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# Eccentric Loads on Columns Formulas

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# List of 18 Eccentric Loads on Columns Formulas

## Eccentric Loads on Columns

### 1) Maximum Stress for Circular Cross-Section Columns

Open Calculator

fx $$S_M = S_c \cdot \left(1 + 8 \cdot \frac{e}{d}\right)$$

ex $$46.875\text{Pa} = 25\text{Pa} \cdot \left(1 + 8 \cdot \frac{35\text{mm}}{320\text{mm}}\right)$$

### 2) Maximum Stress for Circular Section Column under Compression

Open Calculator

fx $$S_M = \left(0.372 + 0.056 \cdot \left(\frac{k}{r}\right) \cdot \left(\frac{P}{k}\right) \cdot \sqrt{r \cdot k}\right)$$

ex $$10.65986\text{Pa} = \left(0.372 + 0.056 \cdot \left(\frac{240\text{mm}}{160\text{mm}}\right) \cdot \left(\frac{150\text{N}}{240\text{mm}}\right) \cdot \sqrt{160\text{mm} \cdot 240\text{mm}}\right)$$

### 3) Maximum Stress for Rectangular Cross-Section Column

Open Calculator

fx $$S_M = S_c \cdot \left(1 + 6 \cdot \frac{e}{b}\right)$$

ex $$46\text{Pa} = 25\text{Pa} \cdot \left(1 + 6 \cdot \frac{35\text{mm}}{250\text{mm}}\right)$$

## 4) Maximum Stress for Rectangular Section Column under Compression

Open Calculator

fx $$S_M = \left(\frac{2}{3}\right) \cdot \frac{P}{h \cdot k}$$

ex $$46.2963\text{Pa} = \left(\frac{2}{3}\right) \cdot \frac{150\text{N}}{9000\text{mm} \cdot 240\text{mm}}$$

## 5) Radius of Kern for Circular Ring

Open Calculator

fx $$r_{kern} = \frac{D \cdot \left(1 + \left(\frac{d_i}{D}\right)^2\right)}{8}$$

ex $$5.416667\text{mm} = \frac{30\text{mm} \cdot \left(1 + \left(\frac{20.0\text{mm}}{30\text{mm}}\right)^2\right)}{8}$$

## 6) Radius of Kern for Hollow Square

Open Calculator

fx $$r_{kern} = 0.1179 \cdot H \cdot \left(1 + \left(\frac{h_i}{H}\right)^2\right)$$

ex $$6.8382\text{mm} = 0.1179 \cdot 50.0\text{mm} \cdot \left(1 + \left(\frac{20\text{mm}}{50.0\text{mm}}\right)^2\right)$$

## 7) Thickness of Wall for Hollow Octagon

Open Calculator

fx $$t = 0.9239 \cdot (R_a - R_i)$$

ex $$41.5755\text{mm} = 0.9239 \cdot (60\text{mm} - 15\text{mm})$$

## Long Columns

### 8) Euler's Formula for Critical Buckling Load

Open Calculator

fx $$P_{\text{Buckling Load}} = n \cdot \left(\pi^2\right) \cdot E \cdot \frac{I}{L^2}$$

ex $$10.96623\text{N} = 2.0 \cdot \left(\pi^2\right) \cdot 50\text{MPa} \cdot \frac{100000\text{mm}^4}{(3000\text{mm})^2}$$

### 9) Euler's Formula for Critical Buckling Load given Area

Open Calculator

fx $$P_{\text{Buckling Load}} = \frac{n \cdot \pi^2 \cdot E \cdot A}{\left(\frac{L}{r_{\text{gyration}}}\right)^2}$$

ex $$51.89219\text{N} = \frac{2.0 \cdot \pi^2 \cdot 50\text{MPa} \cdot 700\text{mm}^2}{\left(\frac{3000\text{mm}}{26\text{mm}}\right)^2}$$

## Typical Short Column Formulas

### 10) Critical Stress for Carbon Steel by AISC code

Open Calculator

fx $$S_w = 17000 - 0.485 \cdot \left(\frac{L}{r_{\text{gyration}}}\right)^2$$

ex $$10542.9\text{Pa} = 17000 - 0.485 \cdot \left(\frac{3000\text{mm}}{26\text{mm}}\right)^2$$

### 11) Critical Stress for Carbon Steel by Am. Br. Co. code

Open Calculator

fx $$S_w = 19000 - 100 \cdot \left( \frac{L}{r_{gyration}} \right)$$

ex $$7461.538\text{Pa} = 19000 - 100 \cdot \left( \frac{3000\text{mm}}{26\text{mm}} \right)$$

### 12) Critical Stress for Carbon Steel by AREA code

Open Calculator

fx $$S_w = 15000 - 50 \cdot \left( \frac{L}{r_{gyration}} \right)$$

ex $$9230.769\text{Pa} = 15000 - 50 \cdot \left( \frac{3000\text{mm}}{26\text{mm}} \right)$$

### 13) Critical Stress for Carbon Steel by Chicago code

Open Calculator

fx $$S_w = 16000 - 70 \cdot \left( \frac{L}{r_{gyration}} \right)$$

ex $$7923.077\text{Pa} = 16000 - 70 \cdot \left( \frac{3000\text{mm}}{26\text{mm}} \right)$$

### 14) Critical Stress for Cast Iron by NYC code

Open Calculator

fx $$S_w = 9000 - 40 \cdot \left( \frac{L}{r_{gyration}} \right)$$

ex $$4384.615\text{Pa} = 9000 - 40 \cdot \left( \frac{3000\text{mm}}{26\text{mm}} \right)$$

### 15) Theoretical Maximum Stress for ANC Code 2017ST Aluminium

Open Calculator

$$S_{cr} = 34500 - \left(\frac{245}{\sqrt{c}}\right) \cdot \left(\frac{L}{r_{gyration}}\right)$$

$$20365.38\text{Pa} = 34500 - \left(\frac{245}{\sqrt{4}}\right) \cdot \left(\frac{3000\text{mm}}{26\text{mm}}\right)$$

### 16) Theoretical Maximum Stress for ANC Code Alloy Steel Tubing

Open Calculator

$$S_{cr} = 135000 - \left(\frac{15.9}{c}\right) \cdot \left(\frac{L}{r_{gyration}}\right)^2$$

$$82078.4\text{Pa} = 135000 - \left(\frac{15.9}{4}\right) \cdot \left(\frac{3000\text{mm}}{26\text{mm}}\right)^2$$

### 17) Theoretical Maximum Stress for ANC Code Spruce

Open Calculator

$$S_{cr} = 5000 - \left(\frac{0.5}{c}\right) \cdot \left(\frac{L}{r_{gyration}}\right)^2$$

$$3335.799\text{Pa} = 5000 - \left(\frac{0.5}{4}\right) \cdot \left(\frac{3000\text{mm}}{26\text{mm}}\right)^2$$

### 18) Theoretical Maximum Stress for Johnson Code Steels

Open Calculator

$$S_{cr} = S_y \cdot \left(1 - \left(\frac{S_y}{4 \cdot n \cdot (\pi^2) \cdot E}\right) \cdot \left(\frac{L}{r_{gyration}}\right)^2\right)$$

$$30868.84\text{Pa} = 35000\text{Pa} \cdot \left(1 - \left(\frac{35000\text{Pa}}{4 \cdot 2.0 \cdot (\pi^2) \cdot 50\text{MPa}}\right) \cdot \left(\frac{3000\text{mm}}{26\text{mm}}\right)^2\right)$$

## Variables Used

- **A** Column Cross-Sectional Area *(Square Millimeter)*
- **b** Rectangular Cross-Section Width *(Millimeter)*
- **c** End Fixity Coefficient
- **d** Diameter of Circular Cross-Section *(Millimeter)*
- **D** Outer Diameter of Hollow Circular Section *(Millimeter)*
- **$d_i$** Inner Diameter of Hollow Circular Section *(Millimeter)*
- **e** Eccentricity of Column *(Millimeter)*
- **E** Modulus of Elasticity *(Megapascal)*
- **h** Height of Cross-Section *(Millimeter)*
- **H** Length of Outer Side *(Millimeter)*
- **$h_i$** Length of Inner Side *(Millimeter)*
- **I** Area Moment of Inertia *(Millimeter$^4$)*
- **k** Distance from Nearest Edge *(Millimeter)*
- **L** Effective Length of Column *(Millimeter)*
- **n** Coefficient for Column End Conditions
- **P** Concentrated Load *(Newton)*
- **$P_{Buckling\ Load}$** Buckling Load *(Newton)*
- **r** Radius of Circular Cross-Section *(Millimeter)*
- **$R_a$** Radii of Circle Circumscribing Outer Side *(Millimeter)*
- **$r_{gyration}$** Radius of Gyration of Column *(Millimeter)*
- **$R_i$** Radii of Circle Circumscribing Inner Side *(Millimeter)*
- **$r_{kern}$** Radius of Kern *(Millimeter)*
- **$S_c$** Unit Stress *(Pascal)*
- **$S_{cr}$** Theoretical Maximum Stress *(Pascal)*
- **$S_M$** Maximum Stress for Section *(Pascal)*

- $S_w$ Critical Stress *(Pascal)*
- $S_y$ Stress at any Point y *(Pascal)*
- **t** Thickness of Wall *(Millimeter)*

## Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  *Archimedes' constant*
- Function: **sqrt**, sqrt(Number)
  *Square root function*
- Measurement: **Length** in Millimeter (mm)
  *Length Unit Conversion*
- Measurement: **Area** in Square Millimeter (mm²)
  *Area Unit Conversion*
- Measurement: **Force** in Newton (N)
  *Force Unit Conversion*
- Measurement: **Second Moment of Area** in Millimeter⁴ (mm⁴)
  *Second Moment of Area Unit Conversion*
- Measurement: **Stress** in Pascal (Pa), Megapascal (MPa)
  *Stress Unit Conversion*

## Check other formula lists

- **Allowable Design for Column Formulas**
- **Column Base Plate Design Formulas**
- **Columns of Special Materials Formulas**
- **Eccentric Loads on Columns Formulas**
- **Elastic Flexural Buckling of Columns Formulas**
- **Short Axially Loaded Columns with Helical Ties Formulas**
- **Ultimate Strength Design of Concrete Columns Formulas**

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