



Concrete Tie Specification

Specification 34 11 33.1
(RC-0506-02TRK-04)

Revision 01
Date: January 2024

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Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Rev 01	January, 2024	Revision 01 of the Metrolinx Concrete Tie Specification allows some flexibility in the production of monoblock concrete ties and addresses equivalency in the rail fastening system as well as some updates to align with the most current version of the AREMA manual Chapter 30, Part 4 Concrete Ties.

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1 PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- 1.1.1 The Work of this Specification includes the supply and delivery of new prestressed monoblock concrete ties inclusive of the cast-in shoulders and associated fastening system for standard gauge 1,435 mm (56 ½ in.) mainline track in accordance with the requirements of this Specification.
- 1.1.2 The concrete ties shall be as specified on Metrolinx Track Standard Plans, and in accordance with the requirements of this Specification.
- 1.1.3 The scope of this specification includes standard concrete ties and guard rail concrete ties, supporting rail base widths of 5 ½ in. and 6 in. as per the Tender and Contract Requirements.
- 1.1.4 The Manufacturer shall furnish all labour, materials, equipment, production-manufacturing facility and transportation necessary to furnish and deliver the concrete ties to the project.

1.2 RELATED SECTIONS

- 1.2.1 Comply with the following sections:

- | | |
|---|---------------|
| 1. General Requirements | Section 01000 |
| 2. Submittals | Section 01300 |
| 3. Quality Control and Assurance | Section 01400 |
| 4. Railway Track Construction | Section 02950 |
| 5. GTS-2004 and GTS-2007 for standard concrete ties and guard rail concrete ties. | |

1.3 REFERENCES

Where applicable, the Manufacturer shall comply with the latest issue of the following Standards, which are invoked and form part of this specification:

- 1.3.1 GO Transit, Design Requirements Manual (DRM), Latest Version.
- 1.3.2 AREMA, American Railway Engineering and Maintenance-of-Way Association - Manual for Railway Engineering.
- 1.3.3 American Association of State Highway and Transportation Officials (AASHTO):
1. T-26, Standard Method of Test for Quality of Water to Be Used in Concrete; and

2. T-277, Permeability of HPC: Rapid Chloride Ion Test vs. Chloride Ponding Test.

1.3.4 American Concrete Institute (ACI):

1. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete;
2. 214, Standard Practice for Evaluation of Strength Test Results of Concrete;
3. 301, Specifications for Structural Concrete; and
4. 318, Building Code Requirements for Structural Concrete.

1.3.5 American Society for Testing and Materials International (ASTM):

1. A 421, Standard Specification for Uncoated Stress- Relieved Steel Wire for Prestressed Concrete;
2. A 536, Standard Specification for Ductile Iron Castings;
3. A 881, Specification for Steel Wire, Deformed, Stress-relieved or Low-relaxation for Prestressed Concrete Railroad Ties;
4. A 886, Standard Specification for Steel Strand, Indented, Seven-Wire Stress-Relieved for Prestressed Concrete;
5. C 29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate;
6. C 31, Standard Practice for Making and Curing Concrete Test Specimens in the Field;
7. C 33, Standard Specification for Concrete Aggregates;
8. C 39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens;
9. C 109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens);
10. C 114, Methods for Chemical Analysis of Hydraulic Cement;
11. C 117, Standard Test Method for Materials Finer than 75 m (No. 200) Sieve in Mineral Aggregates by Washing;
12. C 136, Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates;
13. C 143, Standard Test Method for Slump of Hydraulic- Cement Concrete;
14. C 150, Standard Specification for Portland Cement;

15. C 172, Sampling Fresh Concrete;
16. C 191, Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle;
17. C 192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory;
18. C 227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method);
19. C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method;
20. C 260, Standard Specification for Air-Entraining Admixtures for Concrete;
21. C 295, Standard Guide for Petrographic Examination of Aggregates for Concrete;
22. C 316, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates;
23. C 359, Standard Test Method for Early Stiffening of Hydraulic Cement (Mortar Method);
24. C 403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance;
25. C 430, Standard Test Method for Fineness of Hydraulic Cement by the 45- μ m (No. 325) Sieve;
26. C 451, Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method);
27. C 457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete;
28. C 494, Standard Specification for Chemical Admixtures for Concrete;
29. C 496, Splitting Tensile Strength of Cylindrical Concrete;
30. C 617, Standard Practice for Capping Cylindrical Concrete Specimens;
31. C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete;
32. C 666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing;
33. C 856, Petrographic Examination of Hardened Concrete;

34. C 1105, Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction;
 35. C 1017, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete;
 36. C 1218/C1218M-99, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete;
 37. C 1231, Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders;
 38. C 1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method);
 39. C 1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction;
 40. C 1524, Standard Test Method For Water-Extractable Chloride in Aggregate (Soxhlet Method);
 41. C 1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method);
 42. C 1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete;
 43. C 5329, Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials used in Construction;
 44. D 75, Standard Practice for Sampling Aggregates; and
 45. E 994, Standard Guide for Calibration and Testing Laboratory Accreditation Systems General Requirements for Operation and Recognition.
- 1.3.6 Association of American Railroads (AAR):
1. M-1003, Quality Assurance.
- 1.3.7 Canadian Standards Association (CSA):
1. CSA-A23.1, Concrete Materials and Methods of Concrete Construction;
 2. CSA-A23.2, Methods of Test for Concrete;
 3. CSA-A23.4, Precast Concrete – Materials and Construction; and

4. CSA-A251, Qualification Code for Manufacturers of Architectural and Structural Precast Concrete.

1.3.8 ISO 9001, Quality Management Systems - Requirements;

1.3.9 ISO 9004, Quality Management Systems - Guidelines for Performance Improvements; and

1.3.10 Precast/Prestressed Concrete Institute (PCI):

1. MNL 116, Manual for Quality Control for Plants and Production of Structural Precast and Prestressed Concrete Products; and

2. Canadian Precast Concrete Quality Assurance (CPCQA) Certification Program.

1.4 DEFINITIONS

1.4.1 Definitions of the invoked references above apply to this Specification.

1.5 QUALITY CONTROL

1.5.1 The Manufacturer shall be responsible to plan, establish, implement, and maintain their own quality control program to ensure all materials and products meet the requirements of the specifications.

1.5.2 Production quality control shall be as identified in AREMA Specifications for Concrete Ties, Part 4, Chapter 30 of the AREMA Manual and meeting or exceeding the requirements of Section 1.7 of this Specification.

1.5.3 Records of inspection work by the Manufacturer shall be kept complete and made available to the Owner during the performance of the Contract.

1.5.4 The Owner reserves the right to perform additional testing and periodic inspection, if deemed necessary.

1.6 SUBMITTALS

1.6.1 The following submittals are in addition to the requirements of Section 01300 Submittals.

1.6.2 Within 30 days of the Notice to Proceed, prior to concrete tie and rail fastener assembly qualification testing:

1. Letter with supporting documentation stating that the concrete tie Manufacturer meets or exceeds the requirements of Section 1.7 of this Specification for established and new Manufacturers of concrete ties for heavy rail freight and commuter railroad services. For new Manufacturers, include with the letter audit

- reports from the CPCQA certification program completed by a professional engineer(s) appointed by the third-party Accredited Certification Organization called Canadian Certification Services Inc., including corrective actions, for the last five years;
2. Shop drawings for the standard and guard rail ties, including all information necessary for fabrication and handling. This shall include, but not be limited to, plan, elevation and cross-section with reinforcing wires, rail fastener assemblies, and embedded items. Show dimensions, weight, details, tolerances, surface finishes, concrete strength and material specifications as applicable. Indicate part numbers;
 3. Shop drawings for a guard rail convergence set of concrete ties to allow the convergence of the guard rail beyond the protected area, if specified in the Tender and Contract Drawings;
 4. Shop drawings shall be submitted in hardcopies, PDF and CAD formats. All original data and documents prepared and submitted by the Manufacturer shall be, and remain, the property of the Owner;
 5. General arrangement drawings for tie fastening components, product data, and how these fasteners shall be installed and replaced on the ties; and
 6. Provide a letter confirming that the rail fastener assemblies are compatible with the Manufacturer's shop drawings.
- 1.6.3 Within 45 days of the Notice to Proceed:
1. Concrete mix design with certified concrete and concrete components qualification test results and certificates;
 2. Manufacturer's Quality Assurance and Control Plan. The Plan shall be revised whenever there are changes in personnel, responsibilities, or other items contained in it;
 3. Manufacturer's Test Program Plan. The Plan shall, at a minimum, conform to the requirements of this Specification and shall provide sufficient detail of the Manufacturer's quality assurance program; and
 4. Detailed design calculations that demonstrate that the concrete ties and fastenings meet all the requirements of this Specification. This shall include prestress/flexural strength calculations.

- 1.6.4 Prior to the production of any tie and/or fastening system, and after approval of the shop drawings, submit qualification test results for certified concrete tie and rail fastener assembly.
1. Tests for concrete ties shall be as identified in AREMA Specifications for Concrete Ties, Part 4, Chapter 30 of the AREMA Manual. Test reports for all tests shall be provided from an independent certified laboratory prior to manufacture and/or prior to delivery of the ties, fastening system and its components, as applicable; and
 2. An independent Professional Engineer's design verification certificate to verify that the ties and fastener assemblies have been designed in accordance with the requirements of this Specification.
- 1.6.5 Prior to shipping the concrete ties and rail fastening system, submit production test results for certified concrete tie and rail fastener assembly, certified tie pad production, and certified material test reports.
- 1.6.6 At least thirty (30) days prior to shipment, submit the method of handling, loading, shipping, unloading and stacking, including working drawings showing the concrete tie stacking arrangement.
- 1.6.7 Inventory records of concrete ties shipped at the time of each shipment.
- 1.6.8 Compliance certificates for all concrete ties.
- 1.6.9 Monthly production quality reports. Submit reports for each month in which the specified ties are produced within fifteen (15) days after the last day of the month.
- 1.7 MANUFACTURER QUALIFICATIONS**
- 1.7.1 Established Concrete Tie Manufacture's Qualifications:
1. A minimum of ten (10) years of experience in the large-scale manufacture of pre-stressed monoblock concrete ties by the long line process with 5 to 8 lines per bed or by the carousel process;
 2. The Manufacturer has supplied concrete ties to a Class 1 Freight or Commuter Railroad within the last five (5) years;
 3. Has sufficient production capacity to produce the required number of ties in accordance with the quality requirements and without causing any delay in the Work; and
 4. The manufacturer shall furnish certification that all aspects of the yard operation, including materials testing, storage and handling, conform to the quality control

requirements herein and current industry standards as defined in the PCI Manual for Quality Control of Plants and Production of Prestressed, Precast Concrete Products, MNL 116, AAR-M-1003, Quality Assurance and/or ISO 9001:2008 equivalent. Current certification by PCI or CPCI throughout the fabrication period will be accepted as evidence of conformance with this requirement.

1.7.2 New Concrete Tie Manufacturer's Qualifications:

1. Submittal of a report that substantiates that the firm has sufficient production capacity, the necessary resources, steel moulds/forms, accelerated curing enclosures-appliances, other associated infrastructure, and trained personnel to produce the required number of ties in accordance with the quality requirements of this Specification and without causing any delay in the Work;
2. The Manufacturer must meet the requirements of CSA A23.4, including Appendices A and B, together with PCI Quality Control Manual MNL-116 and CPCI certification requirements;
3. Manufacturer shall be certified to CPCI Certification Program at the time of bid or the US equivalent; and
4. Manufacturer shall provide the appropriate Warranty requirements of Section 1.9 of this Specification.

1.7.3 Rail Fastener Assembly Manufacture's Qualifications:

1. A minimum of five (5) years of experience, in one location, in the large-scale manufacture of rail fastener assemblies for use in prestressed monoblock concrete ties;
2. Has supplied the rail fastener assemblies used on prestressed monoblock concrete ties of a Class 1 Freight or Commuter Railroad within the last five (5) years; and
3. Approved Manufacturers include Pandrol and Vossloh.

1.8 DELIVERY, STORAGE AND HANDLING

- 1.8.1 Concrete ties shall be handled in such manner to prevent chipping, spalling, cracking or other damage during loading, shipping, unloading and stockpiling. Do not drop or skid ties. Use only lifting devices appropriate for handling ties.
- 1.8.2 Unnecessary handling, redistribution and reloading of concrete ties should be avoided. To the extent practical, ties should be distributed in the proper position for use without further handling.

- 1.8.3 Concrete ties shall be shipped in open-top cars or flatbed truck trailers.
- 1.8.4 Concrete ties shall be securely braced for transportation to prevent any movement that will cause damage.
- 1.8.5 Concrete ties shall be shipped in a horizontal position and braced with spacer blocks in such a manner that the top surface or cast-in-place hardware does not contact the ties loaded above. Ties shall not be loaded higher than the top of the cars and not more than six (6) layers deep.
- 1.8.6 When required, concrete ties shall be stacked on firm level ground, not more than ten (10) ties high and supported with spacers at the rail seats only.
- 1.8.7 Package rail fastener assembly parts separately to prevent damage during shipment and to facilitate handling. Do not mix different parts in the same package. Hardware shall be packaged in waterproof containers.
- 1.8.8 If cast-in-place threaded inserts are included in ties, they shall be protected against entry of water and foreign matter by means of a plastic cap, plug or other suitable device (subject to approval). Caps or plugs shall be placed in position at the time of manufacture, left in place during shipping, and not removed until fastenings are affixed to the ties.
- 1.8.9 Segregate ties by types and lengths.
- 1.8.10 The Manufacturer shall replace all concrete ties and rail fastener assemblies damaged during loading, shipping, and, if required as per Contract Requirements, unloading and stockpiling with new concrete ties and rail fastener assemblies, respectively, at no additional cost to the Owner.

1.9 WARRANTY

- 1.9.1 Established Manufacturers, as defined in this Specification of railway pre-stressed monoblock concrete ties, shall guarantee all concrete ties against defective materials and workmanship for a minimum period of five (5) years, or as approved by the Owner, from the date the ties and associated fastening assemblies have been accepted by the Owner, except when a longer guarantee is provided by the Manufacturer.
- 1.9.2 New manufacturers of railway pre-stressed monoblock concrete ties shall guarantee all concrete ties against defective materials and workmanship for a minimum period of eight (8) years, or as approved by the Owner, from the date the ties and associated fastening assemblies have been accepted by the Owner. This includes the cost to the Owner to procure and remove the defective ties. After the eight-year period, the Owner shall be reimbursed only for the procurement cost, FOB Toronto Canada, to replace the defective tie for an additional two (2) years of a total ten-year warranty period.

- 1.9.3 Guarantee all concrete tie fastening assemblies against defective materials and workmanship for a minimum period of one (1) year, or as approved by the Owner, from the date the ties and associated fastening assemblies have been accepted by the Owner, except when a longer guarantee is provided by the supplier or Manufacturer.

1.10 SPARE PARTS

- 1.10.1 Furnish and deliver as spares each of the following, separately packaged and clearly marked "SPARE PARTS" for every 5,000 ties:

1. 100 clips;
2. 50 insulators; and
3. 50 tie pads.

2 PART 2 - DESIGN CRITERIA

2.1 GENERAL

- 2.1.1 The concrete ties shall be designed in accordance with AREMA Specifications for Concrete Ties, Part 4, Chapter 30 of the AREMA Manual and the requirements of this Specification, as applicable.
- 2.1.2 The electrical properties of the concrete ties shall not interfere with the track signal circuits. Future railway electrification must be a viable option.
- 2.1.3 The concrete ties shall have a concave center or a waisted (narrow) center section.
- 2.1.4 The concrete ties shall have scallops suitable to increase lateral stability and prevent track buckling.
- 2.1.5 Guard rail ties shall be constructed using the same means and methods, materials, length and tolerances, except the cross-section will be modified to meet the requirements as indicated on Metrolinx Track Standard Plans.
- 2.1.6 Guard rail ties shall have fasteners (inserts, bolts, washers & clips) suitable for fastening the guard rails in addition to the fasteners for the running rails. Caps to plug guard rail inserts shall be provided and fitted prior to storage and/or shipping.
- 2.1.7 The fastening system shall meet the following requirements as a minimum:
1. Resilient type;
 2. Fix the rail to the concrete ties using a one-piece spring-tension fastener as manufactured by Pandrol, Vossloh, or an approved equivalent;
 3. Spring-leaf-with-bolt style fasteners shall not be used;

4. Designed to ensure that none of its components fail under fatigue during the service life of 40 years;
 5. Provide adequate torsion resistance not only to hold the correct track gauge under specified loads and conditions but also to provide sufficient lateral strength to the track to resist buckling;
 6. Provide longitudinal restraint to control rail movement due to thermal and tractive forces and minimize rail gap in the event of a rail break;
 7. The rail pads shall be designed so that they not only attenuate the dynamic effect on the ties but also reduce the water entrapment within the rail seat to prevent the initiation of rail seat abrasion; and
 8. The rail fastener assembly shall allow for the rail clips to be installed, loosened or removed but not be able to vibrate loose under operating conditions.
- 2.1.8 The Manufacturer is responsible for the manufacturing design of the concrete ties and fastenings and shall undertake all additional manufacturing designs required to ensure compliance with this Specification. This shall include, but not be limited to, the supply and testing of all components, including water, aggregate, sand, cement, reinforcement and the concrete mix design, including calculations of prestress loss and dimensional strain in order to comply with the tie dimensions, tolerances and testing as specified in this Specification.
- 2.1.9 The Manufacturer shall submit such information in support of the manufacturing process and test results upon request by the Owner.

2.2 PERFORMANCE REQUIREMENTS

- 2.2.1 The concrete tie and fastenings shall be designed, tested and manufactured to meet the most current requirements of AREMA, Chapter 30 Ties Part 4 Concrete Ties, Part 4, and the following heavy rail service loads and track conditions:
1. Minimum axle loads of 30 tonnes (metric);
 2. In-track tie spacing of 610 mm (24 in.) (minimum) O.C.;
 3. Minimum annual tonnage of 20 Million Gross Tonnes (metric)/year;
 4. Maximum permissible speed of 160 km/h (100 mph);
 5. 6 in. or 5½ in. base steel rails, set at 1:40 rail cant at a standard gauge of 1,435 mm (56 ½ in.) and continuously welded rail (CWR) main track;
 6. Minimum ballast depth of 300 mm (12 in.); below the bottom of the tie;
 7. Minimum ballast shoulder width of 300 mm (12 in.); and

8. Minimum design service life of 40 years.

2.2.2 Ties shall be designed and tested to meet the following key minimum strength requirements for non-waisted type concrete tie shapes:

Table 1- Key Minimum Strength Requirements for Non-waisted Type Concrete Tie Shapes

TEST	MINIMUM REQUIREMENTS
Factored Rail Seat Positive Bending Moment (M_{R+})	182.9 kip-in
Rail Seat Positive Moment Test Load	33.2 kips
Factored Tie Center Negative Bending Moment (M_C)	179.5 kip-in
Tie Center Negative Moment Test Load	13.3 kips

2.3 TIE DIMENSIONS

2.3.1 The dimensions, configuration and weight of the conforming concrete tie shall be in general accordance with Chapter 30, Part 4, Section 4.3 and manufacturing tolerances prescribed in the AREMA Manual. The preferred tie dimensions are:

1. Length 2,515 mm (8 ft. 3 in.)
2. Base width (below rail seat) 265 mm (10 ½ in.)
3. Height at rail seat 203 mm (8 in.)

2.3.2 The rail seat shall provide for a cant of 1:40 toward the centerline of the concrete tie.

2.3.3 The preferred weight is 277 kg to 295 kg (610 lb. to 650 lb.) including shoulders.

2.3.4 Alternative designs shall have a successful history of performance of at least 10 years of service under comparable heavy rail commuter service conditions.

2.3.5 Dimensions for setting the guard rail shall be as indicated on Metrolinx Track Standard Plans.

2.3.6 Any alternative design shall be specifically approved by the Owner.

2.3.7 Final dimensions shall be confirmed by the Manufacturer in their design submission.

2.4 TOLERANCES

2.4.1 Dimensional tolerances shall be in accordance with the following:

1. Tie:
 - a. Length: ± 3 mm (1/8 in.);
 - b. Cross Section Dimensions: ± 3 mm (1/8 in.); and
 - c. Gauge: ± 1.5 mm (1/16 in.).
2. Rail Seat:
 - a. Cant: 1:40 ± 5 toward the center line of tie;
 - b. The differential tilt in the direction of the rail of one seat to another shall not exceed 1.5 mm (1/16 in.); and
 - c. The rail seat shall be a flat, smooth surface and plane to a tolerance of ± 0.8 mm (1/32 in.) for the portion directly under the rail.
3. Shoulder:
 - a. Inside face to inside face of outside shoulders measured at the base of the shoulder (concrete surface) ± 1.5 mm (1/16 in.);
 - b. Inside face to inside face of Cast-in shoulders over each rail seat ± 1.5 mm (1/16 in.); and
 - c. Placement: $90^\circ + 0.5^\circ$ in plan to rail foot and ± 0.5 mm vertically to the concrete surface.
4. Prestressing Wire or Tendon:
 - a. Projection: Less than 3 mm (1/8 in.) beyond the ends of the ties;
 - b. Depth: ± 3 mm (1/8 in.);
 - c. Location of individual tendons: ± 3 mm (1/8 in.); and
 - d. Concrete cover: 19 mm (3/4 in.) minimum.

2.5 SURFACE FINISH

- 2.5.1 The bottom surface of the tie shall be a rough screed finish, such as may be obtained with a broom. Projections from, or indentations into, the general level of the surface shall not exceed 6.4mm (1/4 in.). Two ties, which show the required bottom surface finish, shall be set aside from an early batch as a comparison standard for the acceptance of later ties.

- 2.5.2 The surface of the rail seat shall have a smooth finish and plane to a tolerance of 0.8mm (1/32 in.).
- 2.5.3 The top and side surfaces shall present a smooth, uniform appearance, which may contain holes less than 6.4 mm (1/4 in.) deep and less than 6.4 mm (1/4 in.) in diameter to a limited extent, excluding rail seats and the bottom of the tie. A heavy concentration of surface voids or evidence of improper mixing, vibrating, or curing will be cause for rejection.
- 2.5.4 Surface conditioning with a mixture of 3 parts sand and 1 part cement mixed with 1 part latex cement mix and 1 part water shall be done on surfaces containing air pockets greater than the allowable tolerances. The maximum size of any one pocket shall not exceed 9.5 mm (3/8 in.) in diameter and 6.4 mm (1/4 in.) deep.
- 2.5.5 Ties with voids not deeper than 38 mm (1½ in.) around not more than 2 end wires shall be repaired with a silicone rubber sealant. Ties with voids beyond this limit shall be rejected.
- 2.5.6 Corner breakage less than 13 mm (½ in.) deep and 38 mm (1½ in.) along the end faces need not be repaired, providing reinforcing wire is not exposed, and the minimum cover is maintained. If the reinforcing wire is exposed or the minimum cover is not maintained, the breakage shall be repaired at no additional cost to the Owner.
- 2.5.7 Corner breakage from 13-38 mm (½ - 1½ in.) in depth shall be repaired at no additional cost to the Owner. Corner breakage in excess of that shall be rejected.
- 2.5.8 The prestressing wires shall not protrude more than 3 mm (1/8 in.) beyond the concrete surface of the end of the tie. The wire ends shall not have sharp ends, which would be hazardous in handling.

2.6 IDENTIFICATION

- 2.6.1 The concrete ties shall be marked, or cast, with indented or raised letters and numerals on an upper inclined surface to ensure that the concrete cover is not reduced below the specified minimum and to the approval of the Owner. These markings shall identify:

Table 2 - Concrete tie marking information

Marking Item	Example
Owner	Owner's Logo (GO)
Manufacturer	Manufacturer's Name/Logo
Date Code & Year	XXXX
Tie type	XXXX
Fastener Code	XXXX
Form & Cavity	XXXX

2.7 FASTENING SYSTEM - RUNNING RAIL

- 2.7.1 All components of the running rail fastening system shall be of non-threaded design and manufactured by a single manufacturer to ensure compatibility with the ties. Written certification of the approval of such compatibility shall be submitted to the Owner.
- 2.7.2 The components listed below may be different due to subsequent production changes. Any proposed or replacement components shall meet or exceed the specified, and shall be as recommended, in writing, by the Manufacturer, and submitted to the Owner for approval.
- 2.7.3 Rail Clips - Pandrol e2055, Vossloh e2055, Pandrol J267 (5½ in. rail base) and Pandrol J273 (6 in. rail base) at standard splice (joint) bars and Pandrol E2063 at insulated joints, or approved equivalent, complying with the following requirements:
1. Rail clips shall be non-threaded type, one-piece elastic, heat treated, alloy spring steel clip;
 2. Where specified in Contract Requirements, rail clips shall be galvanized to protect against corrosion;
 3. Spring-wedge clips are not acceptable; and
 4. Clip installation and removal shall not damage the tie, shoulder, clip, insulators or rail.
- 2.7.4 Rail Tie Pads (Seat Pads) - Pandrol 16146 for a 5½ in. rail base and Pandrol 37693 for a 6 in. rail base, or approved equivalent, minimum 5 mm thick polyurethane, complying with the following requirements:
1. Rail seat pads shall be compatible with the fastening system to minimize abrasion of the rail seat area, reduce wheel impact loads and vibration effects on the track structure and provide electrical insulation of the rail;
 2. Rail seat pads shall provide a positive means of preventing movement of the pad parallel to the rail;
 3. Rail seat pads shall be manufactured to provide the required chemical and physical properties to resist effects of temperature ranging from -40° C to +70° C (-40° F to +160° F), as well as oxidation, water, alkali, petroleum products, synthetic lubricants, sunlight and climatic conditions typical of Ontario, Canada; and
 4. Oil-extended rubber, reclaimed rubber, or rubbers containing wax are not acceptable.

- 2.7.5 Insulators - Pandrol HD-8, or approved equivalent, complying with the following requirements:
1. Insulators shall provide electrical isolation, reduce abrasion, position the rail to the required gauge and transfer dynamic loading from the rail to the rail clip to prevent relative motion in any direction;
 2. Insulators shall be protected against degradation from oxidation, water, alkali, petroleum oils, synthetic lubricants, and sunlight without having a detrimental effect on the performance and electrical insulation properties of the insulator; and
 3. Recycled materials are not acceptable.
- 2.7.6 Embedded Shoulders - Pandrol 13294, or approved equivalent, complying with the following requirements:
1. Embedded shoulders shall be twin-stem, non-threaded type, cast to provide and maintain proper position and alignment of the rail, rail clip, insulators, tie pad and running rail base;
 2. Shoulders shall be made of ductile cast iron conforming to ASTM A536 Grades 80-55-06 or 65-45-12; and
 3. Shoulders shall not be directly anchored to the pretensioned steel.

2.8 FASTENING SYSTEM - GUARD RAIL

- 2.8.1 Provide fasteners suitable to fasten emergency guard rails.
- 2.8.2 The guard rail fastening system shall be shown on the submitted shop drawing for approval, including, but not limited to, the following components:
1. Insert: 7/8" UNC Thread, to be submitted for approval
 2. Bolt: 7/8" UNC Thread, to be submitted for approval
 3. Washer: To be submitted for approval
 4. Clip: To be submitted for approval
 5. Cap Plugs: To be submitted for approval

3 PART 3 - MATERIALS

3.1 CONCRETE

- 3.1.1 Concrete shall meet the requirements of the AREMA Specifications for Material, Section 4.2, Chapter 30 of the AREMA Manual.

- 3.1.2 The choice of materials, concrete mix design, manufacturing process and prestressing details shall all aim to minimize cracking which may be associated with delayed ettringite formation (DEF), alkali-aggregate reactivity (AAR) air-entrainment, other admixtures, sulphate reactions, alkali-silica reactivity (ASR) and De-icing chemicals (chlorides) in accordance with CSA-A23.1, CSA-A23.4 and Industry Standards.
- 3.1.3 Concrete shall accommodate a class of exposure C-1, in accordance with CSA-A23.1-09.
- 3.1.4 Steel fibre reinforced concrete is not permitted.
- 3.1.5 Concrete Mix Design:
1. Qualify concrete mix design based on tests on trial batches, which shall show that concrete mix achieves the specified strengths and properties, including shrinkage and permeability;
 2. The mix design submittal shall include at least the following data to demonstrate conformance with the specified requirements:
 - a. Qualification testing of all concrete components, including admixtures;
 - b. Proportions of all concrete components;
 - c. Concrete strength;
 - d. Range of air contents. In no case shall the air content be less than 4.5% in the plastic concrete;
 - e. Minimum air void content of 3.5% in the hardened concrete; and
 - f. Air void spacing factor not exceeding 0.2 mm (0.008 in.).
 3. Submit a new mix design to qualify the mix if any constituents of the concrete are changed during concrete tie production.
- 3.1.6 Compressive Strength, tested in accordance with ASTM
1. Minimum 28-Day Design Compressive Strength: 48 MPa (7000 psi);
 2. Samples for compressive strength testing shall be obtained in accordance with ASTM C 172. Specimens shall be made and laboratory-cured in accordance with ASTM C 31. Specimens made to check the adequacy of curing and protection of concrete shall be cured entirely under production conditions. Concrete temperature shall be recorded during curing;
 3. Strength tests shall be performed on 6 in. by 12 in. cylinders, or 4 in. by 8 in. cylinders, in accordance with ASTM C39. For each day of production, at least six

cylinders shall be prepared and capped in accordance with ASTM C 617: two for 28-day strength tests, two for checking strength at prestress transfer and two for spares; and

4. Minimum transfer requirement is $f'c = 31$ MPa (4,500 psi) for wire and strand.

3.1.7 Flexural Strength, tested in accordance with ASTM

1. Minimum 28-Day Flexural Strength: 5 MPa (750 psi);
2. Samples from which flexural strength test specimens are moulded shall be obtained in accordance with ASTM C 31. Specimens to check the adequacy of curing and protection of concrete shall be cured entirely under production conditions; and
3. Strength tests shall be made on 152 mm by 152 mm by 508 mm (6 in. by 6 in. by 20 in.) beams in accordance with ASTM C 78. One beam shall be tested for every new mix design.

3.2 CEMENT

- 3.2.1 Cement shall meet the requirements of the AREMA Specifications for Material, Section 4.2, Chapter 30 of the AREMA Manual.
- 3.2.2 Cement shall be portland cement and conform with ASTM C150 or blended hydraulic cement meeting ASTM C595 Type IL. Cement alkali content shall be as low as possible, and less than 0.6% Na₂O equivalent.
- 3.2.3 False set penetration, when tested in accordance with ASTM C451, shall not be less than 50 mm initially, 35 mm at intermediate times, and 40 mm after remix.
- 3.2.4 The Manufacturer shall retain typical analysis reports, including alkali content, of the cement as supplied by the cement producer. At the start of production and at least once every 3 months during production, the Manufacturer shall determine the alkali content of a randomly chosen shipment of cement.
- 3.2.5 Substitution of cement shall only be permitted with written approval from Metrolinx and pre-qualification through appropriate testing.

3.3 ADMIXTURES

- 3.3.1 Admixtures shall meet the requirements of the AREMA Specifications for Concrete Admixtures, Section 1.7, Chapter 8 of the AREMA Manual.
- 3.3.2 Chemical admixtures for concrete shall conform to ASTM C 494.
- 3.3.3 Additives containing chlorides shall not be used.

3.3.4 To combat freeze-thaw conditions, an air entraining agent, according to ASTM C 260, shall be used.

3.4 AGGREGATE

3.4.1 Fine and coarse aggregates shall meet the requirements of the AREMA Specifications for Material, Section 4.2, Chapter 30 of the AREMA Manual.

3.4.2 The maximum size of aggregate in the mix shall be 20 mm (3/4 in.).

3.4.3 The Manufacturer shall have determined that the fine and coarse aggregates do not react with alkalis in the cement to the extent that excessive expansion in the concrete may result. The results shall be interpreted as outlined in the specific standards and ASTM C 33.

3.4.4 At the time of the trial mixes, the Manufacturer shall have the aggregates sampled and tested according to CSA-A23.1, CSA-A23.2, ASTM C 1260 and ASTM C 1293.

3.4.5 Coarse aggregates shall be gravel, crushed gravel, crushed stone, or a combination thereof.

3.4.6 The Manufacturer shall provide a petrographic report on the proposed aggregates in accordance with ASTM C 295.

3.4.7 Should the source of materials - cement, fine or coarse aggregate - change, required material testing shall be repeated prior to the continuing manufacture of ties. A change in source is defined as a new pit/quarry and or new stratum or excavation face in an existing pit/quarry.

3.5 MIXING WATER

3.5.1 Mixing water shall meet the requirements of the AREMA Specifications for Material, Section 4.2, Chapter 30 of the AREMA Manual.

3.5.2 Mixing water shall conform to the requirements of ASTM C 1602.

3.5.3 The mixing water, including that portion of the mixing water contributed in the form of free moisture on the aggregates, shall not contain deleterious amounts of chloride ion.

3.6 REINFORCEMENT

3.6.1 Prestressing wire, tendons or steel bars shall meet the requirements of Chapter 30, Material Section 4.2, of the AREMA Manual.

3.6.2 Prestressing wire shall comply with ASTM A 881, and steel bars shall comply with A 615 and A 911.

3.6.3 Prestressing wire shall be pretensioned, indented and only from one source on each bed.

3.6.4 No joints in wire are permitted within a tie bed.

3.7 CLEANLINESS

3.7.1 The embedded iron shoulders and prestressing wire shall not be contaminated with form oil or any other deleterious substance which would interfere with bond development.

3.8 CURING

3.8.1 Curing shall meet the requirements of the AREMA Specifications for Material, Section 4.2, Chapter 30 of the AREMA Manual.

3.8.2 Accelerated curing shall be in accordance with Standard CSA-A23.4.

4 PART 4 - INSPECTION AND TESTING

4.1 INSPECTION AND TESTING

4.1.1 Testing of materials is the Manufacturer's responsibility. Samples shall be of a suitable size to ascertain compliance with the Specification. The Manufacturer shall conduct all required tests, and the results of these tests shall be made available to the Owner upon request.

4.1.2 Material which does not comply with this Specification or material which, notwithstanding tests, inspection or acceptance at any time or location, is found to contain deficiencies will be subject to rejection and return to the Manufacturer. The Manufacturer shall assume all expenses of handling and transportation in both directions.

END OF SECTION