Moment Redistribution of Continuous Unbounded Post-tensioned High StrengthConcrete Beams Strengthening with CFRP Laminate (Experimental Investigation)

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ABSTRACT

The application of fibre reinforced polymer (FRP) materials to the tension side of a prestressed concrete member has been accepted as a strengthening technique to increase the load carrying capacity and in some cases can enhance member serviceability.

In continuous concrete beams, ductility allows redistribution of moment between the negative and positive moment zones. Although many in situ post-tensioned concrete beams are of continuous construction, there has been very little research on such beams with external reinforcement. Due to premature debonding failures and the linear stress-strain characteristics of fibre reinforced polymer (FRP) up to failure, the ductility of plated members and their ability to redistribute moment is less than that of un-plated.

The present paper describes an experimental investigation of moment redistribution of two-span continuous unbounded post-tensioned high strength concrete, HSC beams strengthened with CFRP plates, in terms of moment redistribution, enhancement of moment and load capacity. Main design variable was area of CFRP laminate in hogging region. To prevent debonding of the CFRP laminates, mechanical anchorages of steel plate and bolts were added to the end of laminates were provided for all of the beam specimens. Various monitoring devices were used to monitor the loading history of the beams. The main results obtained from tests are presented from zero loading up to failure. Increasing the area of CFRP laminates, increased ultimate strength, and decreased ductility, moment redistribution, and ultimate strain on CFRP laminates.

KeyWords: Continuous unbounded post-tensioned beam; HSC; CFRP; Strengthening; Moment redistribution.

1 INTRODUCTION

Concrete structures can become deficient during their service life and require strengthening and repair. While many methods of strengthening structures are available, strengthening structures via external bonding of advanced fibre-reinforced polymer (FRP) composite has become very popular worldwide during the couple of past decade due to the well-known advantages of FRP composites over other materials. A number of studies have been directed at the redistribution of moments in indeterminate reinforced beams and strengthening in determinate prestressed reinforced concrete (PRC) beams. Also very few studies have been reported on the behaviour of CFRP strengthening systems for PRC beams. However, no studies have yet been reported on moment redistribution in flexural strengthened unbounded post-tensioned HSC beams with End-anchored CFRP laminates. Reported studies including Rizkalla et al. [1] studied application of fibre reinforced polymer (FRP) and steel reinforced polymer (SRP) materials to the tension side of a pre-stressed concrete members that were tested under static and fatigue loading conditions.Carlo