Comparative Study on Strength Properties of Concrete with Different Cementitious Materials

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Abstract

Fly ash and Ground Granulated Burnt Slag (GGBS) are chosen mainly as an alternative for cement. In this paper our study is mainly confined to evaluation of changes in both compressive strength and flexural strength in three different mixes of M30 Grade namely i) conventional concrete, ii) concrete made by 50% replacement of cement by GGBS and iii) concrete made by 50% replacement of cement by 20% of Fly Ash and 30% of GGBS . The strength characteristics of the concrete were evaluated by conducting Compressive strength test and Flexural strength test. The compression strength tests were conducted for 7days, 14 days and 28days of curing and flexural strength test were conducted for 28days of curing on a M30 grade concrete. Henceforth we are replacing the OPC by cementitious material like GGBS and fly ash. The test results show that GGBS and FlyAsh concrete have excellent compressive strength and flexural strength and it is suitable for structural applications.

Index terms- *Properties of Concrete GGBS, FlyAsh, Cementitious materials.*

I.INTRODUCTION

Concrete is one of the most widely used construction material. Now a days, the cost of production of cement is increasing at alarming rate and natural resources giving the raw material for its manufacturing are depleting.Many efforts are being made in order to reduce the use of Portland cement in concrete. The Fly ash (FA), Silica Fume (SF), Metakaolin (MK), Ground Granulated Blast Furnace Slag (GGBS) was waste product, which may be used as partial replacement of cement in concrete due to its inherent cementitious properties. In this paper We are going to discuss about the partial replacement of ordinary Portland cement by ground granulated blast furnace(GGBS),and fly ash.

Our study is to compare the results of three mixes of M30 Grade namely conventional aggregate concrete, concrete made by replacing 50% of cement by GGBS and concrete made by replacing 30% replacement of cement by GGBS and together with concrete made by replacing 20% replacement of cement by flyash.

A. Objectives

The main objective of the study is 1.To make a concrete with percentage replacement of cement by GGBS and FLYASH. 2. To compare the compressive strength and flexural strength of replacement concrete with normal concrete.

II. MATERIALS USED AND PROCEDURE

1. Fly ash
2. Ground granulated blast furnace slag (GGBS)
3. Aggregates
   -Fine aggregate
   -Coarse aggregate
4. Ordinary Portland cement (OPC)
5. Water
6. Admixture - CONXL PCDM108(M).

The raw material data and other details are tabulated in Table 1 in which the specific gravity values of the materials and its total absorption are also mentioned.

II. Methodology

The methodology explains about the step by step procedure that is going to be done in the study. The methodology is explained in the following figure.

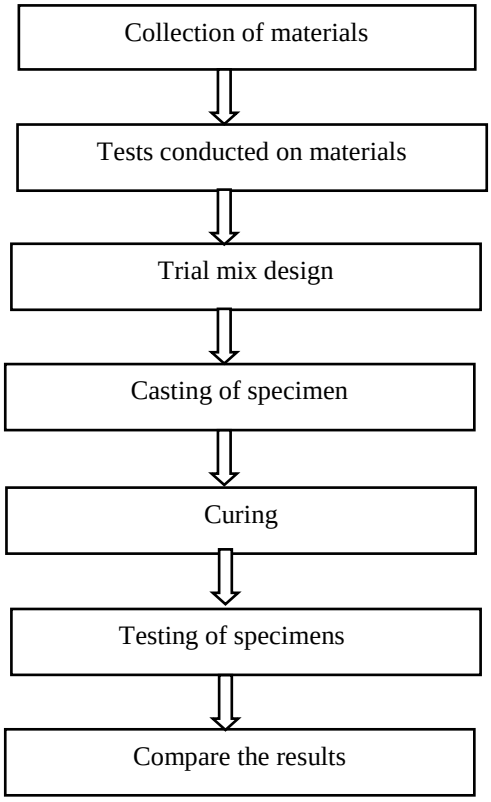

Fig:1 Methodology chart

TABLE 1: RAW MATERIAL DATA

MATERIALS	TYPE/SOURCE	WATER ABSORPTION	SPECIFIC GRAVITY
OPC	53 GRADE	Nil	3.15
COARSE AGGREGATE	20 mm	0.40	2.66
	12.5 mm	0.74	2.65
FINE AGGREGATE	Zone II	1.35	2.63
WATER	Construction Purpose	Nil	1.00
GGBS	JSW	Nil	2.87
FLYASH	Mettur thermal power plant	Nil	2.2

A. Experimental programme

This experimental programme consists of the following steps:

1. Collection of Materials
2. Mixing
3. Casting
4. Curing
5. Testing

TABLE 2: REPLACEMENT OF CEMENTITIOUS MATERIALS

S.NO	OPC (%)	GGBS (%)	FLYASH (%)
1	100	0	0
2	50	50	0
3	50	30	20

B. Test on Fresh Concrete- Slump Cone Test

The slump cone is cleaned and the inside surface of the cone is oiled thoroughly. It is then placed on a level surface and placing the slump cone inside the sheet metal cylindrical pot of the consistometer. The concrete is then filled into the cone in four 29 layers. Each layer is tamped 25 times with standard 16 mm tamping rod. After filling the cone completely, the initial height of the cone is noted, and then the cone is lifted without disturbing it. Final reading corresponding to the decrease in height of the centre of the slumped concrete is noted down.

- ✓ OPC - 70mm
- ✓ OPC + GGBS – 75mm
- ✓ OPC+GGBS+FLYASH – 90mm

FIG 2: GGBS, Cement, Flyash

C. Mix Proportion

As per IS10262:2009 we designed the following mix design.

TABLE 3: MIX DESIGN

1 mix		2 mix		3 mix	
Material	**Design (kg/m^3)**	**Material**	**Design (kg/m^3)**	**Material**	**Design (kg/m^3)**
OPC	370	OPC	185	OPC	185
GGBS	0	GGBS	185	GGBS	111
Fly Ash	0	Fly Ash	0	Fly Ash	74
20mm	567	20mm	558	20mm	551
12.5mm	462	12.5mm	454	12.5mm	449
River sand	834	River sand	837	River sand	827
Water	168	Water	168	Water	168
DM108 (M)	2.0	DM108 (M)	2.0	DM108 (M)	2.0

- 1st mix-1: 2.25: 2.78 –M1
- 2nd mix-1: 2.26: 2.73 – M2
- 3rd mix- 1: 2.23: 2.70 – M3

III. EXPERIMENTATION AND RESULTS

A. Compressive Strength Test

Cubes casted for compressive strength test are of dimension 150 × 150 × 150 mm. They are tested after 7, 14 and 28 days of curing. The test was carried out using CTM (Compressive Strength Testing Machine).

TABLE 4 COMPRESSIVE STRENGTH TEST RESULTS

MIX ID	OPC (%)	GGBS (%)	FLY ASH(%)	COMPRESSIVE STRESS IN Mpa		
				7 th day	14 th day	28TH day
M1	100	0	0	33.2	35.7	38.1
M2	50	50	0	20.8	34.6	41.5
M3	50	30	20	21.4	28.2	39.5

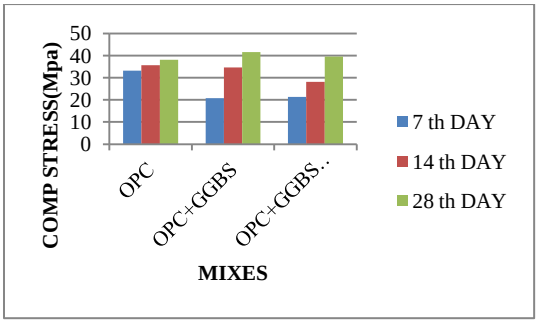

FIG 3: COMPRESSIVE STRENGTH RESULTS

B. Flexural Strength Test

The beam specimen of size 500*100*100 mm, after 28 days of curing was subjected to flexural strength test using UTM (Universal Testing Machine).

TABLE 5 BEAM FLEXURAL STRENGTH TEST RESULTS AT 28TH DAY

Mixes	M1	M2	M3
Flexural strength(Mpa)	4.2	4.6	3.8

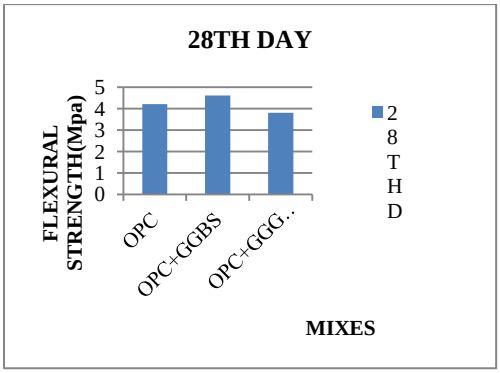

FIG 4: FLEXURAL STRENGTH RESULTS

IV. CONCLUSION

We conclude the following results obtained in this study.

The replacement of 50% of GGBS due to low heat of hydration ,the compressive strength increases gradually as the curing day increases.Along with GGBS, flyash is also blended with cement to make the triple blend mix so as to surpass the compressive strength of OPC. It also acts as green building material and also reduces the cost compared to OPC.

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