A Study On Behaviour Of Flexural Strength Of Fibre Reinforced Concrete Members Subjected To Alternate Wetting And Drying

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ABSTRACT: Concrete is most widely used construction material in the world. However, it has low tensile strength, low flexural strength, low ductility and low energy absorption. An intrinsic cause of poor tensile behaviour of concrete is its low toughness and the presence of defects. Therefore to improve its strength, toughness and ductility fibres are used in concrete. Fibre reinforced concrete is a composite material consisting of cement based matrix with an ordered or random distribution of fibres. The addition of fibres increases the properties of concrete such as flexural strength, impact strength and shrinkage strength. In this present experimental work of investigation the main objective is to study the flexural strength of concrete using different fibres with same aspect ratio for all the fibres and to study the effect of alternate wetting and drying for 30 cycles on Flexural strength of concrete using different fibres such as steel fibre, glass fibre and Polyproplyene fibre with variation of fibre percentage from 0%, 1%, 1.5% and 2% and comparing their strength with 28 days strength of concrete without alternate wetting and drying. From the experimental investigation it is clearly observed that there is very good enhancement in flexural strength for all combinations of fibres and all percentage variation of fibres.

Keywords: Fibre reinforced concrete, flexural strength, alternate wetting and drying, steel fibre, glass fibre and polypropylene fibre, percentage of fibre and aspect ratio.

1. INTRODUCTION

Concrete is most commonly used construction material in the world. Concrete is an artificial rock made from cement, sand and aggregate. The voids in between the aggregates are filled by sand and the cement paste glues the aggregates together when water is added to cement, a chemical process called hydration starts and continues as long as water is available. This process gives strength to concrete. In this present times it is not uncommon to use another ingredient called admixture. Concrete has some inherently brittle nature and have some disadvantages such as poor deformability and weak crack resistance in practical usage. Concrete made with Portland cement is relatively strong in compression but weak in tension. Also, there tensile and flexural strength is relatively low compared to their compressive strength. To overcome this defect fibre reinforced concrete is used. Fibre reinforced concrete is Portland cement concrete reinforced with more or less randomly distributed fibres. In FRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing and thus there is improvement in concrete properties in all directions. Fibre reinforced concrete gives excellent flexural and tensile strength, resistance to splitting, impact resistance and excellent permeability, crack and frost resistance. In this present experimental work study is carried on Steel fibre (Binding wire), Glass fibre and Polyproplene fibre to know the flexural strength. Steel fibres has higher Crack resistance and improves toughness characteristics of hardened concrete and it has relatively low cost. Whereas Polypropylene fibres are a synthetic carbon polymer, is produced as continuous filaments, with circular cross section that can be chopped to required length and section. PP fibres are advantages in many ways as it improves bleeding, plastic settlement, thermal and shrinkage resistance of concrete resistance.

2. OBJECTIVES OF EXPERIMENTAL STUDY

- The main objective of the present experimental investigation is to study the various flexural strengths of concrete using different types of fibres keeping aspect ratio same for all the types of fibres.
- To study the effect of alternate wetting and drying cycles on various flexural strength of concrete using different types of fibres and making comparative analysis with the strengths of specimen subjected to with and without alternate wetting and drying.

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3. MATERIALS AND METHODOLOGY

Materials used

3.1 Cement

In this experiment Ordinary Portland cement (OPC) was used for all concrete mixes. The cement used was fresh and without any lumps. The testing of cement was done as per IS: 8112-1989. The specific gravity of cement was found to be 3.15.

3.2 Fine aggregate

As per IS-383-1970, Table 4 sand used for the experimental program was locally procured and was confirming to zone-III. The specific gravity of fine aggregate was found to be 2.60. Sieve analysis of fine aggregates.

3.3 Coarse aggregate:

Locally available coarse aggregate having the maximum size of 20 mm were used in the present work. The specific gravity of coarse aggregate was found to be 3.03.

3.4 Water:

Portable tap water was used for the preparation of specimens and for the curing of specimens.

TABLE 1 PHYSICAL PROPERTIES OF CEMENT

Particulars	Experimental result	As per standard
1. Fineness	250 m^2/kg	225 m^2 /kg
2. Soundness		
a) Bayle chatelier mould	1.00 mm	10 mm
b) By Autoclave	0.18	0.8 maximum
3. Setting time (min)		
a) Initial setting	152 minutes	30minutes minimum
b) Final setting	265 minutes	600 minutes maximum
4.Comp strength(MPa)		
a) 3 days	25	23 MPa
b) 7 days	36	33 MPa
c) 28 days	48	43 MPa
Temperature during testing	26°c	26°c

3.5 Types of fibres used for experimentation:

The type of fibres selected for the project are Binding wire (Steel fibre), Glass fibre and polypropylene fibre.

Binding wire: Binding wire is procured from local market for experimentation work. The Aspect ratio is kept to 50 i.e. length is kept to 50mm and the diameter is 1mm.

FIGURE 1 *Shows Binding wire used experimental work*

Glass fibre: The Aspect ratio is kept to 50mm i.e. length is kept to 50 and the diameter is 1mm. The volume fraction is varied from1.0%, 1.5% and 2.0%.

FIGURE 2 *shows Glass fibre used for experimental work*

Polyproplyene fibre:. The Aspect ratio is kept to 50. The volume fraction is varied from 1.0%, 1.5% and 2.0%.

FIGURE 3 *shows PP fibre used for experimental work*

Super plasticizer

MasterGlenium SKY 8233(Glenium B233) is an admixture manufactured by BASF India Limited, Mumbai was used in this experimentation. MasterGlenium SKY 8233 is an admixture of new generation based on modified polycarboxylic either. The product has been primarly developed for application is high performance concrete where the highest durability and performance is required.

Features and benefits of Super plasticizer

a) Elimination of vibration and reduced labour cost in placing
b) Marked increase in early & ultimate strengths
c) Higher Young's modulus.
d) Improved adhesion to reinforcing and stressing steel.
e) Better resistance to carbonation and other aggressive atmospheric conditions
f) Low permeability-increased durability.
g) Reduced shrinkage and creep.

3.6 Mix design for M20:

The mix design procedure to obtain a M20 grade concrete is in accordance IS 10262- 2009.

TABLE 2 MIX DESIGN DESIGNATIONS

1	Grade designation	M20
2	Type of Cement	OPC
3	Maximum Nominal Size of Aggregate	20mm & down
4	Minimum Cement Content	220Kg/m^3[IS-456:2000,Table 5]
5	Exposure Condition	Moderate
6	Minimum Water/Cement ratio	0.50
7	Type of aggregate	Crushed Angular aggregate
8	Maximum Cement	450Kg/m^3
9	Chemical Admixture	MasterGlenium SKY 8233

TABLE 3 THE MIX PROPORTION OBTAINED ARE AS SHOWN IN THE TABLE

W/C ratio	Cement	Fine aggre-gate	Coarse aggre-gate
0.50	320 Kg/m^3	766.48 kg/m^3	1339.89 kg/m^3
0.50	1	2.4	4.2

METHODOLOGY

Cement, sand and aggregate were taken in mix proportion 1:2.4:4.2 (M20), which correspond to M20 grade of concrete respectively. Binding wire, Glass fibre and Polyproplyene fibre are used for experimental work and they are taken in varying quantity of 1%, 1.5% and 2.0% of total weight of concrete mix. All the ingredients were dry mixed homogeneously. To this dry mix, required quantity of water was added (W/C= 0.50) and the entire mix was again homogeneously mixed. Super plasticizer was added at the dosage of 1% (by weight of cement). This wet concrete was poured into the moulds which was compacted both through hand compaction in three layers as well as through vibrator. The specimens were given finished smooth and taken out of the table vibrator. After the compaction, the specimens were given smooth finishes and were covered with gunny bags. After 24 hours, the specimens were demoulded and transferred to curing tanks wherein they were allowed to cure for 28 days. After 28 days half of the specimen was kept for alternate wetting and drying and otherhalf were tested for flexural strength. The other half where evaluated after 30 cycles of alternate wetting and drying. The effect on flexural strength of these specimen is evaluated.

4. TEST RESULTS

Flexural Strength:

For evaluating the flexural strength, beam specimens of dimensions 100x100x500mm were prepared. During testing two point loading was adopted on an effective span of 400mm as per IS 516-1959. Flexural strength is calculated using the equation:

$$F= PL/ (b\ d^2)$$

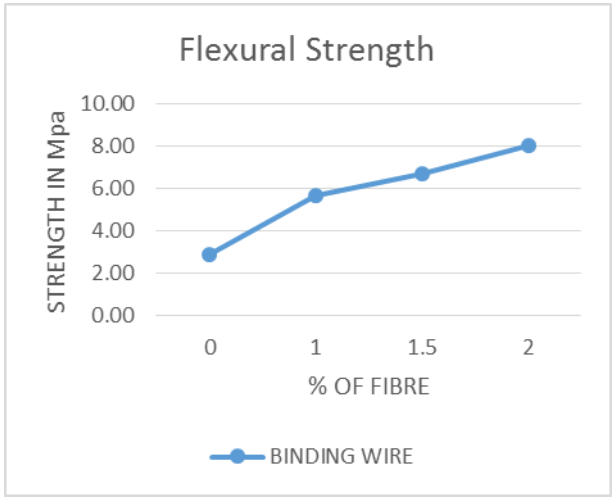
Where, F= Flexural strength of concrete (in MPa). P= Failure load (in N). L= Effective span of the beam (400mm). b= Breadth of the beam (100mm). d= Depth of the beam (100mm).

FIGURE 6 *Testing of specimen*

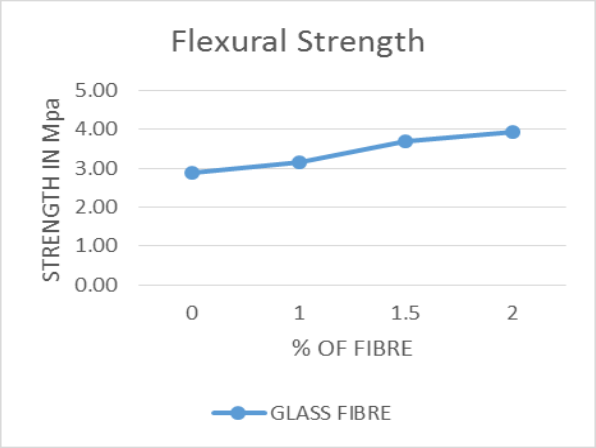
FIGURE 7 *Crack on specimen after testing of specimen*

TABLE 4 SHOWS RESULTS OF FLEXURAL STRENGTH OF SPECIMENS OF WITHOUT ALTERNATE WETTING DRYING (28 CURING).

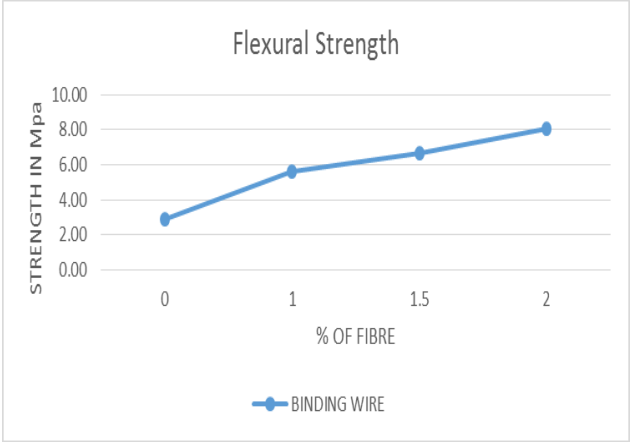
Fibres	Fibre content in %	Strength of flexural test Without alternate wetting drying in (MPa)
Binding wire	0%	3.09
	1%	6.48
	1.5%	7.04
	2%	8.24
Glass fibre	0%	3.09
	1%	3.15
	1.5%	3.70
	2%	4.40
PP fibre	0%	3.09
	1%	3.12
	1.5%	3.43
	2%	4.04



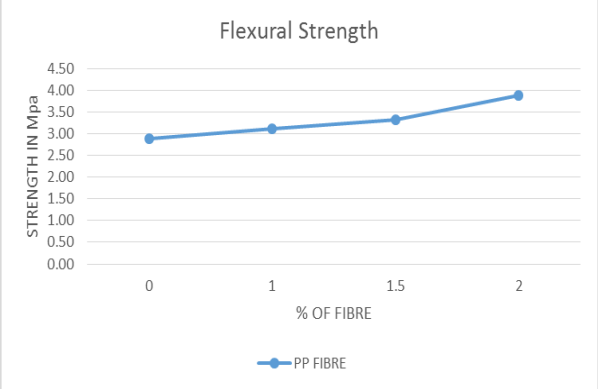
Graph 1 *shows the variation of Flexural Strength for Binding wire for Without Alternate wetting and drying*



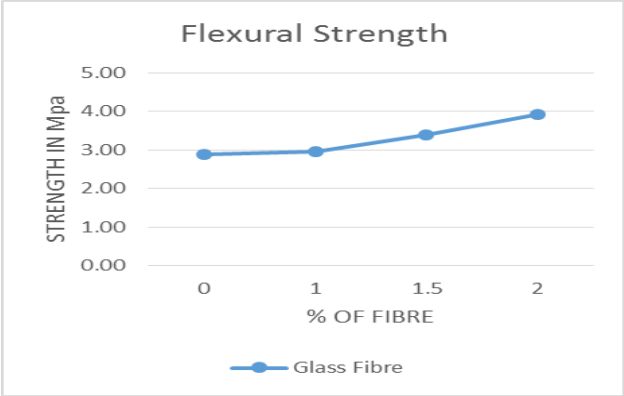
Graph 2 *shows the variation of Flexural Strength for Glass Fibre for Without Alternate wetting and drying*



Graph 4 *shows the variation of Flexural Strength for Binding wire for With Alternate wetting and drying*



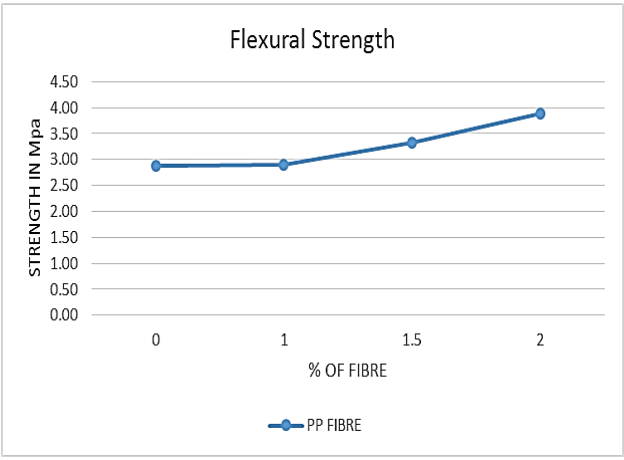
Graph 3 *shows the variation of Flexural Strength for PP Fibre for Without Alternate wetting and drying*



Graph 5 *shows the variation of Flexural Strength for Glass fibre for With Alternate wetting and drying*

TABLE 5 *SHOWS RESULTS OF FLEXURAL STRENGTH OF SPECIMENS OF WITH ALTERNATE WETTING DRYING (30 CYCLES).*

Fibres	Fibre content in %	Strength of flexural test With alternate wetting drying in (MPa)
Binding wire	0%	2.88
	1%	5.64
	1.5%	6.68
	2%	8.04
Glass fibre	0%	2.88
	1%	2.95
	1.5%	3.40
	2%	3.92
PP fibre	0%	2.88
	1%	2.91
	1.5%	3.32
	2%	3.88

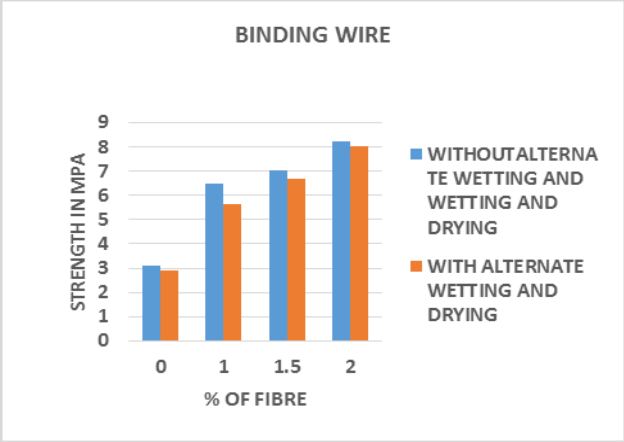


Graph 6 *shows the variation of Flexural Strength for PP fibre for With Alternate wetting and drying*

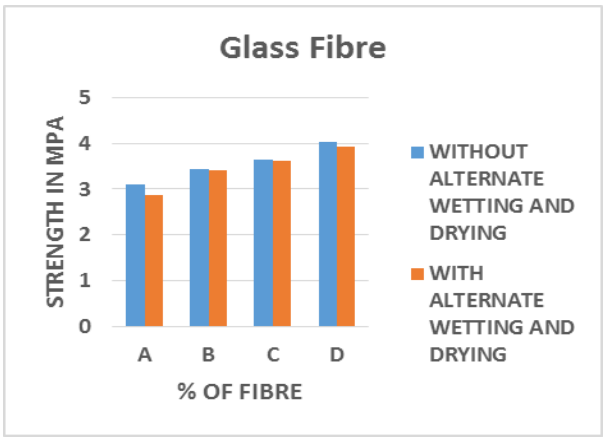
COMPARISON OF FLEXURAL STRENGTH TEST RESULTS OF FIBRES IN CONCRETE WHEN SUBJECTED WITH AND WITHOUT ALTERNATE WETTING AND DRYING.

TABLE 6 *COMPARISON OF FLEXURAL STRENGTH TEST RESULTS OF COMBINATIONS OF FIBRE IN CONCRETE WHEN SUBJECTED WITH AND WITHOUT ALTERNATE WETTING AND DRYING.*

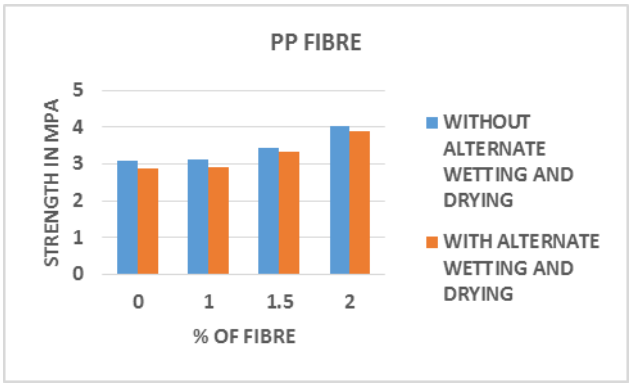
Fibres	Fibre content in %	Strength of flexural test Without alternate wetting drying in (MPa)	Strength of flexural test With alternate wetting drying in (MPa)	Percentage Reduction in strength
Binding wire	0%	3.09	2.88	6.80%
	1%	6.48	5.64	12.96%
	1.5%	7.04	6.68	5.11%
	2%	8.24	8.04	2.43%
Glass fibre	0%	3.09	2.88	6.80%
	1%	3.15	2.95	14.92%
	1.5%	3.7	3.40	8.11%
	2%	4.4	3.92	10.91%
PP fibre	0%	3.09	2.88	6.80%
	1%	3.12	2.91	6.73%
	1.5%	3.43	3.32	3.21%
	2%	4.04	3.88	3.96%



Graph 7 *comparision of flexural strength test results of Binding wire when subjected to with and without alternate wetting and drying*



Graph 8 *comparision of flexural strength test results of Glass Fibre when subjected to with and without alternate wetting and drying*



Graph 9 *comparision of flexural strength test results of PP Fibre when subjected to with and without alternate wetting and drying*

6. OBSERVATION AND DISCUSSION

PART A (without alternate wetting and drying)

There is drastic increase in flexural strength of concrete for all combinations of fibres. The maximum flexural strength at 2% of binding wire is 8.24 MPa. Similar observation were made with glass fibre and polypropylene fibre.There was increase in flexural strength by 4.4MPa and 4.04 MPa and there is increase in strength by 42.39% and 30.74% for glass fibre and polypropylene fibre.

PART B (with Alternate wetting and drying)

There is significant increase in flexural strength of concrete for combination of fibre. The maximum flexural strength was obtained at 2% for binding wire, the flexural strength was 8.04 MPa for binding wire. But there is decrease in flexural strength of concrete when subjected to alternate wetting and drying for 2% the decrease is about 2.43% in flexural strength and when similar observation is made with glass fibre and PP fibre it was found to be 10.91% and 3.96% respectively.

7. CONCLUSION

The following conclusion were drawn based on the study conducted.

- There is increase in flexural strength with increase in percentage addition of fibre from 0%, 1%, 1.5% and 2% for all the three fibres.
- There is significant increase in flexural strength for all three different fibres. The maximum flexural strength obtained for binding wire is 8.24 MPa and for glass and polypropylene fibre is 4.4 MPa and 4.04 MPa respectively at 2% for without alternate wetting and drying.
- There is decrease in flexural strength when subjected to alternate wetting and drying. The decrease in flexural strength is 2.43%, 10.91% and 3.96% for binding wire, glass and polypropylene fibre.

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