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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 boad

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

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

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

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

$$\text{fx } \Delta P_i = P_b - P_i$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 5905\text{N} = 6755\text{N} - 850\text{N}$$

3) External Force on Bolt

$$\text{fx } P_e = n \cdot (P_1')$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 6000\text{N} = 4 \cdot 1500\text{N}$$



4) Initial Preload in Bolt due to Tightening

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

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

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

5) Primary Shear Force on each Bolt

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

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

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

6) Resultant Load on Bolt

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

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

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

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

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

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 66.77631N/mm^2 = \frac{175N/mm^2}{2.62069}$$



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

$$\text{fx } \tau = \frac{P}{\pi \cdot (d_c') \cdot h_n}$$

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

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

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

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

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

$$\text{ex } 72.49999\text{N/mm}^2 = \frac{380\text{N/mm}^2}{2 \cdot 2.62069}$$

10) Tensile Force acting on Bolt

$$\text{fx } P = (\pi \cdot \tau \cdot (d_c') \cdot h_n)$$

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

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

11) Tensile Force acting on Bolt given Shear Stress

$$\text{fx } P = (\pi \cdot \tau \cdot (d_c') \cdot h_n)$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

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



12) Tensile Force acting on Bolt given Tensile Stress

[Open Calculator !\[\]\(bd1a142de767a21e5362c595f844a4ff_img.jpg\)](#)

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

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

13) Tensile Stress Area of Threaded fastener

[Open Calculator !\[\]\(830769b31eeeaca920791081939ff8ba_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(47734e4656765d20df4fdbd5b7aff048_img.jpg\)](#)

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

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



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

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

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

$$\text{ex } 145\text{N/mm}^2 = \frac{380\text{N/mm}^2}{2.62069}$$

16) Tensile Yield Strength of Bolt

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

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

$$\text{ex } 380\text{N/mm}^2 = 2.62069 \cdot 145\text{N/mm}^2$$

17) Ultimate Tensile Strength of Bolt

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

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

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



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_n** 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)
- **P₁'** Primary Shear Load on Bolt (Newton)
- **P_b** Resultant Load on Bolt (Newton)
- **P_e** 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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