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Effect of Mortar Age on the Textile-to-Mortar Bond Behavior

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1 Objective

Textile-reinforced mortar (TRM) composites have received extensive attention as a sustainable solution for seismic strengthening of masonry and historical structures. This new system is composed of textile fibers embedded in an inorganic matrix and is applied on the masonry and the concrete substrate surface as an externally bonded reinforcement (EBR) system (Dalalbashi, Ghiassi, Oliveira, and Freitas, 2018a and 2018b; Ghiassi et al., 2016). The bond at the textile-to-mortar interfaces is the primary stress-transfer mechanism and, therefore, should be thoroughly investigated. Furthermore, the effectiveness of TRMs in improving the seismic performance of existing structures is highly dependent on the durability of its components, materials, textile-to-mortar bond, and their long-term behavior. Due to the novelty of these materials in application to masonry structures, several aspects related to the durability and long-term performance of them are still not clear. To that end, a new study has been launched that looks at the time effect on the mechanical properties and bond behavior between fiber and mortar. For this purpose, two different hydraulic lime-based mortars, as well as steel and glass fibers, are used to investigate the effect of mortar age on the TRM system after 180 days. The results show that at the early age of mortars, their mechanical properties, and the bond behavior of textile-to-mortar have been increased. Another critical point to remember is that by increasing the mortar age, textile-to-mortar bond and mortar strength are decreased.

2 Experimental Program

The experimental program consists of evaluating the role of mortar age on the bond behavior of single fibers embedded in lime-based mortars. For this purpose, two commonly used fiber types (steel and glass) with their counterpart mortars are used for these investigations. Also, a single-sided pull-out test (pull-push type) and mechanical mortar tests (compressive and flexural tests) are performed.

3 Experimental Results and Discussion

3.1 Steel-Based TRM Composite

By comparing the average curves, a slight increase in the pull-out response can be observed in the first 30 days, followed by a slight decrease until 180 days. A possible explanation for this phenomenon is due to the changes in the mechanical properties of the mortar M2 that followed a very similar trend with time. While the toughness follows a similar trend as the peak load (increases initially and then a decrease), the slip corresponding to the first peak load is almost constant. At the same time, the initial stiffness of the pull-out curves seems to be decreasing with time.

3.2 Glass-Based TRM Composite

At the mortar ages of 15 and 30 days, after complete debonding (at peak load), a descending trend in the pull-out force can be observed. In contrast, at the age of 90 and 180 days, the pull-out force increases after complete debonding, showing a slip hardening behavior. This behavior is in-line with the observed changes in the mechanical properties of mortar M1. The summary of the pull-out response shows the slip corresponding to the peak load is relatively constant, while the peak load, toughness, and initial stiffness of the pull-out curves increase with time until 180 days.

4 Conclusions

The following conclusions can be drawn from the obtained experimental results:

- The results show that the 30 days curing that is usually used for cementitious mortars are not suitable for lime-based mortars.
- It is difficult to propose a generic curing time for performing the pull-out tests when lime-based mortar is used as the matrix.
- The changes in the flexural strength of the mortar seemed to be a good indication of the changes in the bond behavior and are suggested for evaluating the mechanical properties and bond response of these systems.

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