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Behavior of Fiber Reinforced Reactive Powder Concrete Columns Following Fire Exposure and Modifications Made To Increase Column Resistance to Fire

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Abstract

This paper offers a test examination of the fiber strengthened responsive powder solid sections' conduct after introduction to fire and upgrades made to improve segment opposition against fire. This examination is for the most part meant to contemplate the test conduct of mixture strengthened segments created by receptive solid powder (RPC) and presentation to the fire of fire at one side and exposed to erratic burden. The test technique comprises of sixteen RC segments that sorted out into four gatherings dependent on the factors utilized in this examination: (SF) steel strands, (PP) polypropylene filaments, (HB) half and half filaments, (PPC-SF) crossover cross-segment (steel fiber responsive powder solid center with polypropylene fiber receptive powder solid spread). All sections were tried under 60 mm capricious burden and the consume segments were presented to fire for various length (1, 1.5 and 2) hours. The outcomes showed that (SF-RPC, PP-RPC, HB-RPC, PPC-SFRPC) sections presented to a fire for the period 2 hours, lost from their heap limit by about (54.39, 40.03, 34.69 and 30.68) % separately. The primary finish of this paper is that the best imperviousness to fire of the segment acquired when utilizing a half breed cross-area (steel fiber responsive powder solid center with polypropylene fiber receptive powder solid spread).
Keywords: *Reactive Powder Concrete (RPC); Hybrid Cross Section Column; Hybrid Fibers (HB); Exposed to Fire and Eccentric Load.*

I. Introduction

The reinforced concrete column is a structural member utilized mainly for standing compressive loads, consisting of concrete with an embedded steel frame for reinforcement purposes. There are rarely axially loaded columns in practice since there is always some bending. The moments that happened in the continuous construction along with unavoidable building imperfections will cause eccentricities and then caused a bending in the member. The strength of the column is controlled by the strength of the used material (in particular, the compression strength of the concrete) and the cross-section geometry [1]. The demand for stronger, products with lower space-consuming has increased as construction and material costs increase. Newly, in Bouygues, France, developed a very high strength and high ductility cement-based composite, known as reactive powder concrete (RPC) [2]. RPC is a cemented material characterized by high-performance characteristics for example low shrinkage creep and permeability, ultra-high strength and increased protection against corrosion [3]. However, the need for high-strength structures always comes with an issue in fire resistance for the structure. It was disclosed collectively that the greater strength of the blend will cause a reduction in the composition's fire resistance. In high temperature, the high-performance concrete compositions which are usually denser tend to be more likely to fail because of their high brittleness. High performance concrete shows greater deterioration than ordinary strength concrete, for example concrete spalling and cracking [4]. Nowadays, many fire accidents have occurred around the world, with the use of fresh cement developments (lately RPC) to build load-carrying

members for high-rise structures composed of beams and columns, and the fire safety design of these structures has become crucial. This is because the fire resistance of these members is the recent line defense, if other means is failed in extinguish the fire [5]. Also, secure constructions must be designed with a minimum danger for both individuals and property as potential [6, 7].

Nevertheless, the previous study concentrated only on the efficiency of the concrete columns during the fire, whereas the performance of these columns after cooling was very crucial since most concrete buildings subjected to fire circumstances did not collapse and could be recycled using appropriate methods for repairing [8]. In spite of that, it is not easy to decide whether it is more economical to repair the fire-exposed buildings or to demolish and repair them. This choice requires a full understanding of the conduct of these constructions after exposure to fire to determine whether the residual load-bearing capability of the load-bearing members is adequate. The previous researches indicated that the main cause of the crash was steel reinforcement failure for most of the concrete buildings that were damaged by fire [9, 10]. The reason is that the position of the reinforcement is generally near to the surface of the concrete member. Therefore, the steel reinforcement initially deteriorates due to its higher transfer rate of heat compared to the concrete
[10]. The tests were carried out as the most critical situation on four sides fired concrete columns. Concrete columns may be exposed to fire from various sides in actual fire events based on the construction's architecture and structural design [11, 12]. For instance, a wall could operate as a column obstacle exposing only one, two or three sides of the column to fire. On the other side, a column can be situated in the center of a space thus exposing all four sides of the column to fire.

In this research improvements made to improve column resistance against fire. One of the improvements is to make a model in which the main component of the column Steel fiber strengthened RPC (SF-RPC) in the (core) and protected using polypropylene fiber strengthened RPC (PP-RPC) in the (cover). In this case, the core column is not significantly affected, the designer that can used after burning by the rehabilitation of the column through maintenance on the cover only. Also hybrid fibers are used in optimal proportions to differ from previous researches columns to obtain a column with elevated burn resistance and it has compared to columns casted, containing only steel fibers or polypropylene fibers. Figure 1 show the research methodology.

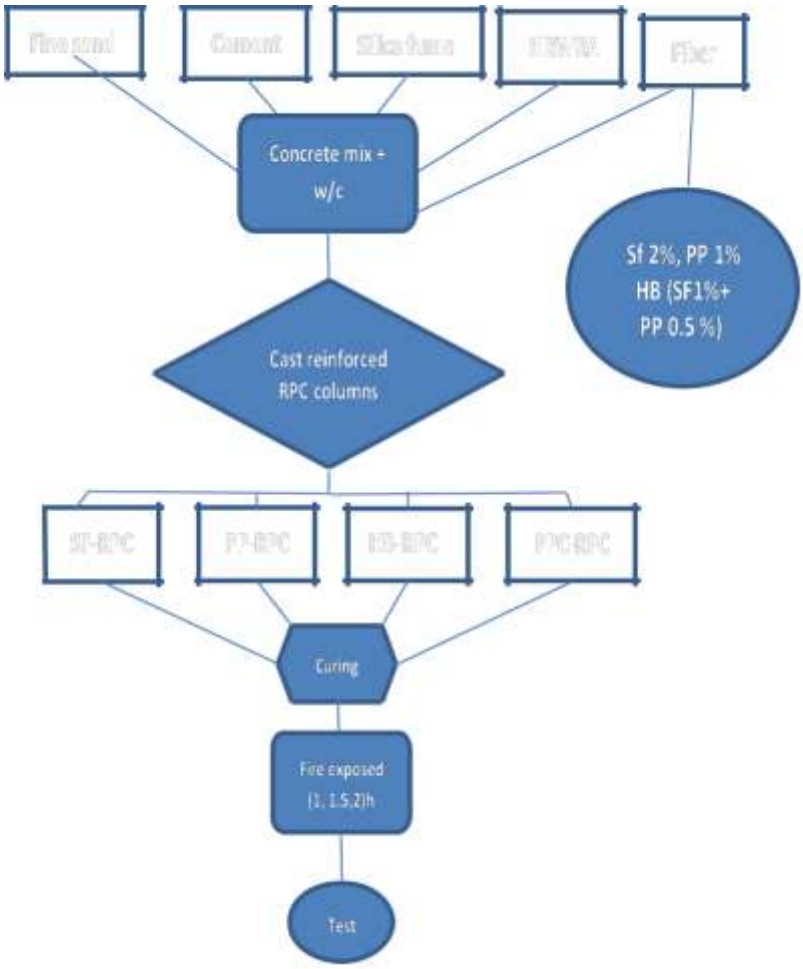

Figure 1. Flow chart of the project of research

II. Experimental Program

2.1. Material

2.1.1. Cement

The cement that utilized in this study is Ordinary Portland cement (Type I), cement produced in Iraqi north and known of commercially as Karasta.

2.1.2. Fine Aggregate

Very fine sand with maximum particle size (600 μm) was utilized as a fine aggregate for reactive powder. In compatible with Iraqi Specification requirements IQS No.45/1984. Figure 2 shows the natural sand grading curve.

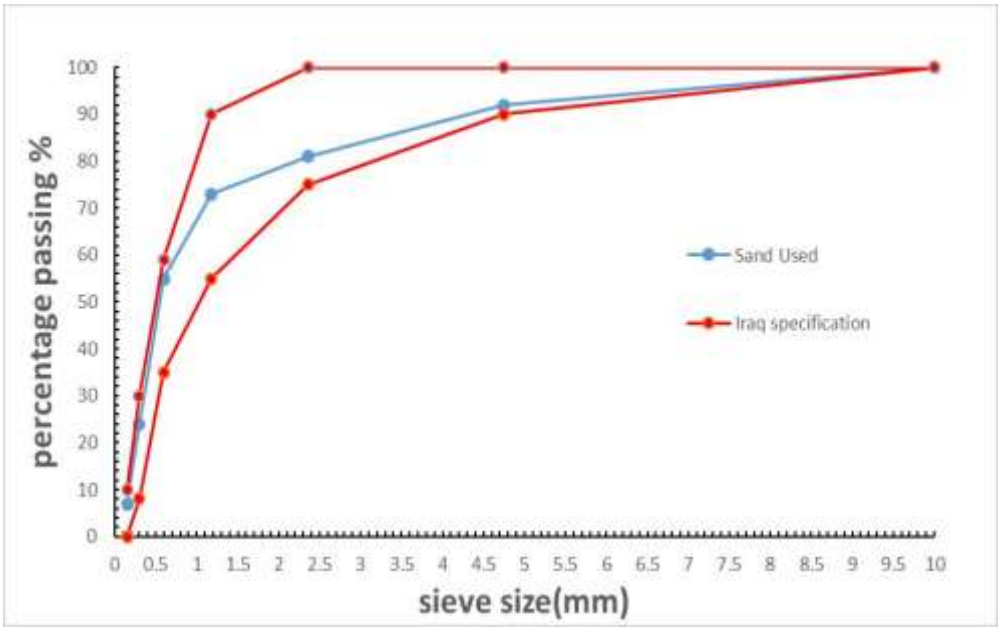

Figure 2. Grading curves for fine sand

III. Conclusions

- For the reference RPC columns of each group, the load carrying capacity was higher when using steel fiber, hybrid fiber and hybrid cross section compared to using polypropylene fiber.
- The effect of the increased duration of fire exposure on the load carrying capacity was less for (HB-RPC, PPC-SFRPC) column specimens than (SF-RPC, PP-RPC) column specimens. For 2 hours fire duration the best residual load carrying capacity is obtained by using (HB-RPC and PPC-SFRPC).
- From the test results, it has been concluded that the cover of concrete contributed to improving the fire resistance of (PPC-SFRPC) columns after burning for different burning durations.
- For the reference columns, it is observed that SF-RPC columns have much greater ductility compared to other references in each group. Also, it is discovered that using polypropylene fiber in RPC such (PP-RPC) columns gives lower ductility compared to other groups.
- The experimental findings show that the absorption energy capacity of RPC columns clearly decreases with increment the duration of fire exposure.
- The first crack load of RPC columns with steel and hybrid fibres, compared to RPC columns with polypropylene fibers was improved to (3-2.5) times. The first crack load of RPC columns decrease with increasing the duration of fire exposure.

- Hybrid, polypropylene and Steel fibers influence the prevention of explosion and spalling concrete cover even after column failure. However, columns (HB-RPC) have no explosive spalling occurred before testing the columns due to elevated temperature and after testing columns.

IV. Conflicts of Interest

The authors declare no conflict of interest.

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