STUDY ON MECHANICAL PROPERTIES OF NYLON FIBER REINFORCEMENT OF CONCRETE

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***Abstract*: this paper deals with experimentally on study of nylon fiber concrete using M30 grade. Nylon was the first truly synthetic fiber to be commercialized. All Nylon absorbs moisture depends on temperature, crystalline & humidity. It provides secondary reinforcement that is always positioned in compliance with building codes. Saving time and money be eliminating the purchase, storage handling, cutting & placing of wire mesh. Allows concrete to reach its designed, strength and integrity without the used for welded wire. It inhibits plastic shrinkage. Compatible with all other admixtures, surface treatments and finally finishes like regular concrete. In the designed concrete the sand was admixture with 0.025%, 0.050%, and 0.075% of Nylon fiber. The mechanical properties such as compressive strength, splitting tensile strength were tested.**

***Index Terms*: Nylon fiber, concrete, workability, strength**

I. INTRODUCTION

Concrete is one of the major construction materials being worldwide. Aggregate besides cement and water forms one of the main constituent materials of concrete since it occupies nearly 55%-80% of concrete volume. The aggregate types utilized are either coarse aggregates (with particle size more than4.75mm) or fine aggregates (with particle size less than 4.75mm) aggregates which are used in concrete are obtained from natural sources or by crushing large size rocks. Coarse aggregates and bound with cement paste during the hydration process to from cement concrete whereas fine aggregates are utilized to fill the gaps between the course aggregate particles. The repaid increase in the natural aggregates consumption every year due to the increase in the construction industry worldwide means that the aggregate reserves are being depleted rapidly particularly in some desert regions such as Arabian gulf region. It has been reported that without proper alternative aggregates being utilized in the near future the concrete industry globally will consume 8-12 billion tons annually of natural aggregates. such large consumption of natural aggregates will cause destruction of the environment. Therefore there is an urgent need to find and supply alternative substitutes for natural aggregates by exploring the possibility of utilization of industrial by-products and waste materials in making concrete. This will lead to sustainable concrete design and greener environment. In order to achieve high strength with good mechanical properties and durability, Fly ash or and silica fume that are considered as waste materials are used as one of the main ingredients. A review of the recent research showed that it is possible to utilize industrials by products of normal concrete and high strength concrete when used as partial and or full replacement of cement or\and aggregates or as admixtures. Also it has been demonstrated that many of the product concrete made with wastes and industrial by- produces possesses superior super properties compared with the conventional concrete in teams of strength, performance and durability.

II. NYLON FIBER

When fiber link is added to a mix, the process of material settlement is altered. Millions of evenly dispersed fibers produce an internal support system that prevent or slows solids form sinking. This results in slower, more uniform bleeding and a reduction in concentrated internal tensile stresses that lead to plastic shrinkage cracking early volume change. The stress induced micro cracks that do start are bridged and intersected by Fiber-Link and crack propagation is stopped. Fiber-Link greatly reduce plastic shrinkage cracking and allows concrete to reach its designed strength and integrity without the use of welded wire fabric. Fiber –Link Fibers are made of 100% pure Nylon.

Manufacturing process of nylon fiber concrete:

Fiber can be added with the coarse and fine aggregate at the batch plant or to the central or truck mixer at the jobsite. If adding the fibers with other mix ingredients, no extra mixing time is needed. If adding the fibers mixed concrete, agitate the concrete an additional 3 to 7 minutes as recommended by ASTM C 94 to disperse the fibers thoroughly. Because nylon fibers don't affect the chemical hydration of cement, they work with all concrete mixes and admixtures without changing required mix proportions. To eliminate measuring, most fiber suppliers package the fibers in the recommended dosage for a cubic yard quantity of concrete. Some fiber manufactures package the fibers in cellulose bags that can be added unopened to the mixing drum. Nylon fibers are compatible with all concrete surface treatments and finishes, such as pattern stamping, exposed aggregate, brooking, and hand or power toweling. The neutral fibers also won't stain or discolor concrete. However, a fiber-reinforced concrete slab usually bleeds less and more slowly than a plain slab because the fibers hold the concrete together and reduce segregation. So it's especially important when finishing fiber- reinforced concrete not to start too early.

III. Mix Design (As per IS 10262-2009)

Mix design is defined as the process of selecting suitable of concrete to determining their relative proportion with the object of producing concrete of certain minimum strength of the cubes cast depends upon the property by the solid shows resistance against externally applied compressive force by inducing internal stresses.

Design stipulation:

1. Grade designation : M30
2. Type of cement : OPC 53 grade
3. Maximum nominal of size aggregate : 20mm
4. Minimum cement content : 320 Kg/m3
5. Maximum water cement ratio : 0.45
6. Workability : 150mm(slump)
7. Exposure condition : Mild
8. Degree of supervision : good
9. Type of aggregate : crushed angular aggregate
10. Maximum cement content : 425 Kg/m3
11. Admixture : Nylon fiber

Test of Material

1. Specific gravity of cement = 3.18
2. Specific gravity
   - Crouse aggregate = 2.71
   - Fine aggregate = 2.75
3. Water absorption
   - Coarse aggregate = 0.5%
   - Fine aggregate = 0.1%
4. Free (surface) moisture
   - Coarse aggregate = Nil
   - Fine aggregate = Nil

Mix Proportion:

Cement = 425.73Kg/m^3
Fine aggregate = 689.107Kg/m^3
Course aggregate = 1067.31Kg/m^3
Water = 191.58 Liter

The end mix proportion is **1 : 1.61 : 2.507**

IV. Experimental Investigation

Compressive Strength:

Compressive strength is one of the important properties of concrete. Concrete cubes of size 150X150X150mm were cast conventional concrete. After 24 hours the specimen were remoulded and subjected to water curing. After 7.14,28 days of curing the three cubes we allowed to dry and tested in compressive strength testing machine. The ultimate loads of the specimen were noted.

Compressive strength fck $= \frac{P}{A}$ N/mm^2

Table 1: Compression Test for Conventional Concrete

S.No	Age of Test	Compression load at failure (KN)	Compression Strength (N/mm^2)	Average
1	7 Days	370	16.42	17.32
		410	18.22	
		390	17.33	
2	14 Days	490	21.77	22.29
		540	24.22	
		470	20.88	
3	28 Days	600	26.66	27.25
		610	27.11	
		630	28	

Table 2: Compression Test for Special Concrete

S.No	Age of Test	Nylon fiber (%)	Compression load at failure (KN)	Compression Strength (N/mm^2)	Average
1	7 Days	0.0255	440	19.55	18.21
		0.050	410	18.22	
		0.075	400	16.88	
2	14 Days	0.0255	560	24.88	23.25
		0.050	530	23.55	
		0.075	500	21.33	
3	28 Days	0.0255	740	32.88	28.29
		0.050	600	26.66	
		0.075	570	25.33	

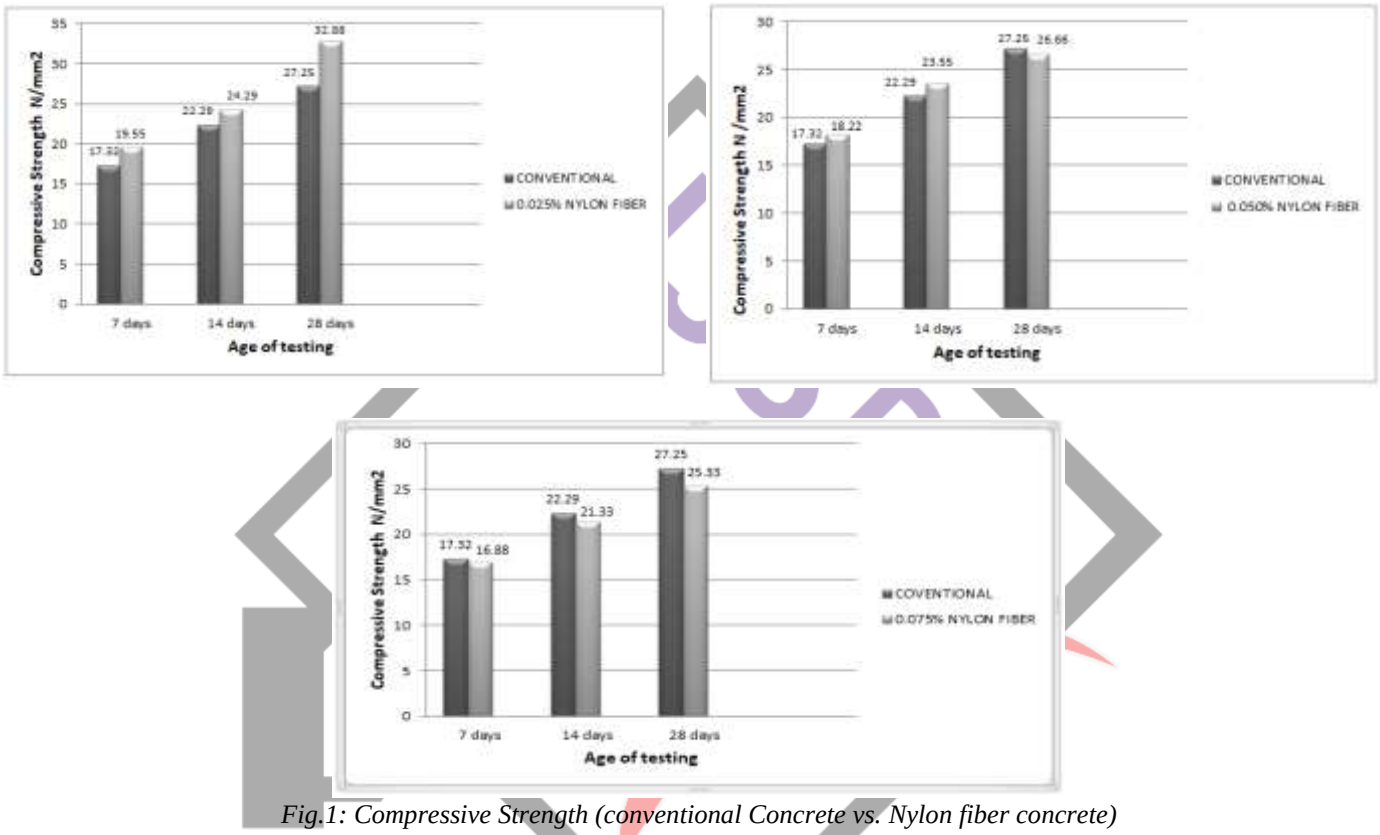

Fig.1: Compressive Strength (conventional Concrete vs. Nylon fiber concrete)

Split Tensile Strength:

Tensile strength is indirect way of finding the tensile strength of concrete by subjected the cylinder to a compressive force. Cylinder of size 150mm diameter and 300mm long were cast conventional. After 24 hours the specimen were remoulded and subjected to water curing, after 7,14,28days of curing, the curing three cylinders were taken and allowed to dry and tested in CTM by placing the specimen horizontal. The ultimate loads of the specimen were noted.

Split tensile strength $= \frac{2P}{\pi dl}$ N/mm^2

Table 3: Split Tensile Test for Conventional Concrete

S.No	Age of Test	Split Tensile load at failure (KN)	Split Tensile Strength (N/mm^2)	Average
1	7 Days	170	2.40	2.77
		220	3.11	
		200	2.82	
2	14 Days	270	3.81	3.53
		300	4.20	
		290	3.95	
3	28 Days	320	4.52	3.83
		280	3.91	
		330	5.16	

Table 4: Split Tensile Test for Special Concrete

S.No	Age of Test	Nylon fiber (%)	Split Tensile load at failure (KN)	Split Tensile Strength (N/mm^2)	Average
1	7 Days	0.0255	210	3.23	2.87
		0.050	220	2.86	
		0.075	180	2.55	
2	14 Days	0.0255	270	3.91	3.73
		0.050	260	3.87	
		0.075	240	3.39	
3	28 Days	0.0255	290	4.01	3.97
		0.050	270	3.81	
		0.075	260	3.67	

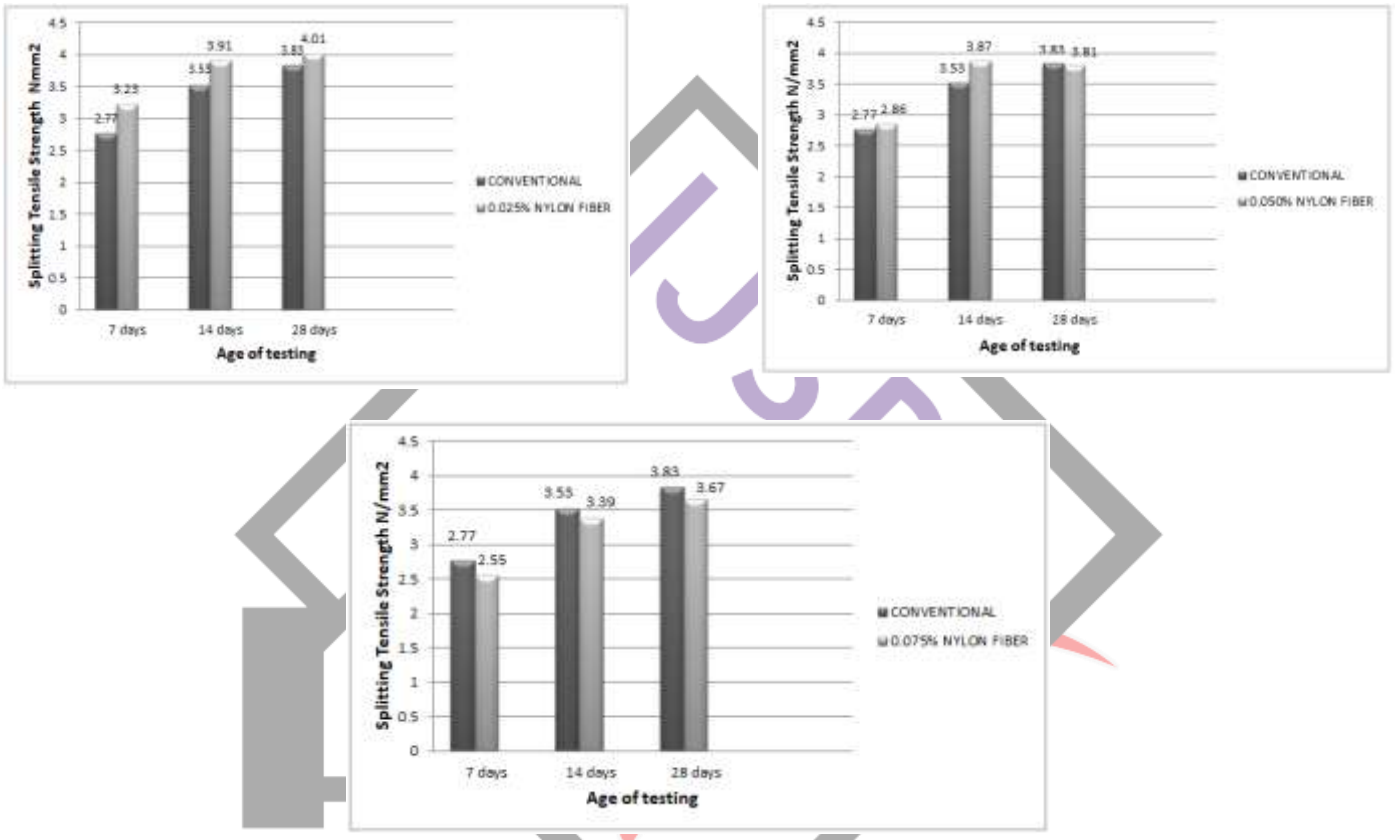

Fig.2: Split Tensile (conventional Concrete vs. Nylon fiber concrete)

V. CONCLUSION

The research concludes the study of the effect of Nylon fiber on the properties of concrete for nominal mix of M_{30} grade of concrete are as follows:

- According to compressive, tensile strength test addition of 0.025%, 0.050%, and 0.075% volume fraction addition of Nylon fiber with the dimensions of 3/4 inch in length.
- Addition of Nylon fiber to concrete 0.025%, 0.050% the compressive strength of concrete is equal to conventional concrete.
- Addition of Nylon fiber to concrete 0.025%, 0.050% the tensile strength of concrete is increased to conventional concrete
- The comparison between the conventional concrete and the Nylon fiber concrete increased in the mechanical properties in terms of tensile strength
- 0.050% of the Nylon fiber is optimum % of nylon fiber concrete
- 0.075% of the Nylon fiber is added in the concrete the strength will be decreased compared to conventional concrete.

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