World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:11, No:05, 2017

Fabric-Reinforced Cementitious Matrix (FRCM)-Repaired Corroded Reinforced Concrete (RC) Beams under Monotonic and Fatigue Loads

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Abstract : Rehabilitating corrosion-damaged reinforced concrete (RC) structures has been accomplished using various techniques such as steel plating, external post-tensioning, and external bonding of fiber reinforced polymer (FRP) composites. This paper reports on the use of an innovative technique to strengthen corrosion-damaged RC structures using fabric-reinforced cementitious matrix (FRCM) composites. FRCM consists of dry-fiber fabric embedded in cement-based matrix. Twelve large-scale RC beams were constructed and tested in flexural monotonic and fatigue loads. Prior to testing, ten specimens were subjected to accelerated corrosion process for 140 days leading to an average mass loss in the tensile steel bars of 18.8 %. Corrosion was restricted to the main reinforcement located in the middle third of the beam span. Eight corroded specimens were repaired and strengthened while two virgin and two corroded-unrepaired/unstrengthened beams were used as benchmarks for comparison purpose. The test parameters included the FRCM materials (Carbon-FRCM, PBO-FRCM), the number of FRCM plies, the strengthening scheme, and the type of loading (monotonic and fatigue). The effects of the pervious parameters on the flexural response, the mode of failure, and the fatigue life were reported. Test results showed that corrosion reduced the yield and ultimate strength of the beams. The corroded-unrepaired specimen failed to meet the provisions of the ACI-318 code for crack width criteria. The use of FRCM significantly increased the ultimate strength of the corroded specimen by 21% and 65% more than that of the corroded-unrepaired specimen. Corrosion significantly decreased the fatigue life of the corroded-unrepaired beam by 77% of that of the virgin beam. The fatigue life of the FRCM repaired-corroded beams increased to 1.5 to 3.8 times that of the corroded-unrepaired beam but was lower than that of the virgin specimen. The specimens repaired with U-wrapped PBO-FRCM strips showed higher fatigue life than those repaired with the end-anchored bottom strips having similar number of PBO-FRCM-layers. PBO-FRCM was more effective than Carbon-FRCM in restoring the fatigue life of the corroded specimens.

Keywords : corrosion, concrete, fabric-reinforced cementitious matrix (FRCM), fatigue, flexure, repair
Conference Title : ICSE 2017 : International Conference on Structural Engineering
Conference Location : London, United Kingdom
Conference Dates : May 25-26, 2017