

DIVISION 5

METALS

BUILDING WORK

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METALS

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SECTION 05120

STRUCTURAL STEEL WORK

PART 1: SCOPE OF WORK

1.01. WORK OF THIS SECTION

- A. Structural Steel Framing
- B. Anchor Bolts, Base Plates, etc.
- C. Erection of Structural Steel

1.02. GENERAL

- A. The structural steelwork specifications apply to all aspects of steel construction used for structural purposes but else where in such instances as the methods and principals would normally be adopted for items utilising steel.
- B. Structural steelwork shall include temporary bracing and connections, shear stud connectors, and all other items required to complete the structural steel work as indicated on the Drawings.
- C. The Work can be broadly divided into the following processes and procedure,
 - 1. Supply of steel and components
 - 2. Fabrication of the steelwork at the factory
 - 3. Delivery from factory to the place of erection.
 - 4. Site erection and other requirement.
- D. The structural steelwork shall include the attachment of other work to structural steel where indicated and/or required for proper subsequent installation of work of other Contractors, or where shown on approved shop drawings. Attachment of other work shall include cutting, punching, drilling, tapping and welding as required.

- E. Where noted on the drawings or where directed, the Contractor shall provide holes in structural steel members for the support of other materials, for passage of services, or for reasons necessary for construction. Structural steel members shall not be cut unless so detailed or approved by the Engineer. Such holes shall be reinforced as required by the Engineer.
- F. Any modification of the structural design shall be clearly stated together with the reasons at the time of submitting shop drawings for approval. Approved modifications (and changes in related portions of the work) shall be co-ordinate by the Contractor and shall be accomplished at no additional cost to the Employer. Shop drawing checking for modifications and/or substitutions shall be paid for by the Contractor.
- G. Substitution of structural steel sections shall be made only with the written approval of the Engineer.
- H. The Contractor shall be solely responsible for errors of detailing, fabrication and for the correct fitting of structural steel members.
- I. The Contractor shall appoint a person regularly employed by him and approved by the Engineer to be the welding specialist. This person shall be responsible for maintaining established quality control standards, and for managing the welding work. He shall be especially knowledgeable and experienced in welding methods, welding metallurgy, and welded steel structures. He shall be assigned to the fabrication shop during fabrication, and to the site during erection to supervise the welding work. He shall have management ability and experience, and shall assure quality control by assigning the welding work to responsible and capable welders. The Contractor shall appoint a person regularly employed by him and approved by the Engineer to be the steel erection specialist. This person shall be responsible for maintaining the quality of erection work established by the drawings, specifications, and applicable codes and standards. He shall be assigned to the site full time, and for the duration of the erection work.
- J. The steel fabricator and steel erection contractor shall be approved by the Engineer.

1.03. CODES AND STANDARDS

Structural steelwork shall conform to the requirements of the following codes and standards issued by the Architectural Institute of Japan. The codes and standards shall have priority over the specifications.

- A. JASS 6; Structural Steel work
- B. Technical Guide and Commentary for Structural Steel Work
- C. Welding Standards and Commentary I to VIII
- D. Design Standards for Steel Structures
- E. Guide and Commentary for Design and Construction for Light Weight Shape Steel
- F. Design and Construction Guide for Frictional Connection by High Strength Bolt
- G. Precision Standards and Commentary for Structural Steelwork
- H. Standards for Inspection by Ultrasonic non-destructive testing for Welds of Steel Building Structures.

The Contractor may request that the structural steel work be in conformity with equivalent codes or standards such as British or American codes or standards.

Written approval to follow British or American codes or standards may then be given by the Engineer. A combination of more than two codes and standards shall not be allowed. The Contractor shall keep one copy of each approved code and standard at the site at all times.

1.04. QUALITY ASSURANCE

A. Testing and Inspection

1. Materials, connections, and workmanship generally shall be subject to tests or inspection in the mill, shop, or field.

2. Tests and inspections shall be conducted by a qualified person or independent testing laboratory retained by the Contractor and approved by the Engineer. The Contractor shall furnish all materials for testing and any access to, or handling of materials required to perform material tests.
3. The testing agency shall perform the following routine tests and inspections in compliance with the applicable codes and standards :
 - a Determine the chemical composition of steel for main members.
 - b Determine the mechanical properties of the following materials :
 - Rolled sections
 - Bars and plates
 - Structural steel tubing
 - Anchor bolts
 - High-strength bolts
 - c Qualify shop and field bolting and welding procedures and personnel
 - d Inspect shop fabricated and erected structural steel members and assemblies for conformance with the specified requirements.
 - e Inspect shop and field assembled high strength bolted connections
 - f Inspect shop and field welds by one or more of the following methods:
 - Visual inspection of all shop welds
 - Liquid penetrate inspection
 - Magnetic particle inspection
 - Radiographic inspection
 - Ultrasonic inspection
4. Clean, grind, and prepare all areas as required for ultrasonic and radiographic inspection.

5. The Engineer shall have the right to carry out and/or order to carrying out of tests and inspections at any time. The Engineer shall have the right, at all reasonable times, to enter the Contractor's fabrication plant for the purpose of testing and inspecting the work and shall have the authority to issue instructions hereon to the Contractor where, in his opinion, modifications or corrections, are seem to be necessary.
The Contractor shall provide suitable facilities, materials, tools, supervision and labour necessary for making and recording the tests and shall comply with further directions and instructions of the Engineer regarding tests and testing.
6. A minimum of thirty (30) percent of the total length of butt welded connections shall be tested during field welding by the testing agency.
7. Tests and/or inspections showing conformity to the required specifications shall not relieve the Contractor of his responsibility to furnish satisfactory work and materials.
8. The cost of testing, including equipment, handling, supervision, labour and incidentals for making the tests, shall be borne by the Contractor.
9. The Engineer reserves the right to reject materials and/or workmanship not conforming to the specifications at any time before final acceptance. The Engineer's acceptance of materials or workmanship shall not prevent its subsequent rejection if defects are discovered later. The Contractor shall remove installed materials which are rejected by the Engineer and replace them at no additional cost to the Employer.

1.05. Welding

All welders shall have valid current licenses. The Contractor shall provide the Engineer with certification that all welders have passed qualification tests using procedures covered in ASTM A529 and ASTM A945 (or equivalent acceptable to the Engineer). If required by the Engineer, the Contractor shall submit test pieces made by any welder whose workmanship is in question. The Contractor shall require any welder to retake the test when, in the opinion of the Engineer, the work of the welder creates reasonable doubt as to the proficiency of the welder.

Tests, when required, shall be conducted at no additional expense to the Employer. Re-certification of the welder shall be made to the Engineer only after the welder has taken and passed the required retest. The Engineer may require test pieces to be cut from any location in any joint for testing.

Sections of welds found defective shall be chipped or cut out to base metal and properly re-welded before proceeding with the work. Should any two test pieces of any welder show strengths, under test, less than that of the base metal, it shall be considered evidence of negligence or incompetence, and the welder shall be permanently removed from the Works.

When test pieces are removed from any part of a structure, the members cut shall be repaired, at no additional cost to the Employer, in a neat and workmanlike manner with joints of the proper type to develop the full strength of the members. Joints shall be cut (complete with peening) as necessary or directed to relieve residual stress.

1.06. Steel Tape Measures

First class tapes conforming to JIS B7512 (steel tape measure). The Contractor shall provide the number of tapes required for the carrying out of the Work (minimum of 3 tapes). Whenever measuring, a tension force of 5 kg shall be applied to the tape. At all times, the ambient temperature shall be recorded and thermal adjustments made to all measurements. Tape measures used in the factory fabrication of the steel work shall be compatible with those used for site erection of the steel work. The Contractor shall arrange such tests as necessary to allow the Engineer to approve the tolerance between the tapes used on either location as negligible. All measurements shall be the Contractors responsibility.

1.07. ENVIRONMENTAL CONDITIONS

Do not erect structural steel during heavy or dusty wind conditions.

1.08 UBMITTALS

A. Shop Drawings

1. Shop drawings shall be submitted for approval in accordance with Section 3 “Submittals”. Material shall not be delivered to the site or fabrication factory prior to the approved shop drawings being returned to the Contractor.
2. Shop drawings shall show the profiles, sizes, spacing and location of structural members and all shop and erection details, including connections. The shop drawing ammonation system shall be clearly defined. Shop and field welds shall be indicated by applicable standard welding symbols. Shop drawings shall show the size, length, and type of each weld.
3. Provide details of all loose items and accessories.

B. Fabrication Drawing

In order to manufacture the steelwork to suit the details given on the Drawings, the Contractor shall produce Fabrication drawings for the purposes of exactly manufacturing and preparing the steelwork to the correct lengths and dimensions and with all connections properly made and positioned to meet site requirements and to satisfy the conditions, reactions and like information indicated. Fabrication should be produced in respect of each structural members or range of typical members and similarly in respect of each end detail and connection. The fabrication drawings shall be clearly identify all member and end or connection particulars, the building concerned and the location therein and any other matter which may affect fabrication, handling or time or incorporation such as intermediate loading capacity etc. All such drawings shall be submitted to and approved by the Engineer before fabrication commences and the Contractor shall incorporate or make any modifications to the drawings, which the Engineer may direct but nevertheless the Contractor shall be and remain entirely responsible for the correct manufacture of the structural steelwork.

- C. Prior to starting shop fabrication, the Contractor shall furnish to the Engineer for approval information on the following:
1. Job management personnel and organisation
 2. Fabrication facilities
 2. Materials intended for use and material manufacturers and suppliers.
 4. Evidence of material compliance
 - a Mill ladle analysis reports for main members
 - b Fabricator's certificate for secondary members
 - c Reports of tensile properties and bend tests for steel shapes, bars and plates
 - d Certificates of conformance for structural steel tubing and steel bar grating
 - e Reports of mechanical tests of high strength bolts
 5. Shop drawings procedures and schedule
 6. Measuring tapes intended for use
 7. Quality control methods and procedures
 8. Product fabrication:
Marking, cutting, bending, drilling, milling and treating of frictional surfaces for high strength bolt connection, etc.
 9. Shop assembly facilities and procedure
 10. Welding: Proposed welding details. Proposed manufacturer for flux, gas, welding rod and wire together with manufacturers recommendations for storage. Temporary welding, welding sequence and procedure, pre-heating, welding equipment and accessories, arc-air gausing / chipping.
 11. Method of embedding anchor bolts and setting base plates.
Installation procedures and allowable tolerance of anchor bolt location.

12. Inspection:
 - a Organisation of fabrication shop inspection.
 - b Type of inspection, including: Full-size drawing inspection, marking drawing inspection, groove inspection, assembly inspection, welding inspection, material inspection, product inspection, ultrasonic inspection of welds inspection of field assemblies.
 - c Criteria for accept.
 - d A copy of the Contractors inspection record proforma shall be submitted.
The proposed inspection record form shall be attached.

13. Proposed methods of correction and repair of faulty work

14. Method of paint application.

15. Marking components and assemblies

16. Storage at plant yard and at site

17. Transporting facilities and route from shop to site

18. Qualifications of welders and other specialists

19. Ultrasonic inspection
 - a Name of inspection company
 - b Organisation chart
 - c Inspection equipment
 - d Calibration of equipment
 - e Personnel
 - f Operation methods
 - g Points and numbers of inspection
 - h Pre-treatment of inspected surface
 - i Criteria for evaluation of defects
 - j Criteria for safe or unsafe judgement
 - k Inspection record form

20. Stud Connectors
 - a Identification of stud connectors installed in shop and in the field
 - b Name of subcontracting organisation, if appropriate
 - c Quality control system
 - d Materials, equipment, quality and shapes
 - e Welding conditions proposed
 - f Proposed operations : test weld procedure, prevention of magnetic blow, etc.
 - g Inspection and tolerances
 - h Proposed methods of correction and repair of defective work
 - i Record procedures and forms proposed

D. Prior to starting field erection, the Contractor shall furnish to the Engineer for approval, information on the following:

1. Structural steel erection
 - a Plan of erection equipment and scaffolding
 - b Details of crane foundation, erection, and removal
 - c Temporary staying and bracing
 - d Required erection accessories
 - e Shipping and delivery (including schedule)
 - f Temporary storage yard and handling methods
 - g Temporary electric supply
 - h Erection sequence, procedures, and methods
 - i Erection tolerances and methods for maintaining
 - j Equipment and procedures for tightening erection bolts and thigh strength bolts
 - k Field welding equipment and methods
2. Setting anchor bolts and base plates
3. Painting
4. Field inspection
5. Safety measures proposed

E. As the work progresses, maintain the following records of the structural steel fabrication and erection prepared separately for the following items :

(Indicate the methods and results of tests and inspections)

1. Material tests
2. Method of examination of welders' skills
3. Tests of welding work
4. Coefficient of friction test for high strength bolts
5. Inspection for shop made products (welds, shape, dimensions, appearance and others)
6. Inspection of work performed in the field (welds, tightening of high strength bolts, erecting tolerance, root gaps of field welds, and others)
7. Records of tests and inspections of stud connectors
8. Tolerance of anchor bolts
9. Records of tests, inspections and corrections required by the Engineer.
10. Photographs of each section of the work, per Section 4 "Construction Photographs".
11. Submit the completed records to the Engineer.

PART 2: PRODUCTS**2.01. MATERIAL**

A. Rolled steel sections and plates shall conform to the requirements of the following codes:

1. Rolled Steel for General Structure : ASTM A27, 27M
2. Rolled Steel for Welded Structure : ASTM A36, 36M
3. Hot-rolled Atmospheric Corrosion Resistant Steel for Welded Structure : ASTM A505, 606, 715
4. Carbon Steel Pipe for General Structural Purposes : ASTM A36, 36M, 450, 500, 595
5. Square Steel Pipe for General Structural Purposes : ASTM A450, 500, 501
6. Light Gauge Steel for General Purpose : ASTM A82
7. Centrifugal Cast Steel Pipes for Welded Structure : ASTM A660

B. High Strength Bolt

1. Sets of high strength bolt, nut, and washers shall conform to the requirements of ASTM A490M, F436. The sets shall be specified on the Drawings.
2. The quality of sets of special high strength bolt, nut, and washers shall exceed the requirements of ASTM A490M, F436. The sets shall be specified in the Particular Specifications. Unless otherwise specified, the sets shall conform to the requirements of the Society of Steel Construction in Japan-II 09.

C. Bolts, nuts and washers shall conform to ASTM A27, 27M.

Bolts and nuts shall be middle class 2 products conforming to :

1. ASTM A468, 540 (Hexagon Bolts)
2. ASTM A194, 436, 468, 490M (Hexagon Nuts)
3. ASTM C954, 1002 (Metric Coarse Thread)

Washers shall conform to ASTM F436, 844.

- D. Spring washers shall conform to No.3 (heavy load) of ASTM A125, F436, F959 (Spring Washer).

The material shall conform to ASTN A805 (Hard Steel Wire Material).

Types shall be SWRH 57, 62, or 72A or B as approved by the Engineer.

- E. Anchor bolts shall conform to ASTM A325 (Foundation Bolts).

The material shall conform to Type 2 (SS41) of ASTM A27, 27M (Rolled Steel for General Structure) or shall have mechanical properties equivalent to or better than Type 2.

Bolt threads shall conform to Class 3 Metric Coarse Thread specified in ASTM C954, 1002. Ordinary washers shall conform to ASTM F436, 844.

- F. Welding Materials

1. Welding materials shall conform to the requirements of Table I.

Table I

| Type | Standard |
|---|---|
| Shielded metal arc Welding electrode | Standard products conforming to ASTM A150(Shielded metal arc welding electrode for mild steel) Standard products conforming to ASTM A4496(Shielded metal arc welding electrode for high tensile steel) |
| Welding wire for Carbon dioxide gas Arc welding | Standard products conforming to ASTM A150(Welding wire for carbon dioxide gas arc welding) |
| Wire for submerged Arc welding | ASTM A150(Welding wire for submerged arc welding) |

2. Flux: The flux used shall be the most suited to the material being welded and to the mechanical properties required of the weld. The flux shall be of a good quality with the correct chemical composition and grading. The flux shall be of

the type approved by the Engineer.

3. Gases used for gas shield arc welding shall conform to the following:
 - Liquefied Carbon Dioxide : ASTM
 - Oxygen : ASTM
 - Argon Gas for Welding : ASTM

G. Shear Stud Connectors

The material, shape and dimension of shear stud connectors shall conform to the manufacturer's standards and be approved by the Engineer. Tests on shear stud connectors shall be made whenever instructed by the Engineer.

H. Painting

1. Surface preparation for steel to be painted shall be in accordance with SSPC SP-3.
 2. Steel work to be painted shall be given one shop coat of anti-corrosive paint, applied thoroughly and evenly to dry clean surfaces, by brush, spray, roller coating, flow coating, or dipping as approved by the Engineer.
 3. Primer shall conform to the following:
 - a ASTM D49, 444, 478
 - b Average dry film thickness : 25 microns
 - c Primer to be applied to field welding faces shall not inhibit or interfere with field welding.
 4. Unless otherwise shown in the Drawings, the following steel surfaces shall not be painted:
 - a Steel to be encased in concrete
 - b Friction faces at high strength bolt connections
 - c Contact Surfaces at column to column connections
 - d Surfaces to be welded
- I. Materials, either plain or fabricated, shall be stored above ground upon platforms, pallets, skids or other approved supports. Materials shall be kept free from dirt, grease and other foreign matter and shall be protected from corrosion.

PART 3: EXECUTION**3.01. FABRICATION****A. General**

1. This work shall be consisted of the preparation and fabrication of steelwork and components including machining and grinding, cutting, welding, drilling, casting and forging which work shall be carried out in accordance with and to the requirements shown on the drawings.

2. Workmanship and finish shall be in accordance with the best general practice in modern shop to the great extend possible and shearing, flame cutting, and chipping shall be done carefully and accurately.

Portion of the work exposed to view shall be finished neatly.

Structural materials, either plain or fabricated shall be stored at the shop above the ground upon platforms, skids or other foreign matter, and shall be protected as far as possible from corrosion but in any event shall be clean and rust free prior to fabrication.

The Contractor shall advise and give adequate notice to the Engineer when fabrication works are to be commenced, or for each occasion if the works are to be carried out in stages, so that his inspection may not cause delay. Any lack of inspection or where the Engineer sets not to make an inspection shall not relieve the Contractor of any of his responsibilities.

B. Scratching

Scratching shall be done accurately in accordance with the shop drawings, full-size drawings, templates and/or rulers. Marks with a chisel, punch or the like on high tensile steel members (50kg and over class) and/or the outer surfaces of bent members shall not be allowed. Scratches or marks which will disappear in the course of welding or cutting shall be allowed. Steel templates of any length can be used. The maximum length of plastic film templates shall be 3m. Highly expansible or contraceptive materials shall not be used for templates.

C. Cutting

1. General

Unless otherwise specified, steelwork may be cut shearing, sawing or flame cutting. Surface produced by such cutting shall be finished square (unless a beveled edge is called for) true and smooth to the required dimensions. In the case of flame cutting (gas cutting), surface having only slight irregularities may be lightly ground only, provided that the finished edges are substantially as straight, true, smooth and regular as those produced by the finishing out of a planing machine.

Shearing will not be permitted for main plates, reinforcing plates, main gussets and splice plates in a direction perpendicular to the direction of their main stresses. Shearing will not allowed for plate more than 9mm in thickness, high tensile steel member, at welding connection and free end of main steel member.

The cutting ends of compression flanges and compression members, and of girders and other member which are to be spliced bolted together, shall be finished after fabrication so as to be in close contact throughout. The length of cutted member shall not exceed the tolerance shown in Table IV hereinafter.

2. Flame cutting (gas cutting):

The torch shall be mechanically and shall be guided by a trammel or template and travel at a uniform speed. The edge as given by the torch shall be clean and straight and smoothing of the edge by the torch after cutting will not be allowed unless approved by the Engineer and them in accordance with his instructions and if required by the Engineer, grinding shall be done by mechanically controlled grinders guided and travelling similarly to the cutting torch. Edges shall be finished free of all traces of slog or burrs.

Free hand cutting shall only be used where approved by the Engineer but will only be permitted in exceptional or special circumstances. At least one bend test shall be made of flame cut edges to qualify the procedures and workmanship for each grade of steel used for main members in the greatest thickness of each grade to be flame cut on the finished edges in manufacture and fabrication. The bend test specimen shall be flame cut while the material is at the lowest temperature at which the materials will be flame cut. The material subject to the bend test shall conform to the bending property requirements of the governing materials specifications when bent with the flame cut surface on the outside of the bend.

The width and depth of the bend test specimen shall be equal to the thickness of the material except that for material over 388mm in thickness or diameter the specimen depth may be 19mm or more.

The corners of the specimen may be rounded to a radius not greater than 1/16 of the width of the test specimen. Should the specimen not meet the bend test requirements, additional tests shall be made of material cut to a revised procedure which shall be agreed with the Engineer prior to so re-testing and all the cost of further testing as necessary shall be at the expense of the Contractor.

D. Straightening

Before any work is done, all plates shall be checked for flatness and all bars and section checked for straightness and free from twist and any corrective action shall be taken so that, when assembled, adjacent surface shall be in close contact through-out. The methods adopted for the works shall be such as not to damage, mark or impair the strength of the material. Extremely distorted sections shall not be allowed. When high tensile steel is straightened, the material shall first be air-cooled to below 650°C, then heated up to the proper temperature for straightening and then cooled down with water.

E. Surface Finish of Machined Parts

The surface finish of bearing and base-plates and other bearing surfaces that are to come into contact with each other or with concrete shall be machined to the highest reasonable quality to eliminate surface roughness, waviness and lay and to produce surface satisfactory to the tolerances and classes of fit appropriate to the location. A butting joint in compression members and girder flanges and in tension members, where so specified on the drawings, shall be forced and brought to an even bearing. Where joints do not faces the opening it shall not exceed 6.4mm.

F. Contact Surfaces

Where a planed finish is specified for contact surfaces between column members and base plates, and joints of columns, such surfaces shall be planed or milled to ensure full surface area contact.

G. Connections

Connections shall be fabricated as detailed. If any connection is not detailed on the Drawings, the Contractor shall detail it on the shop drawings in conformance with the specified codes and standards. The frictional surfaces of material for high strength bolted connections shall comply with the requirements in paragraph 111-B-7 "Frictional Surfaces". No eccentric connections shall be permitted unless shown in detail and approved on the shop drawings. Combinations of bolts and/or welding shall not be permitted in the same face of a connection. Unfinished bolts shall not be used except where detailed.

H. End Connection Angles

Girders and the back having end connecting angles shall be built to plan length back to back of connection angles with permissible tolerance of plus 0mm to minus 1.6mm. If end connections are faced, the finished thickness of the angles shall not be less than shown on the detail drawings.

I. Web Plates

In girders having no cover plates (flange plate) and not encased in concrete, the top edge of web shall not extend above the backs of the flange angles and shall not be more than 3.2mm below at any point. Any portion of the plate projection beyond the angles shall be clipped flush with the backs of the angles. Splices in webs of girders without cover plates shall be sealed on the top by welding. At web splices, the clearance between the end of the web plates shall not exceed 9.5mm. The clearance at the top and bottom ends of the web splice plate shall not exceed 6.4mm.

J. Fit of Stiffeners

End stiffener angles of girders for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit with in 6.4mm at each end.

Welding will be permitted in lieu of milling or grinding if noted on the drawing or accepted by the Engineer. Ends of stiffeners and other attachments may be added to flanges only at points where the flange carry compressive stress or where the tensile stress does not exceed 75% of the maximum allowable stress permitted by the applicable Specifications.

K. Drilling and Reaming

All holes shall be either punched or drilled at right angles to the surface of the member and shall not be formed or enlarged by burning. If any holes must be enlarged to admit the bolts they shall be reamed. Holes shall be clean-cut, without torn or ragged edges and outside burrs resulting from drilling or reaming operation shall be completely removed. Poor matching of holes will cause rejection of the whole member in which the sub-standard hole is situated.

Drilled and reamed holes shall be cylindrical, perpendicular to the member and within the limits of clearance specified in Table-II hereunder. Connecting parts requiring reamed or drilled holes shall be assembled and securely held prior to reaming or drilling but where this is impracticable a template shall be used. Holes required for site erection such as holes for reinforcement bear etc. shall be sub-punched or sub-drilled and reamed immediately prior to final assembly. Drifting to improve holes will not be permitted under any circumstances.

The clearance between holes in material and rivets or bolts shall conform to the following Table-II:

Table – II Clearance in mm

| Diameter | High strength bolt | Rivet | Plain bolt |
|----------------|--------------------|--------|------------|
| Less than 16mm | 1.0 mm | 1.0 mm | 0.5 mm |
| 16mm to 30mm | 1.5 mm | 1.5 mm | 1.0 mm |

The pitch of holes shall conform to the following Table-III :

Table-III Pitch in mm

| Dia. of bolt | | 10 | 12 | 16 | 20 | 22 | 24 | 28 |
|--------------------|------|----|----|----|----|----|----|-----|
| Hole pitch | STD. | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| | MIN. | 25 | 30 | 40 | 50 | 55 | 60 | 70 |
| Distance from edge | STD. | 25 | 30 | 35 | 40 | 45 | 50 | 60 |
| | MIN. | 18 | 22 | 28 | 34 | 38 | 44 | 50 |

L. Welded Connections

1. Details of welding requirements are given on the drawings.

Full particulars of the proposed methods of preparation of joints, welding procedure, type and gauge of electrodes, thickness of plates, size on fruns and welding current, etc. shall be furnished by the Contractor and approved by the Engineer before approval will be given for the use of machine welding.

Welding shall be in respects except where specific deviation are given, comply with the requirements of the AIJ “Welding Standards and Commentary I to VIII” and JASS 6 but not withstanding compliance the materials and workmanship shall still be subject to such tests and procedure as the Engineer may require or are called for herein.

2. Welding Procedures

Welding procedures required for the works will be subject to pre-qualification and acceptability of the Engineer and the Contractor must carry out at his own expense such tests as the necessary to demonstrate overall ability, standards, effectiveness and suitability of the welding techniques and procedures not withstanding those may be carried out at locations and by persons customarily employed on this type of work. The Engineer, at his discretion, may accept evidence or properly documented and inspected previous qualification of joint welding procedures to be employed. Procedure for construction welds shall conform in all respects to the qualification procedures with due regard to the tolerances permitted in Table-V herein. Welding shall not be done surfaces to weld or wet. Welds shall not be in excess of those specified by design requirements and working drawings nor shall their locations be changed without approval of the Engineer. The welder shall place his identification mark, with crayon or paint, near the welds made by him.

3. Preparation of Material for Welding

Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks and other defects which adversely affect the quality of the weld. Surfaces to the welded shall be also free from slag, rust, grease, or heavy scale. Surfaces within 50mm or more if necessary of any weld location shall, unless otherwise approved by the Engineer, be free from paint of any kind for whatever purpose applied or other materials that would prevent proper weldin⁹ or produce objection-able fumes while welding.

When butt joints are used to join material of different thickness or widths there shall be smooth transition between offset surfaces or edges at slope of not more than 1 in 2.5 with the surface or edge of either part except as otherwise permitted below.

The transition of thickness may be accomplished by sloping weld faces by conferring the thicker part or by a combination of the two. Butts joints subject only to shear or compressive stress shall be made with the specified above smooth transition when the offset between surface at either side of the joints is greater than the thickness of the thinner part connected.

When the offset is equal to or less than this amount, the face of the weld shall be sloped 1 in 1.5 from the surface of the thinner part if this requires a lesser slope, except that truss member joints and beam and girder flange joints shall be made with smooth transitions of the type specified in the above paragraph.

4. Assembly

The parts to be joined by fillet welds shall be brought into as close contact as practicable, and in no event be separated more than 4.8mm.

If the separation is 1.6mm or greater, the leg of the fillet weld shall be increased by the amount of the separation. The separation between facing surface of lap joint and of members of butting a backing structure shall not exceed 1.6mm. The fit of joints, which are not sealed by welds throughout their length, shall be sufficiently close to exclude waste after painting. Where irregularities in rolled shapes of plates, after straightening, do not permit contact within the above limits, the procedure necessary to bring the materials within this limits shall be subject to the approval of the Engineer.

The use of fillers is prohibited except where indicated on the drawings or approved by the Engineer.

A butting part to be joined by butt welds shall be carefully aligned.

Where the parts have to be effectively restrained against bending due to eccentricity in alignment, a maximum offset of 10% of the thickness of the thinner part joined, but in no case more than 3.2mm, be permitted as departure from theoretical alignment, but the correction of misalignment shall conform to the requirements of the Engineer, measurement of off-set shall be based upon the center line of parts unless otherwise shown on the drawings.

Dimensions of the cross section of groove welded joints shall be in accordance with those shown on detail drawings subject to the workmanship tolerances specified in the Table V herein. Members to be welded shall be brought into correct alignment and held in position by bolts, clamps, wedges, guy lines, struts, other suitable devices, or by tack welds, until welding has been completed.

The use of jigs and fixtures is recommended where practicable. Suitable allowances shall be made for warpage and shrinkage.

Temporary welds and tack welds shall be subjected to the same welding procedure requirements as final welds. Tack welds that are to be included subject to the approval of the Engineer in the final welds shall be cleaned and fuse thoroughly with the final welds.

Multiple pass tack welds shall have cascaded ends. Defective tack welds shall be removed before final welding. Temporary welds shall be removed and ground flush with the original surface.

On completion of welding it shall be cleaned of slag and welded joints shall not be painted until after the work has been completed and accepted. Surface to be painted shall be cleaned of spatter. Rust, loose scale, oil and dirt and well surface that have not been blast cleaned shall be neutralised by suitable methods before painting.

5. Control of distortion and shrinkage stresses

In assembling and joining parts of a structure or of built-up members, and in welding reinforcing part to members, the procedure and sequence of welding shall be such as minimise distortion and shrinkage stresses and thus the cracking consequent thereon.

In so far as practicable, all welds shall be deposited in a sequence that will balance the applied heat welding on various sides as much as possible whilst the welding progresses.

Before the commencement of welding on butt-welded splices in rolled or built-up member or I, H or box sections or on any members in which severe shrinkage stresses or distortion are likely to occur, a complete programme for welding sequence and distortion control shall be agreed between the Contractor and the Engineer. Regardless of the Engineer's approval, it shall be the responsibility of the Contractor to develop a welding procedure which will produce welding conforming the quality and dimensional requirements of this Specification.

The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position or have large shrinkage with respect to each other toward points where they have a greater relative freedom of movement or lesser anticipated shrinkage.

6. Electrodes for manual shielded metal-arc welding:

Electrodes for manual shielded metal-arc welding shall conform to the requirement of ASTM. The Contractor shall furnish certified copies of reports of test made on electrodes of some class, size and brand, and which were manufactured by the same process and with the same materials as the electrodes furnished. The test may have been for process qualification or quality control and shall have been carried out within one year prior to manufacture of the electrodes furnished.

The Contractor shall furnish copies of the manufacturer's certification that the process and material requirements were the same for manufacturing the tested electrodes and the furnished electrodes. In lieu of requiring the Contractor to furnish copies of test reports for each shipment of electrodes on a project a list of approved brands of electrodes may be maintained for which satisfactory report or tests made within one year have been previously submitted.

All electrodes having low-hydrogen coverings shall be dried for at least 2 hours between 232°C and 260°C before they are used.

Electrodes may be stored immediately after drying in storage ovens held at temperature of at least 121°C.

Electrodes that are not used within 4 hours after removal from a drying or storage oven shall be redried before use.

Electrodes which have become wet at any time shall not be used.

7. Procedure for Manual Shielded-arc Welding:

The work shall whenever practicable and as far as possible be positioned for flat position welding. The classification and size of electrode, arc, length, voltage, and amperage shall be suited to the thickness of the material, type of groove, welding positions and other circumstances attending the work.

The maximum size of electrode shall be as follows;

- a 8mm for all welds made in the flat position, except for root passes.
- b 6.44mm for horizontal fillet welds.
- c 6.44mm for horizontal fillet welds.
- d 6.44mm for root passes of fillet welds made in the flat position and groove welds in the flat positions with backing or spacers having a root opening greater than 6.4mm.
- e 4mm for welds made with low hydrogen electrodes in the vertical and overhead positions.

- f 4.8mm for root passes of groove welds and for all other welds not covered above.
8. The maximum thickness of layers subsequent to the root pass in fillet welds, and of all layers in groove welds shall be:
- a 6.4mm for root passes of groove welds.
 - b 3.2mm for subsequent layers of welds made in flat position.
 - c 4.8mm for subsequent layers of welds made in the vertical, overhead, or horizontal position.

Where welding in the vertical position is necessary the progression of all passes shall be upward.

Before welding over previously deposited, all slag shall be removed and the weld and adjacent base metal shall be brushed clean.

This requirement will apply not only to successive layers but also to successive heads and to the crater area when welding is resumed after any interruption. It will not, however, restrict the making of plug and spot welds. All butt welds, except those produced with the aid of backing, shall have root of the initial weld gouged, chipped or otherwise removed down to sound metal before welding is started from the second side. Butt welds made with the use of backing shall have the weld metal thoroughly fused with the backing.

Where accessible, backing for welds that are subjected to computed stress or which are exposed to view on the completed structure, and which are not otherwise parts of the structure shall be removed and joints ground smooth. Groove welds shall be terminated at the ends of a joint in a manner that will ensure sound welds.

Where possible, this shall be done by use of extension bars or run-off plates. When used extensions, it shall be removed upon completion and cooling of the weld and the weld made smooth and flush with the edge of the butting parts.

9. Preheat

When the temperature of base material is below the temperature listed below for the welding process being used and thickness of material being welded, it shall be preheated for temporary welding, tack welding and production welding in such manner that surface of the parts on which weld metal is being deposited are at or above the minimum temperature for a distance, equal to the thickness

of the part being welded, but not less than 70mm both laterally and in advance of welding.

Minimum preheat and interposes temperatures ;

Table IV

| Thickness of widest part of point of welding | Welding process shield metal arch welding with low-hydrogen electrodes |
|--|--|
| To 19mm inclusive | 10°C |
| Over 19mm and up to and including 38mm | 21°C |
| Over 38mm and up to and including 63.5mm | 66°C |
| Over 63.5mm | 107°C |

10. Quality of Welds:

Welds shall have no cracks, no overlap, no incomplete fusion nor inadequate penetration and conform the requirement of JASS 6.

Under-cut shall not be more than 0.2mm deep when its direction is transverse to the primary stress in the part that is under-cut.

Under-cut shall not be more than 0.8mm deep when its direction is parallel to the primary stress in the part that is under-cut.

11 Inspection of Welding:

Welding shall be subjected to one or any or all of the following inspection and testing procedures at the operation of and it required in the presence of the Engineer. As a result of the inspections and the tests the Engineer may interpret and himself analyse some, approve those which are satisfactory, disapprove or reject those considered to be unacceptable and discuss with the Contractor the means of repairing or replacing those welds which are not of the correct quality. Tests on welds shall be fully logged as to location, type of test, length of weld tested, the defects found, instructions given as to repair etc. and the date of approval together with any other matter the Engineer considers relevant.

a Visual Inspection of Welding

The Engineer may at any time make a visual inspection of welding processes and give instruction accordingly.

Of the welding itself the Engineer shall check the general dimensions and quality and search for cracks, hollows or welding which in any way may be defective. Notwithstanding that work may be condemned on the basis of visual inspection only the Contractor shall comply with the instruction of the Engineer including the re-making or repairing of substandard workmanship.

b Magnetic Particle Inspection of Welds

Where magnetic particle inspection is specified, the Engineer will ascertain that magnetic particle equipment and process and surface preparation are in accordance with ASTM E109. At least 300mm of every 3m length of weld or part thereof of each size and type of shop weld will be examined by the Magnetic Particle Inspection Method in accordance with ASTM E109.

The tests will be selected at random in the members but so as to be typical for each size and type of weld. If unacceptable defects are found in any test length of weld, the full length of weld will be tested. Welds requiring repairs shall be re-tested after the repairs are made.

c Radiographic Inspection of Welds Radiographic inspection of groove welds will be required as specified in ASTM. Where radiographic inspection is specified, the Engineer will ascertain that radiographic equipment and process, resulting radiographs, identification marks, Penetrimeters, and weld surface preparation are in accordance with the standard.

All tension splices and all splices subject to reversals of stress, except that on beam and girder webs only 1/6 of the web depth beginning at the point or points of maximum tension, and 25% of remainder of the web depth, need to be radio-graphed.

Twenty five percent of the compression splices as selected by the Engineer or, alternatively, 25% of each compression and shear splice except that for splices in built-up members requiring less than a total of 1.2m of groove weld in compression, only on joint, connecting the thickness components, in each splice need be radiographed.

Maximum spacing of radiographs shall be 4 times the lengths of the radiograph.

If unacceptable defects are found in more than 10% of the radiographs of the compression and shear splices, the remaining 75% of the splices shall be radiographed. Where partial inspection is required, the radiographs shall be located at random on the welds so as to indicate typical weld quality. If 10% of the random radiographs indicate unacceptable defects the remaining 75% of the welds shall be radiographed. Welds requiring repairs shall be re-radiographed after the repair.

d Ultra-sonic Testing

Where so directed by the Engineer or it is considered necessary welding shall be tested by the ultra-sonic method using the special equipment for the pulse-echo technique operated by personnel qualified in its use. The procedure and requirements in such case shall be complied with ASTM E114.

Unless otherwise required in the Particular specifications, at least 30 welding points of one test group, which are not more than 600 welding points and one welding point is not more than 300mm in length shall be tested.

If unacceptable defects are found within 2 welding spots, that test group will be accepted. If unacceptable defects are found in more than 2 spots of weld and within 7 spots of weld, 30 further spots of weld shall be tested. If unacceptable defects are found more than 6 spots of weld on 60 welding spots test, that test group consist 600 spots of welding shall be rejected.

All welds requiring repairs shall be re-tested after the repairs are made.

12. Correction of Defective Welding

In lieu of rejection of an entire piece or number containing welding which is found to be unseats-factory or which indicates inferior workmanship, the corrective measures listed hereunder may be permitted by the Engineer, but at his absolute discretion. Defective or unsound welds or lose metal shall be corrected either by removing and replacing the entire weld, or as follows;

| Defective | Correction |
|---|--|
| Excessive convexity, overlap. | Reduce by removal of excess weld metal. |
| Excessive concavity or crayer, Excessive under-cut, Under-size weld | Clean and deposit additional weld metal. |

| | |
|---|---|
| Excessive porosity or slag inclusions, incomplete fusion, inadequate joint penetration. | Remove defective portions and reweld. |
| Cracks in weld or base metal. | Remove crack to sound metal throughout its length and 50mm beyond each end of crack, followed by re-welding. The extent of the crack, depth and length, shall be ascertain by use of acid etching, magnetic particle inspection or other equally positive means. |

The removal of weld metal or portions of the base metal shall be done by chipping, grinding, oxygen cutting, oxygen gouging, or carbon arch gouging and in such a manner that the remaining weld metal or base metal is not nicked or undercut. Defective portions of the weld shall be removed without substantial removal of the base metal.

Additional weld metal shall be deposited using an electrode smaller than that use for making the original weld, and not more than 4mm in diameter.

Surfaces shall be cleaned thoroughly before welding.

All procedure for such work shall be agreed with the Engineer particularly where the original welding conditions have changed.

13. Caulking of Welds:

Caulking of welds will not be permitted. Improperly fitted parts may be cut and re-welded. Members distorted by welding shall be straighten by mechanical means or by carefully supervised application of a limited amount of localised heat. The temperature of the heated area shall not exceed 650°C (that is, to a dull red colour). Parts to be heated for straightening shall be substantially free of stress and from external forces, except those stresses resulting from mechanical means used in conjunction of weld and base metal.

14. Peening

No Peening shall be done on the root or surface layers of a weld but peening of intermediate weld layers may be permitted by the Engineer.

Care shall be exercised to prevent over-peening which may cause overlapping, scaling, cracking, flaking or excessive cold working of weld and base metal.

15. Shear Studs

Studs shall be welded to the top of the member; they may face sideward if it is unavoidable, and prior approval has been obtained from the Engineer.

Studs shall be welded perpendicular to the steel surface. The length of the stud shall be the design dimension plus or minus 2 mm.

The following bending test shall be conducted after welding at the rate of 1 per 100 studs: The maximum tensile force shall be applied to the welded portion and there shall be no failure of the weld up to 15 degrees of bending. If a failure of the weld occurs, the number of tests shall be increased as instructed by the Engineer.

Bent studs shall be straightened without the application of heat. Bent studs may be embedded in concrete if they are not defective.

16. Marking

Before factory assembled parts are dismantled or as necessary but after all fabrication, all adjacent sections shall be marked with point or grooved. The Contractor shall submit the drawing of the finished structure showing all parts and match marks to the Engineer.

17. Shop Painting

Shop painting shall be done after fabrication of a components is completed and at times when all surfaces to be painted can be properly treated but always after inspection of fabricated component by the Engineer. However, it shall be done before exposure to weather elements and when absolutely dry and dust-free. The surface of all steelwork, if not otherwise directed, shall be thoroughly cleaned to bright metal by sand or grit blasting or by other approved methods, except machined faces at bearings or shop contact surfaces but surfaces take in contact with wood or after site erection shall be painted. When clean and dry, priming of one coat of specified paint applied by air spray followed when dry by a further application of the same paint or other protective treatment as may be specified in the particular Specifications. The shop treatment of paint shall be applied to a minimum thickness of 0.15mm.

Care shall be taken not to erase re-erection marking or to replace those where necessary and those surfaces left unpainted shall be coated with rust inhibitive petroleum jelly or other mixture acceptable to the Engineer.

Steelwork which has been painted shall not be handled until the paint film is completely dry.

The same type of paint as is used for the shop painting shall be used for touching up damaged surface on site and a supply of the factory paint and those paint shall be supplied with steelwork for this purpose. Paintings and the requirements thereof shall comply with the Section xxxxx "Paintings" of these Specifications. Steelwork which it to be encased in concrete shall not be painted and preparation of those sections prior to encasement shall be as described in Section 27 "Concrete Reinforcement" of those Specifications.

18. Fabrication Tolerances

- a. Products: Imperfections shall not exceed the tolerances shown in Table V

Table - V

| Type | Figures | Tolerance |
|---|---------|--|
| Length (L) | | +3mm |
| Bend (e/L) | | 1/1000 |
| Height (H) | | H=400mm+2mm 400mm H 1000mm +H/200 H=1000mm+5mm |
| Width (b) | | +3mm |
| Angle of member at connection (e1/H, e2/H) | | 1/300, and e1 and e2 are to be less than 3mm |
| Bend of web (e1/H, e2/B) | | 1/150 |
| Slope of flange at connection (e) | | B=200mm B/100 B 200mm 2mm |
| Bend of flange at connection (e) | | B=100mm b/100 B 100mm 1mm |
| Deviation of centre (e) | | 2mm |
| Roughness of gas cut surface | | 200s |
| Notch depth of gas Cut surface | | 1mm |

- b. **Welding:** Imperfections in finished welded work shall not exceed the tolerances shown in Table IV.

End of members fabricated by welding which are to be connected on site by welding shall be shop assembled to a template.

Table VI

| Type | Figures | Tolerance |
|---------------------------------------|---------|--|
| Gap of tee joint (fillet weld) (e) | | E 5mm |
| Gap of lap weld (e) | | 2mm |
| Gap of backing plate (e) | | 1mm |
| Discrepancy of butt weld | | T 15mm 1.5mm 15mm t 30mm t/1:0 t 30mm 3mm |
| Root gap (back chipping) (a1, a2) | | A1 : not less than 3mm A2 : not less than 4mm |
| Root gap (with backing plate) (a) | | +5mm -0 |
| Root face (a) | | A 3mm + 1mm A 3mm + 2mm |
| Groove angle (a1, a2) | | +5° +5° -3° |
| Size of fillet weld (s) | | +3mm -0 |

Table VI (Cont'd)

| Type | Figures | Tolerance |
|-------------------------------------|---------|---|
| Reinforcement of fillet weld (c) | | +(0.15 + 1mm) -0 |
| Reinforcement of butt weld (c) | | Maximum +4mm Minimum +0.5mm |
| Undercut (e) | | E : less than 0.05t And 0.5mm |
| Unevenness of head (e1, e2) | | E1 : less than 2.5mm (L 25mm) e2 : less than 5mm (L 150mm) |

19. Transport, Handling and Delivery

The methods of transporting and handling the steel-work shall be subject to the approval of the Engineer . Special care shall be taken in the packing and methods of support and lifting during handling and transport of structural steelwork, especially that which is shop assembled, to ensure protection from damage and shall be sufficiently and adequately restrained and supported to prevent deflection and distortion.

All open joints, ends and projecting parts shall be protected from damage in transit in such manner as to stiffen the number and prevent distortion. All bolts, nuts and washers shall be placed in bags or metal cases made waterproof, with a separate bag or cases used for each length and diameter. Each bag or case shall have a metal label to indicate its contents.

The Contractor shall take delivery of the steelwork at the site or other point of delivery as may be agreed with the Engineer, and shall carefully unload and hold it in safe storage such that it is free from deterioration until finally erected.

On delivery the steelwork shall be carefully inspected so that any damage can be discovered and repaired or replaced before incorporation into the works. Repair work shall be carried out as agreed by the Engineer but fractured material or components which he considers are beyond repair shall be replaced by new material or components, fabricating a new one may be carried out on site if accepted by the Engineer but otherwise at the factory.

Steelwork shall be stored at the site in such manner that damage or defects do not occur and as far as is necessary shall be placed on skids above the ground and kept clean and properly protected from weather and site hazards and impact.

The shop applied protection painting shall not be relied upon to give long term protection to steelwork stored at the site and exposed to the atmosphere.

3.02. ERECTION

A. General

Erection facilities, equipment and tools shall be appropriate for the work, adequate in number and capacity, and safe at all times. All erection facilities and equipment shall be maintained in good working condition for the duration of the work.

Steelwork shall be erected in an orderly and systematic manner so that the steel frame is progressively constructed and tied in. Free ends of steel members shall be temporarily restrained or supported until connections are made and no steelwork shall be handled or lifted such that deformation or damage shall occur thereto.

All proposals and erection procedures shall be agreed in advance with the Engineer.

Installation shall be in strict accordance with the approved drawings and shall be true to lines and levels indicated. All parts shall at all time be carefully handled and accurately assembled with components used in the proper position in accordance with the marking system and particular attention shall be given to avoid impact between members whilst moving to their fixing positions.

Shop fabricated items that can be easily damaged shall be braced and carefully handled to prevent distortion or damage.

After assembly, the various members forming part of a completed frame or structure shall be aligned and adjusted accurately before being fastened. Fastening of splices of specified compression members shall be done after the contact surfaces have been brought completely into contact. Bearing surfaces and surfaces that shall be in permanent contact shall be cleaned before the members are assembled.

As erection progresses, the work shall be securely braced and fastened to take care of all dead load, wind, and erection stresses. Splices and site connections shall be generally have least 50% of the holes filled with drift and service bolts before permanent bolting is commenced.

In this assembly and fitting at least two holes in the group are to be filled with parallel drifts if possible and at least 40% of the holes shall be filled with bolts.

Further more at least 10% of the holes in the group are to be permanently bolted before any of the erection bolts or drifts are removed. Unless removal is required, all erection bolts used with welded connections shall be tightened securely and left in place. If erection bolts are removed, the holes shall be plug welded. Welding for re-drilling shall not be permitted. Holes shall not be enlarged more than 2mm greater than the specified holes size without approval of the Engineer. Items installed before concrete or masonry is placed shall be properly braced to prevent distortion by the pressure of concrete or masonry.

Field welding shall be permitted only where indicated or approved on the shop drawings. Fasteners shall be installed as specified. Errors in shop fabrication and deformations arising from handling and transportation which prevent the proper assembly and fitting of parts shall be reported immediately to the Engineer.

Approval of the method of correction, or rejection, shall be obtained from the Engineer. Approved corrections shall be made at no additional cost to the Employer.

B. Anchor Bolts and Metal Inserts

Anchors, bolts, inserts, base plates and other miscellaneous fastenings required for erection of the structural steel work shall be supplied to the appropriate Contractor for building into concrete or masonry as indicated on drawings and details. The Contractor shall provide to other Contractors the templates required for the location of structural steel work items to be embedded in concrete, and masonry and setting instructions. The structural steel Contractor shall supervise the installation of such items or shall verify their correct placement after installation.

Anchor bolts shall be fixed in place before pouring concrete by the method shown in the following table (as specified). If the method is not specified, use Method A.

| Method | Description |
|--------|--|
| A | Weld the bolt top and bottom to 9x100mm flat Steel bars welded to the reinforcing bars. |
| B | Weld the bolts to the reinforcing bars, or fasten them to the form using proper auxiliary tie Members. |

Unless otherwise shown on the drawings, anchor bolts shall be embedded in concrete by the method shown in the following table (as specified).

If the method is not specified, use Method A.

| Method A | Method B |
|--|--|
| Washer thickness is equal to that of the base plate. Outer diameter: $d+60\text{mm}$ (min.) Diameter of hole: $d+1\text{mm}$ Perimeter of washer is to be Filled weld all around. | Washer thickness: 9mm (min.) Outer diameter: $d+60\text{mm}$ (min.) Diameter of hole: $d+1\text{mm}$ |
| Double nut Bearing Plate Grout Diameter d | Double nut Bearing Plate Grout Diameter d |

C. Bearing Plates

Steel bearing plates shall be provided for all structural steel members bearing on concrete or masonry. Bearing plates shall be levelled and supported with steel shims to the correct elevation.

After the structural steel has been braced and bolted in place, install the specified grout under the bearing plate in accordance with the manufacturer's printed directions.

D. Drifting

Drifting having diameter no larger than the diameter of bolt holes shall be used to bring the various portions accurately into place and align the steel-work members and shall not distort or damage the members.

Any error in shop work which prevents the accurate and correct assembling and proper lifting of parts by moderate use of drifts shall report immediately to the Engineer.

E. Flame Cutting

The use of gas torch cutting in the field for correcting fabrication errors shall not be permitted on any major member in the structural framing. The use of a gas torch cutting shall be permitted only on minor members, when the member is not under stress, and then only after the approval of the Engineer has been obtained.

F. Erection Tolerances

Tolerance for erection of structural steel shall conform to Table VII :

Table VII

| Type | Figures | Tolerance |
|--|---------|--|
| Leaning of entire Structure (e/H) | | 1/500, and e shall be less than 25mm |
| Bending of entire Structure (e/L) | | 1/2000, and e shall be less than 30mm |
| Height of column installation place and location of anchor bolts | | Error from standard height of column Installation place shall be less than 3mm. Error e of distance between centres of two adjacent columns shall be less than 3mm. Error e2 of distance from common centre line of columns to centre of column shall be less than 2mm |

| | | |
|------------------------------|--|--|
| Alignment of column (e) | | Error from common centre line of column shall be less than 5mm |
| Floor height (H) | | +3mm |
| Leaning of column (e/H) | | 1/500 |
| Level of beam (e/L) | | 1/1000, and e shall be less than 5mm |
| Bend of beam (e/L) | | 1/1000 |

G. Frictional Surfaces

The contact surfaces (frictional surfaces) of material for high strength bolted connections shall be cleaned of all mill scale, rust, oil, paint and other foreign matter. (Splice plates and filler plates shall be sand blasted and shot blasted.) Then the members shall be aged until a coat of rust forms on the contact surfaces, sufficient to achieve a coefficient of friction greater than 0.45 but not excessively heavy. All frictional surfaces shall be inspected before assembly, and protected after inspection. Burrs, distortions or dimples on frictional surfaces shall be removed. The clearance between frictional surfaces shall be less than 1mm before tightening. Excessive clearance shall be reduced with filler plates.

H. Bolt Holes

If bolt holes do not coincide during trial shop assembly they shall be corrected by reaming (with chips sticking to the connection carefully removed) or drifting.

I. Bolting (except high strength bolting)

Bolts shall be installed without damaging the thread. Bolt heads shall be protected from damage during driving.

Bolts heads and nuts shall rest squarely against the metal.

Where bolts are to be used on bevelled surfaces having slopes greater than 1 in 20, bevelled washers shall be provided to give full bearing to the bolt head or nut.

Where self-locking nuts are not furnished, use double nuts and weld. Where bolts are to be pass through box section members the bolts shall complied with the requirements of the Particular Specifications.

J. High Strength and Special High Strength Bolting

1. High strength bolting

The quality of bolts shall be confirmed by examining the manufacturer's quality control records and in-house inspection records.

High strength bolts shall be visually inspected upon delivery to the fabrication shop and/or site confirmation tests for torque values shall be conducted where requested by the Engineer.

High strength bolts shall be stored and handled in separate lots according to class, size and manufacture, and they shall be carefully handled to prevent damage or rust and contact with soil or foreign matter. Bolts shall be properly packed by the manufacturer and unpacked just before the work begins.

Equipment used for tightening and inspecting shall be suited to the application and shall be properly inspected and maintained at all times.

Bolt lengths shall be determined by adding the grip-length values given to the total thickness of connected material. The values shall be compensated for manufacturer's tolerance, the use of a heavy semi-finished hexagon nut and a positive "stick-through" at the end of the bolt. For each hardened flat washer that is used add 4mm to the tabular value and for each bevelled washer add 8mm. The length determined should be adjusted in stages of 6.4mm to the next longer bolt manufactured.

Bolts shall be tightened with properly calibrated wrenches using the turn-of-nut method, and direct tension indication. If required because of bolt entering and wrench operation clearance, tightening may be done by turning the bolt, which the nut is prevented from rotating.

Pneumatic impact wrench, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

When calibrated wrenches are used to provide the bolt tension required, their settings shall be such as to induce a bolt tension 5% to 10% in excess of value required. Calibrated wrenches shall be calibrated at least twice each working day before starting work in the morning and after-noon. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested number.

When using calibrated wrenches to install several bolts in a single connection the wrench shall be returned to bolts previously tightened to check tightness or which may have been loosened by the tightening of subsequent bolts, until all are tightened to prescribed amount.

All tightening and installation procedures shall be subject to the approval of the Engineer who will be witnesses and equipment and method checked from time to time to determine that the selected tightening procedure is properly used and that all bolts are correctly tightened.

When and as directed by the Engineer, the Contractor shall carry out the following test ;

Three bolts of the same grade, size and condition as those to be used in the Works shall be place individually in a calibration device capable of indicating bolt tension, length may be any length structure and there shall be a washer under the part turned in tightening each bolt. An inspecting wrench shall be used which may be either a torque wrench or a power wrench that can be accurately adjusted in accordance with the requirements hereunder.

- If the inspecting wrench is a torque wrench, each of the three bolts specified above shall be tightened in the calibration device by any convenient means to the minimum tension specified for its size. The inspecting wrench shall then be applied to the tightened bolt and the torque necessary to turn the nut or head 5 degrees (approximate 25.4mm at 305mm radius) in the tightening direction shall be ascertained. The average torque measured in the test of three bolts shall be taken as the inspection torque for the respective bolts and used in the manner specified below.

- If the inspection wrench is a power wrench it shall be adjusted so that it will tighten each of the three bolts specified, but not those used in any other test to a tension at least 5% but not more than 10% greater than the minimum tension specified for its size.

This setting of the wrench shall be taken as the inspection torque for the respective bolts and used in the manner specified below. Bolts which have been tightened in the structure shall be checked by applying, in the tightening direction, the inspecting wrench and inspecting torque established above to 10% of the bolts, but in no case less than two bolts selected at random in each connection.

If no nut or bolt head is turned during this inspection the connection shall be accepted as properly tightened. If any nut or bolt head is turned by the application of the inspecting torque, the torque shall be applied to all bolts in the connection, and all bolts whose nut or head is turned by job inspecting torque shall be tightened and re-inspected, or alternatively, the Contractor may retighten all of the bolts in the connection and then resubmit the connection to the specified inspection. Once tightened no bolt assembly shall be loosened and any bolt etc which is over tightened, loosened or removed shall be replaced with a new assembly and any bolt or nut damaged during erection or tightening shall not be used in the works but shall be taken out and renewed.

Torque shall pass inspection if it meets the following equation :

$$0.9 T_o \leq T \leq 1.1 T_o$$

Where

$$T_o = (k \times d_1 \times N_o) / 1,000$$

T : Torque value obtained during inspection (kg/m)

T_o : Standard torque (kg/m)

K : Coefficient of torque

d₁ : Standard value of external diameter of thread of bolt (mm)

N_o : Standard of bolt tension

2. Special high strength bolting

Confirm final bolt tightening by observing partial deformation or partial breaking of each bolt. Confirm the appropriateness of the shape and dimension of bolts for which final tightening is completed.

Use a gauge for the grip system. Submit records of inspection to the Engineer.

3. Friction testing

Prepare and test 3 specimens of high strength bolts in double shear for coefficient of friction. Prepare the test specimens in accordance with JIS Z2241 duplicating the most severe job condition (as determined by the Engineer). Submit test records to the Engineer.

K. Site Welding

Where and insofar as it is necessary site welding of components or for erection purposes shall be carried out in accordance with the requirements and procedure described hereinbefore. The welding techniques specified for factory fabrication shall be adopted in accordance with methods agreed with the Engineer to suit external working conditions and will be subject to his approval at all times. The Contractor shall allow for carrying out the tests and providing the equipment and labour. Notwithstanding the foregoing welders shall be qualified as reviewed by Clause I.E.2 hereof.

L. Final Alignment

Before final tightening of bolts and grouting in of bearing plates etc. , the Contractor shall check the alignment of steelwork structure and make whatever adjustments are necessary to ensure that members are truly vertical, horizontal or at the proper angle as the case may be and exactly positioned. Subject to any adjustment being possible within the tolerances of steelwork as erected the final tightening may proceed but where accurate alignment is rendered impossible the corrective measures which shall be at the expense of the Contractor shall be agreed with the Engineer or, if and where he so directs, the offending member(s) shall be remade and fabricated to suit the site conditions.

M. Site Painting

Decorative painting on site shall be carried out in accordance with the Section 67 "Painting" of those Specifications and the finishing schedule or other details relating thereto. However after erection, steelwork shall be cleaned of all site accumulations such as mud as filing and damaged areas of the factory-applied treatment shall be touched up to the approval of the Engineer.

Immediately after erection and alignment preparatory, site painting shall be done to include the painting of all nuts and bolts etc., and exposed areas of steelwork previously left unpainted. Such paintings shall be carried out on properly prepared surfaces but not whilst wet or in damp conditions. Particular care shall be taken to ensure that paint film is continuous and fully covers and seals all cracks, angles, joints, edges and ends, etc.

End of Section

SECTION 05500**MISCELLANEOUS METAL****PART 1: GENERAL****1.01 SCOPE OF WORK**

- A Furnish all labor materials, equipment and incidentals required to provide all miscellaneous metal as indicated and as specified herein.
- B Miscellaneous metal work include items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not specified in other sections of these specification.
- C This Section cover the following miscellaneous metal items :
 - 1. Steel Screen.
 - 2. Floor channels and gratings.

1.02 RELATED WORK NOT INCLUDED

- A Installation of embedded miscellaneous metal items is included in Division 3 and 4.
- B Masonry reinforcement, masonry ties and anchor slots are included in Division 4.

1.03 SUBMITTALS

- A Submit detail drawings, as provided for in special conditions, showing sizes of members, method of assembly, anchorage, and connection to other members.
- B Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.
- C Samples: Submit 2 sets of representative samples of materials and finished products as may be requested by Engineer.

1.04 COORDINATION

- A The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
- B Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.05 REFERENCE SPECIFICATIONS

A. Unless otherwise specified, materials shall conform to the following:

| | |
|---|---|
| Structural Steel | ASTM A36 |
| Structural Tubing | ASTM A500, Grads B |
| Welded and Seamless Steel pipe | ASTM A53 |
| Gray Iron Castings | ASTM A48, Class 30 |
| Galvanizing, general | ASTM A123 |
| Galvanizing, hardware | ASTM A153 |
| Galvanizing, assemblies | ASTM A386 |
| Aluminum (Extruded Shape) | 6061 T6 |
| Aluminum (Extruded Pipe) | 6063 T6 |
| Aluminum sheet, Plate and Rolled Shapes | 6061 T6 |
| Anchor Bolts and Nuts | ASTM A320,Grade B8 |
| Stainless Steel Bolts, Bars, & Shapes | AISI, Type 304 |
| Stainless Steel Plate and Sheet | AISI, Type 302 |
| Welding Rods for Steel | AWS Spec. for Arc Welding (Type E70XX) |
| High Strength Steel Bolts, Nuts & Washers | ASTM A325 mechanically galvanized per ASTM B454 |
| Screws | Stainless Steel, IFI-04, Grade 303 or 305 |

PART 2: PRODUCTS

2.01 MATERIALS

A Ferrous Metals

1. Metal Surfaces, General: for fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes and including pitting, seam marks, roller marks, rolled trade names and roughness.
2. Steel Plates, shapes and bars: ASTM A 36 or BS 1449 .
3. Steel bar grating: ASTM A 569 or ASTM A 36 .
4. Steel tubing: cold formed, ASTM A500; or hot-rolled, ASTM A 501, BS 4848, or BS 2994 .
5. Structural steel sheet: hot-rolled, ASTM A 570; or cold-rolled ASTM A611, class 1; of grade required for design loading.
6. Galvanized structural steel sheet: ASTM A 446, of grade required for design loading. Coating designation as indicated, or if not indicated, G90.

7. Steel pipe: ASTM A 53 or BS 4848. Type and grade as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (schedule 40), unless otherwise indicated.
8. Grey iron castings: ASTM A 48, Class 30, or BS 1452.
9. Malleable Iron castings: ASTM A 47, grade as selected by fabricator.
10. Brackets, flanges and anchors: cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
11. Concrete inserts: threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153.

B Grout

1. Non-Shrink Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with CE CRD-C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.

C Fasteners

1. General: Provide zinc-coated fasteners for exterior use or where built into exterior walls select fasteners for the type, grade and class required.
2. Bolts and Nuts: Regular-hexagon head type, ASTM A 307, Grad A, or BS 1768.

Lag Bolts: square head type, FS FF-B-561.

Machine Screws: cadmium plated steel, FS FF-S-92, or BS 4183.

Wood screws: flat head carbon steel, FS FF-S-111, or BS 1210.

Plain washers : round, carbon steel, FS FF-W-92, or BS 3410.

Masonry anchorage devices: expansion shields, FS FF-S-325, or BS 5050.

Toggle bolts: tube-wing type, FS FF-S-589, type, class and style as required.

Lock washers: helical spring type carbon steel, FS FF-W-84.

D Paint

1. Shop primer for ferrous metal: Manufacturer's or fabricator's standard, fast-curing, lead-free primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure; complying with performance requirements of FS TT-P-645.
2. Shop primer for ferrous metal: fast-curing, lead-free, abrasion-resistant, rust-inhibitive primer selected for compatibility with substrates and with types of alkyd-type finish paint systems indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure; complying with performance requirements only of FS TT-P-86, Types I, II, and III.
3. Galvanizing repair paint: high zinc dust content paint for reglazing welds in galvanized steel.
4. Polyester Powder Coat Finish:
 - a. Is to be polyester resin powder electrostatically applied and baked to give minimum thickness of 70 microns, to meet the requirements of BS 6496. Colour to be select by the Engineer. Manufacturer is to provide a 10 years warranty, agreeing to repair or replace defective coating, defined as abnormal deterioration, aging or weathering or loss of adhesion.

2.02 STEEL ITEMS**A General:**

- 1 Steel Items shall be fabricated of steel bars, shapes, plates and pipe required, ground smooth as approved. Galvanize after fabrication. Securing of components shall be stainless steel.
- 2 Miscellaneous sleeves not specified in other Sections shall be steel or cast iron pipe in walls and floors with end joints as shown on the Drawing. All pipe sleeves shall have center anchor around circumference.
- 3 Miscellaneous steel shall be fabricated and installed as shown and shall include anchor bolts, lifting hooks, porous checkered plate, miscellaneous steel called for on the Drawings and not otherwise specified.

B Floor Channels and gratings: cast iron floor channels and straight bar gratings with zinc coated finish, of medium duty, as shown on the Drawings.

C Flat and projected Mashrabeya type screens: are to be constructed of galvanized steel hollow tubes and solid steel bars sections of sizes and dimensions shown on the drawings. Units are to be complete with opening portions and bolt fixings; all finished with coloured electrostatically baked applied polyester finish.

PART 3: EXECUTION**3.01 FABRICATION**

- A All miscellaneous metal work shall be formed true to detail with clean, straight, sharply defined profiles and smooth surface of uniform color and texture and free from defects impairing strength or durability.
- B Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.
- C Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.
- D Welding of parts shall be in accordance with the standard AWS practices for arc and gas welding. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.
- E All non-galvanized steel miscellaneous metal work shall be prepared and primed in shop after fabrication as specified in Section 09901. Abrasions and welding damage of primer in the field shall be touched up with the primer used immediately after erection.
- F All steel items not specified to be painted shall be galvanized.

3.02 INSTALLATION

- A Install all items furnished except items to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown or suitable alternate method. Fastening to wood plugs in masonry will not be permitted. All dimensions shall be verified at the site before fabrication is started.
- B All steel surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.
- C Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc. Chromate primer followed by two coats of aluminum metal and masonry point to the dissimilar metal.
- E Where items are cast into concrete, back paint with the above paint the contact areas before setting.

- F Anchor bolts and expansion bolts shall be set accurately. Where indicated on Drawings, specified, or required, anchor bolts shall be provided with head or nut embedded in concrete or suitable pipe sleeves, or both. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates or shall have square heads and washers to be set in the concrete forms with suitable pipe sleeves, or both. If anchor or expansion bolts are set after the concrete had been placed, all necessary drilling and grouting or caulking shall be done and care shall be taken not to damage the structure or finish by cracking, chipping, spilling, or otherwise during the drilling and caulking. Minimum distance between the center of any expansion anchor and an edge or exterior corner of concrete shall be not less the 4-1/2 times the diameter of the hole in which it is installed.
- G Where galvanizing is damaged by field welding or other erection process, an approved 95 % zinc dust primer shall be applied to the properly prepared damaged areas.
- H Welding
1. Ferrous Metal Welding. Permissible weld stress for all structural fillet welding provided under these specifications shall be as tabulated in AWS D1.1 except as specified herein. The allowable shear stress on the effective throat of a fillet weld shall not exceed 124 MPa for ASTM A36, ASTM A441, and ASTM A588 steels. "Effective throat" shall be the shortest distance from the root to the face of the diagrammatic weld regardless of weld size.
 - a. Except as otherwise specified, welding shall be performed using only those joint details which have a prequalified status when performed in accordance with the AWS code and the AISC specification.
 - b. Welds that are not dimensioned on the construction drawings shall be sized to develop the full strength of the least strength component involved in the connection.

End of Section

DIVISION 6
WOODS AND PLASTICS

BUILDING WORK

DIVISION 6

WOODS AND PLASTICS

INDEX

SECTION 06100 : Rough Carpentry
SECTION 06200 : Finish Carpentry

SECTION 06100**ROUGH CARPENTRY****PART 1: GENERAL****1.01 SCOPE OF WORK**

- A Furnish all labor, materials, equipment, and incidentals necessary to install all items of carpentry work not specified as part of other sections and which is generally not exposed, except as otherwise indicated complete as shown and as specified herein.
- B Set in place, all pressed metal frames which are to be built into masonry. Install all other pressed metal and aluminum doorframes as specified in Division 8. Install doors, louvers and finish hardware furnished under other Sections.

1.02 RELATED WORK

- A Other Sections directly related to work covered in this section include the following:
 - 1. Section 03300 - Concrete
 - 2. Section 05500 - Miscellaneous Metals
 - 3. Section 08120 - Aluminum Doors and Frames.

PART 2: PRODUCTS**2.01 MATERIALS**

- A All lumber shall be sound stock, delivered dry, and shall be fully protected at all times from injury and dampness. Split, broken, or otherwise damaged pieces will not be allowed in the work.
- B Wood for blocking, shims, framing and nailers shall be Construction Grade. Wood members that will contact masonry or concrete shall be pressure treated with chromated copper arsenate or fluorochrome arsenate phenol. Minimum net retention of solid preservative shall be 4.6 kg per m³ (0.40 lb per cu ft).
- C All treatment shall be performed in accordance with the requirements of the Standard Specifications of the American Wood Preservers Association for treating wood. Apply a heavy coat of the same preservative used in treating to all surfaces cut after treatment.
- D Nails, spikes, bolts, nuts and washers where sizes are not indicated or specified, shall be of suitable size and number to securely fasten and hold members in place and to develop the structural strength of the members. Hot dip galvanize after fabrication, except bolts and nuts shall be mechanically galvanized to provide for ease of installation.

PART 3: EXECUTION

3.01 INSTALLATION

- A All carpentry shall be accurately cut, fitted, and installed as detailed on the Drawings.
- B Anchors shall be installed, where indicated or required, to anchor carpentry or other items securely to masonry or concrete.
- C Forms for structural concrete work shall be as specified under Division 3. Provide all other miscellaneous wood formwork as may be required for the completion of the work.
- D Temporary wood doors and cloth or transparent plastic covered frames shall be provided for exterior wall openings when and as required for sun, sand and dust control.
- E Installation of Doors, Windows, Louvers, and Finish Hardware

End of Section

SECTION 06200
FINISH CARPENTRY

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install finish carpentry work which is exposed to view, is non-structural, and which is not specified as part of other sections.

1.02 RELATED WORK

- A. Section 06100-Rough Carpentry.
- B. Section 08211-Wood Doors and Frames.
- C. Section 08610-Wood Windows and Screens.
- D. Section 09902-Painting.

1.03 REFERENCES

- A. ANSI A135.4-Basic Hardboard.
- B. ANSI A208.1-Mat Formed Wood Particleboard.
- C. ASTM E84-Test Method for Surface Burning Characteristics of Building Materials.
- D. AWI-Quality Standards.
- E. AWP (American Wood Preservers Association) C2-Lumber, Timbers, Bridge Ties and Mine Ties-Preservative Treatment by Pressure Processes.
- F. AWP (American Wood Preservers Association) C20-Structural Lumber Fire Retardant Treatment by Pressure Process.
- G. BHMA A156.9-Cabinet Hardware.
- H. FS MMM-A-130-Adhesive, Contact.
- I. HPM (Hardwood Plywood Manufacturer's Association) HP-American Standard for Hardwood and Decorative Plywood.
- J. NEMA (National Electric Manufacturers Association) LD3-High Pressure Decorative Laminates.

- K. NHLA (National Hardwood Lumber Association).
- L. NWWDA (National Wood Window and Door Association) I.S.4–Water Repellant Preservative Treatment for Millwork.
- M. PS 1-Construction and Industrial Plywood.
- N. PS 20-American Softwood Lumber Standard.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, and fixing, to a minimum scale of (1:10).
- B. Wood Treatment Data: Submit chemical treatment manufacturer's instructions for handling, storage, installation, and finish of treated material.
- C. Provide instructions for attachment hardware and finish hardware.
- D. Samples: Submit two samples of finish plywood, (200 x150 mm) in size illustrating wood grain and specified finish.
- E. Submit two samples of wood trim (300 mm) long.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect finish carpentry materials during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Do not deliver finish carpentry materials until painting, wet work; grinding and similar operations which could damage, soil or deteriorate woodwork have been completed in installation areas. If, due to unforeseen circumstances, finish carpentry materials must be stored in other than installation areas, store only in areas meeting requirements specified for installation areas.
- C. Protect work from moisture damage.

1.06 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

1.07 COORDINATION

- A. Coordinate the work with plumbing and electrical rough-in, installation of associated and adjacent components.

PART 2: PRODUCTS**2.01 LUMBER MATERIALS**

- A. Softwood Lumber: Comply with PS 20; and with applicable grading rules of the respective grading and inspecting agency for the species and product indicated, maximum moisture content of (8) percent.
- B. Hardwood Lumber: Graded in accordance with AWI Premium; maximum moisture content of (8) percent; with vertical grain, of quality suitable for transparent finish.

2.03 SHEET MATERIALS

- A. Softwood Plywood: Comply with PS 1 Grade C-D; Graded in accordance with AWI Custom; lumber core.
- B. Hardwood Plywood: Graded in accordance with AWI Premium; lumber core, type of glue recommended for application.
- C. Wood Particleboard: Comply with AWI standard, composed of wood chips, medium density, made with high waterproof resin binders; of grade to suit application; sanded faces.
- D. Hardboard: Pressed wood fiber with resin binder, standard grade, smooth two sides.

2.04 PLASTIC LAMINATE MATERIALS

- A. Plastic Laminate: Comply with AWI, colour and surface texture as selected.
- B. Laminate Backing Sheet: Comply with NEMA LD-3 BK20 backing grade, undecorated plastic laminate.

2.05 ADHESIVE

- A. Adhesive: Type recommended by AWI to suit application.

2.06 FASTENERS

- A. Fasteners and anchorages: Provide nails, screws and other anchoring devices of the type, size, material and finish required for application indicated to provide secure attachment, concealed where possible, and complying with applicable specifications.
 - 1. Where finish carpentry is exposed on exterior or in areas of high relative humidity, provide fasteners and anchorages with a hot-dipped zinc coating (ASTM A 153).
- B. Concealed Joint Fasteners: Threaded steel.

2.07 ACCESSORIES

- A. Lumber for Shimming, and Blocking: Softwood lumber.
- B. Plastic Edge Trim: Extruded flat shaped; smooth finish; self-locking serrated tongue; of width to match component thickness; colour as selected.
- C. Float Glass: Clear, top quality; (6 mm) thick minimum.
- D. Primer: Alkyd primer sealer type.
- E. Wood Filler: Solvent or Oil base as suitable, tinted to match surface finish colour.

2.08 WOOD TREATMENT PROCESSES

- A. Preservative treatment: following basic fabrication, provide 3 minute dip treatment of finish carpentry items indicated to receive preservative treatment in 5 percent solution of pentachlorophenol, with vehicle which will not interfere with finish application and will produce minimum effect upon appearance. Apply brush coat on surfaces cut after treatment.

2.09 FABRICATION

- A. Fabricate to AWI Premium.
- B. Shop assemble work for delivery to site, permitting passage through building openings.
- C. Fit exposed sheet material edges with (9.5 mm) matching hardwood edging. Use one piece for full length only.
- D. Cap exposed plastic laminate finish edges with plastic trim.
- E. Shop prepare and identify components for book match grain matching during site erection.
- F. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.
- G. Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners.
- H. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.

2.10 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. On items to receive transparent finishes, use wood filler which matches surrounding surfaces and of types recommended for applied finishes.
- D. Finish work in accordance with AWI-Section 1500 applicable System.
- E. Seal and varnish semi-exposed to view surfaces. Brush apply only.
- F. Seal surfaces in contact with cementitious materials.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Install work in accordance with AWI Premium Quality Standard.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of (1 mm). Do not use additional overlay trim to conceal larger gaps.
- D. Install hardware in accordance with manufacturer's instructions.

3.03 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush applies two coats of preservative treatment on wood in contact with cementitious materials.
- C. Allow preservative to dry prior to erecting members.

3.04 SCHEDULE

- A Refer to the Drawings and B. O.Q.

End of Section