Performance of corrosion resisting steels in chloride-bearing concrete

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Abstract: Bare mild, galvanized, epoxy-coated, and stainless clad reinforcing steels have been evaluated in a 7-year exposure site program for corrosion-resistance performance in chloride-bearing concretes. The two variables studied were reinforcing material and chloride content of concrete. Bars were cast in prismatic specimens of 0.45 water-cement ratio good-quality concrete containing three levels of chloride: 4, 8, and 32 lb/yd3 (2.4, 4.8, and 19.2 kg/m3, corresponding to 0.6, 1.2, and 4.8 percent by weight of cement). The specimens were exposed to the environment of Eastern Saudi Arabia on a site at King Fahd University of Petroleum and Minerals, Dhahran. The results show that mild steel bars had suffered severe rust-related damage for all three chloride levels with significant loss of section and rib degradation for 8- and 32-lb chloride-bearing concretes. For galvanized reinforcing steel in equivalent chloride-bearing concrete, compared to bare mild steel, there was a decay in the onset of cracking, a reduction in metal loss, and an amelioration in the incidence and severity of concrete failure condition. However, in both 8- and 32-lb chloride concretes, there has been severe corrosion accompanied by concrete cracking. Their results indicate that the use of galvanized steel in concretes with high levels of chloride merely delays concrete failure by only a finite period of time. Epoxy-coated bars performed exceedingly well as corrosion-resistant steel in 4- and 8-lb chloride concretes, as no corrosion and concrete cracking were observed. However, for the 32-lb chloride concrete, significant corrosion was observed on the substrate steel under the coating. This caused a systematic breakdown of the coating and cracking of concrete. These results indicate that epoxy barrier coatings may have a finite tolerance limit for chlorides. Among corrosion-resisting steels, the best durability performance is exhibited by the stainless-clad reinforcing bars. After 7 years of embedment in 32-lb chloride concrete, no sign of corrosion was observed on any of the bars tested.