Important Shear Stress Formulas PDF

Formulas
Examples
with Units

List of 42
Important Shear Stress Formulas

1) Horizontal Shear Flow Formulas

1.1) Area given Horizontal Shear Flow Formula

Evaluate Formula

Formula

$$A = \frac{I \cdot \tau}{V \cdot y}$$

Example with Units

$$3.1935\,\text{m}^2 = \frac{36000000\,\text{mm}^4 \cdot 55\,\text{MPa}}{24.8\,\text{kN} \cdot 25\,\text{mm}}$$

1.2) Distance from Centroid given Horizontal Shear Flow Formula

Evaluate Formula

Formula

$$y = \frac{I \cdot \tau}{V \cdot A}$$

Example with Units

$$24.9496\,\text{mm} = \frac{36000000\,\text{mm}^4 \cdot 55\,\text{MPa}}{24.8\,\text{kN} \cdot 3.2\,\text{m}^2}$$

1.3) Horizontal Shear Flow Formula

Evaluate Formula

Formula

$$\tau = \frac{V \cdot A \cdot y}{I}$$

Example with Units

$$55.1111\,\text{MPa} = \frac{24.8\,\text{kN} \cdot 3.2\,\text{m}^2 \cdot 25\,\text{mm}}{36000000\,\text{mm}^4}$$

1.4) Moment of Inertia given Horizontal Shear Flow Formula

Evaluate Formula

Formula

$$I = \frac{V \cdot A \cdot y}{\tau}$$

Example with Units

$$3.6\text{E}{+7}\,\text{mm}^4 = \frac{24.8\,\text{kN} \cdot 3.2\,\text{m}^2 \cdot 25\,\text{mm}}{55\,\text{MPa}}$$

1.5) Shear given Horizontal Shear Flow Formula

Evaluate Formula

Formula

$$V = \frac{I \cdot \tau}{y \cdot A}$$

Example with Units

$$24.75\,\text{kN} = \frac{36000000\,\text{mm}^4 \cdot 55\,\text{MPa}}{25\,\text{mm} \cdot 3.2\,\text{m}^2}$$

2) Longitudinal Shear Stress Formulas

2.1) Area given Longitudinal Shear Stress Formula

Evaluate Formula

Formula

$$A = \frac{\tau \cdot I \cdot b}{V \cdot y}$$

Example with Units

$$0.9581\,\text{m}^2 = \frac{55\,\text{MPa} \cdot 36000000\,\text{mm}^4 \cdot 300\,\text{mm}}{24.8\,\text{kN} \cdot 25\,\text{mm}}$$

2.2) Breadth for given Longitudinal Shear Stress Formula

Evaluate Formula

Formula

$$b = \frac{V \cdot A \cdot y}{I \cdot \tau}$$

Example with Units

$$1002.0202\,\text{mm} = \frac{24.8\,\text{kN} \cdot 3.2\,\text{m}^2 \cdot 25\,\text{mm}}{36000000\,\text{mm}^4 \cdot 55\,\text{MPa}}$$

2.3) Maximum Distance from Neutral Axis to Extreme Fiber given Longitudinal Shear Stress Formula

Evaluate Formula

Formula

$$y = \frac{\tau \cdot I \cdot b}{V \cdot A}$$

Example with Units

$$7.4849\,\text{mm} = \frac{55\,\text{MPa} \cdot 36000000\,\text{mm}^4 \cdot 300\,\text{mm}}{24.8\,\text{kN} \cdot 3.2\,\text{m}^2}$$

2.4) Moment of Inertia given Longitudinal Shear Stress Formula

Evaluate Formula

Formula

$$I = \frac{V \cdot A \cdot y}{\tau \cdot b}$$

Example with Units

$$0.0001\,\text{mm}^4 = \frac{24.8\,\text{kN} \cdot 3.2\,\text{m}^2 \cdot 25\,\text{mm}}{55\,\text{MPa} \cdot 300\,\text{mm}}$$

2.5) I-Beam Formulas

2.5.1) Breadth of Flange Given Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$b_f = \frac{8 \cdot I \cdot \tau \cdot b_w}{V \cdot \left(D^2 - d_w^{\,2}\right)}$$

Example with Units

$$39.9334\,\text{mm} = \frac{8 \cdot 36000000\,\text{mm}^4 \cdot 55\,\text{MPa} \cdot .040\,\text{m}}{24.8\,\text{kN} \cdot \left(800\,\text{mm}^{\,2} - 15\,\text{mm}^{\,2}\right)}$$

2.5.2) Breadth of Web given Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$b_w = \left(\frac{b_f \cdot V}{8 \cdot \tau \cdot I}\right) \cdot \left(D^2 - d_w^{\,2}\right)$$

Example with Units

$$0.2504\,\text{m} = \left(\frac{250\,\text{mm} \cdot 24.8\,\text{kN}}{8 \cdot 55\,\text{MPa} \cdot 36000000\,\text{mm}^4}\right) \cdot \left(800\,\text{mm}^{\,2} - 15\,\text{mm}^{\,2}\right)$$

2.5.3) Longitudinal Shear Stress in Flange at Lower Depth of I beam Formula

Evaluate Formula

Formula

$$\tau = \left(\frac{V}{8 \cdot I}\right) \cdot \left(D^2 - d_w^{\,2}\right)$$

Example with Units

$$55.0917\,\text{MPa} = \left(\frac{24.8\,\text{kN}}{8 \cdot 36000000\,\text{mm}^4}\right) \cdot \left(800\,\text{mm}^{\,2} - 15\,\text{mm}^{\,2}\right)$$

2.5.4) Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$\tau = \left(\frac{b_f \cdot V}{8 \cdot b_w \cdot I}\right) \cdot \left(D^2 - d_w^{\,2}\right)$$

Example with Units

$$344.3234\,\text{MPa} = \left(\frac{250\,\text{mm} \cdot 24.8\,\text{kN}}{8 \cdot .040\,\text{m} \cdot 36000000\,\text{mm}^4}\right) \cdot \left(800\,\text{mm}^{\,2} - 15\,\text{mm}^{\,2}\right)$$

2.5.5) Maximum Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$\tau_{maxlongitudinal} = \left(\left(\frac{b_f \cdot V}{8 \cdot b_w \cdot I} \cdot \left(D^2 - d_w^{\,2}\right)\right)\right) + \left(\frac{V \cdot d_w^{\,2}}{8 \cdot I}\right)$$

Example with Units

$$344.3427\,\text{MPa} = \left(\left(\frac{250\,\text{mm} \cdot 24.8\,\text{kN}}{8 \cdot .040\,\text{m} \cdot 36000000\,\text{mm}^4} \cdot \left(800\,\text{mm}^{\,2} - 15\,\text{mm}^{\,2}\right)\right)\right) + \left(\frac{24.8\,\text{kN} \cdot 15\,\text{mm}^{\,2}}{8 \cdot 36000000\,\text{mm}^4}\right)$$

2.5.6) Moment of Inertia given Longitudinal Shear Stress at lower edge in Flange of I beam Formula

Evaluate Formula

Formula

$$I = \left(\frac{V}{8 \cdot \tau}\right) \cdot \left(D^2 - d_w^{\,2}\right)$$

Example with Units

$$3.6E{+}7\,\text{mm}^4 = \left(\frac{24.8\,\text{kN}}{8 \cdot 55\,\text{MPa}}\right) \cdot \left(800\,\text{mm}^{\,2} - 15\,\text{mm}^{\,2}\right)$$

2.5.7) Moment of Inertia given Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$I = \left(\frac{b_f \cdot V}{8 \cdot \tau \cdot b_w} \right) \cdot \left(D^2 - d_w^2 \right)$$

Example with Units

$$2.3E{+}8\,\text{mm}^4 = \left(\frac{250\,\text{mm} \cdot 24.8\,\text{kN}}{8 \cdot 55\,\text{MPa} \cdot .040\,\text{m}} \right) \cdot \left(800\,\text{mm}^2 - 15\,\text{mm}^2 \right)$$

2.5.8) Moment of Inertia given Maximum Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$I = \frac{\left(\frac{b_f \cdot V}{8 \cdot b_w} \right) \cdot \left(D^2 - d_w^2 \right)}{\tau_{max}} + \frac{\frac{V \cdot d_w^2}{8}}{\tau_{max}}$$

Example with Units

$$3E{+}8\,\text{mm}^4 = \frac{\left(\frac{250\,\text{mm} \cdot 24.8\,\text{kN}}{8 \cdot .040\,\text{m}} \right) \cdot \left(800\,\text{mm}^2 - 15\,\text{mm}^2 \right)}{42\,\text{MPa}} + \frac{\frac{24.8\,\text{kN} \cdot 15\,\text{mm}^2}{8}}{42\,\text{MPa}}$$

2.5.9) Polar Moment of Inertia given Torsional Shear Stress Formula

Evaluate Formula

Formula

$$J = \frac{T \cdot R}{\tau_{max}}$$

Example with Units

$$2.2262\,\text{mm}^4 = \frac{0.85\,\text{kN*m} \cdot 110\,\text{mm}}{42\,\text{MPa}}$$

2.5.10) Transverse Shear for Longitudinal Shear Stress in Web for I Beam Formula

Evaluate Formula

Formula

$$V = \frac{8 \cdot I \cdot \tau \cdot b_w}{b_f \cdot \left(D^2 - d_w^2 \right)}$$

Example with Units

$$3.9614\,\text{kN} = \frac{8 \cdot 36000000\,\text{mm}^4 \cdot 55\,\text{MPa} \cdot .040\,\text{m}}{250\,\text{mm} \cdot \left(800\,\text{mm}^2 - 15\,\text{mm}^2 \right)}$$

2.5.11) Transverse Shear force given Maximum Longitudinal Shear Stress in Web for I beam Formula

Evaluate Formula

Formula

$$V = \frac{\tau_{maxlongitudinal} \cdot b_w \cdot 8 \cdot I}{\left(b_f \cdot \left(D^2 - d_w^2\right)\right) + \left(b_w \cdot \left(d_w^2\right)\right)}$$

Example with Units

$$18.006\,\text{kN} = \frac{250.01\,\text{MPa} \cdot .040\,\text{m} \cdot 8 \cdot 36000000\,\text{mm}^4}{\left(250\,\text{mm} \cdot \left(800\,\text{mm}^2 - 15\,\text{mm}^2\right)\right) + \left(.040\,\text{m} \cdot \left(15\,\text{mm}^2\right)\right)}$$

2.5.12) Transverse Shear given Longitudinal Shear Stress in Flange for I beam Formula

Evaluate Formula

Formula

$$V = \frac{8 \cdot I \cdot \tau}{D^2 - d_w^2}$$

Example with Units

$$24.7587\,\text{kN} = \frac{8 \cdot 36000000\,\text{mm}^4 \cdot 55\,\text{MPa}}{800\,\text{mm}^2 - 15\,\text{mm}^2}$$

2.6) Longitudinal Shear Stress for Rectangular Section Formulas

2.6.1) Average Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$q_{avg} = \frac{V}{b \cdot d}$$

Example with Units

$$0.1837\,\text{MPa} = \frac{24.8\,\text{kN}}{300\,\text{mm} \cdot 450\,\text{mm}}$$

2.6.2) Breadth for given Maximum Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$b = \frac{3 \cdot V}{2 \cdot \tau_{maxlongitudinal} \cdot d}$$

Example with Units

$$0.3307\,\text{mm} = \frac{3 \cdot 24.8\,\text{kN}}{2 \cdot 250.01\,\text{MPa} \cdot 450\,\text{mm}}$$

2.6.3) Breadth given Average Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$b = \frac{V}{q_{avg} \cdot d}$$

Example with Units

$$300.006\,\text{mm} = \frac{24.8\,\text{kN}}{0.1837\,\text{MPa} \cdot 450\,\text{mm}}$$

2.6.4) Depth given Average Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$d = \frac{V}{q_{avg} \cdot b}$$

Example with Units

$$450.0091\,\text{mm} = \frac{24.8\,\text{kN}}{0.1837\,\text{MPa} \cdot 300\,\text{mm}}$$

2.6.5) Maximum Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$\tau_{maxlongitudinal} = \frac{3 \cdot V}{2 \cdot b \cdot d}$$

Example with Units

$$275.5556\,\text{MPa} = \frac{3 \cdot 24.8\,\text{kN}}{2 \cdot 300\,\text{mm} \cdot 450\,\text{mm}}$$

2.6.6) Transverse Shear given Average Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$V = q_{avg} \cdot b \cdot d$$

Example with Units

$$24.7995\,\text{kN} = 0.1837\,\text{MPa} \cdot 300\,\text{mm} \cdot 450\,\text{mm}$$

2.6.7) Transverse Shear given Maximum Longitudinal Shear Stress for Rectangular Section Formula

Evaluate Formula

Formula

$$V = \left(\tau_{maxlongitudinal} \cdot b \cdot d \cdot \left(\frac{2}{3}\right)\right)$$

Example with Units

$$0.0225\,\text{kN} = \left(250.01\,\text{MPa} \cdot 300\,\text{mm} \cdot 450\,\text{mm} \cdot \left(\frac{2}{3}\right)\right)$$

2.7) Longitudinal Shear Stress for Solid Circular Section Formulas

2.7.1) Average Longitudinal Shear Stress for Solid Circular Section Formula

Evaluate Formula

Formula

$$q_{avg} = \frac{V}{\pi \cdot r^2}$$

Example with Units

$$0.1842\,\text{MPa} = \frac{24.8\,\text{kN}}{3.1416 \cdot 207\,\text{mm}^2}$$

2.7.2) Maximum Longitudinal Shear Stress for Solid Circular Section Formula

Evaluate Formula

Formula

$$\tau_{maxlongitudinal} = \frac{4 \cdot V}{3 \cdot \pi \cdot r^2}$$

Example with Units

$$245.6404\,\text{MPa} = \frac{4 \cdot 24.8\,\text{kN}}{3 \cdot 3.1416 \cdot 207\,\text{mm}^2}$$

2.7.3) Radius given Average Longitudinal Shear Stress for Solid Circular Section Formula

Evaluate Formula

Formula

$$r = \sqrt{\frac{V}{\pi \cdot q_{avg}}}$$

Example with Units

$$207.2986\,\text{mm} = \sqrt{\frac{24.8\,\text{kN}}{3.1416 \cdot 0.1837\,\text{MPa}}}$$

2.7.4) Radius given Maximum Longitudinal Shear Stress for Solid Circular Section Formula

Evaluate Formula

Formula

$$r = \sqrt{\frac{4 \cdot V}{3 \cdot \pi \cdot \tau_{maxlongitudinal}}}$$

Example with Units

$$0.0065\,\text{mm} = \sqrt{\frac{4 \cdot 24.8\,\text{kN}}{3 \cdot 3.1416 \cdot 250.01\,\text{MPa}}}$$

2.7.5) Transverse Shear given Average Longitudinal Shear Stress for Solid Circular Section Formula

Evaluate Formula

Formula

$$V = q_{avg} \cdot \pi \cdot r^2$$

Example with Units

$$24.7286\,\text{kN} = 0.1837\,\text{MPa} \cdot 3.1416 \cdot 207\,\text{mm}^2$$

2.7.6) Transverse Shear given Maximum Longitudinal Shear Stress for Solid Circular Section Formula

Evaluate Formula

Formula

$$V = \frac{\tau_{max} \cdot \pi \cdot r^2 \cdot 3}{4}$$

Example with Units

$$4240.3443\,\text{kN} = \frac{42\,\text{MPa} \cdot 3.1416 \cdot 207\,\text{mm}^2 \cdot 3}{4}$$

3) Maximum Stress of a Triangular Section Formulas

3.1) Base of Triangular Section given Maximum Shear Stress Formula

Evaluate Formula

Formula

$$b_{tri} = \frac{3 \cdot V}{\tau_{max} \cdot h_{tri}}$$

Example with Units

$$31.6327\,\text{mm} = \frac{3 \cdot 24.8\,\text{kN}}{42\,\text{MPa} \cdot 56\,\text{mm}}$$

3.2) Base of Triangular Section given Shear Stress at Neutral Axis Formula

Evaluate Formula

Formula

$$b_{tri} = \frac{8 \cdot V}{3 \cdot \tau_{NA} \cdot h_{tri}}$$

Example with Units

$$31.4286\,\text{mm} = \frac{8 \cdot 24.8\,\text{kN}}{3 \cdot 37.5757\,\text{MPa} \cdot 56\,\text{mm}}$$

3.3) Height of Triangular Section given Maximum Shear Stress Formula

Evaluate Formula

Formula

$$h_{tri} = \frac{3 \cdot V}{b_{tri} \cdot \tau_{max}}$$

Example with Units

$$55.3571\,\text{mm} = \frac{3 \cdot 24.8\,\text{kN}}{32\,\text{mm} \cdot 42\,\text{MPa}}$$

3.4) Height of Triangular Section given Shear Stress at Neutral Axis Formula

Evaluate Formula

Formula

$$h_{tri} = \frac{8 \cdot V}{3 \cdot b_{tri} \cdot \tau_{NA}}$$

Example with Units

$$55.0001\,\text{mm} = \frac{8 \cdot 24.8\,\text{kN}}{3 \cdot 32\,\text{mm} \cdot 37.5757\,\text{MPa}}$$

3.5) Maximum Shear Stress of Triangular Section Formula

Evaluate Formula

Formula

$$\tau_{max} = \frac{3 \cdot V}{b_{tri} \cdot h_{tri}}$$

Example with Units

$$41.5179\,\text{MPa} = \frac{3 \cdot 24.8\,\text{kN}}{32\,\text{mm} \cdot 56\,\text{mm}}$$

3.6) Shear Stress at Neutral Axis in Triangular Section Formula

Evaluate Formula

Formula

$$\tau_{NA} = \frac{8 \cdot V}{3 \cdot b_{tri} \cdot h_{tri}}$$

Example with Units

$$36.9048\,\text{MPa} = \frac{8 \cdot 24.8\,\text{kN}}{3 \cdot 32\,\text{mm} \cdot 56\,\text{mm}}$$

3.7) Transverse Shear Force of Triangular Section given Maximum Shear Stress Formula

Evaluate Formula

Formula

$$V = \frac{h_{tri} \cdot b_{tri} \cdot \tau_{max}}{3}$$

Example with Units

$$25.088\,\text{kN} = \frac{56\,\text{mm} \cdot 32\,\text{mm} \cdot 42\,\text{MPa}}{3}$$

3.8) Transverse Shear Force of Triangular Section given Shear Stress at Neutral Axis Formula

Evaluate Formula

Formula

$$V = \frac{3 \cdot b_{tri} \cdot h_{tri} \cdot \tau_{NA}}{8}$$

Example with Units

$$25.2509\,\text{kN} = \frac{3 \cdot 32\,\text{mm} \cdot 56\,\text{mm} \cdot 37.5757\,\text{MPa}}{8}$$

Variables used in list of Shear Stress Formulas above

- **A** Cross Sectional Area *(Square Meter)*
- **b** Breadth of Rectangular Section *(Millimeter)*
- b_f Width of Flange *(Millimeter)*
- b_{tri} Base of Triangular Section *(Millimeter)*
- b_w Width of Web *(Meter)*
- **d** Depth of Rectangular Section *(Millimeter)*
- **D** Overall Depth of I Beam *(Millimeter)*
- d_w Depth of Web *(Millimeter)*
- h_{tri} Height of Triangular Section *(Millimeter)*
- **I** Area Moment of Inertia *(Millimeter⁴)*
- **J** Polar Moment of Inertia *(Millimeter⁴)*
- q_{avg} Average Shear Stress *(Megapascal)*
- **r** Radius of Circular Section *(Millimeter)*
- **R** Radius of Shaft *(Millimeter)*
- **T** Torsional Moment *(Kilonewton Meter)*
- **V** Shear Force *(Kilonewton)*
- **y** Distance from Neutral Axis *(Millimeter)*
- **τ** Shear Stress *(Megapascal)*
- τ_{max} Maximum Shear Stress *(Megapascal)*
- $\tau_{maxlongitudinal}$ Maximum Longitudinal Shear Stress *(Megapascal)*
- τ_{NA} Shear Stress at Neutral Axis *(Megapascal)*

Constants, Functions, Measurements used in list of Shear Stress Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- 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 Millimeter (mm), Meter (m) *Length Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Force** in Kilonewton (kN) *Force Unit Conversion*
- Measurement: **Torque** in Kilonewton Meter (kN*m) *Torque Unit Conversion*
- Measurement: **Second Moment of Area** in Millimeter⁴ (mm⁴) *Second Moment of Area Unit Conversion*
- Measurement: **Stress** in Megapascal (MPa) *Stress Unit Conversion*

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