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Light Transmitting Concrete- A New Innovation

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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. In this paper, based on the excellent properties of light guiding and elasto-optic effect of optical fiber, a novel smart transparent concrete is researched by arranging the optical fibers into the concrete. To evaluate the effectiveness of the smart transparent concrete, the light guiding based on white light test, long-term durability based on freezing and thawing test and chloride ion penetration test, and self-sensing property based on stress elasto-optic effect test are made respectively. The experiments results show that the smart transparent concrete has good transparency, mechanical and self-sensing properties.

Keywords-- Attractive building material**,** Energy Saving, Fiber Bragg Grating, Green Construction Material, Plastic Optical Fiber, Smart Transparent Concrete, Structural Health Monitoring.

INTRODUCTION:

Due to economic development and space utilization requirements, high-rise buildings and skyscrapers are mostly built downtown in metropolitan areas around the world, especially countries with great populations. Those buildings are isolated biosphere only based on man-made lights to maintain people's optical activities. It is considered to be one of the best sensor materials available and has been used widely since the 1990s. Hungarian architect, Aron Losonczi, first introduced the idea of light transmitting concrete in 2001 and then successfully produced the first transparent concrete block in 2003, named LiTraCon . However his transparent concrete did not have smart sensing properties. In this paper, a smart transparent concrete - novel construction material was manufactured with POF by drilling through the cement and mortar in order to utilize the light guiding ability of POF. The main purpose was to use sunlight as a light source in order to reduce the power consumption of illumination. Additionally, experiments to study the mechanical performance of the concrete infused with POF were carried out.

LiTraCon rooms will be brightened and proximal objects situated on the brighter side of a LiTraCon wall will be revealed as silhouettes on the other side. Though the optical fibers compose only 4% of the concrete, some light is transmitted because of their parallel arrangement in a matrix between to the two outer surfaces of each block. Load-bearing structures can also be built from these blocks, since glass fibers have no negative effect on the strength of the concrete. The blocks come in various sizes and with an option of embedded heat-isolation. Since not everyone appreciates the look of exposed concrete, LitraCon is creating light-transmitting building blocks in other textures and colors as well.

PRINCIPLE:

Thousands of optical glass fibers form a matrix and run parallel to each other between the two main surfaces of each block. The fibers mingle in the concrete because of their insignificant size and they become a structural component as a kind of modest aggregate. So, the surface of can be built with these blocks and the blocks can be produced in various sizes and with embedded heat-isolation.

Litracon is a combination of optical Fiber s and fine concrete. It can be produced as prefabricated building blocks and panels. Due to the small size of the Fiber s, they blend into concrete becoming a component of the material like small pieces of aggregate. In this manner, the result is not only two materials - glass in concrete - mixed, but a third, new material, which is homogeneous in its inner structure and on its main surfaces as well.

The glass Fiber s leads light by points between the two sides of the blocks. Because of their parallel position, the light-information on the brighter side of such a wall appears unchanged on the darker side. The most interesting form of this phenomenon is probably the sharp display of shadows on the opposing side of the wall. Moreover, the color of the light also remains the same.

Fig.1 Transparent wall

This new product, then, is a combination of optical fibers and fine concrete and can be produced as building blocks or panels. The fibers blend into the concrete and become part of the material like small pieces of aggregate. You not only get two materials, glass in concrete, but a third new material, which is homogeneous in its inner structure and on its main surfaces, too.

LITERATURE REVIEW:

Research and Development of Plastic Optical Fiber Based Smart Transparent Concrete
Zhi Zhou1,2, GeOu, Ying Hang, Genda Chen, Jinping Ou, School of Civil Engineering, Harbin Institute of Technology, Harbin 150090, P.R. China Center for Infrastructure Engineering Studies, Missouri Univ. of Science and Tech., Rolla, MO 65401-0710, USA School of Civil and Hydraulic Engineering, Dalian University of Technology, Dalian, 116024, P.R. China
Structural Health Monitoring (SHM), it is an architectural energy and 13% of that energy is used to power lighting. At present, green structures focus greatly on saving energy with promising technology for field applications in civil infrastructure. Due to economic development and space utilization requirements, high rise buildings and skyscrapers are mostly built downtown in metropolitan areas around the world, especially those countries with great populations. Those buildings are isolated biosphere only based on man-made lights to maintain people's optical activities. For example, China consumes 25% of global indoor thermal systems. However, in the area of illumination fields, there is very little research offering relevant solutions. Research on the intrinsic characteristics of the optical identity in construction materials is still at its infancy. Due to its outstanding light guiding and sensing advantages, such as anti-electromagnetic interference capability, small dimensions, distributed measurement and anti-corrosion characteristics, optical Fiber s have been widely adopted in the communication and sensing fields. It is considered to be one of the best sensor materials available and has been used widely since the 1990s. Hungarian architect, Aron Losonczi, first introduced the idea of light transmitting concrete in 2001 and then successfully produced the first transparent concrete block in 2003, named LiTraCon.

MATERIALS:

1. **Optical Fibers-**

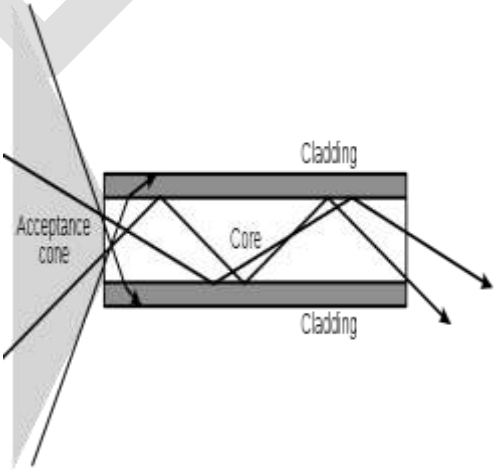

Fig 2. Total Internal Reflection

When light traveling in an optically dense medium hits a boundary at a steep angle (larger than the critical angle for the boundary), the light is completely reflected. This is called total internal reflection. This effect is used in optical fibers to confine light in the

core. Light travels through the fiber core, bouncing back and forth off the boundary between the core and cladding. Because the light must strike the boundary with an angle greater than the critical angle, only light that enters the fiber within a certain range of angles can travel down the fiber without leaking out. This range of angles is called the acceptance cone of the fiber. The size of this acceptance cone is a function of the refractive index difference between the fiber's core and cladding.

2. Translucent Stone-

Fig. 3. Translucent Stone

This naturally occurring stone is highly scissile; so this material can be worked into thinnest layers. These layers are so thin that when backlit, the light can pass through the stone and thereby generates impressive visual effects. The always unique mineral structure, the different colors and different light transmissions generates an always unique materiality, which will convince in various applications, like in interior design, in exhibition design as well as in furniture and display design.

3. Cement-

Selection of the type of cement will depend on overall requirement for the concrete such as strength and durability.

4. Fine Aggregate-

All normal concreting sands are suitable for Litracon. Both crushed and rounded sand can be used. A minimum amount of fine arising from binders and sand must be achieved to avoid segregation. Another deficiency in aggregate is poor gradation. The use of filters is suggested as means of overcoming this problem. At present, a trial and approach is used to fix the type and amount filter. Alternative, particle packing model should be used to reduce the number of experimental trials. The overall idea is to overcome local deficiencies in aggregate shape and to arrive at required packing characteristic irrespective of aggregate. In the view of an increase awareness of the same, use of manufactured sand and other alternative fine aggregate has become essential. In fact, river sand is simply not available in future years.

CHARACTERISTICS:

- Permits the passage of light through the set concrete, permitting colors, shapes and outlines to be seen through it
- Having a resistance to compression that varies from 150 MPa up to 250 MPa
- Having maximum water absorption of 0.35%.
- Having a maximum oxygen index of 25%.
- Having a thermal conductivity of 0.21 W/m °C.
- Having an elastic limit greater than 60 MPa.
- Having a Young's Modulus from 2750 MPa to 3450 MPa
- From its characteristics and composition, can be a conductor of electricity, dispensing with interior.
- From its mechanical and optical characteristics, can be used for purposes that are both architectural and aesthetic, and also structural and under conditions of service equal to and even different from those of a traditional concrete.

APPLICATIONS:

1. Illuminate Your Walls-

Galaxy Translucent Concrete can be used as building material for interior and exterior walls. If sunshine illuminates the wall structure then eastern or western placement is recommended; the rays of the rising or setting sun will hit the optical glass fibers in a lower angle and the intensity of the light will be bigger. Besides the traditional applications of a wall, the light transmitting concrete can also be used as wall covering illuminated from the back.

Fig. 4.Wall Illuminated By Litracon

2. Creative with Design-

The building units are versatile and can be used in many areas of design. You can also create a logo with colorful figures, inscriptions and pictures.

Fig.5. Creative Column

Translucent Concrete Stairs-

With Impact Lighting Inc's Linear LED fixtures our Galaxy Translucent Concrete product can be used in horizontal and vertical applications such as feature stairs, walls, flooring, tables and counter tops.

Fig.6. Translucent Concrete Stairs

ADVANTAGES:

- Translucent concrete inserts on front doors of homes, allowing the resident to see when there is a person standing outside.
- Translucent concrete walls on restaurants, clubs, and other establishments to reveal how many patrons are inside.
- Ceilings of any large office building or commercial structure incorporating translucent concrete would reduce lighting costs during daylight hours.
- Lane markers in roadways could incorporate various colors in the translucent concrete, allowing for dynamic adjustments when required by traffic fluctuations.
- Sidewalks poured with translucent concrete could be made with lighting underneath, creating lit walkways which would enhance safety, and also encourage foot travel where previously avoided at night.
- The use of translucent concrete in an outer wall of an indoor stairwell would provide illumination in a power outage, resulting in enhanced safety.
- Subways using this material could be illuminated in daylight.
- Speed bumps in parking lots and driveways could be illuminated from below, making them more visible and therefore more effective.

DISADVANTAGES:

- It is precision material and the correct procedure need to be followed.
- It is extremely important to ensure the integrity of optic strands if they break within the product property would almost be neglected.
- Costing of this material is difficult as the techniques are just start to develop.

CONCLUSION:

A smart transparent concrete is aesthetically pleasing. POF-based transparent concrete could be regarded as an art which could be used in museums and specific exhibitions rather than just a construction material. Although ease of construction is to be compromised, the material is bound to be accepted universally due to its advantages. With the concept of green technology catching up, electrical supply, being supplemented by natural sources, it becomes absolutely necessary to utilize the natural resource. Although Litracon has yet to be made available for commercial use, it has already been suggested that buildings made with the material could save electricity that would otherwise be required for daytime lighting. When light transmitting properties were examined, the test results have revealed that the produced concrete can be cut into different shapes without losing its transparent property and it can be used as architectural concrete on roofs of special buildings. Moreover, this light transmitting concrete can be utilized in the production of special types of home furniture.

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