Single Pile Capacity Calculation Software Documentation

# 1. Introduction

This document provides detailed information about the theory, calculations, and usage of the Single Pile Capacity Calculation Software. This software is designed to estimate the bearing capacity of single piles based on the Standard Penetration Test (SPT) N-values and the soil type. It is intended for use in preliminary pile design when detailed soil property information is unavailable or unreliable.

# 2. Theory

## 2.1. Bearing Capacity of Single Piles

The bearing capacity of a pile is the maximum load that the pile can support without failure. It consists of two primary components:

1. Ultimate End Bearing Capacity (Q\_b): This is the resistance offered by the soil at the base of the pile.

2. Ultimate Skin Friction Capacity (Q\_s): This is the resistance offered by the soil along the surface of the pile shaft.

## 2.2. Calculation Approach

### 2.2.1. SPT N-value Correction

The field SPT N-value is corrected using the following empirical relationship:

For N > 15:  
N\_corrected = 15 + 0.5 × (N\_field − 15)  
For N ≤ 15:  
N\_corrected = N\_field

### 2.2.2. Soil Cohesion Calculation

The cohesion of the soil (c) in kPa is estimated using the corrected SPT N-value:

Cohesion (c) = k × N\_corrected

Where:  
k is an empirical multiplier (typically ranging from 2.4 to 4.0 depending on the soil stiffness).

### 2.2.3. Skin Friction and End Bearing

The skin friction (f\_su) and end bearing (q\_pu) are calculated based on the soil type:  
Cohesionless Soil:  
f\_su = (4 × N\_corrected) / 200 (in ton/ft^2)  
q\_pu = 4 × N\_corrected (in ton/ft^2)  
Cohesive Soil:  
f\_su = α × c (in ton/ft^2)  
q\_pu = 9 × c (in ton/ft^2)  
Where α is an adhesion factor (typically α = 0.55).

References:  
- Meyerhof, G. G. (1956). Penetration tests and bearing capacity of cohesionless soils. Journal of the Soil Mechanics and Foundations Division, ASCE, 82(1), 1-19.  
- Schmertmann, J. H. (1970). Static cone to compute static settlement over sand. Journal of the Soil Mechanics and Foundations Division, ASCE, 96(3), 1011-1043.  
- Tomlinson, M. J. (1971). The adhesion of piles driven in clay soils. Geotechnique, 21(2), 98-123.

### 2.2.4. Unit Conversion

The calculated values are converted from ton/ft² to kN/m²:  
1 ton/ft² = 95.76 kN/m²

### 2.2.5. Pile Capacity

The total ultimate pile capacity (Qu) is calculated as the sum of skin friction and end bearing:  
Qu = Qs + Qb  
The allowable pile capacity (Qa) is obtained by applying a factor of safety:  
Qa = Qu / Factor of Safety

# 3. Mathematical Example

3.1. Problem Statement  
Calculate the ultimate and allowable pile capacity for a single pile with the following details:  
Pile Diameter: 0.5 m  
Number of Soil Layers: 3  
Factor of Safety: 3.0  
Soil Layers Data:  
Layer 1: Depth = 1.5 m, Soil Type = Cohesive, Field SPT = 6  
Layer 2: Depth = 3.0 m, Soil Type = Cohesive, Field SPT = 5  
Layer 3: Depth = 4.5 m, Soil Type = Cohesionless, Field SPT = 8  
Cohesion Multiplier k: 2.4

3.2. Solution  
3.2.1. Corrected SPT N-value  
Layer 1: N\_corrected = 6  
Layer 2: N\_corrected = 5  
Layer 3: N\_corrected = 8

3.2.2. Cohesion  
Layer 1: c = 2.4 × 6 = 14.4 kPa  
Layer 2: c = 2.4 × 5 = 12.0 kPa  
Layer 3: (Not applicable for cohesionless soil)

3.2.3. Skin Friction and End Bearing  
Layer 1 (Cohesive):  
f\_su = 0.55 × 14.4 = 7.92 ton/ft²  
q\_pu = 9 × 14.4 = 129.6 ton/ft²  
Layer 2 (Cohesive):  
f\_su = 0.55 × 12.0 = 6.6 ton/ft²  
q\_pu = 9 × 12.0 = 108.0 ton/ft²  
Layer 3 (Cohesionless):  
f\_su = (4 × 8) / 200 = 0.16 ton/ft²  
q\_pu = 4 × 8 = 32.0 ton/ft²

3.2.4. Conversion to kN/m²  
Layer 1:  
f\_su = 7.92 × 95.76 = 758.8 kN/m²  
q\_pu = 129.6 × 95.76 = 12413.3 kN/m²  
Layer 2:  
f\_su = 6.6 × 95.76 = 631.9 kN/m²  
q\_pu = 108.0 × 95.76 = 10342.1 kN/m²  
Layer 3:  
f\_su = 0.16 × 95.76 = 15.3 kN/m²  
q\_pu = 32.0 × 95.76 = 3064.3 kN/m²

3.2.5. Pile Capacity  
Skin Friction Qs:  
Qs = As × f\_su  
End Bearing Qb:  
Qb = Ab × q\_pu  
Allowable Capacity Qa:  
Qa = Qu / Factor of Safety  
Perform calculations for each layer and sum the results to find the total pile capacity.

# 4. Conclusion

This software is a useful tool for estimating the pile capacity using SPT N-values and basic soil type information. The empirical approach is beneficial for preliminary design purposes. However, for detailed design, more precise geotechnical investigations are recommended.