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Design of Retaining Walls Formulas

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List of 16 Design of Retaining Walls Formulas

Design of Retaining Walls

Cantilever and Counterfort Retaining Walls

1) Counterfort Shear Unit Stress on Horizontal Section

$$fx \quad v_c = \frac{V_o}{t_c \cdot d}$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$ex \quad 3.136001MPa = \frac{8MPa}{5.1mm \cdot 500.2m}$$

2) Horizontal Distance from Face of Wall to Main Steel

$$fx \quad d = \frac{V_o}{t_c \cdot v_c}$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$ex \quad 490.1961m = \frac{8MPa}{5.1mm \cdot 3.2MPa}$$

3) Normal Shear Unit Stress on Horizontal Section

$$fx \quad V_o = (v_c \cdot t_c \cdot d)$$

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d_img.jpg\)](#)

$$ex \quad 8.163264MPa = (3.2MPa \cdot 5.1mm \cdot 500.2m)$$



4) Shear Force on Section

fx

Open Calculator 

$$F_{\text{shear}} = V_1 + \left(\left(\frac{M_b}{d} \right) \cdot (\tan(\theta) + \tan(\Phi)) \right)$$

$$\text{ex } 3.6 \times 10^{11} \text{ N} = 500 \text{ N} + \left(\left(\frac{53 \text{ N} \cdot \text{m}}{500.2 \text{ m}} \right) \cdot (\tan(180^\circ) + \tan(90^\circ)) \right)$$

5) Shear Force on Section for Vertical Wall Face

fx

Open Calculator 

$$F_{\text{shear}} = V_1 + \left(\frac{M_b}{d} \right) \cdot \tan(\theta)$$

$$\text{ex } 500 \text{ N} = 500 \text{ N} + \left(\frac{53 \text{ N} \cdot \text{m}}{500.2 \text{ m}} \right) \cdot \tan(180^\circ)$$

6) Thickness of Counterfort Shear Unit Stress on Horizontal Section

fx

Open Calculator 

$$t_c = \frac{V_o}{v_c \cdot d}$$

$$\text{ex } 4.998001 \text{ mm} = \frac{8 \text{ MPa}}{3.2 \text{ MPa} \cdot 500.2 \text{ m}}$$



Earth Pressure and Stability

7) Height of Water above Bottom of Wall given Total Thrust from Water Retained behind Wall

$$fx \quad H_w = \sqrt{2 \cdot \frac{T_w}{\gamma_w}}$$

[Open Calculator !\[\]\(23d9fc146e83b5c3013cfa32c784f8d5_img.jpg\)](#)

$$ex \quad 1.806095m = \sqrt{2 \cdot \frac{16kN/m}{9.81kN/m^3}}$$

8) Total Thrust from Water Retained by Wall

$$fx \quad T_w = \left(0.5 \cdot \gamma_w \cdot (H_w)^2\right)$$

[Open Calculator !\[\]\(aa53ad6fea213b8b2226d3077e30533a_img.jpg\)](#)

$$ex \quad 15.8922kN/m = \left(0.5 \cdot 9.81kN/m^3 \cdot (1.80m)^2\right)$$

9) Unit Weight of Water given Total Thrust from Water Retained behind Wall

$$fx \quad \gamma_w = \left(2 \cdot \frac{T_w}{(H_w)^2}\right)$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a_img.jpg\)](#)

$$ex \quad 9.876543kN/m^3 = \left(2 \cdot \frac{16kN/m}{(1.80m)^2}\right)$$



Gravity Retaining Wall

10) Earth Thrust Horizontal Component given Sum of Righting Moments

$$fx \quad P_h = \left(\frac{\mu \cdot R_v}{1.5} \right)$$

[Open Calculator !\[\]\(74d4806277d7e73349d8e8c0897931e9_img.jpg\)](#)

$$ex \quad 200.04N = \left(\frac{0.6 \cdot 500.1N}{1.5} \right)$$

11) Overturning Moment

$$fx \quad M_o = \frac{M_r}{1.5}$$

[Open Calculator !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)

$$ex \quad 10.06667N*m = \frac{15.1N*m}{1.5}$$

12) Pressure when Resultant is Outside Middle Third

$$fx \quad p = 2 \cdot \frac{R_v}{3 \cdot a}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$ex \quad 83.35Pa = 2 \cdot \frac{500.1N}{3 \cdot 4m}$$



13) Resultant Outside Middle Third

$$\text{fx } a = 2 \cdot \frac{R_v}{3 \cdot p}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 4.002401\text{m} = 2 \cdot \frac{500.1\text{N}}{3 \cdot 83.3\text{Pa}}$$

14) Retaining Wall Righting Moment

$$\text{fx } M_r = 1.5 \cdot M_o$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 15.15\text{N}^*\text{m} = 1.5 \cdot 10.1\text{N}^*\text{m}$$

15) Total Downward Force on Soil for Horizontal Component

$$\text{fx } R_v = \frac{P_h \cdot 1.5}{\mu}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 500\text{N} = \frac{200\text{N} \cdot 1.5}{0.6}$$

16) Total Downward Force on Soil when Resultant is Outside Middle Third

$$\text{fx } R_v = \frac{p \cdot 3 \cdot a}{2}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$\text{ex } 499.8\text{N} = \frac{83.3\text{Pa} \cdot 3 \cdot 4\text{m}}{2}$$










Variables Used

- **a** Middle Third Distance (Meter)
- **d** Horizontal Distance (Meter)
- **F_{shear}** Shear Force on Section (Newton)
- **H_w** Height of Water (Meter)
- **M_b** Bending Moment (Newton Meter)
- **M_o** Overturning Moment (Newton Meter)
- **M_r** Retaining Wall Righting Moment (Newton Meter)
- **p** Earth Pressure (Pascal)
- **P_h** Horizontal Component of Earth Thrust (Newton)
- **R_v** Total Downward Force on Soil (Newton)
- **t_c** Thickness of Counterfort (Millimeter)
- **T_w** Thrust from Water (Kilonewton per Meter)
- **V₁** Shear on Section 1 (Newton)
- **v_c** Counterfort Shear Unit Stress (Megapascal)
- **V_o** Normal Shear Unit Stress (Megapascal)
- **Y_w** Unit Weight of Water (Kilonewton per Cubic Meter)
- **θ** Angle between Earth and Wall (Degree)
- **μ** Coefficient of Sliding Friction
- **Φ** Angle Wall Face makes with Vertical (Degree)








Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Function:** **tan**, tan(Angle)
Trigonometric tangent function
- **Measurement:** **Length** in Millimeter (mm), Meter (m)
Length Unit Conversion 
- **Measurement:** **Pressure** in Megapascal (MPa), Pascal (Pa)
Pressure Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Angle** in Degree ($^{\circ}$)
Angle Unit Conversion 
- **Measurement:** **Surface Tension** in Kilonewton per Meter (kN/m)
Surface Tension Unit Conversion 
- **Measurement:** **Moment of Force** in Newton Meter (N*m)
Moment of Force Unit Conversion 
- **Measurement:** **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)
Specific Weight Unit Conversion 



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