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A STUDY ON SMART CONCRETE & ITS APPLICABILITY

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Abstract: Building energy saving and safe evaluation for engineering structures have obtained the worldwide attention. It is much of importance for developing a new kind of building material, which can integrate green energy saving with self-sensing properties of functional material.
The question today is how these needs can be accomplished without compromising the ability of future generations to meet their needs. In this paper there are many smart concrete shown. There are four different concrete had studied deeply to know how they work, how they manufactured and where they applicable. This all four concrete had different characteristics, functions, and mainly different material used to manufacture each concrete. After studied all four concrete it is found that these all concrete are very costly as compare to the normal or conventional concrete.

Keywords: **transparent concrete, pervious concrete, bacterial concrete, self healing concrete**

I. INTRODUCTION

The innovation is the invention of smart concrete, which is concrete that is itself a sensor of strain or stress. The sensing ability is not due to the embedment or attachment of sensors. Rather, the concrete has been modified through the use of admixtures so that it becomes a sensor. Without the admixtures, the sensing ability is poor. The sensing ability is associated with the reversible change of the electrical resistance of the concrete upon deformation in the elastic regime. The extent of the effect is described by the gage factor, which is defined as the fractional change in resistance per unit strain. The gage factor is up to 700, in contrast to the value of 2 for a typical commercial strain gage, which involves metals rather than concrete. Thus, the smart concrete is a highly sensitive strain gage. Since strain and stress are proportional to one another in the elastic regime, strain sensing also means stress sensing. Since stress is force per unit area, stress relates to force. Hence, the smart concrete can serve as a scale for weighing.

II. LIST OF SMART CONCRETE

1. Transparent Concrete.
2. High Volume Fly Ash Concrete.
3. Silica Fumes Concrete.
4. GGBS, Slag Based Concrete.

5. Self Healing Concrete.
6. Light Weight Concrete.
7. Polymer Concrete.
8. Self Compacting Concrete.
9. Bacterial Concrete.
10. Fibre-Reinforced Concrete.
11. Pervious Concrete.
12. Water-Proof Concrete.
13. Temperature Controlled Concrete.
14. Coloured Concrete.

III. CONCRETE TO BE STUDIED

Transparent Concrete:

Just a few decades ago concrete was often misunderstood, disliked and captured by its image fixed due to the rapid urbanization of the1960s. But since that time, concrete has made considerable progress, not only in technical terms, but also in aesthetic terms. It is no longer the heavy, cold and grey material of the past; it has become beautiful and lively. By research and innovation, newly developed concrete has been created which is more resistant, lighter, white or colour, etc. Concrete has learned to adapt to almost all new challenges that appeared. In 2001, the concept of transparent concrete was first put forward by Hungarian architect AronLosonzi, and the first transparent concrete block was successfully produced by mixing large amount of glass fibres into concrete in 2003, named as LiTraCon. Joel S. and Sergio O.G. developed a transparent concrete material, which can allow 80% light through and only 30% of weight of common concrete. It is worth mentioning that Italian Pavilion in Shanghai Expo 2010 shows a kind of transparent concrete developed by mixing glass into concrete in 2010. While the transparent concrete mainly focuses on transparency and its objective of application pertains to green technology and artistic finish. Therefore it is imperative to develop a new functional material to satisfy the structure in terms of safety monitoring (such as damage detection, fire warning), environmental protection and energy saving and artistic modelling. Transparent or translucent concrete can be seen as a recent answer to the architects call for more Transparent Architecture.

Self Healing Concrete:

Self-healing concrete could solve the problem of concrete structures deteriorating well before the end of their service life. Concrete is still one of the main materials used in the construction industry, from the foundation of buildings to the structure of bridges and underground parking lots. Traditional concrete has a flaw; it tends to crack when subjected to tension. A healing agent that works when bacteria embedded in the concrete convert nutrients into limestone has been under development at the Civil Engineering and Geosciences Faculty in Delft since 2006. The project is part of a wider programme to study the self-healing potential of plastics, polymers, composites, asphalt and metals as well as concrete. Dr Henk Jonkers, a microbiologist who specialises in the behaviour of bacteria in the environment, has developed self-healing concrete in the laboratory and full-scale outdoor testing will start in 2011. The first self-healing concrete products (successful research results permitting) are expected to hit the market in two years' time and are expected to increase the lifespan of many civil engineering structures. Jonkers has worked closely with civil and structural engineers to learn about the properties of concrete and steel reinforcement, and develop the concrete. “For a biologist to work with civil engineers to incorporate living matter into structural concrete material is in itself a great innovation,” he says.

Concrete constructions are currently designed according to set norms that allow cracks to form up to 0.2 mm wide. Such micro cracks are generally considered acceptable, as these do not directly impair the safety and strength of a construction. Moreover, micro cracks sometimes heal themselves as many types of concrete feature a certain crack-healing capacity. Research has shown that this so called ‘autonomous’ healing capacity is largely related to the number of non-reacted cement particles present in the concrete matrix. On crack formation, ingress water reacts with these particles, resulting in closure of micro cracks. However, because of the variability of autonomous crack healing of concrete constructions, water leakage as a result of micro crack formation in tunnel and underground structures can occur. The Delft group quantified autonomous self-healing of control samples and compared that to the self-healing capacity of concrete with an inbuilt bacteria-based self-healing agent. While self-healing of 0.2 mm wide cracks occurred in 30% of the control samples, complete closure of all cracks was obtained in all bacteria-based samples. Moreover, the crack sealing capacity of the latter group was found to be extended to 0.5 mm cracks.

Pervious Concrete:

Sustainable construction designs have become extremely popular within the last few years. Reducing the strain on our environment is essential to the overall health and wellbeing of our society. While a variety of new designs and technologies have transpired from this green movement, one of the more profound impacts has been in the area of storm water management (SWM). Named one of the best management practices for SWM quality, pervious concrete has the ability to capture the runoff of rainwater and remove trace pollutants (NRMCA 2004). While pervious concrete has been around for many years, it has seen a significant increase in interest in recent years with the adoption of the federal clean water legislation. One of its first uses was in southern Georgia where the preservation of the natural ecosystem played an important role in selecting pervious concrete (Ferguson 2005). Since then, other states such as Florida, New Mexico, Utah, California, Oklahoma, Illinois, and Wisconsin have implemented pervious concrete designs (Mathis 1990).

Pervious concrete can be defined as an open graded or “no-fines” concrete that allows rain water to percolate through to the underlying sub-base (ACI Committee 522 2006).The principal ingredients are quite similar to conventional concrete: aggregate, Portland cement, admixtures, fine aggregate (optional), and water. The main difference is the percentage of void space within pervious concrete. Typical ranges of void space are between 15-25 percent and roughly .08 in to .32 in (2 mm to 8 mm) (NRMCA 2004). To create a pervious concrete pavement, the pervious concrete (ranging from 4 to 8 inches in thickness) is placed on top of an aggregate base. The thickness of this aggregate base is dependent on a number of influencing factors. A filter fabric can be placed to separate the underlying soil from the pervious concrete (see Figure 2.1). This allows the impediment of the soil from percolating or penetrating up and clogging them 6 pores of the concrete (Tennis et al 2004). The use of sub-base material is dependent on soil conditions as well as the intended application.

Bacterial Concrete:

Concrete which forms major component in the construction industry as it is cheap, easily available and convenient to cast. But drawback of these materials is it is weak in tension so, it

cracks under sustained loading and due to aggressive environmental agents which ultimately reduce the life of the structure which are built using these materials. This process of damage occurs in the early life of the building structure and also during its life time. Synthetic materials like epoxies are used for remediation. But, they are not compatible, costly, reduce aesthetic appearance and need constant maintenance. Therefore bacterial induced Calcium Carbonate (Calcite) precipitation has been proposed as an alternative and environment friendly crack remediation and hence improvement of strength of building materials.
A novel technique is adopted in re-mediating cracks and fissures in concrete by utilizing Microbiologically Induced Calcite or Calcium Carbonate (CaCO3) Precipitation (MICP) is a technique that comes under a broader category of science called bio-mineralization.
MICP is highly desirable because the Calcite precipitation induced as a result of microbial activities is pollution free and natural. The technique can be used to improve the compressive strength and stiffness of cracked concrete specimens. Research leading to microbial Calcium Carbonate precipitation and its ability to heal cracks of construction materials has led to many applications like crack remediation of concrete, sand consolidation, restoration of historical monuments and other such applications. So it can be defined as "The process can occur inside or outside the microbial cell or even some distance away within the concrete. Often bacterial activities simply trigger a change in solution chemistry that leads to over saturation and mineral precipitation. Use of these Bio mineralogy concepts in concrete leads to potential invention of new material called ―Bacterial Concrete."

IV. APPLICATION OF SMART CONCRETE

1. Transparent concrete blocks suitable for floors, pavements and load-bearing walls.
2. Facades, interior wall cladding and dividing walls based on thin panels.
3. Partitions wall and it can be used where the sunlight does not reach properly.
4. In furniture for the decorative and aesthetic purpose.
5. Light fixtures.
6. Light sidewalks at night.
7. Increasing visibility in dark subway stations.
8. Lighting indoor fire escapes in the event of a power failure.
9. Illuminating speed bumps on roadways at night.
10. The use of microbial concrete in Bio Geo Civil Engineering has become increasingly popular. From enhancement in durability of cementations materials to improvement in sand properties, from repair of limestone monuments, sealing of concrete cracks to highly durable bricks, microbial concrete has been successful in one and all.
11. This new technology can provide ways for low cost and durable roads, high strength buildings with more bearing capacity, long lasting river banks, erosion prevention of loose sands and low cost durable housing.
12. Drawbacks of conventional treatments have invited the usage of novel, eco friendly, self-healing and energy efficient technology where microbes are used for remediation of building materials and enhancement in the durability characteristics.

SUMMARY

As the many researchers found out this superior and smart material although due to its various limitations, further study is require to get a more benefit from this material. More work should be done on the retention of nutrients and metabolic products in the building material. Detailed microbial ecology studies are also needed in order to ascertain the effects of the introduction of new bacteria into the natural microbial communities, the development of the communities at short, mid and long-term, And the eventual secondary colonization of heterotrophic microorganisms using bacterial organic matter and dead cells, such as actinomycetes, fungi, etc. So, detailed studies need to focus on different types of nutrients and metabolic products used for growing calcifying microorganisms, as they influence survival, growth, and bio-film and crystal formation. This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials.

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