International Journal of Scientific & Engineering Research Volume 11, Issue 3, March-2020
ISSN 2229-5518

Foam Concrete Brick- An Experimental study

Mr.M.Sathees Kumar*, M.Brindha**, M.Abdul Razack**, N.Gunasekaran**, S.Naveen**
*Asst, professor, Department of Civil Engineering, P. A. College of Engineering and Technology, Pollachi, Tamilnadu, India.
** Student, Department of Civil Engineering, P. A. College of Engineering and Technology, Pollachi, Tamilnadu, India.

Abstract— This project deals with effective utilization of Marble dust from Marble manufacturing unit for economic, environmental and technical aspects. In this paper, a comparative study is done to study the properties of normal foam bricks (made using cement, M-Sand, and foaming agent) and Marble dust foam bricks (made using cement, Marble dust 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 Marble dust such as 1:2, 1:3, and 1:4. Various tests like Compressive strength test, Water absorption test, Thermal resistance test, Thermoshock test were conducted on these brick specimens as per Indian Standards.

Index Terms— Foam brick, Marble Dust, Cement, Foaming Agent, Waste-product, Lightweight.

1. INTRODUCTION

Foam concrete is nowadays largely utilized in construction industry due to light weight and straight forward preparation. It occupies the portion to fill better than any other compound. Uniform distribution of air bubbles through the mass of concrete makes 20% of entrapped air, which makes it so light than the conventional concrete. Foam concrete has been successfully used and it has gained popularity due to lower weight. For foam concrete, generally river sand is employed as filler material. Due to rapid usage, there's a shortage of conventional construction material river sand and so costly one. In order to minimize this it is necessary to think of alternate materials. It is observed from previous study that the maximum ratio of cement with filler for foam concrete as 1:2.5, so in this study we fixed the trial mixes from 1:0 to 1:3 to confirm the maximum ratio. This is an experimental study on how the strength of foam concrete varied when sand is replaced by marble dust.

Normal foam bricks

These bricks are also known as Lightweight cellular bricks. These bricks are made with Ordinary Portland Cement (OPC), M-sand Foaming agent (animal protein based) and Water. The Mortar is placed in the mould. These bricks have wide range of applications.

Marble dust foam bricks

These bricks are also known as Lightweight cellular bricks. These bricks are made with Ordinary Portland Cement (OPC), Marble dust, Foaming agent (animal protein based) and Water. The Mortar is placed in the mould. There is no need of compaction.

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.

2. MATERIALS AND THEIR PROPERTIES

2.1. Cement

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

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

Table 1.Properties of cement

2.2. M-Sand

M-Sand may be a substitute of river sand for concrete construction. It is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges washed and graded to as a construction material. The size m-sand is less than 4.75mm.

Table 2.Properties of M-sand

S.NO	DESCRIPTION	VALUE
1	Specific gravity	2.37
2	Density	1750kg/m³

2.3. MARBLE DUST

Marble dust is a waste product formed during the production of marble. A large quantity of powder is generated during the cutting process.The result is that about 25% of original marble mass is in the form of dust. Marble dust, a solid waste generated from the marble processing often be used either as a filler material in cement or fine aggregates while preparing brick.

Table 3 Properties of Marble dust

S.NO	DESCRIPTION	VALUE
1	Specific gravity	3.05
2	Density	1570kg/m³

2.4. Water

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

2.5. Foaming agent

A foaming agent is a material that facilitates formation of foam like a surfactant or a blowing agent. A surfactant, when present in small amounts, reduces surface tension of a liquid) or increases its colloidal stability by inhibiting coalescence of bubbles. A blowing agent may be 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.

2.6. Mould

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

3. 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.M-Sand & Marble dust foam bricks specimen in Fig.1& Fig 2

Fig.1

Fig 2

4. TESTING PROCEDURE

A. Density test

The specimens (3 no's) were kept in oven at $100^{o}C$ for 60 minutes and then weighed. The density of specimen was calculated and tabulated in table 4.

Table 4.Density of Normal Foam bricks and Marble Dust Foam bricks

Ratio	Weight (kg)	Volume (m^3)	Density (kg/m^3)
1:2	2.74	$1.983x10^{-3}$	1382
1:3	2.63	$1.983x10^{-3}$	1326
1:4	2.58	$1.983x10^{-3}$	1301

B.Water absorption test

The specimen were (3 no's) immersed in water for 24 hours and weighed (W1) then they kept in a ventilated oven for one hour and weighed (W2). Percentage of water absorption W1 - W2/ W2 x 100.The percentage of water absorption was calculated and tabulated in table 5.

Table 5. Compressive strength of the Normal Foambricks after 7 days

Ratio	Normal Foam bricks (in %)	Marble Dust Foam bricks Foam(in %)
1:2	8.1	7.4
1:3	9.4	6.4
1:4	8.7	5.7

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 usually placed in between two plates that distribute the applied load across the whole area of two opposite faces of the test sample 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 7days was calculated and tabulated in table 6 and table 7

Table 6. Compressive strength of the Normal Foam bricks after 7 days

Ratio	Compressive strength after 7 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	2.85	2.82	2.83	2.83
1:3	2.69	2.75	2.71	2.72
1:4	2.65	2.62	2.64	2.64

Table 7. Compressive strength of the Marble Dust Foam bricks after 7 days

Ratio	Compressive strength after 7 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	

1:2	2.66	2.65	2.68	2.66
1:3	2.54	2.52	2.53	2.53
1:4	2.52	2.50	2.48	2.51

The compressive strength of specimen after 28 days was calculated and tabulated in Table 8 and Table 9.

Table 8. Compressive strength of the Normal Foam bricks after 28 days

Table 9 Compressive strength of the Marble Dust Foam bricks after 28 days

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm^2)
	S1	S2	S3	
1:2	5.33	5.44	5.41	5.39
1:3	4.5	4.61	4.52	4.6
1:4	3.71	3.86	3.6	3.72
1:2	5.18	4.99	5.1	5.1
1:3	4.6	4.5	4.4	4.5
1:4	3.7	3.6	3.5	3.6

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 10 and Table 11.

Table 10.Thermal effect on Normal foam bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm2)
	S1	S2	S3	
1:2	5.2	5.07	5.14	5.14
1:3	4.31	4.31	4.3	4.3
1:4	3.67	3.59	3.4	3.6

Table 11.Thermal effect on Marble Dust Foam bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm2)
	S1	S2	S3	
1:2	4.8	4.9	4.7	4.8
1:3	4.5	4.2	4.1	4.2
1:4	3.4	3.3	3.2	3.3

E. Thermo shock 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 then tested in Compression Testing Machine.The compressive strength of specimen was calculated and presented in Table 12 and Table 13.

Table 12. Thermoshock on Normal Foam bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm2)
	S1	S2	S3	
1:2	5.17	5.03	5.14	5.12
1:3	4.31	4.16	4.39	4.28
1:4	3.52	3.36	3.55	3.48

Table 13. Thermoshock on Marble Dust Foam bricks

Ratio	Compressive strength after 28 days (N/mm^2)			Mean (N/mm2)
	S1	S2	S3	
1:2	4.9	4.7	4.6	4.7
1:3	4.2	4.0	4.1	4.1
1:4	3.4	3.3	3.1	3.2

5.RESULT AND DISCUSSION

A Density test at an age of 28 days

From the Table 14, it is observed that the density is in decreasing order for higher mix ratios. It is also observed that the density of normal Foam bricks is greater than that of Marble dust foam bricks. The variation in density is presented in fig.3

Table 14. Density of Normal Foam bricks and Marble Dust Foam bricks

Ratio	Normal Foam bricks (kg/m^3)	Marble Dust Foam bricks(kg/m^3)
1:2	1382	1325

1:3	1326	1296
1:4	1301	1256

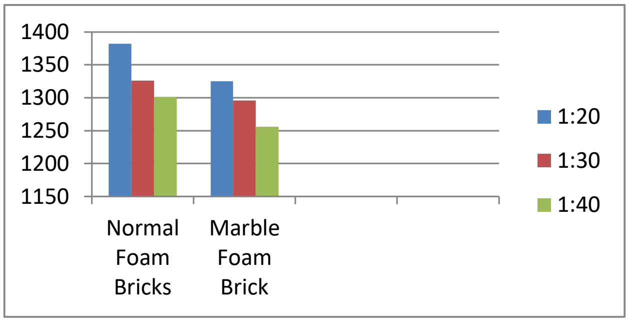

Fig. 3 Density of Normal Foam bricks and Marble Dust Foam bricks

B.Water absorption at an age of 28 days

From the Table5.2, it is observed that the percentage of water absorption is in increasing order for higher mix ratios. It is also observed that marble dust foam brick absorbs more water than normal foam bricks. The variation in percentage of water absorption is presented in fig.4

Table 15. Percentage of water absorption of Normal bricks and Foam bricks

Ratio	**Normal Foam bricks (in %)**	**Marble Dust Foam bricks Foam(in %)**
1:2	8.1	7.4
1:3	9.4	6.4
1:4	8.7	5.7

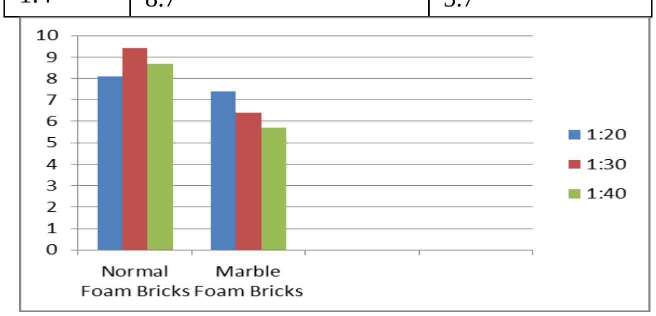

Fig. 4 Percentage of water absorption of Normal Foam bricks and Marble Dust Foam bricks

C.Compressive strength at an age of 28 days

From the Table 16, 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 Foam bricks is greater than that of marble dust foam bricks. The variation in compressive strength is presented in fig.5

Table 16.Compressive strength of Normal Foam bricks and Marble Dust Foam bricks

Ratio	**Normal Foam bricks (N/mm²)**	**Marble Dust Foam bricks (N/mm²)**
1:2	5.39	5.1
1:3	4.6	4.5
1:4	3.72	3.6

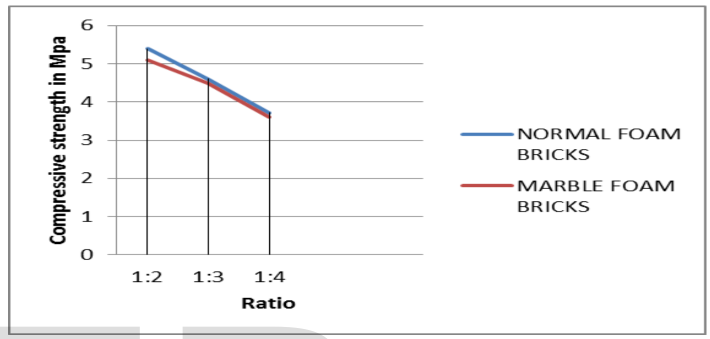

Fig.5 Compressive strength of Normal Foam bricks and Marble Dust Foam bricks

D. Thermal effect at an age of 28 days

From the Table 17 and Table 18, 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.6 and fig.7.

Table.17 Percentage reduction in compressive strength due to thermal effect in Normal Foam brick

Ratio	**Compressive strength (N/mm²)**		**% Reduction in compressive strength (in %)**
	Normal strength	**Thermal effect**	
1:2	5.39	5.14	2.5%
1:3	4.6	4.3	2.2%
1:4	3.72	3.6	1.2%

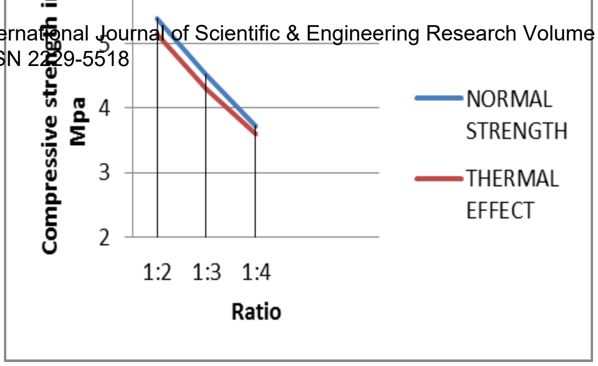

Fig.6Variation in compressive strength due to thermal effect in Normal Foam bricks

Table.18. Percentage reduction in compressive strength due to thermal effect in Marble Dust Foam bricks

Ratio	Compressive strength (N/mm²)		% Reduction in compressive strength (in %)
	Normal strength	Thermal effect	
1:2	5.1	4.8	3%
1:3	4.5	4.2	3%
1:4	3.6	3.3	3%

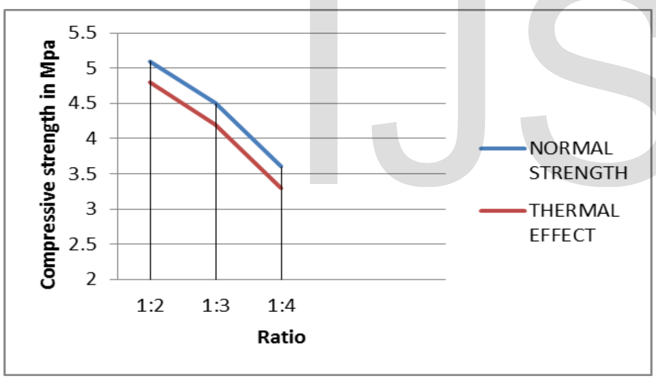

Fig. 7 Variation in compressive strength due to thermal effect in Marble Dust Foam bricks

E.Thermoshock effect at an age of 28 days

From the Table 19 and Table 20 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.8 and fig.9.

Table 19 Percentage reduction in compressive strength due to thermoshock effect in Normal Foam brick

Ratio	Compressive strength (N/mm²)		% Reduction in compressive strength (in %)
	Normal strength	Thermoshock effect	
1[illegible]	[illegible]	[illegible]	[illegible]
1[illegible]	[illegible]	[illegible]	[illegible]
1[illegible]	[illegible]	[illegible]	[illegible]

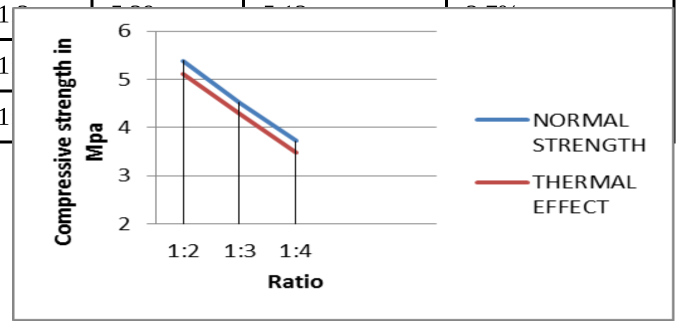

Fig. 8 Variation in compressive strength due to thermoshock effect in Normal Foam bricks

Table 20 Percentage reduction in compressive strength due to thermoshock effect in Marble Dust Foam bricks

Ratio	Compressive strength (N/mm²)		% Reduction in compres-sive strength (in %)
	Normal strength	Thermoshock effect	
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

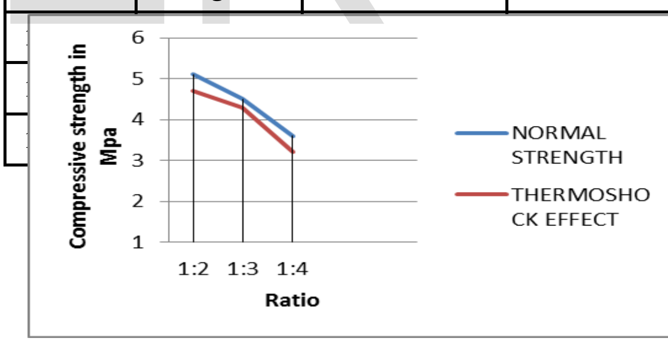

Fig. 9 Variation in compressive strength due to thermoshock effect in Marble Dust Foam bricks

F. Variation in compressive strength due to temperature

Table 21 and Table 22 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 21 Variation in compressive strength due to thermal effect and thermoshock effect in Normal Foam bricks

Ratio	Normal temperature (N/mm^2)	Thermal effect (N/mm^2)	Thermoshock effect (N/mm^2)
1:2	5.39	5.14	5.12
1:3	4.6	4.3	4.28
1:4	3.72	3.66	3.48

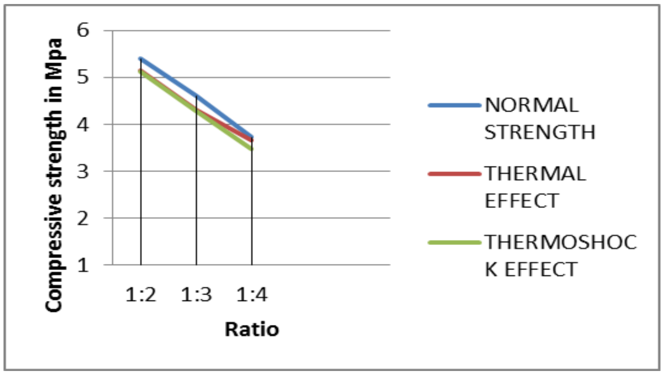

Fig. 10 Variation in compressive strength due to thermal effect and thermoshock effect in Normal Foam bricks

Table 22 Variation in compressive strength due to thermal effect and thermoshock effect in Marble Dust Foam bricks

Ratio	Normal temperature (N/mm^2)	Thermal effect (N/mm^2)	Thermoshock effect (N/mm^2)
1:2	5.1	4.8	4.7
1:3	4.5	4.2	4.1
1:4	3.6	3.3	3.2

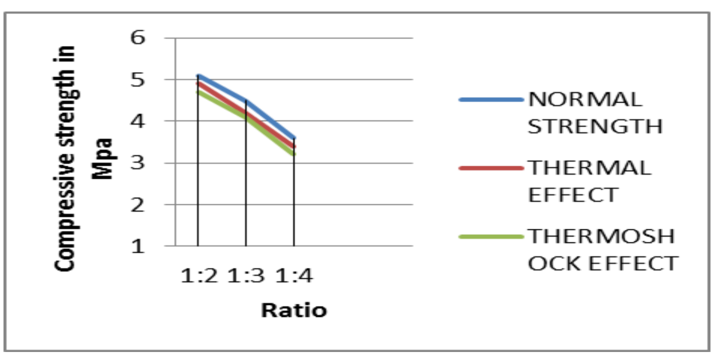

Fig. 11 Variation in compressive strength due to thermal effect and thermoshock effect in Marble Dust Foam bricks

CONCLUSION

- Light weight bricks can be used for framed structures. Normal bricks can be used for both load bearing and framed structures
- Reduction in compressive strength due to thermoshock also in decreasing order for higher mix ratios of all filler materials.
- Minimum compressive strength, thermal effect and thermoshock effect are greater than 3.5 Mpa for bricks with foaming agent upto 1:4 mix.
- Maximum water absorption of normal brick specimen and foam brick specimen is well below the allowable limit of 15%.
- As density decreases, strength also decreases. Hence density is directly proportional to strength.

ACKNOWLEDGEMENT

The Authors thank the Civil Engineering Department and P.A. College of Engineering and Technology, Pollachi, Coimbatore, India for providing materials and granting 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:4 Apr, 2017.
2. **Er. Ankur Kansal,** "An Experimental Study on the Utilization of Marble and Granite Waste Slurry in Manufacturing of Bricks", International Journal on Emerging Technologies, ISSN: 0975-8364, Vol.03 Issue: 12 June, 2018.
3. **Er.P.Sathish and Er.C.Neeladharan,** "Behaviour of Light Weight Foam Concrete Block By Using GGBS and Foaming Agent", International Journal of Advanced Research Trends in Engineering and Technology ,ISSN 2394-3785, Vol.05 Issue: 5, March 2018.
4. **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.
5. **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.
6. **Ms.J.Thivya,** "A Study of Manufacturing and Experimental Behaviour of Cellular Lightweight Concrete (CLC) Bricks", International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319 – 8753, Vol 7, Issue: 5, April 2018.