Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal

.3 Section 03 20 00 – Concrete Reinforcing

.4 Section 03 30 00 – Cast-in-Place Concrete

.5 Section 03 41 00 – Precast Structure Concrete

.6 Section 07 92 00 – Concrete Joint Sealant

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-A23.1-14/A23.2-19, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA A23.4-16 (R2021), Precast Concrete – Materials and Construction

.3 CSA-O86-19, Engineering Design in Wood.

.4 CSA O121-17, Douglas Fir Plywood.

.5 CSA O151-17, Canadian Softwood Plywood.

.6 CSA O153-19, Poplar Plywood.

.7 CAN/CSA-O325-07(R2012), Construction Sheathing.

.8 CSA O437 Series-93(R2011), Standards for OSB and Waferboard.

.9 CAN/CSA-S269.1-16 (R2021), Falsework for Construction Purposes

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings for formwork and falsework.

.1 Submit drawings and calculations stamped and signed by professional engineer registered or licensed in Province of Nova Scotia, Canada at least four (4) weeks before construction. The submission is intended for information purposes only and shall in no way relieve the Contractor of full responsibility to carry out work related in accordance with CSA S269.3 for Concrete Formwork and CSA S269.1 for Falsework.

.3 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CAN/CSA-S269.1 for formwork drawings.

.4 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.

.5 Indicate sequence of erection and removal of formwork/falsework as directed by formwork Engineer.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with jurisdictional requirements.

.2 Deliver, handle and store formwork materials to prevent weathering, warping or damage detrimental to the strength of the materials or to the surface to be formed.

.3 Ensure that formwork surfaces which will be in contact with concrete are not contaminated by foreign material. Handle and erect the fabricated formwork so as to prevent damage.

.4 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

.4 Use sealers, form release and stripping agents that are non-toxic, biodegradable and have zero or low volatile organic compounds (VOC's).

Part 2 Products

2.1 MATERIALS

.1 Formwork materials:

.1 For concrete without special architectural features, use wood and wood product formwork materials to CAN/CSA O121, CAN/CSA-O86.

.2 For concrete with special architectural features such as the end crash block pedestals and exposed sides of bridge deck and curbs, use formwork materials to CSA-A23.1/A23.2.

.3 Formwork shall be constructed from lumber devoid of warped defects in order to achieve a face alignment free of distortion. This shall apply to all panel forms including prefabricated boards, plywood and steel panels.

.4 Formwork on exposed concrete surfaces shall be new or like new to achieve a quality aesthetically pleasing finish.

.2 Form ties:

.1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface. Holes to be filled with non-shrink grout.

.2 For Architectural concrete, use snap ties complete with plastic cones and light grey concrete plugs (applied before concrete sealers and coatings are applied). The exposed surfaces of the concrete on the deck, curbs, and wingwalls are to be considered 'Architectural Concrete' for this project.

.3 Form tie components which remain embedded in concrete are to be galvanized or non-metallic. Dissimilar metals which are in contact must be separated by denso tape barrier.

.3 Form release agent: non-toxic, biodegradable, low VOC. Form release agents must be compatible with waterproofing systems where applicable.

.4 Falsework materials: to CSA-S269.1.

.5 Sealant: to Section 07 92 00 – Concrete Joint Sealant.

Part 3 Execution

3.1 FABRICATION AND ERECTION

.1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.

.2 Fabricate and erect falsework in accordance with CSA S269.1.

.3 Refer to structural drawings and Item 2.1.2 for concrete members requiring architectural exposed finishes.

.4 Do not place shores and mud sills on frozen ground.

.5 Provide site drainage to prevent washout of soil supporting mud sills and shores.

.6 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.

.7 Align form joints and make watertight.

.1 Keep form joints to minimum.

.8 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints, unless specified otherwise.

.9 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

.10 Construct forms for architectural concrete as indicated.

.1 Joint pattern not necessarily based on using standard size panels or maximum permissible spacing of ties.

.11 Built in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.

.1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including concrete texturing.

.2 Anchors and inserts cast into the concrete shall be non-metallic or galvanized metal and either be isolated from dissimilar metals by either a 30 mm clear spacing or denso tape barrier on the formwork anchors / inserts.

.12 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 REMOVAL AND RESHORING

.1 Notify Departmental Representative prior to form removal.

.2 Form removal times are dependent on proper curing in accordance with CAN/CSA-A23.1 and CAN/CSA-S269.1. Provide written evidence of concrete strength to the Departmental Representative 24 hours prior to form removal to show the suitable strength has been achieved. Contractor shall pay for the concrete cylinder strength tests to demonstrate concrete strength prior to form removal.

.3 Leave formwork in place for following minimum periods of time after placing concrete.

.1 Two (2) days for walls.

.2 Four (4) days for beam soffits, slabs, decks and other structural members, or two (2) days when replaced immediately with adequate shoring to standard specified for falsework.

.3 Two (2) days for footings and abutments.

.4 Remove formwork when concrete has reached 70% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring. No vehicle loading or backfilling of abutments shall take place until concrete reaches design strength, unless otherwise approved in writing by Departmental Representative.

.5 If formwork is used to aid curing, it shall not be removed until seven days after the concrete placement.

.6 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 45 00 – Quality Control

.3 Section 03 10 00 – Concrete Forming and Accessories

.4 Section 03 30 00 – Cast-in-Place Concrete

.5 Section 03 41 00 – Precast Structural Concrete

1.2 REFERENCES

.1 American Concrete Institute (ACI)

.1 SP-66-04, ACI Detailing Manual 2020.

.1 ACI 315-99, Details and Detailing of Concrete Reinforcement.

.2 ACI 315R-18, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM A143/A143M-07 (2020), Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

.2 ASTM A780 / A780M-20, Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

.3 Canadian Standards Association (CSA International)

.1 CSA-A23.1-19/A23.2-19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA-A23.3-19, Design of Concrete Structures.

.3 CSA-A23.4-16 (R2021), Precast Concrete – Materials and Construction

.4 CAN/CSA-G30.18-21, Carbon Steel Bars for Concrete Reinforcement, A National Standard of Canada.

.5 CSA-G40.20-13/G40.21-13 (R2018), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.6 CAN/CSA-G164-18, Hot Dip Galvanizing of Irregularly Shaped Articles, A National Standard of Canada.

.7 CSA W186-21, Welding of Reinforcing Bars in Reinforced Concrete Construction.

.8 CSA S6-19, Canadian Highway Bridge Design Code

.4 Reinforcing Steel Institute of Canada (RSIC)

.1 RSIC-2020, Reinforcing Steel Manual of Standard Practice.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315, except as noted herein. Shop drawings are to be submitted at least four (4) weeks prior to commencing fabrication for review and approval. The Contractor retains responsibility for correctly detailing reinforcement, but the shop drawings must be approved for conformity with the design. Fabrication shall not proceed until the final approval of shop drawings. Shop drawings shall be stamped by a Professional Engineer licensed to practice in the Province of Nova Scotia.

.3 Submit shop drawings including placing of reinforcement and indicate:

.1 Bar bending details (Reference Table 3.3.1, Minimum Bend Diameter for Reinforcing Steel (400W)).

.2 Lists.

.3 Quantities of reinforcement.

.4 Sizes, spacings, locations of reinforcement and mechanical splices as specified / if approved by Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings.

.5 Indicate sizes, spacings and locations of chairs, spacers and hangers.

.4 Detail lap lengths and bar development lengths to CSA-S23.3, unless otherwise indicated.

.1 Provide Class B tension lap splices unless otherwise indicated.

1.4 QUALITY ASSURANCE

.1 Submit in accordance with Section 01 45 00 - Quality Control and as described in PART 2.3 - SOURCE QUALITY CONTROL.

.1 Mill Test Report: provide Departmental Representative with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.

.2 Submit in writing to Departmental Representative proposed source of reinforcement material to be supplied.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

.1 Substitute different size bars only if permitted in writing by Departmental Representative.

.2 Reinforcing steel: billet steel, grade 400W (weldable), deformed bars to CAN/CSA-G30.18, unless indicated otherwise.

.3 All reinforcing steel shall be hot dipped galvanized in accordance with CAN/CSA-G-164-M. All minor damage to the galvanizing shall be touched up with organic zinc paint.

.4 Cold-drawn annealed steel wire ties: to ASTM A1064/A1064M. All tie-wires, chairs and bar supports and other material used for the installation of galvanized reinforcing bars shall be covered, either with powdered epoxy resin, or acceptable material, at all contact points and within 50 mm of exposed faces, or be comprised of an acceptable non-metallic material to avoid galvanic reaction with galvanized repair / damage to galvanized coating.

.5 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating 610 g/m^2.

.1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.

.2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.

.1 Temperature of solution equal to or greater than 32 degrees and galvanized steels immersed for minimum 20 seconds.

.3 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.

.1 In this case, no restriction applies to temperature of solution.

.4 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.

.1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.6 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.

.7 Mechanical splices:

.1 Where noted on contract drawings, mechanical rebar splices be threaded style. Strength of coupler and bar shall be equal or greater to the ultimate strength of the rebar size noted in its untreaded state. Proposed rebar splicing system specification sheet shall be provided to the Departmental Representative for approval prior to fabrication.

.2 Unless noted otherwise on drawings, the use of mechanical rebar splices shall be subject to approval of Departmental Representative.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2, ACI 315 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada, except as noted herein (see Table 3.3.1).

.2 Obtain Departmental Representative's approval for locations of reinforcement splices other than those shown on placing drawings.

.3 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.

.4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 SOURCE QUALITY CONTROL

.1 Upon request, provide Departmental Representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.

.2 Upon request inform Departmental Representative of proposed source of material to be supplied.

Part 3 Execution

3.1 PREPARATION

.1 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A 143/A 143M.

.2 All steel reinforcing bars shall have the necessary net sectional area, and shall be cut to the exact lengths, and bent cold to the exact forms and dimensions, shown on the approved plans, or otherwise required, before galvanizing or being placed in position. Bending shall be accurately done, in a bending machine and no welding or heating of any bars shall be allowed, except with written approval from the Departmental Representative. All stirrups and hoops shall accurately fit the rods, and all bends shall be taken out of bars to be used as straight members.

3.2 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by Departmental Representative.

.2 When field bending is authorized, bend without heat, applying slow and steady pressure.

.3 Replace bars which develop cracks or splits.

3.3 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on placing drawings.

.2 Prior to placing concrete, obtain Departmental Representative’s approval of reinforcing material and placement.

.3 Ensure cover to reinforcement is maintained during concrete placement.

.4 All reinforcing bars shall be placed and held rigidly in the exact positions in the forms as shown on the approved plans, or otherwise required, and there shall be no displacement of the same by the placing and tamping of the concrete. Adjusting or moving the bars, while the concrete is being placed, shall not be permitted, unless specified on the plans. Concrete protection required for reinforcing steel shall be in accordance with the Contract Documents, or as directed by the Departmental Representative. All bars shall be tied and properly braced to prevent displacement. No concrete shall be placed until the reinforcement, after being cleaned and placed in position, has been examined and approved by the Departmental Representative. The minimum bend diameter shall conform to the Table 3.3.1, below. Bending of galvanized reinforcing steel will not be permitted after coating.

.5 To avoid contact between dissimilar metals, galvanized reinforcing shall either be separated from black steel (uncoated steel) with a clear space of at least 30 mm, otherwise the galvanized reinforcing shall be locally wrapped with denso tape to provide the required separation.

Table 3.3.1

Minimum Bend Diameter for Reinforcing Steel (400W)

Bar Size (mm)	Bend Diameter (mm)
10	70
15	90
20	150
25	200
30	250
35	300
45	450
55	600

3.4 FIELD TOUCH-UP

.1 Touch up damaged and cut ends of galvanized reinforcing steel with zinc rich paint that is a compatible finish to provide continuous coating. Cold galvanizing touch-up procedure and product shall meet with the approval of the Departmental representative.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 45 00 – Quality Control

.3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal

.4 Section 03 10 00 – Concrete Forming and Accessories

.5 Section 03 20 00 – Concrete Reinforcing

.6 Section 31 61 13 – Pile Foundations, General Requirements

1.2 REFERENCES

.1 ANSI/ACI 117-10, Specifications for Tolerances for Concrete Construction and Materials and Commentary.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM C260/C260M-10a, Standard Specification for Air-Entraining Admixtures for Concrete.

.2 ASTM C309-19, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

.3 ASTM C457-09, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.

.4 ASTM C494/C494M-17, Standard Specification for Chemical Admixtures for Concrete.

.5 ASTM C1017/C1017M-07, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

.6 ASTM C1202-19, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.

.3 Canadian Standards Association (CSA International)

.1 CSA-A23.1-19/A23.2-19, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA A283-19, Qualification Code for Concrete Testing Laboratories.

.3 CAN/CSA-S269.1-16 (R2021), Falsework for Construction Purposes.

.4 CAN/CSA-A3000-18, Cementitious Materials Compendium.

.1 CSA-A3001-18, Cementitious Materials for Use in Concrete.

.2 CSA-A3003-18, Chemical Test Method for Cementitious Materials for Use in Concrete and Masonry.

.3 CSA-A3004-18, Test Methods and Standard Practices for Cementitious Materials for Use in Concrete and Masonry.

.5 CSA S6-19, Canadian Highway Bridge Design Code

1.3 DESIGN REQUIREMENTS

.1 Alternative 1 – Performance: in accordance with CSA-A23.1/A23.2, and as described in MIXES of PART 2 – PRODUCTS.

.1 Concrete mixture designs shall be proportioned as normal density concrete in accordance with CSA-A23.1 latest edition, Alternative #1. Concrete shall be proportioned using Portland cement, Type SF silica fume, fly ash, fine and coarse aggregates, air entraining, water reducing, and superplasticizing and / or set retarding admixtures. Other supplementary cementing materials may include Class F fly ash. Set retarding admixtures may be used as ambient and site conditions warrant.

1.4 ADMINISTRATIVE REQIUREMENTS

.1 At least fifteen days prior to the start of the concrete construction schedule, a pre-concrete conference must be held. The mix designs shall be reviewed and the required methods and procedures to achieve the required concrete shall be discussed. Develop and send a conference agenda to all attendees ten days prior to the scheduled date of the conference.

.2 Arrange for representatives of all parties concerned with the concrete work to attend the conference, including but not limited to the following:

.1 The contractor's superintendent
.2 A representative from the laboratory responsible for the concrete mix design
.3 A representative from the laboratory responsible for the field quality control
.4 The concrete subcontractor
.5 The ready-mix concrete producer
.6 The admixture manufacturer supplier
.7 The hardener supplier
.8 The concrete pumping contractor
.9 The Engineer
.10 The Departmental Representative

.3 Record minutes of the meeting and distribute to all parties concerned within five days of the meeting. Submit minutes to Departmental Representative.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit the following at least four (4) weeks prior to the commencing concrete work:

.1 Certification from the qualified independent inspection and testing company that plant, equipment and materials to be used in the concrete comply with requirements of CSA-A23.1/A23.2.

.2 Manufacturer's test data and certification by qualified independent inspection and testing laboratory that the following materials will meet specified requirements:

.1 Portland cement
.2 Blended hydraulic cement

.3 Supplementary cementing materials
.4 Admixtures
.5 Water
.6 Aggregates

.3 Mix designs for concrete, mix proportions and aggregate sources, which will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA-A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.

.4 Certification for the concrete supplier from the Atlantic Provinces Ready Mixed Concrete Association – APRMCA Concrete Production Facilities Certification Program.

.3 Include in the submission of the mix designs, test results for each mix containing the following information:

.1 Plastic Concrete Tests
.2 Slump (CSA A23.2-5C)
.3 Air Content of Plastic Concrete by Pressure Method (CSA A23.2-4C)
.4 Mass Density and Yield (CSA A23.2-6C)
.5 Compressive Strength Testing (CSA A23.2-9C)
.6 2 cylinders to be tested at 28 days
.7 Air Void Analysis on Hardened Concrete (ASTM C457) tested at 7 days
.8 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (ASTM C1202) tested at 56 days
.9 Alkali Reactivity Test Results

.4 Submit four (4) weeks in advance of concrete placement, relevant test data for all aggregate materials indicating conformance to the requirements of CSA-A23.1 and this specification. The test results required, but not be limited to, shall include:

.1 Sieve Analysis of Fine and Coarse aggregate
.2 Amount of Material Finer than 80 μm in Aggregate
.3 Bulk Relative Density and Absorption of Fine and Coarse Aggregate (SSD basis)
.4 Fineness Modulus of Fine Aggregate
.5 Clay Lumps and Light Weight Pieces
.6 Test for Organic Impurities in Fine Aggregate
.7 Flat and Elongated Particles in Coarse Aggregates
.8 Petrographic Analysis of Coarse Aggregate (PN-NSTIR Test Method-2)
.9 Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles machine
.10 Micro-Deval test for Coarse and Fine Aggregate
.11 Soundness of Coarse and Fine Aggregate by Use of Magnesium Sulphate
.12 Test for Detection of Alkali-Aggregate Reactivity (AAR) on Coarse and Fine Aggregate
.13 Unconfined Freeze and Thaw test

.5 Submit two (2) weeks prior to commencement of the project adequate details of all equipment to be used. Equipment shall include that required for transporting, handling, placement and curing of all concrete.

.6 Concrete pours: submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 – FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.2 Submit to Departmental Representative, minimum of four weeks prior to starting concrete work, valid and recognized certificate from plant delivering concrete.

.1 When plant does not hold valid certification, provide test data and certification by qualified independent inspection and testing laboratory that materials used in concrete mixture will meet specified requirements.

.3 Minimum four weeks prior to starting concrete work, submit proposed quality assurance procedures for review by the Departmental Representative on the following items:

.1 Falsework erection
.2 Hot weather concrete
.3 Cold weather concrete
.4 Placement method(s)
.5 Curing
.6 Finishes
.7 Formwork Removal

.4 Quality Control Plan: submit written report to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 – PRODUCTS.

.5 Health and Safety Requirements: undertake occupational health and safety in accordance with Section 01 35 29.06 – Health and Safety Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Concrete hauling time: maximum allowable time for concrete to be delivered to site of Work and discharged not to exceed 120 minutes after batching.

.1 Modifications to maximum time limit must be agreed to by Departmental Representative and concrete producer as described in CSA A23.1/A23.2.
.2 Deviations to be submitted for review by Departmental Representative.

.2 The concrete materials shall be mixed and transported in a manner which will not segregate or damage the mix in any fashion. Concrete shall be mixed using stationary or truck mixers. The mixer shall carry the Manufacturer’s rating plate in a prominent position that indicates the following:

.1 The gross volume of the mixer
.2 The rated maximum mixing capacity
.3 The minimum and maximum speeds for mixing and agitating of the mixer

.3 The mixer shall be capable of combining the concrete ingredients into a thoroughly mixed and uniform mass and shall not exceed the capabilities of the mixer.

.4 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

.5 Where ready mix trucks are used to transport the concrete, the Departmental Representative reserves the right to subject any truck suspected of poor mixing to a uniformity test as outlined in CSA A23. If the truck fails the test, then the concrete and the truck shall be rejected at the sole cost of the Contractor unless otherwise directed by the Departmental Representative.

.6 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Use trigger operated spray nozzles for water hoses.

.3 Carefully coordinate the specified concrete work with weather conditions.

.4 Divert unused concrete materials from landfill to local facility approved by Departmental Representative.

.5 Designate an appropriate area on the job site where concrete trucks and tools can be safely washed to limit water use and runoff.

.6 Prevent admixtures and additive materials from entering drinking water supplies or streams. Using appropriate safety precautions collect liquid or solidify liquid with inert, non-combustible material and remove for disposal. Dispose of waste in accordance with applicable local, provincial and national regulations.

.7 Choose least harmful, appropriate cleaning method which will perform adequately.

Part 2 Products

2.1 MATERIALS

.1 All cementing materials to CSA A3001.

.2 Cementing material to be a blended Portland cement, fly ash, silica fume cement. The minimum proportion by mass of the total cementing materials for silica fume shall be 6% and a maximum of 10%. The maximum proportion by mass of the total cementing material for fly ash is 20%.

.3 Water: to CSA A23.1 and to be free from injurious amounts of oil, acid, alkali soluble chloride, organic matter, sedimentation and other deleterious substances.

.4 Aggregates: to CSA A23.1/A23.2. The maximum Petrographic Number of course aggregate shall not exceed 140. The maximum absorption of course aggregate shall not exceed 2%.

.5 Coarse aggregates shall consist of washed crushed stone having a nominal size of 20 mm. The maximum combination of flat, elongated and flat and elongated particles, as defined in CSA A23.2-13A, shall not exceed 10% of the total mass.

.6 Fine aggregate shall be washed and classified for conform to the gradation limits specified in CSA A23.1.

.7 The use of Alkali-Silica Reactive Aggregates shall not be permitted. When tested in accordance with CSA A23.2-14A, the expansion of the test samples incorporating the aggregate source shall not exceed 0.04 percent at one year.

.8 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA A23.1/A23.2.

.1 Compressive strength: 50 MPa at 28 days.

.2 Consistency:

.1 Fluid: to ASTM C827. Time of efflux through flow cone (ASTM C939), under 30 seconds.

.2 Flowable: to ASTM C827. Flow tables, 5 drops in 35 (ASTM C109, applicable portion) as to 145%.

.3 Plastic: to ASTM C827. Flow table, 5 drops in 35 (ASTM C109, applicable portions) 100 to 125%.

.9 Curing compound: to ASTM C309, Type 2.

.10 Isolation Joint filler:

.1 Bituminous impregnated fibre board: to ASTM D1751.

.11 Joint Sealant: acceptable products include:

.1 For horizontal joints: two component polyurethane self-leveling elastomeric sealant.

.2 For vertical joints: polyurethane non-sag elastomeric sealant.

.3 Primer to be compatible with sealant.

.12 Dampproofing:

.1 Emulsified asphalt, mineral colloid type: to CAN/CGSB-37.2.

.13 Polyethylene film under approach slabs: 2 sheets each 6 mils thick, to CAN/CGSB-51.34.

.14 Precast concrete toppers on top of decorative crash blocks: fabricated as per the Contract Drawings, CAN3-A23.4, with 32 MPa concrete and 6% air.

2.2 MIXES

.1 Mixture proportions shall be selected on the basis of a 75 year design life and all concrete in the structure shall have a minimum compressive strength of 35 MPa in 28 days, unless noted otherwise on the Contract Drawings. The Contractor shall perform all tests required to demonstrate the long term performance and durability of the materials and concrete mixtures.

.2 Performance Method for specifying concrete: to meet Departmental Representative performance criteria to CAN/CSA A23.1/A23.2 and CSA S6.

.1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as described in PART 3 – FIELD QUALITY CONTROL.

.2 Proportion normal density concrete in accordance with CAN/CSA-A23.1, Alternative #1 to give the following properties for concrete in precast concrete topper for pilasters and approach road drain (baffle drain):

.1 Minimum compressive strength at 28 days: 35 MPa.

.2 Class of exposure: C1.

.3 Chemical admixtures: type as approved and in accordance with ASTM C494.

.4 Normal size of aggregate: 20mm.

.5 Maximum water to cement ratio: 0.40.

.6 Minimum cementitious content: 415 kg/m^3.

.7 Air content: 5 to 8%.

.8 Slump: 80 ± 20mm.

.3 Proportion normal density concrete in accordance with CAN/CSA-A23.1, Alternative #1. High Performance Concrete in curbs, sidewalks, abutments, wingwalls, approach slabs, pilasters shall be proportioned using Portland cement, Type SF silica fume, fine and coarse aggregates, air entraining, water reducing, and/or set regarding admixtures. Concrete mixtures shall be designed to meet the following:

.1 Minimum compressive strength at 28 days: 35 MPa.

.2 Design life of 75 years.

.3 Class of exposure: C1.

.4 Chemical admixtures: type as approved and in accordance with ASTM C494.

.5 Normal size of coarse aggregate: 20 mm.

.6 Maximum water to cement ratio: 0.4.

.7 Air content: 5-8%.

.8 Maximum spacing factor of hardened concrete not to exceed 250 μm.

.9 Chloride ion permeability at 91 days: <1500 coulombs.

.10 Maximum concrete temperature (from delivery equipment):

.1 Thickness >2 metres: 18˚C.

.2 Thickness <2 metres: 25˚C.

.11 Maximum concrete temperature (in situ): 70˚C.

.12 Maximum temperature gradient: 20˚C/metre.

.13 Superplasticizer shall be used in all concrete.

Part 3 Execution

3.1 PREPARATION

.1 Obtain Departmental Representative's written approval before placing concrete. Provide 24 hours minimum notice prior to placing concrete.

.2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.

.3 During concreting operations:

.1 Development of cold joints not allowed.

.2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.

.4 Pumping of concrete is permitted only after review of equipment and mix by Departmental Representative.

.5 Ensure reinforcement and inserts are not disturbed during concrete placement.

.6 Prior to placing of concrete obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing.

.7 Protect previous Work from staining.

.8 Clean and remove stains prior to application for concrete finishes.

.9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

.10 Remove all debris including sawdust, chips and any other deleterious materials from the interior of the forms.

.11 Do not place load upon new concrete until authorized by Departmental Representative.

3.2 CONSTRUCTION

.1 Perform cast-in-place concrete work to CSA A23.1/A23.2.

.2 High performance concrete shall not be placed when the air temperature exceeds 25ºC or is likely predicted to rise above this temperature during placement. The temperature of the formwork, reinforcing steel or other material on which the concrete is places shall not exceed 25ºC.

.3 Sleeves and inserts:

.1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through structural members, except where indicated or approved by Departmental Representative.

.2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.

.3 Sleeves and openings greater than 100 x 100 mm not indicated must be reviewed by Departmental Representative.

.4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Departmental Representative before placing of concrete.

.5 Check locations and sizes of sleeves and openings shown on drawings.

.6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

.4 Anchor bolts:

.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

.2 Coordinate with bridge barrier post anchor bolt requirements prior to setting anchor bolts. Anchor bolts shall be set with a template to ensure accurate positioning.

.3 Locate anchor bolts used in connection with bridge barriers with due regard to ambient temperature at time of erection.

.4 When setting anchor bolts, care shall be taken to not only ensure that the anchor bolts are set in the correct position and orientation, but also that sufficient thread extension is provided to facilitate bolting the assembly to the concrete, complete with compatible nuts and washers (plate washers where specified), as per the detailed on the Contract Drawings.

.5 Placing of concrete:

.1 Contractor is responsible for the placing method used.

.2 Concrete shall be delivered to the point of final deposit in a manner satisfactory to the Departmental Representative using means and equipment which will prevent segregation or loss of materials.

.3 The size of section to be placed in one continuous operation shall be as detailed on the drawings or as directed by the Departmental Representative.

.4 Unless otherwise authorized by the Departmental Representative, forms shall be kept dry during the placing of the concrete until the concrete has reached initial set.

.5 Concrete shall be deposited in the forms in maximum lifts of 500 mm and in layers that are approximately horizontal and as close as practicable to its final position.

.6 Concrete shall not be moved horizontally with vibrators or by other methods which could cause segregation.

.7 Under adverse weather conditions the Contractor shall be prepared to provide suitable protection in order to prevent damage to concrete.

.8 Consolidation:

.1 All methods of consolidation shall be subject to the approval of the Departmental Representative.

.2 Concrete shall be consolidated thoroughly and uniformly by means of hand tamping, vibrators or finishing machines to obtain a dense, homogeneous structure, free from cold joints, voids and honeycomb.

.3 A sufficient number of vibrators shall be employed to adequately handle the anticipated rate of placement. The size and frequency of vibrators shall be as specified in CSA A23.1. A stand-by vibrator shall be available on the site at all times.

.4 Internal vibrators shall be used wherever practicable. External type vibrators may be used where surfaces cannot be properly consolidated with the internal type alone.

.5 Insertion of internal vibrators shall be made systematically at intervals such that the zones of influence of the vibrator overlap.

.6 Extreme care shall be taken to ensure that the internal type vibrators do not displace the reinforcing steel or the forms. Vibrators shall have rubber or non-metallic vibrating heads.

.9 Curing concrete:

.1 Concrete shall be protected from freezing, premature drying, high temperature and moisture loss for a period of time necessary to develop the desired properties of the concrete.

.2 Curing shall be applied to concrete as soon as possible without damaging or marring the surface.

.3 Curing compounds shall conform to ASTM C309 Type 2.

.4 All fresh placed and consolidated concrete shall be suitably protected from the elements and from defacement due to construction activities, traffic and vandals. The effects of direct sunshine, drying winds, cold, excessive heat and running water are particularly harmful. The concrete shall be protected by the use of adequate tarpaulins or other suitable material to completely cover, or enclose, all freshly finished surfaces.

.5 The curing time shall be as indicated in CSA A23.1 or this specification. Curing shall be achieved by one or more of the following:

.1 Burlap: Two layers of pre-soaked burlap shall be carefully laid on the surface as soon as the concrete has set sufficiently to support the mass of the burlap without marking the surface. Strips shall be overlapped 150 mm, secured to the surface and kept wet throughout the curing period. Burlap shall be free from holes or other substance that may have a deleterious effect on the concrete.

.2 Moisture Vapour Barrier: The Contractor shall provide an effective vapour barrier and prevent any flow of air between it and the concrete surface. Where polyethylene sheet is used, it shall be white opaque pigmented with a minimum thickness of 100 µm. The vapour barrier shall be secured to the surface and overlapped 150 mm.

.3 White Pigment Liquid Membrane: Curing compounds shall not be used on a surface where a bond is required for additional concrete. A curing compound may be approved by the Departmental Representative under certain circumstances where the application of moisture is impractical and where such compounds will not jeopardize the appearance of the concrete. Curing compounds shall be applied at the Manufacturer’s recommended application rate. Curing compounds are not permitted on construction joints, surfaces requiring weatherproofing sealants or deck sections.

.4 Water: All concrete bridge decks shall be cured with water unless otherwise directed by the Departmental Representative. Concrete exposed surfaces shall be kept continuously moist for a minimum of seven consecutive days after placing. The water for curing shall be clean and free from any material which could cause staining or discoloration of the concrete. All freshly placed and consolidated concrete shall be suitably protected from the elements.

.5 Prior to covering the deck with burlap, decks shall be cured by fogging. Fogging shall commence 20 minutes after initial

screeding and shall continue until concrete reaches initial set to allow placement of the wet burlap. Curing must commence immediately to prevent cracking or drying of the surface.

.6 Hot Weather Concreting (if approved by Departmental Representative):

.1 When the air temperature is at or above 25˚C, or is likely to rise above 25˚C within 24 hours, special measures, as detailed in CSA A23.1 shall be taken by the Contractor to protect the concrete from the effects of hot and /or drying weather conditions.

.2 The temperature of the formwork, reinforcing steel or the material on which the concrete is to be placed, shall not exceed 25˚C. Concrete temperatures shall not exceed those specified in CSA A23.1, Table 16.

.7 Cold Weather Concreting:

.1 When the mean air temperature is at or below 5˚C or when the temperature is likely to fall below 5˚C within 24 hours, the Contractor shall place, cure and protect concrete in accordance with CSA 23.1 and this specification.

.2 Concrete shall not be placed on or against any surface which is at a temperature less than 5˚C. Snow and ice shall be removed before concrete is deposited on any surface.

.3 Calcium chloride or other de-icing chemicals shall not be used as a de-icing agent in the forms.

.4 If heating of the mix water and/or aggregates is approved for use, the charging cycle shall be altered to prevent flash setting of the concrete.

.5 Aggregates and water shall not be heated above 80˚C. Water and/or aggregates heated to a temperature in excess of 40˚C, prior to the addition of the cementing materials shall be approved by the Departmental Representative.

.6 All frozen lumps of aggregate shall be excluded from the mix.

.10 Protection Classes:

.1 Protection and curing depends upon the outside temperature, the wind velocity, and the size of the concrete section.

.2 Under normal circumstances the following methods of protection may be required to maintain the protection necessary for the conditions described.

.3 Heating of the mixing water and/or aggregates shall be required for all classes of protection.

.4 When the outside temperature during placing or during the protection period may fall below 5˚C, adequate covering of all surfaces with tarpaulins or polyethylene sheets shall be provided.

.5 When the outside temperature during placing or during the protection period may fall below 0˚C, all surfaces shall be covered with an approved insulating material, over which tarpaulins or polyethylene sheets are placed.

.6 When the outside temperature during placing or during the protection period may fall below -5˚C, a complete housing of the concrete, together with supplementary heat, shall be provided. The Contractor shall ensure that heat is supplied uniformly around the concrete.

.7 For mass concrete, defined as minimum section dimension in excess of 2 m, the temperature gradient shall not exceed 20˚C/m from the interior of the element to the exterior face.

.8 In thin sections, less than 2 m, the temperature differential from the interior to the exterior shall not exceed 20˚C.

.6 Finishing of Concrete:

.1 Basic Treatment:

.1 Upon removal of the forms, all cavities, honeycomb, and other deficiencies shall be patched with sand cement mortar of the same composition as that used in the concrete.

.2 Mortar shall be composed of cement, fine aggregate and water, proportioned and mixed as specified.

.3 When the proportioning of cement and fine aggregate is not specified, the mortar shall consist of one (1) part by volume of cement and two (2) parts of fine aggregate.

.4 The quantity of water used in mixing the mortar shall be sufficient to make it capable of being freely spread with the trowel.

.5 Mortar shall be mixed in quantities which can be utilized within 60 minutes.

.6 Mortar shall not be re-tempered or re-mixed with water after initial set.

.7 All bolts, ties, nails, or other metal not specifically required for construction purposes, shall be removed or cut back to a depth of 25 mm from the surface of the concrete unless otherwise directed by the Departmental Representative.

.8 The cavity shall be kept saturated for 60 minutes prior to the application of a latex bonding agent or neat cement paste.

.9 The mortar shall be pressed or packed into the depressions so as to completely fill the cavity and then finished to match the adjacent surface.

.10 Fins, unsightly ridges, or other imperfections shall be chipped or rubbed off flush with the surface.

.11 Mortar patches in excess of 25 mm shall be applied in layers not exceeding 25 mm with a 30 minute interval between the placing of layers.

.12 The surface of the patch shall be textured equivalent to the adjacent concrete.

.13 Honeycomb areas or cavities over 25 mm in diameter shall not be repaired until inspected by the Departmental Representative.

.14 Where honeycombing has occurred in non-structural elements, the affected area shall be removed and filled with mortar as previously described.

.15 Where honeycombing has occurred in structural elements, the corrective method of treatment shall be carried out as directed by the Departmental Representative.

.16 All concrete and mortar shall be cured and protected in accordance with CSA A23.1.

.2 Smooth Form Finish (considered all exposed concrete surfaces as outlined in Section 03 10 00 - Concrete Forming and Accessories):

.1 A Smooth Form Finish shall be a uniform, high quality concrete which has been homogeneously placed and thoroughly compacted.

.2 A Smooth Form Finish shall be uniform in colour, pattern and texture. All exposed bridge components and curbs shall have a Smooth Form Finish.

.3 If the concrete, after form stripping and the basic treatment, does not exhibit such finish, the Contractor shall perform any or all of the following operations, in order to obtain a Smooth Form Finish:

.1 Cut out all corrodible metal within 25 mm of the surface and repair the cavities as indicated in basic treatment.

.2 Remove fins and other projections to leave a smooth, plan surface.

.3 Remove stains, rust marks or other blemishes which detract from the specified uniformity of appearance.

.3 Open Surfaces:

.1 The finished surface of concrete placed for such items as superstructure components, approach slabs, sidewalks and curbs shall conform to the lines, grades and elevations shown on the contract drawings.

.2 Concrete edges and expansion joints shall be formed in the concrete at the designated locations.

.7 Damp-proof Membrane:

.1 All damp-proofing material shall conform to CAN/CGSB-37.2-M and shall be applied in accordance with CGSB-37.3. Provide damp-proofing technical specifications to the Departmental Representative for review four weeks before application.

.2 The back face of abutments and soil face of wingwalls where concrete will be in contact with backfill shall be damp-proofed.

.8 Concrete Sealer and Coatings:

.1 Apply concrete sealers/coatings as described in Section 07 92 00 – Concrete Joint Sealant.

.9 Concrete tolerance in accordance with CSA-A23.1/A23.2, except as noted below:

.1 Bridge Deck Thickness: No more than 6 mm, no less than 3 mm.

.2 For Level or Specified Grade in Deck and Approach Slab: 12 mm in 3 m for exposed area, 25 mm in 3 m for backfilled area.

.3 Cross-Sectional Dimensions: No more than 12 mm, no less than 6 mm.

3.3 CRACKS

.1 All cracks 0.15 mm and greater shall be repaired within the warranty period, regardless of location, size or cause in accordance with the following methodology. Fine cracks are defined as less than 1 mm, medium cracks were 1 to 2 mm, and wide cracks were greater than 2 mm. Fine cracks identified for repair shall be filled with an approved low viscosity epoxy resin. The resin shall be applied by pressure injection or by gravity feed into the crack and allowing the sealant to be absorbed. A second application may be required, depending on the absorption and crack depth. The second application, if required by the Departmental Representative, shall be made as soon as possible after the first application has set. All use and placement of resin materials shall be in accordance with the manufacturer's written instructions. Wider cracks, as identified from the survey may require a higher viscosity resin for repair. The Contractor shall submit manufacturer's data for the proposed resin in this case for approval prior to use. Excess resin in the vicinity of the crack shall require removal by grinding and/or abrasive blast cleaning at the Departmental Representative's direction.

3.4 FIELD QUALITY CONTROL

.1 Site tests: conduct tests as follows in accordance with Section 01 45 00 - Quality Control and Section 1.6, Quality Assurance, of this Section and submit report as described in PART 1 - SUBMITTALS.

.1 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.

.2 Carry out tests for slump, air content, compressive strength and temperature in conformance with CAN/CSA A23.1 and CAN/CSA A23.2

.3 Frequency of Testing as follows:

.1 Air, Slump and Temperature: one test for each load of concrete until satisfactory control is established daily and rate of placement > 35 m^3 per hour; then one (1) test for each three (3) loads of concrete. Satisfactory control is considered to have been established when tests on five consecutive loads or batches or concrete are within specification requirements.

.2 Concrete shall be tested for slump, air content and temperature prior to and after the addition of superplasticizer (if added on site). Testing shall be carried out at the point of discharge from the truck and as close as possible to the final deposit into the forms. Sufficient superplasticizer shall be added to produce the desired consistency and if added on site, the superplasticizer shall be mixed into the load a minimum of five minutes prior to retesting.

.3 Concrete shall also be randomly tested for air content and rapid chloride permeability (RCP) in the hardened state (minimum one test every 150 m^3 of the same class of concrete cast). The hardened air voids shall be tested at 7 days and the RCP shall be tested at 28 and 56 days. A minimum of two hardened air void and two RCP tests shall be conducted during the project, one near the start of concrete casting and one near the end of concrete casting.

.4 A set of three regular compressive strength cylinders shall be made for every 50 m^3 of concrete placed, or fraction thereof, or as directed by the Departmental Representative. In addition, for every regular set of three cylinders, two additional cylinders will be cast to be tested only if requested by the Departmental Representative for appeal purposes.

.5 The responsibility for casting any additional cylinders required for interim testing lies with the Contractor.

.6 Ensure there is no accelerated curing of concrete cylinders

.2 The Departmental Representative shall have the right to sample and test all materials used in the mixture design and given access to the production facilities of the ready mix supplier. Materials failing to meet requirements to be immediately rejected.

.3 Ensure test results are distributed to all parties.

.4 Departmental Representative will pay for costs of tests as specified in Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

.5 Departmental Representative may take additional test cylinders as required. Cure cylinders on job site under same conditions as concrete which they represent.

.6 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.

.7 Inspection or testing by Departmental Representative will not relieve Contractor of his contractual responsibility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 20 00 – Concrete Reinforcing

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

- .1 ASTM A185/A185M-21, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- .2 ASTM C260/C260M-10a, Standard Specification for Air-Entraining Admixtures for Concrete.
- .3 ASTM C1372-17, Standard Specification for Dry-Cast Segmental Retaining Wall Units.
- .4 ASTM D698-12 (2021), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.

.2 Canadian Standards Association (CSA International)

- .1 CSA-A23.1/A23.2-19, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2 CSA-A23.3-19Design of Concrete Structures.
- .3 CSA-A23.4-16 (R2021), Precast Concrete - Materials and Construction.
- .4 CAN/CSA-A3000-18, Cementitious Materials Compendium.
  - .1 CSA-A3001-18, Cementitious Materials for Use in Concrete.
  - .2 CSA-A3003-18, Chemical Test Method for Cementitious Materials for Use in Concrete and Masonry.
  - .3 CSA-A3004-18, Test Methods and Standard Practices for Cementitious Materials for Use in Concrete and Masonry.
- .5 CAN/CSA-G40.20/G40.21-13 (R2018), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .6 CAN/CSA-G164-18, Hot Dip Galvanizing of Irregularly Shaped Articles, A National Standard of Canada.
- .7 CAN/CSA-S6-19, Canadian Highway Bridge Design Code.

1.3 DESIGN REQUIREMENTS

.1 Design precast elements to CSA A23.3 and CSA A23.4 to carry handling stresses.

.2 Design precast elements to carry loads in accordance with CSA S6-19 Canadian Highway Bridge Design Code.

.3 Design connections/attachments of precast elements to load/forces specified by CSA S6-19 Canadian Highway Bridge Design Code.

.4 Provide design brief and design drawings for typical precast elements and connections as described in PART 1 - SUBMITTALS.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings in accordance with CSA-A23.3 and CSA-A23.4 and include following items:

- .1 Design brief for items designed by manufacturer.
- .2 Details of prestressed and non-prestressed members, reinforcement and their connections.
- .3 Camber.
- .4 Finishing schedules.
- .5 Methods of handling and erection.
- .6 Openings, sleeves, inserts and related reinforcement.

.3 Submit 2 copies of design brief and design drawings for typical precast elements and connections for review by the Departmental Representative 2 weeks prior to manufacture. Submission is to be stamped by an Engineer licensed in Nova Scotia.

.4 Shop Drawings: submit drawings stamped and signed by qualified professional engineer registered or licensed in Nova Scotia, Canada.

.5 Submit the following at least four (4) weeks prior to the commencing concrete work:

- .1 Certification from the qualified independent inspection and testing company that plant, equipment and materials to be used in the concrete comply with requirements of CSA-A23.1/A23.2.
- .2 Manufacturer’s test data and certification by qualified independent inspection and testing laboratory that the following materials will meet specified requirements:
  - .1 Portland cement
  - .2 Blended hydraulic cement
  - .3 Supplementary cementing materials
  - .4 Admixtures
  - .5 Water
  - .6 Aggregates
- .3 Mix designs for concrete, mix proportions and aggregate sources, which will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA-A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.
- .4 Certification for the concrete supplier from the Atlantic Provinces Ready Mixed Concrete Association – APRMCA Concrete Production Facilities Certification Program.

.6 Include in the submission of the mix designs, test results for each mix containing the following information:

- .1 Plastic Concrete Tests
- .2 Slump (CSA A23.2-5C)
- .3 Air Content of Plastic Concrete by Pressure Method (CSA A23.2-4C)

.4 Mass Density and Yield (CSA A23.2-6C)

.5 Compressive Strength Testing (CSA A23.2-9C)

.6 2 cylinders to be tested at 28 days

.7 Air Void Analysis on Hardened Concrete (ASTM C457) tested at 7 days

.8 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (ASTM C1202) tested at 56 days

.9 Alkali Reactivity Test Results

.7 Submit four (4) weeks in advance of concrete placement, relevant test data for all aggregate materials indicating conformance to the requirements of CSA-A23.1 and this specification. The test results required, but not be limited to, shall include:

.1 Sieve Analysis of Fine and Coarse aggregate

.2 Amount of Material Finer than 80 μm in Aggregate

.3 Bulk Relative Density and Absorption of Fine and Coarse Aggregate (SSD basis)

.4 Fineness Modulus of Fine Aggregate

.5 Clay Lumps and Light Weight Pieces

.6 Test for Organic Impurities in Fine Aggregate

.7 Flat and Elongated Particles in Coarse Aggregates

.8 Petrographic Analysis of Coarse Aggregate (PN-NSTIR Test Method-2)

.9 Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles machine

.10 Micro-Deval test for Coarse and Fine Aggregate

.11 Soundness of Coarse and Fine Aggregate by Use of Magnesium Sulphate

.12 Test for Detection of Alkali-Aggregate Reactivity (AAR) on Coarse and Fine Aggregate

.13 Unconfined Freeze and Thaw test

1.5 QUALITY ASSURANCE

.1 Quality Control Plan: submit written report, as described in PART 3 - VERIFICATION, to the Departmental Representative verifying compliance that concrete provided meets performance requirements of concrete as established in PART 2 - PRODUCTS.

.2 Submit to Departmental Representative, minimum of four weeks prior to starting concrete work, valid and recognized certificate from plant delivering concrete.

.1 When plant does not hold valid certification, provide test data and certification by qualified independent inspection and testing laboratory that materials used in concrete mixture will meet specified requirements.

1.6 QUALIFICATIONS

.1 Fabricate and erect precast concrete elements by manufacturing plant certified in appropriate categories according to CSA-A23.4

.2 Precast concrete manufacturer to be certified in accordance with CSA's certification procedures for precast concrete plants prior to submitting tender and to specifically verify as part of tender that plant is currently certified in appropriate categories, Structural.

.3 Only precast elements fabricated in such certified plants to be acceptable to the Departmental Representative and plant certification to be maintained for duration of fabrication, erection until warranty expires.

.4 Welding companies certified to CSA-W47.1.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver, handle and store precast/prestressed units according to manufacturer's instructions.

.2 Prevent staining or other defacement of visible surfaces of precast units.

.3 Prevent chipping and cracking of precast units.

.4 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

.1 Tolerance of precast elements to CSA-A23.4.

.2 All cementing materials to CSA A3001.

.3 Cementing material to be a blended Portland cement, fly ash, silica fume cement. The minimum proportion by mass of the total cementing materials for silica fume shall be 6% and a maximum of 10%. The maximum proportion by mass of the total cementing material for fly ash is 20%.

.4 Water: to CSA A23.1 and to be free from injurious amounts of oil, acid, alkali soluble chloride, organic matter, sedimentation and other deleterious substances.

.5 Aggregates: to CSA A23.1/A23.2. The maximum Petrographic Number of course aggregate shall not exceed 140. The maximum absorption of course aggregate shall not exceed 2%.

.6 Coarse aggregates shall consist of washed crushed stone having a nominal size of 20 mm. The maximum combination of flat, elongated and flat and elongated particles, as defined in CSA A23.2-13A, shall not exceed 10% of the total mass.

.7 Fine aggregate shall be washed and classified for conform to the gradation limits specified in CSA A23.1.

.8 The use of Alkali-Silica Reactive Aggregates shall not be permitted. When tested in accordance with CSA A23.2-14A, the expansion of the test samples incorporating the aggregate source shall not exceed 0.04 percent at one year.

.9 Reinforcing steel: to grade 400W (weldable), deformed bars to CAN/CSA-G30.18. All reinforcing steel shall be hot dipped galvanized in accordance with CAN/CSA-G-164-M. All minor damage to the galvanizing shall be touched up with organic zinc paint.

.10 Welded wire fabric: to ASTM A185/A185M hot dipped galvanized in accordance with CAN/CSA-G-164-M. All minor damage to the galvanizing shall be touched up with organic zinc paint.

.11 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating 610 g/m^2.

.1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.

.2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.

.1 Temperature of solution equal to or greater than 32 degrees and galvanized steels immersed for minimum 20 seconds.

.3 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.

.1 In this case, no restriction applies to temperature of solution.

.4 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.

.1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.12 Mechanical splices:

.1 Where noted on contract drawings, mechanical rebar splices be threaded style. Strength of coupler and bar shall be equal or greater to the ultimate strength of the rebar size noted in its untreaded state. Proposed rebar splicing system specification sheet shall be provided to the Departmental Representative for approval prior to fabrication.

.13 Forms: to CSA-A23.4.

.14 Anchors and supports: to CAN/CSA-G40.21 galvanized after fabrication.

.15 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.

.16 Welding materials: to CSA W48.

.17 Welding electrodes: to CSA W48 certified by Canadian Welding Bureau.

.18 Air entrainment admixtures: to ASTM C260.

2.2 MIXES

.1 Concrete:

.1 Alternative 1 – Performance: in accordance with CSA-A23.1/A23.2, and as described in MIXES of PART 2 – PRODUCTS.

.1 Concrete mixture designs shall be proportioned as normal density concrete in accordance with CSA-A23.1 latest edition, Alternative #1. Concrete shall be proportioned using Portland cement, Type SF silica fume, fly ash, fine and coarse aggregates, air entraining, water reducing, and superplasticizing and / or set retarding admixtures. Other supplementary cementing materials may include Class F fly ash. Set retarding admixtures may be used as ambient and site conditions warrant.

.2 Mixture proportions shall be selected on the basis of a 75 year design life and all concrete in the structure shall have a minimum compressive strength of 35 MPa in 28 days, unless noted otherwise on the Contract

Drawings. The Contractor shall perform all tests required to demonstrate the long term performance and durability of the materials and concrete mixtures.

.1 Provide concrete mix to meet following hard state requirements:

.2 Minimum compressive strength at 28 days: 35 MPa.

.3 Design life of 75 years.

.4 Class of exposure: C1.

.5 Chemical admixtures: type as approved and in accordance with ASTM C494.

.6 Normal size of coarse aggregate: 20 mm.

.7 Maximum water to cement ratio: 0.4.

.8 Air content: 5-8%.

.9 Maximum spacing factor of hardened concrete not to exceed 250 μm.

.10 Chloride ion permeability at 91 days: <1500 coulombs.

.11 Maximum concrete temperature (from delivery equipment):

.1 Thickness >2 metres: 18˚C.

.2 Thickness <2 metres: 25˚C.

.12 Maximum concrete temperature (in situ): 70˚C.

.13 Maximum temperature gradient: 20˚C/metre.

.14 Superplasticizer shall be used in all concrete.

2.3 MANUFACTURED UNITS

.1 Manufacture units in accordance with CSA-A23.4.

.2 Mark each precast unit to correspond to identification mark on shop drawings for location with date cast on part of unit not to be exposed.

.3 Provide hardware suitable for handling elements.

.4 Galvanize steel embedments after fabrication and touch up with zinc-rich primer after welding.

2.4 FINISHES

.1 Finish units to standard grade to CSA-A23.4.

.2 Exposed face of segmental retaining wall to be Ashlar or alternate approved by the Departmental Representative.

2.5 SOURCE QUALITY CONTROL

.1 Provide Departmental Representative with certified copies of quality control tests related to this project as specified in CSA-A23.4.

.2 Provide records from in-house quality control programme based upon plant certification requirements to Departmental Representative [for inspection and review.

.3 Provide the Departmental Representative with certified copy of mill test report of reinforcing steel supplied, showing physical and chemical analysis.

.4 Precast plants should keep complete records of supply source of concrete material, steel reinforcement, prestressing steel and provide to Departmental Representative for review upon request.

2.6 PRECAST RIGID FRAME

.1 DESIGN CRITERIA

.1 Design of precast rigid frame units by supplier. Design to be stamped by Engineer licenced to practice in Nova Scotia.

.2 Design in accordance with CSA S6-19 Canadian Highway Bridge Design Code.

.3 Live Loading: CL-625 Truck.

.4 Design Soil Backfill Total Unit Weight: 22 kN/m^3.

.5 Design Soil Backfill Effective Angle of Internal Friction: 36 Degrees.

.6 Design to accommodate “Pin-Roller” and “Pin-Pin” lateral base supports to properly capture range of potential support conditions and associated structural behaviour unless supplier’s Engineer can demonstrate that sufficient strength and stiffness is provided by the backfill soils to provide alternate support conditions (i.e. capture true soil-structure interaction).

.7 Span/Rise: As indicated on contract drawings.

.8 Design to accommodate cast-in-place approach slab as indicated on contract drawings.

.2 DESIGN SUBMISSION

.1 Only proprietary precast rigid frame units are acceptable.

.2 Provide Departmental Representative with one copy of complete working drawings and design brief for review at least 2 weeks prior to fabrication. Drawings and design brief to bear signatures and stamp of qualified professional Engineer registered in Nova Scotia.

.3 Provide the following information on the working drawings:

.1 General arrangement of installed units,

.2 Plan and profile of precast units.

.3 Detailed geometry of units.

.4 Rebar details.

.5 Embedded insert details including anchor bolts, rebar, connectors and lifting points.

.6 Details of all joints and connections.

.7 Design codes.

.8 Design assumptions.

.9 Maximum and minimum assumed design water levels.

.10 Handling and lifting instructions.

.11 Installation procedures and details.

.12 Anticipated deflections.

.13 Vertical design reactions at the base of each unit (unfactored load case and governing combinations).

.3 REBAR AND ANCHOR BOLTS

.1 See Section 03 20 00 for rebar requirements.

.2 Precast rigid frame supplier is to provide all required mechanically spliced rebar and anchor bolts extending from the precast segment into the cast-in-place sidewalk, curb and barrier. This includes portion to be cast into cast-in-place components.

.3 Coordinate with bridge barrier post anchor bolt requirements prior to setting anchor bolts. Anchor bolts shall be set with a template to ensure accurate positioning.

.4 Locate anchor bolts used in connection with bridge barriers with due regard to ambient temperature at time of erection.

.5 When setting anchor bolts, care shall be taken to not only ensure that the anchor bolts are set in the correct position and orientation, but also that sufficient thread extension is provided to facilitate bolting the assembly to the concrete, complete with compatible nuts and washers (plate washers where specified), as per the detailed on the Contract Drawings.

.6 Where noted on contract drawings, mechanical rebar splices be threaded style. Strength of coupler and bar shall be equal or greater to the ultimate strength of the rebar size noted in its untreaded state. Proposed rebar splicing system specification sheet shall be provided to the Departmental Representative for approval prior to fabrication.

.4 FOUNDATION AND BACKFILL

.1 Foundation to be pile supported complete with cast-in-place reinforced concrete pile cap as shown on contract drawings.

.2 Granular backfill material to Section 31 05 16 – Aggregate Materials meeting Nova Scotia Public Works Standard Specification Fill Against Structure (FAS).

.5 WATERPROOFING

.1 The waterproofing system shall be a manufactured waterproofing membrane system consisting of a primer, a membrane, a mastic and a protection board and shall be utilized on the precast rigid frame units. The waterproofing shall cover the full length of the structure and wrap over the top of the footings. The proposed system shall have a documented history of successful use in similar applications. Proposed waterproofing shall be submitted to the Departmental Representative for approval.

2.7 PRECAST SEGMENTAL CONCRETE RETAINING WALL

.1 DESIGN CRITERIA

.1 Design of segmental concrete retaining wall by supplier. Design to be stamped by Engineer licenced to practice in Nova Scotia.

.2 Design to CAN/CSA S6-19.

.3 Consider both internal and external stability of wall system in design. External stability to include safety against sliding, overturning, bearing failure and slop circle failure.

.4 Minimum factor of safety:

.1 Pullout resistance: 1.5.

.2 Sliding: 1.5.

.3 Overturning: 1.5.

.4 Bearing Capacity: 2.0.

.5 Overall slope stability: 1.5.

.5 Finished face of wall shall be vertical or near vertical with normal setback per course.

.2 DESIGN SUBMISSION

.1 Only proprietary wall systems are acceptable.

.2 Provide Departmental Representative with one copy of complete working drawings and design brief for review at least 2 weeks prior to fabrication. Drawings and design brief to bear signatures and stamp of qualified professional Engineer registered in Nova Scotia.

.3 Verity existing site conditions and ground elevations before preparing working drawings.

.4 Use only one type of wall system for the structure. Do not substitute for any component normally supplied by the supplier for proprietary wall system.

.5 Provide the following information on the working drawings:

.1 General arrangement of installed units,

.2 Plan and profile of precast units.

.3 Elevations of top of wall, base of wall and levelling pad.

.4 Detailed geometry of units.

.5 Rebar details.

.6 Embedded insert details including anchor bolts, rebar, connectors and lifting points.

.7 Details of all joints and connections.

.8 Design codes.

.9 Design assumptions.

.10 Maximum and minimum assumed design water levels.

.11 Handling and lifting instructions.

.12 Installation procedures and details.

.3 FOUNDATION AND BACKFILL

.1 Granular backfill material to Section 31 05 16 – Aggregate Materials meeting Nova Scotia Public Works Standard Specification Fill Against Structure (FAS).

.4 WALL UNITS

.1 Exterior block dimensions to be uniform and consistent. Maximum dimensional deviations to be 1% excluding the architectural surface. Maximum width (face to back) deviation including the architectural surface to be 25 mm.

.2 Exposed face to be finished as specified. Other surfaces to be smooth form type. Dime-size bug holes on the block face are to be patched and/or shake-on color stain can be used to blend into the remainder of the block face.

.5 LEVELLING PAD AND FREE DRAINING BACKFILL

.1 Crush stone levelling pad shall be provided under segmental retaining wall units.

.2 Free draining FAS (or approved alternate shall be provided as backfill behind wall.

.3 Place non-woven geotextile between the free draining backfill and other retained soils, if required.

.4 Wall designer to evaluate wall drainage and design wall appropriately for drainage provided.

Part 3 Execution

3.1 ERECTION

.1 Install precast units in accordance with manufacturer's recommendations. Representative from the manufacturer shall be onsite during erection to verity contractor's installation methods.

.2 Do precast concrete work in accordance with CSA-A23.4 and CAN/CSA-S6.

.3 Do welding in accordance with CSA-W59, for welding to steel structures and CSA-W186, for welding of reinforcement.

.4 Non-cumulative erection tolerances in accordance with CSA-A23-4.

.5 Set elevations and alignment between units to within allowable tolerances before connecting units.

3.2 PRECAST RIGID FRAME

.1 PLACING

.1 Ensure leg of each rigid frame unit its in contact with the footing throughout its length.

.2 Provide softening material between bottom of rigid frame leg and top of concrete footing to avoid local stresses from uneven bearing. Softening product to be as per manufacturers recommendations and submitted for approval by the Departmental Representative prior to construction.

.3 Prior to releasing rigid frame from crane, shims are to be installed within footing key between rigid frame leg and keyway verticals to lock frame to footing longitudinally.

.4 Supply and place non-shrink grout in the footing keyway in accordance with manufacturer's instructions.

.5 Connect precast units in accordance with manufacturer's instructions.

.6 Joints between units to be waterproofed.

.2 WATERPROOFING

.1 All concrete surfaces shall be dry and free of foreign materials prior to priming.

.1 Any primed surfaces left overnight shall be re-primed prior to membrane application.

.2 The Contractor shall prepare the are and install waterproofing in accordance with the manufacturer's instructions.

.3 For all waterproofing applications, the following shall apply:

.1 The membrane shall be protected with protection board, adhered to the waterproofed surface.

.2 All waterproofing products shall be stored, handled and installed as per manufacturer's instructions.

.3 All exposed edge terminations shall receive a trowelled bead of mastic.

.4 The membrane shall be applied in strips at each precast unit joint.

.5 Protection board shall be applied over the top of the waterproofing system (except under sidewalk) and sufficiently adhered to the membrane with mastic.

.3 BACKFILLING

.1 Backfill precast rigid frame units as specified in Section 31 24 14 Fill Against Structure. Sequence of backfilling to meet manufacturer's recommendations.

3.3 SEGMENTAL CONCRETE RETAINING WALL

.1 EXCAVATION

.1 Excavate to the lines and grades shown on the construction drawings.

.2 FOUNDATION

.1 Compat foundation soil to a minimum 95% of the maximum dry density (or as directed by the Departmental Representative) in accordance with ASTM D698 prior to placement of the leveling pad material.

.2 Examine in-situ foundation soil to ensure that the actual foundation soil strength meets or exceeds assumed design strength. Remove soil not meeting the required strength and replace with acceptable, compacted material.

.3 LEVELING PAD

.1 Place leveling pad as shown on the construction drawings.

.2 Place leveling pad on suitable material.

.3 Compact leveling pad to a minimum 95% of the maximum dry density (or as directed by the Departmental Representative) in accordance with ASTM D698 to ensure a level, hard surface on which to place the first course of retaining wall. Pad shall be constructed to the proper elevation to ensure the correct final wall elevations.

.4 Leveling pad to have a 150 mm minimum depth for walls under 2.5 m in height and a 300 mm minimum depth for walls over 2.5 m in height. Extend pad dimensions beyond the retaining wall segments in all directions to a distance at least equal to the depth of the leveling pad.

.4 SEGMENTAL UNIT INSTALLATION

.1 Place the first course of wall units on the prepared leveling pad with the aesthetic surface facing out and the front edges tight together. Check all units for level and alignment as they are placed.

.2 Confirm that units are in full contact with the leveling pad. Take proper care to develop straight lines and smooth curves on base course as per wall layout.

.3 Place the backfill in front and back of entire base row and compact to firmly lock units in place. Following this filling, check all units for level and alignment and adjust as required. Sweep all excess material from top of units prior to proceeding.

.4 Proceed installing wall units as per manufacturers recommendations. Take care to maintain proper grades and alignment.

.5 Allowable constriction tolerance at the wall face is 2 degrees vertically and 1 in 120 horizontally.

3.4 VERIFICATION

.1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established in PART 2 - PRODUCTS, by Departmental Representative and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.

3.5 CLEANING

.1 Use cleaning methods as reviewed by Departmental Representative before cleaning soiled precast concrete surfaces.

END OF SECTION