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Unsymmetrical Bending and Three Hinged Arches Formulas

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List of 15 Unsymmetrical Bending and Three Hinged Arches Formulas

Unsymmetrical Bending and Three Hinged Arches

Three Hinged Arches

1) Angle between Horizontal and Arch

Open Calculator

fx $$y' = f \cdot 4 \cdot \frac{l - (2 \cdot x_{Arch})}{l^2}$$

ex $$0.5625 = 3m \cdot 4 \cdot \frac{16m - (2 \cdot 2m)}{(16m)^2}$$

2) Horizontal Distance from Support to Section for Angle between Horizontal and Arch

Open Calculator

fx $$x_{Arch} = \left(\frac{l}{2}\right) - \left(\frac{y' \cdot l^2}{8 \cdot f}\right)$$

ex $$2.666667m = \left(\frac{16m}{2}\right) - \left(\frac{0.5 \cdot (16m)^2}{8 \cdot 3m}\right)$$

3) Ordinate at any point along Central Line of Three-hinged Parabolic Arch

Open Calculator

fx $$y_{Arch} = \left(4 \cdot f \cdot \frac{x_{Arch}}{l^2}\right) \cdot (l - x_{Arch})$$

ex $$1.3125\text{m} = \left(4 \cdot 3\text{m} \cdot \frac{2\text{m}}{(16\text{m})^2}\right) \cdot (16\text{m} - 2\text{m})$$

4) Ordinate of any point along Central Line of Three-hinged Circular Arch

fx

Open Calculator

$$y_{Arch} = \left(\left((R^2) - \left(\left(\frac{l}{2}\right) - x_{Arch}\right)^2\right)^{\frac{1}{2}}\right) \cdot R + f$$

ex $$3\text{m} = \left(\left(\left((6\text{m})^2\right) - \left(\left(\frac{16\text{m}}{2}\right) - 2\text{m}\right)^2\right)^{\frac{1}{2}}\right) \cdot 6\text{m} + 3\text{m}$$

5) Rise of Arch in Three-hinged Circular Arch

Open Calculator

fx $$f = \left(\left((R^2) - \left(\left(\frac{l}{2}\right) - x_{Arch}\right)^2\right)^{\frac{1}{2}}\right) \cdot R + y_{Arch}$$

ex $$1.4m = \left(\left(\left((6m)^2\right) - \left(\left(\frac{16m}{2}\right) - 2m\right)^2\right)^{\frac{1}{2}}\right) \cdot 6m + 1.4m$$

6) Rise of Three-Hinged Arch for Angle between Horizontal and Arch

Open Calculator

fx $$f = \frac{y' \cdot \left(l^2\right)}{4 \cdot (l - (2 \cdot x_{Arch}))}$$

ex $$2.666667m = \frac{0.5 \cdot \left((16m)^2\right)}{4 \cdot (16m - (2 \cdot 2m))}$$

7) Rise of three-hinged Parabolic Arch

Open Calculator

fx $$f = \frac{y_{Arch} \cdot \left(l^2\right)}{4 \cdot x_{Arch} \cdot (l - x_{Arch})}$$

ex $$3.2m = \frac{1.4m \cdot \left((16m)^2\right)}{4 \cdot 2m \cdot (16m - 2m)}$$

8) Span of Arch in Three-hinged Circular Arch

Open Calculator

$$l = 2 \cdot \left(\left(\sqrt{(R^2) - \left(\frac{y_{Arch} - f}{R} \right)^2} \right) + x_{Arch} \right)$$

ex $$15.98814\text{m} = 2 \cdot \left(\left(\sqrt{\left((6\text{m})^2\right) - \left(\frac{1.4\text{m} - 3\text{m}}{6\text{m}} \right)^2} \right) + 2\text{m} \right)$$

Unsymmetrical Bending

9) Bending Moment about Axis XX given Maximum Stress in Unsymmetrical Bending

Open Calculator

$$M_x = \left(f_{Max} - \left(\frac{M_y \cdot x}{I_y} \right) \right) \cdot \frac{I_x}{y}$$

ex $$238.8369\text{N*m} = \left(1430\text{N/m}^2 - \left(\frac{307\text{N*m} \cdot 104\text{mm}}{50\text{kg·m}^2} \right) \right) \cdot \frac{51\text{kg·m}^2}{169\text{mm}}$$

10) Bending Moment about Axis YY given Maximum Stress in Unsymmetrical Bending

Open Calculator

$$M_y = \left(f_{Max} - \left(\frac{M_x \cdot y}{I_x} \right) \right) \cdot \frac{I_y}{x}$$

ex $$306.7402\text{N*m} = \left(1430\text{N/m}^2 - \left(\frac{239\text{N*m} \cdot 169\text{mm}}{51\text{kg·m}^2} \right) \right) \cdot \frac{50\text{kg·m}^2}{104\text{mm}}$$

11) Distance from Point to XX Axis given Maximum Stress in Unsymmetrical Bending

Open Calculator

$$y = \left(f_{Max} - \left(\frac{M_y \cdot x}{I_y}\right)\right) \cdot \frac{I_x}{M_x}$$

$$168.8847\text{mm} = \left(1430\text{N/m}^2 - \left(\frac{307\text{N*m} \cdot 104\text{mm}}{50\text{kg·m}^2}\right)\right) \cdot \frac{51\text{kg·m}^2}{239\text{N*m}}$$

12) Distance from YY axis to stress point given Maximum Stress in Unsymmetrical Bending

Open Calculator

$$x = \left(f_{Max} - \left(\frac{M_x \cdot y}{I_x}\right)\right) \cdot \frac{I_y}{M_y}$$

$$103.912\text{mm} = \left(1430\text{N/m}^2 - \left(\frac{239\text{N*m} \cdot 169\text{mm}}{51\text{kg·m}^2}\right)\right) \cdot \frac{50\text{kg·m}^2}{307\text{N*m}}$$

13) Maximum Stress in Unsymmetrical Bending

Open Calculator

$$f_{Max} = \left(\frac{M_x \cdot y}{I_x}\right) + \left(\frac{M_y \cdot x}{I_y}\right)$$

$$1430.54\text{N/m}^2 = \left(\frac{239\text{N*m} \cdot 169\text{mm}}{51\text{kg·m}^2}\right) + \left(\frac{307\text{N*m} \cdot 104\text{mm}}{50\text{kg·m}^2}\right)$$

14) Moment of Inertia about XX given Maximum Stress in Unsymmetrical Bending

Open Calculator

$$I_x = \frac{M_x \cdot y}{f_{Max} - \left(\frac{M_y \cdot x}{I_y}\right)}$$

$$51.03482\text{kg·m}^2 = \frac{239\text{N*m} \cdot 169\text{mm}}{1430\text{N/m}^2 - \left(\frac{307\text{N*m} \cdot 104\text{mm}}{50\text{kg·m}^2}\right)}$$

15) Moment of Inertia about YY given Maximum Stress in Unsymmetrical Bending

Open Calculator

$$I_y = \frac{M_y \cdot x}{f_{Max} - \left(\frac{M_x \cdot y}{I_x}\right)}$$

$$50.04235\text{kg·m}^2 = \frac{307\text{N*m} \cdot 104\text{mm}}{1430\text{N/m}^2 - \left(\frac{239\text{N*m} \cdot 169\text{mm}}{51\text{kg·m}^2}\right)}$$

Variables Used

- **f** Rise of arch *(Meter)*
- f_{Max} Maximum Stress *(Newton per Square Meter)*
- I_x Moment of Inertia about X-Axis *(Kilogram Square Meter)*
- I_y Moment of Inertia about Y-Axis *(Kilogram Square Meter)*
- **l** Span of Arch *(Meter)*
- M_x Bending Moment about X-Axis *(Newton Meter)*
- M_y Bending Moment about Y-Axis *(Newton Meter)*
- **R** Radius of Arch *(Meter)*
- **x** Distance from Point to YY Axis *(Millimeter)*
- x_{Arch} Horizontal Distance from Support *(Meter)*
- **y** Distance from Point to XX Axis *(Millimeter)*
- **y'** Angle between Horizontal and Arch
- y_{Arch} Ordinate of Point on Arch *(Meter)*

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Pressure** in Newton per Square Meter (N/m²)
  Pressure Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion
- Measurement: **Moment of Force** in Newton Meter (N*m)
  Moment of Force Unit Conversion

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- **Structural Analysis of Beams Formulas**
- **Unsymmetrical Bending and Three Hinged Arches Formulas**

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