

EFFECTIVE APPLICATION OF TRANSPARENT CONCRETE AND ITS PROPERTIES

¹Soumendra Mitra, ²Braja Gopal Dey, ³Kausik Patra, ⁴Himanshu Bakshi

^{1, 2, 3, 4}Lecturer,

Department of Survey Engineering,
Technique Polytechnic Institute, Hooghly, West Bengal, India

Abstract : Transparent concrete is a concrete based building material with light-transmissive properties due to embedded light optical elements usually Optical fibres. Light is conducted through the stone from one end to the other. Therefore the fibres have to go through the whole object. Transparent concrete is also known as the translucent concrete and light transmitting concrete because of its properties. It is used in fine architecture as a facade material and for cladding of interior walls. In this paper, to integrate the merits of concrete and optical fiber, for developing transparent concrete by arranging the high numerical aperture Plastic Optical Fibres (POF) or big diameter glass optical fiber into concrete. The main purpose is to use sunlight as a light source to reduce the power consumption of illumination and to use the optical fibre to sense the stress of structures and also use this concrete as an architectural purpose for good aesthetical view of the building. The binding material in transparent concrete may be able to transmit light by using clear resins the concrete mix. The Paper confines with the need of transparent concrete at present to utilize the sunlight and for architecture technologies. The new type of concrete can satisfy the green energy saving with its own Natural properties.

Keywords: *Transparent concrete, light transmitting, optical fibre, binding material, utilize sunlight, save power.*

1. INTRODUCTION

Transparent concrete was first mentioned in 1935 patent by Bernard Long as "LIGHT TRANSMITTING CONCRETE STRUCTURE" latterly the inventions and development in this field increased drastically. Transparent concrete can be manufactured by mixing 4-5% of optical fibres in the concrete. Transparent concrete in architecture is used as a façade material and for new designs to make the construction look much attractive. In today's time, where whole of the research is concentrated towards utilization of natural resource as much as possible and to reduce the consumption of resource which are decreasing with time, similarly in the field of construction 'GREEN BUILDING' is a good example of this which reduce the cost of construction and utilizes the waste fly-ash. In the same way transparent concrete is also a result of these type of research, which utilize the sunlight to emit light in the internal part of it and for the fine architecture as front. Building an environment which depends on the natural resource which is not expected to be finish in the life-cycle will be a great change towards the atmosphere for the upcoming generation, and transparent concrete is all about it. Our paper on use of transparent concrete aims to utilize the high amount of potential energy which exist in the form of sunlight, to emit light and to make people much aware about the benefits of using it in the construction. There were so many new techniques similar to it is introduced (mixing of Glass fibre, 2010), where transparent concrete mainly focus on Green Technology. While looking towards a material which can give the same strength as of general concrete with different texture we should go towards transparent concrete.

2. OBJECTIVE

To prepare sample model of transparent concrete to make people aware about its benefits towards surrounding and to architecture.

3. MATERIALS REQUIRED FOR TRANSPARENT CONCRETE

As above mentioned that transparent concrete is the type of concrete which has its specific quality of allowing light to pass through it hence it has many materials in common with the traditional concrete, except optical fiber in replace to aggregate. We can also say that transparent concrete is manufactured by combination of two basic materials fine concrete (without aggregate), optical fibers and due to presence of these optical fiber, transparent concrete get the ability to transmit light from natural or artificial source getting into the chemical composition, transparent concrete is the mixture of epoxy matrices and polycarbonate with optical fiber, colloidal SILICA, DETA and Portland cement which gives much more strength as from the standard/traditional concrete.

(Note: - transparent concrete is manufactured using fine materials only i.e. it does not contain any coarse aggregate or coarse material)

Cement: - There is no special cement required for this as light is transmitted by the help of optical fiber. However cement works a binder in transparent concrete too. Cement is a material which dries and sets and become hard and also reacts with CO₂ and binds the rest of materials to each other. Portland cement is the common type of cement widely used, grade of concrete is as per IS 4031-1988. The cement used in the research is ordinary Portland cement with specific gravity 3.15, with initial and final setting time as 48 minutes and 540 minutes.

Water: - Water free from impurities is specifically required for transparent concrete. In brief water should be free from oils, acids and other organic impurities and it shouldn't be soft water as it forms the weak concrete.

Sand: - There is no such specific requirement for sand. Only that it should be free from impurities.

Optical fiber: - optical fiber is the hair like thin fiber of glass or plastic cylindrical in shape that can transmit light through it. It functions on the principle total internal refraction, it allows light wave to pass through it without consuming energy from it. Its shape is identical as cylindrical, the internal part of this is made of glass or plastic which is highly refractive i.e. the core of the

optical fiber is of high refractive index, which result in the passage of light through it without of much loss in the potential energy of light. The outer part of this cylindrical core is known to be cladding and has low refraction. Either then this optical fiber has one more quality which makes it different from others and much useful than any other material, it allows the light to pass through it even at angle more then 60. The commonly available diameter of optical fibers are .25 mm, .5 mm, .75 mm, 1 mm etc.

4. PRINCIPLE

Transparent concrete or translucent concrete is work Based on “Nano-Optics”. Optical fibres passes as much light when tiny slits are placed directly on top of each other as when they are staggered. Transparent concrete is based on the principle of total internal reflection. When a light ray travels from a denser medium to a rarer medium such that the angle of incidence is greater than critical angle, the ray later reflects back to the same medium, and in optical fibre this total internal refraction repeats numerous time till it came out from the other end of fibre. Minor loss to the energies can be observed.

5. MANUFACTURING PROCESS

For the manufacturing of transparent concrete there is no such specific and complicated procedure is there, it is almost same as of the traditional concrete. The only difference is the presence of optical fiber in the aggregate and cement mix. Fibers are placed in layered form in the mould/cover (These moulds are made of wood or steel). Small small layers of concrete are first filled and applied with the fibers and are alternatively be applied to each other, and finished up with the concrete layer on the top. Huge amount of optical fiber is used while doing this, to have maximum exposure to the light, and to maintain its strength. A general transparent concrete can be produced by adding 4% to 5% of optical fiber to the total volume of concrete mixture. This concrete mixture is made of fine materials only, as we are not using coarse aggregate. Various size of fiber is already mentioned (0.25 mm to 2 mm) to have a good transmission of light through it. At the time of filling of concrete with fiber, concrete is poured slowly and carefully so that the position of optical fiber is not disturbed or displaced from its desired place, vibrating tables are used at the time of pouring of concrete to avoid the presence of void at the time of casting. While manufacturing transparent concrete one must follow Indian standard method (IS 10262-2009) for concrete mix ratio and proportion of mixture. Frame work can be removed after 24 hours of casting with proper curing of 2 times a day for consecutive 7 days, to have desired strength of concrete. After, that polishing and cutting work is done according to the need, for good shine and shape.

6. PROPERTIES

6.1. LIGHT GUIDING PROPERTY ON TRANSLUCENT CONCRETE

The following are the factors to be considered for the performance of the transparency of the concrete:

- Transmittance
- Haze
- Bi-fringence
- Refractive index
- Dispersion.

Light guiding property of translucent concrete with the POF volume ratio of 1%, 2%, 3%, 4%, 5% and 6% by using the halogen lamp and incandescent lamp, respectively. It can be seen that the transmittance of each type of translucent concrete almost keeps stable at whole wavelength, and the linear relationship between the POF volume ratio and its transmittance is good.

6.2. PHOTO ELASTIC EFFECT OF GLASS FIBER ON GLASS FIBER

Photoelastic effect of glass fiber applied radial load of 0.4kN under plane polarized optical field. Both the isochromatics and the isoclinics are figured out in the figure. The isoclines, described as black lines in the figure, are changed along with the angle of the rotation of the corresponding orthogonal polarization axis, while the isochromatics remain unchanged at the same load. The isoclinics denote the direction of principle stress of the glass fiber, and the isochromatics are the difference.

6.3. IMPERMEABILITY PROPERTY OF TRANSLUCENT CONCRETE

Photoelastic effect of translucent concrete at three conditions above mentioned under the plane polarized optical field. It can be seen that the isochromatics of glass fiber at the three conditions are different from each other at the same load due to the damage and different loading conditions.

6.4. CASTING AND CURING

After the vacuum water saturation, the initial current strength of the plain concrete, the translucent concrete with 3% POF volume ratio, the translucent concrete with 3% POF volume ratio and POF covered by epoxy resin, the translucent concrete with 6% POF volume ratio and the translucent concrete with 6% POF volume ratio and POF covered by epoxy resin are 70.4mA, 104.5mA, 79mA, 117mA and 114.9mA, respectively. After six hours conduction time, the corresponding current strengths of the above six concretes increase to 113.6mA, 181.7mA, 126.4mA, 201.6mA and 1944.2mA, respectively.

7. ADVANTAGES / DISADVANTAGES

Advantages

- The first and the most noticeable advantage of transparent concrete is that it can transmit light or can say it allows light to pass through it whereas the function of concrete is different.
- It is a part of “GREEN BUILDING”.
- As it transmit light from one side to other, natural or artificial, allows building to Have its own light source.
- It reduce consumption of energy.

- It is economic, and saves huge amount of money to be expended over electricity. A good technique, keeping in mind need of future needs.
- Transparent concrete uses sunlight as light source, i.e. utilization of natural resource is there.
- Can be used in cold countries as fine architecture façade, to transmit heat with sunlight to the inner end. It gives the visibility of texture of large scale object.
- Transparent concrete wall at homes can give the benefit of using less lights in the day time.
- Good appearance of transparent concrete gives an additional benefit as architectural point of view for good aesthetical view of building.
- 100% environment friendly.
- Can be used at the place where light is not able to come properly.

Disadvantages

- Especially skilled person is required for the casting work of transparent concrete.

8. APPLICATIONS

A. Illuminate Your Walls

Transparent Concrete can be used as building material for interior and exterior walls. If sunshine illuminates the wall structure, then eastern or western placement is recommended; the rays of the rising or setting sun will hit the optical glass fibers in a lower angle and the intensity of the light will be bigger. Besides the traditional applications of a wall, the light transmitting concrete can also be used as wall covering illuminated from the back.

B. Watch Your Pavement Shine at Sunset

This concrete can be used as flooring a passable surface illuminated from below. During the day it looks like typical concrete pavement but at sunset the paving blocks begin to shine and in different colors.

C. Get Creative with Design

The building units are versatile and can be used in many areas of design. Two successful designs using the light transmitting concrete were a jewel and a concrete bench. You can also create a logo with colorful figures, inscriptions, and pictures and can be used for beautification purpose

D. Artsy Reception Desk

If you really want to create a look that stands out, you should opt for this artsy and vogue reception desk where light up in the front and the sides.

E. A Lighting fixture and Conversational Piece

The transparent concrete cube is, without a doubt, a great conversation piece. The new cube line consists of four identical pieces of concrete and, due to its special geometry; the pieces form a stable structure without fixing them together.

It can be also applicable at:

- Transparent concrete blocks suitable for floors, pavements and load-bearing walls.
- Facades, interior wall cladding and dividing walls based on thin panels.
- Partitions wall and it can be used where the sunlight does not reach properly.
- In furniture for the decorative and aesthetic purpose.
- Light fixtures.
- Light sidewalks at night.
- Increasing visibility in dark subway station.
- Illuminating speed bumps on roadways at night.

9. CONCLUSIONS

• Transparent concrete is a new innovation in concrete. It is no longer the same old, heavy, grey material with zero transparency. It is now innovated and reformed as a good looking, lively and beautiful concrete with more resistance, lighter in weight, weight or colored etc. Transparent concrete can be produced by adding optical fiber in the fine concrete mixture. It has good light transmitting property, which is directly depended on the ratio of presence of optical fiber to the total volume of concrete. It is nowhere weak when compare to the traditional concrete on the bases of its strength, it carries equal strength of that of general traditional concrete. Either it has one more additional advantage over traditional concrete, its texture, aesthetical architecture point. It can be used as an awesome architecture work, with attractive looks. Can also be used in the area where natural sunlight cannot reach in the desired intensity. This new type of concreting represent the concept of "GREEN BUILDING" with self-sensing property of it.

10. ACKNOWLEDGEMENTS

The authors thankfully acknowledge to Mr. B. G. Dey for motivation and support. And lastly I want to thank my parents for their unconditional support.

11. REFERENCES

- [1] Victoria Bailey, "Translucent Concrete", MEEN 3344-001
- [2] D.D.L. Chung. Cement reinforced with short carbon fibers: a multifunctional material. Composites: Part B.31:511-526, 2000.
- [3] F. Ansari. Practical Implementation of Optical Fiber Sensors in Civil Structural Health Monitoring. Journal of Intelligent Material Systems and Structures, 18(8):879-889, 2007.
- [4] Roye, Andreas; Barlé, Marijan; Thomas, Gries (2009). Faser- und Textilbasierte Lichtleitung in Betonbauteilen. Aachen, Germany: Schaker Verlag. ISBN 978-3-8322-7297-5.

- [5] "Dr. med. aesthete - Aesthetic interior partitioning made from translucent concrete for a dental clinic in Genk". OpusC - Concrete, Architecture & Design. ad-media. 4/2011 (4): 62–63. 2011
- [6] <http://www.lucem.de/index.php?id=375&L=1%2527%2520and%2520char%2528124%2529%252Buser%252Bchar%2528124%2529%253D0%2520and%2520%2527%2527%253D%2527>.
- [7] LUCEM Translucent Concrete - Planning Details (PDF), Stolberg, Germany: LUCEM GmbH, 2011
- [8] CA 353849, Bernard Long, "LIGHT TRANSMITTING CONCRETE STRUCTURE", published 1935-10-29
- [9] GB 1561142, David Kenneth & John Richardson, "DECORATIVE WALLS, FLOORS AND CEILINGS"
- [10] DE 3628083, "Bodenplatten aus Balken mit eingelegten Lichtwellenleiter-Sensoren", published 1988-03-03
- [11] DE 9310500U, Uwe Weidmann, "Lichtdurchlässiges Bauelement", published 1993-07-14.
- [12] FR 2743135, FRANCOIS ORTH, "BORNES ET AUTRES EQUIPEMENTS PUBLICS OU PRIVES EN BETON OU CIMENT ECLAIRES PAR FIBRES OPTIQUES", published 1995-12-29.
- [13] <http://www.lucem.de/index.php?id=354&L=0%252525252C%2525252520onfocus%252525253DblurLink%2525252528t his%2525252529%252525253B>
- [14] P. M. Shanmugavadivu, V. Scinduja, T. Sarathivelan, C.V Shudesamithronn, an Experimental Study on Light Transmitting Concrete, International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
- [15] Zhi Zhou, Ge Ou, Ying Hang, Genda Chen, Jinping Ou, Research and Development of Plastic Optical Fiber Based Smart Transparent Concrete, Proc. of SPIE Vol. 7293 72930F-2.
- [16] Andrea Giovanni Mainini, Tiziana Poli, Michele Zinzi, Stefano Cangiano, Spectral light transmission measure and radiance model validation of an innovative transparent concrete panel for façades, Elsevier SciVerse ScienceDirect, Energy Procedia 30 (2012) 1184 – 1194.
- [17] Basma F. Bashbash, Roaa M. Hajrus, Doaa F. Wafi, Mamoun A. Alqedra, Basics of Light Transmitting Concrete, Global Advanced Research Journal of Engineering, Technology and Innovation (ISSN: 2315-5124) Vol. 2(3) pp. 076-083, March, 2013.
- [18] Neha R. Nagdive & Shekar D. Bhole, to evaluate properties of translucent concrete / Mortar & their panels, IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET) ISSN (E): 2321-8843; ISSN (P): 2347-4599 Vol. 1, Issue 7, Dec 2013, 23- 30.
- [19] Juan She and Zhi Zhou, Some Progress on Smart Transparent Concrete, Pacific Science Review, vol. 15, no 1, 2013, pp. 51~55.

