ASSESSING THE EFFECTS OF WORKABILITY AND COMPRESSIVE STRENGTH IN TRANSPARENT CONCRETE BY USING PLASTIC OPTICAL FIBRES

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Abstract

Concrete is a composite material made out of fine and coarse total reinforced together with a bond glue which solidifies after some time. With the financial development and an expansion in the populace, it made a need to give numerous structures inside a littler piece of land which prompt the advancement of the idea of high rises. These high rises confront an issue of common enlightenment and relies upon manufactured light, thus leading to the development of transparent concrete. The idea of transparent concrete was instituted in 2001 by Hungarian planner, Aron Losonzi. In 2003, he effectively delivered first transparent concrete block by adding 4% to 5% of glass fiber (by volume) into concrete and found out that it can transmit light up to 50 feet. This was a revolutionary idea in the green building industry as it helped in resolving the issue of enlightenment using the naturally available light. Although it was a fantastic breakthrough but it was not a affordable one as it used the glass optical fibers in it. Earlier developed transparent concrete have achieved a strength of about 22-23 kn/m2 but we are trying to increase the strength parameters to about 25-30 kn/m2. So in this paper the work on economical and strength aspects of the transparent concrete is done that is increasing the strength but also decreasing the cost.

Keywords: *Light transmitting concrete, Optical fibre, Transparent concrete*

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1. INTRODUCTION

With the time advancing there have been a great increase in the population and thus came the requirement of places to live but the space is limited. There we came up with the idea of making high rise building apartments so as to utilize the space available. With the rise in number of high rise building and skyscrapers we generated the requirement of artificial lightening. As in the case of china, it uses 25% global architectural energy and 13% of that is used for lightening purpose. So here came the Transparent Concrete which is a newly developed green building material, which uses the sunlight for the illumination purpose in buildings. Aron Losonzi, a Hungarian architect first came up with the concept of transparent concrete in the year 2001 and in 2003 he came up with LiTraCon ("light transmitting concrete") which was the first successfully produced transparent concrete block. LiTraCon is a translucent building material which is made up of 5% by weight optical fiber in fine concrete in which the optical fibers are laid in a strategically way between the two main surfaces of the block of concrete. This idea was a revolutionary one as it was reaping the earlier image of concrete that is a grey, heavy and cold material and transforming the idea of concrete into a more of aesthetical material. This idea was also comprehending the recent trends in world about making everything energy efficient and save as much energy as we can.

2. LITERATURE REVIEW

Akshaya b.kamdi, discussed in his paper "transparent concrete as a green material for building", that transparent concrete holds a great number of opportunities in the coming future and how it was made. Conclusion is that the transparent concrete breaks the idea of conventional concrete and it's a great green building material [1].

Neha R. Nagdive and Shekhar D.Bhole (2013), in paper **"**To Evaluate Properties of Translucent Concrete/Mortar and Their Panels", studied that to fabricate the transparent concrete using optical fiber and assess the panel for the illumination properties of optical fiber by drilling through the concrete. In conclusion it was found that smart transparent concrete have adequate illumination properties [2].

Jianping He et al (2011), "Study on Smart Transparent Concrete Product and Its Performances", proceedings of The 6th International Workshop on Advanced Smart Materials and Smart Structures Technology ANCRiSST2011 July 25-26, 2011, Dalian, China, studied that the marvelous characteristics of optical fiber in light guidance and elasto-optic effect. They concluded that POF volume ratio effects the amount of light transmission in smart transparent concrete. The compressive strength of the transparent concrete is directly proportional to the quantity of plastic optical fiber. The POFs have decreased impermeability of the concrete [3].

M.N.V.Padma Bhushan (2013), "Optical Fibres in the Modelling of Translucent Concrete Blocks" studied that the translucent concrete is a material which gains its light transmissive characteristics from the infused light optical material like Optical fibers with concrete as its base. In conclusion the translucent concrete is a material with various applications with the only con of its high cost [4].

B. Sawant (2014), "Light Transmitting Concrete by using Optical Fibre", International Journal of Inventive Engineering and Sciences (IJIES),ISSN: 2319–9598, Volume-3 Issue-1, December 2014, As the requirement of living space is increasing day by day we have shifted towards high rise buildings and skyscrapers instead of the small buildings. With so many high rise buildings made near to each other have led to the unavailability of natural light to every building. Thus the illumination problem raised is being handled by the artificial source of illuminations. So as to decrease the man-made light consumption in a building we can use the light transmitting concrete. In the end they concluded that the light transmitting concrete have adequate compressive strength, illumination and effectiveness of cost [5].

3. SIGNIFICANCE OF THE STUDY

It is used for aesthetic view of decorating the concrete. It is more economical then glass fiber. It transmit the light continuously due to this in day time more energy will be saved where more infrastructure are built in small areas. It gives higher compressive strength (26 kN/m^2 to 28 kN/m^2) as compared to previous research and it is also a green material.

4. EXPERIMENTAL PROGRAM

For the experimental work of light transmissive concrete specified materials are required. The plastic optical fibres placed in concrete in proper manner.

4.1 Materials and Properties

The materials selected for this experimental study includes normal natural coarse aggregate, fine aggregate, cement, superplasticizer, optical fiber and portable drinking water. The physical and chemical properties of each ingredient has considerable role in the desirable properties of concrete like strength and workability.

4.1.1 Cement

Cement is a binder, a substance that sets and hardens and can bind other materials together. The cement used for this project work is Ordinary Portland cement (OPC-43 grade).

Table 1: Physical Properties of Cement

Physical Properties	Value
Surface Area	3000 cm^2/gm
Initial Setting time	147 minutes
Final setting time	367 minutes
Consistency	32%
Sp. Gravity	3.08

4.1.2 Fine aggregates

Fine aggregates passed through IS Sieve 4.75 mm. The fineness modulus should be 2.50-3.50 and silt contents should not be more than 4%, which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. It confirms to IS 383-1970 which comes under Zone II.

Table 2: Physical Properties of Fine aggregate

Properties	Value
Density (OD)	1625 kg/m3
Density (SSD)	1675 kg/m3
Bulk Density	1625 kg/m3
Dry Bulk Density(SSD)	1675 kg/m3
Sp. Gravity (OD)	2.51
Sp. Gravity (SSD)	2.54
Water Absorption	8.5 %

4.1.3 Coarse aggregates

It should be hard, strong, dense, durable and clean. It must be free from vein, adherent coatings and injurious amount of disintegrated pieces, alkalis, vegetable matters and other deleterious substances. It should be roughly cubical in shape. Flaky pieces should be avoided. It should confirm to IS 2838(I). Coarse Aggregates are used of 6-10 mm size.

Table 3: Physical Properties of Coarse aggregate

Properties	Aggregate size (10 mm)
Density (OD)	1352 kg/m^3
Density (SSD)	1478 kg/m^3
Bulk Density	1525 kg/m^3
Sp. Gravity (OD)	2.652
Sp. Gravity (SSD)	2.71

Water Absorption	0.35 %

4.1.4 Water

Water should be free from acids, oils, alkalies, vegetables or other organic impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form the cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a lubricant in the mixture of fine aggregates and cement.

4.1.5 Plastic Optical Fibres

Plastic Optical Fiber, whose core consisting of plastic, has better flexibility and handling performance. Also core diameter can be thick and able to transmit larger amount of light. Toray Raytela* is Plastic Optical fiber whose core of high purity polymethyl methacrylate and cladding of special fluorinated polymer. Optical fibers typically include a core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fiber to act as a waveguide. Fibers that support many propagation paths or transverse modes are called multi-mode fibers, while those that support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally have a wider core diameter.

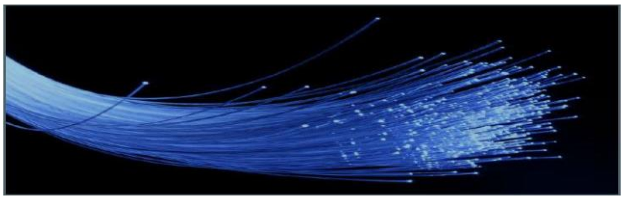

Figure 1: Plastic optical fibres

Fibers are also used for illumination and imaging, and are often wrapped in bundles so they may be used to carry light into, or images out of confined spaces, as in the case of a fiberscope. Specially designed fibers are also used for a variety of other application.

4.2 Mix Proportional

The mix design is carried out as per IS 10262:2009.The proportioning is carried out to achieve strength at specified age, workability of fresh concrete and durability requirements. Relationship between strength and free water cement ratio should be preferably being established for the materials actually to be used. Mix designing is carried out to arrive at the quantities required for 1 m^3 of concrete as shown below table

Table 3: Quantity of materials for Mix Design of M-35 (1 m^3)

W/C ratio	Plastic optical fibre (Kg)	Water (Kg)	Superplasticizer (Kg)	Cement (Kg)	F.A. (Kg)	C.A. (Kg)	Designation
0.41	0.0%	176.79	4.622	431.70	870	905.58	M1
	1.5%						M2
	3%						M3
	4.5%						M4

4.3 Placing of Fibres and Casting the Concrete

To study the effect of plastic optical fibers, cubes of size 150x150x150 mm, for nominal and transmissive concrete cube. Casting of the concrete specimens were done according to IS 516-1959.

Figure 2: Arrangement of plastic optical fibres in mould

For transmissive blocks, we prepared a cardboard sheet with numbers of holes and placed them in concrete block mould. This mould is made up of two plywood faces with a plywood base plate. The two faces of plywood are drilled at a uniform spacing to hold the optical fiber in place during casting concrete into the mould. The plastic optical fiber are cut into sufficient length and placed individually through the holes in the two plywood sides facing opposite to each other. Then concrete is prepared and poured into the mould.

5. RESULTS AND DISCUSSIONS

In the present investigation an attempt has been made to determine the effect of fiber by examining the slump and compressive strength of the sample. The compressive strength test performed by compression testing machine which has a capacity up to 200 Tones and workability test performed by slump cone.

5.1. Effects of Workability

The workability of concrete examined on pumpable and normal concrete. The workability is determined by slump cone test and the workability is target for pumpable concrete was kept 100 mm and for nominal concrete it was kept as 50 mm respectively, the slump value found by the slump cone are 96 mm and 47 mm respectively.

5.2. Compressive Strength

Compressive strength of material is that estimation when material flops totally during gradually applied load. The compressive quality of material generally acquires tentatively by method of a compressive strength test. The compressive strength of concrete is generally determined by cast of cubes of 150×150×150 mm.

Compressive strength=load/area [eq.1]

Figure 3: Experimental set up for compressive strength test

The specimens were tested after curing for 7 days and 28 days fully immersed in water tank as per IS 516:1959 for method of tests for strength of concrete. Compressive strength of concrete as we found are mentioned in graph.

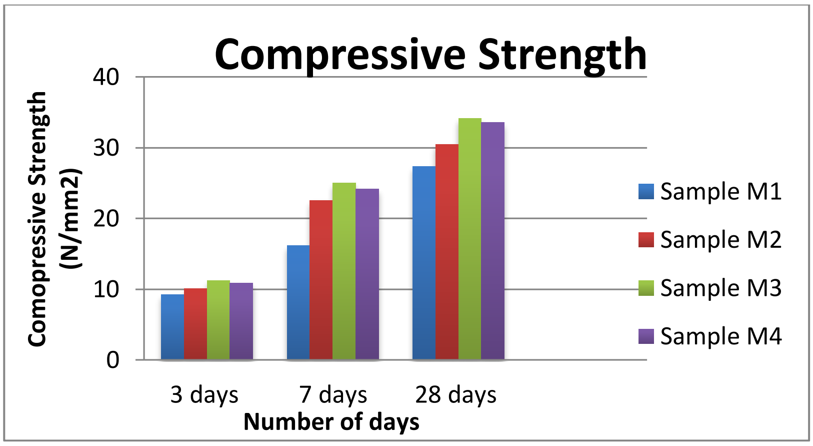

Figure 4: Results of Compressive strength test

The results represented the compressive strength of transmissive concrete after 3, 7 and 28 days. The compressive strength of concrete increased with varying percentage of plastic optical fibres (0%, 1.5% & 3.0%) but after increasing percentage of plastic optical fibres (more than 4.0% or 4.5%), compressive strength of transmissive concrete started to decrease.

6. CONCLUSIONS

Compressive Strength of light transmissive concrete using plastic optical fibres is compared with M-35 nominal concrete using other light transmissive fibres like glass fibres and it is found that it gives strength more than 25 N/mm^2, which is sufficient to use in general construction to save the electric energy. The results shows that use of plastic optical fibres more than 4%-4.5% may cause of reduction in compressive strength. Plastic optical fibres are cheap than the glass optical fibres, So this make cheap light transmissive concrete by using plastic optical fibres than the light transmissive concrete by using glass optical fibres.

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