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## Specifications for Construction of Steel Bridges.

(Attached to the Contract No. ....)

### Imperial Government Railways of Japan.

The bridges constructed under these specifications must be built strictly in accordance with the annexed standard plans.

All dimensions, sectional areas, details of connections and general forms as shown upon these plans must be adhered to, unless changes are distinctly directed in writing by the Consulting Engineer or Inspector.

No work shall be commenced or materials ordered until the detailed working drawings prepared by the contractor have been approved of by the Consulting Engineer or Inspector. The contractor is to furnish the General, Detail, and Marking Drawing to the Imperial Japanese Government Railways.

#### Material.

All parts shall be of steel, made by the Siemens-Martin or open hearth process.

The steel must be uniform in character for each specified kind. The finished bars, plates and shapes must be free from cracks on the faces or corners, and have a clean, smooth finish. No work shall be put upon any steel at or near the blue temperature or between that of boiling water and of ignition of hard wood sawdust.

All test shall be made on samples cut from the finished material after rolling. The samples to be at least 12 inches long, and to have a uniform sectional area not less than  $\frac{1}{2}$  square inch.

Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls.

When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

The elongation shall be measured on an original length of 8 inches. The test pieces shall be taken from each melt or blow of finished material, one for tension and one for bending.

All samples or full-sized pieces must show uniform fine grained fractures of a blue steel-gray colour, entirely free from fiery lustre or a blaskish cast.

The steel shall have an ultimate strength, when tested in samples of the dimensions above stated, of 60,000 to 68,000 pounds per square inch, an elastic limit of not less than one-half of the ultimate strength, and a minimum elongation of 22 per cent. in 8 inches. Steel for pins may have a minimum elongation of 15 per cent.

Before or after heating to a low cherry red and cooling in water at 82 degrees Fah., this steel must stand bending to a curve whose inner radius is one and a half times the

thickness of the sample, without cracking.

Eye-bar material,  $1\frac{1}{2}$  inches and less in thickness, shall, on test pieces cut from finished material, fill the above requirements. For thicknesses greater than  $1\frac{1}{2}$  inches, there will be allowed a reduction in the percentage of elongation of 1 per cent for each  $\frac{1}{8}$  of an inch increase of thickness, to a minimum of 20 per cent.

Full sized eye-bars shall show not less than 10 per cent elongation in the body of the bar, and an ultimate strength not less than 56,000 pounds per square inch. Should a bar break in the head, but develop 10 per cent. elongation and the ultimate strength specified, it shall not be cause for rejection provided not more than one-third of the total number of bars tested break in the head.

Rivet steel shall have an ultimate strength of 50,000 to 58,000 pounds per square inch, and an elongation of 26 per cent.

Before or after heating to a slight yellow heat and quenching in cold water, this steel must stand closing solidly together without any sign of fracture.

The rollers must be of machinery steel.

A variation of cross-section or weight in the finished members or  $2\frac{1}{2}$  per cent from the specified size may be cause for rejection.

### Inspection.

All facilities for the inspection of materials and workmanship shall be furnished by the contractor. He shall furnish without charge such specimens (prepared) of the several kinds of steel to be used, as may be required to determine their character.

The contractor must furnish a testing machine capable of testing the above specimens at all mills where the steel may be manufactured, free of cost.

Full sized parts of the structure may be tested at the option of the Consulting Engineer or Inspector, but if tested to destruction, such material shall be paid for at cost, less its scrap value to the contractor, if it proves satisfactory. If it does not stand the specified tests, it will be considered rejected material, and be solely at the cost of the contractor.

### Workmanship.

All workmanship shall be first-class in every particular.

For punching the diameter of the die shall in no case exceed the diameter of the punch by more than  $\frac{1}{16}$  of an inch, and all holes must be clean cut without torn or ragged edges.

All rivet holes must be so accurately spaced and punched that when the several parts forming one member are assembled together, a rivet  $\frac{1}{16}$  inch less in diameter than the hole can generally be entered, hot, into any hole, without reaming or straining the metal by "drifts"; occasional variations must be corrected by reaming.

All holes for field rivets, except those in connections for lateral and sway bracing, shall be accurately drilled or reamed to an iron template, so that as far as possible all like pieces may be interchangeable. Before shipment the possibility of this must be

determined by assembling corresponding parts selected at random.

The rivets when driven must completely fill the holes. The rivet-heads must be round and of a uniform size for the same sized rivets throughout the work. They must be full and neatly made, and be concentric to the rivet-hole, and thoroughly pinch the connected pieces together.

Wherever possible, all rivets must be machine driven. The machines must be capable of retaining the applied pressure after the upsetting is completed.

The several pieces forming one built member must fit closely together, and when riveted shall be free from twists, bends or open joints.

Wherever there is a tendency for water to collect, the spaces must be filled with a suitable water-proof material.

All surfaces in contact shall be painted before they are put together.

Web-plates of all girders must be arranged so as not to project beyond the faces of the flange angles, nor on the top be more than  $\frac{1}{8}$  inch below the face of these angles, at any point.

Stiffeners must be milled to fit between flanges at bearing points.

The end of floor girders shall be faced true and square.

All abutting surfaces in compression members shall be truly faced to even bearings.

The heads of eye-bars shall be so made that the bars will preferably break in the body of the original bar rather than at any part of the head or neck.

The bars must be free from flaws and of full thickness in the necks. They shall be perfectly straight before boring. The holes shall be in the centre of the head, and on the centre line of the bar.

All members must be free from twists or bends. Portions exposed to view shall be neatly finished.

Pin-holes shall be bored exactly perpendicular to a vertical plane passing through the centre line of each member, when placed in a position similar to that it is to occupy in the finished structure.

In members not adjustable for length, no variation of more than  $\frac{1}{32}$  inch will be allowed in the length between the centres of pin-holes.

Bars which are to be placed side by side in the structure shall be bored at the same temperature and of such equal length that upon being piled on each other the pins shall pass through the holes at both ends at the same time without driving.

The pins shall be turned straight and smooth; chord pins shall fit the pin-holes within  $\frac{1}{60}$  of an inch, for pins less than  $4\frac{1}{2}$  inches diameter; for pins of a larger diameter the clearance may be  $\frac{1}{32}$  inch.

Eye-bars, all forgings and any pieces which have been partially heated or bent cold must be wholly annealed. Crimped stiffeners need not be annealed.

No reliance will be placed upon the welding of steel.

No sharp or unfilleted angles or corners will be allowed in any piece of metal.

All pins shall be supplied with steel pilot nuts, for use during erection, two pilot nuts

for each size pin for each span.

Riveted work will be subjected to the following conditions:

All sheared edges of plates and angles will be planed off to a depth of  $\frac{1}{4}$  of an inch and all punched holes will be reamed to a diameter  $\frac{1}{8}$  of an inch larger so as to remove all the sheared surface of the metal; unless the material is such that any rivet holes punched as in ordinary practice will stand drifting to a diameter one-third greater than the original holes, without cracking either in the periphery of the holes on the external edges of the piece, whether they be sheared or rolled.

Steel may be used in compression in chords, posts, flanges and bearing plates without reaming for any thickness of metal which will stand the above drifting test. Steel may be used in tension without reaming up to thickness of  $\frac{3}{8}$  of an inch, if the metal of this thickness will stand the above drifting test and the adjacent edges of the pieces be rolled or planed off as above required.

### Painting.

All metal work before leaving the shop shall be thoroughly cleaned from all loose scale and rust, and be given one good coating of pure raw linseed oil, well worked into all joints and open spaces.

After the workmanship has been inspected by the Consulting Engineer or Inspector, the metal work will be given an additional coat of red lead and pure linseed oil before shipment.

In riveted work the surface coming in contact shall each be painted before being riveted together. Bottoms of bed-plates, bearing-plates, and any parts which are not accessible for painting after erection, shall have two coats of paint; the paint shall be a good quality of red lead mixed with pure linseed oil.

Pins, bored pin-holes and turned friction rollers shall be coated with white lead and tallow before being shipped from the shop.

### Provisions for Erection.

The contractor shall send out as part of this contract and included in the contract sum, the following articles:—

A quantity of rivets and bolts of proper dimensions sufficient for putting the work together, with 25 per cent. of rivets, and 5 per cent. of bolts and nuts, to spare of every kind used in the work.

### Shipping Directions.

All parts must be carefully marked with letters and numbers indicating the position of each piece for the purpose of facilitating the erection of the spans. The marking will be made both by painting and by punch marks. The pieces must also be marked with the letters I.R.J.

All bolts, nuts (including anchor bolts), rivets, and small pieces must be packed in

strong iron bound boxes. Each box to be marked with list of contents or with a suitable identification letter or number.

N.B.—The Inspector or Consulting Engineer is to be appointed by the Japanese Government.

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#### LIST OF APPROVED MAKERS.

1. Edgemoore Bridge Works, Wilmington, Del, U. S. of the American Bridge Co.
2. Keystone Bridge Co., Pittsburg, Pa., U. S. A. of the American Bridge Co.
3. Penn. Steel Co., Harrisburg Pa., & Baltimore, Md., U. S. A.
4. Phoenix Iron Co., Phoenixville, Pa., U. S. A.
5. Pencoyd Iron Works, Phila., Pa., U. S. A. of the American Bridge Co.