Working Stress Design Formulas

List of 15 Working Stress Design Formulas

Working Stress Design

Working Stress Design of Rectangular Beams with Tension Reinforcement Only

Allowable Shear

1) Allowable Stress in Stirrup Steel given Area in Legs of Vertical Stirrup

Open Calculator

fx $$f_v = \frac{V' \cdot s}{A_v \cdot d'}$$

ex $$34.72277\text{MPa} = \frac{3500\text{N/m}^2 \cdot 50.1\text{mm}}{500\text{mm}^2 \cdot 10.1\text{mm}}$$

2) Area Required in Legs of Vertical Stirrup

Open Calculator

fx $$A_v = \frac{V' \cdot s}{f_v \cdot d'}$$

ex $$496.0396\text{mm}^2 = \frac{3500\text{N/m}^2 \cdot 50.1\text{mm}}{35\text{MPa} \cdot 10.1\text{mm}}$$

3) Distance from Extreme Compression to Centroid given Area in Legs of Vertical Stirrup

Open Calculator

fx $$d' = \frac{V' \cdot s}{f_v \cdot A_v}$$

ex $$10.02\text{mm} = \frac{3500\text{N/m}^2 \cdot 50.1\text{mm}}{35\text{MPa} \cdot 500\text{mm}^2}$$

4) Distance from Extreme Compression to Centroid given Nominal Unit Shear Stress

Open Calculator

fx $$d' = \frac{V}{b_{ns} \cdot V_n}$$

ex $$10\text{mm} = \frac{3000\text{N}}{15\text{mm} \cdot 20\text{N/mm}^2}$$

5) Excess Shear given Area in Legs of Vertical Stirrup

Open Calculator

fx $$V' = \frac{A_v \cdot f_v \cdot d'}{s}$$

ex $$3527.944\text{N/m}^2 = \frac{500\text{mm}^2 \cdot 35\text{MPa} \cdot 10.1\text{mm}}{50.1\text{mm}}$$

6) Excess Shear given Stirrup Leg Area for Group of Bars Bent up Different Distances

Open Calculator

fx $$V'_{LAB} = \frac{A_v \cdot f_v \cdot d' \cdot (\sin(\alpha) + \cos(\alpha))}{s}$$

ex $$4819.261\text{N/m}^2 = \frac{500\text{mm}^2 \cdot 35\text{MPa} \cdot 10.1\text{mm} \cdot (\sin(30°) + \cos(30°))}{50.1\text{mm}}$$

7) Excess Shear given Vertical Stirrup Leg Area for Single Bar Bent at Angle a

Open Calculator

fx $$V'_{vsl} = A_v \cdot f_v \cdot \sin(\alpha)$$

ex $$8750\text{N/m}^2 = 500\text{mm}^2 \cdot 35\text{MPa} \cdot \sin(30°)$$

8) Nominal Unit Shear Stress

Open Calculator

fx $$V_n = \frac{V}{b_{ns} \cdot d'}$$

ex $$19.80198\text{N/mm}^2 = \frac{3000\text{N}}{15\text{mm} \cdot 10.1\text{mm}}$$

9) Shear given Nominal Unit Shear Stress

Open Calculator

fx $$V = b_{ns} \cdot d' \cdot V_n$$

ex $$3030\text{N} = 15\text{mm} \cdot 10.1\text{mm} \cdot 20\text{N/mm}^2$$

10) Stirrups Spacing given Stirrup Leg Area for Group of Bars Bent up Different Distances

Open Calculator

fx $$s = \frac{A_v \cdot f_v \cdot d' \cdot (\sin(\alpha) + \cos(\alpha))}{V'_{LAB}}$$

ex $$50.45872\text{mm} = \frac{500\text{mm}^2 \cdot 35\text{MPa} \cdot 10.1\text{mm} \cdot (\sin(30°) + \cos(30°))}{4785\text{N/m}^2}$$

11) Stirrups Spacing using Area in Legs of Vertical Stirrup

Open Calculator

fx $$s = \frac{A_v \cdot f_v \cdot d'}{V'}$$

ex $$50.5\text{mm} = \frac{500\text{mm}^2 \cdot 35\text{MPa} \cdot 10.1\text{mm}}{3500\text{N/m}^2}$$

12) Vertical Stirrup Leg Area when Group of Bars is Bent at Different Distances

Open Calculator

fx $$A_v = \frac{V'_{LAB} \cdot s}{f_v \cdot d' \cdot (\cos(\alpha) + \sin(\alpha))}$$

ex $$496.4454\text{mm}^2 = \frac{4785\text{N/m}^2 \cdot 50.1\text{mm}}{35\text{MPa} \cdot 10.1\text{mm} \cdot (\cos(30°) + \sin(30°))}$$

13) Vertical Stirrup Leg Area when Single Bar is Bent at Angle a

Open Calculator

fx $$A_v = \frac{V'_{vsl}}{f_v \cdot \sin(\alpha)}$$

ex $$500\text{mm}^2 = \frac{8750\text{N/m}^2}{35\text{MPa} \cdot \sin(30°)}$$

Working Stress Design for Torsion

14) Maximum Torsion due to Service Load for Torsion Effects

Open Calculator

fx $$T = 0.55 \cdot \left(0.5 \cdot f'_c \cdot \left(\Sigma x^2 y\right)\right)$$

ex $$276.375\text{MPa} = 0.55 \cdot (0.5 \cdot 50\text{MPa} \cdot 20.1)$$

15) Spacing of Closed Stirrups for Torsion under Working Stress Design

Open Calculator

fx
$$s = \frac{3 \cdot A_t \cdot \alpha_t \cdot x_1 \cdot y_1 \cdot f_v}{\tau_{torsional} - T_u} \cdot (\Sigma x^2 y)$$

ex
$$46.16725\text{mm} = \frac{3 \cdot 100.00011\text{mm}^2 \cdot 3.5 \cdot 250\text{mm} \cdot 500.0001\text{mm} \cdot 35\text{MPa}}{12\text{MPa} - 10\text{MPa}} \cdot 20.1$$

Variables Used

- A_t Area of One Leg of Closed Stirrup *(Square Millimeter)*
- A_v Stirrup Area *(Square Millimeter)*
- b_{ns} Beam Width for Nominal Shear *(Millimeter)*
- d' Compression to Centroid Reinforcement Distance *(Millimeter)*
- f'_c Specified 28-Day Compressive Strength of Concrete *(Megapascal)*
- f_v Allowable Stress in Stirrup Steel *(Megapascal)*
- s Stirrup Spacing *(Millimeter)*
- T Maximum Torsion *(Megapascal)*
- T_u Maximum Allowable Torsion *(Megapascal)*
- V Total Shear *(Newton)*
- V' Excess Shear *(Newton per Square Meter)*
- V'_{LAB} Excess Shear given Stirrup Leg Area for Bars Bent *(Newton per Square Meter)*
- V_n Nominal Shear Stress *(Newton per Square Millimeter)*
- V'_{vsl} Excess Shear given Vertical Stirrup Leg Area *(Newton per Square Meter)*
- x_1 Shorter Dimension Legs of Closed Stirrup *(Millimeter)*
- y_1 Longer Dimension Legs of Closed Stirrup *(Millimeter)*
- α Angle at which Stirrup is Inclined *(Degree)*
- α_t Coefficient
- Σx^2y Sum for Component Rectangles of Section
- $\tau_{torsional}$ Torsional Stress *(Megapascal)*

Constants, Functions, Measurements used

- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa), Newton per Square Meter (N/m²), Newton per Square Millimeter (N/mm²)
  Pressure Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- Beams, Columns and Other Members Design Methods Formulas
- Deflection Computations, Column Moments and Torsion Formulas
- Frames and Flat Plate Formulas
- Mix Design, Modulus of Elasticity and Tensile Strength of Concrete Formulas
- Working Stress Design Formulas

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