An Experimental Investigation on Carbon Nano Tube in Concrete With Replacement of Coarse Aggregate By Using Recycled C&D Waste

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Abstract- *This Paper is aimed to develop Carbon Nano Tube induced concrete with full replacement of Coarse aggregate by using Recycled aggregate. By previous studies states that CNT can improve the high- temperature resistance in concrete. CNT possess a high modulus of elasticity , tensile strength and yield strain. The tensile strength of CNT is approximately 100 times greater than the steel of same diameter. Recycled aggregates have densities slightly less than natural aggregate and high water absorption due to presence of old cement mortar. This paper is part of research and represents a synthesis of nanomaterial properly to be used in construction along with replacing coarse aggregate with recycled aggregates.*

I. INTRODUCTION

Concrete is the solid composite material and made up of suitable proportion of binding material, fine aggregate, Coarse aggregate and Water. In modern construction, we need advanced admixtures to be enhancing their Properties of concrete which means to be mostly avoid the cracks, shrinkage, and also creep in the structures. The recent researches on nanomaterial's and nanotechnologies have highlighted the potential use of these materials in various fields such as medicine, construction, and automobile industry, energy, telecommunications and informatics.

NANO MATERIAL IN CONCRETE

This nanomaterials have four types which are using for concrete Nano silica,carbon nanotube, titanium, carbon fibre the reduced offer of Nano products. In order to be able to use in the construction industry the nanomaterial at wide scale.It is necessary that the researches to be conducted following the next stages:The Choice of nanomaterial with potential use in construction and the study of their characteristics; the behaviour study of the building elements that contain nanomaterial under various loads; the development of specific design and construction standards.

RECYCLED AGGREGATE IN CONCRETE

Among the ingredients for concrete, aggregates, i.e. inert granular materials such as sand, crushed stone or gravel form the major part. Worldwide, cities generate about 1.3 billion Tonnes of solid waste per year. Building materials account for about half of all materials used and about half the solid waste generated worldwide. The waste, generated in the construction, maintenance, repair and disposal phases of a building, is called Construction and Demolition (C&D) Waste. The recent government initiative to stop sand mining insists the need to recycle, reuse and substitute natural aggregates in order to ensure environmental sustainability

METHODOLOGY

CARBON NANO TUBE [CNT]

Carbon nanotubes are a form of carbon having a cylindrical shape, the name coming from their nanometre diameter.They are of two types:

1. Single-wall carbon nanotubes (SWCNTs)
2. Multi-wall carbon nanotubes (MWCNTs)

They can be several millimeters in length and can have one "layer" or wall (single walled nanotube) or more than one wall (multi walled nanotube).

PROPERTIES OF CARBON NANOTUBE

Carbon nanotubes are the strongest and stiffest materials yet discovered in terms of tensile strength and elastic modulus respectively. This strength results from the covalent sp2 bonds formed between the individual carbon atoms which are stronger than 3D diamond bonds.The physical properties of carbon nanotubes, including their size, shape and ability to be manipulated, yet stay strong, have made them a unique find amongst other macromolecules. Essentially, a carbon nanotube is akin to a sheet of graphite that has been rolled up into a cylindrical shape. This sheet is comprised of a hexagonal latticework, making the physical properties of carbon nanotubes that much more fascinating and strange to both scientists and physicists.Carbon nanotubes have been known for some time to be excellent conductors of electricity. Thermal properties of carbon nanotubes have great implications for science as well. In some experiments, carbon nanotubes have been added to epoxy resin in a successful attempt to double the thermal conductivity in the resin

STRENGTH OF CNTS

- Tensile load testing was performed by Yu et al.
- On SWCNT bundles, tensile strength values ranging from 13 to 52 GPa and maximum tensile strain obtained was 5.3% were reported.
- On MWCNTs, It was found that only the outermost layer breaks during the loading process. The tensile strength corresponding to this layer of CNT ranges from 11 to 63GPa.

APPLICATION OF NANOTECHNOLOGY IN CONCRETE

CARBON NANO TUBES

- Nanotubes are members of the fullerene structural family and exhibit extraordinary strength and unique electrical properties, being efficient thermal conductors.
- For example, they have five times the Young's modulus and eight times (theoretically 100 times) the strength of steel, whilst being 1/6th the density.
- Expected benefits of carbon nanotube are: mechanical durability and crack prevention in concrete enhanced mechanical and thermal properties in ceramics and real-time structural health monitoring capacity*(Mann, 2006).*

TITANIUM DIOXIDE NANO PARTICLES (TIO2)

- The titanium dioxide nanoparticles are added to concrete to improve its properties.
- This white pigment is used as an excellent reflective coating or added to paints, cements and windows for its sterilizing properties.
- The titanium dioxide breaks down organic pollutants, volatile organic compounds and bacterial membranes through powerful photo catalytic reactions, reducing air pollutants when it's applied to outdoor surfaces.*(Mann, 2006).*

SILICON DIOXIDE NANOPARTICLES (SIO2)

- Nano-SiO2 could significantly increase the compressive strength of concretes containing large fly ash volume at early age, by filling the pores between large fly ash and cement particles.
- Nano-silica decreases the setting time of mortar when compared with silica fume (microsilica) and reduce bleeding water and segregation by the improvement of the cohesiveness *(Sadrmomtazi &Barzegar, 2010)*

EFFECTS OF CNT IN CONCRETE

Until today concrete has primarily been seen as a structural material but nanotechnology especially carbon nanotubes helps to make it as a multi-purpose "smart material".

CNTs in concrete increase its tensile strength. The highest tensile strength of an individual multi-walled carbon nanotube has been tested to be is 63Gpa.

They help in controlling the crack propagation.

The addition of CNT to concrete can significantly enhance some mechanical as well as physical properties of the material.

Use of carbon nanotubes increases the strength and durability of cementitious composites as well as for pollution reduction**.**

S. No.	PROPERTIES	SPECIMEN	TEST RESULT
1	Fineness Modulus	Fine Agg	2.31
		Coarse agg	2.88
		Recycled agg	2.84
2	Specific Gravity	Fine Agg	2.12
		Coarse agg	2.60
		Recycled agg	2.66

RECYCLED AGGREGATES

- Waste concrete cubes and cylinders were collected from our college campus.
- The collected waste were taken to a crusher unit nearby and crushed into various sizes.
- After screening, the materials were separated into the size of coarse aggregate required for replacement in concrete.
- Reuse of demolition waste appears to be an effective solution and the most appropriate and large-scale use would be to use it as aggregates to produce concrete for new construction.

Mix % of RA in Concrete	0	30	60	100
7 days	15.6	17	18.5	20.4
28 days	25.2	25.6	27	28.5

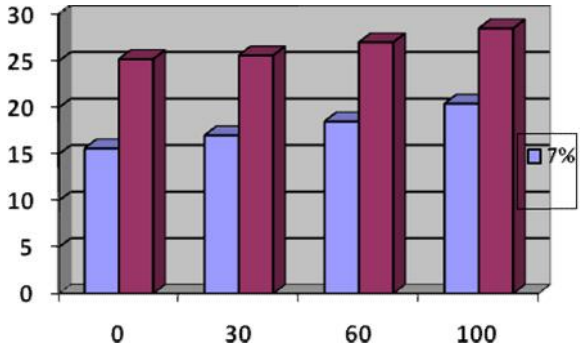
PERCENTAGE OF RA IN CONCRETE

To replace natural coarse aggregate by the recycled coarse aggregate in various percentages (0%, 30%, 60% and 100%)
Concrete mix design for M25 grade is done as per IS: 10262 – 2009.

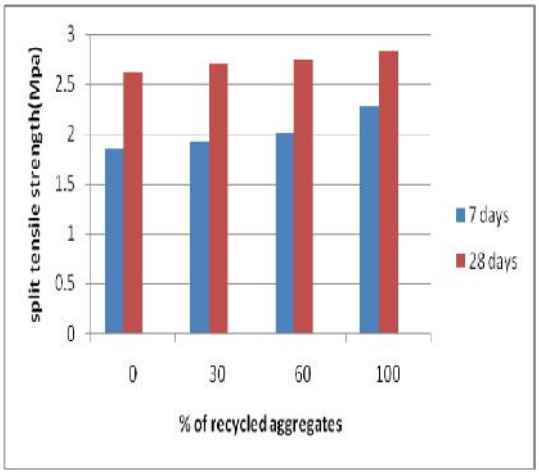
To study and compare the mechanical properties - compressive strength of hardened concrete specimens with and without recycled aggregates

PHYSICAL PROPERTIES OF AGGREGATES

COMPRESSIVE STRENGTH RESULTS for RA CONCRETE CUBES



SPLIT TENSILE STRENGTH RESULTS for RA CONCRETE CUBES



CONCRETE WITH CNT

- Nano-Materials are added in mixes of concrete .If Portland cement can be formulated with nano size cement particles, it will open up a large number of opportunities.
- The cement will not only be more economical than organic polymers but also will be fire resistant.
- Also, nanotechnology enables us to develop materials with improved or totally new properties.
- Nano concrete have the ability to control or manipulate materials at the atomic scale.

PREPARATION OF MIX

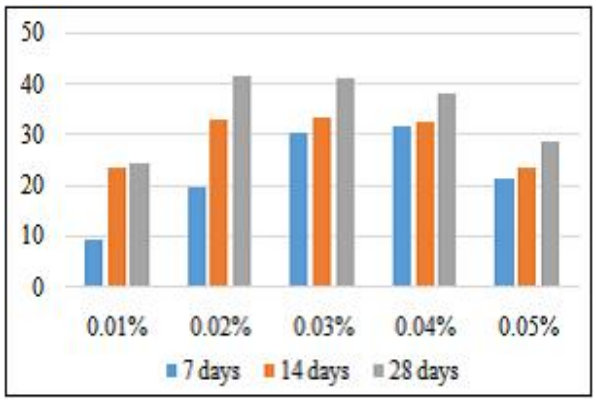
- The materials such as cement, fine aggregate and coarse aggregate were batched and taken.

- W/C ratio of 0.35% of water is measured and taken. The cube moulds were prepared by applying oil on the inner surface of it.
- The CNT is mixed thoroughly with water and left aside for 30 minutes. The dry mix is done.
- Then water with CNT mixed with the dry mix and the mixture is mixed for 3-4 minutes thoroughly.

RESULT AND DISCUSSION

S.NO	MOULD	DIMENSIONS (mm X mm)	COMRESSIVE STRENGTH (N/mm2)		
			7 days	14 days	28days
1	0.01% CNT	70.6 X 70.6	9.4	23.6	24.6
2	0.02% CNT	70.6 X 70.6	19.8	33	41.2
3	0.03% CNT	70.6 X 70.6	30.4	33.8	41.2
4	0.04% CNT	70.6 X 70.6	31.8	32.7	38.2
5	0.05% CNT	70.6 X 70.6	21.6	23.8	28.8

COMPRESSION TEST FOR CNT CONCRETE



RESULT AND DISCUSSION

- From the tabulated observation (Table) and graph (Figure), we can see that 0.02% CNT and 0.03% CNT gives same compressive strength on 28 days, i. e, 41.2 N/mm2.
- But the initial strength of 7 days are different.0.03% CNT gives 30.4 N/mm2 compressive strength in 7 days, whereas 0.02% CNT gives 19.8 N/mm2 compressive strength in 7 days.
- The compressive strength of 28 days is seen reduced for 0.04% CNT and 0.05% CNT

TEST ON FRESH CONCRETE WITH CNT AND RA

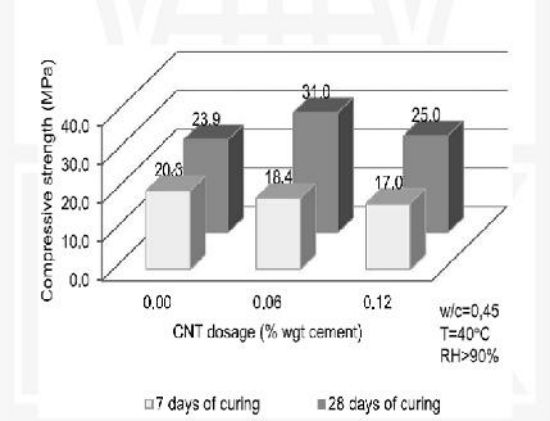
TEST	NORMAL CONCRETE	CNT CONCRETE
Slump cone	**160 mm**	**170 mm**
Flow table	**52**	**70**
Comp factor	**0.93%**	**0.95%**

TEST ON HARD CONCRETE WITH CNT AND RA

- The compressive strength is inversely proportional with the CNTs content in mixture.
- The CNTs mortar with the amount of 0.06% by weight of cement achieved 90% of compressive strength of controlled specimens but the mortar with 0.12% of nanoparticles achieved only 84%.
- After 28 days of curing the significant increase in compressive strength in comparison with the 7 days strength was observed

TEST ON HARD CONCRETE WITH CNT AND RA

- Between 7th and 28th days the compressive strength increased about 17.7% for mortar without nanotubes and 68.5% or 47% for concrete with 0.06% or 0.12% of CNTs, respectively.
- The beneficial effects of CNTs on the strength of cement concrete can be also observed. The compressive strength of mortar with 0.06% and 0.12% of CNTs content were 29.7% and 4.6% higher than the controlled concrete, respectively.



II. CONCLUSION

- In this study it is found that the various properties of Carbon Nano Tube and application of CNT in concrete and also the strength obtained by adding CNT powder in concrete by previous literatures.
- And also there is not much variation in strength between ordinary concrete and 30% replaced aggregate concrete, which proves the previous works.
- Because it has been found that recycled aggregates obtained from recycling concrete are more angular and have higher absorption and specific gravity than natural coarse aggregates it may result on increase of strength and improved load carrying capacity.
- The present investigation has shown it is possible to design and use nano modificated concrete incorporating nano materials and nano products which leads to an improvement in the materials characteristics or give new properties to the considered materials.
- The biggest problem in the preparation of cement composites containing CNTs is their proper dispersion in the mass. The positive effect of nano additive was found. It was almost 30% increase in strength for concrete with CNTs in amount of 0.06%
  by cement.
- The introduction of CNTs into cement concrete caused a decrease in the 7-day compressive strength. However, the significant increase in strength (even more than 68% for CNTs content 0.06% by weight of cement) was observed between 7th and 28th days of curing

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