Important Load, Stress and Fasteners Formulas PDF

Formulas
Examples
with Units

List of 22
Important Load, Stress and Fasteners Formulas

1) Additional Bridge Column Formulas Formulas

1.1) Allowable Load for Bridges using Structural Carbon Steel Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

1.3) Allowable Unit Load for Bridges using Structural Carbon Steel Formula

Evaluate Formula

Formula

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

Example with Units

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

1.4) Ultimate Load for Bridges using Structural Carbon Steel Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

1.6) Ultimate Unit Load for Bridges using Structural Carbon Steel Formula

Evaluate Formula

Formula

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

Example with Units

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

2) Allowable Stress Design for Bridges Formulas

2.1) Allowable Stress Design for Bridge Beams Formulas

2.1.1) Allowable Unit Stress in Bending Formula

Evaluate Formula

Formula

$$F_b = 0.55 \cdot f_y$$

Example with Units

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

2.1.2) Moment Gradient Factor given Smaller and Larger Beam End Moment Formula

Evaluate Formula

Formula

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

Example with Units

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

2.1.3) Steel Yield Strength given Allowable Unit Stress in Bending Formula

Evaluate Formula

Formula

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

Example with Units

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

2.2) Allowable Stress Design for Bridge Columns Formulas

2.2.1) Allowable Stress when Slenderness Ratio is Less than Cc Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$0.0233\,\text{MPa} = \frac{3.1416^2 \cdot 50\,\text{MPa}}{2.12 \cdot \left(0.5 \cdot \frac{3\,\text{m}}{15\,\text{mm}}\right)^2}$$

2.3) Allowable Stress Design for Shear in Bridges Formulas

2.3.1) Allowable Shear Stress in Bridges Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

3) Bearing on Milled Surfaces and Bridge Fasteners Formulas

3.1) Allowable Bearing Stress for High Strength Bolts Formula

Evaluate Formula

Formula

$$F_p = 1.35 \cdot F_u$$

Example with Units

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

3.2) Allowable Bearing Stress on Milled Stiffeners and other Steel Parts Formula

Evaluate Formula

Formula

$$F_p = 0.80 \cdot F_u$$

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$5791.0816\,\text{mm} = \left(\frac{2705.325\,\text{kN/mm}}{\left(\frac{250\,\text{MPa} - 13}{20}\right) \cdot 3}\right)^2$$

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$79.2593\,\text{MPa} = \frac{107\,\text{MPa}}{1.35}$$

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

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Load, Stress and Fasteners Formulas above

- **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 in list of Load, Stress and Fasteners Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sec**, sec(Angle) *Secant is a trigonometric function that is defined ratio of the hypotenuse to the shorter side adjacent to an acute angle (in a right-angled triangle); the reciprocal of a cosine.*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- 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*

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