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Optical Fibres in the Modeling of Translucent Concrete Blocks

M.N.V.Padma Bhushan, D.Johnson, Md. Afzal Basheer Pasha And Ms. K. Prasanthi

*Student of B.Tech. in Civil Engineering; K L University, Green Fields, Vaddeswaram, Guntur District, A.P., INDIA.
**Student of B.Tech. in Civil Engineering, K L University, Green Fields, Vaddeswaram, Guntur District, A.P., INDIA.
***Student of B.Tech. in Civil Engineering, K L University, Green Fields, Vaddeswaram, Guntur District, A.P., INDIA. 522 502
***M.Tech. in Civil Engineering Asst.Prof.,Dept. of Civil Engineering, K L University, Green Fields, Vaddeswaram, Guntur District, A.P., INDIA.

Abstract:

Translucent concrete is a concrete based material with light-transmissive properties, obtained due to embedded light optical elements like Optical fibers in it. Light is conducted through the stone from one end to the other. This results into a certain light pattern on the other surface, depending on the fibre structure. Optical fibres transmit light so effectively that there is virtually no loss of light conducted through the fibres. Our paper deals with the modelling of such translucent or transparent concrete blocks and their usage and also the advantages it brings in the field of smart construction.

Keywords: Translucent concrete, optical fibre, energy saving, smart construction.

1. Introduction:

Engineering has come a long way in the field of construction. Some say it's the science of civilisation. With rise in population like this, when the 7 billionth baby has been celebrated with joy, there is a need for smart construction and wise economical substitutes. Especially keeping in mind the rising pollution levels and also dipping economy, and due to rapid urbanisation, most of the big buildings are built close to each other, all in the same areas, like sky scrapers. 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. Translucent concrete comes in as a blessing solution for easier day lighting. Example, when a room is built with translucent concrete on its two walls, it saves a lot of energy in the form of lighting as well as used as indoor thermal systems in cold cities.
Now, these translucent concrete walls are actually made from optical fibres infused in them. How, is what this paper deals with. 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 lights.

2. Construction of Concrete Blocks using Optical Fibres

The first step is to make a mould for the prototype block using tin. The tin is made into a mould of the desired shape, like a cuboid here for example, with the top end open. For the case of demonstration, many holes are punched on the opposite walls of the cuboid. The optical fibres have to be run through these holes from one end to the other and then concrete is made to set in it with the fibres inside. What happens here is that the light falling on one side of the block gets transferred to the other side through these many optical fibres running from one end to the other.

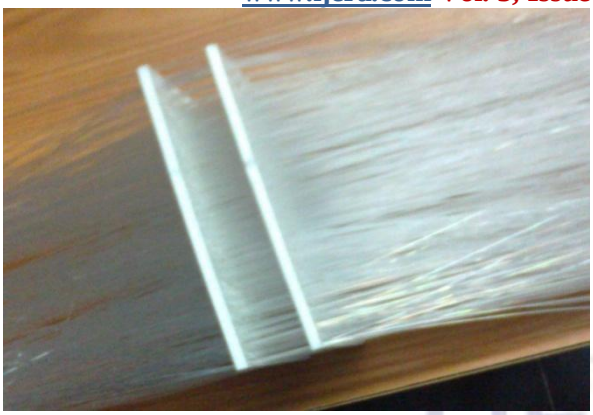
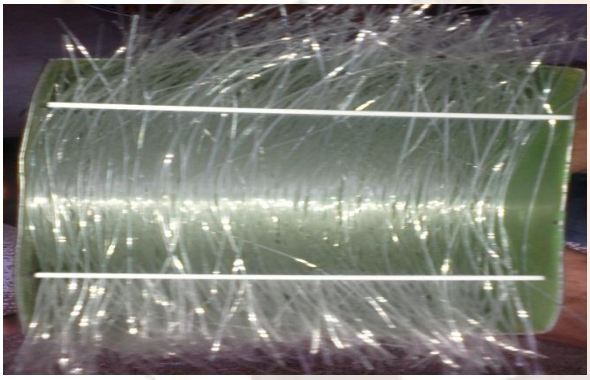


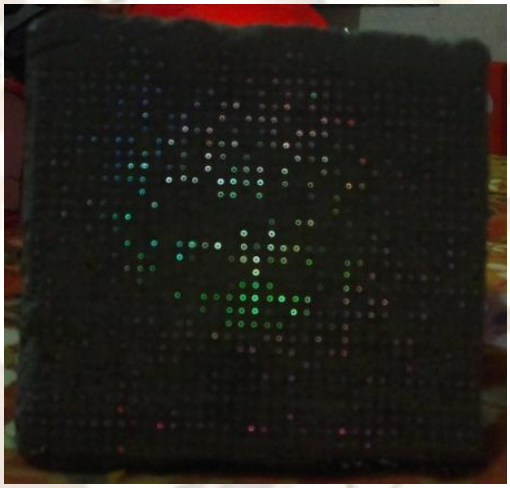
Image 2.1 and 2.2 : Optical Fibres running through 2 perforated sheetings.

This is the trickiest part of the construction, passing each thin fibre through the tiny holes of one perforated sheet to another one. This is also an integral part of the process as the whole ideal of transparency comes from these fibres. The light is transferred from one end to another end through these, as mentioned earlier. So much care has been taking in this process. The next step is to cast the mortar over these fibres placed in the tin mould as shown in the figure.



Figures 2.3 and 2.4 showing the setup of the block before concrete being poured in and after.

The concrete then undergoes a curing process. The excess fibres running out of the block are cut off and slightly polished. The modelling of transparent concrete block is complete.



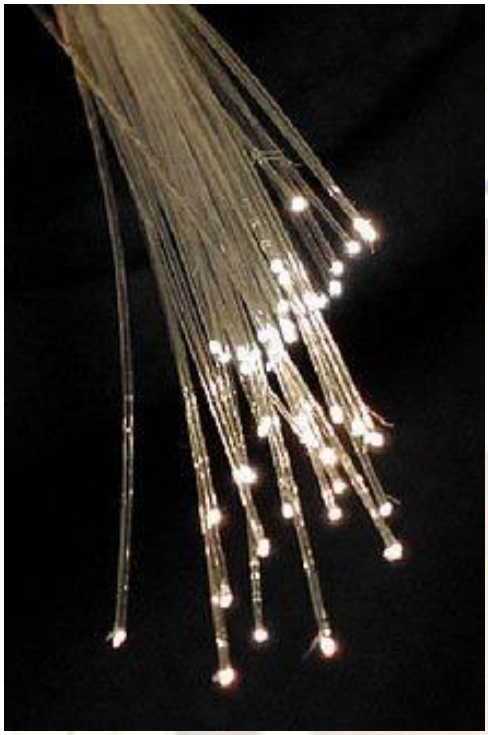
Images 2.4 and 2.5 showing the passage of light from behind the cube to the front.

Usually, large chunks of blocks are made on a large scale and cemented together to form a wall or a desk or any other desired shape. Depending upon the light, the image formed is either a blurry shadow or a dull colour. It cannot be a full reflection like a glass because it's only a combination of many optical fibres together projecting an image.

3. Advantages of Optical Fibres:

Optical fibres are used in a large number fields in modern times, ranging from minor electrical instruments in computers to remote sensing. Developed in the 1970s, these were initially intended for communication purposes (telecommunications industry). One definition states that, Fibre Optic communication is a method of

transmitting information from one place to another by sending pulses of light through an optical fibre.
Plastic optical fibres are the ones used in this research.
There are a few types of optical fibres, each with a certain property like metal free, high fibre count, etc. They have certain advantages over other materials like glass.



Images 3.1 and 3.2 showing optical fibres illuminated. (from online)

More pliable: POF (plastic optical fibres) possesses this ability to bend in different shapes. Their bending radius is very less. They are more resilient to damage and abuse than glass due to its intrinsic material characteristics
Cutting, wiring, bonding, connecting and other processes are easier.
Do not produce radiation and are completely immune to radio magnetic interference and radio frequency interference and noise.
By far, this is the best replacement for glass, being much stronger, and giving more privacy.

4. Usage of Translucent Concrete Blocks:

Translucent concrete blocks inserted on front doors or walls next to it allow the residents to see when there is a person standing outside.
Translucent concrete walls on restaurants, clubs, and other social establishments help see how many people are actually inside it.
Ceilings of large corporate buildings with translucent concrete would help reduce a great deal of lighting costs during day time.
Speed bumps in parking lots and highways can use translucent concrete blocks with a light source beneath or reflecting from other vehicles/sources help in navigation very effectively. Even lane markers in highways can use this material to light up the roads.
Sidewalks with translucent concrete fitted with a single light source beneath would add a lot to the scenic beauty as well as safety and also encourage walking or foot travel during night times.
Translucent concrete blocks incorporated in staircases and inner walls help during times of power cuts at night leading to a great deal of safety.
Similarly for subways and airports etc., this translucent concrete blocks would add to the visibility.
Translucent concrete blocks can be made in desired shapes and used as decorative materials like bookshelves and sunshades, tables and statues.
They can also be placed as random designs on security walls which also enhance security giving the resident a hazy view of the perimeter.
Lamps using translucent concrete blocks with a light source would add a great deal of aesthetic look
Places like schools, museums and prison cells outer walls can find translucent walls very useful as they add safety as well as security and supervision.

A Few Major Examples

Translucent concrete is a pretty rare sight. Not many people have a particular idea about this nor its applications and advantages.
The largest project exhibiting this technology is an artistic installation, called the ’European Gate´ (2004) which was designed to mark the celebration of Hungary joining the European Union (EU). Located at the public entrance of Fortress Monostor in the Hungarian town of Komarom, this is one of the most impressive pieces of art conjugating visual lighting display as well as artistic using translucent concrete.

Image 4.1 showing the European Gate at Komarom in Hungary.

One of the first projects to be ever made in a major way is this road during the day the blocks appear as concrete pavement, but at sunset they start to shine thanks to the light sources placed under then. A ringed light pattern took shape around the main square as dark came.

Image 4.2 showing the illuminated road incorporated with translucent concrete underneath it.

Image 4.3 showing the entrance gate of Luccon, a translucent concrete company in Austria.

More of the uses or applications include partitions or partition walls in office cabins or in houses, and attractive furniture, and intelligent light fixtures, lighting in dark subway stations

5. Advantages of Translucent Concrete Blocks/Walls

Natural sunlight is the best source for light which is actually free of cost. With translucent concrete walls in a room, it'd be brightly illuminated with natural sunlight. It's a requirement for green buildings; therefore it's a very good advantage for them.

These optical fibers also work as heat insulators, so they'll be very effective in cold countries, thereby reducing energy and saving lots of money in both the cases.

As mentioned above, translucent concrete can help add a great deal of security and supervision in places like schools, museums and prisons etc, where the presence of the people and their actions are seen but not their entire image, thereby protecting their privacy as well.

Aesthetically pleasing is the term one gets in mind on looking at a structure that incorporates translucent concrete. Even a simple rectangular block of translucent concrete makes the whole place look so good and attractive.

Summing a few of the above, it is apparent that translucent concrete is a great tool in saving electricity and money as well.

Its stronger than glass and possesses almost the same characteristic strengths of normal concrete blocks, therefore is a better replacement to it.

6. Other Properties of Translucent concrete

There aren't many manufacturers of translucent concrete. There are very few of them, namely LitraCon, Lucon and Lucem Lichbeton. The costing of this, according to Litracon is $\$1000/m^2$ for 25mm thickness. The LitraCube lamp which is hollow cube of four interlocking panels, costs 595 euros. It is quite expensive, as it is pretty rare. But it is totally worth the cost.

On the performance side, it's simply a concrete embedded with optical fibers running in a matrix while still retaining the strength of concrete. Therefore it still retains the high density top layer.
It is also frost and de-icing salt resistant, making it highly recommendable in cold countries.
Similarly, it is under fire protection classification A2 and provides very high UV resistance

7. Conclusion and Remarks

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. That doesn't stop high class architects from using it. It's a great sign of attraction and artistic evolution. Any structure with a small hint of translucent concrete is bound to make heads turn and make them stand in awe.

Apart from the beauty aspects, there's also this security and supervision. Large houses, with big security walls are often low on security. That's why they are mostly fitted with electrocuted fencing. If those outer walls were fitted with translucent concrete blocks, the owner would know right away if there was anybody trying to climb the wall as he/she can visibly see it. Prison guards would know very easily if any of the inmates were trying to escape or if any of them are fighting. The same can be case for schools and colleges too as well as museums and other places.

Green buildings would get an easy accreditation under daylight savings with this. Large and tall office buildings can share the lighting when the ceilings are translucent. Energy savings as well as heat insulation simple adds to the list of its amazing properties. Translucent concrete is the future. It is the smart way of optimising and utilising light, a smart way of living.

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