Best Practice Guidance

Continuity of Waterproofing Systems

PCA
Property Care
ASSOCIATION

Best Practice Guidance
Continuity of Waterproofing Systems

Version History

Date Effective	Description of amendment	Author
February 2017	• Initial Document	
May 2022	• Incorporating amendments to BS 8102: 2022 Protection of below ground structures against water ingress • Updated References • Minor Formatting	James Berry

1. INTRODUCTION

This document has been produced to provide guidance on the prevention of water ingress through the discontinuity of waterproofing systems in below ground structures. One of the key principles laid out in BS8102: 2022 is the need to ensure that waterproofing systems, of any type, should be continuous where possible. Any break in the waterproofing system or interface between different systems increases the risk of a defect or failure.

2. DEFINITIONS

For the purposes of this document, the following definitions refer:

- **TYPE A (BARRIER PROTECTION)**
  Protection against water ingress which is dependent on a separate barrier system applied to the structure.
- **TYPE B (STRUCTURALLY INTEGRAL PROTECTION)**
  Protection against water ingress `which is provided by the structure.
- **TYPE C (DRAINED PROTECTION)**
  Protection against water ingress into usable spaces which is provided by the incorporation of an appropriate internal water management system.
- **CONCRETE BLEED**
  A form of segregation where some of the water in the concrete tends to rise to the surface of the freshly placed material.
- **CONSTRUCTION JOINT**
  Joint formed in-situ in concrete when continuity is not possible. It can also be the construction interfaces between masonry, concrete or other building materials.
- **CRYSTALLISATION**
  The reaction of water meeting “crystallising admixtures” that produces a swelling of the material which then blocks the capillaries within the curing concrete. This can also be an additive at concrete batching stage, or a post applied application.
- **EXPANSION JOINT**
  Joint that permits relative movement caused by expansion and contraction due to changes of temperature or moisture.
- **“HONEYCOMBING”**
  Voids in the concrete caused by poor compaction and or vibration which does not adequately allow entrapped air to escape a concrete mix.
- **HYDRATION**
  Chemical reaction between cement and water.
- **HYDROSTATIC HEAD**
  Water pressure, expressed as an equivalent depth of water.
- **HYDROSTATIC PRESSURE**
  Pressure exerted by depth of water
- **KICKER**
  Small concrete up stand, cast above floor level to position wall or column formwork for the next construction level.
- **KICKERLESS CONSTRUCTION**
  A mechanical means of retaining formwork in position, eliminating a kicker.
- **LAITANCE**
  Is a weak, friable layer on the surface of concrete and sand cement screeds.
- **MEMBRANE**
  A barrier that is impervious to water.
- **PLASTIC CRACKING**
  Plastic shrinkage cracking is produced when fresh concrete in its plastic state is subjected to rapid moisture loss.

- **PRESSURE**
  Pressure is a load which is spread across an area, e.g. hydrostatic pressure.
- **PROTECTION BOARDS**
  A sturdy sheet boarding applied to external membranes to protect from construction damage and material backfill.
- **RENDER**
  The term 'render' refers to any applied coat which is made up of a sand: cement mix only, and can be used for coatings applied internally or externally. It may incorporate water-resisting admixtures, accelerators, plasticisers or other approved additives.
- **SEEPAGE**
  Slow transmission of water through discrete pathways of a structure.
- **SHRINKAGE**
  When a mixture of cement and water hardens, the resultant material occupies a lesser volume than when in its plastic state, as water is lost. This is due to the contraction or decrease in volume of the concrete. The time sequence and shrinkage deformation level are influenced mainly by the start of drying, ambient conditions and the concrete composition.
- **STRESS**
  The pressure that builds up within the elements of a structure to resist applied loads and/or pressures.
- **TANKING**
  Application of an appropriate waterproofing barrier to the walls, the base slab and, where relevant, the roof of a below ground structure, such that the entire envelope of the structure below ground is protected against water ingress.
- **WATERPROOF**
  A material or layer that is impervious to the passage of water.
- **WATERPROOFING**
  The application of a material that is impervious to water.
- **WATER RESISTANT**
  Ability of a material to resist water penetration.
- **WATERSTOP**
  Material designed to inhibit the transmission of water under pressure through joints in the structure.
- **WATER VAPOUR**
  Water in its gaseous state.
- **WATER VAPOUR CONTROL**
  Control of vapour is required as part of waterproofing design.

3. DESIGN PRINCIPLES

BS8102: 2022 Protection of below ground structures against water ingress – Code of practice, provides guidance on the methods which can be adopted to deal with and prevent the entry of water from the ground into a structure that is below ground level. It is widely referred to and used in basement waterproofing with reference to:

- Adoption of a design team
- Water table classification
- Defects and remedial measures

It also refers to other waterproofing protection known as Type A (barrier protection) and Type C (drained protection) and how they can be combined with Type B systems where required.

Design should be in accordance with relevant Building Regulations and applicable statutory requirements. All elements (including foundations, walls and floors) forming a below ground structure requiring waterproofing should be suitable for their intended purpose.

Design and build philosophy
As a general rule, design and construction should be kept as simple as possible. Consulting relevant waterproofing design specialists as early as possible and working through details sequentially will help to avoid unbuildable details on site.

All floors, ceilings and walls below external ground level including the junctions between them, should be designed to resist the passage of water and depending on habitable grade, moisture to the internal surface. The level of protection against water and moisture reaching the internal surfaces should be appropriate for the proposed use.

Habitable accommodation should be designed to “Grade 3” as described in BS 8102: 2022 – that ‘no water ingress or damp areas is acceptable’ and a dry environment will be provided if maintained by adequate ventilation’.

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 a minimum “Grade 2”, no seepage is acceptable, damp areas as a result of condensation tolerable. However consideration should be given to the type of plant and stored items and their sensitivity to damp and any particular environmental controls required.

Retaining walls used to form elements such as light wells ideally could be designed to provide “Grade 1” protection”, however the client should be made fully aware of the limit to this level and whether this is acceptable to the scheme.

Designer
Waterproofing systems should be designed by a Waterproofing Design Specialist who can demonstrate that they have a suitable level of knowledge for designing waterproofing systems.

The Property Care Association (PCA) provides training for surveyors and designers of underground waterproofing systems. The Certificated Surveyor in Structural Waterproofing (CSSW) is a recognised industry qualification which requires an understanding of waterproof systems and the ability to comment on them. The PCA has created a register of Waterproofing Design Specialists (WDS) who have shown further ability to provide design advice for structural waterproofing.

Several Buildings Insurance companies now specify an individual with CSSW or alternative recognised qualification as part of a waterproofing design team.

With the publication of the register of Waterproofing Design Specialists, developers, architects and builders can quickly locate individual practitioners who can assist in the design and planning of underground waterproofing. This ability will allow them to conform to the recommendation set out in BS8102: 2022. The availability of the register will ensure that a properly vetted and approved Waterproofing Design Specialist is available and accessible to the leader of any design team.

The list of Waterproofing Design Specialists can be accessed via: *www.property-care.org/ProGuidance.RWDS.asp*

Site Investigation
A site investigation is important as its results will have a bearing not only on the waterproofing options considered, but also how the structure is designed. Although the findings of a site investigation can be seen as conclusive, consideration should be given that it is often a ‘snap shot in time’ and conditions on or around the site may change in the future.

It should be assumed water will come to bear against the below ground structure at some time in its life. The risk of future failure of a system may be acceptable for the initial use of the structure but it may not be acceptable when the system is changed to ‘higher risk’ use later. As such it may be that designing a system to offer full protection to full height, regardless of any water table classification, should be considered.

There are some overriding principles that need to be highlighted when selecting the form of construction and waterproofing system that a site investigation will assist with.

Aspects of gathering site information are dealt with in the subsections that follow but there are some overriding principles that need to be highlighted when selecting the form of construction and waterproofing system.

As stated in BS 5930, 'Investigation of the site is an essential preliminary to the construction of all civil engineering and building works'. BS EN 1997 provides guidance on geotechnical design. Assessment of ground conditions is particularly important for basements, since the materials used and the performance of the finished structure will be greatly influenced by the ground conditions. Several factors need to be assessed and reference should be made to the above Standards.

It should also be taken in to account that water tables can be seasonal and can fluctuate. The effects of future developments within a vicinity where, for example, deep piled foundations are to be used can have future adverse effects, by changing the level of the water table. This should include the location of any 'spring line' which could affect soil hydrology.

Risk Assessment
A risk assessment should be carried out which identifies any possible long-term water pressures, the effects of surface water percolation, use of external drainage and party wall impact on neighbours.

It should take into consideration the possible effects of climate change, defective water goods, nearby trees, contaminants; and where external drainage is proposed, the effects dewatering may have on adjacent structures along with the potential for silting of drainage. Any designs or risk assessments should be carried out by specialists carrying an appropriate level of Professional Indemnity (P.I) insurance cover.

Water Table
The existence of a watercourse or water table and its seasonal position below ground will need to be established. The site history and name clues such as 'Pond Lane', 'Spring Lane' or 'Winterbourne Lane' can help. Evidence of a flooding site could suggest an impermeable soil or a high or perched water table.

High water tables present the greatest risk of failure to the waterproofing of a basement and it is therefore important to identify. A watercourse or water table that rises and falls and the potential for a perched water table must also be identified. How often and for how long the water table stays high are also important factors.

If the water table rises briefly – say, after heavy rain – and then immediately falls again, the risk of water penetration through external waterproofing and then through the structure is less than if the water table stays high for a much longer period. Consideration should also be given to the effect of possible planned developments adjacent to or near the site either under consideration or potentially in the future. Historic information on past flooding is valuable, including any recording of rate of water ingress. If the water table is variable, then it is advisable to design to the "highest level".

The likely presence of water and the position of the water table must also be established for construction purposes. The main contractor may need to lower the water table temporarily to enable the construction and waterproofing to go ahead. In addition, any lowering of the water table will need to be maintained until the loads acting on the basement, from either itself or in combination with the superstructure, are greater than the forces that would be generated by the water pressures as the water table returns to its original level.

The existence of any aggressive elements in the ground and/or the groundwater must be established to ensure that the most suitable combination of structure category and waterproofing system is selected.

More information on water tables and ground water can be found in the PCA document 'What is groundwater?'

Ground Conditions
The design of the basement should consider all current and likely future ground conditions. The design of the waterproofing system should consider the likely effects of these ground conditions, including water, and assume exposure of the basement to full height of water within the design life of the building.

A summary of common investigations relating to ground conditions along with some useful guidance is given in the table below.

Ground Drainage
The topography of the land and the direction and movement of any groundwater should be determined as they will have a bearing on any proposals to provide drainage to reduce local groundwater pressures.

If there are any drains or land drains, their positions and performance should be established. Any new construction proposals should not interrupt drains that still function unless measures are taken to redirect them or to intercept the water by a new drainage system.

Soil Type and Conditions
The type of soil can greatly influence the volume of water reaching the basement wall. Free -draining soils not subject to variability in water tables generally present fewer problems than clays, which tend to be impermeable.

It is important, therefore, to determine the soil type, in particular its drainage characteristics. It should be noted that the soil around a basement may not be uniform and therefore care needs to be taken when assessing its overall characteristics. Such assessment is best left to specialists. Some soils contain chemicals that may harm both the structure and the waterproofing system. Check the ground for materials that are detrimental, such as peat, sulphates, chlorides, VOCs and hydrocarbons.

BS8102: 2022 advises the designer to take account of the presence of, or potential for, natural gases such as radon and methane, and other gases such as CO2 when considering waterproofing. This is mentioned so that designers can take note of the perceived risks from radon and advise their clients accordingly. It should also be noted that high levels of radon can accumulate even where basements are protected by a waterproofing membrane (that is also effective as a radon barrier), and this may lead to the installation of a radon management system where the risk assessment, particularly in existing structures, indicates that legislation might otherwise apply.

When drained, waterproofing systems are a part of a specification, it is important to check with the relevant bodies / local authorities / utility providers on permitted discharges/consents before deciding whether to discharge any potential ground water into their drainage systems.

Reproduced Table 1 – BS8102: 2022

Risk Associated with water table	Water table classification (see note)	Waterproofing Protection			
		Type A	Type B		Type C
			Piled Wall	Reinforced concrete wall	
Low	Low	Acceptable	Acceptable where a) the piled is directly accessible for repair and maintenance from inside the structure b) the piled wall is combined with a fully bonded waterproofing barrier; or c) the piled wall is faced internally with a concrete wall 9.2.1	Acceptable	Acceptable where appropriate discharge measures are in place (see10.1)
	Variable	Acceptable if the "variable classification is due to surface water. The manufacturers advice should be sought.			
	High	Acceptable where a) an appropriate cementitious multi coat render or cementitious coatings are used b) the wall is of concrete to 9.2.1 or c) a fully bonded Type A system is used (see figure 9)			
High					
Measures to reduce risk		• Use combined protection • Incorporate appropriately designed sub-surface drainage and ensure that this is maintained (see 6.4). • Use a fully bonded waterproofing barrier. • Lower the permeability of the main structural wall. • Use concrete with a water resisting admixture e.g. to BS EN 934-2:2009+A1 2012 (see 9.2.1.3) • Ensure the drainage and discharge systems e.g. pumps, are maintained so that the system remains effective (see 10.3.1)			

NOTE The water table classifications are defined as follows (see also 5.1.3).

- High – Where the water table or perched water table is accessed to be permanently above the underside of the base slab. Ground Permeability might affect risk under a low or variable water table (see 5.1)
- Low – Where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free draining strata.
- Variable – Where the water table fluctuates

Movement Risks
A change in ground moisture content – caused, for example, by the removal of trees – can result in ground movement and affect the load-bearing capacity of soil and applied waterproofing. Clay and peaty soils are particularly prone to volumetric changes leading to varying foundation pressures and movement. There is risk of ground movement caused by the drying out of the ground due to dry periods and drought (as occurred in 1976).

The remains of former buildings or structures on the site need to be assessed. They are best removed to avoid differential movement due to bearing over firmer points. Steeply sloping sites may have high land-slip risks, which should be assessed before proceeding further.

Particular care is needed where there are changes in the soil strata that may cause differential foundation movement.

Although such matters can be catered for structurally, they do present problems. For example, although expansion joints are a common solution, they may not be appropriate.

If the risk of movement is high, movement joints should be considered. Where possible, designers should not attempt to create waterproofed expansion joints but instead should design discrete boxes that can be separately waterproofed.

Sequence and Timing of Work
It is fundamental that the waterproofing elements of a structure are communicated with all relevant parties throughout the construction process. For this reason, the waterproof design should take into consideration the construction stages and timing between them to ensure the result and function of any installed material is as expected. All parties should be aware of the waterproofing materials that are introduced

at each stage to avoid problematic post installations, miss-installations or potentially leaving them out altogether.

4. CONSIDERATIONS

Site De-watering
If de-watering of a site is deemed necessary, it should be done to a degree suitable for the proposed system with due consideration to existing surrounding structures to ensure any potential movement to the surrounding land as a result of de-watering does not have a detrimental effect.

In any case, specialist advice should be sought. Suggested further points of reading regarding dewatering are:

- CIRIA C750. Groundwater control – Design and Practice (2nd Edition)
- Construction Dewatering and Groundwater Control: New Methods and Applications, 3rd Edition (J. Patrick Powers, 2007)
- Groundwater Lowering in Construction: A Practical Guide to dewatering (P.M. Cashman and Martin, Preene, 2020)

Ground Gases
The likelihood of gases can be established from the underlying geological structure, and guidance for its control may be found in a number of documents and via official sources on the internet. BS8102: 2022 makes reference to Building Research Establishment (BRE) reports BR211, the Building Regulations, and to further guidance on the characterisation and remediation of ground gases given in BS8485: 2015. In view of health issues concerning radon, due vigilance should be observed regarding any revisions to these documents and other official sources.

Methane and other gases are likely to be linked to infill and made-up ground, particularly where large amounts of organic matter have been buried. Such sites can also present risks from acid wastes, mineral oil shales, and other fill materials. Some slags and other residues often contain toxic materials and some furnace ashes may be reactive. The Building Regulations give information on site preparation and resistance to moisture, and include guidance on ground contaminants.

PLEASE NOTE THE CONTROL OF GROUND GASES REQUIRES SPECIALIST ADVICE PRIOR TO SPECIFYING ANY FORM OF BARRIER.

Structural Stability
Parts of the building constructed below ground level that form usable spaces should be designed by an Engineer. The existing substrate should be assessed by the Structural Engineer for suitability for the proposed system.

The design should consider all imposed loads including:

- Ground movement
- Lateral forces from ground water and retained ground
- Buoyancy
- Loading from other parts of the building

For further guidance refer to The Basement Information Centre Design guide.

CONTINUITY OF WATERPROOFING SYSTEMS
With all types of waterproofing system, it is recommended that contractors who are trained and experienced in the particular systems used for installation.

TYPE A CONTINUITY

Type A continuity is defined in BS8102: 2022, section 8.1.3 which states:

“The waterproofing barrier should be continuous around the structure and provide continuity to DPC level (see 6.2.54); however, instances might occur where a waterproofing barrier is used to locally enhance the level of protection provided to a specific area where a Type B, C or other Type A system of different performance characteristics is already performing this function.

In order to maintain the continuity of the barrier, penetrations through walls or floors that are to be protected (e.g. openings for services, pipes, cables) should be avoided, wherever possible. Where it is essential to provide such openings, special treatment around the penetration should be provided and reference should be made to the manufacturer’s instructions, detailing and specialist advice. Similarly, where fixings through the barrier are necessary, the manufacturer’s instructions should be followed.”

5. TYPES OF JOINT

Construction Joints are designed to spilt areas of the structure into separate concrete sections for work scheduling reasons.

Construction Joints require special attention, as these are most commonly associated with leaks. Construction joints are generally deemed to be a monolithic strong joint in reinforced concrete, connecting work done on two different days. The reinforcement in construction joints is therefore continuous through the joint.

The first section has starter bars left protruding so that new reinforcement laps with the old. Vertical concrete surfaces may have a trapezoidal profile or be cast against mesh to provide a mechanical key (as recommended in BS EN 1992- formerly BS8007 and BS8110). Horizontal surfaces ought to be prepared to remove laitance or weak concrete as per BS8102: 2022 Protection of below ground structures against water ingress – Code of practice.

Specialist permanent formwork components are often available and need special consideration to ensure a watertight seal.

In addition to the above, construction joints can incorporate services or other penetrations, formwork tie bolts or abutment to other structural elements of differing material nature. Construction joints can be waterproofed in a variety of ways, such as:

- Hydrophilic strips
- Induced contraction joint
- Injection tubing systems
- Paste / sprinkle on active slurries
- Hypalon rubber type strips
- Passive water bars etc

Induced Contraction Joint

Induced Contraction Joints are created, it is imperative that the waterproofing provides continuity and is of correct type.

Movement Joint
A Movement (or Expansion) Joint is an engineered solution to allow shear, compressive and/or tensile forces in a local area. Typically, this is a separation between two structures, leaving a linear gap with no structure that needs to be bridged by the waterproofing system; therefore, the waterproofing system's resistance to anticipated movement should be considered.

Where possible, movement Joints should be designed to be accessible for maintenance.

Movement joints below ground should not be used unless unavoidable. If the risk of movement is high and joints are unavoidable, where possible, designers should not attempt to create waterproofed expansion joints but instead should design discrete boxes that can be separately waterproofed.

Movement joints can also require loading e.g. for screeds, steel plates with sliding bolts etc. It is imperative to check with a structural engineer for the most appropriate loading for their design.

6. TYPES OF SEALING SYSTEM

There are many types of sealing system/solution across all waterproofing system types (A, B and C) as outlined in BS8102: 2022. The type of sealing system must be suitable for the waterproofing systems being used.

Each waterproofing system must be an independent continuous system.

Construction Joints:
Type A and Type C systems can normally cope with construction joints in the concrete structure, whereas Type B waterproofing systems require additional components to maintain continuity.

Movement Joints:
Type A systems should be capable of maintaining continuity whilst accommodating anticipated movement, or otherwise designed with components to ensure the movement does not damage the Type A system.

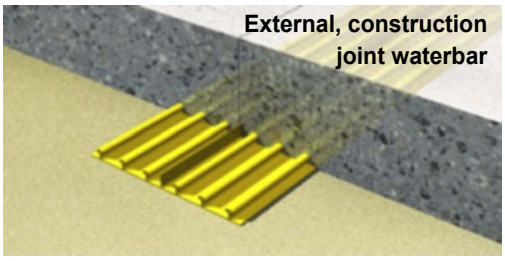
Type C systems are generally not capable of maintaining continuity over Movement Joints. Therefore, if they cannot be designed with components to overcome this, then they should be designed to avoid the movement joint.

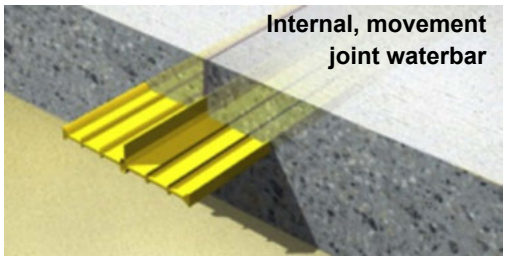
Type B waterproofing systems require additional components to maintain continuity. Options for these are listed below.

PASSIVE

PVC/Rubber Waterstops
PVC/Rubber waterstops can be used to bridge discontinuities in the structure at Construction Joints or Movementc Joints.

Rubber or flexible polyvinyl chloride (PVC) extruded profiles can be cast into the concrete on both sides of the joint, either at the concrete surface or mid-depth of the concrete section, to form a physical obstruction to water transmission:


External, construction joint waterbar


Internal, movement joint waterbar

These are extruded profiles fabricated with junction pieces to provide a linked continuous system through all the joints or discontinuities within a concrete structure.

Plain web profiles are available for non-moving or low-movement construction and contraction joints. Profiles incorporating a centre bulk or box are used where there is movement, as in expansion joints. External waterstop profiles are available and are positioned on the external face of the concrete. These rear- fixed or surface waterstops simplify the shuttering and installation but will resist the passage of water only from the face in which they are installed.

Alternatively, they may be cast totally within the site-placed concrete. These are known as internal or centrally placed waterstops. Internal waterstops will resist the passage of water through a joint from either face. However, they can be more difficult to install and fix, can be dislodged during casting of section and are probably best avoided in domestic basements unless great care is taken and the work properly supervised and inspected.

For all waterstops, the intersections and junctions require welding in situ by competent persons using tools and jigs provided by the system manufacturer. Pre-formed junctions can be provided by the system manufacturer.

PVC waterstops are suitable for variable water tables.

Metal Waterstop
Steel water bar strips are cast in mid-depth of the concrete section to form a continuous fluid -tight diaphragm which acts immediately as a physical obstruction to water transmission. Because of this they are suitable for variable water tables.


Metal Waterstop

These can be passive sections as plain steel or coated with a pressure sensitive adhesive which forms a chemical bond to the concrete when poured to eliminate water tracking, they can also be active systems with addition of a hydrophilic coating.

These strips are tied to the formwork and so care must be taken to ensure the fixing method for these waterstops is compatible with the steel design for that joint.

External bonded / clamped strips
Sometimes referred to as “Bandage joint systems”, these can be used in new build and remedial work, internally or externally, depending on buildability.

These consist of strips of synthetic polymer membrane bonded across the joint with a suitable adhesive or single component cold applied rubber installed across the joint.

Where used internally the component used must be able to withstand negative water pressure.

These solutions can form part of a Type A or Type B waterproofing system. In the case of a dual system, they cannot be used for both Type A and Type B at the same time, as each waterproofing system must have a separate line of defence over the joints.

These can often be suitable for movement as well as construction joints.

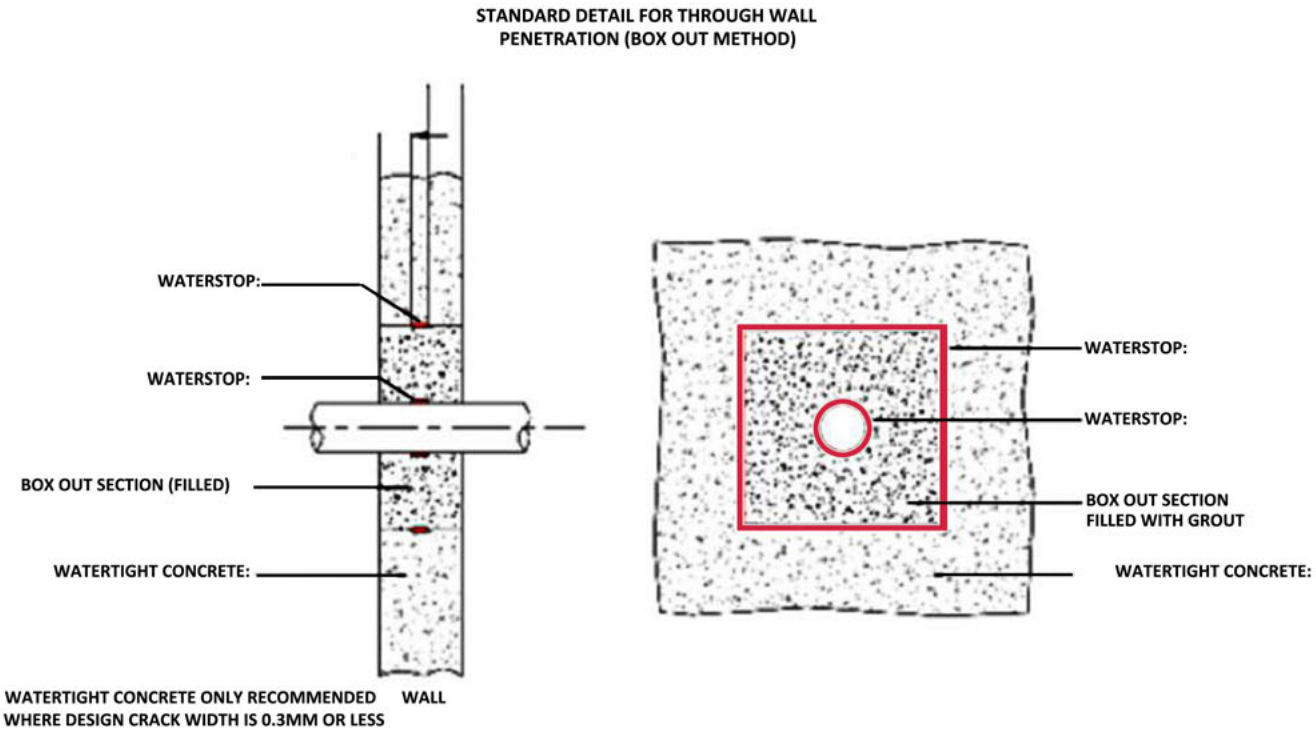
ACTIVE

Hydrophilic strips

Hydrophilic strips react on contact with water and will swell to many times their original size in an unrestrained condition. Within concrete joints they must be fully restrained so that the swell action exerts a sealing pressure as water pressure increases rather than swelling to seal a void.

They are installed in construction joints once part of the joint has been cast and prepared for the next pour. Because they are confined in the concrete, when they swell they exert a pressure inside the joint and therefore block further migration of water.

Waterstop to slab penetration



The strips may be wholly of hydrophilic material, or compounded with a rubber, or part of a composite profile. They can be applied against existing concrete since they avoid the problems of breaking out to install a conventional rubber or PVC waterstop. The use of water-swellable strips is limited to construction joints and should never be used for movement joints.

The manufacturer's minimum dimension of reinforced concrete cover must be followed to suitably restrain the increase in volume and facilitate sealing pressure.

Hydrophilic products should be kept dry until they are fully cast in place to ensure that no pre-hydration or swelling takes place.

Polymer Based
Hydrophilic polymers are inseparably linked to the carrier material so at maximum swell the material maintains its square section.

Polymer base hydrophilic strips will return to their original size and shape when dry. Because of this they can take time to exert full pressure on the surrounding concrete within the joint. Manufacturer's should be contacted regarding delayed swell

Sodium Bentonite Based
Sodium bentonite based hydrophilic extrusions can swell many times their dry volume and upon hydration can change from a solid state to a plastic compound capable of penetrating voids and cavities.

Sodium Bentonite hydrophilic strips when drying will shrink back within the joint, but not always to its original form. Because of this they are not suitable for variable water tables, as some seepage may occur during the swelling process.

Injection Hose
Permeable hose or other sections that are installed in the construction joint once part of the joint has been cast and prepared for the next pour, to facilitate the injection of a specialist sealing resin into the joint after hardening of the concrete.

These consist of a perforated or permeable tube fixed to the first pour of concrete in the construction joint with both ends attached to fittings connected to the formwork. The tube is cast into the construction joint.

When the concrete has hardened, a polyurethane resin or other propriety fluid can be injected under pressure to flow through the tube and, when the exit of the tube is sealed, it flows, under pressure, out of the perforations into any cracks, fissures or holes in the construction joint. The injected material then sets to seal all water paths through the joint.

These post injectable systems provide a repairable solution as required in BS8102: 2009 to an otherwise non-maintainable type of waterproofing.

Injection hoses should not be used on their own. An additional measure (e.g. hydrophilic strip) should be placed in the construction joint as the first protective barrier.

These products are not suitable for use in movement/expansion joints.

Crystallisation Slurries / Cementitious Sealant
Crystallisation slurries or cementitious sealant composition applied to the concrete joint at depth in the section. The materials give rise to crystal growth on contact with water, providing an enhanced obstruction.

These differ from the previously mentioned systems in that the product consists of cements, fillers and chemicals to be mixed on site as slurry. The slurry is applied to the face of the first-poured concrete before the second pour. The waterstopping action results from salt crystallisation, in the presence of water, within the pores and capillaries of the concrete.

These products are not suitable for use in movement/expansion joints.

They will not stop active water ingress.

7. DEFECTS – CAUSES AND REMEDIATION

BS8102: 2022 advises that waterproofing design should allow for defects owing to poor workmanship, the inappropriate use of materials, defects owing to the specific properties of the materials used, actions of follow on trades, as well as the form and feasibility of their elected systems. It is therefore essential that the construction methods and materials used are such that:

- Potential defects owing to poor workmanship or the inappropriate use of materials are avoided
- Potential defects owing to the specific properties of the materials used should be recognised and catered for in the design

TYPES AND CAUSES OF DEFECTS

The hydration regime of the overall concrete structure requires consideration and in accordance with good concreting practice / standards and current local climatic conditions, i.e. consider the use of heated blankets in extreme cold weather and damp hessian / plastic sheeting / regular misting in conditions of extreme heat.

Concrete defects at the joint

Poor concrete compaction or crack formation around any

construction or movement joint can render the sealing system redundant as the defects in the concrete will let water migrate around the sealing system.


Leaking construction joint

Substrate/surface preparation

Poor concrete compaction or crack formation around any

construction or movement joint can render the sealing system redundant as the defects in the concrete will let water migrate around the sealing system.

Wrong component selection

The following parameters should be considered when

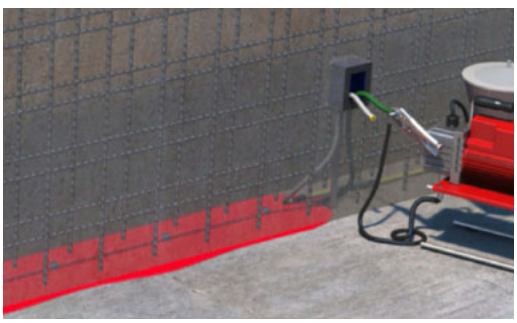
selecting a sealing solution. Incorrect selection could lead to the component failure:

- Contaminants – chemical / saline / VOCs / Gases
- Water Pressure – absolute / positive / negative
- Movement – amount / direction
- Ground Water Level – design for full head of water, but accommodating variable levels
- Concrete cover to hydrophilic strips should be confirmed by the manufacturer and per the dimensions and expansive capacity

As these systems vary, the manufacturer's advice on application method should always be followed.

PVC Waterstop weld/joint failure

Welding of PVC or rubber waterstops is critical to the performance of the whole system. Welds should be tested before installation to ensure they are watertight. This can be done by mechanical and visual means. Preformed joints should be used where possible to reduce the risk of defects. Plastic & metal water bars create micro-cracking between the concrete and the water bar allowing possible migration of water although some manufacturers include sealing technology in their system.



REMEDIAL OPTIONS

Inspection before concreting

All sealing systems should be inspected once installed and before the final concrete pour to ensure they have been placed correctly and will not move during casting.

Injection Hose (if installed)

Injection using various resins or grouts can repair a leaking joint. Depending on the type of hose and injection material used this can be repeated several times if necessary. Care should be taken if drilling through a waterproofing system. This will need to be repaired correctly to provide continuity.

Resin Injection

Specialist Repair Contractors install injection packer around the defect. The drilling should always be across the joint, never parallel with the crack, as the resin must be injected into the crack as it will not pass through solid concrete.

These are injected using various resins or grouts to repair a leaking joint/crack. The packers are removed after the repair has been completed, then made good.

External bonded / clamped strips

These can be used to cover the defect if other measures are unsuccessful. Consideration must be made to ensure the continuity of this repair measure over the defect. They should be checked for compatibility with the waterproofing layer.

8. RELEVANT STANDARDS AND CODES

The following standards, codes and specifications are directly relevant to structural waterproofing:

BS5930: 2015 - Code of practice for ground investigations

BS8002: 2015 - Code of practice for earth retaining structures

BS8102: 2022 Code of practice for protection of below ground structures against water from the ground.

BS8485: 2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

BS 8500 Parts 1&2: Concrete - Complementary British Standard to BS EN 206-1

BS 8500-1:2006+A1: 2012 Method of specifying and guidance for the Specifier

BS 8500-2: 2006+A1: 2012 Specification for constituent materials and concrete

BS EN 197-1:2000 Cement – Part 1: Composition, specification and conformity criteria for common cements.

BS EN 206-1, Concrete, part 1: Specification, performance, production and conformity

Eurocode 2: Part 3: Liquid retaining and containing structures

BS EN 934-2:2001 Concrete admixtures – Definitions, requirements, conformity, marking and labelling.

BS EN 1992-1-1, Eurocode 2: Design of concrete structures, part 1-1 general rules and rules for buildings

BS EN 1992-3, Eurocode 2: design of concrete structures, liquid retaining and containing structures

BS EN 1997-1 Eurocode 7: Geotechnical design, part-1 General rules

BS EN 1997-2 Eurocode 7: Geotechnical design Part 2 ground investigation and testing, BSI 2007

Building Regulations
This is a guidance note. Where recommendations are made for specific tasks, these are intended to represent 'best practice', i.e. recommendations that in the opinion of the PCA meet an acceptable level of competence. Although members are not required to follow the recommendations contained in the note, they should consider the content.

The information contained in this leaflet is given in good faith and believed to be correct. However, it must be stressed that of necessity it is of a general nature. The precise condition may alter in each individual case and the Association is therefore unable to accept responsibility for any loss howsoever arising from the use of the information contained herein.

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