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Corrosie Advies Dienst

Galvanic corrosion of DEMU bar and bolt anchors.

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(English version, translated by Ir. CME van Thoor)

Disclaimer:

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(This report consists of 5 pages excluding attachments and may only be distributed entirely)

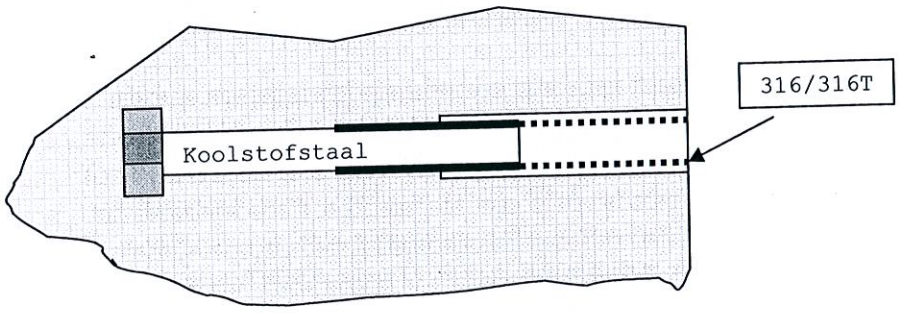
1.0 Introduction

DEMU Metaalindustrie BV has requested the Corrosie Advies Dienst/Nederlands Corrosie Centrum to investigate:
Whether the application of DEMU bar and bolt anchors can lead to galvanic corrosion and if so to what extent.

Remark;
Before we go further into detail on the subject of galvanic corrosion or bimetallic corrosion, we have to state the fact that in most cases where galvanic corrosion occurs, it seldom leads to severe damage. Only when all conditions conspire together, clear damage can arise. These situations rarely occur.
Many people, unfamiliar with corrosion engineering, have the impression that galvanic corrosion will occur automatically when 2 different connected metals will be brought together in a moist environment.

2.0 DEMU bar and bolt anchors

Bar and bolt anchors applied in a stainless steel edition consists of two metal alloys, e.g. Carbon Steel (CS) bolt and an austenitic stainless steel tube, e.g. SS type 316/316Ti.



The SS tube is screwed partly on the CS bolt. After pouring the concrete, the anchor will be embedded entirely in the concrete. See sketch.

3.0 Galvanic corrosion

Two different metals connected in a moist environment would lead to galvanic corrosion according to many people. However the subject of galvanic corrosion is not that easy.

There are a number of conditions to be met before any serious damage due to galvanic corrosion will occur:

- Two metals/metal alloys have to be electrically connected, i.e. for this situation direct physical contact.
- The metal couple must be situated in a corrosive medium with a very good electrical conductivity (low ohmic resistance), a so called "electrolyte".
- The metal couple shall have a difference in potential (compared to standard H_2-electrode)
- The relative surfaces and the distance between anode (less noble metal, CS) and the cathode (noble metal, SS type 316/316Ti) are important.

  A small surface of anode (less noble metal, CS) to a large surface of the cathode (noble metal, SS) will increase the corrosion velocity and as such the damage to the anode.
  A large surface of the anode (CS) to a small surface of the cathode (SS) will decrease the corrosion velocity and as such the damage to the anode. The damage to the anode will be low.
  If the anode and the cathode are at a certain distance, the conductivity of the electrolyte will be the determining factor. Hardly any corrosion will occur with an electrolyte with a low conductivity .

- Degree of polarisation of the cathode

  If above mentioned conditions are met then galvanic corrosion of the anode (CS) will occur. After a short time corrosion products will be formed as different oxides and/or hydrogen. These corrosion products will deposit on the anode (CS). The anode will be polarised by this deposition, i.e. the potential difference between the anode and the cathode will decrease in many situations. As the potential difference decreases the corrosion rate will decrease or comes to a standstill.
  For those situations where the corrosion products will be removed, for example at high medium velocities, the corrosion rates will not be influenced and corrosion will continue.

If all above mentioned conditions are met than serious galvanic corrosion can occur. However in most situations, one or more conditions are not met at all or only very moderately. As a consequence no galvanic corrosion will occur or only minor galvanic corrosion will occur. Practical experience shows that seldom severe corrosion occurs due to galvanic corrosion.

4.0 Galvanic corrosion of DEMU bar and bolt anchors

Considering the situation with the DEMU bar and bolt anchors related to the above mentioned conditions, we can make the next considerations:

Parts of the anchors embedded in the concrete

The potential difference between the 2 metals (CS and SS type 316) is ~ 0.7Volts (measured in seawater). The electrical conductivity of the present electrolyte (rainwater) is much lower than of seawater. (seawater ~ 25 Ohm/cm, water in a natural surroundings ~ 500 - 5000 Ohm/cm). The resistance of the circuit will decrease dramatically. The Carbon Steel part (anode) is situated in the alkaline environment of the concrete. This alkaline medium is not corrosive to CS. The CS is passivated and no corrosion will occur at the CS surfaces embedded in the concrete.
Galvanic corrosion will not occur in the concrete due to the high resistance of the electrolyte and the passivation of the CS.

Parts of the anchors not embedded in the concrete

Galvanic corrosion might occur at the SS tube and the externally attached CS bolt. For this situation the anode surface (CS) is smaller than the cathode surface (SS) and accelerated damage could occur. However for most situations the conductivity of the electrolyte is too low so any damage will be low (rust forming on the bolt). After assembly of the bolt into the tube, the amount of moist/water will evaporate. The CS bolt can show some rust on the surface but due to lack of moist (electrolyte) and polarisation of the anode, the corrosion will stop.
If seawater is present, the CS will be effected more severely. Also valid for this situation is that corrosion will stop as after assembly no electrolyte will be present and the anode is polarised.
As a precaution for seawater environments, one can apply some grease or tectyl on the SS tubes after pouring the concrete followed by assemblying of the bolt. Other moist expelling applicants can be used as well.

Concluding
The risk of severe galvanic corrosion of bar and bolt anchors, embedded and not embedded in concrete, is small and galvanic corrosion is not to be expected. This conclusion is confirmed by many years of practical experience.

Remark;

Moist expelling applicants are available on the market: e.g. Mavom (CRC SP 400, spray), Cortec (369 VCI, grease), Servo (anti-moisture or R41 aerosol dispenser spray).

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