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An experimental analysis about the effects of mortar joints on the efficiency of anchored CFRP-to-masonry reinforcements

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ABSTRACT

Fiber reinforced composite materials are widely used for structural rehabilitation and retrofitting of existing buildings; recent studies, devoted to Carbon Fiber Reinforced Polymers (CFRP) reinforcements of concrete structural elements [1–5], demonstrated that spike anchors are able to effectively increase the load carrying capacity and the ductility of CFRP bonded joints. However, application to masonry structures is disregarded by research since few experimental results are available. One of these, described in Refs. [6,7], compares the efficiency of a CFRP strengthening system provided with one or more CFRP spike anchors, also in dependence of some geometrical parameters; reinforcement sheets and spike anchors were applied only on the brick surface in order to evaluate the effects due to anchors only. In this paper the authors investigate the influence of mortar joints on the efficiency of anchored CFRP reinforcements on brick masonry. For this reason, an experimental campaign was planned on masonry pillars built with the same materials employed in Refs. [6,7], subjected to Near End Supported Single Shear Tests. Masonry pillars were built according to two different patterns, in order to detect the influence of both bed and perpend joints. The results are compared with results obtained from previous experimental campaign.

1. Introduction

The practice of consolidation techniques based on the use of composite materials as reinforcement of concrete and masonry structures, is more and more widespread in the structural rehabilitation and retrofitting of existing buildings. Thanks to wide experience gained in research activities concerning both concrete [8,9] and masonry [10–15] structural elements reinforced by CFRP sheets subjected to in-plane loads, the main features of the mechanical behavior of such reinforcements are known and quite shared among specialists: tensile (in plane) force on a reinforcement sheet is transferred to the substrate mainly via shear stresses mostly concentrated in a limited portion of the bonded surface, which length is called “effective bond length” [16]. The failure load of a reinforcement sheet increases with the bond length until this reaches such a limit length; longer bond lengths do not significantly increase the reinforcement bond capacity, but, eventually, only its “ductility”: while the load remains constant (at failure), the stress transfer zone moves from the loaded to the unloaded end of the reinforced surface. It is noteworthy that some studies presented in the literature [17–19] have shown that reinforcements made bonding Fiber Reinforced Cementitious Matrix (FRCM) materials demonstrate similar behavior with respect to the stress transfer mechanism between the reinforcement and the substrate.

Since failure of bonded CFRP reinforcement sheets, loaded by in-plane loads, generally occurs in the substrate material a few millimeters below the bonding surface, the reinforcement bond capacity strongly depends on the mechanical properties of the substrate material: in Ref. [6], it has been shown that, at least for the reinforcement systems considered in this paper, the ratio between the load carrying capacity of the reinforcements bonded to concrete substrates and the carrying capacity of analogous reinforcements bonded to brick substrates is almost equal to the ratio between the compressive strength of the substrate materials.

Since the bond capacity of CFRP reinforcement sheets is generally lower than the composite tensile strength, several methods have been proposed in the literature to increase their strength [20–22], especially with reference to concrete structural

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