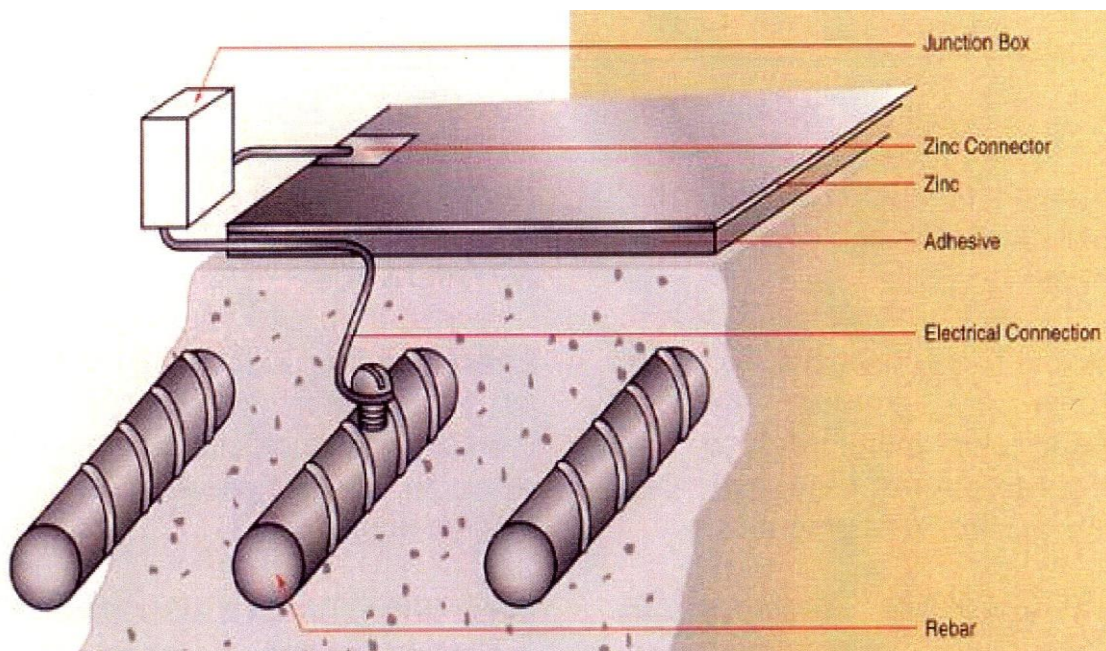

Installation procedures of the ZPA-system

The product is indicated as Zinc Plate Anode or ZPA.

ZPA is a product used in the protection of reinforced concrete constructions against rebar-corrosion. ZPA is a sacrificial galvanic anode specifically designed for giving electrochemical protection, known as cathodic protection, for the prevention of corrosion of the concrete steel reinforcement. The current required for cathodic protection is provided by the galvanic link of the steel reinforcement and the zinc-plate being part of the ZPA. No external power source or whatsoever is necessary.

The presence of chloride-based salts within the concrete can be a threat to the passivation layer (protective oxide-layer) on the carbon steel reinforcement of the concrete. Also, variations in the concrete cover on top of the reinforcement, the quality of the concrete cover and the content of the chlorides around the reinforcement will cause similar corrosive circumstances. These circumstances will cause local corrosion cells. These places are called anodes. Other locations of the reinforcement, where the circumstances are relatively less corrosive and aggressive, remain passivated (passive oxide-layer). These locations are called cathodes.



The combination of anodic and cathodic locations results in electrochemical reactions (redox-reactions) if the distance between the anode and cathode will be relatively small. These electrochemical reactions will convert the steel of the reinforcement into iron-oxides (rust) at the anodic locations. Those corrosion products (rust) formed, can be 5 to 10 times the volume of the original steel reinforcement. For this reason, the tension in the concrete will eventually lead to crack and spall the concrete cover. The loss of steel and concrete will eventually weaken the construction and be a threat to the safety.

The ZPA has been therefore designed to function as an additional anode replacing all the anodic locations of the reinforced concrete construction. It is applied upon the concrete surface. The zinc-plate is electrically linked with the steel reinforcement. In this way the electric-circuit is completed because electric current flows through the adhesive layer and concrete by means of ionic conductance (both materials are so-called electrolytes). Since zinc has a natural potential which is more electronegative than the steel reinforcement, the zinc becomes the anode after installation and forms a new corrosion cell in which the reinforcement is forced to be the cathode. In this way the corrosion process within the concrete is transferred to the zinc-plate avoiding future spalling and cracking of the concrete.

Installation procedures

The ZPA is a thin zinc-plate with an ionic conductive and adhesive electrolyte. It is supplied with a polypropylene topline to protect the adhesive against clogging. The ZPA is provided in rolls (appr. 1mm thickness, 30cm wide and 25m long) with a nominal zinc sheet thickness of 250 micron. Before application the topline is removed manually and the ZPA is adhered onto a cleaned concrete surface. After application the concrete surface is covered with a metal-like foil.

In case of aesthetical requirements or a very wet environment which may cause problems with the ZPA, the ZPA can be covered with a protective cementitious finish (for example: Mapelast Smart of Mapei or similar) and a top coating in any colour (for example: Elastocolor Pittura of Mapei). For protective layers and coating compatibility, please refer to your distributor.

System monitoring can be performed according to ISO standard 12696. Monitoring equipment can be supplied by your distributor together with the ZPA on request. Be aware that monitoring equipment designed for an impressed current CP-system is not always compatible with a CP-system based on galvanic anodes, specifically when current densities are monitored. See for more details Technical Data Sheet of ZPA.

Before installation, check accessibility of the construction and take precautions, if necessary.

If required, observe the instructions mentioned in the Material Safety Data Sheets (MSDS).

The installation procedure includes the following steps:

1. prepare the concrete surface.

2. localize the reinforcement.
3. make mechanically reinforcement connections.
4. check electric continuity of the reinforcement.
5. if required, perform additional potential mapping of the reinforcement to indicate the degree and extend of expected corrosion.
6. apply ZPA onto the concrete surface.
7. make electric connections of the reinforcement with the zinc-plate of the ZPA.
8. check electric connections with a resistance meter.
9. check polarisation of the reinforcement by use of reference electrodes.
10. Monitoring.
11. Protection and waterproofing systems.

It is recommended to keep up a logbook in which all steps are described and checked. Situations which differ from the installation procedures must be indicated accurately in the logbook and checked and signed by the supervisor prior to proceed.

In case certain situations is not clear how to handle the ZPA properly, we recommend contacting your distributor prior to proceed with the installation.

Each step of the installation procedure is described in detail below.

2. Prepare the concrete surface.

Prior to applying the ZPA the concrete surface should be prepared in the following manner:

1. Old concrete surfaces must be structurally sound. Any unsound areas must be repaired prior to proceeding with the installation. Remove existing paint, scale and loose concrete by steam clean, chiseling, rough sanding, sandblasting, shot blasting or dust free grinding. In some cases where plant conditions allow, a stripper may be used to remove excessive build-up of paints or sealers.
2. Paint must be removed the paint by scraping, wire brush, steam clean or power-washing the surface.
3. Dirt, grease, oil, chalk and under-eave deposits must be removed by washing with a detergent solution (TSP) or commercial cleaner recommended for cleaning concrete surfaces using a sponge or brush. Protected areas, such as under eaves and overhangs, need special attention to remove invisible deposits that can promote a premature disbanding problem. After washing, thoroughly rinse with clean water and allow to dry. Power-washing is also a fast, effective method of removing dirt, chalk, etc. If a power-washer is used, follow the manufacturer's recommendations and warnings.
4. Grind or chip all projections from the concrete greater than 5mm. Remove any loose concrete, and clean and fill holes, cracks and other surface defects with an approved method by use of a mineral cement-based mortar. We recommend using the standard ISO12696 when choosing repair mortars. The patch should be smoothed.
5. Make sure that after any surface treatment all dust and dirt is removed thoroughly to avoid futural disbandment of the ZPA.

3. Localize the reinforcement

The best and easy way to localizing the reinforcement is by use of rebar locator, which accurately locates reinforcing bars and welded wire meshes. Some rebar locators also measure the concrete cover and determines the diameter of the bars. A list of suppliers can be forwarded by your distributor upon request.

4. Make mechanically reinforcement connections,

After having localised the reinforcement bars of different concrete elements the locations are marked.

Connections with the reinforcement can be realised in different ways:

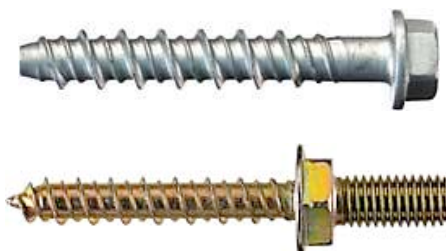
1. By welding a threaded bar on the steel reinforcement



2. By using powder actuated or gas-driven fastening tools. Pre-drilling holes in the concrete cover will make the handling of these type of tools more accurate.



3. By using screw anchor like fasteners (so called tapcons), which can be applied directly into concrete. Be aware of pre-drilling the holes with the appropriate drill bit diameter.



4. By using screw tappers.

5. Check electric continuity of the reinforcement

After making the right mechanical connection check the electric continuity of the reinforcement using a digital multimeter. Contact is obtained by using so called alligator clips. Switch the central knob of the multimeter to the resistance position (Ω) and measure the resistance. The criterion for continuity is less than 1 Ω .

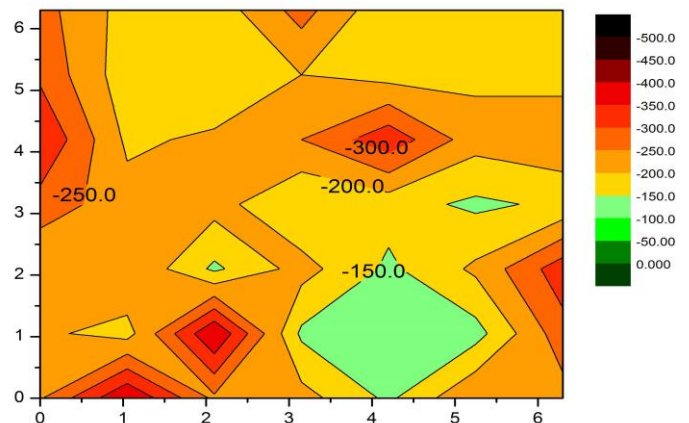


6. If required, perform additional potential mapping of the reinforcement to indicate the degree and extend of expected corrosion.

If a selective approach is desired due to economic reasons potential mapping of all concrete elements involved should be considered. During mapping the values are logged as computer-tables and later, with special software, processed as corrosion-graphics. This type of software analyses potential-values and gradients and calculates for each measuring location the possible chance of active corrosion. After the interpretation the results are presented as colour-cards. By using this measuring method hundreds of square meters of concrete surface per hour can be mapped and processed.

For further information about this technique and making the right interpretations, please contact our distributor or refer to the following standards:

ASTM, C876-09 (2009), Standard Test Method for Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete (USA and international).



7. Apply ZPA onto the concrete surface

After cutting the ZPA into the appropriate length the ZPA can be applied onto the concrete surface by hand-pushing. The topline should be removed first for a small section. Subsequently the topline is removed slowly and the ZPA pushed onto the surface at the same time. It is recommended to check the application by moving and pushing a rubber hammer over the total length of the applied ZPA.

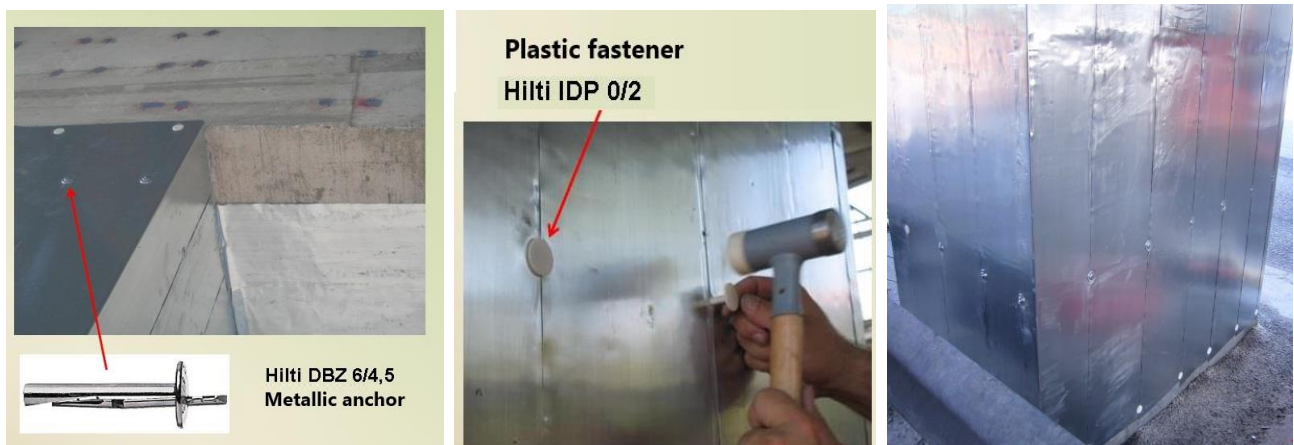
On a new or rehabilitated surface, provide a metal connection to the reinforcement bars on an average of every single element of the structure (column, beam, etc) and in any case no less than two to three connections on a single structure to be protected, depending on its development. The connection may be made as illustrated under.

8. Zinc sheet connections for electric continuity

When the ZPA is applied upon the concrete surface prior to apply a surface protection all the zinc sheets should be interconnected with each other for the electric current to flow to the sheets which are connected to the rebar. The resistance should be checked with a LCR meter and should be less than 1 Ohm.

The zinc sheets must be electrically connected to each other using both plastic fixings and metal anchors. Both fasteners not only provide continuity between the two foils, but also serve for safety reasons, in the unlikely event of the foil becoming detached from the concrete construction.

Please contact your distributor for support and equipment details.



9. Make electric connections of the reinforcement with the zinc-plate of the ZPA

Electric contacts of the zinc-plate of the ZPA with the in no. 4 mentioned mechanical connections as indicated at point 4: The most used way is here below described:

Weld a threaded bar on the steel reinforcement. Use the threaded rod to drill the foil then apply a washer and screw in a bolt securing it.



10. Check electric connections with a resistance meter.

Each electric connection with the ZPA is checked in a similar way as described in step no. 5. Instead of making the contact with alligator clips directly on the connections, it is checked by making contact directly with the zinc-plate of the ZPA.

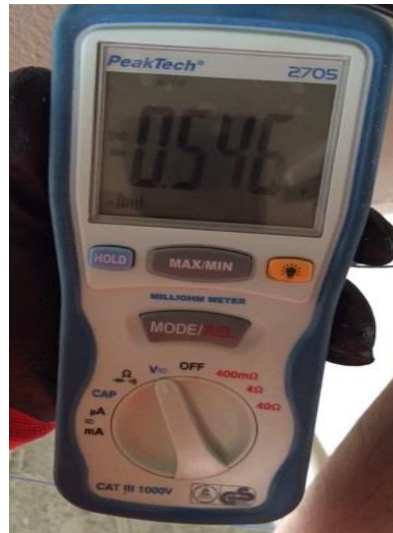
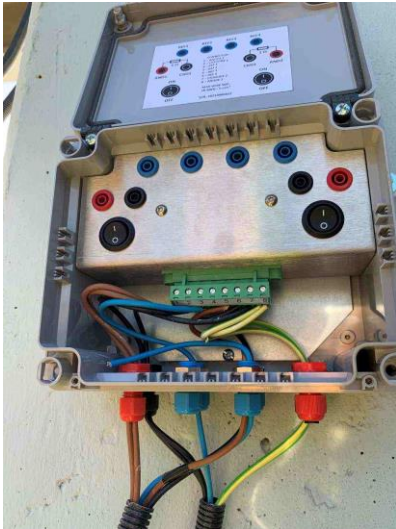


11. Monitoring.

According to the ISO standard EN12696 a monitoring system shall be incorporated In order to determine the performance of the cathodic protection system. Reference electrodes (RE) which are suitable for concrete are applied for monitoring purposes. Reference electrodes can be supplied together with the ZPA upon request.

According to ISO 12696: "the functional check shall be undertaken monthly in the first year of operation and, subject to satisfactory performance, thereafter at 3-month intervals. Typically, the performance assessment shall be undertaken at 3-month intervals in the first year of operation and, subject to satisfactory performance and review at 6 month to 12 month intervals thereafter". " At concrete temperatures below 0 °C potential monitoring may be impossible. The dates for performance monitoring should be selected to avoid measurements at such cold weather".

However, the nature of galvanic anodes implies a simplified monitoring process due to the fact that a galvanic system is self-regulated. Galvanic anodes/systems have no impressed power supply hence need no impressed current monitoring.



12. Protection and waterproofing systems.

A product's service life is its expected lifetime, or the acceptable period of use in service. Service life does not only depend on the estimated service life which can be calculated by the anode's consumption rates but also involves external or environmental factors. These environmental factors may have serious impact on the service life of ZPA if not taken into account.

In the next part some recommended products are presented which -if properly applied- will extend ZPA's service life. It is important however to strictly follow the manufacturers application procedures:

- Surface preparation and cleaning
- Sealing exposed ends, joints and external sheets
- Protection and waterproofing coatings / systems

- Cleaning

Before applying any of the following products it is important to clean the zinc sheet as well as concrete surface from dust, dirt and grease. To degrease the zinc sheet surface, use a clean, soft, absorbent, lint-free cloths. Clean the substrate with a solvent saturated cloth followed by a drying wipe with a separate clean cloth.

Often pieces of adhesive remain on the surface of the zinc sheet during cutting. These adhesive remaining should be removed completely with the use of water prior to any surface treatment.

Please consult the technical datasheets of each product prior to application.

- Sealing external sheets

After applying the anode, and in case of exposure to humidity, condensation or running water, the exposed ends and overlap or joints can be sealed with a sealant (for example: Sikaflex 11FC, Mapeflex PU40 or PU45) to avoid the ingress of water between the sheet and concrete.



- Protection and waterproofing coatings

At the end of the application operation, a topcoat must be applied over the zinc foil following the instructions previously mentioned.

The MAPELASTIC product supplied by Mapei has been used as a topcoat for many years with satisfactory results.

The product is applied directly onto the surface without the use of any primer, and this is certainly an advantage.

In any case, many products are available on the market which are compatible with zinc surfaces. If in doubt, ask your agent or distributor.



If you have any interpretative doubts about the above zinc foil application procedure, please contact your materials supplier.