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EXPERIMENTAL INVESTIGATION ON FLYASH BASED GEOPOLYMER CONCRETE WITH REPLACEMENT OF QUARRY DUST AS FINE AGGREGATE

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ABSTRACT

In India, natural river sand (fine aggregate) is traditionally used in concrete. However, growing environmental restrictions to the exploitation of sand from river beds leads to the research for utilization of an alternative material (industrial waste) for fine aggregates in the construction industry. This project investigates about using quarry dust as a fine aggregate replacement material, was tested as an alternative in geo-polymer concrete. This research work is concerned with experimental investigation on strength of geo-polymer concrete and optimum percentage of replacement by replacing fine aggregates from 10% to15%. In this project, materials were collected and tested for determination and comparison of material properties of fine aggregates and quarry dust. Concrete mixtures were produced, tested and compared in terms of workability and strength with the conventional geo-polymer concrete. Ambient curing method should be preferred in this research work. These tests were carried out to evaluate the mechanical properties for 7days, 14 days and 28 days.

Key words: Fly Ash, Aggregate, Quarry Dust, Geo-polymer concrete, Ambient Curing.

INTRODUCTION

Concrete is one of the most widely used construction material. Portland cement production is a major contributor to carbon-di-oxide emissions. The global warming is caused by the emission of greenhouse gases, such as carbon-di-oxide, to the atmosphere by human activities. Among the greenhouse gases, carbon-di-oxide contributes about 65% of global warming. 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 metakaolin, and finding alternative binders to Portland cement. In terms of reducing the global warming, the geo-polymer technology could reduce the carbon-di-oxide emission to the atmosphere caused by Cement about 80 %. Davidovits proposed that binders could be

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produced by a polymeric reaction of alkaline liquids with the silicon and the aluminum in source materials of geological origin or by-product materials such as fly ash and rice husk ash. He termed these binders as geo-polymers. In this project, the effort was made to study the strength parameters of fly ash based geo-polymer concrete.

To overcome the stress and demand for river sand, researchers have identified some alternatives for sand, namely scale and steel chips, waste iron, crushed granite fine, slag, quarry dust etc. The quarry dust were obtained from quarrying process, the amount produced depends on the rock type, amount of fragmentation by blasting and type of crushing used. Quarry dust is used to replace the fine aggregate some percentages in the production of concrete. It gives better strength. The characteristics of quarry dust were determined in the laboratory as per standard methods. Geo-polymer is inorganic binders, in which the Compressive strength depends on curing time and curing temperature. Geo-polymer concrete reduced CO2 emissions, and makes them a good alternative to ordinary Portland cement. Geo-polymer Concrete is Eco-Friendly. [7] discussed about amplifier power relation, impedance , T π and microstripline matching networks.

II MATERIALS USED

A. Fly ash

Fly ash is one of the most abundant materials on the Earth. It is also a crucial ingredient in the creation of geo-polymer concrete due to its role in the geo polymerization process. A pozzolan is a material that exhibits cementitious properties when combined with calcium hydroxide. Fly ash is the main by product created from the combustion of coal in coal-fired power plants. There are two “classes” of fly ash, Class F and Class C.Each class of fly ash has its own unique properties.

Fig 2.1 Fly Ash

B.Fine Aggregate

Fine aggregate is to make the concrete dense, by filling voids of coarse aggregate and reduce the Shrinkage of cement and makes an economical mix. Natural sand or crushed stone dust is used as a fine aggregate in concrete mix. Fine aggregate is passed through I.S sieve No.480 (4.75mm).

C. Coarse Aggregate

Crushed stone of size 20 mm are used as coarse aggregate. The ideal coarse aggregate should be clean, inert, cubical and

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angular. For this investigation locally available crushed angular aggregate is used.

D. Quarry Dust:

Quarry dust is a waste obtained during quarrying process. It has very recently gained good attention to be used as an effective filler material instead of fine aggregate**.** Crushed sand less than 4.75 mm is produced from hard granite rock using state of crushing plants. The amount produced depends on the rock type, amount of fragmentation by blasting and type of crushing used. The product is washed to remove excess fines to get sand of excellent shape and unwanted contamination.

Fig 2.4 Quarry dust

E. Alkaline Activators

A combination of alkaline silicate solution and alkaline hydroxide solution was chosen as the alkaline liquid. Sodium-based solutions were chosen because they were cheaper than Potassium-based solutions.

Chemicals

The chemicals used as alkaline activators are given below:

- Sodium Hydroxide
- Sodium Silicate
- Potassium Hydroxide
- Potassium Silicate

In this project chemicals are the very important constituents. Sodium Silicate and Sodium Hydroxide liquid are obtained commercially from local suppliers.

Sodium Hydroxide (NaOH)

The sodium hydroxide solids were of a laboratory grade in pellets form with 99% purity, obtained from local suppliers. The sodium hydroxide (NaOH) solution was prepared by dissolving the pellets (a small, rounded, compressed mass of a substance of sodium hydroxide) in water. The mass of sodium hydroxide solids in a solution varied depending on the concentration of the solution expressed in terms of molar, M. For instance, sodium hydroxide solution with a concentration of 8M consisted of 8x40 = 320 grams of sodium hydroxide solids (in pellet form) per liter of the solution, where 40 is the molecular weight of sodium hydroxide. The density of sodium hydroxide is 21 g/cc.During the boiling of sodium hydroxide process the amount of heat liberated should be 266 Cal/gr.

Sodium Silicate (Na_2SiO_3)

Sodium silicate solution (water glass) obtained from local suppliers was used. The

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chemical composition of the sodium silicate solution was Na_2O=8%, SiO_2=28%, and water 64% by mass. The mixture of sodium silicate solution and sodium hydroxide forms the alkaline liquid. Weight ratio and molar ratio of sodium silicate is 2. The reactions should be defined as hydration/dehydration, precipitation due to these reactions the silicate act as film binder, matrix binder and chemical binder. The combination of sodium hydroxide and sodium silicate act as catalytic.

III.MATERIAL PROPERTIES

The materials properties play an important role in the production of concrete. So the properties of materials used in this research work are given below in the tables. In this research work the materials we used as fly ash and quarry dust.

A: Physical Properties of Fly Ash

S.No	Properties	Result
1	colour	whitish gray
2	Bulk density(g/cm^3)	0.92
3	Specific gravity	2.2
4	Moisture (%)	3.90
5	Average particle size(µm)	6.92

B: Chemical Properties of Fly Ash:

S.No	Chemical composition	Percentage (%)
1	Silicon dioxide(SiO_2)	59
2	Aluminium Oxide(Al_2O_3)	21.00
3	Iron Oxide(Fe_2O_3)	3.7
4	CaO	6.91
5	MgO	1.4
6	SO_3	1.00
7	K_2O	0.90
8	loss on ignition (LOI)	4.62

C: Physical Properties of Quarry Dust

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IV MIX DESIGN

A.MIX RATIO

$NaOH – Na_2SiO_3$ ratio = 2.5

Molarity of NaOH = 8M

Fly Ash - Alkaline liquid ratio =0.4

Water – Geopolymer Solids ratio =0.3

B: TRAIL MIXES

Conventional Mix

G Mix 1[100% Fly Ash+100% Fine Aggregate+100%CourseAggregate]

Nominal Mix II

G1 - 100% Fly Ash + [10% Quarry Dust+ 90% Fine Aggregate] +100% Coarse Aggregate.

Nominal Mix III

G2 – 100% Fly Ash + [15% Quarry Dust+ 85%Fine Aggregate] +100% Coarse Aggregate.

V TEST ON CONCRETE

A.COMPRESSIVE STRENGTH TEST

S.No	Properties	Result
1	Specific gravity	2.6
2	Water absorption	0.6%
	Fly Ash	FA	CA
3	395	556.4	1241.6
1	Fineness modulus	1.41	3.27
4	Maximum size		4.75mm

The Compressive strength characteristics of the concrete is calculated for 7, 14, 28 days.
Compressive strength = P/A (N/mm^2).

P - Load (KN or N)

A - Area (mm^2)

VI RESULT AND DISCUSSION

COMPRESSIVE STRENGTH TEST RESULT (N/mm^2)

S.No	Mix	7 Days	14 Days	28 Days
1	G	17.23	28.56	39.76
2	G1	19.34	29.65	40.54
3	G2	23.75	31.86	42.98

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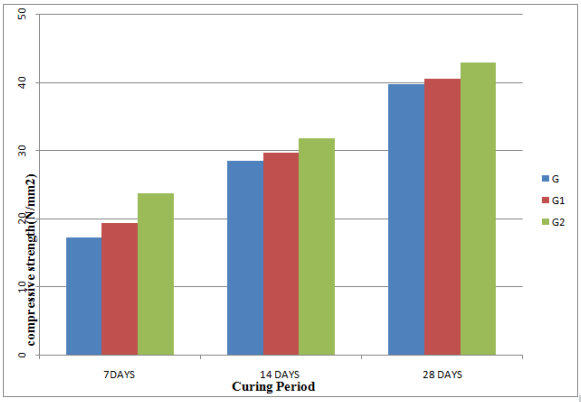

VII CONCULSION

1. Based on the experimental investigation quarry dust is the waste material which is cheap and easily available is made an effective alternative material for fine aggregate to use in concrete.

2. Compressive strength of geo-polymer concrete increases, increasing molarity of sodium hydroxide.

3. Use of quarry dust in concrete is economical.

4. The compressive strength of concrete reaches a satisfactory value at a replacement of 15% of quarry dust.

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