Re-Imagining Structural Stability With Stainless Steel Reinforcement Bars

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From surgical pins to skyscrapers, stainless steel is a quintessential component. The omnicompetent characteristics of stainless steel make it an ideal choice for building future-ready infrastructure. In the wake of a bridge collapse in Minneapolis in 2007, a research paper on the future of infrastructure presented at the New York State City Bridge Engineering Conference proved that stainless steel rebars demonstrate a life expectancy of 100+ years. Improvements in the life of reinforcement bars can translate directly into the extended life of any structure, and automatically, of people's lives too. This ultimately compounds to reaping economic benefits.

Stainless steel is an alloy with minimum 10.5% Chromium content. Unlike other materials, stainless steel does not need any surface treatment to bear environmental agents. This is why this metal is gaining an international repute for infrastructure. In Europe, Molybdenum containing stainless steel rebars have been widely used for the last 20 years. In North America, their use in highway bridges has been steadily growing over the last 10 years, with many large bridges being constructed or extensively repaired.

India boasts of a 7,500 km coast line surrounded by the Indian Ocean on the south, Arabian Sea on the west, and Bay of Bengal on the east. It is natural for the concrete structures in the Indian peninsula to be unceasingly exposed to the marine environment, which enhances the risk of corrosion in the reinforcement bars used in these reinforced cement concrete (RCC) structures. This becomes a cause of great concern, as these structures become vulnerable to encounter high maintenance costs, which if not tended to, lead to inevitable accidents.

The prime reason for quick deterioration of reinforced concrete is corrosion of the carbon steel reinforcement bars. The concrete aggregate consists of oxides of calcium with alkaline condition (pH range of 10-12.5). Carbon steel forms a passive layer under the oxide film and hence does not corrode. However, with the passage of time, moisture (from rain or highly

humid conditions) and pollutants, such as chlorides (from coastal environment), carbon dioxide and sulphur dioxide (from urban environment), penetrate through the concrete cover and reduce pH below 10, leading to initiation of the corrosion process in these rebars. This leads to stress generation, which in-turn forms a pin-hole, followed by small cracks, and finally plaster spallation exposing the rebars.

Untimely wear and tear of concrete infrastructure due to corrosion, especially along the coastline, is a major economic and technical challenge for civil engineers across the world. Stainless steel significantly extends the service life beyond 100 years, without major repair or maintenance, and lowers the public life disruption and cost incurred by avoidable rehabilitation projects. Stainless steel reinforcement bars provide structural strength and are fire-resistant. Moreover, they are easy to install, defy corrosion, and allow thinner concrete cover, thus offering a long-term solution for the infrastructure and construction segment. The stainless steel rebars can be used for highway bridge decks, overpasses, tunnels, marine structures, and restoration work where corrosive conditions can cause premature failure of structures made with carbon steel reinforced bars.

The perception of high cost of stainless-steel reinforcement bars is misplaced. The LCC (life cycle cost) for stainless steel rebars comes out to be significantly low, while repair work becomes necessary for carbon steel reinforced structures earlier in the cycle. Indian stainless steel reinforcement bar standard (BIS) has six grades for different applications at different price points to optimize costs. If used selectively, the impact on the total initial cost of the project may be just 1-2%, but it may lead to much bigger savings on other factors by eliminating problems like rebar coatings, cement inhibitors, concrete sealers, membranes, and thicker concrete overlay, as well as financial loss due to traffic and commercial upsets. In the interest of long-term durability, stainless steel rebar is an ideal choice.

The Progreso Pier in Mexico is a fine example of the benefits of using stainless steel in salinity-affected areas. This pier is the first concrete structure in the world built with Nickel-containing stainless-steel reinforcement bars. Despite the relatively poor grade of concrete used, the pier withstands the harsh marine environment and has been in continuous service for over 70 years without any major repair or routine maintenance activities. On the contrary, a neighbouring pier located just 200 metres to the west of the Progreso Pier, has deteriorated columns and the superstructure has almost entirely vanished, despite being twenty years younger. It's not surprising that the newer pier was built using carbon steel rebars. (Image above)

Recently, built its own 55 km long Hongkong – Zhuhai – Macau bridge built with around 10,000 tonnes of stainless steel rebars, among other metals, declaring a corrosion-free life of more than 120 years. This iconic structure is not only an engineering marvel, but also reiterates that stainless steel is the most suitable metal for coastal regions.

There is an impending need to not only emphasise on the speciality of stainless steel but also mandate its use in civil structures across the coastline. The Indian government needs to make a promise of safety, security, and sustainability to every citizen who is a user of public infrastructure, such as highways, flyovers, and especially bridges, by using the best and ideal construction material. There is thus, an exigency for India to be at par with developed countries by using stainless steel today for a 'stain-less' tomorrow!. ■

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