

1. SCOPE

This procedure applies to the permanent fixing of steel structures including the erection of steel and composite bridges designed in accordance to AS 5100.6-2004 "Bridge Design Part 6 Steel and Composite Construction" by bolting.

2. FASTENERS

Bolted connections in bridges shall be made with steel bolts, nuts and washers that comply with the applicable Australian Standards:

- AS 1110 ISO metric hexagon precision bolts and screws;
- AS 1111 ISO metric hexagon commercial bolts and screws;
- AS 1112 ISO metric hexagon nuts;
- AS 1237 Flat metal washers for general engineering purposes;
- AS 1252 High strength steel bolts with associated nuts and washers for structural engineering;
- AS 1285 Prevailing torque steel hexagon locknuts;
- AS 1420 ISO metric hexagon socket head cap screws.

Bolting conforming to Grade 8.8, category 8.8/TB having a minimum tensile strength of 830MPa shall be used in "Friction-Type" applications.

3. DRAWINGS

Construction drawings shall indicate the grade and diameter of all bolts, nuts and washers required for the construction. Drawings shall indicate whether a "Friction-Type" or "Bearing-Type" connection is required.

4. FASTENING REQUIREMENTS

Length of bolts shall be such that one clear thread shows above the nut and at least one clear thread plus thread run out is clear beneath the nut face after tightening. One washer shall be used under the rotating part which would generally be the nut and the bolt length shall allow for this.

5. BOLT HOLES

The nominal size of the bolt holes (other than holes in a base plate) shall be 2mm larger than the nominal bolt diameter for a bolt not greater than 24mm in diameter and not more than 3mm larger for bolts of diameter more than 24 mm.

6. PREPARATION OF CONTACT SURFACES

- a) *General requirements and Bearing-Type connections.* All oil, dirt, loose scale, loose rust, burrs, fins and any other defects on the contact surfaces shall be removed prior to fitting the parts together;
- b) *Friction-type connections.* In addition to the general requirements, the contact surfaces shall be free from paint, lacquer or galvanising unless the friction coefficient of such finishes has been established.

7. ALIGNMENT AND ASSEMBLY

The parts to be joined shall line up in such a way that a drift of equal diameter to the bolt can pass through the bolt holes. Drifting to align the bolt holes shall be done in such a way as not to bend or damage the parts nor enlarge the holes. Packing shall be provided as required to ensure parts have full contact over the mating surfaces.

Prior to inserting the bolts the nut should be run up the threads to ensure there are no thread defects that would impede the tightening process. Bolts shall be inserted through the holes after alignment

from such a direction that the nut has easiest access for tightening. One correctly sized washer shall be placed over on the extending threads prior to putting on the nut.

Where steel parts with slotted or enlarged holes are to be fastened together, hardened washers or plate washers shall be used under both the bolt head and the nut.

8. BOLT TIGHTENING (SNUG TIGHTENING)

Bolt Tightening is required for all Bearing-Type Connections and as a pre-requisite to Friction-Type connections. The sequence of tightening the bolts shall proceed from the stiffest part of the connection towards the free edges.

High strength bolts that are to be tensioned may be tightened during erection to facilitate assembly but they shall not be finally tensioned until all bolts have been snug tightened in the correct sequence.

Bolt tightening is also known as snug-tightening. Bolt or snug tightening is achieved either by subjecting the nut to a few impacts of an impact wrench after standard effort tightening with a podger spanner or by the full effort of a person using a standard podger spanner.

The sequence of tightening is to firstly tighten all nuts with a standard effort and then to snug tighten using a full effort or an impact wrench.

9. BOLT TENSIONING

Bolt Tensioning is required for Friction-Type connections. To achieve a Friction-Type connection the bolt tensions given in Table 1 shall be achieved:

Table 1. Minimum Bolt Tensions for Friction-Type Connections.

Nominal diameter of bolt	Minimum bolt tension, kN
M16	95
M20	145
M24	210
M30	335
M36	490

Bolts may be tensioned by either of two methods:

- a) Part turn method;
- b) Direct Tension device

10. PART TURN METHOD

After snug tightening, the nut and bolt shall be referenced marked to establish their relative rotational position. Such reference marks shall be permanent to assure third party inspection personnel that the tensioning procedure has been adequately followed.

The bolts shall be tensioned by rotating the nut relative to the bolt head by the amount given in table 2:

Table 2. Nut Rotation Requirements for Tensioning Friction-Type Bolts by the Part Turn Method

Bolt length (measured from underside of head to end of bolt)	Nut rotation ¹
Up to and including four bolt diameters	One third to five twelfths of a turn
Over four but less than eight diameters	One half to seven twelfths of a turn
Over eight but less than twelve diameters	Two thirds to three quarters of a turn

Notes

1. Nut rotation requirements are based on both parts to be joined being parallel and flush with each other. If one of the members is slightly sloped nut rotation shall be increased by 50%. If both members are sloped nut rotation shall be increased by 100%.

Part turn tensioning can be achieved with an impact wrench, rattle gun or torque wrench.

11. DIRECT TENSIONING METHOD

Direct tensioning hydraulic stud tensioning equipment may be used to tension bolts provided the equipment supplier has provided the relevant data on achieving the required bolt tension as given in Table 1. A calibration test shall be established that demonstrates the equipment provides a tension of not less than 1.05 times the minimum tension given in Table 1.

Prior to direct tensioning all bolts shall be in the snug tightened condition.

12. RE-TIGHTENING AND RE-TENSIONING

Bolting may be snug-tightened, slackened and re-tightened again as required during the erection of the steel work. However, once the bolt has been tensioned, slackening and re-tensioning shall be kept to a minimum with a maximum cycle of one re-tensioning permitted provided the bolt is in the same hole. Where a tensioned bolt has been slackened the reference marks shall be removed so as not to cause confusion with the second and final tensioning.

13. INSPECTION

Bolts nuts and washers shall be inspected after snug tightening to ensure mating surfaces have been brought together adequately and reference marks have been placed on each bolt head and nut.

Bolts tensioned by the part turn method shall be re-inspected to ensure the reference marks have been rotated by the required amount. A representative of the owner or inspecting authority shall supervise bolts tensioned by the direct tensioning method. After direct tensioning all bolts shall be suitably marked to indicate they have received the tensioning treatment.

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