

BRITISH STANDARD

Guide to siphonic roof drainage systems

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Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 March 2007. It was prepared by Technical Committee B/505, *Waste water engineering*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

This British Standard should be read in conjunction with BS EN 12056-3.

BS EN 12056-3 deals with the layout and calculation of roof drainage. The provisions for non-siphonic systems are described in detail, but those for siphonic systems are limited to performance requirements. The standard applies to all materials used for roof drainage systems.

This British Standard gives information facilitating the use of BS EN 12056-3 in the United Kingdom with regard to siphonic roof drainage systems; it does not alter any of the provisions of that standard. It is based upon work carried out under a separate study part-funded by the Department of Trade and Industry as part of its Partners in Innovation scheme [1].

The study involved extensive consultation with manufacturers and installers of siphonic roof drainage systems used in the UK and also with specifiers.

Use of this document

As a guide, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

This British Standard has been prepared to give information about the majority of installations of siphonic systems but it is impractical to cover every eventuality. In some particular cases, it might not be possible to reflect all the provisions of this standard. In such cases it is advisable to discuss any departures with the client or the client's appropriately qualified representative.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in italic type, and does not constitute a normative element.

Contractual and legal considerations

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

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

Introduction

BS EN 12056-3:2000, **6.2** specifies the performance requirements for siphonic systems as follows:

- 6.2.1** The system shall drain the runoff from the impermeable area served, calculated in accordance with clause **4**, without taking gutter storage into consideration. It is recommended that the recurrence period method (see **4.2.1**) should be used whenever possible.
- 6.2.2** For flat roof drainage, the system shall conform to clause **5.4**. For gutter drainage, the system shall conform to clauses **5.1** and **5.2**.
- 6.2.3** The siphonic effect shall commence quickly enough to prevent design water depths on the roof or in the gutter being exceeded.
- 6.2.4** The flow capacity of individual outlets shall be balanced to ensure the entire system performs as specified.
- 6.2.5** The siphonic system shall be designed to take into account any surcharging of the buried drainage.
- 6.2.6** Pipes and fittings shall withstand the maximum positive and negative pressures encountered under design conditions.
- 6.2.7** The minimum velocity in the system at the design rainfall shall be chosen to prevent deposition in pipework and to ensure rapid commencement of the siphonic effect.
- 6.2.8** Outlets shall be fitted with strainers to exclude solid material and prevent blockages. The effect of a strainer on water levels in gutters or on flat roofs shall be taken into account.
- 6.2.9** The minimum internal pipe diameter, d_i , shall be 32 mm.
- 6.2.10** The design method shall be validated by physical testing.
- 6.2.11** The lowest design pressure shall be chosen to prevent possible cavitation damage and collapse of pipes.
- 6.2.12** Reductions in diameter in the direction of flow are permitted in siphonic systems.
- 6.2.13** The system shall be installed in accordance with the design assumptions. The effect of any difference between the design and the system as installed shall be calculated and appropriate action taken.

1 Scope

This British Standard applies to roof drainage systems using circular-section pipes that operate under siphonic action. It does not apply to siphonic drainage systems using rectangular or trapezoidal section conduits for water conveyance.

It gives information and provides guidance on design parameters, installation, verification and maintenance needs of siphonic roof drainage systems conforming to the performance requirements specified in BS EN 12056-3:2003, **6.2**. Guidance is also given on carrying out checks of designs, for the use of specifiers and regulatory authorities.

Particular issues for site drainage systems that receive flows from siphonic roof drainage systems are also covered.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 12056-3:2000, *Gravity drainage systems inside buildings – Part 3: Roof drainage, layout and calculation*

BS EN 752, *Drain and sewer systems outside buildings*

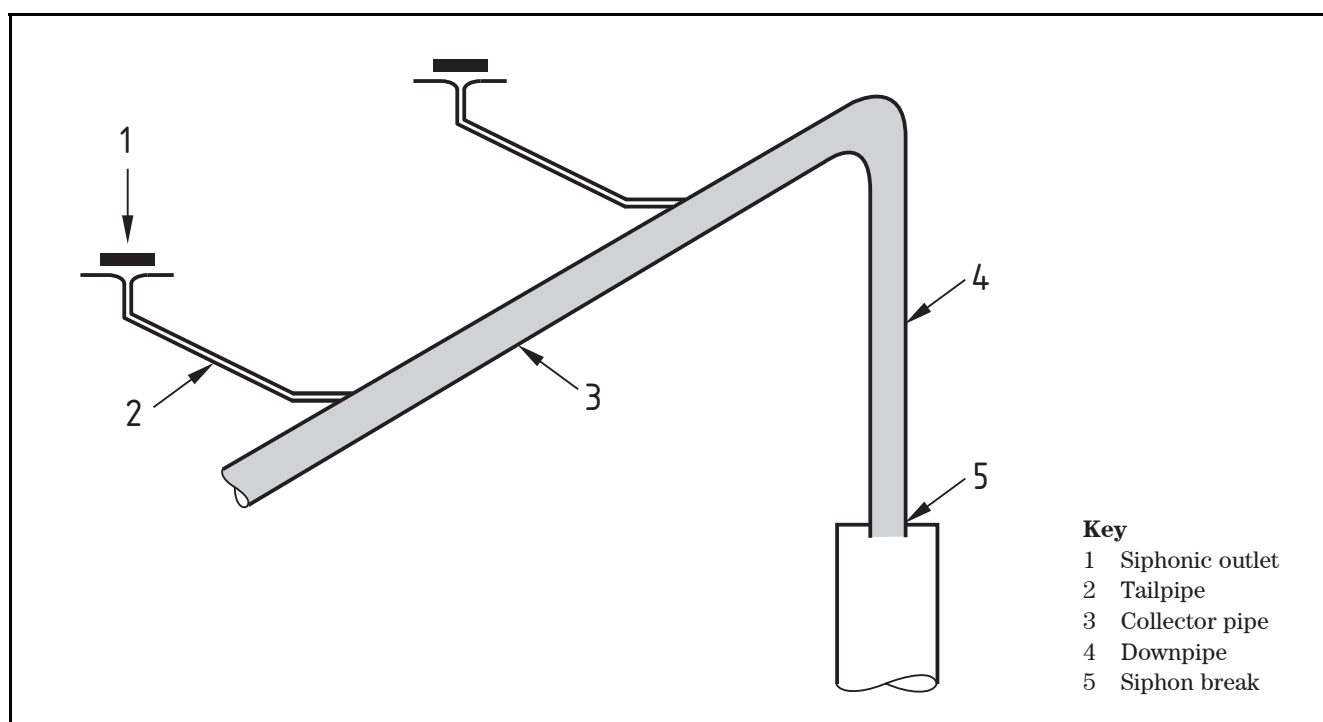
3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS EN 12056-3 and the following apply.

NOTE The principal components of a siphonic roof drainage system are illustrated in Figure 1.

Figure 1 Principal components of siphonic roof drainage systems

**3.1.1 cavitation**

phenomenon involving the formation and subsequent sudden collapse of vapour cavities in a liquid, with the cavities forming when the local pressure within the flow reduces close to that of the vapour pressure of the liquid

3.1.2 collector pipe

horizontal pipe installed below a roof, gutter or floor that collects and conveys the flow from the tailpipes of roof outlets

3.1.3 conventional roof drainage system

non-siphonic system in which the pipework between roof level and ground level is designed to flow part full with internal pressures at or above atmospheric pressure

3.1.4 design flow rate

flow rate in a siphonic roof drainage system or associated gutter, calculated using design rainfall data from BS EN 12056-3 plus a safety factor of not less than 10%

3.1.5 downpipe

section of vertical pipe in pipework connecting a collector pipe to a siphon break or to the point of discharge from a siphonic system

3.1.6 full-bore flow

flow conditions under which the water (and any entrained air carried by the water) occupies the full cross-section of a pipe

3.1.7 overflow

device installed in a gutter or flat roof that discharges the flow if the water level rises above a limiting level (e.g. due to exceptional rainfall or blockages at outlets)

NOTE Possible devices include weirs, chutes, additional conventional outlets, or additional siphonic outlets.

3.1.8 primary system

fittings and pipework designed to drain a roof or gutter for rainfall conditions up to a selected frequency of occurrence

3.1.9 rating curve of outlet

relationship between the flow rate entering an outlet and the water depth in a gutter or flat roof close to the outlet

3.1.10 secondary system

fittings and pipework designed to drain a roof or gutter if rainfall conditions exceed the capacity of the primary system or if a failure of the primary system were to occur

3.1.11 siphon break

termination point of a siphonic system at which the pressure is maintained equal to atmospheric pressure and which is designed to stop siphonic action downstream

3.1.12 siphonic outlet

fitting at the entrance to a siphonic roof drainage system to permit rainwater to drain from a roof or gutter and designed to exclude air entering the pipework

3.1.13 soffit of pipe

highest part of the internal bore of a pipe

3.1.14 tailpipe

section of vertical and possibly horizontal pipework connecting a roof outlet to a horizontal collector pipe

3.1.15 warning pipe

pipe that indicates whether the limiting water level in a gutter or flat roof has been exceeded but does not itself provide a significant discharge capacity

3.2 Symbols

For the purposes of this British Standard, the following symbols apply.

A	effective roof area draining to outlet, in square metres (m^2)
d_i	internal diameter of pipe, in metres (m)
g	acceleration due to gravity, in metres per second per second (m/s^2)
<i>NOTE The value of g is taken as 9.81 m/s^2.</i>	
H_A	overall head of water available for functioning of siphonic system, in metres (m)
H_B	vertical height between floor of test tank and bottom of downpipe, in metres (m)
H_D	loss of water head between top of downpipe and point of discharge from system, in metres (m)
h_M	minimum pressure head of water occurring in system (relative to atmospheric pressure), in metres (m)
H_O	local atmospheric pressure measured above vacuum, expressed as equivalent head of water, in metres (m)
H_T	total loss of water head in system between an outlet and point of discharge, in metres (m)

H_{TF}	total frictional loss of water head in system between an outlet and point of discharge, in metres (m)
H_V	velocity head of flow, in metres (m)
h	static pressure head of water at point in flow (relative to local value of atmospheric pressure), in metres (m)
h_i	value of h at point number i in system, in metres (m)
$h_{\min}$	minimum allowable value of h in system, in metres (m)
h_{vp}	vapour pressure of water (expressed as equivalent head of water), in metres (m)
i_F	frictional head loss gradient in pipe, in metres loss of water head per metre length of pipe (m/m)
k_P	value of pipe roughness in Colebrook–White equation, in millimetres (mm)
L_P	length of section of pipe in siphonic system, in metres (m)
Q_{in}	initial flow rate of water entering collector pipe during priming of siphonic system, in litres per second (l/s)
$Q_{\max}$	maximum flow rate of water used in test of outlet, in litres per second (l/s)
Q_o	design flow rate of water to an outlet (equal to area drained multiplied by design rainfall intensity multiplied by factor of safety), in litres per second (l/s)
Q_P	flow rate of water in pipe, in litres per second (l/s)
Q_T	flow capacity of tailpipe when acting siphonically and discharging to collector pipe at atmospheric pressure, in litres per second (l/s)
r	design rainfall intensity, in litres per second per square metre (l/s per m ²)
S	plan area of water surface in tank for testing outlet, in square metres (m ²)
S_F	factor of safety for design of siphonic system and associated gutters, applied as multiplier to flow rates determined using design rainfall intensity
T_F	time to fill siphonic pipework, in seconds (s)
u	mean flow velocity, in metres per second (m/s)
u_i	value of u at point number i in system, in metres per second (m/s)
u_E	mean flow velocity at exit from downpipe assuming full-bore flow, in metres per second (m/s)
V_P	total volume of collector pipe(s) and downpipe to the point of discharge from siphonic system, in litres (l)
Z_D	height of lip of siphonic outlet above top of downpipe, in metres (m)
z	elevation of point above datum, in metres (m)
Δh	loss of energy head in pipe length, in metres (m) (water head)
Δh_F	loss of energy head in pipe length due to wall friction, in metres (m) (water head)

Δh_L	localized loss of energy head at pipe fitting, in metres (m) (water head)
Δh_o	loss of energy head at siphonic outlet, in metres (m) (water head)
Δh_{12}	loss of energy head between points 1 and 2, in metres (m) (water head)
$\Delta y_{\max}$	maximum allowable increase in water depth in non-steady test of outlet relative to steady-state water depth at same rate of flow, in metres (m)
Δz_{12}	vertical height of point 1 above point 2, in metres (m)
ζ	dimensionless head loss coefficient for pipe fitting
ζ_o	dimensionless head loss coefficient for siphonic outlet
ν	kinematic viscosity of water, in metres squared per second (m ² /s)
	<i>NOTE The value of ν for water at 15 °C is 1.14×10^{-6} m²/s.</i>
σ	cavitation index of flow

4 General

NOTE Annex A describes how siphonic systems operate.

4.1 To ensure efficient long-term working of a siphonic system, the following points should be addressed.

- An effective periodic maintenance regime should be implemented to prevent accumulations of debris (e.g. leaves etc.) blocking rainwater outlets at roof or gutter level.
- Correctly dimensioned siphonic systems might have less reserve capacity than that of equivalent gravity systems and therefore adequate safety margins should be considered, i.e. design safety factors and/or suitable overflows should be included.
- If a siphonic system is subject to a change (during construction and/or throughout the life of the building), a hydraulic reassessment of the system should be carried out.

4.2 When operating under full-bore flow, a siphonic roof drainage system creates a direct flow path between roof level and the site drainage system to which it discharges. Problems below ground can therefore cause flooding at roof level. For this reason, siphonic systems should be designed as an integral component of the building and the drainage infrastructure of the site. Designers of buildings should therefore ensure that appropriate information on requirements for satisfactory installation and operation of siphonic systems is exchanged with others responsible for the design of roofs, gutters, structures and site drainage systems (see also Clause 13). Specific examples include the following.

- A specifically engineered solution is required when draining sloping gutters, in order to reduce local flow velocities at outlets.
- Space provided beneath gutters for tailpipes and horizontal collector pipes should allow a vertical drop that is sufficient to permit rapid priming of the tailpipes.
- When designing the interface between the siphonic and below-ground surface water drainage systems, care should be taken to ensure that any surcharging of the below-ground drainage will not reduce the required design/discharge capacity of the siphonic roof drainage system.
- Acoustically sensitive areas within a building should be taken into account when locating routes of internal siphonic pipes (see also **10.5**).

4.3 In order to exclude air, siphonic outlets have smaller free areas than equivalent gravity outlets for the water to flow through and are therefore prone to blockage by leaves, debris, etc. In areas where leaf fall is heavy, or where other detritus can collect, a siphonic roof drainage system will require additional routine cleaning measures and access to be incorporated in the building design to minimize the amount of debris reaching the areas of the outlets.

5 Performance

BS EN 12056-3 specifies the minimum performance requirements for a siphonic system.

6 Design parameters

6.1 Design rainfall intensity and flow rates

6.1.1 Siphonic roof drainage systems should be designed to cater for the steady-state flow conditions corresponding to the design rainfall intensity, i.e. with no allowance made for any storage effects within either the gutters or the pipework.

6.1.2 The return period used to determine the design rainfall intensity should be based upon the same categories of risk as described in BS EN 12056-3. The choice of return period should take account of the design life of the building, the type of roof construction, and the value of the building contents or risk to processes carried out within it. The design intensity should be based upon a peak duration of 2 min, except for special circumstances (such as green roofs or roofs designed to pond) where longer peak durations might be appropriate.

6.1.3 A factor of safety, S_F , should be introduced into the design of siphonic systems and their associated gutters by sizing the components to cater for design flow rates that are S_F times those calculated using the selected value of design rainfall intensity (see **6.1.2**). The value of S_F should not be less than 1.1.

NOTE It is important to recognize that BS EN 12056-3 does not distinguish between siphonic and conventional gravity drainage systems in the selection of the design value of rainfall intensity.

NOTE The factor S_F provides a margin of safety for siphonic systems and outlets that is similar to the margin of safety incorporated in BS EN 12056-3 for the design of non-siphonic gravity drainage systems.