



## Light Transmitting Concrete: A Review

<sup>1</sup>Priyanka Dutta, <sup>2</sup>Avinaba Bhattacharyya, <sup>3</sup>Dr.Biman Mukherjee

<sup>1,2</sup>Student, Department of Civil Engineering, Narula Institute of Technology, Kolkata, WestBengal, India,

<sup>3</sup>Assistant Professor, Department of Civil Engineering, Narula Institute of Technology, Kolkata, WestBengal, India

**Abstract:** Researchers have focused on the concept of sustainable development looking forward to invent something new using non-conventional energy. Light transmitting concrete (LTC) or LiTraCon is an example of such phenomenal invention. This review evaluates the principles involved in it, manufacturing process, pros and cons and applications of LiTraCon. It has been described how the LiTracon developed from 90's and outstretch. Embedding optical fibres in the concrete reduces electricity demands. Hence, it can be used as an eco-friendly alternative to traditional concrete in the near future. The applications of LiTraCon illustrates its positive impact worldwide. LiTraCon can become an affordable alternative for both commercial and residential projects.

**Index Terms -** Light Transmitting concrete, optical fibre, energy saving, sustainable development, green technology

### I. INTRODUCTION

The proliferating urbanization reveals the growth of concrete fathomlessly. There is no denying that concrete and the technology surrounding it has come a long way since its discovery and development. From the great pyramids at Giza to smart sensors for testing concrete properties, technology swiftly ameliorated. Although extension development creates hazards which includes high production, high consumption, high pollution and other ill-effects to environment. Among all these, power production by using a non-renewable resource is deep-rooted day by day. In 2021, about 4,116 billion kilowatt hours of electricity were generated at utility-scale electricity generation facilities in the United States where 21.8% share of total is coal energy source. The world has proven reserves equivalent to 133.1 times its annual consumption. This means it has about 133 years of coal left (excluding unproven reserves).

To reduce the consumption of power of illumination, effective and efficient material usage introduced Light Transmitting concrete, making use of such elements which has high illuminative power.

“LiTraCon” is the abbreviated form of light transmitting concrete. “**Figure 1**” Other names of this concrete are Light Emitting concrete and Translucent concrete. LiTraCon is a concrete based building material with light-transmissibility properties due to embedded light optical elements. We can use optical fibre made up of glass or plastic as optical elements.



“Fig.1”

The purpose of saving electricity is satisfied in such type of concrete. Addition to it, architectural purpose for good aesthetical view of the building is also persuaded. Now it is increasingly used in fine architecture and cladding for interiors.

## II. HISTORICAL DEVELOPMENT

Light transmitting concrete was first stated on October 27, 1922 a patent filed under United States Patent office Paul Liese of Tempeloh of Germany. His inventions were related to transparent building blocks or panels on August 4, 1925. Later in 1965, a method of constructing a translucent panel by James N. Lowe, London, England; was patented in United States Patent office. The invention relates to a method of making translucent concrete panels which are used, for example, church windows. In the early 1990s, when major advancements in the field of polymer-based optical fibres led to its development, LiTraCon was introduced.

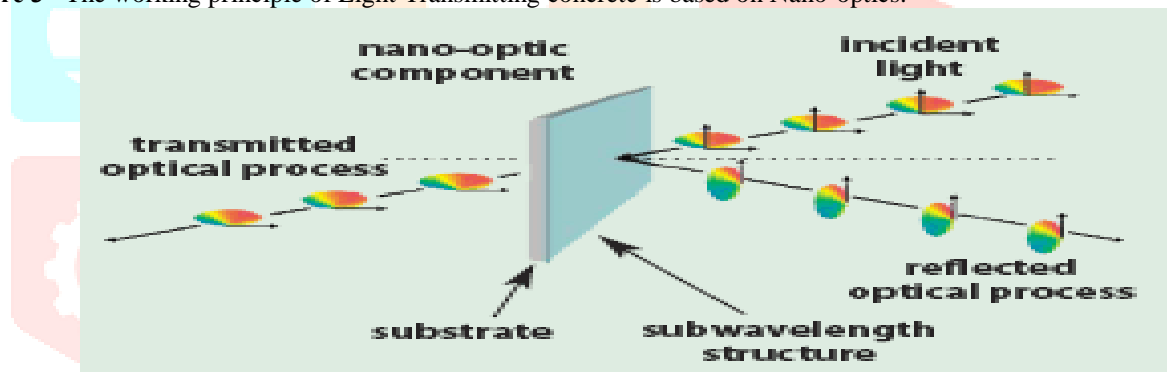
“**Figure 2**” In 2001, first, the concept of Transparent concrete was put forward by Hungarian architect Aron Losonczy, and the first transparent concrete block was successfully casted by mixing a large amount of glass fibre into concrete in 2003. Joel s. and Sergio O.G. casteda transparent concrete material, which allow 80% light through and only 30% the weight of common concrete. The hope is that the new material will create new interior aspect.



“Fig.2”

## III. PRINCIPLE

“**Figure 3**” The working principle of Light Transmitting concrete is based on Nano-optics.

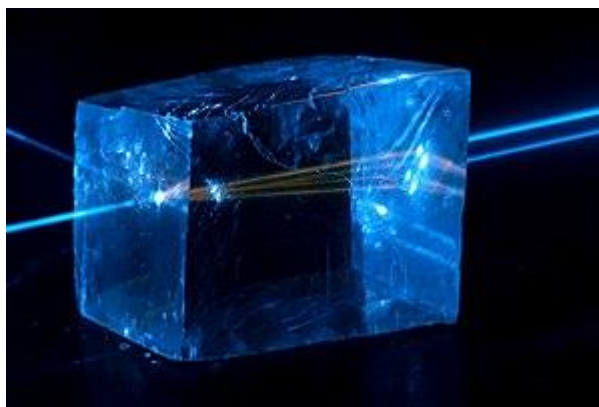


“Fig.3”

Following are the different usage of nano-optics involved:

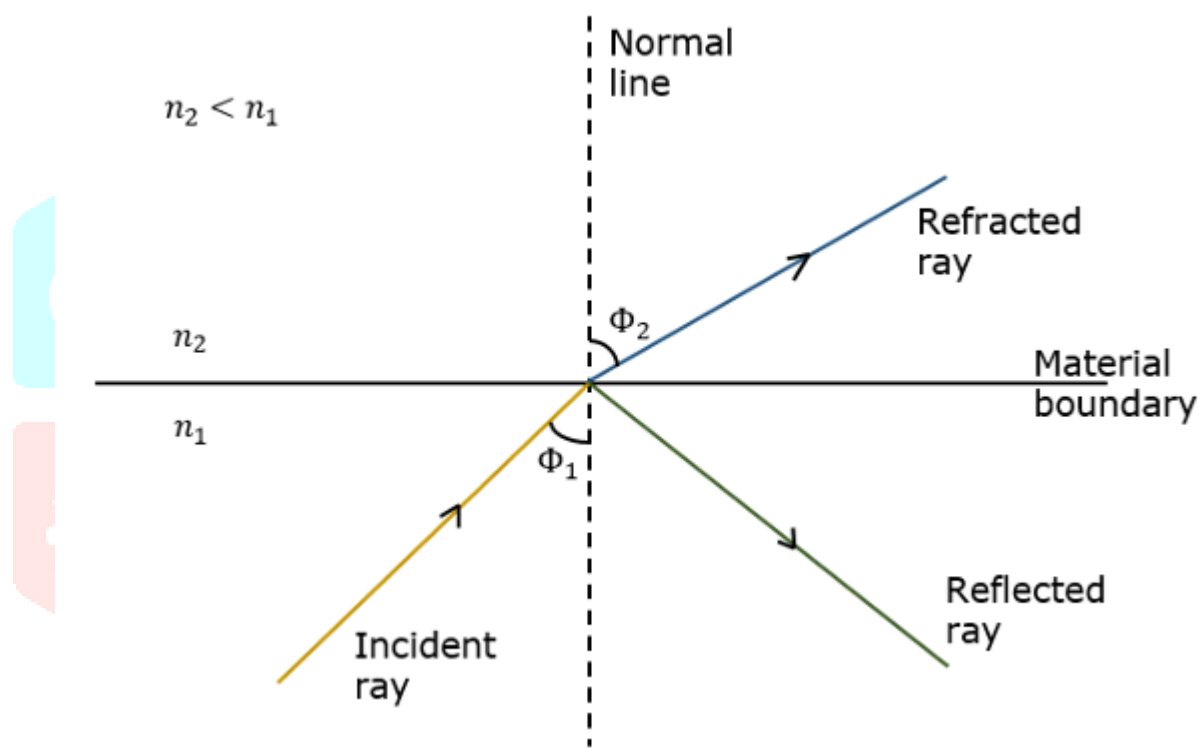
- Interaction of light with nanoscale systems
  - artificial quantum structures
  - photonic bandgap materials
  - molecules/proteins
- Optical interactions between nano-systems
  - optical trapping
  - Vander Waals force
- Resonance phenomenon
  - plasmons
  - surface phonons
- Strongly focused lights
  - confocal microscopy
  - “**Figure 4**” multiphoton microscopy
- Diffraction limit
  - light confinement
  - apertures,tips,fibres
- Theoretical concepts
  - angular spectrum representation

-multiple multipole method



"Fig.4"

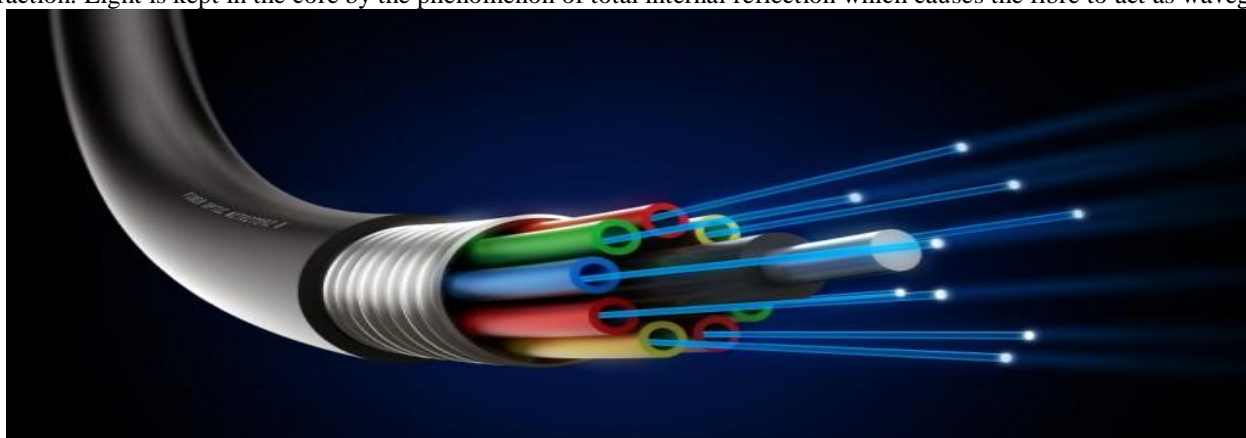
The working principle depends on total internal reflection. "Figure 5" When a ray of light travels from a denser to a rarer medium such that the angle of incidence is greater than the critical angle, the ray reflects back into the same medium this phenomena is called total internal reflection. In the optical fibre the rays undergo repeated total number of reflections until it emerges out the other end of the fibre, even if the fibre is bent.



"Fig.5"

#### IV. OPTICAL FIBRE ELEMENTS

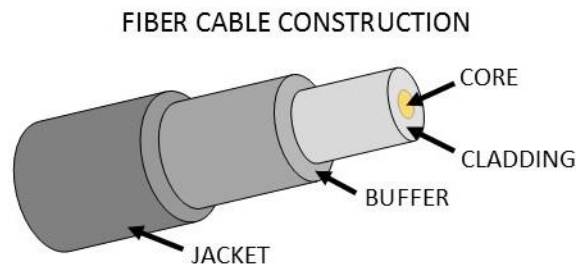
"Figure 6" An optical fibre is a flexible, transparent fibre made by drawing glass (silica), or plastic to a diameter slightly thicker than that of a human hair. Optical fibres typically include a core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fibre to act as waveguide.



"Fig.6"

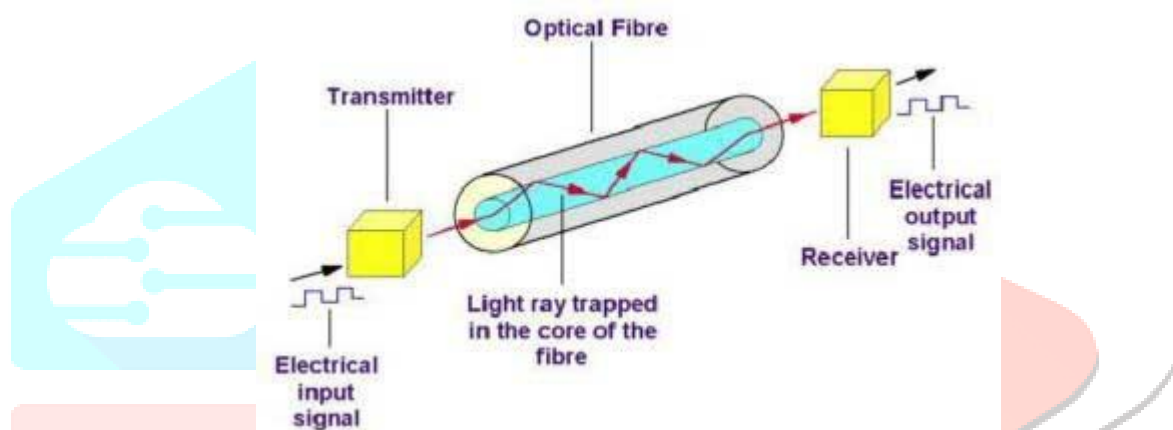
“Figure 7” The four primary components of a fibre optical or cable are,

- Jacket, which protect the fragile fibre within.
- Buffer.
- Cladding, which surround the core with a lower refractive index.
- The core, which carries the light.



“Fig.7”

“Figure 8” These fibres pass as much light when tiny slits are placed directly on top of each other. Hence optical fibres in the concrete act like the slits and carry the light across throughout the concrete.

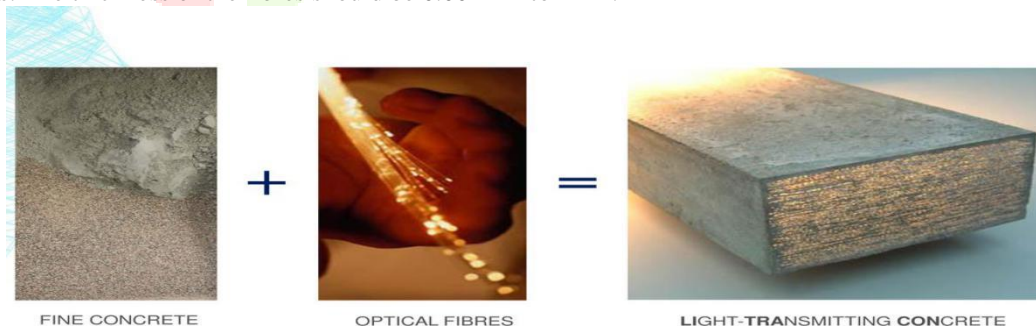


“Fig.8”

## V. MATERIALS AND MANUFACTURING PROCESS

“Figure 9” For the manufacturing of Light Transmitting concrete materials used are as follows:

- Cement/ binder: In case of cement Ordinary Portland Cement(OPC).
- Sand: The size of sand should pass through 1.18mm sieve.
- Water: The quality of water should be potable water.
- Optical fibres: The thickness of the fibres should be 0.002mm to 2mm.



“Fig.9”

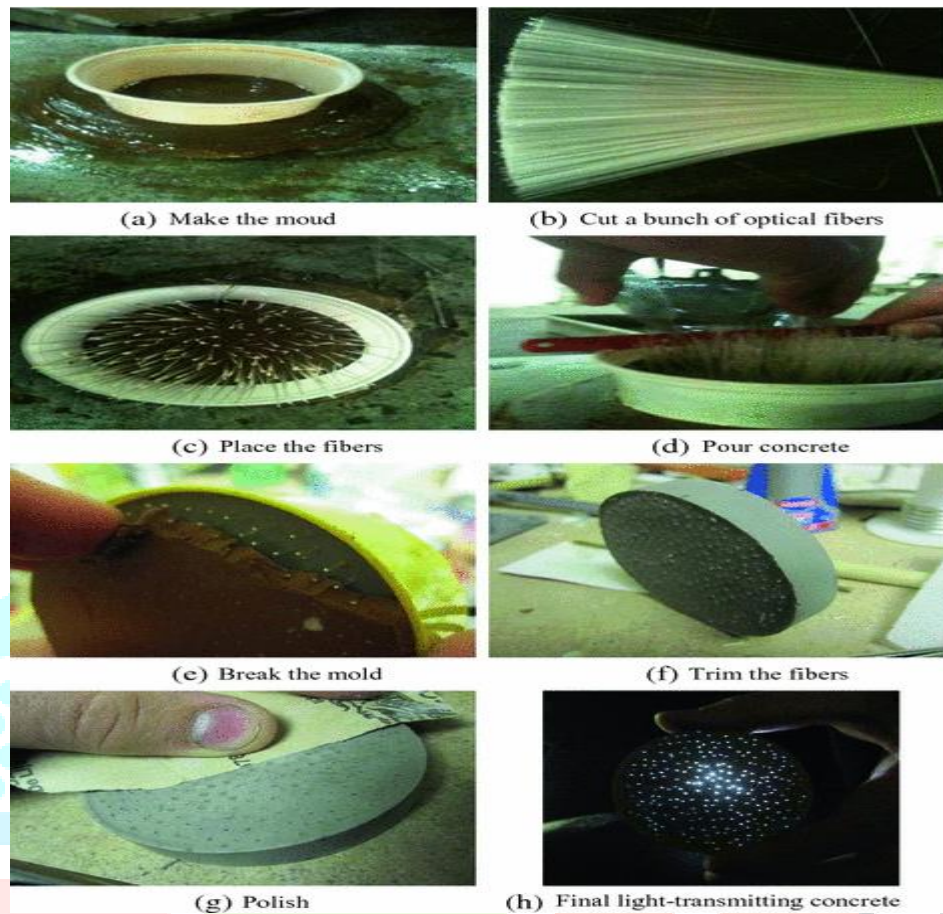
No coarse aggregate is used in this process.

“Figure 10.a” For manufacturing LiTraCon several sequential methodologies are to be taken, so that the product acquires enough qualities.

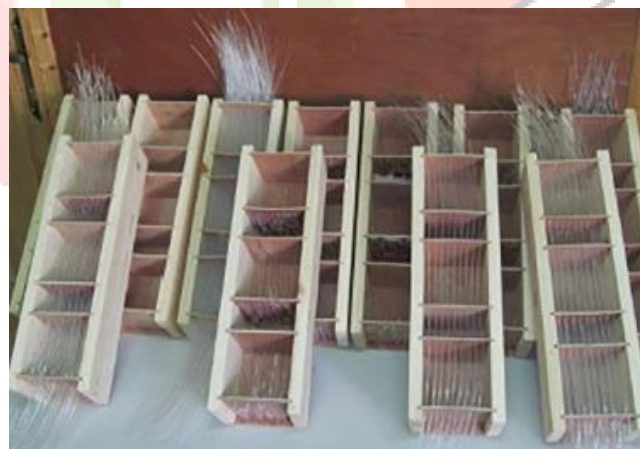
Following are the steps of manufacturing process:

- The selection of materials for concrete from IS: 10262-2009, suitable materials needed to be as per necessary condition.
- Mix proportion, the grade of concrete varies generally in accordance with the changing proportions of its constituent materials. The proportion and the ratio, in which the materials should be mixed together to obtain a certain grade of the concrete, has already been specified by IS: 456- 2000.

- The making of mold for casting LiTraCon. Special molds are made with plywood with holes in the end plates so that optical fibres can be inserted or placed from one end to the other end.
- The placing of optical fibres through the holes properly and tightened at the ends without overstressing it.
- **“Figure 10.b”** The casting of concrete specimens in the mold. De-molding it after 48 hours of casting and keeping for 28 days of curing.



**“Fig.10.a”**



**“ Fig.10.b”**

## VI. APPLICATIONS

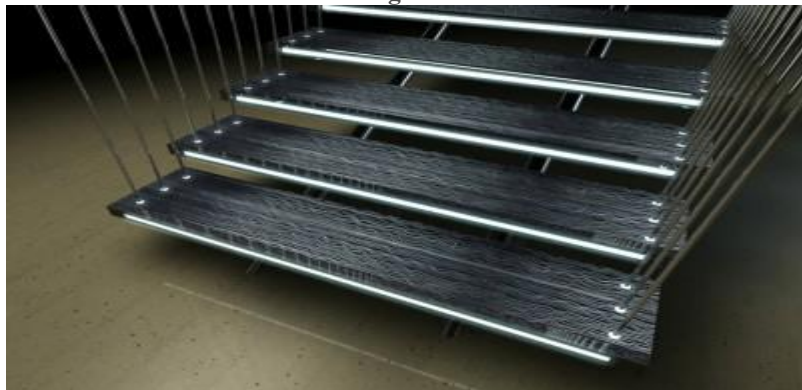
Compared to traditional concrete, the use of light transmitting concrete is not as widespread. **“Figure 11.a”** However, it has been used in a number of fine architectural monuments and buildings as a façade material. **“Figure 11.b”** and **“Figure 11.c”** Light Transmitting concrete blocks are suitable for floorings and pavements, and are also used in staircases and desks. **“Figure 11.d”** Other than that, LiTraCon is used in partition walls, doors, panels, etc., and adds to the beauty of the interior by illuminating the area during day time. **“Figure 11.e”** In addition to lighting up dark places or windowless areas like basements, it is used to construct sidewalks and speed bumps that illuminate at night and provide increased safety for pedestrians and roadside traffic.



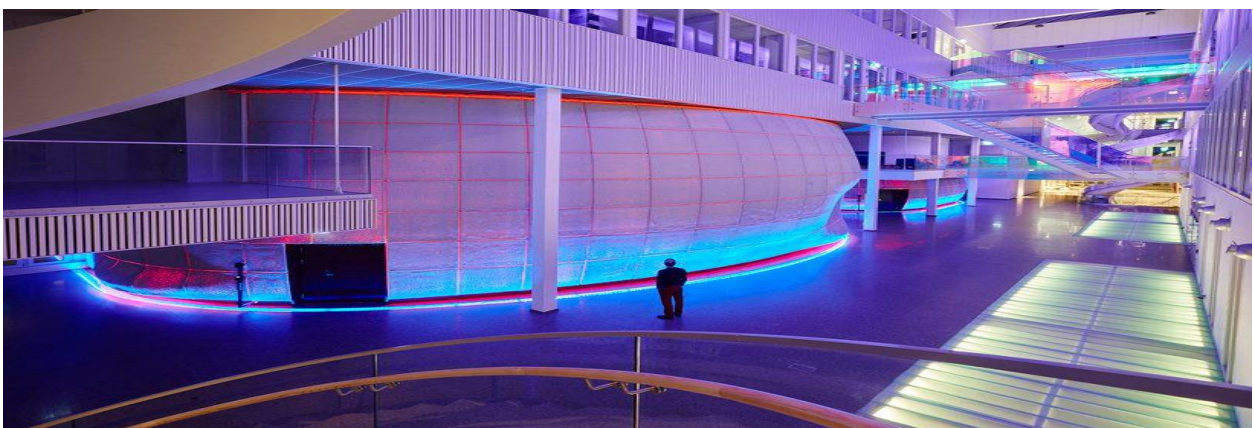
“ Fig.11.a”



“ Fig.11.b”



“ Fig.11.c”



“Fig.11.d”



“Fig.11.e”

“Figure 12” Following are some of the places where LTC is used:

- a) Abu Dhabi, UAE (2015)
- b) Shanghai, China (2010)
- c) Izmir, Turkey (2015)
- d) Berlin, Germany (2014)
- e) Tbilisi, Georgia (2011)
- f) Aachen, Germany (2012)

(a)



(c)



(e)

(b)



(d)



(f)



“Fig.12”

## VII. PROS AND CONS

Light Transmitting concrete gives us light at less cost. Its usability gives good aesthetic view and also saves electricity. It can enlighten the dark where electricity may not reach as easily. Embedding the optical fibres into it creates illumination. If LTC is used in the partition wall then it can brighten both sides of it, reducing the electricity usage. Optical fibres also act as heat insulator, so it can be used in cold countries. Since this concrete is embedded with optical fibre, so it is light weighted than traditional concrete. There is probably no maintenance cost for LiTraCon.

Although this concrete emits enough light, it is less used in this entire world. To produce this concrete skilled labours are required which is unavailable or rarely available. Even the production cost of LiTraCon is high. No less economical method is being found out.

## VIII. CONCLUSIONS AND DISCUSSIONS

We are living in a world, where energy consumption and environmental problem have increased to ultimate level. People are now focusing on “green technology”, new inventions are adapted and pursued by all. Buildings are constructed with artificial light due to closed area. Demands on efficiency makes the researchers thing towards eco-friendly ways. Development and adaptation of different concretes attracts marketing zone. LiTraCon, samely put its effect on people. Construction of buildings and monuments with LTC shows magical effect during non-light hours. In future, LTC may be seen to be used worldwide. Using it in partition walls, panels ,treads of staircase, halls, and other areas of commercial buildings not only increase beauteousness but also saves consumption of electricity. Using LTC in rigid pavements can deduce lots of electricity use. It also can be used as a highlightner on the pavement showing different road features.

But the manufacturing process lends down the growth of market. Need of skilled workers put a barrier in front of production. Availability of the skilled workers at a low rate reduce its rising trend. One more big cause is the economic value. High productivity cost makes constructors to avoid LTC inspite of giving good features. For the upcoming future agenda, researchers need to focus on efficient and economical way for the production of LTC.

This review broadly elaborate about Light Transmitting concrete, concluding with the facts that up gradation in the making process will enhance its uses worldwide. Beyond traditional concrete, it expands the concept of “Green architecture”. Recently, it has been found that a boy in Uttar Pradesh has developed a cheap “transparent concrete” with steel, iron and plastic fibre scraps which will allow the sun rays to filter in. The invention was made by Ramansh Bajpai, a student of the MTech course in civil engineering at the Harcourt Butler Technical University (HBTU) in Kanpur. Apart from it, if we can enhance this concrete by making it to absorb the sunlight energy during the day and illuminate it back during night without any consumption of power. World is escalating, denudation of environment should be ceased, green technology should be enhanced, encouraging sustainable development.

## REFERENCES

- 1) Ismail luhar, Salmabanu Luhar, Pericles Savva, Antreas Theodosiou, Micheal F.Petrou and Demetris Nicolaidis,2021. Light Transmitting Concrete: A Review, Multidisciplinary Digital Publishing Institute(MDPI), 11(480).
- 2) H.B.Valambhiya, T.J.Tuvar and P.V.Rayjada,2017, History and case study on Light Transmitting Concrete, Journal of Emerging Technologies and Innovative Research(JETIR), 4(1).
- 3) Dr.T.Siva Shankar Reddy, Dr.C.Venkata Siva Rama Prasad and Mr.Pavan Kumar Jogi, 2020, An Experimental Investigation on Light Emitting Concrete-Translucent Concrete, Journal of Xi’an University of Architecture & Technology, XII(IV).
- 4) Kavya S, Karthik D and Sivaraja M, 2016, An Experimental Study on Lightemitting Concrete, International Journal of Advanced Research in Education & Technology(IJARET), 3(2).
- 5) Bhrguli Gandhi, 2018, Review on Light Emitting Concrete, International Journal For Technological Research In Engineering, 5(10).
- 6) A Jayaram, S M Gowtham, N Praveen, V Hariharan and M Refak Afrith, 2020, Light Transmittinf Concrete using Eco-Friendly materials(Waste materials), International Journal of ChemTech Research, 13(3): 240)-250.
- 7) Dinesh Babu K, Mercy Shanthi R and Suji D, 2019, Efeect of Fibre Pattern in Strength of Light Transmitting Concrete, International Journal of Recent Technology and Engineering(IJRTE), 7(5S4).
- 8) Avadhut Kulkarni, Nandini Patil, Pragati Desmukh, Swarali Asbe and Nikita Mohite, 2020, Enhancement of Light Intensity By Using Light Transmitting Concrete- A Review, International Journal of Creative Research Thoughts(IJCRT), 8(5).

