Important Properties of Basic Material of Concrete Structures Formulas PDF

Formulas
Examples
with Units

List of 26
Important Properties of Basic Material of Concrete Structures Formulas

1) Combined Stresses Formulas

1.1) Creep Coefficient given Creep Strain Formula

Evaluate Formula

Formula

$$\Phi = \frac{\varepsilon_{cr,ult}}{\varepsilon_{el}}$$

Example

$$1.6 = \frac{0.8}{0.50}$$

1.2) Elastic Strain given Creep Strain Formula

Evaluate Formula

Formula

$$\varepsilon_{el} = \frac{\varepsilon_{cr,ult}}{\Phi}$$

Example

$$0.5 = \frac{0.8}{1.6}$$

2) Compression Formulas

2.1) 28-Day Concrete Compressive Strength Formula

Evaluate Formula

Formula

$$f_c = S_7 + \left(30 \cdot \sqrt{S_7}\right)$$

Example with Units

$$6.8\text{E-}5\,\text{MPa} = 4.5\,\text{MPa} + \left(30 \cdot \sqrt{4.5\,\text{MPa}}\right)$$

2.2) 28-Day Concrete Compressive Strength given Water Cement Ratio Formula

Evaluate Formula

Formula

$$f_c = \left(2700 \cdot CW\right) - 760$$

Example with Units

$$455\,\text{MPa} = \left(2700 \cdot 0.45\right) - 760$$

2.3) Bulk Modulus given Direct Stress Formula

Evaluate Formula

Formula

$$K = \frac{\sigma}{\varepsilon_v}$$

Example with Units

$$180000\,\text{MPa} = \frac{18\,\text{MPa}}{0.0001}$$

2.4) Bulk Modulus using Young's Modulus Formula

Evaluate Formula

Formula

$$K = \frac{E}{3 \cdot (1 - 2 \cdot \nu)}$$

Example with Units

$$16666.6667\,\text{MPa} = \frac{20000\,\text{MPa}}{3 \cdot (1 - 2 \cdot 0.3)}$$

2.5) Direct Stress for given Bulk Modulus and Volumetric Strain Formula

Evaluate Formula

Formula

$$\sigma = K \cdot \varepsilon_v$$

Example with Units

$$1.8\,\text{MPa} = 18000\,\text{MPa} \cdot 0.0001$$

2.6) Lateral Strain given Volumetric and Longitudinal Strain Formula

Evaluate Formula

Formula

$$\varepsilon_L = -\frac{\varepsilon_{longitudinal} - \varepsilon_v}{2}$$

Example

$$-0.1 = -\frac{0.2 - 0.0001}{2}$$

2.7) Longitudinal Strain given Volumetric and Lateral Strain Formula

Evaluate Formula

Formula

$$\varepsilon_{longitudinal} = \varepsilon_v - (2 \cdot \varepsilon_L)$$

Example

$$0.1201 = 0.0001 - (2 \cdot -0.06)$$

2.8) Longitudinal Strain given Volumetric Strain and Poisson's Ratio Formula

Evaluate Formula

Formula

$$\varepsilon_{longitudinal} = \frac{\varepsilon_v}{1 - 2 \cdot \nu}$$

Example

$$0.0002 = \frac{0.0001}{1 - 2 \cdot 0.3}$$

2.9) Modulus of Rupture of Concrete Formula

Evaluate Formula

Formula

$$f_r = 7.5 \cdot \left((fck)^{\frac{1}{2}} \right)$$

Example with Units

$$0.0335\,\text{MPa} = 7.5 \cdot \left((20\,\text{MPa})^{\frac{1}{2}} \right)$$

2.10) Poisson's Ratio given Volumetric Strain and Longitudinal Strain Formula

Evaluate Formula

Formula

$$\nu = \frac{1}{2} \cdot \left(1 - \frac{\varepsilon_v}{\varepsilon_{longitudinal}} \right)$$

Example

$$0.4998 = \frac{1}{2} \cdot \left(1 - \frac{0.0001}{0.2} \right)$$

2.11) Poisson's Ratio using Bulk Modulus and Young's Modulus Formula

Evaluate Formula

Formula

$$\nu = \frac{3 \cdot K - E}{6 \cdot K}$$

Example with Units

$$0.3148 = \frac{3 \cdot 18000\,\text{MPa} - 20000\,\text{MPa}}{6 \cdot 18000\,\text{MPa}}$$

2.12) Volumetric Strain given Bulk Modulus Formula

Evaluate Formula

Formula

$$\varepsilon_v = \frac{\sigma}{K}$$

Example with Units

$$0.001 = \frac{18\,\text{MPa}}{18000\,\text{MPa}}$$

2.13) Volumetric Strain given Change in Length Formula

Evaluate Formula

Formula

$$\varepsilon_v = \left(\frac{\Delta l}{l}\right) \cdot \left(1 - 2 \cdot \nu\right)$$

Example with Units

$$0.0004 = \left(\frac{0.0025\,\text{m}}{2.5\,\text{m}}\right) \cdot \left(1 - 2 \cdot 0.3\right)$$

2.14) Volumetric Strain given Change in Length, Breadth and Width Formula

Evaluate Formula

Formula

$$\varepsilon_v = \frac{\Delta l}{l} + \frac{\Delta b}{b} + \frac{\Delta d}{d}$$

Example with Units

$$0.0203 = \frac{0.0025\,\text{m}}{2.5\,\text{m}} + \frac{0.014\,\text{m}}{1.5\,\text{m}} + \frac{0.012\,\text{m}}{1.2\,\text{m}}$$

2.15) Volumetric Strain given Longitudinal and Lateral Strain Formula

Evaluate Formula

Formula

$$\varepsilon_v = \varepsilon_{longitudinal} + 2 \cdot \varepsilon_L$$

Example

$$0.08 = 0.2 + 2 \cdot -0.06$$

2.16) Volumetric Strain of Cylindrical Rod Formula

Evaluate Formula

Formula

$$\varepsilon_v = \varepsilon_{longitudinal} - 2 \cdot \left(\varepsilon_L\right)$$

Example

$$0.32 = 0.2 - 2 \cdot \left(-0.06\right)$$

2.17) Volumetric Strain of Cylindrical Rod using Poisson's Ratio Formula

Evaluate Formula

Formula

$$\varepsilon_v = \varepsilon_{longitudinal} \cdot \left(1 - 2 \cdot \nu\right)$$

Example

$$0.08 = 0.2 \cdot \left(1 - 2 \cdot 0.3\right)$$

2.18) Volumetric Strain using Young's Modulus and Poisson's Ratio Formula

Evaluate Formula

Formula

$$\varepsilon_v = \frac{3 \cdot \sigma_t \cdot \left(1 - 2 \cdot \nu\right)}{E}$$

Example with Units

$$0.001 = \frac{3 \cdot 16.6\,\text{MPa} \cdot \left(1 - 2 \cdot 0.3\right)}{20000\,\text{MPa}}$$

2.19) Water Cement Ratio given 28-Day Concrete Compressive Strength Formula

Evaluate Formula

Formula

$$CW = \frac{f_c + 760}{2700}$$

Example with Units

$$0.287 = \frac{15\,\text{MPa} + 760}{2700}$$

2.20) Modulus of Elasticity Formulas

2.20.1) Modulus of Elasticity of Normal Weight and Density Concrete in USCS Units Formula

Evaluate Formula

Formula

$$E_c = 57000 \cdot \sqrt{f_c}$$

Example with Units

$$220.7601\,\text{MPa} = 57000 \cdot \sqrt{15\,\text{MPa}}$$

2.20.2) Young's Modulus of Concrete Formula

Evaluate Formula

Formula

$$E_c = 5000 \cdot \left(\sqrt{fck}\right)$$

Example with Units

$$22360.6798\,\text{MPa} = 5000 \cdot \left(\sqrt{20\,\text{MPa}}\right)$$

2.20.3) Young's Modulus of Elasticity as per ACI 318 Building Code Requirements for Reinforced Concrete Formula

Evaluate Formula

Formula

$$E = \left(W^{1.5}\right) \cdot 0.043 \cdot \sqrt{f_c}$$

Example with Units

$$5.2664\,\text{MPa} = \left(1000\,\text{kg/m}^3{}^{1.5}\right) \cdot 0.043 \cdot \sqrt{15\,\text{MPa}}$$

2.20.4) Young's Modulus using Bulk Modulus Formula

Evaluate Formula

Formula

$$E = 3 \cdot K \cdot (1 - 2 \cdot \nu)$$

Example with Units

$$21600\,\text{MPa} = 3 \cdot 18000\,\text{MPa} \cdot (1 - 2 \cdot 0.3)$$

2.20.5) Young's Modulus using Poisson's Ratio Formula

Evaluate Formula

Formula

$$E = \frac{3 \cdot \sigma_t \cdot (1 - 2 \cdot \nu)}{\varepsilon_v}$$

Example with Units

$$199200\,\text{MPa} = \frac{3 \cdot 16.6\,\text{MPa} \cdot (1 - 2 \cdot 0.3)}{0.0001}$$

Variables used in list of Properties of Basic Material of Concrete Structures Formulas above

- **b** Breadth of Bar *(Meter)*
- **CW** Water Cement Ratio
- **d** Depth of Bar *(Meter)*
- **E** Young's Modulus *(Megapascal)*
- E_c Modulus of Elasticity of Concrete *(Megapascal)*
- f_c 28 Day Compressive Strength of Concrete *(Megapascal)*
- f_r Modulus of Rupture of Concrete *(Megapascal)*
- **fck** Characteristic Compressive Strength *(Megapascal)*
- **K** Bulk Modulus *(Megapascal)*
- **l** Length of Section *(Meter)*
- S_7 7 Day Compressive Strength *(Megapascal)*
- **W** Weight of Concrete *(Kilogram per Cubic Meter)*
- **Δb** Change in Breadth *(Meter)*
- **Δd** Change in Depth *(Meter)*
- **Δl** Change in Length *(Meter)*
- $\varepsilon_{cr,ult}$ Ultimate Creep Strain
- ε_{el} Elastic Strain
- ε_L Lateral Strain
- $\varepsilon_{longitudinal}$ Longitudinal Strain
- ε_v Volumetric Strain
- **σ** Direct Stress *(Megapascal)*
- σ_t Tensile Stress *(Megapascal)*
- **Φ** Creep Coefficient of Prestress
- **ν** Poisson's Ratio

Constants, Functions, Measurements used in list of Properties of Basic Material of Concrete Structures 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 Meter (m)
  Length Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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