

# **Transparent Concrete**

By

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## OBJECTIVES

- ✓ To make concrete partly transparent by using optical fibers in it to impart good appearance to structure.
- ✓ To study improvement in performance of concrete in light transmission by using optical fiber and improve performance of structure to derive natural light.
- ✓ To study Energy saving for illumination by using transparent block for building.
- ✓ To study cost effectiveness of this high performance concrete

## INTRODUCTION

I selected Transparent Concrete as my term paper writing because it is interesting to me being a mechanical engineer as well as Transparent Concrete has become most favorable progressive technology for the 21st Century and has the potential to develop both industrial and consumer products by combining optical fibers with normal concrete material. Its uses can change our lives and the way of living passionately.

This paper deals with the introduction of Transparent Concrete, with detailed discussion on recent developments of Transparent Concrete, their desired properties, their making procedure and applications, their behavior in use, commercial applications. Current applications and future applications. Supporting figures and tables have been inserted in the text and in the paper a conclusion of the paper has been made.'

Due to the increasing of population of the world every one want good facilities of living. Due to increase in population space utilization is more effective factor, high rise buildings are constructing in big cities of the world, especially in those countries which have greater population and also gave a good economic condition. In high rise buildings it is a big problem of natural light in buildings due to the blockage of nearby structures. To minimize this effect it is essential to use the material which will not block natural light into the buildings. [9]

A best material is available in the market and which is broadly used since 1990s. An architectural engineer of Hungary country, Aron Losoncz suggested in 2001 about the concrete which will pass on the light from its surface. Transparent concrete block was successfully made in 2003. Light passing concrete is known as Transparent concrete which is act as a construction material which is made by optical fiber ,cement and water.

Transparent concrete is 30% lighter than normal concrete and lets through 80% of the light. It is available in the form of precast panels. It is use as a decorative material. Optical fibers are arranged in parallel form at outer side of the panel and light is transmit due to parallel arrangement. It can bear heavy loads and fibers cannot decrease the strength. The panels are built in every size and shapes, surrounded with an isolation with a property of stopping heat. The concrete is embedded with thousands of optical glass fibers. These fibers form a matrix and run parallel between the two main surfaces. [1] [6]

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. [8]

## RECENT DEVELOPMENT

The community has great challenges and it needs useful solution for the challenges as like the global climate change, using energy in a sustainable way and protecting the environment. We should find a good solution, for instance: using of solar energy, transparent heat insulation, passive buildings etc. The development of the building technology in the field of building

industry is a good way to eliminate the emission of greenhouse gases, because we shall use less loam and the industry will not need to transfer those materials.

The former Research and Development results will be combined with the technologies of the frozen sand concrete and the non-tectonic constructions theories and practices. The results of the last decades in the field of concrete technology and material science could be combined with the new Research and Development results. New Research and Developments are developing of a simple, cheap and productive optical fiber, especially according to the production of the transparent concrete. The use of this material in the solar architecture in a cheap way. The other aim is that the people could use it more. By the results, the transparent concrete will be available for everybody, because the technology is cheap and productive due to the fiber pulling and brick technology methods. [7][8][13]

## **MATERIAL**

Materials which used for the making of transparent concrete are:

### **OPTICAL FIBER**

Flexible, transparent fiber made up of glass or plastic. It transmits light between two ends of the fiber. Optical fiber transmits light so effectively that there is almost no loss of light conducted through the fibers. The thickness of optical fiber should be varied from 2  $\mu\text{m}$  and 2 mm nearly equal to diameter of human hair.

Concrete is produced by adding 4% to 5% optical fiber by volume in concrete mix. [2][13]

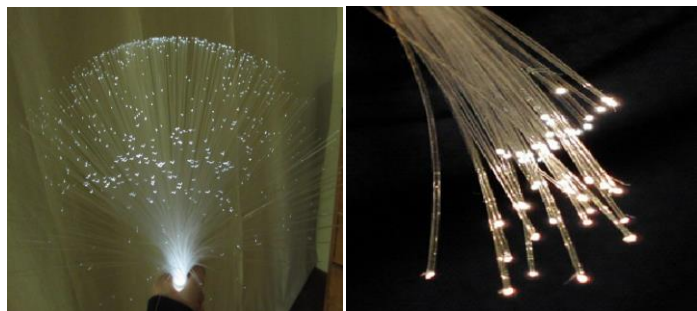


Figure 1 optical fiber [2] [5]

### **CEMENT**

Ordinary port land cement is used for the preparation transparent concrete. [2]

## SAND

Sand is naturally available material which is composed rock and mineral particles. Size of sand should pass through 1.18mm sieve. It should be free from impurities and organic matters. [2]

## WATER

The role of water is important because the water to cement ratio is the most critical factor in the concrete. It should be of drinking water quality. It should be free from all impurities. [2]

## MANUFACTURING PROCESS

The manufacturing process of transparent concrete is almost same as regular concrete. Only optical fibers are spread throughout the aggregate and cement mix. Small layers of the concrete are poured on top of each other and filled with the fibers and are then connected. Thousands of strands of optical fibers are cast into concrete to transmit light, either natural or artificial. Light-transmitting concrete is produced by adding 4% to 5% optical fibers by volume into the concrete mixture. The concrete mixture is made from fine materials only it does not contain coarse aggregate. Thickness of the optical fibers can be varied between 2  $\mu\text{m}$  and 2 mm to suit the particular requirements of light transmission. Automatic production processes use woven fibres fabric instead of single filaments. Fabric and concrete are alternately inserted into molds at intervals of about 2 mm to 5 mm. Smaller or thinner layers allow an increased amount of light to pass through the concrete. Casting, the material is cut into panels or blocks of the specified thickness and the surface is then typically polished, resulting in finishes ranging from semi-gloss to high-gloss. [11]

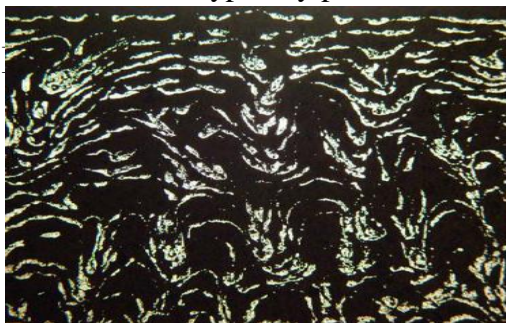


Figure 10: transparent Concrete When Optical Are in Organic Distribution

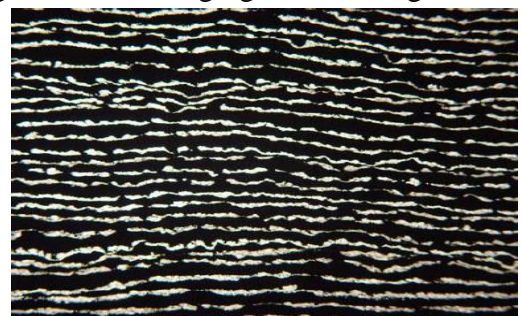


Figure 11: Transparent Concrete When Optical Fibres Are In

## PROPERTIES

The properties of light transmitting concrete are determined by conducting various experiments like compressive strength test and flexural strength. A typical transparent concrete block is shown in figure 10



Fig 12: Transparent concrete block

## COMPRESSIVE STRENGTH:

The compressive strength of a material is the value of uniaxial compressive stress at which the material fails completely. It is only determined by doing an experiment of compressive strength.

The compressive strength is determined by casting the cubes of different sizes (e.g. 150mm x 150mm x 150mm)

The compressive strength of the conventional concrete and light transferring concrete in 7, 14 and 28 days is shown in figure. Transparent concrete has Compressive strength-50-220 N/mm<sup>2</sup>

.Mix proportions are as follows:

Cement – 360 kg	Sand – 560 kg
Fiber – 4.5 kg	Water – 190 liter

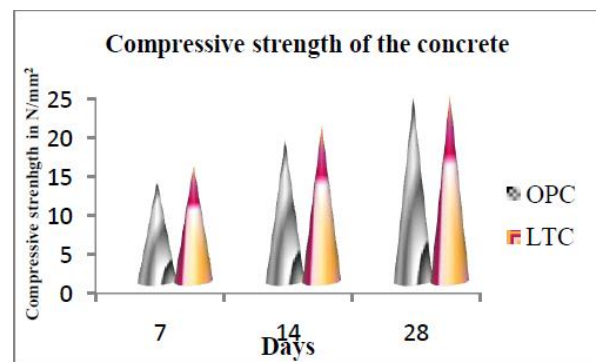


Figure 13 Compressive strength of concrete

By comparing both, transparent concrete and ordinary plain cement concrete the result is same.

Hence it is fit for load bearing structures also. [13][15]

## FLEXURAL STRENGTH:

The flexural strength is determined by conducting two point loading test on the concrete sample

The flexural strength of the conventional concrete and light transmitting concrete having mix proportion as above in 7, 14 and 28 days is shown in figure

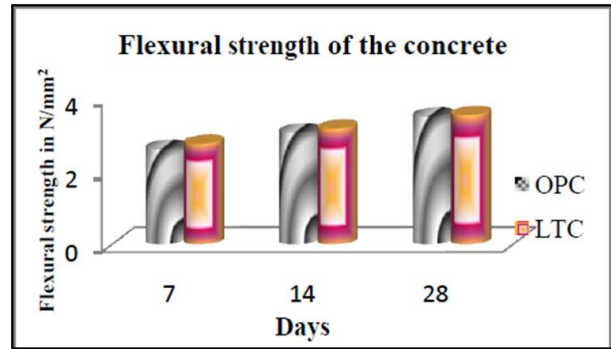


Figure 14 flexural strength of the concrete

The flexural strength result of this concrete is interconnected with results of ordinary plain cement concrete. The results obviously show that the performance of transparent concrete based on the strength characteristic is also considerably high. Flexural Strength of this is 7.7 N/mm<sup>2</sup>. Thus the study accomplishes that the transparency of light is possible in concrete without affecting its compressive strength, as the optical fibers act as fiber reinforcement thereby enhancing the strength and also improves appearance. [15]

#### MATERIAL PERFORMANCE:

- Concrete retains its strength
- High density top layer concrete
- Infused with optical fibers
- Frost and de-icing salt resistant.
- Fire protection.
- Highest Ultra Violets resistance.[15]

#### OTHER PROPERTIES

- It permits the light, colors, shapes and outlines which are seen to through it
- Water absorption capacity of this concrete is 0.35%.
- Maximum oxygen index of transparent concrete is 25%.
- Thermal conductivity is 0.21 W/m C°.



- Elastic limit of this concrete is greater than 60 MPa
- Having a Density from 2100 to 2400 kg/m<sup>3</sup>
- Young's Modulus ranges from 2750 MPa to 3450 MPa.
- It is a good conductor of electricity which is providing with interior.
- From its mechanical and optical characteristics, can be used for purposes that are both architectural and aesthetic, and also.[15]

## APPLICATIONS

Various applications of transparent concrete are:

### ILLUMINATION OF WALL

Transparent 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. [10][12]

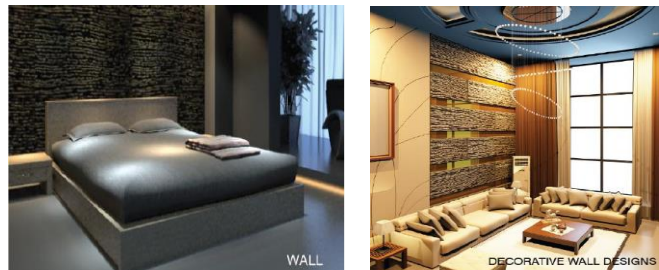


Figure 15 Walls illuminated by transparent concrete [17]

### DESIGN

The building units are multipurpose and can be used in many areas of design. Two successful designs using the light transmitting concrete were an ornament and a concrete workbench. You can also create a logo with colorful figures, engravings, and pictures and can used for redecoration purpose. [10][11]



Figure.16. Creative Column and transparent concrete panels [19]



## STAIRS-

With Impact Lighting Inc.'s Linear LED fixtures, transparent Concrete product can be used in horizontal and vertical applications such as feature stairs, walls, flooring, tables and counter tops. [10][12]



Fig.17. Translucent Concrete Stairs [19]

## PAVEMENT

Light transmitting concrete can be used as flooring a passable surface illuminated from below. During the day it looks like typical concrete pavement but at sunset the paving blocks begin to shine and in different colors. Fig: shows the pavement illuminated by transparent concrete. [10][12]

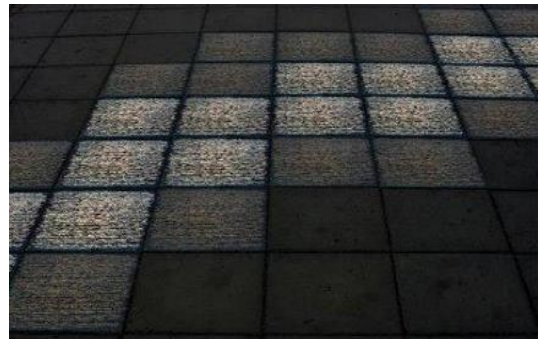


Fig 18: Pavement illuminated

## RECEPTION DESK

If you really want to create a look that stands out, you should choose for this art and style reception desk where light up in the front and the sides. [10][7]



Figure 19: Reception Desk [17]

## LIGHTING FIXTURE

The transparent concrete cube is, without a doubt, a great conversation piece. The new cube line consists of four identical pieces of concrete and, due to its special geometry

The pieces form a stable structure without fixing them together. [10]



Figure 20: Lamps made of transparent concrete [17]

### OTHER APPLICATION

Translucent concrete blocks inserted on front doors or walls next to it allow the residents to when  
There is a person standing outside



Fig 21: Shadow of person standing outside [17]

1. Translucent concrete walls on restaurants, clubs, and other social formations help see how many people are actually inside it. Transparent concrete walls in an office can be seen in fig22



Fig 22: Transparent concrete walls in an office [19]

2. Ceilings of large commercial buildings with transparent concrete would help to decrease a great deal of lighting costs during day time.



Fig 23: Transparent concrete ceiling [19]

3. Speed bumps in parking area's and highways can use transparent concrete blocks with a light source underneath or dazzling from other vehicles help in navigation very effectively. Even lane markers in highways can use this material to light up the roads.



Fig 24: Highway marked with transparent concrete

4. Walkways with transparent concrete fitted with a single light source under would add a lot to the scenic attractiveness as well as protection and also encourage walking or foot travel during night times.

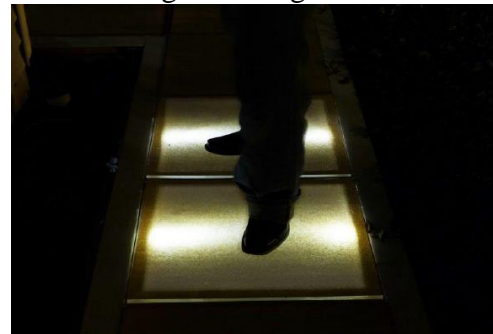


Fig 25: Transparent concrete panel

5. Transparent concrete blocks combined in inner walls help during times of power cuts at night leading to a great deal of safety. In the same way for underpasses and airports etc., this transparent concrete blocks would add to the brightness.



1. Figure 26 Exterior transparent wall [17]

6. Transparent concrete blocks can be made in preferred shapes and used as ornamental materials like shelves and sunshades, tables and sculptures. A wash stand made of light spreading concrete can be seen in figure.



Figure 27: Wash stand [17]

- 7 They can also be placed as casual designs on safety walls which also improve safety giving the resident a smoky view of the outside



Figure 28: Transparent concrete wall [19]

- 8 Places like schools, exhibition hall and prison cells outer walls can find transparent walls very beneficial as they add protection as well as security and administration.[10][14][12]

## TRANSPARENT CONCRETE FUTURE

Although translucent concrete has been used primarily as an interior decoration, its creators have “visions of cities that glow from within, and buildings whose windows need not be flat, rectangular panes, but can be arbitrary regions of transparency within flowing, curving walls” [14]. It “can at the same time be building material and light source, can separate and connect, can be wall or floor, ambient lighting or eye-catcher” [17]. Translucent concrete is also a great insulating material that protects against outdoor extreme temperatures while also letting in daylight [15]. This makes it an excellent compromise for buildings in harsh climates, where it can shut out heat or cold without shutting the building off from daylight. It can be used to illuminate underground buildings and structures, such as subway stations. Translucent concrete could provide safety applications in the future such as speed bumps that could be lit “from below to make them more visible at night”, or to light indoor fire escapes in case of a power failure [16]. It even has the potential to be sustainable; the aggregate can be replaced with crushed recycled glass [15]. The possibilities for translucent concrete are innumerable; the more it is used, the more new uses will be discovered. In the next few years, as engineers further explore this exciting new material, it is sure to be employed in a variety of interesting ways that will change the opacity of architecture as we know it.

## CONCLUSION

A transparent concrete is aesthetically pleasing. Optical fiber 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. Moreover, this light transmitting concrete can be utilized in the production of special types of home furniture. In future, the cost of light transmitting concrete is expected to decrease with the advancement in technology, manufacturers and as well as the users. Translucent concrete is the future. It is the smart way of optimizing and utilizing light, a smart way of living.

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