Single Pile Elastic Settlement (Vesić Method)

Settlement of a single pile under working load from the elastic shortening of the shaft, settlement due to the tip load and settlement due to shaft-transmitted load.

Method: Vesić's method for pile settlement

Input parameters

Unit system: SI

Parameter	Value	Unit
Working load carried at the tip	300.00	kN
Working load carried by the shaft	500.00	kN
Shaft friction distribution factor	0.60000	
Pile length	20.000	m
Pile diameter	500.00	mm
Pile modulus	28.000	GPa
Soil modulus	30.000	MPa
Soil Poisson's ratio	0.30000	

Calculated results

Parameter	Value	Unit
Elastic shortening of the pile	2.1827	mm
Settlement from tip load	19.697	mm
Settlement from shaft load	1.0171	mm
Total settlement	22.897	mm

Notes for this case

• s = s₁ + s₂ + s₃. Shaft shortening s₁ = (Q_wp + ξQ_ws)L/(A_pE_p), ξ = 0.5 for uniform or parabolic friction and 0.67 for triangular. Tip settlement s₂ = (q_wpD/E_s)(1 − ν²)I_wp with I_wp ≈ 0.85. Shaft-load settlement s₃ = (Q_ws/pL)(D/E_s)(1 − ν²)I_ws with I_ws = 2 + 0.35√(L/D). Soil modulus is the main uncertainty; calibrate against load tests where possible.

Formula and method

$$s_1 = \frac{(Q_{wp} + \xi Q_{ws})L}{A_p E_p}, \quad s_2 = \frac{q_{wp} D}{E_s}(1 - \nu_s^2) I_{wp}, \quad s_3 = \frac{Q_{ws}}{pL}\frac{D}{E_s}(1 - \nu_s^2)\left(2 + 0.35\sqrt{\frac{L}{D}}\right)$$

Variables

Q_{wp}	Working load carried at the tip	N
Q_{ws}	Working load carried by the shaft	N
ξ	Shaft friction distribution factor	-
L	Pile length	m
D	Pile diameter	m
E_p	Pile modulus	Pa
E_s	Soil modulus	Pa
ν_s	Soil Poisson's ratio	-
s_1	Elastic shortening of the pile	m
s_2	Settlement from tip load	m
s_3	Settlement from shaft load	m

s	Total settlement	m

Method and standards

Pile settlement.

Assumptions and limits

- Linear elastic soil and pile; circular pile; working load well below ultimate.

References

Vesić's method for pile settlement

Report details

Report reference	FCC-TR6Q-4RV7 (the same inputs always give the same reference)
Generated	23 November 2026, 18:00 UTC
Calculator	Single Pile Elastic Settlement (Vesić Method)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 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-elastic-settlement

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.