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# Expressions For Crippling Load Formulas

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# List of 32 Expressions For Crippling Load Formulas

## Expressions For Crippling Load

### Both Ends of Column are Fixed

#### 1) Crippling Load given Moment of Section if Both Ends of Column are Fixed

$$fx \quad P = \frac{M_{\text{Fixed}} - M_t}{\delta}$$

Open Calculator 

$$ex \quad 1.6625kN = \frac{20000N \cdot mm - 50N \cdot mm}{12mm}$$

#### 2) Crippling Load if Both Ends of Column are Fixed

$$fx \quad P = \frac{\pi^2 \cdot E \cdot I}{l^2}$$

Open Calculator 

$$ex \quad 0.23346kN = \frac{\pi^2 \cdot 10.56MPa \cdot 5600cm^4}{(5000mm)^2}$$



### 3) Deflection at Section given Moment of Section if Both Ends of Column are Fixed

$$fx \quad \delta = \frac{M_{\text{Fixed}} - M_t}{P}$$

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

$$ex \quad 6.65\text{mm} = \frac{20000\text{N} \cdot \text{mm} - 50\text{N} \cdot \text{mm}}{3\text{kN}}$$

### 4) Length of Column given Crippling Load if Both Ends of Column are Fixed

$$fx \quad l = \sqrt{\frac{\pi^2 \cdot E \cdot I}{P}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 1394.811\text{mm} = \sqrt{\frac{\pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{3\text{kN}}}$$

### 5) Modulus of Elasticity given Crippling Load if Both Ends of Column are Fixed

$$fx \quad E = \frac{P \cdot l^2}{\pi^2 \cdot I}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 135.698\text{MPa} = \frac{3\text{kN} \cdot (5000\text{mm})^2}{\pi^2 \cdot 5600\text{cm}^4}$$



## 6) Moment of Fixed Ends given Moment of Section if Both Ends of Column are Fixed

$$fx \quad M_{\text{Fixed}} = M_t + P \cdot \delta$$

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

$$ex \quad 36050\text{N} \cdot \text{mm} = 50\text{N} \cdot \text{mm} + 3\text{kN} \cdot 12\text{mm}$$

## 7) Moment of Inertia given Crippling Load if Both Ends of Column are Fixed

$$fx \quad I = \frac{P \cdot l^2}{\pi^2 \cdot E}$$

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

$$ex \quad 71961.07\text{cm}^4 = \frac{3\text{kN} \cdot (5000\text{mm})^2}{\pi^2 \cdot 10.56\text{MPa}}$$

## 8) Moment of Section if Both Ends of Column are Fixed

$$fx \quad M_t = M_{\text{Fixed}} - P \cdot \delta$$

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

$$ex \quad -16000\text{N} \cdot \text{mm} = 20000\text{N} \cdot \text{mm} - 3\text{kN} \cdot 12\text{mm}$$

## Both Ends of Columns are Hinged

## 9) Crippling Load given Moment at Section if Both Ends of Column are Hinged

$$fx \quad P = -\frac{M_t}{\delta}$$

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

$$ex \quad -0.004167\text{kN} = -\frac{50\text{N} \cdot \text{mm}}{12\text{mm}}$$



## 10) Crippling Load when Both Ends of Column are Hinged

$$\text{fx } P = \frac{\pi^2 \cdot E \cdot I}{l^2}$$

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

$$\text{ex } 0.23346\text{kN} = \frac{\pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{(5000\text{mm})^2}$$

## 11) Deflection at Section given Moment at Section if Both Ends of Column are Hinged

$$\text{fx } \delta = -\frac{M_t}{P}$$

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

$$\text{ex } -0.016667\text{mm} = -\frac{50\text{N} \cdot \text{mm}}{3\text{kN}}$$

## 12) Length of Column given Crippling Load with Both Ends of Column Hinged

$$\text{fx } l = \sqrt{\frac{\pi^2 \cdot E \cdot I}{P}}$$

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

$$\text{ex } 1394.811\text{mm} = \sqrt{\frac{\pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{3\text{kN}}}$$



### 13) Modulus of Elasticity given Crippling Load with Both Ends of Column Hinged

$$\text{fx } E = \frac{P \cdot l^2}{\pi^2 \cdot I}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0\_img.jpg\)](#)

$$\text{ex } 135.698\text{MPa} = \frac{3\text{kN} \cdot (5000\text{mm})^2}{\pi^2 \cdot 5600\text{cm}^4}$$

### 14) Moment due to Crippling Load at Section if Both Ends of Column are Hinged

$$\text{fx } M_t = -P \cdot \delta$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5\_img.jpg\)](#)

$$\text{ex } -36000\text{N} \cdot \text{mm} = -3\text{kN} \cdot 12\text{mm}$$

### 15) Moment of Inertia given Crippling Load with Both Ends of Column Hinged


$$\text{fx } I = \frac{P \cdot l^2}{\pi^2 \cdot E}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60\_img.jpg\)](#)

$$\text{ex } 71961.07\text{cm}^4 = \frac{3\text{kN} \cdot (5000\text{mm})^2}{\pi^2 \cdot 10.56\text{MPa}}$$




## One End of Column is Fixed and Other is Free

16) Crippling Load given Moment of Section if One End of Column is Fixed and Other is Free 

$$\text{fx } P = \frac{M_t}{a - \delta}$$

Open Calculator 


$$\text{ex } 0.025\text{kN} = \frac{50\text{N} \cdot \text{mm}}{14\text{mm} - 12\text{mm}}$$

17) Crippling Load if One End of Column is Fixed and Other is Free 

$$\text{fx } P = \frac{\pi^2 \cdot E \cdot I}{4 \cdot l^2}$$

Open Calculator 

$$\text{ex } 0.058365\text{kN} = \frac{\pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{4 \cdot (5000\text{mm})^2}$$

18) Deflection at Free End given Moment of Section if One End of Column is Fixed and Other is Free 

$$\text{fx } a = \frac{M_t}{P} + \delta$$

Open Calculator 

$$\text{ex } 12.01667\text{mm} = \frac{50\text{N} \cdot \text{mm}}{3\text{kN}} + 12\text{mm}$$



## 19) Deflection of Section given Moment of Section if One End of Column is Fixed and Other is Free

$$\text{fx } \delta = a - \frac{M_t}{P}$$

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

$$\text{ex } 13.98333\text{mm} = 14\text{mm} - \frac{50\text{N} \cdot \text{mm}}{3\text{kN}}$$

## 20) Length of Column given Crippling Load if One End of Column is Fixed and Other is Free

$$\text{fx } l = \sqrt{\frac{\pi^2 \cdot E \cdot I}{4 \cdot P}}$$

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

$$\text{ex } 697.4053\text{mm} = \sqrt{\frac{\pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{4 \cdot 3\text{kN}}}$$

## 21) Modulus of Elasticity given Crippling Load if One End of Column is Fixed and Other is Free

$$\text{fx } E = \frac{4 \cdot l^2 \cdot P}{\pi^2 \cdot I}$$

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

$$\text{ex } 542.7921\text{MPa} = \frac{4 \cdot (5000\text{mm})^2 \cdot 3\text{kN}}{\pi^2 \cdot 5600\text{cm}^4}$$





## 22) Moment of Inertia given Crippling Load if One End of Column is Fixed and Other is Free

$$\text{fx } I = \frac{4 \cdot l^2 \cdot P}{\pi^2 \cdot E}$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0\_img.jpg\)](#)

$$\text{ex } 287844.3\text{cm}^4 = \frac{4 \cdot (5000\text{mm})^2 \cdot 3\text{kN}}{\pi^2 \cdot 10.56\text{MPa}}$$

## 23) Moment of Section due to Crippling Load if One End of Column is Fixed and Other is Free

$$\text{fx } M_t = P \cdot (a - \delta)$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1\_img.jpg\)](#)

$$\text{ex } 6000\text{N} \cdot \text{mm} = 3\text{kN} \cdot (14\text{mm} - 12\text{mm})$$

## One End of Column is Fixed and Other is Hinged

## 24) Crippling Load given Moment at Section if One End of Column is Fixed and Other is Hinged

$$\text{fx } P = \frac{-M_t + H \cdot (l - x)}{\delta}$$

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822\_img.jpg\)](#)

$$\text{ex } 333.3292\text{kN} = \frac{-50\text{N} \cdot \text{mm} + 2\text{kN} \cdot (5000\text{mm} - 3000\text{mm})}{12\text{mm}}$$



## 25) Crippling Load if One End of Column is Fixed and Other is Hinged

$$\text{fx } P = \frac{2 \cdot \pi^2 \cdot E \cdot I}{l^2}$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a\_img.jpg\)](#)

$$\text{ex } 0.466919\text{kN} = \frac{2 \cdot \pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{(5000\text{mm})^2}$$

## 26) Deflection at Section given Moment at Section if One End of Column is Fixed and Other is Hinged

$$\text{fx } \delta = \frac{-M_t + H \cdot (l - x)}{P}$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010\_img.jpg\)](#)

$$\text{ex } 1333.317\text{mm} = \frac{-50\text{N} \cdot \text{mm} + 2\text{kN} \cdot (5000\text{mm} - 3000\text{mm})}{3\text{kN}}$$

## 27) Horizontal Reaction given Moment at Section if One End of Column is Fixed and Other is Hinged

$$\text{fx } H = \frac{M_t + P \cdot \delta}{l - x}$$

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

$$\text{ex } 0.018025\text{kN} = \frac{50\text{N} \cdot \text{mm} + 3\text{kN} \cdot 12\text{mm}}{5000\text{mm} - 3000\text{mm}}$$



## 28) Length of Column given Crippling Load if One End of Column is Fixed and Other is Hinged

$$fx \quad l = \sqrt{\frac{2 \cdot \pi^2 \cdot E \cdot I}{P}}$$

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

$$ex \quad 1972.56\text{mm} = \sqrt{\frac{2 \cdot \pi^2 \cdot 10.56\text{MPa} \cdot 5600\text{cm}^4}{3\text{kN}}}$$

## 29) Length of Column given Moment at Section if One End of Column is Fixed and Other is Hinged

$$fx \quad l = \frac{M_t + P \cdot \delta}{H} + x$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 3018.025\text{mm} = \frac{50\text{N} \cdot \text{mm} + 3\text{kN} \cdot 12\text{mm}}{2\text{kN}} + 3000\text{mm}$$

## 30) Modulus of Elasticity given Crippling Load if One End of Column is Fixed and Other is Hinged

$$fx \quad E = \frac{P \cdot l^2}{2 \cdot \pi^2 \cdot I}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 67.84901\text{MPa} = \frac{3\text{kN} \cdot (5000\text{mm})^2}{2 \cdot \pi^2 \cdot 5600\text{cm}^4}$$



## 31) Moment at Section if One End of Column is Fixed and Other is Hinged



$$fx \quad M_t = -P \cdot \delta + H \cdot (1 - x)$$

Open Calculator

$$ex \quad 4E^6N^*mm = -3kN \cdot 12mm + 2kN \cdot (5000mm - 3000mm)$$

## 32) Moment of Inertia given Crippling Load if One End of Column is Fixed and Other is Hinged



$$fx \quad I = \frac{P \cdot l^2}{2 \cdot \pi^2 \cdot E}$$

Open Calculator

$$ex \quad 35980.53cm^4 = \frac{3kN \cdot (5000mm)^2}{2 \cdot \pi^2 \cdot 10.56MPa}$$








## Variables Used

- **a** Deflection of Free End (*Millimeter*)
- **E** Modulus of Elasticity of Column (*Megapascal*)
- **H** Horizontal Reaction (*Kilonewton*)
- **I** Moment of Inertia Column (*Centimeter<sup>4</sup>*)
- **l** Column Length (*Millimeter*)
- **M<sub>Fixed</sub>** Fixed End Moment (*Newton Millimeter*)
- **M<sub>t</sub>** Moment of Section (*Newton Millimeter*)
- **P** Column Crippling Load (*Kilonewton*)
- **x** Distance b/w Fixed End and Deflection Point (*Millimeter*)
- **δ** Deflection at Section (*Millimeter*)











## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Function:** **sqrt**, sqrt(Number)  
*A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- **Measurement:** **Length** in Millimeter (mm)  
*Length Unit Conversion* 
- **Measurement:** **Pressure** in Megapascal (MPa)  
*Pressure Unit Conversion* 
- **Measurement:** **Force** in Kilonewton (kN)  
*Force Unit Conversion* 
- **Measurement:** **Moment of Force** in Newton Millimeter (N\*mm)  
*Moment of Force Unit Conversion* 
- **Measurement:** **Second Moment of Area** in Centimeter<sup>4</sup> (cm<sup>4</sup>)  
*Second Moment of Area Unit Conversion* 



## Check other formula lists

- [Columns With Initial Curvature Formulas](#) 
- [Effective Length of Column Formulas](#) 
- [Euler and Rankine's Theory Formulas](#) 
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