

Comparative Study of Compressive Strength of CLC Blocks Made With Waste Materials to CLC Blocks

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Abstract

Global warming and environmental pollution is now a global concern. Cellular light weight concrete (CLC) block can be used as an alternative to conventional bricks, to reduce environmental pollution and global warming. The energy consumed in the production of CLC blocks is only a fraction compared to the production of conventional bricks and emits no pollution. Present study work is carry out the work on properties of fly-ash and foaming agent, experimental work (casting cubes) on cellular lightweight concrete and comparison of strength between CLC blocks and conventional brick. The work, shows the comparison of compressive strength of CLC blocks made with waste materials with conventional clay bricks by taking a mould size as a standard size of conventional brick 19cm x 9cm x 9cm. We have used different waste materials (sawdust and rice husk) in protein based CLC blocks, replacing the sawdust and rice husk with sand by 4%, 8%, 12% and 16% and cure the blocks for 21 days to compare the compressive strength by graph.

Keywords- CLC Technology, Foaming Agent, Aluminum Powder, sawdust, rice husk, CLC Blocks, Light Weight Bricks.

I. INTRODUCTION

Lightweight Construction Methods (LCM) (also known as foam concrete (FC)/cellular light weight concrete (CLWC) were developed more than 60 years ago and since then have been used internationally for different construction applications. LCM has been used in the building industry for applications such as apartments, houses, schools, hospitals, and commercial buildings.

Foam concrete is a mixture of cement, fine sand, water and special foam, which, once hardened, results in a strong, lightweight concrete containing millions of evenly distributed, consistently sized air bubbles or cells. The density of FC is determined by the amount of foam added to the basic cement and sand mixture. Foam concrete is both fire-and water resistant. It possesses high (impact and air-borne) sound and thermal insulation properties. Foam concrete is similar to conventional concrete as it uses the same ingredients. However, foam concrete differs from conventional concrete in that the use of aggregates in the former is eliminated. A foam aeration agent is used to absorb humidity for as long as the product is exposed to the

atmosphere, allowing the hydration process of the cement to progress in its ever-continuing strength development.

Global warming and Environmental pollution is now a global concern. Cellular Light Weight Technology blocks can be used as an alternative to the red bricks, to reduce Environmental pollution and Global warming. CLC blocks are environment friendly. The energy consumed in the production of CLC blocks is only a fraction compared to the production of red bricks and emits no pollutants and creates no toxic products or by products. It is produced by initially making a slurry of Cement + Fly Ash + Water, which is further mixed with the addition of pre-formed stable foam in an ordinary concrete mixer under ambient conditions.

Based on the trial mixes, it is found that compressive strength of CLC blocks is more than the compressive strength of conventional clay bricks.

The addition of foam to the concrete mixture creates millions of tiny voids or cells in the material, hence the name Cellular Concrete.

II. MATERIAL SPECIFICATION & BLOCK DIMENSIONS

2.1. Cement

The cement used in all mixtures is commercially available Portland cement of 53 grade conforming to IS 12269:1987 is used in this study. The specific gravity of cement is 3.13.

2.2. Water

The water used in the manufacture of CLC Blocks is potable water.

2.3. Fly-Ash

Class F Fly-ash, the by-product in thermal power plants, is collected from Kankarapar Thermal Power Plants, Gujarat. Fly ash conforming to IS 3812 (part-1) is used and uniform blending of fly ash with cement is ensured.



Figure 1. Class F Fly-Ash

2.4. Foaming Agent

Foaming agent may be used with all types of Portland cement and incorporated into cement only, or sand-cement mortar slurries to produce foamed concrete of every type and for every application. Its cost as a proportion of the total cost of foamed concrete is tiny, typically only about 1-3%.

The foam causes no chemical reaction in the concrete but merely serves as wrapping material for the air entrapped. It produces no fumes or emission over its lifetime. Store-life of the foaming agent is guaranteed to be at least 24 months when adhered to instruction. Only 1 liters of foam foaming agent is sufficient to produce 1m^3 of CLC for instance in a density of 1.200 kg/m^3 .



Figure 2. Protein based foaming agent

2.5. Sawdust

Sawdust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool; it is composed of fine particles of wood. SD used in this research is a mixture of wastes from both hard and soft woods.



Figure 3. Sawdust

2.5. Rice Husk

Rice husk or rice hulls are the hard protecting covering of grains of rice. In addition to protecting rice during the growing season, rice husk can be put to use as building materials, fertilizer, insulation material and fuel.

2.6. Size of CLC Blocks

We have to prepare a mould as same size of the conventional brick. The standard size of conventional brick is $19\text{cm} \times 9\text{cm} \times 9\text{cm}$. So we have casted same size of CLC blocks and check its compressive strength after 21 days of curing in lab.

III. MANUFACTURING PROCESS

3.1. Casting Method

Cellular lightweight concrete is manufactured in two methods.

First method, consists of mixing a pre-formed foam [surfactant] or mix-foaming agents mixture into the cement and water slurry.

Second method, known as Autoclaved Aerated Concrete [AAC] consists of a mix of lime, sand, cement, water and an expansion agent.

3.1.1. MATERIALS USED IN FIRST METHOD

The materials used in first method are given below.

- Ordinary Portland Cement
- Class F fly-ash
- Protein based foaming agent
- Sand

3.1.2. MATERIALS USED IN SECOND METHOD

The CLC blocks which are manufacture from the second method is also known as Autoclaved Aerated Concrete (AAC) blocks. The materials used in this method are given below.

- Cement
- Fly-ash (Class F)
- Quick Lime
- Soluble oil
- Aluminum Powder
- Plaster of perish (POP)

3.2. CASTING OF CLC BLOCKS WITH DIFFERENT WASTE MATERIALS

In this paper, we have casted CLC blocks with different waste materials which are rice husk and saw-dust. The method of casting of CLC blocks is same as the first method. In the first method the dry mixture of cement, sand, fly-ash is mixed first. After the mixing of dry component the water is added. At the same time the foaming agent is generated with the help of drill machine. The foaming agent is dilute into the 40 part of portable water and after the dilute it in water the foam is generates with the help of high rpm machine.

In addition, we had add only two waste materials as fine aggregate with replacement of sand. The foam generation process has been affected by these two materials so the weight of blocks increase by some percentage but not more than conventional clay

brick or red bricks.

3.2. Quantity of blocks

The volume of three blocks is $4.617 \times 10^{(-3)} \text{ m}^3$ so for the 1300 kg/m^3 density the volume of the materials should be 6 kg. The sawdust and rice husk are replaced with sand by 4%, 8%, 12% and 16%.

Table 1: Quantities of materials for 3 block

Sr. No	Materials	Weight of material (kg)
1	Cement	2.2
2	Sand	1.66
3	Fly ash	2.2
4	Faming agent	80 ml
Total		6.06

IV. TEST RESULTS

Table 2: Average Strength of CLC Blocks & Conventional Clay Bricks after 21 Days

Sr. No	Description	Load (kN)	Area (mm ²)	Average Strength (N/mm ²)
1	CLC Blocks(Protein based)	153.33	17100	8.96
2	CLC Blocks (Aluminum as Foaming Agent)	96.67	17100	5.65
3	Conventional Clay Bricks	100	17100	5.84

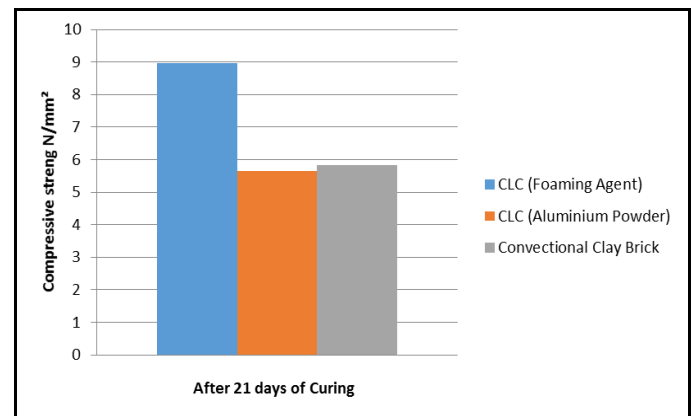


Figure 4: Compressive Strength after 21 Days of Curing

Table 3: Average Strength of CLC Blocks & CLC (Protein based with Sawdust & Rice Husk) Blocks after 21 Days

Sr. No	Description	Waste material	% Of waste materials	Load (kN)	Area (mm ²)	Average Strength (N/mm ²)
1	CLC Blocks(Protein based)	–	–	153.33	17100	8.93
2	CLC Blocks (Aluminum as Foaming Agent)	–	–	96.69	17100	5.65
3	CLC Blocks (Protein based with sawdust 4%)	Sawdust	4	213.67	17100	13.54
			8	170		9.54
			12	48.5		2.83
			16	26.83		1.57
4	CLC Blocks (Protein based with Rice Husk 4%)	Rice husk	4	330.16	17100	19.30
			8	193.33		11.30
			12	90.16		5.27
			16	65		3.80
5	Convectional Clay Bricks	-	-	100	17100	5.84

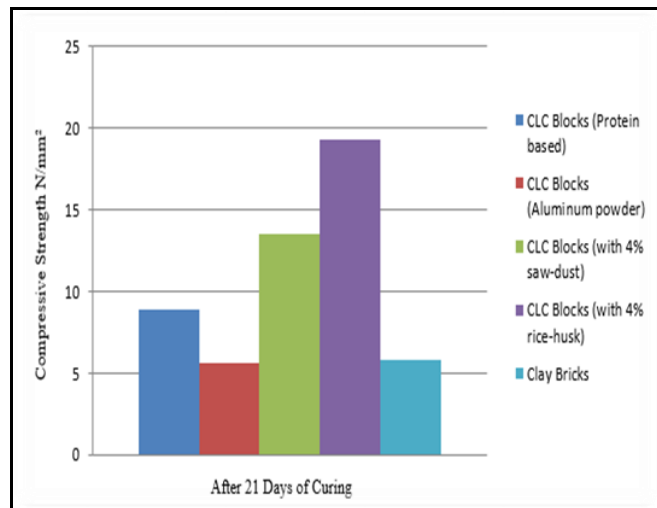


Figure 5: Compressive Strength after 4% replace with saw-dust and rice husk

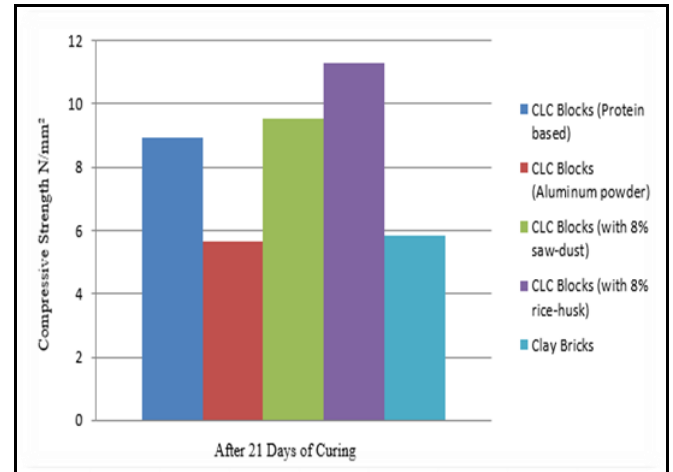


Figure 6: Compressive Strength after 8% replace with saw-dust and rice husk

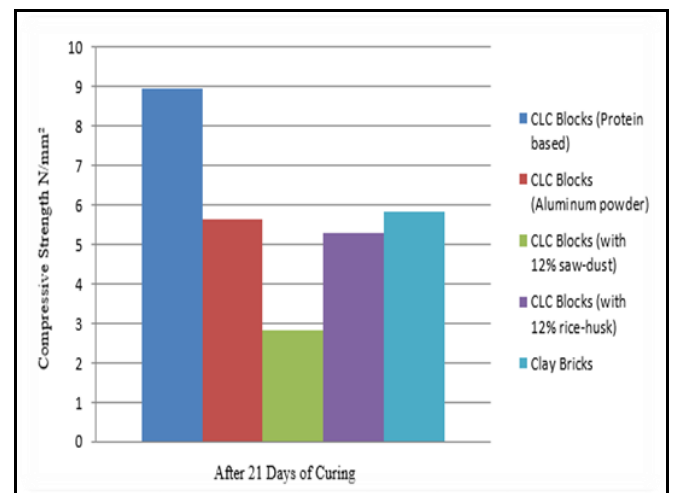


Figure 7: Compressive Strength after 12% replace with saw-dust and rice husk

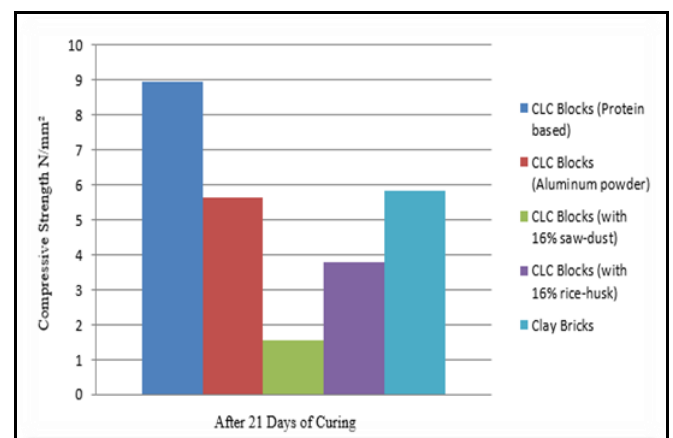


Figure 8: Compressive Strength after 16% replace with saw-dust and rice husk

V. SUMMARY

Sr. No	Parameters	CLC Blocks(Protein Based Foaming Agent)	Burnt Clay Bricks	CLC Blocks (Aluminum as Foaming Agent)
1	Block Density (Kg/m ³)	1000	1900	650
2	Compressive Strength(N/mm ²) at 21 Days	8.96	5.84	5.65
3	Water Absorption (%)	14	20	12.5
4	Drying Shrinkage (mm/meter)	No Shrinkage	No Shrinkage	No Shrinkage

CONCLUSION

This study has shown that the use of fly ash in foamed concrete, either can greatly improve its properties. Most of the cleaner production effort is required in India and hence CLC blocks may be used as a replacement of burnt clay bricks, for construction purpose, which is advantageous in terms of general construction properties as well as eco-friendliness.

In protein based CLC blocks the waste materials are replaced with sand. With increase in percentage of waste materials the strength of blocks is decrease. When we have added sawdust as waste materials, after adding 8% the initial setting is not done properly due to its property. When we have added rice husk as fine aggregate the strength of that block is higher than the sawdust is used as fine aggregate.

This study shows that the reduction in self-weight of CLC blocks is 32% compare to conventional clay bricks and increase in compressive strength is effective upto 4% to 8% replacement of waste materials to CLC blocks after 21 days of curing.

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