International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)

An Experimental Study on Efficiency & Cost Analysis of Pellucid Concrete

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***Abstract*— We all know that concrete is the bonding material. The concrete bonds with the optical fiber. Fiber have property to run parallel to each other that causes light between two surfaces of concrete. In this paper we have optical fiber of diameter 0.2mm and 0.5mm. The volume of optical fiber were 0.5% , 1% ,1.5%, 2%. The tests which were carried out are compression strength test ,flexural strength test, workability test and light transmission test. we have placed fibers vertically as well as horizontally. The presence of optical fiber increases the cost but with its use we can reduce the use of electricity and prevent power cuts . which can be economical as well.**

***Keywords*—Pellucid Concrete, Light Transmitting Concrete (LTC), Optical Fibre, Plastic Optical Fibre (POF). Compressive Strength, Flexural Strength, Workability, Light Transmission, Lux Meter.**

I. INTRODUCTION

Power is the most beneficial and convenient for man, when the consumption of power is not only used for the domestic purpose but for the production to use and convenience in nature, in both states of external and internal trade as well. Then the construction of bridge, moles, ports, roads and lighthouses, by means of artificial power for use of commerce and then in construction and other machinery, it is also used in drainage for cities and towns.

When we are dealing with civil engineering it has come in advancement in the field of construction, few people were having misconcept about civil engineering as a branch of science which deals with Civilization. But, when the time passes the construction of engineering structures, like underground roads, Bridge, elevated Road, Landmark buildings, skyscrapers and many other building structure. When we are considering economic growth, in this time we have extensive growth that is why input, high consumption and high pollution. so we should have energy saving Technologies i.e very low, practically in developing countries.

But when we are dealing with the external structure that are prone to external Environmental effects like rain, snow, wind, Storms and chemical action on structures as well as economic losses and some serious casualties once damaged. So,we have to keep all these things into one's mind when we are going to build structure and should include, self diagnose smart concrete, self compacting concrete, self lining smart concrete, soundproof concrete, self repairing and so on. All these are economic characters but cannot process energy saving. For this we have a different material known as Pellucid concrete which can impart a different feature in concrete and has energy saving as well as economical. The pellucid concrete was first developed in 2001 by Hungarian architect Aron Losonezi at the technical University of Budapest. Pellucid concrete can be precast blocks of different size. In light Pellucid concrete, which is commonly known as transparent concrete, Optical Fibre are cast into concrete to transmit light, either naturally or artificially through pellucid panel. as we know that the fibre concrete runs parallel to each other so light between the two surfaces of concrete is embedded together.

Principle:-

An optical fibre is a cylindrical dielectric wave length that transmits light along its Axis by the process of total internal reflection. It is made of fibre that is surrounded by a cladding layer and that are made up of dielectric material. In order to receive the optical signal, the refractive index of the core must be always greater than the cladding.

II. LITERATURE STUDY

Aron Lasanczi 2001:- Hungrain architect aron was the first who developed the pellucid concrere in 2001 at The Technical University of Budapest. the pellucid concrete comes in precast blocks of different size. in pellucid concrete which is also known as light transmitting concrete, Optical Fibre strands are passed into the concrete to transmit light by either naturally or artificially through pellucid panels.

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This material can be used in the wide range of architectural and interior design applications, which includes cladding and dividers. the fibre in the concrete runs parallel to one another transmitting light between the two surfaces of the concrete component in which they are embedded Optical Fibre transmit light so efficiently that there is almost no loss of light conducted through the fibres. the concrete mixture is made up of fine materials only i.e it contains no coarse aggregates .plastic Optical Fibre (POF) and ROCALITE micro concrete are needed for making pellucid concrete.

Zhi Zhou et at (2006):- according to this the surface roughness in certain sections and light guiding performance of concrete materials is completely determined by the internal POF area ratio. An specific exhibition rather than just a construction materials POF is based pellucid concrete could be regarded as an art which would be used in museums also.

Jianping Heetal (2011):- across the study of excellent properties of light guiding and elasto-optic effect of Optical Fibre the POF volume ratio to concrere is proportion to transmission and evaluate the effectiveness of smart pellucid concrete and they concluded that pellucid concretes good light guiding property. the amount of the POF has seriously influenced the compressive strength of the corresponding concrete. the anti- permeability of the concrete has also been reduced by the POF.

Varsharainaet at 2013:- in Modern construction and consumption of energy with eco friendly way is developed in the building aesthetic. the main purpose of using sunlight as a light source is to reduce the power consumption of illumination and to use the optical fibre to stands the stress of structures and also this concrete as an architecture of purpose for good aesthetic view of the building. this kind of building materials can integrate the concept of green energy saving with the usage of self sensing property of functional materials.

III. Objectives

This project is defined for achieving objectives like

- To check how the introduction of Optical fibre will effect the
  - Compressive Strength
  - Flexural strength
- To check for Light Transmission Test.
- To determine workability by performing slump test.
- To do a Cost Analysis with respect to normal Concrete.

IV. Methodology

Mix design used in this project is M20.

V. Material Used

A. Optical Fibre

The design and application of Optical Fibre is known as fibre optics. This is the field of science and engineering which deals with the optical fibre. These are mostly used in fibre optic communication, which helps in the transmission of longer distance and which have higher bandwidths than other forms of communication.

When light travels in optically denser medium and hits the boundary the critical angle of the light is completely reflected this is called total internal reflection. As this effect of Optical Fibre is confined to light in the core. The light which is reflected back and fore of the boundary between Core and cladding as light strikes the boundary with an angle greater than the critical angle, the light that passes through that particular angle can travel through the fibre without leakage this angle is known as acceptance cone of the fibre. The size of the signal varies between Core and cladding of the refractive index. Silica is mostly used for making class Optical Fibre but fluorozirenate, fluoroaluminate and chalrcogenic glasses are also mostly used for the construction of Glass Optical Fibre, and they also help in longer wavelength infrared or other specialized applications.

B. Cement:

The commonly used cement is of grade 43. The material which has adhesive and cohesive properties is known as cement.

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As these properties of cement helps it to have bonding between the other parts that is minerals which in turn acts as a single part. Cement is made up of silicates and aluminates of lime. they are classified into 3 categories Portland cement, Natural cement and high Alumina cement.

Chemical Composition

Lime, silica, Alumina and iron oxide are the raw material that are used for the manufacture of cement.

Approximate Oxide Composition Limits of Ordinary Portland Cement

Oxide	Per cent content
CaO	60–67
SiO2	17–25
Al2O3	3.0–8.0
Fe2O3	0.5–6.0
MgO	0.1–4.0
Alkalies (K2O, Na2O)	0.4–1.3
SO3	1.3–3.0

C. Aggregates:-

The most important constituent of concrete are aggregate. These help the concrete to reduce shrinkage and effect economy. Aggregates was first considered as inert but now it has been recognised that some of the aggregate are chemically active and has a chemical bond. While we are dealing with concrete we have to get knowledge of aggregate too, as it has a major volume in concrete .

➢ *Fine Aggregate:*

In light transmitting concrete we use sand. Sand is naturally available in the form of Rock and mineral particles and should be free from impurities such as vegetation and gravels. It is necessary that the minimum amount of fine aggregate arising from binders and sand musk be used to avoid its segregation. The zone of fine aggregate is determined by sieve analysis.

Sand passing through IS 2.36mm Sieve is used for casting all the specimens**.**

➢ *Coarse Aggregate:-*

When gravel, slag, crushed parent rock, expanded clay and shales are combined together they forms coarse aggregates. It has the conforming characteristics of having hard, strong, durable, particulars too. Where the aggregate having size always less than 12 mm are used.

VI. RESULTS

Compressive Strength after 7-Days				
Plastic Optical Fiber % Used	**Strength in N/mm^2**			
	Load Applied Parallel to optical fiber		Load Applied Perpendicular to optical fiber	
Ordinary Concrete	**18.60**			
Dia. Of POF in mm	0.2	0.5	0.2	0.5
0.5% POF	19.51	19.84	19.37	19.6
1.0% POF	20.90	21.62	20.40	21.10
1.5% POF	21.82	22.75	20.20	20.85
2.0% POF	22.95	23.60	19.15	19.22

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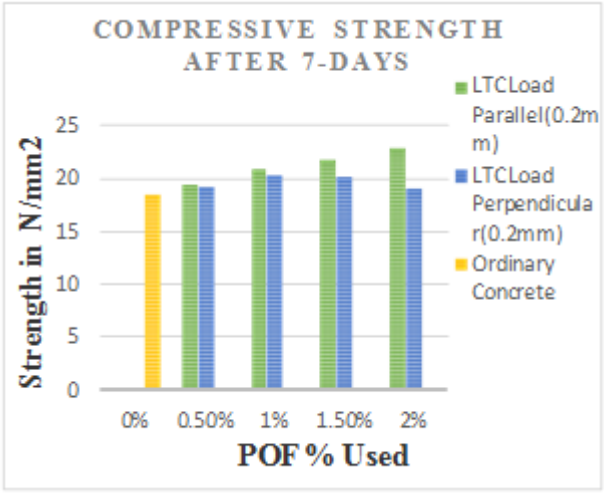
Compressive Strength after 14-Days				
Plastic Optical Fiber % Used	**Strength in N/mm^2**			
	Load Applied Parallel to optical fiber		Load Applied Perpendicular to optical fiber	
Ordinary Concrete	**24.10**			
Dia. Of POF in mm	0.2	0.5	0.2	0.5
0.5% POF	24.89	25.35	24.51	24.70
1.0% POF	26.85	27.45	26.15	26.85
1.5% POF	27.65	28.50	25.66	26.28
2.0% POF	28.22	29.37	23.95	24.18

Compressive Strength after 28-Days				
Plastic Optical Fiber % Used	**Strength in N/mm^2**			
	Load Applied Parallel to optical fiber		Load Applied Perpendicular to optical fiber	
Ordinary Concrete	**26.70**			
Dia. Of POF in mm	0.2	0.5	0.2	0.5
0.5% POF	27.15	28.16	26.93	27.05
1.0% POF	29.61	30.21	28.20	28.89
1.5% POF	30.26	31.44	27.85	28.16
2.0% POF	30.75	32.13	25.91	26.35

Plastic Optical Fiber % Used	**Flexural Strength in Kg/cm^2**					
	7-Days		**14-Days**		**28-Days**	
Ordinary Concrete	**26.62**		**30.43**		**36.31**	
Dia.POF in mm	0.2	0.5	0.2	0.5	0.2	0.5
0.5% POF	27.64	28.15	39.59	41.20	47.12	49.77
1.0% POF	29.47	30.29	42.89	43.36	50.38	51.10
1.5% POF	30.80	32.02	43.54	44.23	51.40	52.42
2.0% POF	31.72	33.35	44.12	45.46	52.12	53.14



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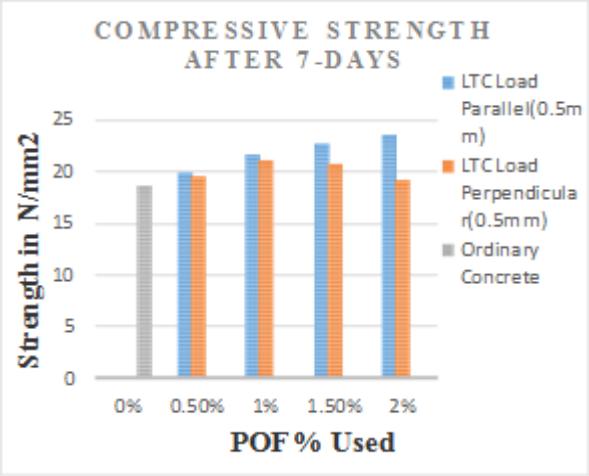

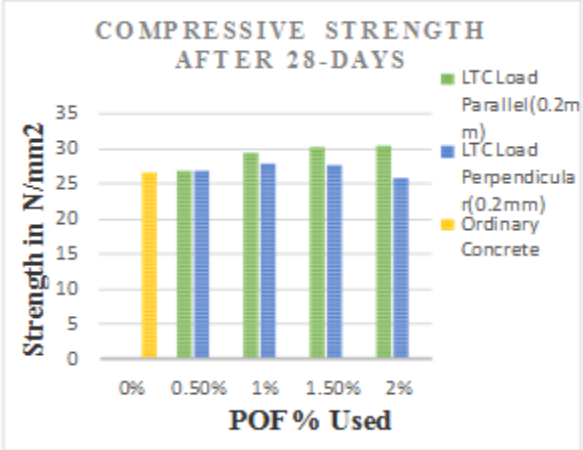

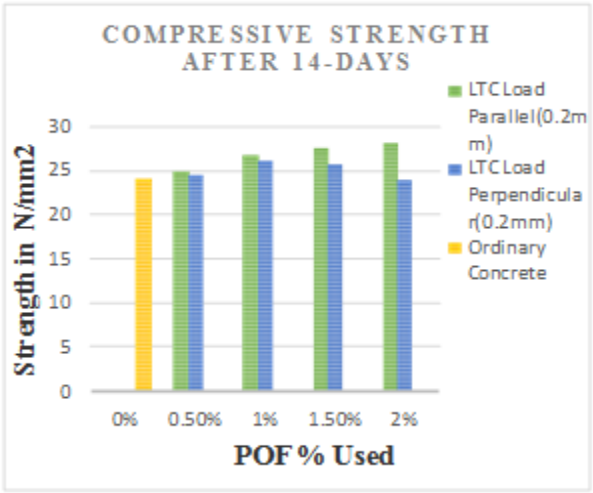

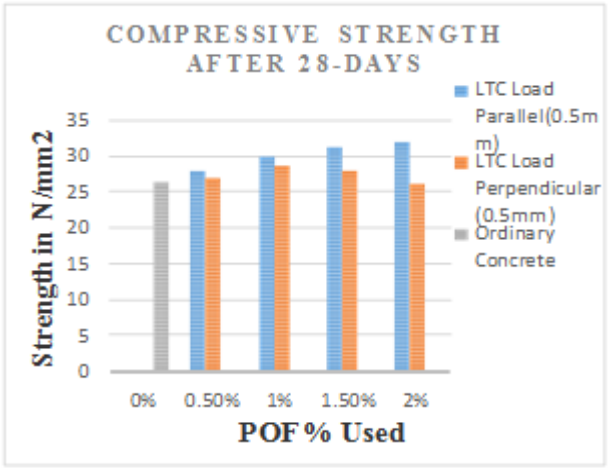

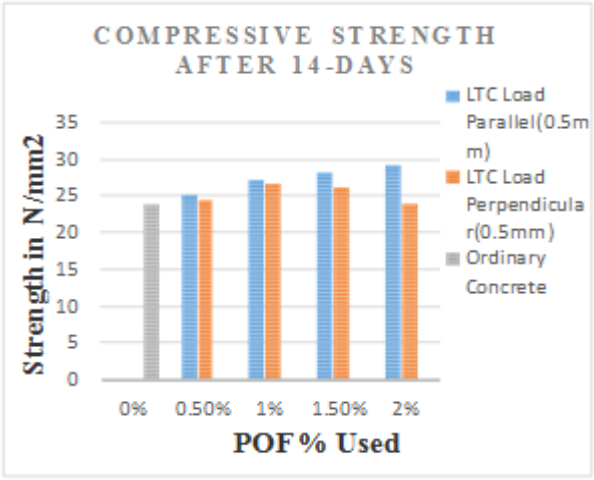

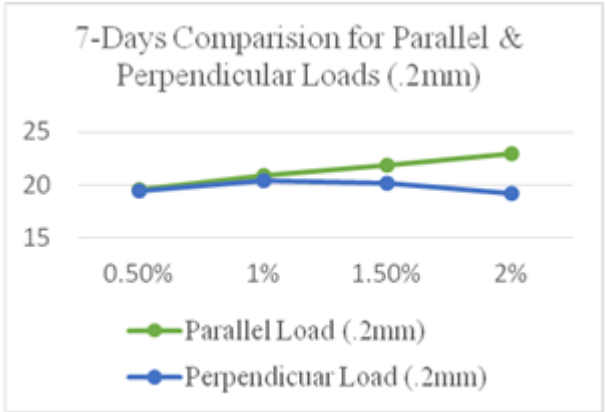

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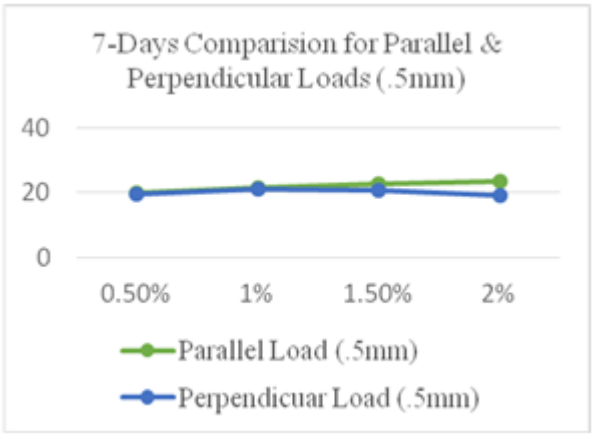

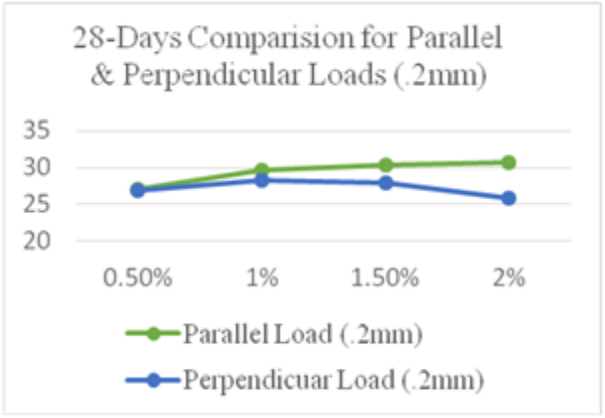

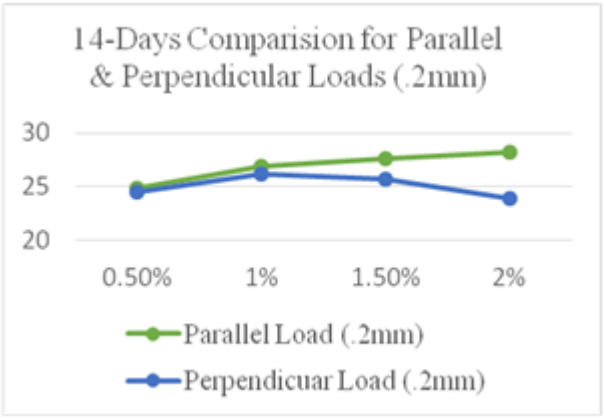

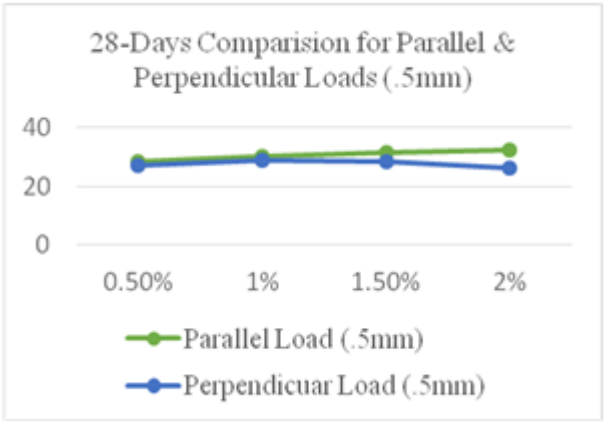

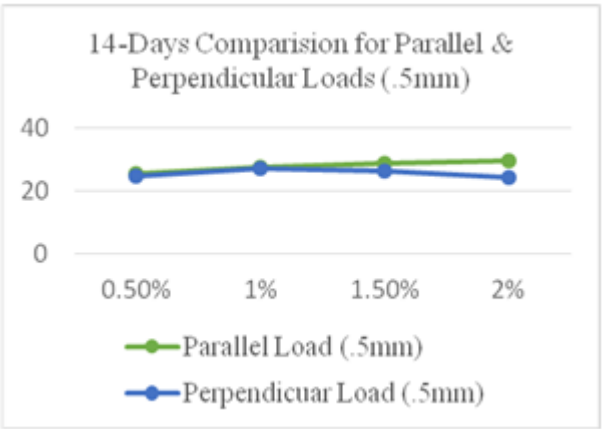

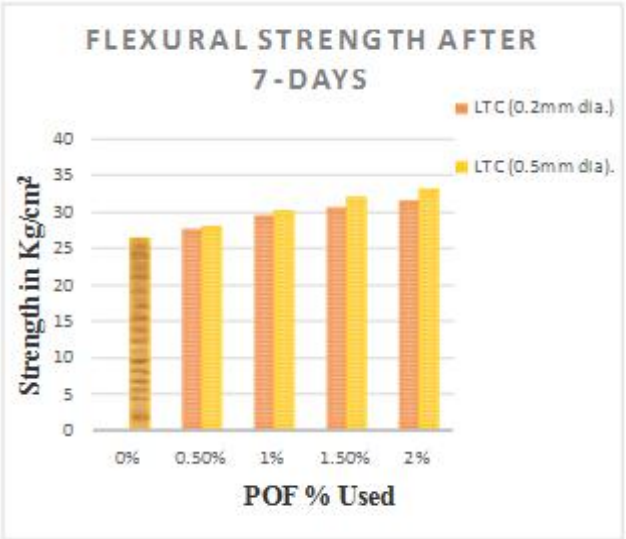

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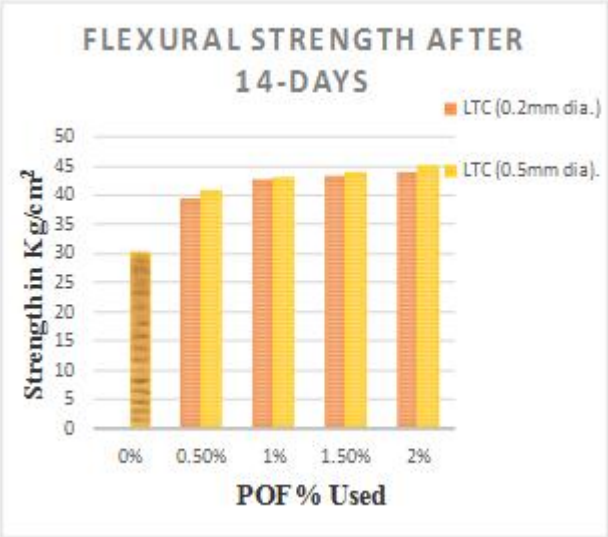

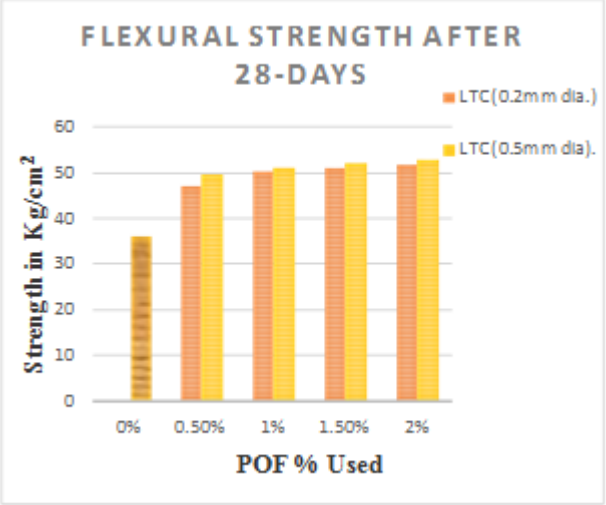

Workability: -

The workability of the concrete is determined by conducting the slump cone test and the observed slump is 86mm.

Grade	Slump in mm
M20 (1:1.5:3)	86

Light transmission test:-

The Light Transmission test was carried by using Lux meter.

In this test, we can simply prepare a heap of cubes which we have already casted & arrange them one over another & side by side forming a wall. Placing optical fibre parallel to the surface on which it is rested, and covering both the faces by a ply board so that we can entrap light between them. And then using lux meter we can calculate the amount of light passing through Pellucid concrete.

%used	**Using Artifical**		**Using Sunlight**	
	0.2mm	0.5mm	0.2mm	0.5mm
0.5%	86	101	79	97
1%	178	286	153	244
1.5%	264	361	231	321
2%	371	492	330	460

VII. Conclusion

- The above performed compression test was done with parallel loading as well as perpendicular loading.
- We have noticed that in parallel loading strength increases continuously while in perpendicular loading strength increases to some particular point then it decreases abruptly.
- In parallel loading Maximum strength change was noted at 1%.
- In this test the Flexure strength is increasing continuously.
- As far as Light transmission test is concerned there will be an increase in the light passing through the block as increase in plastic optical fiber takes place.
- The transmission of light through light transmitting block is dependent on percentage of optical fiber used of that surface area i.e more light passes through .5mm dia than .2mm dia.
- The transparent concrete has the beautifying properties that in turn attracts the new generation, but increase in the cost of optical fiber will directly affect its use, so cost is increasing with the addition of optical fiber with concrete.
- Eventually we have to select the optimum percentage of optical fiber, noticing the maximum amount of strength at 1% to 1.5% and at that percent we have lesser optical fiber consumption that is affordable too, so we should adopt 1% to 1.5% content of POF.

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