Important Stresses at Bends Formulas PDF

Formulas
Examples
with Units

List of 15
Important Stresses at Bends Formulas

1) Angle of Bend given Buttress Resistance Formula

Evaluate Formula

Formula

$$\theta_b = 2 \cdot asin\left(\frac{P_{BR}}{\left(2 \cdot A_{cs}\right) \cdot \left(\left(\frac{\gamma_{water} \cdot \left(V_w\right)^2}{[g]}\right) + P_{wt}\right)}\right)$$

Example with Units

$$36.0446° = 2 \cdot asin\left(\frac{1500\,kN}{\left(2 \cdot 13\,m^2\right) \cdot \left(\left(\frac{9.81\,kN/m^3 \cdot \left(13.47\,m/s\right)^2}{9.8066\,m/s^2}\right) + 4.97\,kN/m^2\right)}\right)$$

2) Angle of Bend given Head of Water and Buttress Resistance Formula

Evaluate Formula

Formula

$$\theta_b = 2 \cdot asin\left(\frac{P_{BR}}{\left(2 \cdot A_{cs}\right) \cdot \left(\left(\frac{\gamma_{water} \cdot \left(V_w\right)^2}{[g]}\right) + \left(\gamma_{water} \cdot H_{liquid}\right)\right)}\right)$$

Example with Units

$$36.1363° = 2 \cdot asin\left(\frac{1500\,kN}{\left(2 \cdot 13\,m^2\right) \cdot \left(\left(\frac{9.81\,kN/m^3 \cdot \left(13.47\,m/s\right)^2}{9.8066\,m/s^2}\right) + \left(9.81\,kN/m^3 \cdot 0.46\,m\right)\right)}\right)$$

3) Area of Section of Pipe given Buttress Resistance Formula

Evaluate Formula

Formula

$$A_{cs} = \frac{P_{BR}}{(2) \cdot \left(\left(\frac{\gamma_{water} \cdot (V_w)^2}{[g]} \right) + p_i \right) \cdot \sin\left(\frac{\theta_b}{2} \right)}$$

Example with Units

$$9.5737\,\text{m}^2 = \frac{1500\,\text{kN}}{(2) \cdot \left(\left(\frac{9.81\,\text{kN/m}^3 \cdot (13.47\,\text{m/s})^2}{9.8066\,\text{m/s}^2} \right) + 72.01\,\text{kN/m}^2 \right) \cdot \sin\left(\frac{36.0°}{2} \right)}$$

4) Area of Section of Pipe given Head of Water Formula

Evaluate Formula

Formula

$$A_{cs} = \frac{T_{tkn}}{\left(\gamma_{water} \cdot H_{liquid} \right) + \left(\frac{\gamma_{water} \cdot (V_{fw})^2}{[g]} \right)}$$

Example with Units

$$13.1625\,\text{m}^2 = \frac{482.7\,\text{kN}}{\left(9.81\,\text{kN/m}^3 \cdot 0.46\,\text{m} \right) + \left(\frac{9.81\,\text{kN/m}^3 \cdot (5.67\,\text{m/s})^2}{9.8066\,\text{m/s}^2} \right)}$$

5) Area of Section of Pipe given Head of Water and Buttress Resistance Formula

Evaluate Formula

Formula

$$A_{cs} = \frac{P_{BR}}{(2) \cdot \left(\left(\frac{\gamma_{water} \cdot (V_w)^2}{[g]} \right) + \left(\gamma_{water} \cdot H_{liquid} \right) \right) \cdot \sin\left(\frac{\theta_b}{2} \right)}$$

Example with Units

$$13.0476\,\text{m}^2 = \frac{1500\,\text{kN}}{(2) \cdot \left(\left(\frac{9.81\,\text{kN/m}^3 \cdot (13.47\,\text{m/s})^2}{9.8066\,\text{m/s}^2} \right) + \left(9.81\,\text{kN/m}^3 \cdot 0.46\,\text{m} \right) \right) \cdot \sin\left(\frac{36.0°}{2} \right)}$$

6) Area of Section of Pipe given Total Tension in Pipe Formula

Evaluate Formula

Formula

$$A_{cs} = \frac{T_{tkn}}{\left(P_{wt}\right) + \left(\frac{\gamma_{water} \cdot \left(V_{fw}\right)^2}{[g]}\right)}$$

Example with Units

$$13.0003\,\text{m}^2 = \frac{482.7\,\text{kN}}{\left(4.97\,\text{kN/m}^2\right) + \left(\frac{9.81\,\text{kN/m}^3 \cdot \left(5.67\,\text{m/s}\right)^2}{9.8066\,\text{m/s}^2}\right)}$$

7) Buttress Resistance using Angle of Bend Formula

Evaluate Formula

Formula

$$P_{BR} = \left(2 \cdot A_{cs}\right) \cdot \left(\left(\left(\gamma_{water} \cdot \left(\frac{V_{fw}^2}{[g]}\right)\right) + p_i\right) \cdot \sin\left(\frac{\theta_b}{2}\right)\right)$$

Example with Units

$$836.9469\,\text{kN} = \left(2 \cdot 13\,\text{m}^2\right) \cdot \left(\left(\left(9.81\,\text{kN/m}^3 \cdot \left(\frac{5.67\,\text{m/s}^2}{9.8066\,\text{m/s}^2}\right)\right) + 72.01\,\text{kN/m}^2\right) \cdot \sin\left(\frac{36.0°}{2}\right)\right)$$

8) Buttress Resistance using Head of Water Formula

Evaluate Formula

Formula

$$P_{BR} = \left(\left(2 \cdot A_{cs}\right) \cdot \left(\left(\frac{\gamma_{water} \cdot \left(V_{fw}^2\right)}{[g]}\right) + \left(\gamma_{water} \cdot H_{liquid}\right)\right) \cdot \sin\left(\frac{\theta_b}{2}\right)\right)$$

Example with Units

$$294.6429\,\text{kN} = \left(\left(2 \cdot 13\,\text{m}^2\right) \cdot \left(\left(\frac{9.81\,\text{kN/m}^3 \cdot \left(5.67\,\text{m/s}^2\right)}{9.8066\,\text{m/s}^2}\right) + \left(9.81\,\text{kN/m}^3 \cdot 0.46\,\text{m}\right)\right) \cdot \sin\left(\frac{36.0°}{2}\right)\right)$$

9) Head of Water given Buttress Resistance Formula

Evaluate Formula

Formula

$$H = \left(\frac{\left(\frac{P_{BR}}{\left(2 \cdot A_{cs}\right) \cdot \sin\left(\frac{\theta_b}{2}\right)} - \left(\frac{\gamma_{water} \cdot V_{fw}^{2}}{[g]} \right) \right)}{\gamma_{water}} \right)$$

Example with Units

$$15.7529\,\text{m} = \left(\frac{\left(\frac{1500\,\text{kN}}{\left(2 \cdot 13\,\text{m}^2\right) \cdot \sin\left(\frac{36.0^\circ}{2}\right)} - \left(\frac{9.81\,\text{kN/m}^3 \cdot 5.67\,\text{m/s}^{2}}{9.8066\,\text{m/s}^2} \right) \right)}{9.81\,\text{kN/m}^3} \right)$$

10) Head of Water given Total Tension in Pipe Formula

Evaluate Formula

Formula

$$H_{liquid} = \frac{T_{tkn} - \left(\frac{\gamma_{water} \cdot A_{cs} \cdot \left(V_{fw}\right)^{2}}{[g]} \right)}{\gamma_{water} \cdot A_{cs}}$$

Example with Units

$$0.5067\,\text{m} = \frac{482.7\,\text{kN} - \left(\frac{9.81\,\text{kN/m}^3 \cdot 13\,\text{m}^2 \cdot \left(5.67\,\text{m/s}\right)^{2}}{9.8066\,\text{m/s}^2} \right)}{9.81\,\text{kN/m}^3 \cdot 13\,\text{m}^2}$$

11) Internal Water Pressure using Buttress Resistance Formula

Evaluate Formula

Formula

$$p_i = \left(\left(\frac{P_{BR}}{2 \cdot A_{cs} \cdot \sin\left(\frac{\theta_b}{2}\right)} \right) - \left(\frac{\gamma_{water} \cdot \left(V_{fw}^{2}\right)}{[g]} \right) \right)$$

Example with Units

$$154.5363\,\text{kN/m}^2 = \left(\left(\frac{1500\,\text{kN}}{2 \cdot 13\,\text{m}^2 \cdot \sin\left(\frac{36.0^\circ}{2}\right)} \right) - \left(\frac{9.81\,\text{kN/m}^3 \cdot \left(5.67\,\text{m/s}^{2}\right)}{9.8066\,\text{m/s}^2} \right) \right)$$

12) Internal Water Pressure using Total Tension in Pipe Formula

Evaluate Formula

Formula

$$p_i = \left(\frac{T_{tkn}}{A_{cs}}\right) - \left(\frac{\gamma_{water} \cdot \left(V_{fw}^{2}\right)}{[g]}\right)$$

Example with Units

$$4.9709\,\text{kN/m}^2 = \left(\frac{482.7\,\text{kN}}{13\,\text{m}^2}\right) - \left(\frac{9.81\,\text{kN/m}^3 \cdot \left(5.67\,\text{m/s}^{2}\right)}{9.8066\,\text{m/s}^2}\right)$$

13) Velocity of Flow of Water given Buttress Resistance Formula

Evaluate Formula

Formula

$$V_{fw} = \sqrt{\left(\frac{P_{BR}}{\left(2 \cdot A_{cs}\right) \cdot \sin\left(\frac{\theta_b}{2}\right)} - p_i\right) \cdot \left(\frac{[g]}{\gamma_{water}}\right)}$$

Example with Units

$$10.7073\,\text{m/s} = \sqrt{\left(\frac{1500\,\text{kN}}{\left(2 \cdot 13\,\text{m}^2\right) \cdot \sin\left(\frac{36.0°}{2}\right)} - 72.01\,\text{kN/m}^2\right) \cdot \left(\frac{9.8066\,\text{m/s}^2}{9.81\,\text{kN/m}^3}\right)}$$

14) Velocity of Flow of Water given Total Tension in Pipe Formula

Evaluate Formula

Formula

$$V_{fw} = \sqrt{\left(T_{tkn} - \left(P_{wt} \cdot A_{cs}\right)\right) \cdot \left(\frac{[g]}{\gamma_{water} \cdot A_{cs}}\right)}$$

Example with Units

$$5.6701\,\text{m/s} = \sqrt{\left(482.7\,\text{kN} - \left(4.97\,\text{kN/m}^2 \cdot 13\,\text{m}^2\right)\right) \cdot \left(\frac{9.8066\,\text{m/s}^2}{9.81\,\text{kN/m}^3 \cdot 13\,\text{m}^2}\right)}$$

15) Velocity of Flow of Water with known Head of Water and Buttress Resistance Formula

Evaluate Formula

Formula

$$V_{fw} = \left(\left(\frac{[g]}{\gamma_{water}} \right) \cdot \left(\left(\frac{P_{BR}}{2 \cdot A_{cs} \cdot \sin\left(\frac{\theta_b}{2} \right)} - H_{liquid} \cdot \gamma_{water} \right) \right) \right)$$

Example with Units

$$182.1214\,\text{m/s} = \left(\left(\frac{9.8066\,\text{m/s}^2}{9.81\,\text{kN/m}^3} \right) \cdot \left(\left(\frac{1500\,\text{kN}}{2 \cdot 13\,\text{m}^2 \cdot \sin\left(\frac{36.0^\circ}{2} \right)} - 0.46\,\text{m} \cdot 9.81\,\text{kN/m}^3 \right) \right) \right)$$

Variables used in list of Stresses at Bends Formulas above

- A_{cs} Cross-Sectional Area *(Square Meter)*
- H Head of the Liquid *(Meter)*
- H_{liquid} Head of Liquid in Pipe *(Meter)*
- P_{BR} Buttress Resistance in Pipe *(Kilonewton)*
- p_i Internal Water Pressure in Pipes *(Kilonewton per Square Meter)*
- P_{wt} Water Pressure in KN per Square Meter *(Kilonewton per Square Meter)*
- T_{mn} Total Tension of Pipe in MN *(Meganewton)*
- T_{tkn} Total Tension in Pipe in KN *(Kilonewton)*
- V_{fw} Velocity of Flowing Water *(Meter per Second)*
- V_w Flow Velocity of Fluid *(Meter per Second)*
- γ_{water} Unit Weight of Water in KN per Cubic Meter *(Kilonewton per Cubic Meter)*
- θ_b Angle of Bend in Environmental Engi. *(Degree)*

Constants, Functions, Measurements used in list of Stresses at Bends Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **asin**, asin(Number)
  The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.
- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- 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)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Kilonewton per Square Meter (kN/m²)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Meganewton (MN)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)
  Specific Weight Unit Conversion

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