CONCRETE GENERAL REQUIREMENTS

1. GENERAL

1.1 Summary

.1 This Section specifies the concrete general requirements.

.2 Design and construct cast-in-place or precast concrete of appropriate properties for the intended use in accordance with the Final Design for the applicable concrete exposure class and to maximize the pozzolans content of the mix. All cast-in-place or pre-cast concrete which is above grade to be designed with an architectural treatment in coordination with the WSTP, including relief, fluting, sandblasting, coloured concrete, or other good industry practice to reduce visual impacts.

1.2 Standards

.1 Canadian Standards Association (CSA): Latest edition unless noted otherwise:

.1 CSA A23.1 - Concrete Materials and Methods of Concrete Construction.

1.3 Submittals

.1 Provide submittals in accordance with Section 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit the proposed mix design for all mixes and quality assurance procedures a minimum of 20 Business Days prior to their initial use.

.3 Submit data sheets for all proposed pre-mixed grouts.

.4 Submit samples of fine and coarse aggregate and all admixtures for concrete mixes to testing laboratory.

.5 Submit data on all concrete accessories specified or proposed.

.6 Submit complete Shop Drawings for material, fabrication, and construction sequence/ procedures for all hinge and slide joints. Submittal details are to depict all facets of all types of concrete joints, including concrete dimensions, reinforcing, waterstops, neoprene, sealant, waterproofing membrane and adhesive, prefabricated waterstop and waterproofing membrane corner and tee-intersections, steel plates and anchors, and void form blockouts. Include data showing that void form blockout material can withstand concrete pressures associated with the planned height of the pour.

.7 For architectural concrete surfaces, show form construction including jointing, reveals, pattern of form ties and other items that affect appearance of exposed surface. Indicate method of sealing forms against leakage at panel joints and form ties.

.8 Submit proposed methods of protection of concrete when air temperatures are expected to be above 25°C or below 5°C.

2. PRODUCTS

2.1 Performance Criteria

.1 Design and construct cast-in-place or precast concrete of appropriate properties as required by the Final Design and for the applicable concrete exposure class.

.2 Concrete left exposed, with no finish materials, to be sealed with an anti-graffiti coating.

.3 Walls below grade to be water-proofed to prevent groundwater ingress. Construction joints to have purpose-made water stops.

.4 Repair cracks in concrete floors, walls, and ceilings to suit the floor finish and long-term serviceability requirements of the floor.

.5 Exposed architectural concrete to comply with CSA A23.1.

.6 Honey combing is not permitted, and surface areas must be repaired or replaced in accordance with Section 03300.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Prepare and submit concrete pour plan a minimum of five (5) business days prior to start of work for City's review.

END OF SECTION

CONCRETE FORMS AND ACCESSORIES

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of concrete formwork and accessories.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

.2 Canadian Standards Association (CSA):

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

.2 CSA O86.1 - Engineering Design in Wood.

.3 CSA O121 - Douglas Fir Plywood.

.4 CSA O151 - Canadian Softwood Plywood.

.5 CSA S269.1 - Falsework and Formwork.

.3 American Concrete Institute (ACI):

.1 ACI 315 - ACI Detailing Manual.

.2 ACI 347 - Guide to Formwork for Concrete.

.4 American Society for Testing and Materials (ASTM):

.1 ASTM C109/C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 50 mm Cube Specimens).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Shop Drawings:

.1 Indicate method and schedule of construction, shoring, stripping and reshoring procedures, materials, arrangement of joints, ties, liners, and locations of temporary embedded parts. Comply with CSA S269.1 for falsework and formwork Drawings.

.2 Indicate formwork design data such as permissible rate of concrete placement and temperature of concrete in forms.

.3 Show formworks for all openings.

.4 Indicate sequence of erection and removal of formwork and falsework.

.5 Indicate hoarding and heating methods for cold weather concrete work.

.6 Indicate concrete protection methods for hot weather concrete work.

.7 Each Shop Drawing submission is to bear the stamp and signature of a Professional Engineer registered in the Province of Manitoba.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Formwork Materials:

.1 For concrete without special architectural features, use plywood and wood formwork materials conforming to CSA O121, CSA O86.1 and CSA O151.

.2 For concrete with special architectural features, use formwork materials to CSA A23.1.

.2 Form Ties:

.1 Architectural concrete: use snap ties complete with plastic cones and light grey concrete plugs.

.2 Concrete not designated architectural: use removable or snap-off metal ties to a distance of not less than 38 mm from the face of the finished concrete, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.

.3 Water retaining structures: use cone-fast coil type or she-bolt type as manufactured by Dywidag or approved equivalent, to provide a 50 mm deep cone pocket for grouting after use. Portion of form tie that remains in concrete wall to be non-plated and to use two (2) O-ring waterstops at midspan 25 mm apart.

.3 Form Release Agent: Colourless, non-staining, non-volatile type. Release agents are to be easily washed off where concrete is to be coated.

.4 Controlled Permeable Formwork Liner:

.1 Use formwork liner for all wall surfaces of water retaining structures except where polyvinyl chloride (PVC) liners are used.

.2 Acceptable product:

.1 Plain Zemdrain formwork liner, MD Type III by Dupont.

.2 Or approved equivalent.

.5 PVC Liner:

.1 Use PVC liner where designated by the Design Builder for concrete protection from severe environments.

.2 Acceptable products:

.1 T-lock PVC liners by Ameron International and Leewens Corporation.

.2 Or approved equivalent.

.6 Falsework materials: to CSA S269.1.

.7 Void forms:

.1 Paper forms: corrugated paper forms with cellular core, to provide minimum void space in accordance with Design Builder's geotechnical report, minimum compressive strength 69 kPa. Protected all four sides by wax coated moisture protection.

.1 VF VoidForm.

.2 Or approved equivalent.

.2 Polystyrene void forms: must maintain minimum void space in accordance with Design Builder's geotechnical report when compressed. Polystyrene void forms shall be selected and designed by the Manufacturer. Void form selected to be forwarded to Design Builder for review prior to construction; submission to include pressures applied to structure in compressed state.

.1 Geospan and Geovoid by Plasti-Fab.

.2 Or approved equivalent.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

3.2 Fabrication and Erection

.1 Verify lines, levels, and centres before proceeding with formwork and falsework.

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

.3 Provide architectural requirements for concrete members requiring architectural exposed finishes.

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

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

.6 Fabricate and erect formwork in accordance with CSA S269.1 to produce finished concrete conforming to shape, dimensions, locations, and levels indicated within tolerances required by CSA A23.1. Coat forms before assembly in final position.

.7 Align form joints and make watertight. Keep form joints to minimum. Allow for deflection of the formwork due to the weight of concrete.

.8 Use 20 mm chamfer strips on external corners and 20 mm fillets at interior corners of concrete members and joints unless specified otherwise.

.9 Form chases, slots, openings, drips, and recesses.

.10 Construct forms and reveals for architectural concrete.

.11 Construction joints are to be placed as required.

.12 Build in anchors, anchor bolts, sleeves, lifting hooks, and inserts required to accommodate Work specified in other Sections. Ensure that all anchors and inserts do not protrude beyond surfaces designated to receive applied finishes, including painting.

.13 Provide access and clean formwork in accordance with CSA A23.1 before placing concrete.

3.3 Removal and Reshoring

.1 Comply with CSA S269.1 for dismantling all formwork and falsework.

.2 Do not remove forms, shores, and bracing until concrete has gained sufficient strength to carry its own weight, construction loads, and the design loads that are liable to be imposed upon it.

.3 Remove forms not directly supporting weight of concrete as soon as stripping operations do not damage concrete but not before a minimum of three (3) days from final concrete placement to prevent rapid loss of moisture from concrete.

.4 Leave formwork in place for the following minimum periods of time after placing concrete:

.1 Formwork may be left in place as part of the curing procedures.

.2 Four (4) days for walls.

.3 Fourteen (14) days for beam soffits, roof slabs and other structural members or until concrete has attained 75 percent of specified design strength.

.5 Retain shores and forms under structural members for a minimum of fourteen (14) days or until the concrete has attained a minimum of 75 percent of the required design strength, whichever occurs later.

.6 Verify strength by field cylinders or insert type tests to ASTM C900 T.

.7 Remove formwork progressively and in accordance with code requirements so that no shock loads or unbalanced loads are imposed on structure.

.8 Loosen forms carefully. Do not damage concrete by wedging pry bars, hammers or tools against concrete surfaces.

.9 Reshore structural members as required by Design or construction conditions. Construction is to be reshored to carry all future anticipated construction loading.

.10 Remove forms so that no damage occurs to the concrete. Finished concrete exhibiting evidence of excessive form displacement and/or excessive deflection will result in rejection of the Work at the City's discretion.

.11 Reuse formwork and falsework subject to requirements of CSA A23.1.

END OF SECTION

CONCRETE REINFORCEMENTS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of reinforcement for cast-in-place concrete.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

.2 Canadian Standards Association (CSA):

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

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

.3 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.3 American Concrete Institute (ACI):

.1 SP-66 - ACI Detailing Manual.

.2 ACI 350 - Code Requirements for Environmental Engineering Concrete Structures.

.4 American Society for Testing and Materials (ASTM):

.1 ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

.5 Reinforcing Steel Institute of Canada (RSIC):

.1 RSIC Reinforcing Steel Manual of Standard Practice.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Shop Drawings:

.1 Submit Shop Drawings including placing of reinforcement at least 10 Business Days before fabrication.

.2 Indicate on Shop Drawings, bar bending details, lists, quantities of reinforcement, sizes and spacings, with identifying code marks to permit correct placement without reference to structural Drawings. Indicate sizes, spacings and locations of chairs, spacers, and hangers. Prepare reinforcement drawings in accordance with RSIC Reinforcing Steel Manual of Standard Practice and SP-66(04): ACI Detailing Manual.

.3 Detail lap lengths and bar development lengths to CSA A23.3. Splices to be as required for the Final Design, or minimum of CSA A23.3, Class B.

.4 Use large scale details for areas of congested reinforcement.

.5 Support and placing details of reinforcing to RSIC and ACI 350.

2. PRODUCTS

2.1 Materials

.1 Reinforcing steel:

.1 Provide a minimum billet steel, grade 400 deformed bars to CSA G30.18.

.2 Weldable low alloy steel deformed bars to CSA G30.18.

.2 Welded steel wire fabric: to ASTM A1064/A1064M. Provide in flat sheets only.

.3 Chairs, bolsters, bar supports, and spacers: to CSA A23.1 and to have sufficient strength to support the reinforcing under normal construction conditions. Brick is not to be used for bar supports. Use accessories that are plastic coated, stainless steel, or as required for the Final Design if more stringent.

.4 Mechanical splices:

.1 Reinforcing steel mechanical splices are to be a positive connecting threaded type mechanical splice system.

.2 Mechanical splices are to develop in tension or compression with the strength not less than 125 percent of the specified minimum yield strength of the reinforcement.

2.2 Fabrication

.1 Fabricate reinforcing steel to CSA A23.1 and SP66(04) ACI Detailing Manual.

.2 Fabricate reinforcing steel from bar sizes and grades with the following tolerances:

.1 Sheared length: plus or minus 25 mm.

.2 Stirrups, ties, and spirals: plus or minus 13 mm.

.3 Location of bends: plus or minus 25 mm.

2.3 Testing Certificates

.1 Provide certified copy of mill test report of reinforcing steel showing physical and chemical analysis, minimum 10 Business Days prior to commencing reinforcing work. Identify proposed source of material to be supplied and country of origin.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

3.2 Delivery, Storage, and Handling

.1 Ship reinforcement in standard bundles easily identifiable and marked in accordance with the bar lists.

.2 Store reinforcement to prevent deterioration or contamination by dirt, detrimental rust, loose scale, paint, oil, or other foreign substance that destroy or reduce bond.

.3 Do not use bars bent or kinked by improper handling or storage. Do not straighten or re-bend reinforcement in any manner.

.4 Bars are to be free of mill scale.

3.3 Field Bending

.1 Do not field bend or field weld reinforcement.

.2 Replace bars that have cracks or splits.

3.4 Placing Reinforcement

.1 Place reinforcing steel as required by the Final Design in accordance with CSA A23.1.

.2 Support reinforcement in position as follows:

.1 Beams and walls: laterally support reinforcement with supports in pairs on opposite faces.

.2 Do not use supports that are forced into the supporting formwork or soil by the weight of the reinforcement or other construction loads.

.3 Do not use pebbles, pieces of broken stone or brick, metal pipe, or wooden blocks to separate layers of bars.

.4 Do not place bars on layers of concrete as the Work progresses or install bars during placing of concrete.

.5 Bar chairs are suitable for placing and compaction loads. Provide plastic protected steel supports. Plastic chairs are not permitted.

.3 Ensure cover to reinforcement is maintained during concrete pour. Minimum concrete cover as follows:

.1 Cast against and permanently exposed to earth: 75 mm.

.2 Formed surfaces exposed to ground, weather, wastewater, or chlorides: 60 mm.

.3 Formed surfaces not exposed to ground, weather, wastewater, or chlorides:

.1 Beams (to stirrups): 40 mm.

.2 Columns (to ties): 40 mm.

.3 Slabs (top and bottom): 40 mm.

.4 Walls: 40 mm.

.4 Provide minimum cover between the reinforcement and waterstop of 25 mm or as per waterstop manufacturer requirement, whichever is larger.

.5 Splice bars according to CSA A23.3, Class B.

.6 Welding of reinforcing bars on site is not permitted.

END OF SECTION

CAST-IN-PLACE CONCRETE

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of cast-in-place concrete.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

.2 American Concrete Institute (ACI):

.1 ACI 301 - Structural Concrete.

.2 ACI 306R - Guide to Cold Weather Concreting.

.3 ACI 350 - Code Requirements for Environmental Engineering Concrete Structures.

.4 ACI 350.1 - Tightness Testing of Environmental Engineering Concrete Containment Structures & Commentary.

.5 ACI 503.7 - Crack Repair by Epoxy Injection.

.6 SP66: ACI Detailing Manual.

.3 Canadian Standards Association (CSA):

.1 CSA A23.1/CSA A23.2 - Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete.

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

.3 CSA S269.1 - Falsework and Formwork.

.4 CSA A283 - Qualification Code for Concrete Testing Laboratories.

.5 CSA-A3000 - Cementitious Materials Compendium.

.4 Canadian General Standards Board (CGSB):

.1 CGSB-19.24 - Multicomponent, Chemical-Curing Sealing Compound.

.2 CGSB 41-GP-35M - Polyvinyl Chloride Waterstop.

.5 American Society for Testing and Materials (ASTM):

.1 ASTM C109/C109M - Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens).

.2 ASTM C157/C157M - Length Change of Hardened Hydraulic-Cement Mortar and Concrete.

.3 ASTM C260/C260M - Air-Entraining Admixtures for Concrete.

.4 ASTM C494/C494M - Chemical Admixtures for Concrete.

.5 ASTM C881/C881M - Epoxy-Resin-Base Bonding Systems for Concrete.

.6 ASTM D994/D994M - Preformed Expansion Joint Filler for Concrete (Bituminous Type).

.7 ASTM C1017/C1017M - Chemical Admixtures for Use in Producing Flowing Concrete.

.8 ASTM D1751 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

.9 ASTM D1752 - Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

.6 Reinforcing Steel Institute of Canada (RSIC):

.1 RSIC - Reinforcing Steel Manual of Standard Practice.

.7 Concrete Reinforcing Steel Institute (CRSI):

.1 CRSI - Manual of Standard Practice.

.8 Have available on site one (1) copy of CSA A23.1/CSA A23.2. These to form basis for acceptable standards of concrete practices and methods.

1.3 Quality Assurance

.1 Cast-in-place concrete to conform to CSA A23.1. Deliver concrete under Performance Alternative as outlined in CSA A23.1, Table 5.

.2 Design Builder to be fully responsible for quality control of all aspects of production, pre-placement, placement, and post-placement of concrete and related testing.

.3 Concrete testing to be performed by a CSA A23.1 certified Third Party Testing Agency. Testing to conform to CSA A23.1/A23.2. Third Party testing to be paid for by Design Builder.

.4 Provide Third Party Testing Agency test data as a submittal immediately upon receiving.

.5 Submit and implement a Quality Control Plan a minimum of four (4) weeks prior to first scheduled concrete casting as a minimum Quality Control Plan to include:

.1 Design Builder Quality Control Manager identification.

.2 Concrete supplier certification with Concrete Manitoba.

.3 Construction supervisory personnel qualifications.

.4 Quality Control testing plan for concrete.

.5 Pre-placement procedures, checklists, and project finishing procedures for concrete.

.6 Contingency plans and procedures during placement.

.7 Post-placement procedures and checklists.

.6 Submit mix design statements for each type of concrete:

.1 Mix design statements to be sealed and signed by a Professional Engineer registered in Province of Manitoba experienced in preparing concrete mix designs.

.2 Submit documentation a minimum of four (4) weeks prior to first scheduled concrete casting demonstrating that proposed mix designs and materials will achieve required strength, durability, and performance requirements.

.3 Mix design statements to incorporate requirements of Clause 2.2 (Concrete mixes).

.7 Checklists supplied by Design Builder to be used for reviewing Work.

.8 Design Builder to schedule review of embedded items and reinforcing in walls prior to closing forms.

.9 Allow ample time for review, and corrective work, if required, before scheduling concrete placement.

.10 City reserves right to arrange and pay for a CSA A23.1 certified Third Party Testing Agency to test concrete works. Provide unencumbered access to all portions of Work and cooperate with appointed Third-Party Testing Agency.

1.4 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit shrinkage test results for concrete for liquid retaining structures.

.3 Submit data sheets for all proposed pre-mixed grouts.

.4 Submit data on all concrete accessories specified or proposed.

.5 Submit documentation demonstrating that fine and coarse aggregates meet requirements to CSA A23.1.

.6 Submit Shop Drawings for material, fabrication, and construction sequence and procedures for all concrete joints. Submittal details are to depict all facets of the concrete joints, including concrete dimensions, reinforcing, waterstops including prefabricated corner and tee-intersections, neoprene, sealant, steel plates, and anchors.

.7 Submit Shop Drawings for architectural concrete surfaces showing form construction including jointing, reveals, pattern of form ties, and other items that affect appearance of exposed surfaces. Indicate method of sealing forms against leakage at panel joints and form ties.

.8 Submit proposed methods of protection of concrete in hot weather when air temperatures are expected to be above 25°C or in cold weather when temperatures are expected to be below 5°C.

.9 Submit all concrete delivery tickets.

2. PRODUCTS

2.1 Materials and Products

.1 Concrete materials:

.1 Portland cement: Type GU or GUb and Type HS or HSb conforming to CSA-A3000.

.2 Supplementary cementing materials: conforming to CSA-A3000.

.3 Fine aggregate: conforming to Normal-Density Fine Aggregate, CSA A23.1, Tables 10 and 12.

.4 Coarse aggregate: conforming to Normal-Density Coarse Aggregate, CSA A23.1, Table 11 and 12.

.5 Water: potable, clean, and free from injurious amounts of oil, alkali, organic matter, or other deleterious matter to CSA A23.1, Table 9.

.6 Materials are to be obtained from same source of supply or Manufacturer for duration of project.

.2 Admixtures:

.1 Air entrainment: to ASTM C260/C260M. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

.2 Chemical admixtures, water-reducing agent, superplasticizer: to ASTM C494/C494M and ASTM C1017/C1017M.

.3 Admixtures containing chlorides will not be permitted.

.4 Air-entraining admixtures are to conform to the requirements of ASTM C260. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

.5 Water-reducing admixtures are to conform to the requirements of ASTM C494, Type A or D. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

.6 High-range water reducers (superplasticizers), if approved by the City, are to conform to the requirements of ASTM C494, Type F.

.7 Shrinkage reducing admixture: select shrinkage reducing admixture for compatibility with air entrainment admixture and other ingredients of the concrete mix.

.1 Acceptable products:

.1 BASF Tetraguard AS20 and Grace Eclipse 4500.

.2 Or approved equivalent.

.8 Integral crystalline waterproofing admixture (permeability reducing admixture – hydrostatic - PRAH): an integral crystalline waterproofing admixture may be used for concrete in liquid containment structures. Dosage rate to be minimum 2 percent of mass of cement in mix.

.1 Acceptable products:

.1 Kryton; Krystol KIM.

.2 Xypex; Xypex Admix C.

.3 ICS/Penetron International Ltd; Penetron Admix.

.4 BASF Corporation; Rheomac 300D.

.5 Or approved equivalent.

.3 Concrete accessories:

.1 Liquid membrane-forming curing compound: to ASTM C309. Must be compatible with dust proofing and hardening agents, floor hardeners, and any sealers or waterproofing used. Curing compounds to be easily removed where concrete is to be coated.

.2 Vapour barrier: 250 µm polyethylene film.

.3 Dovetail anchor slots: minimum 1.5 mm thick galvanized.

.4 Premoulded joint fillers: to ASTM D994.

.5 Bituminous impregnated fiber board: to ASTM D1751.

.6 Sponge rubber: to ASTM D1752, Type 1, flexible grade.

.7 Joint sealant: CAN/CGSB-19.24. Polyurethane to withstand movement to one-quarter of sealant thickness. Refer to Section 07900.

.8 Pigmented concrete sealer:

.1 Acceptable products:

.1 Sikagard Color A-50 by Sika.

.2 Or approved equivalent.

.9 Bonding agent: emulsion. Use for concrete topping on precast roof panels.

.10 Drilled anchors: refer to Section 05501.

.11 PVC waterstops: to CGSB 41-GP-35M. Purpose made PVC, width to be as per Manufacturer design requirement but not less than 150 mm wide, maximum possible lengths, factory fabricated and tested PVC waterstop vertical and horizontal cross, L, and T shaped junction sections. Waterstops in expansion joints are to be a minimum 225 mm wide with centre bulb/ribbed sides.

.1 Acceptable products:

.1 Wirestop CR-6316 and CR-9380 by Paul Murphy.

.2 Greenstreak 705 and Greenstreak 710 by Sika.

.3 Or approved equivalent.

.12 Expandable waterstops:

.1 Sodium bentonite based - Volclay Waterstop – RX.

.2 Hydrophilic waterstop - SikaSwell S-2 by Sika, Adeka Ultra Seal MC-2010MN.

.3 Or approved equivalent.

2.2 Concrete Mixes

.1 Supply concrete to CSA A23.1, Table 5, Alternative 1, except that the additional requirements of this Specification are also to apply.

.2 Only such materials or blends of materials that results in a uniform colour of exposed surfaces are to be used.

.3 Concrete mixes to be placed by concrete pump are to be designed for pumping.

.4 Supply concrete to CSA A23.1 with properties as noted in the following table:

Type	Type Location	Exposure Class	Minimum Design Strength (MPa)	Air Content Category
A	All concrete in contact with soil including liquid retaining structures	S1	35	1
B	Liquid retaining structures not in contact with soil	A1	35	1
C	Interior structural concrete elements	N	30	Not applicable
D	Exterior above grade structural concrete elements – equipment slabs and support pedestals	C1	35	1
E	Exterior non-structural elements - sidewalks, landing pads	C2	32	1
F	Masonry fill	N	20	Not applicable
G	Concrete topping	A1	35	2

.1 Aggregate size: to CSA A23.1. Use of smaller nominal size aggregate is permitted to ease placing near the PVC waterstop and other congested areas. Adjust air content for smaller aggregate to meet exposure class requirements.

.2 Use accelerating admixtures in cold weather only when approved by the designer. If approved, the use of admixtures does not relax cold weather placement requirements.

.3 Do not use calcium chloride or admixtures containing calcium chloride.

.4 Low shrinkage concrete:

.1 Low shrinkage concrete: to CSA A23.1 requirements.

.2 Provide test results for the concrete mix meeting the requirement of drying shrinkage limit in the laboratory as tested by CSA A23.2-21C.

.5 Use all admixtures in strict accordance with the Manufacturer’s recommendations.

.5 Epoxy for crack injection:

.1 Epoxy grout to be used for structural non-movement cracks in liquid-containing concrete. Epoxy for crack injection to be a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency is to be as required to achieve complete penetration in hairline cracks and larger. Material to conform to ASTM C881 Type 1 Grade 1.

.2 Acceptable products:

.1 Sika Corporation “Sikadur-52”, Adhesives Technology Corporation “Crackbond SLV-302”.

.2 Or approved equivalent.

.6 Chemical grout for crack injection:

.1 Chemical (Glycolmethacrylate) grout is to be used for sealing structural movement cracks in structures intended to be watertight.

.2 Acceptable products:

.1 Sika Inject-215.

.2 Duroseal Acrylate Resin.

.3 Or approved equivalent.

.7 Grout mixes to conform to Section 03600.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

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

3.1 Delivery, Storage and Handling

.1 Deliver all materials to the site in bundles easily identified and properly marked.

.2 Store and handle all material on site in a manner to prevent damage and contamination.

.3 Cement to be stored in a suitable weather-tight building that protects these materials from dampness. Cement to be free from lumps at all times during use in the Work. Cement stored for a length of time resulting in the hardening or formation of lumps not to be used in the Work.

.4 All aggregates are to be handled to prevent segregation and to obtain uniformity of materials. The separated aggregates and the aggregates secured from different sources are to be piled in separate stockpiles. The site of the stockpiles is to be cleaned of all foreign materials and is to be reasonably level and firm. If the aggregates are placed directly on the ground, material is not to be removed from the stockpile within 150 mm of the ground level. This material is to remain undisturbed to avoid contaminating the aggregate with the ground material.

.5 Do not straighten or re-bend any reinforcement.

.6 Do not use any reinforcement that has been kinked or bent on site.

3.2 Work Installed but Supplied under Other Sections

.1 Install materials specified to be supplied under other Sections. Materials include, but are not limited to fabricated components, anchor bolts, bearing plates, sleeves, and other inserts to be built into concrete.

.2 Installation to be to satisfaction of trades concerned prior to placing concrete.

3.3 Field Quality Control

.1 Retain a testing firm certified in accordance with CSA A283 for all material testing. Designers to review and approve all testing results and certify the results are in accordance with the DBA.

.2 Inspection and testing of concrete:

.1 Provide properly designed temperature-controlled storage boxes for test cylinders, as specified in CSA A23.2, for a period of at least twenty-four (24) hours and further protection from adverse weather and mishandling until removed from the site. Provide a max-min thermometer for each storage box. Storage facilities are to be provided.

.2 Secure sufficient three (3) day and seven (7) day test cylinders for testing of concrete to ensure quality control and sufficient strength for application of construction loads and stripping.

.3 Conduct all tests in accordance with CSA A23.2.

.4 Samples of concrete to be taken as close to the point of final deposit in the form as possible, at end of pipe when pumping is used.

.5 Take a minimum of five (5) test cylinders for a strength test and not less than one (1) strength test for each 75 m^3 of concrete, or portion thereof, for each type of concrete placed and not less than one (1) test for each type of concrete placed in any one (1) day.

.6 Moist cure and test one (1) cylinder at seven (7) days, two (2) cylinders at twenty-eight (28) days, and two (2) cylinders at fifty-six (56) days.

.7 Take one (1) additional test cylinder during cold weather concreting and cure on job site under same conditions as the concrete it represents.

.8 Take at least one (1) slump test and one (1) entrained air test for each set of test cylinders taken.

.9 Submit certified copies of all test results. Include the following information with the results:

.1 Name of the project.

.2 Date of sampling.

.3 Mix design, specified strength, slump, and air content.

.4 Name of supplier, truck, and ticket number.

.5 Time batched and time placed.

.6 Identification of sampling and testing technician.

.7 Cement type and admixtures used.

.8 Exact location in the structure of the concrete sampled.

.9 Ambient air and concrete temperatures.

.10 Nominal aggregate size.

.11 Water added and personnel authorizing additional water.

.12 Concrete density.

.10 Reject and do not place concrete with slumps and air content out of mix design required ranges and concrete over two (2) hours from batch time.

.3 Inspection and testing of unit core masonry fill:

.1 All clauses pertaining to inspection and testing of concrete contained in this Section are to apply to unit masonry grout unless noted otherwise.

.2 Take a minimum of three (3) test cylinders, one (1) slump test and one (1) entrained air test for each 20 m^3 placed or portion thereof for a project having more than 20 m^3 of grout and for each 10 m^3 placed or portion thereof for a project having less than 20 m^3 and not less than one (1) test in any one (1) day of grout placed.

.3 Reject and do not place job site-mixed grout over 1.5 hours from mixing time.

.4 Inspection and testing of grout: to ASTM C109: provide at least two (2) cube tests on all types of non-shrink grout used.

3.4 Inserts, Embedded Parts and Openings

.1 Provide formed openings where required for pipes, conduits, sleeves, and other work to be embedded in and passing through concrete members.

.2 Provide sleeves and openings required through structural components. These are not to reduce the structural capacity. Locations and sizes are to be approved by the designers.

.3 Maximum size of electrical conduit in structural slabs is 1/5 of the solid portion of slab thickness, and where more than two (2) are adjacent to each other, they are to be spaced a minimum of 100 mm apart. Conduit is to be placed in the middle third of the slab unless the requirements of the designers are more stringent.

.4 Accurately locate and set in place items that are to be cast directly in concrete. Use templates wherever possible.

.5 Do not place anchor bolts, sleeves and inserts into freshly placed concrete. Tie firmly into place prior to placing concrete.

.6 Install all concrete accessories as required by the Design Builder and Manufacturer's recommendations, straight, level, and plumb. Ensure adequate support to prevent movement during concrete placement.

.7 Install waterstops continuous without displacing reinforcement. Do not nail through waterstops. Heat seal all joints watertight.

.8 Wire all waterstops to reinforcing to prevent folding during concrete placement. Secure waterstop minimum 300 mm on centre.

3.5 Placing Concrete

.1 Concrete test pour: one (1) concrete test pour is required for deep tanks to confirm adequacy of mix design and method of placement to prevent honeycombing and other defects in the surface areas.

.2 Notify testing firm a minimum of forty-eight (48) hours prior to commencement of any concrete placement. Allow time for corrective work for areas of unusual formwork and congested reinforcement.

.3 Designers to inspect and verify all pile installations prior to placing concrete for pile caps, grade beams, and base slabs.

.4 Do not place concrete against frozen ground, frozen concrete, or frosted forms.

.5 Place concrete to CSA A23.1 and as specified herein.

.6 Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and other critical items are not disturbed during concrete placement.

.7 Revise, re-seat, and correct improperly positioned reinforcing hardware and other embedded items before concrete placement.

.8 Ensure specified concrete cover around reinforcing is maintained.

.9 Do not add water after batching.

.10 Place concrete and screed in accordance with the lines and levels as required by the designers.

.11 Place concrete in approximate horizontal layers such that each lift can be vibrated into the previous lift.

.12 Maximum vertical free fall of concrete is not to exceed 1200 mm in unexposed work or 800 mm in exposed work. Confine concrete with a suitable vertical drop pipe to prevent segregation.

.13 Place concrete directly into its final position in forms. Do not spread concrete with vibrators.

.14 Compact concrete thoroughly by mechanical vibrators. Ensure concrete is worked around reinforcement, water stops, embedded items, and into all areas and corners of forms.

.15 Use internal vibrators in all sections that are sufficiently large, and supplement with external type vibrators if satisfactory surfaces cannot be obtained.

.16 Check and re-adjust formwork to required lines and levels during placement of concrete.

.17 Place concrete as a continuous operation, stopping only at construction joints.

.18 Allow a minimum of three (3) days for slabs and five (5) days for walls between adjacent concrete placements.

.19 Consolidate and screed floors and slabs on grade level to CSA A23.1, maintaining surface flatness as required for final floor finish. Pitch to drains 20 mm per metre nominal or as required by the Final Design.

.20 Place slabs on grade as one (1) continuous placement between construction joints as required for the Final Design or as limited in Section 03100. For slab on grade less than 250 mm in thickness, sawcut control joints for each placement by sawing a continuous minimum 25 mm deep slot or 1/4 of the slab thickness at maximum 4.5 m centres each way. Sawcut as soon as the concrete has sufficiently hardened to prevent raveling of the edges, but in no case later than twenty-four (24) hours after the concrete has been placed.

.21 Use cold weather concreting methods to CSA A23.1 when the mean daily temperature falls below 5°C, and use hot weather methods when the mean temperature rises above 25°C.

.22 Maintain accurate records of concrete placement. Record date, location of placement, quantity, air temperature, and test samples taken.

3.6 Finishing Flatwork

.1 Finish flatwork to timing and procedures outlined in CSA A23.1.

.2 Achieve flatness and levelness to CSA A23.1, Class A.

.3 Float finish: for all concrete slabs to receive insulation board, final finish surface with a power float to a true plane not exceeding a 10 mm gap under a 3 m straight edge placed in any direction.

.4 Steel trowel: for all concrete slabs to be left exposed, final finish surface with a power trowel to a true plane not exceeding a 5 mm gap under a 3 m straight edge placed in any direction.

.5 Broomed finish: for all concrete slabs to have non-slip surfaces, final finish surface after troweling with fine broom finish.

.6 Repair all surfaces with unacceptable finishes or excessive variation by grinding and/or filling.

.7 Floor hardeners: apply in strict accordance with the Manufacturer’s recommendations.

.8 Floor sealer: apply in strict accordance with the Manufacturer’s recommendations.

3.7 Curing and Protection

.1 Cure and protect concrete to CSA A23.1.

.2 Concrete for water retaining structures to be continuously wet cured for a minimum of seven (7) days to CSA A23.1 curing type 3.

.3 Protect concrete from sudden temperature changes as noted in CSA A23.1.

.4 Acceptable curing methods for CSA A23.1 curing types 1 and 2:

.1 Ponding or continuous sprinkling.

.2 Absorptive mat or fabric kept continuously wet.

.3 Continuous steam vapour mist bath not exceeding 70°C.

.4 Curing compounds approved by the City for type and rate of application.

.5 Waterproof paper or plastic film.

.6 Watertight forms left in place. Wood forms are not considered watertight unless coated or sealed to prevent moisture absorption.

.7 Other moisture-retaining method.

.5 Where curing compounds are used, apply in two (2) applications at right angles to each other.

.6 Do not use curing compounds on concrete surfaces to receive topping, hardener, protective coatings, or other type of bonded finish. Confirm that the coatings and curing compound are compatible.

.7 Protect freshly placed and consolidated concrete against damage or defacement from curing methods or adverse weather conditions.

.8 Exposed concrete walking surfaces not to receive an integral hardener: Coat with curing compound of type that provides permanent seal.

.9 During hot weather, begin curing process immediately after finishing. Use continuous water or absorptive mats.

3.8 Form Removal

.1 Comply with CSA S269.1 and Section 03100, for dismantling all falsework.

3.9 Defective Concrete

.1 Immediately after removing forms, all concrete surfaces are to be inspected, and any imperfect joints, voids, stone pockets, or other defective areas as specified are to be reported to the Professional of Record immediately and repaired before the concrete surface is thoroughly dry. The designers are to include in the Construction Quality Management Plan the procedures

to correct defective concrete. At a minimum, defective surface areas are to be chipped away to a depth of not less than 25 mm with the edges perpendicular or slightly dovetail to the surface. The area to be repaired and a space at least 150 mm wide entirely surrounding it is to be wetted to a saturated surface dry condition to prevent absorption of water from the repair material.

.2 At a minimum, the repair is to be made of the same material and of the same proportions as used for the concrete, except that the coarse aggregate is to be omitted and cement added to match the colour of the surrounding concrete. The amount of mixing water is to be as little as consistent with the requirements for handling and placing. The mortar is to be re-tempered without the addition of water by allowing it to stand for a period of one (1) hour, during which time it is to be mixed with a trowel to prevent setting.

.3 The repair material is to be thoroughly compacted into place and screeded off to leave the repair slightly higher than the surrounding surface. It is then to be left undisturbed for a period of one (1) to two (2) hours to permit initial shrinkage before being finally finished. The repair is then to be finished to match the adjoining surface and cured to the requirements noted in this section.

3.10 Finishing Formed Surfaces

.1 Finish concrete in accordance with CSA A23.1. Ensure all concrete finishes are uniform.

.2 Concrete surfaces not exposed to public view, for all concealed concrete surfaces, including also exposed surfaces of elevator shafts, pits, and trenches: to conform to CSA A23.1: Rough-form Finish.

.3 Concrete exposed to public view including ceilings, soffits, below grade surfaces to receive a waterproofing coating or membrane, and all tank walls interior and exterior to 300 mm below grade: Smooth-form Finish. Additionally, seal tie holes and surface cavities (bugholes) exceeding 5 mm in any dimension with non-shrink grout for water retaining structures.

.4 Do not parge.

3.11 Repair of Concrete Cracking

.1 The designers are to include in the Construction Quality Management Plan the procedures to repair concrete cracking.

.2 If concrete does not meet the requirements of CSA A23.1 and as set out in these Specifications, the concrete is to be repaired in accordance with the Construction Quality Management Plan and as approved by the designers.

.3 Repair methods: damaged concrete or concrete with crack widths exceeding 0.10 mm at water retaining and conveying structures or crack widths exceeding 0.15 mm for other structures unless noted otherwise are to be repaired by one (1) of the following methods. For water retaining and conveying structures, meeting the crack width criteria defined above does not relieve the leakage criteria requirements listed in Section 03700 and performing crack injection repairs as needed to meet the leakage criteria.

.1 Repair method 1: fill the joint or crack by drilling holes to the affected area, install injection ports and force epoxy or chemical grout into the joint under pressure. After injection and curing, ports, sealing mix, and surface are to be cleaned and worked to match the specified finish.

.2 Repair method 2: fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure in accordance with Manufacturer's recommendations. As a minimum, prepare surface to result in a clean, dry surface and with no visible detrimental material in cracks to be filled. Conform to temperature limitations for epoxy to be used. Finish to match adjacent areas.

.3 Repair method 3: cut a bevel groove 10 mm to 12 mm width and depth, and caulk with sealant in accordance with Manufacturer's instructions.

.4 Repair method use:

.1 Repair method 1 is to be used for all cracks in walls, surfaces sloped 1:1 or greater, beams, columns, slabs, overhead surfaces, and for water retaining surfaces. Need for repair depends upon crack width, location, and surface conditions under service conditions. Epoxy grout is to be used for repair of structural non-movement cracks and chemical grout is to be used for repair of structural movement cracks for water retaining structures.

.2 Repair method 2 may be used in lieu of repair method 1 for slabs which receive a raked finish. Repair method 2 may also be used with the approval of the Design Builder's Engineer and the City for exposed troweled and broomed finishes after review of conditions, degree of exposure to public, and proposed repair product and installation. Finish is to substantially match adjacent surfaces.

.3 Repair Method 3 is to be limited to dry surface slabs.

3.12 Grout

.1 Conform to Section 03600.

3.13 Sealers

.1 Interior floor sealer: to be applied by qualified applicator competent in application of sealers in strict accordance with the Manufacturer's recommendations and directions.

3.14 Joint Sealants

.1 Conform to Section 07900.

3.15 External Fastening and Coring

.1 Do not core concrete.

.2 Do not drill inserts or drive power actuated fasteners into structural concrete without prior written approval of the designers.

3.16 Testing of Watertightness of Concrete Structures

.1 Do not proceed with the watertightness testing until the concrete structure is completed and the concrete has attained design strengths. Refer to Section 03700.

.2 Repair and eliminate all evidence of leaks on the exterior tank surfaces of water retaining structures.

.3 Repair leaks to comply with maximum limits specified in Section 03700. Re-test structure after repairs until leakage is less than maximum specified.

.4 Do not apply waterproofing and place sealants until after all requirements for watertightness have been met.

3.17 Cleaning

.1 Repair, remove, and clean all drips and smears resulting from the Work of this Section on exposed, finished surfaces, or surfaces to be subsequently finished.

END OF SECTION

CONTROLLED DENSITY FILL

1. GENERAL

1.1 Summary

.1 This Section specifies high-slump controlled density fill (CDF) concrete for pipe bedding purposes, fill of abandoned buried pipes or structures, and restoration of foundation soil bearing by flow into gaps in foundation soil bearing exposed at existing foundations during excavation for new structures and tie-in to existing structures.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

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

.1 ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.

.3 Canadian Standards Association (CSA):

.1 CAN/CSA-A3000 - Cementitious Materials Compendium.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

1.4 Quality Assurance

.1 Cast-in-place concrete to conform to CSA A23.1. Deliver concrete under Performance Alternative as outlined in CSA A23.1, Table 5.

.2 Include CDF concrete in Quality Control Plan in accordance with Section 03300.

2. PRODUCTS

2.1 Materials

.1 CDF concrete: CDF concrete is to be composed of Portland cement, aggregate, pozzolan, admixtures, and water.

.2 Cementitious materials: consisting of Portland cement and pozzolan to CAN/CSA-3000.

.3 Aggregate: to meet the aggregate criteria of Section 03300.

.4 Water: water to be clean and potable to CSA A23.1.

.5 Air entraining agents: to ASTM C260.

.6 Twenty-eight (28) day compressive strength: Minimum 0.7 MPa but not more than 2.1 MPa.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

3.2 Installation

.1 Mixing: thoroughly mix the CDF concrete in a rotary drum. Continue mixing until the cement and water are thoroughly dispersed throughout the material.

.2 Delivery: place CDF concrete within one (1) hour after mixing.

.3 CDF is to be placed subject to the following weather conditions:

.1 At the time of placement, CDF concrete must have a temperature of at least 5°C.

.2 Stop mixing and placement when the temperature is 4°C or less and falling.

.3 Make each stage of placement of fill as continuous an operation as practicable.

.4 Do not place CDF concrete on frozen ground.

.4 Pipe bedding:

.1 Prior to placing as pipe bedding, place the pipe to proper alignment and grade and support by blocking underneath the pipe to provide the minimum bedding depth required for the Final Design. Place CDF concrete bedding in such a manner and rate that the pipes being installed do not become buoyant or otherwise disturbed.

.2 Remove groundwater in trench prior to placement of CDF. Contain trench sections to be filled at either end of trench section by bulkhead or earth fill. Place in the trench bottom in two (2) lifts. Place the first lift uniformly on both sides of the pipe to approximately the spring line and allow to set prior to placing the second lift. Vibrate the fill by hand-operated mechanical compactor to remove voids underneath the pipe. After the first lift has taken an initial set, place the second lift to provide the remainder of the backfill.

.5 Restoration of Foundation Soil Bearing:

.1 Where a soil bearing gap is discovered at existing foundations, over excavate parallel to the edge of the existing foundation to expose the full extent of the gap. Create adequate head for CDF concrete to flow into the soil bearing gap at existing foundation restoring soil bearing. Place CDF concrete into the gap in such a manner that air is not trapped within the soil bearing gap.

.2 Remove groundwater prior to placement of CDF. Contain sections to be filled at either end of section by bulkhead or earth fill. Place in the trench bottom in two (2) lifts.

Vibrate the fill by hand-operated mechanical compactor to remove voids underneath structure.

3.3 Testing

.1 Prior to the start of construction, demonstrate the workability, setting characteristics, and strength of the resultant mix through the preparation of a trial or test section.

.2 The test section is to simulate, as nearly as possible, the field installation conditions.

END OF SECTION

POST-TENSIONING

1. GENERAL

1.1 Summary

.1 This Section specifies material and performance criteria required for post-tensioned concrete.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

.2 Canadian Standards Association (CSA):

.1 CSA A23.1/CSA A23.2 - Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete.

.2 CSA G279 - Steel for Prestressed Concrete Tendons.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit Shop Drawings showing proposed arrangement, location, and details for sheathing and couplings, manufacture, size, type, and ultimate strength of tendons and details of anchorages, blockout sizes, vent locations, sequence of tensioning to provide post-tensioning forces and eccentricities, grouting methods, and grout mix design. Indicate proposed stressing equipment to be used.

.3 Submittals to be sealed by a Professional Engineer registered in the Province of Manitoba. Submit calculations, samples, and material certification.

.4 Submit calculations of jacking forces and extensions necessary to produce required post-tensioning force with anticipated losses due to friction, wobble, and anchor set.

.5 Submit samples of post-tensioning tendons as follows:

.1 For strand with fittings: 1.5 m between near ends of fittings.

.2 For bars with threaded ends and nuts: 1.5 m between threads at ends.

.3 Anchorage assemblies: two (2) anchorage assemblies complete with distribution plates of each size or type to be used, if anchorage assemblies are not attached to post-tensioning samples.

1.4 Quality Assurance

.1 Submit for review load-strain curves certifying physical properties for each mill heat of bar steel and/or wire steel. Physical properties and chemical composition to conform to minimum Specification requirements indicated for bar steel and/or wire steel.

.2 Submit for review mill certificates for anchorages and X-rays of each multi-strand single wire anchorages. Results of hardness test for heat treated anchorages.

.3 Submit for review Manufacturer's standard test data certifying that all components of system conform to minimum Specification requirements shown for these components. Provide Manufacturer’s quality control procedures.

2. PRODUCTS

2.1 Materials

.1 Post-tensioning tendons: to CSA G279, 7 wire, low-relaxation, Grade 1862 MPa strand.

.2 Anchorages and couplings: to CSA A23.1.

.3 Grout for bonding post-tensioning tendons: to CSA A23.1; aluminum additives are prohibited.

.4 Sheathing for tendons: semi-rigid galvanized, corrugated metal ducting sealed to prevent ingress of cement paste.

3. EXECUTIONS

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

3.2 Sheathing Installation

.1 Install sheathing to CSA A23.1.

.2 Tendon sheathing openings to be plugged at all times to prevent ingress of moisture and foreign matter.

.3 Provide drain holes at low points of all ducts.

3.3 Post-Tensioning

.1 Post-tension tendons in sequence and to stresses to CSA A23.1 and as set out in the Final Design.

.2 Start tensioning with approval of the designers.

.3 Provide signed copy of the following records kept:

.1 Date of tensioning.

.2 Identification and number of elements.

.3 Identification of jacking equipment.

.4 Required total load per strand.

.5 Initial tension.

.6 Anticipated and actual gauge pressure for each strand (or strand group, if stressed in one operation).

.7 Anticipated and actual elongation.

.8 Any unanticipated problems encountered.

.4 Replace any tendon subjected to a jacking force more than 80 percent of its specified ultimate strength.

3.4 Grouting

.1 Inject grout in post-tensioning ducts after post-tensioning work has been approved by the designers.

.2 Prior to grouting, blow out all ducts with oil-free compressed air to ensure ducts are clear of water and debris.

.3 Grout ducts as soon as possible after tensioning strand.

.4 Protect strands that are not grouted within seven (7) days by installing water soluble corrosion-inhibitor in the ducts.

.5 Provide signed copy of grouting records to CSA A23.1.

.6 Provide stand-by equipment to flush ducts in the event of a blockage or an interruption of grouting.

.7 Ensure grouting equipment can produce 700 kPa grouting pressure and of sufficiently high volume to cause a stream of grout to issue freely at the open end of the duct.

3.5 Anchorage Protection

.1 Protect anchorages by filling stressing pocket with 30 MPa concrete or non-shrink grout with a minimum strength of 50 MPa at seven (7) days and curing in accordance with Section 03300.

.2 Prepare the surface of the stressing pocket by sandblasting prior to concreting or grouting.

3.6 Cropping Strand

.1 Crop strand by cold cutting procedure after stressing records have been reviewed by the designers.

END OF SECTION

THERMOPLASTIC LINER FOR STRUCTURES

1. GENERAL

1.1 Summary

.1 This Section specifies material specified and performance criteria required to supply and install thermoplastic liner of high-density polypropylene (HDPP) and high-density polyethylene (HDPE) cast into the walls and ceilings as specified by the Design Builder. Provide thermoplastic lining suitable for exposures and liquid-tight applications at the pH, pressures and temperatures required by the Final Design.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

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

.1 ASTM D2240 - Test Method for Rubber Property – Durometer Hardness.

.2 ASTM D2657 - Butt Fusion of Polyolefin Pipe and Fittings.

.3 ASTM D638 - Test Method for Tensile Properties of Plastics.

.4 ASTM D412 - Test Methods for Rubber Properties in Tension.

.3 Canadian Standards Association (CSA):

.1 ANSI/CSA B149.6 - Code for Biogas Generation and Utilization.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Shop Drawings showing complete thermoplastic liner layout information, including joint locations, details of liner at openings, terminations at all openings and embedments, and methods of repair.

.3 Liner installation and testing requirements, material specifications, and welding instructions.

.4 Certified test results on physical property, chemical resistance, and quality control test data, as specified in Subsection 2.2 of this Section.

.5 500 mm by 500 mm individual samples of liner sheet, joint strips, sealing tape, weld strips, and adhesive.

.6 Design details showing continuous termination at all edges to prevent migration of liquids, sludges or gases between liner surface and concrete.

.7 Proof of installers' and welders' qualifications and results of factory testing prior to commencement of work.

.8 Evidence of installer's experience for similar installations; refer to Subsection 1.4 - Quality Assurance requirements of this Section.

.9 Applicable maintenance information.

.10 Complete equipment check-out inspection and testing forms.

.11 Records of installation: refer to the quality requirements of this Section.

1.4 Quality Assurance

.1 All material, adhesives, and incidentals necessary for proper application of thermoplastic lining are to be furnished by the same Manufacturer and be compatible with each other and with the adhesives employed.

.2 Complete electronic factory checks for all lining material to ensure freedom from pinholes, porosity, and imperfections.

.3 Manufacturer to have at least five (5) reference installations of thermoplastic liners at wastewater treatment facilities of similar scale, complexity, and exposure conditions to the Project that have been in service for at least ten (10) years without failure or requiring repair.

.4 Installer to be factory trained and have at least five (5) years of experience with installation of the thermoplastic liners.

.5 Manufacturer's representative to inspect completed installation prior to placement of concrete, to witness any joint or holiday tests, and provide written certification that installation meets Manufacturer's requirements.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers and Acceptable Products:

.1 T Grip: KST Holland.

.2 AGRU Sure-Grip: AGRU America.

.3 Or approved equivalent.

2.2 Materials

.1 Lining sheets and accessory strips: HDPE or HDPP.

.2 Copolymer resins are not permitted.

.3 The following physical properties are required for all thermoplastic liner sheets and accessory strips.

	Property	Initial	After 112 Days
1	Tensile strength, MPa	15 (min)	14.5 (min)
2	Elongation at break, percent	200 (min)	200 (min)
3	Shore durometer, Type D	50-60 at 1 s	50-60 plus or minus 5 at 1 s
		35-50 at 10 s	35-60 plus or minus 5 at 10 s
4	Weight change, percent	-	plus or minus 1.5
5	Working temperature, °C	30	30

.4 Thermoplastic liner to have good impact resistance and have an elongation sufficient to bridge up to 5 mm settling cracks which may occur in the joint after installation, without damage to the installed thermoplastic liner.

.5 Minimum sheet thickness: 3 mm.

.6 Locking “T” extensions or stubs are to be manufactured from same material as liner sheet and integrally bonded or extruded; locking studs are to be spaced maximum 65 mm apart and minimum 19 mm protrusion.

.7 Provide manufactured weld or joint strips, profile strips, and inside and outside corner profiles for all joints are required.

.8 Minimum width of accessory strips or profiles 100 mm; minimum thickness 3 mm nominal.

.9 Colour: white.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

3.2 Installation

.1 Perform all work in conformance with the Specifications, instructions, and recommendations of the thermoplastic liner Manufacturer.

.2 Flash all pipes, conduits, and sleeves passing through the thermoplastic liner required for DBA or as recommended and demonstrated by the Manufacturer.

.3 Closely fit and properly secure thermoplastic liner sheets to the concrete inner forms prior to any concreting operation.

.4 For thermoplastic liners with locking T extensions place so that thermoplastic liner sheet locking T ribs run vertically on vertical surfaces.

.5 Minimize the number of welding joints.

.6 Protect all joints and make mortar tight.

.7 During placement and consolidation of concrete, exercise caution not to damage the thermoplastic liner and liner joints.

.8 After all forms have been removed, nails, form ties, and protruding wire or metal objects are to be cut back from the surface and holes filled with grout and pointed flush, then sealed with weld patches or strips.

.9 Repair all defective joints, wrinkles, and areas which do not bond to concrete.

.10 Repair damaged area of thermoplastic liner due to modification of existing concrete as recommended by the thermoplastic liner Manufacturer.

.11 Cut sheets to curved surfaces using a minimum number of separate pieces.

.12 Warm sheets and jointing strips to allow easy placement of liner against forms; place sheets over formed surfaces and secure to forms using nails or staples.

.13 Pour concrete and compact to ensure a dense homogenous concrete securely anchoring the locking T extensions or stubs into the concrete.

.14 Do not use sharp instruments to pry forms from lined surfaces; mark form tie holes before ties are broken off.

.15 Weld strips and repair patches using extrusion welding by qualified welders conversant with methods and techniques approved by the Manufacturer and Design Builder’s Engineer; continuously weld liner joint until joint is completed.

.16 Ensure welding gun is compatible with thermoplastic liner system.

.17 Prevent prolonged exposure to ultraviolet radiation during installation.

END OF SECTION

PRECAST STRUCTURAL CONCRETE

1. GENERAL

1.1 Summary

.1 This Section specifies the design, supply, delivery, and installation of pre-cast double tee roof units, beams and columns, and structural wall panels.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

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

.1 ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardwar.

.3 ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.

.4 ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

.5 ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.

.3 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-1.40 - Anticorrosive Structural Steel Alkyd Primer.

.2 CAN/CGSB-1.181 - Ready-Mixed Organic Zinc-Rich Coating.

.4 Canadian Standards Association (CSA):

.1 CSA A23.1/CSA A23.2 - Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete.

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

.3 CSA A23.4 - Precast Concrete - Materials and Construction.

.4 CSA-A3000 - Cementitious Materials Compendium.

.5 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.6 CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.7 CSA S6 PACKAGE Consists of S6 - Canadian Highway Bridge Design Code and S6.1 - Commentary on S6, Canadian Highway Bridge Design Code.

.8 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.9 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.10 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.11 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Provide the following Shop Drawings:

.1 Prepare and submit Shop Drawings of precast/prestressed structural concrete in accordance with CSA A23.4 and CSA A23.3, and as specified below.

.2 Submit detailed and dimensional drawings showing and including to the following:

.1 Design calculation for items designed by the Manufacturer.

.2 Typical details of prestressed and non-prestressed members, reinforcement, and connections.

.3 Estimated camber.

.4 Finish schedules.

.5 Methods of handling and erection.

.6 Openings, sleeves, inserts and related reinforcement.

.7 Show locations of inserts and anchors to cast into precast/prestressed units.

.3 All Shop Drawings and calculations are to be sealed by a Professional Engineer registered in the Province of Manitoba.

1.4 Quality Assurance

.1 Fabricate and erect precast concrete elements by manufacturing plant certified in appropriate category(ies) to CSA A23.4.

.2 Precast concrete Manufacturer to be certified to CSA's certification procedures for precast concrete plants.

.3 Only precast elements fabricated in such certified plants are acceptable. Plant certification is to be maintained for duration of fabrication, erection, and during the Warranty Period.

.4 Welding companies certified to CSA W47.1.

.5 Source Quality Control:

.1 Make available copies of quality tests related to this project to CSA A23.4.

.2 Inspect prestressed concrete tendon to CSA A23.4.

.3 Upon request make available records from in-house quality control program based upon plant certification requirements for inspection and review.

.4 Upon request make available certified copy of mill test reports of steel reinforcement supplied, showing physical and chemical analysis.

.5 In addition to quality control an independent inspection and testing company is to be retained by Design Builder to verify compliance with the Final Design. Reports prepared by the independent inspection and testing company are to be submitted for review.

2. PRODUCTS

2.1 Performance Criteria

.1 Requirements: design and fabricate precast/prestressed structural concrete elements, brackets, and anchorage devices so that when installed they will:

.1 Provide a minimum service life of eighty (80) years in a wastewater facility located in Winnipeg, Manitoba.

.2 Meet Post-Disaster requirements as required by the MBC and National Building Code of Canada (NBCC).

.3 Support design loads as specified in the Final Design.

.4 Meet deflection limits as specified in the Final Design.

.2 Special Surface Treatments:

.1 All exposed anchors and plates with less than 38 mm of concrete cover are to be stainless steel.

.2 Hardware to be protected from exposure by a minimum of 38 mm concrete can be either stainless steel, hot dipped galvanized, electro-zinc plated, or shop coated with grey oxide primer.

.3 Double tee side weld plates are to be stainless steel.

.3 Finishes of formed surfaces:

.1 Finishes are to be (a) Commercial Grade, (b) Standard Grade, (c) Finish Grade B, or (d) Finish Grade A to CSA A23.4.

.4 Allowable Tolerance:

.1 Conform to the requirements of CSA A23.4.

.2 Refer to related Sections of this Specification and fabrication work to accommodate the specified tolerance.

2.2 Materials

.1 Cement to CAN/CSA-A3000, type GU.

.2 Blended hydraulic cement: type GUb to CAN/CSA-A3000.

.3 Water: conform to CSA A23.1.

.4 Reinforcing steel: conform to CAN/CSA-G30.18.

.5 Prestressing steel tendons and bars: conform to CSA S6.

.6 Welded wire fabric: conform to ASTM A1064/A1064M.

.7 Hardware and miscellaneous materials: conform to CSA A23.1.

.8 Forms: conform to CSA A23.4.

.9 Anchors and Supports: conform to CSA G40.20/G40.21 Type 300 W primed after fabrication.

.10 Welding materials: conform to CSA W48.

.11 Welding electrodes: conform to CSA W48 certified by Canadian Welding Bureau (CWB).

.12 Galvanizing (Hot dipped galvanizing): conform to ASTM A123/A123M for steel shapes and to ASTM A153/A153M for hardware.

.13 Epoxy coating: conform to ASTM A775/A775M.

.14 Steel primer: conform to CAN/CGSB-1.40 MPI #23.

.15 Zinc-rich primer: conform to CAN/CGSB-1.181 MPI #18.

.16 Bearing pads: neoprene pads as required by precast Manufacturer.

.17 Air entrainment admixtures: conform to ASTM C260.

.18 Chemical admixtures: as required by precast Manufacturer.

.19 Shims: stainless steel.

.20 Weep hole tubes: purpose made plastic.

.21 Insulation: board and semi-rigid insulation.

2.3 Concrete Mixes

.1 Concrete mixes to conform to CSA A23.1. Deliver concrete under Performance Alternative as outlined in CSA A23.1, Table 5:

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

.1 Workability: free of surface blemishes, loss of mortar, colour variations and segregation.

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

.1 Durability and class of exposure: C-1.

.2 Minimum compressive strength at fifty-six (56) days age: 35 MPa.

.3 Provide quality management plan to ensure verification of concrete quality to specified performance.

.1 Concrete supplier's certification.

.2 Grout

.1 Shrinkage compensating grout: to Section 03600.

2.4 Manufactured Units

.1 Manufacture units to conform to CSA-A23.4.

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

.3 Provide hardware suitable for handling elements.

.4 Design tendons and anchorages and install post tensioning ducts to CSA-A23.3.

.5 Shop prime anchors and steel inserts after fabrication and touch up primer on anchors after welding. Do not apply primer to embedded portion of anchor or inserts.

2.5 Finishes

.1 Precast units to be smooth with a sand-float finish and completed in plant prior to delivery.

.2 Colour: natural.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in Schedule 18 Technical Requirements.

3.2 Erection

.1 Do precast concrete work to conform to CSA A23.4, CSA A23.3, and CSA S6.

.2 Do welding to conform to CSA W59 for welding to steel structures and to CSA W186 for welding of reinforcement.

.3 Fasten precast unit in place as indicated in the Final Design.

END OF SECTION

PRECAST CONCRETE PANELS

1. GENERAL

1.1 Summary

.1 This Section specifies:

.1 Precast concrete wall panels.

.2 Field sealing of all precast concrete wall panels inside where accessible and outside between precast panels and between precast and foundation walls.

.3 Requirements for cast in work boxes, inserts, and openings required by other trades.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

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

.1 ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardwar.

.3 ASTM C260/C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

.4 ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers, Tension.

.5 ASTM D2240 - Standard Test Method for Rubber Property, Durometer Hardness.

.2 Canadian Prestressed Concrete Institute (CPCI):

.1 CPCI Handbook.

.3 Precast/Prestressed Concrete Institute (PCI):

.1 PCI MNL 117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.

.2 PCI MNL 120 - PCI Design Handbook Precast and Prestressed Concrete.

.4 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-1.40 - Anticorrosive Structural Steel Alkyd Primer.

.2 CAN/CGSB-1.181 - Ready-Mixed Organic Zinc-Rich Coating.

.5 Canadian Standards Association (CSA):

.1 CSA A23.1/CSA A23.2 - Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete.

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

.3 CSA A23.4 - Precast Concrete - Materials and Construction.

.4 CSA-A3000 - Cementitious Materials Compendium.

.5 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.6 G279 - Steel for Prestressed Concrete Tendons.

.7 CSA S6 Package Consists of S6 - Canadian Highway Bridge Design Code and S6.1-Commentary on S6, Canadian Highway Bridge Design Code.

.8 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.9 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.10 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.11 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit the following Shop Drawings:

.1 Prepare and submit Shop Drawings in accordance with CSA A23.4 and CSA A23.3, and as specified below.

.2 Submit fully detailed and dimensioned Drawings showing method of fastening and sealing. Indicate type of finish and other pertinent information on each Shop Drawing.

.3 Show exact location of inserts and anchors required to be cast in precast units for interface elements.

.4 Show the system of identifying units for erection purposes on Shop Drawings and apply a similar mark on units at time of manufacture.

.5 Provide Shop Drawings prior to fabrication of the precast panels.

.6 Submit relevant design data prepared by the designer.

.7 Submit detailed calculations and design drawings for typical precast elements and connections.

.8 Submit Shop Drawings sealed by a Professional Engineer registered in the Province of Manitoba.

.3 Provide samples of precast cladding for review and as follows:

.1 Minimum sample size: 300 mm x 300 mm x 25 mm.

.2 Sample finishes are to be representative of finishes specified in the Final Design. Work is to match the reviewed production run panel colour range.

1.4 Quality Assurance

.1 Fabricate precast concrete elements certified by the CSA in the appropriate categories according to CSA A23.4. Precast concrete Manufacturer to be certified to CSA certification program for architectural and structural precast concrete in the following categories:

.1 Precast Concrete Products – Architectural: non-prestressed or prestressed.

.2 Precast Concrete Products – Structural: non-prestressed or prestressed.

.3 Precast Concrete Products – Specialty: non-prestressed or prestressed.

.2 Precast concrete Manufacturer is to be a member in good standing with CPCI and have a proven record and satisfactory experience in design, manufacture, and erection of precast concrete facing units of the type specified.

2. PRODUCTS

2.1 Performance Criteria

.1 Design precast elements to CSA A23.3, CSA A23.4, CSA S6 and to resist handling, stockpiling, shipping, and erection stresses.

.2 Requirements: provide panels, brackets, and anchorage devices to meet the following:

.1 Compensate for allowable construction tolerance in structure.

.2 Tolerate structural deflection of span/360 due to live load and distortion of structure without imposing load on panel assembly.

.3 Sustain the panels themselves and superimposed wind and snow loads without exceeding deflection of span/360.

.4 Permit no water infiltration into the building under design loads.

.3 Provide precast elements to carry loads required for the Final Design. Design is to include resistance to creep, shrinkage, and temperature effects, as well as wind loads.

.4 Carry out vibration analysis and testing.

.5 Design connections and attachments of precast elements to load and forces required for Final Design. Connections to withstand long term corrosion for exposed elements.

.6 Tolerance of precast elements to CSA A23.4.

.7 Length of precast elements not to vary from design length by more than plus or minus 6 mm.

.8 Deviations from straight lines not to exceed 3 mm in 10 m.

.9 Cross sectional dimensions of precast elements not to vary from design dimensions by more than plus or minus 6 mm.

.10 Precast elements not to vary by more than plus or minus 6 mm from true overall cross-sectional shape as measured by difference in diagonal dimensions.

2.2 Materials

.1 Cement, grey cement, white cement, colouring material, aggregates, water admixture: conform to CSA A23.4 and CSA A23.1.

.2 Aggregate and any special facing materials: stone type and size to designer's requirements.

.3 Use same brands and source of cement and aggregate for all Work to ensure uniformity of colouration and other mix characteristics.

.4 Reinforcing steel: conform to CSA A23.4.

.5 Forms: conform to CSA A23.4.

.6 Hardware and miscellaneous materials: conform to CSA A23.4.

.7 Anchors and Supports: conform to CSA G40.20/G40.21, Type 300W.

.8 Welding materials: conform to CSA W47.1 and CSA W186.

.9 Galvanizing: hot dipped galvanizing to conform to ASTM A123/A123M for steel shapes and ASTM A153/A153M for hardware.

.10 Steel primer: conform to CGSB 1-GP-40M.

.11 Air entrainment admixtures: conform to ASTM C260, refer to CSA A23.1 for location and exposure requirements.

.12 Chemical Admixtures: conform to CSA A23.1.

.13 Bearing pads: smooth, high impact plastic or steel to suit application and exposure to chemicals.

.14 Bearing pads: neoprene, 50 to 70 shore A durometer hardness to ASTM D2240, and 17 MPa minimum tensile strength to ASTM D412, moulded to size or cut from moulded sheet.

.15 Shims: plastic or steel to suit application and exposure to chemicals.

.16 Zinc rich primer: conform to CAN/CGSB 1.181.

.17 Curing compound: not permitted without prior approval of Professional of Record and the City.

2.3 Concrete Mixes

.1 Concrete mixes to conform to CSA A23.1. Deliver concrete under performance alternative as outlined in CSA A23.1, Table 5:

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

.1 Workability: free of surface blemishes, loss of mortar, colour variations and segregation.

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

.1 Durability and class of exposure: C-1.

.2 Minimum compressive strength at fifty-six (56) days age: 35 MPa.

.3 Facing matrix: use white or grey cement.

.1 Provide quality management plan to ensure verification of concrete quality to specified performance: concrete supplier's certification.

.4 Air entrainment of concrete mix: refer to CSA A23.4.

.5 Use of calcium chloride is not permitted.

.2 Grout:

.1 Shrinkage compensating grout: to Section 03600.

2.4 Reinforcement and Anchors

.1 Reinforcing steel: to CSA G30.18.

.2 Welding: to CSA W186.

.3 Pre-stressed panels: to CSA A23.3.

.4 Paint anchors after fabrication with zinc rich primer. Touch-up anchors with zinc rich primer after welding.

2.5 Fabrication

.1 Manufacture units to CSA A23.4.

.2 Mark each precast unit to correspond to identification mark on Shop Drawings for location with date cast on part of unit that is not to be exposed.

.3 Design and attach anchors and inserts to precast concrete elements to carry design loads.

.4 Shop prime anchors after fabrication and touch up primer on anchors after welding. Do not apply primer to embedded portion of anchors or inserts.

.5 Galvanize anchors after fabrication and touch up with zinc rich primer after welding.

.6 Ensure surfaces to receive sealant are smooth and free of laitance to provide a suitable base for adhesion. Ensure that release agents do not deleteriously affect the sealing of the joints.

.7 Cast panels in accurate rigid moulds designed to withstand high frequency vibration. Set reinforcing anchors and auxiliary items as specified on the Shop Drawings. Cast in anchors, blocking, and inserts supplied by other Sections as required to accommodate the Work.

.8 Anchors, lifting hooks, shear bars, spacers, and other inserts or fittings: as recommended and/or designed by Manufacturer for a complete and rigid installation. Size lift hooks to safely handle panels according to panel dimension and weight. Conceal anchors/inserts where practical.

.9 Burn off exposed lift cables paint and fill in if required.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Erect precast work to CSA A23.4.

.4 Supply anchors for precast units required to be cast into the concrete frame for installation. Supply layout Drawings locating accurately the position of all cast in items set out in the Final Design.

.5 Provide certified copies of quality control tests as specified in CSA A23.4.

.6 Inspect prestressed concrete tendons to CSA G279.

.7 Provide records from in house quality control program based upon plant certification requirements.

.8 Upon request, provide certified copy of mill test report of reinforcing steel supplied, showing physical and chemical analysis.

.9 Precast plants to keep complete records of supply source of concrete material, steel reinforcement, and pre-stressing steel and provide upon request.

.10 Erect precast elements with allowable tolerances to CSA A23.4.

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

.12 Fasten precast panels in place in accordance with the Final Design.

3.2 Delivery, Storage and Handling

.1 Deliver, handle, and store precast units in a near vertical plane at all times, and by methods approved by the Manufacturer. Do not permit units to contact the ground or staining influences or to rest on corners.

3.3 Finishes

.1 Sack rubbed finish and colour of precast units on all exposed surfaces.

END OF SECTION

PRECAST CONCRETE

1. GENERAL

1.1 Summary

.1 This Section specifies materials and installation for precast concrete fabrications.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

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

.1 ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2 in. or 50 mm cube specimens).

.2 ASTM C330/C330M - Lightweight Aggregates for Structural Concrete.

.3 ASTM C260/C260M - Air Entraining Admixtures for Concrete.

.4 ASTM C494/C494 - Chemical Admixtures for Concrete.

.5 ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

.6 ASTM C939/C939M - Standard Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method).

.2 Canadian Standards Association (CSA):

.1 CSA A23.1/CSA A23.2 - Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete.

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

.3 CSA A23.4 - Precast Concrete - Materials and Construction.

.4 CSA-A3000 - Cementitious Materials Compendium.

.5 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.6 G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel.

.7 CSA S6 Package - Consists of S6 - Canadian Highway Bridge Design Code and S6.1-Commentary on S6, Canadian Highway Bridge Design Code.

.8 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.9 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.10 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.11 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit Shop Drawings indicating reinforcement, anchorage to adjacent work, composite materials, details, and other information to accurately describe the Work of this Section.

.3 Samples for verification: submit two (2) 300 mm by 300 mm samples of precast concrete indicating formed surface texture, colour, aggregates, and corner condition.

2. PRODUCTS

2.1 Materials

.1 Portland cement: conform to CSA A3001.

.2 Supplementary cementing materials: to CSA A3000.

.3 Water: to CSA A23.1.

.4 Aggregates: to CSA A23.1.

.5 Air entraining admixture: to ASTM C260/C260M.

.6 Chemical admixtures: to ASTM C494/C494M. Use of accelerating or set retarding admixtures for cold and hot weather placing to approval designers.

.7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents:

.1 Compressive strength: 50 MPa at twenty-eight (28) days.

.2 Consistency:

.1 Fluid: conform to ASTM C827/C827M. Time of efflux through flow cone, under thirty (30) seconds conform to ASTM C939/C939M.

.2 Flowable: conform to ASTM C827/C827M. Flow table, five (5) drops in three (3) seconds, conform to ASTM C109/C109M, applicable portion 125 to 145 percent.

.3 Plastic: conform to ASTM C827/C827M. Flow table, five (5) drops in three (3) seconds, conform to ASTM C109/C109M, applicable portions 100 to 125 percent.

.4 Dry pack: to manufacturer's requirements.

.3 Net shrinkage at twenty-eight (28) days: maximum 6 percent.

.8 Reinforcing steel: conform to CSA G30.18, 400 MPa yield grade deformed billet steel bars.

.9 Curb anchors: steel dowels or pins to CSA G30.18, minimum 15 mm diameter x 600 mm length.

2.2 Concrete Mixes

.1 Concrete mixes to conform to CSA A23.1. Deliver concrete under Performance Alternative as outlined in CSA A23.1, Table 5.

.2 Determine the following concrete mix parameters to conform to CSA A23.1:

.1 Cement type.

.2 Minimum compressive strength at twenty-eight (28) days.

.3 Class of exposure.

.4 Maximum water/cement ratio.

.5 Nominal size of coarse aggregate.

.6 Slump at time and point of discharge.

.7 Air content category.

.8 Chemical admixtures to conform to ASTM C494M.

.9 Supplementary cementing material type to conform to CSA A3000.

2.3 Fabrication

.1 Fabricate: to conform to CSA A23.4 unless more stringent requirements are set out in Final Design.

.2 Finish: standard grade.

.3 Determine the number of holes to be fabricated per unit to permit securing with curb anchors.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

CONCRETE FINISHES

1. GENERAL

1.1 Summary

.1 This Section specifies the concrete finishing requirements.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

.1 Canadian Standards Association (CSA):

.1 CSA A23.1/CSA A23.2 - Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit the proposed mix design statements in accordance with Section 03300 for all mixes and quality assurance procedures and achieve “Reviewed” a minimum of four (4) weeks prior to their initial use.

.3 Submit data sheets for all proposed pre-mixed grouts.

.4 Submit data on all concrete accessories specified or proposed.

.5 Indicate method of application for all concrete finishes.

2. PRODUCTS

2.1 Formed Surfaces

.1 Architectural concrete finish for exposed exterior concrete surfaces: conform to CSA A23.1, Clause 7.10 - Finishing of formed surfaces, Subclause 7.10.2.6 - Smooth-form finish, and in accordance with procedures under Section 8 – Concrete with special performance or material requirements, with patching to be done in accordance with Subclause 7.10.3 - Patching.

.2 Smooth-form finish for exposed interior concrete surfaces, including exposed concrete columns: conform to CSA A23.1, Clause 7.10 - Finishing of formed surfaces, Subclause 7.10.2.6 - Smooth-form finish, with patching to be done in accordance with Subclause 7.10.3 - Patching.

.3 Rough-form finish for all concealed concrete surfaces, including also exposed surfaces of elevator shafts, pits, and trenches: conform to CSA A23.1, Clause 7.10 - Finishing of formed surfaces, Subclause 7.10.2.5 - Rough Form Finish.

.4 Finish concrete floors and floor toppings with a smooth, dense, steel trowel finish with a Class A Flatness Classification in accordance with CSA A23.1, Table 21. Overlay toppings to level floors are not permitted.

.5 Slope floor to drains.

.6 Concrete floor finishing: floors having a straightedge value of plus or minus 6 mm over 3050 mm with overall F-number of F_F 25 x F_L 20; meet requirements for CSA A23.1, Table 21, Class B slab finishing.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

GROUT

1. GENERAL

1.1 Summary

.1 This Section specifies grout for columns and other structural support bases, equipment bases, crack repair, surface repair, and uses other than masonry.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

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

.1 ASTM C230/C230M - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.

.2 ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.

.3 ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

.4 ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

.5 ASMT C882/C882M - Standard Test Method for Bond Strength for Epoxy-Resin Systems Used with Concrete by Slant Shear.

.6 ASTM C939/C939M - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).

.7 ASTM C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.

.8 ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

.9 ASTM C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

.2 Corps of Engineers (COE):

.1 COE CRD-C611 – Flow of Grout for Preplaced Aggregate Concrete.

.2 COE CRD-C621 – Specification for Nonshrink Grout.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Complete product Shop Drawing with literature and installation instructions for epoxy grout (all uses) and cementitious non-shrink grout.

.3 Current International Code Council (ICC) evaluation report for all adhesive devices used for dowel and anchor setting.

2. PRODUCTS

2.1 Manufacturer and Products

.1 Cementitious Non-shrink Grout:

.1 Cementitious non-shrink non-metallic aggregate grout.

.2 Acceptable products:

.1 Five Star Grout by Five Star Products, Inc.

.2 Masterflow 928 by Master Builders.

.3 Non-Shrink Grout by Burke Company Non-Ferrous.

.4 Hi-Flow Grout by Euclid Chemical Company.

.5 Or approved equivalent.

.2 Epoxy Grout for Equipment Mounting:

.1 Epoxy grout for equipment mounting is to be a non-cementitious, resin based, multi-component formulation. Epoxy grout is to be flowable, with shrinkage minimized to achieve minimum 98 percent effective bearing area.

.2 Acceptable products:

.1 Masterflow 648 CP Plus by Master Builders.

.2 Sikadur 42 by Sika Corporation.

.3 E3-G by Euclid Chemical Company.

.4 Or approved equivalent.

.3 Adhesive for Dowel and Anchor Setting:

.1 Adhesive for setting dowels and anchoring connection/base plate bolts to be an injectable two-component epoxy adhesive. Provide adhesives for the intended use per the product ICC evaluation report.

.2 Acceptable products:

.1 HIT-RE 500 V3 / HIT-HY 200 by Hilti.

.2 Or approved equivalent.

.4 Concrete Repair Mortar:

.1 Horizontal repair mortars acceptable products:

.1 Emaco S66 CI by BASF.

.2 SikaTop 111 Plus by Sika Corp.

.3 Or approved equivalent.

.2 Vertical and overhead applications repair mortars acceptable products:

.1 SikaTop 123 Plus.

.2 Or approved equivalent.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Cementitious Non-shrink Grout

.1 Non-shrink, cementitious, non-metallic aggregate grout is to be used for column base plates, structural bearing plates, and all locations where the general term "non-shrink grout" is required by the Final Design.

.2 Install grout to support the bearing surfaces of machinery as specified in Section 11002 or as required by the Final Design for specific pieces of equipment.

.3 Install and cure grout in accordance with Manufacturer's instructions.

.4 Non-shrink cementitious grout is not to be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

3.3 Epoxy Grout for Equipment Mounting

.1 Prepare concrete surfaces of equipment pads as required by the Final Design and as required by the epoxy grout Manufacturer.

.2 Epoxy grout for equipment mounting is to be placed and cured in accordance with the requirements of Section 11002, and the Final Design, and in strict conformance with Manufacturer's recommendations.

3.4 Concrete Repair Mortar

.1 The designers are to include in the Construction Quality Management Plan the procedures to repair concrete mortar. Concrete mortar repair materials and procedures are to be included in the Construction Quality Management Plan and are to be approved by the designers prior to commencement of the repair work.

.2 Follow all Manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation, and curing. Add aggregate as required per Manufacturer's recommendations. Any deviations from the Manufacturer's instructions are to be submitted for review and approved by the designers prior to commencement of the Work.

END OF SECTION

HYDROSTATIC TESTING

1. GENERAL

1.1 Summary

.1 This Section specifies requirements for hydrostatic testing of concrete water retaining structures.

1.2 Standards

.1 All codes and standards to be latest edition unless noted otherwise.

.2 American Concrete Institute (ACI):

.1 ACI 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures & Commentary.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 03000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit hydrostatic testing plan and procedures at least ten (10) days prior to commencement of testing.

.3 Submit hydrostatic testing results after completion of all tests.

2. PRODUCTS

2.1 Material

.1 All equipment, material, and water required for hydrostatic testing to be supplied by Design Builder.

.2 Water for hydrostatic testing in waterworks system to be clean water.

.3 Water for hydrostatic testing of structures that will not contain potable water shall be clean water, not containing chemicals or any substances likely to cause harm.

.4 Coordinate with City for use of potable water regarding costs, uses, and time of use. Refer to the Schedule 18 Technical Requirements for restrictions.

2.2 Safety

.1 Toxicity of any product to be investigated by Design Builder.

.2 Prior to use or application check the need for ventilation when installing and required protective equipment, such as gloves, goggles, and masks.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Hydrostatic Testing

.1 Concrete tanks and channels to be subjected to hydrostatic testing following installation.

.2 Each water retaining structure and compartment shall be watertight and all precautions shall be taken, especially joint treatment and penetrations, to construct watertight structures.

.3 Hydrostatic testing shall be performed prior to damp-proofing, backfilling of materials against walls, and prior to installation of any specialty concrete coatings.

.4 Perform hydrostatic testing for each water retaining compartment. Hydrostatic testing to be performed according to ACI 350.1, except as described in following clauses.

.5 Filling structures in preparation of hydrostatic test shall be performed only after floor, walls, and roof concrete have attained 100 percent of design strength.

.6 Fill structure to level set out in the Final Design or to 300 mm from top of walls, whichever is greater, for a minimum of seventy-two (72) hours prior to hydrostatic test to allow for full saturation of concrete. Monitor water retaining structure for visible leaks.

.7 Repair all leakage around pipe penetration and openings and leaking dry temperature and shrinkage cracks and dry temperature and shrinkage cracks that appear damp and transfer moisture from structures exterior surfaces to a dry hand to stop all leakage and dampness to satisfaction of the Professional of Record. Epoxy injection is an acceptable repair method; see Section 03300.

.8 Prior to filling compartments with water, ensure penetrations such as pipes, gates, and below water level openings meet the Manufacturer's requirements for water tightness.

.9 Hydrostatic test duration shall be at least the theoretical time required to lower the water surface 10 mm, and shall be at least two (2) days, but need not be longer than five (5) days. Rate of loss of water shall not exceed 0.05 percent of total volume per twenty-four (24) hour period. Measurements shall be adjusted for evaporation and precipitation for open or well-ventilated structures.

.10 Locate and repair all leaks until all leakage is remedied and repeat hydrostatic test for duration indicated following each repair operation.

END OF SECTION