Translucent light weight concrete blocks for Green buildings

Achanya Shaji[1] , Pooja Menon J[2], Tharun S C[3], Varghese Mathew[4] ,Praveen Mathew[5]

[1,2,3,4,5] *Mar Athanasius college of Engineering, Kothamangalam*

***

Abstract - *Translucent concrete is an upcoming innovation in construction engineering. Translucent concrete allows light to pass through it, with the presence of optical fibers embedded in the concrete. The principal objective of this project is to design light weight translucent concrete blocks with the use of plastic optical fibers and aluminium powder to generate form in cement mortar. Compression strength test and light transmitting test were conducted on concrete block to ascertain the practical utility of using translucent concrete as a building material for green building development.*

Key Words: Concrete, Translucent, Light weight.

1. INTRODUCTION

Translucent lightweight Concrete is a new material with various applications in the construction field, aesthetics and even for furniture. As can be imagined, concrete with the characteristic of being translucent will permit a better interaction between the structure and its environment, thereby creating ambient situations that are better and more natural.

Translucent concrete was developed as a light weight concrete block with random air-voids generated by mixing of foam agents in cement mortar. Foamed concrete is recognized for its high flow ability, low cement content, low aggregate usage, and excellent thermal insulation. Furthermore, the foamed concrete is considered as an economical solution in fabrication of large scale lightweight construction materials but due to its low compressive strength it is not used for structural members.

1.1 SCOPE OF THE WORK

Translucent concrete is also a great insulating material that protects against outdoor extreme temperatures while also letting in daylight .This makes it an excellent compromise for buildings in harsh climates, where it can shut out heat or cold without shutting the building off from daylight[5]. It can be used to illuminate underground buildings and structures, such as subway stations. The possibilities for translucent concrete are innumerable; the more it is used, the more new uses will be discovered. In the next few years, as engineers further explore this exciting new material, it is sure to be employed in a variety of interesting ways that will change the opacity of architecture as we know it.

2. MATERIALS USED

2.1 Ordinary Portland cement (OPC)

In this study Ordinary Portland Cement-Grade 53, which is known for its rich quality and high durability is used. It will helps to fill the voids and gives density to the concrete. It is used for constructing bigger structures like building foundations, bridges, tall buildings, and structures design to withstand heavy pressure. As such, Ordinary Portland Cement is used for quite a wide range of applications in pre-stressed concrete, durable pre-cast concrete, and ready mixes for general purposes.

2.2 Fine Aggregate

The influence of fine aggregates on the fresh properties of the concrete is significantly greater than that of coarse aggregate. The high volume of paste in concrete mixes helps to reduce the internal friction between the sand particles but a good grain size distribution is still very important. Fine aggregates can be natural or manufactured. The grading must be uniform throughout the work and must pass through 2.36 mm sieve size which confirms to the code IS: 383 – 1970. Particles smaller than 0.125 mm size are considered as fines which contribute to the powder content.

2.3 Optical fibers

0.75mm Diameter plastic optical fiber Strands are used for construction of translucent concrete. Plastic optical fiber is an optical fiber that is made out of polymer . Similar to glass optical fiber, POF transmits light (for illumination or data) through the core of the fiber. Its chief advantage over the glass product, other aspect being equal, is its robustness under bending and stretching. PMMA and Polystyrene are used as the core, with refractive indices of 1.49 and 1.59 respectively. Generally, fiber cladding is made of silicone resin (refractive index ~1.46). High refractive index difference is maintained between core and cladding.

2.4 Water

Water is the key ingredient, which when mixed with the cement, forms a paste that binds the aggregate together. Potable water available in laboratory was used for casting all the specimens. The quality of water was found to satisfy the requirements of IS: 456-2000

2.5 Aluminium powder

Aluminium powder is used as foaming agent.It is of fine uniform smooth metallic powder free from aggregate. Chemical composition is shown in table 1

Table -1: Composition of chemicals in aluminium powder

COMPOUNDS	COMPOSITION
Assay	99.50
Arsenic	.0005
Lead	.03
Iron	.5

3. EXPERIMENTAL PROGRAMME

3.1 Preparation of mould

In the process of making light transmitting concrete, the first step involved is preparation of mould. The mould required for the prototype can be made with different materials which can be of either tin or wood. In the mould preparation, it is important to fix the basic dimensions of mould. The standard size of building block used is 30cm x 20cmx l5cm.The diameter of the holes and number of holes mainly depends on percentage of fiber used. Holes of size 3mm were drilled at 2cm spacing both horizontally and vertically.

Fig -1: Opticals fibers arranged in the mould

3.2 Manufacturing process

The manufacturing process of translucent concrete is almost same as regular concrete. Optical fibers are arranged at 2cm spacing throughout the mould. The ratio of cement to fine aggregate was fixed as 1:1.5 with a water – cement ratio of 0.45 after a series of trials ,the first stage deals with the determination of optimum percentage of foaming agent by weight to be added to mortar with cement sand ratio 1:1.5. Foamed concrete mixes were prepared with 0%, .5%, 1.5%, 2%, of foaming agent by weight of cement. The optimum percentage of aluminium powder is determined based on density and compressive strength obtained from different percentage of foaming agent. The optimum percentage was chosen as 2% with desired strength and density.

The concrete are poured into the mould provided with strands of optical fibers to transmit light, either naturally or artificially. The concrete mixture was prepared using fine aggregate and cement without any coarse aggregate. Thickness of the optical fibers can be varied between 2 μm and 2 mm to suit the particular requirements of light transmission. Here we used fibres of 0.75mm diameter. After casting, the blocks were cured for 28 days and then polished by grinding the surface, resulting in smooth finishes.

4. TESTS CONDUCTED

4.1 Compression 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 blocks after 28 days of curing ,were dried and then direct loading was applied perpendicular to the axis of optical fibres in the compression testing machine . Compressive strength = load/area

4.2 Light transmitting test

The light transmittance through the block was measured using a lux meter. Lux meter is a simple light meter for measuring illuminances by using a light sensor .A black box of size 1m x 0.6m x 0.6m with an opening of size 30cm x 20cm to properly accommodate the block was made. The lux meter was placed opposite to the opening . The intensity of light entering the black room through the opening and also when the block was placed in the opening was measured The box was rotated in all directions and the readings were noted.

5. RESULTS AND DISCUSSION

Compressive strength test results:

The compressive strength and density for concrete cube with the varying percentage of aluminium powder is tabulated in table 2.

Table-2: Density and compressive strength with the variation in percentageof aluminium powder for cubes.

Percentage of Aluminium powder	Wet density (kg/m^3)	Dry density (kg/m^3)	Compressive strength at 28 days (N/mm^2)
0%	2145	2028	33.35
0.5%	1855	1705	12.38
1.5%	1804	1682	10.25
1.5%	1753	1727	9.01
2%	1698	1570	8.02

It is found that the compressive strength decreases with increasing percentage of aluminium powder, though the density decreases. The compressive strength falls steeply when the percentage of aluminium powder is further increased. Therefore to satisfy the strength parameters the optimum percentage was taken as 2%.

The compressive test result of the finished blocks is tabulated in table 3.

Table-3: Density and compressive strength of block

Concrete Block ID	Wet density (kg/m^3)	Dry density (kg/m^3)	Compressive strength at 28 days (N/mm^2)
1	1611	1561	3.48
2	1683	1633	3.65
3	1711	1661	3.70

Light transmission test results:

The intensity of light transmitted through the block were measured along all directions and is tabulated in table 4.

Table-4: Light intensity along different directions of box **openings.**

Directions	Light intensity (lux)		
	Morning	Afternoon	Evening
EAST	80	30	60
WEST	58	24	84
SOUTH	37	19	35
NORTH	25	18	25

Light transmissive test were conducted in all directions .It is found that the block could illuminate the black room. The maximum light was transmitted when the block face the east direction. It had a maximum light transmittane of 3%.

6. CONCLUSION

• Light transmittance could be achieved by using plastic optical fibers. This can be used efficiently in green buildings to reduce power consumption offering sustainability. It can ensure natural light inside the buildings throughout the day.

•Compressive strength of blocks were found to satisfy the codal provisions.

• The weight of the concrete block was successfully reduced the by the addition of Aluminium powder without compromising the strength.

• Light transmitting concrete can be used in structures to make them aesthetically beautiful with the added advantage of reducing power consumption and protecting privacy.

• Currently, the cost of manufacture of light transmitting concrete is high due to the usage of plastic optical fibers and the effort in laying it ,but this will be offset by the host of advantages it posses.

ACKNOWLEDGEMENT

First and foremost we take immense pleasure in thanking the Management and respected Principal ,Dr. Soosan George T , for providing us with the wide facilities and words are inadequate in offering our thanks to Professor Praveen Mathew, Department of Civil Engineering, for his encouragement and guidance .
Above all we would like to thank the Almighty God for his blessings that helped us to complete this venture smoothly.

REFERENCES

1.Soumyajit Paul, Avik Dutta "Translucent Concrete", International Journal of Scientific and Research Publications, Volume 3, Issue 10, 2013, pp.

2. Shanmugavadivu, P., Scinduja, V., Sarathivelan, T. & Shudhesamithronn, C., "An Experimental Study of Light Transmitting Concrete," *IJRET*, vol. 3, no. 11, 2014.

3. R. Pradheepa,S. Krishnamoorthi"An Experimental Study on Translucent Concrete", International Journal for Scientific Research & Development, Vol. 3, Issue 03, 2015, pp. 174-177
4. Saber Rahimi "Investigating the Use of Fiber Optic Sensors in Ferro concrete Structures", Technical Journal of Engineering and Applied Sciences, 2013, pp. 2796-2798

5. Nikhil K , Ummer Farook NK , Silal Ahmed KS , Juraige MK , Rameesa Saleem , Shabeeba Omar, Experimental Analysis of Translucent Concrete by using Optical Fibers" SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 3 Issue 3–March 2016