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Transparent Concrete: A Brief Review

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Abstract: ***World is actively engaged in the creation of unique materials and technologies since the dawn of human civilization. Humans are different from other animals in that we want to live easier, more sophisticated lives. Concrete is nothing short of a miracle for human evolution in this era of constant advancement. One of those cutting-edge varieties of concrete is transparent concrete, which not only dispels the stereotype of concrete as a lifeless, colorless substance but also contributes to energy conservation, one of the main issues facing the modern world.***

Concrete that transmits light, sometimes referred to as translucent concrete. Due to incorporated light optical elements, the material has light-transmissive qualities. The concrete block allows light to pass through it from one end to the other. Therefore, in order to get maximal light penetration, fibers must travel through the entire object. Natural light in buildings is obstructed by the construction of skyscrapers and high-rise buildings. The use of artificial light has significantly increased as a result of this issue.

Because of transparent concrete, less artificial light must be used in construction. As a result, transparent concrete, a novel type of concrete, is introduced. Fiber-reinforced concrete that has optical fibers inserted for aesthetic purposes is known as transparent concrete (TC).

The research is not limited to decorative purposes alone; the impact of fiber application on the strength aspect is also covered. When fibers are stacked in different layers, transparent concrete load-carrying capability rises. Moreover, diverse patterns can be made to give the concrete a decorative appearance. This concrete can be utilized for interior hallways, lobby areas, and ceilings. It can be used to glow at night thanks to external lighting sources, and during the day it can glow thanks to natural light transmission.

Keywords: transparent concrete, light, optical fibres, transmission, construction.

I. INTRODUCTION

Transparent concrete, or translucent concrete, is a concrete-based building material with light-transmissive properties due to embedded optical elements, i.e., optical fibers as shown in fig 1. Hungarian and Aron Losonczi In 2001, created the first Litracon material, and in 2002, they received his first patent. In 2004, he established Litracon Company. The company, which develops, produces, and markets light-transmitting concrete products, in Hungary. In 2007, Losoncz is ubmitted his second Litracon patent application. Fine architecture uses light-transmitting concrete for internal wall cladding and as a façade material. As a load-bearing structure, light-transmitting concrete has also been used in a variety of design products.

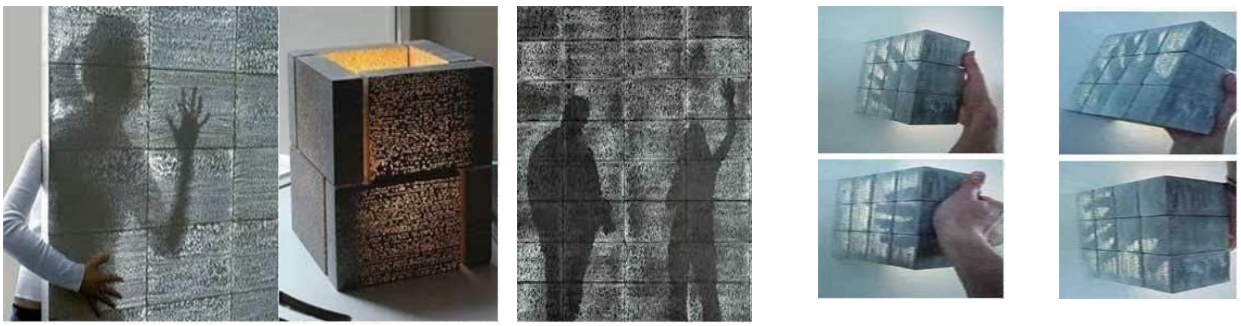


Fig.1Transparent Concrete

A. Need of Transparent Concrete

1) Its excellent architectural qualities provide a pleasing visual aspect to the building
2) Energy saving can be done by utilization of transparent concrete in building.
3) It is essential to innovate something to provide the natural light to building instead of artificial light.

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B. Applications of transparent concrete



(a) wall (b) Road marking (c) staircase

Fig. 2 Applications of transparent concrete[4]

As seen in Fig. 2, translucent concrete can be utilized for walls, roads, and staircases, all of which contribute to the reduction of electrical energy.

II. MATERIALS AND METHODS

Portland cement, coarse aggregate (gravel) with maximum particle sizes ranging from 10 to 12 mm, optical fibers, water, and fine aggregate (sand) with maximum particle sizes ranging from 0.6 to 4.75 mm were the main components. Furthermore, the nominal size of the coarse aggregate is determined by the spacing between the optical fibers placed inside the mold. Some LiTraCons use less expensive light-guiding materials in place of optical fibers, like glass rods, acrylic rods, epoxy resin rods, waste glasses, and unique plastic [2] resins (like those in light transparent cement mortar). Among the components, some authors added additives like fly ash, GGBS, silica fume, and superplasticizer to enhance LiTraCon's qualities. In the mold, optical fibers ought to be arranged parallel to one another.[1]

III.PREPARATION OF TC SPECIMENS

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(a) Insertion of OF groups in Perforated wooden sheets (b) Formwork for TC cubes (c) TC specimen

Fig.3. preparation of cubic TC specimen [6]

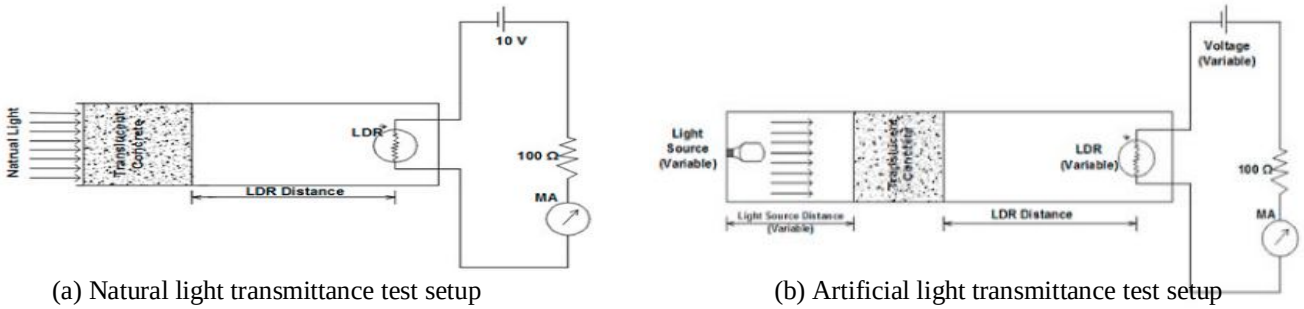
Fig 2 shows preparation of translucent concrete. The wooden sheets were perforated with holes at fixed spacing and parallel direction using an electric drill. the number of optical fibres and the distance between them are important because it influence on the light transmitting ratio. The insertion of wood sheets into the formwork should be carefully, the pour the prepared celf compacting concrete mixture. The form work is removed after 24 hours from execution, trimmed POF, polished the surface of specimen by sand paper and cured with water at room temperature for 28 days before testing.

IV.TESTING

A. Testing Methods of Light Transmittance Tests

A.M. Tahwia et al studied the light transmittance test of Translucent self-compacting concrete (TSCC) and translucent self - compacting mortar (TSCM) using electrical circuit setup with photo resist or light - dependent resistors (LDR) to measure the intensity of the light transmitted through the casted specimen. Light transmittance is a ratio, which is the luminous flux transmitted from the component over the luminous flux falling on the component.

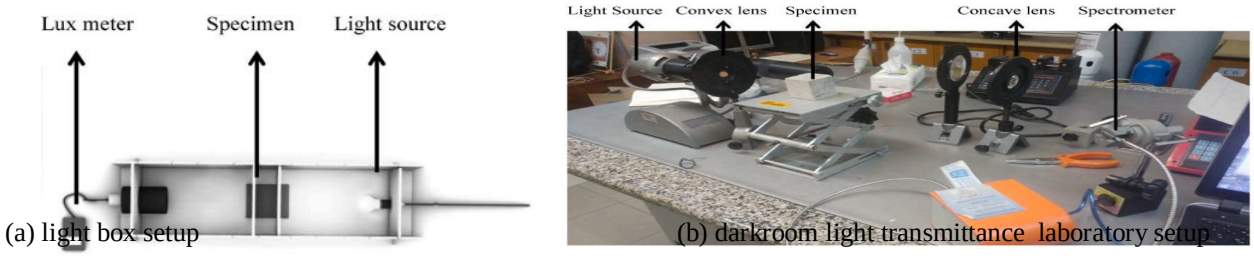
The test was performed under natural light condition [A.M. Tahwia et al.] by exposing the specimen to sunlight and measures the light intensity at distance 0,100,200,300 mm from specimen location from & a.m. to 7 p.m. also under artificial light condition specimen exposed to incandescent lamp by varying parameters like voltage , intensity and distance. Fig. 4 shows the Schematic diagram of natural and artificial light transmittance test



(a) Natural light transmittance test setup (b) Artificial light transmittance test setup

Fig.4. light transmittance test setup

Navabi et al. adopted two methods to investigate the amount of light passing through transmitting concrete first method; a light box was designed and simulated using rhino's softer ware as shown in fig 4.a. Light sources is incandescent lamp with filament of tungsten wire is paced one side, transparent concrete at middle and lux meter on the other side of it to measure quantity of light passed through transparent concrete. In Second method experiment is conducted in the darkroom of the light laboratory placing light source and spectrometer as shown in fig 4.b.



(a) light box setup (b) darkroom light transmittance laboratory setup

Fig.5. light transmittance test setup [3]

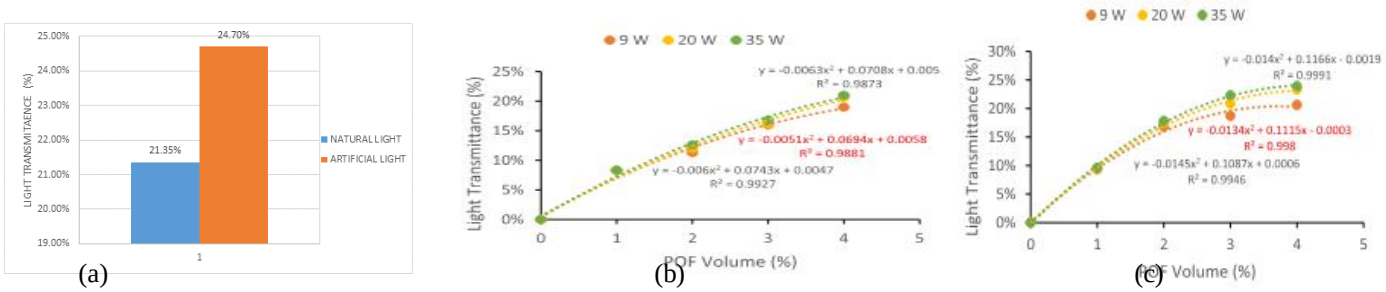
B. Test Method for Investigating Compressive Strength

Compressive strength of concrete is depended on many factors like cementitious material content, fine and coarse aggregate testing age. A.M. Tahwia et al., tested the HPTC, UHPTC, TSCC and TSCM to find the effect of plastic optical fibres ratio and diameter on compressive strength. Similar way D. Navabi et al. performed compressive strength test to investigate the effect of variation of polymethylmethacrylate optical fibres percentage in HPLTC.

V. DISCUSSION OF RESULTS

A. Effect of POF (Plastic Optical Fibers) Volume on of Light Transmittance

The varying relationship of light transmittance with POF's volume percentage for 1 mm and 2 mm diameter is shown in Figs. 6(b) and (c). It is evident from the graphs that the light transmittance is directly impacted by the volume of the POF. Light transmittance increases from 0% to 21% as volume rises from 0% to 4%.

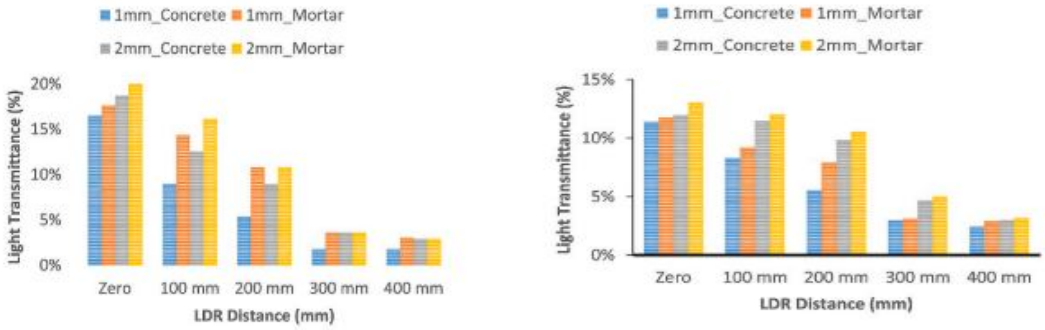


(a) (b) (c)

Fig.6. variation of light transmittance with OF's volume variation [6]

B. Effect of LDR on of Light Transmittance

Figs. 7 (a) and (b) illustrate the changing relationship between light transmittance and LOR's for diameters of 1 mm and 2 mm. The graphs make it explicit that as the LDR's distance increases from 0 mm to 400 mm, the light transmittance reduces from 20% to 2% for both TSCC and TSCM. Also from Fig. 6(a), it is evident that the artificial light transmittance percentage will be higher than the natural one because of the light source distance from the TC.



(a) (b)

Fig.7 variation of light transmittance with LDR distance for TSCC and TSCM [6]

C. *Effect of POF Diameter on of Light Transmittance*

Light transmittance percentage is not varying much because of optical fibre diameter as compared with the optical fibre volume and LDR's distance. The variation is as shown in the fig.6 and 7.

D. Effect of POF on Compressive Strength

D. Navabi et al. analyzed, the compressive strength test findings indicate that the concrete samples that transmit light decrease compressive strength as the volume percentage of optical fibers increases in case of HPTC. One explanation for the decrease in compressive strength of light-transmitting concrete may be that, even though optical fibers are present, they occupy a significant volume of the concrete, similar to pores in the material, in addition to the difference in the elasticity of the fibers with concrete [3]. A.M. Tahwia et al.[2] experimental results were contradictory of the D. Navabi et al.,[3] results. The pozzolanic effect in this study led to the formation of HPTC, which was derived from POF groups incorporated into SCC and mineral materials added to it. These materials penetrate and encapsulate the gaps between cement particles, accelerating up the hydration reaction and helping to obtain a high early strength. Furthermore, because there were fewer voids in the specimens due to the use of less water, the low-water cementitious ratio + 3% SP enhanced the compressive strength while maintaining the fresh SCC qualities.

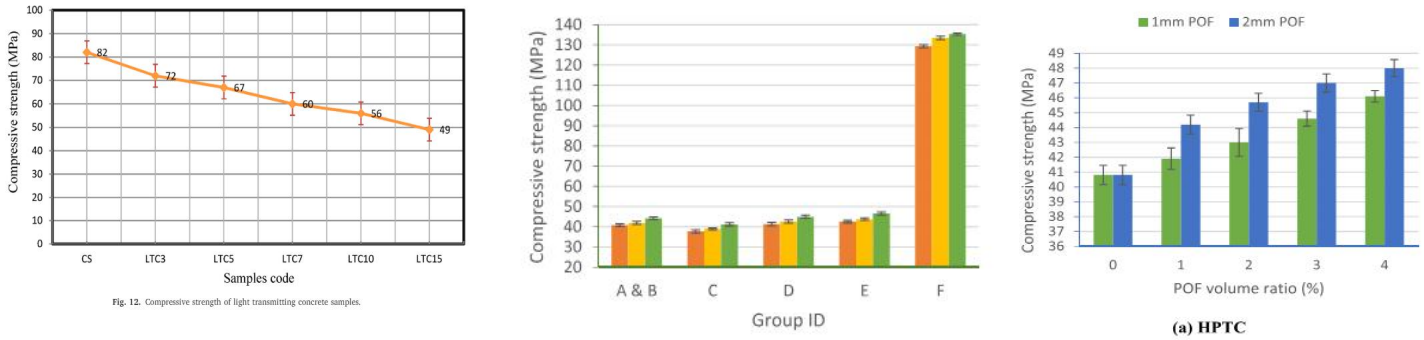


Fig.8 effect of compressive strength with varying OF volume[2,3]

VI. CONCLUSION

1) Light transmission equality provided by TSCC helps save energy and lower electricity costs without sacrificing its mechanical qualities.
2) SCC is a combination that is ideal for making translucent concrete in general and HPTC in particular because it satisfies all the requirements for providing good fresh properties and doesn't damage the POF that is incorporated into the HPTC.

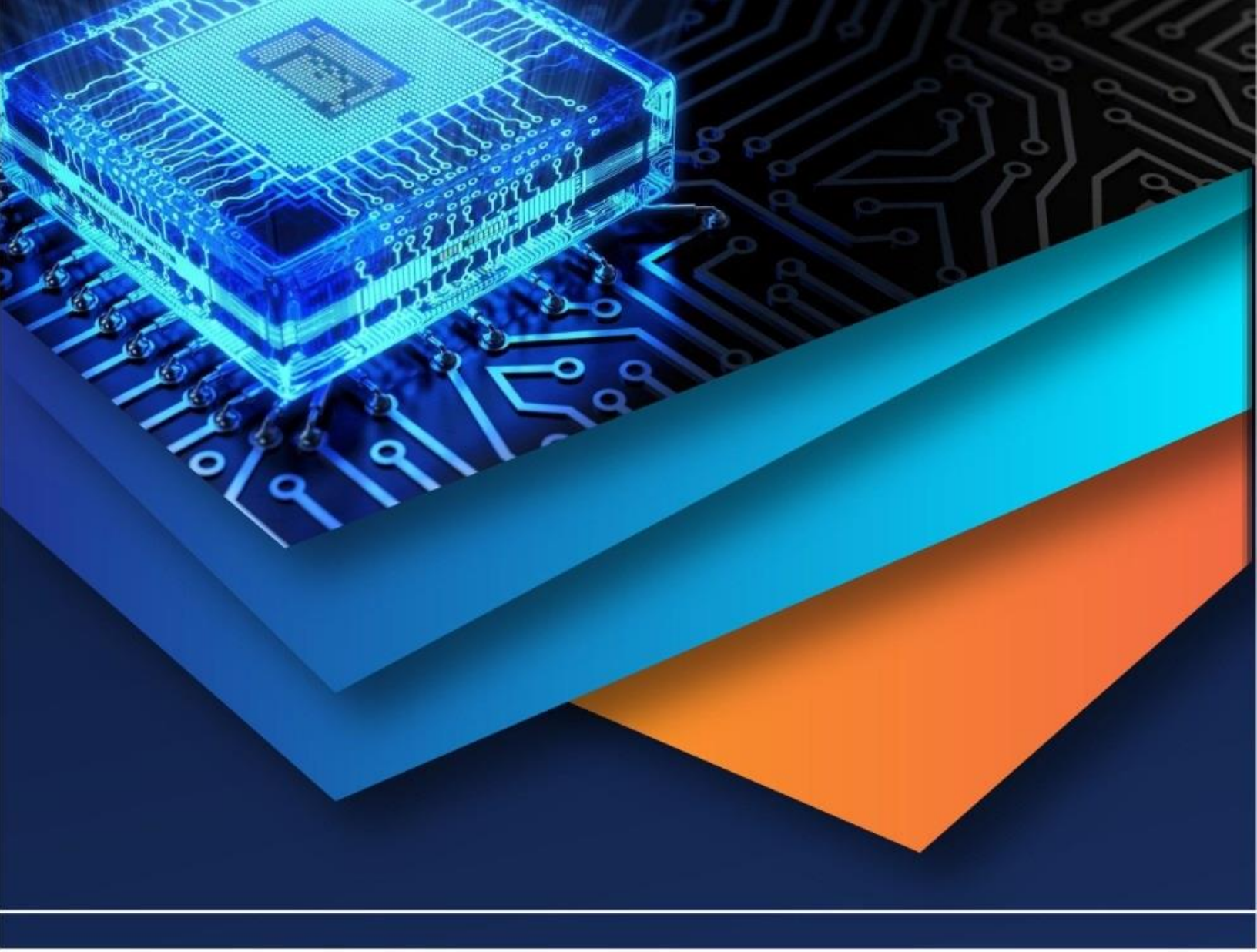
3) The volumetric ratio of POF inclusion has a significant impact on the light transmittance of TSCC, irrespective of the POF diameter. Yet the volumetric ratio of POF inclusion to POF diameter determines the compressive strength of TSCC.

4) Whether the distance is from the specimen to the light source or from the specimen to the LDR, the light transmittance significantly decreases with increasing distance. It is defined as the rate at which light transmittance declines, and it has been showed that this rate is irregular.

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