AN EXPERIMENTAL INVESTIGATION ON BLENDED CEMENT CONCRETE

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ABSTRACT

As the manufacturing process of Portland cement increases the emission of Co_2 in to the atmosphere also increases, so there is an urgent need in construction industry to find an alternative construction material. The main objective of this investigation is to compare a strength parameter and behavior of fresh and hardened concrete with conventional concrete and quaternary blended cement concrete in various percentages. The SCM's used are GGBS, MK, RHA in concrete not only reduces the carbon dioxide emission, but also impart significant improvement in workability and durability. The blend is quaternary type and the materials used are agricultural by products and industrial waste. The workability and strength characteristics of quaternary bend was found out by the replacement of 5%, 10%, 15% and 20% of GGBS, RHA and MK. Out of all pozzolonic material GGBS gives highest strength in Compression after 28 days. By replacing cement with and 10% MK, 5% RHA and 15% GGBS gives the compressive strength 50% more than the reference mix for 28 days respectively.

Key words: Ground Granulated Blast Furnace Slag, Rice Husk Ash, Metakoalin.

I. INTRODUCTION

The world at the end of the 20^{th} Century that has just been left behind was very different to the world that its people inherited at the beginning of that Century. The construction industry has been no exception to these changes when one looks at the exciting achievements in the design and construction of buildings, bridges, offshore structures, dams, and monuments, such as the Channel Tunnel and the Millennium Wheel. There is no doubt that these dramatic changes to the scientific, engineering and industrial face of the world have brought about great social benefits in terms of wealth, good living and leisure, at least to those living in the industrialized nations of the world. But this process of the evolution of the industrial and information technology era has also, however, been followed, particularly during the last four to five decades, by unprecedented social changes, unpredictable upheavals in worlds economy, uncompromising social attitudes, and unacceptable pollution and damage to our natural environment. Currently, the cement industries produce 1.5 billion tons of CO2 into the atmosphere (Malhora 2002), (McCafferry 2002) worldwide, the cement industry alone is estimated to be responsible for about 7% of all CO2 generated (Meyer 2009), The search for any such material, which can be used as an alternative or as a SCM for cement should lead to global sustainable development and lowest possible environment impact. Beside this economic and ecological benefits such as energy saving and resource conservation can be achieved using blended cement concrete (Matha 2006). An attempt to study the optimum percentage of replacement among the 5%, 10%, 15% and 20% of GGBS, RHA and MK is done here with quaternary blend.

II. EXPERIMENTAL INVESTIGATION

Materials needed for concrete are Cement, Metakoalin, Ground Granulated Blast Furnance Slag, Rice Husk Ash, Fine Aggregate (sand), Coarse Aggregate (broken stone) and water.

2.1. Materials Used

(i)Cement

Ordinary Portland Cement (OPC) of 53 grade confirming to IS 12269-1987 was used for this study. The specific gravity and Blaine specific surface area of PC were 3.12 and 2250 cm2/gm respectively. Metakaolin (MK) its specific gravity and Blaine specific surface area were 2.51 and 5300 cm2/gm. Ground Granulated Blast Furnace Slag (GGBS) its specific gravity and Blaine specific surface area were 2.94 and 4320 cm2/gm. Rice Husk Ash (RHA) was used and its specific gravity and Blaine specific surface area were 1.90 and 3450 cm2/gm. The chemical composition of OPC, GGBS, MK, and RHA are shown in Table 1.

Chemical Composition	SiO2	Al2O3	Fe2O3	CaO	MgO	Loss on ignition	Figure
Cement	20.1	4.51	2.5	61.3	1	2.41	
MK	51.6	41.3	0.64	0.52	0.16	0.72	
RHA	87.2	0.15	0.16	0.55	0.35	8.55	
GGBS	35.34	11.59	0.35	41.99	8.04	0.45	

Table 1.CHEMICAL COMPOSITION

(ii) Aggregates

Dry and clean, locally available river sand conforming to grading zone-II as per IS: 383-1970 was used in concrete mixture. Its specific gravity was 2.65 with 1% absorption. Locally available coarse aggregate from quarry was used and they are rather rounded in shape with a maximum size of 20 mm size. The specific gravity and water absorption of coarse aggregate were 2.79 and 0.3% respectively.

(iii) Water

Water conforming to the requirements of IS: 456-2000 is found to be satisfactory for making concrete. It is generally stated that water fit for drinking is suitable for making concrete. For the present research, potable water free from salts is used for concrete mixing and curing.

2.2. Mix Proportion and Mix details

The mix proportions were made for a control mix of slump 80 mm for M20, grade of concrete for w/c ratio of 0.50 respectively by using IS10262-2009 method of mix design. For each grade of concrete, total five mixes were made by replacing normal crushed coarse aggregate and fine aggregate with MK,GGBS and RHA keeping w/c ratio as constant (control mix) by 0, 5, 10, 15 and 20 % replacements given in table 2.

Mix No	Mix Designation	W/C Ratio	CEMENT	MK	RHA	GGBS	FA	CA
M1	CONVENTIONAL CONCRETE	0.5	383	0	0	0	546	1188
M2	70 OPC 5 MK 10 RHA 15 GGBS	0.5	268.1	19.5	38.3	57.8	546	1188
M3	70 OPC 10 MK 5 RHA 15 GGBS	0.5	268.1	38.3	19.5	38.3	546	1188
M4	40 OPC 20 MK 20 RHA 20 GGBS	0.5	153.2	76.6	76.6	76.6	546	1188
M5	50 OPC 10 MK 20 RHA 20 GGBS	0.5	196.5	38.3	76.6	76.6	546	1188

Table 2: MIX PROPORTION

III. TEST RESULTS

The test has conducted for fresh and hardened concrete. The test results are listed below.The properties of concrete were conducted for various mix proportion were tested. The 150 mm cubes (set of 3) each were cast for compressive (7, 14 and 28). All the cubes were de-mould after 24 hours time and put into the water tank for curing maintaining temperature of 27±2ºC as per IS requirements and tabulated below in table 3 and 4

Mix No	Different Percentage of Replacement	Slump (mm)	Compaction factor (%)	Vee bee (sec)	Flow (%)
1	CONVENTIONAL CONCRETE	85	0.9	8	40
2	70 OPC 5 MK 10 RHA 15 GGBS	75	0.86	9.6	37
3	70 OPC 10 MK 5 RHA 15 GGBS	77	0.87	12.8	38.3
4	40 OPC 20 MK 20 RHA 20 GGBS	82	0.83	11	33
5	50 OPC 10 MK 20 RHA 20 GGBS	78	0.85	15.6	36

Table 3: Workability test of quaternary blend

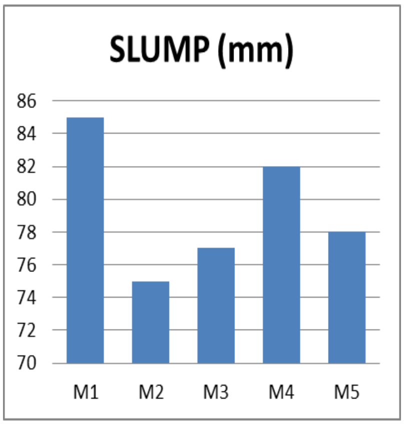


Table 3.1 Variation in Slump

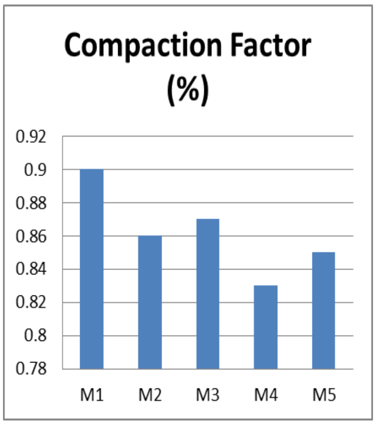
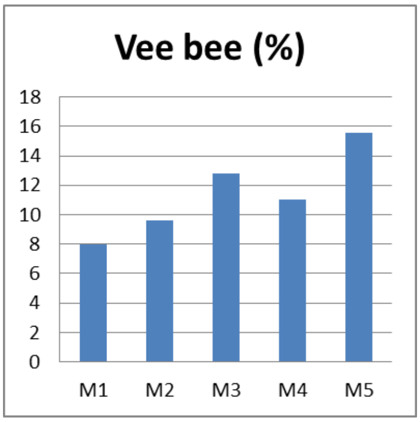


Table 3.2 Variation in compaction Factor



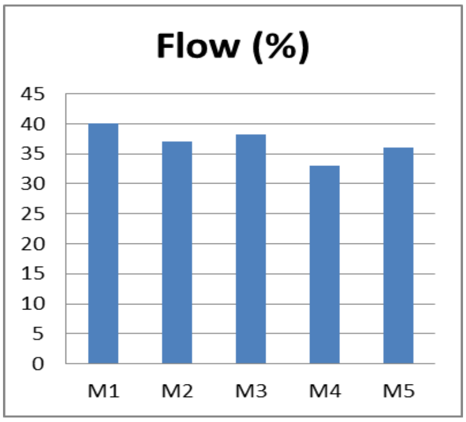
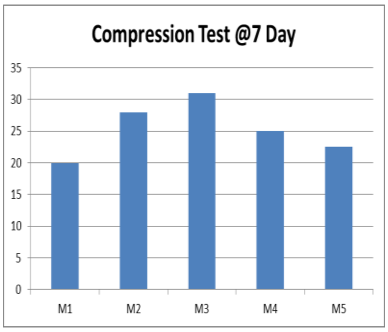


Table 3.3Variation in Vee Bee Consistometer

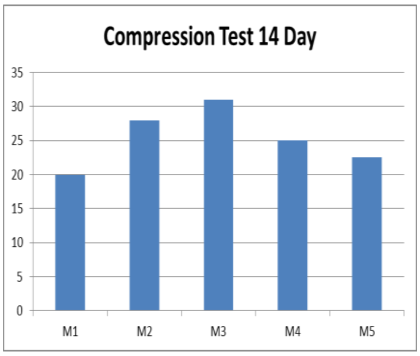
Table 3.4 Variation in Flow.

Mix No	Mix Designation	Compression Test		
		7 Day	14 Day	28 Day
M1	CONVENTIONAL CONCRETE	13	17	20
M2	70 OPC 5 MK 10 RHA 15 GGBS	14.5	18	28
M3	70 OPC 10 MK 5 RHA 15 GGBS	17	24	31
M4	40 OPC 20 MK 20 RHA 20 GGBS	15	20	25
M5	50 OPC 10 MK 20 RHA 20 GGBS	13.5	17.5	22.5

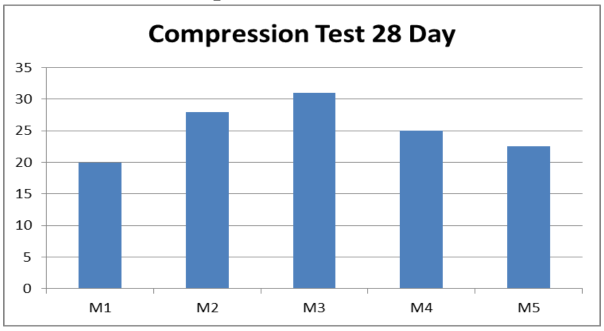
Table 3.5 Compression test



3.6. Compression test result @ 7 day



3.7. Compression test result @ 14



3.6. Compression test result @ 28 day

IV. RESULTS AND DISCUSSION

- Pozzolanic material is easily available material and are very good supplementary cementitous material. Upto 20% replacement of cement with MK, RHA and GGBS can give higher strength than normal concrete at 28 days.
- By Replacing cement with and 10% metakaolin, 5% RHA and 15% GGBS gives the compressive strength 50% more than the reference mix for 28 days respectively.

V. CONCLUSION

- Out of all pozzolonic material GGBS gives highest strength in Compression after 28 days.
- By using industrial waste materials we can make environment more sustainable

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