Bolting Categories 8.8TF/8.8TB

The design, fabrication, assembly and inspection of steel structures using metric high strength structural bolts and nuts to AS 1252 are covered in AS 4100 – SAA Steel Structures Code which should be referred to for more detailed information.

The requirements for bolting Categories 8.8TF/8.8TB are in essence the same as those previously given in AS 1511 – 1984. The ASAA High Strength Structural Bolting Code which was withdrawn on 26/10/91.

The following are abstracts from AS 4100.

(1) Assembly

Each bolt and nut shall be assembled with at least one washer and where only one washer is used it shall be placed under the rotating component. Tightening of the bolts shall proceed from the stiffest part of the joint toward the free edges.

Under no circumstances shall bolts which have been fully tightened be reused in another joint or structure. They may be retightened once in the same hole.

(2) Methods of Tightening

Tightening methods permitted can be either "part turn method" or use of "direct tension indicators" (Coronet® Load Indicators).

a) Part Turn Tightening Method

On assembly all bolts and nuts in the joint are first tightened to a snug tight condition. Snug tight is defined as the tightness attained by the full effort of a man using a standard podger spanner or by a few impacts of an impact wrench. Location marks are then established to mark the relative position of the bolt and nut. The bolts are then finally tightened by the amount shown in Table 24.

b) Direct Tension Indicators[1]

Tightening of bolts and nuts shall be in accordance with the manufacturer's instructions and the following procedure[2]. On assembly all bolts and nuts in the joint are first tightened to the snug tight condition. Then the bolt and nut are tightened to provide the minimum tension specified in Table 25.

b.1) This method of tightening can be carried out with Coronet® Load Indicators. Refer page 51.

b.2) AS 4100 requires that the suitability of the device shall be demonstrated by testing at least three specimens for each diameter and grade in a calibration device capable of indicating bolt tension and proving that the device indicates a tension at least 105% of the specified minimum.

(3) Inspection

Bolts and nuts that show on visual inspection any evidence of physical defects shall be removed and replaced by new ones. The following methods shall be used to check that all bolts are fully tightened. For "part turn" tightening, by ensuring that the correct part turn from the snug position can be measured or observed. For "direct tension indicator" tightening, by ensuring

Bolting Categories 8.8TF/8.8TB

Table 24 AS 4100 - 1990 Nut Rotation from the Snug-Tight condition.

	Disposition of outer face of bolted parts (See notes 1, 2, 3, 4)		
Bolt Length (Underside of head to end of bolt)	**Both Faces normal to axis**	**One Face normal to bolt axis and other sloped**	**Both Faces sloped**
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters (see note 5)	2/3 turn	5/6 turn	1 turn

NOTES

1. *Tolerance on rotation: for 1/2 turn or less, one twelfth of a turn (30°) over and nil under tolerance; for 2/3 turn or more, one eighth of a turn (45°) over and nil under tolerance.*
2. *The bolt tension achieved with the amount of nut rotation specified in Table 24 will be at least equal to the minimum bolt tension specified in Table 25.*
3. *Nut rotation is the rotation relative to the bolt, regardless of the component turned.*
4. *Nut rotations specified are only applicable to connections in which all material within the grip of bolt is steel.*
5. *No research has been performed to establish the turn-of-nut procedure for bolt lengths exceeding 12 diameters. Therefore, the required rotation should be determined by actual test in a suitable tension measuring device which simulates conditions of solidly fitted steel.*

that the manufacturer's specified tightening procedure has been followed and that the development of the minimum bolt tension is indicated by the tension indicating device.

a) Direct Tension Indicators

Inspect according to the manufacturer's recommendations. In the event that Blacks Fasteners Coronet® Load Indicators have been used, these recommendations are set out on page 51.

(4) Inspection of Bolt Tension using a Torque Wrench

a) In the event that the specified procedure for part-turn tightening ie. method verification and application of match marking for later inspection, was not followed and direct tension indicators were not installed some method for subsequent checking of bolt tension is sometimes required by the inspection engineer.

Note that tightening by torque control was found to be reliable in practice, not least because few erectors purchased the equipment necessary to perform the procedure for calibration of the bolts/wrench combinations which are to be used in the structure, and was deleted from the SAA High Strength Bolting Code. Logically, it is also not reliable for inspection of the correct tension in bolts either.

The procedure given in the following is suitable for detecting gross under-tension, eg. bolts which have been "snugged" only, but cannot be relied upon to distinguish bolts which although

tightened well beyond snug may not have been fully tensioned.

NOTE:

The principal factors which limit the reliability of the method are:-

a) the equivalence of thread and bearing face surface condition and lubrication of the calibration samples and job bolts.

b) the occurrence of galling during tightening.

c) the time lapse between tensioning and inspection especially as regards corrosion which may have occurred.

It is emphasised that correct tensioning can only be assured by-

1. Using the correct bolts and nuts (Blacks AS 1252 High Strength Structural)

2. Verifying proper snugging of all bolts in the joint. (This should be the time of first inspection - joint should be solid)

3. Applying match marks - desirably permanent, or verifying about 1-2mm gap at Coronet load indicator. The load indicator inherently provides a permanent witness of correct tensioning.

4. Witnessing that the tooling available can easily achieve the required part-turn or crush the load indicator to the specified average gap.

Bolt Tension Information for Setting Inspection Wrenches

(4.1) Calibration

Inspection Wrench. The inspection wrench may be either a hand-operated or adjustable power-operated wrench. It should be calibrated at least once per shift or more frequently if the need to closely simulate the conditions of the bolts in the structure so demands.

The torque value determined during the calibration may not be transferred to another wrench.

The point being that there is no "inspection torque" for each size of bolt!

Each lot of bolts and each tool to be deployed must be individually calibrated at the time of tightening/inspection.

Adequately inspection with a torque wrench is virtually impossible because it is practically impossible to obtain samples for the calibration procedure which truly represent the bolts to be inspected. This is illustrated by fig. 15 which shows the torque-tension calibration of three M24 galvanised bolt assemblies submitted from a site by a party required to apply torque-wrench inspection.

Samples. At least three bolts, desirably of the same size (minimum length may have to be selected to suit the calibration device) and conditions as those

under inspection should be placed individually in a calibration device capable of indicating bolt tension.

IMPORTANT: Without this calibrating device torque wrench inspection to the code is not possible!

A hardened washer should be placed under the part turned.

Each calibration specimen should be tensioned in the calibrating device by any convenient means to the minimum tension shown for that diameter in Table 25. The inspection wrench then should be applied to the tensioned bolt and the torque necessary to turn the nut or bolt head 5 degrees (approximately 25mm at 300mm radius) in the tensioning direction should be determined. The average torque measured in the tests of at least three bolts should be taken as the job inspection torque.

(4.2) Inspection

Bolts represented by the sample prescribed in Paragraph B2 which have been tensioned in the structure should be inspected by applying, in the tensioning direction, the inspection wrench and its job inspection torque to such proportion of the bolts in the structure as the supervising engineer prescribes.

NOTE For guidance it is suggested that a suitable sample size would be 10 percent of the bolts but not less than two bolts in each connection are to be inspected.

(4.3) Action

Where no nut or bolt is turned by the job inspection torque, the connection should be accepted as properly tensioned. Where any nut or bolt head is turned by the application of the job inspection torque, this torque should then be applied to all other bolts in the connection and all bolts whose nut or head is turned by the job inspection torque should be tensioned and re-inspected. Alternatively, the fabricator or erector at is option, may retention all of the bolts in the connection and then resubmit the connection for inspection.

Table 25
Bolt Tension Information for Setting Inspection Wrenches

Nominal bolt diameter	Bolt Tension Minimum		
	kN	Kips	ton f
M16	95	21.3	9.5
M20	145	32.6	14.55
M24	210	48.6	21.7
M30	335	77.1	34.4
M36	490	112.9	50.3

Bolting Categories 8.8TF/8.8TB

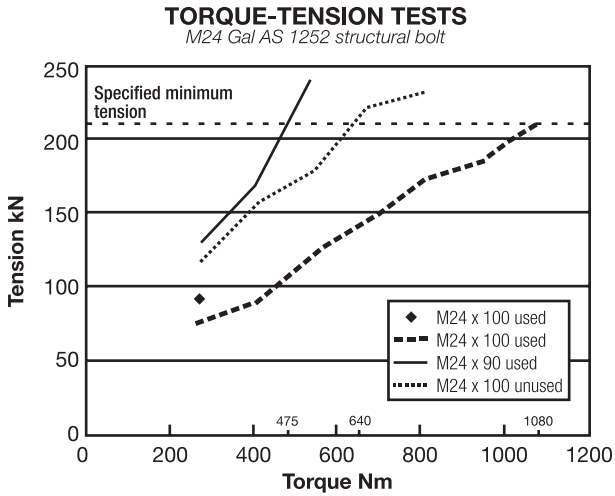

Figure 15

This data, established on specimens returned from a site where inspection was required by the responsible Engineer, illustrates the difficulty of applying torque inspection to establish the correct tensioning of Bolting Categories 8.8TF/8.8TB connections.

The plotted points show tension against the more consistent dynamic friction (nut in motion) torque rather than the torque to overcome static friction of a stationary nut as in the procedure in the Australian Structural Steel Code. Either way the calibration torque is determined on freshly tensioned assemblies which may or may not be what is to be inspected.

The first point for the M24 x 100 removed from the structure is plotted twice as the wrench ran out of travel before reaching the 270 Nm set point the first time.