

Study Of Translucent Glass Concrete

Sisira Sugunan , Nisha Babu, Sowparnika M.

1(Dept. of Civil Engineering, SNGCE, KERALA, INDIA) 2(Dept. of Civil Engineering, SNGCE, KERALA, INDIA) 3 (Dept. of Civil Engineering, SNGCE, KERALA, INDIA)

Abstract: *In today's world, conventional aggregate like river sand are beyond the reach of majority of the population due to the non-availability. Hence it is of great importance to develop a new kind of building material, which integrates green energy with self-sensing properties of functional material. Using the excellent properties of optical fiber, translucent concrete is studied by arranging the optical fibers in the concrete. The majority of glass waste is not being recycled and is the cause of serious problems such as environmental pollution. In this paper, experimental studies were conducted in order to analyze the possibilities for recycling waste glass as fine aggregate for concrete. This paper focuses on making a solid building block by replacing fine aggregate with crushed glass waste and also to introduce translucency for aesthetic effect. The scarcity of building materials like cement and aggregate along with emission of carbon dioxide during construction work can be overcome by the use of glass waste in concrete.*

Keywords - *Concrete, Energy efficiency, Waste management, aesthetics*

I. Introduction

It is a concrete based building material with light transmissive properties due to embedded optical fibers and glass aggregate. Translucent glass concrete (TGC) block gets its name due to its property of light emission through optical fiber strands in it. Its creative design can make great aesthetic ambience to structures where it is used. In TGC building blocks aggregate used is crushed glass pellets and translucency is facilitated through optical fiber embedded across the blocks. The main purpose is to use sunlight as a light source to reduce the power consumption of illumination and to use the optical fiber to sense the stress of structures and also use this concrete as an architectural purpose for good aesthetical view of the building.

In Kerala, conventional aggregate like river sand materials are beyond the reach of majority of the population due to the non-availability. The search for alternative materials is inevitable at this juncture. Use of waste glass instead of material aggregate makes it economical. Solid waste management is one of the major environmental concerns in the world. Waste utilization has become an attractive alternative to disposal because of the scarcity of space for land filling and due to its ever increasing cost. The use of waste products in concrete not only makes it economical, but also helps in reducing disposal problems. Reuse of bulky wastes is considered the best environmental alternative for solving the problem of waste disposal.

II. Scope And Objectives

A novel architectural material called transparent concrete was developed by adding optical fiber in the concrete mixture. The transparent concrete has good light guiding property and the ratio of optical fiber volume to concrete is proportion to transmission. There is a limit on the availability of natural aggregate and minerals used for making cement, and it is necessary to reduce energy consumption and emission of carbon dioxide resulting from construction processes, solution of this problem are sought through usages of waste glass as partial replacement of Portland cement. The main objectives of our project are:

- A. Replacing fine aggregate by crushed waste glass pellets
- B. To determine ideal percentage of waste glass replacement
- C. To manufacture a solid building block having translucency due to embedded optical fiber

III. Methodology

The methodology adopted for this work is shown as a flowchart in fig. 1. The various materials were collected like: Crushed glass of size 90 μ -2.36mm, River sand of size 90 μ -2.36mm, fly ash based Portland Pozzolana cement and plastic optical fiber.

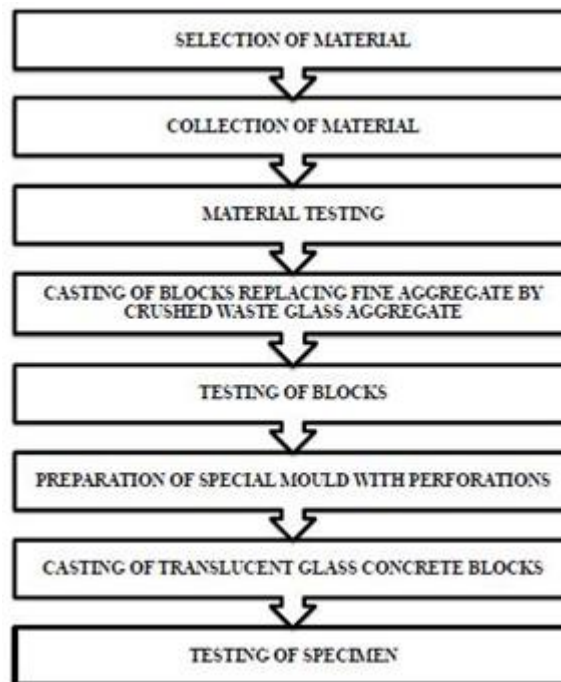


Fig. 1 Methodology

Using the required quantity of above mentioned materials, blocks were casted replacing fine aggregate by crushed glass wastes by 10%, 20%, 30%, 40%, etc. up to 100%. The sample mix with maximum compressive strength was then embedded with optical fibers to produce TGC.

IV. Experimental Study

For the study different laboratory tests were carried out on the different materials used according to the IS standards. Test for aggregates includes specific gravity test, sieve analysis, estimation of bulk density, porosity and void ratio. Whereas testing of cement includes finding the properties like fineness, standard consistency, initial setting time, specific gravity.

Cubes of size 7.06x7.06x7.06 cm were casted as per the IS standards. The quantity estimation for proportion 1:3 is as follows:

For one mortar cube,

Quantity of cement = 200 g

Quantity of fine aggregate = 600 g

Quantity of water = $p/4+3\%$ of combined weight of cement & sand
 = $(36/4+3) \% \times 800$

= $12/100 \times 800$
 = 96 ml

For three mortar cubes, the quantities of materials required are shown in the table 1.

Table 1. Estimation of quantity of materials

% of replacement	Qty of cement(gm)	Qty of sand (gm)	Qty of glass (gm)	Qty of water (ml)
0	600	1800	0	288

5	600	1710	90	288
10	600	1620	180	288
15	600	1530	270	288
20	600	1440	360	288
25	600	1350	450	288
30	600	1260	540	288
40	600	1080	720	288
50	600	900	900	288
100	600	0	1800	288



Fig. 2 Casting of mortar cube



Fig. 3 Curing of mortar cube

The mortar cubes were casted, cured and compressive strengths were obtained. The 7th day strength values obtained for the various percentage replacements is shown in table 2. The percentage replacement corresponding to maximum strength value was then taken for the production of TGC. From the table 2 it was observed that maximum strength was shown by 30% replacement of fine aggregates.



Fig. 4 Testing of mortar cube

Table 2. 7th day compressive strength

% of Replacement	7 day			Average of 7 day compressive strength
	Cube 1 N/mm ²	Cube 2 N/mm ²	Cube 3 N/mm ²	
0	22.87	22.47	16.85	22.67
10	20.06	16.85	16.85	17.92
15	18.06	16.45	17.06	17.19
20	18.06	22.07	22.07	20.73
25	20.06	20.46	16.85	19.26
30	22.07	23.67	20.06	21.93
40	22.07	18.06	16.05	18.73
50	16.05	17.25	18.86	17.39
100	10.03	6.02	14.85	10.3

A. Casting Of TGC

The main idea of TGC is that high numerical aperture optical fibers are directly arranged in the concrete and the optical fiber is used as sensing element and optical transmission element. Since light can transmit in the optical fiber, different shape of TGC can be fabricated by distributing certain amount of optical fibers regularly in the concrete. Plastic optical fiber is an excellent media to transmit light at specific wavelengths which has been widely used in illuminating facility or architectural appearance lighting.

TGC was made by embedding optical fiber and replacing 30% fine aggregate with glass pellets, ie.the mix with greater compressive strength from first set of casting. Proportion for mortar cube was selected as 1:3.The first step was to make a mould with perforations. The mould can be made in any shape with any material such as timber, steel, iron etc. The optical fibers run through these holes from one end to the other and then concrete was made to set in it with the fibers inside. The light falling on one side of the block gets transferred to the other side through the optical fibers running from one end to the other.

Optical fibers generally work as a hollow cylindrical waveguide which transmits light along its axis by the principle of total internal reflection of the optical fiber strands. This property is used and optical fibres were embedded in the estimated quantity. Moulds of same size with perforations were used. The diameter and number of holes were computed as follows:

Size of mould = 7.06 cm
Volume of mould = 351.89 cm³
Percentage of optical fiber = 5%
Volume of optical fiber = $\frac{5}{100} \times 351.89$
= 17.59 cm³
Spacing of holes = 5 mm
Number of holes = 169
 $169 \times \frac{\pi}{4} \times d^2 \times 7.06$
= 17.59
D, diameter = 0.137 cm = 0.2 cm

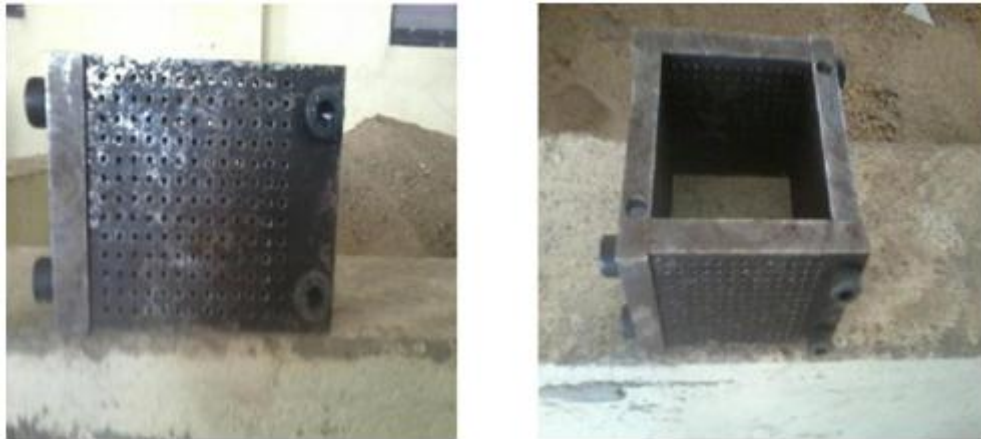


Fig. 5 Mould with perforations



Fig. 6 Optical fiber embedded in the mould

B. Compressive Strength Test On Blocks

The test was conducted on universal testing machine as per IS 2185 part 1-1979. Three specimens were taken for testing. Specimens stored in water were tested after keeping it for 1 hour for surface dry. The dimensions of the specimens were taken to the nearest 0.2 mm and their weights were noted before testing. Age of specimen at the time of testing was 28 days. The load was applied without shock increasing continuously until the specimen breaks down and no greater load can be sustained. Compressive strength of specimen was calculated using the formula:

$$= P/A \quad (1)$$

Where, P = maximum load applied in Newton

A = cross sectional area of the specimen in mm²
 Average of three values is taken as compressive strength

Table 3 shows the 7th day compressive strength

Table 3 Average Compressive strength of TGC

TGC with 30% glass aggregate	7 Day Compressive Strength N/mm ²			Average of 7 day compressive strength
	Cube 1	Cube 2	Cube 3	
	22.25	21.99	22.13	22.12

C. Light Transmittance Test On TGC

Light measuring equipment and setup: 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 was estimated 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 required a separate sensor which would increase the cost of the project. The most apt choice would be LDR.

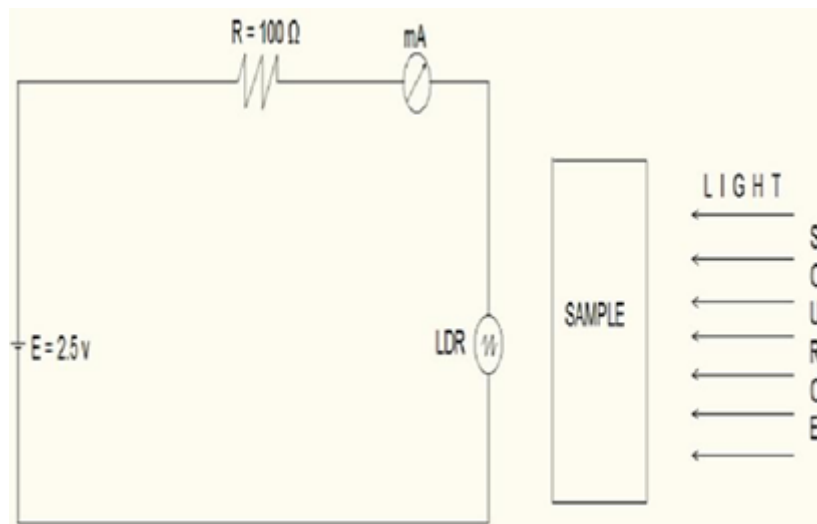


Fig .7 Circuit Diagram

As shown in the above figure 7 the LDR measured the light transmitted through the sample and converts it into the current, which in this case was measured in milli amperes (mA). So two readings were taken, one without sample (A1) and one with sample (A2). The source of light here was taken as 200 W incandescent bulbs, a resistance of 100 Ω was applied in the circuit and a uniform DC voltage of 2.5 V was kept between the circuits. To ensure no light escapes throughout the test, a box made up of plywood was made. The light source was fixed at the top of the box and LDR was placed at the bottom. The sample was placed between source and LDR and test was carried out.



Fig. 8 Final TGC block

$$\text{Light transmittance} = 100 - [(A1 - A2) / A1] \times 100 \quad (2)$$

Using equation 2 the amount of light transmittance is computed and on an average 50% light transmittance was obtained. Figure 8 shows the final TGC block

V. Conclusion

Translucent glass Concrete block was prepared in the laboratory using broken glass as aggregate. The fresh concrete made by using glass aggregate was found to have good workability. The provision of optical fibres along transverse direction gave ornamental effects through its translucency. The translucent glass concrete structures will become very common in the near future due to easiness in construction and the availability of raw materials. This actually makes construction more environmental friendly due to the usage of waste glass

References

- [1]. A.A. Momin, Dr. R.B. Kadiranaikar, Mr.Vakeel.S. Jagirdar, Mr.Arshadahemedinamdar, (2014), study on light transmittance of concrete using optical fibers and glass rods, *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, e-ISSN: 2278 – 1684, p-ISSN: 2320-334X, pp 67- 72
- [2]. Bhavin K. Kashiyani, VarshaRaina, JayeshkumarPitroda, Dr. Bhavnaben K. Shah, (2013), A Study on Transparent Concrete: A Novel Architectural Material to Explore Construction Sector, *International Journal of Engineering and Innovative Technology (IJEIT)*, Volume 2, Issue 8
- [3]. Bhupendra Singh Shekhawat, Dr. Vanita Aggarwal, (2014), Utilisation of Waste Glass Powder in Concrete –A Literature Review, *International Journal of Innovative Research in Science, Engineering and Technology*,
- [4]. Jianping he, Zhizhou and Jinpingou, (2011), Study on smart transparent concrete product and its performances, *The 6th international workshop on advanced smart materials and smart structures technology ANCRiSST2011*, July 25-26, Dalian, China
- [5]. M.N.V. Padma Bhushan, D.Johnson, Md. AfzalBasheer Pasha And Ms. K. Prasanthi, (2013), Optical Fibres in the Modeling of Translucent Concrete Blocks, *International Journal of Engineering Research and Applications (IJERA)*, ISSN: 2248-9622 ,Vol. 3, Issue 3, May-Jun 2013, pp.013.