Experimental Study of Translucent Concrete

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Abstract— Translucent concrete is a light-transmitting concrete which is formed by embedded light optical elements like Plastic Optical fibres (POF) in it. The important purpose behind translucent concrete is to use sunlight as a natural light source to reduce the power consumption of illumination. Translucent concrete is utilized in fine architecture as a facade material and for cladding of interior walls. Optical fibres can transmit light through fibre. The concept of light transmitting concrete is same as a transparent concrete. When it is used in ceiling or side wall, it is exposed to direct natural sun light which transmit the image but not completely transparent. In this paper the smart translucent concrete regarded as a green energy saving construction material. It is a promising technology for field applications in civil Infrastructure development. Main aim of the study is to design translucent concrete blocks with the cement, sand aggregate & plastic optical fibre of 0%, 0.1 %, 0.2%, 0.3 %, 0.4 % & 0.5% by volume of total concrete mix, then analyse their compressive strength and compare it with that of conventional concrete blocks.

Keywords: Translucent Concrete, Energy Saving, Green Construction Material, Plastic Optical Fibre

I. INTRODUCTION

Translucent Concrete is a new material with various applications in the construction field. In today's time where whole of the research is concentrated towards non utilization of natural resources as much as possible and to reduce its consumption which are decreasing with time. Translucent concrete building material made of concrete embedded optical fibres with up to 0.5% by volume of total concrete mix ,so that light can be transmitted from the outside in or inside out of the building.

Due to great economic growth, urbanization, population growth, space utilization worldwide, there is drastic change in concrete technology. Most of the big buildings are built close to each other all in the same areas like sky scrapers. There arises one of biggest problem in deriving natural light in building due obstruction of nearby structures. When buildings are stacks closed to each other, there is not much natural sunlight passing through it. Thousands of optical fibres form a matrix and run parallel to each other between the two main surfaces of every blocks where in which Shadows on the lighter side will appear with sharp outlines on the darker one. An optical fibre is a flexible transparent fibre made of glass (silica) or plastic, slightly thicker than a human hair & is a three layered cable made up of Buffer coating, cladding and core which transmit light through the core of glass rods.

A. Basic Purpose of Translucent Concrete:

A smart translucent concrete - novel construction material manufactured with Plastic Optical Fibre (POF) in order to utilize the light guiding ability of POF. The main purpose is to use sunlight as a light source in order to reduce the power consumption of illumination. Additionally, experiments to study the mechanical performance of the concrete.

The electric energy is derived primarily from thermal power plants that are not clean source sand contribute to greenhouse gas emissions. An innovation like translucent concrete (TC) captures and delivers daylight into buildings, which could reduce our dependence on indoor lighting and save electricity. Such technology can be constructed as a part of a building envelope (i.e., wall and roof), because it satisfies requirements that are usually set apart

- Envelope behaving as a structural subsystem,
- Construction procedure is simple and scalable, and
- Movable and mechanized parts are avoided.

Compared with a traditional electric lighting system, illuminating the indoors with daylight also creates a more appealing and healthy environment for building occupants.

Translucent Concrete is a combination of fibres optics and concrete. It can be produced as prefabricated building blocks and panels. Due to the small size of the fibres, they blend into concrete becoming a component of the material like small pieces of aggregate. Because of their parallel position of fibre, the light-information on the brighter side of a wall appears unchanged on the darker side. The sharp display of shadows will fall on the opposing side of the wall. Moreover, the colour of the light also remains the same. Thousands of optical fibres form a matrix and run parallel to each other between the two main surfaces of each block. These fibres mingle in the concrete because of their insignificant size, and they become a structural component as a kind of modest aggregate. Therefore, the surface of the blocks remains homogeneous concrete.

Translucent concrete is used in fine architecture as a facade material and for cladding of interior walls. Light-transmitting concrete has also been applied to various design products. When a solid wall is imbued with the ability to transmit light, it means that a home can use fewer lights in their house during daylight hours so it is energy saving.

With the economic growth and science and technology development, many large scale civil engineering structures such as tall buildings, underground buildings and landmark buildings and so on are built around the world. Those buildings are based on artificial lightings. Most of the large buildings are built close to each other, like sky scrapers. When many buildings are stacked close to each other, there is not much natural sunlight passing through and the importance of natural sunlight is well known. Translucent concrete comes in as a blessing solution for easier day lighting. By arranging many optical fibres into concrete it transmit light so effectively that there is virtually no loss of light conducted through the fibres.

The optical fibres have proper light guiding property and sensing advantages, such as small dimensions, distributed measurement and anti- corrosion characteristics, optical fibres have been widely adopted in the communication and sensing fields.

II. MATERIALS & METHODOLOGY

A. Materials

(1) Ordinary Portland Cement of 43 Grade
(2) Manufactured Sand of pertaining Sieve size (<4.75mm)
(3) Plastic Optical Fibre of 20 mm in Diameter is used for casting transparent concrete.
(4) Aggregate(Maximum size 10mm)

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 fibre 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 fibre, developing a novel functional material called transparent concrete has an important value in the application of construction and sensing.

B. Optical Fibre

An optical fibre is a flexible, transparent fibre made of silica or plastic, slightly thicker than a human hair. It functions as a waveguide or light pipe, to transmit light between the two ends of the fibre. The field of applied science and engineering concerned with the design and application of optical fibres is known as fibre optics. Optical fibres are widely used in fibre-optic communications, which permits transmission over longer distances and at higher bandwidths .Fibres are used for illumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces. Specially designed fibres are used for a variety of other applications, including sensors and fibre lasers. Optical fibres typically include a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by total internal reflection.

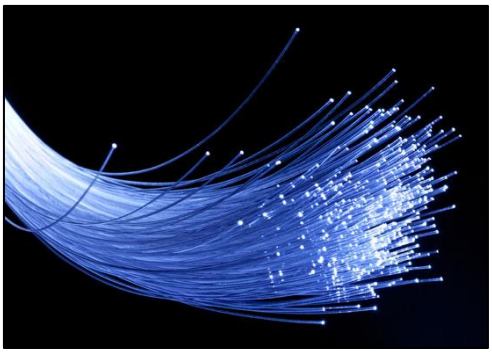

Fig. 1: Optical Fibre

III. EXPERIMENTAL PROGRAM

12 no. of cubes of size $15cm \times 15cm \times 15cm$ were made. Three cubes used as the conventional concrete and others are used for translucent concrete. The optical plastic fibres are adding with different percentage in the concrete specimens.The optical fibres in transparent concrete were distributed in horizontal direction equally and they constituted as 0.2%, 0.4% and 0.6% of total volume of the concrete cubes and cylinders. For transparent concrete Cube, mould of size 15cmx15cmx15cm were prepared each cubes contains the holes for taking the optical fibres in horizontal direction.

Before filling these cubes with concrete they were coated with oil, so that, the concrete cubes would not adhere to the mould. The compressive strength of the cubes was found out using Universal Testing Machine.

IV. RESULTS AND FINDINGS

Mix	Mix %	Compressive Strength (N/mm^2)		
		7 Days	14 Days	28 Days
M1	0	15.72	19.65	26.2
M2	0.2	16.26	20.33	27.1
M3	0.4	16.86	21.08	28.1
M4	0.6	16.08	20.10	26.8

Table. 1: Compressive Strength Test on Cube for 7, 14 And 28 days

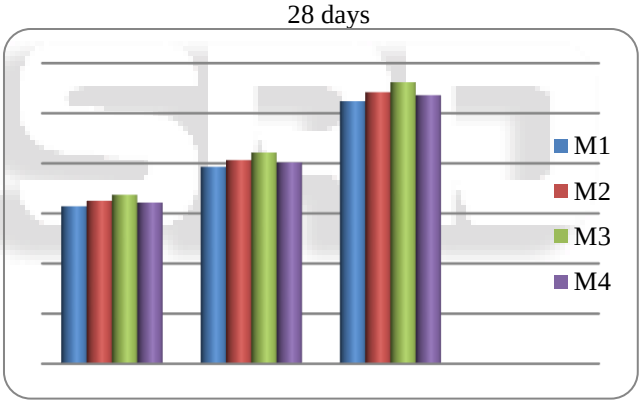

Fig. 2: Chart of Compressive Strength Test on Cube for 7, 14 And 28 days

The results of compressive strength were presented in the table and graph. The cubes were tested using Universal Testing Machine (UTM) and Compression Testing Machine (CTM). The Compressive strength of 7, 14 and 28 days were obtained. From the table the maximum compressive strength obtained is 0.4% addition of Optical plastic fibre to the Concrete cube.

V. CONCLUSION

- All the experimental data shows that the addition of optical fibre improves the hardened properties. This study showed that the transparent concrete can reduce electricity bills without compromising with the strength of the buildings. It has been shown that:
- The efficiency of the application of optical fibre is studied by comparing the strength with the nominal M25 grade concrete and the test results proved that is more in all aspect.
- The ideal percentage of adding optical fibre is 0.4%.

- There is a gradual increase in the compressive strength of the concrete by increasing the optical fibre upto 0.4% and on further addition of the optical fibre decreases the strength parameters.
- Compressive strength of the concrete is higher in the optical fibre parallel to the load applied than the optical fibre perpendicular to the load applied.
- Thus, the reinforcing of the optical fibre will transmit light and also eventually increases the strength of the concrete.

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