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ESS Effects of Addition of Carbon Nanotubes on the Properties of Concrete

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Abstract: Nowadays, the Environmental pollution is one of the greatest problems the world is facing which is causing grave & the damage which is not reparable to the world & about 40% humans have died due to air, water & soil pollution. India is now 4th country in the world to generate nearly 2,454,938 kilo tones is carbon dioxide per year. To reduce the carbon emission we can use a material which is called carbon nanotubes (cnt's). Carbon nanotubes are the materials which have special properties & great potential in various Civil engineering structure. We can convert the waste gases coming from the industrial & automobile or vehicular exhaust or furnace into nano particles called carbon nanotubes which is almost three thousand times stronger than steel & one sixth of its weight. Carbon nanotubes are currently receiving more interest because is it's extremely good mechanical properties & are now know to be materials of 21st century. In the present study the effect of addition of carbon nanotubes on properties of concrete to be studied. And the comparison between carbon nanotubes & conventional concrete will carry out.

Keywords:Carbon Nanotubes (CNT's), Carbon Dioxide, Nano-material, Durability and Strength.

I. INTRODUCTION

Nano-technology is one of the fastest growing fields & the most up to date of science. Great potential has been predicted for nanotechnology in science & also for construction. There are various types of nano-materials such as nano-tubes, nanofibers, nanopoles, nanofoams, nanorods etc. Out of this materials, this paper comprises is carbon nano-tubes. Carbon nanotubes are allotropes of carbon & are belonging of fullerene structural family having cylindrical structure. Because is it's extraordinary properties like mechanical & electrical properties, thermal conductivity, carbon nanotubes has the potential applications in the nanotechnology, optics, electronics & other material science & technology. The creation of carbon nanotubes from carbon dioxide emission is helpful from the environmental as well as economical point of view. It will reduce the air pollution coming from factories like steel, rice mill or cement plant or metal plant etc. And will improve the quality of air. Carbon nanotubes can improve the characteristics of steel, glass, insulating materials & concrete. Increasing the life of materials will reduce pollution by reducing carbon footprint of the building.

Carbon allotropes are carbon nanotubes (CNT's) with a cylindrical nano-structure significantly larger than any other material. Nano-tubes have been constructed with lentho-diameter ratio of 1,32,000,000:1. Nanotechnology, electronics, optics and other branch ofmaterial are valuable for the cylindrical Valuable for the cylindrical carbon molecules which have unusual properties. Can be usedas additives to various structural material carbon nanotubes are alsofound useful in other fieldslike as in addition to their thermalconductivity, mechanical & electrical properties. Small portion of material such as baseball bats, golf clubs and car parts are formedby nanotubes. Members of fullerene structure family are nanotubes. Graphene name comes from their long hollow structure withthe walls form by 1 atom thicksheets of carbon, the sheets are rolled of specific and discret ("chiral") angles, the nanotubes propertiesdecides the combination of rolling angle and radius; e.g. – if the individual nano-tube shell is a metal or semiconductor. Thecategorization of nano-tubes are as single walled nanotubes and multiwalled nano-tubes. Nanotubes naturally align themselves into"ropes" which are held together by van-der-waals force and more specifically, pi-stacking. The best describe chemical bonding in nanotubesare applied quantum chemistry. Specifically orbital hybridization. The chemical bonding of nanotubes are composed of sp2bonds and similarly to graphite. Sp bonds found in aliens and diamond are stronger. Which provide nano-tubes with their unique strength.

II.LITERATURE REVIEW

A. Ashwini B, B.Videvelli study on "Carbon Nanotubes (CNT) in Concrete" IRJET Vol:05 Issue:07| july-2018

In this paper found that the addition of small amounts of (1%wt) of CNT can improve the mechanical properties of samples consisting of the main Portland cement phase and water. Oxidized multiwalled nanotubes (MWCNTs) show

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the best improvements both in compressive strength (25 N/mm2) and flexural strength (8 N/mm2) compared to the sample of without reinforcement. A number of investigations has been carried out developing smart concrete using carbon fibres.

A) Ali Akbar Firoozi, GuneyOlgun,et.al "Carbon Nanotube and Civil Engineering". Saudi Journal of Engineering and Technology. ISSN 2415-6272 (Print) Scholars Middle East Publishers.

B) In this paper the study of importance of achieving the status of green environmental policy and cleaner technology approach, the innovation of using carbon nanotube in tropical soft soil stabilization was investigated.

C) The positive findings of this research work proved the existence of a combined action among the pozzolanic reaction between cement/lime by nanomaterials in clayey soil stabilization. These findings can help attacking two aspects: First, under adequate technical and environmental conditions, massive amounts of this residue would be partially reduced, converted to useful, value-added adsorbents, and second, can result in more economic projects. Although the use of nanomaterials in ground improvement applications is still in its infancy stage, the widespread and significant progress in the application of this environment-friendly stabilizer in tropical soil stabilization can be expected in the future.

- **C.G.N. marcondes, M.H.F.Medeiros, "Carbon nanotubes in Portland cement concrete: Influence of dispersion on mechanical properties and water absorption", ALCONPAT Journal, volume 5, issue 2, may-august 205, pages 91-107.**
- In this paper studied about the contribution to the effect of addition of carbon nanotubes in Portland cement concrete the main findings in this paper is addition of CNTs reduce the absorption of water by immersion pipette test in such case it was found that the series of ultrasound dispersion escalated the advantages rising from CNTs. And the amount of CNT added was 0.30% with respect to cement mass. In all cases, the previous dispersion of CNTs using ultrasound increased the effect of CNTs addition, evidencing the importance of the efficiency of such material when added to cement. With 95% of significance, it had acknowledged the mechanical effects of compressive strength and tensile strength by diametrical compression, to be affected by the increase of compressive and tensile strength by diametrical compression from CNTs had been found. In this research such increase in compressive strength is represented by 19 % of increase in tensilestrength by diametrical compression efficiency of the dispersion of carbon nanotubes in Portland cement concrete.

- **GrigoryYakovleva, GrigoryPervushina, "Modification of Construction Materials with Multi-Walled Carbon Nanotubes" Science Direct, 11th International Conference on Modern Building Materials, Structures and Techniques, MBMST 2013**
- In this paper investigated the theory and experiments of examples of four types of construction products show the possibility of a significant enhancement of the physical and mechanical properties of construction materials, and the cost of products increases by 0.5 – 3% depending on the used technology of modifying materials with multi-walled carbon nanotubes. the modified concrete showed an increase of the frost resistance of the concrete from F150 to F400, the strength by 46% and the water resistance from W6 to W14 and the enhancement of its fracture toughness. The microstructure of cellular silicate concrete modified with carbon nanotubes is seen to improve, at that its strength increases to 30%. Adding carbon nanotubes to fire-proof compositions based on liquid glass contributes to improving the structure and increase of efficiency of protective coating under the flame exposure.

- **Jose Luis Fraga, Jose María del Campo, and Juan Ángel García. "Carbon Nanotube-Cement Composites in the Construction Industry: 1952-2014". A State of the Art Review,(ICETET'2014), May 30-31, 2014 London (UK).**
- This paper studied the feasibility of developing new cements with a maximum carbon nanotube content of 0.5% in order to provide large increases in flexural strength and in compressive strength, along with a reduction in porosity.
- This paper analyzes different research cases that have been carried out with cementitious materials to date and reviews the current state of the art and some future trends for these composites. Carbon nanotubes have been shown to reduce the occurrence of cracks, decrease their porosity, and improve their mechanical properties, thus lengthening their durability. Reinforcing cement with low additions of MWCNTs, ranging from 0.05 to 0.5 weight %, can produce a remarkable enhancement of the mechanical properties of cement. Incorporation of CNTs into concrete thus has the potential to overcome its mechanical limitations, i.e., low tensile strength, low strain capacity, and brittleness. This enhancement could be particularly applicable in building structures and civil works in which the own weight of the structure is one of the main loads they have to bear during their service life. By using concrete of higher strength, the weight of the structure could be reduced, which would lead to a saving of resources and may compensate economically for the currently high cost of CNT synthesis.

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- **Narendra p. Mali, Prasad S.Kawade, "Development of experimental setup for extraction of carbon nanotubes from CO2 emisssion of industrial exhaust", IJCRME, vol.3.issue1 2018.**
- This paper discussed in detail synthesis process of carbon nanotubes and also its successful application in concrete. The carbon nanotubes which are directly harvested from exhaust of industries will have tremendous effect on environment if CO2 leaving to atmosphere. Large amount of pollution comes from cement industries which is about 5% of total pollution. Due to this temperature of planet is increasing. Moreover amount of oxygen is also reducing if this issue is not solve then there might serious problems in future. So use this technique to produce valuable material from waste gaseous coming from industrial outlet. It will cause great contribution to air pollution and improve air quality.

- **Rashid Al Araj, Adil K.Tamimi, "Sustainability of carbon nanotubes reinforced concrete", IJSCE Vol:11, No: 7,2017**
- In this paper Investigated the addition of CNT to concrete mix as percentage of as low as 0.25% weight of cement could increase the flexural strength and toughness of concrete. Addition of more than 45% and 25%, respectively and enhance other durability related properties, given that an effective dispersion of CNT in cementatious mix is achieved. It has also enhanced the durability of concrete through different aspects such as: water resistance, frost resistance, and inhibiting crack initiation and development at the nano-level.

- **R.Sundharam, K.Pavithra, et.al."Experimental Investigation of Carbon Nanotube Concrete", IJCE JOURNAL, Special Issue ICMR Mar 2019,**
- Experimental investigated that Adition of 0.25% and 0.5% of Multi Walled Carbon Nanotubes (MWCNTs) by the weight of cement in the concrete mix. CNT concrete exhibit the multifunctional properties such as self – strain sensing, damage sensing, improves interfacial interaction and also it act as a concrete repair material when it is cement composite.The addition of 0.25 % of dispersing MWCNT by the weight of cement improve the load carrying capacity and thus enhance the mechanical property of concrete. In CNT concrete, the compressive strength increase by 32% and tensile strength by 42% respectively. Because of the tiny nature, it behaves as a filler material to improve bond strength and to resist crack propogation. Enhancement in tensilestrength reduce the usage of steel in structural components. CNT increase the life
- of structure due to the high modulus of elasticity.
- **Shubham Ashish Jha, Somesh Jethwani,"Carbon nanotubes cement composites", volume 7, issue5, sept.oct.2016**,
- This paper studied about the compressive study of researches and development in the field of carbon nanotubes cement composites. But the authors could not determine any optimum dosage of carbon nanotubes, but addition in small amounts ranging from 0.05%-0.5%by weight of cement have shown best result improving strength, durability and reducing porosity.

- **TanvirManzur, NurYazdani, et.al. "Potential of Carbon Nanotube Reinforced Cement Composites as Concrete Repair Material" Hindawi Publishing Corporation Journal of Nanomaterials Volume 2016, Article ID 1421959.**
- Studied the Carbon nanotubes (CNTs) are a virtually ideal reinforcing agent due to extremely high aspect ratios and ultra high strengths. It is evident from contemporary research that utilization of CNT in producing new cement-based composite materials has a great potential. MWNT reinforced cementations composite has already proven its enhanced mechanical properties inters of both compressive and flexural strength. However, past researches have shown variable increase in strengths of nanotube reinforced cementations composites ranging from none to more than 80% for different mixing process and concentration of CNTs. The suitability of the produced MWNT reinforced composites as concrete repair material was then investigated through setting time, bleeding, and slant shear tests. The setting time results show that nanotubes reinforced cement mortar hardened quite more rapidly than normal cement mortar.

RESULTS & GRAPHS

Material	CNT 0	CNT 1 (0.08%)			CNT 2 (0.025%)			CNT 3 (0.048%)		
Days	Strength	Wt Kg	Load KN	Strength MPa	Wt Kg	Load KN	Strength MPa	Wt Kg	Load KN	Strength MPa
3 Days	10	9.0	250	11.11	8.88	285	12.70	8.94	308	13.73
7 Days	17	9.10	365	16.25	8.76	428	19.06	9.08	500	22.25
28 Days	25	9.24	610	27.15	9.22	688	30.62	9.16	792	35.21

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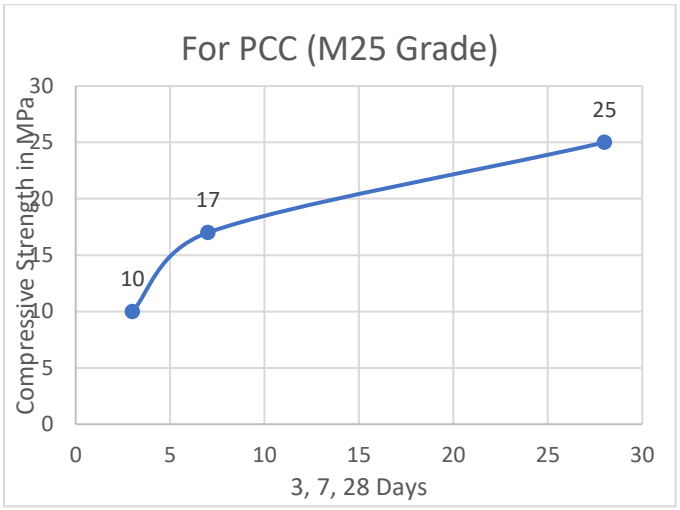

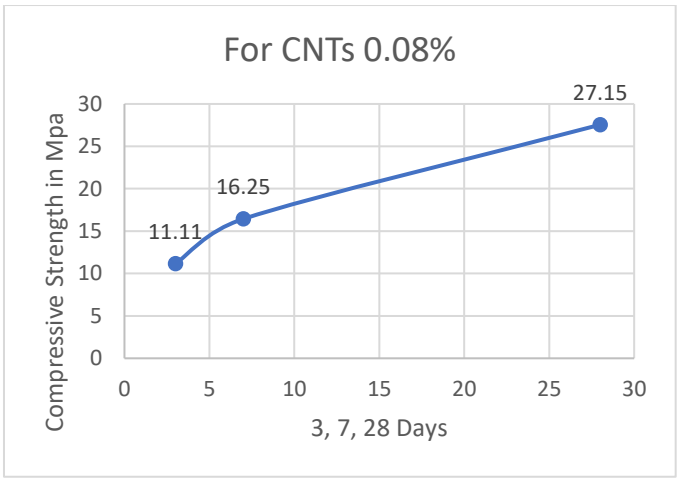

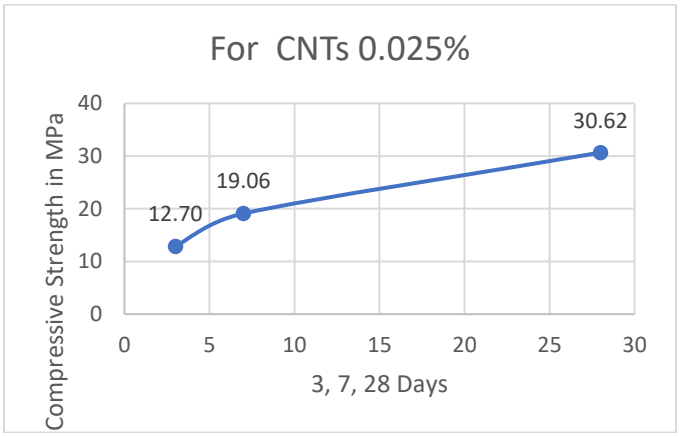

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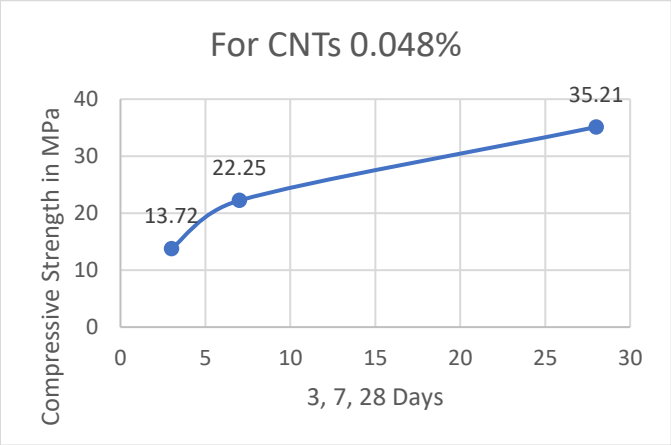

CONCLUSION

1. Use of CNTs achieves Eco-Friendly environment
2. Cubes for M25 Grade were casted and tested under axial load on CTM machine and the result shows that the strength of specimen has increased.
3. Marginal Increase in strength with Addition Of CNT's Powder 0.08%, 0.028%, 0.048% by weight of cement is compared to M25 grade PCC Specimen.
4. From the above conclusion it is concluded that the optimum Addition level of Carbon Nanotubes Powder as by Weight of cement is 0.048%.
5. Carbon nano tubes can be effectively used as ingredient in concrete which will give best required results.
6. Use of Carbon nano Tubes which is recycled material made from waste gases coming from industries reduces carbon emission and environmental pollution by more than 40% and thus reduces global warming.
7. These gases coming from the factories are just the waste but if harvested properly then can proved to be the best product.

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