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Enhancement of Compressive Strength, Split Tensile Strength and Flexural Strength of Geopolymer Concrete by Adding Polypropylene Fibers.

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ABSTRACT:

Geopolymer technology is nascent technology in the world of concrete in which hundred percent replacement of cement is possible with any other source material which is rich in silica and alumina. Rice husk ash, fly ash, ground granulated blast furnace slag (GGBS) are the alternatives to cement which are useful to form geopolymer concrete. At the same time abundant availability of fly ash and disposal problem of fly ash are major issues. Fly ash is a byproduct from coal based thermal power plants. At the initial stage, mix design of plain geopolymer concrete is done by testing various parameters. Sodium based alkaline solutions are used in the present research. Here, 100% replacement of cement is done with fly ash. Fly ash used is Pozzocrete 63.

Present research has Na_2SiO_3/NaOH ratio as 2.0. Molarity of NaOH is taken as 13 molar sodium hydroxide concentrations. Experimental studies are done with polypropylene fibers. In case of polypropylene, maximum strength is achieved at fiber addition of volume fraction of 0.2 % by mass of geopolymer concrete.

Keywords: Fly Ash, Alkaline Solution, Polypropylene Fibers, Geopolymer Concrete

INTRODUCTION

Strong desire of every human being is to live in healthy and pollution free environment which provides safety. Tremendous increase in growth of construction Industry is responsible for increase in demand of cement and hence, production of cement day by day is increasing. It is major factor responsible for global warming. The cement industry is responsible for about 7% of all CO_2 emissions because production of one ton of Portland cement emits approximately one ton of CO_2 into the atmosphere, heating of lime stone releases CO_2 directly. Geopolymer technology is new technology in world of concrete in which hundred percent replacement of cement is possible with any other source material which is rich in silica and alumina. As it is well known that, concrete expands and shrinks with changes in moisture and temperature, it forms cracks. Use of fibers in concrete has gained enormous popularity in the last decade. Balaguru P. N. and Shah S. P. have reported that addition of steel fibers in the concrete matrix improves all mechanical properties of concrete.

METHODOLOGY: Mix design of geopolymer concrete is summarized in Table 1 along with sodium silicate to sodium hydroxide ratio of 2.0.

Table 1
Mix Design of Geopolymer Concrete

Molarity of NaOH	Na_2SiO_3/ NaOH	Fly Ash kg/m^3	Fine Aggregate kg/m^3	Coarse Aggregate kg/m^3	NaOH kg/m^3	Na_2SiO_3 kg/m^3	Additional Water kg/m^3
13	2	420	668.81	1269.77	49	98	29.41

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Polypropylene fiber having diameter 10 µm & length 18 mm was used for study. Density of polypropylene fiber is 0.91 g/cc.

Table 2

Properties of Polypropylene Fibers

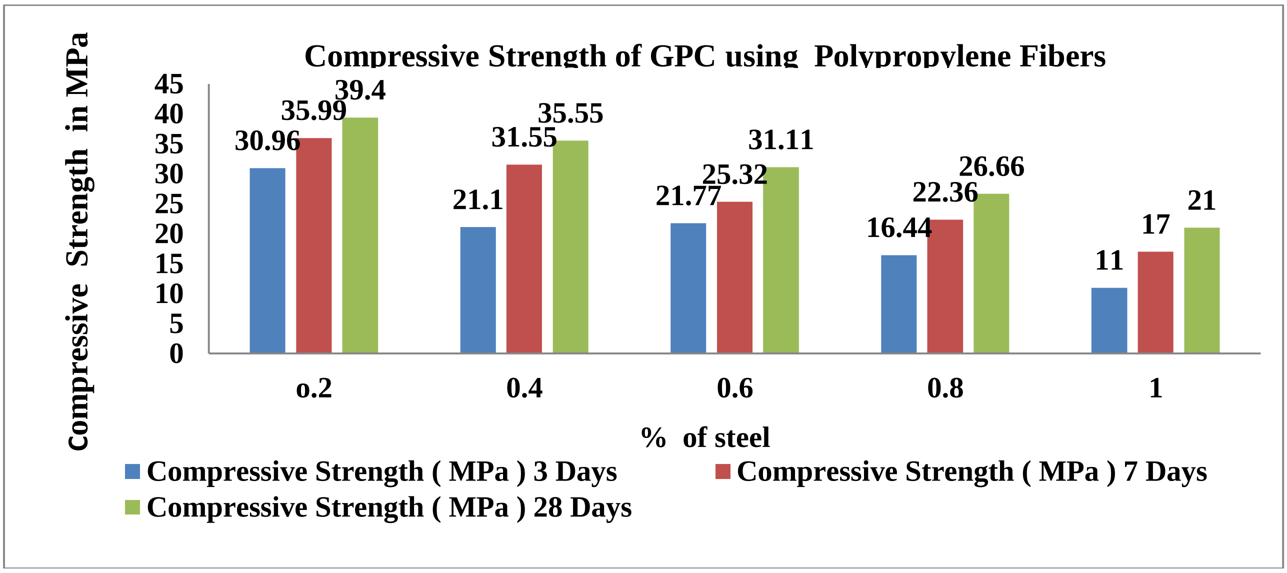
Product	Strongcrete Geosynthetic Fibrillated Mesh Fiber
Polymer	Virgin Polypropylene Homo-Polymer
Construction	Fibrillated Tape
Length	Graded 12 + 24 mm
Melting Range of PP	162 – 164 ^{0}C
Specific Gravity	0.92 g/cc
Water Absorption	Nil
Reactivity	Inert – Not affected by Alkali, Acid & Cement Concrete up to 110 ^{0}C.
Strength	500-550 MPa
Diamond Length	10-12 mm
Elongation	15-18%
Thickness	35-40 u
Width	2.5 mm
Standard Specification	Conforms to ASTM C-1116-97 – Standard Specification for Fiber Reinforced Concrete.

Table 3

Quantity of Fibers used for Specimen

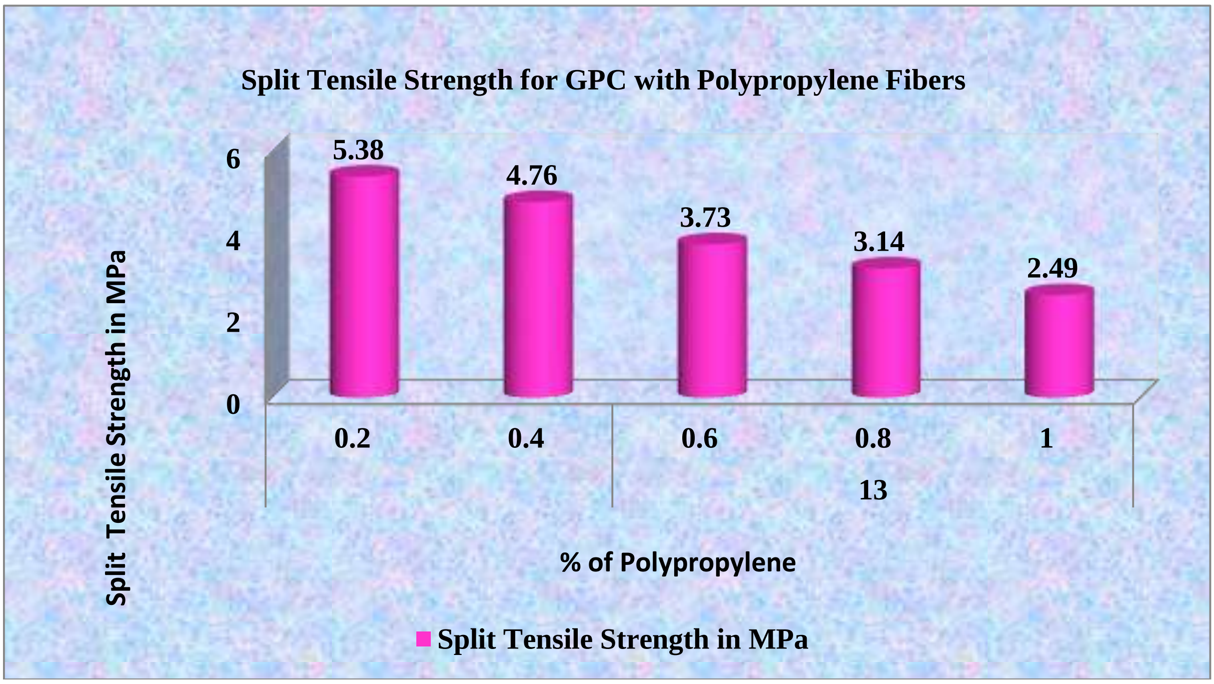
Quantity of fibers used for cube specimen		**Quantity of fibers used for beam specimen**		**Quantity of fibers used for cylinder specimen**	
% of fibers	**Weight of Fibers in gms**	**% of fibers**	**Weight of Fibers in gms**	**% of fibers**	**Weight of Fibers in gms**
0.2	17.1	0.2	25.35	0.2	26.87
0.4	34.22	0.4	50.7	0.4	53.74
0.6	51.33	0.6	76.05	0.6	80.61
0.8	68.445	0.8	101.4	0.8	107.84
1	85.55	1	126.75	1	134.35

Results and Discussions: Compressive Strength, Split Tensile Strength and Results are discussed in following figures



Discussion: Polypropylene fibers are soft fibers having lower modulus of elasticity. [38] It is observed from Figure 4.15 that compressive strength of geopolymer concrete increases up to addition of volume fraction of polypropylene fibers of 0.2% by mass of geopolymer concrete. Beyond that reduction in compressive strength is observed. Also, at 1% addition of volume fraction of polypropylene fibers shows very low compressive strength.

Split Tensile Strength for GPC with Polypropylene Fibers



Discussion: It is observed that addition of polypropylene fibers in geopolymer concrete up to fiber addition of 0.2 %, its split tensile strength increases. Further increase in addition of polypropylene fibers shows reduction in split tensile strength. Less workable mix was observed for addition of polypropylene fibers after 0.4 %. For 1% addition of fibers mix was too less workable but delay in failure was observed. Also, flocculation of fibers at one place is observed for 1% addition of fibers.

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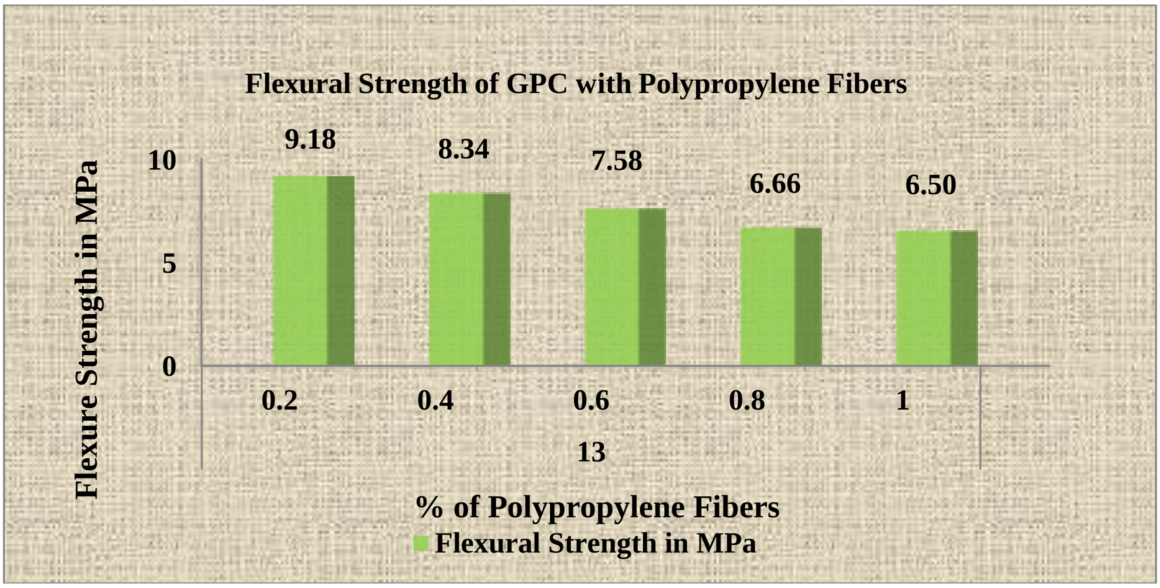

Flexural Strength of Geopolymer Concrete with Polypropylene Fibers

Discussion: Due to addition of polypropylene fibers in geopolymer concrete maximum flexural strength is achieved for fiber addition of volume fraction of 0.2 % by mass of geopolymer concrete. Workability is less for addition of polypropylene fibers as compared to basalt fibers and steel fibers. Flexural strength is maximum for first type of mix. Reduction in flexural strength is observed from 0.2 % to 0.8 % addition of fibers.

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