Load Factor Design (LFD) Formulas

List of 28 Load Factor Design (LFD) Formulas

Load Factor Design (LFD)

Load and Resistance Factor for Bridge Columns

1) Buckling Stress for Q Factor Less than or Equal to 1

Open Calculator

fx $$F_{cr} = \left(1 - \left(\frac{Q_{factor}}{2}\right)\right) \cdot f_y$$

ex $$248.219\text{MPa} = \left(1 - \left(\frac{0.014248}{2}\right)\right) \cdot 250\text{MPa}$$

2) Buckling Stress given Maximum Strength

Open Calculator

fx $$F_{cr} = \frac{P_u}{0.85 \cdot A_g}$$

ex $$248\text{MPa} = \frac{1054\text{kN}}{0.85 \cdot 5000\text{mm}^2}$$

3) Buckling Stress when Q Factor is Greater than 1

Open Calculator

fx $$F_{cr} = \frac{f_y}{2 \cdot Q}$$

ex $$260.4167\text{MPa} = \frac{250\text{MPa}}{2 \cdot 0.48}$$

4) Column Gross Effective Area given Maximum Strength

Open Calculator

fx $$A_g = \frac{P_u}{0.85 \cdot F_{cr}}$$

ex $$5000\text{mm}^2 = \frac{1054\text{kN}}{0.85 \cdot 248\text{MPa}}$$

5) Maximum Strength for Compression Members

Open Calculator

fx $$P_u = 0.85 \cdot A_g \cdot F_{cr}$$

ex $$1054\text{kN} = 0.85 \cdot 5000\text{mm}^2 \cdot 248\text{MPa}$$

6) Q Factor

Open Calculator

fx $$Q_{factor} = \left(\left(k \cdot \frac{L_c}{r}\right)^2\right) \cdot \left(\frac{f_y}{2 \cdot \pi \cdot \pi \cdot E_s}\right)$$

ex $$0.014248 = \left(\left(0.5 \cdot \frac{450\text{mm}}{15\text{mm}}\right)^2\right) \cdot \left(\frac{250\text{MPa}}{2 \cdot \pi \cdot \pi \cdot 200000\text{MPa}}\right)$$

7) Steel Yield Strength given Buckling Stress for Q Factor Greater than 1

Open Calculator

fx $$f_y = F_{cr} \cdot 2 \cdot Q$$

ex $$238.08\text{MPa} = 248\text{MPa} \cdot 2 \cdot 0.48$$

8) Steel Yield Strength given Buckling Stress for Q Factor Less than or Equal to 1

Open Calculator

$$f_y = \frac{F_{cr}}{1 - \left(\frac{Q_{factor}}{2}\right)}$$

$$249.7794\text{MPa} = \frac{248\text{MPa}}{1 - \left(\frac{0.014248}{2}\right)}$$

9) Steel Yield Strength given Q Factor

Open Calculator

$$f_y = \frac{2 \cdot Q_{factor} \cdot \pi \cdot \pi \cdot \left(r^2\right) \cdot E_s}{(k \cdot L_c)^2}$$

$$249.9949\text{MPa} = \frac{2 \cdot 0.014248 \cdot \pi \cdot \pi \cdot \left((15\text{mm})^2\right) \cdot 200000\text{MPa}}{(0.5 \cdot 450\text{mm})^2}$$

Load-Factor Design for Bridge Beams

10) Allowable Bearing Stresses on Pins for Buildings for LFD

Open Calculator

$$F_p = 0.9 \cdot f_y$$

$$225\text{MPa} = 0.9 \cdot 250\text{MPa}$$

11) Allowable Bearing Stresses on Pins not Subject to Rotation for Bridges for LFD

Open Calculator

$$F_p = 0.80 \cdot f_y$$

ex $$200\text{MPa} = 0.80 \cdot 250\text{MPa}$$

12) Allowable Bearing Stresses on Pins Subject to Rotation for Bridges for LFD

Open Calculator

$$F_p = 0.40 \cdot f_y$$

ex $$100\text{MPa} = 0.40 \cdot 250\text{MPa}$$

13) Area of Flange for Braced Non-Compact Section for LFD

Open Calculator

$$A_f = \frac{L_b \cdot f_y \cdot d}{20000}$$

ex $$4375\text{mm}^2 = \frac{1000\text{mm} \cdot 250\text{MPa} \cdot 350\text{mm}}{20000}$$

14) Depth of Section for Braced Non-Compact Section for LFD given Maximum Unbraced Length

Open Calculator

$$d = \frac{20000 \cdot A_f}{f_y \cdot L_b}$$

ex $$350\text{mm} = \frac{20000 \cdot 4375\text{mm}^2}{250\text{MPa} \cdot 1000\text{mm}}$$

15) Maximum Bending Strength for Symmetrical Flexural Braced Non-Compacted Section for LFD of Bridges

Open Calculator

fx $$M_u = f_y \cdot S$$

ex $$19.875\text{kN*mm} = 250\text{MPa} \cdot 79.5\text{mm}^3$$

16) Maximum Bending Strength for Symmetrical Flexural Compact Section for LFD of Bridges

Open Calculator

fx $$M_u = f_y \cdot Z$$

ex $$20\text{kN*mm} = 250\text{MPa} \cdot 80\text{mm}^3$$

17) Maximum Unbraced Length for Symmetrical Flexural Braced Non-Compact Section for LFD of Bridges

Open Calculator

fx $$L_b = \frac{20000 \cdot A_f}{f_y \cdot d}$$

ex $$1000\text{mm} = \frac{20000 \cdot 4375\text{mm}^2}{250\text{MPa} \cdot 350\text{mm}}$$

18) Maximum Unbraced Length for Symmetrical Flexural Compact Section for LFD of Bridges

Open Calculator

fx $$L = \frac{\left(3600 - 2200 \cdot \left(\frac{M_1}{M_u}\right)\right) \cdot r}{f_y}$$

ex $$183\text{mm} = \frac{\left(3600 - 2200 \cdot \left(\frac{5\text{kN*mm}}{20\text{kN*mm}}\right)\right) \cdot 15\text{mm}}{250\text{MPa}}$$

19) Minimum Flange Thickness for Symmetrical Flexural Braced Non-Compact Section for LFD of Bridges

Open Calculator

fx $$t_f = \frac{b' \cdot \sqrt{f_y}}{69.6}$$

ex $$283.9689\text{mm} = \frac{1.25\text{mm} \cdot \sqrt{250\text{MPa}}}{69.6}$$

20) Minimum Flange Thickness for Symmetrical Flexural Compact Section for LFD of Bridges

Open Calculator

fx $$t_f = \frac{b' \cdot \sqrt{f_y}}{65}$$

ex $$304.0652\text{mm} = \frac{1.25\text{mm} \cdot \sqrt{250\text{MPa}}}{65}$$

21) Minimum Web Thickness for Symmetrical Flexural Braced Non-Compact Section for LFD of Bridges

Open Calculator

fx $$t_u = \frac{h}{150}$$

ex $$9\text{mm} = \frac{1350\text{mm}}{150}$$

22) Minimum Web Thickness for Symmetrical Flexural Compact Section for LFD of Bridges

Open Calculator

fx $$t_u = d \cdot \frac{\sqrt{f_y}}{608}$$

ex $$9.101951\text{mm} = 350\text{mm} \cdot \frac{\sqrt{250\text{MPa}}}{608}$$

23) Width of Projection of Flange for Compact Section for LFD given Minimum Flange Thickness

Open Calculator

fx $$b' = \frac{65 \cdot t_f}{\sqrt{f_y}}$$

ex $$1.208623\text{mm} = \frac{65 \cdot 294\text{mm}}{\sqrt{250\text{MPa}}}$$

Steel Yield Strength

24) Steel Yield Strength for Braced Non-Compact Section for LFD given Maximum Unbraced Length

Open Calculator

fx $$f_y = \frac{20000 \cdot A_f}{L_b \cdot d}$$

ex $$250\text{MPa} = \frac{20000 \cdot 4375\text{mm}^2}{1000\text{mm} \cdot 350\text{mm}}$$

25) Steel Yield Strength for Compact Section for LFD given Minimum Flange Thickness

Open Calculator

fx $$f_y = \left(65 \cdot \frac{t_f}{b'}\right)^2$$

ex $$233.7229\text{MPa} = \left(65 \cdot \frac{294\text{mm}}{1.25\text{mm}}\right)^2$$

26) Steel Yield Strength on Pins for Buildings for LFD given Allowable Bearing Stress

Open Calculator

fx $$f_y = \frac{F_p}{0.90}$$

ex $$194.4444\text{MPa} = \frac{175\text{MPa}}{0.90}$$

27) Steel Yield Strength on Pins not Subject to Rotation for Bridges for LFD given Pin Stress

Open Calculator

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

ex $$218.75\text{MPa} = \frac{175\text{MPa}}{0.80}$$

28) Steel Yield Strength on Pins subject to Rotation for Bridges for LFD given Pin Stress

Open Calculator

$$f_y = \frac{F_p}{0.40}$$

$$437.5\text{MPa} = \frac{175\text{MPa}}{0.40}$$

Variables Used

- A_f Flange Area *(Square Millimeter)*
- A_g Gross Effective Area of Column *(Square Millimeter)*
- b' Width of Projection of Flange *(Millimeter)*
- d Depth of Section *(Millimeter)*
- E_s Modulus of Elasticity *(Megapascal)*
- F_{cr} Buckling Stress *(Megapascal)*
- F_p Allowable Bearing Stresses on Pins *(Megapascal)*
- f_y Yield Strength of Steel *(Megapascal)*
- h Unsupported Distance between Flanges *(Millimeter)*
- k Effective Length Factor
- L Max Unbraced Length for Flexural Compact Section *(Millimeter)*
- L_b Maximum Unbraced Length *(Millimeter)*
- L_c Length of Member between Supports *(Millimeter)*
- M_1 Smaller Moment *(Kilonewton Millimeter)*
- M_u Maximum Bending Strength *(Kilonewton Millimeter)*
- P_u Strength of Column *(Kilonewton)*
- Q Q Factors
- Q_{factor} Factor Q
- r Radius of Gyration *(Millimeter)*
- S Section Modulus *(Cubic Millimeter)*
- t_f Flange Minimum Thickness *(Millimeter)*

- t_u Web Minimum Thickness *(Millimeter)*
- Z Plastic Section Modulus *(Cubic Millimeter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Volume** in Cubic Millimeter (mm^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Millimeter (mm^2)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Moment of Force** in Kilonewton Millimeter (kN*mm)
  Moment of Force Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- Additional Bridge Column Formulas
- Allowable Stress Design for Bridges Formulas
- Bearing on Milled Surfaces and Bridge Fasteners Formulas
- Composite Construction in Highway Bridges Formulas
- Load Factor Design (LFD) Formulas
- Number of Connectors in Bridges Formulas
- Stiffeners on Bridge Girders Formulas
- Suspension Cables Formulas

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