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RESEARCH ARTICLE

Influence of time-dependent corrosion on strength and ductility of reinforcing steel bars exposed to natural and aggressive environments

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ABSTRACT

The reinforcement corrosion is a major and most frequent reason of degradation for reinforced-concrete (RC) structures throughout the world, leading to their premature deterioration before design life was attained. Corrosion weakens the mechanical properties of rebar by ingress of aggressive ions due to various environments. In this study, a total of 99 specimens with six different diameters were tested, for three exposure periods, and six different environments, to assess the influence of corrosion on mechanical properties of reinforcing bars. Degradation relationships of strength and ductility with exposure period and rebar diameter, were analyzed, and three equations were proposed to formulate the relations. It was found that, the ultimate strength of 8.6% of the corroded bars falls below the original yield strength; after 5 years of exposure in natural atmosphere, reduction in mechanical properties was insignificant; a detergent solution environment could cause the strength loss of 24.8%.

corrosion; steel bar;

INTRODUCTION

Corrosion of reinforcing steel bars is one of the most frequent and significant types of deterioration mechanisms in existing reinforced concrete structures. Corrosion leads to expansive pressure on the surrounding concrete that causes internal cracking and, eventually, spalling and delamination, even collapse of the structures. It is worth noting that extensive cracking in concrete can be observed even when structure's service life is within 10 years (Wu et al. 2019; Zhang et al. 2020). Corrosion is commonly perceived as one of the most detrimental factors causing degradation of serviceability and durability of RC structures, and it became a global problem over the past decades. Direct and indirect costs of maintenance and repair are very high. The statistics data indicated that the mean mass corrosion rate for natural exposure reached to 0.5% per year. Since corrosive action manifests itself in objects from building structures, constructions and bridges, transportation systems household materials and appliances, the economic damage is huge. For instance, according to investigations, the annual total direct corrosion losses in the USA in 26 sectors of industry are about 276B USD. Therefore, it is of great significance to cast sight on the corrosion-induced problems (Babutskii, 2010; Miao et al. 2019; Bidi et al. 2020). The rate of change in rebar mechanical properties is depending on the corrosion duration, bar size as well as the exposure environments. The yield and ultimate stresses of the naturally and artificial corroded bars are similar, while the ultimate strain of the naturally corroded bars is smaller than that artificially corroded (Fernandez et al. 2015; Diaz et al. 2020). Although many studies have been conducted; however, research on effects of corrosion on mechanical properties of tensile reinforcements still lacks clarity. Studies considering the mechanical properties of naturally corroded rebar obtained from real structures exposed to aggressive environments might include more scattered results, since the corroded bar results were calibrated with those considered un-corroded from the same