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AN EXPERIMENTAL INVESTIGATION ON GEOPOLYMER FLAT PANEL BY USING MINERAL ADMIXTURES

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• ***Abstract:*** Geopolymer concrete utilizes an alternate material including Red Mud and Rice Husk Ash as binding material in place of cement. This Red mud and Rice husk ash reacts with alkaline solution Sodium Hydroxide (NaOH) and Sodium Silicate (Na2SiO3) to form a gel which binds the fine and coarse aggregates. In this experimental carry on replacement of cement with red mud and rice husk ash in various percentages like (10% &90%,20% &80%,30%&70%) An attempt has been made to find out an optimum mix for the Geopolymer mortar. To determine the compressive strength of geopolymer mortar at 28days. This paper has focused on a study on geopolymer ferrocement flat panel in sunlight curing to eliminate oven curing **.**

***Keywords –* Geopolymer Mortar,Mineral Admixtures,Strength Property,ferrocement panel.**

I. INTRODUCTION

The history of aerated foam dates back to the early 1920s and the production of autoclaved aerated concrete, which was used mainly as insulation. A detailed study concerning the composition, physical properties and production of foamed concrete was first carried out in the 1950s and 60s. Foamed concrete typically consists of slurry of cement or fly ash and sand and water, with the foaming agent for very lightweight mixes. Fly ash which is also known as fuel as an by product of coal burning power plants can be used in place of Portland cement. Fly ash being a highly pozzolonic material can induce cementitious property and also proved to increase the workability in concrete therefore partial replacement is done in recent times. Basic research finding on application of foaming agent i.e., hydrogen peroxide in different percentage to the concrete mix consisting of GGBS, fly ash calcium hydroxide geopolymer binder is casted in the moulds of size 70.7*70.7*70.7mm3 in case of cubes and 160mm*40mm*40mm prisms subjected to 28 days of ambient curing. Different mix had been prepared by varying the fly ash percentage as binder1 80% of rice husk ash, 10% of red mud, 10% of Alkaline solution, Binder2 of 70% of rice husk ash, 20% of red mud, 10% of Alkaline solution. Binder3 of 60% of rice husk ash, 30% of red mud, 10% of Alkaline solution

1.1 GEOPOLYMER MORTAR:

Geopolymer is an eco friendly binding material alternative to Ordinary Portland Cement(OPC)**.**Geopolymer can be manufactured by using the low-calcium (ASTM Class F) fly ash obtained from coal-burning power stations. Geopolymer mortar is produced by mixing of flyash, alkaline solution and fine aggregate. Alkaline solution is composed of Sodium hydroxide (NaOH) and Sodium silicate solution. It is recommended that the alkaline liquid is prepared by mixing both the solutions together at least 24 hours prior to use.

1.2 FERROCEMENT

Ferrocement is a thin composite made with a cement based mortar matrix reinforced with closely spaced layers of relatively small diameter wire mesh.Ferrocement have several advantages like, fabricated into any desired shape, semi skilled labour requirement, ease of construction, low weight and long lifetime, low construction material cost and better impact and earthquake resistance.Ferrocement is a highly versatile construction material and possess high performance characteristic, especially in cracking, strength, ductility, and impact resistance.

1.3 OBJECTIVES

- To study the mechanical properties of geopolymer mortar using mineral admixtures
- To investigate the flexural behaviour of geopolymer Flat shaped ferrocement panel

II. LITERATURE REVIEW

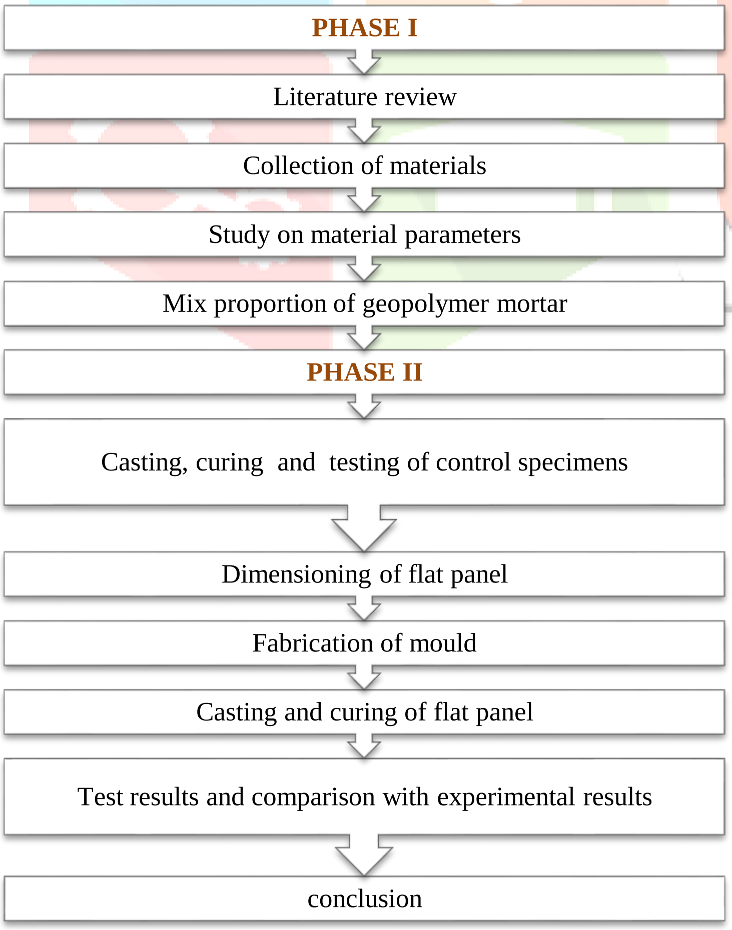
1. P.Rajeswaran, Dr.R.Kumutha, Dr.K.Vijai(2018). Mechanical properties of fly ash blended ceramic waste based geopolymeric binder. This study investigated the various combinations of Fly Ash, GGBS and Ceramic powder with Alkaline liquid . The properties of concrete determined as per relevant Indian and ASTM standards. The density of concrete cube specimens is within the range of 1943-2179 kg/m3. Geopolymer concrete cube specimens having higher density results in higher strength. The compressive Mechanical Properties of Fly Ash Blended Ceramic Waste Based Geopolymeric Binder strength of geopolymer concrete decreases with increases in quantity of Ceramic powder content. The geopolymer concrete cube specimen without ceramic powder produced the maximum strength among all the concrete specimens.

2. Z.Abdollahnejad,F.Pacheco-This paper investigated the joint effect of several mix parameters on the properties of foam geopolymers.The mix parameters analysed through a laboratory experiment of 54 different concrete mix This paper discloses results of a study that has investigated the joint effect of several mix parameters on the properties of foam geopolymer fly ash-based. The results shows that the sodium perborate over performs hydrogen peroxide leading to a lower overall thermal conductibility of foam geopolymer. The use of an activator/binder ratio of 0.8 and a sodium silicate/sodium hydroxide of 2.5 led to the lowest thermal conductivity.

3. M.W.Ferdous,O.Kayali and A.Khennane(2013) .This paper dealt with a mix design method for fly ash based geopolymer concrete has been proposed in a different approach. A mix design method for fly ash-based geopolymer concrete has been proposed in a different approach. Variable concrete densities, the effects of the ingredients' specific gravities, contributions of air volume, flexibility to improve the workability of fresh concrete. Experimental results showed that the compressive strength of the fly ash-based geopolymer concrete decreased linearly with increases in the water-to-geopolymer solids ratio..This observation was in agreement with the basic principles of ordinary Portland cement mortar, the strength of which decreases with increases in the water-cement ratio.

4. Subhash V. Patankar,Yuwaraj M.Ghugal and Sanjay S.Jamkar(2015).This paper proposed the guidelines for the design of fly ash based geopolymer concrete of ordinary and standard grade as mentioned in IS 456:2000.This paper proposed the guidelines for the design of fly ash based geopolymer concrete of ordinary and standard grade on the basis of quantity and fineness of fly ash, quantity of water and grading of fine aggregate by maintaining water- to-geopolymer binder ratio of 0.40, solution-to-fly ash ratio of 0.35, and sodium silicate-to-sodium hydroxide ratio of 2 with concentration of sodium hydroxide as 13 M. Heat curing was done at 60 °C for duration of 24 h and tested after 7 days after oven heating. Experimental results of M20, M25, M30, M35 and M40 grades of geopolymer concrete mixes are used.

III. METHODOLOGY



3.DESIGN OF GEOPOLYMER CONCRETE MIX

3.1 SPECIFICATIONS

Geopolymer concrete ratio 1:2(Binder:Sand)
Binder (rice husk ash, red mud ,CaOH)
Alkaline solution ratio
sodium silicate/ =2.5
sodium hydroxide
Alkaline liquid to binder ratio 0.6

3.2 MIX DESIGN

Unit weight of Geopolymer concrete = 2100kg/m3
(Binder+Fine aggregate+alkaline liquid)
Rice husk ash ash :Fine aggregate =1:2
Alkaline liquid to concrete ratio by mass = 0.6
Binder:Alkaline Liquid:Fine Aggregate =1:0.6:2=3.6
Mass of binder =2100/3.6
=583.33kg/m3
Mass of Alkaline liquid =583.33x0.6
=350kg/m3
Fine Aggregate =583.33x2 =1166.66kg/m3
Ratio of sodium silicate to NaOH = 2.5
Mass of NaOH = 350/1+2.5=100 Mass of Sodium silicate solution =350-100=250

For R80M10C10

Rice husk ash(R80) =583.33x(80/100)
=466.66kg/m3
Red mud(M10) =583.33x(10/100)
=58.33kg/m3
CaOH(C10) =583.33x(10/100)
=58.33kg/m3

For R70M20C10

Rice husk ash(R70) =583.33x(70/100)
=408.33kg/m3
Red mud(M20) =583.33x(20/100)
=116.66kg/m3
CaOH(C10) =583.33x(10/100)
=58.33kg/m3

For R60M30C10

Rice husk ash(R60) =583.33x(60/100)
=349.99kg/m3
Red mud(M30) =583.33x(30/100)
=174.99kg/m3
CaOH(C10) =583.33x(10/100)
=58.33kg/m3

3.3 NOMENCLATURE

R80M10C10 - Binder of 80% of Rice husk ash, 10% of Red mud, 10% of Calcium Hydroxide.
R70M20C10 - Binder of 70% of Rice husk ash, 20% of Red mud, 10% of Calcium Hydroxide.
R60M30C10 - Binder of 60% of Rice husk ash, 30% of Red mud, 10% of Calcium Hydroxide.

3.4 MIX PROPORTION

Proportion of Binder	Rich husk ash kg/m3	Red mud kg/m3	CaOH kg/m^3	Sand kg/m^3	NaOH kg/m^3	Na_2SiO_3kg/m^3	Alkaline liquid kg/m^3
R80M10C10	**466.66**	**58.33**	**58.33**	**1166.6**	**100**	**250**	**350**
R70M20C10	**408.33**	**116.6**	**58.33**	**1166.6**	**100**	**250**	**350**
R60M30C10	**349.99**	**174.9**	**58.33**	**1166.6**	**100**	**250**	**350**

IV. RESULTS AND DISCUSSION

4.1 Compressive strength test

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. Compressive strength were performed on 70.7x70.7x70.7mm^3 concrete specimen. Compresessive strength for each mixture was obtained from an average of 3 cubic specimens.The specimens were tested at after 28 days of ambient curing using Compression Testing Machine of capacity 2000 kN.. The specimens were subjected to a compressive force at the rate of 132 kN per minute until the specimen failed

Table:4.1 Compressive strength test at 28 days

Mix Proportions	**Maximum ultimate load kN**			**Average ultimate load kN**	**Compressive Strength N/mm²**
	C1	**C2**	**C3**		
R80M10C10	92.5 .	73.5	81.7	82.56	17.52
R70M20C10	101.1	83.3	101.5	95.26	19.05
R60M30C10	107.8	108.5	99.3	105.2	21.04

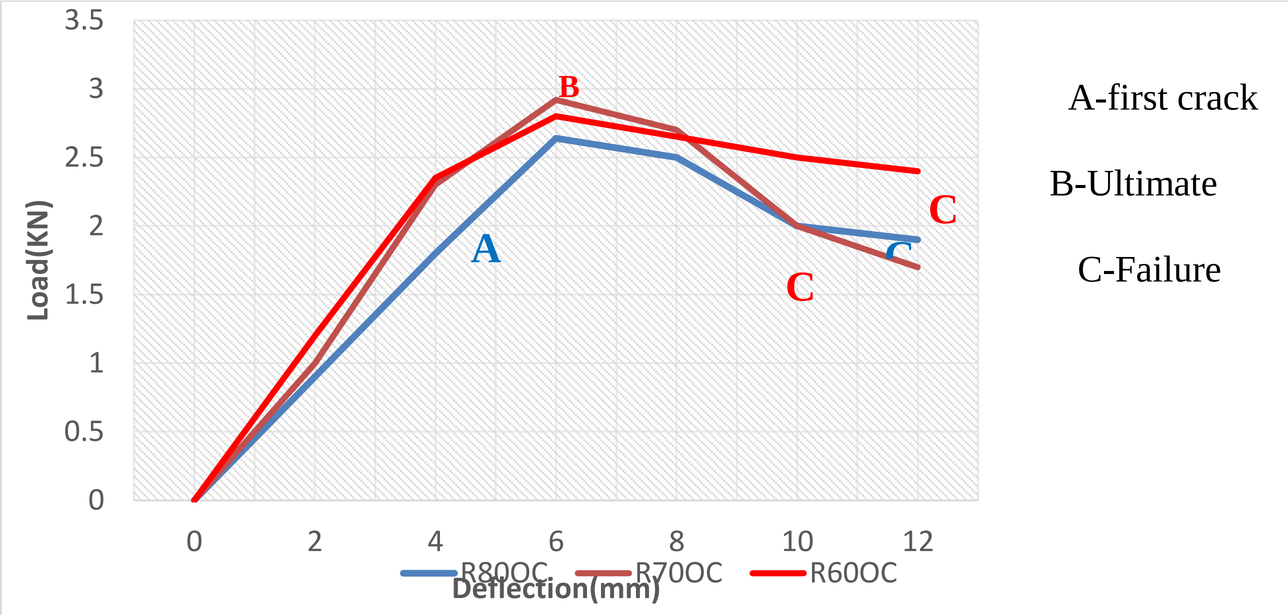
4.2 Flexural behavior on flat panel

Table: 4.2 Flexural behavior on flat panel

Specimen ID	***Cracking***		***Ultimate***		Failure	
	Load (KN)	***Deflection (mm)***	***Load (KN)***	***Deflection (mm)***	***Load (KN)***	***Deflection (mm)***
R80G10C10-OC	1.7	3.9	2.7	6.6	2	9.7
R70G20C10-OC	2.2	3.6	3.1	5.8	2.1	10.1
R60G30C10-OC	2.4	3.7	2.9	6.2	2.4	11.8
R80G10C10-SC	1.9	3.9	2.9	6.2	1.9	10.1
R70G20C10-SC	2.5	3.9	3.2	5.2	1.7	9.7
R60G30C10-SC	2.2	3.3	3	6.7	2.2	10.3

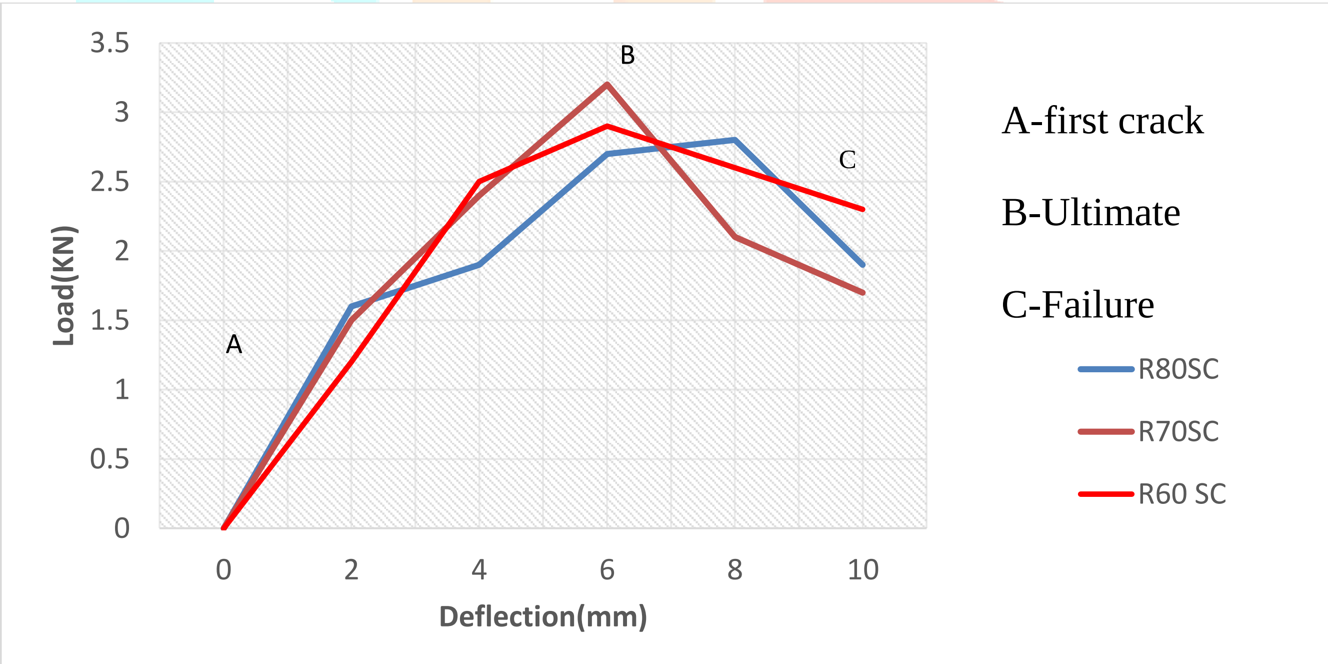
4.3 LOAD SEQUENCE VS DEFLECTION FOR OVEN CURING PANELS

Figure 4.3 LOAD SEQUENCE VS DEFLECTION FOR OVEN CURING PANELS



4.4 LOAD SEQUENCES VS DEFLECTION FOR PANELS UNDER SUNLIGHT CURING

Figure: 4.4 LOAD SEQUENCES VS DEFLECTION FOR PANELS UNDER SUNLIGHT CURING



V. CONCLUSION

- ✓ The test result of compressive strength at 28 days The compressive strength decrease with an increasing percentage of GGBS The compressive strength is increased with increase the quantity of GGBS content. Compressive strength of geopolymer mortar at 28 days ranges from R80G10C10 17.53 MPa. The R70G20C10 mortar mix obtained from maximum compressive strength of 19.05 MPa.The F60G30C10 mortar mix obtained from maximum compressive strength 21.04Mpa
- ✓ The experimental results shows that ultimate load carrying capacity of panels with single layer by 8%increase in term of ultimate load carrying capacity under oven curing
- ✓ The occurrence of first crack of fiber reinforced panels was delayed by 21%and 22% compared to panels with single layer meshes under oven curing and sunlight curing.
- ✓
- ✓ The sunlight curing method can be adopted for Geopolymer ferrocement panels which is more economical for precast elements and can eliminate the purpose of oven curing

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