2.

Waterproofing Below Ground Storeys and Structures

Contents

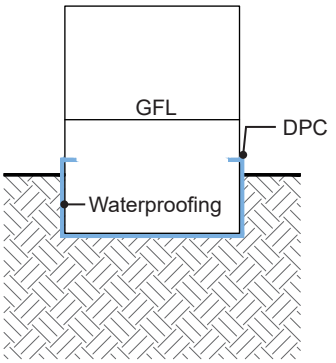
2.1 Waterproofing Below Ground Storeys and Structures: General Requirements

Introduction

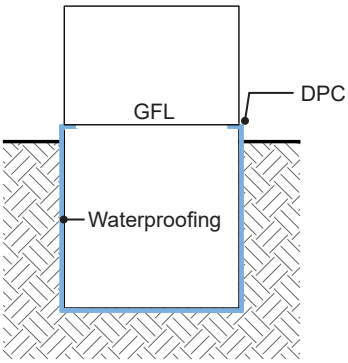
This section provides guidance on meeting the performance requirements for waterproofing below ground storeys and structures. The following situations are covered by this section:

- A building storey wholly or partially below ground e.g. basement.
- Lower ground storeys partially below ground e.g. semi-basements, split levels with voids, stepping slabs.
- Lift pits.

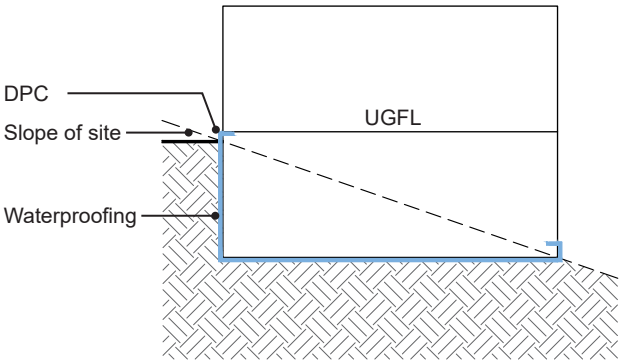
Examples of below ground situations



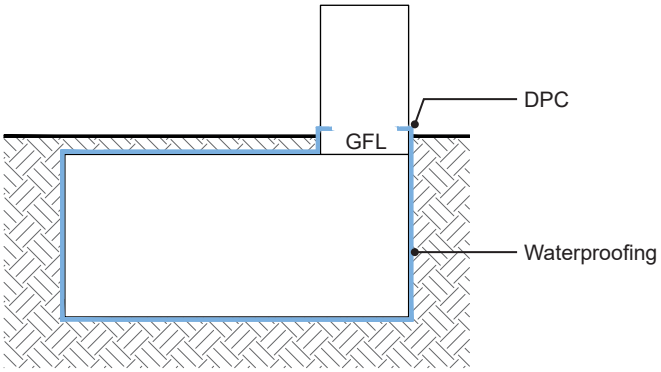
Storey partially below ground



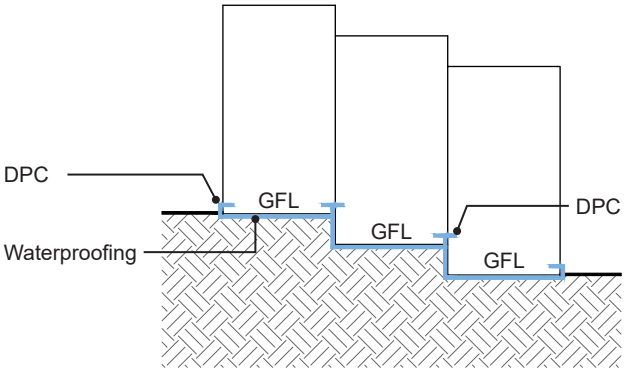
Storey wholly below ground



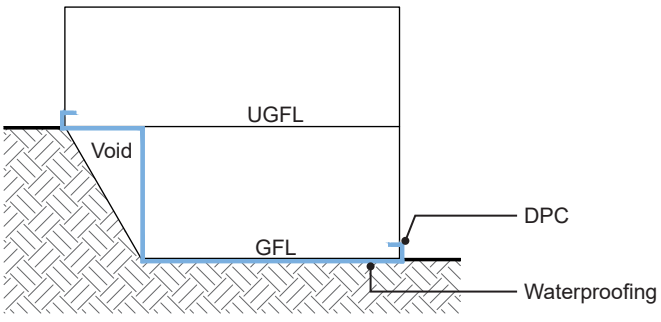
Semi-basement on 3 sides



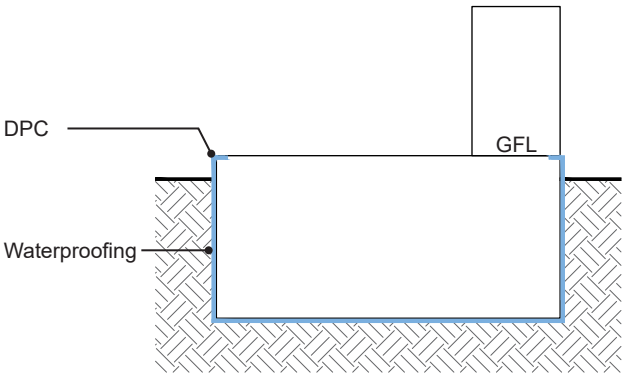
Buried roof



Stepped site



Split level



Podium above ground

2.1.1 Compliance

The construction of any below ground storey or structure shall meet the performance requirements of this section.

2.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

All information related to structural waterproofing design and specification shall be provided at least 8 weeks before the commencement of the waterproofing of any below ground storey(s) and/or structure(s).

1. The Developer is to provide, at least 8 weeks before the commencement of the basement, evidence to us of a waterproofing design specification for protecting the below ground situation/environment and include as a minimum:
   a. A site specific waterproofing design philosophy provided by a suitably qualified Waterproofing design specialist.
   b. A site investigation report (Phase 1 & 2 Geo-Environmental Assessment Report - see the 'Ground Conditions' section of this Technical Manual) to identify the risks, for which the waterproofing design is to be based on.
   c. The 'Environmental Grade' requirement for each below ground situation in accordance with BS 8102.
   d. Site level survey drawings highlighting existing site features.
   e. Proposed general arrangement drawings identifying all the plots and location of any below ground storey levels, lift pits and basements.
   f. Drainage layout plans showing maintainable drainage runs, access provisions and outfalls (this includes all drainage relating to the structural waterproofing proposals).
2. Additional supporting information will be required prior to the work commencing on site and must include, but not limited to:
   a. Waterproofing materials – Systems and material specification for the Design Strategy including sump(s) and pump(s) specification.
   b. Site specific detailing for waterproofing of all construction jointing and service penetrations.
   c. Below ground drainage provisions e.g. below slab - internal drainage systems, surface and foul water, storm water attenuation tanks, etc.
   d. Drainage provisions to hardstanding features e.g. light wells and flush pavement lights.
   e. Landscaping - Intensive roof, podium deck and transfer decks – drainage and waterproofing provisions (see also the 'Roofs' section of this Technical Manual).
   f. Construction and structural waterproofing methodology e.g. Engineers foundation design, walls, floor(s) and roof slab design, temporary and permanent works.
   g. Evidence of a competent approved installer for the structural waterproofing works.
3. On completion of the works the following documentation will need to be provided.
   a. Sump pump(s) commissioning certificate.
   b. Operations and maintenance manual for maintainable systems installed including land drains.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

2.1.3 Durability

The design of the structure and the materials used shall be durable. All load bearing structural elements providing support to the home shall have a service life of not less than 60 years.

The below ground structure and any waterproofing materials should be specified and designed to be durable against the identified site hazards found in the ground investigation. This may include resistance for the effects of:

- Freeze-thaw actions.
- Dispersal of water on the structure.
- Aggressive chemicals in the ground.

2.1.4 Structural design

Elements that are integral to any below ground storey or structure including foundations, walls and floors shall be designed by an Engineer. The following shall be taken into account:

- Vertical loading, horizontal loading and surcharges.
- Structural movement.
- The influence of site features such as nearby trees, topography and/or ground characteristics.

Analysis of the applied loadings should be considered in the design of the structure and should be co-ordinated with the design of the waterproofing, and shall include for:

- Loading from the superstructure and other parts of the building.
- Lateral forces from retained ground, ground water and surcharges.
- Ground movement and the effect of trees.
- Buoyancy and ground heave.
- Temporary loading conditions e.g. the effects of site traffic, proximity of heavy plant placement.
- Movement limitations of proposed waterproofing materials.

Design considerations shall be informed by the:

- Geo-environmental report (Phase 2).
- Structural design.
- Expected structural movement e.g. deflection, load surcharge.
- Below ground environment.
- Durability of materials.

Where a movement joint is deemed to be necessary by the Engineer, it should be constructed as per the Engineers design. Any calculated movement in the structure should be communicated to the Waterproofing Design Specialist and reflected by their system/material choice. Situations where periodic inspection of the movement joints is required by the Engineer should be taken into account within any designs.

Below ground structures and/or below ground storeys e.g. basements, semi-basements, spilt-levels formed from Insulated Concrete Formwork (ICF) are not acceptable for Warranty purposes.

2.1.5 Ground conditions

The waterproofing design shall be based upon specific ground and site conditions.

The waterproofing design strategy provided to the Warranty provider should clearly identify the information sources used to determine the approach taken and the Waterproofing Design Specialist must clearly indicate their findings and conclusions to validate their design decisions.

The Waterproofing Design Specialist shall develop their waterproofing design based upon site specific information contained within the relevant Phase 1 and Phase 2 Geo-Environmental Assessment Reports. Any supplementary sources of information should be clearly identified within any waterproofing design strategy.

The following information should be used to inform the design:

- Topography, ground levels, and site features e.g. roads, ponds and watercourses, trees.
- Historical geological data e.g. ground characteristics, strata profile and description.
- Hydrogeology and hydrology details e.g. ground water, perched water tables, flood risks.
- Drainage characteristic, soakage testing and water infiltration rates.
- Potential contamination from past history due to former usage e.g. brownfield, land fill.
- Ground gases.

Where ground gas protection and/or protection from contaminants in the ground is considered to be required for the site, the Waterproofing Design Specialist should consult with an Engineer (or person holding relevant specialism) with suitable knowledge and relevant experience within this area.

For further guidance on ground conditions, please refer to the ‘Ground Conditions’ section.

2.1.6 Waterproofing designer competence

The waterproofing design shall be provided by a suitably qualified Waterproofing Design Specialist.

The waterproofing design must be completed by a suitably qualified and experienced Waterproofing Design Specialist holding a qualification recognised by the Warranty provider e.g. Certificated Surveyor in Structural Waterproofing (CSSW).

The Waterproofing Design Specialist should be appointed to the design team to co-ordinate the waterproofing design and consider the impact of waterproofing designs and material choices on other elements of the structural and/or architectural design.

It is the responsibility of the Waterproofing Design Specialist to adequately assess the accuracy and appropriateness of any waterproofing product manufacturer’s standard details which are included into a waterproofing design strategy.

2.1.7 Waterproofing design

The waterproofing design shall be suitable for the intended use of the below ground space and provide appropriate protection against ground and surface water. Habitable areas shall have a combined system of waterproofing protection.

The following shall be taken into account:

- Intended use & grades of waterproofing protection.
- Defect repair.
- Waterproofing systems, materials and components.
- Interface with the above ground structure.
- Joints and penetrations.
- Risk mitigation (drainage and maintenance).

A site specific waterproofing design strategy document must be provided to the Warranty provider. It should include:

- The name of the Waterproofing Design Specialist who has prepared the document, along with their credentials and relevant experience.
- An index of documents used to create their document e.g. Architects drawings, Engineers Drawings, titles of any assessments and reports.

- An outline description of the applied waterproofing principles and any referenced standards used to formulate the design e.g. BS 8102.
- Clear and concise observations that are relevant to and influence the waterproofing design. This shall include:
  - Scheme type e.g. residential, commercial, etc.
  - Site topography and the interaction of the structure with that topography.
  - Any features which may impact on the areas of building below ground level.
  - Ground conditions on site such as geology, hydrology, and hydrogeology.
  - The proposed use of the space or spaces e.g. habitable space, plant rooms, lift pits.
  - The construction methods and type e.g. reinforced concrete retaining walls, slab construction.
- Precise statements in relation to the waterproofing strategy. This shall include:
  - A list of all spaces contained below ground.
  - A clear determination of the environmental grade required for each space.
  - A brief statement of how the environmental grade will be maintained and the chosen waterproofing protection repaired in the event of a defect.
- Annotated drawings in relation to the waterproofing strategy, provided by the Waterproofing Design Specialist.
- A brief list of the selected products being used to deliver the strategy, inclusive of any supporting drawings in relation to detailing or interfaces with other elements e.g. penetrations, terminations above ground with cavity trays, etc.
- The extent of drainage required to support a structural waterproofing design by lowering the effects of both ground water and percolation of rainwater into the ground.

Identifying grades of waterproofing protection

The following guidance is based upon BS 8102 and is provided to assist in establishing the use of the space and performance levels.

Grade	Use of structure	Performance level
1a	Enclosing structure of underground car parking[1], underground refuse stores, cycle stores, external light well enclosures.	Seepage and damp areas from internal and external sources are tolerable, where this does not impact on the proposed use of below ground structure. Internal drainage might be necessary to deal with seepage.
1b	Non habitable use: e.g. Enclosing structure of underground car parking[2], plant rooms[3], lift pits[4].	No seepage or beading. Damp areas from internal and external sources are tolerable (dependent on intended use).
2	Non habitable use: e.g. Enclosing structure of underground car parking[5], plant rooms[6], lift pits[7], access stairs and lobbies serving non-habitable storeys.	No seepage or beading is acceptable. Damp areas as a result of internal air moisture/condensation are tolerable; measures might be required to manage water vapour /condensation e.g. ventilation might be required.
3	Habitable accommodation: e.g. Enclosing structure to ventilated residential and commercial areas including offices, restaurants, leisure facilities, associated access stairs and lobbies serving habitable storeys or habitable spaces within non-habitable storeys.	No water ingress or damp areas are acceptable. Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use.

[1] Standard car parking environment where seepage and damp areas from internal and external sources are tolerable.
[2] Parking structures where no seepage is acceptable.
[3] A room containing equipment which supplies building services, and remains unaffected in their operation within a damp environment e.g. water tanks and pipework, sprinkler system pumps and pipework, etc.
[4] A lift pit containing structure or working components of the lift remaining unaffected in their operation by the presence of dampness.
[5] Private car parking where no seepage or dampness through the structure is acceptable.
[6] A room containing equipment which supplies building services, and may be affected in their operation by the cumulative effects of dampness e.g. electrical components and services, generators, communication systems, etc.
[7] A lift pit containing electrical equipment and/or working components and may be affected in their operation by the cumulative effects of dampness.

The terms used in the table are defined below for Warranty purposes.

- **Damp**: When touched, a damp patch may leave a slight film of moisture on the hand, but no droplets of water or greater degrees of wetness are left on the hand. On a concrete surface a damp patch is discernible from a darkening of the colour of the concrete.
- **Beading**: Beading of water is the state in which individual droplets of water (held by surface tension effects) form on the surface of the wall and adhere to the wall. The water beads do not coalesce and do not flow.
- **Seepage** (weeping): Seepage or weeping of water is the state in which droplets of water form on the surface of the wall and coalesce with other droplets. The coalesced water does not remain stationary on the wall surface, but instead flows down the wall.

Habitable space: grades of waterproofing protection

The Warranty provider requires habitable space to be protected a combined system of waterproofing capable of achieving a Grade 3 environmental protection level. Appropriately designed environmental control measures must be included to control vapour introduced by occupation, and thereby preventing problems of condensation.

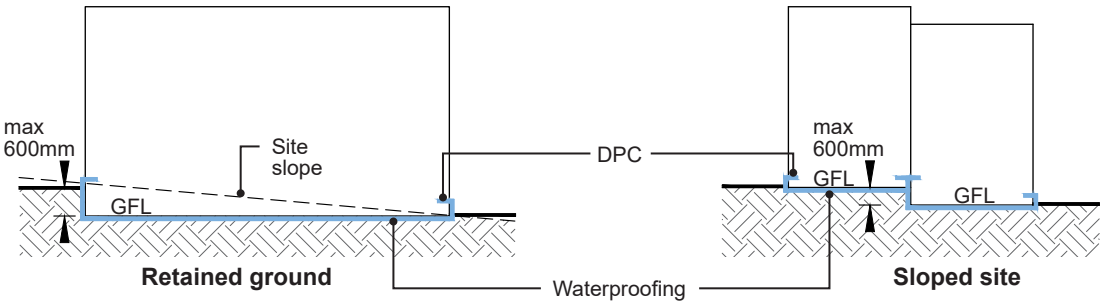
A single form of waterproofing protection to a habitable space where a Grade 3 environmental protection level is required may be acceptable on shallow stepped / gentle sloping sites where all of the below is applicable:

- Is no greater than 600mm above the lowest finished floor level.
- The water table has been proven to be permanently below the lowest floor level.
- A repair strategy for the single protection system has been provided.

In these circumstances, the site conditions must be proven to not result in an unacceptably high risk and the consequences of failure are substantially low. This must be substantiated by a site investigation report and agreed with the Warranty provider before commencing work on site.

A site specific design proposal must be provided before commencement of construction on site, to demonstrate the proposed waterproofing solution (Type A, B or C) is appropriate for the ground conditions (based on the site investigation report). The solution will include proposals for waterproofing walls and floors.

Such scenarios are limited to the above described and as shown in the following images.



In all habitable situations ventilation, dehumidification or air conditioning will be necessary, appropriate to the intended use.

Ancillary spaces: grades of waterproofing protection

The Warranty provider requires that the environmental grade required for ancillary spaces is considered against the proposed use of the space e.g. car parks, plant rooms, lift pits.

It must be assumed that any below ground structure will be exposed to a full height of water during the design life of the building. As such any waterproofing design strategies that propose only 1 system of waterproofing protection for ancillary spaces will only be considered acceptable where a practicable and reasonable approach to defect repair for the end user in the proposed waterproofing protection system has been provided and agreed with the Warranty surveyor at the design stage.

Lift pits

For developments with lift pits, whether they occur within storeys below ground or at ground level, there is a requirement that the lift pit remains free from water to avoid issues with the lift installation e.g. corrosion of fixings, damage the lift mechanism that may heighten risks around lift failures and breakdowns. It is therefore a to requirement that lift pits achieve:

- A Grade 1b protection level as a minimum, **and**
- Use a system that is accessible for repair of any defects occurring in service.

Underground car parking

For developments with underground car parking, the grade of waterproofing should be clearly defined as part of the waterproofing design. The use of Grade 1a waterproofing strategies for underground car parking must be supplemented by clear statements from the Waterproofing Design Specialist around the degree of seepage or dampness (water tightness) agreed with all interested parties, including the Warranty surveyor at the design stage.

Waterproofing protection - defects and remedial measures

For all situations, an accessibility and reparability statement for the waterproofing system(s) chosen should form part of any structural waterproofing design.

Waterproofing systems, materials and components

All waterproofing systems, materials and components shall be appropriately tested and approved for their intended purpose – please refer to ‘Appendix C’.

The following systems are considered acceptable to the Warranty provider when integrated into any waterproofing design strategy by the appointed Waterproofing Design Specialist:

- Type A Barrier protection (can be referred to as ‘tanking’). Barrier membranes must be fully bonded.
- Type B Structurally integral protection.
- Type C Drained protection (can be referred to as ‘water management’).

Glass Reinforced Plastic (GRP) liners are not acceptable for Warranty purposes. This applies to lift pits in isolation or as part of a larger waterproofing scheme.

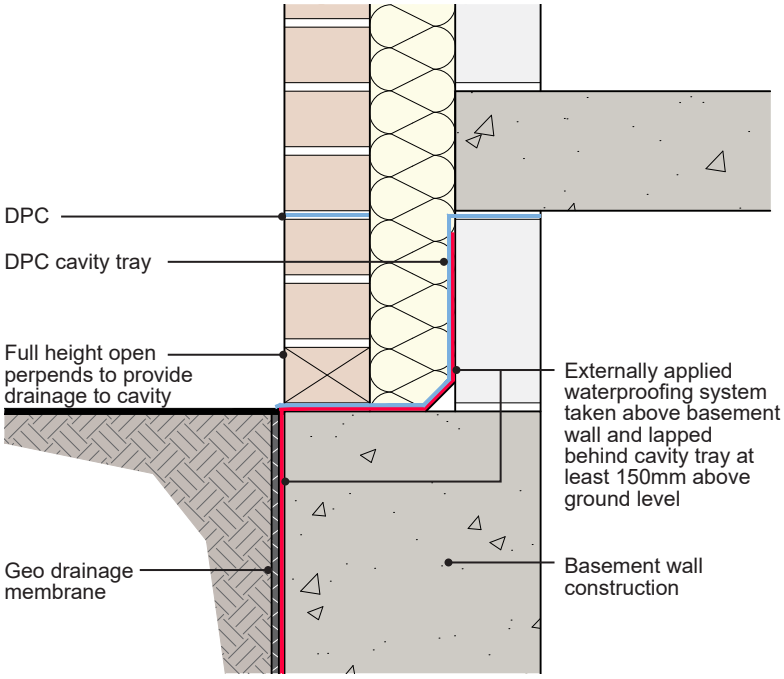
Interface with the above ground structures

Below ground waterproofing must be continuous and link to the damp proofing provision in the superstructure.

Where detailing interfaces with walls above ground level, all detailing should terminate at a level 150mm above ground level into a horizontal damp proof course or cavity tray within the superstructure. Where detailing interfaces directly with a horizontal ground floor damp proof membrane, the minimum overlaps determined by the Waterproofing Design Specialist should be observed. In certain circumstances, proprietary components supplied by the waterproofing system manufacturer shall be used for complex shapes or interfaces.

In all instances, the Waterproofing Design Specialist should take responsibility for all junctions as part of the waterproofing design strategy, and ensure that materials used:

- Are compatible.
- Achieve a watertight seal.
- Are capable of taking loads.
- Are appropriately tested and approved for their intended purpose.



Dealing penetrations through waterproofing protection

Penetrations through the waterproofing should be avoided where possible. Where penetrations cannot be avoided, the Waterproofing Design Specialist shall provide an appropriate design and use appropriate materials capable of creating a continuous waterproofing solution that is watertight and durable.

Penetrations resultant from wall ties must be appropriately detailed by the Waterproofing Design Specialist, approved by the manufacturer of the waterproofing system and appraised by an Engineer to ensure structural performance of the wall ties is not impeded.

Penetrations occurring due to services and drainage systems should be detailed by the Waterproofing Design Specialist and use manufacturers proprietary seals as far as practicable.

Where detailing requires site formation, the manufacturer of each respective system should provide explicit instruction around application to the Waterproofing Design Specialist for inclusion into their waterproofing design strategy.

Risk mitigation measures

The provision of drainage to supplement structural waterproofing is a means of reducing the risk of failure by ensuring that the effects of water in the ground or percolating through the ground from higher levels does not stand against the structure.

External ground-level surfaces around the basement can provide a natural defence against water infiltration into sensitive areas, such as the excavated and backfilled ground, and the implementation of appropriate hard standing and cut-off drains to divert standing water away from these areas may be beneficial.

The use of land drainage can act to remove water from around the structure, thus alleviating pressure and should be considered in all cases to reduce the risk of water ingress where practical.

However, the use of land drainage may not be viable on all sites, examples being:

- Where there is no available location to discharge collected ground water.
- Where high water tables and permeable ground conditions make it impractical to sufficiently remove the quantities of water present.
- Restrictions on the site curtilage due adjacent buildings close to or on the site boundary.
- Draw down, e.g. affecting the stability of other structures by the introduction of a land drain.

Notwithstanding such conditions, the provision of effective land drains is often an economic means of greatly reducing risk and must be included where viable.

2.1.8 Sub-surface drainage systems

Any sub-surface drainage system supplementing the waterproofing design shall be suitably designed and installed. The system shall direct water to a suitable outfall and have provision for maintenance.

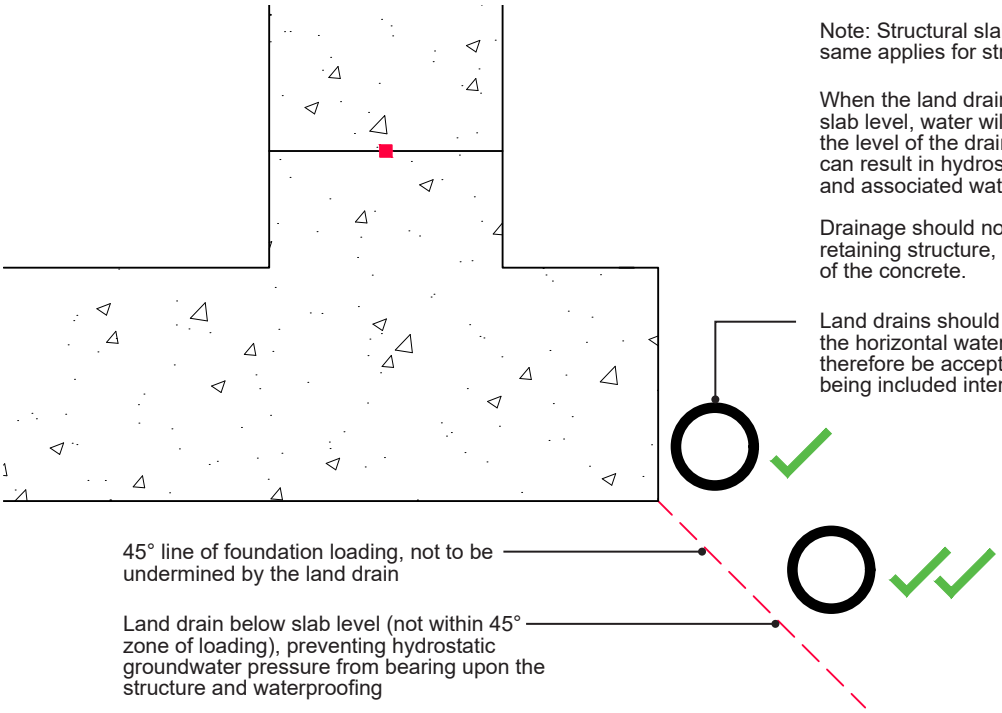
Any proposal must be fully detailed with drainage layout plans showing the line and invert level of all maintainable drainage runs, and include information in relation to access provisions and outfalls related to all drainage supplementing the structural waterproofing proposals.

The Warranty surveyor is to be supplied with design details where external land drainage is included.

Sub-surface drainage systems shall be designed by those holding an appropriate specialism e.g. drainage engineer, and shall ensure that:

- Any perforated land drains are be surrounded in clean graded stone and wrapped in a suitable geo-textile filter fabric to reduce the risk of clogging. This is particularly important in fine granular and clay soils where land drains are susceptible to clogging.
- Rodding points are included at the heads of runs and any changes in direction to facilitate clearance of blockages and periodic maintenance undertaken at suitable intervals (annually as a minimum), with the detail of this being written into the documentation passed to homeowners.
- Land drains must discharge into a suitable outlet. Land drains must not be directly linked to soakaways by gravity, unless it is not possible for water to surcharge, e.g. where the top of the soakaway is below the level of the actual land drains.
- The use of geo-drainage membranes applied to the external face of a retaining wall are detailed to link into any suitable geo-textile filter fabric wrapped around the land drain to reduce the risk of clogging and facilitates water to drain down to the level of the land drains without pressuring the structure.
- Land drains must be positioned at a low enough position to prevent perched water pressure from bearing upon the structure and waterproofing but must not undermine foundations.

Land drain and external drainage



2.1.9 Waterproofing systems, materials and components

All materials, products and building systems shall be appropriately tested and approved for their intended purpose.

All waterproofing systems, materials and components shall be appropriately tested and approved for their intended purpose. Further guidance on acceptable and appropriate testing of material for Warranty purposes can be found in 'Appendix C' of the Technical Manual.

Type A Barrier protection

This form of waterproofing relies on the installation of a physical barrier material applied onto the interior or exterior face of the structure. Types of barrier material considered as Type A Barrier protection are:

- Pre-applied membranes
- Post-applied membranes
- Liquid-applied coatings
- Geosynthetic (bentonite) clay liners
- Cementitious systems

For the purpose of Warranty, when selecting a Type A barrier protection material specifiers should:

- Be fully bonded in their completed state. Any test evidence provided in support of attainment of a full bond, and with an internally applied material should be specific to the substrate and effects of negative pressure.
- Discuss the resistance generated by the waterproofing barrier with the responsible Engineer to incorporate into structural design considerations.
- Ensure that continuity detailing can be achieved without risk of deformation or damage to the waterproofing material e.g. resistance to extrusion or damage under loading when linking through structure and/or linking with DPC within the superstructure.
- Consider the limitations of materials in relation to any complexed detailing created by the structural form e.g. 'Buildability'.
- Consider the environmental factors affecting the waterproofing work e.g. temperatures, weather conditions, risks of standing water in excavations.
- Consider the feasibility of reparation to the system - externally applied systems are not accessible for repair once buried and as such require additional measures to act as risk mitigation e.g. sub-surface drainage, combined protection measures.
- Consider any additional performance expectations not related to the waterproofing performance but integral to any design and specification of material e.g. ground gases, contaminants and aggressive ground conditions may require the inclusion of materials capable of performing a suitable ground barrier to protect the structure appropriately. Specialist advice must be sought in respect of dealing with ground gases, and designers are advised to check current standards at the time of construction for suitable guidance.

Completed waterproofing should be protected by a suitable protection board or cuspated drainage material where a sub-surface perimeter drain is provided as part of the waterproofing strategy. Backfill materials used should be appropriately graded material exhibiting an appropriate rate of drainage.

In all instances, Type A Barrier protection materials and systems 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. All materials and work execution must be strictly in accordance with the Waterproofing Design Specialist design and specification, and supplemented by a Quality Control plan covering aspects of installation, which may be requested by the Warranty surveyor at their discretion.

Type B Structurally integral protection

Type B Structurally integral protection uses reinforced concrete structure to provide protection against water ingress. This form of protection relies on reinforced concrete structural walls, floors and connections being designed by an Engineer to resist and restrict the passage of moisture and water.

Engineer completed designs should be in accordance with all the relevant parts of BS EN 1992, and relevant parts of Appendix C of the Technical Manual in relation to the reinforcing and use of admixtures with concrete.

The Warranty provider considers Type B Structurally integral protection as acceptable, when they are designed by an Engineer and use an approach of:

1. In-situ concrete with waterproofing admixtures, where crack widths are limited to 0.3mm maximum width for flexural cracks, and 0.2mm maximum width for cracks that pass through the section by the design and use of reinforcement.

OR

2. In-situ high-strength concrete without waterproofing admixtures, constructed to a 250mm minimum sectional width, where crack widths by design of reinforcement and post-construction crack injections are limited to 0.2mm maximum for both flexural cracks and for cracks that pass through the section.

The Engineers design should include as a minimum:

- Concrete specification e.g. type, strength, consistence class, aggregate size.
- Details of reinforcement e.g. size, type, position, spacing, required cover.
- Methodology and approaches taken to control crack widths and execute construction joints.
- Type and proportion of any admixture – admixtures shall be appropriately tested and approved for their intended purpose, and used strictly in accordance with the manufacturers recommendations.
- Methodology for placement e.g. – delivery to the area of work, method of delivery into the shutters.
- Extent of temporary works e.g. formwork, support, removal, making good concrete after removal.
- Reparation of foreseeable defects and limitations to effective repair work.
- Construction tolerances.

The Engineer and Waterproofing Design Specialist should work together to:

- Align the waterproofing grades required by the design with the structural designs and water tightness classification.
- Select the concrete mix required to achieve the necessary robustness, durability and waterproofing performance required.

Where the site is affected by ground gases, contaminants and aggressive ground conditions, concrete specification and performance should also be discussed with relevant specialists to determine any additional protection measures that should be included.

Evidence will be required by the Warranty surveyor that concrete has been sourced from a third party accredited supplier registered to either:

- 'The Quality Scheme for Ready Mixed Concrete' (QSRMC), **or**
- BSI Kitemark Certification.

Trained operatives and quality control

Work should be carried out by operatives with demonstrable experience in reinforced concreting works. All materials and work execution must be strictly in accordance with the Engineers design and specification, and supplemented by a Quality Control plan, which may be requested by the Warranty surveyor at their discretion.

The Quality Control plan should include as a minimum:

- All mix designs and supporting delivery documents to site.
- Details of controls for reinforcement work e.g. procurement, storage, bending operations, installation.
- Accurate and organised records of placement e.g. pour locations, pour size, pouring dates and times, weather conditions.
- Photographic records and documented controls relating to preparation and formwork construction.
- Records of concrete testing linked back to each concrete pouring operation e.g. slump testing, cube strength testing.
- Evidence of post-formwork strike checks e.g. areas of defective work, presence of cracks, use of electromagnetic cover meters to determine concrete cover over reinforcement.

Type C Drained protection

Type C Drained protection systems are often referred to as water management systems as they collect and remove any seepage of water occurring through the structure and direct to a suitable point of discharge.

The Warranty provider considers Type C Drained protection to be:

- Proprietary systems formed using cuspated drainage membranes and drainage channels designed in accordance with BS 8102.

A designed system shall satisfactorily dispose of collected water to a suitable point of discharge, either by gravity or through a sump and pump system, and:

- Allow for the regular inspection, servicing and maintenance of drainage channels, pumps and fitments via appropriately located access points.
- Include control measures to avoid the depositing of free lime and/or mineral salts within the system e.g. effective surface preparation, use of inhibitive or sealer treatments onto structure before system installation. The Waterproofing Design Specialist should provide a specification of the treatments to be used appropriate for the particular construction and this should be made available to the Warranty surveyor.
- Include safeguards against the risks associated with backflow e.g. non-return valves, drain surcharging, and the risks associated with flooding e.g. flood loops.
- Include safeguards to address issues associated with ground gas and/or ground contamination that have been developed with an appropriate specialist. These jointly co-ordinated designs should ensure systems avoid risks to the end user(s) via pathways into the protected space and/or that systems are suitably resistant to any identified ground gas or contamination issue.

Drainage capacity

The capacity of the system shall be calculated by the Waterproofing Design Specialist to ensure the required internal environment is maintained and shall factor in the expected levels of water seepage occurring through the structure. The rate of water seepage may be influenced by:

- The structures resistance to water ingress e.g. materials, construction method.
- Size and complexity of the structure e.g. area, shape, junctions and penetrations.
- Hydrostatic pressure e.g. drainage characteristics of the ground, water table, perched water.
- The inclusion of risk mitigation measures e.g. external land drains, applied barrier membranes.

Drainage channels, sumps and pumps and all relevant system components shall be suitably sized to achieve the desired capacity, including any additional capacity identified by the Waterproofing Design Specialist to deal with foreseeable events that may temporarily increase burden on the drainage system e.g. flood events, surcharging.

Expected rates of water entering the drainage system should be communicated to the Engineer responsible for the overall project drainage design to enable determination of suitable points of discharge.

Where collected water is discharged into a suitable drainage system, any proposal shall be supported by appropriate designs that demonstrate receiving systems have suitable capacity for the water expected and include safeguards against risks posed by back-flow of water through the pipes due to water-logging and/or flood events.

Any proposal to discharge collected water via infiltration into the ground must not adversely affect the buildings structural performance or be detrimental to the building fabric. Further guidance can be found within the ‘Drainage’ section of the Technical Manual.

Positioning of drainage system and components

The position of drainage channels, sumps, access provisions and points of discharge shall be clearly determined by the Waterproofing Design Specialist within the waterproofing design strategy via appropriate plans and sections. As the location of drainage channels are typically local to the external wall-to-floor junctions, any formation whether formed during the concrete slab casting or cut into the concrete at a later stage, must be communicated to the Engineer to factor into relevant structural designs. Where larger footprints are involved, cross floor channels required by the design will ideally be local to construction joints where the structure is more vulnerable to seepage.

Pump systems

Pump systems should operate automatically, and be designed to safeguard against any foreseeable mechanical redundancy and any accidental situation that results in deactivation. They should include:

- A primary pump with an independent power supply.
- A secondary pump with an independent power supply, and a battery or generator backup.
- A suitable audio or visual alarm that indicates pump failure or loss of power supply.

Flood testing of a system should be undertaken during construction to check efficiency and that water flows as per the design. The Warranty provider at their discretion may request that such testing is witnessed by the appointed Waterproofing Design Specialist.

Trained operatives, quality control and commissioning

In all instances, Type C Drained protection systems 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. All materials and work execution must be strictly in accordance with the Waterproofing Design Specialist design and specification, and supplemented by a Quality Control plan covering aspects of installation, which may be requested by the Warranty surveyor at their discretion.

Upon completion, and prior to issuing the Certificate of Approval, the Warranty surveyor will require:

- A commissioning certificate for the pump system.
- A copy of the 'Operation and Guidance Manual' and all other documentation that will be made available to the end user in relation to the correct operation of the system, system guarantees, and their obligations to manage an appropriate inspection, servicing and maintenance regime for the installed system.

Combined protection

A combination of waterproofing protection systems may be required to lower the risk of failure, or where the consequences of a single system failure and the loss of use to the protected space considered too high. Any combined protection designs should use materials that have different performance characteristics to mitigate the risk of failure due to a common cause or defect.

For Warranty purposes, habitable spaces must be protected by combined protection.