Cellular Light-Weight Concrete Blocks as a Replacement of Burnt Clay Bricks

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Abstract*—Burnt Clay Brick is the predominant construction material in the country. The CO_2 emissions in the brick manufacture process have been acknowledged as a significant factor to global warming. The focus is now more on seeking environmental solutions for greener environment. The usage of Cellular Light-weight Concrete (CLC) blocks gives a prospective solution to building construction industry along with environmental preservation. In this paper, an attempt is made to compare CLC Blocks and Clay Bricks, and recommend a replacement material to red brick in construction industry.

Keywords: CLC Technology, Foam Concrete, CLC Blocks, Cellular Light weight Concrete, Light Weight Bricks.

I. INTRODUCTION

Bricks remain one of the most important building materials in the country. Brick making is a traditional industry in India, generally confined to rural areas. In recent years, with expanding urbanization and increasing demand for construction materials, brick kilns have to grow to meet the demand. It has directly or indirectly caused a series of environmental and health problems. At a local level (in the vicinity of a brick kiln), environmental pollution from brick-making operations is injurious to human health, animals and plant life. At a global level, environmental pollution from brick-making operations contributes to the phenomena of global warming and climate change. Also, extreme weather may cause degradation of the brick surface due to frost damage.

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. MATERIALS AND 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:

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

D. Foaming Agent:

The containments holding foaming agent must be kept airtight and under temperatures not exceeding 25°C. Once diluted in 40 parts of potable water, the emulsion must be used soonest. The weight of the foam should be minimum 80 g/l, the containment should be as close as possible to 10 Litres in volume, to check the weight (density) of the foam. Under no circumstances must the foaming agent be brought in contact with any oil, fat, chemical or other material that might harm its function (Oil has an influence on the surface-tension of water).

The nominal dimensions of the CLC blocks are as follows:-

Length: 400, 500 or 600 mm

Height: 250 or 300 mm

Width: 100, 150, 200 or 250 mm

III. EXPERIMENTAL PROGRAM

The dry ingredients fly-ash and cement is fed into the mixer first and thoroughly mixed to ensure even distribution of cement. The appropriate amount of water is added and the mixing is continued. The preformed foam, which is made by blending the foam concentrate, water and compressed air in predetermined proportions in foam generator, calibrated for a specific discharge rate, is added in measured amount to the slurry of cement, fly ash and water in the mixer. This mixture is thoroughly churned or beaten (in the same manner as that of preparing foam with the white of egg) to obtain foam effect in concrete.

After an additional mixing to get uniform consistency, the slurry form of foamed cellular concrete is pumped into assembled moulds of blocks. The dimensions of the blocks are 600 X 200 X 150 mm. The foam imparts free flowing characteristics to this slurry due to ball bearing effect of foam bubbles enabling it to easily flow into all corners and compact by itself in the moulds/forms without requiring any kind of vibration or compaction. The blocks are then cured and this curing is done by Water for 2 to 3 weeks. The same curing process can be steam curing also for 8 hours, which is advantageous in terms of time.

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IV. CLASSIFICATION OF CLC BLOCKS

The cellular light weight concrete blocks conform to the following grades:-

GRADE-A: These are used as load bearing units and have a block density in the range of 1200kg/m^3 to 1800kg/m^3

GRADE-B: These are used as non-load bearing units and have a block density in the range of 800kg/m^3 to 1000kg/m^3

GRADE-C: These are used for providing thermal insulation and have block density in the range of 400kg/m^3 to 600kg/m^3

Therefore, CLC can be produced in a density range of 400kg/m^3 to 1800kg/m^3. In cellular light weight concrete, the density is controlled by introduction of gas or foam by foam generator. Information provided in this paper is for density of CLC as 800kg/m^3, which falls under Grade B classification.

V. COMPARISION OF TECHNICAL PARAMETERS

A sample of 20 blocks is taken in random from the 1500 blocks produced. Out of the 20 blocks, 3 blocks are tested for block density, 8 blocks are tested for compressive strength, 3 blocks for thermal conductivity, 3 blocks for water absorption, and 3 blocks for drying shrinkage. The results are compared with the clay bricks and tabulated below:-

Table 1: Test Results – General Properties

SNo	PARAMETERS	CLC BLOCKS	BURNT CLAY BRICKS
1.	**BLOCK DENSITY (Kg/m^3)**	**800**	**1900**
2.	**COMPRESSIVE STRENGTH (Kg/cm^2)**	**35**	**30**
3.	**THERMAL CONDUCTIVITY(W/ m.k)**	**0.132-0.151 for 800 kg/m^3**	**0.184**
4.	**WATER ABSORPTION (%)**	**12.5% for 800 kg/m^3 density**	**20%**
5.	**DRYING SHRINKAGE (mm/meter)**	**No shrinkage**	**No shrinkage**

Table 2: Test Results – Eco-Friendliness

S.No	PARAMETERS	CLC BLOCKS	BURNT CLAY BRICKS
1.	POLLUTION	Pollution Free	Creates Smoke for Burning
2.	ENERGY REQUIREMENT	No Energy Required	High Energy Required for Burning
3.	WASTE REUSE	Can consume 33% Fly-ash around	Uses top Agricultural soil and no waste reuse.

VI. RESULTS AND DISCUSSIONS

The compressive strength of CLC Blocks for 800 kg/m3 is 35 kg/cm2 and for Clay Bricks compressive strength is 30 kg/cm2. The water absorption of CLC Blocks is 12.5% for 800 kg/m3 and 20 % for burnt clay bricks. Due to the cellular structure of foam concrete water absorption of this material is very much less than Clay Bricks.

The thermal conductivity of CLC Blocks varies with density. The thermal conductivity of CLC blocks with 800kg/m^3 is in the range of 0.132-0.151 W/m.k and for red bricks thermal conductivity is 0.184 W/m.k. The excellent insulating property of foam concrete is due to the great number of closed cavities forming the multi-cellular structure.

VII. ADVANTAGES

1. The most significant property is reduced weight at no sacrifice in strength. This enables reduction of dead load. Weight reduction becomes highly beneficial for structural reasons, for reduced dimensions and substantial saving of steel reinforcement in the foundation.
2. Fly-ash is considered as one of the industrial waste product that cannot be easily disposed. It solves the problem of disposal of fly-ash and at the same time it reduces the cost of the construction.
3. Fly-ash based CLC is considered as environment friendly sustainable material produced with least energy demand

VIII. CONCLUSIONS

The clay brick production industry is a major source of air pollution in developing countries. The major issues in environmental improvement involve improving the combustion efficiency of existing kilns, and upgrading kilns to newer and more efficient process designs. The process of manufacturing clay bricks also requires high energy to burn due to the emission of CO_2 gas in the process. 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.

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