



RHONDDA
GEOTECHNICAL
SERVICES

BRE365
SOAKAWAY DESIGN CALCULATIONS
M.T.C.B.C. PLANNING APP. P/16/0177
NEW STORAGE BUILDING
AT
WINCHFAWR ROAD
MERTHYR TYDFIL
CF48 1RD
6/04/2020

INTRODUCTION

M.T.C.B.C. have granted full planning permission for a storage building at Winchfawr Road, Heolgerrig. The application number is P/16/0117. Condition 4 requests that soakaway calculations and porosity information be submitted for approval to the L.P.A. This is to ensure the scheme does not cause or exacerbate flood risk in the area. The preferred method of stormwater disposal is by a soakaway if possible. Rhondda Geotechnical Services have been asked to design a suitably sized soakaway and to investigate if this is feasible. In order to investigate the possibility of an effective soakaway the procedures outlined in BRE Digest 365 (soakaway design 2016 revision) must be followed. These involve obtaining the soil infiltration characteristics (permeability) and then using this figure in the calculations outlined in the digest to design a suitably sized soakaway. In its most simple form this is:-

$I - O = S$ where I is the inflow from the impermeable area to be drained, O is the outflow infiltrating into the soil in the soakaway during rainfall and S is the required storage of the soakaway to balance temporarily inflow and outflow.

To obtain the infiltration characteristic figure (f) a trial pit must be excavated and tested by filling it with water and timing how fast it runs away. The trial pit needs to be in the area where any soakaway would be constructed so any variation in ground conditions is catered for. The initial soakaway trial pit was done with a tracked excavator, and the tests carried out by the planning applicant. The soil in the pit was later described by the author.

BS5930:2015 SOIL DESCRIPTION

G.L.-1.0m

MADE GROUND Sandy angular to subangular, fine to coarse GRAVEL. Gravel is of mudstone, siltstone and ironstone (COLLIERY SPOIL).

The following calculations have been based on the figures recorded. The pit was 1.0m x 1.0m x 1.0 m deep. Assuming an entry invert level of 0.3m this gives an effective storage depth of 0.7m.

40 gallon plastic drums were used to fill the pit. This meant the pit could be filled rapidly, which is a requirement of the guidance. The pit was filled with water and the drop in levels measured and timed. It is normal to measure the time taken for the water to drop from 75% to 25% of the effective storage depth of the pit. The test needs to be repeated three times, and the value from the

third test used. This produces a more conservative infiltration rate for the purpose of soakaway design. The infiltration calculations are shown overleaf. The figure arrived at was 4.17×10^{-5} m/s. This is a reasonably high value due to the granular nature of the Made Ground. Using this infiltration value, rainfall calculations need to be carried out in order to produce a practical soakaway design. The method outlined in the revised 2016 BRE365 must be followed to arrive at the rainfall figures.

INFILTRATION CALCULATION

$$V_{p75-25} = 0.34 \times 1.0 \times 1.0 = 0.34 \text{m}^3$$

$$A_{p50} = (4 \times 0.34) + (1.0 \times 1.0) = 2.36 \text{m}^2$$

$$T_{p75-25} = 58 \text{ mins. (3480secs.)}$$

$$f = \frac{0.34}{2.36 \times 3480}$$

$$= \frac{0.34}{8219}$$

$$f = 4.17 \times 10^{-5}$$

Normally a soakaway must be situated at least five metres from any building or highway and this has been taken into account when choosing the site for the soakaway. 1.3m was chosen as a practical design depth in the chosen location. Assuming an invert depth of 0.3m this gives an effective depth of 1.0m and this figure will be used to design the soakaway. Before doing this the design rainfall needs to be calculated so the volume of water going into the soakaway is known.

DEVELOPMENT DETAILS

The development consists of a flat roofed storage building. The roof of the proposed new building will have an area of 20m^2 . There are no areas of impermeable hard landscaping, only permeable paving. Therefore only the roof area will need to be considered when calculating run off figures.

DESIGN RAINFALL AND INFLOW CALCULATIONS

The basis for design rainfall calculation is the M5-60min. figure. This represents the maximum rainfall in 60 minutes over a five year period. This has been revised

for all areas of the U.K. to be 20mm. This is then multiplied by factor Z1 for different rainfall durations (D). Z1 is obtained from tables in the Digest which need to be read in conjunction with the value r. The value of r varies around the country and is read off an isohyet map in the Digest. From this map the value of r for Merthyr is 0.24. This enables maximum rainfall to be calculated using a table in the Digest. The M5-60 value is $20 \times 1 = 20\text{mm}$. This table can be used for any rainfall duration. For example the maximum rainfall over a six hour period

$$M5-360 (\text{MERTHYR}) = 20 \times 2.0 = 40\text{mm}.$$

In other words the maximum rainfall over a six hour period in a five year return period for Merthyr would be 40mm. There is a further correction factor. This is known as Z2. This is dependent on the rainfall figure in the M5 column. Again this is obtained from a table in the digest and is multiplied by the M5 figure to produce a ten year return period, or in this case a hundred year return period.

$$M100-360 (\text{MERTHYR}) = 40 \times 1.97 = 78.8\text{mm}.$$

In line with current best practise a further 30% increase is added to allow for climate change. This is not however a requirement of building regulations.

$$M100-360 (\text{MERTHYR}) = 8.8 \times 1.3 = 102.44\text{mm}.$$

By now using this figure and multiplying it by the area of the roof we can calculate the maximum volume of water the soakaway would receive over a six hour period. The area of the roof served by the soakaway has been measured and is 20m^2 . So the inflow (I) over a six hour period can be calculated.

$$I = 20 \times 0.1024 = 2.048\text{m}^3$$

OUTFLOW CALCULATION

The outflow is calculated by the equation $O = A_{50} \times f \times D$ where D is the storm duration and A_{50} is the area of the sides of the soakaway (not the base) at half the effective depth. The soakaway sizes can now be worked out by a process of trial and error. The value of f is known, D is variable so $I - O = S$ can be worked out for the full range of rainfall durations (D) from 5 mins to 24hrs. The actual soakaway design can either be an aggregate filled pit or can utilise special plastic frames. The initial calculations will be based on an aggregate filled pit. As an example the first trial calculation overleaf (for an area of 20m^2) will be based on

a pit 2m x 1m x 1.3m depth. This gives an effective storage (below 0.3m invert) of 0.66m³ assuming 30% voids in the local limestone aggregate at graded 50mm single size. The value of A_{s50} will be (6x 0.5) = 3.0m². The calculations for a range of rainfall durations can then be worked out.

From the first set of figures below it can be seen that I-O closely approaches the storage capacity of the design for some rainfall durations (columns O1 and S1). This leaves little factor of safety. Increasing the soakaway dimensions to 2.5m x 1.0m x 1.3m increases the A_{s50} value to 3.5m². The storage capacity is also raised to 0.75m³. This means the storage capacity is greater than is required (Columns O2 and S2). There is a large safety margin (50%) with the second, slightly larger storage capacity. A further criterion is that 50% of the effective storage can be discharged over a 24 hour period. This is also easily achieved by the larger design.

20m2 ROOF AREA		O1 PIT 2x1x1.3 (EFF.STOR. 0.66m3-aggregate) O2 PIT 2.5x1x1.3 (0.75m3 aggregate)									
WYNCHFAWR ROAD ROAD, HEOLGERRIG SOAKAWAY DESIGN CALCULATIONS											
		mm		mm	mm.		FIGURES IN CUBIC METRES				
MINS	Z1	M5	Z2	M100	GW	D(SECS)	I	O1	S1	O2	S2
5	0.31	6.2	1.84	11.408	14.83	300	0.30	0.038	0.26	0.044	0.25
10	0.46	9.2	1.89	17.388	22.60	600	0.45	0.076	0.38	0.088	0.36
15	0.56	11.2	1.92	21.504	27.96	900	0.56	0.114	0.45	0.132	0.43
30	0.75	15	1.95	29.25	38.03	1800	0.76	0.228	0.53	0.264	0.50
60	1	20	2	40	52.00	3600	1.04	0.456	0.58	0.528	0.51
120	1.3	26	2.03	52.78	68.61	7200	1.37	0.912	0.46	1.056	0.32
240	1.71	34.2	1.99	68.058	88.48	14400	1.77	1.824	-0.05	2.112	-0.34
360	2	40	1.97	78.8	102.44	21600	2.05	2.736	-0.69	3.168	-1.12
600	2.4	48	1.94	93.12	121.06	36000	2.42	4.56	-2.14	5.280	-2.86
1440	3.35	67	1.91	127.97	166.36	86400	3.33	10.944	-7.62	12.672	-9.34

DESIGN NOTES

The soakaway pit should be lined with Terram and filled with clean aggregate. The design should have its upper surface covered with Terram, above invert level, to prevent silting up from above. The finished ground surface is can then be laid on top of this. It is advisable to have a proprietary removable silt trap in the drainage run to the soakaway

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5/04/2021