

SPECIFICATIONS FOR
SUPPLY, FABRICATION AND ERECTION OF MISCELLANEOUS METAL

1.0 DESCRIPTION

The Work shall consist of:

- .1 Supply, fabrication, and erection of miscellaneous metal as shown on the Drawings and described in this Specification;
- .2 Galvanizing of miscellaneous metal; and
- .3 Quality control (QC) testing of materials and fabrication, including magnetic particle testing of welds.

2.0 REFERENCES AND RELATED SPECIFICATIONS

All reference standards shall be current issue or latest revision at the date of tender advertisement.

2.1 References

- CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
- CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding
- CSA W59, Welded Steel Construction (Metal Arc Welding)
- CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles
- CSA W47.1, Certification of Companies for Fusion Welding of Steel
- ASTM A 36, Standard Specification for Carbon Structural Steel
- ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
- ASTM A 108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
- ASTM A 123, Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products
- ASTM A 276, Standard Specification for Standard Specification for Stainless Steel Bars and Shapes
- ASTM A 320, Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for Low Temperature Service
- ASTM A 325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- ASTM A 404, Standard Specification for General Requirements for Stainless Steel Bars, Billets and Forgings
- ASTM A 449, Standard Specification for Quenched and Tempered Steel Bolts and Studs
- ASTM A 496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
- ASTM A 500, Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- ASTM A 514, Standard Specification for High- Yield- Strength, Clenched and Tempered Alloy Steel Plate, Suitable for Welding
- ASTM A516, Standard Specification for Pressure Vessel Plates, Carbon Steel, For Moderate and Low Temperature Service
- ASTM A 517, Standard Specification for Pressure Vessel Plates, Alloy Steel, High Strength, Quenched and Tempered
- ASTM A 615, Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
- ASTM B 22, Standard Specification for Bronze Castings for Bridges and Turntables
- ASTM B 29, Standard Specification for Refined Lead

- ASTM B 100, Standard Specification for Wrought Copper-Alloy Bearing and Expansion Plates and Sheets for Bridge and Other Structural Use
- ANSI B46.1, Surface Texture (Surface Roughness, Waviness, and Lay)
- AASHTO/AWS D1.5M/D1.5, Bridge Welding Code
- AWS D1.1, Structural Welding Code – Steel

3.0 SUBMITTALS

The Contractor shall submit the following to the Engineer, in accordance with the Special Provisions:

- .1 Copies of Mill Test Certificates showing chemical analysis and physical tests of all miscellaneous metal prior to commencement of fabrication. Miscellaneous metal without this certification will be rejected.
- .2 Certification of chemical analysis and physical tests for all materials.
- .3 Applicable welding procedures, stamped as approved by the Canadian Welding Bureau.
- .4 Manufacturer's test reports of mechanical tests on high strength bolts, if requested by the Engineer.

4.0 MATERIALS

4.1 General

The Contractor shall mark all materials to identify its material specification and grade. This shall be done by suitable marking or by a recognized colour coding.

4.2 Miscellaneous Metals

Miscellaneous metals shall conform to the material grades specified on the Drawings, and meet the requirements and satisfy the testing procedures of CSA G40.20 M.

4.3 Welded Steel Construction

Welded steel construction (Metal Arc Welding) shall conform to the requirements and satisfy the testing procedures of CSA W59, AASHTO/AWS D1.5 Bridge Welding Code and Welded Highway & Railway Bridges - AWS D1.1 of The American Welding Society & Addendum (latest editions for all).

4.4 Shear Stud Connectors

Shear stud connectors shall conform to the requirements of ASTM A 108, Grades 1015, 1018 and 1020.

4.5 Zinc

Zinc for hot dipped, galvanized coatings shall conform to the requirements of ASTM A 123 and CAN/CSA G164.

4.6 Stainless Steel

Stainless steel bolts, nuts, washers, inserts, etc. as shown on the Drawings shall conform to the requirements of ASTM A 320, Class B8.

Stainless steel double headed studs and stainless steel dowels shall meet the requirements as shown on the Drawings and shall conform to the requirements of ASTM A 276, Type 304L (UNS S30403).

5.0 CONSTRUCTION METHODS

5.1 Fabrication

.1 General

The workmanship shall meet established practice in modern shops. Special emphasis shall be placed in prevention of cracks, notch-like flaws and bruises that may lower the structure's resistance to fatigue and brittle fracture.

All miscellaneous metal material shall be marking using steel marking tags. The punching of identification marks on members will not be allowed unless authorized in writing by the Engineer.

If damage occurs to the miscellaneous metal during fabrication, the Engineer shall be notified immediately to facilitate the implementation of remedial measures. Remedial repair measures are subject to the approval of the Engineer.

Dimensions and fabrication that control field matching of parts shall receive careful attention in order to avoid field adjustments.

Field high-tensile bolted connections shall have all holes drilled or sub-punched and reamed using steel templates. Templates shall be located with utmost care as to position and angle and firmly bolted in place.

Cutting shall be in accordance with AWS D1.1 and CSA W59.

.2 Clean Material

The material shall be clean, free from rust, mill scale, and other foreign matter before being worked in the shop. Material shall be cleaned by wheelabrating, sandblasting or other methods subject to the Engineer's approval.

.3 Finish

All portions of the Work shall be neatly finished. Shearing, cutting, chipping and machining shall be done neatly and accurately. Finished members shall be true to line and free from twists, bends, open joints, and sharp corners and edges.

.4 Machining

.1 General

Machining shall be carried out as shown on the Drawings and described in this Specification in accordance with established machine shop practice. All machined surfaces shall be free of flaws, cracks and machining ridges and shall present a polished appearance.

.2 Facing of Bearing Surfaces

The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I:

Steel Slabs	ANSI 2,000
Heavy plates in contact in shoes to be welded	ANSI 1,000
Milled ends of compression members, milled or ground ends of stiffeners and fillers	ANSI 500

Care shall be taken that the completed surfaces are protected from damage from the time of machining until the installation in a structure.

.3 Grinding

Final grinding and machining of the surface of all tension members shall be done parallel to the tensile forces that will occur in the assembled member.

.4 Butting Joints

Butting joints in compression members shall be faced and brought to an even bearing by milling or other methods meeting the Engineer's approval.

.5 Bored Holes

Bored holes shall be true to specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise required. The final surface shall be produced by a finished cut. Boring of holes in built-up members shall be done after assembly is complete.

.6 Flat Machined Surfaces

Where called for on the Drawings, flat machined surfaces shall be obtained by planing or machine grinding, or other methods meeting the Engineer's approval. The direction of machining and the extent of the areas to be machined shall be as indicated on the Drawings or as directed by the Engineer. Flat machined surfaces shall be straight, true and smooth.

.7 Curved Machined Surfaces

Curved surfaces shall be machined carefully in accordance with the Drawings and this Specification in order to ensure correct fit of mating parts.

.5 Bending

When bending is necessary in order to meet the requirements of the design, it shall be done with care and by methods subject to the approval of the Engineer. The bend line shall be at right angles to the direction of rolling. The internal radius of bend of load carrying sections shall not be less than twice the thickness of the bend section when bent cold, and if a smaller radius of bend is essential, the material shall be bent hot and later annealed. Before bending, the edges of the section in the region of the bend shall be smoothed and rounded to a radius of 3 mm.

.6 Stress Relieving

Stress relieving of the structure or any component parts attached to the structure shall be done only if called for on the Drawings or described in the Special Provisions. If stress relieving is called for, it shall conform to the requirements of AWS D1.1 and CSA W59.

.7 Holes

.1 General

Except where a specific method of holing materials is shown on the Drawings or required in the Special Provisions, all holes shall be either drilled or sub-punched and reamed with the exception of the holes and slots in the rectangular steel guardrail which may be punched. Poor matching holes will be cause for rejection.

.2 Punched Holes and Slots

For holes and slots punched full size, the diameter or size of the die shall not exceed that of the punch by more than 2 mm. All holes and slots which are punched shall have burrs and sharp edges removed. The removal of these burrs and sharp edges shall not reduce the cross-section of the structural member. All holes shall be clean-cut without torn or ragged edges. The punching shall not distort the structural member. If required by the Engineer, a sample of the punching operation shall be carried out to the satisfaction of the Engineer prior to the start of fabrication.

.3 Drilled Holes

Drilling shall be done with twist drills, roto-broach drills or core drills, and all burrs and sharp edges shall be removed carefully. The removal of these burrs and sharp edges shall not reduce the cross-section of the structural member. Care shall be taken to centre the drill accurately and to ensure that the hole is perpendicular to the member. Holes shall be clean-cut, without torn or ragged edges.

.4 Sub-Punched and Reamed Holes

All holes shall be sub-punched or sub-drilled to a diameter 5 mm smaller than the nominal hole diameter, and enlarged by reaming to the correct diameter. The diameter of the die shall not exceed the diameter of the punch by more than 2 mm. Holes shall be clean-cut without torn or ragged edges. Reamed holes shall be truly cylindrical and perpendicular to the member and all burrs shall be removed carefully. The removal of these burrs shall not reduce the cross-section of the structural member. All reaming shall be done with twist reamers which shall be directed by mechanical means.

.5 Allowable Tolerance for Holes

All matching holes for bolts shall register with each other so that a gauge 2 mm less in diameter than the hole shall pass freely through the assembled members in a direction at right angles to such members. Finished holes shall be not more than 2 mm in diameter larger than the diameter of the bolt passing through them unless otherwise specified by the Engineer. The centre-to-centre distance between any two holes of a group of holes shall not vary by more than 1 mm from the dimensioned distance between such holes. Mispunched or misdrilled members shall not be corrected by welding.

.8 Welding

.1 Specifications

Welding shall conform to the requirements of the Structural Welding Code - Steel of the American Welding Society AWS D1.1 and addendum and CSA W59 Welded Steel Construction.

.2 Welding Operator Qualification

Welding operators shall be qualified in accordance with the requirements of C.W.B. at the time of fabrication for the processes that will be required as part of the Work. Qualification shall have been issued within 2 years of commencement of fabrication.

The reports of the results of the qualification tests shall bear the welding operator's name, the identification mark he will use and all pertinent data of the tests. Evidence that the welding operators have been executing satisfactory welding in the required processes within the 6

month period immediately prior to commencement of fabrication shall also be provided to the Engineer. The Contractor shall bear the whole cost and be fully responsible for the qualification of all welding operators.

.3 Welding Procedures, Specifications and Qualification

Welding procedures that conform in all respects to the approved procedures of AWS D1.1 and CSA W59 shall be deemed as pre-qualified.

Welding procedures that do not conform to approved procedures in AWS D1.1 and CSA W59 shall be qualified by tests carried out in accordance with AWS D1.1. The Engineer may accept previous qualifications of the welding procedure.

.4 Welding Materials

All welding materials shall be certified by CWB and meet the requirements of CSA W48.

All electrodes for manual shielded metal arc welding shall conform to the low-hydrogen classification requirements of the latest edition of the American Welding Society's Filler Metal Specification AWS A5.1 or AWS A5.5 and the CAN/CSA W48 Specification and be capable of producing weld metal having an impact strength of at least 27 J (Charpy V-Notch) at -30°C. All bare electrodes and flux used in combination for submerged arc welding, the electrode and gas shielding used in combination for gas metal-arc welding, or the electrode and shielding medium used in combination for flux cored arc welding of steels shall conform to the requirements in the latest edition of the American Welding Society AWS A5.17, A5.18 or A5.20 and CAN/CSA W48 and be capable of producing weld metal having a minimum impact strength of 27 J (Charpy V-Notch) at -30°C or shall be capable of producing low alloy weld metal having the mechanical properties listed in Table 4.1.1 of AWS D1.1.

Every user shall demonstrate that each combination of electrode and shielding medium will produce weld metal having the above mechanical properties.

Low alloy weld properties shall be determined from a multiple pass weld made in accordance with the requirements of the latest edition of the applicable Specification (AWS A5.17, A5.18, or A5.20) or the welding procedure specification.

The Engineer may accept evidence of record of a combination that has been satisfactory tested in lieu of the test required, provided the same electrode as in a CWB welding procedure is used.

Electrodes conforming to AWS A5.1 shall be purchased & delivered in hermetically sealed containers in accordance with CSA W59.

When non-certified welding consumables are used, the company may qualify them by following the provisions outlined in clause 118.8.2.1 in CSA W47.1.

The electrode or electrode-flux combination or grade of weld metal for butt joints using complete joint penetration groove welds shall be in accordance with Table 11.1 or 12.1 as applicable. In cases where the electrode, electrode-flux or gas combination are lower or higher strength than required by Table 11.1 or 12.1, then the conditions from CAN/CSA W59 Table 11.2 (a), 11.2 (b), 12.2 (a) or 12.2(b) as applicable shall be fully satisfied.

Flux used for submerged arc welding shall be non-hygroscopic, dry and free of contamination from dirt, mill-scale, or other foreign material. All flux shall be purchased in moisture-proof packages capable of being stored under normal conditions for at least 6 months without such storage affecting its welding characteristics or weld properties.

Flux from packages damaged in transit or handling shall be discarded or shall be dried in accordance with CSA W59 before use.

.5 Preheat and Interpass Temperature

The minimum preheat and interpass temperatures for welding miscellaneous metal shall conform to AWS D1.1 and CSA W59.

.6 Welding Processes

Welding processes which do not conform to the provisions of AWS D1.1 or CSA W59 shall not be used without the written approval of the Engineer.

BASE METAL	WELDING PROCESS					BASE METAL
	SMAW		GMAW	FCAW	SAW	
CSA G40.21M	CSA W48.1 AWS A.5.1	CSA W48.3 AWS A5.5	CSA W48.4 AWS A5.18,5.28	CSA W48.5 AWS A5.20	CSA W48.6 AWS A5.17,5.23	ASTM
230G 260W,260T	E60XX E70XX		E70S-X E70U-X	E60T-X E70T-X	F6X-XXX F7X-XXXX	A53 Gr B A500 Gr A A516Gr55,60
300W 300T 350G ^d 350W	E70XX or E60XX	E70XX	E70S-X E70U-X	E70T-X ^a or F60T-X	F7X-XXXX or F6X-XXXX	A36 A441>4" A550GrB A501 A529 A570Gr D,E A572Gr42,45 A607Gr45
350R ^{b,c} 350A ^{b,c} 400A ^{b,c}	E70XX	E70XX	E70S-X E70U-X	E70T-X ^a	F7X-XXXX	A242 ^c A441#4" A516Gr65,70 A570Gr50,55 588 ^c A606 A607Gr50,55 A618 A633Gr,A,B,C,D
400G ^d ,400W 400T		E80XX	GrE80S	GrE80T	GrF80	A572Gr60,65
480W 480T		E90XX	GrE90S	Gr390T	GrF90	
480A ^{b,d}		E100XX	GrE100S	GrE100T	GrF100	
700Q ^d		E110XX	GrE110S	Gr3110T	GrF110	A514 A517

Footnotes for Matching of Base Metal and Electrode Combinations

- a) Exclusive of E70T-2, E70T-3, E70T0-G
- b) When steels of Types R and A are used in the exposed, bare, unpainted condition, the electrodes suggested or others producing a similar alloy composition in the deposited metal should be used. For applications where

the material is not boldly exposed, where a colour match is not important, for all but capping passes in multipass welds and for narrow single pass welds, the electrodes suggested for Grades 300T, 400T and 480T may be used (See CAN/CSA G40.21M).

- c) See Clauses 5.2.1.4 and 5.2.1.5 and Table 5-2 of CSA W59.
- d) See Mfg. Specifications.

Use of the same-type filler metal having the next higher mechanical properties as listed in the AWS or CSA Specification is permitted:

- .1 In joints involving base metals of different yield points or strength, filler metal applicable to the lower strength base metal may be used subject to the Contract Administrator's approval.
- .2 When welds are to be stress relieved, the deposited weld metal shall not exceed 0.05% vanadium.
- .3 See AWS D1.1 article 4.20 for Electroslag and Electrode gas weld metal requirements. Appendix C Impact Requirements are mandatory.
- .4 Lower strength filler metal may be used for fillet welds and partial penetration groove welds when indicated on the plans or in the special provisions.

.7 Distortion and Shrinkage Stresses

Distortion and shrinkage stresses shall be kept to a minimum by the use of jigs and fixtures, utilizing heat distribution and a welding sequence. Areas contiguous to welding operations shall be preheated to a maximum temperature of 120°C, if necessary in the estimation of the Engineer to prevent distortion or weld cracking. The provisions of AWS D1.1 and CSA W59 shall be followed in the control of distortion and shrinkage stresses.

.8 Tack Welding

All tack welds shall be a minimum of 10 mm in length and made with low hydrogen electrodes and shall not be incorporated in the final structure without specific written authorization by the Engineer.

.9 Stud Shear Connectors

The accessories, equipment and welding procedures for the installation of the shear connectors shall be in accordance with AWS D1.1 and CSA W59. Welding by hand will not be allowed.

.10 Hot-Dip Galvanizing

Galvanizing, when called for on the Drawings, shall be done in accordance with CAN/CSA G164.

All metal surfaces to be galvanized shall be cleaned thoroughly of rust, rust scale, mill scale, dirt, paint and other foreign material by commercial sand, grit or shop blasting or pickling prior to galvanizing. Heavy deposits of oil and grease shall be removed with solvents prior to blasting or pickling.

5.2 Handling, Delivery and Storage of Materials

Precautionary measures shall be taken to avoid damage to miscellaneous metal during handling, transit, stockpiling and erecting. Pinholes, or other field connection holes shall not be used for lifting purposes. Special attention is directed to the shipping and storing of miscellaneous metal. Damaged parts shall not be installed in the structure and may be rejected at the discretion of the Engineer.

Materials that are not placed directly in the structure shall be stored above probable high water, on skids, platforms or in bins in a manner that will prevent distortion or the accumulation of water or dirt on the miscellaneous metal. The materials shall be kept separate and stored properly for ease of inspection, checking and handling and shall be drained and protected from corrosion.

5.3 Erection

.1 Layout

Before erection of miscellaneous metal, the Contractor shall satisfy himself that the installation locations are in accordance with the Drawings, this Specification and the Special Provisions. All discrepancies discovered by the Contractor shall be brought immediately to the attention of the Engineer.

.2 Workmanship

The parts shall be assembled as shown on the Drawings and all match marks shall be observed. The material shall be handled carefully so that no parts will be bent, broken or otherwise damaged.

Hammering which will injure or distort the member is not permitted. Bolts in splices of butt joints or compression members and bolts in railings shall not be tightened until the span has been completed. Field splices shall have a minimum of 50% of the holes filled with high strength bolts or erection bolts and the remainder of the holes filled with cylindrical erection pins immediately after erection. Erection bolts shall be of the same nominal diameter as the high strength bolts and the cylindrical erection pins shall be 1 mm larger.

.3 Diaphragms

Diaphragms shall not be secured firmly in position until it has been determined to the satisfaction of the Engineer that the holes in the girder webs for high tensile bolting of diaphragms are correctly aligned in a direction normal to road centreline, in order to ensure proper seating of diaphragm end plates.

.4 Drifting

Drifting will be permitted during assembly only to bring the components into position without enlarging or distorting the bolt holes, and without distorting, kinking or bending the metal of any unit. If, in the estimation of the Engineer, holes must be enlarged to admit the bolts, they shall be reamed.

Such reamed holes shall not exceed the size of the bolt used by more than 2 mm. Oversize bolts, with a diameter of up to 3 mm larger than that shown on the Drawings may be used if the Engineer approves the installation.

.5 Misfits and Field Fitting

Misfits of any part or parts to be erected under this Specification may be cause for rejection. No field fitting shall be undertaken by the Contractor until the cause for misfit of parts has been determined and the Engineer, so informed, has given direct approval to accept the Contractor's proposed corrective measures. The Engineer's decision as to the quantity of such work to be performed at the Contractor's expense will be final and binding.

.6 Field Welding

All field welding shall be electric arc welding, and shall be carried out in accordance with the Drawings, AWS D1.1 and CSA W59.

.7 High-Strength Bolting

.1 General

- .1 Mating surfaces in joints to be bolted with heavy hexagon structural bolts shall be cleaned immediately prior to erection of parts. Such surfaces shall be free of dust, grease, oil, paint and all other foreign substances.
- .2 Bolt holes in members shall not be enlarged nor damaged in any way.
- .3 Two carburized washers per bolt shall be used at all times; one washer under the bolt head and one under the nut.
- .4 High-strength bolts which have been tightened to full tension and released shall not be re-used.

Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as a re-use.

- .5 Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth bevelled washer shall be used to compensate for the slope.

.2 Bolt Tension

.1 Turn-of-Nut Tightening

Unless otherwise specified, bolts shall be tightened by turn-of-the-nut method. Where necessary, the bolt may be turned while the nut is prevented from rotating.

After aligning the holes in a joint, sufficient bolts shall be placed and brought to a "snugtight" condition to ensure that the parts of the joint are brought into full contact with each other. "Snug-tight" shall be 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 the initial step, bolts shall be placed in all remaining holes in the connection and brought to snug-tightness. All bolts in the joint shall be tightened additionally by the applicable amount of nut rotation specified in Table 2 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. If this is not practical, the bolt and nut shall be match-marked to enable the amount of relative rotation to be determined.

Table 2: Nut Rotation* from Snug-Tight Condition

Disposition of Outer Faces of Bolted Parts	Bolt Length ²	Turn
Both faces normal to bolt axis or one face normal to axis and other face sloped 1:20 (bevel washer not used) ¹	Up To and Including 4 Diameters	1/3
	Over 4 Diameters and Not Exceeding 8 Diameters or 200 mm	1/2
	Exceeding 8 Diameters or 200 mm	2/3
Both faces sloped 1:20 from normal to bolt axis (bevel washers not used) ¹	For all lengths of bolts	3/4

*Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation is 30° over or under for coarse thread heavy hex structural bolts of all sizes and lengths and heavy hex semi-finished nuts.

- (1) Bevel washers are necessary when A490 bolts are used.
- (2) Bolt length is measured from underside of head to extreme end of point.

All fasteners shall be tightened to give at least the required minimum bolt tension values, as shown in Table 3 on completion of the joint. At no time shall the bolt tension be in excess of the required minimum bolt tension by more than 15%.

Table 3: Minimum Bolt Tension

Nominal Bolt Diameter		Minimum Bolt Tension (kN)	
Inches	mm	A325	A490
1/2		53	67
5/8	M 16	85	107
3/4	M 20	125	156
7/8	M 22	174	218
1	M 24	227	285
1 1/8	M 27	249	356
1 1/4	M 30	316	454
1 3/8	M 36	378	538
1 1/2		458	658

.2 Checking and Testing

The Contractor shall provide equipment for purposes of checking bolt tension. This equipment shall include calibrated manual torque wrenches, and a calibrating device capable of measuring actual bolt tension.

The calibrating device shall be examined and calibrated by a testing firm approved by the Engineer. The certification and calibration results shall be forwarded to the Engineer. Calibration of the device shall be done immediately prior to torquing operations. The device shall be maintained at the site by the Contractor, who shall, in the presence of the Engineer, calibrate all torque wrenches prior to the torquing operation at least once each day during which high-strength bolts are to be torqued.

In calibrating the torque wrenches, the torque equivalent of the required tension shall be determined for at least three high-strength bolts and nuts for each size to be installed in any one day. The mean value of torque of each size shall be used. In all cases where manual torque wrenches are used, torque values shall be read while the high strength nut is in motion relative to the bolt.

The Contractor shall provide the necessary equipment and personnel to check bolt tension during torquing operations. The number of checks to be made will be at the discretion of the Engineer, but will not be less than one bolt in each connection.

All checking shall be done in the presence of the Engineer. In the event the torque values, obtained during checking of tension in high-strength bolts, are not considered acceptable by the Engineer, the Contractor shall then remove the bolts as directed by the Engineer and replace such bolts at his own expense.

.8 Final Cleaning

All metal surfaces shall be left free of dirt, dried concrete, debris or foreign matter to the satisfaction of the Engineer.

6.0 QUALITY MANAGEMENT

6.1 Quality Control

The Contractor shall be responsible for making a thorough inspection of materials to be supplied under this Work. All miscellaneous metal shall be free of surface imperfections, pipes, porosity, laps, laminations and other defects.

.1 Welding

All welding may be subject to inspection by Non-Destructive Testing. This inspection shall be carried out in a manner approved of the Engineer.

The Contractor shall provide sufficient access and shop area to permit the performance of the tests.

The Contractor shall give the Engineer not less than 24 hours notice of when work will be ready for testing and shall advise the Engineer of the type and quantity of work that will be ready for testing.

All defects revealed shall be repaired by the Contractor at his own expense and to the approval of the Engineer.

6.2 Quality Assurance

All materials will be subject to physical inspection by the Engineer and will be subject to rejection during the course of the Work, if, in the opinion of the Engineer, the materials involved do not meet the requirements of the Drawings, this Specification and the Special Provisions.

All materials shall be subject to testing by the Engineer and will be approved only if the requirements of the Drawings and this Specification are met. The Contractor shall supply the specimens for testing in accordance with the requests of the Engineer.

The Contractor shall furnish facilities for the inspection of material and workmanship in the mill, shop and field, and the Engineer shall be allowed free access to the necessary parts of the works.

7.0 METHOD OF MEASUREMENT**7.1 Miscellaneous Metal**

The supply, fabrication and erection of miscellaneous metal will be measured on a kilogram basis. The total mass of miscellaneous metal to be paid for shall be the total mass supplied and installed in accordance with the Drawings and accepted by the Engineer.

The mass of all galvanizing material or other protective coatings, all deposited weld metal used for either shop or field welding, bolts, nuts and washers will not be included in the mass of material to be paid for.

7.2 Double Headed Stainless Steel Dowels

The supply, fabrication and installation of the double headed stainless steel dowels will be measured on a unit basis. The total number of double headed stainless steel dowels to be paid for will be the total number supplied, fabricated and installed as shown on the Drawings and accepted by the Engineer.

8.0 BASIS FOR PAYMENT**8.1 Miscellaneous Metal**

The supply and fabrication of miscellaneous metal will be paid for at the Contract Unit Price for "Supply and Fabricate Miscellaneous Metal", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

The erection of miscellaneous metal will be paid for at the Contract Unit Price for "Placing Miscellaneous Metal", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

8.2 Double Headed Stainless Steel Dowels

The supply and fabrication of double headed stainless steel dowels will be paid for at the Contract Unit Price for "Supply and Fabricate Double Headed S/S Dowels", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

The installation of double headed stainless steel dowels will be paid for at the Contract Unit Price for "Installing Double Headed S/S Dowels", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.