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Experimental Investigation of Geopolymer Concrete by Replacing The Natural Coarse Aggregate Using Building Waste Material

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Abstract- Cement is the integral part of building material, is a binding agent that sets, hardens and adhere with building ingredients. Whether building a new plant or upgrading existing operations which grow emission and environmental impact like degradation of landscape, pollution of water resources and atmosphere is high on coarse aggregate usage. At the same time waste aggregate increased by construction and demolishing which dumped in landfills. The purpose of this paper is to conduct an experimental investigation on Geopolymer concrete which replacing a coarse aggregate. The geopolymer concrete reduced the emission and eco-friendly for the environmental condition. In the geopolymer concrete fly ash are used instead of cement which improves binding and strength added for the alkaline solution to make the gels and added to fine aggregate, recycled coarse aggregate. Finally investigated and compare the compressive strength and flexural strength have been to tested on normal & geopolymer concrete.

Keywords **- Geopolymer Concrete, Recycled coarse aggregate, Alkaline solution.**

I. INTRODUCTION

Coarse aggregates (CA) is the most important for the concrete, they are given to the compressive strength. The natural aggregate is currently used for the constructions 12 -14 million tonnes around the world. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well-known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC manufactured. The recycling potentials of construction and demolition (C&D) waste has encouraging minimization, reuse, recycling, and valorisation of the waste as opposed to its final disposal in landfills.Concrete recycling gains importance because it protects natural resources and eliminates the need for disposal by using the readily available concrete. However, most researchers have focused on the mechanical properties of recycled aggregate concrete as replacement the natural aggregates. Depending on the type of recycled aggregate and its strength, this kind of material might be

used to produceconcrete of comparable compressive strength to concrete made of natural aggregates as well as better fire resistance when crushed bricks and tiles are used. Fly ash is finely divided residue that results from the combustion of coal and transported by flue gas. fly ash of consistence quality is separated and stocked, and it is gaining popularity as a good pozzolanic material partial replacement of cement in concrete. Several studies have been carried out to reduce the use of Portland cement in concrete to address the global warming issues. These include the utilization of supplementary cementing materials such as fly ash, silica fume, granulated blast furnace slag, rice-husk ash and metakaolin, and the development of alternative binder.

Geopolymer concrete based on the industrial by-product materials such as fly ash and slag can play a vital role in the context of sustainability and environmental issues. Geopolymer concrete is an alternative concrete in which an alkali activated alum inosilicate material is used as the binder instead of the traditional cement binder. Geopolymer are very zeolites and can be progressed through a series of several distinct reaction processes from initial pozzolanic activation to final microstructure development.

In geopolymerization, alkaline solution plays an important role. The alkaline solutions are from soluble alkali metals that are either sodium or potassium based. The most frequent alkaline solution used in geopolymerization is a combination of sodium hydroxide or potassium hydroxide and sodium silicate or potassium silicate.Recycle Concrete Aggregate (RCA) is the main components of concrete and for many reasons there is a need to re-use them. It is better to the reuse of waste aggregates as recycled aggregates quantity of silica and alumina, it is suitable source to making the geopolymers. utilization of natural resources. fly ash that contains a large in structural concrete, instead

of propelling out as a total waste material. The use of recycled concrete aggregate has gained great momentum in constructional engineering.

II. LITERATURE REVIEW

The behavior of reinforced geopolymer concrete beam results were similar to that of members made of Portland cement concrete. Curtin research on fly ash-based geopolymer concrete is described in Research Reports 1]. Brooke et al., reported that the behaviour of geo polymer concrete beam column joints was similar to that of members made of Portland cement concrete. It was found that the application of geo polymer concrete structural members was correlated well with the OPC concrete. Fernández-Jim nez et al., the suitability of various types of fly ash to be geo polymer source material.

These researchers proved that to produce optimal binding properties, the low-calcium fly ash should have the percentage of unburned material (LOI) less than 5%, Fe2O3 content should not exceed 10%, and low CaO content, the content of reactive silica should be between 40-50%, and 80-90% of particles should be smaller than 45 µm. Van Jaarsveld et al (2003) found that higher compressive strength can be achieved by using fly ash with higher amount of CaO, in particular the formation of calcium aluminate- hydrate and other calcium compounds in the early ages. The other characteristics that influenced the appropriateness of fly ash to be a source material for geopolymers are the amorphous content, particle size, as well as morphology and the origin of fly ash.

Gourley et al., preferred the Low-calcium (ASTM Class F) fly ash as a source material than high calcium (ASTM Class C) fly ash. The (ASTM Class C) may interfere with the polymerisation process and alter the microstructure due to the presence of calcium in high amount. Swanepoel et al., (2002) conducted a study on geopolymers produced by mixing sodium silica solution, sodium hydroxide, fly ash, and water. Both the curing temperature and the curing time affected the compressive strength, and the optimum strength occurred when specimens were cured at 270C for a period of 28 days. Mohamed Mustafa Al Bakri et al., summarize the properties of fly ash based Geopolymer which make it better compared to normal concrete. The common materials used as alkaline solution in producing fly ash based geopolymer are sodium silicate and potassium hydroxide to produce the alkaline solution. The compressive strength increases with the increasing of fly ash fineness and thus reduction in porosity can be obtained. Fly ash- based Geopolymer is better than normal concrete in many aspects such as compressive strength, exposure to aggressive environment, workability and exposure to high temperature.

Vijaya Rangan et al., (2005) paper covers the materials and the mixture proportions, the manufacturing process, the fresh and hardened state characteristics, the influence of various parameters on the fresh and hardened state concrete, the utilization of the material in structural members, and the long term behaviour. Combination of sodium silicate and sodium hydroxide has been widely used as the alkaline activator. Fly ash based geopolymer concrete has excellent compressive strength and is suitable for structural applications.

III. MATERIAL PREPARATION

Concrete is to be suitable for a particular purpose, it is necessary to select the constituent material and combine them in such a manner as to develop the special qualities required as economical as possible. The selection of material and choice of method of construction is not easy, since many variables affected the quality of concrete produced, and both quality and economy must be considered should be evaluated in relation to the required quality for any given construction purpose. In this investigation, Fly Ash a by-product produced from thermal power plant was used as 100% replacement of cement. Fig.1 shown Fly ash is available in the form of dust. Their physical and chemical properties are given below. However, it is now known that the type of aggregate used for concrete can haveconsiderable effects on plastic hardened state properties of concrete.

Fig.1 Fly ash sample.

They can from 80% of concrete mix so their properties of concrete.They can from 80% of the concrete mix so their properties are crucial to the properties of concrete. most concrete practices only normal weight and light weight aggregates are uses, such as nuclear radiation shielding provided by heavy weight concrete and insulation using light weight concrete.

Table I Physical Properties Of Fly Ash

Properties	Value
Fineness Modulus	7.50
Specific Gravity	2.30

The physical properties and chemical properties of fly ash are shown in Table I and Table II respectively.Samples

shall be representative and certain precautions in sampling have to be made. No detailed procedure can be laid down as the conditions and situations involved in taking samples in the field can vary widely from case to case. Never the less, a practitioner can obtain reliable results bearing in mind that the sample taken is to be representative of the bulk of the material. The main sample shall be made up of portions drawn from different parts of the whole in the case of stockpiles, the sample obtained is variable or segregated, a large sample should be dispatched for testing.

Table 2 Chemical Properties of Fly Ash.

Chemical properties minimum % by mass	AS per IS : 3812-1981	Fly ash
SiO2+Al2O3+FeO3	70	90.50
SiO2	35	56
CaO	5	3.6
SO3	2.5	1.8
Na2O	1.5	2.0
MgO	5.0	1.93

IV.SIEVE ANALYSIS OF FINE AGGREGATE

A set of IS sieves 4.75 mm, 1.18mm, 600 microns, 300 microns,150 microns, is taken cleaned the seines by using brush and arranged one over the other is such a way that the largest sieve opening come at top placed receiver at bottom. Then a weighted 2000 grams of dry sand and put into the top most sieve.Then closed the top most sieves with a lid. The whole set of sieve shaped for15 minutes.

Fig.2 Sieve of Fine Aggregate

Then found the weight of sand retained on each sieve Figure 2 shown. The test is completed then calculated for the % of weight retained cumulative percentage of fine aggregate. This experiment studies the strength characteristic of geopolymer concrete that containing Recycled Concrete Aggregate (RCA). To produce geopolymer concrete in this study, materials which are FlyAsh, sodium hydroxide solution (NaOH) and sodium silicate solution (Na2SiO3), water, recycled concrete aggregate (RCA) and superplastisizer will used. The Aggregate Impact Value (AIV) and Aggregate Crushing Value (ACV) for the aggregate were tested.After casting for 24 hours, the moulded concrete was demoulded. The demoulded concrete specimens were cured at ambient condition. The curing time varied from 4 hours to 96 hours (4 days). After curing process, the concrete specimens were the compressive strength of the geopolymer concrete at the age of 3, 7 14, 21 and 28 days.

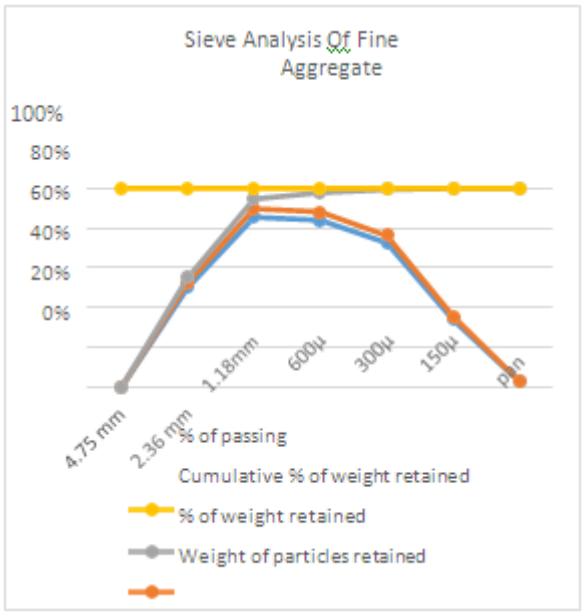

Fig.3 Sieve Analysis of Fine Aggregate.

Figure.3 shown the sieve analysis of fine aggregate and the fineness modulus is 4.31. specific gravity of fine aggregate take place by clean the pycnometer and dry it. Find the mass ml of the pycnometer brass cap and washer accurate to it. Take about 1/3 of over dried fine aggregate and put in the pycnometer brass cap and washer accurate.

Find the mass pycnometer + fine aggregate. Fill pycnometer with water to half it adds more water and still it replaces the screw top and fill the pycnometer flush with hole in theconical cup find the mass. Empty pycnometer clean it thoroughlyfill it with water to hole of conical cup, dry it and find the mass. Specific gravity of fine aggregate is 2.48. The sample shall be immersed in distilled water in a temperature between 220c and 320c with a cover of at least 5 cm of water abovethe top of pan. The sand shall remain completely immersed during the operation and for a period of 24 ± ½ hours after wards The sand is then placed on the dry cloth, transferring it to the second dry cloth. When the first will remove no further moisture. It shall then be spread out on the second cloth, and left exposed to the atmosphere away from direct sunlight or any other

source of heat for no less than 10 minutes or until it appears to be completely surface dry. The sand shall then be placed in the oven in the shallow tray, at a temperature of 100 c to 110 c and maintained at this temperature for 24 ± ½ hrs., it shall then be removed from the oven closed in the air tight container and weighted. Water absorption of Fine aggregate is 1.5%.

V.SIEVE ANALYSIS OF COARSE AGGREGATE

A set of IS sieves 20mm, 16mm, 12.5mm, 10mm, 6.3mm, 4.75 mm, is taken cleaned the seines by using brush and arranged one over the other is such a way that the largest sieve opening come at top placed receiver at bottom. Then a weighted 2000gms of dry aggregate and put into the top most sieve. Then closed the top most sieves with a lid. The whole set of sieve shaped for 15 minutes. Then found the weight of sand retained on each sieve. The test is completed then calculated for the % of weight retained cumulative percentage of coarse aggregate.

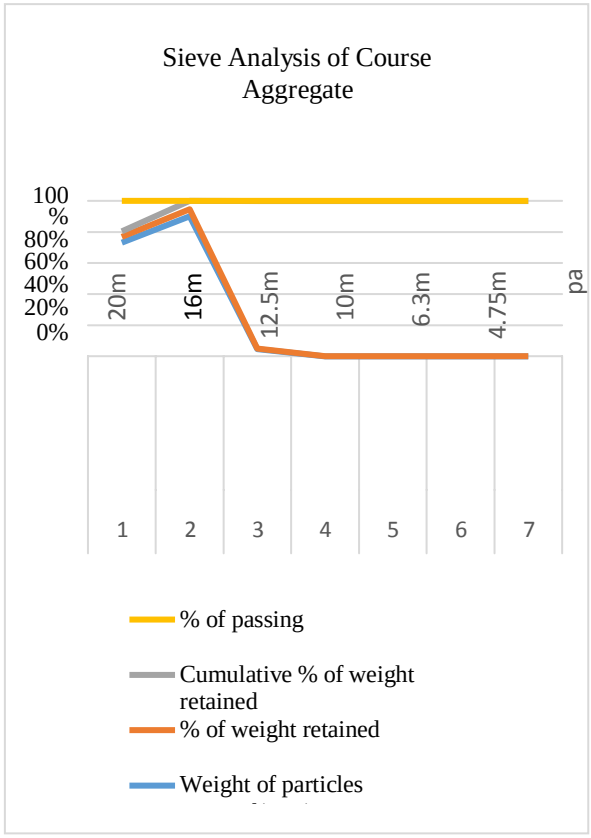

Fig.4 Sieve Analysis of Coarse Aggregate

Figure.4 shown the sieve analysis of coarse aggregate and the fineness modulus is 6.16. Clean the pycnometer and dry it. Find the mass ml of the pycnometer brass cap and washer accurate to it. Take about 1/3 of over dried coarse aggregate and put in the pycnometer brass cap and washer accurate. Find the masspycnometer + coarse aggregate. Fill pycnometer with water to half it adds more water and still it replaces the screw top and fill the pycnometer flush with hole in the conical cup find the mass. Empty pycnometer clean it thoroughly fill it with water to hole of conical cup, dry it and find the mass. Specific gravity of coarse aggregate is 2.97.

VI.OPC CONCRETE MIXTURE PROPORTIONING

Mix Design for M30 OPC Concrete Data are mentioned below Compressive strength at 28 days = 30 N/mm2
Maximum size of coarse aggregate = 20 mm Shape of coarse aggregate = Angular Degree of workability = Medium
Type of exposure = Moderate
Specific gravity of coarse aggregate = 2.97 Specific gravity of fine aggregate = 2.48 Specific gravity of cement = 3.15
Grade of cement = 43 Grade
Grading zone of fine aggregate = Zone II

VII.MIX DESIGN OF GEOPOLYMER CONCRETE

Unit weight of Geopolymer concrete = 2400 kg/m3
Aggregates = 75% of unit weight
= 75 % of 2400
= 1800 kg/m3
Coarse aggregate = 62 % of 1800
= 1116
kg/m3 Fine aggregate = 38 % of 1800
= 684
kg/m3 FOR M30 GRADE
Alkaline liquid to fly ash ratio by mass = 0.46 Mass of fly ash and liquid = 600 kg/m3
Mass of fly ash = 410 kg/m3
Mass of alkaline liquid = 190kg/m3

VII.CONCLUSION

Concrete is one of the usages for civil construction around the world is second only to water. Cement is conventionally used as the primary binder to produce the concrete. They are release large amount of carbon dioxide during the manufacture of ordinary Portland cement and coarse aggregate are must for concrete usage of natural aggregate. At the same time of a large number of old building and construction demolished waste to reduce the usage of natural aggregate. Geopolymer concrete used for construction field is to

improve the Eco–friendly and reduce the greenhouse gas emission. The various literature paper collected and studied. The material properties carried out for fly ash, fine aggregate, coarse aggregate and recycled coarse aggregate. The mix proportion of the geopolymer concrete was done.

VIII.SCOPE FOR FUTURE WORK

The present investigation focused only particular type of cement replacementmaterial. Hence investigation can be made on replacement of coarse aggregate material to study the physical and chemical properties. The fly ash add in the concrete may be varied and studies is made on workability strength and durability strength. To compare study on the conventional concrete and geopolymer concrete and replacement of the recycled building waste coarse aggregate. Studies on the future work (i) flexural strength of the concrete (ii) compressive strength of the concrete. This leads to the determination of the effective of replacement of coarse aggregate.

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