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Threaded Bolted Joints Formulas

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List of 34 Threaded Bolted Joints Formulas

Threaded Bolted Joints

Bolt Dimensions

1) Core Diameter of Bolt given Maximum Tensile Stress in Bolt

$$fx \quad d_c = \sqrt{\frac{P_{tb}}{\left(\frac{\pi}{4}\right) \cdot \sigma_{t_{max}}}}$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$ex \quad 12.02255mm = \sqrt{\frac{9990N}{\left(\frac{\pi}{4}\right) \cdot 88N/mm^2}}$$

2) Core Diameter of Bolt given Shear Area of Nut

$$fx \quad d_c = \frac{A}{\pi \cdot h}$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$ex \quad 11.98967mm = \frac{226mm^2}{\pi \cdot 6mm}$$



3) Core Diameter of Bolt given Tensile Force on Bolt in Shear

$$fx \quad d_c = P_{tb} \cdot \frac{f_s}{\pi \cdot S_{sy} \cdot h}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 11.99063\text{mm} = 9990\text{N} \cdot \frac{3}{\pi \cdot 132.6\text{N}/\text{mm}^2 \cdot 6\text{mm}}$$

4) Core Diameter of Bolt given Tensile Force on Bolt in Tension

$$fx \quad d_c = \sqrt{\frac{P_{tb}}{\frac{\pi}{4} \cdot \frac{S_{yt}}{f_s}}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 11.98854\text{mm} = \sqrt{\frac{9990\text{N}}{\frac{\pi}{4} \cdot \frac{265.5\text{N}/\text{mm}^2}{3}}}$$


5) Nominal Diameter of Bolt given Diameter of Hole inside Bolt

$$fx \quad d = \sqrt{d_1^2 + d_c^2}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 15\text{mm} = \sqrt{(9\text{mm})^2 + (12\text{mm})^2}$$




6) Nominal Diameter of Bolt given Height of Standard Nut 

$$fx \quad d = \frac{h}{0.8}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 7.5mm = \frac{6mm}{0.8}$$

7) Nominal Diameter of Bolt given Stiffness of Bolt 

$$fx \quad d = \sqrt{\frac{(k_b') \cdot l \cdot 4}{E \cdot \pi}}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 14.97437mm = \sqrt{\frac{3.17E^5N/mm \cdot 115mm \cdot 4}{207000N/mm^2 \cdot \pi}}$$

8) Nominal Diameter of Bolt given Wrench Torque 

$$fx \quad d = \frac{M_t}{0.2 \cdot P_i}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 15mm = \frac{49500N \cdot mm}{0.2 \cdot 16500N}$$



Joint Analysis

9) Amount of Compression in Parts Joined by Bolt

$$fx \quad \delta_c = \frac{P_i}{k}$$

[Open Calculator !\[\]\(74d4806277d7e73349d8e8c0897931e9_img.jpg\)](#)

$$ex \quad 11\text{mm} = \frac{16500\text{N}}{1500\text{N/mm}}$$

10) Elongation of Bolt under Action of Pre Load

$$fx \quad \delta_b = \frac{P_i}{k_b}$$

[Open Calculator !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)

$$ex \quad 0.05205\text{mm} = \frac{16500\text{N}}{3.17\text{E}^5\text{N/mm}}$$

11) Factor of Safety given Tensile Force on Bolt in Tension

$$fx \quad f_s = \frac{\pi}{4} \cdot d_c^2 \cdot \frac{S_{yt}}{P_{tb}}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$ex \quad 3.00574 = \frac{\pi}{4} \cdot (12\text{mm})^2 \cdot \frac{265.5\text{N/mm}^2}{9990\text{N}}$$



12) Maximum Tensile Stress in Bolt

$$\text{fx } \sigma_{t_{\max}} = \frac{P_{tb}}{\frac{\pi}{4} \cdot d_c^2}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 88.33099\text{N/mm}^2 = \frac{9990\text{N}}{\frac{\pi}{4} \cdot (12\text{mm})^2}$$

13) Primary Shear Force of Eccentrically Loaded Bolted Connection

$$\text{fx } (P_1') = \frac{P}{n}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 3000\text{N} = \frac{12000\text{N}}{4}$$

14) Yield Strength of Bolt in Shear given Tensile Force on Bolt in Shear

$$\text{fx } S_{sy} = P_{tb} \cdot \frac{f_s}{\pi \cdot d_c \cdot h}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 132.4965\text{N/mm}^2 = 9990\text{N} \cdot \frac{3}{\pi \cdot 12\text{mm} \cdot 6\text{mm}}$$

15) Yield Strength of Bolt in Tension given Tensile Force on Bolt in Shear

$$\text{fx } S_{yt} = \frac{2 \cdot P_{tb} \cdot f_s}{\pi \cdot d_c \cdot h}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$\text{ex } 264.993\text{N/mm}^2 = \frac{2 \cdot 9990\text{N} \cdot 3}{\pi \cdot 12\text{mm} \cdot 6\text{mm}}$$



16) Imaginary Force at Center of Gravity of Bolted Joint given Tensile Force on Bolt in Tension

$$fx \quad S_{yt} = 4 \cdot P_{tb} \cdot \frac{f_s}{\pi \cdot d_c^2}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 264.993\text{N/mm}^2 = 4 \cdot 9990\text{N} \cdot \frac{3}{\pi \cdot (12\text{mm})^2}$$

Load and Strength Characteristics

17) Imaginary Force at Center of Gravity of Bolted Joint given Primary Shear Force

$$fx \quad P = (P_1') \cdot n$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd_img.jpg\)](#)

$$ex \quad 12000\text{N} = 3000\text{N} \cdot 4$$

18) Number of Bolts given Primary Shear Force

$$fx \quad n = \frac{P}{P_1'}$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e_img.jpg\)](#)

$$ex \quad 4 = \frac{12000\text{N}}{3000\text{N}}$$



19) Pre Load in Bolt given Amount of Compression in Parts Joined by Bolt



$$fx \quad P_i = \delta_c \cdot k$$

Open Calculator

$$ex \quad 16500N = 11mm \cdot 1500N/mm$$

20) Pre Load in Bolt given Elongation of Bolt

$$fx \quad P_i = \delta_b \cdot (k_b')$$

Open Calculator

$$ex \quad 15850N = 0.05mm \cdot 3.17E^5N/mm$$

21) Pre Load in Bolt given Wrench Torque

$$fx \quad P_i = \frac{M_t}{0.2 \cdot d}$$

Open Calculator

$$ex \quad 16500N = \frac{49500N \cdot mm}{0.2 \cdot 15mm}$$

22) Resultant Load on Bolt given Pre Load and External Load

$$fx \quad P_b = P_i + \Delta P$$

Open Calculator

$$ex \quad 19000N = 16500N + 2500N$$



23) Stiffness of Bolt given Thickness of Parts Joined by Bolt 

$$fx \quad (k_b') = \frac{\pi \cdot d^2 \cdot E}{4 \cdot l}$$

Open Calculator 


$$ex \quad 318086.3N/mm = \frac{\pi \cdot (15mm)^2 \cdot 207000N/mm^2}{4 \cdot 115mm}$$

24) Tensile Force on Bolt given Maximum Tensile Stress in Bolt 

$$fx \quad P_{tb} = \sigma_{t_{max}} \cdot \frac{\pi}{4} \cdot d_c^2$$

Open Calculator 

$$ex \quad 9952.566N = 88N/mm^2 \cdot \frac{\pi}{4} \cdot (12mm)^2$$

25) Tensile Force on Bolt in Shear 

$$fx \quad P_{tb} = \pi \cdot d_c \cdot h \cdot \frac{S_{sy}}{f_s}$$

Open Calculator 

$$ex \quad 9997.804N = \pi \cdot 12mm \cdot 6mm \cdot \frac{132.6N/mm^2}{3}$$

26) Tensile Force on Bolt in Tension 

$$fx \quad P_{tb} = \frac{\pi}{4} \cdot d_c^2 \cdot \frac{S_{yt}}{f_s}$$

Open Calculator 

$$ex \quad 10009.11N = \frac{\pi}{4} \cdot (12mm)^2 \cdot \frac{265.5N/mm^2}{3}$$



27) Thickness of Parts Held Together by Bolt given Stiffness of Bolt

$$fx \quad l = \frac{\pi \cdot d^2 \cdot E}{4 \cdot (k_b')}$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a_img.jpg\)](#)

$$ex \quad 115.3941\text{mm} = \frac{\pi \cdot (15\text{mm})^2 \cdot 207000\text{N/mm}^2}{4 \cdot 3.17\text{E}^5\text{N/mm}}$$

28) Wrench Torque Required to Create Required Pre Load

$$fx \quad M_t = 0.2 \cdot P_i \cdot d$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010_img.jpg\)](#)

$$ex \quad 49500\text{N} \cdot \text{mm} = 0.2 \cdot 16500\text{N} \cdot 15\text{mm}$$

29) Young's Modulus of Bolt given Stiffness of Bolt

$$fx \quad E = \frac{(k_b') \cdot l \cdot 4}{d^2 \cdot \pi}$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd_img.jpg\)](#)

$$ex \quad 206293.1\text{N/mm}^2 = \frac{3.17\text{E}^5\text{N/mm} \cdot 115\text{mm} \cdot 4}{(15\text{mm})^2 \cdot \pi}$$

Nut Dimensions


30) Diameter of Hole Inside Bolt

$$fx \quad d_1 = \sqrt{d^2 - d_c^2}$$

[Open Calculator !\[\]\(eabd9f9ababee93effadc3b380fe65fd_img.jpg\)](#)

$$ex \quad 9\text{mm} = \sqrt{(15\text{mm})^2 - (12\text{mm})^2}$$



31) Height of Nut given Shear Area of Nut 

$$fx \quad h = \frac{A}{\pi \cdot d_c}$$

Open Calculator 

$$ex \quad 5.994836mm = \frac{226mm^2}{\pi \cdot 12mm}$$

32) Height of Nut given Strength of Bolt in Shear 

$$fx \quad h = P_{tb} \cdot \frac{f_s}{\pi \cdot d_c \cdot S_{sy}}$$

Open Calculator 

$$ex \quad 5.995316mm = 9990N \cdot \frac{3}{\pi \cdot 12mm \cdot 132.6N/mm^2}$$

33) Height of Standard Nut 

$$fx \quad h = 0.8 \cdot d$$

Open Calculator 

$$ex \quad 12mm = 0.8 \cdot 15mm$$

34) Shear Area of Nut 

$$fx \quad A = \pi \cdot d_c \cdot h$$

Open Calculator 

$$ex \quad 226.1947mm^2 = \pi \cdot 12mm \cdot 6mm$$



Variables Used







- ΔP Load due to External Force on Bolt (Newton)
- A Shear Area of Nut (Square Millimeter)
- d Nominal Bolt Diameter (Millimeter)
- d_1 Diameter of Hole inside Bolt (Millimeter)
- d_c Core Diameter of Bolt (Millimeter)
- δ_b Elongation of Bolt (Millimeter)
- E Modulus of Elasticity of Bolt (Newton per Square Millimeter)
- f_s Factor of Safety of Bolted Joint
- h Height of Nut (Millimeter)
- k Combined Stiffness of Bolt (Newton per Millimeter)
- k_b' Stiffness of Bolt (Newton per Millimeter)
- l Total Thickness of Parts held together by Bolt (Millimeter)
- M_t Wrench Torque for Bolt Tightening (Newton Millimeter)
- n Number of Bolts in Bolted Joint
- P Imaginary Force on Bolt (Newton)
- P_1' Primary Shear Force on Bolt (Newton)
- P_b Resultant Load on Bolt (Newton)
- P_i Pre Load in Bolt (Newton)
- P_{tb} Tensile Force in Bolt (Newton)
- S_{sy} Shear Yield Strength of Bolt (Newton per Square Millimeter)
- S_{yt} Tensile Yield Strength of Bolt (Newton per Square Millimeter)
- δ_c Amount of Compression of Bolted Joint (Millimeter)



- $\sigma_{t_{max}}$ Maximum Tensile Stress in Bolt (Newton per Square Millimeter)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Area** in Square Millimeter (mm²)
Area Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Torque** in Newton Millimeter (N*mm)
Torque Unit Conversion 
- **Measurement:** **Stiffness Constant** in Newton per Millimeter (N/mm)
Stiffness Constant Unit Conversion 
- **Measurement:** **Stress** in Newton per Square Millimeter (N/mm²)
Stress Unit Conversion 



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