NOVATEUR PUBLICATIONS
International Journal of Research Publications in Engineering and Technology [IJRPET]
ISSN: 2454-7875
VOLUME 3, ISSUE 7, July-2017

EXPERIMENTAL EXPLORATION OF ASPECT RATIO ON FLEXURAL STRENGTH OF STEEL FIBER REINFORCED GEOPOLYMER CONCRETE

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ABSTRACT:

The experimental study is to examine the influence of the aspect ratio on the steel fiber reinforced geopolymer Concrete Geopolymer blends were prepared with fly ash and activated alkali solution (NaOH and Na2SiO3) 0.35 ash solution. Steel fiber hook machines with a ratio of 30, 60 and 90 with a volumetric fraction of 0.0%, 0.25%, 0.50%, 0.75% and 1.0% by weight of conventional geopolymer gecko. The size of the beam of 100 mm x 100 mm x 500 mm for flexural strength tests of all samples were cured for 28 days with a different percentage of fiber and it was found that reinforced concrete reinforced concrete greatly improved resistance. It has been found that the optimal fiber content compensates for the fraction of volume of 0.75% and the aspect ratio 90 for the flexural strength of the beam. It has also been observed that an increase in fiber content at an optimum value increases the strength of the concrete.
KEYWORDS: Alkaline solution, Fly ash, hooked steel fiber, Flexural strength, GPC.

I. INTRODUCTION:

In this modern age of civil engineering works have their design and durable requirements, each design has its purpose and, consequently, to achieve this goal, a change in traditional concrete has become mandatory. Geopolymer - a new development in the world of concrete, where cement is completely replaced with pozzolanic materials such as fly ash and highly alkaline activated solutions, which act as binders in the concrete mix. Geopolymer is an inorganic polymer. Joseph Davidovits in 1978 proposed the use of an alkaline liquid for interaction with silicon (Si) and aluminum (Al) as a source of geological raw material. Since the chemical reaction that occurs, in this case, is the polymerization process, and are precursors of geological origin, such binders have been mentioned as geopolymer. Geopolymer cement is becoming increasingly important all over the world, as carbon emissions and subsequent global warming have become a major problem for all countries in the world. A tone of cement leads to the release of a carbon dioxide. The most common alkaline liquid used in geopolymerization is a combination of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate or potassium silicate. Alkaline hydroxide solution and sodium silicate are cheap and available locally. To focus on the use of concrete fiber fibers, a pilot program to study the properties of materials and structural components has been designed, such as beams. Here, in this article, we report on work with materials and structural features. In this pilot study, concrete structural properties have been identified.

II. MATERIAL USED:

(A)FLY ASH: Fly ash (FA) is a by-product when burning pulverized coal in thermal power plants. This is a granular material, mealy and solid particles that are collected in the exhaust gases. The particle size is largely dependent on the type of dust collection equipment. The diameter of the fly ash particles ranges from less than 1 μm to 150 μm. It is usually thinner than Portland cement. Their surface is usually from 300 to 500 m2 / kg, although some of the fly ash may have surfaces exceeding 200 m2 / kg and up to 700 m^2/kg. However, the effect of increasing the specific surface area is greater than 600 m^2/kg is considered insignificant.

(B)AGGREGATE: A large aggregate is selected from IS 2386 (Part I) 1963, the characteristics of the cumulative surface structure are classified as in IS 383-1970 [3]. They used coarse aggregates consisting of different sizes of 20 mm, 12 mm with a size module from 8.04 of a density of 1578 kg / m3 and a specific gravity of 2.74. Sand is used as a fine aggregate and is collected from a neighboring area. The sand sifts 4.75 mm sieve, having a specific gravity of 2.62 and a 3.14 finish was used.

(C)ALKALINE ACTIVATORS: Alkaline solution plays most vital role in geopolymerization method. The mixture of sodium silicate and sodium hydroxide solutions are designed for the activation of fly based geopolymer concrete. The molarities used for mixing of NaOH are 13M. It means 13 part of NaOH pellets is to be added in distilled

water. When mixed and stimulated gradually an exothermic reaction takes place and great amount of heat is evolved. The mix solution is left for settling down for 24 hours. The NaOH solution and sodium silicate solution were made separately and mixed together at the time of casting.

(D)STEEL FIBER: In this work, steel fiber having geometry of cylindrical with curved ends was used. The aspect ratio (l/d) of the steel fiber is 30, 60 and 90 respectively. The tensile strength is about 1100 MPa. l/d=30, l/d=60 and l/d=90 as shown in fig. 1.

(A)FLY ASH: Fly ash (FA) is a by-product when burning pulverized coal in thermal power plants. It is a fine-grained material in the form of particles, and a powdered glass that collects exhaust gases from electrostatic precipitators or bag filters. When the pulverized coal burns with the release of heat, the residue contains 80% ash and 20% ash bottom. The particle size is largely dependent on the type of dust collection equipment. The diameter of the fly ash particles ranges from less than 1 μm to 150 μm. It is usually thinner than Portland cement. Their surface is usually from 300 to 500 m^2/kg, although some of the fly ash may have surfaces exceeding 200 m^2/kg and up to 700 m^2/kg. Nevertheless, the effect of increasing the specific surface area of more than 600 m^2/kg is considered insignificant.

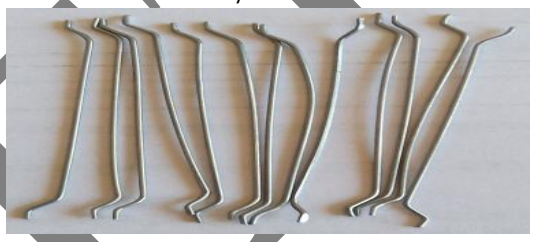
(B)AGGREGATE: The coarse aggregate is selected by shape as per IS 2386 (Part I) 1963, surface texture features of aggregate is classified as in IS 383 – 1970[3]. Coarse aggregates encompassing of different sizes 20mm, 12mm, 6mm having fine quality modulus of 8.04 bulk density of 1578 kg/m3 and specific gravity of 2.74 were used. The sand is used as fine aggregate and it is poised from nearby area. The sand has been filtered in 4.75 mm sieve having specific gravity of 2.62 and superiority of 3.14 was used.

(C)ALKALINE SOLUTION: Alkaline solution acts most significant role in geopolymerization development. The alkaline liquid used was a mixture of sodium silicate and sodium hydroxide solution. The molarities used for mixing of NaOH are 8M. It means 8 part of NaOH pellets is to be added in distilled water. When diversified and stirred gradually an exothermic reaction takes place and extreme amount of heat is evolved. Hence for safety hand gloves are used. The mix solution is left for flustering down for 24 hours. The NaOH solution and sodium silicate solution were prepared distinctly and mixed composed at the time of casting.

(D)STEEL FIBER: In this work, steel fiber having geometry of cylindrical with curved ends was used. The aspect ratio (l/d) of the steel fiber is 30, 60 and 90 respectively. The tensile strength is about 1100 MPa.

l/d=30

l/d=60



l/d=90

Fig. 1 Various aspect ratio of steel fiber

III. METHODOLOGY:

(A)MIX DESIGN:

Table 1 Mix Proportions of M30

Ingredients	Gpc	Gpc1	Gpc2	Gpc3	Gpc4
Fly ash	6.9	20.65	20.60	20.54	20.49
NaOH	1.21	3.62	3.62	3.62	3.62
Na_2SiO_3	1.21	3.62	3.62	3.62	3.62
Fine Aggregate	9.9	29.7	29.7	29.7	29.7
Coarse Aggregate	18.42	55.26	55.26	55.26	55.26
Total water	1.63	4.88	4.88	4.88	4.88
Extra water	0.28	0.85	0.85	0.85	0.85
Steel Fiber	0.0%	0.25%	0.50%	0.75%	1.0%

The mix design of Geopolymer concrete was adopted from S V Patankar et al. Mix proportions for characteristics strength of 40Mpa and mix proportion of conventional concrete are described in below table no.1.

(B)MIXING OF GEOPOLYMER CONCRETE: Solid components of the GPC mix that is Coarse aggregate fly ash is dried in a mixer to stir for about three minutes. After dry mixing, the dry mixture was added an alkaline solution, and wet mixing was performed for 3-4 minutes. Finally, additional water was added together with super fluidizing to obtain a GPC dough. The steel fiber is added to the mixture in different proportions, for example 0,25%, 0,50%, 0,75% and 1,0% by volume of the concrete.

Before the cast, the interior mold walls were covered with lubricating oil to prevent concrete examples from sticking. All samples were horizontally cut into three layers. Each layer was compacted using a tamping rad. The samples examined in this study consisted of 39 beam size 100 mm × 100 mm × 500 mm.

(C)CURING OF GEOPOLYMER CONCRETE: Setting the time of geopolymer concrete depends on many factors, such as the composition of the alkaline solution and the alkaline ratio of the liquid in the mass. When the polymerization temperature increases, setting time of concrete decreases. In the polymerization process Due to the temperature increase, the polymerization process becomes more rapid. The polymerization time can vary from 4 hours to 96 hours (4 days). The increase in the strength rate was rapid up to 24 hours of polymerization time; Within 24 hours, the gain of strength is only moderate. Thus, the curing time of the heat should not be more than 24 hours in practical applications after casting, the samples are placed inside the heat treatment chamber and cured at 80 ° C for 24 hours. After curing, the samples were removed from the chamber and allowed to dry at room temperature for an additional 24 hours prior to removal. The test samples were left in the laboratory environment until the day of the test.

IV. RESULT AND DISCUSSIONS:

FLEXURAL STRENGTH TEST RESULTS:

3.1 DENSITY:

Density of geopolymer concrete compounds is existing in Figure 1. Average density values of Geopolymer concrete complexes ranges from 2347 to 2448 kg/m^3 as shown in Table 2. As the age of concrete growths, there is a slight increase in the average density. The density of geopolymer concrete mixtures was found approximately equivalent to that of conventional concrete.

Table 2: Average density of geopolymer concrete composites

Sr. No.	Mix	Average density in kg/m3 28 Days
1	GPC	2312.75
2	GPC1	2312.75
3	GPC2	2329.06
4	GPC 3	2347.16
5	GPC 4	2384.20
6	GPC5	2378.77
7	GPC 6	2385.88
8	GPC 7	2396.05
9	GPC 8	2425.68
10	GPC 9	2408.89
11	GPC 10	2428.64
12	GPC 11	2443.45
13	GPC 12	2447.90

FLEXURAL STRENGTH:

Different mixtures up to 28 days of tensile strength are shown in Figure 2. Replacement of 100% OPC from fly ash in a gel permeation chromatography mixture resulted in higher resistance to bending. GPC of bending strength increases by about 17% with respect to the gel permeation chromatography mixture. With age, concrete increases from 28 days, a flexible composite without steel fibers. As the volume fraction increases from 0.25 to 1.0%, it increases the bending strength as compared to the control mixture. The increase in the break modulus was about 3%, 34%, and 44% for GPC1, GPC2, GPC3, and GPC4, respectively, with reference to gel permeation chromatography mixtures. Based on the results of the tests of this study, using the minimal regression analysis in the equation for predicting the bending strength of 28 days of geopolymerized reinforced concrete, the percent volume of fiber content (V_f) is obtained as the strength also increases for all mixtures. From the test results, you can see that the average strength of the geopolymer concrete containing steel fibers was better than that of a concrete

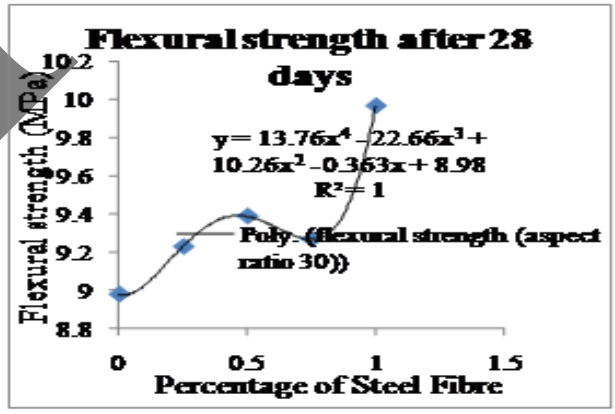
$$f_{fs} = f_{fo} + 3.36\ V_f$$

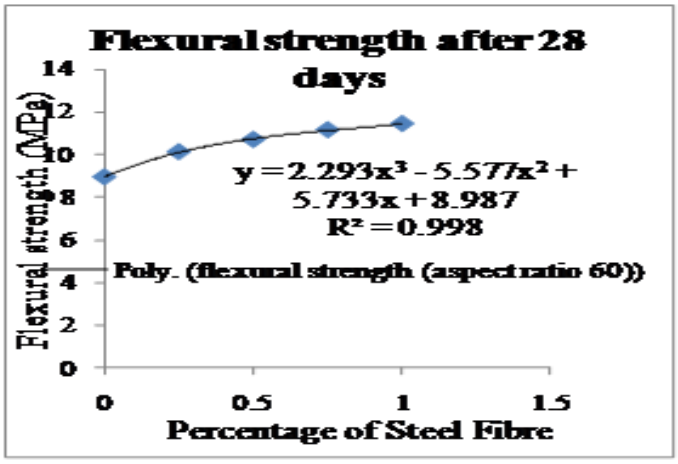
Where,

f_{fs} = 28 days flexural strength of steel fiber reinforced GPC

f_{fo} = 28 days flexural Strength of GPC

V_f = Percentage Volume fraction of steel fibers.





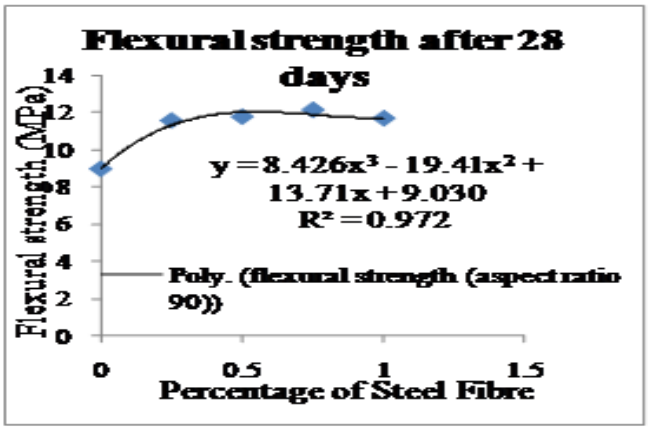


Fig. 2 Effect of addition of steel fibers on flexurals strength (l\d=30,60 and 90)

V. CONCLUSIONS

Following conclusions were drawn from the work carried out.

1. Optimum dry geopolymer density concrete after 28 days GPC12 verified in the mixture which is 244.90 kg / m^3.
2. The flexural strength of cement increases with increasing fiber content at an optimum value. It has been found that the optimal value of the flexural strength of concrete and reinforced concrete is 0.75%.
3. When samples of cement concrete samples tested showed the typical pattern of crack propagation, which led to beam split in two geometric shapes. But because of the addition of cement fiber cement fibers ceases, it leads to SFRC viscous behavior.
4. The results of the experimental study and mathematical analysis, almost equal because the regression analysis can offer to another class GPC.

ACKNOWLEDGMENT:

The authors would like to thank Prof. M. M. Pawar Head of the Civil Department and Prof. M. M. Deshmukh SVERI's college of Engineering Pandharpur, for their kind support and providing good infrastructure. The authors are also greateful to Prof. C. V. Naik and Prof. D. B. Kate for their encouragement and support.

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