SUMMARY OF CHANGES - SPECIFICATIONS FOR BRIDGE CONSTRUCTION 2010

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Front Cover Page	Specifications for Bridge Construction Alberta Infrastructure and Transportation 2007	Specifications for Bridge Construction Alberta Transportation *2010*	
Inside Cover Page	Jay Ramotar Deputy Minister	*Gary Boddez* *Deputy Minister*	Specification revision
Copyright Page	Copyright © July 2007	Copyright © *February 2010*	Specification revision
Summary of Specifications			
General Specifications			
1.1 Definitions	July 2007	Will be a stand alone spec	No longer included in BCS
1.2 General Specifications	July 2007	Will be a stand alone spec	No longer included in BCS
Section 3 Bearing Piles			
3.2.1 Steel "H" Piling Steel "H" piling shall meet the requirements of Specification ASTM A36 or CSA G40.21M 300W. Where piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill certificates shall be provided to the Consultant for review prior to pile installation.		3.2.1 Steel "H" Piling Steel "H" piling shall meet the requirements of Specification ASTM A36 or CSA G40.21M *350*W. Where piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill certificates shall be provided to the Consultant for review prior to pile installation.	
3.2.2 Steel Pipe Piling Steel pipe piling shall meet the requirements of Specification ASTM 252 Grade 2, except that hydrostatic testing is not required. Although piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill certificates shall be provided to the Consultant for review prior to pile installation. Some out-of-roundness of the pipe is acceptable provided an acceptable splice can be completed. Galvanized piling shall be galvanized by the hot dip method, in accordance with CSA Standard G164.		3.2.2 Steel Pipe Piling Steel pipe piling shall meet the requirements of Specification ASTM 252 Grade 2, except that hydrostatic testing is not required. Although piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill certificates shall be provided to the Consultant for review prior to pile installation. Some out-of-roundness of the pipe is acceptable provided an acceptable splice can be completed. Galvanized piling shall be galvanized by the hot dip method, in accordance with *the current version of the ASTM A123/A 123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*.	

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3.4.1 Equipment and Driving Methods All pile driving equipment, driving methods and procedures shall be reviewed by the Consultant before any driving is started. Acceptable driving equipment includes diesel hammers, vibratory hammers, driving frames or other equipment as may be required by the Consultant. The use of multi-component drop hammers will not be permitted under any circumstances. The use of gravity hammers will not be permitted except when the required bearing value is less than 350 kN, and the Consultant deems the gravity hammer and leads to be suitable. Where the use of a gravity hammer is acceptable, the Contractor shall furnish to the Consultant acceptable proof of its weight including the weight of the follower.	3.4.1 Equipment and Driving Methods All pile driving equipment, driving methods and procedures shall be reviewed by the Consultant before any driving is started. Acceptable driving equipment includes diesel hammers, *hydraulic hammers*, vibratory hammers, driving frames or other equipment as may be required by the Consultant. The use of multi-component drop hammers will not be permitted under any circumstances. The use of gravity hammers will not be permitted except when the required bearing value is less than 350 kN, and the Consultant deems the gravity hammer and leads to be suitable. Where the use of a gravity hammer is acceptable, the Contractor shall furnish to the Consultant acceptable proof of its weight including the weight of the follower.
3.4.2 Bearing Values … In the event pile tip elevations are not given on the drawings, the pile bearing capacities shall be estimated by any or all of the methods outlined under Bearing Formulas, Loading Tests, or Test Piles, as determined by the Consultant. In the case of friction piles, the piles shall be driven to the tip elevations shown on the Drawings, or lower, in order to achieve the required stability and design load carrying capacity. Bearing Formulas When not driven to practical refusal, the bearing values of piles may be required to be determined by load tests as specified above. In the absence of loading tests, the safe bearing values for piles shall be determined by the following formulas: For Diesel Hammers $$P = \frac{165xExF}{S+5}$$	3.4.2 Bearing Values … In the event pile tip elevations are not given on the drawings, the pile bearing capacities shall be estimated by any or all of the methods outlined under Bearing Formulas, *Test Piles, or Pile Capacity Test Methods*, as determined by the Consultant. In the case of friction piles, the piles shall be driven to the tip elevations shown on the Drawings, or lower, in order to achieve the required stability and design load carrying capacity. Bearing Formulas When not driven to practical refusal, the bearing values of piles may be required to be determined by *test methods* as specified above. In the absence of *the above noted tests*, the safe bearing values for piles shall be determined by the following formulas: For Diesel *and Hydraulic* Hammers

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… Loading Tests When required, the size and number of piles shall be determined by actual loading tests. In general, these tests shall consist of the application of a test load placed upon a suitable platform supported by the pile, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. In lieu of hydraulic jacks with suitable yokes, pressure gauges may be used. The safe allowable load shall be considered as 50% of that load which, after a continuous application of 48 hours, produces a permanent settlement not greater than 6 mm measured at the top of the pile. This maximum settlement shall not increase by a continuing application of the test load for a further period of 60 hours or longer. At least one pile for each group of 100 piles shall be tested.	$P = \frac{165xExF}{S+5}$ … *Deleted*
3.4.3 Steel Piles Steel piles shall consist of structural steel shapes or pipes of the section shown on the drawings or otherwise specified. When pipe piles are to be driven closed-ended… Specifications. When pipe piles are to be driven open-ended … shall be removed. None.	3.4.3 Steel Piles Steel piles shall consist of structural steel shapes or pipes of the section shown on the drawings or otherwise specified. When pipe piles are to be driven closed-ended … Specifications. When pipe piles are to be driven open-ended …shall be removed. *After installation closed ended or open ended pipe piles shall to be filled with pile concrete.*
3.4.3.1 Steel Pile Splices When splicing, the Contractor shall employ whatever means necessary to match out-of-round piling. Exposed pile splices shall be avoided. Refer to Standard Drawing S-1415 "Standard H-Pile Splice" and Standard Drawing S-1414 "Standard Pipe Pile Splice" included with these Specifications.	3.4.3.1 Steel Pile Splices When splicing, the Contractor shall employ whatever means necessary to match out-of-round piling. Exposed pile splices shall be avoided. Refer to Standard Drawing S-1415 "Standard H-Pile Splice" and Standard Drawing S-1414 "Standard Pipe Pile Splice" included with these Specifications. *All welding in the field shall be in accordance with Section 13.4.1.*

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3.4.4.2 Testing by the Contractor The Contractor shall arrange to have a minimum of 20% of all full penetration pile welds inspected either by ultrasonic testing or radiographic inspection methods. The Consultant will randomly select the splices for inspection. The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic and radiographic testing technicians shall be certified to Level II of CGSB. A copy of test results shall be provided to the Consultant for his review within three days of the inspection. The Consultant may require additional inspection if deemed necessary.	3.4.3.2 Testing by the Contractor The Contractor shall *perform ultrasonic testing for* a minimum of 20% of all full penetration *compression splice welds for all piles for each bridge component. Ultrasonic testing shall be done for welds for which visual inspection may indicate having some defect. Additional testing may be required for the full penetration compression splice welds to ensure the integrity of the structure. In addition, the Contractor shall inspect 100% of the full penetration tension splice welds, as defined on the Detailed Designs.* The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic testing technicians shall be certified to Level II of *Canadian General Standard Board (CGSB)*. A copy of test results shall be provided to the Consultant for his review within three days of the inspection. The Consultant may require additional inspection if deemed necessary.
3.4.3.2 Testing by the Contractor The Contractor shall arrange to have a minimum of 20% of all full penetration splice welds for piles with 600 mm or larger diameter either by ultrasonic testing or radiographic inspection methods. The Consultant will randomly select the splices for inspection. The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic testing technicians shall be certified to Level II of CGSB. A copy of test results shall be provided to the Consultant for his review within three days of the inspection. The Consultant may require additional inspection if deemed necessary.	3.4.3.2 Testing by the Contractor The Contractor shall *perform Ultrasonic testing for* a minimum of 20% of all full penetration *compression* splice welds for *all* piles *for each bridge component. Ultrasonic testing shall be done for welds for which visual inspection may indicate having some defect. Additional testing may be required for the full penetration compression splice welds to ensure the integrity of the structure. In addition, the Contractor shall inspect 100% of the full penetration tension splice welds, as defined on the Detailed Designs.* The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic testing technicians shall be certified to Level II of *Canadian General Standard Board (*CGSB*)*. A copy of test results shall be provided to the Consultant for his review within three days of the inspection. The Consultant may require additional inspection if deemed necessary.
3.4.6 Measurement and Payment … Re-stocking Steel Piling When quantities of plain Steel Pipe or H Piles are reduced by 15% or less due to conditions beyond the Contractor's control, the Department	3.4.6 Measurement and Payment … Re-stocking Steel Piling When quantities of plain Steel Pipe or H Piles are reduced by 15% or *more* due to conditions beyond the Contractor's control, the Department will

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will reimburse the "re-stocking" costs for 6.0 metre lengths or longer, incurred by the supplier to the Contractor. … Pile Splicing When the Contract contains a bid item for **Pile Splicing**, piles which penetrate in excess of 20% from the designed tip elevation, splicing will be paid for at the assigned unit price for **Pile Splicing** and will include all labour, materials, equipment, tools and incidentals necessary to complete the work. Only one splice for each additional length of pile, up to twelve metres, will be paid for.	reimburse the "re-stocking" costs for 6.0 metre lengths or longer, incurred by the supplier to the Contractor. … Pile Splicing When the Contract contains a bid item for **Pile Splicing**, piles which penetrate in excess of 20% *of the estimated length*, splicing will be paid for at the assigned unit price for **Pile Splicing** and will include all labour, materials, equipment, tools and incidentals necessary to complete the work. Only one splice for each additional length of pile, up to twelve metres, will be paid for.
Pile Splicing When the Contract contains a bid item for **Pile Splicing**, piles which penetrate in excess of 20% from the designed tip elevation, splicing will be paid for at the assigned unit price for **Pile Splicing** and will include all labour, materials, equipment, tools and incidentals necessary to complete the work. Only one splice for each additional length of pile, up to twelve metres, will be paid for. …	Deleted
Loading Tests Payment for Loading Tests shall include the cost of all material, equipment and labour incidental to making the loading test or tests as determined by the Consultant, or as specified in the specified in the special provisions. Payment will be made on the basis of the contract price for pile loading tests, or, in the absence of such a price, will be made as specified for Extra Work.	Deleted
None	*3.5.3 Cast-In-Place Pile Bearing Values* *Where cast-in-place piles are designed based on the use of semi-empirical methods, supported by a geotechnical investigation with soil strength parameters determined by laboratory, field testing and local experience, and with appropriate levels of construction monitoring and verification the ultimate bearing capacity may be adjusted for Limit State Design by a geotechnical resistance factor of 0.4. If working state design methods are*

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3.5.3 Drilling Pile Holes 3.5.4 Open Drilled Holes 3.5.5 Reinforcement 3.5.6 Concrete Placement When the reinforcement has been acceptably placed…shall apply. Suitable forms shall be used…above ground level. None 3.5.7 Cold Weather Conditions 3.5.8 Pile Tolerance 3.5.9 Measurement and Payment … Payment for **Pile Installation** will be made on the basis of the unit price per lineal metre bid which shall include full compensation for the cost of supplying all materials including piling, drilling, dewatering and cleaning out the holes to the dimensions shown, removal and disposal of the augered material, detection and purging of any gas hazard, and providing safe inspection access. The quantity to be paid for **Pile Installation** shall be the number of lineal metres required to install the piling in accordance with the drawings and specifications (measured from the pile tip to the underside of pile/pier cap). Drilling will be considered as part of pile installation and no separate or additional payment will be made.	*used the allowable loads shall be as determined by the Consultant.* 3.5.*4* Drilling Pile Holes 3.5.*5* Open Drilled Holes 3.5.*6* Reinforcement 3.5.*7* Concrete Placement When the reinforcement has been acceptably placed…shall apply. Suitable forms shall be used…above ground level. *Pile concrete placed under water will require validation by Crosshole Sonic Logging (CSL) in accordance with section 4.15.3 "Concrete Placed under Water".* 3.5.*8* Cold Weather Conditions 3.5.*9* Pile Tolerance 3.5.*10* Measurement and Payment … Payment for **Pile Installation** will be made on the basis of the unit price per lineal metre bid which shall include full compensation for the cost of supplying all materials including *piles*, drilling, dewatering and cleaning out the holes to the dimensions shown, removal and disposal of the augered material, detection and purging of any gas hazard, and providing safe inspection access. The quantity to be paid for **Pile Installation** shall be the number of lineal metres required to install the *piles* in accordance with the drawings and specifications (measured from the pile tip to the underside of pile/pier cap). Drilling will be considered as part of pile installation and no separate or additional payment will be made.
None	***3.6 Pile Capacity Test Methods*** *3.6.1 Static Load Testing* *When specified, the load carrying capacity of piles shall be determined by static load tests. In general static load tests can be performed on any pile type. Static load tests shall consist of the application of a test load on a*

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	suitable platform supported by the pile, or through the use of adjacent reaction piles, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. The tests shall be in general conformance with ASTM D3689-90 (1995). Osterberg or Statnamic tests may be used in place of static load tests. *Where sufficient static load testing has been done to satisfy Limit State Design, Load and Resistance Factor Design (LRFD), or reliability-based design statistical requirements, the factored geotechnical resistance may be taken as 0.6. Where allowable or working state design methods are used in the design, or where the requirements of Limit State Design are not fulfilled, the allowable load shall be considered as 50% of that load which, after a continuous application of 48 hours, produces a permanent settlement not greater than 6 mm measured at the top of the pile. This maximum settlement shall not increase by a continuing application of the test load for a further period of 60 hours or longer. At least one pile for each group of 100 piles shall be tested. The frequency of testing shall be increased to account for changing soil conditions, pile sections and types, and construction methods.* *3.6.2 Dynamic Load Testing / Pile Driving Analyzer (PDA) Testing* *Dynamic Load Testing provides useful data on piling stresses and can be used as part of a quality control method during pile installation. Pile Driving Analyzer (PDA) testing can be used as an alternate or supplemental test method to static load tests for the determination of pile capacity. This method involves installing instruments on the pile head with accelerometers and strain gauges, then impacting the pile head using a pile driving hammer or similar device over a very short period of time (3-4 milliseconds). The impact imparted on the pile should be sufficient to fully mobilize the pile skin friction and end bearing resistances of the pile. In general, this requires that a net permanent set per blow of at least 3 mm (and not greater than 8 mm) be achieved upon impact from the pile hammer.* *The PDA test can be conducted on either driven or cast-in-place piles. For driven piles, the PDA test shall be conducted at the end of the initial driving stage, such that the end bearing and skin friction resistances can be determined upon initial installation of the pile. Where time dependant changes in the soil conditions are anticipated, such as pile setup or*

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	relaxation, additional tests shall be conducted upon re-strike on a sample of previously tested piles to determine the bearing parameters after driving induced pore pressures have dissipated. The re-strike should be conducted approximately one to two weeks or longer after initial driving, as directed by the Consultant. It is permissible to initially drive piles to a capacity below the required ultimate capacity and rely on pile setup to produce the required capacity. Where the capacity of the pile at re-strike is relied upon for design, a minimum of one third of piles tested during initial drive should be tested again during re-strike. *If dynamic testing is only undertaken upon re-strike, then a minimum of 10% to15% of all piles shall be PDA tested on re-strike.* *The hammer energy used during PDA tests at the end of initial drive and during re-strike driving shall be such that the required ultimate pile capacity can be mobilized in a single blow without additional data interpretation.* *For cast-in-place piles, the PDA test should be conducted at least one week after the installation of the pile, as directed by the Consultant.* *The results of the test can be processed in the short term using the Wave Equation Analysis of Piles (WEAP) method to provide real time monitoring of pile stresses, pile integrity, hammer performance, and pile capacity; and in some cases can be used to confirm pile termination depths when borehole information is not available. This method should only be used as an initial determination of bearing capacity though, and where the test is being used to determine the capacity of the pile for design methods, a signal matching analysis using a Case Pile Wave Equation Program (CAPWAP) should be utilized.* *To ensure good quality data resulting from the PDA test, ASTM D4945-08 should be followed. In addition, at least two accelerometers on a driven pile and four accelerometers on a cast-in-place pile should be installed. All accelerometers and transducers should be calibrated and inspected to ensure proper attachment to the pile.* *Since the PDA test method indirectly calculates the load and settlement characteristics of the pile based on strain and acceleration measurements, PDA testing is deemed secondary in accuracy to Static Load Tests. As a result, where the PDA methods are used strictly as a QA/QC tool, a*

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	minimum of 5% to10% of production piles should be monitored dynamically. When used as a design or confirmatory tool, a minimum of 10% to15% of piles (including tests at such substructure associated with the project or where soil conditions are expected to vary) should be tested, or as required for statistic validation of a LRFD design whichever is greater. The piles selected for testing should be representative of other piles in the same structure. Where driven piles exhibit lower driving resistances and/or shorter penetrations than normal, or where cast-in-place piles experience extraneous soil, ground water, and/or installation conditions, additional tests over and above minimum number of tests specified earlier may be required. Further, additional tests should accompany changes in piling equipment, procedure and pile requirements. *In the situation where one pile in a pile group does not meet capacity requirements, additional tests may be necessary to confirm that this pile is an isolated case. In such case, it may be permissible to rely on group effects to compensate for the lower pile capacity. The geotechnical and structural consultants will have final say in this situation. Under no circumstances will superposition of axial and shaft capacity from different strikes, re-strikes or any combination thereof be permitted.* *Where sufficient dynamic load testing has been done to satisfy Limit State Design, LRFD or reliability-based design statistical requirements, the geotechnical resistance factor for design of pile foundations may be taken as 0.5.* *Pile driving equipment shall be sized such that piles can be driven with reasonable effort to the specified ultimate bearing capacity, without damaging the pile. Approval of the pile driving equipment by the Consultant will be based on the WEAP analysis and/or PDA testing. The Contractor shall submit details of the proposed pile driving equipment for review by the Consultant a minimum of 14 days prior to the commencement of pile installation. The information provided shall include the following:* – *Hammer Data: Hammer type, manufacturer, model number, serial number, maximum rated energy and range in operating energy, stroke at maximum rated energy and range of operating stroke, ram weight, modifications.* – *Striker Plate Data: weight, diameter, thickness, composition*

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	– *Hammer Cushion Data: Manufacturers, area, thickness per plate, number of plates, total thickness, and composition* – *Helmet Data: Weight, composition* – *Pile Cushion Data: Material, area, thickness per sheet, number of sheets, total thickness of cushion* *The PDA testing agency shall prepare a daily field report summarizing the preliminary test results including driving stresses, transferred energy and estimated pile capacity to the Consultant within 24 hours of testing. The final test results shall be presented to the Department within 7 days of testing. The testing report shall be prepared in accordance with the requirements of ASTM D4945-08. As a minimum, the report shall include the following:* – *Pile and driving system information* – *Pile installation data* – *PDA testing equipment and procedure* – *Energy imparted* – *Maximum driving stresses* – *Hammer blow rate* – *CAPWAP input parameters including quake and damping factors* – *Shaft friction, end bearing and total pile capacity* *The Consultant will use the test results to determine the subsequent termination criteria, requirements for modification of driving procedures or equipment, and pile acceptance. Any work done on the foundation elements (pile caps, cut-off, welding, etc) prior to received approval of test results from the Consultant will be at the Contractor's own risk.* *3.6.3 Measurement and Payment* *When the contract contains a bid item for* ***Static Load Testing,*** *payment will be made at the unit price bid and will be full compensation for static load testing and all labour, equipment, tools and incidentals to complete the work.* *When the contract contains a bid item for* ***Dynamic Load Testing/Pile Driving Analyzer (PDA) Testing****, payment will be made at the unit price bid and will be full compensation for dynamic load testing and PDA testing, pile set up for re-strike, pile re-striking and all labour, equipment, tools and*

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	incidentals necessary to complete the work.
Standard Drawing S-1415-87 Standard H-Pile Splice	Standard Drawing S-1415-87 Standard H-Pile Splice Revision 6 - Pile types added to chart.
Section 4 Cast-In-Place Concrete	
4.2 Materials for Concrete Concrete shall consist of Portland cement, aggregates, water and admixtures or additives which shall conform to the requirements as specified. Cement - Normal Portland cement, Type GU, or Sulphate Resistant, Type HS, shall be supplied unless otherwise specified. Cement shall conform to the requirements of CSA Standard A 3001-03, Portland Cements. Water - Water to be used for mixing concrete or mortar shall conform to the requirements of CSA Standard A23.1 and shall be free from injurious amounts of alkali, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources. Aggregates - Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1 and shall be stockpiled separately. Admixtures - All approved admixtures, such as water reducing agents, air entraining agents and superplasticizers shall conform to ASTM C494 and be compatible with all other constituents. The addition of calcium chloride, accelerators, and air-reducing agents, will not be permitted. Silica Fume - Condensed silica fume shall conform to CSA Standard A 3000-03 - Cementitious Material Compendium, Type SF, with a SiO_2 content of at least 85%, of a maximum of 10% ignition loss, and no more than 1% SO_3 content. Air Entraining Agent - Air Entraining Agent shall be added to all concrete and shall conform to the requirements of ASTM C260. Steel Fibres - When specified, steel fibres shall be Xorex 1, Wiremix or an acceptable equivalent. The fibres shall conform to ASTM	**4.2 Materials for Concrete** Concrete shall consist of *hydraulic* cement, aggregates, water and admixtures or additives which shall conform to the requirements as specified. Cement - *Hydraulic* cement *shall conform to the requirements of CSA Standard A 3001. General Use (Normal)* Type GU, or *High* Sulphate Resistant, Type HS *or HSb*, shall be supplied unless otherwise specified. *Silica Fume – Condensed silica fume shall conform to the requirements of CSA Standard A 3001 for a Type SF supplementary cementing material, with a SiO_2 content of at least 85%, a maximum loss on ignition of 10% and no more than 1% SO_3 content.* *Fly Ash – All fly ash shall conform to the requirements of CSA Standard A 3001 for Type F or Type CI fly ash.* Water - Water to be used for mixing concrete or mortar shall conform to the requirements of CSA Standard A23.1 and shall be free from injurious amounts of alkali, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources. Aggregates - Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1 and shall be stockpiled separately. Admixtures - All approved admixtures, such as water reducing agents, air entraining agents and superplasticizers shall conform to ASTM C494 and be compatible with all other constituents *including cement, silica fume and fly ash.* The addition of calcium chloride, air-reducing agents *or accelerators* will not be permitted. *Hydration Stabilizing Admixtures (HSA's) shall meet ASTM C494 requirements for Type D water reducing and retarding admixtures. The maximum allowable time of set retarding shall be three hours, as measured*

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A820/A820M-04 Type 1 or 5 and be 50 mm in length with the aluminum content no more than 0.020% by mass when tested in accordance with test method Environmental Protection Agency (EPA) 3050B. Fly Ash - All fly ash shall conform to the requirements of CSA-A3000-03 Cementitious Material Compendium for Type "F" or "CI" fly ash. Only approved compatible superplasticizing admixtures and air entraining agents shall be used with the fly ash. Characteristic data for fly ash is required to assure conformance to the standards.	*from the time of mixing. The appropriate dosage rates are to be verified with trial batch tests. The use of HSA's requires the approval of the Department and Consultant and their usage is limited to those projects where haul times are expected to exceed the specified times and/or projects which require retardation due to structural considerations.* Air Entraining Agent - Air Entraining Agent shall be added to all concrete and shall conform to the requirements of ASTM C260. Steel Fibres - When specified, steel fibres shall be *Novocon XR, Wire Mix W50* or an acceptable equivalent. The fibres shall conform to ASTM A820/A820M-04 Type 1 or 5 and be 50 mm in length with the aluminum content no more than 0.020% by mass when tested in accordance with test method Environmental Protection Agency (EPA) 3050B.
4.3 Storage of Materials Cement, silica fume, fly ash and steel fibres shall be stored in a suitable weather-tight building which shall protect these materials from dampness. Cement, silica fume and fly ash shall be free from lumps at all times during their use in the work. Cement, silica fume and fly ash which have been stored for a length of time resulting in the hardening or the formation of lumps shall not be used in the work. The steel fibres shall be free from balls and clumps at all times during their use in the work.	**4.3 Storage of Materials** Cement, silica fume, fly ash and steel fibres shall be stored in a suitable weather-tight building which shall protect these materials from dampness. Cement, silica fume and fly ash shall be free from lumps at all times during their use in the work. The steel fibres shall be free from balls and clumps at all times during their use in the work.

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4.4.1 Class of Concrete

Class of Concrete	Minimum Specified Compressive Strength at 28 Days MPa	Size of Coarse Aggregate mm	Range of Slump mm	Total Air Content %	Max Water/Cementing Materials Ratio
B	25	28 to 5	50 to 70	4 - 7	0.45
C	35	20 to 5	60 to 80	5 - 8	0.42
HPC	45	20 to 5	90 to 150	5 - 8	0.38
D	30	14 to 5	50 to 70	5 - 8	0.42
S	20	28 to 5	50 to 70	4 - 7	0.50
Pile	25	28 to 5	100 to 140	4 - 7	0.45

Note
- The size of coarse aggregate shall be 28 to 5mm for Class C concrete when used in mass pours such as piers and abutments.
- Class HPC concrete shall be used for all decks, deck overlays with internal reinforcement, curbs, barriers, medians, roof slabs and approach slabs. Deck overlay concrete shall be Class HPC with steel fibres when no internal reinforcement exists.
- When the thickness of deck overlay concrete is specified as 50 mm or less, the nominal maximum top size of aggregate shall be 14 mm.
- The fly ash shall not exceed 30% by mass of cementing materials, however for High Performance Concrete (HPC) it shall be in accordance with Clauses 4.4.2(e) & (g). Fly ash may be used in concrete mixes where the aggregate is assessed to be potentially alkali-silica reactive.

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4.4.1 Class of Concrete

Class [4] of Concrete	Minimum Specified Compressive Strength at 28 Days MPa	*Nominal Maximum* Coarse Aggregate *Size* mm	Range of Slump mm	Total [5] Air Content %	Max Water/Cementing Materials Ratio
B	25	28 to 5	50 to 70	4 - 7	0.45
C	35	20 to 5 [1]	60 to 80	5 - 8	*0.40*
HPC [3]	45	20 to 5 [2]	90 to	5 - 8	0.38
D	30	14 to 5	50 to 70	5 - 8	0.42
S	20	28 to 5	50 to 70	4 - 7	0.50
Pile	25	28 to 5	100 to	4 - 7	0.45

Notes
1. *The size of coarse aggregate shall be 28 to 5mm for Class C concrete when used in mass pours such as piers and abutments.*
2. *When the thickness of deck overlay concrete is specified as 50 mm or less, the nominal maximum top size of aggregate shall be 14 mm.*
3. *Class HPC concrete shall be used for all decks, deck overlays with internal reinforcement, curbs, barriers, medians, roof slabs, approach slabs and MSE wall coping. Deck overlay concrete shall be Class HPC with steel fibres when no internal reinforcement exists.*
4. *The fly ash shall not exceed 30% by mass of cementing materials, however for High Performance Concrete (HPC) it shall be in accordance with Clauses 4.4.2(e) & (g). Fly ash may be used in concrete mixes where the aggregate is assessed to be potentially alkali-silica reactive.*
5. *Range in air contents to be in compliance with maximum aggregate size as per CSA A23.1 Table 4.*

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4.4.2 Class HPC and Class HPC with Steel Fibres	4.4.2 Class HPC and Class HPC with Steel Fibres
(a) Mix shall include silica fume and fly ash as supplementary materials in combination with compatible air entraining, water reducing and/or superplasticizing admixtures, as required.	(a) Mix shall include silica fume and fly ash as supplementary materials in combination with compatible air entraining, water reducing and/or superplasticizing admixtures, as required.
(a) The gradation limits for the fine aggregate shall conform to CSA A23.1, except that the amount of material finer than 160 µm shall not exceed 5%.	*(b)* The gradation limits for the fine aggregate shall conform to CSA A23.1, except that the amount of material finer than 160 µm shall not exceed 5%.
(c) Coarse aggregate shall conform to CSA A23.1 and the maximum combination of flat and elongated particles (3:1 ratio), as determined by CSA A23.2-13A, shall not exceed 10% of the mass of coarse aggregate.	(c) Coarse aggregate shall conform to CSA A23.1 and the maximum combination of flat and elongated particles (*4:1* ratio), as determined by CSA A23.2-13A, shall not exceed 10% of the mass of coarse aggregate.
(i) Rapid chloride ion penetration shall be determined in accordance with ASTM C1202 on laboratory moist cured samples at 28 days. Rapid chloride ion penetration shall be less than 1000 coulombs for concrete without steel fibres or concrete containing corrosion inhibiting admixtures. A unit weight test shall be taken for every 100 m^3 of concrete placed.	(i) Rapid chloride ion penetration shall be determined in accordance with ASTM C1202 on *duplicate* laboratory moist cured samples at 28 days. *The average of all tests shall not exceed 1000 coulombs with no single test greater than 1250 coulombs. For HPC with steel fibres, testing shall be done without the presence of the steel fibres.*
(j) An air-void spacing factor shall be determined in accordance with ASTM C457, modified point-count method at 100 times magnification. The average of all tests shall not exceed 230 µm with no single test greater than 260 µm. A unit weight test shall be taken for every 100 m^3 of concrete placed.	(j) An air-void spacing factor shall be determined in accordance with ASTM C457, modified point-count method at 100 times magnification. The average of all tests shall not exceed 230 µm with no single test greater than 260 µm.
(k) When Class HPC with steel fibres is specified, it shall contain 60 kg of 50 mm long Xorex 1, or an acceptable equivalent steel fibre, per cubic metre. The Contractor shall provide test results of the aluminum content in the steel fibres, for the consultants review, a minimum of two weeks prior to placing concrete at site.	(k) When Class HPC with steel fibres is specified, it shall contain 60 kg of 50 mm long steel *fibres*, per cubic metre. The Contractor shall provide test results of the aluminum content in the steel fibres, for the consultants review, a minimum of two weeks prior to placing concrete at site.
(l) The temperature of the centre of the in-situ concrete shall not fall below 10°C or exceed 60°C and the temperature difference between the centre and the surface shall not exceed 20°C.	(l) The temperature of the centre of the in-situ concrete shall not fall below 10EC or exceed 60EC and the temperature difference between the centre and the surface shall not exceed 20EC. *In addition the requirements of Table 21 of CSA A23.1 shall apply*.
(m) Trial batch(es) shall be performed at least 35 days prior to placement of concrete at site to verify that requirements pertaining to compressive strengths at 7 and 28 days, rapid chloride ion	(m) Trial batch(es) shall be performed at least 35 days prior to placement of concrete at site to verify that requirements pertaining to compressive strengths at 7 and 28 days, rapid chloride ion penetration and air void system parameters of hardened concrete have all been met. The

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penetration and air void system parameters of hardened concrete have all been met. The shrinkage of the trial batch concrete shall be measured in accordance with ASTM C157 except that drying shall commence after 7 days of curing and shrinkage determined after 28 days of drying. All data shall be submitted to the Consultant for information purposes.	shrinkage of the trial batch concrete shall be measured in accordance with ASTM C157 except that drying shall commence after 7 days of curing and shrinkage determined after 28 days of drying. *Shrinkage test results* shall be submitted to the Consultant *within seven days of test completion.*
4.4.4 Aggregate Tests and Concrete Mix Design The Contractor shall submit the mix design he proposes for each proposed class of concrete for the Consultant's review two weeks before scheduled placing of concrete. Aggregate tests and concrete mix design shall not be required for concrete used for the construction of culvert collars or cut-off walls when culverts are 3 metre diameter or smaller. For each mix design the following aggregate analysis shall be provided: - "Fine and Coarse Aggregate Sieve" (CSA A23.2-2A) - Amount of material finer than 80 µm in aggregate (CSA A23.2-5A) - "Organic Impurities in Sands for Concrete" - Results of deleterious substances and physical properties of aggregates included in Table 12, CSA A23.1-04" (Test Methods A23.2-23A, A23.2-24A and A23.2-29A) - Assessment of Potential for Deleterious Alkali-Aggregate Reactivity (AAR) (CSA A23.2-27A) - "Petrographic Examination of Coarse Aggregate for Concrete" shall be required for Class HPC and Class HPC with steel fibres - "Sources of proposed aggregate" The analysis of the aggregates shall be current and fully represent the material to be used in production. All sampling and testing shall have been done no more than 90 days prior to concrete production, except for petrographic examination of coarse aggregate for concrete which shall be no more than 120 days. Additional analyses of more recent sampling shall be provided as required to confirm that the aggregates continue to meet requirements. A break in production of a particular class of concrete shall not constitute the need for additional testing when the Contractor provides conclusive evidence that the material initially tested, is still representative.	4.4.4 Aggregate Tests and Concrete Mix Design The Contractor shall submit the mix design he proposes for each proposed class of concrete *including applicable material test reports* for the Consultant's review two weeks before scheduled placing of concrete. Aggregate tests and concrete mix design shall not be required for concrete used for the construction of culvert collars or cut-off walls when culverts are 3 metre diameter or smaller. For each mix design the following aggregate analysis shall be provided: - *Source(s) of proposed aggregate(s)* - Fine and Coarse Aggregate Sieve (CSA A23.2-2A) - Amount of material finer than 80 Fm in aggregate (CSA A23.2-5A) - Organic Impurities in Sands for Concrete *(CSA A23.2-7A)* - Results of deleterious substances and physical properties of aggregates included in Table 12, CSA A23.1-04 (Test Methods *A23.2-3A, A23.2-4A,* A23.2-23A, A23.2-24A and A23.2-29A) - Assessment of Potential for Deleterious Alkali-Aggregate Reactivity (AAR) (CSA A23.2-27A) - Petrographic Examination of Coarse Aggregate for Concrete shall be required for Class HPC and Class HPC with steel fibres *(CSA A23.2-15A)* The analysis of the aggregates shall be current and fully represent the material to be used in production. All sampling and testing shall have been done no more than *120* days prior to concrete production, except for *sieve analysis, material finer than 80 µm and organic impurities in sand which shall be no more than 90 days and* petrographic examination of coarse aggregate for concrete which shall be no more than *180* days. Additional analyses of more recent sampling shall be provided as required to confirm that the aggregates continue to meet requirements. A break in production

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…	of a particular class of concrete shall not constitute the need for additional testing when the Contractor provides conclusive evidence that the material initially tested, is still representative.
The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-27A. This assessment shall include the risk level associated with structure size and environment, the level of prevention related to service life requirements and the determination of the appropriate preventative measures. For bridge structures, the service life is considered to be 75 years. Current (less than 18 months old) test data evaluating the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-14A or CSA A23.2-25A is required. In the absence of current test data and outside of areas of known highly reactive aggregate, the aggregate shall be presumed to be moderately reactive.	… The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-27A. This assessment shall include the risk level associated with structure size and environment, the level of prevention related to service life requirements and the determination of the appropriate preventative measures*, including testing in accordance with CSA A23.2-28A*. For bridge structures, the service life is considered to be 75 years. Current (less than 18 months old) test data evaluating the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-14A or CSA A23.2-25A is required. In the absence of current test data and outside of areas of known highly reactive aggregate, the aggregate shall be presumed to be moderately reactive.
4.4.5 Initial Mixes, and Adjustments For all classes of concrete other than HPC and HPC with steel fibres, in cases of initial mixing operations or changes in source of water or aggregates, the mix adopted shall be designed for an excess compression strength of 10% above the specified 28 day nominal compressive strength. After the mix has been adequately proven as to strength and performance, adjustment may be undertaken, but only with the acceptance of the Consultant. If, during the progress of the work, the mix design is found to be unsatisfactory for any reason including poor workmanship, the Contractor shall make necessary adjustments. Notwithstanding the Consultant's review of the design mix, it remains the Contractor's responsibility that the concrete meets all the requirements of this Specification.	4.4.5 *Mix* Adjustments For all classes of concrete other than HPC and HPC with steel fibres, *if during the progress of the work, the mix design is found to be unsatisfactory for any reason including poor workability, the Contractor shall make the necessary adjustments, but only with the prior acceptance of the Consultant*. Notwithstanding the Consultant's review of the *mix* design, it remains the Contractor's responsibility that the concrete meets all the requirements of this Specification.
4.6.2 Truck Mixing Truck mixers, unless otherwise … ratio will not be permitted. The maximum size of batch … to thoroughly mix the concrete. When adjustment to the mix by adding water, air entraining agent or superplasticizer at the site is authorized by the Consultant, the mixer	4.6.2 Truck Mixing Truck mixers, unless otherwise… ratio will not be permitted. The maximum size of batch … to thoroughly mix the concrete. When adjustment to the mix by adding water, air entraining agent or superplasticizer at the site is authorized by the Consultant, the mixer shall

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shall be run for a minimum of 20 additional revolutions to ensure homogeneity of the concrete before discharge. Discharge chutes shall be kept clean and free from hardened concrete and shall be wetted down prior to use.	*rotate* for a minimum of 20 additional revolutions to ensure homogeneity of the concrete before discharge. Discharge chutes shall be kept clean and free from hardened concrete and shall be wetted down prior to use.
4.7 Delivery The Concrete supplier shall have sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that the development of cold joints will be precluded not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of rehandling, and without damage to the structure or the concrete.	**4.7 Delivery** The Concrete supplier shall have sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that the development of cold joints *does* not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of rehandling, and without damage to the structure or the concrete.
4.9 Inspection and Testing The Consultant shall be afforded full facilities for the random quality assurance inspection and testing that may be carried out relative to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete wherever this may be situated. The facilities shall be adequate in the opinion of the Consultant to permit proper sampling of concrete, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete cylinders in accordance with the relevant specifications is the responsibility of the Contractor and shall be provided prior to any concrete pour. The results of the quality assurance testing carried out by the Consultant will serve to monitor and review the quality control program of the Contractor. The Contractor shall utilize ACI or CSA certified tester with extensive experience to test at site, the air content, slump, and temperature of each batch, results of all such tests shall be provided to the Consultant. Additional tests will be required if the results are borderline or widely variable. In case of an unacceptable result, one check test will be permitted. The certified testers shall also cast the test cylinders as	**4.9 Inspection and Testing** The Consultant shall be afforded full facilities for the random quality assurance inspection and testing that may be carried out relative to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete wherever this may be situated. The facilities shall be adequate in the opinion of the Consultant to permit proper sampling of concrete, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete cylinders in accordance with the relevant specifications is the responsibility of the Contractor. The results of the quality assurance testing carried out by the Consultant will serve to monitor and review the quality control program of the Contractor. The Contractor shall utilize ACI or CSA certified testers with extensive related experience to test at site, the air content, *density,* slump and temperature of each batch; results of all such tests shall be provided to the Consultant. Additional tests will be required if the results are borderline or widely variable. In case of an unacceptable result, one check test will be permitted. The certified testers shall also cast the test cylinders as specified in 4.9.3 “Test Cylinders”.

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specified in 4.9.3 "Test Cylinders". The certification of the testers shall be current and available for examination by the Consultant.	*The certified testers shall utilize the "Concrete Testing Summary at Site" forms contained at the end of this section. The completed forms shall accompany the concrete test cylinders to the testing laboratory.* The certification of the testers shall be current and available for examination by the Consultant.
4.9.1 Strength Tests A "Strength Test" shall consist of the compression tests of four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standard Specifications as referenced with modifications as indicated. One cylinder shall be tested at seven days. The 28 day test result shall be the average of the strengths of the remaining three specimens, except that if any specimen in a test showing distinct evidence of improper sampling, molding or testing, shall be discarded and the remaining strengths averaged. Additional cylinders may be cast, at the discretion of the Consultant or Contractor. For Class HPC and Class HPC with steel fibres, the Contractor shall take a strength test to represent each approximate 10 m^3 portion of the concrete pour. For all other concrete, the Contractor shall take a strength test to represent each bridge element or portion of the element (i.e. Abutment seat, abutment backwall, pier footing, pier cap), except on larger pours a strength test will be taken to represent each approximately 30 m^3 portion of the concrete pour. Such tests shall be taken from representative batches as determined by the Consultant.	4.9.1 Strength Tests A "Strength Test" shall consist of the compression tests of four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standard Specifications as *modified herewith*. One cylinder shall be tested at seven days. The 28 day test result shall be the average of the strengths of the remaining three specimens, except that if any specimen in a test showing distinct evidence of improper sampling, molding or testing, shall be discarded and the remaining strengths averaged. Additional cylinders may be cast, at the discretion of the Consultant or Contractor. For Class HPC and Class HPC with steel fibres, the Contractor shall take a strength test to represent each approximate *20* m^3 portion of the concrete pour, *to a minimum of one strength test for every two batches of concrete*. For all other concrete, the Contractor shall take a strength test to represent each bridge element or portion of the element (i.e. Abutment seat, abutment backwall, pier footing, pier cap*, etc.*). *On* larger pours a strength test will be taken to represent each approximately 30 m^3 portion of the concrete pour, *to a minimum of one strength test for every three batches of concrete*. Such tests shall be taken from representative batches as determined by the Consultant.
4.9.3 Test Cylinders Making and curing concrete test cylinders shall be carried out in accordance with CSA Standard A23.2-3C, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor in standard CSA approved heavy duty steel or plastic moulds. Plastic moulds shall have a wall thickness of at least 6 mm. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in Section 5.3.2.1 of CSA Standard A23.2-3C, for	4.9.3 Test Cylinders Making and curing concrete test cylinders shall be carried out in accordance with CSA Standard A23.2-3C, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor in standard CSA approved heavy duty steel or plastic moulds. Plastic moulds shall have a wall thickness of at least 6 mm. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in Section *8*.3.2.1 of CSA Standard A23.2-3C, for a period of at least 24 hours, and further protection, as required, from adverse weather and

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a period of at least 24 hours, and further protection, as required, from adverse weather and mishandling until removed from the site. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a portable building which will be used by Contractor's personnel or the Consultant during the first 24 hour storage period will not be permitted. Storage facilities shall be provided, installed, and accepted before any concrete is placed.	mishandling until removed from the site. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a portable building which will be used by Contractor's personnel or the Consultant during the first 24 hour storage period will not be permitted. Storage facilities shall be provided, installed, and accepted *by the Consultant* before any concrete is placed.
4.9.4 Slump Slump tests shall be made at the discretion of the Consultant in accordance with CSA Standard A23.2-5C.	4.9.4 Slump Slump tests shall be *conducted* at the discretion of the Consultant in accordance with CSA Standard A23.2-5C.
4.9.5 Air Content Air content tests shall be made in accordance with CSA Standard A23.2-4C.	4.9.5 Air Content *& Density* Air content *and Density* tests shall be made in accordance with CSA Standard A23.2- 4C *and A23.2-6C respectively*.
4.9.7 Failure to Meet Slump or Air Content Specifications … For Class HPC and Class HPC with steel fibres the Contractor will be allowed to adjust only the quantities of superplasticizer and air entraining agent. Addition of water at site to the batch will only be permitted subject to an alternate batching procedure accepted by the Consultant and the Department. In no case shall accepted batch adjustment relieve the Contractor of his responsibility for the eventual durability, strength, and acceptability of the concrete concerned. The Department or Consultant reserves the right to reject any batch in the event of confirmed unacceptability, and to require immediate removal of any concrete from this batch which may have already been placed in the structure.	4.9.7 Failure to Meet Slump or Air Content Specifications … *The* Contractor will be allowed to adjust only the quantities of superplasticizer and air entraining agent. In no case shall *an* accepted batch adjustment relieve the Contractor of his responsibility for the eventual durability, strength, and acceptability of the concrete concerned. The Department or *the* Consultant reserves the right to reject any batch in the event of confirmed unacceptability, and to require immediate removal of any concrete from this batch which may have already been placed in the structure.
4.10.3 Forms for Exposed Surfaces Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 20 mm from the concrete surface... Cavities shall be filled with cement mortar and the surface left	4.10.3 Forms for Exposed Surfaces Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 20 mm from the concrete surface… *All cavities created from ties or associated hardware removal* shall be filled with *an approved non-shrink grout* and the surface left sound,

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sound, smooth, even and uniform in color.	smooth, even and uniform in color. *The use of plastic sleeves and removable inner rods shall be discouraged and only used when approved by the Department and the Consultant. If approved for certain applications, the plastic sleeve shall be removed for a distance of 100 mm from the face of the concrete. The inside of the resulting concrete surfaces shall be roughened by wire brushing or other acceptable means. The entire cavity shall be filled with an approved non-shrink grout.*
4.10.6 Deck Formwork Unless otherwise noted, diaphragms and girders will be designed for construction loads during deck concrete pour in accordance with CSA-S6-00 Clause 3.16, and the loads assumed for such design shall be shown on contract drawings. Where construction loads or loading conditions vary from those shown, the Contractor shall be responsible for maintaining girder stability until the deck concrete has gained sufficient strength. Where required, deck formwork design shall include any additional bracing system to those shown on the contract drawings. Care shall be taken in the design and installation of support brackets to avoid damage to girder flanges and webs. Where such brackets bear against girder webs, the girder webs shall be protected by timber or neoprene softeners. Effects of concentrated loads on thin webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners. … Prior to commencing deck formwork, the Contractor shall profile all the girders and determine the deck concrete thickness values required to achieve the specified gradeline. This information shall be provided to the Consultant prior to commencing any deck formwork. In the event that actual girder camber values vary significantly from the estimated values indicated on the drawings, the Consultant will require the Contractor to raise or lower the gradeline accordingly.	4.10.6 Deck Formwork Unless otherwise noted, diaphragms and girders will be designed for construction loads during deck concrete pour in accordance with CSA-S6-*06* Clause 3.16, and the loads assumed for such design shall be shown on contract drawings. Where construction loads or loading conditions *proposed by the Contractor* vary from those shown, the Contractor shall be responsible for maintaining girder stability *and alignment* until the deck concrete has gained sufficient strength. Where required, deck formwork design shall include any additional bracing system to those shown on the contract drawings. Care shall be taken in the design and installation of support brackets to avoid damage to girder flanges and webs. Where such brackets bear against girder webs, the girder webs shall be protected by timber or neoprene softeners. *No drilling of additional holes or any other modifications including field welding shall be made to the superstructure elements.* Effects of concentrated loads on thin webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners. … Prior to commencing deck formwork, the Contractor shall profile all the girders *at stationing corresponding to the camber diagram, as applicable* and determine the *girder haunch dimensions* required to achieve the specified gradeline. This information shall be provided to the Consultant prior to commencing any deck formwork. In the event that actual girder camber values vary significantly from the estimated values indicated on the drawings, the Consultant *may* require the Contractor to raise or lower the gradeline accordingly.

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4.14.4 Pumping The operation of the pump shall produce a continuous flow of concrete without air pockets. The equipment shall be so arranged that the impact on the plastic air content of the concrete shall not vary by ±0.5% and that no vibrations result which might damage freshly placed concrete. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.	4.14.4 Pumping The operation of the pump shall produce a continuous flow of concrete without air pockets. The equipment shall be so arranged that the impact on the plastic air content of the concrete shall not vary by ±0.5% and that *the freshly placed concrete is not damaged by any form of vibration.* When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.
4.15.3 Concrete Placed under Water Placement of pile concrete under water shall be in accordance with Section 4.21 of this Specification. None.	4.15.3 Concrete Placed under Water Placement of pile concrete under water shall be in accordance with Section 4.21 of this Specification *and also with the following additional requirements:* *Crosshole Sonic Logging* *In order to test for voids or other abnormalities in the concrete, all drilled pile shafts cast under water shall be equipped with PVC or steel access tubes to permit inspection by Crosshole Sonic Logging (CSL). The Contractor shall submit the proposed method for the Consultant's review two week before beginning drilled pile work. The Contractor shall supply and install four 50 mm inside diameter tubes in each drilled pile with a diameter of 1.5 meter or less and six tubes in each pile with a diameter of greater than 1.5 meter.* *Tubes supplied shall be round, have a regular internal diameter that is free from defects, obstructions and joints. Tubes shall be watertight, free from corrosion and have clean internal and external faces to ensure a good bond between the concrete and the tubes. Tubes may be extended with watertight mechanical couplings and all coupling locations shall be recorded. Tubes shall be installed by the Contractor in a manner that the CSL probes pass through the entire length of the tube without binding.* *The Contractor shall fit the tubes with a watertight shoe on the bottom and a removable cap on the top. Tubes shall be secured to the interior of the reinforcement cage a minimum of every 1.2 meters along the length of the pile. Tubes shall be installed uniformly and equidistantly around the circumference of the pile such that each tube is spaced parallel for the full*

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	length. Tubes shall extend to within 150 mm of the drilled shaft bottoms, and shall extend a minimum of 600 mm above the drilled shaft tops or to where they are accessible. Tubes shall be capped to prevent debris from entering the access tubes. *The Contractor shall ensure that CSL tubes are not damaged during the installation of the reinforcement cage. If testing equipment does not pass through the entire length of the CSL tube, a 50 mm diameter core hole shall be drilled. Special care must be taken to avoid tube debonding between the concrete and the tubes. If tube debonding occurs, the Contractor shall core drill a 50 mm diameter hole to the depth of debonding for each debonded tube.* *The Contractor shall make CSL measurements at depth intervals of 65 mm from the bottom of the tubes to the top of each pile. Upon completion of testing and acceptance of the pile concrete, the tubes shall be filled with an approved grout mix.* ***Qualification:*** *The testing agency hired by the Contractor shall have a minimum of 3 years experience in CSL testing and have a Professional Engineer registered in the Province of Alberta supervising the testing and interpretation of results. The Contractor shall provide written evidence of successful completion of CSL tests by the testing agency on drilled piles in the Province of Alberta. The Contractor's submission shall also include personnel qualifications and equipment description.* ***CSL Results:*** *The Contractor shall submit two original copies of CSL report to the Consultant within 5 working days of completion of CSL testing. CSL test results provided by the Contractor will be reviewed according to the criteria listed in the table below:* ***Concrete Condition Rating Criteria***

Rating	*Velocity Reduction **	*CSL Results*
Good (G)	*≤ 10%*	*Good quality concrete*
Questionable (Q)	*>10% & <20%*	*Minor contamination or intrusion. C*
Poor/Defect (P/D)	*≥ 20%*	*Defects exists, possible water/slur*
No Signal (NS)	*No Signal Received*	*Soil intrusion or other severe defec*

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	** from highest measured signal velocity in the comparable zone* *CSL test results with ratings other than "G" may require further investigation by the Contractor as determined by the Consultant. Edge defects are critical and any defects that expose the rebar are not acceptable. The Contractor shall not grout the CSL tubes or perform any further work on the CSL tested drilled piles until the Consultant determines whether the drilled pile is acceptable.* *The Contractor shall perform Crosshole Tomography in order to further investigate and delineate the boundaries of any defective/unconsolidated zones. Any further tests deemed necessary by the Consultant in order to determine the acceptability of the drilled pile will be determined after reviewing the CSL test report. Additional test or analysis options include 3D tomographic imaging, single-hole sonic testing, sonic echo or impact response tests and concrete coring.* *The Consultant will determine the depth, location, diameter and number of core holes when concrete coring is required. If the Consultant is concerned about concrete strength or requires the use of a borehole camera for inspection, large diameter cores may be required. Minimum of two cores would be required to intercept the suspected defect zones.* ***Correction of Unacceptable Drilled Pile:*** *When the Consultant determines a drilled pile is unacceptable, the Contractor shall submit a remedial action plan with supporting calculations for the Department and the Consultant's approval. The remedial action shall be designed by the Contractor and stamped by a Professional Engineer registered in the Province of Alberta. No compensation will be made for remedial work or losses or damages due to remedial work of drilled piles found defective or not in accordance with the Specifications.* ***Measurement & Payment:*** *CSL will be considered incidental to the Work and no additional or separate payment will be made for procurements, conducting the CSL testing, reporting of results and incidentals necessary to complete the work including any other test required to determine the acceptability of the drilled pile.*

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4.16Placing Deck, Curb, Barrier, Median and Deck Overlay Concrete 4.16.1 General All deck, curb, barrier, median and deck overlay concrete shall be Class HPC, or Class HPC with Steel Fibres, as specified. Concrete placing will not be permitted when the air temperature is below +5℃ or above 22℃, nor in the event of rain or excessive wind or dust, nor when there are other conditions judged by the Consultant to be detrimental to the concrete. Deck concrete placing shall normally be between the hours of 6:00 pm and 10:00 am except with specific acceptance of the Department and Consultant. Night pours shall require proper lighting as reviewed and accepted by the Consultant. The temperature of the concrete during discharge shall be between 10℃ and 20℃ unless reviewed and accepted otherwise by the Consultant. The temperature of the mix shall be maintained below the 20℃ maximum temperatures by the inclusion of ice to the mix which shall not alter the design water-cement ratio. Immediately prior to placing concrete, the substrates shall be thoroughly wetted down with clean water. Placing/Finishing Machines For all deck concrete and deck overlay concrete, screeding shall be by concrete placing/finishing machines as follows or acceptable equivalents: - Bidwell Model RF200 or Model 364 - Gomaco Model C450 The Contractor shall provide two work bridges, separate from the placing/finishing machine, of adequate length to completely span the width of the pour. The work bridges will facilitate the operations of concrete finishing and placing of wet burlap, and shall also be made available to the Consultant for straight-edge checking. The work bridges shall be supported essentially parallel to the concrete surface, between 250 mm and 600 mm above the concrete surface, and shall be at least 800 mm wide to permit diverse uses concurrently, and be rigid enough that dynamic deflections are insignificant.	**4.16 Placing *HPC Concrete and HPC Concrete with Steel Fibres*** 4.16.1 General Concrete placing will not be permitted when the air temperature is below +5℃ or above *25*℃, nor in the event of rain or excessive wind or dust, nor when there are other conditions judged by the Consultant to be detrimental to the concrete. Deck, *roof slab, approach slab and deck overlay* concrete placing shall be between the hours of 6:00 pm and 10:00 am except with specific acceptance of the Department and Consultant. Night pours shall require proper lighting as reviewed and accepted by the Consultant. The temperature of the concrete during discharge shall be between 10℃ and 20℃ unless reviewed and accepted otherwise by the Consultant. The temperature of the mix shall be maintained below the 20℃ maximum temperatures by the inclusion of ice to the mix which shall not alter the design *water-cementing materials* ratio. Immediately prior to placing concrete, the substrates shall be thoroughly wetted down with clean water. *The Contractor's project manager and field superintendent may be required to attend a pre-construction meeting at a location determined by the consultant, prior to commencement of any field work.* Placing/Finishing Machines For all deck concrete and deck overlay concrete, screeding shall be by concrete placing/finishing machines as follows or acceptable equivalents: - Bidwell Model RF200*,* 364, *2450, 3600 and 4800* - Gomaco Model C450 The Contractor shall provide two work bridges, separate from the placing/finishing machine, of adequate length to completely span the width of the pour. The work bridges will facilitate the operations of concrete finishing and placing of *filter fabric or* wet burlap, and shall also be made available to the Consultant for straight-edge checking. The work bridges shall be supported essentially parallel to the concrete surface, between 250 mm and 600 mm above the concrete surface, and shall be at least 800 mm wide to permit diverse uses concurrently, and be rigid enough that dynamic deflections are insignificant.

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4.16.4 Fog Misting and Wet Cure Systems Details of the fog misting and wet cure systems shall be provided to the Consultant for review and acceptance three weeks prior to the scheduled pour date. Details shall include information with regards to the type and description of equipment and materials being used and work method/techniques employed to satisfactorily carry out the work.	4.16.4 Fog Misting and Wet Cure Systems *The Contractor shall prepare details of the fog misting and wet cure systems.* Details of the fog misting and wet cure systems shall be provided to the Consultant for review and acceptance three weeks prior to the scheduled pour date. Details shall include information with regards to the type and description of equipment and materials being used and work method/techniques employed to satisfactorily carry out the work. *The fog misting and wet cure systems shall be demonstrated for adequacy and suitability, a minimum of 24 hours prior to placing HPC concrete.*
4.19.1 General If not detailed on the drawings, or in the case of emergency, construction joints shall be placed as determined by the Consultant and according to the standard drawing. Shear keys or inclined reinforcement shall be used where necessary to transmit shear, or to bond the two sections together. Construction joints should be located to allow a minimum of 50 mm minimum concrete cover on reinforcing steel running parallel to the joint. Refer to Standard Drawing S-1412 "Standard Construction Joints" included with these Specifications.	4.19.1 General If not detailed on the drawings, or in the case of emergency, construction joints shall be *installed* as determined by the Consultant and according to the standard drawing. Shear keys or inclined reinforcement shall be used where necessary to transmit shear, or to bond the two sections together. Construction joints should be located to allow a minimum of 50 mm minimum concrete cover on reinforcing steel running parallel to the joint. Refer to Standard Drawing S-1412 "Standard Construction Joints" included with these Specifications.
4.20 Concreting in Cold Weather The Contractor shall accept full responsibility for the protection of concrete during adverse weather conditions. When the ambient air temperature is, or is expected to be below 5°C, or when determined by the Consultant, the following provisions for cold weather concreting shall be put in place: (1) All aggregate and mixing water … temperature requirements to suit. (2) The Contractor shall enclose the structure in such a way that the concrete and air within the enclosure can be kept above 15°C for a period of 7 days after placing the concrete. The enclosure shall be constructed so that a minimum 300 mm clearance exists between the enclosure and the concrete. To prevent overheating, the air temperature within the enclosure shall be monitored frequently, especially during the first 24 hours.	**4.20 Concreting in Cold Weather** The Contractor shall accept full responsibility for the protection of concrete during adverse weather conditions. *In addition to the requirements stated below, all concrete shall be cured in accordance with Section 4.22.* When the ambient air temperature is, or is expected to be below 5°C *during the specified minimum curing period*, or when determined by the Consultant, the following requirements for cold weather concreting shall be put in place: (1) All aggregate and mixing water … temperature requirements to suit. (2) The Contractor shall enclose the structure in such a way that the concrete and air within the enclosure can be kept above 15°C for a period of 7 days after placing the concrete. *Where elements being cast consist of HPC concrete, the seven day period is increased to 14 days. Additionally, for deck construction, the Contractor shall submit to the Department and the Consultant, details of the enclosure structure,*

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The relative humidity within the enclosure shall be maintained at not less than 65%. Heaters must be kept well clear of the formwork housing. Adequate ventilation is required to provide air for combustion, and to prevent the accumulation of carbon dioxide which can be harmful to the concrete. The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat is prohibited without the Consultant's specific acceptance. … (5) Protection and heating, where used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air. To achieve this, in a heated housing, the heat shall be slowly reduced and then shut off, and the whole housing allowed to cool to air temperature before the housing itself is removed. However, the protection shall not be removed until the temperature of the concrete has fallen to within 10°C of the temperature of the outside air.	*describing how the HPC concrete will be placed, finished and cured. For casting of HPC concrete, an enclosure structure is mandatory and no alternatives will be considered.* The enclosure shall be constructed so that a minimum 300 mm clearance exists between the enclosure and the concrete. To prevent overheating, the air temperature within the enclosure shall be monitored frequently, especially during the first 24 hours. The relative humidity within the enclosure shall be maintained at not less than *85%*. Heaters must be kept well clear of the formwork housing. Adequate ventilation is required to provide air for combustion, and to prevent the accumulation of carbon dioxide which can be harmful to the concrete. The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat is prohibited without the Consultant's specific acceptance. … (5) Protection and heating, where used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air. To achieve this, in a heated housing, the heat shall be slowly reduced. *The temperature differential between the core of the element and the surface of the element shall not exceed 20°C. In addition, the temperature differential between the surface of the element and the ambient air shall not exceed 15°C ambient air temperature is defined as the temperature at mid-height of the element and 300 mm from the surface of the element.* *The Contractor shall demonstrate to the satisfaction of the Consultant that the temperature and relative humidity requirements are met by continuously monitor and recording air temperature and relative humidity within the curing enclosure.*
4.21 Depositing Concrete under Water Concrete to be deposited in water shall be of the specified class, with mix design modified to yield 150 mm to 175 mm slump, and with an excess of 15% of the cement quantity added beyond this designed	**4.21 Depositing Concrete under Water** Concrete to be deposited in water shall be of the specified class, with mix design modified to yield *170 mm ± 30 mm* slump, and with an excess of 15% of the cement quantity added beyond this designed amount. The

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amount. The mix should contain an approved "anti-washout" admixture to enhance the performance of the mix. The concrete temperature shall be between 10℃ and 25℃. To prevent segregation…shall be watertight. When placing concrete under water the discharge end of the concrete pump line shall be lowered to the bottom of the form or hole. Pumping shall then proceed with the end of the discharge line being continually buried no less than 500 mm below the surface of fresh concrete at all times, to maintain a seal until the form or hole is completely filled with fresh uncontaminated concrete.	concrete temperature shall be between 10℃ and 25℃. To prevent segregation…shall be watertight. *T*he discharge end of the concrete pump line shall be lowered to the bottom of the form or hole. Pumping shall then proceed with the end of the discharge line being continually buried no less than 500 mm below the surface of fresh concrete at all times, to maintain a seal until the form or hole is completely filled with fresh uncontaminated concrete.
4.22.1 General Freshly deposited concrete … desired properties of the concrete. All concrete surfaces other than HPC which are to receive a Class 2 or 3 finishes, shall be moist cured. The Contractor shall cover the concrete surface(s) with a single layer of clean, soaking wet burlap or light colored filter fabric as soon as the surface will not be marred by so doing. The burlap or light colored filter fabric shall be kept continuously wet for 72 hours. All unexposed concrete surfaces not requiring the application of silane sealer shall receive two applications of an approved curing compound. The rate of each application shall not be less than the rate specified by the manufacturer of the compound. Curing shall not be used on any construction joints or when cold weather concreting is in effect. Where the formwork is left in place for 72 hours or more, no additional curing will be required for either exposed or unexposed concrete surfaces.	4.22.1 General Freshly deposited concrete … desired properties of the concrete. All concrete surfaces *consisting of Class B, C or D concrete* shall be moist cured. The Contractor shall cover the concrete surface(s) with a single layer of clean, soaking wet burlap or light colored filter fabric as soon as the surface will not be marred by so doing. The burlap or light colored filter fabric shall be kept continuously wet for 72 hours. *Curing requirements for Class HPC and Class HPC with steel fibres are stated in Section 4.22.3.* Where the formwork is left in place for 72 hours or more, no additional curing will be required.
4.22.2 Curing Requirements for Concrete Slope Protection Concrete slope protection shall receive 2 coats of a curing compound acceptable to the Consultant. The first coat is to be applied immediately after the concrete has been satisfactorily finished, and the second coat is to be applied within 3 hours after the application of the first coat. In cases where premature drying is severe or is anticipated to be severe,	4.22.2 Curing Requirements for Concrete Slope Protection Concrete slope protection shall receive 2 coats of a *Type 2* curing compound *meeting the requirements of ASTM C309 (or ASTM C1315)*. The first coat is to be applied immediately after the concrete has been satisfactorily finished, and the second coat is to be applied within 3 hours after the application of the first coat. *Each application shall be at a rate*

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then moist curing, as specified in 4.22.1, will also be required.	*specified by the Manufacturer.* In cases where premature drying is severe or is anticipated to be severe, then moist curing, as specified in 4.22.1, will also be required.
4.22.3 Curing Requirements for Class HPC and Class HPC with Steel Fibres None.	4.22.3 Curing Requirements for Class HPC and Class HPC with Steel Fibres *Curing methods and procedures shall be reviewed and accepted by the Consultant prior to scheduling placement of Class HPC or HPC with steel fibres concrete. Equipment and materials necessary for the fog mist and wet cure systems shall be demonstrated prior to scheduling placement of Class HPC or HPC with steel fibres concrete.* *During the cure period the Contractor shall provide protection to ensure that the difference between the concrete temperature and the ambient air temperature at the site remains within the limits specified in 4.4.2(l). The Contractor shall supply and install two thermocouples, in the centre and at the surface of the concrete, for every 100 m^2 of deck, at locations determined by the Consultant. The Contractor shall monitor and record the temperatures every four hours for the first 3 days after concrete placement and every 12 hours thereafter for the remainder of the specified cure period. Daily temperature records shall be forwarded to the Consultant and Department.*
For Class HPC and Class HPC with steel fibres, fog mist shall be applied continuously from the time of screeding until the concrete is covered with filter fabric or burlap, in such a way as to maintain high relative humidity above the concrete and prevent drying of the concrete surface. Water shall not be allowed to drip, flow or puddle on the concrete surface during fog misting, when placing the filter fabric or burlap, or at any time before the concrete has achieved final set. Equipment and materials necessary for the fog mist system shall be demonstrated and approved prior to shcduling and placing of Class HPC. Two layers of light colored filter fabric (Nilex C-14 or equivalent) or burlap shall be placed on the fresh concrete surface as soon as the surface will not be marred as a result of this placement. A fine spray of clean water shall be immediately applied to the filter fabric or burlap. Edges of the filter fabric or burlap shall overlap a minimum of 150 mm	*Fog* mist shall be applied continuously from the time of screeding until the concrete is covered with filter fabric or burlap, in such a way as to maintain high relative humidity above the concrete and prevent drying of the concrete surface. Water shall not be allowed to drip, flow or puddle on the concrete surface during fog misting, when placing the filter fabric or burlap, or at any time before the concrete has achieved final set. *Fog misting will not be required for casting of curbs, barrier, or medians and MSE wall coping.* Two layers of light colored filter fabric or burlap shall be placed on the concrete surface as soon as the surface will not be marred as a result of this placement. A fine spray of clean water shall be immediately applied to the filter fabric or burlap. Edges of the filter fabric or burlap shall overlap a minimum of 150 mm and shall be held in place without marring the surface of the concrete. The filter fabric or burlap shall be in a continuously wet

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and shall be held in place without marring the surface of the concrete. The filter fabric or burlap shall be in a continuously wet condition throughout the curing period by means of a soaker hose or other means as reviewed and accepted by the Consultant. Curing with filter fabric or burlap and water shall be maintained for a minimum period of 7 days for deck overlay and concrete rehabilitation and 14 days for new bridge construction, with the exception of concrete for blockouts adjacent to deck joints, where the wet cure period is reduced to 3 days followed by the application of a chlorinated rubber curing compound. During the seven day cure period for Class HPC and Class HPC with steel fibres, following the placement of concrete, the Contractor shall provide protection to ensure that the concrete temperature and the temperature differences remain within the limits specified in 4.4.2(i). The Contractor shall supply and install two thermocouples, in the centre and at the surface of the concrete, for every 100 m2 of deck, at locations determined by the Consultant. The Contractor shall monitor and record the temperatures every four hours for the first 3 days after concrete placement and every 12 hours thereafter during remaining curing period. Daily temperature records shall be forwarded to the Consultant and Department.	condition throughout the curing period by means of a soaker hose or other means as reviewed and accepted by the Consultant. Curing with filter fabric or burlap and water shall be maintained for a minimum period of 7 days for deck overlay and *reconstruction projects where traffic is being impeded* and 14 days for *all* new bridge construction. *In the event that the wet curing is unacceptable, and any portion of the HPC or HPC with steel fibres becomes surface dry during the curing period, the Consultant will have cause to reject the concrete.* *When Class HPC is used for concrete paving lips and deck joint blockouts, the wet cure can be reduced to 3 days followed by the application of a Type 2 curing compound meeting the requirements of ASTM C309 (or ASTM C1315).* *For those locations where formwork is removed prior to the completion of this specified curing period, the resulting exposed concrete surfaces shall be wet cured for the remaining days.*
4.22.4 Class HPC and Class HPC with Steel Fibres After the curing period and before opening to public traffic, the Contractor and the Consultant shall jointly inspect the dry concrete surface(s) to identify all cracks. The Consultant will plot the width in millimetre and length in linear metres of cracks per square metre and report the findings to the Department. The Contractor shall repair the cracks at his own expense if crack width is 0.2 mm or more. The following procedure shall be used in the treatment of the same: (a) Blow out cracks clean and dry with a jet of oil-free compressed air. (b) Seal cracks with a gravity feed epoxy in accordance with the manufacturer's instructions. The gravity feed epoxy shall maximize the penetration by taking into consideration the ambient temperature, substrate temperature, the viscosity and pot life of the material being used. Gravity flow epoxy material shall be reviewed and accepted by	4.22.4 Class HPC and Class HPC with Steel Fibres After the curing period and before opening to public traffic, the Contractor and the Consultant shall jointly inspect the dry concrete surface(s) to identify all cracks. The Consultant will plot the width in *mm* and length in linear metres of cracks per square metre and report the findings to the Department. The Contractor shall repair the cracks at his own expense if crack width is 0.2 mm or more. The following procedure shall be used in the treatment of the same: (a) Blow out cracks clean and dry with a jet of oil-free compressed air. (b) Seal cracks with a gravity *flow* epoxy in accordance with the manufacturer's instructions. The gravity *flow* epoxy shall maximize the penetration by taking into consideration the ambient temperature, substrate temperature, viscosity and pot life of the material. *The gravity*

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the Consultant and the Department prior to its usage. (c) When cracks extend the full depth of the deck slab, barriers or curbs or to the top layer of reinforcement of decks that are cast to grade, epoxy injection will be required. The epoxy material and injection procedure shall be submitted by the Contractor for acceptance of the Department and Consultant.	*flow* epoxy material shall be *chosen from the List posted at following Alberta Transportation website path: Alberta Transportation Product List/Crack Treatment/Concrete Crack filler/Proven or Potential.* (c) When cracks extend the full depth of the deck slab, barriers or curbs or to the top layer of reinforcement of decks that are cast to grade, epoxy injection will be required. The epoxy material and injection procedure shall be submitted by the Contractor for acceptance of the *Consultant and Department*.
4.24.1 General Surfaces requiring concrete finishing shall conform to the requirements of section 4.16.6, "Surface Defects and Tolerances". All mortar patches shall be cured as specified in section 4.22, "Curing Concrete". Class 1 Ordinary Finish - all exposed concrete surfaces unless other finishes are specified. Class 2 Rubbed Finish - solid shaft river piers - inside surfaces of curb, parapet and sidewalk - median vertical faces Class 3 Bonded Concrete Finish - abutment seats except top surface - pier caps except top surface - exterior faces of curtain walls/wingwalls - grade separation piers except top surfaces - exterior concrete girder faces - exposed end surfaces of cast-in-place concrete diaphragms - underside of the deck overhang to top flange of girder - exterior surfaces of curb, parapet and sidewalk. Class 4 Floated Finish - top surfaces of concrete deck and roof slabs which are to be receive waterproofing membranes and wearing surfaces	4.24.1 General Surfaces requiring concrete finishing shall conform to the requirements of section *4.16.7*, "Surface Defects and Tolerances". All mortar patches shall be cured as specified in section 4.22, "Curing Concrete". Class 1 Ordinary *Surface* Finish - all exposed concrete surfaces unless other finishes are specified. - *top surfaces of abutment seats and pier caps* Class 2 Rubbed *Surface* Finish - solid shaft river piers - inside surfaces of curb, *barrier, median* and sidewalk Class 3 Bonded Concrete *Surface* Finish - abutment seats except top surface - pier caps except top surface - exterior faces of curtain walls/wingwalls *cast-in-place walls and MSE wall copings* - grade separation piers except top surfaces - exterior concrete girder faces *(when specified)* - exposed end surfaces of cast-in-place concrete diaphragms - underside of the deck overhang to top flange of girder - exterior surfaces of *deck slab,* curb, *barrier* and sidewalk. Class 4 Floated *Surface* Finish - top surfaces of concrete deck and roof slabs which are to be receive waterproofing membranes and wearing surfaces

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Class 5 Floated Surface Finish, Broomed Texture - top surfaces of curbs, sidewalks, and medians - approach slab concrete which will be covered by a wearing surface only (without waterproofing membrane) - concrete slope protection. Class 6 Floated Finish, Surface Textured - top surfaces of deck, deck overlay, roof and approach slabs which will not be covered with either waterproofing membrane or wearing surface.	Class 5 Floated Surface Finish, Broomed Texture - top surfaces of curbs, sidewalks, and medians - approach slab concrete which will be covered by a wearing surface only (without waterproofing membrane) - concrete slope protection. Class 6 Floated *Surface* Finish, Surface Textured - top surfaces of deck, *deck overlay,* roof and approach slabs which will not be covered with either waterproofing membrane or wearing surface.
4.24.2 Class 1. Ordinary Surface Finish Unformed Surfaces - Immediately following placing and compacting, the concrete shall be screeded to conform to the required surface elevations, and then trowelled to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions. Formed Surfaces - Immediate following the removal of forms, all fins and irregular projections shall be removed from all surfaces. On all surfaces the cavities produced by form ties, and all other holes, honeycomb areas, broken corners or edges and other defects, shall be thoroughly chipped out, cleaned, and after having been kept saturated with water for a period of not less than 30 minutes, shall be filled with cement mortar. Mortar shall be not more than one hour old. The mortar patches shall be cured as specified "Curing Concrete". All concrete joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.	4.24.2 Class 1. Ordinary Surface Finish Unformed Surfaces - Immediately following placing and compacting, the concrete shall be screeded to conform to the required surface elevations, and then trowelled to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions. Formed Surfaces - Immediate following the removal of forms, all fins and irregular projections shall be removed from all surfaces. On all surfaces the cavities produced by form ties, and all other holes, honeycomb areas, broken corners or edges and other defects, shall be thoroughly chipped out, cleaned, and after having been kept saturated with water for a period of not less than 30 minutes, shall be filled with cement mortar. Mortar shall be not more than one hour old. The mortar patches shall be cured as specified *in 4.22* "Curing Concrete". All concrete joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.
4.24.4 Class 3. Bonded Concrete Surface Finish Surface preparation shall be done as is specified for Class "2" Rubbed Finish, except that uniformity in colour is not required. After the surface preparation has been completed to the satisfaction of the Consultant, the Contractor shall then supply and apply an approved pigmented concrete sealer, which meets the requirements for a type 3 sealer of the "Alberta Transportation Concrete Sealer Test Procedure -	4.24.4 Class 3. Bonded Concrete Surface Finish Surface preparation shall be done as is specified for Class "2" Rubbed Finish, except that uniformity in colour is not required. After the surface preparation has been completed to the satisfaction of the Consultant, *the surface shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours, the* Contractor shall apply an

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B388". The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications. The colour of the proposed coating, which shall be similar to the natural colour of cured concrete, must be acceptable to the Consultant before application of the coating. A minimum of two applications of the pigmented sealer are required. The Contractor shall ensure that no colour variation is visible, and shall match the colour of any previously painted adjoining surfaces. Acceptance of the pigmented sealer used will not be taken to relieve the Contractor of full responsibility for its acceptable performance and appearance.	approved pigmented concrete sealer, which meets the requirements for a *Type* 3 sealer of the *Material Testing Specifications for Concrete Sealers* - B388". The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications. The colour*(s)* of the proposed coating *scheme*, which *typically* shall be similar to the natural colour of cured concrete, must be acceptable to the Consultant before application of the coating. A minimum of two applications of the pigmented sealer are required. *When spray application is used the surface shall be back rolled.* The Contractor shall ensure that no colour variation is visible, and shall match the colour of any previously painted adjoining surfaces. Acceptance of the pigmented sealer used will not be taken to relieve the Contractor of full responsibility for its acceptable performance and appearance.
4.24.5 Class 4. Floated Surface Finish Unless otherwise noted on the drawings, concrete which is to receive a waterproofing membrane and a final wearing surface, shall be floated and trowelled as necessary to provide a smoothly textured surface.	4.24.5 Class 4. Floated Surface Finish Unless otherwise noted on the drawings, concrete which is to receive a waterproofing membrane and a final wearing surface, shall be floated and trowelled as necessary to provide a *smooth* surface.
4.24.6 Class 5. Floated Surface Finish, Broomed Texture The concrete surface shall be floated and trowelled as necessary to produce a smooth surface. The surface shall not vary more than 3 mm under a 3 m long straightedge. After the concrete has set sufficiently, the surface shall be given a transversely broomed finish using a coarse broom to produce regular corrugations to a maximum depth of 3 mm. An edging tool shall be used at all edges and expansion joints. Where indicated on the drawing, sidewalk surfaces shall be laid out in blocks using an acceptable grooving tool.	4.24.6 Class 5. Floated Surface Finish, Broomed Texture The concrete surface shall be floated and trowelled as necessary to produce a smooth surface. The surface shall not vary more than 3 mm under a 3 m long straightedge. After the concrete has set sufficiently, the surface shall be given a transversely broomed finish using a coarse broom to produce regular corrugations to a maximum depth of *2* mm. An edging tool shall be used at all edges and expansion joints. Where indicated on the drawing, sidewalk surfaces shall be laid out in blocks using an acceptable grooving tool.
4.25 Sealer The sealer shall be applied in accordance with the manufacturer's recommendations however the application rate shall be increased by 30% from that indicated on the approval list. Before applying the sealer the concrete shall be cured for at least 14 days. Mortar patches shall be cured for at least two days. The concrete surface shall be dry, and air	**4.25 *Type 1c* Sealer** The sealer shall be applied in accordance with the manufacturer's recommendations however the application rate shall be increased by 30% from that indicated on the approval list. Before applying the sealer the concrete shall be cured for at least *28* days. Mortar patches shall be cured for at least two days. The concrete surface shall be dry, and air blasted to

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blasted to remove all dust and accepted by the Consultant prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of 2 coats. Type 1c sealers shall meet the current "Specifications for the supply of Concrete Sealers, Evaluation Procedures for Sealer Used on Concrete Bridge Elements" (B388). Payment for Sealer will be made on the basis of the lump sum price bid which shall include full compensation for the cost of all materials, labour, tools and equipment required to acceptably complete this work.	remove all dust and accepted by the Consultant prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of 2 coats. Type 1c sealers shall meet the current *Material Testing Specifications for Concrete Sealers - B388*. *Deleted*
4.26.1 Payment Scales Class B Concrete, Pile Concrete, 25 MPa Strength Test Results 25 MPa and over — Full bid price 24 MPa to 25 MPa — Bid price less $15 per cu. metre 23 MPa to 24 MPa — Bid price less $30 per cu. metre 22 MPa to 23 MPa — Bid price less $45 per cu. metre 21 MPa to 22 MPa — Bid price less $60per cu. metre 20 MPa to 21 MPa — Bid price less $80 per cu. metre Class C Concrete, 35 MPa Strength Test Results 35 MPa and over — Full bid price 34 MPa to 35 MPa — Bid price less $15 per cu. metre 33 MPa to 34 MPa — Bid price less $30 per cu. metre 32 MPa to 33 MPa — Bid price less $45 per cu. metre 31 MPa to 32 MPa — Bid price less $60 per cu. metre 30 MPa to 31 MPa — Bid price less $80 per cu. metre 29 MPa to 30 MPa — Bid price less $110 per cu. metre 28 MPa to 29 MPa — Bid price less $150 per cu. metre 27 MPa to 28 MPa — Bid price less $200 per cu. metre Class HPC and Class HPC with Steel Fibres Concrete, 45 MPa Strength Test Results	4.26.1 Payment Scales Class B Concrete, Pile Concrete, 25 MPa Strength Test Results 25 MPa and over — Full bid price 24 MPa to 25 MPa — Bid price less $*30* per cu. metre 23 MPa to 24 MPa — Bid price less $*60* per cu. metre 22 MPa to 23 MPa — Bid price less $*90* per cu. metre 21 MPa to 22 MPa — Bid price less $*120* per cu. metre 20 MPa to 21 MPa — Bid price less $*160* per cu. Metre Class C Concrete, 35 MPa Strength Test Results 35 MPa and over — Full bid price 34 MPa to 35 MPa — Bid price less $*30* per cu. metre 33 MPa to 34 MPa — Bid price less $*60* per cu. metre 32 MPa to 33 MPa — Bid price less $*90* per cu. metre 31 MPa to 32 MPa — Bid price less $*120* per cu. metre 30 MPa to 31 MPa — Bid price less $*160* per cu. metre 29 MPa to 30 MPa — Bid price less $*220* per cu. metre 28 MPa to 29 MPa — Bid price less $*300* per cu. metre 27 MPa to 28 MPa — Bid price less $*400* per cu. metre Class HPC and Class HPC with Steel Fibres Concrete, 45 MPa Strength Test Results

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45 MPa and over — Full bid price 44 MPa to 45 MPa — Bid Price less $20 per cu. metre 43 MPa to 44 MPa — Bid Price less $50 per cu. metre 42 MPa to 43 MPa — Bid Price less $90 per cu. metre 41 MPa to 42 MPa — Bid Price less $140 per cu. metre 40 MPa to 41 MPa — Bid Price less $200 per cu. metre	45 MPa and over — Full bid price 44 MPa to 45 MPa — Bid Price less $*40* per cu. metre 43 MPa to 44 MPa — Bid Price less $*100* per cu. metre 42 MPa to 43 MPa — Bid Price less $*180* per cu. metre 41 MPa to 42 MPa — Bid Price less $*280* per cu. metre 40 MPa to 41 MPa — Bid Price less $*400* per cu. metre
Class D Concrete, 30 MPa Strength Test Results 30 MPa and over — Full bid price 29 MPa to 30 MPa — Bid price less $15 per cu. metre 28 MPa to 29 MPa — Bid price less $30 per cu. metre 27 MPa to 28 MPa — Bid price less $45 per cu. metre 26 MPa to 27 MPa — Bid price less $60 per cu. metre 25 MPa to 26 MPa — Bid price less $80 per cu. metre 24 MPa to 25 MPa — Bid price less $110 per cu. metre	Class D Concrete, 30 MPa Strength Test Results 30 MPa and over — Full bid price 29 MPa to 30 MPa — Bid price less $*30* per cu. metre 28 MPa to 29 MPa — Bid price less $*60* per cu. metre 27 MPa to 28 MPa — Bid price less $*90* per cu. metre 26 MPa to 27 MPa — Bid price less $*120* per cu. metre 25 MPa to 26 MPa — Bid price less $*160* per cu. metre 24 MPa to 25 MPa — Bid price less $*220* per cu. metre
Class S Concrete, 20 MPa Strength Test Results 20 MPa and over — Full bid price 18 MPa to 20 MPa — Bid price less $15 per cu. metre 16 MPa to 18 MPa — Bid price less $35 per cu. Metre	Class S Concrete, 20 MPa Strength Test Results 20 MPa and over — Full bid price 18 MPa to 20 MPa — Bid price less $*30* per cu. metre 16 MPa to 18 MPa — Bid price less $*70* per cu. Metre
The reduced payment shall apply to the volume of concrete represented by the strength test as defined in Section 4.9.1.	The reduced payment shall apply to the volume of concrete represented by the strength test as defined in Section 4.9.1.
Concrete with strengths below the scales shown; i.e. - Class B and Pile concrete below 20 MPa - Class C concrete below 27 MPa - Class HPC and Class HPC with steel fibres concrete below 40 MPa - Class D concrete below 24 MPa - Class S concrete below 16 MPa will be rejected.	Concrete *will be rejected* with strengths below the scales shown; i.e. - Class B and Pile concrete below 20 MPa - Class C concrete below 27 MPa - Class HPC and Class HPC with steel fibres concrete below 40 MPa - Class D concrete below 24 MPa - Class S concrete below 16 MPa
4.27 Measurement and Payment Payment will be made on the basis of the actual volume within the neat lines of the structures as shown on the drawings or revised by authority	**4.27 Measurement and Payment** Payment will be made on the basis of the actual volume within the neat lines of the structures as shown on the drawings or revised by authority of

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of the Department and Consultant, except deductions will be made for volume of concrete displaced by ducts and voids, and by timber, pipe, or concrete piles. No deduction will be made for the volume of concrete displaced by steel reinforcement, expansion material or steel H-piles, nor for fillets and chamfers…	the Department and Consultant, except deductions will be made for volume of concrete displaced by ducts and voids, *girder flanges/webs* and by timber, pipe, or concrete piles. No deduction will be made for the volume of concrete displaced by steel reinforcement, expansion material or steel H-piles, nor for fillets and chamfers…
The payment for concrete shall include full compensation for the cost of furnishing all material, tools, equipment, falsework, forms, bracing, labour, curing, heating, surface finish and all other items of expense required to complete the concrete work shown on the drawings, and as outlined in the specifications.	The payment for concrete shall include full compensation for the cost of furnishing all material, tools, equipment, falsework, forms, bracing, labour, curing, heating, surface finish *including application of Type 1c sealer and/or Type 3 pigmented sealer* and all other items of expense required to complete the concrete work shown on the drawings, and as outlined in the specifications.
Section 5 Reinforcing Steel	
5.1 General	**5.1 General**
This specification is for the supply, fabrication, handling and placing of reinforcing steel. Reinforcement bars shall be supplied in the lengths and shapes, and installed as indicated on the drawings. The Bar Lists in the drawings are provided for estimating purposes only. No substitution of bars or changes to bar details will be allowed without the prior acceptance of the Consultant.	This specification is for the supply, fabrication, handling and placing of reinforcing steel. Reinforcement bars shall be supplied in the lengths and shapes, and installed as indicated on the drawings. *All reinforcing steel shall meet the requirements of the current edition of Reinforcing Steel Institute of Canada Manual of Standard Practise.* The Bar Lists in the drawings are provided for estimating purposes only. No substitution of bars or changes to bar details will be allowed without the prior acceptance of the Consultant.

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Section 6 Structural Steel	
6.2 Supply and Fabrication None	**6.2 Supply and Fabrication** *A pre-fabrication meeting is required prior to commencement of fabrication of structural steel girders, trusses, finger plate deck joint assemblies or when any other specialized construction is included in the Contract. The meeting will be held at fabricator's plant and the Contractor shall ensure the plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Department/Consultant will conduct this meeting after the shop drawings have been approved and welding procedures have been reviewed. The Contractor shall provide two weeks notice to the Department/Consultant prior to the meeting.*
6.2.3.3 Shop Drawings (g) Alberta Infrastructure and Transportation bridge file number and project name shall be shown on all the shop drawings.	6.2.3.3 Shop Drawings (g) Alberta Transportation bridge file number and project name shall be shown on all the shop drawings.
6.2.3.4 Proposed Fabrication Sequence Prior to commencement of fabrication, the Contractor shall present for review and acceptance an outline of the fabrication sequence that clearly describes the order of make-up and assembly of all the component parts, as well as shop assembly, inspection stations, and surface preparation.	6.2.3.4 Proposed Fabrication Sequence Prior to commencement of fabrication, the Contractor shall present for review and acceptance an outline of the fabrication sequence *and details of equipment which will be used for the fabrication. The fabrication scheme shall include* the order of make-up and assembly of all the component parts, as well as shop assembly, inspection stations, and surface preparation. *If any equipment causes repeated defective work as determined by the Department/Consultant, it shall be substituted with a suitable alternative*
6.2.4.4 Bearings Certified mill test reports for all bearing material shall be provided prior to installation. (a) Stainless Steel Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish. (b) Elastomer Elastomer shall conform to Section 18 "Bearings" Division II of AASHTO Standard Specifications for Highway Bridges. Elastomer	6.2.4.4 Bearings Certified mill test reports for all bearing material shall be provided prior to installation. (a) Stainless Steel Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish. (b) Elastomer Elastomer shall conform to Section 18 "Bearings" Division II of *the* AASHTO Standard Specifications for Highway Bridges *2002 edition*.

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compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness.	Elastomer compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness.
6.2.5.3 Tack and Temporary Welds Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and length shall not exceed 15 times the weld size, and shall be subject to the same quality requirements as the final welds. Cracked tack welds shall be completely removed prior to welding over.	6.2.5.3 Tack and Temporary Welds Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and length shall not exceed 15 times the weld size, and shall be subject to the same quality requirements as the final welds. *Tack welds shall be sufficiently ground-out prior to final weld in order to obtain a uniform weld bead.* Cracked tack welds shall be completely removed prior to welding over.
6.2.5.4 Run-off Tabs Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.	6.2.5.4 Run-off Tabs Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. *The tab shall be a minimum of 100 mm long unless greater length is required for satisfactory work.* They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.
6.2.5.6 Welding at Stiffener Ends To prevent notching effects, stiffeners and attachments fillet welded to structural members shall have the fillet welds terminate 15 mm short of edges.	6.2.5.6 Welding at Stiffener Ends To prevent notching effects, stiffeners and attachments fillet welded to structural members shall have the fillet welds terminate *10* mm short of edges.
6.2.5.9 Grinding of Welds Flange butt welds shall be ground flush or to a specified slope on both sides. Web butt welds which are sufficiently smooth with a neat appearance and uniform profile will not require grinding. Fillet welds not conforming to acceptable profile shall be ground to the proper profile without substantial removal of the base metal. Grinding shall be smooth and parallel to the line of stress. Caution shall be exercised to prevent over grinding. Acceptability of the welds without grinding will be determined by the Consultant.	6.2.5.9 Grinding of Welds Flange butt welds shall be ground flush or to a specified slope on both sides. Web butt welds which are sufficiently smooth with a neat appearance and uniform profile *as determined by the Consultant* will not require grinding. Fillet welds not conforming to acceptable profile shall be ground to the proper profile without substantial removal of the base metal. Grinding shall be smooth and parallel to the line of stress. Caution shall be exercised to prevent over grinding. Acceptability of the welds without grinding will be determined by the Consultant.

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None	*6.2.5.11 Welding to Girder Flanges and Webs* *With the exception of longitudinal web to flange welds, all stiffeners, gusset plates, or any other detail material welded to girder flanges shall be a minimum of 300 mm from the flange butt welds.* *With the exception of longitudinal web to flange welds and longitudinal stiffeners to web welds, all stiffeners, gusset plate, or any other detail material welded to girder webs shall be a minimum of 300 mm from the web butt welds.*
6.2.6 Fabrication Fabrication shall be performed in an enclosed area which is adequately heated.	6.2.6 Fabrication Fabrication shall be performed in *a fully* enclosed area which is adequately heated. *The shop temperature shall be at least 10°C.*
6.2.6.8 Shop Assembly (a) Plate Girders Shop assembly of girders shall be by the progressive assembly method according to AASHTO except that only two, instead of three, sections need to be assembled… this is to allow the Consultant to call for the best fit line to reduce the effect of any camber differences should it be deemed necessary. Camber for plate girders will be measured on the top of the top flange.	6.2.6.8 Shop Assembly (a) Plate Girders Shop assembly of girders shall be by the progressive assembly method according to AASHTO except that only two, instead of three, sections need to be assembled… this is to allow the Consultant to call for the best fit line to reduce the effect of any camber differences should it be deemed necessary. Camber for plate girders will be measured on the top of the top flange. *The camber of plate girders shall be measured in the "no load" condition.*
6.2.6.10 Bolt Holes Clause 11.4.8 in Division II of AASHTO shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or subpunched and reamed to full size. All holes in girder splices shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.	6.2.6.10 Bolt Holes Clause 11.4.8 in Division II of AASHTO shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or subpunched *5 mm smaller* and reamed to full size. *Punching of full size holes for secondary members such as bracings which are not welded to main member is allowed for material less than 16 mm thick.* All holes in girder splices shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.
6.2.6.12 Flange Corner Chamfer	6.2.6.12 Flange Corner Chamfer Corners of all flanges shall be ground to a 2 mm chamfer. *Corners of*

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Corners of all flanges shall be ground to a 2 mm chamfer.	*stiffeners, structural sections and plates shall be ground to a 1 mm chamfer.*
6.2.6.14 Web Panning The maximum variation from flatness for webs shall be 0.01d where d is the least dimension of the panel formed by the girder flanges and/or stiffeners. Should the panning in one panel convex and the panning in the adjacent panel concave then the sum of the panning in the two adjacent sections shall not exceed that allowed for one panel.	6.2.6.14 Web Panning The maximum variation from flatness for webs shall be 0.01d where d is the least dimension of the panel formed by the girder flanges and/or stiffeners. Should the panning in one panel convex and the panning in the adjacent panel concave then the sum of the panning in the two adjacent sections shall not exceed that allowed for one panel. *Localized deformation in the web shall not exceed 3 mm in 1 m.*
6.2.7 Surface Preparation 6.2.7.1 Blast Cleaning Unless otherwise noted, all steel components shall be blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) No. SP6. Essentially this is a surface from which all oil, grease, dirt, rust, Scale and foreign matter have been completely removed, and all rust, mill scale and old paint have been removed except for slight shadows, streaks or discolorations caused by rust stain or mill scale oxide binder.	6.2.7 Surface Preparation *and Coating* 6.2.7.1 Blast Cleaning Unless otherwise noted, all steel components shall be blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) No. SP6. Essentially this is a surface from which all oil, grease, dirt, rust, foreign matter, mill scale and old paint have been *completely* removed except for slight shadows, streaks or discolorations caused by rust stain or mill scale oxide binder. *The exterior face of the exterior girders shall be uniform in appearance as determined by the Consultant.*
6.2.7.2 Galvanizing Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of CSA Standard G164 with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.	6.2.7.2 Galvanizing Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware* with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.
6.2.8.3 Testing by the Contractor The exception to 6.2.8.2 is that inspection made necessary by the repair of faulty work, and additional unspecified material splices shall be paid	6.2.8.3 Testing by the Contractor The exception to 6.2.8.2 is that inspection made necessary *for any* repair work *during the course of fabrication or handling,* and additional unspecified

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for by the Contractor. Any test records made by the fabricating shop in the course of normal quality control shall be open to the Consultant for inspection.	material splices shall be paid for by the Contractor. Any test records made by the fabricating shop in the course of normal quality control shall be open to the Consultant for inspection.
6.2.8.6 Radiographic Inspection Schedule Unless otherwise noted, radiographic inspection of welded plate girders will be performed in accordance with the following schedule: (a) 100 percent of all tension flange butt welds, all stiffener butt welds, and all diaphragm butt welds, and any groove welded attachments to flange plates. (b) 25 percent of all other flange butt welds (c) All web butt welds in tension zone plus additional 300 mm of web butt weld in compression zone at the end of the web.	6.2.8.6 Radiographic Inspection Schedule Unless otherwise noted, radiographic inspection of welded plate girders will be performed in accordance with the following schedule: (a) *100%* of all tension flange *and stress reversal* butt welds, all stiffener butt welds and all diaphragm butt welds, and any groove welded attachments to flange plates. (b) *A minimum of 25%* of all other flange butt welds *randomly selected for each structure. Additional testing may be required to ensure the quality of welds.* (c) All web butt welds in tension *and stress reversal zones* plus additional 300 mm of web butt weld in compression zone at the end of the web.
6.2.8.7 Radiographic Inspection of Miscellaneous Material Unless otherwise noted, radiographic inspection of miscellaneous material will be performed in accordance with the following schedule: (a) 100% of all tension members (b) 50% of all other members None	6.2.8.7 Radiographic Inspection of Miscellaneous Material Unless otherwise noted, radiographic inspection of miscellaneous material will be performed *by the Contractor* in accordance with the following schedule: (a) 100% of all tension members (b) 50% of all other members *The radiographic inspection report and the film shall be provided to the Consultant within 48 hours of the completion of inspection.*
6.2.8.8 Magnetic Particle Inspection Schedule Unless otherwise noted, magnetic particle inspection of welded plate girders will be performed in accordance with the following schedule: (a) 50 percent of the web to flange welds or any fillet welds placed on flange plate (b) 10 percent of the web to stiffener welds	6.2.8.8 Magnetic Particle Inspection Schedule Unless otherwise noted, magnetic particle inspection of welded plate girders will be performed in accordance with the following schedule: (a) *50%* of the web to flange welds or any fillet welds placed on flange plate (b) *10%* of the web to stiffener welds (c) *100%* of the stiffeners to flange welds

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(c) 100 percent of the stiffeners to flange welds (d) 100 percent of the bearing sole plate to flange welds (e) 20 percent of the diaphragm connector plate welds	(d) *100%* of the bearing sole plate to flange welds (e) *20%* of the diaphragm connector plate welds
6.3 Structural Steel Erection The Contractor shall erect the structural steel, remove any temporary construction and do all work required to complete the erection in accordance with the drawings and these specifications. No field welding, additional drilling or any other modifications shall be made to steel elements other than deck Joints. The Contractor shall not erect structural steel until the substructure concrete has been cured a minimum of three days and achieved 80% of the specified concrete strength requirement…	**6.3 Structural Steel Erection** The Contractor shall erect the structural steel, remove any temporary construction and do all work required to complete the erection in accordance with the drawings and these specifications. *No drilling of additional holes or any other modifications including field welding shall be made to steel elements other than deck joints. Lifting devices shall not be welded to the girders.* The Contractor shall not erect structural steel until the substructure concrete has been cured a minimum of three days and achieved 80% of the specified concrete strength requirement…
6.3.1 Handling and Storing Materials None. Material to be stored shall be placed on timber blocking. It shall be kept clean, and stored in a properly drained area. Girders and beams shall be placed upright and shored. Long members, such as deck joint assemblies, buffer angles, columns and chords, shall be supported on timber blocking to prevent damage from deflection. Galvanized material shall be handled and stored as per section 12.2.8.	6.3.1 *Transportation,* Handling and Storing Materials *Girders and beams shall be transported in the vertical position. However these elements may be transported in other positions provided:* • *A Professional Engineer performs the analysis and provides a written statement that the proposed method will not damage the elements.* • *Upon arrival at the site and prior to erection, the elements shall be checked by the Contractor in the presence of the Consultant to ensure all tolerances are met. The Contractor shall provide an adequate flat storage area for the inspection.* *Any structural steel member damaged during transportation, handling, storing or erection shall be immediately reported to the Department and the Consultant. The Contractor shall provide an engineering assessment report prepared by a Professional Engineer experienced in evaluation and inspection of damaged steel members.* *The Consultant will also arrange to have an independent inspection and assessment performed on the damaged member. The Contractor shall provide at least three working days notice for the inspection and facilitate all the activities associated with the inspection. All costs associated with the*

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	independent inspection will be the responsibility of the Contractor. Material to be stored shall be placed on timber blocking. It shall be kept clean, and stored in a properly drained area. Girders and beams shall be placed upright and shored. Long members, such as deck joint assemblies, buffer angles, columns and chords, shall be supported on timber blocking to prevent damage from deflection. Galvanized material shall be handled and stored as per section 12.2.8.
6.3.2.1 Temporary Supporting Structures and Berms The temporary supporting structures…Professional Engineer registered in Alberta. Temporary supporting structures … obtained from the Consultant. <u>Incidental damage</u> to other property, such as earth fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.	6.3.2.1 Temporary Supporting Structures and Berms The temporary supporting structures…Professional Engineer registered in Alberta. Temporary supporting structures … obtained from the Consultant. *Repair to any damage* to other property, such as earth fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.
6.3.2.2 Review of Erection Procedure The Contractor shall submit to the Consultant, for record purposes and for examination four copies of the detailed erection procedure four weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following: (a) Traffic Accommodation Strategy (TAS), as applicable. (b) Access to work, earth berms and work bridges. (c) Type and capacity of equipment. …	6.3.2.2 Review of Erection Procedure The Contractor shall submit to the Consultant, for record purposes and for examination four copies of the detailed erection procedure four weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following: (b) Traffic Accommodation Strategy (TAS), as applicable. (b) Access to work, earth berms and work bridges. (c) Type and capacity of equipment. *Cranes shall be used for handling and erecting structural steel girders.* …
6.3.2.4 Bearings and Anchorage Masonry bearing plates shall…set level in their exact position. The Contractor shall remove…permit free movement of the spans. When steel bearings are employed…even bearing on the concrete.	6.3.2.4 Bearings and Anchorage Masonry bearing plates shall…set level in their exact position. The Contractor shall remove…permit free movement of the spans. When steel bearings are employed…even bearing on the concrete. *When required, field welding adjacent to elastomeric pads shall be*

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	performed with care to avoid damage to the Elastomer. The temperature of the steel adjacent to the Elastomer should be kept below 120°C. The distant between the weld and the Elastomer should be at least 40 mm.
6.3.2.6 Assembly … Should adjustments in elevation of the girder splices become necessary only enough pins or bolts shall be removed to allow free rotation of the joints.	6.3.2.6 Assembly … Should adjustments in elevation of the girder splices become necessary to *allow free rotation of the joint, only enough pins or bolts shall be removed.*
6.3.2.8 Misfits The correction of minor misfits involving reasonable amounts of reaming, cold cutting and chipping will be considered incidental to the work of erection. However, any deformation which prevents the proper assembly and fitting up of parts by the moderate use of drift pins, or by a moderate amount or reaming and slight chipping or cutting, shall be reported immediately to the Department and Consultant, and their acceptance of the method of correction obtained. The correction shall be made in Consultant's presence.	6.3.2.8 Misfits The correction of minor misfits involving *any* reaming, cold cutting and chipping *for secondary members may be allowed. However, If reaming is considered required, it shall be immediately reported to the Department and the Consultant. The Contractor shall submit a repair procedure to the Consultant for review. If accepted, the repairs* shall be made in *the* Consultant's presence.

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Section 7 Precast Concrete Units	
7.2 Supply and Manufacture None	**7.2 Supply and Manufacture** *A pre-fabrication meeting is required prior to commencement of fabrication of precast concrete elements. The meeting will be held at fabricator's plant and the Contractor shall ensure the plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Department/Consultant will conduct this meeting after the shop drawings have been approved. The Contractor shall provide two weeks notice to the Department/Consultant prior to the meeting.*
7.2.2 Qualification The Contractor shall notify the Department and Consultant of any subcontractors in his employ. The Contractor shall remain responsible for the work of the subcontractors. All terms of the contract, such as right to access, shall apply to the subcontractor. The manufacturer shall operate a plant that is certified by the Canadian Standards Association in appropriate category(ies) according to CSA Standard A251, Qualification Code for Manufacturers of Architectural and Structural Concrete.	7.2.2 Qualification The Contractor shall notify the Department and Consultant of any subcontractors in his employ. The Contractor shall remain responsible for the work of the subcontractors. All terms of the contract, such as right to access, shall apply to the subcontractor. The *fabricator* shall operate a *recognized precast concrete fabricating plant and be fully certified by the Canadian Precast/Prestressed Concrete Institute (CPCI) certification Program.*
7.2.3.4 Concrete and Grout Mix Design A copy of the concrete mix design … brand names of all admixtures. The mix design shall include…the air-void analysis shall be repeated.	7.2.3.4 Concrete and Grout Mix Design A copy of the concrete mix design … brand names of all admixtures. *The sampling and testing of aggregates, and the concrete mix design shall be completed by an independent CSA certified and qualified concrete testing laboratory which shall have a permit to practice in the Province of Alberta. Concrete mix designs including sampling and testing of aggregates may be completed by the concrete supplier, with the condition that documentation is stamped by a Professional Engineer registered in the Province of Alberta. For either situation, the mix design, including sampling and testing, shall be reviewed and stamped for compliance with the respective specifications by an independent CSA certified and qualified concrete testing laboratory having a permit to practice in the Province of Alberta. For either case, the testing laboratory shall provide an engineering opinion that the concrete aggregate and mix designs are suitable for the*

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	intended use and are expected to perform to specified standards. The mix design shall include…the air-void analysis shall be repeated.
7.2.4.1 Cement Portland Cement conforming to the requirements of CSA Standard A5 shall be used.	7.2.4.1 Cement *Hydraulic cement* conforming to the requirements of CSA Standard *A 3001* shall be use
7.2.4.3 Silica Fume Ten percent condensed silica fume by weight of cement (plus or minus 0.5 percent) shall be used in all precast concrete. Condensed silica fume shall conform to Table 5 & 6 of CSA Standard A 3000-03 – Cementitious Material Compendium, Type SF, with a SiO_2 content of at least 85%, a maximum of 10% ignition loss, and no more than 1% SO_3 content. An acceptable, compatible, superplasticizing admixture shall be used together with the silica fume.	7.2.4.3 Silica Fume *10%* condensed silica fume by weight of cement *(± 0.5%)* shall be used in all precast concrete. Condensed silica fume shall conform to *the requirements of CSA Standard A 3001 for a Type SF supplementary cementing material, with a SiO_2 content of at least 85%, a maximum loss on ignition of 10%* and no more than 1% SO_3 content. An acceptable, compatible, superplasticizing admixture shall be used together with the silica fume.
7.2.4.6 Chemical Admixtures Chemical admixtures shall conform to the requirements of ASTM Standard C494 and shall be accepted by the Consultant. All chemical admixtures must be suitable for use in precast concrete, be supplied by the same manufacturer as the air entraining agent, and be compatible with each other.	7.2.4.6 Chemical Admixtures Chemical admixtures shall conform to the requirements of ASTM Standard C494 and shall be accepted by the Consultant. All chemical admixtures must be suitable for use in precast concrete, be supplied by the same manufacturer as the air entraining agent, and be compatible with each other. *The addition of calcium chloride, retarders, accelerators, set controlling admixtures and air reducing agents will not be permitted.* *Acceptable admixtures are air-entraining agents, superplasticizers and water reducing agents.*
7.2.4.7 Concrete Concrete shall consist of Portland Cement, condensed silica fume, aggregates, water and acceptable admixtures. The type of concrete to be used will be specified on the drawings. The unit weight, entrained air and air void spacing requirements for the various types of concrete are specified in Table 7.1.	7.2.4.7 Concrete Concrete shall consist of *hydraulic cement*, condensed silica fume, aggregates, water and acceptable admixtures. The type of concrete to be used will be specified on the drawings. The *density*, entrained air and air void spacing requirements for the various types of concrete are specified in Table 7.1.
7.2.4.14 Bearings Certified mill test reports for all bearing material shall be provided prior to	7.2.4.14 Bearings Certified mill test reports for all bearing material shall be provided prior to

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installation. (a) Stainless Steel Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish. (b) Elastomer Elastomer shall conform to Section 18 "Bearings" Division II of AASHTO Standard Specifications for Highway Bridges 2002 edition. Elastomer compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness. (c) Teflon Teflon shall be unfilled, 100% virgin polymer.	installation. (a) Stainless Steel Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish. (b) Elastomer Elastomer shall conform to Section 18 "Bearings" Division II of *the* AASHTO Standard Specifications for Highway Bridges *2002 edition*. Elastomer compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness. (c) Teflon Teflon shall be unfilled, 100% virgin polymer.
7.2.4.15 Galvanizing Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of CSA Standard G164 with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters and all welding flux residue from the steel components prior to galvanizing.	7.2.4.15 Galvanizing Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware* with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters and all welding flux residue from the steel components prior to galvanizing.
7.2.5.1 Forms Precast concrete units are to be manufactured in steel forms accepted by the Consultant.	7.2.5.1 Forms Precast concrete units are to be manufactured in steel forms accepted by the Consultant. *For all beam members, the forms shall be designed to be removed without damaging the beam. For all "I" or "T" beam members the side forms shall be removed horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. The top flange shall not be subjected to a vertical force at any time.* *Holes or voids cast into the top flange of "I" or "T" girders to accommodate deck formwork, will not be permitted.*

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7.2.5.3 Stressing Strand Stressing strands shall be free of corrosion, dirt, grease, rust, oil or other foreign material that may impede bond between the steel and the concrete. Stressing strand shall be protected at all times from manufacture to encasing in concrete or grouting. Stressing strand that has sustained physical damage at any time shall be rejected. The Contractor shall submit for review and acceptance the methods, procedures and devices to accurately position the stressing strand. The submission shall include strand anchorage, draping, hold downs, guides or any other required devices. The stress in the stressing strands shall be measured both by jacking gauges and by elongation of the strands. The maximum allowable discrepancy between jack pressure and elongation shall be within 5%, or the factors contributing to the difference must be identified and corrected before proceeding.	7.2.5.3 Stressing Strand Stressing strands shall be free of corrosion, dirt, grease, rust, oil or other foreign material that may impede bond between the steel and the concrete. Stressing strand shall be protected at all times from manufacture to encasing in concrete or grouting. Stressing strand that has sustained physical damage at any time shall be rejected. *Stressing strand splices shall not be placed within a precast concrete unit.* The Contractor shall submit for review and acceptance the methods, procedures and devices to accurately position the stressing strand. The submission shall include strand anchorage, draping, hold downs, guides or any other required devices. *Stressing strands shall not be stressed more than 36 hours prior to being encased in concrete.* The stress in the stressing strands shall be measured both by jack gauges and by elongation of the strands. The maximum allowable discrepancy between jack pressure and elongation shall be within 5%, or the factors contributing to the difference must be identified and corrected before proceeding. *Changes in strand temperature and slippage at strand anchorages shall be measured between stressing and concrete encasement and any changes in strand stress due to these effects shall be accounted for in the design.*
7.2.5.6 Concrete Measuring, Mixing and Placing The procedures outlined in the ACI Standard 304 “Guide for Measuring, Mixing, Transporting and Placing Concrete” shall be followed. The time from initial mixing of the concrete until placing the concrete in the forms shall not exceed one hour.	7.2.5.6 Concrete Measuring, Mixing and Placing The procedures outlined in the ACI Standard 304 “Guide for Measuring, Mixing, Transporting and Placing Concrete” shall be followed. The time from initial mixing of the concrete until placing the concrete in the forms shall not exceed one hour. *The elapsed time between the successive placing of concrete onto previously placed concrete shall not exceed 45 minutes.*
7.2.5.7 Concrete Temperature The concrete temperature shall neither less than 10℃ nor greater than 30℃ at the time of placing in the forms.	7.2.5.7 Concrete Temperature The concrete temperature shall *be between* 10℃ *and* 30℃ at the time of placing in the forms.

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7.2.5.9 Camber Hubs The Contractor shall store the members in such a manner as to provide access for measuring camber as determined by the Consultant. The Contractor shall provide personnel as requested to assist the Consultant with the camber readings.	7.2.5.9 Camber Hubs The Contractor shall store the members in such a manner as to provide access for measuring camber as determined by the Consultant. The Contractor shall provide personnel as requested to assist the Consultant with the camber readings. *The Contractor shall record the girder camber at the midpoint of each girder within 24 hours of girder destressing.*
7.2.5.10 Concrete Finish The concrete surfaces of units shall be finished as specify, and completed to the acceptance of the Consultant. … (c) Class 3 Bonded Concrete Surface Finish The surface shall be prepared in accordance with the requirements of Class 2 Rubbed Finish except that it need not be of uniform colour. The pigmented sealer shall be applied at site and in accordance with the manufacturer's specifications. The colour of the pigmented sealer must be accepted by the Consultant before application. At least two applications of the pigmented sealer are required and the Contractor shall ensure that no colour variation is visible. Approval of the pigmented sealer will not relieve the Contractor of full responsibility for its acceptable performance and appearance.	7.2.5.10 Concrete Finish *The exterior concrete girder faces shall have a Class 2 Rubbed surface Finish, unless specified otherwise. Except the top, all the remaining surfaces shall have a Class 1 Form Surface Finish.* *…* (c) Class 3 Bonded Concrete Surface Finish The surface shall be prepared in accordance with the requirements of Class 2 Rubbed Finish except that it need not be of uniform colour. *After the surface preparation has been completed to the satisfaction of the Consultant, the surface shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours, the Contractor shall apply an approved pigmented concrete sealer, which meets the requirements for a type 3 sealer of the "Alberta Transportation Concrete Sealer Test Procedure – B388".* The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications. The colour*(s)* of the *proposed coating scheme, which typically shall be similar to the natural colour of cured concrete,* must be *acceptable to* the Consultant before application *of the coating*. *A minimum of* two applications of the pigmented sealer are required. *When spray application is used the surface shall be back rolled. The* Contractor shall ensure that no colour variation is visible, *and shall match the colour of any previously painted adjoining surfaces. Acceptance* of the pigmented sealer *used* will not *be considered to* relieve the Contractor of full responsibility for its acceptable performance and appearance.

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7.2.5.11 Curing All concrete units shall be cured at an elevated temperature. The curing of concrete units shall essentially be in accordance with ACI 517 unless otherwise specified or required by the Consultant. The ambient curing temperature shall be increased at a rate not exceeding 20°C per hour until a maximum ambient temperature of not less than 50°C nor more than 60°C is attained. During cooling, the units shall not be subjected to a rapid temperature decrease. (a) Curing in the Form The initial application of heat shall commence only after the last of the freshly placed concrete has attained its initial set, normally two to four hours after casting, or longer if normal cement or retarder type admixtures have been used. Heat shall not be applied directly to the concrete, but by a method that will produce a consistent temperature throughout the entire form and enclosure. The increase in temperature and the holding temperature shall be monitored and permanently recorded on a chart at a minimum of 3 quarter points along the form. (b) Steam Curing After Removal from the Form Upon removal from the forms the units shall be cleaned, patched, finished, and ready for inspection by the Consultant within a period not exceeding 12 hours. The units shall be placed in a manner that will facilitate any clean up or repair work, and that will allow full inspection of all surfaces by the Consultant. Within 24 hours of removal from the form, the units shall be placed within a suitable enclosure for steam curing. The steam must be in a saturated condition maintaining an atmosphere of 100% relative humidity and a uniform ambient temperature of 50°C – 60°C for a period of 4 days. The concrete units shall not be exposed to temperatures below freezing until the steam curing process has been fully completed.	7.2.5.11 Curing All *prestressed* concrete units shall be cured at an elevated temperature. The curing of *prestressed* concrete units shall essentially be in accordance with *CSA A23.4* unless otherwise specified. The ambient curing temperature shall be increased at a rate not exceeding 20°C per hour until a maximum ambient temperature of not more than 60°C is attained. *After curing, the temperature of the units shall be reduced at a rate not exceeding 10°C per hour until the temperature of the concrete has fallen to within 10°C of the temperature of the outside air.* *Care must be exercised to protect prestressed and non-prestressed concrete units from thermal shock at all times until these have been fully cured.* *(a) Prestressed Concrete* *(i) Curing in the form* The initial application of heat shall commence only after the last of the freshly placed concrete has attained its initial set, normally two to four hours after casting. *Heat shall not be applied directly to the concrete, but by a method that will produce a consistent ambient temperature throughout the entire form and enclosure. The increase in temperature and the holding temperature shall be monitored and permanently recorded on a chart at a minimum of 3 quarter points along the form.* *(ii) Curing after Removal from the Form* Upon removal from the forms the units shall be cleaned, patched and finished within a period not exceeding 12 hours. The units shall be placed in a manner that will facilitate any clean up or repair work, and that will allow full inspection of all surfaces. Within 24 hours of removal from the form, the units shall be placed within a suitable enclosure, for curing. *The curing enclosure shall provide a minimum of 150 mm of free air space between the concrete surfaces and the coverings. Flexible coverings shall be secured to prevent any moisture loss.*

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	The difference in ambient air temperature adjacent to the concrete at different locations within the enclosure shall not exceed 10℃ at any time. *The curing process shall be continued for a period of 4 days with one of the following methods:* *1) Steam Curing* *Steam jets shall not directly impinge on the concrete surfaces. The steam must be in a saturated condition maintaining an atmosphere of 95% to 100% relative humidity and a uniform ambient temperature of 40℃ to 60℃.* *For days with periods of 4 or more hours within a 24 hour period, where measured temperature or humidity levels do not meet the required limits, these days will not be count as a full day of steam cure. An additional day of steam cure beyond the specified 4 days will be required for each non compliant day.* *2) Curing with Continuous Misting and Heat* *Sufficient number of atomizing misting nozzles shall be strategically located to produce a fine mist with 95% to 100% relative humidity in the enclosure. The water shall be preheated to a temperature which will produce a misting temperature compatible with the ambient temperature. The enclosure shall be heated with radiant heater to a temperature of 40℃ to 60℃. Dry heat shall never touch the concrete surface at any time. A control system shall be installed to shut off the heat when the humidity level drops below 90% in the enclosure. Should the temperature in the concrete rise above 40℃ without the misting, the unit will be rejected.* *Two continuously recording thermometers and two continuously recording hygrometers are to be provided for each curing enclosure to monitor the concrete ambient temperature and relative humidity. All time-temperature and time-humidity recordings shall be clearly shown on the graph.* *(b) <u>Non-Prestressed Concrete</u>*

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	Curing of all non-prestressed concrete shall be in accordance with one of the following methods. *(i) Elevated Temperature Curing* *Upon removal from the forms the units shall be cleaned, patched, finished and elevated temperature cured for four days as per Section 7.2.5.11(a) Prestressed Concrete.* *(ii) Moist Curing* *The units may be moist cured in lieu of elevated temperature curing in accordance with the following:* *Upon removal from the forms the units shall be cleaned, patched, finished, and ready for inspection within a period not exceeding 12 hours. Patching shall be performed with an approved product and at an ambient temperature of 15℃ to 30℃. After completion of patching and finishing, within 24 hours of removal from the form, the units shall be placed under two layers of light colored filter fabric or burlap at an ambient temperature of not less than 15℃. The filter fabric or burlap shall be kept in a continuously wet condition throughout the curing period by means of a soaker hose or other means as reviewed and accepted by the Department. Curing with filter fabric or burlap and water shall be maintained for a minimum period of seven days.*
7.2.5.13 Repairing Damaged Concrete Serious damage, honeycomb and other casting defects shall be immediately reported to the Department and Consultant. Repair procedures shall be submitted for review and acceptance by the Department and Consultant prior to the commencement of the repair. All repairs shall be completed prior to curing of the unit.	7.2.5.13 Repairing Damaged Concrete Serious damage, honeycomb and other casting defects shall be immediately reported to the Department and Consultant. Repair procedures shall be developed by *a Professional Engineer and* submitted for review and acceptance by the Department and Consultant prior to the commencement of the repair. All repairs shall be completed prior to curing of the unit *at an ambient temperature of 15℃ to 30℃*. *Repairs to defects such as cracks, honeycombs or spalls shall be carried out in accordance with this section. Any unacceptable cracks, honeycombs or spalls will result in rejection of the unit.* *In this section the "bearing area" of a girder is defined as the portion of the*

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	girder bottom flange up to the underside, but not including the radiused transition between the bottom flange and the web, directly above the bearing. The bearing area extends from the end of the unit to 75 mm beyond the edge of the shoe plate. The "anchorage area" of a girder is defined as the full height portion of the girder that is two times the girder depth from the end of the girder but is not in the bearing area. *(a) Cracks* *The following cracks are unacceptable and may result in rejection of the unit unless reviewed and accepted by the Consultant and the Department:* • *Cracks in the bearing area of a girder* • *Cracks in the anchorage area of a girder exceeding 0.5 mm in width.* • *Cracks outside of the girder bearing and anchorage areas exceeding 0.2 mm or longer than 300 mm.* *All cracks 0.2 mm or greater in width shall be repaired by epoxy injection in accordance with the manufacturer's instructions. Coring shall be carried out to confirm the penetration of the epoxy into the cracks if requested by the Department.* *The Contractor shall immediately notify the Department and the Consultant, if a crack has a potential to be shear crack exceeds 0.15 mm in width and longer than 0.25 times the girder depth. Crack length shall be measured along the horizontal axis and a crack will be considered to be a shear crack if inclined at an angle between 30° and 60° from the horizontal.* *(b) Honeycombs and Spalls* *The following conditions of honeycomb or spall are unacceptable and may result in rejection of the unit unless reviewed and accepted by the Consultant and the Department:* • *Any honeycombs or spalls in the bearing or anchorage areas of the girder* • *Major honeycomb or spall in areas outside the bearing and anchorage areas of a girder. Major honeycombs and spalls are described as honeycombs and spalls that are more than 30 mm*

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	deep or more than 0.1 m^2 in area. *When accepted by the Consultant and the Department, repairs for honeycombs and spalls may be made using a cementitious material. Repairs of minor honeycombs and spalls may be made after destressing of the girder. However major honeycombs and spalls shall be repaired before destressing the girder.*
7.2.5.14 Sealer The Contractor shall supply and apply an approved Type 1c sealer to the girder surfaces as shown on Standard Drawing S-1637 "Type 1c Sealer for Precast Girders" included with these specifications. Type 1c sealers shall meet the current "Specifications for the Supply of Concrete Sealers, Evaluation Procedures for Sealers Used on Concrete Bridge Elements" (B388).	7.2.5.14 *Type 1c* Sealer The Contractor shall supply and apply an approved Type 1c sealer to the girder surfaces as shown on Standard Drawing S-1637 "Type 1c Sealer for Precast Girders" included with these specifications. Type 1c sealers shall meet the current *Material Testing Specifications for Concrete Sealers – B388*.
7.2.6.3 Test Methods Sampling, making, curing and testing concrete specimens shall be in accordance with the requirements of the following CSA standards: - Sampling - A23.2 - 1C - Concrete Test Cylinders - A23.2 - 3C - Testing Concrete Cylinders - A23.2 - 9C - Air Content - A23.2 - 4C - Unit Weight of Concrete - A23.2 - 6C - Air Void Determination - A23.2 - 17C	7.2.6.3 Test Methods Sampling, making, curing and testing concrete specimens shall be in accordance with the requirements of the following CSA standards: - Sampling - A23.2 - 1C - Concrete Test Cylinders - A23.2 - 3C - Testing Concrete Cylinders - A23.2 - 9C - Air Content - A23.2 - 4C - *Density* of Concrete - A23.2 - 6C - Air Void Determination - A23.2 - 17C
7.2.6.6 Strength Testing by the Consultant The Consultant will make and test concrete cylinders to determine the 28-day strength. Samples for testing will be taken from the fresh concrete being placed in the forms at the rate of one set of cylinders for every three bridge units cast continuously. Additional cylinders may be cast at the discretion of the Consultant. A set shall consist of three cylinders. A strength test will be the average of the 28-day strengths of the three cylinders (one set). Continuous casting shall mean no break in the casting longer than one hour. The concrete test cylinders will be tested by an independent testing	7.2.6.6 *28 Day* Strength Testing *The Contractor shall make concrete test cylinders* to determine the 28-day strength. *The Consultant will determine from which batch the test cylinders shall be taken.* Samples for testing will be taken from the fresh concrete being placed in the forms at the rate of one set of cylinders for every three bridge units cast continuously. Additional cylinders may be cast at the discretion of the Consultant. A set shall consist of three cylinders. A strength test will be the average of the 28-day strengths of the three cylinders (one set). Continuous casting shall mean no break in the casting longer than one hour.

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laboratory at the Consultant's expense. These tests shall represent the strength of the cast concrete. Test results will be forwarded to the Contractor. The Contractor shall be … site visits during the course of fabrication.	*The Contractor shall be responsible for transporting the test cylinders to an independent CSA testing laboratory. The transportation and testing of concrete test cylinders will be at the Contractor's expense.* These tests shall represent the strength of the cast concrete. *Test results shall be forwarded to the Consultant within 24 hours of testing.* The Contractor shall be … site visits during the course of fabrication.
7.2.6.7 Transportation of Test Cylinders The Contractor shall be responsible to transport the test cylinders made by the Consultant to the testing laboratory retained to do the testing.	7.2.6.7 *Fabrication of Prestressed/Precast Units in Cold Weather* *The Contractor shall accept full responsibility for the protection of prestressed/precast concrete units when fabricating in adverse weather conditions.* *When the ambient temperature is, or is expected to be, below 5°C during fabrication the following provisions for cold weather casting shall be put in place:* *(a) The Contractor shall construct an enclosure capable of maintaining an ambient temperature within the structure of between 15°C and 30°C. The enclosure shall be sufficiently sized to accommodate steel forms, workers and the casting equipment. The enclosure temperature shall be constantly monitored and shall be maintained within the specified range.* *(b) The heating system shall be designed to provide uniform distribution of heat and the combustion by-products shall be kept out of the enclosure.* *(c) Before casting concrete, adequate preheat shall be provided to raise the temperature of the formwork, reinforcing steel, stressing strand, miscellaneous iron, etc. to at least 10°C.* *(d) The fabricated units shall be kept in the enclosure until they are patched, repaired and transferred to the curing enclosure.*
7.3.1 General The Contractor shall erect the girders, remove any temporary construction, and do all work required to complete the erection in accordance with the drawings and these specifications. The Contractor shall not erect the precast concrete girders until the substructure concrete has been cured a minimum of three days and achieved 80% of	7.3.1 General The Contractor shall erect the girders, remove any temporary construction, and do all work required to complete the erection in accordance with the drawings and these specifications. *Drilling, coring or the installation of any fasteners or anchoring systems or any modifications shall not be made to the concrete elements.* The Contractor shall not erect the precast concrete

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the 28 day specified concrete strength requirements.	girders until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirements.
7.3.4 Review of Erection Procedure The Contractor shall submit to the Consultant, for record purposes and for examination as to concept only, four copies of a detailed erection procedure three weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following: (a) Access to work, earth berms and work bridges. (b) Type and capacity of equipment. …	7.3.4 Review of Erection Procedure The Contractor shall submit to the Consultant, for record purposes and for examination as to concept only, four copies of a detailed erection procedure three weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following: (a) Access to work, earth berms and work bridges. (b) Type and capacity of equipment. *Cranes shall be used for handling and erecting precast concrete units.* …
7.3.8 Bearings and Anchorage … None.	7.3.8 Bearings and Anchorage … *When required, field welding adjacent to elastomeric pads shall be performed with care to avoid damage to the Elastomer. The temperature of the steel adjacent to the Elastomer should be kept below 120°C. The distance between the weld and the Elastomer should be at least 40 mm.*
7.3.12.5 Materials (a) Stressing Strand Stressing strand shall conform to the requirements of sections 7.2.4.8 and 7.2.5.3. (b) Anchorages and Distribution All stressing steel shall be secured at the ends by means of permanent anchoring devices accepted by the Consultant. These devices shall comply with S6-00 Clause 8.4.4.1. (c) Ducts Ducts shall be corrugated, semi-rigid galvanized metal tubes and be capable of withstanding concrete pressures without excessive deformation or permitting the entrance of cement paste during the	7.3.12.5 Materials (a) Stressing Strand Stressing strand shall conform to the requirements of sections *7.2.4.9* and 7.2.5.3. (b) Anchorages and Distribution All stressing steel shall be secured at the ends by means of permanent anchoring devices accepted by the Consultant. These devices shall comply with S6-*06* Clause 8.4.4.1. (c) Ducts The Contractor shall provide mortar tight inlets and outlets in all ducts with a nominal diameter of 20 mm in the following locations:

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placement of concrete. The duct shall have sufficient rigidity to maintain the required profile between points of supports. The interval between supports shall not exceed 1.0 m. The Contractor shall provide mortar tight inlets and outlets in all ducts with a nominal diameter of 20 mm in the following locations: • The anchorage area • All high points of the duct, when the vertical distance between the highest and lowest point is more than 0.5 m. • Place an inlet at or near the lowest point. • Place free draining outlet at all low points of duct. The Contractor shall provide inlets and outlets with values, caps or other devices capable of withstanding the grouting pressure. The ducts and vents shall be securely fastened in place to prevent movement. The Contractor shall provide detailed inlets and outlets on the shop drawings. (e) Grout Grout shall be Class B or Class C as described in Table 10.9.3-1 and the properties as described in Table 10.9.3-2 of the 2002 Interim AASHTO LRFD Bridge Construction Specification. The average minimum compressive strength of 3 cubes at 28 days shall be a minimum of 35 MPa as per CSA A23.2-1B. The Contractor is responsible to perform all grout testing at his cost. The frequency of grout strength testing shall be as follows: Precast Concrete Girders: One strength test per girder line Cast-In-Place Girders: One strength test for every four longitudinal ducts	• The anchorage area • All high points of the duct, when the vertical distance between the highest and lowest point is more than 0.5 m. • Place an inlet at or near the lowest point. • Place free draining outlet at all low points of duct. The Contractor shall provide inlets and outlets with *valves*, caps or other devices capable of withstanding the grouting pressure. The ducts and vents shall be securely fastened in place to prevent movement. The Contractor shall provide *details of* inlets and outlets on the shop drawings. (e) Grout Grout shall be Class C as described in Table 10.9.3-1 and the properties as described in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specification. *In addition to the requirements noted in tables, a test for wet density shall also be performed in accordance with the "Standard Method for Density" ASTM C138. Prebagged grouts shall be packaged in plastic lined bags or coated containers, stamped with the date of manufacture, lot number and mixing instructions. Copies of the quality control data for each lot number and shipment sent to the job site shall be provided to the Consultant for review. Materials with a total time from manufacture to usage in excess of six months shall be retested and certified by the supplier before use, or shall be removed from the job site and replaced.* The average minimum compressive strength of 3 cubes at 28 days shall be a minimum of *50* MPa as per CSA A23.2-1B. *The results for bleed test and fluidity test shall meet the requirements noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications.* The Contractor is responsible to perform all grout testing *in the field* at his cost *and he shall ensure that the testing is witnessed by the Consultant*. The frequency of grout testing shall be as follows: *Strength Test* Precast Concrete Girders: One strength test per girder line Cast-In-Place Girders: One strength test for every four longitudinal ducts

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	Bleed Test *At the beginning of each day's grouting operation, perform a wick induced bleed test in accordance with ASTM C 940 and with modifications noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications.* *Fluidity Test* *At the inlet and outlet, perform fluidity test in accordance with the standard ASTM C 939 flow cone test or the modified ASTM C 939 test.* *Wet Density Test* *Perform wet density test in accordance with American Petroleum Institute Mud Balance Test API Practice 13B-1" "Standard Procedures for Field Testing Water-Based Drilling Fluids".*
7.3.12.7 Construction (d) Concreting The anchorage recesses shall be concreted after tensioning but before grouting the tendons. The concrete surface of the anchorage recesses shall be abrasive blasted. The recesses shall be thoroughly wetted and covered with a thin cement paste coating immediately before placing fresh concrete. (e) Grouting The pumping pressure at the injection vent shall not exceed 1 MPa. If the actual pressure exceeds the maximum allowed, the injection vent shall be closed and the grout shall be injected at the next vent that has been or is ready to be closed as long as one way flow is maintained. Grout shall not be injected a succeeding vent from which grout has not yet flowed. A fluidity test shall be performed on each tendon from the discharge outlet. The measured grout efflux time shall not be faster than the efflux time measured at the inlet or the minimum efflux time established. If the grout efflux time is not	7.3.12.7 Construction (d) Concreting The anchorage recesses shall be concreted after tensioning but before grouting the tendons. The concrete surface of the anchorage recesses shall be abrasive blasted. The recesses shall be thoroughly wetted and covered with a thin cement *scrub coat* immediately before placing fresh concrete. (e) Grouting *Normal pumping pressure shall be between 0.1 MPa to 0.4 MPa measured at the inlet.* The pumping pressure at the injection vent shall not exceed 1 MPa. If the actual pressure exceeds the maximum allowed, the injection vent shall be closed and the grout shall be injected at the next vent that has been or is ready to be closed as long as one way flow is maintained. Grout shall not be injected a succeeding vent from which grout has not yet flowed. *For each tendon, immediately after uncontaminated uniform grout discharge begins, a* fluidity test shall be performed. The measured grout efflux time shall not be faster than the efflux time measured at the inlet or the minimum efflux time established. If the grout efflux time is not

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acceptable, additional grout shall be discharge from the discharge outlet. Grout efflux time shall be tested. This cycle shall be continued until acceptable grout fluidity is achieved. To ensure the tendon remains filled with grout, the ejection and injection vents shall be closed in sequence, respectively under pressure when the tendon duct is completely filled with grout. Valves and caps are not to be removed until the grout has set. Grouting will not be permitted when the air temperature is below 5°C or above 25°C, nor when there are other conditions judged by the Consultant to be detrimental to the grouting operations.	acceptable, additional grout shall be *discharged* from the discharge outlet. Grout efflux time shall be tested. This cycle shall be continued until acceptable grout fluidity is achieved. *In addition to fluidity test, check the grout density using the Wet Density Method. The density at the final outlet shall not be less than the grout density at the inlet.* To ensure the tendon remains filled with grout, the ejection and injection vents shall be closed in sequence, respectively under pressure when the tendon duct is completely filled with grout. Valves and caps are not to be removed until the grout has set. Grouting will not be permitted when the air temperature is below 5°C or above 25°C, nor when there are other conditions judged by the Consultant to be detrimental to the grouting operations. *Check grouted tendons in accordance with AASHTO LRFD Bridge Construction Specifications to ensure no leakage exist. If leaks are present, the Contractor shall submit, a proposed method of repair for review and acceptance by the Consultant and the Department.*
7.4 Payment Payment for the **Supply of Girders** will be made on the basis of the unit prices bid, and in accordance with Section 7.2.7, "Failure to Meet Strength Requirements". The unit prices bid shall include full compensation for the cost of furnishing all materials, labour, tools, equipment and incidentals necessary for fabrication.	**7.4 Payment** Payment for the **Supply of Girders** *and associated material* will be made on the basis of the unit prices bid, and in accordance with Section 7.2.7, "Failure to Meet Strength Requirements". The unit prices bid shall include full compensation for the cost of furnishing all materials, labour, tools, equipment and incidentals necessary for fabrication.
Standard Drawing S-1637-97 Type 1c Sealer for Precast Girders	Standard Drawing S-1637-97 Type 1c Sealer for Precast Girders Revision 3 - Sealer note revised
Section 8 Concrete Slope Protection	
Standard Drawing S-1409-99 Concrete Slope Protection	Standard Drawing S-1409-99 Concrete Slope Protection Revision 5 - Cut-off wall revised.
Section 10 Heavy Rock Riprap	
10.3 Rock Material The rock supplied shall be hard, durable and angular in shape…unit weight of the rock is 2.5 t/m^3.	**10.3 Rock Material** The rock supplied shall be hard, durable and angular in shape…unit weight of the rock is 2.5 t/m^3.

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The Contractor shall provide the Consultant with evidence of the acceptability of the riprap material. Reliable performance records of proposed material, other than fieldstone, will be considered evidence of acceptability. Fieldstone shall be considered to have a reliable performance record, and will be accepted if it meets the gradation requirements.	The Contractor shall provide the Consultant with evidence of the acceptability of the riprap material. Reliable performance records of proposed material, other than fieldstone, will be considered evidence of acceptability. *Angular fieldstone* shall be considered to have a reliable performance record, and will be accepted if it meets the gradation requirements.
Section 11 Ducts and Voids	
11.2 Material All utility ducts and voids, and accompanying hardware, to be incorporated in or erected on the structure, shall be supplied by the Contractor and meet the acceptance of the appropriate electrical code and standard.	**11.2 Material** All utility ducts and voids, *fittings* and accompanying hardware, to be incorporated in or erected on the structure, shall be *rigid PVC type DB2 meeting the requirements of CSA C22.2 No. 211.1 and in accordance with the Rules of the Canadian Electrical Code, Part I. Coupling shall be solvent bell ends (SBE). Rigid conduit shall be bent only with a standard conduit bender.* *Expansion assemblies shall be Scepter type 'O' ring expansion joints or approved equivalent.*
11.2 Material All utility ducts and voids, and accompanying hardware, to be incorporated in or erected on the structure, shall be supplied by the Contractor and meet the acceptance of the appropriate electrical code and standard.	**11.2 Material** All utility ducts and voids, fittings and accompanying hardware, to be incorporated in or erected on the structure, shall be *rigid PVC type DB2 meeting the requirements of CSA C22.2 No. 211.1 and in accordance with the Rules of the Canadian Electrical Code, Part 1. Coupling shall be solvent bell ends (SBE). Rigid conduit shall be bent only with a standard conduit bender.* *Expansion assemblies shall be Scepter type 'O' ting expansion joints or approved equivalent.*
11.3 Installation The various components shall be erected or placed in the locations shown on the drawings. Rigid conduit shall be bent only with a standard conduit bender.	**11.3 Installation** The various components shall be erected or placed in the locations shown on the drawings.

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Section 12 Bridgerail	
12.2 Supply and Fabrication None	**12.2 Supply and Fabrication** *A pre-fabrication meeting is required prior to commencement of fabrication of bridgerail. The meeting will be held at fabricator's plant and the Contractor shall ensure the plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Department/ Consultant will conduct this meeting after the shop drawings have been approved and welding procedures have been reviewed. The Contractor shall provide one week notice to the Department/Consultant prior to the meeting.*
12.2.5.1 Filler Metals Low hydrogen fillers, fluxes and welding practices shall be used throughout. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filled wires in the submerged arc process or shielding gas processes will not be permitted. Metal core welding process utilizing low hydrogen consumables with AWS designation of H4 is allowed. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to base metal.	12.2.5.1 Filler Metals Low hydrogen fillers, fluxes and welding practices shall be used throughout. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filled wires in the submerged arc process or shielding gas processes will not be permitted. Metal core welding process utilizing low hydrogen consumables with AWS designation of H4 is allowed. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to base metal. *Field application of metal core arc welding is not allowed.*
12.2.6 Fabrication Fabrication shall be performed in an enclosed area which is adequately heated.	12.2.6 Fabrication Fabrication shall be performed in *a fully* enclosed area which is adequately heated *to be at least 10 ℃.*
12.2.6.4 Anchor Bolts The threaded ends of all anchor bolts shall be chamfered. All anchor bolts, hardware and anchor bolt template shall be hot dip galvanized, after fabrication in accordance with CSA G164. Nuts shall freely spin on the bolt threads after galvanizing. The anchor bolts shall be shop assembled in cages after galvanizing with bolts aligned square and	12.2.6.4 Anchor Bolts The threaded ends of all anchor bolts shall be chamfered. All anchor bolts, hardware and anchor bolt template shall be hot dip galvanized, after fabrication in accordance with *ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*. Nuts shall freely spin on the bolt threads after galvanizing. The anchor bolts shall be shop assembled in cages after galvanizing with bolts aligned square and plumb.

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plumb. Alignment nuts shall not exceed 16 mm in thickness.	Alignment nuts shall not exceed 16 mm in thickness.
12.2.6.7 Galvanizing Galvanizing shall be by the hot dip method after fabrication, in accordance with the current edition of CSA Standard G164 with additions and exceptions as described in this specification.	12.2.6.7 Galvanizing Galvanizing shall be by the hot dip method after fabrication, in accordance with the current edition of *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware* with additions and exceptions as described in this specification.
12.3 Erection … The method of forming and pouring the grout shall be submitted to the Consultant for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted. Sealer shall be applied to the exposed grout pad surfaces in accordance with Section 4.25 of the specifications for "Cast-In-Place Concrete".	**12.3 Erection** … The method of forming and pouring the grout shall be submitted to the Consultant for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted. *All structural bolts shall be tightened by using turn of nut method as specified in 6.3.2.7.* Sealer shall be applied to the exposed grout pad surfaces in accordance with Section 4.25 *"Type 1c Sealer"*.
Section 13 Miscellaneous Iron	
Standard Drawing S-1617-04 Standard Large Bridge Plaque Casting Details	Standard Drawing S-1617-04 Standard Large Bridge Plaque Casting Details Revision 2 – General note added.
Section 14 Guardrail	
14.2.1.3 Sheet Width … All rails and terminal elements shall be hot dip galvanized after fabrication conforming to the current edition of CSA G164.	14.2.1.3 Sheet Width … All rails and terminal elements shall be hot dip galvanized after fabrication conforming to the current edition of *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*.
14.2.2 Bolts, Nuts and Washers All bolts, nuts and washers shall conform to ASTM A307, unless noted	14.2.2 Bolts, Nuts and Washers All bolts, nuts and washers shall conform to ASTM A307, unless noted

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otherwise on the drawings, and shall be hot dip galvanized conforming to the current edition of CSA G164.	otherwise on the drawings, and shall be hot dip galvanized conforming to the current edition of *ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.*
14.2.4 Steel Posts Steel for posts, spacers and hardware shall conform to CSA Standard G40.21 Grade 350W or ASTM Standard A36 and shall be hot dip galvanized after fabrication conforming to CSA G164M.	14.2.4 Steel Posts Steel for posts, spacers and hardware shall conform to CSA Standard G40.21 Grade 350W or ASTM Standard A36 and shall be hot dip galvanized after fabrication conforming to *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*.
14.4 Installation Excavated material which is unsuitable for use as backfill… None.	**14.4 Installation** Excavated material which is unsuitable for use as backfill… *Any guardrail material requiring field modification to fit shall be reported to the Department and Consultant for their acceptance of the modification method use before work to be carried out. Modification by flame cutting method is prohibited. Modification by cold cutting method with a suitable drill press is allowed. Field guardrail modification is considered incidental to the work. Adequate edge distances of guardrail material shall be maintained during the modification process. All exposed steel areas shall be patched with two coats of zinc rich paint.*
Section 16 Bridge Deck Waterproofing	
16.1 General This specification shall include the supply and installation of an approved waterproof asphaltic membrane. The area to be covered by the waterproofing shall be as shown on the drawings, or as determined by the Consultant.	**16.1 General** This specification shall include the supply and installation of an approved waterproof asphaltic membrane. The area to be covered by the waterproofing shall be as shown on *the site specific construction drawings. The work shall be completed in accordance with standard drawing S-1443 "Deck Waterproofing System with 80mm Two-Course Hot-Mix Asphalt Concrete Pavement".*
16.2 Materials All materials for this application shall be reviewed and accepted by the Consultant. Tack Coat The tack coat used in conjunction with the asphalt membrane shall be	**16.2 Materials** All materials for this application shall be reviewed and accepted by the Consultant. Tack Coat The tack coat used in conjunction with the asphalt membrane shall be

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primer, cut back with an equal volume of gasoline type solvent, or an acceptable alternative cut-back asphalt product and be compatible with the asphalt membrane.	primer, cut back with an equal volume of gasoline type solvent, or an acceptable alternative cut-back asphalt product and be compatible with the asphalt membrane.
Asphalt Membrane Asphalt membrane shall be hot applied rubberized asphalt and shall be supplied in cakes ready for melting and application.	Asphalt Membrane Asphalt membrane shall be hot applied rubberized asphalt and *meet all requirements of the Ontario Ministry of Transportation's OPSS 1213 Specification. The asphalt membrane* shall be supplied in cakes ready for melting and application.
Rubber Membrane The rubber membrane shall be 1.2 mm thick butyl rubber.	Rubber Membrane The rubber membrane shall be 1.2 mm thick butyl rubber.
None	*Membrane Reinforcing Fabric* *Membrane reinforcing fabric shall be spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points. The membrane shall be supplied in minimum widths of 300 mm. The performance of the material shall be unaffected by the heat generated by the waterproofing processes.*
None	*Wick Drain* *Wick drain shall be composite polypropylene with a total thickness of 3.6 mm and supplied in 100 mm widths. The puncture strength shall be a minimum of 45 N measured in accordance with ASTM D4833. The performance of the material shall be unaffected by the heat generated by the waterproofing processes.*
Waterproofing Protection Board The protection board shall be a durable panel of 3 mm thickness specifically designed to provide a protective cushion between the hot mix asphaltic concrete pavement and the asphalt waterproofing membrane. It shall have a water absorption property of 5% or less and shall meet the Ontario Ministry of Transportation and Communications Material Specification for Protection Board.	Waterproofing Protection Board The protection board shall be a durable panel of 3 mm thickness specifically designed to provide a protective cushion between the hot mix asphaltic concrete pavement and the asphalt waterproofing membrane. It shall have a water absorption property of 5% or less and shall meet the Ontario Ministry of Transportation Specification *OPSS 1215* for Protection Board.
16.4.5 Waterproofing of Joints and Cracks Special attention shall be paid to waterproofing over all construction joints, and over cracks designated by the Consultant that would not be bridged by the asphalt membrane.	16.4.5 Waterproofing of Joints and Cracks Special attention shall be paid to waterproofing over all construction joints, *lift hook pockets, patches* and cracks. Prior to the application of the hot asphalt membrane to the deck, a coat of

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Prior to the application of the hot asphalt membrane to the deck, a coat of hot asphalt membrane at least 4 mm thick and wide enough to extend 200 mm on either side of the joint or crack shall be applied in accordance with Section 16.4.7 below, to the tack-coated concrete surface. A strip of butyl rubber membrane material wide enough to extend 150 mm on either side of the joint or crack shall be applied while the asphalt membrane is still hot. Along all curbs, barrier walls, and deck drains the hot asphalt membrane shall be applied to the height of the top of the hot mix surface course, and 150 mm onto the deck. The rubber membrane shall extend 40 mm up the vertical faces and 110 mm onto the deck surface.	hot asphalt membrane at least 4 mm thick and wide enough to extend 200 mm on either side of the joint or crack shall be applied in accordance with Section *16.4.6*, to the tack-coated concrete surface. A strip of membrane reinforcing fabric material wide enough to extend 150 mm on either side of the construction joint, *lift hook pocket, patch or crack shall be applied while the asphalt membrane is still hot and tacky. Membrane reinforcing fabric shall be overlapped 100 mm when multiple strips are used.* *Along all curbs, barrier walls, and deck drains the hot asphalt membrane shall be applied to the height of the top of the hot mix ACP surface course, and 150 mm onto the deck. The butyl rubber membrane shall extend 50 mm up the vertical face, 100 mm onto the deck surface, and overlapped 100 mm when multiple strips are used. The rubber membrane shall be applied while the asphalt membrane is still hot and tacky.*
16.4.7 Application of Asphalt Membrane Cakes of asphalt membrane … recommended by the Manufacturer. Membrane shall not be applied until…any joints lapped 150 mm. The membrane shall be applied over all waterproofed joints and cracks, and shall extend up the face of curbs, median, barrier walls, and deck drains, to the height of the top of the hot mix surface course. Deck drains and drainage tubes shall not be plugged.	16.4.*6* Application of Asphalt Membrane Cakes of asphalt membrane … recommended by the Manufacturer. Membrane shall not be applied until…any joints lapped 150 mm. The membrane shall be applied over all waterproofed joints and cracks, and shall extend up the face of curbs, barrier walls, and deck drains, to the height of the top of the hot mix surface course. Deck drains and drainage tubes shall not be plugged.
None	*16.4.7 Installation of Wick Drain* *Wick drains shall be placed along the full length of gutters and installed when the asphalt membrane is still hot and tacky. Special attention shall be given to waterproofing and wick drain modifications at deck drain pipe locations. Wick drain details shall be in conformance with standard drawing S-1443.*
16.4.8 Application of Protection Board The Contractor shall check and ensure that the asphalt membrane thickness conforms to the specified requirement, prior to placing the protection board. Protection boards shall be laid on the asphalt membrane, while the membrane is still hot, with the length of the board running transversely, on the deck. The protection boards shall be	16.4.8 Application of Protection Board The Contractor shall check and ensure that the asphalt membrane thickness conforms to the specified requirement, prior to placing the protection board. Protection boards shall be laid on the asphalt membrane, while the membrane is still hot, with the length of the board running transversely, on the deck. The protection boards shall be placed with

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placed with edges overlapping 25 mm to maximum of 25 mm both longitudinally and transversely. The protection board edge shall be within 5 mm of all curbs, drain verticals, and deck joint verticals.	edges overlapping *minimum 12 mm to maximum of* 25 mm both longitudinally and transversely. The protection board edge shall be within 5 mm of all curbs, drain verticals, and deck joint verticals.
16.5 Sampling and Testing The Consultant may require that sufficient quantities of the asphalt membrane, rubber membrane, and protection board be supplied from the materials being used on the project for immediate analysis, flow tests, water absorption, or for other future testing purposes.	**16.5 Sampling and Testing** The Consultant may require that sufficient quantities of the asphalt membrane, rubber membrane, *membrane reinforcing fabric* and protection board be supplied from the materials being used on the project for immediate analysis, flow tests, water absorption, or for other future testing purposes.
16.6.1 Hot Applied Rubberized Asphalt Membrane - "Bakor" 790-11 - "Tremproof" 150 - "Permaquick 6100" W.I. 250 - " Hydrotech 6125" - "Beamalastic 1213 BDM"	16.6.1 Hot Applied Rubberized Asphalt Membrane - "Bakor" 790-11 - "Beamalastic 1213 BDM" - *"Ultraseal 3750"*
None	*16.6.3 Membrane Reinforcing Fabric* *- "Remay 2016"* *-"Bakor Polyester Fabric"*
None	*16.6.4 Wick Drain* *- "Nilex MD/7407"* - "Amerdrain 407"
16.6.3 Waterproofing Protection Board	16.6.*5* Waterproofing Protection Board
Standard Drawing S-1443-98 Deck Waterproofing System with 80mm Two-Course Hot-mix Asphalt Concrete Pavement **This drawing is located elsewhere not in this spec book.**	Standard Drawing S-1443-98 Deck Waterproofing System with 80mm Two-Course Hot-mix Asphalt Concrete Pavement Revision 7 – Membrane reinforcing fabric added.

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Section 17 Asphalt Concrete Pavement	
17.7.5.1 General The mixture shall be placed only upon a dry, unfrozen substrate on which the tack coat has cured, and under weather and temperature conditions acceptable to the Consultant. Prior to the delivery of the mixture on the work, the base shall be cleaned of all loose or foreign material. The mixture shall be spread and compacted during daylight hours only, unless artificial light satisfactory to the Consultant is provided.	17.7.5.1 General The mixture shall be placed only upon a dry, *frost free* substrate on which the tack coat has cured and under weather and temperature conditions acceptable to the Consultant. Prior to the delivery of the mixture on the work, the base shall be cleaned of all loose or foreign material. The mixture shall be spread and compacted during daylight hours only, unless artificial light satisfactory to the Consultant is provided.
Section 18 Supply and Construction of CSP and SPCSP Structures	
18.2.1 Standards The supply and fabrication of all galvanized, polymer coated and aluminum coated Corrugated Steel Pipe including couplers and appurtenances and Structural Plate Corrugated Steel Pipe shall be in accordance with the current edition of CSA Standard G401 with additions and exceptions as described in this specification. When specifying Double Zinc SPCSP & CSP, the zinc coating mass (total on both sides) shall be not less than 1220 g/m2 when tested by the triple spot test. The zinc coating mass shall be not less than 1100 g/m2 when tested by single spot test. The Double Zinc coating for SPCSP shall only be applied to base metal thickness of 4.0 mm and greater.	18.2.1 Standards The supply and fabrication of all galvanized, polymer coated and aluminum coated Corrugated Steel Pipe including couplers and appurtenances and Structural Plate Corrugated Steel Pipe shall be in accordance with the current edition of CSA Standard G401 with additions and exceptions as described in this specification. Deleted.
None 18.3.1 Excavation 18.3.2 Bedding 18.3.3 Assembly 18.3.4 Backfilling	*18.3.1 Care of Water* *The Contractor shall be responsible to make adequate provisions for handling water in and around the construction site. Care of water will be considered incidental to the work and no separate or additional payment will be made.* 18.3.*2* Excavation 18.3.*3* Bedding 18.3.*4* Assembly 18.3.*5* Backfilling

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…	…
When water jetting methods are used, water jetting shall proceed on a 300 mm pattern measured along the longitudinal axis of the structure for its entire length, and at a 300 mm pattern perpendicular to the structure for a distance of 1000 mm. The Consultant may recommend a more concentrated pattern if all voids adjacent to the structure are not filled. Equipment for water jetting shall provide a maximum nozzle pressure of 550 kPa. When the air temperature is below 0EC, water jetting will not be permitted, and backfilling may only proceed under the inspection of the Consultant, providing the backfill materials are in a thawed state when excavated, placed and compacted.	Deleted
18.3.5 Strutting for Composite Concrete/SPCSP Structure	18.3.*6* Strutting for Composite Concrete/SPCSP Structure
Section 20 Deck Overlay and Concrete Rehabilitation	
20.5.3 Longitudinal Overlay Construction Joints	20.5.3 Longitudinal *and Transverse* Overlay Construction Joints
The Contractor shall construct an approved bulkhead at the construction joint location which will maintain horizontal and vertical alignments during concrete placing and finishing. The resulting vertical face of concrete shall be sandblasted in conformance to 20.3.4 of the specifications. The sandblasting at the vertical face is considered to be incidental and no extra payment will be made.	The Contractor shall construct an approved bulkhead at the construction joint location which will maintain horizontal and vertical alignments during concrete placing and finishing. The resulting vertical face of concrete shall be sandblasted in conformance to 20.3.4 of the specifications. The sandblasting at the vertical face is considered to be incidental *to the work* and no extra payment will be made.
All longitudinal and transverse construction joints shall be sealed by applying gravity feed epoxy Capweld 524 or approved equal. The Contractor shall sawcut along the joint to a depth of 25 mm below the surface. Sandblasting and air blow cleaning are required to remove all sand, dust, water and other contaminants prior to gravity filling the sawcut with the epoxy.	*For* longitudinal and transverse construction joints, *the top edge of the overlay concrete at faces of curbs, barriers, medians, previously placed overlay concrete or existing concrete shall be tooled to a depth of 12 mm and a width of 6 mm. The tooled groove shall be filled with a gravity flow epoxy listed in the following Alberta Transportation website path: Alberta Transportation Product List/Crack Treatment/Concrete Crack Filler/ Proven. Prior to installation, the contact concrete surfaces shall be blown clean to remove all deleterious materials and prepared in accordance with the manufacturer's recommendations. The tooled groove shall be full of epoxy material upon completion of the work and may require subsequent applications for maximum penetration. The creation of the tooled groove and the application of the gravity flow epoxy is considered incidental to the work and no extra payment will be made.*

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Section 22 Painting	
22.2 Standards Alberta Infrastructure and Transportation BRIDGE COATING SYSTEM (APPROVED PRODUCTS) are available on the internet at: http://www.infratrans.gov.ab.ca/INFTRA_Content/docType253/Production/BRCOATING.pdf	**22.2 Standards** Alberta Transportation APPROVED PRODUCTS – Bridge Coating Systems (Paint) are available on the internet at: ***http://www.transportation.alberta.ca/Content/docType253/Production/paintlist.pdf***
22.6.3 Fish Habitat When working on structures over water inhabited by fish the Contractor shall conform to the requirements of the Alberta Fish and Wildlife Services "Fishery Habitat Protection Guidelines". The Contractor shall ensure that deleterious material does not enter into waters frequented by fish.	22.6.3 Fish Habitat When working on structures over water inhabited by fish the Contractor shall conform to the *requirements of the Alberta Transportation "Fish Habitat Manual". This manual is available on the internet at:* ***http://www.transportation.alberta.ca/Content/docType245/Production/Complete_Fish_Habitat_Manual.pdf***
22.7 Permits The Contractor shall obtain the necessary permits and approvals, and conform to all requirements of Environmental Screening Reports, Municipal bylaws, Provincial and Federal Environmental Protection laws, for all work carried out. The Contractor shall be familiar with and comply with all regulations, such as, but not limited to, Environmental permits, the Worker's Compensation Act, Workplace Safety and Insurance Act and the Occupational Health and Safety Act, Regulation and Code which control the exposure of workers to chemical hazards.	**22.7 Permits*, Licences and Approvals*** The Contractor shall obtain the necessary permits, *licences* and approvals, and conform to all requirements of Environmental Screening Reports, Municipal bylaws, Provincial and Federal Environmental Protection laws, for all work carried out. The Contractor shall be familiar with and comply with all regulations, such as, but not limited to, Environmental permits, the Worker's Compensation Act, Workplace Safety and Insurance Act and the Occupational Health and Safety Act, Regulation and Code which control the exposure of workers to chemical hazards.

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Section 24 Sign Structures and Panels	
24.2.1.1 Design Standards … … AASHTO equation 3-1, Clause 3.8.1, shall be modified as follows: Pz = 2.7 q Kz Cd where q shall be taken from CAN/CSA S6-00, Table A3.1.7 for a return period of 50 years. The design ice thickness for ice accretion shall be the value given in CAN/CSA S6-00 Figure A3.1.4.	24.2.1.1 Design Standards … … AASHTO equation 3-1, Clause 3.8.1, shall be modified as follows: Pz = 2.7 q Kz Cd where q shall be taken from CAN/CSA S6-*06*, Table *A3.1.1* for a return period of 50 years. The design ice thickness for ice accretion shall be the value given in CAN/CSA S6-*06* Figure A3.1.4.
24.2.1.2 Design Notes and Drawings … (b) Design criteria meeting the requirements of Section 24.2.1.1, for each individual sign structure, including: • AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" 4th Edition and 2002 Interims • Initial sign panel area and/or minimum design sign panel area • Design wind pressure • Fatigue category and fatigue loadings • Design ice thickness • Other dead loads • Design temperature range • Foundation soils parameters • Critical anchor bolt forces	24.2.1.2 Design Notes and Drawings … (b) Design criteria meeting the requirements of Section 24.2.1.1, for each individual sign structure, including: • AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" *latest* Edition and Interims • Initial sign panel area and/or minimum design sign panel area • Design wind pressure • Fatigue category and fatigue loadings • Design ice thickness • Other dead loads • Design temperature range • Foundation soils parameters • Critical anchor bolt forces
24.2.2.5 Welding (1) **Filler Metals** Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout…The deposited weld metal shall provide strength,	24.2.2.5 Welding (1) **Filler Metals** Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout... The deposited weld metal shall provide strength,

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durability, impact toughness and corrosion resistance equivalent to base metal. … (6) **Run-off Tabs** Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.	durability, impact toughness and corrosion resistance equivalent to base metal. *Field application of metal core arc welding is not allowed.* *…* (6) **Run-off Tabs** Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. *The tabs shall be a minimum of 100 mm long unless greater length is required for satisfactory work.* They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.
24.2.2.6 Fabrication Fabrication shall be performed in an enclosed area which is adequately heated. Field welding will not be allowed. (1) **Pre-job Meeting** Prior to commencement of fabrication, a pre-job meeting will be conducted by the Consultant. This meeting will be conducted after the shop drawings have been accepted. The Contractor shall ensure the plant superintendent, plant manager responsible for the work and any manufacturer's representative directly involved in the specialized work are in attendance. (2) **Cutting of Plate** All plate material for main members and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing is not allowed. … (4) **Additional Requirements** … (7) **Galvanizing** Galvanizing shall be by the hot dip method, after fabrication, in	24.2.2.6 Fabrication Fabrication shall be performed in *a fully* enclosed area which is adequately heated. *The shop temperature shall be at least 10 ℃.* Field welding will not be allowed. (1) **Pre-job Meeting** *A pre-fabrication meeting is required prior to commencement of fabrication of sign structures. The meeting will be held at fabricator's plant and the Contractor shall ensure the plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Department/Consultant will conduct this meeting after the shop drawings have been approved and welding procedures have been reviewed. The Contractor shall provide two weeks notice to the Department/Consultant prior to the meeting.* (2) **Cutting of Plate** All plate material for main members and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing is not allowed. *Corners of plates and structural sections shall be ground to a 1 mm chamfer.*

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accordance with the current edition of CSA Standard G164 with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing. Lumps, globules or heavy deposits of zinc will not be permitted. All threaded holes or threaded couplings shall be retapped after galvanizing.	… (4) **Additional Requirements** *(k) Stiffeners are not allowed on column to base plate and member to flange plate connections.* *…* (7) **Galvanizing** Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware* with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing. Lumps, globules or heavy deposits of zinc will not be permitted. All threaded holes or threaded couplings shall be retapped after galvanizing.
24.2.2.7 Testing and Inspection (3) **Testing by the Consultant** The visual, radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Consultant or by his testing agencies at the Consultant's expense.	24.2.2.7 Testing and Inspection (3) **Testing by the Consultant** The *Consultant will perform visual inspection. Any additional NDT; such as* radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Consultant or by his testing agencies at the Consultant's expense.
24.2.4 Foundation … (5) **Grouting in Cold Weather** When the daily minimum air temperature, or the temperature of the girders, bearings or substructure concrete, in the immediate area of the grouting, falls below 5℃, the following provisions for cold weather grouting shall be effected: (a) Before grouting, adequate preheat shall be provided to raise the temperature of the substructure concrete to at least 10℃.	24.2.4 Foundation … *(5) **Protection of Sign Structures*** *The Contractor shall erect the sign structure in a manner that addresses all safety issues including the interim period between erection, grouting and post-tensioning.* *After erection of sign structure, the Contractor shall place grout pockets and pads and post tension anchor bolts as soon as possible. However the Contractor shall provide adequate safe traffic accommodation until post*

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(b) Temperature of the grout during placing shall be between 10℃ and 25℃. (c) The grout pads shall be enclosed and kept at 10℃ to 25℃ for at least five days. The system of heating shall be designed to prevent excessive drying out of the grout. (6) **Clean-Up** All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.	*tensioning and grouting is complete*. (*6*) **Grouting in Cold Weather** When the daily minimum air temperature, or the temperature of the girders, bearings or substructure concrete, in the immediate area of the grouting, falls below 5℃, the following provisions for cold weather grouting shall be effected: (a) Before grouting, adequate preheat shall be provided to raise the temperature of the substructure concrete to at least 10℃. (b) Temperature of the grout during placing shall be between 10℃ and 25℃. (c) The grout pads shall be enclosed and kept at 10℃ to 25℃ for at least five days. The system of heating shall be designed to prevent excessive drying out of the grout. (*7*) **Clean-Up** All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

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Section 25 Mechanical Stabilized Earth Walls	
None	***25.1 General*** *This specification is for the design, supply, fabrication and construction of mechanically stabilized earth (MSE) retaining walls with precast concrete facing panels. MSE retaining walls shall include, but not be limited to, excavation for the wall, concrete leveling pads, precast concrete panels, compacted granular backfill, soil reinforcement, perforated drain pipe complete with filter fabric sock, surface drains, cast-in-place concrete wall coping, traffic barrier, pedestrian railing, permanent safety railing or fence, hardware and all associated materials.* *MSE retaining walls shall be designed and constructed in accordance with the provisions contained herein and as determined by the Department and the Consultant.* *The Contractor shall supply all necessary materials. All components of the MSE wall system shall be supplied from one MSE supplier.* ***25.2 Design*** *25.2.1 Design Requirements* *Location, layout, geometry control, global stability and allowable bearing capacity requirements shall be as specified in the contract documents. The Contractor's design responsibility shall include internal stability and all elements for a complete MSE wall system.* *The most stringent requirements of the current version of the following standards shall be met:* • *CAN/CSA S6 – Canadian Highway Bridge Design Code* • *AASHTO LRFD Bridge Design Specifications* • *Alberta Transportation Bridge Structures Design Criteria* • *Alberta Transportation Roadside Design Guide Section H7.6* *The design life for all MSE wall components shall be 100 years.* *Highway and bridge surface drainage shall be controlled and channeled away from the back of the MSE walls and mechanically stabilized earth mass.* *Weeping drains consisting of perforated 150 mm diameter pipe complete with filter sock shall be provided near the front and the back bottom corner of the mechanically stabilized earth mass. The weeping drains shall be day lighted or connected for positive drainage. A water level within the mechanically stabilized earth mass shall be assumed to be at the invert level of the weeping drains.*

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	MSE walls with traffic running parallel to the top of the wall shall have rigid bridge barriers meeting the requirements of CHBDC Section 12. Such bridge barriers shall be located on top of the MSE walls and supported on the moment slab to resist sliding and overturning. Flexible guardrail systems shall not be used. All obstacles, such as sign supports and lighting posts, mounted on top of the barriers shall meet set-back and clearance requirements specified in the Roadside Design Guide. The MSE wall design shall account for all load effects from such accessories. *Water carrying appurtenances, such as catch basins, drainage inlets/outlets, culverts etc., shall preferably be placed away from, or close to the end of the soil reinforcement zone, and provisions shall be made to mitigate the detrimental effects of potential leakage.* *Obstructions such as foundation piles and associated casings, or casings for future pile installations in the soil reinforcement zone, shall be accommodated with appropriate arrangement of soil reinforcing around such obstructions. For those MSE wall systems that lend themselves to splaying of the soil reinforcement, the splay angle shall not exceed 20^{o} from the perpendicular of the facing panel. For other MSE wall systems, coverage ratios of soil reinforcement shall be specifically developed for each project.* *Pedestrian railing and permanent safety railing or fence may be mounted on top of MSE wall coping.* *Minimum precast concrete panel thickness shall be 140 mm, excluding any additional thickness required for aesthetic surface treatment. Minimum cover to reinforcing steel shall be 50 mm on both the front and back faces.* *Precast concrete panels shall be designed to accommodate a differential settlement of 100 mm in 10 metres of length along the wall. The spacing between adjacent panels shall be designed to be 20 mm nominal.* *Joints between panels should have a lip and recess (ship lap) configuration so that joint material is protected and overall aesthetics is enhanced. Butt joints may also be used if the Contractor can provide a backing board with sufficient strength and durability to meet 100 years life expectancy requirement.* *Acute corners less than 70° inside panels shall not be allowed.* *Special corner units shall be used when interior angle between adjacent panels is 130° or less.* *The top of the cast-in-place concrete wall coping shall be smooth and have no steps or abrupt changes in height.* *MSE wall panels shall be fully supported by compacted backfill without voids on the non-exposed*

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	side. *For stepped leveling pads, the maximum elevation difference between adjacent steps shall not exceed 1250 mm. The minimum length of each stepped section shall be 1500 mm.* *Where staged construction is required and large differential settlement is expected between stages, appropriately located full height vertical slip joints shall be provided.* *25.2.2 Submissions and Consultant Review* *Design notes and shop drawings shall be stamped, signed and sealed by a professional engineer, registered to practice in the Province of Alberta.* *Design notes shall be presented in a legible and logical format, and shall be sufficiently detailed to allow a technical review of design concepts and assumptions used in the design. Where necessary, the design package shall be accompanied by properties of materials used together with the appropriate test certificates.* *Shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. Each drawing shall have sufficient blank space for the Consultant's acceptance stamp.* *As a minimum, shop drawings shall contain:* • *Alberta Transportation bridge file number and project name on each drawing.* • *Design criteria and materials lists.* • *Wall layout plan and elevation complete with dimensions and elevations, and typical wall cross-sections.* • *All component and connection details.* • *Site drainage and drainage details.* *Two copies of the design notes and five copies of the shop drawings shall be submitted to the Consultant for review and acceptance at least three weeks in advance of scheduled fabrication.* *The design notes and shop drawings will be reviewed by the Consultant solely to ascertain conformance with codes and specifications. Responsibility of the final design remains solely with the Contractor. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions in the calculations and drawings or for the proper completion of the work in accordance with the Contract.* *After the Consultant's review, the Contractor shall revise the drawings and calculations as required to the satisfaction of the Consultant without any additional cost to the Department.* *Prior to commencing fabrication, all shop drawings shall be clearly signed by the Department's*

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	Consultant as verification that the Consultant has completed his review and accepted the Shop Drawings. *The Contractor shall incorporate as-built conditions and re-submit the revised design notes and shop drawings for records at the completion of construction.* ***25.3 Materials*** *25.3.1 Concrete Materials* *The fabrication of precast concrete panels shall conform to the requirements of Section 7 "Precast Concrete Units" of the Specifications for Bridge Construction. Any panel with crack exceeding 0.15 mm in width or 0.1 mm/m2 (of panel area) in length shall be rejected. The concrete for the panels shall be Class HPC, conforming to the requirements of Section 4.4 "Class and Composition of Concrete" of the Specifications for Bridge Construction, with the exception that maximum aggregate size shall be 14 mm. The concrete leveling pads and the MSE wall coping shall conform to the requirements of Section 4 "Cast-In-Place Concrete" of the Specifications for Bridge Construction. The concrete for the leveling pads shall be Class B and the concrete for the wall coping shall be Class HPC. Chamfered edges shall be created around the periphery of all precast facing panels. The exposed faces of the precast panels and the cast-in-place wall coping shall have a Class 2 finish.* *25.3.2 Concrete Reinforcing Materials* *Reinforcing steel is to be in accordance with Section 5 "Reinforcing Steel" of the Specifications for Bridge Construction.* *Reinforcing steel shall conform to CAN/CSA G30.18 Grade 400 deformed billet steel bars and be epoxy coated.* *25.3.3 Soil Reinforcing Materials* *Steel reinforcement shall be galvanized in accordance with the current edition of ASTM Standard A123/A123M. Geosynthetic reinforcing shall meet AASHTO LRFD Bridge Design Specifications Clause 11.10.6.4.3b. The requirements for "applications involving severe consequences of poor performance or failure" shall apply. Results of product specific durability studies carried out to determine the product-specific long term strength reduction factor (RF) shall be submitted for the Consultant's review and approval. These studies shall be used to estimate the short term and long term effects of the environment factors on the strength and deformational characteristics of the geosynthetic reinforcement throughout the specified design life.*

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Geosynthetic reinforcing materials shall satisfy the requirements of the following tests:

- *GG 1-87 "Standard Test Method for Geogrid Rib Tensile Strength"*
- *GG 2-87 "Standard Test Method for Geogrid Rib Junction Strength"*
- *GG 3-90 "Standard Test Method for Tensile Creep Testing of Geogrids"*
- *GG 4-05 "Standard Practice for Determination of the Long Term Creep Design Strengths of Geogrids"*

Geosynthetic reinforcing materials shall contain stabilizers or inhibitors to prevent degradation of properties due to ultraviolet light exposure.

25.3.4 Safety Rail Materials

Safety rail shall be fabricated in accordance with Section 12 "Bridgerail" of the Specifications for Bridge Construction.

25.3.5 Backfill Materials

The structural backfill shall be "Crushed Aggregate Material" meeting the requirements of the following table:

	Designation/Class		
Metric Sieve Size (CGSB 8-GP-2M)	***Crushed Aggregate Material Des 2 Class 20***	***Crushed Aggregate Material Des 2 Class 25***	***Crushed Aggregate Material Des 2 Class 40***
Sieve Size µm	***Percent Passing***	***Percent Passing***	***Percent Passing***
125 000			
80 000			
50 000			
40 000			*100*
125 000		*100*	*70 - 94*

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20 000	*100*	*82 - 97*	
16 000	*84 - 94*	*70 - 94*	*55 - 85*
10 000	*63 - 86*	*52 - 79*	*44 - 74*
5 000	*40 - 67*	*35 - 64*	*32 - 62*
1 250	*22 - 43*	*18 - 43*	*17 - 43*
630	*14 - 34*	*12 - 34*	*12 - 34*
315	*9 - 26*	*8 - 26*	*8 - 26*
160	*5 - 18*	*5 - 18*	*5 -18*
80	*2 - 10*	*2 - 10*	*2 - 10*
% fractures by weight (2 faces)	*60+*	*60+*	*50+*
Plasticity Index		*NP - 6*	*NP - 6*
L.A. Abrasion Loss Percent Maximum		*50*	*50*

**Note: For MSE wall systems consisting of geosynthetic soil reinforcement, the backfill Designation/Class should be chosen by the designer based on expected performance of the geosynthetic reinforcement.*

The physical properties of the structural granular backfill material selected by the Contractor shall be used by the MSE wall supplier in the design of the MSE walls. The selected structural granular backfill material shall also meet the following electrochemical parameters:

REQUIREMENTS FOR STEEL REINFORCING

Select Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
Resistivity	≥ 3000 ohm-cm	G57	T 288-91 I
pH	5 - 10	G51	T 289-91 I
Chlorides	≤ 100 ppm	G512	T 291-91 I
Sulphates	≤ 200 ppm	G516	T 290-91 I

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Organic Content	≤ 0.1%	D2974	N/A

REQUIREMENTS FOR GEOSYNTHETIC REINFORCING

Select Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
pH	3 - 12	G51	T 289-91 I
Organic Content	≤ 0.1%	D2974	N/A
Design Temperature at the Wall Site	≤ 30°C	N/A	N/A

In no case shall any backfill material placed within 2.0 m of the face panels have more than 5% passing the 0.75 mm sieve size.

25.3.6 Sealer Materials

Sealer shall be applied to the exposed concrete surfaces of the precast concrete panels and the cast-in-place wall coping in accordance with Section 4.25 "Sealer" of the Specifications for Bridge Construction.

25.3.7 Geotextile Filter Fabric

Non-Woven geotextile filter fabric shall be in accordance with the following table of minimum average roll value properties:

Non-Woven Geotextile Filter Fabric	
Specifications and Physical Properties	
Grab Strength	*650 N*
Elongation (Failure)	*50%*
Puncture Strength	*275 N*
Burst Strength	*2.1 MPa*
Trapezoidal Tear	*250 N*
Minimum Fabric Lap to be 300 mm	

25.4 Construction

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	The Contractor shall employ qualified personnel experienced in constructing MSE walls to complete this work. The MSE wall shall be installed in accordance with the supplier's recommendation. The supplier of the MSE wall system shall provide a qualified representative on site to advise the erection crew regarding construction procedures. The representative shall be present for a minimum of 25% of the time throughout the construction of all phases of MSE wall as determined by the wall supplier. *The construction of the MSE wall system shall conform to the details on the approved shop drawings.* *25.4.1 Conformance Criteria* *The Contractor shall provide formalized documentation, sealed and signed by the engineer, who is responsible for each of the following construction phases and prior to commencement of each subsequent construction activity:* • *Foundation base preparation* • *On-site delivery of all components* • *Alignment of precast wall panels as per contract requirements* • *Backfill material gradations and compaction requirements* *25.4.2 Excavation* *Excavation for the wall shall be carried out in conformance with Section 1 "Excavation" of the Specifications for Bridge Construction. Excavation shall be done to establish grades to within reasonably close conformity to the design grades and limits shown on the drawings and shop drawings. The foundation subgrade shall be proof rolled to identify any soft spots. Soft material shall be removed and replaced with compacted granular material to the satisfaction of the geotechnical consultant. Temporary excavation support as required shall be the responsibility of the Contractor. In addition, the Contractor shall establish the locations and extents of all underground services in the work area prior to commencement of work. All underground service locations shall be clearly marked and protected during the course of construction. All damages to existing services resulting from the Contractor's operations shall be repaired at the Contractor's expense.* *25.4.3 Backfill* *Backfill shall be in accordance with Section 2 "Backfill" of the Specifications for Bridge Construction and shall include the supply, placing and compaction required for construction of the MSE walls. Backfill placement shall closely follow erection of each course of panels. Backfill*

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	shall be placed in such a manner as to avoid any damage or disturbances of the wall materials or misalignment of the face panels. All wall materials that are damaged during backfill placement shall be removed and replaced at the Contractor's expense. Any misalignment or distortion of the face panels due to placement of backfill shall be corrected by the Contractor at his expense. *A minimum 300 mm wide strip of filter fabric shall be installed behind all face panel joints. An adhesive shall be used to hold the fabric securely against the panels.* *No equipment shall be allowed to run directly on the soil reinforcement. Backfill compaction shall be performed in such a manner that the compactor shall move in a direction parallel to the wall panels and work toward the end of the soil reinforcement away from the wall facing. Only hand operated power tampers and vibrators shall be used for compaction within 1000 mm of the wall panels. The Contractor shall slope the last level of backfill material away from the wall panels, at the completion of each day's work to direct potential run-off away from the wall face. In addition, the Contractor shall not permit any surface runoff from adjacent areas to enter the wall construction site.* *25.4.4 Precast Panel Tolerance* *Precast concrete panel manufacturing tolerances shall be as described in CSA A23.4. The tolerances after installation shall be:* *1. The flatness tolerance of wall surfaces measured in any direction shall not exceed 10 mm/m.* *2. The offset of adjacent panel edges at joints shall not exceed 10 mm.* *3. The variation of nominal joint gap shall not exceed 1.5 mm/m* *4. The overall vertical tolerance of the completed wall (top and bottom) shall not exceed 13 mm/3 m of wall height.* *Should any panels be out of tolerance, the backfill shall be removed and the panels reset to the proper tolerance.* *To facilitate construction of the cast-in-place concrete coping, nominal-sized, pre-formed holes in the precast panels are permitted providing the holes are located a minimum of 100 mm above the coping soffit.* *25.4.5 Material Storage* *The Contractor's lay-down area shall be level graded to ensure the panels are safely and uniformly supported on timber bearing blocks. Precast concrete panels shall be stacked on*

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	timber planks or pallets and separated by timber blocks as required by the precast design engineer. Soil reinforcing material and connectors shall be stored clear of the ground. All materials shall be covered and protected from rain, snow, dirt and ultraviolet light. The precast panels shall be stored such that the uniform color of the panels is maintained and protected from staining or discoloration. ***25.5 Payment*** *Measurement for payment for the design and construction of Mechanically Stabilized Earth Wall will be by lump sum price bid and shall include full compensation for design and construction including, but not limited to such items as all excavation, backfill and compaction below the MSE walls where required; all excavation, leveling pad construction, backfill and compaction within and beyond the MSE wall zone necessary for construction of the MSE wall; the supply and installation of precast concrete panels complete with epoxy coated reinforcing steel; cast-in-place concrete coping complete with epoxy coated reinforcing steel; soil reinforcement; sealer; drains; traffic barriers; the supply and installation of galvanized steel safety railing including anchor bolts and concrete swale at the top of the MSE wall; and all labour, material, equipment, tools and incidentals necessary to complete the Work.* *All costs associated with the design of the MSE wall will be considered incidental to the Work, and no separate or additional payment will be made.*