Date Issued	Sept 24
Replaces	

Helpful Information for You and Your Pool

Water beneath your concrete pool means….

Can be serious…

Fortunately, it's a very rare experience to witness with concrete pools but can be more prevalent with fibreglass.

UNDERSTANDING HYDROSTATIC PRESSURE

Hydrostatic pressure is an important topic for waterproofing professionals to understand. Hydrostatic pressure refers to the lateral pressure exerted by a fluid, and in the waterproofing world that typically means water, against a surface due to the weight and force of the fluid. Hydrostatic pressure increases with depth, so deeper water exerts higher hydrostatic pressure. Groundwater and rising floodwaters can create substantial hydrostatic pressures on foundations and below-grade walls and surfaces.

Cory Deyell, sales representative for DMX Membranes Limited, says hydrostatic pressure in soil refers to the pressure exerted by water within the soil pores due to the force of gravity. “It is a significant factor in geotechnical engineering and soil mechanics, as it affects the stability and behaviour of soil masses,” he says.

When water accumulates and cannot drain properly, hydrostatic pressure builds up and pushes against the waterproofing membrane or material. This can lead to leaks if the pressure exceeds the membrane strength. A good way to visualise the force that a foundation must be able to endure from hydrostatic pressure is to think about the inverse of a swimming pool — swimming pool walls must withstand the lateral hydrostatic pressure of the large volume of water in the pool. In a similar way, anything below ground must be able to withstand the pressure of the water from the outside.

Anything below ground, such as foundations, basements, parking garages, below-grade rooms, elevator pits, etc., are vulnerable to hydrostatic pressure and require waterproofing designed to withstand the pressure. Proper drainage, such as drainage boards and perforated pipe, helps relieve hydrostatic pressure by giving water a path to drain away from the structure.

“When soil contains water, the water molecules fill the spaces between soil particles, creating a network of interconnected pores,” Dyell says. “The weight of the water in the pores, combined with the force of gravity acting on it, results in hydrostatic pressure. This pressure increases with depth in the soil profile.”

Causes of Hydrostatic Pressure

The main causes of hydrostatic pressure stem from situations that allow water to accumulate and press laterally against the structure because it has no way to drain or disperse properly. This is typically caused by a high groundwater table. As the water table rises, the hydrostatic pressure from this groundwater increases.

“The water table represents the upper boundary of the saturated zone, where the soil is fully saturated with water,” explains Deyell. “Below the water table, the hydrostatic pressure increases linearly with depth.”

Heavy rainfall or flooding can also increase this tendency because prolonged rain can overwhelm drainage systems, leading to water accumulation and increased lateral pressure. When there is improper or poor drainage for whatever reason, pressure also increases. Often, this is from improperly graded soil and or clogged drains that don't allow water to move through and away.

The water doesn't always have to come from the environment. A leak from pipes, pools, or water features, leaks from indoor plumbing, outdoor irrigation, or other water sources in the building environment can be a source of excess water that causes hydrostatic pressure that must be managed.

Effects of Hydrostatic Pressure

"Hydrostatic pressure affects the stability of slopes, retaining walls, and foundations," says Deyell. "It can cause seepage and water flow through the soil, leading to erosion, piping, or even landslides. In geotechnical engineering, the estimation and analysis of hydrostatic pressure are crucial in designing structures to ensure their stability and prevent failures caused by excessive water pressure."

Hydrostatic pressure can have several effects on a concrete foundation, depending on the specific conditions and design of the foundation. It can crush objects, it can cause objects to float, or it can cause objects to sink. Dyell outlines some of the effects of hydrostatic pressure:

Upward Pressure

If the groundwater level rises above the bottom of the foundation, hydrostatic pressure can exert an upward force on the foundation. This upward pressure can cause the foundation to lift or heave, leading to cracks, uneven settlement, or even structural damage.

Buoyancy

In cases where the groundwater level is high and the soil beneath the foundation is less dense than water, the hydrostatic pressure can cause the foundation to float or become partially buoyant. This can result in the foundation being displaced or uplifted, leading to structural instability.

Soil Erosion

Hydrostatic pressure can induce water flow through the soil and create erosion. If water seeps through the foundation or accumulates around it, it can wash away the supporting soil or weaken the foundation's subsoil. This erosion can compromise the stability and integrity of the foundation.

Cracking and Leaking

Excessive hydrostatic pressure against the foundation walls or basement can lead to cracking or leakage issues. The pressure can push water through cracks or weak points in the concrete, causing water intrusion and potential water damage to the structure.

Differential Settlement

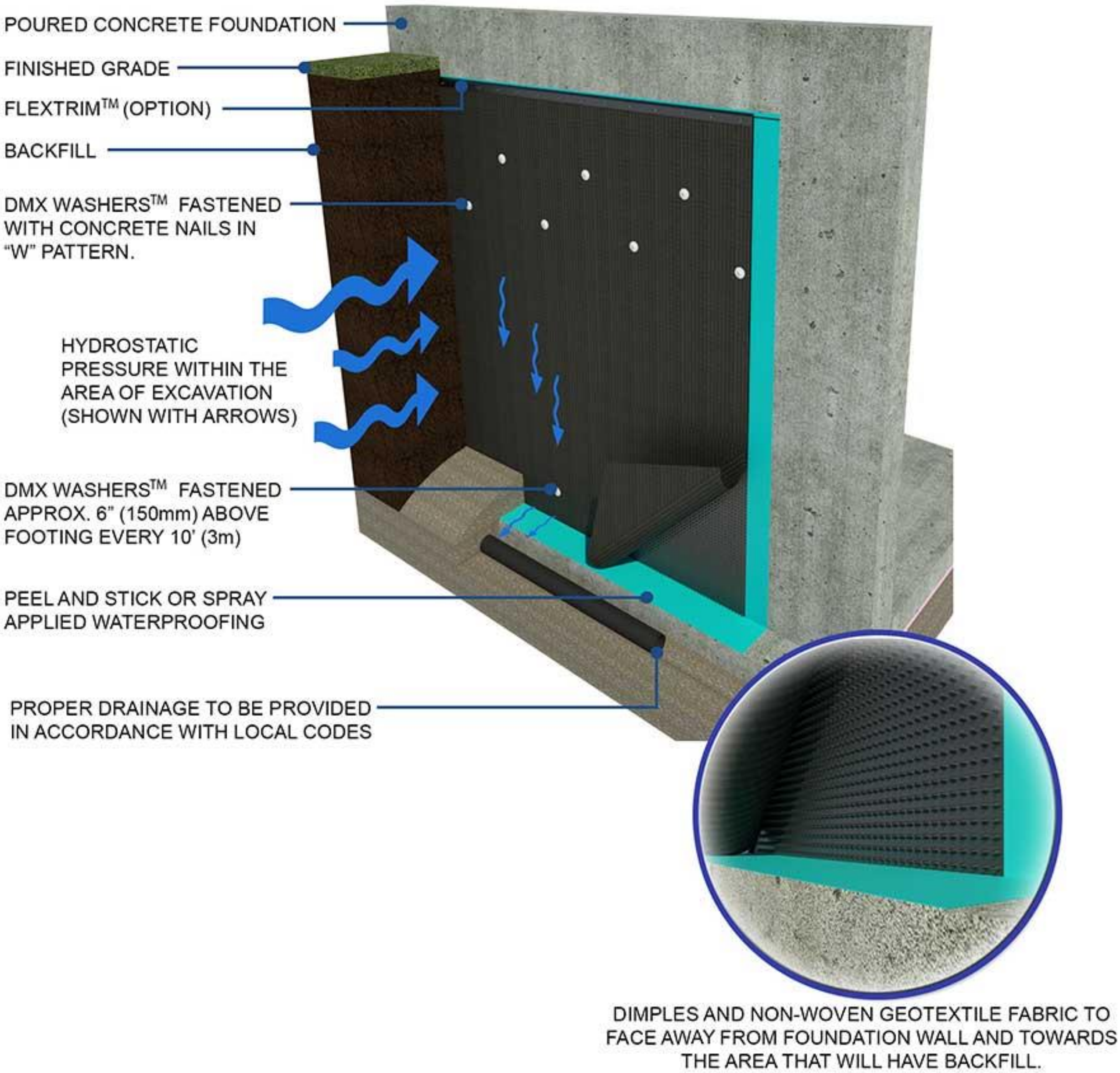
Hydrostatic pressure imbalances can cause differential settlement, where different parts of the foundation settle unevenly. This can lead to structural distortions, cracks, and other stability problems.

Magnitude of Hydrostatic Pressure

Hydrostatic pressure is an important factor that engineers consider when making design calculations and assessments, because it influences the stability of slopes and excavation walls. Additionally, properly accounting for hydrostatic pressures is crucial when designing drainage systems around structures and in civil engineering projects. Engineers use techniques like soil permeability testing and groundwater monitoring to evaluate hydrostatic pressures within the soil and groundwater profile at a site. These assessments of hydrostatic pressure help engineers understand the water pressures that will act on structures and inform appropriate designs to withstand or relieve these pressures.

"The magnitude of hydrostatic pressure depends on various factors, including the height of the water table or groundwater level, the specific weight of water, and the density and porosity of the soil," says Deyell.

Overall, analysing and accounting for hydrostatic pressures is key for engineers across many disciplines to create stable infrastructure, robust foundations and excavations, and effective drainage systems.



Mitigating the Effects

Matt Veazey, president of Rubber Polymer Corp., explains that water needs a way to move away from the building so the pressure doesn't build up. "Water is going to take the path of least resistance," Veazey says. "Let's say you have no functioning drain tile, with water against the wall. That's a mighty force that could crack that wall, seep into that wall, or if there is already a crack, it will find a way into your dwelling."

When it comes to mitigating the effects of hydrostatic pressure on concrete foundations, several measures can be taken. One of the most important is installing an effective drainage system, including high flow rate drainage boards like the ones that DMX manufactures, proper surface grading, gutters, downspouts, and a French drain or weeping tile system, to control the water flow around the foundation.

Deyell recommends using a purpose-built drainage board with sufficient compressive strength and flow rate. 100% virgin resin ensures product longevity and performance. “DMX Drain 5X is a great example of this for residential/light commercial foundations,” he says. Additionally, waterproofing the foundation walls and using appropriate sealants to prevent water infiltration is key.

“Drainage boards provide six main benefits that aid in reducing hydrostatic pressure,” says Deyell. “Those benefits are water diversion, vertical water movement, horizontal water movement, water collection and channelling drainage into the French drain or weeping tile system, and protection of waterproofing systems.”

Understanding Head Pressure

Veazey says that a functioning drain is key to any waterproofing system or warranty. “That alleviates that head pressure because the free-flowing water moving away from the structure doesn’t build up pressure.”

Water head pressure refers to the pressure exerted by a column of water due to the weight and force of gravity. It is directly related to the height of the water column. The taller the column of water, the greater the water head pressure at the bottom of the column. This is because there is more water weight pressing down from above. For example, a 10-foot-tall column of water would exert more pressure at the base than a 5-foot column.

This pressure is calculated by multiplying the height of the water column (in feet) by 0.433 to get the pressure in pounds per square inch (psi). So a water column 10 feet high produces a pressure of 4.33 psi at the base. While water proofers could perform these calculations, most of the time they wouldn’t need to as long as there is a functioning drain. They can also look at the specifications of the materials they are using. Veazey’s Rub-R-Wall all-polymer spray-on waterproofing coating holds back 138 feet of head pressure. “That’s more than enough for a typical situation,” says Veazey.

The Bottom Line

Hydrostatic pressure can be an issue from groundwater as well as from water leaking from plumbing, pools, outdoor irrigation, or other water sources in the building environment.

Drainage boards are a necessary product to deal with hydrostatic head pressure below grade. Properly managing lateral water force through design and drainage will ensure structures remain protected.

Thanks to: https://www.waterproofmag.com

Are Concrete pools Waterproof?

Most people probably think swimming pools are waterproof. You might be surprised to learn that most pools are *not* actually waterproof. Sure, vinyl liner and fiberglass pools are, or at least should be. But in-ground concrete pools are not. In this article, let's discuss the process of waterproofing for concrete pools, and if waterproofing is necessary for *your* pool.

Concrete is not waterproof

Concrete is naturally porous and *not* waterproof. It actually absorbs water quite well, making it an ideal surface for airport runways, sidewalks, and pool decks. But when water absorption is not desired, like the shell of an in-ground swimming pool, higher density shotcrete is needed. Additionally, waterproofing products can be applied to densify and seal the concrete from absorbing moisture.

While the *type* of concrete is similar for all pools, its density and method of application can make a difference in its waterproofness (...is that a real word?).

Most concrete pool shells are made of pneumatically applied shotcrete.

The minimum concrete density needed (in pounds-per-square-inch, or PSI), according to Genesis and Watershapes University, is 4000 PSI, and 5000+ PSI for saltwater pools. This is much denser than a sidewalk or driveway. If such density is achieved, there is less porosity and therefore the concrete is more watertight.

Concrete density matters

According to master pool builder and Watershapes University instructor Paolo Benedetti of Aquatic Technology, properly applied shotcrete should be dense enough to be watertight, even if not technically water*proof.* Most problems with concrete pool shells stem from weak shotcrete and bad application. We discuss these problems in-depth in another article.

If shotcrete is properly applied and has the right PSI (pounds-per-square-inch) density, according to Benedetti, additional waterproofing is unnecessary in the pool shell is in the ground.

Do concrete pools need to be waterproofed?

We spoke to many subject matter experts for this article, because Orenda is not in the concrete business. One such expert is Bill Drakeley of Watershapes University, who told us if shotcrete is properly applied and cured, usually *waterproofing is not necessary* for the shell in the ground. Too often, bad shotcrete application is the cause of water penetrating through the concrete shell. Bob Guarino of South Shore Gunite echoed this opinion. Bad shotcrete placement is a common problem, and a costly one to undo and redo.

Bill, Bob, and the other experts we asked noted some circumstances where waterproofing may make sense. One such circumstance is concrete out of the ground.

Raised concrete walls

The concrete above the ground is a different story from the in-ground pool shell. Think about raised spas, vanishing edge walls, and water features. These concrete walls are basically water retaining walls. Based on who we spoke with, **in our opinion, raised walls should always have a pool waterproofing layer applied to them before plaster or tile are installed.**

Raised spas and vanishing edge walls should be waterproofed on the inside *and* outside of the wall. This is to prevent moisture migration and efflorescence. We at Orenda get many calls about "scale", when in fact it's often efflorescence, caused by moisture penetrating through the concrete spa wall. Never underestimate hydraulic pressure.

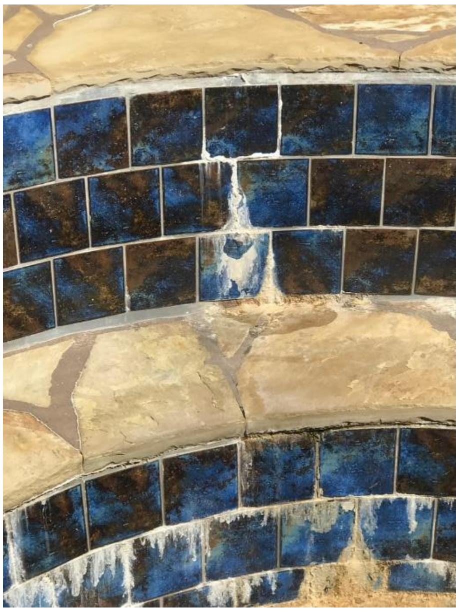


PHOTO: Failure to waterproof. Water pushes through concrete, creating efflorescence on the other side. In this case, a recessed firepit in the middle of the pool.

When concrete cracks on such raised walls, according to Vito, moisture will follow. "Concrete will eventually crack at a microscopic level, so adding a flexible membrane to seal it helps prevent moisture from pushing through the concrete."

*PHOTO: **Efflorescence** looks like carbonate scale because it is also calcium carbonate ($CaCO_3$). But it is from moisture pushing through the concrete wall of the raised spa, taking minerals with it to the outside.*

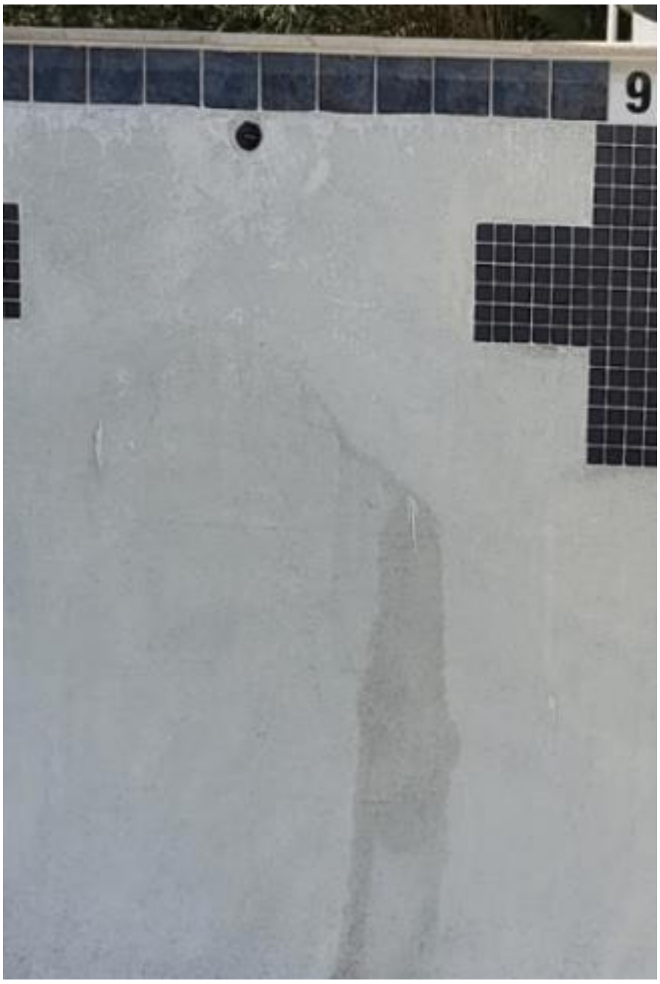
If the pool itself is raised above the ground, such as a steep hillside, go ahead and waterproof everything you can. This is essential for rooftop pools too. We have seen some absolutely amazing pools off the edge of hills, and they need to be thoroughly waterproofed, just like a raised spa.

High water table (groundwater)

If the concrete pool shell is dense enough, it should be watertight, as we mentioned earlier. But what about water pressure from *behind* the shell? This was the topic of a few previous articles we have on weepers and calcium nodules. When the water table is high enough, groundwater can have enough pressure to push into the pool. This is not as rare as you might think. We see these problems most often in coastal areas, but also in Florida, Louisiana, and Houston TX, to name a few regions.

A brief note on calcium nodules is in the footnotes below.[1] We have found a direct correlation between calcium nodules and a lack of waterproofing. If you have one or two nodules in your pool, the affected area is small, and perhaps isolated. But sometimes pools have hundreds or even thousands of calcium nodules. In our experience, most of these are caused by groundwater and a lack of waterproofing. So if you're in a coastal area or you know you have a high water table, **Orenda strongly recommends waterproofing your entire pool before plastering.**

PHOTO: Thousands of tiny calcium nodules plagued this otherwise beautiful pool in a coastal town. Groundwater caused these, and the pool builder has since waterproofed every pool they build. No calcium nodules since.



Weepers are a far more severe problem. Weepers are when water *leaks* into a pool through weaknesses in the concrete shell. This is usually from bad shotcrete installation, improper curing, and weak density. According to Bob Guarino of South Shore Gunite, weepers usually occur in the weakest parts of the concrete, which are often where the **rebound** is trowelled back into the walls or floor. Rebound is the excess shotcrete material that does not adhere when the shotcrete is initially sprayed in place. Such excess is waste and should be discarded. Putting rebound back into the walls creates void spaces that water can travel through, causing weepers.

Weepers are often accompanied by calcium nodules too because the flowing water takes minerals with it, and as it presses through the plaster, nodules can form. You may not notice a weeper at first when the pool is full (because who can see water trickling into water?), but when the pool is empty, they are readily visible.

How to waterproof a swimming pool

We interviewed concrete waterproofing expert Vito Mariano of Basecrete for this article. According to Vito, pool waterproofing is applied in stages, starting within 3 days of shooting the pool shell.

Colloidal silica

First, a **colloidal silica**[2] is sprayed onto the fresh concrete and absorbs into the concrete, increasing its density. There is a ton of information online about colloidal silica (or colloidal silicates), and we will not go into detail here on how they work. Just know they are a valuable first step in the concrete waterproofing process.

Waterproof membrane

After at least 15 days, a waterproof membrane can be manually rolled onto the concrete. This membrane is flexible and adheres to the concrete, helping it maintain moisture. We are only paraphrasing this process because we are not experts in this space. So you should consult the waterproofing product manufacturer for specific instructions.

What's important here is to follow the instructions in order and give the necessary time in between steps. Concrete curing takes time! Do not rush to apply the pool plaster if you have not given the concrete time to do its thing. Otherwise, it can crack and shrink behind the plaster, causing future problems.

Conclusion

Is concrete waterproof? No. Can it be water*tight*? Yes, if it is dense enough, applied correctly, and cured properly. If the pool is in the ground with a solid 4000+ PSI concrete shell, perhaps waterproofing is unnecessary–unless your area has high groundwater. Raised concrete should always be waterproofed if they hold water. Concrete is porous, no matter how dense it is, and water can eventually work its way into it. That is unless you have added pool waterproofing layers to it.

We do not have direct expertise with concrete shells. We at Orenda only wrote about this because many problems we are called about are related to weaknesses with the concrete pool shell itself. And as we are establishing the best practices for pool chemistry, we also want to share best practices for pool materials and construction. To do this, we have asked the experts, and they were gracious to share their knowledge with us so that we can share it with you.

Now that we have an informed opinion, **Orenda recommends waterproofing for every concrete pool.** It's more money, yes, but whether you're a homeowner or pool builder, waterproofing is a cheap insurance policy against major problems that can occur. Why take the risk? Why not waterproof and be sure your vessel is watertight?

Some may think it's overkill, and that's fine. A local pool builder should know your soil better than we do. We're just saying it's an affordable way to reinforce the concrete pool shell, and we like that. Waterproofing, in our experience, has prevented most efflorescence and calcium nodule problems, which usually lead to a "chip out, waterproof, bond coat and re-plaster" type of repair. That kind of "repair" is a major renovation that costs over $10,000 for a typical residential pool.

Pool waterproofing is a wise, proactive decision. You decide if it's right for you.

Thanks to: https://blog.orendatech.com

Contact us: info@pooladvise.com.au

Sealing concrete pools

The ability to apply a waterproof coating via brush or roller makes it easier to ensure all nooks and crannies are covered.

By Mike Mudrick

One of the most important steps in gunite or concrete swimming pool construction is selecting the right type of waterproofing. Concrete is a porous substrate prone to water penetration; therefore, it has to be sealed to keep water in the pool, in addition to keeping ground water out, which is often forgotten.

Every single swimming pool or water feature must be waterproofed in one way or another. Sometimes these structures present challenges and are often tricky to waterproof due to the various penetrations included in the design to accommodate elements such as lighting, piping and drainage.

There are several products on the market today for waterproofing swimming pools. Before any final decisions are made, the following information will help make material selection easier and success rates higher.

Forming a bond

Cementitious coating and waterproof barrier products tend to bond better to concrete substrates because they are similar in chemical composition and enhanced by polymer bonding agents. These products also allow various finishing options; plaster, overlays and adhesives attach better to cementitious substrates, as opposed to a pure polymer waterproof coating.

When dealing with new pool construction, cementitious coatings are not susceptible to failure from moisture vapour transmission (MVT), which is the rate at which water vapour passes through a material at a specified temperature and relative humidity. These coatings are breathable, so they can be applied just days after pouring the concrete or placing the gunite, which leads to faster turnaround times. In comparison, pure polymer systems require the concrete to cure for a minimum of 28 days to prevent failure from MVT.

In swimming pool restoration cases, it is usually difficult to completely dry the substrate before waterproofing is applied. Pure polymer coating systems cannot be applied to substrates that are not completely dry, whereas cementitious products are moisture tolerant. In fact, many manufacturers even require pre-wetting the substrate prior to application.

Ease of application

Spray equipment can be used to apply waterproof coatings on large surface areas.

When selecting a waterproof coating, keep the project at hand in mind. Vinyl-lined pools, for example, can be more difficult to work with if they have a non-standard shape. Larger surface areas, however, can be covered more economically by using spray equipment, as opposed to applying via a trowel or brush.

If applying a waterproof coating to an irregular substrate, (*e.g.* artificial rockwork in a pond or waterfall feature), the ability to apply the coating via brush or roller will make it easier to ensure all nooks and crannies are covered. Additionally, coatings that can be applied by hand do not require costly sprayers or air compressors.

Appearance matters

Should the pool owner desire a specific aesthetic appearance, it is important the waterproof coating or membrane allows for what the pool owner may desire. Keep in mind, not all coatings are compatible with all tile adhesives, plasters or other finishes.

Since tiles and pool plaster are not waterproof, a waterproofing membrane should be used beneath them to extend the service life of the pool.

The potential for leaks rises significantly when a waterproofing product is not used. Leaks can result in water loss, cause damage to the surrounding area (if the pool is suspended) and ruin the plaster/finish coat. Additionally, the rebar/reinforcing steel in a concrete or gunite pool could also be damaged.

Some cementitious waterproofing products can be used as a standalone coating and be made to look like other materials, *e.g.* inlaid designs or specialty tiles, by using faux-finishing techniques and metallic pigments.

Resisting pressure

One of the most important factors to consider when selecting a waterproofing product is its ability to resist negative-side hydrostatic pressure, which is water pressure that passes through the substrate and presses on the back side of the coating.

Remember, the coating is working to keep water in the structure (*i.e.* the swimming pool); however, its job is to also make sure that ground water does not interfere with or cause failures for the coatings applied to the pool’s interior.

As ground or rainwater accumulates, it can travel through the concrete pool shell from the outside, creating a build-up of negative-side hydrostatic pressure behind the coating. When water comes up against the coating, it literally tries to push the coating away from the surface. Flexible coatings can, and usually will, bubble up and fail under this type of pressure. To counter this, it is important to use a base or first coat capable of withstanding negative-side hydrostatic pressure when constructing an inground swimming pool.

A good starting point

While these are not the only factors to consider when selecting a waterproofing system for a swimming pool, they provide a good starting point and should be taken into consideration on every project. Following these guidelines will also generally highlight any other potential issues that might pose problems, allowing them to be addressed before construction begins. When in doubt consult the product manufacturer, as they can provide assistance in selecting the proper solution.

Thanks to: Pool and Spa Marketing

What is Positive side/Negative side Waterproofing?

One of the most interesting questions in the waterproofing sector is “What is positive side” or “What is negative side” waterproofing. It is a great question and one that gets us interaction hopping from the get-go.

Let us firstly look at the types of waterproofing. There are many different approaches to structural waterproofing. The construction methods will in part contribute to the specification of types of waterproofing systems (positive or negative side) and may also determine the overall structural waterproofing strategy.

Structural waterproofing falls into 3 categories:

Type A – Barrier Protection

Type B – Structurally Integral Protection

Type C – Drained Protection

With 3 grades:

Grade 1 – Some water seepage and damp are tolerable depending on the intended use

Grade 2 – No water penetration is acceptable

Grade 3 – No dampness or water penetration is acceptable

From these categories we can offer designs based on:

- Positive side waterproofing
- Negative side waterproofing
- Integral waterproofing

Integral waterproofing

(Type B Structurally Integral Protection) is comprised of admixtures that are incorporated into the concrete mixture during the initial pour and are not usually seen as a “positive” or “negative” side waterproofing solution.

On some occasions, warranty providers may ask for two (2) forms of waterproofing, meaning both the positive and negative sides are offered protection.

What is Positive side waterproofing?

Positive side applied waterproofing is an external waterproofing system. A waterproofing system installed to the exterior face of the below ground structure. A suitably designed positive system can protect the structure and the interior against the effects of moisture and pressurised water.

A positive side applied system takes the water pressure in conjunction with the structure to which it is applied to effectively create a permanent consistent barrier.

What is negative side waterproofing?

Negative side applied waterproofing is applied to the internal surfaces of the structure, usually when there is no access or ability to either get access to the access to the external surfaces or where continuity is not possible. An internal negative side system is often reliant on the ability of those surfaces in accept the waterproofing treatment. A general rule of thumb is that an internally applied system is as good as the sum of the integrity of the structure and the preparation undertaken.

Negative side waterproofing in some instances has the capability of dealing with an incredible 13 bar pressure (this equates to just over 130m head of water)!!

Both positive and negative waterproofing systems have pro's and con's – For example, a piled structure cannot be waterproofed on the positive side and it is also difficult to waterproof structures where access is limited. Internal waterproofing for example, can be applied to piled structures because access is not a problem and continuity is not a problem.

Full site investigations are important when mitigating and reducing risk in waterproofing design. The results will have a bearing not only on the design but on the waterproofing system itself (positive (external)/negative (internal). Whilst findings of a site investigation are often seen as conclusive, it needs to be remembered that this is just a 'snapshot in time'. It should be assumed that water will come to bear against the full height of the below ground structure at some time in its life.

The system designed may be acceptable at the time of construction meeting the 'snapshot in time' investigations, however this system may not be adequate for environmental changes of the future.

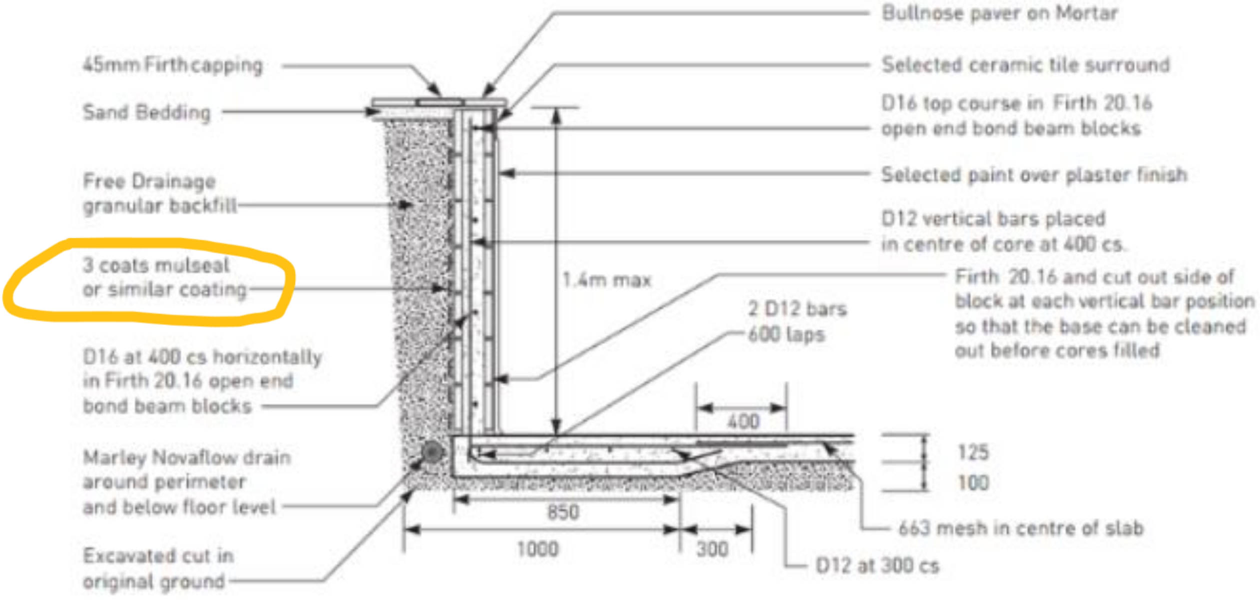
The decision to use positive side or negative side waterproofing can be made after exploring:

- Changes in water tables
- Changes in hydrostatic pressure
- Thermal changes
- Dynamic Movement
- Heave
- Subsidence
- Clay soils
- Changes in environment
- Stress
- Changes in ground drainage
- Structural stability

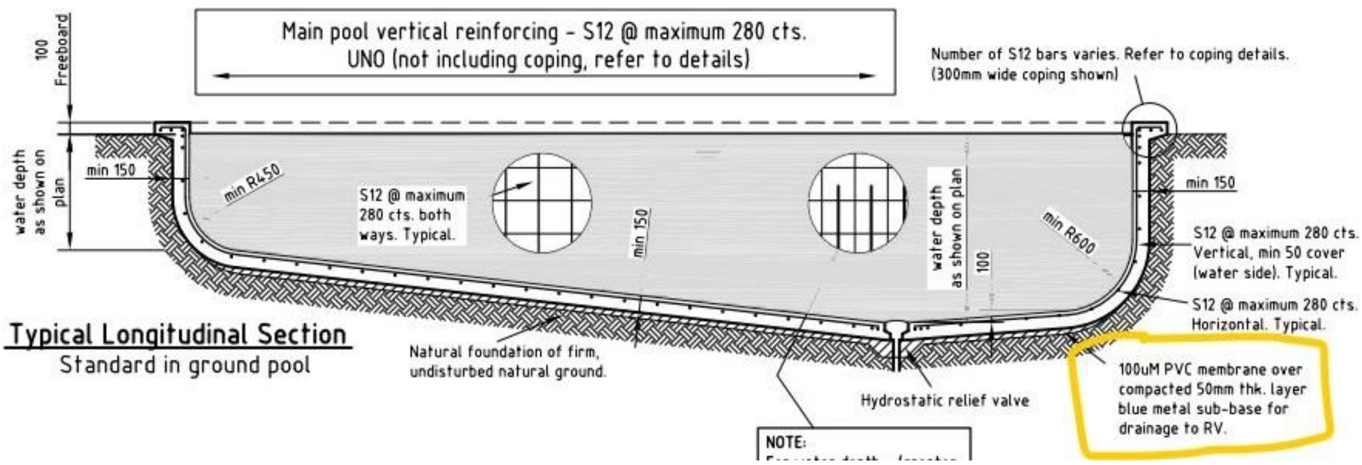
Thanks to: https://www.deltamembranes.com

Contact us: info@pooladvise.com.au

MOISTURE CONTROL



Thanks to Firth Concrete



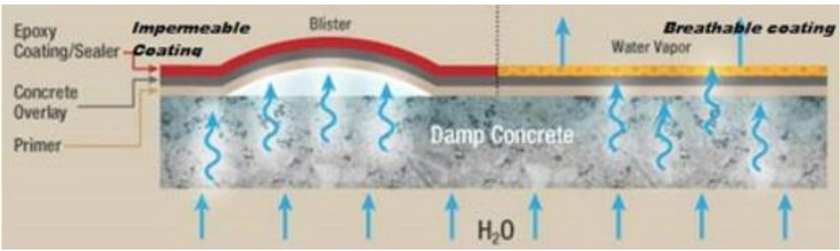
There are two sources of moisture that influence the level within a concrete substrate. Free-water that is not consumed in the process of cement hydration and remains as nonchemically bound water in the concrete. Time and suitable drying conditions are required to reduce the amount of free-water in a concrete slab to a level acceptable for a flooring installation.

The second major source of moisture in a slab-on-ground is that which originates below the slab. When an effective vapor barrier/retarder material has not been properly installed directly beneath the concrete, moisture vapour from below the slab will migrate upward to, and into the concrete which will cause blistering and bond failure if not treated before installing the new epoxy floor.

Floorcrete uses different methods of testing to measure the moisture vapour transmission rate and the moisture content. There are at least five systems to mitigate a high moisture or pH condition.

- Reactive Penetrants
- Cementitious Densification
- Sealers
- Specialty Coatings
- Dispersement Membranes
- Combination of Systems

How to know what system to use depends on the condition of the floor, amount of moisture, what epoxy system is being applied, and budget.



Thanks to: https://www.floorcreteinc.com

Pool Paints And Hydrostatic Pressure

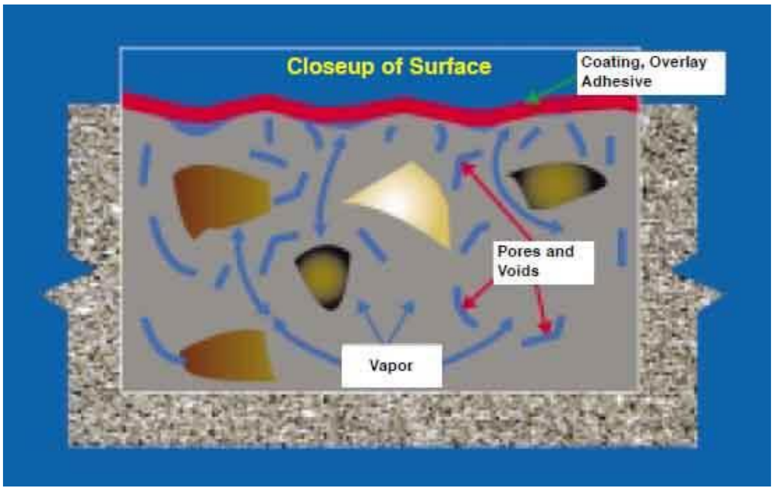
Swimming pool paint can generally be considered both water and vapour proof. This means that neither liquid water nor water vapour (gas) can pass easily through the coating when applied at the correct film thickness.

Concrete is a hygroscopic material, meaning it tends to absorb moisture like a sponge. If humidity on one side is different to the other, it will transmit moisture as liquid or gas, through the concrete.

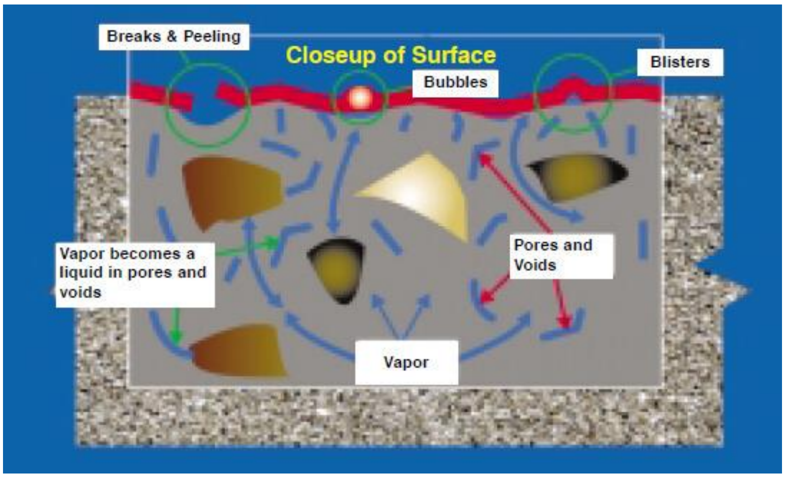
Hydrostatic water pressure: Hydrostatic or “head” pressure is the force caused by a column of liquid water, which generally does not harm solid concrete. However, it will force itself through as a liquid, even in quite dense concrete, especially if there are imperfections such as sand streaking, honey combing, cracks and areas of lower density. Higher water – cement ratio concrete (<0.40) tends to form more permeable concrete, with lots of capillaries being created. Hydrostatic water pressure is only a problem when liquid water is in direct contact with the concrete mass.

Water Vapour: Water vapour (gas) molecules (not liquid) can more easily pass through mass concrete, and they are much smaller and compressible too. This tends to be more of a problem in areas of high-water table, or where the waterproof membrane (if installed) has failed.

What causes the Water Vapour to move within concrete?



Voids in concrete provide space for condensation



A void near the surface can lead to de bonding

As gases can change shape they can wiggle through tiny voids as small as 5 micrometres. The gas is harmless to the concrete, however when it condenses into water it takes on a much bigger size. As the concrete cools (such as in winter – pool water cools) its ability to keep the water vapour in a gaseous phase diminishes, and it condenses into liquid. This "new" water will have a pH of 7 which allows it to attack other molecules in the voids including weak cement ions and this continues enlarging the void. Over time the destructive effect grows, and other molecules, previously bound to the now missing cement molecules, are affected. When these voids are near the surface of the concrete, large voids cause the de bonding of the surface of the concrete and any coating attached to it. Also, when vapour turns into liquid, another force is created called capillary action. The “new” water is attracted more to the surrounding surfaces (inside of voids) than to itself. Meaning, it can move around both vertically and horizontally within the pores and capillaries in the concrete. As this water gets near the outer deteriorating concrete surfaces just below the coating, it will often force the coating to blister or bubble just before final delamination.

Other related causes:

These can be from rain runoff, such as when water absorbed into the soil near the pool and runs past, under or around the pool and in so doing saturates the pool structure. This can be seen on pools on hillsides and near to buildings, where the collection of water from nearby areas is channelled to areas around the pool. Pathways, patios and lawns near pools are also ways to generate large areas that saturate the ground with rain runoff, causing the pool to get “wet feet.” Sometimes we find leaking plumbing can also be a cause, especially if blisters near to outlets below the water line.

The Effect of Temperature on Moisture Transport in Concrete

Yao Wang [1,*] **and Yunping Xi** [2]
[1] Department of Civil, Environmental and Architectural Engineering, University of Colorado Boulder, Boulder, CO 80309, USA
[2] Department of Civil, Environmental and Architectural Engineering, University of Colorado Boulder, Boulder, CO 80309, USA; yunping.xi@colorado.edu
* Correspondence: yao.wang-1@colorado.edu; Tel.: +1-303-492-8991
Received: 20 July 2017; Accepted: 8 August 2017; Published: 9 August 2017

Summary

(3) The experimental data indicates that the elevated temperature without a temperature gradient (an isothermal condition) does not have a significant effect on moisture transfer in concrete. On the other hand, the effect of the temperature gradient under a non-isothermal condition is significant and becomes more significant as the temperature gradient increases.

This can be more easily understood as: if there is a temperature gradient through concrete and there is a high level of moisture at one side, then as the temperature gradient increases in the concrete, water vapour increases in transmission rate to the warmer side. (It is somewhat like an oil lamp and the wicking affect).

A recent example is found with spun concrete plunge pools partly buried in the ground and heated, but no external water proofing or damp proofing.

General view inside the plunge pool showing blisters above and below the water line.

Assessing Pools for Ground Water Issues

1 Introduction:

When you come to look at and assess a concrete pool for re coating there are some aspects that you need to take note of apart from the internal surfaces. By doing so you will begin to understand the pool's situation relative to other issues that may impact on your coating and its long-term success. If you ignore these factors, then you run the risk of missing important clues, which may save you and the client much angst.

2 Concrete Shell:

When a pool is designed it will be of a compressive strength suitable for its intended use and with sufficient reenforcing steel correctly imbedded. As an example, the engineer may specify 30 Mpa strength and at least 50 mm concrete cover for the steel work. The actual onsite results may not be such. Poor shotcrete application techniques, insufficient compaction, and movement of the steel reinforcing chairs, all lead to porous areas of concrete, insufficient cover and many other factors. This overtime may show up with leaks, failure of the finishes and rusted steel work, staining the surfaces. In addition, the design engineer should have specified a water membrane on the outside of the concrete shell. (see yellow box in image 1, below) This may NOT have been installed or if installed, damaged at some point.

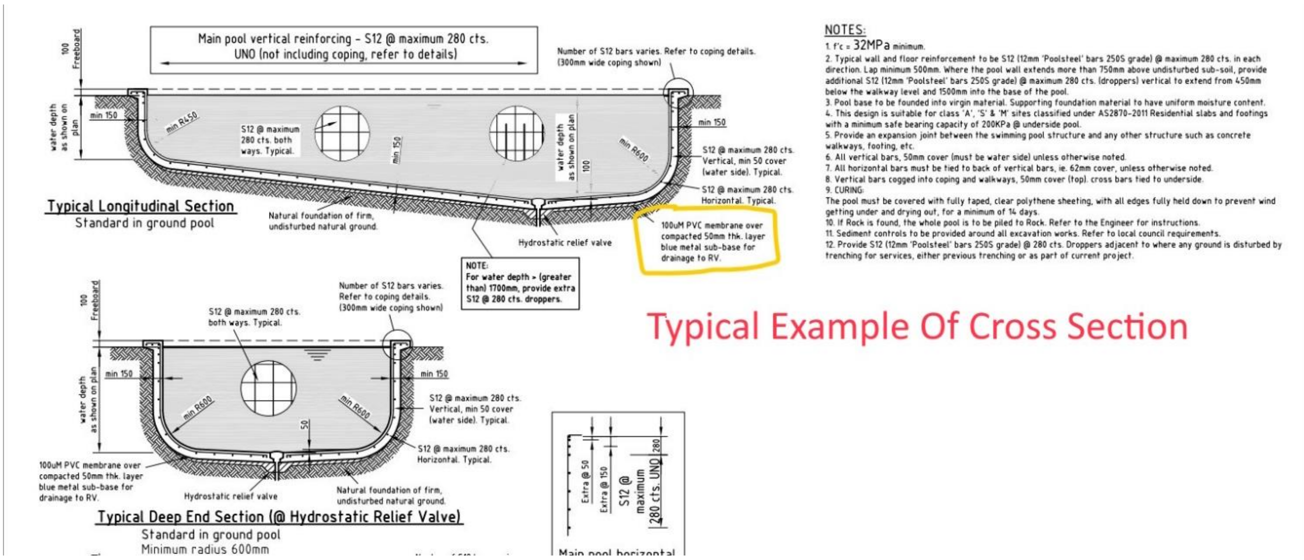


Image 1. Typical well designed concrete pool, showing DPC outside of concrete shell.

3 Look out for:

When assessing the pool in question check the following in addition to the normal items:

- Is the pool on a hillside, or is there a nearby bank or hillside, that allows water to run off or flow towards, under or around the pool and its immediate surroundings? (See image 2, below)
- Is the pool near the sea, marina, or river or at the bottom of a valley?
- Does the roof or rain run off flow away from the pool area? If not be aware.
- Are the pavers or coping tiles buckled, with gaps between them or lose?
- Is the pathway or coping tiles, pavers that surround the pool showing any signs of white efflorescence? (Also look at the tile line above the water for the same white efflorescence)
- Are the coping tiles or pavers dark in colour?
- If the pool is already painted, then are there any blisters on the existing paint (above or below the water line).

Image 2 Here is a pool with rising ground along one side (rises higher on neighbour's land) and combined with the rising bank and garden, is a great trap for rainwater and resultant seepage. (Into or under pool)

If you see any of the above factors then it's highly indicative of water being in, around or under the pool and this may impact on the success of the coating, now or many years later on.

- Efflorescence is a very good indicator of water being in the concrete (or in the ground surrounding the pool) and as the water moves in and out of the substrate, leaving behind the white powder (efflorescence) as the liquid evaporates.

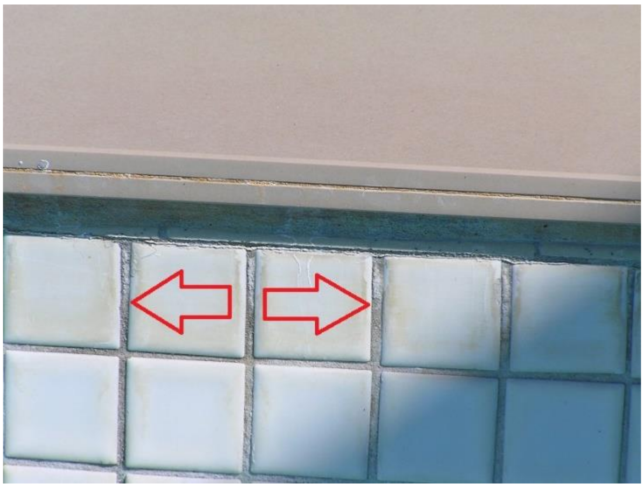
- Dark colour pavers or coping tiles on the tops of pool walls can heat up on summer days. Due the thermal differential with the bottom of the wall (being buried and much cooler) creates a wicking effect with ground moisture. The moisture rises up the walls and leaves near the top, often leaving telltale white efflorescence too.

- Any blisters in the existing pool coating will indicate moisture passing through the concrete shell into the pool (hydrostatic pressure). Note: A well-worn, thin pool coating may not show any effects as the water and vapour can pass readily through it. A worn coating is one key reason to recoat a pool. Also, porous surfaces like Marblesheen and Pebblecrete usually show no issues with moisture issues.

Contact us: info@pooladvise.com.au

Figure 3 Dark pavers and coping with efflorescence present, with drainage. Resulted in blisters on pool walls.

Figure 4 So many water related issues resulting in tiles being pushed off. Note area below tiles seems fine, as being porous.



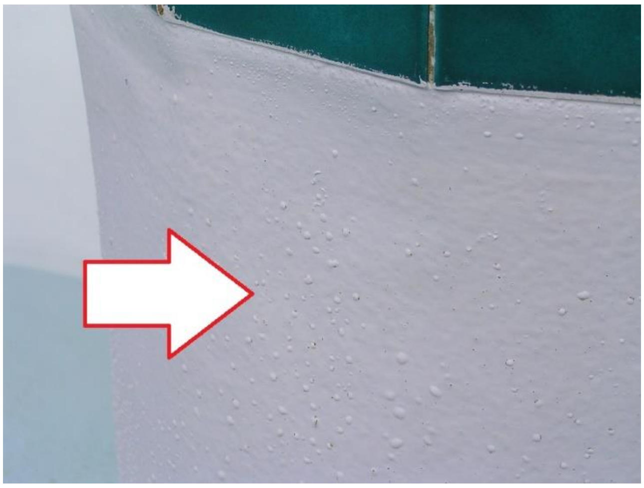


Figure 5 Water from leaking pathway above, causing efflorescence on tiles below.

Figure 6 Hydrostatic blisters in painted surface, due to water (leakage, building up) behind pool shell.

Figure 7 Extensive issues due to water trapped behind wall.

4 Checking:

It's best to satisfy yourself that no water issues are present or likely. The use of a moisture meter is a good place to start. Bunnings stock a Crommelin Moisture Meter currently for $50 I/N 0911078. Should be less than 12% moisture content everywhere.
Also, a quick way to check is to use some black plastic sheets. Use several heavy-duty black plastic sheets about 400 mm sq, well-sealed at each edge with "duck" tape and left for 18 – 24 hrs. Do at least 8 - 12 around the pool inc deep end, shallow end, and walls top and bottom and inc areas with little sunshine on them. Any moisture droplets on the underside mean there is a water issue and needs to be carefully considered.
If in doubt, ask us.

5 Solutions:

The best coating to use in a concrete pool is one that is both water and vapour proof as it's going to keep the pool (salty) water away from the reinforcing steel and save the pool owner issues to do with concrete cancer.
The V 790 System, (often being a high build coating system) fits this requirement well.

However, if there are issues with moisture within or under the concrete surface, there is a chance that in time it will cause the coating to blister. This can be hard to forecast, unless you see signs as indicated on page one.

If you have seen these signs or have concerns, then you should:

- Advise the pool owner (in writing) of what you see and that there may be issues later on. As it's not something you can be absolute about it's best to err on the side of caution.
- Consider the use of a waterproofing coating first, namely Ardex WPM 300 (Ardex 02 9851 9199) or Vandex water proofing (Fosroc 1800 812 864) This may be a good insurance policy. It can then be over coated once cured with V 790 system in the normal manner.

As an alternative you may want to suggest the use of a porous finishing system, such as a trowel on finish which generally lets water in and out of the pool surfaces. However, these being "open", collect stains, dirt, algae and also let calcium nodules form.

6 Summary:

Water is insidious and can make one's life difficult. More so if these aspects above are not noted and then considered. Most times there are no issues, and the project goes well, as does the performance of the coating. However, every now and then, situations arise, which are quite easy to detect beforehand. When noted and the issues discussed with the pool owner a resolution can be forthcoming or at least the situation monitored so that if matters arise later on, there are no surprises to argue over.

Contact us: info@pooladvise.com.au