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BEHAVIOUR OF FOAM CONCRETE AT HIGH TEMPERATURE

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Abstract

A concrete is composite material whose chief ingredients are cement, water, and natural aggregates like coarse and fine. Foamed slag concrete is alightweight concrete which is being used in construction industries. To prepare foam concrete coarse aggregate is replaced by foam and fine aggregate by fly ash. The properties such as compressive strength, flexural strength, and weight loss under high temperature at 200° C, 400° C and 600° C have been studied. A comparative study is done between conventional and foam concrete for compressive strength, flexure strength and weight loss in which it was found that foam concrete yields better strength at high temperature up to 600°C.

***Key Words*:**conventional concrete, light weight concrete, foam concrete, vegetable protein oil, high temperature

1 INTRODUCTION

Lightweight concrete are produced using a variety of lightweight aggregates. These has strengths equivalent to normal weight concrete.

Most commonly they are used in house construction. Lightweight concrete has an oven dry density between 800kg/m to 2000kg/m^3, depending on the materials used[2].

Foam concrete is a concrete is a material with low density and high workability which can incorporate up to 50 per cent entrained air. Foam concrete is manufactured by adding foam, prepared by aerating a foam agent solution, to cement paste. It is an inorganic material and therefore unlikely to catch fire.

The strength of foam concrete can be increased by adding reinforcement and the same procedure is repeated to determine its adequacy for strength. The same plastic curing shall be repeated. Since adding steel, hot air oven test can be avoided as because steel tends to melt. It was studied about the compression and flexural testing.

Compressive strength and flexural strength of conventional cubes and foam cubes was taken before heating as well as after heating. At various stages of 200° C, 400° C, 600° C was kept in an oven and compressive strength and flexural strength was determined. From these studies we compare both strengths between foam and conventional cubes at various Temperatures (up to 600° C). Flexural strength and weight losses were determined by heating flexural beams of conventional and foam at various temperatures (up to 600° C).

2 SPECIAL MATERIALS USED

2.1 Fly ash

Fly ash is most used pozzolanic material. It is used in making high strength and high performance concrete. The technical advantages of concrete is increased and the environmental pollution is controlled by the use of fly ash as concrete admixture.

2.2 Foam agent (vegetable protein oil)

Foaming agent (Fig1) are organic materials also defined as air entraining agent. Bubble cavities are produced when foaming agent is mixed with water and is incorporated in cement paste. The properties of foamed concrete depend on the quality of foam. Synthetic

foams have a density of about 40 g/lit. Synthetic foaming agents are purely chemical products. They are very stable at concrete densities above 1000 Kg/m3 and give good strength [9]. In this study synthetic foaming is used.

Fig1. Foam agent (vegetable protein oil)

3 CURING PROCESS

Curing is a process of preventing freshly placed concrete from drying at its first day of life. It minimize any crack and allows to develop strength.

4 TEST PROCEDURE

4.1 Compressive strength test

For determination of compression, cube specimens of dimension of 150x150x150mm were cast and tested on a digital compression testing machine after 7 and 28 days of curing. As per ASTM standards [1] cube compressive strength (fcy) was computed from the fundamental principle. Fig2.

cube compressive strength (f_cy)= (load at failure (N))/(Area of cube (mm))

Fig2.Compressive strength test for cube

4.2 Flexure strength test

The size of 100x100x500mm of beam specimens were cast and tested to find out the flexure load the concrete can bear .The beam was simply supported over a span of 400mm, and a two point loading system was adopted having an end bearing of 50mm from each support is shown in Fig 3.

MIX	Water (Kg)	Cement (Kg)	Fly ash (Kg)	Foam (lit.)	W/(c+fa)	Wet Density (Kg / m3)	Dry Density (Kg / m^3)
A	260	210	490	110	0.37	900	875
B	275	220	480	105	0.39	894	873
C	290	230	470	100	0.41	885	865
D	300	240	460	95	0.43	872	853
E	330	250	450	90	0.44	852	837

Fig 3. Flexure strength test in UTM machine

4.3 Weight loss test

The loss of weight of concrete is determined by heating up to 600oC for 6 hours. Initially normal weight of concrete should be weighted and then the specimen should be placed in an oven and maintained in the temperature up to 600oC. Then the dried specimen is weighted and it is deducted from the original weight to find out the loss of weight of concrete.

4.4 Oven test

In this test the casted cubes and beams are tested in the oven. The degree of heat is kept as 200, 400 and 600oC and is tested for 2, 4 and 6 hours respectively. A total of nine cubes and beams are taken and for each degree three specimens are tested in oven. In the same way casted foam cubes and beams are tested for each degree in the oven.

5 MIX PROPORTIONS

The mix proportion was determined based on trial and error method. Trial mixes with various w/(c+fa) ratio were carried out. In Table 1 optimum mix proportion was determined.

Table 1. Trial mix to find optimum mix proportion

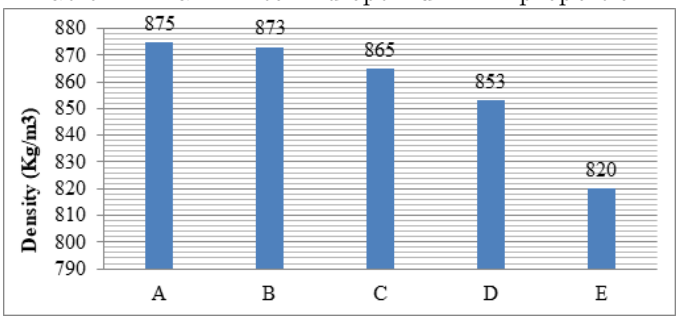


Fig 4. Density of A, B, C, D and E trial mix

Density test results for trial A, B, C, D and E were illustrated in Fig4 and Fig5 it shows that the trial mix E has the average minimum density of 820 Kg/m^3. IS: 2185 (2008) [2] says that the density of G2.5 grade light weight foam concrete must be 800 Kg/m^3 it might vary to ±5%.

W / (c+fa)	0.37	0.39	0.41	0.43	0.44
7 days	1.88	1.80	1.74	1.68	1.60
14 days	2.34	2.31	2.26	2.18	2.04
28 days	2.73	2.68	2.65	2.63	2.58

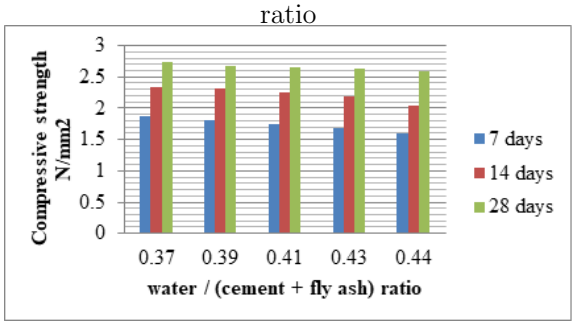
Fig 5. Adding foam to concrete

6 RESULTS AND DISCUSSION

6.1 Compressive strength test

Table 2.Shows the compressive strength results for trial mix A, B, C, D and E.

Table 2.Compression test for various water / (cement + fly ash) ratio



From figure the mix proportions used for water / (cement + fly ash) ratio of 0.44 has the average minimum compressive strength as mentioned in IS: 2185 (2008), [2].

Temperature in °C	Conventional concrete		Foam concrete	
	7 days	28 days	7 days	28 days
0	22.82	34.03	1.60	2.58
200	20.32	32.07	2.04	2.98
400	17.67	29.46	2.37	3.78
600	14.02	26.16	3.27	4.98

Fig 6.Compressive strength developed on A, B, C, D and E trial mix

Table3.Shows the values of compression made on conventional concrete and foam concrete at different degree of temperature at varying time interval.

Table 3.Determination of compressive strength of conventional concrete and foam concrete

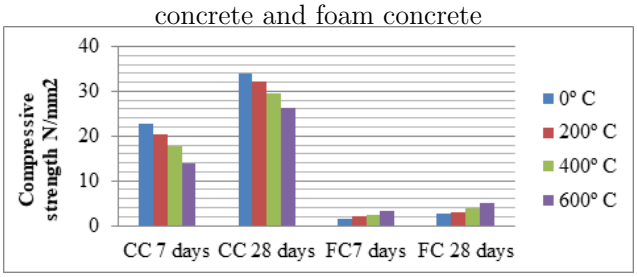


Fig 7.Gives the detailed study on compression test between conventional concrete and foam concrete

Temperature in °C	Conventional concrete		Foam concrete	
	7 days	28 days	7 days	28 days
0	6.5	7	2.5	3.5
200	5.5	5	3	4
400	4.5	4	3.5	4.5
600	2.5	3.5	4	5.5

Fig 7.Comparison chat for compressive strength of CC and FC

From the above figure and table it is clear that the compressive strength of conventional concrete losses its strength as there is rise in temperature but in case of foam concrete the strength of concrete rises simultaneously with temperature.

6.2 Flexural strength test

Table 4 shows the values of flexure test made on conventional concrete and foam concrete at different degree of temperature at varying time interval.

Table 4. Determination of flexural strength of conventional concrete and foam concrete

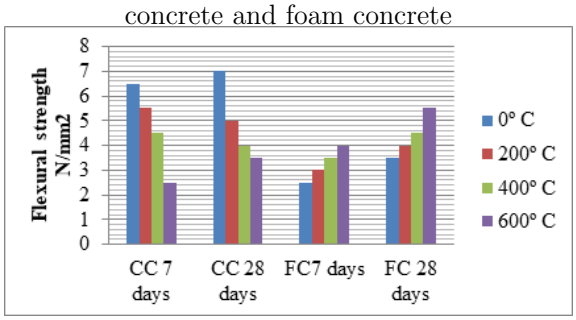


Fig 8.Comparison chats for flexure strength of CC and FC

From the above fig 8 and table 4 it is clear that the flexural strength of conventional concrete losses its strength as there is rise in temperature but in case of foam concrete the strength of concrete rises simultaneously with temperature.

6.3 Weight loss

Table 5 gives the appropriate values of loss in weight due to the effect of temperature over the concrete.

Table 5. Determination of weight loss in % fpr conventional concrete and foam concrete

Temperature in ºC	WEIGHT LOSS (%)			
	Conventional concrete		Foam concrete	
	7 days	28 days	7 days	28 days
200	2	4	1.6	3
400	6	9	2.8	6
600	7	10	3.5	7

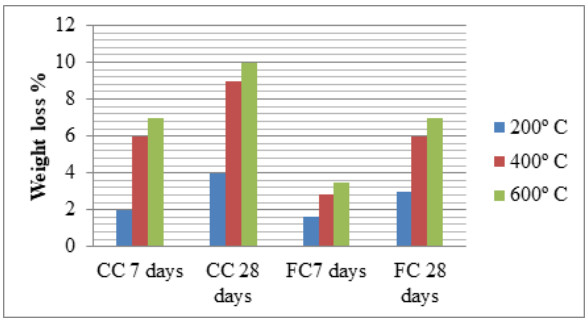


Fig 9.Comparison between CC and FC for % of weight loss

From the table 5 and fig 9 it is clear that the percentage of weight loss for light weight foam concrete is minimum that the conventional concrete.

7 CONCLUSION

The compressive strength for concrete was found to decrease upon heating (200oC to 600oC) from 32.07N/mm^{2}to 26.16 N/mm^2 and whereas foam concrete is increased from 2.04 N/mm^2 to 4.98 N/mm^2 at same temperature.

The flexural strength was found to decrease upon heating (200°C to 600°C) from 5 N/mm2to 3.5 N/mm2and whereas foam concrete in increased from 3.5 N/mm^{2}to 5 N/mm^{2}at the same temperature.

The weight loss of conventional concrete was found to increase upon heating (200°C to 600°C) from4% to 10% and whereas foam concrete increased minimum from 3% to 7% at the same temperature.

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