Durability performance of GFRP bars under aggressive local exposure conditions

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Abstract

This study is focused to evaluate performance of three types of commercially available GFRP bars after they are subjected to accelerated aggressive exposure conditions such as alkaline environment, alkaline + sabkha environment, alkaline + seawater environment, thermal variation and outdoor environment for stand-alone bars and bars in concrete beams. It also includes comparison and correlation between the changes in tensile strength, compressive strength and water absorption properties of three types of GFRP bars. Lastly the effective cover thickness required for GFRP bars in concrete structures when subjected to different levels of thermal loads are determined.

The work includes a thorough literature review on durability of GFRP bars, extensive exposure set up, monitoring of results up to one year for stand alone bars and two years for concrete beam. Finally strength and service life was predicted. The experimental results showed that the three commercially available GFRP bars though have glass as common material but have different durability performance. This can be attributed mainly to the difference in resin type, manufacturing process and surface treatment. The Fulcrum GFRP type demonstrated best performance followed by C-bar and then Aslan 100 in all aspects of tension behavior under the different exposure conditions. It is confirmed from experimental results that Alkaline is the most basic deteriorating environment for GFRP bars which caused damaged up to 65% in Aslan 100.

The service life was predicted using Time Shift Factor method and Ficks first law was used to determine strength prediction. It was found that FULCRUM needs approximately 25 years to have only 10% reduction in its tensile strength. From the concrete cover experiments, it was evident that a minimum concrete cover of three times diameter for any GFRP bar is required to avoid cracking under thermal loads.