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EXPERIMENTAL INVESTIGATION ON THE PROPERTIES OF NYLON FYBRE REINFORCED CONCRETE

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Abstract : Concrete is a resourceful material for civil engineering construction. It has many properties such as compressive strength, durability and fire resistance. Concrete is made up of aggregates, cement, water and various admixtures. This article is about the study of waste fishing nets. Normally fish nets (made up of plastics) are adding 1%, 2%, 3%, 4% and 5% in concrete and compared the fibre concrete with the conventional concrete with the mechanical properties. By using the fibre in concrete as 10 mm length and the diameter is to fix as per the aspect ratio. Concrete is a composite material. Normal concrete is strong in competition but it has very low tensile strength and also micro cracks developed due to shrinkage. This paper presents and experimental examination of how the different combinations of nylon fiber percentage influence the tensile strength, compressive strength and flexural strength of concrete. It includes laboratory tests on normal concrete and nylon fiber reinforced concrete cylinder to investigate the behavior of specimens subjected to compressive and tensile loading. An experimental investigation on the flexural behavior of rectangular concrete beam specimens reinforced with and without nylon fiber under flexural loading is presented. The laboratory tests were conducted on specimens with seven different percentages of nylon fibers with three trials of each combinations. It was observed that nylon fiber reinforced concrete specimens shows enhanced strength properties compared to the normal concrete. The incorporation of nylon fibers in concrete enhances its tensile strength, durability, and resistance to cracking. This composite material exhibits improved structural integrity and resilience, making it suitable for applications in construction where flexibility and toughness are essential. The nylon fibers act as reinforcement, mitigating the formation of cracks and enhancing the overall performance of the concrete.This has been done in order to reduce the disposal of plastics and for effective utilization of waste plastics that are hazardous to environment. This study attempts to give a contribution to the effective use of domestic wastes (plastics) in concrete as fibres in order to prevent the environmental strains caused by them, also to limit the consumption of natural resources.

I. INTRODUCTION

Concrete is a composite material of fine aggregates and coarse aggregates which are binded with a cementecious material. In most of the concretes Ordinary Portland Cement (OPC) is used as the cementecious material. However Asphalt concrete are also frequently used in concrete pavements. The first strip of concrete pavement was completed in 1893. Concrete is extensively using for paving highways and airports as well as business and residential streets. Concrete pavements are made with dowels or with reinforcement as purpose. Even though concrete pavements are better than bituminous pavements it has many drawbacks like cracks , abrasion etc. The cracks are generally developed with time and stresses to penetrate the concrete, which affects the waterproofing properties and exposing the interior of the concrete to the damaging substances like moisture, acids, etc. Fibre Reinforced Concrete (FRC) increase tensile strength , reduce the air voids , increases durability , creep resistance, etc. has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. Nylon is a soft, heat resistant (Thermal conductivity = 0.25 W/(m·K)), with more compact molecular structure have high melting point ((256 °C/492.8 °F) and excellent abrasion resistance is selected as fibre here. The nylon fibers stepped up the performance after the presence of cracks and sustained high stresses when compared to other FRC. In this paper, the strength properties of nylon-fiber-reinforced concrete were under investigation, in comparison with conventional concrete.

1.1 Experimental Investigation

The materials selected for this experimental study includes normal natural coarse aggregate, river sand as fine aggregate, cement, nylon fiber and water. The physical and chemical properties of each ingredient has considerable role in the desirable strength properties of concrete.Compressive Strength test of concrete cubes Place the prepared concrete mix in the steel cube mould for casting. Once it sets, After 24 hours remove the concrete cube from the mould. Keep the test specimens submerged underwater for stipulated time. As mentioned the specimen must be kept in water for 7 or 14 or 28 days and for every 7 days the water is changed. Ensure that concrete specimen must be well dried before placing it on the UTM. Weight of samples is noted in order to proceed with testing and it must not be less than 8.1Kg. Testing specimens are placed in the space between bearing surfaces. Care must be taken to prevent the existence of any loose material or grit on the metal plates of machine or specimen block. The concrete cubes are placed on bearing plate and aligned properly with the center of thrust in the testing machine plates. The loading must be applied axially on specimen without any shock and increased at the rate of 140kg/sq cm/min. till the specimen collapse. Due to the constant application of load, the specimen starts cracking at a point & final breakdown of the specimen must be noted.

Design Mix

We used seven combinations for the trial mix as per the percentage of nylon fiber used. We did three trial mixes with zero percentage of nylon fiber, two trial mixes with 0.25% of nylon fiber, three trial mixes with 0.5% of nylon fiber, four trial mixes with 0.75% of nylon fiber, two trial mixes with 1% of nylon fiber, four trial mixes with 1.25% of nylon fiber, three trial mixes with 1.5% of nylon fiber. In this project we used M30 grade of concrete.

Results. This paper presents an experimental investigation to determine the effect of fiber by examining the compressive strength, split tensile strength and flexural strength of the cube samples. The compression test and splitting tension test were conducted by the same compression testing machine for cube.

1.2 Objectives

- Improved Strength:* Nylon fibers enhance the tensile and flexural strength of concrete, providing increased resistance to cracking and improving overall durability.
- Crack Control:* Incorporating nylon fibers helps control the formation and propagation of cracks in concrete, contributing to better structural integrity and longevity.
- Impact Resistance:* The use of nylon fibers enhances the concrete's ability to withstand impact and dynamic loads, making it suitable for applications where resistance to physical stresses is crucial.
- Reduced Shrinkage Cracking:* Nylon fibers mitigate shrinkage cracking in concrete, particularly during the curing process, leading to a more stable and resilient structure.
- Enhanced Toughness:* The addition of nylon fibers improves the toughness of concrete, making it less prone to brittle failure and better able to withstand various environmental and loading conditions.

1.3 Significance

Nylon fibers enhance the durability of concrete by reducing the likelihood of cracks and improving resistance to various forms of wear and tear.By reinforcing the concrete matrix, nylon fibers contribute to increased strength and toughness, enhancing the overall structural integrity of the material. Nylon fibers help prevent the formation of cracks in concrete and control the spread of existing cracks, minimizing the potential for structural weaknesses and water infiltration.Enhanced Performance under Stress:* The incorporation of nylon fibers improves the performance of concrete under dynamic and impact loads, making it suitable for applications where structural resilience is essential.Mitigation of Shrinkage Issues:* Shrinkage is a common challenge in concrete. Nylon fibers assist in reducing shrinkage cracking during the curing process, leading to a more stable and robust final product. The use of nylon fibers provides versatility in concrete applications, allowing for the construction of structures that can withstand diverse environmental conditions and loading scenarios.In summary, the significance of using nylon fibers in concrete lies in the material's ability to enhance durability, prevent cracks, improve structural strength, and adapt to a variety of construction requirements. The use of fibers in concrete enhances its structural performance by improving properties such as tensile strength, toughness, and durability. Fibers, commonly made of materials like steel, glass, or synthetic polymers, act as reinforcement, reducing cracking and increasing the resistance to impact and fatigue. This reinforcement also helps control shrinkage and provides additional support, particularly in applications like pavements, industrial floors, and precast elements. Overall, incorporating fibers in concrete contributes to a more resilient and durable construction material. Fibers help control the formation and width of cracks in concrete, especially during the early stages of curing. This is crucial for maintaining structural integrity and preventing water infiltration. The addition of fibers improves the flexural strength of concrete, making it better able to withstand bending or stretching forces without breaking. This is particularly important in applications where the concrete is subjected to dynamic loads. Fibers enhance the impact resistance of concrete, making it more suitable for structures that may be exposed to sudden loads or impacts, such as industrial floors and pavements. Fibrous concrete exhibits increased ductility, allowing it to deform without fracturing extensively. This property is valuable in earthquake-prone regions where structures need to withstand significant lateral forces. Fiberreinforced concrete exhibits improved toughness, absorbing and distributing energy more effectively. This is beneficial in structures where resistance to dynamic loading, such as blast or seismic events, is a priority.Certain fibers contribute to better freeze-thaw resistance, making fiber-reinforced concrete suitable for applications in cold climates where the concrete is exposed to freezing and thawing cycles.Fibers allow for the construction of thinner sections of concrete without compromising strength, offering material savings and reduced overall weight in structures. Fiber reinforcement provides added durability in harsh environmental conditions, such as exposure to chemicals, salt, or aggressive industrial atmospheres. Fiber reinforcement can simplify construction processes by reducing the need for traditional steel reinforcement in certain applications, streamlining construction practices and reducing labor costs.Incorporating fibers into concrete mixtures is a versatile strategy with widespread applications, contributing to improved performance and longevity in various construction scenarios.

II. LITERATURE SURVEY

1. E. Siva Subramanian et al[1] has studied DzExperimental)nvestigation Of Concrete Composite Using Nylon Fibredz and identified that Nylon Fibre Reinforced Concrete has far better strength than normal concrete. He took four mix designs of concrete including Nylon Fibre Reinforced of 1%, 2%, 3% and Normal Concrete and also found that adding 1% Nylon of total volume of concrete achieves more strength than that of normal concrete.
2. Anirudh Swami et al has studied DzUse of Nylon Fibre in Concretedz and concluded that nylon fibre is non-environmental friendly so it must be properly disposed off. The fibres improves its strength, tensile strength, durability.If used in concrete, it decreases the nylon in disposing off making it environmental friendly concrete. The workability of concrete is reduced as nylon absorbs water thus reducing the slump value. It gives best strength when used with 1% of nylon fibre. The tensile strength also increases by 60- 70% at high amount of nylon fibre which makes it useful in places where it is expected that slight tensile stresses may overcome like temperature stresses, creep etc.
3. Jaya Saxena et al has studied DzEnhancement the Strength of Conventional Concrete by using Nylon Fibredz and concluded that nylon fibre mixed with concrete gives better compressive strength. He also tested with 0.2%, 0.25%, 0.3% nylon fibre reinforced concrete and found the strength of concrete increased. He added 10%, 20%, 30% fly ash with concrete having different percentage of nylon fibre as mentioned above and found good strength of concrete.
4. K.Manikandan et al has studied "Experimental Investigation On Nylon Fiber Reinforced Concretedz and found that 2% nylon fibre replaced with fine aggregate gives improved strength of concrete. The compressive strength is increased by 1.1%, split tensile strength is increased by 1.06% and flexural strength is increased by 1.29%. The specimen was also cast with 4% and 6% nylon fibre and the strength was improved.
5. Saravanakumar Jagannathan et al studied DzAn Experimental Investigation on Nylon Fibre îTextile WasteÒ Reinforced Concretedz and concluded that addition of fibre 0.5%, 1.0% and 1.5% in concrete and found that the concrete containing 1.0% of fibre has the good strength as compared to others. He also got that there will be reduction in pollution caused due to nylon fibre as it is utilized in concrete.
6. M. Nazeer et al has studied DzStrength Studies on Metakaolin Blended High-Volume Fly Ash Concretedz and concluded that flyash and metakaolin mixed with concrete reduces the workability of concrete. Addition of metakaolin reduces compressive strength, split tensile strength, flexural strength of concrete specimen.
7. Kamaldeep Kaur et al studied DzDetermination of Optimum Percentage of Metakaolin by Compressive Strength and XRD Analysis and found that compressive strength is increased on addition of 0%, 7%, 8% but it gets decreased after further addition of metakaolin.
8. Nova John studied DzStrength Properties of Metakaolin Admixed Concretedz and observed that addition of metakaolin increases faster early age strength. 15% replacement of metakaolin with cement gives better strength of concrete.
9. Rakesh Kumar studied DzEffect of Metakaolin and Recycled Fine Aggregate on Workability and Compressive Strength of Concretedz and observed that metakaolin is used with 13% as a replacement of cement and after testing he found that there is 41% increase in strength at the age of 7 days.
10. Vikas Srivastava et al has studied DzEffect of Silica Fume and Metakaolin combination on concretedz and concluded that the slump is found to decreases with increase in Metakaolin content at all the Silica fume contents considerably. The optimum dose of Silica fume and Metakaolin in combination is found to be 6% and 15% (by weight) respectively at both 7 and 28 day compressive strength.

III. METHODOLOGY

3.1 MATERIAL INVESTIGATION

a. Nylon Fiber

fishing net is a net used for fishing. Nets are devices made from fibers woven in a grid-like structure. Some fishing nets are also called fish traps, for example fyke nets. Fishing nets are usually meshes formed by knotting a relatively thin thread. Early nets were woven from grasses, flaxes and other fibrous plant material. Later cotton was used. Modern nets are usually made of artificial polyamides like nylon, although nets of organic polyamides such as wool or silk thread were common until recently and are still used.

b. Cement

Cement is a binder, a substance used for construction that sets, hardens and adheres to other material to bind them together. Cement is one of the main constituent in concrete. Table I shows that the physical properties of cement as per IS 4031

Table I Physical Properties Of Cement

Sl. No	Description	Quantity
1	Specific gravity	3.15
2	Standard Consistency (%)	31
3	Initial Setting Time (minutes)	50
4	Final Setting Time (minutes)	330

c. Fine Aggregate

The aggregate which is passing 4.75 mm sieve is called fine aggregate. Table II shows that the physical properties of Fine aggregate as per IS 2386.

Table II Physical Properties of Fine aggregate

Sl. No	Description	Quantity
1	Specific gravity	2.6
2	Water Absorption (%)	1.5
3	Fineness modulus	2.9
4	Zone	II

d. Coarse Aggregate

The aggregate which is retained 4.75 mm sieve is called coarse aggregate. Table III shows that the physical properties of coarse aggregate as per IS 2386.

Table III Physical Properties of Coarse aggregate

Sl. No	Description	Quantity
1	Specific gravity	2.7
2	Water Absorption (%)	1.2
3	Fineness modulus	5.2

e. Waste Nylon Fibers

Waste nylon fibers which is mainly made up of plastics. Usage of nylon fibers in concrete by 10 mm length and the aspect ratio of about 52.6. Table IV shows the physical properties of nylon fibers.

Table IV Physical Properties of nylon fibers

Sl. No	Description	Quantity
1	Density (g/cm^3)	1.14
2	Diameter (mm)	0.19

f. Super plasticizer

Admixtures play a vital role in concrete especially super plasticizer is the high range water reducer by the range of 29% in water. Here we are using supaflo as a chemical admixture. Which have specific gravity of about 1.145.

3.2 MATERIALS USED:

1) Natural Aggregate:

Gravels are obtained by crushing natural basalt stone obtain from quarries . They are hard, strong, tough, clear and free from veins, alkali, vegetable matter and other deleterious substances. Aggregates are free from such material, which will reduce strength or durability of concrete. 2) Sand: Natural sand free from silt, veins, alkali, vegetable matter and other deleterious substances, obtained from Bhima, Ghod River. 3) Cement: Ultratech 53 GRADE ordinary Portland cement is used for all mixes. 4) Ceramic Waste : Fine Ceramic Waste obtained from grinding and cutting of glass. 5) Coconut fibre: Obtained from coconut husk.

3.2.1 Cement: The cement used in the tests was Ordinary Portland Cement (Grade 53) locally available.

Table 3.2.1. Properties of Cement

Sr. No.	Characteristic	Result	Requirement
01	Fineness	6.7%	Residue less than 10 %
02	Soundness	8.1 mm	Not be more than 10 mm
03	i. Setting Time		
	I. Initial		

3.2.2 Fine Aggregate (Sand)- Locally available clean and good graded fine aggregate was used after passing through I.Ssieve2.36 mm.

Table Properties of Fine Aggregate (Sand)

Sr. No.	Characteristics	Result
1	Specific gravity	2.74
2	Water absorption	1.2%
3	Bulk density	1650 kg/m^3
4	Grain size	0-2.36 mm

Table. Sieve Analysis of Sand

Sr. No.	IS Sieve	% Passing
1	2.36 mm	100
2	1.18mm	72.34
3	600 Microns	32.9
4	300 Microns	7.8
5	150 Microns	1.3

3.3 Coarse aggregate: The fractions from 80 mm to 4.75 mm are termed as coarse aggregate. The material which is retained on BIS test sieve no. 480 is termed as a coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having maximum size of 20 mm was used in the present work.
Material = 20 mm
Weight = 1000 grams

Table No.3.2.3.1- Sieve analysis of coarse aggregate (20mm)

Sieve size	Weight Retained (gm)	Cumulative Weight Retained (gm)	% Cumulative Weight Retained (gm)	% Passing
25 mm	0	0	0.00	100.00
20 mm	140	140	14.00	86.00

10 mm	810	950	95.00	5.00
4.75 mm	50	1000	100.00	0.00
Pan	0	1000	100.00	0.00

3.3.1 Properties of nilon fiber:

Waste nylon fibers which is mainly made up of plastics. Usage of nylon fibers in concrete by 10 mm length and the aspect ratio of about 52.6. Table IV shows the physical properties of nylon fibers.

Table IV Physical Properties of nylon fibers

Sl. No	Description	Quantity
1	Density (g/cm^3)	1.14
2	Diameter (mm)	0.19

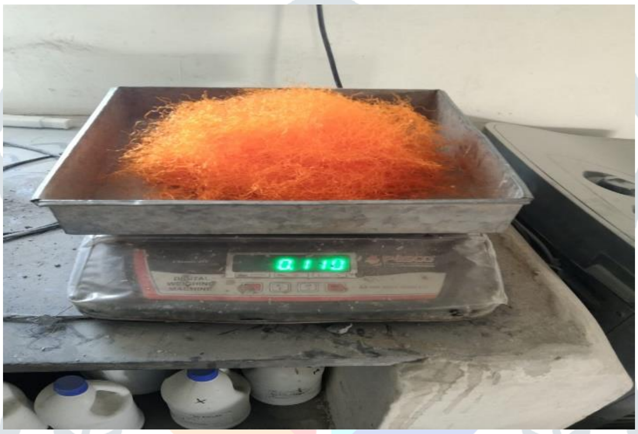

Fig. Raw Nilon Fiber

Water: Ordinary drinking water was used for mixing and curing of concrete. The water was clean and free from acids, alkalis and organic impurities.

3.4 Test procedure:

3.4.1 Slump cone test-

This test is extensively used on site. The test is very useful in detecting variations in uniformity of a mix for a given nominal proportion. This test shows behaviour of compacted concrete under the action of gravitational field slump occurs due to self weight of concrete there is no external energy supplied for the subsidence of concrete.

Degree of Workability	Slump value in mm	Suitability
Very Low	0-25	Concrete roads.
Low	25-50	Mass concrete foundations, lightly reinforced sections.
Medium	50-100	Manually compacted flat slabs,
High	100-175	For sections with congested sections.

The slump measured for the given sample is 48 mm. From the slump measured it can be concluded that the concrete has low workability such concrete is suitable for mass concrete foundations, lightly reinforced sections.

3.4.2 Casting of Concrete Cube (IS: 10086-1982)

3.4.3 Curing of cubes:

3.5 Testing on Hardened Concrete:

3.5.1 Testing for Compressive Strength on Concrete Cube Specimen (IS: 516) 1959-

Among the many properties of concrete, the compressive strength of concrete is considered to be most important and useful property. It has been held as an index of its overall properties. Although in some case, the durability and impermeability of concrete may be more important, yet compressive strength is directly or indirectly related to other properties viz. tensile strength, shear strength, resistance to shrinkage, young‟s modulus, etc. Thus compressive strength reflects overall quality of concrete and hence its grade according to its compressive strength. Compressive strength of concrete can be found by destructive and non destructive test. Following procedure is destructive testing.

IV. RESULTS AND DISCUSSION

4.1 Results of Test on Hardened Concrete:

4.1.1 Compressive Strength of Concrete cube:

Table 4.1.1: Compressive strength of concrete cube specimen tested after 7 days of curing.

Nylon fibre (%)	Load (KN)	Compressive Strength (N/mm2)	Average Compressive Strength (N/mm2)
0.5	709	31.51	30.236
	788	35.02	
1	752	33.42	31.97
	740	32.88	
1.5	629	27.95	37.42
	630	28	
2	705	31.33	28.54
	669	29.73	

Table 4.1.2: Compressive strength of concrete cube specimen tested after 28 days of curing.

Copper slag (%)	Load (KN)	Compressive Strength (N/mm2)	Average Compressive Strength (N/mm2)
0.5	1104	49.06	43.15
	914	40.62	
1	911	40.48	36.74
	864	38.40	
1.5	918	40.8	30.80
	842	37.42	
2	930	41.33	36.07
	810	36	

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