Important General Principles of Prestressed Concrete Formulas PDF

Formulas
Examples
with Units

List of 19
Important General Principles of Prestressed Concrete Formulas

1) Compressive Stress due to External Moment Formula

Evaluate Formula

Formula

$$f = M_b \cdot \left(\frac{y}{I_a} \right)$$

Example with Units

$$166.6667\,\text{MPa} = 4\,\text{kN*m} \cdot \left(\frac{30\,\text{mm}}{720000\,\text{mm}^4} \right)$$

2) Cross Sectional Area given Compressive Stress Formula

Evaluate Formula

Formula

$$A = \frac{F}{\sigma_c}$$

Example with Units

$$200\,\text{mm}^2 = \frac{400\,\text{kN}}{2\,\text{Pa}}$$

3) External Moment with Known Compressive Stress Formula

Evaluate Formula

Formula

$$M = f \cdot \frac{I_a}{y}$$

Example with Units

$$4.0001\,\text{kN*m} = 166.67\,\text{MPa} \cdot \frac{720000\,\text{mm}^4}{30\,\text{mm}}$$

4) Length of Span given Uniform Load Formula

Evaluate Formula

Formula

$$L = \sqrt{8 \cdot L_s \cdot \frac{F}{w_b}}$$

Example with Units

$$5.099\,\text{m} = \sqrt{8 \cdot 5.2\,\text{m} \cdot \frac{400\,\text{kN}}{0.64\,\text{kN/m}}}$$

5) Prestressing Force given Compressive Stress Formula

Evaluate Formula

Formula

$$F = A \cdot \sigma_c$$

Example with Units

$$400\,\text{kN} = 200\,\text{mm}^2 \cdot 2\,\text{Pa}$$

6) Prestressing Force given Uniform Load Formula

Evaluate Formula

Formula

$$F = w_b \cdot \frac{L^2}{8 \cdot L_s}$$

Example with Units

$$384.6154\,\text{kN} = 0.64\,\text{kN/m} \cdot \frac{5\,\text{m}^2}{8 \cdot 5.2\,\text{m}}$$

7) Resulting Stress due to Moment and Prestress and Eccentric Strands Formula

Evaluate Formula

Formula

$$\sigma_c = \frac{F}{A} + \left(M \cdot \frac{y}{I_a} \right) + \left(F \cdot e \cdot \frac{y}{I_a} \right)$$

Example with Units

$$2.0008\,\text{Pa} = \frac{400\,\text{kN}}{200\,\text{mm}^2} + \left(20\,\text{kN*m} \cdot \frac{30\,\text{mm}}{720000\,\text{mm}^4} \right) + \left(400\,\text{kN} \cdot 5.01\,\text{mm} \cdot \frac{30\,\text{mm}}{720000\,\text{mm}^4} \right)$$

8) Resulting Stress due to Moment and Prestressing Force Formula

Evaluate Formula

Formula

$$\sigma_c = \frac{F}{A} + \left(M_b \cdot \frac{y}{I_a} \right)$$

Example with Units

$$2\,\text{Pa} = \frac{400\,\text{kN}}{200\,\text{mm}^2} + \left(4\,\text{kN*m} \cdot \frac{30\,\text{mm}}{720000\,\text{mm}^4} \right)$$

9) Sag of Parabola given Uniform Load Formula

Evaluate Formula

Formula

$$L_s = w_b \cdot \frac{L^2}{8 \cdot F}$$

Example with Units

$$5\,\text{m} = 0.64\,\text{kN/m} \cdot \frac{5\,\text{m}^2}{8 \cdot 400\,\text{kN}}$$

10) Stress due to Prestress Moment Formula

Evaluate Formula

Formula

$$f = F \cdot e \cdot \frac{y}{I_a}$$

Example with Units

$$83.5\,\text{MPa} = 400\,\text{kN} \cdot 5.01\,\text{mm} \cdot \frac{30\,\text{mm}}{720000\,\text{mm}^4}$$

11) Uniform Compressive Stress due to Prestress Formula

Evaluate Formula

Formula

$$\sigma_c = \frac{F}{A}$$

Example with Units

$$2\,\text{Pa} = \frac{400\,\text{kN}}{200\,\text{mm}^2}$$

12) Upward Uniform Load using Load Balancing Method Formula

Evaluate Formula

Formula

$$w_b = 8 \cdot F \cdot \frac{L_s}{L^2}$$

Example with Units

$$0.6656\,\text{kN/m} = 8 \cdot 400\,\text{kN} \cdot \frac{5.2\,\text{m}}{5\,\text{m}^2}$$

13) Materials Formulas

13.1) Creep Coefficient in European Code Formula

Evaluate Formula

Formula

$$\Phi = \frac{\delta_t}{\delta_i}$$

Example

$$1.6 = \frac{0.2}{0.125}$$

13.2) Empirical Formula for Secant Modulus Proposed by Hognestad in ACI Code Formula

Evaluate Formula

Formula

$$E_c = 1800000 + \left(460 \cdot f_{c'}\right)$$

Example with Units

$$300.8\,\text{MPa} = 1800000 + \left(460 \cdot 0.65\,\text{MPa}\right)$$

13.3) Empirical Formula for Secant Modulus Proposed by Jensen Formula

Evaluate Formula

Formula

$$E_c = \frac{6 \cdot 10^6}{1 + \left(\frac{2000}{f_{c'}}\right)}$$

Example with Units

$$1949.3665\,\text{MPa} = \frac{6 \cdot 10^6}{1 + \left(\frac{2000}{0.65\,\text{MPa}}\right)}$$

13.4) Empirical Formula for Secant Modulus using ACI Code Provisions Formula

Evaluate Formula

Formula

$$E_c = {w_m}^{1.5} \cdot 33 \cdot \sqrt{f_{c'}}$$

Example with Units

$$9690.047\,\text{MPa} = {5.1\,\text{kN/m}^3}^{1.5} \cdot 33 \cdot \sqrt{0.65\,\text{MPa}}$$

13.5) Instantaneous Strain given Cc Formula

Evaluate Formula

Formula

$$\delta_i = \frac{\delta_t}{\Phi}$$

Example

$$0.125 = \frac{0.2}{1.6}$$

13.6) Total Strain Formula

Evaluate Formula

Formula

$$\delta_t = \delta_i + \delta_c$$

Example

$$0.625 = 0.125 + 0.5$$

13.7) Total Strain given Creep Coefficient Formula

Evaluate Formula

Formula

$$\delta_t = \delta_i \cdot \Phi$$

Example

$$0.2 = 0.125 \cdot 1.6$$

Variables used in list of General Principles of Prestressed Concrete Formulas above

- **A** Area of Beam Section *(Square Millimeter)*
- **e** Distance from Centroidal Geometric Axis *(Millimeter)*
- E_c Secant Modulus *(Megapascal)*
- **f** Bending Stress in Section *(Megapascal)*
- **F** Prestressing Force *(Kilonewton)*
- $f_{c'}$ Cylinder Strength *(Megapascal)*
- I_a Moment of Inertia of Section *(Millimeter⁴)*
- **L** Span Length *(Meter)*
- L_s Sag Length of Cable *(Meter)*
- **M** External Moment *(Kilonewton Meter)*
- M_b Bending Moment in Prestress *(Kilonewton Meter)*
- w_b Uniform Load *(Kilonewton per Meter)*
- w_m Unit Weight of Material *(Kilonewton per Cubic Meter)*
- **y** Distance from Centroidal Axis *(Millimeter)*
- δ_c Creep Strain
- δ_i Instantaneous Strain
- δ_t Total Strain
- σ_c Compressive Stress in Prestress *(Pascal)*
- Φ Creep Coefficient

Constants, Functions, Measurements used in list of General Principles of Prestressed Concrete 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), Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa), Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Surface Tension** in Kilonewton per Meter (kN/m)
  Surface Tension Unit Conversion
- Measurement: **Moment of Force** in Kilonewton Meter (kN*m)
  Moment of Force Unit Conversion
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)
  Specific Weight Unit Conversion
- Measurement: **Second Moment of Area** in Millimeter⁴ (mm⁴)
  Second Moment of Area Unit Conversion

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