Important Analysis of Prestressing and Bending Stresses Formulas PDF

Formulas
Examples
with Units

List of 18
Important Analysis of Prestressing and Bending Stresses Formulas

1) Analysis of Behaviour Formulas

1.1) Strain Difference in Prestressed Tendons given Strain in Concrete at level of Steel Formula

Evaluate Formula

Formula

$$\Delta\varepsilon_p = \left(\varepsilon_p - \varepsilon_c\right)$$

Example

$$0.02 = \left(1.71 - 1.69\right)$$

1.2) Strain Difference in Tendons at any Loading Stage Formula

Evaluate Formula

Formula

$$\Delta\varepsilon_p = \varepsilon_{pe} - \varepsilon_{ce}$$

Example

$$0.02 = 0.05 - 0.03$$

1.3) Strain in Concrete at Level of Steel Formula

Evaluate Formula

Formula

$$\varepsilon_c = \varepsilon_p - \Delta\varepsilon_p$$

Example

$$1.69 = 1.71 - 0.02$$

1.4) Strain in Prestressed Tendons Formula

Evaluate Formula

Formula

$$\varepsilon_p = \varepsilon_c + \Delta\varepsilon_p$$

Example

$$1.71 = 1.69 + 0.02$$

2) Analysis of Ultimate Strength Formulas

2.1) Area of Prestressing Tendon for Known Tensile Strength of Section Formula

Evaluate Formula

Formula

$$As = \frac{P_{uR}}{0.87 \cdot F_{pkf}}$$

Example with Units

$$20.0803\,\text{mm}^2 = \frac{4.35\,\text{kN}}{0.87 \cdot 249\,\text{MPa}}$$

2.2) Characteristic Tensile Strength of Prestressing Tendons for Known Tensile Strength of Section Formula

Evaluate Formula

Formula

$$F_{pkf} = \frac{P_{uR}}{0.87 \cdot As}$$

Example with Units

$$247.5248\,\text{MPa} = \frac{4.35\,\text{kN}}{0.87 \cdot 20.2\,\text{mm}^2}$$

2.3) Ultimate Tensile Force in Absence of Non-Prestressed Reinforcement Formula

Evaluate Formula

Formula

$$P_{uR} = 0.87 \cdot F_{pkf} \cdot As$$

Example with Units

$$4.3759\,\text{kN} = 0.87 \cdot 249\,\text{MPa} \cdot 20.2\,\text{mm}^2$$

2.4) Ultimate Tensile Strength of Section in Presence of Non-Prestressing Reinforcement Formula

Evaluate Formula

Formula

$$P_{uR} = 0.87 \cdot F_{pkf} \cdot As + \left(0.87 \cdot fy_{steel} \cdot A_s\right)$$

Example with Units

$$113.1259\,\text{kN} = 0.87 \cdot 249\,\text{MPa} \cdot 20.2\,\text{mm}^2 + \left(0.87 \cdot 250\,\text{MPa} \cdot 500\,\text{mm}^2\right)$$

3) At Service Load Formulas

3.1) Strain in Concrete due to Effective Prestress Formula

Evaluate Formula

Formula

$$\varepsilon_{ce} = \varepsilon_{pe} - \Delta\varepsilon_p$$

Example

$$0.03 = 0.05 - 0.02$$

3.2) Strain in Tendons due to Effective Prestress Formula

Evaluate Formula

Formula

$$\varepsilon_{pe} = \Delta\varepsilon_p + \varepsilon_{ce}$$

Example

$$0.05 = 0.02 + 0.03$$

3.3) Stress in Concrete Member with Non-Prestressing Steel at Service Load Having Compressive Axial Load Formula

Evaluate Formula

Formula

$$f_{concrete} = \left(\frac{P_e}{A_T + \left(\frac{E_s}{E_{concrete}}\right) \cdot A_s}\right) + \left(\frac{P}{A_t}\right)$$

Example with Units

$$2.2222\,\text{MPa} = \left(\frac{20\,\text{kN}}{1000\,\text{mm}^2 + \left(\frac{210000\,\text{MPa}}{100\,\text{MPa}}\right) \cdot 500\,\text{mm}^2}\right) + \left(\frac{10\,\text{N}}{4500.14\,\text{mm}^2}\right)$$

4) At Transfer Formulas

4.1) Area of Concrete for Known Stress in Concrete without Non-Prestressed Reinforcement Formula

Evaluate Formula

Formula

$$A_T = \left(\frac{P_o}{f_{concrete}} \right)$$

Example with Units

$$6024.0964\,\text{mm}^2 = \left(\frac{100\,\text{kN}}{16.6\,\text{MPa}} \right)$$

4.2) Area of Non-Prestressed Reinforcement given Stress in Concrete Formula

Evaluate Formula

Formula

$$A_s = \left(\left(\frac{P_o}{f_{concrete}} \right) + A_T \right) \cdot \left(\frac{E_{concrete}}{E_s} \right)$$

Example with Units

$$0.4762\,\text{mm}^2 = \left(\left(\frac{100\,\text{kN}}{16.6\,\text{MPa}} \right) + 1000\,\text{mm}^2 \right) \cdot \left(\frac{100\,\text{MPa}}{210000\,\text{MPa}} \right)$$

4.3) Stress in Concrete in Member without Non-Prestressed Reinforcement Formula

Evaluate Formula

Formula

$$f_{concrete} = \left(\frac{P_o}{A_T} \right)$$

Example with Units

$$100\,\text{MPa} = \left(\frac{100\,\text{kN}}{1000\,\text{mm}^2} \right)$$

5) Geometrics Properties Formulas

5.1) Area of Concrete about Non-Prestressed Reinforcements and Transformed Section Formula

Evaluate Formula

Formula

$$A_T = A_t - \left(\frac{E_s}{E_c} \right) \cdot A_s - \left(\frac{E_P}{E_c} \right) \cdot As$$

Example with Units

$$999.9986\,\text{mm}^2 = 4500.14\,\text{mm}^2 - \left(\frac{210000\,\text{MPa}}{30000\,\text{MPa}} \right) \cdot 500\,\text{mm}^2 - \left(\frac{210\,\text{MPa}}{30000\,\text{MPa}} \right) \cdot 20.2\,\text{mm}^2$$

5.2) Area of Non-Prestressed Reinforcement in Partially Prestressed Members Formula

Evaluate Formula

Formula

$$A_s = \left(A_t - A_T - \left(\frac{E_P}{E_c} \right) \cdot As \right) \cdot \left(\frac{E_c}{E_s} \right)$$

Example with Units

$$499.9998\,\text{mm}^2 = \left(4500.14\,\text{mm}^2 - 1000\,\text{mm}^2 - \left(\frac{210\,\text{MPa}}{30000\,\text{MPa}} \right) \cdot 20.2\,\text{mm}^2 \right) \cdot \left(\frac{30000\,\text{MPa}}{210000\,\text{MPa}} \right)$$

5.3) Area of Prestressing Tendons about Non-Prestressed Reinforcements and Transformed Section Formula

Evaluate Formula

Formula

$$As = \left(A_t - A_T - \left(\frac{E_s}{E_c} \right) \cdot A_s \right) \cdot \left(\frac{E_c}{E_P} \right)$$

Example with Units

$$20\,\text{mm}^2 = \left(4500.14\,\text{mm}^2 - 1000\,\text{mm}^2 - \left(\frac{210000\,\text{MPa}}{30000\,\text{MPa}} \right) \cdot 500\,\text{mm}^2 \right) \cdot \left(\frac{30000\,\text{MPa}}{210\,\text{MPa}} \right)$$

5.4) Transformed Area of Partially Prestressed Members Formula

Evaluate Formula

Formula

$$A_t = A_T + \left(\frac{E_s}{E_c} \right) \cdot A_s + \left(\frac{E_P}{E_c} \right) \cdot As$$

Example with Units

$$4500.1414\,\text{mm}^2 = 1000\,\text{mm}^2 + \left(\frac{210000\,\text{MPa}}{30000\,\text{MPa}} \right) \cdot 500\,\text{mm}^2 + \left(\frac{210\,\text{MPa}}{30000\,\text{MPa}} \right) \cdot 20.2\,\text{mm}^2$$

Variables used in list of Analysis of Prestressing and Bending Stresses Formulas above

- A_s Area of Reinforcement *(Square Millimeter)*
- A_t Transformed Area of Prestressed Member *(Square Millimeter)*
- A_T Transformed Area of Concrete *(Square Millimeter)*
- **As** Area of Prestressing Steel *(Square Millimeter)*
- E_c Modulus of Elasticity of Concrete *(Megapascal)*
- $E_{concrete}$ Modulus of Elasticity Concrete *(Megapascal)*
- E_P Modulus of Elasticity of Prestressing Steel *(Megapascal)*
- E_s Modulus of Elasticity of Steel *(Megapascal)*
- $f_{concrete}$ Stress in Concrete Section *(Megapascal)*
- F_{pkf} Tensile Strength of Prestressed Steel *(Megapascal)*
- fy_{steel} Yield Strength of Steel *(Megapascal)*
- **P** Axial Force *(Newton)*
- P_e Effective Prestress *(Kilonewton)*
- P_o Prestress at Transfer *(Kilonewton)*
- P_{uR} Tensile Force *(Kilonewton)*
- $\Delta\varepsilon_p$ Strain Difference
- ε_c Strain in Concrete
- ε_{ce} Concrete Strain
- ε_p Strain in Prestress Steel
- ε_{pe} Strain in Tendon

Constants, Functions, Measurements used in list of Analysis of Prestressing and Bending Stresses Formulas above

- 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: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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