Experimental Study of Aerated Concrete with Addition of Polypropylene Fibre

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Abstract — **Aerated concrete is being used successfully in construction due to its improved properties such as workability, less dead load, better insulation and durability. Its use is increasing rapidly. In this work, the investigation on the effect of using polypropylene fibre in aerated concrete is presented through tests. Aerated concrete is produced by using fly ash, cement, gypsum, aluminium powder and water. Based on earlier investigation and experience, water to dry materials ratio is taken as 0.65. The dry density, water absorption and compression strength of aerated concrete blocks are obtained at varied percentages (0.5%, 0.75% & 0.1%) of polypropylene fibre.**

Keywords - Polypropylene Fibre, Aluminium powder, Fly ash, density, Water absorption and Compressive Strength.

I. INTRODUCTION

Aerated concrete has been recognized as a cellular concrete. It is of two primary types based on tactics of production as non – autoclaved aerated concrete and autoclaved aerated concrete (AAC). Aerated light–weight concrete have numerous benefits in comparison with conventional concrete including enhanced strength to weight ratio, lower coefficient of thermal expansion, and superior sound resistance by virtue of air voids within aerated concrete [1]. This paper is an attention to aerated light- weight concrete subjected to autoclaving. Also, it exhibits the raw materials utilized in aerated concrete, forms of agent, properties and applications. The properties - strength, durability, toughness, heat transfer and moisture transport - get influenced by the pore size and small structure. This porous material will give high acoustic and thermal insulation properties [2]. However, due to enhanced pores the compressive strength of blocks decreases. It is lighter than the conventional clay bricks with a dry density between 600 kg/m^3 to 1600 kg/m^3.

Foamed concrete is not a particularly new material; its first recorded use date back to the early 1920s. However, the application of foamed concrete for construction works was not recognized until the late 1970s. Beside the AAC began approximately 100 years ago [3]. In 1914, the Swedes discovered a mixture of cement, lime, water and sand that was expanded by the adding aluminium powder to generate hydrogen gas in cement slurry [4]. It was reported that foamed concrete was manufactured in Europe over 60 years ago and has since then been on the international market for more than 20 years. Foamed concrete can be characterized with high flowability, low self-weight, minimum consumption of aggregate, controlled low strength, and excellent thermal insulation properties [5]. Non autoclaved aerated concrete using polypropylene fibre will be made either by using foaming agent or by using air entraining agent. In this analysis, aluminium powder has been used as an air entraining agent. Aerated concrete is obtained by the chemical process that takes place in fresh mortar with the addition of aluminium powder. The reaction of aluminum powder with the hydroxide of calcium and alkali from cement and lime liberates hydrogen that forms bubbles within the mixture. The bubbles expand the mixture and the concrete rises. The hardened concrete contains voids left by the reaction.

Aerated Concrete blocks can be appropriate in different parts of a building; it can be used in both non-load bearing and load bearing walls. Autoclaved aerated concrete blocks are applicable in construction engineering as compensation for foundation, pipeline backfilling, roof insulation, etc., and also get some application results in infrastructure facilities as bridge and culvert backfill, road widening, resolving bumping at bridge-head of soft base embankment.

Aerated concrete polypropylene fibre blocks made using fly ash assists in decreasing the difficulty of fly ash disposal. Further, these light weight aerated concrete blocks with reduced dead load, help in easy transfer and rapid construction. Aerated Concrete using polypropylene fibre in light weight concrete may further improve the desirable properties of concrete.

II. EXPERIMENTAL

The materials used in the investigation were Ordinary Portland Cement (OPC), fly ash, gypsum, Lime, aluminium powder, polypropylene fibre potable water. The quantity of water was taken as 0.65 times the weight of dry materials. A constant amount of aluminium powder 0.8% was added to all the samples. The quantity of polypropylene fibre was varied in the samples as 0%, 0.5%, 0.75%, and 1%. The figure below illustrates the methodology of the work.

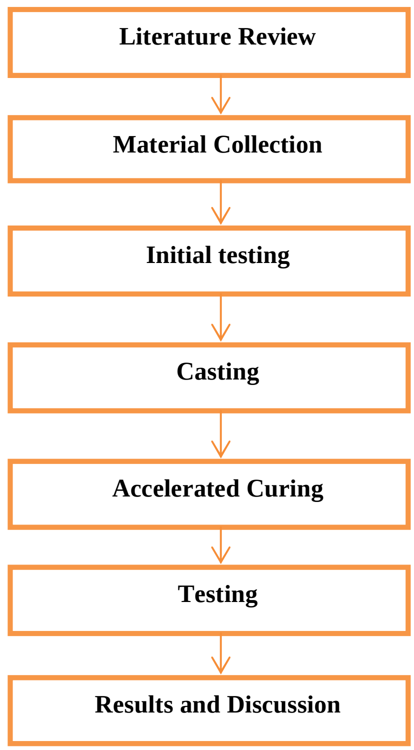

Figure 1. Methodology

The materials cement, lime, gypsum, aluminium powder, polypropylene fibre and water were thoroughly mixed in accurate proportions. The quantities of materials in percentage by weight, used in each sample, are presented in table 1.

TABLE 1. QUANTITIES OF MATERIALS IN PERCENTAGE BY WEIGHT

Sample designation	Cement	Fly ash	Lime	Gypsum	Polypropylene fibre	Water/Dry material ratio
SC	40	50	7	3	0.00	65
S1	40	50	7	3	0.50	65
S2	40	50	7	3	0.75	65
S3	40	50	7	3	1.00	65

Cube and prism specimens were prepared. The samples were cast by applying oil in moulds and pouring the mixture in the moulds. The expansion of concrete in the moulds was observed and the excess concrete was cut down and finished. The specimens were left at room temperature for 24 hours, and then transferred to oven and left for 24 hours. Then they were demoulded and kept in accelerated curing tank for 2 hours, and then taken for test.

III. RESULTS AND DISCUSSION

A. WATER ABSORPTION

The cube specimens were immersed in water for 24 hours. After 24 hours immersion, the cubes were removed from water and wiped out for traces of water with cloth and weighed. Then, the cubes were dried in oven for 24 hours and weighed. This test shows the permeability of the concrete. Through this test, the water absorption percentages of the concrete blocks were determined. By immersing the concrete blocks in water for a day, the maximum amount of water can be taken in by the block and hence the results can be effective. Water absorption test results are presented in the graph below.

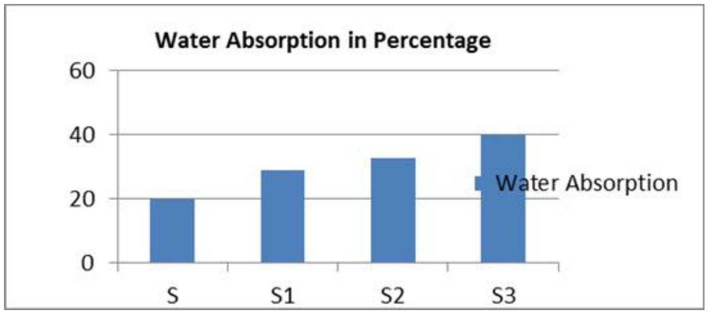

Figure 2. Graph showing water absorption test results

The graph is plotted between Sample along X-axis and Water Absorption along Y-axis. The test results show that the water absorption capacity of the blocks increases with the addition of fibre. The water absorption rate of the aerated concrete is due the presence of polypropylene fibre, because fibre can absorb more water.

B. COMPRESSIVE STRENGTH

This test is performed using compression testing machine. The compressive strengths of aerated concrete blocks using polypropylene fibre were obtained at 2 hours and 4 hours of accelerated curing. The Compression Strength test is the most important test which shows the efficiency of blocks. Compressive strength of foamed concrete can be influenced by many factors such as density, age, curing method, component and mix proportion. The compressive strengths in almost all mixes revealed a continuous increase with age. The rate of strength development was greater initially and then decreased as age increased. The results of the tests are shown below.

TABLE 3. COMPRESSIVE STRENGTH OF AERATED CONCRETE BLOCK

Sample designation	Area of Sample (mm)	2hrs accelerated curing		4hrs accelerated curing	
		Maximum Load (KN)	Compressive Strength (N/mm^2)	Maximum Load (KN)	Compressive Strength (N/mm^2)
S	100 x 100	60	6	70	7
S1	100 x 100	90	9	100	10
S2	100 x 100	110	11	130	13
S3	100 x 100	100	10	110	11

From the test results, it can be concluded that the compressive strength of the aerated concrete blocks increased with the addition of certain proportion of fibre. But when the proportion is increased beyond the limit, declination in strength can be noted.

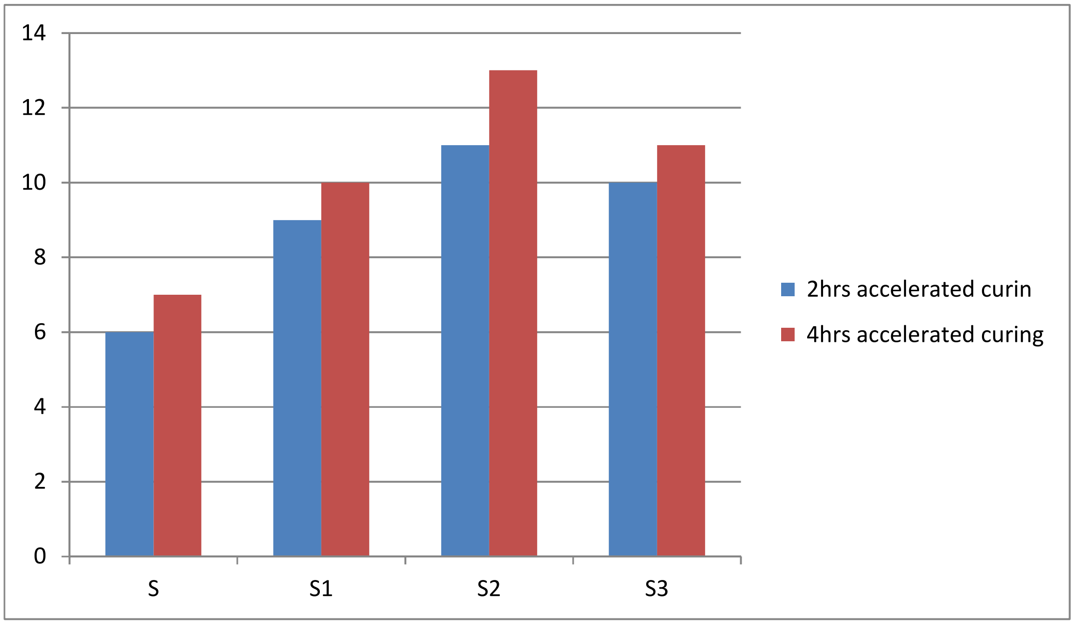

Figure 3. Graph showing Compressive Strength Test Results

Figure 3 exhibits the graph plotted between Sample along X-axis and Compressive Strength in N/mm^2 along Y-axis. The test results show that the compressive strength of aerated concrete block increased when 0.75% polypropylene fibre was added. It showed a maximum strength of 13 N/mm^2 when subjected to 4 hours accelerated curing.

IV. CONCLUSION

The following conclusions could be drawn from this experimental work:

1) Water absorption of aerated concrete block using polypropylene fibre increases with increase in fibre content.
2) Light weight concrete polypropylene fibre block is lighter than conventional clay bricks.
3) Aerated concrete block units have the least compressive strength when compared to any other type of masonry.
4) Aerated lightweight concrete does not contain coarse aggregate, and it is possess many beneficials such as low density with higher strength compared with conventional concrete, enhanced with thermal and sound insulation, and reduced dead load.
5) The compressive strength of foamed concrete can be developed to reach a structural strength in comparison with autoclaved aerated concrete.
6) The compressive strength of aerated concrete reaches its peak when it is subjected to an accelerated curing for 4 hours.
7) Aerated lightweight concrete considers economy in materials, and consumption of by-products and waste materials such as fly ash.

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