iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** VI **Month of publication:** June 2016

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Compressive strength of fly ash based Geopolymer concrete

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Abstract— The present paper is an effort to investigate the compressive strength properties offly ash based geopolymer concrete. Large scale production of cement is causing environmental problems. This has made the researchers to use supplementary cementatious material in making concrete. Fly ash obtained from thermal power plant is a waste material produced industry. Fly ash is used as filler material to way towards the waste utilization. M40 grade of concrete is used in the study and mix design was carried out according to guidelines10262 (2009). A constant 85% of fly ash was used as on cement replacement for all the mix. Compressive strength analysed by replacing cement by 85% of fly ash with alkaline solution (NaOH&Na2SiO3) with extra water and superplasticizers.

Keywords— Geopolymer concrete, Fly ash, Alkaline solution, Compressive strength, Superplasticizers.

I. INTRODUCTION

Concrete is the world's most versatile, durable and reliable construction material. Next to water, concrete is most used material, required large quantity of Portland cement. Ordinary Portland cement production is the second to the automobile as the major generator of carbon dioxide, which polluted the atmosphere .In addition to that large amount of energy was also consumed for the cement production. Hence, it is inevitable to find an alternative to the existing most expensive, resource consuming Portland cement, geopolymer concrete is an innovative construction material which shall be produced by the chemical action of inorganic molecules.Fly ash a bi-product of coal obtained from the thermal power plant is plenty available worldwide.Fly ash is rich in silica and alumina reacted with alkaline solution produced aluminosilicate gel that acted as the binding material for concrete. It is an excellent alternative construction material to the existing plain cement concrete. Geopolymer concrete shall be produced without using any amount of ordinary Portland cement.

Various studies have highlighted the potential application of fly ash geopolymer concrete because of its strength and durability in aggressive environment such as those containing sulphets and acids, or those subject to high temperatures. Fly ash geopolymers have greater durability than ordinary Portland cement (OPC) in such saver environments, which can be attributed to their lower calcium content. calcium is major component of OPC that reacts with aggressive sulphate and acids.

The alkaline liquids are from soluble alkali metals that are usually Sodium or Potassium based. The most common alkaline liquid used in geopolymerisation is a combination of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate or potassium silicate.

II. OBJECTIVES OF STUDY

A. To prepare mix design of M40 grade for Experimental Analysis with 85% fly ash and 15% cement with proper alkaline solution,water and super plasticizers.
B. To analyse compressive strength property of designed concrete mix.

III. MATERIAL ,ITS PROPERTIES AND METHODOLOGY

A. Materials

1) Cement: Ordinary Portland cement of 43 grade of conforming to IS 8112-1989 was used. Table 1 shows the physical properties.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table 1: Physical Properties of Cement

Properties	Result
Specific gravity	3.15
Standered concistancy	30%
Initial setting time	42 min
Final setting time	485 min
Fineness	5.4%

2) *Fly Ash:* Class *f* low calcium fly ash obtained from themal power plant was used for experimental work.Table 2 shows physical properties of fly ash.

Table 2: Physical properties of fly ash.

Properties	Result
colour	Blakish gray
Specific gravity	2.9
Fineness	430m^2/kg

3) *Fine Aggregate*: Natural river sand of size below 4.75mm conforming to zone II of IS 383-1970 was used as fine aggregate. Table 3 shows the Physical properties of fine aggregates.

Table 3: Physical properties of fine aggregates.

Properties	Result
Specific gravity	2.61
Fineness modulus	2.72
Bulk density (loose)kg/m^3	1560
Bulk density (compact)kg/m^3	1682
Water Absorption	1 %
Surface Moisture	Nil

4) *Coarse Aggregate:* Natural crushed stone with 20mm down size was used as coarse aggregate. Table 4shows the physical properties of coarse aggregates.

Table 4:Physical properties of coarse aggregates.

Properties	Result
Specific gravity	2.61
Fineness modulus	6.15
Bulk density (loose)kg/m^3	1470
Bulk density (compact)kg/m^3	1685
Water Absorption	0.5 %
Moisture content	Nil

5) *Alkaline Solution:*combination of NaOH and Na_2SiO_3 is used as a alakaline solution.The ratio of both solution taken as 1.Alkaline solution to fly ash ration was taken as 0.35.
6) *Water*: Potable water was used in this investigation for workability purpose only.
7) *Superplasticizers:* Superplasticizer used for the workability purpose.It was added by 2% of weight of fly ash.

B. Methodology

1) Collection of relevant research data from national and international journals, technical magazines, reference books and through internet.
2) In this present work fly ash material from industrial(thermal power palnt class f) west were used as geopolymer.

3) Testing has been done for concrete mixes of grade m40 with combinations of cement and fly ash as-15% & 85% respectively.

4) NaOH or KOH and sodium silicate or potassium silicate used as alkaline solution for geopolymerization.

5) After casting 24 hours oven curing has been done at 60^0 temperature.

6) After 24H oven curing of the geopolymer concrete specimens 28 days curing (open to atmosphere) is done.

7) Conclusions will be drawn from the results of analysis.

IV. LITERATURE REVIEW

M. I. Abdul Aleem,P. D. Arumairaj(2012): carried out study on 'Geopolymer Concrete' This paper briefly reviews the constituents of geopolymer concrete, its strength and potential applications. Concrete is the world's most versatile, durable and reliable construction material. Next to water, concrete is the most used material, which required large quantities of Portland Cement. Ordinary Portland Cement production is the second only to the automobile as the major generator of carbon di oxide, which polluted the atmosphere. In addition to that large amount Of energy was also consumed for the cement production. Hence, it is inevitable to find an alternative material to the existing most expensive, most resource consuming Portland Cement.Geopolymer concrete is an innovative construction material which shall be produced by the chemical action of inorganic molecules. Fly Ash, a by- product of coal obtained from the thermal power plant is plenty available worldwide. Fly ash is rich in silica and alumina reacted with alkaline solution produced aluminosilicate gel that acted as the binding material for the concrete. It is an excellent alternative construction material to the existing plain cement concrete.

Shankar H. Sanni, Khadiranaikar R.B(2012):carried out study on 'Performance of geopolymer concrete under severe environmental conditions' The geopolymer technology was first introduced by Davidovits in 1978. His work considerably shows that the adoption of the geopolymer technology could reduce the CO2 emission caused due to cement industries.

Geopolymers are members of the family of inorganic polymers. The chemical composition of the geopolymer material is similar to natural zeolitic materials, but the microstructure is amorphous. Any material that contains mostly silicon (Si) and aluminum (Al) in amorphous form is a possible source material for the manufacture of geopolymer. Met kaolin or calcined Kaolin, low calcium ASTM Class fly ash, natural Al-Si minerals, combination of calcined minerals and non calcined minerals, combination of fly ash and metakolin, combination of granulated blast furnace slag and metakaolin have been studied as source materials.

Prabir K. Sarker (2013):study on 'Fracture Behavior Of Heat Cured Ash Based Geopolymer Concrete.' Use of fly ash based geopolymer as an alternative binder can help reduce CO2 emission of concrete. The binder of geopolymer concrete (GPC) is different from that of ordinary Portland cement (OPC) concrete. Thus, it is necessary to study the effects of the geopolymer binder on the behavior of concrete. In this study, the effect of the geopolymer binder on fracture characteristics of concrete has been investigated by three point bending test of RILEM TC 50 – FMC type notched beam specimens. The peak load was generally higher in the GPC specimens than the OPC concrete specimens of similar compressive strength. The failure modes of the GPC specimens were found to be more brittle with relatively smooth fracture planes as compared to the OPC concrete specimens. The post-peak parts of the load–detection curves of GPC specimens were steeper than that of OPC concrete specimens. Fracture energy calculated by the work of fracture method was found to be similar in both types of concrete.

L.Krishnan,S.Karthikeyan (2014):carried out study on 'Geopolymer Concrete An Eco-Friendly Construction Material' The objective of this research work was to produce a carbon dioxide emission free cementious material. The geopolymer concrete is such a vital and promising one. In this present study the main limitations of fly ash based geopolymer concrete are slow setting of concrete at ambient temperature and the necessity of heat curing are eliminated by addition of Ground Granulated Blast Furnace Slag (GGBS) powder which shows considerable gain in strength. The Alkaline liquids used in this study for the polymerization process are the solutions of sodium hydroxide (NaoH) and sodium silicate (Na2Sio3). A 12 Molarity solution was taken to prepare the mix. The cube compressive strength was calculated for 12M solution for different mix Id i.e. F90G10, F80G20,F70G30, and F60G40 (Where F and G are, respectively, Fly Ash and GGBS and the numerical value indicates the percentage of replacement of cement by fly ash and GGBS).The cube specimens are taken of size 100 mm x 100 mm x 100 mm. Ambient curing of concrete at room temperature was adopted. In total 36 cubes were cast for different mix Id and the cube specimens are tested for their compressive strength at age of 1 day, 7 days and 28 days respectively. The result shows that geopolymer concrete cubes gains strength within 24 hours without water curing at ambient temperature.

Vaibhav A. Kalmegh, Dr. P.P.Saklecha, Prof.R.S.Kedar(2015) :paper on "Experimntal Study on Geopolymer concrete with fly ash" Cement is the important material for the constructions. But, ordinary Portland cement concrete structure emits large amounts of carbon dioxide, which results the global warming. Global warming is a big challenge for earth. Portland cement

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

industry is one of the largest producers of carbon dioxide. The production of one ton of Portland clinker produces approximately one ton of carbon dioxide. A need of present status is to find alternative binder system to make concrete. On the other scenario huge quantity of fly ash generated around the globe from thermal power plants and generally used as a filler material in low level areas. The main constituent of geo-polymer concrete is fly ash and alkaline solutions. Fly ash is the main by product created from the combustion of coal in coal-fired power plants. Geo-polymer is an inorganic alumina-Hydroxide polymer synthesized from predominantly silicon (Si) and aluminum (Al) materials of geological origin or byproduct materials such as fly ash. Geo-polymer is a type of alumino-hydroxide product having ideal properties of rock-forming elements. The main advantage of geo-polymer concrete is that it is eco-friendly.

V. MIX DESIGN

The M40 Mix proportion was designed as per guidelines, according to the Indian standard recommended method IS 10262-2009 and advances in structural engineering vol.3. The mix proportions was calculated and presented in Table 5.

TABLE 5:FONT SIZES FOR PAPERS

Sr.no.	Material	Quantity(kg/m^3)	Proportion
1.	Fly ash	425	1
2.	Cement	75	0.17
3.	Sodium hydroxide solution	87.5	0.20
4.	Sodium silicate solution	87.5	0.20
5.	Fine aggregate	602.6	1.41
6.	Course Aggregate	1240.22	2.91
7.	Water	110	0.25
8.	Extra water	12.71	0.029

VI. TEST AND RESULTS

Compressive strength of concrete is defined as the load, which causes the failure of a standard specimen.(Ex. 150 mm cube according to IS)divided by the area of cross section in uniaxial compression under a given rate of loading. The test of compressive strength should be made on 150mm size cubes. Nine specimens were used for compression testing for each batch of mix , 3 each to check 3days ,7days and 28days compressive strength of concrete. Clean and surface dried specimens were placed in the testing machine. The platen was lowered and touched the top surface of the specimen, the load was applied gradually and maximum load was recorded.

Total 6 no. of cube casted for this test.Testing was done for 7 and 28 days after proper curing of specimens.Table 6 shows test results.

Fig. 1 testing of geopolymer concrete

Table:6 Compressive strength for M40 concrete at 7th and 28th day.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
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Test.No.	Mix	Compressive strength in N/mm^2			
-	M 40	7 Days	28.26	28 Days	42.40
1.		27.2		42.3	
2.		29.43		43.52	
3.		28.15		41.4	

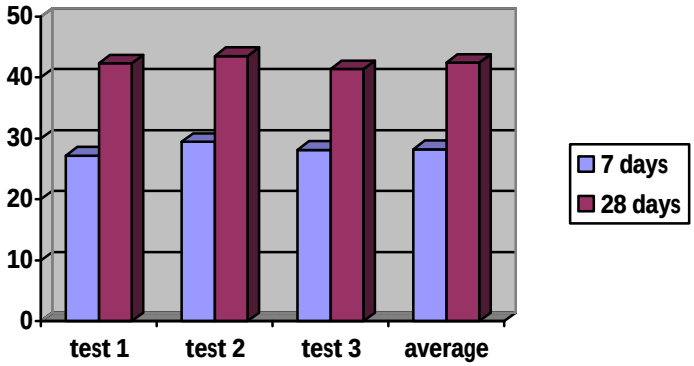


Fig. 2 graph for 7 and 28 days test results

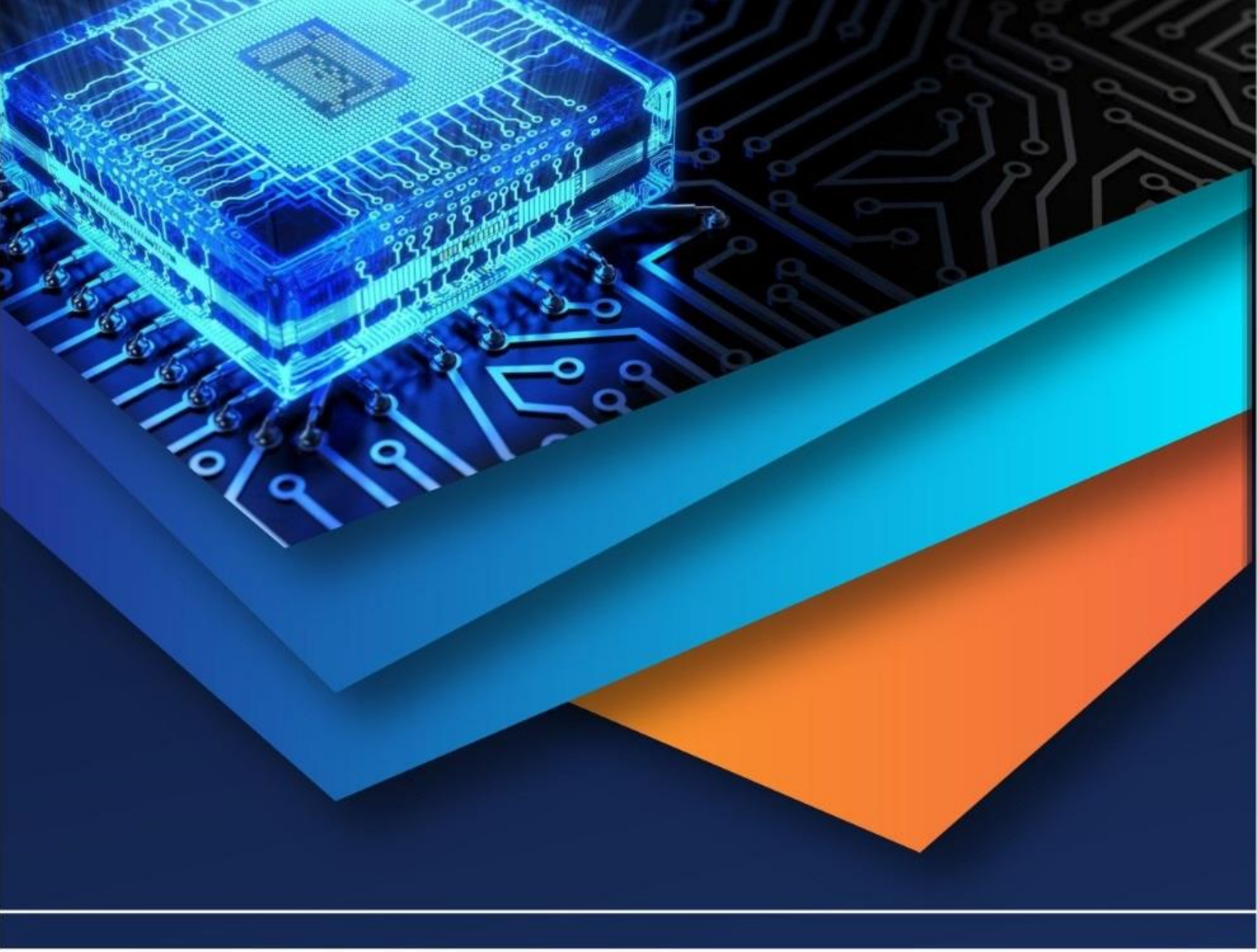
VII. CONCLUSIONS

Based on experimental investigation following conclusions are drawn-

A. 1Concrete mix which is designed by using 85% fly ash has medium workability.
B. For given replacement concrete giving about 67% results of standered value of strength i.e.28.26 Mpa.
C. Also 28 days results are very good i.e. 100% average strength is 42.40 Mpa.
D. By above results we can conclude that this concrete can be used for mass concrete work,as well as highway construction work.
E. We can replace fly ash about 85% by cement.
F. After satisfactory results of tesile and flextural test we can use this concrete for R.C.C. work.

REFERENCES

[1] Advances in structural engineering volume 3.
[2] Er.parag desai,deputy manager QC,ACC concrete,ACC limited,ACC thane complex,l.b.s. marg.thane 400604,india.paragdesai@acclimite.com
[3] Ict prague,Czech tu prague,(2006)"Mechanical and engineering properties of geopolymer materials based on alkali activated ashes".
[4] Olivia, Monita and Nikraz(2011)"Properties of fly ash geopolymer concrete designed by Taguchi method",Journel of engineering and technology research vol.3.
[5] Mohd Mustafa Al Bakri, H. Mohammed, H. Kamarudin(Jan.2011) "Review on fly ash-based geopolymer concrete without Portland cement" Journal of Engineering and Technology Research Vol. 3(1)
[6] Shankar H.Sanni,Khadiranaikar R.B.(Nov.2012) "performance of geopolymer concrete under severe environmental conditions" international journal of structural engineering.
[7] Prabir K. Sarker (Jan.2013)"Fracture properties of geopolymer concrete cured in ambient temperature" Materials and Design 44.
[8] l.krishnan l,s. karthikeyan, s.nathiya, k.suganya,knowledge institute of technology, salem.(June.2014)"Geopolymer concrete an ecofriendly construction material" international journal of research in engineering and technology vol.03.
[9] Vaibhav A. Kalmegh, Dr. P.P.Saklecha, Prof.R.S.Kedar-2015. "Experimntal Study on Geopolymer concrete with fly ash".
[10] Mohammed Areeb Qidwai -2015."to study the properties of geopolymer concrete using ggbs".



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