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Experimental Study of Fiber Reinforced Bendable Concrete With M-Sand

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ABSTRACT: By minimizing the brittle nature of concrete has opened a new opportunity to enhance the safety, durability and sustainability of the next generation of construction industry. Polypropylene fibers are used in order to get maximum flexibility. The bendable concrete is made of same ingredient of concrete only by eliminating the coarse aggregate. Bendable concrete helps to stay away from brittleness and breakage problem of normal concrete. M- Sand is used to make bendable concrete. For future prediction of flexural strength and compressive strength regression technique is used. Superplasticizer is used as admixture.

KEYWORDS: Bendable concrete, M-Sand, Compressive Strength, Flexural strength, Fibers, Regression Technique.

I. INTRODUCTION

Concrete as we know it's a brittle material, and tend to cracks easily when subjected to tensile loading. Recently, researchers have turned such conventional concrete into a new type of concrete that is more ductile than ordinary concrete. When ordinary concrete is subjected to tensile, load it tends to crack. For this reason, researcher have long been interested in making concrete more composite (ECC) has proved to be 50 time more flexible and 40 times lighter than conventional concrete. Additionally, the excellent energy absorbing properties of ECC makes it especially suitable for critical elements in seismic zones. The prime role of fibers in bendable concrete composites is to increase their toughness. The behaviour of fibers in bendable concrete is dependent on their length and composition and on the quality of fiber – matrix bond. When a crack appears in the matrix, micro fibers are pulled out after progressive deboning. Fiber should be small in length and have good strength. In both cases, fibers help to reduce cracks.

1.1 Bendable Concrete

Bendable concrete also known as Engineers Cementitious Composites abbreviated as ECC is class of ultra – ductile Fiber Reinforced Cementitious Composites, characterized by high ductility and tight crack width control. This material is capable to show considerably enhanced flexibility. An ECC has a strain capacity of more than 3.5% and thus it acts as ductile in nature than brittleness. A bendable concrete is reinforced with micromechanically design polymer fibers.

II.METHODOLOGY

1. DETERMINATION OF PROPERTIES OF MATERIALS
2. DESIGN OF MIX PROPORTION
3. PRELIMINARY STUDIES ON MIX PROPORTION AND FIBER CONTENT
4. STUDY OF WORKABILITY OF FRESH CONCRETE
5. CASTING OF CONTROL CONCRETE SAMPLES AND FLEXIBLE CONCRETE SAMPLES FOR VARYING FIBER CONTENT
6. OBTAINING THE MECHANICAL PROPERTIES SUCH AS COMPRESSIVE STRENGTH, FLEXURAL STRENGTH AND IMPACT STRENGTH OF THE FIVE SERIES OF FIBER REINFORCED CONCRETE AND FLEXIBLE CONCRETE
7. STUDY OF THE LOAD – DEFLECTION BEHAVIOR TO OBTAIN OPTIMUM FIBER CONTENT FOR FLEXIBLE CONCRETE
8. COMPARISONS THE PROPERTIES OF FLEXIBLE CONCRETE WITH THAT OF CONVENTIONAL CONCRETE

III. MATERIAL USED**3.1 Cement**

Ordinary Portland cement (OPC)-53grade (Ultratech cement) is normally used.

Specific gravity of cement = 3.16

3.2 Fine Aggregate (M- Sand)

The fine aggregate used in these investigations is M- sand passing through 4.75 mm sieve.

Water absorption, fineness modulus and specific gravity of fine aggregate is determined.

Water absorption = 2.5%

Specific gravity = 2.65

The M- sand used in the mix conforms to zone II

3.3 Coarse Aggregate

Maximum size of 20 mm angular aggregates was used, water absorption, fineness modulus and specific gravity of coarse aggregate is determined.

Water absorption = 0.86%

Specific gravity = 2.82

3.4 Superplasticizer

Super plasticizer used is Fosrockconplaste 430. This is used to control deformation properties of fresh concrete. Super plasticizers are additive to fresh concrete which helps in dispersing the cement uniformly in the mix. When used to achieve reduction in mixing water they can reduce water up to 14-20% and hence decrease W/C ratio by same amount. This helps in increase in strength and other properties like density, water tightness. A dosage range of 327 ml for per bag of cement. In this project 0.75% by weight of cement was used.

3.5 Water

Drinking water is generally used for making concrete. Water should be free from foreign matters like acids, oils, alkalis, vegetables, or other organic impurities. Soft waters also produce weaker concrete. Water acts in two ways in a concrete mix. In the beginning it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Then, it acts as a lubricant in the mixture of fine aggregates.

3.6 Polypropylene Fiber

The properties of polypropylene fiber used in this experimental program as supplied by the manufacturer are given below.

Fiber length = 12mm Tensile strength = 560 – 780 Mpa Cost = Rs.560/Kg

Youngs modulus = 3 – 15 Gpa Elongation = 8% Specific gravity = 0.91

IV. SLUMP CONE TEST AND MIX DISGN OF CONCRETE

Slump Cone Test: The test was carried out in accordance with IS: 1199 – 1959.

Average Slump:

The slump test indicates trend as the fiber percentage increases. Table below shows the slump height recorded during the test and the difference in percentage dropped for all mix batches compared to control batch.

Table.01: Slump Cone test results (Average)

Type of mix	Slump (mm)	Percentage difference (%)
Plane (0%)	132	-
1.0% Fiber	63	52
1.20% Fiber	55	58
1.5% Fiber	46	65

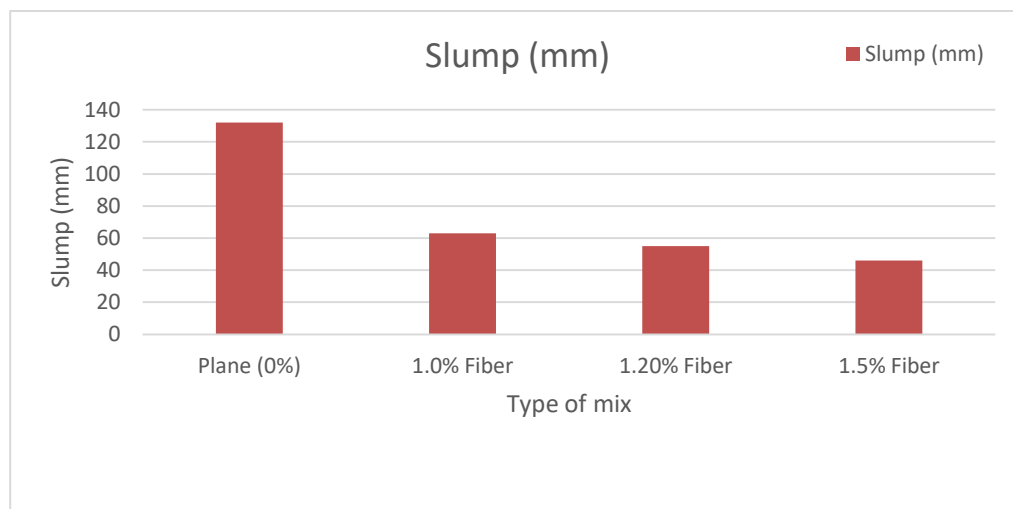


Figure. 3.1 Slump Test

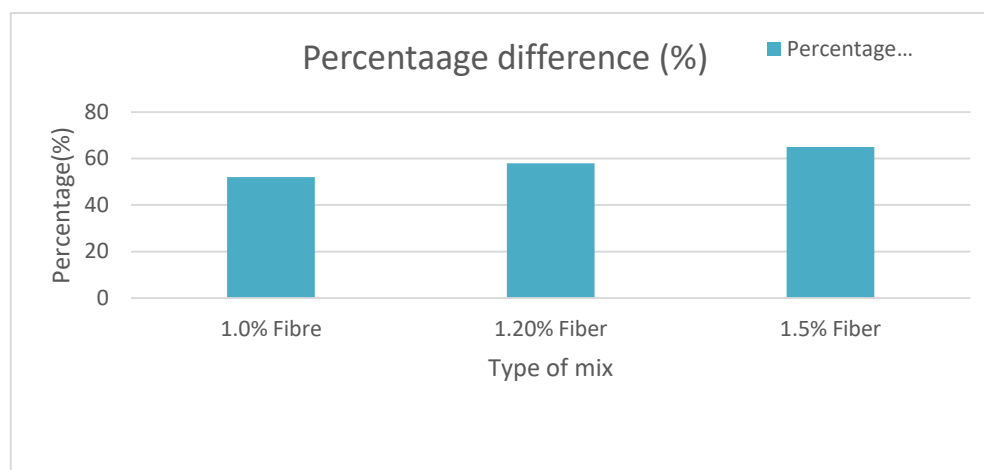


Figure. 3.2 Difference of Slump Test

Figure.3.2 shows comparison of fibers for varying percentage of fibers. The experimental observation as seen in figure. 3.1 indicate that the slump value decreases.

According to IS 456-2000, Page. No. 17 Point No. 7 [Workability of concrete] the slump value (in mm) of the concrete used in ordinary RCC work for beams and slabs, etc. is 50 to 100 mm. For concrete work, low workable concrete is preferred.

From this we found that 1.2 % of Polypropylene fiber by weight of cement used is good for bendable concrete, by judging workability of concrete more fibers will cause less workability so optimal fibers by trial is 1.2 %.

3.7 MIX DESIGN

Indian standard method of mix design as per IS- 10262:2009 is used for the design of concrete mix grade M25

Proportion for trial mix

Cement = 351 kg/m³

Water = 158 kg/m³

Fine aggregate = 812 kg/m³

Coarse aggregate = 1132 kg/m³Admixture = 0.0023 kg/m³

W/C Ratio = 0.45

Table.02 Design mix

Batch	A) Concrete mix design for ordinary concrete(M25)				B) Concrete mix design for Bendable concrete				
	Cement	Fine aggregate	Coarse aggregate	Water	Cement	Fine aggregate	Fiber	Water	Admixture
Per Cum	351kg	812kg	1132kg	158Liter	351kg	812kg	4.21Kg	351Ltr	2.30 Liter

V.RESULTS AND DISCUSSIONS

Table.03 Compressive strength of Cubes at 7 days

Sr. No.	Grade	Name	Percentage of fiber used	Load kN	Compressive strength (N/mm ²)	Average strength (N/mm ²)
1. 2. 3.	M25 M25 M25	Normal Concrete	0 0 0	445 450 453	19.78 20.00 20.13	19.97
1. 2. 3.	M25 M25 M25	Fiber concrete	1 1 1	480 490 470	21.33 21.78 20.89	21.33
1. 2. 3.	M25 M25 M25	Fiber concrete	1.2 1.2 1.2	700 650 695	31.11 28.89 30.67	30.22
1. 2. 3.	M25 M25 M25	Fiber concrete	1.5 1.5 1.5	630 640 685	28.00 28.44 30.44	28.96

Table:04 Compressive strength of Cubes at 14 days

Sr. No.	Grade	Name	Percentage of fiber used	Load kN	Compressive strength (N/mm ²)	Average strength (N/mm ²)
1 2. 3.	M25 M25 M25	Normal Concrete	0 0 0	570 580 576	25.33 25.78 25.60	25.57
1.	M25	Fiber concrete	1	560	24.89	25.24

2.	M25		1	567	25.20	
3.	M25		1	577	25.64	
1.	M25	Fiber concrete	1.2	857	38.09	36.73
2.	M25		1.2	822	36.53	
3.	M25		1.2	800	35.56	
1.	M25	Fiber concrete	1.5	750	33.33	33.96
2.	M25		1.5	763	33.91	
3.	M25		1.5	779	34.62	

Table:05. Compressive strength of Cubes at 28 days

Sr. No.	Grade	Name	Percentage of fiber used	Load kN	Compressive strength (N/mm ²)	Average strength (N/mm ²)
1 2. 3.	M25 M25 M25	Normal Concrete	0 0 0	636 645 641	28.29 28.67 28.50	28.48
1. 2. 3.	M25 M25 M25		1 1 1	730 776 702	32.44 34.49 31.20	
1. 2. 3.	M25 M25 M25		1.2 1.2 1.2	791 820 752	35.16 36.44 33.40	
1. 2. 3.	M25 M25 M25	Fiber concrete	1.5 1.5 1.5	658 706 661	29.24 31.38 29.38	30.00

Flexural Strength Calculation at 28 Days:

Table: 06. Normal Concrete Specimen Test Result:

Beam No.	Length (mm) (L)	Distance between the line of fracture and the nearer support (a)	Load at failure (kN) (p)	Flexural strength (fb) N/mm ²	Average Flexural strength (fb) N/mm ²
1.	600	213	17.50	3.11	3.25
2.	600	210	18	3.20	
3.	600	209	19.40	3.45	

Table: 07. Fiber (1%) Concrete Specimen Test Result:

Beam No.	Length (mm) (L)	Distance between the line of fracture and the nearer support (a)	Load at failure (kN) (p)	Flexural strength (fb) N/mm ²	Average Flexural strength (fb) N/mm ²
1.	600	215	23.70	4.21	4.25
2.	600	217	24.50	4.36	
3.	600	225	23.50	4.18	

Table: 08 Fiber (1.2%) Concrete Specimen Test Result:

Beam No.	Length (mm) (L)	Distance between the line of fracture and the nearer support (a)	Load at failure (kN) (p)	Flexural strength (fb) N/mm ²	Average Flexural strength (fb) N/mm ²
1.	600	213	23.00	4.00	4.28
2.	600	210	25.70	4.44	
3.	600	209	27.40	4.87	

Table: 09 Fiber (1.5%) Concrete Specimen Test Result:

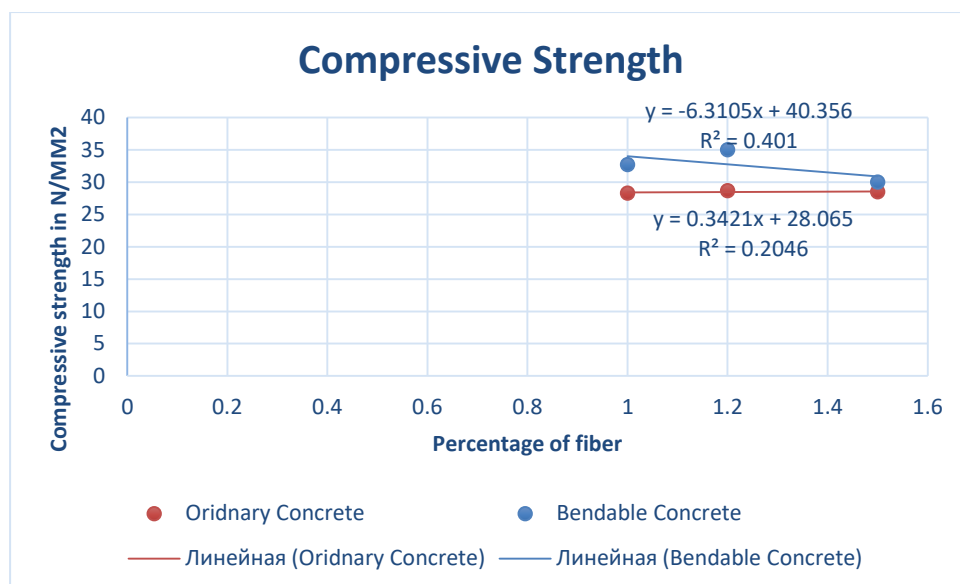
Beam No.	Length (mm) (L)	Distance between the line of fracture and the nearer support (a)	Load at failure (kN) (p)	Flexural strength (fb) N/mm ²	Average Flexural strength (fb) N/mm ²
1.	600	213	19.30	3.43	3.75
2.	600	210	21.50	3.82	
3.	600	209	22.50	4.00	

Table:10. Flexural strength of Beams at 28 days

Sr. No.	Grade	Name	Percentage of fiber used	Load kN	Flexural strength (N/mm ²)	Average strength (N/mm ²)
1	M25	Normal Concrete	0	17.50	3.11	3.25
2.	M25		0	18	3.20	
3.	M25		0	19.40	3.45	
1.	M25	Fiber concrete	1	23.70	4.21	4.25
2.	M25		1	24.50	4.36	
3.	M25		1	23.50	4.18	
1.	M25	Fiber concrete	1.2	23.00	4.00	4.28
2.	M25		1.2	25.70	4.44	
3.	M25		1.2	27.40	4.87	
1.	M25	Fiber concrete	1.5	19.30	3.43	3.75
2.	M25		1.5	21.50	3.82	
3.	M25		1.5	22.50	4.00	

VI. REGRESSION TECHNIQUE FOR STRENGTH PREDICTION

Regression analysis by Polynomial:



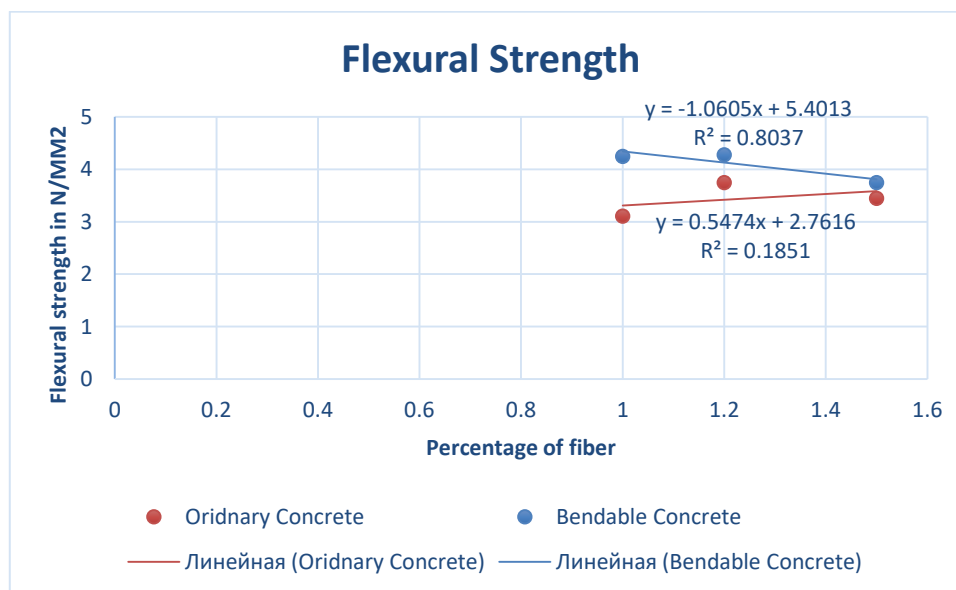
Graph No. 4.1: Compressive strength vs Percentage of fiber

Discussion-

We know that in the above graph, if increases the age of concrete that is days of curing will also increase the Compressive strength of M25 grade of concrete for different days 7, 14, 28 days. The compressive strength test of concrete was found out the equation for M25 grade of concrete in 4.1 graph, we can find out compressive strength by following equation.

Table:11. Coefficient determination table

Sr. No.	Comp. Strength of different concrete	Polynomial Equation	R ²
1	Ordinary Concrete	$y = 0.3421x + 28.065$	0.2046
2	Bendable Concrete	$y = -6.3079x + 50.35$	0.4023



Graph No. 4.2: Flexural Strength vs Percentage of fiber

Discussion-

We know that in the above graph, if increases the load over concrete will also increase the displacement of M25 grade of concrete for different days 7, 14, 21 days. The flexural strength test of concrete was found out the equation for M25 grade of concrete in 4.1 graph, we can find out flexural strength by following equation in table below table.

Table:11. Coefficient determination table

Sr. No.	Flexural Strength of different concrete	Linear Equation	R ²
1	Ordinary Concrete	$y = 0.5474x + 2.7616$	0.1851
2	Bendable Concrete	$y = -1.0605x + 5.4013$	0.8037

Here,

R²- Coefficient of determination.

x- Independent variable.

y- Dependent variable.

VII.CONCLUSION

1. The compressive strength of the concrete was found to be maximum when cement/sand taken as per design of M-25 mix design.
2. The flexural strength of the concrete was found to be maximum for specimen of 150 mm depth at fiber content of 1.2%. From the Flexural strength test results, it can be concluded that for length: breadth: depth ratio of 700:150:150 and fiber content = 1.2% the flexural strength is maximum.
3. By regression technique prediction of compressive and flexural strength is found satisfactory.

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