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PERFORMANCE ANALYSIS OF TRANSLUCENT CEMENT MORTAR BLOCK

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Abstract - *The translucent block has good light transmitting property and the ratio of optic fiber volume is proportional to transmission capacity. It is mainly recommended on aesthetic point of view and on architectural aspects. The light transmittance through various specimen was seen to increase with the amount of optical fibers used. The light transmittance of 10.97 % (maximum achieved through experiment) was achieved by using 1.4% of optic fiber. Thus it proves that light transmitting block can be used in green buildings. It will ensure natural sunlight enter inside the building.*

The translucent block not loses the strength parameter when compared to regular block 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 used where the light cannot reach with appropriate intensity. This new kind of building material can integrate with the concept of green building.

Key Words: **Cement, Fine Aggregate, Optical Fibers, Plywood**

1.0 Introduction

Translucent cement mortar block has various applications such as to illuminate the walls in flooring, to create aesthetic design etc. It is also applicable to make translucent cement mortar block suitable for floors, pavements and load-bearing walls, facades, interior wall cladding, dividing walls based on thin panels, light fixtures and partitions wall. It can be used where the sunlight does not reach properly. It increases visibility in dark subway stations. Today we are living in a world where energy expenditure and environmental problems have escalated to global scale. Translucent cement mortar block aims at reducing this operating energy by exploiting vast amount of potential energy in the form of sunlight. Another additional feature is its pleasing aesthetics that can change the image of the building blocks which is generally perceived as dull, pale, opaque grey material.

1.1 Objectives

The following are the objectives

- To study the compressive strength characteristics of translucent block
- To compare compressive strength characteristics of translucent block and normal mortar block of same dimension
- To study the light transmittance property of translucent block
- To study the cost effectiveness of translucent block

2.0 Literature review

Thiago Dos S. Henriques et al. (2018) to investigate the mechanical behavior of LTCM (light transmitting cement based material) reinforced with POF at three fiber contents (2%, 3.5%, and 5%) arranged in an orderly manner and compare it to the reference specimen free of fiber. In general LTCM is becoming a high-tech material that provides excellent performance and a wide range of applications but requires competent design and execution.

Aashish Ahuja et al. (2017) represents translucent concrete as a building envelope can offset some lighting energy that is consumed within a room in an office. It is constructed by embedding optical fibers during the manufacturing phase to transmit sunlight. From results, a volumetric fiber ratio of 6% used in the TC panels leads to savings in lighting energy by around 50%.

3.0 Materials

3.1 Cement: In this work, 53 grade ordinary Portland cement was used. The properties are tabulated in table.

Table -1: Physical Properties of Cement

Sl . no	Property	Results obtained	Specification as per IS Code
1	Specific gravity	3.17	3 -3.5
2	Normal consistency	30 %	30%
3	Fineness modulus	5.2 %	Less than 10

3.2 Fine Aggregate

Table -2: Physical Properties of M Sand

Sl. no	property	Results obtained	Specification as per IS code
1	Specific gravity	2.55	2.5 -2.7
2	Fineness modulus	3.08	2 -4

3.3 Optical Fibers

Light travels through the fiber core, bouncing back and forth off the boundary between the core and cladding. Because the light must strike the boundary with an angle greater than the critical angle, only light that enters the fiber within a certain range of angles can travel down the fiber without leaking out. This range of angles is called the acceptance cone of the fiber. The size of this acceptance cone is a function of the refractive index difference between the fiber core and cladding. The diameter of optical fiber used is 1 mm.

3.3.1 Working principle of optical fibers

The optical fibers works on the principle of total internal reflection.

3.3.2 Total internal reflection

The rays of light always strike the internal surface of the glass at an angle greater than the critical angle. A commercial optical fibre has a fiber core of high refractive index surrounded by a thin, outer cladding of glass with lower refractive index than the core. This ensures that total internal reflection takes place.

3.4 Water

Water is an important ingredient of cement sand mix. As a general guidance, if the water is fit for drinking it is fit for making the mix. Potable tap water available in laboratory with pH value of 7.0± 1 and conforming to the required of IS: 456-2000 was used.

3.5 Plywood mould

A square mould of size 150 x 150 mm is used.

4.0 Methodology

In the process of making translucent cement mortar block, the first step involved in preparation of mould The standard minimum size of the cube according to IS 456-2000 is 150x150x150 mm. 5 such moulds were made for casting. The number of holes was calculated according to the 0.2%, 0.6%, 1 and 1.4% percentages of the total volume of the cube.

Optical fibers are embedded through the holes according to the varying percentages in each cube. Cement mortar mix is prepared and fill each of the mould. Mould is vibrated by hand without disturbing the optical fiber at the time of filling to achieve full compaction of mix. The cubes are then kept for a curing period of 28 days. Specimens are removed from the mould after 24 hours. After demoulding, cubes must be cured before they are tested.

Fig -2: Different Percentage of Optical Fiber Embedded in Cubes.

5.0 Test Results

5.1 Compressive strength

The compressive strength is one of the most significant and useful properties for the design of the structure. The compressive strength of concrete cubes of varying percentages of optical fiber was tested after 28 days curing period. Testing of cubes was carried out in Compression Testing Machine of 1000 KN capacity to determine the compression strength of design mix. The cubes were tested by placing the cube with fibers parallel to load.

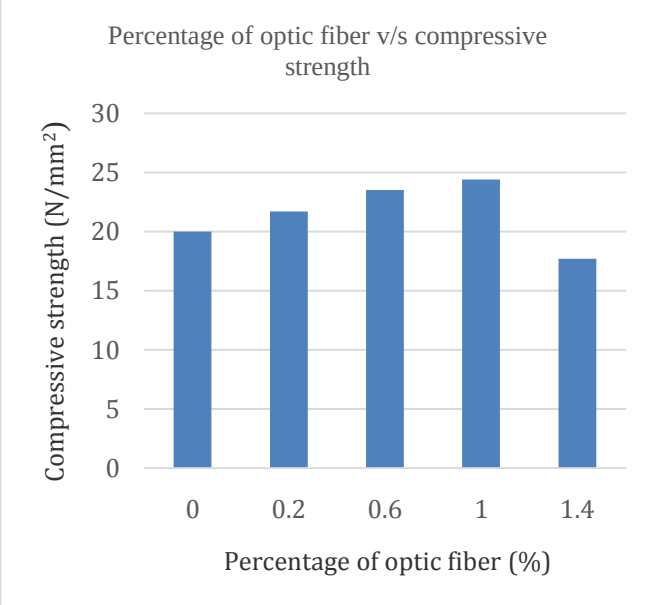

Chart -1: Compressive Strength Variation Graph

The effects of the volume fraction of fiber on compression strength is shown in chart 1. The results show that the compressive strength increases with increasing fiber percentage. The maximum compressive strength of translucent cement mortar block obtained is 24.4 N/mm2, with optic fiber of 1% and is higher than 20 N/mm2 of normal cube with 0% optic fiber. The compressive strengths of cubes with 0.2% and 0.4% of optic fiber are greater than 0% mix. However, the results also show that despite the increase in fiber percentage, the 1.4% mix has lower compressive strength than 1% mix. This might be due to the fact that smaller spacing arrangements of optic fiber resulted in weaker cubes.

5.2 Light Transmittance Test

The light transmittance ability of the specimens was tested by an electrical circuit set up with a light dependent resistor.

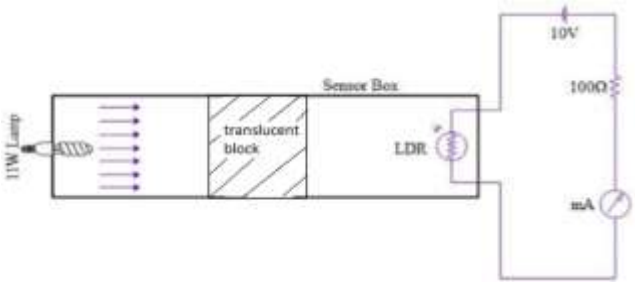

Fig -3: Light Transmittance Test Setup

The light transmittance test of all specimens was conducted after 28 days of curing. Figure 3 shows the experimental test setup.

Table -4: Light Transmittance Test Result

Specimen		$P_{0.2}$	$P_{0.6}$	P_1	$P_{1.4}$
% of optic fiber		0.2	0.4	1	1.4
Ammeter reading (mA)	Without sample	8.2	8.2	8.2	8.2
	With sample	0.5	0.6	0.7	0.9
Light transmittance (%)		6.09	7.31	8.53	10.97

The transmission of light through the translucent cement mortar block depends on the percentage of optic fiber used on the surface area. From the result it can be concluded that, the transmission of light increases with the percentage of optic fiber used.

5.3 Cost Analysis

The study showed that the cost for translucent cement mortar block varies from 2 to 9 times of normal block according to the percentage of optic fiber content. But the translucent block can reduce electricity bills without compromising with the strength of the building. It will reduce the energy consumption of both residential and industrial buildings. It can be used for construction of green buildings since it will save energy and will also provide aesthetic beauty to the building. Hence translucent cement mortar block can be considered as cost effective.

6 Conclusions

The light transmittance through various specimen was seen to increase with the amount of optical fibers used. Thus it proves that light transmitting block can be used in green buildings. It will ensure natural sunlight enter inside the building.

The compressive strength of specimen is best with 1% of optic fiber, after that the strength begins to reduce as the percentage of optic fiber increases. This might be due to the fact that smaller spacing arrangements of optic fiber resulted in weaker cubes. The compressive strength was found to be less for 1.4% of optic fiber than 1% optic fiber, this may be attributed to the improper compaction due to smaller space during casting and resulted in honey combed specimen.

It can also be concluded that, if there is a breakage in the optic fiber during any stage of preparation of specimen, the light transmittance property will be lost, hence proper care has to be given during casting.

Compared to normal block, the translucent block has slight increase in compressive strength and it has the property to transmit light. The translucent block achieves maximum effect when used in an environment with a high degree of light contrast. From all this conclusions, this material can be suggested for new contribution, giving importance to aesthetics.

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