Important Elastic Stability of Columns Formulas PDF

Formulas
Examples
with Units

List of 19
Important Elastic Stability of Columns Formulas

1) Crippling Load by Euler's Formula Formulas

1.1) Crippling Load by Euler's Formula Formula

Evaluate Formula

Formula

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

Example with Units

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

1.2) Crippling Load by Euler's Formula given Crippling Load by Rankine's Formula Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

2) Rankine's Formula Formulas

2.1) Crippling Load by Rankine's Formula Formula

Evaluate Formula

Formula

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

Example with Units

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

2.2) Crippling Load given Rankine's Constant Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

2.4) Cross-Sectional Area of Column given Crushing Load Formula

Evaluate Formula

Formula

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

Example with Units

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

2.5) Crushing Load by Rankine's Formula Formula

Evaluate Formula

Formula

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

Example with Units

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

2.6) Crushing Load given Ultimate Crushing Stress Formula

Evaluate Formula

Formula

$$P_c = \sigma_c \cdot A$$

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

2.9) Modulus of Elasticity given Rankine's Constant Formula

Evaluate Formula

Formula

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

Example with Units

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

2.10) Rankine's Constant Formula

Evaluate Formula

Formula

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

Example with Units

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

2.11) Rankine's Constant given Crippling Load Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

2.13) Ultimate Crushing Stress given Crushing Load Formula

Evaluate Formula

Formula

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

Example with Units

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

2.14) Ultimate Crushing Stress given Rankine's Constant Formula

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Elastic Stability of Columns Formulas above

- **A** Column Cross Sectional Area *(Square Millimeter)*
- **E** Modulus of Elasticity Column *(Megapascal)*
- **I** Moment of Inertia Column *(Millimeter⁴)*
- L_{eff} Effective Column Length *(Millimeter)*
- **P** Crippling Load *(Kilonewton)*
- P_c Crushing Load *(Kilonewton)*
- P_E Euler's Buckling Load *(Kilonewton)*
- P_r Rankine's Critical Load *(Kilonewton)*
- r_{least} Least Radius of Gyration Column *(Millimeter)*
- **α** Rankine's Constant
- σ_c Column Crushing Stress *(Megapascal)*

Constants, Functions, Measurements used in list of Elastic Stability of Columns 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 (mm²) *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 Millimeter⁴ (mm⁴) *Second Moment of Area Unit Conversion*

Download other Important Strength of Materials PDFs

- Important Beam Moments Formulas
- Important Bending Stress Formulas
- Important Combined Axial and Bending Loads Formulas
- Important Principal Stress Formulas
- Important Shear Stress Formulas
- Important Slope and Deflection Formulas
- Important Strain Energy Formulas
- Important Stress and Strain Formulas
- Important Thermal Stress Formulas
- Important Torsion Formulas

Try our Unique Visual Calculators

- Percentage error
- LCM of three numbers
- Subtract fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/9/2024 | 12:56:01 PM UTC