SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 6

STRUCTURAL STEEL

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6.1 General

This specification is for the supply, fabrication, delivery and erection of structural steel. Structural steel shall include steel girders, trusses, diaphragms, bracing, splice plates, deck drains, structural bearings, anchor bolts, dowels, deck joint assemblies, buffer angles, connector angles, anchor bolt sleeves, curb and median cover and trough plates, pier nose plates, steel caps and capitals pier bracing and miscellaneous components.

6.2 Supply and Fabrication

6.2.1 Standards

Fabrication of structural steel shall conform to "The American Association of State Highway and Transport Officials (AASHTO), Standard Specifications for Highway Bridges" and the American Welding Society (AWS) - Bridge Welding Code, D1.5.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN3-Z234.1-79 shall be used as the basis of conversion.

All welding, cutting and preparation shall be in accordance with the AWS - Bridge Welding Code, D1.5.

6.2.2 Qualification

The Contractor shall notify the Department and Consultant of any subcontractors in his employ. The Contractor shall remain responsible for the work of the subcontractors. All terms of the contract, such as Canadian Welding Bureau (CWB) approval and right of access shall apply to the subcontractor.

The Fabricator shall operate a recognized steel fabricating shop accepted by the Consultant.

The Fabricator shall be fully approved by the CWB as per Canadian Standards Association (CSA) Standard W47.1 in the following Divisions:

Fabrication of steel girders, girder components and welded steel trusses...........Division 1
All other bridge components............Division 2

Only welders, welding operators and tackers approved by the CWB in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Consultant.

6.2.3 Engineering Data

6.2.3.1 Review of Plate Arrangement for Welded Plate Girders

Prior to the placing of material orders, the Contractor shall submit to the Department and Consultant for review and acceptance, three copies of sketch drawings showing the general description of the proposed fabrication scheme. This shall include the general arrangement of plates or shapes, the location of all shop and field splices and such other information as may be requested by the Department and Consultant to permit an assessment of the acceptability of the proposal.
6.2.3.2 Welding Procedures

Welding procedures shall be submitted for each type of weld used in the structure. The procedures shall bear the approval of the CWB and shall also be reviewed by the Department prior to use on the structure.

6.2.3.3 Shop Drawings

Five copies of the shop drawings showing all details shall be prepared by the Contractor and submitted to the Consultant for review and acceptance prior to fabrication. The shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. Each drawing shall have a sufficient blank space for the Consultant's acceptance stamp. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions. All shop drawings will be stamped as follows:

"This acceptance applies to general arrangements and details of design but not to dimensions or details of fabrication and is subject to the requirements of specifications and to such corrections as may be marked here on."

Fabrication shall not commence prior to the review and acceptance of the shop drawings.

In addition to specific details, the shop drawings shall include the following:

(a) Drawings showing details of connections designed by the Contractor shall bear the signature and stamp of a Professional Engineer registered in the Province of Alberta.

(b) All dimensions shall be correct at 20°C unless otherwise noted.

(c) Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols.

(d) All material splice locations shall be shown on the drawings.

(e) Bearings shall be centered at -5°C.

(f) Shop assembly drawings shall indicate camber and splice joint offsets measured to the top of top flange at a maximum spacing of 4 m.

(g) Alberta Infrastructure and Transportation bridge file number and project name shall be shown on all the shop drawings.

6.2.3.4 Proposed Fabrication Sequence

Prior to commencement of fabrication, the Contractor shall present for review and acceptance an outline of the fabrication sequence that clearly describes the order of make-up and assembly of all the component parts, as well as shop assembly, inspection stations, and surface preparation.

6.2.3.5 Mill Certificates

Mill certificates shall be provided for all material before fabrication commences.
6.2.3.6 Schedules

The Contractor shall provide and keep current a complete fabrication schedule in a form satisfactory to the Consultant.

6.2.4 Materials

6.2.4.1 Structural Steel

Structural Steel shall conform to the standard noted on the drawings. Interpretation of equivalent steels will be as per Appendix "A" of the CSA Standard G40.21 (1976 only). Mill certificate data and results of impact tests shall be provided to the Consultant for review and acceptance prior to shipment of material from the mill to provide sufficient time for replacement or for heat treating of material that does not meet the specification.

6.2.4.2 Bolts

All bolts, nuts and washers shall conform to American Society for Testing and Materials (ASTM) Standard A 325 or shall meet property class 8.8 of the Industrial Fasteners Institute for metric high strength structural bolts, nuts and washers. Metric bolts shall be marked with the symbol A 325M and those of a "weathering" steel shall have the A 325M symbol underlined. Metric nuts shall be marked with three circumferential lines with an "M" between two of them or shall be marked with a "3" if made of a weathering grade. Washers shall be identified as metric preferably by having an "M" indented in the surface or a "3" for weathering grades. Certified mill test reports for the fastener material shall be provided.

6.2.4.3 Stud Shear Connectors

All stud shear connectors shall conform to the chemical requirements of ASTM Standard A 108, Grades 1015, 1018 or 1020. In addition they shall meet the mechanical properties specified in AWS D1.5, Table 7.1 for Type B studs. Certified mill test reports for the stud material shall be provided.

6.2.4.4 Bearings

Certified mill test reports for all bearing material shall be provided prior to installation.

(a) Stainless Steel

Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish.

(b) Elastomer

Elastomer shall conform to Section 18 "Bearings" Division II of AASHTO Standard Specifications for Highway Bridges. Elastomer compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness.

(c) Teflon

Teflon shall be unfilled, 100% virgin polymer.
(d) **Base Plate Corrosion Protection**

Bearing base plate corrosion protection shall be as per section 12.2.6.8.

6.2.5 **Welding**

6.2.5.1 **Filler Metals & Welding Processes**

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filler wires in the submerged arc process or shielding gas process are not considered as conforming to low hydrogen practice. These methods will not be permitted.

(a) **Submerged Arc Welding (SAW)**

Submerged arc welding process is allowed for all flat and horizontal position welds. All flange and web butt joints shall be made by an approved semi or fully automatic submerged arc process. All web to flange fillet welds and all longitudinal stiffener to web fillet welds shall be made by an approved fully automatic submerged arc process.

(b) **Shielded Metal Arc Welding (SMAW)**

Shielded metal arc welding is allowed for girder vertical stiffener to flange fillet welds and for miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates and buffer angles.

(c) **Metal Core Arc Welding (MCAW)**

Metal core welding process utilizing low hydrogen consumables with AWS designation of H4 is allowed for vertical stiffeners and horizontal gussets of the girders and miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates and buffer angles.

Field application of metal core arc welding is not allowed.

6.2.5.2 **Cleaning Prior to Welding**

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding.

6.2.5.3 **Tack and Temporary Welds**

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and length shall not exceed 15 times the weld size, and shall be subject to the same quality requirements as the final welds. Cracked tack welds shall be completely removed prior to welding over.
6.2.5.4 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

6.2.5.5 Preheat

Preheat requirements shall be performed and maintained as per AWS D1.5, except that all welds on girder flanges shall be preheated to a minimum temperature of 100°C unless a higher temperature is required by AWS D1.5 for the flange thickness. The preheat temperature of the web to flange joint shall be measured 75 mm from the point of welding on the side of the flange opposite to the side where the weld is being applied.

6.2.5.6 Welding at Stiffener Ends

To prevent notching effects, stiffeners and attachments fillet welded to structural members shall have the fillet welds terminate 15 mm short of edges.

6.2.5.7 Methods of Weldment Repair

Repair procedures for unsatisfactory weldments shall be submitted for review and acceptance by the Department and Consultant prior to repair work commencing.

6.2.5.8 Arc Strikes

Arc strikes will not be permitted. In the event of accidental arc strikes, the Contractor shall submit to the Department and Consultant for review and acceptance a proposed repair procedure. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. These areas will be examined by the Consultant to ensure complete removal of the metal in the affected area.

6.2.5.9 Grinding of Welds

Flange butt welds shall be ground flush or to a specified slope on both sides. Web butt welds which are sufficiently smooth with a neat appearance and uniform profile will not require grinding. Fillet welds not conforming to acceptable profile shall be ground to the proper profile without substantial removal of the base metal. Grinding shall be smooth and parallel to the line of stress. Caution shall be exercised to prevent over grinding. Acceptability of the welds without grinding will be determined by the Consultant.

6.2.5.10 Plug and Slot Welds

Plug welds or slot welds shall not be permitted.

6.2.6 Fabrication

Fabrication shall be performed in an enclosed area which is adequately heated.
6.2.6.1 Heat Number Transfer

As the plate is subdivided for webs and flanges, all heat numbers shall be transferred to each individual section. The numbers shall remain legible until such time as the material location in the final assembly has been recorded. Mill identification numbers stamped into the material shall be removed by grinding at an appropriate time.

6.2.6.2 Marking Systems

Methods and medium of marking and the location of marks shall be accepted by the Consultant. Steel stamps shall not be used. The only exception is the match marking of splice plates which may be steel stamped using low stress stamps. The stamps and specific locations of such stamps must be shown on the drawings and accepted by the Consultant.

6.2.6.3 Cutting of Plate

All plate material for main members, splice plates and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing is not allowed.

6.2.6.4 Flange Stripping

All flange material shall be cut so that the direction of the applied stress will be parallel to the direction of the plate rolling.

6.2.6.5 Flame Cut Edges

The flame cut edges of girder flanges shall have a maximum Brinell hardness as stated by Section 6.2.8.10. The surface roughness of the flame cut edge shall not be greater than ANSI B46.1 500 \( \mu \)in. (12.5 \( \mu \)m) and be such that as to allow Brinell hardness testing without spot grinding. The Contractor shall report all blow backs or signs of lamination observed during the cutting of the material. The Consultant will perform Brinell hardness tests at random on the as is flame cut edge. If the hardness exceeds the requirements, the Contractor shall submit for review and acceptance, his procedures for repairing the edges to meet the requirements.

The surface of flame cut apertures shall be finished by grinding and shall be free of nicks and gouges.

6.2.6.6 Additional Material Splices

Additional splices, other than those shown on the shop drawings, will require review and acceptance of the Department and Consultant. The Contractor shall bear the cost of inspection of these splices.

6.2.6.7 Vertical Alignment

The structure shall be fabricated to conform to the requirements of the deflection and vertical curve, as noted on the drawings. For rolled shapes, advantage shall be taken of mill camber that may be inherent in the material.
6.2.6.8 Shop Assembly

(a) Plate Girders
Shop assembly of girders shall be by the progressive assembly method according to AASHTO, except that only two, instead of three, sections need to be assembled. The detailed method of assembly, including points of support, dimensional checks, method of trimming to length, drilling and marking of splices, shall be to the procedure submitted and accepted by the Consultant as per section 6.2.3.4. Each individual girder section shall meet the camber requirements for that particular length, with the splices between these sections falling on the theoretical camber line for the entire span. Correction for variation in flange thickness must be considered. When the camber of the girder fails to meet the required tolerance, the Contractor shall submit a proposed method of repair for review and acceptance by the Department. No flame cambering will be allowed without prior acceptance and supervision of the Consultant. The camber of each individual girder section must be known for the next two girder sections in the girder line prior to shop assembly of any particular girder section. This is to allow the Consultant to call for the best fit line to reduce the effect of any camber differences should it be deemed necessary. Camber for plate girders will be measured on the top of the top flange.

(b) Box Girders
The progressive shop assembly for box girders shall be as per section 6.2.6.8(a), items described in this section are specific to box girders.

The camber of box girders shall be measured on the top of the top flange, and each top flange of a box shall individually meet the required camber. Girder sections assembled for splicing shall be supported within 2 m of the end of each section. Girder sections shall be supported in such a manner as to provide the correct angular relationship at the splice between girder sections while the splices are being reamed or drilled. Shop drawings shall clearly indicate the expected dead load deflection of each section and the elevations of the sections while supported for the drilling or reaming of each splice.

(c) Drilling
All splices shall be drilled from solid material while assembled or shall be subpunched or sub-drilled and then reamed to full size while in the shop assembly position. No reaming shall take place until acceptance of the assembly has been obtained from the Consultant.

6.2.6.9 Splice Plates
After shop assembly, splice plates and girders shall be clearly match marked to assure proper orientation and location of splice material for erection. All holes shall align with holes in the attached member. Splice plates shall then be removed, de-burred, solvent cleaned to remove all oil and sandblasted to remove all mill scale, in order to provide a suitable faying surface. These plates shall then be securely ship-bolted to the girders. The match marking system shall be shown on the drawings.
6.2.6.10 Bolt Holes

Clause 11.4.8 in Division II of AASHTO shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or subpunched and reamed to full size. All holes in girder splices shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.

6.2.6.11 Dimensional Tolerances

Normal tolerance for structural steel fabrication and fitting between hole groups will be ±3 mm unless specified otherwise. The dimensional tolerances for structural members shall be within the AWS Standard D1.5, Section 3.5, except as otherwise noted below:

(a) Combined Warpage & Tilt
Combined warpage and tilt of flange at any cross section of welded I-shape beams or girders shall be determined by measuring the offset at the toe of the flange from a line normal to the plane of the web through the intersection of the centerline of the web with the outside surface of the flange plate. This offset shall not exceed 1/200 of the total width of the flange or 3 mm whichever is greater at bolted splice location. Bolted splices of main stress carrying members shall have parallel planes and the surfaces shall be in full contact without any gap.

(b) Girder Camber
Camber of beams and girders shall be uniform, true and accurate to the centreline of the top flange. Permissible variation in camber shall be within ±(0.2Lt + 3) mm; where Lt is the test length in metres. This applies to fabricated pieces only, prior to shop assembly. During shop assembly, splice points shall be located on the theoretical camber line or at a specified amount from the line should the Consultant choose to correct for shop camber deviations.

Where field splices are eliminated by combining girder segments into longer girder lengths, the cambers of the girders at the eliminated splice points shall be within ±3 mm.

(c) Box Girders
Tolerances for box girder camber, sweep and depth shall be measured relative to two imaginary surfaces: a vertical plane passing through the centre line of the girder, and a surface located at the theoretical underside of the top flanges following the theoretical camber of the girder.

(d) Splices
Fill plates shall not be permitted at main girder field splices unless specified. The tolerance for girder depth or box girder geometry shall be as specified by AWS D1.5, except that the difference between similar dimensions of the adjoining sections being spliced shall not exceed ±3 mm.

(e) Fitted Stiffeners
The Bearing ends of bearing stiffeners shall be flush and square with the web and shall have at least 75% of this area in contact with the flanges whereas fitted stiffeners may have a gap of up to 1 mm between stiffener and flange.

(f) Bearing to Bearing Dimension
Bearing to bearing distance is a set dimension and therefore has no tolerance.
(g) **Deck Joint Assemblies**

Deck joint assemblies shall be assembled for inspection in a relaxed condition with erection angles removed. Acceptance of the assembly is required prior to application of the erection angles. Tolerances for straightness shall be considered over the length of the assembly between the crown and gutter line both before and after galvanizing. Deviation from straightness in a vertical plane shall not exceed ± 6 mm. Horizontal sweep or variations in gap setting shall not be greater than 3 mm.

6.2.6.12 **Flange Corner Chamfer**

Corners of all flanges shall be ground to a 2 mm chamfer.

6.2.6.13 **Milling Tolerances**

Tolerance for milled to bear stiffeners shall be 0.05 mm with at least 75 percent of the area in bearing.

6.2.6.14 **Web Panning**

The maximum variation from flatness for webs shall be 0.01d where d is the least dimension of the panel formed by the girder flanges and/or stiffeners. Should the panning in one panel convex and the panning in the adjacent panel concave then the sum of the panning in the two adjacent sections shall not exceed that allowed for one panel.

6.2.6.15 **Field Weld Preparation**

All material to be field welded shall be prepared in the shop.

6.2.6.16 **Flame Straightening**

Flame straightening shall not be performed on any material or member without a written request to the Department and the Consultant. The Contractor shall submit a procedure stating location, temperatures and cooling rates, to the Department and the Consultant for review and acceptance.

6.2.6.17 **Stress Relieving**

When stress relieving is specified, it shall be performed in accordance with AWS D1.5. Copies of the furnace charts shall be supplied to the Consultant.

6.2.6.18 **Handling and Storage**

All lifting and handling shall be done using devices that do not mark, damage, or distort the assemblies or members in any way. Girders shall be stored upright, supported on sufficient skids and safely shored to maintain the proper section without buckling, twisting or in any way damaging or misaligning the material.
6.2.7 Surface Preparation

6.2.7.1 Blast Cleaning

Unless otherwise noted, all steel components shall be blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) No. SP6. Essentially this is a surface from which all oil, grease, dirt, rust, scale and foreign matter have been completely removed, and all rust, mill scale and old paint have been removed except for slight shadows, streaks or discolorations caused by rust stain or mill scale oxide binder.

6.2.7.2 Galvanizing

Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of CSA Standard G164 with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be submitted for review and acceptance prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A 780, Method A3 Metallizing. The thickness of the metallizing shall be 180 \( \mu \text{m} \), and the repair tested for adhesion. The finished appearance shall be similar to the adjacent galvanizing. The Consultant will determine the acceptability of repaired areas.

6.2.8 Testing and Inspection

6.2.8.1 Access

The Contractor shall provide full facilities for the inspection of material and workmanship. Free access shall be allowed to the Consultant to all parts of the works. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

6.2.8.2 Testing by the Consultant

The visual, radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Consultant or by his testing agencies at the Consultant's expense.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Consultant to inspect bridge girders and finger plate deck joints being fabricated outside the Province of Alberta. The cost shall also include for a Department's representative to attend the prejob meeting and three additional trips to oversee the inspection of girders during the course of fabrication. This requirement for attending the prejob meeting will also apply for the finger plate deck joint, however the additional trip requirement will be reduced to one for the Department's representative.
6.2.8.3 Testing by the Contractor

The exception to 6.2.8.2 is that inspection made necessary by the repair of faulty work and additional unspecified material splices shall be paid for by the Contractor. Any test records made by the fabricating shop in the course of normal quality control shall be open to the Consultant for inspection.

6.2.8.4 Inspection Station

To insure that each stage of inspection is performed in an orderly manner, during the fabrication of major structures, Inspection Stations will be set up at specific points. Sub-assemblies of the work will then be checked by the Contractor, confirmed and tested by the Consultant, and all deficiencies shall be corrected, prior to the work being sent to the next stage of fabrication.

Typical check points for a plate girder are:

- Flange plates prepared.
- Web plates prepared.
- Web to flange welds completed prior to fitting any stiffeners.
- Completion of all welding prior to splicing.
- Splice set-up prior to drilling.
- Surface preparation and coating.
- Clearance to ship.

6.2.8.5 Non-destructive Methods of Examination

The methods of non-destructive examination shall be in accordance with the following standards:

- Radiography - AWS Standard D1.5
- Ultrasonic - AWS Standard D1.5
- Magnetic Particle - ASTM Standard E-709
- Dye-Penetrant - ASTM Standard E-165
- Hardness tests - ASTM Standard E-103

6.2.8.6 Radiographic Inspection Schedule

Unless otherwise noted, radiographic inspection of welded plate girders will be performed in accordance with the following schedule:

(a) 100 percent of all tension flange butt welds, all stiffener butt welds and all diaphragm butt welds, and any groove welded attachments to flange plates.

(b) 25 percent of all other flange butt welds.

(c) All web butt welds in tension zone plus additional 300 mm of web butt weld in compression zone at the end of the web.
6.2.8.7 Radiographic Inspection of Miscellaneous Material

Unless otherwise noted, radiographic inspection of miscellaneous material will be performed in accordance with the following schedule:

(a) 100% of all tension members.
(b) 50% of all other members.

6.2.8.8 Magnetic Particle Inspection Schedule

Unless otherwise noted, magnetic particle inspection of welded plate girders will be performed in accordance with the following schedule:

(a) 50 percent of the web to flange welds or any fillet welds placed on flange plates
(b) 10 percent of the web to stiffener welds
(c) 100 percent of the stiffeners to flange welds
(d) 100 percent of the bearing sole plate to flange welds
(e) 20 percent of the diaphragm connector plate welds

6.2.8.9 Dye Penetrant Inspection

Dye penetrant inspection will be performed in areas of the structure deemed necessary by the Consultant. In particular, the ends of the weld metal of all flange butt welds after the removal of run-off tabs will be inspected using this method. Defects discovered by this inspection shall be repaired by the Contractor, and the suspect area reinspected.

6.2.8.10 Hardness Tests

Hardness tests will be performed by the Consultant on the flame cut edges of the girder flange prior to assembly. Unless otherwise noted, the hardness of the flame cut edges shall not exceed a maximum Brinell as noted below:

(a) For carbon steels with a yield strength less than and including 300 MPa, the maximum Brinell shall be 200 BHN.
(b) For carbon steels with a yield strength greater than 300 MPa, the maximum Brinell shall be 220 BHN.

Remedial work to the edges which exceed the specified hardness shall be performed and reinspected prior to assembly.
6.2.8.11 Testing Stud Shear Connectors

Stud shear connectors shall meet all requirements as outlined by AWS D1.5. When bend testing, the studs shall be bent towards the centre of the girder.

6.2.8.12 Inspection Schedules

The Contractor shall ensure that adequate notice of scheduled inspection requirements be given to the Consultant and inspection agencies, and that access to the work is provided at all times. The Contractor shall provide the Consultant with his sequence of fabrication in order that the inspection program can be properly integrated and agreed to, prior to commencement of fabrication.

6.2.8.13 Testing of Deck Joint Strip Seal

The installation of strip seal shall be tested by the Contractor in the presence of the Consultant for leakage. The failed areas shall be corrected and retested. The defective or torn seal shall be replaced at the Contractor's expense.

6.2.8.14 Notification

The Contractor shall notify the Consultant 48 hours prior to contemplate shipment to facilitate final inspection of the materials. Material that has not been inspected in the fabrication plant will not be paid for until such material has been inspected and accepted. The Contractor may be charged with all expenses incurred for inspection of the material at the site.

6.3 Structural Steel Erection

The Contractor shall erect the structural steel, remove any temporary construction and do all work required to complete the erection in accordance with the drawings and these specifications. No field welding, additional drilling or any other modifications shall be made to steel elements other than deck joints. The Contractor shall not erect the structural steel until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirement. Without restricting generality, erection includes:

- placing of anchor bolts and bearings
- erection of temporary supporting structures
- erection of structural steel
- placing of expansion assemblies
- grouting of anchor bolts
- placing and sealing of grout pads
- touch-up painting as required

6.3.1 Handling and Storing Materials

Material to be stored shall be placed on timber blocking. It shall be kept clean, and stored in a properly drained area. Girders and beams shall be placed upright and shored. Long members, such as deck joint assemblies, buffer angles, columns and chords, shall be supported on timber blocking to prevent damage from deflection. Galvanized material shall be handled and stored as per section 12.2.8.
6.3.2 Bridge Girders

6.3.2.1 Temporary Supporting Structures and Berms

The temporary supporting structures and berms shall be designed, constructed and maintained to safely support all loads. Berms shall be constructed in a manner and of such materials that they will not be eroded by stream flow nor introduce silt into the water. The Contractor shall prepare and submit drawings for the Consultant’s review and acceptance for temporary supporting structures and berms where applicable. Acceptance of the Contractor’s drawings shall not be considered as relieving the Contractor of any responsibility. All drawings submitted shall bear the seal of a Professional Engineer registered in Alberta.

Temporary supporting structures and/or berms will not be permitted to remain in any stream channel during spring break-up or run-off periods, unless all necessary approvals have been obtained from pertinent agencies and prior written acceptance obtained from the Consultant.

Incidental damage to other property, such as earth fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.

6.3.2.2 Review of Erection Procedure

The Contractor shall submit to the Consultant, for record purposes and for examination four copies of the detailed erection procedure four weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following:

(a) Traffic Accommodation Strategy (TAS), as applicable.
(b) Access to work, earth berms and work bridges.
(c) Type and capacity of equipment.
(d) Sequence of operation including position of cranes, trucks with members.
(e) Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers.
(f) Lifting devices and lifting points.
(g) Details of temporary works, supporting structures drawings including proposed methods to be used to ensure the required splice elevations and structure shape prior to bolt torquing, method of providing temporary supports for stability, top of girder elevations at each bearing and each splice location where appropriate.
(h) Bolt tightening sequence.
(i) Grout Pad Construction. Refer to Section 6.3.2.10 of these Specifications.
(j) Details of release of temporary supporting structures.
(k) Provide an "As-Constructed" detailed survey of the substructure showing the following:
- location and elevation of all bearing grout pad recesses including anchor bolt voids,
- shim height at each bearing location,
- top of girder elevations at each bearing and each splice location where appropriate.
- longitudinal measurements between centreline of bearings of all substructure elements.

The erection procedure shall bear the Seal of a Professional Engineer registered in Alberta, who shall assume full responsibility to ensure that his erection procedure is being followed. Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder, shall be an integral part of the design.

The Contractor shall continue to be fully responsible for the results obtained by the use of these sealed drawings, with the Professional Engineer also assuming responsibility, as the Contractor's Agent, for the results obtained.

Site work shall not commence until acceptance of the proposal by the Consultant has been obtained. The Contractor's project manager and field superintendent may be required to attend a pre-job meeting at a location determined by the Consultant prior to commencement of any field work.

The Consultant's acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from carrying out the work in full accordance with the drawings and specifications.

Before erection begins the Contractor shall do a complete superstructure layout by means of chalk lines and markings applied to all substructure units, showing bearing and girder positions in accordance with the contractor's accepted layout plan.

6.3.2.3 Fall Protection for Girder Erection and Deck Forming

In order to provide a safe working area for girder erection and deck formwork, the Contractor shall provide 100% fall protection and a safe work procedure.

6.3.2.4 Bearings and Anchorage

Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in their exact position.

The Contractor shall remove anchor bolt void forming materials, and accurately set the anchor bolts, except where the bolts were cast into the concrete. Any residues on the concrete surfaces, such as oils, grease or other contaminants, shall be removed by sandblasting. All methods and materials for setting anchor bolts and constructing bearing pads shall be subject to the Consultant's review and acceptance. The location of the anchor bolts, in relation to the slotted holes in the expansion shoes, shall correspond with the temperature at the time of erection. The nuts on the anchor bolts, at the expansion ends of spans, shall be adjusted to permit free movement of the spans.
Specifications for Bridge Construction

When steel bearings are employed in conjunction with grout pockets in the substructure, the bearings shall be set accurately on galvanized steel shims, and grouted as detailed on the drawings, after the girder erection has been completed. The shims must be located so that a minimum 75 mm grout coverage is provided. When grout pockets are not detailed, the bearing plates shall be set on the properly finished bearing areas in exact position and shall have a full and even bearing on the concrete.

6.3.2.5 Straightening Bent Material

Straightening of plates, angles or other shapes will not be permitted without the acceptance of the Department and Consultant. In all cases a detailed procedure in writing must be submitted by the Contractor, and accepted prior to any straightening being undertaken.

Following the accepted straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fractures, which may include non-destructive testing. All costs shall be the responsibility of the Contractor.

6.3.2.6 Assembly

The parts shall be accurately assembled as shown on the drawings and all match-marks shall be followed. The material shall be carefully handled to avoid damage. Hammering, which will injure or distort the members, shall not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be clean before the members are assembled.

Splices and field connections shall have one half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins evenly distributed throughout the splice or connection) before bolting. Splices and connections carrying traffic during erection shall have three-fourths of the holes filled.

Fitting-up bolts shall be of the same nominal diameter as the bolts, and cylindrical erection pins shall be sized to accurately fit the holes.

Should adjustments in elevation of the girder splices become necessary only enough pins or bolts shall be removed to allow free rotation of the joints.

6.3.2.7 High-Tensile-Strength Bolted Connections

(a) General

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, paint, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts. Bolts in exterior girders shall be installed with the heads on the outside face of the girder web and on the bottom faces of lower flanges unless otherwise noted. Nuts for bolts that will be partially embedded in concrete shall be located on the side of the member that will be encased in concrete.

Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel.
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For sloped surfaces, bevelled washers shall be used. The bevelled washers shall be designed to produce a bearing surface normal to the bolt axis.

Bolts shall be of new quality and stored in weatherproof containers to prevent loss of lubrication or accumulation of dirt.

All girders shall be erected with elevations and alignments checked by the Consultant, prior to any bolt tightening unless otherwise accepted by the Department and the Consultant.

(b) Bolt Tension
Each bolt shall be tightened so as to provide, when all bolts in the joint are tight, at least the minimum bolt tension shown in the following table for the size of bolt used:

<table>
<thead>
<tr>
<th>Specified Bolt Size (A325M Bolts)</th>
<th>Minimum Bolt Tension</th>
<th>Commonly Supplied Equivalent Imperial Size (A325 Bolts)</th>
<th>Minimum Bolt Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kilonewtons</td>
<td>pounds-force</td>
<td></td>
</tr>
<tr>
<td>M16X2</td>
<td>94</td>
<td>21,180</td>
<td>5/8</td>
</tr>
<tr>
<td>M20X2.5</td>
<td>147</td>
<td>33,050</td>
<td>3/4</td>
</tr>
<tr>
<td>M22X2.5</td>
<td>181</td>
<td>40,700</td>
<td>7/8</td>
</tr>
<tr>
<td>M24X3</td>
<td>212</td>
<td>47,660</td>
<td>1</td>
</tr>
<tr>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1 1/8</td>
</tr>
<tr>
<td>M30X3.5</td>
<td>337</td>
<td>75,760</td>
<td>1 1/4</td>
</tr>
<tr>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1 3/8</td>
</tr>
<tr>
<td>M36X4</td>
<td>490</td>
<td>110,160</td>
<td>1 1/2</td>
</tr>
</tbody>
</table>

(c) Turn-of-nut tightening
Tightening of all high strength bolts shall be by the turn-of-nut method. Before final tightening there shall be a sufficient number of bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. After all bolts have been taken to the snug tight condition, the Contractor shall match mark the outer face of each nut and protruding end of bolt to have a common reference line to determine the relative rotation. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified below, with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.
Amount of rotation of nut relative to bolt, regardless of which is turned:
- 1/3 turn where bolt length is 4 bolt diameters or less
- 1/2 turn where bolt length is over 4 bolt diameters and not exceeding 8 bolt diameters
- 2/3 turn where bolt length exceeds 8 bolt diameters

Notes
- tolerance 1/6 turn (60°) over, nothing under
- length of bolt measured from underside of head

(d) Reuse of Fasteners
High strength bolts shall be tensioned only once and shall not be reused. Retightening previously tightened bolts, which may have been loosened by tightening of adjacent bolts shall not be considered as reuse.

(e) Inspection
The Contractor shall provide safe and adequate access meeting Occupational Health and Safety requirements to all working areas, including all necessary scaffolding to enable the Consultant to carry out his inspection. The Contractor shall provide a competent workman to assist the Consultant in the checking of bolt tightening work.

6.3.2.8 Misfits
The correction of minor misfits involving reasonable amounts of reaming, cold cutting and chipping will be considered incidental to the work of erection. However, any deformation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, or by a moderate amount or reaming and slight chipping or cutting, shall be reported immediately to the Department and Consultant, and their acceptance of the method of correction obtained. The correction shall be made in Consultant's presence.

6.3.2.9 Girder Adjustment
It is essential that the girders are erected with utmost attention being given to girder positioning, alignment, and elevation. Adjustment to girder position, bearing location and bearing elevation shall be done in order to achieve as closely as possible the lines and grades shown on the drawings.

The Contractor shall ensure that the structural steel is maintained in correct alignment until the adjoining or encasing concrete components have been completed.

6.3.2.10 Grout Pockets and Grout Pads
The Contractor shall fill the grout pockets and construct the grout pads using Sika 212 flowable grout or approved equivalent. Filling of grout pockets and construction of grout pads shall be done by workers competent in this work.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed, placed, and cured in strict accordance with the manufacturer's recommendations.
The method of forming and pouring the grout shall be submitted to the Consultant for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted.

Sealer shall be supplied and applied to the exposed grout pad surfaces in accordance with Section 4.25 of the specifications for "Cast-In-Place Concrete".

6.3.2.11 Grouting in Cold Weather

When the daily minimum air temperature or the temperature of the girders, bearings or substructure concrete in the immediate area of the grouting falls below 5°C, the following provisions for cold weather grouting shall be effected:

(a) Before grouting, adequate preheat shall be provided to raise the temperature of the adjacent areas of the girders, bearings and substructure concrete to at least 10°C.

(b) Temperature of the grout during placing shall be between 10°C and 25°C.

(c) The grout pads (or girders where appropriate) shall be enclosed and kept at 10°C to 25°C for at least five days. The system of heating shall be designed to prevent excessive drying-out of the grout.

6.3.2.12 Removal of Temporary Supporting Structures, Berms, and Clean-Up

Upon completion of the erection and before final acceptance, the Contractor shall remove all earth material or temporary supporting structures placed in the stream channel or elsewhere during construction. He shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of his work. Disposal of surplus materials shall be in a manner and location satisfactory to the Consultant.

The Contractor shall leave the bridge site, roadway and adjacent property in a neatly restored and presentable condition, satisfactory to the Consultant. When required, he shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

6.4 Payment

**Supply of Structural Steel Girders and Associated Material** will be paid for on the basis of the lump sum price bid. Items to be included in **Supply of Structural Steel** shall be as listed in the Special Provisions.

**Supply and Delivery of Bearings** will be paid for on the basis of the lump sum price bid. Items to be included in **Supply of Bearings** shall be as listed in the Special Provisions.

**Installation of Bearings** including grouting will be paid for on the basis of the lump sum price bid. Items to be included in **Installation of Bearings** shall be as listed in the Special Provisions.
Supply and Delivery of Deck Joint Assemblies will be paid for on the basis of the lump sum price bid. Items to be included in Supply of Deck Joint Assemblies shall be as listed in the Special Provisions.

Installation of Deck Joint Assemblies will be paid for on the basis of the lump sum price bid. Items to be included in Installation of Deck Joint Assemblies shall be as listed in the Special Provisions.

Payment for Delivery of Girders will be made on the basis of the lump sum price bid. It shall include full compensation for the costs to deliver all structural steel and associated materials to the bridge site, and shall include the costs to obtain the necessary approvals and permits from the Motor Transport Board and/or the appropriate local road authorities to transport these materials. Payment for Delivery of Girders shall also include the costs to remove all road dirt and spray.

Payment for Erection of Girders will be made on the basis of the lump sum price bid which price shall include full compensation for the cost of furnishing all labour, tools, equipment, and incidentals necessary to acceptably erect the structural steel and complete site clean-up.

When materials are delivered to the work site, payments for:
Supply of Structural Steel girders and Associated Materials,
Supply and Delivery of Bearings,
Supply and Delivery of Deck Joint Assemblies, and
Delivery of Girders
will be made to a maximum of 90% of the bid price of the materials and delivery. Payment for the remainder of the prices bid for supply and delivery will be made as the materials are acceptably installed.