Translucent Concrete by Using Optical Fibers and Glass Rods

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Abstract- Concrete is traditionally a solid, substantial building material. It needs to makeover. Small buildings are replaced by high rise buildings and skyscraper. This arises one of the major problem in deriving natural light in building, due to obstruction of nearby structures. To overcome this problem, artificial sources are used to illuminate building, but artificial light leads to increase of heat level in the buildings. To evaluate the effectiveness of the smart transparent concrete, the present study aims at producing the concrete specimens by combining glass rods and optical fibers with different percentage and comparing it with the normal concrete. Two tests are carried out compressive test and light transmission test and cost comparisons are also done.

Index Terms- Glass Rods, Lux, Optical Fibre, Transparent Concrete.

I. INTRODUCTION

A. General

Concrete has a key role in development of infrastructure & housing. Concrete has been used since roman times but its basic component has remained the same .Three ingredients make the dry mix, coarse aggregates, fine aggregates and cement. Due to great economical growth, urbanization, population growth, space utilization worldwide, there is drastic change in concrete technology. Most of the big buildings are built close to each other all in the same areas like sky scrapers There arises one of biggest problem in deriving natural light in building due obstruction of nearby structures. When buildings are stacks closed to each other, there is not much natural sunlight passing through it. Translucence is doing a great deal to change that image of concrete through the score of creative and sustainable application for their patterned light transmitting concrete.

B. Power Consumption

In total domestic usage of electricity; 30% of electricity is used for lightening purpose only, so it is necessary to utilize natural light for illuminating interior of building.

1) Optical Fiber

An optical fiber is a flexible transparent fiber made of glass (silica) or plastic, slightly thicker than a human hair. Optical fiber is a three layered cable made up of Buffer coating, cladding and core. And light transmission carried out through the core of fiber.

Benefits of optical fibers.

1. Safe –There no electric, heat or ultraviolet light in the fibers optics cable. Ideal for use in the water precious artifacts paintings, combustible surfaces etc.

2. Versatile- Multi applications possible from one light source.

3. User friendly- The cable is durable, UV protected plastic so there is nothing to break or burn out, virtually maintenance free.

These optical fibers have great light transmission capability. The typical fibers today are made out of glass or plastic since it is possible to make them thin and long. Also both glass and plastic are transparent at particular Wavelengths, which allow the fiber to guide light efficiently.

2)Glass

Glass is a non-crystalline amorphous solid that is often transparent and has widespread practical technological and decorative usage in many things. Glass has many useful properties.

1. It is transparent. One can see through it.
2. Strong & hard. One can put a lot of load on it.
3. It is impermeable. It does not allow water or other liquid to pass through and it doesn't get soggy or stained itself.

3) Common and Recommended Indoor Light Levels

The outdoor light level is approximately 10,000 lux on a clear day. In the building, in the area closest to windows, the light level may be reduced to approximately 1,000 lux. In the middle area it's may be as low as levels. Earlier it was common with light levels in the range 100 - 300 lux for normal activities. Today the light level is more common in the range of 500 - 1000 lux - depending on activity. For precision and detailed works, the light level may even approach 1500 – 2000 lux.

C. Objectives of Present Investigation (Paper)

Traditionally concrete members are considered as a

Structural member only, but in recent days this concept is changed and use of concrete as a decorative material for structure has come up. It is observed that high performance concrete using optical fibers can also be utilized as a decorative material to improve elegance of structure by making it partly transparent. Hence this project is defined for achieving objectives like;

1. Translucent concrete aims at reducing operating energy by exploiting vast amount of potential energy in the form of sunlight.

2. Another additional aim is its pleasing aesthetics that can change the image of concrete which is generally perceived as dull, pale, opaque, grey material.

3. Optical fiber and glass based transparent concrete could be regarded as an art which could be used in museum and specific exhibitions rather than just construction material.

4. The main objective is saving energy using natural light and therefore reducing the amount of heat produced from artificial light.

5.To study Energy saving for illumination by using transparent block for building.

6.To study cost effectiveness of this high performance Concrete.

II. MIX PROPORTION

A. Control mixture for M-20 grade concrete was designed as per IS:10262-2009.

Cement :Fine Aggregate :Coarse Aggregate :Water
1 : 1.83 : 2.21 : 0.50

B. Mould and Specimen Fabrication of Light Transmitting Concrete.

The glass samples to be fabricated are of 150x150x150mm cube. The mould is made up of four plywood faces having thickness 5mm with steel based plate. The two faces of plywood are undrilled and remaining two faces of plywood are drilled at a spacing of 15mm to hold the glass rod in place during casting concrete into the mould. Drilled and undrilled plywood plates are nailed with each other. Two drilled plywood faces are placed opposite to each other so as to orient the glass rods in a single direction. The glass rods are cut into sufficient length and placed individually through the holes in the two plywood sides facing opposite to each other. The samples containing optical fibers fabricated are of size 150X150X150 mm cuboids. The mould is made up of two plywood side facing each other and the other two sides are made up of sun mica which is used for making furniture. The specimens were prepared by compaction the concrete in three layers. Table vibrator was used for compaction of concrete. After completion of compaction, excess material was removed and the mould was leveled by using a travel.

Fig.1: Glass Rod & Optical Fiber Specimen

C. De-Moulding and Curing of Cube Specimens

The casted mould was kept undisturbed on the leveled platform. Then it was de-moulded carefully after 24 hours, from casting immediately after de-moulding, the cube specimens were marked by their respective identification mark/numbers (ID). Carefully transferred these cube to the curing tank for water curing.

III. TESTING OF SPECIMENS

A. Compressive strength

Testing of cubes was carried out in Compression Testing Machine of 2000 KN capacity to determine the compression strength of design mix.

Table.2 Test Results for optical fiber &glass rods.

Samples		**Without optical fibers specimen**	**Optical fiber specimen**	
Area		150x150	150x150	
Spacing		-	0.8%	0.4%
Compressive strength (N/mm^2)	3 days	15.61	14.62	14.81
	7 days	21.80	20.52	20.79
	28 days	26.9	25.65	25.99

Samples		**Without glass specimen**	**Glass specimen**		
Area		150x150	150x150		
Spacing		-	1.5cm Spacing	3.0cm Spacing	4.5cm Spacing
Compressive strength (N/mm^2)	3 days	15.61	14.57	14.79	14.97
	7 days	21.80	20.71	21.02	21.28
	28 days	26.90	25.57	25.95	26.27

Cost Of Material For 0.4% Optical Fibers
Optical fibers= 4.5(RMT)XRs.150/- = 675/-
Cement=9(bags)XRs.350/- = 3150/-
FA=0.560(m^3)X Rs.600/- =336/-
CA=0.660(m^3) Rs.560/- =372.96/-
Total cost of material
=675+3150+336+372.96=Rs.4533.96/-
The 1 m^3 of concrete cost as per DSR Rs.4500/-

Table 3.Cost Comparison for Optical Fibers.

Sr	**%Of Optical Fibers**	**Cost**		**% increases in cost**
		Conventional Block	**Optical Fibers Block**	
1	0.8%	Rs.3861.20 +504 =4365.20	Rs.5206.72 +522 =5728.72/-	31.24%
2	0.4%	Rs.3861.20 +504 =4365.20	Rs.4533.96 +522 =5055.96/-	15.82%

Sr No	% Glass Rod	Cost		% increases in cost
		Conventional Block	Glass rod Block	
1	12%	Rs.3861.20 +510 =4371.20	Rs.4076.57 +520 =4596.57/-	5.36%
2	6%	Rs.3861.20 +510 =4371.20	Rs.3848.20 +520 =4368.20/-	0.11%
3.	4%	Rs.3861.20 +510 =4371.20	Rs.3854.40 +520 =4374.40/-	0.26%

Payback period for glass rod and optical fibers
0.8% optical fiber- Residential =1year12months)&0.72 year(9months)
0.4% optical fiber- Residential=0.5year(6months)&0.36 year(4months)
12% glass rod- Residential=0.16year(2months)&0.12 year(1months)
8% glass rod- Residential=0year&0year
4% glass rod- Residential=0year&0year

IV. CONCLUSION

1. Conclusion regarding compressive strength.

28 days compressive strength of conventional concrete of M-20 grade is 26.90 N/mm^2 whereas the 28 days compressive strength of light transmit concrete, prepare with glass rods varies from 25.57 N/mm^2 for spacing of rods 1.5cm (12%) to 26.27 N/mm^2 for spacing of rods 4.5cm (4%).thus the 28days compressive strength reduces by 5.2% to 2.4% for 12%,4% glass rods respectively. Further the 28days compressive strength of concrete prepared with 0.8% and 0.4% of optical fibers is found to be 25.65 N/mm^2 and 25.99 N/mm^2 respectively. Thus reduction in the 28 days compressive strength 4.9% and 3.5% resp The transparent concrete made with glass rods and optical fibers finds its applications mainly in partition wall rather than structural element such as columns and beams. The main focus of this concrete is transmission of light through it rather than its compressive strength. Still the 28days compressive strength is slightly reduced as compared to conventional concrete.

2. Conclusion regarding cost:

Even if initial cost of the light transmitting concrete is more than conventional concrete, but due to continuous increase in tariff and payback calculation done, from the payback analysis it can be concluded that the saving of electricity bill is Rs.1368.58/-. So the payback period for excess amount invested for light transmitting block will be 1.00 years for domestic consumption and 0.72 years for commercial and industrial consumption.

It will also reduce the carbon emission which is dangerous for environment. Hence this can be treated as one of the high performance concrete. The use of this high performance light transmitting concrete is beneficial for protecting mother earth.

REFERENCES

[1] B. Huiszoon, Interferometric element, interferometric N-stage tree element,and method of processing a ¯ rst optical input signal and a second optical input signal so as to provide a plurality of orthogonal output signals, PCTpatent WO2007/133066/A3, Eindhoven University of Technology, May 17,2006.

[2] Carl Hartman, Seeing the future of construction through translucent concrete, The Associated Press, July 8, 2004.

[3] Craig A. Shutt, Yeshiva Keter Torah, Fall 08 Ascent magazine, Awards for Best Elementary School, and Best Sustainable Design Innovation Award.

[4] Craig C. Freudenrich, Ph.D., How Fiber Optics Work,.Hanna Kite; Yuki Oda/Tokyo, Coolest Inventions 2004, Time Magazine, Nov. 29,2004

[5] IS 10262:2009, Bureau of Indian standard- Concrete Mix Proportioning-Guidelines (first revision)

[6] IS 456:2000, Bureau of Indian standard- plain and reinforced concrete- code of practice (fourth revision)

[7] IS 383:1970, Bureau of Indian standard- specification for coarse and fine aggregate from natural sources for concrete (second revision).

[8] Light transmitting concrete is set to go on sale this year, Mar 11, 2004.

[9] Light Transmitting Concrete: www.litracon.hu

[10] Luccon - Translucent Concrete: www.luccon.com Schott North America

[11] Massai, Hormigón: Ideas concretas e iluminadas, Todoarquitectura.com-Noticias de arquitectura, diseño, construction CAD, October 19, 2005.

[12] Zhi Zhou,Ge Ou ,Ying Hang,Genda Chen,Jinping Ou(2006). “Research And Development Of Plastic Optical Fiber Based Smart Transparent Concrete” proc of SPIE vol.7293OF-2.

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