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A REPORT SUBMITTED ON AN ANALYTICAL STUDY OF HYBRID FIBRE REINFORCED CONCRETE

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Abstract

Concrete is a very adaptable material that may be used in a variety of environments, including extremely hot and cold temperatures, in chemically charged conditions, and in atomic reactors. In addition to having very low tensile strength and very limited flexibility, concrete also has very strong compressive strength and negligible crack resistance. Concrete naturally contains internal microcracking, and because of the spread of these microcracks, which causes brittle concrete fracture, the tensile strength of concrete is inadequate In hybrid fiber reinforced concrete (HFRC), two or more types of fibers are strategically blended and added to the concrete to create a composite material that benefits from each of the individual fibers and exhibits a synergistic reaction. The primary goal of the current experimental inquiry was to create HFRC using various glass fiber and galvanized steel fiber fractions and to assess its performance under compression and flexure strength as well as study the behavior of fibre as a crack arrestor. Based on IS Code method of mix design of concrete for grade M30 is carried out and proportion of different ingredients of concrete is obtained. Grading is done according to IS Code method prescribed in IS: 10262-1982. Samples were prepared various proportions of these two fibers. The weight of the cement prevents the fiber content from exceeding 3%. Five samples are prepared with different ratio of steel & glass fibre. To identify the best sample outcome, the strength of each specimen is examined.

INTRODUCTION

Fine aggregate, coarse aggregate, water, and cement are the main ingredients of concrete. Concrete is very hard and strong like hard stones, the reason of this the chemical reaction which take place between water and cement. Concrete's most adaptable use in the construction sector is its biggest benefit. Concrete is the versatile material which can be mould in any desirable shape and fit to cast from ordinary rectangular or circular structure to dome or hemispherical shape. The strength of concrete keep on increases with age up to a limit and it has least maintenance during the service period of structure as compare to other construction materials like steel, wood etc. However, because concrete is fragile and weak under tension, it breaks easily. For this reason, concrete needs reinforcing to be stronger and more durable. Hybrid fibre reinforced concrete is an attempt for enhancing the inherent property of concrete to make it more valuable. Fibre

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reinforced concrete can be considered to be a composite material made using concrete and short, discrete, and randomly distributed fibers. Research and development work in Fiber Reinforced Concrete (FRC) started in India at the early 1970. Fiber reinforced concrete was developed to overcome the problems associated with cement based materials such as low tensile strength, poor fracture toughness and brittleness of cementitious composites. Hybrid Fibre reinforced concrete is used to increase the tensile strength and toughness of concrete. Within the concrete matrix, the fiber is dispersed at random. FRC was first mainly utilized for industrial floors and pavements. But now a day, the FRC composite is being used for a wide variety of applications including bridges, tunnel and canal linings, hydraulic structures, pipes, slab, precast etc. Hybrid Fibre concrete also used use in the repair work of structure to avoid spalling of concrete from repair structure. The use of HFRC in structural members such as beams, columns, staircase, slabs and pre-stressed concrete structures is being investigated by a number of researchers at present in India and abroad. Basically fibers can be divided into following two groups: Fibre may have various types and size, basically classified as i) Natural fibre & ii) Artificial fibre. Natural fibre like sisal, baggase ash, banana, soya bean, animal hair etc and artificial fibre like nylon, steel, glass, recron , polypropylene, asbestos etc. Another classification of fibre is based on modulus of elasticity of fibres as compare to cement matrix. In this way fibre can classified as fibre with lower moduli than cement matrix such as polypropylene, cellulose, coir, etc and other one is classified as moduli greater than cement matrix such as steel, glass, asbestos etc.

A composite fibre reinforced concrete enhances the compressive stress, strain and flexure and split tensile strength of concrete. Additionally, fibers serve as a crack arrestor and slow the spread of cracks in concrete. In order to create hybrid fiber reinforced concrete (HFRC), various fiber types are mixed together. These fibers keep their individuality and material capabilities while remaining linked to one another when added to concrete.

The function of steel fiber to enhance the strength of concrete in fiber reinforced concrete under compression and flexural strength and glass fibre reduce the brittleness also act as a crack arrestor. So the combination of two different nature of fiber shows better prospect for hybridization. HFRC can sustain large degree of deformation. For comparative evaluation of performance, six different types of sample and 9 different types of specimens for each sample were prepared and tested under UPV, compression and flexural strength. M30 grade concrete is prepared, among six samples first sample S0C0 is prepared with without fibre and others samples are made with the fraction of steel is 3%, 2%, 1.5%, 1%, & 0% and respectively glass fibre in the same sample is 0%, 1%,1.5%, 2%, & 3%. Combined fraction of fibre in concrete is kept 3% by the weight of cement. Here the numbers shows the fraction of fibre in percentage by the weight of cement.

LITERATURE REVIEW AND PROBLEM IDENTIFICATION

INTRODUCTION

The second most common material on Earth, after water, is concrete. Concrete is a versatile construction material which can be cast to fit any structural shape from ordinary rectangular or circular structure to dome or shell structure. Concrete is good fire resistant, water resistant, chemical resistant, durable and requires minimum maintenance during service life. Basically concrete is strong in compression but weak in tension. Many researches had been done for enhancing the intrinsic properties of concrete by adding various kinds of fibrous material such as steel baggase, glass, sisal, recron, coconut coir, asbestos etc. Introducing hybrid fibre is an effort to improve the inbuilt property of concrete.

LITERATURE SURVEY

(2018) Priyaranjan Pal [1] To ascertain the dynamic Poisson's ratio and elastic modulus of pozzolana Portland cement concrete, an experimental examination was conducted. For the purpose of the experiment, several concrete cubes were made and analyzed in the lab. Concrete cubes of various ages were subjected to destructive and non-destructive tests. To determine the compressive strength of concrete cubes, a destructive test was performed. According to IS 13311 (Part 1), the ultrasonic pulse velocity of cube specimens was calculated, and the transit duration of longitudinal and shear wave transmission was noted. The dynamic Poisson's ratio and elastic modulus of concrete are calculated using the recorded measurements.

(2014) Ozge Andiç [2] This study examined significant mechanical and physical characteristics of cement composites made with fine aggregate and fibers. Fiber included composites were made by adding 0.4%, 0.6%, and 0.75% fiber by weight of the total mixes, respectively, in addition to control mortar mixtures without fiber inclusion.

G. Ruby Selina, C. Geethanjali (2014) [3] hybrid fiber reinforced concrete for M40 grade concrete has been studied Steel fiber and polypropylene are combined in this hybridization. Concrete that has been reinforced with fibers improves the structural integrity of the concrete. The concrete mix containing 0.75 percent steel and 0.25 percent polypropylene fiber fraction produced the best results. Hybrid fiber exhibits a delay in the cracking load and ultimate load when single fiber and hybrid fiber concrete beams are compared.

Vaibhav Dhawale and Shrikant Harle (2014) [4] the various Natural Fiber Reinforced Concrete were contrasted. The comparative analysis of fiber shows that, to a certain extent, the compressive strength of concrete increases as the percentage of natural fibers grows, while the value of slump falls as the percentage of natural fiber increases. Additionally, it was shown that as the percentage of natural fibers rises, so does the flexural strength.

R. Vasudev and B.G. Vishnuram (2013) [5] Concrete with steel fiber reinforcement has been studied as a sustainable approach. Separately, other studies on steel-fiber reinforced concrete have been conducted. Steel fibers come in a variety of shapes, sizes, geometries, and resources. According to the cement volume fraction, steel is added at 0%, 0.25%, 0.50%, 0.75%, and 1.0% in this study. For the investigation, two distinct concrete mixtures—M20 and M30—with variable percentages of steel fiber are used. The performance of steel fiber is quite good; it increases tensile strength by up to 100% and also increases compressive and flexural strength when added. Studies demonstrate that adding steel fiber to cement up to 0.5% by volume enhances performance, but adding more fiber often has no effect.

B. Rajarajeshwari Vibhuti, N. Arvind et al (2013) [6] have reported that hybridization of fibers is superior than single fibers in experimental research on the mechanical properties of hybrid fiber reinforced concrete in pavement. The compressive strength increased by around 17% as a result of hybridization. The split was encouraged by hybridization

flexural strength and tensile strength by 52.87% and 34.25%, respectively. The HFRC's increased mechanical characteristics would reduce warping strains and both short-term and long-term cracking.

Mohammad Adnan Farooq, Dr Mohammad Shafi Mir (2013) [7] Found fibers improve the fundamental qualities of reinforced concrete while also altering the material's properties, turning it from brittle to ductile. The research done to ascertain how changes in fiber volume fraction and fiber aspect ratio affect the workability of new concrete as well as the compressive, flexural, and split tensile strengths of hardened concrete is presented in this study. The analysis establishes the ideal volume fraction and aspect ratio of fiber needed to provide the desired workability and maximum strength. The investigation reveals that, whereas flexural strength exhibits varied behavior, compressive strength and split tensile strength behave similarly for a range of fiber contents and aspect ratios. According to this study, it was shown that when aspect ratio is increased, fiber workability gradually declines. Additionally, it was discovered that 1% steel fiber produces the best compressive and flexural results when aspect ratio is taken into account, which is 63.

Researchers **R. N. Nibudey and Dr. P. B. Nagarnaik (2013) [8]** examined how to forecast the strength of concrete reinforced with plastic fibers. Additionally, this study aims to safeguard the ecosystem from incorrect garbage management. According to the study's findings, concrete loses density and, at 1% fiber inclusion, compressive strength and split tensile strength both rise by

4.3% and 11.2%, respectively.

S. C. Patodi and C. V. Kulkarni (2012) [9] conducted research on the hybrid fiber, which is a mixture of two fibers. To enhance the inherent qualities of concrete and mortar, fibers have been employed in both materials for many years. "Hybrid Fibre Reinforced Concrete Matrix Performance Evaluation." In this study, concrete is mixed with recron fiber and steel fiber in varying proportions. Some gratifying outcome has emerged. Concrete's flexural and tensile strength is increased by hybrid fiber.

The creation of fibers was made possible by **M. Sivaraja's presentation of an R&D project report in 2010 [10]** on the issue of using fiber as a composite for disaster-prone structures and studying typical investigations to reduce concrete's post-yield energy absorption.

Discrete fibers embedded into the mass of concrete are used to reinforce it. The Central Institute of Technology, located in Bangalore, has received the investigative report.

In his research, **Ali Majid (2010) [11]** came to the conclusion that coconut fibers are versatile and can be used in a variety of industries. According to reports, coconut fibers are the most ductile and energy-absorbing substance. The study's findings support the possibility of using coconut fibers in composites for a variety of uses. In this work, the usage of coconut fiber for reinforcement is described. Discussion of the physical and chemical characteristics of fiber.

According to **Shahiron Shahidan (2009) [12],** the behavior of steel fiber reinforced concrete is obvious since the volume percent of the fibers varies. When steel fibers were present in concrete at volume fractions of 1%, 1.5%, and 2.0%, the compressive strength increased from 3% to 26%. The trials show that 2% fiber content produces the best results, and a 26% increase in compressive strength is observed.

(2007) Baruah and Talukdar [13] Compressive strength, split tensile strength, rupture modulus, shear strength, and toughness constantly increase up to 2% volume fraction of concrete in the investigated fiber reinforced concrete with the volume fraction 0%, 0.5%, 1.0%, 1.5%, and 2.0% by the volume fraction of concrete.

According to **P. P. Yalley and A. S. K. Kwan's** experimental study on "Use of coconut fibres as an enhancement of concrete" from **2005 [14]**, the addition of coconut fiber significantly improves the many engineering properties of concrete, such as torsional strength, toughness and tensile strength, and resistance to cracking. however, negatively impact concrete's compressive strength. It is also done to compare the results for fibers with varied aspect ratios.

In 2002, **M. Nataraja [15]** did research on SFRC in compression. Compressive specimens with strengths ranging from 30 N/mm2 to 50 N/mm2 are cylindrical. For two alternative aspect ratios, 55 and 82, round crimpled steel fibers with volume fractions of 0.5, 0.7, and 1 are taken into consideration. It was determined that fiber improved the toughness and compressive strength.

Steel fibers have been tested to see how they affect the strength and quality of concrete by **Balaguru and Shah (1992) [16].** The author has noted how the shape, volume percentage, and aspect ratio of steel fibers affect concrete's strength.

Compressive strength of steel fiber reinforced concrete (SFRC) is found by **H.V. Dwarakanath and T.S. Nagaraj (1991) [17]** to increase sharply with increase in fibre content up to 1% by volume, and beyond this ratio, fiber strength decreases. Additionally, compressive strength is said to rise with aspect ratio up to 60. Additionally, the author conducted a comparative analysis to predict the flexural strength of steel fiber concrete.

Short steel fiber boosts the tensile strength of concrete even at low volume fractions, according to a study by **Goash et al. (1989) [18]** on the tensile strength of steel fiber reinforced concrete. With a fibre content of 0.7% by volume, the split tensile strength was enhanced by 33.14% and the ideal aspect ratio was discovered to be 80.

Otter and Naaman (1988) [19] demonstrated that the volume fraction of steel fiber utilized is directly proportional to the compressive strength of lower strength concretes, which is much higher than that of plain unreinforced concrete. Compared to straight steel, hooked fibers see a greater rise.

Lee S. L., Paramsivam P. Das Gupta, and others (1979) [20] The authors came to the conclusion that beyond a certain length and volume proportion of fibers, the tensile strength and rupture modulus of fiber concrete matrix increased, and that an additional increase in length or volume fraction lowered the strength of concrete.

METHODOLOGY

CONTENT OF MATERIAL

i) Portland Pozzolana cement (PPC)

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ii) Fine aggregate (FA)
iii) Coarse aggregate (CA)
iv) Fly ash
v) Galvanized Steel fiber (GSF)
vi) Glass Fibre (GF)

PHYSICAL TEST OF MATERIAL

SPECIFIC GRAVITY OF CEMENT

The weight of cement to the weight of an equivalent amount of kerosene oil is known as the specific gravity of cement. The density bottle method is used to determine it. The calculation's output was 2.99.

Specific gravity (G) = $(W_2-W_1)/((W_2-W_1)-(W_3-W_4))*S_k$

W_1= weight of empty density bottle = 30.5 gm

W_2 = weight of density bottle with cement = 82.5gm

W_3 = weight of density bottle +cement +kerosene=137.96gm W_4 = weight of density bottle full with kerosene = 98.5 gm

S_k = Specific gravity of kerosene (0.79)

SPECIFIC GRAVITY OF FINE AGGREGATE

By using the pycnometer method, the specific gravity of fine aggregate is assessed in a laboratory.

Specific gravity (G) = $(W_2-W_1)/(W_2-W_1)-(W_3-W_4)$

W_1= weight of empty pycnometer bottle = 642 gm

W_2 = weight of pycnometer bottle with sand = 1018 gm

W_3 = weight of pycnometer bottle +sand+full water =1889gm W_4 = weight of pycnometer bottle full with water = 1658 gm

The calculation's output was 2.593

SPECIFIC GRAVITY OF COARSE AGGREGATE

Specific gravity (G) = $(W_2-W_1)/(W_2-W_1)- (W_3-W_4)$

W_1= weight of empty pyscnomete = 642gm

W_2 = weight of pycnomete with dry sand = 1127gm

W_3 = weight of pycnomete sand and full water = 1962gm

W_4 = weight of pycnometer full with water = 1658gm

G = 2.68

MOISTURE CONTENT OF FINE AGGREGATE

The oven dry method is used to determine moisture content. It weighs a sample of sand that has been taken. Sand is placed in a tray, spread evenly over the surface, and kept in an oven set at 1100C for 24 hours. Additionally, the fine aggregate has a moisture content of 1.74%.

MOISTURE CONTENT OF COARSE AGGREGATE

The oven dry method is used to determine moisture content. Weighing is done on a sample of coarse aggregate. The coarse aggregate is placed in a tray, spread evenly, and kept in the oven for 24 hours at 1100 C. Additionally, the aggregate's moisture content is 0.96%.

METHOD OF EXPERIMENTAL INVESTIGATION

The entire experimental process is made up of many steps. Specimens made of composite fibers are prepared for the examination of hybrid fiber reinforced concrete. As a result, the entire approach can be divided into the primary categories listed below for carrying out the task that corresponds to the flow chart.

CONCRETE MIX DESIGN

The fundamental premise behind mix design is that the water to cement ratio mostly determines the compressive strength of workable concrete. The process of choosing appropriate concrete materials and figuring out their relative proportions with the goal of making concrete with a particular minimum strength and durability as cheaply as feasible is referred to as the "mix design principle." Consequently, the primary mix design goal is to meet the required minimum.

compressive endurance and strength. The production of concrete economically is the second goal. Trial mixes were made in accordance with the IS code procedure outlined in IS: 10262 -1982.

STEPS FOR M30 MIX DESIGN CONCRETE

Mean target strength (f_t)= 38.25 N/mm^2

(i) Adopted w/c ratio= 0.45

(ii) Workability= 125 mm

(iii) Water content (W) = 186 kg/m^3

(iv) Sand percentage= 35 %

(v) Difference in w/c ratio= 0.50-0.45 = 0.05

(vi) Correction in water content and sand content

Required water content = 186 + 9* 186/100= 202.74 kg/m3

Adopted Volume of coarse aggregate = 0.64+0.01=0.65 Volume required sand content= 0.35

(vii) Expected entrapped air for 20 mm aggregate = 2 %

(viii) For absolute volume(V) = 1 cum

(ix) Coarse aggregate (C_a)= (1-P)/P*f_a*Sc_a/S_{fa}

(x) Determination of cement content Adopted W/C Ratio= 0.45 Water= 202.74 Kg/m^3

In case of admixture reduce 9% water content from estimated value. So adopted water content = 202.74- 0.09*202.74= 184.5 kg Cement content = 184.5/0.45= 410 Kg

xi) Determination of admixture Volume of admixture =1.2% of cementitious material= 1.2* weight of cement/ sp. gravity of admixture*1000 0.0044 m^3

(xi) Determination of fine aggregate and coarse aggregate a) Volume of C.A and F.A = 1- { 184.5/1000 + 410/1000*2.99 +0.02+0.0044}= 0.654 cum Mass of coarse aggregate= 0.654*0.65* 2.68*1000= 1139.44 kg/m^3 Adopted mass of coarse aggregate= 1140 kg/m^3b) Mass of fine aggregate =0.654*0.35*2.59*1000= 592.8 kg/m^3 Adopted mass of coarse aggregate= 593 kg/m^3

(xii) Calculation for quantity of fibre:In the following table quantity of fibre is determined by the weight of cement, Quantity of fibre is calculated for one cubic meter concrete given in following table

Sample	Ratio	For one cubic meter of concrete	
		Steel fibre (Kg)	Glass fibre (Kg)
Sample I	S0G0	0	0
Sample II	S3G0	12.3	0
Sample III	S2G1	8.2	4.1
Sample IV	S1.5G1.5	6.15	6.15
Sample V	S1G2	4.1	8.2
Sample VI	S0G3	0	12.3

PREPARATION OF SAMPLE

Six samples of various fiber fractions were created; these samples are S0G0, S3G0, S2G1, S1.5G1.5, S1G2, and S0G3. The percentage of fiber is indicated by the number. Steel fibers are cut into 40 mm long pieces with a 0.5 mm diameter. The glass fiber is 20 mm long with a diameter of 14 microns. Table 3.8 below provides the amount of fibers used in each sample, while Table 3.9 lists the amount of concrete's ingredients. the amount of fiber determined by the fluctuating ratio of fiber to cement weight.

Ingredients	Sample I	Sample II	Sample III	Sample IV	Sample V	Sample VI
	S0G0	S3G0	S2G1	S1.5G1.5	S1G2	S0G3
Steel Fibre	0%	3%	2%	1.5%	1%	0%
Glass Fibre	0%	0%	1%	1.5%	2%	3%

Samples	Quantity of ingredient for each sample (in Kg)						
	Water	Cement	F.A	C.A	Steel fibre	Admixture	Glass fibre
S0G0	10	22.25	32.3	62.15	0	0.267	0
S3G0	10	22.25	32.3	62.15	0.665	0.267	0
S2G1	10	22.25	32.3	62.15	0.445	0.267	0.222
S1.5G1.5	10	22.25	32.3	62.15	0.333	0.267	0.333
S1G2	10	22.25	32.3	62.15	0.222	0.267	0.445
S0G3	10	22.25	32.3	62.15	0	0.267	0.665

LABORATORY TEST OF CONCRETE

- Workability, which is defined as the ease and uniformity of the concrete mix during mixing, transporting, putting, and compacting without segregation, is a crucial component of fresh concrete.
- The most popular technique for gauging concrete consistency is the slump test, which can be carried out either in a lab or on the job site. Concrete that is too wet or too dry is not a good candidate for this procedure.

Samples	S0G0	S3G0	S2G1	S1.5G1.5	S1G2	S0G3
Slump value(mm)	128	127.5	124.5	123	118	105

PREPARATION OF MOULD AND CASTING OF SPECIMENS

a) Cube mould of size 150mm X 150mm X 150mm
b) Beam mould of size 100mm X 100mm X 500mm

Before filling with concrete, the cube and beam cast iron molds are kept ready; all bolts are tightened, the interior of the mold is properly cleaned, and oil is applied within the plate. When casting cubes, the mould is partially filled with concrete and vibrated for 30 seconds, then it is fully filled and vibrated for 60 seconds, then the top surface of the mould is finished using a trowel. For the beam, concrete is poured in two layers, with each layer being vibrated into place for 30 seconds. The top of the concrete is finished using a trowel, and the molds are kept at standard room temperature. There are six samples created using various fiber fractions. Each sample has three beam specimens and six cube specimens. Total 36 number of cube and 18 number of beam specimens are prepared.

CURING OF SPECIMEN

After the concrete examples are cast, they are initially allowed to set at room temperature for 24 hours between 240 and 300 C before being placed in a water tank to cure. Three of each sample's cubes are aged for curing for 7 days, while the other three are aged for 28 days. Each sample's three beams undergo a 28-day curing process.

TESTING OF CONCRETE SPECIMENS

ULTRASONIC PULSE VELOCITY

Concrete's quality and integrity are evaluated using the non-destructive testing technique known as ultrasonic pulse velocity (UPV) testing. It determines the uniformity, homogeneity, and existence of faults such as fractures or cavities by measuring the velocity of ultrasonic pulses traveling through the concrete.

Data Analysis: Calculating the pulse velocity of the ultrasonic waves in the concrete is done using the recorded time. By dividing the distance between the two transducers by the duration of the ultrasonic pulses, the pulse velocity is calculated.

Interpretation: To evaluate the state of the concrete, the pulse velocity is compared to specified norms or reference values. Lower pulse velocities may signify the existence of flaws or deterioration, while higher velocities often indicate good-quality and well-compacted concrete.

COMPRESSIVE STRENGTH

After the curing process is complete, the cubes are removed from the curing tank and tested. The water is then wiped off using a dry cloth. Consider the specimen's weight when calculating the sample cube's density. Keep the specimen inside the compression testing apparatus or the universal testing apparatus at this time. Calculate the load-bearing area's size. The specimen is loaded gradually until it can bear no more weight, at which point the cube's maximum load is recorded. Other samples are examined in a similar manner, and the load is reduced. By dividing the load by the load bearing area, compressive stress is computed. The average value of compressive stress is then calculated for each specimen. Greek letter sigma () stands for compressive strength.

FLEXURAL STRENGTH

This test is performed on the beam 28 days after curing. From the water tank, beams are removed and cleaned with a dry cloth. A 50mm distance from the beam's edge is measured, marked, and the beam's center is also marked. The beam is ready for testing; it is maintained in a simply supported position, and load is imparted using a roller mounted in the beam's center. The

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specimen is loaded at a rate of 18 kg per minute, and the weight is increased until the test object fails. The maximum load given to the test object is recorded. Failure is indicated by the presence of a fracture on the beam's face. The phrase "modulus of rupture" is used to describe the specimen's flexure strength.

RESULT ANALYSIS AND DISCUSSION
INTRODUCTION

The experimental examination was carried out using beams and cubes for testing. In a laboratory, six separate samples are created, each including three beam specimens and six cube specimens. There are six samples with various fiber contents. Prior to testing for compression and flexural strength, each cube and beam has its ultrasonic pulse velocity and the traveling velocity of a pulse generated by an electronics circuit through concrete determined. Then, three of these six specimens from each sample are examined for the cube's 7-day compressive strength and the cube's 28-day compressive and flexural strength, respectively.

TESTING OF SPECIMEN

18 beams and a total of 36 cubes are cast for the experimental investigation of the results. Three distinct tests are performed on two different types of specimens. Tests are run across two distinct time periods. Three cube samples of each sample are removed from the curing tank after seven days and put through a compression test. At the age of 7 days, all six samples are subjected to a compression test, with readings being recorded.

The remaining specimens are held in curing for a further 28 days, after which the cubes undergo a UPV test, a compression test, and a flexural strength test to determine the modulus of rupture. All six samples are subjected to a comparable test protocol, and the findings are meticulously tabulated for each specimen.

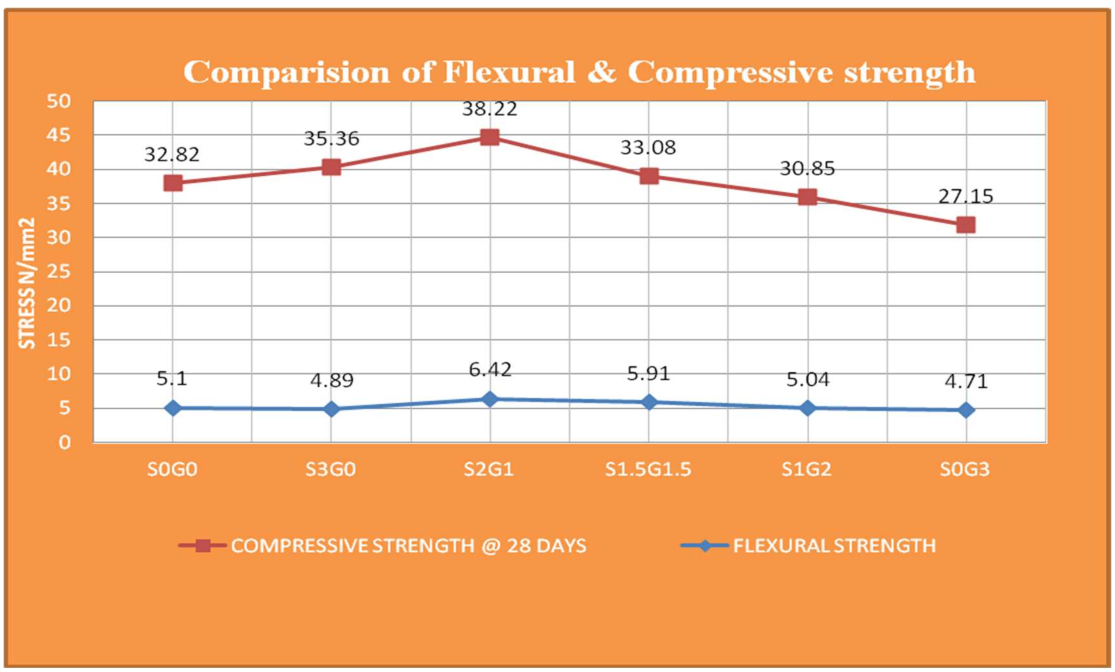
Sample	Specification	Average Density (Kg/m^3)	Mean Compressive strength (N/mm^2)		Mean Flexure Strength (N/mm^2)	Mean UPV (m/s)
			7 days	28 days		
Sample I	S0G0	2503.7	21.95	32.82	5.10	3831.33
Sample II	S3G0	2564.74	23.27	35.36	4.89	4001.67
Sample III	S2G1	2499.36	24.75	38.22	6.42	4107.33
Sample IV	S1.5G1.5	2493.92	22.26	34.08	5.91	3907.00
Sample V	S1G2	2484.45	20.13	30.85	5.04	3717.67
Sample VI	S0G3	2479.55	17.50	27.15	4.71	3704.67

COMPARISON OF RESULTS

Results are being compared to establish the ideal fiber fraction in the sample. Results are compared according to specimen compressive strength testing for seven days and 28 days, with the best outcome among the sample being highlighted. Similar to this, the modulus of rupture of each sample at the age of 28 days is compared to the results of the UPV test, and the results are compared across all samples. Each sample's peak value is highlighted.

COMPARISON BETWEEN COMPRESSIVE AND FLEXURAL STRENGTH

It is proven that flexural strength and compressive strength are related. The graph's representation demonstrates a linear relationship between compression and flexural strength. The sample's flexural strength, which is lower due to lower compressive strength, rises as the corresponding value rises.



DETERMINATION OF POISSON’S RATIO AND MODULUS OF ELASTICITY

Numerous investigations looked into the connections between the Poisson's ratio, elasticity moduli, density, and typical compressive strength of concretes. The elastic moduli and dynamic Poisson's ratio of concretes with M-30 grades are derived in this work, and the resulting correlations are shown below.

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SAMPLE	Average Density (Kg/m^3)	Mean Compressive strength (N/mm^2)	UPV (km/s)	Dynamic Poisson's ratio (μ_d)	Modulus Of Elasticity (E)
				$\mu d = 3.537\rho^{1.5}\sqrt{f_{ck}}\ x10^{-7}$	$E = \frac{\rho(1+\mu)(1-2\mu)V^{\wedge}2}{(1-\mu)}$
S0G0	2503.7	32.82	3.83133	0.254	30403.98
S3G0	2564.74	35.36	4.00167	0.273	32635.91
S2G1	2499.36	38.22	4.10733	0.273	33502.44
S1.5G1.5	2493.92	34.08	3.907	0.257	31290.48
S1G2	2484.45	30.85	3.71767	0.243	28966.41
S0G3	2479.55	27.15	3.70467	0.228	29468.41

CONCLUSION AND FUTURE SCOPE OF WORK

CONCLUSION

Experimental results revealed some significant outcomes, the compressive strength of the sample III S2G1 which has 2% steel fibre and 1% glass fibre content are mixed is found optimum. The compressive strength of S2G1 is found 16.14% greater than sample without fibre S0G0. Inclusion of 1% glass fibre also gives the good result but by increasing the glass fibre more than 1%, decreases the compressive strength and least compressive strength is found at the sample VI which contains maximum 3% glass fibre and 0% steel fibre. Only steel fibre also gives good result in compression. The sample contains 3% steel fibre has 12.65% greater compressive strength than sample S0G0.

In the case of flexural strength there is found sample III S2G1 contains 2% steel fibre and 1% glass fiber has 18.91% greater flexural strength than sample S0G0. Two other samples, S3G0 & S1.5G1.5 also shows the growth in flexural strength as compare to S0G0 this increment is 5.12% & 5.44% respectively. But further increment in percentage of glass fibre diminishing the flexural strength of concrete.

In the case of modulus of elaticity there is found sample III S2G1 contains 2% steel fibre and 1% glass fiber has 33502.44 Mpa greater Modulus of elasticity than sample S0G0 i.e 30403.98 Mpa. Two other samples, S3G0 & S1.5G1.5 also shows the growth in value as compare to S0G0 this increment is 32635.99 & 31290.48 Mpa respectively. But further increment in percentage of glass fibre diminishing the Modulus of Elasticity of concrete.

SCOPE FOR FUTURE WORK

In this research it was studied the how hybrid fibres improve the inbuilt property of concrete by mean of compressive strength and flexural strength. Here five different fractions of fibres were implemented. This work can be proceed by extension of experimental investigation so other properties of harden concrete such as impact resistant, split tensile strength, propagation of cracks can be investigated.

After the testing of specimens it is observed in sample S0G0, S3G0, S2G1, the results are improving or stable in the higher fraction of steel fibre with the partial combination of glass upto a limit of 1.0% by the weight of cement. But further increment in glass fibre and decrement in steel fibre adversely affect the strength of specimen. Both the compression and flexural strength reduces as well as modulus of elasticity for the sample S1G2, S0G3. So the new investigation can be done for the higher fraction of steel fibre beyond 3% and the fraction of glass is kept limited up to 1.0% by the weight of cement.

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