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Finite Element Modelling of FRP – Strengthened Structural Elements

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Abstract

Numerical aspects of the analysis of structural elements strengthened with FRP reinforcement are discussed in this contribution. Constitutive laws are defined on the meso – scale for the materials involved (steel, concrete, FRP).

The evolutions of experimentally observable parameters of FRP-strengthened concrete elements loaded in flexure are obtained by finite element analysis. Numerical results are compared to experimental data.

The employed numerical strategy consists in defining a damage-based constitutive law for concrete. A beneficial outcome of the implementation of such constitutive relation is the possibility to monitor the damage evolution for a given period of exploitation. Since the remaining structural life can be assessed in this way, monitoring of damage accumulation appears as a prerequisite for an accurate and efficient design of the reinforcement.

Keywords: FRP; basalt fiber; concrete; pre-tensioning; finite element modelling; damage.

1. Introduction

Basalt fiber reinforced polymer (BFRP) is a relatively new material that recently started to draw the attention of researchers engaged in the field of strengthening and refurbishment of structures. Because of the many positive qualities of this material, it can be stated that it is a promising option for FRP construction. BFRP are eco - friendly, nontoxic, noncorrosive, and have good magnetic insulation properties [1]. Moreover, compared to some other FRP products (specifically, glass fibers-based composites), they are characterized by a good resistance to alkalinity in surrounding concrete ([1], [2]). BFRP are also resistant to high temperature and high moisture conditions [1],[3] and according to Ref. [4] and Ref. [5] they are chemically stable. In addition to the above-mentioned, it can be pointed out that BFRP have excellent fatigue resistance [6]. Some information about the mechanical characteristics of BFRP can be found in Ref. [2], Ref. [7] and Ref. [8].

Studies on the potential application of BFRP for strengthening of concrete structures have been reported in Ref. [2], Ref. [9] and Ref. [10]. Experimental results on the mechanical response (in terms of stress-strain curves) of concrete columns of circular cross section and reinforced concrete columns of rectangular cross section

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