

A Review on: “Nanocomposite Material in Bridge Construction”

Vaishnavi V. Khot^{1*} Aarati S. Suravase² Dr. Indrajit N. Yadav³

¹ Department of Civil Engineering, PAH Solapur University, India

² Department of Civil Engineering, PAH Solapur University, India

Abstract – Nanotechnology is the study of nanoparticle and their novel properties of material. From the current scenario of construction industry it has been seen that there are many drawbacks in terms of various properties such as cracks, shrinkages, bulking of sand, expansion in joints, punching of soil, differential settlement in soil, etc. which occur in structure using traditional materials. It may be sometimes emits carbon dioxide which cause pollution. Therefore this structure have less service life and high life-cycle cost. Nanocomposite material can generate products with many unique characteristic that can improve current construction materials like lighter & stronger structural composites, better cementations materials, lower thermal transfer rate of fire retardant & insulation. These review paper going to highlight & summarise different phenomenon of nanocomposites material and their methodological effect along with specific applications.

Keywords - Concrete, Construction, Nanocomposite, Nanotechnology, Structure.

-----X-----

I. INTRODUCTION

Bridge is common thing that we can see on any river, stream. It also helps in transportation. Now days due to change in climate, use of cheap materials in construction the lifespan of bridges is decreases as comparative to the old life span of bridges. Therefore it is necessary to study the construction of bridges, stress acting on bridge, load & traffic volume study, material study etc. Recovery of losses due to natural disasters is not fully possible in practical manner. So we have to do the prevention against this and also society should be aware against such problems. We can't control the amount or quantity of flood so we have to set prevention against such disaster so that we can avoid the damage and loss of needed things. If we study the materials structure and understand it thoroughly it can help to increase the possibility of increase in strength of it. Nanotechnology will help to study the atomic structure and nanoproperties of materials that are we use in construction of bridge. Nowadays nanocomposites are efficient way to increase the strength of materials without increasing the total weight of it.

Nanotechnology is the re-engineering of materials and devices by controlling the matter at the atomic level. In other words, nanotechnology is a field that is dominated by developments in basic physics and chemistry research. According to the report of RILEM TC 197-NCM, “Nanotechnology in construction materials” (Zhu et al., 2004), is the rest document

that synthesis in a clear manner the potential of nanotechnology in terms of the development of construction and building materials, namely: -

- The use of nano-particles, carbon nano-tubes, and nano-fibers to increase the strength and durability of cementitious composites, as well as for pollution reduction.
- Production of cheap corrosion free steel.
- Production of thermal insulation materials with performance of 10 times the current commercial options.
- Production of coats and thin films with self-cleansing ability and self-colour change to minimize energy consumption.(1)

Size limits for these effects have been proposed:-

- <5 nm for catalytic activity,
- <20 nm for making a hard-magnetic material soft,
- <50 nm for refractive index changes,
- <100 nm for achieving super paramagnetic, mechanical strengthening or

restricting matrix dislocation movement. (19)

Nanotechnology is not new and is known to exist for ages, be it in the sword of tipu sultan or in the windows of the medieval churches in Europe. A common question in the minds of all of us living in today's world is about how the mechanism of nanotechnology can be used in the healthy compatibility with the constructional structures like that of massive buildings and bridges, which have been thought to encroach upon huge masses of land, leading to the destroying of homes of wildlife and putting pressure in the limited reserves of energy(11).

II. LITRATURE REVIEW

KURAPATI SRINIVAS (2014)

In(2) this paper they are discussed the current research work regarding applications of nanotechnology in cement-based materials is either related to coating or enhancement of mechanical properties .they had study in nanocomposites material such as Titanium dioxide (TiO₂), Nano silica (SiO₂), Alumina(Al₂O₃), ZrO₂, Carbon nanotube (CNT) nanoclay, etc. this are cement based material is related to the coating or enhancement of mechanical properties. They are discussed about the general experiment methods as like compressive stress, split tensile test & flexural strength etc for the nanocement .they are discussed about the water proofing, acid resitive and self-healing qualities of nanocement.

ANWAR KHITAB(2015)

In(3) this paper the aim of this research paper is to address the futuristic construction materials. The innovations could be two-types; one is the modification of classical materials and the other should cover the invention of novel materials. The primary goal of all such materials should be environment friendly. Secondly, they should had durable and cost effective. It is by now evident that the knowledge of the very small things is creating vast changes, with various economic benefits to the construction industry.

ASHWANI K. RANA (2009), DR. A.S. KANAGALAKSHMI (2019)

In(4,20) this Paper they had mentioned that nanotechnology growing fastly .it is also used in construction engineering. It most recent research that had happen in civil engineering and construction material. The properties like self-sensing, self-rehabilitation, self-structural health monitoring, self-vibration damping, self-cleaning and self-healing are studied. The objective of this study is to review the role of nanotechnology in civil engineering applications. The result of the research paper was

construction material with high performance in strength, durability & other properties.

KAIZAR HOSSAIN & SHAIK RAMEEJA (2015)

In(5) this paper they are the studied the important of the nanotechnology & Nano construction material in civil engineering. At the nanoscale, familiar materials can have dramatically different properties: changes can affect colour, elasticity, strength, conductivity, and other properties. The use of coatings made from nanotechnology helps improve fire-resistance, corrosion protection, insulation, and countless other applications.

SHIVAM DESHMUKH (2018)

In(6) this paper they are studied the better alternative for metal & other conventional material for the oil & gas pipelines. Therefore, nanocomposites promise new applications in many fields such as mechanically-reinforced lightweight components, non-linear optics, battery cathodes and ionics, nanowires, battery cathodes, nanowires, sensors and numerous other systems.

FARZANA HUSSAIN & MEHDI HOJJATI (2006)

In(7) this review paper offers a comprehensive discussion on technology, modeling, characterization, processing, manufacturing, applications, and health/safety concerns for polymer nanocomposites. Hence, this review offers a brifely discussion on technology, modeling, characterization, processing, manufacturing, applications, and health/safety concerns for polymer nanocomposites.

MALGORZATA KRYSTEK AND MARCIN GÓRSKI (2018)

In(8) this paper the nanomaterials used in structural engineering. They are present the use of nanomaterials in structural engineering in different areas including mechanical and electrical properties as well as problems referring to durability.

A.D'ALESSANDRO, F. UBERTINI, A. L. MATERAZZI (2016)

In(9) this paper they are studied to the self-sensing concrete nanocomposite material for smart structure & construction material. The research work present in literature gives the idea about the growing interest of the scientific community about self-sensing cementitious materials with conductive nanofillers.

DARSHAN A. PATEL, PROF. C.B. MISHRA (2017)

In(10) this paper they are studied to nanomaterial for highway infrastructure .The investigation of about nanoscience and different nanoparticles potential points of interest of Nano silica, smaller scale silica, carbon nanotubes, Nano TiO₂, Nano phosphorus and their execution in transportation field are shown in this paper. This paper focuses on the advancement of important nanotechnology and its effect on roadway designing practice is presented for widening vision and inspiring the creativity of highway engineering keeping in viewpoint safety, durability, financial aspects and maintainability of the transportation framework of India is considered.

B. B. DAS AND ARKADEEP MITRA (2014)

In(11) this paper they are studied on the nano material used in construction engineering . This review paper on the sustainable usage of nano based materials like carbon nanotube, electrochromic windows, nanoclays, sandvik nanoflex™, nanowires, titanium dioxide, nanoceramic coating, nanocrystalline materials, nanosilica, nanocomposites, MMFX2 steel, nanometals, nanofibres, nanomyte™ mend MW, nanocement, which could be used for providing singular or multiple functions of potential reinforcement, corrosion resistance, insulation, fire protection, temperature resistance, reducing air conditioning loads, pollution control, UV ray absorption, lighting, when used as a part of building materials.

MATTIA FEDERICO LEONE (2012)

In(12) this paper they are studied Nanotechnology for Architecture, Innovation and Eco-Efficiency of Nanostructured Cement-Based Materials. The specific focus on the characteristics and potential applications of nanostructured cement-based materials is intended to reaffirm the need to develop an adequate level of knowledge internal to architectural disciplines on nanotechnology-related innovations, starting from the prominent role that cement and concrete plays in the construction industry.

SHERIEF ABULMAGD AND ZEINAB A. ETMAN (2018)

In(13) this paper they are studied the Nanotechnology in Repair and Protection of Structures. This paper was help to aware the most recent progress in this important of the field such as construction industry.It also helps in health of humans and then environment.

MANISH KUMAR SAHU, LOKESH SINGH (2018)

In(14) this paper they are studied on use of Nanotechnology in Civil Engineeering. it was

improves the characteristics of concrete, steel ,glass, bricks .& industrial materials.this paper result it reduce the significant reductions of CO₂ pollution & use as thermal insulationwhich leads to efficient use for air conditioning

YOUSRY B. I. SHAHEEN (2014)

In(15) they are studied the structural behaviour on nano composite material(Cu_{0.5}Ni_{0.5}Fe₂O₃) by applying simple laboratory method and output was analyzed to make sure it conformed to the required using X-ray diffraction (XRD) and X-ray Fluorescence (XRF). They added to cement mortar as a replacement percentage of cement weight and the compressive strength was evaluated at the age of 7 and 28 days and they determine optimum ratio of nano particles. The ratio is 0.055 % of cement weight.

VAIBHAV RAGHAVAN (2016)

In(16) this paper they are studied on influence of silica based carbon nano tube composites in concrete.the shrinkage of the concrete mix was increased but after 28 days the compressive strength was start to decreasing. They were observed that the addition of silica fumes to CNT-cement composites has no significant increase in mechanical strength and durability. But during the study it was observed that the addition of silica fumes make the concrete more impermeable.

P. RAMAKRISHNAN (2019)

In(17) they are studied on the rise husk-polymer matrix . From results we had seen that the crystalline of nanocomposite decreases with increase in wt% of Rise Husk.

NARESH R. SHIMPI (2013)

In(18) Carbon tubes have incredible strength and fascinating electronic properties which is to ready to overtake fullerenes in the race to the technological marketplace. This paper are basically discusses about the Carbon Nano tubes and platelets, techniques for manufacturing, properties and recent advances in this segment. Unique structure, topology and dimensions of carbon nanotubes have created a superb all-carbon material, which can be considered as the most perfect fiber that has ever been fabricated. The strength and flexibility of carbon nanotubes makes them of potential use in controlling other nanoscale structures, which suggests they will have an important role in nanotechnology engineering.

HARISH B. A. (2016)

In(21) this paper summarizes information ON the mechanical & durability properties of cementitious systems containing a fine glass powder. It is shown

on this paper that concrete mixtures could be proportioned to achieve similar or higher compressive strengths. A better alternative material for non-standard cement & this material, consequently contributing to sustainability.

MOHAMMAD FAIZAN UL HAQ (2020)

In(22) this paper the effect of CNTs on an asphalt binder is highly dependent on the properties of the base bitumen and the type of CNTs being used. The most difficult process in the case of bitumen modification with CNTs is the homogenous dispersion of CNTs.

JOÃO V. STAUB DE MELO (2018)

In(23) this paper they are studied Optimization of Carbon Nanotube Content of Asphalt Nanocomposites with Regard to Resistance to Permanent Deformation. paper presents the results of the development of asphalt nanocomposites containing carbon nanotubes (CNTs) with high resistance to permanent deformation, aiming to increase the performance of asphalt surfaces in relation to the rutting problem. The reduction in the sensitivity to temperature is greater with an increase in the CNT content incorporated. The complex shear modulus increased and the phase angle decreased at high temperatures with the addition of CNTs.

III. SUMMARY

The objective of study nanotechnology and nanomaterials is to review the application of it in Civil Engineering. The primarily goal of all such materials should be environment friendliness secondarily they should be durable and cost effective ,thirdly they should address the space shortage, fourthly they should have adequate strength to cater the natural and manmade calamities. Expected benefites from nanocomposites include improvement in modulus, flexural strength, heat distortion temperature, barrier properties and other benefits. Currently the most active research areas are dealing with the cement and concrete. Improvement of mechanical properties & durability of cementitious materials is mostly obtained by their nanostructure modification that is the incorporation of nanomaterials into cement matrix. In particular cement-matrix composite materials are capable of diagnosing their own state of strain & tension could be originated by addition of specific conductive nanofillers. It is already possible to identify in certain types of nanostructured materials a significant response to the need of reducing the environment impacts of industrial processes in the construction field. The use of nanomaterial in composition of some material such as cement will result in significant reduction of carbon dioxide pollution. Nanomaterial effect on roadway designing practice is presented for widening vision & inspiring the creativity of Highway Engineering. Keeping in viewpoint safety, durability financial

aspects & maintainability of the transportation framework of India is considered. A reduction in emission of greenhouse gases, energy consumption, maintenance costs, resistance to moisture are some of the advantages of using asphalt containing nanoparticles. In general nanomaterials provide reinforcing efficiency because of their high aspect ratios. The self-healing polymer could be specially applicable to fix the micro cracking in bridge piers and columns but it requires costly epoxy injection.

IV. TABLE

S. No.	TITLE OF PAPER	AUTHOR	METHOD	REMARK
1	Nanotechnology In Civil Engineering	Ali Akbar Firozi, Mohd Irfan, Taha, Agha Firozi	-	Enlist & shortly explained Microscopy Methods.
2	Nanomaterials for Concrete technology	Kurapati shrinivas	Laboratory Methods	Use of various nanocomposites in concrete & their results.
3	Future Of Civil Engineering Materials: A Review From Recent Development	Amir Alital, Waqas Anwar, Iman Mansouri, Malik Kashan Tariq and Iman Mehmoed	-	Described future Civil Engineering materials.
4	Significance of Nanotechnology In Civil Engineering	Ashwani K. Rana, Shashi B Rana, Anuja Kumar and Vaidhyan Rana	-	Necessity of Nanotechnology in Civil Engineering.
5	Importance Of Nanotechnology In Civil Engineering	Kulzar Hussain & Shaik Rameez	-	Applications of Nanotechnology in Civil Engineering.
6	Recent Advances In Nanocomposites: an overview	Kulzar Hussain & Shaik Rameez	-	Current scenario of nanocomposite.
7	Review Article: Polymer Matrix, Nanocomposite, Processing, manufacturing and application: An overview	Farzana Hussain	-	Conventional method of manufacturing & Characterized techniques of Nanocomposites.
8	Nanomaterials In: Structural Engineering	Malgornata Krystek and Marcin	-	Introduction to self-monitoring materials
9	Self-Sensing Concrete Nanocomposites For Smart Structures	A. D'Alessandro, F. Ubertini, A.L. Materazzi	Scanning Electron Microscopy & Laboratory Method	Introduction to self-sensing concrete & their laboratory test.
10	Nanomaterial For Highway Construction	Darshan A. Patil, Prof. C.B. Mishra	-	Application of Nanomaterial in pavement.
11	Nanomaterials For construction Engineering: An Overview	E. B. Dincel and Arkanalp Mitra	Laboratory Methods	Current scenario & types of Nanomaterial used in construction engineering.
12	Nanotechnology For Architecture	Mattia Federico Leone	-	Introduction to Nanostructure cement-based materials.
13	Nanotechnology In Repair & Protection of Structure State -Of-Art	Sherief Abdulmagid and Zeinab A. Elman	-	Application of Nanotechnology in repair & protection of structure.
14	Review On Use Nanotechnology In Civil Engineering	Manish Kumar Saha, Lokesh Singh	-	Application of Nanotechnology in construction materials.
15	Structural Behaviour of Nanocomposite Materials (Cat.5900.5Fe203)	Yasuni B. S. Shashan	High-Resolution Transmission Electronic Microscopy, X-Ray Diffraction, X-Ray Fluorescence, Scanning Electron Microscopy	They gain early compressive strength higher than the normal mixes by 15-20 % at age of 7 days. The results of tested columns that contain 0.555% of nano Copper-Nickel Particles showed good behavior in the axial load test by 54 % compared to these that do not contain.
16	Influence of silica based carbon nanotube composites in concrete.	B.P. Dhruva Swamy, Vaibhav Raghavan, K. Srinivas, K. Narasimha Rao, Mahadevan Lakshmanan, K. Jayanarayanan, K.M. Muni	Laboratory Methods, Scanning Electron Microscopy	Mortar composite with 0.3 % CNT and without any silica fumes has the highest strength of all the mixes tested. Mortar composite with 0.4 % CNT and with 10% silica fumes has the least strength of all the mixes tested. Without addition of silica fumes, after 0.3% addition of CNT, 28-day compressive strength started decreasing.
17	A Study on Rice Husk Polymer Matrix	Balashankh Charan Prusty, Subrat Pradhan, P. Ramakrishnan	X-Ray Diffraction Method, Laboratory Method	From results and discussion it concluded that the crystallinity of nanocomposite decreases with increase in wt% of RH.
18	Carbon Nano-Particle As A Composite Structure: A Technical Review	Raveesh R. Shargel Prof.D.N.Jadhav	Laboratory Method	They briefly discussed about Carbon as a composite structure.
19	Nanocomposites and Their Applications	Balaji V., B. Manasa, Ashwin N, Chandrakanth BS, Kiran Kumar KC	-	They discussed briefly about types, application of nanocomposite.
20	Nano Technology in Construction	Dr. A.S. Ramagopalakrishni, Professor M.C. Arivokaras, C.M. Keerthana, B. Subashri, V. Vidhya Priya.	-	They briefly discussed applications Nanotechnology in construction.

21.	An Experimental Investigation on Partial Replacement of Cement by Glass Powder in Concrete	Harish B A, Hanumesh B M, Siddesh T M, Siddalingesh B K	Laboratory Methods	Increasing the amount of glass above 30% in mortar causes a general decrease of compressive strength.
22.	Carbon nanotubes and their use for asphalt binder modification: a review	Muhammad Fatmah ul Haq	Arc discharge, Laser ablation, Chemical vapour deposition, Scanning Electron Microscopy.	Addition of CNT's to bitumen increases the strength and elastic properties of bitumen, which in terms of decrease penetration and increase in softening point and G* value. A stiffer binder shows more resistance against the rutting.
23.	Optimization of Carbon Nanotube Content of Asphalt Nanocomposites with Regard to Resistance to Permanent Deformation	Joko V. Stanch de Melo, Glécio Triches, Luanne P. Thives	X-Ray Fluorescence Method.	This paper presents the results of research carried out to develop asphalt nanocomposites containing CNTs with a high potential for the resistance of permanent deformation.

V. CONCLUSION

As a future engineer we would like to be able to do research on finding new materials to help create stronger, better, longer lasting buildings and structures. In general, the unique combination of the nanomaterial's characteristics, such as size, mechanical properties, and low concentrations necessary to effect change in a polymer matrix, coupled with the advanced characterization and simulation techniques now available, have generated much interest in the field of nanocomposites. Current efforts in the field of nanotechnology are focused on the fabrication, characterization and use of these materials on a nanoscale domain. This leads to most of the development work focusing on very small quantities of material that is typically far removed from the type of quantities required for typical construction infrastructure. The development of environmentally friendly, non-foil and better packaging materials can reduce the amount of solid waste, improve package manufacturing capabilities, and reduce the overall logistics burden to users.

REFERENCES

1. Ali Akbar Firoozi, Mohd Raihan Taha, Asghar Firoozi (2014). "Nanotechnology in Civil Engineering" *JGE*. Vol. 19, pg. 4672-4682.
2. Kurapati Shrinivas (2014). "Nanomaterials for concrete technology". *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)* Vol. 4, Issue 3, pg.79-90.
3. Anwar Khatab, Waqas Anwar, Iman Mansouri, Malik Kashan Tariq and Imran Mehmood (2015). "Future of civil engineering materials: A review from recent development". pg. 20-27.
4. Ashwani K. Rana, Shashi B Rana, Anjna Kumari and Vaishnav Kiran (2009). "Significance of Nanotechnology in Construction Engineering". *International Journal of Recent Trends in Engineering* Vol. 1, No. 4, pg. 46-48.
5. By Kaizar Hossain & Shaik Rameeja (2015). "Importance of Nanotechnology in Civil Engineering" *European Journal of Sustainable Development*, pg. 161-166.
6. Nand Jee Kanu, Bharat S. Phalak, Shivam Deshmukh, Manish Chhailkar, Research Scholar (2018). "Recent Advances in Nanocomposites: An overview". *IOSR Journal of Mechanical and Civil engineering (IOSR-JMCE)*, pp. 70-75.
7. Farzana Hussain (2006). "Review article: Polymer-matrix Nanocomposites, Processing, Manufacturing, and Application: An Overview" *Journal of Composite materials*, Vol. 40, pg. 1511-1559.
8. Małgorzata Krystek and Marcin (2018). "Nanomaterials in Structural Engineering" *Chapter 7* Pg. 115-131.
9. A. D'Alessandro, F. Ubertini, A. L. Materazzi (2016). "Self-sensing concreting nanocomposites for smart structure" *International Journal of Civil and Environmental Engineering*, Vol. 10 Pg. 599-604.
10. Darshan A. Patel, Prof. C.B. Mishra (2017). "Nano Material for Highway Infrastructure", *Kalpa Publications in Civil Engineering Volume 1*, Pages 321-328.
11. B. B. Das and Arkadeep Mitra (2014). "Nanomaterials for Construction Engineering-A Review" *International Journal of Materials, Mechanics and Manufacturing*, Vol. 2, No. 1, Pg. 41-46.
12. Mattia Federico Leone (2012). "Nanotechnology for Architecture. Innovation and Eco-Efficiency of Nanostructured Cement-Based Materials" Vol. 1, Pg. 1-9.
13. Sherief Abulmagd and Zeinab A. Etman (2018). "Nanotechnology in Repair and Protection of Structures State-of-the-Art" *Journal of Civil & Environment Engg*, Vol. 8, Pg. 1-7.
14. Manish Kumar Sahu, Lokesh Singh (2018). "Review on Use of Nanotechnology in Civil Engineering" *International Journal of Engineering Research & Technology (IJERT)*, Vol. 6 Issue 1, Pg. 1-4.
15. Yousry B. I. Shaheen (2014). Structural Behavior of Nano Composite Materials (Cu_{0.5}Ni_{0.5}Fe₂O₃)" *International Journal*

of Materials Science and Engineering Vol. 2, No. 1, Pg. 27-32.

16. BLP Dheeraj Swamy, Vaibhav Raghavan, K Srinivas, K Narasinga Rao, Mahadevan Lakshmanan, K.Jayanarayanan, K.M. Mini (2017). Influence of silica based carbon nanotube composites in concrete" *Advanced Composites Letters*, Vol. 26, Issue-1, Pg. 12-17.
17. Baishnab Charan Prusty, Subrat Pradhan , P Ramakrishnan (2019). "A Study on Rice Husk-Polymer Matrix" *International Journal of Engineering Research & Technology (IJERT)* Vol. 8 Issue 11, Pg. 829-839.
18. Naresh R. Shimpi Prof. D. N. Jadhav (2013). "Carbon Nano-Particle As A Composite Structure: A Technical Review" *International Journal of Engineering Research & Technology (IJERT)*, Vol. 2, Issue 6, Pg. 1557-1563.
19. Balaji V., B. Manasa, Aakash N., Chandrakaanth BS, Kiran Kumar KC (2017). "Nanocomposites and Their Applications" *International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)* Vol. 2, Issue 11, Pg. 81-85.
20. Dr. A.S. Kanagalakshmi, Professor M. C. Arivukarasi, C. M. Keerthana, R. Subashri, V. Vishnu Priya (2018). Corresponding Author: Dr. A.S. Kanagalakshmi ." Nano Technology in Construction" *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* Volume 15, Issue 1 Ver. II ,Pg. 53-56.
21. Harish B A, Hanumesh B. M., Siddesh T. M., Siddhalinges B. K. (2016). "An Experimental Investigation on Partial Replacement of Cement by Glass Powder in Concrete" *International Research Journal of Engineering and Technology (IRJET)* Volume: 03 Issue: 10, Pg. 1218-1224.
22. Muhammad Faizan ul Haq (2020). "Carbon nanotubes and their use for asphalt binder modification: a review". Pg. 1-14.
23. João V. Staub de Melo, Glicério Trichês, Liseane P. Thives (2018). "Optimization of Carbon Nanotube Content of Asphalt Nanocomposites with Regard to Resistance to Permanent Deformation" *International Journal of Civil and Environmental Engineering* Vol. 12, No:2, Pg. 153-159.

Corresponding Author

Vaishnavi V. Khot*

Department of Civil Engineering, PAH Solapur University, India