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Pile Foundations Formulas

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List of 25 Pile Foundations Formulas

Pile Foundations

Allowable Load on Piles

1) Allowable Load for Drop Hammer Driven Piles

Open Calculator

fx $$P_a = \frac{2 \cdot W_h \cdot H_d}{p + 1}$$

ex $$12.08982\text{kg} = \frac{2 \cdot 20.19\text{kg} \cdot 0.3\text{m}}{2.00\text{mm} + 1}$$

2) Height of Drop given Allowable Load for Drop Hammer Driven Piles

Open Calculator

fx $$H_d = \frac{P_a \cdot (p + 1)}{2 \cdot W_h}$$

ex $$0.300004\text{m} = \frac{12.09\text{kg} \cdot (2.00\text{mm} + 1)}{2 \cdot 20.19\text{kg}}$$

3) Height of Drop given Allowable Load for Steam Hammer Driven Piles

Open Calculator

fx $$H_{sd} = \frac{P_a \cdot (p + 0.1)}{2 \cdot W_h}$$

ex $$0.030539\text{m} = \frac{12.09\text{kg} \cdot (2.00\text{mm} + 0.1)}{2 \cdot 20.19\text{kg}}$$

4) Weight of Hammer given Allowable Load for Drop Hammer Driven Piles

Open Calculator

$$W_h = \frac{P_a \cdot (p + 1)}{2 \cdot H_d}$$

$$20.1903\text{kg} = \frac{12.09\text{kg} \cdot (2.00\text{mm} + 1)}{2 \cdot 0.3\text{m}}$$

5) Weight of Hammer given Allowable Load for Steam Hammer Driven Piles

Open Calculator

$$W_s = \frac{P_a \cdot (p + 0.1)}{2 \cdot H_d}$$

$$2.0553\text{kg} = \frac{12.09\text{kg} \cdot (2.00\text{mm} + 0.1)}{2 \cdot 0.3\text{m}}$$

Axial Load Capacity of Single Piles

6) Allowable Load for given Safety Factor

Open Calculator

$$P_{allow} = \frac{Q_{su} + Q_{bu}}{F_s}$$

$$10\text{kN} = \frac{17.77\text{kN} + 10.23\text{kN}}{2.8}$$

7) Allowable Load using Safety Factors

Open Calculator

$$P_{allow} = \left(\frac{Q_{su}}{F1}\right) + \left(\frac{Q_{bu}}{F2}\right)$$

$$12.5207\text{kN} = \left(\frac{17.77\text{kN}}{2.5}\right) + \left(\frac{10.23\text{kN}}{1.89}\right)$$

8) Pile Capacity

Open Calculator

fx $Q_u = Q_{su} + Q_{bu}$

ex $28\text{kN} = 17.77\text{kN} + 10.23\text{kN}$

9) Shaft Resistance using Allowable Load and Safety Factor

Open Calculator

fx $Q_{su} = (F_s \cdot P_{allow}) - Q_{bu}$

ex $17.77\text{kN} = (2.8 \cdot 10\text{kN}) - 10.23\text{kN}$

10) Toe Resistance using Allowable Load and Safety Factor

Open Calculator

fx $Q_{bu} = (P_{allow} \cdot F_s) - Q_{su}$

ex $10.23\text{kN} = (10\text{kN} \cdot 2.8) - 17.77\text{kN}$

Group of Piles

11) Allowable Bearing Pressure on Rock given Allowable Design Load

Open Calculator

fx $$q_a = \frac{Q_d - (\pi \cdot d_s \cdot L_s \cdot f_g)}{\frac{\pi \cdot (d_s^2)}{4}}$$

ex $$18.92958\text{MPa} = \frac{10.0\text{MPa} - (\pi \cdot 0.5\text{m} \cdot 2.0\text{m} \cdot 2\text{MPa})}{\frac{\pi \cdot \left((0.5\text{m})^2\right)}{4}}$$

12) Allowable Concrete-Rock Bond Stress given Allowable Design Load

Open Calculator

fx $$f_g = \frac{Q_d - \left(\frac{\pi \cdot \left(d_s^2\right) \cdot q_a}{4}\right)}{\pi \cdot d_s \cdot L_s}$$

ex $$2.000599\text{MPa} = \frac{10.0\text{MPa} - \left(\frac{\pi \cdot \left((0.5\text{m})^2\right) \cdot 18.92\text{MPa}}{4}\right)}{\pi \cdot 0.5\text{m} \cdot 2.0\text{m}}$$

13) Allowable Design Load on Rock Socket

Open Calculator

fx $$Q_d = (\pi \cdot d_s \cdot L_s \cdot f_g) + \left(\frac{\pi \cdot \left(d_s^2\right) \cdot q_a}{4}\right)$$

ex $$9.998119\text{MPa} = (\pi \cdot 0.5\text{m} \cdot 2.0\text{m} \cdot 2\text{MPa}) + \left(\frac{\pi \cdot \left((0.5\text{m})^2\right) \cdot 18.92\text{MPa}}{4}\right)$$

14) Efficiency Factor for Group of Piles

Open Calculator

fx $$E_g = \frac{(2 \cdot f_s \cdot (b \cdot L + w \cdot L)) + (b \cdot W_g)}{n \cdot Q_u}$$

ex $$1.719358 = \frac{(2 \cdot 15\text{N/m}^2 \cdot (2.2\text{m} \cdot 0.52\text{m} + 2.921\text{m} \cdot 0.52\text{m})) + (2.2\text{m} \cdot 8\text{m})}{6.0 \cdot 9.45}$$

15) Group Drag Load in Pile Group Analysis

Open Calculator

fx $$Q_{gd} = A_F \cdot Y_F \cdot H_F + C_g \cdot H \cdot c_u$$

ex $$17.192\text{MPa} = 1024\text{m}^2 \cdot 2000\text{kg/m}^3 \cdot 4\text{m} + 80\text{m} \cdot 1.5\text{m} \cdot 0.075\text{MPa}$$

16) Socket Length given Allowable Design Load on Rock Socket

Open Calculator

fx $$L_s = \frac{Q_d - \left(\frac{\pi \cdot (d_s^2) \cdot q_a}{4}\right)}{\pi \cdot d_s \cdot f_g}$$

ex $$2.000599\text{m} = \frac{10.0\text{MPa} - \left(\frac{\pi \cdot \left((0.5\text{m})^2\right) \cdot 18.92\text{MPa}}{4}\right)}{\pi \cdot 0.5\text{m} \cdot 2\text{MPa}}$$

Laterally Loaded Vertical Piles

17) Characteristic Pile Length for Laterally Loaded Vertical Piles

Open Calculator

fx $$T = \left(\frac{EI}{n_h}\right)^{0.5}$$

ex $$1.749636\text{m} = \left(\frac{12.0\text{N/m}}{3.92}\right)^{0.5}$$

18) Horizontal Subgrade Reaction Coefficient given Characteristic Pile Length

Open Calculator

fx $$n_h = \frac{EI}{(T)^2}$$

ex $$3.936341 = \frac{12.0\text{N/m}}{(1.746\text{m})^2}$$

19) Lateral Deflection for Fixed Head Pile Case

Open Calculator

fx $$\delta = \left(\frac{P_h \cdot (T)^3}{EI}\right) \cdot \left(A_y - \left(\frac{A_\vartheta \cdot B_y}{B_\vartheta}\right)\right)$$

ex $$5.830551\text{m} = \left(\frac{9.32\text{N} \cdot (1.746\text{m})^3}{12.0\text{N/m}}\right) \cdot \left(2.01 - \left(\frac{0.60 \cdot 1.50}{1.501}\right)\right)$$

20) Lateral Deflection of Pile with Head Free to Move

Open Calculator

fx $$y = \left(\frac{A_y \cdot P_h \cdot (T^3)}{EI}\right) + \left(\frac{B_y \cdot M_t \cdot (T^2)}{EI}\right)$$

ex $$30.79209 = \left(\frac{2.01 \cdot 9.32\text{N} \cdot \left((1.746\text{m})^3\right)}{12.0\text{N/m}}\right) + \left(\frac{1.50 \cdot 59\text{N*m} \cdot \left((1.746\text{m})^2\right)}{12.0\text{N/m}}\right)$$

21) Negative Moment Imposed on Pile

Open Calculator

fx $$M_n = \left(\frac{A_\vartheta \cdot P_t \cdot T}{B_\vartheta}\right) - \left(\frac{\vartheta_s \cdot EI}{B_\vartheta \cdot T}\right)$$

ex $$690.7459\text{N*m} = \left(\frac{0.60 \cdot 1000\text{N} \cdot 1.746\text{m}}{1.501}\right) - \left(\frac{1.57\text{rad} \cdot 12.0\text{N/m}}{1.501 \cdot 1.746\text{m}}\right)$$

22) Pile Stiffness given Characteristic Pile Length for Laterally Loaded Piles

Open Calculator

fx $$EI = \left((T)^2\right) \cdot n_h$$

ex $$11.95018\text{N/m} = \left((1.746\text{m})^2\right) \cdot 3.92$$

23) Positive Moment Imposed on Pile

Open Calculator

$$M_p = (A_m \cdot P_h \cdot T) + (B_m \cdot M_t)$$

$$293.0563\text{N*m} = (3.47 \cdot 9.32\text{N} \cdot 1.746\text{m}) + (4.01 \cdot 59\text{N*m})$$

Toe Capacity Load

24) Quasi Constant Value for Piles in Sands

Open Calculator

$$q_l = 0.5 \cdot N_q \cdot \tan(\Phi_i)$$

$$12.0315 = 0.5 \cdot 3.01 \cdot \tan(82.87^\circ)$$

25) Ultimate Tip Load for Piles Installed in Cohesive Soils

Open Calculator

$$Q_b = A_b \cdot N_c \cdot C_u$$

$$798.12\text{N} = 7.39\text{m}^2 \cdot 9 \cdot 12.00\text{Pa}$$

Variables Used

- A_b Base Area of Pile *(Square Meter)*
- A_F Area of Fill *(Square Meter)*
- A_m Coefficient of Lateral Load in Positive Moment
- A_y Coefficient Ay
- A_ϑ Coefficient Aϑ
- **b** Thickness of Dam *(Meter)*
- B_m Coefficient of Moment Term in Positive Moment
- B_y Coefficient By
- B_ϑ Coefficient Bϑ
- C_g Circumference of Group in Foundation *(Meter)*
- c_u Undrained Shear Strength of Soil *(Megapascal)*
- C_u Undrained Strength in Shear *(Pascal)*
- d_s Socket Diameter *(Meter)*
- E_g Efficiency Factor
- **EI** Stiffness of Pile *(Newton per Meter)*
- f_g Allowable Concrete-Rock Bond Stress *(Megapascal)*
- f_s Average Peripheral Friction Stress of Block *(Newton per Square Meter)*
- F_s Factor of Safety in Pile Foundation
- **F1** Factor of Safety F1
- **F2** Factor of Safety F2
- **H** Thickness of Consolidating Soil Layers *(Meter)*
- H_d Height of Drop *(Meter)*
- H_F Thickness of Fill *(Meter)*
- H_{sd} Height of Drop for Steam Hammer *(Meter)*

- **L** Length of Soil Section *(Meter)*
- **L_s** Socket Length *(Meter)*
- **M_n** Moment Negative *(Newton Meter)*
- **M_p** Moment Positive *(Newton Meter)*
- **M_t** Moment in Soil *(Newton Meter)*
- **n** Number of Piles
- **N_c** Bearing Capacity Factor dependent on Cohesion
- **n_h** Coefficient of Horizontal Subgrade
- **N_q** Bearing Capacity Factor
- **p** Penetration per Blow *(Millimeter)*
- **P_a** Allowable Pile Load *(Kilogram)*
- **P_{allow}** Allowable Load *(Kilonewton)*
- **P_h** Laterally Applied Load *(Newton)*
- **P_t** Lateral Load *(Newton)*
- **Q_{bu}** Toe Resistance *(Kilonewton)*
- **Q_{su}** Shaft Resistance *(Kilonewton)*
- **Q_u** Pile Capacity *(Kilonewton)*
- **q_a** Allowable Bearing Pressure on Rock *(Megapascal)*
- **Q_b** Ultimate Point Load *(Newton)*
- **Q_d** Allowable Design Load on Rock Socket *(Megapascal)*
- **Q_{gd}** Group Drag Load *(Megapascal)*
- **q_l** Quasi Constant Value
- **Q_u** Single Pile Capacity
- **T** Characteristic Pile Length *(Meter)*
- **w** Width of Soil Section *(Meter)*
- **W_g** Width of Group *(Meter)*

- W_h Hammer Weight *(Kilogram)*
- W_s Steam Hammer Weight *(Kilogram)*
- y Lateral Deflection
- Y_F Unit Weight of Fill *(Kilogram per Cubic Meter)*
- δ Lateral Deflection Fixed Head *(Meter)*
- ϑ_s Angle of Rotation *(Radian)*
- Φ_i Angle of Internal Friction of Soil *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Meter (m), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa), Newton per Square Meter (N/m²), Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Energy** in Newton Meter (N*m)
  Energy Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Radian (rad), Degree (°)
  Angle Unit Conversion
- Measurement: **Surface Tension** in Newton per Meter (N/m)
  Surface Tension Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

Check other formula lists

- Bearing Capacity for Strip Footing for C-Φ Soils Formulas
- Bearing Capacity of Cohesive Soil Formulas
- Bearing Capacity of Non-cohesive Soil Formulas
- Bearing Capacity of Soils Formulas
- Bearing Capacity of Soils: Meyerhof's Analysis Formulas
- Foundation Stability Analysis Formulas
- Atterberg Limits Formulas
- Bearing Capacity of Soil: Terzaghi's Analysis Formulas
- Compaction of Soil Formulas
- Earth Moving Formulas
- Lateral Pressure for Cohesive and Non Cohesive Soil Formulas
- Minimum Depth of Foundation by Rankine's Analysis Formulas
- Pile Foundations Formulas
- Scraper Production Formulas
- Seepage Analysis Formulas
- Slope Stability Analysis using Bishops Method Formulas
- Slope Stability Analysis using Culman's Method Formulas
- Soil Origin and Its Properties Formulas
- Specific Gravity of Soil Formulas
- Stability Analysis of Infinite Slopes in Prism Formulas
- Vibration Control in Blasting Formulas
- Void Ratio of Soil Sample Formulas
- Water Content of Soil and Related Formulas

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