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1. **SCOPE**

1.1. This specification covers TPT's requirements for the design, manufacture and erection of structural steelwork for dynamic structures like cranes, including associated components.

2. **GOVERNING CODES AND STANDARDS**

ANSI/AWS D1.1 :	Structural Welding Code - Steel
BS-EN 287 Part 1 :	Approval testing of welders/fusion welding
BS-EN 288 Part 3 :	Specification and approval of welding procedures for metallic materials
BS 5135 :	Metal arc welding of carbon and carbon manganese steels
BS 4360/SABS 1431:	Weldable structural steel
BS 2573 : Part 1 :	Classification, stress calculations and design of structures
BS 3923 :	Methods for ultrasonic examination of welds
BS 2600 :	Radiographic examination of fusion welded butt joints in steel
DIN 1026	Metric channels
ISO R657	Angles
SABS 094	The use of high strength friction grip bolts and nuts
SABS 135	ISO metric bolts, screws and nuts (hexagon and square) (coarse thread free fit series)
SABS 136	ISO metric precision hexagon-head bolts and screws, and hexagon nuts (coarse thread medium fit series)
SABS 435	Mild steel rivets

### 3. STRUCTURAL STEELWORK

- 3.1. The design of all structural steelwork shall be such as to provide a robust and rigid structure requiring the minimum of maintenance and providing a long service life.
- 3.2. In the design of steel structures, due cognisance shall be taken of environmental and wind load conditions as specified in the main specification.
- 3.3. Due to the highly corrosive conditions experienced in Transnet Port Terminals, the permissible stresses shall not exceed those set out in British Standard No. 2573. The minimum thickness of steel for load bearing members shall be 15mm for gussets, 10mm for angles, tees, plates and flats and 9mm for webs of channels and joists. Punching of holes over and above that permitted in BS 2573, shall not be permitted. Other structural steel shall be of not less than 6 mm thickness.
- 3.4. The design of mobile structures shall be such that the induced von Mises stress (effective stress in triaxial loading) will not exceed 90% of the elastic limit strength of the steel when the equipment is travelling at maximum speed and colliding with either other stationary equipment or fixed stop blocks. In calculating von Mises stresses, due cognisance must be taken of stress concentrations. If the elastic limit strength of the steel is not known, it will be determined by using a 0,5% strain offset on the stress-strain curve of the material.
- 3.5. Where applicable, the design may be in bolted, riveted or welded box construction except that no site welding will be permitted in the final erection at the port except with the approval of TPT's.
  - 3.5.1. Alternatively, a welded hollow section lattice type structure will be acceptable, subject to the following requirements:
    - 3.5.1.1. The members must be structural sections manufactured from grade 43C/grade 300W weldable structural steel complying with BS4360/SABS1431. The hollow sections can either be seamless for all sizes (BS6323HFS) or welded for sizes above 114.3mm outside diameter (BS 6323HFW).
    - 3.5.1.2. Tube wall thickness must not be less than 6mm.
    - 3.5.1.3. All joints must be completely seal welded in accordance with BS 5135. Special care must be taken to prevent the ingress of moisture into hollow section members by ensuring that each member is airtight.
    - 3.5.1.4. Bolted or screwed attachments which require drilled holes through a hollow section will not be permitted.
    - 3.5.1.5. Non-hollow structural sections and plate used on the structure, in conjunction with the hollow section framework, must comply with the relevant requirements of this specification.

- 3.6. All steel sections shall be manufactured in accordance with the following standards: -

Weldable structural steel :	BS 4360/SABS 1431
I and H sections :	BS 4 Part 1
Metric channels :	DIN 1026
Structural steel, hot rolled sections :	BS 4 Part 1
Angles :	ISO - R657
Hot finished hollow sections :	BS 4848 Part 2
Cold formed sections :	BS 6363
Forgings :	BS 29
Steel castings :	BS 3100
Cast iron :	BS 1452

- 3.7. All steel plates and rolled steel sections used in the construction of the structures shall be of steel made by the open hearth process (acid or basic) and shall comply in every respect with BS 4360, "A" quality Structural Steel for Bridges and General Building Construction, Grade 43A or Grade 50B. That is, the percentage of phosphorous and sulphur shall not exceed 0,06.

3.7.1. The above is laid down as a standard, but tenders will also be considered for rolled steel not conforming strictly to the above standard. Full particulars of the guaranteed properties of the steel tendered for should in this case be furnished, i.e. chemical composition, tensile strength, yield point, reduction in area, bend tests, etc.

- 3.8. Forgings and drop forgings shall be free from flaws and surface defects of any kind and be accurately finished to the prescribed dimensions.

- 3.9. Steel castings shall be sound, clean and free from all defects and distortion of any kind and should, except where otherwise specified, conform with the conditions and tests specified in B.S. No. 3100/Latest Edition, for grades A, B and C according to requirements. They shall be thoroughly annealed and all working parts and bearing surfaces shall be machined and turned accurately with correct finish.

- 3.10. Cast iron used throughout must be close grained, tough and free from all defects, and shall conform with the conditions and tests specified in B.S. 1452/Latest Edition, for grades 12 to 14 according to requirements.

This applies to functional components only. A lower grade is acceptable for portal and machinery house ballast. Tenderers to state grade of cast iron proposed.

- 3.11. The dimensional and out-of-square tolerance as specified in the above Standards shall also apply to built-up components. Edge preparations, welding techniques, straight beds and material fit-up shall be considered when welded joints are designed.
- 3.12. The shape of all members and connections must allow easy accessibility for maintenance painting of all surfaces. No members shall comprise a double member which cannot be painted and maintained.
- 3.13. Structural details must be so designed as to eliminate or seal off any cavities or pockets where water or condensation could collect and promote corrosion. Horizontal members with upstanding flanges require special drainage.
- 3.14. All hollow sections shall be completely closed and airtight, and all welding is to be of such size and quality as to ensure complete airtightness. No tapping or drilling of holes into sealed sections will be permitted.

#### 4. **WELDING**

- 4.1. All the provisions of BS 5135 shall be complied with as far as applicable.
- 4.2. Design of weld joints shall be such that crevices, overlaps, pockets, arc strikes and dead ends do not exist.
- 4.3. All joints shall be completely seal welded in accordance with BS 5135. Special care must be taken to prevent the ingress of moisture into the tubular members by ensuring that each such tubular member is airtight. "Stitch" welding will not be permitted. Only continuous welding will be accepted.
- 4.4. Weld cracks, undercut, or pock marks will not be accepted.
- 4.5. All welds on the load bearing frame structure, containers, piping, pipe line flanges, etc., shall be continuous and shall be visually inspected for cracks and other discontinuities.
- 4.6. Welds on the main chords must be tested ultrasonically in accordance with BS 3923 or X-rayed in accordance with BS 2600 and those on minor joints by the dye-penetrant method. The equipment required for these tests must be supplied by the Contractor and the testing done at his cost.
- 4.7. Steel, except in minor details, which has been partially heated, shall be properly annealed. (Electrically welded structural members excepted.)
- 4.8. All brackets, clamps, lugs, straps, suspenders, etc. required for attaching mechanical and electrical equipment must be welded on prior to erection and special precautions must be taken not to damage welds or puncture tubes during erection.
- 4.9. The welding of all rails shall be done by an approved method.

- 4.10. Welding shall only be carried out by a coded welder according to SABS 044, BS-EN 287 Part 1 and BS-EN 288 Part 3 or ANSI/AWS D1.1.
- 4.11. All parts to be welded shall be thoroughly cleaned and dried before welding. The welding will only be done in dry surroundings and all steps taken to prevent hydrogen embrittlement.
- 4.12. Where materials of different compositions are joined by welding, especially carbon steel to chrome steel, the filler welding method and post welding treatment shall be such that embrittlement and other degradation of both steel and filler are prevented.
- 4.13. It must be ensured that welded joints are ductile.

## 5. FASTENERS

- 5.1. All bolts, nuts and rivets shall be manufactured in accordance with the following standards: -

Commercial bolts and nuts Grade 4,6:	SABS 135
Precision bolts and nuts Grade 8,8:	SABS 136
Friction Grip Bolts and nuts Grade General:	SABS 094
Rivets:	SABS 435

- 5.2. All fasteners (excluding friction grip) shall be hot dipped galvanised (and their nuts and washers), structural rivets and Huck Bolts.

- 5.2.1. All holding down bolts and nuts and brackets, as well as all fixing bolts, washers, studs and nuts, less than 12mm diameter shall be of stainless steel. Fixing rivets shall be of either stainless steel or brass.

- 5.3. Bolts and setscrews shall be locked in an approved manner and shall not be stressed in tightening to beyond the recommended loads.

- 5.4. The quality of friction grip bolts, nuts and washers, bolt lengths, sizes of holes, tightening standards, surface condition of clamped components, shop and site assembling and acceptance inspection of friction grip joints shall comply with the latest edition of SABS 094. Certificates shall be supplied for all bolts of grade 8.8 and 10.9.

- 5.5. All bolt and rivet holes must be accurate to size and location, the centres of holes shall not be placed nearer the edge of a plate than 1,5 diameters with an extra allowance of 3mm for sheared edges. All holes in the structural work shall be drilled or otherwise punched to a diameter not exceeding 1,5mm less than the diameter of the finished hole on the die side, and afterward reamed out to the exact size

Where possible the adjoining parts forming a connection shall be drilled or reamed together, with holes not exceeding 1,5 mm diameter the rivet or bolt for which it is made. No rough or broken edge shall be left around any of the holes.

- 5.6. For turned and fitted bolts, the holes shall be accurately drilled or reamed, the diameter of the hole shall not exceed the finished diameter of the bolt by more than 0,25mm.
- 5.7. The holes, after assembly of the parts, shall be true throughout the thickness of all the parts and perpendicular to the axis of the member.
- 5.8. Rivets shall be cup-headed or countersunk as required, unless otherwise specified. No rivet head shall contain less metal than does a length of the rivet equal to 1,25 times its diameter. All loose and defective rivets shall be cut and replaced by sound ones; also others when required for the purpose of examining the work. Rivets shall be driven with pressure tools whenever possible and pneumatic hammers shall be used in preference to hand driving.
- 5.9. All field rivets must be supplied with shanks of suitable length for pneumatic riveting.
- 5.10. Bolts shall be of such length as to accommodate a full nut and washer when tightening up, and protrude a maximum of 3 thread pitches beyond the nut. Excessive projection of threads beyond the nut must be avoided. Bolts that are flush or under top of nut are not acceptable.
- 5.11. All bolts having countersunk heads shall have strong feathers forged on the neck and head to prevent turning and the bolt holes shall be cut to receive same. All nuts and bolts (excluding countersunk bolts) shall be furnished with circular washers of sufficient thickness, the outside diameter being at least twice the nominal diameter of the bolt, and washers fitted correctly.
- 5.12. Where bolt heads or nuts are seated on bevelled surfaces of beams or channel flanges, bevelled washers must be inserted.

## 6. JOINTS AND MATING SURFACES OF MEMBERS

- 6.1. Mating surfaces of members to be joined by high tensile steel bolts in friction grip shall be cleaned and primed as specified for the rest of the steelwork. Mating surfaces shall lay flat against each other to eliminate gaps which may allow ingress of water. After joining, the edges shall be sealed with an approved brand of Butyl/ Rubber sealing compound by means of a suitable caulking gun, or shall be seal welded.
- 6.2. Other joints shall be formed by one of the following methods:
  - 6.2.1. The mating surfaces of members shall be blast cleaned, primed and protected prior to sub-assembly by the liberal application of caulking compound. While the compound is still wet, the members shall be bolted together and caulking compound which is squeezed out shall be completely removed.
  - 6.2.2. The mating surfaces shall be protected with the full corrosion protection system as specified, the surfaces joined together and the joint so formed shall be sealed with butyl rubber sealer.



6.2.3. After being cleaned and primed the surface shall be joined together and the joint so formed shall be seal welded.

6.3. The primer coating on mating surfaces must be applied not more than 4 hours after cleaning and the edges must be sealed within 3 weeks of assembly of the part.

## 7. **FABRICATED PARTS**

7.1. All fabricated parts shall be properly fitted during assembly to result in properly aligned equipment having a neat appearance. Fabrications of load bearing members shall have no abrupt changes in cross section and regions of severe stress concentration. All sharp corners accessible by personnel during erection or operation shall be ground, rounded, or removed by other methods. Burrs, welding spatter and stubs of welding wire shall be removed.

## 8. **BALLAST OR COUNTER MASS**

8.1. Tenderers must include for the supply of all necessary ballast or counter mass.

8.2. These must preferably be of cast iron and be removable for maintenance of structural steelwork.

8.3. Concrete ballast is not recommended but will be accepted provided the Tenderer satisfies TPT that it will not cause corrosion of any steel parts.

8.4. Fastenings used for removable pieces must be of non-corrosive material.

8.5. Ballast must be in suitable shapes to be secured in position against movement but in sizes easily removable for maintenance.

8.6. Lifting hooks or eyes of non-corrosive material and of adequate strength must be provided in the removable ballast pieces.

8.7. Concrete ballast must be reinforced so as to prevent cracking or breaking, and must be coated with an approved corrosion protection system for concrete.

## 9. **STAIRS, LADDERS, PLATFORMS AND WALKWAYS**

9.1. Platforms, stairways, walkways, hatches and ladders, shall be provided where necessary to give easy access to all parts of the equipment for inspection, maintenance and lubrication purposes (including the insides of all box sections if inspection covers are provided).

9.2. The hand rails and ladders shall be complete with stanchions, knee rails, back hoops, mounting brackets etc. and shall be manufactured in

sections which are hot-dipped galvanized and painted and bolted onto the structure.

9.2.1. The handrail shall have a minimum diameter of 25mm and shall not be less than 1 050mm above the platform level. Toe boards shall not be less than 150mm high.

9.3. Stairs shall be inclined no more than 45° to the horizontal and shall be broken at suitable intervals by platforms.

9.4. Stairs and walkways shall not be less than 700 mm wide and working areas around drives etc. shall be of sufficient size to allow for ease of maintenance.

9.5. Vertical ladders must be provided with back hoops.

9.6. Trap doors and hatches must be of light, but robust, construction, suitably hinged with stainless steel hinges and provided with a catch to keep them in the open position, if necessary. Trap door openings are to be protected by means of toe boards and removable handrails.

9.7. All external platforms, stair treads and walkways shall be hot dipped galvanised open grating construction, similar to Andrew Mentis "Rectagrid" type RS40 to allow for free drainage and avoid the accumulation of water and dust. Bearer bar thickness shall not be less than 4,5 mm. The top surface shall provide for adequate grip to avoid underfoot slipping.

9.8. TPT's prior approval is required for all external platforms and walkways where open grating cannot be used. This will only be permitted where the primary purpose of the walkway/platform is for maintenance purposes. All such surfaces are to be provided with a non slip surface coating.

9.9. No obstructions or sudden changes in levels will be permitted on walkways.

## 10. **MACHINERY AND ELECTRICAL HOUSES AND OPERATOR'S CABINS**

10.1. Where required, separate, self contained fully weather proof machinery and electrical houses as well as operators cabins shall be provided. The houses shall be of the steel framed metal clad type, and shall allow ample space and strength for all equipment and control panels housed therein, permitting unrestricted access to all equipment for routine service and maintenance. Headroom shall not be less than 2,13 metres. A minimum of 700mm working space must be provided around all machinery and in front of all panels.

10.2. The major items of machinery, electrical equipment and panels shall be so arranged that it can be removed for repairs or replacement without disturbing the walls, roof, floor or structural framework and furthermore shall be so arranged that full access to all holding down bolts is provided from inside the house.

- 10.3. For electrical houses both the inner and outer cladding must be stainless steel, unless otherwise approved. Side cladding plates are to be joined with butting joints with butt cover straps where required (no lap joints), and the plates must be in as large sizes as practicable to reduce the number of vertical joints, and to eliminate horizontal joints. Alternatively cladding may be welded to the frame and all joints completely seal welded. All angles around windows are to be suitably joggled to obtain a waterproof and flat surface butting on the side sheets. The whole of the framing shall be well stayed and fixed on its base. Air-conditioned electrical houses shall be provided with thermal insulation material of an approved type between the cladding.
- 10.4. Machinery houses must be cladded with prepainted Aluminium sheeting, minimum thickness 0.8 mm, colour coated with the appropriate colour. The profile and fastenings must be suitable for the spans and wind uplift forces corresponding to the windspeeds stated in the main specification. Flashing, corner trim, closure pieces ridge cappings etc. shall consist of prepainted Aluminium of minimum thickness 1.2mm
  - 10.4.1. Sheeting fasteners shall be 6.3 mm grade 304 stainless steel self-tapping screws with hexagonal washer heads.
  - 10.4.2. Galvanic isolation rubber strips shall be used between the metal frame and Aluminium cladding.
- 10.5. Both machinery and electrical houses shall be provided with two access doors, sealed to suit pressurisation and/or air-conditioning, one on each side of the house, arranged for external locking, but allowing exit from the inside without a key. Rain guards must be provided above external doors.
- 10.6. Operator's cabins shall be fully constructed from 3CR12 or similar type stainless steel. Cladding shall be welded to the frame and shall be smoothed over to provide an aesthetic appearance. The cabin shall be insulated from the heat of the sun with an approved material. A stainless steel or similar material door with a robust industrial type door lock shall be provided. The door must be lockable from the outside, but must allow exit without a key from the inside.
- 10.7 All windows shall be of solar heat reducing toughened safety glass.

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**END OF SPECIFICATION HE9/2/6 [Version 9]**

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