Translucent Concrete: A Review

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Abstract— The concrete made up of least cement water and aggregate for the used in construction industries, infrastructure and so on. In this way translucent concrete with light transmission property arrived due to insert optical fibre in it. As we know that concrete has greyish color and its high density which not admit passage of light through it. As can be imagined, concrete has a specific property of being transparent will permit a better passage of light between construction and its natural ambience, creating circumstances that are better and more naturally lit. Light is conducted through the fibre from one end to the other. This results into a certain light pattern on the other surface, depending on the fibre structure. Optical fibres transmit light so effectively that there is virtually no loss of light conducted through the fibres. It is one of the newest, most functional and revolutionary element green construction material. Our paper deal with transparent or translucent concrete blocks and also give the uses and advantages in the field of smart construction.

Keywords: Optical Fibre, Aggregate, Concrete, Translucent

I. Introduction

At global scale problem of environment and energy consumption having rapidly increase. Today we can see that a great population countries have number of building is higher than that of small population. For example, India consumes 20% of total electrical energy for lighting the building. Now a days, we focusing on saving energy with indoor thermal system by Green structure. By the use of transparent concrete which aims to utilise potential energy which exist in the form of sunlight, to emit light and to make people much aware about the benefits of using it in the construction work.

Especially keeping in mind the rising pollution levels and also dipping economy, and due to rapid urbanisation, most of the big buildings are built close to each other, all in the same areas, like sky scrapers. When many buildings are stacked close to each other, there is not much natural sunlight passing through and the importance of natural sunlight is pretty well known. In fact, 50% day lighting is a mandatory requirement in a building. The use of sunlight source of light instead of using electrical energy is main purpose of translucent concrete, so as to reduce the load on non-renewable sources and result it into the energy saving. Optical fibers is a sensing or transmission element, so decrease the use of artificial light, the normal concrete is replaced by translucent concrete, which has natural lighting and art design.

II. Basic purpose of translucent concrete

A smart transparent concrete - novel construction material manufactured with Plastic Optical Fibre (POF) by drilling through the concrete in order to utilize the light guiding ability and the sensing properties of POF, respectively is studied. The main purpose is to use sunlight as a light source in order to reduce the power consumption of illumination. Translucent Concrete is a combination of fibres optics and concrete. It can be produced as prefabricated building blocks and panels. Due to the small size of the fibres, they blend into concrete becoming a component of the material like small pieces of aggregate. Because of their parallel position of fibre, the light information on the brighter side of a wall appears unchanged on the darker side. The sharp display of shadows will fall of the opposing side of the wall.

III. Literature review

Soumyajit Paul, Avik Dutta "Translucent Concrete", International Journal of Scientific and Research Publications, Volume 3, Issue 10, October 2013, ISSN 2250-3153 worked on transparent concrete with different percentage of optical fiber (1 to 6 %) and large diameter glass fiber. Analyze the light Guiding property of optical fiber and glass fiber and concluded that transparent concrete has good light Guiding property and the light transmission is directly proportional to the amount optical fiber.

Prof.Sonali, M.Kankriya "Translucent Concrete By using Optical fiber and Glass rods" International Journal of Scientific and Research Publications, Volume 6, Issue 10, October 2016, ISSN 2250-3153, Compare the Compressive strength of optical fiber reinforced transparent concrete and glass rod reinforced transparent concrete. Cost of optical fiber and glass rod reinforce concrete is also compare and concluded that the compressive strength of Transparent concrete is reduced to some amount and therefore it is applicable for mainly partition wall rather than structural element such as column and beam.

Abhishek Tiwari, Parmod Saharan, "Study of Behavior of Translucent Concrete using Rice Husk and and Steel fiber" SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 3 Issue 7 – July 2016, worked on Transparent concrete with addition of Rice husk Ash and 0.125% of steel fiber. The percentage of optical fiber used in the paper varies from 0.25% to 4% and compare the compressive strength of concrete. It concluded that as the percentage of optical fiber is increased the compressive strength of concrete is decreased but by the addition of rice husk ash and steel fiber compressive strength of concrete is increased. The cost of transparent concrete is more but it is justified due to its various advantages such as energy saving property, aesthetically beautiful, sustainable etc.

IV. Material used

A. Cement

Ordinary Portland cement of 43 grade should use for casting all the specimens.

B. Fine Aggregate

Clean and dry river sand available locally is used. Sand passing through IS 4.75mm Sieve is used for casting all the specimens.

C. Coarse Aggregate

Coarse aggregate passing through 10mm sieve is used for casting all specimens.

D. Water

Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen.

E. Optical Fibre

An optical fibre is a flexible, transparent fibre made of 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. Fibres are used for illumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces. Optical fibre consist of different elements which are:

1) Core

The thin glass centre of the fiber where the light travels.

2) 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.

3) Coating

Plastic coating that protects the fiber from damage and moisture.

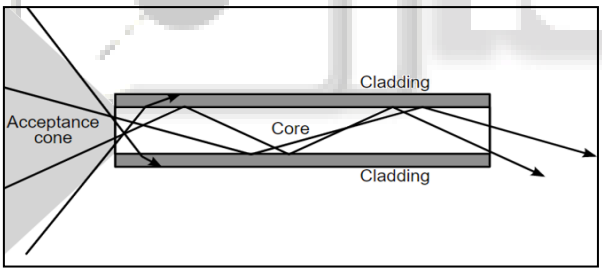

Fig. 1: Working Principle of Optical Fiber

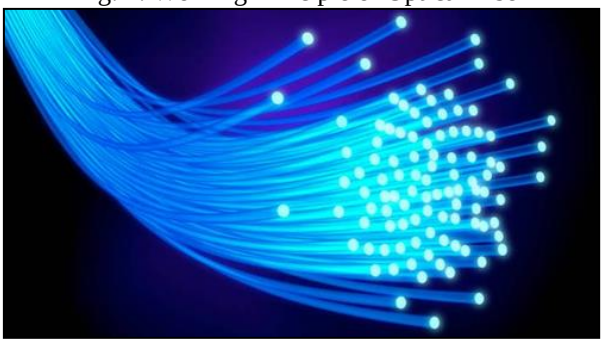

Fig. 2: Plastic Optical Fiber

V. Working Principle

Transparent Concrete is based on "Nano-Optics", fibers are act as slit and carry light throughout. Thousands of optical fiber is reinforced from one face to another and transmit lights. 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. The process of total internal reflection is shown below. 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.

VI. Methodology

A. Step 1: Preparation of the Mould

A mould of rectangular size 150mm*150mm*150mm is prepared with wood or steel. The required size of rectangular mould from wood or tin is prepared. Place the clay or mud in the sides where the optical fibers are exposed to the mould for the easy demoulding after the concreting.

B. Step 2: Optical Fiber

The cleavage of the optical fibre is done very carefully as per the mould size. The diameters of optical fibers which are commonly available are given as following:
0.25 mm, 0.5 mm, 0.75 mm, 1 mm, and 2 mm.

C. Step 3: Fixing the Fibers

Fibers are usually placed in layer distribution because in layer distribution or organized distribution they provide good reflection properties. Several holes are driven on steel mould so that optical fibres can pass through them in an organized manner.

D. Step 4: Concreting

As optical fibres are inserted first in the mould through holes provided in mould the concreting is done after this very carefully so that it does not disturbs the optical fibres. For obtaining the good compaction the concrete is filled in thinner layers also a needle vibrator is used to avoid the voids formation in concrete.

E. Step 5: Removing the Mould

The mould is removed after 24 hours. The casted mould was placed on a much leveled surface or undisturbed surface. Then it was de-moulded very carefully after 24 hours from casting. The respective identification mark/numbers were given immediately after de-moulding, the cube specimens.

F. Step 6: Cutting & Polishing

The extra fibres can be cut as per the size of the mould. Finally the polishing is done with the help of sand paper or some polishing paper.

VII. Application

– Transparent concrete blocks suitable for floors, pavements and load-bearing walls.

- Facades, interior wall cladding and dividing walls based on thin panels.
- Partitions wall and it can be used where the sunlight does not reach properly.
- In furniture for the decorative and aesthetic purpose.
- Light fixtures.
- Light sidewalks at night.
- Increasing visibility in dark subway stations.
- Lighting indoor fire escapes in the event of a power failure.

A. Few Examples

Fig. 3: Europeon Gate

The Euopean Gate was built by Aron losonczi and Orsolya Vadasz in 2004 situated at Fortress Monostorin the Hungarian town of Komarom. It is made up with light transmitting concrete. The sun lights illuminate its wall at morning, afternoon. By using artificial light at night it give pleasant view.

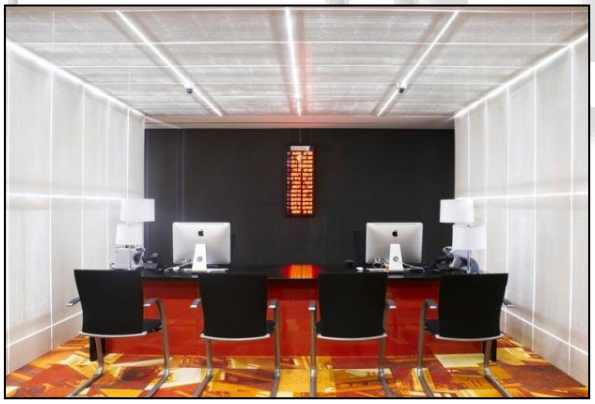

Fig. 4: New Headquarters of Bank of Georgia

The wall of Headquarter of bank of Georgia, Tbilisi, is made with LiTracon as shown above.

Fig. 5: Cella Septichora Visitor Centre

The main gate of Visitor center is made with transparent concrete blocks of 10cmm thick. The blocks is arranged and fixed in steel frame.

VIII. Conclusion

The transparent concrete is a good architectural material. As discussed in various papers the strength of concrete is reduced by some amount but it can be achieved by using some addition fiber, therefore the strength parameter of transparent concrete is same as conventional concrete. Transparent concrete give aesthetical view to buildings. It is energy efficient and makes green building.

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