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Nanotechnology and Nanotech Materials in Civil Engineering

Arbaz Rahmany
Jamia Polytechnic,
New Delhi

***Abstract*- The development of nanotechnology in the material science is progressing rapidly. In last three decades, nanotechnology helped throughout globe to improve the performance of various fields like microbiology, medicine, electronic, chemical, and materials sciences. The objective of this paper is to presents the review and uses of nanotechnology in Civil Engineering. The paper also includes applications and properties with which construction materials could be more affective, durable and high performing by using nano-materials. Complex Structures made by Cement, Concrete and Steel can be made at nano-level to improve their performance. Using nanomaterials in construction will give lots of benefits such as behavior and mechanical properties like durability, skid resistance of pavement used in highway work can be improved. Furthermore structures made by nanomaterials give good aesthetics, glasses made by nanomaterials are self cleaning and improves many more properties. These materials are eco-friendly as well as minimize the global warming as the emission of Carbon Dioxide is very less. Structures made at nano-level will definitely change the new era of construction as there are fast and durable results with lesser effort.**

Keywords- Nanotechnology, Nanoparticles, Nanomaterials, Supramolecular, Threshold, Electro chromic Window, Sandvik nanoflex, MMFX₂ Steel

1. INTRODUCTION

1.1 Introduction to Nanotechnology

Before getting started we should learn what nanotechnology is. The word "Nano" is adopted from Greek Language which means dwarf. One Nanometer (abbreviated as nm) is equals to one Billion times of Meter or 10^{-9} meters. Generally, one nanometer is $\frac{1}{80,000}$ times of a human hair. Biologically, the Mycoplasma genus Bacteria is about 200 nm in length. Chemically, the spacing of Carbon-Carbon typical bond are in range 0.12 to 0.15 nm and diameter of double helix DNA is around 2 nm.

The manipulation of matter on an atomic, molecular and supramolecular scale is called as Nanotechnology. Description of nanotechnology was more established by National Nanotechnology Initiative. They define as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. Functional systems of materials are engineered at molecular scale in nanotechnology. The projected ability to construct items is referred by nanotechnology. The mentioned process is done through various techniques and tools which make the resultant products as complete and high performing. Varieties of devices are made in nanotechnology to produce nanomaterials. To build such materials we have to deal with atoms and molecules.

In simple words, using very small particles to create new large scale materials is called as nanotechnology. The particles are used either by themselves only or by manipulation. By following these processes nanomaterials are build and then these materials are used to improve the properties of construction materials.

1.2 Nanotechnology in early ages

Richard Feynman, a physicist and father of Nanotechnology, introduced the nanotechnology at first. During his lecture in 1959 named "There's Plenty of Room at the Bottom" he first discussed about nanotechnology and nanomaterials. But the term "Nanotechnology" was used by Norio Taniguchi in 1974. Later in 1986, K. Eric Drexler got inspired by Feynman's concept and wrote a book "Engines of Creation: The coming Era of Nanotechnology" in which he proposed an idea about nano-scale assembler. This device would be able to build a copy of itself and other items of arbitrary complex with atomic control.

1.3 Introduction to Nanomaterials

On 18 October 2011, the European Commission adopted the following definition of a nanomaterial: "A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and for 50% or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm – 100 nm. In specific cases and where warranted by concerns for the environment, health, safety or competitiveness the number size distribution threshold of 50% may be replaced by a threshold between 1 to 50%."

In ISO/TS 80004, nanomaterial is defined as the "material with any external dimension in the nano-scale or having internal structure or surface structure in the nano-scale". This includes both nano-objects, which are discrete pieces of material, and nano-structured materials, which have internal or surface structure on the nano-scale; a nanomaterial may be a member of both these categories.

In general words, Nanomaterials or Nanoparticles are nothing but the materials with morphological features on nano-scale that ranges from 1 to 1000 nm but generally 1 to 100 nm is taken. These particles can be in liquids or solids material. Those particles which have special properties stemming from nano-scale dimension are specially referred as nanomaterials. Nanomaterials have become the commercialized and began to emerge as commodities.

1.4 Classification of Nanomaterials

Nanomaterials can be classified mainly into two categories, Natural and artificially fabricated.

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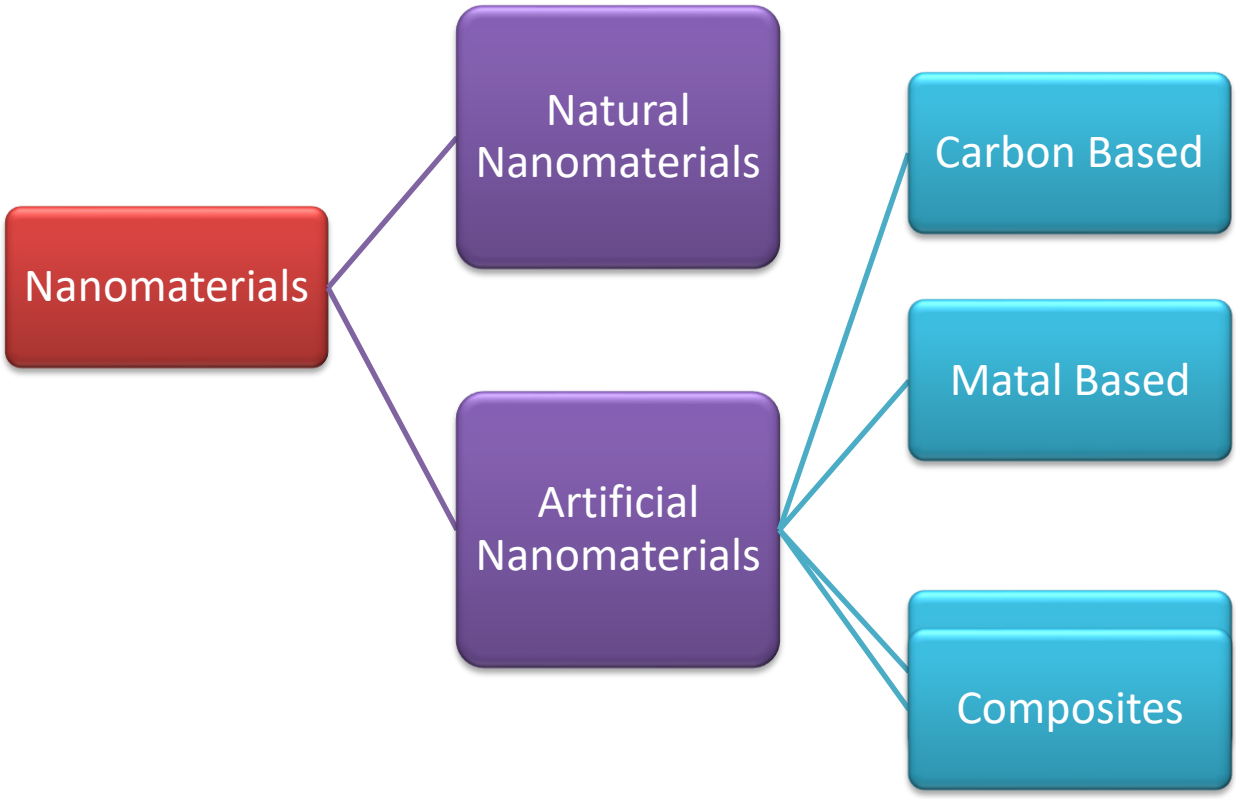

Fig. 1: Classification of Nanomaterials

1.4.1 Natural nanomaterials

Materials having biological systems

e.g. viruses (capsid), substances in our bone matrix, etc.

1.4.2 Artificial nanomaterials

These are the ones that are fabricated by different experiments. They can further sub-divided into 4 classes:

1.4.2.1 Carbon Based:

Carbon is the main content of these nanomaterials.

1.4.2.2 Metal Based:

These nanomaterials contains quantum dots, nanogold, nanosilver and metal oxides, such as titanium dioxide.

1.4.2.3 Dendrimers:

These are built from branched units. On the surface of Dendrimers there are number of chains present. These chains can be made to perform different chemical properties.

1.4.2.4 Composites:

Two or more than two nanoparticles are combined together to get composite nanomaterial

1.5 Properties of nanomaterials

Following are major three properties of nanomaterials

1.5.1 Magnetic properties

Nanoparticles have magnetic property that is helpful in imaging, bio-processing as well as in refrigeration.

1.5.2 Optical properties

Changing in color and functional properties falls in category of optical property. Many metals and semiconductors show the optical property.

1.5.3 Electronic properties

Owing to reduction in system length, changes occur in electron which results in change in electronic properties like scarcity of scattering centers.

1.6 Commonly used nanomaterials in Civil Engineering

These are some names of nanomaterials which are generally used in various fields such as Construction, Medicine, Chemistry and Environment, Energy, Automobile Industries, Agriculture, Information and Communication, Heavy Industries, Consumer Goods, Telecommunication etc.

- Carbon Nanotubes
- Iron Nanoparticles
- Copper Nanoparticles
- Silver Nanoparticles
- Aluminium Oxide Nanoparticles
- Zinc Oxide Nanoparticles
- Zirconium Oxide Nanoparticles
- Silicon Dioxide Nanoparticles
- Titanium Dioxide Nanoparticles
- Wolfram Trioxide Nanoparticles etc

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Now, let's discuss each nanomaterial briefly

1.6.1 Carbon Nanotubes (CNTs)

Carbon nanotubes are in the shape of hollow cylinder made up of carbon atoms having two dimensional hexagonal lattices. As they structurally belong to fullerene family therefore they show the extraordinary strength, unique electrical properties, and thermal conductivity. They are also durable mechanically and have crack preventing ability that's why it can be used in concrete. Their enhanced mechanical and thermal properties can be used in ceramics. They are five times stronger than Young's modulus and eight times stronger than steel.

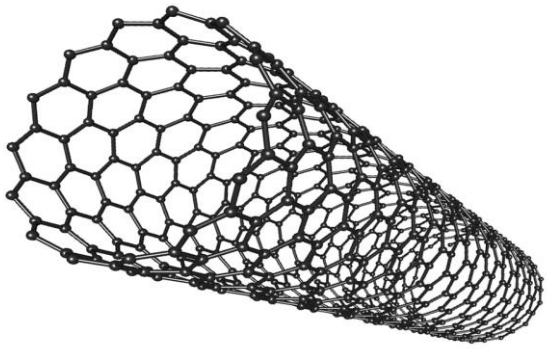

Fig. 2(a) Structure of Carbon Nanotube

Fig. 2(b) Carbon Nanotubes

1.6.2 Iron Nanoparticles

Iron Nanoparticles are sub-micrometer particles of iron metal. They are highly reactive as they have large surface area. Their particle size ranges from 1 to 100 nm.

Iron Nanoparticles are mostly used for degradation of contaminants present in Environment such as Chlorinated Organic Solvents, Organochlorine pesticides, Polychlorinated Biphenyls and Organic Dyes. In concrete, they increase compressive strength and abrasion resistance.

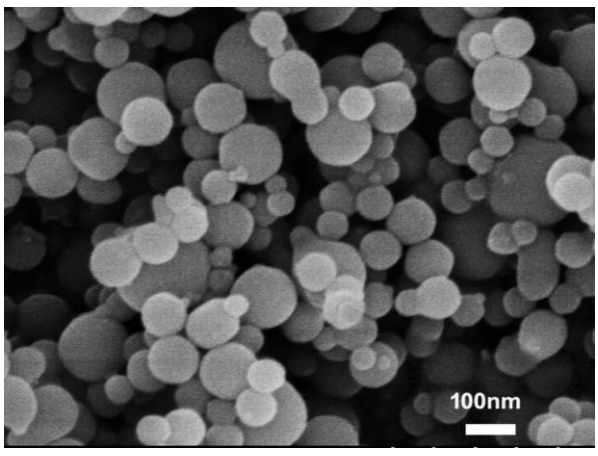

Fig. 3(a) Structure of Iron Nanoparticles

Fig. 3(b) Iron Nanopowder

1.6.3 Copper Nanoparticles

Copper Nanoparticles are particles of copper metal at nano-scale range of 1 to 100 nm. They can be formed naturally or by chemical synthesis like other nanoparticles.

They are useful in welding work and formability in steel. They also show resistance against corrosion.

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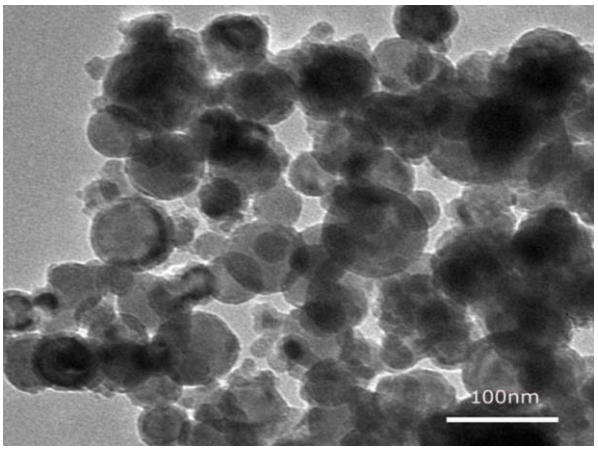

Fig. 4(a) Structure of Copper Nanoparticles

Fig. 4(b) Copper Nanopowder

1.6.4 Silver Nanoparticles

Silver Nanoparticles are powdered particles of Silver having the dimension ranges from 1 to 100 nm. Silver nanoparticles have long lasting resistance against bacteria as compared to bigger silver particles. Due to Silver particles it gives good aesthetic look when used in coatings and paints.

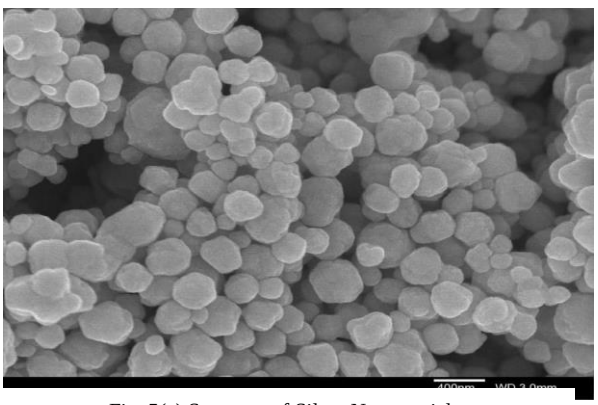

Fig. 5(a) Structure of Silver Nanoparticles

Fig. 5(b) Silver Nanopowder

1.6.5 Aluminium Oxide Nanoparticles (Al_2O_3)

Aluminium Oxide Nanoparticles are the particles of alpha aluminium oxide nano-powder that range from 40 nm to 10 μm.

In addition in concrete, Aluminium Oxide Nanoparticles can improve the split tensile strength and flexural strength. Depending upon the area of surface reaction, the pezzolanic reaction occurs. In concrete, it can replace cement upto 2%.

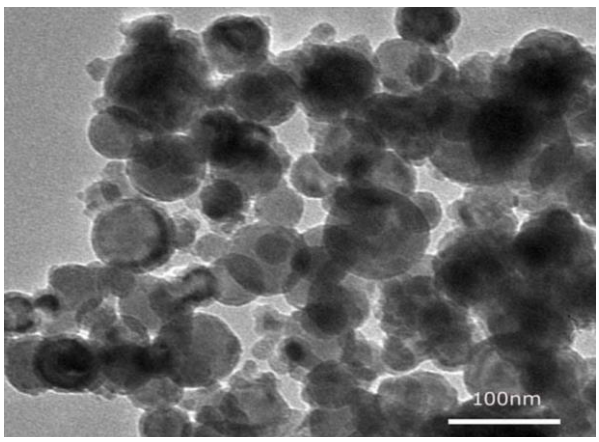

Fig. 6(a) Structure of Aluminium Oxide Nanoparticles

Fig. 6(b) Aluminium Oxide Nanopowder

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1.6.6 Zinc Oxide Nanoparticles (ZnO)

Zinc Oxide Nanoparticles are the nanoparticles having diameter less than 100 nm. They are basically semiconductors with energy gap of 3.37eV at room temperature. Zinc Oxide Nanoparticles are also piezoelectric materials.

Zinc Oxide Nanoparticles can be added into different Civil Engineering materials like cement, ceramics, glass, plastic, rubber, adhesives, sealant, pigments and fire resistant materials.

Zinc Oxide Nanoparticles, when added to cement, improves processing time as well as resistance of concrete against water.

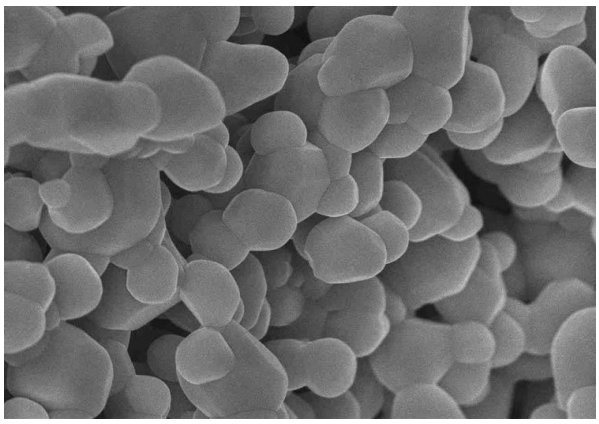

Fig. 7(a) Structure of Zinc Oxide Nanoparticles

Fig. 7(b) Zinc Oxide Nanopowder

1.6.7 Zirconium Oxide Nanoparticles (ZrO_2)

Zirconium Oxide Nanoparticles are powder shaped nanoparticles of Zirconium having diameter of 5 to 100 nm. Their surface area is high (25 to 50m^2/g).

As it looks white in color so it is beneficial to aesthetics. Also, they show hardness, flexibility, durability, chemical resistance and are very good insulators.

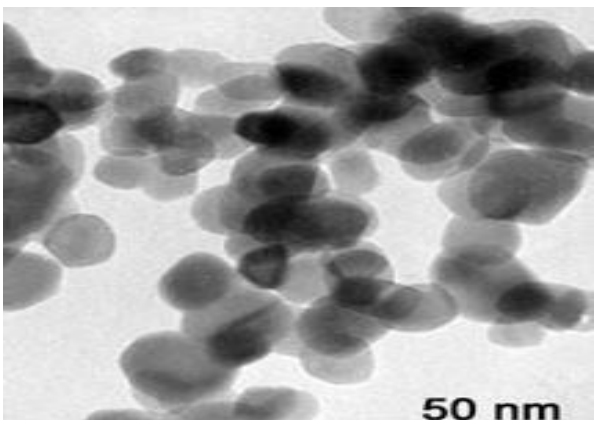

Fig. 8(a) Structure of Zirconium Oxide Nanoparticles

Fig. 8(b) Zirconium Oxide Nanopowder

1.6.8 Silicon Dioxide Nanoparticles (SiO_2)

Silicon Dioxide Nanoparticles or silica powder or nano-silica is the powdered shaped material which contains fly ash.

As they contain fly ash particles, they significantly increase the compressive strength by filling the voids between large fly ash particles and cement particles. Setting time of mortar, bleeding and segregation in concrete can be decreased by improvement in cohesiveness.

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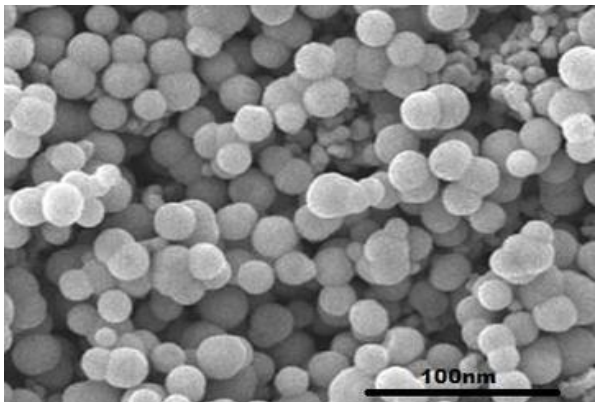

Fig. 9(a) Structure of Silicon Dioxide Nanoparticles

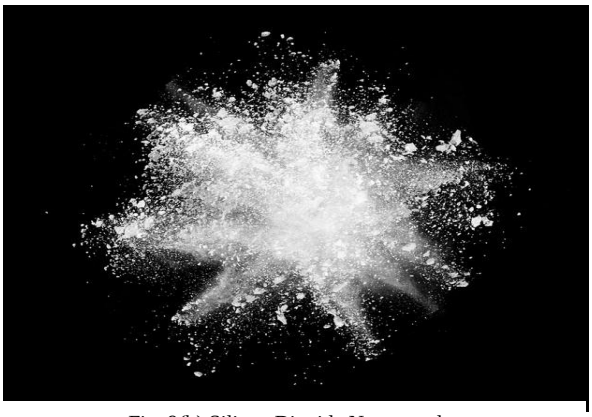

Fig. 9(b) Silicon Dioxide Nanopowder

1.6.9 Titanium Dioxide Nanoparticles (TiO_2)

Titanium Dioxide Nanoparticles are white pigments with sterilizing properties. It can be used as an additive in cement, concrete, window glasses and paints.

They show better abrasion resistance as compared to Silicon Dioxide Nanoparticles. They have self cleaning property because of hydrophilic nature. They also show rapid hydration property and increased degree of hydration therefore it is beneficial to use them in concrete. Being anti-fogging and fouling resistant, they can be used in glass window.

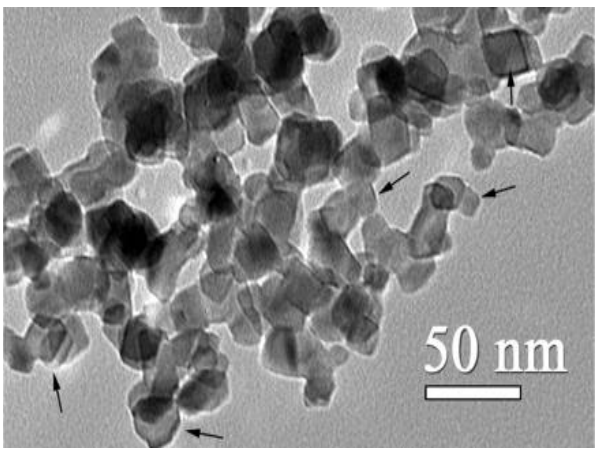

Fig. 10(a) Structure of Titanium Dioxide Nanoparticles

Fig. 6(b) Titanium Dioxide Nanopowder

1.6.10 Wolfram Trioxide Nanoparticles (WO_3)

Wolfram Trioxide Nanoparticles or Tungsten Trioxide is a yellow powder having the spherical morphology. Due to its rich yellow color, it is used as pigment in ceramics and paints.

These are used in electro chromic windows (commonly known as Smart windows). These windows have electric operated switchable glasses which allows user to control the intensity of passing light through window.

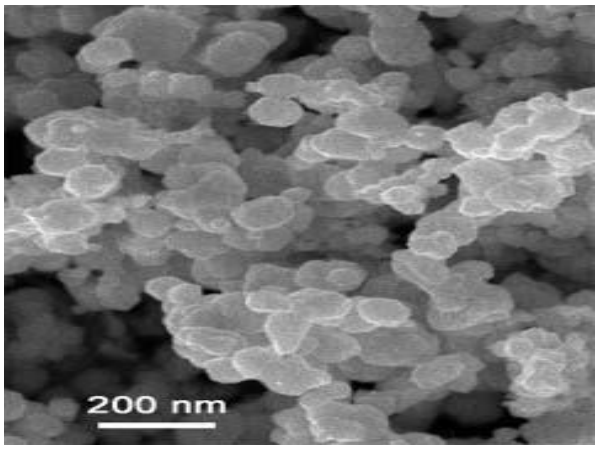

Fig. 11(a) Structure of Wolfram Trioxide Nanoparticles

Fig. 6(b) Wolfram Trioxide Nanopowder

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2. INTRODUCTION OF NANOTECHNOLOGY IN CIVIL ENGINEERING

Civil Engineering does not only mean construction of residential buildings, it have to deal with a lots of fields such as construction of Roadways, Bridges, Canals, Tunnels, Traffic Systems, Public transportations and other structures that operate on large scale. These fields require special treatment from Earthquake, Winds, Massive Public Movement and even Military strikes. By using nanotechnology, these structures can be strengthened. Nanotechnology can be applied to build lighter but stronger structural composites. Nanotechnology have the property of 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. These reasons are strong enough for nanotechnology to be beneficial for construction industry.

2.1 Improvement of Construction Materials using Nanotechnology

Civil Engineers have to deal with many construction materials such as cement, concrete, steel, wood, glass etc. They also have to go through different construction processes like structural monitoring, painting, coating, thermal insulation, fire protection etc. these materials and techniques require some standard time to achieve their particular strengths. By adaptation of nanotechnology these processes can be enhanced by means of strength and performance.

2.1.1 Improvement of Cement using Nanotechnology (Nano Cement)

Cement is a basic and must material for construction. As civil engineer we all know that the cement is a binding material commonly used to cast concrete. Portland cement is most commonly used cement. Lime stone, shells and chalk or marl combined with shale, clay, slate, blast furnace slag, silica sand and iron ore are the common materials to manufacture cement. Although particles of cement are very small but they are not at nano level that is why we can not get 100% result. Studying cement at nano level, best results can be achieved.

There are two ways from which performance of cement can be improved. Particles of cement either can be reduced to nano-level or some nanomaterials like carbon fiber, carbon nanotubes can be added to cement. Latest researches found that Carbon Nanotubes give better results than Carbon Fiber. As discussed in 1.5.1, CNT have various properties like extraordinary strength, thermal resistivity, durability and crack prevention, therefore it is very beneficial to use CNTs as an additive in cement. Also dimension of CNT varies from 0.25 to 25nm hence their particles will fill the voids between large sized cement particles and will provide better strength.

2.1.2 Improvement of Concrete using Nanotechnology (Nano-Crete)

As we all know, Concrete is a mixture of cement, fine aggregate (sand), course aggregate mixed with water which hardens with time. Concrete have some major properties like Mechanical Strength, Compressive Strength, Durability, Porosity, Density, Thermal and acoustic insulation. These properties can be improved by nanotechnology and nanomaterials.

Nano-silica (SiO_2) densifies the micro and nanostructure of Concrete. This results in improvement of mechanical properties of concrete. Nano-silica has the property to control degradation of fundamental Calcium-Silicate-Hydrate (C-S-H) reaction of concrete caused by calcium leaching in water penetration, therefore leads to improve durability. Nano-silica can also be used for pre-existing concrete structures. Fiber sheet (also known as Matrix) containing nano-silica along with hardeners, penetrate in small cracks and fills them. Fiber Sheet forms very good bond between surfaces of concrete and fiber reinforcement, resulting in improvement of particle packing in concrete and gives very good strength.

Titanium Dioxide (TiO_2) is also a nanomaterial used for improved performance of concrete owing to its property to break down the organic pollutants, volatile organic compounds and bacterial membrane via catalytic reactions. It can therefore reduce airborne pollutants. In like manner, TiO_2 have self-cleaning property, for this reason they attract and make sheet of rainwater to the concrete surface and then this sheet collect the pollutants as well as dirt particles and washes them off. This result the concrete surfaces clean and good aesthetically as they remain the concrete surface white.

Carbon Nanotubes (CNTs) can also be used for health monitoring and damage detection of concrete as they improve compressive strength. Adding CNT in cement can give better void filling thus better concrete can be casted.

2.1.3 Improvement of Steel using Nanotechnology (Nano Steel)

Steel plays an important role in construction. Steel can be used as reinforcement in concrete or fully steel structure can also be constructed. Fully steel structure faces fatigue problem. This leads the structure failure if steel is loaded in cycle loading manner. Fatigue problem occurs in case of bridges, towers and off-shore platforms where the stresses are lower than the yield stress. This problem can be covered using copper nanoparticles as they make the surface of steel flat by reducing unevenness. Copper nanoparticles limit the number of stress risers which causes reduction in fatigue.

Steel structural members are often joined by bolts. Steel bolts may fail when the tensile strength of tempered martensite steel increases above 1200MPa. After this much tensile strength, very small amount of hydrogen embrittles the gain boundaries. This phenomenon is known as delayed fracture and it can cause the steel failure during use. High strength bolts usually falls under this phenomenon. It can be limited by use of Vanadium and Molybdenum nanoparticles. These nanoparticles are reduces the embrittlement of hydrogen which directly is responsible for steel bolt strengthening. They limit their strength in between 1000 to 1200MPa.

Another problem faced by steel structure is corrosion. There are two nanomaterials available in market

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named Sandvik Nanoflex and $MMFX_2$ steel. These two nanomaterials have the ability to resist corrosion. By addition of these two nanomaterials, corrosion-less structure can be constructed.

2.1.4 Improvement of Wood using Nanotechnology (Nano Wood)

Wood is also an important material for construction. Wood can be fully used for construction of houses in villages specially. Woods are mainly preferred in construction of doors and windows. Wood is a major construction material in case of Timber Dams. Although they are temporary dams but the required strength to hold the water is must. As we all know that wood is much weaker material than concrete and steel. It can be strengthen by addition of nanoparticles. As discussed in 1.5.5 about Al_2O_3 and in 1.5.8 about SiO_2. These two nanoparticles are water repellant therefore can be used as coating in wooden work. Water makes wood weak when it gets penetrated. By coating of Al_2O_3 and SiO_2, woods become water repellant so water will not get a chance to be penetrated resulting the structure more strong and durable.

2.1.5 Improvement of Glass using Nanotechnology (Nano Glasses)

Using glasses in construction is increasing day to day. In last two decades, glasses were used in windows and doors but nowadays construction of fully glassed structure are getting popular. From this point it can be concluded that there should be improvement in glasses as they are brittle material. Improvement can be done through nanotechnology.

Glasses are generally used in exterior of a building which makes it look good. Using glass, in exterior, has to face light and heat majorly. Sometimes heat can break the glasses. This is why fire-protective glasses are needed. It can be made using SiO_2 nanoparticles. Fumed Silica is sandwiched between two glass panels. This will make the glass fire protective. As far as light is concerned, it can be controlled using Tungsten Trioxide nanoparticles. *(Refer section 1.6.10)*

2.1.6 Improvement of Coatings using Nanotechnology (Nano Coatings)

Coating is nothing but a covering applied on the surface of any object for decorative or functional or both the purposes. Coating is mainly done to reduce corrosion, as protective barriers against abrasion, ingress of harmful chemical attack, hydro-thermal variations, to change the electrical properties of metals and for good aesthetics.

The process of coating can also be improved through nanotechnology. One of the nanomaterial discussed in 1.5.9 i.e. TiO_2, have the some properties to improve the coating work. They can enable the self cleaning property and can enhance the abrasion resistance. TiO_2 coatings are used in roadways. By capturing organic and inorganic air pollutants, TiO_2 may help in putting roads to good environment.

Furthermore, many new materials along with techniques are being developed to improve coatings at nanometer scale so that they can increase its durability and reduce heat of friction.

2.2 Nanotechnology in Construction processes

Public safety is preferred over any factor in construction. To build safe structure, Civil Engineer must have to follow some construction processes. Using nanotechnology in the process may aid to build better structures. By the use of some nanoparticles, problems like thermal insulation can be reduced. Also there will be more safety from fire and bacterial attacks on structures.

Many processes can be upgraded using nanoparticles are discussed as below:

2.2.1 Process of Thermal Insulation using Nanotechnology

Bodies having different temperature exchange their temperature with each other. Reduction in heat transfer between two or more objects is nothing but thermal insulation. In Civil Engineering many construction materials like concrete, steel, clay etc have the property to absorb heat. They absorb sunlight and transfer heat to the room. This causes rise of room temperature which is not good for human health. With nanotechnology, thermal insulation can be achieved by the help of some specially engineered nanomaterials.

There is a nanomaterial named Nanoporous Silica Aerogel has the property of low thermal conductivity, good compressive strength, light weight, fire protection anti-fungal, low shrinkage ability, sound proof, non-toxicity, non-corrosive and eco-friendly. Owing to thermal insulation they can be used in construction so that reduction in heat transfer can be achieved.

2.2.2 Process of Fire Resistance using Nanotechnology

Fire is another problem for construction safety. Structures should be constructed in such a way that it should resist fire. In that way accidents caused by fire can be avoided.

Researches conclude that nano-cement (*refer section 2.1.1*) have some properties including thermal resistance so it can be used as fire resistance material as well as coating on steel structure as steel absorbs more heat. Nano-cement is made by mixing CNTs therefore it is durable, fire protective as well as crack preventing. Other than CNTs, there is nanomaterial called Polypropylene which can also be used as fire resistive material because they also have property to prevent structures from fire. Also it is cheaper process than conventional materials used for fire resistivity.

2.2.3 Process of reducing Bacterial Attack using Nanotechnology

Bacteria and fungi are one of the main reasons for degradation of construction materials. Their growth can also affect on human health. For these reasons Civil Engineers must take strict action on it.

With the help of TiO_2 powder, the bacterial attack can be minimized because TiO_2 powder has the property to destroy bacteria and termites. Within 1 to 2 hours it destroys all the bacteria. This will lead to healthy

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constructions. Researches have proved that the powder having low particle diameter is more affective. Best results can be achieved with the addition of 0.01 and 10 mg/ml concentrated TiO_2.

2.2.4 Process of Structural Health Monitoring using Nanotechnology

Structural Health Monitoring means observation of damages and its conditions periodically. It can be done by Nano and Micro Electrical Mechanical System (MEMS). This process involves monitoring and control environment conductor and material performance. Concrete may absorb moisture, humidity, heat or can show early age strength, corrosion and cracking. Controlling these can be mess sometimes that's why nanotechnology is needed here. These can be monitored using low cost piezoceramic based, multi-functional devices.

2.3 Nanotechnology in Various Fields of Civil Engineering

As we have discussed many nanoparticles, their properties and construction materials which can be modified by nanomaterials to improve in construction methods. Now we will see how these materials can be beneficial in various streams of Civil Engineering.

2.3.1 Nanotechnology in Transportation Engineering

Planning, functional design, operation and management of facilities for any mode of transportation (roadways, railways, waterways, airways etc) are called as Transportation Engineering. Applying technology with scientific principles to provide safe, rapid, efficient, convenient, comfortable, economical as well as environmentally compatible movements to the said aspects are included in Transportation Engineering.

As discussed in nano-steel (refer *section 2.1.3*) and copper nanoparticles (refer *section 1.6.3*), about properties of Cu-nanoparticles have ability to control steel fatigue problem therefore it can be used in steel bridges. Apart from Cu-nanoparticles, TiO_2 are widely used in roadway construction due to their self cleaning property and enhanced abrasion resistance. It provides healthy environment to roadways.

2.3.2 Nanotechnology in Geotechnical Engineering

Geotechnical Engineering is concerned with behavior of earth materials. It uses principle of soil and rock mechanics so that the investigation of subsurface condition as well as material can be done in means of their physical and chemical properties.

By using nanotechnology, problems related to soil like controlling their size, distribution of size, composition, shape, surface chemistry and manipulating their assembly can be modified and can be used like we want. This can be done through nanoscale building blocks. Many researches proved that using nanotechnology can improve the soil properties like silica nanoparticles can improve consolidation, permeability and strength. Also CNTs can be used as voids filler material so that the soil can have more compaction. In this way compressive strength can be improved.

2.3.3 Nanotechnology in Water Resource Engineering

Study of planning and management of facilities constructed for making canals, sewers and to avoid water-logging along with multiple issues related with usage and control of water is called as Water Resource Engineering. It generally deals with provision of water for human use and the development of techniques for the provision of destruction from flood.

Water purification can also be dealt in Water Resource Engineering. It can be done by more accurate and easy way using nanoparticles. CNT and Al_2O_3 (*refer Section 1.6.1 and 1.5.5*) can be used for nano-filtration. Adsorption of chlorine is much higher is case of nano-filtration using nanoparticles than the conventional filtration method. TiO_2 nanowires and palladium nanoparticles are used to detect contaminants, removal of sediments, chemical effluence, charged particles, bacteria and other pathogens (*refer section 1.6.9 and 2.2.3*).

3. CONCLUSION

From the introduction of nanotechnology, nanomaterials and nanoparticles, one can conclude its importance in modern era. Nanotechnology, based on this review, can be used as an addition to some construction materials to enhance their basic properties. Briefly, it can be understood that nanotechnology is very beneficial to many fields specially Civil Engineering. Vast amount of enhancement can be applied to many construction materials to improve their quality and solve many issues related to Civil Engineering. Nanotechnology can be used not only in construction material but also in various equipments and construction techniques as well as various fields of Civil Engineering. Nanotechnology is the key to develop a smart and brand new world. Although this field is still in underdevelopment and many more researches are needed so that projects can be made sustainable, save energy, reduce usage and avoid damages to environment.

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