Pile Capacity by Static Formulae (α and β Methods)

Ultimate shaft and base capacity of a pile in clay (α method) or sand (β method), with the allowable load for a chosen factor of safety.

Method: α and β methods for pile capacity (Das, Principles of Foundation Engineering, 7th ed. (Cengage, 2011), ch. 11)

Input parameters

Unit system: SI

Parameter	Value	Unit
Soil	Clay (α method)	
Pile diameter	600.00	mm
Embedded length	15.000	m
Undrained shear strength (clay)	60.000	kPa
Adhesion factor (clay)	0.50000	
Effective unit weight (sand)	9.0000	kN/m³
Shaft friction factor (sand)	0.30000	
Base bearing factor (sand)	40.000	
Factor of safety	2.5000	
Critical depth in diameters (sand) Below about 10–20 diameters the effective vertical stress used for shaft friction and end bearing is held constant. 15 is on the cautious side; enter 100 to apply no limit.	15.000	

Calculated results

Parameter	Value	Unit
Shaft capacity	848.23	kN
Base capacity	152.68	kN
Ultimate capacity	1,000.9	kN
Allowable load	400.36	kN

Notes for this case

- Single uniform layer, water table at the surface for γ′. Clay: Q_s = αc_uA_s, Q_b = 9c_uA_b. Sand: Q_s = βσ′_v,avgA_s, Q_b = N_qσ′_v,tipA_b, with σ′_v held constant below the critical depth. Confirm by a load test.

Formula and method

The formula is shown on the calculator page: https://calc.firecad.com/civil/foundations/pile-capacity-static

Variables

soil	Soil	-
D	Pile diameter	m
L	Embedded length	m
c_u	Undrained shear strength (clay)	Pa
α	Adhesion factor (clay)	-
\gamma'	Effective unit weight (sand)	N/m³
β	Shaft friction factor (sand)	-
N_q	Base bearing factor (sand)	-
FS	Factor of safety	-
z_c/D	Critical depth in diameters (sand)	-
Q_s	Shaft capacity	N
Q_b	Base capacity	N

Q_u	Ultimate capacity	N
Q_a	Allowable load	N

Method and standards

Static capacity.

Assumptions and limits

- Single layer; vertical load; water table at the ground surface (γ′ is the submerged unit weight).
- The pile's own weight is not subtracted from Q_a; subtract it (less the displaced soil) for a net allowable load.
- Sand: the effective vertical stress for shaft friction and end bearing stops rising below the critical depth (10–20 diameters is the usual range; 15 is the default).

References

• α and β methods for pile capacity (Das, Principles of Foundation Engineering, 7th ed. (Cengage, 2011), ch. 11)

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/civil/foundations/pile-capacity-static

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.