

BS 8102:2009



BSI Standards Publication

Code of practice for protection of below ground structures against water from the ground

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 38, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 November 2009. It was prepared by Technical Committee B/526, *Geotechnics*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 8102:1990, which is withdrawn.

Information about this document

This British Standard was originally published in 1990, superseding the earlier CP102 (1973). This is a full revision of the standard, and introduces the following principal changes:

- a) a number of recent developments are addressed, which are important when specifying, designing and constructing below ground structures, including:
 - 1) more deep construction in congested urban areas;
 - 2) an increase in the provision of residential basements;
 - 3) development and use of new materials for waterproofing;
- b) a more detailed assessment is provided of the risks inherent in below ground construction and how these might best be addressed.

In addition to the introduction of these key changes, the publication of the Eurocodes and the approaching withdrawal of the corresponding British Standards make this revision timely.

It is noted that the figures used in this document are only representative of different installation methods, and should not be translated directly into practice without first checking all the parameters specific to the installation.

Use of this document

As a code of practice, 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.

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

It has been assumed in the drafting of this document that the execution of its provisions is entrusted to suitably qualified and experienced people, for whose guidance it has been prepared.

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 smaller 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.

1 Scope

This British Standard gives recommendations and provides guidance on methods of dealing with and preventing the entry of water from surrounding ground into a structure below ground level.

It covers the use of:

- a) waterproofing barrier materials applied to the structure,
- b) structurally integral watertight construction; and
- c) drained cavity construction.

It also covers the evaluation of groundwater conditions, risk assessment and options for drainage outside the structure.

It applies to structures which extend below ground level and those on sloping sites.

This British Standard does not give recommendations concerning the use of embedded heating in structures, floors and walls or for the special requirements in connection with the design and construction of cold stores.

NOTE Structures are generally characterized as “deep” if they have more than one storey below ground level, or “shallow” if they have only a single storey below ground. This standard is applicable to both.

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 743:1970, *Specification for materials for damp-proof courses*

BS 5930, *Code of practice for site investigations*

BS 6100-3, *Building and civil engineering – Vocabulary – Part 3: Civil engineering – General*

BS 8004, *Code of practice for foundations*

BS 8204-1, *Screeds, bases and in situ floorings – Part 1: Concrete bases and cement sand levelling screeds to receive floorings – Code of practice*

BS 8747, *Reinforced bitumen membranes (RBMs) for roofing – Guide to selection and specification*

BS EN 1504, *Products and systems for the protection and repair of concrete structures – Definitions, requirements, quality control and evaluation of conformity*

BS EN 1992, *Eurocode 2: Design of concrete structures*

BS EN 1993, *Eurocode 3: Design of steel structures*

BS EN 1993-5, *Eurocode 3: Design of steel structures – Part 5: Piling*

BS EN 1997, *Eurocode 7: Geotechnical design*

BS EN 10210, *Hot finished structural hollow sections of non-alloy and fine grain steels*

BS EN 10219, *Cold formed welded structural hollow sections of non-alloy and fine grain steels*

BS EN 10248, *Hot rolled sheet piling of non alloy steels*

BS EN 10249, *Cold formed sheet piling of non alloy steels*

BS EN 12063, *Execution of special geotechnical work – Sheet pile walls*

BS EN 12970, *Mastic asphalt for waterproofing – Definitions, requirements and test methods*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 6100-3 and the following apply.

3.1 cavity drain membrane

dimpled, flexible, high-density polymer sheet, which can be placed against the internal face of a structure after construction and is designed to intercept water penetrating the structure and direct it to a drainage system

3.2 cut-off wall

embedded retaining wall (see 3.4) designed to surround and seal-off an area, to inhibit water inflow from the surrounding area

3.3 damp area

area which, when touched, might leave a light film of moisture on the hand but no droplets of water (i.e. beading)

NOTE This definition has been taken from the ICE publication, Specification for piling and embedded retaining walls [1].

3.4 embedded retaining wall

wall used to support the sides of an excavation, installed in advance and penetrating below the lowest level of the below ground construction

NOTE Within this standard the principal forms considered constitute the primary permanent wall for the below ground construction, and are taken as diaphragm walls, contiguous or secant piles (which may be installed in different configurations) or steel sheet piles.

3.5 ground barrier

impermeable barrier between the structure and the ground intended to prevent or impede the ingress of water, dampness, radon, methane and other ground gases and contaminants

3.6 loading coat

layer of material designed to hold a Type A waterproofing material in place when resisting water pressure

3.7 perched water table

reservoir of water in the ground maintained permanently or temporarily above the standing water level in the ground below it, and is caused by the presence of an impervious soil or a stratum of low permeability

3.8 seepage

slow transmission of water through discrete pathways of a structure

NOTE This can also be known as weeping, as defined in ICE publication, Specification for piling and embedded retaining walls [1].

3.9 tanking

application of an appropriate waterproofing barrier to the walls, the base slab and, where relevant, the roof of a below ground structure, such that the entire envelope of the structure below ground is protected against water ingress

NOTE A cavity drain membrane is not considered to constitute tanking.

- 3.10 Type A (barrier) protection**
protection against water ingress which is dependent on a separate barrier system applied to the structure
- 3.11 Type B (structurally integral) protection**
protection against water ingress which is provided by the structure
- 3.12 Type C (drained) protection**
protection against water ingress into usable spaces which is provided by the incorporation of an appropriate internal water management system
- 3.13 vapour check**
membrane or other element that restricts the transmission of water vapour
- 3.14 waterproof**
impervious to water
NOTE This can also be known as "watertight".
- 3.15 waterproofing**
application of waterproof/water-resisting materials
- 3.16 waterproofing barrier**
material that does not permit the transmission of free water, but might allow some water vapour permeability
- 3.17 waterproofing system**
materials and methods used to protect a structure from water ingress and might also provide resistance to the diffusion of water vapour
- 3.18 water resistance**
ability of a material to resist water penetration
- 3.19 waterstop**
material designed to inhibit the transmission of water through joints in the structure
- 3.20 water vapour**
water in its gaseous state
- 3.21 water vapour resistance**
ability of a material to resist water vapour penetration

4 Design philosophy

4.1 General

It is essential for the success of any project involving below ground structures that strategies for dealing with groundwater, soil gases and contaminants are considered from the very earliest stages of the planning and design processes.

For new structures, it is recommended that the structural design, overall weatherproofing design, waterproofing design and construction processes are considered together, as they generally interact.

In addition, it is recommended that, during the design process and at all stages of the construction process, the designers, specialists, manufacturers/suppliers and installing contractors establish and

maintain effective channels of communication. Regular and clear communication coupled with good site supervision allows variations and amendments to the design to be planned and executed without compromising the performance of the waterproofed structure (see also 4.2).

4.2 Design team

The advice of a geotechnical specialist should be sought on the geology and hydrogeology, the external drainage options and groundwater conditions (see Clause 5).

A waterproofing specialist should be included as part of the design team so that an integrated waterproofing solution is created. The waterproofing specialist should:

- a) be suitably experienced;
- b) be capable of devising solutions that accommodate the various project constraints and needs;
- c) provide the design team with information and guidance that assists with and influences the design, installation and future maintenance of the waterproofed structure.

NOTE The waterproofing specialist could be the manufacturer or material supplier, provided that the manufacturer/supplier has the relevant expertise.

All design decisions made by others that might have an impact on the waterproofing design should be brought to the attention of the waterproofing specialist/designer and installing contractors. Final decisions and any recommendations should be approved by the designer.

4.3 Principal considerations

4.3.1 General

In order to develop a robust design for protecting a structure against groundwater, the following factors should be assessed:

- a) the likely highest level of the water table, the drainage characteristics of the soil and other site-specific properties (see Clause 5);
- b) the appropriate waterproofing measures (see Clause 6), i.e. Type A, B or C protection and, where necessary, external drainage based on:
 - 1) the results of the site evaluation, including the classification of the water table; and
 - 2) the intended use of structure, with consideration given to any requirement for future flexibility. This should be undertaken in consultation with the client;
- c) the appropriate type of primary waterproofing system (see Clause 8, Clause 9 and Clause 10).

NOTE 1 The general principle is to assess the risk of water reaching the structure and then to select a waterproofing system capable of achieving the required internal environment.

NOTE 2 Mechanical heating and ventilation often play an important role in creating the internal environment, particularly where higher grades are required. The design of such systems is a specialist activity, outside the scope of this standard.

Condensation may also be controlled by the provision of adequate ventilation (assisted by heating), coupled with the suitable treatment of floor and wall surfaces.

A three-dimensional review of structure and waterproofing should be undertaken so as to identify any complex geometries, which are not readily identified from normal two-dimensional details.

Service entries are particularly vulnerable to water penetration; where they cannot be avoided, they should be carefully detailed, incorporating sealing, to minimize the risk of water ingress (see 8.1.3).

NOTE 3 The three-dimensional review needs to include detailed information on the proposed waterproofing system (e.g. the effect that this has on wall base details, laps in membranes and waterstops). Examples of complex geometries are corner details and where the wall adjoins: the base slab/foundation; the superstructure; differing floor levels; and windows below ground.

4.3.2 Defects and remedial measures

An ideal waterproofing solution would be defect-free. However, it should be noted that two types of defects might occur in any waterproofing, where a structure is subjected to water pressure, and this could mean that the required internal environment is not achieved. These defects are as follows:

- a) defects owing to poor workmanship or the inappropriate use of materials;
- b) defects owing to the specific properties of the materials being used.

NOTE Reference to "defects" does not apply to normal designed flexural cracks or surface crazing in concrete elements but only to through cracking, which might need to be locally sealed.

It is essential that the construction methods and materials used to realise the design are such that the defects in a) are avoided.

The defects in b), which are generally minor, should be recognized and catered for in the design. Contingency planning for dealing with any localized defects or system failure that arise should be included as part of the overall water-resisting design for the structure (see also Clause 11).

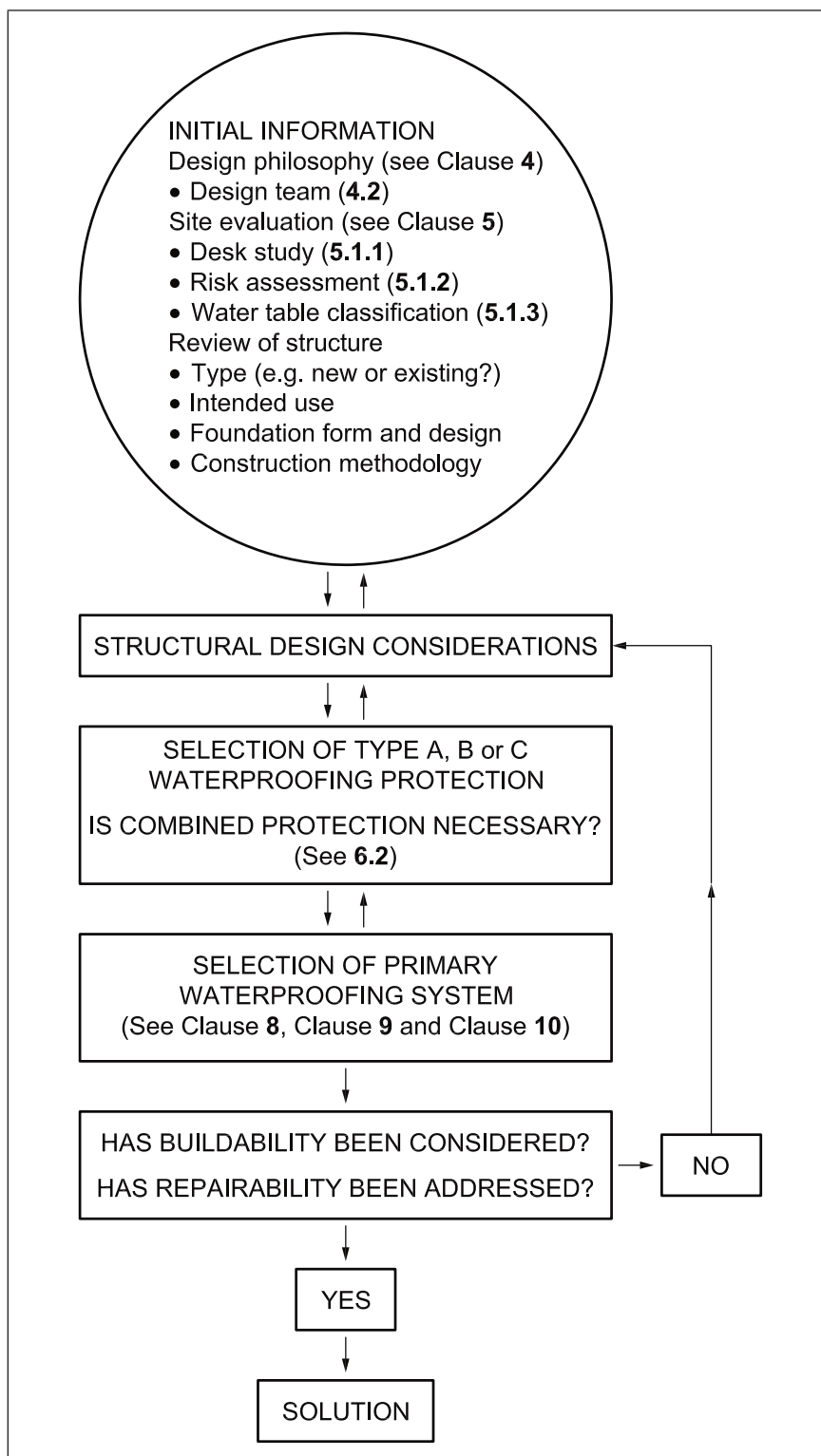
In either case, the issue of repairability should be taken into account and the feasibility of remedial measures assessed.

Figure 1 Design flowchart

COMMENTARY ON FIGURE 1

Figure 1 outlines the principal factors and stages that need to be addressed in order to produce a robust waterproofing solution for a below ground structure.

It demonstrates that some matters are interrelated and that a degree of iteration might result from a need to address buildability and repairability. The principal issues (boxes) do not necessarily need to be addressed in the order shown but all need to be understood and evaluated.



5 Site evaluation

COMMENTARY ON CLAUSE 5

Attention is drawn to the fact that many of the issues addressed in this clause are also relevant to the design of the structure itself. For further guidance, see the relevant Eurocodes, e.g. BS EN 1992 or BS EN 1997.

5.1 General

5.1.1 Desk study

A desk study should be carried out in accordance with BS 5930 and BS EN 1997:

- a) to assess the geology and hydrogeology, including soil permeabilities, flood risk, radon, methane and other ground gases and contaminants (e.g. chlorides and acids);
- b) to assess the topography of the surrounding ground in relation to the below ground structure;
- c) to establish the likely highest level of the water table and the potential for the occurrence of a perched water table; and
- d) to identify any missing ground and groundwater information, which should then be obtained by undertaking a site investigation in accordance with BS 5930 and BS EN 1997.

NOTE Guidance on best practice in ground investigation, laboratory and field-testing for embedded retaining walls is given in CIRIA publication C580 [2].

The drainage characteristics from analysis of the soil should be determined in accordance with BS 8004.

5.1.2 Risk assessment

NOTE 1 The principal risks with respect to water ingress into structures are the external environmental conditions.

A risk assessment should be carried out which considers the long-term water pressures, the effects of surface water infiltration and the use of external drainage and cut-off walls.

Risk assessment should also consider:

- a) the effects of climate change, burst water mains and sewers, adjacent trees, sulfates, radon, methane and other ground gases and contaminants; and
- b) where external drainage is proposed, the effects of drawdown on adjacent structures, the potential silting of drainage and biofouling issues.

Even when the site investigation indicates dry conditions, the risk of some waterlogging (see Note 2) in the future should be assumed.

NOTE 2 Even in a permeable subsoil, groundwater requires time to drain away and this can result in limited pressure periodically coming to bear against the structure.

5.1.3 Water table classification

Where assessment of the water table is undertaken, this should be classed into the following three categories, which can then be used to determine the suitability of different types of waterproofing protection (see 6.2).

- High – where the water table or perched water table is assessed to be permanently above the underside of the base slab.
- Low – where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free-draining strata.
- Variable – where the water table fluctuates.

NOTE In certain ground conditions, external drainage systems can be used to convert the “high” and “variable” water tables to the “low” condition (see also 6.3).

5.2 Inspection and survey for existing structures

5.2.1 General

Following an assessment of the external risk (see 5.1.2), a comprehensive survey should be undertaken of any existing waterproofing arrangements.

The structure should also be examined in order to determine any potential movement that might occur between the walls and floor.

NOTE 1 The base slab of many older structures is likely to abut the external walls. This can give rise to movement between wall and floor. Special flexible joint details might be required so that strains in the waterproofing materials are controlled within acceptable limits where bonded or surface-applied barrier materials are used in such situations. Similar details might also be required at other locations where structural movement can occur.

NOTE 2 Less movement would be expected in cases where the floor is set into the wall although horizontal movement can occur unless the floor is reinforced such as to achieve the necessary fixity.

As the space available in below ground structures is often converted into habitable rooms during refurbishments, the survey should also consider the previous use, e.g. this might have been such that dampness was of less concern than for the proposed use.

NOTE 3 Existing waterproofing might have to be removed completely and replaced with an entirely new system, although in some instances it might be possible to apply a Type A barrier or a Type C drained cavity system directly. These systems can be considered where there is no existing waterproofing but the suitability of Type A barrier materials depends on the characteristics of the surface of the wall or floor.

5.2.2 External walls

An old external cavity form of waterproofing protection might be encountered that is not immediately obvious. Where an external cavity is found, it should be inspected to confirm that:

- a) the cavity is not bridged by debris;
- b) any drainage is still functioning and has not been silted up; and
- c) air bricks are not obstructed by soil or vegetation.