
Utilisation of Smart Transparent Concrete Product - A Step towards Green Building Construction

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Abstract

Building energy-saving and safe evaluation for engineering structures have obtained worldwide attention. Transparent concrete is a concrete based building material with light-transmissive properties due to embedded light optical elements, usually optical fibres. Light is conducted numerical aperture Plastic Optical Fibres (POF) or big diameter glass optical fibre into the concrete. The main purpose is to use sunlight as a light source to reduce power consumption 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 translucent concrete and light-transmitting concrete because of its properties. It is used in fine architecture as a facade material and for the cladding of interior walls. Paper discusses the integration of merits of concrete and optical fibre, for developing transparent concrete by arranging the high of illumination and to use the optical fiber to sense the stress of structures. The paper discusses a new kind of building material, which can integrate green energy saving with self-sensing properties of functional materials are important for the construction industry. The evaluation of the effectiveness of the smart, transparent concrete, the light-guiding based on the white light test, long term durability and chloride ion penetration test and self-sensing property based on stress elasto optic effect test are made. The experiment results show that the smart, transparent concrete has good transparency, mechanical and self-sensing properties.

Keywords: - *Transparent concrete, Optical fibre, Architectural, Concrete, Cladding.*

INTRODUCTION

With economic development and technology, more and larger-scale civil engineering structures such as tall buildings, underground buildings, and landmark buildings are built around the world. The Optical fibre sensors such as fibre Bragg Grating, Brillouin distributor sensor and plastic optical fibre sensors have been widely used for the in situ monitoring of major projects (Ou and Zhou, 2003; Anshari, 2007; Wu, 2006; Audi Zquez et al., 2004; Kalymnos, 2005; Kurashima, 1997; Kuang, 2006). New building materials are developed and used in structures, including self-diagnosis

smart concrete, self-tuning smart concrete, self-repairing concrete, soundproof concrete, thermal insulation concrete and so on. This fun was successfully prepared by mixing a 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 the weight of common concrete. The Italian Pavilion in Shanghai Expo 2010 shows a type of transparent concrete developed by mixing glass into concrete in 2010. While the transparent concrete is mainly focused on “transparent” and its application object is the art design.



Figure 1

Optical fibre acts as a base material in the construction and sensing field, which can arrange the sunlight transmit according to the pre-designed road without light – heat, light – electrical or photochemical process, photoelastic effect which can be used to study the stress distribution of structures.

Combining the advantages of concrete and optical fiber, developing a novel functional material has an important value of application for construction.

NEED FOR TRANSPARENT CONCRETE

Civil engineering structures always suffer from external environmental effects, such as fatigue, corrosion and wind load and so on in long term service.

Mechanical property and anticorrosion property of building material in adverse environments are two key facts for the durability of in-service structures, which directly impact the safety of structures.

By the study of the mechanical properties of smart, transparent concrete with different POF volume ratio under mal-condition, the frozen process helps in finding the compressive strength rate of the material.

Properties of transparent concrete

For the smart, transparent concrete, the interfacial bonding of the POF's and concrete is a crucial factor in determining ultimate impermeable properties.

The chloride diffusion coefficient method is used to test the impermeability property of smart, transparent concrete, which can rapidly evaluate the permeability of concrete by mixing the electric energy through concrete.

In this paper, the smart, transparent concrete with 0%, 3% and 6% POF volume ratio is chosen for the test. The electric energy is recorded by the electric flux detector NJW-RCP-6A made in China and cylindrical concrete specimens with 100mm diameter and 50mm height are fabricated from the pre-fabricated smart, transparent concrete by core drilling method.

Moreover, in order to evaluate the interface bonding on the impermeability property, each model of specimen has been divided into two types. One is that the border of POF and concrete is covered by epoxy resin; the other is not covered by epoxy resin.

Table -1 Properties of Transparent Concrete

PRODUCT	LiTraCon
Form	Prefabricated blocks
Ingredients	96% concrete,4% optical fiber
Density	2100-2400kg/sq.mtr
Block size	600mm*300mm
Thickness	25-500mm
Colour	White, gray or black
Fibre distribution	Organic
Finished	Polished
Compressive strength	50 N/sq.mm
Bending tensile strength	7 N/sq.mm

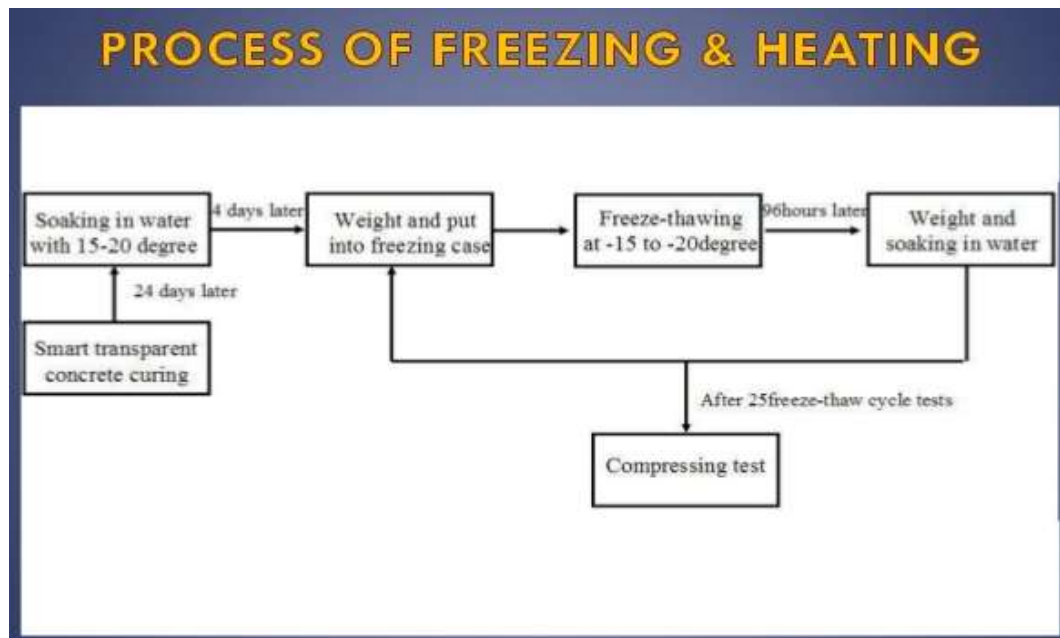


Figure 2

MANUFACTURING PROCESS

The manufacturing process of transparent concrete is almost the same as regular concrete. Only optical fibres are spread throughout the aggregate and cement mix. Small layers of the concrete are poured on top of each other and infused with the fibers and are then connected. Thousands of strands of optical fibers are cast into concrete to transmit light, either natural or

artificial. Light transmitting concrete is produced by adding 4% to 5% optical fibers by volume into the concrete mixture. The concrete mixture is made from fine materials only. It does not contain coarse aggregate. The thickness of the optical fibers can be varied between 2micrometre to 2 millimetres to suit the particular requirements of light transmission.



Figure 3

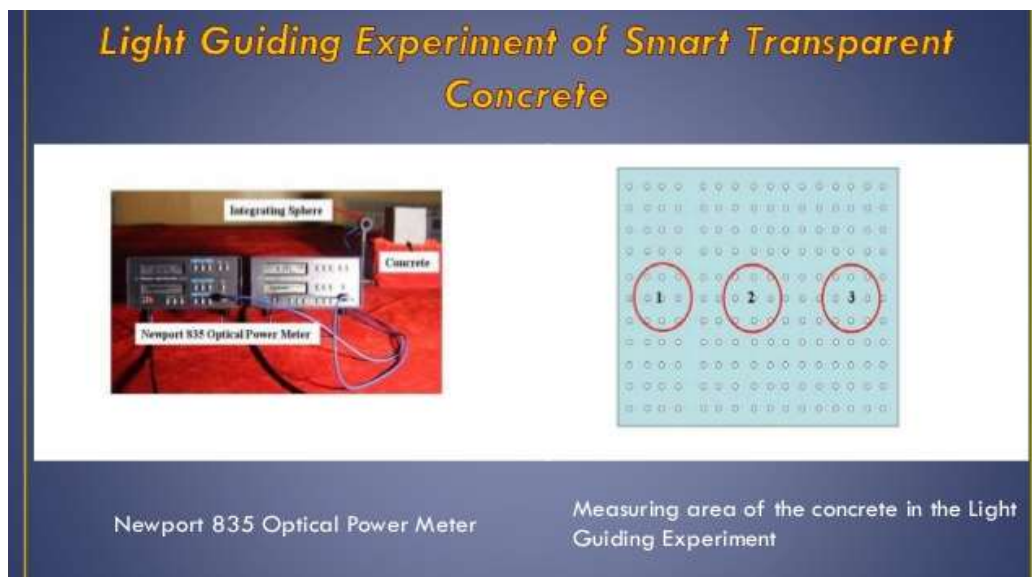


Figure 4

ADVANTAGES AND DISADVANTAGES

- The main advantage of these products is that on a large scale object, the texture is still visible –while the texture of the final translation concrete becomes indistinct at a distance.

- 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.
- It has very good architectural properties for giving a good aesthetical view of the building.

- When light is not able to come properly at that place, transparent concrete can be used.
- Energy saving can be done by utilisation of transparent concrete in the building.
- Totally environment friendly because of its light-transmitting characteristics, so energy consumption can be reduced.
- The main disadvantage is this concrete is very costly because of the optical fibers.
- Casting of transparent concrete block is difficult for labor, so a special skilled person is required.

Applications

- Illuminate your walls.
- Transparent concrete can be used as a building material for interior and exterior walls.
- Watch your payment shine at sunset.
- Get creative with the design.
- Artsy reception desk.
- A lighting fixture and conversational piece.
- In furniture for decorative purposes.
- Light sidewalks at night

- Increasing visibility in dark subway stations.

CONCLUSION

A novel architectural material called transparent concrete can be developed by adding optical fiber or large diameter glass fiber in the concrete mixture. The transparent concrete has good light-transmitting properties and the ratio of optical fiber volume to concrete is in proportion to transmission. The transparent concrete does not lose the strength parameter when compared to regular concrete. And also, it has a vital property for the aesthetical point of view.

It can be used for the best architectural appearance of the building and also used where the light cannot reach with approximate intensity. This new kind of building material can integrate the concept of green energy saving with the usage of self-sensing properties of functional materials. One can conclude that transparent concrete is a positive step towards making of Greenhouse. It also helps in improving the LED score rating of a building.



Figure 5

REFERENCES

- I. D.D.L Chung cement reinforced with short carbon fibers; composites: part B.31:511-526, 2000.
- II. 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.
- III. H.Li,HG Xiao,JP Ou. Microstructure of cement mortar with Nano particles.35:185-189, 2004.
- IV. Jianping He, Zhi Zhou, Jinping Ou, Minghua Huang, “Study on small transparent concrete product and its performances’’, Dalian, China, 2011.
- V. Kalymnios, D. Plastic optical fibers in sensing – current status and prospects.17th international conference on optical fiber sensors SPIE,5855,2005.
- VI. K.S.C. Kuang, M.Maalej, S.T.Quok. Hybrid optical fiber sensor system based on fiber Bragg gratings and plastic optical fibers for health monitoring of engineering structures. Proc of SPIE, 6174(61742P):1-12, 2006.

- VII. Scherafe, T."FABRIC STRUCTURE OUTSPACE APPLICATIONS: Recent structural development expand the range of fabric options", building design and construction, pp.128-138, 1988.
- VIII. Victoria Bailey, "Translucent Concrete," MEEN 3344-001.
- IX. Z.Zhou, J.P.Ou and B Wang. Smart FRP-OFGB Bars and their applications in reinforced concrete beams. Proceedings of the first international conference on structural health monitoring and intelligence structure, Japan 861-8