ZINGA

Film Galvanizing System

On Reinforcing Bars (Rebars)

Katodisk beskyttelse på stål i betong

ZINGA can be used on all rebars regardless of the steel's composition

Katodisk beskyttelse på stål i betong

THE PROBLEM 1 : Corrosion of rebars

- Rebar corrosion is the principal cause of concrete deterioration globally.
- Poor quality concrete, high ambient temperatures during the pouring, poor compaction/low densities and carbonation of the cured concrete are some of the causes of concrete deterioration.

THE PROBLEM 2: Corrosion of rebars

- It is, however, the **chloride ion** which is the principal cause of rebar corrosion.
- Whether it is in the form of sodium chloride from de-icing salts / sea-spray, or calcium chloride additives used in the concrete, the **chloride ion** is to blame.
- This sets in motion a chain of events that lead to the destruction of the rebars.
- In USA there are 600,000 concrete bridges – 24% are structurally deficient.

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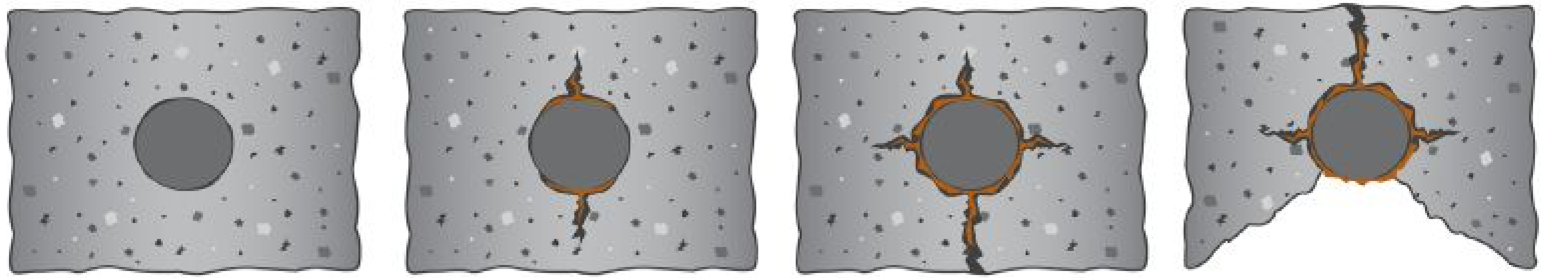
Katodisk beskyttelse på stål i betong

THE PROBLEM 3: Corrosion of rebars



BEFORE CORROSION.

BUILD-UP OF CORROSION PRODUCTS.

FURTHER CORROSION. SURFACE CRACKS. STAINS.

EVENTUAL SPALLING. CORRODED BAR. EXPOSED.

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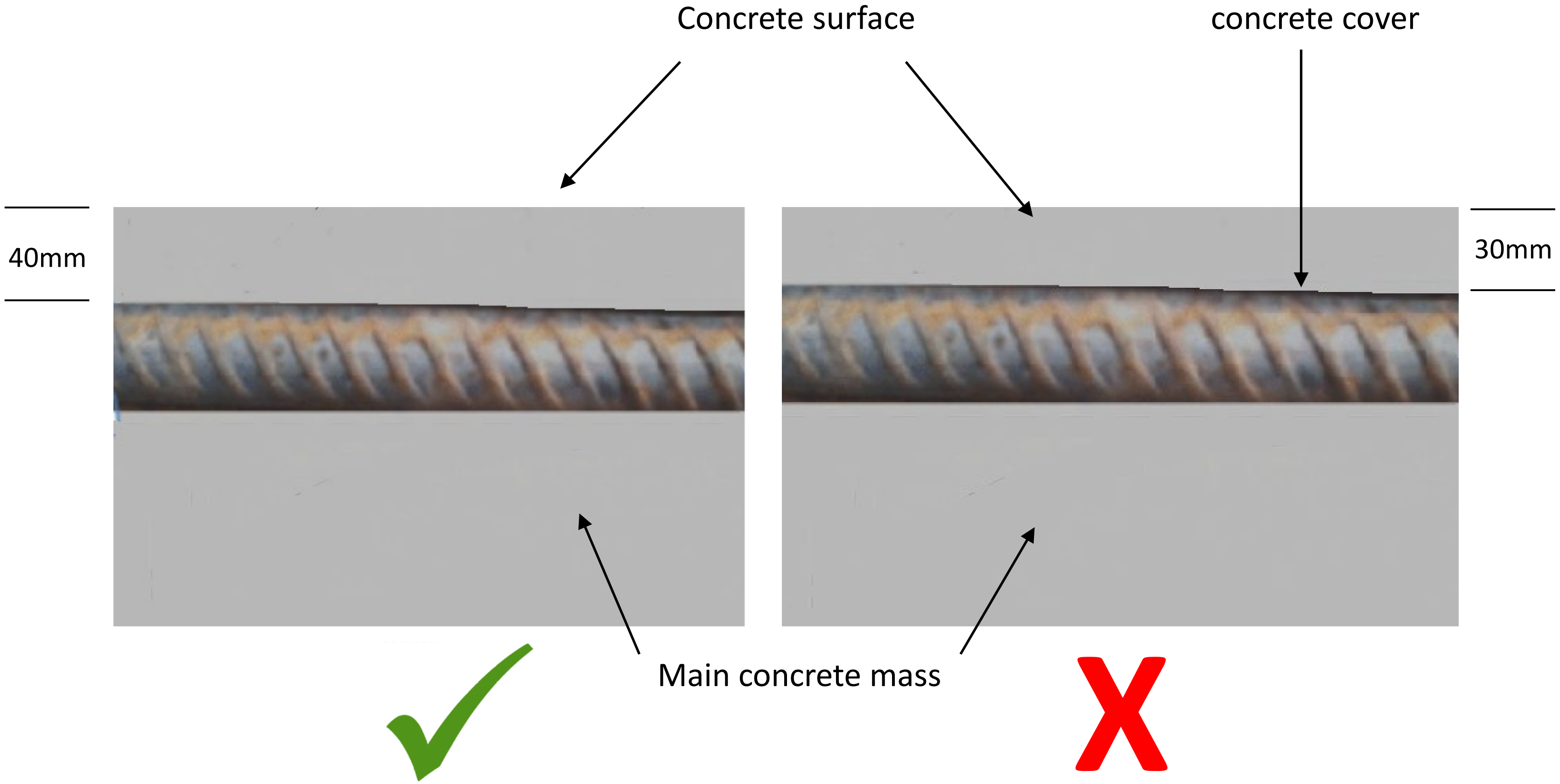
Katodisk beskyttelse på stål i betong

THE SOLUTION : ZINGA coated rebars

Katodisk beskyttelse på stål i betong

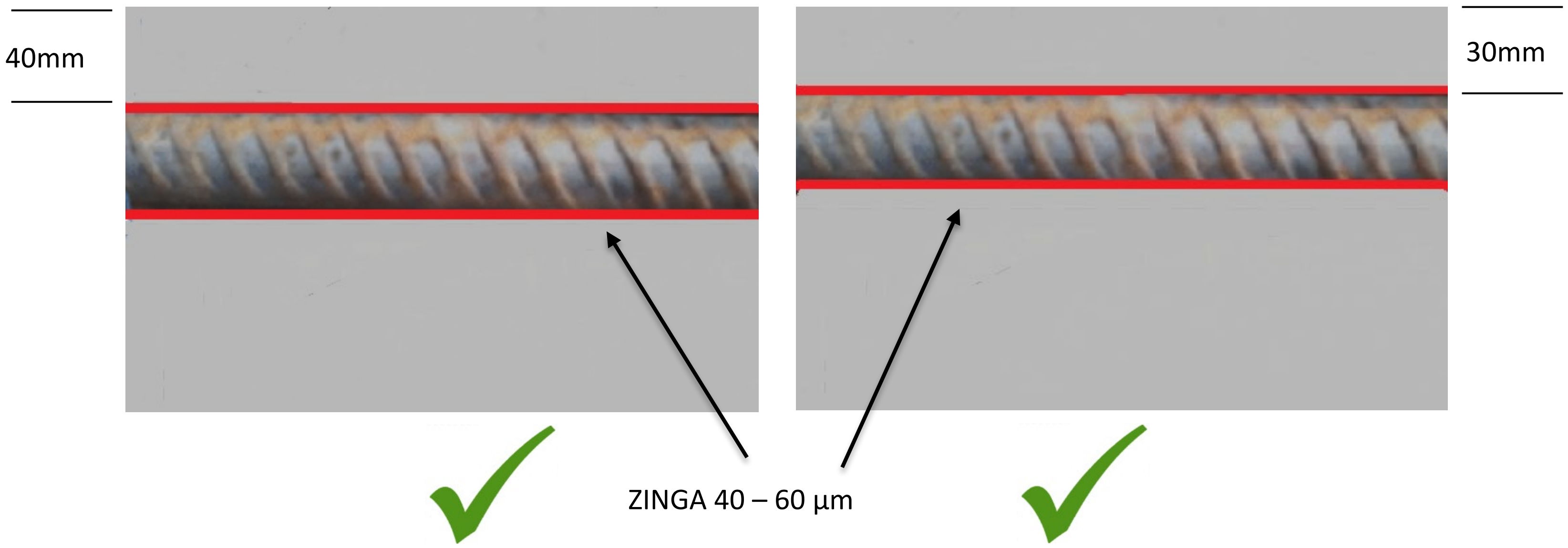
The importance of concrete cover-thickness



Katodisk beskyttelse på stål i betong

The importance of concrete cover-thickness

Zinganised rebars make a big difference at lower cover thicknesses



Concrete cover-thickness

Country	Concrete Code	Range of Concrete Cover (mm)
UK	BS:8110	25-50
EU	EN 1992 (EC2)	10 - 55
USA	ACI:318	40-50
Australia	AS:3600	15-78

Some levels of cover are very low in some countries, and this is where it becomes critical to have the correct coating on the rebars.

Katodisk beskyttelse på stål i betong

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The importance of rebar coating flexibility

Bending multiple 12mm rebars simultaneously

Katodisk beskyttelse på stålbruer

The importance of flexibility of the coating at rebars

Concrete structures often require many thousands of bent ends or mid-sections on the rebars before tying-off begins. Flexibility of the rebar coating is always crucial.

Rebars – tying off

Tying-off can take three days..

…or three months!

Rebar composition: its affect on coatings

In some countries scrap metal is alloyed with certain elements to produce local rebar steel, and the composition of the rebars can play an important role in the selection of the most effective coating.

The addition of manganese to produce an extremely hard, strong steel is quite a straighfroward process.

There are regional variations of steel composition around the world, and most steels contain silicon to obtain a good compactness/density to increase strength. This silicon content can be added-to, but it cannot be removed.

Where the silicon content of the steel is too high, it can preclude the use of HDG coatings because they tend to keep building on themselves.

This produces heavy, sometimes flaky (and expensive) zinc coatings that will crack when the rebars are bent on site for tying-off, or even under impact

Katodisk beskyttelse på stål i betong

HDG coatings on rebars (negative aspects) 1

- HDG rebars cannot always be bent on site for tying-off, as the coating will crack.

- In countries where rebars are made from scrap steel, any rebars containing more than 0.4% silicon will tend to 'over-build' the zinc layers, sometimes in a layered format. This uses a lot of excess zinc and puts up the coating costs per batch or rebars and also deposits a weakened zinc-film onto the rebars.

- In concrete, only the eta layer of the HDG is doing any 'work' to protect the rebar, and the intermetalic alloy-layers contribute very little towards the cathodic protection.

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Katodisk beskyttelse på stål i betong

HDG coatings on rebars (negative aspects) **2**

- It is widely acknowledged that HDG zinc on rebars will produce hydrogen during the concrete-pour, creating a lot of porosities along the length of the rebar and lowering the density (and subsequent pull-out values) of the concrete in the affected areas of rebars. Many scientists and engineers are not happy about this issue.

- *The zinc in ZINGA produces a certain volume of zinc salts that will effectively fill and block any porosities. So the degree of porosity is far lower than that produced by HDG when it comes to blocking ingress of carbon dioxide and sulphur fumes from vehicle exhausts.*

- HDG coatings generate a large carbon foot-print:
  (a) at source during production of the zinc ingots
  (b) at the dip-tank site where it requires a lot of energy to keep the bath molten (@ 450°C)

Katodisk beskyttelse på stål i betong

Zinganised rebars

- Zinganising can be used on all rebars regardless of the steel's composition
- It does not require a large energy supply on site
- It generates a small carbon footprint (manufacturing the zinc dust)
- Zinganised rebars have a pure continuous eta layer on them (96% pure zinc overall)
- The coating has an excellent flexibility factor.
- It is a highly reactive coating, sealing the concrete pores adjacent to the rebar surface during the hydration phase.
- This actively blocks carbonation from taking place for a few decades.
- Very easy to touch-up any rebars damaged by severe impact.

Katodisk beskyttelse på stålbruer

Some Tests & Certificates:

- **Surface Engineering & Coating Consultant (Mumbai):** ASTM D3359 (Adhesion)
  ASTM D4060 (Taber Abrasion)
  ASTM A775 (Immersion)
  ASTM B117 (Salt spray 1000h)
  IS 1786 (Bend test)
  IS 2770 (Bond strength)
- **Jadavpur University:**
  Corrosion resistance of ZINGA is 2 times higher than HDG and less susceptible to stress corrosion cracking
- **Steel Authority of India:**
  Greater degree of corrosion protection & lower sacrificial zinc consumption compared to FBE coated rebars and HDG rebars
- **National Metallurgical Laboratory of India:**
  ZINGA coated rebars exhibit superior corrosion protection than FBE, HDG and CRS
- **Steel Authority of India:** ZINGA coated rebars demonstrate superior corrosion performance over FBE and HDG
- **SABS Laboratory (South African Standard):**
  ASTM B117 – ISO 9227 (Salt spray) – loss in weight of ZINGA is 1/10th of loss of HDG
- **COT Laboratory (Netherlands):**
  ISO 1519 (Bend test): ZINGA 60µm DFT shows no cracks when bending on a cylindrical mandrel with a diameter of 12 mm

… and many other tests & certificates showing the exceptional behaviour and performance of ZINGA on rebars

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Katodisk beskyttelse på stål i betong

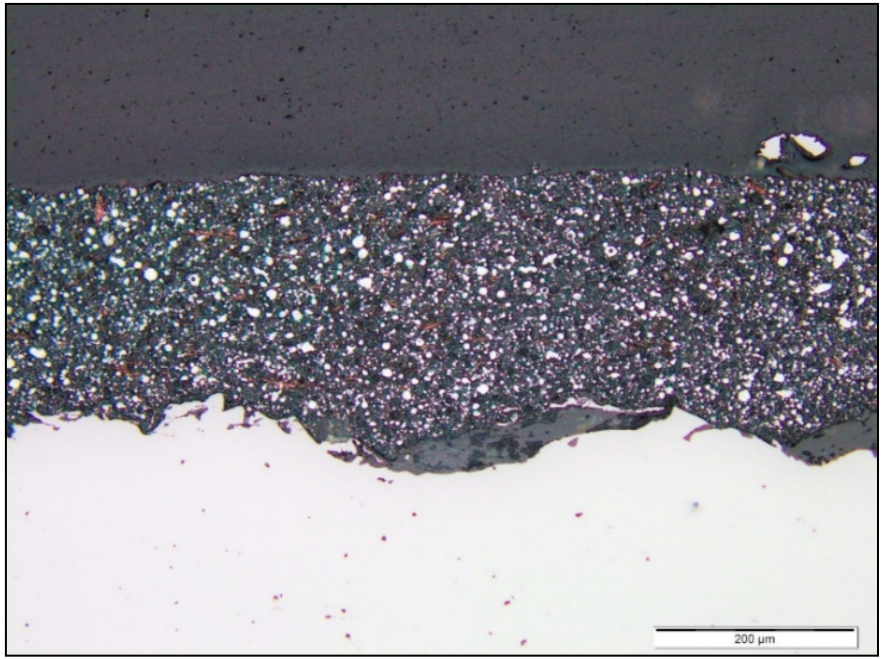
Rebar Corrosion Protection

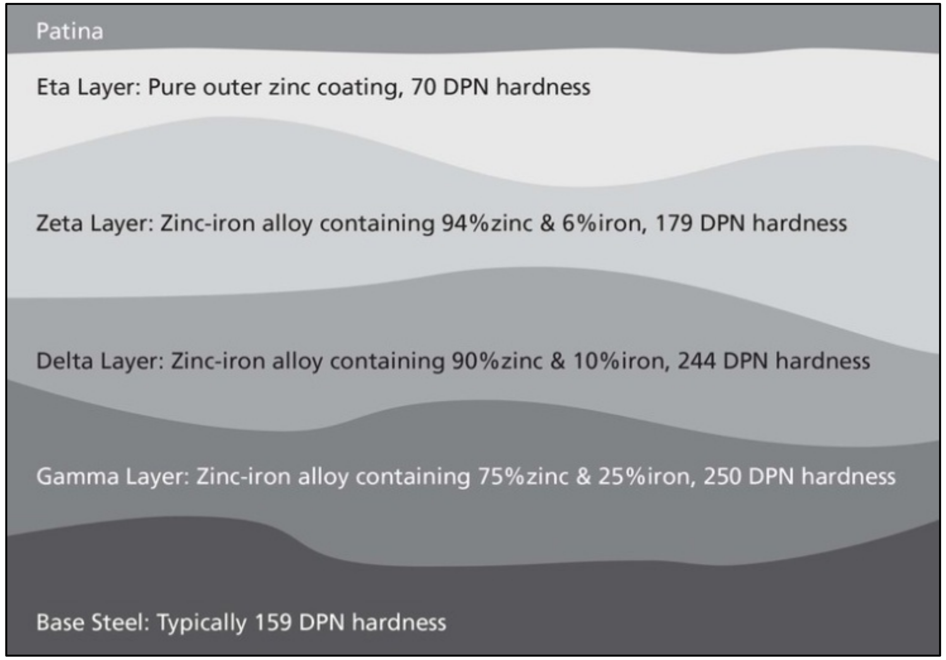
	HDG	Zinga
Toxic ingredients post application	No	No
Adhesion to / bonding with concrete?	Good	Excellent
Cracks, peels off	No	No
Provides active (cathodic) corrosion protection?	Yes	Yes
Welding tolerance	Limited	Good
Re-coatable/ re-loadable after transport	with ZINGA	Yes
Long pot / shelf life	N/A	Long
Significant embrittlement when bending	Yes	No
Underfilm Corrosion	No	No
Requires special handling	Yes	No
Flash point (solvents) during application	N/A	Low Risk (<47°)
Large carbon foot-print	Yes	No
Expected Service-life	+100 y	+100 y

Katodisk beskyttelse på stål i betong

ZINGA layer

HDG layer





ZINGA layer = 96% atomised pure zinc over the whole layer

HDG layer = when depletion rate becomes higher, less zinc to protect the rebars

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Katodisk beskyttelse på stålbruer

ZINGA versus HDG on steel

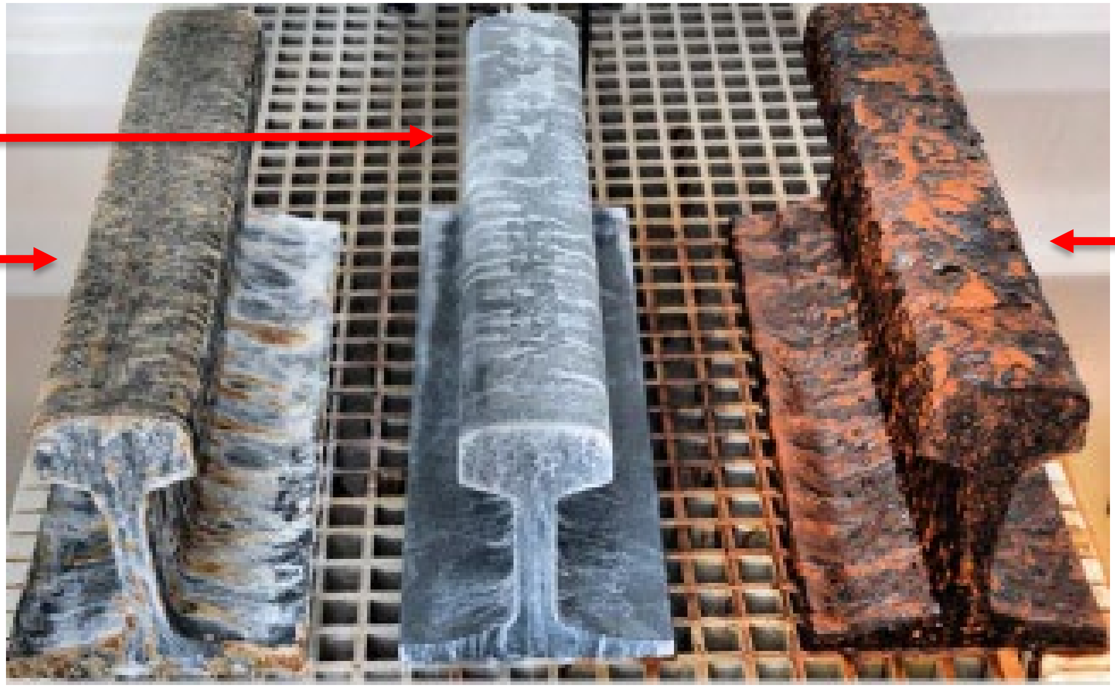
Test by TATA STEEL RAILCOTE

After 624 hours salt spray exposure.

ZINGA rail :   150 µm to 200 µm DFT
HDG rail :   210 µm to 320 µm DFT

ZINGA

HDG



Not coated

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Thank you for your attention!

Questions?

www.zinga.no
post@zinga.no

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