An Experimental Study on the Impact of Incorporating Glass on the Photocatalytic Capacity of Concrete Blocks

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Abstract. Today's world is more concerned about the preservation of natural sources. Consumption of less amount of natural resources in construction activities is equally important as energy saving after construction. To combine both the aspects, one such thing tried in this work is translucent concrete. As everyone knows, concrete is termed as traditional material for a building. The important property hidden in this concrete is light emission. When light hits the concrete, some amount light gets transmitted to the other side of concrete. This characteristic is achievable when optical fibers are included in concrete. Optical fiber is a medium where it is associated with the transmission of information as light pulses along the fiber. In addition, the use of glass as a coarse aggregate is also studied and it also plays a major role in strength of the concrete. Concrete blocks containing glass particles as a partial replacement for coarse aggregates are casted and tested for mechanical properties and light transmission. Results shows the blocks transfer light in an efficient manner without major changes in the strength aspects.

Introduction

Translucent Concrete is a new class of concrete that focus on the conveyance of light. By the help of optical fiber, the transmission of light is practicable. Optical fiber is a medium and a technology accompanied with the transversion of particulars as light impulse along a glass or plastic strand or fiber. The core part of optical fiber is of high refractive index, which emerges the transit of light through it without much loss in potential energy of light. In recent times, the generation of waste glass is increased. So, it was used in this study. The fragmentary substitution of glass is done which results in durable and eco-friendly outcome.

Ahmed M Tahwia et al. [1] conducted research demonstrating that transparent self-compacting concrete may provide a wide range of light transmittance while maintaining good mechanical qualities. According to the findings of Yat Chhoy Wong[2], 10% recycled plastic waste and recycled crushed glass aggregates of the concrete design mix have the potential to be incorporated into concrete footpaths as a sustainable material, resulting in a significant reduction of plastic and glass wastes ending up in landfills. According to Pengwei Guo[3,] the use of glass particles can enhance the microstructure and reduce the permeability of concrete, enhancing sulphate attack resistance and freeze-thaw resistance. In modern architecture, Ping Liang noted how daylight plays an important role in both biological and psychological needs [4].

Nicholas [5] highlighted how using recycled waste glass to replace up to 25% of natural coarse particles in concrete did not have a major impact on its abrasion resistance. According to Zhuan Shen [6, the natural lighting coefficient in the room improved by 100 percent, the light was uniformly raised by approximately 50 percent, and the artificial lighting device's running time was reduced from 72 percent to 41 percent. Shing Mei [7] discussed how light transmitting concrete (LTC) might minimise light energy consumption and carbon emissions, promoting green building construction, particularly in cities. With the addition of more optical fibres, the optical power of light-transmitting concrete increased nonlinearly. According to Danial Navabi[8,] LTC does not transmit infrared radiation as well as visible ones.

In order to achieve the standard living criterion, Shing Mei Chiew [9] suggests that, in addition to examining light transmittance attributes, simulation modelling of LTC should focus more on thermal comfort and energy savings. According to Nadeem Gulzar Shahmir[10], translucent cement can be used in green structures as a vitality effective and efficient source that has acceptable flexural quality, compressive quality, and light trans mitting qualities when used fine totals.

Experimental Investigation

Materials Used

Cement

Ordinary Portland Cement (OPC) of Grade 53 was employed in this research work. Specific gravity, fineness modulus, initial setting time and final setting time. And their values are 3.15, 6, 38 mins and 585 mins respectively.

Water

The most vital and least costly component of concrete is water. For the experimental studies and curing, ordinary potable water available in the laboratory was used. The specific gravity of water is ideal i.e., 1.

Fine Aggregate

Locally available river sand which passes through 2.5 mm sieve is used as as fine aggregate in the present study. The values for specific gravity and fineness modulus are 2.70 and 2.50 respectively. Water absorption value is 1.3%.

Coarse Aggregate

The work was done with angular coarse aggregate. The aggregate seemed to have a nominal size of 20mm. The values for specific gravity and fineness modulus are 2.80 and 7 respectively. Water absorption value is 1.1%.

Optical Fiber

The optical fiber is collected from the market. The optical fiber is inserted into the wooden mould for about 10 cm, for the light transmission purpose. The diameter and aspect ratio are 0.75 mm and 133.33 respectively.

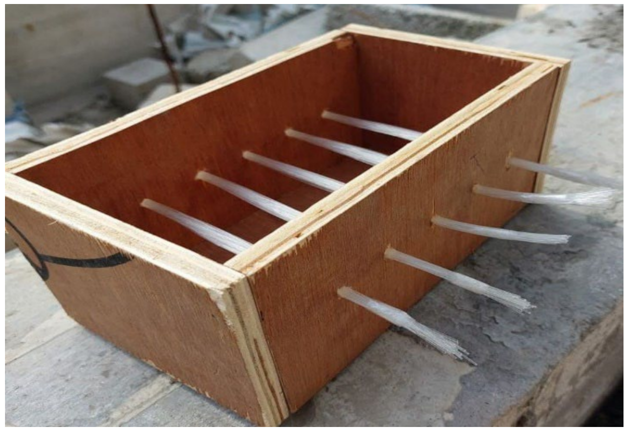

Figure 1 Wooden Mould with Optical fiber

Glass

The glass we have used is taken from old glass bottles. They are broken down into pieces and sieved using the sieve sets 20 mm, 16 mm and 12 mm. The broken glass particles which were passed through 20 mm sieve and retained on 16 mm and 12 mm sieve.

Figure 2 Broken Glass Aggregate

Superplasticizer

Superplasticizers, often known as water reducers, have a wide spectrum of water reduction properties. In this work, Master Gelenium 430 is used.

Mix Design

IS 10262 – 2019 is used to calculate the mix percentage for M30 grade. The mix proportion obtained is 1:1.74:2.64.

Tests Conducted

Compressive Strength Test For Blocks

The block size employed was 200*100*100 mm in dimension. After wiping away the surface moisture from the specimen, the mould was examined in a saturated state. At the age of 28 days, cubes were examined using a compression testing equipment for this study. The block is placed on the testing equipment and the equipment is switched on. When the block attains a ultimate load the block gets broken or gets cracked and the load transmission is dropped off. The specimens were casted and tested as per IS 516:1959 The blocks tested in compressive testing machine setup is shown in Figure 3.

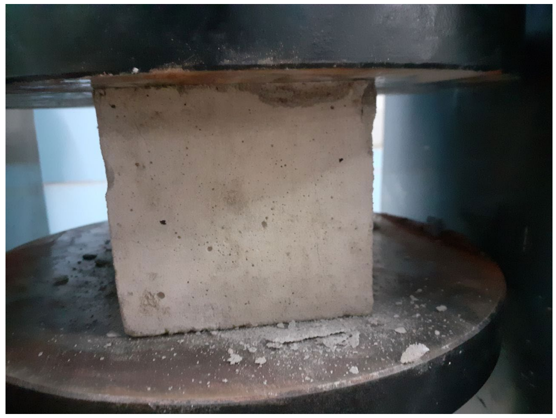

Figure 3 Block during Compression Test

Water Absorption Test for Blocks

For water absorption test, the block is weighed soon after demolding. This weight is termed as dry weight of the block. For wet weight of the block, the block weight is taken after 28 days of curing. And then the results were made.

Results and discussions

Compressive strength test results

The specimens were tested as per IS 516:1959. The blocks were tested in compressive testing machine as shown in Figure 4. The compressive strength results were tabulated in Table 1.

Figure 4 Compression Test Setup

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Table 2 Compression Test Results

Specimen	% of glass	Average compressive strength N/mm^2 (28 days)
Conventional concrete	10%	31
Translucent Concrete (Block 1)	0%	32
Translucent Concrete (Block 2)	5%	35
Translucent Concrete (Block 3)	10%	33

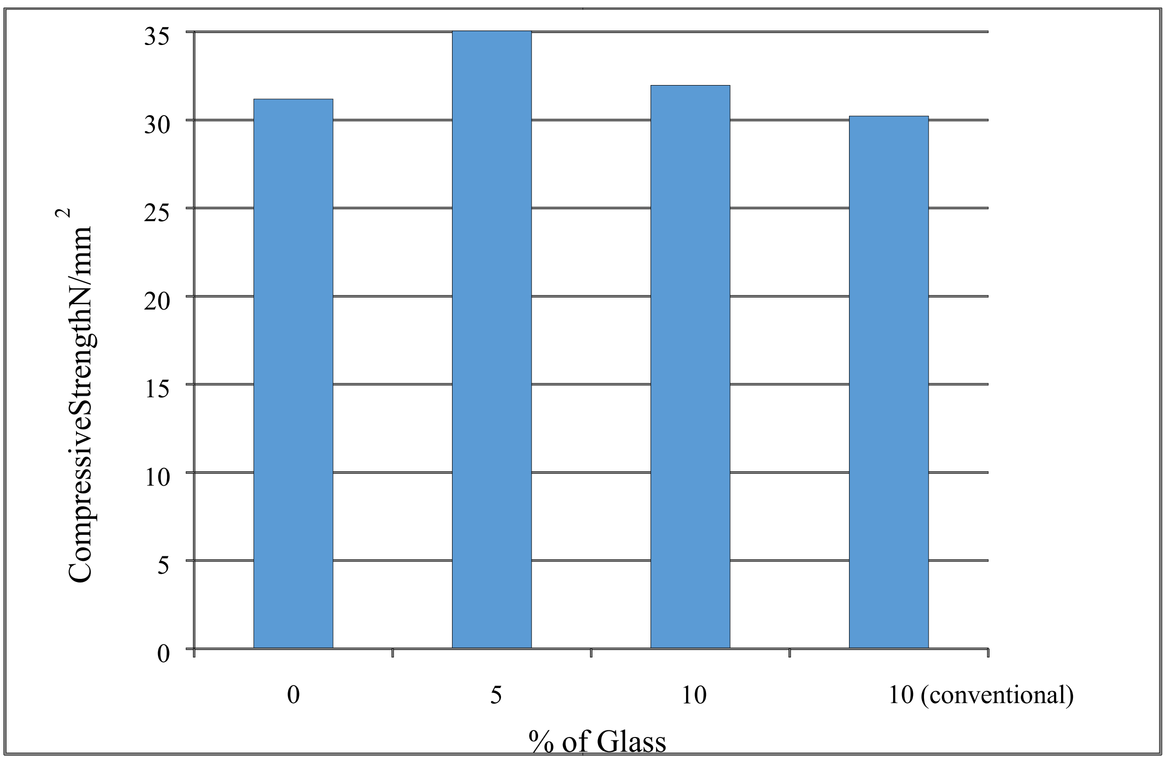

Figure 5 Variation in compressive strength

Water Absorption Test Results
Water Absorption (%) of the specimens were performed and the results are tabulated in Table 3.

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Table 3 Water Absorption Test Results

Specimen	Water Absorption (%)
Conventional concrete	1%
Translucent Concrete (Block 1)	2%
Translucent Concrete (Block 2)	2%
Translucent Concrete (Block 3)	1.2%

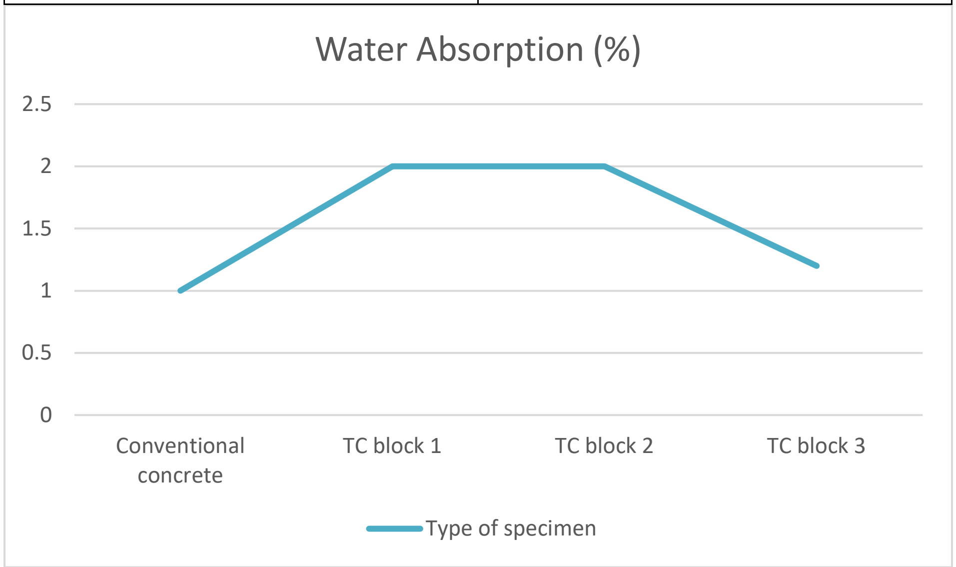

Figure 6 Variation in Water Absorption Capacity of Blocks

From the test results, it was observed that addition of glass particles contributes to the compressive strength of concrete. Glass aggregates when replaced up to 5% gives good compressive strength. Water absorption capacity of the blocks are also within allowable limit.

Light Emitting Property

The light transmission of the block is examined. When light is supplied to one end of the block, the light is transferred to the opposite end without major loss in transmission. As a result, light transmission is a successful one in this type of blocks. Light emitting property of block is shown in Figure 7.

Figure 7 (a) Light emitting property of translucent block

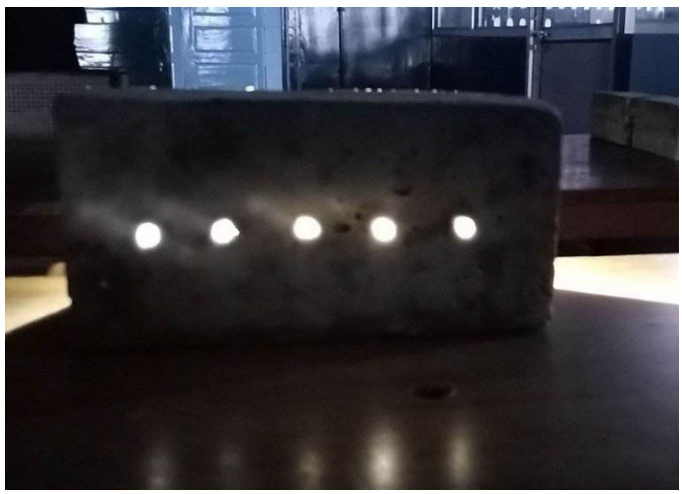

Figure 7 (b) Translucent block

Conclusion

An attempt has been made to prepare a concrete using waste glass pieces which also contribute to the translucent properties. Optical fibers are incorporated inside concrete without affecting the conventional properties. Concrete blocks were prepared of dimension 200*100*100 mm and properties like compression strength and water absorption were studied. When coarse aggregate are replaced with 5% glass aggregates, the compressive strength is effective. Light transmission is also provided with the help of optical fibres. The work can be continued with more layers of optical fiber.

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