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Micro-mechanical FE numerical model for masonry curved pillars reinforced with FRP strips subjected to single lap shear tests

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Abstract

The present paper discusses the results obtained using a micro-mechanical FE numerical model used to study the bond behavior of some curved specimens strengthened by Fiber Reinforced Polymer (FRP) composite materials. The numerical model, implemented into the FE code Abaqus, is a sophisticated micro-modelling (heterogeneous) approach, where bricks and mortar are meshed separately by means of 4-noded plane strain elements exhibiting distinct damage in tension and compression, FRP is assumed elastic and an elastic uncoupled cohesive layer is interposed between FRP reinforcement and masonry pillar. The experimental investigation considered to benchmark the numerical approach is aimed at characterizing the influence of normal stresses induced by curved supports on the stress-transfer mechanism of FRP materials. To this scope some single lap shear tests performed at the University of Florence on FRP reinforced curved pillars with two different curvature radii (1500 and 3000 mm) are here considered. The obtained numerical results obtained show a promising match with experimental evidences, in terms of elastic stiffness, peak loads and post-peak behavior. Indeed, the proposed approach allows to correctly account for important local effects, such as the effect of FRP-masonry interfacial normal stresses on the global delamination strength and the distribution of damage in the pillar volume. By using the proposed modelling approach, comprehensive numerical sensitivity analyses to investigate the role played by the curvature on the ultimate delamination strength, are also presented in the paper.

Keywords: heterogeneous damage-plasticity FE model; validation against experiments; curvature effect; masonry; FRP; delamination

1 Introduction

Fiber Reinforced Polymer (FRP) materials have been extensively used in the last decades for repairing and upgrading of concrete and masonry structures. Nowadays, such strengthening systems comprise different types of fiber textiles (i.e. carbon or glass fibers) arranged in various forms but always glued by means of a thin layer of epoxy resin. The final composite material to be used on load bearing elements is characterized