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# Beams, Columns and Other Members Design Methods Formulas

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# List of 16 Beams, Columns and Other Members Design Methods Formulas

## Beams, Columns and Other Members Design Methods

### Beams

#### 1) Straight Beam Deflection

$$fx \quad \delta = \left( \frac{k_b \cdot T_1 \cdot (l)^3}{E_c \cdot I} \right) + \left( \frac{k_s \cdot T_1 \cdot l}{G \cdot A} \right)$$

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

ex

$$19.92665\text{mm} = \left( \frac{0.85 \cdot 10\text{kN} \cdot (3000\text{mm})^3}{30000\text{MPa} \cdot 3.56\text{kg} \cdot \text{m}^2} \right) + \left( \frac{0.75 \cdot 10\text{kN} \cdot 3000\text{mm}}{25000\text{MPa} \cdot 50625\text{mm}^2} \right)$$

#### 2) Tapered Beam Deflection for Mid-Span Concentrated Load

$$fx \quad \delta = \frac{3 \cdot T_1 \cdot l}{10 \cdot G \cdot b \cdot d}$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd\_img.jpg\)](#)

ex

$$4.141501\text{mm} = \frac{3 \cdot 10\text{kN} \cdot 3000\text{mm}}{10 \cdot 25000\text{MPa} \cdot 305\text{mm} \cdot 285\text{mm}}$$



### 3) Tapered beam Deflection for Uniformly Distributed Load

$$\text{fx } \delta = \frac{3 \cdot T_1 \cdot l}{20 \cdot G \cdot b \cdot d}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 2.070751\text{mm} = \frac{3 \cdot 10\text{kN} \cdot 3000\text{mm}}{20 \cdot 25000\text{MPa} \cdot 305\text{mm} \cdot 285\text{mm}}$$

### Rectangular Beams with Tensile Reinforcing Only

#### 4) Bending Moment of Beam due to Stress in Concrete

$$\text{fx } M = \left(\frac{1}{2}\right) \cdot f_c \cdot k \cdot j \cdot b \cdot d^2$$

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

$$\text{ex } 35.07772\text{kN}\cdot\text{m} = \left(\frac{1}{2}\right) \cdot 7.3\text{MPa} \cdot 0.458 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2$$

#### 5) Bending Moment of Beam due to Stress in Steel

$$\text{fx } M = f_s \cdot p \cdot j \cdot b \cdot d^2$$

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

$$\text{ex } 35.18893\text{kN}\cdot\text{m} = 130\text{MPa} \cdot 0.0129 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2$$

#### 6) Stress in Concrete using Working-Stress Design

$$\text{fx } f_c = \frac{2 \cdot M}{k \cdot j \cdot b \cdot d^2}$$

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

$$\text{ex } 7.283826\text{MPa} = \frac{2 \cdot 35\text{kN}\cdot\text{m}}{0.458 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2}$$



## 7) Stress in Steel by Working-Stress Design

$$\text{fx } f_s = \frac{M}{A_s \cdot j \cdot d}$$

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

$$\text{ex } 129.3404\text{MPa} = \frac{35\text{kN}\cdot\text{m}}{1121\text{mm}^2 \cdot 0.847 \cdot 285\text{mm}}$$

## 8) Stress in Steel using Working-Stress Design

$$\text{fx } f_s = \frac{M}{p \cdot j \cdot b \cdot d^2}$$

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

$$\text{ex } 129.302\text{MPa} = \frac{35\text{kN}\cdot\text{m}}{0.0129 \cdot 0.847 \cdot 305\text{mm} \cdot (285\text{mm})^2}$$

## Shear and Diagonal Tension in Beams

## 9) Cross-Sectional Area of Web Reinforcement

$$\text{fx } A_v = (V - V') \cdot \frac{s}{f_v \cdot d}$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a\_img.jpg\)](#)

$$\text{ex } 8789.474\text{mm}^2 = (500.00\text{N} - 495\text{N}) \cdot \frac{50.1\text{mm}}{100\text{MPa} \cdot 285\text{mm}}$$

## 10) Effective Depth given Cross-Sectional Area of Web Reinforcement

$$\text{fx } d = \frac{(V - V') \cdot s}{f_v \cdot A_v}$$

[Open Calculator !\[\]\(c1168d6a8b365d11e842ece304635fa7\_img.jpg\)](#)

$$\text{ex } 285.5677\text{mm} = \frac{(500.00\text{N} - 495\text{N}) \cdot 50.1\text{mm}}{100\text{MPa} \cdot 8772\text{mm}^2}$$



### 11) Effective Depth of Beam given Shearing Unit Stress in Reinforced Concrete Beam

$$fx \quad d = \frac{V}{b \cdot v}$$

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

$$ex \quad 285.0042mm = \frac{500.00N}{305mm \cdot 0.005752MPa}$$

### 12) Shear Carried by Concrete given Cross-Sectional Area of Web Reinforcement

$$fx \quad V' = V - \left( \frac{A_v \cdot f_v \cdot d}{s} \right)$$

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

$$ex \quad 495.0099N = 500.00N - \left( \frac{8772mm^2 \cdot 100MPa \cdot 285mm}{50.1mm} \right)$$

### 13) Shearing Unit Stress in Reinforced Concrete Beam

$$fx \quad v = \frac{V}{b \cdot d}$$

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

$$ex \quad 0.005752MPa = \frac{500.00N}{305mm \cdot 285mm}$$

### 14) Stirrups Spacing given Cross-Sectional Area of Web Reinforcement

$$fx \quad s = \frac{A_v \cdot f_v \cdot d}{V - V'}$$

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

$$ex \quad 50.0004mm = \frac{8772mm^2 \cdot 100MPa \cdot 285mm}{500.00N - 495N}$$



15) Total Shear given Cross-Sectional Area of Web Reinforcement 

$$\text{fx } V = \left( \frac{A_v \cdot f_v \cdot d}{s} \right) + V'$$

Open Calculator 

$$\text{ex } 499.9901\text{N} = \left( \frac{8772\text{mm}^2 \cdot 100\text{MPa} \cdot 285\text{mm}}{50.1\text{mm}} \right) + 495\text{N}$$

16) Width of Beam given Shearing Unit Stress in Reinforced Concrete Beam 

$$\text{fx } b = \frac{V}{d \cdot v}$$

Open Calculator 

$$\text{ex } 305.0045\text{mm} = \frac{500.00\text{N}}{285\text{mm} \cdot 0.005752\text{MPa}}$$




## Variables Used

- **A** Cross-Sectional Area of Beam (Square Millimeter)
- **A<sub>S</sub>** Cross-Sectional Area of Tensile Reinforcing (Square Millimeter)
- **A<sub>V</sub>** Cross-Sectional Area of Web Reinforcement (Square Millimeter)
- **b** Width of Beam (Millimeter)
- **d** Effective Depth of Beam (Millimeter)
- **E<sub>C</sub>** Modulus of Elasticity of Concrete (Megapascal)
- **f<sub>C</sub>** Compressive Stress in Extreme Fiber of Concrete (Megapascal)
- **f<sub>S</sub>** Stress in Reinforcement (Megapascal)
- **f<sub>V</sub>** Allowable Unit Stress in Web Reinforcement (Megapascal)
- **G** Shear Modulus (Megapascal)
- **I** Moment of Inertia (Kilogram Square Meter)
- **j** Ratio of Distance between Centroid
- **k** Ratio of Depth
- **k<sub>b</sub>** Beam Loading Constant
- **k<sub>s</sub>** Support Condition Constant
- **l** Beam Span (Millimeter)
- **M** Bending Moment (Kilonewton Meter)
- **p** Ratio of Cross-Sectional Area
- **s** Stirrup Spacing (Millimeter)
- **T<sub>l</sub>** Total Beam Load (Kilonewton)
- **v** Shearing Unit Stress (Megapascal)
- **V** Total Shear (Newton)
- **V'** Shear that Concrete should carry (Newton)
- **δ** Deflection of Beam (Millimeter)



## Constants, Functions, Measurements used

- **Measurement: Length** in Millimeter (mm)  
*Length Unit Conversion* 
- **Measurement: Area** in Square Millimeter (mm<sup>2</sup>)  
*Area Unit Conversion* 
- **Measurement: Pressure** in Megapascal (MPa)  
*Pressure Unit Conversion* 
- **Measurement: Force** in Kilonewton (kN), Newton (N)  
*Force Unit Conversion* 
- **Measurement: Moment of Inertia** in Kilogram Square Meter (kg·m<sup>2</sup>)  
*Moment of Inertia Unit Conversion* 
- **Measurement: Moment of Force** in Kilonewton Meter (kN\*m)  
*Moment of Force Unit Conversion* 
- **Measurement: Stress** in Megapascal (MPa)  
*Stress Unit Conversion* 



## Check other formula lists

- **Beams, Columns and Other Members Design Methods Formulas** 
- **Braced and Unbraced Frames Formulas** 
- **Deflection Computations, Column Moments and Torsion Formulas** 
- **Flat Plate Construction Formulas** 
- **Mix Design, Modulus of Elasticity and Tensile Strength of Concrete Formulas** 
- **Working Stress Design Formulas** 

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