

Guidance Document

G1919

Fleet Maintenance "Torque Tightening"

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1 Purpose

- 1.1 To provide a good practice torque tightening guide for London Underground fleet maintainers and overhaulers. It covers proof strength, various fixing methods, torque settings, torque wrench setting procedures, how torque fixings are detailed on drawings and the importance of complying with assembly work instructions to prevent dangerous and expensive failures due to incorrectly tightened assemblies.

2 Scope

- 2.1 This Guidance applies to fleet train maintenance and equipment overhaul carried out by London Underground Limited.

3 Guidance

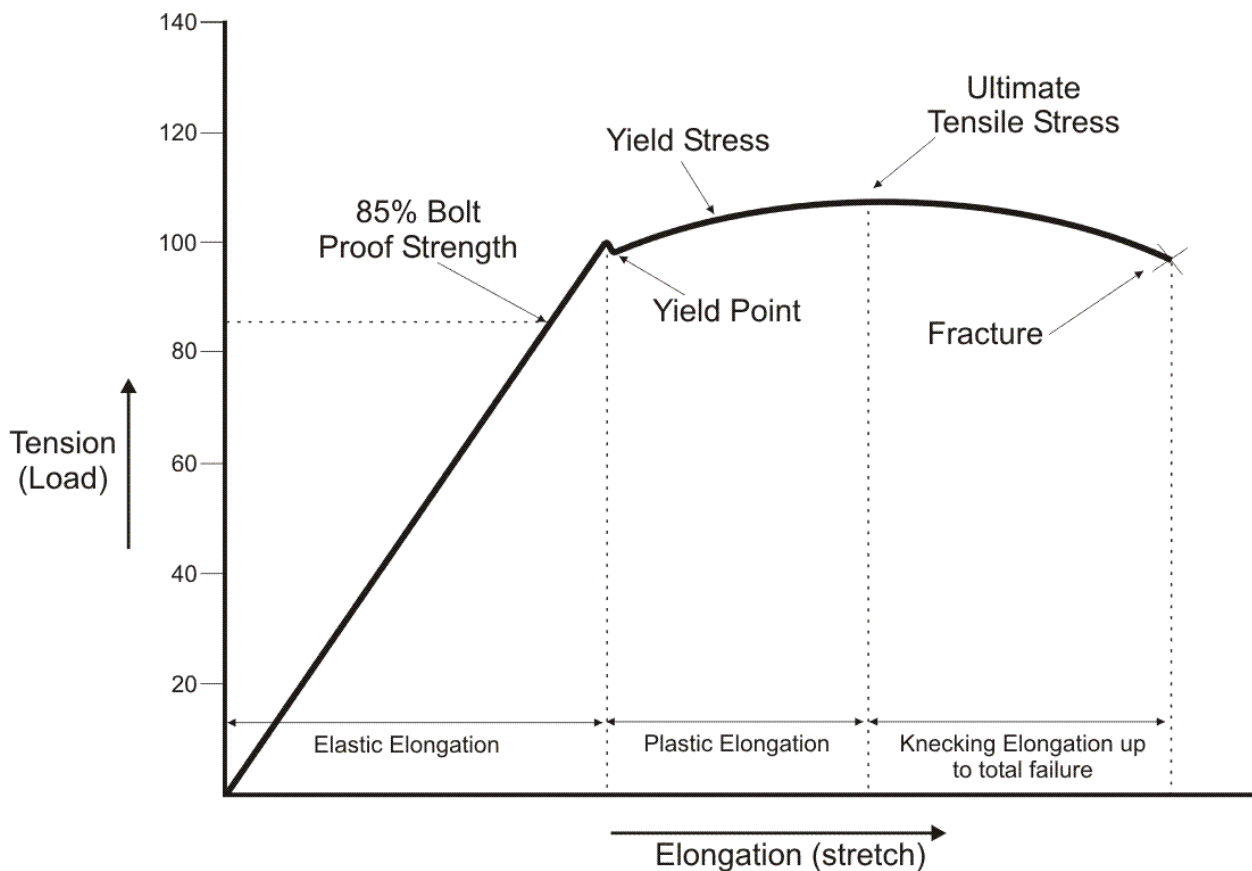
3.1 Why are torque settings important?

- 3.2.1 A bolted joint works by clamping the two fastened parts together. The applied torque provides clamping load to hold the parts together securely.
- 3.2.2 When a fastener is tightened, it is stretched. This creates tension in the bolt, which in turn creates a compression force between the two parts being fastened. This force is known as Preload.
- 3.2.3 The required preload is determined so that external forces that are applied to the joint are less than the preload. This means there is 'no separation' of the faces and load 'is shared between' the compressed faces of the two parts 'and the bolt'. 'The stiffer the bolt, the larger proportion of the load that it takes'.
- 3.2.4 'Preload also allows friction between the faces to resist slippage of the faces, ensuring the bolt never acts in shear, where it is weakest.'
- 3.2.5 It is important to generate the correct preload in a joint – too much can plastically deform the fastener, too little and face slippage could occur leading to shear forces acting on the bolt or excessive load will be transferred to the fastener, both of which can result in failure.

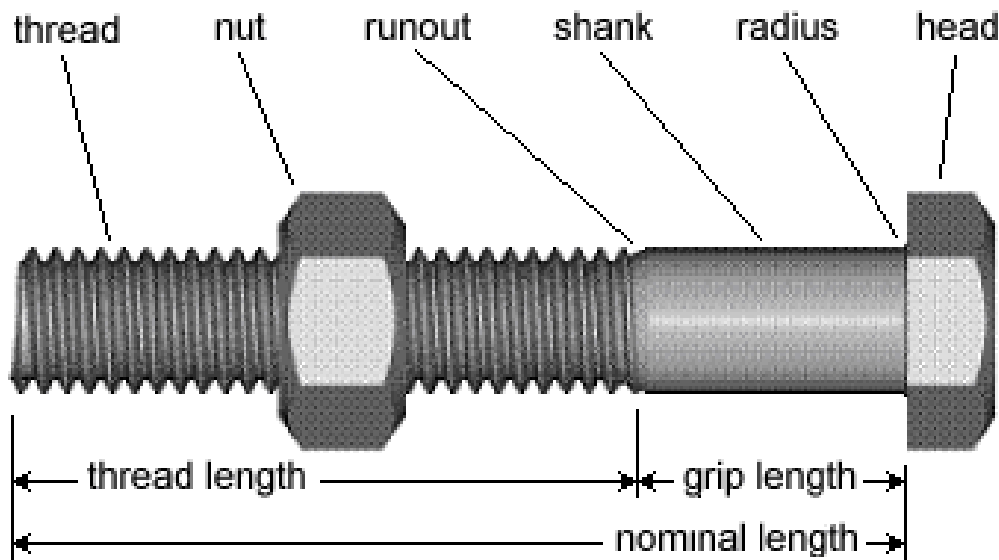
3.2 Bolt proof strength and yield point

- 3.3.1 Yield Strength' is the maximum tensile stress that a material can withstand before it plastically deforms.
- 3.3.2 If plastic deformation occurs in a bolt, the preload in the joint is reduced as the 'tension' in the bolt is reduced due to the material deforming. 'No more preload can now be applied to the interface, and hence may be lower than what you require. Further tightening of the bolt cannot be achieved and may result in catastrophic failure of the bolt.'

- 3.3.3 'Should a plastically deformed bolt be put into service it is most likely to fail when subjected to any increase in load'.
- 3.3.4 However, in order to create a secure joint, a tensile stress of more than 75% of the Bolt Proof Strength must be generated.
- 3.3.5 Recommended torques will typically result in a bolt stress at approximately 85% of a fastener's Bolt Proof Strength. This gives a suitable tension in the bolt, while not risking exceeding the yield point of the material.
- 3.3.6 Graph of Tension vs Elongation showing the various stages of deformation.

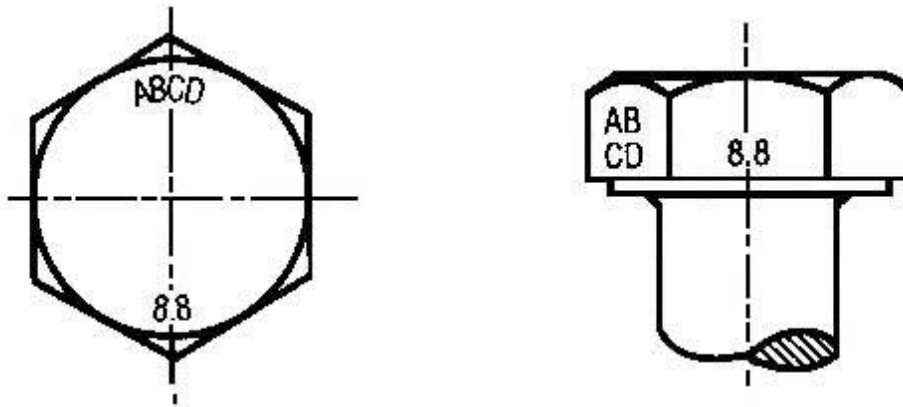


3.3 Anatomy of a bolt



3.4 Bolt markings

- 3.4.1 The marking shall be made preferably on the top of the head by indenting or embossing, or on the side of the head by indenting (see Figure 11). In the case of bolts or screws with flange, marking shall be on the flange when the manufacturing process does not allow marking on the top of the head.

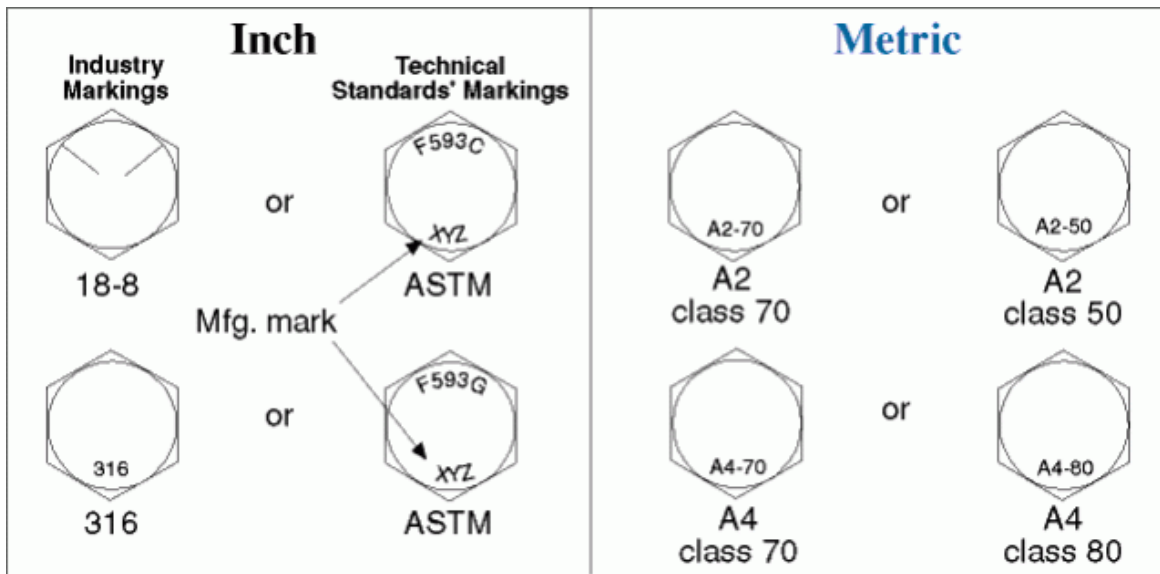


Examples of marking on hexagon head bolts and screws

ABCD - Manufacturer's identification mark.

8.8 - Property class symbol.

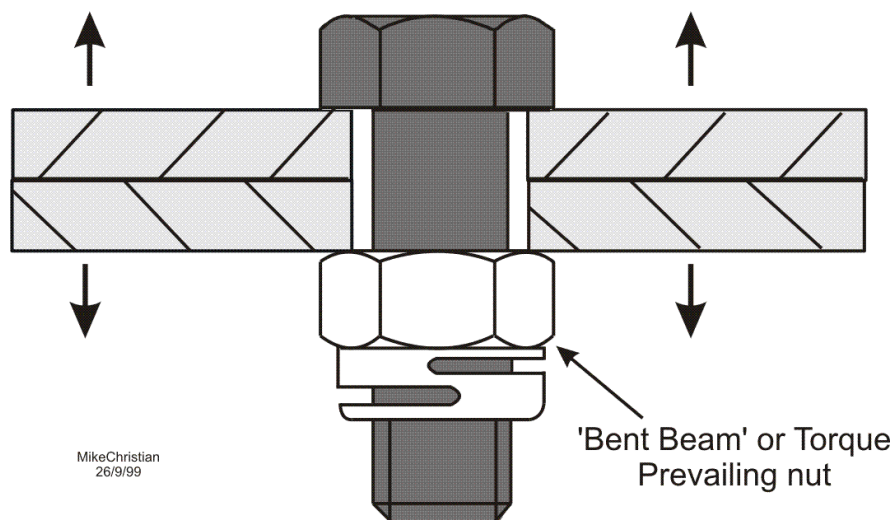
3.5 Stainless steel bolts



- 3.5.1 A2 and A4 bolts come in different metric classes. The bolt type and metric class is usually marked on top of the bolt head, for instance "A2-70." The class depicts the tensile strength of the bolt divided by 10. For example, a bolt marked "A2-70" is a 304 stainless steel bolt with a 700 N/mm² tensile strength.
- 3.5.2 The A2 stainless steel grade bolt has a decent corrosion resistance under normal conditions such as wet surroundings, oxidizing and organic acids or alkali and salt solutions. The A4, however, is also called an "acid proof" steel grade, as it is more corrosion resistant than the A2. The A4 "marine grade" proves to be resistant in highly corrosive environments such as sea climates, and industrial atmospheres with lots of oxidizing acids.

3.6 Tensile loads

When the load force is less than the Preload of the joint, no movement of the joint, "and the load is shared proportionally by the clamped material and fixings."



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26/9/99