Experimental Investiagtion on Strength Characteristics of Stell Slag Hydrated Concrete

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Abstract: In the construction industry the materials used for making concrete are cement, fine aggregate, coarse aggregate and water. In the present days the availability of natural resources like coarse aggregate and fine aggregate is becoming into very difficult and cement cost is also increasing of day by day. For this reason in this project I am using the steel slag as a replacement of coarse aggregate and ggbs as a replacement of fine aggregate and using the fly ash as partial replacement of cement with different percentages in M20 grade concrete.

Index Terms—Steel slag, GGBS, fly ash, Compressive strength test

I. INTRODUCTION

Concrete is the most liked and single biggest structural material used in construction industry. The materials used for making concrete are cement, fine aggregate and coarse aggregate. In the present days the cement cost is increasing in day by day because of less availability of the ingredient used for manufacturing cement and availability of fine aggregate and coarse aggregate is also becoming into very difficult. For avoiding this problem in the construction industry I am doing this project and using the fly ash as a partial replacement of cement with different percentages and GGBS as a fine aggregate and Steel Slag as a Coarse aggregate.

In Every year approximately more than 400 million tonnes of sleel slag is producing as a byproduct from steel industry and also 450 million tonnes Ground Granulated Blast Furnace slag is producing as a byproduct from steel plant and more than 400 million tonnes of fly ash in producing from coal manufacturing plant.

In this project I am using the steel slag as a coarse aggregate and GGBS as a fine aggregate and using the fly ash as with partial replacement of cement for saving the natural resources as Fine aggregates such as sand and coarse aggregate and by using the fly ash with cement as partial replacement for decreasing the construction cost in M20 grade concrete.

In this present study I am doing the different tests like compressive strength, flexural strength test, split tensile strength for knowing the strength of steel slag hydrated matrix and comparing with the normal concrete.

2. METHODOLOGY

In this present study, a series of experiments have been done to evaluate the strength characteristics of steel slag hydrated concrete and compared to normal conventional concrete.

The physical and chemical properties of the raw materials have been studied to characterize the raw materials properties such as fly ash, GGBS and steel slag by conduction different test.

The strength characteristics of normal conventional concrete and steel stag hydrated concrete is studied by the conducting the different tests like work ability, setting time, compressive strength, flexural strength, split tensile strength and comparing to the normal concrete and steel slag hydrated concrete we can know the strength variations.

The study is done on M20 grade concrete with mix proportion of 1:1.5:3 and w/c ration of 0.45 and the fly ash replacement percentages with cement are 0%, 20%, 35% and 50% and tests are conducted on 7, 14 and 28 days.

3. EXPERIMENTAL STUDY

3.1: Fly ash

The fly ash is grayish white colour. The chemical, morphological, mineralogical and physical data for the fly ash is presented as follows. The tests on fly ash were carried out as per IS: 1727-1967. The specific gravity of fly ash is 2.25 and fineness is 8 % (by dry sieving method).
Fly ash consists of silica, alumina, oxides of iron, calcium and magnesium and toxic heavy metals like lead, arsenic, cobalt, and copper. The chemical composition of fly ash is given in the table below.

Table 3.1: Chemical composition of Fly ash

Type	Fly ash (Present study) (%)	ASTM requirement C-618 Class F (%)
SiO_2	56.04	-
Al_2O_3	33.85	-
Fe_2O_3	3.90	-
$SiO_2+Al_2O_3+Fe_2O_3$	93.84	70.00 minimum
CaO	0.73	-
MgO	0.68	5.00 maximum
K_2O	1.22	
Na_2O	0.19	1.50 maximum
TiO_2	2.69	-
MnO_2	0.31	-
SO_3	0.05	5.00 maximum
L.O.I(900° C)	1.40	6.00 maximum

3.2: GGBS (Ground Granulated Blast Furnace slag)

The Ground granulated blast furnace slag had off white colour. Blast furnace slag is a by-product from the manufacture of iron in a blast furnace. When GGFS is added to concrete in powered form it accelerates the pozzolanic reaction. The main chemical composition of GGFS is SiO2 Al2O3 and CaO. The chemical, morphological, mineralogical and physical data for the ground granulated blast furnace slag is presented as follows.

The tests on ground granulated blast furnace slag were carried out as per IS: 12089-1987.The different physical and chemical properties of ground granulated blast furnace slag are given below.

Table 3.2: Physical properties of GGBS

Fine Aggregate	Water absorption (%)	Specific Gravity
Ground granulated Blast furnace Slag	1.4	2.17

Table 3.3: Chemical Composition of GGFS

Composition	GGFS Present Study (%)	CPBC
Fe	0.4	0.82
CaO	39	40
SiO_2	33	33.41
MgO	7	8.86
P_2O_5	13	12
Al_2O_3	19.5	20.05
MnO	0	0

3.3: Steel Slag

The steel slag created during the essential phase of steel making is known as heater slag or tap-slag which is the significant portion of the all-out slag delivered in the activity. The steel slag is used as aggregates for the Natural aggregate resources are becoming more difficult to develop or remove aggregate from the ground when slag can be used as a sub statute which reduce waste and conserve resources. It protects and preserves our environment. Benefit from technical advantages offered by many of the steel making slags.

Extraction of 'iron' from metals is an unpredictable interaction requiring various different materials which are added as transition or impetuses. Subsequent to making steel these fixings shaping a grid are to be occasionally tidied up. Taken out in mass, it is known as steel – slag

This is the main ingredient used in steel slag hydrated concrete. The steel slag had gray ash white colour. The chemical, morphological, mineralogical and physical data for the above steel slag is presented as follows. The tests on steel slag were carried out as per IS: 1727-1967. The specific gravity of fly ash is 2.98 and it comes under Zone-II (by IS: 12020-1982).

Table 3.4: Physical properties of Steel Slag

Aggregates	Absorption (%)	Bulk Specific Gravity	Los Angeles Abrasion (%)
Steel slag	0.6	2.98	35

Table 3.5: Chemical Composition of steel slag

Composition	Steel slag Present study (%)	CPCB
Fe	18	14.22
Cao	34	34.32
SiO	15	14.22
MgO	2	5
Al_2O_3	4	4.17
P_2O_5	5	5.6
MnO	4	4.5

4. RESULTS AND DISCUSSUONS

In this chapter I am doing the different tests like workability, setting time, compressive strength, flexural strength, split tensile strength of normal concrete and steel sag hydrated concrete and comparing the with two concretes tests values we can found the strength variation and maximum strength giving percentage of fly ash with replacement of cement for using in the construction industry.

4.1: Work ability tests on fly ash and steel slag with different Percentage

Table 4.1 Setting time and consistency test

cement + Fly ash	Consistency		Initial Setting Time		Final Setting time	
100+0	0.58	0.58	1hr30min	2hr17min	23hr30min	25hr02min
80+20	0.56	0.56	1hr25min	2hr14min	23hr35min	25hr01min
65+35	0.56	0.56	1hr48min	4hr52min	26hr20min	27hr30min
50+50	0.53	0.51	5hr40min	8hr20min	26hr20min	27hr30min

Table: 4.2 Slump test of steel slag hydrated concrete

Fly ash %	Maximum Diameter of steel slag(mm)	Slump (mm
0	20	42
20	20	48
35	20	54
50	20	58

4.2: COMPRESSIVE STRENGTH OF CONCRETE

Tablen4.3: Compressive strength of Normal concrete

Maximum Diameter of aggregate (mm)	Slump(mm)	Compressive strength at 28 days ($N/mm^{2)}$
20	13	28.25

Table 4.4: Compressive strength of steel slag hydrated concrete

S.No	Cement +Fly ash %	Test results		
		7 days	14 days	28 days
1	100+0	6	8	11
2	80+20	6.8	10.2	13
3	65+35	7.6	11.2	18
4	50+50	4.67	7.6	9.2

4.3: Flexural strength

The Flexural strength of Normal conventional concrete at 7, 14, 28 days are 1.5, 3.2 and 4.2 MPa.

Table 4.5: flexural strength of steel slag hydrated concrete and normal concrete

S.No	Cement +Fly ash %	Steel Slag Hydrated Concrete		
		7 days	14 days	28 days
1	100+0	0.50	1.2	2.1
2	80+20	0.60	1.45	2.45
3	65+35	0.80	1.65	3.2
4	50+50	0.35	0.95	1.45

4.4: Split Tensile Strength

The split tensile strength of the Normal concrete was found at 7, 14, 28 days are 0.5, 1.6 and 2.22 MPa

Table 4.6: Split tensile strength of steel slag hydrated concrete

S.No	Cement +Fly ash %	Steel Slag Hydrated Concrete		
		7 days	14 days	28 days
1	100+0	0.3	0.85	1.2
2	80+20	0.45	0.92	1.3
3	65+35	0.60	1.35	1.8
4	50+50	0.35	0.95	1.6

5. CONCLUSIONS

The compressive strength of normal after 28 days curing was found as 28.25 N/mm^2 and in present research we found the compressive strength on Steel Slag Hydrated Concrete is less than normal concrete.

The Flexural Strength of Normal concrete after 28 days was found as 4.2 MPa and and the Steel Slag Hydrated concrete was found is lesser than normal concrete.

The Split tensile strength of Steel Slag Hydrated concrete is also lesser than Normal concrete
In the Compressive Strength, Flexural Strength and Split Tensile Strengths test results we found that the 35% fly ash replacement with cement gives Higher Strength Values comparing with other percentages.

6. REFERENCES

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