Important Beams, Columns and Other Members Design Methods Formulas PDF

Formulas
Examples
with Units

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

1) Beams Formulas

1.1) Straight Beam Deflection Formula

Evaluate Formula

Formula

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

Example with Units

$$19.9267\,\text{mm} = \left(\frac{0.85 \cdot 10\,\text{kN} \cdot (3000\,\text{mm})^3}{30000\,\text{MPa} \cdot 3.56\,\text{kg·m²}}\right) + \left(\frac{0.75 \cdot 10\,\text{kN} \cdot 3000\,\text{mm}}{25000\,\text{MPa} \cdot 50625\,\text{mm²}}\right)$$

1.2) Tapered Beam Deflection for Mid-Span Concentrated Load Formula

Evaluate Formula

Formula

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

Example with Units

$$4.1415\,\text{mm} = \frac{3 \cdot 10\,\text{kN} \cdot 3000\,\text{mm}}{10 \cdot 25000\,\text{MPa} \cdot 305\,\text{mm} \cdot 285\,\text{mm}}$$

1.3) Tapered beam Deflection for Uniformly Distributed Load Formula

Evaluate Formula

Formula

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

Example with Units

$$2.0708\,\text{mm} = \frac{3 \cdot 10\,\text{kN} \cdot 3000\,\text{mm}}{20 \cdot 25000\,\text{MPa} \cdot 305\,\text{mm} \cdot 285\,\text{mm}}$$

1.4) Rectangular Beams with Tensile Reinforcing Only Formulas

1.4.1) Bending Moment of Beam due to Stress in Concrete Formula

Evaluate Formula

Formula

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

Example with Units

$$35.0777\,\text{kN*m} = \left(\frac{1}{2}\right) \cdot 7.3\,\text{MPa} \cdot 0.458 \cdot 0.847 \cdot 305\,\text{mm} \cdot 285\,\text{mm}^2$$

1.4.2) Bending Moment of Beam due to Stress in Steel Formula

Evaluate Formula

Formula

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

Example with Units

$$35.1889\,\text{kN*m} = 130\,\text{MPa} \cdot 0.0129 \cdot 0.847 \cdot 305\,\text{mm} \cdot 285\,\text{mm}^2$$

1.4.3) Stress in Concrete using Working-Stress Design Formula

Evaluate Formula

Formula

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

Example with Units

$$7.2838\,\text{MPa} = \frac{2 \cdot 35\,\text{kN*m}}{0.458 \cdot 0.847 \cdot 305\,\text{mm} \cdot 285\,\text{mm}^2}$$

1.4.4) Stress in Steel by Working-Stress Design Formula

Evaluate Formula

Formula

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

Example with Units

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

1.4.5) Stress in Steel using Working-Stress Design Formula

Evaluate Formula

Formula

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

Example with Units

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

1.5) Shear and Diagonal Tension in Beams Formulas

1.5.1) Cross-Sectional Area of Web Reinforcement Formula

Evaluate Formula

Formula

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

Example with Units

$$8789.4737\,\text{mm}^2 = \left(500.00\,\text{N} - 495\,\text{N} \right) \cdot \frac{50.1\,\text{mm}}{100\,\text{MPa} \cdot 285\,\text{mm}}$$

1.5.2) Effective Depth given Cross-Sectional Area of Web Reinforcement Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

1.5.5) Shearing Unit Stress in Reinforced Concrete Beam Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0058\,\text{MPa} = \frac{500.00\,\text{N}}{305\,\text{mm} \cdot 285\,\text{mm}}$$

1.5.6) Stirrups Spacing given Cross-Sectional Area of Web Reinforcement Formula

Evaluate Formula

Formula

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

Example with Units

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

1.5.7) Total Shear given Cross-Sectional Area of Web Reinforcement Formula

Evaluate Formula

Formula

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

Example with Units

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

1.5.8) Width of Beam given Shearing Unit Stress in Reinforced Concrete Beam Formula

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Beams, Columns and Other Members Design Methods Formulas above

- **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 in list of Beams, Columns and Other Members Design Methods Formulas above

- 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

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