Study on Strength Properties of Geopolymer Concrete with Sisal and Polypropylene Fibers

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Abstract: This paper includes Geopolymer concrete of M 30 grade Fly ash and Ground granulated blast-furnace slag (GGBS) as a binder, and alkaline solution as the activator, the ratio of sodium hydroxide solution to sodium silicate solution was fixed to 1:2. The concentration of sodium hydroxide solution is retained at 12M. The ratio of activator solution to the weight of binder (Fly ash and GGBS) is kept as 0.35.The total Volume of coarse and fine aggregate percentage was kept at 79%, the super plasticizer was used for the workability of concrete. To overcome the limitations, such as the shrinkage cracks of the Geopolymer concrete, the certain fibers such as the sisal and polypropylene fibers can be utilized to improve the inherent properties of the Geopolymer concrete. This paper deals with the study of strength properties with various mix proportion of fly ash and GGBS with the different percentage of fly ash replacement of GGBS such as 100 % of FA + 0 % of GG, 75 % of FA + 25 % of GG, 50 % of FA + 50 % of GG, 25 % of FA + 75 % of GG, 0 % of FA + 100 % of GG and with addition of combination of fibers like sisal and polypropylene fibers. Addition percentage of combination of fibers is fixed to 1% of total volume of concrete, here the variation in addition of percentage of sisal and polypropylene fiber within 1% of volume of concrete such as 0 % of SF + 0 % of PF, 0.25 % of SF + 0.75 % of PF, 0.50 % of SF + 0.50 % of PF, 0.75 % of SF + 0.25 % of PF. Compare all the various percentage of addition of combination of fibers with conventional concrete, under various tests like compression, split tensile, flexural tests for the samples of cube, cylinders, beam respectively and justifies the advantage of Geopolymer concrete with combination of sisal and polypropylene fibers of varying percentage within 1% of volume of concrete with conventional concrete.

Index Terms **- Geopolymer concrete, Fly Ash, GGBS, Alkaline solution, Sisal fiber, Polypropylene fiber, Compression test**

I. INTRODUCTION

Manufacturing of cement is a totally intensive process, which discharges vast amount of dangerous gases like carbon dioxide into the atmosphere, Hence to overcome this tremendous hazardous gas, alternative binding material might be chosen for environmental friendly. The fly and GGBS can be a choice of a binding material. Geopolymer concrete means absence of hundred percent of cement content in it. Even Geopolymer concrete is formed from chemical reaction not from hydration reaction. To obtain a good polymer concrete, the fly ash and GGBS can be a choice of a binder material. The alkaline solution of sodium silicate and sodium hydroxide is utilized as Activator. The Supplementary fibers on used to overcome the restrictions of Geopolymer concrete such as shrinkage cracks, and addition of fiber to the Geopolymer concrete gives a mechanical properties Superior to the conventional concrete. The sisal and polypropylene fiber is used as a reinforcing material. Use of fibers increases the strength results. Addition of 1% of the combination of sisal and polypropylene fibers to the whole volume of concrete and with varying percentage of fly ash and GGBS mix proportion. Sisal fiber results in the resistant against moist, heat and good tension resistance. Polypropylene fiber results in the reduction in the settlement of aggregate particles, resistance to abrasion, chemical, corrosion and heat. The specimens of cube, cylinder, beams are casted for both Geopolymer concrete with fly ash and GGBS mix proportion without fiber and with the combination of sisal and polypropylene fibers with variation of fibers of 1% of volume of concrete, were tested to determine the compression, split tensile, flexural behavior.

II. AIM AND OBJECTIVE OF THE PROJECT

The following are the aim and objective of the project:-

- To recognize and learn the outcome of salient parameters that affect the properties of fly ash and GGBS mix proportion and based on Geopolymer concrete mix with the combination of sisal and polypropylene fibers
- To revise the engineering properties of fresh and hardened concrete by means of fly ash and GGBS mix proportion in Geopolymer concrete.
- To gain knowledge of the strength properties of fresh Geopolymer concrete with mix proportion of fly ash and GGBS and with addition of combination of sisal and polypropylene fiber.
- To determine and compare the strength results of compression, split tensile , flexural tests of Geopolymer concrete using combination of sisal and polypropylene fiber with conventional concrete.
- To bring the conclusion on whether fly ash and GGBS with combination of fibers of sisal and polypropylene fiber can provide an appropriate alternative for cement concrete.
- To bring out economic and eco-friendly by using Geopolymer concrete instead of conventional concrete.

III. COMPRESSION TEST

Compressive strength is done mainly to know the properties and characteristics of concrete and even to know the nature of concrete. Compressive strength of the concrete depends up on factors like water cement ratio, cement strength, nature of concrete

material, quality control during making of concrete etc. Here in this project Geopolymer concrete the compressive strength depends upon alkaline solution to the binder ratio, Sodium Hydroxide to sodium silicate ratio, concentration of sodium hydroxide, preparation of Alkaline solution, addition of water ,Percentage of fly ash and GGBS, and proper mixing of Geopolymer concrete. The four type of mix of Geopolymer concrete with varying percentage of fiber within one percent of volume of concrete is considered and for each type of mix the 5 type's different percentage of mix proportion is made with fly ash and GGBS by replacement of cement. Hence twenty type of different mixing is prepared each mix of three Cubes, therefore, for 7 days-60 cubes, for 14 days-60 cubes, for 28 days-60 cubes, totally 180 cubes specimens are prepared.

Procedure:

- For a compression test, the cube dimension of sample adopted is 100 mm X 100 mm.
- Clean the cube mould and apply the oil totally on the interior surface of the cube mould.
- The volume of the mould is calculated and the required ingredients for the mixing of concrete are calculated for the chosen cube size.
- The Geopolymer concrete mix is prepared by mixing by addition fly ash, GGBS, alkaline solution of sodium hydroxide and sodium silicate, with and without addition of fibers, water super plasticizer these ingredients are mixed thoroughly till it attains uniformity.
- After preparation of Geopolymer concrete mixture the cube mould is located on rigid horizontal and non-absorbent plane, now the concrete is pour in the cube mould in three layers and. each layer tamping with tamping rod.
- The mould are placed on the vibrator for compaction and vibrated for few seconds. The prepared mould Cube ,date of the day is noted down.
- After 24 hours of duration of time the specimens are removed from the cube mould And weight of the cube is noted down and immediately the cubes are kept for ambient temperature of 40 degree Celsius.
- The cube specimen surface exposed to the ambient temperature is carried out, for 7 days-60 cubes, for 14 days-60 cubes, for 28 days-60 cubes
- After 7, 14 and 28 days the cube specimen is tested for strength of compression.
- Now the cubes from the mould are kept in Compression testing machine and the load is applied till the cube fail to retain the maximum load and load is noted down
- The values are tabulated and calculations are done for compressive strength.

$$\text{Compressive strength} = \frac{Load}{Area\ of\ the\ specimen}$$

$$Fc = \frac{P}{A}$$

Where,
Fc = Compressive strength of prepared cube in N/mm2
P = Maximum load at the time of failure in N
A = Cross sectional area of prepared cube in mm2

3.1 RESULTS AND OPINIONS

3.1.1 General

In this study the mixtures of fly ash and GGBS mix proportions of 100 % of FA + 0 % of GG, 75 % of FA + 25 % of GG, 50 % of FA + 50 % of GG, 25 % of FA + 75 % of GG, 0 % of FA + 100 % of GG of varying percentage are carried out with addition of combination of sisal and polypropylene fiber by different percentage like, 0% of fibers, 0.25%SF+0.75%PF, 0.5%SF+0.5%PF, 0.75%SF+0.25%PF these are carried out by fixing 1% of total combination of fiber by considering the total volume of Geopolymer concrete.

3.1.2 Compression Test

Table 3.1: Compressive strength test results for the 0% of fiber.

STRENGTH TEST	AGE IN DAYS	MIX TYPE- 1 (0% OF FIBERS)				
		F-100% +G-0%	F-75% +G-25%	F-50% +G-50%	F-25% +G-75%	F-0% +G-100%
COMPRESSIVE STRENGTH IN Mpa	7	31	42	55	62	61
	14	32	45	57	64	62
	28	36	47	59	69	68

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Table 3.2: Compressive strength test results for combination of 0.25% of sisal and 0.75% of polypropylene fiber

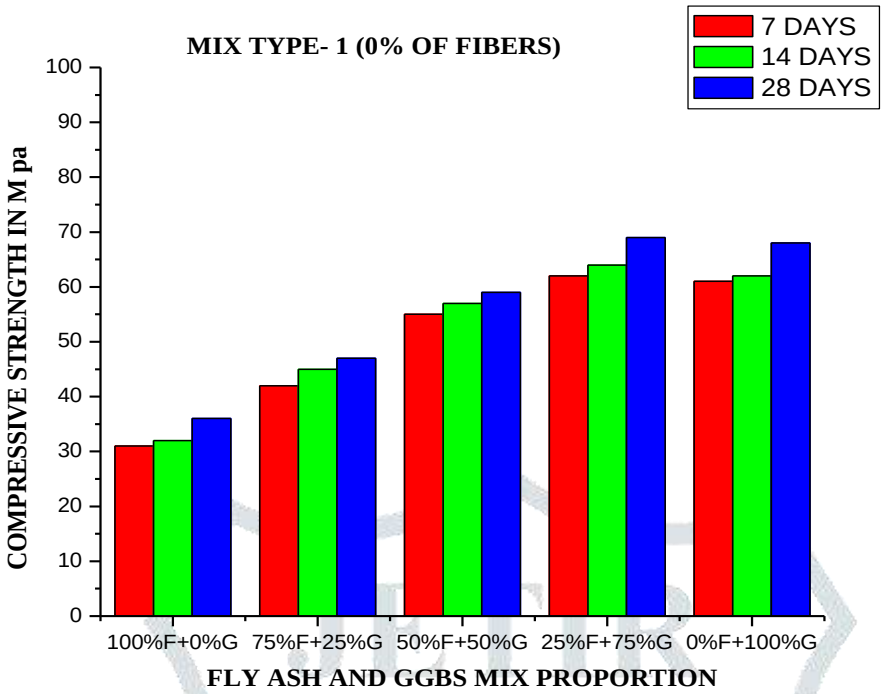
STRENGTH TEST	AGE IN DAYS	MIX TYPE- 2 (0.25%SF+0.75%PF)				
		F-100% +G-0%	F-75% +G-25%	F-50% +G-50%	F-25% +G-75%	F-0% +G-100%
COMPRESSIVE STRENGTH IN Mpa	7	33	43	56	64	61
	14	34	46	61	67	62
	28	38	49	69	73	68

Table 3.3: Compressive strength test results for combination of 0.50% of sisal and 0.50% of polypropylene fiber.

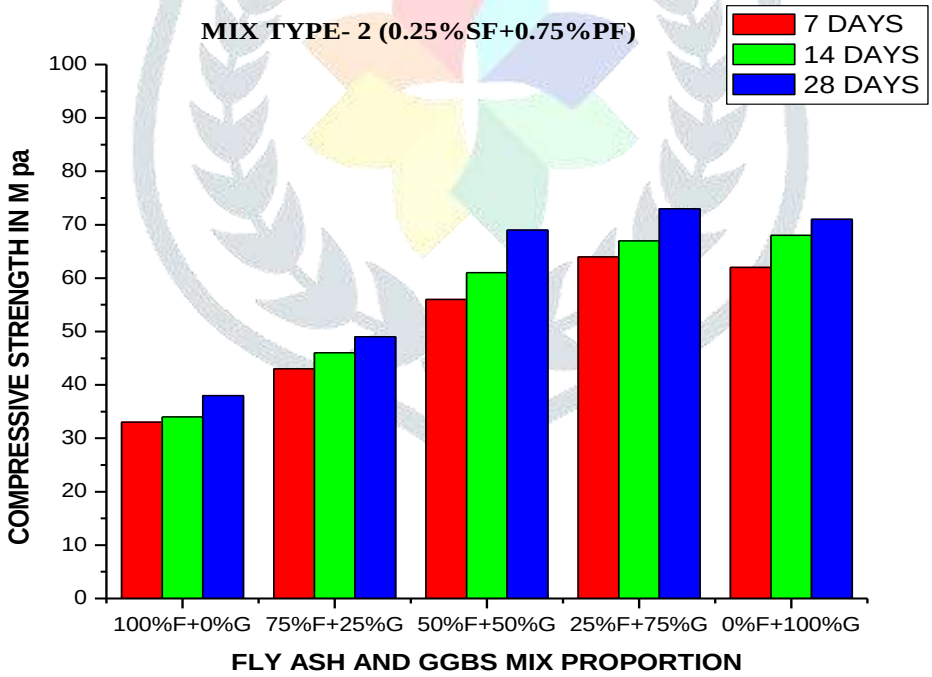
STRENGTH TEST	AGE IN DAYS	MIX TYPE- 3 (0.50%SF+0.50%PF)				
		F-100% +G-0%	F-75% +G-25%	F-50% +G-50%	F-25% +G-75%	F-0% +G-100%
COMPRESSIVE STRENGTH IN Mpa	7	34	45	57	66	65
	14	36	47	62	69	66
	28	39	51	71	76	75

Table 3.4: Compressive strength test results for combination of 0.75% of sisal and 0.25% of polypropylene fiber.

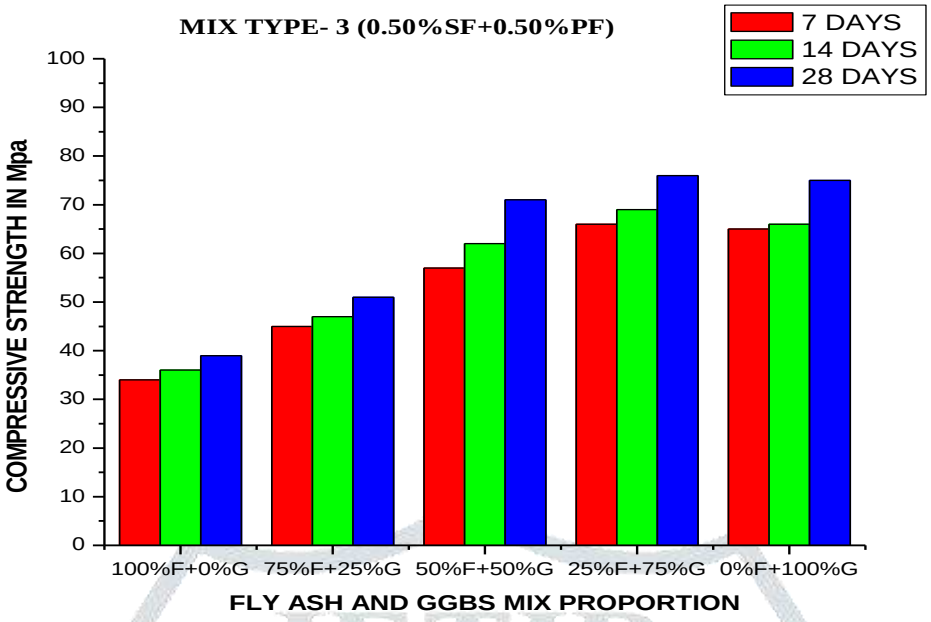
STRENGTH TEST	AGE IN DAYS	MIX TYPE- 4 (0.75%SF+0.25%PF)				
		F-100% +G-0%	F-75% +G-25%	F-50% +G-50%	F-25% +G-75%	F-0% +G-100%
COMPRESSIVE STRENGTH IN Mpa	7	33	43	55	64	63
	14	35	45	61	68	65
	28	38	50	69	75	74



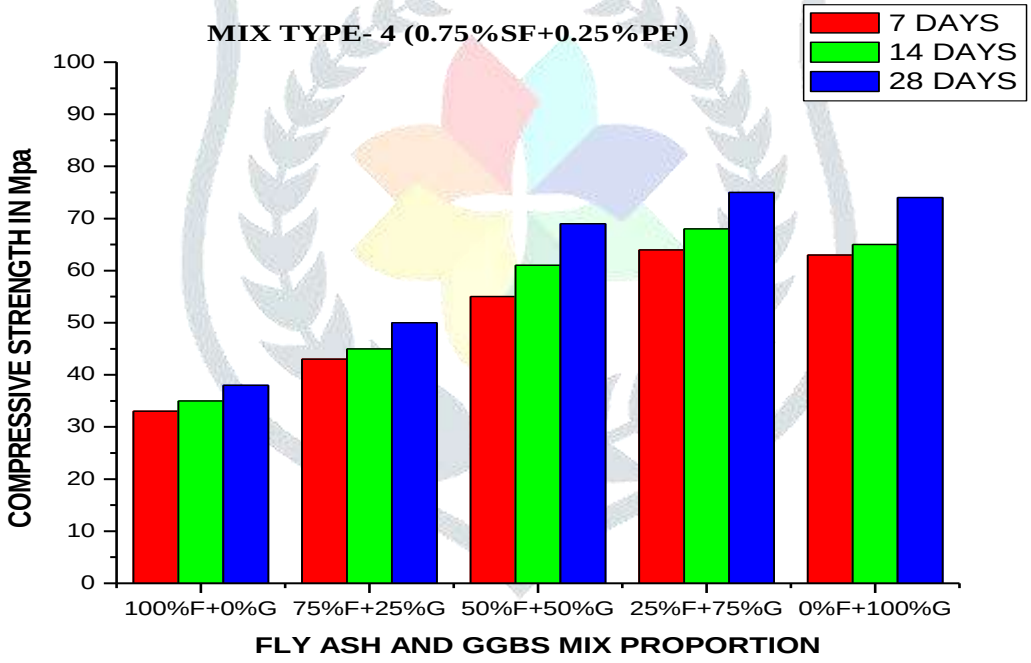
Graph 3.1: The above graph shows the 7, 14, 28 days compressive strength with 0% addition of fibers for different % of fly and GGBS mix proportion.



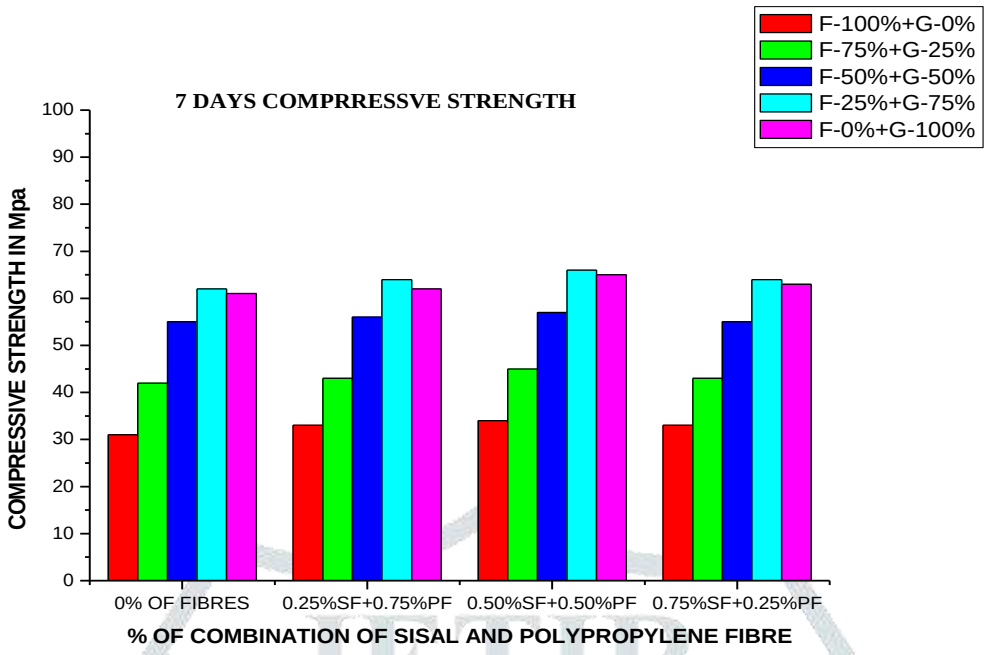
Graph 3.2: The above graph shows the 7, 14, 28 days compressive strength with addition of combination of 0.25% of sisal and 0.75% of polypropylene fibers for different % of fly and GGBS mix proportion.



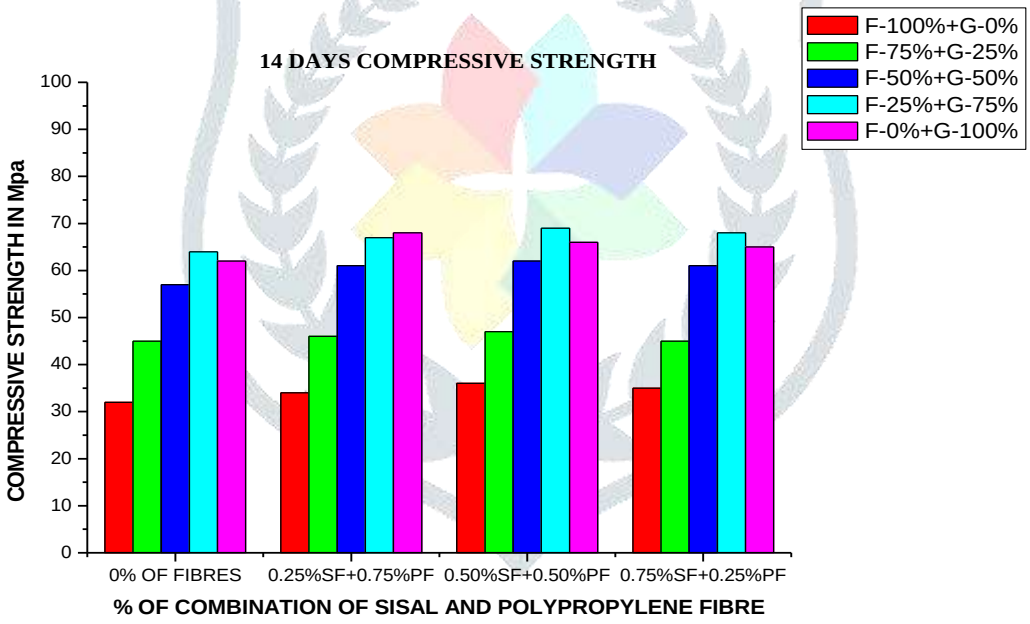
Graph 3.3: The above graph shows the 7, 14, 28 days compressive strength with addition of combination of 0.50% of sisal and 0.50% of polypropylene fibers for different % of fly and GGBS mix proportion.



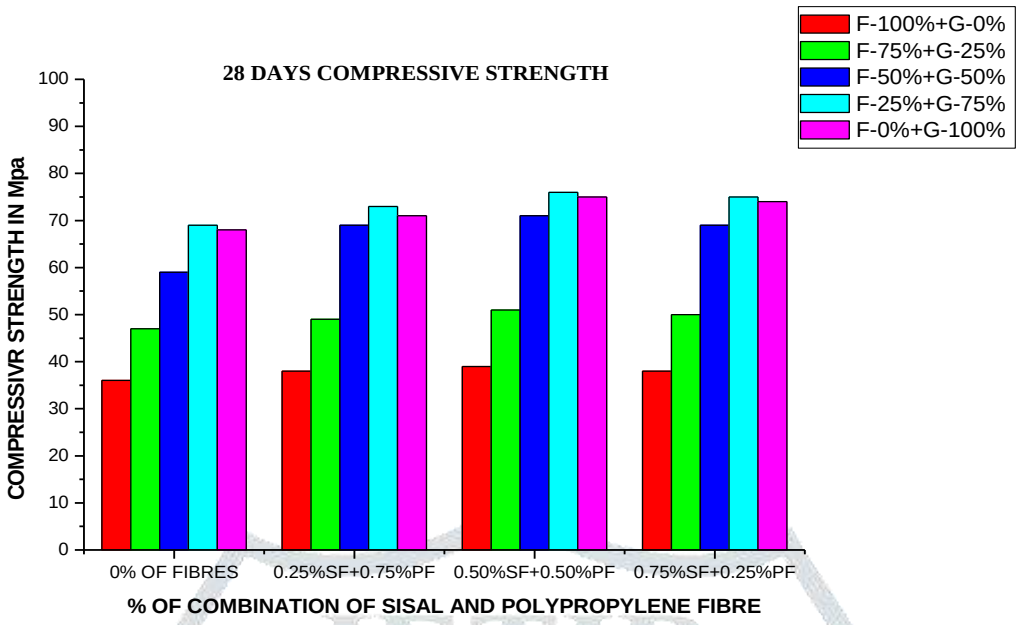
Graph 3.4: The above graph shows the 7, 14, 28 days compressive strength with addition of combination of 0.75% of sisal and 0.25% of polypropylene fibers for different % of fly and GGBS mix proportion.



Graph 3.5: The above graph shows the 7 days compressive strength with different % of addition of combination of sisal and polypropylene fibers for different % of fly and GGBS mix proportion.



Graph 3.6: The above graph shows the 14 days compressive strength with different % of addition of combination of sisal and polypropylene fibers for different % of fly and GGBS mix proportion.



Graph 3.7: The above graph shows the 28 days compressive strength with different % of addition of combination of sisal and polypropylene fibers for different % of fly and GGBS mix proportion.

IV. CONCLUSION

- The strength of compression for 0% addition of fibers (mix 1) increases with increases in number of days like 7, 14 and 28 days with increases in the percentage of GGBS with replacing fly ash in Geopolymer concrete and shows maximum value at mix proportion of 25% of FA and 75% of GG.
- The strength of compression for 0.25% of sisal and 0.75% of polypropylene fibers increases with increases in number of days for 7,14 and 28 days with 2% increases in the strength values when compare to the 0% addition fibers and similarly with mix 3, there is 2% increase in the compressive strength values when compare to mix 2.
- It was observed that the strength of compression values increases till the addition 0.75% of sisal and 0.25% of polypropylene fiber (mix 4).
- The overall strength of compression is maximum at the mix proportion of 25% of FA and 75% of GG with addition of combination of 0.50% of sisal and 0.50% of polypropylene fibers
- Hence with increase in the percentage of sisal fiber the compressive strength decreases with combination of sisal and polypropylene fiber by fixing 1% of addition of combination of fibers for overall volume of concrete.
- Hence we can conclude that Geopolymer concrete can be enhanced with addition of combination of sisal and polypropylene fiber with 0.5% sisal and 0.5% of polypropylene fiber with mix proportion of 25% of FA and 75% of GG cube by fixing 1% of volume of Geopolymer concrete to gain good strength results.

V. REFERENCES

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