

# **An Experimental Investigation on the Reactivity of Carbon Nano Tubes (CNT) By Using SEM**

Manikandan.T<sup>1</sup>, Bharath.P<sup>2</sup>, Govindhan.S<sup>3</sup>, Rashmiya.R<sup>4</sup>

Assistant Professor , Department of Civil Engineering, Sembodai Rukmani Varatharajan Engineering College,  
Sembodai, Vedaraniyam (Tk), Nagapattinam (Dt), Tamilnadu, India<sup>1,2,3</sup>

Lecturer, Department of Civil Engineering, Sembodai Rukmani Varatharajan Engineering College, Sembodai,  
Vedaraniyam (Tk), Nagapattinam (Dt), Tamilnadu, India<sup>4</sup>

**ABSTRACT:** Nanotechnology is the use of very small pieces of material by themselves or their manipulation to create new large scale materials. The role of nanotechnology in the conceiving of innovative infrastructure systems has the potential to revolutionize the civil engineering practice and widen the vision of civil engineering. This project deals with the study on the reactivity of cement and Multi walled Carbon Nano Tubes (CNT). Various experiments were carried out to understand compression strength of a cement mortar cube of different size of 7cm X 7cm X 7cm and 4cm X 4cm X 4cm and prism size of 4cm X 4cm X 16cm and 1cm X 1cm X 6cm. Further, Raman study was carried out to understand the bonding characteristics of nanotubes with cement particles.

**KEYWORDS:** Cement, Carbon Nano Tubes (CNT), Scanning Electron Microscope, Raman's Spectroscopy, and Bonding.

## **I. INTRODUCTION**

Nanotechnology is a new emerging branch of technology, which bears high expectations of its potential to change the world fundamentally. Some policy makers and technology developers even speak about "the Next Industrial Revolution", which advancing nanotechnology is supposed to bring along development. However, the development of nanotechnology is in such an early state that there is not even complete consensus about the definition of nanotechnology and its essence. Some claim that nanotechnology is a specific area of research and it can be defined as a general purpose technology (GPT). However, there have been also efforts to define various terms in the field of nanotechnology, and thus build common understanding about the issue. An area of nanotechnology that has been evolving for the last 40 years is the technique of micro- and nano-lithography and etching. At the nanoscale, properties of materials behave differently, governed by atomic and molecular rules. Researchers are using the unique properties of materials at this small scale to create new and exciting tools and products in all areas of science and engineering. Nanotechnology combines solid state physics, chemistry, electrical engineering, chemical engineering, biochemistry, biophysics, and materials science. It is thus a highly interdisciplinary area – integrating ideas and techniques from a wide array of traditional disciplines. Some universities have begun to issue degrees in nanotechnology; others view it as a portion of existing academic areas.

This paper showcases the reactivity of Nano Cement and the reactivity of carbon nano tubes (CNT) with Scanning Electron Microscope (SEM), Raman's Spectroscopy. As a result it improves the properties of cement matrix and further the study also possible to carry out the experiments with different ratios.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 1, January 2018

### II. LITERATURE SURVEY

Nanotechnology is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. Interest in nanotechnology concept for Portland cement composites is steadily growing. Currently, the most active research areas dealing with cement and concrete are: understanding of the hydration of cement particles and the use of nano-size ingredients such as alumina and silica particles. If cement with nano-size particles can be manufactured and processed, it will open up a large number of opportunities in the fields of ceramics, high strength composites and electronic applications.

### III. METHODOLOGY AND MATERIALS

Various experiments were carried out to understand compression strength of a cement mortar cube of different size of 7cm X 7cm X 7cm and 4cm X 4cm X 4cm and prism size of 4cm X 4cm X 16cm and 1cm X 1cm X 6cm. The main aim is study on the reactivity of cement and Multi walled carbon nano tubes. To carry out reduced specimen sizes and compare it with standard specimens. To carry out Raman study on cement-MWCNT composites. It improves the property of cement matrix. Further the study also possible upon carry out experiments with different ratio.



**Prism with OPC 53 and PPC with size 6 cm X 1 cm X 1 cm.**

This work is done by the following systematic work such as:

1. Procurement of nano cement.
2. Existing market available cement particle.
3. Ball mill facilities and particle size analyzer.
4. Procurement of finest cement in market i.e., OPC 53 and PPC.
5. Preparation of samples.
6. Comparisons of OPC 53 and PPC with standard specimen.
7. Determining compressive strength using addition of MWCNT of sizes 1cm X 1cm X 6cm and 4cm X 4cm X 16cm.
8. Scanning Electron Microscopic (SEM) analysis.
9. Raman's Spectroscopy analysis.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 1, January 2018

10. Results and discussions.
- 11.

### IV. OBSRVATIONS AND DISCUSSIONS

#### CUBE TEST FOR OPC 53 WITH W/C RATIO 0.30:

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	4 x 4 x 4	0.3	100	30	1600	64	40
2	4 x 4 x 4	0.3	100	30	1600	66	41.25
3	4 x 4 x 4	0.3	100	30	1600	42	26.25
						Average	35.83

#### CUBE TEST FOR OPC 53 WITH W/C RATIO 0.35:

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	4 x 4 x 4	0.35	100	30	1600	66	41.25
2	4 x 4 x 4	0.35	100	30	1600	66	41.25
3	4 x 4 x 4	0.35	100	30	1600	80	50
						Average	44.16

#### CUBE TEST FOR PPC WITH W/C RATIO 0.30:

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	4 x 4 x 4	0.3	100	30	1600	0	0
2	4 x 4 x 4	0.3	100	30	1600	0	0
3	4 x 4 x 4	0.3	100	30	1600	0	0
						Average	0

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 1, January 2018

### CUBE TEST FOR OPC 53 WITH W/C RATIO 0.30:

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	7 x 7 x 7	0.3	700	210	4900	180	36.73
2	7 x 7 x 7	0.3	700	210	4900	62	12.65
3	7 x 7 x 7	0.3	700	210	4900	116	23.67
						Average	24.35

### PRISM TEST FOR OPC 53 WITH W/C RATIO 0.38, 0.35, 0.30:

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	16 x 4 x 4	0.38	500	190	6400	80	12.5
2	16 x 4 x 4	0.35	500	175	6400	170	26.56
3	16 x 4 x 4	0.30	500	150	6400	154	24.06

### PRISM TEST FOR OPC 53 WITH W/C RATIO 0.30:

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	16 x 4 x 4	0.3	500	150	6400	92	14.375
2	16 x 4 x 4	0.3	500	150	6400	140	21.875
3	16 x 4 x 4	0.3	500	150	6400	134	20.93
						Average	19.06

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 1, January 2018

**PRISM TEST FOR PPC WITH W/C RATIO 0.30:**

S.No	Size of specimen (cm)	w/c Ratio	Weight of cement (g)	Amount of water (ml)	Area of specimen (mm <sup>2</sup> )	Load (KN)	Compressive strength of specimen (N/mm <sup>2</sup> )
1	16 x 4 x 4	0.3	500	150	6400	15	2.34
2	16 x 4 x 4	0.3	500	150	6400	18	2.81
3	16 x 4 x 4	0.3	500	150	6400	16	2.5
						Average	2.55

**CONSOLIDATION OF OBSERVATIONS:**

S.No	Size of the Specimen (cm)	Grade of Cement	w/c Ratio	Cube (N/mm <sup>2</sup> )	Prism (N/mm <sup>2</sup> )
1	4 x 4 x 4	OPC 53	0.3	35.83	-
2	4 x 4 x 4	OPC 53	0.35	44.16	-
3	4 x 4 x 4	PPC	0.3	0	-
4	7 x 7 x 7	OPC 53	0.3	24.35	-
5	16 x 4 x 4	OPC 53	0.3	-	19.06
6	16 x 4 x 4	PPC	0.3	-	2.55

### V. RESULTS

From the above observations the following results are obtained:

S.No	Size of the Specimen (cm)	Grade of Cement	MWCNT	w/c Ratio	Cube (N/mm <sup>2</sup> )	Prism (N/mm <sup>2</sup> )
A	4 x 4 x 4	OPC 53	-	0.3	35.83	-
B	4 x 4 x 4	OPC 53	-	0.35	44.16	-
C	4 x 4 x 4	PPC	-	0.3	0	-
D	7 x 7 x 7	OPC 53	-	0.3	24.35	-
E	16 x 4 x 4	OPC 53	-	0.3	-	19.06
F	16 x 4 x 4	PPC	-	0.3	-	2.55

The above table shows the summary of experiments carried out. Here the w/c ratio is maintained constant and the experiments are carried out in standard laboratory conditions in our university. The present market price of multi walled carbon nanotube is much higher compared to other construction materials. Hence, to carry out our experiments, we have undergone smaller specimen sizes than standard size. Also the size reduction was carried out gradually with

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

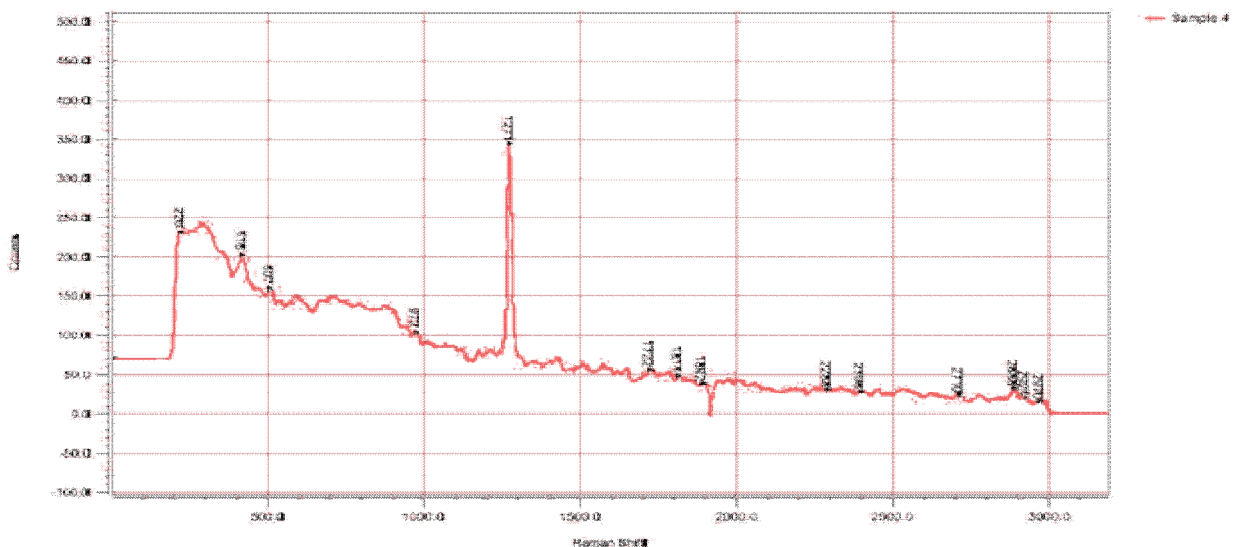
Vol. 7, Issue 1, January 2018

reference to published journal. This size reduction also helped in this project to incorporate nanotubes economically. From the above table, samples C and F showed very less strength than other samples. Hence further study on these samples (PPC) was not carried out, as it is not in the scope of our study. At the same time, sample B showed higher strength than other samples but at increased w/c ratio. Samples A and D are compared and found that sample A showed an increased strength than sample D. But the sample E showed less strength when compared to sample A. sample E has taken more load 140 kN and sample E has taken 66 kN. Here, sample E showed a better performance by taking more load with increased surface area than other samples. Further sizes of the samples are reduced to 1cm x 1cm x 6cm and specimens are prepared without and with multi walled carbon nanotubes. These specimens are examined in Raman study and showed the presence of surrounding of nanotubes by calcium silicate hydrate. This proved that nanotubes could be used a reinforcing material for cement matrices. Further, the Raman Spectroscopy was carried out.



**RAMAN'S SPECTROSCOPY ANALYSIS**

**CUBE SIZE OF 7 CM X 7 CM X 7CM**



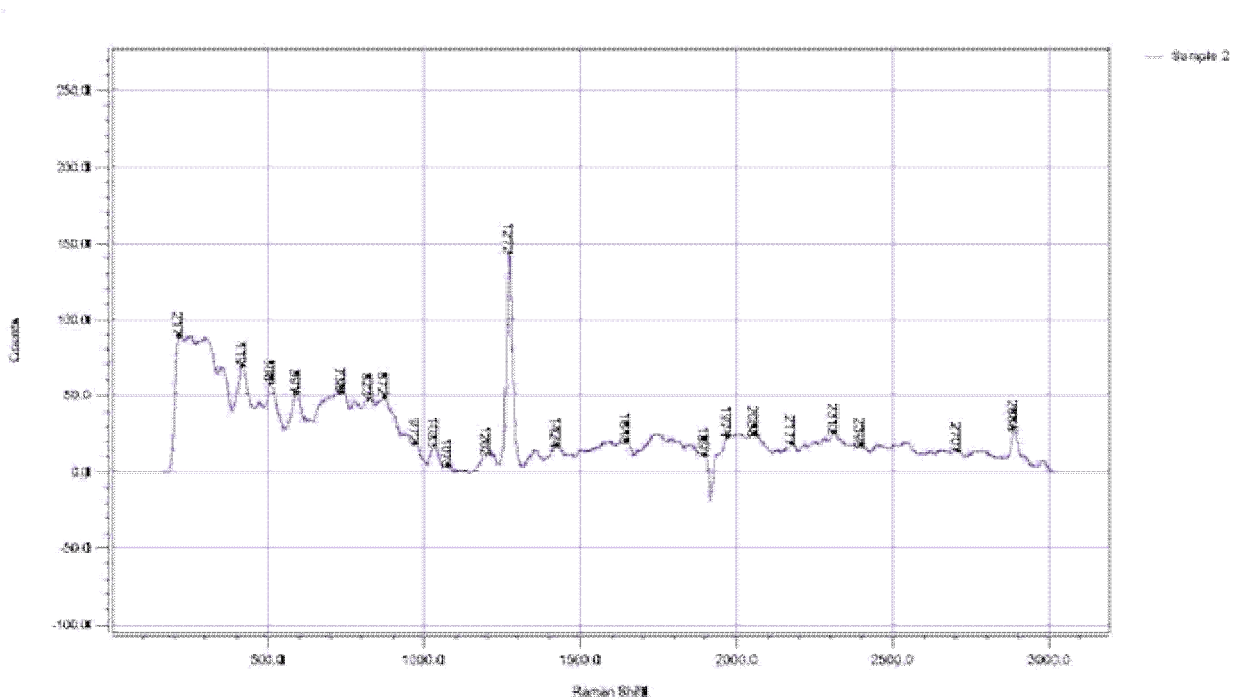
**RAMAN SPECTROSCOPY SHOWING THE PEAK VALUE (127) OPC53 SPECIMEN WITHOUT MWCNT ADDED**

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 1, January 2018



**RAMAN SPECTROSCOPY SHOWING THE PEAK VALUE (128) OPC53 SPECIMEN WITH MWCNT ADDED**

First objective of our study is to compare and carry out reduction in specimen sizes with the standard sizes. This was achieved through our studies and we reduced the sizes from cubes 7cm x 7cm x 7cm, 4cm x 4cm x 4cm and for prisms from 4cm x 4cm x 16cm to 1cm x 1cm x 1cm. Though the specimen 1cm x 1cm x 6cm was studied in Raman other samples were studied in compression testing and reduced sample size showed a better and increased load and strength. Hence we found that for making sample testing reduced sizes could also be used as this would be economical consumption. Second objective of our study is to carry out Raman study for cement-CNT sample. This was carried out with the smallest sample 1cm x 1cm x 6cm specimen G. The result from Raman study showed the completed interaction of CNT and cement particles. That is nanotubes were surrounded with hydrated calcium silicate hydrate which proved that possibilities of improvement of bonding strength of the composite. Hence, nanotubes could be used as a reinforcing material in cement matrices. The mechanical property of the specimen G requires further facilities in our laboratory and this could be taken as future scope of our project.

## REFERENCES

- Balaguru, P., and Chong, K. "Nanotechnology and concrete: Research opportunities." Proceedings of ACI Session on "Nanotechnology of Concrete: Recent Developments and Future Perspectives" November 7, 2006, Denver, USA, 16-27.
- Boresi, Arthur P.; Chong, Ken P.; Saigal, Sunil. Approximate Solution Methods in Engineering Mechanics, John Wiley, New York, 2002, 280 pp.
- Chong, K.P. "Research and Challenges in Nanomechanics" 90- minute.
- Concretes", Proceeding of First International Conference on Innovative Materials and Technologies for construction and Rehabilitation, Lecce, Italy, 2004, 459-468.
- Collepari, M.; Collepari, S.; Troli, R.; and Skarp, U. "Combination of Silica Fume.
- Concretes", Proceeding of First International Conference on Innovative Materials.
- Deb, B-Woods. (2008). "Nanotechnology: Ethics and Society." Taylor and Francis Group, N.Y.
- Drexler, K. E. (1986) 'Engine of Creations' Book Edition, N.Y
- A carbon Nano Tube / Cement Composites with piezoresistive properties, Xun Yu and Eil Kwon, IOP Science, Smart Materials and Science, Volume 18, No: 5, Published on 30<sup>th</sup> march 2009.



ISSN (Online): 2319-8753  
ISSN (Print) : 2347-6710

## International Journal of Innovative Research in Science, Engineering and Technology

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

Visit: [www.ijirset.com](http://www.ijirset.com)

**Vol. 7, Issue 1, January 2018**

10. Aligned Multi Walled Carbon Nano tubes – reinforced composites, processing and mechanical characterization, IOP science, Erik T Thostenson and Tsu-Wei Chou, Applied Physics, volume 35, No: 16, Published on 6<sup>th</sup> August 2002.
11. Rajkumar R and Ramya Sajeevan, “Experimental study on the strength and durability of nano concrete”, International journal on applied engineering research, volume 11, pg no: 2854 – 2858.
12. R.Sakthivel and Dr.N.Balasundharam, international journal of Civil Engineering and Technology, Volume 7, Issue 2, Pg No: 315 to 320.