ABSTRACT

This investigation presents the performance evaluation of protective coatings such as inhibited cement slurry coating, cement polymer composite coating, galvanization and the newly developed cement polymer anticorrosive coating for corrosion control of steel rebars in concrete. Sodium nitrite based anodic mixed inhibitor was also developed and evaluated for its performance. Over seven hundred experiments were conducted to assess the performance of protective coatings on high yield strength Cold Twisted Deformed (CTD) and Thermomechanically Treated (TMT) rebars with and without coating damage in control and inhibitor admixed concrete.

Performance evaluation tests such as chemical resistance test, applied voltage test, impressed voltage test, open circuit potential test, macrocell corrosion test, impedance technique and atmospheric exposure tests were conducted to assess the corrosion control efficacy of coated rebars. Bond strength to concrete test, impact test and adhesion tests were also conducted to evaluate the mechanical properties of the coating material. All the experiments were conducted according to Indian and ASTM Standards.

Chemical resistance test results revealed that all the coated rebars except galvanized rebar possessed the necessary corrosion resistance
properties as required by Indian and ASTM Standards. Galvanization offered excellent sacrificial protection to steel rebars in all the tested mediums except in 3M NaOH. The one hour applied voltage test conducted on coated bars showed that all the coated bars except galvanized rebar resisted the electrical and electrochemical stresses and passed the codal requirements of Indian Standards. Impressed voltage test results showed increased cracking resistance time of the order of 6 times for cement polymer composite coated bars as compared to uncoated bars in control concrete. Whereas appreciable increase in cracking resistance time of the order of 2 to 2.5 times for galvanized bars, inhibited cement slurry coated bars and cement polymer anticorrosive coated bars were observed. Inhibitor admixed concrete increased the cracking resistance time significantly for uncoated bars as compared to control concrete.

Open circuit potential test results revealed that all the coated bars except galvanized bars offered excellent resistance against chloride in the tested period irrespective of the type of bar, coating damage and the type of concrete. Galvanization offered excellent sacrificial protection to steel rebar in the tested period. Based on ASTM criteria and visual examination of rebars, it was concluded that all the coated rebars are under low corrosion risk. Macrocell corrosion studies revealed a remarkable reduction in current density and corrosion rate for uncoated bars in inhibitor admixed concrete. It was found that inhibited cement slurry coating and cement polymer
anticorrosive coating on rebars offered significant reduction in corrosion rate irrespective of the type of rebar, coating damage and inhibitor modification. Cement polymer composite coated bars and galvanized bars exhibited appreciable corrosion rate at the end of test period.

The analysis of impedance test results showed high coating resistance values for cement polymer composite coated bars in control concrete as compared to other coated bars. Inhibited cement slurry coated bars and cement polymer anticorrosive coated bars showed similar resistance values irrespective of the coating damage, type of rebar, exposure period and inhibitor modification. There is a marginal increase in resistance for galvanized bars compared to uncoated bars irrespective of exposure period. Atmospheric exposure test results revealed an improved performance of galvanized bars as compared to other coated bars.

There is an increase in bond strength of the order of 17% for inhibited cement slurry coated bars and reduction in bond strength of the order of 13% for cement polymer composite coated bars as compared to uncoated bars. Cement polymer anticorrosive coated bars and galvanized bars exhibited similar bond strength values as compared to uncoated bars. All the coating systems possessed the necessary bond strength with concrete and validated the codal requirements of Indian Standards. Impact test results showed no shattering, cracking or bond loss of coating around the
impact area for all the coating systems and satisfied the codal requirements of Indian Standards. In the adhesion test, no cracking on the coating surface was observed for cement polymer composite coated bars and galvanized bars and passes the codal requirements of Indian and ASTM Standards. It is recommended that inhibited cement slurry coating and cement polymer anticorrosive coating have to be applied over rebars after cutting and bending operation is over.

Based on the experimental investigation, the performance of the inhibited cement slurry coating, cement polymer composite coating, galvanization and cement polymer anticorrosive coating on CTD and TMT rebars were well established as per Indian and American Standards. The performance of coated rebars with and without coating damage in control and inhibitor admixed concrete were also analysed and established.