

Project	MMU BIRLEY FIELDS, MANCHESTER				
Revision	R0	Date	05/12/2019		
Description					
Drainge Layout No.	BF CUR XX 0G DR C 90002/ R (C05) / CURTINS				
Contractor					
Tank Information (m)	Tank Depth	BOT	TOT	CL	COVER
	1.075	32.580	33.655	34.850	1.195

Load Distribution on Pluvial Cube (Vertical Load)

Strength of Pluvial Cube modules

Characteristic Creep rupture strength P_{ck} = 317 kN/m²

Partial factor of safety for materials (γ_m) = 1.8

Considering Factory Production, 50yrs Design Period,
Permanent works to design the tanks (CIRIA C737)

50 Years Design Life of Pluvial Cube modules = 176 kN/m²

Weight of cover fill and surcharge load over Pluvial Cube module

Unit weight Backfill (γ_a)	=	20	kN/m ³	<i>Backfill Materials must be well compacted & finishing surface must be finished with suitable materials for trafficed areas</i>
Depth of Backfill (z1)	=	1.195	m	
Load from each wheel (Pedestrian footpath or Landscaped area where drive on mowers used & emergency vehicles)	=	1.00	tons	<i>Vehicles up to 3,000kg GVW DIN 1072 Classification 3/3)</i>
	=	10	kN	

Area of applied load on Pluvial Cube modules

Considering the soil is well compacted, the load distribution to be (degrees): 26.5

Depth of cover on the modules (D_1) = **1.195** m Min.

Considering the area of contact of the wheel and the road is 200 x 200 mm
(Loading Model - GVW DIN 1072 Classification 3/3)

$$L \text{ (m)} = 0.2$$

$$B \text{ (m)} = 0.2$$

The total area of load applied on the modules = $0.5975 + 0.2 + 0.5975 \text{ m}$
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$$B' = 1.395 \text{ m}$$

$$L' = 1.395 \text{ m}$$

$$\text{Contact area } A' = \mathbf{1.395 \times 1.395 \text{ m}}$$

Evaluation of Load Model GVW DIN 1072 Classification 3/3

$$Q_w = 10 \text{ kN}$$

Equivalent pressure per wheel at a depth of (D_1)

$$Q'_w = \frac{Q_w}{B' \times L'}$$

$$Q'_w = 5.1 \text{ kN/m}^2$$

$$\text{Additional UDL} = 5 \text{ kN/m}^2 \quad (\text{Table 5.6/ CIRIA C737})$$

$$Q_{max,k} = Q_{OL} + \text{Additional UDL}$$

$$Q_{max,k} = 10.1 \text{ kN/m}^2$$

Calculation of design Factors of safety

Permanent Action unfavourable loading $\gamma_G = 1.35$ (Table 5.9/C737)

Variable Action unfavourable loading $\gamma_Q = 1.5$ (Table 5.9/C737)

Dynamic Factor for z1 = 1 (Table 5.10/C737)
(Speed < 15 mph)

Design vertical traffic loading:

$$Q_b = (\gamma_a \times z1 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

$$= \mathbf{47.47 \text{ kN/m}^2} < \mathbf{176 \text{ kN/m}^2}$$

Loading design is safe

CALCULATION OF HORIZONTAL EARTH PRESSURE LOADING (ULS)

Compressive strength of Pluvial Cube modules

Characteristic Creep rupture strength P_{ck} = 201.4 kN/m²

Partial factor of safety for materials (F_m) = 1.8

*Considering Factory Production, 50yrs Design Period,
Multiple, Permanent works to design the tanks (CIRIA C737)*

Allowable load on Pluvial Cube modules = **111.89 kN/m²**

Horizontal earth pressure on Pluvial Cube Modules

Total horizontal pressure =

Where,

K_a - is the co-efficient of active earth pressure = $(1 - \sin\Phi) / (1 + \sin\Phi)$

Φ - angle of shearing resistance of soil

d - is the height of fill material till the base of the tank, m

γ - is the unit weight of fill material, kN/m³

w - water pressure

$\sigma_{\text{surcharge load}}$ - is the surcharge load, kN/m²

Considering the soil is well compacted, the load distribution to be 30°

*Brown loose slightly gravelly medium to coarse Sand & Gravel
B060164 ML R2_Phase 2 Ground Investigation Report_Issue(1)*

$$\begin{aligned} \text{Co-efficient of active earth pressure (K}_a\text{)} &= (1 - \sin\Phi) / (1 + \sin\Phi) \\ &= (1 - \sin 30^\circ) / (1 + \sin 30^\circ) \\ &= 0.3 \end{aligned}$$

Unit weight fill material (γ) = 20 kN/m³

Depth of fill till the (d) bottom of the tank = **2.27** m

Water pressure (W) = 10.6 kN/m²

*NOTE:- Groundwater level at 33.64m based on WS01 - As worst case -
B060164 ML R2_Phase 2 Ground Investigation Report_Issue(1)
1.06m above the tank base.*

Surcharge load ($\sigma_{\text{surcharge load}}$) = 5 kN/m²

Partial factors applied to loading:

Permanent unfavourable loading $\gamma_G = 1.35$ (Table 5.9/CIRIA C737)

Variable unfavourable loading, $\gamma_Q = 1.5$ (Table 5.9/CIRIA C737)

Dynamic factor for speed < 15mph $\gamma_{DF} = 1.0$ (Table 5.10/CIRIA C737)

Site importance factor for Class 1 site for ULS calculation $\gamma_{SF} = 1.0$
(Table 5.11/CIRIA C737)

Total horizontal pressure(σ_h) on module =

$$\sigma'_{h,a} = K a x [(\gamma x d) + \sigma_{surcharge load}]$$

Including partial factors $\gamma_{DF}, \gamma_{SF}, \gamma_G$ and γ_Q

$$\sigma'_{h,a} = K a x \gamma_{DF} x \gamma_{SF} x [(\gamma x d x \gamma_G) + (\sigma_{surcharge} x \gamma_Q)]$$

$$= (0.3 x (20 x 2.27)) + 10.6 + (0.3 x 5)$$

Design load on the module =

$$= \boxed{31.24} \text{ kN/m}^2 < \boxed{111.89} \text{ kN/m}^2$$

Loading design is safe

Note:-The above calculations only apply when the relevant system is installed and signed off by an accredited contractor using Alderburgh membrane and connections.