

Code of practice for

Drainage of roofs and paved areas —

(Formerly CP 308)

UDC 696.12

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The preparation of this British Standard was entrusted by the Building Services Standards Committee (SEB/-) to Technical Committee SEB/14 upon which the following bodies were represented:

- British Plastics Federation
- Clay Pipe Development Association limited
- Department of the Environment (PSA)
- Department of the Environment (Hydraulic Research Station)
- Incorporated Association of Architects and Surveyors
- Institution of Plumbing
- Institution of Public Health Engineers
- Institute of Structural Engineers
- Ministry of Defence
- National Coal Board
- Royal Institute of British Architects

This British Standard, having been prepared under the direction of the Building Services Standards Committee, was published under the authority of the Executive Board and comes into effect on 30 September 1983

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First published, as CP 308, April 1974
First revision, as BS 6367, September 1983

The following BSI references relate to the work on this standard:
Committee reference SEB/14
Draft for comment 81/11326 DC

ISBN 0 580 13402 4

Amendments issued since publication

Amd. No.	Date of issue	Comments
4444	January 1984	Indicated by a sideline in the margin

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Foreword

This code, prepared under the direction of the Building Services Standards Committee, is a complete revision of CP 308:1974, which is withdrawn. The principal innovations in this new code are as follows.

- a) More information is now available on the incidence of rain storms in the UK and it has therefore been possible to include geographical location as a factor in design.
- b) Recent research has provided new experimental information on gutter outlets and certain equations have been revised to take full account of the cross-sectional shape of the gutter. This leads to greater economy. In CP 308:1974, for example, the theoretical safety factor in terms of discharge varied from 24 % in rectangular gutters to 164 % in triangular gutters. In this revised code all valley gutters have a safety factor of 24 %.
- c) A section has been added on the effect of resistance in long gutters.
- d) The section on paved areas is presented in a new way so as to make it easier to use, but the basis of the design method has not been altered.

In the past, the basic principles of roof and yard drainage have not been available in a convenient form, in some cases resulting in inadequate design.

In this revision, by the use of tables and similar methods, the body of the code has been kept as simple as possible for those dealing with standard products and applications. In order to help provide solutions where special problems arise, the appendices give the fundamental meteorological and hydraulic data.

Acknowledgement is made to all committee members but in particular to the representatives of the Hydraulics Research Station and of the Meteorological Office for their very considerable contributions.

The numbers in square brackets in the text of this standard relate to the bibliographic references in Appendix D.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 56, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This code deals with the drainage of surface water from roofs, walls and paved areas and recommends methods of designing gutters, gutter outlets, rainwater pipes, and inlets to gullies and to discharge stacks as described in BS 5572. Paved areas include estate roads but not high-speed roads.

The code also gives guidance on the choice of materials (section 2) and on fixing and jointing the drainage systems (section 4). Section 5 deals with inspection, testing and maintenance.

NOTE The titles of the publications referred to in this code are listed on the inside back cover.

2 Definitions

For the purposes of this code the definitions given in BS 892, BS 2717, BS 4118 and BS 5168 apply.

3 Letter symbols

The letter symbols used in this code are listed and defined in Appendix E.

Section 2. Materials and components

4 Materials and components for rainwater goods

4.1 General

Materials and components for rainwater goods, e.g. gullies, pipes, fittings and fixing accessories, should comply with British Standards, for example those listed below.

BS 65, *Specification for vitrified clay pipes, fittings and joints.*

BS 416, *Cast iron spigot and socket soil, waste and ventilating pipes (sand cast and spun) and fittings.*

BS 437, *Specification for cast iron spigot and socket drain pipes and fittings.*

BS 460, *Cast iron rainwater goods.*

BS 497, *Specification for manhole covers, road gully gratings and frames for drainage purposes.*

BS 569, *Asbestos-cement rainwater goods.*

BS 1091, *Pressed steel gutters, rainwater pipes, fittings and accessories.*

BS 1178, *Milled lead sheet and strip for building purposes.*

BS 1431, *Wrought copper and wrought zinc rainwater goods.*

BS 1494, *Fixing accessories for building purposes.*

BS 2997, *Aluminium rainwater goods.*

BS 3656, *Specification for asbestos-cement pipes, joints and fittings for sewerage and drainage.*

BS 4514, *Unplasticized PVC soil and ventilating pipe, fittings and accessories.*

BS 4576, *Unplasticized PVC rainwater goods.*

BS 4660, *Unplasticized PVC underground drain pipe and fittings.*

BS 5493, *Code of practice for protective coating of iron and steel structures against corrosion.*

BS 5911, *Precast concrete pipes and fittings for drainage and sewerage.*

BS 6150, *Code of practice for painting of buildings.*

CP 143, *Sheet roof and wall covering.*

CP 144, *Roof coverings.*

The materials listed in a) to j) below are widely and successfully used in roof and paving drainage work. They have different physical characteristics that should be taken into account during handling and fixing and for each of these materials reference should be made to the relevant code of practice and to manufacturer's instructions. Materials should be used in sections that enable the system to withstand the maximum hydraulic head that could occur should a blockage take place at the lowest point (see clause 17).

Guidance on the avoidance of bimetallic corrosion is given in PD 6484. See also clause 18 of this code.

a) *Aluminium*¹⁾ (BS 2997 and BS 6150).

Aluminium should be protected from contact with or run-off to or from cast iron, steel (including stainless), copper, alkaline concrete, mortar or plaster. Protect where necessary by bitumen or other suitable coating. Paint or seal joints or overlaps. Protect overall in heavily polluted atmospheres.

b) *Asbestos-cement* (BS 569). Mechanical working of asbestos-cement is subject to the provisions of the Asbestos Regulations 1969. Methods of controlling dust levels are detailed in control and safety guides published by the Asbestos Research Council.

c) *Cast iron* (BS 416, BS 460, BS 5493 and BS 6150). Light cast iron sections are usually supplied primed, and heavy sections are usually supplied with a bituminous coating. External pipes should be fitted with stand-off ears, spacing pieces or holderbats so that subsequent painting can be continuous around the pipe. Inside surfaces of gutters should be painted.

d) *Copper*¹⁾ (BS 1431 and BS 6150). Copper should be protected by bituminous or other suitable coating from contact with or run-off from alkaline concrete, mortar or plaster. Unprotected copper may develop a green patina in the course of time which, however, is not generally harmful.

e) *Lead*¹⁾ (BS 1178). Lead should be protected from contact with or run-off from porous concrete or mortar which will lead to the formation of a carbonate scale.

f) *Low carbon steel* (BS 5493 and BS 6150). Low carbon steel should be hot dip galvanized, painted or stove enamelled.

¹⁾ These materials are suitable also for non-standard and decorative sections.

g) *Unplasticized PVC (uPVC) (BS 4514, BS 4576 and BS 4660)*. The impact strength of unplasticized PVC reduces with temperature and care should therefore be taken in handling at or below freezing point. Allow for a relatively high coefficient of thermal expansion.

h) *Zinc*²⁾ (BS 1431). Zinc should be protected by bituminous or other suitable coating from contact with or run-off from alkaline concrete, mortar or plaster.

i) *Precast concrete* (BS 5911)³⁾.

j) *Vitrified clay* (BS 65)³⁾.

²⁾ These materials are suitable also for non-standard and decorative sections.

³⁾ These material are suitable for certain drainage fitting, e.g. gullies, channels and kerbs.

Section 3. Design

5 Meteorological aspects of design

5.1 General

When designing drainage systems for roofs and paved areas it is normally impracticable to guard against very infrequent extremely heavy rainfall events. The designer should aim to achieve a balance between the cost of the rainwater run-off system and the frequency and consequences of flooding.

The capacity of roof and paved area drainage systems should be adequate to dispose of intense summer rains that usually occur in thunderstorms. Allowance should be made, where necessary, for the effect on the drainage capacity of wind concurrent with rain.

The frequency and severity of the intense short duration rains appropriate to this code are related to a number of factors, themselves dependent on geographical location. A report [1] prepared by the Meteorological Office allows for these factors and provides a method of estimating the return periods of high intensity, short duration rainfall events. The report shows that although the upland areas of northern and western Britain receive higher average annual rainfalls than lowland areas, it is in these lowland areas that very intense short duration rainfalls are more frequent.

Some examples of the return periods of design rainfall events are included in Appendix A.

5.2 Design rates of rainfall

It is not possible to ensure complete safety from flooding or overflow.

For the design of paved areas, except when overflow from them will present undue risk to persons or property (as, for example, in adjacent basements), a design rate of rainfall of 50 mm/h (category 1 in Appendix A) is recommended. A design rate of rainfall of 75 mm/h (category 2 in Appendix A) is generally satisfactory for roof gutters where overflow is not likely to occur inside a building and for other gutters where some risk to the contents of the building may be acceptable.

For other cases, design rates of rainfall corresponding approximately to a chosen return period should be used. The method to be used in the selection of these rates is described in Appendix A.

5.3 Wind

The entrance to a rain gauge lies in a horizontal plane and, as a result, recorded rates of rainfall take no account of the driving effect of wind concurrent with the rain. Allowance for the effect of the wind is not required when designing drainage for horizontal surfaces, or for other surfaces protected from the wind by nearby objects, but such an allowance should be considered where sloping or vertical surfaces occur that are freely exposed to the wind.

Information on the strength of the wind concurrent with intense rain is very limited. A recent analysis has shown that at times of peak rainfall an average angle of descent of wind-driven rain of one unit horizontal for each two units of descent should be allowed (26° to the vertical).

The method of determining the effect of wind on the run-off from pitched roofs and vertical surfaces is described in 7.1.3 and 7.1.4.

Each eaves gutter should be designed for the wind direction that will make the flow in the gutter a maximum.

5.4 Snowfall

Although precautions are often required to prevent undue accumulation of snow on roofs, it is not necessary to allow for the removal of melted snow in sizing gutters and rain-water pipes as the maximum run-off resulting is less than the minimum recommended design rate of rainfall. Gutters and outlets may, however, become blocked by frozen snow but this can be avoided by the use of snowboards, the openings of which may be bridged by snow during heavy falls.

Snowguards may be fitted to the eaves of a pitched roof where sliding snow may cause damage to persons or structures below. Depending on what is at risk snowguards may be required for roof pitches up to 60° from the horizontal and need not be higher than 300 mm for most situations. The fixings should be strong enough to withstand a force per unit length F_s given by the equation:

$$F_s = kW \tan \alpha \quad \dots (1)$$

where

- F_s is the horizontal force (in N) per metre length of snowguard acting half-way up the snowguard;
- k is the vertical pressure (in N/m²) exerted by an exceptional snowfall;
- W is the plan width (in m) of the roof perpendicular to the eaves;
- α is the slope of the roof from the horizontal.

Typical values of k are:

- coasts in South-West England: 300 N/m²
- lowland southern England: 500 N/m²
- upland England and Wales: 1 200 N/m²
- Scottish Highlands: 2 000 N/m².

5.5 Thermal movement

5.5.1 Gutters. Supports and fixings to gutters should allow thermal movement to take place and, in addition, expansion joints may be necessary. The spacing of expansion joints depends upon the flexibility of the jointing material used, the method of jointing and supporting, and the coefficient of expansion of the material of which the gutter is made.

Except where the methods of jointing and fixing provide adequate allowance for movement, very long lengths of gutter may have to be divided into suitable sections. In such cases the allowance for expansion may be by means of a gap provided between sections and weathered by a suitable material. Where the ends of gutters abut a structure (e.g. gutters fixed between brick walls) a suitably weathered gap should be left between the end of the gutter and the structure.

Where structural expansion joints are provided in a building, expansion joints should be provided in the gutter to coincide.

5.5.2 Rainwater pipes. The type of jointing used for rainwater pipes should allow for thermal movement to take place without leakage, distortion and displacement of fittings. Particular care is necessary when rainwater pipes of long length are used.

6 Mining subsidence

6.1 General

Undermined ground is displaced downwards and inwards towards the centre of the subsided area and damage may be caused by both the vertical and horizontal components of displacement. The vertical displacement can vary in magnitude over the subsided area resulting in a tilting of the ground, while the strains resulting from the horizontal component can range from zero through maxima of compression and tension and back to zero in only a few hundred metres.

The effects of undermining can be predicted with reasonable accuracy and it is advisable to consult the Area Surveyor and Minerals Manager of the National Coal Board in the case of coal mining, or the responsible company in the case of other minerals, for advice on precautionary measures to be adopted. Where development involves public expenditure, the mineral valuers of the Inland Revenue may be called upon by a local authority.

6.2 Effect upon drainage systems

Differential subsidence, or tilt, may increase or decrease pipe and gutter gradients by 1 in 50 in extreme cases but on average the value would be of the order of 1 in 400. Increase or decrease in length may amount to 1 % in exceptional cases but will commonly be of the order of 0.25 % and can be accommodated in a similar manner to thermal movement.

7 Run-off

7.1 Effective catchment area

7.1.1 General. The effective catchment area of a sloping or vertical surface depends upon the angle of descent of the rain. It may normally be assumed for purposes of design that the rain falls at an angle of one unit horizontal to two units vertical (but see 5.3), and that its direction is such as to produce the maximum rate of run-off to each length of gutter; this is the basis of the recommendations in 7.1.2 to 7.1.4. Air flow patterns around buildings can, however, affect the local angle of descent of the rain, and particular consideration should be given to tall buildings and buildings in exposed positions.

7.1.2 Flat roofs and paved areas. The effective catchment area, A_e , of a freely exposed horizontal surface is equal to the plan area of the surface [see Figure 1 (a)]. Where sloping or vertical surfaces drain to a flat roof or paved area, the additional area of catchment should be calculated as described in 7.1.3 and 7.1.4.

7.1.3 Sloping roofs. The effective catchment area, A_e , of a freely exposed roof draining to an eaves or parapet-wall gutter is equal to the plan area of the roof, plus half its maximum area in elevation [see Figure 1(b)]. For a valley gutter, one side of the roof will tend to be exposed to the wind and the other side will tend to be sheltered; the method of calculating the effective catchment area is illustrated in Figure 1(c). Run-off from any vertical walls should be allowed for (see 7.1.4).

The effect of wind can be appreciated by noting that, compared to a horizontal roof of the same plan width, the run-off will be 25 % greater if the roof has a slope of one unit vertical to two units horizontal and 50 % greater if it has a slope of one unit vertical to one unit horizontal.

7.1.4 Vertical surfaces. Wind-driven rain will cause run-off from walls and other vertical surfaces that are freely exposed to the wind but where the run-off is to a paved area, run-off from vertical surfaces will normally only need to be considered where flooding of the paved area cannot be tolerated.

Not all the rain approaching a wall will reach it [2, 3]. Some is carried around or above the wall by cross-winds created by the presence of the wall. Of the rain that reaches the wall, some may:

- a) rebound, falling in a curtain of drops up to 150 mm from the face of the wall;
- b) be driven laterally by the cross-wind, collect in re-entrant angles and cause heavy vertical flow there;
- c) be driven upward to the top of the wall where it may collect beneath cornices or other overhangs;
- d) be shed from string courses, lintels, sills, or other projecting features of the wall;
- e) be stripped from the wall by the strength of the wind.

At present it is not possible to quantify these various flows or to deal with the effect of wall materials and textures on flow. In designing wall-drainage the total rain approaching the wall may be used, bearing in mind that the resulting figure will normally have a large margin of safety.

For a single wall, the effective catchment area, A_e , should be taken as half the exposed vertical area of the wall. Where two or more walls form an angle or bay, the direction of the wind should be assumed to be such that the walls, considered together, present the maximum vertical area to the rain. The method of calculating A_e is illustrated in Figure 2. For an enclosed area, the value of A_e will be equal to the horizontal plan area unless the surrounding walls are of unequal height. In the latter case the value of A_e should be increased by half the area in elevation by which the higher wall exceeds the lower wall (see also 8.9).

7.2 Rate of run-off

Run-off from roofs, paved areas and vertical surfaces should be calculated assuming that the surfaces are impermeable. The rate of run-off, Q (in L/s), is given by the equation:

$$Q = \frac{A_e l}{3600} \quad \dots (2)$$

where

- A_e is the effective catchment area (in m^2) (see 7.1);
- l is the design rate of rainfall (in mm/h) (see clause 5).

Run-off may occur from unpaved areas, and should be prevented from draining on to paved areas.

8 Hydraulic design of roof drainage

8.1 General principles

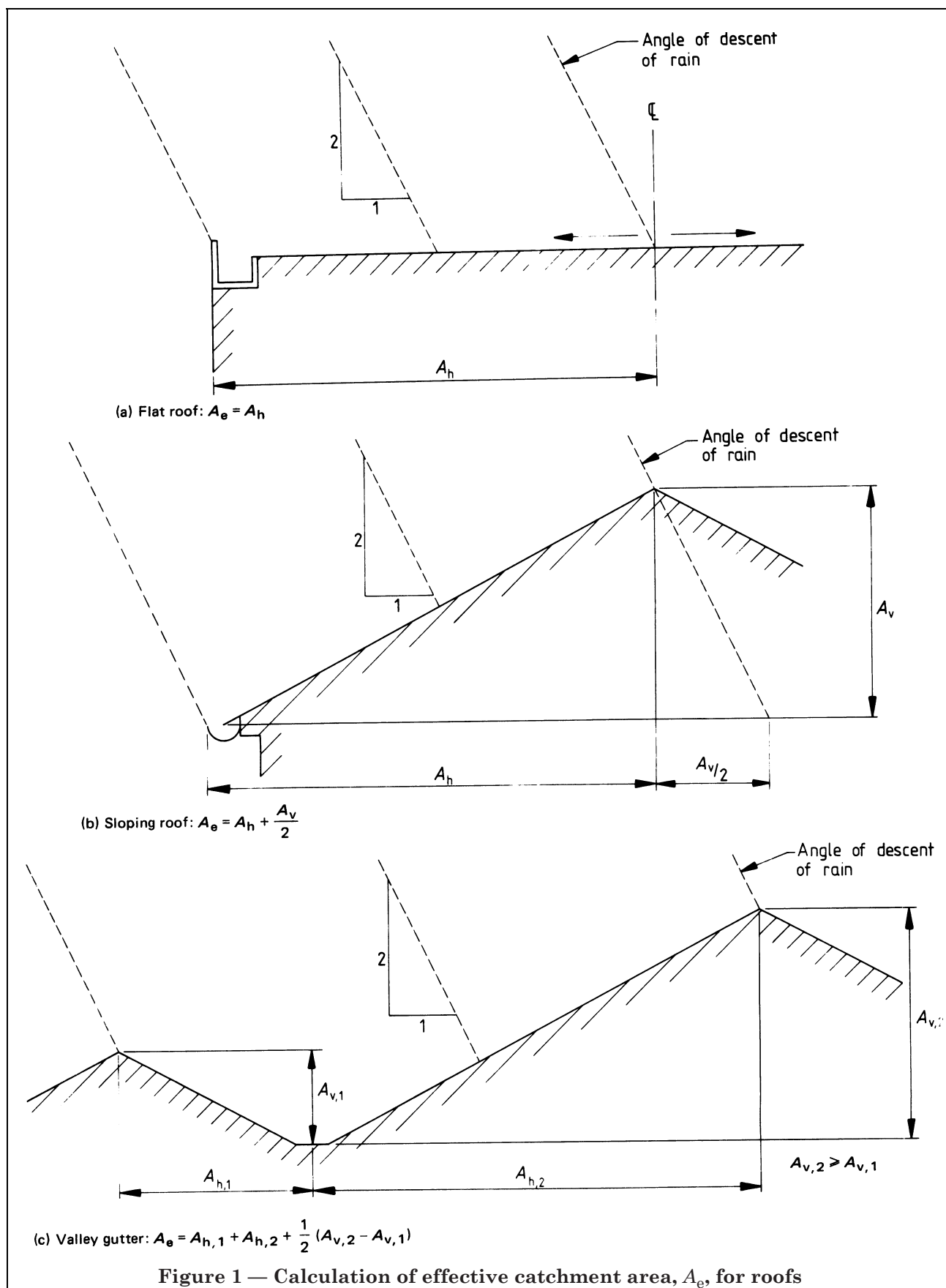
A roof drainage system generally comprises three parts:

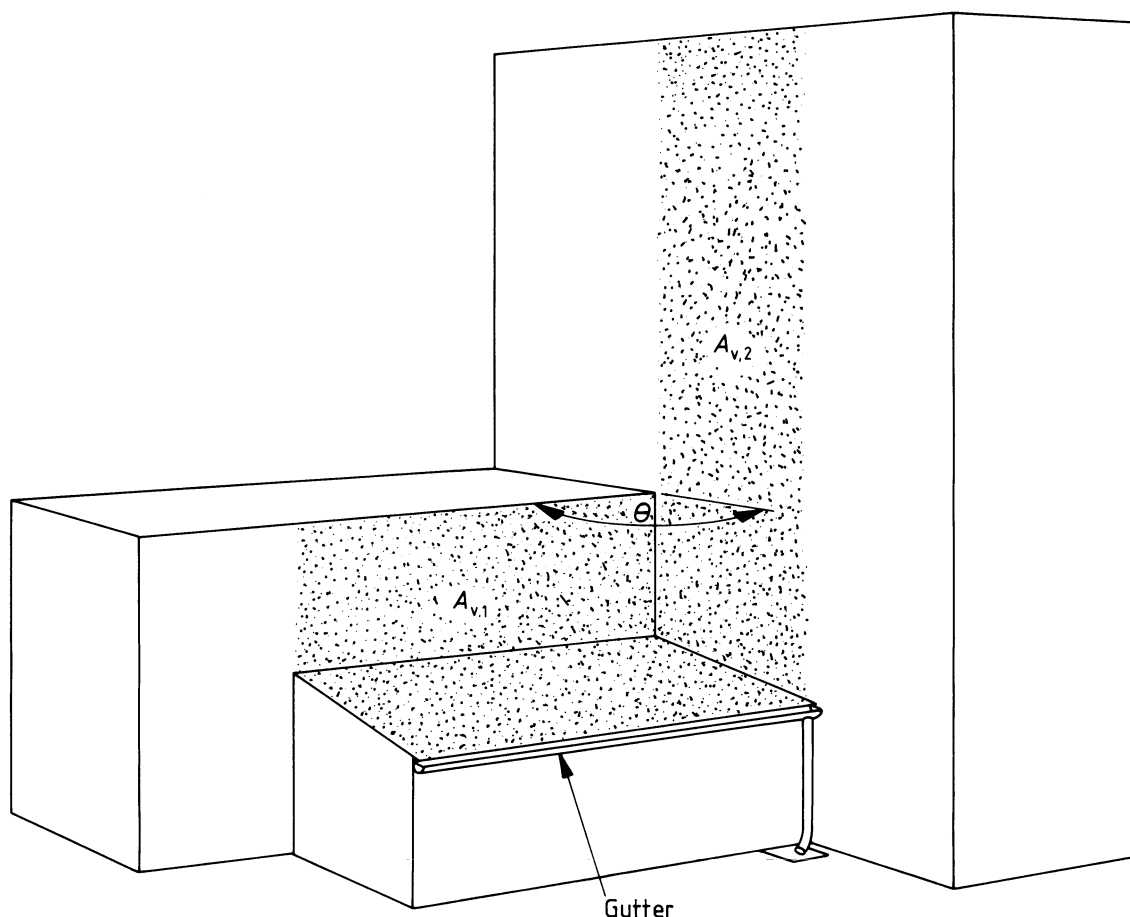
- a) the gutter or channel that collects the flow from the roof;
- b) the outlet into which the flow from the gutter or channel discharges;
- c) the pipework that conveys the flow from the outlet to the below-ground drainage system.

NOTE The design of the below-ground drainage system is dealt with in CP 301.

The three parts of the drainage system can be designed separately if the outlet and the pipework are made large enough for the flow to discharge freely from the gutter; this is the basis of the method of design described in 8.2 to 8.7. Occasionally it is necessary to use outlets or pipework that are smaller than those required by this method. When this occurs the capacity of the gutter is less than the capacity that it has when it discharges freely, and a more complicated method of design is necessary (see 8.2 and Appendix B).

Gutters and downpipes may be omitted from a roof at any height provided that it has an area of $6 m^2$ or less and provided that no roof or other surface drains on to it. Consideration may be given to the omission of gutters and rainwater pipes from tall structures where run-off would be dispersed before reaching the ground; such run-off should be directed so as to avoid undesirable pattern staining and splashing of windows.





$$A_e = \frac{1}{2} \sqrt{(A_{v,1}^2 + A_{v,2}^2 - 2A_{v,1} \cdot A_{v,2} \cos \theta)}$$

where $A_{v,1}$ and $A_{v,2}$ are areas of the vertical walls, as shown, contributing to the flow of the gutter.

Figure 2 — Calculation of effective catchment area, A_e , for vertical surfaces

8.2 Method of design

The method of design described in this standard is based on the following assumptions:

- the gutter slope is not steeper than 1 in 350 (i.e. it is nominally level);
- the gutter has a uniform cross-sectional shape;
- the outlets are large enough to allow the gutter to discharge freely;
- The distance between a stop end and an outlet is less than 50 times the upstream water depth, or the distance between two outlets is less than 100 times the water depth.

Eaves gutters should wherever possible be designed to discharge freely.

If the length of an eaves gutter exceeds the limits given in d) it is necessary to reduce its design capacity. Methods of designing valley gutters that do not discharge freely or that exceed the limits in d) are described in Appendix B.

8.3 Calculation of flows in gutters

8.3.1 General. The method of determining the design rate of run-off from the roof of a building is described in clause 7. After the run-off has been collected by the gutter, its direction of flow is determined by the position of the outlets.

8.3.2 Position of gutter outlets. If a length is served by two outlets, the flow will split equally between them even if the flow does not enter the gutter uniformly along its length. Figure 3(a) shows how the flow at each outlet in a length of gutter can be calculated. If a strong wind blows along a gutter, the flow may be increased in that direction.

Figure 3(b) and Figure 3(c) show how the capacity of a gutter can be used most efficiently. In Figure 3(b), the outlets split the gutter into three sections, the middle one of which collects half the total flow and discharges at both ends; if the total flow from the roof is Q , then each section of gutter needs to have a discharge capacity of $Q/4$. Figure 3(c) shows a less efficient arrangement in which the outlets are positioned at the ends of the gutter; in this case a larger gutter is required since each section needs to have a discharge capacity of $Q/2$.

8.3.3 Additional factors. Although there is an optimum arrangement for the outlets (see 8.3.2), their number and position will often be determined by the layout of the building or the need to maintain a good appearance. If for either reason internal rainwater pipes are fitted, underfloor drainage should be avoided if at all possible.

For eaves gutters, an outlet should be located, where possible, near to each angle, i.e. where there is a change in direction of the flow. The reduction that such angles cause in the capacity of eaves gutters is detailed in 8.4.4.

For valley and parapet wall gutters it is essential to position an outlet so that the direction of flow is not changed sharply (e.g. through 90°) just before reaching it. Where overflowing of such a gutter cannot be tolerated, a minimum of two outlets is desirable. It may also be necessary either to provide a weir overflow at the end of the gutter (see 8.6.6), so that any flow in excess of the design rate is discharged clear of the building, or to design for a rate of rainfall that corresponds to a high degree of security (see 5.2).

8.4 Eaves gutters

8.4.1 Gutter location. The spread of water as it leaves the roof edge depends on the rate of rainfall, the roof covering used and the pitch of the roof. The most satisfactory roof edge is one with the upper corner rounded and the lower corner sharp. The gutter should, where practicable, be fixed centrally under the roof edge and close beneath it, particularly where roof edges that give a wide spread of water are used (see Figure 4).

8.4.2 Capacity. The capacities of standard sizes of true and nominal half-round gutters are given in Table 1. Capacities of half-round gutters whose sizes do not correspond exactly to those in Table 1 may be estimated from Figure 5 which shows the relationship between the capacity, Q , and the top width, W_g , of the gutter. The figures in Table 1 and Figure 5 assume that the gutters discharge freely, and that the depth of flow at the downstream end is five-ninths of the depth of flow at the upstream end when the gutter is just flowing full. These figures provide a small margin of safety compared with experimental measurements of the capacity of cast iron and plastics eaves gutters when just flowing full [4]. No allowance for freeboard need normally be made provided that any overflow from the gutter falls clear of the building.

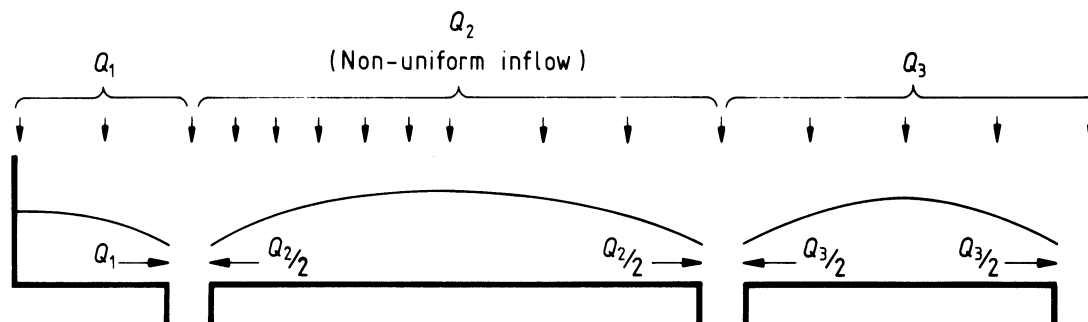
The capacity of other types of eaves gutters should be determined by the general design method given in 8.5.

NOTE Capacities should be determined for the actual internal dimensions which may not equal the nominal dimensions given in British Standards.

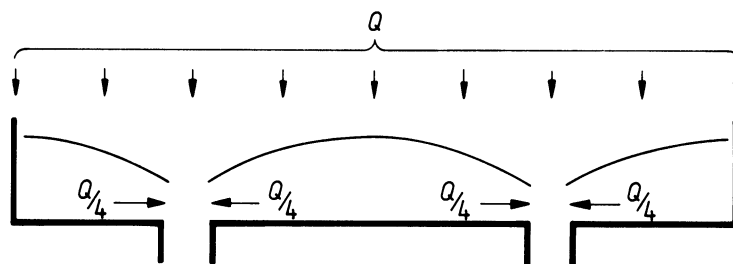
Table 1 — Flow capacities of standard eaves gutters (level)

Size of gutter	Flow capacity	
	True half-round	Nominal half-round
mm	L/s	L/s
75	0.38	0.27
100	0.78	0.55
115	1.11	0.78
125	1.37	0.96
150	2.16	1.52

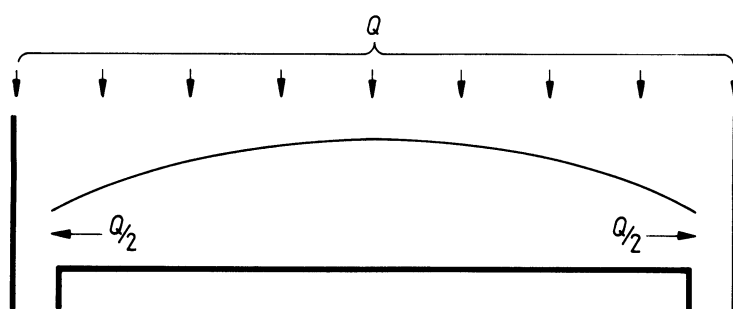
8.4.3 Long gutters. Frictional resistance reduces the capacities of long gutters and should be taken into account if the length, L_g , of an eaves gutter is more than 50 times its overall depth, y_g ; the gutter length is defined as either the distance between a stop end and an outlet, or as half the distance between two adjacent outlets. If the length of a gutter exceeds this limit, the design capacity obtained from Table 1 or Figure 5 should be multiplied by a reduction factor estimated from Table 2.



(a)



(b)



(c)

NOTE. For the same total flow, the gutter in (c) requires twice the capacity of the gutter in (b).

Figure 3 — Division of flow between gutter outlets

Table 2 — Reduction factors for capacities of long half-round eaves gutters

L_g/y_g	Reduction factor
50	1.0
100	0.93
150	0.86
200	0.80

8.4.4 Effect of angles. If a length of eaves gutter includes an angle, the flow in the gutter will be impeded and its capacity reduced. Table 3 gives factors by which the capacity of a gutter (as found from Table 1) should be reduced, according to the position and type of the angle; the factors in Table 3 were determined from experiment [4]. Where an angle occurs in a length of gutter served by two outlets, the reduction factor from Table 3 should only be applied to that part of the gutter in which the angle obstructs the flow.

Table 3 — Reduction factors for capacities of standard eaves gutters containing angles

Type of angle	Reduction factor	
	Angle less than 2 m from outlet	Angle between 2 m and 4 m from outlet
Sharp corner	0.80	0.90
Round corner	0.90	0.95

8.5 Valley, parapet and boundary-wall gutters

8.5.1 Cross-sectional shape. Gutters complying with British Standards are available, although in the case of valley gutters the shape may often be chosen so as to conform to the cross-sectional shape of the roof. Gutters should be large enough to enable a person to walk along them for maintenance purposes; for valley gutters the recommended minimum top width is 500 mm, and for parapet and boundary-wall gutters it is 300 mm. A satisfactory shape of valley gutter is obtained if the sides are sloped at the same slope as the roof up to a height that gives the required flow capacity, and if the sides are then turned vertically upwards in order to provide the required amount of freeboard (see 8.5.3 and Figure 6).

8.5.2 Fall. The fall to which the gutter is laid will depend on structural considerations and on the material used for the gutter or gutter lining. Where prefabricated gutters (e.g. asbestos-cement, cast iron, pressed steel) are fitted, a fall may not necessarily be required but supports should be adjustable in order to avoid ponding. The method of design described in 8.5.4 to 8.5.8 assumes that the gutter is level; a gutter laid to a fall will have a somewhat higher capacity, but this increase should be viewed as an additional factor of safety.

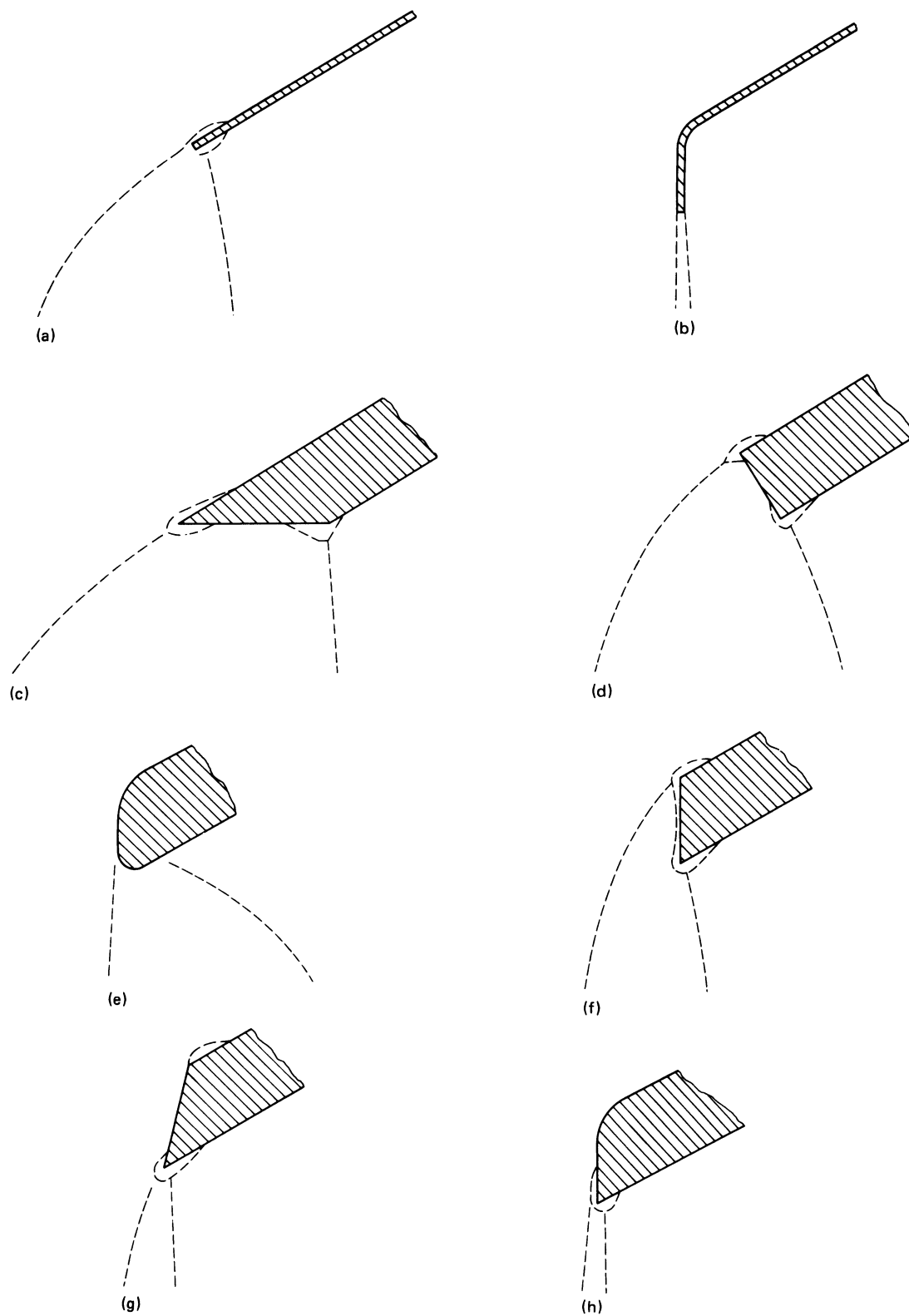
8.5.3 Freeboard. The overall depth of a gutter should be greater than the depth needed to give the design capacity, so as to prevent it being overtopped by splashing or by waves produced by strong winds. For valley, parapet and boundary wall gutters, the amount of freeboard should be taken as two-fifths of the maximum depth of flow in the gutter, with an upper limit of 75 mm. For eaves gutters, as stated in 8.4.2, no allowance for freeboard need normally be made provided that any overflow from the gutter falls clear of the building (see 8.5.8).

8.5.4 Principles of design method. In a level gutter, the depth of flow is greatest at the upstream end and decreases towards the outlet. Subtracting the allowable freeboard from the overall depth of the gutter therefore gives the design depth of flow at the upstream end y_u ; the discharge that produces the depth y_u is the design capacity of the gutter. A level gutter attains its maximum capacity when the outlet is large enough to allow the gutter to discharge freely; when this occurs the depth of flow in the gutter just upstream of the outlet is equal to what is termed the critical depth, y_c .

The ratio of the depth of flow at the upstream end of the gutter, y_u , to the critical depth at the downstream end, y_c , depends only upon the cross-sectional shape of the gutter (provided that the requirements of 8.2 are met). The effect of flow resistance is normally small so that the length of the gutter does not affect the value of y_u/y_c unless the gutter is longer than the limit given in 8.2 d). The discharge corresponding to the critical depth, y_c , can be calculated directly if the cross-sectional shape of the gutter is known.

Rectangular and triangular gutters may be considered as special types of trapezoidal gutter, and can therefore be designed in the same way as trapezoidal gutters (see 8.5.6 and 8.5.7).

8.5.5 Capacity of freely-discharging trapezoidal gutters complying with BS 569. The design capacities of level trapezoidal gutters whose cross-sectional shapes comply with BS 569 are given in Table 4. The figures assume that the gutters discharge freely, and include a freeboard allowance equal to two-sevenths of the overall depth of the gutter (see 8.5.3). Table 4 also gives the depths of flow at the downstream ends of the gutters for the specified design capacities.



Spread of water is shown by broken lines.

Figure 4 — Flow patterns at various roof edges

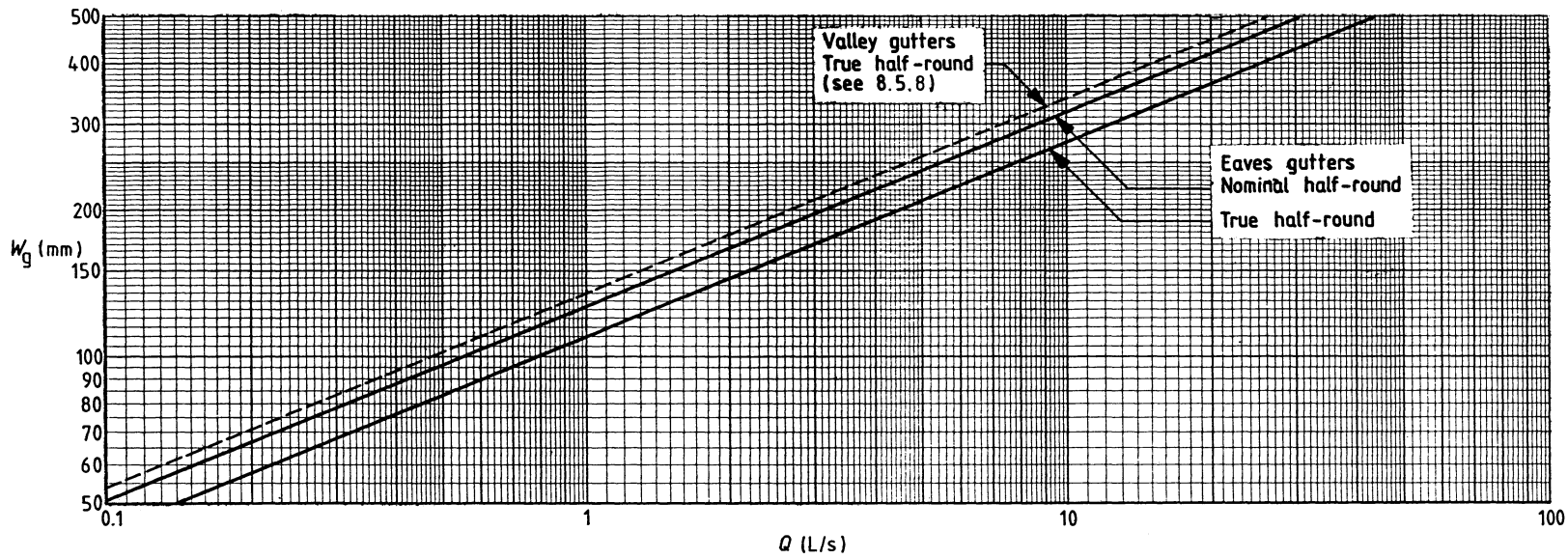


Figure 5 — Flow capacities of freely-discharging half-round gutter

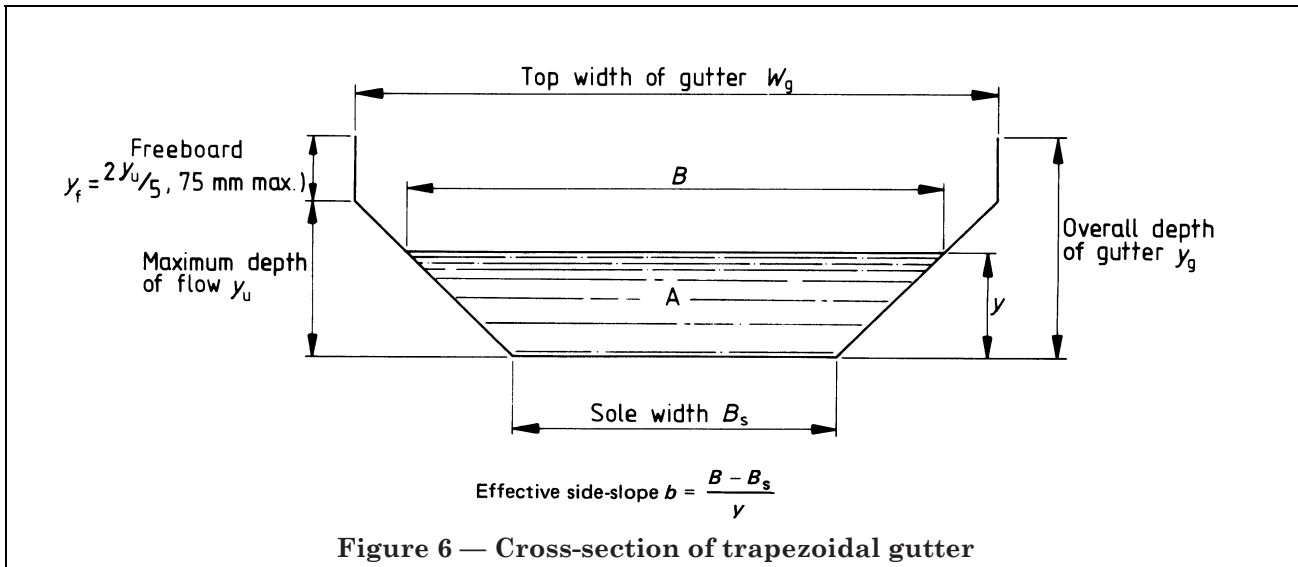


Figure 6 — Cross-section of trapezoidal gutter

8.5.6 Other types of freely-discharging trapezoidal gutter. The capacities of other types of gutter may be determined by means of the procedure given in a) to, c) below if their size and shape are known⁴⁾.

a) Determine the design depth of flow at the upstream end of the gutter, y_u , by subtracting the required amount of freeboard (8.5.3) from the overall depth, y_g , of the gutter. For eaves gutters, $y_u = y_g$. For valley, parapet and boundary wall gutters, $y_u = 5y_g/7$ or $y_u = y_g - 75$ mm, whichever gives the greater value.

b) Find the value of the critical depth at the down-stream end of the gutter, y_c . The ratio y_u/y_c depends upon the shape factor, B_s/B_u , of the gutter, where B_s is the sole width and B_u is the width of flow corresponding to the depth y_u . Calculate the value of B_s/B_u and use Figure 7 to find the corresponding value of y_u/y_c ; thus determine y_c . Note that for rectangular gutters $B_s/B_u = 1$ and the critical depth is equal to half the depth at the upstream end.

c) The capacity, Q , of the gutter is found from the value of y_c . First calculate the cross-sectional area A_c and the surface width of flow B_c , both corresponding to the depth y_c . Then determine Q from Figure 8 or from equation (4) of Appendix B.

The calculated value of Q assumes that the outlet is large enough to allow the gutter to discharge freely (see 8.6). The method of determining the capacity of trapezoidal gutters with restricted discharge is described in B.2.

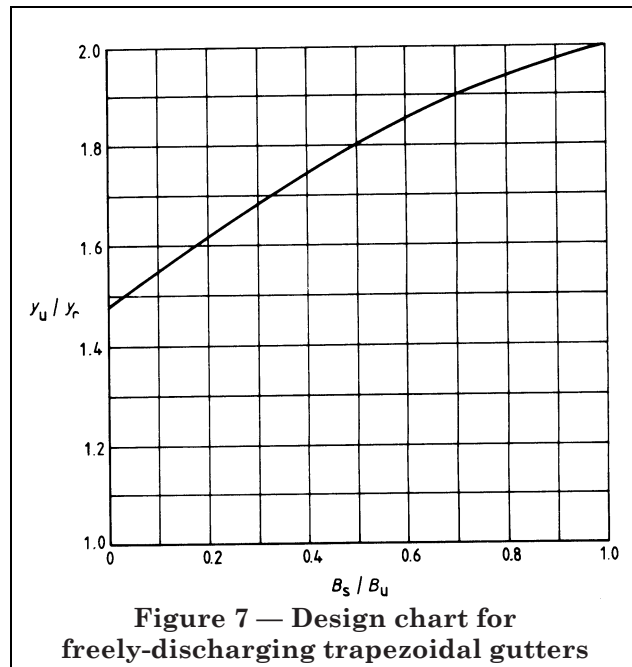


Figure 7 — Design chart for freely-discharging trapezoidal gutters

8.5.7 Dimensions of freely discharging trapezoidal gutters. If, for example, the sole width and side-slopes are fixed⁵⁾, the unknown quantity is the overall depth y_g of the gutter. Therefore, an estimated value of y_g should be chosen and the capacity Q determined by means of the procedure given in 8.5.5. If the calculated value of Q does not equal the required capacity, the procedure is then repeated using a revised value of y_g .

⁴⁾ See B.3 for trapezoidal gutters which have sides that vary in slope between the sole and the maximum depth of flow.

⁵⁾ "See B.3 for trapezoidal gutters which have sides that vary in slope between the sole and the maximum depth of flow."