Concrete fire protection with lightweight aggregate concrete

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ABSTRACT

Construction of structures is progressively requiring the use of higher compression strength cement based materials to withstand extreme loads. As a counterpart, these materials are more brittle and exhibit higher spalling tendency when subjected to high temperatures. Steel fibers are usually added to counteract these effects and improve tensile behavior. Lightweight aggregate concrete covering can also contribute to fire protection to concrete core [1].

The effect of temperature exposure on concrete and fiber reinforced concrete (FRC) protected with different types of lightweight aggregate concrete is numerically simulated in this paper. Concrete is modelled with a thermo-mechanical plastic model including thermal damage [2]. An elastoplastic model that takes into account the effect of temperature is used to simulate fibers and fiber debonding [3][4]. The thermo-mechanical behavior of FRC is obtained through a simple homogenization procedure based on a modification of mixture theory [3].

The proposed model is first validated with numerical examples and comparison with experimental results. For this purpose, thermal problems [5] in concrete proves with lightweight aggregate concrete cover and residual flexure behavior of FRC beams previously exposed to elevated temperatures [6] are numerically reproduced. Then, the mechanical behavior of protected concrete and FRC elements exposed to elevated temperatures is simulated to show the benefits of using this type of fire protection. Numerical results show that thermal deterioration of concrete core can be attenuated with these thermal barriers. The numerical tool developed is useful for the design and assessment of this kind of thermal protective covers.

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