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An Experimental Investigation of Partial Replacement of NANO Cement with Polypropylene Fibre in Concrete

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Abstract— *Nano technology has contributed a number of materials that have excellent properties and a lot of research has been put into effect in order to create nano particles which could be infused into cement paste in order to improve their performance. Although cementitious construction materials are mainly used in a large scale and in huge quantities, fundamental properties such as strength, ductility, creep, shrinkage, and fracture behavior depend, to a great extent, on structural elements and phenomena which are effective at the micro- and nanoscale. Although concrete offers many advantages regarding mechanical characteristics and economic aspects of the construction, the brittle behavior of the material remains a larger handicap for the seismic and other applications where flexible behavior is essentially required. Recently, however the development of polypropylene fiber-reinforced concrete (PFRC) has provided a technical basis for improving these deficiencies. This project presents an overview of the effect of polypropylene (PP) fibers on various properties of concrete in fresh and hardened state such as compressive strength, tensile strength, flexural strength, workability, bond strength, fracture properties, creep strain, impact. The role of fibers in crack prevention has also been discussed. So in this project, an attempt has been made to assess the suitability of providing different percentages (10,20,30%)of Nano cement to Ordinary Portland Cement with an incorporation of different percentages (1,2,3%) of Polypropylene fiber reinforced concrete to increase the strength by the survey of the literature and the tests were experimentally conducted and the results have been found with its cost comparison.*

Keywords— ***Nano cement,*** *polypropylene* ***fibres, Compressive strength, Flexural strength, split tensile strength test.***

I. INTRODUCTION

Concrete as a material is the most commonly used material (other than water) on the planet. Its significance to the basic infrastructure of modern civilization is immeasurable, and it is difficult to imagine life without it. It is estimated that up to 10% of concrete placed in a given year fails prematurely or is below standard from the beginning. Considering that concrete construction is a 700 billion dollar industry worldwide, even a small reduction in the number of problems would amount to significant economic savings and performance benefits. A challenge facing materials engineers working in concrete is that most other modern systems are several orders of magnitude smaller and cheaper than they were a few decades ago, but the same is not true of structures. This is partially so because buildings still have to be big enough for us to fit into. Even so, section thicknesses in structures have not changed significantly over time.

Concrete modification by using polymeric materials has been studied for the past four decades . In general, the reinforcement of brittle building materials with fibers has been known from ancient period such as putting straw into the mud for housing walls or reinforcing mortar using animal hair etc. Many materials like jute, bamboo, coconut, rice husk, cane bagasse, and sawdust as well as synthetic materials such as polyvinyl alcohol, polypropylene (PP), polyethylene, polyamides etc., have also been used for reinforcing the concrete. Research and development into new fiber reinforced concrete is going on today as well.

Polypropylene fibers were first suggested as an admixture to concrete in 1965 for the construction of blast resistant buildings for the US Corps of Engineers. The fiber has subsequently been improved further and at present it is used either as short discontinuous fibrillated material for production of fiber reinforced concrete or a continuous mat for production of thin sheet component.

II. LITERATURE REVIEW

1.ALI SADRMOMTAZI AND ALI FASIHI : PRELIMINARY STUDY ON THE MECHANICAL BEHAVIOR OF MORTAR CONTAINING WASTE POLYPROPYLENE FIBER AND NANO PARTICLES. Three fiber volume fractions, 0.1%, 0.3% and 0.5% were considered. The measured properties included compressive and flexural strength. Results showed that the presence of nano-SiO2 in mortar enhanced the polypropylene fiber's effectiveness in the strengthening of mechanical properties.

2.ARMANDO GARCÍA-LUNA, DIEGO R. BERNAL, NICOM 2: HIGH STRENGTH MICRO NANO FINE CEMENT - 2nd International Symposium on Nanotechnology in Construction, RILEM Publications SARL Publication year: 2006: Results using this Nano/Micro cement show an increment up to 4-6 times compression strength at 24 hours. The setting time and the compression strength can be modified according to different mixtures and different particle size distributions of this nano-cement-binder.
3.W. R. MALISCH: POLYPROPYLENE FIBERS IN CONCRETE: Adding polypropylene fibers to the concrete has been suggested as one way of controlling cracking include reducing the potential shrinkage of the concrete.
4.Mr. MEHUL J. PATEL, & MRS. S. M. KULKARNI: EFFECT OF POLYPROPYLENE FIBRE ON THE HIGH STRENTH CONCRETE**:** The paper deals with the effects of addition of various proportions of polypropylene fibers on the properties of High strength concrete
5.PERUMALSAMY BALAGURU AND KEN CHONG : NANOTECHNOLOGY AND CONCRETE RESEARCH OPPORTUNITIES **:** The fibers become aligned in the direction of applied stress which will result in even greater tensile and flexural strengths.

III. EXPERIMENTAL STUDY

A. Material Properties

The materials to be used for experimental work was tested in the laboratory. Their details and properties are as follows:
Cement: Cement is a binding material used in the preparation of concrete. It bends the coarse aggregates and fine aggregates with help of water, to a monolithic matter and also it fills the voids in the concrete.53 Grade Ordinary Portland cement conforming to IS 12269-1987 was used in this study. The cement has been tested for various physical properties according to IS 4031. The specific gravity of cement obtained is 3.15. The standard consistency is 29%.
Fine Aggregate: The fine aggregate used in the manufacturing of concrete should be free from debris, fungi and chemical attack. It plays a vital role in concrete, so it should durable, angular and sharp edges then only it gives a rich mix concrete and workability. Fineness modulus of fine aggregate is 4.47 and its specific gravity obtained as 2.27.
Coarse Aggregate: Aggregate are the important constituents in concrete. They give body to the concrete, reduces shrinkage and effect economy. Earlier, aggregates were considered as chemically insert materials but now it has been recognized that some of aggregates are chemically active and also that certain aggregate exhibit chemical bond at the interface of aggregate and paste. The more aggregates occupy 70 – 80 percentage of concrete; their impact on various characteristics and properties of concrete is undoubtedly considerable.
Water: Water is an important ingredient of concrete, as it actively participates in the chemical reaction with cement. The strength of cement concrete comes from the bonding action of the hydrated cement gel. In the present study potable water is used.
Polypropylene fibre technology: The use of these fibers has increased tremendously in construction of structures because addition of fibers in concrete improves the toughness, flexural strength, tensile strength and impact strength as well as failure mode of concrete. Polypropylene twine is cheap, abundantly available, and like all manmade fibers of a consistent quality.In this study micro-filament fibre is used.
Nano cement technology: Nanotechnology can play a significant role in the construction industry and stands at eighth position in terms of most significant areas of applications in nanotechnology. Nanoengineering of cement-based materials can result in outstanding or smart properties. Introduction of nanotechnology in cement industry has the potential to address some of the challenges such as CO_2 emissions, poor crack resistance, long curing time, low tensile strength, high water absorption, low ductility and many other mechanical performance.

B. Mix Design

Concrete mix of grade M 20 was designed using IS 10262 code procedure. The aggregates used in the mix design were under saturated surface dry conditions.

C. Methodology

The effect of addition of nano cement and polypropylene fibre on portland cement concrete has to be studied in the present investigation. Concrete mix of strength M20 has been designed and to be modified with 10% - 30% of nano cement and varying percentages of polypropylene fibre(0%,1%,2%) by weight of cement.

D. Physical Tests on Concrete

To study the properties of nano cement and Polypropylene fibre modified concrete in fresh and hardened state, standard tests has to be conducted. The testing methods of cement concrete as per IS guidelines has been used for testing concrete specimens.

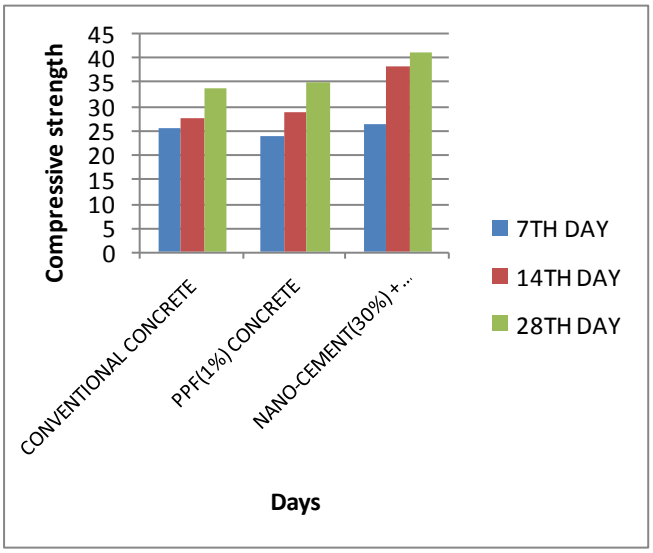
E. TESTING TECHNIQUES AND RESULTS

1.Slump Test: Slump test is intended for measuring workability of concrete. Table 1 shows the slump cone test results of the M20 concrete mix.

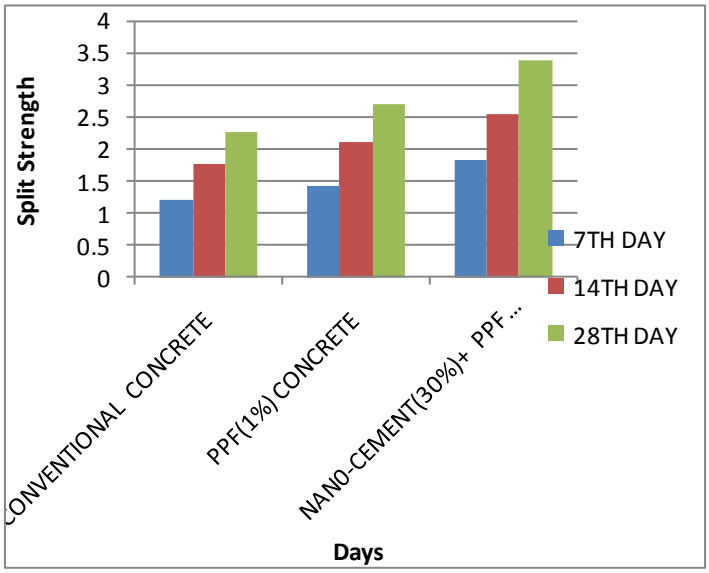
TABLE 1. Slump Cone Test Results

Trial No.	M20 Slump cone (mm)	Slump prescribed by IS:456-2000 code	Remarks
1	78	The Recommended slump values for concrete RCC beams and slabs are 50-100	Satisfied as per IS:456-2000
2	76		
3	79		
4	80		

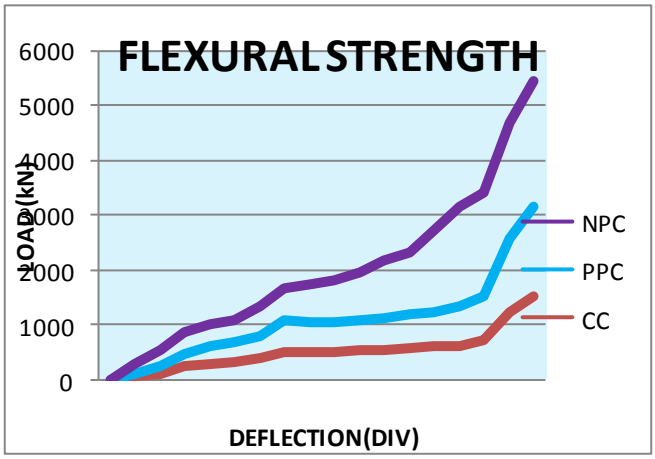
2.COMPRESSIVE STRENGTH



3.SPLIT TENSILE STRENGTH



4. FLEXURAL STRENGTH



IV. CONCLUSION

There is wide scope for the use of nanotechnology including nano ingredients for harnessing improved mechanical and electrical properties such as higher strength, toughness, flexibility, stability, conductivity, besides self-cleaning property of cement-based composites.

The mix design for the experiment is 1:1.46:2.74. Thus this study features the summary from survey of literature reviews and the methodology features has been studied and also the future study with experimental investigation is studied with references.In conclusion, nanotechnology offers the possibility of great advances whereas conventional approaches, at best, offer only incremental improvements.

Hence in this project, an attempt will be made to assess the suitability of providing nano cement to Ordinary Portland Cement with an incorporation of Poly propylene fiber reinforced with different aspect ratio to reduce the percentage of steel as the future process**.** The purpose of this present study is to prove that the use of Nano-materials such as Nano-cement and also Polypropylene fiber in concrete has more strength than the conventional concrete.

V.FUTURE STUDY

The hardened concrete properties are to be found out after curing period of the specimens. The tests to be conducted are compressive strength test, Flexural strength test, and split tensile strength tests for cubes, prisms and cylinders with different aspect ratio (nano cement 10%- 30% and polypropylene fibre 1%-2%)

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