

TRANSPARENT CONCRETE: AN OVERVIEW

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Abstract: Concrete is one of the oldest building materials, just like brick and stone, being used since the roman civilization. It generally consists of four basic materials: cement, coarse aggregate, fine aggregate and water. But the desire for making life easier with newer technologies, solutions and capabilities has developed a curious mind-set in humans. This human approach has not left the material of concrete alone. Concrete no longer carries its old disliked image of a heavy, grey, dull and pale material as it used to in the past. By continuous research and innovation in the past 50 years, concrete has evolved and improved continuously, both in aesthetics as well as technical properties. By changing its physical as well as chemical compositions, we can make various types of concrete in desirable way. Transparent Concrete is one such innovative type of concrete found in the modern times which contains light transmitting properties due to the inclusion of special glass rods. It is also known as light transmitting concrete or translucent concrete. This research article mainly focuses on the basic concept and principles, study of past research work, applications and uses of transparent concrete.

Keywords: - transparent concrete, LiTraCon, light transmission, optical fibres.

I. INTRODUCTION

Transparent Concrete or light-transmitting concrete is a modern type of concrete material having light transmitting properties which is achieved due to addition of light optical elements or other transparent materials to the concrete; Usually optical fibers are added into concrete in desired proportion to achieve the light transmission properties. Transparent concrete was initially developed back in 2001 by a Hungarian architect, Aron Losonzi with the use of glass fibers. The first block of transparent concrete was made in 2003 by using the glass fibers and it was termed as LiTraCon (shortened for light-transmitting concrete). Joel S. and Sergio developed such transparent concrete which allows 80% of light to be transmitted while the weight is just 30% of conventional concrete. The need for such a material aroused when the whole world faced problems of deprivation of natural light and excess energy consumption due to rapid urbanization. Buildings and towers are stacked together and hence limited sunlight is allowed to pass through. The discovered material of transparent concrete has the strength of conventional concrete and also solves the problem of minimum to no sunlight by having an array of transparent material which can help pass natural daylight and also provide a view to the outside world. The transparent concrete mainly focuses on transparency or light emission as its property and its applications pertain to green buildings and artistic finishes.

A. RESEARCH OBJECTIVES

1. To study the concept of transparent concrete.
2. To study the various materials or ingredients used in manufacture of transparent concrete.
3. To study the working principle of transparent concrete.
4. To study various applications of transparent concrete.
5. Advantages and Disadvantages of transparent concrete

II. MATERIALS USED FOR TRANSPARENT CONCRETE

- A. Cement** – The main property of transparent concrete is transmission of light, therefore there is no need of using any special type of cement. Ordinary Portland cement of 43 or 53 grade can be used
- B. Fine Aggregate** – Fine aggregate passing through 4.75mm IS Sieve containing not more than 5% coarser material should be used.
- C. Coarse Aggregate** – The maximum size of coarse aggregates used must be 10mm.
- D. Water** – Water is used for mixing all of the dry ingredients of concrete. Potable water should be used.
- E. Optical Fibers** – An optical fiber is a wave guide, made of transparent glass or plastic. It is used as means to transmit light from one end to its other end. Due to the small size of such fibers, they blend into concrete and become a component material just like smaller pieces of aggregate. Many of such fibers are induced into concrete to transmit light.

Types of Optical Fibers

An optical fiber consists mainly of three parts – core, cladding and coating as shown in figure below

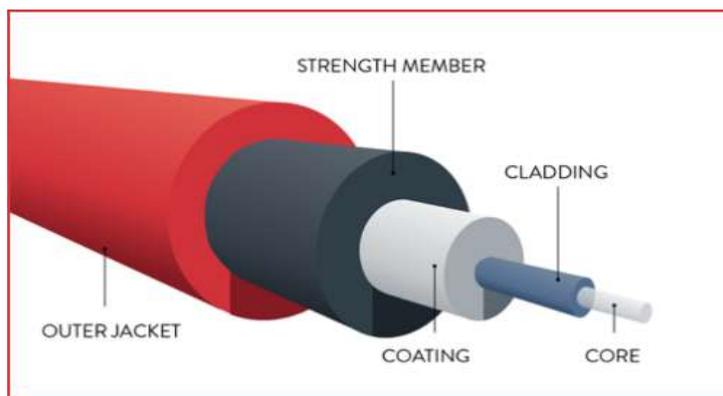


Figure 1 – Structure of an optical fiber (Source: ofsoptics.com)

There are three basic types of optical fibers:

- 1) Single-mode step index fiber
- 2) Multi-mode step index fiber
- 3) Multi-mode graded index fiber

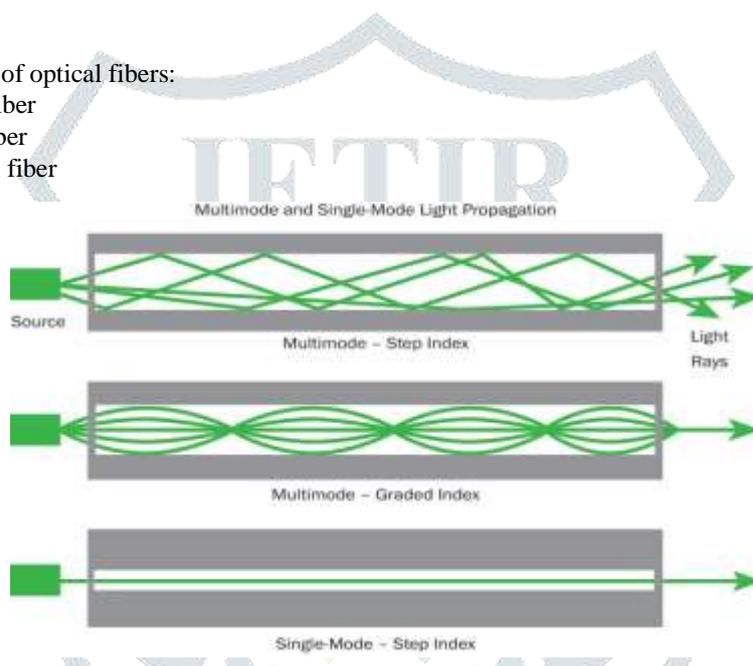


Figure 2 – types of optical fibers (Source: mefiberoptic.com)

The multimode fibers propagate hundreds of light modes at one time while single mode fibers only propagate one mode.

III. WORKING PRINCIPLE

The transparent concrete or light transmitting concrete is based on the principle of ‘Nano-Optics’. These fibers act as a slit and carry light throughout when placed on top of each other. The main principle behind transmission of light is the total internal reflection within the fiber. It is used to confine the light into the core of the fiber. The light travels through the core, bouncing back and forth off the boundary between core and cladding of the fiber. The total internal reflection within the fiber occurs when the light incidents the boundary with an angle greater than critical angle and hence only the light that enters the fiber within a certain range of angles travels down the fiber without leaking out. This range of angle is called acceptance core. It is depicted in the figure shown below.

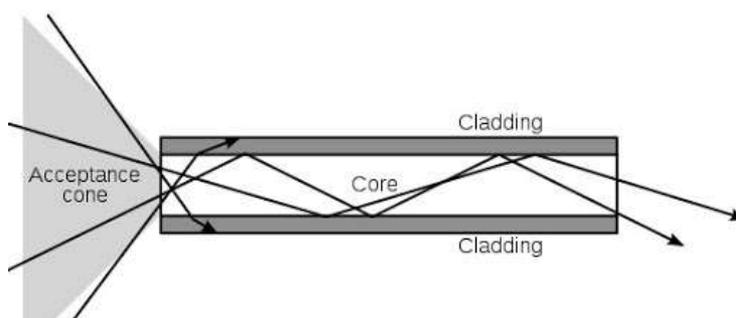


Figure 3 – working of an optical fiber (source: fiberfin)

IV. APPLICATIONS OF TRANSPARENT CONCRETE

A. Illuminations of walls –

Transparent concrete can be used for both interior as well as exterior walls. If using on exterior walls and sunshine illuminates the structure, an eastern or western placement must be applied. The rays of sun will hit the fibers and intensity of light achieved will be greater. Besides other traditional applications, it can also be used as a wall covering illuminated from the back.



Figure 4 - Translucent concrete wall (source: homedesigning)

B. Decorative Designs –

Transparent concrete can be used as artistic and creative designs in the interiors. You can use it in inscriptions, pictures, concrete benches and for various other beautification purposes.

C. Use in Roadways and Pavements –

Speed bumps in highways or roads can use transparent concrete blocks with a light source beneath or by reflecting from other sources to help in navigation effectively. The lane markers on roadways could use this material to light up the roads and help increase visibility. This can also be used for road crossings to properly highlight them.



Figure 5 – transparent concrete in road crossings (Source: bftinternational)

Transparent Concrete can also be applicable at.

1. Sidewalks at roads during night time.
2. In the interior of buildings, for example staircases, partition walls, etc.
3. For facades and wall cladding purposes.
4. To illuminate the interior in window-less rooms.
5. In decorative pieces, furniture or any other aesthetic purpose.
6. Light fixtures.
7. Reception desks, waiting rooms, etc.
8. To increase visibility at darker places.

V. ADVANTAGES AND DISADVANTAGES OF TRANSPARENT CONCRETE

Advantages

1. The most important advantage of transparent concrete is that it can transmit light; this makes it a material to be used in green buildings.
2. Since it has the ability to transmit light through both artificial as well as natural sources, a building can have much fewer lights, thus saving great cost for energy.

3. As transparent concrete can use sunlight as a source of energy, it can potentially be used on cold regions to transmit heat with the help of sunlight.
4. It contains very good artistic and architectural properties and hence can be very good for aesthetics of a building or structure.
5. It can be used at such places where there is minimum to no light, thus saving a lot of energy, for example in window-less rooms.
6. It can potentially be used in replacement of glass facades in buildings, thus performing the work of having maximum utilization of daylight without compromising on privacy.

Disadvantages

1. Transparent concrete comes with a higher initial cost due to the use of optical fibers which are expensive.
2. Casting and manufacture of transparent requires skilled labor as well as skilled supervision for the process of installation of optical fibers.

VI. FUTURE SCOPE OF TRANSPARENT CONCRETE AS A BUILDING MATERIAL

1. Due to its higher manufacture cost, it will take a while before transparent concrete can be seen renovating the cities.
2. A lot of research work is being done so that a more affordable version of transparent concrete can be produced.
3. It can be used as an eco-friendly alternative to conventional concrete in the future due to its light transmitting properties.
4. Transparent concrete cannot readily replace the conventional concrete due to lack of expertise in its manufacture. It requires skilled personnel to manufacture and cast transparent concrete.
5. Transparent concrete at the same time can be a building material as well as a light source, can be a wall of concrete or a floor; hence could be a high potential building material in the near future.
6. Transparent concrete is a very good insulating material which can protect from extreme weather conditions without actually shutting on the daylight.
7. Illumination of underground structures can be done with the help of such concrete without having to spend a lot on energy consumption.
8. Transparent concrete can prove to be a sustainable material, and hence can be used for green building construction.

VII. CONCLUSION

1. Currently, transparent concrete mainly has applications in partition walls and aesthetic purposes rather than in structural parts like beams and slabs.
2. It is light weight as compared to conventional concrete.
3. Transparent concrete can be used in decorative purposes in buildings such as wall cladding, panels, in place of glass facades, etc.
4. It is very less likely that transparent concrete will lose the strength parameter when compared to conventional concrete.
5. Transparent concrete can save energy consumption to a great extent thus reducing electricity bills.
6. This energy saving property of transparent concrete makes it an eco-friendly and sustainable material and hence can be used extensively in green buildings.
7. Due to its very good aesthetical properties, transparent concrete could also be used as an art in museums and elsewhere instead of just limiting it to a building material.
8. With more research and more use of light-transmitting concrete, more uses and applications of transparent concrete can be discovered.

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