Chapter

5.4

Waterproofing of basements and other below ground structures

This chapter gives guidance on meeting the Technical Requirements for the waterproofing of basements and other structures below, or near to, ground level.

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Introduction

This chapter includes guidance for walls, floors and foundations below, or near to, ground level that are intended to prevent the passage of water from the ground (including from sources such as run-off, burst pipes, etc) entering the building near to or below ground level.

Guidance for the following types of waterproofing systems is included in this chapter:

- **Type A waterproofing barriers**
- **Type B structurally integral construction**
- **Type C drained cavity construction.**

Constructions that are at risk of coming into contact with water and generally require waterproofing include:

- **basements**
- **semi-basements**
- **below ground parking areas**
- **lift pits**
- **cellars**
- **storage or plant rooms**
- **service ducts, or similar, that are connected to the below ground structure**
- **stepped floor slabs where the retained ground is greater than 150mm.**

Types of construction that, depending on the findings of a risk assessment, may require waterproofing include:

- **external walls where the lowest finished floor level is less than 150mm higher than the external ground level**
- **voids caused by split levels.**

Typical examples of construction types:

Waterproofing should be provided where due to the construction details and the ground conditions, there is a risk of contact with groundwater (see Table 1)

Waterproofing is required

Figure 1: Basement

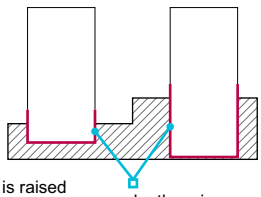


Figure 2: Retained ground and semi-basement

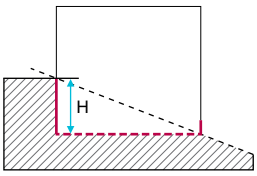


Figure 3: Lift pit

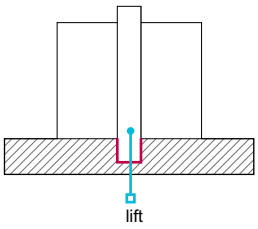


Figure 4: Stairs adjacent to the structure

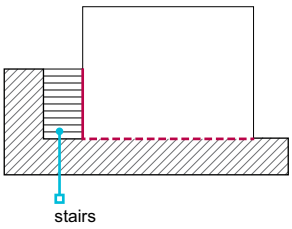


Figure 5: Stepped floor slabs where the retained ground is greater than 150mm

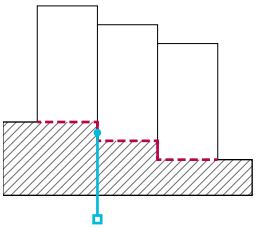


Figure 6: Raised external ground levels

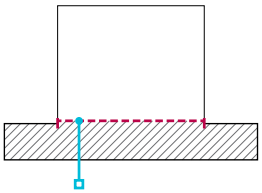


Figure 7: Buried podium

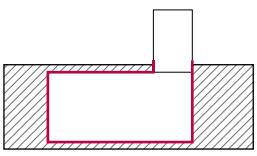


Figure 8: Raised podium

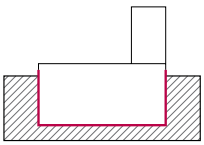


Figure 9: Retaining walls forming lightwells

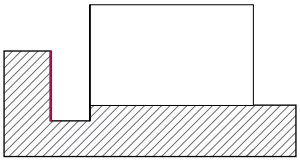
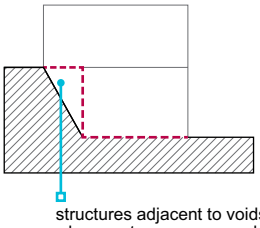


Figure 10: Split levels



Definitions for this chapter

For the purposes of this chapter, the following definitions apply:

Cavity drain membrane	Semi-flexible sheet designed to form a cavity that intercepts water penetrating the structure and directs it to a suitable drainage point. See Type C drained cavity construction.
Combined system	For the purposes of this chapter, a combined system includes: • Type A and Type B • Type A and Type C • Type B and Type C It does not include Type A and Type A of different performance characteristics as recognised in BS 8102.
Ground barrier	A barrier used to resist the ingress of moisture and/or hazardous gases into the building.
Lowest finished floor level	The top surface of the lowest finished floor, including lift pit floors, car park surfaces and other similar surfaces; excluding coverings such as carpet and tiles.
Retained ground	In this chapter retained ground levels are taken from the top of the retained ground to the lowest finished floor level.
Type A fully bonded barrier	Type A barrier that forms part of a composite structural wall, including liquid applied and cementitious systems. Typically, when membranes, they will prevent water from tracking from a defect in the membrane to a crack/joint in the structure. Post-applied sheet membranes are not considered to be fully bonded barriers for the purposes of this chapter.
Type A post-applied membrane	A sheet membrane applied to the completed structure, typically with hot or cold adhesive.
Type A waterproofing barrier	A waterproofing barrier applied to the structural element being waterproofed, also known as tanking.
Type B structurally integral construction	Where the water-resistant properties of the retaining structure provide waterproofing to the building This chapter provides specific guidance for the use of Type B concrete systems cast in-situ, with or without water-resisting admixtures. The principles are applicable to other Type B systems listed in BS 8102.
Type C drained cavity construction	Construction that incorporates a cavity, generally formed with a cavity drain membrane Water is removed from the cavity via a managed drainage system.
Waterproofing design specialist	A suitably qualified person co-ordinating the team involved in the design of waterproofing to basements and other below ground structures.
Waterproofing system	A fully assessed and certified system of compatible materials and components used to provide waterproofing. These are normally considered to be Type A, B or C as defined above.

5.4.1 Compliance

Also see: Chapter 2.1, BS 8102 and The Basement Information Centre Guidance Document — Basements for Dwellings and Basements: Ground Gases and Structural Waterproofing

Basements and other below ground structures shall comply with the Technical Requirements.

Waterproofing of basements and other below ground structures, including foundations, walls and floors that complies with the guidance in this chapter will generally be acceptable.

5.4.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to all appropriate personnel.

Design and specification information should be issued to site supervisors, relevant specialist subcontractors and/or suppliers and include the following information:

- a full set of current drawings
- details of joints, junctions and service penetrations. Complex details should be considered and presented in three dimensions
- the manufacturer's information, including relevant parts of the system design manual
- an installation method statement detailing the sequence of works
- a ground condition report
- third-party certifications
- details of the waterproofing design specialist.

Design and specification information should be provided to NHBC at least eight weeks in advance of the works starting on site, in accordance with the NHBC Rules.

5.4.3 Waterproofing

Also see: BS 8102

The design of waterproofing systems shall be undertaken by a suitably qualified person and be appropriate for the specific performance required. Issues to be taken into account include:

1) waterproofing design

2) risk-based design.

5.4.3.1 Waterproofing design

Waterproofing systems should be designed by a waterproofing design specialist. Designers who have successfully completed the Certified Surveyor in Structural Waterproofing (CSSW) qualification available from the Property Care Association (PCA) are generally acceptable to NHBC. An alternative demonstration of competence may be acceptable, subject to successful review.

The waterproofing design specialist should be appointed in the early design stages to co-ordinate with other designers, including the engineer, and to ensure satisfactory integration of the waterproofing system.

5.4.3.2 Risk-based design

Waterproofing should be appropriate to the risk, and generally assume exposure to a full height of water during the design life of the building.

Combined systems should be used where:

- a Grade 3 environment is needed, and
- the wall retains more than 600mm.

Alternatively, where the builder has demonstrated that the water table is permanently below the underside of the lowest floor slab, a Type B structurally integral concrete system is acceptable without further protection from a combined system.

The following Types of waterproofing are acceptable where a Grade 1b environment is needed and more than 600mm of ground is retained:

- Type A fully bonded barrier
- Type B
- Type C
- a combined system.

5.4.4 Ground conditions

Also see: Chapter 4.1

The waterproofing system shall take account of ground conditions.

The ground conditions should be fully considered by the engineer and waterproofing design specialist in the design of the waterproofing system.

NHBC may request investigation and a report of the ground conditions where the below ground waterproofed structure:

- retains more than 600mm of ground, measured from the top of the retained ground to the lowest finished floor level
- comprises more than 15% of the perimeter of an individual building (eg terraced homes, apartment blocks and detached garages), measured on plan.

The ground conditions report should take into account appropriate investigations, as described in Table 1.

Table 1: Investigation of ground conditions

Further investigation	Guidance and information
Desk study, including review of: • groundwater, lost rivers and flooding issues • flood potential of the site • available groundwater data • SuDS impact assessment • flood risk assessment • topography of the site • effects of adjacent surface finishes	**www.environment-agency.gov.uk/homeandleisure/floods** **www.bgs.ac.uk/geology-projects/groundwater-research/groundwater-data/** **www.metoffice.gov.uk/weather/climate/uk-climate** **climate-change.data.gov.uk** **Historical Publications Ltd 'The Lost Rivers of London' by Nicholas Barton**
Contaminated or aggressive ground and/or groundwater conditions	Testing required where there is the potential for chemically aggressive ground and/or groundwater
Water level change, including potential for flash flooding and waterlogging	Identifying likely fluctuations and short-term flooding events
Impact assessment of groundwater flow where the construction is likely to have a 'damming' effect	Interpretative report by a qualified engineer, hydrologist or hydrogeologist to include: • assessment of the direction of groundwater flow • damming effects on the groundwater regime • damming effect of adjacent structures

Where it is necessary to establish the water table, a detailed hydrogeological assessment should be undertaken by a suitably qualified engineer, and include:

- long-term water level monitoring over at least one year to capture seasonal fluctuations
- short-term flooding events that typically occur during autumn and spring
- information based on a suitable number of boreholes monitored at intervals of three months or less.

5.4.5 Structural stability

Also see: Chapters 4.1, 4.2 and 5.1

Elements forming a waterproofing structure below ground including: foundations, walls and floors, shall adequately resist movement and be suitable for their intended purpose. Issues to be taken into account include:

1) **site conditions**
2) **structural design**
3) **durability**
4) **movement**
5) **design co-ordination.**

5.4.5.1 Site conditions

Parts of the building constructed below ground level that form the structural elements of usable spaces should be designed by an engineer in accordance with Technical Requirement R5 where they are retaining more than 600mm. Issues that should be taken into account include:

- characteristics of the site
- ground conditions
- hazards.

5.4.5.2 Structural design

The structure should be designed to take account of all imposed loads and actions, including:

- ground movement
- lateral forces from groundwater, retained ground and ground surcharge loads
- buoyancy
- loading from other parts of the building
- temporary loading conditions.

5.4.5.3 Durability

The structure should be designed to be sufficiently durable against site hazards, including:

- chemicals
- frost action
- cyclical wet-dry conditions.

5.4.5.4 Movement

Movement within the structure should be limited to the capacity of the waterproofing system's resistance to such movement, ensuring that the designed level of watertightness is achieved. Detailed guidance for the limitation of movement should be provided where appropriate.

Movement joints in below ground waterproofed structures should be avoided and adopted only as a last resort. Although there are likely to be movement joints in the superstructure, typically they are not required to be continued through. Where it is necessary to provide movement joints, the design should clarify why they are necessary and ensure satisfactory in-service performance, including watertightness. Such joints should be accessible for maintenance, and not permanently concealed by other structural elements of the building.

5.4.5.5 Design co-ordination

Structural design should be co-ordinated with the design of the waterproofing.

5.4.6 Design considerations

Also see: Chapters 5.1, 5.2. 5.3 and 6.3

The waterproofing of all elements, including walls, floors and foundations, forming below ground structures shall be suitable for intended use. Issues to be taken into account include:

1) grade of waterproofing protection
2) waterproofing systems, materials and components
3) interface with the above ground structure
4) joints, abutments and service penetrations
5) steps and level changes.

5.4.6.1 Grade of waterproofing protection

Waterproofing systems should be designed to resist the passage of water and moisture to internal surfaces.

The waterproofing grade should be appropriate for the proposed use of the internal space and the equipment located within.

Table 2: Waterproofing grades

Grade	Description	Generally required for:
Grade 3	No water ingress or damp areas is acceptable. Ventilation, dehumidification or air conditioning necessary; appropriate for the intended use.	Habitable accommodation
Grade 2	No seepage is acceptable. Damp areas as a result of internal air moisture/ condensation are tolerable; measures might be required to manage water vapour/condensation.	Non-habitable areas, such as car parks, storage or plant rooms where the internal finishes are not readily damaged by moisture (Some water ingress may occur where openings are provided in car parks, eg for ventilation. To minimise potential for standing water, refer to Chapter 9.1 A consistent approach to finishes. Car parks should be provided with drainage to a suitable outfall).
Grade 1b	No seepage. Damp areas from internal and external sources are tolerable.	
Grade 1a	Seepage and damp areas from internal and external sources are tolerable, where this does not impact on intended use.	Retaining walls typically used to form external lightwells (Drainage may be required to deal with seepage).

Where there is doubt about potential use, minimum Grade 3 protection should be considered in the waterproofing design.

5.4.6.2 Waterproofing systems, materials and components

Components forming the waterproofing system should be predefined and assessed to demonstrate suitable performance.

The assessment should recognise waterproofing may extend or continue across different substrates and/or other materials, products or building systems, or that materials and components may be interchangeable between systems. To ensure performance will be maintained, checks should be undertaken on chemical and adhesive compatibility before installation. Manufacturers often have material compatibility data that can be referred to, however undertaking on-site tests prior to full application are recommended to verify predicted suitability. Substrates should be suitably primed, prepared, dried, cured, cleaned of dirt, dust or other debris and/or protected in accordance with manufacturers' instructions throughout the site works.

The design information and documentation should detail waterproofing systems, materials and components in accordance with manufacturers' recommendations.

Proprietary waterproofing systems, materials and components should be assessed in accordance with Technical Requirement R3.

5.4.6.3 Interface with the above ground structure

Waterproofing should extend at least 150mm above the external ground level and connect with the superstructure damp proofing. This can generally be achieved by linking the below ground waterproofing system to a continuous cavity tray.

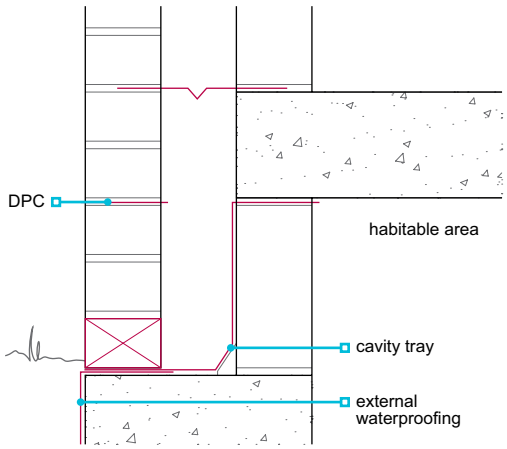
The connection between the below and above ground waterproofing should be bonded and formed with appropriate materials.

Where the waterproofing is linked to the above ground structure via a cavity tray, the materials should:

- compress to form a watertight seal
- be capable of taking the load.

Bitumen-based materials in accordance with BS 6398 or suitable materials assessed in accordance with Technical Requirement R3 should be used.

Figure 11: Ground level interface



5.4.6.4 Joints, abutments and service penetrations

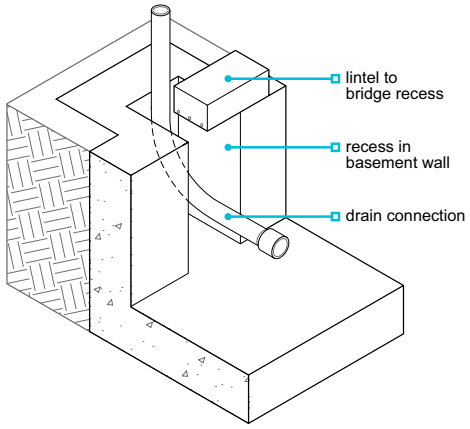
The design of waterproofing systems should include the correct method and detailing to form joints, abutments and service penetrations, including those between:

- the waterproofing system and superstructure damp proofing
- horizontal and vertical waterproofing
- system components.

The manufacturer should confirm compatibility between different materials where they are used to form joints.

Details of how junctions and abutments are formed should be provided to site personnel. Proprietary components that are part of, or compatible with, the waterproofing system should be used for complex joints, abutments and service penetrations.

Figure 12: Service entry



Penetrations through the waterproofing should be avoided where possible. Where penetrations cannot be avoided, the design should detail the method of waterproofing to ensure that it is watertight and durable.

Penetrations, including those for wall ties, services and drainage systems, should:

- be suitably separated to allow for proprietary seals to be correctly installed
- account for differential settlement and movement between the structure/finishes and services.

5.4.6.5 Steps and level changes

Situations where steps and level changes occur within buildings are not uncommon and it is often necessary to consider where normal damp proofing arrangements are likely to become ineffective, resulting in a need for waterproofing to be applied.

Issues to be taken into account include:

- nature of both the substructure and superstructure constructions and their resistance/susceptibility to liquid water and/or water vapour. For example, use of timber or light gauge steel framed superstructures, requirements for drained and/or vented cavities, ability for timber sole plates to breathe, inclusion of insulation(s)
- height difference between finished floor levels
- height of soil retention and/or presence of voids
- robustness of damp proofing or waterproofing solution(s) proposed
- accessibility for repair
- ground conditions and hydrology
- inclusion of subsurface drainage
- provision and continuity of damp proofing to walls and/or floors, interface with the above ground structure (particularly relevant should hazardous gases be present)
- relationship between internal and external ground levels
- continuation at returns, possibly of a different construction type (for example a change from solid to cavity walls or from concrete to masonry construction). Such situations should be considered in three dimensions.

5.4.7 Waterproofing systems

Also see: Chapters 3.1, 3.2, 4.1, BS 8102 and The Concrete Centre Concrete Basements Guidance on the design and construction of in-situ concrete basement structures

The waterproofing shall be suitable for intended use and installed in accordance with the design. Issues to be taken into account include:

1) **Type A waterproofing barriers**
2) **Type B structure, integral**
3) **Type C drained cavity**
4) **ancillary components.**

Appropriate sequencing of work will enable logical and timely construction of the waterproofing system and prevent unnecessary damage to completed elements of work. Installation should be undertaken in accordance with the design and the installation method statement detailing the sequence of works.

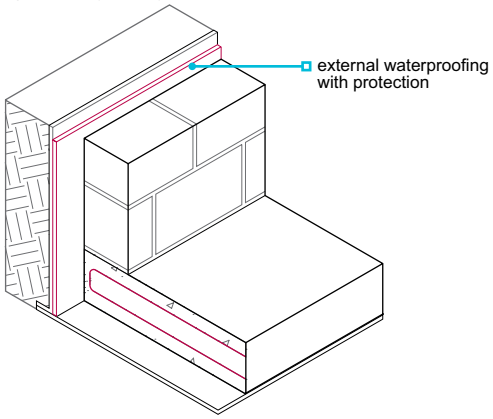
5.4.7.1 Type A waterproofing barrier

Type A systems generally accepted by NHBC when assessed in accordance with Technical Requirement R3 include:

- post-applied membrane (hot or cold adhesive)
- liquid-applied membranes
- geosynthetic (bentonite) clay liners
- mastic asphalt to BS EN 12970
- cementitious systems
- pre-applied fully bonded systems
- proprietary systems or products assessed in accordance with Technical Requirement R3.

Plain polyethylene sheet should not be used as a waterproofing system.

Figure 13: Type A system



In addition to key characteristics typically declared on product marking or technical literature, when assessing Type A system suitability it could also be important to consider its crack bridging ability and/or resistance to aggressive exposure environments (eg to UV, chemicals or hazardous gases) depending on the system's location, the substrate to which it is applied and the substrate's potential performance under load (eg for there to be cracking, a potential for cracks to generate and for these to be dynamic).

Only fully bonded systems assessed in accordance with Technical Requirement R3 for the specific purpose should be used internally.

Design at junctions and corners should account for proprietary components and be in accordance with the manufacturer's recommendations. Waterproofing barriers should return at corners to prevent water tracking behind.

The substrate to which the Type A system is to be applied should be clean, free from debris and prepared in accordance with the manufacturer's recommendations. Bonded sheet membranes should only be applied directly to masonry substrates that are smooth and have flush pointed joints.

Type A waterproofing should be installed in accordance with the manufacturer's instructions by operatives:

- who are suitably qualified or have been trained by the manufacturer or supplier, and
- who are fully aware of the design and the manufacturer's recommendations for installation.

Completed waterproofing should be protected by:

- protection board, or
- carefully placed backfill material.

The manufacturer's recommendations for climatic conditions at the time of installation should be followed.

5.4.7.2 Type B structure, integral construction, concrete and application

Structural design should be undertaken by an engineer in accordance with Technical Requirement R5. The design of in-situ Type B concrete systems should be in accordance with:

- BS EN 1992-1-1
- BS EN 1992-3
- Chapter 3.1 Concrete and its reinforcement.

Type B systems acceptable to NHBC include:

- in-situ concrete with or without water-resisting admixtures and crack widths limited by design
- in-situ high-strength concrete with crack widths limited by design and post-construction crack injections
- precast concrete systems assessed in accordance with Technical Requirement R3.

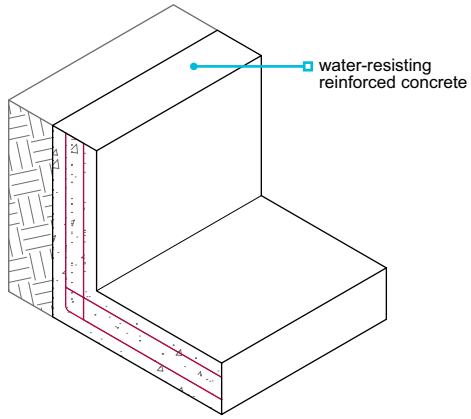
BS 8102 contains advice on the relationship between tightness classes given in BS EN 1992-3 and grades of performance given in BS 8102 for Grades 1a and 1b. Specialist advice should be sought where other Type B systems are specified.

Ready-mixed concrete should be of sufficient strength and durability, and from a supplier operating under a quality control system acceptable to NHBC such as:

- the Quality Scheme for Ready-Mixed Concrete (QSRMC), or
- the BSI Kitemark scheme.

Other suppliers may be accepted if they operate to a standard acceptable to NHBC.

Figure 14: Type B system



The concrete mix should be agreed between the engineer and the waterproofing design specialist, and:

- achieve the necessary robustness, durability and waterproofing
- be suitable for the environmental exposure and ground conditions.

Type B waterproofing should be installed:

- by suitably qualified operatives who are fully aware of the requirements for placing concrete and reinforcement and for installing ancillary components used in Type B systems
- in accordance with the design.

The line, level and position of formwork and reinforcement should be checked prior to concrete placement to ensure that it is in accordance with the design.

Penetrations from tie bars, etc should be made good in accordance with the design.

Where joints are formed in concrete, surfaces should be clean and free of excessive laitance. Hydrophilic strips should be protected from water before the joint is formed.

Quality management systems and quality audits should be used to record and monitor the placement of concrete on site. Monitoring records should be supplied to NHBC as requested.

Design details for reinforced concrete structures should include:

- concrete specification
- type of concrete
- concrete strength
- proportion of any admixture
- proposals for limiting crack widths
- consideration of temporary support to the formwork
- type and position of reinforcement
- method of making good holes in the concrete formed for shutter bolts and tie bars
- positioning of structural elements
- appropriate tolerances for the line and level of structural elements.

Joints between components, including day work joints, should be durable and made watertight with appropriate waterstops or hydrophilic strips. Kickers cast monolithically as part of the slab should be used to form the joint between floors and walls.

Concrete with admixtures

Where the design of in-situ concrete waterproofing includes admixtures:

- the ratio of admixture to concrete specified in the design should take account of the recommendations of the admixture supplier and requirements of the independent assessment
- the reinforcement should be used to control crack widths, which should be in accordance with the design, but not be greater than 0.3mm maximum for flexural cracks and 0.2mm maximum for cracks that pass through the section
- suitable quality management systems and quality audits should be used to record and monitor the batching of admixture. This is best achieved by using ready-mixed concrete (see Clause 3.1.5).

Admixtures should be:

- independently assessed, in accordance with Technical Requirement R3
- assessed according to the intended use
- used strictly in accordance with the manufacturer's recommendations and requirements of the independent assessment.

Concrete without admixtures

Where the design of in-situ concrete waterproofing does not include admixtures:

- high-strength concrete may be specified in order to achieve the necessary level of waterproofing, but post-construction crack injection may be required in order to deal with cracking induced by increased thermal and shrinkage strains
- the reinforcement should be used to control crack widths, which should be in accordance with the design, but not be greater than 0.2mm maximum for both flexural cracks and for cracks that pass through the section
- a minimum section thickness of 250mm should be used in the design.

5.4.7.3 Type C drained cavity construction

Type C systems rely on water being resisted by the structure, with any water penetrating the external shell of the structure being collected within a cavity and directed to a suitable discharge point. The cavity may be formed between the external wall and an inner lining/wall or by a cavity drained membrane.

Factors influencing the amount of water that could enter the cavity are:

- resistance of the structure to water ingress
- size of structure
- volume and flow of external water
- hydrostatic pressure.

Features of the structure could also have an influence, for example service penetrations, construction joints, movement joints or dry packing.

Type C systems formed using a drained masonry cavity wall should follow the guidance in BS 8102. Type C systems that include a cavity drained membrane which forms a waterproof barrier are acceptable to NHBC when assessed in accordance with Technical Requirement R3.

Suitable discharge points should be reached by a designed drainage system, either by gravity or through a sump and pump, to adequately dispose of collected water. Drainage channels, sumps and pumps should include appropriately located access points for servicing and maintenance. To prevent backflow, the drainage system should be fitted with a one-way valve. Also, in areas which are susceptible to flooding the guidance in BS 8102 concerning inclusion of a flood loop should be considered.

Particular care should be taken if adopting Type C systems on contaminated sites to ensure no pathways are introduced that could present a risk or risks to the end user(s) and/or that systems are suitably chemically resistant; specialist advice should be sought.

Type C waterproofing should be installed in accordance with the manufacturer's instructions by operatives:

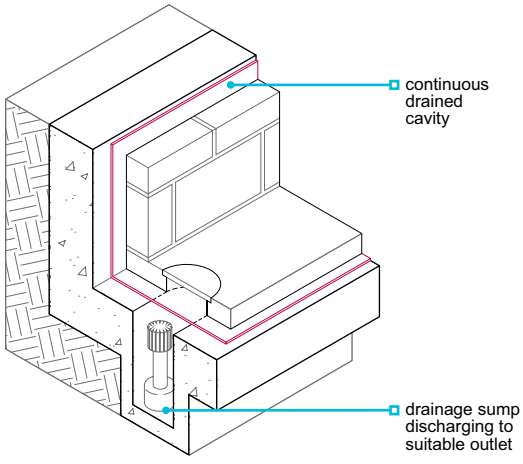
- who are suitably qualified or have been trained by the manufacturer or supplier
- who are fully aware of the design and the manufacturer's recommendations for installation
- using the fixings recommended by the manufacturer.

Pump systems should operate automatically and include:

- a primary pump
- a secondary pump with battery or generator backup
- a suitable audio or visual alarm that indicates pump failure.

Further guidance on multi-level and inverted cavity drain systems can be found in BS 8102.

Figure 15: Type C system



Free lime and/or mineral salts leach from new construction with water ingress, which can deposit within cavity drained membranes, drainage channels and pump sump chambers. It is therefore important to ensure access points for servicing and maintenance are well considered and a maintenance plan prepared.

Anti-lime solutions as advised by the waterproofing design specialist may, or, as required by manufacturer's instructions should, be employed to minimise risk that can be further reduced by cleaning and removing loose debris from the structure before closing cavities or applying cavity drained membranes.

5.4.7.4 Ancillary components

Ancillary components should be assessed as part of the waterproofing system. Alternatively, an assessment of compatibility satisfactory performance should be provided for materials and products that are interchangeable between different systems.

Ancillary components include:

- preformed junctions and corners
- reinforcement
- waterstops
- hydrophilic strips.

5.4.8 Handling, storage and protection

Waterproofing materials, products and systems shall be handled, stored and protected in a satisfactory manner to prevent damage, distortion, weathering or degradation. Issues to be taken into account include:

1) handling and storage

2) protection from ongoing works.

5.4.8.1 Handling and storage

Materials, products and systems should be transported, lifted, handled and stored in accordance with the manufacturer's recommendations.

5.4.8.2 Protection from ongoing works

Design should consider the risk of damage caused by ongoing works. Details of suitable protection measures should be specified in the design and include:

- fixing of other components, such as skirtings, wall ties and wall linings
- protection of the waterproofing from backfilling.

Proprietary products and systems should be protected and tested before backfilling occurs.

5.4.9 Buried podiums

Also see: Chapters 7.1, 10.1, BS 8102 and PCA's Best Practice Guidance Podium Decks and Buried Roofs

Buried podiums shall be protected by adequate waterproofing and drainage.

A buried podium forms a below ground roof to an area of basement that extends beyond the outline of the main building or buildings above. The waterproofing layer must link with damp proofing in any abutting walls. In most cases, the waterproofing should extend to DPC level or a minimum of 150mm above finished external ground level.

The make-up of the waterproofing layer and subsequent toppings that could include sustainable green, biodiverse (brown) or blue roofs, and provisions for drainage, should be co-ordinated at the planning stage. Guidance on the design, detailing and construction of sustainable roof and associated drainage systems (SuDS) is covered in Chapter 7.1 Flat roofs, terraces and balconies.

Provisions should be made to ensure the waterproofing layer and drainage system will not be susceptible to damage or obstruction from tree/vegetation root activity or structural movement. Drainage design should prevent ponding or accumulated/retained water unless part of a proprietary rainwater attenuation system (also see below).

Structural designs should allow for loadings from emergency, maintenance or other vehicular traffic access, mature planting/trees and/or saturated ground, as applicable. Further allowance should be taken of accumulated/retained water where blue roofs are adopted, or it is otherwise predicted by design (but kept to an absolute minimum), for example in the case of a drainage system temporary service fault or blockage prior to overflow provisions, land drainage or another water relieving strategy becoming active.

5.4.10 Further information

- *BS 8102:2022 Protection of below ground structures against water ingress — Code of practice*
- *The Basement Information Centre Basements: Ground Gases and Structural Waterproofing (updated June 2024)*
- *The Basement Information Centre Guidance Document — Basements for Dwellings (2014)*
- *The Concrete Centre Concrete Basements — Guidance on the design and construction of in-situ concrete basement structures (April 2012)*
- *Property Care Association (PCA) Best Practice Guidance — Podium Decks and Buried Roofs (March 2017)*

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