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Construction Fibres

TECH NOTE

The reaction of galvanised steel in concrete

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Galvanization (or galvanizing) is the process of applying a protective zinc coating to steel or iron, to prevent rusting. The most common method is hot-dip galvanizing, in which parts are submerged in a bath of molten zinc.

Corrosion

Corrosion of steel is an electrochemical process with different reactions occurring at the anodic and cathodic sites. A supply of water and oxygen is required to maintain the reaction.

In new concrete the background pH is about 12.5. In these conditions a stable oxide "passive" layer is formed on the surface of the steel which provides protection from corrosion. If the concrete carbonates to the depth of the steel and/or chlorides are present the protection can be lost.

Products of corrosion generally occupy a larger volume than the uncorroded steel. Unhydrated ferric oxide is about twice the volume, once hydrated it may be up to 6 to 10 times the volume.

This will cause the concrete to spall once the tension generated by the extra volume of the corroded steel, exceeds the strength of the concrete. Consequently the rebar is not protected by the alkaline environment of the concrete and it will oxidate even quicker. The reinforcement loses his strenght , hence the structure becomes unsafe.

Galvanised steel

To avoid steel from rusting often a sacrificial layer is applied by means of galvanisation. Galvanised reinforcement will provide some improved corrosion resistance in situations in which carbonation is the main problem. It does not provide any significant protection against chloride attack. Standard reinforcing bars are hot dip galvanized, in accordance with BS EN ISO 1461.

It should be noted that the cost of galvanised reinforcement will be about twice that of carbon steel. However, it may be a viable alternative in aggressive locations with the higher initial cost being justified by reduced maintenance or an extended service life. The normal requirements for concrete quality and cover should not be relaxed.

Chemical reaction with galvanised steel

Tube reactions between galvanized reinforcement bars and concrete are only of concern during the initial curing stages of the concrete. The initial stages of curing include the time when the concrete mix is still wet. During this time the pH of the concrete is very alkaline with a pH of approximately 12.5. The wet concrete reacts with the zinc to form hydroxyzincates (Ca[Zn(OI-OH x 2 H20), which protect the zinc from further corrosion, but can evolve *hydrogen gas*. Excessive hydrogen evolution during curing results in a more tenuous interface between the galvanized steel and the concrete, thus reducing the bond strength. Using concrete mixes with extremely high pH's may increase these reactions to unacceptable levels. Wet concrete mixes with a pH of over 13.3 have shown to significantly increase the reactions between concrete and galvanized rebar and should be avoided if possible without chromates.

The reactions that occur during the initial curing phases of the concrete can be limited by use of chromate. Chromating the galvanized steel has shown to limit the reaction between the concrete and the zinc, thus reducing the amount of hydrogen evolved. Chromate can either be applied to the rebar directly after galvanizing, or small chromate additions can be made to the concrete mix. The amount of chromate that is added to the concrete remains in question.

Galvanised steel fibre reinforced concrete must always contain chromates otherwise the performance of the composite can not be guaranteed.

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