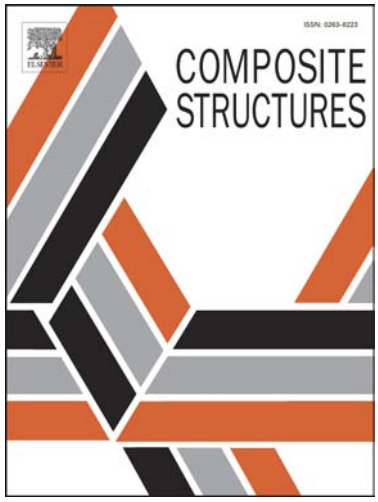

letter

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Bond behaviour of Steel Reinforced Polymer strengthening systems

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ABSTRACT

Steel Reinforced Polymer (SRP) systems, consisting of Ultra High Tensile Strength Steel cords and epoxy resin, are emerging as an effective and cost efficient solution for the externally bonded strengthening of structures. Their applications in civil engineering are more recent than those with Fibre Reinforced Polymers (FRP) employing carbon, glass or aramid textiles, and their mechanical properties still need to be deeply investigated. This paper presents an experimental study on SRP reinforcements comprising textiles with 4, 12 and 18 cord/in density. First, the mechanical properties of both textiles and SRP composites were derived through direct tensile tests. The shear bond behaviour, which is crucial for the effectiveness of most applications, was then investigated on strong and weak concrete, tuff, clay brick and brick masonry substrates, providing information on bond strength, failure mode, load-slip response and effective transfer length. Finally, test results and data available in the scientific literature are collected to calibrate the tuning coefficients for the estimate of the bond strength according to the design relationships provided by the Guidelines on FRP.

Keywords

Steel Reinforced Polymer (SRP); Bond; Concrete; Masonry; Experimental testing; Digital Image Correlation (DIC).

1. INTRODUCTION

Steel Reinforced Polymers (SRP) are an innovative class of composites for the externally bonded reinforcement of existing structures. They comprise unidirectional textiles made by twisting Ultra High Tensile Strength Steel (UHTSS) micro-wires to form cords. The first application of SRP in civil engineering was proposed in 2004 for the flexural strengthening of reinforced concrete beams [1]. Since then, a number of studies have been carried out to investigate the mechanical properties and durability of the steel textiles [2, 3], and the shear bond performance on concrete [4-7] and masonry [8-12] substrates. Experimental tests on medium and large scale specimens have shown that Steel Reinforced Polymer is an effective and cost efficient solution for the strengthening of reinforced concrete (see, amongst others [13-17]) and masonry [18-20] structures. Nevertheless, the most advanced standards, such as the Fib Bulletin 14 [21], the US guides ACI 440.2R-08 and ACI 440.7R-10 [22,23], and the Italian Guidelines CNR DT-200 R1/2013 [24], explicitly refer to Fibre Reinforced Polymers with carbon (CFRP), glass (GFRP) and aramid (AFRP) fibres (for which a more consolidated knowledge has already been developed), whereas steel textiles have been not included so far.
There are some differences related to manufacturing and nature of the steel textile with respect to carbon, glass and aramid ones: it is stiffer than glass and thicker than carbon and aramid, it is made of separated cords instead of being produced in compact fibre sheets, no bidirectional or multidirectional textiles are available. Nevertheless, the studies carried out to date (a state-of-the-art of which is provided in [25]) suggest that the mechanical behaviour of the SRP systems and of the structural elements reinforced with SRP can