

Important Structural Response and Force Analysis Formulas PDF



Formulas Examples with Units

List of 17 Important Structural Response and Force Analysis Formulas

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

Formula

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

Example with Units

$$5905.5118 \text{ N} = 6000 \text{ N} \cdot \left(\frac{75000 \text{ N/mm}}{75000 \text{ N/mm} + 1200 \text{ N/mm}} \right)$$

Evaluate Formula

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

Formula

$$\Delta P_i = P_b - P_i$$

Example with Units

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

Evaluate Formula

3) External Force on Bolt Formula

Formula

$$P_e = n \cdot P_1'$$

Example with Units

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

Evaluate Formula

4) Initial Preload in Bolt due to Tightening Formula

Formula

$$P_i = P_b - \Delta P_i$$

Example with Units

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

Evaluate Formula

5) Primary Shear Force on each Bolt Formula

Formula

$$P_1' = \frac{P_e}{n}$$

Example with Units

$$1500 \text{ N} = \frac{6000 \text{ N}}{4}$$

Evaluate Formula

6) Resultant Load on Bolt Formula

Formula

$$P_b = P_i + \Delta P_i$$

Example with Units

$$6755 \text{ N} = 850 \text{ N} + 5905 \text{ N}$$

Evaluate Formula



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

Formula

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

Example with Units

$$66.7763 \text{ N/mm}^2 = \frac{175 \text{ N/mm}^2}{2.62069}$$

Evaluate Formula 

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

Formula

$$\tau = \frac{P}{\pi \cdot d_c' \cdot h_n}$$

Example with Units

$$120.0045 \text{ N/mm}^2 = \frac{28200 \text{ N}}{3.1416 \cdot 8.5 \text{ mm} \cdot 8.8 \text{ mm}}$$

Evaluate Formula 

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

Formula

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

Example with Units

$$72.5 \text{ N/mm}^2 = \frac{380 \text{ N/mm}^2}{2 \cdot 2.62069}$$

Evaluate Formula 

10) Tensile Force acting on Bolt Formula

Formula

$$P = (\pi \cdot \tau \cdot d_c' \cdot h_n)$$

Example with Units

$$28198.9357 \text{ N} = (3.1416 \cdot 120 \text{ N/mm}^2 \cdot 8.5 \text{ mm} \cdot 8.8 \text{ mm})$$

Evaluate Formula 

11) Tensile Force acting on Bolt given Shear Stress Formula

Formula

$$P = (\pi \cdot \tau \cdot d_c' \cdot h_n)$$

Example with Units

$$28198.9357 \text{ N} = (3.1416 \cdot 120 \text{ N/mm}^2 \cdot 8.5 \text{ mm} \cdot 8.8 \text{ mm})$$

Evaluate Formula 

12) Tensile Force acting on Bolt given Tensile Stress Formula

Formula

$$P = \sigma_t \cdot \pi \cdot \frac{d_c'^2}{4}$$

Example with Units

$$8228.0275 \text{ N} = 145 \text{ N/mm}^2 \cdot 3.1416 \cdot \frac{8.5 \text{ mm}^2}{4}$$

Evaluate Formula 

13) Tensile Stress Area of Threaded fastener Formula

Formula

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

Example with Units

$$532.7686 \text{ mm}^2 = \frac{3.1416}{4} \cdot \left(\frac{27.2 \text{ mm} + 24.89 \text{ mm}}{2} \right)^2$$

Evaluate Formula 



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

Formula 

Formula

$$\sigma_t = \frac{P}{\frac{\pi}{4} \cdot d_c^2}$$

Example with Units

$$496.9599 \text{ N/mm}^2 = \frac{28200 \text{ N}}{\frac{3.1416}{4} \cdot 8.5 \text{ mm}^2}$$

Evaluate Formula 

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

Formula

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

Example with Units

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

Evaluate Formula 

16) Tensile Yield Strength of Bolt Formula

Formula

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

Example with Units

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

Evaluate Formula 

17) Ultimate Tensile Strength of Bolt Formula

Formula

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

Example with Units

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

Evaluate Formula 



Variables used in list of Structural Response and Force Analysis Formulas above

- **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 in list of Structural Response and Force Analysis Formulas above

- **constant(s):** 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 



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