Evaluation of the behaviour of lime and cement based mortars exposed at elevated temperatures

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ABSTRACT

Exposure to fire and elevated temperatures is diachronically a significant decay factor, influencing the stability of structures. When subjected to fire, the performance of building materials is severely affected (i.e. physico-chemical and mechanical characteristics, microstructure), according to a synergy of factors. The type and properties of materials, as well as the characteristics of the fire (i.e. maximum temperature attained, temperature development rate, fire duration), are the main parameters taken into account. Research on the topic, launched in the beginning of the 20th century and is induced during the last two decades. According to literature, during a fire, temperature is immediately rising up at 822^{o}C at the first 30 minutes of the action. Due to the difficulty of simulating such an extreme temperature increase in laboratory scale, the proposed temperature development rate for testing materials is around 5-10^{o}C/min.

According to former research, cement and lime-based mortars have a different behaviour when exposed at elevated temperatures, usually testified by the post-fire preservation state of historic and contemporary constructions [1-2]. In this paper, the correlation of their properties is envisaged, in order to identify the key elements of their performance. To this direction, six compositions of cement and lime based mortars were manufactured and tested, after their exposure at 200^{o}C, 400^{o}C, 600^{o}C, 800^{o}C and 1000^{o}C. The binders used concerned CEM I42.5N, hydrated lime (L) and natural pozzolan (P), while the systems applied regarded I42.5, I42.5:L (1:1), L, L:P (1:1). Specific additives were also included in the case of cement-based mortars in order to assess their efficacy. The aggregates used were natural, siliceous and their gradation varied from 0-4mm to 0-8mm. The B/A ratio was 1/2 and the W/B ratio was adjusted in order to maintain workability around 15±1cm. The physico-mechanical properties of the specimens, were recorded before and after their exposure at the selected temperatures.

From the evaluation of the results, it was concluded that whereas the strength of the cement-based mortars was continuously decreased throughout the temperature increase, the lime-based ones presented significant strength increase up to 600^{o}C. In all cases, at 800^{o}C the residual strength was corresponding to the 30-60% of the initial one, while at 1000^{o}C to 10-20%. It was generally asserted that the mortars' behaviour was different at the early temperature rate (up to 600^{o}C) according to their type, whereas the results were more comparable at the extreme temperature level. Generally it was observed that although the initial strength of the lime-based mortars was low (1-4MPa), they presented a more stable and efficient performance at the elevated temperatures, rendering them probably more resistant to fire actions.

REFERENCES

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