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Short Columns Formulas

Calculators!

Examples!

Conversions!

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

6) Compressive Stress Induced during Failure of Short Column

Open Calculator

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

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

7) Crushing Load for Short Column

Open Calculator

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

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

8) Crushing Stress for Short Column

Open Calculator

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

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

9) Maximum Stress for Failure of Long Column

Open Calculator

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

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

10) Minimum Stress for Failure of Long Column

Open Calculator

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

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

11) Section Modulus about Axis of Bending for Long Column

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

14) Stress Due to Direct Load for Long Column

Open Calculator

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

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

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

Open Calculator

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

ex $6E\hat{}\text{-}5\text{MPa} = 0.00506\text{MPa} - 0.005\text{MPa}$

Design of Short Column under Axial Compression

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

$$f'_s = \frac{\frac{P_{allow}}{A_g} - 0.25 \cdot f'_c}{p_g}$$

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

19) Concrete Compressive Strength given Total Allowable Axial Load

Open Calculator

$$fck = \frac{\left(\frac{p_T}{A_g}\right) - (f'_s \cdot p_g)}{0.25}$$

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

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

Open Calculator

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

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

21) Spiral Volume to Concrete-Core Volume Ratio

Open Calculator

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

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

22) Total Allowable Axial Load for Short Columns

Open Calculator

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

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

Design Under Axial Compression with Biaxial Bending

23) Axial Load at Balanced Condition

Open Calculator

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

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

24) Axial Moment at Balanced Condition

Open Calculator

fx $$M_b = N_b \cdot e_b$$

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

25) Bending Moment for Spiral Columns

Open Calculator

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

$$12.38121\text{kN*m} = 0.12 \cdot 8\text{m}^2 \cdot 9.99\text{MPa} \cdot 1.291\text{m}$$

26) Bending Moment for Tied Columns

Open Calculator

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

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

27) Circle Diameter given Maximum Permissible Eccentricity for Spiral Columns

Open Calculator

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

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

28) Column Diameter given Maximum Permissible Eccentricity for Spiral Columns

Open Calculator

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

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

29) Maximum Permissible Eccentricity for Spiral Columns

Open Calculator

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

$$15.37475\text{m} = 0.43 \cdot 8.01 \cdot 0.41 \cdot 10.01\text{m} + 0.14 \cdot 8.85\text{m}$$

30) Maximum Permissible Eccentricity for Tied Columns

Open Calculator

$$e_b = \left(0.67 \cdot p_g \cdot m \cdot D + 0.17\right) \cdot d$$

$$44.05655\text{m} = (0.67 \cdot 8.01 \cdot 0.41 \cdot 10.01\text{m} + 0.17) \cdot 20.001\text{mm}$$

31) Reinforcement Yield Strength given Axial Load for Tied Columns

Open Calculator

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

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

32) Tension Reinforcement Area given Axial Load for Tied Columns

Open Calculator

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

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

Slender Columns

33) Load Reduction Factor for Column with Fixed Ends

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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)*
- **fy_{steel}** 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)*
- $P_{compressive}$ 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)*
- $\sigma_{crushing}$ 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 (mm^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2), Square Millimeter (mm^2)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa), Newton per Square Meter (N/m^2), Pascal (Pa), Newton per Square Millimeter (N/mm^2)
  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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