

Transparent concrete as an eco-friendly material for building

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ABSTRACT : Engineers have now developed concrete mixtures that are capable of transmitting light. By switching the ingredients of traditional concrete with transparent ones, or embedding fibre optics, translucent concrete has become a reality. Light Transmitting concrete, also known as translucent concrete. The main purpose was to use sunlight as a light source in order to reduce the power consumption of illumination. Translucent concrete is a concrete based material with light-transmissive properties, obtained due to embedded light optical elements like Optical fibres in it. Light is conducted through the stone from one end to the other. Translucent concrete is also used in the smart construction. 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. Light transmitting concrete is one of the fibre reinforced concrete which is used for aesthetic application by incorporating the optical fibres in concrete. Optical fibres are one which helps for transmission of light through fibre. The end-lite type of fibre is used to increase the aesthetic appearance of the concrete. The concept of light transmitting concrete is like a transparent concrete. When it is used in ceiling or side wall, it is exposed to direct sun light which transmit the image but not completely transparent. In this paper the smart translucent concrete can be regarded as a green energy saving construction material. It is a promising technology for field applications in civil Infrastructure.

KEYWORDS – Architectural, attractive building material, energy saving, green construction material, optical fibre, Translucent concrete

I. INTRODUCTION

Just a few decades ago concrete was often misunderstood, disliked and captured by its image fixed due to the rapid urbanization of the 1960s. But since that time, concrete has made considerable progress, not only in technical terms, but also in aesthetic terms. It is no longer the heavy, cold and grey material of the past; it has become gorgeous and lively. By research and innovation, newly developed concrete has been created which is more resistant, lighter, white or coloured, etc. Concrete has learned to adapt to almost all new challenges that appeared. In 2001, the concept of transparent concrete was first put forward by Hungarian architect Aron Losonzi, and the first transparent concrete block was successfully twisted by mixing large amount of glass fiber into concrete in 2003, named as LiTraCon. Joel S. and Sergio O.G. developed a transparent concrete material, which can allow 80% light through and only 30% of weight of common concrete. The term “translucent concrete” has the potential to be somewhat misleading. The concrete itself is not translucent, nor is it any different to conventional concrete.[6] Translucent concrete has been first mentioned in a 1935 Canadian patent. But since the development of optical glass fibers and polymer based optical fibres the rate of inventions and developments in this field has drastically increased. There have also been inventions that apply this concept to more technical applications like fissure detection. In the early 1990s forms like translucent concrete products popular today with fine & layered patterns were developed.

Concrete is one component of a revolutionary new material marketed as “translucent concrete”[1]. Engineering has come a long way in the field of construction [4]. When many buildings are stacked close to each other, there is not much natural sunlight passing through and the importance of natural sunlight is pretty well known. In fact, 50% day lighting is a mandatory requirement in a green building according to (IGBC) Indian Green Building Council accounting for 3 credits.[4] A concrete block is going to be built with optical fibres in it and going to be tested for other optional properties. But the main reason or purpose of the blocks is saving energy using natural light and therefore reducing the amount of heat produced from artificial light.[4] In Light-transmitting concrete, which is also known as translucent concrete, optical fiber’s strands are cast into the concrete to transmit light, by either naturally or artificially through translucent panels. This material can be used in a wide range of architectural and interior design. building energy saving and building safety have been attracted much attention.[7] While the translucent concrete mainly focuses on transparency and its objective of application

pertains to green technology and artistic finish.[6]Transparent or translucent concrete can be seen as a recent answer to the architects call for more Transparent Architecture. Meanwhile some new building materials are developed and used in structures, including self-diagnosis smart concrete, self-tuning smart concrete, self-repairing smart concrete, soundproof concrete, thermal insulation concrete and so on. All these functional materials only focus on the intelligence characteristics.



Fig. 1 Transparent Wall

Table 1- properties of transparent concrete blocks Litracon Company

Product	Litracon- Light Transmitting Concrete
Form	Prefabricated blocks
Ingredients	96% concrete, 4% optical fibre
Density	2100-2400 Kg/m ²
Block size	600mm x 300mm
Thickness	25-500mm
Colour	White, Grey or Black
Fibre distribution	Organic
Finished	Polished
Compressive strength	50 N/mm ²
Bending Tensile strength	7 N/mm ²

(www.litracon.hu/productlist.php)

A wall made of "Light LitraCon" has the strength of traditional concrete and an embedded array of glass fibres that can display a view of the outside world [12]. Since concrete is strong in compression and weak in tension and flexure.

II. LITERATURE SURVEY

- A. akshaya b.kamdi, issn 2319 – 6009 www.ijscer.com, vol. 2, no. 3, august 2013, “transparent concrete as a green material for building”, studied that how transparent concrete made and it’s glowing future. they concluded that the translucent concrete is one of the most interesting new takes on the historically stiff and uninspiring building material.
- B. Neha R. Nagdive and Shekhar D.Bhole (2013) ISSN(E): 2321-8843; ISSN(P): 2347-4599 Vol. 1, Issue 7, Dec 2013, 23-30, “To Evaluate Properties of Translucent Concrete/Mortar and Their Panels”, To evaluated that the properties of translucent concrete/mortar and their panels and was manufactured with optical Fibre by drilling through the cement and mortar in order to utilize the light guiding ability of optical Fibre. They concluded that the smart transparent concrete has good light guiding property.
- C. 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 excellent properties of light guiding and elasto-optic effect of optical fiber. To evaluate the effectiveness of smart transparent concrete and they concluded the transparent concrete has good light guiding property, and the POF volume ratio to concrete is proportion to transmission. The amount of POFs has seriously influenced

the compressive strength of the corresponding concrete. The POFs have reduced the anti-permeability of the concrete.

- D.** M.N.V.Padma Bhushan (2013), “Optical Fibres in the Modelling of Translucent Concrete Blocks”, ISSN:22489622www.ijera.com, Vol.3, Issue-3, May-Jun-2013, pp.013-017(2013), studied that the Translucent concrete is a concrete based material with light-transmissive properties, obtained due to embedded light optical elements like Optical fibres in it. They concluded that translucent concrete blocks can be used in many ways and implemented into many forms and be highly advantageous. Yet, the only drawback would be its high cost.
- E.** Prof.A.A.Momin(2014), “Study on Light Transmittance of Concrete Using Optical Fibers and Glass Rods”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 67-72, studied or investigated that the present investigation aims at producing the concrete specimens by reinforcing glass rods and optical fibres with different percentage and comparing it with the normal concrete. Different tests were carried out on the concrete specimens like compressive strength test, light transmission test etc. They conclude after the experimental investigation, the compressive strength of Light Transmitting Concrete was found to be ranging between 20 – 23 N/mm² with optical fibre specimen and with glass rods specimen the compressive strength was found to be ranging between 24-26 N/mm², which indicates that the concrete satisfies the compressive strength requirement for M20 grade concrete.
- F.** Varshara in a et al(2013), “A Study on Transparent Concrete: A Novel Architectural Material to Explore Construction Sector”, International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 8, February 2013, Investigated to developed the building aesthetic in modern construction and consumption of energy with eco-friendly way. 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 this concrete as an architectural purpose for good aesthetical view of the building. They conclude that the not loses the strength parameter when compared to regular concrete. This kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional material.
- G.** P.M.Shanmugavadivu (2014), “An Experimental Study On Light Transmitting Concrete”, ISSN: 2319-1163 ,Volume: 03 Special Issue: 11, Jun-2014, studied that the Light transmitting concrete is one of the fiber reinforced concrete which is used for aesthetic application by incorporating the optical fibers in concrete. Optical fibers are one which helps for transmission of light through fiber. They concluded that the efficiency of the application of optical fiber is studied by comparing the strength with the normal M20 grade concrete and the test results proved that the efficiency is more in all aspect. The major purpose of light transmitting concrete is created as a model and the light transmission is made of the illuminating side of the concrete.
- H.** Basma F.Bashbash et al(2013), “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, discussed about the development of a light transmitting concrete using plastic optical fibre, which will help to reduce the consumption of electric energy. They concluded that an optical fibre can be easily combined with concrete and that the POF could provide a steady light transmitting ratio. The smart transparent concrete can be regarded as a green energy saving construction material.
- I.** Patil Gaurao S., Patil Swapnal V.(2015), “Light Transmitting Concrete- A New Innovation”, International Journal of Engineering Research and General Science Volume 3, Issue 2, Part 2, March-April, 2015 ISSN 2091-2730, studied that the light transmitting concrete has a new innovative material. Based on excellent properties of light guiding and elasto-optic effect of optical fiber the light guiding based on white light test, long-term durability based on freezing and thawing test and chloride ion penetration test, and self-sensing property based on stress elasto-optic effect test are made respectively. The experiments results show that the smart transparent concrete has good transparency, mechanical and self-sensing properties. they concluded that the A smart transparent concrete is aesthetically pleasing. POF-based transparent concrete could be regarded as an art which could be used in museums and specific exhibitions rather than just a construction material.
- J.** Soumyajit Paul, Avik Dutta, (2013), “Transparent Concrete”, International Journal of Scientific and Research Publications, Volume 3, Issue 10, October 2013 ISSN 2250-3153, studied that the special type of concrete casted with light transmitting properties and to develop a functioning material which is not only energy saving but gives out artistic finish. They concluded that A novel architectural material called translucent concrete can be developed by adding optical fiber or large diameter glass fiber in the concrete

mixture. This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials.

- K.** M. Sangeetha,(2014), “An Experimental Investigation on Energy Efficient Lightweight Light Translucent Concrete”, IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 | ISSN (online): 2321-0613,studied that the light weight concrete. Lightweight concrete is one of the advanced concrete which is used to reduce the self-weight of the concrete. This is lighter than conventional concrete Its main speciality is its low density and thermal conductivity. The main advantages of light weight concrete are reduction in dead weight, faster building rate in construction, lower haulage, handling cost. They concluded that lightweight concrete to reduce the dead weight of the structure by using lightweight materials Portland Pozzolana cement, Natural sand, Coir Pith, Water, Admixture and Optical fibre. it is used for decorative purpose.
- L.** 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, Small buildings are replaced by high rise buildings and sky scrapers. This arises one of the problem in deriving natural light in building, due to obstruction of nearby structures. Due to this problem use of artificial sources for illumination of building is increased by great amount. So it is very essential to reduce the artificial light consumption in structure. They concluded that the Light Transmitting Concrete, Compressive Strength, capability of light transmission through it, and effectiveness of cost.

III. SCOPE OF WORK

The community has great challenges and it needs useful solution for the challenges as like the global climate change, using energy in a sustainable way and protecting the environment. We should find a good solution, for instance: using of solar energy, translucent heat insulation, passive buildings etc. The development of the building technology in the field of building industry (using the best methods) is a good way to abolish the emission of greenhouse gases, because we shall use less loam and the industry will not need to transfer those materials The former Research and Development results will be combined with the technologies of the frozen sand concrete and the non-tectonic constructions theories and practices. The results of the last decades in the field of concrete technology and material science could be combined with the new Research and Development results. New Research and Developments are developing of a simple, cheap and productive optical fiber, especially according to the production of the transparent concrete. The use of this material in the solar architecture in a cheap way. The other aim is that the people could use it more. By the results, the transparent concrete will be available for everybody, because the technology is cheap and productive due to the fiber pulling and brick technology methods. It is much of importance for developing a new kind of building material, which can integrate green energy saving with self-sensing properties of functional material. In this paper, based on the excellent properties of light guiding and elasto-optic effect of optical fibre, a novel smart transparent concrete is researched by arranging the optical fibers into the concrete. To evaluate the effectiveness of the smart transparent concrete, the light guiding based on white light test, long-term durability based on freezing and thawing test and chloride ion penetration test, and self-sensing property based on stress elasto-optic effect test are made respectively. The experiments results show that the smart transparent concrete has good transparency, mechanical and self-sensing properties.

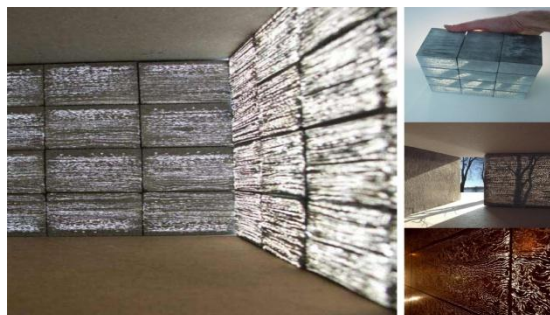


Fig.2 Transparent concrete wall

IV. PRACTICAL ORIENTATION

A. MATERIALS :

Materials which used for the making of transparent concrete are:

CEMENT:

Cement is described as a material with adhesive and cohesive properties which make it capable of bonding Mineral fragments into a compact whole. It embraces large variety of cementing materials. For construction purposes the Meaning of the term cement is restricted to the bonding material used with stones, sand, bricks, building blocks, etc. The principal constituents of this type of cement compounds of lime, so that in building and civil engineering we are connected with calcareous cement. The cements have property of setting in under water by chemical reaction releasing heat of hydration. So called as hydraulic cement.[2]

WATER:

Is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water needs to be pure in order to prevent side reactions from occurring which may weaken the concrete, the role of water is important because the water to cement ratio is the most critical factor in the production of "perfect" concrete.[8]

SAND

Sand is naturally available material which is composed rock and mineral particles. It is found in different sizes but the size of sand should pass through 1.18mm sieve. It should be free from impurities such as vegetation and gravels. Some inert material such as sand, surkhi or cinder and lubricating material water, a paste is formed which is plastic in nature; this paste is known as mortar.[2]

OPTICAL FIBER:

Flexible, transparent fiber made up of glass or plastic. It transmits light between two ends of the fiber. Optical fiber transmits light so effectively that there is almost no loss of light conducted through the fibers. For light transmission the thickness of optical fiber should be varied from 2 μm and 2 mm nearly equal to diameter of human hair. Concrete is produced by adding 4% to 5% optical fiber by volume in concrete mix

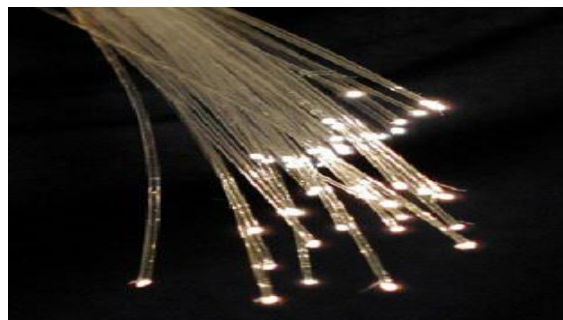


Fig. 3 optical fibre

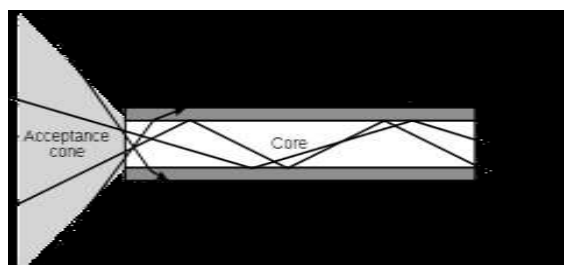


Fig.4 Total internal reflection

TYPES OF OPTICAL FIBRE:

1. Multimode Fiber
2. Single-mode Fiber
3. Multimode Step-index Fiber
4. Multimode Graded-index Fiber

MULTIMODE STEP INDEX FIBER:

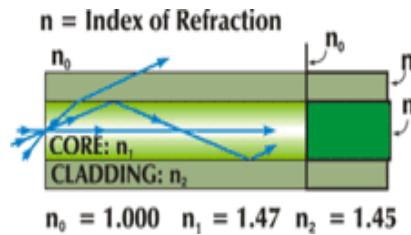


Fig.5 Total Internal Reflection in Multimode Step- index fiber

MULTIMODE GRADED INDEX FIBER:

Graded-index refers to the fact that the refractive index of the core gradually decreases farther from the center of the core. The increased refraction in the center of the core slows the speed of some light rays, allowing all the light rays to reach the receiving end at approximately the same time, reducing dispersion. Figure 6 - Multimode Graded-index Fiber.

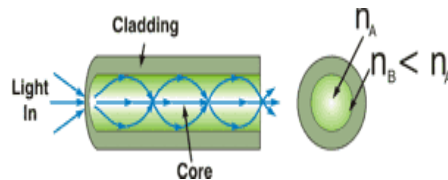


Fig.6 Multimode Graded-index Fiber

B. HOW TRANSPARENT CONCRETE MADE

- Strands of optical fibers are cast by the thousands into concrete to transmit light, either natural or artificial, into all spaces surrounding the resulting translucent panels. Light-transmitting concrete is produced by adding 4% to 5% optical fibers (by volume) into the concrete mixture. The fibers run parallel to each other, transmitting light between two surfaces of the concrete element in which they are embedded. Thickness of the optical fibers can be varied Between 2 μm and 2 mm to suit the particular requirements of light Transmission.[1]
- Initially, the fiber filaments were placed individually in the concrete, making production time-consuming and costly. Newer, semi-automatic production processes use woven fiber fabric instead of single filaments. Fabric and concrete alternately insert into moulds at intervals allow an increased the material is cut into panels or Blocks of the specified thickness and the surface are then typically polished, resulting in finishes ranging from semi-gloss to high gloss

C. TEST:

- 1] Workability test.
- 2] Compressive test.
- 3] Flexural test.

1] WORKABILITY:

The workability of the concrete is determined by conducting the slump cone test.

2] COMPRESSIVE TEST:

By definition, the compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The compressive strength of the concrete is determined by cast the cubes of size 150mmx150mmx150mm.

Compressive strength = load/area

[1]



Fig.6 Concrete block

3] FLEXURAL TEST:

The flexural strength of the concrete is determined by conducting the test on prism by two point loading.

$$\text{Flexural strength} = Pl/bd^2 \quad [2]$$

Where, P – Load, l – Length of the specimen, b - width of the prism, d – depth of the prism

V. ADVANTAGES

1. The main advantage of these products is that on large scale objects the texture is still visible - while the texture of finer translucent concrete becomes indistinct at distance.
2. When a solid wall is imbued with the ability to transmit light, it means that a home can use fewer lights in their house during daylight hours.
3. It has very good architectural properties for giving good aesthetical view to the building.
4. Where light is not able to come properly at that place transparent concrete can be used.
5. Energy saving can be done by utilization of transparent concrete in building.
6. Totally environment friendly because of its light transmitting characteristics, so energy consumption can be reduced.
7. Speed bumps in parking lots and driveways could be illuminated from below, making them more visible and therefore more.
8. Translucent concrete walls on restaurants, clubs, and other establishment to reveal how many patrons are inside.

VI. DISADVANTAGES

The main disadvantage is these concrete is very costly because of the optical fibers.

1. Casting of translucent concrete block is difficult for the labour so special skilled person is required.
2. Costing of this material is difficult as the techniques are just start to develop.
3. It is precision material and the correct procedure need to be followed.
4. It is extremely important to ensure the integrity of optic strands if they break within the product property would almost be neglected.

VII. OBJECTIVE

1. To cast a special type of concrete with light transmitting properties.
2. To study development in performance of concrete in light transmission by using optical fibre and improve performance of structure to derive natural light.
3. To make concrete partially transparent by using optical fibres in it to impart good appearance to structure.
4. To study cost effectiveness of this high performance concrete.
5. To study Energy saving for illumination by using transparent block for building.

VIII. CONCLUSION

A novel architectural material called transparent concrete can be developed by adding optical fibre or large diameter glass fibre in the concrete mixture. The transparent concrete has good light guiding property and the ratio of optical fibre volume to concrete is proportion to transmission.[3] The translucent concrete not loses the strength parameter when compared to regular concrete and also it has very vital property for the aesthetical point of view. It can be used for the best architectural facade of the building. Translucent concrete is one of the most interesting new takes on the in the past rigid and uninspiring building material. It could be used almost

anywhere glass or traditional concrete are used. green energy saving with the usage self-sensing property of functional materials.[6]


IX. ACKNOWLEDGEMENTS



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REFERENCES

[1] Akshaya B.Kamdi,Transparent Concrete as a Green Material for Building,IJSCER, Vol. 2, No. 3,172-175,2013.
 [2] Neha R.Nagdive, Shekhar D.Bhole,“To Evaluate Properties of Translucent Concrete/Mortar and Their Panels”,IJRET, Vol. 1, Issue 7, 23-30,Dec-2013.
 [3] Jianping He, Zhi Zhou and Jinping Ou, “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.
 [4] M.N.V.Padma Bhushan, D.Johnson, Md. Afzal Basheer Pasha And Ms. K. Prasanthi,“Optical Fibres in the Modelling of Translucent Concrete Blocks,IJERA,Vol. 3, Issue 3, pp.013-017,(2013).
 [5] Prof. A.A. Momin, Dr. R.B. Kadiranaikar , Mr.Vakeel.S. Jagirdar, Mr. Arshad Ahemed Inamdar, “Study on Light Transmittance of Concrete Using Optical Fibers and Glass Rods”, IOSR-JMCE, pp-67-72,2014.
 [6] Bhavin K. Kashiyani, Varsha Raina, JayeshkumarPitroda, Dr. Bhavnaben K. Shah,A Study on Transparent Concrete: A Novel Architectural Material to Explore Construction Sector, IJEIT, Volume 2, Issue 8, pp.83-87, 2013.
 [7] P.M.Shanmugavadivu, V. Scinduja, T.Sarathivelan, C.V Shudsamithronn,An Experimental Study On Light Transmitting Concrete, IJRET, Volume: 03, Issue: 11,pp.160-163, (2014).
 [8] Basma F. Bashbash,“Basics of light Transmitting Concrete”,GARJE, Vol. 2(3), pp.076-083,pp 079-083,(2013).
 [9] Patil Gaurao S.,Patil Swapnal V.(2015) “Light Transmitting Concrete- A New Innovation”,IJERGS, Volume 3, Issue 2, Part 2,pp.806-811, March-April, 2015.
 [10] Soumyajit Paul,Avik Dutta, Translucent Concrete, IJSR,Volume 3, Issue 10,2013.
 [11] M. Sangeetha,V. Nivetha, S. Jothish, R. Madhan Gopal, T. Sarathivelan, An Experimental Investigation on Energy Efficient Lightweight Light Translucent Concrete,IJSRD, Vol. 3, Issue 02,pp.127-130, 2015.
 [12] A. B. Sawant, R. V. Jugdar, S. G. Sawant,“Light Transmitting Concrete by using Optical Fibre,”IJIES, Volume-3 Issue-1,pp.23-28,Dec-2014.
 [13] <http://www.arclect.com/fibercable.htm>
 [14] [http:// www.l-com.com/content/article.aspx?](http://www.l-com.com/content/article.aspx?)
 [15] <http://www.litracon.hu/en/products>

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