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AN EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT WITH GGBS AND FLY-ASH IN RIGID PAVEMENTS

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Abstract - *The vision of being a developed nation is today's scenario where in considering the lowest level of individuality. The term concrete mix design is the methodology of selecting suitable material of concrete and finding out their relative amounts with an objective of generating a concrete of required characteristics such as strength, durability and workability in an economical manner.*

GGBS and Fly-ash are among the solid wastes are generated by the industries. Thus they are considered as a pollutant or the wastes that they are very cheap and easily available and so they are used as a partial replacement. In this project the replacement method is executed. The partial replacement of cement with GGBS and Fly Ash can be economical alternative. GGBS and Fly Ash replaces the cement at 20%, 40% and 20%,30%.The grade of concrete is M40.Thus the concrete tests are carried out for 7,14, and 28(days). The water cement ratio was maintained at 0.45 for all mixes.

***Key Words*: GGBS, Fly-Ash, Compression Strength and Flexural Strength, M40 grade of concrete...**

1.INTRODUCTION

GGBS is a by-product obtained during the manufacture of iron in the blast furnace. It is economically available in large quantities, requiring storage facilities and, therefore, it is suitable for use in ready-mix concrete, in the production of large quantities of site-batched concrete and in precast product manufacturing. Blast furnaces are fed carefully with controlled mixtures of iron ore, coke and limestone at a temperature of *2000_C. The iron ore is reduced to iron and sinks to the bottom of the furnace. The remaining material that floats on top is the slag. The annual production of GGBS in China alone is *15 million tones, which is used as raw material in cement production, concrete and pavements. The authors reported that replacement of cement by slag up to 40% has greater compressive and flexural strength than normal concrete. In the authors studied the behavior of GGBS-added concrete at elevated temperatures. The cementitious properties of GGBS depends on the chemical composition of the GGBS slag, alkali concentration of the reacting system, glass content of the GGBS, fineness of the GGBS and Portland cement and temperature

1.1 Methodology

The Experimental work has been carried out in the following stages

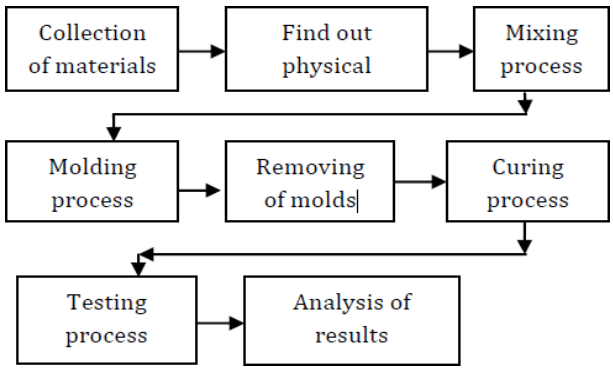

Chart 1: methodology of the work

1.2 Materials Used

The materials used in experimental investigation

Cement: Ordinary Portland Cement OPC 53 Grade was used in the present experimental investigation.

Ground granulated blast furnace slag (GGBS) obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Ground granulated blast furnace slag is obtained from kakatiya power plant located in Warangal.

Table no 1 : Physical properties of GGBS

Property	GGBS
Specific gravity	2.82
Specific surface ($c\ m^2/g$)	4222
Colour	whitish

Fly-ash: The fly ash was obtained from Navyug thermal plants which are classified as Low calcium, Class F (American Society for Testing and Materials 2001) dry fly ash which is grey in color this fly ash contained a very low percentage of carbon as indicated by the low Loss on Ignition (LOI) values

Table no 2 : Physical Properties of Fly-ash

Property	Fly ash
Specific gravity	2.21
Bulk density	540-860
Appearance	Grey
Particle size	30 microns

Fine aggregate: Locally available sand is used. The specific gravity of 2.655 and fineness modulus of 3.682 are used as fine aggregate. The water absorption is about 1%.

Coarse aggregate: The fine Crushed aggregate available from local sources has been used. The coarse aggregates with maximum size of 20mm having the specific gravity value of nearly 2.82.The water absorption of coarse aggregate was about 0.55 %.

Water: Water acts as lubricates for the fine and coarse aggregate and acts chemical with cement to form the binding paste for the aggregate water is used for curing the concrete after it has cast in to the forms. Water used for both mixing and curing should be free from injurious amount of deleterious materials. Potable water is generally considered satisfactory for mixing and curing of concrete. If water contains any sugar or an excess of acid or salt, it should not be used. Ordinary tap water from our college was used for preparation of concrete

MATERIAL TESTS:

SPECIMEN FOR COMPRESSIVE STRENGTH:

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. Concrete compressive strength for general construction varies from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in commercial and industrial structures.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc.

Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommends concrete cylinder or concrete cube as the standard specimen for the test. American Society for Testing Materials ASTM C39/C39M provides Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
To study compressive strength, the cubes of 150mmx150mmx150mm are casted for various mixes. The quantities of cement, coarse aggregate, fine aggregate, fly ash, GGBS and water for each batch replacement are weighed separately. The cement, GGBS and fly ash are mixed dry to a uniform color separately. Fine aggregate are mixed to this mixture in dry form. The coarse aggregates are mixed to get uniform distribution throughout the batch. Then water is added to the mix. Firstly, 50-70% of water is added to the mix and the mixed thoroughly for 2 to 3 minutes.

Then admixture is diluted in water and then added to the mix. After this slump test was done for each mix. The slump for the mix is 50 to 75mm. The cubes are filled with fresh concrete using vibrating table. Three cubes are casted for each parameter. The compressive strength test is carried out for 7 days, 14 days and 28 days. Therefore, 9 identical specimens are casted for each concrete mix.

Fig: compressive strength testing of cube

SPECIMENS FOR FLEXURAL STRENGTH:

The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers shall be so mounted that the distance from centre to centre is 60 cm for 15.0 cm specimens or 40 cm for 10.0 cm specimens. The load shall be applied through two similar rollers mounted at the third points of the supporting span that is, spaced at 20 or 13.3 cm centre to centre. The load shall be divided equally between the two loading rollers, and all rollers shall be mounted in such a manner that the load is applied axially and without subjecting the specimen to any tensional stresses or restraints.

Beam mould of size 15 x 15x 70 cm (when size of aggregate is less than 38 mm) or of size 10 x 10 x 50 cm (when size of aggregate is less than 19 mm).

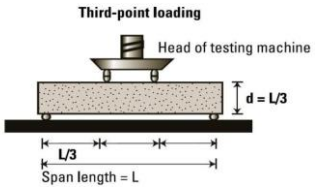

Fig-1: Typical section of applying of load

Fig-2: Testing for flexure strength

2. RESULT AND DISCUSSION

GENERAL: The present chapter deals with the materials properties and the results obtained from the various test conducted on the materials used for designing of rigid pavement quality. In order to achieve the objective of the present study. An experiment program was devised to investigate the effect of fly ash and GGBS, as partial cement replacement, on the compressive and flexure strength and durability of concrete.

COMPRESSIVE STRENGTH TESTS ON CONCRETE CUBES

Table -3: Compressive strength of cube without replacement

Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	24.52	38.53	45.91
2	26.23	36.88	43.06
3	25.22	27.02	47.55
Avg Compressive Test	**25.32**	**34.14**	**45.50**

Table -4: Compressive strength of cube with replacement of 20% of GGBS and 30% of fly ash

Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	26.44	32	40.88
2	27.25	30.22	38.8
3	25.33	30.8	37.06
Avg Compressive Test	**26.35**	**31.00**	**38.91**

Table -5: Compressive strength of cube with Replacement of 40% of GGBS and 20% of fly ash

Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	31.06	44.97	48.26
2	32.22	43.2	47.91
3	31.73	43.5	48.3
Avg Compressive Test	**31.67**	**43.89**	**48.15**

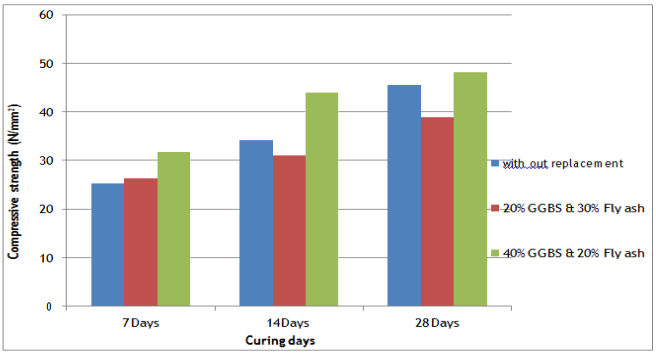

Chart 2: Compressive Strength of Concrete at Various Ages

Table -6: Flexure strength for nominal concrete

Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	5.39	5.39	7.19
2	5.99	6.39	7.99
3	4.79	6.39	8.79
Average flexural strength	**5.48**	**6.06**	**7.72**

Table -7: Flexure strength for 20% replacement of GGBS and 30% Fly-ash

Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	4.9	5.99	7.19
2	4.39	6.39	7.99
3	5.19	5.19	7.19
Average flexural strength	**4.82**	**5.85**	**7.45**

Table -8: Flexure strength for 40% replacement of GGBS and 20% Fly-ash

Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	5.99	7.19	8.79
2	5.19	6.39	9.59
3	5.79	7.99	7.99
Average flexural strength	**5.65**	**7.19**	**8.79**

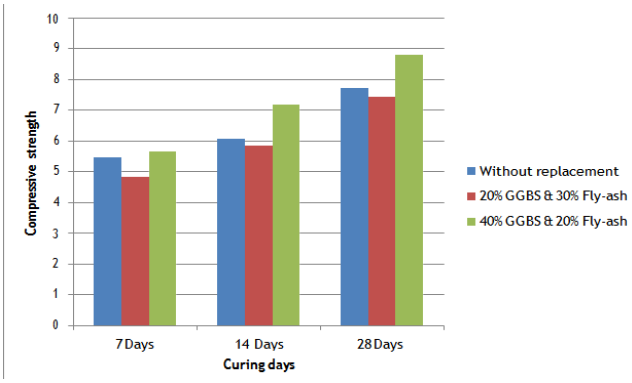

Chart 3: Flexural strength of concrete at different ages

3. CONCLUSIONS

GENERAL: An experimental program is devised to study the strength and durability characteristics of pavement quality concrete containing GGBS and fly ash. Tests are performed on hard concrete cured under clean and fresh water, and compressive and flexure strength were observed at curing ages of 7,14 and 28 days. A discussion of results was carried

out and the major conclusions drawn from the study are elaborated here in.

1. It is observed that an increasing trend has been observed in compressive strength of rigid pavement mixes up to partial replacement level of fly ash and GGBS.
2. The rate of gain in compressive strength, and flexural strength of concrete is very fast at 14 days curing period and the rate gets increases with age.
3. 65% of strength is achieved at 7th day. Therefore speedy construction is possible.
4. The concrete using GGBS as a sole binder achieves more strength than that of normal control concrete when oven curing is done. A higher concentration of GGBS result in higher compressive strength and flexural strength of concrete.
5. High Strength Concrete is achieved by using GGBS in concrete.
6. Fly ash and GGBS based concrete can be used for structural use.
7. Mix design with 20% fly ash and 40% GGBS as binding material gives economic design with better strength.
8. However GGBS based concrete give best results in all aspect.
9. Thus concrete can be recommended as an innovative construction material for the use of construction.

SUMMARY

- Based on the results obtained we can summarize our experimental work as follows
- The replacement of GGBS & fly ash gives high strength when compared to conventional concrete test.
- Cubes attain of compressive strength, flexural strength in less curing period and mainly it economical & eco friendly

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