Paper Title:
Structural Damage Assessment of FRP Strengthened Reinforced Concrete Beams under Cyclic Loads

Abstract

Worldwide, the need for structural retrofit is on the rise and the use of Fibre Reinforced Polymer (FRP) composite material systems is becoming an accepted method for repairs, rehabilitations, and strengthening of deficient structures. The great qualities of the FRP materials, certified in the laboratories and confirmed in the fields have all contributed to propel the material as a very promising one, though more works need to be done to certify the fatigue resistance and durability criteria. This research looked at the experimental investigations of Reinforced Concrete (RC) beams strengthened flexurally with externally-epoxy bonded FRP laminates under four point cyclic loads. Dynamic tests are used to assess damages in the FRP-strengthened RC beams under cyclic loads. 6 RC beams of 150 x 200 mm cross-section and length of 2.20m and were reinforced with four 12mm ribbed longitudinal steel bars. Three types of FRP laminates made of high modulus carbon fibre, high strength carbon fibre and glass fibre were adopted. The results confirm that dynamic-based method is an efficient way of assessing damage evolution in RC beams strengthened with FRP laminates under cyclic loads. The results offered a criterion that can be adopted for quick assessment of the efficiency of FRP composite systems before applying them to civil applications.

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Structural Damage Assessment of FRP Strengthened Reinforced Concrete Beams under Cyclic Loads

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Abstract. Worldwide, the need for structural retrofit is on the rise and the use of Fibre Reinforced Polymer (FRP) composite material systems is becoming an accepted method for repairs, rehabilitations, and strengthening of deficient structures. The great qualities of the FRP materials, certified in the laboratories and confirmed in the fields have all contributed to propel the material as a very promising one, though more works need to be done to certify the fatigue resistance and durability criteria. This research looked at the experimental investigations of Reinforced Concrete (RC) beams strengthened flexurally with externally-epoxy bonded FRP laminates under four point cyclic loads. Dynamic tests are used to assess damages in the FRP-strengthened RC beams under cyclic loads.6 RC beams of 150 x 200 mm cross-section and length of 2.20m and were reinforced with four 12mm ribbed longitudinal steel bars. Three types of FRP laminates made of high modulus carbon fibre, high strength carbon fibre and glass fibre were adopted. The results confirm that dynamic-based method is an efficient way of assessing damage evolution in RC beams strengthened with FRP laminates under cyclic loads. The results offered a criterion that can be adopted for quick assessment of the efficiency of FRP composite systems before applying them to civil applications.

Introduction

Universal, the necessity for structural strengthening is on the increase and the use of Fibre Reinforced Polymer (FRP) composite material systems has become an accepted method for repairs, rehabilitations, and retrofit of deficient structures. As the need to renovate aging infrastructures and historic buildings with lighter and environmentally friendly materials becomes increasingly evident in the advanced world, the application is beginning to gain ground in the less developed nations as the outstanding qualities of FRP composites becomes more evident to the world. For instance, in Nigeria, researchers are beginning to recommend the use of FRP composites as means of strengthening deficient structures and thereby reducing the high incidence of building collapse.

The necessity for rehabilitation in the built industry arises from deterioration/aging of structures, adaptation of existing structures to new design standards, mistakes in design/construction, accidental overloading, and change in the functionality requirements of the structure. Based on the amount of capital invested in building many structures, it is often uneconomical to simply replace them with new ones without considering the available options of strengthening and restoration [1, 2]. For safety reasons, the adoption of FRP composites for strengthening of weak structures will save a lot of lives in building collapse prone nations like Nigeria where thousands of lives have been lost in the last couple of years. These collapses are often caused by deterioration due to poor maintenance culture, design/construction mistakes, widespread overloading, and unauthorised change of use of structures.

The Fibre Reinforced Polymer (FRP) composites' growing popularity is due to their superior material properties such as corrosion and weather resistance, high mechanical strength and low weight, ease of handling and versatility of size, shape or quality. Unlike most of the conventional building materials, the FRP composites can be specifically designed by blending the best combination of material properties in response to specific necessities. As the costs of FRP