

1.0 GENERAL

1.1 Documents

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description of Work Included

- .1 Provide all labour, materials, equipment, access, cooperation, coordination, and services to allow the testing of concrete and concrete reinforcement to be carried out by a Testing Agency.
- .2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and to allow the Contractor to make appropriate allowances.
- .3 It is the responsibility of the Contractor to schedule the testing described, to coordinate construction schedules with the Testing Agency, and to cooperate with the Testing Agency in the execution of this work.
- .4 Testing required by the Contractor for the Contractor's own quality control or as noted in clause 1.6.3 will be paid for by the Contractor.

1.3 Related Work Specified Elsewhere

- .1 Section 03 20 00 – Concrete Reinforcing
- .2 Section 03 30 00 – Structural Cast-in-Place Concrete

1.4 Reference Standards

- .1 Testing of concrete and reinforcement shall conform to the requirements of the following Building Code:
 - .1 Ontario Building Code - 2012 0 REG 88/19
- .2 Testing of concrete and reinforcement shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
 - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete

- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 "Owner", "Contractor", and "Consultant" as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Testing Agency" shall mean a third party testing and inspection agency.
- .4 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 Appointment of Testing Agency

- .1 A CSA-approved Testing Agency shall be appointed to test concrete, reinforcement, and grout as per this specification and shall include:
 - .1 Review of initial mix designs.
 - .2 Testing as outlined in Article 3.0.
- .2 Unless stated otherwise in Division 0 / Division 1, the Testing Agency shall be engaged by the Owner.
- .3 The Contractor shall pay for testing not covered in clause 1.6.1., which shall include but not be limited to:
 - .1 Review of Contractor-requested mix design changes.

- .2 Any waiting time incurred by the Testing Agency in excess of 30 minutes.
- .3 Testing required by the Contractor for stripping of formwork, such as field-cured cylinders, etc.
- .4 Any additional costs due to overtime, shift work, holiday or weekend work, except that the Owner will pay for holiday or weekend pickup when the concrete was placed on a regular workday.
- .5 Retesting or additional testing of concrete or reinforcement where tests have failed to meet the specified requirements.

2.0 DUTIES

2.1 Responsibility of the Contractor

- .1 The Contractor shall cooperate fully with the Testing Agency.
- .2 The Contractor shall give the Testing Agency at least 24 hours prior notice of concrete placement.
- .3 It is the Contractor's responsibility to provide a finished product that meets the specification. If initial tests indicate that the concrete failed to meet the specification, the Consultant shall decide if any additional testing is necessary. This testing shall be done by a CSA-approved Testing Agency, but need not be the Owner's agency. The proposed additional testing shall have prior approval of the Consultants.
- .4 Strengths of cored samples must equal the specified strength if tested dry or 85% of specified if tested wet, with wet or dry tests as per the Standard.

2.2 Responsibility and Duties of the Testing Agency

- .1 The Testing Agency has the authority to, and is expected to reject any concrete, not meeting the specifications.
- .2 All testing results and reviews performed by the Testing Agency shall be submitted to the Consultant.
- .3 The Testing Agency shall immediately notify the Consultant if concrete is being placed without their notification, or if insufficient notice is provided.
- .4 Bring low 7-day, 28-day, and 56-day strength tests to the immediate attention of the Consultant and the Contractor.

- .5 At the completion of the project, the Testing Agency to provide a signed letter to the Owner, with a copy to the Consultant. The letter shall confirm that testing has been carried out as per the specifications and that the Contractor and Consultant have been notified of any deficiencies in material properties.

3.0 TESTING - CONCRETE AND REINFORCEMENT

3.1 General

- .1 All strength tests shall be numbered consecutively and the cylinders marked as follows:
 - .1 7-Day Test: Marked "A".
 - .2 28-Day Test: Two cylinders marked "B" and "C".
- .2 All tests reports shall record:
 - .1 Name of Project
 - .2 Date and time of sampling
 - .3 Name of supplier
 - .4 Delivery truck number
 - .5 Batch time and discharge time
 - .6 Identification of sampling and testing technicians
 - .7 Exact location in the structure of the concrete sampled
 - .8 Design strength of concrete sampled
 - .9 Admixtures, cement type, maximum aggregate size
 - .10 Air and concrete temperature
 - .11 Slump, and air content
- .3 All field-cured cylinders shall be marked "F".
- .4 Slump tests shall be performed prior to the addition of superplasticizers.
- .5 Tests for slump and air content shall be taken with each strength test and as required by the specifications and drawings.

3.2 Regular Testing - Concrete

- .1 To conform to the Standard, except each test shall consist of three cylinders - one for 7-day strength and two for 28-day strength.
- .2 Regular testing applied to all elements not listed in Clause 3.3 - Full Time Testing.

3.3 Full-Time Testing - Concrete

- .1 Full time testing shall apply to:
 - .1 Concrete specified as exposure class F-2, and C-1 in non-parking applications.
- .2 Full time testing shall conform to the Standard and regular testing except:
 - .1 The Testing Agency shall have a representative on the job site at all times that the concrete requiring full time testing is being placed.
 - .2 Test the slump and air content from every truck and reject any concrete not within specification.
- .3 Full time testing applies for the duration of the project as follows:
 - .1 Provide full-time testing for all elements listed in 3.3.1 and for each mix type by the Supplier until the satisfactory control of the concrete mix is established by the Testing Agency.
 - .1 For slump and air content, satisfactory performance shall be established from test results on not less than 5 consecutive batches of concrete placed.
 - .2 For strength, satisfactory performance shall be established from 28-day test results in comparison to data from trial batches as defined in 03 30 00 on not less than 5 consecutive tests placed within a period of 24 to 48 hours.
 - .2 The Testing Agency shall notify the Contractor and Structural Consultant in writing that Regular Testing can be used with a testing frequency for the mix reduced to a rate not less than 1 test every 100 cu. m. The first and last batch of concrete to be placed each day shall always be tested.

- .3 Where Regular Testing has been initiated for a mix, the Testing Agency shall resume Full Time Testing per 3.3.2 if any test fails to satisfy the Standard, the agreed strength criteria or as directed by the Structural Consultant or Owner.
- .4 Where a mix type has not been utilized on the project for more than 30 consecutive days, Full Time Testing shall apply until satisfactory compliance with this Standard is re-established.

3.4 Field-Cured Cylinders

- .1 Field-cured cylinders shall be protected against wind and stored on the floor immediately below the slab they represent, unless the floor below is heated. In that case, they shall be stored on top of the slab but covered with a plywood box. The cylinders are to be undisturbed at this location until picked up by the Testing Agency. Field-cured cylinders are not to be stored in temperature-controlled containers.

3.5 Testing of Reinforcing Bars and Accessories

- .1 The Testing Agency shall, over the duration of the project, perform at least one tensile and bend test for each bar size and mill stamp used on the project. Such testing shall comply with the applicable CSA documents. Further testing may be requested at the Consultant's discretion.
- .2 The Testing Agency will select the bars to be tested from the reinforcing supplied to the construction site, not from the suppliers' yard. The Contractor shall cut the bars to the required length and replace the shortened bars without cost to the Owner.
- .3 The Contractor shall supply mill certificates of chemical analysis in accordance with CSA G30.18R and G30.18W for all bar supplied to site.
- .4 Cut samples of mechanical splices and welded reinforcement as directed by the Consultant. Replace mechanical splices and welded reinforcement cut out for testing.
- .5 When requested, provide samples of support accessories (chairs, bolsters, spacers) that are intended to be used.

END OF SECTION

1.0 GENERAL

1.1 Documents

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description of Work Included

- .1 Provide all labour, materials, equipment, and services necessary to supply, erect, and strip all formwork and falsework for poured-in-place concrete shown or indicated on the contract drawings and specifications.
- .2 Install all anchor bolts, embedded metal, inserts, hangers, reglets, dovetail anchors, etc. supplied by applicable trades for casting into concrete, and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.
- .3 Install all openings, sleeves, block-outs, etc. required by other trades and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.

1.3 Related Work Specified Elsewhere

- .1 Section 03 20 00 – Concrete Reinforcing
- .2 Section 03 30 00 – Structural Cast-in-Place Concrete

1.4 Reference Standards

- .1 Concrete formwork shall conform to the requirements of the following Building Code:
 - .1 Ontario Building Code - 2012 0 REG 88/19
- .2 Concrete formwork shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
 - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
 - .3 CSA A23.3 – Design of Concrete Structures
 - .4 CSA S269.1 – Falsework and Formwork

- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 "Owner", "Contractor", and "Consultant" as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 Submittals

- .1 Shop Drawings for Formwork, Falsework, and Re-Shoring
 - .1 The structural drawings shall not be reproduced, in whole or in part, for use as shop drawings.
 - .2 Well in advance of construction, submit to the Consultant drawings showing the complete design of the slab formwork, falsework, and re-shoring systems stamped by a qualified Professional Engineer licensed in the Province of Ontario.
 - .3 As a minimum, show the following:
 - .1 Stripping schedule;
 - .2 Sequence for installing re-shores;
 - .3 Number of slabs re-shored at any given time;
 - .4 Formwork details related to stripping and re-shoring;

- .5 Locations of proposed construction joints; and
- .6 Camber.
- .4 When requested, submit a written proposal for review by the Consultant as to how the specified cambers are to be achieved, in the field.
- .5 Opening information
 - .1 Submit drawings of the structure showing formed holes, recesses, and sleeving required under all Sections.
- .6 As-Built Drawings
 - .1 Mark on a complete set of final reproducible drawings any changes, additions, or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reason.

2.0 PRODUCTS

2.1 General

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 Materials

- .1 Form Material
 - .1 Exposed surfaces - High-density overlay form ply (Ainsworth 107 or preapproved equal), metal, plywood, or plywood lined. Plywood to conform to the Standard.
 - .2 Unexposed surfaces - metal, plywood, or wood lumber to conform to the Standard.
 - .3 Plywood and wood formwork materials shall conform to the Standard, and be free from warp and sawn straight so that lines and shapes will be accurately retained.
 - .4 Un-lined forms for unexposed surfaces shall be made with a good grade of lumber or plywood and fitted so that there will be no leakage of mortar.

- .5 Use metal forms, plywood lined forms, or plywood forms of sufficient structural strength for exposed surfaces. Plywood for lining shall be GIS exterior grade fir plywood with waterproof glue.
- .6 Proprietary and/or modular forming systems shall be designed such that they do not interfere with the specified placement of reinforcement or other embedded hardware and must be pre-approved by the Consultant.
- .2 Ties and Spreaders
 - .1 Use metal form ties that are adjustable in length to permit tightening of forms. Use only the snap-off type of form ties, which will permit no metal within 25 mm (1") of the concrete surface after removal. Twisted wire form ties will not be accepted.
 - .2 Wood spreaders inside wall forms will not be permitted.
- .3 Form Release Agent
 - .1 Use a non-staining form release agent that is compatible with any finishes/membranes specified elsewhere in the contract documents.

3.0 EXECUTION

3.1 General

- .1 All phases of concrete formwork construction shall be in accordance with the Standard unless otherwise specified herein or on the drawings. Only workers who are skilled and experienced in their trade shall do the work.

3.2 Lines and Levels

- .1 Verify lines, levels, and column centers before proceeding with work and ensure that dimensions agree with drawings.
- .2 Co-ordinate and co-operate with all other trades in forming and setting of recesses, chases, sleeves, inserts, bolts, and hangers.

3.3 Design of Formwork, Falsework, and Re-Shoring

- .1 Conform to the Standard.

- .2 Design formwork and re-shoring to safely support vertical and lateral loads until they can be supported by the structure. Design formwork for loads and lateral pressures recommended in CSA S269.1. The Contractor shall assume full responsibility for the structural adequacy of the forms to withstand all concrete, environmental, and construction loads.
- .3 Design and provide shoring and bracing to excavations and underpinning to safely withstand any lateral pressures to which they may be subjected.
- .4 See drawings for locations where reinforced concrete members are not structurally stable until walls and slabs intersecting with them have been constructed to the specified level and the concrete has reached at least 70% of the specified strength.
- .5 Design shores for these slabs and walls to safely support the total vertical and lateral loads until the walls and slabs are complete and have reached 70% of their specified strength. Design the shores so that they can be unloaded gradually.
- .6 As a minimum, the work shall conform to the Standard. Refer to "Formwork for special Architectural finishes" in CSA A23.1 for architectural concrete.
- .7 Where concrete is exposed to view, forms are to be laid out so that joints are kept to a minimum and located in an orderly and symmetrical arrangement wherever possible. Form ties shall be evenly spaced and located in straight horizontal and vertical lines. Spacing and location of form tie holes shall be detailed by the Contractor and approved by the Consultant. See also the architectural drawings and specifications for any special requirements for architectural, or exposed, concrete.
- .8 The strength and rigidity of forms shall be such that they will not leak mortar or result in visible irregularities in the finished concrete. In addition, the deflection of facing materials between studs, as well as the deflection of studs and walers, shall not exceed 0.0025 times the span.

- .9 Forms shall be constructed so that the finished concrete will conform to the shape, dimensions, and tolerances as specified in the Standard or on the structural drawing, whichever is most rigorous. They shall also incorporate the cambers specified on the structural drawings. Movement resulting from form support deflection, closure of form joints, and elastic shortening of forms and shoring must be calculated and added to the cambers indicated on the drawings. Coordination to achieve more rigorous tolerances on concrete dimensions required to accommodate the geometric tolerance of various trades and finishes (cladding, structural steel, etc.) shall be completed by the contractor"
- .10 Construct forms so that they may be dismantled and removed without damaging the concrete.
- .11 The Contractor shall submit details of the sequence and extent of formwork removal and re-shoring to the Consultant for review. Such details shall include magnitude of loads and location of all re-shores at each level. Forms shall not be removed or adjusted until the review is complete. Such review does not relieve the Contractor of responsibility for formwork and safety during construction.
- .12 Set shores on wedges or use adjustable shores so they may be removed without causing undue strains in the concrete.
- .13 Do not exceed the safe capacity of the structure with any construction or shoring loads. The safe capacity of the structure may be taken as the design live load, as indicated on the structural drawings, multiplied by the ratio of the concrete strength at the time of loading to the specified concrete strength, but not greater than 1.0.

3.4 Erection

- .1 Sleeves and openings shown on the structural drawings must be confirmed with mechanical, electrical, and architectural drawings. Any discrepancies are to be reported to the Consultant.
- .2 Sleeves and openings not shown on the structural drawings must be approved by the Consultant.
- .3 Keep all untreated forms moist to prevent shrinkage prior to placing of concrete and wet the surface at time of placing.

- .4 Treated formwork surfaces shall have the approved form coating applied in accordance with the manufacturer's recommendations, prior to placing reinforcing steel. Remove any excess form coating. Do not apply form release agent after reinforcing steel has been placed. Ensure reinforcing steel does not come in contact with form release oil.
- .5 Erect, support, brace, and maintain formwork to safely support vertical and lateral loads until they can be supported by the structure.
- .6 All falsework erection shall be supervised by the Professional Engineer responsible for its design.
- .7 All forms shall be inspected by the Contractor prior to the concrete pour to ensure that they have been erected in conformance with the formwork shop drawings.
- .8 Construction
 - .1 Form footing sides unless footings are shown to be placed against undisturbed soil.
 - .2 Construct formwork such that hardened concrete, prior to stripping of forms, is cambered as indicated. Maintain beam depth and slab thickness from cambered surface.
 - .3 Camber slabs and beams 1 in 500 of span unless shown otherwise.
 - .4 Mark building, grid, or other lines on forms to permit the accurate positioning of reinforcing steel.
 - .5 Construct templates and supports to rigidly fix reinforcing dowels in the forms prior to concreting.
 - .6 Provide suitable markers to indicate the location and configuration of continuing concrete members so that dowels can be positioned accurately in relation to their position in the continuing members.
 - .7 Set anchor bolts, templates, steel connection units, hardware, or other inserts into the forms and secure them rigidly so that they do not become displaced during concreting. Set and secure these items to the tolerances specified and required in the appropriate Sections.
 - .8 Build top forms on sloping concrete where required to prevent flow of the concrete out of the forms. Provide vents to top forms to permit air or bleed water to escape from the forms.

- .9 In the case of sloping roof slabs, employ suitable forming procedures compatible with the concrete placing and compaction techniques to ensure that completed concrete has the specified design characteristics and, in particular, to prevent movement of plastic concrete resulting in cracking, loss of bond, etc., and to achieve a surface equivalent to a fine wood float finish suitable to receive the roofing membrane.

.9 Sleeves, Chases and Formed Openings

- .1 Form sleeves, chases, and openings except where such items are specified to be formed or sleeved by the appropriate trade.
- .2 All openings, sleeves, and chases are not necessarily shown on the structural drawings nor are their sizes or locations shown. Refer to architectural, mechanical, and electrical drawings and specifications for openings and sleeving requirements not shown, located, and dimensioned on the structural drawings.
- .3 No sleeves, chases, and openings through structural members shall be formed without RJC's approval.
- .4 All galvanized hardware to be electrically isolated from non-galvanized reinforcing bars unless noted otherwise in details.

3.5 Tolerances

- .1 The tolerances for all concrete work shall conform to the requirements of the Standard and Drawings.
- .2 Variations in building lines that result in extension of the building over lot lines or restriction lines will not be permitted.
- .3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

3.6 Product Handling

- .1 Protect formwork materials before, during, and after installation and protect installed work and materials of other trades.
- .2 In the event of damage, immediately make required repairs or replacements necessary to the approval of the Consultant at no extra cost to the Owners.

3.7 Removal of Formwork

- .1 Forms shall not be removed until concrete has attained sufficient strength that no damage to strength or continuity of concrete will occur when forms are removed. Time for formwork removal of suspended concrete shall be approved by the Consultant. See also the requirements of Article 3.2.
- .2 Prying against face of concrete to remove forms is not allowed, only wooden wedges shall be used.
- .3 Where forms are being reused, thoroughly clean and retreat them.
- .4 Removal of form ties shall be done carefully to avoid marking concrete and to allow for patching. Grout bottom of form tie hole to prevent rust staining.
- .5 As a minimum, conform to requirements of CSA S269.1 and the following:
 - .1 Design of re-shore shall accommodate load distribution resulting from differences in stiffness between storeys such as slabs, transfer floors, and grade.
 - .2 Do not strip within one and a half bays of a construction joint until new concrete beyond the construction joint has reached 75% of its specified 28-day strength.
 - .3 Provide and install adequate shoring to safely support horizontal or inclined members after the 28-day specified strength is achieved where superimposed loads exceed design loads.
 - .4 Side forms for vertical members may be stripped as soon as the concrete is sufficiently strong to stand unsupported and safely resist imposed loads.

3.8 Delay Strips

- .1 Maintain bays containing delay strips and each adjacent bay fully formed and shored until the strip is complete, and has reached its specified 28-day strength. Ensure that the forms and shores are designed so that no settlement of the forms occurs during the period that the strip is open.

END OF SECTION

1.0 GENERAL

1.1 Documents

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description of Work Included

- .1 Provide all labour, materials, equipment, and services necessary to supply and install reinforcing steel work shown or indicated in all the contract drawings and specifications including accessories such as hanger bars, spirals, wire ties, support bars, chairs, spacers, supports, or other devices required to position reinforcing properly.

1.3 Related Work Specified Elsewhere

- .1 Section 03 00 50 – Testing of Concrete and Reinforcement
- .2 Section 03 11 00 – Concrete Forming and Accessories
- .3 Section 03 30 00 – Structural Cast-in-Place Concrete

1.4 Reference Standards

- .1 Concrete reinforcing shall conform to the requirements of the following Building Code:
 - .1 Ontario Building Code - 2012 0 REG 88/19
- .2 Concrete reinforcing shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
 - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
 - .3 CSA A23.3 – Design of Concrete Structures
 - .4 ASTM A1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
 - .5 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement

- .6 CSA W47.1 – Certification of Companies for Fusion Welding of Steel
- .7 Reinforcing Steel Institute of Canada (RSIC) – Manual of Standard Practice
- .8 ASTM A820M – Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
- .9 ASTM C1116M – Standard Specification for Fiber-Reinforced Concrete
- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
- .2 “Specialty Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 Testing

- .1 As per Section 03 00 50 - Testing of Concrete and Reinforcement.

2.0 PRODUCTS

2.1 General

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 Materials

- .1 Reinforcing bars shall conform to the Standard unless otherwise specified herein or on the drawings.
- .2 Reinforcing bars to be welded shall conform to the Standard, G30.18W.
- .3 Welded wire fabric shall conform to the Standard; size and gauges as shown on the drawings.
- .4 Welded wire fabric for slabs shall be delivered in flat sheets.
- .5 In suspended parking slabs, bar support chairs shall be plastic or plastic coated.
- .6 Chairs, Bolsters, Bar Supports, Spacers: To CSA A23.1. In the case of concrete exposed to view or weather, the accessories shall be such that no metal is permitted to come closer than 40 mm (1-5/8") from a formed face and 50 mm (2") from a troweled surface. Use precast concrete supports for exposed concrete beams and soffits and concrete cast against soil/rock. Precast concrete supports shall be made of concrete of quality and strength at least equal to that specified for the member in which they are used.
- .7 Support accessories: Approved plastic or non-corroding type of chair, bolster, or spacer of sufficient strength to rigidly support the weight of reinforcement and construction loads. Do not use plastic-coated or plastic-tipped steel chairs.
- .8 Mechanical Tension Splices: LENTON Couplers, LENTON Transition Couplers, LENTON Formsaver, or LENTON Positional Couplers as manufactured by nVent where appropriate, complete with bar end protectors and coupler end protectors, as supplied by manufacturer. or approved alternative.
- .9 Mechanical Compression Splices: End-Bearing Compression Splice LENTON Speed-Sleeve as manufactured by nVent or approved alternative.

- .10 Steel fibers shall meet the requirements of ASTM A820 Type 1, deformed fibers. Minimum ultimate tensile strength shall be 1036 MPa. Minimum aspect ratio shall be 80. Minimum fiber length shall be 60 mm. Maximum fiber diameter shall be 0.03 inches. Steel fibers shall be Dramix RC 80/60 BN manufactured by Bekaert Corporation.
- .11 Steel fiber concrete shall be proportioned as required in ASTM C1116, alternative 3, in consultation with fiber manufacturer based on the required concrete properties indicated on drawings and specifications.
- .12 Bar Terminators: Anchorage that is at least five (5) times the area of the bar. Provide LENTON Terminator D6 or D16 as manufactured by nVent Inc. or approved alternate.
- .13 Headed Reinforcement: Reinforcement with anchorage that is at least 10 times the area of the bar. Provide LENTON Terminator D14 manufactured by nVent, Taper-Lock D350 manufactured by Dayton Superior or approved alternate.
- .14 Rebar End Welded to Structural Steel: LENTON Weldable Coupler as manufactured by nVent Inc. or approved alternate.

3.0 EXECUTION

3.1 General

- .1 All phases of concrete reinforcement work shall be in accordance with the Standards unless otherwise specified herein or on the drawings. The Contractor shall ensure that the work is executed only by workers skilled and experienced in their trade.
- .2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed in order that the Consultant may review the work.
- .3 Identify with a tag each bundle of bars with a code mark corresponding to that appearing on the bar list.
- .4 Bend reinforcement once only and at room temperature of 18°C. Do not straighten or re-bend reinforcement. Do not use bars with kinks or bends not shown on the drawings.
- .5 Replace bars that develop cracks or splits.
- .6 Non-galvanized reinforcement to be electrically isolated from galvanized steel including but not limited to reinforcement, hardware (sleeves, conduit), embedded plates, structural steel, or window washing anchors.

- .7 Williams All-Thread - Bar must not be welded or subjected to the heat of a torch or used as a ground.

3.2 Field Bending

- .1 Do not field bend reinforcement except where indicated or authorized in writing by the Consultant.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars that develop cracks or splits.

3.3 Construction Joints in Cast-in-Place Concrete

- .1 Obtain acceptance from the Consultant for details of construction joints not shown.
- .2 Continue reinforcement through the joint in its normal position. Add additional reinforcement across the joint as shown or directed. Where a mechanical splice is required at a construction joint, use of the LENTON Formsaver type coupler manufactured by nVent or approved equivalent is appropriate.

3.4 Mechanical Splicing of Reinforcement

- .1 Tension Splices
 - .1 Provide mechanical tension splices at locations indicated. Where mechanical splice/coupler is indicated, correct type of coupler should be used. Typically standard coupler is appropriate. Transitional couplers to be provided whenever the bar diameter changes. Positional couplers to be provided when both sides of the bar cannot be rotated (hooks, bends, coupled both ends, etc.)
 - .2 Unless noted otherwise, mechanical tension splices shall develop 120% of the specified yield strength, but not less than 110% of the actual yield strength, of the reinforcement being spliced or of the smaller bar if the spliced bars are of different sizes.
 - .3 In each concrete member, unless otherwise indicated, mechanical tension splices in adjacent bars shall be staggered not less than the greater of 800 mm or 40 bar diameters.

.2 **Compression Splices**

.1 Provide compression splices at locations indicated.

.2 **Non End-Bearing Mechanical Splices**

.1 Unless noted otherwise, mechanical compression splices shall develop 120% of the specified tensile yield strength, but not less than 110% of the actual tensile yield strength of the reinforcement being spliced or of the smaller bar, if the bars spliced are of different sizes.

.2 In each concrete member, stagger splices of adjacent bars by at least 800 mm.

.3 **End-bearing splices**

.1 End bearing splices shall develop the ultimate compressive strength of the reinforcing bars spliced.

.2 Accurately sawcut the end bearing surfaces of all bars to be spliced 90 degrees to the axis of the bar with a tolerance of 1-1/2 degrees.

.3 In setting the bars, rotate until the angle between bearing surfaces is at a minimum, but not more than 3 degrees of full bearing.

.4 In each concrete member, stagger splices in adjacent bars by 800 mm but not less than 20 bar diameters.

.4 **Rebar End Welded to Plates**

.1 Provide weld details for weldable couples where bars are specified to be end welded to plates, steel sections, etc. for the amount as specified in above sections.

3.5 Shop Drawings

.1 Refer to Section 01 33 00 for submittals.

.2 Allow at least two weeks for shop drawing review by the Structural Engineer of concrete reinforcement, bar support, and accessories. Allow sufficient time for review, correction, fabrication, shipping to site, and placement.

- .3 Clearly indicate bar sizes, grades, spacing, location and quantities of reinforcing mesh, bar supports, and accessories, mechanical splices, and identifying code marks to permit correct placement without reference to structural drawings. Include total weight of materials being installed.
- .4 Placing drawings and bar lists will be reviewed for number and size of bars only and this review shall in no way relieve the Contractor of the Contractor's responsibility for carrying out the Work in accordance with the drawings.
- .5 Substitution of imperial reinforcing sizes and grades will only be accepted if placing drawings showing imperial sizes are submitted to the Consultant for review. Approval must be obtained before any work commences.
- .6 Clearly indicate placing order of reinforcement.
- .7 Prepare sections of congested joints to avoid site issues.
- .8 Prepare reinforcement shop drawings and bar lists taking into account all openings and recesses shown on the architectural, structural, mechanical, and electrical drawings, and on the sleeving shop drawings. Reinforcement shop drawings may only be reviewed if sleeving and conduit shop drawing are submitted in parallel.
- .9 Completely dimension openings, recesses, and sleeves, and relate to suitable grid lines and elevation datum.
- .10 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias may be used by the Contractor under the following conditions:
 - .1 Copyright remains with Read Jones Christoffersen Ltd.
 - .2 The drawings will only be used for shop drawings for this project and not be put to any other use.
 - .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of the Contractor's work.
 - .4 References to Read Jones Christoffersen Ltd. must be deleted from the title block.
 - .5 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

- .11 Detail reinforcement in accordance with the contract documents, CSA A23.1, CSA S304.1, and detailing standards in CRSI Manual of Standard Practice.
- .12 Where 10M top bars and welded wire fabric are shown, provide adequate chairs, bolsters, or supports to ensure that these bars are not bent or displaced prior to or during the concreting operation.
- .13 Detail sections to fully illustrate placement of concrete reinforcement at areas such as openings, change of levels, spandrel, stairs, and wherever else required.
- .14 Provide large-scale detail concrete sections at areas of steel concentrations, such as at intersections of beams and columns, column splices, or wherever else required.
- .15 Indicate placing sequence for reinforcement, such as intersections of beams and beams, slabs and beams, and within slabs.
- .16 Indicate minimum clearances between reinforcement and minimum concrete cover to reinforcement.
- .17 Indicate location and embedment of dowels.
- .18 Location, number, and type of support accessories, including support bars suitably sized and spaced to rigidly support the weight of reinforcement and construction load.
- .19 Submit code marks or symbols used on reinforcement of each manufacturer so that RJC may identify grades and sizes of reinforcement.
- .20 Shop Drawings for Mechanical Splices
 - .1 Submit drawings showing, as a minimum, the following: location, elevations, and size of splices; materials; and procedures.
- .21 Certificates
 - .1 Reinforcing Steel from Canadian Manufacturers: When requested, provide the Consultant with certified copy of reports of reinforcing steel showing physical and chemical analysis a minimum 4 weeks prior to commencing fabrication.

- .2 Reinforcing Steel from Other than Canadian Manufacturers: When requested, provide test data from a Canadian Testing Laboratory proving that each size and grade of reinforcement proposed meets specification requirements. Reinforcement reviewed for use by the Consultant shall be identified in a manner suitable to the consultant. Only steel that has been reviewed and accepted may be used in the project. This analysis should be provided for each heat of steel.
- .3 Provide Steel Fibers: Certification and test reports for each shipment of fibers.
- .22 Substitutions
 - .1 Substitution of different size bars permitted only upon written acceptance of the Consultant.
- .23 As-Built Drawings
 - .1 Mark on a complete set of final reproducible drawings any changes, additions, or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reasons.

3.6 Fabrication

- .1 Fabricate all reinforcing to the Standard and contract documents.
- .2 Reinforcing bars shall be cold bent. Bars shall not be straightened or re-bent.
- .3 Colour code each bar to correspond with code mark appearing on bar list.
- .4 Steel stud assemblies for shear reinforcement shall be fabricated in accordance with ASTM A1044/A1044M.

3.7 Product Delivery, Storage, and Handling

- .1 Store reinforcement in a manner to prevent excessive rusting and fouling with dirt, grease, form-oil, and other bond-breaking coatings.
- .2 Reinforcement at the time concrete is placed shall be free from excessive rusting, mud, oil, or other coatings that adversely affect its bonding capacity.

3.8 Placing

- .1 Reinforcing of size and shapes shown on the structural drawings shall be accurately placed in accordance with the drawings and the requirements of the Standard.
- .2 Reinforcement shall be adequately supported by chairs, spacers, support bars, hangers, or other accessories, and secured against displacement within the tolerances permitted in the Standard. Support devices contacting surfaces exposed to the exterior shall be non-corroding.
- .3 Bars that are not part of the structural design or drawings, and whose only function is supporting other reinforcing in lieu of other support accessories, shall be considered accessories.
- .4 In suspended parking slabs, uncoated metal ties shall not extend more than 5.0 mm (3/16") into the concrete cover.
- .5 All reinforcement shall be adequately tied and chaired to maintain it in the specified location during pouring. Lifting of reinforcing or welded wire mesh into specified position during the concrete pour will not be allowed.
- .6 Tolerances for bar placement shall be as per the Standard. Tolerances shall not be used to justify the use of chair, bolsters, or chair/support combinations that result in improper cover.
- .7 Williams All-Thread Bar must not be welded, subjected to the high heat of a torch, nor used as a ground.
- .8 Field cutting is to be done with an abrasive wheel or band saw.
- .9 Prior to concreting, accurately place reinforcement, support, and secure against displacement, as indicated on reviewed placing drawings and in accordance with CSA A23.1. Tack welding of reinforcement to secure in place will not be permitted.
- .10 Set column anchor bolts and wall dowels prior to concreting with wooden templates or other approved means.
- .11 Do not 'wet set' reinforcement into fresh concrete.
- .12 Secure reinforcement in columns and walls using sufficient spacers on each face to maintain the requisite distance between reinforcement and column or wall face and so that vertical bars are plumb.

- .13 Where continuous drop panels or slab thickenings are noted on the drawings, place bottom slab reinforcement in the bottom of the continuous drop panel or slab thickening, unless noted otherwise on the drawings.
- .14 Where toppings are placed on waterproof membranes, vapour barriers, and the like, prevent reinforcement or tie wire from contacting these items.
- .15 Ensure that longitudinal bars in beams have adequate vertical spacing between layers in accordance with the Standard.
- .16 Pre-assemble column and beam cages as necessary. Do not "spring" or bend ties and stirrups in order to place longitudinal reinforcement.
- .17 All splice locations are subject to review by the Consultant.

3.9 Welding

- .1 Any welding of reinforcing steel shall be in accordance with the applicable Standard.
- .2 Welding of concrete reinforcement shall be performed by workers who are approved by the Canadian Welding Bureau in accordance with the Standard. Copies of the Canadian Welding Bureau approved welding procedure and certificate of current operator qualification shall be submitted to the Consultant prior to commencement of welding.
- .3 Welding to reinforcement is only permitted as indicated in the Contract Documents or with prior written approval of the Consultant.

3.10 Construction Review

- .1 No concrete shall be placed until the Consultant has completed a review of reinforcement in place. The Contractor shall provide a minimum of 24 hours notice of the time when the reinforcement will be substantially in place and ready for the Consultant's review. A minimum of 6 hours is to be provided for review and any required remedial work prior to concrete placement.
- .2 The Consultant's general review during construction and inspection and testing by Independent Inspection and Testing Companies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.11 Tolerances

- .1 Perform fabrication and setting so that completed work will be within the tolerances set out in CSA A23.1.
- .2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

END OF SECTION

1.0 GENERAL

1.1 Documents

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description of Work Included

- .1 Provide all labour, materials, equipment, and services necessary to supply and install cast-in-place concrete work shown or indicated in all the contract drawings and specifications including concrete toppings, bases, sumps, curbs, posts, manholes, pits, paving, sidewalks, equipment bases or curbs, grouting of baseplates, etc.
- .2 Coordinate concrete placement fully with other trades. Ensure other related work, such as inserts, dowels, sleeves, reinforcement, etc., is complete before placing concrete.

1.3 Related Work Specified Elsewhere

- .1 Section 03 00 50 – Testing of Concrete and Reinforcement
- .2 Section 03 11 00 – Concrete Forming and Accessories
- .3 Section 03 20 00 – Concrete Reinforcing

1.4 Reference Standards

- .1 Concrete work shall conform to the requirements of the following Building Code:
 - .1 Ontario Building Code - 2012 0 REG 88/19
- .2 Concrete work shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
 - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
 - .3 CSA A23.3 – Design of Concrete Structures
 - .4 CSA S413 – Parking Structures

- .5 CSA A3000 – Cementitious Materials Compendium
- .6 ACI 347 – Guide to Formwork for Concrete
- .7 CSA S269.1 – Falsework and Formwork
- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
- .2 “Specialty Engineer” is a Professional Engineer registered in [Ontario](#) responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 Submittals

- .1 Keep a record at the job site showing time and place of each pour of concrete, together with a transit-mix delivery slip certifying contents of pour. Make the record available to the Owner for inspection upon request. Upon completion of this portion of work, submit placing records and delivery slips to the Owner.
- .2 Submit details of proposed methods of concrete curing and provisions for weather protection to the Consultant for review.
- .3 Submit plan locations and details of construction joints for the Consultant's review.

.4 Certificates

- .1 The concrete supplier shall have a current "Certificate of Ready Mixed (or Mobile Mix) Concrete Production Facilities," as issued by the National Ready Mixed Concrete Association (NRMCA). The certificate shall be submitted to the Consultant upon request.
- .2 When requested, prior to beginning work and when any change in materials or source of supply is proposed, provide the following certificates prepared by an independent inspection company. The cost of this work shall be borne by the Contractor.
 - .1 Certification that all raw materials used in the production of concrete proposed for the work comply with requirements of the specifications and CSA A23.1. Specifically, the Contractor must confirm that aggregates used will not react with alkalis in the concrete to cause deleterious expansion.
 - .2 Certification that compressive strength, water-cement ratio, slump, entrained air content, and other specified properties will be met using the proposed mixes.
 - .3 Certification that classes of exposure C-1, A-1, and C-XL will meet the 56-day limits specified in CSA A23.1 for the rapid chloride permeability test using the proposed mixes.
 - .4 The concrete supplier shall submit representative chloride permeability test data distributed over a period of 56 days for concrete exposure classes C-1, A-1, and C-XL with and without calcium nitrite corrosion inhibitor or any other admixture containing ionic salts.
- .3 Concrete Quality Plan
 - .1 When requested, submit a complete "Concrete Quality Plan", in the format provided by the NRMCA.
 - .4 When requested and well in advance of construction, submit complete details of placing and consolidation procedures for sloping roofs, including details of construction and placing of top forms and top form panel.

2.0 PRODUCTS

2.1 General

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.
- .2 Provide samples of materials upon request.

2.2 Materials

- .1 Mixing water shall conform to the Standard.
- .2 Air entraining admixtures to the Standard.
- .3 Calcium chloride, either as a raw material or as a constituent in other admixtures, shall not be used unless approved in writing by the Consultant.
- .4 Curing compounds shall conform to the specification and shall also be compatible with specified floor hardeners, covering adhesives, and waterproofing compounds.
- .5 Grout shall be pre-approved, pre-mixed, and non-shrink conforming to the Standard. Exposed grout shall be non-staining, cement grey in colour.
- .6 Modulus of Elasticity (E): For each concrete mix design,
 - .1 The Modulus of Elasticity at all times during construction is to be not less than $4,500\sqrt{f'c}$ MPa.
- .7 Concrete: Normal density concrete with air-dry density of 23 ± 1 kN/cu. m. Conform to CSA A23.1.
- .8 Cement Type: General Use Portland Cement (Type GU) or Low Heat of Hydration Portland Cement (Type LH) meeting the requirements of CSA A3000.
- .9 Admixture:

- .1 Corrosion Inhibiting Admixture: Calcium nitrite based corrosion inhibitor, "DCI" or "DCI(S)" by W.R. Grace & Co. or Masterlife CI 30 by BASF Construction Chemicals (or approved alternative), shall be added at the rate of 10 L/cu. m of concrete where required on the structural drawings. The corrosion inhibitor shall contain $30 \pm 3\%$ of calcium nitrite by weight. The selection of "DCI", "DCI(S)" or "CI 30" (or approved alternative) shall be as directed by the admixture supplier, based on anticipated placing and curing conditions and the specific concrete mix design selected.
- .10 Shrinkage Control Fibres: "Dramix" steel fibres by Bekaert or approved alternative, 60/1.05.
- .11 Curing Compound: Conform to CSA A23.1.
- .12 Grout Beneath Base Plates: Non-shrink, non-metallic, flowable grout, In Pakt or approved alternative having a compressive strength at 28 days of at least 35 MPa (5 ksi). Where grout is exposed to view or weather, use non-ferrous grout.
- .13 Aggregates
 - .1 The concrete supplier shall demonstrate by appropriate tests and test results that the aggregates chosen have the potential to meet the design strength requirements specified herein.
 - .2 Coarse Aggregate: Crushed rock conforming in all respects to CSA A23.1. The maximum size of the coarse aggregates shall be 20 mm but smaller maximum sizes may be used.
 - .3 Fine Aggregate: Natural and conforming to CSA A23.1.

3.0 EXECUTION

3.1 General

- .1 All phases of concrete work shall be in accordance with the Standard unless otherwise specified herein or on the drawings. The work shall be executed only by experienced and skilled workers.
- .2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed to allow the Consultant to review the work.
- .3 Prior to the initial supply of concrete to the project, the contractor must schedule a "Pre-Pour Meeting" as outlined in the Concrete Supplier's Concrete Quality plan.

3.2 Mix Designs

- .1 Concrete mixes shall be proportioned by the supplier to meet the compressive strength, exposure class, and other performance specifications noted in the contract documents. In addition, concrete mix design shall satisfy the transport, placing, and finishing requirements of the Contractor. All concrete shall be normal weight unless noted otherwise. Concrete types are specified in accordance with CSA A23.1 Table "Alternate methods for specifying concrete", Alternate 1.
- .2 Concrete mix design is the responsibility of the supplier, including the use of admixtures, alone or in combination. The supplier is also responsible for ensuring the plastic and hardened properties of the concrete meet the construction and specified requirements. This includes the long-term performance of the hardened mix.
- .3 Pump mix slumps shall also conform to the above.
- .4 Water/Cement ratios and air contents for exposure class shall be as per the Standard.
- .5 The proposed mixes shall be submitted to the Consultant and Testing Agency for review.
- .6 The mix designs shall note the constituents by the properties required by the structural drawings, and the structural elements for which the mix is to be used.

3.3 Testing

- .1 As per Section 03 00 50 - Testing of Concrete and Reinforcement

3.4 Placing of Concrete

- .1 Conveying and placing of concrete is to conform to the Standard.
- .2 All concrete shall be consolidated by means of vibrators of appropriate size operated by experienced workers.
- .3 The use of vibrators to transport concrete shall not be permitted.
- .4 Cement slurry used to prime concrete pumps shall be discarded and not placed in the project.
- .5 Immediately before placing concrete, clean forms and reinforcement of foreign matter.

- .6 A maximum time limit of 120 min from the time of initial mixing to complete discharge shall be observed. Exemptions to the maximum time limit, if required, shall be agreed upon by the Engineer, Owner, and the concrete supplier prior to placement of the concrete. In some circumstances, set retarders or hydration stabilizers may be used to extend the discharge time.
- .7 During hot weather conditions, as defined by CSA A23.1, do not use concrete mixed more than 1 hour after introduction of mixing water.
- .8 Allow 24 hours minimum to elapse after placing concrete in columns, piers, or walls before placing concrete in beams or slabs supported thereon.
- .9 Prior to pouring the concrete elements directly supported above, remove forms to such an extent to allow the Architect/Owner/Engineer to review the quality of any exposed column surface. Provide necessary protection to the exposed surfaces upon completion of review.
- .10 Place concrete on steel joist and steel deck floors in a manner that avoids piling up of concrete. Do not drop concrete directly from buckets, but employ suitable means of distribution. Wet down deck during hot weather prior to concreting.
- .11 Remove concrete spilled onto forms around hoisting equipment before depositing concrete in these areas.
- .12 Pumping Concrete
 - .1 Pumping or pneumatic placing of concrete shall only be used if the velocity of discharge is reduced to a point where no separation or scattering of the concrete occurs, and the consistency of the mix has been designed to allow such a system with no adverse effects on the quality of concrete.
 - .2 Excess grout or mortar used to lubricate pipelines, or washout water, must not be discharged into the forms.

3.5 Openings and Inserts

- .1 The Contractor shall notify all trades sufficiently in advance to ensure that provision is made for openings, inserts, and fasteners. The Contractor shall cooperate with all trades in the forming and setting of all slots, sleeves, bolts, dowels, hangers, inserts, conduits, clips, etc. Any embedded hardware may be subject to review by the Consultant.

- .2 Openings and sleeves shown on the structural drawings must be confirmed with mechanical, electrical, and architectural drawings.
- .3 Openings and sleeves not shown on the structural drawings must be approved by the Consultant.
- .4 Do not pass sleeves, ducts, pipes, or other openings through joists, beams, columns, or wall zones without written approval of the Consultant.
- .5 Do not eliminate, cut, or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications by the Consultant before placing concrete.

3.6 Construction and Control Joints

- .1 Joints in slabs-on-grade shall be located as indicated on the structural and/or architectural drawings. Unless noted otherwise on the drawings, a joint in the slab-on-grade may be a pour joint, trowelled joint, saw cut, or other pre-approved method. The depth of joints shall be a minimum of 1/4 of the thickness of the slab. Saw cut joints are to be completed within 12 hours of placing. Alternative joint details are to be submitted in writing to the Consultant.
- .2 For vertical joints in walls below grade, see standard detail on structural drawings. For locations, see architectural and structural drawings.
- .3 Construction joints in walls and columns shall occur at the top of slab and at the underside of slab/beam systems unless noted otherwise on the structural drawings.
- .4 Construction joints not shown in the drawings or specifications shall be subject to the approval of the Consultant. The Consultant may require keys or extra reinforcing to be provided at the Consultant's discretion with associated costs borne by the Contractor.
- .5 The existing concrete surface at construction joints shall be brought to a saturated surface dry condition immediately prior to placement of concrete.
- .6 Construction joints exposed to view may be subject to non-structural review by Consultant.
- .7 Supply and install pre-molded waterstops in construction joints where indicated on the drawings. Weld joints to make watertight. Install waterstops in accordance with manufacturer's specifications and recommendations. Waterstop procedures require approval of Consultant.

- .8 Obtain approval from RJC for location and details of construction joints not shown.
- .9 The maximum length of a concrete slab pour shall be 40 m (120'-0).
- .10 The maximum length of a concrete foundation wall pour shall be 12 m (40').
- .11 The maximum height of a concrete pour shall be 5 m (15'-0).
- .12 If the construction joint (including joints around temporary openings) will be exposed in its permanent condition, such as in a parking garage, the joint must be caulked as outlined under the Materials section.

3.7 Curing and Protection

- .1 Curing procedures shall be in accordance with the Standard. Alternate methods with Consultants approval, may be used providing they produce concrete that meets the contract documents.
- .2 Cold and hot weather protection shall comply with the Standard or the requirements on the structural drawings, whichever are more rigorous.
- .3 Concrete placed during extreme drying conditions shall satisfy A23.1.
- .4 (Reference Standard CSA A23.1/A23.2) Contractor shall submit a plan for curing to the Owner, for review and approval, together with other tender documents. The curing plan shall be prepared in strict accordance with the Standard, including:
 - .1 The method for protecting the concrete from evaporation of surface moisture from the fresh concrete.
 - .2 The type of curing material to be used.
 - .3 How the surface will be kept moist and the quality control requirements for keeping the surface moist.
 - .4 The time of initiation and duration of curing.
 - .5 Provisions to address potential problems such as high winds and hot and cold weather.
 - .6 The limitations of access, if any, to the surfaces being cured.

- .5 (Reference Standard CSA A23.1/A23.2) All concrete mixes proportioned for C-XL class of exposure shall have Extended Curing. Concrete mixes that meet the definition of HVSCM-1 and where classes of exposure C-1, A-1, F-1, S-1, and S-2 apply shall have Extended Curing. For other exposure classifications, concrete mixes that meet the definition of HVSCM-1 or 2 shall have Additional Curing.

- $HVSCM-1 = FA/40 + S/45 > 1.00$
- $HVSCM-2 = FA/30 + S/35 > 1.00$

where FA = fly ash (Type F, C11, or CH content of the concrete (% mass of total cementing materials) and S = slag content of the concrete (% mass of total cementing materials)

- Additional Curing = 7 days at $> 10^{\circ}\text{C}$ for a time necessary to attain 70% of the specified strength. When using silica fume concrete, additional curing procedures shall be used. See Standard.
 - Extended Curing = a wet-curing period of 7 days. The curing types allowed are ponding, continuous sprinkling, absorptive mat, or fabric kept continuously wet.
- .6 Contractor shall obtain the approval of the Owner for proposed means of monitoring concrete curing conditions. Contractor shall be responsible for confirming completion of curing.
- .7 Protect all concrete in accordance with CSA A23.1, the concrete supplier's requirements, and as specified herein to prevent freshly deposited concrete from freezing, being exposed to abnormally high temperatures or temperature differentials, premature drying, and moisture loss for a period of time necessary to develop the specified properties of the concrete.
- .1 When requested, submit a detailed description of the procedures that will be employed to wet cure.
- .2 As a minimum, the procedures shall indicate:
- .1 the method for protecting the concrete from evaporation of surface moisture from the fresh concrete;
 - .2 the type of curing material to be used;
 - .3 how the surface will be kept moist, and the quality control requirements for keeping the surface moist;
 - .4 the time of initiation and duration of curing;

- .5 provisions to address potential problems such as high winds and hot and cold weather; and
- .6 the limitations of access, if any, to the surfaces being cured.
- .3 Submit a 300 mm x 300 mm (12" x 12") sample of each type of material (absorptive mat, fabric, plastic film, waterproof paper etc.) that will be used to wet cure the concrete.

3.8 Slabs-on-Grade

- .1 Do not place concrete slabs-on-grade until the specified sub-floor material has been placed, inspected, and approved.
- .2 Do not place concrete on a frozen sub-grade, or on one that contains frozen materials.
- .3 Do not place concrete on a sub-grade that has been frozen and thawed until the sub-grade has been reviewed by the geotechnical engineer and approved. If, in the geotechnical engineer's opinion, the bearing capacity of the sub-grade has been compromised, remove the affected materials and replace with compacted granular fill at no additional cost to the Owner.
- .4 Upon approval of the placement of the sub-floor material and setting of reinforcement, place and consolidate concrete, and finish and cure as specified herein.
- .5 Where slab-on-grade is exposed to de-icing chemicals, provide an approved sealant at the joint between the slab-on-grade and abutting surfaces.
- .6 Saw-cut slab-on-grade as shown with a maximum length between saw-cuts of 4.5 m (15' 0"). Arrange panels as shown or to the Consultant's approval.
- .7 Carry out cutting in accordance with recommendations contained in CSA A23.1, but in any event between 6 and 18 hours after placement of concrete.
- .8 After a period of at least 28 days, fill saw-cuts with mortar containing cement, sand, and latex bonding agent. Ensure that joints to be filled are clean, dry, and free of foreign matter.
- .9 Mask edges of saw-cuts as required to prevent concrete floors from becoming stained.

- .10 Construction joints may be provided in slabs-on-grade so that pours on any one day may be kept to reasonable sizes. Locate construction joints to the Consultant's approval.

3.9 Making Good

- .1 Where directed by the Consultant, make good temporary openings left in concrete construction around pipes, ducts, and the like using a mortar of the same proportions as the surrounding work. Reinforce mortar with welded wire fabric where openings exceed 75 mm (3"). Roughen existing surfaces to receive mortar or apply suitable bonding agent such that mortar will be securely bonded to existing concrete.

3.10 Grouting Beneath Base Plates

- .1 Grout beneath plates bearing on concrete with an approved non-shrink flowable grout. Conform with the manufacturer's directions for mixing and placing grout. Completely fill voids below plates. Fill voids left by shims after shims are removed.
- .2 During cold weather, preheat base plates and footings and maintain temperature at minimum 12°C for 6 days after grouting.

3.11 Sloping Slabs

- .1 In the case of sloping slabs, employ suitable concrete placing and consolidation procedures to ensure the completed concrete has the specified design characteristics, and in particular, to prevent movement of plastic concrete resulting in thickness variation, cracking, tearing, loss of bond, etc.
- .2 Upon approval of the placement of the sub-floor material, place and consolidate a uniform thickness of slab on grade concrete to within 40 mm of top. Note 50 mm (2") maximum slump. Coordinate with Section 03 20 00 the immediate placement of reinforcement on top of the first layer of concrete. Place, consolidate, finish, and cure the final 40 mm (1-1/2) thickness of slab to the tolerances specified.

3.12 Patching

- .1 Honeycombing, exposed reinforcement, and other defects shall be repaired and patched by the Contractor at the Contractor's cost to the satisfaction of the Consultant using a procedure preapproved by the Consultant. Exposed patching must also be accepted by the Consultant.

- .2 Immediately after the removal of forms, all bolts, ties, nails, or other metal not specifically required for construction purposes shall be removed or cut back to a depth of 25 mm (1") from the surface of the concrete.

3.13 Tolerances

- .1 Tolerances shall conform to the Standard or the requirements on the structural or architectural contract documents, whichever are more rigorous.
- .2 Variations in building lines that result in extension of the building over lot lines or restriction lines will not be permitted.
- .3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

3.14 Finishing - Floors

- .1 Finishing shall conform to CSA A23.1 - Section 7.5 as a minimum. Care shall be taken during finishing to maintain the cambers specified on the structural drawings. See also the architectural drawings and specifications for additional finish requirements.
- .2 Unless noted otherwise, floor finishes shall be Class A "institutional and commercial floors" and have gaps less than or equal to 8.0 mm (5/16") under a 3000 mm (10'-0") straight edge. Only a single curvature within this distance is allowed.

3.15 Finishes - Formed Surfaces

- .1 All formed surfaces shall be treated in accordance with CSA A23.1, Section 7.7 as a minimum. See also architectural drawings and specifications for additional finish requirements.

3.16 Openings Through Structural Work

- .1 If, after any part of the structural work has been completed, it is required that additional openings be made through the structure, the Consultant shall be so informed. No opening, including cored sleeves, shall be made through completed work without authorization in writing from the Consultant.

- .2 Where the location of openings is approved, locate the reinforcement by x-ray, GPR, cover meter, or other positive means as required by the Consultant and adjust the location of the opening so that no reinforcement is cut unless specifically approved otherwise in writing by the Consultant.
- .3 In the case of precast concrete slabs, holes shall be cut or drilled only by the precast concrete fabricator.

3.17 Rejection of Defective Work

- .1 In the event that concrete tests do not conform to the requirements of this specification, or when conditions are such to cause doubt about the safety of the structure, testing of the structure will be undertaken at the direction of the Consultant. This may entail further concrete tests, coring, or load testing as per the Standard, or any other test the Consultant deems suitable. Such test shall be made at the expense of the Contractor and to the satisfaction of the Consultant.
- .2 Where, in the opinion of the Consultant, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the Consultant and at no additional cost to the Owner.

END OF SECTION

1.0 GENERAL

1.1 Documents

- .1 This Section, along with the Drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical Drawings.

1.2 Description of Work Included

- .1 Provide all labour, materials, equipment, access, cooperation, coordination, and services to allow testing of structural steel, open web steel joists, structural steel deck, and welds to be carried out by Testing Agency.
- .2 Scope of required quality assurance testing is described in this Section to inform Contractor of type and scope of testing on project and to allow Contractor to make appropriate allowances.
- .3 Testing required for Contractor's own quality control or as noted in clause 1.6.3 will be paid for by Contractor.

1.3 Related Work Specified Elsewhere

- .1 Section 05 12 00 – Structural Steel Framing

1.4 Reference Standards

- .1 Testing of structural steel shall conform to requirements of the following Building Code and Standards unless otherwise required by this Specification:
 - .1 Ontario Building Code - 2012 (O. Reg. 88/19 and subsequent updates)
 - .2 CSA S16 – Limit States Design of Steel Structures
 - .3 CSA W178.1 – Certification of Welding Inspection Organizations
 - .4 CSA W59 – Welded Steel Construction (Metal Arc Welding)
 - .5 CSA W47.1 – Certification of Companies for Fusion Welding of Steel Structures

- .6 CSA G40.20/G40.21 – General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
- .7 CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members
- .8 ASTM A6/A6M – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
- .9 CSSBI 10M – Standard for Steel Roof Deck
- .10 CSSBI 12M – Standard for Composite Steel Deck
- .11 RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts
- .12 SDI Manual of Steel Construction with Steel Deck
- .13 ASTM A653/A653M – Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .14 ASTM A435/A435M – Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates
- .15 ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products
- .16 ASTM A143/A143M – Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
- .17 ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .18 ASTM A384/A384M – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- .19 ASTM A385/A385M – Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- .20 ASTM E376 – Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods

- .21 ASTM A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .2 Revision date of referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .3 Where the Standard is referenced in this Specification, it means documents specified in this clause and their referenced Standards.
- .4 Where there are differences between the Specifications and Drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 “Owner”, “Contractor”, and “Consultant” per the General Conditions and Definitions.
- .2 “Structural Engineer” means a representative of Read Jones Christoffersen Ltd.
- .3 “Testing Agency” means a third-party testing and inspection agency.
- .4 “Non-Destructive Testing” means liquid penetrant (LP), magnetic particle (MP), ultrasonic (UT), or radiographic testing (RT) as determined appropriate by Testing Agency.
- .5 “Standard” and “Standards” mean reference standards listed under “Reference Standards” in this Section.

1.6 Appointment of Testing Agency

- .1 A CSA-Approved Testing Agency (approved under W178.1 - Building Category) shall be appointed to test structural steel and connections in accordance with Part 3.0.
- .2 Unless stated otherwise in Division 0 / Division 1, Testing Agency shall be engaged by Owner.
- .3 Contractor shall pay for testing not covered in clause 1.6.1, including but not be limited to:
 - .1 Testing of pre-approved connections not on structural Drawings and required by Contractor for ease of fabrication, transportation, or erection.

- .2 Additional costs due to overtime, shift work, and holiday or weekend work required to meet schedule.
- .3 Costs for retesting or additional testing due to work having failed to meet specified requirements.
- .4 Non-destructive testing will be performed on samples of work as outlined in Article 3.4 of Specification. Repair and re-testing shall be done at Contractor's expense.
- .5 Deficiencies in work will trigger required additional testing

2.0 DUTIES

2.1 Responsibility of Contractor

- .1 Cooperate fully with Testing Agency. Allow free access to all parts of the work for testing and review at all times.
- .2 Notify Testing Agency and Structural Engineer when work is ready for review.
- .3 Prior to commencement of work, provide schedule of shop fabrication and erection to Testing Agency and Structural Engineer. Changes in this schedule shall be communicated to these parties in a timely fashion.
- .4 Provide quantity takeoff of all members in project for use in determining number of members required for testing. This takeoff should also indicate divisions in which members are to be fabricated to aid in shop inspection planning.
- .5 Provide mill certificates in accordance with the Standard, properly correlated to elements being fabricated.
- .6 Make available non-destructive testing reports performed in shop during fabrication.
- .7 Prep areas requiring NDE to an acceptable level. Preparation includes, but is not limited to:
 - .1 Ultrasonic Testing (UT) to 300 mm away from weld by grinding off weld splatter and buffing area with wire wheel.
 - .2 Provision of necessary access platforms or scaffolding to allow inspections to be carried out.

- .8 Contractor is solely responsible to provide finished product that meets Specifications and Contract Documents. Testing is not carried out for Contractor's benefit, nor does it make Structural Engineer or Testing Agency guarantors of Contractor's work.

2.2 Responsibility and Duties of Testing Agency

- .1 Testing Agency has authority to, and is expected to, reject any work not meeting Specifications.
- .2 Identify number, type, and locations of members, connections, studs, etc. to be tested and coordinate required shop and site visits.
- .3 Review structural Drawings and Specifications prior to carrying out work.
- .4 Provide testing per the Standards and this Specification.
- .5 Provide timely test reports to Structural Engineer, Consultant, and Contractor.

3.0 TESTING AND INSPECTION

3.1 General

- .1 Structural Engineer may reject, at any time during progress of work, a piece of material or member which Structural Engineer may find defective or not in accordance with detailed drawings. This material may be rejected notwithstanding any previous acceptance; replace rejected components at no expense to Owner. In case of dispute, decision of Structural Engineer will be final.
- .2 If initial tests indicate that work failed to meet Specification, Structural Engineer will decide if additional testing is necessary. This testing shall be done by Owner's agency. Proposed additional testing shall have prior approval of Structural Engineer.
- .3 Non-destructive testing operators shall have Level II qualification as a minimum.

3.2 Documents and Materials

- .1 Confirm that fabricator and erector are certified to CSA W47.1 and that welders are properly qualified.
- .2 Review mill certificates for all types of material used in project to ensure they meet requirements of 05 12 00 and forward to Structural Engineer.

- .3 Review approved shop welding procedures.
- .4 Confirm welding consumables provided will meet levels of strength, notch toughness, and quality of base member and that they are properly stored in shop and field.
- .5 Review bolt storage, handling, and installation procedures including pre-installation verification testing as required depending on types of bolts or washers to be used.
 - .1 Tension Control (TC) Bolts
 - .1 Carry out pre-installation verification in accordance with CSA S16 to confirm bolts will function as intended.
 - .2 Direct Tension Indicator (DTI) Washers
 - .1 Review fabricator installation procedures.
 - .2 General review for damage to washers prior to installation.
- .6 Review available non-destructive testing reports performed by Contractor.
- .7 Where more than one type of paint is specified, colour of each coat of paint shall differ so they can be visually identified after applications.
- .8 Obtain invoices and product data from steel supplier for purchase of specified primers and paints required for project. Circulate these documents to Structural and Architectural Consultants.

3.3 Visual Testing (VT) of Members and Connections (Welded or Bolted)

Perform visual testing of structural components, framing, and connections through a combination of shop and field visits to meet requirements below. Base Plates	20%
Bracing	20%
Beams	20%
Moment Connections (By Member Weight)	50%
Splices	100%
Section Reinforcement & Stiffeners	20%

- .1 Visual Testing (VT) requirements above include but are not limited to verifying:
 - .1 Grade markings on structural steel in fabricator's plant prior to fabrication.

- .2 Dimensions, including cross-section, in relation to specified members (in-house plant QC may be relied upon to perform this task assuming testing agency is satisfied with level of QC being carried out).
- .3 Locations of holes, cuts, fittings, and milling of member ends.
- .4 Tolerances of joint preparation and fit up (bevel angle, etc.) to be in accordance with CSA S16.1, clause 28.5 Joints in Contact Bearing.
- .5 Preheat and interpass temperatures based on approved welding procedures.
- .6 Snug tight bolted connections are properly compacted and brought to snug tight condition progressing outward from most rigid part.
- .7 Specified beam and / or truss camber and cambering procedure do not reduce member capacity.
- .8 Erection tolerances meet tolerances of CSA S16.
- .9 Joist and truss erection tolerances meet CSA S16 requirements, and report twisting, sweeping, and local damage.
- .10 Adequate joist bearing on supporting structure as detailed in Drawings.
- .11 Truss permanent top and bottom chord bridging and end connections are complete.
- .12 Number of headed studs per beam and that stud placement is properly offset towards closest beam support within composite deck flutes per typical details.
- .13 Steel surface preparation prior to priming and / or painting is in conformance with requirements of Structural and Architectural Specifications.
- .14 Steel that is exposed or in unconditioned spaces, such as canopies, parapet walls, steel lintels, shelf angles, etc., are galvanized and or painted in accordance with Contract Documents.
- .2 Defects noted during Visual Testing (VT) work shall be reviewed using appropriate comprehensive Non-Destructive Evaluation (NDE), which shall be in addition to requirements in clause 3.4.

3.4 Comprehensive NDE Testing of Connections (Welded or Bolted)

- .1 Perform testing of connections through combination of shop and field visits to meet sampling required in Tables 1 and 2.
- .2 Requirements of Tables 1 and 2 include but are not limited to verifying:
 - .1 At least one type of unique connection shall be tested irrespective of sampling requirements.
 - .2 Bolt types conform to Drawings and Specifications prior to start of bolting operations and that pre-installation verification has been completed.
 - .3 Bolted connections shall be tested by CSA S16 with minimum two bolts tested for each pre-tensioned connection.
 - .4 For bolted connections that are indicated as pre-tensioned or slip critical, pre-installation verification testing is performed by inspector in cooperation with Contractor.
 - .5 For bolted connections indicated as pre-tensioned or slip critical, Testing Agency shall be present during installation with sufficient frequency so pre-tensioning methods of RCSC 8.2.1, 8.2.3, or 8.2.4, as appropriate, are performed.
 - .6 Welded connections shall be tested in accordance with Annex P of CSA S16 clause 9.5 with an inspection class of **IC2 (Medium)**.
 - .7 When overall length of weld is less than 900 mm, test entire length.
 - .8 Splices not shown on structural drawings shall be 100% ultrasonically tested (UT) at Contractor's expense.
- .3 Post-installation review of bolts using following techniques:
 - .1 Conventional bolts
 - .1 Turn of nut method marked on washer and bolt head or calibrated torque wrench.
 - .2 Tension Control (TC) Bolts
 - .1 Post-installation review should be carried out to ensure bolt tip is sheared off at tension control point.

.3 Direct Tension Indicator (DTI) Washers

- .1 Post-installation review shall be carried out to ensure even bearing of connection and no obstructions are present that would cause uneven pressure to be applied to DTI.

Table 1: Single Piece Members

Structural Framing	Comments (Weights, Forces, Descriptions, Etc.)	Tier 4		Tier 3		Tier 2		Tier 1		Minimum Total % Connection Testing
		Sample Size	Required Testing	Sample Size	Required Testing	Sample Size	Required Testing	Sample Size	Required Testing	
Base/Brg Plates	$W \leq 30 \text{ kg/m}$	-	-	5.0%	75%	5%	50%	5.0%	35%	10%
	$30 \leq W \leq 100 \text{ kg/m}$	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	$W \geq 100 \text{ kg/m}$	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
Bracing	$W \leq 20 \text{ kg/m}$	-	-	5%	75%	5%	50%	5.0%	35%	10%
	$20 \leq W \leq 40 \text{ kg/m}$	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	$W \geq 40 \text{ kg/m}$	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
Beams	$W \leq 40 \text{ kg/m}$	-	-	5.0%	75%	5%	50%	5.0%	35%	7.5%
	$40 \leq W \leq 70 \text{ kg/m}$	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	$W \geq 70 \text{ kg/m}$	10.0%	100%	5%	80%	5%	65%	5%	55%	
	$W \geq 70 \text{ kg/m}$	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
Moment Connections	$W \leq 30 \text{ kg/m}$	-	-	10%	75%	10%	50%	15%	35%	20%
	$30 \leq W \leq 60 \text{ kg/m}$	20%	100%	20%	75%	10%	60%	10%	45%	
	$W \geq 60 \text{ kg/m}$	40%	100%	20%	80%	10%	65%	10%	55%	
Splices	Any Members	100%	100%	-	-	-	-	-	-	100%

END OF SECTION

1.0 GENERAL

1.1 Documents

- .1 This Section, along with the Drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical Drawings.

1.2 Description of Work Included

- .1 Provide labour, materials, equipment, and services to supply, design, and erect structural steel required and/or indicated on Drawings or specified herein, including supply of plates and/or angles for support of masonry, embedded steel parts, headed stud, mechanical couplers; deformed bar anchors, wedge anchors, and epoxy anchors that will form connection between structural steel, open web steel joists and masonry or concrete; and reinforcement of steel deck openings. Report discrepancies between structural, mechanical, electrical, and architectural Drawings to Consultant and Structural Engineer immediately.
- .2 Co-ordinate with Sections 03 20 00 and 03 30 00 for design, supply, installation, and erection of embedded steel parts.
- .3 Co-ordinate with Section 05 21 00 for design, fabrication, supply, installation, and erection of open web steel joists.
- .4 Co-ordinate with Section 05 31 00 for design, supply, and installation of headed stud shear connectors for composite beams and girders, and where required on other beams, girders, and drag struts.
- .5 Co-ordinate with Section 05 12 50 where required as indicated in structural and architectural Contract Documents.

1.3 Related Work Specified Elsewhere

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 03 11 00 – Concrete Forming and Accessories
- .3 Section 03 20 00 – Concrete Reinforcing
- .4 Section 03 30 00 – Structural Cast-in-Place Concrete
- .5 Section 05 00 50 – Testing of Structural Steel

1.4 Reference Standards

- .1 Structural steel shall conform to requirements of following Building Code and Standards unless otherwise required by this Specification:
 - .1 Ontario Building Code - 2012 (O. Reg. 88/19 and subsequent updates)
 - .2 CSA S16 – Design of Steel Structures
 - .3 CSA G40.20/G40.21 – General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
 - .4 CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members
 - .5 ASTM A6/A6M – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
 - .6 CISC Code of Standard Practice for Structural Steel
 - .7 ASTM A992/A992M – Standard Specification for Structural Steel Shapes
 - .8 ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - .9 ASTM F3125/F3125M – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
 - .10 ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated 120 / 105 ksi Minimum Tensile Strength (**Note: This standard has been superseded by ASTM F3125. It is included in this list as it is currently referenced by CSA-S16-14)
 - .11 ASTM A490 – Standard Specification for Structural Bolts, Alloy Steel, Heat Treated 150 ksi Minimum Tensile Strength (**Note: This standard has been superseded by ASTM F3125. It is included in this list as it is currently referenced by CSA-S16-14)
 - .12 ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

- .13 CSA W47.1 – Certification of Companies for Fusion Welding of Steel Structures
- .14 CSA W59 – Welded Steel Construction (Metal Arc Welding) (Metric version)
- .15 SSPC SP-6 – Commercial Blast Cleaning
- .16 CSA G189 – Sprayed Metal Coatings for Atmosphere Corrosion Protection.
- .17 CISC / CPMA Standard 1-73a – A Quick-Drying One-Coat Paint for Use on Structural Steel.
- .18 Architectural Exposed Structural Steel shall conform to Appendix I of CISC Code of Standard Practice for Structural Steel.
- .1 CSA G164 – Hot Dip Galvanizing of Irregularly Shaped Articles
- .2 ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products
- .3 ASTM A143/A143M – Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
- .4 ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .5 ASTM A384/A384M – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- .6 ASTM A385/A385M – Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- .7 ASTM A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .8 CGSB-85-GP-16M – Painting Galvanized Steel
- .2 Revision date of referenced codes, standards, and guidelines shall be as indicated in the above-referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.

- .3 Where the Standard is referenced in this Specification, it means documents specified in this clause and their referenced Standards.
- .4 Keep a copy of S16 and W59 on site and available for reference for duration of the Work.
- .5 Where there are differences between the Specifications and Drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 "Owner", "Contractor", and "Consultant" per the General Conditions and Definitions.
- .2 "Structural Engineer" means a representative of Read Jones Christoffersen Ltd., herein also referred to as RJC.
- .3 "Specialty Structural Engineer" is a Professional Engineer registered in Ontario responsible for components designed by Contractor and who seals and signs shop drawings.
- .4 "Testing Agency" means the testing agency responsible to Owner.
- .5 "Standard" and "Standards" mean reference standards listed under "Reference Standards" in this Section.

1.6 Qualifications

- .1 Fabricator, erector, and subcontractors performing structural steel work shall be certified under requirements of Division 1, or Division 2.1 of W47.1.
- .2 Design calculations shall be carried out by or under direct supervision of qualified Specialty Structural Engineer licensed in Ontario, with minimum five years Canadian experience in design of structural steel work and connections including design of weldments, as appropriate.
- .3 Engineers responsible for welding design, procedures, and practice shall be certified in accordance with CSA W47.1, section 6.1.
- .4 Specialty Structural Engineers responsible for design of steel work, connections, and the like, shall be insured in accordance with Professional Engineers Ontario Act and covered under a General Liability Insurance Policy in accordance with provisions of the Contract.

- .5 Structural steel fabricator shall have minimum than **five** years experience in fabrication of structural steel and hold CISC Steel Structures Certification under CISC Quality Certification Program.
- .6 Erector shall have minimum **five years** experience in erection of structural steel.

1.7 Examinations

- .1 Take dimensions from Drawings and verify by field measurement (including verification of interfacing with existing structures). Be responsible for correctness of such measurements and report to Consultant and Structural Engineer in writing of discrepancies between measurements in field and those shown on Drawings prior to commencing work. Verify location of anchor rods and embedded steel, and confirm that work prepared by other trades is at proper elevation, on line, level, and true.

1.8 Submittals

- .1 Refer to Section 01 33 00 for submittals.
- .2 Submit the following documents:
 - .1 Any documents required as a part of Section 1.6 Qualifications.
 - .2 Qualifications of Fabricator
 - .1 Submit appropriate documentation for fabricator responsible for steel work in accordance with Section **Error! Reference source not found.**
 - .3 When requested, Fabricator and Erector CWB Welding Qualifications and Procedures
 - .1 Qualification of steel fabricators and erectors for welding under Canadian Welding Bureau requirements.
 - .2 Description of welding procedures for use on structural steel minimum one month prior to fabrication or use.
 - .3 Ability to weld reinforcing steel to structural steel in accordance with CSA W186.
 - .4 Material Properties Reports

- .1 When requested, copies of mill test reports properly correlated to materials used on project. Review clause **Error! Reference source not found.** and provide reports as required to demonstrate conformance with chemical content parameters.
- .5 Fabrication Schedule
 - .1 Provide schedule to Consultant, Structural Engineer, and Testing Agency.
- .6 Testing and Inspection Reports (submit throughout construction)
 - .1 Non-destructive testing reports, steel testing, and weld testing reports performed in addition to third party testing.
- .7 Shop and Erection Drawings
 - .1 Submit appropriate documentation for fabricator responsible for steel work in accordance with Section 1.8.
- .8 Erection Surveys
 - .1 When requested, submit accurate surveys of steel erection as noted in this Specification and on Drawings.

1.9 Shop and Erection Drawings

- .1 Specialty Structural Engineer(s) responsible for structural steel work, connections, joist systems, and the like shall either:
 - .1 Seal and sign all necessary shop and erection drawings and field sketches, or
 - .2 Submit sealed and signed letter prior to commencement of shop drawing preparation identifying fabricator's engineer who has been retained by steel fabricator to carry out design of steel connections, and the like AND submit second letter after completion of shop drawing preparation stating that design of steel work for which they are responsible has been completed in accordance with Contract Documents and relevant building codes, standards, and acts. Letter shall identify what was designed by Professional Engineer(s) and list final shop drawings by number with dates and revision numbers.

- .2 Structural Drawings, structural models, and electronic files shall not be reproduced in whole or in part, and shall not be used to prepare shop, erection, or setting drawings. Structural models and electronic files may be used by Contractor under the following conditions:
 - .1 Copyright remains with Read Jones Christoffersen Ltd.
 - .2 Drawings will only be used for shop drawings for this project and not put to any other use.
 - .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in Drawings. Contractor assumes all risk and expenses associated with use of structural Drawings in production of their work.
 - .4 References to Read Jones Christoffersen Ltd. must be deleted from title block.
 - .5 Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.
- .3 Structural drawings shall not be scaled.
- .4 Submit structural steel connection design details shop, erection, field work details, and setting drawings for Consultant review.
- .5 Connection Design Details:
 - .1 Submit "design" drawings for review summarizing proposed connection details to be used on project. These drawings to be prepared by or under supervision of Specialty Structural Engineer and submitted for review before start of shop drawing production. These design drawings shall show complete connection and:
 - .1 How connection assembly fits with connected members.
 - .2 Sizes of plates, bolts, welds, etc.
 - .3 Capacities of connection.
 - .4 Assumed eccentricities, lines of action of forces, etc.
- .6 Erection Drawings
 - .1 Include erection drawings with each submission of detailed shop drawings.

- .2 Erection drawings shall clearly show setting out dimensions for structural steel frame, including dimensions confirmed by site measurement. Dimensions shall be tied into relevant grid lines or reference points wherever possible.

.7 Shop Drawings

- .1 Submit detailed shop drawings for structural members that show details necessary for fabrication of component parts of structure.
- .2 Shop drawings, as a minimum, show the following:
 - .1 layout;
 - .2 member sizes;
 - .3 connection details, including member cuts and copes where applicable;
 - .4 bearing details;
 - .5 splice locations and details (splices not shown on shop drawings will be rejected);
 - .6 truss details;
 - .7 holes;
 - .8 camber;
 - .9 finishes;
 - .10 grade(s) of steel;
 - .11 bolt or threaded fastener material grade, size, and designation;
 - .12 weld type, size, extent, and if shop or field applied with AWS welding symbols as specified in CSA W59 Appendix D and E;
 - .13 sliding expansion joint bearing pad details, including materials, size, and thickness of pads; setting out dimensions; and load capacity;
 - .14 Architectural clearance lines and finishes where connection and the like may encroach with other work.
- .3 Provide shop drawing clearly locating anchor rods, embedded plates, baseplates, etc.
- .4 Provide setting drawings, templates, and directions for installation of anchor rods, plates, and other devices.

- .5 Review of shop drawings by Structural Engineer is intended as an assistance to Contractor and does not relieve Contractor of responsibility for completeness or accuracy of their work and its conformance with Contract Documents.
 - .6 Fabrication that commences prior to shop drawing review by Structural Engineer is at risk of Contractor.
 - .7 Clearly identify on shop drawing all revisions, changes, or modifications.
 - .8 Resubmit reviewed shop drawings where noted in review stamp, or when Contractor makes revisions for their own purposes.
 - .9 Perform and submit complete survey, before steel erection commences, of position and alignment at all points where construction by other trades will support steel elements, including but not limited to pockets, embedded plates, anchor rods, rebar, and base plates. Include plan location positions relative to building gridlines, and elevations of bearing surfaces and tops of bolts/rods relative to building Datum elevation.
 - .10 Allow at least two weeks (10 working days) for shop drawing review by Structural Engineer.
- .8 Field Work Details
- .1 Submit details for field work in accordance with requirements of Division 01.
 - .2 Location of field work details shall be clearly identified or referenced on erection drawings.
 - .3 Prepare setting drawings showing dimensions and details for setting structural steel bearings, anchorages, assemblies and the like where they interface with other building components and support work of this Section.
 - .4 Steel contractor shall incorporate other trade's work as directed by Construction Manager.
 - .5 Furnish Inspection Company with a copy of each shop, erection, and setting drawing bearing Consultant's shop drawing stamp marked reviewed.

1.10 Supply of Alternate Products

- .1 Should rolled sections or any other structural steel element shown on Drawings not be available or procurable, or should substitution for those sections be desired, sections of equivalent or greater mechanical properties (strength, stiffness, etc.) may be substituted if approved by RJC in writing. Material and structural section substitutions, if accepted, will be at Contractor's cost.

1.11 Testing and Field Review

- .1 See Section 05 00 50.
- .2 Prior to commencement of work, provide schedule of shop fabrication to Testing Agency.
- .3 Advise Testing Agency of scheduling of shop and field work pertaining to this Project. Permit testing agency full access to fabrication shop and site for purpose of carrying out their work and provide assistance required to aid in performance of inspection and testing.
- .4 Specialty Structural Engineer (or approved representative) responsible for shop drawings shall visit site to review in place connections and components to verify that these connections and components substantially comply with design drawings. Specialty Structural Engineer shall then provide a sealed and signed letter to Consultant and Structural Engineer to this effect.

1.12 Storage and Handling

- .1 Protect steelwork during fabrication, shipping, storage, and construction. Steel work that is bent, broken, or otherwise damaged shall be repaired or replaced by Contractor prior to erection, to satisfaction of Structural Engineer and at no cost to Owner.
- .2 Contractor shall be responsible for proper scheduling of delivery and erection for structural steel in accordance with construction schedule.
- .3 Store structural steel members at site above ground on platforms, skids, or other devices so that ground dampness will not affect bottom members of stacks.
- .4 Protect steel that is stored outdoors after fabrication from accumulations of standing water.

- .5 Store other materials in a weather tight and dry place until ready for use in the Work.
- .6 Store packaged materials in their original unbroken packages or containers.

1.13 Coordination with Other Trades

- .1 Supply necessary instructions and drawings to other trades for setting bearing plates, anchor rods, and other members that are built in with work of other trades. Provide punched holes for convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply necessary material in accordance with construction schedule.

2.0 PRODUCTS

2.1 Materials

- .1 Structural Steel
 - .1 Steel shall be new, unless otherwise indicated, of sizes and shapes listed in current CISC Handbook or AISC Handbook, and as indicated on Drawings.
 - .2 CISC and CWB recommend steel have a maximum boron content of .0008%. Refer to CISC and CWB bulletins detailing these recommendations. Contractor is fully responsible for providing steel meeting this boron content limit. Where this is not possible, or cannot be verified, ensure welding procedures address high boron content present in steel to prevent cracking, premature failure, or other undesirable performance of weldments from occurring. When requested, provide stamped letter from Fabricator's Welding Engineer confirming this provision has been met.
 - .3 Structural wide flange shapes (W) to conform to CSA G40.20/ G40.21 grade 345WM.
 - .4 Angles (L), plates, channels (C, MC) and miscellaneous beams (S, ST, M and MT) to conform to CSA G40.20/ G40.21 grade 350W.
 - .5 Square and rectangular hollow structural sections (HSS) to conform to ASTM A500 Grade C. (**Standard for Eastern Canada is A500 Grade C while Western Canada should choose 350W Class C)

- .6 Round hollow structural sections (HSS) to conform to ** Choose Material Properties (ASTM A500, CSA G40 H/C, ASTM A1085).
- .7 Rolled plates and bars shall conform to CSA G40.20/ G40.21 grade 300W.
- .8 Anchor Rods: Conform to **ASTM F1554 Grade 36, 55, 105** unless otherwise noted or shown.
- .9 Bolts, Nuts and Washers: Conform to ASTM F3125. Galvanized grade 325 bolts over 22 mm (7/8") diameter shall have a dry lubricant, such as Johnson's Stick Wax #140, on threads before installation.
- .10 High Strength Bolts: High strength bolting shall be of North American manufacture and conform to provisions of Research Council on Structural Connections (RCSC) "Specifications for Structural Joints Using High-Strength Bolts", latest edition.
- .2 Concrete Anchors
 - .1 Headed studs shall meet requirements of CSA W59 Appendix H.
 - .2 Types A and B shall be Nelson anchors (or pre-approved equivalent) with fluxed ends and meet mechanical properties as specified in ASTM A29, Grades 1010 to 1020. Studs to be automatically end welded with suitable stud welding equipment or shop fillet welded to develop full strength of stud. Field fillet welded studs will be rejected.
 - .3 Type C shall be deformed steel bars meeting mechanical properties of ASTM A496 and welded per manufacturer's recommendations. Reinforcing steel bars with Lenton weldable couplers or pre-approved equal couplers to be used as specified on drawings.
 - .4 Unless noted otherwise, studs shall be considered to be Type B and have a length equal to deck profile depth plus half the concrete topping above the high flute.
- .3 Shop Paint/Primer
 - .1 Confirm shop primer or paint and joint filler are compatible with spray fireproofing intumescent paint and/or top coat paint system specified, where applicable.

- .2 Shop Paint: To CISC/CPMA 1-73a or SSPC Paint 15, unless noted otherwise.
- .3 Shop Primer: To CISC/CPMA Standard 2-75, unless noted otherwise.
- .4 Primer used in a multi-coat system where a final shop or field paint finish is to be applied shall conform to Section 09 91 00 and be selected and preapproved by Architect based on surface preparation, exposure conditions, and compatibility with subsequent coatings, unless noted otherwise.
- .5 Hot Dip Galvanizing: To CSA G164, minimum zinc coating of 600 g/m².
- .6 Zinc-Rich Primer: Catha-Coat 302 as supplied by Devoe Coating Company (3 mils dry film thickness) or Carbozinc 11 as supplied by Carboline Company (2 to 3 mils dry film thickness or approved alternative.
- .7 Epoxy Paint: Devran 224 HS high build epoxy coating (4 to 6 mils dry film thickness) or approved alternative.
- .8 Zinc-Rich Touch-up Paint: Galvalite as supplied by ZRC Products Company or Galvafruid as supplied by W.R. Meadows Limited or approved alternative.
- .9 "Corrosion Protective" Paint: Tenemec Series 394 Perimeprime or Sherwin Williams Macropoxy 646 or approved alternative. Refer to drawings for extent of steel work to receive this paint. Field-applied paints shall meet requirements of Section 01 52 00. Maximum allowable VOC content for anti-corrosive paint is 250 g/L.
- .4 Structural steel elements outside building envelope, within enclosed unconditioned space, or exposed to weather shall be galvanized in accordance with CSA G164. Examples of this include, but are not limited to, canopies, cladding back-up structure, air-well, grating and supporting structure, brick support angles, and related framing materials.
- .5 Welding consumables for processes shall be fully approved by Canadian Welding Bureau and certified by manufacturers as complying with requirements of this Specification. Such certificates shall be not more than two years old.
- .6 Welding electrode strengths to be equal to E49XX (E70XX) or better, and to be matched to base metal capacity.

- .7 Grout for column bases shall be non-metallic, non-expanding, and non-shrink type with minimum strength of 35 MPa (minimum) at 28 days, unless noted otherwise on Drawings. Grout may be placed in a dry pack or flowable consistency.

2.2 Design

.1 General

- .1 Design connections and the like for loads shown or implied in accordance with requirements of S16.
- .2 If fabricator's engineer requires additional information or clarification to aid in design of their work, request this information in a timely and appropriate manner.

.2 Connections

- .1 Unless otherwise noted, fabricator's Specialty Structural Engineer shall design and be responsible for connections between steel members, including but not limited to columns, beams, girders, trusses, and braces, and between such members as spandrel angles and beams, hangers, stiffeners, etc. and their supporting members be they steel or concrete. Design of plates or anchors into concrete will be by Consultant for load and required in final building loading condition (temporary loading conditions requiring enhancements shall be by Contractor).
- .2 Unless otherwise noted, fabricator's engineer shall design and be responsible for specifying stiffeners, doubler plates, and the like required to maintain local strength and stability of a member and where these stiffeners and doubler plates become an integral part of connection or where they affect connection of other steel framing members. Typical examples include but are not limited to cranked sections, moment connections between columns and beams, connections to hollow structural sections, and the like. Where connections are exposed to view, detailing of stiffeners, double plates, and the like are subject to review by Architect and should conform to Architectural Exposed Structural Steel referred to herein.
- .3 Use types of shop or field connections shown, or in absence of such indication, use most appropriate type of connections.

- .4 Design connections to safely withstand combined primary effects of axial forces, shear, moment, and torque, and any secondary effects due to welding and bolting configurations.
- .5 Where no axial force is shown for beam-to-column connections, connect beams framing into column such that combined capacities of connection are able to resist total horizontal force of 2% of factored axial load in column, in each direction.
- .6 Unless otherwise noted, design of beams and girders is based on assumption that fastener holes through flanges will not exceed 15% of gross flange area. If area of holes exceeds 15%, member size shall be altered or reinforced accordingly unless member can be shown to have sufficient capacity to resist factored loads with presence of holes.
- .7 Design connections for fastening together double angles used to resist compression, tension, or bending in such a way that slenderness ratio of component, based on its least radius of gyration and distance between interconnections, shall not exceed that of built-up member.
- .8 Statically loaded bolted connections shall be designed as snug tight (ST) joints.
- .9 Following types of connections shall be designed as bearing connections but shall be pre-tensioned (PT):
 - .1 Connections for wind or seismic lateral load-resisting elements, such as those noted below or noted on structural drawings.
 - .1 Vertical or horizontal bracing
 - .2 Moment connections
 - .3 Truss connections
 - .4 Transfer beams
 - .5 Diaphragm collectors / struts
 - .6 All pedestrian bridge connections
 - .2 Connections where bolts are subject to tensile or tensile and shear loadings.

- .10 Design connections exposed to weather so moisture, foreign matter, and the like cannot be trapped or gain entry to interior of hollow built-up members.
- .11 Design and detail connections to not encroach on architectural clearance lines or finishes.
- .12 Where connections between beams and columns and the like result in loss of bearing to steel deck, design and provide support for steel deck.
- .13 Design connections that are to be cast into concrete to provide for maximum deviation that can occur in erection and based on following:
 - .1 Specified steel erection tolerances,
 - .2 Maximum permissible tolerances in location of inserts cast into concrete, specified in Section 03 11 00.
- .14 Beam connection design to be for forces and loads shown on Drawings and allow for effects of beam deflections. Provide minimum two 19 mm (3/4") ASTM F3125 Grade 325 bolts or equivalent weld for beam-to-girder and beam-to-column connections.
- .15 Provide separators for double members in accordance with CSA S16.
- .3 Temporary Work
 - .1 Structure as shown on Contract Documents is designed to withstand design loads only when structural elements are installed and fully connected. Analysis of components and assemblies under temporary configurations, including but not limited to stability, stresses, displacements, fabrication, shipping, handling, erection (at various stages), and construction loads, are sole responsibility of Contractor.
 - .2 Erection procedures and design of erection bracing and related provisions are sole responsibility of Contractor.
 - .3 Design temporary erection bracing to safely resist dead loads, live loads, lateral loads, construction loads, and other loads imposed during construction.

- .4 Design erection bracing to limit inter-storey and total drift as required for construction purposes and ensure that inter-storey drift does not exceed $h/400$ at floors where cladding has been installed by cladding contractor.
 - .5 During erection, forces or reaction in steel frame members and their connections might exceed those on which final or permanent building design is based. Determine magnitude of such erection forces and reactions and take such necessary measures to maintain safety and stability of structure during construction.
- .4 Bearing Assemblies
- .1 General
 - .1 Design bearings so they conform to configurations shown and can safely transmit loads and permit movements noted.
 - .2 Neoprene Bearing Pads
 - .1 Design and provide neoprene bearing pads of suitable shape and material that can safely transmit forces shown while permitting rotation and movements specified.
 - .3 Sliding Expansion Joint Bearings
 - .1 Design bearings to safely transmit range of movements and loads indicated at a bearing stress not exceeding 17 MPa live load, and such that maximum static or dynamic co-efficient of friction shall not be greater than 0.06 at a bearing stress of 12 MPa.
 - .2 Bearings shall consist of Teflon bonded to an elastomeric pad of suitable material to provide safe bearing capacity and stainless steel bonded to a steel sole plate.
 - .3 Design bearings to provide range of movements of ± 35 mm in any direction.

3.0 EXECUTION

3.1 Fabrication

- .1 Fabrication shall confirm to requirements of CSA S16 and reviewed shop drawings.

- .2 Fabricated units shall be straight and true, without sharp kinks or bends, and accurate to sizes shown.
- .3 Flame cut steel columns shall have their ends milled. Steel base plates supporting columns shall be flat.
- .4 Prior to fabrication of structural steel, take field measurements where connections are to be made to existing work.
- .5 Modify installation methods and methods for connecting to suit site conditions encountered.
- .6 Unless noted otherwise, provide holes up to 12 mm (1/2") in diameter, as required, to permit attachment of other materials. Cross sectional area of section is not to be reduced by more than 10% at any point on its length.
- .7 Provide drain holes in closed sections to prevent water build-up during erection.
- .8 Provide vent and drain holes in assemblies with closed sections or closed fabricated spaces that are to be hot dipped galvanized to provide full exterior and interior galvanization. Vent and drain holes shall be provided for RJC review prior to fabrication.
- .9 Visually inspect plates and shapes for laminations. **Replace plates or shapes that contain laminations.**
- .10 Headed shear stud connectors and deformed bar anchors shall be applied in accordance with manufacturer's instructions and the Standards or shop fillet welded per the Standards. Procedural control to be in accordance with W59 as a minimum. Field fillet welds will be rejected.
- .11 Splices
 - .1 Splices in members, other than those shown, that are provided for ease of fabrication or transportation shall not be permitted without Consultant's approval.
 - .1 These connections shall be designed to develop full strength and stiffness of member.
 - .2 Welded splices shall be subject to non-destructive testing as directed by Structural Engineer for which full cost of such testing shall be borne by Contractor.

- .3 Bolted splices shall be designed so slip is not permitted in connection assembly and to have same performance as a welded splice.

.12 Cambers

- .1 Fabrication of rolled steel sections without specified camber shall account for natural mill camber and/or sweep resulting from manufacturing and result in orientation of that camber in a positive upward direction.
- .2 Provide indicated camber to trusses, beams, and girders for a uniform parabolic profile. Method used to provide camber must not reduce safe load carrying capacity or cause distortion of members.
- .3 Camber stated on Drawings is required camber after fabrication.

.13 Openings

- .1 Conform to requirements shown for location, size, reinforcement, and cutting of openings through structural steel.
- .2 No openings through structural steel members will be permitted without written approval of RJC.

.14 Curved Steel Sections

- .1 Bend sections to geometry noted on Contract Documents in a manner that provides a smooth uniform profile. Method used to bend steel sections must not reduce safe load carrying capacity or cause distortion of members.

.15 Holes and Cutting

- .1 Holes shall be drilled or punched at right angles to surface of metal, or CNC-guided plasma or flame-cut in accordance with CISC specifications. Burning holes is not permitted.
- .2 Provide holes in members to permit connections to work of other trades or contracts.

.16 Bolts, Anchor Rods, and Embedded Parts

- .1 Drive bolts accurately into holes without damaging threads and heads. Bolt heads and nuts shall rest squarely against metal surfaces.

- .2 Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis, provide beveled washers to give full bearing to thread or nut.
- .3 Unless noted otherwise, install high strength bolts that are required to have full pretension using Turn-of-Nut Pretensioning, Twist-Off Type Tension Control Bolt Pretensioning, or Direct-Tension-Indicator (DTI) Pretensioning in accordance with "Specification for Structural Joints Using High-Strength Bolts". Use Calibrated Wrench Pretensioning only where specifically approved by RJC.
- .4 Clean and re-lubricate bolts and nuts that become dry or rusty before use, except Tension Control bolts which must be re-lubricated by manufacturer.
- .5 Label and ship anchor rods and base plates in sets indicating size and locations of columns and deliver in ample time prior to start of related concrete work. Furnish templates together with instructions for setting of anchor rods. Ascertain that anchor rods are set properly during progress of the Work.
- .6 Label and ship other embedded parts, parts with welded couplers, and the like with locations and deliver in ample time prior to start of related concrete work. Furnish templates together with instructions for setting of embedded parts where applicable. Ascertain that embedded parts are set properly during progress of the Work.
- .17 Welding of Structural Steel
 - .1 Pre-Weld Inspection
 - .1 The surface to be welded and the filler material to be used shall be subject to inspection by quality control personnel before welding is performed.
 - .2 Method and Type
 - .1 Welding shall be electric arc welding and comply with Codes and Standards noted herein.
- .18 Stiffeners
 - .1 Provide welded stiffeners in all girders, columns, and beams at points of concentrated loads where required by S16 or where specifically shown on Drawings. Fitted stiffeners shall be ground to fit closely against bearing surfaces.

- .2 In locations of concentrated loads or bearing points shown on Drawings, these stiffeners shall be fabricated to transfer their full compressive capacity through top and bottom flange connection through end bearing, fabricated by CISC approved methods, or by welds where welds are designed to transfer this load.
- .19 Remove and replace, or repair (with Consultant approval) defective work. Such operation shall be at no extra charge to Owner.
- .20 Where roof slopes exceed 5% and do not permit flush bearing of steel deck on beams, provide continuous 3 mm bent plates to pitch as necessary for full bearing of steel deck. Coordinate with deck supplier for locations that will require these bent plates.

3.2 Cleaning and Priming

- .1 Structural steel shall have surface contamination (salts, oils, grease, drilling and cutting compounds), rust, and mill scale removed and an adequate surface profile provided in accordance with minimum surface preparation specified.
- .2 Coordinate surface preparation with finishes specified by Architect in Section 09 91 00. Should material data sheets require a more stringent level of surface preparation, this shall take precedence over following minimum requirements.
- .3 Clean and prime architecturally exposed structural steel (AESS) members when applicable in accordance and coordination with intumescent paint fireproofing or finished paint system procedure. Application to be coordinated with Section 09 91 00 and fireproofing specifications and structural documents.
- .4 Apply primers in accordance with manufacturer's instructions.
- .5 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C or as indicated within paint manufacturer's specification and application procedures.
- .6 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of two different colours so missed areas can be detected.

- .1 Steel that will be non-intumescent paint fireproofed, zinc coated or galvanized, welded, receive shear studs, faying surfaces of slip resistant connections, and underside of base plates and bearing plates steel shall not be primed unless specifically noted by applied coating manufacturer's specifications.

.7 Exterior Structural Steel Unless Noted Otherwise by Architect

Zone	Description	Expected Finish	Minimum Surface Preparation
E1	Standard exposure to exterior elements.	1. Primed and Painted 2. Galvanized	SP3
E2	Frequently exposed to fresh water. Involves condensation, splash, spray, or immersion.	1. Primed and Painted 2. Galvanized	SP6
E3	Frequently exposed to water with chlorides. Involves condensation, splash, spray, or immersion.	1. Primed and Painted 2. Galvanized	SP10

- .8 Provide following touch-up for steel in an exterior exposure or which has a finish paint coat: After erection and after connections are completed, provide a field touch-up coat of primer to surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint shop coat painted areas that have been chipped or scraped.

.9 Hot Dip Galvanized Structural Steel

- .1 Produce hot dip galvanized steel in accordance with the Reference Standards.
- .2 In cases where galvanized members are to have a secondary finish applied on top, consult Architect and finish supplier about post galvanizing treatments including but not limited to surface smoothing, cleaning, preparation, and profiling.
- .3 Provide following touch-up for galvanized steel: After erection and after connections are completed, provide field touch-up coat of **zinc-rich paint** to surfaces that have been chipped or scraped.

3.3 Erection

- .1 Structural steel shall be assembled and erected in accordance with approved erection drawings and specified reference Standards.
- .2 Erector is fully responsible for erection methods, equipment, workmanship, and safety precautions.

- .3 Confirm setting of anchor rods and bearing plates and make an instrument survey to verify setting prior to erection of steel members.
- .4 Cutting or burning of baseplates to accommodate anchor rods shall be cause for rejection of baseplates. Costs associated with replacement or remedial work cause by field modifications of baseplates are Contractor's responsibility.
- .5 Adequately distribute construction loads due to temporary storage of materials, erection equipment, or other loads during construction phase so as to not exceed capacity of structure.
- .6 Proper fit up of members in compression is critical to correctly load members. Tolerance for joint fit up to be in accordance with CSA S16, clause 28.5 Joints in Contact Bearing.
- .7 Temporary bolts, clips, angles, etc. used to facilitate erection shall be removed unless noted otherwise on Drawings.
 - .1 Splices: Fastening of splices of compression members shall be done after abutting surfaces have been brought completely into contact. Splices will be permitted only where indicated on Contract Drawings or reviewed shop drawings.
 - .2 Errors: Report errors in shop fabrication or deformations resulting from handling and transportation that prevent proper assembly and fitting of parts or in erection operation. Make suggestions for corrective work and obtain approval of method of correction. Costs of corrective work are Contractor's responsibility.
- .8 Plumb, level, and align individual members of steel work as specified in CSA S16.

3.4 Welding

- .1 Welding shall be done by shielded metal-arc method in accordance with requirements CSA W59. Welding operators shall be currently certified under CSA W47.1 for work they are performing.
- .2 Submit, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer for review.

- .3 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two or more layers, clean each layer before depositing next layer. Take care to minimize stresses due to heat expansion, contraction, and distortion by using proper sequence in welding and by approved methods.
- .4 Appearance, quality of welds made, and methods of correcting defective work shall be in accordance with CSA W59.
- .5 Welding of reinforcing bars to structural steel as per CSA W186.

3.5 Completion

- .1 Specialty Structural Engineer responsible for sealed shop drawings or their representative shall visit site to review in place connections and components designed by that Specialty Structural Engineer to verify substantial compliance with their sealed shop drawings. They shall then submit signed and sealed letter of substantial compliance to Consultant and Structural Engineer.
- .2 On completion of work of this Section, remove temporary works, surplus materials, debris, tools, plant, and equipment from site.

END OF SECTION

1.0 GENERAL

1.1 Documents

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 Description of Work Included

- .1 Provide labour, materials, equipment, and services to supply, and install glued-laminated units required and/or indicated on Contract Drawings or specified herein.
- .2 Report discrepancies between structural, mechanical, electrical, and architectural drawings to Consultant and Structural Engineer immediately.
- .3 Co-ordinate with Section 06 17 00 – Cross Lam Timber Units for design, fabrication, supply, installation, and erection of CLT floor panels and accessories.

1.3 Related Work Specified Elsewhere

- .1 Section 03 31 00 – Structural Cast-in-Place Concrete
- .2 Section 04 20 00 – Unit Masonry

1.4 Reference Standards

- .1 Glued-Laminated units shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by this specification:
 - .1 Building Code
 - .1 Ontario Building Code - 2012 0 REG 88/19
 - .2 Reference Standards
 - .1 General
 - .1 CSA 086 – Engineering Design in Wood – Limit States.

- .2 CAN/CSA 0122-16 – Structural Glued-Laminated Timber.
 - .3 CAN/CSA 0177-06 (R2020) – Qualification Codes for Manufacturers of Structural Glued-Laminated Timber.
 - .4 CSA O112.10-08 (R2013), Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure).
 - .5 CSA O112.9-10 (R2014), Evaluation of Adhesives for Structural Wood Products (Exterior Exposure).
 - .6 NLGA, Standard Grading Rules for Canadian Lumber.
 - .7 CAN/CSA 080 – Wood Preservation.
 - .8 CSA O141-05, Softwood Lumber.
 - .9 CSA 0122.7 – Resorcinol and Phenol-Resorcinol Resin Adhesives for Wood.
 - .10 CSA B111-1974 (R2003) – Wire Nails, Spikes and Staples.
 - .11 ASME B18.2.1 (2012) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws
-
- .2 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
 - .3 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
 - .4 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 Definitions - For This Section

- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
- .2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd., herein also referred to as RJC.

- .3 "Specialty Structural Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .4 "Subcontractor" shall mean the Subcontractor responsible for the glued-laminated beams.
- .5 "Testing Agency" shall mean the testing agency responsible to the Owner.
- .6 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 Qualifications

- .1 Structural glued-laminated members shall be manufactured in plant certified by CSA as meeting requirements of CSA 0177 to manufacture Class X exterior members.
 - .1 Plant certification must be valid at the time of tender and be maintained throughout the duration of the project.
- .2 The Subcontractor shall have not less than **ten year(s)** experience in the fabrication of glued-laminated structural units.
- .3 The Erector shall not have less than **five year(s)** experience in the erection of glued-laminated structural units.
- .4 The Specialty Structural Engineer responsible for supervision of the project and design of connections shall be licensed in the Province of Ontario.
- .5 The Specialty Structural Engineer and Fabricator responsible for welded steel connections shall be certified per Section – 05 12 00 Structural Steel Framing.
- .6 Place authorization labels on all glue laminated members indicating manufactured in CSA certified plant.
- .7 Third party certified calculation and fabrication processes for mass timber material and connection detailing required for manufacturing through installation.

1.7 Examinations

- .1 Take dimensions from drawings and verify by field measurement. Be responsible for correctness of such measurements and report to Consultant and Structural Engineer in writing of discrepancies between field measurements and those shown on drawings prior to commencing work. Verify location of embedded connections and confirm that work prepared by other trades is at a proper elevation, on line, level, and true.

1.8 Submittals

- .1 The Subcontractor shall submit the following certificates in accordance with CSA 0177 Annex B:
 - .1 Certificate of Qualification and the plant certification label with the tender.
 - .2 Certificate of Conformance at completion of fabrication.
- .2 The Subcontractor shall submit printed product literature, specifications and data sheets, installation instructions and special handling criteria, installation sequence and cleaning procedures.
- .3 The Subcontractor shall submit certified test reports for the glued-laminated units from an approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics, physical properties and moisture content.
- .4 Submit MSDS sheets or official manufacturer literature for all adhesives which meet the requirements of section 2.1.
- .5 Provide a schedule of fabrication to Consultant, Structural Engineer, and Testing Agency prior to commencement of fabrication.

1.9 Samples

- .1 The Subcontractor shall submit samples or arrange for visual inspection of the following items by the consulting team.
 - .1 Connection mock ups

1.10 Shop Drawings

- .1 Submit shop drawings in accordance with General Sections 00 13 40.

- .2 Indicate all dimensions, stress grade, service grade, appearance grade, shop applied finishes, camber, cuts, ledgers, holes and connection details as well as shop and erection details, including cuts, holes, fastenings, connection hardware and full connection designs, camber and sizes.
- .3 Each shop drawing submitted shall be signed and sealed by the Specialty Engineer stating the product substantially complies with the drawings, specifications, and the standards, and for the design of connections and components designed by the Specialty Engineer.
- .4 Review of shop drawings by Structural Engineer is intended as an assistance to Contractor and does not relieve Contractor of responsibility for completeness or accuracy of work and its conformance to contract documents.
- .5 Fabrication that commences prior to shop drawing review by Structural Engineer is at risk of Contractor.
- .6 Clearly identify revisions, changes, or modifications on shop drawing.
- .7 Resubmit reviewed shop drawings where noted in Read Jones Christoffersen Ltd.'s review stamp, or when Contractor makes revisions for own purposes.
- .8 Allow at least two weeks for shop drawing review by Structural Engineer.
- .9 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias can be used by the Contractor under the following conditions:
 - .1 Copyright remains with Read Jones Christoffersen Ltd.
 - .2 Drawings will only be used for shop drawings for this project and not be put to any other use.
 - .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in drawings. Contractor assumes all risk and expenses associated with use of structural drawings in production of their work.
 - .4 References to Read Jones Christoffersen Ltd. must be deleted from title block.
 - .5 Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

1.11 Connection Design

- .1 All wood to wood connection details illustrated for design intent and min requirements. All connection details to be designed by timber Specialty Structural Engineer based on loads provided and subject to review and approval by RJC and architect. Sealed shop drawings for all connection details to be submitted to RJC for review prior to fabrication.
- .2 Mass timber drawings are prepared to present loads and performance-based design in order to prepare connection designs and shop drawings.

1.12 Supply of Alternate Products

- .1 Should the Subcontractor propose a substitution for glued-laminated units as shown on the drawings, those sections shall be of equivalent or greater mechanical properties (strength, stiffness, etc.) and may only be substituted if approved by RJC in writing. In such cases, full particulars thereof must be submitted prior to the closing of Bid. Material and structural section substitutions after the closing of Bid, if accepted, will be at the Contractor's cost.
- .2 If European elements are proposed, the supplier must also supply an Equivalency Report from an Engineer stating that the element meet all the requirements of CSA in comparison to the Canadian Specification.

1.13 Field Quality Control

- .1 Testing
 - .1 Testing of units will take place at both plant and site.
 - .2 Costs of tests will be paid by the Contractor.
- .2 Field Review
 - .1 Subcontractor to submit written reports to the Structural Engineer within three [3] days of review, verifying compliance of Work, in handling, storing, protection and installation at the following stages:
 - .1 After delivery and storage of products.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of work.

1.14 Delivery, Storage and Handling

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 All materials shall be delivered to the site in consultation with the supplier and contractor to suit the construction schedule.
- .3 Use padded, non-marring slings for handling glued-laminated members.
- .4 Protect corners with wood blocking.
- .5 Wrap quality appearance grade members prior to leaving plant with a moisture-resistant wrapping.
- .6 Make adequate provision for delivery and handling stresses.
- .7 Store glued-laminated timber, blocked off the ground, on raised skids or racking system and separated with stripping, so air may circulate around all faces of members.
- .8 Slit underside of membrane covering during storage at site. Do not deface member.
- .9 Cover top and sides with opaque moisture resistant membrane if outside.
- .10 Exterior grade finish ILVA KLIMA 3:1 + 10ml wet film or approved equivalent.
- .11 Maintain protection of glued-laminated members until deck over is installed.
- .12 Replace defective or damaged materials with new, unless written approval is provided by the Subcontractor.

1.15 Coordination with Other Trades

- .1 Provide punched holes for convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to construction schedule.

2.0 PRODUCTS

2.1 Materials

- .1 Laminating Stock: Spruce Lodgepole Pine-Jack Pine, in accordance with CSA O122, S4S, moisture content 12% (+/- 3%) or less in accordance with CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
- .2 Laminating Adhesive:
 - .1 In accordance with CSA 0112.10 (Limited Moisture Exposure)
- .3 Sealer for cross-laminated-timber panels: Penetrating type, clear, non yellowing liquid which will protect wood against moisture entry.
- .4 Galvanizing: To CSA G164, hot-dipped, minimum zinc coating of 600 g/m².
- .5 Fastenings:
 - .1 Split ring connections: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
 - .2 Shear plate connections:
 - .1 Pressed steel type: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
 - .2 Malleable iron type: to ASTM A47M, grade 350.
 - .3 Lag screws: to ASME B18.2.1.
 - .4 Bolts: to ASTM A307.
 - .5 Side plates: to CAN/CSA-G40.21 or ASTM A36.
 - .6 Drift pins: to ASTM A307.
 - .7 Glued-laminated rivets: hot dip galvanized to CAN/CSA-G40.21 or ASTM A36.
 - .8 Nails and spikes: to CSA B111.
 - .9 Truss plates: light gauge galvanized sheet steel to ASTM A 653, grade A, yield point 255 MPa.

- .10 Steel for Connections: To CAN3-G40.21, Type 300W unless noted otherwise
- .6 Shop coat primer for steel connections: to CAN/CGSB-1.40.
- .7 Galvanizing: to CAN/CSA-G164, hot dipped, minimum zinc coating of 610 g/m².
- .8 Preservative: Sansin KP11 sealer, or equivalent.

3.0 EXECUTION

3.1 Fabrication

- .1 Fabricate members to the minimum following classifications:
 - .1 Stress Grade:
 - .1 Bending grades: 20f-E and 20f-EX
 - .2 Compression grades: 16c-E
 - .3 Tension grades: 18t-E
 - .4 See also General notes for further requirements, breakdowns and acceptable alternatives.
 - .2 Service Grade:
 - .1 "Interior" for all members within the building envelope and within a conditioned space.
 - .2 "Exterior" for exterior applications and where exposed to weather.
 - .3 See also General notes for further breakdown and acceptable alternatives.
 - .3 Appearance Grade: Commercial
 - .4 Moisture Content:
 - .1 At delivery to site: 15% max
 - .2 At time of installation: 15% max
- .2 Mark laminated members for identification during erection. Marks must be concealed in final assembly. Clearly mark top surface of straight beams.

- .3 Apply sealer to sides and ends of members concealed from view when installed. Do not apply sealer to areas which are to receive stained finish or preservative treatment.
- .4 Connections: Designed by the Subcontractor in accordance with CSA 086 and CSA S16.1 except where connections are detailed. Submit shop drawings per Clause 1.12 above for fabricator designed connections.
- .5 Prepare and paint connections after fabrication as per Section 099000 - Painting.

3.2 Erection

- .1 At least 60 days prior to the commencing of on-site installation, the Contractor shall hold a meeting to review the detailed requirements and staging for erection. A detailed schedule should be developed with the following parties involved:
 - .1 Subcontractor & Erector
 - .2 Concrete Contractor
 - .3 Consultant
 - .4 Owner's Representative
- .2 Ensure protective sealer is not damaged before erection. If damaged, touch up on site before erection.
- .3 Erect glued-laminated members in accordance with reviewed erection shop drawings.
- .4 Brace and anchor materials until permanently secured by structure.
- .5 Make adequate provisions for erection stresses.
- .6 Splice and joint only at locations indicated on reviewed shop drawings.
- .7 Fit members closely and accurately to other members and other assemblies.
- .8 Do no field cut, notch, drill or alter members in other ways without the Consultant's approval. If approved, ensure all exposed wood grain is treated with a water-repellent sealer equivalent to that provided by the manufacturer prior to leaving the factory.

3.3 Installation

- .1 Store members supported off the ground and separated with strapping, to allow air to circulate around all faces of members.
- .2 Temporary construction heating should be arranged to avoid excessive temperature within the enclosed space and locally at discharge points which could cause rapid drying of the glulam members.
- .3 Upon installation of the members the subcontractor shall maintain protection until permanent weather protection is ready to be installed. At this point:
 - .1 Member protection can be removed to allow the moisture content of the glulam member to stabilize naturally during construction.
 - .2 The relative humidity within the enclosed space should be gradually reduced to avoid rapid drying glulam members.
 - .3 Avoid rapid temperature changes that can affect the rate of drying.

END OF SECTION