Performance of Externally Bonded Reinforcement In Grooves (EBRIG) Method for Flexural Strengthening of RC Beams

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Abstract

One of the most prominent challenges of flexural strengthening of beams using Fiber Reinforced Polymer (FRP) composites, is the premature debonding of FRP laminate from concrete substrate, which makes the strengthening calculations less reliable. The new Externally Bonded Reinforcement In grooves (EBRIG) method, being recently developed at Isfahan University of Technology (IUT), has yielded completely satisfactory results in postponing premature debonding of FRP laminates in concrete beam specimens without internal flexural bars. In the current study, the performance of EBRIG method in reinforced concrete beams has been evaluated. To reach the aforementioned purpose, five reinforced beam specimens with dimensions of 120×140×1000 mm were cast and externally strengthened with the conventional Externally Bonded Reinforcement (EBR) and new EBRIG methods. Beams were then subjected to four-point flexural loading. As a means of comparison, one reinforced beam without any external strengthening was also tested. The Experimental results showed a significant increase in the failure load of the beam strengthened with multi FRP layers using EBIRG method.

Keywords: Fiber Reinforced Polymer (FRP), Debonding, Externally Bonded Reinforcement (EBR), Strengthening, Reinforced concrete beam.

1. INTRODUCTION

The strengthening or retrofitting of existing concrete structures to resist higher design loads, correct strength loss due to deterioration, correct design or construction deficiencies, or increase ductility has traditionally been accomplished using conventional materials and construction techniques [1]. Over the last decade, an increase in the application of FRPs has been seen in construction industry because of their good engineering properties such as high tensile strength, high durability and corrosion resistant, low weight and easy installation [1-3]. All the FRP strengthening techniques rely on adhesively bonding external tensile FRP composites on the element sides; consequently, the performance of the strengthened members critically depends on the bond mechanism. Indeed, one of the most prominent challenges for flexural strengthening of beams using FRP materials is the premature debonding of FRP composite from concrete substrate, which makes the strengthening calculations less reliable. So an important issue in the strengthening of concrete structures using FRP composites is to design against various debonding failure modes [4].

Externally Bonded Reinforcement (EBR) is the most conventional method of bonding FRP laminates to a concrete beam and researches have shown that EBR method can increase load carrying capacity and stiffness of strengthened beams [5]. However, the probability of premature debonding of FRP sheets increases by augmenting the cross section of the FRP sheet in this method.

The new Externally Bonded Reinforcement In grooves (EBRIG) method, being recently developed at Isfahan University of Technology, has yielded completely satisfactory results in postponing or in some cases, completely eliminating the debonding of FRP sheets. However, the performance of EBRIG technique have just examined for concrete beam specimens without any flexural steel bars and no test results are available for beams containing internal steel flexural reinforcement [6]. Thus, in the current study, the performance of EBRIG method in longitudinally reinforced beams has been tested.

2. EXPERIMENTAL PROCEDURE