

## **A STUDY ON COMPATIBILITY OF BLENDED FIBERS ON PROPERTIES OF GEOPOLYMER CONCRETE**

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### **ABSTRACT**

Concrete is the most adaptable, dependable, and durable construction material available. Concrete, which utilises a tonne of Portland cement, is the substance that is used the most after water. The greenhouse effect brought on by CO<sub>2</sub> emissions affects several industries, including the cement industry, as it raises world temperatures and may cause climate change. One attempt to manufacture more ecologically friendly concrete is to reduce the quantity of cement used in the mixture by using Geopolymer instead of cement. Geopolymer concrete (GPC) is the most promising ecologically friendly cement alternative. The binder required to make geopolymer concrete, which is manufactured without the use of cement, is made from fly ash and alkaline solutions such as sodium hydroxide (NaOH) and sodium silicate (Na<sub>2</sub>SiO<sub>3</sub>). Concrete has a low flexural strength, is brittle, and a moderate compressive strength. In stress, it is feeble.

It is possible to alter the concrete's properties and increase its ductility by incorporating discrete fibres into the matrix at random locations. This improves the flexural toughness, flexural strength, ductility, impact strength, and tensile strength of the hardened concrete as well as its capacity to prevent or control fracture initiation, propagation, and coalescence.

The usage of steel fibre, loads, and climatic changes all contribute to the development of microfracture in concrete. A short, discrete, discontinuous polypropylene monofilament fibre called Recron-3s may be used in concrete to control and stop cracking. Adding steel and polypropylene to concrete significantly reduces its bleeding, plastic settling, heat and shrinkage stresses, and stress concentrations brought on by external constraints.

This research aims to determine the ideal dosage of steel and Recron 3S while also examining the strength of M30 grade Geopolymer concrete with the addition of different quantities of steel and polypropylene (Recron-3S fibre). The mechanical qualities of concrete, such as its compressive strength (CS), tensile strength (TS), flexural strength (FS), and durability test, had been significantly improved overall, according to the findings. Additionally, research is done on the effects of steel and polypropylene fibres, both alone and together, on the characteristics of concrete.

The combined fibres of RF2SF2 (0.4% Recron and 1% steel) with Geopolymer concrete have been observed to boost the strength of the CS, FS, and TS, respectively, by 22.23%, 21.14%, and 24.57%, in comparison to controlled concrete.

Following the addition of RF3SF4, the mass resulting from the assault of sulfuric acid on GPC rose by 0.933%. Following the addition of RF3SF3, the CS resulting from the assault of sulfuric acid on GPC is raised by 9.24%. Following the addition of RF3SF3, the mass resulting from the assault of sodium chloride on GPC increases by 0.91%. Following the addition of RF3SF3, the CS resulting from a sodium chloride assault on GPC rose by 4.8%.

**Key words** Fly ash, ground-granulated blast furnace slag, steel fibre, polypropylene fibre, durability, and geopolymer concrete

## INTRODUCTION

### General

Concrete is widely used to construct buildings, infrastructure, reservoirs, airports, parking garages, pools, boats, and dams. Concrete is utilized in huge amounts wherever humankind has a requirement for infrastructure. Tonne for tonne, the amount of cement used worldwide is two times greater than the combined amounts of wood, steel, aluminum, and plastic. The use of concrete in the developed world is only surpassed by that of existing water.

Concrete is a material which is the most utilized structure material on the planet. In any case, the creation of concrete means the creation of contamination in view of the discharge of CO<sub>2</sub> during its creation. Emission of CO<sub>2</sub> into the atmosphere is an influence for the industries, even for the cement industries. When the impact of greenhouse gases brought on by emissions is taken into account, a rise in global temperature that could lead to changes in the climate takes place. Cement is a major contribution to the production of CO<sub>2</sub> emissions and this accounts for 5-8 % of total CO<sub>2</sub> produced as a result of human activities. Cement production already exceeds 2.6 billion tonnes annually and is expanding at a rate of 5%.

Worldwide concrete employment is expanding quickly, thus the creation of acceptable concrete is predicted for both environmental and strength-related reasons. By replacing concrete with GPC, one attempt is being made to make concrete even more eco-friendly by reducing the use of cement. Fly ash and alkaline solutions like NaOH and Na<sub>2</sub>SiO<sub>3</sub> are used to create the binder necessary to construct the concrete in geopolymer instead of cement. For the construction of approximately 2.5 cubic meters of top-notch GPC, one tonne of fly ash is required.

An assortment of materials like steel, polypropylene, polyester, nylon, carbon, glass, and basalt fibers can be utilized in fiber reinforced concrete (FRC). Numerous variables, including the kind, flexible characteristics, size, volume fractions, and aspect ratio of the fibers, affect the attributes of FRC. The qualities of concrete in the hardened stage, such as flexural toughness, flexural strength, ductility, impact strength, and tensile strength, are significantly improved by the addition of steel fibers. These fibers have already been used in numerous significant projects, including the construction of pavements, industrial floors, and highway overlays in India.

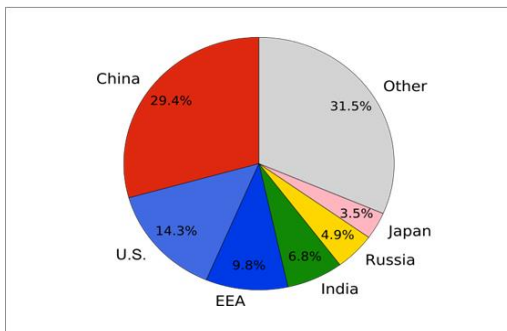


Figure 1.1 Global CO<sub>2</sub> emissions by country wise, 2020

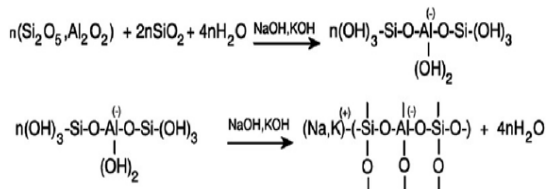
Concrete is utilized all around the world in extremely high add up to fabricate structures, bridges, roads, runways and any infrastructure. Concrete has a strong connection to the global economy because it is essential for the advancement of development. Concrete production is expected to increase from 2.55 billion tonnes in 2006 to 3.7–4.4 billion tonnes by 2050, growing by 25% a year. The world's cement production structure by the nations displayed previously.

### Geopolymer concrete

Portland concrete is a key component of ordinary cement. One tonne of carbon dioxide is released into the atmosphere during the production of one tonne of concrete. Up to 85% of the energy and 90% of the carbon dioxide attributed to a normal prepared mixed cement are attributable to Portland concrete. The primary industrial waste used in geopolymer concrete is fly ash. Fly ash is produced from industrial waste and is readily available all over the world. The majority of the fly ash isn't successfully utilized and a huge piece of it is arranged in landfills. Thinking about this, plainly the utilization of

geopolymer cement can be demonstrated efficient and furthermore eco-accommodating.

This breakthrough technology is currently being widely used in Australia, Europe, and USA. It is used for waste containment, street pavements, electric power shafts, rail line sleepers, and concrete mortar. The most recent research is being done to develop geopolymer systems that provide a low-type energy, low CO<sub>2</sub> binder with qualities similar to Portland concrete. Similar to this, flow research is focusing on the development of simple to comprehend geopolymer concrete. Utilising geopolymer concrete helps the economy grow, reduces pollution, and is safer for the environment. GPC is currently being used in India's Delhi Metro Project. As a result, it can be said that India has a large market for GPC as a cement substitute.



A substance called GPC doesn't require cement to act as a binder. When all else is equal, alkaline liquids are used to activate the reservoir of materials, such as fly ash, that are rich in Silicon (Si) and Aluminum (Al), to generate the binder. Therefore, concrete is devoid of cement.

Alumino-silicate substances like fly ash, metakaolin, activated bentonites, etc. are examples of geopolymers. In order to create a binder, Davidovits proposed using an alkaline liquid to react with source materials such as byproduct materials like fly ash. The most commonly used raw material for creating geopolymers is fly ash. Great high-strength geopolymers are often class-F fly ash. To form geopolymer precursors and ultimately alumino-silicate materials, Si and Al molecules must dissolve under the influence of an alkaline actuation arrangement. Aluminosilicate-responsive material and solid basic arrangements, such as NaOH and Na<sub>2</sub>SiO<sub>3</sub>, are combined to create a geopolymer. The mixture can be adjusted to room temperature or it should be exposed to heat curing.

#### Ingredients required for creation of Geopolymer binders

The fixings needed for making of geopolymer binders are clarified underneath, Cementitious binders - Various industrial results and normally accessible materials such as aggregates, alkaline binders, alkaline solution and super plasticizers can be utilized to deliver geopolymer concrete.

#### 1.2.2 Benefits to the environment

- Cement industry decreases in greenhouse gas emissions.
- Lessening the amount of coal combustion byproducts disposed of.
- Extending the lifespan of structures made of concrete by enhancing concrete durability.
- Take significant steps to protect the environment from global warming.

GPC is a method which utilizes industrial waste like fly ash (FA) and ground granulated blast furnace slag (GGBS). A tremendous measure of fly ash (FA) is created in nuclear energy stations, causing a few removal related issues as the complete use of FA is just around half of delivered. Removal of fly ash is a developing issue as just 15% of fly ash is presently utilized for high worth addition applications like cement and building blocks, the excess being utilized for landfills. Geopolymer innovation can be suitable cycle innovation use all classes and grades of FA and along these lines there is an incredible potential for lessening reserves of waste FA materials. GGBS is a by-product from the blast furnaces used to make iron. Geopolymer is utilized as the binder, rather than cementitious material, to deliver concrete.

#### Advantages and disadvantages of using GPC

Any material is not an idle material with all advantages, geopolymer cement also have advantages as well as disadvantages.

#### Advantages:

- Has CO<sub>2</sub> emissions that are up to 90% lower than OPC concrete.
- Improved thermal insulating qualities.
- Greater heat and fire resistance.
- Offers a practical purpose for 'waste' materials that are frequently dumped in landfills.

- Increased compressive resistance.
- Save energy by using the waste and by-products.
- Increase in the environmental gain by reducing the huge landfill blindered by the by-products.
- Could also increase the job opportunity by this new technology.

#### Disadvantages:

- Lack of specifications and guidelines.
- Initial cost is high due to the chemical incorporated with the alkaline activator.
- Climatic conditions affect the strength parameters.

Concrete is weak in tension and strong in compression, hence it need to be supplemented with a material which gives tensile strength to concrete. Fibers are such materials added to concrete to improve tensile strength of concrete.

#### Need for the present investigation

Concrete is the most widely used material in the construction. Since GPC behaviour is in similar way as that of OPC, it also shows less tensile strength compared to compressive strength. Fibers improve the tensile strength of concrete. Further Tensile strength of concrete play important role in the construction of pavements etc. It is already identified that fiber addition to concrete improves tensile strength. Hence, the role of fibers on improving Tensile strength of GPC need to be evaluated. Further, the compatibility of new generated fibers such as Recron-3s need to be checked with the Traditional Steel fibers.

#### Research significance

- To find the optimum dosage of Recron fibers with GPC.
- To determine the optimum steel fibre dosage when combined with GPC.
- To propose the optimum mixed fiber dosage of Recron and steel fibers with GPC.
- To identify the compressive strength (CS), flexural strength (FS) and split tensile strength (TS) of GPC with optimum fiber dosage of Recron, steel and optimum mixed fiber dosage and without Fibers.

#### Scope of the investigation

1. Addition of Recron fibers to GPC in different proportions from 0% to 1% with increase in variation of 0.2% Recron (0%(G1), 0.2%(R1), 0.4%(R2), 0.6%(R3), 0.8%(R4), and 1.0%(R5)). For each mix 6 cubes of size 150x150x150 mm were casted. Altogether total 36 specimens were casted.
2. Addition of steel fibers to GPC in different proportions from 0.2% to 2.0% with increase in variation of 0.2% steel (0.2%(S1), 0.4%(S2), 0.6%(S3), 0.8%(S4), 1.0%(S5), 1.2%(S6), 1.4%(S7), 1.6%(S8), 1.8%(S9) 2.0%(S10) and 2.5% to 3.5% with increase in variation of 0.5% steel (2.5%(S11), 3.0%(S12), and 3.5%(S13)). For each mix 6 cubes of size 150x150x150 mm were casted. Altogether total 78 specimens were casted
3. Mixed Fibers addition to GPC in different Proportions (i.e Recron and steel) RF1SF1(0.2,0.5), RF1SF2(0.2,1), RF1SF3(0.2,1.5), RF1SF4(0.2,2), RF2SF1(0.4,0.5), RF2SF2(0.4,1), RF2SF3(0.4,1.5), RF3SF1(0.6,0.5), RF3SF2(0.6,1), RF3SF3(0.6,1.5). For each mix 6 cubes of 150x150x150 mm were casted. Altogether total 60 specimens were casted.
4. Compressive, flexural, split tensile strength is calculated for optimum dosage of R3, S11, RF1SF3(0.2R,1.5S), RF2SF2(0.4R,1S), RF3SF2(0.6R,1S). The GPC cube, Prisms and Cylinders were casted with optimum dosage of recron of R3, steel S11, Mixed fiber of RF1 SF3, RF2 SF2, RF3 SF1. Altogether total 51 specimens were casted.

## LITERATURE REVIEW

### LITERATURE ON GEOPOLYMER CONCRETE

**Annapurna shivakumar et al. (2017)** evaluated the mechanical characteristics of GGBS- and FA-based GPC. Geopolymer (GP) has limitations that can be removed by using GGBS, such as sluggish setting at ambient temperature. This evaluation makes an effort to focus on the mechanical

characteristics of GPC that include GGBS as an additional repair. To focus on the mechanical qualities, five mix scenarios with shifting GGBS measurements have been taken into account. The results of the tests show that every mechanical property of the FA and GGBS-based GPC is in good agreement with the qualities of conventional concrete (CC).

**S.S.Bachhav et al,(2016)** explored compound Resistance properties of CC and GPC, thought about the compressive strength of GPC & CC after openness to the carbonation interaction. The compressive strength of CC was seen to be less as contrasted and fly ash based GPC. It increments with increment molarities in an alkaline solution. GPC includes brilliant properties inside both corrosive and salt conditions contrasting with CC, the creation of GPC have an overall higher strength, incredible volume steadiness, well durability.

**Pithadiya.S et al (2015)** completed an exploratory concentrate on GPC by utilizing GGBS. They led tests on GPC by supplanting FA by GGBS and the examples were relieved at ambient curing just as oven curing. They affirmed that supplanting of FA by GGBS expanded the strength continuously ambient curing arrangement.

**Madheswaran C.K et.al (2013)** concentrated on the variety of solidarity for various grades of GPC by shifting the NaOH. Various molarities of NaOH were taken to plan distinctive blends and restored in the surrounding temperature. GPC blend definitions in with CS going from 15 to 52 MPa had been created. The examples were tried for their CS at 7 years old and 28 days. The CS of GPC expanded with expanding centralization of NaOH.

#### LITERATURE ON FIBER REINFORCED CONCRETE.

**Pawan Kumar 1, et.al (2016)** examined and presumed that the Compressive Strength increments with adding the level of polypropylene fiber. Compressive strength gets most extreme at a specific rates of strands (here 1.50%) and afterward diminishes with adding the filaments. Flexural strength increments with expanding the level of polypropylene fiber. The most extreme flexural strength has gotten at 2.00% of polypropylene fiber. The droop esteem diminishes with expanding the level of polypropylene fiber.

**Dr Sunil V Desale, et.al (2015)**, examined and inferred that, on immersion of Recron 3s fiber with cement matrix, the CS and TS decline with expansion in Recron 3s fiber content, but the FS increments with expansion in Recron 3s fiber content. At the point when muck and Recron 3s fiber are added, the ideal measurement of fly ash is 20% and ideal Recron 3s fiber content is 0.4%. Utilization of Recron 3s fiber will lessen the expense of support by decreasing the miniature breaks and porousness and subsequently the solidness will increment. The use of Recron 3s fiber lessens the isolation.

**Nandish S C1, et.al (2015)**, in their exploratory examination inferred that with expansion in with the increment in the addition of filaments to the concrete, the TS and the FS increments somewhat and bit by bit diminishes with additional increment in the level of the strands. CS decline with increasing the duration of curing. Utilising strands will typically improve the FS of the fiber-mixed concrete, which will have a higher value than the control mix. The FS was found to be fourteen percent greater for concrete that contained 2.0%CF and 0.4%PF of fiber than control mix concrete. The TS of the fiber-mixed concrete is more valuable compared to that of the control mix when strands are used. The total solids (TS) were found to be 11.76% greater compared to that of the control mix for fiber contents of 2.0%CF and 0.4%PF. The enlargement of coconut fiber and polypropylene fiber in the concrete mix has been observed to reduce the functioning of the fiber concrete (PF and CF).

**Kamaldeep Kaur, (2015)**, has considered and inferred that addition of recron works on the presentation of concrete at 0.2% and 0.5% addition, beyond 0.5% there is no beneficial outcome on the CS of concrete. Failure example of the shape overall has portrayed that concrete with recron works on break resistance. Addition of strands lessens the usefulness of concrete. Utilization of flyash and superplasticizers works on the functionality.

**T.Sandeep, (2015)** , considered and presumed that the 28 days in regard of the two grades of concrete is achieving most extreme worth at 25-30% of fly ash replacement. There is an expansion of 12% in CS with addition of FA when analyzed plane concrete. There gives off an impression of being most prominent expansion in 7 days strength with use of fly ash when thought about 28 days strength. Almost 25% more strength is accounted for to have been gotten at 7 days with 25% replacement of fly



ash this enjoys a benefit as far as early deshuttering and when the foundation of development is relied upon to be exceptionally high there is a comparative propensity consumed and truth be told all the more pronouncedly at 3days strength of concrete there is a half expansion in strength at 3 days thought about plane traditional concrete. The addition of Recron fiber has additionally expanded beginning 3days and 7days strength. These filaments are causing 30% f expansion in the 28-days CS within the sight of fly ash the most extreme in 28-days strength is seen with 0.25% Recron and 25% fly ash replacement.

## EXPERIMENTAL WORK

### Materials

#### Fly ash

Class F fly ash was used as the base material conforming to ASTM class F. The appearance of FA is shown in Figure 3.1. The Physical characterizes and chemical properties of FA are assumed in Table 3.1

Aluminium oxide ( $\text{Al}_2\text{O}_3$ )	
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Table 3.1 Physical and chemical properties of fly ash

Properties	Experimental values	IS:3812-2003
Fineness, m <sup>2</sup> /kg	290	Within limits
Bulk density, g/cc	1.16	
Colour	Cream White	
Specific gravity	2.08	
Oxide composition (% by mass)		
Silica (SiO <sub>2</sub> )	52.0	
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> )	4.0	
Calcium oxide (CaO)	1.3	
Magnesium oxide (MgO)	0.80	
Potassium oxide (K <sub>2</sub> O)	0.82	
Titanium oxide (TiO <sub>2</sub> )	0.28	
Aluminium oxide (Al <sub>2</sub> O <sub>3</sub> )	33.8	
Loss of ignition(LOI)	1.46	
Alkali oxide	0.39	
Sulphur Oxide	1.46	



Figure 3.1 fly ash

#### Ground granulated blast furnace slag (GGBS)

GGBS is a by-product of iron production. Figure 3.2, shows the appearance of GGBS. TheGGBS is replaced with FA to obtain strength in ambient curing.

Table 3.2 Physical and chemical properties of GGBS

Oxide composition (% by mass)		
Silica ( $\text{SiO}_2$ )	35	70 min
Iron oxide ( $\text{Fe}_2\text{O}_3$ )	1.3	
Aluminium oxide ( $\text{Al}_2\text{O}_3$ )	10	
Calcium oxide ( $\text{CaO}$ )	40.3	45
Magnesium oxide ( $\text{MgO}$ )	8	17.0 max
Sulphide Sulphur	2.93	2 max
Phosphorous	0.6	within limits
Alkali oxide	0.15	1.5 max
Loss of ignition (LOI)	1.80	12 max



**Figure 3.2 Ground granulated blast furnace slag (GGBS)**

#### Sodium hydroxide

The appearance of NaOH is shown in figure 3.3. Its properties are as given in the table (3.3). Solution is prepared by adding water to the flakes based on the molarity conditions.

**Table 3.3 Physical and chemical properties of Sodium hydroxide**

Appearance	Solution
Colour	White colourless
Specific gravity	1.16
Assay	96-98%

\*Supplied by Manufacturer



**Figure 3.3 Sodium hydroxide**

#### Sodium silicate

Generally,  $\text{Na}_2\text{SiO}_3$  is available in liquid (gel) form as revealed figure 3.4. The ratio of  $\text{SiO}_2$  to  $\text{Na}_2\text{O}$  is 2.2. The specification details of the  $\text{Na}_2\text{SiO}_3$  solution are given in table 3.4.

**Table 3.4 Properties of sodium silicate**

Chemical formula	$\text{Na}_2\text{SiO}_3$
$\text{Na}_2\text{O}$	14.70%
$\text{SiO}_2$	29.40%
Water	55.90%
Appearance	Liquid (gel)
Colour	Light yellow liquid
Specific gravity	1.57

\* Supplied by Manufacturer



Figure 3.4 Sodium silicate

### Super plasticizer

In order to improve the workability of fresh geopolymer concrete, high- range water reducing naphthalene based super plasticizer (Conplast SP430) was added during the concrete mixing.

### Aggregates

#### 3.5.1 Fine Aggregate

In the present investigations Fine Aggregate used is of natural sand obtained from local market. Sand was confirming to zone II as per IS 383:1970. The properties of Fine Aggregates and the details of test results are tabulated in the Table 3.5 and Table 3.6

Table 3.5 Physical Properties of Fine Aggregate

S.No.	Properties of FA tested	Test result
1	Specific gravity	2.5
2	Fineness modulus	2.12
3	Water absorption	0.50%
4	Silt content	3%

### Coarse Aggregate

Locally available Crushed granite stones of size 20mm and 10mm were used as coarse aggregate. The properties of Coarse Aggregates and the details of test results are as tabulated in the Table 3.7 and Table 3.8

Table 3.6 Properties of Coarse Aggregate

S.No.	Properties of CA tested	Test result
1	Specific gravity	2.6
2	Fineness modulus	6.9
3	Water absorption	0.50%



## RESULTS AND DISCUSSION

### 4.1 General

All of the observations made during the experimental programme have been meticulously tabulated. For easier understanding, the test results are presented in both table and graphical form. All of the test results are included in this chapter in the various formats described above.

Both steel and Recron 3 fibres were used in the test. These fibres were purchased at a nearby market. The compressive strength, flexural strength, and split tensile strengths are examined in light of the findings of the experimental tests.

### 4.2. Properties of fresh concrete

#### 4.2.1 Workability

Employing the slump test and the compaction factor test, the workability of freshly mixed concrete is determined.

##### 4.2.1.1 Slump test

Table 4.1 Slump Values of RGPC

Mix ID	% of Recron fiber	GPC M30 grade concrete
		Slump (mm)
G <sub>1</sub>	0	80
R1	0.2	75
R2	0.4	60
R3	0.60	50
R4	0.8	45
R5	1.0	40

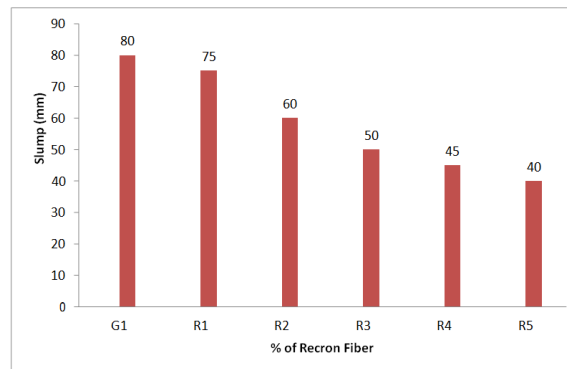
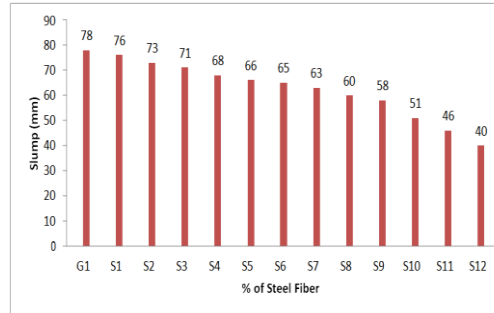


Fig 4.1: Slump v/s Recron 3s

The figure 4.1 shows the slump v/s variations of Recron3s in GPC. Table 4.1 displays the results of the slump tests conducted on the fresh concrete mixtures. Test Results reveals that concrete without fiber have maximum slump value (80mm) whereas concrete with R1 fiber have slump value of 75mm and followed by 60mm, 50mm, 45mm for decrease in fiber content from R2 to R5. The slump test results conclude that the workability decreases as percentage of Recron 3s increase. As the amount of fiber increases, the slump values decrease; this may be due to increased high fiber volume fraction at the constant water level.

Table 4.2 Slump Values SGPC

Mix ID	% Of Steel fiber	GPC M30 grade concrete
		Slump (mm)
G <sub>1</sub>	0	80
S1	0.2	78
S2	0.4	76
S3	0.60	73
S4	0.8	71
S5	1.0	68
S6	1.2	66
S7	1.4	65
S8	1.6	63
S9	1.8	60
S10	2.0	58
S11	2.5	51
S12	3.0	46
S13	3.5	40

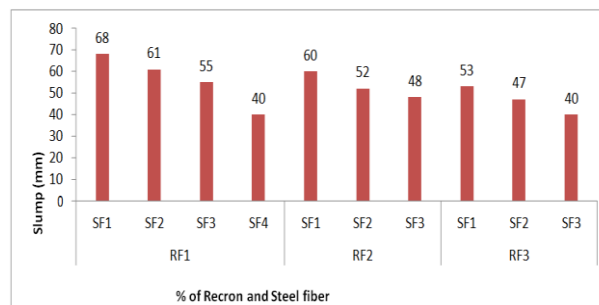


**Fig 4.2: Slump v/s Steel fiber**

The figure 4.2 shows the slump v/s variations of steel fiber with GPC. The test results for SGPC are given in table 4.2. Results reveals that concrete without fiber have maximum slump value 80mm whereas concrete with S1 fiber have slump value of 78mm, followed by 76mm, 73mm, 71mm, 68mm, 66 mm, 65mm, 63mm, 60mm, 58mm, 51mm, 46mm, 40mm decrease in fiber content from S1 to S13. As the amount of fiber increases, the slump values decreases; this may be due to increased solid state at the constant water level.

**Table 4.3 Slump Values of blended fiber dosage with GPC**

Mix ID	% of Recron	% of Steel	GPC M30 grade concrete
			Slump (mm)
RF <sub>1</sub> SF <sub>1</sub>	0.2	0.5	68
RF <sub>1</sub> SF <sub>2</sub>		1	61
RF <sub>1</sub> SF <sub>3</sub>		1.5	55
RF <sub>1</sub> SF <sub>4</sub>		2	40
RF <sub>2</sub> SF <sub>1</sub>	0.4	0.5	60
RF <sub>2</sub> SF <sub>2</sub>		1	52
RF <sub>2</sub> SF <sub>3</sub>		1.5	48
RF <sub>2</sub> SF <sub>4</sub>		2	45
RF <sub>3</sub> SF <sub>1</sub>	0.6	0.5	53
RF <sub>3</sub> SF <sub>2</sub>		1	47
RF <sub>3</sub> SF <sub>3</sub>		1.5	40
RF <sub>3</sub> SF <sub>4</sub>		2	40



**Fig 4.3: Slump v/s blended fiber dosage**

The figure 4.3 shows the slump v/s blended fiber dosage in GPC. The slump test results obtained are given in table 4.3. Results reveals that concrete without fiber have maximum slump value 80mm whereas with blended fiber of RF<sub>1</sub>SF<sub>1</sub> have highest slump value 68mm, whereas concrete with contact RF<sub>1</sub> and variations of SF<sub>1</sub>, SF<sub>2</sub> SF<sub>3</sub> and SF<sub>4</sub> fiber have slump value are 61mm, 55mm, 40mm. With the blended fiber of RF<sub>2</sub>SF<sub>1</sub> have highest slump value 60mm, whereas concrete with contact RF<sub>2</sub> and variations of SF<sub>1</sub>, SF<sub>2</sub>, and SF<sub>3</sub> fiber have slump value are 52mm, and 48mm. With the blended fiber of RF<sub>3</sub>SF<sub>1</sub> have highest slump value 53mm, whereas concrete with contact RF<sub>3</sub> and variations of SF<sub>1</sub>, SF<sub>2</sub>, and SF<sub>3</sub> fiber have slump value are 47mm, and The slump test results conclude that the workability decrease as percentage of Steel and Recron fiber goes on increasing in the concrete mix.

## SUMMARY AND CONCLUSIONS

### Summary

Based on conducted trials, the following results were drawn on the improvement in CS, FS, and TS that the steel and Recron fibres in the geopolymer concrete showed.

### CONCLUSIONS

1. Based on the CS findings, 0.6% is the ideal amount of Recron fibre that is advised. Up to a 0.6% threshold, the CS rises 18.18% above controlled concrete; beyond that, strength declines. It suggests that the ideal dose, up to which all holes are successfully filled, is 0.6%.
2. Based on the CS findings, 2.5% is the ideal amount of steel fibre that is advised. Up to a 2.5% threshold, the CS rises 19.01% above controlled concrete; beyond that, strength declines. Once again, it can be said that 2.5% is the ideal amount of steel to use; much more and the steel fibre mixture would become quite difficult to work with.
3. The ideal blended fibre dose in the three distinct blended fibre dosages—RF1 SF3(0.2,1.5), RF2SF2(0.4,1), and RF3SF2(0.6,0.5)—is an increase in CS of RF2SF2(0.4,1). 22.23%, 21.14%, and 24.57% in relation to controlled concrete, respectively
4. In terms of mechanical characteristics, the CS, FS, and TS rose by 18.18%, 17.80%, and 20.75%, respectively, above controlled concrete at the optimal dose of Recron 0.6%.
5. In terms of mechanical characteristics, the CS, FS, and TS rose by 19.01%, 18.94%, and 22.45%, respectively, above controlled concrete at the optimal steel dosage of 2.5 percent.
6. Compared to controlled concrete, the optimal blended dose of RF2SF2 resulted in increases of 22.23%, 21.14%, and 24.57% for CS, FS, and TS, respectively. A mixed fibre dose of RF2SF2 is reported to exhibit greater strength and an overall improvement in mechanical characteristics. Thus, this is considered the ideal dose of mixed fibre.
7. GPC for blended fibre is more affordable than for individual fibre.
8. When compared to individual fibre, the flexural strength of the blended fibre reinforced GPC is improving.
9. The mass resulting from the assault of sulfuric acid on GPC is raised by 0.933% with the addition of RF3SF4.
10. Following the addition of RF3SF3, the CS resulting from a sulfuric acid assault on GPC is raised by 9.24%.
11. The mass resulting from the assault of sodium chloride on GPC is enhanced by 0.91% with the addition of RF3SF3.
12. After adding RF3SF3, the CS from the sodium chloride assault on GPC rose by 4.8%.

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