

Structural calculation to check design compliance with CIRIA C680

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Scheme Name	Victoria House Manchester-10268 Rev B Geo-Environmental Assessment Report		
Revision No.	B		
Supplier	Graf	Product	Ecobloc
Surfacing	Concrete	Depth (m)	0.275

Assumptions

Backfill density of 20.0 kN/m³

Angle of shearing resistance of 30.0 degrees for native soil / backfill material

****Contractor to ensure that a minimum 300mm working space is left at the base of the tank and backfilled with self compacting material such as coarse sand, 6h Material or 10mm pipe bedding, minimum shear angle of 30°.**

Tank Position

Proposed Cover Level is 48.00m

Proposed Invert Level is 46.50m

Depth to base of tank is 1.5m 2

Depth of tank is 1.00m 1

Cover above tank is 0.50m

Maximum groundwater level 0.00m Ground water level above invert of tank

Load classification of 9/9 for Cars or light delivery vehicle up to 9,000kg GVW

As per CIRIA C680 surcharges and partial safety factors are applied to all the loadings to obtain the design loads.

Vertical Loads

Dead Load = $0.5 \times 20 = -1248 \text{ kN/m}^2$

Surcharge (distributed load) = 5 kN/m^2 (for class 9/9 from C680)

Apply PSF of 1.4 to fixed load and 1.5 to variable load to obtain Design Load

Design Dead Load = -1747.2 kN/m^2

Vertical Live Load

Wheel load for 9/9 classification is 30kN on area of $0.26\text{m} \times 0.2\text{m}$

Area of load spread at 0.5m depth = 1.009125

Design Dead Load + Distributed Live Load = -1717.47 kN/m^2

Therefore Wheel Load at this depth = 29.73 kN/m^2

Apply PSF of 1.6 for Live Load and Design Live Load = 47.57 kN/m^2

Total Design Vertical Load = -1699.63 kN/m^2 *

* worst case of Dead Load + Distributed Live Load or the Wheel Loading = -1699.63 kN/m^2

This must be less than the ultimate short term compressive strength of the cell with a partial safety factor of 2.75 applied which = 123.64 kN/m^2

Therefore this design loading complies with the requirements of CIRIA C680 for Vertical Loads

Lateral Loads at base of tank

Earth pressure on side of tank

$$oh = Ka(Vz+q)$$

Where Ka = Coefficient of shear resistance = $(1 - \sin a) / (1 + \sin a)$

a = angle of shear resistance - 30 degrees $Ka = 0.333$

V = density (20kN/m³)

z = depth (1.5m)

q = surcharge (5kN/m²)

Dead Load = 27.1kN/m²

Liveloading = 5kN/m²

Dead Load + LiveLoad = 32.1kN/m²

Lateral Pressure (Unfactored) = 10.69kN/m²

Hydrostatic Pressure = 0 kN/m²

Factored Design Lateral Pressure (PSF 1.35) = 14.43kN/m²

This must be less than the ultimate short term lateral compressive strength of the cell with a partial safety factor of 2.75 applied = 29.82kN/m²

Therefore this design loading complies with the requirements of CIRIA C680 for Lateral Loads

Serviceability Limit State Checks (Deflection & Creep)

The serviceability of the proposed product can be assessed by predicting possible unit deflection (short Term) and creep (long term).

Design Strength (kN/m² per mm) = 34

Deflection mm = 0.87

SLS (Serviceability Limit State) = 29.73

Vertical Creep

Creep Test load = 78.1kN/m^2

SLS (Serviceability Limit State) = -1248kN/m^2

Degree of Utilisation = -1598.00%

We are therefore happy to confirm that the cells used in this scheme will have a design life in excess of 50 Years.

The backfill to the working space around the tanks and the first 100mm above the tank should be a well graded granular fill, such as course sand, 6H material or single sized pipe bedding.

Given the supplied information and that groundwater does not encroach above the base of the tank, uplift calculations are not necessary, and we are pleased to confirm the use of Graf cells is suitable for this application.

Regards

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Uplift / Bouyancy Check - Based on C680

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Design factor of s_i B

Ultimate Limit State		Uplift (UPL)
Permanent actions (G)	Stabilizing, $\gamma_{G,stab}$	0.9
	Destabilizing, $\gamma_{G,dst}$	1.1
Variable actions (Q)	Stabilizing, $\gamma_{Q,stab}$	0.0
	Destabilizing, $\gamma_{Q,dst}$	1.5

Assumed Installation Parameters

Material density	granular backfill, γ_{Bk}	20.0 kN/m ³	Assumed
	water, γ_{Wk}	9.8 kN/m ³	Assumed
	saturated backfill, γ'_{bk}	10.2 kN/m ³	
Depths	GL to structure IL, H	1.500 m	
	GL to GWL, h_w	1.500 m	

Proposed Structure

Unit type	Standard
Density	0.475 kN/m ³
Structure depth, h_1	1.000 m
Cover depth, h_c	0.500 m

Actions

Displaced water volume	0.00 m ³ /m ²
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Characteristic destabilising

Water uplift, U_{Gk}	0.00 kN/m ²
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Characteristic stabilising

Self weight of	Structure, W_{Gk1}	0.48 kN/m ²
	Backfill, W_{Gk2}	10.00 kN/m ²
	Saturated fill, W'_{Gk2}	N/A kN/m ²

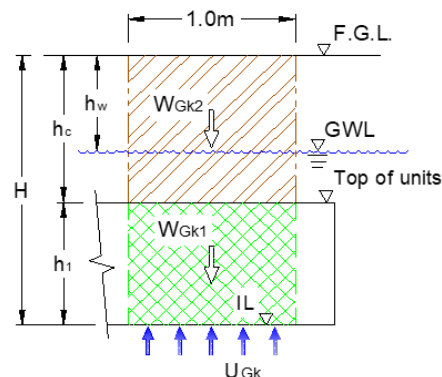


Fig 1) Definitions illustration

Effects of Actions

Destabilising design vertical actions [$\gamma_{Q,dst} \times U_{Gk}$]	$V_{d,dst}$	0.00 kN/m ²
Stabalising design vertical actions [$\gamma_{G,stab} \times W_{Gk}$]	$V_{d,stab}$	9.43 kN/m ²
Degree of utilization [$V_{d,dst} / V_{d,stab}$]		0 % < 100% OK

Traditional Verificartion of Stability Against Uplift

Traditional lumped FoS, F	0.0
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- 1 Groundwater assumed to act as a permanent destabilising action
- 2 If uncertainty in the level of ground or free water exists, consideration should be given to the application of a safety margin to the assumed charictaristic water level
- 3 The above assessment assumes that the structure is completely flexible and that there is negliable frictional resistance between the geocellular structure and the native soil. The uplift stability verification has therefore has been simplified, based on 2 m² (plan area) basis.