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Structural Response and Force Analysis Formulas

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List of 17 Structural Response and Force Analysis Formulas

Structural Response and Force Analysis ↗

1) Change in external load on bolt given external load and stiffness of bolt ↗

fx $\Delta P_i = P_{ext} \cdot \left(\frac{k_b'}{(k_b') + (k_c')} \right)$

[Open Calculator ↗](#)

ex $5905.512N = 6000N \cdot \left(\frac{75000N/mm}{75000N/mm + 1200N/mm} \right)$

2) Change in Load on Bolt given Resultant Load and Initial Preload in Bolt ↗

fx $\Delta P_i = P_b - P_i$

[Open Calculator ↗](#)

ex $5905N = 6755N - 850N$

3) External Force on Bolt ↗

fx $P_{ext} = n \cdot (P_1')$

[Open Calculator ↗](#)

ex $6000N = 4 \cdot 1500N$



4) Initial Preload in Bolt due to Tightening ↗

$$fx \quad P_i = P_b - \Delta P_i$$

[Open Calculator ↗](#)

$$ex \quad 850N = 6755N - 5905N$$

5) Primary Shear Force on each Bolt ↗

$$fx \quad (P_1') = \frac{P_{ext}}{n}$$

[Open Calculator ↗](#)

$$ex \quad 1500N = \frac{6000N}{4}$$

6) Resultant Load on Bolt ↗

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

[Open Calculator ↗](#)

$$ex \quad 6755N = 850N + 5905N$$

7) Shear Stress at Core Diameter given Shear Yield Strength of Threaded Fastener ↗

$$fx \quad \tau = \frac{S_{sy}}{f_s}$$

[Open Calculator ↗](#)

$$ex \quad 67.30769N/mm^2 = \frac{175N/mm^2}{2.6}$$



8) Shear Stress at Core Diameter of Threaded Fastener given Tensile Force ↗

$$fx \quad \tau = \frac{P}{\pi \cdot (d_c') \cdot h_{nut}}$$

[Open Calculator ↗](#)

$$ex \quad 120.0045N/mm^2 = \frac{28200N}{\pi \cdot 8.5mm \cdot 8.8mm}$$

9) Shear Stress at Core Diameter of Threaded Fasteners given Tensile Yield Strength ↗

$$fx \quad \tau = \frac{\sigma_{yt}}{2 \cdot f_s}$$

[Open Calculator ↗](#)

$$ex \quad 73.07692N/mm^2 = \frac{380N/mm^2}{2 \cdot 2.6}$$

10) Tensile Force acting on Bolt ↗

$$fx \quad P = (\pi \cdot \tau \cdot (d_c') \cdot h_{nut})$$

[Open Calculator ↗](#)

$$ex \quad 28198.94N = (\pi \cdot 120N/mm^2 \cdot 8.5mm \cdot 8.8mm)$$

11) Tensile Force acting on Bolt given Shear Stress ↗

$$fx \quad P = (\pi \cdot \tau \cdot (d_c') \cdot h_{nut})$$

[Open Calculator ↗](#)

$$ex \quad 28198.94N = (\pi \cdot 120N/mm^2 \cdot 8.5mm \cdot 8.8mm)$$



12) Tensile Force acting on Bolt given Tensile Stress ↗

$$fx \quad P = \sigma_t \cdot \pi \cdot \frac{(d_c')^2}{4}$$

Open Calculator ↗

$$ex \quad 8228.028N = 145N/mm^2 \cdot \pi \cdot \frac{(8.5mm)^2}{4}$$

13) Tensile Stress Area of Threaded fastener ↗

$$fx \quad A = \left(\frac{\pi}{4}\right) \cdot \left(\left(\frac{d_p + d_c}{2}\right)^2\right)$$

Open Calculator ↗

$$ex \quad 532.7686mm^2 = \left(\frac{\pi}{4}\right) \cdot \left(\left(\frac{27.2mm + 24.89mm}{2}\right)^2\right)$$

14) Tensile Stress in Core Cross-Section of Bolt given Tensile Force and Core Diameter ↗

$$fx \quad \sigma_t = \frac{P}{\left(\frac{\pi}{4}\right) \cdot \left((d_c')^2\right)}$$

Open Calculator ↗

$$ex \quad 496.9599N/mm^2 = \frac{28200N}{\left(\frac{\pi}{4}\right) \cdot \left((8.5mm)^2\right)}$$



15) Tensile Stress in Core Cross-Section of Bolt given Tensile Yield Strength

$$fx \quad \sigma_t = \frac{\sigma_{yt}}{f_s}$$

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

$$ex \quad 146.1538 \text{N/mm}^2 = \frac{380 \text{N/mm}^2}{2.6}$$

16) Tensile Yield Strength of Bolt

$$fx \quad \sigma_{yt} = f_s \cdot \sigma_t$$

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

$$ex \quad 377 \text{N/mm}^2 = 2.6 \cdot 145 \text{N/mm}^2$$

17) Ultimate Tensile Strength of Bolt

$$fx \quad \sigma_{ut} = 2 \cdot S'_e$$

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

$$ex \quad 440 \text{N/mm}^2 = 2 \cdot 220 \text{N/mm}^2$$



Variables Used

- A Tensile stress area of threaded fastener (*Square Millimeter*)
- d_c Minor Diameter of External Thread (*Millimeter*)
- d_c' Core Diameter of Threaded Bolt (*Millimeter*)
- d_p Pitch Diameter of External Thread (*Millimeter*)
- f_s Factor of Safety for Bolt
- h_{nut} Height of nut (*Millimeter*)
- k_b' Stiffness of Threaded Bolt (*Newton per Millimeter*)
- k_c' Combined Stiffness of Gasket and Parts (*Newton per Millimeter*)
- n Number of Bolts in Joint
- P Tensile Force on Bolt (*Newton*)
- P_1' Primary shear load on bolt (*Newton*)
- P_b Resultant load on bolt (*Newton*)
- P_{ext} External Force on Bolt (*Newton*)
- P_i Initial preload in bolt due to tightening of nut (*Newton*)
- S_e' Endurance limit of rotating beam bolt specimen (*Newton per Square Millimeter*)
- S_{sy} Shear yield strength of bolt (*Newton per Square Millimeter*)
- ΔP_i Change in External Load (*Newton*)
- σ_t Tensile stress in bolt (*Newton per Square Millimeter*)
- σ_{ut} Ultimate tensile strength of bolt (*Newton per Square Millimeter*)
- σ_{yt} Tensile yield strength of bolt (*Newton per Square Millimeter*)



- τ Shear 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: **Area** in Square Millimeter (mm²)
Area Unit Conversion 
- Measurement: **Force** in Newton (N)
Force Unit Conversion 
- Measurement: **Surface Tension** in Newton per Millimeter (N/mm)
Surface Tension 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 



Check other formula lists

- Structural Response and Force Analysis Formulas ↗

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