Important Deflection Computations, Column Moments and Torsion Formulas PDF

Formulas
Examples
with Units

List of 15
Important Deflection Computations, Column Moments and Torsion Formulas

1) Deflection Computations and Concrete Beams Criteria Formulas

1.1) Cracking Moment for Reinforced Concrete Beams Formula

Evaluate Formula

Formula

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

Example with Units

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

1.2) Distance from Centroidal Axis given Cracking Moment Formula

Evaluate Formula

Formula

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

Example with Units

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

1.3) Moment of Inertia of Gross Concrete Section given Cracking Moment Formula

Evaluate Formula

Formula

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

Example with Units

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

2) Column Moments Formulas

2.1) Design Shear given Shear Friction Reinforcement Area Formula

Evaluate Formula

Formula

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

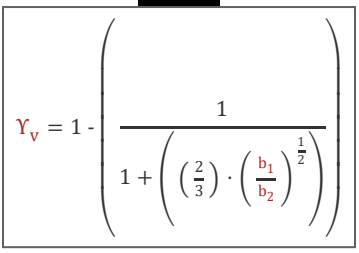
Example with Units

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

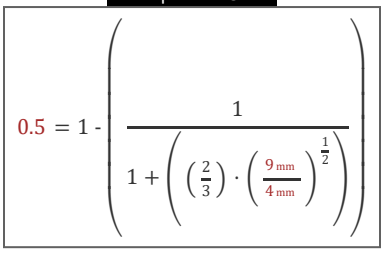
2.2) Eccentricity of Shear Formula

Evaluate Formula

Formula



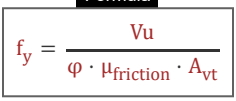
Example with Units



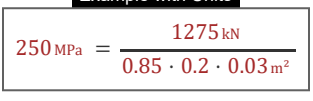
2.3) Reinforcement Yield Strength given Shear Friction Reinforcement Area Formula

Evaluate Formula

Formula



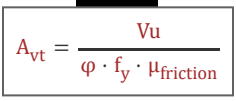
Example with Units



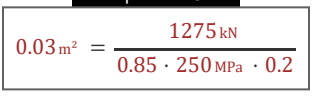
2.4) Shear Friction Reinforcement Area Formula

Evaluate Formula

Formula



Example with Units

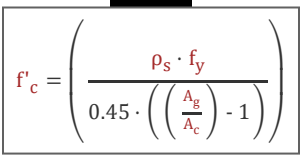


2.5) Spirals in Columns Formulas

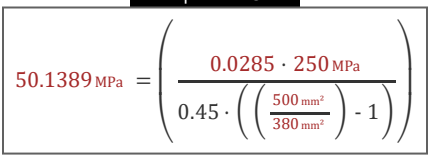
2.5.1) 28-Day Concrete Compressive Strength given Volume of Spiral Steel to Concrete Core Ratio Formula

Evaluate Formula

Formula



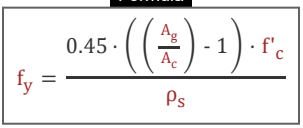
Example with Units



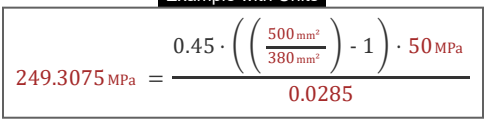
2.5.2) Spiral Steel Yield Strength given Volume of Spiral Steel to Concrete Core Ratio Formula

Evaluate Formula

Formula



Example with Units



2.5.3) Volume of Spiral Steel to Volume of Concrete Core Ratio Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0284 = \left(0.45 \cdot \left(\left(\frac{500\,\text{mm}^2}{380\,\text{mm}^2}\right) - 1\right) \cdot \frac{50\,\text{MPa}}{250\,\text{MPa}}\right)$$

3) Ultimate Strength Design for Torsion Formulas

3.1) Area of One Leg of Closed Stirrup given Shear Reinforcement Area Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4956\,\text{mm}^2 = \frac{\left(50 \cdot 50.00011\,\text{mm} \cdot \frac{50.1\,\text{mm}}{250\,\text{MPa}}\right) - 500.01\,\text{mm}^2}{2}$$

3.2) Maximum Ultimate Torsion for Torsion Effects Formula

Evaluate Formula

Formula

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

Example with Units

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

3.3) Shear Reinforcement Area Formula

Evaluate Formula

Formula

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

Example with Units

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

3.4) Spacing of Closed Stirrups for Torsion Formula

Evaluate Formula

Formula

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

Example with Units

$$78.0613\,\text{mm} = \frac{0.9\,\text{mm}^2 \cdot 0.85 \cdot 250\,\text{MPa} \cdot 200\,\text{mm} \cdot 500.0001\,\text{mm}}{330\,\text{N*m} - 0.85 \cdot 100.00012\,\text{N/m}^2}$$

3.5) Ultimate Design Torsional Moment Formula

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Deflection Computations, Column Moments and Torsion Formulas above

- 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 *(Meter⁴)*
- 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

Constants, Functions, Measurements used in list of Deflection Computations, Column Moments and Torsion Formulas above

- 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: **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

- $\Sigma a^2 b$ 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

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