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Deflection Computations, Column Moments and Torsion Formulas

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List of 15 Deflection Computations, Column Moments and Torsion Formulas

Deflection Computations, Column Moments and Torsion

Deflection Computations and Concrete Beams Criteria

1) Cracking Moment for Reinforced Concrete Beams

Open Calculator

fx $$M_{cr} = \frac{f_{cr} \cdot I_g}{y_t}$$

ex $$400.2\text{kN*m} = \frac{3\text{MPa} \cdot 20.01\text{m}^4}{150\text{mm}}$$

2) Distance from Centroidal Axis given Cracking Moment

Open Calculator

fx $$y_t = \frac{f_{cr} \cdot I_g}{M_{cr}}$$

ex $$150.075\text{mm} = \frac{3\text{MPa} \cdot 20.01\text{m}^4}{400\text{kN*m}}$$

3) Moment of Inertia of Gross Concrete Section given Cracking Moment

Open Calculator

fx $$I_g = \frac{M_{cr} \cdot y_t}{f_{cr}}$$

ex $$20m^4 = \frac{400kN*m \cdot 150mm}{3MPa}$$

Column Moments

4) Design Shear given Shear Friction Reinforcement Area

Open Calculator

fx $$Vu = \varphi \cdot f_y \cdot \mu_{friction} \cdot A_{vt}$$

ex $$1275kN = 0.85 \cdot 250MPa \cdot 0.2 \cdot 0.03m^2$$

5) Eccentricity of Shear

Open Calculator

fx $$\Upsilon_v = 1 - \left(\frac{1}{1 + \left(\left(\frac{2}{3} \right) \cdot \left(\frac{b_1}{b_2} \right)^{\frac{1}{2}} \right)} \right)$$

ex $$0.5 = 1 - \left(\frac{1}{1 + \left(\left(\frac{2}{3} \right) \cdot \left(\frac{9mm}{4mm} \right)^{\frac{1}{2}} \right)} \right)$$

6) Reinforcement Yield Strength given Shear Friction Reinforcement Area

Open Calculator

fx $$f_y = \frac{Vu}{\varphi \cdot \mu_{friction} \cdot A_{vt}}$$

ex $$250\text{MPa} = \frac{1275\text{kN}}{0.85 \cdot 0.2 \cdot 0.03\text{m}^2}$$

7) Shear Friction Reinforcement Area

Open Calculator

fx $$A_{vt} = \frac{Vu}{\varphi \cdot f_y \cdot \mu_{friction}}$$

ex $$0.03\text{m}^2 = \frac{1275\text{kN}}{0.85 \cdot 250\text{MPa} \cdot 0.2}$$

Spirals in Columns

8) 28-Day Concrete Compressive Strength given Volume of Spiral Steel to Concrete Core Ratio

Open Calculator

fx $$f'_c = \left(\frac{\rho_s \cdot f_y}{0.45 \cdot \left(\left(\frac{A_g}{A_c} \right) - 1 \right)} \right)$$

ex $$50.13889\text{MPa} = \left(\frac{0.0285 \cdot 250\text{MPa}}{0.45 \cdot \left(\left(\frac{500\text{mm}^2}{380\text{mm}^2} \right) - 1 \right)} \right)$$

9) Spiral Steel Yield Strength given Volume of Spiral Steel to Concrete Core Ratio

Open Calculator

fx $$f_y = \frac{0.45 \cdot \left(\left(\frac{A_g}{A_c}\right) - 1\right) \cdot f'_c}{\rho_s}$$

ex $$249.3075\text{MPa} = \frac{0.45 \cdot \left(\left(\frac{500\text{mm}^2}{380\text{mm}^2}\right) - 1\right) \cdot 50\text{MPa}}{0.0285}$$

10) Volume of Spiral Steel to Volume of Concrete Core Ratio

Open Calculator

fx $$\rho_s = \left(0.45 \cdot \left(\left(\frac{A_g}{A_c}\right) - 1\right) \cdot \frac{f'_c}{f_y}\right)$$

ex $$0.028421 = \left(0.45 \cdot \left(\left(\frac{500\text{mm}^2}{380\text{mm}^2}\right) - 1\right) \cdot \frac{50\text{MPa}}{250\text{MPa}}\right)$$

Ultimate Strength Design for Torsion

11) Area of One Leg of Closed Stirrup given Shear Reinforcement Area

Open Calculator

fx $$A_t = \frac{\left(50 \cdot b_w \cdot \frac{s}{f_y}\right) - A_v}{2}$$

ex $$0.495551\text{mm}^2 = \frac{\left(50 \cdot 50.00011\text{mm} \cdot \frac{50.1\text{mm}}{250\text{MPa}}\right) - 500.01\text{mm}^2}{2}$$

12) Maximum Ultimate Torsion for Torsion Effects

Open Calculator

$$T_u = \varphi \cdot \left(0.5 \cdot \sqrt{f'_c} \cdot \left(\Sigma a^2 b\right)\right)$$

$$102.1769\text{N*m} = 0.85 \cdot \left(0.5 \cdot \sqrt{50\text{MPa}} \cdot 34\right)$$

13) Shear Reinforcement Area

Open Calculator

$$A_v = \frac{50 \cdot b_w \cdot s}{f_y}$$

$$501.0011\text{mm}^2 = \frac{50 \cdot 50.00011\text{mm} \cdot 50.1\text{mm}}{250\text{MPa}}$$

14) Spacing of Closed Stirrups for Torsion

Open Calculator

$$s = \frac{A_t \cdot \varphi \cdot f_y \cdot x_{stirrup} \cdot y_1}{T_u - \varphi \cdot T_c}$$

$$78.06127\text{mm} = \frac{0.9\text{mm}^2 \cdot 0.85 \cdot 250\text{MPa} \cdot 200\text{mm} \cdot 500.0001\text{mm}}{330\text{N*m} - 0.85 \cdot 100.00012\text{N/m}^2}$$

15) Ultimate Design Torsional Moment

Open Calculator

$$T_u = 0.85 \cdot 5 \cdot \sqrt{f'_c} \cdot \left(\Sigma x^2 y\right)$$

$$604.046\text{N*m} = 0.85 \cdot 5 \cdot \sqrt{50\text{MPa}} \cdot 20.1$$

Variables Used

- A_c Cross Sectional Area of Column *(Square Millimeter)*
- A_g Gross Area of Column *(Square Millimeter)*
- A_t Area of One Leg of Closed Stirrup *(Square Millimeter)*
- A_v Shear Reinforcement Area *(Square Millimeter)*
- A_{vt} Area of Shear Friction Reinforcement *(Square Meter)*
- b_1 Width of Critical Section *(Millimeter)*
- b_2 Width Perpendicular to Critical Section *(Millimeter)*
- b_w Width of Beam Web *(Millimeter)*
- f'_c Specified 28-Day Compressive Strength of Concrete *(Megapascal)*
- f_{cr} Modulus of Rupture of Concrete *(Megapascal)*
- f_y Yield Strength of Steel *(Megapascal)*
- I_g Moment of Inertia of Gross Concrete Section *(Meter^4)*
- M_{cr} Cracking Moment *(Kilonewton Meter)*
- s Stirrup Spacing *(Millimeter)*
- T_c Maximum Concrete Torsion *(Newton per Square Meter)*
- T_u Ultimate Design Torsional Moment *(Newton Meter)*
- Vu Design Shear *(Kilonewton)*
- $x_{stirrup}$ Shorter Dimension between Legs of Closed Stirrup *(Millimeter)*
- y_1 Longer Dimension Legs of Closed Stirrup *(Millimeter)*
- y_t Distance from Centroidal *(Millimeter)*
- $\mu_{friction}$ Coefficient of Friction

- ρ_s Ratio of Volume of Spiral Steel to Concrete Core
- $\Sigma a^2 b$ Sum of Component Rectangles for Cross Section
- $\Sigma x^2 y$ Sum for Component Rectangles of Section
- Y_v Eccentricity of Shear
- φ Capacity Reduction Factor

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²), Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Meter (N/m²)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Moment of Force** in Kilonewton Meter (kN*m)
  Moment of Force Unit Conversion
- Measurement: **Second Moment of Area** in Meter⁴ (m⁴)
  Second Moment of Area Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

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

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