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EXPERIMENTAL INVESTIGATION OF LITRACON BY USING PLASTIC OPTICAL FIBER

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Abstract: Light transmitting concrete is cement based building material with light transmitting property due to embedded light optical elements usually optical fiber. Light is conducted through the optical fiber one end to other. Light transmitting concrete is also knows as translucent concrete because of its transparent property. It is used in fine architecture as a decorative material and for internal walls. The main purpose is to use natural sunlight as a light source to reduce the power consumption of illumination and to use optical fiber to sense the stress of structure and also use this concrete as architectural purpose for good aesthetic view of the building. The present investigation aims to producing the light translucent concrete by using optical fiber with different percentage and comparing it with normal concrete. Different tests will be performed on the concrete specimen i.e. compressive strength test and light transmission test.

Keywords: Light transmitting concrete, Litracon, Optical Fiber, Cement and Aggregate.

1. INTRODUCTION

Concrete has a key role in development of infrastructure and housing. Due to great economic growth, population growth and space utilization worldwide, there is drastic change in construction technology. Small buildings are replaced by high rise buildings and sky scrapers. This arises one of the problem in deriving natural light in building, due to obstruction of nearby structures. Due to this problem use of artificial sources for illumination of building is increased by great amount. So it is very essential to reduce the artificial light consumption in structure.

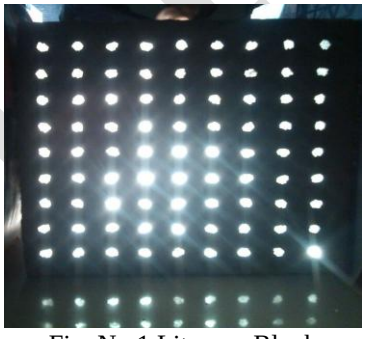

Fig. No.1 Litracon Block

It is considered to be one of the best sensor materials available and has been used widely since 1990. Hungarian architect, Aron Losonczi, first introduced the idea of light transmitting concrete in 2001 and then successfully produced the first translucent concrete block in 2003, named Litracon.
Since concrete is strong in compression and weak in tension and flexure.

Fig.No. 2 Litracon Panel

Litracon (Light Transmitting Concrete) is a cement based material which includes cement, fine aggregate, coarse aggregate, optical fiber and water. It is also known as translucent concrete. Its light transmitting properties depends on the large numbers of optical fiber in the form of strands which transmit the light through the fine concrete. But the large volume fraction of optical fiber reduces the compressive strength hence it is necessary to maintain the volume fraction of optical fiber ranges between 4% to 5% of volume of fine concrete mixture. Optical fiber use in a fine concrete which may be plastic, glassy or organic fiber. It transmits light which may be natural or artificial from one end of concrete element to another end. Light transmitting concrete greatly enhance the lighting effect of building which reduces the energy consumption of architectural lighting and promotes building energy saving. Litracon gives a good aesthetic view.

2. OBJECT OF PROJECT

- To produce light transmitting concrete by using optical fiber.
- Experimentally investigation on Litracon by compressive strength and light transmitting capacity test.
- Economical perspective of using optical fiber.
- To study properties of conventional concrete and its limitations with respect to light transmission.
- To improve performance of concrete by using plastic optical fibers as an inhere material for reinforcing.
- 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 plastic 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.

3. MATERIALS USED

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.

4. OPTICAL FIBER IS MADE UP OF THREE SECTIONS:

1) **CORE** –(carries light signals) thin glass center of fiber where light travels
2) **CLADDING** – (keeps light in the core) made of a material which has a lower refractive index than the core which keeps light within the core.
3) **COATING**–(protects the cladding) Plastic coating that protects the fiber from damage made up of silicon rubber

5. CASTING OF CONCRETE

- Concrete design mix of different grades i.e. M 25 was prepared by Trial & Error Method and the mixing of ingredients cement, fine aggregate, coarse aggregate and optical fiber was done as per the design.

5.1 Casting of Conventional Concrete (0% Plastic Optical Fiber):

- Firstly the mould is oiled at bottom and at each face.
- Mixing of concrete as per design and then slump cone test is carried out.
- The mixed concrete is then poured into the mould.
- For the compaction of concrete, the poured mould is placed on the table vibrator.

5.2 Casting Of 3% Plastic Optical Fiber Concrete:

- Before placing fiber the mould is firstly oiled from inside.
- Then the fibers are placed through the hole as per design such that they are parallel to each other.
- As per design the concrete is mixed and followed by slump cone test.
- Then the mixed concrete is poured into prepared mould (containing 3% fiber) carefully.
- After pouring concrete into mould, poured mould is placed on the table vibrator for compaction of concrete.

5.3 Casting Of 4% Plastic Optical Fiber Concrete:

- Before placing fiber the mould is firstly oiled from inside.
- Then the fibers are placed through the hole as per design such that they are parallel to each other.
- As per design the concrete is mixed and followed by slump cone test.
- Then the mixed concrete is poured into prepared mould (containing 4% fiber) carefully.
- After pouring concrete into mould, poured mould is placed on the table vibrator for compaction of concrete.

Fig No -3. Casting of Cube

6. Testing on Cube

2 **Compression Test**

- The compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely.
- The compressive strength is of a compressive test.
- The compressive strength of the concrete is determined by cast the cubes of size 150mm x150mm x 150mm.
- Compressive strength = load/area.
- The compressive strength of the conventional usually obtained experimentally by means concrete and light transmitting concrete in 7, 14 and 28 days is shown in Mix proportions

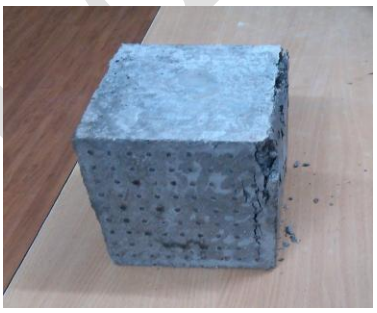

Fig. No. 4 Failure of Light Transmitting Concrete Cube

6.2 LIGHT TRANSMISSION TEST:

- For transmission of light through Litracon block is determine by Lux meter which measures light intensity in Lux.
- A hollow cube of size (150mmx150mmx150mm) which is made of mild steel plate use for transmission test
- A source of light used 60W

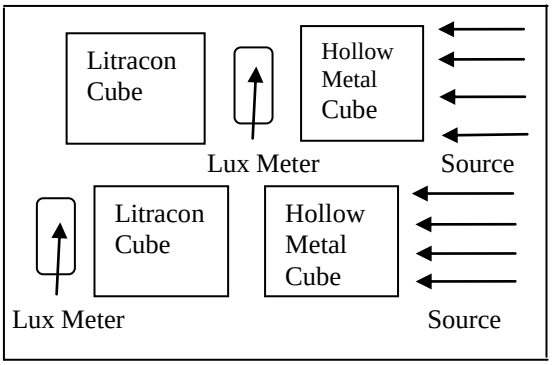

Fig. No.5 Assembly of Light Transmission Test

7. Applications

- Translucent concrete inserts on front doors of homes, allowing the resident to see when there is a person standing outside.
- Translucent concrete walls on restaurants, clubs, and other establishments to reveal how many patrons are inside.
- Ceilings of any large office building or commercial structure incorporating translucent concrete would reduce lighting costs during daylight hours.
- Sidewalks poured with translucent concrete could be made with lighting underneath, creating lit walkways which would enhance safety, and also encourage foot travel where previously avoided at night.
- The use of translucent concrete in an outer wall of an indoor stairwell would provide illumination in a power outage, resulting in enhanced safety.
- Subways using this material could be illuminated with daylight.
- The building is crack filled but not painted; which has to be attended periodically to avoid further distress in the building.
- At many places joints between RCC members and brick / block work have separated and water is found to be seeping inside.
- Most of the plaster in the building sides which are not exposed to monsoons directly, the extent of seepage is lesser than the side's facing monsoon.

8. CONCLUSION

8.1 Conclusion Regarding Transmission Of Light Through Litracon:

The transmission of light through Litracon cube is depends upon percentage of optical fiber used of that surface area. The transmission of light increases with increase in percentage of optical fiber. For 60W bulb used as light source and for 3% optical fiber light reflected through block is 160 lux and for 4% is 550 lux. The percentage of light transmission capacity for 3% fiber is 10.51% and for 4% fiber is 12.55%.

8.2 Conclusion Regarding Cost:

Even if initial cost of light transmitting concrete is more than conventional concrete by 20 times, but due to continuous increase in electricity charge, from payback period analysis it can be concluded that a wall of 10 cube constructed then saving of electricity bill is 838.03 Rs. So payback period for excess amount invested for light transmitting cube (3%) will be recovered in 4.6 years for residential consumption and 2.83 years for commercial consumption. So payback period for excess amount invested for light transmitting cube (4%) will be recovered in 6.14 years for residential consumption and 3.76 years for commercial consumption.

8.3 Conclusion Regarding Compressive Strength:

The compressive strength of conventional concrete (0% Optical Fiber), 3% Optical fiber concrete and 4% Optical fiber concrete is nearly same. The compressive strength of light transmitting concrete is inversely proportional to plastic optical fiber volume fraction used. Compressive strength reduces with increase in volume of fiber.

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