# Performance of RECRON 3S Polyester Fibre Reinforced Concrete

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***Abstract-*** *The conventional plain concrete possesses high compressive strength, low tensile strength, poor impact strength, ductility, and little resistance to cracking and poor resistance to chemical attack. So it is necessary to overcome these drawbacks of concrete. Continuous research by concrete technologist to understand, improve, and develop a property of concrete has resulted in a new type of concrete known as fiber reinforced concrete.*

*This paper deals with the results of experimental investigations on Recron 3s Polyester fibre reinforced concrete. Fibre is replacing 0.2% to 1% with an interval of 0.2% by weight of cement. Various test considered for investigation are compressive strength, flexural strength and Split tensile strength. The workability is measure with the slump cone test. A comparison of results of Recron 3s polyester fiber reinforced concrete with that of control mix concrete showed the significant improvements in the results of various strengths.*

***Keywords***- Polyester fibers, FRC, Fiber, Polyester

## I. INTRODUCTION

Fibre reinforced concrete can be defined as a composite material consisting of hydraulic cements containing fine and coarse aggregate and discontinuous discrete fibres. Fibre reinforced concrete is found to have improved strengths against shear, flexure, tension and increased resistances against impact, fatigue, wear and enhanced toughness and ductility. Various research works have been conducted on the glass fibres, steel fibres and polypropylene fibres. This has paved way for research in addition of polyester fibre reinforcement. More recently micro fibres, such as those used in traditional composite materials have been introduced into the concrete mixture to increase its toughness, or ability to resist crack growth.

FRC 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 improve concrete properties in all directions. Fibres help to improve the post peak ductility performance, pre-crack tensile strength, fatigue strength, impact strength and eliminate temperature and shrinkage cracks. Several different types of fibers, both manmade and natural, have been incorporated into concrete. The technical aspects of FRC systems remained essentially undeveloped. The choice of fibres varies from synthetic organic materials such as polypropylene or carbon, synthetic inorganic such as steel or glass, natural organic such as cellulose or sisal to natural inorganic asbestos. Currently the commercial products are reinforced with steel, glass, polyester and polypropylene fibers. The selection of the type of fibres is guided by the properties of the fibres such as diameter, specific gravity, youngs modulus, tensile strength etc and the extent these fibres affect the properties of the cement matrix. Polyester fibre designed specifically to provide concrete with protection against early age crack formation.

Recron 3s fibres help in controlling micro shrinking cracks in plastic stage. Reduces water permeability in concrete Reduces the rebound loss of mortar and concrete as confirmed by user feedback taken during field inspection. Due to high modulus of elasticity, Recron 3s has found to be helping in increasing the flexural strength of the concrete. Recron 3s has acceptable range of alkali resistance. Due to its special shape and finish and specific gravity of 1.36 Recron 3s has shown good dispersion properties both in dry and wet mix. Fibre used to enhance the performance of industrial and commercial floors, pavements, overlays, elevated slabs, residential concrete, precast concrete, barrier walls, tunnel and culvert linings, water reservoir linings, bridge deck overlays and various concrete repair systems.

## II. LITERATURE STUDY

Jothi (2008) constructed two small slabs (100cm x 50cm x 20cm) with one as constructed without recron 3s fibre and other slab was constructed incorporating Recron 3s fibre in cement matrix. The fibre application rate was 120 gm/m2, mortar mix with 1:4 by volume and water cement ratio 0.8. The procedure consists in first dipping half quantity of fibre in water and mixing thoroughly. Then the half quantity of fibre was added then thoroughly mixed together. The resulting mix was then applied over selected construction areas. The compressive strength of construction with FRC was increased by 22.2%. This was due to the anisotropic characteristics of polyester fibre. Moraliya and Modhera (2010) presented experimental investigation of compressive strength of plain reactive powder concrete (RPC) and RPC reinforced with corrugated steel fibres and recron3sfibres were compared. The water cement ratio kept 0.22. The diameter of corrugated steel fibreswas0.4mmand12mmlongrecron3sfibreoftriangular shape was used. The compressive test was conducted on cube specimen of size 50 X 50 X50 mm. This study resulted that, the compressive strength of SFRPC is 30% higher because of more confined and densed concrete while strength of RSFRPC was reduced by 19%.

Ferdiansyah and Razak (2011) presented the engineering properties of concrete containing black sugar palm fibre. Three fibres of length 15 mm, 25mm, 35 mm, in four volume fractions 0.2%, 0.4%, 0.6%, 0.8 % were utilized in this study. The compressive strength, flexural strength, toughness, first crack deflection, first crack toughness were observed upto 90 days. The compressive strength did not show any significant improvement and a consistent trend with addition the fibres while some mixes exhibited a drop in strength with fibre volume fraction of 0.8% due to difficulty in compaction.

Jothi (2008) constructed two small slabs (100cm x 50cm x 20cm) with one as constructed without recron 3s fibre and other slab was constructed incorporating Recron 3s fibre in cement matrix. The fibre application rate was 120 gm/m2, mortar mix with 1:4 by volume and water cement ratio 0.8. The procedure consists in first dipping half quantity of fibre in water and mixing thoroughly. Then the half quantity of fibre was added then thoroughly mixed together. The resulting mix was then applied over selected construction areas. The flexural strength of construction with FRC was increased by 32.7%.This was due to the property of fibre which enables the structure to bear the tension applied on them in all direction and formation of 3D structure between fibre, cement and other ingredients involved in mix. Moraliya and Modhera (2010) presented experimental investigation of compressive strength of plain reactive powder concrete (RPC) and RPC reinforced with corrugated steel fibres and recron 3s fibres were compared. The water cement ratio kept 0.22. The diameter of corrugated steel fibres was 0.4 mm and 12 mm long recron 3s fibre of triangular shape was used. The flexural test was conducted on beam specimen of size 40 X 40 X 160 mm. This study resulted that, the increase in flexural strength of SFRPC and RSFRPC was 60% and 40% respectively than the RPC. It was observed that the four point loading arrangement was used in testing, the failure occurs in middle third portion of specimen in case of plain RPC failure was sudden, without showing the first cracking load. While in case of SFRPC and RSFRPC beam the first crack could be seen easily. Cracks start slowly from bottom layer of the specimen and as the load increases the cracks propagate upto top layer of specimen.

Ferdiansyah and Razak (2011) presented the engineering properties of concrete containing black sugar palm fibre. Three fibres of length 15 mm, 25mm, 35 mm, in four volume fractions 0.2%, 0.4%, 0.6%, 0.8 % were utilized in this study. The addition of fibres increased the flexural strength but was not significant, with increase not less than 10% compared to controlled mix. Fibre length had a more influencing role on flexural strength compared to fibre volume. The ability of sustain load after cracking was observed only in the 0.6% and 0.8% fibre volume mixes. The post cracking behavior of 0.2% and 0.4% fibre volume mixes failed in brittle manner.

Jothi (2008) constructed two small slabs (100cm x 50cm x 20cm) with one as constructed without recron 3s fibre and other slab was constructed incorporating Recron 3s fibre in cement matrix. The fibre application rate was 120 gm/m2, mortar mix with 1:4 by volume and water cement ratio 0.8. The procedure consists in first dipping half quantity of fibre in water and mixing thoroughly. Then the half quantity of fibre was added then thoroughly mixed together. The resulting mix was then applied over selected construction areas. The split tensile strength of construction with FRC was increased by 6.6 % due to high tenacity of recron 3s fibres. Moraliya and Modhera (2010) presented experimental investigation of compressive strength of plain reactive powder concrete (RPC) and RPC reinforced with corrugated steel fibres and recron 3s fibres were compared. The water cement ratio kept 0.22. The diameter of corrugated steel fibres was 0.4 mm and 12 mm long recron 3s fibre of triangular shape was used. The split tensile test was conducted on beam specimen of 100 mm diameter and 150 mm length. This study resulted that, the increase in spilt tensile strength of SFRPC and RSFRPC was 50% and 30% respectively than the RPC.

Gore and Kulkarni (2012) prepared the strength of concrete of grade M40 with locally available ingredients and then study the effect of different proportion of Basalt fibre in the mix and then found optimum range of Basalt fibre content in the mix. The concrete specimen were tested at different age level for mechanical properties of concrete such as compressive strength, spilt tensile strength, flexural strength, durability of concrete and other test were conducted for cement, chemical admixture, coarse aggregate fine aggregate. Cement, sand, Basalt Fibre and fine aggregate, coarse aggregate were properly mixed together in accordance with IS code in the ratio 1:1.73:3.02 by weight before water was added and was properly mixed together to achieve homogenous material. The replacement of Basalt Fibre was 0%, 1%, 1.5%, 2%. This study concluded that, the split tensile strength of concrete was decreasing by 45% after 7 days curing by adding 1% of Basalt fibre.

## III. METHODOLOGY

The methodology for the project work depends on the objectives. This dissertation work which has an objective of achieving M40 grade of concrete with utilization of recron 3s polyester fibre, natural aggregate and cement in concrete contains extensive experimental work.

### A. Codal Provision:

**1) Size of Specimen:**

As per IS 10086 : 1982 the standard size of cube mould are 50 mm, 100mm, 150mm, 225mm and 300 mm. The standard size of beam mould is 100 X 100 X 500mm and 150 X 150 X 700mm. the standard size of cylinder mould is 150 mm in diameter and 300 mm in height. In this dissertation work the size of specimen should be taken as for cube mould of 150 X 150 X 150 mm, for beam mould of 150 X 150 X 700mm and for cylinder mould of 150 mm in diameter and 300 mm in height.

**2) Equipments:**

Compression Testing Machine: As per IS 516-1959 the compression testing machine may be of any reliable type of sufficient capacity for the test and capable of applying the load at the rate. the permissible error shall not be greater than 2% of maximum load. The testing machine shall be equipped with two steel bearing platens with hardened faces. One of the platen shall be fitted with a ball seating in the form of a portion of sphere, the centre of which coincides with center point of the face of the platen. The other compression platen shall be plain rigid bearing block. The load shall be applied without shock and increased continuously at rate of approximately 140 kg/cm2/min until the resistance of the specimen to the increasing load breaks down and no longer load can be sustained.

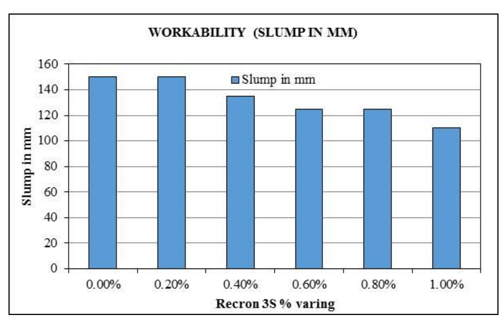
Universal testing machine: As per IS 516- 1959 the testing machine may be any reliable type of sufficient capacity for the tests and capable of applying the load at the specified rate. The permissible error shall not be greater than 0.5 % of applied load where a high degree of accuracy is required and not greater than 1.5 % of applied load. The bed of testing machine shall be provided with two steel rollers, 38 mm in diameter on which specimen should be supported and these roller shall be mounted that the distance from centre to centre is 60 cm for 15 cm specimens or 40 cm for 10 cm specimens. The load shall be applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/cm2/min that is at a rate of loading of 400 kg/min for the 15 cm specimen and at a rate of 180 kg/min for 10 cm specimen. The load shall be increased until the specimen fails and the maximum load applied to the specimen during the test shall be recorded.

### B. Tests Conducted on Concrete

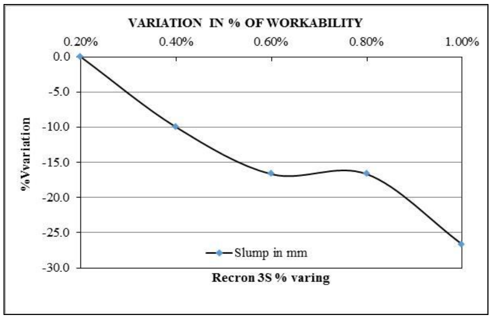
1) Test on fresh concrete: Slum cone test Slum cone test is most well known and widely used test method to characterize the workability of fresh concrete. The inexpensive test, which measures consistency, is used on job sites to determine rapidly whether a concrete batch should be accepted or rejected. The apparatus consist of mould in the shape of frustum of a cone with a base diameter of 20 cm, a top diameter 10 cm and a height of 30 cm. the mould is filled with concrete in three layers of equal volume. Each layer is compacted with 25 strokes of a tamping rod. The slum cone mould is lifted vertically upward and the change in height of the concrete is measured. Four types of slumps are commonly encountered. The only type of slum is frequently referred to as the true slump, where the concrete remains intact and retains a symmetric shape. A zero slump and a collapsed slump are both outside the range of workability that can be measured with the slump test. If part of the concrete shears from the mass, the test must be replaced with a different sample of concrete. A concrete that exhibits a shear slump in a second test is not sufficiently cohesive and should be rejected.

## IV. GRAPHICAL RESULTS

### A. Workability



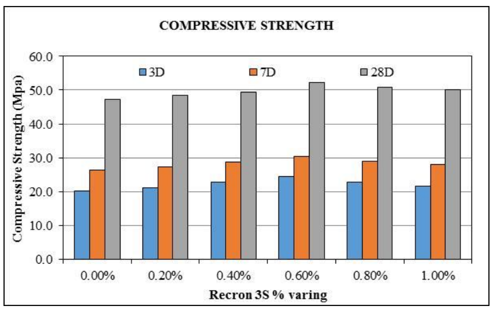

Graph 1: Slump in mm comparison graph



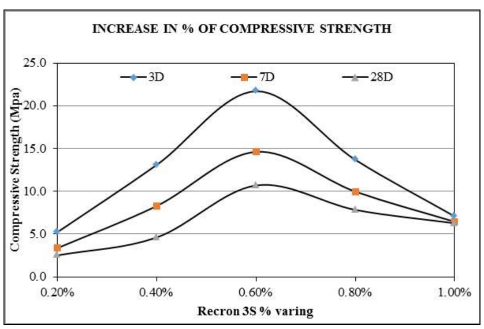

Graph 2 : Slump in mm % variation comparison graph

## B. Compression strength

Following is the graphs from results of the Compressive tests performed.



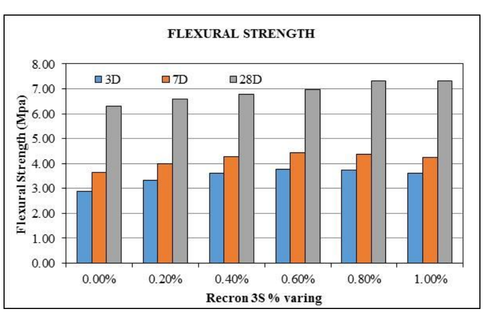

Graph 3: Compressive Strength in MPa comparison graph



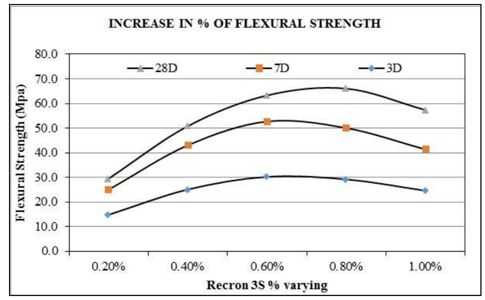

Graph 4: Compressive Strength % increase comparison graph

## C. Flexural Strength

Following are the graphs from results of the Flexural tests performed.



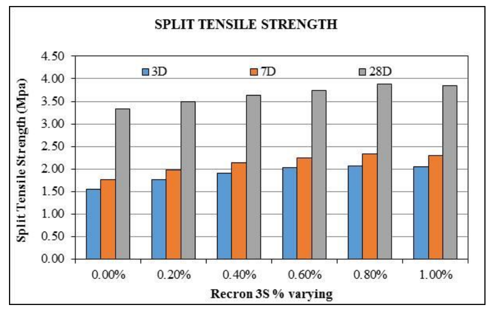

Graph 5: Flexural Strength in MPa comparison graph



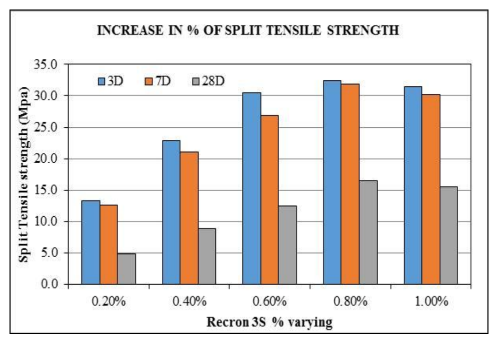

Graph 6: Flexural Strength % increase comparison graph

## D. Split Tensile Strength

Following are the graphs from results of the Split tensile tests performed.




Graph 7: Split tensile Strength in MPa comparison graph




Graph 8: Split tensile Strength % increase comparison graph

# V. CONCLUSION

## A. Workability : From Graph 1 and 2

With addition of % Recron 3s polyester fibre the Workability variation is as follow:

| 0.2% | 0.4% | 0.6% | 0.8% | 1% |
|---|---|---|---|---|
| 0.00% | -10.00% | -16.67% | -16.67% | -26.67% |

## B. **Compressive Strength : From Graph 3 and 4**

Compressive strength when compared with control mix for 3D, 7D & 28D 's goes on increasing .

With addition of 0.2% Recron 3s polyester fibre the compressive strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 2.51 | 3.37 | 5.22 |

With addition of 0.4% Recron 3s polyester fibre the compressive strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 4.61 | 8.29 | 13.12 |

With addition of 0.6% Recron 3s polyester fibre the compressive strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 10.70 | 14.60 | 21.72 |

With addition of with 0.8% Recron 3s polyester fibre the compressive strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 7.85 | 8.70 | 13.67 |

With addition of 1% Recron 3s polyester fibre the compressive strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 6.28 | 6.43 | 7.06 |

C. **Flexural Strength : From Graph 5 and 6**

Flexural strength when compared with control mix for 3D, 7D & 28D ‘s goes on increasing .

With addition of 0.2% Recron 3s polyester fibre the flexural strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 4.5 | 10.2 | 14.9 |

With addition of 0.4% Recron 3s polyester fibre the flexural strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 7.8 | 18.0 | 25.1 |

With addition of 0.6% Recron 3s polyester fibre the flexural strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 16.0 | 20.8 | 29.2 |

With addition of with 0.8% Recron 3s polyester fibre the flexural strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 16.0 | 20.8 | 29.2 |

With addition of1% Recron 3s polyester fibre the flexural strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 16.0 | 16.7 | 24.6 |

It is observed that flexural strength at 3days, 7days and 28 days increases with increasing quantity of Recron 3s polyster fibre.

**D. Split Strength : From Graph 7 and 8**

Split Tensile strength when compared with control mix for 3D, 7D & 28D ‘s goes on increasing .

With addition of 0.2% Recron 3s polyester fibre the Split Tensile strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 5.005 | 13.06 | 12.82 |

With addition of 0.4% Recron 3s polyester fibre the Split Tensile strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 8.9 | 21.02 | 22.43 |

With addition of 0.6% Recron 3s polyester fibre the Split Tensile strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 10.51 | 27.27 | 30.12 |

With addition of with 0.8% Recron 3s polyester fibre the Split Tensile strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 16.61 | 31.25 | 32.05 |

With addition of1% Recron 3s polyester fibre the Split Tensile strength goes on increasing as follow:

| 3D | 7D | 28D |
|---|---|---|
| 15.72 | 30.11 | 30.76 |

It is observed that Split tensile strength at 3days, 7days and 28days increases with increasing quantity of Recron 3s polyster fibre.

### E. Overall Conclusion

Workability of Control Mix concrete is higher than polyester fibre mix but the concrete mix with fiber showed the better cohesiveness.

The control batch specimens containing no fibres failed suddenly once the concrete cracked, while the fibre reinforced concrete specimens were still intact together.

The indirect tensile test results have an increasing trend of average tensile strength for fibre reinforced concrete when the fibre volume dosage rate increased. This increase in tensile strength was due to the nature of binding of fibre available in concrete.

When the reinforced concrete was force to split apart in the tensile strength test, the load was transferred into the fibres as pull-out behaviour when the concrete matrix began to crack where it exceeded the pre-crack state.

This shows that the fibre reinforced concrete has the ability to absorb energy in the post-cracking state.

## VI. ACKNOWLEDGMENT

I would like to thank my Guide Prof. S. T. Pawar for her immense help in my project work from selecting my project topic until completing the project study. I would also like to thank our ME coordinator Prof. A. B. Pujari for his help in the project work.

## REFERENCES

[1] Jothi D. (2008), Application of fiber reinforced concrete technique in civil construction, an International multidisciplinary journal, Volume 2, pp. 157-172

[2] Moraliya M and Modhera C. (2010), A comparative study of reactive powder concrete containing steel fibres and recron 3s fibres. Journal of engineering research and studies, Volume I, issue I, pp 83-89

[3] Sigh A. and Singhal D. (2010), Strength and permeability relationship of steel fibrous concrete, our world in concrete and structure 35th conference Singapore.

[4] Ferdiansyah T. and Razak H. (2011), Mechanical properties of black sugar palm fibre reinforced concrete, Journal of reinforced plastic and composites, Volume 2.

[5] Gore K. and Kulkarni S. (2012), The performance of Basalt Fibre in High Strength Concrete, Journal of information, knowledge research in Civil engineering, Volume 2, Issue 2.

[6] Patodi S. and Kulkarni C. (2012), Performance evaluation of hybrid fiber concrete matrix, International journal of engineering research and applications, Volume 2 Issue 5.

[7] Borhan T. (2012), Properties of glass concrete reinforced with short fibre, Journal of material and design, Volume 1

[8] Dharani N. Ashwini A., Pavitha G. and Arulraj G. (2013), Experimental investigation on mechanical properties of recron 3s fiber reinforced hyposludge concrete, International journal of civil engineering and technology, Volume 4, Issue 1.

[9] KolliR.(2013),Strengthpropertiesofpolypropylenefibrerein forcedconcrete, International journal of innovative research in science, engineering and technology, Volume 2, Issue 8.

[10] KolliR.(2013),Strengthpropertiesofpolypropylenefibrerein forcedconcrete, International journal of innovative research in science, engineering and technology, Volume 2, Issue 8.