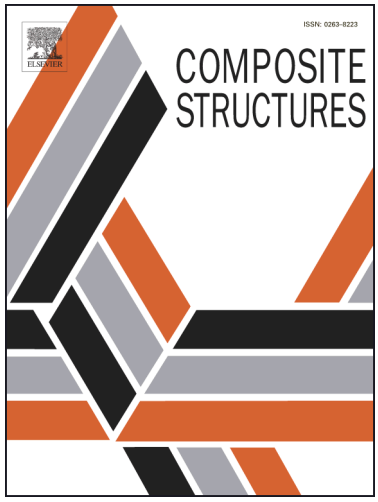

Experimental study of concrete beams prestressed with basalt fiber reinforced polymers under cyclic load

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Experimental study of concrete beams prestressed with basalt fiber reinforced polymers under cyclic load

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Abstract. This paper summarizes a study undertaken to analyse a fatigue behaviour and variation on modulus of elasticity of basalt fiber reinforced polymer (hereinafter–BFRP) under experimental cyclic loading. The impact of load frequency and amplitude of cyclic load to ultimate strength of BFRP was investigated and the number of the cycles to degradation of modulus of the elasticity, respectively. Based on experimental results a relationship of stress range and number of load cycles of BFRP bars is proposed. Also, a brand new results of non–common fatigue resistance experiments of concrete beams prestressed by BFRP bars are introduced. Moreover, impact of the number of load cycles to deflection and crack width is estimated. The effect of the degree of the prestressing to concrete beams under cyclic load is described and the main figures and relationships appear in the text bellow.

Keywords. Prestressed concrete; cyclic load; basalt fiber-reinforced polymer (BFRP); deflection; crack; fatigue

1. Introduction

Composites use dates back to the earliest civilizations, but the use of engineered composites dramatically increased in the last century. Codes and standards are rapidly evolving to keep up with the recent growth of composites in civil infrastructure such as bridges, parking slabs, industrial facilities, airplane components, wind turbines, high pressure pipes, natural gas transmission etc. Advances in the fields of fiber reinforced polymers (hereinafter–FRPs) have resulted in the development of high strength, lightweight and cost–effective design life. Also, FRPs are characterized by excellent corrosion resistance, fatigue resistance and low density, thus the use of such high performance materials might increase the flexural strength and stiffness of concrete elements and improved durability over conventional steel either the external (strengthening) or internal reinforcement would be employed [1, 2, 3]. Among these, the application of FRP to strengthen concrete beams perhaps received the most attention from the research community and many researchers have reported improvements in strength and stiffness of strengthened beams [4, 5, 6]. As mentioned above, FRP offer a great potential for fatigue resistance and further research is significantly needed in order to expand application of composite materials in the industry practice [7]. Nevertheless, effective application of FRP to structural concrete systems is not possible until a fundamental understanding of the fatigue resistance and failure mechanisms under cyclic load is available: fatigue behaviour of FRP bars in air and surrounded by concrete [8], more reliable, innovative and efficient anchorage systems are introduced for reinforced concrete applications [9–12], fatigue life of different type of structures undergoing cyclic loading [14-16].

With respect to fatigue of structural element, attention shall be addressed to degradation of the mechanical characteristics of the certain material, where the stress depend on load amplitude under repeat loading. Moreover, those stress are varied due to time and considering fatigue resistance of the structure a long–term test, in most cases, are being employed. In order to understand the mechanism of the behaviour of the structural element under cyclic loading, separate analysis of certain materials, forming that element, is required. Concrete stress–strain relationship depends on impact of cyclic load as well. The effect of fatigue in the concrete is caused due to variation of plastic deformation, thus, cracking occurs and vibro–creep (hereinafter–fatigue creep) appears. In addition, if concrete stresses are increased by cyclic load, the effect of fatigue creep is even more significant and notable, and thus, growth of cracking occurs due to damage of the bond interface between con-