



Formulas Examples with Units

List of 17 Important Frames and Flat Plate Formulas

1) Braced and Unbraced Frames Formulas

1.1) Load Bearing Walls Formulas

1.1.1) 28-Day Concrete Compressive Strength given Axial Capacity of Wall Formula

Formula

Evaluate Formula

$$f'_c = \frac{\phi P_n}{0.55 \cdot \phi \cdot A_g \cdot \left(1 - \left(\frac{k \cdot l_c}{32 \cdot h}\right)^2\right)}$$

Example with Units

$$52.2671 \text{ MPa} = \frac{10 \text{ kN}}{0.55 \cdot 0.7 \cdot 500 \text{ mm}^2 \cdot \left(1 - \left(\frac{0.5 \cdot 1000 \text{ mm}}{32 \cdot 200 \text{ mm}}\right)^2\right)}$$

1.1.2) Axial Capacity of Wall Formula

Formula

Evaluate Formula

$$\phi P_n = 0.55 \cdot \phi \cdot f'_c \cdot A_g \cdot \left(1 - \left(\frac{k \cdot l_c}{32 \cdot h}\right)^2\right)$$

Example with Units

$$9.5663 \text{ kN} = 0.55 \cdot 0.7 \cdot 50 \text{ MPa} \cdot 500 \text{ mm}^2 \cdot \left(1 - \left(\frac{0.5 \cdot 1000 \text{ mm}}{32 \cdot 200 \text{ mm}}\right)^2\right)$$



1.1.3) Wall Section Gross Area given Axial Capacity of Wall Formula

Formula

$$A_g = \frac{\phi P_n}{0.55 \cdot \phi \cdot f'_c \cdot \left(1 - \left(\frac{k \cdot l_c}{32 \cdot h}\right)^2\right)}$$

Evaluate Formula 

Example with Units

$$522.6706 \text{ mm}^2 = \frac{10 \text{ kN}}{0.55 \cdot 0.7 \cdot 50 \text{ MPa} \cdot \left(1 - \left(\frac{0.5 \cdot 1000 \text{ mm}}{32 \cdot 200 \text{ mm}}\right)^2\right)}$$

1.2) Shear Walls Formulas

1.2.1) Concrete Strength given Shear Force Formula

Formula

$$f'_c = \left(\left(\frac{1}{3.3 \cdot d \cdot h} \right) \cdot \left(V_c + \left(\frac{N_u \cdot d}{4 \cdot l_w} \right) \right) \right)^2$$

Evaluate Formula 

Example with Units

$$52.8926 \text{ MPa} = \left(\left(\frac{1}{3.3 \cdot 2500 \text{ mm} \cdot 200 \text{ mm}} \right) \cdot \left(6 \text{ N} + \left(\frac{30 \text{ N} \cdot 2500 \text{ mm}}{4 \cdot 3125 \text{ mm}} \right) \right) \right)^2$$

1.2.2) Maximum Shear Strength Formula

Formula

$$V_n = 10 \cdot h \cdot 0.8 \cdot l_w \cdot \sqrt{f'_c}$$

Example with Units

$$0.0354 \text{ MPa} = 10 \cdot 200 \text{ mm} \cdot 0.8 \cdot 3125 \text{ mm} \cdot \sqrt{50 \text{ MPa}}$$

Evaluate Formula 

1.2.3) Minimum Horizontal Reinforcement Formula

Formula

$$\rho_n = 0.0025 + 0.5 \cdot \left(2.5 - \left(\frac{h_w}{l_w} \right) \right)$$

Example with Units

$$0.7725 = 0.0025 + 0.5 \cdot \left(2.5 - \left(\frac{3000 \text{ mm}}{3125 \text{ mm}} \right) \right)$$

Evaluate Formula 

1.2.4) Nominal Shear Stress Formula

Formula

$$v_u = \left(\frac{V}{\phi \cdot h \cdot d} \right)$$

Example with Units

$$1176.4706 \text{ N/m}^2 = \left(\frac{500.00 \text{ N}}{0.85 \cdot 200 \text{ mm} \cdot 2500 \text{ mm}} \right)$$

Evaluate Formula 



1.2.5) Shear carried by Concrete Formula ↻

Formula

$$V_c = 3.3 \cdot \sqrt{f'_c} \cdot h \cdot d - \left(\frac{N_u \cdot d}{4 \cdot l_w} \right)$$

Evaluate Formula ↻

Example with Units

$$5.6673 \text{ N} = 3.3 \cdot \sqrt{50 \text{ MPa}} \cdot 200 \text{ mm} \cdot 2500 \text{ mm} - \left(\frac{30 \text{ N} \cdot 2500 \text{ mm}}{4 \cdot 3125 \text{ mm}} \right)$$

1.2.6) Total Design Shear Force given Nominal Shear Stress Formula ↻

Formula

$$V = v_u \cdot \varphi \cdot h \cdot d$$

Example with Units

$$499.8 \text{ N} = 1176 \text{ N/m}^2 \cdot 0.85 \cdot 200 \text{ mm} \cdot 2500 \text{ mm}$$

Evaluate Formula ↻

1.2.7) Wall Horizontal Length given Nominal Shear Stress Formula ↻

Formula

$$d = \frac{V}{h \cdot \varphi \cdot v_u}$$

Example with Units

$$2501.0004 \text{ mm} = \frac{500.00 \text{ N}}{200 \text{ mm} \cdot 0.85 \cdot 1176 \text{ N/m}^2}$$

Evaluate Formula ↻

1.2.8) Wall Overall Thickness given Nominal Shear Stress Formula ↻

Formula

$$h = \frac{V}{\varphi \cdot v_u \cdot d}$$

Example with Units

$$200.08 \text{ mm} = \frac{500.00 \text{ N}}{0.85 \cdot 1176 \text{ N/m}^2 \cdot 2500 \text{ mm}}$$

Evaluate Formula ↻

2) Flat Plate Construction Formulas ↻

2.1) Clear Span in Direction Moments given Total Static Design Moment Formula ↻

Formula

$$l_n = \sqrt{\frac{M_o \cdot 8}{W \cdot l_2}}$$

Example with Units

$$5 \text{ m} = \sqrt{\frac{125 \text{ kN} \cdot \text{m} \cdot 8}{20 \text{ kN/m} \cdot 2 \text{ m}}}$$

Evaluate Formula ↻

2.2) Concrete Column Elasticity Modulus using Flexural Stiffness Formula ↻

Formula

$$E_c = \frac{K_c}{I}$$

Example with Units

$$0.1573 \text{ MPa} = \frac{0.56 \text{ MPa}}{3.56 \text{ kg} \cdot \text{m}^2}$$

Evaluate Formula ↻



2.3) Moment of Inertia of Centroidal Axis given Flexural Stiffness Formula

Formula

$$I = \frac{K_c}{E_c}$$

Example with Units

$$3.5669 \text{ kg}\cdot\text{m}^2 = \frac{0.56 \text{ MPa}}{0.157 \text{ MPa}}$$

Evaluate Formula 

2.4) Strip Width given Total Static Design Moment Formula

Formula

$$l_2 = \frac{8 \cdot M_o}{W \cdot (l_n)^2}$$

Example with Units

$$2_m = \frac{8 \cdot 125 \text{ kN}\cdot\text{m}}{20 \text{ kN/m} \cdot (5_m)^2}$$

Evaluate Formula 

2.5) Total Static Design Moment in Strip Formula

Formula

$$M_o = \frac{W \cdot l_2 \cdot (l_n)^2}{8}$$

Example with Units

$$125 \text{ kN}\cdot\text{m} = \frac{20 \text{ kN/m} \cdot 2_m \cdot (5_m)^2}{8}$$

Evaluate Formula 

2.6) Uniform Design Load Per Unit of Slab Area given Total Static Design Moment Formula

Formula

$$W = \frac{M_o \cdot 8}{l_2 \cdot l_n^2}$$

Example with Units

$$20 \text{ kN/m} = \frac{125 \text{ kN}\cdot\text{m} \cdot 8}{2_m \cdot 5_m^2}$$

Evaluate Formula 



Variables used in list of Frames and Flat Plate Formulas above

- **A_g** Gross Area of Column (Square Millimeter)
- **d** Design Horizontal Length (Millimeter)
- **E_c** Modulus of Elasticity of Concrete (Megapascal)
- **f'_c** Specified 28-Day Compressive Strength of Concrete (Megapascal)
- **h** Overall Thickness of Wall (Millimeter)
- **h_w** Total Height of Wall (Millimeter)
- **I** Moment of Inertia (Kilogram Square Meter)
- **k** Effective Length Factor
- **K_c** Flexural Stiffness of Column (Megapascal)
- **l_2** Span Perpendicular to L1 (Meter)
- **l_c** Vertical Distance between Supports (Millimeter)
- **l_n** Clear Span in Direction of Moments (Meter)
- **l_w** Horizontal Length of Wall (Millimeter)
- **M_o** Total Static Design Moment in Strip (Kilonewton Meter)
- **N_u** Design Axial Load (Newton)
- **V** Total Shear (Newton)
- **V_c** Shear carried by Concrete (Newton)
- **V_n** Shear Strength (Megapascal)
- **v_u** Nominal Shear Stress (Newton per Square Meter)
- **W** Uniform Design Load (Kilonewton per Meter)
- **ρ_n** Horizontal Reinforcement
- **ϕ** Capacity Reduction Factor
- **ϕ** Strength Reduction Factor for Bearing Walls
- **ϕP_n** Axial Capacity of Wall (Kilonewton)

Constants, Functions, Measurements used in list of Frames and Flat Plate 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 Millimeter (mm), Meter (m)
Length Unit Conversion 
- **Measurement:** **Area** in Square Millimeter (mm²)
Area Unit Conversion 
- **Measurement:** **Pressure** in Megapascal (MPa)
Pressure Unit Conversion 
- **Measurement:** **Force** in Kilonewton (kN), Newton (N)
Force Unit Conversion 
- **Measurement:** **Surface Tension** in Kilonewton per Meter (kN/m)
Surface Tension Unit Conversion 
- **Measurement:** **Moment of Inertia** in Kilogram Square Meter (kg·m²)
Moment of Inertia Unit Conversion 
- **Measurement:** **Moment of Force** in Kilonewton Meter (kN*m)
Moment of Force Unit Conversion 
- **Measurement:** **Stress** in Megapascal (MPa), Newton per Square Meter (N/m²)
Stress Unit Conversion 



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