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Experimental Behavior of Different Grades concrete with partial replacement of cement and sand with GGBFS and M-sand

D Aravind
M.Tech Scholar
Department of Civil Engineering
Vaagdevi College of Engineering
Bollikunta, Warangal
Email: aravind.dharmapuri@yahoo.com
Cell: +91 86866 64653

Syed Riyaz
Assistant Professor
Department of Civil Engineering
Vaagdevi College of Engineering
Bollikunta, Warangal
Email: riyazsyed134n431@gmail.com
Cell: +91 97010 10244

Abstract— Concrete is a composite material composed of fine and coarse aggregate bonded together with fluid cement which hardens over time. Manufacturing sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world. The research aim is to study the effect of different grades of concrete using GGBS and M-sand. To conduct the experimental program and to determine the ultimate Compressive Strength, Split Tensile and Flexural Strength of grades M40 and M60 comparing these with that of M25 Mix proportion

Index Terms - (ground granulated blast furnace slag (GGBS), m-sand,*)*

I. Introduction

Most use of the term "Concrete" refers to Portland cement concrete or to concretes made with other hydraulic cements, such as cement foundation. However, road surfaces are also a type of concrete, "Asphaltic concrete", where the cement material is bitumen.

A range of materials can be used as the cement in concrete. One of the most familiar of these alternative cements is asphalt concrete. Other cementitious materials such as fly ash and slag cement, are sometimes added as mineral admixtures (see below) - either pre-blended with the cement or directly as a concrete component - and become a part of the binder for the aggregate.

The most conspicuous of these are fly ash, a by-product of coal-fired power plants, ground granulated blast furnace slag, and silica fume, a by-product of industrial electric arc furnaces.[2] The use of these materials in concrete reduces the amount of resources required, as the mineral admixtures act as a partial cement replacement.

II. literature review

RavindraGettu et al (1990) studied the "Fracture properties and Brittlenes of High strength concrete", ACI Material journal. In this to observe the fracture properties of high performance concrete cylinders and beams have been casted. Test was conducted on two sizes of cylinders and four sizes of Beams for M80 grade. They observed that the maximum compressive strength of 96 Mpa was achieved for M80 grade concrete specimens they have tested. They also found that the fracture toughness properties of concrete are increasing with increase in strength concrete.

Sailakshmi et al (2013) studied that "Strength and Workability characteristics of High performance concrete with partial replacement of Cement and sand with GGBS and Robosand", journal of IJERT. In this the sand had replaced with Robosand at a various percentages of 0%, 25%, 50%, 75% and 100%. Along with this, cement has been replaced with GGBS at percentages of 40%, 50% and 60%. They have observed that the Robosand can be replaced with Natural sand upto 100% and GGBS can be replaced in cement upto 50%. Maximum strength of 53 Mpa was obtained for M35 grade.

Shanmugapriya et al. 2012 concluded from experimental researchers that compressive and flexural strength of concrete can be improved by partial replacement of cement by silica fume and manufactured sand for natural fine aggregates. They suggested that optimum replacement of natural sand by manufactured sand is 50%.

Saeed Ahmaed et al. 2008 have found that compressive strength of various mix ratios increasd from 7% to 33% whereas workability decreased from 11% to 67% with increasing proportion of manufactured sand.

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Shyam Prakash et la. 2007 says that manufactured sand satisfies the requirements fine aggregates such as strength, graduation, shape angularity. It is also possible to produce manufactured sand falling into the desired grade. They say that the mechanical properties of manufactured sand depend upon the source of its raw material, i.e., parent rock. Hence the selection of the quarry is very important to quality fine aggregate.

Mahendra R Chitlange et al. 2010 experimentally proved that due to addition of steel fiber to natural sand concrete and manufactured sand concrete there is a consistent increase in flexural and split tensile strength whereas there is only a marginal rise in compressive strength.

III. materials

Cement:

Ordinary Portland cement of 53 Grade conforming to IS 8112 – 1989, and the specific gravity of cement was found to be 3.15. The physical properties of cement given in Table 1

Table 1 . Physical Properties of cement

Component	**Results(%)**	**Requirements of IS : 8112**
Fineness,m²/kg	320	Minimum 225
Initial setting Time, minutes	55	Minimum 30
Final setting Time, minutes	258	Maximum 600
Standard Consistency	26.4	-
Soundness, Le Chatelier, mm	1.0	Maximum 10

Fine Aggregates:

a) Natural Sand:

Locally available River Sand having bulk density 1860 kg/m³ was used and the specific gravity is 2.56. The fineness modulus of river sand is 2.64.

b) Manufactured sand :

M- Sand was used as partial replacement of fine aggregate. The bulk density of manufactured sand was 1860 kg/m³, specific gravity and fineness modulus was found to be 2.56 and 3.10 respectively.

Table 2 . Sieve analysis of River sand & M – Sand

Sieve Size	River sand % Passing	M- Sand %Passing
4.75mm	98	99.78
2.36mm	96	87.14
1.18mm	78	63.12
600 µm	51	45.75
300 µm	26	25.50
150 µm	7	7.98

c) GGBS:

GGBS is obtained by quenching molten iron slag from a blast furnance in water or steam, to producea glassy, granular product that is then dried and ground into a fine powder. GGBS is used to make durable concrete structures in combination with ordinary port land cement and other pozzolanic materials. The fineness modulus of GGBS using blaine' fineness is 320m²/kg and other properties of GGBS.

Glenium B-233

Glenium B233 is an admixture of a new generation, based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. Glenium B233 is free of chloride & low alkali. It is compatible with all types of cements.

Properties	**Limits**
Color	Light brown liquid
Relative density	1.09 ± 0.09
PH	>6
Chloride ion content	<0.2%

Coarse Aggregates:

20mm size aggregates-The coarse aggregates with size of 20mm were tested and the specific gravity value of 2.78 and fineness modulus of 7 was found out. Aggregates were available from local sources.

Water:

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. In general, water fit for drinking is suitable for mixing concrete. Impuritiesw in the water may affect setting time, strength, shrinkage of concrete or promote corrosion of reinforcement. Locally available drinking water was in the present work.

Study Requirement:

Due to the depletion of good quality of river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-sand is its availability and transportation cost. Since this sand can be crushed from hard granite rocks, it can be readily available at the nearby places, reducing the cost of transportation from far-off river sand bed. The chemical composition of GGBS contributes to the production of superior cement. Over the period of time, its load-bearing properties continue to increase as it absorbs surplus lime released during hydration to form more calcium silicate hydrates.7 These hydrates add to the strength of

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cement. Hence it is economical to use in the construction.

IV.EXPERIMENTAL PROCEDURE

Study Requirement

Literature Review

Mix design of M25, M40 and M60

Partial replacement of GGBS and M-Sand

Experimental program and Results

Compressive Strength Test:

It is the capacity of a material or structure to withstand loads. The size for the specimen of the cube is 15ommx150mmx150mm, we have done the casting and he curing period was taken is 14, 28 and 56 days for M25, M40, and M60 grades of concrete. Totally 27 samples are taken for each grade and for one ratio three samples are taken. So for three grades we have taken three different ratios hence totally 54 cubes are casted. The test results for the compression strength are listed below in the table

Grade	% of proportion	Comp strength in N/mm^2		
		14 days	28 days	56 days
M25	Nominal mix	22.62	28.40	31.86
	25%	26.22	31.65	33.42
	50%	25.15	30.40	32.57
M40	Nominal mix	36.67	45.33	47.46
	25%	42.93	48.35	49.33
	50%	41.02	46.48	48.53
M60	Nominal mix	53.42	63.33	72.36
	25%	58.13	68.09	77.24
	50%	56.35	67.02	75.38

Split Tensile test:

The tensile strength of the concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle in nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concede member may crack. The size of the cylinder is 300mmx150mm where it is also casted and cured for 14 and 28 days.

Flexural Strength Test:

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

Hence the size of the beam we used is 750x150x150mm since beam is also casted and cured for 14 28 and56 days for the M25, M40 and M60 grades of concrete. Similarly for flexural strength we have taken two beams for each grade so totally for three different ratios for 14 and 28 days, we have casted 24 beams for the three different grades. The test result for the flexural strength is listed below in the Table

Grade	% of Proportion	Tensile strength in N/mm^2		
		14 days	28 days	56 days
M25	Conventional	2.72	3.13	3.52
	25%	2.78	3.26	3.66
	50%	2.71	3.16	3.41
M40	Conventional	2.94	3.38	3.62
	25%	3.02	3.56	3.91

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	50%	2.93	3.42	3.78
M60	Conventional	3.92	4.78	5.83
	25%	4.16	4.86	5.94
	50%	3.98	4.71	5.65

Grade	**% of proportion**	**Flexural strength in N/mm^2**		
		14 days	**28 days**	**56 days**
M25	Nominal mix	3.18	3.78	4.22
	25%	3.42	4.02	4.47
	50%	3.34	3.89	4.34
M60	Nominal mix	3.98	4.53	4.84
	25%	4.26	5.02	5.18
	50%	4.12	4.89	4.96
M80	Nominal mix	4.98	5.79	7.03
	25%	5.03	5.92	7.20
	50%	5.00	5.79	7.12

The flexural strength for the reinforced beams are arrived by providing point loads on it specific distance. By comparing the flexural strength of various grades of various percentage of replacement shows that the 25% of replacement of GGBS in cement gives the high flexural strength value, if the percentage of replacement of GGBS increases it decrease its flexural strength.

Fig: Compressive Strength on N/mm^2 for M40 Grade

Fig : Compressive Strength on N/mm^2 for M25 Grade

Fig: Tensile Strength on N/mm^2 for M60 Grade

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Fig: Tensile Strength on N/mm^2 for M40 Grade

Fig: Tensile Strength on N/mm^2 for M60 Grade

Fig: Tensile Strength on N/mm^2 for M25 Grade

Conclusions

Based on the experimental studies conducted the following conclusions are drawn.

1. The optimum replacement level of GGBS in cement is 25%, because 25% replacement gives higher strength whereas the strength gradually reduces for the 50% of replacement proportion.
2. In high performance concrete also 25% of replacement gives efficient strength.
3. The chemical admixture Fosroc increases the strength in nominal mix. Whereas Glenium B233 increase the 2% of strength in high performance.

4. Compressive strength of concrete had shown an increasing trend with the increase of curing period.

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