EXPERIMENTAL INVESTIGATION ON CELLULAR LIGHTWEIGHT CONCRETE BLOCKS FOR VARYING GRADES OF DENSITY

Nagesh. Mustapure[1], H.Eramma[2]
[1]*M.Tech (Cads), University BDT College of Engineering, Davangere(India)*
[2]*M-Tech (I.S), Associate Professor, University BDT College of Engineering, Davangere(India)*

ABSTRACT

The usage of Cellular Light-weight Concrete (CLC) blocks gives a prospective solution to building construction industry. In this paper, an attempt is made to study on cellular lightweight concrete blocks, and recommend as it can be used in construction industry.

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

I. INTRODUCTION

Light weight foamed concrete has become more popular in recent years owing to the tremendous advantages it offers over the conventional concrete. Modern technology and a better understanding of the concrete have also helped much in the promotion and use of light weight foamed concrete. This chapter describes the nature of foamed concrete, its composition and properties and how it use in civil engineering works. Because the properties of foamed concrete can vary widely, and it can be used in a wide variety of applications, it is important to define performance requirements for each case.

Conventional concrete made with natural aggregate originating from hard rock has a high density lies within the range of 2200 to 2260 kg/M3 and represents a large proportion of the dead load on a structure. According to BS: 8110: Part 2: *1985* classifies the lightweight foamed concrete is one with a density of 2000 kg/M 3 or less. Lightweight foamed concrete can be gaseous or foamed concrete that uses specially prepared chemicals; it can be a no-fines concrete that uses ordinary gravel or crushed stone, a normal-weight aggregate concrete with an excessive amount of entrained air, or a concrete that is made from lightweight aggregates. Lightweight foamed concrete is a class of aerated concrete. Aerated concrete can be classified according to the methods and agents used to introduce air in the concrete. Aerated concrete can be produced by introducing air entraining agent, gas forming chemicals and foaming agents. Concrete which is aerated using foaming agent is known as lightweight foamed concrete. Foaming agents can be synthetic based or protein based.

The use of lightweight foamed concrete offer many benefits and advantageous particularly cost saving, fast completion and easy application compared to other materials such as steel and timber. Lightweight foamed concrete is characterized by its low compressive strength and high insulation against heat and sound. The compressive strength and other functional properties of lightweight foamed concrete are greatly influenced by the amount of air content introduced by foaming agents. The application of lightweight foamed concrete in civil

engineering works is very broad as it can be used in almost every parts of building from the superstructure right down to the substructure, including wall panels and roofing. Any conventional panels or masonry units used for load and non-load bearing walls using normal concrete can be replaced directly by foamed concrete panels and units. Very low density lightweight foamed concrete can be used as thermal and sound insulation panels, filtering media and floating blocks for fishery purposes. Lightweight foamed concrete can also be used to cast elements for architectural purposes, pottery, void filling, trench reinstatement, foundation raising and swimming pool. In highway construction, lightweight foamed concrete can be applied as soil filling for sub-base, bridge abutments and bridge embankment. It is worth noting that the use of lightweight foamed concrete is popular in other countries such Europe, Japan and United Kingdom.

II. MATERIALS AND BLOCK DIMENSIONS

A. Cement:

Portland cement of 53 grade confirming to IS 12269:1987 is used in this study. The specific gravity of cement is 3.15.

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 used. 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 20 parts of potable water, the emulsion must be used soonest. The weight of the foam should be minimum 50 g/l. 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: 100,150,200or250mm.

II. EXPERIMENTAL PROGRAM

At first start with the water and fly ash. Mix for a few minutes and add cement in stages and make sure the mixing is thorough (Mortar slurry preparation). Then, Preparation of pre-foamed by diluted the foam agent with water and extracted by using foam generator and air compressor. After that, add foam to the wet slurry and ensure foam has been completely mixed with the mortar. After mixing is completed check that the wet density of the foamed concrete is close to what is required.

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 10 hours, which is advantageous in terms of time.

Fig 3.1 Mould

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/m3 to 1800kg/m3.

GRADE-B: These are used as non-load bearing units and have a block density in the range of 800kg/m3 to 1000kg/m3.

GRADE-C: These are used for providing thermal insulation and have block density in the range of 400kg/m3 to 600kg/m3.

Therefore, CLC can be produced in a density range of 400kg/m3 to 1800kg/m3. 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/m3 to 1100kg/m3, which falls under Grade B classification.

Fig 4.1 CLC Blocks

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 for water curing

SL.	PARAMETERS	CLC BLOCKS			
1	DRY DENSITY (Kg/m3)	800	900	1000	1100
2	COMPRESSIVE STRENGTH (N/mm2)	2.6	3.2	3.8	5.4
3	DRYING SHRINKAGE (MM/METER)	NO SHRINKAGE	NO SHRINKAGE	NO SHRINKAGE	NO SHRINKAGE
4	THERMAL CONDUCTIVITY (W/M.K)	0.32	0.34	0.36	0.37
5	WATER ABSORPTION (%)	11.87	11.51	11.37	10.96

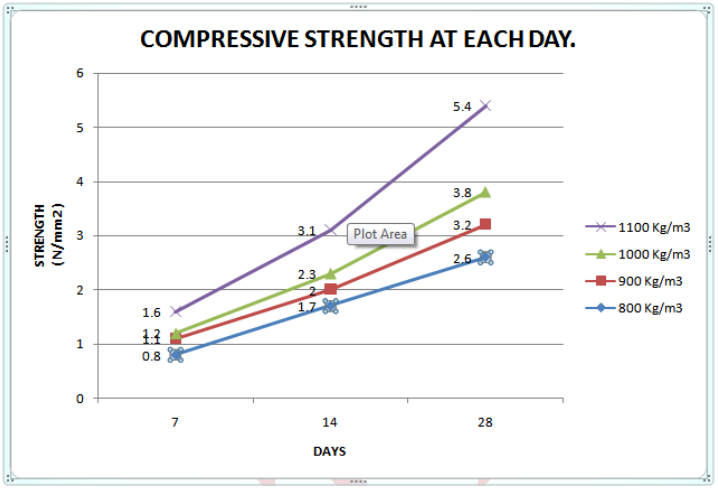

Fig 5.1 compressive strength at each day

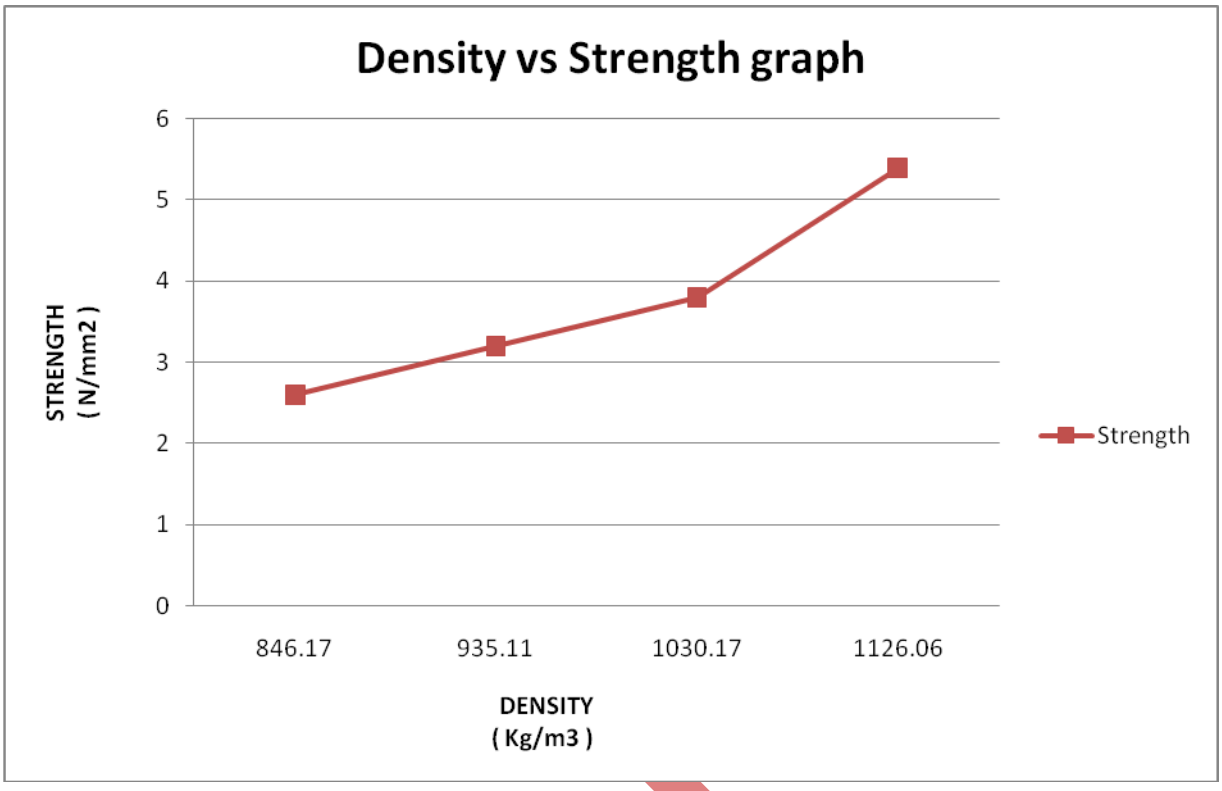

Fig 5.2 Density vs Strength graph

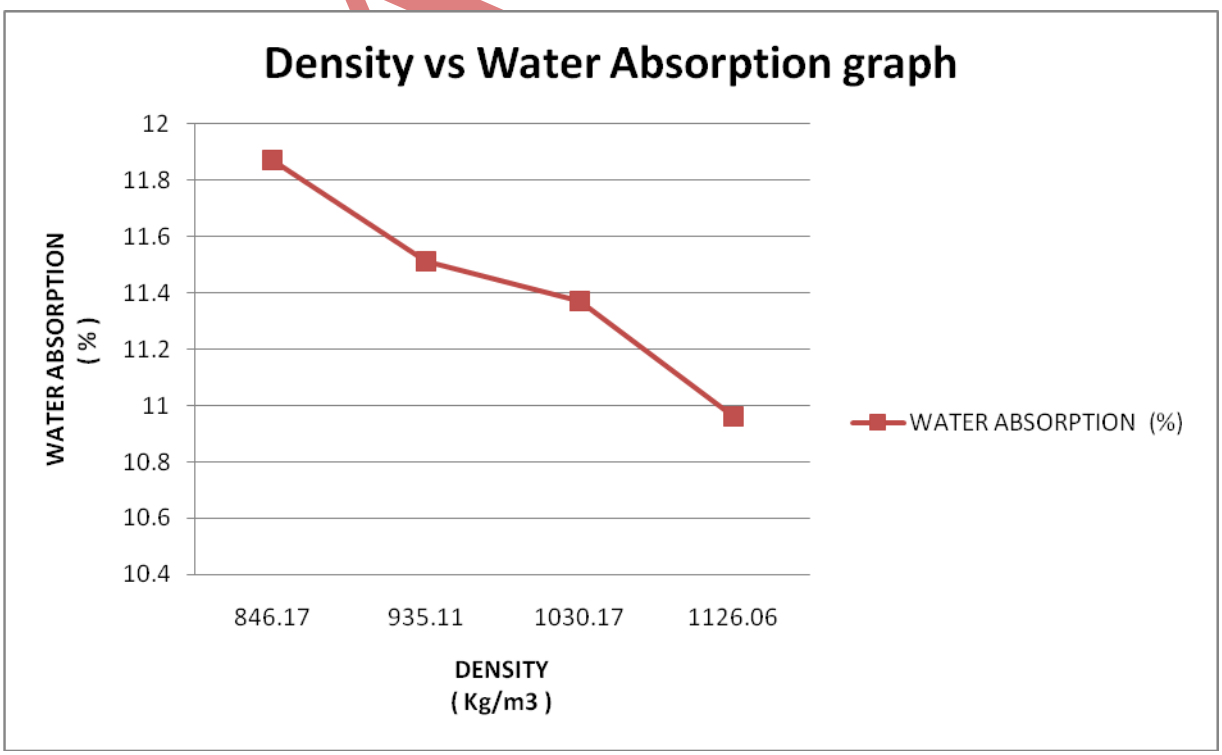

Fig 5.3 Density vs Water Absorption graph

Table 2: Test Results – General Properties for steam curing

SL.	PARAMETERS	CLC BLOCKS			
1	DRY DENSITY (Kg/m3)	800	900	1000	1100
2	COMPRESSIVE STRENGTH (N/mm2)	2.7	3.3	4.1	5.8
3	DRYING SHRINKAGE (MM/METER)	NO SHRINKAGE	NO SHRINKAGE	NO SHRINKAGE	NO SHRINKAGE
4	THERMAL CONDUCTIVITY (W/M.K)	0.32	0.34	0.36	0.37
5	WATER ABSORPTION (%)	11.68	11.47	11.26	10.90

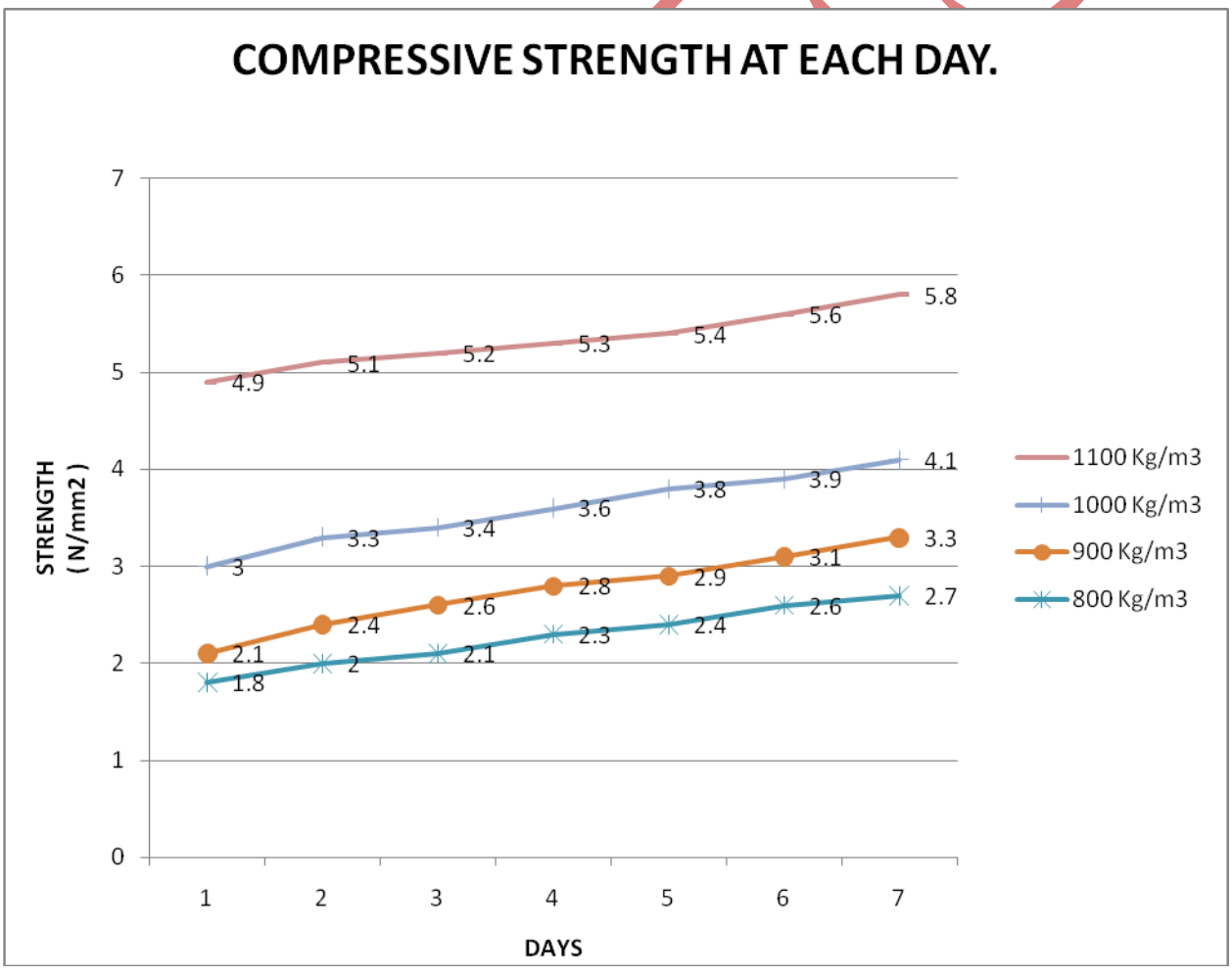

Fig 5.4 compressive strength at each day

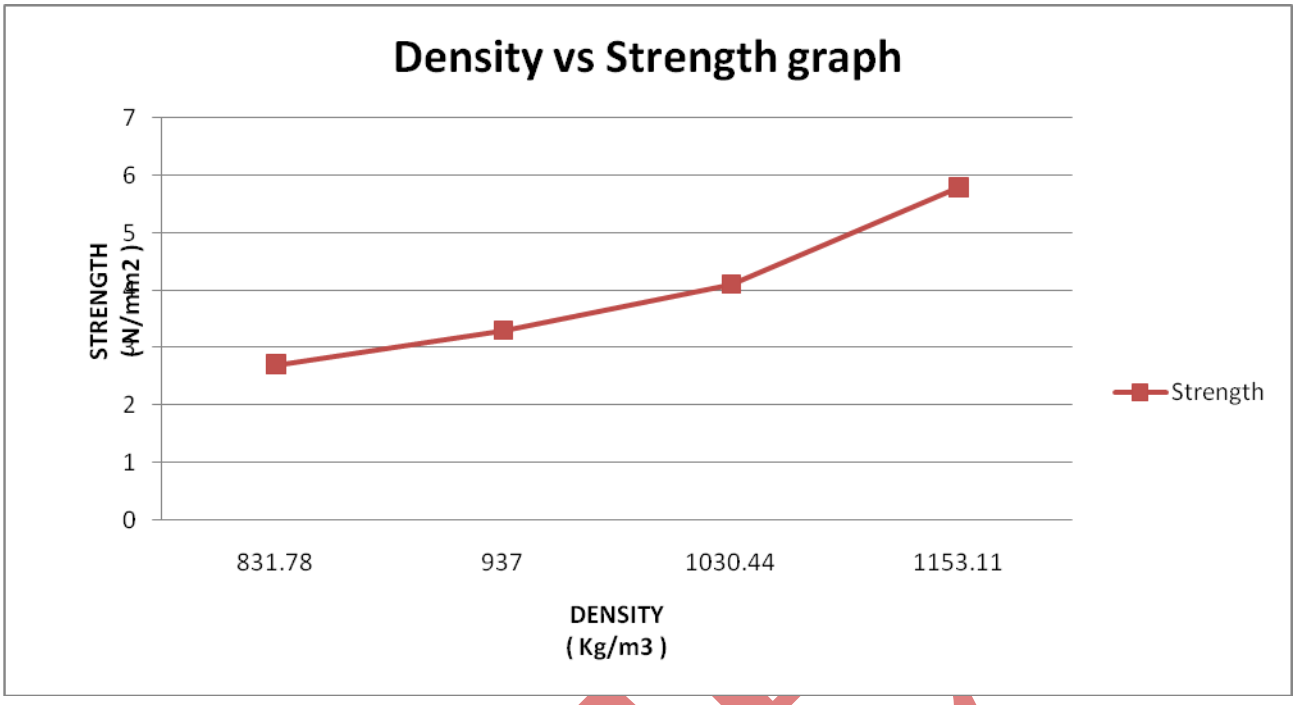

Fig 5.5 Density vs Strength graph

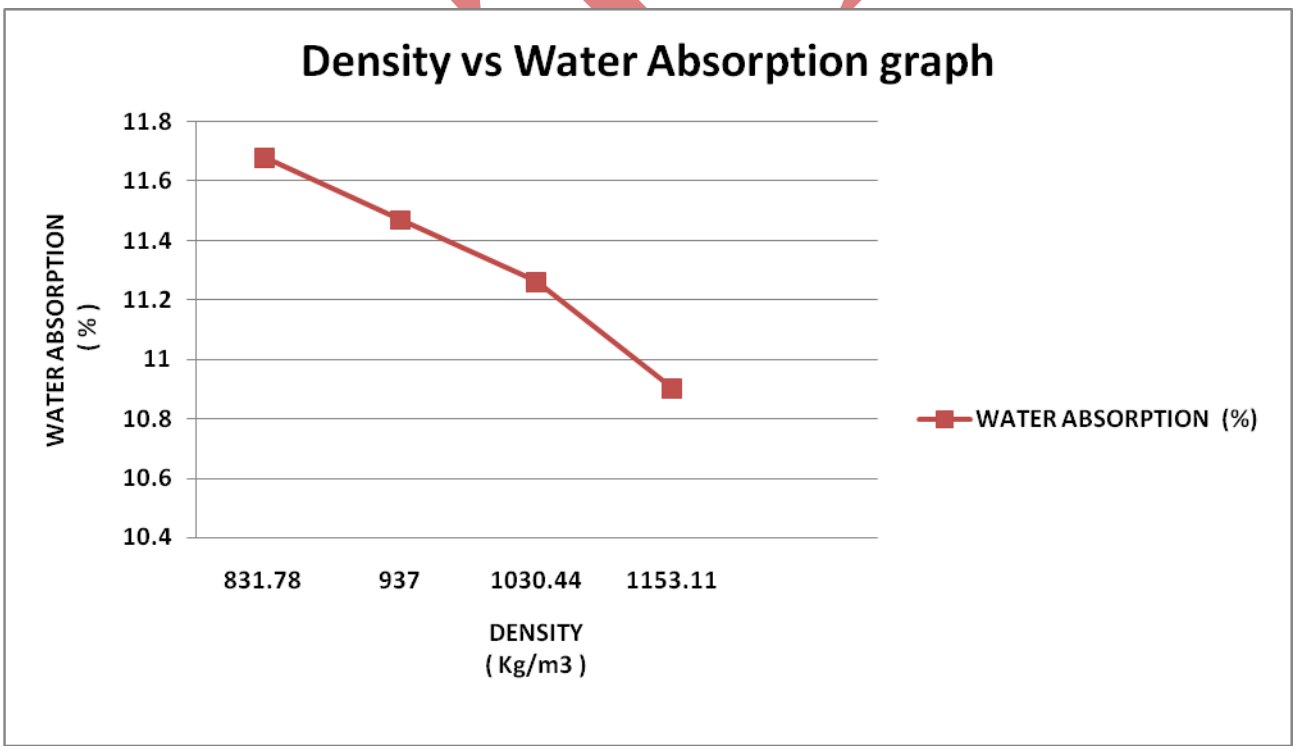

Fig 5.6 Density vs Water Absorption graph

VI. RESULTS AND DISCUSSIONS

The compressive strength of CLC Blocks for 800 kg/m3, 900 kg/m3, 1000 kg/m3 and 1100 kg/m3 is 2.6 N/mm2, 3.2 N/mm2, 3.8 N/mm2 and 5.8 N/mm2 for water curing and 2.7 N/mm2 , 3.3 N/mm2 , 4.1 N/mm2 and 5.8 N/mm2 for steam curing. The water absorption of CLC Blocks for 800 kg/m3, 900 kg/m3, 1000 kg/m3 and 1100 kg/m3 is 11.87 **%**, 11.51 **%**, 11.37 **%** and 10.96 **%** for water curing and 11.68 **%** , 11.47 **%** , 11.26 **%** and 10.90 **%** for steam curing. The thermal conductivity of CLC Blocks varies with density. The thermal conductivity of CLC blocks for 800 kg/m3, 900 kg/m3, 1000 kg/m3 and 1100 kg/m3 is 0.32 W/m.k, 0.34 W/m.k, 0.36 W/m.k and 0.37 W/m.k for both water and steam curing. The excellent insulating property of foam concrete is due to the great number of closed cavities forming the multi-cellular structure.

VII. ADVANTAGES

1. 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

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 for construction purpose, which is advantageous in terms of general construction properties as well as eco-friendliness.

IX. ACKNOWLEDGEMENTS

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