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Light Transmitting Mortar Blocks

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Abstract **- Concrete has taken many new dimensions from the day of its invention. In that way LiTraMor - Light Transmitting Mortar blocks is a newer form of concrete that is experimented in this study. The materials used for the manufacture of this type are concrete and single mode optical fiber cable. Light is made to transmit through concrete block by the principles of single mode optical fiber cable. Literally, Optical fiber cables are embedded in the mortar blocks to obtain the transmissive properties of concrete. The materials used for the manufacture of mortar are tested by the well-conditioned equipment and all the results are compared with Indian standards. Strength of the block is not reduced by the usage of optical fiber cable because; the diameter of optical fiber cable is less so it serves as homogenous component. The number of optical fiber to be used is finalized by trials and the nominal percentage of optical fiber cable is finalized. These blocks were casted and tested for their compressive strength after 28 days of curing and an optional test was carried out at 7days, to test the strength of concrete. Tests were carried out to test the compressive strength of conventional and fiber introduced blocks. Light transmitting blocks showed good properties similar to that of the conventional blocks.**

Keywords - Light Transmitting Concrete, Optical Fiber Application, Transmissive Concrete, Energy Efficient Concrete

1. INTRODUCTION

The mortar currently used in the construction industry generally consists of cement, water and aggregate. Traditional mortar has a greyish color and its high density prevents the light to transmit inside the concrete. We are living in a world where energy expenditure and environmental problems are extended to global scale. In this world, the developing countries need the energy saving materials to the buildings. Now a day's buildings are built in a closed way without sufficient ventilation inside the buildings. In the developing countries like India, energy saving is an important factor, so this paper attempted to integrate a light source and concrete in construction. This can be termed as light transmitting blocks which serve as an energy efficient concrete block. The materials used for the manufacture of this type are concrete and single mode optical fiber cable. Light is made to transmit through concrete block by the principle of single mode optical fiber. Light transmitting mortar blocks are casted by cement, aggregate dust and optical fiber. The principle of optical fiber cables are involved and implemented in this study. Optical fibers are embedded in the concrete block to obtain the light transmissive properties in mortar. The properties of light transmitting concrete comprises of both concrete and optical fiber cable. Source for optical fiber is received by the natural sun light.

2. REVIEW OF LITERATURES

2.1 Translucent concrete

Victoria Bailey explained that the glass fiber had light transmitting property. It works on the principle of Nano optics present in the glass fiber. It was found that mechanical strength increased It has great advantage with its translucency. Self-sensing property of the translucent concrete is based on the stress elasto-optic effect. The concrete can emit light no matter how thick it is. It also acts as good aesthetical view of the building. The disadvantage is that this type of concrete have high installation cost. So the economical way of producing good concrete to the users is worked out in this project.

2.2 Study on smart transparent concrete product

This study explains about the light guiding and elasto – optic effect of the optical fiber. It also explains about the various test based on optical fiber like white light test, long term durability test based on freezing and thawing effect. The transmittance property of the optical fiber is measured by power meter and also from its wave length. The conclusion was that the light transparent concrete has good transparent property, mechanical and self – sensing property.

2.3 Systems and Structures

This study explains about various properties of the optical fiber like light transmitter, receiver, monitor, a modulator element and a signal processing unit. It has wide applications in the field of civil engineering with its needful functions. It is used in integrated bridge monitoring systems, monitoring of rehabilitated and antique structures, monitoring of bridge cables and suspenders, monitoring of bridge scouring, monitoring of tall rise buildings, and also in the tunnels and pipe lines and so on. In this journal we can learn the various necessary application of the optical fiber.

2.4 Existing light transmitting block using plastic optical fiber

The existing light transmitting block consists of conventional concrete materials with plastic optical fiber. It is formed as light weight concrete and also as light transmitting concrete by the help of adding the small size of coarse aggregate with minimum thickness in the concrete. Hence the light source can be easily passed from the small size of coarse aggregate. The concrete has high compressive strength when compared to conventional concrete but it has high cost.

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2.5 Smart transparent block using epoxy resin

The transparent blocks can be made with the help of plastic optical fiber. In order to check the feasibility of the concrete the epoxy resin can be used to check the light guiding property of the concrete. They finally concluded that the optical fiber not only has the transmitting power of the light source, hence it also has the capacity of transmitting the thermal energy. Hence it reduces reduce the power consumption.

3 STUDY OF MATERIALS

The materials used in this study are cement, fine aggregate, aggregate dust, and optical fibers.

3.1 Ordinary Portland cement (OPC): The ordinary Portland cement used for the project was 43 grade. The technical requirements of the cement were tested by IS 4031. The following tests were done to understand the properties of cement:

Specific gravity of cement	–	IS 4031 part 11
Fineness test of cement	–	IS 4031 part 1
Consistency of cement	–	IS 4031 part 4
Initial and final setting time	–	IS 4031 part 5
Soundness test	–	IS 4031 part 3

3.2 Fine aggregate: The fine aggregate obtained from the river bed were used in the experimental program. The fine aggregate passing through 4.75mm sieve with specific gravity of 2.6 to 2.9 was used.

3.3 Aggregate dust: Aggregate dust is obtained by crushing the aggregate. Generally the strength of the mortar blocks tends to increase by adding them. Generally the aggregates are crushed by jaw crusher, cone crusher, impact crusher, hammer crusher, compound crusher, mobile jaw crusher, metal crusher, briquette machine or stone crusher. Impact crusher was used in this project to obtain the aggregate dust. The technical properties of aggregate dust were tested to compare the properties with that of the sand. *Fig.1: Aggregate dust*

Specific gravity, water absorption and bulk density tests were conducted on fine aggregate and the aggregate dust.

Table 1: Comparison of properties of fine aggregate and aggregate dust

Tests conducted	Sand	Aggregate dust
Specific gravity	2.55	2.62
Water absorption	1.11%	2.2%
Bulk density	25.79%	20.12%

3.4 Optical fiber: Optical fibers were readily available in the market. Optical fiber is an excellent media to transmit light at specific wavelengths since its refractive index is greater in core than in coating. It has a much larger core size and larger numerical and can absorb light at an incident angle as large as 60° and still provide a better light guiding system. The optical fiber cables were purchased from the market and the thin wires were extracted with the help of technicians as it should be done with care.

Fig. 2: Optical fiber cable

4. CALCULATION OF MATERIALS

Ratio of cement and sand =1:3
Zone of sand and aggregate dust = zone II
Type of exposure = Mild
Water content as per IS 4031 part 4: Water content = 0.11 %

4.1 Final quantity of materials: For casting three cubes each of size 70.6mm x 70.6mm x 70.6mm, the following quantity of materials were calculated:
Cement = 374 g
Aggregate dust as fine aggregate = 1320 g

4.2 Details on Optical Fiber
Diameter of fiber = 1.5 mm
Length of fiber = 70.6 mm
No of fibers for 2% addition of optical fiber = 60 approximately
No of fibers for 4% addition of optical fiber = 115 approximately

5. CASTING OF LIGHT TRANSMITTING BLOCKS

Cement and aggregate dust is used to prepare light transmitting blocks. The mortar is prepared in the same way as conventional mortar. The water cement ratio is taken as 0.45

A special mould consisting of perforated plates is used, as the perforations are needed to insert the optical fibers. The optical fibers are arranged in such a way that the distribution is uniform in the block and they are held in position with the help of the perforations available on two sides of the mould. The mortar is then poured in the mould and compacted with the help of a tamping rod. High tamping effect may dislocate the fibers, so heavy tamping and vibrators should be avoided for compaction. Three cubes for each percentage i.e. 2% and 4% were casted and tested. Curing of light transmitting mortar blocks is carried out in the same way as conventional mortar.

Fig.3: Special mould for the blocks

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Fig. 4: Finished mortar blocks with fibers

The mortar blocks were tested for light transmitting property by taking it into a dark room. A light source was given at one side of the block it was found that the light was transmitted on the other side with better brightness as shown in figure.4. Further testing was done with sunlight source and the light transmission was found to be better.

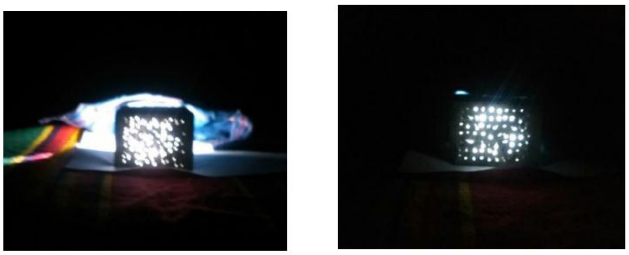

Fig. 5: LitraMor blocks

5. TEST RESULTS

The cubes were tested for compressive strength and it was observed that the compressive test of aggregate dust and cement were 20 % to 25 % higher than the compressive strength of conventional mortar block.

Table 2: Compressive strength obtained for mortar blocks without optical fibers

Details	Compressive strength at 7 days	Compressive strength at 28 days
Cube with cement and sand	16.88 N/mm^2	20.70 N/mm^2
Cube with cement and aggregate dust	24.33 N/mm^2	24.58 N/mm^2
Cube with cement, aggregate dust and sand	22.57 N/mm^2	26.95 N/mm^2

From the test it was observed that the full replacement of aggregate dust has shown higher compressive strength than the conventional mortar block. Also partial replacement of aggregate dust has yielded better compressive strengths.

Table 3: Compressive strength obtained for conventional mortar blocks with optical fibers

Fiber percentage	Compressive strength of fiber at 7 days	Compressive strength of fiber at 28 days
2 %	20.44 N \ mm^2	24.88 N \ mm^2
4%	20.83 N \ mm^2	25.00 N \ mm^2

Table 3 shows the compressive strength of the mortar blocks with fibers being tested at 7 days and 28 days. On 4% addition of fibers the mortar blocks are said to have higher compressive strengths. The fibers are increasing the compressive strength of the blocks.

6. CONCLUSION

The use of aggregate dust with cement decreases the sand content in mortar and it gains strength. Both the chemical and physical properties of sand and aggregate dust are studied clearly by carrying out the test. From the test carried out, it is clearly defined that compressive test of aggregate dust and cement gives nearly 20 % to 25 % increase than the compressive strength of conventional mortar block. Natural river sand, if replaced by hundred percent quarry rock dust from quarries, may give equal or better than the reference concrete made with natural sand, in terms of compressive strength.

“Light Transmitting Blocks” can be developed by adding large diameter of optical fiber strands with aggregate dust and cement. Since, the diameter of optical fiber is small the strength of concrete is remain unchanged. Light transmitting blocks can be used as non-load bearing walls so; the strength of blocks can be lower.

The transmission power of light transmitting mortar blocks is visualized from the picture. It has vital property in aesthetic view of the structure. In this project, the percent of fiber added is 4% and the number of fiber is 100. The number is calculated by the ordinary volume formula. Cost of light transmitting mortar block is high because of the use of optical fiber but in the future these blocks will have several benefits and its application will be very efficient in energy consumption.

The diameter used for this project is less but to attain a high velocity larger diameter of fiber can be used. Glass fibers can be used instead of optical fiber. The privacy of the user is not affected by using translucent mortar block. This will reduce power consumption. The light source from one side can transmit the light to the other parts of the building. So this new kind of building material can develop the concept of green energy saving. The percentage of fiber can be increased to increase the efficiency of light transmitting power. The source for light transmitting mortar block is sunlight. During, rainy season and at night solar panels are installed to get the source. The intensity of light depends on intensity of sunlight.

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