

Specimen of Light Transmitting Concrete

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ABSTRACT

Transparent concrete is a modern construction material which has the ability to transmit light. This property is achieved by placing glass rods or optical fibers inside the concrete. Because of this feature, it is also called light transmitting concrete. Compared to conventional concrete, this concrete has lower density and lower thermal conductivity. It also helps in reducing the dead weight of structures, increasing construction speed, and reducing transportation and handling cost. In this material, light passes from one side of the wall to the other side through optical fibers placed inside the concrete. Optical fiber is a flexible and transparent fiber made of glass or plastic, which is slightly thicker than a human hair. It works as a light guide and helps in transmitting light from one end to the other. The main aim of this study is to prepare translucent concrete blocks using cement, sand, glass rods, and optical fibers and to compare their physical and engineering properties with conventional concrete blocks. In this project, glass rods and optical fibers are added in different percentages such as 1%, 1.3%, 1.6%, and 1.9% of the total weight of the concrete mix with 1 cm spacing. Concrete cubes of size 100 mm × 100 mm × 100 mm are prepared to determine important properties like compressive strength and density for fiber percentages ranging from 0% to 1.9%. Due to the increasing population and high energy consumption in the world, non-renewable energy resources may get exhausted in the future. Light transmitting concrete is one such material which can help in reducing electricity consumption by allowing natural light to pass through walls.

Key words: transmitting concrete, compressive strength, density of concrete, compressive strength, optical fibers.

1. INTRODUCTION

Concrete is one of the most commonly used construction materials because of its strength and durability. However, normal concrete does not allow light to pass through it, which increases the need for artificial lighting in buildings. To overcome this problem, a new material called light transmitting concrete has been developed. Transparent concrete is made by placing optical fibers inside the concrete. These fibers help to transmit light from one side of the concrete block to the other. Because of this property, natural light can pass through walls, which helps in saving electricity and improving the appearance of buildings. In this project, translucent concrete blocks are prepared using cement, sand, glass rods, and optical fibers. Different percentages of fibers are used to study their effect on properties such as compressive strength and density of concrete cubes and to compare them with conventional concrete.

Transparent concrete is considered an innovative and sustainable construction material in modern civil engineering. It not only provides structural strength like conventional concrete but also allows the passage of light through it. Because of this property, it can be used in walls, facades, partitions, and decorative elements of buildings. The use of optical fibers in concrete helps to improve the aesthetic appearance of structures while also making them more energy efficient.

2. LITERATURE REVIEW

Shing Mei Chiew, Izni Syahrizal Ibrahim, et al., (2020):

This paper provides an overview on the development of Light-transmitting Concrete (LTC). Concrete is improved in terms of transparency by installing optical fibers into the concrete. The application of LTC in building enables light transmission, which reduces light energy consumptions and carbon footprint, providing a more sustainable living environment. From this project we conclude that Light transmitting concrete (LTC) is an innovative construction material which transmits light through the concrete and improves the lighting effect inside the building. LTC can reduce the light energy consumptions and carbon footprint produced, which promotes green building construction especially in urban area.

Sisira Sugunan, Nisha Babu, Sowparnika M (2016):

They prepared Translucent Concrete block was laboratory using broken glass as aggregate. Then they get to know with all study and test on the concrete that fresh concrete made by using glass aggregate was found to

have good workability. The provision of optical fibers along transverse direction gave ornamental effects through its translucency. The translucent glass concrete structures will become very common in the near future due to easiness in construction and the availability of raw materials. This actually makes construction more environmentally friendly due to the usage of waste glass

Bhavin K. Kashiyani, Varsha Raina, Jayeshkumar Pitroda, Dr. Bhavnaben K. Shah (February 2013):

They prepared transparent concrete by adding optical fiber or large diameter glass fiber in the concrete mixture and they come to result with some study and test 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.

3.METHODOLOGY

3.1Material Used –

Optical fibers - An optical fiber is a very thin and flexible fiber made of glass or plastic, slightly thicker than human hair. It is used to transmit light from one end to another. When optical fibers are used in concrete, they allow light to pass through the concrete block. In this project, plastic optical fiber of **0.5 mm diameter** is used to prepare the samples.

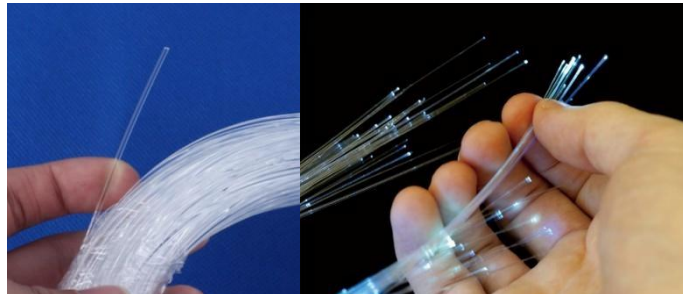


Fig No. 3.1 – Optical fibers



Fig No. 3.2 - Cement

● **Cement** - Cement is a binding material used to join fine and coarse aggregates to form concrete. When mixed with water, it hardens and gives strength and density to the concrete. In this project, Ordinary Portland Cement is used because of its high strength and durability.

● **Sand** - Sand is a fine aggregate used in concrete. It helps to fill the voids between coarse aggregates and improves the strength and workability of concrete. In this project, **clean and well-graded river sand** is used for preparing the concrete mix.



Fig No. 3.3 - Sand

● **Coarse Aggregate** - Coarse aggregates are particles with size greater than 4.75 mm, usually between 10 mm to 20 mm. They are mainly obtained from crushed stone or gravel and are used to give strength and stability to concrete. In this study, 12 mm and 20 mm size coarse aggregates are used.



Fig No. 3.4 – Coarse Aggregate



Fig No. 3.5 - Water

Water – Water is used in concrete for mixing cement, sand, and aggregates. It helps in the hydration process of cement, which gives strength and hardness to the concrete. In this project, clean and potable water is used for preparing the concrete mix.

4. METHODOLOGY PHASE DIAGRAM –

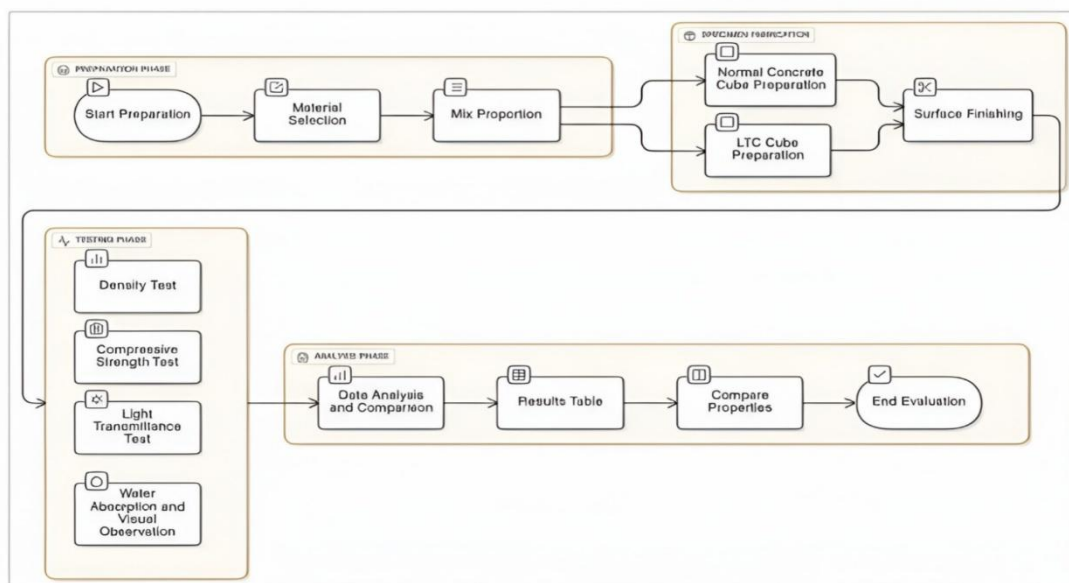


Fig No. 3.6 – Methodology Phase Diagram

Selection of Materials

Ordinary Portland Cement (Grade 53), river sand as fine aggregate, crushed coarse aggregates (nominal size 20 mm and 12 mm), potable water, and plastic optical fibers (POF Ø 0.5 mm) were used. All materials were tested for compliance with IS 12269 – 1987 and IS 456 – 2000.

Mix Proportion

Concrete mix ratio adopted: 1: 1: 2 (cement: fine aggregate: coarse aggregate) Water–cement ratio: 0.45

Preparation of Normal Concrete Cube

A 10 cm × 10 cm × 10 cm wooden mold was oiled internally.

Concrete was mixed thoroughly until a uniform consistency was obtained.

The mix was poured into the mold in three layers, each compacted on a vibrating table to remove air voids. After 24 hours, the cube was demolded and cured in water for 28 days.

Preparation of Light Transmitting Concrete Cube

A similar 10 cm × 10 cm × 10 cm mould was used, but perforated plates were attached on opposite faces to hold optical fibers.

POFs were inserted horizontally at uniform spacing (depending on required % of fibers). Concrete mix of the same ratio was poured and compacted carefully to avoid fiber displacement. After 24 hours, the specimen was demolded and cured in clean water for 28 days.

Surface Finishing

Both cubes were surface-finished and cleaned to remove burrs. Fiber ends were cut flush to the concrete surface using a sharp blade for neat light transmission.

Density Test

Each cube was oven-dried and weighed. Density = Mass / Volume (kg/m³).

Readings were compared for both specimens.

Compressive Strength Test

Both cubes were tested under a Compression Testing Machine (CTM – 200 T capacity) as per IS 516 – 1959. Compressive strength = Load / Cross-sectional Area (N/mm²). Results of both cubes were compared to study strength variation.



Fig No. 3.6 – Fiber Arrangement in Concrete Mould



Fig No. 3.7- Compressive Strength Test

Light Transmittance Test

Each cube was placed between a light source and a photometer (lux meter). Incident and transmitted light intensity were measured in lux.

$$\text{Transmittance \%} = \left(\frac{I_t}{I_i} \right) \times 100.$$

Normal cube readings served as the control.

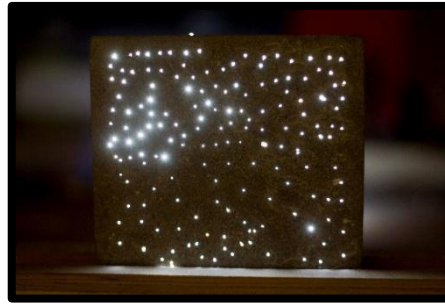


Fig No. 3.8 – Light Transmitting Concrete

Water Absorption and Visual Observation

Cubes were immersed in water for 24 hours; percentage water absorption was calculated. Visible illumination through LTC was observed under daylight and artificial lighting.

3.2 Data Analysis and Comparison

All test results were tabulated and compared to evaluate performance differences between normal and light-transmitting concrete in terms of density, strength, and light behavior.

5. RESULT

Table No. 4.1- Result

S.N.	Test	Normal Concrete	Light Transmitting Concrete
1	Density Test (kg/m ³)	2400 kg/m ³	2300 kg/m ³
2	Compressive Strength (After 28 Days Curing M25) (N/mm ²)	25 N/mm ²	22 N/mm ²
3	Light Transmittance (%)	0% (No Light Passes)	5% (Light Passes Through Optical Fibers)
4	Water Absorption (%)	4%	4%
5	Surface Finish Observation	Opaque Surface	Semi-Transparent Surface
6	Visual Appearance	Dull Grey Typical Cement Surface	Glowing Fiber Pattern Visible
7	Workability (Slump Test) (cm)	110 mm (Medium Workability)	100 mm (Medium Workability)
8	Durability	Good, Strong & Durable under normal conditions	Good and Durable
9	Cost Per Cube (Rs.)	Rs. 60	Rs. 120
10	Overall Performance	High Strength, No Light Transmittance	Moderate Strength with Light Transmittance

4. EXAMPLES

1) The Europe Gate

It is located in Fortress Monostor in the Hungarian town, Komarom

The sun illuminates the 37.6ft large Litracon piece of the statue in the mornings and late afternoons In night an even more impressive view can be seen because of the embedded light sources.



Day view



Night view

Fig no. 5.1- The Europe Gate

2) Cella Septichora, Pecs, Hungary

This historical site beautifully showcases the use of light transmitting concrete to enhance the visibility of ancient structures. The material allows natural light to pass through, creating an elegant and illuminating effect without damaging the original architecture. It has a door made of Litracon Panels set in a steel frame.



Night view



Day view

Fig No. 5.2 - Cella Septichora, Pecs, Hungary

3) New Headquarters of Bank of Georgia:

Walls, walks, receptions, offices and consultation desks are illuminated by transparent concrete.

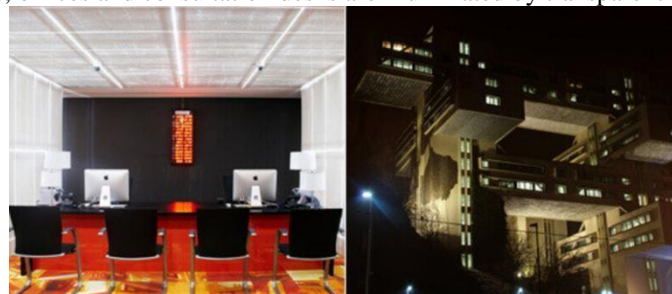


Fig No. 5.3 - New Headquarters of Bank of Georgia

5. ADVANTAGES

1. Integrated Structural Health Monitoring:

Optical fibers can act as crack or strain sensors, detecting internal damage by change in light transmission.

2. Passive Daylighting Control:

LTC panels can be designed to control light intensity and direction, helping maintain indoor visual comfort without glare.

3. Thermal Stability:

The embedded fibers slightly reduce heat transfer, providing better thermal insulation compared to glass or acrylic panels.

4. Reduced Light Pollution:

By channeling light exactly where needed (through fibers), LTC minimizes wasted illumination and improves visual efficiency.

5. Future-Ready Material for Smart Cities:

Compatible with IoT-based building systems, where light transmission can be integrated with sensors for smart façades or energy tracking.

6. CONCLUSION

From the experimental study, it is observed that light transmitting concrete allows light to pass through the concrete with the help of optical fibers. As the percentage of optical fibers increases, the light transmission capacity of the concrete also increases. This property makes the material useful in buildings where natural light is required.

The compressive strength of light transmitting concrete is slightly lower than conventional concrete, but it is still suitable for many construction purposes. The density of the concrete also decreases slightly with the increase in the percentage of optical fibers. However, the concrete still maintains enough strength and durability for practical use.

Transparent concrete also improves the architectural appearance of buildings because of the light patterns created by the optical fibers. It can be used in walls, partitions, and decorative structures where light is needed but direct openings are not possible.

Overall, light transmitting concrete is an energy-saving and eco-friendly construction material. It helps in reducing electricity consumption during daytime by allowing natural light to enter buildings, and it can become an important material for future sustainable construction.

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