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Enhancement of Compression and Flexural Strength of Concrete by addition of Cellulose Nano Crystal.

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ABSTRACT:

Concrete is widely used construction material. These concrete can withstand heavy compressive loads under various conditions but can fail in flexure. Hence, reinforcement are added in concrete to increase its flexural strength. In this project we are mainly focusing on weakness of concrete i.e. flexural strength. Cellulose nonmaterial are being investigated for new utility in cementations material. This experiment considers the use of cellulose fibers as an inexpensive alternative to synthetic fiber. Cellulose Nano Crystal, extracted from nature is been used for this project. This enhances the flexure strength of concrete up to 30% on addition. This material works as Nano sized reinforcement thus increasing the flexure. Addition of nano crystal will result into filling of micro cracks and which will lead to improvement of static and dynamic properties of concrete. They have high surface area to volume ratio, giving potential to increase chemical reaction also they have unique properties such as high aspect ratio, high elastic modulus, high tensile strength, low density that allow easy water dispensability. Moreover being in suspension form it provides more workable concrete. Small size can allow a smaller inter fiber spacing and more interaction between cellulose and cement system, and as a result, the CNCs have a greater potential combat to micro-cracking and increase the strength of the system.

KEYWORDS: Concrete, Cellulose Nano Crystal, dispensability, flexural strength.

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INTRODUCTION:

Cement is the most commonly used construction material due to its low cost and durability, but experiences shrinkage and brittle fractures [1]. Cement being binder material provides high compressive strength to concrete but low in tensile strength. Various experiments have been conducted by researchers to increase tensile strength and other properties of concrete by adding different fibers. Fibers such as carbon fibers are highly expensive and even these fibers are made from high energy consumption process[2]. So an alternative additives are required to enhance the properties of concrete which can replace this carbon and other fibers.Considering these factors, an eco friendly fibers are introduced namely Nano Cellulose Crystal (NCC). These can be generated from acid hydrolysis of cellulose rich materials such as wood pulp, wheat straw, algae, cotton and much more [3]. Length of these fiber ranges from 100 nm to 200 nm and has diameter ranging from 2nm to 10nm[4]. These fibers enhances tensile as well as other properties of concrete[5].

MATERIALS AND TESTS:

For current project work various materials like Coarse aggregate and fine aggregate are collected. We ordered CNCs from the CIRCOT industry. We conducted various tests on aggregate in the laboratory.

Materials:In this study we used cement of 43 grade, aggregates, crushed sand and cellulose Nano fibers.

Test on aggregates: We have conducted tests on coarse aggregates and fine aggregate, the details of the test and their results are shown in the table.1 and table. 2

Table No. 1: "Tests on Coarse aggregates"

Sr.No	Test	Value
1	Specific gravity	2.77
2	Water absorption	1.62%

Table No. 2: "Tests on Fine aggregate"

Sr.No	Test	Value
1	Specific gravity	2.67
2	Water absorption	1.61%
3	Fineness modulus	3.42

Test on cement: We have conducted various tests on cement, the details of the test and their results are shown in the table. 3. The properties of Cellulose Nano crystal are listed in table.4

Table No 3: "Tests on cement"

Sr.No	Test	Value
1	Specific Gravity	3.10
2	Fineness	305 sq. m per kg
3	Consistency	30%
4	Initial setting time	30 min
5	Final setting time	600 min

Table No. 4:"Properties of Cellulose Nano Crystal"

Form	Suspension
Specific Gravity	0.63-0.67
Diameter	2nm-10nm
Length	100nm-200nm
Nature	Pseudo plastic
Geometry	Thixotrophy
Strength	Stronger than Kevlar and carbon fibers
Type of source	Renewable source

EXPERIMENTAL WORK:

We have made an attempt to design concrete of grade M-60. The mix design has been carried out for the material details specified. The no. of cubes and beams casted for the present study are listed in the table 4. Casting and curing of cubes and beams are done as per the standard procedure. For the curing process we opt for water immersion curing technique, after curing for 7 and 28 days we have performed compressive strength test on concrete cubes and Third point flexural test on concrete beams, both with and without CNCs. Investigation has been carried out for the effect of CNCs in the enhancement of the flexural strength by adding different percentage of the CNCs. For the present experimental work 1% and 2% of CNCs by weight of cement is carried out the details of the sample and the no. of sample casted for the testing are listed in the table.5.

Table No. 5: "The specimen details for the experimental work"

Sr.no	Specimen	Specimen Dimension	Sample Description	Total No.
1	Cubes	150mm x 150mm x 150mm	Concrete Without CNC	6
			Concrete With 1% CNC	6
			Concrete With 2% CNC	6
2	Beams	700mm x 150mm x 150mm	Concrete Without CNC	3
			Concrete With 1% CNC	3
			Concrete With 2% CNC	3

RESULTS:

Samples were tested after 7 days and 28 days and all the data and results are given in charts. The test result obtained from Compressive test as per IS 456:2000 and Flexural strength as per IS 516:1959 for concrete are analyzed graphically. In this section , average compressive strength for 7

days and 28 days of concrete have been compared between concrete without CNC's and with different dosage of CNC's. Similarly, flexural strength for the concrete are compared graphically.

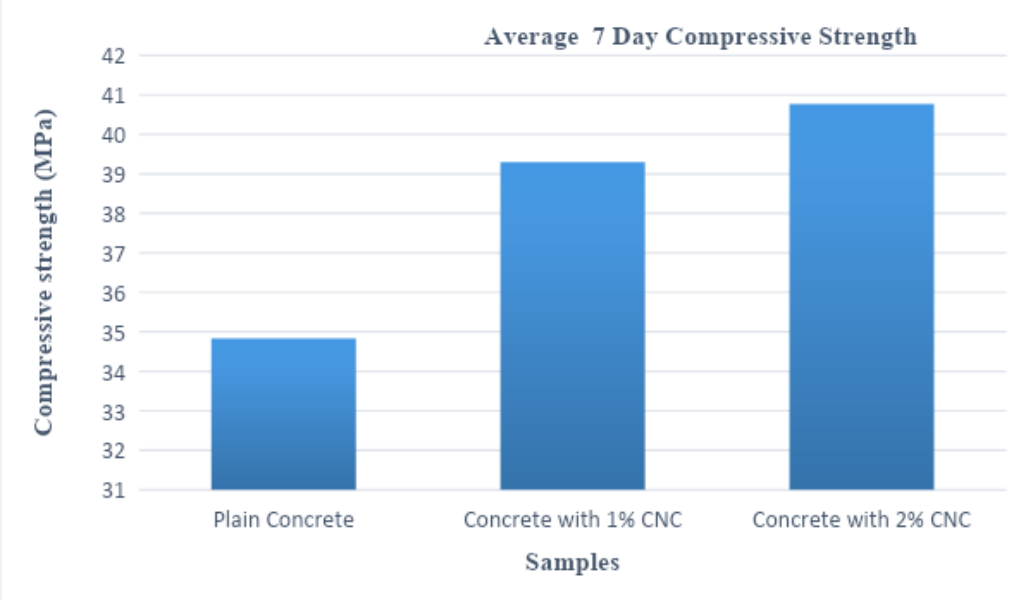

Fig.1 Typical graph showing variation of 7 day Compressive strength with samples.

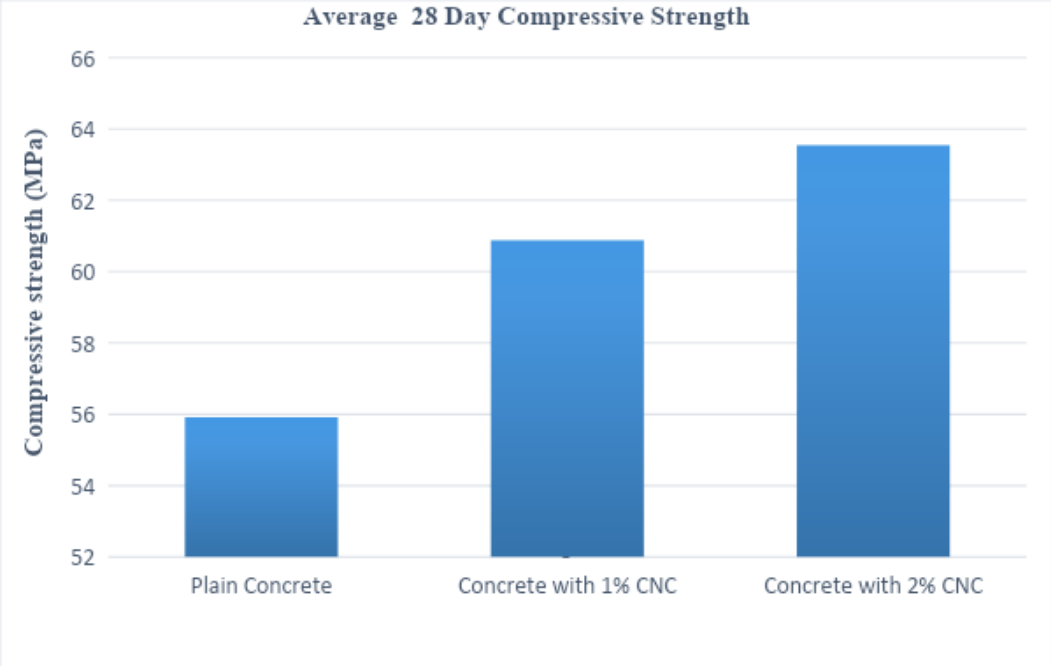

Fig.2 Typical graph showing variation of 28 day Compressive strength with samples.

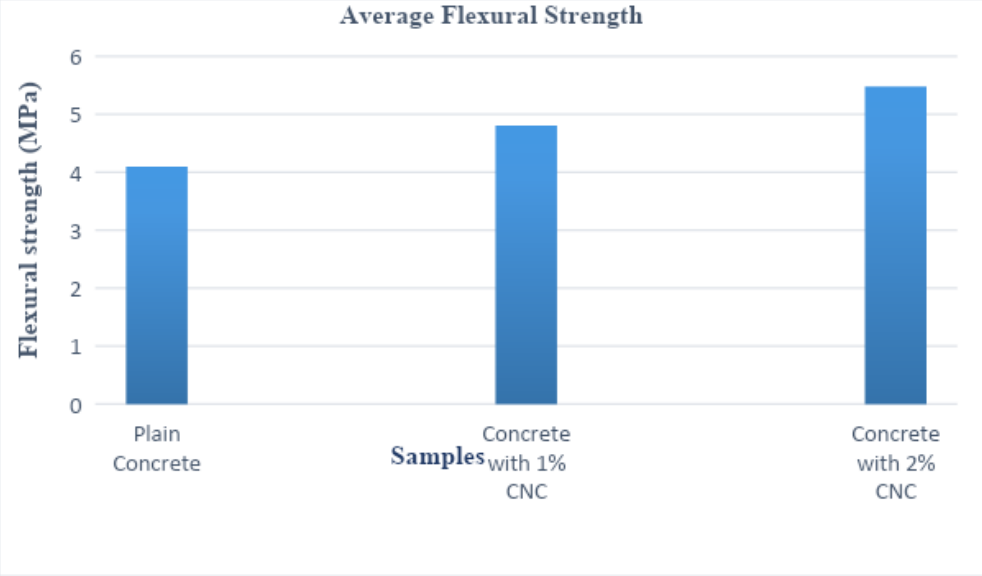

Fig.3 Typical graph showing variation of Flexural strength of samples.

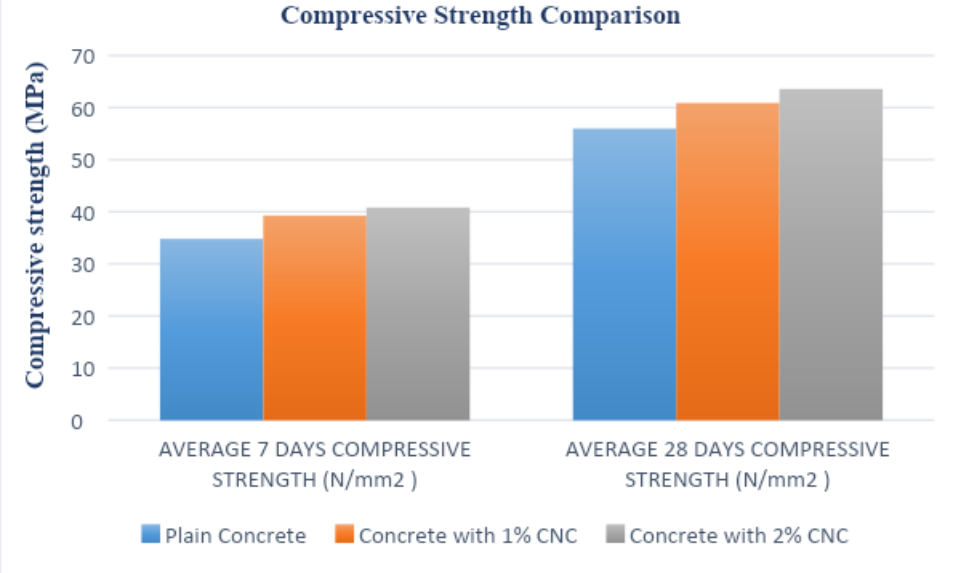

Fig.4 Typical graph showing compressive strength comparison.

DISCUSSION ON RESULT:

Addition of 1% CNC's in concrete increased the compressive strength of concrete near to 8% while 2% CNC addition showed increase of 13% compressive strength. While addition of CNC in concrete beam showed significant increase in the flexural strength. Concrete specimen with 1% CNC showed 13 % increase in flexural strength and that of concrete with 2% CNC gave 28% increase of flexural strength. CNC's addition have greater impact on flexural strength of concrete than that of compressive strength of concrete.

CONCLUSION:

Concrete without CNC's suspension was found to be less workable and moreover compressive strength provided was less. Addition of CNC's made the concrete, increase in the slump value and more workable concrete was attained. Concrete with CNC's showed increase in compressive strength and flexural strength of concrete. It improved the heat of hydration of cement and hence attained high strength in lesser time. CNC's in concrete acted as Nano Sized reinforcement to concrete thus providing higher flexural strength.

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