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Experimental Study on Translucent Concrete

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Abstract: ***Light-transmitting concrete, known also as translucent concrete, is literally the brightest concrete development in recent years. Strands of optical fibers are cast by the thousands into concrete to transmit light, either natural or artificial, into all spaces surrounding the resulting translucent panels. The material can be used in a variety of architectural and interior design applications, such as wall cladding and dividers. The main theme of this paper is use of optical fibers in concrete, which is energy saving and green technology. It lends great energy savings in closed and non-ventilated spaces. Due to small size of the fibers, they blend into concrete becoming a component of the material like small pieces of aggregate. By using plastic optical fibers in concrete specimens, light transmission occurs through optical fibers, which make it possible to see light, shades and even colors through very thick walls. The work presented in this paper reports an investigation on the behavior of concrete and mortar with optical fiber. Concrete and mortar cube are casted with fibers to study the properties and to compare with optical fiber. The light transmission of concrete samples made with different fiber amount varies from 2% to 4% and with thickness 0.25mm to 0.75mm were studied. The light transmission is seen to increase with the increase in fiber content and increase in the diameter.***

Keywords: Optical fibre, Light transmitting concrete, Translucent concrete.

I. INTRODUCTION

With the economic growth and science-technology development, more and more large-scale civil engineering structures such as tall buildings, underground buildings and landmark buildings and so on are built around the world. While the economic growth is a kind of extensive growth: high input, high consumption and high pollution, for that the energy saving technology is low, especially in developing countries. The brightness of indoor environment is entirely maintained by artificial lighting, which has consumed a large number of resources. Moreover, civil engineering structures always suffer from external environmental effects, economic loss and casualties are serious once damaged. And now, building energy saving and building safety have been attracted much attention. Optical fiber sensors such as fiber Bragg Grating, Brillouin distributed sensors and plastic optical fiber sensors have been widely used for the in-situ monitoring of major projects. Meanwhile some new building materials are developed and used in structures, including self-diagnosis smart concrete, self-tuning smart concrete, self-repairing smart concrete, soundproof concrete, thermal insulation concrete and so on.

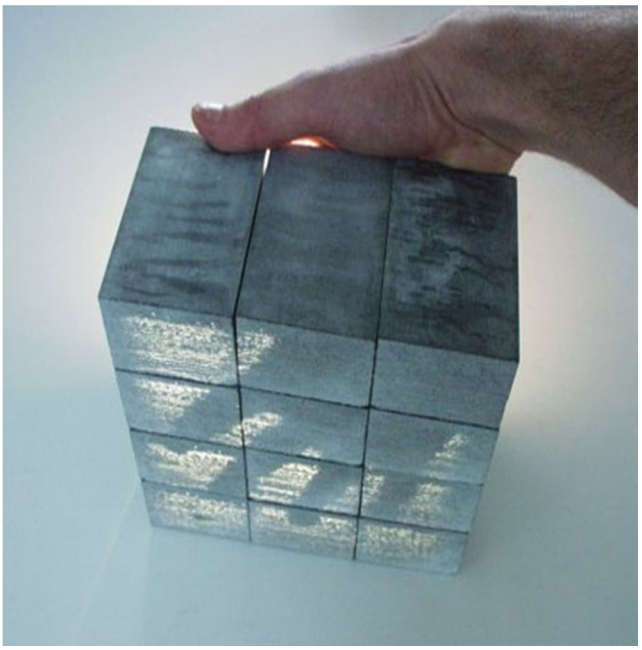

Fig 1 – Translucent concrete

II. LITERATURE SURVEY

Soumyajit Paul and Avik Dutta studied various percentages of optical fibre (1–6%), and large diameter glass fibre. Analyze the light-guiding properties of optical fibre and glass fibre and conclude that transparent concrete has good light-guiding properties and that light transmission is directly proportional to the amount of optical fibre.

Monika et al., 2017 said that the materials used in this concrete are cement (53 grade), sand (2.36 mm sieve passing), optical fibre cables 200-micron diameter, and a fine cement concrete mix ratio of 1:2 and a water cement ratio of 0.45. The results of this experimental investigation concrete. the compressive strength of light transmitting concrete ranged between 20 and 23N/m when tested with optical fibre specimens, indicating that it meets the compressive strength requirements for M20 grade.

"Study of Behavior of Translucent Concrete Using Rice Husk," Abhishek Tiwari and Pramod Saharan worked on Transparent concrete with the addition of Rice Husk Ash and 0.125 percent steel fibre. The percentage of optical fibre used in the paper ranges from 0.25 to 4 percent, and the compressive strength of concrete is compared.

Joao Manuel et al. (2013) discovered that lightweight concrete has important properties that make it useful, such as weight reduction, improved physical properties, and durability. The lightweight aggregate used in the various types of lightweight concrete varies, such as expanded granulated cork, expanded clay, pumice stone, polystyrene foam, or EPS. They created a translucent lightweight concrete as a construction material, decoration material, and furniture material by combining cork, fibre optics, and special mortar cement.

Zhi Zhou et al. (2013) investigated the development of smart transparent concrete using plastic optical fibre (POF) and Fiber Bragg Grating (FBG), as well as its transparency and smart sensing properties. The results of the experiments show that an optical fibre can be easily combined with concrete and that the POF can provide a consistent light transmitting ratio.

Sergio Galvan (2007), studied formulation using a mixture of polycarbonate and epoxy materials, as well as glass fibers, optical fibers, colloidal silica, silica, diethylenetriamine (DETA) and Portland cement. Gravel and sand are replaced by resins and fibers. They claim the invention has greater mechanical strength properties than those of a standard concrete, with lower density and mechanical characteristics that enable same to be used in both a structural and architectural manner, allowing strengths of 4500 kg/cm2, volumetric weight of 2,000 kilograms per cubic meter and that its final setting is under 7 days.

M.N.V. Padma Bhushan et al. (2013) investigated Translucent concrete, a concrete-based material with light-transmissive properties obtained through the incorporation of light optical elements such as optical fibres. Light travels from one end of the stone to the other. Depending on the fibre structure, this produces a specific light pattern on the opposite surface. Optical fibres transmit light so efficiently that there is almost no light loss as it travels through the fibres.

III. MATERIALS AND METHODOLOGY

The sand for this experiment should have less silt content, which attract moisture from atmosphere. For binding material ordinary Portland cement having 43 grades can be used, 53 grade ordinary Portland cement develops crack in early stages and also after construction because of heat of evaluation. These 43 grades develop strength slowly. Ultimately it reaches the same strength as 53 grades. Water used should not have salts as it caused efflorescence. Water available for potable purpose is only used in construction and during curing purpose.

The optical fibre of size 1 mm in diameter is used for this study.

A. Preliminary Work On Experimental Study Of Translucent Concrete Are

1) A mold of the rectangular cross-section 100 mm x 100 mm X 100 mm made up of wooden.
2) For easy de-molding after concreting, place the optical fiber in the oil besides the sides where the optical fibers are in contact with the frame.
3) The fibers are placed either in an organic distribution or in a layered distribution.
4) The holes are operated on wooden or metal plates by which optical fibers are allowed to move.
5) In present work Indian standard method (IS 10226-2009) is used for mix design.
6) The well-mixed translucent concrete is poured carefully and slowly so that there is no disturbance to the optical fiber already laid.
7) Concrete is filled in small or thin layers and stirred with the help of hill tables to avoid the void formation.
8) After 24 hours, remove the mold and sludge, the molded mold is laid unattended on a flat platform.
9) Then, it is carefully removed after 24 hours of casting.
10) Immediately after de-molding, the cube samples had been marked by their respective identification marks/quantity (ID).
11) Cut the extra-long fibers, the same as the thickness of the panel.
12) Polish the panel surface using polishing paper or using sandpaper.

Fig 2 – Preparation of Mould

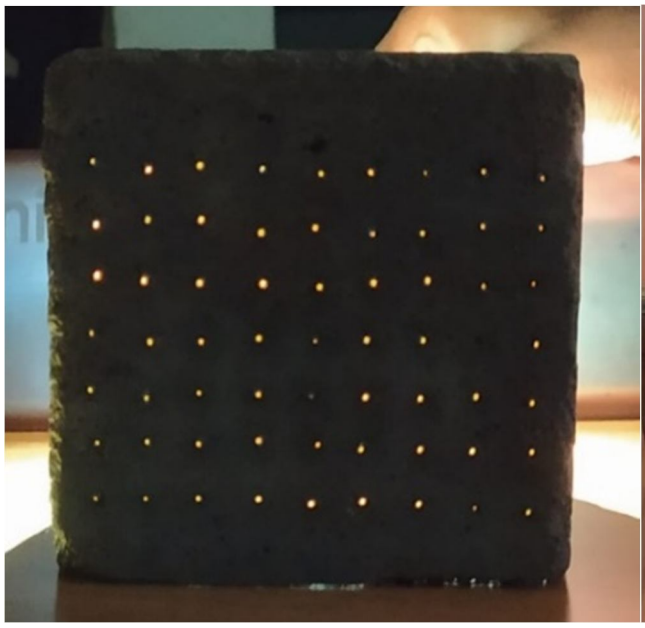

Fig 3 Casting

Fig 4 De-moulding of Cube

IV. RESULT

A. Compressive Strength Test

The strength test is worked on the studied translucent sample for determination of bearing capacity which is given below-

S.NO.	Curing Period (In Days)	Compressive Strength (in N/mm^2)		Average Compressive Strength (in N/mm^2)	
		Conventional concrete	Translucent concrete	Conventional concrete	Translucent concrete
1	7 days	27	23	25	22
2		24	22		
3		25	21		
4	28 days	41	37	39	36
5		38	36		
6		40	35		

The 28 days compressive strength of translucent concrete is found to be 36 N/mm^2, Which is similar to compressive strength of conventional concrete i.e. 39 N/mm^2.

B. Light Transmission Test

S.NO.	Transmissibility in lux	% Transmissibility	Average transmissibility (in %)
1	190	3.7	4.0
2	215	4.2	
3	207	4.1	

For the casted translucent concrete sample, the average transmissibility is found to be 4%.

V. CONCLUSION

A. The compressive strength of translucent concrete is very similar to conventional concrete i.e., 36 /mm^2 in this studied case. Also, the properties of transparent concrete are best in place where natural light is unreachable.

B. The light emission reflects around 4% of transmissibility which is effective.

C. The studied cases is done on 100 mm cube mould, if the structure thickness is less then light transmissibility will surely get enhanced.

D. The transparent concrete is a good architectural material. The strength of concrete is reduced by some amount but it can be achieved by using some addition fiber, therefore the strength parameter of transparent concrete is same as conventional concrete.

E. Transparent concrete give aesthetical view to buildings. It is energy efficient and makes green building.

F. The decorative concrete can be used in place of windows because it can transmit the sunlight. Hence the application of optical fiber will make the concrete decorative as well as can make the concrete structural efficient.

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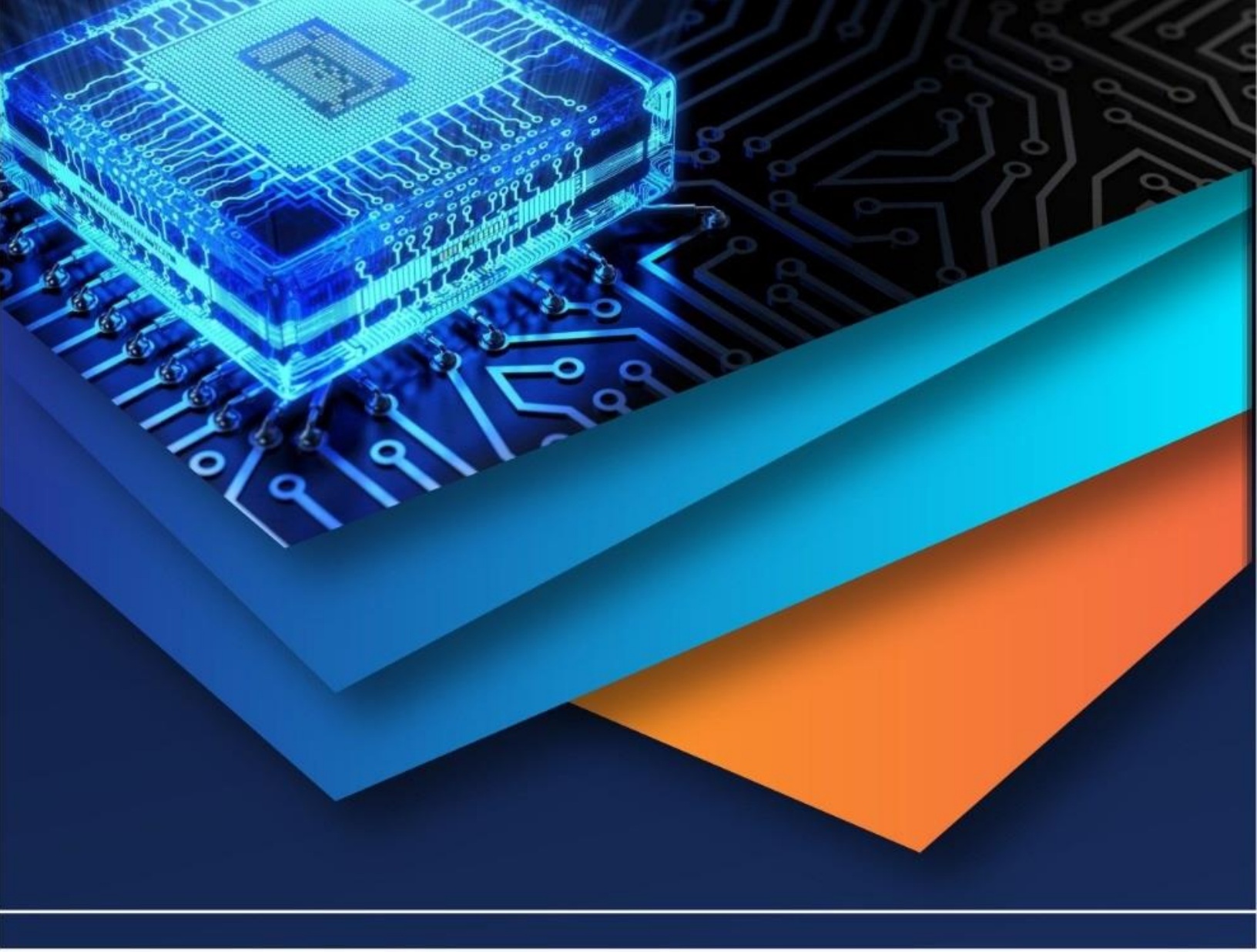

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