

Code of Practice for

Protection of buildings against water from the ground

UDC 699.82 + 69.034.9

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Protection against ground water

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This Code of Practice has been prepared by a Committee convened by the Code of Practice Committee for Building. Having been endorsed by the Council for Codes of Practice, it was published under the authority of the Executive Board on 20 October, 1973

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First published October 1963
First revision October 1973

The following BSI reference relates to the work on this Code of Practice:
Committee reference BLCP/22

ISBN 0 580 07671 7

Amendments issued since publication

Amd. No.	Date of issue	Comments
1511	July 1974	
2196	January 1977	
2470	February 1978	Indicated by a sideline in the margin

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Foreword

As part of BSI's programme of metrication, this Code is expressed in metric terms. The metric values are given in SI units; for further information on SI units, reference should be made to BS 3763, "The International System of units (SI)".

The values in this Code represent the equivalent of the values in imperial units in the 1963 edition rounded to convenient numbers. Although the values are not exact equivalents of the imperial units, this is not a technical revision but it is proposed to withdraw the existing Code when this edition is published.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with it does not confer immunity from relevant statutory and legal requirements.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, 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 methods of preventing the entry of ground water and surface water into a building from the surrounding areas. It makes recommendations for the drainage of adjoining areas, for special waterproof or water-resisting types of construction below ground level and for the damp-proofing of walls and floors at or near ground level.

It has been assumed that the design of all constructional work within the scope of this Code will be carried out by an architect and/or engineer experienced in the type of construction concerned and referred to throughout this Code as the designer.

Section 2 of this Code describes methods of preventing the entry of ground water into a building at or below ground level where ground or surface water may not be able to escape immediately.

Section 3 of this Code describes methods of providing damp-proofing of walls and floors at or near ground level.

In Section 2 two types of structure are considered:

- 1) Type A in which protection is provided by a continuous impervious membrane which excludes visible penetration of water and provides a vapour seal.
- 2) Type B in which visible penetration of water is prevented, but transmission in the form of vapour may not be wholly excluded. For the purposes of this Code, this degree of protection is assumed to be provided by high quality reinforced or prestressed concrete.

No recommendations are included in this Code for the use of embedded heating in basements, floors and wall or for the special requirements in connection with the design and construction of cold-stores.

NOTE The titles of the British Standards referred to in this Code are listed on page 26.

2 Exchange of information and time schedule

The working drawings and specifications should be prepared in sufficient detail to afford proper guidance to all concerned in estimating and in the execution of the work. There should be exchange of information between those responsible for the site preparation, the constructional work, pumping or dewatering, the tanking and waterproofing work and other subsequent work, and these should take place in the early stages to ensure that the various operations can be carried out at the proper time and that all necessary provisions for satisfactory execution have been made in advance.

A time schedule should be prepared before the work is commenced so as to provide for the greatest rate of progress consistent with the most economical use of plant and scaffolding by the various specialists and trades and with a minimum of pumping. In particular, the schedule should provide a sequence agreed by the various specialists and trades which ensures the least interference with the work of others.

Section 2. Waterproofing of structures below ground

3 Materials

3.1 Constructional materials

3.1.1 Cement. The cement used should be Portland cement or Portland-blastfurnace cement. Portland cement should comply with the requirements of BS 12-2.

Portland-blastfurnace cement should comply with the requirements of BS 146.

Other cements, such as low heat Portland cement, sulphate resisting Portland cement, high alumina cement and supersulphated cement may be desirable in certain circumstances, but they should only be used with the designer's approval.

High alumina cement should not be mixed with either of the other kinds of cement. It may be unsuitable for use with certain aggregates which may liberate appreciable amounts of soluble alkalies or lime, and the user can only be guided by previous experience in determining whether it is suitable for use with such aggregates. Concretes made with high alumina cement are sometimes unsatisfactory in warm, moist conditions. This cement should be used only in accordance with the manufacturer's recommendations.

Supersulphated cement should be used only in accordance with the manufacturer's recommendations and especially in regard to storage, curing and concreting in cold weather. Supersulphated cement should not be mixed with the other kinds of cement.

3.1.2 Aggregates for concrete. Aggregates for concrete should be selected from 1) or 2).

- 1) Coarse and fine aggregate complying with the requirements of BS 882. The combined aggregates should have an absorption of not greater than 5 %, measured in accordance with BS 812, Section 4.
- 2) Other types of aggregates which are suitable, having regard to their strength, durability, absorption and freedom from harmful properties.

Fine aggregates, with gradings complying with Zones 1, 2 and 3 only of BS 882 should be used for nominal mixes but fine aggregates within Zone 4 may be suitable for special mixes.

The combined grading of the aggregates should be such as to produce a concrete of the specified proportions which will work readily into position without segregation and without the use of an excessive water content. The grading should be controlled throughout the work so that it conforms to that used for the preliminary tests.

3.1.3 Fine aggregate for mortar. Fine aggregate for mortar should be clean and well graded. It should comply with the requirements for natural sands in BS 1200.

3.1.4 Water. Water for concrete should be clean and free from harmful matter. Attention is drawn to the requirements of BS 3148.

3.1.5 Reinforcement. In reinforced concrete the reinforcement should be one of the following:

- 1) Steel bars and hard drawn steel wire complying with the requirements of BS 4449 and BS 4482.
- 2) Cold twisted steel bars complying with the requirements of BS 4461.
- 3) Steel fabric complying with the requirements of BS 4483.
- 4) Such other reinforcement as may be suitable having regard to the yield strength, ductility, tensile strength and other essential properties.

3.1.6 Prestressing steel. In prestressed concrete the prestressing steel should be one of the following:

- 1) Plain hard-drawn steel wire complying with the requirements of BS 2691.
- 2) Indented or crimped hard-drawn steel wire complying with the requirements of BS 2691 in all respects except that for the bend test.

3) Cold worked high tensile alloy steel bars complying with the requirements of BS 4486.

4) Such other wires, strand or bars having properties not inferior to those laid down in BS 2691 or BS 4486 respectively.

3.2 Waterproofing materials

3.2.1 Mastic asphalt. Mastic asphalt for tanking should conform to the requirements of either BS 1097 or BS 1418.

3.2.2 Bitumen sheeting. Bitumen sheeting for tanking should conform to the requirements of Class A of BS 743. For three layer work the minimum weight should be 3.8 kg/m². For two layer work the minimum weight should be 5.4 kg/m².

3.2.3 Bitumen compound. Bitumen compound for bonding and sealing bitumen sheeting should be oxidized bitumen of penetration at 25 °C 20/30 softening point (R and B) 80/100 °C.

NOTE The properties of the bitumen materials referred to in 3.2.3 are based on the methods of test given in BS 4692.

4 Preliminary investigations and design criteria for basements

4.1 General. Before commencing work on any structure below ground level a thorough site investigation and exploration of soil and water levels should be made. The testing of soil and ground water samples for sulphate or other aggressive chemicals should also be included. The procedure described in CP 2001 is recommended in all cases, care being taken to ensure that the whole of the area is surveyed by a considered selection of positions for borings or test holes.

Where high concentrations of sulphate are found in the soil or ground water consideration should be given to the provision of an impervious membrane or to the use of special cements to provide a concrete of adequate resistance to sulphate attack.

Almost all basement structures are likely to be subjected to water pressure at some period of their life. Even when the site examination indicates dry conditions, it should be borne in mind that there is a possibility of waterlogged conditions at some time in the future. In a permeable subsoil ground water requires time to drain away and the action of constructing a basement in a hole in the ground may of itself induce a water head. It is, therefore, recommended that all basement structures should be designed on the basis that water pressure will need to be resisted at some stage in their life (see 4.3).

Basements of reinforced or prestressed concrete, if properly designed and constructed, will resist the penetration of water under a pressure many times in excess of that normally encountered in this type of structure. Water has the capacity, however, of penetrating even minor defects and a high standard of workmanship is required if the structure is to be completely watertight. Minor defects, however, can often be repaired by grouting or rendering and some recommendations are given in this Code (see Clause 9).

Many basements give the physical impression of dampness unless mechanically ventilated. Additional protection against the ingress of moisture and dampness may be provided by the inclusion of an impervious membrane in the construction, but membranes are only fully effective where the supporting structure is sound and free from cracks.

4.2 Preventative measures. Water or moisture penetration of the basement may be reduced by one or more of the following measures depending on the conditions of the site.

4.2.1 Reduction of surface water entering into adjacent ground. Where possible the ground should slope away from the building for a distance of about 3 m to divert the surface run-off and to prevent water from standing near or against the walls. The surface near the walls should preferably be paved. On sloping sites it is usually desirable to construct a cut-off land drain on the high side to lead water around the building to a lower level.

Rainwater from the roof of the building and from impervious external wall surfaces, if any, or paved areas, should generally be collected in a separate drain and diverted away from the building. It should not be allowed to enter the ground near the walls nor be connected to the open-jointed sub-surface drain around the foundations. The methods of collection and disposal of surface water and subsoil water described in CP 301 should be followed.

4.2.2 Provision of sub-surface drainage around basement walls and under floor, and drainage by gravity or by pumping. If excavation involves cutting through existing land drains they should be carefully diverted into the ground drainage system, or reconstructed so as to be laid in straight lines which are capable of being rodded.

Water may be prevented from remaining in contact with basement walls or floors for long periods by installing a system of drainage round the wall footings or beneath the floor or both together. The provision of drains around the perimeter of the basement is recommended for any site where the ground water table is likely to rise above the top of the footings. These drains should be placed beside the wall footing and should be graded to an open outlet or storm water sewer or to a sump within the building and pumps provided. Drains should be porous or laid with open joints, and should be covered by a graded filter starting with coarse stone around the pipe and changing gradually to material a little coarser than the surrounding soil. Detailed design for a graded filter is discussed in Clause 1.84 of Civil Engineering Code of Practice No. 2.

In porous soils such as sands and gravels, footing drains may have the effect of lowering the ground water table in the vicinity of the basement. In clay soils the movement of water is generally very slow and the drains may not act in this way but will provide a means of removing water which penetrate through fissures in the clay after a period of dry weather.

If adequate surface and footing drains are provided it may not be necessary to provide special drainage under basement floors but a blinding layer of concrete 75 mm thick or a layer of granular material about 125 mm or 150 mm should always be placed as a base for the concrete floor.

4.2.3 Provision of special waterproof or water-resisting construction in the floors and walls for which this Code gives guidance. In providing recommendations for the design and construction of buildings below ground level in order to prevent or minimize the entrance of ground water to the inner surface of the building, two types of construction are considered:

- 1) Type A structures in which protection is provided by a continuous impervious membrane which excludes visible penetration of water and provides a vapour seal.
- 2) Type B structures in which high quality concrete alone is relied on to provide protection against visible penetration of water, but transmission in the form of vapour may not be wholly excluded.

4.3 Basis of design. The stability of the structure as a whole and the stresses in the materials of construction should be determined in accordance with any relevant byelaws or regulations and the appropriate Code of Practice.

The imposed loadings on the building should be in accordance with CP 3:Chapter V-1 and CP 3:Chapter V-2.

The pressure exerted by the surrounding earth and by subsoil water is generally somewhat indeterminate, but monolithic structures are capable of successfully resisting a variation in service conditions and are generally recommended. It is generally necessary to design for a positive water head and in a normal single storey basement a minimum allowance of not less than one-third of the depth below ground will be necessary.

The maximum head of water cannot in practice exceed the full depth of the structure below ground level, and although it may be difficult to be precise on intermediate conditions, some reduction in the normal load factor used in the design can be accommodated. It is suggested that the design head of water for the purpose of calculating the stresses in the structural walls need not normally exceed three-quarters of the full depth below ground when the design is based on normal stresses.

It is essential that an allowance for the additional pressure of the submerged earth is added to the simple water pressure but it will seldom be necessary to make an additional allowance for superimposed loading on the surface unless heavy loading is likely to occur against the boundary of the building.

Consideration should also be given to ensure that the basement will not float, by checking the overall dead load of the structure against the upward water pressure at various stages of construction, and in these cases the possibility of a full water head may have to be considered. Temporary arrangements to balance the water pressure may need to be provided to cater for intermediate conditions during construction (see also Clause 8).

5 Type A structures: structures requiring the protection of an impervious membrane

5.1 Structural requirements. Type A structures may be constructed of reinforced concrete or prestressed concrete. In special circumstances plain concrete, brickwork or dense concrete blockwork may be used. Structural steel may also form part of the main structure in conjunction with other materials. The structure should be designed so as to avoid movements which could damage the impervious membrane.

Although mastic asphalt will accept some movement it may be split by differential movement or cracking of the supporting structure. Extra care is therefore necessary when designing in mixed materials, e.g. concrete and brickwork and in any unreinforced structures. Least risk of damage to the membrane is involved in a reinforced or prestressed concrete structure.

5.1.1 Reinforced concrete. Structures in reinforced concrete should be designed and constructed in accordance with the recommendations of CP 114-2 or CP 2007-2, except when these are at variance with the specific recommendations of this Code and the special clauses on reinforced concrete in Civil Engineering Code of Practice No. 2. Special attention should be given to the provision of sufficient reinforcement to control cracking.

5.1.2 Prestressed concrete. Structures in prestressed concrete should be designed and constructed in accordance with the requirements of CP 115-2, or CP 2007-2 except where these are at variance with the specific recommendations of this Code.

5.1.3 Plain concrete, brickwork or blockwork. Plain concrete walls should be designed and constructed in accordance with the recommendations for mass concrete in Civil Engineering Code of Practice No. 2 or CP 123.101. Brickwork or blockwork should comply with the special recommendations of Civil Engineering Code of Practice No. 2 and for brickwork and blockwork below damp-proof course with the recommendations of CP 121.101.

Construction joints should be kept to a minimum. Their probable positions should be foreseen when the design is being prepared and details of the joints shown on the drawings. They should be designed to provide thorough keying of the faces of the concrete and may include the provision of water bars if necessary to prevent the ingress of water. Movement joints in a basement which is to be tanked cannot be tolerated. Special consideration should be given to the resistance to shear at the junction of the wall and the base in order to cater for the pressure due to earth and water at all stages. It is further recommended that any basements with a length exceeding 7.5 m, whether tanked or otherwise, should be constructed in reinforced or prestressed concrete.

5.1.4 Mastic asphalt. When the mastic asphalt is fully confined it may be regarded as having the same compressive strength as the containing material. When mastic asphalt is not fully confined to prevent extrusion the maximum design load should not exceed 650 kN/m^2 at normal temperature.

5.1.5 Bitumen sheeting. When bitumen sheeting is fully confined it may be regarded as having the same compressive strength as the containing material.

Bitumen sheeting is of a plastic nature and deformation will take place under load if it is not fully confined but this does not impair the waterproofing properties of the sheeting. When unconfined the maximum design load on bitumen sheeting should not exceed 54 kN/m^2 .

5.1.6 Other sheeting material. Other forms of impervious sheeting are available which can provide a vapour seal, such as polyisobutylene. Before specifying these materials the designer should satisfy himself that advantage is to be gained from their use. No recommendations are given in this Code as to methods of application.

5.2 Requirements for the impervious membrane. The function of an impervious membrane is to provide a continuous waterproof lining to the walls, floors and foundations of structures below ground and to prevent rising moisture through ground floors constructed in direct contact with the ground.

Horizontal membranes may be applied to structurally sound concrete bases. Vertical mastic asphalt membranes may be applied to structurally sound walls of concrete, brickwork or dense concrete blockwork. Vertical membranes of bitumen sheeting may be applied to structurally sound concrete walls of flush faced brickwork or blockwork. Examples of their use are shown in Figure 1 to Figure 11.

