EXPERIMENTAL INVESTIGATION ON LIGHT TRANSLUCENT CONCRETE BY USING STONE POWDER & GGBS AS PARTIAL REPLACEMENT OF CEMENT

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***Abstract*—Light translucent concrete is the innovative concrete now a days. LTC is similar to conventional concrete but it carries a special property of transmitting the light through the concrete with the help of plastic optical fibers(POF). LTC can be achieved by embedding optical fibers in to the concrete placed parallel in both the directions by 4 layers. The illumination of light takes place because of the material(POF) that used in the concrete. The concept of LTC is introduced in 2001 by Hungarian architect ARONLOSONZI & first transparent concrete block was successful it was produced by mixing large amount of glass fibers in to concrete and then it was implemented by JOEL.S & SERIGO in 2006 development made to allowing the 80% light through only 30% weight of common concrete. By using the optical fibers in to the concrete it increases the strength and durability of concrete. The materials used in this concrete is kadapa stone powder, Ground granulated blast furnance slag, coarse & fine aggregate, water and plastic optical fibers (POF). Ggbs & kdp stone powder is used as partial replacement of cement with various percentages, coarse aggregates range 6.75mm to 4.75mm. LTC reduces the power consumption & usage of artificial light it increases the utilization of natural source. The new type of concrete can satisfy the green energy savings and its own natural propertie sand used for decorating interior walls, ceiling & increases the visual apperance**

***key words*- M20, kdp stone powder, Ggbs, coarse & fine aggregate, POF, energy saving, environmental, utilize of natural light.**

I. INTRODUCTION

Today we are living in a world where energy expenditure and environmental problems have escalated to global scale. Developing the materials in which Energy passes through the materials that provides lighting in building with safety & good view. As we know that concrete is considered as one of the most significant material in building industry and also 2nd largest material produced by man. As per the developing population, high raised buildings are constructed to satisfy the human needs ex. office, builder etc. As per the developing technologies problem is related to environmental and power consumption is excluded to great extent. New technologies are introduced in to the concrete which reduces the usage of operational or artificial energy, i.e light translucent concrete the basic idea of translucent concrete is quite simple, which transfers the light from one to other end, this light translucent concrete is similar to conventional concrete but LTC attains one special property in which the plastic optical fibers are embedded in to the concrete while casting, the fibers are placed parallel in both directions. The scientific name of LTC is LITRACON, the thickness of plastic fiber is slightly thicker than human hair.

As per the **IGBC** Indian Green Building Council50% day lighting is a mandatory requirement for GREEN BUILDING accounting for 3 credits. These concrete provides a better intraction between environmental and structures. There are new technologies introduced, while the LTC mainly focus on operational energy saving and increase the usage of solar energy or sunlight. The LTC provides higher strength than compare to normal concrete. The materials used in these concrete are opc 53 grade cement, kadapa stone powder, Ground granulated blast furnance slag, Plastic optical fibers, water.

II. LITERATURE REVIEW

Zhi Zhou et al (2006) reported that the light guiding performance of concrete materials is completely determined by the internal Plastic Optical Fibres (POF) area ratio and the surface roughness in certain sections. They concluded that POF based concrete allows the use of sunlight for illumination in the case of emergencies, transparent concrete will be provided some relief in the case of daytime power outage for sky scrapers making evacuation safer and more efficient additionally, a smart transparent concrete is aesthetically pleasing to be used in museums and specific exhibitions rather than just a construction material.

Varsha raina et al(2013). investigated to develop the building aesthetic in modern construction and consumption of energy with eco-friendly way. The main purpose is to use sunlight as a light source to reduce the power consumption of illumination and to use the optical fiber to sense the stress of structures and also this concrete as an architectural purpose for good aesthetical view of the building. They concluded that of will not effect strength parameter when compared to regular concrete. This kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional material. From this literature it is inferred that the plastic optical fibers increases aesthetical sense of structural elements. In this experimental work M20 grade with plastic optical fibres and flyash is used.

III.MATERIAL

(A).Cement:
In this project 53 grade ordinary Portland cement is used. The properties of cement is given below in table(1)

Sl.no	Description	Values
1	Specific gravity	3.15
2	Standard consistency	29%
3	Initial setting	40min

(B).Coarse aggregate:
Coarse aggregate of range 6.25mm and to 4.75mm sieve. The specific gravity of coarse aggregate is 2.74 is used.

(C).Fine aggregate:
Sand which is clean and dry is used , it is locally available near the river**.** The sp.gr of sand is about 2.64. the grade of zone-2 sand is used.

(D).Water
Portable water is used for mixing and curing and PH value of water is 6.7 to 7.5.

(E).Stone powder
Stone powder is a byproduct is abtained by dressing the stone at quarry. Stone powder is used as partial replacement of cement, with varying percentages 5%,10%,15%. Sp.gr of these material is about 2.72. the chemical properties of stone powder as shown in table(2)

Oxide compounds	Marble dust mass(%)
Sio_2	28.35
Al_2O_3	0.42
Fe_2O_3	9.70
TiO_2	40.45
Cao	16.25
MgO	2.80

(F)Ground granulated blast furnance slag:
Ggbs is the byproduct obtained by quenching molten iron slag or by product of iron and steel manufacturing industry fast cooling by way of water. This fast quenching of molten slag allows formation of “Granulated slag”. These material is also used as substitute material in cement with varying percentages as 20%,30%,40% in this project.
The chemical composition of ggbs as shown in the below table(3).

Compound	Content %wt
Cao	36.5
SiO_2	38.1
Al_2O_3	12.4
MgO	10.9
K_2O	0.6

(G)Plastic optical fibers:
POFs are the long cylindrical fibers which allows light to pass through them without significant loss of energy.

POFs works on the principal of total internal refraction. Plastic optical fibers are used to transmit the light from to other and increases the strength & ascentic view of concrete, reduces the powerusage. Size of optical fiber is about 200µ to 1 mm.

Materials used in LTC & its specifications in table (4)

Sl.no	Materials	specifications
1	Cement	Opc 53 grade
2	Coarse aggregate	Less than 10mm
3	Fine aggregate	2mm
4	Stone powder	150 µ
5	GGBS	90µ
6	Optical fibers	200µ to 1 mm
7	Water/cement ratio	0.5

H).MOULDS AND FABRICATION
For casting of translucent concrete it is required to construct different type of mould. Mould is prepared in which base and two side is of wooden surface and other surface is made up of PCB(printed circuit board) of size 7cm×7cm. PCB is chosen because it has defined holes in which optical fibers can be laid out in transverse direction. Perforated board rest on plywood base. Optical fiber are laid or batched by volume, placed through the holes individually. It is provided with holes on 4 sides each side 16holes with 2mmø.

IV.METHODOLOGY

In this project, materials used in the light translucent concrete is discussed above. As per IS 10262-2009 code book as considered for design of light translucent concrete for M20 grade. Different percentages of stone powder and ggbs used in this project. Firstly concrete cubes with 5,10,15

percentages replacement in cement & casted, then 20,30,40 percentages of replacement in cement and then casted. Now finally stone powder and ggbs are used as combinations in 5+20,10+20,15+20, and 5+30,& 5+40are in casted all there 12 proportions shown in table mix proportions of cubes are casted for 28days and 60 days.

Workability is that property of plastic concrete mixture which determines the ease with which it can be placed and the degree to which it resists the segregation to produce full compaction. Workability was measured by the slump cone test. The mix design of m20 concrete quantities are detailed in below table(5). The experiments conducted for light translucent concrete(LTC) of hardened concrete such as compressive strength, electrical resistivity test, light lux meter, continuity test, scanning electron microscopy analysis test.

Mix proportions

Mix Designation	Proportions of Binding Materials
A1,B1,C1,D1,& E1	Conventional OPC concrete.
A2	5% stone dust + 95% cement
A3	10% stone dust + 90% cement
A4	15% stone dust + 85% cement
B2	20% ggbs+ 80% cement
B3	30% ggbs + 70% cement
B4	40% ggbs + 60% cement
D2	5% stone dust+20%ggbs+ 75% cement
D3	10% stone dust+20%ggbs+ 70% cement
D4	15% stone dust+20%ggbs+ 65% cement
E2	5% stone dust+30%ggbs+ 65% cement
F2	5% stone dust+40%ggbs+ 55% cement

Table no 5 mix design details		
Sl.no	**Description**	**Quantity kg/m3**
1	Cement	436
2	Coarse aggregate	983
3	Fine aggregate	778
4	Water	218.4

	Table no 6 specimen details

Sl.no	Specimen size	Curing days	No of specimens
1	70.6mm×70.6mm	28	2
2	70.6mm×70.6mm	60	2

Curing days

Firstly the LTC specimens are casted then allowed to dry or to get hardened for 24hours under normal humidity temperature

Then it placed in curing tank for 28 and 60 of curing.

V.EXPERIMENTAL INVESTIGATION

The following as to be conducted in this LTC project they are

- Compressive strength test
- Electrical resistivity measurement test
- Light luxmetre test
- Continuity test
- Scanning electron microscopy test

EXPERIMENTAL PROGRAM & RESULTS

In this experimental program, fourty-eight concrete cubes are casted and were used to investigate the effect of using the POF on compressive strength test & electrical measurement resistivity test. Illumianace properties of optical fibers can be investigated by using the light luxmeter & continuity tester tests. To examine the surface bonding of LTC concrete cubes on which the combination of substitutes used in concrete.

1.Compressive strength test

Normal conventional concrete (4)cubes are casted. 44cubes are casted for LTC and using 4% of optical fibers by volume of concrete. In this project stone powder & ggbs are used as different percentages in these project. Before filling the concrete perforated mould is firstly coated with the oil so that concrete would not the adhere with the mould. Compressive test is one of most common test conducted on hardened concrete, the test can be conducted by using compressive test machine. the strength of the cube is obtained by f_c=P/A N/mm^2.

Where,

P is an ultimate load in N, A is a cross sectional area of cube in mm^2.

Test Results

Mix Designation	Compressive strength(N/mm^2)	
	28-Days	**60- Days**
A1,B1, C1,	18	19.15
A2	23.3	25.2
A3	29.1	29.6

A4	20.7	21.1
B2	20.8	24.1
B3	19.35	19.85
B4	22.8	26.65
D2	17.75	19.92
D3	16.55	17.05
D4	17.5	22.3
E2	24.3	24.85
F2	19.7	21.25

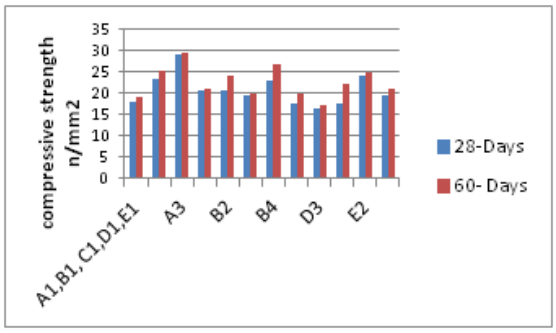

Fig5.1.Compressive strength test

Max strength attained **A3** LTC cube.A1,B1,C1,D1,E1, are normal conventional concrete cubes & A2,A3,A4 are stone powder used as substitutes in LTC .B2,B3,B4,are ggbs used as substitute in LTC.D2,D3,D4, are combination of stone powder(5,10,15)% & ggbs (20%). E2 are combination of stone powder(5%)& ggbs(30%), F2 are combination of stone powder(5%)& ggbs(40%),

2. Electrical resistivity measurement test;

The electrical resistivity measurement of concrete test is conducted by applying the current in to the concrete and measure the reaction voltage. This method is one of non destructive method, In this project onsite method is used i.e four probes method is used for electrical resistivity measurement test.

These four probes method is conducted for 12 proportions of LTC cubes are normal cubes, stone powder(5,10,15) percentages, ggbs (20,30,40) percentages and combinations ggbs & stone powder (20,5) (20,10) (20,15) & (30,5)&(40,5) percentages cubes are tested. The resistivity can be calculated by using following formulae is given by

$$\boldsymbol{\rho = 2\pi a\frac{v}{i}}$$

V =is the voltage measured between the inner two probes (measured in volts, V)

I= is the current injected in the two outer probes (measured in amps, A)

a= is the equal distance of the probes (measured in metres, m).

TEST RESULTS

Mix Designation	Electrical resistivity measurement test(kΩcm)	
	28-Days	60- Days
A1,B1, C1,	15.848	16.28
A2	15.77	16.23
A3	15.79	16.94
A4	15.86	15.96
B2	15.63	16.27
B3	15.65	16.47
B4	15.60	16.67
D2	15.75	15.72
D3	15.90	16.76
D4	15.63	16.45
E2	15.87	16.95
F2	15.819	16.97

There is a slight difference in these results of electrical resistivity method Max resistivity attained @f2, observing the above graph 5.1,among stone dust is used by varying proportions A1,A2,A3& A4 proportion has attained max strength. A1,A2,A3&A4 i.e, stone dust is replaced with cement by varying proportion of 5%, 10%,15%. In which A3-10% stone dust attained max strength of 29.6 n/mm2 comparatively with 20% of strength is increased.

Graph for compressive strength results;

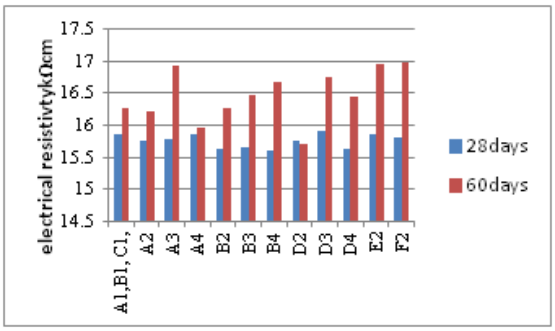

FIG 5.2 Electrical resistivity test results

3.Continuity tester

continuity tester is an item of electrical test equipment used to determine if an electrical path can be established between two points, that is if an electrical circuit can be made. The circuit under test

is completely de-energized prior to connecting the apparatus. This test is conducted by using continuity tester in which LED light is projected on LTC cubes that transfers light from one side to other side. As shown in fig 5.3

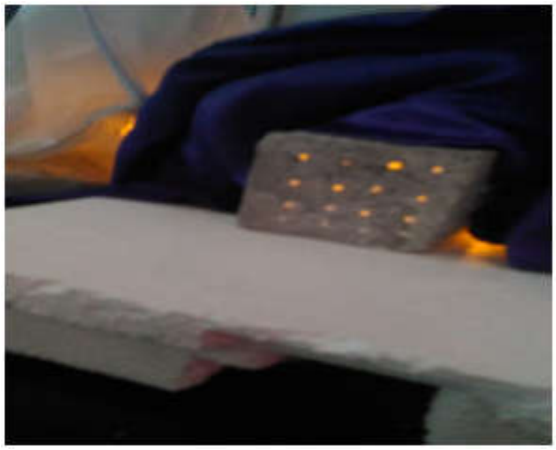

Fig continuity testing for LTC

In this test values are dosent attained because the fibers used is slightly thinner than hair.

4. light lux meter test;

The equipment utilized for light translucent test is light lux meter to discover the rate of illuminance passes through the plastic optical fibers which are embedded in the concrete blocks. The unit of illuminance and glowing emittance is got from s.i units is indicated by lux. The main proposes of conducting the light luxmeter test is to get the amount of light passing through these fibers and these fibers are applicable for constructions to receive solar light from sun and transfers to another side to get illuminance in the room. The light luxmeter test results are given table. The light lux meter is conducted for light translucent concrete cube by applying different illuminance of light sources projected on ltc cubes and the amount of light illuminance transferred on other end obtained by lux meter.

Test results

Sl.no	**Source of light (artificial light)**	**Direct illumination intensity by light lux meter (LUX)**	**Amount of Illumination transfer from one to other end in POF**	**One LTC concrete cube intensity of illumianance (LUX)**
1	1 LED bulb	80	0.11	2.75
2	2.5 LED bulb	185	0.30	9.1
3	5 LED bulb	400	1.02	17
4	12 CFL bulb	33.4	2.70	-
5	40 tube light	156.6	8.75	-

Graph for light translucent concrete

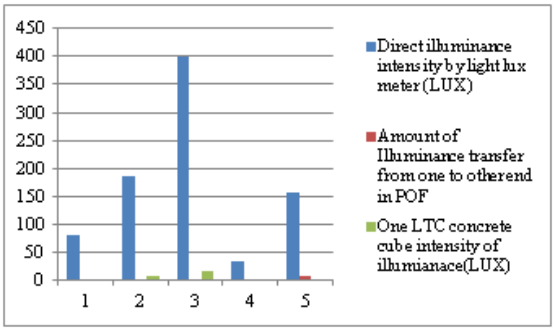

Fig 5.3 light translucent concrete

5.scanning electron microscope (SEM scanning electron magnifying lens (SEM) is a sort of electron magnifying instrument that produces pictures of an example by examining the surface with an engaged light emission. The electrons communicate with particles in the example, delivering different signs that contain data about the example's surface geology and organization. The electron pillar is examined in a raster filter design, and the bar's position is joined with the recognized flag to create a picture. In this project the max strength from the LTC samples attained is 29.6 n/mm2 for 10% sample cubes. The Sem graph is as shown in below fig.

Graph for SEM analysis

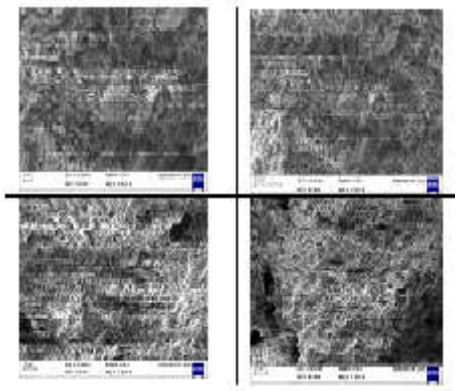

Fig 5.4 graph for SEM

VI. Pratical applications light translucent concrete;

The translucent concrete cubes are used for different ways in the construction world. The following are the areas where it can be used,

1.The translucent concrete cubes are used in the apartments or high raised buildings where the artificial light usage is more, it reduces the use of power
2. these cubes used in dark subway places where the usage of light is needed through out the day.
3. light translucent cubes used in the wall of residential buildings, restaurants and also for other buildings
4. it can be used for speed bumps and line marking at highways, its reflection can be used for navigation.
5 By using these cubes good asethetic & decorative appearance .
6.these cubes can be used for security purposes

CONCLUSION

1.The translucent concrete cubes has an noval architectural material. The light translucent concrete cubes are consists of plastic fibers which are embedded while casting. The fibers which are embedded in concrete cubes has good light guiding property.
2.In this project 2 replacement are used as partial replacement in cement are stone powder(5,10,15)% and ground granulated blasted furnance slag(20,30,40)%.
3.The compressive strength of light translucent concrete cubes compared to normal cubes as increased by 9%.
4.Max strength attained for 10% stone powder used as substitutes is about 29.6.
5.the light lux meter test is conducted, the illumianance through the fibers is great enough, the shadow of object is visible clearly on other side
6.electrical resistivity test is conducted to concrete cubes and the resistance of ltc concrete cube attained at 10% is more than compared to normal cubes.
7.the continuity tester is conducted to translucent cubes.
8.the scanning electron microscopy test conducted for 10% stone powder it attains the high strength, these test is conducted to know the surface behavior of LTC CUBES.
9. Optical fibers are cheaply available but it casting is difficult and it requried the skilled labour.
10. This new kind of building material can integrate the concept of green energy saving with the usage self sensing properties of functional materials.

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