Chapter 5.4

Waterproofing of basements and other below ground structures

5.4 Waterproofing of basements and other below ground structures

CONTENTS

SCOPE

This Chapter gives guidance on meeting the Technical Requirements and recommendations for the waterproofing of basements and other structures below (or near to) ground level. It includes guidance for walls, floors and foundations intended to prevent the passage of moisture into the building, and considers water from the ground and other sources that could reasonably be expected during the design life of the building.

INTRODUCTION

Below ground constructions that 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 step is greater than 150mm.

Near to ground constructions that may require waterproofing include:

- external walls where the lowest finished floor level is less than 150mm higher than the external 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.

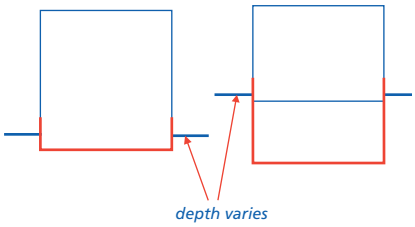
CONSTRUCTIONS REQUIRING WATERPROOFING

Typical examples of construction types generally requiring waterproofing:

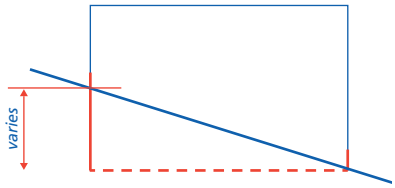
Dashed red line indicates where waterproofing should be considered.

Solid red line indicates where waterproofing is required.

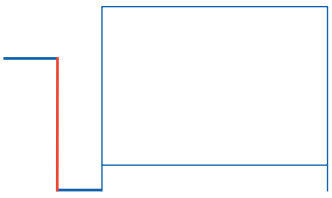
Basement



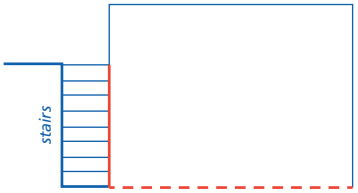
Semi-basement



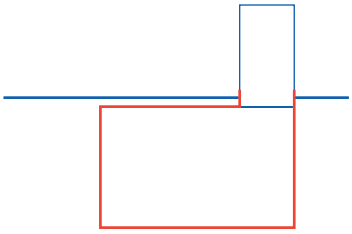
Retaining walls forming lightwells



Stairs adjacent to the structure

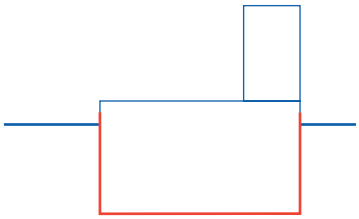


Buried podium

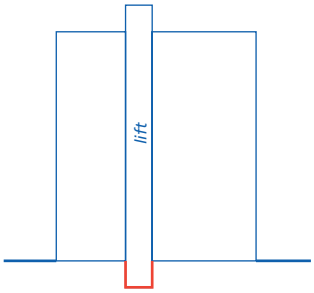


buried podium (guidance for roof coverings, including green roofs, can be found in Chapter 7.1 'Flat roofs and balconies')

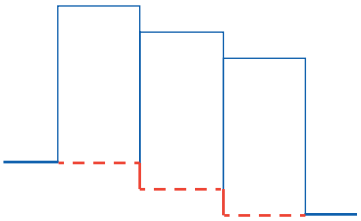
Raised podium



Lift pit

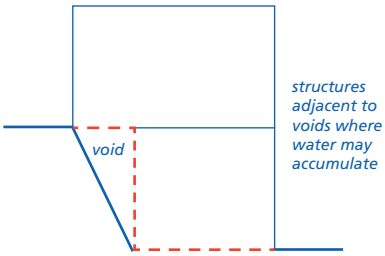


Stepped floor slab



stepped floor slabs (where the step is greater than 150mm)

Split levels



Raised external ground levels

lowest finished floor level is generally less than 150mm above the external ground level

Note
(guidance for acceptable detailing of the junction between timber framed walls and external ground can also be found in Chapter 6.2 'External timber framed walls')

DEFINITIONS FOR THIS CHAPTER

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.

Fully bonded barrier
Type A barrier that forms part of a composite with the structural wall. Includes liquid applied and cementitious systems.

Note: post-applied sheet membranes are not considered to be fully bonded barriers for the purposes of this Chapter.

Ground barrier
A barrier used to resist the ingress of moisture and/or ground gasses into the building.

Lowest finished floor level
The top surface of the lowest finished floor (excluding coverings such as carpet and tiles).

Note: this includes lift pit floors, car park surfaces and other similar surfaces.

Type A waterproofing barrier
A waterproofing barrier applied to the structural element being waterproofed. Also known as tanking.

Type B structurally integral construction
The water-resistant properties of the retaining structure, providing waterproofing to the building.

Note: this Chapter provides specific guidance for the use of Type B concrete systems cast in-situ, with or without waterproofing admixtures. Where appropriate, the principles are also applicable to other Type B systems listed in BS 8102.

Type C drained cavity construction
Construction that incorporates a cavity, normally 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.

DESIGN STANDARDS

5.4 - D1 Design shall meet the Technical Requirements

Design that follows the guidance below will be acceptable for the waterproofing of basements and below ground structures, including foundations, walls and floors.

Further guidance can be found in , 'Basements for Dwellings; Guidance Document' published by The Basement Information Centre.

STATUTORY REQUIREMENTS

5.4 - D2 Design shall comply with all relevant statutory requirements

Design should be in accordance with relevant building regulations and other statutory requirements.

Design should take account of regulatory guidance to avoid thermal bridging.

ENGINEER DESIGN

5.4 - D3 Design of structural elements of below ground waterproofing structures shall be undertaken by an engineer and take account of the characteristics of the site, its ground conditions and any hazards

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 - (see Chapter 1.1 'Introduction and Technical Requirements') where they are retaining more than 600mm.

STRUCTURAL DESIGN

5.4 - D4 All elements forming a below ground waterproofing structure including foundations, walls and floors, shall be designed to adequately resist movement and be suitable for their intended purpose

Where appropriate, the design of below ground structures should take account of other Chapters including:

- 4.1 'Land quality - managing ground conditions'
- 4.2 'Building near trees'
- 5.1 'Substructure and ground bearing floors'.

Items to be taken into account include:

(a) structural stability
The design should take account of all imposed loads and actions including:

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

(b) durability
The structure should be designed to be sufficiently durable against site hazards, including:

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

(c) 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. Where appropriate, detailed guidance for the limitation of movement should be provided.

Movement joints in below ground waterproofed walls should be avoided. However, where it is necessary to provide movement joints, the design should ensure satisfactory in-service performance, including watertightness. Such joints should be accessible for maintenance, e.g. not permanently concealed by other structural elements of the building.

Guidance for limitations of crack widths for Type B concrete waterproofing systems can be found in Clause D7(b).

(d) design co-ordination
Structural design should be co-ordinated with the design of the waterproofing in accordance with Clause D5(a).

WATERPROOFING DESIGN

5.4 – D5 Waterproofing design shall be undertaken by suitably qualified persons and be appropriate for the specific performance required

Items to be taken into account include:

(a) 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) would normally be acceptable to NHBC.

An alternative demonstration of competence may be acceptable to NHBC, subject to successful review.

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

Design information should be provided in accordance with Clause D8.

Further guidance for the design of waterproofing systems can be found in BS 8102.

(b) risk-based design
Waterproofing design should be appropriate to the risk and generally assume exposure to a full height of water during the design life of the building. Where 'Grade 3 protection' (see Clause D7(a)) is required, and the below ground wall retains more than 600mm, measured from the lowest finished floor level, the waterproofing design should include a combination of two of the Types of waterproofing systems detailed in Clause D7(b). For the purpose of this Chapter combined systems include:

- Type A and Type B
- Type A and Type C
- Type B and Type C

Alternatively, where the builder has demonstrated that the water table is permanently below the underside of the lowest floor slab (see Clause D6), a Type B structurally integral concrete system in accordance with D7(b) is acceptable without further protection from a combined system.

Where Grade 2 waterproofing is required to walls retaining ground greater than 600mm, Type A systems that are not fully bonded should only be used as part of a combined system.

GROUND CONDITIONS

5.4 – D6 Design of the waterproofing system shall take account of ground conditions

Design of the waterproofing system should fully consider existing ground conditions. Any likely changes, should be established and, where requested, a report provided to NHBC where the below ground waterproofed structure is:

- retaining more than 600mm of ground, measured from the top of the retained ground to the lowest finished floor level
- more than 15% of the perimeter of an individual building measured on plan (terraced homes and apartment blocks should be considered as a single building, separate buildings such as detached garages should be considered individually).

The ground conditions report should take into account Chapter 4.1 'Land quality – managing ground conditions' and other appropriate investigations, including those listed in the table contained in Appendix A. The results of the investigations should be taken into account by the engineer and the waterproofing design specialist, and considered in the design.

Where it is necessary to establish the likely level of the water table, a detailed hydrogeological assessment should be undertaken by a suitably qualified engineer.

The assessment should include long-term water level monitoring over at least one year to capture seasonal fluctuations and short- term flooding events that typically occur during autumn and spring.
The assessment should be from a suitable number of boreholes monitored at a minimum of three-month intervals.

DESIGN CONSIDERATIONS

5.4 – D7 Design of waterproofing to all elements (including walls, floors and foundations) forming a below ground structure shall be suitable for the intended use

Items to be taken into account include:

(a) level of waterproofing protection
Waterproofing systems should be designed to resist the passage of water/moisture to the internal surfaces of walls, floors and ceilings. The level of protection against water/moisture reaching the internal surfaces should be appropriate for the proposed use of the internal space, including equipment located within it.

Waterproofing grades:

- Grade 3
  Habitable accommodation should be designed to 'Grade 3' described in BS 8102 as 'no water penetration acceptable' and a dry environment provided if maintained by adequate ventilation,
- Grade 2
  Non-habitable areas, such as parking areas, storage or plant rooms, where the internal finishes are not readily damaged by moisture should be designed to 'Grade 2' described in BS 8102 as 'no water penetration is acceptable' although damp areas are tolerated.

  Some water ingress may occur where openings are provided in car parks, e.g. for ventilation. In such cases, to minimise the potential for standing water (see Chapter 1.2 'A consistent approach to finishes'). The car park should be provided with drainage to a suitable outfall.
- Grade 1
  Retaining walls typically used to form external lightwells should be designed to provide 'Grade 1' protection, described in BS 8102 as 'Some seepage and damp

areas are tolerable, dependent on intended use'. Drainage may also be required to deal with seepage.

Where there is any doubt about use, Grade 3 protection should be provided.

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

Components forming the waterproofing system should be predefined and assessed to demonstrate suitable performance. The assessment should specificity consider compatibility where materials and components are intended to be interchangeable between systems.

The project-specific design and construction documentation should detail waterproofing systems, materials and components in accordance with the manufacturer's recommendations.

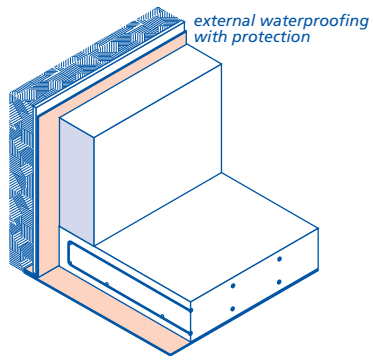
Design, including the selection of the waterproofing system, should take into account all likely ground and weather conditions.

The following should be considered for the design of specific waterproofing systems:

Type A – Waterproofing barrier

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

- bonded sheet membranes
- liquid-applied membranes
- geosynthetic (bentonite) clay liners
- mastic asphalt
- cementitious systems
- pre-applied fully bonded systems.



Type A structure - tanked protection

The substrate to which the Type A system is to be applied should be compatible and prepared in accordance with the manufacturer's recommendations.

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

Externally applied membranes to waterproofed walls forming a return should continue around the return to prevent water tracking back through the structure.

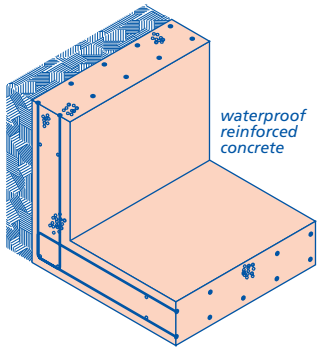
Design at junctions and corners should include for proprietary components such as reinforcement in accordance with the manufacturer's recommendations (see Clause S2(d)).

Type B – Structural integral construction

General information:
Type B systems acceptable to NHBC include:

- in-situ concrete with or without admixtures and crack widths limited by design
- in-situ high-strength concrete with crack widths limited by design and post-construction crack injection
- pre-cast concrete systems assessed in accordance with Technical Requirement R3.

Specialist advice should be sought where other Type B systems are specified.



Type B structure

BS 8102 contains guidance for the use of Type B systems, including secant piled, contiguous piled and sheet piled.

Structural design should be undertaken by an engineer in accordance with Technical Requirement R5 (see Clause D3).

The design of in-situ Type B concrete systems should be in accordance with BS EN 1992-1-1 and BS EN 1992-3. Reference should be made to Chapter 2.1 'Concrete and its reinforcement'. Further guidance acceptable to NHBC may be found in the Mineral Products Association (MPA) publication 'Concrete basements. Guidance on the design and construction of in-situ concrete basement structures'.

The design of in-situ concrete systems should be suitable for the environmental exposure and ground conditions.

Ready-mixed concrete will only be acceptable from suppliers operating a full quality control system, which ensures that the concrete specified is delivered.

Suppliers of ready-mixed concrete operating under the Quality Scheme for Ready mixed Concrete (QSRMC) or BSI Kitemark scheme are acceptable.

Other suppliers of ready-mixed concrete may be accepted if their operations are to an equivalent quality standard acceptable to NHBC.

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

Suitable quality management systems and quality audits should be used to record and monitor the placement of concrete. Monitoring records should be supplied to NHBC upon request.

Design details for reinforced concrete structures should include:

- concrete specification
- the type of concrete
- concrete strength
- proportion of any admixture
- proposals for limiting crack widths
- type and position of reinforcement
- consideration of temporary support to the formwork
- the 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.

The concrete mix should be agreed between the engineer and the waterproofing design specialist, and should achieve the necessary robustness, durability and waterproofing.

Concrete with admixtures:

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

- the reinforcement should limit crack widths to 0.3mm for flexural cracks and 0.2mm for cracks that pass through the section
- the ratio of admixture to concrete specified in the design should take account of the recommendations of the admixture supplier
- suitable quality management systems and quality audits should be used to record and monitor the batching of admixture.

Admixtures should be independently assessed, in accordance with Technical Requirement R3, specifically for the

intended use, and used strictly in accordance with the manufacturer's recommendations.

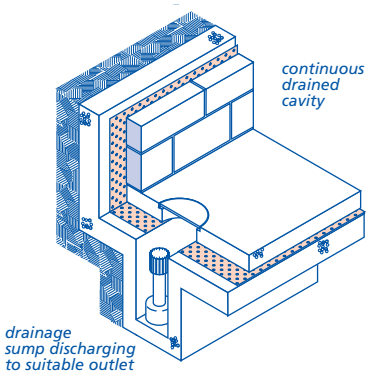
Concrete without admixtures:

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 limit crack widths to 0.2mm for both flexural cracks and for cracks that pass through the section
- a minimum section thickness of 250mm should be used in the design.

Type C – Drained cavity construction

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



Type C structure - drained cavity

Type C systems should be designed to include a drainage system that adequately disposes of water to a suitable outlet either by gravity or through a sump and pump.

The drainage channel, sump and pump should include appropriately located access points for servicing and maintenance. To prevent backflow, the drainage system should be fitted with a one-way valve.

Materials Clause M2(c) contains further guidance for the correct selection of pumps.

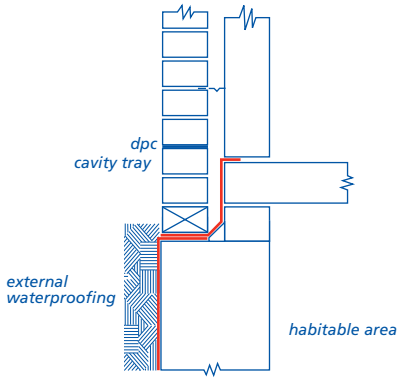
(c) detailing joints and junctions
Design should include the correct method and detailing to form all joints and junctions, to ensure they are correctly lapped and sealed in accordance with the manufacturer's recommendations, including those between:

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

The design should detail proprietary components for complex junctions.

(d) interface with the above ground structure
Waterproofing should extend at least 150mm above the external ground level where it connects with the superstructure. Where appropriate, this can be achieved by linking the below ground waterproofing system to a continuous cavity tray.

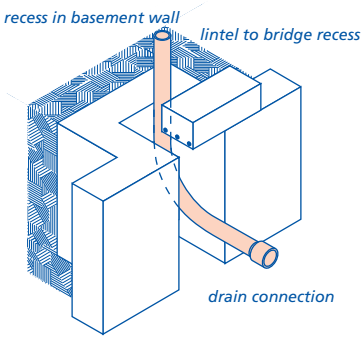
The connection between the below and above ground waterproofing should be bonded and formed with appropriate materials (see Clause M2(d)).



Example of linking waterproofing with DPC/cavity tray

(e) penetrations through the waterproofing system
The design should avoid penetrations through the waterproofing system. However, where penetrations cannot be avoided, the design should detail the method of waterproofing to ensure it is watertight and durable. Penetrations include those for wall ties, services and drainage systems.

Penetrations should be suitably separated to allow for proprietary seals to be correctly installed. Suitable allowance should be made for differential settlement and movement between the structure/finishes and services.



Drainage connection avoiding penetration of the waterproofing system by the soil stack

(f) protection from ongoing works
Design should consider the risk of damage being caused by ongoing works.

Details of suitable protection measures should be included in the design. Items to be taken into account include:

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

PROVISION OF INFORMATION

5.4 – D8 Designs and specifications shall be produced in a clearly understandable format and include all relevant information

Designs and specifications should include:

- a full set of current drawings
- details of joints, junctions and service penetrations
- 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
- information detailed in Clause D7(b)
- details of the waterproofing design specialist.

Design and specification information should be:

- provided to NHBC at least 8 weeks in advance of the works starting on site, in accordance with NHBC Rules
- available on site
- distributed to all relevant personnel.

MATERIALS STANDARDS

5.4 - M1 All materials shall:

(a) meet the Technical Requirements

(b) take account of the design

Materials that comply with the design and the guidance below will be acceptable for waterproofing of basements and below ground structures.

Further guidance for the selection of materials can be found in Technical Requirement R3 (see Chapter 1.1 'Introduction and Technical Requirements').

5.1 – M2 Waterproofing systems shall adequately resist the passage of water and moisture into the building

(a) waterproofing systems
Waterproofing systems should be:

- mastic asphalt to BS 6925 or BS EN 12970
- proprietary systems or products assessed in accordance with Technical Requirement R3.

The manufacturer should confirm compatibility between different materials where they are used to form joints and junctions. Plain polyethylene sheet should not be used as a waterproofing system.

(b) ancillary components
Ancillary components should be assessed as part of the waterproofing system. Alternatively, an assessment of compatibility and 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.

(c) pumps
Pumped systems should include a:

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

Pumps should operate automatically.

(d) connection with the structure
Where the waterproofing is linked to the above ground structure via a cavity tray, the materials should compress to form a watertight seal and 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.

(e) reinforcement
Guidance for reinforcement used in concrete can be found in Chapter 2.1 'Concrete and its reinforcement'.

SITEWORK STANDARDS

5.1 - S1 All sitework shall:

(a) meet the Technical Requirements

(b) take account of the design

(c) follow established good practice and workmanship

Sitework that complies with the design and the guidance below will be acceptable for waterproofing of below ground structures.

5.4 - S2 Waterproofing to basements and below ground structures shall be installed in accordance with the design

Appropriate sequencing of work will enable logical and timely construction of the waterproofing system and prevent unnecessary damage.

Installation should be undertaken in accordance with the design and the installation method statement detailing the sequence of works.

Fixing of internal finishes, such as wall linings and skirting boards, should not damage the waterproofing system.

(a) Type A - Waterproofing barrier
Type A waterproofing systems should be applied in accordance with the manufacturer's instructions, by installers who are suitably qualified or have been trained by the manufacturer or supplier of the waterproofing system. Installers should be made fully aware of the design and the manufacturer's recommendations for preparation and installation.

Completed waterproofing should be protected. A protection board should be provided against the waterproofing material to prevent damage. Where the waterproofing system is protected by backfilled material, this should be placed carefully in layers.

Weather conditions at the time of installation should be appropriate for the system being installed. The manufacturer's recommendations in relation to weather conditions should be followed.

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 directly applied to masonry substrates that have flush pointed joints and are smooth.

(b) Type B - Structural integral construction
Type B waterproofing should be installed in accordance with the design 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.

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 and the like should be made good in accordance with the design.

Where joints are formed in concrete, the 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.

Reference should also be made to Chapter 2.1 'Concrete and its reinforcement' (Sitework) and Chapter 1.4 'Cold weather working'.

(c) Type C - Drained cavity construction
Type C waterproofing systems should be applied in accordance with the design by installers who are suitably qualified or have been trained by the manufacturer or supplier of the waterproofing system. Installers should be made fully aware of the design and the manufacturer's recommendations for preparation and installation.

Access points for drainage systems should be installed in accordance with the design.

Cavity drain membranes should be installed using the fixings recommended by the manufacturer.

(d) junctions, abutments and services
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 to form junctions such as:

- complex changes in direction
- service penetrations.

The waterproofing system should be linked to the damp proofing arrangements for the superstructure in accordance with the design.

HANDLING, STORAGE AND PROTECTION

5.4 - S3 Materials, products and systems shall be handled, stored and protected in a satisfactory manner to prevent damage, distortion, weathering or degradation

Items to be taken into account include:

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

(b) protection
Proprietary products and systems should be protected and, where appropriate, tested before backfilling occurs.

HANDOVER REQUIREMENTS

5.4 - S4 Detailed information shall be provided to the end user

Items to be taken into account include:

- details of any appropriate user instructions
- details of any servicing requirements, i.e. for pumps and drainage systems
- the importance of not puncturing waterproofing systems, e.g. with fixings.

APPENDIX A

Ground conditions investigations

Further investigations	Guidance and information
Desk study including review of: • groundwater 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/research/groundwater/datainfo/levels/home.html www.metoffice.gov.uk/climate/uk/stationdata
Contaminated and aggressive groundwater and/or ground conditions.	Testing required if there is the potential for chemically aggressive ground and/or groundwater.
Water level change, including risks of flash flooding and waterlogging.	The report should consider likely fluctuations and short term flooding events.
Assessment of impact on the 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.

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