	FABRICATION, INSTALLATION OF NEW PONTOON AND REPAIR AND MAINTENANCE OF EXISTING PONTOON FOR RORO/ROPAX FACILITY AT GHOGHA- GUJARAT. SPECIFICATION FOR MODIFICATION OF STEEL LINKSPAN AND PONTOON STEEL WORKS	PAGE: 1/ 73
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FABRICATION, INSTALLATION OF NEW PONTOON AND REPAIR AND MAINTENANCE OF EXISTING PONTOON FOR RORO/ROPAX FACILITY AT GHOGHA- GUJARAT.

(DPA/RORO/2024, Dated:25/07/2024)

PART 3 – TECHNICAL DOCUMENTS





TENDER DOCUMENT

FOR

**FABRICATION, INSTALLATION OF NEW
PONTOON AND REPAIR AND
MAINTENANCE OF EXISTING PONTOON
FOR RORO/ROPAX FACILITY AT
GHOGHA- GUJARAT.**

VOLUME III

**SPECIFICATION FOR MODIFICATION OF STEEL
LINKSPAN AND PONTOON STEEL WORKS**



DEENDAYAL PORT AUTHORITY

ADMINISTRATIVE OFFICE BUILDING

POST BOX NO. 50

GANDHIDHAM (KUTCH)


GUJARAT – 370201



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1. SPECIFICATION FOR STEEL FABRICATION AND ERECTION

1.1. Scope

This specification covers the requirements for furnishing of all materials, labour, equipment and services for supply and delivery of all structural and miscellaneous steel for the project. General requirements and procedures for the Contractor's supply and control of materials are covered in this specification.

1.2. Codes and Standards


The design and construction of steel structures shall be in accordance with the following Codes and Standards referenced herein. Fabrication of steel structure, except as modified herein, shall be in accordance with latest edition of the following codes and standards:

IS 800	General Construction in steel – Code of practice Hot
IS 814	Specification for Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
IS1363 Part 1	Hexagon head bolts, screws, and nuts of product grade `c' - part 1: hexagon head bolts
IS1363 Part 2	Hexagon head bolts, screws and nuts of product grade `c' - part 2: hexagon head screws
IS1363 Part 3	Hexagon head bolts, screws and nuts of product grade c - part 3: hexagon nuts
IS1477	Code of practice for painting of ferrous metals in buildings - part 1: pretreatment
IS 2062	Hot rolled low, medium, and high tensile structural steel
AISC	Structural Steel for Buildings of the American Institute of Steel Construction.
AWS D1.1	Structural Welding Code of the American Welding Society.
IS 816: 1969	Code of Practice for use of metal arc welding for general construction in mild steel.
IS 822: 1970	Code of Practice for inspection of welds.
IS 1024: 1999	Code of Practice for use of welding in bridges and structures subject to dynamic loading.
IS 1182: 1983	Recommended practice for radiographic examination of fusion welded joints in steel plates.
IS 1363: Pt1 2002, Pt 2	Specification for hexagon head bolts, screws and nuts of product grade C. 2002, Pt 3 1992
IS 1367: 2002	Technical supply of threaded steel fasteners.
IS 2062: 1999	Steel for general structural purposes - specification.
IS 3757: 1985	Specification for high strength structural bolts.
IS 4260: 2004	Ultrasonic testing of butt welds in ferritic steel.



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IS 5334: 2003	Code of practice for magnetic particle flaw detection of welds. IS 6623: 2004 High strength structural nuts.
IS 7215: 1975	Tolerances for fabrication of steel structures.
IS 7307 (Part 1): 1974	Approval testing of welding procedures.
IS 7310 (Part 1): 1974	Approval tests for welders working to approved welding procedures.
IS 8500: 1991	Structural steel - micro alloyed (medium and high strength qualities).
IS 9595: 1996	Recommendations for metal arc welding of carbon and carbon manganese steels.
ASTM A36:2005	Specification for Structural Steel
ASTM A435: 1990	Specification for straight-beam ultrasonic examination of steel plates for pressure vessels
ASTM E709: 2001	Guide for magnetic particle examination
ISO 10474: 1991	Steel and steel products - Inspection documents
ISO 10474: 1991	Steel and steel products - Inspection documents

In the event of conflict, inconsistency or ambiguity between material requisition, data sheets, drawings, this Specification, Standards and Codes referenced herein, or other documents, the Contractor shall refer to the Engineer's Representative, whose decision shall prevail. In principle the requirements of the most stringent document shall apply.

1.3. Working Drawings


The design of the subject structures with descriptions, sizes, sections and relative locations of various structural members is shown on the Construction Drawings.

The shop drawings to be prepared by the Contractor to facilitate the fabrication and assembly of the structures shall provide full and complete information and instructions including typical shop details and procedures needed for that purpose. Review of shop drawings by the Engineer's Representative or its representative does not relieve the Contractor of his responsibility to complete the work in accordance with the contract and specifications.

The Contractor shall provide drawings and calculations of temporary works, inclusive of support points, jacking points, sling points, etc.

The Contractor shall provide the Engineer's Representative with "as built" drawings upon the completion of fabrication. These drawings shall be the latest revision of the Contract Drawings modified to show the structural members as fabricated, including such items



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as additional weld splices, windows, material substitutions, etc. Electronic copies shall also be provided to the Engineer's Representative.

Substitution and modifications shall not be allowed without prior approval by the Engineer's Representative. The Contractor shall detail the extent of substitutions and modifications, provide the effect on schedule, and cost and submit proof of equivalency of material.

The modifications/alterations required due to small dimensional mismatch from engineering drawings is to be carried out by the Contractor under his Scope of Work.

Contractor shall notify the Engineer's Representative in writing, at time of submission, the deviations from requirements of Contract Documents stating the reason for these deviations.

1.4. Submittals

Submit mill certificates, weld procedures, fabrication procedures and Inspection and Test Plans to the Engineer's Representative in accordance with the Contract requirements.

All materials shall be properly marked and traceable in accordance with this Specification.


Shop drawings conforming to the format used for the Contract Drawings shall be submitted.

Ensure the accuracy and quality of shop drawings are verified by the Contractor's Engineer's Representative before the drawings are submitted to the Engineer's Representative for his review.

Submit, in accordance with the Contract Schedule and in accordance with the Contract requirements, shop drawings to the Engineer's Representative for their review. One print shall be returned by the Engineer's Representative, stamped to indicate that the drawings have been reviewed and comments added where applicable. If the shop drawings are illegible, obscure or incomplete, they may be returned by the Engineer's Representative marked "not reviewed", and such shop drawings are to be properly redrawn and resubmitted.

The Contractor shall make changes in shop drawings, which the Engineer's Representative may require consistent with the Contract Documents and resubmit. When the Engineer's Representative's review is complete and requested changes made, the Contractor shall provide copies of shop drawings incorporating requested changes in accordance with the Contract requirements for the use of and distribution by the Engineer's Representative. Ensure work and units supplied conform to the final shop drawings.



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The Engineer's Representative's review of shop drawings is for general concept only, and in no way relieves or mitigates the Contractor's obligation for drawing accuracy, suitability or materials and to produce works that are complete, accurate and fit for their intended purpose. Any errors in dimensions, sizes, welds, connections, fasteners and details shown on the shop drawings are the responsibility of the Contractor.

The Contractor shall allow a three-week period for the Engineer's Representative's review. Any work that proceeds before the shop drawings have been accepted for fabrication by the Engineer's Representative is at the risk of the Contractor.

The Contractor shall submit to the Engineer's Representative as-built documents in the quantity and format as required by the Contract. As-built documents shall be submitted to the Engineer's Representative within 14 days after completion of fabrication.

The Contractor shall submit a proposed fabrication, delivery and erection schedule for all steelwork items. The Contractor shall submit a progress report at the end of every week identifying the progress of shop drawings, material ordered and expected delivery date, material received, material fabricated, material painted, material shipped, and material erected.


1.5. Materials

1.5.1. Structural Steel

All steelwork comprising of rolled shapes, plates and pipes shall comply with IS 800, IS 808, IS 2062 and relevant international standards such as British codes, ASTM, API and Euro Norms, unless specified otherwise. The material for the steel structures shall be selected from the table below together with the material requirement specified in the GFC drawings. Any substitution shall not be allowed unless it is approved by the Engineer.


No	Application	Specification	Minimum Yield Strength (MPa)
1	Plates and Shapes for Floating Pontoon secondary structures – handrails support, coming, pile liners and miscellaneous applications.	IS 2062 E250 Quality A	250
2	Plates and Shapes for Floating Pontoon <ul style="list-style-type: none"> Plates [bottom, Side shell, Deck and Bulkhead], Primary Girders/Web Frames, all Secondary members & brackets for all primary & secondary members 	ASTM-A131-DH36 Or Equivalent Indian Grade Steel (IS 2062 E350 Quality C)	350



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No	Application	Specification	Minimum Yield Strength (MPa)
	<ul style="list-style-type: none"> manhole cover, hatch covers, crash barrier, stiffening under equipment. Pile Guide SHS 500X500 section <p>Plates & Shapes for Linkspan Bridge</p> <ul style="list-style-type: none"> Roadway Plate in Linkspan bridge, Transition Flap structural plates Longitudinal & Transverse Girders in Linkspan Bridge, Stiffener plates in Transition flap structure, brackets, Hinge plates & wing plates in flap structure Main Hinge plates, stiffener plates, side plates, vertical & Horizontal plates, closing plates at Sliding & Hinge support of Bridge structure 		
3	Plates for rolled tubulars for linkspan bridge top and bottom chords (other than at joints) and guide pin piles. Ø 508X16mm, Ø 508X25mm, Ø 610X20 mm Diameter larger than 406mm (Rolled as per API Spec. 2B)	ASTM-A131-DH36 Or Equivalent Indian Grade Steel (IS 2062 E350 Quality C) (Rolled as per API Spec. 2B)	350
4	Plates and plates for rolled tubulars for through thickness application (Z”) above 19mm thickness involving primary items at critical areas like tubular joint in linkspan bridge, framed steel structure, installation pad eyes, lifting eyes and cheek plates and other applications requiring through thickness load transfer.	API 2H Grade 50Z with through thickness property (Z35) and Low Sulphur content (Rolled as per API Spec. 2B)	345
5	Solid Pin for Linkspan bearing supports at both ends.	42CrMo4 Steel pin	600
6	Anchors bolts for all base plates.	IS5624 & IS 1367 Part 3 – Class 8.8	640
7	Structural bolts for steel connections.	IS3757 & IS	640



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No	Application	Specification	Minimum Yield Strength (MPa)
		1367 Part 3 – Class 8.8	
8	Steel Grating	ASTM A36	250
9	Handrail pipes	IS 1161 Yst 250	250
10	Sacrificial Anodes	GALVALUM III or equivalent	-


Notes

- All material shall be new stock and shall be free from deformations.
- All steel shall be manufactured by processes which ensure a product which is substantially free of segregation.
- All fabricated structural pipe shall conform to API Specification 2B, "Specification for Fabricated Structural Steel Pipe", except as modified by this General Specification.
- Spirally welded pipe shall not be used. ERW pipe may be allowed provided that it is supplied from an API certified manufacturer.
- All fabricated structural pipe less than 762mm O.D. shall conform to API Specification 5L, "Specification for Line Pipe", except as modified by this General Specification.
- Contractor shall furnish three (3) certified original mill certificates for all pipe, structural shapes, and plate for integration into the Trace of Material Notebook. Mill certificates shall include chemical analysis, and mechanical and non-destructive examinations and shall be identified by heat number, plate number, mill certificate number, page number, purchase order number, and mill identification.
- All testing of material shall be witnessed by an Engineer/Engineer's Representative who shall also countersign the mill certificate and shall be approved by the classification society surveyor.
- Grating and stair treads shall be steel, 32mm X 5mm serrated bar grating with bearing bars at 30mm on centres and cross bars at 50mm on centre except as modified on Fabrication Drawings. All gratings shall be serrated and galvanized.

1.5.2. Special Requirements

Fabrication, welding, cutting bending of plates to be as per BS5400 Part 6 and relevant classification society (IRS/ABS/BV/DNV etc.) rules. Contractor has to bear the cost of classification society surveyor visits including transportation and day charges based on the number of visits during inspection and approval. Where provisions of BS: 5400-6 differ from Classification Society rules, the Classification Society rules shall be adopted.



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Structural steel shall comply with the applicable national steel standards listed in section 2.0. and the supplementary requirements given in this section. All steel shall be new and unused. All steel shall be manufactured by basic oxygen or electric arc furnace processes. All steel shall be fully killed and made to fine grain practice.

Unless further restricted by the applicable national material standard, the maximum permitted carbon equivalent (C.E.) shall be 0.43.

$$CE = C + (Mn/6) + (Cr+Mo+V)/5 + (Ni+Cu)/15$$

Steel greater than 10mm thick shall be Charpy-V impact tested at a maximum temp of 0°C, at a minimum frequency of one test set per cast and heat treatment batch.

Plate material shall be examined by ultrasonic examination in accordance with ASTM A435 as follows: -

For plate thickness of 12.5mm and above, 5% of plates from each heat produced shall be examined. Should any plates not comply with the acceptance criteria of ASTM A435 then a further 5% of plates from the same heat shall be examined. Should any of these plates then be found defective then all other plates from that heat shall be examined.

For plate used to fabricate lifting points (padeyes, padears), 100% of plates from each heat shall be examined by ultrasonic examination.


Where structural members are identified during structural analysis as being subject to high through thickness stress the use of material with guaranteed through thickness properties (Z-Quality) (Z35) is required.

Z-Quality Plate shall comply with the following:

All plate to be subject to 100% ultrasonic examination in accordance with ASTM A435 or BS 5996.

1. Maximum permitted sulphur content to be 0.005% (Ladle).
2. The through-thickness tensile strength shall be not less than 80% of the minimum specified tensile strength.
3. The minimum short transverse reduction of area shall be 35% average, and 25% individual reading when measured in accordance with the testing and sampling requirements of BS EN 10164.



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CONTRACTOR shall fully define materials requirements in his steel MR including any items listed in the applicable national steel standard that are subject to purchaser / supplier agreement.

CONTRACTOR shall also specify material certification level and inspection requirements to the steel supplier. Minimum Certification level for primary structural members shall be ISO 10474 3.1B.

All structural steel shall be fully identified against the relevant material certificate. Material identification marking shall be transferred during cutting such that full traceability is achieved.

All bolting materials shall be hot dip galvanized in accordance with IS 1367 (Part 13) or equivalent.

1.5.3. Fasteners

All bolts, screws, nuts and other fasteners shall be of adequate cross-sectional area to safely withstand the envisaged or specified working forces. Unless otherwise specified all fasteners shall be at least of carbon steel according to IS 1363 and shall be hot dip galvanized. All anchor bolts shall be furnished with at least two nuts to facilitate installation.

1.5.4. Welding Electrodes


Steel welding electrodes shall comply with the requirements of IS 814, except that they shall be uniformly and heavily coated (not washed) and shall be of such a nature that the coating will not chip or peel during its use with the maximum amperage as specified by the manufacturer.

1.5.5. Plant Inspection

The Contractor shall provide the Engineer's Representative with full access to inspect materials and fabrication. The Engineer's Representative may undertake the inspection of materials at the source. Manufacturing plants may be inspected periodically for compliance with specified manufacturing methods, and materials samples shall be obtained for laboratory testing for compliance with materials quality requirements. This may be the basis for acceptance of manufactured lots as to quality. In the event plant inspection is undertaken, the following conditions shall be met:

- The Engineer's Representative shall have the cooperation and assistance of the Contractor and the producer with whom he has contracted for materials.
- The Engineer's Representative shall have full entry at all times to such parts of the



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plant as may concern the manufacture or production of the materials being furnished.


- The inspection agency shall be advised of the production and/or fabrication schedule a minimum of 48 hours prior to beginning work on any item requiring inspection. All materials for which the Engineer's Representative has requested plant inspection and which are fabricated without such inspection shall be considered unacceptable. Any testing required proving acceptability of such materials shall be performed at the Contractor's expense.
- The type and extent of inspection shall be at the discretion of the Engineer's Representative's representatives: every item, procedure and connection associated with the work shall be subject to non-destructive inspection by the Engineer's Representative's representatives.
- Methods of non-destructive control shall include but not be limited to visual, dimensional, radiographic, ultrasonic and magnetic particle inspections.
- The Engineer's Representative may call for a coupon to be cut out for destructive testing.
- During the progress of the work, the Engineer's Representative may order in writing to the Contractor:
 - The removal from the Contractor's or Subcontractor's yard of any improper materials and equipment which are not appropriate for the work and their replacement.
 - The repair or proper re-execution, notwithstanding any previous test, of any works which in respect of materials or workmanship, is not in accordance with the contract.
- Acceptability of materials and fabrication shall be as stated in each corresponding specification and in the contract drawings. All material and work found not in conformity with these documents shall be rejected or repaired at the Contractor's sole expense to the satisfaction of the Engineer's Representative.
- The Engineer's Representative shall be the sole judges for the acceptability and their decisions shall be final.

The Engineer's Representative reserves the right to retest all materials which have been tested at the source of supply, prior to incorporation into the Work, and to reject all materials which, when retested, do not meet the requirements of the specifications.

1.5.6. Manufacturer's Certification

The Engineer's Representative may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's certificates of compliance stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or



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assemblies delivered to the Work shall be accompanied by a certificate of compliance in which the lot is clearly identified.

Materials or assemblies used on the basis of certificates of compliance shall be sampled and tested at any time and if found not to be in conformity with contract requirements shall be subject to rejection whether in place or not.

All steel for the steel work and fasteners shall be supplied with test certificates. The contractor shall submit these certificates to the Engineer's Representative prior to the supply of the materials. Materials obtained from stocks may be checked by the Engineer's Representative for exterior defects either in the workshop or at the site.

Test requirements for the materials to be ordered are specified in IS 2062 and shall include V notch impact tests at 0° C from each quantity of 20 tonnes or part thereof. The results of these tests shall be included in the test certificates.

1.5.7. Storage of Materials

Materials shall be so stored as to assure the preservation of their quality and fitness for the Work. Stored materials, even though approved before storage, shall again be inspected prior to their use in the Work. Stored materials shall be located so as to facilitate their prompt inspection.

Storage locations shall be approved by the Engineer's Representative.

Private property shall not be used for storage purposes without written permission of the owner or lessee. Evidence of permission shall be furnished to the Engineer's Representative upon his request.


All material shall be properly stored on wood timbers or pallets and shall be protected from standing water, corrosive products, blast cleaning, painting and dropped object.

Damaged materials or materials with defects shall not be used in the fabrication. Replacement or reparation of this material shall be decided by the Inspector.

1.5.8. Handling Materials

All materials shall be handled in such a manner as to preserve their quality and fitness for the Work. Material shall be transported to the work area in vehicles so constructed as to prevent damage or loss of material.



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All materials shall be handled with suitable and approved handling devices and methods, which do not induce excessive deformation or stresses.

1.5.9. Unacceptable Materials

All materials not conforming to the Plans and Specifications at the time they are used shall be considered unacceptable and all such materials shall be rejected and shall be removed immediately from the site of the Work unless otherwise instructed by the Engineer's Representative. No rejected material, with defects corrected, shall be used until approval has been given by the Engineer's Representative.

1.5.10. Materials Traceability and Tracking System

The Contractor shall be responsible for maintaining the tracking system for all materials, including primary and secondary steelwork, from receipt of materials to final assembly within the structure. The material's tracking system shall include material utilization forms. The Contractor shall submit procedure to the Engineer's Representative for approval.


1.5.11. Marking of Steel

All structural steel shall be fully identified against the relevant mill test certificate. The cutting of plates, pipes and beams, and transferring of unique identification numbers and other marks shall be carried out such that a particular grade of steel, including scrap, can be identified against its materials certificate. The specified identification shall be maintained at all times. The Contractor shall transfer markings when cutting steel, using round nosed dies only. The Contractor shall submit procedure to the Engineer's Representative for approval.

If any material is found without the appropriate reference or material certification, it shall not be used in any part of the fabrication until it can be identified to the satisfaction of the Engineer's Representative. For unidentified material found in the fabrication, the Contractor shall be responsible for proving the identity of the material to the satisfaction of the Engineer's Representative at no extra cost to the Engineer's Representative. The Contractor shall establish and maintain a quarantine area and an appropriate marking system, for material found defective, damaged or certification. This material shall not be used without the prior authorization of the Engineer's Representative.

The Contractor shall take care to preserve the plate rolling direction in marking plates.



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Different grades of steel, including cut segments or shapes, plate and remnants shall be marked. The steel types shall be stored in well-defined locations to avoid inadvertent mixing.

1.5.12. Member Identification

Before starting the works, the Contractor shall establish a numbering system to identify each member or element of the structure. This identification numbering system shall be used as an aid for indexing radiographs, repairs, etc. Identification system shall be furnished to the Engineer's Representative and the Inspector before the start of the job. This numbering shall be used on all shop drawings.

1.5.13. Marking

It is the Contractor's responsibility that all materials supplied are adequately marked for identification against delivered test certificates. When materials are stored, the identification marking shall be easily accessible. Material that cannot be identified by proper marking shall be rejected.

Each rolled plate and shape shall be mechanically marked with the following information:

- Material heat or batch number.
- Steel type and supply condition (see below)
- Producer's trademark.
- Section number (if relevant).

Supply condition shall be indicated by marking after the Steel Type designation.


All such markings shall be carried out by die stamping in a frame of white paint. The letters used for the stamping shall be at least 8 mm in height and performed with a round nose tool.

Die stamping shall include the certifying Engineer's Representative stamp for all primary and special categories steel.

Paint marking shall be as follows:

- A 300mm-by-300mm rectangle with the following data stencilled in 50mm high white letters shall be printed on each item of the material:
 - Project Reference
 - Purchase Order number and designation
 - Item size (thickness, width, length, section identification diameter and wall thickness, etc...)
 - Type of steel and grade
 - Heat number from which it was produced.
 - Destination



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- Gross and Net Weights
- Package Number
- Mark principal rolling direction for plates (arrow)

1.5.14. Inspection by the Engineer's Representative

The Engineer's Representative shall inspect the material, fabrication, assembly, coating, loading and transport of all items and shall have free access at all times to any part of the Contractor's or Subcontractor's mill or yard that concerns his work.

The Engineer's Representative shall have the right to inspect at all times any tools, materials, procedures and equipment used or to be used in the fabrication, assembly, coating and loading of the structures.

The Contractor shall furnish, install and maintain in a safe operating condition the necessary scaffolding, ladders, walkways, adequate lighting, etc., for a safe and thorough inspection by the Engineer's Representative's representative.

The Contractor shall assist the Engineer's Representative in the execution of inspections and tests by providing personnel, inspection and test equipment as required.

1.5.15. Inspection by the Contractor


The Contractor shall give or provide all necessary superintendence and constant inspection during the completion and maintenance of the works.

The Contractor shall provide and have continuously available equipment required for inspection of the works or parts of the works. This equipment (including X-Ray or radiographic equipment) shall be suitable for examining, measuring and testing any work and quality of specification. All inspection equipment shall be calibrated whenever necessary, be in good condition and properly maintained. The equipment shall be used and maintained exclusively by personnel qualified to an approved standard. All inspection personnel shall be subject to the approval of the Engineer's Representative.

1.6. Execution

This section defines the Engineer's Representative's minimum requirements regarding preparation of structural members and materials, and final tolerance in the fabrication of steel structures.



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The Contractor shall design and prepare proper procedures and submit them for the approval of the Engineer's Representative and provide all equipment necessary for the fabrication of the structures.

Items specified to be offshore installed shall be fabricated so that offshore work will be minimal.

Prior to start the work in the Contractor's or Subcontractor's mills or yards, the Contractor shall submit for Engineer's Representative's approval sufficiently detailed documents pertaining to the proposed procedures and sequences they plan to use in the fabrication, assembling and joining of the various parts of the structures. Parts to be prefabricated shall be clearly indicated.

The Contractor shall do the fabrication and erection of structural steel in accordance with IS 800 and IS 2062.

1.7. Fabrication and Erection

1.7.1. General


The Contractor shall fix the steelwork complete and shall provide and erect all temporary stages necessary for the carrying out of the work in such manner as not to interfere with traffic or roads etc. and provide all cranes, plant and labour required for the same. Before any work is begun by the Contractor on the site, he shall submit to the Engineer for his approval the procedures he proposes for the erection of the steelwork together with drawings of all temporary works required. Such approval by the Engineer shall not relieve the Contractor of his obligations under the Contract.

The Contractor shall fix the steelwork and erect and maintain all temporary works in such a manner as to ensure complete safety at all times for all members of the workforce and any other persons in the vicinity of the works.

Steelwork shall be fabricated and erected in accordance with IS 800 or equivalent approved by the Engineer and with this Specification. The method of construction welding sequences, etc. shall be arranged to give minimum distortion. No holes or notches shall be made in the steelwork other than those shown on the drawings without approval of the Engineer. Similar approval must be obtained prior to the enlargement of any hole.

The butting end of members shall be faced in a milling or ending machine after the members have been completely fabricated so as to butt in close contact over the entire surface.



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1.7.2. Shop Drawings

The GFC drawings provided to contractor by employer is design drawings. It is to be noted that these drawings shall not be directly used for fabrication. The Contractor shall prepare shop drawings and provide two (2) copies of all shop drawings prior to commencing fabrication. Engineer shall review the shop drawings, mark in red any necessary corrections, sign the shop drawings as having been reviewed and return one (1) copy to the Contractor. This review by Engineer shall not relieve Contractor of his responsibilities and obligations to fabricate all items in accordance with the Contract Documents. It is intended to determine if Contractor has correctly interpreted the Work and to identify possible errors or omissions in a timely, efficient, and economic manner.

Shop drawings shall include, but not be limited to weld joint details showing joint preparation and welding symbols, all fabrication dimensions, and qualified welding procedures. In addition to these requirements, the shop drawings shall indicate a numbering system to identify each weld. This weld numbering system shall be used for all non-destructive testing and identification purposes.


Contractor shall provide three (3) sets of as-built drawings after the completion of fabrication and installation at site indicating any changes to design drawings received from Employer marked in RED colour and obtain approval for the same.

1.7.3. Welded Connections

All structural welding and welding procedures shall be in accordance with approved drawings and this specification. Following points shall be noted.

- All structural welding between beams web to web, flange to flange or flange to web, plated connections shall be full penetration butt weld unless otherwise noted.
- The welds between plates can be single bevel or double bevel depending on the thickness. Usually, for plates less than 20mm, single bevel butt weld can be permitted. For plates thicker than 20mm, double bevel butt weld is required.
- All tubular connections forming a junction between pipes of two different or equal diameters shall be welded from outside using single bevel full penetration weld using approved weld procedure depending on the thickness.
- Bevels shall be prepared in accordance with the details shown in GFC drawings and codes and standards for the type of welding adopted. The deviations shall be strictly in accordance with IS 816, IS 822 / AWS D1.1 whichever is applicable.
- Tubular connections for the walkway structure, tower monitor structure and other connections shall be carefully fitted with a root gap not exceeding 3mm. The edge



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preparation shall be carried out by automatic or manual profiling machines, but manual cutting is not permitted.

1.7.4. Bolted Connections

Bolted connections wherever employed shall be used with appropriate considerations, tolerances and fabrication sequence.

- a) All holes shall be drilled or punched in the structure prior to sandblasting and painting. Bolt holes shall be punched or drilled at right angles to the metal surface and shall be finish-reamed to a diameter of 1.5mm larger than the specified bolt diameter. Any drilling or punching that is required but not clearly specified or shown on the Fabrication Drawings shall be completed only after approval of Engineer.
- b) Use of a drift pin in bolt holes during assembly shall not distort the metal or enlarge the hole. Holes that must be enlarged to admit the bolts in connections using high strength bolts shall be reamed. For all bolted connections, poor matching of holes shall be cause for rejection.
- c) Bolts shall be driven accurately into the holes without damaging the threads. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Unfinished bolts transmitting shear shall be threaded to such a length that no more than one (1) thread shall be within the grip of the structural members. The bolts shall be of a length that shall extend entirely through, but no more than 7mm beyond the nuts.
- d) Bolt heads and nuts shall be drawn tight against the work with a suitable wrench. Bolt heads shall be tapped with a hammer while the nut is being tightened. After having been finally tightened the nuts shall be locked by a locking procedure approved by Engineer. High strength bolts shall be tightened to a bolt tension not less than the "Minimum Bolt (Pre-Tension)" value specified in Bolt specification or IS standards and shall not be less than 70% of its axial strength.
- e) When bolt heads or nuts bear upon bevelled surfaces they shall be provided with square tapered washers to afford a seating for the nut square with the axis of the bolt.
- f) All dissimilar metals which induce electrolytic action are to be isolated with suitable nylon washers/plates. These metals include stainless steel and zinc coated mild steel (e.g., galvanized, sherardised and zinc sprayed items) which need to be isolated from un-treated mild steel.
- g) All nuts and bolts specified on the Drawings shall be to the required size with correct threaded length and be supplied with matching nuts and washers also of the same material, except where electrolytic action is to be avoided.
- h) Where small parts such as bolts and nuts etc. are to be sherardised, they shall be treated to receive a coating of finished thickness not less than 30 microns.



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- i) Where bolts, nuts and washers etc. are to be hot dip galvanised, they shall be treated to receive a finished thickness of zinc coating of not less than 80 microns thickness.

1.7.5. Structural Pipe Splices

1.7.5.1. General

- a) Segments of pipe of the same diameter may be spliced. Minimum distance between splices shall be 1.20 meters or one (1) pipe diameter, whichever is greater. There shall be no more than two (2) splices in any 3.05 meters interval of pipe. Splices shall be in accordance with API Specification 2B.
- b) Splices shall be made to produce members whose straightness equals that of the uncut pipe. The alignment of abutting pipe ends shall minimize offset between pipe surfaces.
- c) When two (2) sections of pipe to be joined are of different wall thicknesses, there shall be a smooth transition. The slope of this transition shall not exceed one in three (1:3) along the length of the pipe. This may be accomplished by sloping the weld surface, by chamfering the thicker cylinder, or by a combination thereof.
- d) Where wall thickness changes within a bracing member, the outer diameter (O.D.) shall remain constant unless explicitly shown otherwise in the Fabrication Drawings.


1.7.5.2. Welds

- a) Splices in 762 mm diameter and larger pipe members shall be full penetration double-V-groove butt joints. Ends of members shall be bevelled to give a minimum included angle of sixty (60) degrees on each side. Root openings for manual welding shall be not less than 1.5mm inch nor greater than 5mm.
- b) Splices in sections of pipe less than 762 mm in diameter shall be full penetration, single-V-groove butt joints, welded from one (1) side only. Ends of member shall be bevelled to give a minimum included angle of sixty (60) degrees. Root openings for manual welding shall not be less than 1.5mm nor greater than 3mm.
- c) Maximum weld reinforcement at splices shall be 2.5mm for members having a thickness of 13mm or less; 3mm for thicknesses of over 13mm, but not greater than 26mm; and 5mm for thicknesses greater than 26mm.

1.7.5.3. Location of Splice or Weld Seam

- a) Longitudinal weld seams of adjoining sections shall be staggered a minimum of ninety (90) degrees apart.
- b) The orientation of jacket leg or skirt pile sleeve node cans shall be such that the longitudinal seam does not intersect with jacket bracing at the joint. Permitted



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locations for circumferential weld seams on jacket leg or skirt pile sleeve node cans shall be approved by Engineer. In the case of joints other than at jacket leg or skirt pile sleeve node cans, effort shall be spent to ensure that an intersecting brace weld line does not intersect a circumferential seam of the through brace member. Where this requirement cannot be met, the circumferential seam shall be within a zone as agreed upon by Engineer.

- c) No circumferential brace pipe splice shall be located closer than two times (2X) the outside diameter of the brace pipe from a jacket leg or skirt pile sleeve joint can.
- d) Where one brace pipe intersects another, no circumferential splice on the intersecting brace shall be located closer than two times (2X) the outside diameter of the intersecting brace from the joint.
- e) With the exception of brace pipe X-joints, effort shall be made to ensure that the orientation of the longitudinal seam on the through brace member shall be such that it does not intersect with the intersecting brace pipe. Where this requirement cannot be met, the longitudinal seam on the through brace shall be located as agreed upon by Engineer.
- f) With the exception of brace pipe X-joints, the orientation of the longitudinal seam on the intersecting brace member shall not fall in line with the toe or heel of the connection or within fifteen (15) degrees from these positions in each direction.
- g) In the case of brace pipe X-joints, the orientation of the longitudinal seam on the through brace member shall be at the centre line of either of the incoming braces.

1.7.6. Beam Splices

Segments of beams with the same cross sections may be spliced. The use of the beam shall determine the locations and frequency of splicing. In cantilever beams, there shall be no splice located closer to the point of support than one-half of the cantilevered length. For beams employed in any span between supports, there shall be no splice in the middle one-fourth of any span nor in the one-eighth of the span nearest any support nor over any support. Splices shall not be located closer together than twice the depth of the beam or 1.0 m whichever is smaller.


1.8. Welding

1.8.1. General

Welding electrodes shall be in accordance with IS 814/ IS 815/ IS 816. Only electrodes of the grade compatible with the characteristics of the parent metal shall be used.

At all stages of fabrication and treatment the steelwork shall be subject to inspection by the Engineer or his appointed representative. Any work not to the satisfaction of the Engineer



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shall be immediately rectified at the Contractor's expense.

Approval given to steelwork at an earlier stage of fabrication or supply shall not preclude rejection of any steelwork either before, during, or after erection.

1.8.2. Weld Sizes and Specifications

All welds shall be of size, length, and type as shown on the GFC Drawings or specified herein. Where no designation is given, all structural welds shall be continuous, full penetration groove welds. Joint details showing other than full penetration groove welds can be submitted to Engineer for review and approval. All welds shall be sized to develop the full strength of the smaller of the two (2) members being joined.

1.8.3. Welding Equipment

All welding equipment shall be in good condition and subject to inspection by Engineer. All voltage, amperage, and/or wire feed speed gauges on SAW machines shall be fully operable and properly calibrated. Any equipment found in need of repairs shall not be used for production welding until repairs have been made and the machine has been approved for use by Engineer.

1.8.4. Electrodes


Electrodes for SAW shall conform to IS 816 and subjected to following conditions.

- All electrodes shall be subject to inspection by Engineer and electrodes which show signs of deterioration or damage shall be rejected.
- The maximum size of electrodes shall be 4mm for stringer or starting beads and 5mm for passes following starting beads in multi-pass welds.
- Jet rods shall not be used for any field welding and shall only be permitted in yard welding upon prior approval by Engineer.
- Heating and storage temperatures shall be as per the electrode manufacturer's recommendations. Only one (1) package of electrodes of each size shall be removed from the store at a time by each welder. No open package of electrodes shall be left exposed to the atmosphere. Electrodes left as mentioned shall not be used and shall be rejected by Engineer. Fabrication Contractor's electrode handling procedure must be submitted to Engineer for approval.

1.8.5. Workmanship

It shall be of the highest quality in relation to the class of work. Care shall be taken in all



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preparation of the work, the selection of the finest materials and in the employment of fully qualified and tested operators.

All welds shall be designed to seal the joints between sections completely unless specified otherwise by the Engineer.

Welding operations shall be completed before any final machining or other fitting work is carried out.

All main butt welds shall have complete penetration, shall be made between prepared fusion faces and when possible, shall be welded from both sides.

The ends of the welds shall have full throat thickness obtained by the use of extension pieces secured on each side of the main plates. Additional metal remaining after removal of the extension pieces shall be removed by machining or other approved means and ends and surfaces of the welds smoothly finished.

In the fabrication of built-up assemblies all butt welds in each component part shall be completed before final assembly. Where butt welds are to be ground flush there shall be no loss of parent metal.

All fillet welds shall be continuous and where sealing runs are adopted, they shall have the appropriate corrosion allowance. All welds shall be smooth in preparation for painting.

Peening of welds resulting in deformation of the weld surface shall only be carried out with express permission of the Engineer but all spatters shall be cleaned off and all slag removed on completion of the weld and before examination by the Engineer.


Before welding commences the Contractor must ensure there is no paint within 75mm of the surface to be welded except in so far as wash primers for blast cleaned steel declared by their manufacturers to be suitable for welding may be permitted.

After fabrication, all fins caused by welding shall be removed and the weld shall be smoothly finished all round.

1.8.6. Submerged Arc Welding (SAW) Process

All welding (including tack welding) shall be accomplished using low hydrogen process. Automatic submerged arc (SAW) or manual shielded metal arc (SMAW) welding processes shall be used wherever practical.



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Arc welding shall be carried out in conformity with IS 816 / 4353 / AWS D1.1 and all other relevant IS Standards. The welding procedure shall conform to the recommendations of the electrode manufacturer.

All electrodes shall be stored in a warm dry place and shall not be kept loose in the welding bay unless required for immediate use. Electrodes which have areas of the flux covering broken away or damaged shall be discarded.

1.8.7. Welder and Welding Operator Qualification

Initial Qualification

It is the intent that only qualified welders and welding operators shall be used in the fabrication of structural steel work. Engineer intends to test each welder and welding operator who has not been:

- engaged in a given process of welding for which he is qualified for a period exceeding six (6) months, and
- qualified by Engineer within the past one (1) year.

Contractor shall bear all expense of each initial qualification.

Requalification

Welders and welding operators are subject to requalification during fabrication at the discretion of Engineer where their work appears to be below the requirements of this General Specification. If subject welder fails the requalification test, Contractor shall be responsible for all costs for the test. If welder passes the requalification test, Engineer shall be responsible for welder time, radiographic, ultrasonic, and laboratory testing costs for the test.


Disqualification

Welders and welding operators who have been disqualified by Engineer for defective work may be retested at Contractor's request if they have received additional training and documentation of the additional training is acceptable to Engineer. Expenses for this qualification test shall be borne by Contractor whether the welder passes or fails.

Qualification Tests

For welding qualification tests, each welder and welding operator shall be assigned an identifying number or symbol that they shall use to identify all welding performed by them. Contractor shall ensure that numbering systems and/or symbols are not duplicated between the material supplier, Contractor, and various Subcontractors. A welder or welding operator may not change this symbol, with which he is qualified, after qualification or during the Work.



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Records of the test results for qualification of welders and welding operators shall be established and certified by Engineer. Records shall be kept by Contractor and shall be available to those authorized to examine them. A list of welders and welding operators qualified shall be established and furnished to Engineer before start of fabrication. The records shall be maintained and updated by Contractor as required and furnished to Engineer throughout the term of the Contract.

- a) All qualification tests shall be in accordance with the IS 816 / AWS D1.1. Welding operators shall be qualified in the appropriate position for the work to be performed.
- b) Engineer shall specify the material to be used for qualification tests. The tests shall be witnessed and approved by Engineer / Welding Inspector before the welder or welding operator is permitted to work on the structure. The decision of Engineer / Welding Inspector regarding the qualifications of any welder or welding operator shall be final.
- c) The Contractor shall provide all equipment and material for the qualification tests and shall bear all costs for cutting, machining, and testing the test specimens.
- d) Welders and welding operators not passing the tests are disqualified from working on the job.

1.8.8. Welding Procedure Qualification


General

Prior to beginning production welding, Contractor shall establish detailed procedures for welding the various parts of the structure as per the connection details of the Contract Drawings, and in accordance with the applicable requirements of IS 816 / AWS D1.1, and as specified hereafter. All proposed welding procedures shall be submitted to Engineer for preliminary approval prior to carrying out the qualification tests. No qualification test shall be carried out until approval from Engineer has been received.

Procedure Qualification Testing

- a) General requirements for welding procedure qualifications shall be specified in IS 816, IS 822 /AWS D1.1 unless otherwise indicated herein.
- b) Welding procedure qualification tests shall be at the sole expense of Contractor.
- c) Procedures shall be tested and certified by an approved testing laboratory, agency, or equivalent. Engineer shall witness all welding and testing.
- d) Procedure testing shall be valid in the range of diameters and thicknesses as given in GFC drawings.



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- e) Welding procedures which conform in all respects to the provisions of this Specification, and the GFC Drawings, and any other welding proposed by the Contractor for application in the fabrication of structures shall be subject to the mechanical tests described below prior to use in production welding.
- f) Each completed welding procedure to be used shall be compiled by Contractor in a Procedure Specification Manual; three (3) copies of which shall be submitted to Engineer for approval four (4) weeks prior to start of fabrication. The minimum acceptable written procedure specification shall detail information on the following parameters:
 - Scope of Work performed under each procedure,
 - Base metals, applicable specifications, and relevant characteristics,
 - Welding process and equipment,
 - Type, size, classification, and composition of electrodes or filler metals (specify wire/flux combinations for submerged arc welding),
 - Type of current characteristics (pulse type, etc.) and current range,
 - Heat input and welding speed where applicable,
 - Joint preparation and cleaning procedures,
 - Preheat and inter pass temperatures and control,
 - Weld type and sizes,
 - Root preparation prior to welding from second side where applicable,
 - Sketch of joint showing pass sequences employed to control warpage, distortion, and excessive accumulations of residual stresses and range of thicknesses covered,
 - Removal methods of weld defects,
 - Repair welding procedures,
 - All other pertinent details.

Previously Certified Procedures


Where procedures exist for similar materials and thicknesses, which have been previously certified, retesting may be waived only at the discretion of Engineer.

Method of Test

Provision must be made for procedure trials and testing to be carried out in accordance with IS 816 and IS 822 / AWS D1.1.

Trials shall include specimen weld details from the actual construction which shall be welded in a manner simulating the most unfavourable situation which will occur. Where priming coats are to be applied to the work before fabrication they shall similarly be applied to the samples before trials are made. After completion, the welds shall be held at approximately 16°C for not less than 72 hours and shall then be sectioned and examined for



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cracking.

Procedures shall be adopted to enable welds to be traced to the welder by whom they were made.

Method of testing specimens shall be in accordance with the following requirements:

- a) Visual Inspection - as per applicable sections of IS 816 / AWS D1.1,
- b) Reduced Section Tension Tests, Root, Face, and Side Bend Test and Macrotech Tests shall be performed in accordance with IS 816 /AWS D1.1.
- c) Charpy V-notch Tests shall be performed in accordance with ASTM A370 and ASTM E23.
- d) Radiographic or Ultrasonic Inspection (chosen by Engineer when required) - as per IS 816, IS 822 / AWS D1.1.

1.8.9. Joint Preparation and Welding

General

Surface to be welded shall be free from loose scale, slag, rust, hydrocarbons (oil, grease, etc.), paint, and any other foreign material, except that mill scale which withstands vigorous wire brushing may remain.

If painted before erection, the paint on surfaces adjacent to joints to be welded shall be thoroughly removed to expose clean steel for a distance of at least 51mm on either side of the joint.

Joint Preparation


a) Edge Preparation

Preparation of edges by gas cutting shall, whenever practicable, be done with a mechanically guided torch. Edges shall be ground to bright metal and cleaned of all slag. The edge preparation shall meet the requirements of IS 816, IS 822/AWS D1.1.

b) Bevel Preparation

- All bevels shall be ground to bright metal before welding.
- Where practical all pipe bevels shall be made by bevelling machine.
- Any bevelled edge that has been damaged shall be restored to minimum tolerances.
- Contractor shall visually and ultrasonically inspect all edges prepared for welding. The limits of acceptability and the repair of edge defects shall be in accordance with IS 816, IS 822/AWS D1.1.



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c) Joint Details

Joint details shall be in accordance with GFC drawings/IS816, IS 822/AWS D1.1, and shall be subject to approval by Engineer. Approval may be obtained by Contractor by submitting to Engineer, details of joints, showing welding symbols, along with the weld procedures for approval. Drawings of complete joint details shall be provided by Contractor for Engineer's use.

d) Joint Alignment and Gaps

- The parts to be joined by fillet welds shall be brought into as close contact as practical. The gap between parts shall not exceed 5mm. If the gap is larger than 1.5mm the leg of the weld shall be increased by the amount of the gap.
- The separation between faying surfaces of lap joints shall not exceed 1.5mm. The use of fillers is not allowed.
- The parts to be joined by butt welds shall be carefully aligned. Dimensions of the cross section of groove welded joints as shown on the GFC Drawings shall be within the tolerances specified in IS 816/AWS D1.1.
- No welding shall be commenced until the structural members have been properly aligned. The structural members shall be aligned and held in position during welding by bolts, clamps, wedges, tack welds, or other suitable means.

e) Backing Rings


Unless specifically approved by Engineer in writing, backing rings shall not be used unless they are completely removed to sound metal and the back side of the weld is rewelded. Ceramic backup tape is permitted, provided, Engineer approved welding procedure using the specific tape type is used.

Splices

- All splices shall be prepared for continuous full penetration welds with V-butt joints, single or double, depending on the size/thickness of the member.
- Welded joints of axially aligned structural members of different material size, thicknesses, diameters, or widths, shall be made in such a manner that the slope through the transition zone does not exceed 26mm thickness change in 76mm (1:3) along length of pipe. The transition shall be accomplished by chamfering the thicker part, tapering the wider part, sloping the weld metal, or by any combination of these.
- The mismatch of mating surfaces of the joint preparation root face on tapered member splices shall not exceed 1.5mm.

Connections between Structural Tubulars and Shape Sections



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- a) When one (1) or more structural rolled shape sections are connected to a tubular member which is the continuous member, the rolled shapes shall be appropriately coped and positioned to allow welding all around the edges.
- b) Preparation of the ends of shapes shall be made in such a manner that the flanges shall be full penetration butt welded to the tubular and the webs shall be fillet welded to the tubular member.

Tubular Joints

- a) All tubular joints shall be prepared for full penetration welds.
- b) Tubular members shall be carefully contoured to obtain accurate alignment and the bevel shall be formed so as to provide a continuous transition from maximum to minimum bevel angle around the circumference. Bevels shall be feather edged. Root faces shall not be permitted. Root openings shall be not less than 1.5mm and not more than 5mm.

Inspection of Joints before Welding

- a) For major structural joints, no welding shall commence until Engineer Representative has had the opportunity to inspect the fit up of the joint. The Contractor shall be responsible for informing Engineer forty-eight (48) hours in advance of the fit up in order to schedule an inspection of these joints.
- b) Engineer's Representative shall notify the Contractor of his intent to inspect certain joints prior to the scheduled weld time.

Welding Sequence


The sequence in assembling, joining, and welding the various parts of the structure shall be carefully designed and scheduled to minimize distortion, warpage, and accumulations of residual joint stresses in each part of the structure. Special care shall be taken to minimize through thickness residual stresses. Suitable heat treatments shall be provided for and performed successively after each weld when distortion, warpage and residual joint stresses cannot be avoided. Contractor shall provide and exert all necessary supervision to ensure that the planned sequences are observed.

All structural welding shall conform to approved welding procedures. The Contractor shall post copies of the procedures in a conspicuous location in each fabrication area and provide adequate supervision to ensure strict adherence to Engineer approved procedures.

Repairing of Defects

- a) All costs connected with repairs and retests are at Contractor's sole expense.
- a) Defects, except cracks, in weld deposits may be repaired without prior authorization by Engineer. Removal of defects for repair must be carried out in accordance with the approved welding procedure and must produce a clean,



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uncontaminated surface for installation of the repair of weld. Oxygen-acetylene gouging shall not be acceptable. All air arc gouges shall be power disc ground to remove residual carbon.

- b) All corrective work consisting of removal of defects and deposition of repair welds, shall be in accordance with the approved welding procedure and requirements of ANSI/AWS D1.1. A second repair of the same area shall not be allowed without prior approval of Engineer. A third repair of the same area will not be allowed. Should the second repair attempt fail to remove the indicated defect, then the entire weldment will be removed from the structure and the joint shall be prefabricated in accordance with the Contract Specifications.
- c) Details of the weld repair procedure, e. g. preheat, post heat, type of electrode, etc. must be documented for Engineer's future reference.
- d) All repaired welds shall be inspected as per original Inspection and Acceptance criteria.

1.8.10. Weld Inspection and Testing

General

No defects in welds or fabrication, including fit up shall be permitted which, in the opinion of Engineer's Representative, is detrimental to the strength of the weld. If for any reason Engineer believes that a defect exists in any weld, the Contractor, at the direction of Engineer's Representative, shall cut and test each weld. If the weld proves defective, it shall be repaired and retested to the satisfaction of Engineer at the Contractor's expense. If the weld tests are satisfactory, Engineer shall pay the Contractor for cutting and testing the weld and repairing the structure.

All welds, including structural pipe fabricated from plates, may be subject to radiographic, ultrasonic, magnetic particle, and/or liquid penetrant examination in accordance requirements given in this section. The extent of weld inspection and testing shall be in accordance with Inspection and Testing Requirements specified in this specification. If any weld proves to be defective, it shall be repaired or replaced by and at the expense of the Contractor. Examination of the repaired or replaced weld shall be performed at the expense of the Contractor.

Non-destructive testing shall be performed in accordance with IS 816, IS 822/AWS D1.1.


Inspection Requirement

The Contractor shall carry out weld examination to the following minimum levels:

- I. All welds to be visually inspected.



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- II. 50% of all fillet welds to be tested using dye penetrant or magnetic particle testing.
- III. 20% of all butt welds to be tested using Radiographic or Ultra-Sonic methods.
- Welding shall be carried out only on dry surfaces, according I.S. 822 and welds shall be inspected according to I.S. 822.

Acceptance Criteria

Section of welds that are shown by radiographic or ultra-sonic methods to have any of the following imperfections shall be judged unacceptable:

- Any crack, incomplete fusion, or incomplete penetration.
- Any individual elongated inclusion having a length greater than two thirds of the thickness of the thinner plate of the joint except that regardless of the plate thickness any inclusion longer than 20mm. No such inclusion shorter than 6mm shall be the cause of rejection.
- Any group of inclusions in line where the sum of the longest dimensions of all such imperfections is greater than T (where T is the thickness of the thinner plate joined) in a length of 6T except where each of the individual spaces between imperfection is greater than three times the length of the longer of the adjacent imperfections. When the length of the radiograph is less than 6T the permissible sum of the length of all inclusions shall be proportionally less than T providing the limits of the deficient welding are clearly defined.

Ultrasonic Testing


Testing of welds shall be undertaken by an independent accredited testing authority selected by the Contractor to the approval of the Engineer. The Contractor shall be responsible for all costs of such testing. All welds shall be tested.

The Contractor shall inspect each welded joint for edge fusion and the possibility of cracking. Testing of welds shall be by ultrasonic examination and shall be carried out by the Contractor in accordance with standards to the approval of the Engineer. The Engineer shall have the opportunity to witness any or all of the tests. The Contractor shall give adequate prior notice before the commencement of any tests. All ultrasonic operators shall be fully qualified, and each weld shall be examined with sufficient probe angles to guarantee full coverage of the joint.

The Contractor shall produce a test report for each weld joint or weld repair examined, comprising:

- a sketch of all flaws
- the location and size of each flaw



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- dB level used.
- conclusions as to acceptance or rejection of the flaw with reference to these Engineer's Requirements

he Contractor shall make an initial assessment of defects against acceptance criteria. All ultrasonic reports including recommendations shall be reviewed by the Engineer. Acceptance criteria shall be in accordance with IS 4260 or another approved standard. The standard on which the slag indication acceptability is to be finally determined is to be agreed and confirmed prior to any ultrasonic testing. When positive flaw type interpretations cannot be ascertained in any instance the flaw shall be considered planar and in need of repair.

1.9. Painting

1.9.1. Painting Generally

All preparation, priming and painting, in colours selected by the Engineer, shall be deemed to be included in the Contract price.

Painting shall generally be in accordance with ISO 12944 and IS 14428:1997.

All items of equipment shall be suitably protected and packed to resist corrosion and impact damage. Machined surfaces treated with a proprietary sealing agent for transportation and storage.

Paint materials shall be in accordance with the appropriate Indian Standard and shall be obtained from approved manufacturers and applied in accordance with the manufacturers' instructions or as ordered by the Engineer. All materials shall be delivered to the Site in sealed and labelled containers.


The paint for each coat shall be from the same manufacturer, compatible with the underlying coat and shall be a different colour for ease of identification.

Particular regard shall be paid to the maintenance of the recommended temperature and humidity during application and curing. Painted steelwork shall not be over coated or handled until the recommended curing period has elapsed. No finished paint coating will be accepted until the specified dry film thickness has been achieved to the entire surface including edges.

All steel surfaces shall be completely dry and free from oil and grease and all welds ground smooth and weld spatter removed. All fins at saw cuts, burrs and sharp edges shall be removed, and the edges shall be rounded off.

Where steelwork is to be blast cleaned, an approved method shall be used in accordance



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with BS 7079 so as to achieve Swedish Standard SA 2.5. The average blast profile is to be 75 microns; below 25 microns or above 100 microns is not acceptable. After blasting, all spent shot or grit shall be removed by vacuum cleaning or by air line and brush.

An approved primer to a minimum dry film thickness of 75 microns in one coat shall be applied after blast cleaning before visible deterioration has occurred as compared with a freshly blast cleaned area. The primer proposed must be compatible with all other paints used and full details must be submitted to the Engineer for approval. If this preparation is done before fabrication a blast primer shall be applied within four hours of the preparation. The Contractor shall put his proposals for such a primer to the Engineer for prior approval. If shot blasting is carried out after fabrication the application of a blast primer may be omitted but the first coat of paint shall be applied within four hours of shot blasting.

For all painted items, the Contractor shall submit for approval a 'Paint System Sheet' stating full details of each paint system proposed indicating the following information.

- surface preparation
- system reference together with manufacturer's brand name and product reference
- dry film thickness
- colour
- time to repaint.


1.9.2. Coating system

Steel shall be protected from corrosion in accordance with EN ISO 12944. Durability shall be high (H). The environment category shall be C5M and Im2, i.e. the selected protection system shall provide high durability for both environment categories. The Contractor shall furnish the details of the painting / coating system he proposes to adopt to the Engineer for his prior approval.

The painting / coating system proposed for all steel surfaces shall be as follows:

System parameters	System 1	System 2
Environmental class	C5M as per ISO 12944	Im2 as per ISO 12944
Surface preparation	SA 2.5	SA 2.5
Design life	10 years	10 years
Primer	1 coat of Zinc Rich Primer, 75 microns	2 coats of Epoxy primer, 75 microns each
Coating	3 coats of High Build Epoxy 150 microns each	4 coats of Ultra High Build Glass Flake Epoxy 150 microns each
Total thickness	525 microns	750 microns
Finishing color	Orange	Black
Application	Linkspan Bridge (external surfaces)	Fender frame (external surfaces) Pontoon (internal and external surfaces)



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		Linkspan support structure (external surface)
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1.9.3. Application of Painting

Steelwork will be primed and painted under shop conditions before delivery to site unless the Engineer approves an alternative approach.

All joints shall receive the full specified preparatory and painting treatment. All primed areas shall receive sweep blasting before the application of any further coats of paint.

The Contractor shall take all precautions to keep areas of painting clean and dry and to maintain the recommended temperature and humidity. Care shall be taken during loading, unloading, stacking and erection of any painted steelwork to minimise damage to the protection system. All slings, ropes and chains used to handle the steelwork shall be protected with rubber sheaths or similar. The Contractor shall make good to the approval of the Engineer all paint work damaged during fabrication, transport, assembly and erection.

Where a paint system is required, but not specified, the Contractor shall submit to the Engineer for his approval details of a paint system which will meet the requirements of BS 5493: 1977 Table 3 Part 9 minimum 15 years to first maintenance. In proposing a paint system for approval, the Contractor shall take into account the system's resistance to mechanical damage and abrasion as well as the exposure conditions. A minimum total dry film thickness of 450 microns shall be applied. All paints used are to be solvent free. Full technical details of any paint system proposed shall be submitted to the Engineer for approval.


1.9.4. Standard

The pretreatment, workmanship and equipment for painting shall generally comply with the requirements of IS 1477 (Parts I & II) "Pretreatment and Painting" except in so far this specification modified it.

1.9.5. Pre-Treatment

After inspection and approval and before leaving the fabrication shop, the surfaces of all steel work to be painted shall be prepared. Traces of oil and grease shall be removed with solvent and cleaning rags and scales and rust removed by hand tools. Hand tool cleaning consists of chipping and scrapping followed by vigorous wire brushing and emery paper cleaning. The rust and scales shall be removed by the use of electric or pneumatic tools such as sanding



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machine, scalers, etc. No painting shall commence until the prepared surface has been approved by the Engineer.

1.9.6. Painting Schedule


Immediately after the surface has been prepared, the steel work shall be given one coat of Bison Metal conditioning solution manufactured by Berger Paints or Rust converter developed by Central Electro-Chemical Research Institute, Karaikudi or approved equivalent. The first coat of primer paint shall be applied within 24 hours of the application of the conditioning solution. The primer paint shall consist of one coat of Linosol High Build Zinc Phosphate Primer manufactured by Berger Paints or approved equivalent. The dry film thickness of the primer shall be at least 50 Microns. Thereafter the steel work shall be given one coat of Linosol High Build Micaceous Iron Oxide Paint manufactured by Berger Paints or approved equivalent with dry film thickness of not less than 50 microns. The colour and the shade of the paints shall be as approved by the Engineer. All priming and finishing paints shall, preferably, be obtained from the same manufacturer. The contractor shall guarantee that the paints for priming and finishing coats are compatible with each other, in addition to their satisfying the specified requirements. The first and second coats of finishing paint shall have different tints to distinguish one from the other.

1.9.7. Painting at Shop

All painting shall be carried out by brushing spray and roller application of paint shall not be allowed without the written permission of the Engineer. Painting shall be done immediately after surface preparation. The prepared surface shall not be allowed to stand in rain or overnight before painting. Where galvanized surfaces are to be painted, they shall be cleaned and washed with a solution of Copper Sulphate before the application of the first coat of primer. Each coat of paint shall be allowed to dry thoroughly before the subsequent coat is applied. The drying time shall be in accordance with the manufacturer's specifications. The first primer coat shall follow immediately thereafter. Unless otherwise approved by the Engineer, finishing painting shall not commence before four days or after thirty days from the application of the second primer coat in the shop. Before the application of the second coat of the primer, all steel work shall be cleaned with emery paper and all damaged areas shall be carefully cleaned and repainted.

1.9.8. Painting after Erection



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After erection, the whole of the steel work shall be thoroughly cleaned of all dirt, marks, grease and overspills of primer paint. Areas where the coat has either been damaged or has deteriorated shall be cut back and repainted with primer in the same manner in the fabrication shop. All exposed surfaces of metal, bolt heads and connections left unpainted in the shop shall be similarly treated. After preliminary work of making good has been approved by the Engineer, all surfaces shall be thoroughly washed down with fresh water and when dried, the finishing coat shall be applied. The finishing coat shall consist of one coat of Linosol Chlorinated Rubber Paint manufacturer by Berger Paints or approved equivalent.

1.10. Galvanization of Steel

All steel work on jetty head and as mentioned in the tender drawings should be galvanised. All hot dip galvanising shall be in accordance with I.S. 2629 / ASTM A153.

Before galvanising, all components shall be grit blasted to give a clean roughened surface as a pre-treatment.

The minimum nominal thickness of coating shall be **120 microns** and shall conform to IS: 4759: 1996- Hot dip zinc coatings on structural steel and other allied products.

Samples of galvanised steelwork shall be tested at the galvaniser's works prior to despatch to ensure compliance with the coating requirements.

1.11. Quality Control


The Contractor shall be responsible for Quality Control (QC) inspection and testing services carried out by CSA or applicable certified testing agencies. Engineer's Representative shall carry out Quality Assurance (QA) reviews and testing where necessary.

The Engineer's Representative reserves the right to audit and verify the Contractor's QC procedures and services.

Procurement documents shall ensure the Engineer's Representative's right of access. Contractor's documents, instructions, procedures, drawings, specifications, ITP's and test records shall be made available to Engineer's Representative for review.

The Contractor shall establish and provide the Engineer's Representative with schedules for inspections, surveillance, witness points, hold points, tests and final inspections for release of fabricated materials.



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Maintain identification procedures for all materials including those that are partly assembled in accordance with Supply and Control of Materials Section.

The Contractor shall identify all processes and provide Engineer's Representative with copies of all applicable records that require procedure and personnel qualifications.

The Contractor's inspection plan shall define inspections, tests and hold points from start to completion of fabrication at which conformance shall be verified. Hold points for those inspections that are rendered inaccessible shall be verified before the start of the next operation.

The QC Work includes but is not necessarily limited to:

- Paint testing
- Weld testing.
- Dimension controls

The Contractor shall appoint and pay for services of independent testing agencies, approved by Engineer's Representative for the following:

- Paint testing, Weld testing and Dimension controls
- Inspection and testing required by laws, ordinances, rules and regulations or orders of public authorities.
- Inspection and testing performed exclusively for the Contractor's convenience.
- Mill tests and certificates of compliance.


No separate payment shall be made for testing. Payment shall be considered incidental to the Work and shall be included under other appropriate items.

Where tests or inspections reveal Work not in accordance with Contract requirements, the Contractor shall pay costs for additional tests or inspections as the Engineer's Representative shall require verifying acceptability of corrected Work.

The Contractor's Responsibilities shall be to furnish labour and facilities to:

- Provide access to Work to be inspected and tested.
- Provide details of all quality plans and testing programs to the Engineer's Representative for approval
- Carry out all QC inspections and tests.
- Provide an experienced QC supervisor to supervise and administer the QC program.
- Contractor's records shall identify inspector, test type, procedure, test equipment, traceability certificate, acceptance criteria, results, signature and date.



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Where materials are specified to be tested, deliver representative samples in required quantity to testing agency's laboratory.

Pay costs for uncovering and making good Work that is covered before required inspection or testing is completed and approved by the Engineer's Representative.

Copies of all test results with both electronic and paper submissions shall be issued to the Engineer's Representative to witness sampling and testing and additional Q/A testing if required.

The Engineer's Representative shall be responsible for Quality Assurance, including review and approval of the Contractor's Q/C plans, witnessing the Contractor's Q/C sampling and testing, reviewing the Contractor's Q/C test results and arranging for additional independent Q/A testing were considered necessary.



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2. SPECIFICATION FOR FLOATING PONTOON

2.1. Scope

The scope includes the following to fabrication / assemble of a pontoon fit for service as depicted in the construction drawings and to obtain IRS approval for inland waterway rules for floating pontoon.

- Cutting, bending assembly of plates, shapes, pipes and assembly as per construction drawings.
- Welding as per the design requirements specified in the construction drawings.
- All welding shall be continuous full penetration but welds unless specified otherwise and spot welds and discontinuous welds are not permitted,
- All compartments shall be watertight and considered for ballasting.
- Fully fabricated pontoon fitted with anodes and other ancillary equipment such as piping for ballasting, ballast pumps, anodes and fenders shall be launched in the slipway and towed to the site of installation as per IRS guidelines and IRS surveyor requirements.

2.2. Material

Structural steel shall comply with the requirements in Clause 1.5.

2.3. Fabrication tolerances

2.3.1. Rolled and built-up sections

Unless otherwise agreed by the Engineer, all components of rolled and built-up sections (other than those with curved flanges with a radius of curvature less than 25 times the spacing of cross frames) shall be fabricated within the tolerances given in Table 8.


2.3.2. Flatness of a machined bearing surface

Where a machined bearing surface is specified by the Engineer, it shall be machined within a deviation of 0.25 mm for surfaces that can be inscribed within a square of side of 0.5 m.

2.3.3. Alignment at splices and butt joints

Any unintended deviation from planarity due only to a misalignment of parts to be joined shall not exceed the lesser of 0.15 times the thickness of the thinner part or 3 mm. However, if, due either to different thicknesses arising from rolling tolerances or a combination of rolling tolerances with the above permitted misalignment, this deviation exceeds 3 mm, it shall be smoothed by a slope not steeper than 1 in 4.



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2.3.4. Welding, fabrication, and erection

Welding, fabrication and erection shall be in accordance with Clause 1.7 and 1.8.

2.4. Inspection

2.4.1. Extent of Inspection

100 % of all welds shall be visually inspected.

Magnetic particle inspection

The extent of magnetic particle inspection shall be at least as follows:

- a) 5 % of the length of each continuous weld.
- b) 1 in 20 welds along intermittently welded longitudinal stiffener to plate joints when there are 3 or more stiffeners within the width of a fabricated panel between longitudinal plate splices.
- c) 1 in 10 welds along all other intermittently welded joints.
- d) a length of 25 mm at the end of any longitudinal attachment including terminations at cope holes.
- e) 100 % of all transverse joints where either:
 - 1) a minimum class requirement is shown on the drawings; or
 - 2) the joint consists of a fillet welded attachment of length greater than 150 mm in the longitudinal direction.
- f) areas from which temporary attachments have been removed.

NOTE Drawn arc welded studs need not be subjected to magnetic particle inspection.

Ultrasonic inspection


The extent of ultrasonic inspection shall be at least as follows:

- a) 100 % of all transverse in line butt joints. This shall be reduced to 5 % of the length of each joint provided that there is no minimum class requirement shown on the drawings and the drawings specify that the design stresses in the joint at serviceability limit states:
 - 1) are always compressive; or
 - 2) are tensile but do not exceed 75 N/mm².
- b) 100 % of all transverse, tee, corner or cruciform joints made with butt welds or fillet welds of leg length 12 mm, or greater and minimum required Class E or F.

NOTE 1 This may be reduced to 5 % of the length where no minimum class requirement is shown on the drawings.

- c) 10 % of each 10 m length or part thereof of all in line longitudinal butt joints or 5 % of each 10 m length of fillet welds with leg lengths of 12 mm and greater.



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Where specified by the Engineer, ultrasonic testing of support diaphragms or bearing stiffeners adjacent to welds, plates in box girder construction adjacent to corner welds, flange plates adjacent to web/flange welds, material at cruciform welds or other details shall be carried out after fabrication.

NOTE 2 Radiography may be used in cases of dispute to clarify the nature, sizes or extent of multiple internal flaws detected ultrasonically.

Table 5 — Examination levels to be used in the ultrasonic inspection of welds

Joint type	Examination level requirements with reference to BS 3923-1			
	Minimum class requirement			
	Class D	Class E	Class F	Not specified
Transverse in line butt joints	Special treatment	Examination level 2A (See note 1)	Examination level 2B (See note 1)	
Transverse tee, cruciform and corner joints	Not applicable		Examination level 3 (See note 2)	
Full penetration longitudinal butt joints	Examination level 3			
Longitudinal tee, cruciform and corner joints	Examination level 3			
NOTE 1 Scans for discontinuities transverse to the weld axis are not required.				
NOTE 2 The primary purpose of these scans is the detection of lamellar tearing and toe cracking.				

2.4.2. Acceptance criteria

Visual and magnetic particle inspection

The fillet weld profile shall be such that the minimum leg length shown on the drawings, and the corresponding throat dimension are maintained. Undercut is not permitted:


- within 25 mm of weld terminations, external corners, and member edges or ends; or
- on transverse welds where a minimum class requirement is shown on the drawings. In transverse welds where no minimum class requirement is shown on the drawings the depths of undercut, shrinkage grooves, and root concavity shall not exceed 0.5 mm. On longitudinal welds it shall not exceed 1 mm regardless of minimum class requirement.

Nowhere shall the average net section thickness of material over any length of 100 mm be less than 95 % of the nominal material thickness.

Butt weld reinforcement height shall not exceed 3 mm and weld overlap shall not be permitted. Excess penetration beads exceeding 1.5 mm in height shall not be permitted on single sided transverse butt welds and shall not exceed 3 mm on longitudinal butt welds.

NOTE 1 In all cases the bead should blend smoothly with the parent material. Surface breaking cracks and other discontinuities shall not be permitted except for the following.



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- 1) Surface breaking porosity up to 2 mm diameter in longitudinal welds and in transverse welds where there is no specific class requirement except:
 - i) within 6 mm of a longitudinal weld termination; or
 - ii) or within 3 mm of a transverse weld toe; or
 - iii) anywhere in a transverse weld with a specific class requirement when the size shall be limited to 1 mm diameter.

In no case shall the cumulative length of surface breaking porosity in any 100 mm exceed: 20 mm for longitudinal welds; 10 mm for transverse welds.

- 2) Specified unpenetrated regions at the weld root inherent in fillet and partial penetration butt welded tee, cruciform and corner joints.

Repair by grinding shall not reduce the average net section thickness of the material over any length of 100 mm to less than 95 % of the nominal material thickness. The direction of final grinding marks shall be parallel to the direction of stress fluctuation shown on the drawings. Where the latter is not shown it shall be taken as parallel to the long axis of the member. At transverse weld toes burr machining shall be used.

Ultrasonic inspection

Discontinuities identified as cracks, other than lamellar tearing permitted below, shall be rejected. Where porosity or slag lines are such as to impede reliable detection or evaluation of other discontinuities the joint shall be rejected. Embedded discontinuities shall comply with the requirements of Table 6.

In the case of cruciform, tee and corner joint the maximum permitted lengths l and $_{l}$ may be doubled in the case of lamellar tears or laminations within the zone indicated in Figure 3.

Minimum class requirement (see note 1)	Permissible limits (mm)			
	(for definitions of dimensions see Notation)			
	Σl max.	h max.	l max. (see notes 2, 3 and 4)	
			$H < 6$	$H \geq 6$
E	$10t$	3	5	10
F	$10t$	3	10	20
Not specified	$10t$	3	10	$10t$

Notation (see also Figure 2)

l is the length of a single discontinuity;

Σl is the sum of l over any length of 600 mm or the weld length whichever is the lesser;

h is the height of a single discontinuity measured in the thickness direction;

t is the thickness of the thinner plate, or the throat size in the case of a fillet weld;

L is the longitudinal distance between adjacent ends of discontinuities;

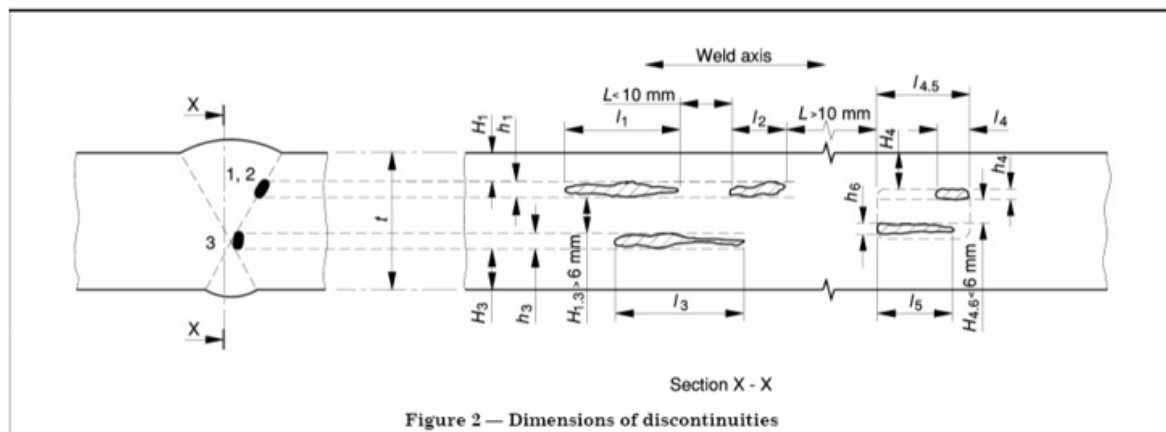
H is the clear distance between two discontinuities or between a discontinuity and the nearest surface, both measured in a through thickness direction.

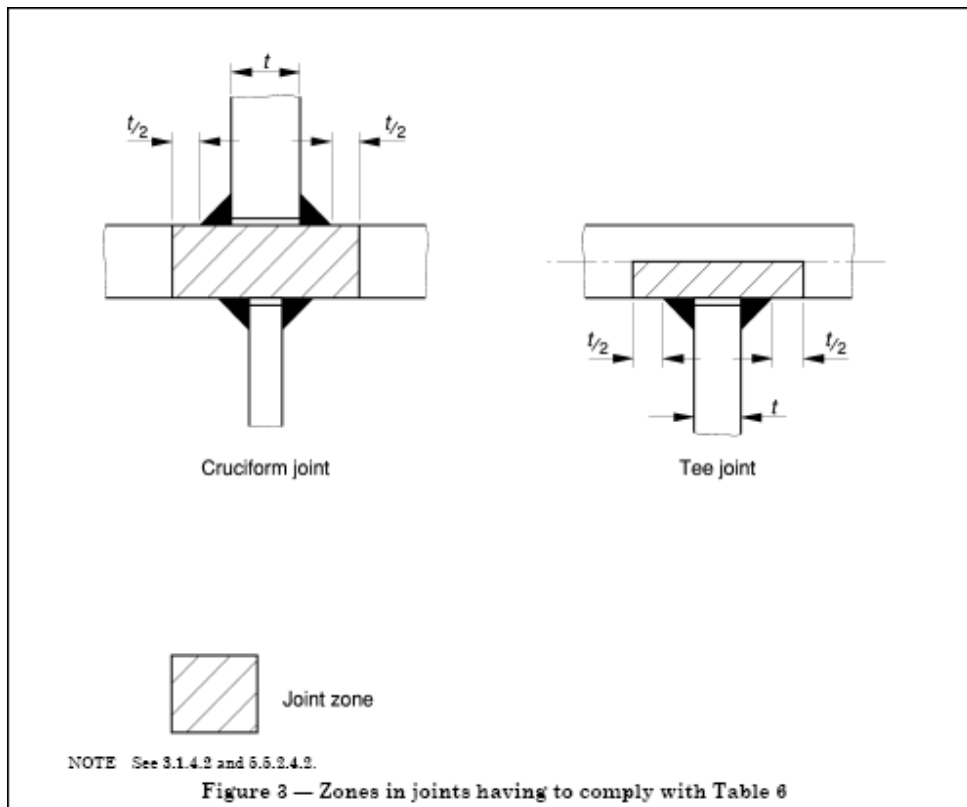
NOTE 1 The minimum class requirement shall relate to the stresses normal to the plane containing the dimensions h and l .

NOTE 2 Where two or more adjacent discontinuities exist such that the spacing between them is $H < 6$ mm and $0 < L < 10$ mm, their individual lengths, l , shall not exceed the value for $H < 6$ mm. Where $H < 6$ mm and $L < 0$ (i.e. overlap) they shall not be permitted for a minimum class of E and, in the cases of F and not specified, when the length, l , of either discontinuity exceeds the maximum value given for classes E and F respectively. Only one discontinuity in that group shall be permitted to be within 6 mm of a free surface.

NOTE 3 Where the weld length is less than 600 mm, the permitted value of Σl shall be reduced in linear proportion.

NOTE 4 In the case of fillet or partial penetration butt welds, the root shall not be considered as an outer surface.





2.4.3. Checking requirements

Members/components of rolled and built-up sections shall be checked for compliance with the tolerances given in Table 8 in accordance with the requirements given in Table 7. Additionally, all such members/components not subject to the checking requirements of Table 7 shall be visually examined for deviations in excess of the tolerances given in Table 8 and any such parts shall be quantitatively checked where necessary.

When inspecting members/components for compliance with tolerances, the checks for deviations shall be made over the full gauge length.

In making any checks, the scanning device shall be placed so that local surface irregularities do not influence the results.

The out-of-plane deviation of a plate panel at right angles to the surface shall be checked over the full area of the panel.

The checking of the out-of-straightness deviation at right angles to the plate surface for stiffeners may be checked either on the stiffener or on the plate attached to the stiffener on the line of the stiffener except in the vicinity of a site splice.

The out-of-straightness deviation parallel to the plate surface on the stiffener outstand shall be checked over the specified gauge length for the length of the stiffener.

The relative cross girder or cross frame deviation shall be checked over the middle third of the length of the cross girder or cross frame between each pair of webs. For cantilevers the relative deviation shall be checked at the end of the member.

The out-of-plane deviation of the web of a rolled beam or channel section shall be checked over a distance in the longitudinal direction equal to the depth of the section. Member/component types 1 and 2 shall be checked at each site joint as follows.

Member/component type 1: checks shall be made for a distance of 1 m either side of the joint centre line or to the next boundary stiffener, whichever is the minimum distance. Member/component type 2: checks shall be made over the length of the stiffened panel containing the joint.

Completed parts in which deviations have apparently increased since being inspected and checked shall be re-checked where required by the Engineer.


Table 7 — Tolerance checking requirements

Member/component type	Form of construction	Percentage of total number of members/components to be checked	Selection of members/components for checking
1, 2 and 5	Plate and box girders	5	50 % of the checks shall be made in critical areas specified by the Engineer. The remainder of the checks shall be made in areas selected at random by the Engineer
	Orthotropic decks	5	
	All other forms	10	
3, 4 and 6	All forms	100	

2.4.4. Support during inspection

Component stiffened plate panels shall be supported either on surfaces representing their intended fabricated shape or at their boundaries in a manner similar to that in the completed structure.

NOTE 1 Checks on member/component types 1, 2 and 5 (cross frames only), when these are incorporated in plate girders or box sections and checks on member/component types 3 and 6, may be done when the completed part is in either its horizontal or vertical position.

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For member/component type 4 the checks shall be made with the web of the completed part in a vertical position.

NOTE 2 Girders capable of significant deflection under self-weight may also be supported at an intermediate position beneath an internal cross frame or vertical stiffener in such a way as to eliminate the deflection without inducing twist.

There shall be no external restraint or load on any completed part or component. Stiffened plate panel during inspection for and checking or measurement of deviations.

2.4.5. Equipment

Scanning devices capable of making the specified checks shall be calibrated with respect to a straight-line datum so that the accuracy of recording is within ± 0.5 mm.

2.4.6. Gauge length

The gauge lengths to be used shall be as given in Table 8 for each member/component type.

2.4.7. Checking stages


Checking for compliance with the tolerances given in Table 8 shall be carried out at the following stages:

- a) for component stiffened plate panels and other completed parts, on completion of fabrication and before any subsequent operation of surface preparation, painting, lifting, transport or erection.
- b) for member/component types 1 and 2 at site joints, on completion of the site joint.
- c) for member/component type 5 (cross girders and cantilevers) and other parts in which deviations have apparently increased, on completion of site assembly.

2.4.8. Non-compliance and rejection

Where, on checking member/component types 1 and 2 for the deviations in respect of out-of-plane or out-of-straightness at right angles to the plate surface, the tolerances specified in Table 8 are exceeded, then the maximum deviation for the member/component shall be measured and recorded. In the case of member/component type 1 the maximum deviations in the plate panels adjoining the sides of the panel in question shall also be measured and recorded. For member/component type 2, the maximum deviation in respect of out-of-straightness at right angles to the plate surface for the stiffeners which are in line with the stiffener in question but in the adjacent bays shall also be measured and recorded. Only the



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maximum deviation shall be measured and recorded for all other instances where the tolerances given in Table 8 are exceeded.

The recorded measurements shall be submitted to the Engineer who will determine whether the member/component may be accepted without rectification, with rectification, or rejected.

In the case of member/component types 1, 2, 5 and 6, where 10 % or more of the checks made on any one member/component type exceed the appropriate tolerances given in Table 8 then additional checks shall be made as directed by the Engineer.

2.5. Checking of alignment at joints

The alignment of plates at all splice joints and welded butt joints shall be checked for compliance with the requirements of 2.3.3.

2.6. Temporary erection at contractor's works

Where specified by the Engineer, steelwork shall be temporarily erected at the contractor's works to the Engineer's specification.

2.6.1. Handling and stacking

Fabricated parts shall be handled and stacked in such a way that permanent damage is not caused to the components. Means shall be provided to minimize damage to the protective treatment on the steelwork and any damage which does occur shall be made good.


2.6.2. Packing for transport

All work shall be protected from damage in transit. Particular care shall be taken to stiffen free ends and prevent permanent distortion and adequately protect all machined surfaces. All rivets, bolts, nuts, washers, screws, small plates and small articles generally shall be suitably packed and identified.

2.6.3. Launching into water

Fully fabricated pontoon complete with anodes, pumps, and piping shall be launched from a fabricator yard using a suitable launch skid or slipway. The location of slipway, and the arrangement shall be approved by the Engineer's representative prior to start of fabrication.



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2.7. Towing, Installation and Commissioning

The towing of pontoon shall be using tugboats of suitable bollard pull. Bollard pull calculations shall be carried out and submitted for approval of Engineer. Installation of pontoon shall be supervised by qualified personnel and third-party inspector and surveyor. The installation includes fitting guides, fenders, ballasting compartments etc complete for functional requirements of integrating it with the linkspan bridge for full operation in tidal variations.

Table 8 — Tolerances

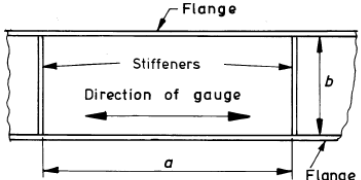
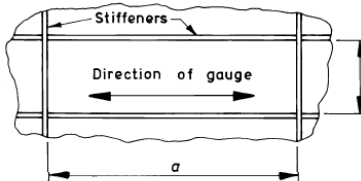
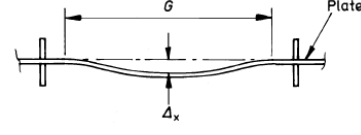
Member/ component type	Description	Gauge length	Tolerance	Examples
1. Plate panels in webs of plate and box girders in stiffened compression flanges and in box columns				
a) $\frac{b}{t} > 25 \sqrt{\frac{355}{\sigma_y}}$	Flatness at right angles to plate surface, measured parallel to the longer side in either direction	$G = a$ where $a < 2b$ $G = 2b$ where $a > 2b$	$\Delta_x = \frac{G}{165} \sqrt{\frac{\sigma_y}{355}}$ or 3 mm whichever is the greater (see note 4)	  
b) $\frac{b}{t} \leq 25 \sqrt{\frac{355}{\sigma_y}}$			No tolerance required unless otherwise specified by the Engineer	
<p>where</p> <p>a is the length of the longer side of a plate panel;</p> <p>b is the length of the shorter side of a plate panel;</p> <p>G is the gauge length;</p> <p>t is the thickness of plate;</p> <p>Δ_x is the maximum deviation from flatness within a specified gauge length;</p> <p>σ_y is the specified yield stress of steel used (in N/mm²).</p>				
<p>NOTE 1 The unit of measurement is millimetres.</p> <p>NOTE 2 Measurements should be taken to the nearest 1 mm and should be related to a sign convention as agreed with the Engineer.</p> <p>NOTE 3 Calculated tolerances should be rounded to the next whole 1 mm.</p> <p>NOTE 4 Any step at splices should be taken into account when checking and/or measuring deviations.</p> <p>NOTE 5 Allowance for any intended curvature as shown in the examples should be made when checking and/or measuring deviations.</p>				



Table 8 — Tolerances (continued)

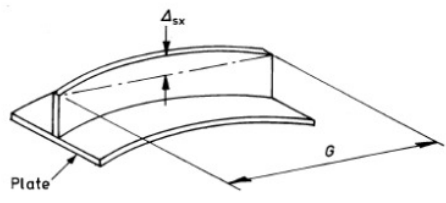
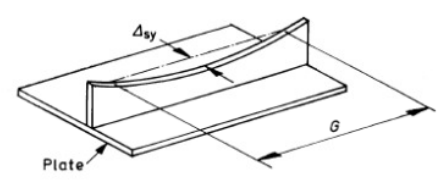
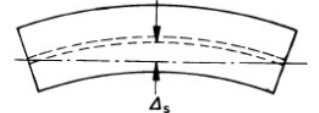
Member/ component type	Description	Gauge length	Tolerance	Examples
2. Longitudinal compression flange stiffeners in box girders, box columns and orthotropic decks. All web stiffeners in plate and box girders	a) Straightness at right angles to the plate surface in either direction	$G = L$	$\Delta_{sx} = \frac{G}{750}$ or 2 mm whichever is the greater	
	b) Straightness parallel to plate surface in either direction (not applicable to closed section stiffeners)	$G = 2b$ or L whichever is the lesser	$\Delta_{sy} = \frac{G}{375} \sqrt{\frac{\sigma_y}{355}}$ or 2 mm whichever is the greater	
3. Columns and struts	Maximum deviation from straightness including that of individual flanges in either direction	$G = L_s$ and L_F	$\Delta_s = \frac{G}{1000}$ or 3 mm whichever is the greater	
<p>where</p> <p>b is the length of the shorter side of a plate panel; G is the gauge length; L is the clear length of the stiffener between adjacent transverse stiffeners, cross frames, cantilevers or diaphragms; L_F is the length of each fabricated piece; L_s is the clear length of struts and columns; Δ_s Δ_{sx} Δ_{sy} } are the maximum deviations from straightness within a specified gauge length; σ_y is the specified yield stress of steel used (in N/mm²).</p>				
<p>NOTE 1 The unit of measurement is millimetres.</p> <p>NOTE 2 Measurements should be taken to the nearest 1 mm and should be related to a sign convention as agreed with the Engineer.</p> <p>NOTE 3 Calculated tolerances should be rounded to the next whole 1 mm.</p> <p>NOTE4 Any step at splices should be taken into account when checking and/or measuring deviations.</p> <p>NOTE5 Allowance for any intended curvature as shown in the examples should be made when checking and/or measuring deviations</p>				

Table 8 — Tolerances (continued)

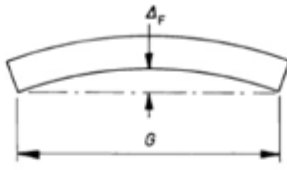
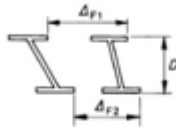
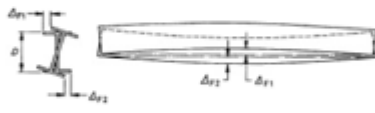
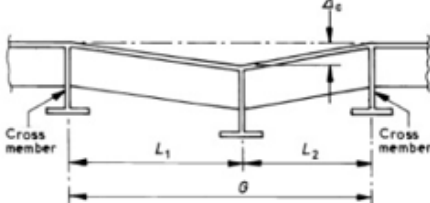
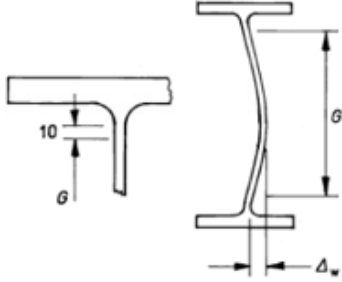

Member/ component type	Description	Gauge length	Tolerance	Examples
4. Rolled or fabricated girders	a) Including box sections	$G = L_G$ and L_F	$\Delta_F = \frac{G}{1000}$ or 3 mm whichever is the greater	
	b) Excluding box sections	$G = L_F$	$\Delta_F = \frac{G}{1000}$ or $\frac{D}{75}$ whichever is the lesser with a minimum of 3 mm	 $\Delta_F = \Delta_{F1} - \Delta_{F2}$ (at any one section)
	Verticality of web at supports	$G = D$	$\Delta_D = \frac{G}{300}$ or 3 mm whichever is the greater	 $\Delta_F = \Delta_{F1} + \Delta_{F2}$ (at any one section)
<p>where</p> <p>D is the depth of plate girder or rolled section; G is the gauge length; L_G is the length of girder in the completed structure; L_F is the length of each fabricated piece; Δ_D is the maximum deviation of girder from verticality at supports; Δ_F Δ_{F1}, Δ_{F2} } are the maximum deviations from straightness within a specified gauge length.</p>				
<p>NOTE 1 The unit of measurement is millimetres.</p> <p>NOTE 2 Measurements should be taken to the nearest 1 mm and should be related to a sign convention as agreed with the Engineer.</p> <p>NOTE 3 Calculated tolerances should be rounded to the next whole 1 mm.</p> <p>NOTE 4 Any step at splices should be taken into account when checking and/or measuring deviations.</p> <p>NOTE 5 Allowance for any intended curvature as shown in the examples should be made when checking and/or measuring deviations.</p>				

Table 8 — Tolerances (concluded)

Member/ component type	Description	Gauge length	Tolerance	Examples
5. Cross girders, cross frames and cantilevers in orthotropic decks or in compression flanges of box girders or on all sides of stiffened box columns	Levels between cross girder under consideration and the two adjacent cross girders in either direction	$G = L_1 + L_2$	$\Delta_c = \frac{G}{500}$ or 3 mm whichever is the greater	
6. Webs of rolled sections in the regions of the internal supports of continuous beams and elsewhere (as shown on the drawings)	Flatness at right angles to web plate surface measured over the gauge length in either direction	$G = W$	$\Delta_w = \frac{G}{165} \sqrt{\frac{\sigma_y}{355}}$ or 3 mm whichever is the greater	
<p>where</p> <p>G is the gauge length;</p> <p>L_1 and L_2 are the distances between two adjacent cross girders, cross frames or cantilevers;</p> <p>W is the depth of rolled section between fillets minus 20 mm;</p> <p>Δ_c } are the maximum deviations from flatness within a specified gauge length;</p> <p>Δ_w }</p> <p>σ_y is the specified yield stress of steel used (in N/mm²).</p>				
<p>NOTE 1 The unit of measurement is millimetres.</p> <p>NOTE 2 Measurements should be taken to the nearest 1 mm and should be related to a sign convention as agreed with the Engineer.</p> <p>NOTE 3 Calculated tolerances should be rounded to the next whole 1 mm.</p> <p>NOTE 4 Any step at splices should be taken into account when checking and/or measuring deviations.</p> <p>NOTE 5 Allowance for any intended curvature as shown in the examples should be made when checking and/or measuring deviations.</p>				

2.8. Third Party Inspection

The pontoon fabrication, material inspection from source, assembly, erection, handling, launching, towing, installation, and commissioning of the whole system including pumps, piping, ballasting and de-ballasting activities shall be inspected and certified by third party IRS including classification requirements for the floating system.

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3. SPECIFICATION FOR MODIFICATION OF EXISTING PONTOON

3.1. Scope

The scope includes the following to dismantling of plates and built-up sections, fabrication / assemble of a pontoon fit for service as depicted in the construction drawings and to obtain IRS approval for inland waterway rules for floating pontoon.

- Removal and towing of the existing pontoon to the dry dock/ repair yard suitable for the pontoon size and weight.
- Dismantling of the plates, built-up sections as specified in the drawings using pre-qualified procedures and approved welders.
- Demolition of existing concrete ramp on the pontoon and preparation of surfaces for modification works.
- Cutting, bending assembly of plates, shapes, pipes, and assembly as per construction drawings.
- Welding as per the design requirements specified in the construction drawings.
- All welding shall be continuous full penetration but welds unless specified otherwise and spot welds and discontinuous welds are not permitted,
- All compartments (30 Nos) shall be watertight and considered for ballasting.
- Fully fabricated pontoon fitted with anodes and other ancillary equipment such as piping for ballasting, ballast pumps, anodes and fenders shall be launched in the slipway and towed to the site of installation as per IRS guidelines and IRS surveyor requirements.


3.2. Removal and towing of existing pontoon.

The scope includes disconnection of existing pontoon of weight 1350 MT from the guide pin piles (after securing the linkspan structure with new guide pile support), inspection, obtaining permission/approval from IRS, DNV, and/or BV. for towing to the pontoon from Ghogha to the proposed dry-docking location by the contractor including any dry transport by barge and safely storing in dry dock / repair yard suitable for the pontoon size and weight.

The cost should include all manpower, equipment hire / rental or own such as crane, floating vessels or floating crane, barge, tugboats, trailers, hydraulic jacks etc. and all other accessories for the relocation and temporary supports beneath the pontoon etc.

The bidder shall propose in the bid the details about the proposed yard or dry dock and transportation methodology as approved by the approving agency such as IRS, DNV, and/or BV.



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The duration of drydocking / storage shall be based on the schedule of repair for the old pontoon but shall not be less than 1 year. Any additional storage or safe keeping of the pontoon after the repair and modification shall be outside the scope of the bidder.

3.3. Dismantling of structural steel.

This work includes dismantling and removal of the structural steel shapes, plates and built-up sections as specified in the drawings. Dismantling and removal operations shall be carried out with such equipment and in such a manner as to leave undisturbed, adjacent members of the pontoon.

3.4. Demolition of existing concrete.

This work includes demolition and removal of the existing concrete ramp and other concrete structures on the pontoon as specified in the drawings. The ramp shall be demolished carefully, and the resulting materials shall be removed so as not to cause any damage to the serviceable materials adjacent to the ramp. It is to be noted that the top deck plate of the existing pontoon shall not be damaged during the demolition of the concrete.

3.5. Material

Structural steel shall comply with the requirements in Clause 1.5.

3.6. Fabrication tolerances

The fabrication tolerances shall comply with the requirements of Clause 2.3.


3.7. Inspection

The extent, acceptance criteria, checking requirements, support during inspection, equipment, gauge length, checking stages, Non-compliance and rejection of inspection shall comply with the requirements of Clause 2.4.

3.8. Checking of alignment at joints

The alignment of plates at all splice joints and welded butt joints shall be checked for compliance with the requirements of **2.3.3**.



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3.9. Temporary erection at contractor's works

Handling and stacking, packing for transport and launching into water shall comply with the Clause 2.6.

3.10. Third Party Inspection

The pontoon fabrication, material inspection from source, assembly, erection, handling, launching, towing, installation and commissioning of the whole system including pumps, piping, ballasting and de-ballasting activities shall be inspected and certified by third party IRS including classification requirements for the floating system.



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4. SPECIFICATION FOR MODIFICATION OF LINKSPAN BRIDGE

4.1. Scope

The scope includes the following to modify / assemble the existing linkspan fit for service as depicted in the construction drawings and to obtain IRS approval for inland waterway rules for linkspan bridge.

- Dismantling of structural shapes and plates as per the construction drawings and confirming to the specifications.
- Cutting, bending assembly of plates, shapes, pipes, and assembly as per construction drawings.
- Welding as per the design requirements specified in the construction drawings.
- All welding shall be continuous and full penetration welds unless specified otherwise and spot welds and discontinuous welds are not permitted,
- All joints shall be fabricated in accordance with construction drawings using through thickness material (2Z35) and tested for full penetration and fusion using NDT such as Ultrasonic test and other tests specified in the specification elsewhere in this document and drawings.
- Fully modified linkspan bridge shall be reinstalled over the pontoon and installation as per IRS guidelines and IRS surveyor requirements.

4.2. Dismantling of structural steel

This work includes dismantling and removal of the structural steel shapes, plates and built-up sections as specified in the drawings. Dismantling and removal operations shall be carried out with such equipment and in such a manner as to leave undisturbed adjacent members of the linkspan.


4.3. Material

Structural steel shall comply with the requirements in clause 1.5.

4.4. Fabrication tolerances

Fabrication tolerances shall comply with API Spec 2B and clause 1.5.



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4.5. Welding, fabrication and erection

Welding, Fabrication and erection Structural steel shall comply with the requirements in clause 1.5. Tubular welding between brace and chord shall comply with the AWS D1.1 and details provided in the drawings.

4.6. Inspection

All full penetration welds major brace/chord interface shall be inspected 100% visual and 100% NDT using ultrasonic testing (UT) methods. All other minor welds shall be inspected 100% visually and 50% using UT methods.


4.7. Handling, lifting and erection.

4.7.1. Lifting

The linkspan bridge shall be lifted from the existing position and shall be hung on to the linkspan support frame. The modification works on the linkspan shall be performed in this position.

4.7.2. Installation

Upon successful completion of the modification works, the linkspan shall be installed on to the sliding support on pontoon. The lateral supports on the pontoon shall be fixed to prevent lateral swaying of the bridge.

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5. SPECIFICATION FOR LINKSPAN SUPPORT FRAME

5.1. Scope

The scope includes procurement of material, fabrication and assemble installation and connecting all accessories for successful installation of linkspan support frame. The scope shall include,

- Cutting, bending assembly of plates, shapes, pipes and assembly as per construction drawings.
- Welding as per the design requirements specified in the construction drawings.
- All welding shall be continuous and full penetration welds unless specified otherwise and spot welds and discontinuous welds are not permitted,
- All joints shall be fabricated in accordance with construction drawings using through thickness material (2Z35) and tested for full penetration and fusion using NDT such as Ultrasonic test and other tests specified in the specification elsewhere in this document and drawings.
- Hammering and installation of steel piles, boring and concreting the steel piles till the termination depth.
- Transportation, lifting and installation of the linkspan support frame over the steel piles using the stabbing cone arrangement.

5.2. Material


The structural steel material for the linkspan support frame shall confirm to clause 1.5.

5.3. Fabrication and Finish.

The fabrication of pile shall be in accordance with API Specification 2B. The longitudinal and circumferential seam welds shall be inspected 100% using UT and X-ray methods. The inspection shall be carried out with the third party to be approved by Engineers' representative. All the inspection records shall be subjected to third party approval.

The fabricated tubular shall be blast cleaned and painted before transporting to the site. The coating system shall be in accordance with clause 1.9. Any damaged part of the coating during transportation to site shall be repaired before lowering the guide pin pile into the drilled hole.



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5.4. Welding

The longitudinal and circumferential welding for the pipe pile shall be full penetration double groove weld in accordance with AWS D1.1. The welding specification, procedure, qualification test, welder approval shall be in accordance with AWS D1.1. All procedures and specifications shall be submitted for the approval of the Engineer's Representative.

5.5. Anodes

The stiffeners and base plates for the anode attachments on the guide pin piles shall be welded and coated prior to the assembly of steel piles in to one single piece. The location of these attachments and anodes shall be in accordance with the construction drawings. The complete assembly of the steel pile and its attachments shall be erected in position as a single piece using a suitable capacity crane with sufficient boom length and height.

5.6. Lifting and installation of steel pile

The steel pile shall be lifted and handled carefully using padeye attachments welded to the pipe and these padeye shall be cut and removed prior to the hammering of the pile. The steel pile shall be installed by hammering to the refusal. The suitable hammer shall be selected by the contractor with the approval of the Engineer in charge considering the geotechnical data.

At the point of refusal, the internal soil shall be removed by boring, and the hammering shall be resumed till the pile termination level.


5.7. Drilling

The drilling of pile hole shall be carried out using either RCD type pile top drilling machine or suitable chisel and bailer to the target depth with a diameter as per construction drawings. The drilled hole shall be cleaned thoroughly and all debri and loose material at the bottom shall be removed.

5.8. Alignment and tolerance

The pile position in relation to the jetty and the spacing of two guide pin piles shall be in accordance with the construction drawings and the tolerance indicated on the drawings. The deviations indicated are maximum and the same shall not exceed the limits specified. Following summary of tolerances is given and the same shall not exceed.



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Out of roundedness : should be less than 1%
Out of verticality : Less than 1: 500
Out of position : ± 10 mm (in any direction) in relation to the other guide pin pile

5.9. Concrete fill and reinforcement

The guide pin pile shall be filled with concrete and reinforcement up to the top as per construction drawings. The construction procedure shall be followed as per bored concrete in situ RC piles discussed in earlier section.

5.10. Inspection

All full penetration welds major brace/chord interface shall be inspected 100% visual and 100% NDT using ultrasonic testing (UT) methods. All other minor welds shall be inspected 100% visually and 50% using UT methods.

5.11. Handling, lifting and erection.

5.11.1. Transportation

The linkspan support frame fabricated in the contractor's yard shall be transported by suitable barge/trucks shall be fully assembled as a single unit to enable a single lift for installation.

5.11.2. Lifting

The linkspan support frame shall be lifted in single piece using single crane of sufficient capacity from floating crane. The bidder shall assess the lifting radius and capacity for the single piece lifting of the support frame.

5.11.3. Installation

Upon lifting the support frame shall be placed on the steel piles using the stabbing cone arrangement.



6. SPECIFICATION FOR CATHODIC PROTECTION

6.1 Scope

This specification describes the minimum requirements for an aluminium alloy sacrificial Anodes for cathodic protection system to be installed on the pontoon (external and internal) and guide pin piles. The detailed scope of work is as below.

- Procurement, Manufacture, Inspection, Testing, Delivery, Installation, Pre-Commissioning and Final Commissioning of following packages complete with all accessories and attachments as per Codes, Standards, Data Sheets and Specifications as attached.
- Slender Standoff Type Aluminium-Indium-Zinc Alloy Sacrificial Anodes with 4” diameter schedule 80 seamless steel pipes.
- Zinc Reference Electrodes.
- Identical Monitored Anodes.
- Monitoring Panel including all control & monitoring instruments/devices.
- All relevant cables for the Monitoring System mentioned above, from each reference electrode and monitored anode to junction box, and from junction boxes to Monitoring Panel.
- Metallic Weatherproof / waterproof Junction Boxes.
- Conduits, mounting, supports and accessories.
- Filling Compound, etc.

6.2 Standards and codes

The cathodic protection system shall be in accordance with good marine practice in corrosion protection, and in compliance with the following codes and standards to the extent applicable:

Table 6.1 Codes and Standards

DNVGL-RP -B401	Recommended Practice for Cathodic Protection Design 2017.
API RP-2A WSD	Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms (21 st latest edition).
SSPC-SP-10	Steel Structure Painting Council Near-White Blast Cleaning.
ASTM A36	American Society of Testing and Material, Specification for Structural Steel.

Any aspect of cathodic protection not specifically addressed in this specification, or for which specification requirements are ambiguous, shall comply with the Recommended Practice



DNVGL-RP-B401 “Cathodic Protection Design”, 2017. This standard and other project specifications referenced herein shall be considered complementary to this specification and similarly binding on the Contractor/Vendor/Manufacturer.

6.3 System design

A cathodic protection system, utilizing sacrificial aluminium alloy anodes suitable for protection of steel in a submerged marine environment.

6.3.1. Environmental Conditions

Following environmental conditions are used for the design of cathodic protection design of the pontoon and guide pin piles.

Location	: Ghogha, Gujarat
Seawater Depth	: 17 m
Maximum Tide	: 10.94m
Seawater Temperature	: 70°F (at sea bottom) 95°F (at surface)
Ph Value	: 8.1
Dissolved Oxygen	: 3.5 to 5.3 ml/l
Resistivity	: 18 to 22 ohm/cm

6.3.2. Design Parameters

The design parameters used for the anodes is summarised in table below.

Design Life	: 25 years
Current Densities Initial	: 150 mA/m ² (seawater) 20 mA/m ² (below mudline)
Maintenance (Mean)	: 75 mA/m ² (seawater) 20 mA/m ² (below mudline)
Final	: 100 mA/m ²

6.3.3. Design Protective Potential

The cathodic protection system when complete shall have a polarisation potential of 0.80 volts, negative as referred to a standard silver/silver chloride (Ag/AgCl) reference cell.

6.3.4. Number of Anodes Required

The system shall consist of Aluminium Alloy Anodes (GALVALUM III), or equivalent, as located on the contract drawings. Factors such as anode end face geometry (trapezoidal, rectangular, circular, etc.) and anode length shall be considered and optimized in order to provide the most efficient current distribution about the structure.

6.3.5. Preferred Anode Locations

Anodes shall be located to achieve maximum efficiency of current distribution and uniform structure polarization. Anodes shall be located such that a uniform distribution is attained. Anodes shall be attached to the structure as per drawings.

6.4 Anodes

6.4.1. Anode Composition

Anode shall be Indium Activated Aluminium Alloy and shall confirm to following compositional requirement.

Zn	In	Fe	Cu	Si	Al	Hg
2 - 6%	0.01 - 0.03%	0.12% max.	0.005% max.	0.2% max.	Remainder	Nil

Certain additional alloying elements (proprietary additives) such as Ti or Ga are permissible but shall be documented in the elemental analysis.

6.4.2. Electro-Chemical Value

The protective quality of the anode material shall be 2500 ampere-hours per kg.

6.4.3. Closed-Circuit Potential


The potential of the sacrificial alloy material shall be no greater than (-) 1.05 volts referred to the Silver/Silver Chloride (Ag/AgCl) reference cell.

6.4.4. Construction

Anode shall be the standard offshore stand-off type.

- Size and weight - Anodes shall be of weight and dimensional shape suitable for a minimum 10years protection. The size and weight shall be as per contract drawings.



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- b) Core - The core shall consist of nominal $\phi 114 \times 6$ A106 GR B pipe. Anode material shall completely surround the core.
- c) The anode material in general is made by casting the anode around a steel core. Prior to casting the melt, these cores shall be de-scaled, degreased, grit-blasted and cleaned to a "near-white" finish in accordance with SSPC-SP-10 within 24 hours of casting or before rust blooming appears.
- d) As most of the alloys do not at all fuse with the steel core, they shall be provided with indentations or other means to mechanically key the anode material adequately.
- e) The design of the core in the anode material shall be such that excessive loss of anode material, caused by crumbling away of the anode from the core, is unlikely before 90% depletion of the anode has been reached.
- f) Steel core bar type anodes shall have sufficient exposed steel to allow for easy installation by means of welding.
- g) The steel core should be of sufficient strength to support the anode material in combination with 16.75 MPa storm force. Particular attention should be paid to the attachment details of core to the marine structure.
- h) Stand-off - Legs shall be offset per manufacturer requirements from the core centreline. Stand-off legs shall be fabricated by (2) smooth bends of the core through anode end faces; curvature of the core to begin no closer than 25 mm from each anode end face. Fabrication of legs by bending the anode core through the lower anode face is prohibited.


The free ends of the legs will be welded to the bottom of the pontoon with four 10mm gusset plates on each pipe stand-off unless otherwise shown on the Drawings. CONTRACTOR shall shape the gusset plates to fit the contour of respective doubler plates and weld all around the gusset and doubler plates.

Doubler plates of 12mm ASTM A36 are required where anodes are attached to pontoon or guide pin piles. The stand-offs shall be seamless ASTM A106 GR B or API-5L GRB.

6.5 Guarantee

The VENDOR shall guarantee the minimum Electro-chemical value of the anode material offered, in ampere-hours per kg, and this guarantee shall be furnished with the information shown required in 7.0 below. Furthermore, the VENDOR shall warrant that all data, calculations, assumptions, etc. used in the subject cathodic protection system are applicable and in accordance with responsible engineering practices and industry standards. A listing of all pertinent design criteria, assumptions and sample calculations demonstrating the effectiveness of the subject system shall be supplied with any and all proposals.



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6.6 Material information

VENDOR shall furnish the following information relative to the anodes:

6.6.1. Dimensions

Dimensions of drawings of all anodes and supporting parts or accessories and as follows:

- Dimensional Tolerances: The maximum deviation of anode dimensions shall not exceed ± 12 mm of that specified.
- Surface Defect Tolerances: The anode surface should be generally free from defects affecting the anode efficiency. Anodes with the following defects will be rejected:
 - Cavities exceeding 12.5 mm in the largest dimension and 6 mm in depth.
 - Cracks exceeding 2 mm in width, 300 mm in length and intersect each other.
 - Cracks penetrating to the core.
 - Apparent slag or dirt inclusion.

6.6.2. Electro-Chemical Value

VENDOR shall supply guaranteed minimum Electro-chemical values in ampere-hour per kg for the anodes.

6.6.3. Anode Weights

The weight of each anode shall be within 2% of that specified and the total weight of anodes shall be within 1/2% of that required, based on parameters stipulated herein.


6.6.4. Electric Potential

VENDOR shall supply minimum, maximum, and average closed-circuit potential in volts for each pour.

6.6.5. Anode Composition

CONTRACTOR shall supply chemical components and percent by weight.



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6.6.6. Handling

Proper anode storage, handling and transportation procedures shall be followed to prevent physical damages to the anodes or corrosion to the anode core steel legs.

6.6.7. Certificates

All anodes shall be supplied with foundry certificates. The certificates shall contain all relevant data, including purchase order number, manufacturer name, batch (charge, heat) number, chemical composition, and inspection and test reports. The certificates shall be in English with units clearly stated.

Endorsement of anode certificates by a certification agency is required as per the purchase order/Fabrication Contractor or governmental requirements of India.

6.7 Installation

The CONTRACTOR shall install the anodes in accordance with COMPANY approved construction drawings at the locations indicated and with the connection details shown. Installation procedures including, but not limited to, welding processes, welder qualifications, and welding procedure qualifications, shall be in accordance with COMPANY general specifications.

6.8 Monitoring system

Monitoring system shall be provided for the cathodic protection. The system shall be designed to provide the following:

- The measurements of the effectiveness of the cathodic protection system, as judged by potential measurements.
- The performance of the sacrificial anodes, as judged by measurements of current output of monitored anodes.


System shall include 4 Nos. monitored anodes and 12 Nos. reference electrodes, electrically connected to a monitoring panel located on the control room.

Monitoring system shall meet the following requirements as applicable.

6.8.1. Monitored Anodes

The monitored anodes shall be identical to those supplied for the structural protection system and have the same physical characteristics but suitably modified so that current outputs can



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be electrically measured at the monitoring panel. The anodic material of the monitoring anodes shall be electrically insulated for those parts of the anode core, to be welded to the structure, with an insulation resistance, when dry, of not less than one mega ohm reducing when wet, to not less than one thousand ohms. Prefabricated isolating joints, with suitable mechanical properties, shall be utilized. The vendor may offer alternative means of isolation, subject to approval of the Company. A single shunt, affixed to the anode and having a resistance of not more than 0.005 ohm, shall bridge this insulation, and the shunt voltage drop shall be carried to the monitoring panel via a two (2) conductor cable.

The monitoring system shall be supplied with four (4) monitored anodes which shall be located at two (2) different elevations on the structure with two (2) anodes at each elevation. The monitored anodes shall be in addition to the sacrificial anodes required for structural protection.

6.8.2. Reference Electrodes

Potential reference electrodes shall be of the dual faced, 99.99 percent zinc block epoxy encapsulated within a plastic P.V.C. coated steel housing & designed for direct welded attachment to the structure. Each reference electrodes shall be supplied with sufficient cable length to run between the selected location and the junction box. The reference electrodes and the electrodes housing shall each be connected uniquely to one core.


The electrodes shall be located in areas where the potential is expected to be least negative. 4 Nos. electrodes shall be installed in vertical planes. The vertical plane electrodes shall be installed at two different planes with two electrodes in each plane. 8 Nos. electrodes shall be installed in horizontal planes. The horizontal plane electrodes shall be installed in two different elevations with four electrodes in each elevation.

6.8.3. Monitoring panel

The monitoring panel shall be located in the control room or other suitable location in safe area. The panel shall be of sheet steel (14 SWG) construction with an enclosure protection equivalent of IP-51. The monitoring panel as a minimum, shall contain the following.

- Selector Switches-Manually operated selector Switches-One (1) for each set of the reference electrodes and monitored anodes. However, all signal switching shall be through Reed relays which, in turn, shall be selected through these switches.
- Voltmeter-Panel mounted high sensitivity voltmeter of not less than 100,000 ohms per volts which shall have the capability of measuring the potential difference between the structure and each of the zinc reference electrodes. Range (+) 1 volts to (-) 1 volt.



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- Ammeter- Panel mounted ammeter with the capability of reading the current output of each of the monitored anodes. Range 0 to 10 Amp.
- Meter calibration – The panel shall have the built-in capability for checking the calibration and accuracy of the instruments.
- Mimic diagram - On the front of the panel mimic diagrams showing the sheet pile to be cathodically protected shall be included. Positioning of all reference electrodes and monitored anodes shall be marked distinctly on it. Different colours shall be used for marking structures, monitored anodes and reference electrodes. Positions of reference electrodes, monitored anodes, shall be illuminated on mimic diagram when they are selected for voltage or current readings respectively. This should be achieved by providing preferably light emitting diodes display.
- Recording unit provisions -The panel shall be equipped with provision to accept plug-in recording unit for periodic recordings of current & voltage.
- Electric Power Supply - 24V \pm 10%, D.C. supply shall be made available at one point by Contractor. Vendor shall indicate total power (WATT) required at the time of bidding.
- Painting - The panel & associated components shall be painted in accordance with the requirements of Specification - `Protective Coating`.

6.8.4. Cabling

All cabling from each reference electrodes and monitored anode shall be brought to a metallic waterproof junction box, mastik filled and mounted in the safe area. Two number junction boxes shall be provided for twenty terminals each. The cables from reference electrodes and monitored anodes to junction box shall have double insulation of EPR and inner & outer sheath shall be of CSP. The cables shall be suitable for operation under conditions of total and continuous immersion in sea water. Shielded cable may be provided, if in the opinion of the vendor, considered necessary. The cables shall be routed through conduits and supported by welded brackets. The main riser conduit shall be clamped at frequent intervals for adequate supporting. All conduits shall be of steel and conform to API-5L grade B seamless schedule 80 pipe.

All cables from reference electrodes and monitored anodes to junction box shall be with 2 X 2.5 mm² tinned copper conductor and shall be armoured. All cable connections shall be watertight. Each junction box shall be suitable for termination of all cables from reference electrodes and monitored anodes and one no. 19 X 2.5mm² tinned copper conductor armoured cable from junction box to monitoring panel. Cables from junction box to monitoring panel shall be FRLS type.



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6.9 Service after installation

The installation contractor shall carry out a potential survey, not later than six months of immersion, to verify that the structure is cathodically protected. If not, suitable remedial action shall be taken. Anode vendor shall provide all necessary support during the potential survey.


6.10 Testing and Inspection

Anode composition analysis shall be undertaken by methods agreed upon in advance. Three samples from each melt heat shall be taken for chemical analysis and electrochemical tests. The samples shall be taken in the beginning, at the middle and at the end of casting from the pouring string. Checking of closed-circuit potential and practical mass consumptions shall be done once for every 5 tons of anodes produced. Ampere hour capacity shall be determined by weight loss method only. Tests shall be done as per DNVGL-RBP-401, Annexure-1 for capacity and closed-circuit potential. Open circuit potential shall also be measured every 24 hours for 96 hours before start of test. All Chemical Analysis and Electrochemical Tests to be carried out at independent accredited laboratory.

After casting, the inspection of the anodes shall be done to ensure that:

- i. AH capacity of anodes shall not be less than the figures considered for design i.e., no negative tolerance shall be permitted.
- ii. The anodes have minimum net weight (Gross weight minus core weight) within a tolerance of +2.0% to -1.0%. However, overall negative tolerance shall be 0% to ensure that there is no shortfall in total alloy weight.
- iii. Dimensions are within tolerance limits indicated in the approved drawings. No negative tolerance is allowed in stand-off dimensions.
- iv. Closed circuit Potential shall be within (+) 10 mV and (-) 50 mV of the guaranteed value. For example, for guaranteed value of (-) 1.08v, anodes having closed Ckt. Potential less negative than (-) 1.07 volts shall be rejected.
- v. The anodes are free from mechanical defects. For these following criteria shall be used:
 - In general, the anode surface shall be free from cracks which reduce the performance of anode. The combination of cracks and lack of bond to the anode core is detrimental and will not be accepted. Criteria for accepting the cracks in anode will be:
 - Any crack which follows the longitudinal direction of elongated anodes are not acceptable.
 - Smaller cracks in the transverse direction of elongated anodes and in anodes of other shapes may be accepted provided the cracks would not cause any



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mechanical failure during service of the anode.

- For transverse cracks, the following limits shall be used:
 - Cracks with a length of less than 50mm and width less than 5mm are acceptable.
 - Cracks with a length of 50-200 mm shall be limited to 2 per anode face but maximum 4 Nos. per anode.
 - Cracks with a length more than 200mm or which are more than 5mm in width are not acceptable.
 - The above-mentioned cracks if penetrating more than three fourth of the depth to core shall not be acceptable.
 - The anodes shall be free from excessive shrinkages. Shrinkage cavities maximum up to 0% of the depth of anode or 50% of the depth of the anode core, whichever is less, will be acceptable. The same will be measured from the edges of one side.
 - The anodes shall be free from excessive flash, sharp or other surface projections, laminations, cold laps and surface slag as consistent with good casting practice. In general, the anodes shall show good workmanship on visual examination.
- All the above inspection/tests shall be witnessed by Third Party Inspection Agency DNV, TUV, BV or Lloyds.
- All anodes shall be delivered with material certificates from the Vendor stating batch identification number and chemical analysis.
- All work, materials, and equipment will be subjected to inspection by company at all reasonable times. Inspection by the company shall not relieve the vendor of his responsibility under terms of contract.
- vi. Electrical continuity test between anode and core/insert shall be done for each anode by measurement of resistance between anode and core. Value shall not exceed 0.9 milliohms.
 - vii. The monitoring system shall be inspected after completion of fabrication and prior to load out. This check shall include:
 - Polarity checks on all monitored anodes.
 - Insulation and continuity test of all cables.
 - Calibration tests shall subsequently be carried out on all instrumentation and on reference electrodes.
 - viii. At least one anode per delivery or at least 0.5% of the anodes shall be subjected to destructive testing to check that the casting is to an acceptable standard. Each anode should be cut at 3 of the most relevant locations. The cut surface should generally be free from visible pores and slag/dross inclusions. The lack of bond or void between anode core and anode material should not exceed 5%.

Alternative to a destructive testing, a non-destructive testing by radiography may be used to check for lack of bond or slag/dross inclusions.

