World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:9, No:07, 2015

The Flexural Behavior of Reinforced Concrete Beams Externally Strengthened with CFRP Composites Exposed for Different Environment Conditions

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Abstract : The repair and strengthening of concrete structures is a big challenge for the concrete industry for both engineers and contractors. Due to increasing economical constraints, the current trend is to repair/upgrade deteriorated and functionally obsolete structures rather than replacing them with new structures. CFRP has been used previously by air space industries regardless of the high costs. The decrease in the costs of the composite materials, as results of the technology improvement, has made CFRP an alternative to conventional materials for many applications. The primary objective of this research is to investigate the flexural behavior of reinforced concrete (RC) beams externally strengthened with CFRP composites exposed for three years for the following conditions: (a) room temperature, (b) cyclic ponding in 15% salt-water solution, (c) hot-water of 65oC, and (d) rapid freeze/thaw cycles. Results indicated that the after three years of various environmental conditions, the bond strength between the concrete beams and CFRP sheets was not affected. No signs of separation or debonding of CFRP sheets were observed before testing. Also, externally strengthening RC beams with CFRP sheets leads to a substantial increase in the ductility of concrete structures. This is a result of forcing the concrete to undergo inelastic deformation, resulting in compression failure of the structure after yielding of steel reinforcement. In addition, exposure to heat water tank for three years reduces the ultimate load by about 11%. This 11% reduction in the ultimate load equates to about 53%, 46% and 68% loss of the gain of the strength attributed to the CFRP of 2/3 Layer, 1 Layers and 2 Layers CFRP Sheets respectively. This mean that with decreasing of number of layers the environmental exposure had an efficient effect on concrete by protection concrete from environmental effect and adverse effect on the bond performance.

Keywords : flexural, behavior, CFRP, composites, environment, conditions
Conference Title : ICSCE 2015 : International Conference on Structural and Construction Engineering
Conference Location : Istanbul, Türkiye
Conference Dates : July 29-30, 2015