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Load, Stress and Fasteners Formulas

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List of 22 Load, Stress and Fasteners Formulas

Load, Stress and Fasteners

Additional Bridge Column Formulas

1) Allowable Load for Bridges using Structural Carbon Steel

Open Calculator

fx $$Q = \left(15000 - \left(\frac{1}{4}\right) \cdot L|r^2\right) \cdot A$$

ex $$527.8054\text{lbs} = \left(15000 - \left(\frac{1}{4}\right) \cdot (140)^2\right) \cdot 81\text{in}^2$$

2) Allowable Load for Bridges using Structural Carbon Steel when Column Ends are Pinned

Open Calculator

fx $$Q = \left(15000 - \left(\frac{1}{3}\right) \cdot L|r^2\right) \cdot A$$

ex $$442.4507\text{lbs} = \left(15000 - \left(\frac{1}{3}\right) \cdot (140)^2\right) \cdot 81\text{in}^2$$

3) Allowable Unit Load for Bridges using Structural Carbon Steel

Open Calculator

fx
$$Q = \frac{\frac{S_y}{f_s}}{1 + \left(0.25 \cdot \sec\left(0.375 \cdot L|r\right) \cdot \sqrt{\frac{f_s \cdot P}{\varepsilon \cdot A}}\right)} \cdot A$$

ex
$$592.0573\text{lbs} = \frac{\frac{32000\text{lbf/in}^2}{3}}{1 + \left(0.25 \cdot \sec\left(0.375 \cdot 140\right) \cdot \sqrt{\frac{3 \cdot 10.5\text{kN}}{29000000\text{lbf/in}^2 \cdot 81\text{in}^2}}\right)} \cdot 81\text{in}^2$$

4) Ultimate Load for Bridges using Structural Carbon Steel

Open Calculator

fx
$$P_u = \left(26500 - 0.425 \cdot L|r^2\right) \cdot A$$

ex
$$949.5271\text{lbs} = \left(26500 - 0.425 \cdot (140)^2\right) \cdot 81\text{in}^2$$

5) Ultimate Load for Bridges using Structural Carbon Steel when Columns are Pinned

Open Calculator

fx
$$P_u = \left(25600 - 0.566 \cdot L|r^2\right) \cdot A$$

ex
$$758.0749\text{lbs} = \left(25600 - 0.566 \cdot (140)^2\right) \cdot 81\text{in}^2$$

6) Ultimate Unit Load for Bridges using Structural Carbon Steel

Open Calculator

fx $$P_u = \left(\frac{S_y}{1 + 0.25 \cdot \sec\left(0.375 \cdot l \cdot \sqrt{\frac{P_{cs}}{\varepsilon \cdot A}}\right)} \right) \cdot A$$

ex $$960.2793\text{lbs} = \left(\frac{32000\text{lbf/in}^2}{1 + 0.25 \cdot \sec\left(0.375 \cdot 120\text{in} \cdot \sqrt{\frac{520\text{kN}}{29000000\text{lbf/in}^2 \cdot 81\text{in}^2}}\right)} \right) \cdot 81\text{in}^2$$

Allowable Stress Design for Bridges

Allowable Stress Design for Bridge Beams

7) Allowable Unit Stress in Bending

Open Calculator

fx $$F_b = 0.55 \cdot f_y$$

ex $$137500\text{kN} = 0.55 \cdot 250\text{MPa}$$

8) Moment Gradient Factor given Smaller and Larger Beam End Moment

Open Calculator

fx $$C_b = 1.75 + 1.05 \cdot \left(\frac{M^1}{M^2}\right) + 0.3 \cdot \left(\frac{M^1}{M^2}\right)^2$$

ex $$2.218 = 1.75 + 1.05 \cdot \left(\frac{4\text{N*m}}{10\text{N*m}}\right) + 0.3 \cdot \left(\frac{4\text{N*m}}{10\text{N*m}}\right)^2$$

9) Steel Yield Strength given Allowable Unit Stress in Bending

Open Calculator

fx $$f_y = \frac{F_b}{0.55}$$

ex $$250\text{MPa} = \frac{137500\text{kN}}{0.55}$$

Allowable Stress Design for Bridge Columns

10) Allowable Stress when Slenderness Ratio is Less than Cc

Open Calculator

fx $$F_a = \left(\frac{f_y}{2.12}\right) \cdot \left(1 - \frac{\left(k \cdot \frac{L}{r}\right)^2}{2 \cdot C_c^2}\right)$$

ex $$103.184\text{MPa} = \left(\frac{250\text{MPa}}{2.12}\right) \cdot \left(1 - \frac{\left(0.5 \cdot \frac{3\text{m}}{15\text{mm}}\right)^2}{2 \cdot (200)^2}\right)$$

11) Allowable Stresses in Concentrically Loaded Columns based on AASHTO Bridge Design Specifications

Open Calculator

fx $$F_a = \frac{\pi^2 \cdot E}{2.12 \cdot \left(k \cdot \frac{L}{r}\right)^2}$$

ex $$0.023277\text{MPa} = \frac{\pi^2 \cdot 50\text{MPa}}{2.12 \cdot \left(0.5 \cdot \frac{3\text{m}}{15\text{mm}}\right)^2}$$

Allowable Stress Design for Shear in Bridges

12) Allowable Shear Stress in Bridges

Open Calculator

fx $$\tau = f_y \cdot \frac{C}{3}$$

ex $$75\text{MPa} = 250\text{MPa} \cdot \frac{0.90}{3}$$

13) Shear Buckling Coefficient given Allowable Shear Stress for Flexural Members in Bridges

Open Calculator

fx $$C = 3 \cdot \frac{\tau}{f_y}$$

ex $$0.9 = 3 \cdot \frac{75\text{MPa}}{250\text{MPa}}$$

14) Steel Yield Strength using Allowable Shear Stress for Flexural Members in Bridges

Open Calculator

fx $$f_y = 3 \cdot \frac{\tau}{C}$$

ex $$250\text{MPa} = 3 \cdot \frac{75\text{MPa}}{0.90}$$

Bearing on Milled Surfaces and Bridge Fasteners

15) Allowable Bearing Stress for High Strength Bolts

Open Calculator

fx $F_p = 1.35 \cdot F_u$

ex $137.7\text{MPa} = 1.35 \cdot 102\text{MPa}$

16) Allowable Bearing Stress on Milled Stiffeners and other Steel Parts

Open Calculator

fx $F_p = 0.80 \cdot F_u$

ex $81.6\text{MPa} = 0.80 \cdot 102\text{MPa}$

17) Allowable Stress for Expansion Rollers and Rockers where Diameter is from 635 mm to 3175 mm

Open Calculator

fx $p = \left(\frac{f_y - 13}{20}\right) \cdot 3 \cdot \sqrt{d}$

ex $895.8318\text{kN/mm} = \left(\frac{250\text{MPa} - 13}{20}\right) \cdot 3 \cdot \sqrt{635\text{mm}}$

18) Allowable Stress for Expansion Rollers and Rockers where Diameter is up to 635 mm

Open Calculator

fx $p = \left(\frac{f_y - 13}{20}\right) \cdot 0.6 \cdot d$

ex $4514.85\text{kN/mm} = \left(\frac{250\text{MPa} - 13}{20}\right) \cdot 0.6 \cdot 635\text{mm}$

19) Diameter of Roller or Rocker for d from 635 to 3125mm

Open Calculator

$$d = \left(\frac{p}{\left(\frac{f_y - 13}{20} \right) \cdot 3} \right)^2$$

$$5791.082\text{mm} = \left(\frac{2705.325\text{kN/mm}}{\left(\frac{250\text{MPa} - 13}{20} \right) \cdot 3} \right)^2$$

20) Diameter of Roller or Rocker for d up to 635 mm

Open Calculator

$$d = \frac{p}{\left(\frac{f_y}{20} \right) \cdot 0.6}$$

$$360.71\text{mm} = \frac{2705.325\text{kN/mm}}{\left(\frac{250\text{MPa}}{20} \right) \cdot 0.6}$$

21) Tensile Strength of Connected Part given Allowable Bearing Stress for High Strength Bolts

Open Calculator

$$F_u = \frac{F_p}{1.35}$$

$$79.25926\text{MPa} = \frac{107\text{MPa}}{1.35}$$

22) Tensile Strength of Connected Part given Allowable Bearing Stress on Milled Stiffeners

Open Calculator

fx $$F_u = \frac{F_p}{0.80}$$

ex $$133.75\text{MPa} = \frac{107\text{MPa}}{0.80}$$

Variables Used

- **A** Section Area of Column *(Square Inch)*
- **C** Shear Buckling Coefficient C
- **C_b** Moment Gradient Factor for Bridge Beams
- **C_c** Slenderness Ratio Cc
- **d** Diameter of Roller or Rocker *(Millimeter)*
- **E** Modulus of Elasticity *(Megapascal)*
- **F_a** Allowable Stresses in Columns *(Megapascal)*
- **F_b** Allowable Unit Tensile Stress in bending *(Kilonewton)*
- **F_p** Allowable Bearing Stress *(Megapascal)*
- **f_s** Factor of Safety for Bridge Column
- **F_u** Tensile Strength of connected part *(Megapascal)*
- **f_y** Yield Strength of Steel *(Megapascal)*
- **k** Effective Length Factor
- **l** Column Length *(Inch)*
- **L** Length of Bridge Column *(Meter)*
- **L|r** Critical Slenderness Ratio
- **M^1** Smaller Moment *(Newton Meter)*
- **M^2** Larger Beam End Moment *(Newton Meter)*
- **p** Allowable Stress *(Kilonewton per Millimeter)*
- **P** Total Allowable Load for Bridges *(Kilonewton)*
- **P_{cs}** Ultimate Crushing Load for Columns *(Kilonewton)*
- **P_u** Ultimate Load *(Pound)*
- **Q** Allowable Load *(Pound)*

- **r** Radius of Gyration *(Millimeter)*
- S_y Yield Point of Material *(Pound-Force per Square Inch)*
- **ε** Modulus of Elasticity of Material *(Pound-Force per Square Inch)*
- τ Shear Stress for Flexural Members *(Megapascal)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sec**, sec(Angle)
  Trigonometric secant function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Inch (in), Meter (m), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Pound (lbs)
  Weight Unit Conversion
- Measurement: **Area** in Square Inch (in²)
  Area Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Stress** in Pound-Force per Square Inch (lbf/in²), Megapascal (MPa)
  Stress Unit Conversion
- Measurement: **Shear Range** in Kilonewton per Millimeter (kN/mm)
  Shear Range Unit Conversion

Check other formula lists

- **Composite Construction in Highway Bridges Formulas**
- **Connectors and Stiffeners in Bridges Formulas**
- **Load Factor Design (LFD) Formulas**
- **Load, Stress and Fasteners Formulas**
- **Suspension Cables Formulas**

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