

# To Study the Effect of Pet Fiber (Polyethylene Terephthalate Fiber) on Geopolymer Concrete by using GGBS and Fly Ash

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**Abstract:-** The demand of utilization of the waste product from the industries is at its peak therefore, several experimental investigations have been carried out to examine their physical and chemical properties when they are used as a replacement material in concrete. In this investigation the fly ash and GGBS were utilized to make the Geopolymer concrete and PET fibers or strands were present in it with various quantities. The fly ash and ggbs based Geopolymer concrete was utilized with equivalent amount (half fly ash and half ggbs) and PET strands were utilized in it (volume division of fine totals/weight level of fine totals) with various rate for example 0%, 2%, 3% and 4% to consider the mechanical properties. The Geopolymer concrete containing PET Fibers were restored with two strategies for example Broiler relieving/Oven curing (24 hours at 600°C) and encompassing restoring/room temperature curing. The PET strands measurements was utilized relating to 45 perspective proportion 90x2mm (length x width). The prepared samples were tested at 7 and 28 days. This study has been done on the fresh property, compressive strength, elasticity/tensile and flexure strength of PET fiber exemplified Geopolymer concrete. The compressive quality improved a step by step with the joining of PET fibers, rigidity and flexural quality tests gave huge improvement over controlled example.

**Key words:** Geopolymer concrete, fly ash, GGBS, PET fiber.

## 1. INTRODUCTION

Concrete is the development material that is comprehensively utilized in development industry. Concrete is a man-made material enormous zone utilized for development reason. Concrete is a blend of, coarse total, sand, concrete and water. The solid is legitimate drawn out period previously so. Advantageous mineral admixtures are joined in best quantum by the concrete change an immense property. The utilization of industrial facility squander has upgraded in zone of development of solid production since, it's put at deficiency the ordinary utilization of naturalistic methodology. At, the ongoing past, significant examination considers have been perform to discover all conceivable reusing and use again strategy. Development useless materials that is copper slag, fly ash, steel slag, iron slag and others numerous materials have been conceded at better places in asphalts establishment, roadway, and numerous development fields, ill-equipped item to the erection by conventional Portland concrete.

A few nations are proving the quick amplification to the development processing plant that incorporates the use of inartificial methodology to the advancement of structure. Consequently, locaters develop useless lead strategy to apply for replacement of fine total for select prerequisite. The useless material is utilized in the main secure area of development industry, which decrease the issues of ecological, issues of room and development cost. Utilization of useless materials as a replacement for sand and concrete in concrete characterizes recovery in mechanical characters' correlation with common cement and have discovered their use in the various structures.

It very well may be inferred that that the Geopolymer cement might be the material which can be utilized for the development reason and economical material for our development businesses and condition. Geopolymer concrete arranged by utilizing crude material of mechanical waste from warm force plants and steel ventures by the salt enactment of pozzolanic materials. Geopolymer solid wording was first presented by a researcher to be specific Davidovits et al. (1984, 1988,1989, 1994,2005). To deliver Geopolymer solid, we need the materials which have pozzolanic properties, for example, GGBS which is a waste material from steel industry, class c or class f fly debris which is a side-effect from warm force plant and antacid initiated arrangements by the blend of watery arrangements of sodium hydroxide and sodium silicate. The response of polymerization with pozzolanic materials utilizing soluble arrangements prompts a few cycles. The different cycles can be obliteration of covalent bond, disintegration, coagulation, gelation, buildup and redesign which at last outcomes in solidifying and polymerization of Geopolymer concrete by expulsion of overabundance of water from grid. Geopolymer solid outcomes in items which transforms it math from undefined to solidify calculation structure.

## 2. LITERATURE REVIEW

**Duxson et al., (2007)** examined that the utilization of cement is quickly expanding each day as the requirement for cover and financial exercises are expanding, additionally because of the globalization and industrialization more infrastructural offices were created which utilize concrete. It has been perceived that the manufacturing of OPC discharges gigantic amount of energy

and carbon dioxide to the general condition. Along these lines, it is fundamental to locate a substitute folio to create ecological agreeable cement.

**Rovnanik (2010)** investigated that restoring temperature has a significant impact on solidifying and Geopolymerization of mineral-based Geopolymer. At a mood and higher temperature, the example for all intents and purposes set in the initial 4 hours. Unexpectedly, the setting was additionally delayed for a time of 4 days when the blend was taken care of at temperature of at most 10 °C, yet this doesn't influence the evaluation and properties of cemented Geopolymer item at the age of 28 days. Quickened quality arrangement was seen on rock based Geopolymer restored at 40 to 80°C temperature. It merits referencing that the impact of temperature is depended on term of restoring. Relieving for a shorter period in broiler didn't respect noteworthy changes in quality turn of events, however stretched out restoring cycle to at any rate 20 hours was the caused for an observable quick pace of response rate and brought about early quality picked up.

**Vijai et al., (2010)** studied the couple of varieties of strands yield more significant impact, scratched spot, and break obstacle in concrete. For essential applications, fiber concrete has various novel inclinations when stood out from the ordinary assistant concrete and recorded as a hard copy it has been represented that may look at bunches have investigated the effect of thought of fibers in concrete involving either 100% bond or fragmented replacement of bond by fly blazing remains. In the current work, an assessment has been had to consider the effect of volume of steel fibers on mechanical properties of Geopolymer concrete orchestrated using 90% fly powder and 10% GGBS under incorporating and warmth soothing conditions.

**Hasan et al., (2011)** examined that solid in pressure and delicate in strain to beat this difficult strands are utilized in concrete. He took a shot at mechanical conduct of fortified cement with miniature manufactured strands. He arranged four blends: one without any filaments and staying three with three distinctive fiber measurements 0.32, 0.43 and 0.50 percent separately. He projected the solid shapes for the assurance of mechanical conduct, for example, rigidity, stress-strain connections, compressive quality and shear quality. He inferred that a large scale manufactured fiber upgrades the compressive quality fundamentally. For large scale manufactured filaments at 0.33, 0.42 and 0.51 percent volume parts a definitive shear quality was expanded by in any event 15, 45 and 65 percent separately contrasted with control radiates.

**Olivia and Nikraz (2011)** dissected that the water penetrability of Geopolymer concrete made with fly debris proportion of 0.36 – 0.46 exposed to broiler relieving at sixty-degree Celsius temperature for 24 hours. They found that Geopolymer concrete demonstrated lower water porousness esteems ( $2.45-4.65 \times 10^{-11}$  m/s) than the standard cement in view of its denser blend and little between pore connect. They likewise expressed that the most significant limitation influencing the properties of Geopolymer concrete was its water-Geopolymer proportion.

**Naidu (2017)** analyzed progressed work Class F fly debris and ground granulated impact heater slag (GGBS) are utilized in comparable extents (FA\_50-GGBS\_50) with basic activator arrangements. Manufactured strands (Polypropylene and Polyester filaments) are utilized at fiber measurement of 0, 0.2, 0.25, 0.3, 0.35 and 0.4 percent individually and different progressed mechanical properties are tentatively contemplated. The greatest compressive quality of Geopolymer concrete for 7 days, 28 days and 90 days relieving period is 35.85 N/mm<sup>2</sup>, 46.81 N/mm<sup>2</sup> and 52.65 N/mm<sup>2</sup> individually by incomplete supplanting with ideal level of engineered filaments of 0.3 percent substitution. The most extreme split pliable specialty of Geopolymer concrete for 7days, 28days and 90 days restoring period is 3.27 N/mm<sup>2</sup>, 4.26 N/mm<sup>2</sup> and 4.53 N/mm<sup>2</sup> individually by fractional supplanting with ideal level of manufactured filaments of 0.3 percent substitution

### 3. MATERIALS AND METHODS

#### Fly Ash:

The fly ash is the residual obtained from the combustion of powered coal and transferred by flue gases and collected by electrostatic precipitation. It has surface area of 0.3-0.70 m<sup>2</sup>/g. Its particles are finer than cement particle. It is light grey, dark grey in Colour. Fly Ash was obtained from Ropar Thermal Power Plant. The class F fly ash used is this research. It is low calcium based fly ash, calcium content is low in it. The specific gravity of ash is 2.24. The annual production of fly ash in India is 225 million tons.

Table 1 Fly Ash Chemical Composition and its Properties

Particulars	Class F fly ash
Silica (SiO <sub>2</sub> )	65.67%
Alumina (Al <sub>2</sub> O <sub>3</sub> )	28.01%
Iron Oxide (Fe <sub>2</sub> O <sub>3</sub> )	3.01%
Lime (CaO)	1%
Magnesia (MgO)	1%
Titanium Oxide (TiO <sub>2</sub> )	0.54%
Sulphur Trioxide (SO <sub>3</sub> )	0.21%
Loss on Ignition	0.30%
<b>Physical properties</b>	
Specific gravity	2.25
Fineness (m <sup>2</sup> /Kg)	360-365

#### GGBS:

GGBS is a waste product obtained from the iron manufacturing plant. It is termed as ground granulated blast furnace slag. GGBS is produced when steel is heating at high temperature and waste is come out after that process and that waste is grind up

and powder is made, that powder is known as GGBS. It was obtained from Ecogen Industries Private Limited, Dehradun. The specific gravity of GGBS is 2.86. It is non-metallic and it is in slag form and powered into small particles that can be replace cement or fly ash. It is rich in calcium silicate and imparts strength to concrete. Now a days GGBS based cement is coming.

Table 2 Chemical Composition and Properties of GGBS

Particulars	GGBS
Silica(SiO <sub>2</sub> )	30.63%
Alumina(Al <sub>2</sub> O <sub>3</sub> )	16.25%
Iron Oxide(Fe <sub>2</sub> O <sub>3</sub> )	0.597%
Lime(CaO)	34.49%
Magnesia(MgO)	6.80%
Titanium Oxide (TiO <sub>2</sub> )	-
Sulphur Trioxide (SO <sub>3</sub> )	1.89%
Loss on Ignition	2.12%
<b>Physical properties</b>	
Specific gravity	2.89
Fineness (m <sup>2</sup> /Kg)	402

#### PET Fiber:

PET bottles were acquired from the nearby piece seller, at that point these bottles cut into long ropes. From that point onward, these ropes are cut into an angle proportion of AR45 for example 90mm length and 2mm broadness. The covering of epoxy gum has been done to shield the fiber from the compound assault. The level of PET Fiber's utilized in this examination are 0,2,3,4 percent volume of portion of fine total. (it dependent on past the examination did on concrete based cement).

Properties of polyethylene terephthalate

Density: 1.37~1.40g/mm<sup>3</sup>

Melting Point: 215-256°C

#### FINE AGGREGATE:

It was gotten after strainer of fine total which went through 4.75mm from zone II. The fineness modulus of sand was 2.93 and explicit gravity was 2.68. IS 383-2016 code use for fine totals.

Table 3 Sieve analysis of fine aggregate

Indian standard Sieve Size	Retained Weight (grams)	Retained % Weight	Cumulative% Weight of Retained	Cumulative % of passing
4.75	95	4.75	4.75	95.25
2.36	148	7.4	12.15	87.85
1.18	230	11.5	23.65	76.35
600	796	39.8	63.45	36.55
300	543	27.15	90.6	9.4
150	158	7.9	98.5	1.5
Pan	28	1.4	--	--
Total				293.1

**Fineness modulus= 2.9**

#### COARSE AGGREGATE:

It is obtained from a local source. This coarse aggregate used size 20mm and 10mm with specific gravity is 2.54. Aggregates 20mm were used 60% of the total weight of coarse aggregate and 10mm aggregates were used 40% of the total weight of coarse aggregate. IS 383-2016 code use for coarse aggregate.

#### WATER:

Very less amount of water was used in the Geopolymer concrete. Normal water was used to full fill the demand for solid content present in the alkaline solution. It is according to the amount of solid content present in sodium silicate liquid.

#### MIXTURE:

As there was no specific code for making the Geopolymer concrete, a study carried out from the past research work and from the IS codes IS 456:2000 and IS 10262:2009 this mix was made.

Table 4 Mixture

% of PET Fiber	Fly Ash Kg/m <sup>3</sup>	GGBS Kg/m <sup>3</sup>	Fine Aggregate Kg/m <sup>3</sup>	Coarse Aggregate Kg/m <sup>3</sup>	Sodium silicate Kg/m <sup>3</sup>	Sodium hydroxide Kg/m <sup>3</sup>	Extra water Kg/m <sup>3</sup>	Admixture Kg/m <sup>3</sup>
0%	189	189	553	1293	124	50	15	3.78
2%	189	189	553	1293	124	50	15	3.78
3%	189	189	553	1293	124	50	15	3.78
4%	189	189	553	1293	124	50	15	3.78

**CURING:**

In this examination work, two sorts of restoring procedures were utilized one is stove dry relieving and other is room temperature restoring. In stove dry relieving example place in the broiler at 600C for 24 hours, after that example place in the room restoring for the 7 days and 28 days testing. In the room temperature relieving examples were not put in the stove, examples were kept in the space for restoring for the 7 days and 28 days relieving. Two unique techniques for relieving were utilized to check the distinction between the stove dry restoring and room temperature relieving. In this sort of relieving no water is required, that is helping us to spare the water. The relieving utilized in the examination appeared in figure 1 and 2.



Figure 1 Room Temperature Curing



Figure 2 Oven Dry Curing

4 RESULTS AND DISCUSSION:

**4.1 Compressive Strength Test:**

Compressive strength testing is done under universal testing machine, to determine the strength of the different grade of concrete by casting cubes of size 150x150x150 mm (under over drying curing and room temperature curing). All the test samples were prepared and tested according to code IS 516-1959. The results of the compressive strength show good up to 3% PET fibers adding, after that the results were converted into lower side as shown in graph 5.1(a) and 5.1(b). The overall result shows that the Oven dry curing samples show's good strength as compared to the room temperature cured samples.

Table 5 Results of Compressive Strength Test (Oven Dry Curing)

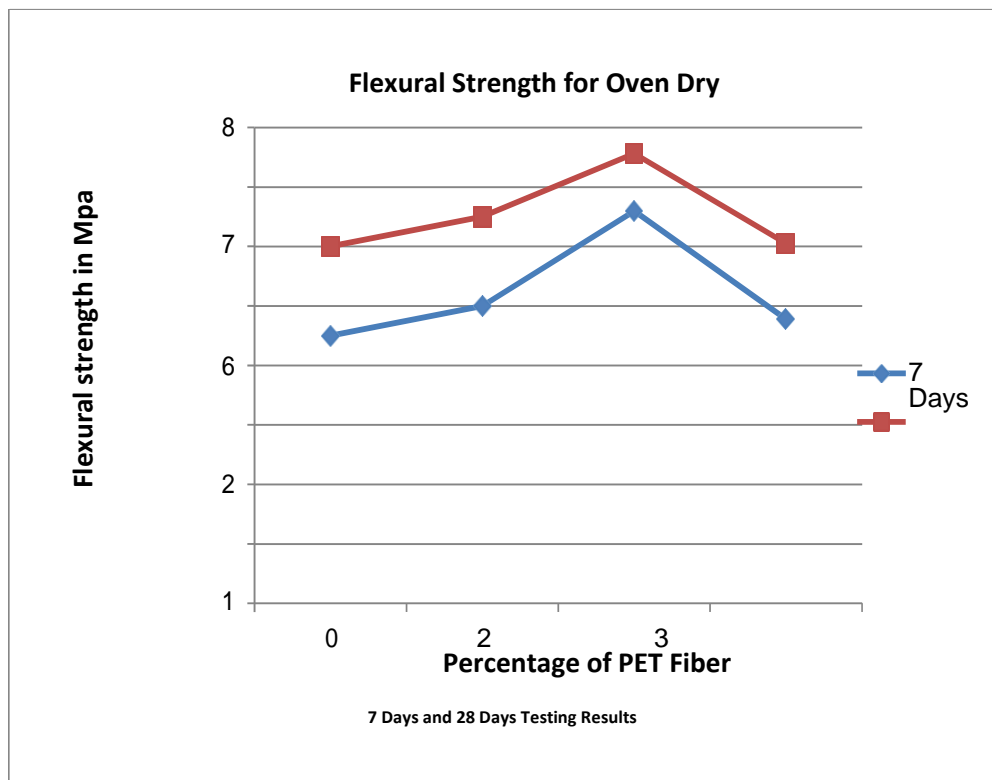
PERCENTAGE OF PET FIBER	COMPRESSIVE STRENGTH (MPA)	
	7 Days	28 Days
0%	20.82	30.61
2%	21.58	31.73
3%	24.79	35.58
4%	3.24	32.56

Table 6 Test Results of Compressive Strength Test (Room temp. curing)

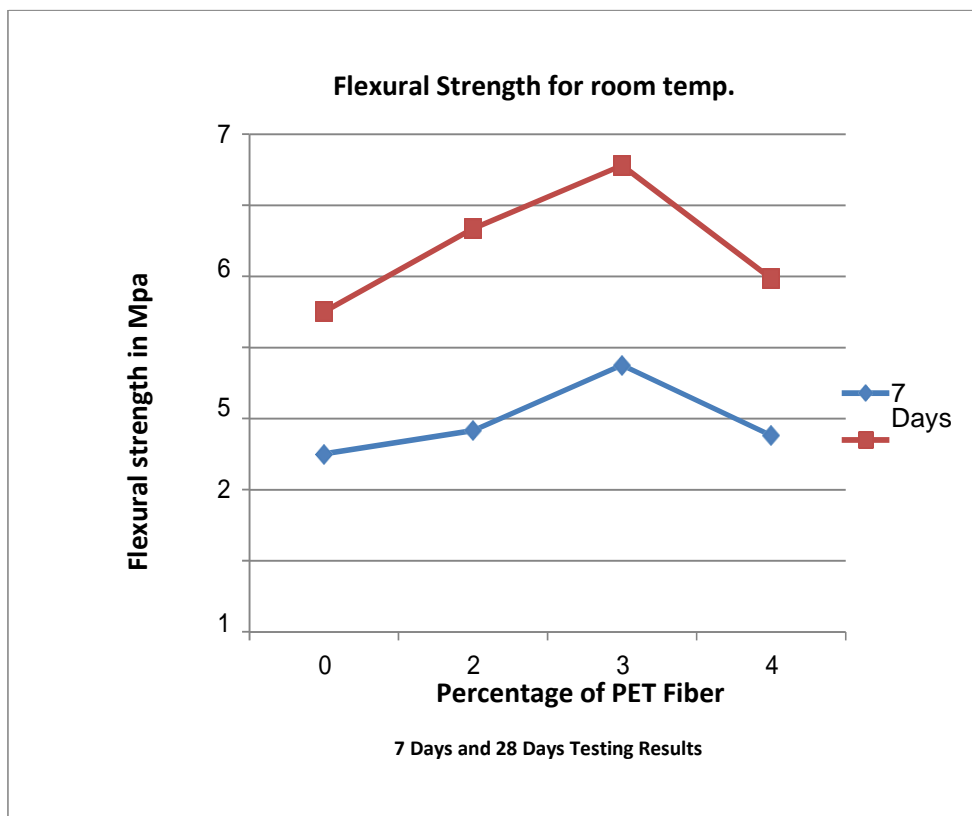
PERCENTAGE OF PET FIBER	COMPRESSIVE STRENGTH (MPA)	
	7 Days	28 Days
0%	18.23	28.68
2%	20.59	30.79
3%	24.38	32.39
4%	22.39	29.71

**4.2 Flexural Strength Test:**

The main aim of the Flexural strength test to measure the strength of concrete by casting a beam of size 500x100x100 mm. In this test, the crack width is measured with the ultimate load on the prepared samples. The three beams were casted to calculate the flexural strength with the help of universal testing machine as per code IS 516-1959. The result of Flexural Strength is higher for Geopolymer concrete with PET fiber as compared with the Geopolymer concrete without PET fiber. Strength of Geopolymer concrete increase with the increase in the percentage of PET fiber up to 3%, after that it start's Maximum flexural strength was obtained at 3% PET fiber. curing



Graph 1 Showing the results of Flexural Strength Test (Oven dry curing)



Graph 2 Showing the results of Flexural Strength Test (Room Temp. curing)

#### 4.3 Split Tensile Strength Test:

The split tensile test is a type of destructive test in which a sample is destructed to check the strength of the material. The size of the specimen is 150 mm diameter and 300 mm length of the cylinder. The compressive testing machine is used for testing the split tensile strength. All the procedures of this test were performed according to the code IS 5816-1999.

Table 5.3(a) Test Results of Split Tensile Strength Test (Oven Dry Curing)

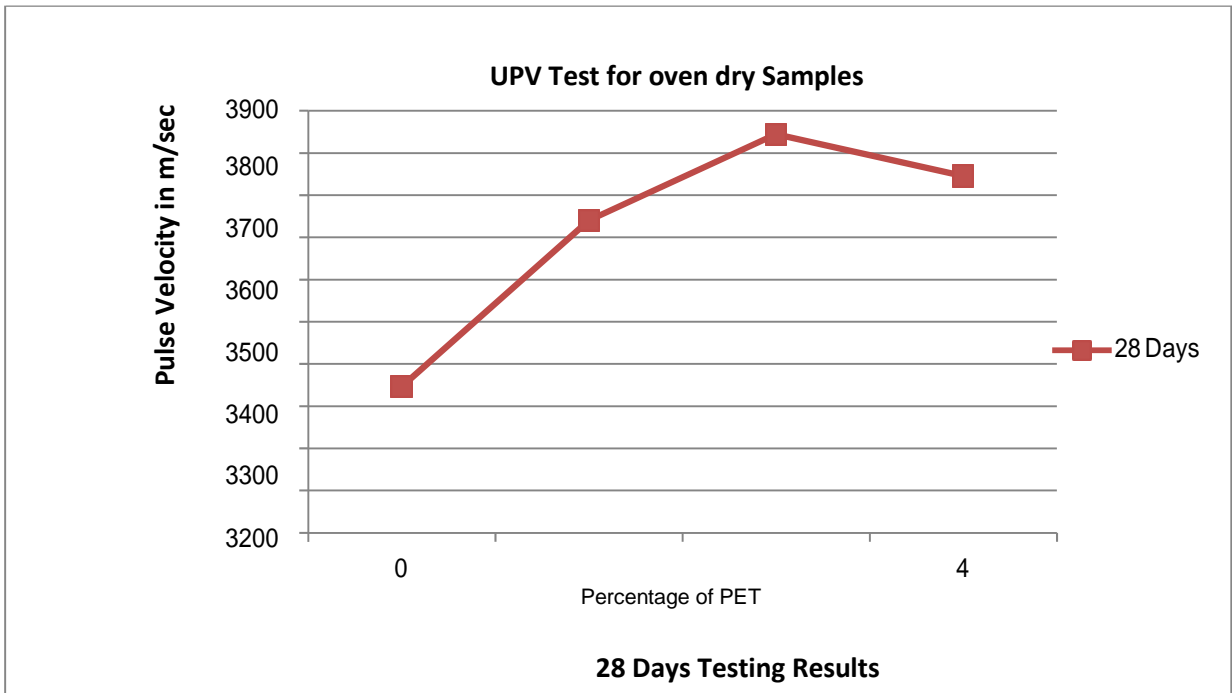
PERCENTAGE OF PET FIBER	SPLIT TENSILE STRENGTH (MPA)	
	7 Days	28 Days
0%	2.07	3.31
2%	2.49	3.70
3%	2.98	3.96
4%	2.65	3.50

Table 5.3(b) Test Results of Split Tensile Strength Test (Room Temp. Curing)

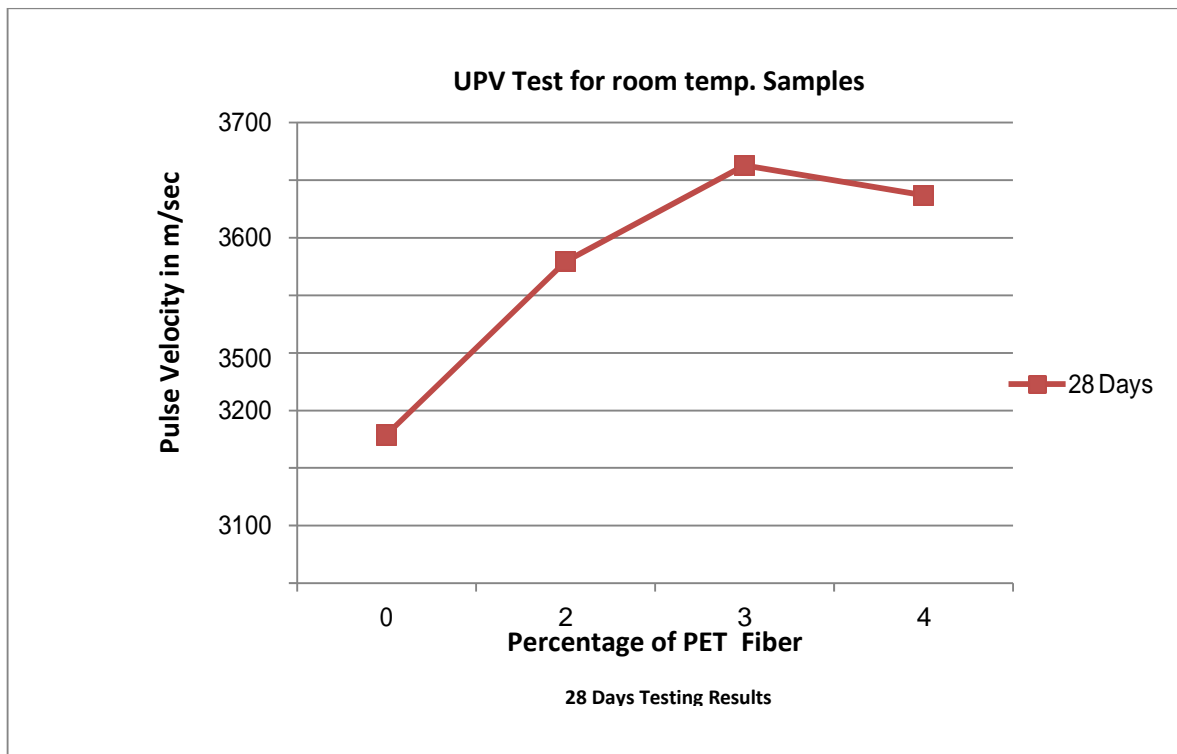
PERCENTAGE OF PET FIBER	SPLIT TENSILE STRENGTH (MPA)	
	7 Days	28 Days
0%	1.31	1.98
2%	1.60	2.33
3%	1.69	2.54
4%	1.54	2.21

#### 4.4 UPV (Ultrasonic Sonic Pulse Velocity) TEST:

It is a type of non-destructive test and this test helps us to find out the quality of the concrete with the help of ultrasonic sonic pulse velocity machine according to IS 13311(part-1)-1992. Test conducted on cubes after 28 days for 24 samples.



Graph 3 Showing the Result of UPV Test Result (Oven Dry Curing)



Graph 4 Showing the Result of UPV Test Result (Room temp. Curing)

5 CONCLUSION:

5.1 Compressive strength

- The maximum compressive strength result for Geopolymer concrete with 3% PET fiber for 7 days is 24.79 MPa and 28 days is 35.58 MPa in oven drying curing. On the other hand, the maximum compressive strength result for Geopolymer concrete with 3% PET fiber for 7 days is 24.38 MPa and 28 days is 32.39 MPa with room temperature curing.
- The strength is maximum for both oven drying curing and room temperature curing with 3% PET fibers.

## 5.2 Flexural strength

- The strength of oven drying curing and room temperature curing shows maximum results with 3% PET fibers adding in Geopolymer concrete.
- The strength values for over drying curing for 7 days is 5.48 MPa and for 28 days is 7.62 MPa. Similarly, the values for room temperature curing for 7 days is 4.20 MPa and for 28 days is 5.93 MPa

## 5.3 Split tensile strength

- The split strength of oven drying curing and room temperature curing shows maximum results with 3% PET fibers adding in Geopolymer concrete.
- The strength values for over drying curing for 7 days is 2.98 MPa and for 28 days is 3.96 MPa. Similarly, the values for room temperature curing for 7 days is 1.70 MPa and for 28 days is 2.54 MPa

## 5.4 UPV (Ultrasonic Sonic Pulse Velocity)

- In UPV test, the maximum velocity value shows for over drying curing is 3850 m/s, the values for room temperature curing is 3630 m/s.
- The maximum values show by adding 3% percent PET fibers.

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