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Short Columns Formulas

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List of 37 Short Columns Formulas

Short Columns

Design of Short Column in Compression with Uniaxial Bending

Modes of Failure in Eccentric Compression

1) Area of Cross Section of Column given Crushing Stress

$$\text{fx } A_{\text{sectional}} = \frac{P_c}{\sigma_{\text{crushing}}}$$

Open Calculator 

$$\text{ex } 6.25\text{m}^2 = \frac{1500\text{kN}}{0.24\text{MPa}}$$

2) Area of Cross-Section given Compressive Stress Induced during Failure of Short Column

$$\text{fx } A_{\text{sectional}} = \frac{P_{\text{compressive}}}{\sigma_c}$$

Open Calculator 

$$\text{ex } 6.25\text{m}^2 = \frac{0.4\text{kN}}{0.000064\text{MPa}}$$



3) Area of Cross-Section given Stress due to Direct Load for Long Column

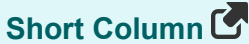


$$fx \quad A_{\text{sectional}} = \frac{P_{\text{compressive}}}{\sigma}$$

[Open Calculator](#)

$$ex \quad 6.666667m^2 = \frac{0.4kN}{0.00006MPa}$$

4) Compressive Load given Compressive Stress Induced during Failure of Short Column



$$fx \quad P_{\text{compressive}} = A_{\text{sectional}} \cdot \sigma_c$$

[Open Calculator](#)

$$ex \quad 0.4kN = 6.25m^2 \cdot 0.000064MPa$$

5) Compressive Load given Stress Due to Direct Load for Long Column



$$fx \quad P_{\text{compressive}} = A_{\text{sectional}} \cdot \sigma$$

[Open Calculator](#)

$$ex \quad 0.375kN = 6.25m^2 \cdot 0.00006MPa$$

6) Compressive Stress Induced during Failure of Short Column



$$fx \quad \sigma_c = \frac{P_{\text{compressive}}}{A_{\text{sectional}}}$$

[Open Calculator](#)

$$ex \quad 6.4E^{-5}MPa = \frac{0.4kN}{6.25m^2}$$



7) Crushing Load for Short Column

$$fx \quad P_c = A_{\text{sectional}} \cdot \sigma_{\text{crushing}}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 1500\text{kN} = 6.25\text{m}^2 \cdot 0.24\text{MPa}$$

8) Crushing Stress for Short Column

$$fx \quad \sigma_{\text{crushing}} = \frac{P_c}{A_{\text{sectional}}}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 0.24\text{MPa} = \frac{1500\text{kN}}{6.25\text{m}^2}$$

9) Maximum Stress for Failure of Long Column

$$fx \quad \sigma_{\text{max}} = \sigma + \sigma_b$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 0.00506\text{MPa} = 0.00006\text{MPa} + 0.005\text{MPa}$$

10) Minimum Stress for Failure of Long Column

$$fx \quad \sigma_{\text{min}} = \sigma + \sigma_b$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 0.00506\text{MPa} = 0.00006\text{MPa} + 0.005\text{MPa}$$



11) Section Modulus about Axis of Bending for Long Column

$$fx \quad S = \frac{P_{\text{compressive}} \cdot e}{\sigma_b}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 320000\text{mm}^3 = \frac{0.4\text{kN} \cdot 4\text{mm}}{0.005\text{MPa}}$$

12) Stress Due to Bending at Center of Column given Maximum Stress for Failure of Long Column

$$fx \quad \sigma_b = \sigma_{\text{max}} - \sigma$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.005\text{MPa} = 0.00506\text{MPa} - 0.00006\text{MPa}$$

13) Stress Due to Bending at Center of Column given Minimum Stress for Failure of Long Column

$$fx \quad \sigma_b = \sigma_{\text{min}} - \sigma$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.00094\text{MPa} = 0.001\text{MPa} - 0.00006\text{MPa}$$

14) Stress Due to Direct Load for Long Column

$$fx \quad \sigma = \frac{P_{\text{compressive}}}{A_{\text{sectional}}}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 6.4\text{E}^{-5}\text{MPa} = \frac{0.4\text{kN}}{6.25\text{m}^2}$$



15) Stress Due to Direct Load given Maximum Stress for Failure of Long Column

$$fx \quad \sigma = \sigma_{\max} - \sigma_b$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$ex \quad 6E^{-5}MPa = 0.00506MPa - 0.005MPa$$

Design of Short Column under Axial Compression

16) Allowable Bond Stress for Horizontal Tension Bars of Sizes and Deformations Conforming to ASTM A 408

$$fx \quad S_b = 2.1 \cdot \sqrt{f'_c}$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719_img.jpg\)](#)

$$ex \quad 18.78297N/m^2 = 2.1 \cdot \sqrt{80Pa}$$

17) Allowable Bond Stress for Other Tension Bars of Sizes and Deformations Conforming to ASTM A 408

$$fx \quad S_b = 3 \cdot \sqrt{f'_c}$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7_img.jpg\)](#)

$$ex \quad 26.83282N/m^2 = 3 \cdot \sqrt{80Pa}$$



18) Allowable Stress in Vertical Concrete Reinforcing given Total Allowable Axial Load

$$f_x \quad f'_s = \frac{\frac{P_{\text{allow}}}{A_g} - 0.25 \cdot f'_c}{P_g}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 3.995006\text{N/mm}^2 = \frac{\frac{16.00001\text{kN}}{500\text{mm}^2} - 0.25 \cdot 80\text{Pa}}{8.01}$$

19) Concrete Compressive Strength given Total Allowable Axial Load

$$f_x \quad f_{ck} = \frac{\left(\frac{P_T}{A_g}\right) - (f'_s \cdot p_g)}{0.25}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$ex \quad 19.80796\text{MPa} = \frac{\left(\frac{18.5\text{N}}{500\text{mm}^2}\right) - (4.001\text{N/mm}^2 \cdot 8.01)}{0.25}$$


20) Gross Cross-Sectional Area of Column given Total Allowable Axial Load

$$f_x \quad A_g = \frac{P_{\text{allow}}}{0.25 \cdot f'_c + f'_s \cdot p_g}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 499.251\text{mm}^2 = \frac{16.00001\text{kN}}{0.25 \cdot 80\text{Pa} + 4.001\text{N/mm}^2 \cdot 8.01}$$



21) Spiral Volume to Concrete-Core Volume Ratio 

$$fx \quad p_s = 0.45 \cdot \left(\frac{A_g}{A_c} - 1 \right) \cdot \frac{f'_c}{f_{y_{steel}}}$$

Open Calculator 


$$ex \quad 0.045474 = 0.45 \cdot \left(\frac{500\text{mm}^2}{380\text{mm}^2} - 1 \right) \cdot \frac{80\text{Pa}}{250\text{MPa}}$$

22) Total Allowable Axial Load for Short Columns 

$$fx \quad P_{allow} = A_g \cdot (0.25 \cdot f'_c + f'_s \cdot p_g)$$

Open Calculator 

$$ex \quad 16.02402\text{kN} = 500\text{mm}^2 \cdot (0.25 \cdot 80\text{Pa} + 4.001\text{N}/\text{mm}^2 \cdot 8.01)$$

Design Under Axial Compression with Biaxial Bending 23) Axial Load at Balanced Condition 

$$fx \quad N_b = \frac{M_b}{e_b}$$

Open Calculator 

$$ex \quad 0.666733\text{N} = \frac{10.001\text{N} \cdot \text{m}}{15\text{m}}$$

24) Axial Moment at Balanced Condition 

$$fx \quad M_b = N_b \cdot e_b$$

Open Calculator 

$$ex \quad 9.9\text{N} \cdot \text{m} = 0.66\text{N} \cdot 15\text{m}$$



25) Bending Moment for Spiral Columns

$$fx \quad M = 0.12 \cdot A_{st} \cdot f_y \cdot D_b$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$ex \quad 12.38121kN^*m = 0.12 \cdot 8m^2 \cdot 9.99MPa \cdot 1.291m$$

26) Bending Moment for Tied Columns

$$fx \quad M = 0.40 \cdot A \cdot f_y \cdot (d - d')$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$ex \quad 419.62kN^*m = 0.40 \cdot 10m^2 \cdot 9.99MPa \cdot (20.001mm - 9.5mm)$$

27) Circle Diameter given Maximum Permissible Eccentricity for Spiral Columns

$$fx \quad D = \frac{e_b - 0.14 \cdot t}{0.43 \cdot p_g \cdot m}$$

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a_img.jpg\)](#)

$$ex \quad 9.744626m = \frac{15m - 0.14 \cdot 8.85m}{0.43 \cdot 8.01 \cdot 0.41}$$

28) Column Diameter given Maximum Permissible Eccentricity for Spiral Columns

$$fx \quad t = \frac{e_b - 0.43 \cdot p_g \cdot m \cdot D}{0.14}$$

[Open Calculator !\[\]\(3342c215b2a8b663596a81468d5dc314_img.jpg\)](#)

$$ex \quad 6.173203m = \frac{15m - 0.43 \cdot 8.01 \cdot 0.41 \cdot 10.01m}{0.14}$$



29) Maximum Permissible Eccentricity for Spiral Columns

$$fx \quad e_b = 0.43 \cdot p_g \cdot m \cdot D + 0.14 \cdot t$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a_img.jpg\)](#)

$$ex \quad 15.37475m = 0.43 \cdot 8.01 \cdot 0.41 \cdot 10.01m + 0.14 \cdot 8.85m$$

30) Maximum Permissible Eccentricity for Tied Columns

$$fx \quad e_b = (0.67 \cdot p_g \cdot m \cdot D + 0.17) \cdot d$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010_img.jpg\)](#)

$$ex \quad 44.05655m = (0.67 \cdot 8.01 \cdot 0.41 \cdot 10.01m + 0.17) \cdot 20.001mm$$

31) Reinforcement Yield Strength given Axial Load for Tied Columns

$$fx \quad f_y = \frac{M}{0.40 \cdot A \cdot (d - d')}$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd_img.jpg\)](#)

$$ex \quad 9.522903MPa = \frac{400kN \cdot m}{0.40 \cdot 10m^2 \cdot (20.001mm - 9.5mm)}$$

32) Tension Reinforcement Area given Axial Load for Tied Columns

$$fx \quad A = \frac{M}{0.40 \cdot f_y \cdot (d - d')}$$

[Open Calculator !\[\]\(235bfe13ebf007ce2eea9e689707fac7_img.jpg\)](#)

$$ex \quad 9.532435m^2 = \frac{400kN \cdot m}{0.40 \cdot 9.99MPa \cdot (20.001mm - 9.5mm)}$$



Slender Columns

33) Load Reduction Factor for Column with Fixed Ends

$$\text{fx } R = 1.32 - \left(0.006 \cdot \frac{1}{r} \right)$$

[Open Calculator !\[\]\(a03a7eb2f4046e1d3c76772003e549ea_img.jpg\)](#)

$$\text{ex } 1.292727 = 1.32 - \left(0.006 \cdot \frac{5000\text{mm}}{1.1\text{m}} \right)$$

34) Load Reduction Factor for Member Bent in Single Curvature

$$\text{fx } R = 1.07 - \left(0.008 \cdot \frac{1}{r} \right)$$

[Open Calculator !\[\]\(5361750c22c4e047a52f4eac1ec2d4cc_img.jpg\)](#)

$$\text{ex } 1.033636 = 1.07 - \left(0.008 \cdot \frac{5000\text{mm}}{1.1\text{m}} \right)$$

35) Radius of Gyration for Fixed End Columns using Load Reduction Factor

$$\text{fx } r = 1.32 - \left(0.006 \cdot \frac{1}{R} \right)$$

[Open Calculator !\[\]\(b792654f2cef9719eabeb6c5be00811e_img.jpg\)](#)

$$\text{ex } 1.290958\text{m} = 1.32 - \left(0.006 \cdot \frac{5000\text{mm}}{1.033} \right)$$



36) Radius of Gyration for Single Curvature Bent Member using Load Reduction Factor

$$\text{fx } r = 1.07 - \left(0.008 \cdot \frac{1}{R} \right)$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 1.031278\text{m} = 1.07 - \left(0.008 \cdot \frac{5000\text{mm}}{1.033} \right)$$

37) Unsupported Column Length for Single Curvature Bent Member given Load Reduction Factor

$$\text{fx } l = (1.07 - R) \cdot \frac{r}{0.008}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 5087.5\text{mm} = (1.07 - 1.033) \cdot \frac{1.1\text{m}}{0.008}$$



Variables Used








- **A** Area of Tension Reinforcement (*Square Meter*)
- **A_c** Cross Sectional Area of Column (*Square Millimeter*)
- **A_g** Gross Area of Column (*Square Millimeter*)
- **A_{sectional}** Column Cross Sectional Area (*Square Meter*)
- **A_{st}** Total Area (*Square Meter*)
- **d** Distance from Compression to Tensile Reinforcement (*Millimeter*)
- **d'** Distance Compression to Centroid Reinforcement (*Millimeter*)
- **D** Column Diameter (*Meter*)
- **D_b** Bar Diameter (*Meter*)
- **e** Column Maximum Bending (*Millimeter*)
- **e_b** Maximum Permissible Eccentricity (*Meter*)
- **f'_c** Specified Compressive Strength at 28 Days (*Pascal*)
- **f'_s** Allowable Stress in Vertical Reinforcement (*Newton per Square Millimeter*)
- **f_y** Yield Strength of Reinforcement (*Megapascal*)
- **fck** Characteristic Compressive Strength (*Megapascal*)
- **f_{ysteel}** Yield Strength of Steel (*Megapascal*)
- **l** Length of Column (*Millimeter*)
- **m** Force Ratio of Strengths of Reinforcements
- **M** Bending Moment (*Kilonewton Meter*)
- **M_b** Moment at Balanced Condition (*Newton Meter*)
- **N_b** Axial Load at Balanced Condition (*Newton*)



- P_{allow} Allowable Load (Kilonewton)
- P_c Crushing load (Kilonewton)
- $P_{\text{compressive}}$ Column Compressive Load (Kilonewton)
- p_g Area Ratio of Cross Sectional Area to Gross Area
- p_s Ratio of Spiral to Concrete Core Volume
- p_T Total Allowable Load (Newton)
- r Radius of Gyration of Gross Concrete Area (Meter)
- R Long Column Load Reduction Factor
- S Section Modulus (Cubic Millimeter)
- S_b Allowable Bond Stress (Newton per Square Meter)
- t Overall Depth of Column (Meter)
- σ Direct Stress (Megapascal)
- σ_b Column Bending Stress (Megapascal)
- σ_c Column Compressive Stress (Megapascal)
- σ_{crushing} Column Crushing Stress (Megapascal)
- σ_{max} Maximum Stress (Megapascal)
- σ_{min} Minimum Stress Value (Megapascal)



Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Millimeter (mm), Meter (m)
Length Unit Conversion 
- **Measurement:** **Volume** in Cubic Millimeter (mm³)
Volume Unit Conversion 
- **Measurement:** **Area** in Square Meter (m²), Square Millimeter (mm²)
Area Unit Conversion 
- **Measurement:** **Pressure** in Megapascal (MPa), Newton per Square Meter (N/m²), Pascal (Pa), Newton per Square Millimeter (N/mm²)
Pressure Unit Conversion 
- **Measurement:** **Force** in Kilonewton (kN), Newton (N)
Force Unit Conversion 
- **Measurement:** **Moment of Force** in Newton Meter (N*m), Kilonewton Meter (kN*m)
Moment of Force Unit Conversion 
- **Measurement:** **Stress** in Megapascal (MPa)
Stress Unit Conversion 



Check other formula lists

- [Estimation of Effective Length of Columns Formulas](#) 
- [Short Columns Formulas](#) 

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