Important Unsymmetrical Bending and Three Hinged Arches Formulas PDF

Formulas
Examples
with Units

List of 15
Important Unsymmetrical Bending and Three Hinged Arches Formulas

1) Three Hinged Arches Formulas

1.1) Angle between Horizontal and Arch Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$2.6667\,m = \left(\frac{16\,m}{2}\right) - \left(\frac{0.5 \cdot 16\,m^2}{8 \cdot 3\,m}\right)$$

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

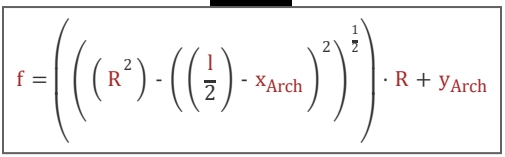
Example with Units

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

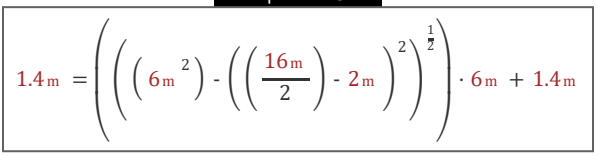
1.5) Rise of Arch in Three-hinged Circular Arch Formula

Evaluate Formula

Formula



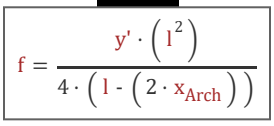
Example with Units



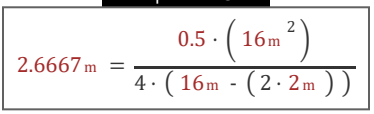
1.6) Rise of Three-Hinged Arch for Angle between Horizontal and Arch Formula

Evaluate Formula

Formula



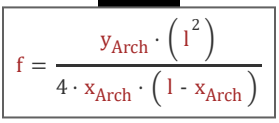
Example with Units



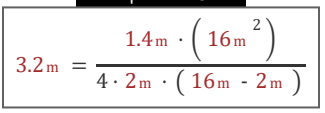
1.7) Rise of three-hinged Parabolic Arch Formula

Evaluate Formula

Formula



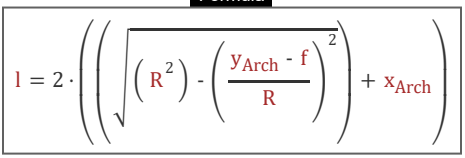
Example with Units



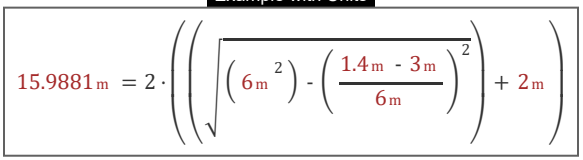
1.8) Span of Arch in Three-hinged Circular Arch Formula

Evaluate Formula

Formula



Example with Units



2) Unsymmetrical Bending Formulas

2.1) Bending Moment about Axis XX given Maximum Stress in Unsymmetrical Bending Formula

Evaluate Formula

Formula

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

Example with Units

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

2.2) Bending Moment about Axis YY given Maximum Stress in Unsymmetrical Bending Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

2.5) Maximum Stress in Unsymmetrical Bending Formula

Evaluate Formula

Formula

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

Example with Units

$$1430.5404\,\text{N/m}^2 = \left(\frac{239\,\text{N*m} \cdot 169\,\text{mm}}{51\,\text{kg·m}^2} \right) + \left(\frac{307\,\text{N*m} \cdot 104\,\text{mm}}{50\,\text{kg·m}^2} \right)$$

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

Evaluate Formula

Formula

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

Example with Units

$$51.0348\,\text{kg·m}^2 = \frac{239\,\text{N*m} \cdot 169\,\text{mm}}{1430\,\text{N/m}^2 - \left(\frac{307\,\text{N*m} \cdot 104\,\text{mm}}{50\,\text{kg·m}^2} \right)}$$

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

Evaluate Formula

Formula

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

Example with Units

$$50.0423\,\text{kg·m}^2 = \frac{307\,\text{N*m} \cdot 104\,\text{mm}}{1430\,\text{N/m}^2 - \left(\frac{239\,\text{N*m} \cdot 169\,\text{mm}}{51\,\text{kg·m}^2} \right)}$$

Variables used in list of Unsymmetrical Bending and Three Hinged Arches Formulas above

- **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 in list of Unsymmetrical Bending and Three Hinged Arches Formulas above

- 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 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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