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Experimental Study of Hollow Beam Using Concrete Geopolymer Concrete

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Abstract - The demand of concrete is increasing day by day for satisfying the need of development of infrastructure facilities. It is well established fact that the production of OPC not only consumes significant amount of natural resources and energy but also releases substantial quantity of carbon dioxide to the atmosphere. Therefore, it is essential to find alternatives to make the concrete environment friendly. Geo polymer is an inorganic alumino-silicate compound, synthesized from fly ash. The fly ash, one of the source materials for geo polymer binders, is available abundantly in India. Hence it is essential to make the efforts to utilize this by-product in concrete manufacturing. This investigation describes the experimental work conducted by casting 20 geo polymer concrete mixes to evaluate the effect of various parameters affecting the compressive cube size100 mm x 100mm x 100mm, Beam size100mm×150mm×1000strength in order to enhance its overall performance. The test results show that compressive strength increases with increase in the curing time, curing temperature, rest period, concentration of sodium hydroxide solution and decreases with increase in the ratio of water to geopolymer solids by mass & admixture dosage, respectively. The addition of naphthalene based superplasticizer improves the workability of fresh geopolymer concrete. It was further observed that the water content in the geopolymer concrete mix plays significant role in achieving the desired compressive strength. Geopolymer Concretes (GPCs) are a new class of concrete based on an inorganic alumino-silicate possessing the advantages of rapid strength gain, elimination of water curing, good mechanical and durability properties and sustainable alternative to Ordinary Portland Cement (OPC). This paper describes experimental investigation on behaviour of reinforced GPC beams subjected to monotonic static loading. The overall dimensions of the GPC beams. The specimens were produced from a mix incorporating Fly ash and GGBS, which was designed for a compressive strength of 40MPa at 28 days.

***Key Words*:** Geopolymer, alumino-silicate

1.INTRODUCTION

The Ordinary Portland cement is widely used in the construction industry all over the world. But the manufacturing of the cement has many disadvantages like liberation of high amount of carbon di-oxide leading to global warming and also disintegration of materials. Hence alternate materials like Fly-ash, Slag, and Silica fume etc. may be used in place of cement. The replacement may be either partial or full replacement. Making use of these waste materials effectively also reduces environmental pollution.

Geo-polymer cement is an innovative material and a real alternative to conventional Portland cement. Geo-polymers are a type of inorganic polymer that can be formed at room temperature by using industrial waste or by-products as source materials to form a solid binder that looks like and performs similar functions to OPC. Instead, the base material such as fly ash, that is rich in silica (SiO2) &aluminium (Al) is activated by alkaline solution to produce the blinder. Low calcium fly ash is used as the base material. The Geo-polymer paste binds the loose coarse aggregates, fine aggregates and other un-reacted materials together to form the Geo-polymer concrete. To know the behaviour of reinforced beams made out of Geo-polymer concrete and comparison of results with reinforced beams made out of OPC concrete beams. The Geo-polymer concrete beams and Ordinary Portland Cement Concrete beams will be subjected to loading and flexural behaviour and shear behaviour will be studied and compared..

2.PROPERTIES OF MATERILAS USED

2.1Cement

Ordinary Portland cement of 43 grade confirming IS 8112 : 1989 was used in the experimental work and properties as mentioned in the table below. The brand used is Dalmia cements obtained from the Salem locality.

Table: 1 Properties of Cement

S.No	Types of Test	Values obtained
1	Standard Consistency Test	31%
2	Specific Gravity	3.15
3	Fineness test	2%
4	Initial Setting Time	32min
5	Final Setting Time	260min
6	Soundness	3mm

2.2. Geo Polymer

GPC (GEO POLYMER CONCRETE)Geo-polymer cement is an innovative material and a real alternative to conventionalPortland cement. Geo-polymers are a type of inorganic polymer that can be formed at room temperature by using industrial waste or by-products as source materials to form a solid binder that looks like and performs. similar functions to OPC. Instead, the base material such as fly ash, that is rich in silica (si) &aluminum (Ai) is activated by alkaline solution to produce the blinder. Low calcium fly ash is used as the base material.

2.3. Silica Fume

Silica Fume used was confirming to ASTM-C(1240- 2000) and was supplied by ―ELKEM INDUSTRIES‖ was named Elkem-micro silica 920D. The Silica Fume is used as a partial replacement of cement. The properties of silica fume are shown below.

2.4.Fine Aggregate

The sand used for the experimental programme was locally procured and conformed to grading zone II as per IS: 383 (1970).The sand was first sieved through 4.75mm sieve to remove any practices greater than 4.75mm and then was washed to remove the dust. Properties of the fine aggregates used in the experimental work are tabulated below.

Table: 4 Properties of Fine Aggregate

S.No	Characteristics	Results
1	Grading Zone	Zone II
2	Specific Gravity	2.47
3	Water absorption	0.5%
4	Fineness Modulus	2.1
5	Moisture Content	Nil

2.5.Coarse Aggregate

In the present investigation, crushed hard blue granite aggregates were obtained from the locally available and approved quarries were used. Testing was done on the aggregates and the results were tabulated.

Table: 5 Properties of Coarse aggregate

S.No	Characteristics	Coarse Aggregate
1	Type	Crushed
2	Maximum size	20mm
3	Specific gravity	2.7
4	Total water adsorption	0.3%
5	Fineness Modulus	2.39
6	Impact value	13%
7	Crushing value	8%

2.7.Water

Potable tap water available in laboratory with pH value 6 to 8 and conforming to the requirements of IS: 456-2000 is used for mixing concrete and curing the specimens as well.

3.MIX DESIGN

The concrete mix is designed for **M40** Grade of concrete as per IS 10262 – 1982, IS 456- 2000 and SP 23 for the conventional concrete and finally cement has been replaced by Fly Ash and Silica Fume by volume.

Table: 7 Beam With hollow Cross section

Mix Id.	% of FA/GGBS In %	Fly Ash In kg/m³	GGBS In kg/m³	F.A kg/m³	C.A kg/m³	Water lit/m³	SP lit/m³	NaoH (kg/m³)	Na_2sio_3 (kg/m³)
NRB	--	--	--	648.14	1046.79	64.81	19.44	61.95	154.87
HGPRB1	50/50	10	10	648.14	1046.79	64.81	19.44	61.95	154.87
HGPRB2	60/40	12	8	648.14	1046.79	64.81	19.44	61.95	154.87
HGPRB3	70/30	14	6	648.14	1046.79	64.81	19.44	61.95	154.87

3.NUMERICAL RESULTS

3.2. Compressive Strength Results

The compressive strength is tested for the nominal concrete and different proportions of fly ash and silica fume. The test was carried out conforming to IS 516 - 1959 to obtain compressive strength of concrete at the age of 7, 28 and 90 days. . Cubes were casted in the size 150 x 150 x 150 mm. The results of compressive strength were presented in Table 8. The cubes were tested using Compression Testing Machine (CTM) of capacity 100 Tonnes.

Table: 9 Compressive Strength Results

Mix ID	Compressive strength (M Pa)			
	7 Days	14Days	21 Days	28 Days
NRC	25.30	30.25	34.55	37.40

3.3.Flexural Test Results

Flexural strength test were performed on the prism of size 500 x 100 x 100 mm. The results of flexural strength were presented in Table10. The test was carried out conforming to IS 516-1959 to obtain Flexural strength of concrete at the age of 28 days. The prism were tested using Universal Testing Machine (UTM) of capacity 100 tonnes .Ultimate Load 7.15 kN has beed Calculated

LOAD IN KN	DEFLECTION IN MM			
	NRB	HGPRB1 50/50%	HGPRB2 60/40%	HGPRB 3 70/30%
5	14.5	21	16.6	14.4
10	30	40	35	28
15	70	47	78	68
20	120	140	130	118
25	145	176	150	143
30	179	210	190	175
35	250	300	260	248
40	275	350	280	273
45	320	370	330	318
50	360	385	380	357
55	450	406	500	495

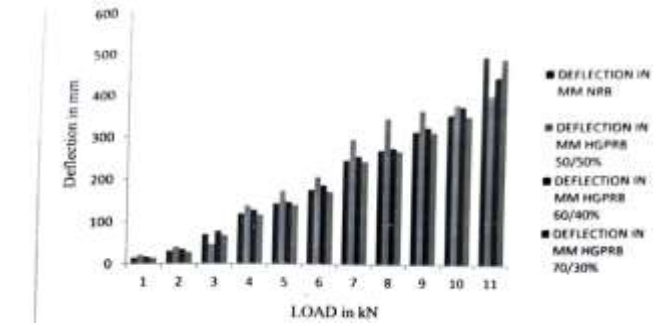
Table: 9 Flexural Strength Beam Results

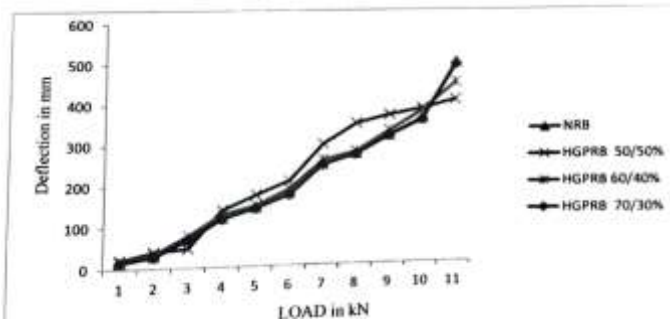
3.4.Fresh Concrete Test Results

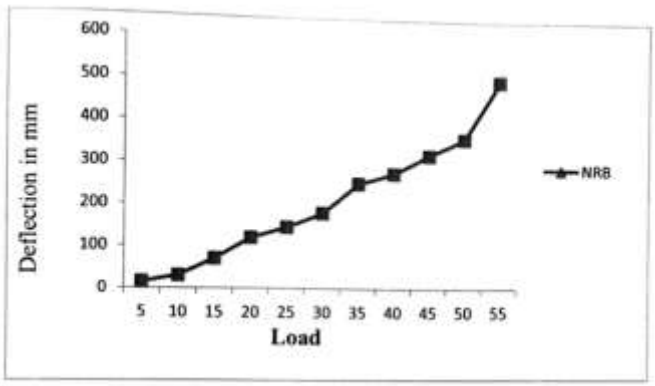
Table: 10 Fresh Concrete Results

MIX ID	Slump test (mm)	Unit weight (kg/m3)	Temperature (° C)
NRC	95	2433	28.5

3.5.Charts







4. CONCLUSIONS

The following conclusions can be drawn from the previous experimental investigations.

- The workability of concrete reduces with increase in volume. The maximum of volume that results in highly workable concrete is 1%, volume higher than 1% will have medium workable concrete. The slump of values of various mixture proportions provides an idea about the various workable limits of the proposed mixtures. The control mixwithout and the mix with 1% micro reinforcement are highly workable. The mixes containing further increased percentage of have medium workability. The slump of mix with 4% has slump magnitude of medium workability. The comparison of slump values of all proposed mixes is graphically shown in Fig..

- The unit weight of concrete increases with the addition of fibrvolume, it may be considered insignificant in altering unit weight of the concrete.The durability test analysis shows that the addition of fly ash and silica fume will have greater resistance to acid attack, which is given in the above result.

- Temperature of the fresh concrete may be reduced with addition of sit may be assumed that the steel are inert.

- Steel may be considered as a good supplement to the concrete for imparting good physical strength of the concrete. Strength and flexural strength of both the conventional mix and the replaced mix were compared.

- The Optimum percentage of steel that produces a good concrete with better physical strength is 3%, above which the strength of the concrete is getting reduced.

- The tensile strength of concrete can be increased by introducing steel in optimum percentages. The tensile strength of concrete members with 3% volume of is comparatively higher than 4% volume.

- The flexural rigidity of beam members can be increased by adding steel in optimum quantities. The flexural strength of the beam with 3% volume of steel is showing good flexural rigidity, above or below this volume of percentage, the flexure strength is comparatively less

- The impact strength and impact energy of concrete increases with increase in volume up to 3%. The number of blows required for first visible crack and number of blows for complete failure may also be increased by addition

This study is mainly aimed at strength and impact response of concrete flexural members with micro reinforcement. The experimental test results show that the addition of micro reinforcement to the concrete increases the physical strength and impact strength. The optimum content that can be added to the concrete without altering the strength parameters is 3%. The concrete members with 4% micro reinforcement volume are showing a comparative reduction in strength

REFERENCES

[1] j. Davidovits, (1991) "geopolymers: inorganic polymeric new materials". Journal of thermal analysis, 1991, 37, p1633-1656.

[2]. p. Duxson, a. Fernandez Jimenez, J.L. Provis, G.C. lucky, a. Palomo, j. Van Deventer, (2007) "geopolymer technology the current state of the art". Journal of materials science,

[3]. C. Shi, P. Krivenko and D.M. Roy, (2002) alkali-activated cements and concretes, Taylor and Francis, Abingdon, UK

[4]. 1. Turner and f. Collins "geopolymers: a greener alternative to Portland cement?" Concrete inAustralia vol 38 no 1 p49-56

[5]. Provis, JL., van Deventer, JSJ.Krivenko, PV.(2003) "Characterization of slag concretes", ACIMaterials journal, 2003.

[6]. Provis, JL., Van Deventer, JSJ.(2003) (Editors), geopolymers: structures, processing, properties, andIndustrial applications. Cambridge: wood head publishing limited.

[7]. E. Gartner, (2004) "industrially interesting approaches to "low-co2" cements". Cement and concreteResearch, 2004, 34, p1489-1498.

[8]. W. Phair, (2006) "green chemistry for sustainable cement production and use". Green chem., 2006, 8, P763-780.

[9]. Concrete institute of Australia recommended practice (2011)-geopolymer concrete z16 (2011)

[10]. Pan z., SantayanaJG., RanganBV., (2011) "fracture properties of geopolymer paste and concrete", Mag of concrete research October 2011

[11]. Standards Australia, (2010), "as 3972-2010 general purpose and blended cements". Sydney: Standard Australia.

[12]. Astminternational, (2010) astm c595/c595m 10 standard specification for blended hydraulicCements, astm volume 04.01, September 2010

[13]. Rangaraj. (2000) cement. Composition, specifications and conformity criteria for low heatCommon cements

[14]. Vicroads(2010) section 703 - general concrete paving

[15]. T. Kishi (2010) "crack self-healing behaviour of cementations compositesIncorporating various mineral admixtures" journal of advanced concrete technology vol. 8, no. 2,