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Mechanical Properties of Light Transmitting Concrete

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Abstract: ***This research paper deals with the mechanical properties of translucent concrete. Translucent concrete block is prepared by inserting the optical fibers from one side to other. The casted translucent concrete cubes are tested for mechanical properties and compare the results with mechanical properties. The cost analysis is carried out for both the concretes. Results show the improved tensile strength and similar compressive strength of translucent concrete than conventional concrete.***

Keywords: Translucent concrete, optical fibers, wooden moulds and total internal reflection.

I. INTRODUCTION

Translucent concrete has a bright future in the coming days as there is an increase in construction and alternate materials for making of green buildings. Due to increase in the civil engineering construction on land and beneath the earth surface such as underwater constructions, engineers are finding out best material which can be strong and light emitting properties to with stand the pressure. Concrete is a solid substance with can withstand the maximum load; properties of each material can be changed by changing the manufacturing process or elements used in manufacturing the material .what if physics add to civil engineering? Yes the material comes out from mixing up the two important subjects to change the world aesthetic view is “translucent concrete” which is also called as light transmitting concrete[1].

To produce high amount of concrete, a high quantity of materials required such as aggregates and cement. Coarse aggregate exceeds 60% of concrete by volume so new concepts and technology is increasing widely to re-use of industrial wastes and some alternate materials. Using of self-compacting concrete makes the compressive strength more appropriate. Using of 2% of self-compacting concrete will gives the much easier mix of concrete.

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II. MATERIALS AND METHODOLOGY

A. Materials required for making of translucent concrete

Six types of concrete cubes were prepared for testing of mechanical properties. Optical fibers, wooden mould and cement constituent material are required to make the translucent concrete. For making of translucent concrete wooden mould are prepared with two ends drilled with 1mm driller. The optical fibers are inserted in drilled moulds and the concrete is poured in the moulds and cured for 24 hours.

Fig.1.Translucent concrete block.

B. Translucent concrete mould preparation.

As per the given Indian standards cubes, panels, beams , cylinders are to be made of is moulds which are made of cast iron or iron moulds , for making of translucent concrete such moulds are not adaptable to make such concrete , we need a special characteristic moulds which are flexible to make translucent concrete . For making of translucent concrete on can use moulds made of wood or form boards which are very flexible to mould and keep holes where ever it is required. Here the faces of wooden moulds are drilled with the drilling bit of 10 mm diameter and 5mm diameter .optical fibers are passed into the drilled holes and are tightened [2]. Standard mould size of 150*150*150 mm and panel size of 500*250*20 mm are made with wood. Fig 2 shows the optical fiber insertion in wooden moulds.

Fig.2 Wooden moulds with optical fibers.

C. Preparation of Translucent Concrete cubes

Translucent concrete is prepared by following steps.

- Wooden moulds drilled with 3 mm holes with uniform variations.
- Insert the optical fibers where the holes are drilled. These holes are drilled according to the weight % of cement.
- Calculation of mix design according to IS10262:2009, and by considering sieve analysis according to IS 456:2000
- Concrete is prepared and casted in moulds.
- Casted moulds are kept in room temperature for 24 hours and demoulded.
- Then the translucent concrete cubes are kept in curing tank for 28 days and subjected testing.

Fig.3. Insertion of optical fiber in concrete mould.

III. QUANTITATIVE ANALYSIS OF MATERIALS

Analysis of material's % by mix design concept

This project here presents that light transmitting concrete as a smart building material. It is based on transmitting light from concrete and to give aesthetic look without any loss in strength parameters. Optical fibres are used for light transmitting because they work with the principle of internal reflection which transmits light efficiently. This project will be performed by using of different percentage of optical fibres (1% to 5%) in the replacement of volume of the concrete and it discusses the experimentations performed like various destructive and non-destructive tests on light transmitting concrete had used basic M20 concrete for making of translucent concrete. Coarse and fine aggregates are taken as 10mm and 1.75mm. Water/ cement ratio is taken as 0.45, the technical data for making of translucent concrete is

1.Concrete strength	: M20
2.Cement Type	:OPC
3.Optical fibers used	: 1.3 %
4.Water/Cement ratio	:0.40
5.Cube size	:150*150*150
6.Optical fiber diameter	: 1mm
7.Fine Aggregate	: 1.75mm
8.Coarse Aggregate	:10-12mm

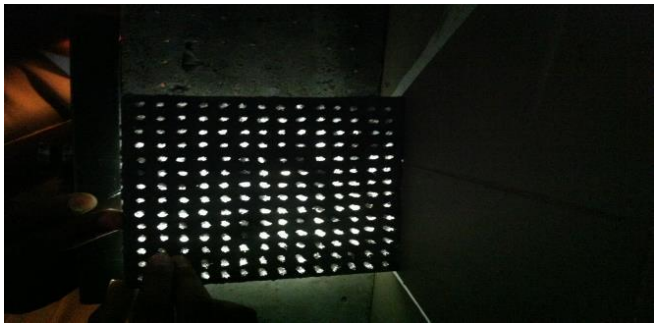

Fig.4. Translucent Concrete Panel

IV. RESULTS AND DISCUSSIONS.

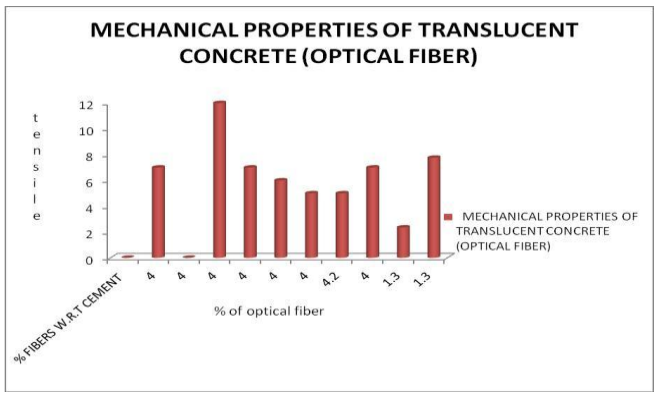

Fig.5. Mechanical properties of different optical fiber's.

Lux meter was used for this test. This device measures the intensity of light falling on its sensor. This reading is different from the measurements of light energy produced by the actual light source. It works by using a photo cell to capture light, which is then converted to an electric current and finally it gives the lux value. It is used to measuring the brightness of a room. The imagination of permitting light through the concrete by optical fibers there will be a better interaction between the construction and its environment and diminishing the energy expenses in modern infrastructures

A. Mechanical properties of Translucent Concrete.

Conventional concrete for M20 mix design the maximum compressive strength attained is 22-30 N/mm^2. The concrete which contains optical fiber in the concrete shows decrease in compressive strength when compared to normal concrete. This is due to the addition of optical fibers which does not have much contact with the cement paste. The graph represents the cross head travel and the load. The load for 14 days of curing is 18.6 N/mm^2 as shown in Fig 7. The normal concrete it is 23 N/mm^2. Graph showing the 28 days compressive strength of Optical fiber translucent concrete. With the replacement of fibers in volume of concrete (0.10%-0.20%) the compressive strength was found to be increase with 3%.The maximum amount of light passing through the cubes was 2122lux. The ratios used is sand/cement/water ratio of 1:. They had four various POF area ratios: 0%,.10%,0.15%,0.20% and for these ratios the compressive strength attained is 17.31,17.36,17.88,18.40 N/mm^2.

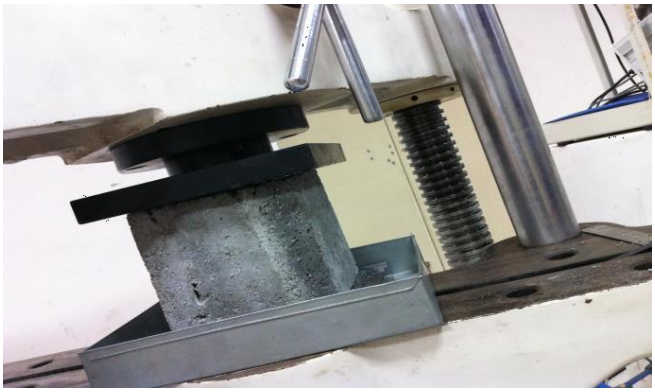

Fig.6.Translucent concrete cube of 150*150*150 mm

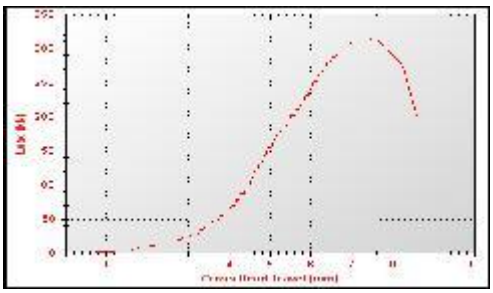

Fig7.Translucent concrete specimen crosshead Vs Load

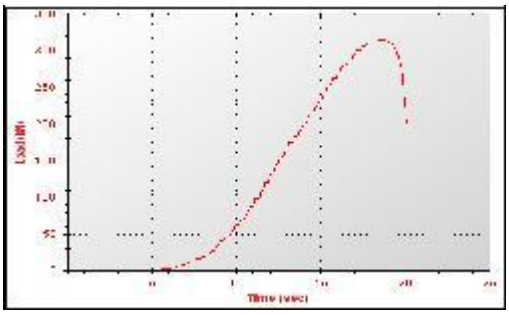

Fig.8. Load Vs Time variation for translucent concrete cube.

B. Tensile Strength of Translucent concrete

Translucent concrete cylinders of 100*300 mm are subjected to tensile strength in universal testing machine. Stress Vs strain represents the uniform elastic deformation for translucent concrete specimens when compared to conventional concrete. The maximum tensile strength attained is 7 N/mm^2 when they were using a optical fiber of 2mm in diameter. Where as in conventional concrete sudden failure of concrete can be noticed and maximum strain attained is 3.14 N/mm^2.

Technical Results

1) Compressive strength for optical fiber translucent concrete is 18.40 N/mm^2

2) Compressive strength of normal concrete : 17N/mm^2

3) Tensile strength of optical fiber of 1mm diameter is : 2.8 N/mm^2

4) Tensile strength of optical fiber of 2 mm diameter : 7.2 N/mm^2

5) Ingredients : 99.8% concrete and 0.20% optical fiber

Block size: 150*150*150mm

V. COST ANALYSIS

In this research paper two types of concretes are tested to understand the cost analysis. Concrete made with conventional aggregates and concrete made with optical fibers. Concrete made with conventional aggregates show low coast when compared to optical fiber concrete as shown in Fig 10. Translucent concrete made with optical fiber shows increase in cost as the optical fibers used for making concrete have higher tensile nature and having light guiding properties. This advantage of translucent concrete shows high cost when compared to conventional concrete.

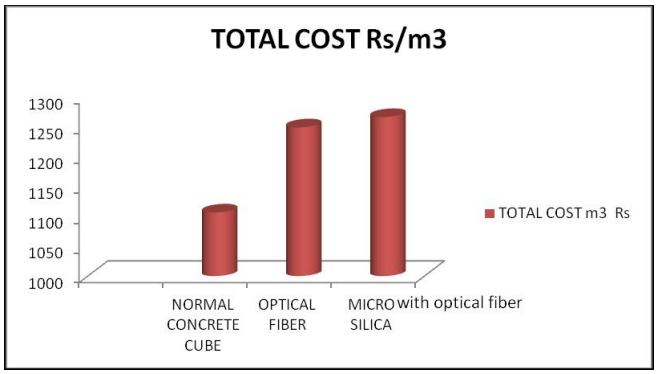

Fig.10.Cost analysis of different types of concretes

This aims of the present study is to investigate various experimental properties of the light transmitting concrete. Plastic optical fibers are added to concrete, to allow light to pass through it. Effect of plastic optical fiber on various properties of concrete such as light transmittance compressive strength is tested.in further scope we can investigate about air and water permeability characteristics by experimental tests and also we can conduct non-destructive tests like rebound hammer and ultrasonic pulse velocity etc, to know complete properties of light transmitting concrete and for light transmission we can investigate with any other material such as glass fiber instead of optical fiber.

VI. CONCLUSION

This study investigates the compressive behavior and light transmitting capacity of light transmitting concrete. The standard concrete compressive strength was found to be 26.6N/mm².With the replacement of fibers in volume of concrete (0.10%-0.20%) the compressive strength was found to be increase with 3%.The maximum amount of light passing through the cubes was 2122lux.In the concrete cubes it was found that as per the percent of optical fiber increases there is increase in light transmission capacity. In motor cubes the replacement of fibers was from 1% to 3%. We observed that there is increase in compressive strength up to 2% and decreases at 3%. As per the percentage increase light transparent also increases. Hence can be concluded transparent concrete as a smart building material.

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