Design and Experimental Study of Transparent Concrete

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***Abstract*— The present study aims at producing the concrete specimens by reinforcing optical fibers with varying percentage from 1% to 5% of diameter 1mm. and comparing it with conventional concrete. The concrete specimens subjected to different test such as Compressive strength, Split tensile strength, Flexural strength and Light transmission test. The strength obtained for the transparent concrete specimens is seen increase with increase in percentage of optical fibers content up to 4%. The results of transmission test were satisfactory as the optical fibers retain its efficiency. Thus it's evident that the transparency of concrete structures can be introduced with the insertion of optical fibers without compromising the strength, which may be a breakthrough to the aspirations of achieving some new feet in modern architecture. This research experiment will be a series of initiatives to look closely at new and emerging advanced constructions in future.**

***Index Terms*— Compressive strength, Conventional concrete, Flexural strength, Light transmission test, Optical fibers, Split tensile strength, Transparent concrete.**

I. INTRODUCTION

Transparent concrete or Light transmitting concrete or Translucent concrete is a concrete which transmitting light through it by using optical fiber. It is a material which makes green building and provides pleasing appearance to the structures. Conventional concrete is formed with the mixture of cement, fine aggregate, coarse aggregate and water which is unable to transmit lights. Transparent concrete is formed with cement, fine aggregate, coarse aggregate and water with optical fibers reinforced in concrete from one face to another which guide the light passing through it following the reflection property. Our project of casting transparent concrete aims at reducing this operating energy by exploring vast amount of potential energy in the form of sunlight. Another additional feature is its pleasing aesthetic view.

II. OBJECTIVE AND SCOPE

A. OBJECTIVE

To cast Transparent concrete, to compare their strength characteristics with the conventional concrete and to examine their efficiency in transmitting light to develop construction materials which is not only energy efficient but also aesthetically pleasing.

B. SCOPE

Thus by using light emitting concrete produces a prefabricated building block and panels. With the economic growth and science and technology development, many large scale civil engineering structures such as tall buildings and so on are built around the world. Most of the large buildings are built close to each other, there is not much natural sunlight passing through and the importance of natural sunlight is well known. In total usage of electricity 30% of electricity is employed for lightening purpose only, so it is necessary to utilize natural light for illuminating interior of building. It is totally environment friendly due to of its light transmissive characteristics. Moreover the light emitting concrete does not lose the strength parameter when compared to conventional concrete.

III. MATERIALS

ORDINARY PORTLAND CEMENT (OPC)

The ordinary Portland cement used for the project was 53grade. The technical requirement of the cement was tested by IS 12269-1987 and IS 4031-1996. Cement is a material; generally they are in

powdered form that can be made into a paste by the addition of water. After they are hardened they consume required strength.

- Test on Cement

Fineness of cement = 5%
Normal Consistency of cement = 32%
Soundness test = 4mm
Initial setting time = 55 min
Final setting time = 365 min
Specific gravity = 3.15

FINE AGGREGATE

Locally available sand passed through 2.36 mm IS sieve was used.

- Test on sand

Specific gravity = 2.6
Fineness Modulus = 2.5
Water absorption = 1%

COARSE AGGREGATE

Crush granite aggregate available from local sources has been used. The coarse aggregate with maximum size of 10 mm

- Test on coarse aggregate

Specific gravity = 2.85
Fineness Modulus = 7.09
Water absorption = 0.8%

WATER

Water fit for drinking is generally fit for making concrete. The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability, water tightness, durability, drying shrinkage and weathering are potential for cracking. For these reasons, limiting and controlling the amount of water in concrete is important for both constructability and service life.

OPTICAL FIBER

Optical fibres works on the principle of Total Internal Reflection. The strands of the fibre act as a hollow cylindrical waveguide that permits transmission of light along its axis. Constituents of Optical Fibres –

1. Core – It is the thin glass cylinder in the innermost layer of the fibre through which the light travels.
2. Cladding – It is the outer layer surrounding the core. It has relatively lower refractive index than the core. Thus, light passing through the core, can't come out of it and get reflected at the interface.
3. Coating – It is the plastic covering which protects the fibres from damage and moisture.

IV. METHODOLOGY

A. MIX DESIGN

TABLE I: Mix Ratio of M30 Grade of Concrete

Cement	Fine Aggregate	Coarse Aggregate	W/C
1	1.87	3.37	0.45

TABLE II: Mix Proportion of Transparent Concrete

% of OF	0% OF	1% OF	2% OF	3% OF	4% OF	5% OF
Cement	380	380	380	380	380	380
LEC	0	7.1	14.2	21.3	28.4	35.5
FA	710	702.9	695.8	688.7	681.6	674.5
CA	1280	1280	1280	1280	1280	1280
w/c	0.45	0.45	0.45	0.45	0.45	0.45

B. PREPARATION OF MOULD

The mould required for the prototype is made with wood material. In the mould preparation, it is important to fix the basic dimensions of mould. The standard minimum size of cube according to IS 456:2000 is 150 mm x 150 mm x 150 mm. In the mould, markings are made exactly according to the size of the cube, so that the perforated plates can be used. The plates are of wood comprising of perforations/holes drilled. The perforations are made in the plate of equal interval along the length and depth. Then the optical fibers are tied to the perforated plates on either side tightly before filling of the mix.

Fig 1.Preparation of Mould

C. MANUFACTURING PROCESS

Mixing procedure is same as that of a normal one. Making desired equal proportion of cement and sand to get mixed thoroughly and then addition of water in desired quantity to get a uniform mix. The thoroughly mixed sample to be poured into the prepared mould. Once the layer of mix has been placed in the prepared mould, the layer has to be compacted with the help of tamping rod at the spacing intervals of the plastic optical fibers placed. After compaction, the top surface of the cube to get finished perfectly. Finishing operation is the last operation in making a translucent concrete. Cubes must be cured before they are tested. The process of curing should be continued as long as possible up to the time of testing. In order to provide adequate circulation of water, adequate space should be provided between the cubes, and between the cubes and the side of the curing tank. Similar to the conventional one, the translucent concrete cubes were also taken at the days of 7, 14 and 28 for testing purposes.

Fig 2.Finishing

V. TEST CONDUCTED

A. COMPRESSION TEST

In this study, several wooden moulds that are made in Certain form. These wooden moulds contain three cubes of 15*15*15 cm, each cube separated by perforated plates, these perforated plates were provided with the maximum number of holes to allow all fibres to pass through. After casting and specified curing time remove the specimen from water and wipe out excess water from the surface. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube. Align the specimen centrally on the base plate of the machine. Apply the load gradually without shock and continuously at the same rate until cracks formed over the surface of the specimen. In this study Average compression test Results of Conventional concrete with Optical fibre concrete of 1% to 5% respectively.

Ultimate compressive strength =
Ultimate load / Cross sectional area.

TABLE III: Compression test result of conventional concrete and Optical fibre concrete with different %

No of Days	0% OF	1% OF	2% OF	3% OF	4% OF	5% OF
7 Days	23.5	24.1	25.1	26.2	27.6	26.0
14 Days	28.5	29.1	29.5	30.4	30.7	29.5
28 Days	36.5	36.8	37.1	37.2	38.2	36.1

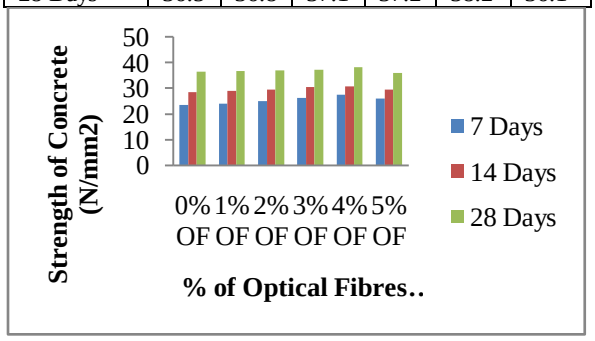

Fig 3.Compression Strength

B. FLEXURAL TEST

Table IV: Flexural test result of conventional concrete and optical fibre concrete with different percentage.

No of Days	0% OF	1% OF	2% OF	3% OF	4% OF	5% OF
28 Days	4.12	4.49	4.6	4.72	5.1	4.8

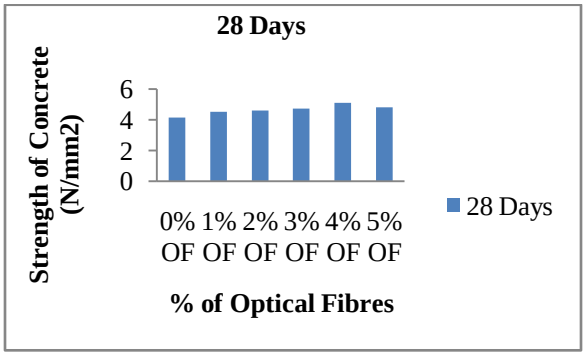

Fig 4.Flexural Strength

C. SPLIT TENSILE TEST

Table V: Flexural test result of conventional concrete and optical fibre concrete with different percentage.

No of Days	0% OF	1% OF	2% OF	3% OF	4% OF	5% OF
28 Days	3.20	3.25	3.32	3.42	3.50	3.36

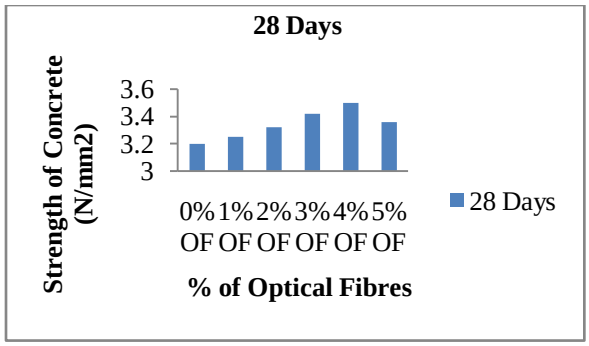

Fig 5.Split Tensile Strength

D. LIGHT TRANSMISSIBILITY TEST

Lux meter was used for this test. A lux meter is a device which measures the intensity of light falling on its' sensor. This reading is different from the measurements of the actual light energy produced by a light source. It works by using a photocell to capture light, which is then converted to an electric current and finally it gives the lux value. It is used in photography and video filming, measuring the brightness of a room.

Transmissibility of the bulb kept at a certain distance was found to be 5030 lux. Then, the Transmissibility values were obtained by placing translucent concrete samples. 100watt bulb is used.

% Transmissibility = Transmissibility through concrete / Transmissibility through air.

Table VI: Transmissibility Test Result of 4% Optical Fibre.

SR.NO	Transmissibility (in LUX)	% Transmissibility
1	315	6.26

VI. CONCLUSION

The above research paper gives the following conclusion.

An innovative material called transparent concrete can be established by introducing optical fiber in concrete mix. The Translucent concreter has good lightening property and gives greatest architectural appearance to structures. Transparent concrete can be used in areas where natural light cannot be reach with required intensity. It can create eco friendly construction that reduces the energy consumption of project.

The strength parameter of transparent concrete is observed to be same as the conventional concrete it was observed that strength of transparent concrete found to be increase till 4% optical fiber and then decreases.

As per discussion, cost of transparent concrete is high but cost is justified because of its advantages and energy saving.

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