

# Transparent Concrete

Rasvir Singh<sup>1</sup>, Sunil Priyadarshi<sup>2</sup>

<sup>1</sup>M. Tech. Student, Department of Civil Engineering, Rayat Bahra University, Chandigarh, India

<sup>2</sup>Assistant Professor, Department of Civil Engineering, Rayat Bahra University, Chandigarh, India

**Abstract:** Transparent concrete is a concrete based building material with light-transmissive properties due to embedded light optical elements usually Optical fibers. Light is conducted through the stone from one end to the other. Therefore, the fibers have to go through the whole object. Transparent concrete is also known as the translucent concrete and light transmitting concrete because of its properties. It is used in fine architecture as a facade material and for cladding of interior walls. In this paper, to integrate the merits of concrete and optical fiber, for developing transparent concrete by arranging the high numerical aperture Plastic Optical fibers (POF) or big diameter glass optical fiber into concrete. The main purpose is to use sunlight as a light source to reduce the power consumption of illumination and to use the optical fiber to sense the stress of structures and also use this concrete as an architectural purpose for good aesthetical view of the building.

**Keywords:** multimode fiber “Nano-Optics and semi-gloss

## 1. Introduction

Just a few decades ago concrete was often misunderstood, disliked and captured by its image fixed due to the rapid urbanization of the 1960s. But since that time, concrete has made considerable progress, not only in technical terms, but also in aesthetic terms. It is no longer the heavy, cold and grey material of the past; it has become beautiful and lively. By research and innovation, newly developed concrete has been created which is more resistant, lighter, white or colored, etc. Concrete has learned to adapt to almost all new challenges that appeared. In 2001, the concept of transparent concrete was first put forward by Hungarian architect Aron Losonzi, and the first transparent concrete block was successfully produced by mixing large amount of glass fiber into concrete in 2003, named as LiTraCon. Joel S. and Sergio O.G. developed a transparent concrete material, which can allow 80% light through and only 30% of weight of common concrete. It is worth mentioning that Italian Pavilion in Shanghai Expo 2010 shows a kind of transparent concrete developed by mixing glass into concrete in 2010. While the transparent concrete mainly focuses on transparency and its objective of application pertains to green technology and artistic finish. Therefore, it is imperative to develop a new functional material to satisfy the structure in terms of safety monitoring (such as damage detection, fire warning), environmental protection and energy saving and artistic modeling. Transparent or translucent concrete can be seen as a recent answer to the architects call for more transparent Architecture.

Table 1  
 Properties of Transparent Concrete Blocks By Litracon Company

Product	Litracon- Light Transmitting Concrete
Form	Prefabricated blocks
Ingredients	96% concrete, 4% optical fibre
Density	2100-2400 Kg/m <sup>3</sup>
Block size	600mm x 300mm
Thickness	25-500mm
Colour	White, Grey or Black
Fibre distribution	Organic
Finished	Polished
Compressive strength	50 N/mm <sup>2</sup>
Bending Tensile strength	7 N/mm <sup>2</sup>

Source: www.litracon.hu/productlist.php

## 2. Material used for transparent concrete

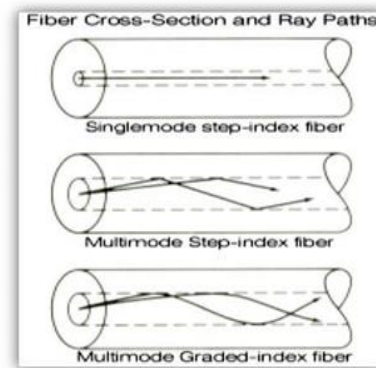


Fig. 1. Types of fibers

Source: Simon Kwan, “Principles of Optical Fibers”, San Jose State University, 2002 Since the single-mode fibers propagate light in one clearly defined path, intermodal dispersion effects is not present, allowing the fiber to operate at larger bandwidths than a multimode fiber. On the other hand, multimode fibers have large intermodal dispersion effects due to the many light modes of propagations it handles at one time.

There are two basic materials used for making transparent concrete, one is from construction field and another from sensing field. First, concrete is one of the most important civil engineering materials with the advantages of rich raw materials, low cost and simple production process and second the optical fiber has good light guiding property which can be arrange to transmit the light and the sun light transmit according to pre-

design road without light-heat, light-electrical or photochemical process, and photo elastic effect which can be used to study the stress distribution of structures. Combining the advantages of the concrete and optical fiber, developing a novel functional material called transparent concrete has an important value in the application of construction and sensing. Types of optical fiber, there are three basic types of optical fibers:

- Multimode graded-index fiber
- Multimode step-index fiber
- Single-mode step-index fibers.

A multimode fiber can propagate hundreds of light modes at one time while single-mode fibers only propagate one mode as shown in Fig. 1.

### 3. Principle

Transparent concrete or translucent concrete is work Based on “Nano-Optics”. Optical fibers pass as much light when tiny slits are placed directly on top of each other as when they are staggered. Principal can carry because optical fibers in the concrete act like the slits and carry the light across throughout the concrete.



Fig. 2. Transparent panels

### 4. Construction

Transparent concrete is produced out of fine-grain concrete and translucent fabric which is layer cast in pre-fabricated mould. Because of relatively small amount of fabric, solidity and consistency of transparent concrete are the same as the high-strength concrete. Almost free energy loss light penetration through optic fibers makes it possible to see light, shadows and even colors through concrete even by very thick walls. It can be produced as prefabricated building blocks and panels. Due to the small size of the fibers, they blend into concrete becoming a component of the material like small pieces of aggregate. In this manner, the result is not mixed material like glass in concrete but a new material, which is homogeneous in its inner structure as well as on its main surfaces. The optical fibers lead 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.

### 5. 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 infused 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 fibers fabric instead of single filaments. Fabric and concrete are alternately inserted into molds at intervals of approximately 2 mm to 5 mm. Smaller or thinner layers allow an increased amount of light to pass through the concrete. Following 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.



Fig. 3. Transparent concrete when optical fibers are in organic distribution

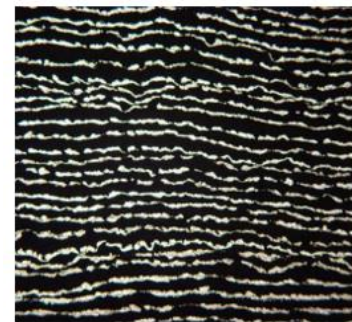


Fig. 4. Transparent Concrete When Optical Fibers Are in Layered Distribution

### 6. Application

#### A. *Illuminate your walls*

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.



Fig. 5. Translucent Wall for Architectural View

**B. Watch your pavement shine at sunset**

This 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.

**C. Get creative with design**

The building units are versatile and can be used in many areas of design. Two successful designs using the light transmitting concrete were a jewel and a concrete bench. You can also create a logo with colorful figures, inscriptions, and pictures and can be used for beautification purpose



Fig. 6. Decorative Wall Design

**D. Artsy reception desk**

If you really want to create a look that stands out, you should opt for this artsy and vogue reception desk where light up in the front and the sides.

**E. A Lighting fixture and conversational piece**

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.



Fig. 7. Transparent Partition Wall

**F. It can be also applicable at**

- 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 aVallabh power failure.
- Illuminating speed bumps on roadways at night.

**7. Advantages and disadvantages**

- The main advantage of these products is that on large scale objects the texture is still visible - while the texture of finer translucent concrete becomes indistinct at distance.
- When a solid wall is imbued with the ability to transmit light, it means that a home can use fewer lights in their house during daylight hours.
- It has very good architectural properties for giving good aesthetical view to the building.
- Where light is not able to come properly at that place transparent concrete can be used.
- Energy saving can be done by utilization of transparent concrete in building.
- Totally environment friendly because of its light transmitting characteristics, so energy consumption can be reduced.
- The main disadvantage is these concrete is very costly because of the optical fibers.
- Casting of transparent concrete block is difficult for the labor so special skilled person is required.

**8. Conclusion**

A novel architectural material called transparent concrete can be developed by adding optical fiber or large diameter glass

fiber in the concrete mixture. The transparent concrete has good light guiding property and the ratio of optical fiber volume to concrete is proportion to transmission. The transparent concrete not loses the strength parameter when compared to regular concrete and also it has very vital property for the aesthetical point of view. It can be used for the best architectural appearance of the building. Also used where the light cannot reach with appropriate intensity. This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials.

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