

ENVIROCALC DESIGN REPORT

ENVIROCALC DEMONSTRATION

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DOCUMENT CONTROL					
PROJECT TITLE		Envirocalc Demonstration			
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CLIENT	Test Corp		CLIENT CONTACT	Joe Bloggs	
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APPROVAL			
AUTHOR SIGNATURE		APPROVER SIGNATURE	
NAME		NAME	
TITLE		TITLE	

1. INTRODUCTION

1.1 PURPOSE

The Design Features Report (DFR) is a detailed document defining the structure's design criteria and recording key decisions or outcomes. It outlines design loading, structural modelling assumptions, material properties, foundation requirements, and design standards. The DFR also defines the calculation procedure and checking principles to be followed, providing a clear explanation of the full design.

1.2 SCOPE OF WORK

Testing

1.3 MEANS OF COMPLIANCE

The following standards have been used:

- AS/NZS 1170.0:2002 General Principals
- AS/NZS 1170.1:2002 Permanent, imposed, and other actions
- AS 4678:2002 Earth-retaining structures

2. DESIGN PARAMETERS

2.1 GENERAL

The [PROJECT TITLE] is an Importance level 2 structure and the design loads have been assessed in accordance with AS/NZS 1170.0:2002.

The design life is 50 years.

2.2 LOADINGS

2.2.1 Dead and Imposed Loads

NA Test

2.2.2 Horizontal Acceleration Component

Peak ground acceleration = 0.15g

2.3 LIMIT STATE DESIGNS

Serviceability limit state design parameters are considered not critical for the foundation design

Ultimate limit state design(strength) has been carried out in accordance with the appropriate materials standard as referenced in 1.3 "Means of Compliance (B1)" and as detailed in the structural calculations provided in Appendix B.

2.4 SOIL CONDITIONS

Test Geotech Report

3. PROJECT SPECIFICATIONS

3.1 STANDARD NOTES

3.1.1. General notes

- G.1** Structural drawings shall be read in conjunction with the Specification, Architectural, Civil, and Building Services documents.
- G.2** All existing components are to be confirmed on site. Make appropriate provisions for unforeseen situations.
- G.3** The stability of the structure during construction, including temporary works design, is the responsibility of the Contractor.
- G.4** The method of excavation and temporary support of all cut faces is the responsibility of the contractor.
- G.5** All materials and workmanship shall be in accordance with the current Codes of Practice except where varied by the specification or the drawings.
- G.6** No substitutions are permitted and all Envirocon manufacturer's specification is to be followed.

3.1.2. Foundations

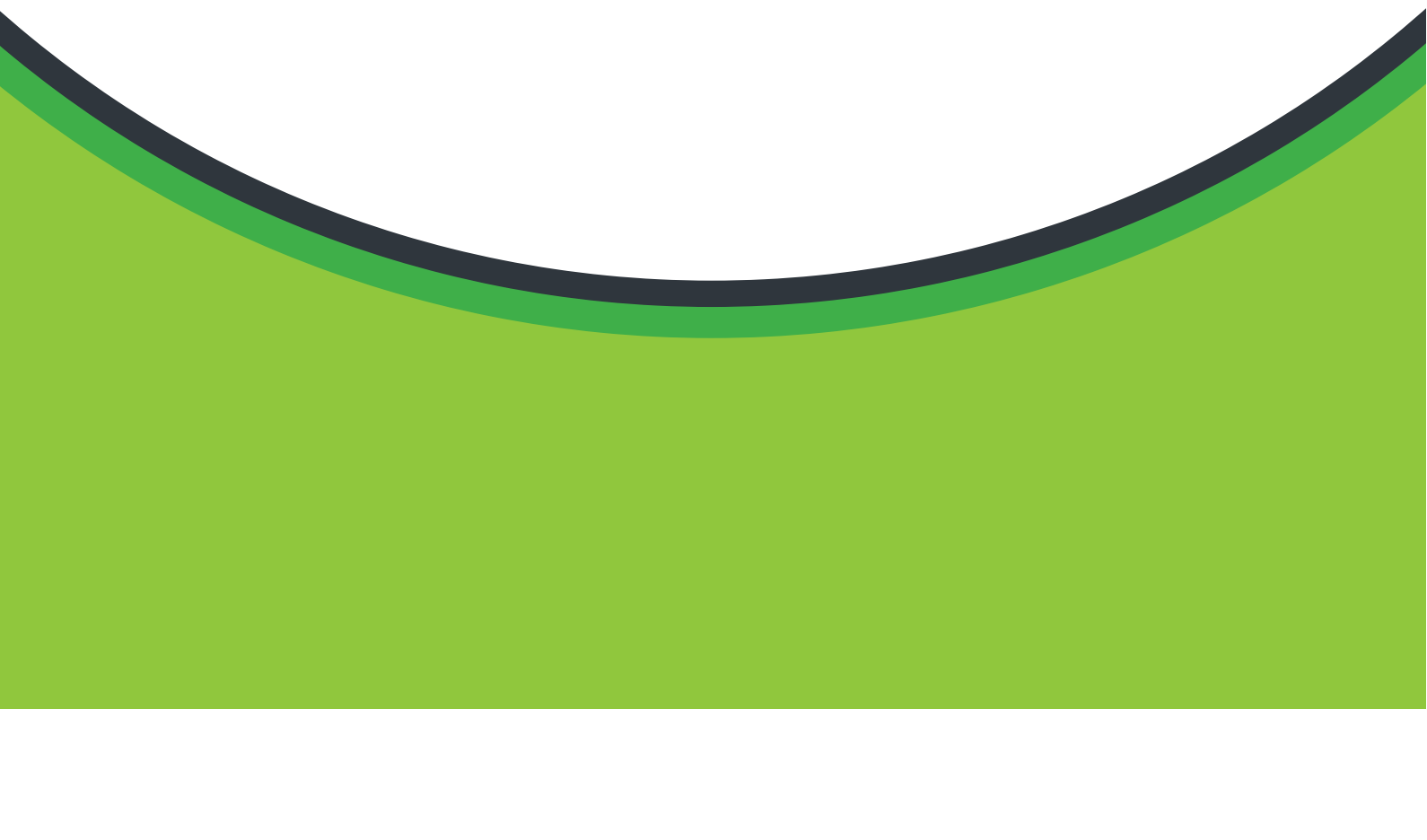
- F.1** Foundation material shall be approved by the Engineer for ultimate bearing capacity 450kPa at FGL and other requirements specified on the drawings prior to the construction of any footings.
- F.2** Subgrade below base course for slabs shall be of a suitable material and be compacted to 95% of maximum dry density.
- F.3** All walls and columns shall be concentric with supporting foundations unless otherwise noted on drawings.
- F.4** Behind all retaining walls back fill with free draining granular fill and install any de-watering drains specified by the Architect. Min GAP40 compacted in 150mm layers.
- F.5** The contractor shall not excavate access tracks into the site that compromise the stability of the site or form cut faces to adjacent properties.
- F.6** The temporary stability of all exposed cuts is the responsibility of the contractor.
- F.7** The hardfill shown under the slab (if noted on the drawings) may be deleted in lieu of the excavated surface being cut clean with a smooth edge bucket and the final surface being of a tight, compact material. Crusher dust and DPM are to be used, over the top of this clean-cut surface.
- F.8** All soft material is to be removed. If the top layer of cut material is loose it is to be re-compacted with a plate compactor or roller to a hard firm finished layer.
- F.9** The Engineer is to verify the subgrade prior to DPM laying.

3.1.3. Post-Installed Reinforcement

- R.1** Vertical reinforcement shall be **Reidbar Grade 500E** (Deformed bar), sizes as specified in the design tables.
- R.2** Chemical adhesive shall be **Ramset Epcon G5 Xtrem** installed strictly in accordance with the manufacturer's technical specifications and European Technical Assessment (ETA-25/647).

- R.3** Drilling Method: Holes must be drilled using **Hammer Drilling**.
- R.4** Hole Cleaning: Holes must be thoroughly cleaned (blown and brushed) in accordance with the adhesive manufacturer's instructions prior to injection. Improper cleaning will significantly reduce capacity.
- R.5** Installation: The adhesive must be injected to fill the hole from the bottom up to prevent air voids. The bar must be inserted with a twisting motion.
- R.6** Curing: Do not disturb the bar or apply load until the full curing time has elapsed, as specified by the adhesive manufacturer for the ambient site temperature.
- R.7** Geometry: Ensure minimum concrete cover and edge distances are maintained as specified in the Anchorage Verification section of this report.

STRUCTURAL DESIGN

A decorative graphic at the bottom of the page. It features a solid green area that transitions into a dark blue curved line, resembling a stylized horizon or a structural element.

INPUTS

BACKFILL PARAMETERS

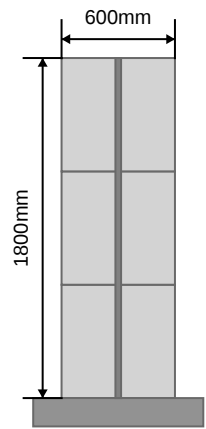
Characteristic Angle of Friction (ϕ_r)	30 °
Design Uncertainty Factor for Friction ($\varphi_{u\phi r}$)	0.85
Design Angle of Friction (ϕ_r^*)	26.14 °
Backfill Slope (β)	5 °
Characteristic Cohesion (c_r)	2 kPa
Design Uncertainty Factor for Cohesion (φ_{ucr})	0.7
Backfill Design Cohesion (c_r^*)	1.4 kPa
Backfill Density (γ)	18 kN/m³

BASE SOIL PARAMETERS

Undrained Bearing Capacity (c_{uf})	60 kPa
Characteristic Cohesion (c_f)	4 kPa
Design Uncertainty Factor for Cohesion (φ_{ucf})	0.75
Base Soil Design Cohesion (c_f^*)	3 kPa
Characteristic Angle of Friction (ϕ_f)	35 °
Design Uncertainty Factor for Friction ($\varphi_{u\phi f}$)	0.9
Design Angle of Friction (ϕ_f^*)	32.22 °
Base Soil Density (γ)	18 kN/m³

STRUCTURE DIMENSIONS

Height of Retaining Wall (H)	1.8 m
Base of Retaining Wall (B)	0.6 m
Foundation block length (L)	1.2 m
Number of heels	0
Base of top heel (B_{h1})	0 m
Height of top heel (H_{h1})	0 m
Base of bottom heel (B_{h2})	0 m
Height of bottom heel (H_{h2})	0 m
Wall Embedment Depth (H_{em})	0.3 m
Base of Third Heel (B_{h3})	0 m
Height of Third Heel (H_{h3})	0 m
Base of Fourth Heel (B_{h4})	0 m
Height of Fourth Heel (H_{h4})	0 m
Bar Spacing (s)	0.6 m



REINFORCEMENT PARAMETERS

System	Post-Installed Reinforcing (PIR)
Adhesive Product	Ramset Epcon G5 Xtrem
Bar Type	Reidbar Grade 500E
Bar Size (ϕ_b)	RB16 mm
Drilling Method	Hammer Drilling
Foundation Thickness (t_{found})	600 mm
Foundation Width (B_{found})	600 mm
Foundation Condition	Cast against ground
Jacking Force (T_j)	0 kN
Foundation Concrete ($f'c$)	25 MPa

LIVE LOAD

(Q)	3 kPa
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DEAD LOAD CALCULATION

Driveway Thickness (T_{dl})	0 m
Width within virtual back of the wall (W_{dl})	0 m
(G)	0 kPa

PRESSURE COEFFICIENTS

ACTIVE/AT REST EARTH PRESSURE COEFFICIENT

Although the notation K_a is used for earth pressure coefficient in the static case, the used value may present either at rest or active earth pressure coefficients depending on the inputted value by the user

$$K_a = 0.3698$$

$$K_{a,eq} = 0.4021$$

$$K_p = 5.8728$$

OVERALL LOAD CALCULATIONS

STATIC

ACTIONS

Pressure caused by the backfill:

$$P_{a,bf} = K_a G_{do} \gamma \frac{H^2}{2}$$

Vertical and horizontal components:

$$P_{av,bf} = P_{a,bf} \sin(\delta)$$

$$P_{ah,bf} = P_{a,bf} \cos(\delta)$$

$$P_{a,bf} = 13.48 \text{ kN/m}$$

$$P_{av,bf} = 4.04 \text{ kN/m}$$

$$P_{ah,bf} = 12.86 \text{ kN/m}$$

Pressure caused by surcharge:

$$P_{a,su} = K_a ((G_{lo} Q) + (G_{do} G)) H$$

Vertical and horizontal components:

$$P_{av,su} = P_{a,su} \sin(\delta)$$

$$P_{ah,su} = P_{a,su} \cos(\delta)$$

$$P_{a,su} = 3 \text{ kN/m}$$

$$P_{av,su} = 0.9 \text{ kN/m}$$

$$P_{ah,su} = 2.86 \text{ kN/m}$$

Total active pressure:

$$P_a = P_{a,bf} + P_{a,su}$$

Vertical and horizontal components:

$$P_{av} = P_{av,bf} + P_{av,su}$$

$$P_{ah} = P_{ah,bf} + P_{ah,su}$$

$$P_a = 16.47kN/m$$

$$P_{av} = 4.93kN/m$$

$$P_{ah} = 15.72kN/m$$

LOCATION OF THE TOTAL ACTIVE PRESSURE

$$h_{pa} = \frac{M_{backfill} + M_{surcharge} + M_{diff,backfill}}{P_a}$$

$$h_{pa} = 0.65m$$

SUMMARY AND FACTORED ACTIONS

ACTIVE PRESSURE								
BACKFILL			SURCHARGE			TOTAL		
Component	Unfactored	Factored	Component	Unfactored	Factored	Component	Unfactored	Factored
$P_{a,bf}$	13.48		$P_{a,su}$	3		P_a	16.47	
$P_{av,bf}$	4.04		$P_{av,su}$	0.9		P_{av}	4.93	
$P_{ah,bf}$	12.86		$P_{ah,su}$	2.86		P_{ah}	15.72	
OWN WEIGHT								
Component			Unfactored			Factored		
W_1			6.91					
W_2			6.91					
W_3			6.91					
W_{total}			20.74					

STATIC CAPACITY CHECKS

$$z = \frac{B}{41000}$$

$$M_{bar} = M_{ah}s$$

$$T_{demand} = \left(\frac{M_{bar}}{z}\right) + T_j$$

$$z = 0.15m$$

$$M_{bar} = 6.17kNm$$

$$T_{demand} = 41.15kN$$



$$V_{u,steel} = 0.6A_s \frac{f_y}{1000}$$

$$V_{d,steel} = \phi_{shear} V_{u,steel}$$

$$V_{bar} = P_{ah}s$$

$$V_{u,steel} = 60.3kN$$

$$V_{d,steel} = 45.23kN$$

$$V_{bar} = 9.43kN$$



EARTHQUAKE

ACTIONS

Pressure caused by the backfill:

$$P_{a,bf} = K_{a,eq} G_{edo} \gamma \frac{H^2}{2}$$

Vertical and horizontal components:

$$P_{av,bf} = P_{a,bf} \sin(\delta)$$

$$P_{ah,bf} = P_{a,bf} \cos(\delta)$$

$$P_{a,bf} = 14.65kN/m$$

$$P_{av,bf} = 4.39kN/m$$

$$P_{ah,bf} = 13.98kN/m$$

Pressure caused by surcharge:

$$P_{a,su} = K_{a,eq} ((G_{elo}Q) + (G_{edo}G))H$$

Vertical and horizontal components:

$$P_{av,su} = P_{a,su} \sin(\delta)$$

$$P_{ah,su} = P_{a,su} \cos(\delta)$$

$$P_{a,su} = 0.65kN/m$$

$$P_{av,su} = 0.2kN/m$$

$$P_{ah,su} = 0.62kN/m$$

Total active pressure:

$$P_a = P_{a,bf} + P_{a,su}$$

Vertical and horizontal components:

$$P_{av} = P_{av,bf} + P_{av,su}$$

$$P_{ah} = P_{ah,bf} + P_{ah,su}$$

$$P_a = 15.31kN/m$$

$$P_{av} = 4.58kN/m$$

$$P_{ah} = 14.6kN/m$$

LOCATION OF THE TOTAL ACTIVE PRESSURE

$$h_{pa} = \frac{M_{backfill} + M_{surcharge} + M_{diff,backfill}}{P_a}$$

$$h_{pa} = 0.65m$$

EARTHQUAKE CAPACITY CHECKS

$$z = \frac{B}{41000}$$

$$M_{dst,eq} = M_{ah} + M_I$$

$$M_{bar,eq} = M_{dst,eq}s$$

$$T_{demand,eq} = \left(\frac{M_{bar,eq}}{z} \right) + T_j$$

$$V_{u,steel} = 0.6A_s \frac{f_y}{1000}$$

$$V_{d,steel} = \phi_{shear} V_{u,steel}$$

$$V_{bar,eq} = P_a h + W I s$$

$$z = 0.15m$$

$$M_{dst,eq} = 10.23kNm/m$$

$$M_{bar,eq} = 6.14kNm$$

$$T_{demand,eq} = 40.94kN$$



$$V_{u,steel} = 60.3kN$$

$$V_{d,steel} = 45.23kN$$

$$V_{bar,eq} = 9.26kN$$



ANCHORAGE VERIFICATION

DESIGN EMBEDMENT DEPTH

$$L_{b,rqd} = \frac{N_{Rd}1000}{PIf_{bd}\phi_b}$$

$$C_{prov} = d_2 - \left(\frac{\phi_b}{2} \right)$$

$$C_d = \min \left(\frac{C_{prov}}{2}, \frac{s1000}{2}, 100 \right)$$

$$\alpha_2 = \max \left(0.7, \min \left(1.0, 1 - 0.15 \left(\frac{C_d - \phi_b}{\phi_b} \right) \right) \right)$$

$$L_{bd,calc} = L_{b,rqd}\alpha_2$$

$$L_{b,min} = \alpha_{lb} \max (0.3L_{b,rqd}, 10\phi_b, 100)$$

$$L_{bd} = \max (L_{bd,calc}, L_{b,min})$$

$$L_{b,rqd} = 740.5mm$$

$$C_{prov} = 292mm$$

$$C_d = 100mm$$

$$\alpha_2 = 0.7$$

$$L_{bd,calc} = 518.4mm$$

$$L_{b,min} = 222.2mm$$

$$L_{bd} = 518.4mm$$

GEOMETRIC VALIDATION

$$C_{min,req} = \max (C_{base} + k_{dev}L_{bd}, 2\phi_b)$$

$$t_{req} = L_{bd} + \max (C_{bottom}, 2\phi_b)$$

$$C_{min,req} = 61.1mm$$



$$t_{req} = 593.4mm$$



BEARING CAPACITY CALCULATIONS

SHORT TERM

STATIC

Effective Area Of the Footing

$$B_{eff} = \frac{B_{found}}{1000}$$

$$L_{eff} = L$$

$$A_{eff} = B_{eff}L_{eff}$$

$B_{eff} = 0.6m$
$L_{eff} = 1.2m$
$A_{eff} = 0.72m^2$

Design Bearing Pressure

$$q_d = \frac{V}{B_{eff}}$$

$q_d = 57.18kPa$

Bearing Strength From Embedment

$$q = H_{em}\gamma$$

$$\phi_d = 0$$

$$N_q = 1$$

$$N_c = 5.14$$

$q = 5.4kPa$
$\phi_d = 0^\circ$
$N_q = 1$
$N_c = 5.14$

Factors

$$\lambda_{cs} = 1$$

$$\lambda_{ci} = 0.5 \left(1 + \sqrt{1 - \frac{P_{ah}}{B_{eff}c_{uf}}} \right)$$

$$\lambda_{cg} = 1$$

$$\lambda_{qg} = 1$$

$\lambda_{cs} = 1$
$\lambda_{ci} = 0.88$
$\lambda_{cg} = 1$
$\lambda_{qg} = 1$

Short Term Bearing Strength Safety Factor

$$p_{Vcap} = \varphi_n(c_{uf}\lambda_{cs}\lambda_{ci}\lambda_{cg}N_c + q\lambda_{qg})$$

$$p_{Vcap} = 302.88 kPa$$

EARTHQUAKE

Vertical Load

$$V = W_{total} + P_{av} + W_{slab}$$

$$V = 33.96 kN/m$$

Effective Area Of the Footing

$$B_{eff} = \frac{B_{found}}{1000}$$

$$L_{eff} = L$$

$$A_{eff} = B_{eff} L_{eff}$$

$$B_{eff} = 0.6m$$

$$L_{eff} = 1.2m$$

$$A_{eff} = 0.72m^2$$

Design Bearing Pressure

$$q_d = \frac{V}{B_{eff}}$$

$$q_d = 56.6 kPa$$

Bearing Strength From Embedment

$$q = H_{em} \gamma$$

$$\phi_d = 0$$

$$N_q = 1$$

$$N_c = 5.14$$

$$q = 5.4 kPa$$

$$\phi_d = 0^\circ$$

$$N_q = 1$$

$$N_c = 5.14$$

Factors

$$\lambda_{cs} = 1$$

$$\lambda_{ci} = 0.5 \left(1 + \sqrt{1 - \frac{P_{ah}}{B_{eff} c_{uf}}} \right)$$

$$\lambda_{cg} = 1$$

$$\lambda_{qg} = 1$$

$$\lambda_{cs} = 1$$

$$\lambda_{ci} = 0.89$$

$$\lambda_{cg} = 1$$

$$\lambda_{qg} = 1$$

Short Term Bearing Strength Safety Factor

$p_{Vcap} = \varphi_n(c_{uf}\lambda_{cs}\lambda_{ci}\lambda_{cg}N_c + q\lambda_{qg})$

$p_{Vcap} = 306.33kPa$

LONG TERM

Vertical Load

$V = W_{total} + P_{av} + W_{slab}$

$V = 34.31kN/m$

Effective Area Of the Footing

$B_{eff} = \frac{B_{found}}{1000}$

$B_{eff} = 0.6m$

$L_{eff} = L$

$L_{eff} = 1.2m$

$A_{eff} = B_{eff}L_{eff}$

$A_{eff} = 0.72m^2$

Design Bearing Pressure

$q_d = \frac{V}{B_{eff}}$

$q_d = 57.18kPa$

Bearing Strength From Embedment

$q = H_{em}\gamma$

$q = 5.4kPa$

$\phi_d = a \tan\left(\tan\left(\frac{\phi_{f(PI)}}{180}\right)\varphi_{u\phi f}\right) \frac{180}{PI}$

$\phi_d = 32.22^\circ$

$N_q = \exp((PI) \tan(\phi_d)) \tan\left(\left(45\left(\frac{PI}{180}\right)\right) + \frac{\phi_d}{2}\right)^2$

$N_q = 23.7805$

$N_c = (N_q - 1) \cot(\phi_d)$

$N_c = 36.1487$

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

$N_\gamma = 31.2326$

Factors

$$\lambda_{cs} = 1$$

$$\lambda_{qs} = 1$$

$$\lambda_{\gamma s} = 1$$

$$\lambda_{qi} = \left(1 - 0.7 \frac{P_{ah}}{V + A_{eff} c_f \cot(\phi_d)}\right)^3$$

$$\lambda_{ci} = \frac{\lambda_{qi} N_q - 1}{N_q - 1}$$

$$\lambda_{\gamma i} = \left(1 - \frac{P_{ah}}{V + A_{eff} c_f \cot(\phi_d)}\right)^3$$

$$\lambda_{cg} = 1$$

$$\lambda_{qg} = 1$$

$$\lambda_{\gamma g} = 1$$

$$\lambda_{cs} = 1$$

$$\lambda_{qs} = 1$$

$$\lambda_{\gamma s} = 1$$

$$\lambda_{qi} = 0.36$$

$$\lambda_{ci} = 0.33$$

$$\lambda_{\gamma i} = 0.2$$

$$\lambda_{cg} = 1$$

$$\lambda_{qg} = 1$$

$$\lambda_{\gamma g} = 1$$

Long Term Bearing Strength Safety Factor

$$p_{Vcap} = \varphi_n (c_f N_c \lambda_{cs} \lambda_{ci} \lambda_{cg} + q N_q \lambda_{qs} \lambda_{qi} \lambda_{qg} + 0.5 \gamma B_{eff} N_\gamma \lambda_{\gamma s} \lambda_{\gamma i} \lambda_{\gamma g})$$

$$p_{Vcap} = 126.12 kPa$$