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Evaluation Of Concrete Performance Using Recron Fibre (RF) As Secondary Reinforcement For Highly Flexible Structure

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ABSTRACT :

This research investigates the utilization of Recron fibre and fly ash as replacements for cement in concrete composites to enhance its performance characteristics. This study focuses on evaluating the compressive strength, flexural strength, and young's modulus of M25 grade concrete with a constant 40% fly ash content and varying percentages of Recron fibre (3%, 5%, 7% and 10%). Through systematic experimentation, mix designs were optimized by casting cubes, prisms, and cylinders in three trials alongside conventional concrete mixes. The specimens underwent curing for different periods, followed by performance evaluation after 28 days of curing in water. The investigation aims to analyze the efficiency of Recron fibre and fly ash in enhancing the properties of M25 grade concrete. Notably, the composite with Recron fibre demonstrates resistance to molecular separation in concrete and crack arrestation, increased resistance to abrasion, and potential cost-efficiency in producing precast elements

Keywords: Recron fibre, fly ash, compressive strength, flexural strength, precast elements.

1. Introduction :

The construction industry stands on the threshold of modernization, constantly seeking novel solutions to address the evolving challenges of modern infrastructure development. Central to this quest is the enhancement of concrete, the cornerstone of construction, to meet the demands of increasingly flexible structures. Traditional concrete, while ubiquitous, grapples with intrinsic limitations such as low tensile strength, limited ductility, and susceptibility to cracking. These shortcomings not only compromise structural integrity but also impede the realization of sustainable and resilient built environments. In response, researchers and practitioners alike have turned their attention to alternative materials and reinforcement techniques to augment the performance and durability of concrete structures.

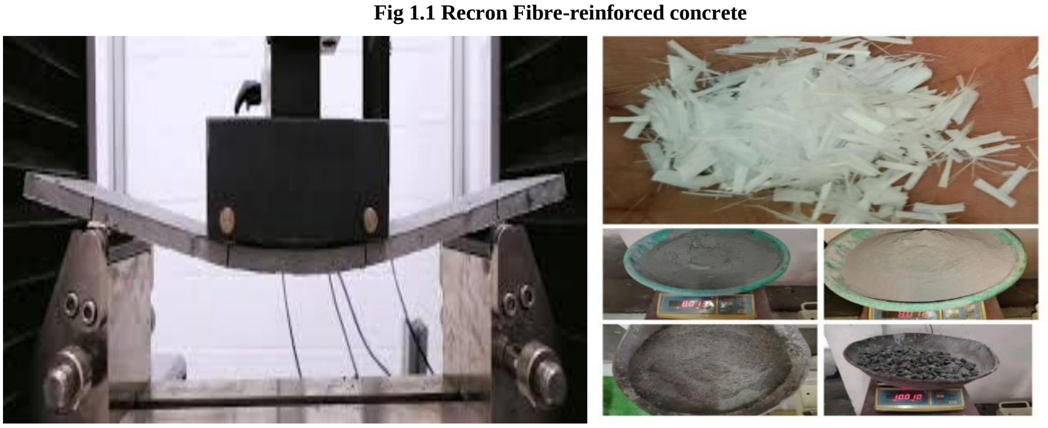
This research embarks on a comprehensive investigation of the efficacy of Recron Fibre as secondary reinforcement in highly flexible concrete structures. By delving into its multifaceted properties, applications, and performance benefits, this study endeavors to elucidate the transformative potential of Recron Fibre in revolutionizing concrete construction practices. Through a nuanced analysis encompassing laboratory experiments, field evaluations, and numerical simulations, this research aims to provide empirical evidence and actionable insights for engineers, architects, and construction professionals grappling with the challenges of modern infrastructure expansion.

Recron 3S is a modified polyester fibre. It is generally used as secondary reinforcing material in concrete and soil to increase their performance and arrests shrinkage cracks resistance to impact/abrasion & greatly improves quality of construction. The uniqueness of Recron- 3S Fibre is its triangular shape, which give better anchoring with concrete, which is not found in most of the Fibres available worldwide.

1.1 Recron Fibre-Reinforced Concrete

Recron Fibre-reinforced concrete (RFRC) emerges as a viable solution for enhancing the performance and durability of highly flexible structures, offering a host of benefits that address the specific challenges associated with dynamic loading, structural deformation, and crack propagation. Below, we delve into the implications of RFRC in the context of highly flexible structures, highlighting its role in optimizing structural resilience, mitigating cracking, and promoting sustainable construction practices.

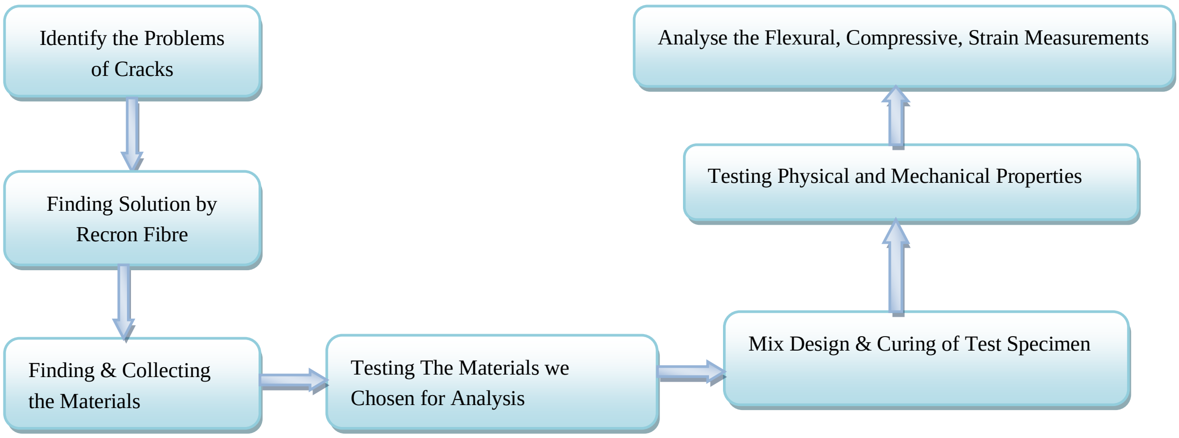
Fig 1.1 Recron Fibre-reinforced concrete



One of the primary benefits of Recron Fibre in concrete is its ability to enhance tensile strength. Traditional concrete is inherently weak in tension, leading to susceptibility to cracking and structural failure. By incorporating Recron Fibre as secondary reinforcement, the tensile strength of concrete is significantly improved, thereby mitigating the formation and propagation of cracks, especially under dynamic loading conditions.

Recron Fibre-reinforced concrete exhibits improved ductility compared to traditional concrete. Ductility refers to the ability of a material to deform plastically before failure, thereby providing advanced warning signs of potential structural failure and allowing for remedial action. The addition of Recron Fibre enhances the ductility of concrete, contributing to its resilience and structural integrity.

Methodology :



Literature Review :

1. **Bharadwaj Et Al ;** August 2018 Strength Characteristics Of Recron 3s Fibre Reinforced Concrete Of Different Grades Exposed To Elevated Temperatures In The Journal Of Novateur Publications. The present study is to investigate the effect of high temperatures on the properties of Conventional concrete by adding Recron 3s Fibre.Authors have presented the experimental results for the reinforced concrete of different grades at different temperatures.
2. **Burad Et Al ;** May 2022 To Determine Compressive Strength Of Concrete Using Recron Fibre In The Journal Of Ire Journals. This paper describes the results of a study carried out for investigating the structural behavior of fibre reinforced concrete is of high strength compared to normal concrete.
3. **Gupta Et Al** ; April 2019 Effect Of Recron 3s Fibre On Fine Grained Soil At Subgrade Level In The Journal Of IJERA Journals. The present study aims at studying the effect of Recron 3S Fibre on the CBR behaviour of the fine grained soils when applied in various percentages.
4. **Gurram Et Al** ; April 2017 Strength And Durability Studies Of Recron 3s Fibre Reinforced Concrete In The Journal Of IJARTET. The experimental study of this investigation consists of design of concrete mix of mix for characteristic mean strength. This keeping the obtained water cement ratio constant this mix was obtained with water cement ratio as 0.50.
5. **Kumar Et Al ;** April 2015 BehaviourOf Combination Of Coconut Fibre And Recron Fibre In Concrete in the journal of International Journal of Research in Engineering and Technology. To determine the strength of fibre concrete and to compare the strength of the conventional concrete, coconut fibre and recron fibre concrete.
6. **Madihalli Et Al** ; August 2017 Study On Influence Of Recron Polyester Fibres And Slag Sand On The Performance Of Concrete in journal of International Journal of Civil Engineering and Technology. The present study involves use of polyester Fibre for 0%, 1%, 1.25% and 1.5% of cement content and slag sand at 0%, 10%, 15% and 20 % as replacement of fine aggregates respectively.
7. **Sudhikumar Et Al ;** August 2022 An Experimental Study On Bendable Concrete Using RECRON 3s FIBRE in the journal of International Research Journal of Engineering and Technology. In this project, An experimental study is carried out for bendable M25 grade concrete using Recron 3s fibres and the test results were compared with conventional M25 grade concrete.
8. **MalathiNarra Et Al**; December 2021 Strengthening of Flexible Pavement by Adding Recron Fibre in journal of IOP Conference Series: Materials Science and Engineering. In the present study, various proportions of Recron Fibre such as 3%, 6%, 9% and 12% are added to Bitumen to prevent the deterioration of pavement surface and various tests are performed on aggregate and bitumen.
9. **Bhosale Et Al** ; September 2015 Effect of Recron 3s Fibres on GGBS Replaced Cement Concrete in the journal of International Journal of Science and Research (IJSR). The present work is to develop concrete with good strength, less porous, less capillarity so that durability will be reached.For this purpose it requires the use of different pozzalanic materials like fly ash, ground granulated blast furnace slag, silica fume along with Fibre.
10. **Prahatheswaran Et Al ;** March 2017 Study On Structural Behaviour Of Fibre Reinforced Concrete With Recron 3s Fibres IN the journal of SSRG International Journal of Civil Engineering.This project work is on the study of comparison of Recron 3s Fibre reinforced concrete

elements with the conventional concrete specimens. The influence of Fibre content on the mechanical properties of Recron 3s Fibre reinforced specimens having different Fibre -volume fractions will be investigated.

11. **Pandey Et Al ;** February 2020 Effect Of Addition of Recron 3s Fibre And Glass Fibre On The Strength Characteristics Of M-30 Concrete in the journal of Journal of Emerging Technologies and Innovative Research (JETIR).This research explores the Fibre-3S blend in cement reinforcement and Fibreglass blend in concrete reinforcement.
12. **Sathish Et Al** ; September 2023 Experiment And Introduction Of Recron 3s Fibre And Plastic For Production Of Concrete Solid Blocks And Paver Blocks in the journal of Journal of University of Shanghai for Science and Technology.This project is based on the concept the idea to make the utilization of plastics & RECRON Fibre 3S in manufacturing of Concrete blocks and concrete paver blocks.
13. **Anil Et Al ;** December 2023 Influence of Recron 3S Fibres on Consolidation Behaviour of Expansive Black Soils in the journal of Research Gate. The present experimental study is to reduce foundation failures by reinforcing the fibres to the expansive soils. Two soils having extreme liquid limits of 58% and 85% in the range were selected and reinforced with Recron 3S fibres.
14. **Husain Et Al ;** April 2015 Application of Recron 3S Fibre in Improving Silty Subgrade Behaviour in the journal of IOSR Journal of Mechanical and Civil Engineering. The present paper is to check the usefulness of Recron 3S fibre in improving soil subgrade strength of local silty soil of Kurukshetra.

Materials Properties :

Cement (OPC 43 Grade)

Physical properties			**Chemical properties**		
01	Consistency	37%	01	Lime(CaO)	62.72%
02	Specific gravity	3.28	02	Silica(SiO_2)	31.38%
03	Initial setting time	30min	03	Fe_2O_3 and Al_2O_3	6.89%
04	Final setting time	600min	04	Magnesia(MgO)	2.02%
05	Fineness by sieving	1% residue	05	Sulphur Trioxide(SO_3)	3.14%
06	Soundness	1.5mm	06	Loss on ignition	2.76%
			07	Insoluble residue	1.25%

3.2 Flyash

F grade fly ash, a by product of coal combustion, adds value to pervious geopolymer concrete as a supplementary cementitious material. Its fine particle size and high silica content enhance the concrete's properties, including strength and durability. By utilizing industrial waste, it contributes to sustainable construction practices, reducing environmental impact. Through proper dosage and activation, F grade fly ash optimizes workability and reduces permeability, ensuring long-term performance of the concrete.

Physical properties			**Chemical properties**		
01	Bulk density(gm/cc)	0.9-1.3	01	SiO2	59.00%
02	Specific gravity	1.6-2.6	02	Al2O3	21.00%
03	Plasticity	Non-plastic	03	Fe2O3	3.70%
04	Shrinkage limit (volume stability)	Higher	04	CaO	6.90%
05	Water holding capacity(percent)	40-60	05	MgO	1.40%
06	Porosity(percent)	30-65	06	SO3	1.00%
07	Surface area(m2/kg)	500-5000	07	K2O	0.90%

3.3 Recron Fibre

Recron is a state of art reinforcing material which is used to increase strength in a variety of applications like filtration fabrics, asbestos cement sheets, cement based pre-cast products and for improving quality of construction. Recron is manufactured by polymerization of raw materials, high-quality polyester textured yarn and PET bottles.

S.No	**Parameter**	**Value**
1.	Appearance	Short cut staple fibre
2.	Diameter	30-40 micron
3.	Viscosity	Not applicable

4.	Ignition Temperature	>450 degree Celsius
5.	Melting point	162-167 degree Celsius
6.	Flash point	>329 degree Celsius
7.	Relative density	0.89-0.94 g/cc
8.	Colour	White

Compressive Strength of Recron Fibre Concrete :

The average compressive strength of Recron Fibre Concrete with different coarse aggregate sizes is detailed in Table

Fig 3.1 Compression Testing Machine

The compressive strength of concrete is one of the most important and use full properties of concrete. In most structural application concrete are employed primarily to resist compressive stresses. The compressive strength is frequently used as a measure of these properties. Concrete cube specimen of 150mm×150mm×150mm were casting. Concrete specimen was prepared using mix ratio 1:1.5:3 having water cement ratio as 0.50 the specimen were mechanically vibrated. After 24hrs of setting the specimen were remolded and they cured for 28 days in normal water. After the curing period was over the specimens were tested for compressive strength.

The measurement was taken by Universal Testing Machine (UTM) compression concrete testing machine. Compression testing machine is shown in fig 3.1

Compressive strength was calculated by using a formula:

$$\textbf{Stress} = \frac{P}{A}\textbf{[load/area]}$$

$$F_{ck}\ \textbf{(N/mm}^2\textbf{) = Ultimate load (N/area of specimen (mm}^2\textbf{))}$$

5.1 Compressive Strength of Concrete

CALCULATIONS

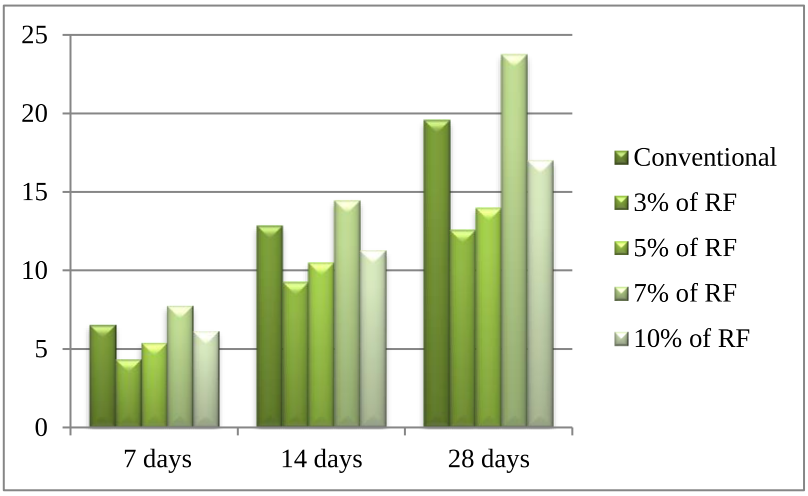
Table 3.1 Compressive Strength of Conventional Concrete:

S. No	Size (mm)	Age of loading in days	Compressive strength (N/mm^2)
1.	150 x 150	7	6.53
2.	150 x 150	14	12.84
3.	150 x 150	28	19.56

Table 3.2 Compressive Strength of Concrete with RF

S. No	Size (mm)	Percentage of RF	Age of loading in days	Compressive strength (N/mm^2)
1.	150 x 150	3%	7	4.35
2.	150 x 150	3%	14	9.25
3.	150 x 150	3%	28	12.57

4.	150 x 150	5%	7	5.38
5.	150 x 150	5%	14	10.48
6.	150 x 150	5%	28	13.98
7.	150 x 150	7%	7	7.75
8.	150 x 150	7%	14	14.45
9.	150 x 150	7%	28	23.75
10.	150 x 150	10%	7	6.12
11.	150 x 150	10%	14	11.25
12.	150 x 150	10%	28	17.00



Flexural strength of Recron Fibre Concrete :

Fig 4.1 Flexural Strength of Concrete

Flexural tests are generally used to determine the flexural modulus or flexural strength of a material. The flexural strength test on concrete prism of size 700mm×150mm×150mm the concrete was casted. After 24hrs specimen were de-mould and cured. After curing prism tested in the flexural testing machine. The specimen is laid horizontally over two point of contact (lower support span) and force is applied to the top of the material through either one points of contact (upper loading span) until the sample fails.

Flexural strength was calculated by given formula,

$$F_{bt} = \frac{pl}{bd^2}$$

Where,

P = Load at failure, L = Beam span between supports
d = Depth of beam&b = Width of the beam

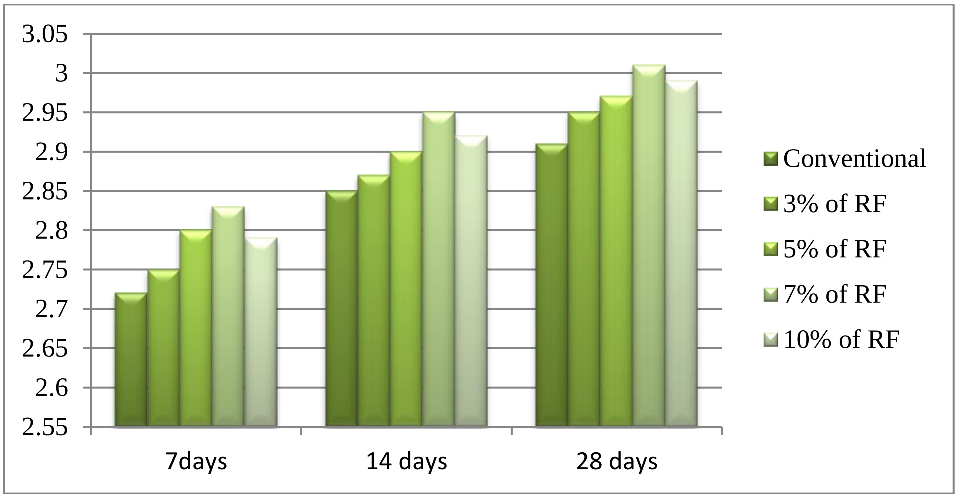
4.1 Flexural Strength of Concrete

Table 4.1 Flexural Strength of Conventional Concrete

S. No	Dimension			Age of loading in days	Flexural Strength $=\frac{pl}{bd^2}$ (N/mm²)
	Length (mm)	Breadth (mm)	Height (mm)		
1.	700	150	150	7	2.72
2.	700	150	150	14	2.85
3.	700	150	150	28	2.91

Table 4.2 Flexural Strength of Concrete with RF

S. No	Dimension			Percentage of RF	Age of loading in days	Flexural Strength $=\frac{pl}{bd^2}$ (N/mm²)
	Length (mm)	Breadth (mm)	Height (mm)			
1.	700	150	150	3%	7	2.75
2.	700	150	150	3%	14	2.87
3.	700	150	150	3%	28	2.95
4.	700	150	150	5%	7	2.80
5.	700	150	150	5%	14	2.90
6.	700	150	150	5%	28	2.97
7.	700	150	150	7%	7	2.83
8.	700	150	150	7%	14	2.95
9.	700	150	150	7%	28	3.01
10.	700	150	150	10%	7	2.79
11.	700	150	150	10%	14	2.92
12.	700	150	150	10%	28	2.99



Conclusion :

The experimental result reveals that the maximum compressive strength achieved for seven, fourteen & 28 days are 7.75, 14.45& 23.75 N/mm^2respectively by 7% replacement of Recron fibre.

By adding the 7% of Recron fibre will eventually increase the strength of concrete and found to be optimum replacement. also flexure strength are always maintained by 7% replace RF.

There is Adding RF in the Concrete by proving the secondary reinforcement for highly flexible structure.

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