Light transmittability and Strength Characteristics of Transparent Concrete Produced by Supplimentary Cementitious Materials

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Abstract-*Concrete structural components exists in the buildings in different forms and shapes. This concrete plays vital role in construction industry and at present scenario it is important to produce concrete structures without affecting the environment. So to produce sustainable concrete a new development is necessary to deal with. Therefore light transmitting concrete is one option that utilise the natural light source effectively and at the same time satisfying the strength and aesthetic needs. This project deals with producing light transmitting blocks using the plastic optical fiber (pof) in cement mortar and concrete. and comparative study carryout on sorptivity, light transmittability and compressive strength test of the normal concrete, concrete with different admixtures and concrete with addition of pof in constant percentage. The result indicates that the sorptivity of transparent concrete produced by GGBFS will be the least and compressive strength of transparent concrete produced by GGBFS is higher as compared to that for transparent concrete produced by silica fume or metakaolin or fly ash or conventional concrete. The light transmittability will remain same in all transparent concrete irrespective of whether it is produced by GGBFS or SF or FA or CC*

***Key Words*: Transparent Concrete, Admixtures, Plastic optical fibers, Light dependent resistor, Sorptivity etc**

1. INTRODUCTION

Transparent lightweight Concrete is a new material with various applications in the construction field, architecture, decoration and even furniture. As can be imagined, concrete with the characteristic of being transparent will permit a better interaction between the construction and its environment, at the same time as significantly reducing the expenses of laying and maintenance of the concrete. 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. Many large span bridges and new landmark buildings have been successfully implemented structural health monitoring systems.

1.1 OBJECTIVES OF THE WORK

[1] To study strength characteristics of transparent concrete.

[2]To check the light transmittance of transparent concrete by using optical fibers.

[3] To reduce the artificial light consumption in structure.

[4] To study improvement in performance of concrete in light transmission by using optical fiber and improve performance of structure to derive natural light.

[4] To study energy saving for illumination by using transparent block for building.

[5] To make concrete partly transparent by using optical fibers in it to impart good appearance to structure.

1.2 LITERATURE REVIEW

1.2.1 Patil Gaurao S., Patil Swapnal V: "Light Transmitting Concrete- A New Innovation". In this paper, based on the excellent properties of light guiding and elastooptic effect of optical fibre, a novel smart transparent concrete is researched by arranging the optical fibers into the concrete. Their aim is to evaluate the effectiveness of the smart transparent concrete, the light guiding based on white light test, long-term durability based on freezing and thawing test and chloride ion penetration test, and self-sensing property based on stress elasto-optic effect test are made respectively. Then they are concluding that the smart transparent concrete has good transparency, mechanical and self-sensing properties

1.2.2 Momin A.A, Kadiranaikar R.B , Vakeel.S. Jagirdar, Arshad Ahemed Inamdar:"Study on Light Transmittance of Concrete Using Optical Fibersand Glass Rods". Their investigation aims is to producing the concrete specimens by reinforcing glass rods and optical fibers with different percentage and comparing it with the normal concrete. Different tests were carried out on the concrete specimens like compressive strength test, light transmission test etc.

Based on experimental results they conclude that, the compressive strength obtained for the specimens with optical fibers was almost same as that of normal concrete specimen. The transparency of concrete specimens with glass fibers was found to be more as compared to the specimens with glass rods, for which the compressive strength of the latter was more than the normal concrete specimens, which clearly indicates that without affecting the strength transparency of light is possible in concrete which enhances the architectural view.

1.2.3 Neha R. Nagdive . Shekar D & Bhole: "To Evaluate Properties of Translucent Concrete / Mortar & Their Panels". In this paper, a translucent concrete - novel construction material was manufactured with optical fibreby drilling through the cement and mortar in order to utilize the light guiding ability of optical fibre. The main purpose was to use sunlight as a light source in order to reduce the power consumption of illumination. Experiments to study the mechanical performance of the concrete infused with optical fibre were carried out.

2. MATERIALS

2.1 Plastic optical fibers (POF):

Plastic optical fibers are readily available in market with different dimensions. The POF used here of thickness 0.75mm.

POF helps to transfer light from one side to another side and act as a fiber reinforcement.

Fig [1] Plastic optical fibers

2.2 Cement:

In this experimental work, ordinary Portland cement (OPC) 43 grade confirming to IS:8112-1989 was used. The cement used is zuvari cement from the local distribution

Fig [2] Cement

2.3 Fine aggregates:

Locally available river sand belonging to zone II of IS:383-1970 was used for the project work.

Fig [3] Fine aggregates

2.4 Coarse aggregates:

Locally available crushed aggregates confirming to IS 383-1970 are used in this experimentation. Size of aggregates in this experiment 10mm down size.

Fig [4] Coarse aggregates

2.5 Supplimentary cementitious materials

2.5.1 Fly ash:

In this experimental work, low calcium, class F dry fly ash from the silos of Raichur thermal power plant conforming to IS: 3812 (Part 1) – 2003 was used.

Fig [5] Fly ash

2.5.2 Silica fume (SF):

In this experimental work, silica fume as supplied by SaiDurga Enterprises, Mariyappana playa , Rajajinagar, Bangalore was used. Table 4.5 gives the chemical composition of silica fume.

Fig [6] Silica fume

2.5.3 Ground granulated blast furnace slag (GGBFS):

In this experimental work, low calcium, ground granulated blast furnace slag from the RMC cement plant, Harihara was used. It is Confirming to IS: 3812 (Part 1) –2003.

Fig [7] GGBFS

2.5.4 Water:

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalis, vegetables or other organic impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement

3. MIX DESIGN:

Table-1: Mix proportion

W/C ratio	C	F.A	C.A
0.45	463kg/m^3	896kg/m^3	809.5kg/m^3
0.45	1	1.935	1.75

3.1 Some important properties

Table-2: Important Properties

Grade designation	M30
Type of cement	OPC
Maximum size of aggregate	10mm down size
Max water cement ratio	0.45
Workability	Good

4. METHODOLOGY

4.1 Step 1- Placing of fibers

One mould consists of total 162 holes, Each plate having 9*9=81 holes

Two numbers of POF are made to run in the holes, holes in the plate are at intervals of 10mm c/c.

Fig [8] Placing of fibers

4.2 Step 2- Mixing

Make the dry mix of cement, supplementary cementitious materials, fine aggregate and

coarse aggregate. Add required quantity of water for the wet mix.

Fig [9] Dry mix

Fig [10] Wet mix

4.3 Step 3-Pouring of concrete

The well mixed concrete is poured into the fiber placed mould in 4 equal layers with the help of spatula and travers. Each layer is compacted with the help of vibrator machine. After pouring of concrete the top surface should be leveled.

Fig [11] Pouring of concrete

4.4 Step 4 – Curing

After casting the mould should be kept in air dry for 24 hours, then demould the specimen. The demoulded specimen is then kept in water for curing upto 28 days.

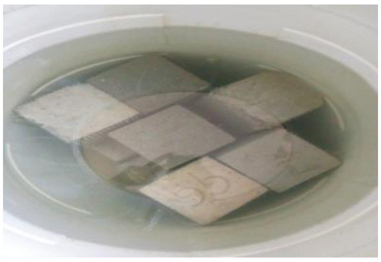

Fig [12] Curing

4.5 Step 5 – Surfacing of specimen

After 28 days of curing the specimen is taken out and leave it for complete dry. Cut the extended optical fibers by using knife or blades. and by using sand paper the surface is smoothened.

Fig [13] Surfaced specimen

5.TESTING PROCEDURE

5.1. Workability tests

The following workability tests are conducted on fresh concrete.

4.1.1 Slump cone test.

4.1.2 Compaction factor test.

4.1.3 Vee-Bee consistometer test.

4.1.4 Flow table test.

5.2 Sorptivity test:

Essentially, the sorptivity test determines the rate of capillary- rise absorption by a concrete prism which rest on small support in a manner such that 30mm of the prism is submerged as show in figure. The increase in the water level of the prism with time is recorded. It has been shown that there exists relation of the following.

$$S=i/(t^{0.5})$$

Where S = sorptivity in $mm/min^{0.5}$.

i=depth of water level increased by capillary action, expressed in mm.

t= time measured in minutes at which the depth determined.

Fig [14] Sorptivity test

5.3 Light transmittance test on specimen:

Various light measuring equipments is available such as Lux meter, however, a simple Lux meter can be made in a laboratory using simple components. The light transmittance through the sample can be measured by measuring the current corresponding to the light which can be measured by a photo diode or a Light Dependent Resistors (LDR). The use of photo diode would require a separate sensor which would increase the cost of the project. The most aptimum choice would be LDR, the LDR are soldered onto a PCB board as shown in figure below. The experimental set up is as shown below in figure.

The amount of light transmitted is calculated as follows-

$$\text{Light transmittance}=100-[\{(A1-A2)/(A1)\}*100]$$

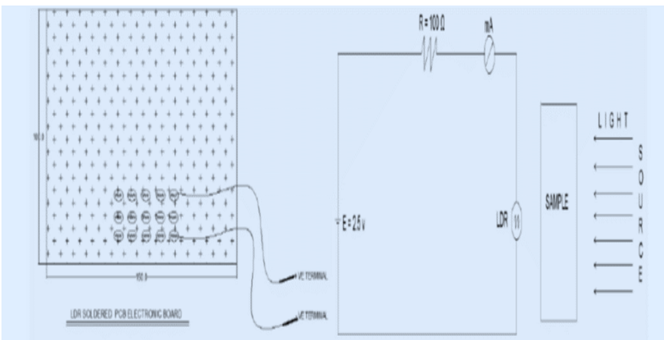

Fig [15] Circuit diagram of light transmission test

7. CONCLUSIONS

The following conclusions may be drawn based on the experimentation conducted on the transparent concrete produced by using different supplementary cementitious materials.

[1] It can be concluded that the sorptivity of transparent concrete produced by GGBFS will be the least as compared to that for transparent concrete produced by silica fume or fly ash or conventional concrete.

[2] Thus it can be concluded that the light transmittability will remain same in all transparent concrete irrespective of whether it is produced by GGBFS or SF or FA or CC.

[3] Thus it can be concluded that the compressive strength of transparent concrete produced by GGBFS is higher as compared to transparent concrete produced by SF or FA or CC.

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