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Elastic Stability of Columns Formulas

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List of 19 Elastic Stability of Columns Formulas

Elastic Stability of Columns

Crippling Load by Euler's Formula

1) Crippling Load by Euler's Formula

Open Calculator

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

ex $$1491.407\text{kN} = \frac{\pi^2 \cdot 200000\text{MPa} \cdot 6800000\text{mm}^4}{(3000\text{mm})^2}$$

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

Open Calculator

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

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

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

Open Calculator

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

ex $$3000mm = \sqrt{\frac{\pi^2 \cdot 200000MPa \cdot 6800000mm^4}{1491.407kN}}$$

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

Open Calculator

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

ex $$200000MPa = \frac{1491.407kN \cdot (3000mm)^2}{\pi^2 \cdot 6800000mm^4}$$

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

Open Calculator

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

ex $$6.8E\hat{}6mm^4 = \frac{1491.407kN \cdot (3000mm)^2}{\pi^2 \cdot 200000MPa}$$

Rankine's Formula

6) Crippling Load by Rankine's Formula

Open Calculator

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

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

7) Crippling Load given Rankine's Constant

Open Calculator

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

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

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

Open Calculator

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

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

9) Cross-Sectional Area of Column given Crushing Load

Open Calculator

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

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

10) Crushing Load by Rankine's Formula

Open Calculator

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

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

11) Crushing Load given Ultimate Crushing Stress

Open Calculator

$$P_c = \sigma_c \cdot A$$

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

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

Open Calculator

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

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

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

Open Calculator

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

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

14) Modulus of Elasticity given Rankine's Constant

Open Calculator

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

ex $$199976\text{MPa} = \frac{750\text{MPa}}{\pi^2 \cdot 0.00038}$$

15) Rankine's Constant

Open Calculator

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

ex $$0.00038 = \frac{750\text{MPa}}{\pi^2 \cdot 200000\text{MPa}}$$

16) Rankine's Constant given Crippling Load

Open Calculator

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

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

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

Open Calculator

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

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

18) Ultimate Crushing Stress given Crushing Load

Open Calculator

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

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

19) Ultimate Crushing Stress given Rankine's Constant

Open Calculator

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

ex $750.0899\text{MPa} = 0.00038 \cdot \pi^2 \cdot 200000\text{MPa}$

Variables Used

- **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

- 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: **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

Check other formula lists

- **Mohr's Circle of Stresses Formulas**
- **Beam Moments Formulas**
- **Bending Stress Formulas**
- **Combined Axial and Bending Loads Formulas**
- **Elastic Stability of Columns Formulas**
- **Principal Stress Formulas**
- **Slope and Deflection Formulas**

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