

Future of Sustainable Concrete Through Nanotechnology

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Abstract-Sustain development of concrete technology is the need of hour for civil industry and nanotechnology which is one of the popular developments of recent technologies significantly provides a lot of scope of development for improving sustainability. Cement based materials at the nano scale improves the functionality of concrete. This paper aims at using nano sized particles in order to improve the properties of cement based materials. It also focuses on the concept of sustainable construction.

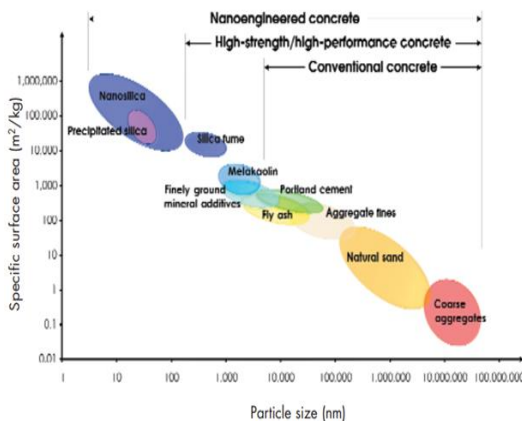
Keywords :- Nanotechnology, Sustainable Construction, Cement Based Materials ,Nano-Sized Material Particles

1. INTRODUCTION

“There’s plenty of room at the Bottom.” It was the first time nanotechnology was introduced by famous noble prize awardee, physicist Richard Feynman at the lecture held in 1959[1]. Nanotechnology is referred as manipulating and controlling matter at the atomic level i.e. on the nanoscale (from 0.1 nm to 100 nm). One nanometer is the billionth of a meter[2]. Size of particles in nanotechnology plays a key role as the nanometer sized particles leads to change in the properties of materials dramatically. When the dimensions of a material are reduced to nano-size, there are significant changes in the mechanical properties, chemical reactivity, conductivity, optical absorption etc. Nano-materials are

2. NANOTECHNOLOGY & CHANGE

Nanotechnology has provided various advantages such as the ability to observe the structure at the atomic level as well as measure the strength & hardness of nanometer sized composite materials.[5]



expected to improve the environmental effects such as reducing toxicity, carbon – emissions to a great extent.

Sustainable development is the call of the hour. Sustainable development is the development that meets the needs of the present without comprising the ability of future generation to meet their own needs. [3] Concrete is widely used basic materials for all types of constructions. Concrete consumes large amount of energy as well as emits carbon dioxide due to the huge production of cement. Thus it has effected on environment and ecology of our planet in an adverse way. Emissions of green house gas are a concern as it leads to global climate change. [4]

In order to solve this major problem several studies have been made to use nanotechnology in order to find an alternative for cement or sand.

Several studies have been conducted to implement nanotechnology in the field of cement based materials so as to solve this problem. Attempts have been made to substitute cement or sand as their increased use affects the environment .This paper focuses on the used raw materials in nanoscale to improve the properties of the cement based materials and highlighting the role of nano technology in sustainable construction of building.

The above figure shows how nanopowders having specific surface area, affects the surface energy & morphology.

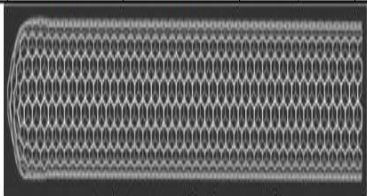
This in turn has a new class of nano-engineered polymers who are high efficient super plasticizers that can be used for concrete & high strength fibers. Nanoparticles such as silica when added to polymer & concrete develops high performance & self compact concrete with enhanced workability, strength, ductility & super plasticity behavior.

3. NANOTECHNOLOGY IN CONCRETE TECHNOLOGY

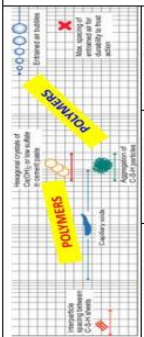
Recent studies have shown that mechanical strength increase as well as water-cement ratio has reached to a stressed level which is to the limit. Therefore in order to improve the characteristics and sustainable concrete with enhanced properties, nano modification has opened up new dimensions of development. It is found that tensile strength of nano tubes is about 40 times that of steel fibre & their elasticity modulus is 5000 times that of steel. Hence nano

modifications can significantly improve the surface properties, specific surface phase, high surface area etc. In case of concrete-polymer composites, it is found that if 10% of micro-polymers are added then polymers help in bridging the cracks and tensile strength obtained is 10 Mpa. If 1% of polymer is used, 15 MPa of tensile strength is obtained. It shows the effectiveness of adding nano polymers.[2]

	Structure	D	E, GPa	f _t , GPa
Carbon nanotube	graphite	nm	1 000	60
Steel fibre	Fe	mm	0,2	1,5



atomic structure of carbon nanotube

Structural level of intervention	Micro-structure	Polymer content, P/C, %	Tensile strength f _t , MPa	Mechanism
	macro No polymers	0	2,5	Cracking
	micro Polymers	10	10	Polymer bridging cracks
	nano Polymers	1	15	Polymer bridging cracks C-S-H sheets

4. NANO-MATERIALS IN CONSTRUCTION INDUSTRY

Recent research results have focused on improvement of strength, durability, toughness, flexural strength tensile of cement based materials. Using nano-cement in concrete mix causes modification and increases its effectiveness. Addition of copper nano-particles reduces the unevenness of steel. Vanadium & molybdenum nano particles enhance the fracture problems. Adding TiO₂ in nano form to glass

improves the self-cleaning, sterilizing and anti-fouling properties. Nano-meter thick coatings protect the concrete from corrosion, chemical reactions. Smart nano dust sensors can be used as wireless sensors in concrete mix can be used for studying the density, viscosity, moisture content etc. Nano SiO₂, Al₂O₃ can be used to improve the strength and performance of concrete.[6&7]

Adding nano-silica to concrete increases viscosity of concrete mix and fills in the voids between the cement based particles. Production of Calcium Silicate Hydrate controls all mechanical & strength properties. It also improves the hydration of cement due to high surface area of nanoparticles.

5. CONCLUSION

The growing concern over Carbon dioxide emissions, global warming & ecological changes. This Nanotechnology in turn affects our environment and plays a significant role in saving energy, reducing resource as well as improve sustainability of construction of building materials. Nanotechnology still has a lot of scope that needs to be explored before its full fledged application for constructional purposes. Sustainability is the major requirement of concrete & nano –technology is the future of concrete technology.

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