ZINGA ON REBARS

In the second half of the 20th century, the construction and building sector was characterised by a concrete-craze that assumed vast proportions in all continents. At the same time the technique of reinforcing the concrete with steel bars or rebars was developed. In the beginning people did not realise that these steel bars would cause such major problems after only a short period of time. Due to the formation of rust, the steel bars began to expand and the concrete began to crack, which led to gigantic safety problems.

THE MECHANISM OF CONCRETE CRACKING

The highly alkaline conditions inside concrete provide a passivating environment for the reinforcement bars. A thin layer of oxides forms on the steel surface. This oxide layer is stable in the alkali rich solution and protects the steel against further corrosion. The steel is unlikely to rust as long as the passivating conditions remain at a pH of 10.

Well compacted concrete and an adequate protection of the rebars also provide a physical barrier against corrosion by reducing the penetration of atmospheric carbon dioxide (CO2), oxygen and moisture. (These 3 elements initiate and sustain corrosion reactions.)

Passivation can be destroyed due to a reduction in alkalinity. This can have various causes :

- infiltration of atmospheric carbon dioxide (CO2) (carbonation)
- infiltration of sulphur dioxide (SO2) in industrial climates
- infiltration of aggressive chloride ions in marine environments
- infiltration of de-icing salts sprayed on the concrete surface of roads in winter

The rust can form up to 2 times the volume of the initial steel and can cause cracking of the concrete or even the complete destruction of it.

ANTI-CORROSION PROTECTION OF REBARS

Over the years, people have tried to protect concrete from cracking in several ways:

- By making a better compacted concrete
- By adding corrosion inhibitors to the concrete
- By active and passive protection of the rebars


HDG Rebar

The first type of protection that was used on rebars was paint. But coating rebars with an ordinary paint is of course no solution for the corrosion of the rebars. Very few paints sustain the high pH of fresh concrete (approx. pH 13). Moreover, a paint coating is porous. Penetration of moisture and oxygen can not be prohibited.

The second solution was hot-dip galvanisation, but this is still far from perfect. Cracks caused by the bending of the rebars, can easily destroy the galvanising layer. Another problem is that hot-dip galvanised rebars do not provide enough adhesion for the concrete. Moreover, the rebars need to be galvanised in a specialised workshop, equipped with a galvanising bath, which means that the rebars have to be restricted in size. This will cost time and money due to the distance and the transport to this galvanising workshop, which can be very expensive in some parts of the world.

The latest developments in the attempts to protect rebars against corrosion, prove to be ineffective as well. In North America, reinforcing concrete can be done with rebars made out of polypropylene, which is very expensive. This is still not a good solution because polypropylene does not provide an adequate adhesion for the concrete. In Germany a steel laminating plant will offer you stainless reinforcing steel (at a very high price of course). Here also there is a problem of adhesion with the concrete. Moreover, bending a stainless steel rebar is practically impossible without cracking.

THE PROTECTION OF REBARS WITH ZINGA

In comparison with all other methods of protection that have been tried out on reinforcing steel, a thin layer of ZINGA (approx. 40-60 µm) provides the best protection at a very low and cost effective price.

The surface preparation of new rebars should be done by blasting to cleanliness degree SA 2.5 and roughness degree Ra 12.5 µm. For repair of already rusted rebars, the rust should be removed by means of a steel brush, or high pressure water jetting (100 bars to 200 bars).

A ZINGA layer is flexible and compressible and will not crack or be damaged by bending the rebars (to a certain extent). This is surely an important aspect in view of the fact that rebars are generally very roughly manipulated. Moreover, ZINGA offers a good adhesion to the concrete.

The drying time of ZINGA before the contact with the concrete is very short (approx. 1 hour). As soon as ZINGA is touch dry, the concrete can be cast. From the moment that the fresh concrete encapsulates the reinforcing steel protected by a ZINGA layer, some oxidation of the ZINGA layer will occur (due to the pH of the fresh concrete), which will have the following consequences:
- Zinc salts are formed on the surface of the coating. They will seal off the ZINGA layer completely, thus providing an additional barrier protection.
- The zinc salts will roughen the ZINGA surface. This will provide an even better adhesion for the concrete.

Extensive testing at the University of Gent (Belgium) has confirmed these unique qualities of ZINGA to protect rebars in concrete (see below).

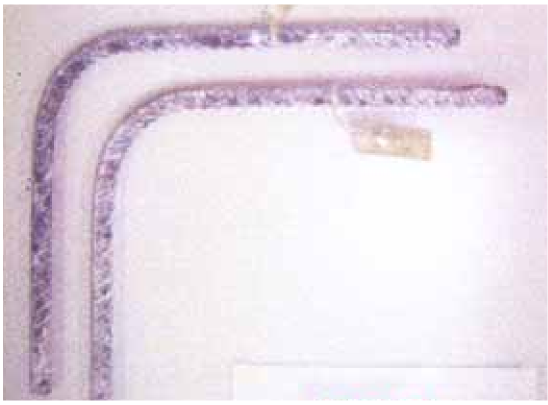
TEST REPORTS ON ZINGANISED REBARS

ASTM B117/ISO 9227 (SALT SPRAY TESTING) - SAI/JU/AUPTT*

Steel Authority of India (2006):
A comparison was made between uncoated steel rebars, fusion bonded epoxy coated rebars (FBEC), hot-dip galvanised rebars (HDG) and zinganised rebars (ZINGA). The corrosion rate per year was measured after immersion and salt spray. This test demonstrated several advantages of ZINGA: the greater degree of galvanic protection, the lower sacrificial zinc consumption due to the dispersion of zinc dust in the binder and the additional barrier protection created by the binder.
ZINGA > FBEC > HDG > Uncoated

Jadavpur University (2006):
A comparison was made between uncoated steel (Mild steel and Stainless steel) rebars, fusion bonded epoxy coated rebars (FBEC), hot-dip galvanised rebars (HDG) and zinganised rebars (ZINGA). The salt spray test pointed out that the zinganised rebars have a corrosion resistance that is about 2 times higher than that of hot-dip galvanised rebars. ZINGA is also least susceptible for stress corrosion cracking.
in NACE solution: ZINGA > HDG > FBEC > Stainless steel > Mild steel

Amirkabir University Poly Technic Tehran (2008):
The zinganised rebars passed the 500 hours salt spray test without formation of rust, peeling or blistering, not even in places where the coating was mechanically damaged. The rebars that were not zinganised were heavily corroded.



ISO 1519 (BEND TEST) - COT

ISO 1519: Paints and varnishes -- Bend test (cylindrical mandrel)

ZINGA has been applied at a layer thickness of 60 µm DFT on test panels and bent by a mandrel tester at 23°C and 50% RV. The diameter of the mandrels are 32 mm, 25 mm, 20 mm, 16 mm, 13 mm, 12 mm, 10 mm, 8 mm, 6 mm, 5 mm, 4 mm, 3 mm and 2 mm.
Immediately after bending, the coating has been examined under good illumination with normal corrected vision.

ZINGA showed no cracks when bending on a cylindrical mandrel with a diameter of 12 mm.

RILEM/CEB/FIP RC6 (PULL OUT TEST) - UGENT

RILEM/CEM/FIP Recommendation RC6-1978: Technical Recommendations for the Testing and Use of Construction Materials: Bond test reinforcing steel - 2. Pull-out test

Three rebars with enhanced adhercnce L = 1000 mm; ø =18 mm were tested.
- One rebar is embedded in concrete in the uncoated condition.
- Two rebars were first coated with a ZINGA coating of 25 μm over a length of 500 mm and subsequenty. after 72 hours of drying time, embedded in concrete.

The rebars were embedded in the center of concrete cubes and a plastic tube is slipped over the rebar in such a way that only 90 mm of the rebar is in contact with the concrete.
After 28 days cure, the pull-out test was performed.

An average adhesion force for ZINGA on rebars of 17.03 N/mm was found. This was comparable to the uncoated rebars (18.90 N/mm).
It was concluded by Prof. Dr. Eng. Defrancq that the adhesion to concrete of rebars coated with ZINGA is not advesely affected compared to the adhesion of non coated rebars.

CLEAVE ADHESION TEST - B-HOLDING

A custom test was designed to test the adhesion of (zinganised) rebars to the concrete. A rebar coated with ZINGA, an untreated and a sandblasted rebar were imbedded in concrete.
The rebars were aged using SO_2 (Kesternich).

The concrete was cleaved, in order to set free the steel reinforcement.

Conclusion:
It is clearly more difficult to cleave the rebar bloc containing the steel rod protected with ZINGA. The adherence of the concrete to the Zinganised rod is better. The actual cleavage happens in the concrete (in contrast to the other two rebars, which cleaved neatly between steel and concrete), which indicates a strong adherence.

APPLICATION METHODS

SMALLER APPLICATIONS

ZINGA can be easily applied by brush, roller or spray on rebars.

LARGE QUANTITIES

For the treatment of large amounts of rebars, an automatic rebar installation becomes price efficient.

In the period 2005-2010 large quantities of Zinganised rebars have been produced at an automatic rebar coating installation in Iran by our distributor.

Technical specifications:

1. Incoming uncoated rebars are stocked above the feeding line, up to a quantity of 50 tons.
2. All rebars are manually handled onto an automatic side conveyor. Up to 16 rebars per charge.
3. The side loader is automatically transferred to the treatment line. The 16 rebars are lifted and positioned in the treatment line.
4. The rebars are then heated. The heat will loose the mill scale from the underlying steel. The surface temperature of the rebars mounts up to 60°C.
5. The rebars automatically enter the wheel blast machine. Automatic (electrically driven) wheel blasters are grit-blasting the rebars to cleanliness degree SA 2,5 and roughness degree 30 to 40 µm Rz. The surface temperature of the rebars is still too high after blasting.
6. The rebars are then pushed through brushes in order to remove the dust and grit, this is followed by dedusting with clean air.
7. The rebars automatically enter the temperature equalising area. In order to avoid temperature stresses in the steel, the inner and outer temperature of the rebars is equalised.
8. The rebars pass through an automatic spray booth in which two reciprocators are spraying the Zinga.
9. The rebars pass through a drying oven.
10. The rebars are transferred automatically to the end station for unloading.
11. The rebars are automatically unloaded and are manually bound together, so that they are ready for transport.