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An Study Report on Nanomaterials for Concrete Technology

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Abstract-
Concrete is a macro- material strongly influenced by its nano-properties. The addition of nano-silica (SiO2) to cement based materials can control the degradation of the calcium-silicate hydrate reaction caused by calcium leaching in water, blocking water penetration and leading to improvements in durability (Mann, 2006).Nano-sensors have a great potential to be used in concrete structures for quality control and durability monitoring (to measure concrete density and viscosity, to monitor concre curing and to measure shrinkage or temperature, moisture, chlorine concentration, pH, carbon dioxide, stresses, reinforcement corrosion or vibration) Carbon nano tubes increase the compressive strength of cement mortar specimens and change their electrical properties which can be used for health monitoring and damage detection The addition of small amounts (1%) of carbon nano tubes can improve the mechanical properties of mixture samples of portland cement and water. Oxidized multi- walled nano tubes show the best improvements both in compressive strength and flexural strength compared to the reference samples
Key Words: *Nanomaterials: Nanotechnologies, Structural Behavior, Construction.*

I. INTRODUCTION

Nano materials can be defined as those physical substances with at least one dimension between..150 nm (1 nm - 10-9 m). The nano materials properties can be very different from the properties of the same materials at micro (10-6 m) or macro scale (10-6.. 10-3 m). The nano science represents the study of phenomena and the manipulation of materials at nano scale and is an extension of comman sciences into the nano scale. The nanotechnologies can be defined as the design, characterization production and application of structures, devices and systems by controlling shape and size at the nana scale. Nanotechnology requires advanced imaging techniques for studying and improving the material behavior and for designing and producing very fine powiders, liquids or solids of materials with partice size between 1 and 100 nm, known as nano particles.

Nano materials

Nanomaterials can be defined as those physical substances with at least one dimension between ..150 nm (1 nm-10-9 m). The nanomaterials properties can be very different from the properties of the same materials at micro (10-6 m) or macro scale (10-6...10-3 m). The nano science represents the study of phenomena and the manipulation of materials at nano scale and is an extension of commen zation sciences into the nano scale. The nanotechnologies can be defined as the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nano scale. Nanotechnology requires advanced imaging techniques for studying and improving the material behavior and for designing and producing very fine powders, liquids or solids of materials with particle size between 1 and 100 nm, known as nanoparticles [4]. Currently, the use of nanomaterials in construction is reduced, mainly for the following reasons: the lack of knowledge concerning the suitable nanomaterials for construction and their behavior; the lack of specific standards for design and execution of the construction elements using nanomaterials; the reduced offer of nano products, the lack of detailed informations regarding the nano products content; high costs: the unknows of health risks associated with nanomaterials. In order to be able to use in the construction industry the nanomaterials at wide scale it is necessary that the researches to be conducted following the next stages the choice of nanomaterials with potential use in construction and the study of their characteristics, the behavior stody of the building elements that contain nanomaterials under various loads the development of specific design and construction standards. This paper is part of the first stage of research and represents a synthesis of nanomaterials proper to be used in construction

Nano material for Construction

Because the size of the particles is a critical factor, the material properties significant differ at the nano scale from that at larger scales. Physical phenomena begin to occur differently below the boundary limit: gravity becomes unimportant, electrostatic forces and quantum effects start to prevail in the same time, the proportion of atoms on the surface increases relative to those intide, creating so-called "an efect". All these nano-properties actually affect the materials behavior at macro-scale and, from this point, the power of nanotechnology is emphasized. If the elements are proper manipulated at the Bul inst Polit. Tai, t. LVII (LX), f. 4, 2011 111 rano scale, the macro-properties are affected and new materials and processes can be developed [3] In what follows the most important nanomaterials with potential use in construction are presented

The Carbon Nano tubes

Carbon nano tubes 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 nano tube) or more than one wall (multi walled nano tube) [7]. Nano tubes 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 nano tubes are mechanical durability and crack prevention in concrete, enhanced mechanical and thermal properties in ceramics and real-time structural health monitoring capacity [5].

Titanium Dioxide Nanoparticles (TiO2)

The titanium dioxide nanoparticles are added to concrete to improve properties. This white pigment is used as an its excellent reflective coating or added to paints, cements and windows for its sterilizing properties. The titanium dioxide breaks down organic pollutants, volatile organic compounds and ranes through powerful photo catalytic reactions, reducing air pollutants when it's applied bacterial membranes to outdoor surfaces. Being hydrophilic gives self cleaning properties to surfaces to which it is applied. because the rain water is attracted to the surface arid forms sheets which collect the pollutants and dirt particles previously broken down and washes them off. The resulting concrete surface has a white colour that retains its whiteness very effectively [5]

Silicon Dioxide Nanoparticles (SiO2)

Nano-SI02 could significantly increase the compressive strength of concretes containing large fly ash volume at early age, by filling the pores between large fly ash and cement particles. Nano-silica decreases the setting time of mortar when compared with silica fume (microsilica) and reduces bleeding water and segregation by the improvement of the cohesiveness [7].

Zinc Oxide Nanoparticles (ZnO)

Zinc oxide is a unique material that exhibits semiconducting and piezoelectric dual properties. is added into various materials and products, including plastics, ceramics, glass, cement, rubber, paints adhesive, sealants, pigments, fire retardants. Used for concrete manufacturing. ZnO improves the processing time and the resistance of concrete against water [1

Silver Nanoparticles (Ag)

The nano silver will affect, in contact with bacteria, viruses and fungi, the cellular metabolism and inhibit cells growth. The nano silver inhibits multiplication and growth of bacteria and fungi, which causes infection, odour, itchiness and sores. The core technology of nano silver is the ability to produce particles as small as possible and to distribute these particles very uniformly. When the nanoparticles are coated on the surface of any material, the surface area is increasing several million times than the normal silver foil. 26 Aluminum Oxide Nanoparticles (A1203)

Alumina (A1203) component reacts with calcium hydroxide produced from the hydration of calcium silicates. The rate of the pazzolanic reaction is proportional to the amount of surface area available for reaction. The addition of nano-A1203 of high purity improves the characteristics of concretes, in terms of higher split tensile and flexural strength. The cement could be CPCA04000 15

0kv.mm 50.0k DCIM) advantageously replaced in the concrete mixture with nano-A1203 particles up to maximum limit of 2.0% with average particle sizes of 15 nm, the optimal level of nano- A1203 particles content being achieved with 1.0% replacement [6].

Zirconium Nanoparticles (ZrO2)

Zirconium oxide (or Zirconia) nano powder or nanoparticles are white high surface area particles with typical dimensions of 5...100 nanometers and specific surface area in the 25...50 m2/g range. Nano zirconium

shows good aesthetics (translucency), superior physical resistance (hardness, flexibility, durability), chemical resistance (practically inert) and is a very good insulator Wolfram (Tungsten) Oxide Nanoparticles (WO3).

Wolfram (Tungsten) Oxide Nanoparticles (WO3)

In recent years, tungsten trioodde has been employed in the production of electro chromic windows, or smart windows. These windows are electrically switchable glass that change light transmission properties with an applied Bul. Inst. Polit. lai, t. LVII (LXI), f. 4, 2011 113 voltage. This allows the user to tint their windows, changing the amount of heat or light passing through [2].

Nanotechnologies for Construction

Nanotechnology can generate products with many unique characteristics that can improve the current construction materials: lighter and stronger structural composites, low maintenance coatings, better cementitious materials, lower thermal transfer rate of fire retardant and insulation, better sound absorption of acoustic absorbers and better reflectivity of glass [4].

Nanotechnologies for Concrete

Concrete is a macro-material strongly influenced by its nano-properties. The addition of nano ilica (S02) to cement based materials can control the degradation of the calcium-silicate hydrate reaction caused by calcium leaching in water, blocking water penetration and leading to improvements in durability 15). Nano-sensors have a great potential to be used in concrete structures for quality control and durability monitoring (to measure concrete density and viscosity, to monitor concrete curing and to measure shrinkage or temperature, moisture, chlorine concentration, pH, carbon dioxide, stresses, reinforcement corrosion or vibration). Carbon nano tubes increase the compressive strength of cement mortar specimens and change their electrical properties which can be used for health monitoring and damage detection The addition of small amounts (1%) of carbon nano tubes can improve the mechanical properties of mixture samples of portland cement and water. Oxidized multi-walled nano tubes show the best improvements both in compressive strength and flexural strength compared to the reference samples.

Nanotechnologies for Steel

The addition of copper nanoparticles reduces the surface uneverness 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 use in construction subjected to fatigue issues (Mann, 2006). 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 nano tubes 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 [5]. 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 nano tubes structure.

Nanotechnologies for Wood

Wood is composed of nano tubes or "nanofibrils" Lignocellulosic surfaces at the nano scale could open new opportunities for such things as selfsterilizing surfaces, internal self-repair, and electronic lignocellulosic devices, providing feedback for product performance and environmental conditions during service [5]. Highly water repellent coatings incorporating silica and alumina nanoparticles and hydrophobic polymers are proper to be used for wood.

Nanotechnologies for Glass

The use of TiO2 nanoparticles to glasses leads to so-called self cleaning technology. Due to the nanoparticles photo catalytic reactions, the organic pollutants, volatile organic compounds and bacterial membranes are decomposed. As well, TiO2 being hydrophilic, his attraction to water forms drops which then wash off the dirt particles decomposed in the previous process. Fire-protective glass is obtained using fumed silica (SiO2) nanoparticles as a clear interlayer sandwiched between two glass panels which turns into a rigid and opaque fire shield when is heated [7].

Paintings Nanotechnologies for Coatings and

Nanotechnology is applied to paints in order to assure the corrosion protection under insulation since it is hydrophobic and repels water from the metal pipe and can also protect metal from salt water attack. Others applications refer to coatings that have self healing capabilities through a process of "selfassembly". In addition to the self-cleaning coatings mentioned above for glazing, the remarkable properties of TiO2 nanoparticles are

put to use as a coating material on roadways in tests around the world [5].

Nanotechnologies for Thermal Insulation

Micro- and nanoporous aerogel materials are appropiate for being core materials of vacuum Insulation panels but they are sensitive to moisture. As a Bul. Inst. Polit. lai, t. LVII (LXI), f. 4, 2011 115 possible remedy it was produced an ultra-thin wall insulation which uses a hydrophobic nanoporos aerogel structure. Another application of aerogels is silica based products for transparent Insulation, which leads to the possibility of super-insulating windows[7]. Micro or nano eomechanical systema offer the possibility of monitoring and controlling the internal environmentlect of buildings and this could lead to energy savings.

Nanotechnologies for Fire Protection

Fire resistance of steel structures is often provided by a coating produced by a spray-on cementitious process Nano-cement (made of nano sized particles) has the potential to create a tough, durable, high temperature coatings [4]. This is achieved by the mixing of carbon nano tubes with the cementio tubes material to fabricate fibre composites that can inherit some of the outstanding properties of the nao tubes .

Nanotechnologies For Structural Monitoring.

Nano- and micro electrical mechanical systems (MEMS) sensors have been developed and used in construction to monitor and/or control the environment condition and the materials/structure performance. Nano sensor ranges from 10-9 to 10-5m. These sensors could be embedded into the structure during the construction process and could monitor internal stresses, cracks and other physical forces in the structures during the structures' life [4].

II. CONCLUSION

Nanomaterials (a nanometer, nm, and 10-9 m) have smallest particle size and largest surface area. Nanomaterials have great potential in improving properties of the concrete. Until today concrete has primarily been seen as a structural material but nanotechnology can help to make it as multipurpose "smart" functional material. They can improve overall performance of concrete since they have high surface area to volume ratio providing the potential for tremendous chemical reactivity.

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