NANOTECHNOLOGY IN CONSTRUCTIONS

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ABSTRACT

A broad range of challenges are faced by the construction industry, ranging from the performance of the materials to environmental and safety issues related to basic materials and their properties. Recent developments in various areas of nanotechnology show significant promise in addressing many of these challenges. Research and developments have demonstrated that the application of nanotechnology can improve the performance of traditional construction materials, such as concrete, steel, glass, paint, coatings, insulating materials, et. al. Noteworthy improvements in concrete strength, durability and sustainability are being achieved with considered use of metal/metal oxide nanoparticles and engineered nanoparticles (carbon nanotubes and carbon Nano-fiber), and environment-responsive anticorrosion coatings formed using Nano encapsulation techniques are showing promise in laboratory settings. Research demonstrates that nanotechnology can contribute to novel cooling systems, and improve the functionality of solar cells and insulation. A range of nanomaterials are also being used to add new functionalities, such as self-cleaning properties, to traditional construction industry products, for example paint, glass, cement mortar and concrete. The application of nanotechnology innovations deals with a highly multidisciplinary field of engineering. Nanotechnology is expected to bring vast changes in robotics, chemical, mechanical, biological as well as electrical engineering.

Keyword : - *Nanomaterials, Nanotechnology, CNT, Fibers and Nanosilica*

1. INTRODUCTION

Nanotechnology is one of the most active research areas that include a number of disciplines including civil engineering and construction materials. Nanotechnology is the understanding, control, and restructuring of matter on the order of nanometers (i.e., less than 100 nm) to create materials with fundamentally new properties and functions. Nanotechnology encompasses two main approaches: (i) the ‘‘top down” approach, in which larger structures are reduced in size to the nanoscale while maintaining their original properties or deconstructed from larger structures into their smaller, composite parts and (ii) the ‘‘bottom-up” approach, also called ‘‘molecular nanotechnology” or ‘‘molecular manufacturing,” in which materials are engineered from atoms or molecular components through a process of assembly or self-assembly. However, the potential for applications of many developments in the nanotechnology field in the area of construction engineering is growing. There are many potential areas where nanotechnology can benefit construction engineering like its applications in concrete, structural composites, coating materials and in Nano-sensors, etc. Nanotechnology products can be used for design and construction processes in many areas. The nanotechnology generated products have unique characteristics, and can significantly fix current construction problems, and may change the requirement and organization of construction process. The recent developments in the study and manipulation of materials and processes at the nanoscale offer the great prospect of producing new macro materials, properties and product. Nanotechnology is expected to bring vast changes in robotics, chemical, mechanical, biological as well as electrical engineering.

1.1 Nano Material CNT

Carbon nanotubes are a form of carbon having a cylindrical shape, the name coming from their nanometer diameter. 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). 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 nanotubes are: mechanical durability and crack prevention in concrete enhanced mechanical and thermal properties in ceramics and real-time structural health monitoring capacity.

1.2 Nano Material Nano fibre

High temperature withstanding (upto 3000C in case of Aramid Nanofiber) insulation (0.96 for 10% weight of carbon nanofibers put into graphite, other sources say that graphitized ones have a value of 0.0520) services are provided by the nanofibers. Temperatures are brought down in summer by presence of thin film Nano-scale stainless steel coatings in masa curtains.

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2. Application

Nanotechnology can be used for design and construction processes in many areas since nanotechnology generated products have many unique characteristics. These characteristics can, again, significantly fix current construction problems, and may change the requirement and organization of construction process

1. Lighter and stronger structural composites
2. Low maintenance coating
3. Improving pipe joining materials and techniques.
4. Better properties of cementations materials
5. Reducing the thermal transfer rate of fire retardant and insulation
6. Increasing the sound absorption of acoustic absorber
7. Increasing the reflectivity of glass

The abbreviated list is not an exhaustive list of applications of nanotechnology in construction. Some of these applications are examined in detail below.

2.1 Nanotechnology for Concrete

Much analysis of concrete is being done at the nano-level in order to understand its structure. Such analysis uses various techniques developed for study at that scale such as Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM) and Focused Ion Beam (FIB). This has come about as a side benefit of the development of these instruments to study the nanoscale in general, but the understanding of the structure and behavior of concrete at the fundamental level is an important and very appropriate use of nanotechnology. One of the fundamental aspects of nanotechnology is its interdisciplinary nature and there has already been cross over research between the mechanical modeling of bones for medical engineering to that of concrete which has enabled the study of chloride diffusion in concrete (which causes corrosion of reinforcement). Concrete is, after all, a macro-material strongly influenced by its nano-properties and understanding it at this new level is yielding new avenues for improvement of strength, durability and monitoring as outlined in the following paragraphs.

Silica (SiO_2) is present in conventional concrete as part of the normal mix. However, one of the advancements made by the study of concrete at the nanoscale is that particle packing in concrete can be improved by using nano-silica which leads to a densification of the micro and nanostructure resulting in improved mechanical properties. Nano-silica addition to cement based materials can also control the degradation of the fundamental C-S-H (calcium-silicate hydrate) reaction of concrete caused by calcium leaching in water as well as block water penetration and therefore lead to improvements in durability. Related to improved particle packing, high energy milling of ordinary Portland cement (OPC) clinker and standard sand, produces a greater particle size diminution with respect to conventional OPC and, as a result, the compressive strength of the refined material is also 3 to 6 times higher (at different ages). Nano-silica particles, better known as silica fume, improve the overall panicle packing in concrete matrix resulting in very high compressive strengths (>15,000 psi1).

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2.2 Nanotechnology for Steel

The addition of copper nanoparticles reduces the surface unevenness of steel which then limits the number of stress risers and hence fatigue cracking, leading to increased safety, less need for monitoring and more efficient materials used in construction subjected to fatigue issues. Vanadium and molybdenum nanoparticles improve the delayed fracture problems associated with high strength bolts, reducing the effects of hydrogen embrittlement and improving the steel micro-structure. The addition of nanoparticles of magnesium and calcium leads to an increase in weld toughness. The carbon nanotubes have little application as an addition to steel because of their inherent slipperiness, due to the graphitic nature, making them difficult to bind to the bulk material. Also, the high temperatures involved in the steel elements production process enhances the vibration of carbon atoms significantly, leading to bond breaking and deffects in the nanotubes structures.

3. Advantages & Disadvantages

1. Nano-modified concrete cuts down construction schedules while reducing labour-intensive (and expensive) tasks. Also it can reduce the cost of repair and maintenance.
2. Nano sensors embedded in infrastructural materials can provide, at minimum cost, fully integrated and self-powered failure prediction and forecasting mechanisms for high-capital structures.
3. Compared with conventional TiO_2, TiO_2 at the nano-scale experiences a 500% increase in surface area and a 400% decrease in opacity.
4. Because of their small particle size, nano particles have the potential to negatively affect the respiratory and digestive tracks and the skin or eye surface [4] thus exposes workers to hazards.
5. Since nanotechnology-related industries are relatively new, the type of worker who is employed in construction research and development (or even some field applications) must have an interdisciplinary background.
6. New policies in the context of nanotechnology will require cooperation between various levels of government, R&D agencies, manufacturers, and other industries.

4. CONCLUSIONS

Nanotechnology is a rapidly growing area of exploration where innovative properties of materials Manufactured on the nanoscale can be developed for the benefit of construction infrastructure. Nanotechnology offers vast amounts of enhancement in the civil engineering field. It has helped to improve the quality of and solved many issues with building materials such as concrete and steel. The employ of nanotechnology has also helped created more efficient and sustainable materials such as self-cleaning and self-repairing concrete and windows. The use of coatings made from nanotechnology helps improve fire-resistance, corrosion protection, insulation, and countless other applications. Even though construction materials may constitute only a small part of this overall effort, it could pay enormous rewards in the areas of technological breakthroughs and economic benefits.

5. REFERENCES

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