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Sustainable Studies on Structural Performance and Thermal cycle on Cement Concrete Pavement with using GGBS

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ABSTRACT

Due to the increase in construction industry which results the demand of concrete rapidly, Therefore the Production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, The utilization of supplementary cementation materials is well accepted, since it leads to several possible improvements in the concrete composites, as well as the overall economy. The aim of our investigation is to determine GGBS as partial replacement of cement with compare to conventional cement concrete pavement. In the present study M20 grade of concrete were consider, With the W/C ratio as 0.5 were used. The specimens are casted for investigating the mechanical properties like Compression strength, Flexural, and Split tensile, Thermal cycle compressive strength tests. The percentage of Cement is replacing by 5%, 10%, 15%, 20%, 25% and 30% of GGBS. The results were founds to be satisfactory with percentage replacement of 15 to 30%.

Keyword: Mechanical Properties Like Compression Strength, Flexural, And Split Tensile, Thermal Cycle Compressive Strength Tests, GGBS.

INTRODUCTION

As increasing in the usage of concrete in all over the world, the production of cement is also increasing rapidly. Due to rapid production of cement, the cement industry producing toxic emission that is causing two major impacts like green house effect and global warming on the environment. To reduce or to control of these impacts on the environment it is refer to replace the cement with various waste materials like GGBS, FLY-ASH, Granite dust, Rice husk ash, e.t.c, partially or fully. In our project we are partially replacing Cement with GGBS with various % like 0,5,10,15,20,25 and 30 % with constant w/c ratio 0.5. As all of us knowing that the Ground Granulated Blast Furnace Slag (GGBS) is a byproduct of pig iron ore. It is obtained from cooling with water or molten slag. Molten slag produced sudden tamping and quenched by water.

OBJECTIVE

- Determination of strength parameters of M20 grade of concrete.
- Determination of strength parameters of M20 grade concrete with partial replacement of GGBS with cement.
- Determination of thermal behavior of M20 grade of concrete and M20 grade of concrete with partial replacement of GGBS with cement.

Materials

A. *Cement*: The ACC cement of OPC 43 grade of cement confirming to IS: 8112-1989 is referring to the experimental works.

B. *Manufacture sand*: The Sample of M.sand satisfy the zone II, (as per IS 383-1970) is referred to the experimental work.

C. *Coarse aggregate*: Locally available crushed angular aggregate of different sizes which is confirming to IS 383 – 1970 is used in the experimental work.

D. *GGBS*: Varying % like 0,5,10,15,20,25 and 30 % of Ground Granulated Blast furnace Slag (GGBS) is replacing with cement.

METHODOLOGY:

According to IS: 456:2002, the mix proportion for M20 grade of concrete has been designed with constant w/c ratio 0.5 has to maintain. For obtained mix proportion, compressive strength and thermal behavior of cubes are determined. In above obtained mix proportion was partially replace cement by GGBS with different % like 0 (CM), 5, 10,15,20,25 and 30 % with same w/c ratio 0.5. Total 63 cubes casted (each proportion 9 cubes again in that 3 for 7 days, 3 for 28 days and 3 for 56 days of curing) for compressive strength test. Total 90 cubes are casted (each % 15 cubes again in that 5 for 3 days, 5 for 28 days and 5 for 56 days of curing) for thermal behavior test. All casted specimens are kept for curing for 7 days, 28 days and 56 days of curing.

1 Test procedure

The M20 grade concrete cubes of size 150*150*150 are casted for compression and tested in compressive testing machine after the completion of 7 days, 28 days and 56 days of curing period. For thermal behavior of M20 grade of concrete cubes of size 150*150*150mm has to casted and kept it in oven with varying temperature of 70,80,90,80 and 70 degree after the curing period of 7 days , 28 days and 56 days. And specimens are tested in compressive testing machine after temperature marinated 30 minutes.

Results and discussion

1 compressive strength test results of 7 and 28 days curing specimen

Table No.1 Compressive strength on 7 and 28days.

% of GGBS	Weight of Mould at 7 days curing	Weight of Mould at 28 days curing	Average Compressive Strength of 7-Days	Average Compressive Strength of 28-Days	Standard Deviation	Standard Deviation	Recommendation
0	9.12	9.14	15.12	24.22	0.1	0.3	As per IS:516-1959, 7-Days and 28 days Compressive strength of M20 Grade concrete is 15 N/mm^2 and 26 N/mm2
5	9.07	9.43	18.15	22.52	0.4	7.0	
10	9.21	9.64	24.13	25.81	4.7	3.9	

15	8.96	9.42	22.15	28.59	4.2	0.1
20	9.03	9.48	22.07	27.01	18.1	3.3
25	9.43	9.10	24.89	26.87	6.5	8.4
30	8.89	9.39	18.80	34.48	0.2	0.9

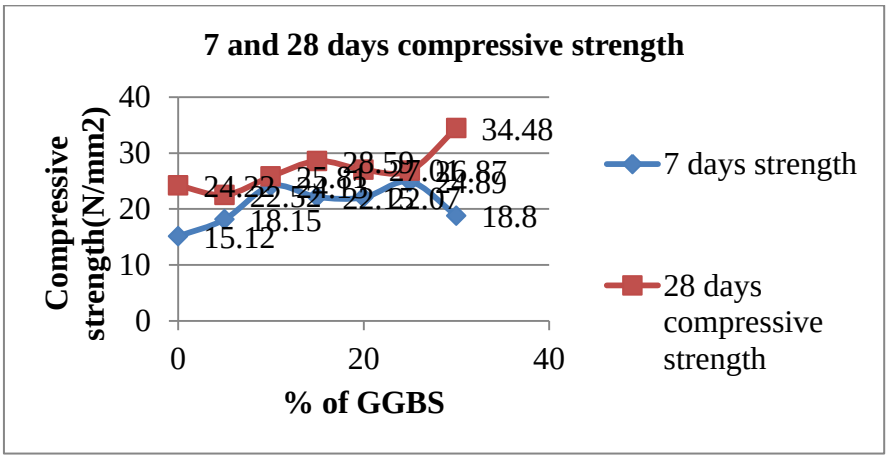

Fig 1. 7 and 28 days compressive strength

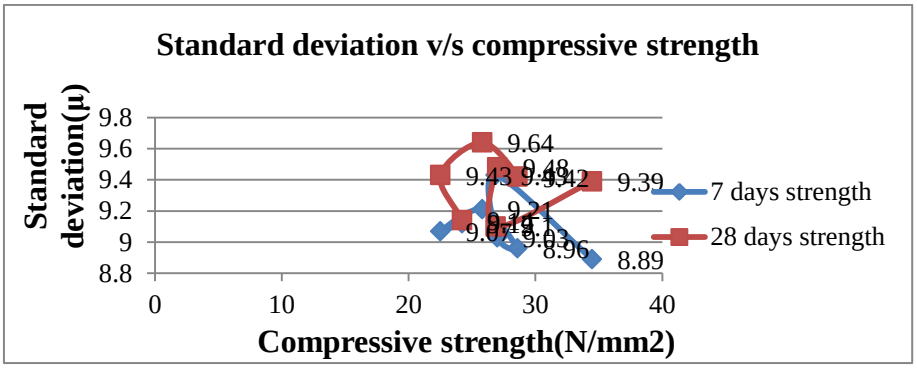

Fig 2.Standard deviation v/s Compressive strength

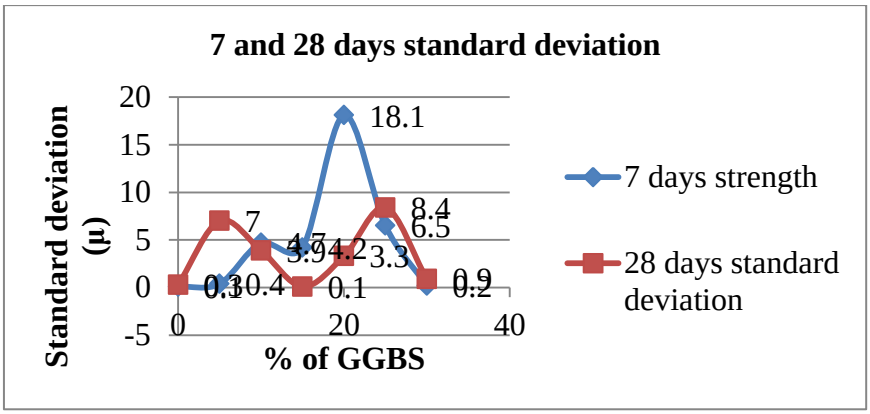

Fig 3. 7 and 28 days standard deviation

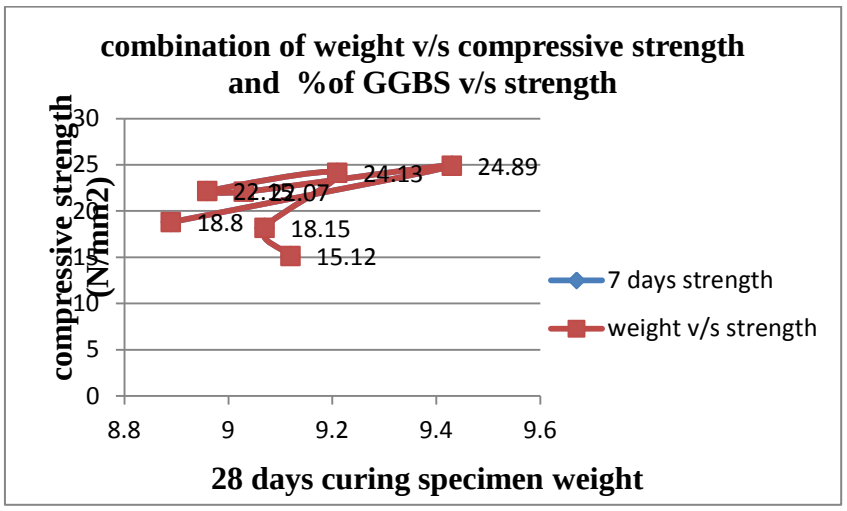

Fig 4. Combination chart of weight v/s compressive strength and % of GGBS v/s compressive strength

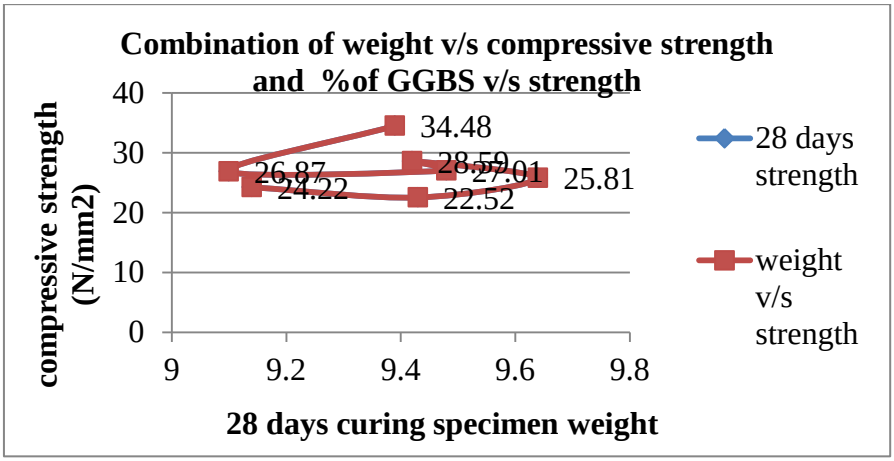

Fig 5. Combination chart of weight v/s strength and % of GGBS v/s strength

2. Thermal behavior of concrete test of 7 and 28 days curing specimens

Table No.2 Thermal strength results @ 7 and 28 days

% of GGBS	Days of curing	Temperature (°c)				
		70	80	90	80	70
0	7	24.67	24.44	23.33	24.22	24
	28	32.44	31.78	31.33	31.56	32.67
5	7	23.33	19.11	22.44	24.44	24.67
	28	19.25	24.25	20.81	21.92	23.08

10	7	18.22	24.44	19.78	18.22	26.89
	28	26.84	28.64	27.39	20.96	21.5
15	7	24.44	20.89	29.78	21.11	24.67
	28	32	29.78	25.27	33.7	33.73
20	7	28	25.56	32.22	24.89	16
	28	30.22	31.33	32.82	14.17	27.68
25	7	20	16.67	32.22	20	33.33
	28	41.78	40.28	34.86	27.62	39.41
30	7	31.56	27.11	30.44	30.67	27.11
	28	33.03	34.86	35.72	35.37	33.62

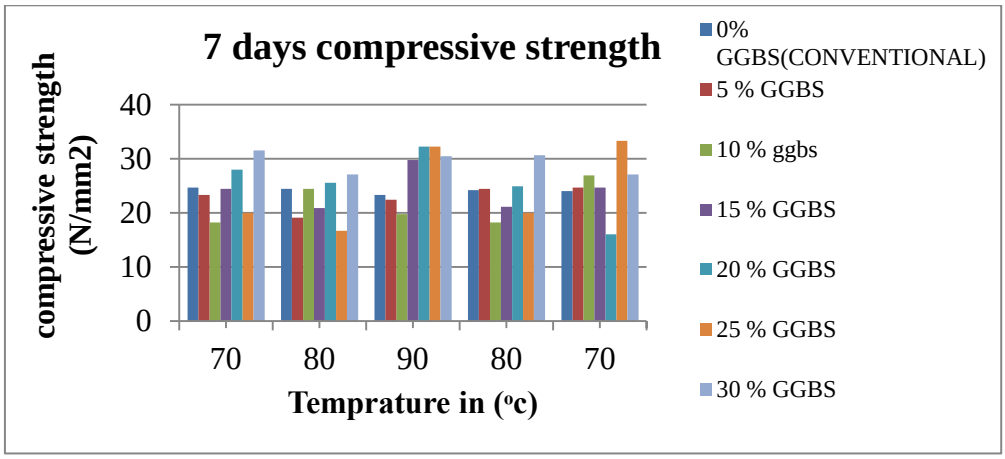

Fig 6 -Column chart of Thermal strength on 7 days

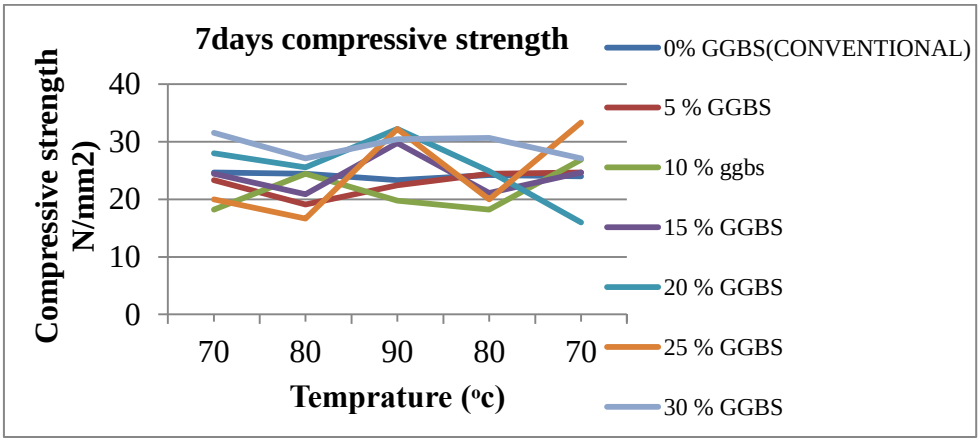

Fig 7-Line chart of Thermal strength on 7 days

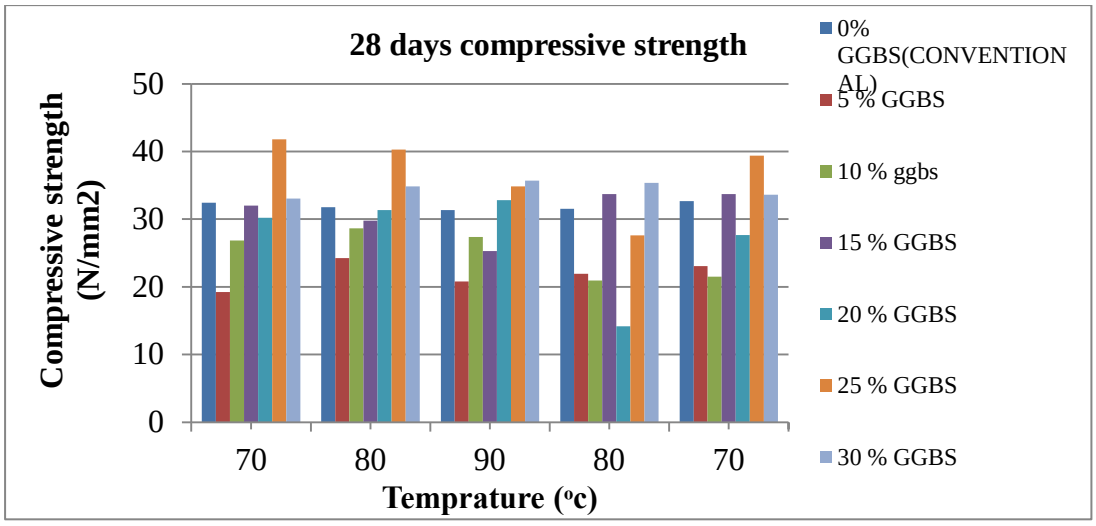

Fig 8- Thermal strength on 28 days

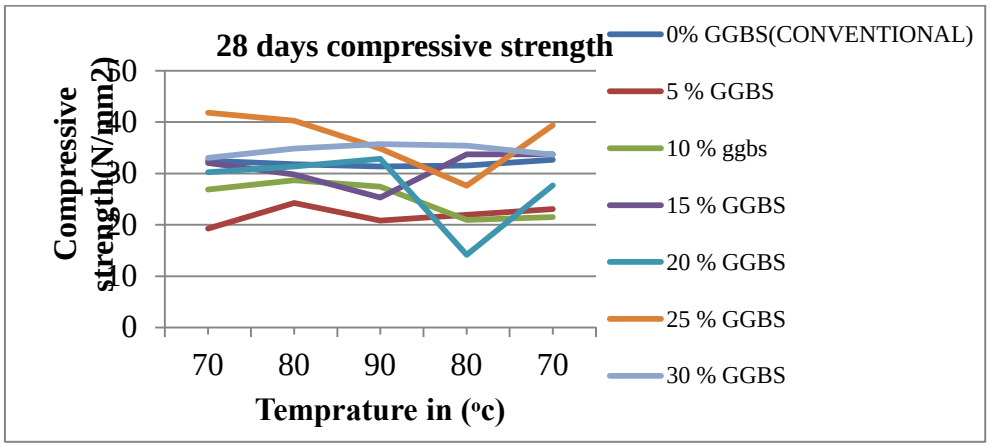

Fig 9 - Thermal strength on 28 days

The investigation are performed M20 concrete by GGBS replace with cement in various %(5,10,15,20,25 and 30%) and M20 conventional concrete(0%) and from test results it is observed that the compressive strength of M20 grade of concrete with replacing cement by GGBS with comparing of M20 grade of conventional concrete. And thermal behavior of M20 grade of concrete replacing with cement by GGBS as compare with conventional concrete. The table 5.1 shows the 7 and 28 days compressive strength of conventional concrete (0 %) and replacing concrete (various % of GGBS replacement).Table 5.2 shows the 7 and 28 days test results of Thermal strength of conventional and replacement concrete of varying temperature like 70,80,90,80 and 70 degree. The fig 5.1 shows the 7 and 28 days compressive strength chart. Fig 5.2 and 5.3 shows the 7 and 28 days Thermal strength tests chart.

CONCLUSION

Based on our investigation tests results it is concluded that the,

1. Compressive strength of M20 grade of concrete is increases with increasing of replacement of GGBS with cement.
2. Up to 25 % replacement of GGBS with cement at 7 days can achieve more strength and up to 30% replacement of GGBS with cement at 28 days has achieved the higher strength as compare with the conventional concrete (0%).
3. The M20 grade of concrete at 90°c at 7 days curing specimens and 80°c at 28 days curing specimens of replacing GGBS with cement has achieve the more Thermal strength as comparing with the conventional concrete.
4. From the test results it is observed that the GGBS replaced up to 30 % with cement in the M20 grade of concrete can be achieve the mechanical properties of concrete.

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