Behaviour of Concrete Subjected to Elevated Temperature by Replacing of Fine Aggregate with GBFS and Quarry Dust

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***Abstract*—Concrete structure are occasionally subjected to elevated temperature to know it's mechanical property. In most of the cases tests at elevated temperature results in considerable damage to concrete structure in present case industrial by product have been adopted as fine aggregate.**

This investigation aims to come up with a new mix proportion M30 concrete by the use of quarry dust and Granulated Blast Furnace Slag instead of normal river sand for concrete mix. And also focuses the Behavior of concrete at elevated temperature

Fine aggregate is replaced by Quarry dust and GBFS in varying proportion like 0%, 25%, 50%, 75% and 100%.test and compared with regular concrete for mechanical properties like compression and split tensile strength at elevated temperature (100°C, 200°C and 300°C)

Keywords — Concretre, Quarrydust, GBFS, elevated temperature, mechanical proprties.

I. INTRODUCTION

Concrete is a manmade material used in the building and construction industry and consists of aggregates which are bonded together by cement and water. The major constituent of concrete besides the cement is the aggregate. Various types of aggregates that may be used include sand, crushed-stone, gravel, slag, ashes, burned shale, and burned clay. Fine aggregates refer to the size of aggregate used in making concrete slabs and in providing smooth surfaces. Coarse aggregates are used for massive structures or sections of Concrete.

Another material used in the formation of concrete is quarry dust as replacement material of sand. Quarry dust is classified as fine material obtained from the crushing process during quarrying activity at the quarry site. In this study, quarry dust will be studied as replacement material of river-sand as a fine aggregate for concrete. Quarry dust has been in use for various activities in the construction industry such as for road construction and manufacture of building materials such as lightweight aggregates, bricks, tiles and autoclave blocks.

Granulated blast furnace slag (GBFS) is another material used making the concrete as replaced by fine aggregate. Blast furnace slag is mildly alkaline and exhibits a pH in solution in the range of 8 to 10 and does not present a corrosion risk to steel in pilings or to steel embedded in concrete made with blast furnace slag cement or aggregates. The blast furnace slag could be used for the cement raw material, the roadbed material, the mineral admixture for concrete and aggregate for concrete. In this study GBFS will be studied as replacement of fine aggregate. GBFS has been used for various activities in the manufacturing of cement.

In rigorous study is necessary for use of Granulated Blast Furnace Slag (GBFS) and Quarry dust mixed in place of natural sand. In this paper comparable test results of compression and split tensile strength of concrete by replacing of natural sand 0%, 25%, 50%, 75% and 100% by GBFS and Quarry dust for M30 grade concrete and also compare the harden concrete at elevated temperature

II. LITERATURE REVIEW

A Shivakumar and M Prakas(October 2011) studies Characteristic on the mechanical properties of quarry dust addition in conventional concrete and reports the experimental study which investigated the influence of 100% replacement of sand with quarry dust. The results showed that the addition of quarry dust for a fine to coarse aggregate ratio of 0.6 was found to enhance the compressive properties. When the quarry dust has high fineness, compressive and split tensile strength of 100% replacement of sand with quarry dust of mortar cube are increased 11.8% and 15.25% higher than the controlled cement mortar

Chandana Sukesh, P.Sri Lakshmi Sai, S.Kanakambara Rao (May 201 They investigated Partial Replacement of Sand with Quarry Dust in Concrete. They are concluded Replacement of the sand with quarry dust shows an improved in the compressive strength of the concrete. As the replacement of the sand with quarry dust increases the workability of the concrete is decreasing due to the absorption of the water by the quarry dust

P PERUMAL and BALAMURUGAN (December 2013) Experimental study presents the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. M20 and M25 grades of concrete are taken for the study keeping a constant slump of 60mm. The compressive strength of concrete cubes at age of 7 and 28 days is obtained at room temperature. Split tensile strength and flexural strength of concrete are found at the age of 28 days. From the test results it is found that the maximum compressive strength, tensile strength and flexural strength are obtained only at 50% replacement. This result gives clear picture that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand at 50% replacement with additional strength than control concrete.

Mohammed Nadeem, A.D.Pofale (October2012) experiment on Replacement of Natural Fine Aggregate with Granular Slag - A Waste Industrial By-Product in Cement Mortar Applications as an Alternative Construction Materials. This paper highlights upon the feasibility study for the utilization of granular slag as replacement of natural fine aggregate in construction applications.In this investigation, cement mortar mixes 1:3, 1:4, 1:5 & 1:6 by volume were selected for 0, 25, 50, 75 & 100% replacements of natural sand with granular slag for w/c ratios of 0.60, 0.65, 0.70 & 0.72 respectively. Sand by slag gives better results in both the applications i.e. masonry & plastering. The sand replacement from 50 to 75% improved mortar flow properties by 7%, the compressive strength improved by 11 to 15 % for the replacement level from 25 to 75%. At the same time brick mortar crushing & pull strengths improved by 10 to 13% at 50 to 75% replacement levels.
Sujata D. nandagawali N. R. Dhamge(July 2014) They Study of Blast Furnace Slag for Improving Mechanical Property of Concrete in this paper investigation of mechanical and durability properties of concrete by adding iron slag as replacement of sand in various percentages. Two major uses of GGBS are in the production of quality-improved slag cement, namely Portland Blast furnace cement (PBFC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging typically from 30 to 70%;Blast furnace slags can be used as partial replacement of cement as well as send. Thus blast furnace slags are to be used as fine aggregates although they are used increasingly as a cement admixture because this use has a higher value. Blast furnace slag is nonreactive in a high alkali environment, such as concrete and soils.

Netingeretal (2011) studied about the effect of high temperatures on the mechanical properties of concrete made with different types of aggregates. They conducted the study on the presumption that all materials formed at high temperatures and usable as aggregates can improve the fire resistance of concrete. And materials used as fire resistant aggregates include diabase, steel slag, crushed bricks and crushed tiles. For the experiment all the mixtures were prepared with same water cement ratio 0.5 The specimens were subjected to temperatures (200, 400, 600, 800 and 1000 °C) for 1.5h after 28 days curing. In this research the authors found that diabase ensures good mechanical properties of concrete at room temperature and better mechanical properties at temperatures up to 600 °C in comparison with the river aggregate and dolomite mixtures

III. MATERIAL

CEMENT

Ordinary Portland cement of 53 grades conforming to IS 8112-1989 was used. The physical properties are tabulated as shown below (Table-1)

Table – 1 Physical properties of cement (53 grade)

No	Properties	value
1	Specific gravity	3.15
2	Soundness	1.20mm
3	Initial setting time	167 minutes
4	Final setting time	255 minutes
5	Normal consistency	31%
6	Fineness m^3/kg	320
7	28 days compressive strength	58.25 MPa

Fine Aggregates

Natural sand obtained from river bed. Quarry dust is obtained from the local crusher was used. GBFS obtained from JSW, Bellary. The physical properties of Natural sand ,quarry dust and GBFS are as below.

Table – 2 Physical properties of natural sand, quarry dust and GBFS

Properties	Natural sand	Quarry dist	GBFS
Specific gravity	2.58	2.67	2.52
Fineness modulus	2.78	2.82	2.97
Bulk density kg/m^3	1519.8	1560.52	1245.8

Table – 3Seive analysis details of natural sand, quarry dust and GBFS

IS Sieve	Percentage of passing		
	Natural sand	Quarry dust	GBFS
4.75mm	100	100	100
2.36mm	99.59	90.52	99.5
1.18mm	97.78	80.24	97.4
600 micron	87.12	60.88	86.5
300 micron	48.62	45.36	48
150 micron	2	24.79	2.4
75 micron	0.2	9.2	0.7
Pan	0	0	0.5

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Coarse aggregate

Locally available rock stone aggregate of nominal size 20mm mixed aggregate are used. The physical properties of these coarse are as below

Table – 4 Physical properties of coarse aggregate

NO	Properties	Value
1	Specific gravity	2.72
2	Bulk density kg/m^3	1610
3	Fine modules	7.35

Material for M30 concrete

Table – 5 ingredients for 1m^3 concrete

Cement	394
Water	197
Coarse aggregate	1143.37
Fine aggregate	669.86
Water cement ratio	0.5

Percentage of replaced sand for M30 concrete

Table – 6 replaced material for 1m^3 concrete

% of replaced	0	25	50	75	100
Natural sand	669.86	502.4	334.93	167.47	0
Quarry dust	0	83.73	167.46	251.19	334.93
GBFS	0	83.73	167.46	251.19	334.93

IV. EXPERIMENTATION

The physical characteristics of material used that is cement, natural river sand, quarry dust, granulated blast furnace slag and coarse aggregate are tested initially.

The exact amount of concrete ingredient (table-5 & table 6) were weighed and mixed thoroughly in concrete mixer till the consistent mix was achieved. The workability of fresh concrete was measured by slump test. Fresh concrete are casted in to standard cubic mould size of 150mm and cylinder mold size of 150mm diameter & 300mm in length. Compaction is carried on a vibrating table. A set of five cubes and cylinders are casted and cured for 28 days by varying percentage of natural sand replaced with quarry dust and GBFS for every incremental percentage replacement (0%, 25%, 50%, 75% & 100%). Curing of cubes and cylinders is done for period of 28 days. The test specimens were kept at elevated temperature of 100°C, 200°C & 300°C each for duration of 2 hours. The compressive strength and split tensile strength of thermally treated concrete specimens after cooling was determined.

CONCLUSION

The conclusions based on the experimental result are as below

- Its observed that optimum replacement of natural sand by quarry dust and GBFS is 100%
- There is consistent increase in strength of concrete by replacing natural sand with quarry dust and GBFS upto 75%
- For optimum replacement of natural sand by 50% of GBFS & 50% quarry dust, the compressive and split tensile strength is extended by 75%
- GBFS & quarry dust are waste material and by product of iron ore, the material is easily available & costs less compared to natural sand
- The compressive strength of specimens with sand replacement increase with increase in temperature up to 300°C.
- The split tensile strength increase up to 75% replace of the material beyond the strength is decrease.
- In temperature increases split tensile strength of sand replaced specimen decreases for every increasing the temperature.

Table – 7 compressive and split tensile strength with different replacement percentage at elevated temperature

Sr No	Natural sand (%)	Replacement by QD & GBFS (%)	Temperature (°C)	Average compressive strength (KN/m^3)	Average split tensile strength (KN/m^3)
1	100	0	room	33.15	2.59
2	100	0	100	35.02	2.34
3	100	0	200	36.62	2.28
4	100	0	300	38.92	2.22
5	75	25	room	35.55	2.74
6	75	25	100	37.68	2.49
7	75	25	200	38.22	2.38
8	75	25	300	39.91	2.30
9	50	50	Room	37.15	2.86
10	50	50	100	38.31	2.63
11	50	50	200	39.55	2.54
12	50	50	300	40.80	2.46
13	25	75	Room	39.24	2.97
14	25	75	100	41.15	2.85
15	25	75	200	42.67	2.67
16	25	75	300	43.46	2.59
17	0	100	Room	40.8	2.60
18	0	100	100	42.13	2.34
19	0	100	200	43.82	2.20
20	0	100	300	45.60	2.15

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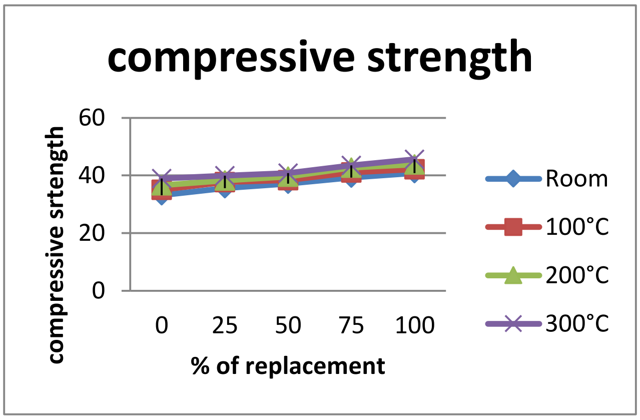

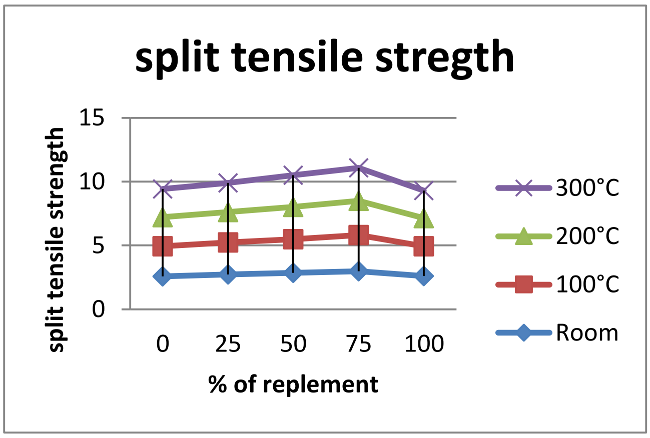

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