

A Study of Manufacturing and Experimental Behaviour of Cellular Lightweight Concrete (CLC) Bricks

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ABSTRACT: This paper presents an experimental study on the effect in strength of foam concrete using three different filler materials such as river sand, sea sand and quarry dust with cement. Cement and filler mixed in proportions 1:0, 1:1, 1:2 and 1:3 in weight basis. The foaming agent was added with water and mixed thoroughly. Mixed cement and filler added slowly with this and after certain minutes this gel poured in to the mould of size 19 x 9 x 9 cm to get the brick specimen. The specimens were water cured for 28 days. The compressive strength of this light weight foam concrete bricks at an age of 28 days was obtained at normal temperature. Then the specimens after 28 days curing were heated to 100°C in an oven for 24 hours and tested. Also the specimens kept at 100°C for 24 hours were suddenly immersed in water and subjected to thermoshock and tested for compressive strength. The loss of strength due to thermal and thermo shock effect were compared with conventional concrete (River sand as filler). From the results, it is found that sea sand as well as quarry dust can be used as alternate filler material for natural river sand in foam concrete.

Although building techniques and materials have evolved over thousands of years, construction is still along, complex, and expensive process. Construction industry boom can be seen in almost all the developing countries. With the increase in material costs in the construction industry, there is a need to find more cost saving alternatives so as to maintain the cost of constructing houses at prices affordable to people. There is need to develop an alternative system of building component which would impart more benefits and are multifunctional with optimum use of labour and material. Cellular light weight brick wall in Rat-trap bond is an innovative technique for building masonry unit which reduces the construction cost, time and labor considerably. This may not solve all construction problems but they do resolve many issues associated with traditional materials.

KEYWORDS: Foam concrete, Foaming agent, Cement, Sea sand, River sand, Quarry dust.

I. INTRODUCTION

The construction method of using conventional bricks has been revolutionized by the development and usage of lightweight concrete blocks. The tedious and time-consuming traditional brick-laying tasks are greatly simplified by the usage of these effective alternative solutions. The focus is now more on seeking environmental solutions for greener environment. The usage of Cellular Light-weight Concrete (CLC) blocks in Rat-Trap bond would gives a prospective solution to building construction industry along with environmental preservation. The demand of

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 7, Special Issue 5, April 2018

1st International Conference on Recent Innovation in Civil Engineering and Management (ICRICEM '18)

22nd March 2018

Organized by

Department of Civil Engineering & MBA, Loyola Institute of Technology, Chennai, Tamilnadu, India

bricks could be met by establishing small units near thermal power stations and to meet the local demand with less transportation costs.

Foam concrete is nowadays largely used in construction industry due to light weight and easy 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 used as filler material. Due to rapid usage, there is a shortage of conventional construction material river sand and so costly one. In order to minimise 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 sea sand as well as quarry dust.

1.1 OBJECTIVE

- To reduce the weight of the bricks
- To control the co2 emission
- Low investment
- Quick returns
- Future products for construction industries
- Green Product
- Less competition market
- Can earn more percentage of profit
- Only 10HP power is required to run the plant and can be owned without major engineering expertise.
- Environmental friendly
- Quantity of cement is less when making a wall why because accurate edges and even surface
- CLC bricks life span is more than other bricks
- CLC block size can be made of any size according to our requirements

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3. COMPARISON BETWEEN BURNT CLAY BRICK, FLY ASH BRICK AND CLC BRICK

Table 1 Comparison between burnt clay brick, Fly ash brick and CLC brick

S.NO	Parameters	Burnt clay bricks	Fly ash bricks	CLC-bricks
1	Basic raw material	Agricultural /Ret soil and wood coal or Bagasse	Cement, fly ash, sand, & aggregate	Cement, fly ash, foaming agent
2	Production process	Process Brick kiln	Plant/ projectsite	Plant/ projectsite
3	Dry Density	1800-2000	900-2100	400-1800
4	Application	Load bearing & non load bearing	Load bearing & non load bearing	Thermal insulation wall non load bearing external wall
5	Compressive strength Kg/cm ²	20-80	30-150	25-40
6	Brick size LXB	190x90x90, 230x110x76 & 230x150x	190x90x90, 230x110x	230x76x95, 300x150

	H mm	76	76 & 230x150x76	230x150x600x300x100/150/200
7	Efflorescence	Slight to Moderate	Nil	Nil
8	Warping	<2.5 to 3.0 mm	<1.0 to 2.0mm	<1.0 to 2.0mm
9	Aging	No	Yes	Gains strength with age
10	Thermal Insulation	Better	Normal	Very good
11	Sound	Normal	Better	Very good
12	Ease in working	Normal	Normal	Very easy
13	Labour requirement	100%	100%	50% of normal brick work
14	Eco-Friendliness	- Process creates smoke-Uses high energy for firing-	-No smoke -Low energy hydraulic	- Pollution free, -least energy

Cellular Lightweight Concrete (CLC) is conventional concrete, where natural aggregate (gravel) is exchanged for the best insulation medium available, namely air, embedded in organic and bio-degradable foam that offers no chemical reaction but solely serves as wrapping material for the air. Consequently CLC behaves, like conventional concrete, in particular concerning curing, hardening and most important “ageing “. CLC infinitely increases its strength by hydration (forming of crystals in cement) as long as exposed to humidity in the atmosphere. For structural (steel-reinforced) application, CLC is used in densities of 1,200 to 1,400 kg/m³, which, due to the billion of micro-sized and uniform air bubbles offer 500 % more thermal insulation and a substantially higher fire-rating than conventional concrete. If a wall of conventional concrete should offer the same thermal insulation as CLC, the wall produced would have to measure 5 times thicker and therefore also use 10 times more material (sand, gravel, cement) to produce. CLC structures in hot climatic zones require only 1/5th energy for air-conditioning when

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compared to traditional clay- brick structures. Since the early twentieth century, two ideas were developed to produce lightweight concrete – Aerated Autoclave Concrete (AAC) and Cellular Lightweight Concrete conserve fertile agricultural soil. It has a dramatic impact on emission of Green House Gases created during cement manufacturing.

II. MATERIALS AND THEIR PROPERTIES

2.1 Cement

The cement used for this study is Ordinary Portland cement (OPC) of 53 grade conforming to IS 1226: 1978. The specific gravity of cement was found to be 3.15.

2.2 River Sand

Sand used for this study was collected from river Cauvery, Tiruchirappalli. In this study sand passing through IS sieve of size 600 microns was used. The specific gravity of river sand was found to be 2.61.

2.3 Quarry Dust

Quarry dust is a residue obtained during stone crushing process in crusher units. It is also used as an effective alternative material in normal concrete instead of fine aggregate sand. In this study Quarry dust passing through IS sieve of size 600 microns was used. The specific gravity of quarry dust was found to be 2.84

2.4 Sea Sand

Sea sand is the material which is available in plenty all over the world along the shore. The sea sand was used in the construction field after the removal of salt content from it. An experimental setup with sea sand has been made suitable for construction purpose by reducing the salt content to equalize its properties similar to the river sand. The salt was removed from sea sand by washing with ample water. Hence, it is converted in to inert material free from nature of corrosion. Sea sand passing through IS sieve of size 600 microns was used for this study. The specific gravity of sea sand was found to be 2.38 .

2.5 Water

Potable water with pH value 7 was used for mixing and curing throughout this experiment.

2.6 Foaming Agent

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

For this experiment animal Protein based Foaming agent was used. Foams from protein-based have a weight of around 800 g/litre. Protein-based foaming agents produced from animal proteins other than horn, blood, bone of animals. The recommended dosage is 30 ml per litre of water.

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III. MIX PROPORTIONING

In this study four different mix ratios of cement with filler were prepared. Two alternate fillers were used in place of sand. The different mix ratios are tabulated in Table 3.

Table 4: Mix ratios

SL.NO	DESCRIPTION	MIX RADIO
1	Cement : River sand	1:0, 1:1, 1:2, 1:3
2	Cement : Sea sand	1:0, 1:1, 1:2, 1:3
3	Cement : Quarry dust	1:0, 1:1, 1:2, 1:3

VI. DENSITY TEST

The specimen were (3 no's) kept in oven at 100 C for 60 minutes and then weighed. The density of specimen was calculated and is tabulated in Table 4.

Table 5: Density of brick specimen (Kg/m3)

Ratio	cement :River sand	cement : Sea sand	cement : Quarry dust
1:0	607.54	607.53	607.53
1:1	964.91	897.98	1341.78
1:2	1120.89	1026.64	1510.72
1:3	1435.99	1341.78	1767.38

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 test 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. A compression test is essentially the opposite of the more common tension test. The compressive strength of specimen was calculated and tabulated in Table 6, Table 7 and Table 8.

Table 7: Compressive strength of foam concrete bricks using river sand as filler

CEMENT:R IVER SAND	COMPRESSIVE STRENGTH(N- MM ²)			MEAN COMPRESSIVE STRENGTH(N/MM ²)
	S1	S2	S3	
1:0	1.82	1.69	1.70	1.73
1:1	1.99	1.91	1.96	1.95
1:2	2.82	2.80	2.92	2.84
1:3	3.70	3.77	4.02	3.83

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Table 8: Compressive strength of foam concrete bricks using sea sand as filler

CEMENT:R IVER SAND	COMPRESSIVE STRENGTH(N- MM ²)			MEAN COMPRESSI VE STRENGTH(N-MM ²)
	S1	S2	S3	
1:0	1.82	1.69	1.70	1.73
1:1	1.78	1.82	1.74	1.78
1:2	2.21	2.11	2.28	2.2
1:3	3.13	3.20	3.29	3.21

Table 9: Compressive strength of foam concrete bricks using quarry dust as filler

CEMENT:R IVER SAND	COMPRESSIVE STRENGTH(N- MM ²)			MEAN COMPRESSI VE STRENGTH(N-MM ²)
	S1	S2	S3	
1:0	1.82	1.69	1.70	1.73
1:1	2.90	2.94	3.09	2.98
1:2	4.65	4.77	4.69	4.70
1:3	5.27	5.51	5.67	5.49

5.1 WATER ABSORPTION TEST

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

Ratio	cement :River sand	cement : Sea sand	cement : Quarry
1:0	13.43	13.43	13.43
1:1	11.67	11.86	10.58
1:2	9.78	10.26	9.50
1:3	9.37	9.36	8.54

Table 6: Percentage of water absorption

From the Table 6, it is observed that the density of foam concrete bricks increased with increase in mix ratio. Further Quarry dust as filler foam concrete density is higher than sea sand or river sand as filler. The variation in density is presented in Chart - 1.

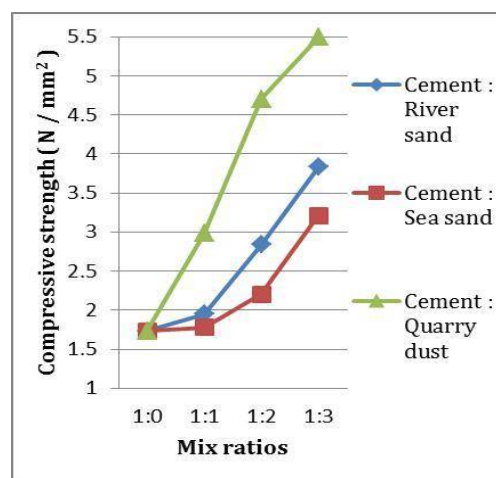
5.2 DENSITY OF FOAM CONCRETE BRICK

Ratio	cement :River sand	cement : Sea sand	cement : Quarry dust
1:0	13.43	13.43	13.43
1:1	11.67	11.86	10.58
1:2	9.78	10.26	9.50
1:3	9.37	9.36	8.54

5.3 COMPRESSION TEST

In a compression test a material experiences opposing forces that push inward upon the specimen from

Chart -3: Compressive Strength of foam concrete bricks at an age of 28 days



V. CONCLUSIONS

From the test results the following conclusions are made

- ❖ .Foam concrete specimen with quarry dust as filler gained more density and sea sand as filler gained very close density with conventional foam concrete (River sand as filler).
- ❖ Maximum water absorption of foam concrete brick specimen is well below the allowable limit of 15%.
- ❖ Compressive strength of specimen using quarry dust as filler gained more and sea sand as filler gained very close results with conventional foam concrete.
- ❖ Reduction in compressive strength due to thermal effect is in decreasing order for higher mix ratios of all filler materials.
- ❖ Reduction in compressive strength due to thermoshock also in decreasing order for higher mix ratios of all filler materials.

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From the above conclusions sea sand as well as quarry dust may be used as alternate materials in foam concrete as filler.

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