Ground Granulated Blast Furnace Slag (Ggbs or Ggbfs) and Fly Ash (Fa) in Concrete – A Study Report

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Abstract

Now a days more cementitious waste materials are produced by the many industries like (GGBS) from Iron industries, (FLY ASH) which produced in coal industries and (PAPER ASH) which produced in paper industries. Cement is the most important used material in the construction sector. But the cement production from the industries affects the environment, due to emission of CO2 and greenhouse effect. In this paper studied various literature about the effect of GGBS and FLY ASH in concrete, based on this study concluded GGBS attains high compressive strength up to 40% replacement and Fly ASH up to 60% replacement attains good strength.

Keywords —Fly *ash, GGBS, compressive strength.*

I. 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 large 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 & superplasticers (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 Bura pukaria fly ash was blended with ordinary Portland cement without sacrificing strength and disability [10]

II. DIFFERENT TYPES OF CONCRETE.

Plain or Ordinary Concrete, Lightweight Concrete, High Density Concrete, Reinforced Concrete, Precast Concrete, Prestressed Concrete, Air Entrained Concrete.

A. Plain cement or Ordinary cement Concrete

Plain cement or Ordinary cement Concrete is the most commonly used types in construction and its essential constituents are cement, Fine aggregate and coarse aggregates based on mix design with a required quantity of water. The commonly used mix design, commonly known as *Nominal Mix Design* is 1:2:4.

- Density: 2200 – 2500 Kg/m^3
- Compressive Strength: 200 – 500 Kg/cm^2.
- Tensile Strength: 50 – 100 Kg/cm.
- Durability: Very Satisfactory.

B. Lightweight Concrete:

Lightweight Concrete having a density less than *1920 Kg/m^3*. The light weight concrete is made up of various aggregates, they are natural materials like pumice and scoria, special materials like expanded shale's and clay and processed materials like perlite and vermiculite.

C. High Density Concrete

The *heavy weight concrete is also called high density concrete*. This type of concrete have the density varies between 3000-4000 Kg/m^3. These types of concrete are used high density crushed rocks as coarse aggregates.

D. Reinforced Concrete

Reinforced Cement Concrete is termed as RCC. This concrete have steel in various forms is used as reinforcement to give very high tensile strength

E. Precast Concrete:

A special type of reinforced concrete is known as prestressed concrete in which the reinforcement bars are tensioned before being embedded in the concrete. These tensioned wires are hold tight at each end where the concrete mix is placed. The result is that when concrete sets and hardens the whole concrete members so cast is put into compression. Examples of precast concrete: precast poles, fence posts, concrete lintels, staircase units, concrete blocks and cast stones, etc.

F. Air Entrained Concrete

It is a special type of plain concrete in which air is entrained as uniformly distributed thousands of particles. Thus the entrained Volume of air is range between 3-6% of the concrete.

III. CEMENT AND CEMENTITIOUS MATERIALS:

A. Cement:

Portland cement is the basic ingredient of concrete, mortar, stucco and non-specially grout and it is the most common type of cement used all around the world. It was developed from other types of hydraulic lime in England in the mid 19th century, and usually originates from limestone.

B. Ground-Granulated Blast-Furnace Slag (Ggbs):

GGBS is produced by the quenching process that is the process of sudden cooling of ions slag from a blast furnace using water or stream. At the end of the process a glassy, granular product is obtained and then dried and grinded into fine powder. 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 langin. 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

Advantages:

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

C. 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. The main composition of fly ash is Silica dioxide (sio_2), Ferric oxide (Fe_20_3), Aluminum oxide (Al_2O_3), Calcium oxide (Cao). It is a pozzolans and binding material.

Fly ash is mostly used as replacement of Portland cement with the percentage of 0-30% by the total weight of the cement. Fly ash and lime combination could reduce CO2 emission and it requires less energy to produce cement leads to green concrete

Advantages:

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

Table: 1 Chemical Properties Of Cement, Ggbs, Fly Ash

Material	Sio_2	Al_2O_3	Fe_2O_3	CaO	Mgo	SO_3	K_2O	Na_2O	LOI
CEMENT(%)	19.71	5.20	3.73	62.91	2.54	2.72	0.90	0.25	0.96
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: 1 shows about the chemical properties present in cement, GGBS and fly ash in concrete. The sio2 (silicon dioxide) is more in fly ash and low in GGBS. The Cao(Calcium oxide) more in cement and medium in GGBS and low in fly ash.Al2O3(Aluminum oxide) present more in fly ash and low in cement, it shows there is a similar chemical properties between the three materials .

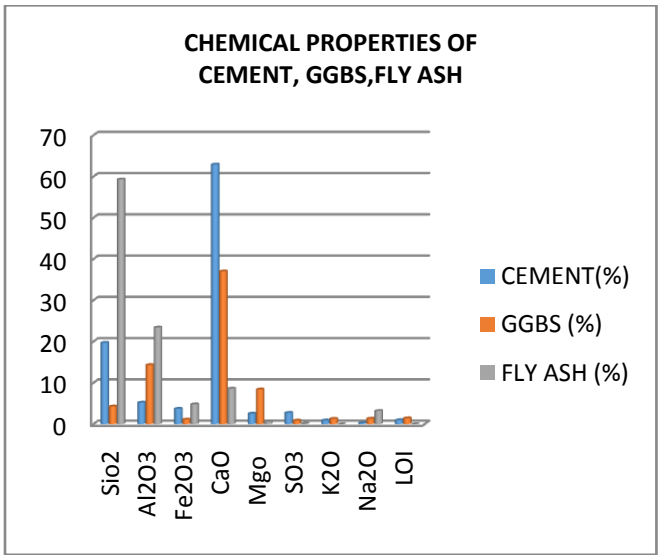

Fig: 1 Chemical Properties of Cement, GGBS,FLY ASH

Table: 2 Comparative Analysis Of Ggbs And Fly Ash

Si.no	Title of the project	Journals name	Author name	Year of publish	Replacement %	*7 DAYS (N/mm^2)*	*28 DAYS (N/mm^2)*
1.	EFFECT OF CEMENTITIOUS WASTE MATERIAL (GGBS) ON CONCRETTE AS A REPLACEMENT IN CEMENT	INTERNATIONAL JOURNALS OF SCIENCE TECHNOLOGY AND ENGINEERING (IJSTE)	QUAID JOHAR BHATTIWALA & KULDEEP DABHEKAR	May 2016	**C-60%,G-40%**	**33.95**	**45.44**
2.	EXPERIMENTAL STUDIES ON POZZOLANIC ACTION OF GGBS AND STRENGTH PROPERTIES OF	INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN SCIENCE AND TECHNOLOGY	PROF M SUTAR, RAMESHWARI& TARANNUM	May 2015	**C-70%,G-30%**	**33.19**	**44**

	GGBS CONCRETTE						
3	EFFECT OF GRANULATED BLAS FURNACE SLAG AS SUBSTITUTE FOR FINE AGGREGATE IN CEMENT MORTAR IN CONCRETTE	INTERNATIONAL JOURNALS OF RESEARCH IN ENGINEERING AND TECHNOLOGY (IJRET)	C.G KONA PURE & S.S PATIL	AUG 2016	**G-40%**	***31.68***	***48.20***
4	EXPERIMENTAL INVESTIGATION ON HIGH STRENGTH CONCRETTE USING GGBS , FLY ASH & SP 430 SUPER PLASTICIZER	INTERNATIONAL JOURNALS OF CIVIL ENGINEERING AND TECHNOLOGY (IJCIET)	M PRATHAP KUMAR, VADDI SRINIVAS& M ZOHEB NAWAZ	SEP 2017	**F-20%C-60%,G-20%**	***56.5***	***70.2***
6.	A REVIEW OF COMPRESSIVE STRENGTH OF MORTAR USING FLY ASH AS A PARTIAL REPLACEMENT OF CEMENT	INTERNATIONAL JOURNALS OF ADVANCE ENGINEERING AND RESEARCH DEVELOPMENT (IJAERD)	RAVI MAHIDA , JASMIN GADHIYA & ANAND MEHTA	2014	**C-60%,F-40%**	***16.2***	***27.7***
7.	STRENGTH BEHAVIOUR OF MORTAR USING FLY ASHES PARCIAL REPLACEMENT OF CEMENT	INTERNATIONAL SOCIETY FOR SCIENCE AND RELEGION (ISSR)	MD MOINUL ISLAM & MD SAIFUL ISLAM	SEP 2010	**C-60%,F-40%**	***16.2***	***27.7***
8.	REPLACEMENT OF CEMENT IN CONCRETTE	INTERNATIONAL JOURNALS OF ENVIRONMENTAL RESEARCH AND DEVELOPMENT (RESEARCH INDIA PUBLICATION)	P.VAIPUL NAIDU & PAWAN KUMAR PANDEY	NOV 2014	**C-60%,F-40%**	***31.44***	***47.56***

IV. RESULT AND DISCUSSION

The above table shows the cement has replaced by GGBS as 40 % , the compressive strength in 7days and 28days has attain the highest strength of 45.44 N/mm^2 And also the 30 % of replacement attains 44N/mm^2.The GGBS has replaced as Fine aggregate by 40 % it achieve 48.20 N/mm^2 . The above table shows that replacement of GGBS, Fly ash and Sp-430 super plasticizer could give various strength at various ratio as follows. The replacement of fly ash 20% and 20% GGBS gives strength of 70.2 N/mm^2 in 28 days. By

replacing GGBS as slag concrete by 30% with mare chemical admixtures in concrete produced high compressive strength of 64.04N/mm^2. And fly ash has replaced by 40% in M_{30} grade concrete it attains the maximum compressive strength of 27.7 N/mm^2 by increasing the grade as M_{40} grade concrete it attains the maximum compressive strength of 47.56 N/mm^2.Based on the above studied concluded that replacement of GGBS as cement by 40 % in concrete attains high compressive strength and Fly ash as 40% with high grade also produced high compressive strength.

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