



# **Pile Foundations Formulas**

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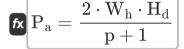


#### **List of 25 Pile Foundations Formulas**

## Pile Foundations **3**

### Allowable Load on Piles

1) Allowable Load for Drop Hammer Driven Piles



Open Calculator

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

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

$$\mathbf{H}_{\mathrm{d}} = rac{\mathrm{P_a} \cdot (\mathrm{p} + 1)}{2 \cdot \mathrm{W_h}}$$

Open Calculator 🗗

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

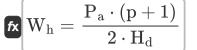
$$\mathbf{H}_{\mathrm{sd}} = rac{\mathrm{P_a} \cdot (\mathrm{p} + 0.1)}{2 \cdot \mathrm{W_h}}$$

Open Calculator 🗗

$$oxed{ex} 0.030539 \mathrm{m} = rac{12.09 \mathrm{kg} \cdot (2.00 \mathrm{mm} + 0.1)}{2 \cdot 20.19 \mathrm{kg}}$$



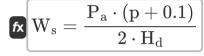
#### 4) Weight of Hammer given Allowable Load for Drop Hammer Driven Piles



Open Calculator

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

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



Open Calculator

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

# Axial Load Capacity of Single Piles

## 6) Allowable Load for given Safety Factor



Open Calculator 🚰

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

## 7) Allowable Load using Safety Factors

$$ext{P}_{
m allow} = \left(rac{ ext{Q}_{
m su}}{ ext{F1}}
ight) + \left(rac{ ext{Q}_{
m bu}}{ ext{F2}}
ight)$$

Open Calculator

$$extbf{ex} 12.5207 ext{kN} = \left(rac{17.77 ext{kN}}{2.5}
ight) + \left(rac{10.23 ext{kN}}{1.89}
ight)$$



#### 8) Pile Capacity

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

Open Calculator

- $28 \mathrm{kN} = 17.77 \mathrm{kN} + 10.23 \mathrm{kN}$
- 9) Shaft Resistance using Allowable Load and Safety Factor
- $egin{aligned} \mathbf{R} \left[ \mathrm{Q}_{\mathrm{su}} = \left( \mathrm{F}_{\mathrm{s}} \cdot \mathrm{P}_{\mathrm{allow}} 
  ight) \mathrm{Q}_{\mathrm{bu}} \end{aligned} \end{aligned}$

Open Calculator

- $\texttt{ex} \ 17.77 \text{kN} = (2.8 \cdot 10 \text{kN}) 10.23 \text{kN}$
- 10) Toe Resistance using Allowable Load and Safety Factor
- $\left[ egin{aligned} \mathbf{Q}_{\mathrm{bu}} &= (\mathbf{P}_{\mathrm{allow}} \cdot \mathbf{F}_{\mathrm{s}}) \mathbf{Q}_{\mathrm{su}} \end{aligned} 
  ight]$

Open Calculator

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

## Group of Piles

- 11) Allowable Bearing Pressure on Rock given Allowable Design Load
- $\mathbf{q}_{\mathrm{a}} = rac{\mathrm{Q_d} (\pi \cdot \mathrm{d_s} \cdot \mathrm{L_s} \cdot \mathrm{f_g})}{rac{\pi \cdot (\mathrm{d_s^2})}{4}}$

- Open Calculator 🗗



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

 $\mathbf{f_g} = rac{\mathrm{Q_d} - \left(rac{\pi \cdot (\mathrm{d_s^2}) \cdot \mathrm{q_a}}{4}
ight)}{\pi \cdot \mathrm{d_s} \cdot \mathrm{L_s}}$ 

Open Calculator 🗗

 $\mathbf{ex} = \mathbf{10.0MPa} - \left( rac{\pi \cdot \left( (0.5 \mathrm{m})^2 
ight) \cdot 18.92 \mathrm{MPa}}{4} 
ight)}{\pi \cdot 0.5 \mathrm{m} \cdot 2.0 \mathrm{m}}$ 

### 13) Allowable Design Load on Rock Socket

 $\mathbf{Q}_{\mathrm{d}} = (\pi \cdot \mathrm{d_s} \cdot \mathrm{L_s} \cdot \mathrm{f_g}) + \left(rac{\pi \cdot \left(\mathrm{d_s^2}
ight) \cdot \mathrm{q_a}}{4}
ight)$ 

Open Calculator

### 14) Efficiency Factor for Group of Piles 🗗

 $\mathbf{E}_{\mathrm{g}} = rac{\left(2 \cdot f_{\mathrm{s}} \cdot \left(b \cdot L + w \cdot L
ight)
ight) + \left(b \cdot W_{\mathrm{g}}
ight)}{n \cdot Q_{\mathrm{u}}}$ 

Open Calculator 🗗

 $\boxed{1.719358 = \frac{\left(2 \cdot 15 \mathrm{N/m^2} \cdot \left(2.2 \mathrm{m} \cdot 0.52 \mathrm{m} + 2.921 \mathrm{m} \cdot 0.52 \mathrm{m}\right)\right) + \left(2.2 \mathrm{m} \cdot 8 \mathrm{m}\right)}{6.0 \cdot 9.45} }$ 

## 15) Group Drag Load in Pile Group Analysis 🚰

 $\mathbf{R} \mathrm{Q}_{\mathrm{gd}} = \mathrm{A}_{\mathrm{F}} \cdot \mathrm{Y}_{\mathrm{F}} \cdot \mathrm{H}_{\mathrm{F}} + \mathrm{C}_{\mathrm{g}} \cdot \mathrm{H} \cdot \mathrm{c}_{\mathrm{u}}$ 

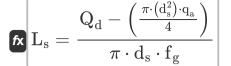
Open Calculator 🗗

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





#### 16) Socket Length given Allowable Design Load on Rock Socket

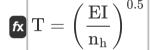


Open Calculator

$$\mathbf{ex} = rac{10.0 \mathrm{MPa} - \left(rac{\pi \cdot \left(\left(0.5 \mathrm{m}
ight)^2
ight) \cdot 18.92 \mathrm{MPa}}{4}
ight)}{\pi \cdot 0.5 \mathrm{m} \cdot 2 \mathrm{MPa}}$$

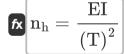
## Laterally Loaded Vertical Piles

### 17) Characteristic Pile Length for Laterally Loaded Vertical Piles



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

### 18) Horizontal Subgrade Reaction Coefficient given Characteristic Pile Length



$$oxed{ex} 3.936341 = rac{12.0 \mathrm{N/m}}{ig(1.746 \mathrm{m}ig)^2}$$



#### 19) Lateral Deflection for Fixed Head Pile Case

 $\delta = \left(rac{{{
m P}_h} \cdot {{
m (T)}^3}}{{
m EI}}
ight) \cdot \left({{
m A}_y} - \left(rac{{{
m A}_{artheta}} \cdot {{
m B}_y}}{{
m B}_{artheta}}
ight)
ight)$ 

Open Calculator

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

#### 20) Lateral Deflection of Pile with Head Free to Move

 $\mathbf{x} = \left( rac{A_{y} \cdot P_{h} \cdot \left(T^{3}\right)}{EI} \right) + \left( rac{B_{y} \cdot M_{t} \cdot \left(T^{2}\right)}{EI} \right)$ 

Open Calculator

ex

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

### 21) Negative Moment Imposed on Pile

 $\mathbf{M}_{\mathrm{n}} = \left(rac{A_{\vartheta} \cdot P_{\mathrm{t}} \cdot T}{B_{\vartheta}}
ight) - \left(rac{\vartheta_{\mathrm{s}} \cdot \mathrm{EI}}{B_{\vartheta} \cdot T}
ight)$ 

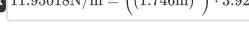
Open Calculator 🗗

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

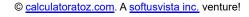
$$\mathbf{E} \mathbf{I} = \left( \left( \mathbf{T} \right)^2 \right) \cdot \mathbf{n}_{\mathrm{h}}$$

Open Calculator

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









### 23) Positive Moment Imposed on Pile

 $M_{
m p} = ({
m A_m}\cdot{
m P_h}\cdot{
m T}) + ({
m B_m}\cdot{
m M_t})$ 

Open Calculator

Open Calculator 🚰

Open Calculator

## Toe Capacity Load

# 24) Quasi Constant Value for Piles in Sands

- fx  $q_{
  m l} = 0.5 \cdot {
  m N}_{
  m q} \cdot {
  m tan}(\Phi_{
  m i})$
- $\boxed{12.0315 = 0.5 \cdot 3.01 \cdot \tan(82.87°) }$

# 25) Ultimate Tip Load for Piles Installed in Cohesive Soils

- fx  $Q_{b} = A_{b} \cdot N_{c} \cdot C_{u}$



#### Variables Used

- Ab Base Area of Pile (Square Meter)
- A<sub>F</sub> Area of Fill (Square Meter)
- A<sub>m</sub> Coefficient of Lateral Load in Positive Moment
- A<sub>v</sub> Coefficient Ay
- A₃ Coefficient Aϑ
- **b** Thickness of Dam (Meter)
- B<sub>m</sub> Coefficient of Moment Term in Positive Moment
- B<sub>v</sub> Coefficient By
- B₃ Coefficient Bϑ
- C<sub>q</sub> Circumference of Group in Foundation (Meter)
- Cu Undrained Shear Strength of Soil (Megapascal)
- C<sub>II</sub> Undrained Strength in Shear (Pascal)
- ds Socket Diameter (Meter)
- E<sub>a</sub> Efficiency Factor
- El Stiffness of Pile (Newton per Meter)
- f<sub>g</sub> Allowable Concrete-Rock Bond Stress (Megapascal)
- fs Average Peripheral Friction Stress of Block (Newton per Square Meter)
- F<sub>S</sub> Factor of Safety in Pile Foundation
- F1 Factor of Safety F1
- F2 Factor of Safety F2
- H Thickness of Consolidating Soil Layers (Meter)
- H<sub>d</sub> Height of Drop (Meter)
- H<sub>F</sub> Thickness of Fill (Meter)
- **H**<sub>sd</sub> Height of Drop for Steam Hammer (*Meter*)





- L Length of Soil Section (Meter)
- L<sub>s</sub> Socket Length (Meter)
- M<sub>n</sub> Moment Negative (Newton Meter)
- M<sub>D</sub> Moment Positive (Newton Meter)
- M<sub>t</sub> Moment in Soil (Newton Meter)
- n Number of Piles
- N<sub>C</sub> Bearing Capacity Factor dependent on Cohesion
- nh Coefficient of Horizontal Subgrade
- N<sub>a</sub> Bearing Capacity Factor
- p Penetration per Blow (Millimeter)
- Pa Allowable Pile Load (Kilogram)
- Pallow Allowable Load (Kilonewton)
- P<sub>h</sub> Laterally Applied Load (Newton)
- Pt Lateral Load (Newton)
- Q bu Toe Resistance (Kilonewton)
- Q <sub>Su</sub> Shaft Resistance (Kilonewton)
- Q I Pile Capacity (Kilonewton)
- **q**<sub>a</sub> Allowable Bearing Pressure on Rock (Megapascal)
- Q<sub>b</sub> Ultimate Point Load (Newton)
- Q<sub>d</sub> Allowable Design Load on Rock Socket (Megapascal)
- Q<sub>qd</sub> Group Drag Load (Megapascal)
- q<sub>I</sub> Quasi Constant Value
- Q<sub>II</sub> Single Pile Capacity
- T Characteristic Pile Length (Meter)
- w Width of Soil Section (Meter)
- Wa Width of Group (Meter)





- W<sub>h</sub> Hammer Weight (Kilogram)
- W<sub>S</sub> Steam Hammer Weight (Kilogram)
- y Lateral Deflection
- YF Unit Weight of Fill (Kilogram per Cubic Meter)
- δ Lateral Deflection Fixed Head (Meter)
- $\vartheta_s$  Angle of Rotation (Radian)
- Φ<sub>i</sub> 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 Minimum Depth of Foundation by 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

- Rankine's Analysis Formulas
- Pile Foundations Formulas
- Scraper Production Formulas
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