Important Load Factor Design (LFD) Formulas PDF

Formulas
Examples
with Units

List of 28
Important Load Factor Design (LFD) Formulas

1) Load and Resistance Factor for Bridge Columns Formulas

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

Evaluate Formula

Formula

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

Example with Units

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

1.2) Buckling Stress given Maximum Strength Formula

Evaluate Formula

Formula

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

Example with Units

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

1.3) Buckling Stress when Q Factor is Greater than 1 Formula

Evaluate Formula

Formula

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

Example with Units

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

1.4) Column Gross Effective Area given Maximum Strength Formula

Evaluate Formula

Formula

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

Example with Units

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

1.5) Maximum Strength for Compression Members Formula

Evaluate Formula

Formula

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

Example with Units

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

1.6) Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0142 = \left(\left(0.5 \cdot \frac{450\,\text{mm}}{15\,\text{mm}}\right)^2\right) \cdot \left(\frac{250\,\text{MPa}}{2 \cdot 3.1416 \cdot 3.1416 \cdot 200000\,\text{MPa}}\right)$$

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

1.9) Steel Yield Strength given Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$249.9949\,\text{MPa} = \frac{2 \cdot 0.014248 \cdot 3.1416 \cdot 3.1416 \cdot \left(15\,\text{mm}^2\right) \cdot 200000\,\text{MPa}}{\left(0.5 \cdot 450\,\text{mm}\right)^2}$$

2) Load-Factor Design for Bridge Beams Formulas

2.1) Allowable Bearing Stresses on Pins for Buildings for LFD Formula

Evaluate Formula

Formula

$$F_p = 0.9 \cdot f_y$$

Example with Units

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

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

Evaluate Formula

Formula

$$F_p = 0.80 \cdot f_y$$

Example with Units

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

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

Evaluate Formula

Formula

$$F_p = 0.40 \cdot f_y$$

Example with Units

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

2.4) Area of Flange for Braced Non-Compact Section for LFD Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

$$M_u = f_y \cdot S$$

Example with Units

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

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

Evaluate Formula

Formula

$$M_u = f_y \cdot Z$$

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$9.102\,\text{mm} = 350\,\text{mm} \cdot \frac{\sqrt{250\,\text{MPa}}}{608}$$

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

Evaluate Formula

Formula

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

Example with Units

$$1.2086\,\text{mm} = \frac{65 \cdot 294\,\text{mm}}{\sqrt{250\,\text{MPa}}}$$

2.15) Steel Yield Strength Formulas

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Load Factor Design (LFD) Formulas above

- 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 in list of Load Factor Design (LFD) Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- 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 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*

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