

# Important Euler and Rankine's Theory Formulas PDF

**Formulas**  
**Examples**  
**with Units**

## List of 19 Important Euler and Rankine's Theory Formulas

### 1) Crippling Load by Euler's Formula Formula

Formula

$$P_E = \frac{\pi^2 \cdot E \cdot I}{L_{\text{eff}}^2}$$

Example with Units

$$1491.4069 \text{ kN} = \frac{3.1416^2 \cdot 200000 \text{ MPa} \cdot 6800000 \text{ mm}^4}{3000 \text{ mm}^2}$$

Evaluate Formula 

### 2) Crippling Load by Euler's Formula given Crippling Load by Rankine's Formula Formula

Formula

$$P_E = \frac{P_c \cdot P_R}{P_c - P_R}$$

Example with Units

$$1491.4071 \text{ kN} = \frac{1500 \text{ kN} \cdot 747.8456 \text{ kN}}{1500 \text{ kN} - 747.8456 \text{ kN}}$$

Evaluate Formula 

### 3) Crippling Load by Rankine's Formula Formula

Formula

$$P_R = \frac{P_c \cdot P_E}{P_c + P_E}$$

Example with Units

$$747.8456 \text{ kN} = \frac{1500 \text{ kN} \cdot 1491.407 \text{ kN}}{1500 \text{ kN} + 1491.407 \text{ kN}}$$

Evaluate Formula 

### 4) Crippling Load given Rankine's Constant Formula

Formula

$$P = \frac{\sigma_c \cdot A}{1 + \alpha \cdot \left( \frac{L_{\text{eff}}}{r_{\text{least}}} \right)^2}$$

Example with Units

$$588.9524 \text{ kN} = \frac{750 \text{ MPa} \cdot 2000 \text{ mm}^2}{1 + 0.00038 \cdot \left( \frac{3000 \text{ mm}}{47.02 \text{ mm}} \right)^2}$$

Evaluate Formula 

### 5) Cross-Sectional Area of Column given Crippling Load and Rankine's Constant Formula

Formula

$$A = \frac{P \cdot \left( 1 + \alpha \cdot \left( \frac{L_{\text{eff}}}{r_{\text{least}}} \right)^2 \right)}{\sigma_c}$$

Example with Units

$$2000 \text{ mm}^2 = \frac{588.9524 \text{ kN} \cdot \left( 1 + 0.00038 \cdot \left( \frac{3000 \text{ mm}}{47.02 \text{ mm}} \right)^2 \right)}{750 \text{ MPa}}$$

Evaluate Formula 



## 6) Cross-Sectional Area of Column given Crushing Load Formula

Formula

$$A = \frac{P_c}{\sigma_c}$$

Example with Units

$$2000 \text{ mm}^2 = \frac{1500 \text{ kN}}{750 \text{ MPa}}$$

Evaluate Formula 

## 7) Crushing Load by Rankine's Formula

Formula

$$P_c = \frac{P_r \cdot P_E}{P_E - P_r}$$

Example with Units

$$1500.0001 \text{ kN} = \frac{747.8456 \text{ kN} \cdot 1491.407 \text{ kN}}{1491.407 \text{ kN} - 747.8456 \text{ kN}}$$

Evaluate Formula 

## 8) Crushing Load given Ultimate Crushing Stress Formula

Formula

$$P_c = \sigma_c \cdot A$$

Example with Units

$$1500 \text{ kN} = 750 \text{ MPa} \cdot 2000 \text{ mm}^2$$

Evaluate Formula 

## 9) Effective Length of Column given Crippling Load and Rankine's Constant Formula

Formula

$$L_{\text{eff}} = \sqrt{\left( \sigma_c \cdot \frac{A}{P} - 1 \right) \cdot \frac{r_{\text{least}}^2}{\alpha}}$$

Evaluate Formula 

Example with Units

$$3000.0001 \text{ mm} = \sqrt{\left( 750 \text{ MPa} \cdot \frac{2000 \text{ mm}^2}{588.9524 \text{ kN}} - 1 \right) \cdot \frac{47.02 \text{ mm}^2}{0.00038}}$$

## 10) Effective Length of Column given Crippling Load by Euler's Formula

Formula

$$L_{\text{eff}} = \sqrt{\frac{\pi^2 \cdot E \cdot I}{P_E}}$$

Example with Units

$$2999.9999 \text{ mm} = \sqrt{\frac{3.1416^2 \cdot 200000 \text{ MPa} \cdot 6800000 \text{ mm}^4}{1491.407 \text{ kN}}}$$

Evaluate Formula 

## 11) Least Radius of Gyration given Crippling Load and Rankine's Constant Formula

Formula

$$r_{\text{least}} = \sqrt{\frac{\alpha \cdot L_{\text{eff}}^2}{\sigma_c \cdot \frac{A}{P} - 1}}$$

Example with Units

$$47.02 \text{ mm} = \sqrt{\frac{0.00038 \cdot 3000 \text{ mm}^2}{750 \text{ MPa} \cdot \frac{2000 \text{ mm}^2}{588.9524 \text{ kN}} - 1}}$$

Evaluate Formula 



## 12) Modulus of Elasticity given Crippling Load by Euler's Formula Formula

Formula

$$E = \frac{P_E \cdot L_{\text{eff}}^2}{\pi^2 \cdot I}$$

Example with Units

$$200000.0151 \text{ MPa} = \frac{1491.407 \text{ kN} \cdot 3000 \text{ mm}^2}{3.1416^2 \cdot 6800000 \text{ mm}^4}$$

Evaluate Formula 

## 13) Modulus of Elasticity given Rankine's Constant Formula

Formula

$$E = \frac{\sigma_c}{\pi^2 \cdot \alpha}$$

Example with Units

$$199976.0203 \text{ MPa} = \frac{750 \text{ MPa}}{3.1416^2 \cdot 0.00038}$$

Evaluate Formula 

## 14) Moment of Inertia given Crippling Load by Euler's Formula Formula

Formula

$$I = \frac{P_E \cdot L_{\text{eff}}^2}{\pi^2 \cdot E}$$

Example with Units

$$6.8E+6 \text{ mm}^4 = \frac{1491.407 \text{ kN} \cdot 3000 \text{ mm}^2}{3.1416^2 \cdot 200000 \text{ MPa}}$$

Evaluate Formula 

## 15) Rankine's Constant Formula

Formula

$$\alpha = \frac{\sigma_c}{\pi^2 \cdot E}$$

Example with Units

$$0.0004 = \frac{750 \text{ MPa}}{3.1416^2 \cdot 200000 \text{ MPa}}$$

Evaluate Formula 

## 16) Rankine's Constant given Crippling Load Formula

Formula

$$\alpha = \left( \frac{\sigma_c \cdot A}{P} - 1 \right) \cdot \left( \frac{r_{\text{least}}}{L_{\text{eff}}} \right)^2$$

Example with Units

$$0.0004 = \left( \frac{750 \text{ MPa} \cdot 2000 \text{ mm}^2}{588.9524 \text{ kN}} - 1 \right) \cdot \left( \frac{47.02 \text{ mm}}{3000 \text{ mm}} \right)^2$$

Evaluate Formula 

## 17) Ultimate Crushing Stress given Crippling Load and Rankine's Constant Formula

Formula

$$\sigma_c = \frac{P \cdot \left( 1 + \alpha \cdot \left( \frac{L_{\text{eff}}}{r_{\text{least}}} \right)^2 \right)}{A}$$

Example with Units

$$750 \text{ MPa} = \frac{588.9524 \text{ kN} \cdot \left( 1 + 0.00038 \cdot \left( \frac{3000 \text{ mm}}{47.02 \text{ mm}} \right)^2 \right)}{2000 \text{ mm}^2}$$

Evaluate Formula 

## 18) Ultimate Crushing Stress given Crushing Load Formula

Formula

$$\sigma_c = \frac{P_c}{A}$$

Example with Units

$$750 \text{ MPa} = \frac{1500 \text{ kN}}{2000 \text{ mm}^2}$$

Evaluate Formula 



## 19) Ultimate Crushing Stress given Rankine's Constant Formula

Formula

$$\sigma_c = \alpha \cdot \pi^2 \cdot E$$

Example with Units

$$750.0899_{\text{MPa}} = 0.00038 \cdot 3.1416^2 \cdot 200000_{\text{MPa}}$$






Evaluate Formula 



## Variables used in list of Euler and Rankine's Theory Formulas above






- **A** Column Cross Sectional Area (Square Millimeter)
- **E** Modulus of Elasticity Column (Megapascal)
- **I** Moment of Inertia Column (Millimeter<sup>4</sup>)
- **L<sub>eff</sub>** Effective Column Length (Millimeter)
- **P** Crippling Load (Kilonewton)
- **P<sub>C</sub>** Crushing Load (Kilonewton)
- **P<sub>E</sub>** Euler's Buckling Load (Kilonewton)
- **P<sub>r</sub>** Rankine's Critical Load (Kilonewton)
- **r<sub>least</sub>** Least Radius of Gyration Column (Millimeter)
- **α** Rankine's Constant
- **σ<sub>C</sub>** Column Crushing Stress (Megapascal)

## Constants, Functions, Measurements used in list of Euler and Rankine's Theory Formulas above


- **constant(s):** pi, 3.14159265358979323846264338327950288  
Archimedes' constant
- **Functions:** 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: Area** in Square Millimeter (mm<sup>2</sup>)  
Area Unit Conversion 
- **Measurement: Pressure** in Megapascal (MPa)  
Pressure Unit Conversion 
- **Measurement: Force** in Kilonewton (kN)  
Force Unit Conversion 
- **Measurement: Second Moment of Area** in Millimeter<sup>4</sup> (mm<sup>4</sup>)  
Second Moment of Area Unit Conversion 



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