Soakaways

Design Example for BRE Digest 365

If the area of your development being drained by a soakaway exceeds 100m^2 it must be designed in accordance with BRE Digest 365 to ensure that it will function correctly.

Carrying out a soakaway test

In order to carry out the test you need to excavate a trial pit to an adequate depth beneath the estimated invert level of the inlet pipe. This is to ensure that the soil being tested is representative of what will actually be constructed. The trial pit needs to be filled with water by a bowser to ensure it is filled as rapidly as possible. Using a hose is not acceptable as water may infiltrate prior to the pit being full rendering inaccurate results. The height of the water below ground level must be recorded at regular intervals in order for the calculation of the infiltration rate of the soil to be made.

The BRE Digest 365 guidance document contains a worked example on page 5 explaining how to calculate the soil infiltration rate.

Designing a rectangular soakaway

Example: Calculating the size of a soakway to receive storm water from 125m^2 impermeable surface for a site in Shropshire. (Refer also to BRE Digest 365)

The following rainfall amounts have been calculated for a range of storm durations in Shropshire using r= 0.39. These figures should be used when calculating the size of your soakaway.

Table 1: Rainfall results for a range of storm durations in Shropshire

Storm duration *D* min	M5-*D*min =20mm x Z1	Z2	M10-*D* min =R mm
10	10.4	1.22	12.7
15	12.6	1.23	15.5
30	16.0	1.24	19.8
60	20.0	1.24	24.8
120	24.2	1.24	30.0

240	29.2	1.22	35.6
360	32.4	1.21	39.2
600	36.4	1.19	43.3

Assuming the results from a soakage trial pit giving a soil infiltration rate of $f = 3.33 \times 10^{-5}$ m/s were obtained at the site, this can be used to design a soakaway which will be filled with granular material having 30% free volume. The percentage void space of any granular fill material must be pre-determined for use in the design.

Assuming the trial pit dimensions were 2.4m wide x 2.5m long x 1.5m (effective storage depth below incoming invert), this can then form part of the full scale soakaway. The required width of the soakaway therefore needs to be calculated depending on the rainfall amount and infiltration rate of the soil. The base area of the soakaway is not included in the calculations as it is assumed that this will become less permeable over time due to siltation.

Calculate the design width of the soakaway: Volume equation $I - O = S$

Inflow to soakaway *I*

$I = A \times R$

= *Impermeable surface area of development* x *M10-D min rainfall*

e.g. for 10 min storm duration, M10-10min = 12.7mm = 0.0127m

$I = 125 \times 0.0127$

$= 1.588\text{m}^3$

Outflow from soakaway O

$O = a_{s50} \times f \times D$

= Internal surface area of soakaway pit to 50% storage depth (excluding base area) x soil percolation rate x storm duration

For rectangular pit 2.4m long x 1.5m effective depth x *W* m wide:

$a_{s50} = 2 \times (2.4 + W) \times (1.5 \div 2)$

$= 3.6 + 1.5\,W\ \text{m}^2$

$f = 3.3 \times 10^{-5}$ m/s from soakage trial

$O = (3.6 + 1.5\,W) \times (3.3 \times 10^{-5}) \times (D \times 60)\ \text{m}^3$

Soakaway storage volume S

S = effective volume of soakaway with 30% free volume

= 2.4 x 1.5 x W x 0.3

= 1.08 W m^3

For satisfactory storage of the M10–10min runoff, therefore D = 10

$I - O = S$

$1.588 - ((3.6 + 1.5\,W) \times (3.3 \times 10^{-5}) \times (10 \times 60)) = 1.08\,W$

$1.588 - ((3.6 + 1.5\,W) \times 0.000033 \times 600) = 1.08\,W$

$1.588 - ((3.6 + 1.5\,W) \times 0.0198) = 1.08\,W$

$1.588 - 0.07128 - 0.0297W = 1.08W$

$1.5167 - 0.0297W = 1.08\,W$

$1.5167 = 1.11W$

$1.366 = W$

Required soakaway width, W = 1.366 m

Repeat the calculation for a range of M10-*D*min storms and determine the maximum width required for the soakaway, this is the size of soakaway you will need to construct. Results are summarised in Table 2.

Table 2: Rainfall results for a range of M10-*D* min storms

Storm duration *D*- min	Required soakaway width *W* -m
10	1.37
15	1.63
30	1.93
60	**2.12**
120	2.02
240	1.53

As shown in Table 2 your results should show an increase in width to a certain point and then decrease. The largest width calculated is that required for construction.

A soakaway 2.4m long x 1.5m effective depth x **2.12m** wide would be suitable for the critical storm duration of around 1 hour for a 10 year event.

To check the time for half emptying of the storage volume, t_{s50}.

$$t_{s50} = \frac{S \times 0.5}{a_{s50} \times f} = \frac{(1.08 \times 2.12) \times 0.5}{(3.6 + [1.5 \times 2.12]) \times (3.3 \times 10^{-5})} \text{ seconds}$$

t_{s50} = 1.6 hours

This design is satisfactory with the soakaway half empty within 24 hours.

You should note that if your soakaway is designed to cater for flows from a 1 in 10 year event, as above, you will still need to manage exceedance flows from a 1 in 100 year (+ appropriate allowance for climate change) within your site boundary.

The following rainfall amounts have been calculated for a 100 year return period storm in Shropshire and can be used to calculate the size of soakaway required to cater for such an event. You should note, however, that an appropriate allowance for climate change should be added (20% for non residential development, 30% for residential development) when considering how flows generated by a 100 year return event will be managed on site.

Table 3: Rainfall results for a range of storm durations

Storm duration *D* min	M5-*D*min =20mm x Z1	Z2 (M100)	M10-*D* min =R mm
10	10.4	1.91	19.864
30	16.0	1.99	31.84
60	20.0	2.03	40.6
120	24.2	2.01	48.6
240	29.2	1.97	57.5
600	36.4	1.89	68.8