Beams, Columns and Other Members Design Methods Formulas

List of 16 Beams, Columns and Other Members Design Methods Formulas

Beams, Columns and Other Members Design Methods

Beams

1) Straight Beam Deflection

Open Calculator

fx
$$\delta = \left(\frac{k_b \cdot T_l \cdot (l)^3}{E_c \cdot I} \right) + \left(\frac{k_s \cdot T_l \cdot l}{G \cdot A} \right)$$

ex
$$19.92665\text{mm} = \left(\frac{0.85 \cdot 10\text{kN} \cdot (3000\text{mm})^3}{30000\text{MPa} \cdot 3.56\text{kg·m}^2} \right) + \left(\frac{0.75 \cdot 10\text{kN} \cdot 3000\text{mm}}{25000\text{MPa} \cdot 50625\text{mm}^2} \right)$$

2) Tapered Beam Deflection for Mid-Span Concentrated Load

Open Calculator

fx
$$\delta = \frac{3 \cdot T_l \cdot l}{10 \cdot G \cdot b \cdot d}$$

ex
$$4.141501\text{mm} = \frac{3 \cdot 10\text{kN} \cdot 3000\text{mm}}{10 \cdot 25000\text{MPa} \cdot 305\text{mm} \cdot 285\text{mm}}$$

3) Tapered beam Deflection for Uniformly Distributed Load

Open Calculator

fx $$\delta = \frac{3 \cdot T_l \cdot l}{20 \cdot G \cdot b \cdot d}$$

ex $$2.070751\text{mm} = \frac{3 \cdot 10\text{kN} \cdot 3000\text{mm}}{20 \cdot 25000\text{MPa} \cdot 305\text{mm} \cdot 285\text{mm}}$$

Rectangular Beams with Tensile Reinforcing Only

4) Bending Moment of Beam due to Stress in Concrete

Open Calculator

fx $$M = \left(\frac{1}{2}\right) \cdot f_c \cdot k \cdot j \cdot b \cdot d^2$$

ex $$35.07772\text{kN*m} = \left(\frac{1}{2}\right) \cdot 7.3\text{MPa} \cdot 0.458 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2$$

5) Bending Moment of Beam due to Stress in Steel

Open Calculator

fx $$M = f_s \cdot p \cdot j \cdot b \cdot d^2$$

ex $$35.18893\text{kN*m} = 130\text{MPa} \cdot 0.0129 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2$$

6) Stress in Concrete using Working-Stress Design

Open Calculator

fx $$f_c = \frac{2 \cdot M}{k \cdot j \cdot b \cdot d^2}$$

ex $$7.283826\text{MPa} = \frac{2 \cdot 35\text{kN*m}}{0.458 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2}$$

7) Stress in Steel by Working-Stress Design

Open Calculator

fx $$f_s = \frac{M}{A_s \cdot j \cdot d}$$

ex $$129.3404\text{MPa} = \frac{35\text{kN*m}}{1121\text{mm}^2 \cdot 0.847 \cdot 285\text{mm}}$$

8) Stress in Steel using Working-Stress Design

Open Calculator

fx $$f_s = \frac{M}{p \cdot j \cdot b \cdot d^2}$$

ex $$129.302\text{MPa} = \frac{35\text{kN*m}}{0.0129 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2}$$

Shear and Diagonal Tension in Beams

9) Cross-Sectional Area of Web Reinforcement

Open Calculator

fx $$A_v = (V - V') \cdot \frac{s}{f_v \cdot d}$$

ex $$8789.474\text{mm}^2 = (500.00\text{N} - 495\text{N}) \cdot \frac{50.1\text{mm}}{100\text{MPa} \cdot 285\text{mm}}$$

10) Effective Depth given Cross-Sectional Area of Web Reinforcement

Open Calculator

fx $$d = \frac{(V - V') \cdot s}{f_v \cdot A_v}$$

ex $$285.5677\text{mm} = \frac{(500.00\text{N} - 495\text{N}) \cdot 50.1\text{mm}}{100\text{MPa} \cdot 8772\text{mm}^2}$$

11) Effective Depth of Beam given Shearing Unit Stress in Reinforced Concrete Beam

Open Calculator

fx $$d = \frac{V}{b \cdot v}$$

ex $$285.0042\text{mm} = \frac{500.00\text{N}}{305\text{mm} \cdot 0.005752\text{MPa}}$$

12) Shear Carried by Concrete given Cross-Sectional Area of Web Reinforcement

Open Calculator

fx $$V' = V - \left(\frac{A_v \cdot f_v \cdot d}{s} \right)$$

ex $$495.0099\text{N} = 500.00\text{N} - \left(\frac{8772\text{mm}^2 \cdot 100\text{MPa} \cdot 285\text{mm}}{50.1\text{mm}} \right)$$

13) Shearing Unit Stress in Reinforced Concrete Beam

Open Calculator

fx $$v = \frac{V}{b \cdot d}$$

ex $$0.005752\text{MPa} = \frac{500.00\text{N}}{305\text{mm} \cdot 285\text{mm}}$$

14) Stirrups Spacing given Cross-Sectional Area of Web Reinforcement

Open Calculator

fx $$s = \frac{A_v \cdot f_v \cdot d}{V - V'}$$

ex $$50.0004\text{mm} = \frac{8772\text{mm}^2 \cdot 100\text{MPa} \cdot 285\text{mm}}{500.00\text{N} - 495\text{N}}$$

15) Total Shear given Cross-Sectional Area of Web Reinforcement

Open Calculator

fx $$V = \left(\frac{A_v \cdot f_v \cdot d}{s}\right) + V'$$

ex $$499.9901\text{N} = \left(\frac{8772\text{mm}^2 \cdot 100\text{MPa} \cdot 285\text{mm}}{50.1\text{mm}}\right) + 495\text{N}$$

16) Width of Beam given Shearing Unit Stress in Reinforced Concrete Beam

Open Calculator

fx $$b = \frac{V}{d \cdot v}$$

ex $$305.0045\text{mm} = \frac{500.00\text{N}}{285\text{mm} \cdot 0.005752\text{MPa}}$$

Variables Used

- **A** Cross-Sectional Area of Beam *(Square Millimeter)*
- **A_s** Cross-Sectional Area of Tensile Reinforcing *(Square Millimeter)*
- **A_v** Cross-Sectional Area of Web Reinforcement *(Square Millimeter)*
- **b** Width of Beam *(Millimeter)*
- **d** Effective Depth of Beam *(Millimeter)*
- **E_c** Modulus of Elasticity of Concrete *(Megapascal)*
- **f_c** Compressive Stress in Extreme Fiber of Concrete *(Megapascal)*
- **f_s** Stress in Reinforcement *(Megapascal)*
- **f_v** Allowable Unit Stress in Web Reinforcement *(Megapascal)*
- **G** Shear Modulus *(Megapascal)*
- **I** Moment of Inertia *(Kilogram Square Meter)*
- **j** Ratio of Distance between Centroid
- **k** Ratio of Depth
- **k_b** Beam Loading Constant
- **k_s** Support Condition Constant
- **l** Beam Span *(Millimeter)*
- **M** Bending Moment *(Kilonewton Meter)*
- **p** Ratio of Cross-Sectional Area
- **s** Stirrup Spacing *(Millimeter)*
- **T_l** Total Beam Load *(Kilonewton)*
- **v** Shearing Unit Stress *(Megapascal)*
- **V** Total Shear *(Newton)*
- **V'** Shear that Concrete should carry *(Newton)*
- **δ** Deflection of Beam *(Millimeter)*

Constants, Functions, Measurements used

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Newton (N)
  Force Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion
- Measurement: **Moment of Force** in Kilonewton Meter (kN*m)
  Moment of Force Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- Beams, Columns and Other Members Design Methods Formulas
- Braced and Unbraced Frames Formulas
- Deflection Computations, Column Moments and Torsion Formulas
- Flat Plate Construction Formulas
- Mix Design, Modulus of Elasticity and Tensile Strength of Concrete Formulas
- Working Stress Design Formulas

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