Structural calculations to check compliance with Ciria C680

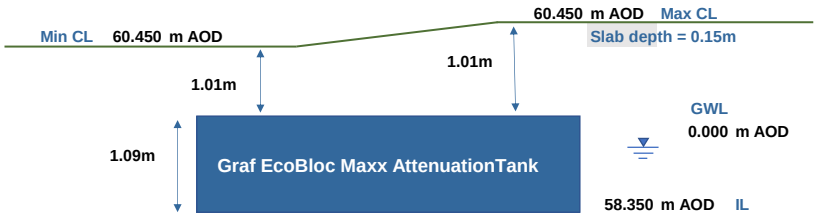
Detailed Analysis

Project: Data Centre
Customer: PL Infrastructure
Contact: John Snape

Hydro WMS Contact: Warren Gillen
Project ID:
12/03/2024

Supplier: Graf
Product: EcoBloc Maxx

Load Classification - Vehicles up to 60,000kg GVW (eg articulated lorries):



Surface Type: Reinforced Concrete

Lateral Backfill Material: Loose sand & gravel: AoF - 30 deg, Bulk Density - 18 kN/m3

Vertical Loads - Case 1 (shallowest cover)

Surcharge load

Depth of backfill =	1.01	m		
Bulk unit weight (averaged including weight of slab if present) =	18	kN/m^3		
Partial load factor for surcharge soil =	1.4			
Soil load = depth x weight x factor = 1.01 x 18 x 1.4 =			25.5	kN/m^2
Distrib. Load from vehicles (from table 4.2) =	10	kN/m^2		
Partial load factor for loading =	1.6			
Traffic load = load x factor = 10 x 1.6 =			16	kN/m^2
Total load = 25.5 + 16 =			**41.5**	kN/m^2
Material factor of safety =	2.75			
Vertical design strength of EcoBloc Maxx units = 365.7 / 2.75 =			**133.0**	kN/m^2
Degree of utilisation			31.17%	✓

Wheel load

Wheel load classification is Vehicles up to 60,000kg GVW (eg articulated lorries)				
Wheel load 100kN on a 0.6m x 0.2m area (from Table 4.2)				
Load spread angle (a) =	32.99	degrees		
Cover depth =	1.01	m		
Tan a = Tan (32.99) =			0.650	
Loaded area = [(2xdepthxTana)+ tyre area 1] x [(2xdepthxTana)+ tyre area 2]				
= [(2 x 1.01 x 0.65) + 0.6] x [(2 x 1.01 x 0.65) + 0.2] =			2.894	m²
Distributed wheel load on top of tank will be 100 ÷ 2.894 =			34.55	kN/m²
Partial factor for loading =	1.6			
Design load = 34.55 x 1.6 =			**55.3**	kN/m^2
Material factor of safety =	2.75			
Vertical design strength of EcoBloc Maxx units = 365.7 / 2.75 =			**133**	kN/m^2
Degree of utilisation			41.56%	✓

Soil load + Wheel Load

Total load could be surcharge soil load plus wheel point load				
From above, design soil load is 18 x 1.01 x 1.4 =			25.5	kN/m^2
From above, wheel point load is 34.55 x 1.6 =			55.3	kN/m^2
Total of soil load + point wheel load = 25.45 + 55.28 =			**80.7**	kN/m^2
Vertical design strength of EcoBloc Maxx units = 365.7 / 2.75 =			**133.0**	kN/m^2
Degree of utilisation			60.71%	✓

Accidental Load Case Check

No accidental load type considered

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Vertical Loads - Case 2 (deepest cover)

Surcharge load

Depth of backfill =	1.01	m		
Bulk unit weight (averaged including weight of slab if present) =	18	kN/m^3		
Partial load factor for surcharge soil =	1.4			
Soil load = depth x weight x factor = 1.01 x 18 x 1.4 =			25.5	kN/m^2
Distrib. Load from vehicles (from table 4.2) =	10	kN/m^2		
Partial load factor for loading =	1.6			
Traffic load = load x factor = 10 x 1.6 =			16	kN/m^2
Total load = 25.5 + 16 =			**41.5**	kN/m^2
Material factor of safety =	2.75			
Vertical design strength of EcoBloc Maxx units = 365.7 / 2.75 =			**133.0**	kN/m^2
Degree of utilisation			**31.17%**	✔

Wheel load

Wheel load classification is				
Wheel load 100kN on a 0.6m x 0.2m area (from Table 4.2)				
Load spread angle (a) =	32.99	degrees		
Cover depth =	1.01	m		
Tan a = Tan (32.99) =			0.650	
Loaded area = [(2xdepthxTana)+ tyre area 1] x [(2xdepthxTana)+ tyre area 2]				
= [(2 x 1.01 x 0.65) + 0.6] x [(2 x 1.01 x 0.65) + 0.2] =			2.894	m²
Distributed wheel load on top of tank will be 100 ÷ 2.894 =			34.55	kN/m²
Partial factor for loading =	1.6			
Design load = 34.55 x 1.6 =			**55.3**	kN/m^2
Material factor of safety =	2.75			
Vertical design strength of EcoBloc Maxx units = 365.7 / 2.75 =			**133**	kN/m^2
Degree of utilisation			**41.56%**	✔

Soil load + Wheel Load

Total load could be surcharge soil load plus wheel point load				
From above, design soil load is 18 x 1.01 x 1.4 =			25.5	kN/m^2
From above, wheel point load is 34.55 x 1.6 =			55.3	kN/m^2
Total of soil load + point wheel load = 25.45 + 55.28 =			**80.7**	kN/m^2
Vertical design strength of EcoBloc Maxx units = 365.7 / 2.75 =			**133.0**	kN/m^2
Degree of utilisation			**60.71%**	✔

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HydroWMS
Complete Water Management Solutions

Lateral Loads

Worst case will be with maximum depth of cover + vehicle loading

Internal angle of friction F'_{crit} =	30.00	degrees	
Active earth pressure coefficient Ka = $(1-\sin F'_{crit})/(1+\sin F'_{crit})$			
= (1-Sin 30)/(1 + Sin 30) =			0.333
Density of soil (averaged including weight of slab if present) = g_1 =	18	kN/m^3	
Calculation allows for the case where ground water level may be above the invert of the tank			
Then submerged density of soil $g_2 = g_1 - 10$ =			8 kN/m^3

Soil Load

Depth of soil for earth pressure calc = depth to invert - 200mm = 2.1 - 0.2 = Z =			1.900 m
Depth of soil for earth pressure calculation above ground water level = Z1 =			1.900 m
Depth of soil for earth pressure below ground water level = Z2 =			0.000 m
Partial load factor =	1.35		
Applied soil pressure = Ka x $(g_1Z_1 + g_2Z_2)$ x factor			
= 0.333 x (18 x 1.9 + 8 x 0) x 1.35 =			15.39 kN/m^2
Vehicle surcharge load = q =	10	kN/m^2	
Partial load factor =	1.35		
Applied vehicle pressure = Ka x q x factor = 0.333 x 10 x 1.35 =			4.50 kN/m^2
Total load = 15.39 + 4.5 =			**19.89** kN/m^2
Material factor of safety =	2.75		
Lateral design strength of EcoBloc Maxx units = 99.6 / 2.75 =			**36.22** kN/m^2
Degree of utilisation			**54.92%** ✔

Hydrostatic load

Depth of water above base of tank - 0.2m			0 m
Water pressure = density (1.0) x depth of water x g =			0.0 kN/m^2
Design load = Applied pressure x Load factor =			**0.0** kN/m^2
Total lateral load = soil load + hydrostatic load =			**19.9 kN/m^2**
Lateral strength of EcoBloc Maxx units =			**36.22 kN/m^2**
Degree of utilisation			**54.92%** ✔

Floatation

There are three possible scenarios: water level below, part way up or over the tank
From the data given at the head of this calculation, the case is water level below the tank

Depth of water displaced =			0 m
Uplift force = depth of water displaced x buoyancy = 0 x 10 =			0 kN/m^2
Partial factor of safety for uplift =	1.5		
Design uplift force = Uplift force x factor = (0 x 1.5) =			**0.00** kN/m^2
Weight of soil, saturated soil and concrete slab if present =			19.08 kN/m^2
Partial factor of safety for soil =	0.95		
Design pressure = weight of soil x factor = 19.08 x 0.95 =			**18.13** kN/m^2
Therefore, design pressure is greater than design uplift			
Degree of utilisation			**0.00%** ✔

Surface Deflections

Deflection of EcoBloc Maxx units is 1mm for every 38.6kN/m2 applied pressure
From above calcs for vertical loads (at shallowest cover)

Pressure from wheel loads on the top of the tank =	34.5	kN/m^2	
For serviceability analyses the factor of safety on live loads is 1.0			
This is a live load so the design load is 34.5 x 1.0 =	34.5	kN/m^2	
Deflection of the tank = 34.5 ÷ 38.6 =			**0.90 mm**

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