Experimental Study on Bricks Using Slurry Sand

Mr.T.Ravindaran[1], V.Deepak[2], S.Hari haran[3], B.Karthik[4], K.Sathish kumar[5]

[1]Asst. professor Dept of Civil Engineering

[2, 3, 4, 5]Dept of Civil Engineering

[1, 2, 3, 4, 5] P. A. College of Engineering and Technology, Pollachi, Tamilnadu, India.

Abstract- *This project work deals with effective utilization of slurry sand from M-Sand manufacturing unit for economic, environmental and technical aspects. In this paper, a comparative study is done to study the properties of normal bricks (made using cement and slurry sand) and light weight bricks (made using cement, slurry sand and foaming agent). To make the bricks of light weight for ease of lifting and handling, foaming agent is introduced. Trial bricks of size 230x115x75 mm were tested with different proportions of cement and slurry sand such as 1:2, 1:3, 1:4, 1:5 and 1:6. Various tests like Compressive strength test, Water absorption test, Thermal resistance test, Thermoshock test were conducted on these brick specimens as per Indian Standards.*

Keywords- Brick, Foam brick, M-Sand waste, Slurry sand, Waste-product.

I. INTRODUCTION

Brick is one of the oldest building materials. A brick is used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes which vary with region and time period, and are produced in bulk quantities. Two basic categories of bricks are fired and non-fired bricks.

A. Normal bricks

These are cement blocks made of Ordinary Portland Cement (OPC), slurry sand and water. These bricks are also known as cement solid blocks. Dry mix of cement and slurry sand are mixed thoroughly and water is added to it. The mortar is placed in the mould in three layers and each layer is compacted with 25 blows with the help of tamping rod. These bricks have wide range of applications in construction field.

B. Foam bricks

Foam bricks are also known as Lightweight Cellular Bricks (LCB), Low Density Cellular Bricks (LDCB), foamed bricks, cellular lightweight bricks or reduced density bricks, is defined as a cement based slurry, with a minimum of 20% (per volume) foam entrained into the plastic mortar. These bricks are made with Ordinary Portland Cement (OPC), slurry sand, foaming agent (animal protein based) and water. As mostly no coarse aggregate is used for production of foam bricks. The density of foam bricks usually varies from 400 kg/m³ to 1600 kg/ m³.

OBJECTIVE

The main objective of this project is to make economical and green bricks to maintain environmental balance, and overcome problem of slurry sand disposal.

II. MATERIALS AND THEIR PROPERTIES

A. Cement

The cement used for this study is Ordinary Portland Cement(OPC) of 53 grade conforming to is 1226: 1978. The various properties of cement are tabulated in Table 1.

Table 1: Properties of cement

S.NO	DESCRIPTION	RESULT
1	Fineness of Cement	8%
2	Standard Consistency	32%
3	Specific gravity	3.15
4	Initial setting time	30 mins
5	Final setting time	10 hrs

B. Slurry sand

Slurry sand is waste-product obtained from manufactured sand when it is washed. There is a huge amount of slurry sand is available.

Table 2: Properties of Slurry Sand

S.NO	DESCRIPTION	VALUE
1	Specific gravity	2.62
2	Density	1426.67kg/m³

C. Water

Potable water with pH value 6.5-8.5 is used for mixing and curing throughout the experiment.

D. Foaming agent

A foaming agent is a material that facilitates formation of foam such as a surfactant or a blowing agent. A surfactant, when present in small amounts, reduces surface tension of a liquid (reduces the work needed to create the foam) or increases its colloidal stability by inhibiting coalescence of bubbles. A blowing agent is a gas that forms the gaseous part of the foam. There are two types of foaming agent. They are

- Synthetic-suitable for densities of 1000 kg/m³ and above.
- Protein-suitable for densities from 400 kg/m³ to 1600 kg/m³.

For this experiment animal protein based foaming agent was used, having a weight of around 800 g/litre. The recommended dosage is 20 ml per litre of water.

E. Mould

The size of the mould is 230 x 115 x 75 mm. The mould is made up of waterproof Plywood.

III. CASTING OF SPECIMEN

The mould of size 230x115x75mm was used to prepare the specimen. After 24hrs of casting the moulds were removed and the specimens were cured in water for 28days in room temperature.

Figure 1: Normal bricks

Figure 2: Foam bricks

IV. TESTING PROCEDURE

A. Density test

The specimens (3 no's) were kept in oven at 100°C for 60 minutes and then weighed. The density of specimen was calculated and tabulated in Table 3.

Table 3: Density of Normal bricks and Foam bricks

Ratio (Cement: Slurry sand)	Normal bricks (kg/m³)	Foam bricks (kg/m³)
1:2	1971.01	1320.73
1:3	1955.89	1280.40
1:4	1940.77	1245.12
1:5	1930.69	1204.79
1:6	1900.44	1149.34

B. Water absorption test

The specimen were (3 no's) kept in a ventilated oven for one hour and weighed(W_1), then immersed in water for 24 hours and weighed (W_2). Percentage of water absorption (W_2 – W_1)/ W_1 x 100. The percentage of water absorption was calculated and tabulated in Table 4.

Table 4: Percentage of water absorption of Normal bricks and Foam bricks

Ratio (Cement: Slurry sand)	Normal bricks (in %)	Foam bricks (in %)
1:2	5.24	9.27
1:3	6.57	10.46
1:4	7.98	11.97
1:5	9.16	13.18
1:6	10.55	14.51

C. Compressive strength

In a compression test a material experiences opposing forces that push inward upon the specimen from opposite sides or is otherwise compressed, squashed, crushed, or flattened. The test sample is generally placed in between two plates that distribute the applied load across the entire surface area of two opposite faces of the test sample and then the plates are pushed together by a universal testing machine causing the sample to flatten. A compressed sample is usually shortened in the direction of the applied forces and expands in the direction perpendicular to the force.The compressive strength of specimen after 7 days was calculated and tabulated in Table 5 and Table 6.

Table 5: Compressive strength of the Normal bricks after 7 days

Ratio	Compressive strength after 7 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	4.91	4.95	4.99	4.95
1:3	4.34	4.42	4.42	4.39
1:4	3.36	3.29	3.36	3.33
1:5	2.38	2.42	2.46	2.42
1:6	1.74	1.66	1.66	1.69

Table 6: Compressive strength of the Foam bricks after 7 days

Ratio	Compressive strength after 7 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	2.65	2.61	2.63	2.63
1:3	2.27	2.26	2.19	2.24
1:4	1.79	1.84	1.8	1.81
1:5	1.6	1.59	1.56	1.58
1:6	1.22	1.24	1.21	1.22

The compressive strength of specimen after 28 days was calculated and tabulated in Table 7 and Table 8.

Table 7: Compressive strength of the Normal bricks after 28 days

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	11.04	11.15	11.07	11.08
1:3	9.22	9.3	9.33	9.28
1:4	7.06	6.99	6.95	7.0
1:5	5.03	5.1	5.14	5.09
1:6	3.59	3.63	3.59	3.6

Table 8: Compressive strength of the Foam bricks after 28 days

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	5.48	5.46	5.47	5.47
1:3	4.6	4.54	4.59	4.58
1:4	3.72	3.74	3.7	3.72
1:5	3.07	3.11	3.12	3.1
1:6	2.47	2.47	2.5	2.48

D. Thermal Effect

The strength of brick gets affected due to the increase in temperature. To find the change in strength, the bricks of age 28 days were kept at 100°c in an oven for 24 hours. Then it is immediately tested in compression. The compressive strength of specimen was calculated and tabulated in Table 9 and Table 10.

Table 9: Thermal effect on Normal bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	10.9	10.93	10.9	10.91
1:3	9.2	9.05	9.2	9.15
1:4	6.99	6.86	6.85	6.9
1:5	5.0	5.05	4.97	5.01
1:6	3.52	3.54	3.52	3.53

Table 10: Thermal effect on Foam bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	5.35	5.42	5.4	5.39
1:3	4.5	4.55	4.48	4.51
1:4	3.68	3.62	3.64	3.65
1:5	3.0	3.06	3.03	3.03
1:6	2.4	2.41	2.45	2.42

E. Thermoshock Effect

The strength of brick also gets affected when the concrete is exposed to high temperature like fire and then due to sudden cooling. To find the change in strength, the concrete cubes of age 28 days were kept at 100°c in an oven for 24 hours and then immersed in water for a few minutes and then tested in Compression Testing Machine. The compressive strength of specimen was calculated and presented in Table 11 and Table 12.

Table 11: Thermal effect on Normal bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	10.84	10.86	10.84	10.84
1:3	9.1	9	9.1	9.06
1:4	6.87	6.7	6.87	6.81
1:5	4.92	4.94	4.98	4.95
1:6	3.5	3.51	3.5	3.5

Table 12: Thermal effect on Foam bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	5.32	5.33	5.32	5.32
1:3	4.42	4.39	4.47	4.43
1:4	3.6	3.55	3.62	3.59
1:5	2.96	2.92	2.98	2.95
1:6	2.32	2.37	2.34	2.34

V. RESULT AND DISCUSSION

A. *Density test at an age of 28 days*

From the Table 3, it is observed that the density is in decreasing order for higher mix ratios. It is also observed that the density of normal bricks is greater than that of foam bricks. The variation in density is presented in fig 4.

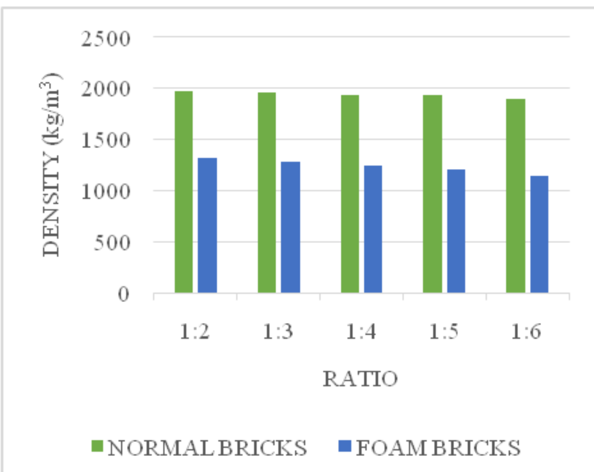

Figure 4: Density of Normal bricks and Foam bricks

B. *Water absorption at an age of 28 days*

From the Table 3, it is observed that the percentage of water absorption is in increasing order for higher mix ratios. It is also observed that foam brick absorbs more water than normal bricks. The variation in percentage of water absorption is presented in fig 5.

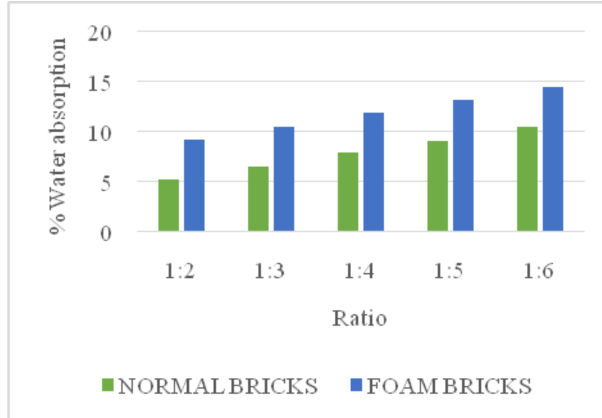

Figure 5: Percentage of water absorption of normal bricks and Foam bricks

C. *Compressive strength at an age of 28 days*

From the Table 7 & 8 , it is observed that the compressive strength is in decreasing order for higher mix ratios. It is also observed that the compressive strength of normal bricks is greater than that of foam bricks. The variation in compressive strength is presented in fig 6.

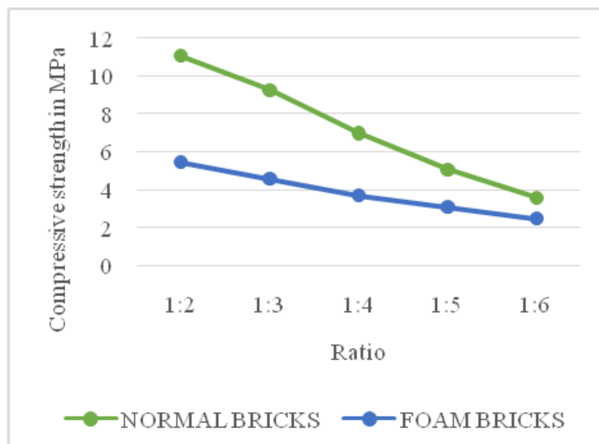

Figure 6: Compressive strength of Normal bricks and Foam bricks

D. *Thermal effect at an age of 28 days*

From the Table 13 and Table 14, it is observed that due to thermal effect the compressive strength is decreasing from its original compressive strength. The variation in compressive strength is presented in fig 7 and fig 8.

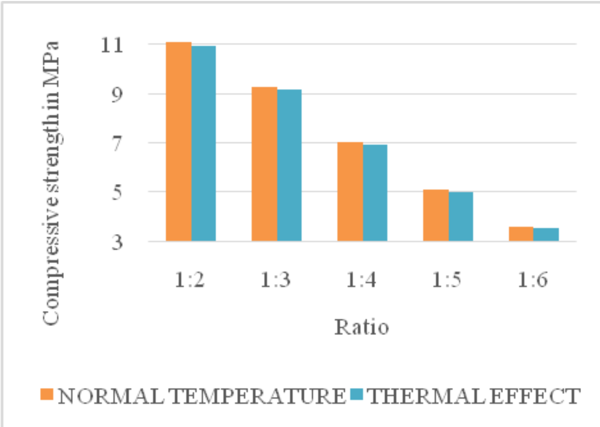

Figure 7: Variation in compressive strength due to thermal effect in Normal bricks

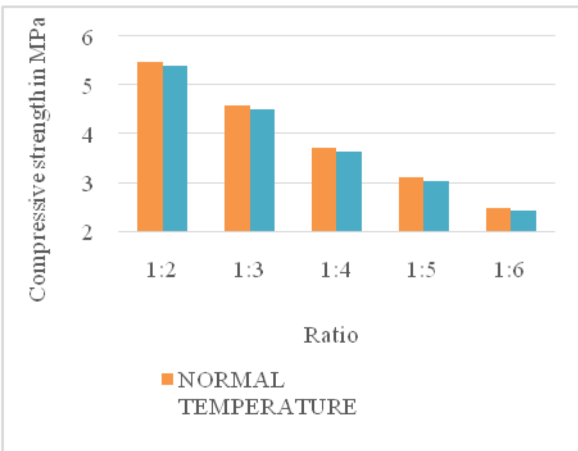

Figure 8: Variation in compressive strength due to thermal effect inFoam bricks

Table 13: Percentage reduction in compressive strength due to thermal effect in normal brick

Ratio	Compressive strength (N/mm²)		% Reduction in compressive strength (in %)
	Normal Temperature	Thermal effect	
1:2	11.08	10.94	1.26
1:3	9.28	9.15	1.40
1:4	7.00	6.90	1.43
1:5	5.09	5.01	1.57
1:6	3.60	3.53	1.94

Table 14: Percentage reduction in compressive strength due to thermal effect in Foam brick

Ratio	Compressive strength (N/mm²)		% Reduction in compressive strength (in %)
	Normal Temperature	Thermal effect	
1:2	5.47	5.39	1.46
1:3	4.58	4.51	1.53
1:4	3.72	3.65	1.88
1:5	3.10	3.03	2.26
1:6	2.48	2.42	2.42

E. Thermoshock effect at an age of 28 days

From the Table 15 and Table 16, it is observed that due to thermoshock effect the compressive strength is decreasing from its original compressive strength. The variation in compressive strength is presented in fig 9 and fig 10.

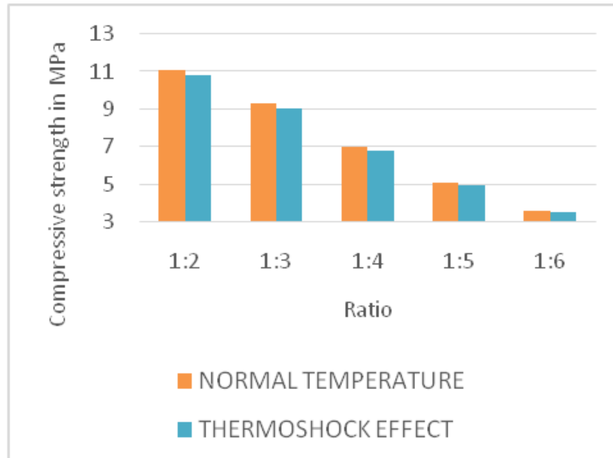

Figure 9: Variation in compressive strength due to thermoshock effect in Normal bricks

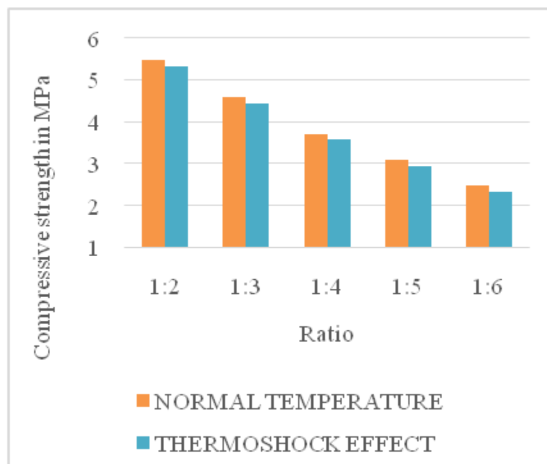

Figure 10: Variation in compressive strength due to thermoshock effect in Foam bricks

F. Percentage reduction in compressive strength

Table 15: Percentage reduction in compressive strength due to thermoshock effect in Normal brick

Ratio	Compressive strength (N/mm²)		% Reduction in compressive strength (in %)
	Normal Temperature	Thermo shock effect	
1:2	11.08	10.84	2.16
1:3	9.28	9.06	2.37
1:4	7.00	6.81	2.71
1:5	5.09	4.95	2.75
1:6	3.60	3.50	2.78

Table 16: Percentage reduction in compressive strength due to thermoshock effect in Foam brick

Ratio	Compressive strength (N/mm^2)		% Reduction in compressive strength (in %)
	Normal Temperature	Thermo shock effect	
1:2	5.47	5.32	2.74
1:3	4.58	4.43	3.26
1:4	3.72	3.59	3.49
1:5	3.10	2.95	4.84
1:6	2.48	2.34	5.65

G . Variation in compressive strength due to temperature

Table 17 and Table 18 shows the comparison of compressive strength of normal brick and foam brick subjected to temperature effect respectively. From this it is observed that even after thermoshock also the compressive strength of normal brick is greater than or equal to 3.5MPa. But in foam bricks the compressive strength is above 3.5MPa only upto the ratio 1:4.

Table 17: Variation in compressive strength due to thermal effect and thermoshock effect in Normal bricks

Ratio	Normal temperature (N/mm^2)	Thermal effect (N/mm^2)	Thermo shock effect (N/mm^2)
1:2	11.08	10.94	10.84
1:3	9.28	9.15	9.06
1:4	7.00	6.90	6.81
1:5	5.09	5.01	4.95
1:6	3.60	3.53	3.50

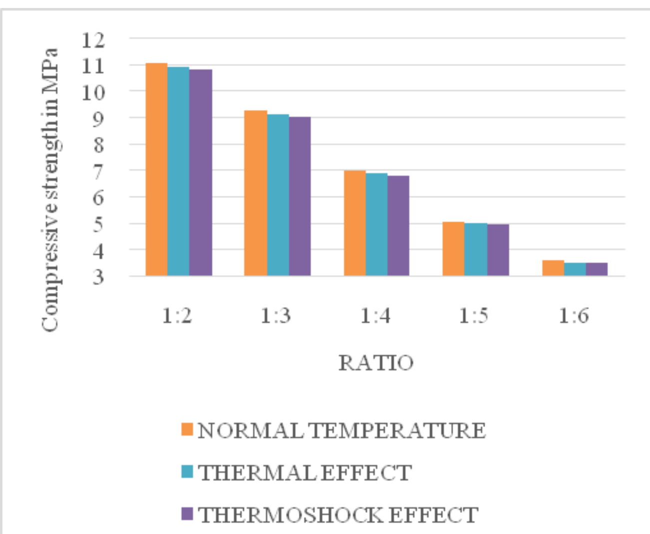

Figure 11: Variation in compressive strength due to thermal effect and thermoshock effect in Normal bricks

Table 18: Variation in compressive strength due to thermal effect and thermoshock effect in Foam bricks

Ratio	Normal temperature (N/mm^2)	Thermal effect (N/mm^2)	Thermo shock effect (N/mm^2)
1:2	5.47	5.39	5.32
1:3	4.58	4.51	4.43
1:4	3.72	3.65	3.59
1:5	3.10	3.03	2.95
1:6	2.48	2.42	2.34

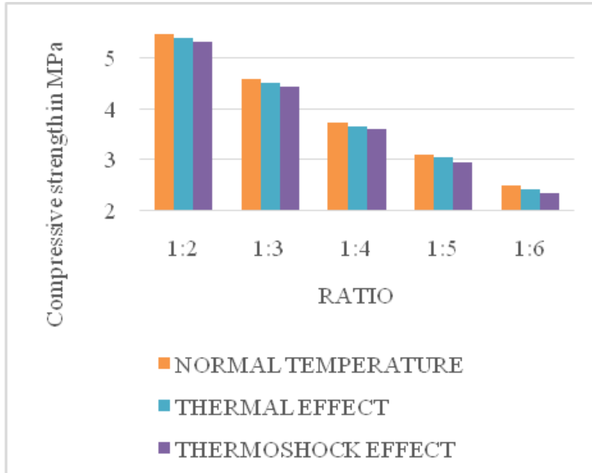

Figure 12: Variation in compressive strength due to thermal effect and thermoshock effect in Foam bricks

VI. CONCLUSION

From the test results, the following conclusions were made

- As density decreases, strength also decreases. Hence density is directly proportional to strength.
- Maximum water absorption of normal brick specimen and foam brick specimen is well below the allowable limit of 15%.
- 7 days compressive strength of the bricks is about 45 – 50% of the compressive strength of the brick attained at an age of 28 days.
- Minimum compressive strength and compressive strength due to thermal effect and thermoshock effect are greater than 3.5 MPa for normal bricks.
- Minimum compressive strength and compressive strength due to thermal effect and thermoshock effect are greater than 3.5 MPa for bricks with foaming agent upto 1:4 mix.
- Percentage reduction in compressive strength due to thermal effect is 1-2% for normal bricks and 1.4 - 2.5% for foam bricks.

- Percentage reduction in compressive strength due to thermoshock effect is2 - 3% for normal bricks and 2.5 – 6% for foam bricks.
- Normal bricks can be used for both load bearing and framed structures.
- Light weight bricks can be used for framed structures.

VII. ACKNOWLEDGEMENT

The Authors thank the Civil Engineering Department and P.A. College of Engineering and Technology, Pollachi, Coimbatore, India for providing materials and laboratory facilities to carry out the project work.

REFERENCES

[1] **Dr.G.Balamurugan,** "Experimental study on light weight foam concrete bricks", International Research Journal of Engineering and Technology, ISSN:2395-0056, Vol.04 Issue:11, 2017.

[2] **Dr.A.S.Kanagalakshmi,** "Investigation on foam concrete with quarry dust replacement for filler in mix design", An International journal, ISSN: 0976-1353, Vol.13 Issue:01, 2015.

[3] **Dr.T.Tharakarama,** "An Experimental investigation on light weight foam cement blocks with quarry dust replacement for fine aggregate", International Research Journal of Engineering and Technology, ISSN:2395-0056, Vol.04 Issue:11, 2017.

[4] **Mr.S.Ravi Shankar,** "Experiment of foam concrete with quarry dust as partial replacement for filler", International Journal of Engineering Research and Technology, ISSN:2278-0181, Vol.4 Issue:03, 2015.

[5] **G.Balamurugan** and **Dr.P.Perumal,** ''Use of Quarry Dust to Replace Sand in Concrete- An Experimental Study", International Journal of Scientific and Research Publications, ISSN:2250-3153, Vol. 3 Issue 12, December 2013.

[6] **G.Balamurugan** and **Dr.P.Perumal,** ''Experimental Study on the Thermal and Thermoshock Effects on the Concrete Strength due to the Use of Quarry Dust for Replacing Sand",European Journal of Scientific Research, ISSN: 1450-216X, Vol. 92 No.1,December 2012.

[7] **T.Ravindaran** and **R.Gowri Shankar** "Partial Replacement of fly Ash with Slurry Sand in fly Ash Bricks",ISBN NO:978-93-5311-224-0.

[8] **B.Veena & K.Sivakumar "**Experimental study on the effect of liquid foam on Lightweight bricks",International Journal of Scientific Development and Research, ISSN: 2455-2631,Volume 2, Issue 1.

[9] **N.Mohamad & A. S. Mat Said "**Experimental study to determine the mechanical properties of Lightweight foam concrete bricks", Journal of Materials and Environmental Sciences, ISSN : 2028-2508.