Anaco Stainless

Experts in stainless steel for engineering and construction

History of Stainless Steels' Use in Construction

In the last 30 years, stainless steel has gradually grown in popularity and understanding as a form of steel reinforcement which is capable of enabling reinforced concrete structures to meet their expected design and service lives. This is because stainless steel does not corrode like carbon steel reinforcement.

Since the 1970s, engineers have invested time and expertise in optimising the use of concrete for reinforced structures. This has led to a new and excellent generation of concretes called High Performance Concretes. The HPC are the thoroughbreds of concrete. They were designed to reduce cover, cure and reach working strengths quickly to speed up the delivery of projects and, therefore, time on site. In recent years, exciting new Self-Compacting Concretes are reducing requirement for mechanical compaction. Simple Portland Cement and aggregate mixes with thick cover gave way to this new breed of concrete in an attempt to optimise concrete usage and address the greater susceptibility of carbon steels to corrode. The onset of environmental concerns have increased interest in limiting the quantity of concrete used in structures. Limitation of use leads to lower CO2 emmisions resulting from reduction in cement production and, in the case of precast structures, improved logistics of delivery.

Unfortunately, HPCs have, to date, not managed to guarantee an impervious barrier between the external environment and the reinforcement lying within the concrete. Many 'coated' forms of carbon steel reinforcement have been introduced and developed. However, these have not 'significantly' improved the life of the reinforced structures. Other intelligent attempts to create impervious barriers in terms of coatings on the surface of concrete structures as well as incorporating chemicals which inhibit flow rate and, or, assist in neutralising the influence of deleterious substances diffusing into the concrete have been used. Not one of these 'cheap' solutions have led to 'significant' long term durability for structures. A charitable interpretation may be to state that they do not have a sufficient 'track record' and tend to be used to salve consciences on the basis of:

'look, what happens in 30 years isn't going to be my problem and even if I'm still alive to witness bridge collapse, you can't blame me because I had a tight budget – anyway, I didn't build the blooming bridge the civil engineering contractor did so they're to blame I'm only the specifier'.

The critical problem is that some of these solutions are not even surviving 30 years.

This has led to the reluctant realisation that a much more expensive alternative, namely, stainless steel, might be a viable alternative. The North England expression, 'you don't get owt for nowt' rings true yet again.

The appreciation for the use of stainless is now gaining worldwide momentum. It may cost considerably more 'upfront' when compared in isolation, on a like for like basis, with carbon steel or coated alternatives but, if used intelligently in a structure in conjunction with carbon steel reinforcement, the additional cost to the overall project is negligible. When evaluated on a 'whole life-cycle' cost analysis stainless becomes the obvious choice to include to prevent early degradation of a project.

It is recognised that stainless steel should only be used where deleterious materials form part of the concrete; the aggregate or water is contaminated or the environment into which the reinforced concrete structure is to be introduced is an aggressive one. The most common 'aggressive' environment is caused by salts which either attack the reinforcement or the concrete or both depending upon their nature. These can migrate from aggressive ground conditions assisted by hydrostatic forces or capillary action or, more commonly in the temperate Northern European environment, from marine or road salts.

Finally, the progressive carbonation of concrete cannot be ignored for those structures which are designed for genuine long term Service Life Design. Carbonation lowers the pH of the concrete which, at the outset, will normally range from 12.5 to 13.5. The reaction of Ca(OH)2 with CO2 to yield calcium carbonate.

$CO_2 + H_2O$ yields $CaCO_3 + H_2O$

The gradual diminution of Ca(OH)2 reduces the alkalinity of the concrete. This helps to initiate corrosion in carbon steel. The protective oxide layer preventing the initiation of pitting starts depassivate at around pH 9. Carbonation therefore has to be considered for Service Life Design of 100 years plus if concrete cover does not also increase to compensate for the rate of diffusion of carbon dioxide through the concrete. One of the imponderable variables to be considered is the influence of temperature. As we enter what some consider to be a period of global warming, with also much higher levels of CO2, the period to initiation of pitting will decline for a fixed value of cover. The rate of reaction will approximately double for every 10°C increase in ambient temperature.

Turning a blind eye today to such issues is no better than an irresponsible attitude towards abuse the environment – both have causal effects which are in the long run much more damaging and costly than correct (proven in the case of stainless steel) remedies today.

What we have not addressed here is the cracking of concrete which clearly will depend on the type of concrete used, method by which both reinforcement and concrete is set and formed. In addition, freeze thaw cycle in Northern regions is not considered.

The ‘break through’ for stainless steels as a form of reinforcement has come with recent research which has confirmed that stainless steel can be used together with carbon steel reinforcement without any need to isolate the one steel from the other. This is always on the basis that the two are embedded in concrete. The confirmation that there is no Galvanic Reaction when the two steels are coupled together has only been verified since 2001.