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TO EVALUATE PROPERTIES OF TRANSLUCENT CONCRETE / MORTAR & THEIR PANELS

NEHA R. NAGDIVE[1] & SHEKAR D. BHOLE[2]

[1]Research Scholar (Structural Engineering), Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra, India

[2]Associate Professor, Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra, India

ABSTRACT

In this paper, a TRANSLUCENT CONCRETE - novel construction material was manufactured with OPTICAL FIBRE by drilling through the cement and mortar in order to utilize the light guiding ability of OPTICAL FIBRE. The main purpose was to use sunlight as a light source in order to reduce the power consumption of illumination. Experiments to study the mechanical performance of the concrete infused with OPTICAL FIBRE were carried out.

KEYWORDS: Translucent Concrete, Optical Fibre, Mortar

INTRODUCTION

The term “translucent concrete” has the potential to be somewhat misleading. The concrete itself is not translucent, nor is it any different to conventional concrete. Concrete is one component of a revolutionary new material marketed as “translucent concrete”. This product also contains glass fibre optics which has the capacity to communicate light frequencies. Perhaps a more suitable term could be “light transmitting concrete”. It is important to differentiate, as past attempts have been made to create an actual translucent concrete, however such attempts have generally proven unsuccessful as the product becomes fragile, and incapable of withstanding wind and rain.

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 architectural energy and 13% of that energy is used to power lighting. At present, green structures focus greatly on saving energy with 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 fibers 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.

PRINCIPLE OF OPERATION

Optical fibers work as a cylindrical waveguide that transmits light along its axis, by the process of internal reflection.

Optical Fiber Elements

Core - The thin glass center of the fiber where the light travels.

Cladding - The outer optical material surrounding the core that reflects the light back into the core. To confine the reflection in the core, the refractive index of the core must be greater than that of the cladding.

Coating - Plastic coating that protects the fiber from damage and moisture.

Our solution used the same principle. For our translucent concrete panel, we needed a core material such as acrylic that will transmit light continuously into the inside of the building, a white cladding layer that reflects the light back into the core and concrete as the protective coating.

Light Reflected in Concrete Panel

With this idea, we tried with acrylic cylinders of different diameters to evaluate its reflection when casted into different mixes using white cement and white aggregates and sand. With those results we found a diameter that could reflect enough light using our standard 10cm thick panel cast into our typical white concrete mix.

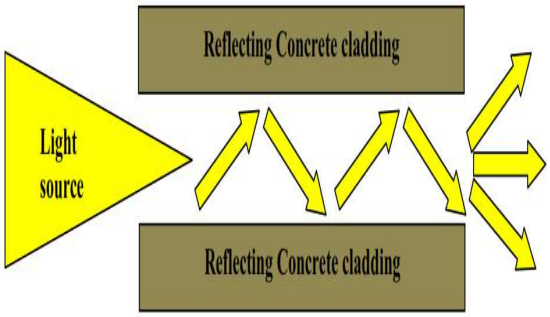

Figure 1

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MATERIALS

Non sticky clay, Cement, OPTICAL FIBRES, Mortar, concrete, etc.

PROPERTIES OF MATERIALS

The properties of materials are as follows:

Cement

Cement is described as a material with adhesive and cohesive properties which make it capable of bonding mineral fragments into a compact whole. It embraces large variety of cementing materials. For construction purposes the meaning of the term cement is restricted to the bonding material used with stones, sand, bricks, building blocks, etc. The principal constituents of this type of cement compounds of lime, so that in building and civil engineering we are connected with calcareous cement. The cements have property of setting in under water by chemical reaction releasing heat of hydration. So called as hydraulic cement. Hydraulic cement consist mainly of silicates and aluminates of lime, and can be classified broadly as natural cements, Portland cements, and high alumina cements.

Optical Fibre

An OPTICAL FIBRE is a flexible, transparent fibre made of glass (silica) or plastic, slightly thicker than a human hair. It functions as a waveguide or light pipe, to transmit light between the two ends of the fibre.

The field of applied science and engineering concerned with the design and application of optical fibres is known as fibre optics. Optical fibres are widely used in fibre-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication. Fibres are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Fibres are also used for illumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces. Specially designed fibres are used for a variety of other applications, including sensors and fibre lasers.

Optical fibers typically include a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by total internal reflection. This causes the fibre to act as a waveguide. Fibres that support many propagation paths or transverse modes are called multi-mode fibres (MMF), while those that only support a single mode are called single-mode fibres (SMF). Multi-mode fibres generally have a wider core diameter, and are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibres are used for most communication links longer than 1,050 meters (3,440 ft). Joining lengths of optical fibre is more complex than joining electrical wire or cable. The ends of the fibres must be carefully cleaved, and then spliced together, either mechanically or by fusing them with heat. Special optical fibre connectors for removable connections are also available.

Mortar

When some binding materials i.e., cement or lime is mixed with some inert material such as sand, surkhi or cinder and lubricating material water, a paste is formed which is plastic in nature; this paste is known as mortar. This is used as a binding material for stone or brick masonry and covering material to walls in the form of plaster to provide smooth, hard and decorative surface to the walls.

Mortar must have sufficient strength to remain at its own position. It should be durable and have sufficient workability so as to facilitate for application and spreading to ensure that all joints are completely filled up. It should be stiff and must have capacity to hold water against the suction of brick.

Concrete

Concrete is a matrix of cement (or lime), sand, brick or stone ballast and water, which when placed in the forms and allowed to cure, becomes hard like stone. The hardening is caused by chemical reaction between the cement and water. The cement and water form a paste which, upon hardening, binds the aggregates to a permanent mass. Cement is called as ‘binding material’. The stone or brick ballast is called the ‘coarse aggregate’ as distinguished from the ‘fine aggregate’ which is sand. The mortar is called as ‘matrix’. Cement concrete when use by itself is known as ‘mass concrete’.

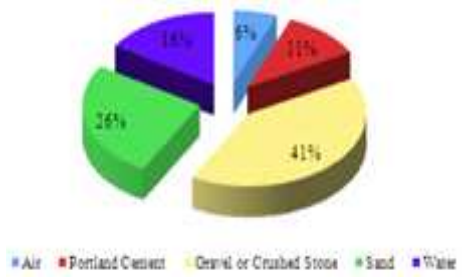

Figure 2: Typical Ratio of Concrete Ingredients (%)

PROCEDURE OF MAKING TRANSLUCENT CONCRETE

- **Step 1** - Making the Mould

- **Step 2** - Fibre optics
- **Step 3** - Placing the Fibres
- **Step 4** - Pouring the Concrete
- **Step 5** - Breaking the Mould
- **Step 6** - Trim the Fibers
- **Step 7** - Polishing

Step 1- Making the Mould

You need to roll some polymer craft clay into a flat circle. Make it as level as possible,

Figure 3

Cut out a ring from a spray paint can lid...anything that is waterproof will work. After you cut it, press it into the clay. The whole point of this is to make a mold to cast the concrete into.

Figure 4

Step 2- Fibre Optics

Get one of those plastic fibre optic toys. They have that sort of 'frill' of glowing wires... see the photo. Cut a bunch of small 1 inch segments by breaking off about 10 wires from the bundle, and cutting them short en masse.

Figure 5

Step 3- Placing the Fibers

Fiber are placed individually in mold

Figure 6

Step 4- Pouring the Concrete

Figure 7

Pour the concrete carefully and slowly in fiber placed mould

Figure 8

Step 5- Breaking the Mold

Once the concrete is cured for 24 hours, pull off the polymer clay and cut off the plastic ring. The concrete will not stick to the clay...in fact, it's practically repelled by it!

Figure 9

Step 6- Trim the Fibers

After you let the de-moulded concrete dry out over night, cut off the extra long fibers.

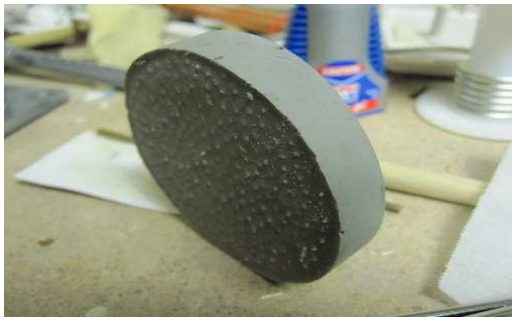

Figure 10

Step 7- Polishing

- Use sandpaper to polish
- Light, even colored light, is able to pass right through and create a pixelized likeness on the opposite side...!

Figure 11

CONCLUSIONS

- The smart transparent concrete has good light guiding property.
- The OPTICAL FIBRE volume ratio of concrete is proportionate to transmission light guiding property.
- Weighs about the same as conventional concrete.
- Carries the same amount of light through a brick no matter how thick it is.
- Creating an Ecologically Solution that Reduces to Minimum Energy Consumption of this Project.

It is a Clear Example of Technology Transformed into Art Creating an Ecologically Solution that Reduces to Minimum Energy Consumption of this Project.

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