

5th World Congress and Exhibition on

CONSTRUCTION AND STEEL STRUCTURE

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World Congress on

CONCRETE STRUCTURES & CONCRETE TECHNOLOGY

October 05-06, 2018 | Los Angeles, USA

An innovative method for the strengthening of concrete flexural elements using pre-stressed CFRP laminates-Part II: Experimental study

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Application of adhesively bonded CFRP laminates from strengthening and repair of concrete structures and attracted a great deal of attention in the past four decades. A large number of FRP strengthened structures around the world demonstrate the structural effectiveness and economic efficiency of this method. It is well known that the structural effectiveness of FRP bonding can further be increased by introducing pre-stressing the CFRP laminates prior to bonding. A drawback, however, is the need for mechanical anchoring of such laminates. An innovative method and a device are developed at the Chalmers University of Technology by which it is possible to eliminate the mechanical anchorage system. This paper presents an experimental program carried out to verify the numerical models presented in part one of the paper. Three RC beams with a length of 4.2m were tested under four-point bending-one beam as control specimen, one with passive externally bonded (EB) CFRP laminates, and one with EB pre-stressed CFRP using the new pre-stressing technique. The strain values monitored during the pre-stressing process, curing of the epoxy, after curing and during testing of the beam. The readings demonstrated that a gradually decreasing pre-stressing force profile towards the CFRP ends was achieved by using this new pre-stressing method. The test results from four-point bending also revealed that using pre-stressed CFRP led to higher flexural stiffness, reduced crack width, postponed yielding load, higher ultimate load bearing capacity and higher utilization of CFRP material tensile strength compared to passive CFRP EB beam. Examples of field applications using this method are also presented and discussed in the paper.

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