Negative Skin Friction (Downdrag) on a Pile

Drag load on a pile through a consolidating layer under fill by the effective-stress β method, and the allowable load left after subtracting downdrag.

Method: Effective-stress (β) method for drag load; Fellenius; …

Input parameters

Unit system: SI

Parameter	Value	Unit
Pile diameter	500.00	mm
Thickness of settling layer	8.0000	m
Fill surcharge on top of the layer	40.000	kPa
Effective unit weight of the layer	7.0000	kN/m³
Shaft friction coefficient β	0.25000	
Ultimate pile capacity below the neutral plane	2,400.0	kN
Factor of safety	2.5000	

Calculated results

Parameter	Value	Unit
Average vertical effective stress	68.000	kPa
Average negative skin friction	17.000	kPa
Drag load	213.63	kN
Allowable load after downdrag	746.37	kN

Notes for this case

• Q_n = πD·β·∫σ'_v dz = πDβ(qH + γ'H²/2). β ≈ 0.2–0.3 for clay and silt, 0.3–0.5 for sand. This takes the whole layer as moving down relative to the pile; with a neutral plane inside the layer, only the part above it drags. A negative allowable load means downdrag alone exceeds the safe capacity.

Formula and method

The formula is shown on the calculator page: https://calc.firecad.com/civil/foundations/pile-negative-skin-friction

Variables

D	Pile diameter	m
H	Thickness of settling layer	m
q	Fill surcharge on top of the layer	Pa
\gamma'	Effective unit weight of the layer	N/m³
β	Shaft friction coefficient β	-
Q_u	Ultimate pile capacity below the neutral plane	N
FS	Factor of safety	-
\bar\sigma'_v	Average vertical effective stress	Pa
f_n	Average negative skin friction	Pa
Q_n	Drag load	N
Q_a	Allowable load after downdrag	N

Method and standards

Downdrag.

Assumptions and limits

- Whole layer settles relative to the pile; uniform γ' and β.

References

Effective-stress (β) method for drag load, Fellenius, Basics of Foundation Design (electronic edition)

Report details

Report reference	FCC-SF2A-R8FQ (the same inputs always give the same reference)
Generated	23 November 2026, 18:00 UTC
Calculator	Negative Skin Friction (Downdrag) on a Pile
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-negative-skin-friction

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.