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Nano Technology in Civil Engineering

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Abstract: ***It is known that nanotechnology is the most influential technologies since its contribution has been to the most of the fields of technology. Traditionally, nanotechnology has been concerned with developments in most of the fields like microbiology, medicine, electronic, chemical, and materials sciences. However, the potential for application of many of the developments in the nanotechnology field in the area of construction engineering has been growing. Current civil engineering education should address the need to provide a broad vision, develop the higher-order skills of future civil engineers, enable them to adopt emerging technologies, and formulate innovative solutions to complex problems. This paper introduces relevant nanotechnology developments to convey the new vision and inspire creativity in civil engineering. It also discusses the application of instruments to reach material properties of Nano-scale. Furthermore, it has been observed that better understanding and engineering of complex structures made by cement, steel or composite materials at Nano-level will definitely result in a new generation of construction materials with higher performance in strength, durability, and other properties.***
Keywords: Nano Tio2, Nano Sillica, Nano Alumina, Nano Ferrous Oxide, Nano Iron.

I. INTRODUCTION

Nano science has paved the way to tailor the properties of materials based on particular requirement by working in atomic or molecular level. In general, nanotechnology is not an isolated technology for certain purposes, but it is an enabling technology to achieve many goals by engineering a material at Nano level. Similar to the fields like energy, medicine, electronics, etc., nanotechnology shows remarkable potentiality of its role to play by opening a new way to solve many of the perennial problems civil engineers do face every day. A more accurate definition of nanotechnology was presented in 1981 by Drexler , such as the production with dimensions and precision between 0.1 and 100 nm. In medium terms, nanotechnology involves the study at microscopic scale (1 nm = 1 × 10 -9 m). As a comparison, one must realize that a strand of human hair has 80,000 nm thickness and that the DNA double helix has 2 nm diameter. In nano-level, gravity becomes unimportant, electrostatic forces take over, and quantum effects come in. Furthermore, as particles become nano-sized, the proportion of atoms on the surface increases relative to those inside, and this leads to novel properties. Current researchers dealing with nano-science and nanotechnology are exploring these novel properties since at nano-scale, we can alter the macro-properties and produce significantly new materials and processes. Discussion on the application of nanotechnology in civil engineering, specifically in construction, is extremely important. According to a study by the Canadian Program on Genomics and Global Health (CPGGH), nanotechnology in civil engineering was ranked 8 of 10 applications that most likely have an impact in the developing world (ARI News 2007). The countries like India, where growth of infrastructure plays a significant role in the growth of the country, engineering of green and smart construction material will enormously help to generate public, private, strategic and societal goods.

Many disciplines of civil engineering, including design and construction processes, can be benefited from nanotechnology. These include products that are for: Lighter structure, Stronger structural composites, e.g. for bridges and others. Low maintenance coating, Improved pipe joining materials and techniques, Better properties of cementitious materials, Reduced thermal transfer rate of fire retardant and insulation, Increased sound absorption of acoustic absorber, Increased reflectivity of glass, water repellents, nano-clay filled polymers, self-disinfecting surfaces, UV light protector, air cleaners, nano-sized sensors, and solar cells.

There are a large number of applications of nanotechnology in the construction engineering/industry. Some of these applications are examined in detail below.

II. NANO-MATERIALS AND PROPERTIES

A. Nano-Sillica

Silicon dioxide nanoparticles appear in the form of a white powder. Nano silica occurs with high stability, low toxicity and has ability to be functionalized with a range of molecules and polymers. Nano Silica can be incorporated into the concrete in 2 ways

1) By replacing cement with nano silica
2) By adding nano silica into concrete.
3) Nano Silica is prepared by various methods.

Some of the methods are Vaporization of Silica, Precipitation method, Sol gel process

B. NanoTio₂

Titanium oxide (TiO_2) is available in the form of nanocrystals or Nano dots having a high surface area. They exhibit magnetic properties. Nano TiO2 occurs in the form of black hexagonal crystals. Titanium oxide nanoparticles are known for their ability to inhibit bacterial growth and prevent further formation of cell structures. Nano Titanium Di Oxide is prepared by the synthesis of titanium dioxide using Sol-Gel Method. Nano Titanium Dioxide is used as an additive for concrete. There are many changes that take place on addition of Nano TiO2

C. Nano Alumina

It occurs in the form of white powder. Nano Al2O3 is 100% crystalline, Non-Porous, Non- Agglommerated Particles. Nano Alumina is introduced into the concrete as an additive.

D. Nano Ferrous Oxide

Nano Iron Oxide is 100% crystalline, non-porous, non-agglomerated particles. It occurs in the form of Reddish brown powder. Nano Iron also acts as an additive for concrete.This is also known as Nano Iron .The formula for Nano Iron is Nano Fe2O3

III. RESULTS AND DISCUSSION

A. Effect of Nano TiO2 on Concrete

It shows effective self-Cleaning property in concrete. It helps in accelerating the early-age hydration of Portland cement. It enhances the abrasion resistance of concrete. It also improves compressive and flexural strengths of concrete.

It finally produces a Green concrete due to its self cleaning activity. TiO2 is a white pigment and can be used as an excellent reflective coating. Since TiO2 breaks down organic pollutants, volatile organic compounds, and bacterial membranes through powerful catalytic reactions, it can therefore reduce airborne pollutants when applied to outdoor surfaces. It is hydrophilic and therefore gives self cleaning properties to the applied surfaces. In this process rain water is attracted to the surface and forms sheets which collect the pollutants and dirt particles previously broken down and washes them off. The resulting concrete has a white colour that retains its whiteness very effectively.

B. Effect of Nano Alumina on Concrete

Nano Alumina plays a major role in the improving strength of concrete. Its provides early strength to concrete. This increase the elasticity modulus. It produces quick setting nature to concrete. It allows for fabrication at low temperatures, reducing energy consumption

C. Effect of Nano Iron on Concrete

The compressive strength of concrete increases by adding 1% in case of 28 days.On addition of more than 1%, it was observed to decrease.The compressive strength of concrete increases by adding 1% in case of 28 days. On addition of more than 1%, it was observe to decrease. They show low slump and high workability. It increases the self sensing property of concrete. It increases the resistance to water penetration on 1.5% addition of Nano Iron. The compressive and flexural strengths at the 7th and 28th days of the cement mortars mixed with nanoparticles were higher than those of a plain cement mortar. On conducting experiments it was found that the compaction factor was little increased at different water-cement ratios. On the other hand the Vee Bee Time was decreased at different water-cement ratio.

D. Effect of Nano Silica on Concrete

Nano Silica works in 2 levels as physical effect and chemical effect. It was seen that addition of 1 kg of nano silica reduces 4kg of cement in preparing concrete mix. Nano silicon dioxide in concrete can increase the density, reduces porosity, and improves the bond between cement matrix and aggregates with higher compressive and flexural strength. Nano-SiO2 have been found to boost concrete workability and strength. It also Controls leaching of concrete and offers resistance to water penetration

E. Nano Technology in Wood

Wood is also composed of nanotubes or “Nano fibrils”; namely, lignocellulose (woody tissue) elements which are twice as strong as steel. Researchers have developed a highly water repellent coating based on the actions of the lotus leaf as a result of the incorporation of silica and alumina nanoparticles and hydrophobic polymers.

F. Nano Technology in Glass

Most of the glass used on the exterior surface of buildings to control light and heat in order to control the building environment and contribute to sustainability. Titanium dioxide (TiO2) is used as nanoparticle form to coat glazing since it has sterilizing and anti-fouling properties. Glass incorporating this self cleaning technology is available on the market today. Fire-protective glass is another application of nanotechnology. This is achieved by using a layer sandwiched between glass panels (an interlayer) formed of fumed silica (SiO2) nanoparticles which turns into a rigid and opaque fire shield when heated.

G. Nano Technology in Coating

Coating is an area of significant research in nanotechnology.Nanotechnology is being applied to paints and insulating properties, produced by the addition of Nano-sized cells, pores and particles. The TiO2 will break down and disintegrate organic dirt through powerful catalytic reaction.This research opens up the intriguing possibility of putting roads to good environmental use.

H. Nano Technology in Steel

Sandvik Nano flexTM is new stainless steel with ultra-high strength, good formability, and a good surface finish developed by Sandvik Nanoflex Materials Technology. Due to its high performance, Sandvik NanoflexTM is suitable for application which requires lightweight and rigid designs.MMFX2 is nanostructure modified steel, produced by MMFX Steel Corp, The MMFX2 steel could be an alternative because it has the similar corrosion resistance to that of stainless steel, but Due to high cost, the stainless steel reinforcement in concrete structure is limited in high risk environments.

IV. CONCLUSIONS

A. The construction business will inevitably be beneficiary of this Nano technology In fact it already is in the field of concrete , steel & glass and many more…

B. Concrete is made much stronger and more durable

C. Addition of Nano tio_2 Makes concrete having self cleaning capacity and It enhances the abrasion resistance of concrete. It also improves compressive and flexural strengths of concrete.

D. Addition of Nano alumina concrete provides early strength to concrete. This increase the elasticity modulus. It produces quick setting nature to concrete. It allows for fabrication at low temperatures, reducing energy consumption

E. Addition of Nano silicon dioxide in concrete can increase the density, reduces porosity, and improves the bond between cement matrix and aggregates with higher compressive and flexural strength. Nano-SiO2 have been found to boost concrete workability and strength. It also Controls leaching of concrete and offers resistance to water penetration

F. Steel is made tougher than conventional steel.

G. Glass is made of having self cleaning capability.

H. Paints are made more insulating and water repelling.

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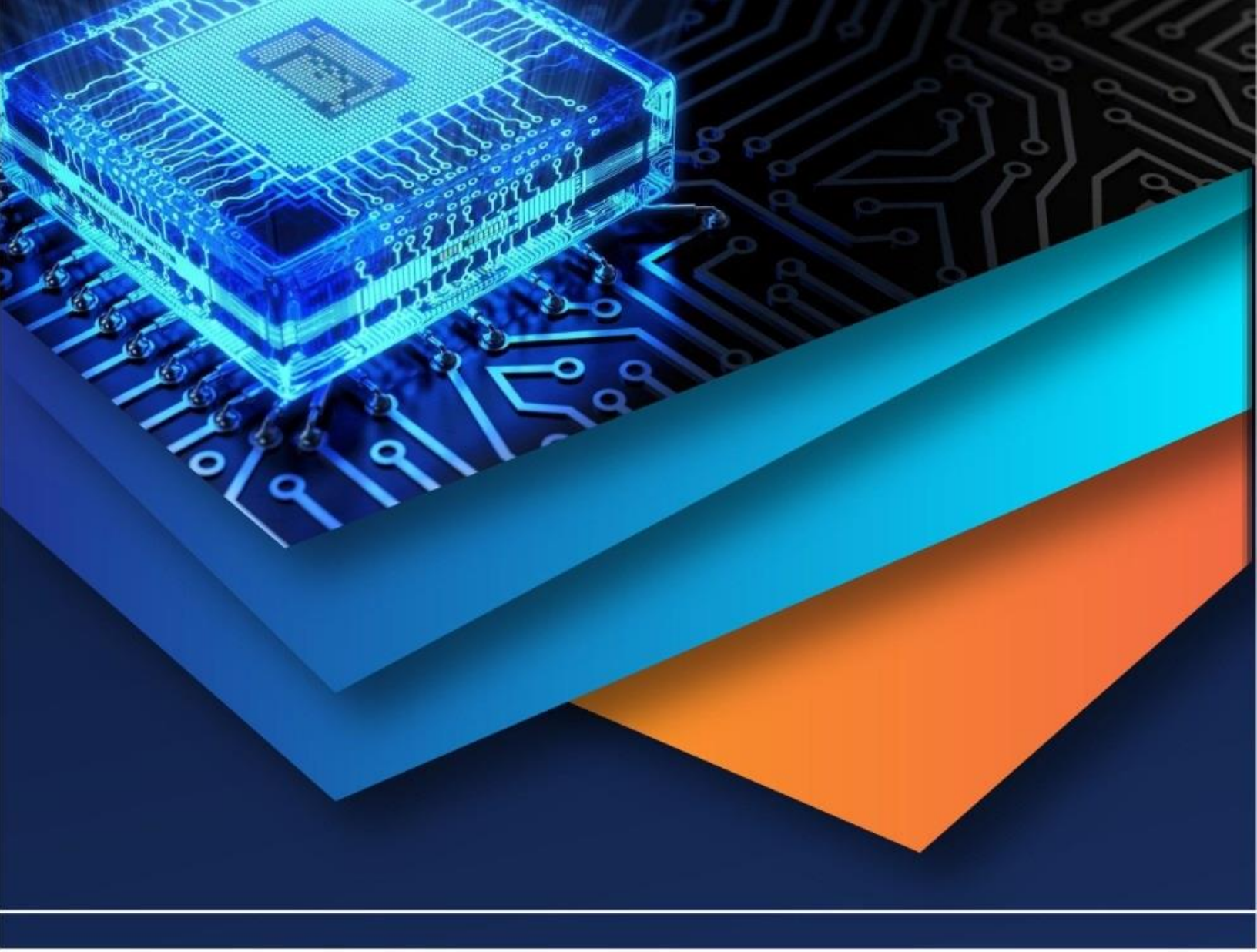

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