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Assessment of Strength Properties for Hybrid Fiber Reinforced for Ultra High Performance Concrete

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***Abstract*: A study has been made of mineral admixtures, such as ultra-fine Fly-ash and Metakoalin, and glass fibers and polypropylene fibers, to produce high performance Concrete. Glass fiber is maintained stable by volume by 0.25 percent by cement content in varying fractions (0.5 percent, 0.75 percent & 1.0 percent) and polypropylene fiber. SP 430 is applied to the concrete mix to ensure greater workability. The grade of concrete M70 is used. The cubes, cylinders and beams are casted for different water cement ratios of 0.275%, 0.30% and 1.00%. The strength tests are carried out for 14, 28 days and durability tests are carried for 56 days. The Behavior of the HPC specimens in compressive strength, flexure and splitting tensile strength were calculated. Due to the addition of mineral admixture & fiber volume into the mix, it gives very good performance & Suitable for construction.**

***Keywords*: Ultra fine flyash, Glass fibre, Polypropylene fibre, High Performance Concrete (HPC), Super plasticizer.**

1. Introduction

Concrete is a plastic substance consisting of coarse and fine overall reinforcing aggregates, as well as a solvent (cement glue) which validates (remedies) with time. Many other – anti forms of concrete occur with varying methods for reducing overall combined, for example, dark skinned cement with a bitumen folio, that is occasionally used during front of, and silicone affirms, which use adhesives as an adhesive.

A. Hybrid Fiber Reinforced Concrete

Fiber Reinforced Concrete is a mixed breed. A compound is called a combination when at most two types of fibers are carefully combined in a standard structure and build a compound which generates gains by all of the detecting objects and exhibits a dynamic response.

Growth of small irregular strings plays an important role in improving the properties of concrete. It increases flexible density; reduces vulnerability regulates split emergence and subsequent growth and distribution. Quality of the decisions and fiber pulling in necessitate further heat storage, resulting in a substantial improvement throughout the key analytical but cracking resistance of a fabrics to linear and open spaces.

Fig. 1. Hybrid fiber reinforced concrete

B. High Performance Concrete

As compared to standard cement, Advanced concrete is a sturdy mix of strong durability and endurance. It tough includes cementing substances such as fly waste, Silica smoke, or gravitational field intensify slag, as well as a super plasticizer. The adjective 'elite' is rather personality mostly on basis that now the key aspect of the this strong was that goodies and extremes are deliberately chosen to also have particularly appropriate characteristics for the regular use of the structure, for example, high stability and high porosity. As a result, high skill concrete is not a special form of concrete. It uses the same ingredients as concrete block cement. The use of certain material and material additives, such as Silica smoke and Super plasticizer, significantly improves the strength, solidity, and functionality characteristics.

Outstanding concrete turns out that it was prudent, especially given the fact that one inherent cost is lower than those of traditional cement, since the use of High Concrete mixes in production increases the assist strength and ductility and the architecture sustains less damage, that will decrease in miscellaneous spending.

2. Objectives

1. The functionality qualities of new cement with expansion of admixtures are to be concentrated by droop cone test.
2. To decide the impacts of multi-strands, by fluctuating the level of glass filaments and saving similar rate for

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polypropylene strands. The mineral admixture like Metakaolin and ultrafine fly debris are utilized with super plasticizer for various water concrete proportion on strength and usefulness of FRHPC.

3. Cubes, chamber and crystals will be projected with incomplete concrete supplanting with differing level of water concrete proportion and tried to get Strength qualities of Concrete.
4. Attempts have made to contemplate the impacts of glass and polypropylene fiber in half breed structure on the conduct of Strength qualities of Concrete.
5. To produce financially savvy solid utilizing mechanical waste materials like Fly debris and Metakoalin.

3. Literature Review

Vigneshkannan S, Rangaraj A, Oorkalan A, Logachandran D (2020) done work on 'An Experimental Investigation on Polypropylene Fiber and Glass Fiber in High Performance Concrete utilizing GGBS as Partial Replacement of Cement' in which they did the exploratory examination on High Performance Concrete (HPC) utilizing GGBS as fractional substitution of concrete in different rates (0% 10%, 20%, 30%, 40% and half) of cement. The previous examination works were bring to advance a normal cement into uncommon cement (HPC). Material properties are assessed by leading a research facility tests (actual properties and mechanical properties). The expansion of glass fiber in various rates (0%, 1%, 2%, 3% and 4%) and polypropylene fiber in various rates (0%, 0.1%, 0.2%, 0.3% and 0.4%) by volume of concrete substance. To accomplish higher usefulness CONPLAST SP 430 is included solid blend. The evaluation of cement M35 is utilized. The two distinct filaments of cement blends were casted by as blocks, chambers and crystals. In this manner the trial results show that polypropylene fiber in HPC solid blend is more successful than glass fiber in HPC solid blend.

The given end is that The ideal amount for fractional substitution of concrete by GGBS was acquired at 40% of weight of concrete. The fractional substitution of concrete in the feeling of to diminish a concrete substance in the solid and furthermore to save the development costs. The solid blend of 40% GGBS and 0.3% glass fiber has the greatest compressive strength, Splitrigidity and Flexural Strength. Thesolid blend of 40% GGBS and 3% polypropylene fiber has the most extreme compressive strength, Split elasticity and Flexural Strength. The trial test results show that the polypropylene fiber more compelling than glass fiber.

Sudheer Jirobe, Brijbhushan S, Maneeth P. D. (2015) completed work on 'Exploratory Investigation on Strength and Durability Properties of Hybrid Fiber Reinforced Concrete' Wherein those who regarded also that magnitude of physical and mechanical properties strands were also introduced by half with maybe multiple synthesis allocations such as 0 percent, 0.5 percent, 1.0 percent, and 1.5 percent. Besides hardness limitations concrete strength, ductile, split tensile, and sway hardness examples were also did cast as well as comforted besides 28 days but also attempted for cemented concrete. Porosity process is finished for hardness research to evaluate dehydration besides curvy.

A specified final outcome is there's an enhancement in HFRC strength properties when compared to conventional are about to strand expansion. This same biggest increase in the compressive was observed when the mixture proportion was 1.5 percent, besides instance, 0.75 percent metal fibre and 0.75 percent epoxy resin. Deformation may have been reduced and for amount of 0.5 percent of layers in compare to conventional concrete, after which stiffness may increase, and the spinoff amount of 1.5 percent rejuvenates the most in comparison to certain other lengths. Elastic modulus may be highest when a wall herd quantity of 1.5 percent is compared to frequent concrete. As a result of this, we can conclude that as fibrous concentration increased, so does strength development. Impact modulus increases as the growth of fibres with in expanded. The effect strength of HFRC grows as the number of layers' increases, as does the amount of knocks required to defeat the example. As a result, influence strength increases as the number of filaments in the blend increases. Absorption increases also as stage of polymer development increases. Based on the results, we can conclude that 0.5 percent development of half and half polymers provides the same Tensile valve contrast as standard cement. The optimal strand expansion rate is 1.5 percent. Growth of layers up to 1.5 percent type identification best results overall limits when compared to other mixture limited extend.

Harish B. A, Chetan K. N, Kotresh D. N, Mamatha M. M, Nishath Anjum M, Sumanjali (2017) completed work on 'An Experimental Study on Silica Fume Concrete with Addition of Glass Fiber' where they have considered the analysis work did by silica seethe as a beneficial material for concrete and assesses concrete for M20 evaluation of cement. We are adding 0%, 5%, 10%, and 15% by weight of concrete in concrete and furthermore added glass fiber. The point of examination is study the prospects to utilize glass fiber notwithstanding different constituents of cement and strength properties. The impact of 0%, 0.5% 1%, and 1.5% fiber content by mass of concrete and angle proportion 857, fiber slice length 12mm is researched to assess the impact of glass filaments improving the properties of cement. At 1% expansion of glass fiber, 10% silica rage with water concrete proportion 0.50 the compressive strength test and split elasticity gives best outcome in concrete.

The given end is that the joining of silica smoke and glass fiber in solid causes orderly abatement in usefulness. The Compressive Strength of cement is duplicated via the utilization of silica rage upto 10percent option of concrete. From 10% there is a compressive strength diminished. The Split rigidity of cement is sped up via utilization of silica seethe as much as 10% substitution of concrete. From 10% there is a part elasticity decline. The ideal percent of elective concrete through Silica Fume is 10% for M20 evaluation of cement. At 1% expansion of glass fiber, 10% silica smolder with water concrete proportion 0.50 the compressive strength and split elasticity improved by 33.32 % and 19.73% individually.

4. Methodology

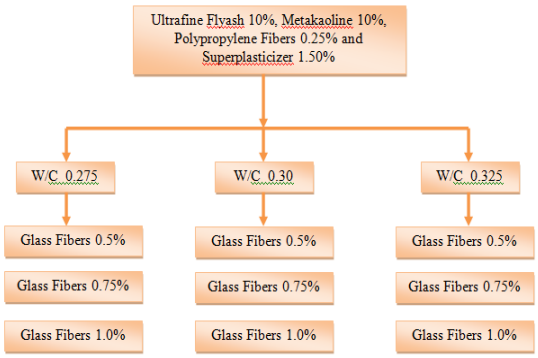


Fig. 2. Methodology

5. Materials and Experimental Details

A. *Cement*

The concrete utilized in this trial is Ordinary Portland Cement of 43 Grade, adjusting to IS8112-1989.The concrete utilized has been tried for different properties according to IS 4031–1988.

Table 1
Physical properties of cement

Physical Property	Results
Fineness	2946 cm^2/g
Norma lConsistency	31%
Initial Setting Time	55 Min
Final Setting Time	192 Min
Specific Gravity	3.15
Compressive Strength at 7 Days	38.01 N/mm^2
Compressive Strength at 28 Days	46.12 N/mm^2

B. *Ultra Fine Fly Ash*

The ultrafine flydebris having size of 3-micron meter. POOZZOCRETE 100 was utilized in the examination. The particular gravity is 1.9.

C. *Metakaolin*

The hydroxide silica form of the dirt mineral kaolinite is known as metakaolin. Raw materials rich in clays were also recognised as chinese earth or bentonite, and are commonly used in the production of porcelain. Metakaolin's molecule size is smaller than that of consolidated, but not as perfectly acceptable as that of silica rage.

Table 2
Physical properties of Metakaolin

Specific Gravity	2.55
Mean Grain Size	2.45 micron meter
Colour	Ivory to Cream

D. *Aggregates*

Table 3
Properties of sand

Properties	Values
Specific Gravity of Sand	2.48
Fineness Modulus of Sand	2.59
Bulk Density of Sand Loose State Compacted State	 15.71 KN/m^3 17.15 KN/m^3

Table 4
Properties of coarse aggregate

Properties	Values
Specific Gravity	2.69
Grading Analysis	2.18
Impact Test	9.89%
Crushing Test	24.79%
Flakiness Index	13.58%
Elongation Index	13.78%
Bulk Density Loose Compacted	 14.2 KN/m^3 15.7 KN/m^3
Water Absorption 4.75mm Retained 20mm Passing	 0.88% 0.99%

E. *Super Plasticizers*

Superplasticizers, also known as full reach solve problems in an effective, were also additives used in the creation of large compression strength. Plasticizers are substance enhancers which enable the production with concrete with approximately 15% fewer water absorption. Polymeric materials allow for a 30 percent or greater reduction in water content. SP 430 Super Plasticizers are used here.

Table 5
Typical properties

Appearance	Brown Liquid
Specific Gravity	1.18
Chloride Content	Nil
Air Entrainment	< 2%

F. *Mix Design*

The M_{70} evaluation of cement is considered for the investigation according to IS 10262: 2019.

Table 6
Mix proportions

S. No.	W/C	Glass Fibers	Ultrafine Flyash = 10% Metakaolin = 10%			Polypropylene Fibers = 0.25% Super Platicizers = 1.5%			
			Cement	Ultrafine Fly ash	Metakaolin	Fine Aggregate	Coarse Aggregate	Water	SP 430
1	0.275	0.5%	451.2	56.40	56.40	487.97	1264.93	124.08	6.77
		0.75%	451.2	56.40	56.40	487.97	1264.93	124.08	6.77
		1.0%	451.2	56.40	56.40	487.97	1264.93	124.08	6.77
2	0.3	0.5%	413.6	51.70	51.70	478.91	1211.71	124.08	6.20
		0.75%	413.6	51.70	51.70	478.91	1211.71	124.08	6.20
		1.0%	413.6	51.70	51.70	478.91	1211.71	124.08	6.20
3	0.325	0.5%	381.92	47.74	47.74	499.90	1235.77	124.124	5.72
		0.75%	381.92	47.74	47.74	499.90	1235.77	124.124	5.72
		1.0%	381.92	47.74	47.74	499.90	1235.77	124.124	5.72

Fig. 3. Mixing of materials

Fig. 4. Casting of cubes and cylinders

6. Results and Discussions

A. Tests on Fresh Concrete

1) Slump test

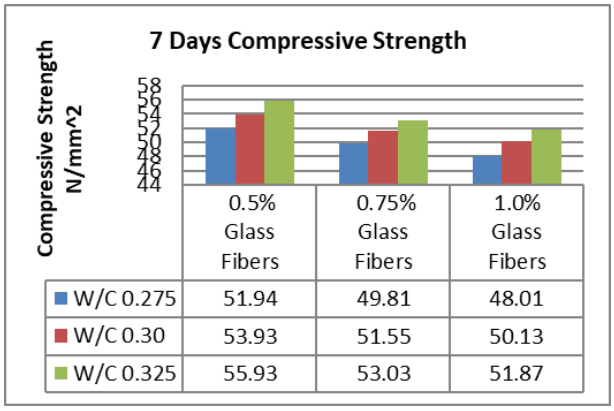
Fig. 5. Slump test

For the 0.275 water cement ratio, it is Zero slump (100mm)
For the 0.30 water cement ratio, it is True slump (80mm)
For the 0.325 water cement ratio, it is Shear slump (45mm)

B. Tests on Hardened Concrete

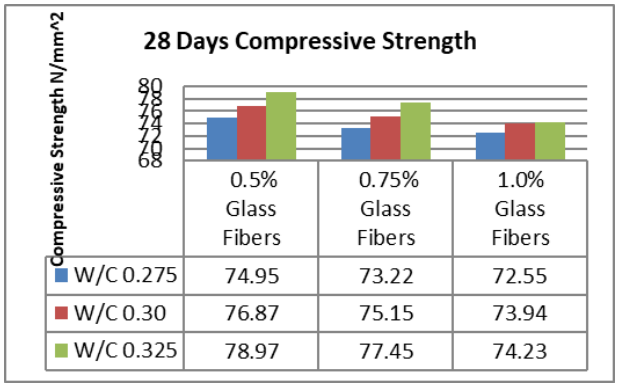
1) Compressive strength test

Fig. 6. Testing of cubes



	0.5% Glass Fibers	0.75% Glass Fibers	1.0% Glass Fibers
W/C 0.275	51.94	49.81	48.01
W/C 0.30	53.93	51.55	50.13
W/C 0.325	55.93	53.03	51.87

Fig. 7. 7 days' compressive strength



	0.5% Glass Fibers	0.75% Glass Fibers	1.0% Glass Fibers
W/C 0.275	74.95	73.22	72.55
W/C 0.30	76.87	75.15	73.94
W/C 0.325	78.97	77.45	74.23

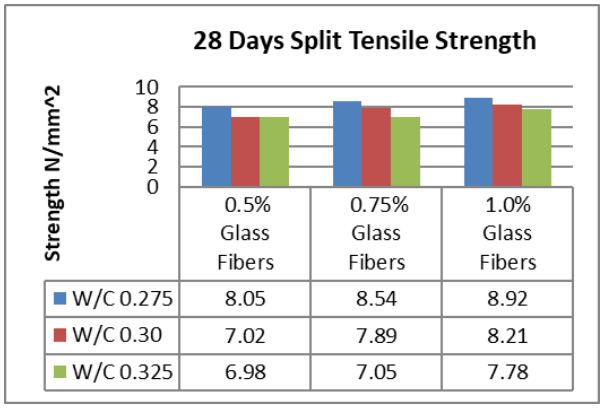
Fig. 8. 28 days' compressive strength

From 7 to 28 days, the compressive strength decreases as the liquid cement context increases, while the compressive strength increases as the glass strands expand up to 1.0 percent.

2) Split tensile strength of concrete cylinders

Fig. 9. Testing on Cylinders

Of above figure shows that the elasticity expands as the glass fibre proportion increases, while the strength decreases as the water concrete proportion increases.

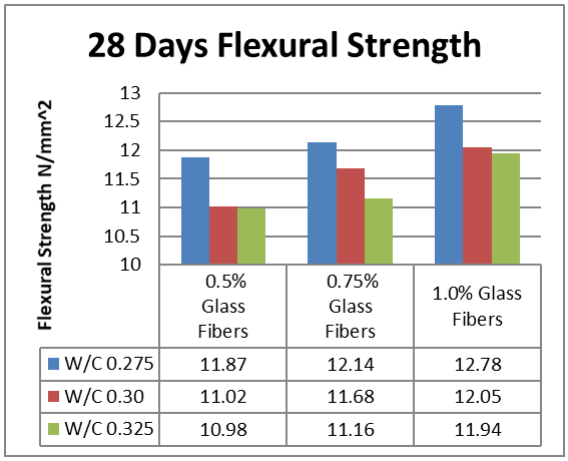


	0.5% Glass Fibers	0.75% Glass Fibers	1.0% Glass Fibers
W/C 0.275	8.05	8.54	8.92
W/C 0.30	7.02	7.89	8.21
W/C 0.325	6.98	7.05	7.78

Fig. 10. 28 days' split tensile strength

3) Flexural strength

Fig. 11. Testing on Beams



	0.5% Glass Fibers	0.75% Glass Fibers	1.0% Glass Fibers
W/C 0.275	11.87	12.14	12.78
W/C 0.30	11.02	11.68	12.05
W/C 0.325	10.98	11.16	11.94

Fig. 12. 28 days' flexural strength

For the greatest glass filaments utilized the flexural strength is expanded and as the water concrete proportion expanded the flexural strength diminishes.

C. Durability Test

1) Durability test resistance against sulphuric acid attack

For corrosive assault test solid shapes of size 100x100x100 mm are readied. The tests are led for 28 and 56 days. The examples are submerged in 5% of concentrated H_2SO_4 and

water. Rate deficiency of weight of examples and loss of compressive strength concerning referred to concrete have been determined.

2) Durability test resistance against chloride acid attack

For corrosive assault test solid blocks of size 100x100x100 mm are readied. The tests are directed for 28 and 56 days. The examples are inundated in 5% of concentrated HCL and water. Rate deficiency of weight of examples and loss of compressive strength concerning referred to concrete have been determined.

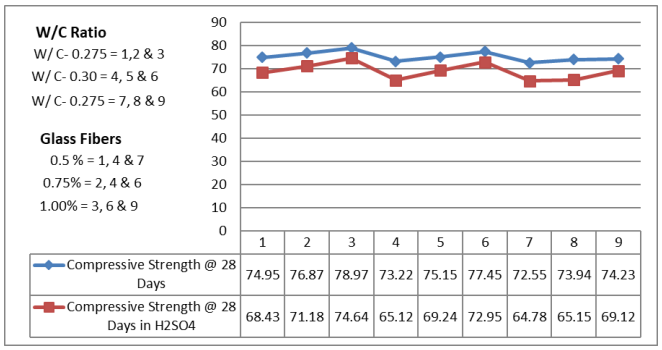


Fig. 13. Compressive strength decrease for ductility against sulphuric attack

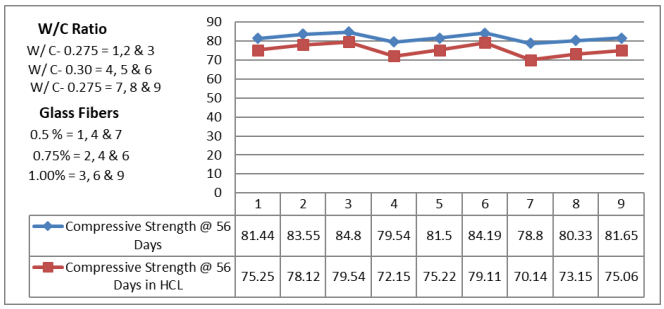


Fig. 14. Compressive strength decrease for ductility against chloride attack

As the water concrete proportion builds the strength additionally diminishes and furthermore as the glass filaments expands the solidness increments up to 1.0%.

7. Conclusion

1. Admixtures like mineral admixtures and compound admixtures will build the usefulness and strength of cement.
2. Fibers increment the compressive strength of the solid and furthermore oppose abrupt breakdown in solidified state.
3. Increasing the level of volume part of cross breed fiber diminishes the droop esteem, to keep up the steady droop we need to build the super plasticizers portion in concrete.
4. As the water concrete proportion expands the compressive strength of the solid blocks additionally diminishes. Essentially for the split malleable and flexural strength. Be that as it may, there is expansion in their solidarity as the glass filaments expanded up to 1.00%.
5. Durability of the concrete
   - In concentrated H2SO4 and HCL the strength of solid declines as the water concretes proportion increments.
   - In strength against sulphuric corrosive assault, most extreme rate decline is 9.78% and least rate decline is 5.50%.
   - In strength against chloride corrosive assault, greatest rate decline is 9.39% and least rate decline is 5.4%.
6. The test examination demonstrate that the joined impact of polypropylene fiber and glass fiber improve strength qualities of cement. Likewise, these examinations demonstrate that multi fiber supported cement with mineral admixtures seems, by all accounts, to be a promising material on account of designs which require high strength and pliability
7. The mineral admixtures like fly debris, silica smolder are results of modern waste and they have no further use in any creation cycle. This remaining parts as waste and ought to be arranged off. Be that as it may, these items have high cementitious properties which can supplant concrete somewhat.

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