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Light Transmitting Concrete-A Brief Review

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Abstract - *The increase in population leads to the growth of construction sector and hence construction activities increases day by day. Construction of tall storied and multi storied buildings result in obstructing natural light in the building, thus leading to increase in artificial light. To overcome the issue, light transmitting concrete can be used. Light-transmitting concrete has property of passing artificial as well as natural light due to optical fibers present in it. Optical fiber is flexible made of glass or plastic to diameter marginally thicker than that of human hair. Light theory of optical fiber is based on internal reflection. The properties of light-transmitting concrete are marginally not the same as ordinary cement. This type of concrete gives pleasing aesthetics to the structure. Light-transmitting concrete can plays an important part in construction and environment fields.*

Key Words: Light Transmitting concrete, Cement, Fine aggregate, Optical Fiber

1. INTRODUCTION

In past concrete was considered as a member for structural purpose only, now the concept has changed. Due to various inventions and infrastructure development new material for building like Light-transmitting concrete has come up as decorative material. Idea of light-transmitting concrete was first introduced in 2001 by Aron Losonczi and further in 2003 first light-transmitting concrete block was produced named LiTraCon. Due to globalization the empty place between buildings is reduced and this has resulted in increase in the use of energy sources, leading to new technique like green building. The green building generally focuses on saving energy with indoor thermal system. Light-transmitting concrete concentrates on generating green technology. Light transmitting concrete isn't unique in relation to ordinary concrete it has same material with expansion of optical fiber. Light-transmitting concrete has same strength as normal concrete.

2. MATERIALS FOR LIGHT TRANSMITTING CONCRETE

Cement – Light-transmitting concrete is commonly utilized for transmitting light, so no exceptional cement is required for it. OPC of 43 grade can be utilized.

Sand - Sand through 1.18mm size sieve should be utilized.

Water - Water is utilized to blend all element of concrete. For concrete preparation portable water to be utilized.

Optical fiber - Optical fiber is the main component in light transmitting concrete. The fibers are flexible, transparent made of glass or plastic to diameter marginally thicker than that of human hair. Light theory of optical fiber is based on internal reflection in which light travels from denser medium to rarer medium having greater angle of incidence than critical angle resulting in reflecting the ray back in same medium. The fiber undergoes many reflections till ray of light emerges out from other face of the optical fiber. There is no effect of bent in optical fiber. The optical fiber includes three element i.e. core, cladding and coating. Core consists of thin glass center through which light travels. Cladding is the outer surrounding of core and it helps to reflect the light into the core. Coating is useful for protecting the fiber from damage.

3. REVIEW ON LITERATURE

Amlan kumar sahoo and Sachin Sahu (2017)[1] : The aim of the study was to produce concrete specimen with optical fiber and compared it with conventional concrete. The specimen were tested for Compression test, light transmitting test, etc. The cube dimension was 70.6 X70.6 X 70.6 mm. For comparison, 6 ordinary and 6 translucent concrete was cast. From which, three from each tested for 7 days compression strength and other three for 28 days compression strength test. The compression strength for translucent concrete found to decrease little as compared to ordinary concrete. Light transmitting test was conducted with use of Lux Meter. Lux meter is device which measures intensity of light falling on the sensor. Meter uses photocell for adopting light, converts to current than gives value of lux. A 100 watt bulb was placed and illumination in air was measured. Later, concrete specimen was kept inside the tube and new illumination was measured. The ratio of both the values gave percentage of transmission. Average value of transmissibility of translucent concrete was 4%. Concluded that advancement in technology, our infrastructures should be modified.For sustainable development, we have to emphasize the use of renewable energy sources meet increasing demand for energy.

B Yamini Nirmal and K. Nehemiya (2017)[2] : In this paper study on light transmitting concrete was carried out with the use of pof 0.38 mm diameter. Compression strength and flexural strength was studied in this paper. Compressive strength test results were conducted for 7 day, 14 days and 28 days whereas Flexural strength test results were compared for 7 days and 28 days respectively. Cement mortar cubes were used. Cement used was 1100gm and fine aggregate 3300gm respectively for one cube. 2% and 4% optical fibers were used in different configurations. For 2%, 36 strands of optical fibers were embedded in different configurations and for 4%, 72 strands of optical fibers. These cubes of different optical fiber configuration were compared with conventional concrete for varying w/c ratio. It was investigated that compression strength of light transmitting concrete was increased than ordinary concrete upto certain limit and after that limit, the compressive strength decreases with increase volume of optical fiber. The highest compressive strength occurs at optimum 4% of fibers with 18 strands at 4 positions. Flexural strength test was compared with four cubes i.e. conventional concrete, light transmitting concrete with mesh, with fiber and with both fiber and mesh. The flexural strength for light-transmitting concrete is increased compared to ordinary concrete.

Abhishek Pathade et al (2016)[3] : Suggested that light transmitting concrete can be utilized as smart building material with attractive appearance. It observed concrete with light-transmitting property gives increase strength and gives pleasing appearance to concrete. According to Indian Green Building, 50% day lighting is necessary in green building and this can be achieved by the light transmitting concrete. The materials used for casting of cubes were cement, sand (passing through 4.75mm sieve size), water and optical fiber. The cubes were casted for M20 Grade, type of cement used was OPC 53, w/c ratio of 0.5. Formwork was made with holes drilled on two opposite sides of the cube and then optical fibers were passed through holes. Concrete was poured in formwork, was set for 24 hrs and curing was carried out. Translucent concrete saves upto 25% of electrical energy during day. It was concluded that light transmitting concrete do not loose strength compared to regular concrete. This concrete be useful for architectural beauty in the building and also useful where light cant reach with required intensity. In this paper, it was also suggested that optical fiber can also behave as reinforcement for concrete.

Kavya.S et al (2016)[4] : In this paper strength of optical fibers in concrete was analysed by increasing percent of fibers from 2.5% to 5.5% in concrete. The concrete deflection is determined by using ANSYS software. For analysis of strength, Compressive strength test and Flexural test was conducted on concrete. Cement, fine and coarse aggregate are used as materials. M30 grade of mix design is used for casting of cubes. A mould is prepared of 15X15X15 cm with wood as material. Holes are drilled on the sheet of approximate 2mm diameter. The rectangular mould was filled with clay mud up to half height of mould and optical fiber were placed vertically. The concrete is poured in the mould. After curing, the cube is exposed to light and light emitting is achieved. For Compressive test, three cubes of 15X15X15 cm were casted and holes were provided to fix fibers for maximum fiber content to pass for the study. Cubes tested for 7,14and 28 days respectively with different percentage of optical fibers i.e. 0%, 2.5%, 3.5%, 4.5% and 5.5%. As per the results obtained, it was concluded that compression strength increases with increase in the optical fiber percentage. Similarly, cubes tested for flexural strength. It was observed that, the flexural strength is high at 4.5% optical fiber and gradually decreased at 5.5% optical fiber. Deflection in concrete is determined by ANSYS analysis, in which conventional and light emitting concrete are tested for deflection. It was evaluated that deflection in light-emitting concrete less in comparison to ordinary concrete.The efficiency of light-emitting concrete more in all aspect and weight is almost same as conventional concrete.

Abhishek Tiwari and Parmod Saharan (2016)[5] In this study, experiment was conducted and compression strength of light-emitting concrete was compared with traditional concrete. The optical fibers results in decreasing the compression strength, to increase this strength, steel fibers and rice husk were added in the concrete. Rice husk is high in the percentage of silica about 85-90% silica content. The rice husk used in fine cracks in civil structures. Steel fiber were used to improve resistance to impact loading and also resists material fragmentation. In the given experiment, about 0.125% of steel fiber was used. Wooden moulds of size 15X15X15 cm were prepared and wooden sheets with number of drilled holes were attached in the moulds. The diameter and spacing of holes depend on the fiber percentage. Concrete mix of 1:1.5:3 was used and water-cement ratio 0.45 for cubes casting. Different percentage of fibers was used for studying strength. After casting and curing for 7 days, the compressive strength for 28 day was tested. From the above study, it was concluded that when optical fiber percentage was increased, the compression strength of translucent-concrete cube decreased but by adding rice husk and steel fiber the strength was increased.

Urmila M Bhanuse et al (2015)[6] The translucent concrete has great light controlling property, and the optical strands volume proportion to concrete is extent to transmission. As number of Optical strands are expanded, the lesser the compression strength. Thus the transmissions cannot endless increase. The only drawback is more manufacturing expense. Regardless of whether initial price of light-transmitting concrete is more than ordinary concrete by 33.4 times, yet because of ceaseless increment in tariff and pay back period, it is observed that

investment turns out to be advantageous as payback period consumption is 6 years and 4 years for commercial consumption and industrial consumption. It also reduces carbon discharge that is dangerous for the environment. Hence this type of concrete be considered as high performance concrete. The utilization of high performance transparent concrete is useful for saving earth. Concluded that light-transmitting concrete is a tool that helps in electricity saving and money.

A. B. Sawant et al (2014)[7] : The objective of this study was study cost of high performance concrete and make the concrete little transparent with use of optical fibers for aesthetic appearance in structure. Cubes were tested in CTM for 2000KN for calculating compressive strength. Compression test and Light reflection test was carried out, reflection of light through blocks was done for different percent of fiber and for different block area. The light transmission was increased with increased percentage of optical fiber. The light intensity through the block was maximum at 13P.M. According to results from Cost Analysis if initial amount for light-transmitting concrete is more compared to ordinary concrete by 12 times, yet because of increase in tariff and pay back count, from payback period analysis it was reported if a wall made of 16 blocks i.e.0.360sqm area is built then electricity bill can be saved upto 838.03/-Rs. It means that, the excess cost of light-transmitting concrete can be recovered during 3.5 years in case of domestic and 2.1 yrs for commercial consumption and industrial consumption. This will reduce the emission of carbon that is dangerous for the environment.

4. ADVANTAGES [3]

1. It has excellent architectural properties and gives good aesthetical view to the building.
2. Light-transmitting blocks can be used in cold countries because they help as heat insulation. Blocks work as heat insulator which can be adopted in cold countries.
3. It emits less amount of carbon.
4. Saving energy is possible with the use of light-transmitting concrete block in building.

5. DISADVANTAGES [9]

1. The important disadvantage in case of light-transmitting concrete is excessive cost due to use of optical fiber.
2. It requires skilled labor for installation of optical fibers.

6. APPLICATIONS [8]

1. Light-transmitting concrete blocks are most appropriate for floors, asphalts and load bearing walls.
2. This type of blocks can also be utilized where natural light cannot reach easily.
3. Transparent concrete can be useful in furniture for fancy and creative purpose.
4. Light hanging from ceiling.
5. At night, it can be used to glow the sidewalks.
6. In subway, this type of concrete will be useful to increase the range of vision in darkness.
7. In case of shortage of electricity, can be utilized to lighten the indoor fire exit.
8. To light indoor fire exit in case of power failure.
9. Highlighting speed bumps on Freeways, Highways and expressways at night.

7. DISCUSSION

It was reported that compression and flexural strength of light-transmitting concrete increases and this has been shown in graphical form in Chart 1 and 2. Also the effect of light intensity on light transmitting concrete is shown in Chart 3.

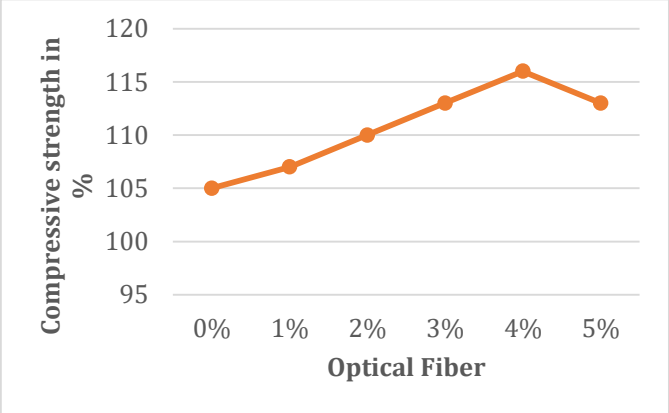

Chart -1: 28 days compressive Strength of concrete.

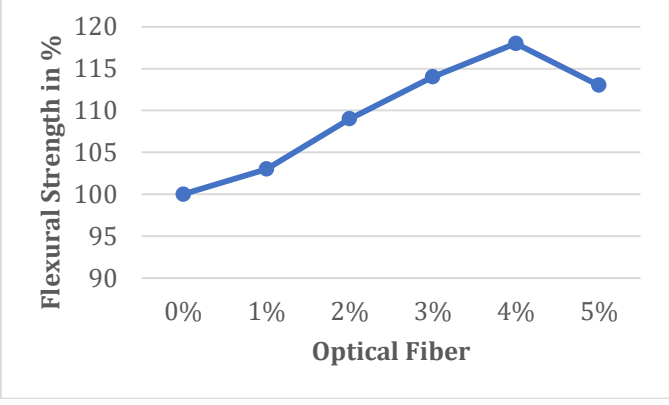

Chart -2: 28 days flexural Strength of concrete.

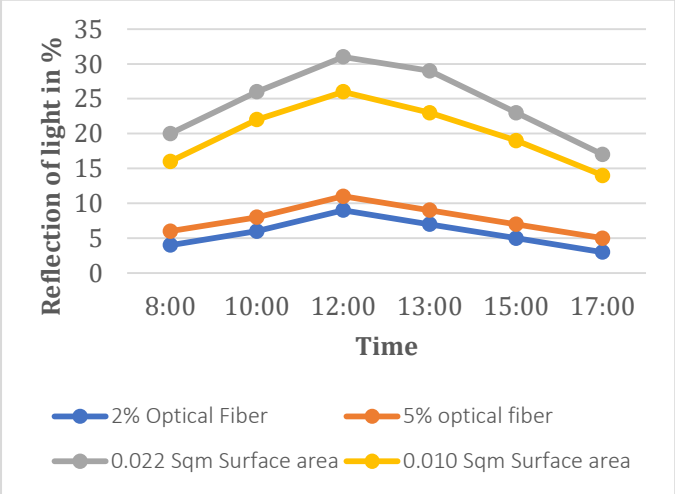

Chart -3: Reflection of Light through concrete block.

8. CONCLUSION

The light-transmitting concrete is good architectural material. It was reported strength of concrete found to be increase till 4% optical fiber and decreased at 5% optical fiber. As we increased the percent of optical fiber from 2% to 3%, light intensity increased and was high during afternoon. It was reported that, change in surface area of concrete block lead to decrease in the light intensity. Light transmitting concrete gives aesthetical view to buildings and is energy efficient. As per discussion, cost of light-transmitting concrete is high but cost is justified because of its advantages.

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