Experimental Investigation on Translucent Concrete

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Abstract- **Translucent concrete allows light to pass through it because of the presence of optical fibers within the opaque concrete wall. Light is transmitted from one surface of the side wall to the other wall, because the presence of the optical fibers strands along the width of the wall, which allows the light to pass through them. The principle objective of the project is to design translucent concrete blocks with the use plastic optical fibers of varying diameter and then to analyse the amount of light transmittance by light transmittance test and then to compare the compression strength of translucent concrete and conventional concrete by varied diameter with same mix ratio and the diameter used were 0.9mm and 2mm respectively. If the spacing between the setup increased means the illuminance of light is decreased. The performance of translucent concrete specimens made by using different dosages and spacings of Plastic Optical Fibers is investigated. The results evidently show that translucent concrete can be successfully used as a energy efficient construction material for sustainable construction.**

Index Terms- Compressive Strength, Light Transmittance Test, Normal Cement Concrete(NCC), Translucent Concrete(TSC).

I. INTRODUCTION

Translucent concrete is a new material with various applications in the construction field, architecture, decoration and even furniture. As can be imagined concrete with the characteristics of being translucent will permit a better interaction between the construction and its environment, thereby creating ambiences that are better and more naturally lit at the same time as significantly reducing the expenses of laying and maintenance of the concrete.

Optical fibers are arranged side by side on a concrete base leaving the light to pass from one side to other side. Due to small thickness of fiber that the fibers are combined to transmit light. Compared with a traditional electric lighting system illuminating the indoors with daylight also creates a more appealing and healthy environment for building occupants. It was a combination of optical fiber and fine concrete combined in such a way that the material was both internally and externally homogeneous. It was manufactured in blocks and used primarily for decoration. It can be used for both the interior walls and exterior walls, illuminated pavements or even in arts or design objects.

Our project of casting translucent concrete aims at analysing the amount of transmittance by and light transmittance test and to compare the compression strength of normal concrete and translucent concrete by varying the diameter of the plastic optical fibers with same mix ratio and the diameter used were 0.9mm and 2mm respectively

II. LITERATURE REVIEW

The concept of light transmitting concrete was introduced by the young Hungarian architect, Aron Losonzi in 2001. Losonzi begun working on his project with other scientists while he was doing his postgraduate in Sweden's Royal University College of Fine Arts. After returning to his hometown, Mr. Losonzi had completed his project and presented his design in exibitions across Europe.

Abdelmajeed Aitlomate, Fidelis Mashiri, Faesal Alatshan – "Experimental study of light transmitting concrete" (November 2016)

In this study, the performance of light transmitting concrete specimens made by using different dosages and spacings of plastic optical fibre with varying diameter have been investigated. The physical and mechanical properties of the light transmitting concrete such as compressive behaviour of it. The compressive strength with the studied concrete mix samples was obtained. Therefore the study shows that the transparency of light is possible in concrete without affecting its compressive strength, as the

fiber and fiber reinforcement enhances the strength and appearance.

R. Vaswani, Er. Rohan – "A Study on Translucent Concrete and it's properties"(October 2017)

The principle objective of this project is to design translucent concrete blocks with the use of glass optical fibres and then analyse their various properties and characteristics. The translucent concrete has good light guiding property and the ratio of optical fibre volume to concrete is proportion to transmission. The translucent concrete not loses the strength parameter when compared to regular concrete and also it has very vital property for the aesthetical point of view. It can be used for the best architectural appearance of the building. Also where the light cannot reach with appropriate intensity. This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials.

Momin, Kadiranaikar, Jagirdar, Inamdar – "Study of Light Transmittance of Concrete using Optical Fibers and Glass Rods" (2013)

Studies on producing the concrete specimen by reinforcing optical fibres with different percentage and comparing it with the normal concrete. The various test conducted for this are compression strength test and light transmission test. The result of this experimental investigation shows that the compression strength of light transmitting concrete was ranging between 20- 23N/mm2 with optical fibre specimen. Which indicates that it satisfy the compression strength requirements for M20 grade concrete and also it conclude that the transparency of light is possible in concrete without affecting its compression strength.

III.OBJECTIVE AND SCOPE

A.OBJECTIVE

To study the strength characteristics of translucent concrete.

To compare strength characteristics of translucent concrete with various diameters plastic optical fibres used, with normal conventional concrete.

To check the light transmittance of the translucent concrete.

To provide an aesthetic view to the building at both the exterior and interior of the structure by the use of translucent concrete.

B. SCOPE

It is also a great insulating material that protects against outdoor extreme temperatures while also letting in daylight.

It serves as cladding wall, interior wall, partition wall etc.

It helps power consumption.

It can be used to illuminate underground buildings and structures such as subway stations.

IV. EXPERIMENTAL PROGRAM

4.1 ORDINARY PORTLAND CEMENT (OPC)

The ordinary Portland cement used for the project was 53 grade. The technical requirement of the cement was tested by IS 4031. It has been possible to upgrade the qualities of cement by using high quality limestone, modern equipments, closer on line control of constituents, maintaining better particle size distribution, finer grinding and better packing. Cement is a material, generally they are in powdered form that can be made into a paste by the addition of water. After they are hardened they consume required strength.

4.2 FINE AGGREGATE (M-SAND)

Manufactured sand is a alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world and also due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Since manufactured sand can be crushed from hard granite rocks it can be readily available at the nearby place reducing the cost of transportation from far-off river sand bed. Thus the cost of construction can be controlled by the use of manufactured sand as a material for construction.

4.3 WATER

Water fit for drinking is generally fit for making concrete. The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability, water tightness, durability, drying shrinkage and weathering are potential for cracking. For these reasons, limiting and controlling the amount of water in concrete is important for both constructability and service life.

4.4 PLASTIC OPTICAL FIBRE

An optical fibre is a flexible, transparent fibre made by glass (silica) or plastic to a diameter slightly thicker than that of a human hair. It is a dielectric wave guide and ideally has a cylindrical shape. It consists of a core made up of dielectric material which is surrounded by a cladding made up of a dielectric material of lower refractive index than core. Light can be transmitted through plastic optical fibre in the form of "TOTAL INTERNAL REFLECTION". Plastic optical fibre has a much core size and larger numerical aperture than common SiO2 based optical fibres, it can absorb light at an incident angle as large as 60º and still provide a better light guiding system. The light transmitted in plastic optical fibre in the form of electromagnetic waves whose amplitude, phase, polazised state and frequency are affected by various physical parameters such as temperature, pressure, stress, strain, electric field and magnetic field.

V. METHODOLOGY

A. PREPARATION OF MOULD

The mould required for the prototype is made with wood material. In the mould preparation, it is important to fix the basic dimensions of mould. The standard minimum size of cube according to IS 456:2000 is 150 mm x150 mm x150 mm. In the mould, markings are made exactly according to the size of the cube, so that the perforated plates can be used. The plates are of wood comprising of perforations/holes drilled. The perforations are made in the plate of equal interval along the length and depth. Then the optical fibers are tied to the perforated plates on either side tightly before filling of the mix.

Fig 1.Preparation of Mould

B. MANUFACTURING PROCESS

Mixing procedure is same as that of a normal one. Making desired equal proportion of cement and sand to get mixed thoroughly and then addition of water in desired quantity to get a uniform mix. The thoroughly mixed sample to be poured into the prepared mould. Once the layer of mix has been placed in the prepared mould , the layer has to be compacted with the help of tamping rod at the spacing intervals of the plastic optical fibers placed. After compaction the top surface of the cube to get finished perfectly. Finishing operation is the last operation in making a translucent concrete. Cubes must be cured before they are tested. The process of curing should be continued as long as possible up to the time of testing. In order to provide adequate circulation of water, adequate space should be provided between the cubes, and between the cubes and the side of the curing tank. Similar to the conventional one, the translucent concrete cubes were also taken at the days of 7, 14 and 28 for testing purposes.

Fig 2. Finishing

VI. TEST CONDUCTED

COMPRESSION TEST

Remove the specimen from water after specified curing time and wipe out excess water from the surface. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the load gradually without shock and continuously at the same rate until cracks formed over the surface of the specimen.

Ultimate compressive strength = Ultimate load / Cross section area

LIGHT TRANSMITTANCE TEST

The light transmittance performance of translucent concrete was investigated by measuring the current

corresponding to the light intensity that transmitted through the specimens using an electrical setup with light dependent resistor (LDR).LDR also known as photo resistor is a light sensitive resistor whose resistance varies with the wavelength of the light, red led bulb and resistor was placed in white bread board and that was connected to the voltmeter. The translucent concrete specimen were situated at the centre and lamp was applied at varying distance. The lamp and LDR were situated in front and behind the specimens respectively. A 60W bulb were used to observe the light transmittance of translucent concrete.

Fig 3. Light Transmitting Test

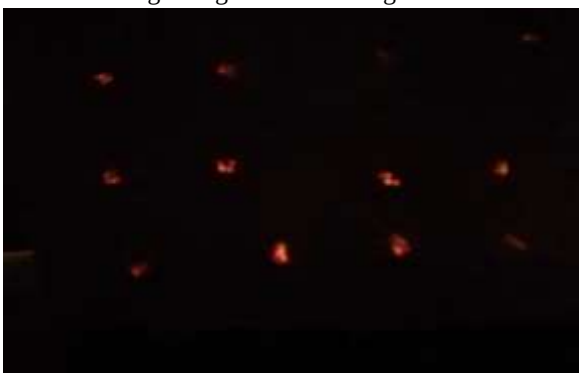

Fig 4. Light Transmitting Concrete

VII. RESULT AND DISCUSSION COMPRESSION STRENGTH TEST RESULTS

TABLE I COMPRESSION STRENGTH OF NCC & TSC – 7 DAYS CURING

S.NO.	MIX DETAILS Cement:Sand(1:3)	COMPRESSION STRENGTH(N/mm^2
1	Nominal mix	12.6
2	Fiber(0.9 mm)	11.0
3	Fiber(2 mm)	9.70

TABLE II COMPRESSION STRENGTH OF NCC & TSC – 14 DAYS CURING

S.NO.	MIX DETAILS Cement:Sand(1:3)	COMPRESSION STRENGTH(N/mm^2
1	Nominal mix	18.5
2	Fiber(0.9 mm)	16.6
3	Fiber(2 mm)	15.2

TABLE III COMPRESSION STRENGTH OF NCC & TSC – 28 DAYS CURING

S.NO.	MIX DETAILS Cement:Sand(1:3)	COMPRESSION STRENGTH(N/mm^2
1	Nominal mix	23.7
2	Fiber(0.9 mm)	22.1
3	Fiber(2 mm)	20.7

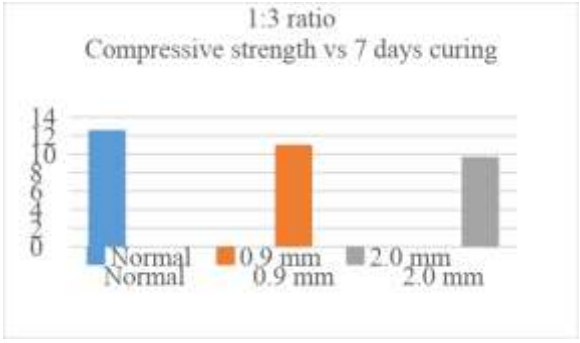

FIG 5 COMPRESSION STRENGTH VS 7 DAYS CURING

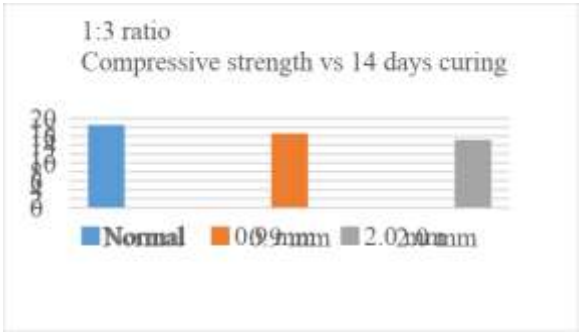

FIG 6 COMPRESSION STRENGTH VS 14 DAYS CURING

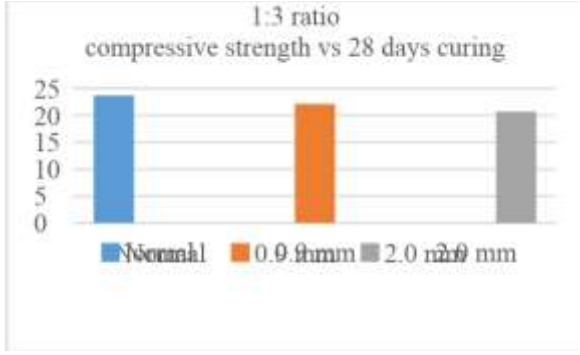

FIG 7 COMPRESSION STRENGTH VS 14 DAYS CURING

TABLE 4 LIGHT TRANSNITTANCE TEST RESULTS

S.NO	CONCRETE	POF DIA(mm)	DISTANCE(cm)	VOLTMETER (V)
1	Conventional concrete	Nil	0	Nil
			0.1	
			0.2	
			0.3	
			0.4	
2	Translucent concrete	Nil	0	3
			0.1	2.5
			0.2	1.5
			0.3	1
			0.4	0.5

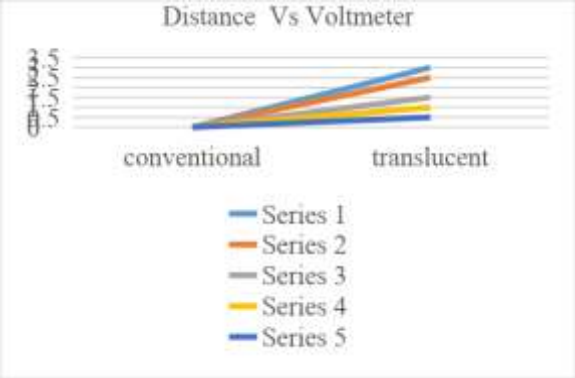

FIG 8 LIGHT TRANSMISSION TEST RESULT

DESCRIPTION

The fiber optic cables can be quite pricey, it will be especially important to make sure that you take enough time to see which companies there are to choose from before buying from one in particular with regards to quality concern. Due to above reason 2mm diameter translucent concrete does not transmit light.

VIII. CONCLUSION

Due an increasing anxiety about energy consumption and its impact on the national economy as well as the local environment. Using new materials in building that depend on renewable energy will help. Light transmissive property is mainly due to uniform distribution of high numerical aperture plastic optical fibers throughout.

In our project usage of two different diameters of plastic optical fibers to get infused into the concrete mix to get the blocks of translucent concrete.

The efforts were taken to know the compression test performed on our concrete samples and on the optical fiber as such were done to ascertain the improvement of casted blocks over normal concrete blocks. On the strength comparison of conventional block with the translucent ones results in slight depreciation variation of strength which could be neutralized by addition of any additives in future ones.

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