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Comparison Of Mechanical Properties of Aerated Concrete with And Without Steel Fibres.

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Abstract- Present scenario of construction industry is facing problems of organizations of by-product materials like disposal and ground water contamination etc. that are producing naturally in the process of converting one form to other. Scientific experts are trying to create new building materials from these by-product materials that will fit in current situations to avoid damage to society and environment. The addition of these by-product materials to make new building materials makes the environment stable and also produces the durable building products. Aerated concrete is one which uses some of these by-products like fly ash, GGBS etc. and reduces the use of natural sand and cement with enhanced mechanical properties like compressive and tensile strength. As aerated is concrete is poor in flexural strength to improve this property steel fibres are used in proportion This paper mainly focuses on the mechanical properties of aerated concrete like compressive, tensile and pull-out strength with and without addition of steel fibres. After addition of fibres mechanical properties are enhanced up to certain extant.

1. INTRODUCTION

Concrete, the existing most used material in civil engineering projects. It is produced worldwide directly or indirectly by adding chemical and mineral admixtures. Currently the demand for building materials is increasing due to urbanization but decremental of raw materials created a gap between raising demand and supply. In order to overcome this situation and to avoid negative impacts of these materials on environment it is necessity to make new building product so that these by-products building materials meets the gap. Aerated concrete is the one which is produced by adding aluminium powder to cementitious and non-cementitious materials slurry. Results in production of hydrogen gas, which in turn creates pores in it. These mixtures when added with fibers, it will change mechanical properties of the mix. Borvorn Israngkurana Ayudhya [1] concluded that by adding polypropylene fibers to aerated concrete, compressive strength increased up to 0.5 percentage fibers content beyond that decrease in compressive strength was observed. Ali J. Hamad [2] explained the process of manufacturing of AAC and recommends the use of 0.2 percentage aluminium powder. Density plays key role in determining strengths but keeping the density low and increasing mechanical properties is making difficult. In order to avoid this problem and to increase additional strength, fibers plays a very important role in strength.

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Parth Desani [3] compared AAC blocks with clay bricks and concluded that AAC blocks have smooth finishing and appearance. Aerated concrete does not require any additional mortar because it looks same appearance as finished mortar coat. It ultimately reduces the cost of construction. S. Gopalakrishnan et al. [4,7] performed mechanical tests on aerated concrete like compressive, tensile and pull-out tests on AAC blocks. In this literature surveys increase in bar diameter in pull out test shows an increase in pull out load because of more surface area. Rana Shabbar [5] conducted compressive and flexural tests on AAC blocks with varying content of aluminium content and concluded that flexural strength of aerated concrete has direct relationship with compressive strength. Muthu Krishnan [6] explained that increase in temperatures in autoclave beyond normal results in increase of compressive strength and water absorption by 10 percentage.

2. MATERIALS

Materials used in this study are explained in detail below.

2.1 CEMENT

There are so many types of cement available in market. Out of them ordinary Portland cement of grade 53 is used in this study. Tests on hydraulic cement of grade 53, Is done by using IS 4031 (part 6):1988 Code.

Table 1. properties of cement

S.NO	TESTS OF CEMENT	TEST RESULTS
1	Fineness of cement using sieve method	4%
2	Specific gravity by Le-chartlier apparatus	3.2
3	Natural consistency	31%
4	Time taken for initial setting	1 hour
5	Time taken for final setting	4.833 hours
6	Compressive strength after 28 days	54 MPa

2.2 GGBS

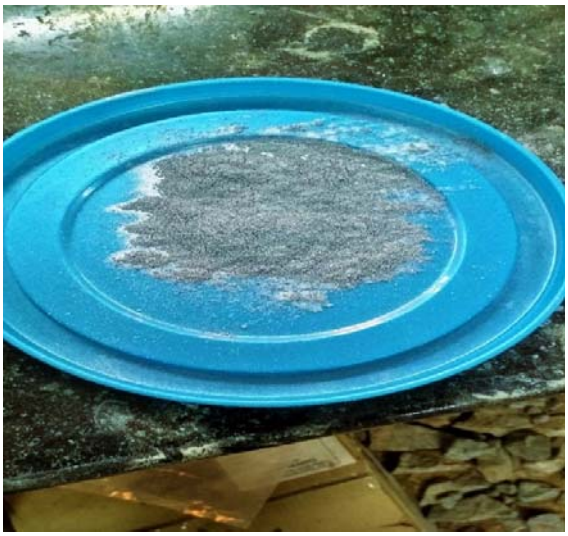
It prevents the concrete from sulphate attack and has high content of cementitious property. It makes concrete more durable. GGBS tested as per IS 16714:2018 code and confirmed.

2.3 FLY ASH

Class-F fly ash used in this experiment and it is tested as per IS Code 3812(part 1):2013.

2.4 ALUMINIUM POWDER

It is the main component of aerated concrete and it produces hydrogen gas bubbles in the mix. It is procured locally.



2.5 STEEL FIBERS

The diameter and length of steel fibres used in this study are 0.25mm and 20mm. The Aspect ratio corresponding to steel fibres length and diameter is 80.

2.6 QUARRY DUST

3. METHODOLOGY

This paper deals with the production of Aerated concrete by adding a varying percentage of aluminium powder to the cementitious slurry. Based on strength and durability criteria mix proportions are fixed. After the number of trials, final and best mix proportion is achieved. Using the above final proportion mix, materials for one 100mm is calculated and then based on the requirement of cubes used for tests, material contents are calculated by multiplying materials content needed for one cube. After mixing of all these materials with water, aluminium powder is added in the 0.05 to 0.2 % range. Then steel fibres are added to these mixes ranging from 0.04 to 0.2% of total volume. Then finally water is added to this mix about 0.4 percentage of whole mix. After addition of water, all these materials are mixed using the mechanical mixer for 2 to 3 minutes to obtain a uniform concentration of mix so that uniform expansion of heights in all cubes takes place. But in actual situation even after mixing of all these materials thoroughly there is possibility of different expansions in different cubes. Aluminium powder is highly reactive in nature and it takes only 2 to 3 minutes to react with mix and most of reactions takes place within 3 minutes after adding aluminium powder to the mix. after that it will slow all of its reactions and rate of expansion become zero. so it is necessary to take precautions before adding aluminium powder to mix. Then the slurry is poured into 100mm cubes prepared before the experiment starts. All the nuts of cubes are tightly fitted such that there is no leaking occurs and grease is applied to the sides and bottom of moulds to avoid sticking of materials to it. After pouring the slurry in moulds, initial heights of pouring is recorded at same time of pouring then final expansion heights are noted down after four to five hours for dry density calculations. Dry density is calculated after total moisture in cubes escaped during the process of oven drying. In oven drying these cubes are dried at a temperature of 100 degrees for ten hours. These cubes take a minimum of 4 to 5 days for attaining self-carrying capability because of slow rate of gaining strength. After 5 days cubes are unmoulded and these cubes are submerged in water of temperature 27 to 35 degrees for 28 days to prevent loss of moisture and to avoid small hairline cracks. After 28 days compressive, tensile and pull-out tests are conducted to determine any change in strengths.

4. MIX DESIGN

After number of trails and materials adjustments, final and fixed proportion is obtained.

Mix proportion are as follows (cement: fly ash: GGBS: Quarry dust: lime powder) (1:1:0.32:0.32:0.32). water is added to the mix based on quality requirements, corresponding to IS Code 456(2000).

5. EXPERIMENTAL RESULTS

5.1 AVERAGE WATER ABSORPTION OF CUBES

For each aluminium content Three cubes are placed in oven drying machine for ten hours to loss all moisture present in them. Then initial dry weights of samples are noted, after that they are placed in water for 24 hours under normal room temperature. final saturated weights of three cubes recorded. Average of water absorption these 3 cubes of each aluminium content is noted down.

Table 1. results of water absorption of three samples

S.NO	PERCENTAGE ALUMINIUM POWDER	AVERAGE WATER ABSORPTION IN (%)
Sample 1	0.05	23
Sample 2	0.1	27
Sample 3	0.15	32
Sample 4	0.2	35

5.2 COMPRESSIVE STRENGTH

For compression test total of 32 cubes are prepared out of 32 cubes, 12 cubes are prepared without steel fibres content for determination of compressive strength and to compare it with results of with fibers Compressive strength of remaining varying content of fibers of different aluminium powder percentages. The average compressive strength of one aluminium percentage cubes taken for same aluminium percentage with fibres compressive strength is calculated and compared. The Size of specimens used in the compressive test is 100mm cubes.

Fig. 1. Compression test of specimens

Table 2. Compressive strength of specimens without fibers

PERCENTAGE OF ALUMINUM POWDER	S.NO	DRY DENSITY	COMPRESSIVE STRENGTH
0.05	1	898	11.6
	2	998	12
	3	954	11.8
0.1	4	870	9.8
	5	829	11
	6	760	10.6
0.15	7	750	8.2
	8	689	7.5
	9	790	8.8
0.2	10	698	7
	11	650	6.8
	12	642	6.2

Table 3. Compressive strength versus varying percentage of fibres content

ALUMINUM CONTENT	PERCENATGE OF STEEL FIBERS BY VOLUME	COMPRESSIVE STRENGTH
0.05% of cement	0.04	11.94
	0.08	11.97
	0.12	12.036
	0.16	12.01
	0.2	12

Table 4. Compressive strength versus varying percentage of fibres content

ALUMINUM CONTENT	PERCENATGE OF STEEL FIBERS BY VOLUME	COMPRESSIVE STRENGTH
0.1% of cement	0.04	10.51
	0.08	10.54
	0.12	10.57
	0.16	10.55
	0.2	10.53

Table 5. Compressive strength versus varying percentage of fibres content

ALUMINUM CONTENT	PERCENATGE OF STEEL FIBERS BY VOLUME	COMPRESSIVE STRENGTH
0.15% of cement	0.04	8.38
	0.08	8.38
	0.12	8.4
	0.16	8.39
	0.2	8.37

Table 6. Compressive strength versus varying percentage of fibres content

ALUMINUM CONTENT	PERCENATGE OF STEEL FIBERS BY VOLUME	COMPRESSIVE STRENGTH
0.2% of cement	0.04	6.74
	0.08	6.76
	0.12	6.78
	0.16	6.77
	0.2	6.75

5.3 TENSILE STRENGTH

Total of 8 cubes are casted out of them, three cubes tested for tensile strength test without fibers for comparing tensile strength of same cubes with varying percentage of fibres content with same aluminium content. The size of specimens used for tensile test are 150mm*300mm cylinders. Average tensile strength of 3 cubes without fibres obtained as 0.78 Mpa. The formula for calculating tensile strength of cylinders is ($\frac{2P}{\pi DL}$). Here 'P' indicates load in kilonewton and 'L' Length of cylinder.

Fig. 2. Tensile test of specimens

Table 7. Tensile strength versus varying percentage of fibre content

ALUMINUM CONTENT	PERCENATGE OF STEEL FIBERS BY VOLUME	TENSILE STRENGTH
0.05% of cement	0.04	0.94
	0.08	0.9
	0.12	0.87
	0.16	0.6
	0.2	0.54

5.4 PULL OUT TEST

For pull out test total eight specimens of size 100mm cubes are prepared. Three of them used without steel fibers and remaining five used with steel fibers. For this test 8mm diameter steel bars are used. The test is conducted according to as per IS Code 11309 (1985). Without fibres maximum value of obtained bond strength load is 5.2 kilonewton.

Fig. 3. Pull out test on 100mm cube with 8mm diameter steel bar

Table 7. pull out load for 8mm bar versus varying steel fibers content

ALUMINUM CONTENT	STEEL FIBERS CONTENT	PULLOUT LOAD IN KILO NEWTON
0.05% of cement	0.04	5
	0.08	4.7
	0.12	5.4
	0.16	3.9
	0.2	4.4

6. CONCLUSIONS

1. water absorption of cubes increased with increasing in volume of aluminium content due to formation of more air void.
2. By addition of fibres to aerated concrete the compressive strength is increased from 0.04 to 0.12 percentage with steel fibers when compared to normal aerated concrete. And then a slight decrease in

compressive strength was observed from 0.16 to 0.2 percentage.
3. addition of fibre to aerated concrete results in slight increased tensile strength was observed.
4. In pull out test, no bond resistance is increased by addition of steel fibers.
5. in this investigation observed that number of small cracks developed during volume change without fibres.
6. The formation of small cracks reduced when fibres are added during volume change.

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