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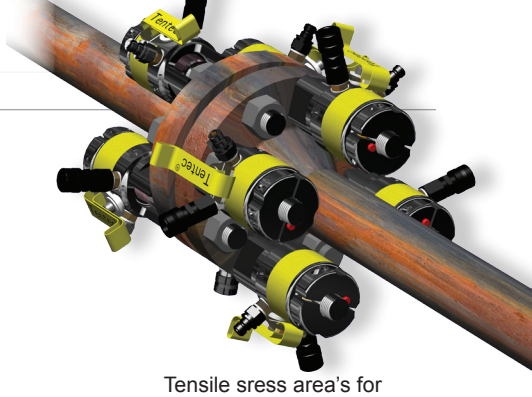


Tips on Bolt Tensioning

Calculation notes on using Hydraulic bolt tensioning tools.

Step1: Determining required bolt load from a known bolt stress.

Formula to use:

Residual Bolt Load = Bolt Stress x Bolt Tensile Stress Area

Units:

Residual Bolt Load = (N or Tons)

Bolt Tensile Stress Area = (mm2 or In2)

Below are tables of standard ISO Metric and Imperial Thread forms along with applicable tensile stress area's.

⚠ *Caution:*

Using these Tensile Stress Area values is only applicable for fully threaded studs, if the stud in question is wasted or reduced in diameter, the Tensile Stress Area will need to be calculated using the smallest stressed diameter on the bolt.

Formula to use:

Bolt Tensile Stress Area = pi/4 x (d2)

Units

Bolt Tensile Stress Area = (mm2 or In2)

d = Smallest Stressed Diameter on bolt = (mm or In)

⚠ Design Check:

It is always good practise to determine the % of bolt yield you are applying, if the final bolt stress exceeds 75% of the bolt yield strength, then it may be neccasary to consider the fatigue characteristics of the bolt and joint.

NEVER EXCEED 95% OF THE BOLT YIELD STRENGH

Formula to use:

% of Yield = (Bolt Stress Required / Yield Strength of bolt) x 100

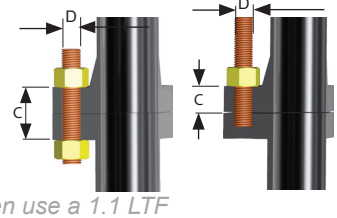
Units:

Bolt Stress Required =(N/mm2 or Ton/In2)

Yield Strength of Bolt =(N/mm2 or Ton/In2)

Step 2: Determining the Load Transfer Factor

Any stretch Bolt Tensioner regardless of make, exhibits a Load Transfer Loss as the bolt load is transferred from the Tensioner to the joints hexagon or round nuts. The Bolt load loss is a direct loss of stud elongation, this is due to many different factors, such as thread deflections, radial expansion of the nut and 'bedding in' of the nut into the joint reaction surface. Because of this phenomena it is essential that a load allowance is made when calculating the required operating pressure of a Tensioner, to achieve a known residual bolt load, extra load must be applied so the bolt will relax down to the required load on transfer. The load transfer factor can be accurately calculated and is a direct function of joint clamp length and the nominal diameter of the stud.



Formula to use:

Load Transfer Factor = 1.01 + (D / C)

Units

D = Nominal Thread Diameter (mm or In)

C = Bolt Clamp Length (mm or In)

Note: If the calculated LTF is less than 1.1, then use a 1.1 LTF

⚠ Caution:

Applying the Load Transfer Factor to the Required bolt Stress will Increase the % of yield being generated on the bolt this value must be checked again

.....continued over page

Tensile sress area's for standard unified threads. Extracted from BS.1507

Nom Dia	TPI	Tensile Stress Area In2
1	8	0.612
1.125	8	0.798
1.25	8	1.008
1.375	8	1.242
1.5	8	1.502
1.625	8	1.79
1.75	8	2.09
1.875	8	2.43
2	8	2.78
2.25	8	3.57
2.5	8	4.46
2.75	8	5.44
3	8	6.53
3.25	8	7.71
3.5	8	8.99
3.75	8	10.36
4	8	11.84
4.25	8	13.41
4.5	8	15.06
4.75	8	16.9
5	8	18.7
5.25	8	20.7
5.5	8	22.8
5.75	8	24.9
6	8	27.2

ISO Metric screw threads - coarse series. Extracted from BS.3643

Nom Dia	Pitch	Tensile Stress Area mm2
16	2	157
18	2.5	192
20	2.5	245
22	2.5	303
24	3	353
27	3	459
30	3.5	561
33	3.5	694
36	4	801
39	4	976
42	4.5	1120
45	4.5	1300
48	5	1470
52	5	1760
56	5.5	2030
60	5.5	2360
64	6	2680
68	6	3060

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Formula to use:
% of Yield = (Bolt Stress Required / Yield Strength of bolt) x 100 x LTF
Units
Bolt Stress Required (N/mm2 or Ton/In2)
Bolt Stress Required (N/mm2 or Ton/In2)
Design Check
if the final bolt stress exceeds 75%, then it may be necessary to consider the fatigue characteristics of the bolt and joint.
NEVER EXCEED 95% OF THE BOLT YIELD STRENGH

Step 3: Determining tool pressure to achieve required bolt load.

Formula to use:
Tool Pressure = (Required Bolt Load x LTF) / Tool Hydraulic Pressure Area
Units
Tool Pressure = (N/mm2 or Ton/In2)
Required Bolt Load = (N or Ton)
LTF = (No Units)
Tool Hydraulic Pressure Area = (mm2 or In2)
**To convert N/mm2 to bar: Multiply by 10*
** To Convert Ton/In2 to psi: Multiply by 2240*
Caution:
Check that the calculated tool pressure does not exceed the Maximum Working Pressure of the tool. This value is hard stamped on all Tentec tools and is documented on the tool technical data sheet which came with the tools.

Worked Example.
Required Bolt Stress = 365.8N/mm2
Bolt Clamp Length = 144mm
Bolt Diameter M36 x 4
Bolt Yield Strength = 720 N/mm2
Bolt Tensile Stress Area = 817mm2 (Taken from above table)
Tool Hydraulic Pressure Area = 2955mm2 (Taken from the tool)

Required Bolt Load = Reqd Bolt Stress x Tensile Stress Area
= 365.8 x 817
= 298858N

LTF= 1.01 + (Bolt Dia / Clamp Length)
= 1.01 + (36/144) = 1.26

% Yield Check = (Reqd Bolt Stress / Bolt Yield Strength) x LTF x 100
= (365.8 / 720)x 1.26 x 100 = 64.01%

Tool Pressure = (Reqd Bolt Load x LTF) / Tool Hydraulic Pressure Area
= (298858 x 1.26) / 2955
= 127.43 N/mm2 = 1274.3 bar

Step 4: Useful Formula

Bolt Stress = Bolt Load / Bolt Tensile Stress Area

Bolt Load = Bolt Stress x Bolt Tensile Stress Area

Tool Pressure = ((Required Bolt Load x LTF) / (Tool Hydraulic Area))

Safety Notes
Never exceed the Tensioner maximum working pressure
Never exceed the Tensioner maximum piston/ram stroke

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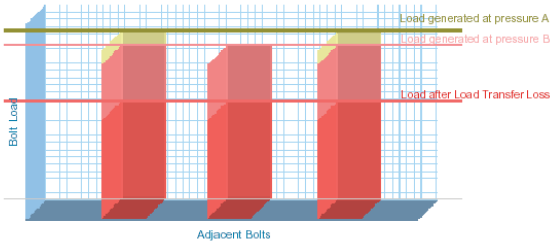
Step 5: Cross Loading Factor

Cross Load Loss.

For less than 100% tensioning it is necessary to use two tightening pressures. Tentec refer to these pressures as Pressure A and Pressure B. These two pressures are necessary in order to compensate for the bolt load loss that occurs when a bolt is tensioned adjacent to an already tensioned bolt. The already tensioned bolt looses load as load is being applied to its adjacent partner. To compensate for this load loss extra load is applied in the form of pump pressure A, to the first bolt so that it relaxes down to the required load.

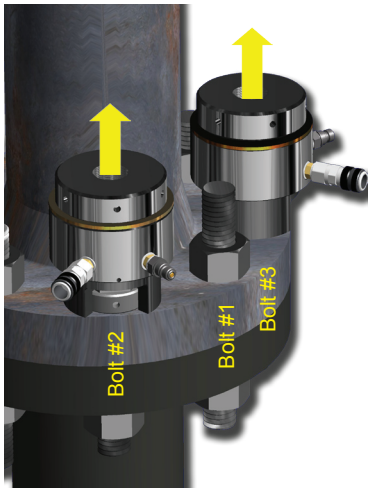


Bolt #1 - Proportion of load lost diagram

This indicates the lost load due to the cross loading factor as bolt B2 is being tensioned.

This indicates the loast load due to the Load Transfer Factor occuring when the tool pressure is released.

This indicates the final retained load retained in the bolt.



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