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A. RamachandraMurthy, P. Vindhya Rani, D. ShanmugaPriya

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Fatigue behaviour of damaged RC beams Strengthened with Ultra high performance fibre Reinforced Concrete

RamachandraMurthy A*, Vindhya Rani P[1] and ShanmugaPriya D[2]

*CSIR-Structural Engineering Research Centre, Chennai, India, 600113

[1]M.E. Student, GVP college of Engineering, Visakhapatnam, India

[2]Assistant Professor, Dhanalakshmi College of Engineering, Chennai, India, 601301

Abstract. This paper critically examines the performance of reinforced concrete (RC) beams retrofitted with a thin strip of ultra-high performance fibre-reinforced concrete (UHPFRC) under cyclic loading. RC beams were preloaded under static loading approximately to 70%, 80% and 90% of maximum load of control beams and then tested under fatigue loading with a stress ratio of 0.1 and frequency 2 Hz after retrofitting with a UHPFRC thin strip of 10 mm thickness. It has been found that the damaged RC beams can be successfully strengthened and rehabilitated by using a thin precast UHPFRC strip adhesively bonded to the prepared tensile surface of the damaged beams. No de-lamination of the strip was observed in any of the retrofitted beams. A finite element model was developed to predict the number of cycles to failure and load-deflection behavior of the retrofitted RC beams. The model accounts for the (i) degree of pre-damage, (ii) fracture behavior of concrete and UHPFRC through their respective specific fracture energy and stress-crack opening relation, and (iii) elasto-plastic behavior of the reinforcing steel. The model predictions are in very good agreement with the corresponding test results. It can be concluded that this UHPFRC is an excellent candidate for the repair and rehabilitation of damaged RC flexural elements.

Keywords: RC beam; Static loading; Pre-damage; Ultrahigh strength concrete; Retrofitting; fatigue loading; Finite element analysis

1. Introduction

In recent years, many reinforced concrete (RC) structures have been found to suffer from various deteriorations such as cracks, concrete spalling, large deflections, etc., which need to be rectified to support the design or to resist possible higher loading or to repair existing cracks. These deteriorations are caused by numerous factors such as aging, corrosion of steel reinforcement, environmental effects from seawater or accidental impacts on the structure.

*Corresponding author, Ph.D., E-mail: murthyarc@serc.res.in

[1]M. Tech., E-mail: vindhyacivil@gmail.com

[2]M.E, E-mail: dspshanmu1992@gmail.com