

SDS Structural Design Calculations

Elizabeth Street, Cheetham Hill

E/1445/22

23/08/23

Version 2

1 Introduction

This is a report showing the structural analysis of a geocellular modular drainage tank for the new proposed Elizabeth Street, Cheetham Hill.

ATT Tank 1 1.125m deep 481m³ tank is to be installed.

ATT Tank 2 0.750m deep 528m³ tank is to be installed.

Tank loading is calculated using DIN 1072 loading classification 60/30.

Assumptions:

- Pressure from point load of tyre disperses at an angle of 26°.
- Shear angle of resistance taken as 38°.
- Soil/ fill density of 19kNm³.
- Maximum and minimum cover depths;

ATT Tank 1 of 1.365m and 0.885m respectively.

ATT Tank 2 of 0.960m and 0.680m respectively.

2 Design information

Calculations are based on the following design information:

Site Levels and tank dimensions	<i>E144522_01 - ATT1 - Elizabeth Street, Cheetham Hill</i>
	<i>E144522_02 - ATT2 - Elizabeth Street, Cheetham Hill</i>
Loading	<i>CIRIA C680 – Table 4.2 Characteristic loads for different land use 2008</i>
Factors	<i>CIRIA C680 – Table 4.5 Partial load factors (based on EN 1997-1:2004) 2008</i>

3 Design equations

3.1 Vertical pressure equations:

Vertical loading takes account of permanent loading from cover backfill c according to (3.1), variable load from vehicles etc (surcharge) q and accidental loading from HGVs (point) w . Pressure from HGV assumes a 26° distribution, from point of application. Load due to depth of cover over tank is given by equation (3.1)

$$c = \gamma.z \quad (3.1)$$

where γ is soil density and z the cover depth. Therefore design vertical pressure given by:

$$\sigma_{v,d} = c.\lambda + q.\lambda + w.\lambda \quad (3.2)$$

where λ are appropriate the load factors.

3.2 Lateral pressure equations:

Lateral pressures calculated using the coefficient of lateral earth pressure and vertical pressure resulting from permanent backfill and variable surcharge. Maximum pressure taken at 200mm above the base of tank.

$$\sigma_{h,d} = \{K_a(q + \gamma h)\} \times \lambda \quad (3.3)$$

where K_a is the coefficient of lateral earth pressure given by equation (3.4), h is the reference depth at which the lateral pressure is ascertained. Again λ is the factor of safety.

$$K_a = \frac{1 - \sin \phi}{1 + \sin \phi} \quad (3.4)$$

where ϕ is the angle of shear resistance.

4 Design calculation spreadsheets

ATT Tank 1

Proposal number:	E/1445/22
Date:	23/08/2023

Job Name:	Elizabeth Street, Cheetham
Author:	JC

Site Elevations (m)		
Ground Level AOD	Max	56.490
	Min	56.010
Tank Level	Top	55.125
	Bottom	54.000
Cover Depth, z	Max, z_{max}	1.365
	Min, z_{min}	0.885

Soil/Fill Characteristics	
γ (kNm ⁻³)	19.00
ϕ (°)	38.00

VERTICAL		
Area Due To Spread Of Point Load, A (m ²)		
Spread angle (degrees)		26.00
A (z_{max})		2.96
A (z_{min})		1.56
Loading Case (Din 1072)		
Surcharge, q	10.00	kNm ⁻²
Cover Fill, c Max/Min [$\gamma \cdot z$]	25.94	kNm ⁻²
	16.82	kNm ⁻²
Point, w	100.00	kN
Factored Vertical Loading, (kNm ⁻²)		
Surcharge [$q_d = q \cdot \lambda$]	15.00	
Cover [$c_d = c \cdot \lambda$]	35.01	
	22.70	
Point [$w_d = (w/A) \cdot \lambda$]	50.71	
	96.41	
Load Area (m.m)		
0.20	0.60	
Factors, λ		
Surcharge	1.50	
Cover	1.35	
Point	1.50	
Design Vertical Loading, $\sigma_{v,d}$		
$\sigma_{v,d}(z_{max})$	100.72	kNm ⁻²
$\sigma_{v,d}(z_{min})$	134.11	kNm ⁻²

LATERAL		
Reference Depth		
h (m)	2.29	
Loading Case (Din 1072)		
Surcharge, q	10.00	kNm ⁻²
Cover, c [$\gamma \cdot h$]	43.51	kNm ⁻²
Factored Lateral Loading, (kNm ⁻²)		
Surcharge [$q_d = k_a \cdot q \cdot \lambda$]	3.57	
Cover Fill [$c_d = k_a \cdot c \cdot \lambda$]	13.97	
ϕ (rad)		
0.66		
$k_a [1 - \sin\phi / 1 + \sin\phi]$		
0.24		
Factors, λ		
Lateral	1.35	
Variable	1.50	
Design Lateral Loading, $\sigma_{l,d}$		
$\sigma_{l,d}(z_{max})$	17.54	kNm ⁻²

ATT Tank 2

Proposal number:	E/1445/22
Date:	23/08/2023

Job Name:	Elizabeth Street, Cheetham
Author:	JC

Site Elevations (m)		
Ground Level AOD	Max	55.870
	Min	55.590
Tank Level	Top	54.910
	Bottom	54.160
Cover Depth, z	Max, $z_{\max}$	0.960
	Min, $z_{\min}$	0.680

Soil/Fill Characteristics	
γ (kNm^{-3})	19.00
ϕ ($^{\circ}$)	38.00

VERTICAL

Area Due To Spread Of Point Load, A (m^2)		
Spread angle (degrees)		26.00
A ($z_{\max}$)		1.75
A ($z_{\min}$)		1.09

Load Area (m.m)	
0.20	0.60

Loading Case (Din 1072)		
Surcharge, q	10.00	kNm^{-2}
Cover Fill, c Max/Min [$\gamma \cdot z$]	18.24	kNm^{-2}
	12.92	kNm^{-2}
Point, w	100.00	kN

Factors, λ	
Surcharge	1.50
Cover	1.35
Point	1.50

Factored Vertical Loading, (kNm^{-2})	
Surcharge [$q_d = q \cdot \lambda$]	15.00
Cover [$c_d = c \cdot \lambda$]	24.62
	17.44
Point [$w_d = (w/A) \cdot \lambda$]	85.91
	137.53

Design Vertical Loading, $\sigma_{v,d}$		
$\sigma_{v,d}(z_{\max})$	125.53	kNm^{-2}
$\sigma_{v,d}(z_{\min})$	169.98	

LATERAL

Reference Depth	
h (m)	1.51

ϕ (rad)	0.66
$k_a [1 - \sin\phi / 1 + \sin\phi]$	0.24

Loading Case (Din 1072)		
Surcharge, q	10.00	kNm^{-2}
Cover, c [$\gamma \cdot h$]	28.69	kNm^{-2}

Factors, λ	
Lateral	1.35
Variable	1.50

Factored Lateral Loading, (kNm^{-2})	
Surcharge [$q_d = k_a \cdot q \cdot \lambda$]	3.57
Cover Fill [$c_d = k_a \cdot c \cdot \lambda$]	9.21

Design Lateral Loading, $\sigma_{l,d}$		
$\sigma_{l,d}(z_{\max})$	12.78	kNm^{-2}