

Designing the drainage layer



$$q' = \frac{A \times C \times r}{Lr} \text{ in l/(s.m)}$$

- Green roofs
- Roof terraces
- Parking decks

Drainage capacity of ND Drainage Composites

Product	ND 100 ND 120	ND 200 ND 220	ND 600 ND 620 ND 600hd ND 620hd	ND 600s ND 600sv ND 600hds ND 600hdsv	ND 4+1	ND 5+1
Vertical Drainage in l/(s.m) - wall						
Surface load 0 kN/m ² Build-in depth 0.0 m	2.80	4.70	4.20	4.20	-	-
Surface load 30 kN/m ² Build-in depth 3.0 m	2.00	4.20	4.10	4.10	-	-
Surface load 50 kN/m ² Build-in depth 5.0 m	1.90	4.10	4.00	4.00	-	-
Surface load 100 kN/m ² Build-in depth 10.0 m	1.80	3.90	3.90	3.90	-	-
Surface load 200 kN/m ² Exceptional case	1.60	3.60	3.80	3.80	-	-
Horizontal drainage in l/(s.m) - deck						
Rainfall intensity 0.03 l/(s.m ²)						
Fall ratio <1:500 - exceptional case						
Surface load ≤ 0.2 kN/m ² extensive green roof	-	-	-	-	-	0.36
Surface load ≤ 10.0 kN/m ² intensive green roof	-	-	-	-	-	0.30
Fall ratio 1:80 - Standard green roof						
Surface load 10 kN/m ² extensive green roof	0.12	0.41	0.25	0.25	0.41	1.18
Surface load 20 kN/m ² intensive green roof	0.11	0.36	0.24	0.24	0.36	1.18
Surface load 100 kN/m ² roof terrace	-	0.31	0.20	0.20	0.31	1.14
Surface load 200 kN/m ² parking deck	-	0.27	0.18	0.18	0.27	1.08
Fall ratio 1:60						
Surface load 10 kN/m ² extensive green roof	0.16	0.47	0.31	0.31	0.47	1.60
Surface load 20 kN/m ² intensive green roof	0.14	0.44	0.29	0.29	0.44	1.60
Surface load 100 kN/m ² roof terrace	-	0.37	0.25	0.25	0.37	1.48
Surface load 200 kN/m ² parking deck	-	0.34	0.23	0.23	0.34	1.30
Fall ratio 1:40 - Standard paved surface						
Surface load 10 kN/m ² extensive green roof	0.22	0.60	0.41	0.41	0.60	2.10
Surface load 20 kN/m ² intensive green roof	0.19	0.56	0.39	0.39	0.56	2.05
Surface load 100 kN/m ² roof terrace	-	0.48	0.34	0.34	0.48	1.92
Surface load 200 kN/m ² parking deck	-	0.45	0.31	0.31	0.45	1.70

Table 1. Drainage capacity of ND Drainage Composites

1. Green roofs

On green roofs, the storm water is partly retained by the growing medium layer and partly passed on to the drainage layer.

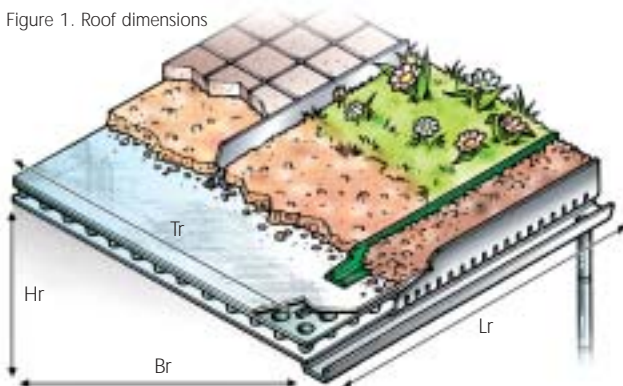
1.1 Calculating the drainage capacity in l/(s.m) of the drainage layer of a green roof build-up

The amount of water that needs to be discharged by the drainage layer (q') can be calculated in l/(s.m) by using the following equation:

$$q' = \frac{A \times C \times r}{Lr} \text{ in l/(s.m)}$$

- q' = required l/(s.m) (table 1)
- A = effective roof area m² (Lr x Br)
- C = runoff coefficient (table 2)
- r = rainfall intensity l/(s.m²) in accordance with BS EN 12056-3:2000
- Lr = length of the roof to be drained, in metres

Figure 1. Roof dimensions



- Lr = the length of roof to be drained
- Br = the plan width of roof from gutter to ridge
- Hr = the height of roof from gutter to ridge
- Tr = the distance from gutter to ridge measured along the roof

1.2 Calculating the maximum flow length (in metres) of ND Drainage Composites used in a green roof build-up

The maximum flow length (in metres) of the ND Drainage Composites, taking into account the runoff coefficient of the growing medium layer, can be calculated by using the following equation:

$$L_{\max} = \frac{\text{drainage capacity of ND Drainage Composite}^*}{C \times r}$$

L_{\max} = flow length in metres
 C = runoff coefficient (table 2)
 r = rainfall intensity $l/(s \cdot m^2)$ in accordance with BS EN 12056-3:2000

* See table 1. Drainage capacity ND Drainage Composites

1.3 Run-off coefficients for green roofs

For green roofs, the following runoff coefficients (C) can be used. The values depend on the depth of the growing medium and the roof slope:

Growing medium layer depth in mm	Roof slope $\leq 15^\circ$ (~26.8%)	Roof slope $> 15^\circ$ (~26.8%)
60	C = 0.6	C = 0.7
> 60 - 100	C = 0.5	C = 0.6
> 100 - 150	C = 0.4	C = 0.5
> 150 - 250	C = 0.3	-
> 250 - 500	C = 0.2	-
> 500	C = 0.1	-

Table 2. Runoff coefficient (C)

These figures apply for the stated layer depth at a 15 minute rainfall intensity of $r_{(15)} = 0.03 l/(s \cdot m^2)$. The growing medium has previously been saturated with water and drip-dried for 24 hour prior to testing.

2. Roof terraces and Parking decks

On those roofs built-up with paved surfaces, storm water is partly drained over the paved surface (q_o), the so-called 1st discharge level. The drainage layer or the 2nd discharge level, has to intercept the storm water that has penetrated the paved surface ($q_{a,s}$).

$$q_{a,s} = r - q_o$$

$q_{a,s}$ = storm water penetrating the paved surface $l/(s \cdot m^2)$ (table 3)
 r = rainfall intensity $l/(s \cdot m^2)$ in accordance with BS EN 12056-3:2000
 q_o = storm water discharged over the paved surface $l/(s \cdot m^2)$

Based upon a 15 minute rainfall intensity happening once every 10 years of $r_{(15^{0,1})} = 0.03 l/(s \cdot m^2)$ the following values can be used to determine the amount of storm water penetrating the paved surface ($q_{a,s}$):

Paving	$q_{a,s}$ ($l/(s \cdot m^2)$)
Concrete block pavers	0.01
Paved area with > 15% joints	0.012
Self-binding gravel	0.015
Turf paving on water permeable sub base	0.03

Table 3. Storm water penetrating the paved surface $q_{a,s}$

2.1 Calculating the drainage capacity in $l/(s \cdot m)$ of the drainage layer underneath a paved surface

The amount of water that needs to be discharged by the drainage layer (q') can be calculated per $l/(s \cdot m)$ by using the following equation:

$$q' = \frac{q_{a,s} \times A}{Lr} \text{ in } l/(s \cdot m)$$

q' = required $l/(s \cdot m)$ (table 1)
 $q_{a,s}$ = storm water penetrating the paved surface $l/(s \cdot m^2)$ (table 3)
 A = effective roof area m^2 ($Lr \times Br$)
 Lr = length of the roof to be drained m

2.2 Calculating the maximum flow length (in metres) of ND Drainage Composites used underneath a paved surface

The maximum flow length in metres of the ND Drainage Composites taking into account the storm water that penetrates the paved surface can be calculated by using the following equation:

$$L_{\max} = \frac{\text{drainage capacity of ND Drainage Composite}^*}{q_{a.s}}$$

L_{\max} = flow length in metres
 $q_{a.s}$ = storm water penetrating the paved surface $l/(s \cdot m^2)$ (table 3)

* See table 1. Drainage capacity ND Drainage Composites

3. Roof drainage

EN 12056-3:2000, the European roof drainage standard, provides for a runoff coefficient to allow for absorbent roofing surfaces if national and local regulations and practice permit. However, at present in the United Kingdom, no guidance is available, and so the designer is forced to adopt alternative methods if the runoff reduction effect of a green roof is to be taken into account.

For roofs with a fall of 1 in 40 (2.5%) or flatter (nominally flat roofs) the designer should use a BS EN 12056-3:2000 Category 1 storm event for design purposes. This storm event will occur on average once every 1 year in the United Kingdom, and will generate rainfall intensities which vary from $0.011 l/(s \cdot m^2)$ to $0.022 l/(s \cdot m^2)$ depending on geographical location. This is very short duration thunderstorm rain, and will occur on average for 2 minutes, usually in summer, when a green roof build-up could be expected to be at its driest.

It is assumed by using this method that any storm greater than this intensity would be absorbed into the green roof build-up, or would pond on any hard surfacing between green areas. The roof deck should however be strong enough to resist the loads imposed by minor ponding, as it should have been designed to cope with the loadings from the green roof.

For roof falls greater than 1 in 40 (2.5%), a BS EN 12056-3:2000 Category 2 or 3 storm event should be used, as there is a risk of structurally significant ponding in the event of the green roof area not absorbing all the storm water. Category 2 and 3 storm events are based on the building life multiplied by a factor of safety of 1.5 or 4.5, and results in much higher rainfall intensities ($0.029 l/(s \cdot m^2)$ to $0.088 l/(s \cdot m^2)$).

For further guidance on rainfall intensity in the United Kingdom see National Annex NB of BS EN 12056-3:2000.

Guide figures for Category 1 storm event

Area	Rainfall intensity $l/(s \cdot m^2)$
England	0.022
Scotland, Wales, and Northern Ireland	0.016
Northern Scotland, Shetlands and Orkneys	0.010

Table 4. Category 1 storm event



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