Non-Destructive Assessment of the Adhesion at the Interface Between FRCM Reinforcements and Masonry Substrates by Non-Linear Ultrasonic

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ABSTRACT

In recent years, the development of suitable strengthening techniques for historic masonry constructions has received increasing attention from research community. One of the main motivations is the pronounced seismic vulnerability of these constructions, entailing the risk of losing important parts of our cultural heritage. Among possible strengthening materials, Fiber Reinforced Cementitious Matrix (FRCM) composites have gained interest over the classical Fiber Reinforced Polymer (FRP) composites since FRCM composites appear to be more compatible with historical masonries, both from the technological and the structural point of view [1].

A number of studies deal with issues like the interactions, the adhesion and the delamination strength between FRCM composites and masonry, investigating possible collapse modes and the overall structural capacity of the strengthened constructions, both from the theoretical and the experimental point of view. Anyway, the problem of the detection of possible defects in the adhesion between FRCM and masonry, formed during the application of the reinforcement or during the service life of the construction, for example due to exceptional loads like earthquake actions, fire, etc., needs to be further investigated. Indeed, defects in the adhesion may strongly undermine the strength of the reinforced construction. Thus, suitable experimental techniques must be developed. Here, an innovative non-linear ultrasonic technique is proposed for detecting defects in the adhesion between FRCM composite layers and masonry substrates.

Non-linear ultrasonic techniques may be very effective in the detection of defects and damage [2]; basically, the principle exploited for experimental evaluations is that defects act like an active non-linear radiation source of new frequency components rather than passive scatters as in the case of classical linear ultrasonic techniques [3]. Based on this, the Side-band Peak Count (SPC) technique reprocesses results of ultrasonic guided waves tests by relating the level of the non-linearity of the ultrasonic response, i.e., the damage, to the appearance of additional minor components in the spectrum of the received signal [4].

Experiments performed on specimens made of masonry tuff substrates reinforced with FRCM mortars embedding a basalt fibers grid and having known artificial defects allows for discussing the proposed approach. Experimental results show the effectiveness of SPC technique in detecting the defect and allows for highlighting the influence of the defect dimensions on the variation in SPC.

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