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Study on Strength and Energy In-take Capacity of Steel-Polyester Composite Fibre Strengthened Concrete

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ABSTRACT- In the field of civil engineering, cement concrete is a building material that is utilised extensively across the board. However, there are certain worries about its tensile strength. Many academics have conducted study to find a remedy. Fibre strengthening is the most effective and flexible technique to increase after-crack tensile strength and energy absorption capacity. Plain concrete was manufactured with Portland cement, fine and coarse aggregate, flyash, silicafume, and water-reducing admixtures. Without modifying the concrete components, steel fibre reinforced concrete specimens with aspect ratios of 70 and 50 and volume fractions of 0.25, 0.5%, and 0.75 were constructed. Using 12mm synthetic polyester fibres, we made 0.75, 1%, and 2% polyester fibre reinforced concrete. Steel and polyester fibres were mixed in volume ratios of 0.5:0.6, 0.5:0.7, 0.5:1.0, 0.5:2.0, 0.75:1.5, and 0.75:2.0 to create composite fibre reinforced concrete samples. We used IS 516-1956 and IS 5816-1999 to test fibre-reinforced and composite-reinforced concrete. All fibre-reinforced single and hybrid specimens improved tensile and flexural strength over plain concrete. Steel-polyester composite fibres outperform single-fibre reinforced concrete because of their synergistic impact. Schrader drop weight impact testing was used to determine disc fracture and failure. Each 160 mm cylinder specimen was examined using the Brazilian method to measure its energy-intake capacity under split tensile loading. The 120-220 mm cylinder specimens were all compressed uniaxially. Area under load deformation curves was drawn for each loading conditions and those areas were used to determine the energy In-take capacity Adding polyester, steel, or hybrid fibre to concrete boosts its compressive strength. The polyester/steel combination increases split tensile strength.

KEYWORDS- Fibre Strengthened Concrete, Plain Concrete, Composite fibre, Self-Compacting Concrete , Admixtures.

I. INTRODUCTION

In many parts of the world, including India, cement concrete is the material of choice for building. A mixture of cement, coarse aggregate, fine aggregate, and water, concrete is a composite material. These four ingredients are combined in a certain ratio to provide the material's intended strength and durability. Although concrete has many good qualities, its heterogeneous structure causes a few drawbacks. Recognizing the behaviour of concrete is important since its components come from numerous places. Along with water, concrete is another substance that sees extensive use. There seems to be no future in which concrete is not used as a building material. Constant upkeep, frequent repairs, and catastrophic collapse of concrete buildings are an increasing concern in modern society, leading to high costs and even fatalities. Since then, a lot of research and development (R&D) work has been put in all over the globe to create High Performance Concrete (HPC) to fix this issue[4].

High Performance Concrete (HPC) is intended to provide the optimal performance characteristics for a specific combination of materials, use, and exposure conditions, while achieving cost, service life, and durability criteria. Over the last two decades, several technologies have been created to either boost the relevance of the concrete construction industry or improve the usefulness of concrete as a better engineered material. Some of them include Polymer concrete; latex-modified concrete; chemically-bonded ceramics; macro defect-free cement products; high-strength concrete; fibre-strengthened concrete composed of steel, glass, polymer, carbon, and ordinary fibres; etc[5].

HPC is a concrete, in which some or all the following properties have been enhanced

- Convenience of installation
- Durability from a mechanical standpoint
- Toughness
- Long durability even under the worst conditions.

II. LITERATURE SURVEY

Banthia & Gupta[1] calculated outcomes of compositeization outcomes on a high-strength matrix with average compressive strength 85MPa . By changing the fibre quantities, we were able to generate 17 unique sample sets. Six cylinders and six beams in each series were tested to determine the compressive strength and flexural toughness characteristics. Compared to crimped or self-fibrillating polypropylene macro-fibres, deformed steel macro-fibre was shown to be the toughest material. And the combination of carbon and polypropylene microfibres with crimped macrofibres proved to be the most synergistic.

Sivakumar & Santhanam[2] studied the mechanical characteristics of strengthened concrete made with up to 0.5% volume of metallic and non-metallic fibres. The compressive strength, split tensile strength, flexural strength, and energy In-Take of concrete containing steel fibres were evaluated separately and in composite combinations with fibres of glass, polyester, and polypropylene. There was a little boost in compressive strength of about 15% when the fibre content was greater than before in both steel fibre concrete and other composite fibre concrete. The split tensile strength of composite fibre concrete made with polyester and polypropylene fibres linked with steel fibre considerably improved due to the high stiffness of steel fibre and the larger availability of fibres. The shorter length and high aspect ratio of polyester fibres contributed to a notable rise in flexural strength values in steel-polyester composites. Steel and polypropylene's synergistic effect led to the greatest gain in toughness.

Wu Yao et al.[3] compared three different types of composite fibre strengthened concrete containing 0.5% volume fraction. Examined were the fundamental characteristics of concrete for three fibre combinations, including polypropylene-carbon, carbon-steel, and steel-polypropylene. Carbon-steel combinations were better to the other three kinds for reinforcing and hardening the concrete matrix. The increase in strength was determined to be 31.4% in compression, 36.5% in split tension, and 32.5% in rupture modulus values. In addition, toughness indices were raised by between 33.9% and 199.5% compared to ordinary concrete without fibres. owing to the high strength and flexural toughness of carbon and steel fibres, their synergy was superior to that of other composite fibre combinations.

III. RESEARCH METHODOLOGY

HPC, or high-performance concrete, is a composite material lauded for its exceptional strength, workability, and durability. Reduced water uses in the mixing process and the addition of cementitious ingredients help it achieve a set of performance and uniformity standards. Some characteristics of HPC's strength are particularly sensitive to the quality and performance of its individual ingredients. In order to make high performance concrete that is both effective and affordable, it is sufficient to use the finest material available. To create high-performance fibre strengthened concrete, tiny fibres are added to the cement or cement-based matrix. In this work we employed fibres in addition to cement, fine aggregate, coarse aggregate, water, chemical and mineral admixtures, and other additives to create this high performance fibre strengthened concrete.

To determine the impact of fibres on the composite's behaviour, its qualities, both single and composite, must be tested. Traditional testing techniques may be used to evaluate FSC composites, since their qualities are mostly determined by the strength of the matrix. However, the matrix and fibre -matrix interactions greatly increase qualities including toughness, fracture control, and impact resistance when fibres are added to concrete. Therefore, conventional testing methods are used to evaluate these attributes for study and specialised applications. Compressive strength, split tensile strength, flexural strength, and impact strength, as well as other strength-related parameters, are tested on specimens manufactured to the standard sizes specified by the applicable codes. In this study, the toughness values under uni-axial compression and split tensile position of steel and polyester fibres, which are well-known for their energy In-Take ability, are examined.

A. Test On Fresh Concrete

- ***Slump Test***

This standard measures concrete workability and ensures FSC consistency during batching. Placement, compacting, and finishing require workable FSC. Slump tests involve vertically raising concrete in a cone. 200mm cone base, 100mm tip, 300mm height.. A 16-millimeter-diameter, 600-millimeter-long tamping bar compacts new concrete. Two feet support the steel mold's base plate. Each layer of new concrete fills 25% of the mould. Each layer receives 25 tamping rod strokes. Raising the mould 300 mm removes excess concrete. The mold's rim's height difference is slump. Millimetres measure sinking. Fibre-less concrete sagged the most, 145 mm. Steel and polyester reduce composites' workability. PC-based admixtures improve workability and keep the mix plastic for an acceptable time, reducing slump values for single and composite FSC series to 90mm to 130mm.

B. Tests On Hardened Concrete

- ***Compressive Strength Test***

Compressive strength of 28-day-old 160-mm cubes is tested. In accordance with IS 516:1959, three specimens from each series are examined using a 2000kN Compression Testing Machine (CTM). Before testing, each sample is measured and weighed. The load is increased until the specimen breaks. Maximum compressive strength is derived by dividing the applied force by the specimen's cross sectional area under stress and is expressed in N/mm2. Each series' compressive strength is calculated by averaging three specimens, and individual cube strength variations are within +/- 15% of the IS 516-1959 range.

- ***Splitting Tensile Strength Test***

Concrete cylinders' splitting tensile strength is evaluated after 28 days, per IS 5816-1999. 160mm x 300mm cylindrical specimens are tested in a 1000kN UTM. Three concrete samples are tested for split tensile strength. The cylindrical specimens are compressed along their length, which may generate tensile strains on the plane and tensile failure around the load. Before the test, the specimen's dimensions and weight are documented, and any grit or protrusion are removed. Drawing a central line on opposite sides of the cylinder applies axial load. After aligning the top and lower platens, the specimen is placed in the loading planes. Below the contact region, a 3-mm-thick, 25-mm-wide, one-time-use ply wood strip is inserted. After preparing the specimen for testing, the load is applied continuously and raised at 2kN/min till failure. After the specimen was shattered, the loading rate was slowed and maximum force was measured.

- ***Flexural strength (Modulus of rupture) Test***

This method measures concrete's flexural strength by third-point loading single beam specimens. Two point loads are applied at one-third distances along a

500x100x100mm beam. Using concrete's tensile strength, the flexural strength, or modulus of rupture, may be calculated (MOR). IS 516: 1959 specifies a 250kN universal testing machine for this examination. As per the codal guideline, two point loads are delivered using rollers spaced 13.3cm apart. Test span is 400mm. If needed, the top and bottom bearing sides of the concrete specimen are also cleaned. We designate the prism's width, depth, and one-third span length. Top and bottom formed faces are in contact with the load and support points, and the sample is centred above the supports. Without torsional stresses or shock, the load is increased at 2kN/min until the specimen cracks. Record the sample's maximum force and fracture pattern.

- ***Drop Weight Impact Test***

The Schrader drop weight impact test was used to test concrete composites' collision resistance per ACI 544-R. Concrete stress thresholds are determined by this test. Before failing, this test measures energy absorption. This allows us to compare the impact resistance of Plain concrete, single fibre-reinforced concrete, and composite fibre-reinforced concrete. 160mm-diameter, 64mm-thick concrete discs are used in this drop weight impact test. In this impact study, a standard cylindrical specimen with fibres longer than 20 mm was used to make a concrete disc specimen. This FSC evaluation method may prevent fibre alignment [2]. Before testing, discs are measured and greased. The specimen is centred on the base plate and attached with four lugs. Elastomer pads are placed between the specimen and lugs after the first crack. A steel ball inside a cylindrical sleeve is vertically slid over the disc specimen to generate impact force. 45 Newton hammer has 457 mm vertical movement. Record how many times the hammer must be lowered to break. Test specimens fail if hit hard enough. Hammer strikes are 20.2 Nm. By painting the disc specimen, we can see the first cracks. Failure occurs when the first crack deepens and concrete particles touch the steel lugs.

- ***Energy In-Take Capacity Under Diagonal Split Tension***

The region under the load-deformation curves measures fibre-reinforced concrete's toughness. Each of the 11 studied series' load-deformation area is measured. High toughness permits the structure to withstand further deformation beyond its initial distortion. Several approaches can identify post-crack behaviour in fibre-reinforced composites. The uni-axial tensile test is best for determining FSC load-deformation qualities. Other important tests include split tension, three-point notched beam bending, and wedge splitting. Complex test setup and expensive equipment make this test impractical. This study examines FSC and Composite FSC load-deformation behaviour using a simple and cost-effective testing system. Split Tensile Test, or Brazilian Test, measures force absorption. This low-cost, simple approach can treat cylindrical and cubic specimens. The results are more like a uni-axial tensile test since the tensile stress is uniform along the probable fracture plane and longitudinal compressive stress is also applied.160mm diameter and 300mm long cylinders are tested on 1000kN universal testing equipment. ASTM C496 standards are used to analyse load-deformation data. A 3mm-thick, 25mm-wide plywood bearing strip spreads the diametral compressive load along the cylinders. Before testing, round test specimens are polished to remove surface defects. Normal adhesive is used to adhere a steel plate to the diametral lines. Along this radial line, a 0.002 mm dial gauge measures the crack's diameter. Applying 5kN increments, we observe vertical deformation with a dial gauge. After a fracture, the post-crack loading rate is carefully regulated as the specimen's deformation is monitored. Three cylinders are evaluated for each series to yield load-deformation curves. FSC composites' energy-absorbing capacity is calculated using the simpson rule. Under split tensile loading, the first cracking stress and energy-intake capacity were assessed for control, single-fibre strengthened, and composite-fibre strengthened concrete specimens.

- ***In-Take Potential of Energy under Uniaxial Stress***

Energy comparison Under uniaxial compressive stress, concrete composites' intake capacities are measured. A 220 mm tall, 120 mm diameter cylindrical specimen was compressed uniaxially. A thin layer of plaster of paris is applied to the specimen's surface to smooth out any abnormalities, and the weight is spread evenly. A compressometer linked to a 0.002 mm dial gauge is used to calculate the test specimen's vertical displacement. Evaluation uses 1000kN universal testing equipment. The dial gauge was read every 5kN during continuous loading. We caught strain softening by loading to maximum and stopping. Before and after fractures, the concrete will deform similarly. Each test set employed three specimens to create load-deformation charts. Simpson's rule calculates energy-absorbing capacity by adding load and deformation curve regions. The failure pattern of a compressed concrete cylinder is also analysed to compare the control, single-fibre strengthened, and composite-fibre strengthened composites.

IV. RESULTS & DISCUSSION

A. Compressive Strength

Compressive strength is a measure of how fragile materials like Plain concrete and fibre strengthened concrete are. Compressive strength result from Plain concrete, Single fibre strengthened concrete, and composite fibre strengthened concrete are analysed at 28 days of age to investigate the impact of fibres on concrete's strength properties. Check out Table 1 for the final tally. Three specimens were tested for compressive strength in each series of tests, and the average was calculated.

Table 1 shows that the compressive strength of the CF1 series of composite fibre strengthened concrete was the greatest of all the tested series, while that of the Plain concrete, which included no fibres, was the lowest. Table 1 shows that the compressive strength of the concrete mixes tested in this programme ranges from 54.89MPa to 63.72MPa, and it is noteworthy to notice that none of the FSC series tested has a lesser compressive strength than the non-fibrous control concrete.

Table 1: Compressive Strength (in Megapascals)

Combination Set	Mix	Fibre quantityportion % Vf		Compressive- Strength MPa	Standard Variation +/- MPa	Efficiency
		Steel	Polyester			
Plain Concrete	P C	--	--	54.89	3.42	Indication
Steel fibre strengthened concrete	MS0.25	0.25	--	59.35	1.25	1.13
	MS0.5	0.50	--	61.45	2.42	1.14
	MS0.75	0.75	--	62.92	3.13	1.10
Polyester fibre strengthened concrete	MP0.5	--	0.50	63.33	3.46	1.14
	MP1.0	--	1.00	60.62	1.90	1.09
	MP2.0	--	2.00	56.84	3.68	1.03
Composite fibre strengthened concrete	CF1	0.50	1.00	63.72	3.80	1.15
	CF2	0.50	0.60	62.32	3.90	1.14
	CF3	0.50	2.00	59.29	1.10	1.02
	CF4	0.75	1.50	63.36	3.84	1.13

B. Splitting Tensile Strength

The splitting tensile strength, in which a cylinder is loaded with tension along its diameter, is more often used than the direct tensile strength. Table 2 displays the results of split tensile strength tests performed on 28-day-old specimens of Plain concrete combination, steel FSC, polyester FSC, and its mixtures.

Table 2: Split- tensile potency (MPa) result

Combination set	Mix	Fibre quantity_fraction % Vf		SpliT_tensile StrengthMPa	Standard_variation +/- MPa	Efficiency
		Steel	Polyester			
Plain Concrete	PC	--	--	3.35	0.43	Indication
Steel-fibre strengthened concrete	MS0.25	0.25	--	4.10	0.40	1.46
	MS0.5	0.50	--	4.75	0.42	1.63
	MS0.75	0.75	--	5.62	0.20	1.88
Polyester fibre strengthened concrete	MP0.5	--	0.50	3.79	0.09	1.26
	MP1.0	--	1.00	3.46	0.29	1.18
	MP2.0	--	2.00	3.55	0.17	1.07
Composite fibre strengthened concrete	CF1	0.50	1.00	5.04	0.25	1.72
	CF2	0.50	0.60	5.89	0.19	1.72
	CF3	0.50	2.00	5.85	0.18	1.66
	CF4	0.75	1.50	6.12	0.07	1.80

C. Flexural Strength (Modulus of rupture)

In this segment we compare the flexural power of various composites to that of Plain concrete, single steel_FSC, single polyester_FSC, and finally, Composite FSC, using the modulus of rupture values provided in Table 3.

Table 3: Flexural power (MPa) Result

CombinationGroup	Mix Series	Fibre Volume_ fraction % Vf		Modulus of rupturepotency MPa	Standard variation +/- MPa	Efficiency
		Steel	Polyester			
Plain-Concrete	P C	--	--	4.15	0.27	Indication
Steel-fibrestrengthened concrete	MS0.25	0.25	--	4.32	0.39	1.16
	MS0.5	0.50	--	5.21	0.50	1.36
	MS0.75	0.75	--	6.13	0.42	1.56
Polyester fibre strengthened concrete	MP0.5	--	0.50	5.15	0.49	1.13
	MP1.0	--	1.00	6.36	0.56	1.17
	MP2.0	--	2.00	6.78	0.23	1.31
Composite fibre strengthened concrete	CF1	0.50	1.00	6.80	0.33	1.37
	CF2	0.50	0.60	6.95	0.68	1.40
	CF3	0.50	2.00	7.12	0.88	1.36
	CF4	0.75	1.50	7.29	0.50	1.60

D. Impact resistance under Drop weight impact test

Concrete with single steel, polyester, and hybrid fibre reinforcement was tested for impact resistance under drop weight impact, and the findings are presented in Table 4. The disc specimens' impact resistance is documented as the number of hits it takes to produce the first fracture and ultimately induce failure. It is clear from Table 4 that incorporating fibres into concrete significantly improves the material's resistance to impact. Resistance to impact is measured in terms of the potential energy absorbed by the specimen between the onset of cracking and the point of complete failure.

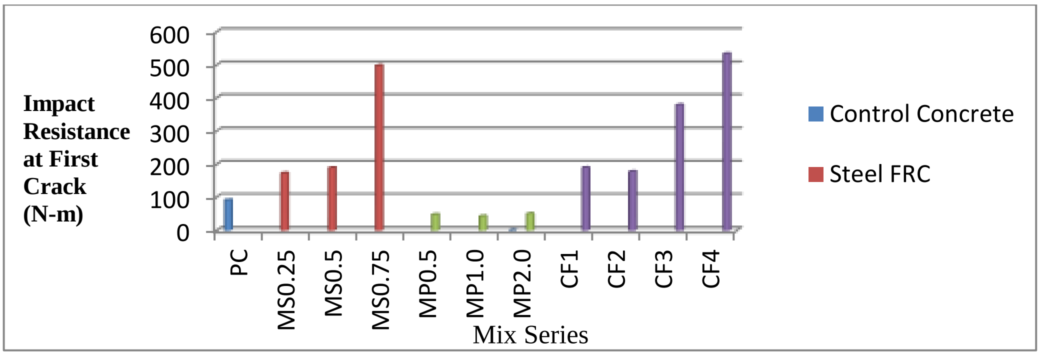

Figure 1: Impact resistance at first crack

Increased impact energy is shown in Figure 1 for all eleven series, with a clear distinction between the Plain concrete without fibres and the single steel FSC and Composite FSC series. Many mechanical qualities, like as impact strength, are greatly improved by the adding of fibres to the concrete mixture. The addition of steel fibres to FSC enhances the impact resistance of both the single steel FSC and CFSC series, whereas the addition of polyester fibres to FSC significantly decreases the impact resistance of the single polyester FSC.

Table 4: Impact resistance (N-m) values

combination set	Mix	Fibre volume-portion % Vf		No of blows required to cause		Impact resistancein N-m	
		Steel	Polyester	Firstcrack	Ultimatefailure	First crack	Ultimate failure
Plain Concrete	PC	--	--	5	7	91.34	122.39
Steel fibrestrengthened concrete	MS0.25	0.30	--	10	54	173.52	1092.77
	MS0.5	0.50	--	9	68	189.50	1349.55
	MS0.75	0.75	--	29	91	498.39	1781.42
Polyester fibre strengthened concrete	MP0.5	--	0.50	2	4	47.89	81.98
	MP1.0	--	1.00	2	3	42.78	76.23
	MP2.0	--	2.00	2	5	50.45	92.34
Composite fibre strengthened concrete	CF1	0.50	1.00	9	75	190.09	1709.23
	CF2	0.50	0.60	8	238	178.52	4988.43
	CF3	0.50	2.00	15	71	378.74	1358.42
	CF4	0.75	1.50	22	345	534.13	7633.18

E. Energy In-Take Under Split Tension

Plain, Single, and Composite fibre strengthened concrete specimens were tested for their ability to absorb energy (Toughness) when exposed to split tensile stress. In this chapter, we draw load-deformation curves for each test specimen.

F. Energy In-Take capacity values

Energy In-Take capability under split tensile stress conditions on cylinder specimens is shown in Table 5. For the Plain concrete, single FSC, and Composite FSC series, load-deformation curves are calculated. Energy In-Take capacity or toughness ratings under the diametral split tension are found by calculating the area beneath the load-deformation curves. Values of toughness up to deformations of 0.4 mm are computed, and the findings are compared across the four classes and listed in Table 5. The data reveal that plain concrete is brittle because its energy In-Take capacity value is so little in the PC series, whereas the inclusion of fibres results in ductile performance in the other series. All Composite FSC series show improved performance over their individual steel and polyester FSC counterparts. Toughness values are improved by using a specimen with a greater fibre volume fraction, and energy In-Take capacity is enhanced at high strains when fibre combinations are used.

G. Energy In-Take Under Uni-Axial Compression

Fibres improve toughness in terms of energy In-Take during fracture and post-cracking tensile strength. Because of this, the FSC may be used in places where Plain concrete or strengthened concrete would be impractical. For the uniaxial compressive loading condition, load-deformation curves have been produced, and the function of fibres and its compositeisation impact in the post-cracking zone has been thoroughly investigated.

Table 5: Energy In-Take capacity under split tension

Combinations Set	Mix	Fibre volume portion % Vf		Energy In-Take ability(up to 0.4mmdeformation) in kN-mm
		Steel	Polyester	
Plain- Concrete	PC	--	--	3.237`
Steel-fibrestrengthened concrete	MS0.25	0.25	--	94.605
	MS0.5	0.50	--	105.250
	MS0.75	0.75	--	125.565
Polyester fibre strengthened concrete	MP0.5	--	0.50	81.901
	MP1.0	--	1.00	70.975
	MP2.0	--	2.00	107.837
Composite fibrestrengthened concrete	CF1	0.50	1.00	132.200
	CF2	0.50	0.60	116.525
	CF3	0.50	2.00	127.075
	CF4	0.75	1.50	145.95

H. Energy In-Take Capacity Values

Toughness or energy In-Take capacity under uniaxial compression is measured by the part underneath the load displacement arc up to 0.6mm displacement, and this area is then utilised to conduct series comparisons. It is a representation of the work done by the cylindrical specimen during uniaxial compression. Toughness is determined for 12 series of specimens constructed from steel and polyester fibres alone and in different configurations. In Table 6, we see the maximum compressive strength and toughness or energy In-Take capacity.

Table 6: Energy In-Take capacity under uni_axial compression

Combination Group	Mix-sequence	Fibre volume portion % Vf		Energy In-Take capacity up to 0.6 mmdeformation in kN-mm
		Steel fibre	Polyester fibre	
Plain Concrete	PC	--	--	58.41
Steel fibrestrengthenedconcrete	MS0.25	0.25	--	182.40
	MS0.5	0.50	--	194.40
	MS0.75	0.75	--	213.00
Polyester fibre strengthened concrete	MP0.5	--	0.50	174.60
	MP1.0	--	1.00	170.30
	MP2.0	--	2.00	182.70
Composite fibre strengthened concrete	CFS1	0.50	0.60	271.40
	CFS2	0.50	0.70	262.50
	CFS3	0.50	1.00	218.10
	CFS4	0.50	2.00	265.40
	CFS5	0.75	1.50	239.12

when subjected to uniaxial stress, composite FSCs are much more durable than their component steel and polyester FSCs. The hardness values for the composite series CFS1, CFS2, CFS3, and CFS4 are 23%, 19%, 8%, and 11% greater than those for 0.5% steel FSC. Additionally, compared to the other composite FSCs, the one made up of 0.5% steel and 0.5% polyester fibre composite is the best option. Incorporating polyester fibres into a material was successful at a volume fraction of 0.5%, however increasing the amount of low modulus polyester fibre decreased the energy In-Take capacity.

V. CONCLUSIONS

Conventional concrete in numerous civil engineering applications is being replaced by fibre strengthened concrete and Composite Fibre Strengthened Concrete due to the rise in characteristics in terms of mechanics. The most extensively employed fibres for reinforcement are natural, metallic, cellulose and polymeric etc.

A. Compressive Strength

The experimental investigation found that adding a single steel fibre to Plain concrete increased its compressive strength by 14% at a volume fraction of 0.75 percent and by up to 12 percent at a volume fraction of 5 percent. If you use polyester fibres to reinforce concrete at a volume fraction of 2%, you'll only get a 3.5% improvement, whereas at a volume fraction of 0.5%, you'll see an increase of 15%.

• It is clear that adding fibre increases compressive strength; nevertheless, greater doses tend to reduce the percentage gain because air infiltration during mixing reduces the improvement's certainty.

B. Split Tensile Strength

• Thorough investigation of split tensile strength showed that volume fractions of steel of 0.25%, 0.5%, and 0.75% all outperformed the Plain concrete by between 22% and 67%. There is a 13% increase in performance when using polyester fibre with a volume percentage of 0.5%, but only a 5% increase when using polyester fibre with a volume fraction of 2%.• According to these predictions, a high amount of steel and a low percentage of polyester may boost concrete's split tensile strength more than other combinations.

• Because the long steel fibres activated at larger cracks, the composite fibre strengthened concrete made with steel and polyester exhibits advantages in terms of improvement in split tensile strength. This is because the micro polyester fibre were effective in controlling the micro cracks in the initial phases.

C. Flexural Strength

• Extensive research into the enhancement of flexural strength was carried out, and the findings are as follows. With steel fibre, substantial improvements of 25% and 47%, respectively, were realised for volume fractions of 0.50% and 0.75%, respectively. The corresponding improvement for 0.5% polyester was 24%, while for 2% polyester it was 63%.

• For the composite concrete, 0.5% steel and 1% polyester enhance performance by 64%, while 0.75% and 1.50% polyester improve performance by 75%. This is owing to more fibre availability near the crack opening and polyester fibre composites' high reinforcing index, as predicted.

D. Impact resistance at first crack and ultimate failure

• Using a drop weight impact test, the impact resistance of Plain concrete, polyester fibre, steel fibre, and composite fibre strengthened concrete was calculated. When compared to ordinary concrete, all polyester fibre strengthened specimens need nearily half as many strikes to cause the first break. For 0.25% steel fibre it is doubled, and nearly six times for 0.75% steel fibre reinforcement.

• For 0.25%, 0.5%, and 0.75% volume fractions of steel alone reinforcement, the difference in blows between the final failure and first crack is 44, 59, and 62, respectively. This is because steel fibres are more rigid and powerful than polyester fibres.

• The number of blows (N2 - N1) difference for 0.5% polyester and 0.6% steel composite reinforcement is 230. In compared to 0.75% steel alone and 1.50% polyester alone, the (N2-N1) is 323.

E. Energy In-Take Capacity

• Under splitting tensile and uni-axial compressive stress conditions, the toughness (energy In-Take capacity) was measured. When compared to Plain concrete, the earlier findings showed a significant improvement for all steel, polyester, and composite reinforcing specimens.

• It is also clear that improvements in Composite Fibre strengthened concrete in range from 10% to 38% when compared to steel fibre(MS0.5) reinforcement and between 42% and 78% when compared to polyester fibre(MP0.5) reinforcement under Splitting tensile loading.

• All polyester, steel, and composite fibre reinforcement showed better energy In-Take capability, according to the findings of the uni-axial compression test.

According to the results of the experimental inquiry, ordinary concrete's desired qualities have all been enhanced by steel fibre reinforcing.This steel-polyester composite fibre strengthened concrete can be used in elements that call for increased service life and reduced crack formation due to its improved energy In-Take capacity under compression and tensile loading cases, such as concrete pavement, industrial slabs, overlays, precast concrete industry, and structural rehabilitation works.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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