Microstructure and structural analysis of polypropylene fibre reinforced reactive powder concrete beams exposed to elevated temperature

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ABSTRACT
Despite the superior properties of reactive powder concrete (RPC), the possibility of spalling under fire conditions still exists, which can lead to a significant reduction in the fire endurance of reinforced concrete members. This study investigates the efficiency of using the different percentages of polypropylene fibres (PPFs) for enhancing the fire resistance of reinforced beams made from RPC. Five RPC beams were tested by applying two concentrated loads. One of them (without PPFs) was tested under monotonic load up to failure. The other four beams were subjected to service load, and then controlled fire was applied for 120 min in accordance with the fire temperature vs. time curve prescribed in ASTM E 119. Loading tests were then conducted on the beams that were not completely damaged through fire testing, in order to examine their remaining strength after cooling. Experimental results showed that non-fibrous reinforced RPC beams suffer early spalling during the fire test, thus causing beam failure after 38 min of fire exposure. The addition of PPFs in a low volume percentage (0.25%) decreases spalling and delays beam failure until 115 min, whereas PPFs in high percentages (0.75% and 1.25%) completely prevent the spalling and beam collapse. Moreover, an increase in PPF content reduces the total deflection of a beam and improves the residual strength and ultimate strength of fire-failed beams subsequent to cooling.

KEYWORDS
Reactive powder concrete; Beam; Fire; Polypropylene fibres; Spalling

References

1. M. Cheyrezy, V. Maret, L. Frouin
   Microstructural analysis of RPC (reactive powder concrete)
   Cement Concr. Res., 25 (1995), pp. 1491-1500

2. O. Bonneau, C. Poulin, M. Dugat, P.-C.A. Tcin
   Reactive powder concretes: from theory to practice
   Concr. Int., 18 (1996), pp. 47-49

3. Y. Ju, L. Wang, H. Liu, K. Tian
   An experimental investigation of the thermal spalling of polypropylene-fibreed reactive powder concrete exposed to elevated temperatures
   Sci. Bull., 60 (2015), pp. 2022-2040

4. H. Li, G. Liu
   Tensile properties of hybrid fibre-reinforced reactive powder concrete after exposure to elevated temperatures
   International Journal of Concrete Structures and Materials, 10 (2016), pp. 29-37

5. G.-F. Peng, Y.-R. Kang, Y.-Z. Huang, X.-P. Liu, Q. Chen
   Experimental research on fire resistance of reactive powder concrete
   Advances in Materials Science and Engineering, 2012 (2012), p. 6860303