

Best Practice Guidance

Type A Waterproofing Systems



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Best Practice Guidance - Type A Waterproofing Systems (BS8102: 2009)

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1. INTRODUCTION

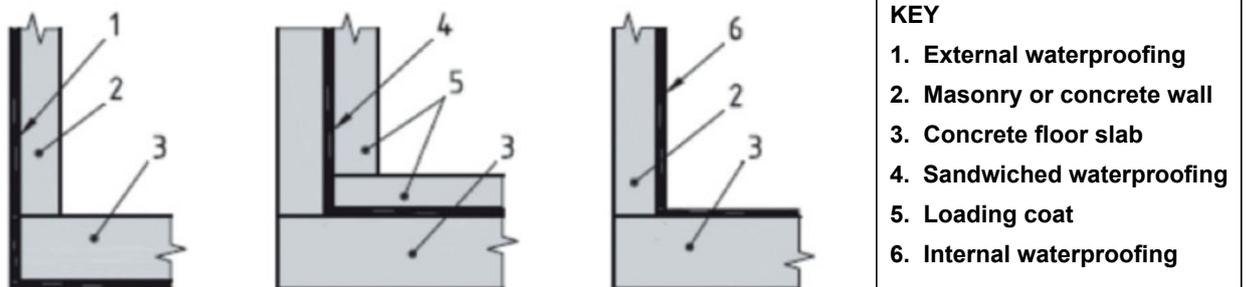
This document has been produced to provide guidance on the design, adoption and use of Type A waterproofing in below ground structures.

Type A protection is defined by BS8102: 2009 (Code of practice for protection of below ground structures against water from the ground) as 'barrier protection'. This is where a material is put in place that offers a barrier to the passage of water with the aim of keeping the target environment within a prescribed level of 'dryness'.

Although generally referred to when looking at designing basement waterproofing, Type A systems can be utilised for a number of different applications. Structures where a Type A system could be adopted include:

- New build basements
- Basement refurbishment
- Semi basements
- Storage or plant rooms
- Car parks
- Retaining walls
- Swimming pools
- Lift pits
- Service ducts or similar that are connected to the below ground structure
- Tunnels
- Podium decks
- External walls where the lowest finished floor level is generally less than 150mm higher than the external ground level

Typical positioning of a Type A system:



It should be noted that although 'sandwiching' the waterproofing layer within the structure is an option (item 4 above), it should be used with caution as access for remedial measures should they be required is greatly reduced. If such an option is to be adopted the manufacturer of the material should be consulted.

The water tightness of the Type A system relies fundamentally on the effectiveness of the waterproofing system, the preparation, the application and the structure. With a high water table, any defects in the waterproofing barrier could allow water to penetrate and if the structural elements are permeable (e.g. masonry) will allow free water to enter the basement. If this water is not removed, the basement will fill to the level of the water table. Structural elements that are less permeable e.g. concrete walls which resist or lessen the occurrence of free water can extend the usage of Type A construction.

Since fundamental reliance is placed on the waterproofing system in Type A systems, account must be taken of the need to gain access if a defect occurs, along with the correct product selection to ensure any materials satisfy the requirements of their intended purpose (robustness, protection requirements, self-healing etc.).

Externally applied systems may require subsequent excavation. However, locating the source of a defect in a system not continuously bonded to the substrate wall can be difficult. An internal system can make accessing and remediating the defect more straightforward but consideration needs to be given to internal fittings, the location of any load bearing/structural elements and if the structure is playing a part in the supporting of the waterproofing system.

With a varying water table, significant water ingress through defects will occur only during storm or water-logged conditions and again will depend on the resistance of the structural elements. If the water table is high only briefly, the ingress might not be enough to show itself. The longer it stays high, the greater the risk of significant water ingress.

The incorporation of maintainable land drains can be used under appropriate ground conditions to achieve a situation where all moisture is under capillary action. Scheduled maintenance of land drains is required. Much of the failure associated with structural waterproofing is attributable to insufficient consideration of the relevant factors, leading to poor design. It is therefore advisable that where specifying waterproofing, these factors are examined rigorously, and that waterproofing specialists are consulted about a design at the earliest stage.

BS8102: 2009 defines:

A waterproofing specialist should be included as part of the design team so that an integrated waterproofing solution is created. The waterproofing specialist should:

- a) be suitably experienced;
- b) be capable of devising solutions that accommodate the various project constraints and needs;
- c) provide the design team with information and guidance that assists with and influences the design, installation and future maintenance of the waterproofed structure.

NOTE The waterproofing specialist could be the manufacturer or material supplier, provided that the manufacturer/supplier has the relevant expertise.

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.

Schemes offered by bodies such as the NHBC and LABC have requirements for suitably qualified persons to be involved in the design and installation of structural waterproofing systems. If a project is involving such a scheme it should be confirmed if such qualifications are a requirement of any warranty application.

In any case manufacturer's guidance and recommendations should be followed, unless any bespoke details have been confirmed with them and other relevant parties.

Installer

One of the most regular causations of failed waterproofing systems is defects in the installation.

Conditions of certification for waterproofing systems will usually require that they are installed 'under license' of the supplier/manufacturer. In practice this does not always happen and it is not uncommon for waterproofing systems to be installed by operatives who have no relevant qualifications and/or no previous experience of installing waterproofing systems. This should not happen and in the main is the responsibility of the Main Contractor.

To improve this undesirable situation it is suggested that installations SHOULD be undertaken by suitably trained operatives. This could be by operatives holding a relevant qualification in the application of structural

waterproofing, such as a relevant vocational qualification. Alternatively operatives trained and licensed by the supplier/manufacturer or PCA training could also provide a suitable demonstration of skill and knowledge.

2. DEFINITIONS

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

- **TYPE A (BARRIER PROTECTION)**
Structure constructed from concrete or masonry, offering only limited protection against the ingress of water by the nature of its design. Protection is therefore primarily dependent on a barrier system applied to the structure, combined with serviceable land drainage where appropriate.
- **TYPE B (STRUCTURALLY INTEGRATED PROTECTION)**
Designed and constructed in reinforced or pre-stressed concrete to Eurocode 2; or to BS EN 8500 (to minimise water penetration); BS 8102 or to BS EN 1992 part 3 formerly BS 8007 (to prevent water penetration) dependent on the chosen grade of basement use.
- **TYPE C (DRAINED PROTECTION)**
Constructed from structural concrete (including diaphragm walls) or masonry to minimise the ingress of water. Any water that does find its way into the basement is channelled, collected and discharged within the cavity created through the addition of an inner skin to both walls and floor.
- **BCA**
British Cement Association.
- **BRE**
Building Research Establishment.
- **BSWA**
British Structural Waterproofing Association.
- **BUNDING**
A constructed retaining wall designed to prevent inundation or breaches from a known source. It is a secondary containment system commonly used to protect environments from spills where chemicals or liquids are stored.
- **CIRIA**
Construction Industry Research and Information Centre.
- **CAPILLARY MOISTURE**
Capillary moisture means moisture held in the capillaries of a material, and which exerts no hydrostatic pressure on the structure.
- **GEOCOMPOSIT DRAINAGE MEMBRANE**
Geocomposite membrane materials consisting of a high flow rate drainage core coupled on one or both sides with filtering and/or impermeable elements to the other side.
- **HYDROSTATIC PRESSURE**
Water pressure exerted as a result of hydrostatic head pressure created by water.
- **INTERSTITIAL CONDENSATION**
Interstitial condensation is condensation occurring WITHIN the system, as opposed to the more common surface condensation.
- **ICF**
Insulating Concrete Form or insulated concrete form (ICF) is a system of formwork for concrete usually made with a rigid thermal insulation that stays in place as a permanent interior and exterior substrate for walls, floors, and roofs.
- **LABC**
Local Authority Building Control.
- **MPA**
Material Products Association.

- **MEMBRANE**
A barrier that is impervious to water.
- **NHBC**
National House Building Council.
- **PLASTER**
The term 'plaster' refers to any applied coat whose cementing action comes from either gypsum or cement / lime.
- **PRESSURE**
Pressure is a load which is spread across an area, e.g. hydrostatic pressure.
- **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.
- **STRESS**
Stress is the pressure that builds up within the elements of a structure to resist applied loads and / or pressures.
- **TANKING**
The term 'tanking' refers to a pressure resisting waterproofing system that is applied internally or externally to a structure, which will prevent any lateral penetration of liquid, either by capillary action or by hydrostatic pressure.
- **TBIC**
The Basement Information Centre.
- **VAPOUR CHECK**
Any layer which reduces the passage of water vapour, resulting in a build-up of humidity immediately behind it, is known as a vapour check.
- **VAPOUR CONTROL LAYER**
A vapour control layer is a strategically placed vapour check, used where control of water vapour is needed.
- **VAPOUR RESISTANCE**
The ability to resist water vapour.
- **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**
A material or layer with a high resistance to the passage of water.
- **WATER VAPOUR**
Water in its gaseous phase.

3. PRINCIPLES OF DESIGN

3.1 BS8102: 2009

Code of Practice for the protection of below ground structures against water from the ground 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, making particular reference to:

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

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

3.2 Design and Build Philosophy

As a general rule, design and construction should be kept as simple as possible. Consulting relevant waterproofing 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 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: 2009 – that ‘no water penetration 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” as described in BS 8102:2009, as no water penetration is acceptable although damp is tolerated.

Retaining walls used to form elements such as light wells ideally should be designed to provide “Grade 1” protection.

Where there is any doubt about use, the level of protection required for habitable accommodation should be provided.

3.3 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 recognized industry qualification which requires an understanding of waterproof systems and the ability to comment on them. PCA has created a register of Waterproofing Design Specialists (WDS) who have shown further ability to provide design advice for structural waterproofing.

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 so clearly in BS8102: 2009. 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 - www.property-care.org/ProGuidance.RWDS.asp Information about training courses and qualifications are available from the PCA website: www.property-care.org

Further guidance for the design of waterproofing systems can be found in BS 8102 'Code of practice for protection of below ground structures against water from the ground' or in the excerpt on page 4 of this document.

3.4 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 full height of the below ground structure at some time in its life. Initial designed use may find risk of future failure acceptable, but it may be 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.

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 the effects of party wall impaction 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.

3.5.1 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' 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 or in close proximity to the site either under consideration or potentially possible 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?’

3.5.2 Ground Conditions

The design of the basement should take into account 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.

Investigations	Guidance and information
Desk study including reviewing <ul style="list-style-type: none"> • groundwater and flooding issues • flood potential of the site • available groundwater data • SuD’s 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 TBIC - Guidance Documents (various) PCA - ‘What is Groundwater?’
Contaminated and aggressive ground	Testing required if there is the potential for chemically aggressive ground and/or groundwater
Seasonal water level change including risks of flash flooding and water logging	The report should consider likely fluctuations and short term flooding events that typically occur during Autumn, Winter and Spring
Assessment of impact on the ground water flow where the construction is likely to have a “damming” effect	Interpretative report by a qualified engineer or hydrogeologists to include: <ul style="list-style-type: none"> • assessment of the direction of groundwater flow, • “Damming” effects on the groundwater regime, • “Damming” effect of adjacent structures.

3.5.3 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.

3.5.4 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 and, 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: 2009 advises the designer to also take account of the presence of, or potential for, natural gases such as radon, 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. See section 3.7.2 for more information.

3.5.5 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.

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.

3.6 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 end 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.

3.7 Considerations

3.7.1 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 Document 515. Groundwater control – Design and Practice
- Construction Dewatering and Groundwater Control: New Methods and Applications, 3rd Edition (J. Patrick Powers, 2007)
- Groundwater Lowering in Construction: A Practical Guide (P.M. Cashman and Martin Preene, Ove Arup & Partners, UK, 2001)

3.7.2 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: 2009 makes reference to maps of areas where basic or full protection against radon needs to be provided that are contained in the Building Research Establishment (BRE) reports BR211, BR376, BR413 and the

Health Protection Agency (HPA) documents:

- HPA-RPD-033, Indicative Atlas of Radon in England and Wales, 2007, ISBN 978-0-85951-608-2, available from HPA
- HPA-RPD-051, Radon in Dwellings in Scotland: 2008 Review and Atlas, ISBN 978-0-85951-634-1, available from HPA
- NRPB Documents, Vol 4, No.6, 1993, Radon affected areas: Scotland and Northern Ireland ISBN 085951367X, available from HPA

Attention is also drawn to the Building Regulations, and to further guidance on the characterisation and remediation of ground gases given in BS8485: 2015. Guidance on measures for large buildings is given in BRE guidance *Radon protection for new large buildings*. 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.

3.7.3 Existing Structures

Many of the considerations applicable to structural waterproofing design in new construction apply equally to the design of systems for existing structures, and this document serves equally well as a guide to review these necessary considerations for this purpose.

However, contrary to new-build scenarios, there are limitations inherent when working within the confines of an existing structure, in that there is typically a limited opportunity or scope to make structural alterations for the purpose of installing a given system.

Additionally, while in the case of new construction waterproofing, the designer is providing the initial or first-stage measures of protection against groundwater, in existing structures it is often the case that designs are provided for the purpose of remedying failures in those initial measures, to address problems with systems of considerable age in older or historic property, or to facilitate change of use.

If options are limited by the confines of the structure, it is important to understand what that structure is, and equally, the nature of any installed waterproofing measures within it, which may further influence design.

Therefore, an analysis, through visual inspection, inspection of drawings (where available), and potentially intrusive investigation, i.e. trial hole formation, should be undertaken so that a thorough understanding of the structure and how it is constructed, is developed. The effects of any structural discontinuity as may typically occur in an existing structure must also be assessed.

Once the structure is understood, and objectives and instructions are defined, it is the role of the Waterproofing Design Specialist to configure products and systems within that structure, all while considering the appropriate factors detailed within this guide, so that the objectives are successfully met and structures are protected in the long term.

3.8 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.

4. PRODUCTS

Since reliance has often to be placed on the waterproofing system, the designer must ensure that the materials are properly selected and adequate for the proposed location and conditions. It is imperative that all continuous horizontal, sloping or vertical waterproofing be specified, and executed, in one proprietary waterproofing system. Consideration should also be given to the scope of where products are sourced, as supply from differing sources can lead to complications when trying to identify a root cause of possible failure.

Most proprietary systems and materials are covered by British Standards, Agrément certificates or manufacturers' and installers' warranties.

Reference MUST always be made to Manufacturers Product Recommendations for the application of these products.

There is a wide range of products used for structural waterproofing. The typical range of barrier materials and cavity drain membranes is given in BS8102: 2009. For ease of understanding, this publication separates them into seven distinct categories according to product type, form and application as follows:

Category 1: Bonded sheet membranes

Category 2: Drainage membranes

Category 3: Bentonite clay active membranes

Category 4: Liquid-applied membranes

Category 5: Mastic asphalt membranes

Category 6: Cementitious crystallisation active systems

Category 7: Proprietary cementitious multi-coat renders, toppings and coatings

Category 8: Loose Laid Membrane systems

Categories 1 and 3–8 are regarded as barrier materials for use as Type A protection (and may be combined with a Type B protection) whereas Category 2 is a membrane that creates a drainable cavity and is part of a Type C protection system. Type B and Type C systems are covered in their own documents.

Combination systems

Consideration can be given to the use of combined systems (e.g. Type A and Type B, Type A and Type C or Type B and Type C) where the assessed risks are deemed to be high, where consequences of defects or inadequate workmanship are high, or where additional vapour checks are required to a system where water vapour penetration can occur.

As an example, Type B structures are designed to be water resistant, however additional waterproofing systems may be applied internally or externally to control water vapour movement, where appropriate, or to provide further protection against water ingress.

Thus combining a Type B system with a Type A or Type C would be deemed to have the least risk associated with them in areas of high risk (see BS8102: 2009 clauses 5.1.2 and 5.1.3).

It is also important that any waterproofing works are correctly detailed to maintain continuation with above ground works such as damp proof courses, damp proof membranes and cavity trays.

The design should ensure that waterproofing systems, materials and components are designed in accordance with the manufacturer's recommendations.

4.1. Product Selection

Given the wide range of waterproofing materials and certifications available it is clear there are many options when it comes to deciding upon a product or system for a given project.

Historically and in most cases holding a current British Board of Agrément Certificate or accreditation through appropriate independent testing body has been sufficient. However with the changing requirements of government, Europe and further afield an assessment of the product for its given application should be carried out. Areas which may be important to the application and that need assessing could be:

- Product durability
- Expected life in service
- Crack bridging ability
- Resistance to aggressive environments (UV, contaminants, ground gases etc.)
- Bi-Axial behaviours
- Resistance to stress cracking

When selecting a product or system, it is also important to look at the supplier and/or manufacturer to confirm what support they offer. This could include:

- Design advice
- Range and type of products
- Site support
- Post-application support
- Product training (designers and applicators)

CE marked products

As from 1st July 2013, construction products placed on the market in the UK and covered by a harmonised standard (hEN) or a European Technical Assessment (ETA) will have to be accompanied by a Declaration of Performance (DoP) and will need to have the CE marking.

The scope of harmonised standards is likely to increase over time and as such it would not be practical to list them in this document. It is however important that checks are made to ensure any products being used in works covered by a hEN include appropriately CE marked products, as failure to do so can lead to financial penalties and further legal complications further down the line (this applies to manufacturers, distributors, contractors and specifiers).

4.2 Bonded sheet membranes

A fully bonded barrier is a barrier that forms part of a composite structural wall and/or floor. This includes liquid applied and cementitious systems. Systems that form a composite with the wall or are bonded with a high degree of adhesion and will not allow water to track behind.

Bonded sheet membranes fall into two distinct categories:-

Pre applied

- Bonded to the structural concrete. Laid out on blinding and / or lining the formwork prior to concrete placement – bond through either a pressure sensitive adhesive or a mechanical bond (polypropylene fleece or laminated grid).

Design considerations:

- Bonded to structural concrete not to blinding so offer greater protection and resist lateral migration of water if the system is breached (e.g. mechanical damage)
- Various different plastics used e.g. HDPE, Flexible Polyolefin. The material has an effect on ease of installation, crack bridging ability and stress crack resistance. Generally the thicker the membrane the longer service life will be
- Can offer additional protection against VOC's and other aggressive contaminants as well as common ground gases
- Joint details must be to manufacturer's guidelines / recommendations

Post applied

- Cold-applied or heat-bonded to the finished structural walls. Both are modified bitumen on a range of carrier films. They are applied externally. Composite polymeric sheet membranes are also available

Design considerations

- Flexible and able to adapt to minor movement and shrinkage within the substrate
- They are of consistent thickness and quality
- May provide protection against aggressive soils and groundwater when applied externally
- Require good surface preparation
- Substrate must be free from surface water for bonding to occur
- Generally, suitable only for uncomplicated foundation systems such as plain rafts
- Bitumen membranes can have a reduced service life as a result of Anti-Oxidant depletion (applies to all plastics) and loss of bitumen mass over time. Manufacturers should be consulted as to the expected life span of their product in a given application
- Can offer additional protection against common ground gases



4.3 Bentonite clay active membranes

Bentonite clay active membranes are sheets of sodium bentonite clay sandwiched between two layers of geotextile or bentonite fixed to a foil membrane. The bentonite within these sheets comes in two forms: dry bentonite which requires hydration of the bentonite for it to swell, bond together and form an impermeable barrier to the passage of liquid; and factory prehydrated bentonite where the bentonite has been activated to provide an immediate impermeable barrier in its as-delivered state. Both systems have the capacity to swell to many times their original thickness, potentially sealing the surface of any cracks in the structure and self-sealing any movement in the sheets. These membranes are used either externally or sandwiched between secant or sheet piles and the structural concrete of the building they waterproof.

Design considerations

- Bentonite membranes can be applied with minimum surface preparation
- They can be applied to green concrete and where the surface to which they are applied is damp.
- Bentonite remains 'live' and as such can self-seal minor punctures and defects when installed
- Geotextile bound systems which form a mechanical bond with the concrete have benefits in boundary line construction (restricted working space)
- Manufacturers should be consulted when using in saline, acidic or alkaline environments as some bentonite systems have limitations of usage in these conditions

4.4 Liquid-applied membranes

Liquid-applied membranes are one- or two-part systems. They are applied cold, generally in two coats as a bitumen solution, elastomeric urethane, polyurea or modified epoxy. They can be applied both externally and internally. In the latter case, the loading coat must be strong enough to resist hydrostatic pressure, unless used as a vapour barrier in Type B construction.

Design considerations

- Being jointless, they maintain continuity of membrane
- Fully bonded to substrate*
- May be applied to difficult substrate profiles
- Elastic and flexible, thus accommodating minor movement and shrinkage within the structure
- Can protect the structure against aggressive soils and groundwater when applied externally
- Have high substrate adhesion and chemical resistance
- When applied internally, must be restrained by a loading coat
- Substrate must be free from surface water for bonding to occur
- Requires good surface preparation
- Careful application needed to achieve correct thickness of dried film
- Additional detailing and reinforcement at angles and joints may be required

*membrane should be fully bonded to the structural concrete. When bonding to blinding (under slab) and not the structural concrete there is a possible increased risk of lateral water migration in the event of a leak. Refer to Manufacturer's details and guidance.

4.5 Mastic asphalt membranes

Mastic asphalt membranes are applied in three coats as hot, mastic liquid. They cool to a hard, waterproof coating, but retain a degree of flexibility. Application can be external or internal. If internal, the loading coat must be strong enough to resist hydrostatic pressure.

Design considerations

- Because of the multiple coats, there is little risk of defects in one coat being carried right through the total membrane
- May provide protection against aggressive soils and groundwater when applied externally

- Substrate must be dry before application
- Requires protective screed on horizontal membrane before loading coat is installed
- Externally applied membranes are generally unsuitable for complicated foundations such as piles

4.6 Cementitious crystallisation active systems

Cementitious crystallisation active systems are coatings applied as internal or external slurries. By reacting with free lime in concrete, they block cracks and capillaries.

Design considerations

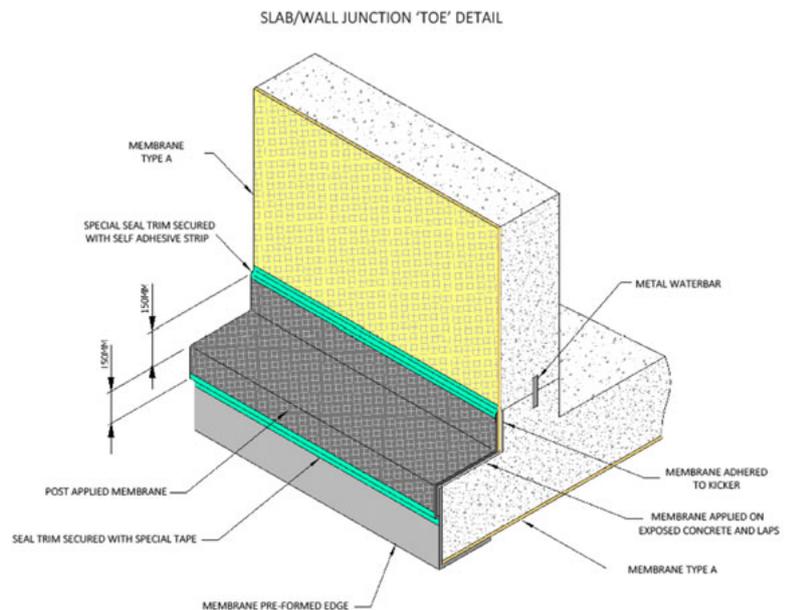
- Provide in-depth waterproofing of concrete and construction joints
- The chemicals remain active and will potentially self-seal leaks
- In construction joints, they assist repair of local defects
- Applied externally, may protect against aggressive soils and groundwater
- Require good surface preparation
- Will not self-seal cracks greater than hairline (0.3 mm)
- Cannot be used on building materials containing no free lime
- Will not waterproof defective concrete, such as honeycombing
- Requires free lime to be available
- Some can be applied as pre-application between blinding and slab and also post-application as 'dry sprinkle' on newly laid slabs

4.7 Proprietary cementitious multi-coat renders, toppings and coatings

Proprietary cementitious multi-coat renders, toppings and coatings are applied as a layer(s) to form a dense, waterproof membrane. Waterproof renders or toppings consist of a layer or layers of dense cementitious material incorporating a waterproofing component. Cementitious coatings are premixed slurries applied as a thin layer.

Design considerations

- Can be applied internally with no loading coat requirement
- Effective against severe groundwater infiltration
- Easily applied to difficult substrate profiles
- When applied internally, defects are easy to find and repair
- Require good surface preparation
- Provide a durable surface suitable for direct finish
- When applied externally, may protect against aggressive soils and groundwater
- They may be rigid and may reflect any cracking of the substrate, although flexible versions are available
- Services, steelwork, mechanical fixings and joints subject to movement should be appropriately detailed
- Bonding of waterproof membranes to concrete or masonry substrates should be continuous, permanent and durable
- Manufacturers guidance should be sought to identify if and what proprietary products might be required



4.8 Loose laid membranes

Although not common in the UK for basement waterproofing (but used for waterproofing of tunnels and other heavy civil engineering structures), loose laid membrane systems are used extensively in other parts of the world, particularly where a highly durable system is required, for example in the Middle East which presents particular challenges due to the highly aggressive ground and ambient conditions. Typically $\geq 2\text{mm}$ PVC-P or FPO (flexible Polyolefin) with heat welded seams, these products provide superior resistance to damage during construction and life expectancy versus thinner membranes produced from other stiffer plastics or bitumen. A protection screed can be used during steel fixing for example, a practice which should not be used with a fully bonded system which needs to be bonded to the structural concrete.

5. PRODUCTS

5.1 Surface preparation

It is imperative to refer to the Manufacturer of the Product for correct guidance on preparation. The substrate to which the Type A system is to be applied should be 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. Water resistant fairing coats and renders are available and can be used for such surface preparation.

5.2 Bandage joint systems

(for construction joints see section 6)

Where movement is expected in joints or cracks – in both new and remedial work – bandage joint systems may be used.

These consist of strips of synthetic polymer membrane, bonded across the joint with a suitable adhesive. As systems vary, the manufacturer's advice on application method and adhesive should always be followed.

5.3 Membrane protection products

If construction operations may damage applied membranes, adequate protection must be provided. This can consist of vertical blockwork and a 50 mm screed to horizontal surfaces. Alternatively, protection boards supplied by most membrane manufacturers may be used. They are more convenient since they provide immediate protection. They also eliminate a 'wet trade' operation and allow the following works to continue immediately after laying.

Protection boards should be rot-proof and robust enough to withstand site operations. They should therefore be chosen in consultation with the supplier of the waterproofing system. A protection board may be used in vertical applications.

Alternatively, if vertical protection and drainage are required, a geocomposite drainage sheet could be used; its greater cost may be offset by the reduction or elimination of hydrostatic pressure on the membrane as a result of the better drainage.

Where protection products are used to protect the waterproofing membrane, backfilling should be carried out in layers with care, compacting each layer to avoid subsequent settlement of backfill material. This should minimise the likelihood of the waterproofing membrane and protection boards being dragged down the structure as uncompacted backfill settles.

6. PRODUCTS

6.1 General advice

Attention should be given to the need for land drainage requirements for Type A tanked structures and reinforced concrete Type B structures. Lack of proper maintainable drainage to basement surrounds may result in hydrostatic pressure and subsequent leakage if there are any defects in the waterproofing or concrete.

Installing an appropriate geocomposite drainage sheet and fin or land drains will help deflect and drain water away from the perimeter of buildings, so improving the total waterproofing.

An additional water-activated pump may be used to deal with runoff water. This can be particularly useful where the water table becomes perched because the soil is too impermeable to handle the percolating surface water, as with a clay soil. Such pumps, which are normally installed outside the structure, can be used to ensure that the severity of water conditions does not exceed that taken for design purposes. They can be used either to extend the application of Type A, B and C construction or to provide an additional escape for water, but may not be appropriate in all situations. The outlet from such pumps must discharge to areas where the water cannot feed back to the pump inlet.

The orientation of the basement area to the general flow of groundwater should also be considered. Any L or V-shapes with a re-entrant angle against the natural drainage flow can act as dams and increase the risk of hydrostatic pressure. Where basements are constructed against the flow of water, sub-drainage should be provided and graded to storm drains or open outlets on the downside of the building.

With ALL types of waterproofing it should be stressed that it is rarely the material that fails but the detailing / installation / lack of care that fails.

Avoid complicated shapes - keep internal / external corners, movement / expansion joints and penetrations etc. to a minimum. External 90 degree angles should have rounded corners and internal corners should be filleted.

6.2 Joints

Construction joints need particular attention as these are the vulnerable areas that are most commonly associated with leaks. While attention needs to be paid to jointing and positioning of water stops, great care is required in the placing and compaction of the concrete.

An alternative method of controlling water ingress at construction joints is to use a crystallisation or hydrophilic system which react in the presence of water to seal the joint. Other systems are also used (see Section 5 - Ancillary materials).

Joints between components, movement joints and day work joints should be durable, watertight and include appropriate water stops or hydrophilic protection. Kickers, usually cast as part of the slab should also be "watertight concrete" and are used to form the joint with the walls.

Construction Joints need particular attention as these are the area's most commonly associated with leaks.

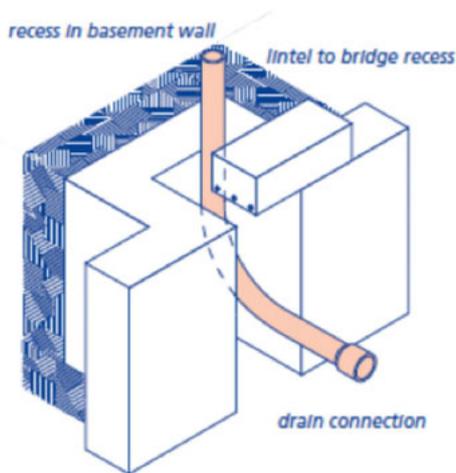
Dealing with joints formed within the construction of the structure can be dealt with in a manner of ways. Ideally any static joint will have a material installed in-between the construction elements in order to stop any water penetration. A range of options are available and are discussed in more detail in the PCA document 'Best Practice Guidance – Type B Waterproofing Systems'.

Where surface applied solutions are to be adopted, these should be assessed and confirmed suitable for use with the proposed waterproofing system and in the case of an internally applied solution whether or not a form of bracing is required. The manufacturer should be consulted for the most appropriate detail for their system.

The detailing of movement joints should ensure satisfactory in-service performance and be watertight. Where movement joints are included in the design they should be accessible for maintenance and not permanently concealed.

6.3 Services

Services entering through a waterproofing system should be avoided where possible. Elements within the construction such as service ducts or light wells can allow for services to be brought in from above, therefore avoiding any compromising of the system.



Where services penetrating the system are unavoidable the design and detailing to seal such elements should ensure that they are watertight and durable and suitably situated to allow for such works to be carried out (having them too close together can be problematic for detailing). In all cases details that penetrate a waterproofing system should be detailed and installed in accordance with the relevant manufacturer's guidelines.

6.4 Puddle Flanges

Puddle Flanges are designed to be cast into concrete blocks, walls & slabs to provide cable and service penetration points. In order to function correctly the principle of how puddle flanges work should be understood and the recommended and intended installation guidelines should be followed.

6.5 Pre-formed details

Preformed components provide a more robust method of forming corners and interfaces than on-site folded sheet material.

6.6 Continuity with other systems and trades

Careful detailing of connections to above ground elements (e.g. dpm's, dpc's) is important to ensure consistency for the overall structures performance. Where possible have a complete system from one source. Details can then be more easily confirmed as compatible.

As important as maintaining consistency between systems, communication and an appreciation of other trades are vital for a successful installation and end result. Regular meetings and communication sessions should be held to ensure that all parties involved at any one stage are aware of current or future works to ensure each can take place, be installed and ultimately function as intended.

7. DEFECTS & REPAIRS

BS8102: 2009 recognises that there are many reasons for seepage in new and existing structures, including poor design and / or specification, defective materials, defective workmanship, deterioration of the structure, or a change in the external environment.

In the case that remedial action is needed, prior to it being taken, any defects should be established to determine the cause and extent of the problem. The correct diagnosis of the defect is imperative in establishing whether faults exist with the system as a whole, or whether faults are localised and can be dealt with as such.

Remedial works could include but not exhaustively:

- the installation of a tanking system or a drained cavity
- the installation of external drainage
- localised works to the fabric of the structure

An example of building in a remedial strategy is where a membrane system is being used it may be possible to incorporate a compartment strategy, whereby water bars are welded to the membrane in a grid formation. In the event of a breach of the system, for example through physical damage, water ingress is contained within a compartment and can be eliminated through resin injection into the compartment.

8. STANDARDS AND CODES

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

- BS8102: 2009 Code of practice for protection of below ground structures against water from the ground
- BS EN 1990: Basis of structural design
- 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
- BS EN 12970 Mastic asphalt for waterproofing – Definitions, requirements and test methods
- Eurocode 2: Part 3: Liquid retaining and containing structures
- BS8002: 2015 Code of practice for earth retaining structures
- BS5454: 2000 Recommendation for the storage and exhibition of archival documents BSI 2000
- Building Regulations

Other reference documents

- The Basement Information Centre (TBIC): Basements: Waterproofing – General Guidance to BS8102: 2009 (Design Guide)
- TBIC - The Building Regulations 2010 – Basements for Dwellings – Guidance Document 2014
- CIRIA Report R140 - Water resisting basements
- BCA: Basement Waterproofing Design Guide
- BCA: Basement Waterproofing Site Guide
- BSWA: Waterproofing Existing Basements
- NHBC: Waterproofing of below ground structures (New Standard)
- ASUCplus: Guidelines on safe and efficient basement construction directly below or near to existing structures 2013.

9. WARRANTIES, GUARANTIES AND INSURANCE

Installer Warranties

Typically these are where the contractor or installer guarantees their own workmanship for a period of years (normally up to 10 years for Structural Waterproofing).

Insurance Backed Guarantees (IBG)

An Insurance Backed Guarantee (IBG) is a low cost, long term insurance policy (normally up to 10 years for Structural Waterproofing) which provides valuable protection for consumers when undertaking improvement projects. The principle of an Insurance Backed Guarantee is to honour the terms of the written guarantee, originally issued by the installing contractor, where that contractor has ceased to trade as defined within the policy document and is therefore unable to satisfy claims against that guarantee.

Latent Defect Insurance (For New Build Renovation and Repair work)

Property owners, construction professionals and other building stakeholders will know that defects can become evident long after practical completion of building works. The rectification of these defects can be a costly undertaking, and may result in expenditure which has not been budgeted, or otherwise provided for. For construction professionals, this naturally jeopardises the availability of funding, time and manpower for future projects.

Latent Defect Insurance products take approaches to protecting stakeholder's investments in construction projects. The propensity for defects to occur is minimized from the outset, as technical audits are carried out prior to and during the build. In addition to indemnifying insured parties in respect of latent defects themselves, the insurance may also confer additional benefits in the event of a valid claim, such as meeting the costs of alternative accommodation, and the fees of architects or other professionals.

Manufacturer Warranties

These are typically but not always accompanied by the contractors own guarantee. They offer protection in the event of a product being proven not to have performed as intended, in which result the manufacturer is often limited to re-supply of the material only. It is extremely unlikely that any ISO9001 compliant company will supply defective materials, hence why these types of warranty / guarantee are issued alongside the installer's commitment.

Other schemes

There are other schemes and companies who offer insurance products covering waterproofing in new-build projects. The National House Building Council (NHBC) has the Buildmark scheme that provides 10 year warranty and insurance cover for newly-built and some new-build basement conversions in private homes. Premier Guarantee and LABC offer similar insurance products in the UK.

10. TRAINING / SUPERVISION

One of the most regular causations of failed waterproofing systems is defects in the installation. Conditions of certification for waterproofing systems will usually require that they are installed 'under license' of the supplier/ manufacturer. In practice this does not always happen and it is not uncommon for waterproofing systems to be installed by operatives who have no relevant qualifications and/or no previous experience of installing waterproofing systems. This should not happen and in the main is the responsibility of the Main Contractor.

Type A waterproofing systems should be installed in accordance not only with the design, but also in accordance with manufacturers' specifications and by installers who can demonstrate relevant competence, experience and 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. Qualities that should be sought after when selecting an installer include:

- Approval/accreditation by manufacturer
- Past experience in installing the subject product/system
- Quality Audit Systems
- Member of PCA or similar
- Product/system datasheets and guidance available on site
- Offer "PI" (Professional Indemnity Insurance) covering relevant construction stage
- Financial ability to remedy any problems
- Relevant vocational qualifications

11. BIBLIOGRAPHY

Reading Lists

- The Basement Information Centre: Basements: Waterproofing - General guidance to BS8102: 2009 known as TBIC Waterproofing Design Guide (MPA – The Concrete Centre)
- MPA The Concrete Centre: National Concrete Specification for Building Construction – Fourth edition complying with BS EN 13670: 2009
- Concrete Society -CONCRETE ADVICE No. 09 - Autogenous healing: the self-sealing of fine cracks - Dick Roberts BSc CEng MICE FCS
- BRE Digest – Concrete in aggressive ground / good concrete practice
- BRE – Basement construction and waterproofing – good building guide, GBG 72-1 BRE 2007
- BRE - Scriver C. Radon protection for new large buildings, GBG 75 BRE 2009
- HMSO - Party wall Act 1996
- The Institution of Structural Engineers (ICE) – Design and construction of deep basements including cut and cover structures - Craig RF. Soil Mechanics. Chapman & Hall 1992
- MPA guidance document - Concrete Basements: Guidance on design and construction of in-situ concrete basement structures.

12. ACKNOWLEDGMENTS

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Refer via PCA website for Waterproofing related links

<http://www.property-care.org/ProGuidance.Waterproofing.asp>

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