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"AN EXPERIMENTAL WORK ON LIGHT RANSMITTING CONCRETE"

Comparison of Compressive Strength In Between Normal Mix Concrete And Concrete Embedded With Plactic Optical Fiber

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Abstract — Smart Light transmitting concrete is a concrete based building material with its transparent and smart sensing properties through embedding light optical elements such as Optical fibers. Due to "green" requirements and safe evaluation for engineering structures have obtained the worldwide attention, in this experiment development of Smart light transmitting concrete based on its excellent properties of transparent and smart sensing. By dealing with its usage and also the advantages it brings in the field of smart construction, we find that it can reduce the power consumption of illumination and use the optical fiber to sense the stress of structures and also use this concrete as an architectural purpose for good aesthetical view of the building.

The work presented in this project reports an investigation on the behavior of concrete and mortar with optical fiber. A total of 45 concrete and mortar cube will be casted to study the effect of concrete and mortar with optical fiber and to compare the compressive strength between normal mix concrete to normal mix concrete with optical fiber and normal mortar to normal mortar with optical fiber after 7 days, 14 days and 28 days respectively.

Keywords - Smart transparent concrete, optical fiber, energy saving, smart sensing, architectural.

I. INTRODUCTION

With the economic growth and science technology development, more and more large-scale civil engineering structures such as tall buildings, underground buildings and landmark buildings and so on are built around the world. Those buildings are isolated biosphere only based on man-made lights to maintain people's optical activities. At the same time, 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. Translucent concrete comes in as a blessing solution for easier day lighting. By arranging the high numerical aperture Plastic Optical Fibers (POF) or big diameter glass optical fiber into concrete, Optical fibers transmit light so effectively that there is virtually no loss of light conducted through the fibers.

Due to Optical fibres' outstanding light guiding and sensing advantages, such as anti-electromagnetic interference capability, small dimensions, distributed measurement and anti-corrosion characteristics, optical fibres have been widely adopted in the communication and

sensing fields. Hungarian architect, Aron Losonczi, first introduced the idea of light transmitting concrete in 2001 and then successfully produced the first transparent concrete block in 2003, named LiTraCon, shown as figure 1. However, his transparent concrete did not have smart sensing properties In 2009, Professor Zhi Zhou introduced a smart transparent concrete-novel construction material was manufactured with POF and FBG (Fibre Bragg Grating) by drilling through the cement and mortar in order to utilize the light guiding ability of POF and the sensing properties of FBG respectively, shown as figure 2. The smart transparent concrete not only reduced the power consumption of illumination but also hade detection of potential internal deformation of the concrete. In 2010, Italian Pavilion in Shanghai Expo 2010 shows a kind of transparent concrete developed by mixing glass into concrete, the transparent concrete showed its application of good aesthetical view of the building. In 2013, Alejandro Fastag achieved a translucent product of embedding the cylinders. The use of architectural precast concrete components with translucent capacity has transformed the buildings appearance, making the interior areas feel light and airy.

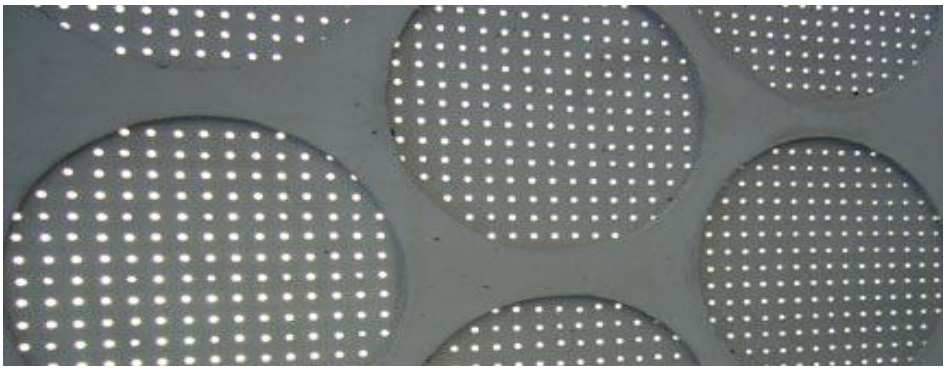


Figure:1 - Picture of LiTraCon

Figure:2 - Transparent demonstration of smart transparent concrete

II. MATERIAL SPECIFICATION

Table:1 - Material specification of concrete with POF diameter 3.5mm

SR. NO.	Material	Specifications
1.	Cement	53 Grade
2.	Aggregates	10 mm Down Size
3.	Sand	2.36 mm Sieve Passing
4.	Concrete	1.0 : 1.5 : 3.0
5.	W/C Ratio	0.5
6	Optical fiber	2.1% 49(holes)

Table:2 - Material specification of concrete with POF diameter 2.5mm

SR. NO.	Material	Specifications
1.	Cement	53 Grade
2.	Aggregates	4.76 mm Down Size
3.	Sand	2.36 mm Sieve Passing
4.	Concrete	1.0 : 1.5 : 3.0
5.	W/C Ratio	0.5
6.	Optical fiber	1.39% 64(holes)

Table:3 - Material specification of Mortar with POF diameter 0.5mm

SI. NO.	Material	Specifications
1.	Cement	53 Grade
2.	Aggregates	4.76 mm Down Size
3.	Sand	2.36 mm Sieve Passing
4.	Concrete	1.0: 3.0
5.	W/C Ratio	0.5
6.	Optical fiber	0.2% 200(holes)

Table:4 - Specimen dimension

SR.NO	Material	Specifications
1.	Cube size	150 × 150 × 150 mm
2.	Panel size	300 × 300 × 45 mm
3.	Volume of cement bag	0.035 m^3
4	Dry density of sand	1791 kg/ m^3
5	Dry density of aggregate	1340 kg/ m^3

Table:5 - Total quantity

SR.NO	specification	No. of block	Cement (kg)	Sand (kg)	Aggregate (kg)
1	Concrete M20	27	36.18	66.83	105.57
2	Mortar M (1:3)	18	33.12	124.92	-
	Total	45	69.30	191.75	105.57

III. MANUFACTURING PROCESS

Step 1:- To prepare mould size of 150 × 150 × 150 mm cube and panel size of 300 × 300 × 45 mm. The mould is made up of two steel faces and two plywood faces with a steel base plate. The two faces of plywood are drilled at a uniform spacing to hold the plastic optical fibre in place during casting concrete into the mould as shown in Figure-3. All the side faces, two of drilled plywood and the remaining two of steel plates, are bolted down to a steel base plate. The two drilled plywood faces are placed opposite to each other so as to orient the plastic optical fiber in a single direction. The plastic optical fiber are cut into sufficient length and placed individually through the holes in the two plywood sides facing opposite to each other.

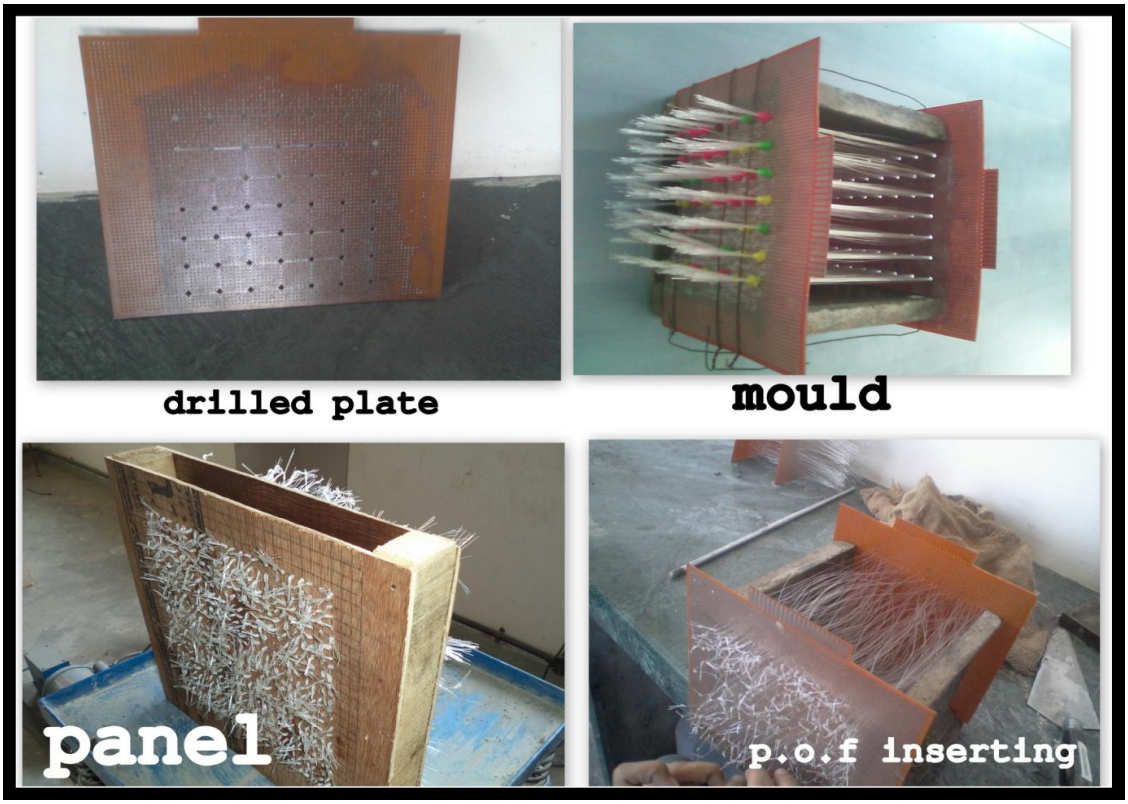


Figure:3 - Preparation of Mould

Step 2: Now the concrete is prepared and poured into the mould. The mould is agitated with the help of mechanical vibrator so as to avoid improper filling and void formation.

Figure:4 - Casting Of Mould

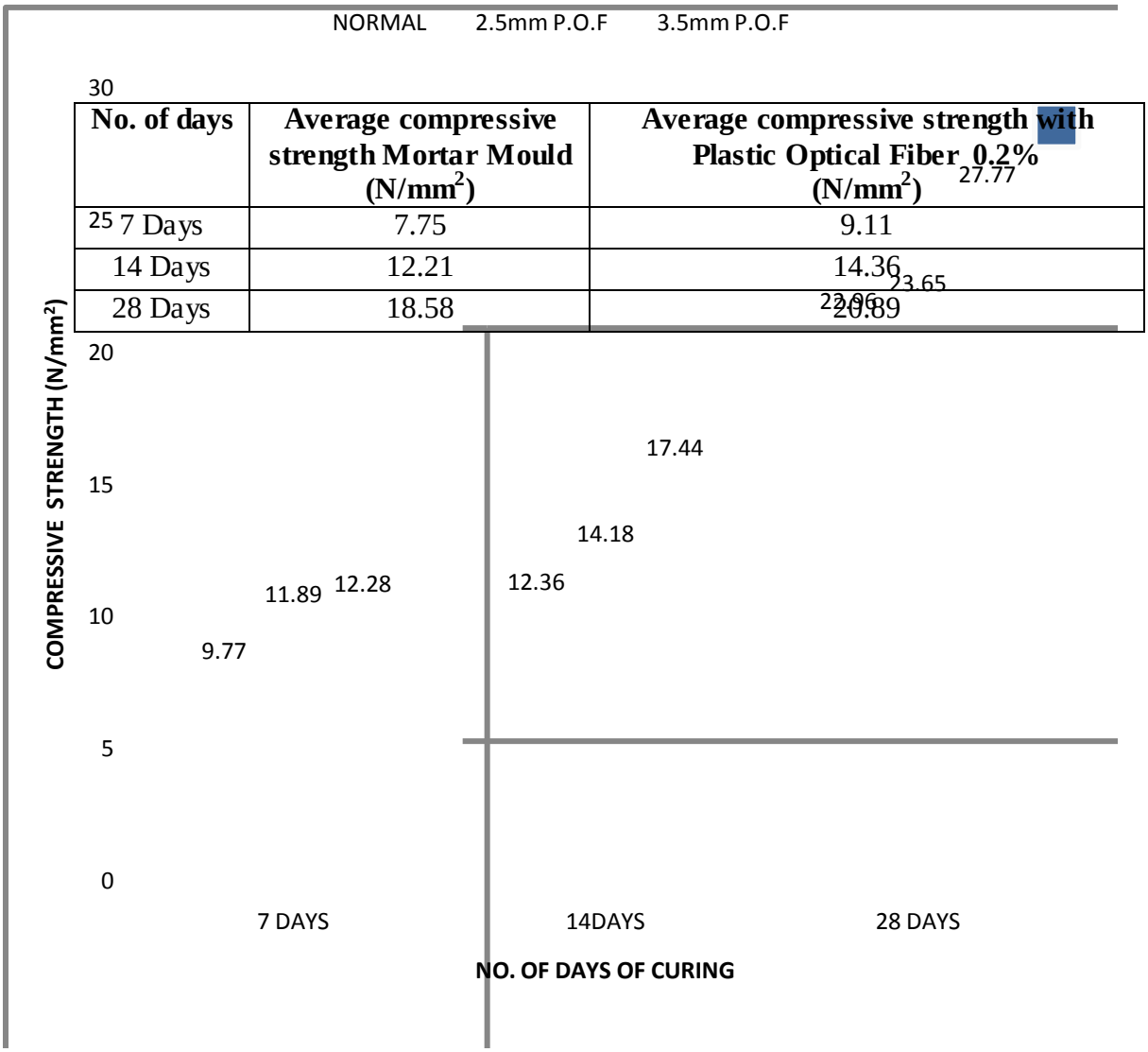
STEP 3 - The sample is then allowed to harden for 24 hours and then the mould is removed and the sample is kept for curing

Figure:5 - Light Transmitting Concrete Block

IV. RESULT AND SUMMARY

Table:6 - Results of Normal Concrete and Concrete with P.O.F

No. of days	Average compressive strength Normal Mix concrete (N/mm^2)	Average compressive strength with Plastic Optical Fiber 1.39% (N/mm^2)	Average compressive strength with Plastic Optical Fiber 2.1% (N/mm^2)
7 Days	9.77	11.89	12.28
14 Days	12.36	14.18	17.44
28 Days	22.96	23.65	27.77



No. of days	Average compressive strength Mortar Mould (N/mm^2)	Average compressive strength with Plastic Optical Fiber 0.2% (N/mm^2)
7 Days	7.75	9.11
14 Days	12.21	14.36
28 Days	18.58	20.89

Figure:6 – Graph of Compressive Strength Testing of Concrete Mould

Table:7 - Results of Normal Mortar and Mortar with P.O.F

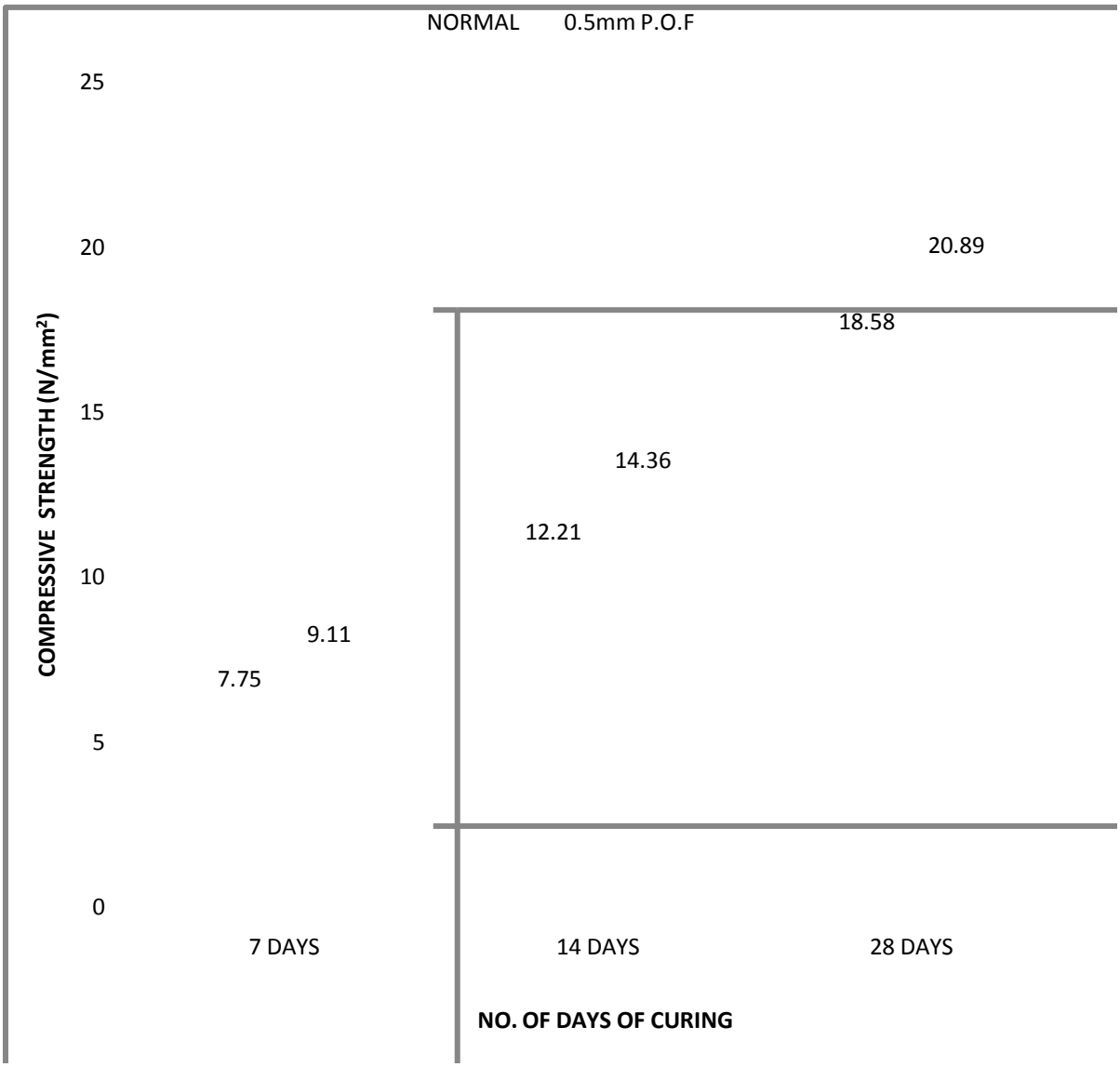


Figure:7 – Graph of Compressive Strength Testing of Mortar Mould

CONCLUSION

After the experimental work done the following conclusion are made:

1. After 28 days the compressive strength of the normal mix concrete is 22.96 N/mm^2 and 3.5mm diameter plastic optical fiber the compressive strength is 27.77 N/mm^2. From the results it is clear that the compressive strength of concrete with plastic optical fiber is more compare to normal concrete. The compressive strength increases with increase the diameter of optical fiber.
2. The transparent concrete has good light guiding property and the ratio of optical fibre volume to concrete is proportion to transmission. The transparent concrete not looses the strength parameter when compared to regular concrete and also it has very vital

property for the aesthetical point of view.

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