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Mechanical Properties of Geo Polymer Concrete

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Abstract- Concrete has occupied an important place in the construction industry in the past few decades and it is used widely in all types of constructions ranging from small buildings to large infrastructural dams or reservoirs. Cement is a major ingredient of concrete. The cost of cement is increasing day by day due to its limited availability and large demand. At the same time global warming is increasing day by day. Manufacturing of cement releases carbon dioxide. In the present study an attempt has been made on concrete and an experimental investigation on the concrete by replacing cement with FLYASH and GGBS to decrease the usage of cement as well as emission of carbon dioxide. Experimental studies were performed on plain cement concrete and replacement of cement with Fly ash and GGBS was done. In this study the concrete mix was prepared by using fly ash, GGBS, sodium silicate, sodium hydroxide. A comparative analysis has been carried out for concrete to the Geo polymer concrete in relation to their compressive strength, workability, tests on aggregate. The Geo- polymer concrete is an innovative and eco-friendly in construction. To reduce carbon dioxide emission, we are making geo-polymer concrete. The concrete made with fly ash (50%) and GGBS (50%) performed well in term of compressive strength, shows higher performance at the age of 7,14,28 days than conventional concrete. slump cone, compaction factor test was conducted to find the workability of Geo-polymer concrete and normal concrete. And test conducted on aggregate such as crushing strength, abrasion test, impact test.

Keywords- Fly ash, GGBS, sodium hydroxide, sodium silicate.

I. INTRODUCTION

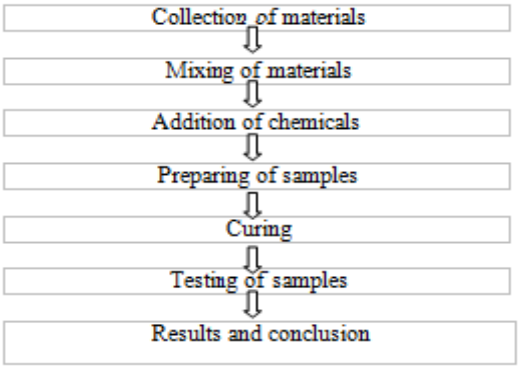
The major problem that the world is facing today is the environmental pollution. In the construction industry mainly the production of ordinary Portland cement (OPC) will cause the emission of pollutants which results in environmental pollution. Cement production is growing by 2.5% annually, and is expected to rise from 2.55 billion tons in 2006 to 3.7-4.4 billion tons by 2050.The emission of carbon dioxide during the production of ordinary Portland cement is tremendous because the production of one ton of Portland cement emits approximately one ton of CO2 into the atmosphere. On the other hand, the climate change due to global warming, one of the greatest environmental issues has become a major concern during the last decade. The global warming is caused by the emission of greenhouse gases, such as CO2, to the atmosphere by human activities. Although the use of Portland cement is still unavoidable many efforts are being made in order to reduce the use of Portland cement in concrete. These efforts include the utilization of supplementary cementing materials such as fly ash, silica fume, granulated blast furnace slag, rice-husk ash and finding alternative binders to Portland cement. In this aspect, the geo polymer technology proposed by Davidovits (1988a; 1988b) shows considerable promise for application in concrete industry as an alternative binder to the Portland cement. The role of binder in geo polymer concrete is replaced by fly ash and GGBS which also possess pozzolanic properties as OPC and rich with alumina and silicate. Fly ash is residue from the combustion of coal which is widely available worldwide and lead to waste management proposal. Hence, fly ash-based geo polymer concrete is a good alternative to overcome the abundant of fly ash In Geo polymer concrete, the silica and the alumina present in the source materials are first induced by alkaline activators to form a gel known as aluminosilicate. This gel binds the loose aggregates and other unreacted materials in the mixture to form the Geo polymer concrete. Besides that, the reaction also depends on a few parameters such as size of aggregates, chemical composition of fly ash and GGBS the curing process of geo polymer concrete play shows a great influence on the development of micro-structure, and subsequently on the mechanical characteristics of geo polymer.

OBJECTIVE OF GPC:

- To make concrete without using cement.

- To evaluate the optimum mix proportion of geo polymer concrete with Fly ash and GGBS replaced of cement.
- To study the different strength, durability properties of Ordinary and Geo polymer concrete.

II.METHODOLOGY



III.MATERIALS

Fly Ash

Fly ash is a recycling material which comes under sustainable development. Fly ash is a coal combusted residue and pulverized fly ash. It can be obtained from the coal industries from the boilers with fuel gases. Also Fly ash can be obtained from the coal related power plant industries. Fly ash has minerals components like Silicon dioxide (SiO2), Aluminum oxide (Al_2O_3), Ferric oxide (Fe_2O_3) and Calcium Oxide (Cao). Fly ash can be used as a Partial replacement material to the Portland cement and can be said to be Hydraulic Cement. As per American Society for Testing and Materials (ASTM) C618 Fly ash is classified into two classes. One is Class F - Fly ash and the other is Class C Fly ash. The difference between these two classes is the percentage of minerals present in it. Class F - Fly ash is made from the burning of older bituminous coal having less than 7% lime. Class C Fly ash can form as geo-polymer. Class C Fly ash is made from the burning of sub bituminous. It has some self-cementations materials. Class C Fly ash has lime content more than 20%.

Table 1. Chemical Composition Of Fly Ash

Chemical Composition	*Fly Ash* (%)
C	23.29
CaO	3.10
SiO_2	36.10
Al_2O_3	25.03
FeO	8.66
MgO	1.24
Na_2O	0
SO_3	0.59
TiO_2	0.91
K_2O	1.08
TOTAL	100.00

Physical Properties Of Fly Ash:

Table 2. Properties Of Fly Ash

Specific gravity	2.07
Fineness	290m^2/kg
Color	Light grey
Particle shape	spherical
Bulk density	1100-1200kg/m^3

Fig 1. Fly Ash

Ground Granualted Blast Furnance Slag (Ggbs)-

Slag is a by-product from steel plants obtained from blast furnaces, during the separation of iron from iron ore. The process involves cooling of the slag through high-pressure water jets, which enables the formation of granular particles. The granulated slag is further processed by drying and then grinding in a vertical roller mill or rotating ball mill or roller press to a very fine powder, which is called GGBS.

Table 3. Chemical Composition Of Ggbs

Oxide	Mass Percentage (%)
SiO_2	35.47
Al_2O_3	19.36
Fe_2O_3	0.8
CaO	33.25
MgO	8.69
Others	3.25

GGBS is wastes by product generated from the iron ore industry which can be replaced with cement in concrete for the increasing of workability and improve the strength and durability of concrete. GGBS is the mixture of iron ore, lime and coke together temperatures with a 15000C. Therefore, the material is called as blast furnace slag. GGBS can be used as a partial replacement of OPC cement in concrete production at batching plants. It is highly cementations and high in Calcium Silicate Hydrates (CSH) which is a strength enhancing compound which improves the strength, durability and appearance of the concrete. The main constituents of GGBS are Cao, SiO_2, Al_2O_3 and MgO. The chemical composition of a slag

varies considerably depending on the composition of the raw materials in the iron production process.

Table 4 Physical Properties Of Fly Ash

Specific gravity	2.6
Color	White
Surface moisture	Nil
Bulk density	1195kg/m3

Fig 2. GGBS

Fine Aggregate & Coarse Aggregate:
The sand which passes through sieve 4.75mm is fine aggregate. Usually, natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates.

- Specific gravity of fine aggregate is 2.415
- Fineness modulus for fine aggregate is 2.47

Fig 3. Fine Aggregate

Coarse Aggregate:
The aggregate which passes through 20mm sieve is collected. The broken stone is used as coarse aggregate.

Fig 4. Coarse Aggregate

Alkaline Activating Solutions
In geo polymerization, alkaline solution also plays an active role. The most common alkaline solution used in geo polymerization is a combination of sodium hydroxide or potassium hydroxide and sodium silicate or potassium silicate. The alkaline liquid was a combination of sodium silicate and sodium hydroxide. The sodium hydroxide (NAOH) was in flakes or pellets form and sodium silicate was in liquid form.

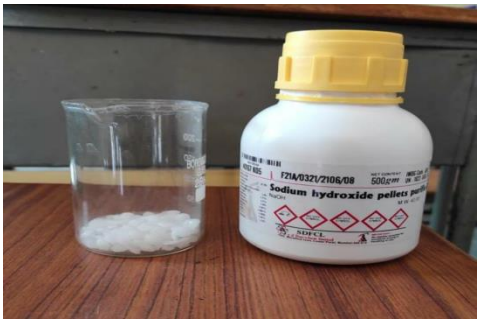


Fig 5 Sodium Hydroxide

Fig 6. Sodium Silicate

IV.MIX DESIGN

Table 5 MIX DESIGN

S.No	Materials	Kgs
1.	Fly Ash (50%)	0.68
2.	Ggbs (50%)	0.68
3.	Fine Aggregate	2.26
4.	Coarse Aggregate	4.11

V.EXPERIMENTAL WORKS

Fig. 8.Mix Of Gpc

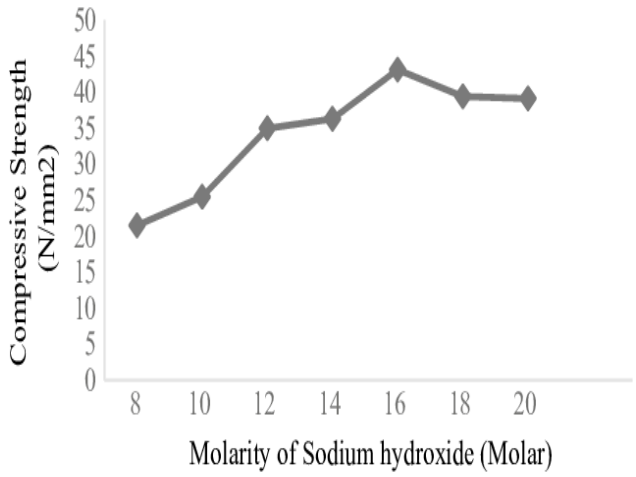


Fig.9 Effect Of Sodium Hydroxide On Compressive Strength

VI.EXPERIMENTAL TESTS

1.Impact Test

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Fig 11. Impact Test

2.Crushing Strenth Test

Fig 12 Crushing Strength Test.

3.Abrasion Value Test

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Fig 12. Abrasion Test

Slump Cone Test

Fig 13 Slump Cone

Compaction Factor Test

Fig 14 Compaction Factor

Compressive Strength Test

Fig 15. Compression Testing Machine

VII.RESULTS

Impact Value	26.67
Crushing Value	24.33%
Abrasion Value	51.3%

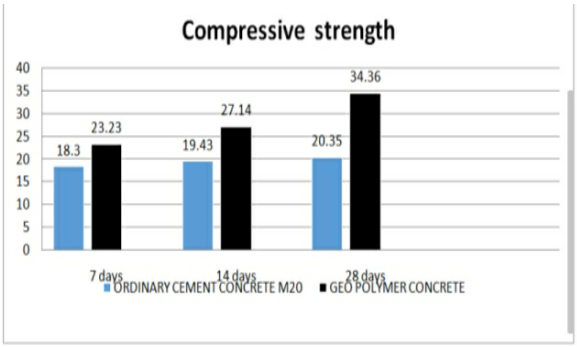

Fig.16 Compressive Value

VIII.CONCLUSIONS

The impact value of an aggregate is greater than 26.67% then it is used for constructing purpose.The crushing strength of an aggregate 24.33% used for the construction of building purpose. The abrasion value of an aggregate is 51.33% then it is used for constructing building purpose. The workability of geo polymer concrete is more than the normal concrete because of adding the GGBS as 50%. The compressive strength of geo polymer is increased than the normal concrete by the concentration of sodium hydroxide. Sodium hydroxide helps in increasing the compressive strength. The carbon dioxide emission will decrease by using geo polymer concrete.

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