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Stresses at Bends Formulas

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List of 15 Stresses at Bends Formulas

Stresses at Bends

1) Angle of Bend given Buttress Resistance

Open Calculator

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

ex $$36.0446^\circ = 2 \cdot a\sin\left(\frac{1500\text{kN}}{(2 \cdot 13\text{m}^2) \cdot \left(\left(\frac{9.81\text{kN/m}^3 \cdot (13.47\text{m/s})^2}{[g]}\right) + 4.97\text{kN/m}^2\right)}\right)$$

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

Open Calculator

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

ex $$36.13629^\circ = 2 \cdot a\sin\left(\frac{1500\text{kN}}{(2 \cdot 13\text{m}^2) \cdot \left(\left(\frac{9.81\text{kN/m}^3 \cdot (13.47\text{m/s})^2}{[g]}\right) + (9.81\text{kN/m}^3 \cdot 0.46\text{m})\right)}\right)$$

3) Area of Section of Pipe given Buttress Resistance

Open Calculator

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

ex $$9.573679\text{m}^2 = \frac{1500\text{kN}}{(2) \cdot \left(\left(\frac{9.81\text{kN/m}^3 \cdot (13.47\text{m/s})^2}{[g]}\right) + 72.01\text{kN/m}^2\right) \cdot \sin\left(\frac{36.0^\circ}{2}\right)}$$

4) Area of Section of Pipe given Head of Water

Open Calculator

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

$$13.16246\text{m}^2 = \frac{482.7\text{kN}}{(9.81\text{kN/m}^3 \cdot 0.46\text{m}) + \left(\frac{9.81\text{kN/m}^3 \cdot (5.67\text{m/s})^2}{[g]}\right)}$$

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

Open Calculator

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

$$13.04758\text{m}^2 = \frac{1500\text{kN}}{(2) \cdot \left(\left(\frac{9.81\text{kN/m}^3 \cdot (13.47\text{m/s})^2}{[g]}\right) + (9.81\text{kN/m}^3 \cdot 0.46\text{m})\right) \cdot \sin\left(\frac{36.0^\circ}{2}\right)}$$

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

Open Calculator

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

$$13.00031\text{m}^2 = \frac{482.7\text{kN}}{(4.97\text{kN/m}^2) + \left(\frac{9.81\text{kN/m}^3 \cdot (5.67\text{m/s})^2}{[g]}\right)}$$

7) Buttress Resistance using Angle of Bend

Open Calculator

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

$$836.9469\text{kN} = (2 \cdot 13\text{m}^2) \cdot \left(\left(\left(9.81\text{kN/m}^3 \cdot \left(\frac{(5.67\text{m/s})^2}{[g]}\right)\right) + 72.01\text{kN/m}^2\right) \cdot \sin\left(\frac{36.0^\circ}{2}\right)\right)$$

8) Buttress Resistance using Head of Water

Open Calculator

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

ex

$$1440.655\text{kN} = \left((2 \cdot 13\text{m}^2) \cdot \left(\left(\frac{9.81\text{kN/m}^3 \cdot \left((5.67\text{m/s})^2 \right)}{[g]} \right) + (9.81\text{kN/m}^3 \cdot 15\text{m}) \right) \cdot \sin\left(\frac{36.0^\circ}{2} \right) \right)$$

9) Head of Water given Buttress Resistance

Open Calculator

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

ex

$$15.75294\text{m} = \left(\frac{\left(\frac{1500\text{kN}}{(2 \cdot 13\text{m}^2) \cdot \sin\left(\frac{36.0^\circ}{2} \right)} - \left(\frac{9.81\text{kN/m}^3 \cdot (5.67\text{m/s})^2}{[g]} \right) \right)}{9.81\text{kN/m}^3} \right)$$

10) Head of Water given Total Tension in Pipe

Open Calculator

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

ex

$$0.506716\text{m} = \frac{482.7\text{kN} - \left(\frac{9.81\text{kN/m}^3 \cdot 13\text{m}^2 \cdot (5.67\text{m/s})^2}{[g]} \right)}{9.81\text{kN/m}^3 \cdot 13\text{m}^2}$$

11) Internal Water Pressure using Buttress Resistance

Open Calculator

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

ex

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

12) Internal Water Pressure using Total Tension in Pipe

Open Calculator

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

$$72.4555\text{kN/m}^2 = \left(\frac{1.36\text{MN}}{13\text{m}^2}\right) - \left(\frac{9.81\text{kN/m}^3 \cdot \left((5.67\text{m/s})^2\right)}{[g]}\right)$$

13) Velocity of Flow of Water given Buttress Resistance

Open Calculator

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

$$10.70734\text{m/s} = \sqrt{\left(\frac{1500\text{kN}}{(2 \cdot 13\text{m}^2) \cdot \sin\left(\frac{36.0^\circ}{2}\right)} - 72.01\text{kN/m}^2\right) \cdot \left(\frac{[g]}{9.81\text{kN/m}^3}\right)}$$

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

Open Calculator

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

$$5.670078\text{m/s} = \sqrt{(482.7\text{kN} - (4.97\text{kN/m}^2 \cdot 13\text{m}^2)) \cdot \left(\frac{[g]}{9.81\text{kN/m}^3 \cdot 13\text{m}^2}\right)}$$

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

Open Calculator

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

$$39.53272\text{m/s} = \left(\left(\frac{[g]}{9.81\text{kN/m}^3}\right) \cdot \left(\left(\frac{1500\text{kN}}{2 \cdot 13\text{m}^2 \cdot \sin\left(\frac{36.0^\circ}{2}\right)} - 15\text{m} \cdot 9.81\text{kN/m}^3\right)\right)\right)$$

Variables Used

- 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

- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Function: **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.
- Function: **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.
- Function: **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

Check other formula lists

- **Internal Water Pressure Formulas**
- **Stresses at Bends Formulas**

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