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Geo Polymer Concrete Slab with Bamboo Reinforcement

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***Abstract*—The use of Portland cement has causes the emission of carbon dioxide which is a major greenhouse gas. The generation of carbon dioxide due to the use of cement produces millions of tons of toxic impurities each year, contributing to respiratory and pollution health risks. Also, the steel making process exhibit high impact in the categories of human health and climate change as the workers involved in the factories ae exposed to pollution and huge amount of pollution and waste are produced yearly in these factories.**

Keywords—Geopolymer; Bamboo.

I. INTRODUCTION

Construction industry is an important fast-growing industry. It plays a major role in the economic and sociologic development of a country. Concrete is a widely used and important material among the different construction materials. The components of concrete are the binding material cement, coarse and fine aggregates and the tension members that is steel reinforcement. More then 10billion tons of concrete is being used worldwide every year and this is only increasing. So, the usage of the huge quantity of materials puts a heavy toll on the environment. During its costly production large quantity of greenhouse gas like carbon dioxide is being expelled into the atmosphere. for production of cement approximately 5 gigajoule of energy and 1.7 tons of raw materials are required and for 1 ton steel about 2.26x109 joule of energy is required. Thus, to reduce the exploitation of the resources researchers all over the globe are looking for replacement materials for cement, steel and aggregates. Many materials like various geopolymers, fly ash etc. have been identified to replace or reduce the cement content in concrete thus reducing the co2 production. As an alternative solution in this project cement has been replaced by geopolymer (fly ash, GGBFS and alkali activator) and steel have been replaced by treated bamboo.

II. SCOPE AND OBJECTIVE

A. Scope

From the above journals it can be summarized that geopolymer concrete made with fly ash, GGBFS and alkali activator will provide excellent strength than conventional OPC based concrete. It also helps to reduce the environmental problems caused due to production of cement. Also, it can be said that bamboo is an excellent over steel as reinforcement in concrete due to its excellent durability and resistance to chemical attacks which can be identified by proper treatment of bamboo

B. Objective

One of the important construction materials around the world is CEMENT and due to its demand, its production has made it a significant source of global carbon dioxide emission. Cement production makes up approx. 2.5 percent of global co2 emission from industries. The process of making steel from low grade iron ore requires long mining crushing, separating, concentrating, mixing, pelletizing, and shipping. It requires heavy equipments and resources for mining. Also 98% of the mined iron ore is used in the production of steel and the quantity of iron ore in the environment is decreasing at a rapid rate

III. METHODOLOGY

The materials required for the work is collected. The initial test on the collected materials are done which includes

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specific gravity, sieve analysis, grading test, and consistency test was done. As per requirement mix design was determined.

With the replaced materials concrete paste was prepared and casting of 18 cube was done similarly cylinder and beam was done. The slab was designed and casted as per the mix design and curing was done.

Compressive strength test and flexural strength test was done on 7 th,14 th, 28 th day respectively and values were obtained. It was found that the strength increased on the 28 th day.

IV. MATERIALS REPLACED

A. Fly ash

Fly ash is the by product of coal combustion in industries that use coal powered boilers. When burning coal in boilers two types of ashes are produced one is which falls to the bottom of the boilers called bottom ash and the other type is captured by electrostatic precipitators and particle filters in the chimneys called fly ash.

B. Ground granulated blast furnace slag (GGBFS)

GGBFS is a by product of the iron industry it is obtained by quenching molten iron slag or iron waste in water. Upon quenching the material obtained is a glassy granular material which is later dried and crushed into a fine powder. molten metal which is then removed.

C. Alkaline Solution

Alkaline solution is a mixture of base solutions dissolved in water. Alkali solution plays an important part in the polymerization process.

Geopolymer

Geo polymer concrete is an inorganic polymer composite concrete made with the aim of reducing/replacing the quantity of cement used in concrete and to promote sustainable construction practices The geopolymer used in this project is a mixture of fly ash, GGBFS and alkali solution.

D. Bamboo

Bamboo is one of the largest members of the grass family. It grows long and has good strength due to this bamboo has been used in construction practices for centuries for scaffolding works, house construction etc. but ut was after It grows naturally and at a fast rate making it readily available. Due to the reducing steel quantity bamboo can be treated and used as a reinforcement material in place of steel.

V TEST ON MATERIALS

A. Test on cement

Specific gravity

Specific gravity of a material is the ratio between the weight of a given volume of material and weight of an equal volume of water. In this test firstly the flask is made dry and the weight of the flask is taken (w1). Then the flask is filled to about half with 50gm cement and closed with a stopper and its weight is taken as w2. Then kerosene is poured into the flask upto the top. This is mixed and again the weight is taken and noted as w3. Next the flask is emptied and filled with kerosene closed and its weighed and its weight is noted as w4

Consistency test

The standard consistency of cement is that consistency, which permit the vicat plunger to penetrate to a point from the bottom of the vicat mould when tested. In this test the vicat apparatus was placed on a level base. The top of the dashpot was unscrewed and the dash pot was filled upto half with any suitable oil of viscosity and the top was screwed. then the plunger is attached for determining standard consistency to the movable rod and plunger is worked for a number of times. 400 gm of cement was taken in a pan and a weighed quantity of water was taken in a beaker.. Plunger was gently lowered to touch the surface of the cement paste and quickly release, this operation was done immediately after filling the mould. Trial test specimens was prepared with varying percentages of water until plunger penetrates to a point 5 to 7mm from the bottom of the vicat mould, which is read on the scale. The water required is expressed as percentage by weight of the dry cement.

Fineness of Cement

100g cement which is free of lumps was taken and noted as W1. This 100g of cement was poured in 90 µm sieve and was closed with a lid. Now the sieve was shaken manually for around 15 minutes. After this the weight of the residue retained on the 90 µm sieve was taken as W2. Then the percentage of Wt of cement-retained on Sieve was calculated. Three samples were taken in the similar way and the average was taken.

B. Test on Fly ash

Specific Gravity

The specific gravity of fly ash was carried out in the same procedure as that of the specific gravity test conducted on cement

Fineness Test

Fineness test of fly ash was done in the same procedure as that of the fineness test conducted on cement

C. Test on GGBFS

Specific Gravity

The specific gravity of GGBS was carried out in the same procedure as that of the specific gravity test conducted on cement

Fineness Test

The fineness test of GGBS was carried out in the same procedure as that of the fineness test conducted on cement

D. Test on Coarse Aggregate

Grading of coarse aggregate

The aggregate is sieved using the appropriate sieves (80mm,63mm,50mm, 40mm,33.5mm,25mm, 20 mm,12.5mm, 10 mm, 5.75 mm). Then weight of aggregate retained on each sieve is recorded. Cumulative weight of aggregate retained on each sieve is calculated. Now the cumulative percentage of aggregate retained is calculated. Cumulative weight of aggregate retained is added and then the sum is divided by

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100. This value is termed as fineness modulus. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fineness modulus

E. Test on Fine Aggregate

Grading of Fine aggregate

The aggregate is sieved using the appropriate sieves (80mm,63mm,50mm, 40mm,33.5mm,25mm, 20 mm,12.5mm, 10 mm, 5.75 mm). Then weight of aggregate retained on each sieve is recorded. Cumulative weight of aggregate retained on each sieve is calculated. Now the cumulative percentage of aggregate retained is calculated. Cumulative weight of aggregate retained is added and then the sum is divided by 100. This value is termed as fineness modulus. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fineness modulus.

Composition Of Geopolymer

A mixture of ground granulated blast furnace slag (GGBFS), fly ash and an alkali solution is used the geopolymer in this project. The alkali solution has been prepared by mixing the 8M NaOH solution (prepared by mixing 320gms of NaOH in 1 litre of water) with the Sodium Silicate solution in the ratio 1:2.5. that is the 8M NaOH solution prepared by mixing 320gms of NaOH crystals in 1 litre of water is mixed with 800gms of Sodium silicate solution and is kept for 24 hours, this is the alkaline solution.

Reinforcement

A special type of bamboo known as 'KALLU BAMBOO' was taken for the project. It was found to be one of the strongest type of bamboo. 1 metre long bamboo peces were cut from a bamboo tree and this cylindrical piece was split into 6 pieces of 1 metre length. Then the bamboo pieces were dipped on copper sulphate solution for 7 days and sried in shade for 3 days to prevent various attack that may happen on the bamboo in the future.

F.Test On Fresh Concrete

Slump Test on Normal Cement Concrete

Concrete slump test or slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction.

Slump Test on Geopolymer Concrete

A mixture of ground granulated blast furnace slag (GGBFS), fly ash and an alkali solution is used the geopolymer in this project. The alkali solution has been prepared by mixing the 8M NaOH solution (prepared by mixing 320gms of NaOH in 1 litre of water) with the Sodium Silicate solution in the ratio 1:2.5.

G. Tests On Hardened Concrete

Compression Test on Normal Cement Concrete

In this test, we had tested cubes of 15cm×15cm×15cm of M20 grade concrete. The concrete was poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds were removed and these test specimens were put in water for curing. The top surface of these specimens was made even and smooth

Compression Test on Geopolymer Concrete

Geopolymer concrete is prepared in the above-mentioned procedure and was casted in the same procedure as that of normal cement concrete. These specimens were tested using compression testing machine in which some specimens were exposed to water curing and was tested at the end of 7,14 and 28days.

Split Tensile Test on Cement Concrete

Split tensile test on concrete is mainly carried out to determine the tensile strength of concrete. The below Fig.3.13 represent the split tensile test conducted on cement concrete. Initially, the wet specimen from water after 7 days of curing age were taken to find the tensile strength and the water from the surface of specimen is wiped off. The test was also done on 14 and 28 days

Split Tensile Test on Geopolymer Concrete

The split tensile test conducted on geopolymer concrete. Geopolymer concrete cube was prepared using the above procedure and the specimen was tested using the same procedure as that of the normal cement concrete.

Flexural strength test on cement concrete

Flexural strength test on concrete is mainly carried out to determine the Flexural strength of concrete. The Flexural strength test conducted on cement concrete. Initially, the wet specimen from water after 7 days of curing age were taken to find the tensile strength and the water from the surface of specimen is wiped off. After that, centre of the specimen was marked and the specimen is put on the flexural strength testing machine.

Fig. 1 Flexural strength

Flexural strength test on geopolymer concrete

The flexural strength test conducted on geopolymer concrete. Geopolymer concrete cube was prepared using the above procedure and the specimen was tested using the same procedure as that of the normal cement concrete.

TABLE 1. FLEXURAL STRENGTH

Type of concrete	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
Cement concrete	4.375	4.37	4.625
Geopolymer concrete	5	5.62	6.25

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CONCLUSION

Geopolymer concrete is a good construction material for the future. It can produce low cost, nontoxic concrete. It settles rapidly at room temperature without bleeding. Geopolymer concrete attains compressive strength rapidly and it attains full strength at 7ndays. This can be seen as geopolymer concrete attains double the compressive strength of cement concrete at 7 days. Also, the 28-day compressive strength has a large margin as compared with cement concrete.

Bamboo can carry greater loads then any type of wood of same cross-sectional area. It is a low cost easily available material that can be used to replace steel as reinforcement. The

only downside of bamboo is that it requires treatment for longer durability and to attain resistance to chemical attacks and insect attacks.

Bamboo reinforced geopolymer concrete (BRGC) slab has greater flexural strength than RCC slab. Brge slab also has more deflection tha rcc slab. RCC slab is good in resisting

shear crack and BRGC slab is better in resisting flexural crack. The use of geopolymer and bamboo can greatly reduce the cost of concrete and reduce the exploitation of natural resources.

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