From the Editor's Desk

ReBuild

India having more than 3000 kms of coastline loses more than ₹ 2 lakh crore a year - about 4 percent of the size of the total economy - due to corrosion in infrastructure and industry segments. In case of buildings and civil structures, a large proportion of such damage is caused due to insufficient planning and incorrect assessment of environmental attack such as carbonation and chloride exposure. The RCC structures are very much susceptible to environmental attack and can severely reduce the strength and life of these structures due to corrosion of reinforcement.

The factors that influence the corrosion of steel reinforcing bars embedded in concrete need to be controlled to an acceptable level, by which the resulting concrete deterioration can be minimized. This is the first step in most corrosion-control strategies in addition to other suitable corrosion-protection systems. Corrosion-control methods or systems are classified as mechanical or electrochemical. Mechanical methods are physical barriers that prevent or delay the ingress of chlorides, oxygen and moisture through the concrete cover to the reinforcing steel. They include admixtures, sealers and membranes, overlays, and coatings on steel reinforcing bars. Sealers and membranes made with materials such as resins, epoxies, emulsions, etc. are used to reduce the ingress of deleterious species. There are concerns about their effectiveness and durability on the traffic-bearing surfaces (bridge decks) due to the abrasion of applied sealers or the cracking of installed membranes. Coatings used on steel reinforcing bars are either organic or metallic. Organic coatings include the non-metallic fusion-bonded epoxy coatings. Metallic coatings include materials such as nickel, stainless steel and zinc. The nickel and stainless steel coatings protect steel by being a barrier system and more noble, i.e. have a lower potential than iron to corrode. The zinc coatings protect steel by being sacrificial or more active (i.e. it has a greater potential than iron to corrode). Corrosion-resistant material includes austenitic stainless steels and fiber-reinforced polymer (FRP) rebars.

The corrosion protection method is also recognized as a means of prevention of corrosion damage in new structures, where for a small percentage of the capital cost the design life expectations can be met without repeated and expensive repairs. For prevention of corrosion of existing RCC structures migration of corrosion inhibitor of sodium monoflurophosphate is most suitable method. It creates high vapour pressure at the surface thus forcing these inhibitor molecules to traverse inside through the pores of the concrete for forming a protective layer around the rebar. Where ever carbonation is the major cause of corrosion, in such structures anti-carbonation coating of acrylic based is most suitable. It can also be used in marine and industrial environments.

Electrochemical methods force the steel reinforcing bars to be cathodic. They include chloride extraction and cathodic protection. Chloride ion extraction and cathodic protection are typically used to the rehabilitation of reinforced concrete structures and not as a corrosion-control measure for new construction.

Cathodic protection is designed to halt all the active corrosion and prevent new sites from developing corrosion. Although it has been used for immersed and buried structures for over 100 years, cathodic protection of reinforced concrete by means of an impressed current has been widely used only since the early 1980s. Cathodic protection is an economical alternative to patch repairs in chloride-damaged structures, not only because it provides a long-term solution but also because it obviates the need for massive removal and replacement of contaminated concrete. It is also cost-effective in severely carbonated structures. It is now used extensively as a means of corrosion control in concrete and has been applied to a wide variety of structures in coastal regions in Australia and America. The most recent development in cathodic protection of concrete structures is the internal anode system, where probe anodes, usually made from titanium mesh ribbon, are placed in drilled holes in the concrete surface and embedded in grout.

Electrochemical chloride extraction methods helps to reduce the chloride ions from the surroundings of reinforcing steel in contaminated concrete down to a level below the threshold limit for corrosion. On the contrary, electrochemical realkalization is the method where the carbonated concrete is again realkalised which helps in preventing the corrosion of rebar.

However, there are three categories of variables that influence the corrosion process and the extent of the corrosion-induced deterioration of reinforced and prestressed concrete members – material, design and environmental variables. Material variables for making durable concrete include cement type, admixtures, aggregate type and gradation and the water cement ratio. Design variables include the depth of concrete cover, physical properties of the hardened concrete, the size and spacing of the steel reinforcing bars, and the efficiency of drainage from the structure. Environmental variables include the source of chloride ions, temperature extremes, wet-dry cycles, relative humidity, and, to a certain extent, applied live loading.

Although little can be done to control environmental variables, material and design variables can be adjusted to build durable concrete structure that can resist corrosion-induced deterioration in environments conductive to the initiation and sustenance of the corrosion process. Since rebar corrosion is the most widely pervading ailment of concrete construction, we decided to present this issue of ReBuild to our readers with all interesting and advanced methods for corrosion protection including some case studies.