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# Properties of Basic Material of Concrete Structures Formulas

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

## Properties of Basic Material of Concrete Structures

### Combined Stresses

#### 1) Creep Coefficient given Creep Strain

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

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2\_img.jpg\)](#)

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

#### 2) Elastic Strain given Creep Strain

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

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa\_img.jpg\)](#)

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



## Compression

### 3) 28-Day Concrete Compressive Strength

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

[Open Calculator !\[\]\(a03a7eb2f4046e1d3c76772003e549ea\_img.jpg\)](#)

$$\text{ex } 6.8 \text{E}^{-5} \text{MPa} = 4.5 \text{MPa} + (30 \cdot \sqrt{4.5 \text{MPa}})$$

### 4) 28-Day Concrete Compressive Strength given Water Cement Ratio

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

[Open Calculator !\[\]\(5361750c22c4e047a52f4eac1ec2d4cc\_img.jpg\)](#)

$$\text{ex } 455 \text{MPa} = (2700 \cdot 0.45) - 760$$

### 5) Bulk Modulus given Direct Stress

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

[Open Calculator !\[\]\(b792654f2cef9719eabeb6c5be00811e\_img.jpg\)](#)

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

### 6) Bulk Modulus using Young's Modulus

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

[Open Calculator !\[\]\(84f47badaad7772cd95667a7c387a639\_img.jpg\)](#)

$$\text{ex } 16666.67 \text{MPa} = \frac{20000 \text{MPa}}{3 \cdot (1 - 2 \cdot 0.3)}$$



## 7) Direct Stress for given Bulk Modulus and Volumetric Strain

$$fx \quad \sigma = K \cdot \varepsilon_v$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$ex \quad 1.8MPa = 18000MPa \cdot 0.0001$$

## 8) Lateral Strain given Volumetric and Longitudinal Strain

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad -0.09995 = - \frac{0.2 - 0.0001}{2}$$

## 9) Longitudinal Strain given Volumetric and Lateral Strain

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

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

## 10) Longitudinal Strain given Volumetric Strain and Poisson's Ratio

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

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

$$ex \quad 0.00025 = \frac{0.0001}{1 - 2 \cdot 0.3}$$



### 11) Modulus of Rupture of Concrete

$$fx \quad f_r = 7.5 \cdot \left( (f_{ck})^{\frac{1}{2}} \right)$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$ex \quad 0.033541 \text{MPa} = 7.5 \cdot \left( (20 \text{MPa})^{\frac{1}{2}} \right)$$

### 12) Poisson's Ratio given Volumetric Strain and Longitudinal Strain

$$fx \quad \nu = \frac{1}{2} \cdot \left( 1 - \frac{\epsilon_v}{\epsilon_{\text{longitudinal}}} \right)$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$ex \quad 0.49975 = \frac{1}{2} \cdot \left( 1 - \frac{0.0001}{0.2} \right)$$

### 13) Poisson's Ratio using Bulk Modulus and Young's Modulus

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

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 0.314815 = \frac{3 \cdot 18000 \text{MPa} - 20000 \text{MPa}}{6 \cdot 18000 \text{MPa}}$$


### 14) Volumetric Strain given Bulk Modulus

$$fx \quad \epsilon_v = \frac{\sigma}{K}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$ex \quad 0.001 = \frac{18 \text{MPa}}{18000 \text{MPa}}$$



15) Volumetric Strain given Change in Length 

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

Open Calculator 


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

16) Volumetric Strain given Change in Length, Breadth and Width 

$$fx \quad \epsilon_v = \frac{\Delta l}{l} + \frac{\Delta b}{b} + \frac{\Delta d}{d}$$

Open Calculator 


$$ex \quad 0.020333 = \frac{0.0025m}{2.5m} + \frac{0.014m}{1.5m} + \frac{0.012m}{1.2m}$$

17) Volumetric Strain given Longitudinal and Lateral Strain 

$$fx \quad \epsilon_v = \epsilon_{\text{longitudinal}} + 2 \cdot \epsilon_L$$

Open Calculator 

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

18) Volumetric Strain of Cylindrical Rod 

$$fx \quad \epsilon_v = \epsilon_{\text{longitudinal}} - 2 \cdot (\epsilon_L)$$

Open Calculator 

$$ex \quad 0.32 = 0.2 - 2 \cdot (-0.06)$$



## 19) Volumetric Strain of Cylindrical Rod using Poisson's Ratio

$$fx \quad \varepsilon_v = \varepsilon_{\text{longitudinal}} \cdot (1 - 2 \cdot \nu)$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5\_img.jpg\)](#)

$$ex \quad 0.08 = 0.2 \cdot (1 - 2 \cdot 0.3)$$

## 20) Volumetric Strain using Young's Modulus and Poisson's Ratio

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

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5\_img.jpg\)](#)

$$ex \quad 0.000996 = \frac{3 \cdot 16.6\text{MPa} \cdot (1 - 2 \cdot 0.3)}{20000\text{MPa}}$$

## 21) Water Cement Ratio given 28-Day Concrete Compressive Strength

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

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2\_img.jpg\)](#)

$$ex \quad 0.287037 = \frac{15\text{MPa} + 760}{2700}$$

## Modulus of Elasticity

### 22) Modulus of Elasticity of Normal Weight and Density Concrete in USCS Units

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

[Open Calculator !\[\]\(683dba75afe26e28cd4de5730b776760\_img.jpg\)](#)

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



### 23) Young's Modulus of Concrete

$$fx \quad E_c = 5000 \cdot \left( \sqrt{f_{ck}} \right)$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107\_img.jpg\)](#)

$$ex \quad 22360.68 \text{MPa} = 5000 \cdot \left( \sqrt{20 \text{MPa}} \right)$$

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

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

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6\_img.jpg\)](#)

$$ex \quad 5.266403 \text{MPa} = \left( (1000 \text{kg/m}^3)^{1.5} \right) \cdot 0.043 \cdot \sqrt{15 \text{MPa}}$$

### 25) Young's Modulus using Bulk Modulus

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

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9\_img.jpg\)](#)

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

### 26) Young's Modulus using Poisson's Ratio

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

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d\_img.jpg\)](#)

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





## Variables Used





- **b** Breadth of Bar (Meter)
- **CW** Water Cement Ratio
- **d** Depth of Bar (Meter)
- **E** Young's Modulus (Megapascal)
- **E<sub>C</sub>** Modulus of Elasticity of Concrete (Megapascal)
- **f<sub>C</sub>** 28 Day Compressive Strength of Concrete (Megapascal)
- **f<sub>r</sub>** Modulus of Rupture of Concrete (Megapascal)
- **fck** Characteristic Compressive Strength (Megapascal)
- **K** Bulk Modulus (Megapascal)
- **l** Length of Section (Meter)
- **S<sub>7</sub>** 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)
- **ε<sub>cr,ult</sub>** Ultimate Creep Strain
- **ε<sub>el</sub>** Elastic Strain
- **ε<sub>L</sub>** Lateral Strain
- **ε<sub>longitudinal</sub>** Longitudinal Strain
- **ε<sub>v</sub>** Volumetric Strain
- **σ** Direct Stress (Megapascal)
- **σ<sub>t</sub>** Tensile Stress (Megapascal)



- $\Phi$  Creep Coefficient of Prestress
- $\nu$  Poisson's Ratio



## Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)  
*Square root function*
- **Measurement:** **Length** in Meter (m)  
*Length Unit Conversion* 
- **Measurement:** **Pressure** in Megapascal (MPa)  
*Pressure Unit Conversion* 
- **Measurement:** **Density** in Kilogram per Cubic Meter ( $\text{kg/m}^3$ )  
*Density Unit Conversion* 
- **Measurement:** **Stress** in Megapascal (MPa)  
*Stress Unit Conversion* 



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