SHALLOW FOUNDATION BEARING CAPACITY ANALYSIS

Project:	I-95 Bridge Abutment	**Number:**	2024-001
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Company:	Geotech Associates		

1. INPUT PARAMETERS

Parameter	Symbol	Value	Unit
Footing width	B	2.0	m
Footing shape	$Shape$	square	
Embedment depth	D_f	1.5	m
Cohesion	c	0.0	kPa
Friction angle	φ	30	deg
Unit weight	γ	18	kN/m³
Factor of safety	FS	3.0	
Nγ method	$Method$	Vesic	

1. EFFECTIVE DIMENSIONS & OVERBURDEN

Effective Footing Dimensions (no eccentricity)

$$B' = B, L' = L(noloadeccentricity)$$

$B', L' =$ **2.000m, 2.000m**

Overburden Pressure at Footing Base

$$q = \gamma \times D_f$$

$$q = 18.00 \times 1.500$$

$q = 27.00$ kPa

Effective Unit Weight Below Footing

$$\gamma' = \gamma(GWTbelowfooting)$$

$\gamma' = 18.00$ kN/m³

1. BEARING CAPACITY FACTORS

Bearing Capacity Factor N_q

$$N_q = \exp(\pi \times \tan(\varphi)) \times \tan^2(45 + \varphi/2)$$

$$N_q = \exp(\pi \times \tan(30.0°)) \times \tan^2(45 + 15.0°)$$

$N_q = 18.40$

Reissner (1924); FHWA GEC-6 Eq. 6-2

Bearing Capacity Factor N_c

$$N_c = (N_q - 1)/\tan(\varphi)$$

$$N_c = (18.40 - 1)/\tan(30.0°)$$

$N_c = 30.14$

Prandtl (1921); FHWA GEC-6 Eq. 6-1

Bearing Capacity Factor N_γ

$$N_\gamma = 2 \times (N_q + 1) \times \tan(\varphi)$$

$$N_\gamma = 2 \times (18.40 + 1) \times \tan(30.0°)$$

$N_\gamma = 22.40$

Vesic (1973); FHWA GEC-6 Table 6-1

1. CORRECTION FACTORS

Shape Factors

$$s_c = 1 + (B/L)(N_q/N_c), s_q = 1 + (B/L)\tan(\varphi), s_\gamma = 1 - 0.4(B/L)$$

s_c, s_q, s_γ = **1.6105, 1.5774, 0.6000**

Vesic; FHWA GEC-6 Table 6-2

Depth Factors

$$d_q = 1 + 2 \times \tan(\varphi) \times (1 - \sin(\varphi))^2 \times k, d_\gamma = 1.0, k = D_f/B if D_f/B \leq 1 else \arctan(D_f/B)$$

d_c, d_q, d_γ = **1.2289, 1.2165, 1.0000**

Vesic; FHWA GEC-6 Table 6-3

Correction Factor Summary

Factor Type	c-term	q-term	γ-term
Shape (s)	1.6105	1.5774	0.6000
Depth (d)	1.2289	1.2165	1.0000
Inclination (i)	1.0000	1.0000	1.0000
Base tilt (b)	1.0000	1.0000	1.0000
Ground (g)	1.0000	1.0000	1.0000

1. GENERAL BEARING CAPACITY EQUATION

General Bearing Capacity Equation

$$q_{ult} = c \times N_c \times s_c \times d_c \times i_c \times b_c \times g_c + q \times N_q \times s_q \times d_q \times i_q \times b_q \times g_q + 0.5 \times \gamma' \times B' \times N_\gamma \times s_\gamma \times d_\gamma \times i_\gamma \times b_\gamma \times g_\gamma$$

q_{ult} = **1,195.3** kPa

FHWA GEC-6, Eq. 6-1

Term Breakdown

Term	Value (kPa)	Contribution (%)
Cohesion	0.0	0%
Overburden	953.3	80%
Self-weight	241.9	20%
Total q_ult	1,195.3	100%

Allowable Bearing Capacity

$$q_{all} = q_{ult}/FS$$

$$q_{all} = 1,195.3/3.0$$

$q_{all} =$ **398.4** kPa

1. FIGURES

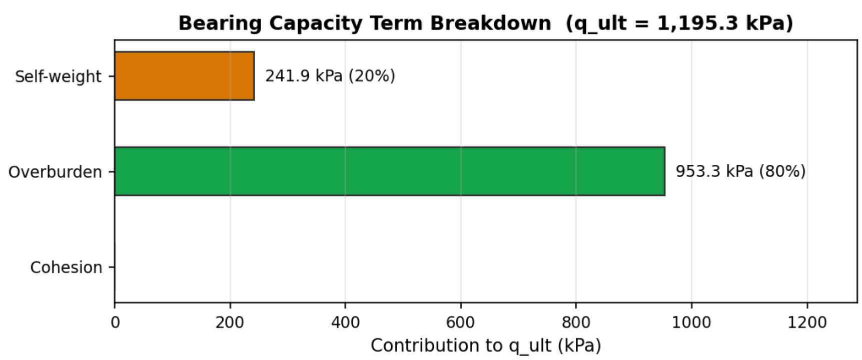

Figure 1: *
Figure 1: Contribution of cohesion, overburden, and self-weight terms to ultimate bearing capacity (q_ult = 1,195.3 kPa).

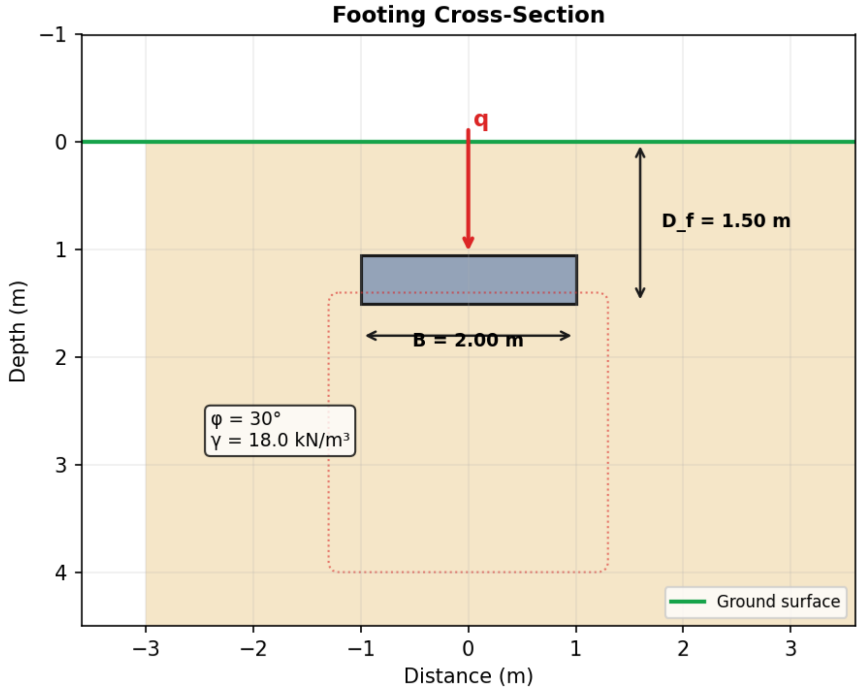

Figure 2: *
Figure 2: Footing geometry — B = 2.00 m, D_f = 1.50 m.

1. REFERENCES

1. Vesic, A.S. (1973). "Analysis of Ultimate Loads of Shallow Foundations." JSMFD, ASCE, Vol. 99, No. SM1, pp. 45-73.
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4. Prandtl, L. (1921). "Uber die Eindringungsfestigkeit plastischer Baustoffe." Zeitschrift fur Angewandte Mathematik und Mechanik, 1(1).
5. Hansen, J.B. (1970). "A Revised and Extended Formula for Bearing Capacity." Danish Geotechnical Institute Bulletin 28.