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Effects of harsh environmental exposures on the bond capacity between concrete and GFRP reinforcing bars

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Abstract. This paper demonstrates an experimental study to evaluate the effects of environmental exposures on the bond between ribbed Glass Fiber Reinforced Polymer (GFRP) reinforcing bars and concrete. The equation recommended by ACI 440-1R-06, for the bond stress,was evaluated in this study. A total of 16 pullout samples, 12with GFRP bars and 4with steel bars, were exposed to two different harsh environments for different periods of time. The exposed harsh environments included direct sun exposure and cyclic splash zone sea water. The variation in the shear (bond) strengths before and after exposure was considered as a measure of the durability of the bond between GFRP bars and concrete.Experimental results showed there is no significant difference of the bond strength between 60 and 90 days of exposures.It also showed that the empirical equation of the bond stress calculated by ACI 440-IR-06 is very conservative.

Keywords: bond; GFRP; pullout; shear; exposure; sea water

1. Introduction

Extensive research has been conducted in the search of an alternative to the steel material that resists corrosion under different environmental exposures in the long run. Glass Fiber Reinforced Polymer (GFRP) rebar was introduced as an alternative to substitute steel. GFRP is well known forits anti-corrosion behavior and its high strength to weight ratio. It can be used in places where severe environment, which can cause steel corrosion, is introduced. These harsh environments include marine environment structures, underground tunnels and bridges where most girders are exposed to salt and water evaporation. However, bonding behavior of GFRP bars needs further investigation due to the limited amount of research done in this area. Several investigations have been carried out to determine GFRP bars bonding durability under certain environmental conditions. Binmokrane and Cousin (2005) investigated the bond between GFRP bars and the concrete by conducting microscopic and physicochemical analysis and tests on cylindrical core samples in order to observe the effect of degradation and aging. It was pointed out that though alkaline ions are available in FRP materials, hydrolysis reactions do not occur and therefore no acidic formation was found. Under the X-ray analysis of GFRP, concrete structure environment

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