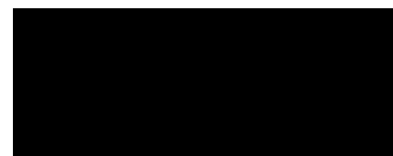


Yapton Road
Barnham
Uplift calculations
May 2021



	Structural Engineering
	Civil Engineering
	CDM Consultants
	Sustainability and BREEAM
	Traffic and Transport
	Flood Risk Assessments
	Highway Engineering
	Event Engineering

Uplift calculations for an attenuation tank and pond.**Job Information**

Site: Yapton Road, Barnham

Date: 25/05/2021

Significant values:Weight of 6F2 granular fill - 20kN/m³Weight of water - 9.81kN/m³Weight of soil - 20kN/m³
(silty sandy clay from soil
report)Weight of concrete - 24kN/m³Submerged Weight of concrete - 14kN/m³**Attenuation Tank Data:**

Width - 20.8m

Length - 12.8m

Depth - 0.66m

Invert Level - 7.28m

Ground Level - 8.35m

Assumed Water Table Level - 7.43m

Pond Data:

Invert Level - 7.12m

Volume - 188m³

Ground Level - 8.25m

Assumed Water Table Level - 7.43m

Output:

Method of Assessment - BS EN 1997-1-1 Geotechnical Design.

Job. 203434 – Yapton Road, Barnham

Sheet No.	203434
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L01

Section Title		Computer Analysis Used?			
Wind Calculation		No			
Date Of External Issue	Calculation Description	Page No.	Prepared By	Chkd By	Appr' By
26.05.2021	Attenuation tank uplift calculations.	01 – 01	RE	JD	JD
26.05.2021	Pond uplift calculations.	02 – 03	RE	JD	JD

Job: 203434 – Yapton Road, Barnham – Attenuation tank uplift calculation

Prepared By: RE

Checked By: JD

Issued:

Sheet No.

203434

01

01

Date: 25-05-2021

Approved By: JD

Revised:

Using Eurocode 7 – Geotechnical Design – Part 1.

From table A.15 safety factors are:

Unfavourable permanent action - $\gamma_{G,dst,d} = 1$

Favourable permanent action - $\gamma_{G,stb,d} = 0.9$

Unfavourable variable action - $\gamma_{Q,dst,d} = 1.5$

Clause 10.2 (2) state failure by uplift should be checked against equation 2.8 from clause 2.4.7.4

Equation 2.8:

$$V_{dst,d} \leq G_{stb,d}$$

Where:

$$V_{dst,d} = G_{dst,d} + Q_{dst,d}$$

$$G_{stb,d} = \gamma_{G,stb,d} g_{stb,d}$$

$$G_{dst,d} = \gamma_{G,dst,d} g_{dst,d}$$

$$Q_{dst,d} = \gamma_{Q,dst,d} q_{dst,d}$$

$$\text{Volume of tank per } 1\text{m}^2 = 1 \times 1 \times 0.66 = 0.66\text{m}^3$$

Proposed invert level of tank is 7.28m, Water table is 7.43m

$$\text{Depth of tank below water table} = 7.43 - 7.28 = 0.15\text{m}$$

$$\text{Displaced water } q_{dst,d} = 0.15 \times 9.81 = 1.47\text{kN}$$

$$Q_{dst,d} = 1.5 \times 1.47 = 2.21\text{kN}$$

No destabilising permanent load $\therefore g_{dst,d} \& G_{dst,d} = 0$

$$V_{dst,d} = 2.21\text{kN}$$

for equation 2.8 to be satisfied $G_{stb,d} > 2.21\text{kN}$

$$\therefore g_{stb,d} > 2.21 / 0.9 = 2.46\text{kN}$$

$g_{stb,d}$ = volume of soil above tank x soil density

$$\therefore \text{minimum depth of soil above tank} = 2.46 / (20 \times 1 \times 1) = 0.13\text{m}$$

proposed invert level of the tank is 7.28m, tank height is 0.66m, ground level is 8.35m $\therefore$

proposed depth of soil above tank = $8.35 - (7.28 + 0.66) = 0.41\text{m} > 0.13\text{m}$ $\therefore$ No uplift occurs with an invert level of 7.28m and ground level of 8.35m

Job: 203434 – Yapton Road, Barnham – Attenuation pond uplift calculation

Prepared By: RE

Checked By: JD

Issued:

Sheet No.

203434

01

01

Date: 25-05-2021

Approved By: JD

Revised:

Using Eurocode 7 – Geotechnical Design – Part 1.

From table A.15 safety factors are:

Unfavourable permanent action - $\gamma_{G,dst,d} = 1$

Favourable permanent action - $\gamma_{G,stb,d} = 0.9$

Unfavourable variable action - $\gamma_{Q,dst,d} = 1.5$

Clause 10.2 (2) state failure by uplift should be checked against equation 2.8 from clause 2.4.7.4

Equation 2.8:

$$V_{dst,d} \leq G_{stb,d}$$

Where:

$$V_{dst,d} = G_{dst,d} + Q_{dst,d}$$

$$G_{stb,d} = \gamma_{G,stb,d} g_{stb,d}$$

$$G_{dst,d} = \gamma_{G,dst,d} g_{dst,d}$$

$$Q_{dst,d} = \gamma_{Q,dst,d} q_{dst,d}$$

Looking at 1m² of pond:

$$\text{Volume} = 1 \times 1 \times 1.13 = 1.13 \text{m}^3$$

Proposed invert level of tank is 7.12m, Water table is 7.43m

$$\text{Depth of pond below water table} = 7.43 - 7.12 = 0.31 \text{m}$$

$$\text{Displaced water } q_{dst,d} = 0.31 \times 9.81 = 3.01 \text{kN}$$

$$Q_{dst,d} = 1.5 \times 3.01 = 4.57 \text{kN}$$

No destabilising permanent load $\therefore g_{dst,d} \& G_{dst,d} = 0$

$$V_{dst,d} = 4.57 \text{kN}$$

for equation 2.8 to be satisfied $G_{stb,d} > 4.57$

$$\therefore g_{stb,d} > 4.57 / 0.9 = 5.08 \text{kN}$$

$g_{stb,d}$ = volume of soil above membrane x soil density

$$\therefore \text{minimum depth of soil above membrane} = 5.08 / (20 \times 1 \times 1) = 0.26 \text{m}$$

Now check uplift with increased depth of membrane:

(This is an iterative procedure 1st and the last iterations are shown on the next page)

Job: 203434 – Yapton Road, Barnham – Attenuation pond uplift calculation

Prepared By: RE

Checked By: JD

Issued:

Sheet No.

203434

01

01

Date: 25-05-2021

Approved By: JD

Revised:

First iteration

$$\text{Volume} = 1 \times 1 \times (0.31 + 0.26) = 0.57 \text{m}^3$$

$$\text{Displaced water } q_{\text{dst,d}} = 0.57 \times 9.81 = 5.60 \text{kN} \quad Q_{\text{dst,d}} = V_{\text{dst,d}} = 1.5 \times 5.60 = 8.39 \text{kN}$$

for equation 2.8 to be satisfied $G_{\text{stb,d}} > 8.39$

$$\therefore g_{\text{stb,d}} > 8.39 / 0.9 = 9.32 \text{kN}$$

$g_{\text{stb,d}}$ = volume of soil above membrane x soil density

$$\therefore \text{minimum depth of soil above membrane} = 9.32 / (20 \times 1 \times 1) = 0.47 \text{m}$$

Last iteration

$$\text{Volume} = 1 \times 1 \times (0.31 + 1.4) = 1.71 \text{m}^3$$

$$\text{Displaced water } q_{\text{dst,d}} = 1.71 \times 9.81 = 16.78 \text{kN}$$

$$Q_{\text{dst,d}} = V_{\text{dst,d}} = 1.5 \times 16.78 = 25.17 \text{kN}$$

for equation 2.8 to be satisfied $G_{\text{stb,d}} > 25.17$

$$\therefore g_{\text{stb,d}} > 25.17 / 0.9 = 27.96 \text{kN}$$

$g_{\text{stb,d}}$ = volume of soil above membrane x soil density

$\therefore \text{minimum depth of soil above membrane} = 27.96 / (20 \times 1 \times 1) = 1.39 \text{m} < 1.4 \text{m}$ (which was added to the depth in the volume calculation).

$\therefore$ membrane requires 1.4m of soil on top to prevent uplift.

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