Shallow Footing Bearing Capacity (General Equation, Vesić Factors)

Ultimate and safe bearing capacity of a strip, square, circular or rectangular footing from soil strength, depth and width, with Vesić factors and De Beer shape factors.

Method: Terzaghi (1943) general form; Prandtl–Reissner N_c; N_q; Vesić (1973) N_γ; De Beer (1970) shape factors (Das, Principles of Foundation Engineering)

Input parameters

Unit system: SI

Parameter	Value	Unit
Footing	Square	
Width (or diameter)	2.0000	m
Length (rectangular footing)	3.0000	m
Depth of the base below ground	1.5000	m
Bulk density of the soil	1,800.0	kg/m³
Angle of internal friction	30.000	°
Cohesion	0	kPa
Factor of safety	3.0000	
Depth of the water table below ground Leave at 100 m when the water table is deep. Below it the soil is taken as saturated at the bulk density entered, with submerged weight (ρ − 1000) g.	100.00	m

Calculated results

Parameter	Value	Unit
Bearing capacity factor N_c	30.140	
Bearing capacity factor N_q	18.401	
Bearing capacity factor N_γ	22.402	
Effective overburden pressure at the base	26.478	kPa
Ultimate bearing capacity	1,005.8	kPa
Safe bearing capacity (gross, q_u / F_s)	335.26	kPa
Net safe bearing capacity (q_u − q)/F_s	326.44	kPa

Notes for this case

- General shear failure, vertical central load, level ground; depth factors are left out (conservative). Settlement often governs: check it separately.

Formula and method

$$q_u = cN_cF_{cs} + qN_qF_{qs} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s}$$

$$N_q = e^{\pi \tan\varphi}\tan^2\left(45° + \frac{\varphi}{2}\right), \quad N_c = (N_q - 1)\cot\varphi, \quad N_\gamma = 2(N_q + 1)\tan\varphi$$

$$F_{cs} = 1 + \frac{B}{L}\frac{N_q}{N_c}, \quad F_{qs} = 1 + \frac{B}{L}\tan\varphi, \quad F_{\gamma s} = 1 - 0.4\frac{B}{L}$$

One further formula is shown on the calculator page: https://calc.firecad.com/civil/foundations/soil-bearing-capacity

Variables

shape	Footing	-
B	Width (or diameter)	m
L	Length (rectangular footing)	m
D_f	Depth of the base below ground	m
ρ	Bulk density of the soil	kg/m³
φ	Angle of internal friction	rad
C	Cohesion	Pa
F_s	Factor of safety	-
D_w	Depth of the water table below ground	m
\gamma, \gamma'	Bulk and submerged unit weight	N/m³
ρ_w	Density of water, 1000	kg/m³
N_c	Bearing capacity factor N_c	-
N_q	Bearing capacity factor N_q	-
N_γ	Bearing capacity factor N_γ	-
q	Effective overburden pressure at the base	Pa
q_u	Ultimate bearing capacity	Pa
q_a	Safe bearing capacity (gross, q_u / F_s)	Pa
q_{ns}	Net safe bearing capacity (q_u − q)/F_s	Pa
g	Standard gravity	m/s²
$F_{cs}, F_{qs}, F_{\gamma s}$	Shape factors	-

Method and standards

The general bearing capacity equation with Prandtl–Reissner N_c and N_q, Vesić's N_γ and De Beer's shape factors as given by Das; depth and inclination factors are left out, which is conservative.

Assumptions and limits

- General shear failure; vertical, central load; level ground. The factors are Prandtl–Reissner N_c and N_q, Vesić N_γ and De Beer shape factors in Terzaghi's general form, not Terzaghi's own factors (1.3 c N_c, 0.4 γ B N_γ).
- No local or punching shear reduction is applied: for loose sand or soft clay, where local shear governs, the result is unconservative; a common practice is to repeat with c and tan φ reduced to two-thirds (Terzaghi's local shear).
- A water table within B below the base reduces the overburden and N_γ terms (Das's three cases); the soil below it is taken as saturated at the bulk density entered.

References

• Terzaghi (1943) general form; Prandtl–Reissner N_c
• N_q; Vesić (1973) N_γ; De Beer (1970) shape factors (Das, Principles of Foundation Engineering)

Report details

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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/soil-bearing-capacity

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Reopens the calculator with the inputs of this report.