International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 04 | Apr 2024 www.irjet.net p-ISSN: 2395-0072

Investigative Research on providing Synthetic Macro Fiber (Twisted Monofilament Ferro Fiber) in Concrete

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Abstract - *The goal of the current study is to investigate how adding synthetic macrofibres, or twisted monofilament ferro fiber, to concrete affects its mechanical properties. Numerous physical and mechanical properties of concrete will be improved by the application of carefully tailored macro-fiber. Throughout this inquiry, M30 grade concrete with a 0.4 water-to-cement ratio was used. Numerous strength attributes, including split tensile strength, flexural strength, and compressive strength, were investigated and documented.*

Key Words: Synthetic Macro Fiber-Twisted Monofilament Ferro Fiber (TMF Fiber), Concrete, Compressive strength, Split Tensile strength, Flexural strength.

1.INTRODUCTION

While it has less resistance to tension and flexure, concrete has a stronger resistance to compression. As a result, some fractures are visible, but most are hidden because they have developed deep below the surface, inside the concrete mass. Cracks form when tensile strains are too high. Any alteration in the weather has an impact on the mechanism that causes cracking. The reinforcement holds the cracks in the concrete together as they occur. Subsequently, the weight is transferred through bond action and bar anchorage. Similar results are obtained by the use of Twisted Monofilament Ferro Fiber (TMF Fiber) reinforcement: a decrease in crack width and an increase in tensile strength. One important factor in stopping these cracks is TMF Fiber. TMF Fiber evenly holds the concrete in place and prevents cracks from forming.

1.1 Applications

The main area for Twisted Monofilament Fiber (TMF Fiber) applications are as follows:
1. Highway (PQC)
2. Industrial Flooring
3. Tunnel lining
4. Airport Runway
5. Parking area
6. Canal lining
7. Nuclear power plant
8. Paver blocks and solid/Halo blocks
9. Precast concrete

2. LITERATURE REVIEW

Mydin M.A.O et al. (2023) [3]
By experimental study of concrete specimens PTBF was provided in 0%, 0.5% up to 2.5% ratios providing concrete densities of 500,700 and 900kg/m^3 (as per British standards). Slump flow falls as it rises. in PTBF. Test results of compression, flexural and split tensile strength is found -500 and 700kg/m^3 density the optimum value is 1.5% and for 900kg/m^3 density the optimum value is 2.0%. Thus beyond 2.0% the diminished significantly. Thus, there will be reduction in air voids, thermal insulation and boost the light weight fiber concrete.

Buratti N et al. (2011) [4]
By experimental study of concrete specimen prisms/beams were casted in different ratios of same mix design (British standard). To determine the effect of fiber distribution on Flexural toughness by using 3-point bending test. Both Steel fiber and macro synthetic fiber were casted separately and combination of both in concrete. Synthetic fiber has tensile strength greater than 575MPa. Steel fiber concrete shows high strength in flexural toughness and macro synthetic fiber shows low strength in flexural toughness however, synthetic fiber increases in reduction of crack opening due to shrinkage. Thus, macro synthetic fiber is proposed for alternative to steel fiber in structural applications. Synthetic fiber is still limited.

A. J. Babafemi (2016) [5]
By experimental investigation fiber was used at a volume of 1% throughout the conduction by considering one mix design. Diameter of fiber is 0.8mm, tensile strength-400MPa, length-40mm, elastic modulus-4GPa, aspect ratio-50. study examines the creep response of cracked reinforced concrete that has been macro synthetic fibers and mechanism responsible for creep behavior. Stress of 30%, 40%,50%, 60% about 70% of average uniaxial tensile strength(2.90MPa) is accustomed to determine uniaxial tensile creep test. Result showed tensile creep over 8 months even at stress level as low as 30% and creep fracture specimen occurred at 60 and 70% stress level. Its compressive strength is 40.19MPa. large-scale synthetic fiber is becoming increasingly preferred to steel fiber, due to light weight, resistance to corrosion and cheap in cost

Estela Oliari Garcez et al. (2019) [6]
Slump flow, compressive strength and split tensile strength were compared for performance. and flexural strength. 3 different concrete mixtures with fiber dosage of 4, 6, and 8kg/m^3 were produced. Mixture with 4 and 6kg/m^3 fiber content has most satisfactory flowability and slump flow for 6kg/m^3 was 670mm without any bleeding and segregation. Mixture of 6kg/m^3 exhibits high split tensile, compressive, and 8kg/m^3 mixture achieved maximum flexural strength residual (indicates greater moment of carry capacity).

2.1. LITERATURE SUMMARY

1. By use of Synthetic macro fiber pores in concrete structures will be minimized, leads less corrosion to steel reinforcement placed within concrete.

2. Polypropylene twisted bundle fiber has tensile strength >575MPa. Thus, it is applicable as partial replacement to steel reinforcement or fully replaced for ground level touched surface.

3. Improves in bending Tensile power additionally also prevent in cracking in horizontal formed structure.

4. Increase in strain or deformation of structural element under a constant or sustained loading (Creep) can be minimized.

2.2. GAP ANALYSIS

1. After studying the previous research papers, came across those researchers had been performed on lower grade concrete and low densities and adding fibers 0.5% to 2.5% weight of concrete mix.

2. Therefore, investigation by experiment of concrete of M30 grade is used and Twisted Monofilament fibers are introduced to the concrete of the mass of the, respectively, 0.1%, 0.2%, and 0.3% concrete mix design.

3. OBJECTIVE

1. Finding the Compressive Strength, Split-Tensile Strength, and Flexural Strength of Twisted Monofilament Ferro (TMF) Fiber in concrete of grade M30 by adding 0.1%, 0.2%, and 0.3% percentage of fiber.

2. To Research the Impact of Strength differences between TMF Fiber in both concrete and conventional concrete strength values.

4. METHODOLOGY

Steps involved in methodology are as follows:
1. Literature survey was made by collecting prior studies that are similar to current investigation
2. Research gap and proper objectives of the research was documented
3. Collection of Materials
4. Design of Concrete Mix
5. Casting of cube, cylinder and prism samples
6. Demolding the samples after 24 hours
7. Curing of the samples over a span of 28 days
8. Concrete that has hardened is tested
9. Results and comparison
10. Conclusions

5. EXPERIMENTAL PROGRAMME

5.1. Materials

Table-1: Material properties

Cement	OPC-53grade
Fine aggregate	Well graded (zone II)
Coarse aggregate	crushed (20mm – 12mm)
Water	Potable water (drinking water)
Admixture	Fosroc conplast SP 430 DIS
TMF Fiber (As per Kalyani polymers Pvt.Ltd)	Material- Polypropylene
	Color- cement grey
	Diameter/thickness - 0.3mm
	Tensile strength >575 MPa
	Aspect ratio >90
	Available length- 30mm

Fig-1: TMF Fiber Available length

5.2. Design of Concrete Mix

In this experiment, The M30 concrete grade was created as per Indian Standard (IS) - 1026-2009 code. The quantity of TMF fiber was added in 0.1%, 0.2% and 0.3% volume of concrete. The quantity of materials used per m^3

Table-2: Material Quantity

Slump	100mm
Ratio of water to cement	0.40
Water	158kg/m^3
Chemical admixture	7.9kg/m^3
Cement	395kg/m^3
Coarse Aggregate	1223.78kg/m^3
Fine Aggregate	660.54kg/m^3

6. EXPERIMENTAL TEST

6.1. Test of Compressive Strength

150 x 150 x 150 mm size cube specimen was utilized to measure the strength under compression. The steps and techniques used were in line with IS 516-1959. Subsequently, the specimen sample was positioned in the Compression Testing Machine (CTM) with the force applied perpendicular to the casting side at a consistent 1000 kg/mm rate.

Compressive Strength = failure Load in N / Area in mm^2

6.2. Test of Split Tensile Strength

For Split Tensile test, a specimen with a diameter of 150 mm and a height of 300 mm was utilized. The procedures and methods followed IS 5816-1999. The load was applied in the compression testing machine at a steady rate of 250 kg/mm.

Tensile Strength = $2P/\pi LD$

P = failure load
D, L = diameter and length of specimen respectively (mm)

6.3. Test of Flexural Strength

The 100X100X500mm beam specimen was used to test the concrete's flexural strength. A flexural testing apparatus was employed to conduct a three-point test in compliance with IS 516-1959.

Table-3: Flexural strength formula

Cases	strength
If a > 13cm	PL/ bd2
If a < 13cm	3Pa/bd2

P = Failure load
L = span length
a = length from failure point to reference line
b = width of specimen
d = depth of specimen (mm)

7. RESULTS

7.1. Test of Compressive Strength

Table-4: Values of the Test for Compressive Strength

Sl no	concrete	ratio of fiber (%)	load capacity (Ton)	strength (MPa)
1	Conventional concrete	0	69	30.08
2	TMF Fiber in concrete	0.1	102	44.47
		0.2	70	30.52
		0.3	59	25.72

Area of specimen (cube) = 22500 mm^2

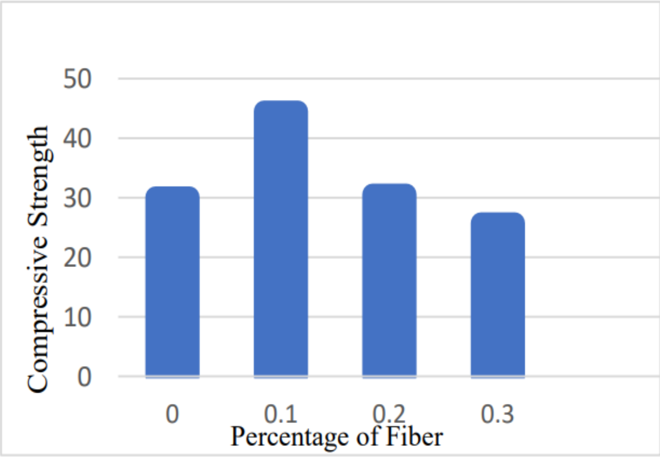

Chart 1: Percentage of Fiber vs Compressive strength

Figure-2: Cube after application of load

7.2. Test of Split Tensile Strength

Table-5: Values of test for Split Tensile Strength

Sl no	concrete	ratio of fiber (%)	load capacity (Ton)	strength (MPa)
1	Conventional concrete	0	17	2.36
2	TMF Fiber in concrete	0.1	20	2.77
		0.2	18.5	2.57
		0.3	17	2.36

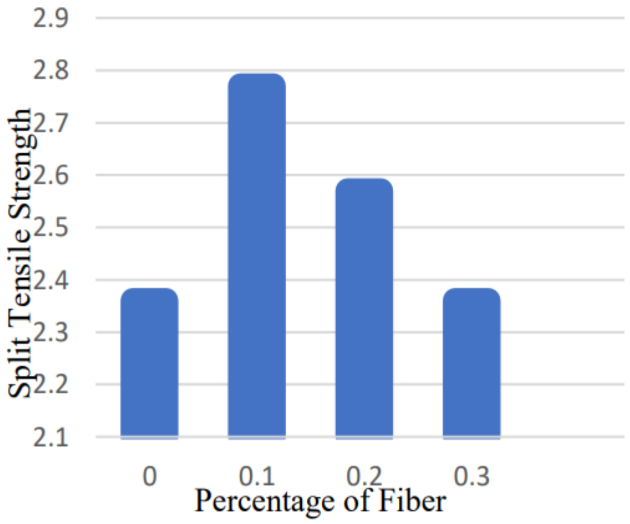

Chart 2: Percentage of Fiber vs split tensile strength

Fig-3: concrete specimen incorporated with TMF fiber showing comparatively less porous

7.3. Test of Flexural Strength

Table-6: Values of test for Flexural Strength

Sl no	concrete	ratio of fiber (%)	load capacity (Ton)	strength (MPa)
1	Conventional concrete	0	11.5	4.14
2	TMF Fiber in concrete	0.1	14.5	5.8
		0.2	12.5	5
		0.3	12	4.8

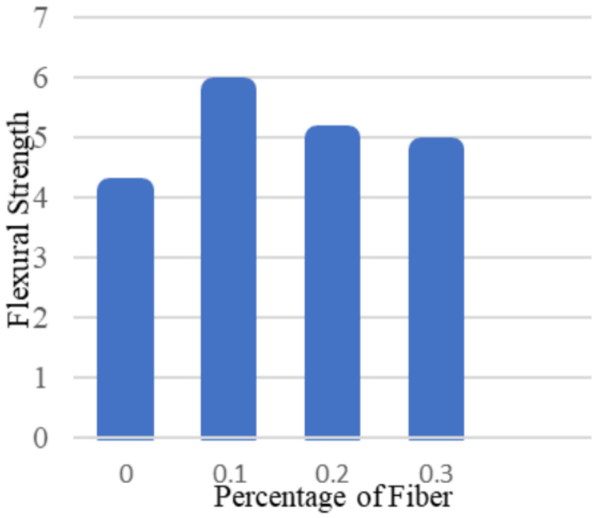

Chart 3: Percentage of Fiber vs Flexural strength

Fig -4: prisms after application of load

8. CONCLUSION

From Experimental Test report, the Amount of Strength is calculated Regarding Percentage (shown below table)

Table-7: Amount of Strength calculated in percentage

TMF fiber concrete strength increased (%) is compared with conventional concrete				
Sl no	Fiber in %	Compressive Strength (%)	Split Tensile Strength (%)	Flexural Strength (%)
1	0.1	+32.36	+14.80	+28.62
2	0.2	+1.5	+8.2	+17.2
3	0.3	-16.95	0	+13.75

1. It's clear from the above testing that 0.1% of TMF Fiber in concrete is the highest possible value to increase concrete strength.

2. 0.1% of fiber can achieve good cohesion, workability, less pores, ductility and durability to concrete structures.

3. 0.2% of fiber have strength greater than regular concrete, but less than 0.1% of fiber strength.

4. 0.3% of fibers strength values decreased in compressive strength and split tensile strength, however there is increase in flexural strength.

5. As the fiber content increased in concrete the workability becomes very stiff and leads to being brittle in nature.

9. REFERENCE

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