ZAP Magnesite System

Chlorides in magnesite toppings penetrate to the floor reinforcement which then corrodes causing concrete spalling and delamination. Conventional repairs can be expensive and unreliable as it is difficult to remove all the chlorides. corrPRE have developed two low cost effective electro chemical systems. One is to bond zinc sheet with Zinc Activator Paste (ZAP™) to the floor surface, the other is to apply Zinc Layer Anode (ZLATM) to the soffit. With a connection to the reinforcement either system provides galvanic cathodic protection to the reinforcement to ensure corrosion is halted with minimal concrete and topping removal.

Magnesite floor toppings were used extensively in the 60’s and 70’s to provide a smooth flat finish on rough finished slabs. The main components of these toppings were magnesia, fillers and magnesium chloride solution. After hardening the pores in the topping remained filled with the hygroscopic magnesium chloride solution. Over time the chlorides penetrate to the floor reinforcement and can cause corrosion. Corrosion typically occurs first at wetted areas as the chlorides diffuse through water in the pores and the water lowers the electrical resistance of the corrosion cell. However once damage is observed in wetted areas corrosion is likely to have commenced elsewhere and the whole floor must be considered in the repair solution.

**Conventional Repair Issues**

In discussions with corrPRE repair contractors involved in Magnesite floor repairs noted the following concerns with conventional patch repairs:

- Corroding reinforcement is often repaired by breaking out the damaged concrete and patching. Where chlorides are involved it is universally agreed that the concrete behind the bar must be broken out to remove the chlorides. This undamaged concrete behind bars is difficult to remove.

- If only damaged areas are broken out then incipient anodes will form unless some form of cathodic prevention is included for the areas around the patch (e.g. corrPRE’s GSC super anodes).

- If only damaged concrete is repaired then it is likely other areas in the slab with slightly less chloride penetration will fail in the future unless other measures are taken, e.g. remove the entire Magnesite topping to remove the chloride reservoir and dry out the concrete and provide a water proof membrane to keep out any future dampness.

These measures are expensive and still leave a risk of failure. The contractors recognise that cathodic protection is the only assured way of stopping corrosion without the need for all of the above measures but note practical systems for this application have not been developed.

**Cathodic Protection**

Cathodic Protection (CP) is where an anode is connected to the reinforcement and embedded in or adhered to the concrete. The anode is designed such that all the reinforcement becomes cathodic and cannot corrode. Anodes may either be impressed current (ICCP) or sacrificial (SACP).

ICCP requires extensive wiring and monitoring around twice a year to check functionality and are considered impractical for apartments as maintenance costs are too high.

SACP systems have been available in Australia for 10 years but the anodes are generally too small to provide a practical means of applying global CP. Their main purpose is for use around the edges of repairs to reduce the risk of incipient anode failure.

By contrast ZLA or zinc sheet with ZAP provides a very high surface area capable of polarizing the reinforcement globally to give a true SACP system that negates the need to break out chloride contaminated toppings and concrete. The concept of CP is described in other SRCP data sheets on ZLA.

**corrPRE’s ZAP Magnesite**

corrPRE are the inventors of a series of sacrificial zinc anode systems for reinforced concrete. These systems have been applied in Europe for 15 years.

On introducing these systems to Australia in 2011 various repair contractors asked if corrPRE’s ZLA system could be applied to prevent future corrosion without removal of Magnesite toppings and without extensive concrete breakout. corrPRE knew the ZLA system would provide adequate protection if it could be applied to soffits (see SRCP data sheet on ZLA for details of application) but the contractors advised this was often not possible.
The problem of using ZLA on tops of slabs is that the activation paste can get squeezed out. Hence corrPRE set about developing a system specifically for the tops of slabs that could be applied before applying a topping (photos of trials to the right).

The system adopted is to use zinc sheet with site applied ZAP. ZAP dries to a relatively stiff paste that is less likely to squeeze out. But the system is also designed with a topping that will bridge the zinc strips and an application method to avoid squeeze out during topping application.

For full compliance with Cathodic Protection codes monitoring of CP systems is required and this entails wiring of the electrical connections back to a junction box to permit intermittent monitoring. This is important with ICCP systems as the current has to be adjusted over time. With SACP system there is no such adjustment and hence monitoring is not generally required. On large projects a couple of areas can be designed to be monitored.

The ZAP Magnesite system is based on checking for continuity of the reinforcement and connections and accepting that once connected the current will inevitably flow. On large projects a small component of the system may be monitored as the cost of doing that can be spread over a wide area.

Various steps in the sheet and ZAP system application are shown in the figure above and a step by step guide is given below.

**Application Guide**

a) Break out surface to sound concrete. No need to remove sound but chloride contaminated concrete and no need to remove the Magnesite topping unless the thickness of the ZAP Magnesite protective topping is an issue.

b) Make connections to reinforcement in the top mat. Where bottom mat steel is to be protected make connections between bottom and top steel. If the design engineer is confident that the bottom mat is electrically continuous with the top mat, or that the bottom mat doesn’t need protections [probable] then the connection to the bottom mat can be omitted.

c) Use standard concrete patch repair system suitable for use with cathodic protection (e.g. Renderoc HB40) to build floor to flat surface.

d) Where testing is required inspect the surface for any steel protrusion (e.g. bar or tying wire) and cover with patch repair mortar to prevent short circuits.

e) Cut 125mm wide 250 micron thick corrPre zinc sheet rolls to lengths equal to the width of the floor less 200mm (leaves 100mm tolerance / topping bonding strip at each end).

f) Apply ZAP to one side of a strip of zinc sheet. Turn sheet and press firmly down onto concrete surface. Typically, the sheet is pressed out by firmly rubbing with a rubber mallet. Significant effort should be applied. ZAP paste should be bought to the edge of the zinc.

g) Repeat process for each strip of zinc leaving 100-120mm between each strip. Preference is to walk on the 100-120mm gaps. The zinc sheet can be walked on but this should be avoided, particularly during application of the topping.

h) Electrically connect each end of zinc strips in series by soldering connections to the zinc sheet. (NB exclude sheets connected to rebar where testing is required).

i) Where testing is required the current (around 50-200mA DC is common but depends on the zinc area and concrete resistance) and voltage (approx. 200-400mV DC expected) between the zinc sheet system and rebar shall be measured and reported.

j) All soldered connections to the zinc shall be coated with high build epoxy paint ensuring the solder and any exposed wire is coated.

k) If polarization trials are to be undertaken, make rebar connections switchable. All reinforcement connections shall be by tack welding a small diameter bar to the steel and potting the bolted steel bar to wire connection unless alternative connection is approved.

l) Leave to polarize reinforcement for seven days. If de-polarization tests are required undertake tests using half cells to check measured depolarizations against code CP protection criteria. Switch on rebar connections permanently if no further testing required (i.e. soldered and insulated).

m) Place self levelling topping in accordance with manufacturer’s instructions to give 20mm min thickness (i.e. include fill in the product) over the ZAP Magnesite and to fill to the top of the Ardex topping a method statement shall be prepared, for approval of the consultant, that shows how walking on the ZAP Magnesite during pouring of the Ardex topping a method statement shall be prepared, for approval of the consultant, that shows how walking on the ZAP Magnesite will be avoided. Typically, this involves use of walk boards supported of the slab.
Pre-Application Inspection

To identify the extent of corrosion electrical potential measurement may be able to be used. In this method an electrical connection is made between a voltmeter and the reinforcement, and a half cell connected to the other side of the voltmeter used to take measurements over the surface of the floor.

Beul 2003 assessed the active potential for Magnesite floors and found it was approximately -150mv vs CuSO₄ cells. Where potentials are more positive than -150mv it suggests that chlorides have not penetrated to the rebar and if these areas of floor are kept dry there may be no future corrosion.

Hence the ZAP Magnesite system is only applied to area where the potentials are more negative than -150m vs CuSO₄. Criteria should be established specific to the project.
Self Leveling Topping
CorrPre have trialed Ardex K22F, a gypsum based self levelling topping, in Europe and this has proven successful. It was selected because it is fibre reinforced which will improve ductility and for its high tensile strength. Prior to its application Ardex P22 is applied to the top of the Zinc. Ardex K22F is not available in Australia but SRCP can arrange its supply in the kits noted below.

ZAP Magnesite Kits
SRCP supply three kits that cater for all needs. All kits are based on covering a 20m² area but in some cases the kits will only be economic when shipped as Full Container Loads (FCL)

Full ZAP Magnesite Kit
In this kit everything the contractor needs for a full installation, including topping and tools are supplied:
1. 2 rolls 125mm x 40m long zinc strips
2. 15 ZAP cartridges
3. 1 ZAP application nozzle
4. 4 potted rebar connections
5. 6kg Ardex P82 primer kit
6. 80 bags Ardex K22F
7. Application nozzle & gun
8. Prepared wiring
9. Soldering system
10. Epoxy connection coat
The system is shipped with 6 kits/FCL

Basic ZAP Magnesite Kit
In this system only the anode and topping materials are supplied:
1. 2 rolls 125mm x 40m long zinc strips
2. 15 ZAP cartridges
3. 6kg Ardex P82 primer kit
4. 80 bags Ardex K22F
The system is shipped with 6 kits/FCL

Minimal ZAP Magnesite Kit
Only the anode materials are supplied
1. 2 rolls 125mm x 40m long zinc strips
2. 15 ZAP cartridges
The system is shipped with 20 kits/FCL or in single or multiple kits by sea or air.

Example of ZAP Magnesite Installations Prior to Topping

Self Leveling Topping

Example of a Bolted Rebar Connection without Epoxy Protection

Schematic of a Potted Rebar Connection.