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GROUND GRANULATED BLAST FURNACE SLAG (GGBS or GGBFS) AND FLYASH IN CONCRETE

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ABSTRACT - *Now a days more cementitious waste materials are produced by the many industries like iron industries (GGBS), coal industries (FLY ASH), paper industries (PAPER ASH) etc. Cement is the most important material in the construction sector. But the cement production from the industries affects the environment, due to emission of CO_2 and greenhouse effect. This paper mainly focus on the strength of the concrete by determining the compressive strength and tensile strength of the concrete by various replacement of Flyash and GGBS. The test results shows that strength increasing with the increase of flyash and GGBS up to optimum value beyond which strength value start decreasing with further addition of flyash and GGBS.*

Key words: Fly ash, GGBS, Environment problem, compressive strength, tensile strength.

1. INTRODUCTION

Cement is the most important material of the concrete which produced by natural raw material like silica and lime over consumption of lime may lead to the condition there will be no lime production of cement for concrete. The effect of cementitious waste material (GGBS) as cement in concrete give more compressive strength and flexural strength 0-80% replacement of GGBS in different grade of concrete. The GGBS give more strength in 40% of replacement and attains more than 9% strength in 7 days and increasing of 6% strength with 30% replacement attains in 28 days [1]. The high replacement of GGBS cause reduction in flexural & compressive strength in adding 30% of GGBS compressive strength lower than the plain cement concrete addition. Concrete achieve adequate strength in GGBS. The compressive & flexural strength will be high in adding 15%-45%.it will identical to achieve mechanical Properties [2].

The iron industries waste furnace slag generation would be dual problem in disposal and environmental pollution and it bio degradable. The architecture application masonry and plastering achieve abstraction and bearing .slag substitute fine aggregate and increase Strength [3].The high strength concrete need more cost and material. A three type of admixtures fly ash GGBS & super plasticers (SP- 430) used and finally get a 10.3% and 30.8% strength increase in 28 & 180 days .A 50% 0f replacement will decrease compressive and flexural strength of M60 grade concrete [4]. The ordinary Portland cement replaced as ground granulated slag in a mix proportion varies o-40%. A GGBS concrete strength, GGBS give sustainable gain and strength 30% of GGBS strength decrease compared with control of concrete. A 30% of replacement gives 13.13%in compressive strength gives 6.97% for 28 days [5]. Cement is use as a binder material in conventional concrete but it involves heat of hydration .which leads to shrinkage of concrete so, that we replace GGBS as a binder material in concrete. Improves workability and reduce cement utilization, so cost will economical and reduce environment used pollution of industry waste [6]. The paper give the compressive strength by the replacement of cement by fly ash (5,10,15,20,25,30,35,40,45) %. This test gives the result of laterally improvement of strength properties of mortar by the replacement of fly ash in cement in different Proportion [7]. Among six fly ash mortar (10, 20, 30, 40, 50, 60) the 40%replacement of mortar provides 14% compressive strength and 8% high tensile strength compared with ordinary Portland cement. The result shows strength increase of strength with increase of fly ash. The increase of fly ash gives low impact on environment reduce (co_2) and judicious energy (conservation energy, by product)[8].

The replacement of high volume fly ash and lime in M40 grade of concrete as per normal mix design. We get a high strength in M40 grade of concrete by replacing a 75% of Cement Compared with normal mix design; the cost will reduce up to 40 to 75 % replacement of cement by HVFA and lime stone. Our strength give a 40.78% benefit of original mix cost [9].To reduce cement cost we used shah special cement and fly ash in different proportion and to control environment pollution, as greenhouse effect problem of fly ash and solid waste. The 10% of proportion with fly ash tells no sacrifice of the strength the curing of plain cement concrete is chloride environment and not desirable the right time of moulding. The Burapukaria fly ash was blended with cement without sacrificing strength and disability [10].

2. BENEFITS OF USING CEMENTITIOUS WASTE MATERIAL

2.1 GGBS:

Ground granulated blast furnace slag (GGBS) is a off-white cementitious material. In mid 1800[s] the GGBS has been used all over the world and it is discovered by Emil login. It is also referred as slag cement by UK it has used in Europe, united states and Asia.

GGBS is a binding material and mostly used in ready mix concrete with the ratio of 30-70% it is used to produce a eco friendly concrete. Since, it has less emission of CO2 and also more durable compared to ordinary Portland cement and other pozzolanic material. It extend the life span of building from 50-100 years and it produced less heat of hydration, low temperature rises and avoid cold joint easier

FIG :1 GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Advantages

- Reducing compression reinforcement.
- Reduction of CO2 emission.
- High resistance to sulphate and other chemicals.
- Good workability

2.2 FLY ASH:

Fly Ash is a byproduct of coal-fired electric generating plants. For immediate combustion the pulverized coal is blown into the burning chamber of the furnace. After the burning of coal the ash that is heavier in weight would fall down but the lighter weight ash would fly out thus it is known as fly ash. Fly Ash is used in the following applications, in addition to Ready-mix concrete, Concrete block & pipe, Cement manufacture, Mineral filler for asphalt roads, Soil stabilization, Structural fill, Waste stabilization/treatment, Specialty applications. Fly ash is also known as pulverized fuel ash, which is a product of coal combustion that is when the coal is burned in thermal power plant ash is created. Fly ash and lime combination could reduce CO2 emission and it requires less energy to produce cement leads to green concrete.

FIG :2FLY ASH(FA)

Advantages

- Reduction of cost.
- Reduce the heat of hydration.
- Increase the compressive strength.
- Decrease the porosity and pore size.

3. EXPERIMENTAL PROGRAMME

3.1 Materials used:

The materials used in this experiment were GGBS, FLY ASH, fine aggregate, coarse aggregate and water.

3.2 GGBS and FLY ASH:

The chemical composition of Ground Granulated Blast Furnace Slag and Fly Ash is similar to that of cement clinker.

TABLE: 1 CHEMICAL PROPERTIES OF GGBS, FLY ASH

Material	SIO_2	Al_2O_3	Fe_2O_3	CaO	Mgo	SO_3	K_2O	Na_2O	LOI
GGBS (%)	4.27	14.33	1.11	37.02	8.41	0.85	1.28	1.32	1.41
FLY ASH(%)	59.3	23.4	4.8	8.6	0.6	0.1	-	3.2	-

The Fig:3 shows about the chemical properties present in GGBS and fly ash in concrete. The sio_2 (silicon dioxide) is more in fly ash and low in GGBS. The CaO (Calcium oxide) more in GGBS and low in fly ash.$Al2O_3$ (Aluminum oxide) present more in fly ash and low in GGBS, it shows there is a similar chemical properties between the three materials.

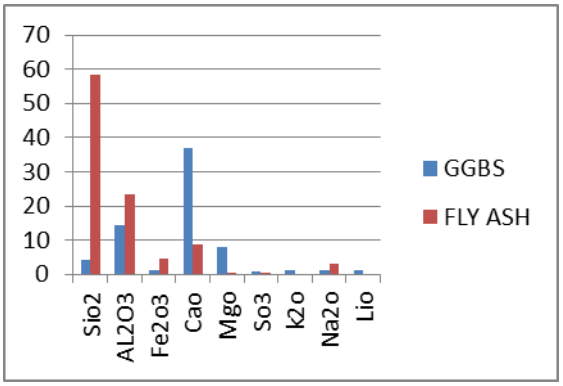

Fig 3: CHEMICAL PROPERTIES OF GGBS AND FLY ASH

3.3 Fine aggregate:

Locally available river sand belonging to zone 2 of IS 383-1970, was used in this project work. The sieve analysis data and physical properties of fine aggregate used are shown in table 2

Table : 2 Properties Of Fine Aggregates

S.NO	CHARECTERISTICS	VALUES
1.	Type	Uncrushed (natural)
2.	Specific gravity	2.5
3.	Bulk density	1668 kg/m^3
4.	Fineness modulus	2.74
5.	Grading zone	Zone 2
6.	Water absorption	1%

The above table shows that properties of fine aggregate such as specific gravity as 2.5, bulk density 1668 kg/m^3, fineness modulus 2.74, water absorption 1percentage.

3.4 Coarse aggregate:

Locally available coarse aggregate having the maximum size of (10-20mm) were used in this project work conforming by IS 383-1970.properties of coarse aggregate are tabulated in table 3.

Table: 3 Properties of coarse aggregate

S.NO	CHARECTERISTICS	VALUES
1.	Type	Crushed
2.	Specific gravity	2.73
3.	Bulk density	1765 kg/m^3
4.	Fineness modulus	6.40
5.	Maximum size	20mm
6.	Water absorption	0.80%

The above table shows that properties of coarse aggregate such as specific gravity 2.73, bulk density 1765 kg/m^3, fineness modulus 6.40, water absorption 0.80 percentage.

3.5 Water:

Portable clean water was used in the present investigation for both casting and curing of concrete.

3.6Mix design and mix details:

The design formulation is based on the IS CODE 10262-2000 for M_{40} grade of concrete (Fck40Mpa).water cement ratio is calculated as 0.35. The mix ratio is (1:1.53:2.13).

3.7 Fresh concrete test:

The workability test was taken as per IS CODE 456-2000. The test conduct are slump cone test and flow table test. The test result satisfied the water cement ratio 0.35. which was calculated from mix design using IS CODE 10262-2000.

3.8 Hardened concrete Test:

As per IS CODE 456-2000 the hardened concrete test for compressive strength and tensile strength were taken result are given below

4. RESULT AND DISCUSSION

Compressive strength:

The compressive strength gain of concrete was determined at the time period of 7 days, 14 days, and 28 days as presented in table 6. The cubes were casted for compression test. The cubes were casted and tested as per IS: 516-1959.

Table : 4 Compressive strength of GGBS and Fly ash

Mix	GGBS (%)	Fly ash (%)	Compressive strength in (Mpa)		
			7 days	14 days	28 days
A_0	0	0	22	36	41
A_1	70	30	17.5	20.88	24.4
A_2	60	40	22	26.6	32
A_3	50	50	20.22	24.4	27.5
A_4	40	60	18.8	22.88	26.4

From the above table 4, It is observed that the compressive strength of 60 percentage replacement of GGBS and 40 percentage replacement of fly ash comes as 32 Mpa. It is somewhat equivalent to the compressive strength of conventional concrete comes as 41 MPa.

Fig 4: Compression testing on cube specimen

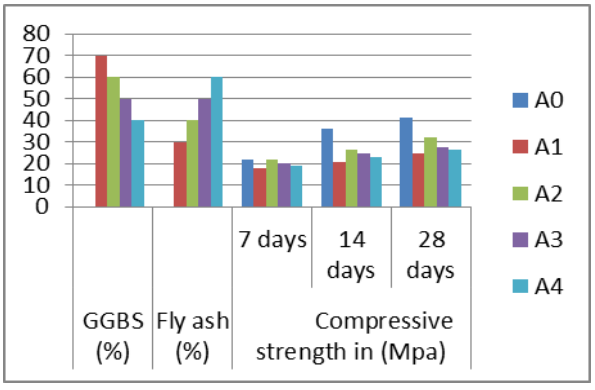

Fig 5: compressive strength

Tensile strength:

Tensile strength of concrete was determined at the age of 7 days, 14 days and 28 days as presented in table 7.the cylinder were casted and tested as per IS 516-1959.

Table: 5 Tensile strength of GGBS and Fly ash

Mix	GGBS (%)	Fly ash (%)	Tensile strength in (Mpa)		
			7 days	14 days	28 days
A_0	0	0	2.1	2.8	3.5
A_1	70	30	0.424	0.9	1.27
A_2	60	40	1.06	1.9	2.5
A_3	50	50	0.849	1.27	1.8
A_4	40	60	0.636	1.06	1.6

From the above table, It is observed that the split tensile strength of 60 percentage replacement of GGBS and 40 percentage replacement of fly ash comes as 2.5 Mpa. It is conventional concrete comes as 3.5 MPa.

Fig 6: Tensile testing on cylinder specimen

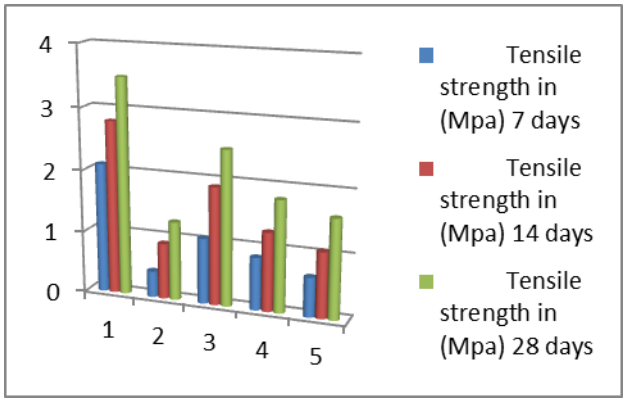

Fig 7: Graphical representation of tensile strength

5. CONCLUSION:

The GGBS and FlyAsh has fully replaced by the cement in concrete for reducing the carbon dioxide emission in the atmosphere. The M_{40} grade of concrete has attain the compressive strength of 32Mpa in 28 days and tensile strength of 2.5 Mpa in 28 days. This strength of GGBS and Fly ash in concrete without adding admixtures . To improve the compressive strength by adding admixtures with GGBS and Fly Ash may gives more strength.

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