Guidance notes
Bolted joints

Fact sheet
June 2021

Background

Joints are critical for mechanically joining pipes and fittings. They are also components that can fail if not correctly selected or fitted.

Matching the correct bolts, joint seal, bolting parameters and expected service is important for the longevity and safety of a joint.

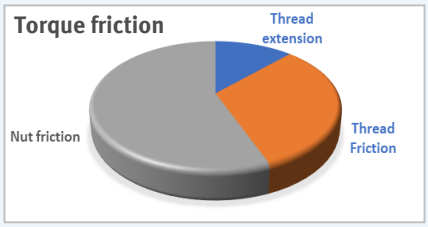
Flange standards and bolt grade recommendations

Most standards will cover the recommended bolt size and class often refer to a recommended bolting standard.

- AS/NZS4087 recommends bolt classes change at 600mm from class 4.6 to 8.8 and the equivalent for stainless-steel bolts.
- EN1092 links the bolt type to the material grade, which for materials typically used by us relates to class 8.8 as described in EN1515-2.
- Specialist equipment may provide a recommended bolt grade,bolt load and torque requirement.

Factors that impact bolt tightening

- **Torque distribution:**
  - Nut surface friction
  - Thread friction
  - Thread extension



- **Lubrication:** Determines the friction that affects the bolt torque calculation to obtain the bolt load, as demonstrated by the Rotzler equation (DIN946).
- **Bolt yield strength:** Achieving suitable bolt load (within the material strength curve) to withstand the joint forces yet not be too low to cause self-loosening (from bolt and joint movement).
- **Gasket properties:** The deformation of the gasket under loading and suitability to seal with the flange load distribution.
- **Pressure rating:** Extra loading that can occur when pressure is increased in a joint that will run up the bolt material yield curve.
- **Dynamic forces on the joint:** Movement during transportation and installation, support of the joint and flow dynamics.

References

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- MS – Material supply standard
- ME – General mechanical construction standard

Other

- AS/NZS4087 metallic flanges for waterworks purposes
- EN1092-1; – two flanges and their joints for pipes, valves, fittings and accessories, PN designated (steel and cast-iron flanges)
- DIN946 – determination of coefficients of friction of bolts
- EN 1591-1 flanges and their joints. Design rules for gasketed circular flange connections
- EN 1515-2 flanges and their joints. Bolting. Classification of bolt materials for steel flanges

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Bolt tightening methods

- **Torque control tightening** – Common method recommended by us for applying a set of friction factors that translates to a calculated bolting load.
- **Angle control tightening (nut turn)** – The bolt is tightened to a predetermined angle beyond the elastic range. The method requires experimental determination of the correct angle. More suited to structural joints.
- **Yield controlled tightening** – Incorporating sensors to read torque and angle during the tightening process to 'feel' the point where the yield curve changes. This minimises the influence of friction. More suited to structural joints.
- **Bolt stretch** – This method is a solution for large bolts that require high torque to achieve the bolt load. A ram fits over the bolt and nut. The extended bolt thread is pulled to pre-stretch to the correct bolt load and the nut is snug up by hand. Bolt load slightly reduces as this method does not account for stretch in the nut and requires slightly longer bolts to be used.
- **Heat tightening** – The heated bolt expands and once the nut is installed it will contract as it cools down and loads the bolt.
- **Tension indicating** – Special bolts and washers with a physical indicator to show when bolt load is achieved. The use of indicating washers is widely used in structural engineering where the washer indicator plasticizes under load from the bolt.

Risks of the common torque control method

- ! Under lubricating will result in not reaching the required bolt load that will result in leakage or self loosening.
- ! Over lubrication will lead to very rapid over-loading of the bolt that can result in bolt failure or failure under operation.
- ! Using surface contact areas to over or under estimate the required torque values.
- ! Equipment inaccuracy can dramatically influence the load.

Following good practice involves:

- Matching the gasket with joint performance required and bolt specification
- Ensure lubrication is correctly achieved
- Ensure equipment is calibrated and certified
- Assemblies should follow best practice and must be re-checked as the materials may relax.

Useful links:

www.watercare.co.nz/Water-and-wastewater/Building-and-developing/Engineering-standards-framework

www.aucklanddesignmanual.co.nz/regulations/codes-of-practice

http://www.legislation.govt.nz/act/public/2009/0032/latest/DLM2044909.html

References

Other

- Self-loosening of threaded fasteners, Dr. Bill Eccles, Bolt Science
- Guidelines for the management of the integrity of bolted joints for pressurised systems, Energy Institute (UK), 2007

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