International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-6 Issue-1, March 2017

Experimental Study on Low Density Brick (Cenosphere Bricks)

S. Lalithkumar, A. Priyadharshni, M. Manoj Kumar, N. Sekar Pandian

Abstract: ***A flyash bricks can be extensively used in all types of building construction activities. Our project was based on low density brick, using cenosphere material. The cenosphere bricks may be comparatively lighter in weight and stronger than common flyash bricks. Since cenosphere is being accumulated as waste material in large quantity in thermal power plants and creating serious environmental pollution problems. Flyash is replacing to cenosphere of flyash bricks with proportion as using specimen size 230mm x 100mm x 75mm were cast for mix percentage of cenosphere(60%), OPC(10%) and Quarry dust (30%). The results shows the variation of compressive strength and water absorption for mix proportions of materials mentioned earlier at curing ages. Then we may consider the specimen size 230mm x 100mm x 100mm to casting the bricks of different mix proportions to the percentage of cenosphere (15 to 50%), OPC (5 to 35%) and Quarry dust (20 to 55%).We had tested various specimen as per proportion considered for casting. After this, we compared the weight, compressive strength and water absorption of cenosphere with different proportion of flyash bricks.***

Keywords: Cenosphere, OPC (Ordinary Portland Cement), Quarry dust, weight, Compressive strength and Water absorption

I. INTRODUCTION

This chapter tells about the literature review of low density bricks using cenosphere and also we include review for methodology of manufacturing of low density and mix design procedure.

A. Objectives

1. To find out the optimum mix design for making brick so as to achieve the maximum compressive strength, water absorption, weight
2. Bricks with low density and light weight can be handled easily.

II. METHODOLOGY

A. Materials and Methods

The details regarding the methods and properties of materials used in this study.

B. Materials used

Revised Manuscript Received on 30 March 2017.
***** Correspondence Author
S. Lalithkumar*, Student, Department of Civil Engineering, Park College of Technology, Coimbatore (Tamil Nadu). India.
A. Priyadharshni, Student, Department of Civil Engineering, Park College of Technology, Coimbatore (Tamil Nadu).
M. Manoj Kumar, Assistant Professor, Department of Civil Engineering, Park College of Technology, Coimbatore (Tamil Nadu).
N. Sekar Pandian, Professor & Head, Department of Civil Engineering, Park College of Technology, Coimbatore (Tamil Nadu).

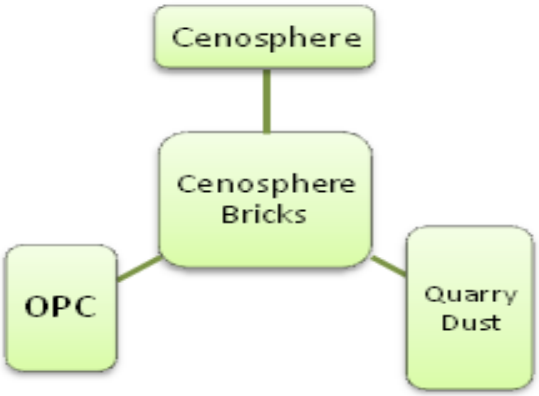

Fig. 1 Flowchart Shows the Materials Used.

III. PROPERTIES OF MATERIALS

A. Chemosphere

A **cenosphere** is a lightweight, inert, hollow sphere made largely of silica and alumina and filled with air or inert gas, typically produced as a by product of coal combustion at thermal power plants. The colour of cenospheres varies from gray to almost white and their density is about 0.4–0.8 g/cm^3 (0.014–0.029 lb/cu in), which gives them a great buoyancy. *Cf.* glass microspheres. Cenospheres are hard and rigid, light, waterproof, innoxious, and insulative. This makes them highly useful in a variety of products, notably fillers. Cenospheres are now used as fillers in cement to produce low-density concrete. Recently, some manufacturers have begun filling metals and polymers with cenospheres to make lightweight composite materials with higher strength than other types of foam materials. Such composite materials are called syntactic foam. Aluminium-based syntactic foams are finding applications in the automotive sector. Silver-coated cenospheres are used in conductive coatings, tiles and fabrics. Another use is in conductive paints for antistatic coatings and electromagnetic shielding

B. OPC (Ordinary Portland Cement)

OPC is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-speciality grout. It was developed from other types of hydraulic lime in England in the mid 19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other materials. Several types of Portland

cement are available, with the most common being called ordinary Portland cement (OPC) which is grey in color, but a white Portland cement is also available.

Portland cement is caustic, so it can cause chemical burns. The powder can cause irritation or,
with severe exposure, lung cancer and can contain some hazardous components such as crystalline silica and hexavalent chromium. Environmental concerns are the high energy consumption required to mine, manufacture, and transport the cement and the related air pollution, including the release of greenhouse gases (e.g., carbon dioxide), dioxin, NO_x, SO_2, and particulates.

The low cost and widespread availability of the limestone, shales, and other naturally occurring materials used in Portland cement make it one of the lowest-cost materials widely used over the last century throughout the world. Concrete produced from Portland cement is one of the most versatile construction materials available in the world.

C. Quarry dust

It is residue taken from granite quarry. Due to excessive cost of transportation from natural sources locally available river sand is expensive. Also creates environmental problems of large-scale depletion of these sources. Use of river sand in construction becomes less attractive, a substitute or replacement product for concrete industry needs to be found. Whose continued use has started posing serious problems with respect to its availability, cost and environmental impact. In such a case the Quarry rock dust can be an economic alternative to the river sand. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated Elements. After processing fine particles of size less than 4.75 mm is used in this work.

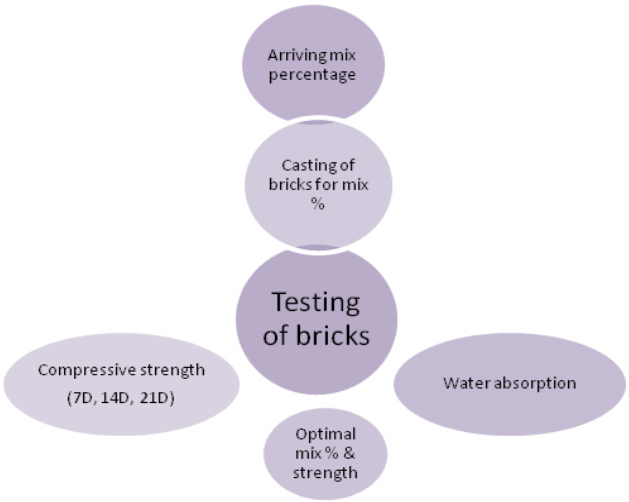

Fig. 2 Flowchart shows the Methodology

First Arriving mix percentage of cenosphere bricks of cenosphere(60%), OPC(10%) and Quarry dust (30%).Standard brick size of 230 mm x 100mm x 75 mm are used to cast the bricks. For each proportion 12 number of bricks are casting, in that 4 bricks are used to determine the compressive strength of brick in N/mm² at 7days,14days,21days curing time and 4 bricks are used to determine the water absorption. Compressive Stress is determined using Compression Testing Machine (CTM) of 3000 kN capacity. The following Flow chart describes the methodology of this study.

D. Mix Proportion

To make the cenosphere brick following mix proportions are arrived by trial and error method. The Table.1shows the various mix proportions.

Table. 1 standard Mix Proportions

Cenosphere	OPC	Quarry dust
60%	10%	30%

E. Water-Binder Ratio

Water- binder ratio is calculated based on weight of fly ash and weight of lime to total weight of the brick. It also plays the significant role on the compressive strength of the brick. Considering the water content or water to binder ratio is an indirect approach to sizing the volume, thus ensuring greater durability in the mixture proportions for bricks made.

IV. PREPARATION AND TESTING OF SPECIMENS

A. Casting of Bricks

The normal hand mould is used to cast the bricks with the standard size of 230mm x 100mm x 75mm.They were cast according to the standard procedure with various mix proportions arrived. The required quantity of Cenosphere, Cement, Quarry dust is calculated previously, according to that the materials mixed properly. Then required quantity of water was added. Then they mixed thoroughly.

Then the prepared mix was poured in to the mould and it is compacted. After compacting gets over then the mould is removed. Then the wet brick was kept under air curing for 24 hours and then bricks were water cured for a period of 7,14,21 days.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Fig. 3 Cenosphere

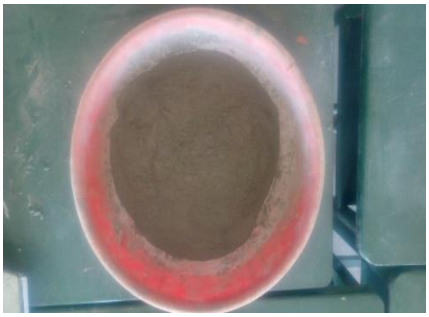

Fig. 4 OPC

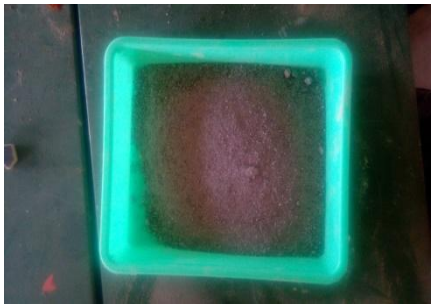

Fig. 5 Quarry Dust

Fig. 6 Brick Hand Mould

Fig. 7 Mixing of Materials

Fig. 8 Casting of Brick

Fig. 9 Casted Brick Kept for Air Curing

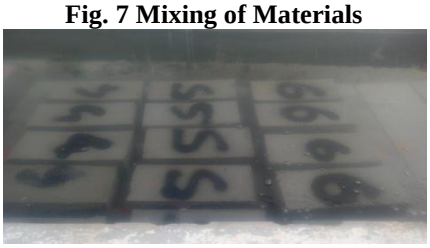

Fig. 10 Curing of Bricks

V. RESULTS AND DISCUSSIONS

The investigation was carried out to determine the optimal mix percentage of fly ash brick admixed with lime, gypsum, and quarry dust and also to determine the water absorption.

A. Arriving Proportions

Mix proportions are arrived by referring the articles and data collecting from local manufacturing companies. For the various proportions arrived bricks are casted and the following tests were conducted.

B. Tests Applied to Bricks

Compressive Strength test
Water Absorption test

C. Compressive Strength Test

The compressive strength of cenosphere brick is three times lesser than the flyash brick. The minimum compressive strength of flyash brick is 10-12 N/mm².So as the cenosphere brick has compressive strength of 3.5-4.5 N/mm². Bricks should not be used for different works, should not have compressive strength more than as mentioned above. The universal testing machine is used for testing the compressive strength of bricks.

After the curing period gets over bricks are kept for testing. To test the specimens the bricks are placed in the calibrated Compression testing machine of capacity 3000 kN applied a load uniform at the rate of 2.9 kN/min. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that 12 numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of 12 bricks was taken.

Table. 2 values of Compressive Strength (N/mm²) are obtained on age of bricks

Specimen No.	Compressive strength (N/mm²)		
	7 days	14 days	21 days
S1	1.73	3.45	7.00
S2	0.74	1.49	2.99
S3	0.74	1.50	3.12
S4	0.49	0.95	2.10
S5	0.40	0.83	1.65
S6	1.14	2.29	4.55
S7	0.49	1.00	1.98
S8	1.38	2.77	5.53
S9	0.40	0.79	1.57
S10	1.24	2.49	4.99
S11	0.89	1.79	3.59
S12	0.99	1.99	3.96

Published By:
Blue Eyes Intelligence Engineering and
Sciences Publication (BEIESP)

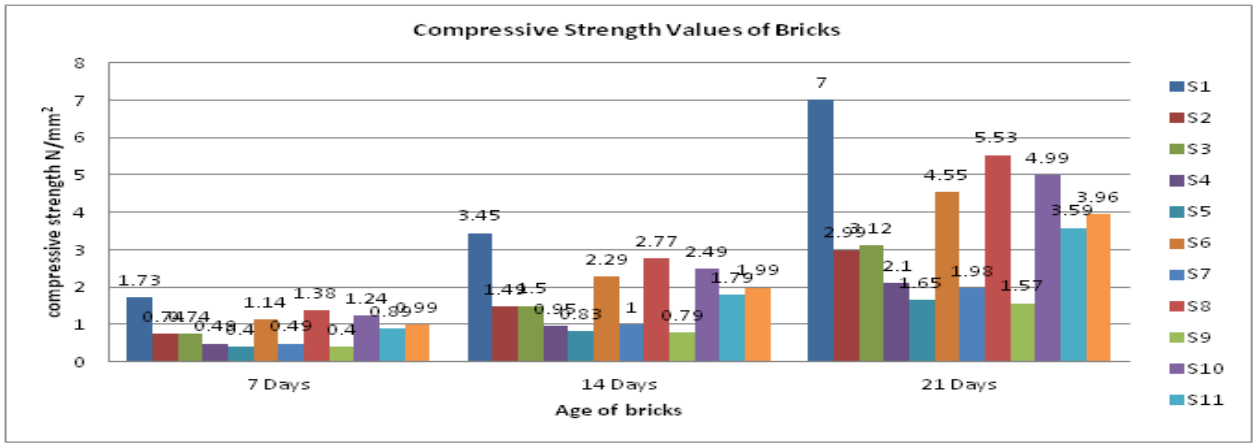

Fig. 11 Compressive strength for standard proportions at 7, 14, 21 days curing

Table. 3 Mean values of Compressive Strength (N/mm²) are obtained on age of bricks

Age of bricks	Average Compressive strength (N/mm^2)
7 days	0.89
14 days	1.78
21 days	3.59

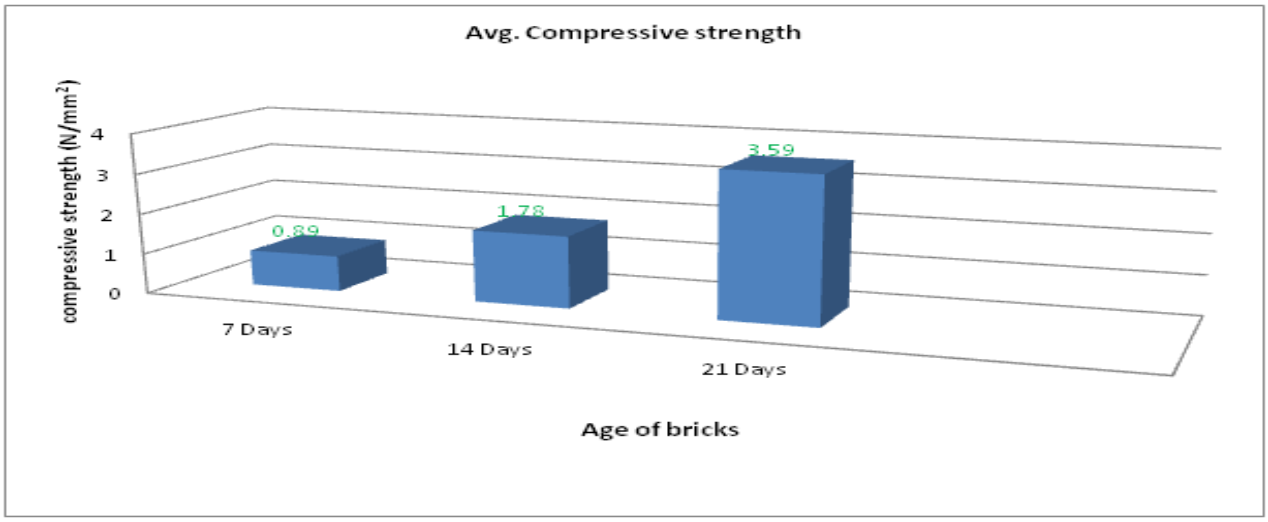

Fig.12 Mean value of Compressive strength for standard proportions at 7, 14, 21 days curing

Fig. 13 Crushing strength tested on bricks

Fig. 14 failure mode of bricks

Fig. 15 tested bricks

D. Water Absorption

Fly ash Bricks should not absorb water more than 12%. The bricks to be tested should be dried in an oven at a temperature of 105 to 115o C till attains constant weight cool the bricks to room temperature and weight (W1). Immerse completely dried and weighed W1 brick in clean water for 24 hrs at a temperature of 27±20 Degree Celsius. Remove the bricks and wipe out any traces of water and weigh immediately (W2).

Water absorption in % by weight = (W2 – W1/W1) x 100

Table 4 Water Absorption value (%)

Specimen No.	Water Absorption value (%)
S1	10.87
S2	12.09
S3	12.22
S4	12.22

S5	10.44
S6	10.49
S7	8.94
S8	12.09
S9	10.06
S10	10.49
S11	10.33
S12	10.08

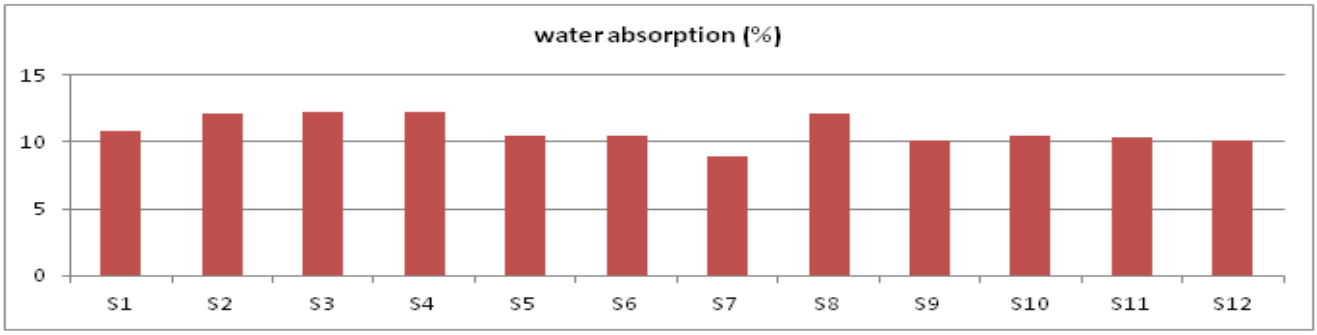

Fig. 16 Water Absorption Values

The average of 12 bricks should be taken. Our bricks absorb 10.86 % of water only; it has less water absorption property.

From the results obtained water absorption for standard mix percentage is 10.89%.It is lesser then the standard value of 12%.And also observed that for maximum strength only a good water absorption obtained.

E. Weight of the bricks

The main aim of our project is to decrease the weight of bricks, which means there bricks were made as low density bricks. when compared to cenosphere bricks were giving as loss of weight from the flyash bricks. Hence, the average weight of cenosphere bricks was 1.800Kg from 12 number of specimen. It's weight is 1.83 times lesser than flyash bricks.

F. Different mix proportion

In after testing bricks, they did not achieve good compressive strength with comparison of flyash bricks. we know the another standard size of bricks and different mix proportion. We would be increasing the size of bricks with using different mix proportion. Since, it achieved the good compressive strength to differ the different proportions. And include the methodology to be as same as before. But mix proportion were varied.

First Arriving mix percentage of cenosphere (15 to 50%), OPC (5 to 35%) and Quarry dust (20 to 55%).Standard brick size of 230 mm x 100mm x 100mm are used to cast the bricks. For each proportion 9 number of bricks are casting in that bricks are used to determine the compressive strength of brick in N/mm² at 7days,14days,21days curing time and 3 bricks are used to determine the water absorption. Compressive Stress is determined using Compression Testing Machine (CTM) of 3000 kN capacity.

Table. 5 Various Mix Proportions

Proportion	Cenosphere %	OPC %	Quarry dust %
1	15	32	53
2	20	27	53
3	20	32	48
4	25	22	53
5	30	17	53
6	35	12	53
7	40	07	53
8	40	12	48
9	50	27	23

Compressive strength of bricks(230mm x 100mm x 100mm)

G. Compressive strength of Cenosphere Bricks

The compressive strength of 230mm X 100mm X 100mm size of cenosphere brick is three times lesser than the flyash brick. The minimum compressive strength of flyash brick is 10-12 N/mm². As 5 various mix proportion(2,3,4,7,8) cenosphere brick has compressive strength of good (35-175 N/mm²)and another 4 proportion (1,5,6,9) bricks has not reach good strength(10-25 N/mm^2). Bricks may be used for different works should consider as compressive strength with various proportions. The universal testing machine is used for testing the compressive strength of bricks.

After the curing period gets over bricks are kept for testing. To test the specimens the bricks are placed in the calibrated Compression testing machine of capacity 3000 kN applied a load uniform at the rate of 2.9 kN/min. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that 9 numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of 19 bricks was taken.

Table. 6 Mean values of Compressive Strength (N/mm²) are obtained on age of cenosphere bricks

Specimen No.	Compressive strength (N/mm^2)		
	7 days	14 days	21 days
Prop1	2.05	4.00	7.99
Prop2	8.65	17.3	34.51
Prop3	6.18	12.34	24.69
Prop4	1.73	3.48	6.93
Prop5	1.36	2.70	5.42

Published By:
Blue Eyes Intelligence Engineering and
Sciences Publication (BEIESP)

Prop6	1.24	2.49	4.96
Prop7	1.73	3.45	6.93

Prop8	3.71	7.41	14.81
Prop9	1.51	3.03	6.05

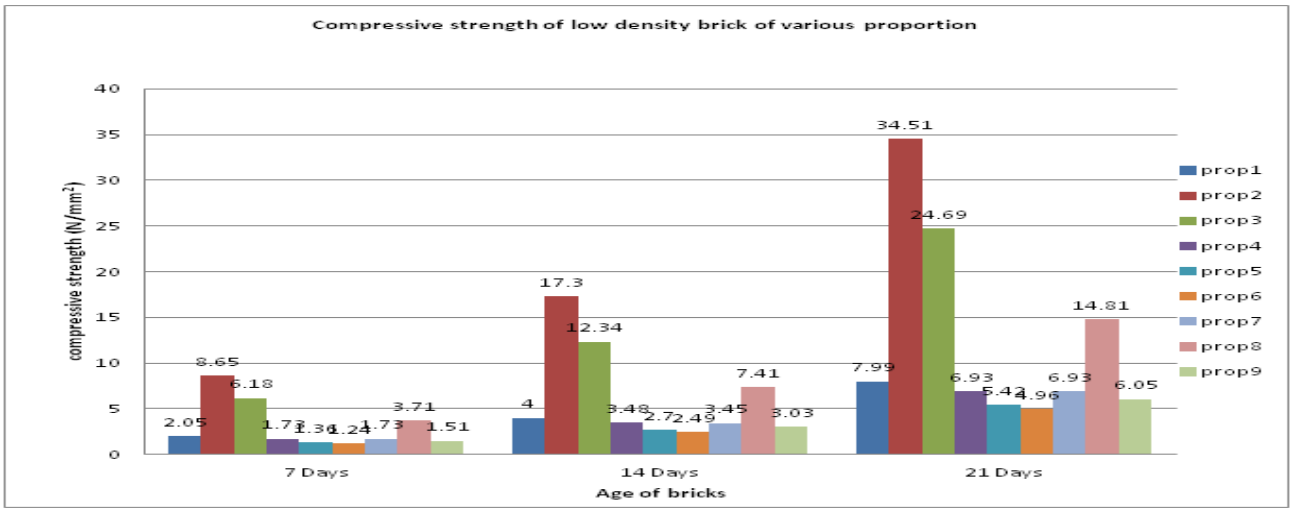

Fig.17 Mean value of Compressive strength for standard proportions at 7, 14, 21 days curing

H. Compressive Strength of Flyash Bricks

Flyash bricks have compressive strength of better than cenosphere as before in size of specimen.we collected the flyash bricks about the strength of various proportion. Detailed compressive strength as given table.9

Table. 7 Mean values of Compressive Strength (N/mm²) Are Obtained on age of Flyash Bricks

Specimen No.	Compressive strength (N/mm²)		
	7 days	14 days	21 days
Prop1	1.98	3.15	7.91
Prop2	1.68	3.36	6.78
Prop3	1.81	3.43	6.97
Prop4	1.44	3.08	5.98
Prop5	1.22	2.43	5.34
Prop6	1.03	1.97	5.04
Prop7	1.12	2.23	5.14
Prop8	1.21	2.67	5.28
Prop9	1.34	2.62	5.45

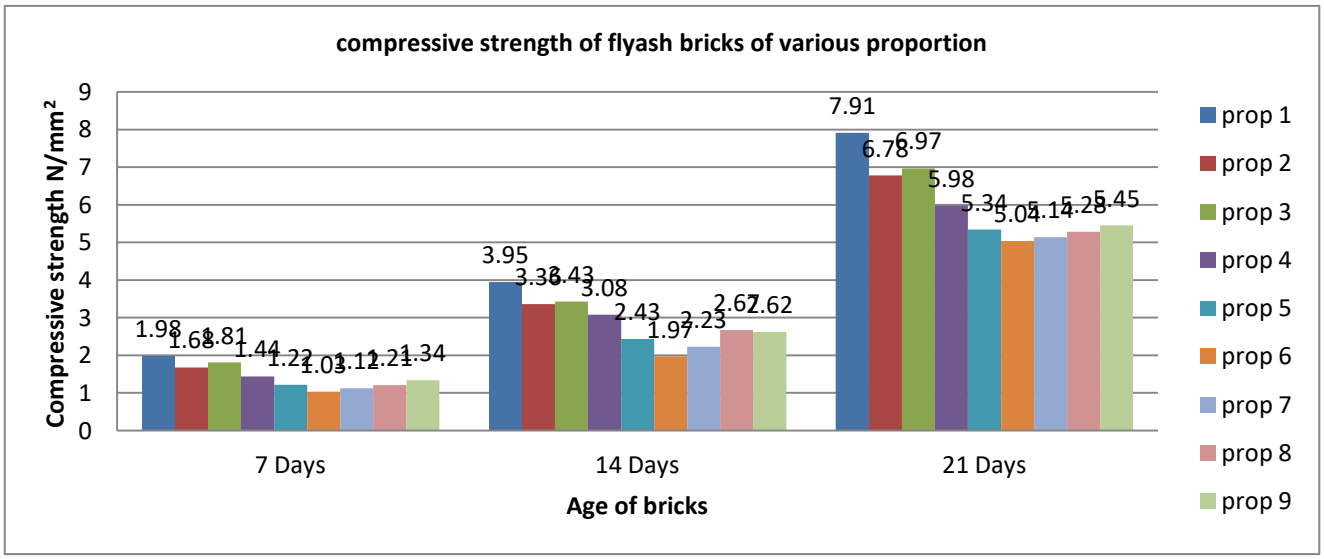

Fig.13 Mean value of Compressive strength for different proportions at 7, 14, 21 days curing

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

From the experimental results, proportion-2 shows the maximum compressive strength value. So that proportion-2 was taken as a optimal mix percentage of cenosphere brick (cenosphere -20% OPC-27%,Quarry dust-53%).The compressive strength decreases with increases of cenosphere content. The Fig. 13 shows the compressive strength decreases with increases of cenosphere

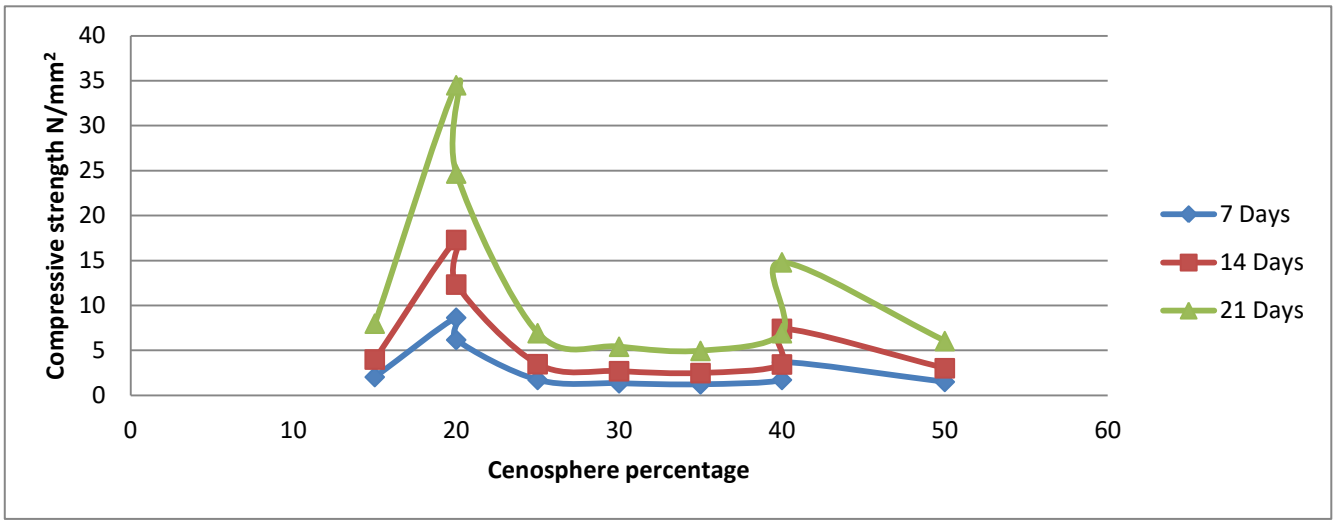

Fig.18 Variation of Compressive Strength with Increase of Cenosphere

When low content of flyash is used the proportion of compressive strength increases. Flyash bricks has good strength have proportion 1(7.91N/mm^2). But cenosphere brick has better strength form flyash bricks on the proportion 2(34.51N/mm^2).

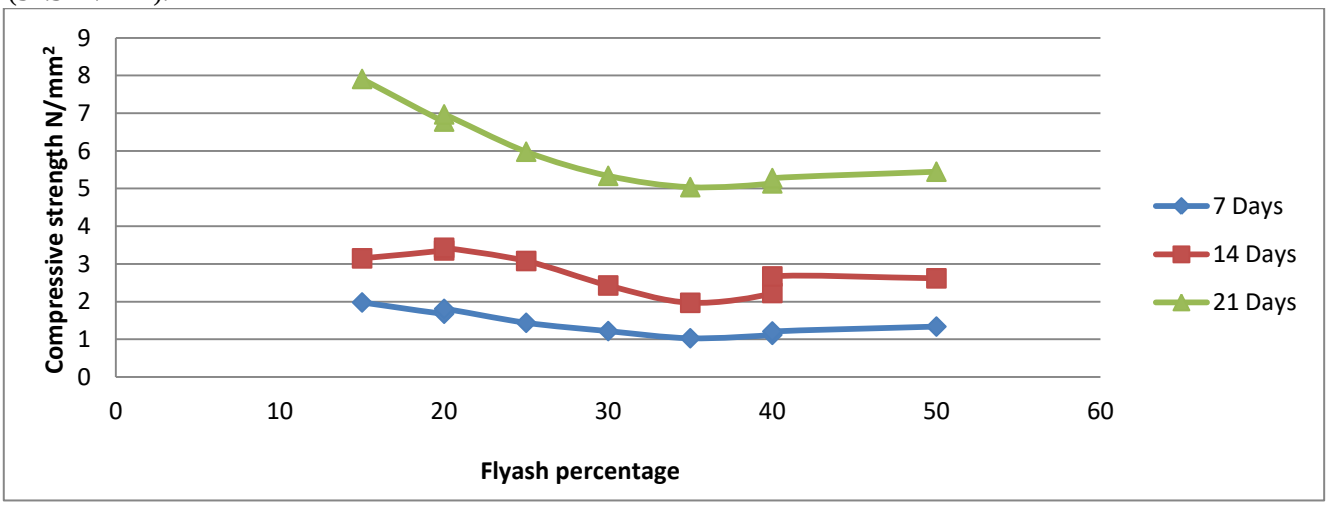

Fig.19 Variation of compressive strength with increase of cenosphere

I. Water Absorption Test

The procedure of this test as same as before. Highly expensive result was been given from there various mix proportion, except proportion 7. There is also good absorb content. Since compared from another proportions. Proportion 7 was 2 times greater than another proportion. water absorb content is minimum. Hence also the result was good.

Table 8 Water Absorption value (%)

Specimen No.	Water Absorption value (%) of low density bricks	Water Absorption value (%) of flyash bricks
Prop1	2.94	10.9
Prop2	5.79	12.4
Prop3	3.31	12.6
Prop4	5.22	13.3
Prop5	5.51	15.1

Published By:
Blue Eyes Intelligence Engineering and
Sciences Publication (BEIESP)

Prop6	5.81	15.6
Prop7	10.9	15.7
Prop8	4.96	16.2
Prop9	5.42	16.8

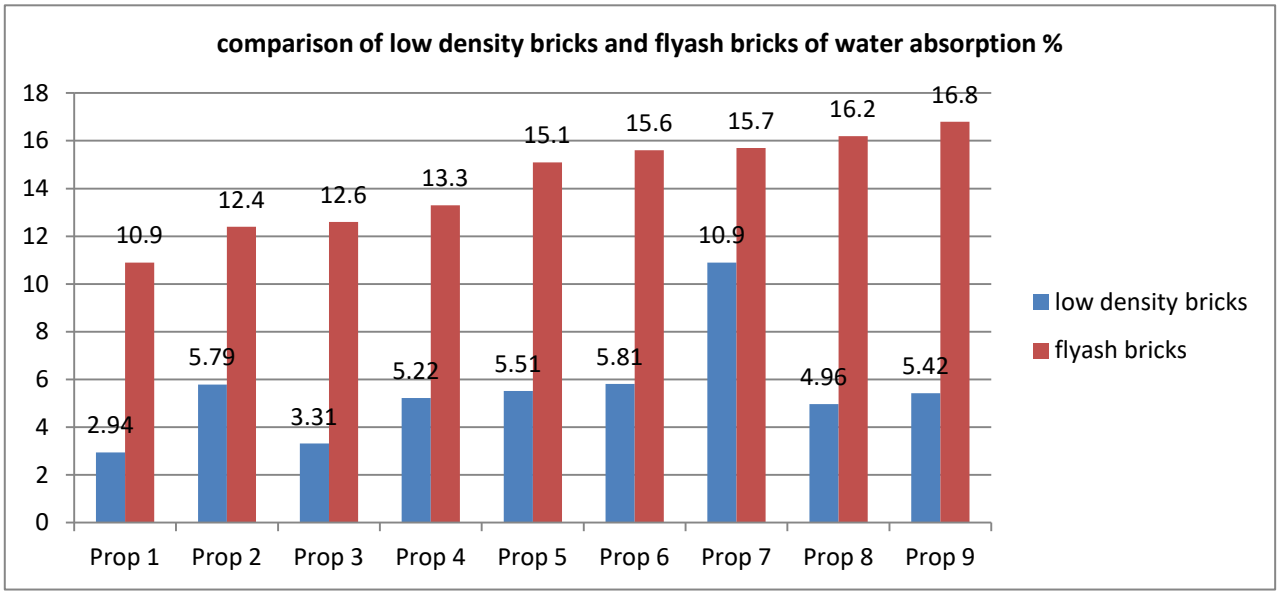

Fig. 20 Water Absorption Values

VI. CONCLUSION

1. Cenosphere brick has reached estimated strength for some proportion and silica fume is added for the bricks which does not attain its strength. Silica fume is added to the brick in order to reduce the shear that is occurred on the brick while taking compression test on the brick.
2. Cenosphere brick is also similar to the cost of flyash brick.
3. Weight of cenosphere brick is 2 times lesser than flyash brick.
4. Absorption of water in cenosphere brick is less when compared to the flyash brick.
5. Cenosphere brick is most eco-friendly in nature, because it is prepared by only considering the waste material collected from thermal power plant.
6. Compressive strength is minimum due to the spherical shape of cenosphere in the brick, if the binding strength of cenosphere was increased the strength of brick might be increased.
7. And so to increase the binding property of cenosphere, various binding materials should be considered for binding the cenosphere in the future projects

REFERENCES

1. Tahmina Banu, Md. Muktadir Billah, et. al, Experimental Studies on Fly Ash-Sand-Lime Bricks with Gypsum Addition: American Journal of Materials Engineering and Technology, 2013, Vol. 1, No. 3, 3540
2. Prabir Kumar Chaulia and Reeta Das, Process Parameter Optimization for Fly Ash Brick by Taguchi Method: Material Research; 2008.11. 159-164.
3. Tutunlu Faith, and Atalay Umit.Utilization of Fly ash in Manufacturing of Building Brick: International Ash utilization Symposium, Center for applied Engineering Research; 2001 paper 13.
4. Wang, J., Zhang, M., Li, W., Chia, k., and, Liew, R. (2012). Stability of cenospheres in lightweight cement composites in terms of alkali–silica reaction. Cement and Concrete Research, 42, 721–727.
5. Y, X., Shen, Z., Xu, Z., and, Wang, S. (2007).Fabrication and structural characterization of metal films coated on cenosphere particle by magnetron sputtering deposition. Applied Surface Science, 253, 7082-7088.
6. Cao, X., and, Zhang, H. (2013).Investigation into conductivity of silver-coated cenosphere composites prepared by a modified electroless process. Applied Surface Science, 264, 756- 760.