A New Method for Application of Pre-stressed FRP laminates for Strengthening of Concrete Structures

Reza Haghani, Mohammad Al-Emrani

Chalmers University of Technology, Gothenburg, Sweden

Contact: reza.haghani@chalmers.se

Abstract

Using bonded fiber reinforced polymer (FRP) laminates for strengthening and repair of structural members has been proven to be an effective and economic method. High strength and stiffness, light weight and good fatigue and durability properties of FRP composites together with advantages offered by adhesive bonding have made FRP bonding a suitable alternative for traditional strengthening and repair techniques. It has also been recognized that pre-stressing the FRP laminates prior to bonding would bring additional advantages such as reduced crack widths, postponing the yielding in tensile reinforcement, increasing the load bearing capacity and saving reinforcement material. Using pre-stressed laminates, however, is associated with very high interfacial stresses in the bond line at the laminate ends, which necessitates the use of mechanical anchors. This paper presents a new method and a device for applying pre-stressed FRP laminates to flexural structural members without the need for mechanical anchorage of the laminates.

Keywords: Strengthening; Repair; Concrete; FRP; Bonding; Pre-stressing; Anchorage.

1 Introduction

A large stock of existing bridges in Europe and elsewhere in the world is in urgent need for rehabilitation including strengthening and repair. Majority of existing bridges are relatively old and have been subjected to various degradation mechanisms through their service life. In addition, the traffic intensity and allowable axel loads have increased substantially over the time to accommodate the increasing demands exerted on modern transportation networks. This has, in recent years, motivated intensive focus on research and development of effective methods for strengthening and upgrading of existing bridges around the world. Rehabilitation measures, especially strengthening and repair works, are among the most disturbing activities at bridge sites and as the subject of "sustainable construction methods" takes more attention in the construction sector, there is an interest among bridge authorities towards using more cost efficient and less disruptive maintenance methods. In this context, using externally bonded fiber reinforced composites, FRP, mostly carbon fiber reinforced polymer, CFRP, for strengthening and repair of bridge structures has attracted a great deal of attention. The large difference in modulus of elasticity of concrete and CFRP composites makes it ideal for strengthening concrete structures, since at already small deformations the CFRP material is activated as a load bearing agent and contributes in stiffness and ultimate strength of the structural member. In order to obtain a large contribution of CFRP strengthening in load bearing capacity, a large transfer of force to CFRP laminate is necessary. Study of the force transfer mechanism in adhesive joints shows that a large portion of the force is normally transferred at a rather short distance at

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