

Polystorm System - Recommended Installation Details

The information given in the following document has been provided to aid in the preliminary assessment of the Polystorm geocellular units' suitability for a proposed installation; however, a detailed site specific structural assessment should be undertaken before final design or construction activities commence.

It should be noted that this document is uncontrolled and updates will not be issued automatically. Polypipe reserves the right to change product specifications without prior notice.

1.0 Polystorm Unit Properties

The characteristic unit parameters detailed in Table 1 may be used for design purposes

1.1 Characteristic Parameters, X_k

Polystorm Unit		Lite (PSM2)	Standard (PSM1)	Polystorm-R (PSM1A)	Xtra (PSM3)
Ultimate Compressive Strength [kN/m ²]	Vertical	200	440	610	834
	Lateral	40	63	63	93
Short Term Deflection [mm per kN/m ²]	Vertical	43	83	60.0	97.8
	Lateral	6.4	4.2	4.4	7.1

Table 1 Characteristic Polystorm unit parameters

1.2 Recommended Material Factor of Safety (FoS)

Limit State	Material, fm (Cellular unit)
Ultimate (ULS)	2.75
Serviceability (SLS)	1.5

Table 2 Recommended material FoS

Material factors of safety quoted in Table 2 have been based on the minimum recommendations within CIRIA C680 (RP782; 2008).

1.3 Design Parameters, X_d

$$X_d = X_k / f_m$$

Polystorm Unit		Lite (PSM2)	Standard (PSM1)	Polystorm-R (PSM1A)	Xtra (PSM3)
Ultimate Compressive Strength [kN/m ²]	Vertical	72.7	160	221	303.2
	Lateral	14.5	22.9	22.9	33.8
Short Term Deflection [mm per kN/m ²]	Vertical	28.6	55.3	40.0	65.2
	Lateral	4.2	2.8	2.9	4.7

Table 3 Polystorm unit design parameters (based on Table 1 unit strengths and application of Table 2 material FoS)

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2.0 CIRIA Report C680 (2008; RP782) Parameters

2.1 Vehicle Loads

Table 4 summarises the vehicle loads suggested by Steve Wilson (2008) in CIRIA C680; 'Structural design of modular geocellular drainage tanks'; Table 4.2.

Vehicle load classifications have been based on DIN 1072, where relevant / available.

Load Case		Load Magnitude by Type			Tyre Footprint [m]	
Ref	Description	UDL [kN/m ²]	Point [kN]	Dynamic Factor	Width	Length
NTA	Small gardens or landscaped areas (No vehicles)	0	0	0	0	0
LA	Landscaped area (Motorised mower)	5	1.4	1.0	0.150	0.150
CP-R	Driveway / Car parking (Cars < 3,000 Kg GVW) [DIN 1072 Class 3/3]	5	10	1.0	0.200	0.200
CP-U	Parking; no height restriction (Cars & vans < 6,000 Kg GVW) [DIN 1072 Class 6/6]	5	20	1 – 1.25	0.200	0.200
CP-LDV	Parking; no height restriction (Occasional LDV < 9,000 Kg GVW) [DIN 1072 Class 9/9]	5	30	1 – 1.5	0.200	0.260
LAR	Parking & light access Rd (GVW < 12,000 Kg) [DIN 1072 Class 12/12]	10	40	1 – 1.5	0.200	0.300
MEWS	Rigid vehicle parking, Mews etc (GVW < 16,000 Kg; eg. med rigid fire engine) [DIN 1072 Class 16/16]	10	50	1 – 1.5	0.200	0.400
SER	Rigid HGV parking, access or small estate road (GVW < 30,000 Kg; eg. rigid refuse lorry) [DIN 1072 Class 30/30]	10	50	1 – 1.5	0.200	0.400
LSR	Low speed roads (< 15 mph) (Articulated HGV < 60,000 Kg) [DIN 1072 Class 60/30]	10	100	1 – 2.0	0.200	0.600
HA	Full HA road loading (GVW < 44,000 Kg)	10	100	1.0	0.266	0.266

Table 4 Recommended vehicle load classifications (CIRIA C680, Table 4.2)

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2.2 Partial Factors of Safety, f_m

Recommended permanent (dead) & transient (live) load partial FoS can vary according to the check being performed. Tables 7 to 9 are based on standardised load FoS (summarised in Table 5); which have been based on CIRIA C680 (RP782; 2008), Table 4.5.

Hydrostatic pressure has been assumed to act as a permanent load (highest credible water level). It should be noted that where the probable variability of an assumed ground water level is unknown, the associated hydrostatic pressures may be assumed to act as a variable load.

Limit State	Vertical Load		Lateral Load	
	Permanent (Dead Load); f_{DL}	Variable (Live Load); f_{LL}	Permanent (Dead Load); $f_{L;DL}$	Variable (Live Load); $f_{L;LL}$
Ultimate (ULS)	1.4	1.6	1.35	1.5
Serviceability (SLS)	1.0	1.0	1.0	1.0

Table 5 Recommended partial FoS [CIRIA C680 (RP782; 2008), Table 4.5; (lateral loads - Combination 1 in EN 1997-1)]

2.3 Typical Angle of Shearing Resistance

Table 6 is an abridged reproduction of the one given in Polypipe's Polystorm BBA certificate (N° 06/4297, Product Sheet 3; table 9); indicating a typical angle of friction which can be expected for a range of soil descriptions.

This information is provided to facilitate preliminary design; the ground conditions of a proposed installation should be confirmed prior to final design or the commencement of construction activities.

Typical Soil Type (Description)	Soil Weight [kN/m ³]	Angle of Friction (Typical Shearing Resistance), ϕ
Stiff over consolidated Clay, (e.g. London Clay)	20	24°
Normally consolidated Silty Sandy Clay (e.g. Alluvium, Made Ground)	19	26°
Loose Sand and Gravel	18	30°
Medium dense Sand and Gravel	19	34°
Dense Sand and Gravel	20	38°

Table 6 Typical angle of friction for given soil description

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3.0 Maximum recommended burial depth (to cell invert)

Angle of friction, ϕ	Soil Weight [kN/m ³]	Vehicle Surcharge Load								
		NTA			LA & CP-R (GVW ≤ 3,000Kg) CP-U (GVW ≤ 6,000Kg) CP-LDV (GVW ≤ 9,000Kg)			LAR (GVW ≤ 12,000Kg) MEWS (GVW ≤ 16,000Kg) SER (GVW ≤ 30,000Kg) LSR (GVW ≤ 60,000Kg) & HA (Full HA load)		
Unit		PSM2	PSM1 & PSM1A	PSM3	PSM2 ³⁾	PSM1 & PSM1A	PSM3	PSM2 ³⁾	PSM1 & PSM1A	PSM3
a) No groundwater present										
24°	20	1.477	2.212	3.075	1.227	1.962	2.825	0.977	1.712	2.575
26°	19	1.652	2.487	3.482	1.389	2.224	3.218	1.126	1.961	2.955
28°		1.771	2.674	3.757	1.508	2.411	3.494	1.244	2.148	3.231
29°		1.834	2.774	3.905	1.571	2.511	3.642	1.308	2.248	3.379
30°	18	1.996	3.028	4.280	1.718	2.751	4.002	1.440	2.473	3.725
32°	19	2.046	3.107	4.396	1.782	2.844	4.133	1.519	2.580	3.870
33°		2.124	3.230	4.577	1.860	2.966	4.314	1.597	2.703	4.051
34°		2.206	3.359	4.769	1.943	3.096	4.505	1.680	2.833	4.242
36°	20	2.275	3.468	4.930	2.025	3.218	4.680	1.775	2.968	4.430
38°		2.465	3.767	5.370	2.215	3.517	5.120	1.965	3.267	4.870
40°		2.678	4.102	5.865	2.428	3.852	5.615	2.178	3.602	5.365
b) Groundwater assumed 1.0m below ground level										
24°	20	1.365	1.800	2.274	1.216	1.652	2.125	0.977	1.504	1.977
26°	19	1.448	1.907	2.410	1.304	1.762	2.265	1.126	1.618	2.121
28°		1.495	1.963	2.478	1.359	1.827	2.342	1.223	1.691	2.205
29°		1.519	1.991	2.512	1.386	1.859	2.379	1.254	1.726	2.247
30°	18	1.577	2.066	2.609	1.445	1.934	2.477	1.314	1.803	2.346
32°	19	1.587	2.072	2.610	1.466	1.952	2.490	1.346	1.831	2.369
33°		1.609	2.098	2.642	1.492	1.982	2.526	1.376	1.865	2.409
34°		1.631	2.125	2.674	1.518	2.012	2.561	1.405	1.899	2.448
36°	20	1.643	2.135	2.682	1.540	2.032	2.578	1.437	1.929	2.475
38°		1.686	2.187	2.744	1.590	2.090	2.648	1.494	1.994	2.552
40°		1.728	2.237	2.805	1.638	2.147	2.716	1.549	2.058	2.627
Note 1. Maximum burial depth recommendation has been based on the following expression: $X_d = [K_a (\text{Live load} + \text{Dead load})] \cdot fm_{L,DL} + \text{Hydrostatic pressure } fm_{L,DL}$ 2. Assumed density of water = 10.0 kN/m ³ 3. Polystorm Lite is not recommended for regularly trafficked areas; depths given for reference only										

Table 7 Summary of recommended installation depths [CIRIA C680 (2008) FoS and methodology]

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4.0 Minimum recommended cover depth above Polystorm structure

Polystorm Unit	Surcharge Load Type	NTA	LA	CP-R (≤ 3,000 Kg)	CP-U (≤ 6,000 Kg)		CP-LDV (≤ 9,000 Kg)	
	Unfactored Load @ GL [kN/m ²]	N/A	62	250	500	625	577	865
	Inc. Dynamic Load Factor		1	1	1	1.25	1	1.5
	Assumed load distribution [1 in]		2	2	2		2	
Polystorm Lite (PSM2)	ULS	-	N/A	0.269	0.463	0.542	0.583	0.765
	SLS (0.5mm vertical deflection)	-	0.163	0.635	0.981	1.121	1.217	1.542
	SLS (1.0mm vertical deflection)	-	0.071	0.391	0.635	0.734	0.793	1.023
	Recommended	0.500	0.500	0.600	0.650	N/A	N/A	
Polystorm (PSM1)	ULS	-	N/A	0.116	0.247	0.300	0.319	0.441
	SLS (0.5mm vertical deflection)	-	0.075	0.401	0.650	0.751	0.812	1.046
	SLS (1.0mm vertical deflection)	-	0.009	0.225	0.401	0.472	0.507	0.672
	Recommended	0.500	0.500	0.600	0.600	0.750	0.600	1.050
Polystorm-R (PSM1A)	ULS	-	N/A	0.069	0.180	0.225	0.236	0.341
	SLS (0.5mm vertical deflection)	-	0.115	0.507	0.800	0.918	0.995	1.270
	SLS (1.0mm vertical deflection)	-	0.037	0.300	0.507	0.591	0.637	0.831
	Recommended	0.500	0.500	0.500	0.510	0.920	0.640	1.270
Polystorm Xtra (PSM3)	ULS	-	N/A	0.030	0.125	0.163	0.169	0.258
	SLS (0.5mm vertical deflection)	-	0.057	0.354	0.583	0.676	0.730	0.945
	SLS (1.0mm vertical deflection)	-	0.003	0.192	0.354	0.419	0.449	0.601
	Recommended	0.500	0.500	0.375	0.375	0.675	0.450	0.950

Table 8 Minimum cover depths recommended for stated vehicle load classification (CIRIA C680 FoS and methodology, assuming 1 in 2 load distribution)

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Polystorm Unit	Surcharge Load Type	LAR (≤ 12,000 Kg)		MEWs (≤ 16,000 Kg)		SER (≤ 30,000 Kg)		LSR (≤ 60,000 Kg)		HA
	Unfactored Load @ GL [kN/m ²]	667	1000	625	938	625	938	833	1667	1413
	Inc. Dynamic Load Factor	1	1.5	1	1.5	1.0	1.5	1	2.0	1.0
	Assumed load distribution [1 in]	2		2		2		2		2
Polystorm Lite (PSM2)	ULS	0.689	0.900	0.754	0.988	0.754	0.988	1.097	1.707	1.217
	SLS (0.5mm vertical deflection)	1.421	1.797	1.570	1.990	1.570	1.990	2.249	3.341	2.375
	SLS (1.0mm vertical deflection)	0.932	1.198	1.024	1.321	1.024	1.321	1.478	2.249	1.602
	Recommended	N/A		N/A		N/A		N/A		N/A
Polystorm (PSM1)	ULS	0.384	0.526	0.414	0.572	0.414	0.572	0.620	1.028	0.734
	SLS (0.5mm vertical deflection)	0.953	1.223	1.048	1.349	1.048	1.349	1.512	2.296	1.635
	SLS (1.0mm vertical deflection)	0.602	0.793	0.656	0.869	0.656	0.869	0.959	1.512	1.078
	Recommended	0.600	1.225	1.050	1.350	1.050	1.350	1.525	2.300	1.650
Polystorm-R (PSM1A)	ULS	0.289	0.410	0.309	0.442	0.309	0.442	0.473	0.818	0.583
	SLS (0.5mm vertical deflection)	1.165	1.483	1.284	1.639	1.284	1.639	1.845	2.769	1.970
	SLS (1.0mm vertical deflection)	0.751	0.976	0.822	1.073	0.822	1.073	1.194	1.845	1.315
	Recommended	0.750	1.485	1.285	1.640	1.285	1.640	1.845	2.770	1.970
Polystorm Xtra (PSM3)	ULS	0.212	0.315	0.223	0.337	0.223	0.337	0.353	0.646	0.460
	SLS (0.5mm vertical deflection)	0.859	1.108	0.942	1.220	0.942	1.220	1.363	2.085	1.485
	SLS (1.0mm vertical deflection)	0.535	0.711	0.581	0.777	0.581	0.777	0.854	1.363	0.972
	Recommended	0.550	1.125	0.950	1.225	0.950	1.225	1.375	2.100	1.500

Table 9 Minimum cover depths recommended for stated vehicle load classification (CIRIA C680 FoS and methodology, assuming 1 in 2 load distribution)

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