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An Investigation into Transparent Concrete: A Fresh Approach to Building Materials

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Research Article
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Abstract: *When light-transmissive optical devices, such as optical fibres, are implanted in concrete, the resulting material is known as transparent concrete. The stone allows light to pass through it from one side to the other. Consequently, the fibres must traverse the whole object. Due to its qualities, transparent concrete is also called light-transmitting concrete and translucent concrete. Its usage as a façade material and for cladding internal walls is common in excellent architecture. Transparent concrete made from high numerical aperture Plastic Optical Fibres (POF) or large diameter glass optical fibres is the goal of this research, which aims to combine the best features of both concrete and optical fibre. Using solar energy to power lights while simultaneously reducing electricity use, sensing structural stress via optical fibre, and enhancing the building's aesthetics are the primary goals.*

Keywords: **Transparent Concrete, Optical Fibre, Architectural, Concrete.**

I. INTRODUCTION

Because of the fast urbanisation that occurred in the 1960s, concrete was widely misunderstood and despised only a few decades ago. However, concrete has come a long way since then, both technically and aesthetically. Material that was formerly drab and uninspiring is now vibrant and lovely. Modern concrete is stronger, lighter, whiter, more colourful, etc., thanks to scientific advancements and creative thinking. As new obstacles have arisen, concrete has learnt to adapt to almost all of them. Originally proposed by Hungarian architect AronLosonzi in 2001, the first transparent concrete block, LiTraCon, was manufactured in 2003 using a combination of concrete and a substantial quantity of glass fibre. A translucent concrete substance was created by Joel S. and Sergio O.G.; it allows 80% light through while weighing just 30% of regular concrete. Notably, a kind of see-through concrete was shown during the 2010 Shanghai Expo by the Italian Pavilion. This material was created by incorporating glass with concrete. Transparent concrete, on the other hand, is primarily concerned with being transparent, and its intended applications include environmentally friendly technologies and decorative finishes. In order to meet the needs of the building in terms of safety monitoring—including damage detection and fire warning—environmental protection, energy savings, and artistic modeling—a new functional material must be developed. Clear or see-through concrete more Openness in Building Design.

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^2
Block size	600mm x 300mm
Thickness	25-500mm
Colour	White, Grey or Black
Fibre distribution	Organic
Finished	Polished
Compressive strength	50 N/mm^2
Bending Tensile strength	7 N/mm^2

Source: www.litracon.hu/productlist.php

II. MATERIAL USED FOR TRANSPARENT CONCRETE

Transparent concrete is primarily made from two types of materials: one from the building industry and one from the sensing industry. With its abundant raw materials, cheap production costs, and straightforward manufacturing process, concrete is a crucial material in civil engineering. On the other hand, optical fibres have excellent light-guiding properties, allowing them to be arranged to transmit light and sunlight according to pre-designed roads. This is all without the need for light-heat, light-electrical, or photochemical

processes, and they can even be utilised to study the stress distribution of structures through the photo elastic effect. Transparent concrete, a new functional material that combines the best features of concrete with optical fibre, has significant potential uses in building and sensing.

Types of optical fibre

There are three basic types of optical fibers:

[1] Multimode graded-index fiber
[2] Multimode step-index fiber
[3] 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 below.

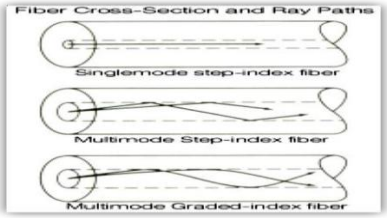


Fig 1: Types of Fibre

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.

III. PRINCIPLE

Transparent concrete or translucent concrete is work Based on "Nano-Optics". Optical fibres passes 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.

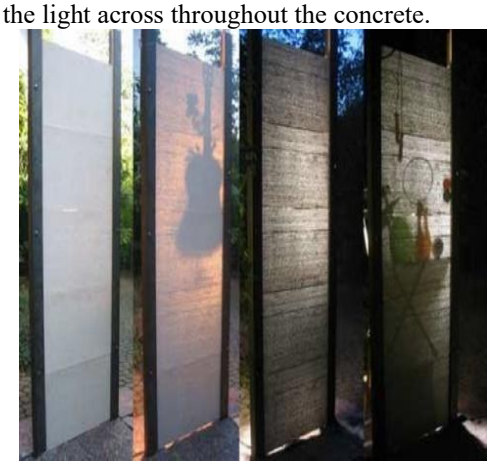


Fig 2: Transparent Panels

Source: entertainingscience.blogspot.com

IV. 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 fibres makes it possible to see light, shadows and even colours through concrete even by very thick walls. 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. 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 fibres 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 colour of the light also remains the same.

V. MANUFACTURING PROCESS

The manufacturing process of transparent concrete is almost same as regular concrete. Only optical fibres 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 µm 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 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 Fibres Are In Organic Distribution

Source: Victoria Bailey, "Translucent Concrete", MEEN 3344-001

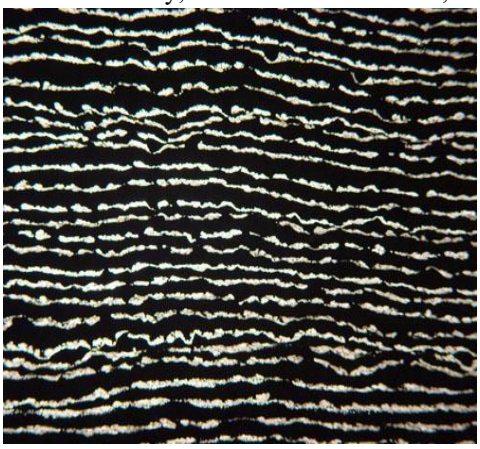




Fig 4: Transparent Concrete When Optical Fibres Are In Layered Distribution

Source: Victoria Bailey, "Translucent Concrete", MEEN 3344-001

VI. 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

Source: www.impactlightinginc.com

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 used for beautification purpose.

Fig 6: Decorative Wall Design

Source: www.impactlightinginc.com

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

Source: www.litracon.hu

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

VII. 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 fibres.
- Casting of transparent concrete block is difficult

for the labour so special skilled person is required.

VIII. CONCLUSION

By incorporating optical fibre or large diameter glass fibre into the concrete mixture, a new architectural material known as transparent concrete may be created. Transparent concrete has excellent light-guiding properties, and transmission is directly proportional to the volume of optical fibres to concrete. In comparison to conventional concrete, translucent concrete retains its strength parameter and has important aesthetic properties. It may be used to enhance the building's architectural appeal. Used as well in areas where strong enough illumination is not available. The novel self-sensing characteristics of functional materials may be combined with the idea of green energy conservation in this innovative construction material.

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[19]Several websites provide information on translucent concrete, including: [20] nbmcw.com, www.thesurfacegallery.com, and http://www.magtudin.org/Translucent%20concrete.htm.