# FEW

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# BELOW GROUND TANKING

**Basement & Foundation Waterproofing Systems - What, Why & How**

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**Did you know that waterproofing represents 1.8% of a building's construction costs, but accounts for a whopping 83% of building defect complaints?**

**Below Ground Waterproofing – Overview**

I have compiled the following information based upon my personal experience as a Registered Building Practitioner specialising in waterproofing applications and with over 30 years in the construction industry.

My aim is to inform about the choices of below ground tanking methods, factors involved when selecting waterproofing materials and hopefully by knowing this information may also help to identify experienced and knowledgeable applicators.

I have witnessed some appalling mistakes in regard to waterproofing and in particular below ground systems.

As a builder I truly believe below ground waterproofing is as important as your foundations supporting the entire structure. Without the combination of sound footings and waterproof structures a building will deteriorate rapidly.

Unlike some other building components that might be designed to be replaced several times within the overall building service life, below grade systems need to be built to approximate overall service life.

Below grade systems are often inaccessible for repairs and extremely costly if modifications or rectifications are necessary at a future date.

# Below Ground Waterproofing – Design & Planning

**Durability of design and materials is mandatory with below grade waterproofing systems.**

**Below ground waterproofing is one of those areas usually unseen and I am not sure if it is this "out of sight, out of mind" mentality, however it is an area of construction often neglected**

This may go some way to explain some of the hasty decisions made in relation to below ground tanking.

Lack of planning has the potential to lead to some very expensive and time consuming future waterproofing rectification projects.

Without due diligence and correct time and attention given to the task of planning the below ground waterproof system, corners maybe cut at the time of construction due to the necessity of "on the fly" decisions.

It is critical to select the appropriate foundation waterproofing method as a case-by-case project and it is at the planning stage which is the appropriate time for these decisions.

Below ground waterproofing is not a generic "one size fits all" scenario and design should be as required by the respective project.

For below grade waterproofing design, the sole focus should not be on the initial cost of materials but rather consideration to the life cycle costs of various design options. This is especially important as costs to repair or replace systems that are buried can be exorbitant.

The following section provides specific description of waterproofing materials and systems common in foundation walls and below grade building enclosure systems.

**Descriptions and guidelines are provided on the following topics:**

- Drainage Materials
- Filter Fabrics
- Damp Proofing
- Waterproofing Membranes
- Protection Board
- Insulation Materials
- Waterstops
- Drainage- AG Systems

## Drainage Materials

Drainage Materials for below grade enclosures include:

- Aggregate Drainage Layers
- Prefabricated Synthetic Drainage Layers

**Aggregate Drainage Layers** — Aggregate drainage layers include graded gravel aggregate or coarse sands. Graded gravel refers to naturally rounded stone between 6 to10 mm in diameter. Coarse sands varying from No. 30 to No. 8 sieve are suitable.

**Prefabricated Synthetic Drainage Layers** —these products consist of a combination of plastic composite drainage cores with adhered geotextile fabrics.

The plastic composite "dimpled" drainage cores are available in various configurations and are typically constructed using polypropylene, polystyrene and polyethylene.

The geotextile fabrics retain sand, soil, concrete, or grout allowing water to migrate into the free draining core. The fabrics are available in various forms including non-woven for clay type soils and woven or small opening geotextiles for sandy or high-silt type soils.

Many drainage mats also include a polyethylene sheet backer to uniformly disperse the loads imposed on the membrane and reduce the potential for damage caused by non-uniform profiles (dimples) in the composite core.

Design considerations include selecting an appropriate design to achieve the required flow rate. In general, drainage core widths of 6 mm to 12mm provide drainage flow rates 3 to 5 times the rate of commonly used natural backfill materials. These systems are advantageous in their lightweight design and cost effectiveness.

Although marketed to be used with excavated soils during backfill in lieu of a granular drainage layer, it is recommended that a full system approach be used in applications where water leakage is not tolerable; a full system approach should include both a synthetic drainage layer and granular drainage layer.

## Filter Fabrics

Geotextile filter fabrics are also used for separating differing soil types in below grade enclosure applications.

This separation of differing soil types maintains flow rates of soils used as drainage layers and minimizes settlement from finer materials filling in more coarse materials. Geotextile fabrics are typically constructed using polypropylene, polyester, or nylon and are available in either woven or non-woven designs.

Woven products are constructed using individual threads or filaments and have good strength and stiffness; however, the material can be penetrated by angular aggregate reducing the ability to properly filter or separate fine elements.

Non-woven products are typically continuously extruded and spun and then needle-punched to create uniform openings that can be selected depending on the design.

In general, when properly designed, non-woven products have good filtration and separation properties.

## Damp Proofing

Damp proofing materials are generally applied by sprayer, roller, brush,

Damp proofing is intended to control vapour diffusion through the foundation, which can contribute to damp conditions on the interior.

Damp proofing is not intended to control liquid water leakage through the foundation wall; waterproofing is required to control water leakage.

Since damp proofing cannot withstand hydrostatic pressures, it should not be used on structural elements below the water table where the intent is to prevent interior water leakage.

Waterproofing is more effective in eliminating the risk of leakage and may be no more expensive than damp proofing, depending on the material used. Most waterproofing materials also control vapour diffusion.

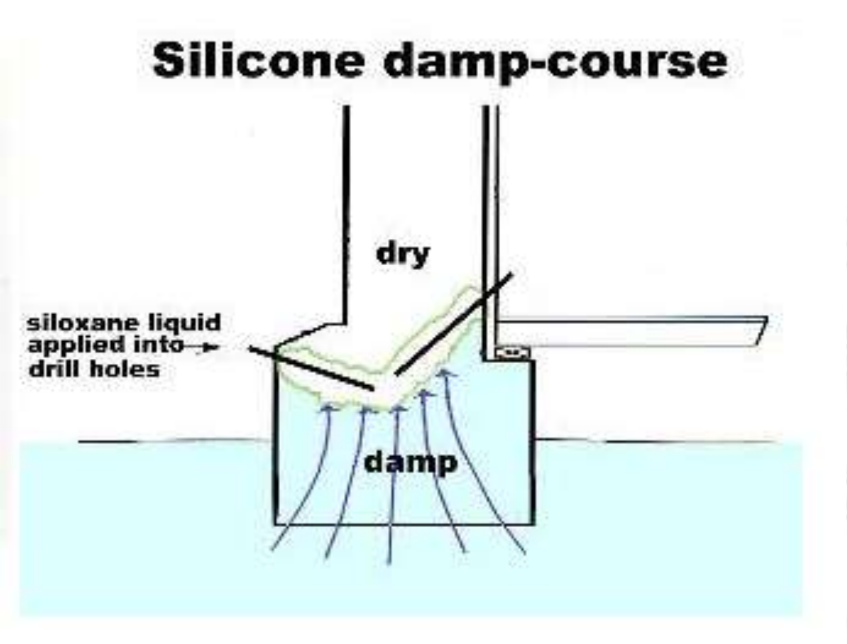
Other available damp proofing technologies include both cementitious and reactive products.

Cementitious products are generally Portland cement based and typically trowel-applied or brush-applied.

Reactive/crystalline products are typically proprietary blends made from cement, silicates, metal oxides, and chemicals introduced through concrete admixtures or surface-applied applications. These materials require the presence of moisture to set off a reaction with the concrete. Understanding the specific chemical admixture is important in determining its potential performance in below-grade damp proofing or waterproofing applications.

Reactive/crystalline applications tend to be long term (not immediate) defence systems and generally do not work very well if cracking occurs.

Wall & floor damage due to water at foundation




*Courtesy Wacker-Chemie GmbH*

## Waterproofing Membranes

Waterproofing membrane systems are available as either post-applied or pre-applied products for use in either positive-side, negative-side, or blind-side applications.

Positive-side waterproofing systems are post-applied to the surface of the element that is directly exposed to moisture, typically the exterior side of the foundation wall.

Negative-side waterproofing systems are post-applied to the surface of the element opposite the surface exposed to moisture, typically the interior of the foundation wall.

Blind-side waterproofing systems are pre-applied to the area where the concrete element will be placed that is directly exposed to moisture.

Positive-side systems are available in numerous materials and forms. Negative systems are generally limited to cementitious systems.

A blind-side system designed by F.E.W Waterproofing is called F.E.W CLOAKING SYSTEM which is a polyethylene pin punched fabric draped  and bonded at the base of footing or top edge of slab to beyond the height of site cut.

This "cloak of fabric" is then sprayed with LIQUID RUBBER to completely saturate the fabric forming one continuous seamless barrier or a flexible waterproof screen which is then encouraged into place once the wall has been placed. Design is specific to each project.

### Waterproofing membranes can be categorized into four (4) types:

### Extract from Institute of Building Sciences

1. **Fluid-Applied Systems** — these systems include urethanes, rubbers, plastics and modified asphalts. Fluid-applied membranes are applied in liquid form and cure to form one monolithic seamless membrane. For foundation wall applications, typical cold applied fluid applied systems are approximately 60 mils in thickness.
   Some systems include reinforcing mesh embedded into the liquid. Hot applied, rubberized asphalt systems can be 125 mils to 180 mils thick, plus embedded 60 mil neoprene sheets.

**Spray Applied Elastomeric Liquid Membrane**

2. **Sheet-Membrane Systems** —Sheet membranes used in foundation wall applications include thermoplastics, vulcanized rubbers, and rubberized asphalts. The thickness of these systems varies from 20 to 120 mils. If heat-welded seaming is employed and loose-hung membranes are tough and protected from damage by protection board, they may be effective waterproofing materials, but if a leak occurs, the leak will be difficult to locate and correct due to the loose application of the waterproofing layer in those cases.

   It is always better to have a continuously fully bonded and adhered waterproofing layer to reduce the potential for lateral moisture migration beneath the membrane.

**Heat Applied Sheet Membrane**

3. **Bentonite Clays** — these systems include composite sodium bentonite systems with HDPE liners and geotextile fabrics, which are more common and more effective than the traditional systems. Bentonite clays act as waterproofing by swelling when exposed to moisture thus becoming impervious to water. This swelling can be 10 to 15 percent of the thickness of the base material. Bentonite is, therefore, most effective when properly confined so the product can swell to fill voids and so that it cannot be washed away!

   Clay panels and geotextile sheets are popular for use in blind-side waterproofing applications such as on retaining earth systems and elevator and sump pits.

**If Bentonite clay is unconfined, it can shrink upon drying, creating gaps that undermine waterproofing characteristics.**

http://www.eurobent.com/en/offer/bentonite.html

4. **Cementitious Systems** — these systems contain Portland cement and sand combined with an active waterproofing agent. These systems include metallic (metal oxide), crystalline, chemical additive, and acrylic modified systems.

   The latter two should not be used as waterproofing except for the most non-critical conditions. The first two systems can be applied as negative-side or positive-side waterproofing.

   Even these systems should only be considered for use as a secondary (back-up) waterproofing to a positive-side waterproofing system, unless they are used with special details provided by a waterproofing expert which are beyond the scope of what are usually provided by system manufacturers.

## Below Ground Waterproofing installation - General Guidelines

Weather plays a large part in the success or otherwise with waterproofing installation. This needs to be appreciated and understood.

Inclement weather will adversely affect the below ground waterproofing system during installation. Generally wet seasons are very difficult to achieve successful waterproofing. Planning and timing the below ground waterproofing installation around climatic conditions can be problematic.

Waterproofing should be applied a minimum of 50 mm above the finished grade, and then applied to a point 300mm below the top surface of the interior slab ( base of footing) on a constant grade.

Typically, the waterproofing membrane is wrapped over a masonry brick shelf, or up behind the finish exterior materials at grade so that it may be terminated and shingle lapped by the weather barrier.

When the membrane is wrapped over masonry ledges, care must be taken to coordinate with masonry ties and thru-wall flashings.

Where grade slopes down along an exterior wall, the waterproofing membrane will step down incrementally so that it continues to protect the below grade, occupied space.

If the exterior wall materials will not protect the waterproofing at grade, base flashings should be used to protect the waterproofing from ultraviolet (UV) radiation exposure - IF THE MEMBRANE IS NOT UV STABLE.

These flashings are usually stainless steel to resist corrosion in contact with grade soils and moisture.

## Protecting the Waterproof Membrane from Damage - Protection Board

Protection Boards are used to protect waterproofing membranes from damage. Most damage comes from backfill materials containing sharps and or rubbish.

However unfortunately (and sadly) we often find damage has been caused by the contractors and sub-contract trades, such as electricians/plumbers/landscapers/data cable or TV cable installers etc, cutting holes in the finished membrane to pass a wire/pipe, etc through a wall.

Some trades don't even try to seal the penetration, others try and fail - very few get it right!

The message here is to plan ahead and ensure any penetration is done before or is above the membrane height.

The most commonly used protection board in Australia is a Polypropylene Copolymer extruded sheet commonly known as "Core Flute".

Other materials sometimes used as protection layers are extruded polystyrene rigid board insulation, cement sheet or prefabricated synthetic drainage layers.

F.E.W Waterproofing recommend, use and install and also supply an Australian made product called ARMA BLUE.

https://youtu.be/4eTzRypJ-HI

Arma-Blue is a roll of flexible 3mm thick poly-woven fabric bonded to a foam impact resisting core.

The back side is “sticky backed” or peel and stick adhesive which prevents stone, debris, grit, etc getting between the protection board and membrane and causing damage to the membrane, resulting in leaks.

In general, using prefabricated composite drainage board directly against certain waterproofing membranes as a protection layer is not recommended.

Although the composite board may have a polyethylene sheet on the membrane-side, this sheet is often cut, damaged, or missing. If installed, soil pressures can cause the "dimples" in the drainage core to displace or damage the waterproofing membrane. Additionally, the composite cores have sharp corners that can cut the waterproofing membrane during installation or backfill operations.

**Therefore, we always recommend a protection layer such as ARMA BLUE between the waterproofing membrane and the drainage layer.**

## Insulation Materials

Insulation materials used in below grade enclosure applications are primarily limited to rigid extruded polystyrene board due to the need for high compressive strength and moisture absorption resistance.

For optimum drainage and thermal performance, install a composite drainage board with integral filter fabric to the exterior of the insulation.

## Waterstops

Waterstops should be utilized at construction joints in below grade walls, footings, slabs, and other elements where a waterproof system is required.

Waterstop systems provide a secondary barrier to the passage of water across these construction joints.

Waterstops are manufactured products available in a wide range of configurations and sizes. Common materials include polyvinyl chloride (PVC), neoprene, expanding sodium bentonite and thermoplastic rubber.

Although not as common, pre-installed permeable grout injection waterstops may also be considered.

Typically constructed with flexible PVC, permeable grout injection tubes are installed in construction joints and are injected with grout only if leakage is observed.

In some cases, the tubes may also be re-injected if leakage persists. Injection ports/sites are typically accessed from the building interior.

Common areas of concern for waterstops are at corners and laps in the materials. These areas must be properly detailed and installed to be effective.

In general, the manufacturer's standard instructions should be followed.

If PVC is used, corners and laps should be heat welded and properly inspected.

## Drainage Pipe – Agricultural Systems (AG) or "Aggie Pipe"

Drainage pipes, typically 100mm or 150mm in diameter, used in below grade systems are primarily made of corrugated PVC or polyethylene. PVC and polyethylene pipes are available in smooth or corrugated configurations and are slotted on the bottom half of their cross-section to allow water infiltration. A good quality pipe is essential so it will not crush under the weight of backfill.

Based on extensive excavation and waterproofing experience, it has been found that corrugated PVC drain tile piping can collapse under the weight of backfill, and the preference is to use stiffer PVC pipe if possible.

All Agricultural piping should be laid at the lowest point where water will flow and then graded to a pit for discharge.

Backfill with an aggregate stone such as ¼ minus blue-metal, scoria, etc, which is laid onto a filter fabric covering the AG pipe. The fabric should be wrapped around and over the drain to try to prevent fine soils from filling the drain pipe.

Ensure a slope or "fall" to drainage system. AG systems should be designed to be installed with some slope to ensure that the water moves toward the silt pit for connection to the storm water system or collection tanks.

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