TECHNICAL BULLETIN – TB072

WATERPROOFING OF CONCRETE RAIL SUPPORTS & BRIDGE STRUCTURES AGAINST WATER INGRESS CAUSING CONCRETE SPALLING

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INTRODUCTION & SCOPE

Concrete is commonly used as the structural material in road and rail bridge construction as well as foundation support for rail sleepers supporting railway lines. During aging, this concrete develops micro and macro non-structural cracks which under normal circumstances cause no problem.

In cold wet conditions where the ambient temperature frequently falls below the freezing point of water, that is 0˚C, the cracking becomes a major problem resulting in concrete spalling requiring regular expensive maintenance to prevent premature failure of the structure.

While the ambient temperature is above 0˚C, water enters and collects within the cracks. In hot conditions, this water evaporates over time and normally causes little problem unless there is a high atmospheric chloride ion, sulfate ion, or carbon dioxide level that can cause spalling through neutralisation of the concrete alkaline passive environment protecting the reinforcing steel.

In cool conditions which precede ambient temperatures falling below 0˚C, the water entering the cracks evaporates very slowly, if at all. As the temperature falls below 0˚C, the water in the cracks freezes and expands. The stresses caused by the ice formation in the crack causes the concrete to fracture and either expose the reinforcing steel or seriously reduce the concrete cover over the steel.

If the fractured concrete protection of the reinforcing steel is not repaired immediately, the corrosion of the reinforcing steel is accelerated as the temperatures again rise above 0˚C because of the increase in contact with oxygenated water.

PROBLEM PREVENTION

Since some of the cracking is caused by plastic shrinkage of the concrete and some is caused by operation vibration and settling, the proactive method of prevention involves applying a very high efficiency concrete curing compound immediately following the final set of the concrete. This curing membrane will retain the water within the concrete mix facilitating optimum hydration and strength, and hence minimise the plastic shrinkage. Following a short term under operational conditions, the final waterproof membrane is applied to prevent any water ingress into the concrete and therefore prevent water freezing and causing concrete spalling.

Prevention of the problem recurring involves reinstatement of all spalled concrete and macro cracking, followed by the application of a waterproof membrane to prevent future water ingress and therefore future concrete spalling.

Whichever method is employed the principal remains to stop water ingress into the concrete and therefore prevent the concrete spalling. The membrane recommended should be overcoated with ARDEX WPM330 Facade membrane to prevent degradation by ultra violet light and to provide a flexible waterproof anti-carbonation membrane, providing a very low diffusion rate of carbon dioxide and chloride ions, in the event of excessive cracking of the semi rigid epoxy membrane.

STRUCTURAL CONSIDERATIONS

Generally the concrete used in these structures is off-form or pre-stressed. In either case the surface is normally dense, high strength and therefore highly impermeable except for developed cracks and optimum adhesion of any membrane will be inhibited.

Low permeability concrete surfaces (such as dense concrete, concrete of greater than 35 MPa compressive strength, off-form concrete or overworked concrete surfaces) should be mechanically treated by abrasive blast cleaning, scabbling, scarifying or other suitable means if applicable, to open the pores of the concrete surface to allow the waterproof membrane to gain optimum adhesion (refer Ardex Technical Bulletin TB058).

Any residual form-release agent, dirt, grease, oil or other surface contaminants must be totally removed since these products act as efficient coating release agents as well as form release agents.

APPLICATION OF HIGH EFFICIENCY CONCRETE CURING MEMBRANE

To minimise the formation of cracks in the concrete and aid in achieving the optimum strength of the concrete design mix, a high efficiency concrete curing membrane is applied as part of the total membrane system. This membrane retains the mix water within the concrete allowing maximum hydration of the concrete and minimising plastic shrinkage during curing.

Application of the concrete curing membrane should be carried out as soon as practical after the concrete has achieved its final set and can resist physical deformation. Note that with off-form concrete the formwork is not normally removed until the concrete has fully set. Because of the developed surface density and the risk of 'blow holes' in the sub-surface, surface preparation as described above should be carried out before the application of the curing membrane system.

To avoid blistering during curing this coating should be applied while the surface temperature is below 35°C and declining.

Apply one coat of ARDEX WPM256 HydrEpoxy (thinned 50% with water) to all surfaces at a coverage rate of 5 to 6 square metres per litre. Apply using brush or roller application techniques and work well into the surface during application.

In not less than 15 minutes nor more than 4 hours of the application of the ARDEX WPM256 HydrEpoxy, apply one coat of ARDEX WPM300 HydrEpoxy by brush, roller or spray techniques at a coverage rate of 3 square metres per litre (wet film thickness nominally 0.3mm). Allow to cure to a scratch hard finish before proceeding.

APPLICATION OF WATERPROOFING MEMBRANE

WHEN HIGH EFFICIENCY CURING MEMBRANE HAS BEEN APPLIED

Application of the waterproof membrane following the use of the high efficiency concrete curing membrane enables the waterproof membrane to be applied with minimal surface preparation.

All surfaces should be cleaned free from grease, oil, dirt, loosely bound materials or other surface contaminants by high pressure detergent water washing using a nozzle pressure in the order of 10 MPa (1,500 psi) followed by thorough rinsing to remove all traces of detergent or other suitable methods as required. Allow all excess surface water to dry before proceeding.

Apply to all surfaces to be treated one coat of ARDEX WPM300 HydrEpoxy at a coverage rate of 3.0 square metres per litre (nominal wet film thickness of 0.3 mm). Allow the coating to become scratch hard, normally overnight, before proceeding.

Apply to all surfaces a further coat of ARDEX WPM300 HydrEpoxy at a coverage rate of 3.0 square metres per litre (nominal wet film thickness of 0.3 mm). Allow the coating to become scratch hard, normally overnight, before proceeding.

Following application of the waterproof membrane the surface should be overcoated using ARDEX WPM330 Façade flexible anti-carbonation membrane protective finish to protect the epoxy membrane from the ultra violet rays and to provide protection against chemical attack as well as providing an aesthetic appearance to the structure.

WHEN APPLYING TO BARE PREPARED CONCRETE

All surfaces should be prepared as described in the section on 'Structural Considerations' above. To avoid blistering during curing, the membrane coating should be applied while the surface temperature is below 35°C and declining.

Apply one coat of ARDEX WPM256 HydrEpoxy (thinned 50% with water) to all surfaces at a coverage rate of 5 - 6 square metres per litre. Apply using brush or roller application techniques and work well into the surface during application.

In not less than 15 minutes nor more than 4 hours of the application of the ARDEX WPM256 HydrEpoxy, apply one coat of ARDEX WPM300 HydrEpoxy by brush, roller or spray techniques at a coverage rate of 3 square metres per litre (nominal wet film thickness of 0.3 mm). Allow to cure overnight before proceeding.

Apply to all surfaces to be treated a further coat of ARDEX WPM300 HydrEpoxy at a coverage rate of 3.0 square metres per litre (nominal wet film thickness of 0.3 mm). Allow the coating to become scratch hard, normally overnight, before proceeding.

Following application of the waterproof membrane the surface should be overcoated using ARDEX WPM330 Façade flexible anti-carbonation membrane protective finish to protect the epoxy membrane from the ultra violet rays and to provide protection against chemical attack as well as providing an aesthetic appearance to the structure.

REASON FOR REVISION

Review and update

NSW 02 9851 9100, **QLD** 07 3817 6000, **VIC** 03 8339 3100, **SA/NT** 08 8406 2500, **WA** 08 9256 8600
New Zealand (Christchurch) 643 384 3029

Web: http://www.ardex.com email: technicalservices@ardexaustralia.com