Coating technology to mitigate corrosion of rebars in concrete structures

Infrastructural development, especially civil engineering works, plays a pivotal role in the economic growth of a Nation, wherein critical and major structures like bridges, tunnels, dams, flyovers, and power plants are constructed with an average service life of 75 to 100 years.

Concrete is the lifeline of a country's civil infrastructure whereas steel (rebar) is the backbone of concrete. Our infrastructural projects face numerous challenges related to long coastal belts and exposure to harsh marine environment conditions which affect the rebars. Pollutants such as chloride, CO2, sulphates, moisture, and oxygen present in the marine environment / sea water deteriorate the structures and severely reduce its service life by 10 to 15 years.

CPCC rebars at site

CPCC rebars in DFCC Vaitarna to Surat

India loses around 5–7% GDP every year as a cost of corrosion towards replacement/rehabilitation of such structures. To protect them and to enhance their shelf lives, suitable technologies should be deployed during the construction stage itself.

Common methods for corrosion protection of marine concrete structures are: (i) use of corrosion resistant steel (CRS) rebar (ii) Application of protective coating to steel (iii) Application of protective coating to concrete surface and (iv) Addition of inhibitor admixture to concrete. Among the above, application of protective coating to rebar is the most promising and widely adopted method in India.

CSIR-Central Electrochemical Research Institute (CSIR-CECRI) developed a novel coating system, Cement Polymer Composite Coating (CPCC), that is efficient, economical, easy to use and could be carried out at the site as well. This technology was developed during 1992-93 and Indian Patents were obtained in 2001 and 2004 for primer & sealer, respectively. Till now, CPCC has been transferred to 15 licensees out of which, 3 companies have renewed their licenses twice. Using this technology, more than 3 lakh tonnes of steel/rebars have been treated so far.

CPCC coated rods at various construction sites

CPCC system fulfills all the requirements as specified in the ASTM A775/775M-19 for fusion bonded epoxy coated rebar. The bars could be coated and used within a short span of time as the coating itself gets cured within a few hours. Repairing and touchup could be done as required with the same material that was used for coating. The coating is flexible (could be bent after coating) and at the same time, has good abrasion, impact, and weather resistance. The chloride tolerable limit is 7 times more than that of CRS (uncoated) rebar. Marine exposure studies conducted at CECRI's Corrosion Testing Centre at Mandapam, Tamil Nadu (one of the World's most aggressive site in terms of corrosion rate and paint deterioration) revealed that CPCC rebar exhibited 15 times more corrosion resistance than the CRS rebar.

Studies conducted on the relative bond strength of coated rebar (conducted as per the procedure given in BIS 2770 – Part I) concluded that the rebar was unaffected up to a thickness of 231± 66 µm compared to that of uncoated rebar. Similarly, studies conducted in cracked concrete proved that up to the crack width of 0.2 mm, the CPCC rebars showed no signs of corrosion whereas at 2 mm crack width, negligible corrosion was observed. Under similar conditions, uncoated rods showed severe rusting. Also, coated rebars could tolerate up to 2% of surface damage which may occur during construction practices. Concrete embedded with coated rods are expected to have a service life of up to 80 years whereas for uncoated rods it is less than 5 years in aggressive marine environment.

CPCC system is a boon for all major civil structures, especially those brought up in the vicinity of marine regions, offering enhanced protection and extended design life.

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