EFFECT OF PLASTIC OPTICAL FIBERS ON LIGHT TRANSMITTING CONCRETE

Dr. SELWYN BABU[1], DASARAPU RAHUL[2]

[1]Professor, Department of Civil Engineering, Malla Reddy Engineering College, Dulapally Road Maisammaguda Post via. Kompally Rangareddy Dist Secunderabad, Hyderabad, Telangana 500100

[2]M. Tech student, Department of Civil Engineering, Malla Reddy Engineering College, Dulapally Road Maisammaguda Post via. Kompally Rangareddy Dist Secunderabad, Hyderabad, Telangana 500100

ABSTRACT

Transparent concrete, often referred to as translucent concrete or light transmission concrete, is a novel form of concrete that was created in the contemporary age. It has the unique ability of transmitting light because it contains glass rods or optical fibres. The major benefits of this concrete are a decrease in dead weight, faster building rates during construction, and cheaper transport and handling costs. It is lighter than ordinary concrete and has specific qualities including low density and thermal conductivity. Glass poles along the length of the wall's all out width, which grant light to move through, send light from one surface of the block facade to the next. An optical glass fiber, also known as an optical fiber, is a transparent, flexible fiber that can be used as a waveguide or "light pipe" to move light between its two ends. It is slightly thicker than a human hair. It is developed of glass (silica) or plastic. The review's fundamental goal is to plan clear substantial blocks utilizing glass poles and optical filaments alongside sand and concrete, and afterward to assess their different physical and designing properties in contrast with those of ordinary substantial blocks. This is finished by adding glass poles and optical strands at paces of 1%, 1.3%, 1.6%, and 1.9% of the substantial blend weight, individually, and separating them out at time frames cm.

The main objectives of this project is to study the values of compressive strength and density of concrete cubes of 100mmX100mmX100mm is measured for various percentages of fibres from 0% to 1.9%.

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

1. INTRODUCTION

Cement (frequently Portland cement), alongside extra cementitious materials including fly debris and slag concrete, total (commonly a coarse total, for example, rock, limestone or stone, in addition to a fine total like sand), water, and synthetic admixtures are fixings in concrete, a structure material. The Latin word "concretus" (which signifying "solidified" or "hard") is where the expression "concrete" starts. After combining with water, concrete undergoes a chemical process called as hydration that causes it to solidify and harden.

More than some other man-made substance, concrete is used everywhere. As of 2006, approximately 7 cubic kilo meters of concrete were produced annually, or more than one cubic meter for each person on the planet. In 1907, Thomas Edison obtained a patent for Portland cement. Since then, it has been put to a wide range of purposes. Concrete may be used to create a variety of items, including furniture, sinks, buildings, and sidewalks. Concrete is made from dry cement, which is combined with additional ingredients and water. New varieties of concrete and cement have been developed over the past ten years that can bend, grow plants, and let light through, among other things.

1.1 Light Transmitting Concrete

Concrete with light transmission is one of these advanced structure materials. Aron Losonczi, a Hungarian planner, made a special cement in 2001 that pre-owned 4 to 5 percent optical strands to permit light to enter through it. A special assortment of substantial that grants light to go through it is known as light sending concrete. This substantial has practically a similar strength as ordinary cement, and its solidarity doesn't essentially decline. It is possible for the fiber to continue transmitting light through barriers of up to that thickness due to its capacity to carry light without loss up to a distance of 20 meters.

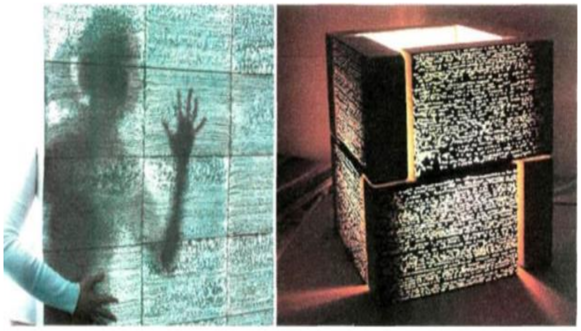


Fig 1: Light transmitting Concrete

1.2 Need for Light Transmitting Concrete

The need for useable space has grown as a result of globalisation, economic growth, and infrastructural development in emerging nations like China, India, etc., which has led to an increase in the construction of high rise structures and skyscrapers. In these structures, only artificial energy sources are used to provide people's needs for visual activity. Complete reliance on artificial energy sources is harmful to both the environment and the health of those who reside in these structures. By releasing toxic byproducts into the environment during production, these artificial energy sources degrade our ecosystem.

Concrete that transmits light, often known as transparent concrete, is a unique variety of concrete. Cement, sand, tiny particles, and optical fibres are layered alternately to create the structure. Any visible light, including daylight, may flow through light-transmitting concrete, increasing the amount of natural light in the structure and improving people's ocular activity. As a result, there is less reliance on synthetic resources. Its foundation is the plastic optical fiber's core's entire internal reflection of light. When light strikes an optical fibre, it completely internally reflects in the fibre before being sent to the other end.

From the perspective of sustainable development and green architecture, this concrete is crucial because it enables for more effective utilisation of natural light without significantly reducing strength. IGBC (Indian Green Building Council) states that green buildings must receive three credits and must receive 50% of the recommended daily light. Buildings with light-transmitting concrete can more easily receive better ratings since it allows for enough light to enter the structure.

The appropriateness of light-transmitting concrete as a building material has received very little study attention. The primary goal of this experimental programme is to investigate the features of its strength and light transmission by modifying the concrete grade and amount of plastic optical fibre.

1.3 Functional principle of light transmitting Concrete

The colourful spectrum that shines through the concrete panels is created by diffused natural light and sunlight. The cheapest source of illumination is sunlight. There is no requirement for an artificial light source if the panel is installed free-standing or in front of a window. According to "Nano-Optics"-based work, transparent or translucent concrete is forthcoming. When microscopic holes are stacked one on top of the other instead of staggered, optical fibres pass the same amount of light as when they are not. Concrete's optical fibres operate as slits and transmit light throughout the material.

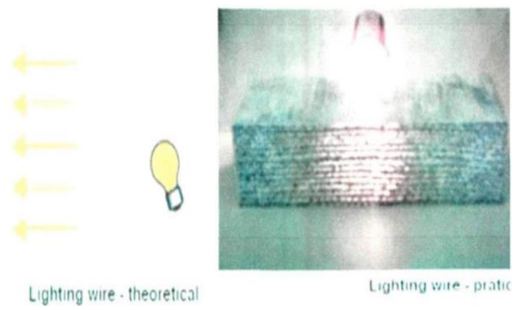


Fig 2: Functional principle of light transmitting concrete

1.4 Objectives of the study

In order to perform an experimental research on the light transmitting concrete and analyse its many qualities, light transmitting concrete was created in the lab with the aid of plastic optical fibre.

The impact of changing the volume fraction of plastic optical fibres on different concrete characteristics is examined in the current study. The study's specific goals are as follows:

1. To create a unique form of "Light Transmitting Concrete" for use in building.
2. To direct a trial examination on the light conveyance power of light-sending substantial utilizing known-force radiant and incandescent lamp sources, considering different plastic optical fiber content levels.
3. To research the compressive strength of light-sending concrete by changing the grade of concrete and how much plastic optical fiber,

concurring per "IS 516:1959 techniques for test for strength of cement".

2. EXPERIMENTAL PROGRAM

An thorough experimental programme was developed in order to accomplish the goals of this study, which included examining the properties of light transmission and determining the compressive strength of concrete that transmits light for different plastic optical fibre ratios.

The following test plan was designed to examine compressive strength and light transmittance. Permeability of the light-transmitting concrete to air and water. Tests were directed as per the appropriate Indian Standard Codes of Training to decide the actual attributes of the parts of light-sending concrete, including Normal Portland Concrete (OPC), sand, coarse total, plastic optical fiber, and water.

1. Getting the concrete design mix.
2. Casting and curing of specimens in accordance with the test's specifications.
3. Testing of samples for compressive strength and properties of light transmission.
4. Examining the data to determine the different characteristics of the light-transmitting concrete.

3. MATERIALS AND METHODOLOGY

3.1 Materials used

3.1.1 Cement

Ordinary Portland concrete with a 53 review rating (ACC bond) has been acquired and used in this study.

Fig 3: OPC 53 grade cement

3.1.2 Coarse aggregate

The expression "coarse totals" alludes to particles that are bigger than 4.75 mm yet frequently range in size from 9.5 mm to 37.5 mm. They might come from essential, optional, or reused sources. The most significant or flawless totals come from either the land or the ocean. Rock is a sort of coarse marine-won total; beat shake is likewise remembered for won coarse totals. The bulk of the coarse aggregates used in concrete are made of rock, with the majority of the remainder being made of pulverised stone.

In this investigation, 12mm and 20mm nominal sizes of coarse aggregate are employed.

Fig 4: 20mm coarse aggregates and 12mm coarse aggregates

3.1.3 Fine aggregate

Sands collected from the land or the sea make up the majority of fine aggregates. Generally speaking, fine aggregates are made out of crushed stone or ordinary sand, with the majority of the particles passing through a 4.75mm sifter. Stream sand, which is obtained from a local organisation, is one of the fine materials used in this experiment.

Fig 5: Fine aggregates

3.1.4 Water

Water has a crucial role in the synthetic reaction with bond, making it an essential component of concrete. It is necessary to consciously explore the kind and amount of water since it moulds the quality that gives concrete gel. Compared to C2S, C3S requires 24% more water by weight.

3.1.5 Plastic Optical fiber

An optical fiber (or optical fiber) is an adaptable, straightforward fiber that is somewhat thicker than a human hair and is developed of expelled glass (silica) or plastic. It can act as a waveguide or "light line" to move light between the closures of the fiber. Fiber optics alludes to the part of applied science and designing that arrangements with the creation and utilization of optical strands.

These can be up to 2 mm in diameter. Sunlight or light from any other source may flow through POF. These fibres allow light to pass from one concrete face to the other when utilised in concrete. When light travels into the core of the POF, there is minimal to no signal loss. P.O.F. with a diameter of 0.5 mm was utilised to prepare samples.

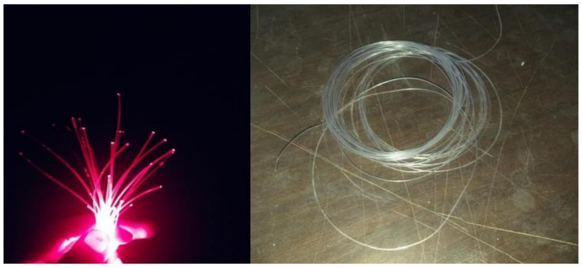


Fig 6: Plastic Optical Fiber

3.1.6 Water

In the concrete lab, tap water that is safe to drink was utilised. In order to create concrete examples, this water was employed. The qualities of fresh and cured concrete might not have been altered by the water's lack of suspended solid and organic elements. The water's P" value was 7.6.

3.2 Percentage and number of fibers need for cube specimen

According to the percentage of plastic optical fibre used in the cubes, the number of O.5 mm diameter POF strands is employed.

Percentage of plastic optical fibre	Number of PDF strands used
0%	0
1%	500
2%	1000
3%	1500

3.3 Preparation of specimen for light transmittance and compressive strength test

As per ASTM, 3D shapes utilized for compressive strength testing ought to go in size from 5cmx5cmx5cm to 15cmxl5cmxl5cm. In this work, punctured hardwood sheets were utilized to make wooden molds that were lOcmxlOcmxlOcm in size. Electrical switch sheets are made of wooden sheets, which were used. To make P.O.F. blocks with variable rates, punctured hardwood sheets with shifting quantities of penetrated openings were joined to the molds. How much fiber in the 3D square impacted the distance across and dividing of the openings.

Fig 7: Bundle of Optical Fiber Plates

Fig 8: Bundle of Optical Fiber

3.4 Preparation specimens

3D shapes of lOcmxlOcmxlOcm size were arranged utilizing concrete with two blend extents, for example 1:1.5:3 (concrete: sand: totals), and a water concrete proportion of 0.45. To investigate the strength and light transmission properties of POF, several percentages of Plastic Optical Fibres, such as 0%, 1%, 2%, and 3%, were employed. Plates were affixed to the wooden moulds once the fibres had been placed. Moulds were placed on the vibrating table and then concrete was poured into them. By vibrating the concrete, the moulds were entirely filled, leaving no space between the fibres. On the vibrating table, the cubes were correctly pressed together. In the cubes, POF with a 0.5mm diameter was employed.

Fig 9: Cubes after curing for 7 days curing

3.5 Test for light transmittance property

To research the properties of light conveyance, a light conveyance test was led. Considering that straightforward substantial's essential capability is to communicate light, this test should be finished. By estimating the force of approaching light and communicated light, the conveyance proportion might be determined. The photometer is utilized to quantify light force. Lumens are the units used to quantify light power by photometers.

3.6 Experimental setup for light guiding property test

Samples of P.O.F volume ratios of 0.00%, 1%, 2%, and 3% were cast in light transmitting concrete in order to evaluate the light directing characteristic of the material. The photometer (or lux metre), which measures light intensity in lumens and has a range of 0.1 to 1,00,000 lux, was used to measure the transmittance. The 200W lOOW incandescent bulb and the 500W halogen lamp were selected as the light sources.

A wooden box was connected with a light source on one face and a photometer on the other, such that all of the light that the sample transmitted fell into the photometer's box. Photometer readings for transmitted light were recorded. The photometer's box was carefully affixed, and all transmitted light was made sure to fall into the box.

Fig 10: Experimental setup to find light guiding property of light transmitting concrete

3.7 Density of concrete

Development material thickness is characterized as its mass per unit volume of materials. This estimation of development material conservativeness is expressed in kg/m3 or lb/ft3.

Density is defined as the ratio of mass to volume

p = m/v

3.8 Compressive strength test

The headings for this test depended on ([9] IS516-1959). The compressive strength of cement was resolved utilizing shapes with the standard elements of 150x150x150mm. Models were put on the CTM's bearing surface, with a constraint of 200T, regardless, and a steady pace of stacking associated until the strong shape was frustrated.

Fig 11: Specimen after failure in CTM

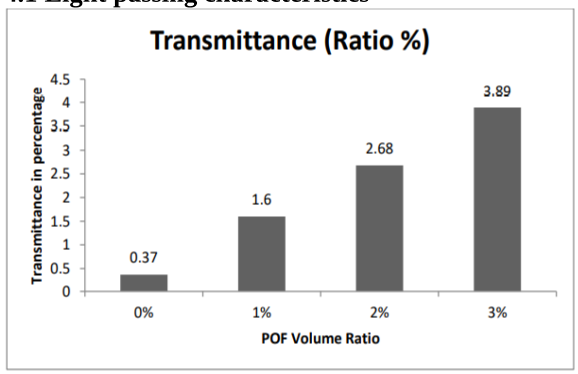
The compressive strength of cube = (P/A) N/mm2

Where, P is load at failure in N,

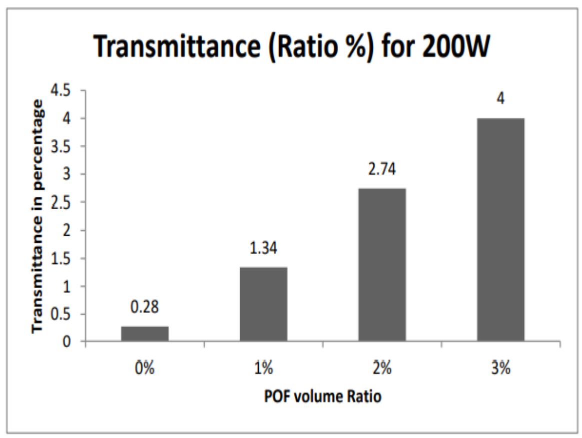
A is area of cube/contact in mm2.

4. EXPERIMENTAL RESULTS

4.1 Light passing characteristics

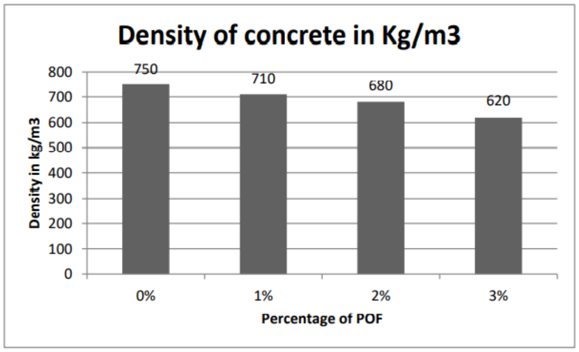


Graph 1: Comparison of transmittance ratio in percentage (100W)



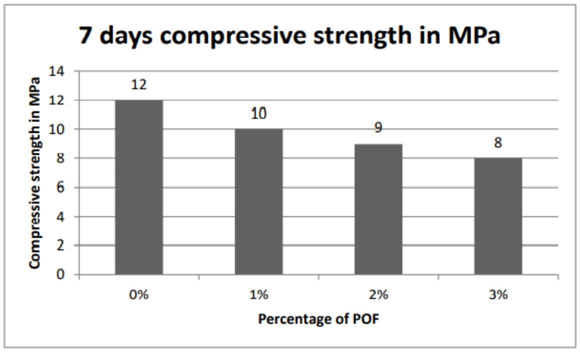
Graph 2: Comparison of transmittance ratio in percentage (200W)

4.2 Density of concrete

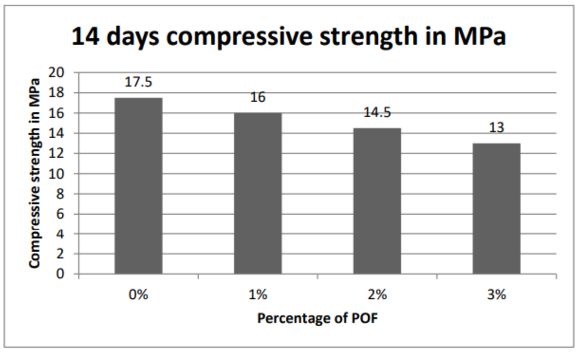


Graph 3: Comparison of density of concrete

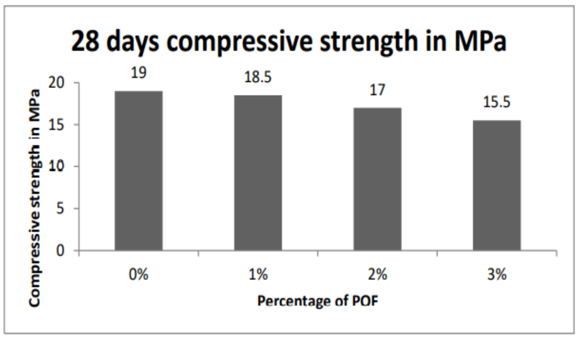
4.3 Compressive strength of concrete



Graph 4: 7days compressive strength in MPa



Graph 5: 14 days compressive strength in MPa



Graph 6: 28 days compressive strength in MPa

5. CONCLUSIONS

In light of the discoveries of this exploratory exertion, the accompanying ends can be made.

1. Light-sending concrete is an exceptionally valuable structure material. It could be applied to green structures to further develop the structure's energy productivity.
2. It is irrefutably the structure material representing things to come for structural designing, and over the long haul, its application in development will develop.
3. As the proportion of the POF rises, the transmittance (ratio%) of 100w and 200w also rises.
4. The density of concrete that transmits light diminishes as the POF percentage rises. 5. As the proportion of the POF increases, the value of compressive strength for 7, 14, and 28 days of curing drops.

REFERENCES

[1]. Shing Mei Chiew, Izni Syahrizal Ibrahim,et al., (2020), ―DEVELOPMENT OF LIGHTTRANSMITTING CONCRETE‖, Materials Today: Proceedings.

[2]. H.B.Valambhiya, T.J.Tuvar, P.V.Rayjada, et al., (2017), ―HISTORY AND CASE STUDY ON LIGHT TRANSMITTING CONCRETE‖. Journal of Emerging Technologies and Innovative Research (JETIR).

[3]. Awadhesh Kumar, Rahul Ahlawat, et al., (2016) , ―EXPERIMENTAL STUDY ON LIGHT TRANSMITTING CONCRETE‖. IJISET - International Journal of Innovative Science, Engineering & Technology.

[4]. Poornima D, Shailaja T, Pooja H P, et al., (2019), ―AN EXPERIMENTAL STUDY ON LIGHT TRANSMITTING CONCRETE‖. International Research Journal of Engineering and Technology (IRJET).

[5]. Kavya S, Karthik D, Sivaraja M, et al., (2016) ―AN EXPERIMENTAL STUDY ON LIGHTEMITTING CONCRETE‖. International Journal of Advanced Research in Education & Technology (IJARET).

[6]. Nikhil k, Ummer farook nk, Silal ahmed ks, et al., (2016), ―Experimental Analysis of Translucent Concrete by using Optical Fibers‖, SSR G International Journal of Civil Engineering (SSRG-IJCE).

[7]. Bhruguli Gandhi, et al., (2018), ―REVIEW ON LIGHT EMITTING CONCRETE‖, International Journal For Technological Research In Engineering.

[8]. A Jayaraman, et al., (2020), ―LIGHT TRANSMITTING CONCRETE USING ECO FRIENDLY MATERIALS (WASTE MATERIALS)‖