FRP Retrofitting of Reinforced Concrete Beam-Column Joints

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ABSTRACT

Fibre reinforced polymer (FRP) has been widely used for retrofitting/upgrading of reinforced concrete joints. The efficiency of this composite system in enhancing the performance of deficient RC joints has been proven in past studies. Relocating plastic hinge from the column face toward the beam is accounted as one of the most effective methods for upgrading of RC beam-column joints which could prevent the formation of undesirable weak-column strong-beams mechanism. This study is conducted in order to investigate the effectiveness of FRP retrofits in improving the performance of the beam to column joints through the relocation of plastic hinges away from the beam-column connections. The studied joints are selected from the RC frames designed based on intermediate ductility levels.

The well-known finite element software, ANSYS, is employed to carry out the nonlinear finite element analysis. Different configurations of FRP application including a novel configuration at beam-column joints are assessed and the efficiency of each composite architecture in relocating the plastic hinge is discussed. The parameters studied for each technique are the thickness of FRP and the length of FRP. The results show that the proposed configuration is not only capable of relocating plastic hinges and improving the load carrying capacity of the joints but also prevents the premature failure of de-bonding. The latter also has been proven by the experimental tests.

Key Words: FE analysis, FRP, RC joint, plastic hinge.

1 INTRODUCTION

Application of fibre reinforced polymers for strengthening/restoring reinforced concrete structures has attracted a lot of attention from researchers and engineers alike in recent years. FRP has outstanding advantages over steel including light weight, high corrosion resistance, superior strength and ease of application. FRP laminates and sheets can be moulded to the concrete surface for structural repair/retrofitting purposes. Increasing the applied load, human errors and a lack of seismic detailing have been accounted as some of the main reasons of the strengthening. In addition, FRP composites in the form of bar, sheet, and/or laminate can be used in new construction.

Beam-column joints are critical regions of RC structures designed for inelastic response to seismic forces. The overall structural strength, stiffness and ductility, are highly dependent upon the performance of joint core and end critical regions of beams and columns in the vicinity of beam to column connections. The well-known design philosophy of strong-column weak-beam would only work properly if the joints of RC structures perform as intended without any brittle failure. The effectiveness of FRP composites to improve/restore the seismic capacity of beam-column connections has been confirmed in many studies [1-7]. Recently, Attari et al. [8] carried out an experimental study to evaluate the effect of external strengthening of beam-column joints using different types of fibre reinforced composites. They concluded that a combination of carbon and