Below Ground Waterproofing

Principles for protection of Below Ground Structures against water from the ground

Primary reference British Standard BS8102: 2009

Waterproofing Design

Performance Solution for Below Ground

Application and product options

Practical notes

Below Ground Waterproofing

Principles for protection of Below Ground Structures against water from the ground

This summary is an adaption of the British Standard BS8102: 2009, modified for Australian conditions, tailored more specifically to Melbourne, Victoria.

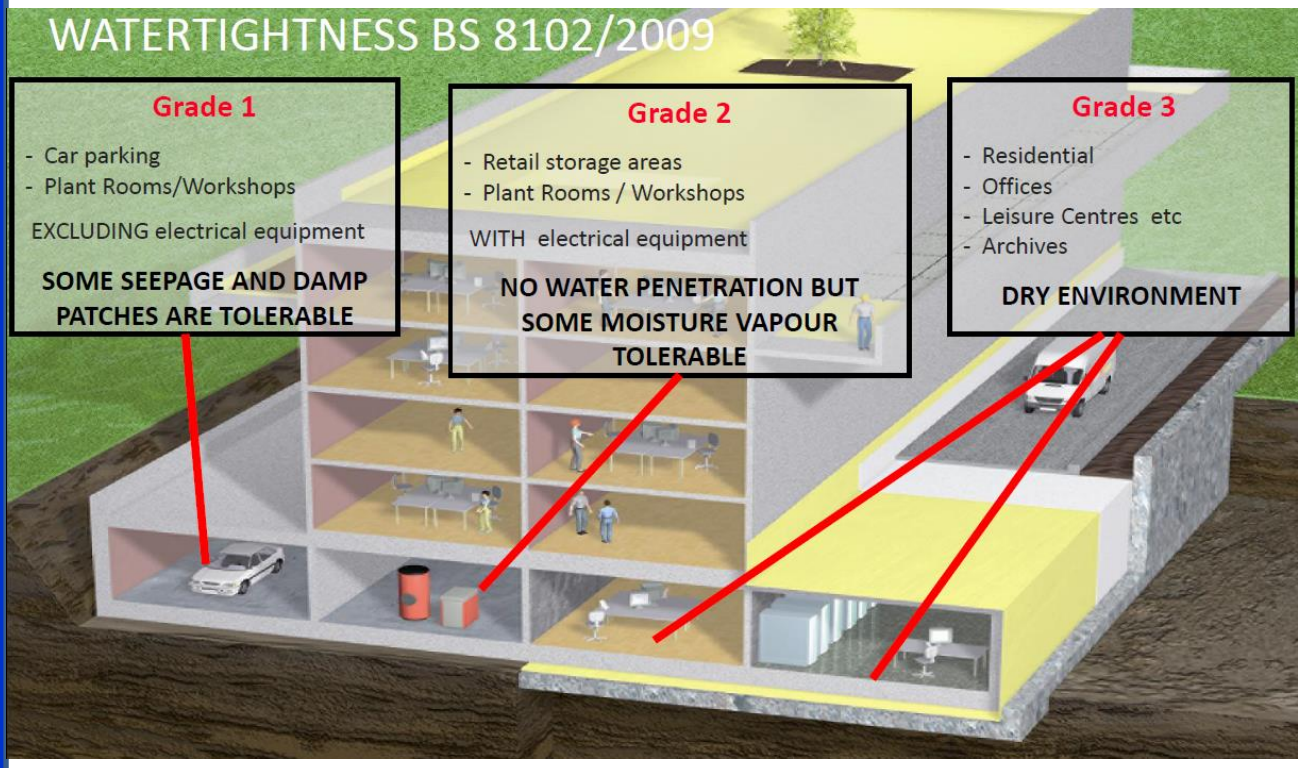
Applicable to NCC Building Classes : 1 through to 10

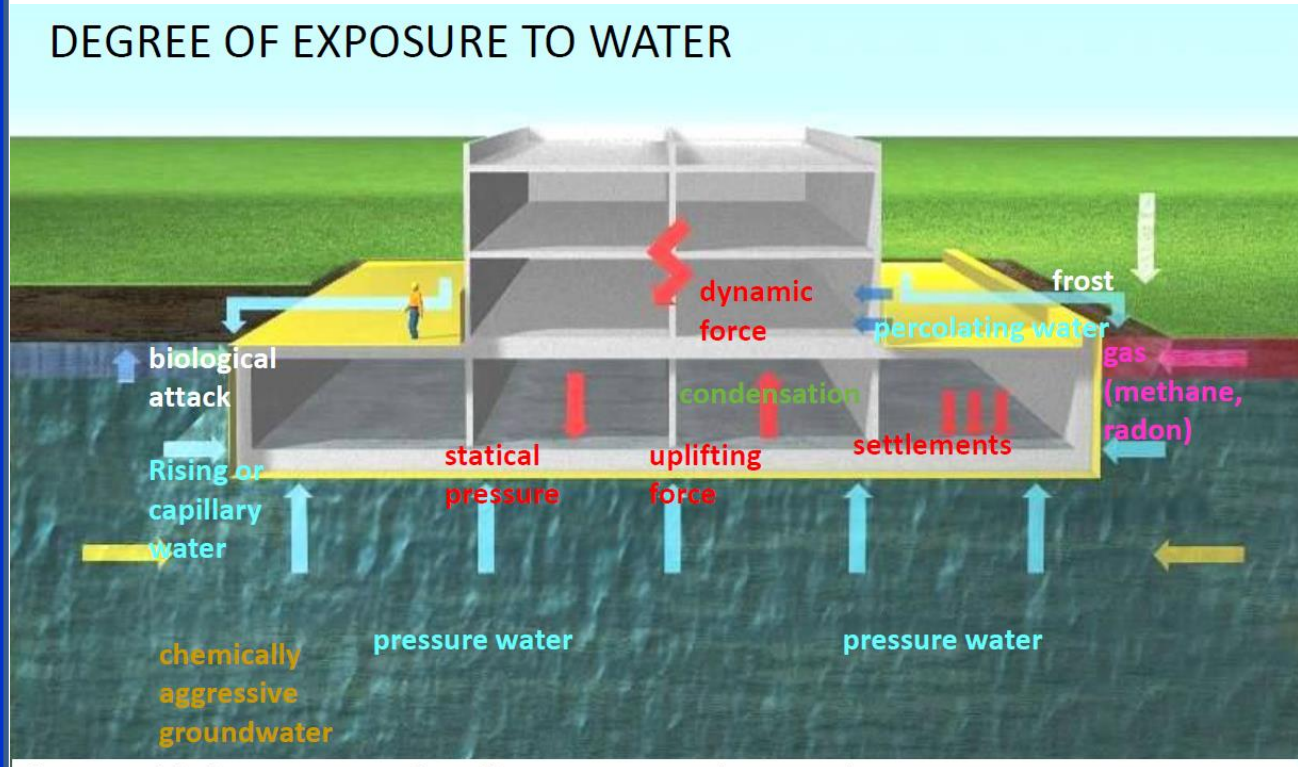
Climate Zone : 6

Wind Class: N1

Contents:

PRACTICAL CONSIDERATION NOTES





Plus possible location specific influences: example coastal region, marine structures etc.

1. Terms and Definitions

Cavity drain membrane
dimpled, flexible, high-density polymer sheet, which can be placed against the internal face of a structure after construction and is designed to intercept water penetrating the structure and direct it to a drainage system.

Cur-off wall
embedded retaining wall designed to surround and seal-off an area, to inhibit water inflow from the surrounding area

Damp area
area which, when touched, might leave a light film of moisture on the hand but no droplets of water (i.e. beading)

Embedded retaining wall
wall used to support the sides of an excavation, installed in advance and penetrating below the lowest level of the below ground construction

Ground barrier
impermeable barrier between the structure and the ground intended to prevent or impede the ingress of water, dampness, radon, methane and other ground gases and contaminants

Loading coat
layer of material designed to hold a Type A waterproofing material in place when resisting water pressure

Perched water table
reservoir of water in the ground maintained permanently or temporarily above the standing water level in the ground below it, and is caused by the presence of an impervious soil or a stratum of low permeability

Seepage
slow transmission of water through discrete pathways of a structure

Tanking
application of an appropriate waterproofing barrier to the walls, the base slab and, where relevent, the roof of the below ground structure, such that the entire envelope of the structure below ground is protected against water ingress

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

Vapour check
membrane or other element that restricts the transmission of water vapour.

Waterproof
impervious to water (also known as “watertight”)

Waterproofing
application of waterproofing/water-resisting materials

Waterproofing barrier
material that does not permit the transmission of free water, but might allow some water vapour permeability

Waterproofing system
materials and methods used to protect a structure from water ingress and might also provide resistance to the diffusion of water vapour

Water resistance
ability of a material to resist water penetration

Waterstop
material designed to inhibit the transmission of water through joints in the structure

Water vapour
water in its gaseous state

Water vapour resistance
ability of a material to resist water vapour penetration

2. Design philosophy

General

Effective planning for any below ground structures requires immediate consideration of the site and neighbouring environment a conditions. This should incorporate investigation of the soil quality and the possible presence of groundwater, gases and any unwanted contaminants.

When designing new structures, the structural design, overall weatherproofing, waterproofing and construction process are considered together, as they generally interact.

It is proposed that during the design process, plus all stages of the construction process, the designers, specialists, manufacturers/suppliers and installing contractors establish and maintain effective channels of communication..

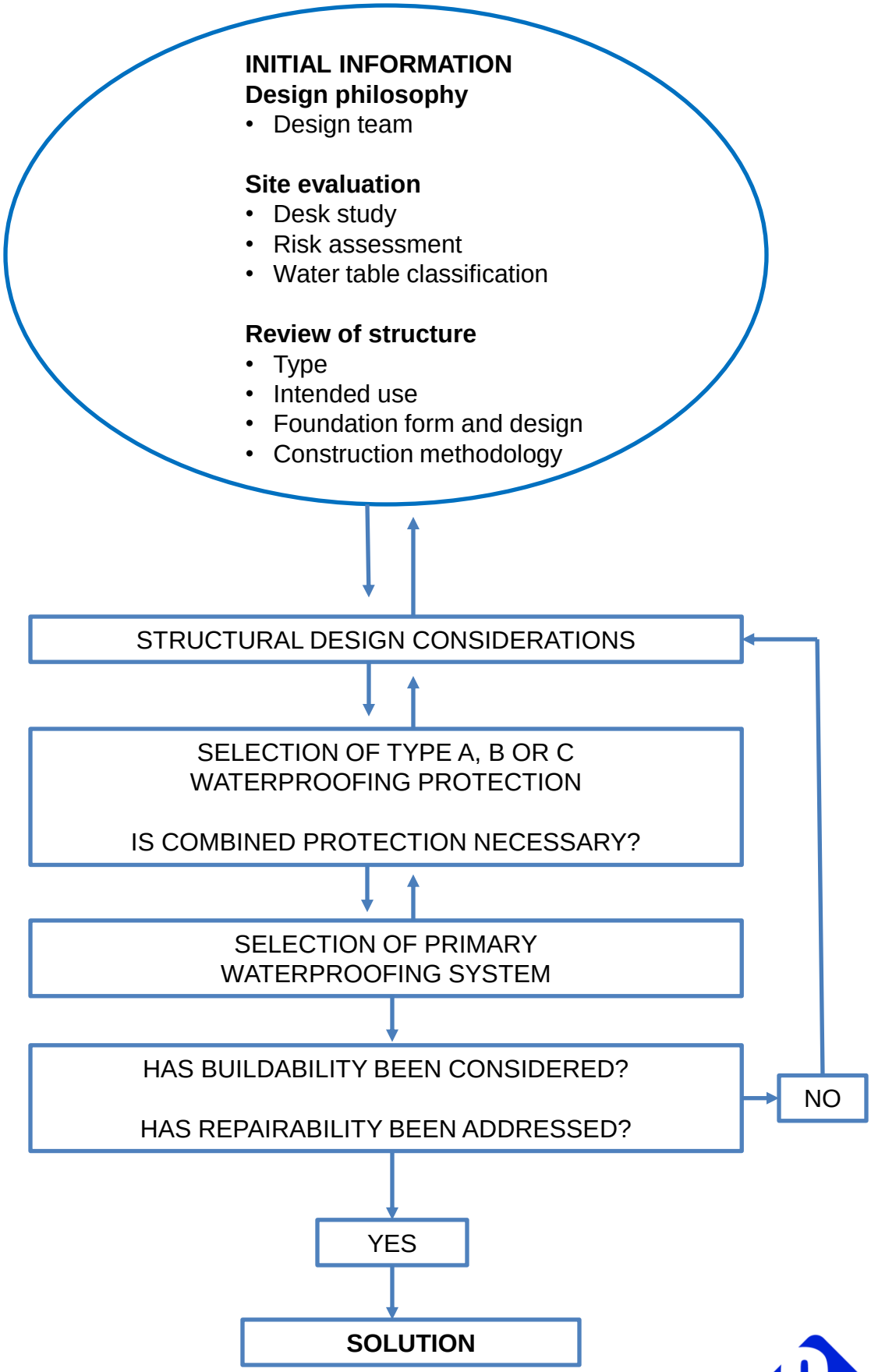
Principle considerations

In order to develop a robust design for protecting a structure against groundwater, the following factors should be assessed;

a. The likely highest level of the water table, the drainage characteristics of the soil and other site-specific properties
b. The appropriate waterproofing measures i.e. Type A, B or C protection and, where necessary, external drainage based on:
    1. the results of the site evaluation, including the classification of the water table
    2. the intended use of the structure, with consideration given to any requirement for future flexibility.
c. The appropriate type of primary waterproofing system
d. Should defects occur, allow for potential remedial measures

Note: The waterproofing specialist could be the manufacturer or material supplier whom has the relevant expertise.

Design Flow Chart



3. Site Evaluations

Desk study
the desk study should at least cover;

a. Assessment of geology and hydrogeology, including soil permeabilities, flood risk, radon, methane and other ground gases and contaminants.
b. To assess the topography of the surrounding ground in relation to the below ground structure
c. To establish the likely highest level of the water table and the potential for the occurrence of a perched water table; and
d. To identify any missing ground and groundwater information, which should then be obtained by site investigation.

Risk assessment
A risk assessment should be carried out which considers the long-term water pressures, the effects of surface water infiltration and the use of external drainage and cut-off walls.

Risk assessment should also consider;

a. The effects of climate change, burst water mains and sewers, adjacent trees, sulfates, radon, methane and other ground gases and contaminates; and
b. Where external drainage is proposed, the effects of drawdown on adjacent structures, the potential silting of drainage and biofouling issues

Even when the site investigation indicates dry conditions, the risk of some waterlogging in the future should be assumed

Water table classification
Assessment of water table should be classified into three categories:

- High – where the water table or perched water table is assessed to be permanently above the underside of the base slab
- Low – where the water table is assessed to be permanently below the underside of the base slab
- Variable – where the water table fluctuates

Inspection of existing structures
The code states the need to inspect existing structures carefully before any risk assessment is completed and the waterproofing system is specified or installed. Typical issues: a change in ground water moisture content; the remains of former buildings or structures; changes in soil strata affecting foundation movement.

Characteristics of soils which affect basement construction

Material	Major divisions	Sub-groups	Drainage characteristics	Shrinkage or swelling properties
Coarse soils and other materials	Boulder and cobbles	Boulder gravels	Good	Almost none
	Other materials	Hard: hard broken rock, hardcore, etc.	Excellent	Almost none
		Soft: chalk, soft rocks, rubble	Fair to practically impervious	Almost none to slight
	Gravels and gravelly soils	Well-graded gravel and gravel–sand mixture, little or no fines	Excellent	Almost none
		Well-graded gravel–sand mixture with excellent clay binder	Practically impervious	Very slight
		Uniform gravel with little or no fines	Excellent	Almost none
		Poorly graded gravel and gravel–sand mixture, little or no fines	Excellent	Almost none
		Gravel with fines, silty gravel, clayey gravel, poorly graded gravel–sand–clay mixtures	Fair to practically impervious	Almost none to slight
	Sands and sandy soils	Well-graded sands and gravelly sands, little or no fines	Excellent	Almost none
		Well-graded sand with excellent clay binder	Practically impervious	Very slight
		Uniform sands with little or no fines	Excellent	Almost none
Fine soils	Soils having low compressibility	Silts (inorganic) and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Fair to poor	Slight to medium
		Clayey silts (inorganic)	Practically impervious	Medium
		Organic silts of low plasticity	Poor	Medium to high
		Heavily over-consolidated clays independent of plasticity	Practically impervious	Medium to high
	Soils having medium compressibility	Silt and sandy clays (inorganic) of medium plasticity	Fair to poor	Medium to high
		Clays (inorganic) of medium plasticity	Fair to practically impervious	High
		Organic clays of medium plasticity	Fair to practically impervious	High
		Intermediate over-consolidated clays independent of plasticity	Practically impervious	Medium to high
	Soils having high compressibility	Micaceous or diatomaceous fine sandy and silty soils, elastic silts	Poor	High
		Normally consolidated clays (inorganic) of high plasticity, fat clays	Practically impervious	High
		Normally consolidated organic clays of high plasticity	Practically impervious	High
		Normally consolidated and lightly over-consolidated clays independent of plasticity	Practically impervious	High
		Peat and other highly organic swamp soils	Fair to poor	Very high

4. Water-Resisting Design

Groundwater Design

Waterproofing measures should be designed on the basis of water to the full height of the retained ground at some time during the structure's life where:

a) No detailed geological or hydrogeological assessment has been undertaken;
b) The results of the soil investigations are inconclusive with respect to groundwater;
c) The ground drainage characteristics are unreliable;
d) The drainage measures (internal or external) are unreliable or un-maintainable and infiltration cannot be controlled.

Consideration from the following sources of water ingress protection should be considered:

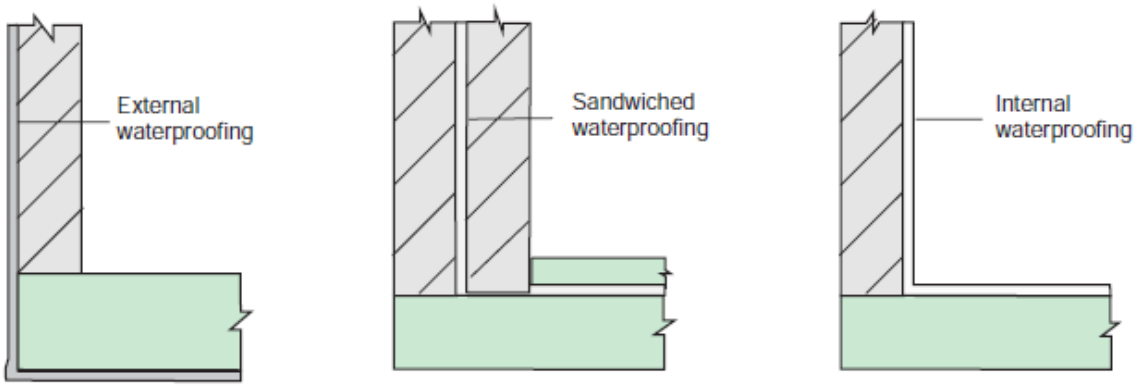
- Inflow of surface water: ranging from rain percolation to inundation of water from a burst water mains
- The water pressure acting on the external retaining wall system
- The water pressure below the base slab

Types of Waterproofing Protection

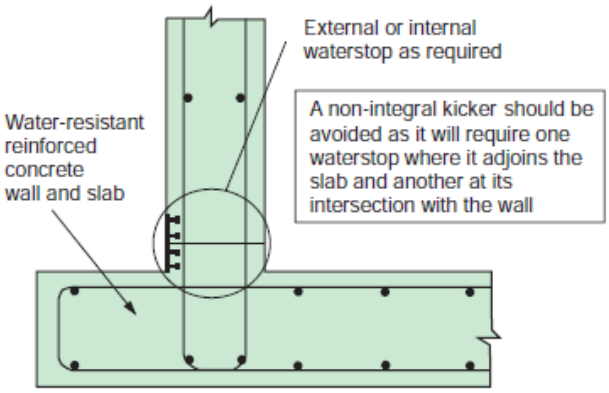
BS 8102 describes three types of waterproofing protection:

Type A – Barrier Protection: where the structure has limited integral protection against water penetration and therefore relies permanently on a waterproofing membrane to keep water out.

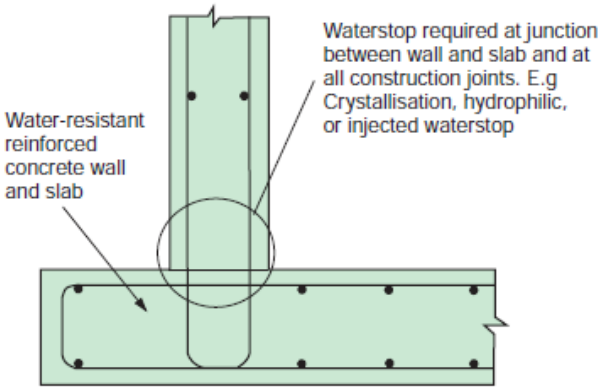
Note: Walls shown as masonry but may also be concrete



Type B – Structurally integral Protection: where the structure itself is constructed as an integral water-resistant shell.

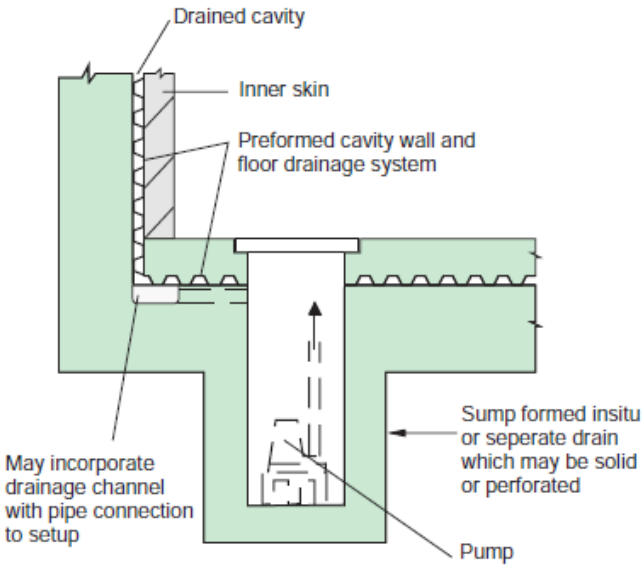


Slab with integral kicker

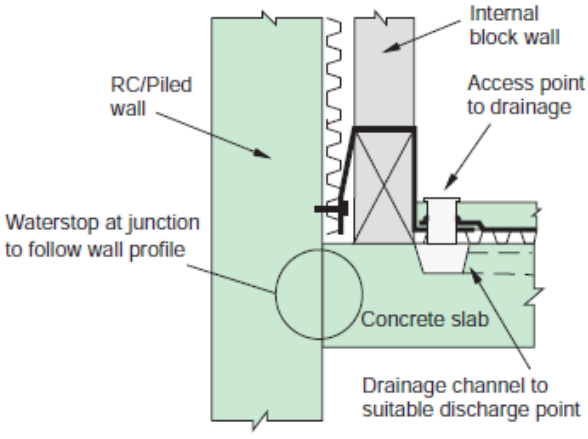


Slab with kickerless construction

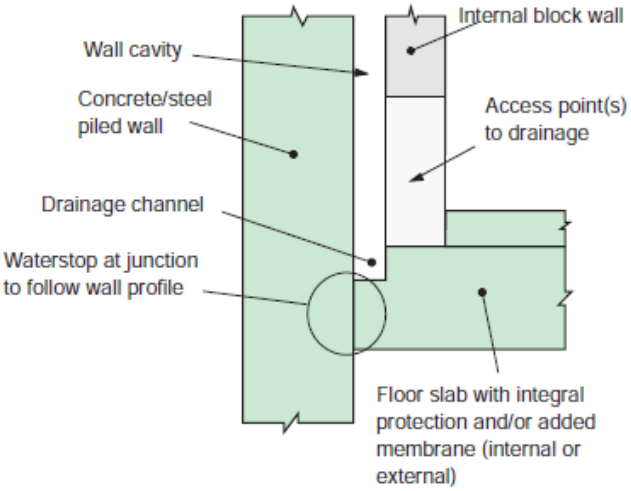
Type C – Drained Protection: where the structure provides primary resistance against penetration and incorporates a drained cavity within the basement structure. There is a permanent reliance on this cavity to collect groundwater seepage through the structure and direct it to drains or a sump for removal by drainage or pumping.



1) Cavity drain membrane on raft construction



2) Cavity drainage on piled wall construction witha cavity drain membrane



3) Cavity drainage on piled wall construction without a cavity drain membrane

Combined/Combination Systems

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

Water table classification and grades of waterproofing protection

When selecting a type of waterproofing protection the following charts outline options, in conjunction with these points.

a) During the life of the structure, some degree of groundwater pressure is likely to build up against the chosen waterproofing system
b) Cracking or defective construction joints can provide path for water ingress
c) Water ingress can occur where there is groundwater pressure
d) There are a number of risks associated with not carrying out planned maintenance for structures with Type C protection. .e.g. pump failure

Risk associated with water table	Water table classification (see Notes)	Types of water-resisting construction			
		Type A	Type B		Type C
			Piled wall	RC wall to BS EN 1992[20]	
Low	Low	Acceptable	Acceptable	Acceptable	Acceptable
	Variable	Acceptable if 'variable' classification is due to surface water: seek manufacturer's advice.	Acceptable where: a) the piled wall is directly accessible for repair and maintenance from inside the structure or b) the piled wall is combined with a fully bonded waterproofing membrane or c) the piled wall is faced internally with a concrete wall to BS EN 1992[20].	Acceptable	Acceptable
High	High	Acceptable where: a) an appropriate cementitious multi-coat render or cementitious coating is used or b) the wall is of concrete to BS EN 1992[20].		Acceptable	Acceptable
Measures to reduce risk		• Appropriately designed and maintained subsoil drainage (see BS 8102:2009 clause 6.1) • A fully bonded waterproofing membrane (see Figure 6). • Lower permeability of the main structural wall. • Waterproofing admixture (to BS EN 934(21)) with appropriate supervision (see BS 8102:2009 clause 10.2.1.5). • Discharge systems (e.g. pumps) must be maintained for the system to remain effective (see BS 8102:2009 clause 11.4.1). • Combined systems (see BS 8102 clause 12).			
Notes: Low : where the water table is assessed to be permanently *below* the underside of the base slab. High : where the water table is assessed to be permanently *above* the underside of the base slab. Variable : where the water table fluctuates. Soil permeability may affect risk under a low and variable water table (see *Assessing risk*).					

Watertightness – Grade 1 , 2 & 3

Grade 1
Car Parking
Plant Rooms/ workshops
(Excluding electrical equipment)

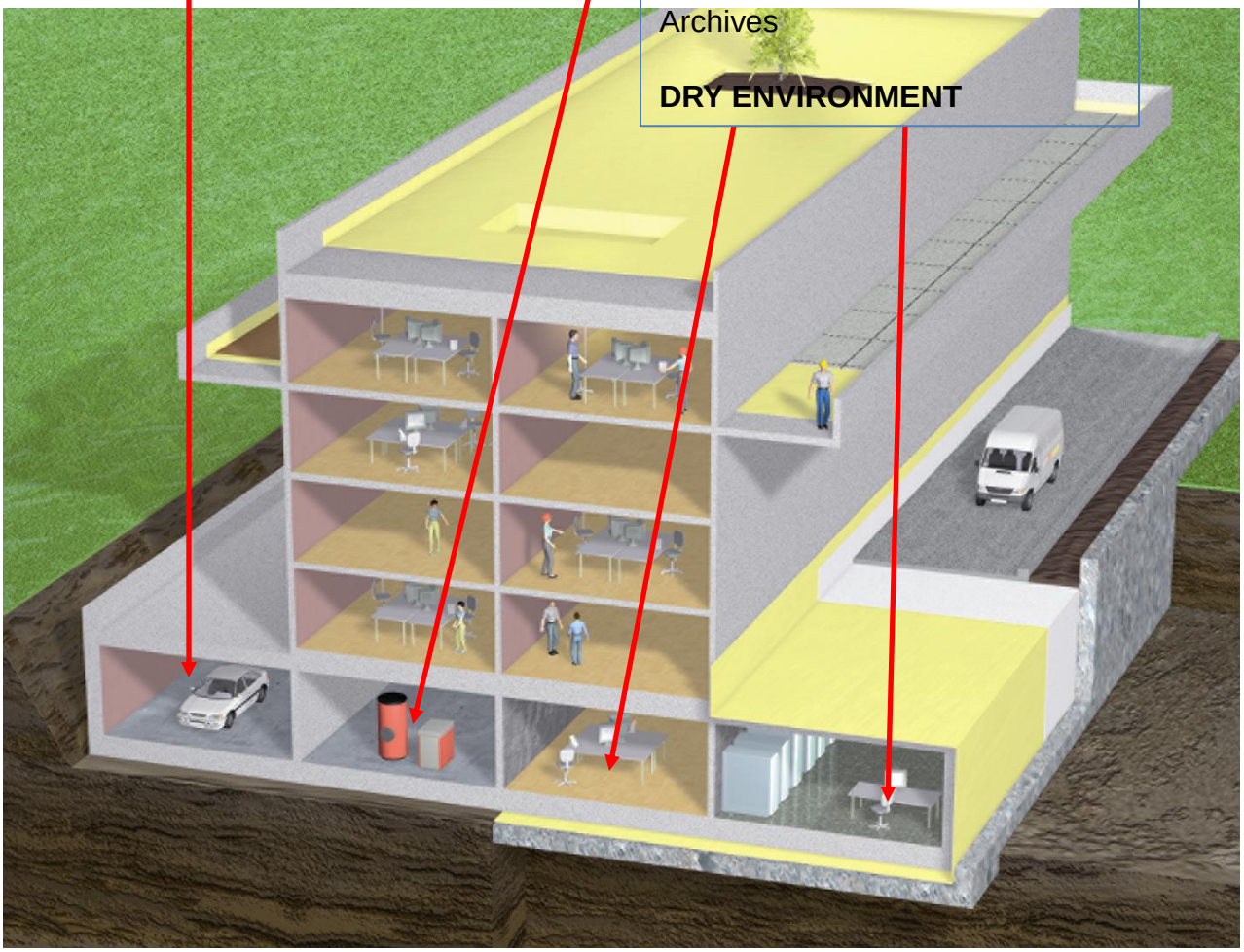
SOME SEEPAGE AND DAMP PATCHES ARE TOLERABLE

Grade 2
retail storage areas
Plant Rooms/ workshops
(with electrical equipment)

NO WATER PENETRATION BUT SOME MOISTURE VAPOUR TOLERABLE

Grade 3
Residential
Offices
Leisure Centres etc
Archives

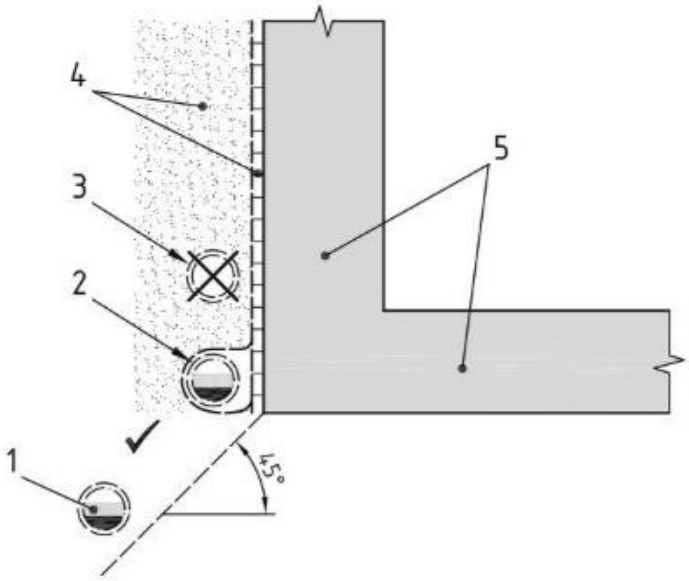
DRY ENVIRONMENT



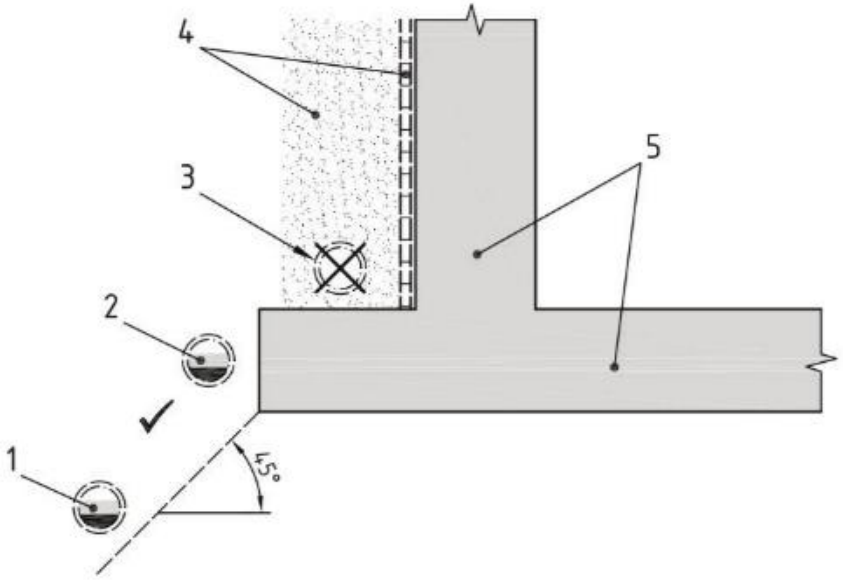
Sub-surface drainage

Where sub- surface drainage is deemed necessary to lower the potential for hydrostatic pressure on the waterproofing system and lesson the risk of water ingress through defects, it should be provided by one of the following methods:

a) Permeable granular fill;
b) No-fines or hollow blockwork;
c) Geosynthetic drainage composite;
d) Under slab drainage



a) Construction without a toe



b) Construction with a toe

Key

1 Maintainable land drain (see **6.4**) not to be positioned closer than a line of 45° from the underside of the slab/blinding or with an invert above the upper surface of the floor slab

2 Measures to control water vapour might be necessary where the invert of the land drain is above the underside of the floor slab

3 Incorrect position of land drain, which can cause hydrostatic pressure on barrier leading to water ingress if defects are present

4 Subsoil drainage layer, where appropriate (see **6.4**)

5 Structural wall and foundation slab

Ground Gases
The insertion of a ground barrier for the prevention or radon, methane and other ground gases and contaminants from entering a structure should be considered in the design, choice of materials and installation of any waterproofing system.

5. General Construction Issues

Site de-watering
Where appropriate, the site should be de-watered at least until such time as the below ground structure and waterproofing is completed.
On open sites, where any adjacent structures are sufficiently remote to be unaffected by groundwater lowering, de-watering or pumping from carefully arranged sumps with appropriate drainage channels should be continuous while the laying of any waterproofing barrier material is in progress and until all loading coats have fully cured. Also ensuring the structure itself has developed sufficient strength to resist the full water pressure.

Structural Elements
Forms of construction to receive below ground waterproofing protection may include the following.

a) Walls – constructed from:
   i. Masonry (plain or reinforced brick or block)
   ii. Precast concrete
   iii. In-situ concrete, either cast in form or embedded walls
   iv. Steel or concrete piles in embedded walls

b) Base slab – constructed from concrete cast in situ, plain or reinforced, raft or other form

c) Roof, where applicable – constructed from reinforced in-situ concrete, precast concrete with an in-situ topping, or a steel composite slab, raft or other form.

NB: refer to National Construction Code (NCC / ABC) ; AS3600 Concrete Structures and AS3700 Masonry Structures

6. Waterproofing Type A – Barrier Protection

General

Structures using Type A – Barrier Protection are normally constructed of concrete or masonry. Deeper structures are of concrete construction. Steel can also form part of the construction as temporary sheet piling.

Barrier protection design should be based on an evaluation of:

a) The nature of the substrate
b) The likely overall and local movements that might cause distress in the waterproofing barrier
c) The ability of the barrier system to accommodate these movements
d) The essential characteristics of the waterproofing system
e) The need for external or internal application
f) The effects of environmental contaminants

Materials for Barrier Waterproofing

The waterproofing barrier for Type A protection should be installed in one of the following locations;

i. On the exterior face of walls or slabs (external waterproofing)
ii. On some external source of support (reverse waterproofing)
iii. Within the structure (sandwich waterproofing)
iv. On the interior face of perimeter walls (internal waterproofing)

All barriers should be installed strictly in accordance with the manufacturer's instructions.

Type of Barrier	Description	Application
Bonded sheet membranes	Bitumen based sheet membranes applied hot or cold Composite sheet membranes	Can be applied externally or sandwiched
Liquid Applied membranes	Many types of membranes Covered by AS4858	Can be applied externally or sandwiched
Geosynthetic clay liners (Bentonite)	Comprising of bentonite with single or dual carrier material	Can be applied externally or sandwiched
Mastic asphalt membranes	These are applied in three coats as a hot liquid	Can be applied externally or sandwiched
Cementitious crystallization	Used as a additive or applied as a coating to surfaces	Can be applied internally or externally
Cementitious multi-coat renders	Multi-coats are resistant to liquid water but allow water vapour penetration	Can be applied internally or externally

7. Waterproofing Type B - Structural Integral Protection

General
For water and water vapour resistance, Type B protection relies upon the design and the materials incorporated into the external shell of the structure itself.

Materials for structurally integral protection
The main considerations relate to concrete and steel design.

Reinforced concrete structures may be designed and detailed specifically to minimize water ingress with no additional protective measures.

The following factors are considered as being of particular importance in achieving a water-resistance concrete structure:

a) The design of the structure and materials specification
b) The quality of workmanship in preparing and placing concrete
c) Curing
d) Site organisation
e) The condition of the formation
f) Material storage
g) The close – fitting of formwork, the fixing of reinforcements and preparation of joints

Materials supporting concrete structures protection include;
i. Reinforced and prestressed concrete (in-situ or precast)
ii. Concrete containing waterproofing admixures
iii. Waterstops –typically passive sections embedded; hydrophilic strips or crystalline growth compounds or post-injected systems
iv. Steel piles in either sheet or tubular form may be used as the permanent structural wall in cases where the pile clutch interlock system between individual sections can be adequately sealed.

Embedded Retaining Walls
Construction for deep structures may be either top down or bottom up, or a combination thereof. The construction method should determine the use and type of embedded piled walls.
For all embedded retaining walls, whether concrete or steel, the joint between the base slab and the wall should be precisely detailed to achieve structural continuity consistent with the design.

8. Waterproofing Type C – Drained Protection

Type C waterproofing protection manages water that penetrates the external shell of a structure, by collecting it in a cavity formed between the external wall and an internal lining/wall. There is a permanent reliance on this cavity to collect groundwater seepage and direct it to a suitable discharge point, e.g. drains or a sump for removal by gravity drainage or mechanical pumping.

Structural aspects
The outer leaf of the exterior wall is to be capable of controlling the water quantity that can pass through the structure, in order not to exceed the drainage capacity of the system.

Maintenance and Commissioning
To maximise the long term integrity and effectiveness of a waterproofing system incorporating Type C protection, the waterproofing system should be designed for ongoing maintenance.
Access points that allow routine maintenance to be incorporated in the design.

Immediately after the installation of a cavity drain system, drainage channels and sumps should be cleared out and tested. Pumping devises should be checked, tested and fully commissioned in accordance with the manufacturer's instructions.

9. Remedial Measures

There can be many causes of seepage in new and existing structures, principally caused by ; poor design and/or specification; defective materials; defective workmanship; deterioration of the structure; or change in the external environment.

Before any remedial action is taken, defects should be diagnosed to identify the cause and extent of the failure. The correct diagnosis of the fault is of vital importance in establishing if the fault exist within the system as a whole, or whether faults are localised.

Where remedial works are required, the following measures should be considered:

a) The installation of a tanking system or a drained cavity

b) The installation of external drainage

c) Localised works to the fabric of the structure (such as)

i. Pressure or vacuum grouting
Grouting to cut off seepage might repair isolated defects. However, where a large number of defects occur, it is more effective to prevent water ingress by other means. Many grouting materials are available inclusive of: cement, bentonite, chemicals, resins, expansive polyurethane, modified rubber latex

ii Crack sealing with resin or cementitious mortar
Where structural continuity is not required, with no hydrostatic pressure against adhesion the following can seal against water ingress: cement grout; crystallisation systems or low viscosity latex emulsions

iii Crack filling by pressure or vacuum injection
Pressure or vacuum injection can be used to fill and seal cracks and joints. Materials include multiple types of resins, SBR and cementitious grouts

iv The replacement of locally defective material
Where a relatively small number of well-separated defects in walls or floors results in seepage, adequate repairs can be achieved by cutting out and replacing the defective areas.

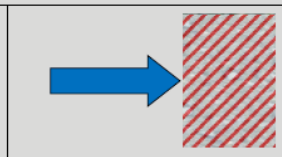
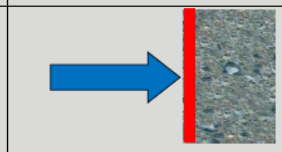
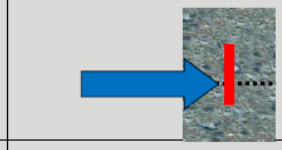
PRACTICAL CONSIDERATION NOTES

When considering waterproofing of basements, the principle of 'what can go wrong – will go wrong' applies. Thus a multi-strategy defence is important. The approach BS8102 takes by placing a vital emphasis on the 'design phase' to identify the project issues and utilize a combination of waterproofing protection (Types A, B, C) to satisfy the level of Watertightness required (Grade 1, 2, 3) is good practice.

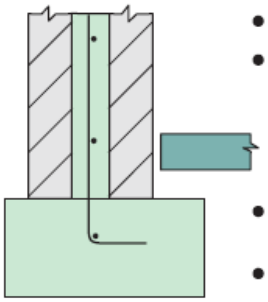
NB: in Australia many projects have adopted standard building practices without sufficient consideration for the final building use. Grade 2 & 3 watertightness have been attempted as post build modifications.

1. The 'Design Team' should include a Waterproofing expert.
Working with a waterproofing Consultant, Material Reseller or Manufacturer will be great advantage.

2. Main Waterproofing Systems.

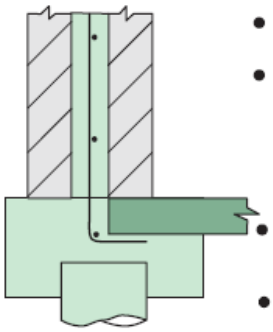
System		Effects
Waterproof concrete		Stops water at external surfaces, structure is dry, joint treatment needed
Waterproofing located outside the structure		Stops water at external surfaces, structure is dry
Waterproofing located in centre (joint waterproofing)		Stops water inside the structure at joint waterproofing
Waterproofing located inside the structure		Stops water at the internal surface, structure is wet / dry According to ground

3. Notes on Foundation Design
Structures should be designed to keep foundations as simple as possible. Expansion joints and complicated shapes are best avoided, since they are points of weakness and require a lot of attention to detail. When deciding on the form of construction and waterproofing, paramount consideration for 'buildability' and acceptable risk in relation to the cost of achieving desired performance. Common foundation designs are covered by the following diagram.



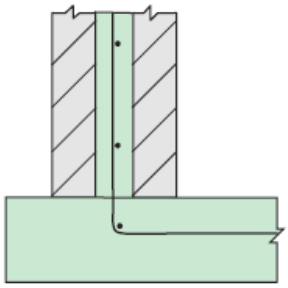
- Type A (barrier) protection
- External or internal waterproofing. But external waterproofing may be required to modify the exposure situation of a masonry retaining wall
- Retaining wall may also be of in-situ concrete
- High-risk design due to lack of continuity between wall and floor. Reinforcement may be required to control cracking

(a) Strip foundation



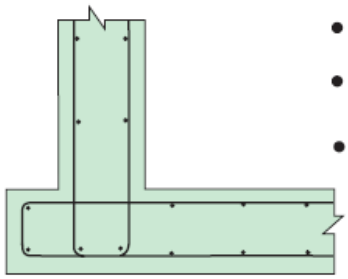
- Type A (barrier) protection
- External or internal waterproofing. But external waterproofing may be required to modify the exposure situation of the retaining wall
- Retaining wall may also be of in-situ concrete
- Care needed to achieve continuity of waterproofing membrane when applied externally

(b) Piled ring beam and reinforced masonry wall



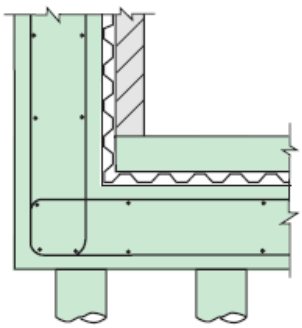
- Type A (barrier) protection
- Simple design
- Retaining wall may also be of in-situ concrete
- External waterproofing may be rquired to modify the exposure situation of the retaining wall

(c) Reinforced masonry wall with reinforced concrete raft



- Type B (structurally integral) protection
- Reinforced concrete design to BS EN 1992
- May be combined with external/internal waterproofing or drained cavity construction to enhance performance

(d) Reinforced water-resistant concrete box



- Type C (drained) protection
- Internal drained cavity construction
- Concrete design to BS EN 1992
- Without a drained cavity this could represent a Type B structure on a piled foundation

4. Watertight Concrete

There is often confusion between waterproof concrete and the relationship to indicate the water tightness of the concrete structure.
Waterproof concrete describes only the concrete mixture, which is impermeable to water and focused on the concrete quality, often modified using concrete admixtures such as superplasticizers, pore blockers and crack healers.

Defining ‘Watertightness of Concrete’ *,: “the water resistance of concrete is defined by the amount of water or moisture that emerges on the side opposite to the water contact”*

So What makes Watertight Concrete?

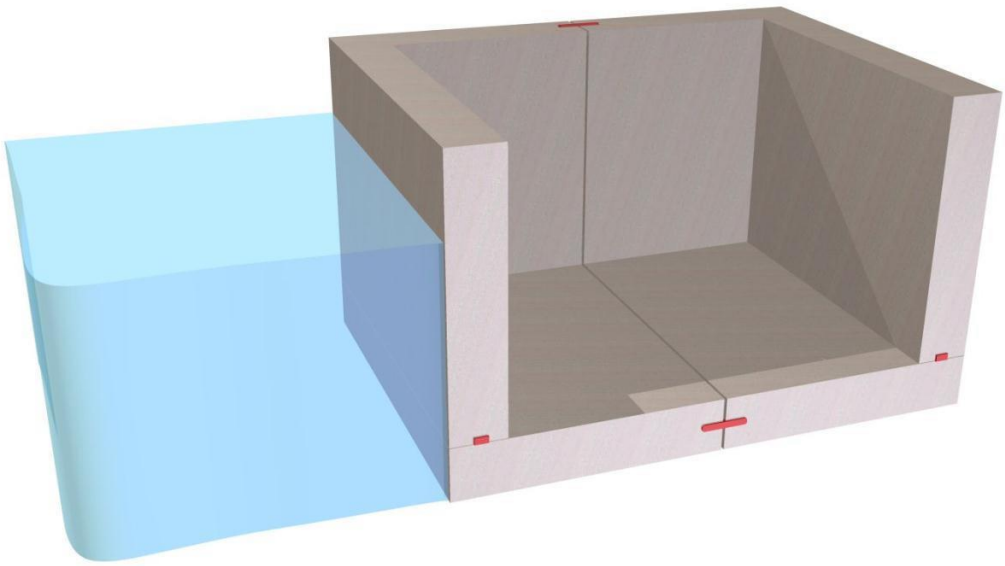
Nearly all significant properties of concrete will be influenced by the water content and/or water/cement ratio.

- The lower the water content; the higher the strength & consequential E-modulus
- The lower the water content; the less porosity in the matrix & as a consequence tighter the cement stone.
- The lower the water content; the less shrinkage and crack risk
- The lower the water content; the more critical the curing with consequential risk of surface defects
- The lower the water content; the more critical the placing of the mix, with a higher potential of compaction defects.

5. Joint Details

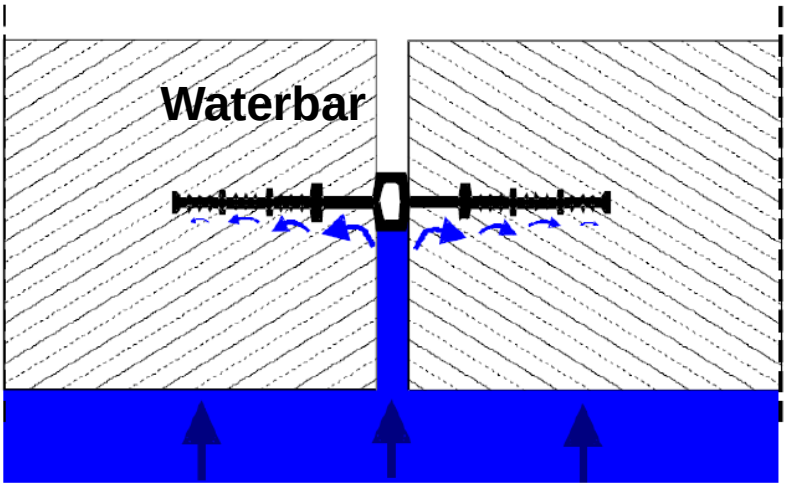
Often the major weakness in a structure relates to joint sealing solutions. The two major types are:

- Construction Joints (non movement)
- Movement Joints



Common solutions include:

- Waterbars – using the Labyrinth Principle to provide for an enlarged way for the water around the waterbar, reducing water flow until it stops
- Hydrophilic Gasket – installing a swellable product to seal the joint
- Injection Systems - often repair applications , with many different product performance characteristics
- Adhesive Sealing systems - a multitude of performance products

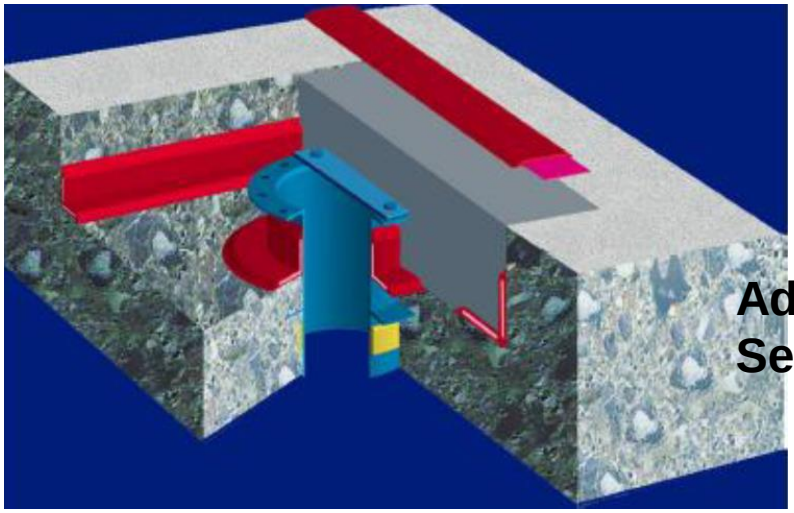


No joint – water ingress

Hydrophilic gasket in joint – water ingress reducing

Hydrophilic Gasket

Expands after contact with water and seals the joint



Adhesive Sealing

6. Membrane Systems

Most membrane systems relate to Type A – Barrier Protection. The basic principle of stopping the water getting into the structure. The most common cause of failure of these systems relate to:

- Joins
- Application detailing
- Environmental suitability
- Relying on only one type of defence system.

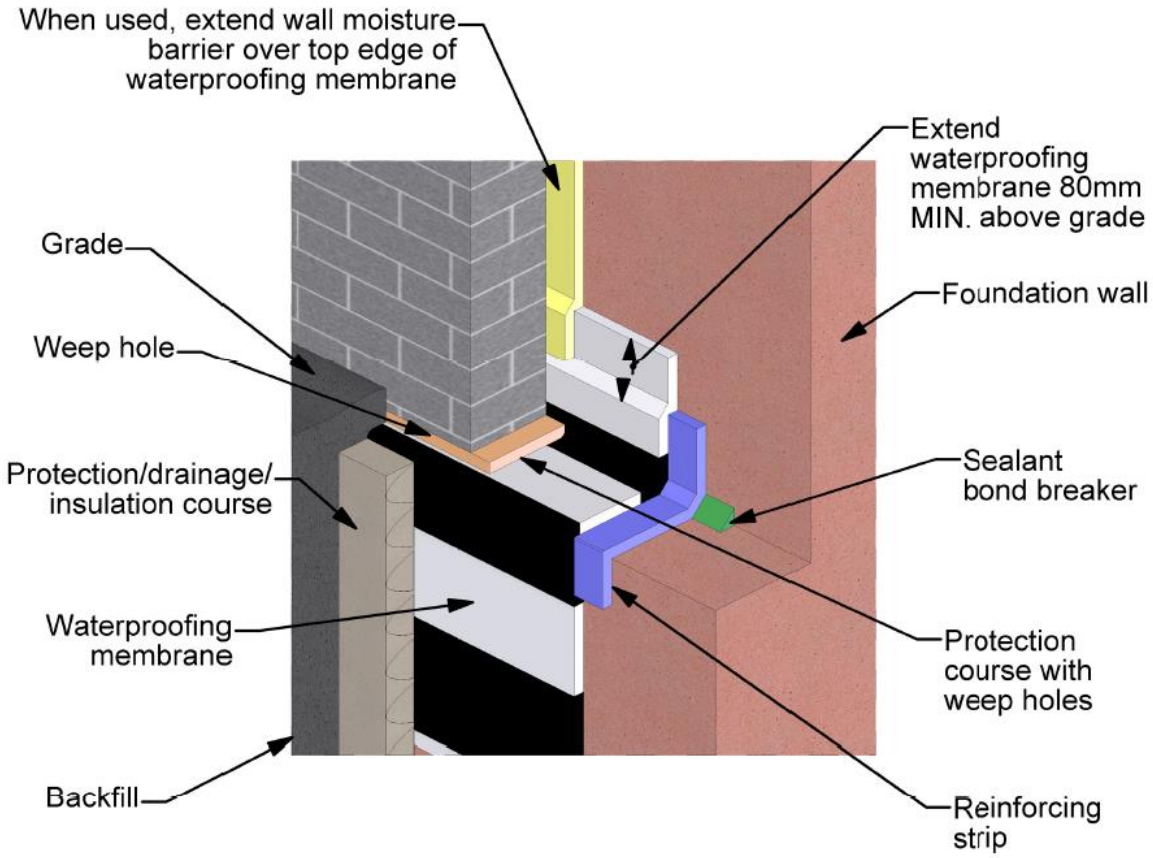
The basic types of membrane systems include:

- Lose laid membranes
- Bonded Membranes
- Liquid applied Membranes

7. Other checks

Your system need multiple defences inclusive of drainage and sometimes a negative tanking defence. It is very important to test your systems before providing a 'Deemed to satisfy' compliance statement. Also allow for on-going maintenance of your system.

The following are some useful technical drawings supplied by AIW.



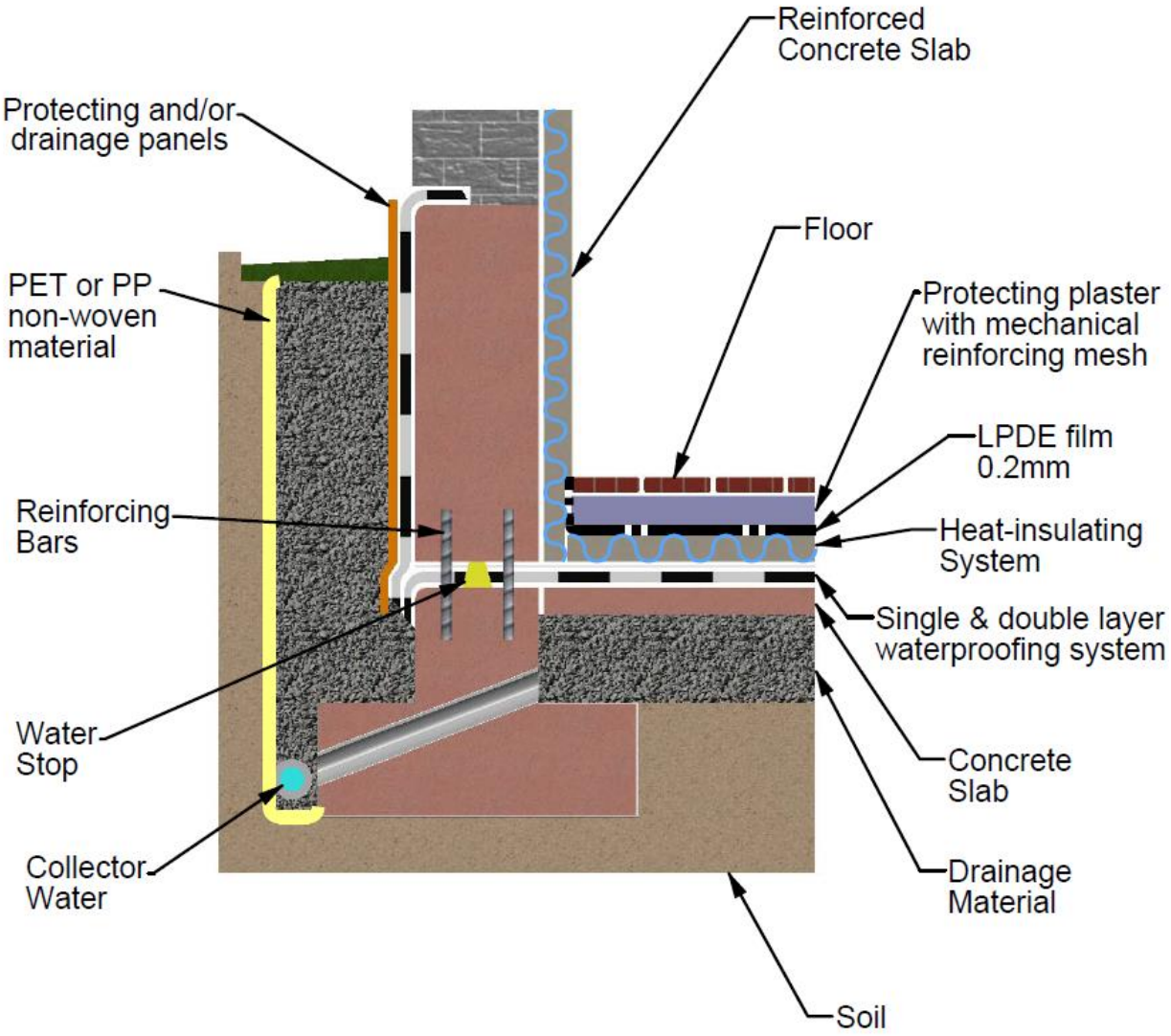
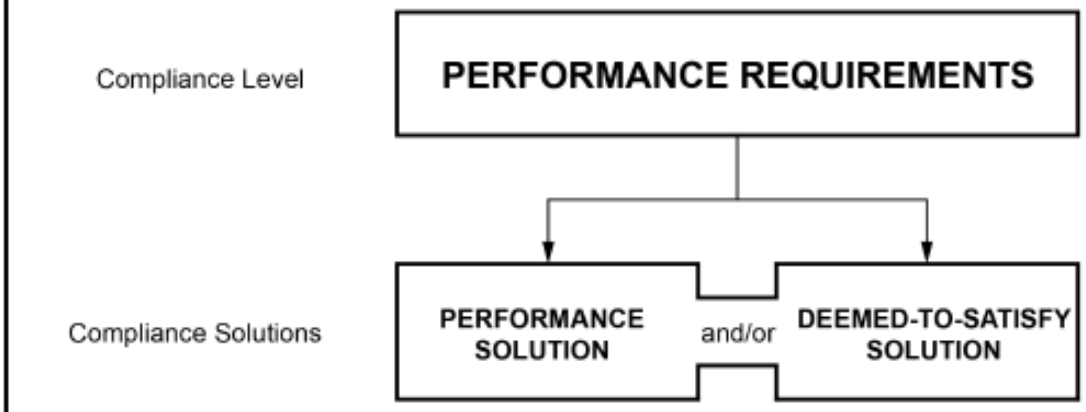


Figure 1.0.2
NCC COMPLIANCE STRUCTURE



Notes:

1. The term *Performance Solution* was formerly known as *Alternative Solution*.
2. The terms *Performance Solution* and *Deemed-to-Satisfy Solution* were formerly used under the term *Building Solution*.

8. Compliance Structure

Careful review of the compliance steps are required. However, in general, the NCC Vol 1 & 2 have no reference to “Below Ground Waterproofing”. As such, the NCC Compliance Structure will require a “Deemed-to-satisfy” solution.

Outline Steps Required:

a) Determine the “Performance Requirements”

The guidelines provided by BS 8102 help determine both the “Performance Requirements” and the “Performance Solution”, which is likely to have a “Deemed-to-satisfy” component.

Key elements include;

- Establishing the Design Team (inclusive of a professional engineer and waterproofing expert
- Rigorous testing and review of the waterproofing system solution in the design phase
    - Site Evaluations
    - Types of Waterproofing Protection
    - Level of Watertightness
    - Remedial applications

- Nomination of applicable NCC clauses and Australian Standards where “Performance Solutions” are identified
- Nomination of other International Standards which product criteria meet.
- Nomination of Application Methods which are considered as “Deemed-to-satisfy”

b) Certification with evidence of support from a “Professional Engineer”

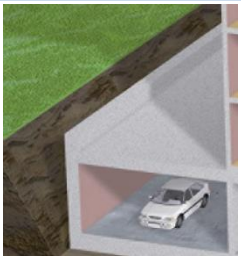
c) Detailed final design and specifications prepared for lodgement of a Building Permit.

Example Defence Strategy options for Watertightness

Grade 1

Car Parking
Plant Rooms/ workshops
(Excluding electrical equipment)

SOME SEEPAGE AND DAMP PATCHES ARE TOLERABLE

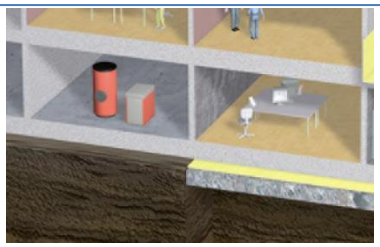


Typical Design Options
External drainage
Waterproof Membrane and dampcourse external structure
Internal Drainage, Sump pump

Grade 2

retail storage areas
Plant Rooms/ workshops
(with electrical equipment)

NO WATER PENETRATION BUT SOME MOISTURE VAPOUR TOLERABLE

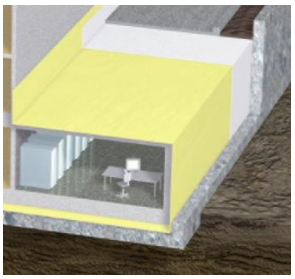


Typical Design Options
External Drainage
Waterproof Membrane and dampcourse external structure
Waterstop's and concrete additives. Joint seal detailing to concrete structure
Structural internal drainage
Internal negative tanking

Grade 3

Residential
Offices
Leisure Centres etc
Archives

DRY ENVIRONMENT



Typical Design Options
Elaborate water table drainage
Waterproof envelope case sub level structure
Waterstop's and concrete additives. Joint seal detailing to concrete structure
Structural internal drainage
Internal negative tanking and moisture barrier coatings