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Combination of GGBS / GLSS / Bio Additives / OPC with Fly Ash in Geopolymer Concrete Cured At Ambient Temperature – Review

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ABSTRACT: Cement manufacturing is one of the biggest endowments to global warming by process of 5-7% of the total reaching throughout the world emissions and 17% of the total discharge of harmful gas related to constructing and building field. Ordinary Portland cement (OPC) is used in the field of construction of infrastructure and it become progressively worse due to sulphate attack, emission of carbon-di-oxide and it is largely observed and recorded in various places. Investigation have bring out in the open that the disintegrating of opc concrete takes place because of reaction in between cement hydration products and sulphate relevance solutions. To overcome builders have to consume geo-polymer concrete with fly ash and GGBS. This review paper shows the compressive strength, workability tensile strength setting and earlier achievement of strength of the geo-polymer concrete by the composites of fly ash and GGBS accompanied with cement in geo-polymer concrete.

KEYWORDS: Geo polymer concrete, GGBS, Flyash.

I.INTRODUCTION

Geopolymer concrete is the type of concrete that is made by reacting aluminate and silicate bearing materials with caustic activator. The materials required for production geo-polymer is precursor materials such as metakaolin or fly ash sodium or potassium. Geopolymer concrete reduces carbon emission by reducing Portland cement demand. In action of including ground granulated blast furnace slag with class F fly ash may have a remarkable effect on the setting and strength enhancement of geo-polymer binders while cured in ambient temperature[2]. This review paper forms an idea of about the effect different proportions of GGBS and others such as metakaolin fly ash with alkaline solutions. Geo-polymer concrete was first introduced by Davidoviots in 1978 with a target to happen green sustainable concrete. Significant increase in strength and some decrease in workability will observed in geo-polymer concretes with higher GGBS and lower sodium silicate to sodium nitrates ratio in the mixtures. Similar to OPC concrete, development of tensile strength correlated well with the compressive strength of ambient cure geo-polymer concrete[2]. Most of the investigations focused on strength and durability feature of GGBS. Geopolymer uses the reaction of definite alkaline solution with the silicon and the aluminium in a material of geological arises or otherwise in a secondary results materials such as fly ash. GGBS and rice husk ash to manufacture cement like binders[1]. Containing of additional NaOH and Na₂SiO₃ in the alkaline activator had been endorse as with a capacity to develop in effective way to increase the strength enhancement rate and final strength of the ambient cured GPC. Much research is required to predict the properties of GPC combine execute in practice. These study focus on the placed on heat cured GPC as the presently substitute to opc. Geopolymer consist of silicon and aluminium atoms adhesive to create a polymer fuse. They were made up of dissolution, polycondensation reactions into a reactive aluminosilicate material and an alkaline solution[5].

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Various types of geo-polymers were prepared by using rice husk ash, fly ash, GGBS, red mud, metakaolin palm oil fuel[5]. Above all GGBS and fly ash were much intended result materials for geo-polymer concretes for the reason that good polymerization that offers high standard strength and stability.

II.MATERIALS

In these review paper the materials used for geo-polymer concrete is GGBS, class F fly ash coarse aggregate, fine aggregate, cement, sodium nitrate and sodium silicate were used.

Fly ash:

It is the alumino silicate source material used for synthesis of geopolymeric binder. There are two types of fly ash. They are but in this stud they prefer class F fly ash.

- Class F fly ash
- Class C fly ash

Class F fly ash:

This fly ash is pozzolanic in nature, and contains less than 7% lime. Possessing pozzolanic properties, the glassy silica and aluminium of class F fly ash requires a cementing agent, such as Portland cement, quick lime, or hydrated lime-mixed with water to react and produce cementitious compounds.

GGBS:

GGBS is used to fill voids between fly ash and fine aggregate sodium hydroxide and sodium silicate or sodium nitrate solution used as alkaline liquids react with fly ash and GGBS to form the polymer gel binding the aggregates to produce GPC[2].GGBS is the by-product of steel industry. Blast furnace slag is defined as the non-metallic product consisting essentially of calcium silicates and other bases. About 10% by mass of binders was replaced with GGBS. The chemical composition of fly ash and GGBS predicted by X-ray fluorescence were given in the table 2.

Alkaline liquid:

A merging of successfully obtainable 98% without any extraneous sodium hydroxide & sodium silicate was taking as alkaline activators for the purpose of geopolymerization[5].

Aggregates:

Locally available river sand & grained granites were taken as fine aggregate and coarse aggregate. The sieve analysis test had been carried out for the fine aggregate. In a similar way water absorption test specific gravity test, bulk density test, fineness modulus test were carried out for various sized 6mm, 12mm, 20mm coarse aggregates[5].

High range water reducing admixture:

In some investigates high range water reducer such as Conplast SP 430 getting from chemical industries to enhance the workability of concrete.

Table 1
Physical properties of materials[2]

Materials	Fly ash	SS	CA	FA
Specific gravity	2.64	1.458	-	2.62
Fineness modulus	-	-	6.12	1.97
Bulk density	-	-	1686.8	1645.2

SS – sodium silicate
CA – coarse aggregate
FA - fine aggregate

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Table 2
Chemical composition of raw materials by XRF analysis[2]

Composition	Fly ash	GGBS
SiO ₂	53.71	29.96
Al ₂ O ₃	27.20	12.25
Fe ₂ O ₃	11.71	0.52
CaO	1.90	45.45
Na ₂ O	0.36	0.31
K ₂ O	0.54	0.38
SO ₃	0.30	3.62
P ₂ O ₅	0.71	0.04
TiO ₂	1.62	0.46
LOI ^a	0.68	2.39

The above compositions of fly ash & GGBS were predicted by X-Ray Fluorescence.

III. PROCEDURE FOR MAKING, CASTING AND CURING OF TEST SPECIMEN

According to geo-polymer concrete the mix proportions and curing conditions were slightly differ from conventional concrete, therefore the aggregates were made to saturated surface dry condition. The alkaline solution was ready to deal with in the laboratory by the composition of sodium hydroxide and sodium silicate solutions at the considerable ratio 30 min before the mixing of geo-polymer concrete. Fly ash GGBS and aggregates were initially dry mixed with in a pan mixer. Further it continued by mixing of the activator liquids to the dry materials the mixing should be continued for 5 min to manufacture of fresh geo-polymer concrete. Superplasticizers were added in the permissible amount. The above procedure is the official way for manufacture of geo-polymer concrete. A35 S20 R1.5 constitute a geopolymer concrete mixture having in what percentage they have to added to the concrete. Superplasticizers were added to enhance the workability of geopolymer concrete. And also prepare the conventional concrete, casting the specimen according to some specifications and compare their compressive strength, tensile strength and workability results with that geopolymer concrete[5].

IV. AUTHORS REVIEW ABOUT WORKABILITY AND COMPRESSIVE STRENGTH OF GEOPOLYMER CONCRETE

workability of geopolymer concrete

Workability is defined as the ease of working with easily transported, placed, compacted and finished without any segregation. Workability is a property of freshly mixed concrete, and a concrete is a mixture of cement, aggregate, water & admixture. The workability of concrete depends on many factors which are explained in factors affecting workability of concrete. Water cement ratio has much effect on the workability. Workability is directly proportional to water cement ratio. An increase in water cement ratio increases the workability of concrete.

According to A.Karthick (149) 2017, he investigated that there was high improvement in workability and extend the duration of setting time for various geo-polymer mixes the slump values of geo-polymer differed between 235mm & 240mm from these he observed that enhancement in workability of geo-polymer concrete by mixing bio additives such as terminalia chebula and natural sugars like molasses /palm/jaggery/honey were mixed along with GGBS and fly ash in the geopolymer concrete mix[5].

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As per the observation of Azizul Islam (101) 2015 he says that the greater mortar necessity in the adding of oil palm shell geopolymer concrete testing specimens manufactured consume pulverize OPS aggregate predicted in less slump values equate to the mixes with not crushed OPS aggregate[10].

In the research of Partha Sarathi (62) 2014 According to his experiment he predicted that workability of GPC lowered with the high quantity of GGBS along with fly ash. The reason is the comparison between the fly ash particles which is inspherical shape and the accelerated reaction of the calcium & the angular shape of the slag[2].

Compressive strength of geopolymer concrete

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size as opposed to tensile strength, which withstand loads tending to elongate. Compressive strengths are usually reported in relationship to a specific technical standard.

It measures the pushing force that one needs to break a material. When the limit of compressive strength is reached, materials are pulverized. Concrete can be made to have high compressive strength e.g. many concrete floors have compressive strength of 20670 kPa. Compressive strength is one of the most important factors to examine quality of concrete.

In the observation of A.Karthik (149) 2017 he says that the composites of terminalia chebula and palm jaggery with fly ash & GGBS mixes self curing bio additives GPC increased the compressive strength of about 31.31% because of when the specimens were cured at ambient condition for 28 days or the days may vary by depending on the previous journal paper. For the ultimate load of 83 kN and the specimen has the deflection about 11.99mm was predicted in the load-deflection performance[5].

In this experiment Ankur Mehta(146)2017 had found that the low calcium & fly ash mixed GPC showed the greater compressive strength with the addition of OPC as a replacement of fly ash of about 20%[9].

According to Partha Sarathi Deb (62) 2014, he reveals that the compressive strength enhancement of the GGBS with fly ash based GPC specimens cured at ambient temperature was same as the water cured OPC concrete.

In this paper Albitar (136) 2017 evaluated by conducting two variety of programs of accelerating the disintegration one is without interruption deeply immersed the specimens in highly concentrated liquid for up-to nine months and the another one is wetting-drying and heating – cooling cycles about ten cycles which is completely immersion for six days in the solutions such as sodium chloride with sodium sulphate solutions and kept in oven at a temperature of 110° c for six days. The wetting-drying & heating cooling process expressed service conditions in which the compressive strength rise or fall irregularly because of the lack of proportion in the internal stresses affected temperature and passed chlorides and sulphates in the GPC specimen[3].

In this experiment Muhammad.N.S.Hadi (140) 2017 reveals using Taguchi method to design a geo-polymer concrete with GGBS based. Taguchi method is defined as the fractional factorial design method which based on special set of arrays is called orthogonal array for the experiment design. The addition of fly ash metakaoline and silica fumes as partial replacement of GGBS decreases the GPC compressive strength[4].

IV.CONCLUSION

From the above reviews, it can be concluded that GPC are good candidates materials of construction from the strength and workability considerations. GPC shows significant potential to be a material for the future because it is not only environmentally friendly but also possesses excellent mechanical properties. Practical recommendations on use of GPC technology in practical applications such as precast concrete products band waste encapsulation need to be developed in India context.

Because of lower internal energy and lower carbon-di-oxide emission contents of ingredients of geopolymer based composites to those of conventional Portland cement concretes, the new composites can be considered to be more eco-friendly and hence their utility in practical applications need to be developed and encouraged.

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