Insulated Hollow Concrete

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Abstract— The ever increasing construction sector leading to an increase in the demand of smart materials has become quite necessary. Therefore there is a need to improve the already existing materials. The synthesis of Insulated Hollow Concrete Blocks or IHC Blocks serves this purpose quite nicely. The IHC Blocks, being lightweight because of being hollow result in reduced dead load of structure. Its predecessor, Hollow Concrete Block is able to provide Thermal as well as Sound Insulation, but these prove to be better than them because of the introduction of an Insulating material. They are also economical as well in comparison to the existing building materials and are also helpful in planning piping system. The use of fly ash along with Cement helps to make it an Environment Friendly material. It has many more uses in reducing the need for formwork. The paper includes preparation of 20 IHC Blocks using four different concrete mixes which include M20, M25, M30, and M35. The compressive strengths of all the samples are taken into consideration after allowing them to cure for 28 days in the curing tank. The Thermal Insulation tests as well as the Sound Insulation Tests are also carried out. The results showed a great deal of Insulation from both sound and temperature. The Compressive strength of these blocks also came to be way more than those construction materials that are being used contemporarily. Therefore this material can prove to revolutionize the way we design and build our structures.

Index Terms: Insulated Hollow Concrete Blocks, Compressive Strength, Sound Insulation, Thermal Insulation, Environment Friendly, Load Bearing, Thermocol as an Insulating Material.

1. INTRODUCTION

The "Insulated Hollow Concrete Blocks" are an improvement over the "Hollow Concrete Blocks" [2], "Autoclave Aerated Concrete Blocks "as well as the traditionally used "Clay Bricks" .The use of "Insulated Hollow Concrete Blocks" is generally done due to the following reasons:

1. Highly Durable: The concrete, if compacted by high pressure and vibration gives substantial strength to the block. Proper curing increases the compressive strength of the block.
2. Low Maintenance, Colour and brilliance of masonry helps withstands outdoor elements.
3. Provide thermal and sound insulation. The air in hollow of the block, does not allow outside heat or cold in the house. So it keeps house cool in summer and warm in winter.
4. Environment Friendly: The use of Thermocol as an insulator which is non-biodegradable in nature as well as Fly Ash for preparation of blocks help to reduce the overall wastes produced both domestically as well as industrially. Moreover the concrete used in these blocks is approximately half of that used to prepare the solid concrete block.
5. Load Bearing, strength can be specified as per the requirement.
6. Fire Resistant. Because of concrete's inherent material properties, it can be used to minimise fire risk for the lowest initial cost while requiring the least in terms of ongoing maintenance. In most cases, concrete does not require any additional fire-protection because of its built-in resistance to fire. It is a non-combustible material (i.e. it does not burn), and has a slow rate of heat transfer. Concrete ensures that structural integrity remains, fire compartmentation is not compromised and shielding from heat can be relied upon. That makes it very sturdy material.

2. METHODOLOGY

2.1 Mould Selection and Creation

A mould of the required shape and size was created. The mould can be divided into three components. They are: the external (or the outer) mould, the internal (or the inner) mould and the base of the mould.

The external (or the outer) mould was made up of shuttering Board. Shuttering Board has the property of being a very good material that doesn't absorb water even after several times of use and is therefore very useful due to its longevity. It was a temporary mould and hence, can be used repeatedly for the casting of many IHC blocks. It has an inner dimension of 300mmx125mmx150mm [1]. The thickness of the shuttering wood used for the external (or the outer) mould is 12.5mm.

Fig. 1. Outer Mould made of Shuttering Board

The internal (or the inner) mould was made up of Thermocol or polystyrene [3]. It is a permanent mould and hence, could be used only once for the casting of a single IHC block. It has an outer dimension of 200mmx50mmx150mm.The thickness of the Thermocol is 12.5mm.

Fig. 2. Inner Thermocol Mould

The base of the mould was the next requirement for the completion of the mould. For this, the base of the mould was created by cutting the gunny bags into pieces of such sizes that it could be easily attached with the external (or the outer) mould by means of tape. Gunny Bags don't allow the water to get out of them and therefore are responsible for providing a sealed layer.

Fig. 3. Placing Gunny Bag as a base of the mould

2.2 Selection of Grade of Concrete

After the mould was prepared, the next thing to be done was to decide the grade of concrete mix to be used for making the IHC blocks. It was decided that four IHC blocks of four different grades of concrete would be prepared and then, all of them would be tested (for the compressive strength achieved by the casted IHC blocks) after (about) 28 days of curing. The four grades of concrete mix used are: M20, M25, M30 and M35.

Fig. 4. Preparation of Concrete

2.3 Post Concreting Procedure.

After about 24 hours of casting an IHC block, first of all, removing the taping through which the base of the mould (gunny bag piece) attached with the external (or the outer) mould. Then, the external (or the outer) mould was readily removed (by a bit of hammering action).

2.4 Curing

The then obtained IHC block was immersed in the water and then, it was left in the curing tank for 28 days.

Fig. 5. Cubes in curing tank

Finally, the IHC block was removed from the curing tank after completion of the curing period (which is 28 days) and then, it was tested for the compressive strength achieved by the block.

3. EXPERIMENTS AND OBSERVATION

Experiments were conducted into two parts.

1 Experiments on Raw materials

2 Experiments on IHC Block

3.1 Experiments on Raw materials:

1. Specific Gravity of Coarse Aggregate
2. Specific Gravity of Fine Aggregate and Water Absorption
3. Bulk Density and Percentage Voids of Aggregates
4. Water Absorption of Coarse Aggregates
5. Gradation of Fine Aggregate by Sieve Analysis
6. Gradation of Coarse Aggregates by Sieve Analysis
7. Slump Test

3.2 Experiments on IHC Block:

1. Compressive Strength Test of Concrete
2. Sound Level Test
3. Thermal Insulation Test

3.3 Observations for experiments on Raw materials

1. Specific gravity of coarse aggregates =**2.746** [5]
2. Specific gravity of fine aggregates =**1.6** [4] and water absorption [7] =**1%.**
3. Coarse Aggregates:
   - Bulk density of compacted coarse aggregates [6] =**1.85**
   - Bulk density of compacted coarse aggregates [6] =**1.79**
   - Percentage of voids=**32.48%**
4. Fine Aggregates:
   - Bulk density of compacted coarse aggregates [6] =**1.70**
   - Bulk density of compacted coarse aggregates [6] =**1.60**
   - Percentage of voids=**37.96%**
5. Water absorption of coarse aggregates [7] =**1.1%**
6. Sand used was of **zone 2.**
7. Grading of Coarse Aggregates correspond to a diameter of 12.5mm as per IS 383:1970, Table 2.
8. Slump value of **105mm** was observed.

3.4 Observations for experiments on IHC Blocks

3.4.1. Compressive Strength Test [2]

1. Designing of different grades of concrete was done.
2. Test cubes of dimension 150mm x 150mm x 150mm and IHC Blocks of the same concrete were made.
3. After curing for 28 days test cubes were compression tested for the strength achieved vs. grade on CTM.**IS : 516-1959**
4. Also after 28 days IHC Blocks were compression tested for strength achieved compared to cubes for same grade of concrete on CTM.**IS : 2185 (pert-I) – 1979.**

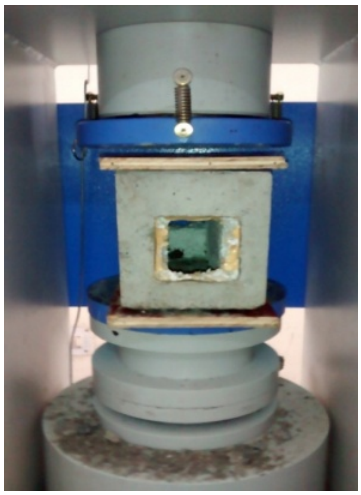
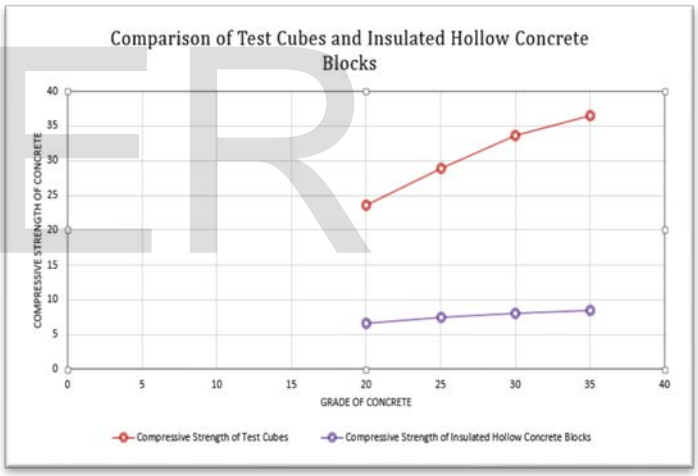


Fig. 6. Compressive Strength Testing Machine

5. Graph for strength achieved of IHC Blocks vs. cubes was plotted.



Graph. 1. Compressive Strength comparison with Grade of Concrete

Table.1. Compressive Strength comparison with Grade of Concrete

Grade of Concrete	Compressive Strength of Test Cubes to be achieved after 28 days	Compressive Strength of Test Cubes achieved after 28 days	Compressive Strength of IHCB achieved after 28 days
M20	20 MPa	23.56 MPa	6.67 MPa
M25	25 MPa	28.89 MPa	7.5 MPa
M30	30 MPa	33.33MPa	8 MPa
M35	35 MPa	36.44Mpa	8.5MPa

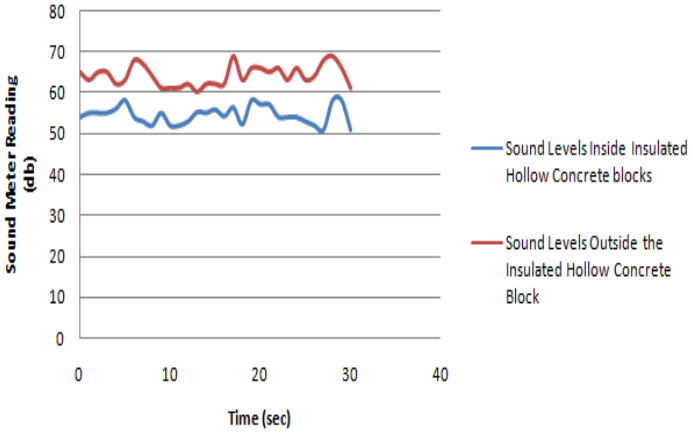
3.4.2. Sound Level Test

1. Sound testing was done on a room of 2ft x 2ft x 2ft.

Fig. 7. Test Room

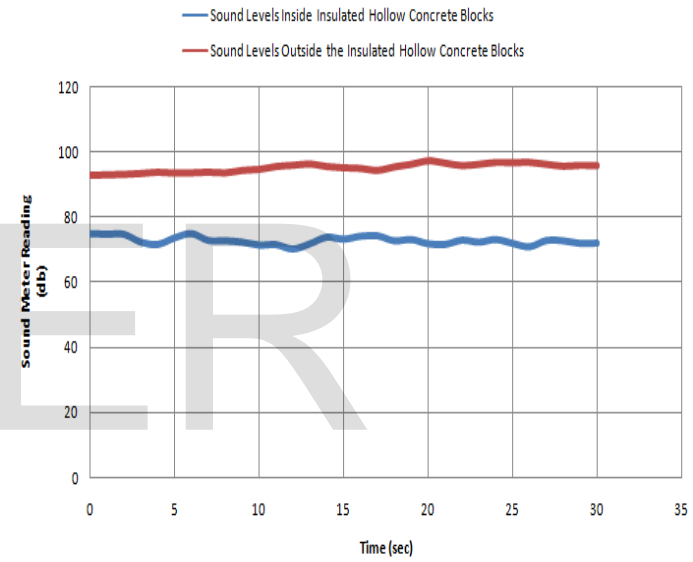
2. Standard Lutron sound level meter was used.(**ISO 9001 Certified)** [9]
3. Two constant sound sources of 200 hertz and 500 hertz were used alternatively and readings of inside vs. outside sound pressure were measured for various time periods.

a) Sound source of 200 hertz



Graph. 2. Sound Meter Reading at 200Hz sound source

b) Sound source used was of 500 hertz



Graph. 3. Sound Meter Reading for 500 Hz sound source

The formula used for calculating the Average Sound Pressure Level is:

$$Lp = 20 \log_{10} \frac{1}{N} \sum_{n=1}^{n=N} (10)^{Ln/20} \quad (1)$$

where:

Lp is Average sound pressure level,

N is the Number of measurement readings,

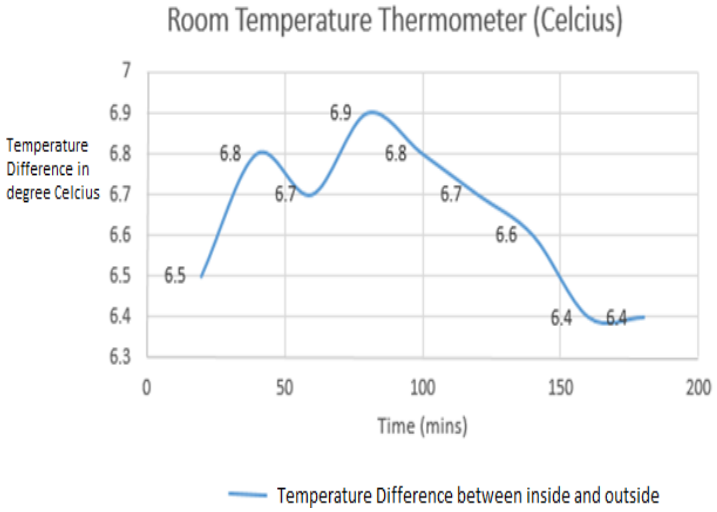
Ln = nth sound pressure level in dB re. 20μPa

n= 1, 2, 3... N.

Therefore the Average Sound Pressure calculated for Inside came out to be 71.69dB while for the outside it came out to be 92.38dB.

3.4.3 Thermal Insulation Test

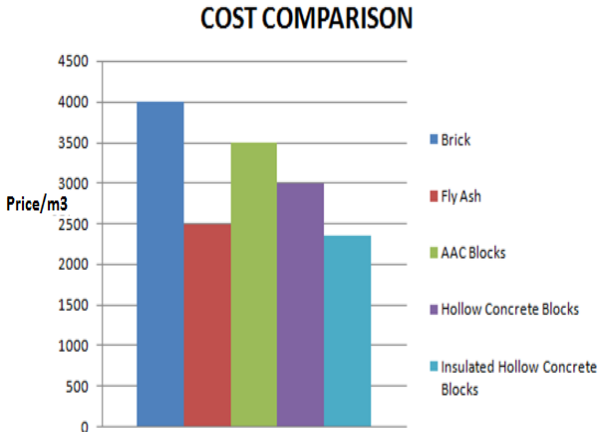
1. Thermal testing was done in a room of 2ft x 2ft x 2ft.
2. Temperature was simultaneously measured inside and outside of the test room between 10am-12pm with standard digital thermometers.**(IS: 3055 Part-I, 2004)**
3. Graph of temperature difference between inside and outside was plotted.



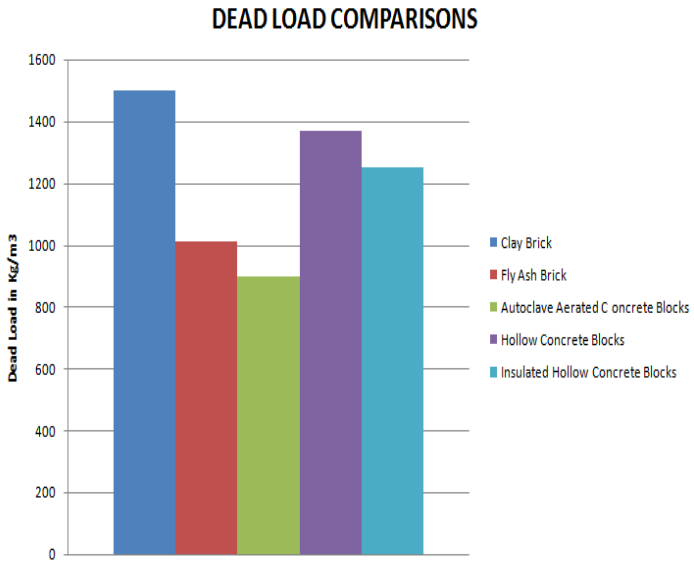
Graph. 4. Temperature Difference Between Inside and Outside.

4. CONCLUSION

THE graphs below depict the cost comparison and dead load comparison between the various types of building materials like Clay Bricks, Fly Ash Bricks, Hollow Concrete Blocks and AAC Blocks and Insulated Hollow Concrete Blocks. In this comparison we come to know that the cost of Insulated Hollow Concrete Block is less than all it competitors. The factors considered in calculating cost are the cost of raw materials, cost of labour, cost of facilities, cost of insulation techniques used in conventional materials and cost of mortar used [10].



Graph. 5. Cost Comparison



Graph. 6. Dead Load Kg/m^3

Therefore Insulated Hollow Concrete Blocks are a boon in the construction/building material industry. It is found that IHC blocks are a very good sound insulating material, very effective thermal insulating material and results in drastic dead load reduction. It is highly recommended in all types of construction.

4. References

[1] IS 2572.2005 (Construction of Hollow and Solid Concrete Block Masonry).
[2] IS 2185 (Part 1):2005 (Concrete Masonry Units — Specifications)
[3] The Whole truth about polystyrene article
[4] Specific Gravity and of Coarse Aggregate Reference IS: 2386 (Part III)-1963
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