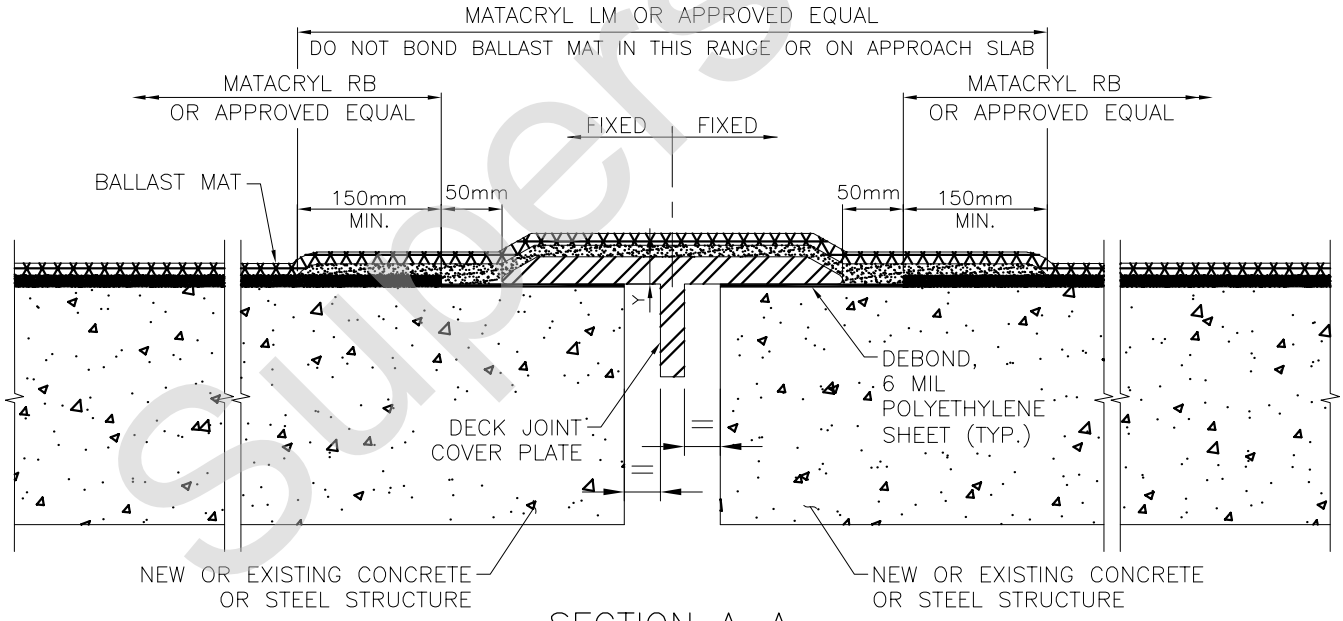
SECTION B–B

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



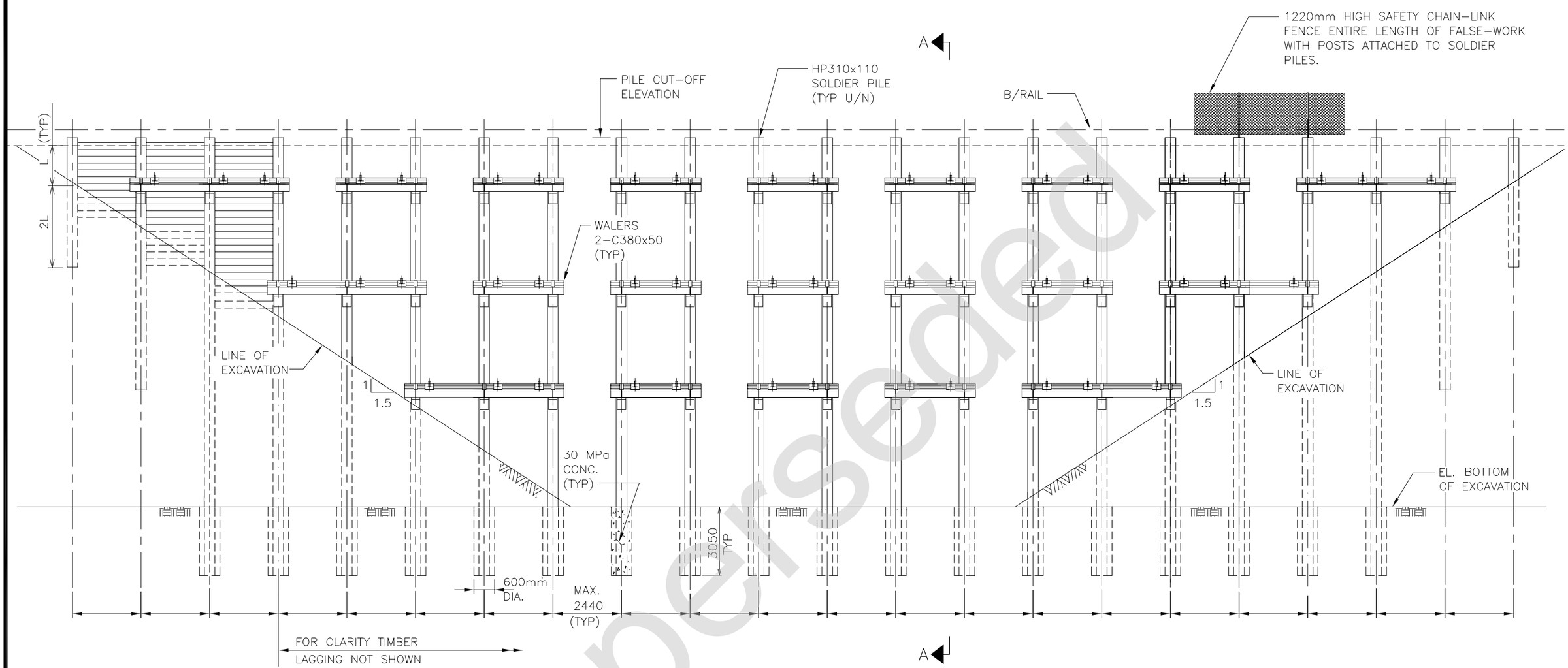
SECTION A–A
(SCHEMATIC)

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

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

METROLINX

Drawing Number
Dessin Numero
C19m –

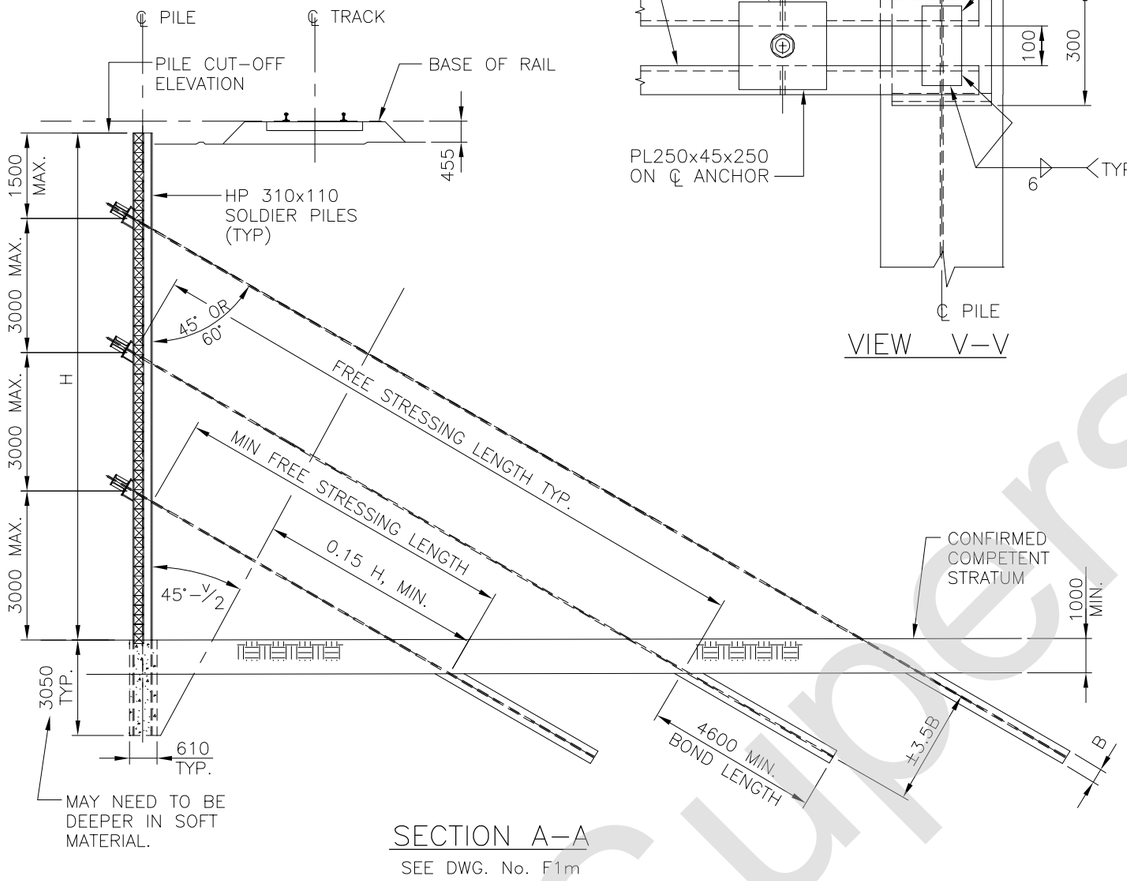


ELEVATION

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.

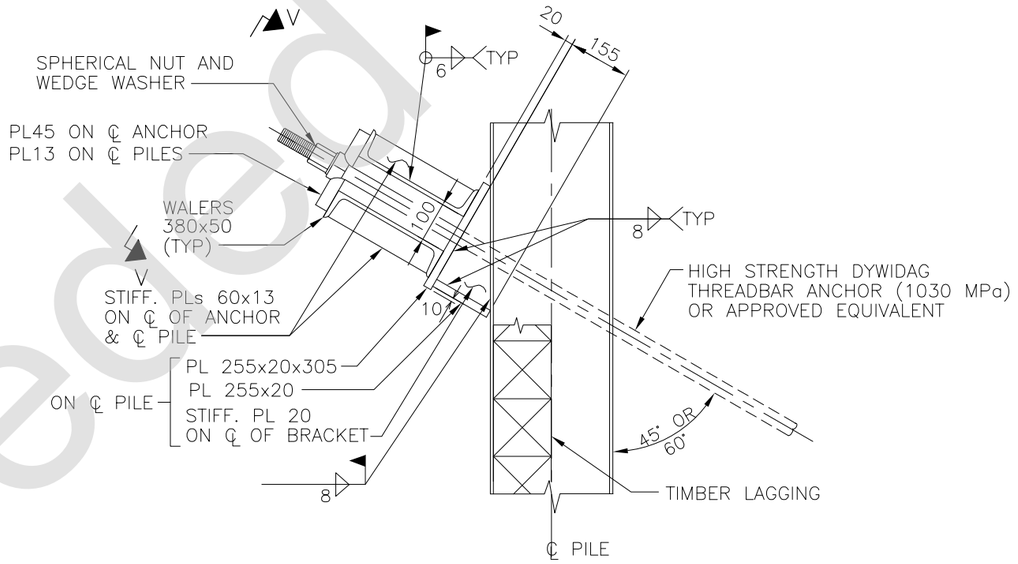
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**EXAMPLE OF TYPICAL TEMPORARY SHORING WALL**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **F1m**	–



SECTION A–A

SEE DWG. No. F1m

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 **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

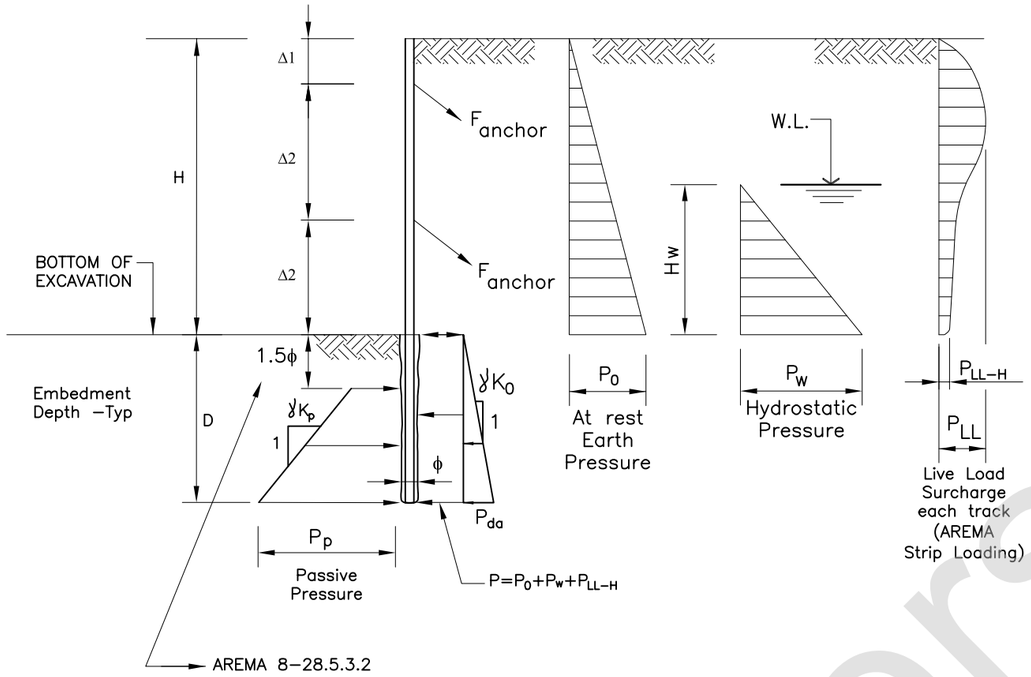
CONSTRUCTION PROCEDURE FOR SOLDIER PILES, LAGGING AND TIE BACK ANCHORS:

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:
γ_{soil} = 21 kN/m3
γ_w = 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

$P_w = \gamma_w H_w$ (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).

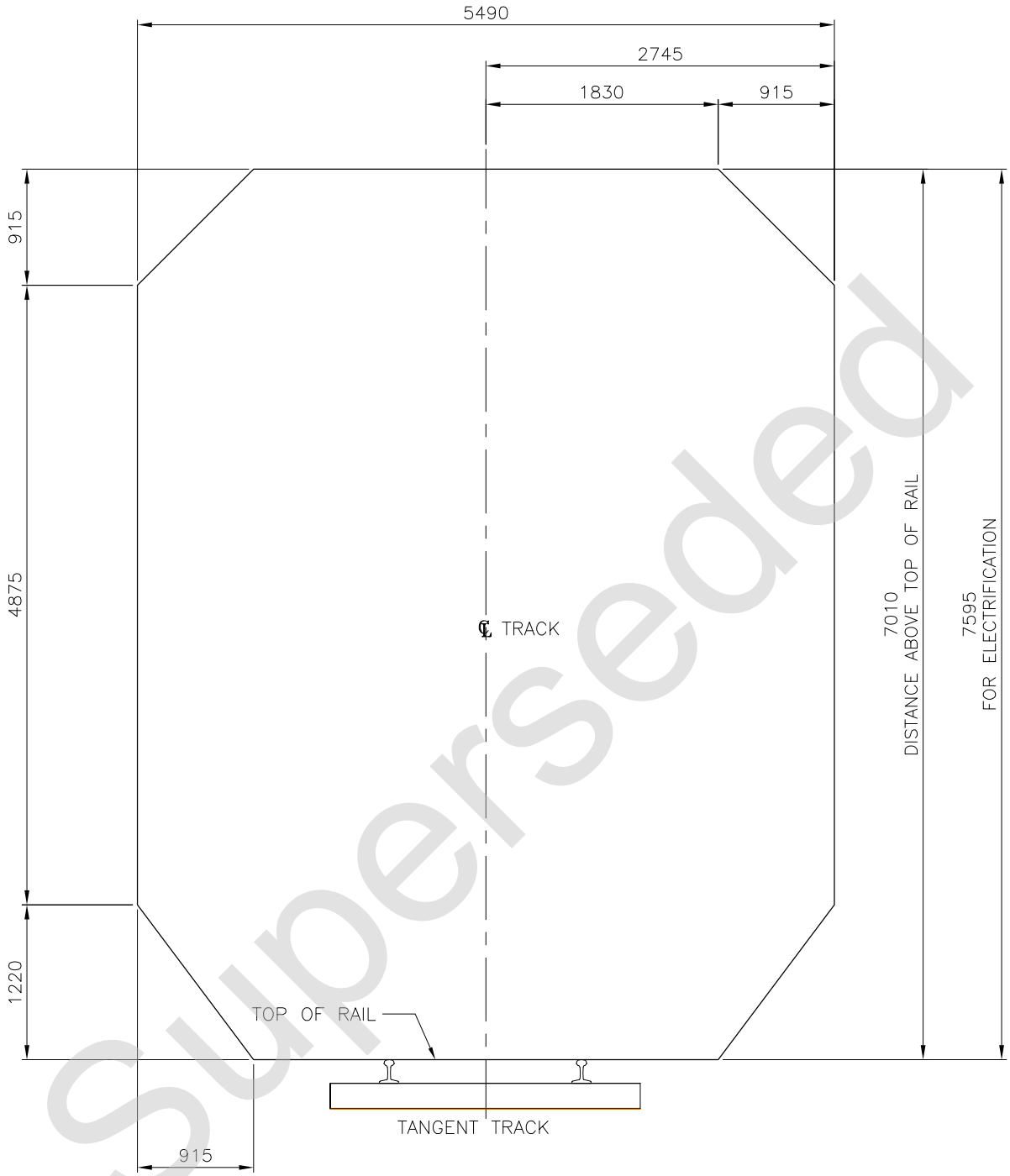
BOUSSINESQ METHOD

–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** –



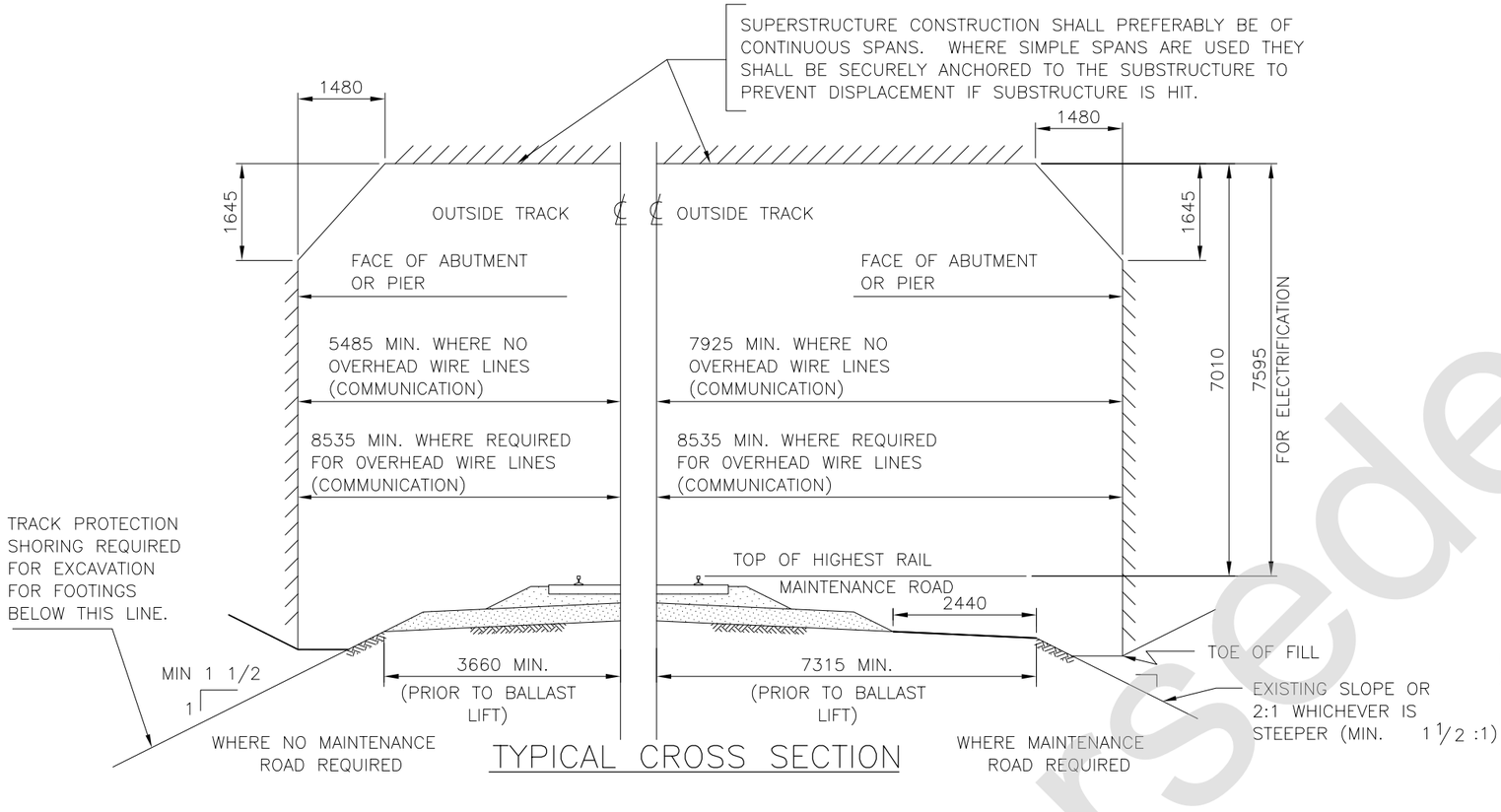
NOTE: SEE ARTICLE 1.2.6a FOR CURVE CORRECTIONS.
AREMA MANUEL FOR RAILWAY ENGINEERING – CHAPTER 15

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	

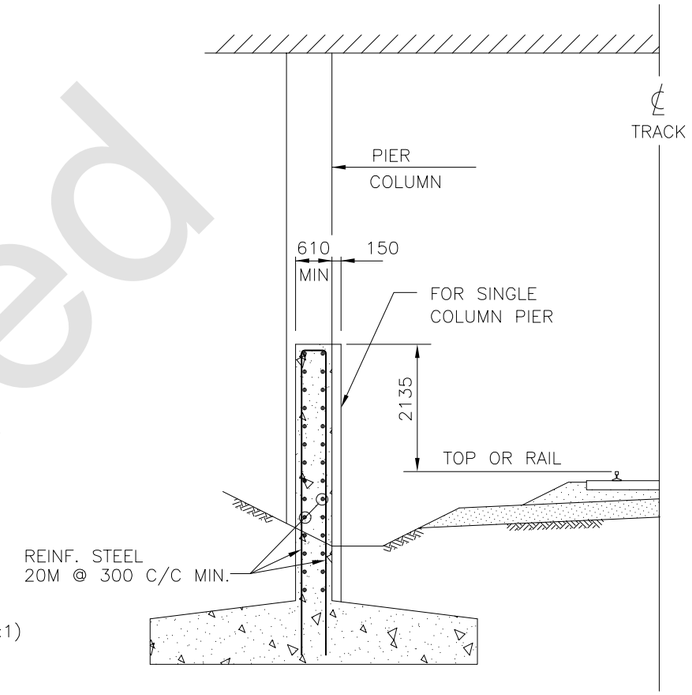
METROLINX

Drawing Number
Dessin Numero

K1U-10.1m –



TYPICAL CROSS SECTION



PROTECTION WALL DETAIL

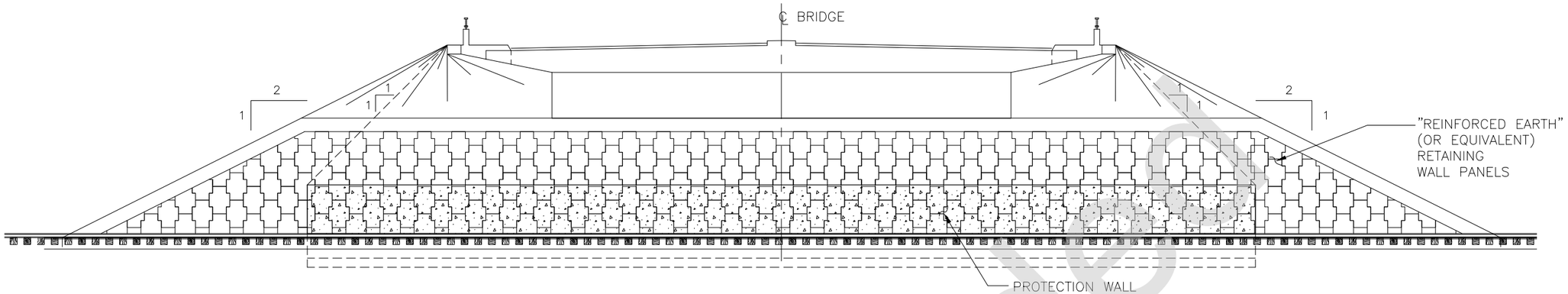
NOTES

- 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.

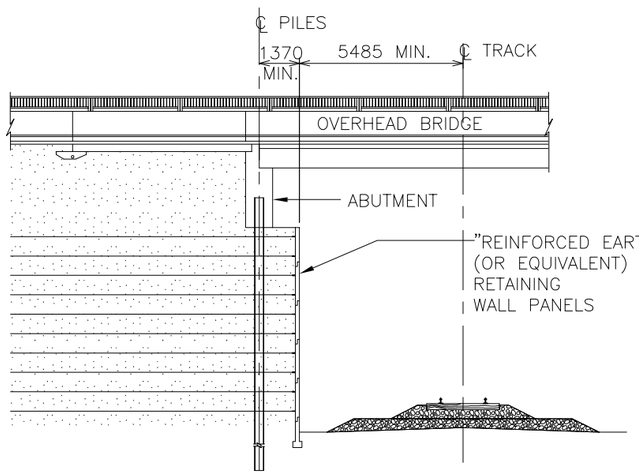
PIER PROTECTION

- 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.

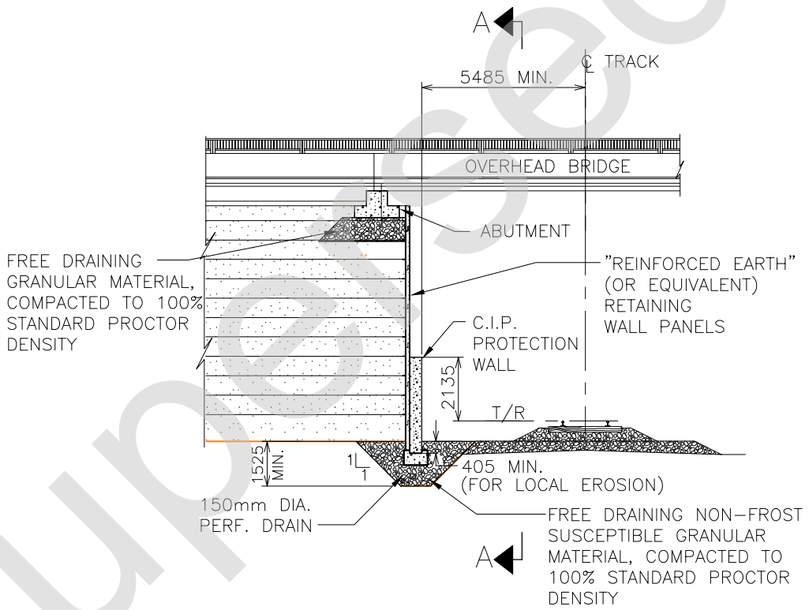
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**PROTECTION AND MINIMUM CLEARANCE FOR OVERHEAD BRIDGES**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero	**K1U-10.2m** –



SECTION A–A



TYPICAL SECTION FOR ABUTMENTS ON PILES

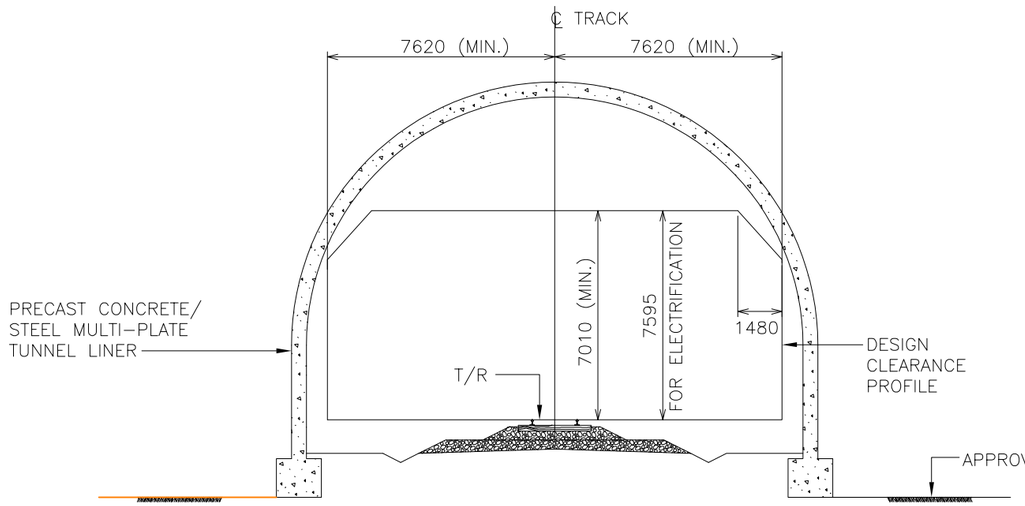


TYPICAL SECTION FOR ABUTMENTS ON GRANULAR BASE

NOTES:

- WHEN "REINFORCED EARTH" WALLS (OR EQUIVALENT) ARE TO BE CONSTRUCTED WITHIN 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.

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** –



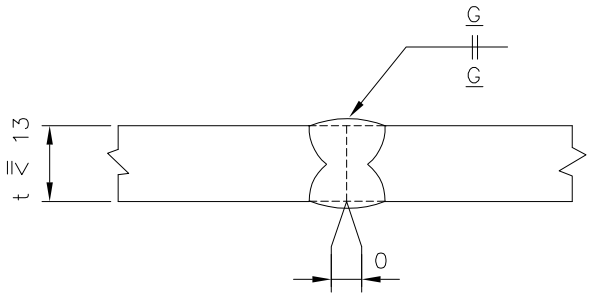
TYPICAL TUNNEL SECTION

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

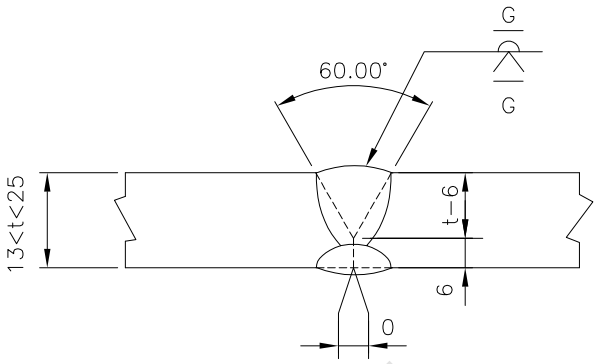
NOTES:

- 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** –



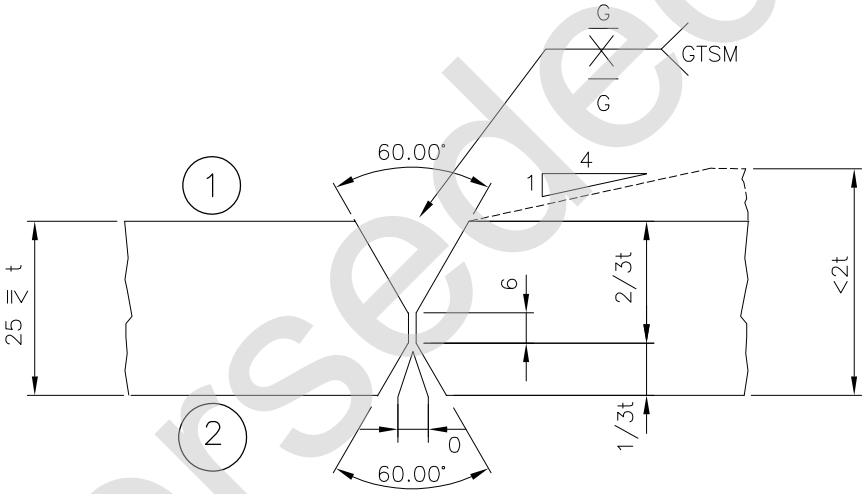
PLATES OF EQUAL THICKNESSES



PLATES OF EQUAL THICKNESSES

NO. OF PASSES WILL VARY WITH THICKNESS

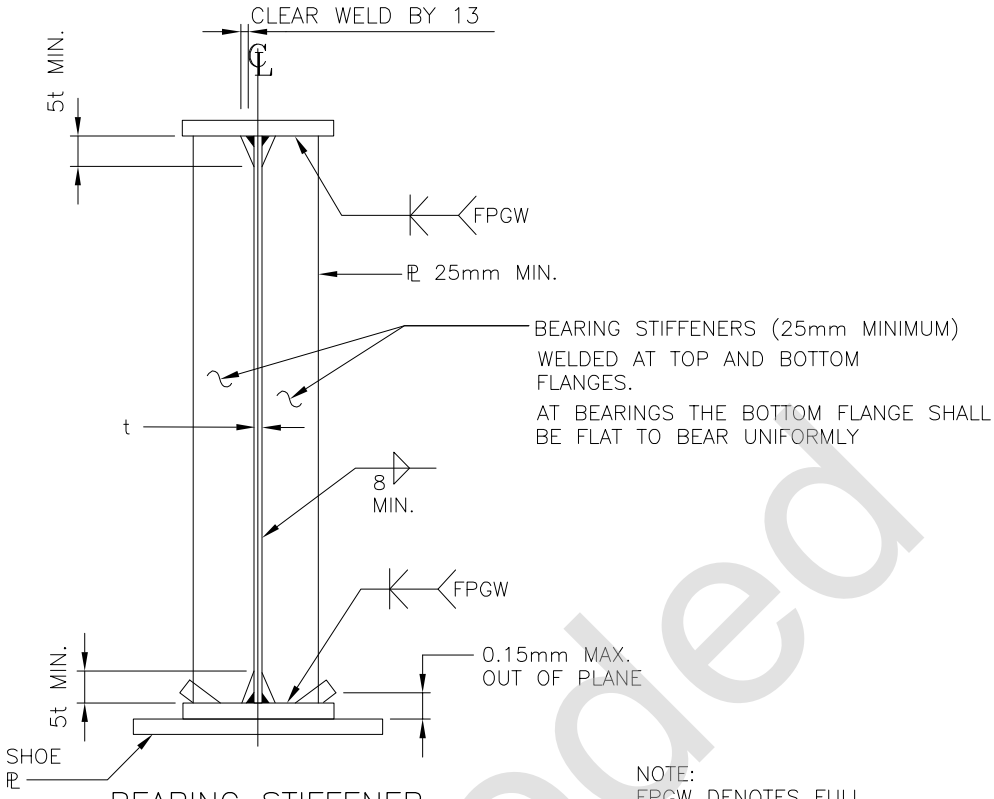
SIDE (2) GOUGED OUT TO SOUND METAL AFTER SIDE (1) IS WELDED, AND THEN WELD.



PLATES OF EQUAL OR UNEQUAL THICKNESSES

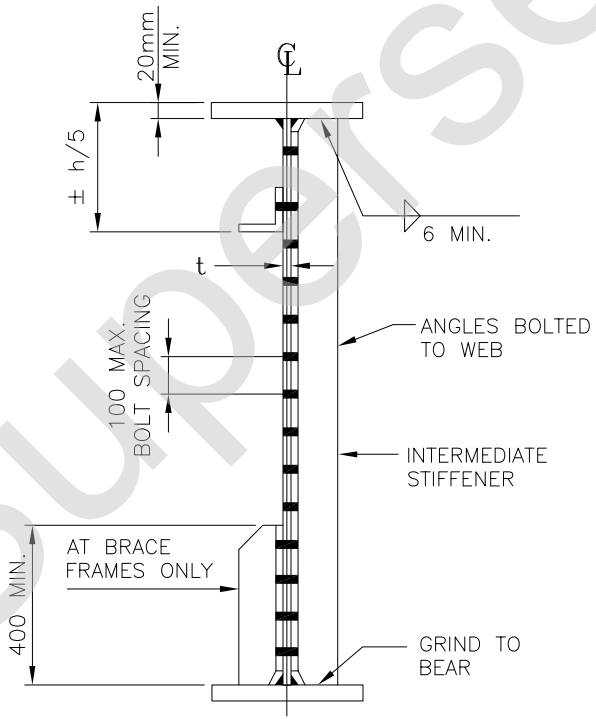
WELDING SHALL BE PERFORMED IN FLAT POSITION IN ACCORDANCE WITH CSA STANDARD W59. RUN-OFF PLATES SHALL BE USED TO ENSURE SOUND WELDS AND FULL THROAT THICKNESS, AND SHALL BE OF SAME MATERIAL AND GEOMETRY AS FLANGE AT JOINT. AFTER COMPLETION AND COOLING OF WELD, REMOVE RUN-OFF PLATES AND GRIND WELD FLUSH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



BEARING STIFFENER

NOTE:
FPGW DENOTES FULL
PENETRATION GROOVE WELD



INTERMEDIATE STIFFENER

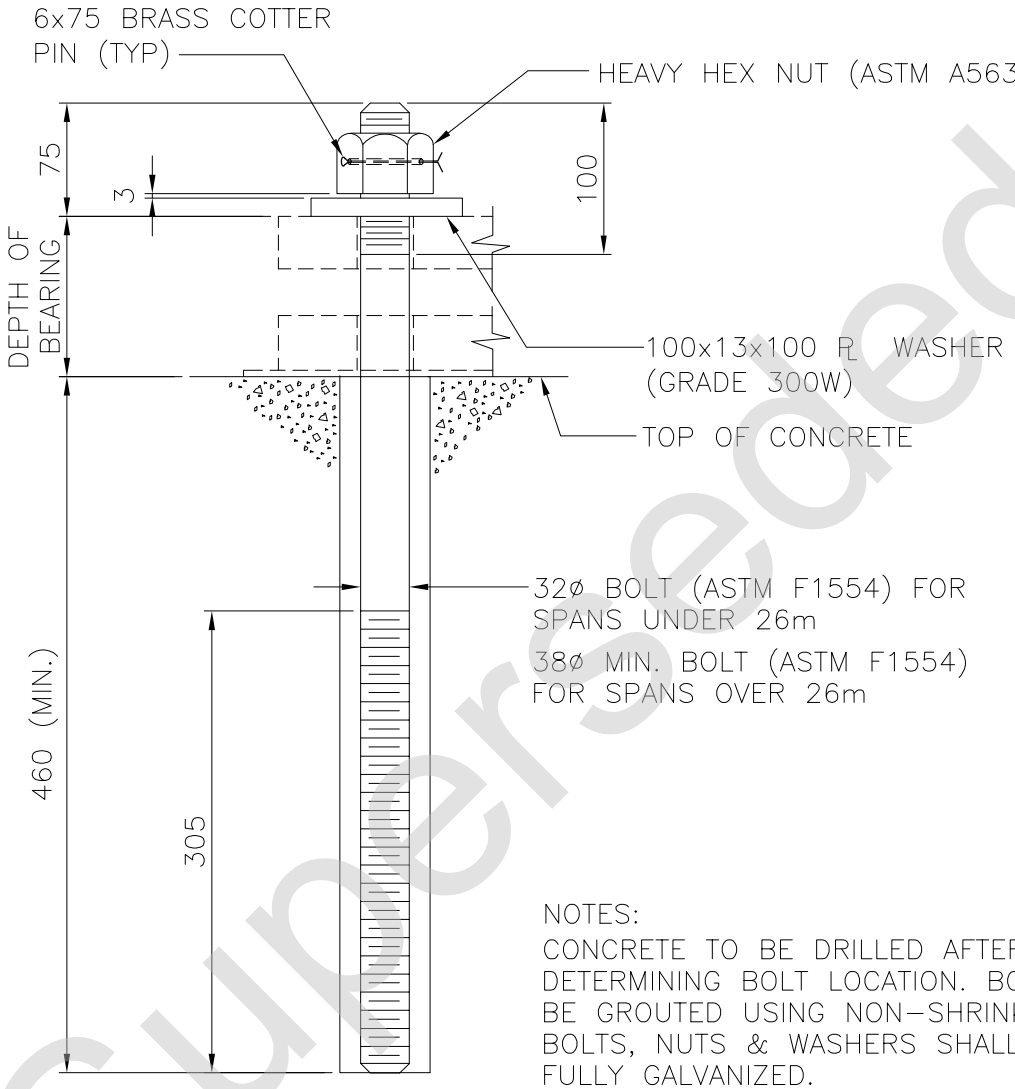
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STIFFENERS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

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.

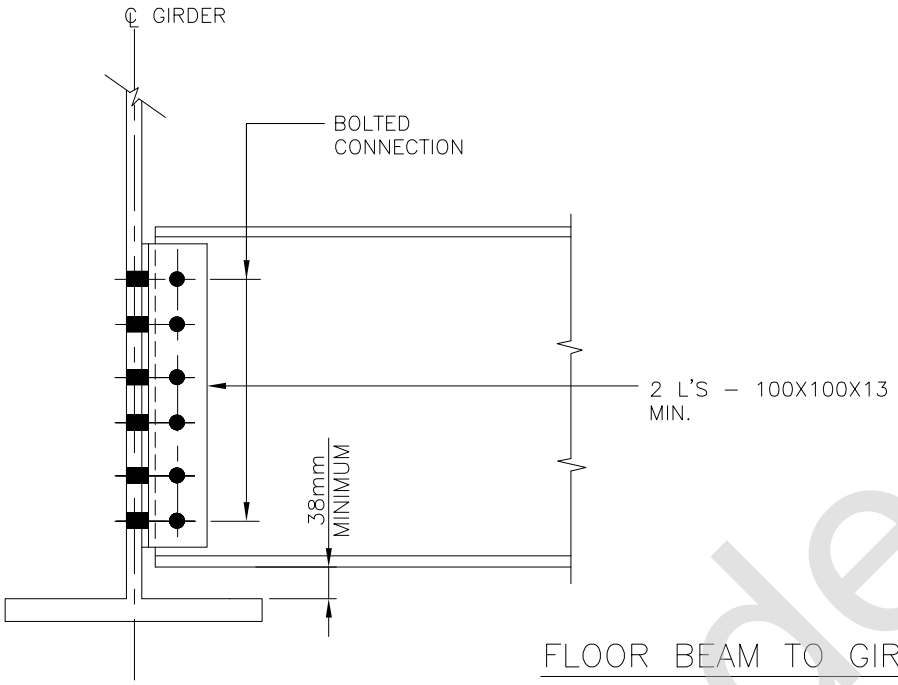
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ANCHOR BOLT**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

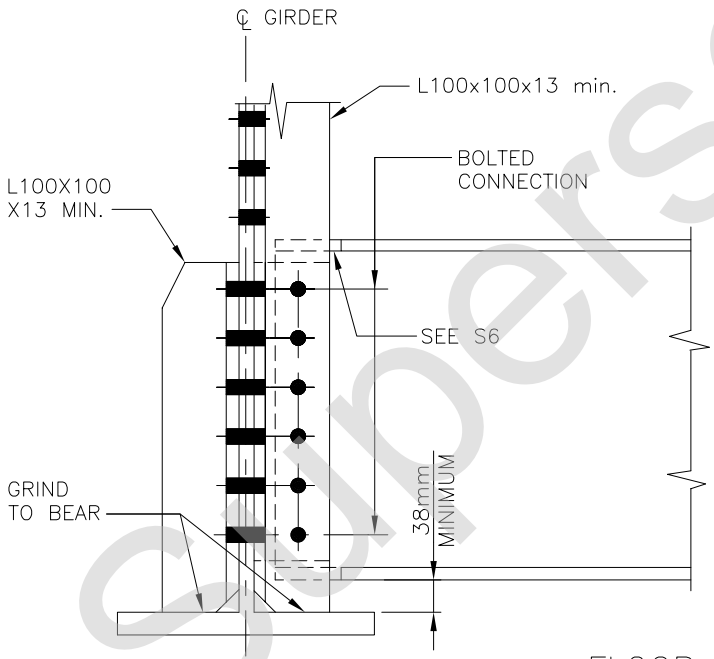
Drawing Number
Dessin Numero

S3m

–



FLOOR BEAM TO GIRDER WEB



NOTE

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

FLOOR BEAM TO GIRDER STIFFENER

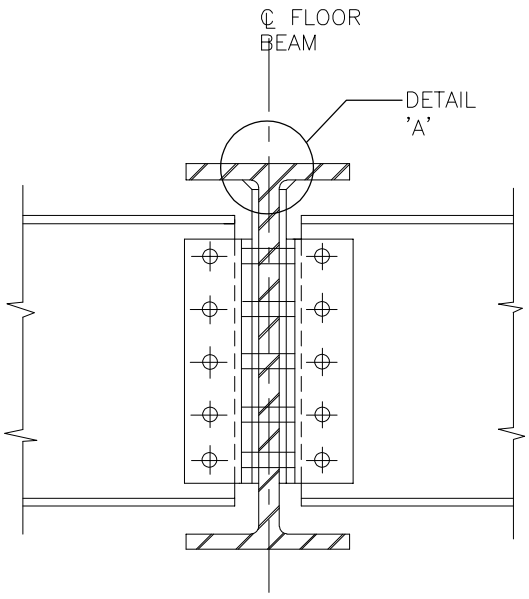
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**FLOOR BEAM CONNECTIONS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

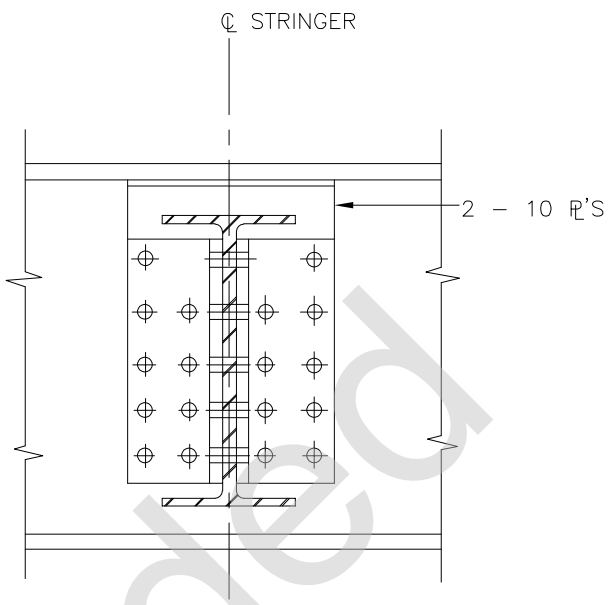
METROLINX

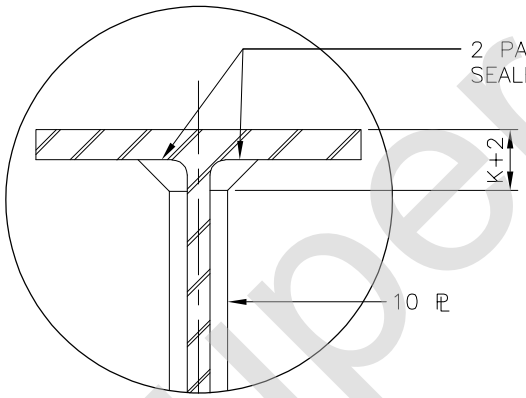
Drawing Number
Dessin Numero

S4m

–







DETAIL 'A'

NOTE:

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

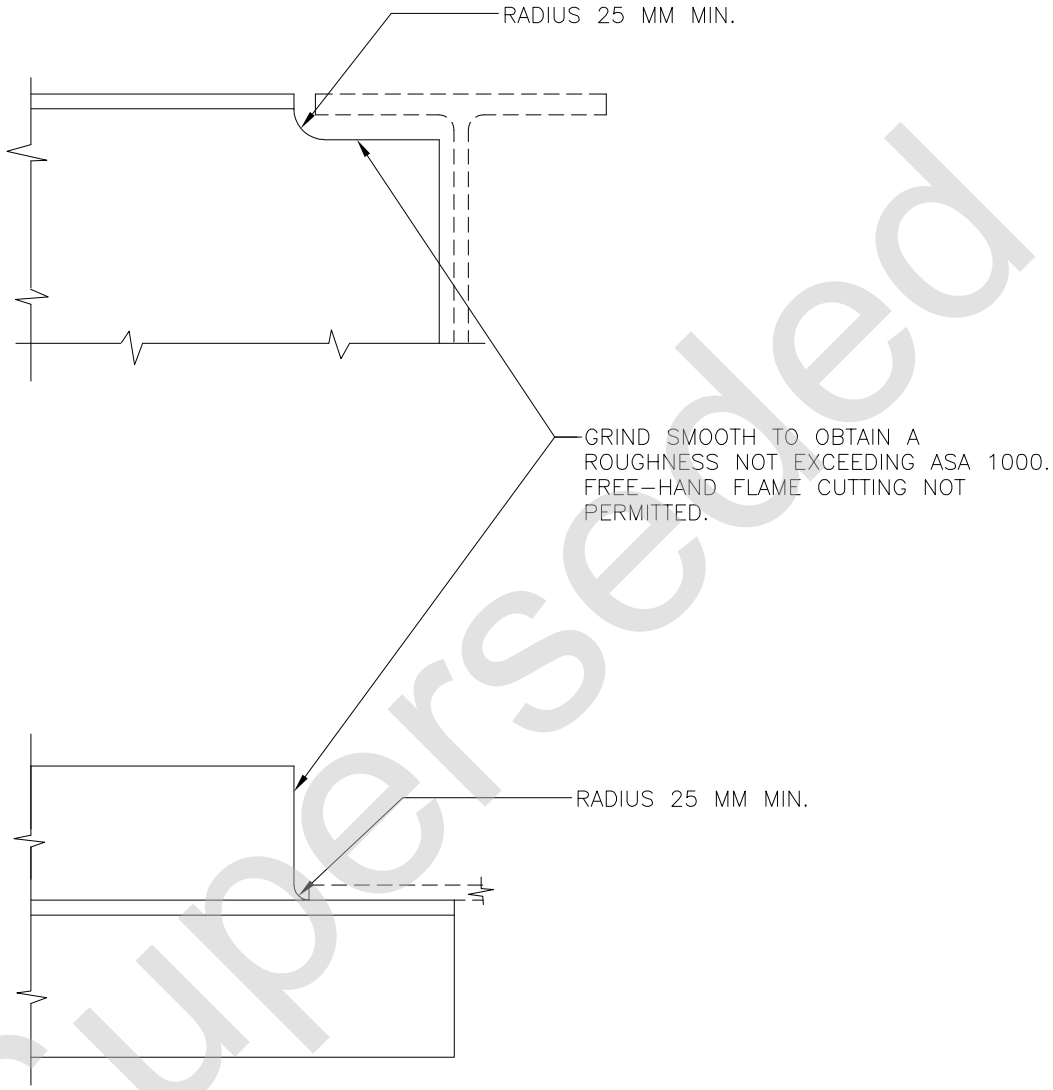
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STRINGER TO FLOOR BEAM CONNECTION OPEN DECK ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

S5m

–



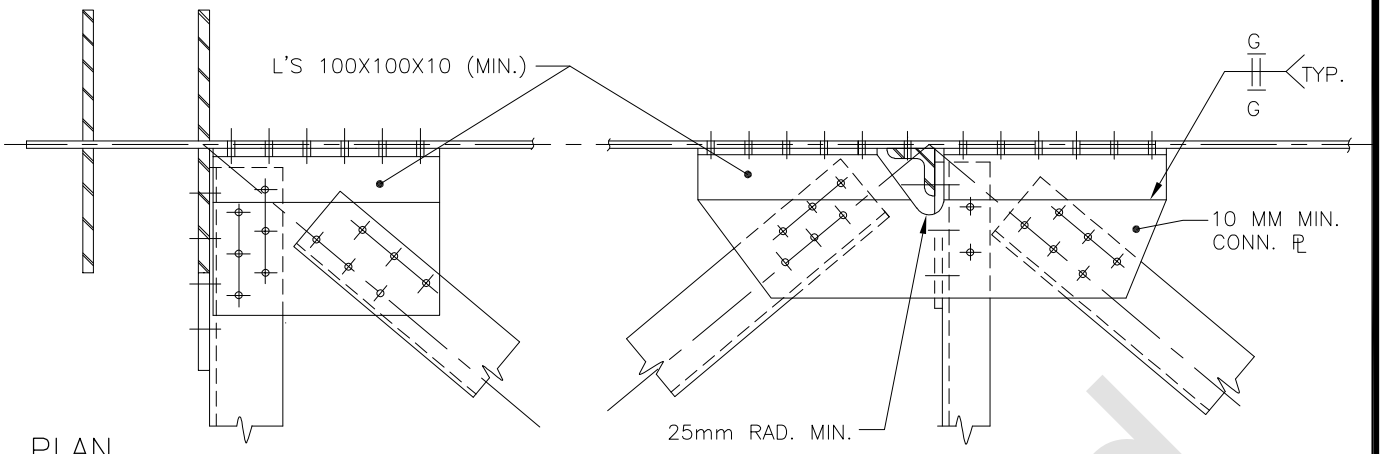
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**BEAM COPES**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

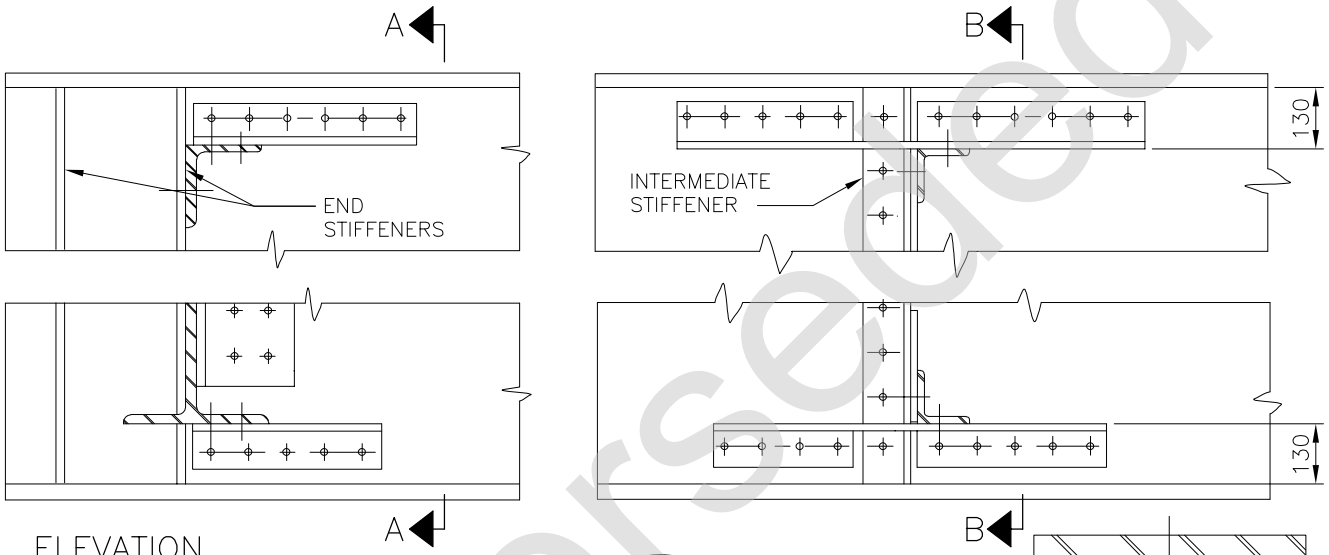
Drawing Number
Dessin Numero

S6m

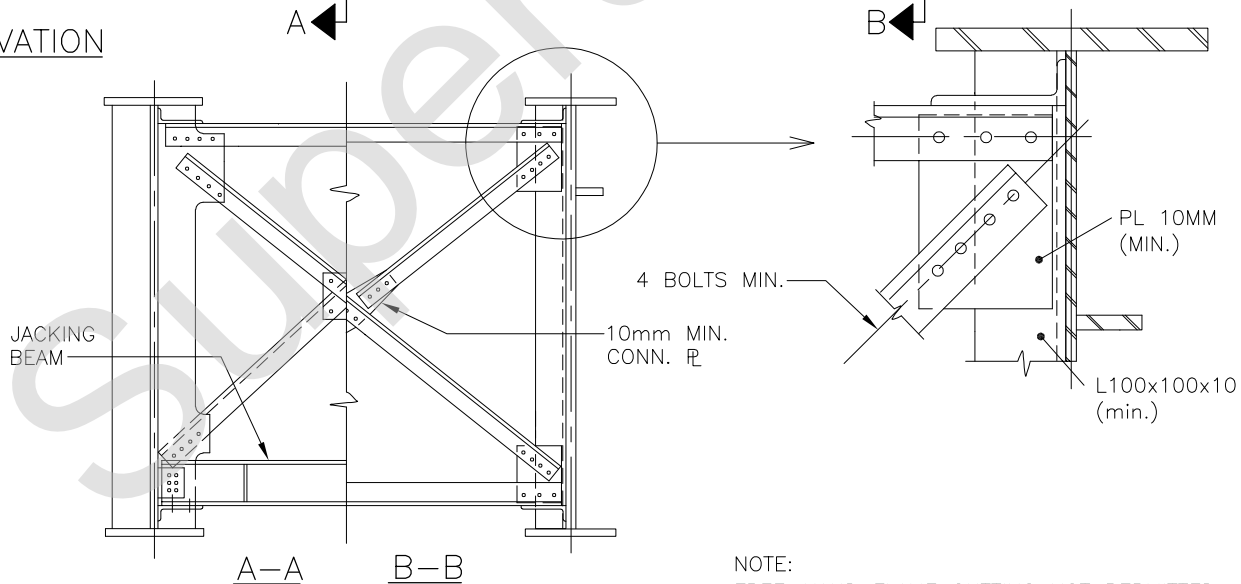
–



PLAN



ELEVATION



A–A B–B

HALF SECTION

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

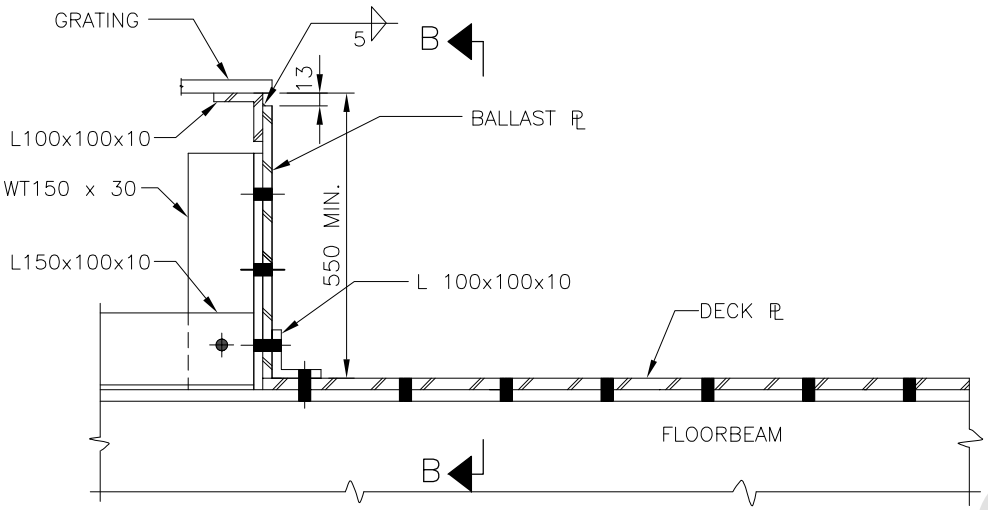
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**LATERAL BRACING FOR DPG SPANS**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

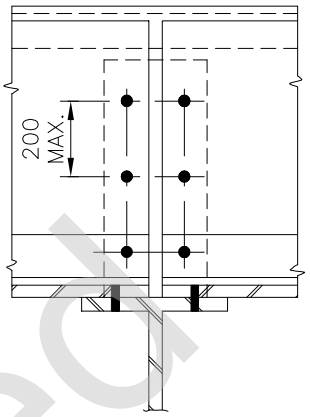
Drawing Number
Dessin Numero

S7m

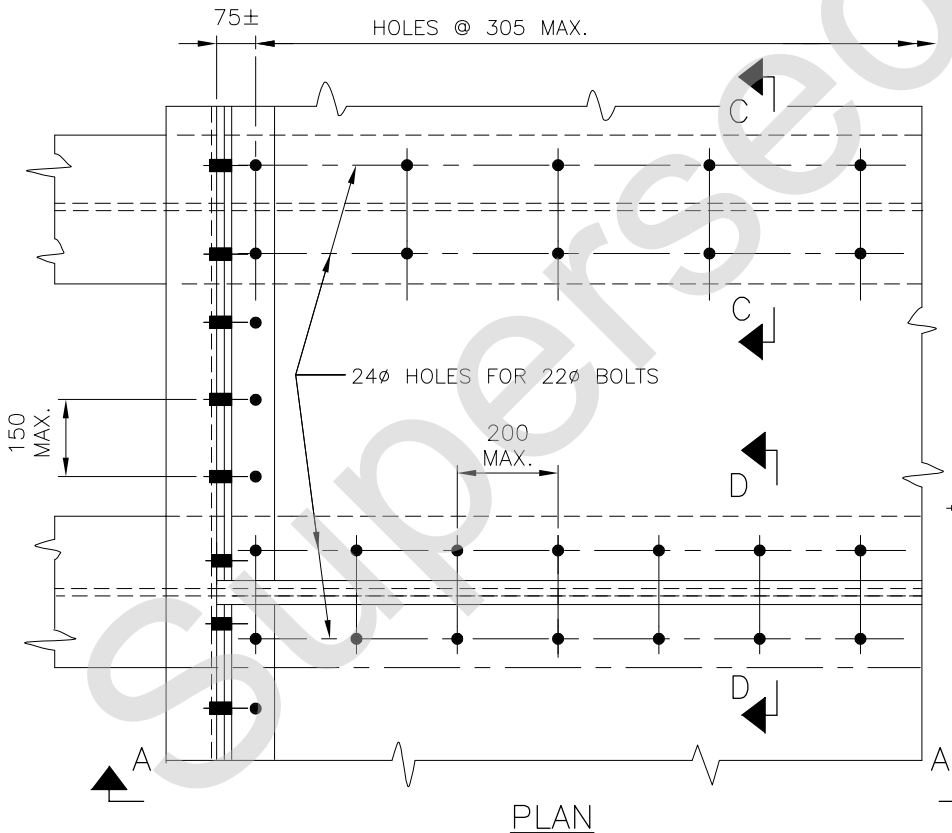
–



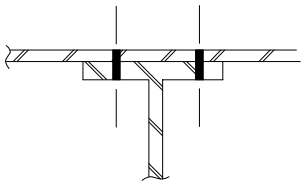
SECTION A–A



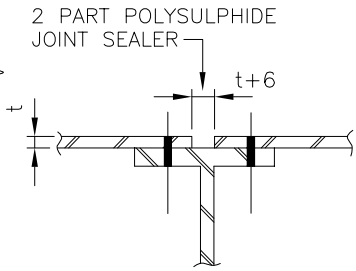
ELEVATION B–B



PLAN



SECTION C–C



SECTION D–D

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

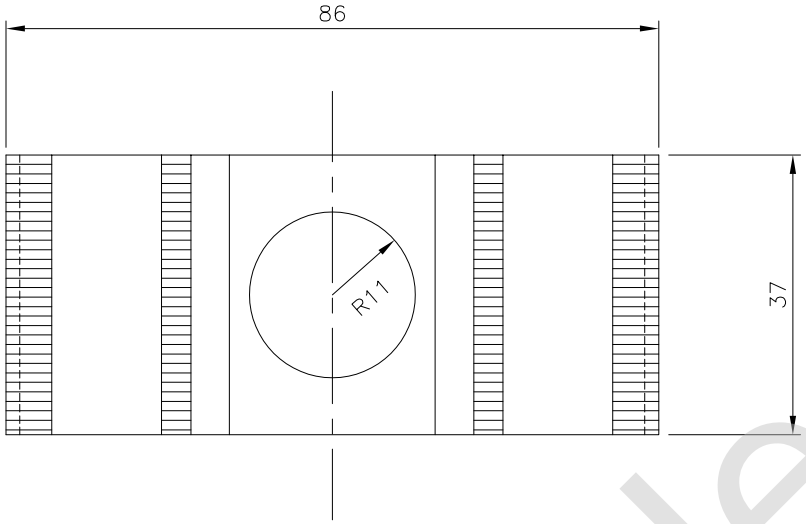
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**ATTACHMENT OF DECK PLATE BY BOLTING IN SHOP OR FIELD**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

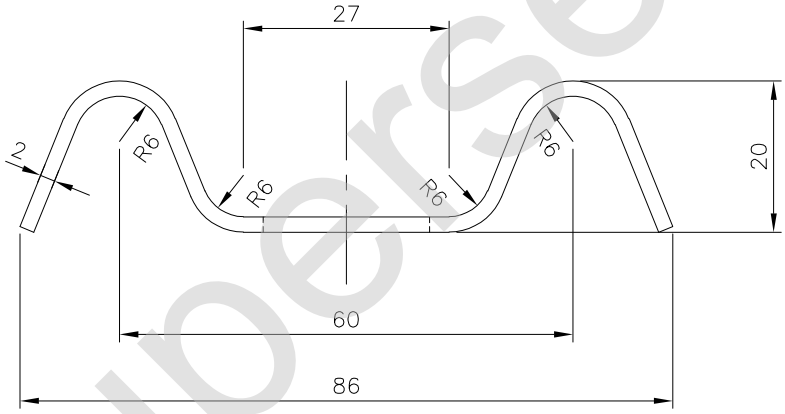
Drawing Number
Dessin Numero

S8m

–



PLAN



ELEVATION

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

CLIPS AVAILABLE FROM FISHER & LUDLOW OR APPROVED EQUIVALENT

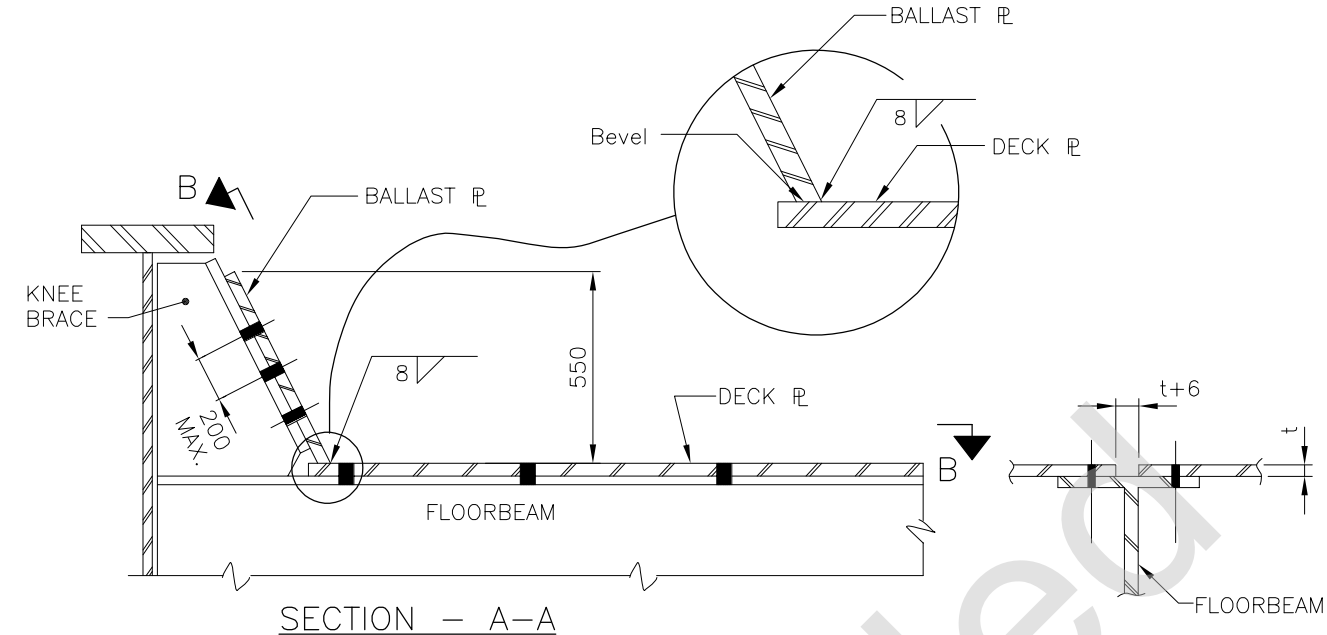
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TYPE H-3 SADDLE CLIP FOR 38-H-4 HEAVY DUTY GRATING**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

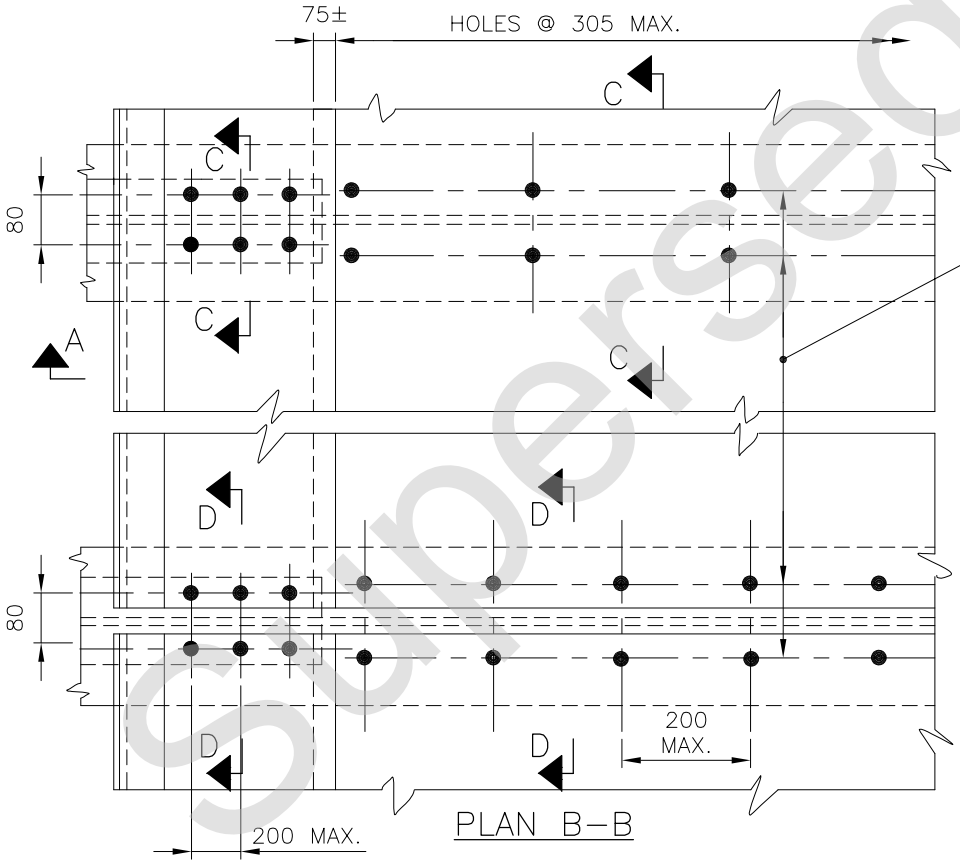
S9m

–

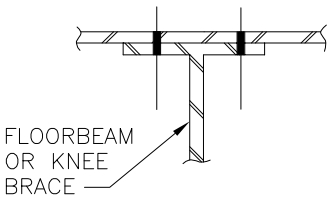


SECTION – A–A

SECTION D–D



PLAN B–B



SECTION C–C

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

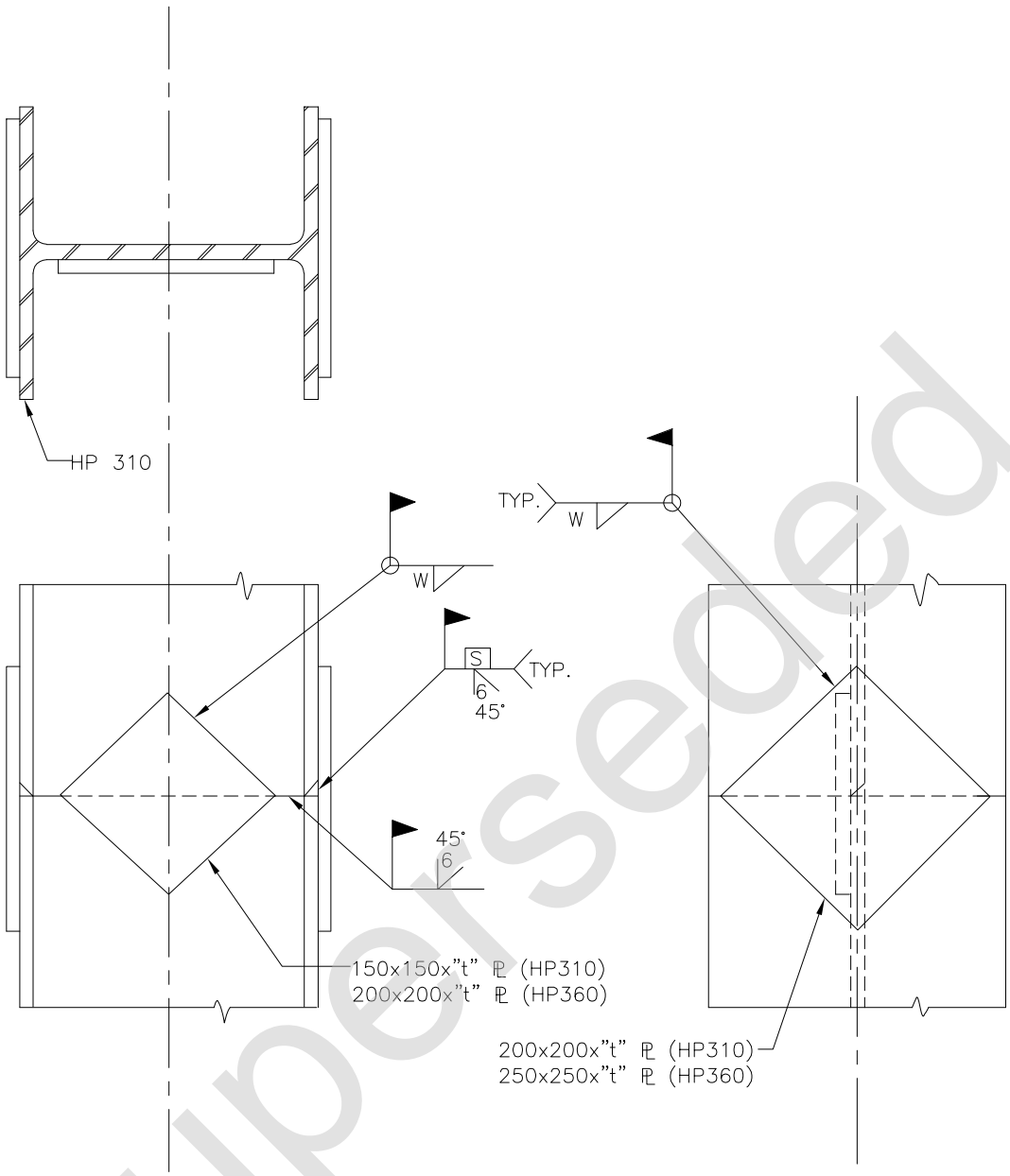
(FOR SQUARE SPANS 12M & OVER & ALL SKEWED SPANS)

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

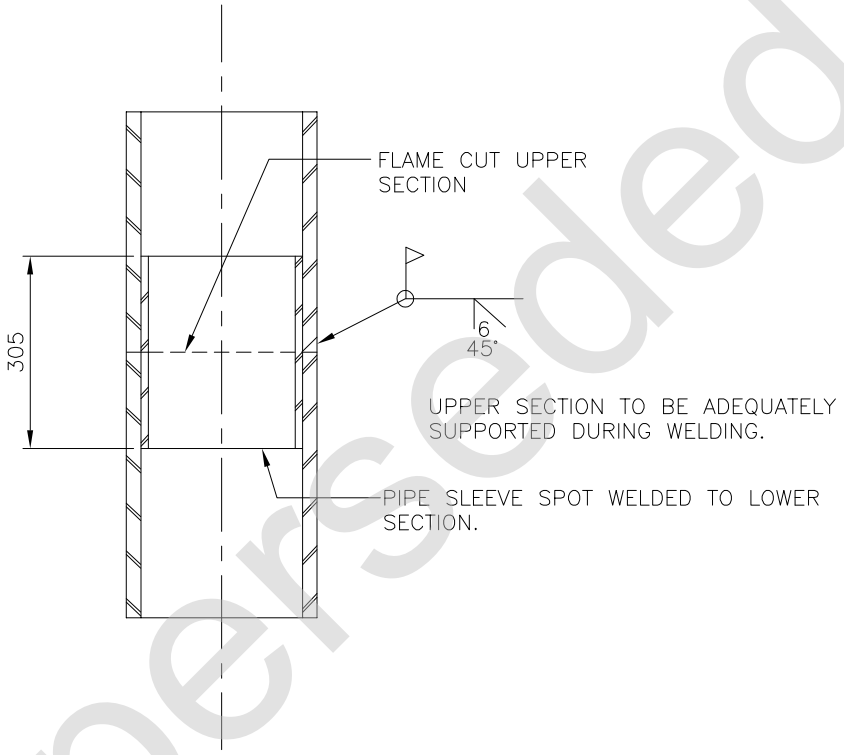
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**HP 310 & 360 PILE SPLICE FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

Drawing Number
Dessin Numero

S12m

–

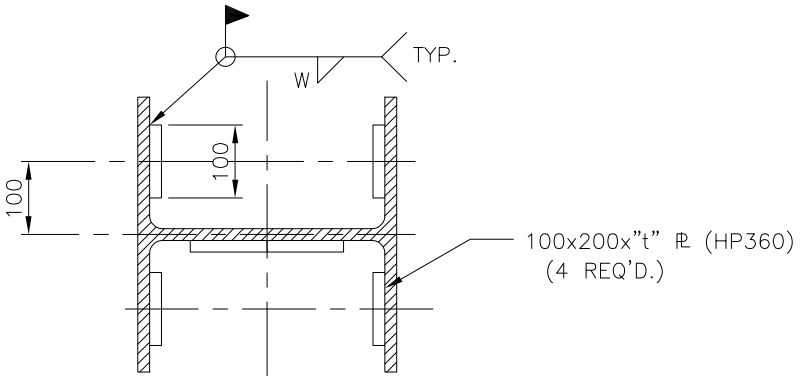


Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TUBULAR PILE SPLICE FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

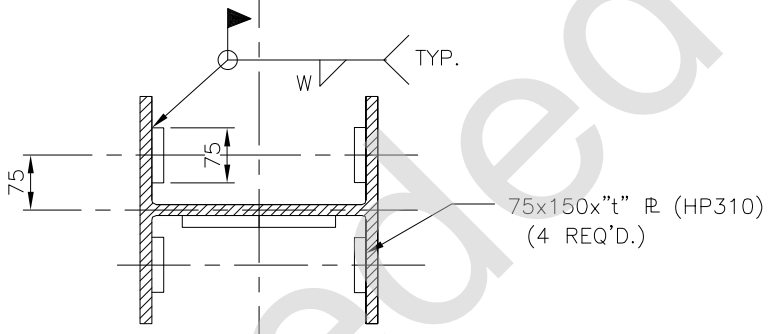
METROLINX

Drawing Number
Dessin Numero

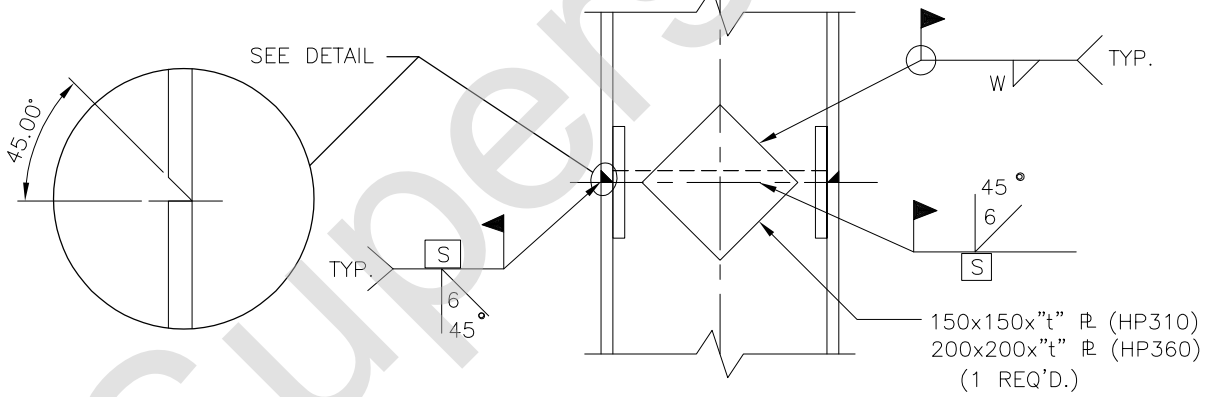
S13m –



HP360



HP310



USE E48018 ELECTRODES

PILE	t	W
HP310x79	13	8
HP310x110	16	10
HP360x108	13	10
HP360x132	16	10

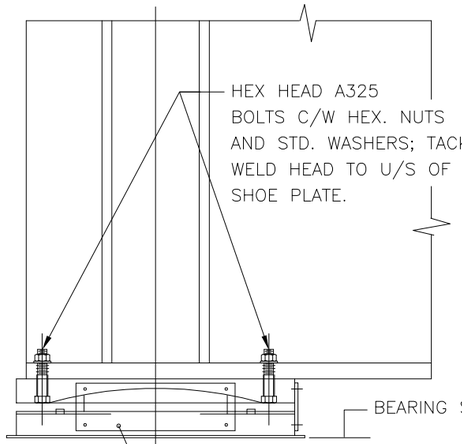
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**HP 310 & 360 PILE SPLICE DETAIL FOR DRIVING THROUGH TEMPLATE FOR AXIAL LOAD ONLY**
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31	

METROLINX

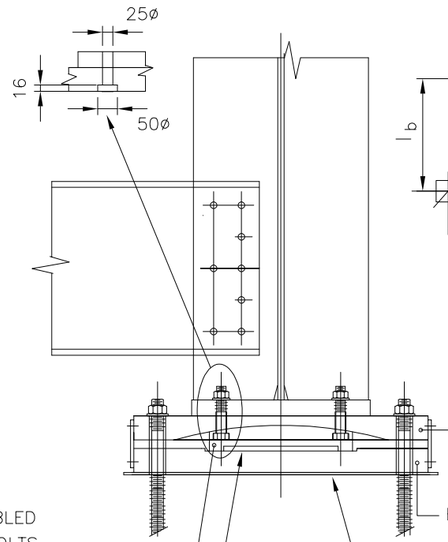
Drawing Number
Dessin Numero

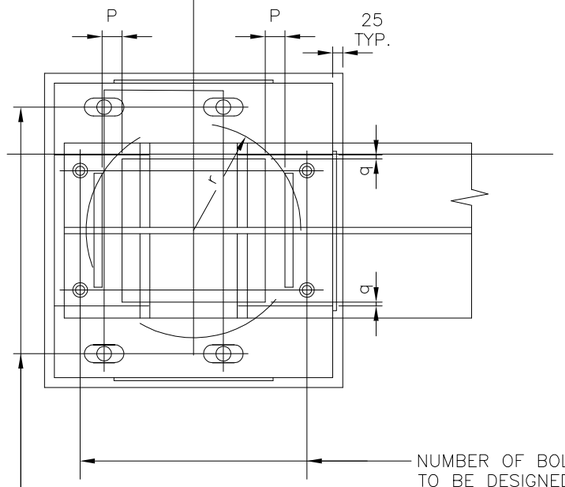
S14m

–

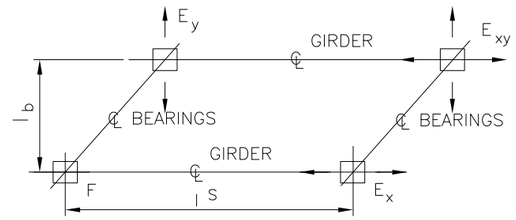


BEARINGS SHALL BE SHIPPED ASSEMBLED WITH PLATES 8 AND M16 MACHINE BOLTS. PLATES SHALL BE REMOVED AFTER ANCHOR BOLTS HAVE BEEN INSTALLED.(3 PLATES PER BEARING)

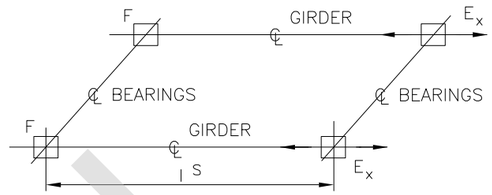




HOLES IN SHOE & BED PL & LEVELING PAD FOR M30ø OR M36ø ANCHOR BOLTS AS PER CN STD. S3A. FOR SIZES OF HOLES SEE DWG. NO. S−16.



TPG SPANS



DPG SPANS

NOTE: ARROW INDICATES FREEDOM OF MOVEMENT DIRECTION.

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" :

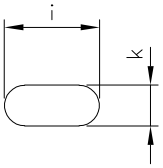
TPG SPANS

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

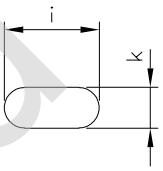
DPG SPANS

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"	1 mm	1 mm
	EXPANSION "E"	SPAN EXP. + w_x	1 mm
TPG	FIXED "F"	1 mm	1 mm
	EXPANSION "E_x"	SPAN EXP. + w_x	1 mm
	EXPANSION "E_y"	1 mm	FL.BEAM EXP.+ w_y
	EXPANSION "E_{xy}"	SPAN EXP. + w_x	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

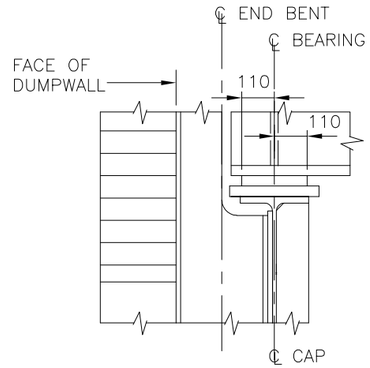
δ_b = max. deflection of end floor beam due to L + I

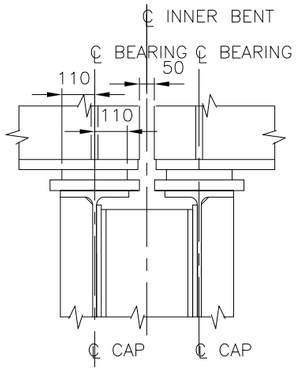
R = radius of spherical surface

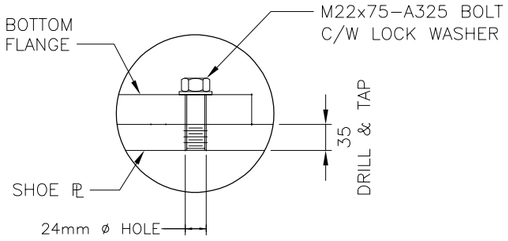
l_s = bridge span length

l_b = distance c. to c. girders

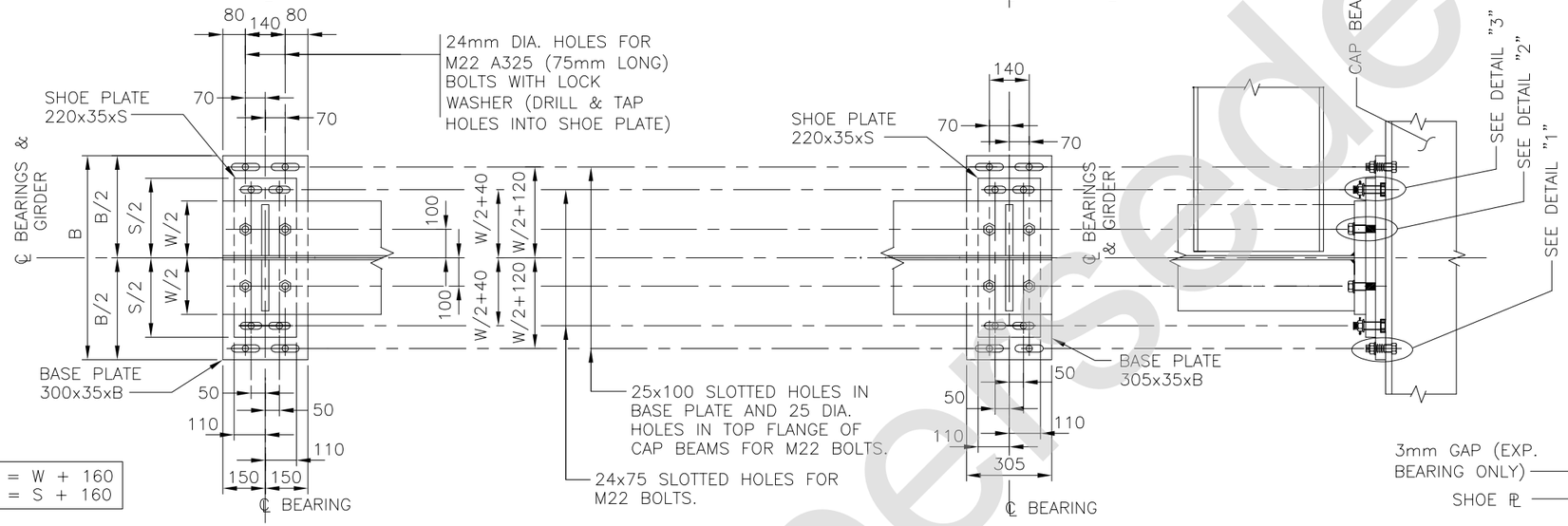
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**STANDARD BEARINGS FOR DPG & TPG STEEL SPANS (sheet 2)**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		
METROLINX		Drawing Number Dessin Numero **S16m**	–

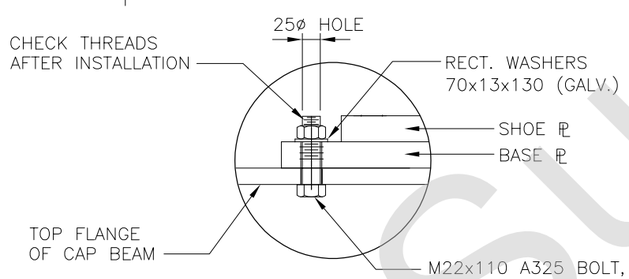




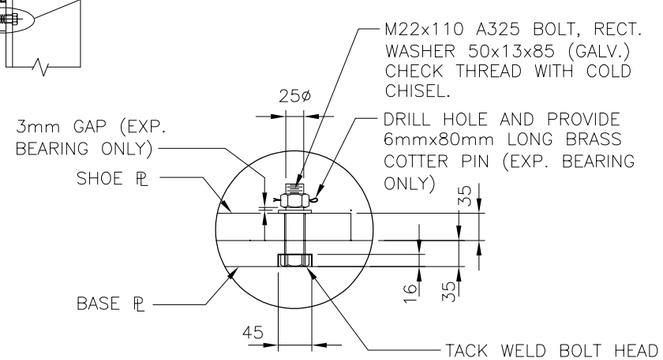


DETAIL 2





DETAIL 1



DETAIL 3

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 $\frac{\text{WORKING}}{\text{PERMISS.}} =$

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

$\frac{\text{MAX. STRESS RANGE}}{\text{PERMISS. FATIGUE STRESS}} =$

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	—		—	

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

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:

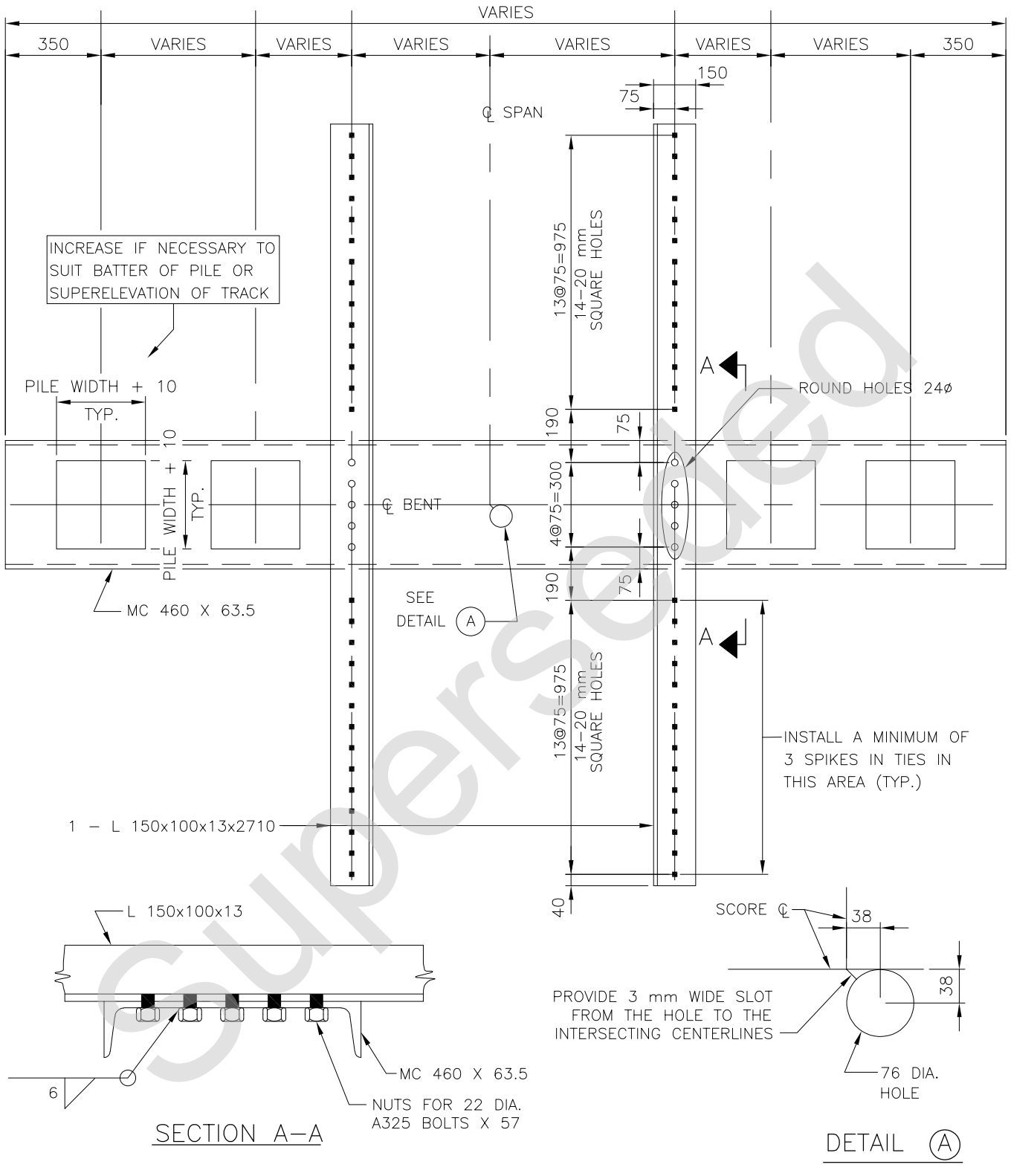
- FOR GENERAL NOTES SEE DRAWING –1.1
- DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AREMA 2016 MANUAL CHAPTER 15
- MATERIAL SHALL BE IN ACCORDANCE WITH THE FOLLOWING SPEC'S.:
  - STRUCTURAL STEEL: SEE PART 2A GUIDELINES FOR DESIGN OF STEEL BRIDGES & STRUCTURES.
  - WELDING: C.S.A. CAN3–W59
  - 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.
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31

TYPICAL NOTES FOR STEEL SPANS

METROLINX

Drawing Number
Dessin Numero
S18m –



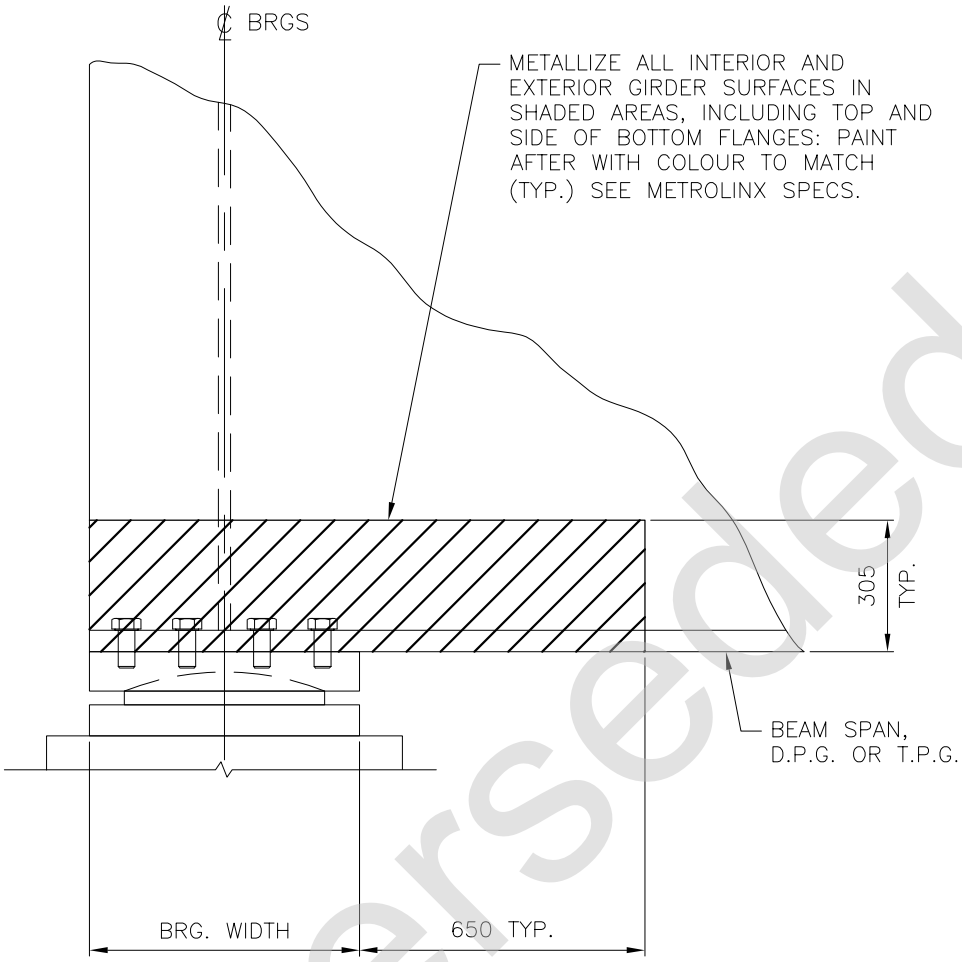
Drawn: Dessin: J.E.	Checked: Verification: S.Kh.	**TEMPLATE FOR PILE DRIVING**	
Scale: Echelle: NOT TO SCALE	Date: 2017/03/31		

METROLINX

Drawing Number
Dessin Numero

S19m

-



NOTES:

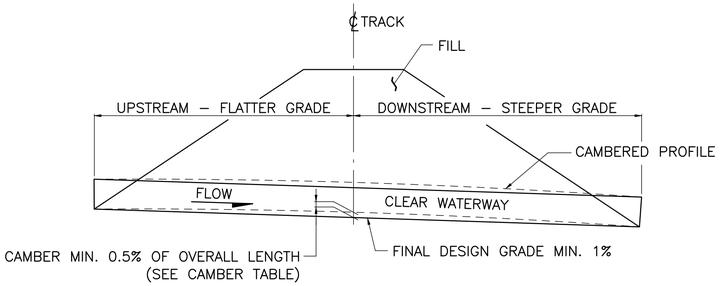
METALLIZING IN ACCORDANCE WITH SSPC–CS 23.00 OR A.S.T.M. B833
ZINC METALLIZING SHALL NOT BE LESS THAN 0.25mm THICKNESS

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	

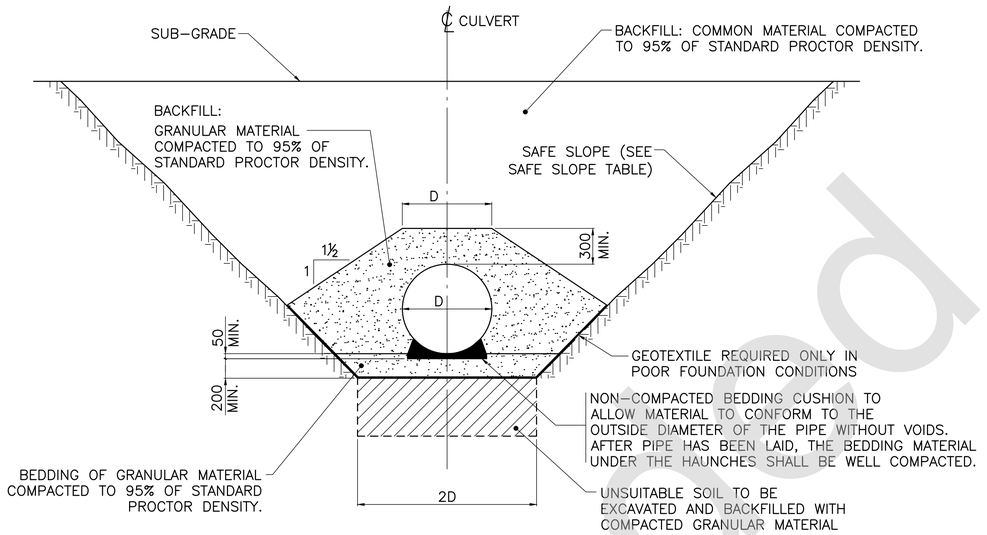
METROLINX

Drawing Number
Dessin Numero

S20m –

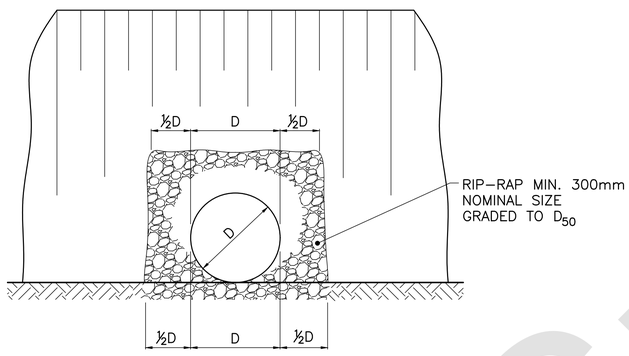


MINIMUM GRADE AND CAMBERING REQUIREMENTS FOR CULVERT INSTALLATION

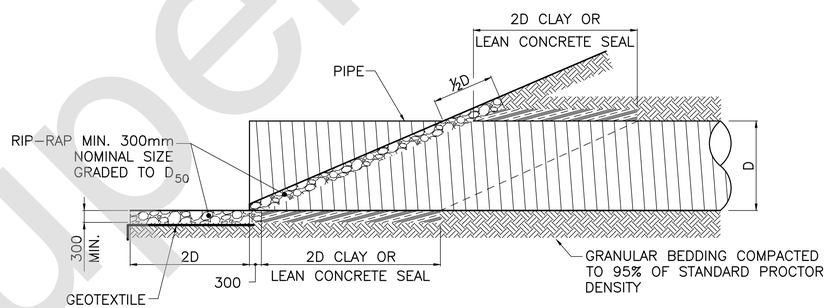


GRANULAR MATERIAL FOR BEDDING AND BACKFILLING TO BE APPROVED BY THE ENGINEER. IN GENERAL, PIT–RUN SAND AND GRAVEL, REASONABLY WELL GRADED FROM MAXIMUM SIZE 100mm TO NOT MORE THAN 8% FINER THAN SIEVE No. 200.

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	

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

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

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

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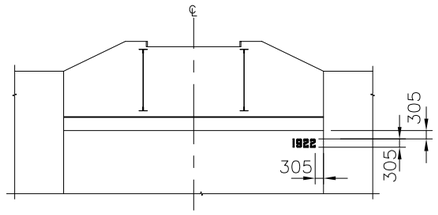
REFERENCE DRAWINGS		ISSUE			REVISIONS		
DWG NO.	TITLE	NO.	DATE	ISSUED FOR	REV.	DATE	

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	

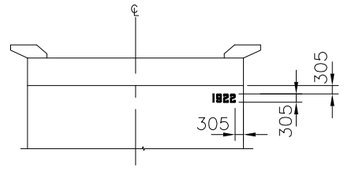
METROLINX

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

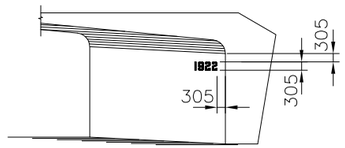
CONTRACT NO.	DWG. NO.	REV.	SHEET
–	R7A–80.1m–2		



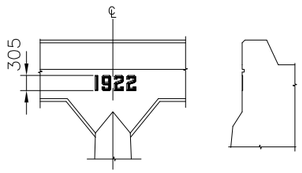
STEEL BRIDGES



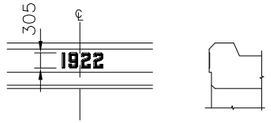
CONCRETE BRIDGES



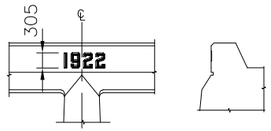
CONCRETE FRAME BRIDGES



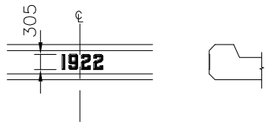
FOR 3.65m & 6.09m DOUBLE R.C. CULVERTS



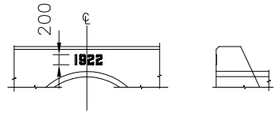
FOR 2.43m TO 3.05m R.C. CULVERTS



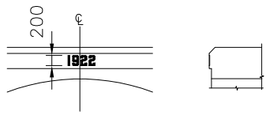
FOR 2.43m & 3.05m DOUBLE R.C. CULVERTS



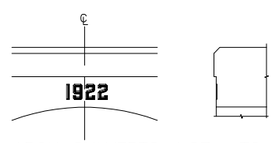
FOR 1.22m TO 2.13m R.C. CULVERTS



FOR R.C. PIPES

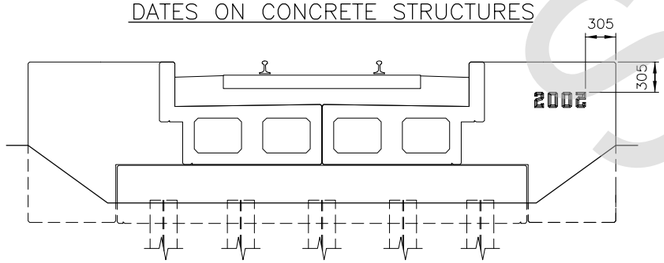


FOR ARCH CULVERTS 4.26m & SMALLER

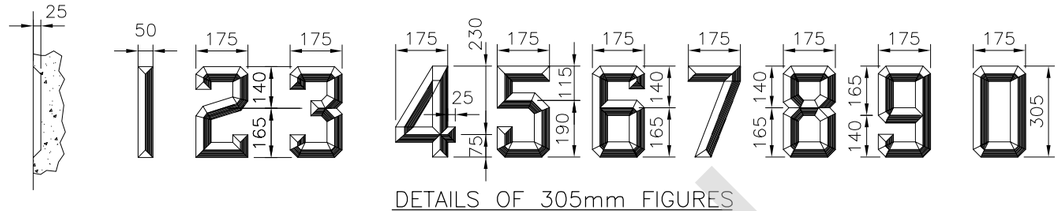


FOR ARCH CULVERTS 4.87m TO 9.14m

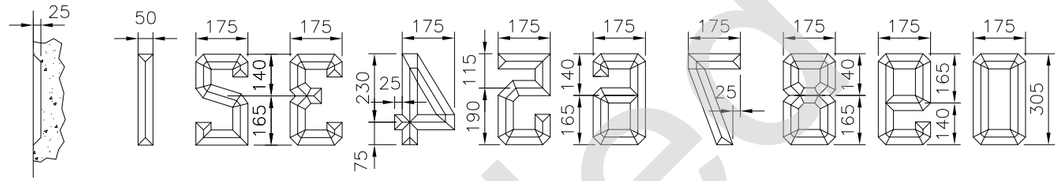
TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON CONCRETE STRUCTURES



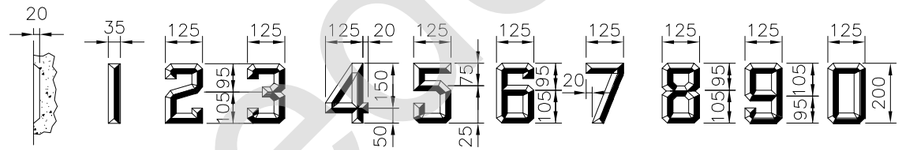
TYPICAL SKETCHES SHOWING ARRANGEMENT OF DATES ON PRECAST BALLAST WALLS



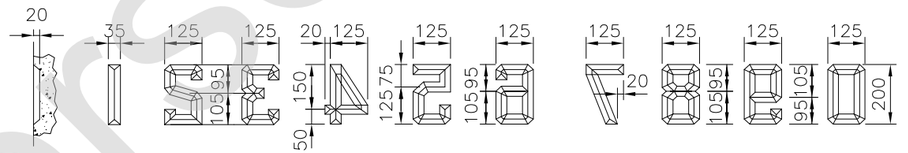
DETAILS OF 305mm FIGURES



DETAILS OF PATTERNS FOR 305mm FIGURES



DETAILS OF 200mm FIGURES



DETAILS OF PATTERNS FOR 200mm FIGURES

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** –