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# Implementation of Nanotechnology in Concrete Technology

Er. Amrita P. Syubudhiray*, Er. Subhradipta Pattanayak**, Er. Pratibha M. Barik***

*Department of Civil Engineering, Swami Vivekananda School of Engineering and Technology, BBSR, ODISHA, INDIA, PIN-752054

**Department of Computer Science & Engineering, Swami Vivekananda School of Engineering and Technology, BBSR, ODISHA, INDIA, PIN-752054

***Department of Computer Science & Engineering, Swami Vivekananda School of Engineering and Technology, BBSR, ODISHA, INDIA, PIN-752054

***ABSTRACT***

*The review of implementation of nanotechnology in civil engineering. There are so many reasons that the construction in civil engineering are not sustainable. Because it consumes huge quantities of virgin materials. Second thing the principal binder in concrete is a Portland cement and its production is a major factor for green house gas emission which are implicated in global warming and climate change. So in order to reduce the carbon or gas emission due to cement manufacturing then the fly ash is partially replaced by ordinary Portland cement which is named as Portland Pozzalana Cement(PPC). Which not only reduces the environmental effect but also improves the work ability and durability. But the replacement of fly ash by Portland cement straying its strength therefore here nano-silica can be used to fill up the deviation. It is possible because silica(S) in the sand react with calcium hydrate(CH) the cement at nano-silica to form C-S-H bond which improve the strength of concrete which turn the concrete less alkaline due to concentration of CH. This paper represents review of the theory and construction practice with concrete mixture containing less fly ash and sustained concrete technology using nano technology.*

***Keyword:*** *Nano Silica, Portland Pozzalana Cement, Nanotechnology, Fly Ash, Calcium Silica Hydrate, Permeability, Concrete Technology*

## I. INTRODUCTION

To fulfil the needs of society toward housing and infrastructure in sustainable manner is a most important challenge for concrete industry today. There are some major factors which are affect sustainability. The factors are

In different parts of the world extreme weather condition are occurring which are mostly responsible for the high emission rates of green house gases, primarily carbon dioxide, environmental concentrations which has increased from 280-370 parts per million. The Portland cement industry and the transportation industry are mainly produces carbon dioxide which affect the sustainable concrete technology.

The concrete industry is the largest consumer of virgin materials such as sand, gravel, crushed rock, and fresh water. It is consuming Portland and modified Portland cements at an annual rate of about 1.6 billion metric tons. The cement production consumes vast amounts of limestone and clay besides being energy-intensive[1].

Achieving a dramatic improvement in resource productivity through durability enhancement of products is, of course, a long-term solution for sustainable development. A short-term strategy that must be pursued simultaneously is to practice industrial ecology at a larger scale than is the case today. Simply defined, the practice of industrial ecology by a manufacturing industry involve the reclamation and re-use of its own waste products and, to the extent possible, the waste products of other industries which are unable to recycle them in their own manufacturing process[1].

### WHAT IS CONCRETE?

Concrete is made up of three basic components that are water, aggregate (rocks, sand or gravels) and Portland cement. Cement is a component of concrete which is in powder form and act like a binding component. We can say that concrete is the most popular artificial material. It is in everywhere at road, houses, bridges, buildings, pipes, dams, etc. When cement mixed with water its result is a paste which is used to binding all other ingredients in concrete together. When aggregate are added with cement then its gives a new product i.e. either Mortar or Concrete (if fine aggregate added then MORTAR & if coarse aggregate added then CONCRETE) [6].

**WHAT IS NANOTECHNOLOGY?**

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering[2]. We also say that nanotechnology is a technique towards fabrication of devices or materials with atomic or molecular scale precision[8].

**WHAT IS NANO-CONCRETE?**

S. Yuvaraj at all Nano-concrete is defined as "A concrete made with Portland cement particles that are less than 500 Nano-meters as the cementing agent. Currently cement particle sizes ranges from a few Nano-meters to a maximum of about 100 micro meters. In the case of micro-cement the average particle size is reduced to 5 micro meters. An order of magnitude reduction is needed to produce Nano-cement. The SEM image of the Nano silica we had taken for our investigation is shown in Fig. 1 below [3,4]

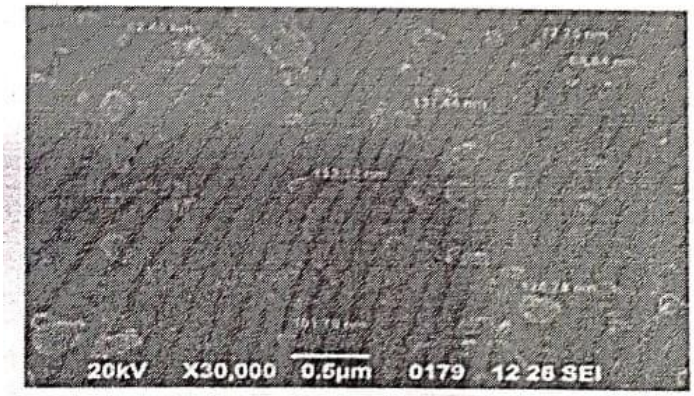


**Fig.1 The SEM image of Nano silica**

**HIGH-PERFORMANCE CONCRETE**

P.Kumar Mehta What is high-performance concrete? According to a recent paper by what was known as high-strength concrete in the late 1970s is now referred to as high-performance concrete (HPC) because it has been found to be much more than simply stronger. ACI defines HPC as a specially engineered concrete, one or more specific characteristics of which have been enhanced through the selection of component materials and mix proportions. Note that this definition does not cover a single product but a family of high-tech concrete products whose properties have been tailored to meet specific engineering needs, such as high workability, very-high early strength (e.g. 30-40 MPa compressive strength in 24 hours), high toughness, and high durability to exposure conditions[1,8].

**IMPLEMENTATION OF NANOTECHNOLOGY IN CONCRETE TECHNOLOGY**

Feldman R.F. at all Taking advantage of nanostructure characterization tools and materials, the optimal use of nano silica will create a new concrete mixture that will result in long lasting concrete structures in the future. Generally, concrete is two phase system with cement paste and aggregate, but the aggregates are inert in nature, The hydrated cement paste is composed of capillary pores and the hydration product - gel' pores, C-S-H, CH, Aft [Ettringite], AFm [Monosulfates] etc and one third of the pore space is comprised of gel pores and the rest are capillary pores. There are various indications that confirm the layered nature of C-S-11. Study conducted by Feldman and Sereda indicated that the cement paste inflow increases as water is removed until a point, at which the flow decrease. This point is the indication of a possible collapse in the nano-structure of hydration products and the C-S-H that is produced during the hydration of Portland cement has the microstructure as shown in Fig.2[3.5.7]

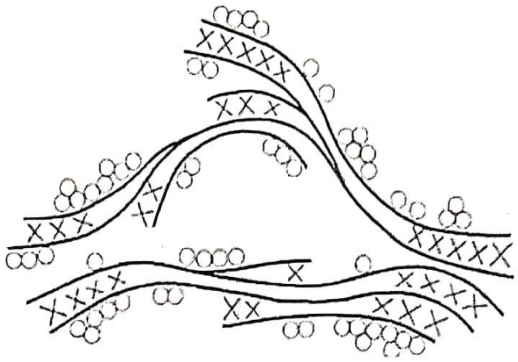

Fig.2 Feldman-Sereda model for the microstructure of C-S-H Black lines: C-S-H sheet, Circles: Adsorbed water, Crosses: Interlayer water[3]

**Table-1( Ranges of pore sizes in concrete[3]**

| Item | Size |
|---|---|
| Interparticle spacing between CSH sheets | 1-4 nm |
| Capillary voids | 10-1000 nm (0.01-μm) |
| Hexagonal crystals of $Ca(OH)_2$ | 0.7 - 3μm |
| Aggregation of CSH particles | 0.7 - 3μm |
| Entrained air bubbles<br>Entrapped air voids | 60-1000 μm (0.06-1 mm)<br>1-5 mm |

Table-1 depicts the relative sizes of pores in concrete. At one end of the scale are entrapped air voids, while on the lower extreme are the inter-particle spaces between sheets of C-S-H.

According to the above model of C-S-H, the cement paste is mostly having the gel pores, capillary pores, interlayer water etc. At the same time, in the concrete, there is an ITZ between the cement paste and aggregates, which is a weak link in the concrete usually the site of first occurrence of cracking. Therefore, avenues are available for further research towards the generation of crack free concrete with the possible incorporation of NS towards the promotion of cement hydration with high reactivity in the locations discussed earlier, with enhancement of the delay in development of micro crack, pore filing effect, creation of strong bond between the aggregates and cement paste and/or C-S-H[3,7].

## II. CONCLUSION

The above paper describe about the implementation of nanotechnology in concrete. Considerably improvement of the property of permeability. Throughout the world, the waste disposal costs have escalated greatly. At the same time, the concrete construction industry has realized that coal fly ash is relatively inexpensive and widely available by-product that can be used for partial cement replacement to achieve excellent workability in fresh concrete mixtures. There are so many reasons that the construction in civil engineering are not sustainable. Because it consumes huge quantities of virgin materials. Second thing the principal binder in concrete is a Portland cement and its production is a major factor for green house gas emission which are implicated in global warming and climate change. So in order to reduce the carbon or gas emission due to cement manufacturing then the fly ash is partially replaced by ordinary Portland cement which is named as Portland Pozzalana Cement(PPC). Which not only reduces the environmental effect but also improves the work ability and durability. But the replacement of fly ash by portland cement straying its strength therefore here nano silica can be used to fill up the deviation. It is possible because silica(S) in the sand react with calcium hydrate(CH) the cement at nano silica to form C-S-H bond which improve the strength of concrete which turn the concrete less alkaline due to concentration of CH.

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