

Gravity drainage systems inside buildings —

Part 3: Roof drainage, layout and calculation

The European Standard EN 12056-3:2000 has the status of a
British Standard

ICS 91.060.20; 91.140.80

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 12056-3:2000. It supersedes BS 6367:1983 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee B/505, Wastewater engineering, to Subcommittee B/505/21, Roof drainage and sanitary pipework. Subcommittee B/505/21 was disbanded on 2 November 2000 and so Technical Committee B/505 assumes responsibility for this work.

A list of organizations represented on the technical committee can be obtained on request to its secretary.

In March 2007, Technical Committee B/505 introduced an amendment to BS EN 12056-3:2000 to delete National Annex NF. This annex is replaced by the test method given in BS 8490:2007, Annex B.

The remaining national annexes are an informative element of this standard and contain information provided to support easier implementation of EN 12056-3:2000 in the United Kingdom, within the framework envisaged by the scope of that standard. The remaining national annexes constitute a revision of those parts of BS 6367:1983 that were not otherwise superseded by BS EN 12056-3:2000. However, users are reminded that only the normative elements of the adopted European Standard set out the provisions to which it is necessary to conform in order to form part of a trade description when citing this British Standard by number or when compliance with it is claimed.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Additional information

It is recognized that Figure 2, Figure 3, Figure 4 and Figure 11, along with the logic diagrams contained in Annex D, are of poor quality. This has been reported to CEN in a proposal to correct them in the English language version of EN 12056-3:2000.

Until the standard is corrected, which BSI is not authorized to do, it is strongly recommended that these figures be used with care.

Textual errors

The textual errors set out below were discovered when the English language version of EN 12056-3:2000 was adopted as the national standard. They have been reported to CEN in a proposal to amend the text of the European Standard.

- Note 1 to Figure 8 should refer to Table 8, rather than Table 7.
- Note 3 to Figure 8 should refer to Table 8, rather than Table 7.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 September 2000

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Amendments issued since publication

Amd. No.	Date	Comments
17041	30 March 2007	Deletion of National Annex NF and revision of national foreword

English version

Gravity drainage systems inside buildings - Part 3: Roof drainage, layout and calculation

Réseaux d'évacuation gravitaire à l'intérieur des bâtiments -
Partie 3: Système d'évacuation des eaux pluviales,
conception et calculs

Schwerkraftentwässerungsanlagen innerhalb von
Gebäuden - Teil 3: Dachentwässerung, Planung und
Bemessung

This European Standard was approved by CEN on 27 October 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 165 "Waste water engineering", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2000, and conflicting national standards shall be withdrawn at the latest by June 2001.

This part is the third in a series relating to the functional requirements of gravity drainage systems inside buildings. There will be five parts, as follows: Gravity drainage systems inside buildings

Part 1: General and performance requirements

Part 2: Sanitary pipework - Layout and calculation

Part 3: Roof drainage - Layout and calculation

Part 4: Waste water lifting plants - Layout and calculation

Part 5: Installation and testing, instructions for operation, maintenance and use

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard applies to wastewater drainage systems, which operate under gravity. It is applicable for drainage systems inside dwellings and commercial, institutional and industrial buildings.

This third part of this European Standard describes a method of calculating the hydraulic adequacy of non-siphonic roof drainage systems and gives performance requirements for siphonic roof drainage systems. It also sets standards for the layout and installation of roof drainage insofar as they affect flow capacity.

This part of this European Standard applies to all roof drainage systems where the outlets are large enough not to limit the flow capacity of the gutter (i.e. free discharge conditions). It applies to all materials used for roof drainage systems.

Detailed information additional to that contained in this Standard may be obtained by referring to the technical documents listed in Annex B.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 12056-1:	Gravity drainage systems inside buildings Part 1: General and performance requirements
EN 12056-2:	Gravity drainage systems inside buildings Part 2: Sanitary pipework, layout and calculation
EN 12056-5	Gravity drainage systems inside buildings Part 5: Installation and testing, instructions for operation, maintenance and use

3 Definitions and symbols

3.1 Definitions

For the purposes of this European Standard, the following definitions apply:

- 3.1.1 **gutter angle**
deviation in gutter direction
- 3.1.2 **design water depth**
maximum depth of water under design rainfall conditions
- 3.1.3 **drainage length**
length of gutter from a stop end to an outlet or half the distance between adjacent outlets, in millimetres
- 3.1.4 **eaves gutter**
gutter where any spillover will discharge outside the building
- 3.1.5 **flat sole**
sole of the gutter, which is horizontal in cross-section for at least the width of the outlet
- 3.1.6 **freeboard**
total depth of gutter minus the designed water depth
- 3.1.7 **long gutter**
gutter whose drainage length is greater than 50 times its design water depth
- 3.1.8 **roof drainage of buildings**
all pipework and fittings outside and inside, fixed to or passing through the building structure, including drains below the building, to the point of connection to the buried drain adjacent to the building, used to remove precipitation from a roof (See Scope of EN 12056-1.)
- 3.1.9 **short gutter**
gutter whose drainage length is not greater than 50 times its design water depth
- 3.1.10 **siphonic drainage system**
drainage system in which the outlets and pipework enable the system to flow completely full under design conditions and make use of the total head available between the outlets and the discharge point
- 3.1.11 **spillover level**
level at which water will overflow the gutter

3.2 Symbols

For the purposes of this European Standard, the following symbols have been used:

Symbol	Description	Unit	Text reference
A	effective roof area	m^2	Table 3
A_E	full cross-sectional area of gutter	mm^2	5.1.2
A_W	cross-sectional area of the gutter below the freeboard	mm^2	5.2.3
A_O	plan area of a gutter outlet	mm^2	Figure 8
B_R	width of roof from gutter to ridge	m	Figure 1
C	runoff coefficient	dimensionless	4.1
d_i	internal diameter of pipe	mm	Table 8
D	effective diameter of a gutter outlet	mm	Figure 9
D_O	actual diameter of a gutter outlet	mm	Figure 9
f	filling degree of rainwater pipe which is equal to the proportion of cross-section of rainwater pipe filled with water	dimensionless	Table 8
F_d	depth factor	dimensionless	Figure 5
F_h	outlet head factor	dimensionless	Figure 10
F_L	capacity factor for long and sloping gutters	dimensionless	Table 6
F_s	shape factor	dimensionless	Figure 6
h	head at outlet	mm	Table 7
H_R	height of roof from gutter to ridge	m	Figure 1
h_d	water depth in drain	mm	annex C
i	pipe or gutter gradient	dimensionless	annex C
k_b	effective pipe roughness	mm	Table 8
k_O	outlet coefficient	dimensionless	Table 7
L	drainage length of gutter, i.e. length of gutter from a stop end to an outlet or half the distance between two adjacent outlets	mm	Table 6
L_R	length of roof to be drained	m	Figure 1
L_S	length of sump	mm	Figure 11
L_K	length of taper of a gutter outlet	mm	Figure 9
L_W	length of weir over which water can flow	mm	5.3.5 and Figure 12
Q	rate of flow of water	l/s	4.1
Q_d	drain capacity	l/s	annex C
Q_L	design capacity of "short" gutter, laid level	l/s	5.1.2
Q_N	nominal capacity of gutter	l/s	5.1.2
Q_O	total flow to an outlet (calculated on area drained multiplied by the rainfall intensity)	l/s	Table 7

Symbol	Description	Unit	Text reference
Q_{RWP}	capacity of a rainwater pipe	l/s	Table 8
Q_{SE}	capacity of an equivalent square eaves gutter	l/s	5.1.4 and Figure 3
Q_{SV}	capacity of an equivalent square valley or parapet gutter	l/s	5.2.3
R	is the radius of a gutter outlet	mm	Figure 9
r	rainfall intensity	l/(s·m ²)	4.2
S	width of gutter at sole	mm	Figure 4
T	width of gutter at designated water line	mm	Figure 4
T_R	distance from gutter to ridge measured along the roof	m	Figure 1
P	wetted perimeter	mm	annex A
v	flow velocity	m/s	annex C
W	design water depth	mm	Figure 4
Z	total depth of gutter to spillover level, including freeboard	mm	Figure 4
ν	kinematic viscosity of water	m ² /s	annex C

4 Runoff calculations

4.1 Quantity of rainwater runoff

The rate of flow of rainwater to be drained away from a roof under steady state conditions shall be calculated from equation 1:

$$Q = r \cdot A \cdot C \quad (1)$$

where

- Q is the rate of flow of water, in litres per second (l/s);
- r is the rainfall intensity, in litres per second per square metre [l/(s · m²)];
- A is the effective roof area, in square metres (m²);
- C is a runoff coefficient (taken as 1,0 unless national and local regulations and practice state otherwise), dimensionless.

4.2 Rainfall intensity, r

- 4.2.1 Where there is adequate statistical rainfall data related to the frequency of recurrence of storms of specific intensity and duration, the rainfall intensity, r , used in equation 1 shall be chosen with due regard to the nature and use of the building and appropriate to the degree of risk that can be accepted. Where statistical rainfall data is used, clause 4.2.2 shall not apply.
- 4.2.2 Where statistical rainfall data does not exist, a minimum rainfall intensity used as a basis for design shall be chosen from the intensities listed in Table 1, appropriate to the climate at the location of the building and in accordance with national and local regulations and practice. The minimum rainfall intensity shall be multiplied by a risk factor given in Table 2 to give the rainfall intensity, r , to be used in equation 1, unless national and local regulations and practice state otherwise.

Table 1 — Rainfall intensity rates

Rainfall intensity $l/(s \cdot m^2)$
0,010
0,015
0,020
0,025
0,030
0,040
0,050
0,060

Table 2 — Risk factors

Situation	Risk factor
Eaves gutters	1,0
Eaves gutters where water overflowing would cause particular inconvenience, e.g. over entrances to public buildings	1,5
Non-eaves gutters and in all other circumstances where abnormally heavy rain or blockage in the roof drainage system could cause water to spillover into the building	2,0
For non-eaves gutters in buildings where an exceptional degree of protection is necessary, e.g. - hospital operating theatres - critical communications facilities - storage for substances that give off toxic or flammable fumes when wet - buildings housing outstanding works of art	3,0

4.3 Effective roof area, A

4.3.1 No allowance shall be made for the effects of wind when calculating the effective roof area, unless national and local regulations and practice state otherwise.

4.3.2 Where no allowance is made for wind, the effective roof area shall be calculated from equation (2):

$$A = L_R \cdot B_R \quad (2)$$

where

A is the effective roof area, in square metres (m²);
 L_R is the length of roof to be drained (see Figure 1), in metres (m);
 B_R is the width of roof from gutter to ridge (see Figure 1), in metres (m).

4.3.3 Where allowance is made for wind, the effective roof area shall be calculated in accordance with a method selected from Table 3.

4.3.4 In areas where wind is taken into account in rainfall calculations, where rain driven against a wall by the wind can run down onto the roof or into a gutter, 50% of the area of the wall shall be added to the effective area of the roof.

Table 3 — Effective impermeable roof area

Allowance to be made for the effect of wind	Effective impermeable roof area, A m ²
Wind driven rain, 26° to vertical	$A = L_R \cdot \left(B_R + \frac{H_R}{2} \right)$
Rain perpendicular to roof (i.e. surface area of roof used)	$A = L_R \cdot T_R$
NOTES: L_R is the length of roof to be drained, in metres (m); B_R is the plan width of roof from gutter to ridge, in metres (m); H_R is the height of roof from gutter to ridge, in metres (m); T_R is the distance from gutter to ridge measured along the roof, in metres (m); A is the effective impermeable roof area, in square metres (m²). Figure 1 illustrates these dimensions.	

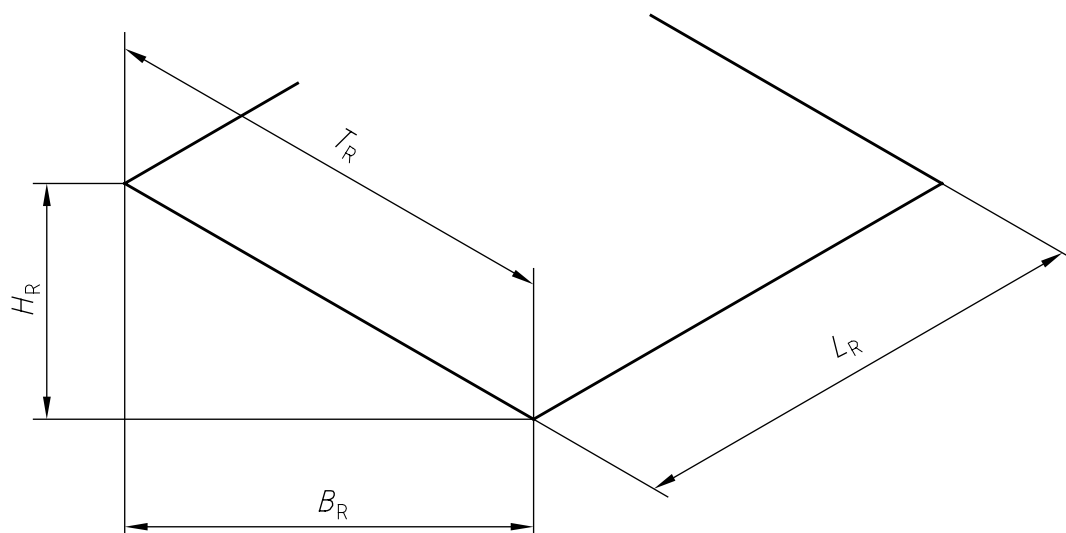


Figure 1 — Roof dimensions

5 Hydraulic design

5.1 Eaves gutters

- 5.1.1 Gutters may be laid level or to a gradient, unless stated otherwise by local or national regulation. A gutter laid to a nominal gradient of 3 mm/m or less (referred to as "nominally level") shall be designed as a level gutter.
- 5.1.2 For eaves gutters of semi-circular and similar shape, designed as level and with outlets capable of allowing free discharge, the capacity shall be calculated using its cross-sectional area and shape, from equation (3):

$$Q_L = 0,9 \cdot Q_N \quad (3)$$

where

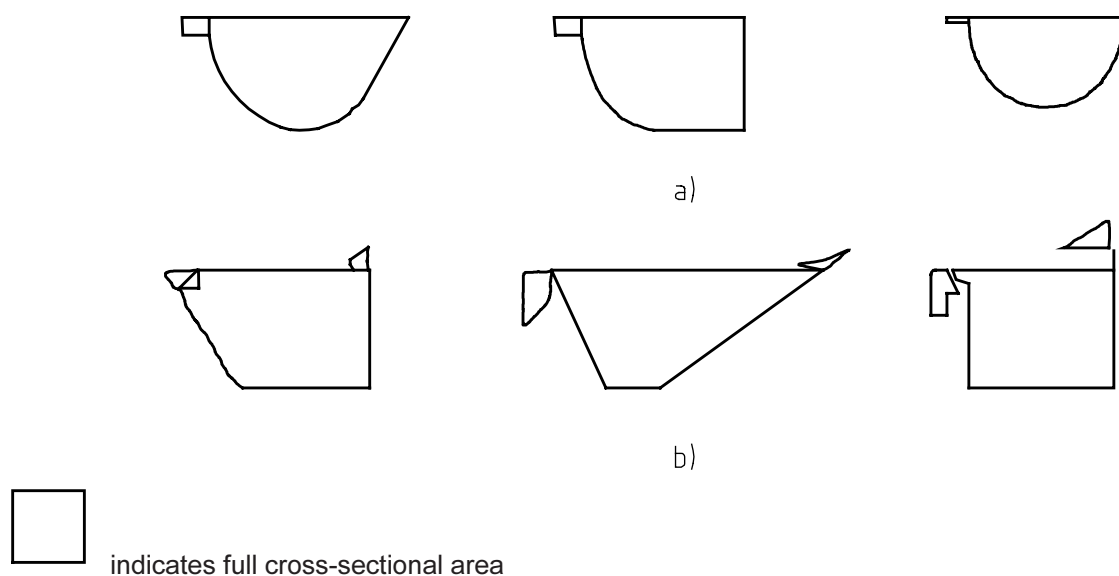
Q_L is the design capacity of "short" gutter, see 5.1.6, laid level, in litres per second (l/s);
 0,9 is a factor of safety, dimensionless;
 Q_N is the nominal capacity of the gutter, calculated as
 $2,78 \cdot 10^{-5} \cdot A_E^{1,25}$ or determined by test, in litres per second (l/s);
 A_E is the full cross-sectional area of gutter, in square millimetres (mm²).

NOTE 1:

The full cross-sectional area of a gutter is the area of the cross-section below spillover level, as illustrated in Figure 2.

NOTE 2:

For convenience, the variation of Q_N with A_E is shown in Figure 3.



a) semi-circular and similar shape gutters

b) trapezoidal gutters

Figure 2 — Illustrations of full cross-sectional area of gutters

- 5.1.3 The capacity of a gutter of semi-circular or similar shape when tested in accordance with annex A may be substituted for calculated values of Q_N . Q_N determined by test shall be multiplied by a safety factor of 0,9 to give Q_L used for design purposes.
- 5.1.4 For eaves gutters of rectangular, trapezoidal and similar shapes (see Figure 4), designed as level and with outlets capable of allowing free discharge, the capacity shall be calculated from equation (4):

$$Q_L = 0,9 \cdot Q_N \quad (4)$$

where

- Q_L is the design capacity of "short" gutter, see 5.1.6, laid level, in litres per second (l/s);
- 0,9 is the factor of safety, dimensionless;
- Q_N is the nominal capacity of the gutter, calculated as $Q_{SE} \cdot F_d \cdot F_s$ or determined by test, in litres per second (l/s);
- Q_{SE} is the capacity of an equivalent square eaves gutter, calculated as $3,48 \times 10^{-5} \cdot A_E^{1,25}$, in litres per second (l/s);
- A_E is the full cross-sectional area of gutter, in square millimetres (mm²);
- F_d is the depth factor, determined from Figure 5, dimensionless;
- F_s is the shape factor, determined from Figure 6, dimensionless.

NOTE 1:

The full cross-sectional area of a gutter is the area of the cross-section below spillover level, as illustrated in Figure 2.

NOTE 2:

For convenience, the variation of Q_{SE} with A_E is shown in Figure 3.

NOTE 3:

Figure 4 illustrates the shapes and dimensions of gutters to which Figures 5, 6, 7 and 10 apply.

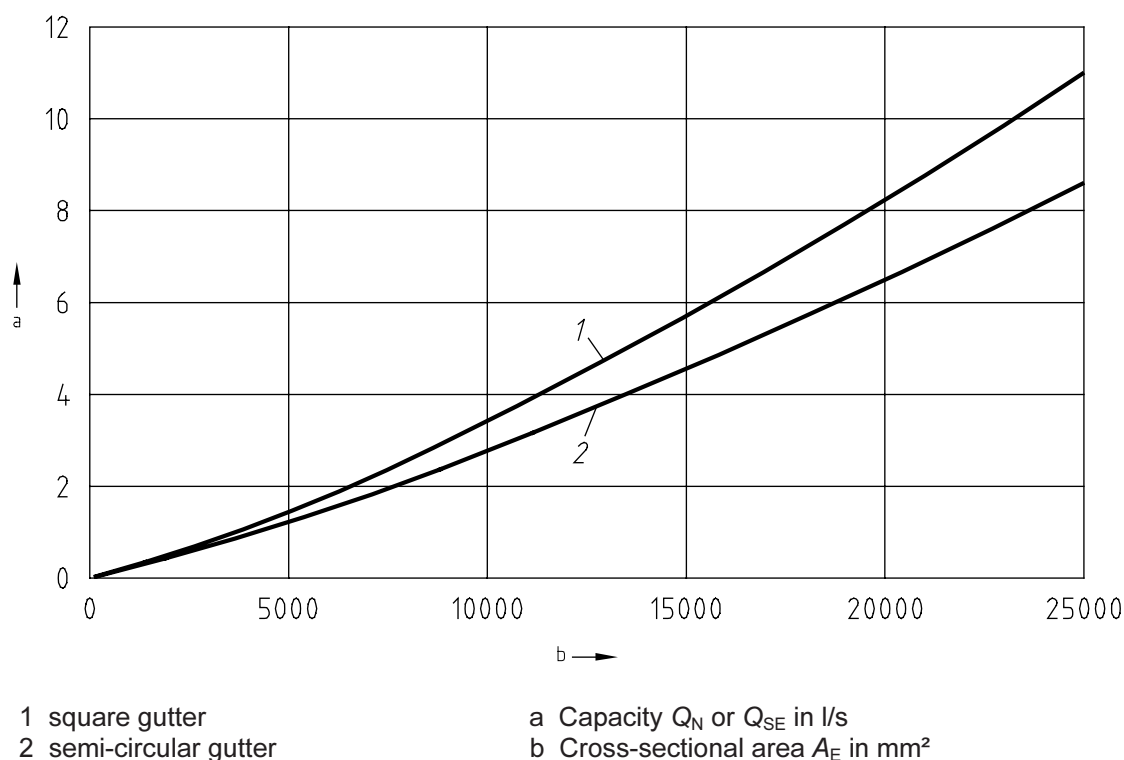


Figure 3 — Capacity of eaves gutters

- 5.1.5 The capacity of a gutter of rectangular, trapezoidal and similar shapes when tested in accordance with annex A may be substituted for calculated values of Q_N . Q_N determined by test shall be multiplied by a safety factor of 0,9 to give Q_L used for design purposes.
- 5.1.6 A gutter shall be considered to be hydraulically "short" if its length, L , (see Table 6) is not greater than 50 times the design depth of water, W , (see Figure 4) which in the case of an eaves gutter is equal to its overall depth to spillover. For sloping or level gutters that exceed this limit, the design capacity Q_L from 5.1.2 or 5.1.4 shall be multiplied by the appropriate capacity factor, F_L , from Table 6, i.e. the gutter capacity is $Q_L \cdot F_L$.
- 5.1.7 The capacity factors, F_L , for sloping gutters given in Table 6 are only applicable if each section of gutter in a continuous length has a downward slope towards the outlet that drains it. If a gutter with a continuous slope has more than one outlet, the increase in capacity of a length with a favourable slope will be approximately balanced by the decrease in capacity of a length with an adverse slope. In such cases, all gutter lengths shall be designed as though they were nominally level.
- 5.1.8 Values of gutter design capacity, Q_L , obtained from 5.1.2 or 5.1.4, shall be multiplied by a reduction factor of 0,85 where a gutter length contains one or more gutter angles greater than 10° . Angles should be avoided close to an outlet.

5.2 Valley and parapet gutters

- 5.2.1 Valley and parapet gutters may be laid level or to a gradient, unless stated otherwise by local and national regulation and practice. A gutter laid to a nominal gradient of 3 mm/m or less (referred to as "nominally level") shall be designed as a level gutter.
- 5.2.2 The minimum freeboard at the upstream end of a valley or parapet gutter shall be not less than the dimension given in Table 5. Above the water line, the sides of the gutter are not required to continue at the same slope as below the water line but shall not slope sharply inwards (see Figure 4).

Table 5 — Minimum freeboard for valley and parapet gutters

Depth of gutter including freeboard, Z mm	Minimum freeboard mm
Less than 85	25
85 to 250	0,3 Z
Greater than 250	75

- 5.2.3 For a valley or parapet gutter of rectangular, trapezoidal or similar shape (see Figure 4), designed as level and with an outlet capable of allowing free discharge, the capacity shall be calculated from equation (5):

$$Q_L = 0,9 \cdot Q_N \quad (5)$$

where

- Q_L is the design capacity of "short" gutter, see 5.2.5, laid level, in litres per second (l/s);
0,9 is a factor of safety, (dimensionless);
 Q_N is the nominal capacity of the gutter, calculated as $Q_{SV} \cdot F_d \cdot F_s$, in litres per second (l/s);
 Q_{SV} is the capacity of an equivalent square valley or parapet gutter, calculated as $3,89 \cdot 10^{-5} \cdot A_W^{1,25}$, in litres per second (l/s);
 A_W is the cross-sectional area of the gutter below the freeboard, in square millimetres (mm²);
 F_d is the depth factor, determined from Figure 5, dimensionless;
 F_s is the shape factor, determined from Figure 6, dimensionless.

NOTE:

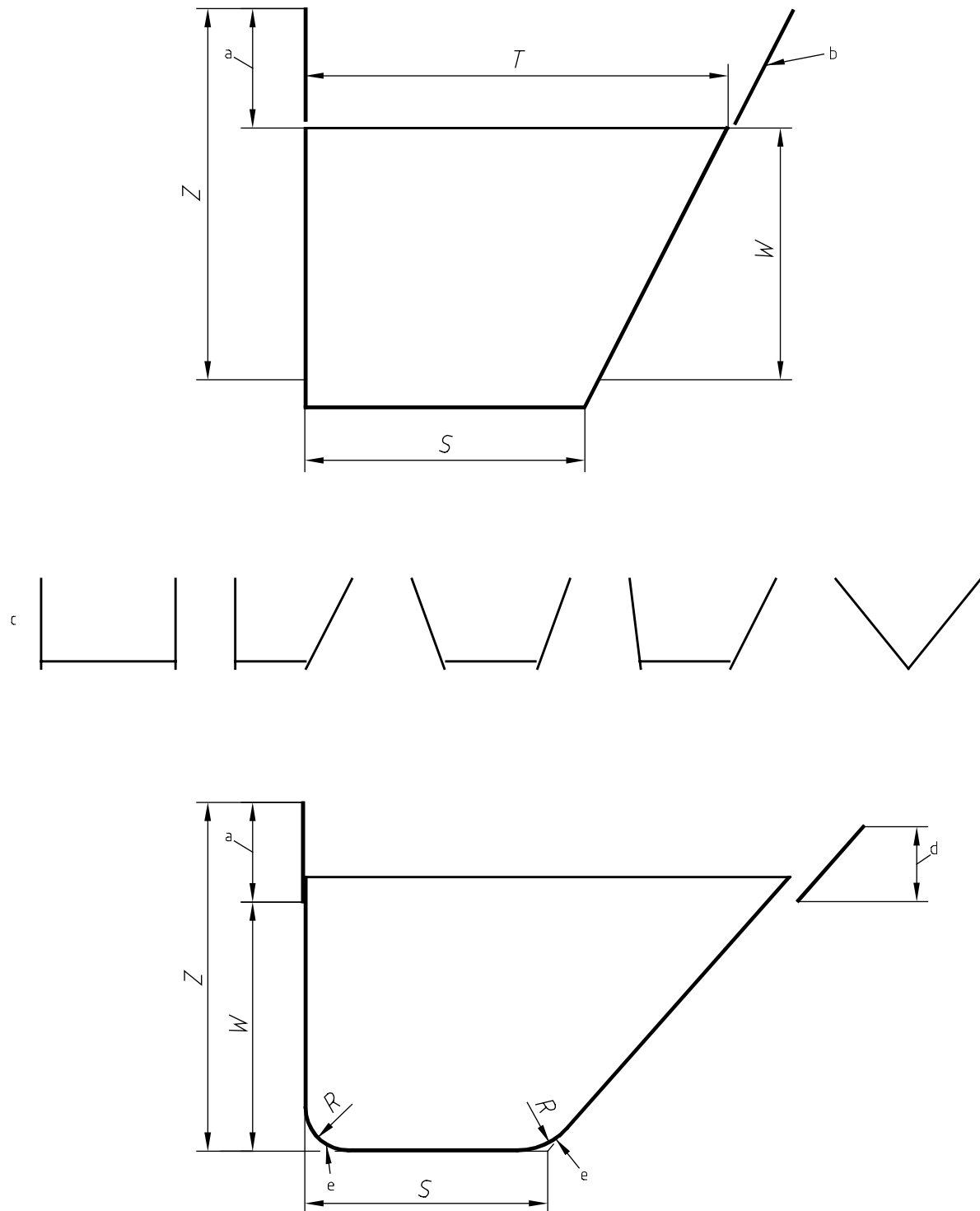
For convenience, the variation of Q_{SV} with A_W is plotted in Figure 7.

- 5.2.4 The capacity of a gutter when tested in accordance with annex A may be substituted for calculated values of Q_N . Q_N determined by test shall be multiplied by a safety factor of 0,9 to give Q_L used for design purposes.

- 5.2.5 A gutter shall be considered to be hydraulically "short" if its drainage length, L , is not greater than 50 times the design depth of water, W , which in the case of a valley or parapet gutter is equal to its overall depth to spillover less the allowance for freeboard. For sloping or level gutters that exceed this limit, the design capacity Q_L from 5.2.3 or 5.2.4 shall be multiplied by the appropriate capacity factor, F_L , from Table 6, i.e. the overall gutter capacity is $Q_L \cdot F_L$.
- 5.2.6 The capacity factors, F_L , for sloping gutters given in Table 6 are only applicable if each section of gutter in a continuous length has a downward slope towards the outlet that drains it. If a gutter with a continuous slope has more than one outlet, the increase in capacity of a length with a favourable slope will be approximately balanced by the decrease in capacity of a length with an adverse slope. In such cases, all gutter lengths shall be designed as though they were nominally level.
- 5.2.7 Where obstructions are present in a valley or parapet gutter (such as walkways), twice the area of the obstruction viewed in the direction of the cross-section, shall be deducted from the cross-sectional area of the gutter, A_W , when calculating its capacity.

5.2.8 Table 6 — Capacity factor, F_L , for long gutters, nominally level or sloping towards an outlet

$\frac{L}{W}$	Capacity factor, F_L				
	Nominally level 0 mm/m to 3 mm/m	Gradient 4 mm/m	Gradient 6 mm/m	Gradient 8 mm/m	Gradient 10 mm/m
50	1,00	1,00	1,00	1,00	1,00
75	0,97	1,02	1,04	1,07	1,09
100	0,93	1,03	1,08	1,13	1,18
125	0,90	1,05	1,12	1,20	1,27
150	0,86	1,07	1,17	1,27	1,37
175	0,83	1,08	1,21	1,33	1,46
200	0,80	1,10	1,25	1,40	1,55
225	0,78	1,10	1,25	1,40	1,55
250	0,77	1,10	1,25	1,40	1,55
275	0,75	1,10	1,25	1,40	1,55
300	0,73	1,10	1,25	1,40	1,55
325	0,72	1,10	1,25	1,40	1,55
350	0,70	1,10	1,25	1,40	1,55
375	0,68	1,10	1,25	1,40	1,55
400	0,67	1,10	1,25	1,40	1,55
425	0,65	1,10	1,25	1,40	1,55
450	0,63	1,10	1,25	1,40	1,55
475	0,62	1,10	1,25	1,40	1,55
500	0,60	1,10	1,25	1,40	1,55
NOTES: L is the drainage length of gutter, in millimetres (mm); W is the design water depth, i.e. full depth of gutter to spillover level for eaves gutters or depth of gutter to spillover level less freeboard allowance for valley and parapet gutters, in millimetres (mm).					



- a Freeboard
- b Extensions of the sides of valley gutters do not form part of the gutter for the purposes of Figures 5, 6, 7 and 10 (see 5.2.2)
- c Applicable to:
- d Spillover level
- e Rounded corners shall be allowed for in calculating cross-sectional area but, for the purpose of Figures 6 and 10, S may be measured to the point indicated provided that R is not greater than $W/4$
- S Width at sole
- T Width at designed water line
- W Depth below designed water line

Figure 4 — Dimensions for use with Figures 5, 6, 7 and 10

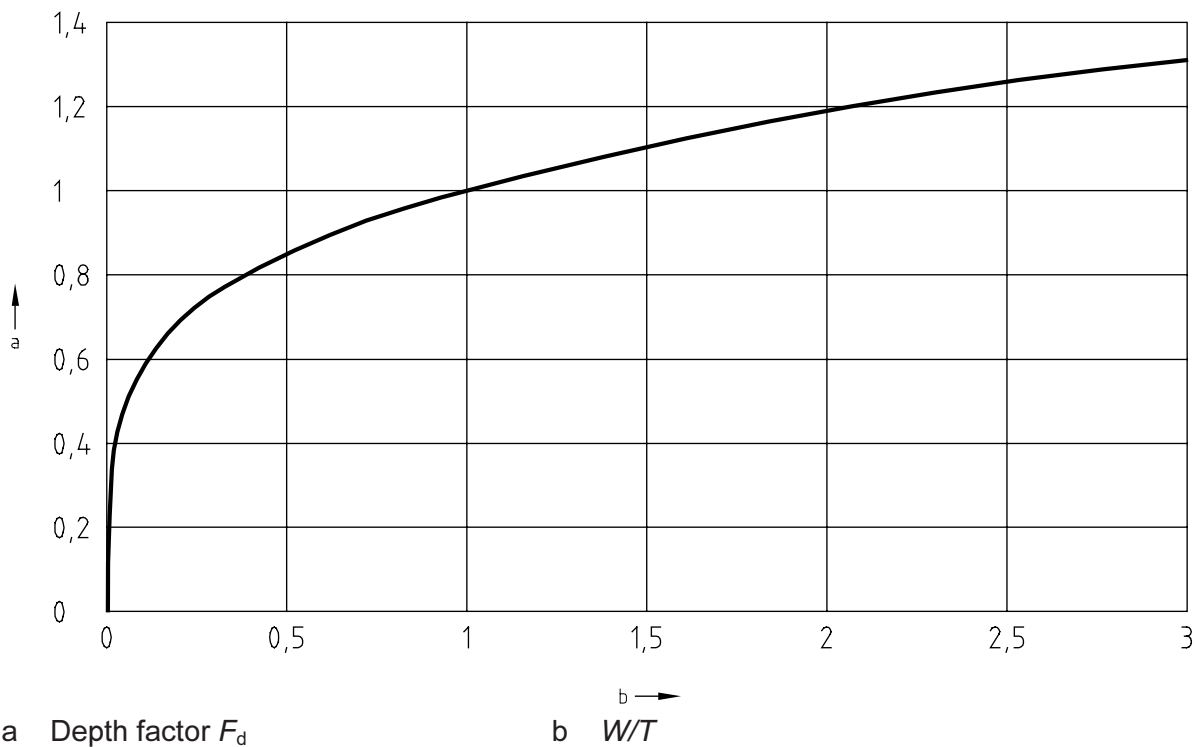


Figure 5 — Depth factor, F_d

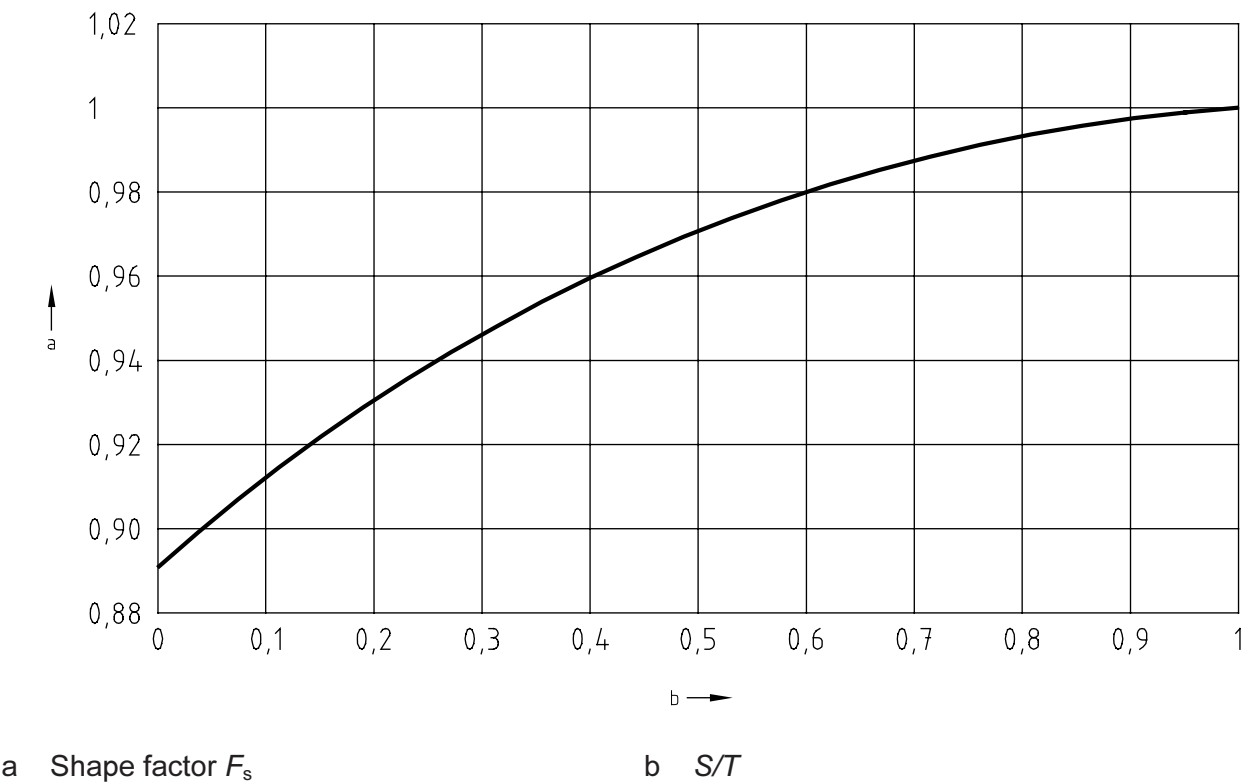
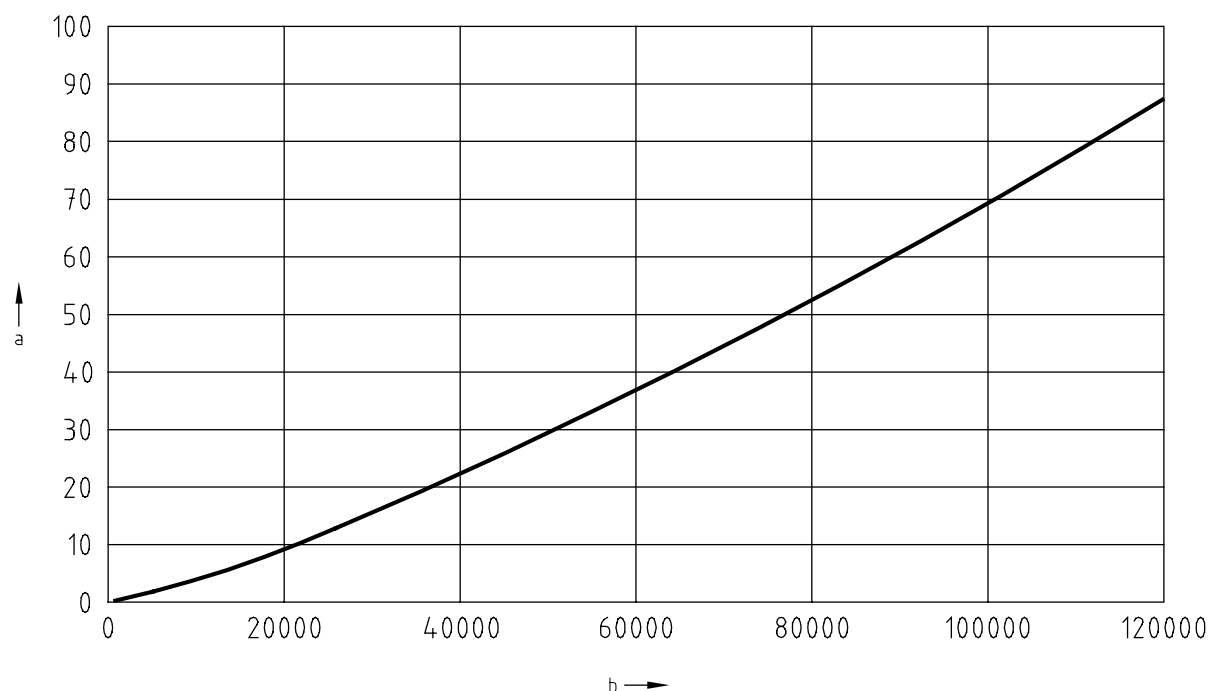


Figure 6 — Shape factor, F_s

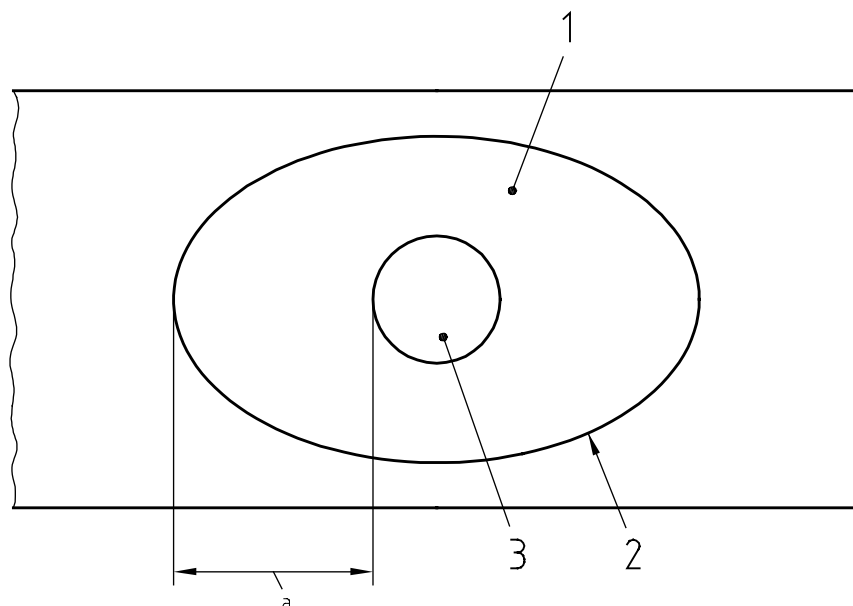


- a Capacity Q_{sv} in l/s
- b Cross-sectional area to design water line A_w in mm²

Figure 7 — Capacity of square valley and parapet gutters, hydraulically short and nominally level

5.3 Gutter outlets

- 5.3.1 It is impractical to lay down simple rules for the dimensions of outlets from gutters with non-flat soles, and in general their capacities should be established by test (see annex A). Outlets from gutters with flat soles should be calculated in accordance with 5.3.4 or determined by test.
- 5.3.2 For non-flat soled gutters, experience has shown that, where the opening in the sole of the gutter has a plan area approximately twice that of the cross-sectional area of the smallest rainwater pipe capable of taking the flow (calculated from Table 8), and a smooth transition to the rainwater pipe, the outlet is deemed to be adequate for the capacity of the gutter laid nominally level. This arrangement is shown in Figure 8. National and local regulation and practice may also dictate minimum dimensions of outlets.
- 5.3.3 When an outlet from a non-flat soled gutter is fitted with a strainer, the capacity of the gutters leading to it shall be multiplied by a factor of 0,5.
- 5.3.4 The capacity of an outlet from a gutter, having a flat sole wider than the diameter of the outlet, shall be calculated using the equations given in Table 7.



- 1 Area $\geq 2 \times$ cross-sectional area of rainwater pipe calculated from Table 7
 - 2 Edge of outlet transition
 - 3 Minimum size of rainwater pipe capable of taking flow (Table 7)
- a $\geq$ gutter depth, Z

Figure 8 — Outlets from non-flat soled gutters, to illustrate 5.3.2

- 5.3.5 When an outlet from a gutter is fitted in the bottom of a sump or box receiver (see Figure 11), the minimum length of weir from the gutter to the box shall be calculated from Figure 12, using a head not exceeding that necessary to allow free discharge conditions in the gutter which may be obtained from Figure 10. The length of weir may be taken as being the perimeter of the box receiver, over which water can flow; for a circular outlet this is $\pi \cdot D_o$ (where D_o is defined in Figure 9).

NOTE:

Figure 12 may be used to find the capacity of overflows from valley gutters, overflow openings in parapets and chutes discharging through openings in parapets of flat roofs into rainwater heads.

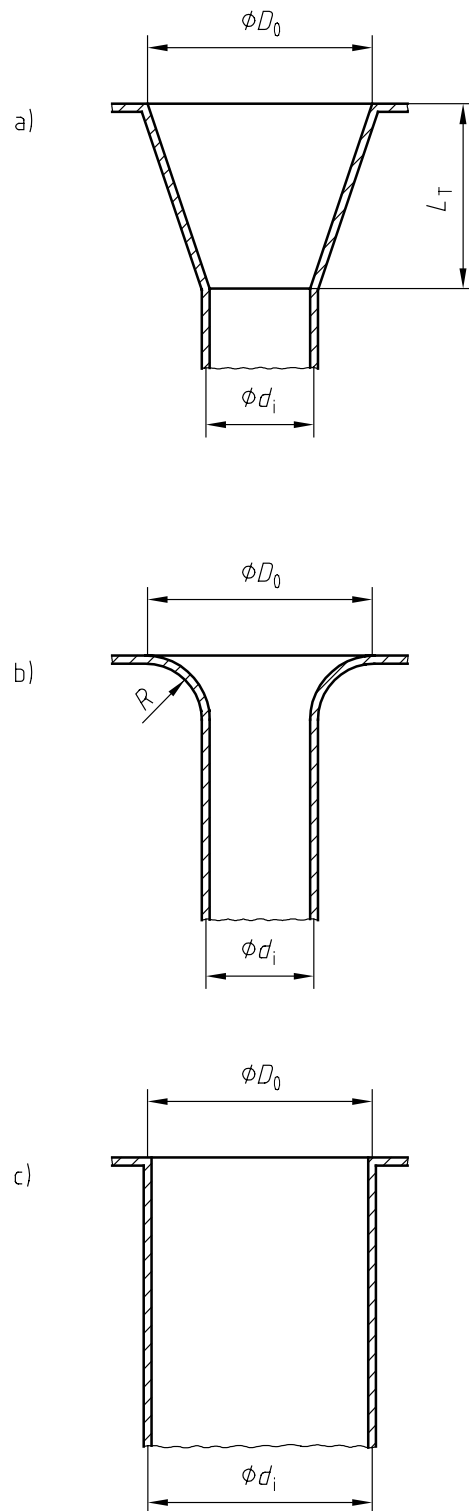
Table 7 — Outlet capacity

	Circular outlets	Non-circular outlets
Weir flow	$Q_O = \frac{k_O D h^{1.5}}{7\,500}$ Valid where $h = \frac{D}{2}$ or less	$Q_O = \frac{k_O L_W h^{1.5}}{24\,000}$ Valid where $h = \frac{2 A_O}{L_W}$ or less
Orifice flow	$Q_O = \frac{k_O D^2 h^{0.5}}{15\,000}$ Valid where $h > \frac{D}{2}$	$Q_O = \frac{k_O A_O h^{0.5}}{12\,000}$ Valid where $h > \frac{2 A_O}{L_W}$
NOTES: Q_O is the total flow to the outlet (calculated on area drained by the outlet in accordance with section 4), in litres per second; D is the effective diameter of the outlet (see Figure 9), in millimetres; h is the head at outlet (see note 3), in millimetres; k_O is the outlet coefficient, dimensionless, taken as: 1,0 for unobstructed outlets, 0,5 for outlets fitted with strainers or gratings; L_W is the length of weir over which water can flow, in millimetres; A_O is the plan area of outlet, in square millimetres. - For the weir flow equation to be applicable, there shall be a gap between the edge of the outlet and the side of the gutter of at least 5% of the diameter of the outlet. - The head at the outlet, h, of a trapezoidal, rectangular or triangular gutter is the designed maximum depth of flow, W, multiplied by the outlet head factor, F_h, taken from Figure 10, depending upon S/T (see Figure 4), i.e. $h = F_h \cdot W$.		

5.4 Flat roof outlets

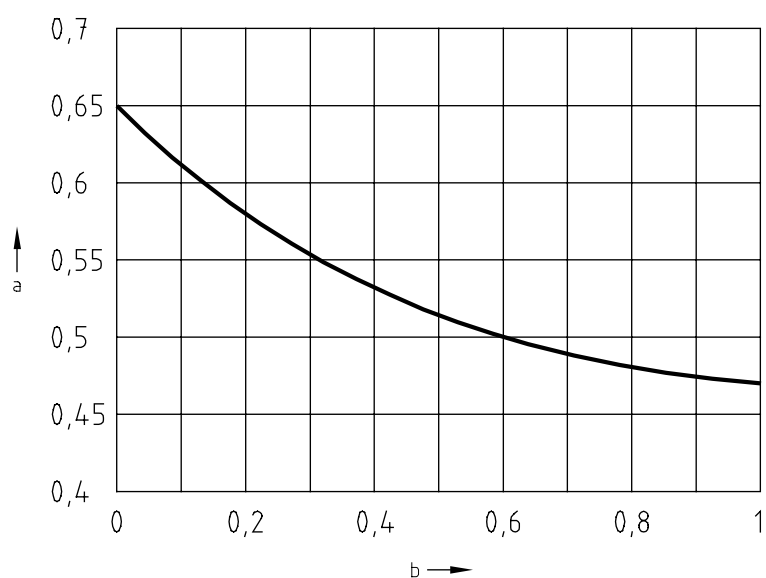
5.4.1 The drainage of flat roofs shall take into account the strength and construction of the roof.

5.4.2 Any outlet, overflow or chute shall be designed so that its operating head does not cause a build up of water that exceeds the roof design loading or penetrates the roof covering, e.g. through joints.



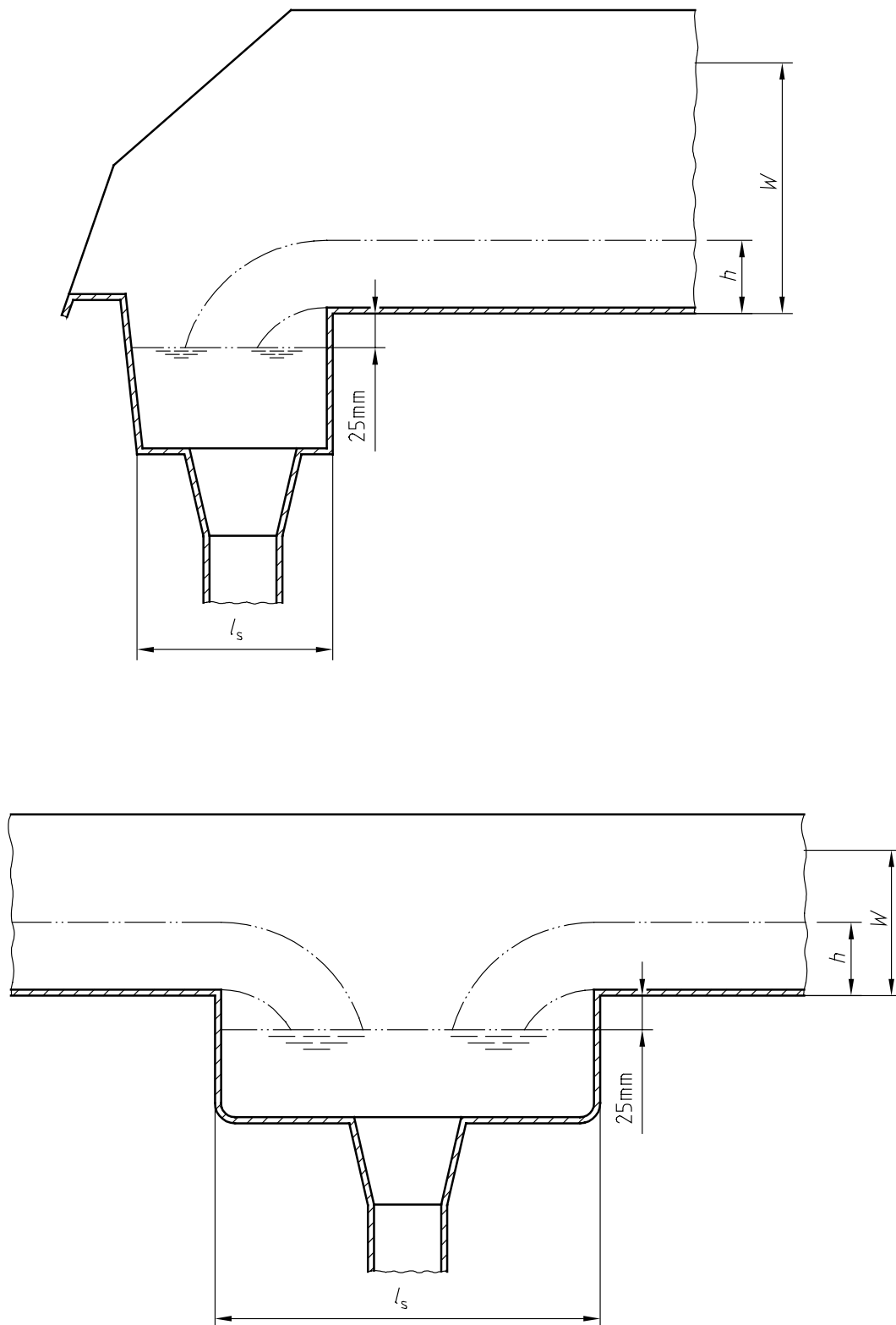
- a) Tapered outlet
 $D_0 \geq 1,5 \cdot d_i$; $L_T \geq D_0$; Effective diameter $D = D_0$
- b) Round-edged outlet
 $D_0 \geq 1,5 \cdot d_i$; $R \geq D_0/6$; Effective diameter $D = 0,9 \cdot D_0$
- c) Sharp-edged outlet
 Effective diameter $D = D_0 = d_i$

Figure 9 — Effective diameters of gutter outlets



a Outlet head factor F_h
b S/T

Figure 10 — Outlet head factor, F_h , for determining available head at outlet



above: Sump at end of valley gutter or parapet outlet
below: Sump in valley gutter

Figure 11 — Box receivers or sumps