TECHNICAL BULLETIN – TB257

WEATHER AND RELATED SITE EFFECTS ON LIQUID MEMBRANES

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INTRODUCTION & SCOPE

When products are designed and tested for performance, this is done at a set of specified conditions with the intent of making direct comparisons between products and batches feasible. The standard conditions for laboratory testing are normally set at between 20 and 23 degrees Celsius and 50-55% relative humidity, with the substrates used for test substantially dry or at equilibrium with the laboratory conditions.

Clearly this situation is divergent from real world field conditions where temperatures range from low single figures to 40^0C plus, and humidity from less than 10% on hot dry days to 100% in rainy conditions. As such, when the membranes are being installed in the field, it is incumbent on the installers to make adjustments for conditions, and not simply proceed when the environment is unsuitable.

In this bulletin we will examine some of the issues that can arise from not following the recommended installation conditions, and have in the past resulted in difficulties and failures.

AMBIENT VS SUBSTRATE

There is a misunderstanding that it is only the ambient temperature + moisture (%RH) that needs to be considered, but this is not the case. There are two conditions to consider, the air temperature/%RH, but also the substrate condition, its temperature and moisture level.

In areas exposed to direct sunlight, particularly in warm weather, the substrate condition is commonly several tens of degrees warmer than the air, especially if it is a darker shade. If the surface is hot to touch, then there is a problem. If the substrate exceeds around 40^0C then the working/application time will be significantly reduced and other premature drying issues can follow.

Conversely in cold weather the substrate is colder than the air, and this can easily be observed touching external concrete on cool day, particularly in the morning. The air can be 5 to 10 degrees warmer than the surface, and even a bigger difference if there has been frost. ARDEX applies the general rule that 10^0C is the cut off substrate temperature.

Moisture is the final part of the puzzle, and it is nearly always true that masonry on ground or exposed will have different moisture levels to the air around it. Where the air is dry, the substrate surface will be dry too, but deeper down in the material this may not apply, especially slab on ground or below grade situations. When the air is wet, depending on how long and how much rain has fallen, or how humid the room is, the surface will be high in moisture, but not necessarily deeper into the material; an example here is a masonry roof or verandah exposed to the weather or a wet area surrounded by dry areas.

These considerations mean that in real terms the surface needs to be examined and checked for temperature, and moisture testing is always a sound idea where there is suspicion of dampness.

Cold Conditions

The concept of cold conditions really applies once the temperature falls below 20^{0}C with progressive increasing deterioration in drying and curing down to 15^{0}C and then 10^{0}C. The latter figure is the effective cut off for many products, because below 10^{0}C the physical changes and chemical reactions related to drying and curing are retarded or even stop completely. For example, materials containing Portland cement (part of cement-polymer liquid membranes) and epoxy resin, display delayed hardening and cure, and in the case of Portland cement, the reaction grinds to a halt at around 5^{0}C.

While materials such as epoxies or polyurethanes can start reacting again when they warm (assuming nothing has been lost or disrupted), materials that use or contain water as part of the cure are another matter. Cement paste, or a water borne liquid membrane, can lose its water slowly due to evaporation or absorption into the substrate surface while not actually curing. In the case of cement, the hydration reaction is stymied and the cure is incomplete, whilst for the membrane the film may not coalesce properly and leave voids and holes. A secondary effect for membranes is that the surface might skin, but inside the membrane can remain a paste and then not cure properly at all, remain soft, or be susceptible to water re-solvation/extraction of the unhardened polymer fraction when exposed to water (an effect commonly misnamed as ‘re-emulsification’).

An even worse scenario is if the material freezes (≤0^{0}C) which creates ice crystals that destroyed the structure of both polymeric materials and the wet cementitious matrices. Examination of the packaging will usually indicate whether a liquid material is subject to freezing problems.

Liquid materials also tend to become more viscous in cold conditions, particularly resinous products, and this makes them difficult to mix, and also degrades workability, flow out, wetting and self-healing properties.

Hot Conditions

At the other end of the spectrum, hot conditions in the first instance produce problems for pot life and working time for the applied membranes. Two part systems are prone to rapid hardening and loss of workability because the heat increases the rate of reaction; compounding this in two part resin systems, initially heated materials (where the materials are stored in the sun and not in the shade) when combined promote a rapidly increasing positive feedback loop in the cure, which is in itself a heat producing reaction (exothermic) making it go suddenly hard.

When applied to a surface which is hot itself or working exposed to the sun, ironically results in some of the same sorts of issues as cold weather, as well as making its own unique problems. The membrane can rapidly skin on the surface which then traps moisture inside leading to prolonged softness; this can be a worse issue than the cold version because the skin formed is normally tighter to losing moisture. The applied membrane can flash dry and not coalesce properly leading to pinhole porosity, or the water can actually vaporise and bubble out creating pinhole.

The hot substrate can rapidly draw the water out of a water borne material. For a cement containing system this loss of water degrades cure. Workability when being applied is often reduced, because of moisture loss or partially going to gel, which leads to peel off and stringing, poor healing, and compromised film porosity.

A point which catches the unwary is when working indoors with picture windows which allows direct solar heating, and can also act as a greenhouse making the room hot and stuffy. Where the building is not properly enclosed, the ambient conditions can easily mirror the external shade conditions.

WIND AND AIRFLOWS

In an external environment, wind is a constant factor that needs to be considered for any sort of installation that involved liquid materials.

Dry and hot winds produce rapid and flash surface skinning, mud cracking reduced and workability.

Cold dry winds create a form of wind chill onto damp surface because they produce a degree of evaporative cooling on the surface. So as well as removing moisture, they also tend to drop the working surface temperature even further.

Surface drying can also be a problem where fans are used for internal situations and they blow directly onto the surface of the membrane and not simply just provide ventilation.

Winds also carry debris and dust which can become trapped or incorporated into the membrane or contaminate the surface as it is being applied.

RAIN AND HIGH HUMIDITY

When the humidity starts to approach 100% RH, the water coalesces and rain starts to form and then falls. Rain is almost always predicted by the Weather Bureau and there is no excuse for being caught out by wet weather.

Rainfall can occur any time of year, but in Australia there tends to be periods where it is more likely to fall.

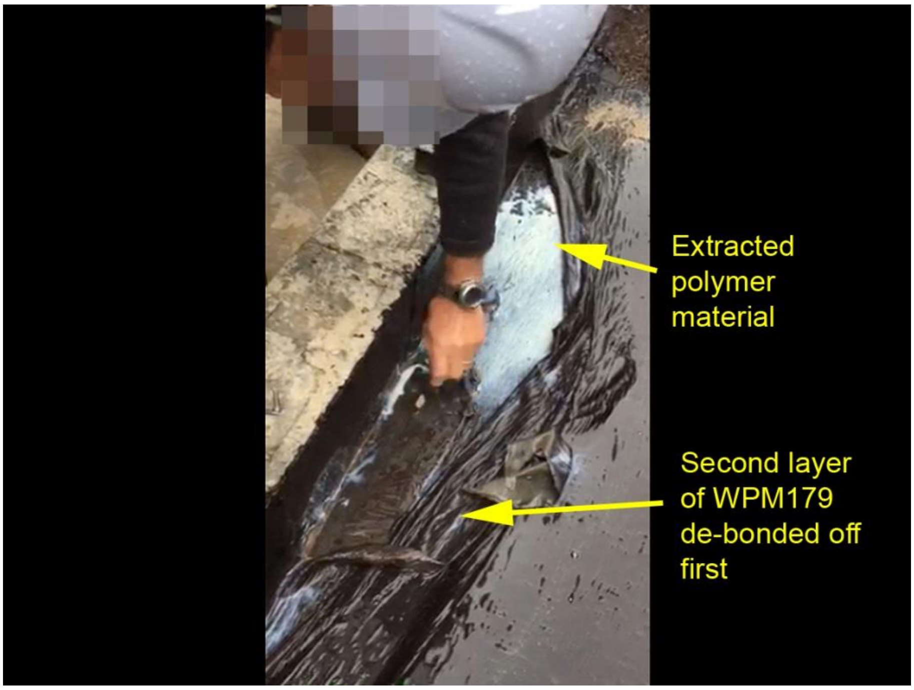
For example:

- The Northern Territory, Northern Western Australia and North Queensland have monsoonal climates and heavy rain falls in the summer months, while the cooler months are the ‘dry’,
- In eastern NSW and SE Queensland the rain tends to fall in the late summer and autumn,
- Tasmania, Victoria and the SW of Western Australia have cold damp winters,
- Heavy rain associated with thunderstorms after a ‘change’ on hot southern Australia days, or when topical lows or cyclones threaten,
- Snow and rainy sleet in the alpine areas.

Another related effect is the development of wet mists, fogs and dew which leave a sheen of moisture on exposed surfaces. This is a consequence of reaching the dew point where the air can no longer hold the moisture as a vapour, and it then deposits out as a cloud and the moisture settles on surfaces that it touches. Another classic example of this is the dew that forms on cold external objects, on otherwise clear nights.

The effect of moisture falling onto uncured or partially cured membranes is variable. Whilst moisture cure urethanes can actually cure faster when dampened, epoxy resins can be inhibited because the water affects the amine catalyst. Water falling onto water borne membranes and cement containing ones, results in the material not drying, and if soft enough, being diluted and even washed away. Strong enough rain can produce physical damage to the surface such as cratering and pinholes, and leads to water being trapped in and under the membrane. Where water lands on the surface between coats of multiple coat systems, this normally disrupts the performance of second layer applied.

This problem can be seen in the below image, where the first and second layers of the membrane have not physically welded together because of water laying between them. The white material is hydrolysed and remobilised water borne polymer extracted from the second layer (so called re-emulsification) where it sat on the water covered first layer.



In the near marine environments, the onshore winds carry water droplets and salt deposits, which tend to coat surfaces with a damp sticky film.

Humidity is basically moisture that is held in the air as vapour. There is an equilibrium between water evaporating out of a surface and going into the air, and visa-versa.

We have already stated that low humidity (warm air and drying winds) results in rapid loss of moisture from a membrane, but high humidity, greater than around 70%, starts to impede the exchange of moisture and slows down drying.

Above 85% humidity water proofing materials such as ARDEX WPM300 display retarded drying and slower cure (although this water borne epoxy can eventually cure under water). In an external environment where the humidity is high (for example near coastal environments or rain pending), the surface drying properties of applied materials can be poor, and this leaves them susceptible if water does fall or condense on the surface.

Working in enclosed spaces without ventilation also can create a situation where the localised humidity increases, and then retards the drying properties of applied products. This can be seen in waterproofed bathrooms in cool and damp weather, where the applied membrane remains soft, or extremely tacky for several days. It can also happen with some cement based materials as well.

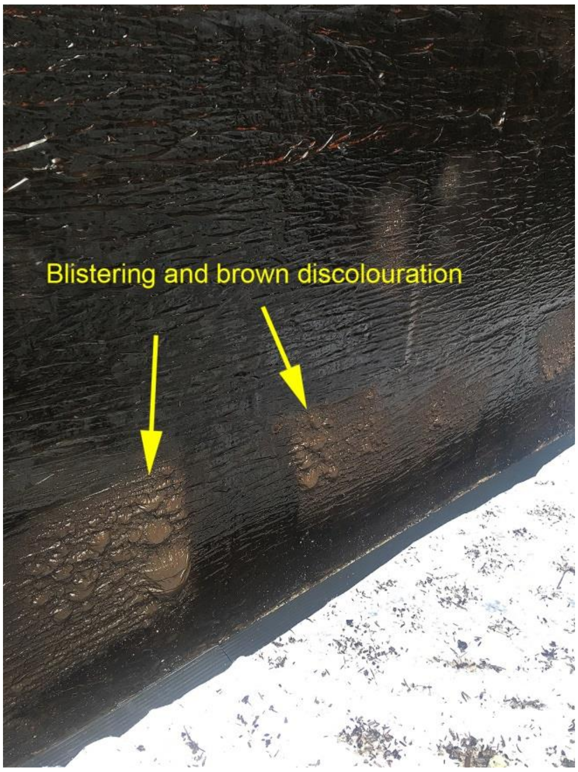
Substrate Moisture

The final part of the issue is substrate moisture. Where a surface is damp, this compromises the performance and adhesion of many types of membrane unless they are specifically designed to be a moisture barrier for rising moisture. But, even some materials, such as epoxies and urethanes can have limitations as to how wet a surface can be, since moisture can interfere with the cure or ultimate bond.

Another effect can be that the moisture penetrating through the drying membrane delays the drying process and possibly impedes the cure, but also produces blisters and bubbling or in some extreme cases pinholes as it escapes through the drying film.

There are two common types of blisters associated with membranes;

a) Water vapour that is mobilised by sun exposure. The sun falling on the surface heats and causes the water to vaporise and generates a blister. When the surface cools back down, the water vapour coalesces and the blister subsides, however the membrane has been stretched and damaged regardless.
b) Water filled blisters that arise from hydrostatic pressure. In this case we are usually referring to below grade areas where ground water can be present, or the situation where moisture can develop a head of pressure due to the height of the water column. A latter example being water saturated masonry walls, such as blockwork were the upper surfaces or top edge is exposed to rainfall which then penetrates and percolates down. An example is shown below.



This image shows water blisters in a membrane not designed to resist hydrostatic pressure, and water accumulating in the wall structure due to rainfall on the top.

In this type of situation, a membrane system (positive side waterproofing) requires a hydrostatic moisture barrier as the primer to suppress the moisture, or the substrate has to be left to dry out sufficiently.

SOLUTIONS TO AVOID THESE SORTS OF PROBLEMS

Temperature extremes are difficult to avoid; scheduling works in expected weather extremes should be avoided, but if there is no choice and they are not accounted for, then problems follow in their train,

In hot weather;

- Avoid working in the heat of the day, work in the evening, early morning or at night. The substrates will take some time to cool after extreme highs.

- Shade the working area(s).
- Keep all products stored in cool conditions and out of the direct sun.
- Do not add water to products that are not intended to be diluted.
- Mix smaller quantities at a time to reduce self heating.

In cold weather;

These situations are more difficult to deal with than hot conditions.

- Keep all products stored out of the cold, especially products not intended to be frozen
- Warming materials to around 35^0C can help, but they will go to the substrate temperature rapidly when applied.
- Use heated tents or enclosures around work areas.

High humidity and wet weather;

- Installation when rain has recently fallen, is currently falling, or is expected to fall soon has to be avoided where possible.
- Check the weather forecasts. Don't work in the rain. Take extra precautions after extreme rainfall events.
- Use tents or protection to cover areas to be worked on.
- Remove water that has accumulated from rain and allow the area to dry.
- Use fans or driers and ventilation to remove moisture and lower humidity.

Damp substrates;

- Use an appropriate moisture barrier as a membrane or membrane's primer.
- Make sure that below grade drainage is adequate.
- Prevent water getting into building elements in the first place (protection of parapets).
- Test for moisture content.

General considerations;

- Several thinner coats of most membranes is superior to one or two overly thick coats. This allows more effective drying and curing in general.
- Aim for the correct film thickness and select the correct product for the application.

REASON FOR REVISION - ISSUER

New document

DOCUMENT REVIEW REQUIRED

5 years from issue

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