

Preliminary Polystorm Performance Assessment

Tyrone House, Aldingbourne, PSM1A Structural Check, 0.6m Cover

1.0 Proposal Brief

The following section details the assumed parameters on which our proposed product offering has been based. Please refer to CIRIA Report C680 (2008; RP782) & BBA Certificate No 06/4297 for further details on typical product testing procedures and the calculation methodology proposed.

1.1 Proposed Polystorm Geocellular Unit

The Polystorm unit(s) proposed, along with the relevant unit characteristic parameters which may be used for design purposes, are given below:

Polystorm unit	- Description - Product Code	Polystorm-R PSM1A
Ultimate compressive strength [kN/m ²]	- Vertical, $X_{k;VC}$	610
	- Lateral, $X_{k;LC}$	63.0
Short term deflection [kN/m ² per mm]	- Vertical, $X_{k;VD}$	60
	- Lateral, $X_{k;LD}$	4.4
Creep equation co-efficient, x [mm] [$x \ln(\text{design life; hrs})$]	- Vertical, $X_{k;VCr}$	0.2798
	- Lateral, $X_{k;LCr}$	1.0192
Allowable deflection [mm]	- Vertical, $\delta_{k;V}$	9.0
	- Lateral, $\delta_{k;L}$	14.0
Allowable creep deformation [mm]	- Vertical, $\epsilon_{k;V}$	9.0
	- Lateral, $\epsilon_{k;L}$	18.0

1.2 Recommended Material and Partial Factor of Safety

Factor of safety	ULS	SLS
Material, $f_{m,*}$	2.75	1.5
<i>(Polypipe recommended factor; based on the minimum values proposed in CIRIA C680; Clause 4.6)</i>		

Partial factor of safety	ULS	SLS
Variable loads, γ_Q	1.6	1.0
Permanent loads, γ_G	1.4	1.0
Lateral earth pressure, γ_e	1.35	1.0
Hydrostatic, γ_u	1.35	1.0
<i>(Based on CIRIA C680, Clause 4.6)</i>		

1.3 Proposed Installation

Idealised details of the proposed Polystorm installation are summarised below (refer to figure 1).

Depths	
Depth to structure invert, H	1.000 m
Polystorm structure depth, h_1	0.400 m
Design depth, z ($= H - 0.2m$)	0.800 m
Cover depth, h_c ($= H - h_1$)	0.600 m

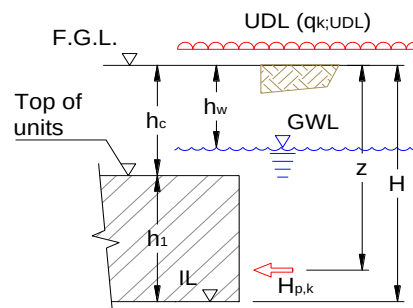


Figure 1) Idealised illustration of installation

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Assumed ground conditions

Based on assumed ground conditions of silty sandy clay

Native soil

Shearing resistance, ϕ	26°	
Density, γ_k	20.0 kN/m ³	[Assumed]

Active earth pressure co-efficient, K_a	0.390	
($= [1 - \sin \phi] / [1 + \sin \phi]$)		

Ground water

Depth below FGL, h_w	0.600 m	
Density, u_k	10.0 kN/m ³	[Assumed]

1.4 Assumed Transient (Live) Loads

For illustrative purposes, vehicle loading assumed

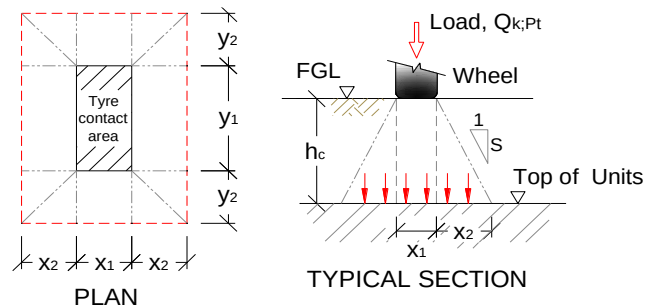


Figure 2) Concentrated load parameters

Loading classification	Car parking; unrestricted height	[CIRIA C680; Table 4.2]
DIN 1072 classification	6/6	[CIRIA C680; Table 4.2]
Max Gross vehicle weight	< 6,000 Kg	[CIRIA C680; Table 4.2]
Uniformly distributed load, $q_{k;UDL}$	5.0 kN/m ²	[CIRIA C680; Table 4.2]
Concentrated wheel load, $Q_{k;Pt}$	20.0 kN	[CIRIA C680; Table 4.2]
Dynamic load factor, Φ	1.0	[Assumed]
Contact area - Length, y_1	0.200 m	[CIRIA C680; Table 4.2]
Contact area - Width, x_1	0.200 m	[CIRIA C680; Table 4.2]
Load distribution, S	1 in 2.0	[Assumed]
Additional load spread, x_2 & y_2	0.300 m	
($= h_c / S$)		

Unfactored

Imposed load, $q_{k;Pt}$	31.3 kN/m ²	[> Uniformly distributed load]
($= [Q_{k;Pt} \cdot \Phi] / [(x_1 + 2x_2) \times (y_1 + 2y_2)]$)		

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2.0 Assumed Imposed Loading

The following section illustrates how Polypipe would typically expect imposed loads on a proposed Polystorm structure to be derived; in accordance with the guidance given in CIRIA C680 (2008; RP782)

2.1 Vertical Loads Imposed on Upper Structure Face

The following section estimates the vertical imposed load at the Polystorm structure soffit.

Unfactored

Pressure derived from concentrated load gave worst case transient parameter, refer to Section 1.4

Live load, $q_{k,*}$	31.3 kN/m²	[* - Pt; refer to Section 1.4]
Dead load, G_k	12.0 kN/m²	
$(= [h_c \times \gamma_k])$		

Factored

ULS, $V_{d;ULS}$	66.8 kN/m²	[< 221.8 kN/m ² Therefore OK]
$(= [q_{k,*}] \gamma_{Q;ULS} + [G_k] \gamma_{G;ULS})$		
Degree of utilization, Λ_{STR}	30%	$(= X_{k;VC} / f_{m;ULS} ; \text{Refer to Section 1.0})$
SLS, $V_{d;SLS, \delta}$	31.3 kN/m²	
$(= [q_{k;Pt}] \gamma_{Q;SLS})$		
SLS, $V_{d;SLS, \epsilon}$	12.0 kN/m²	
$(= [G_k] \gamma_{G;SLS})$		

2.2 Lateral Load Imposed at Depth z

The following section estimates the lateral pressure imposed on the proposed Polystorm structure, at design depth z (worst case imposed load assumed to occur at the centre of the unit, due to additional support provided by the unit's external faces)

Unfactored

Live load, $q_{k;UDL}$	5.0 kN/m²
Dead load, W_{Gk}	14.0 kN/m²
Hydrostatic load, U_k	2.0 kN/m²
<u>Where $h_w \leq z$</u>	
$(W_{Gk} = [h_w \times \gamma_k] + [(z - h_w) \cdot (\gamma_k - U_k)])$	
$(U_k = [z - h_w] \times \gamma_u)$	
<u>Where $h_w > z$</u>	
$(W_{Gk} = z \times \gamma_k)$	

Lateral pressure, $H_{p;k}$	9.4 kN/m²
$(= Ka [q_k + W_{Gk}] + U_k)$	

Factored

ULS, $H_{d;ULS}$	12.7 kN/m²	[< 22.9 kN/m ² Therefore OK]
$(= Ka [q_k + W_{Gk}] \gamma_{e;ULS} + [U_k] \gamma_{u;ULS})$		
SLS, $H_{d;SLS}$	9.4 kN/m²	$(= X_{k;LC} / f_{m;ULS} ; \text{Refer to Section 1.0})$
$(= Ka [q_k + W_{Gk}] \gamma_{e;SLS} + [U_k] \gamma_{u;SLS})$		

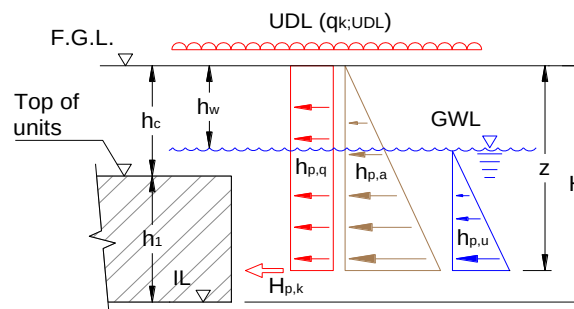


Figure 3) Idealised illustration of lateral pressure(s)

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3.0 Serviceability Limit State Checks (Deflection & Creep)

The serviceability of the proposed Polystorm structure (Section 1.3) may be assessed by predicting possible unit deflection (short term) and creep (long term)

3.1 Vertical Deflection Due to Expected Traffic Loading

The overseeing engineer should be consulted to ensure that the deformation predicted below, would not compromise the structural integrity of any proposed surface pavement. Where excessive deflections are predicted, protective measures may be introduced.

Design strength; $X_{d;VD}$	40.0 kN/m² per mm		
$(= X_{k;VD} / f_{m;SLS}; \text{refer to Section 1.0})$			
SLS, $V_{d;SLS, \delta}$	31.3 kN/m²		
Deflection, δ_V	0.78 mm	[< 1.0 mm	Typically OK]
$(= V_{d;SLS} / X_{d;VD})$			

3.2 Vertical Creep

Derived creep equation is only valid if expected imposed load(s) do not exceed the creep test load

Creep test load, $X_{d;V,cr}$	162.0 kN/m²		
SLS, $V_{d;SLS, \epsilon}$	12.0 kN/m²	[< 162.0 kN/m ²	Therefore OK]
Degree of utilization, Λ_{STR}	7%		
Creep data limit, t	60 years	[Unit has a durability life in excess of 60yrs]	
Estimated unit creep, $\epsilon_{h,c}$	3.7 mm	[< 9.0 mm	Therefore OK]
$(= 0.2798 \ln[\text{design life}, t]); t \text{ in hours}$			
Degree of utilization, Λ_{STR}	41%	[Refer to Section 1.1; based on test load]	

3.3 Lateral Deflection

Design strength; $X_{d;LD}$	2.9 kN/m² per mm		
$(= X_{k;LD} / f_{m;SLS}; \text{refer to Section 1.0})$			
SLS, $H_{d;SLS}$	9.4 kN/m²		
Deflection, δ_L	3.21 mm	[< 14.0 mm	Therefore OK]
$(= H_{d;SLS} / X_{d;LD})$			
Degree of utilization, Λ_{STR}	23%	[Refer to Section 1.1; based on test load]	

3.4 Lateral Creep

Derived creep equation is only valid if expected imposed load(s) do not exceed the creep test load

Test load, $X_{d;V,cr}$	30.9 kN/m²		
SLS, $H_{d;SLS}$	9.4 kN/m²	[< 30.9 kN/m ²	Therefore OK]
Degree of utilization, Λ_{STR}	31%		
Creep data limit, t	60 years	[Unit has a durability life in excess of 60yrs]	
Estimated unit creep, $\epsilon_{h,c}$	13.4 mm	[< 18.0 mm	Therefore OK]
$(= 1.0192 \ln[\text{design life}, t]); t \text{ in hours}$			
Degree of utilization, Λ_{STR}	75%	[Refer to Section 1.1; based on test load]	

Note

Where ground water is expected to be present above the invert level of the proposed geocellular structure, due consideration should be given to undertaking a buoyancy (Uplift limit state, UPL) check

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