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AN EXPERIMENTAL WORK ON CELLULAR LIGHT-WEIGHT CONCRETE

Comparison of Compressive Strength In Between Conventional Clay Bricks and Cellular Light-weight Concrete 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. In present work, shows the comparison of CLC blocks with conventional clay bricks. So for this type of comparison we have to prepare a mould as same size of the conventional brick. The standard size of conventional brick is 19cm x 9cm x 9cm. So we have casted same size of CLC blocks and check its compressive strength after 7th day, 14th day, and 21th day of curing in lab.

Keywords *– CLC Technology, Foaming Agent, Aluminum Powder, 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

A. Cement:

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

B. Water:

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

C. Fly-Ash:

Class F Fly-ash, the bye- 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

D. 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

E. Size of CLC Blocks:

We have to prepare a mould as same size of the conventional brick. The standard size of conventional brick is 19cm x 9cm x 9cm. So we have casted same size of CLC blocks and check its compressive strength after 7th day, 14th day, and 21th day of curing in lab.

III. MANUFACTURING PROCESS

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.

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

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
- Aluminium Powder
- Plaster of perish (POP)

In this method the aluminium powder is work as foaming agent. After the addition of the aluminium powder, the air bubble is generates in few second and the slurry starts rising up. Quick lime is works as temperature riser in this method.

QUANTITY OF MATERIALS

In these test, we are comparing CLC blocks and conventional clay brick. The standard size of the brick is 190mm X 90mm X 90mm so we make the same size of the mould for the comparison of both. Here, the volume of the one mould is 1.593×10^{-3} m^3. So volume of three moulds is 4.617×10^{-3} m^3. If the density of the block is 800 kg/m^3 then the material used for it given below in table 1 for 1m^3.

Table 1: Recommended mix design to produce 1 m^3 of CLC

Density in kg/ m^3 / Material	600 kg/ m^3	800 kg/ m^3	1000 kg/ m^3
Cement	310	320	350
Sand	210	400	560

Table 2: Recommended mix design to produce 0.004617 m^3 of CLC (Protein Based Foaming Agent)

Density in kg/ m^3 / Material	600 kg/ m^3	800 kg/ m^3	1000 kg/ m^3
Cement	1.43 kg	1.47 kg	1.61 kg
Sand	0.96 kg	1.84 kg	2.58 kg

Fly ash replaced by weight of cement	30%	0.42 kg	0.44 kg	0.48 kg
	35%	0.50 kg	0.51 kg	0.56 kg
	40%	0.57 kg	0.58 kg	0.64 kg

Table 3: Recommended mix design to produce 0.004617 m^3 of CLC (Aluminium as Foaming Agent)

Sr. No.	Material Name	Quantity	Percentage (%)
1	Cement	1.8 Kg	45.3
2	Fly ash	1.6 Kg	40
3	Quick Lime	0.5 Kg	12.6
4	Aluminium Powder	3.2 g	0.09
5	Soluble Oil	5-6 ml	0.15
6	Plaster of Paris	70-100 g	1.86

CASTING OF CLC BLOCKS

The classification of CLC blocks based on its casting process is done in two methods.

First Method: In the first method, the casting of CLC block is carried out by mixing of a pre-formed foam or mix-foaming agent mixture into the cement, fly-ash, and sand and water slurry. As the concrete hardens, the bubbles disintegrate leaving air voids of similar sizes.

In this 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.

Second Method: In this method, the casting of CLC block is carried out by addition of the aluminum powder as foaming agent. Because of the aluminum powder the slurry is starts rising up and tiny voids are generating in the slurry. Then, the slurry is dispensed into the mould.

In this method, the materials used for the second method are cement, fly-ash, POP and quick lime. The aluminum powder is used as foaming agent in this method. First of all the fly-ash and water slurry is prepared and mixed it for 2-3 minute. After that the slurry of cement, quick lime and POP is added into the first slurry. Both slurries are mixed for two minute at mare than 900 rpm. The aluminum powder is dilute into the water and added diluted aluminum into the slurry and mixed in up to the 40 seconds. This creates a chemical reaction that generates gas, either as hydrogen or as oxygen to form a gas-bubble structure within the concrete. Then the slurry is immediately dispensed in to the mould.

IV. RESULT AND SUMMARY

Table 4: Average Strength of CLC Blocks & Conventional Clay Bricks after 7 Days

Sr. No	Description	Load (kN)	Area (mm^2)	Average Strength (N/mm^2)
1	CLC Blocks(Protein based)	36.59	17100	2.14
2	CLC Blocks (Aluminum as Foaming Agent)	38.81	17100	2.27

3	Conventional Clay Bricks	39.84	17100	2.33

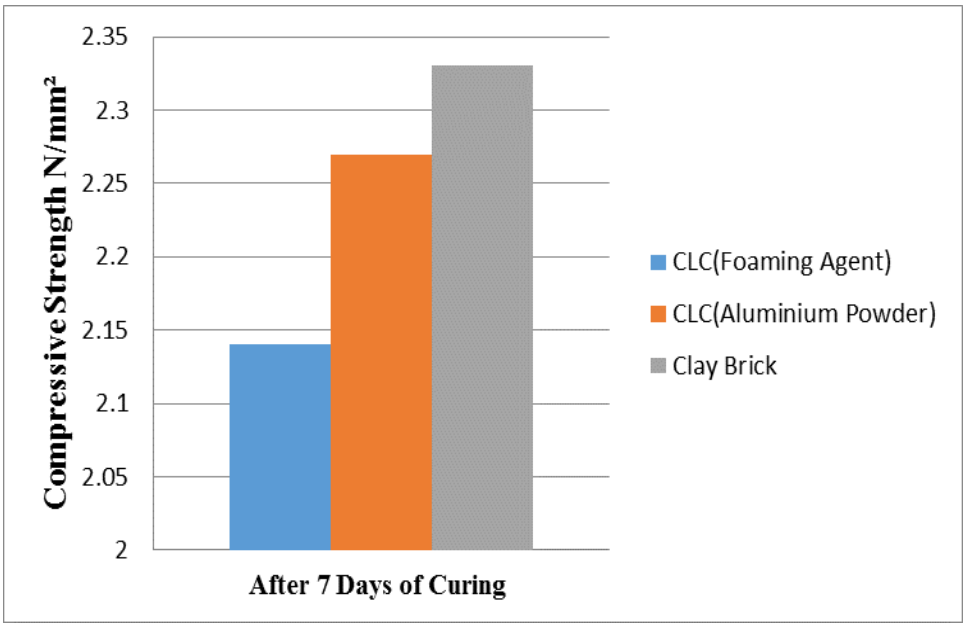

Figure 3: Compressive Strength after 7 Days of Curing

Table 5: Average Strength of CLC Blocks & Conventional Clay Bricks after 14 Days

Sr. No	Description	Load (kN)	Area (mm^2)	Average Strength (N/mm^2)
1	CLC Blocks(Protein based)	78.147	17100	4.57
2	CLC Blocks (Aluminum as Foaming Agent)	61.56	17100	3.6
3	Conventional Clay Bricks	64.98	17100	3.8

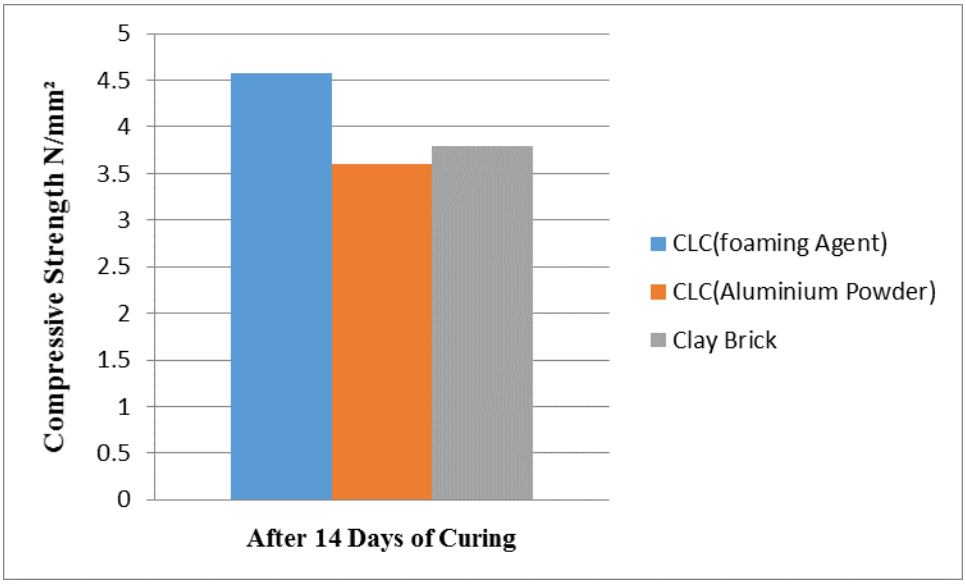

Figure 4: Compressive Strength after 14 Days of Curing

Table 6: Average Strength of CLC Blocks & Conventional Clay Bricks after 21 Days

Sr. No	Description	Load (kN)	Area (mm²)	Average Strength (N/mm²)
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

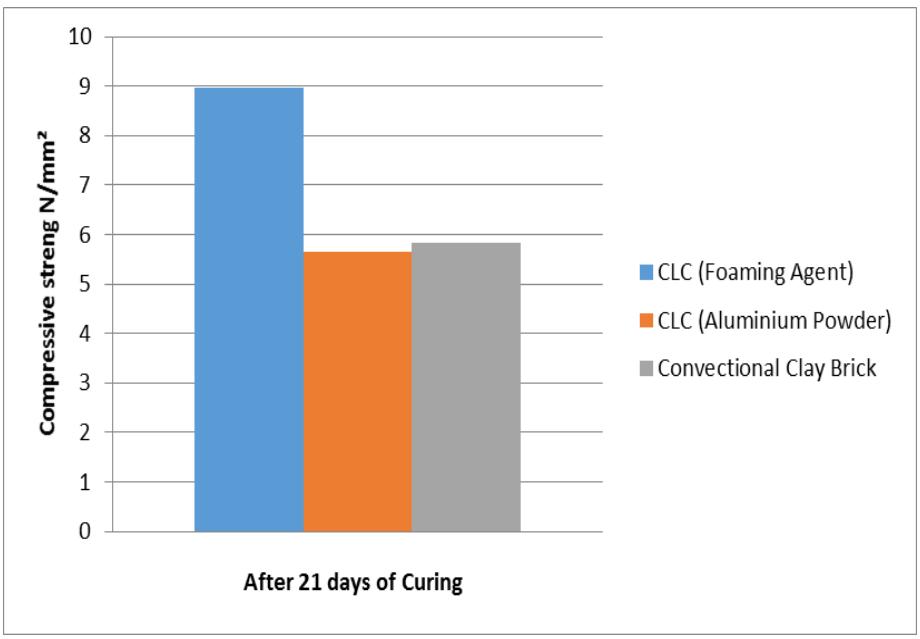

Figure 5: Compressive Strength after 21 Days of Curing

SUMMARY

Table 7: Test Result

Sr. No.	Parameters	CLC Blocks(Protein Based Foaming Agent)	Burnt Clay Bricks	CLC Blocks (Aluminium as Foaming Agent)
1	Block Density (Kg/m^3)	800	1900	800
2	Compressive Strength(N/mm^2) at 21 Days	8.96	5.84	5.65
3	Water Absorption (%)	12.5	20	12.5
4	Drying Shrinkage (mm/meter)	No Shrinkage	No Shrinkage	No Shrinkage

V. CONCLUSION

After the experimental work done the following conclusion are made:
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.
This study shows that the reduction in self-weight of CLC blocks is 32% compare to conventional clay bricks and increase in compressive strength after 21 days of curing is 36% compare to conventional clay bricks.

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