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# Load and Strength Characteristics Formulas

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# List of 13 Load and Strength Characteristics Formulas

## Load and Strength Characteristics

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

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

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$ex \quad 12000N = 3000N \cdot 4$$

### 2) Number of Bolts given Primary Shear Force

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

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

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


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

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

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

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




4) Pre Load in Bolt given Elongation of Bolt 

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

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

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

5) Pre Load in Bolt given Wrench Torque 

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

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

7) 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 !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

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



8) 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 !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)


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

9) Tensile Force on Bolt in Shear 

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)


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

10) 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 !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

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

11) 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 !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

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



## 12) Wrench Torque Required to Create Required Pre Load

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

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

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

## 13) 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 !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

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








## Variables Used

- $\Delta P$  Load due to External Force on Bolt (Newton)
- $d$  Nominal Bolt Diameter (Millimeter)
- $d_c$  Core Diameter of Bolt (Millimeter)
- $\delta_b$  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)
- $\delta_c$  Amount of Compression of Bolted Joint (Millimeter)
- $\sigma_{tmax}$  Maximum Tensile Stress in Bolt (Newton per Square Millimeter)



## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Measurement:** **Length** in Millimeter (mm)  
*Length 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/mm<sup>2</sup>)  
*Stress Unit Conversion* 



## Check other formula lists

- [Joint Analysis Formulas](#) 
- [Load and Strength Characteristics Formulas](#) 

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