COMPARATIVE STUDY ON PROPERTIES OF INSULATING CONCRETE FOAMING (ICF) AND SOLID CONCRETE BLOCK

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Abstract. Insulating Concrete Foaming (ICF) system is an advance technique in construction of walls. ICF block wall consists of two layers of expanded polystyrene insulation connected with plastic hangers. This paper presents the comparative study of ICF block wall and solid block wall system based on the compressive strength and sound resistance. Three square models of reinforced Insulating concrete forms and three solid concrete blocks were casted. The objective of compressive strength test is to investigate the effect of compressive force action on two different blocks. Insulation quality of both the materials related to sound absorption can be determined with sound resistance test. This test was carried out by passing sound waves through existing walls constructed with ICF and solid concrete blocks. The experimental results show that the performance of ICF wall system is superior by comparing the solid block wall system.

Keyword. ICF block; Solid block; Sound resistance test; Compressive strength test

INTRODUCTION

Insulated Concrete Forms (ICFs) represents an innovative construction technique that provides an alternative to conventional concrete formwork commonly used in the construction industry. Not a new technology, ICFs have been utilized for over 20 years and have been gaining ground in concrete construction applications.

ICFs are hollow foam blocks or panels that are stacked to form the shape of an exterior wall of a building. Reinforcement and concrete are then placed inside of the foam form, thereby creating a foam-concrete-foam sandwich.

ICFs are used in a variety of construction applications, ranging from single unit residential homes to industrial buildings. This Evaluating report defines and identifies ICF Wall System. Include definition of physical components for flat ICF wall systems, minimum dimensional requirements and testing for construction use.

The comparative study of ICF block wall and solid block wall system based on the compressive strength and sound resistance. Three models (30cm x 30cm x 20cm) of reinforced Insulating concrete forms and three solid concrete blocks (20cm x 20cm x40cm) were casted and bought from factory respectively. The objective of compressive strength test is to investigate the effect of compressive force action on two different blocks. Acoustical properties of both the materials were determined with sound resistance test. This test was carried out by passing sound waves through walls constructed with ICF and solid concrete blocks.

The construction of ICF walls are structurally the same as cast-in place walls built removable forms; however, the foam forms are left in place. Structurally, the foam does not add to the engineered wall strength. The design of reinforced concrete walls is governed by the Bs8110-1997 Building Code Requirements for Reinforced Concrete.

METHODOLOGY

The figures shows the method which was followed to study the mechanical and physical properties of two different type of block.

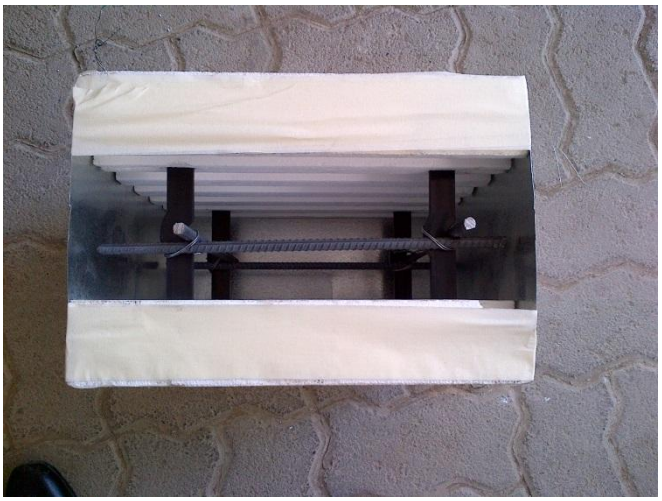

Figure 1. Insulated concrete block with reinforcement

Figure 2. Insulated concrete block under compression test

Figure 3. Solid concrete block under compression test

Figure 4. Room made of solid block

Figure 5. Room made of Insulated concrete blocks

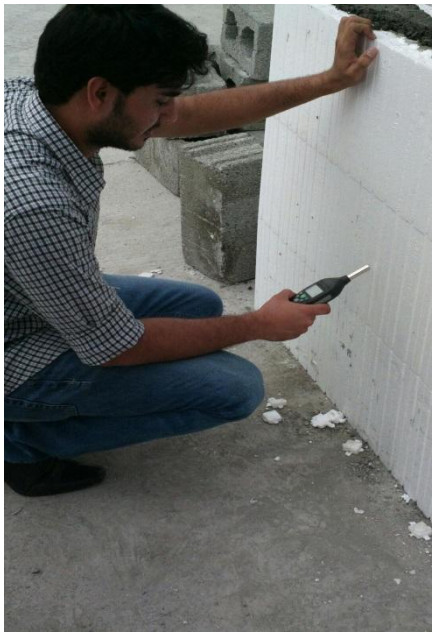

Figure 6. Checking sound passing through room made of Insulated concrete blocks.

RESULTS AND DISCUSSION

Mix Ratio

Mix ratio of concrete of grade C_{30} was calculated and maximum coarse aggregate size was kept at 10mm as the molds size was not big to support larger size of aggregates.

Table 1. Concrete Mix Ratio

Water	Cement	Fine Aggregates	Coarse Aggregates
0.54	1	1.82	2.16

Table 2. Cube (Compression Test)

S.No.	F – Max Force(kN)
1	669.6
2	723.3
3	949.9
Ave	780.9

Ave Compressive Strength $f_c = \frac{F}{A_c} = \frac{780.9X10^3}{150X150}$ = 34.7N/mm^2

F = maximum load at failure
f_c = Compressive Strength
A_c = Cross sectional area of specimen where force acts

ICF Block (Compression Test)
Dimension – 300x300x200 mm^3

Table 2. ICF block (Compression Test)

S.No.	F - Max Force(kN)
1	265
2	275.3
3	575.3
Ave	371.86

Ave Compressive Strength = $f_c = \frac{F}{A_c} = \frac{371.86X10^3}{300X200}$ = 6.2 N/mm^2

F = maximum load at failure
f_c = Compressive Strength
A_c = Cross sectional area of specimen where force acts

Solid Concrete Block (Compression Test)
Dimension – 200x400x200 mm^3

Table 3. Solid Concrete Block (Compression Test)

S.No.	F - Max Force(kN)
1	201.1
2	182.7
3	198.4
Ave	194

Ave Compressive Strength = $f_c = \frac{F}{A_c} = \frac{194X10^3}{400X200}$ = 2.425 N/mm^2

F = maximum load at failure
f_c = Compressive Strength

A_c = Cross sectional area of specimen where force acts

ICF Block Room (Sound Test)
Dimension – 800x1200x900 mm^3

Table 4. ICF Block Room* (Sound Test)

S.No.	Sound inside room (dBA)	Sound outside room (dBA)
1	119.9	85.5
2	120.6	86.1
3	120.3	88.3
Ave	120.26	86.6

Solid Concrete Block Room (Sound Test)
Dimension – 1200x1200x1000 mm^3

Table 5. Solid Concrete Block Room* (Sound Test)

S.No.	Sound inside room (dBA)	Sound outside room (dBA)
1	119.9	95.0
2	120.6	91.3
3	120.3	93.8
Ave	120.26	93.3

**Source of sound was placed inside the room and reading was measured outside the room. Distance of measuring device to source was 0.5 meter.*

The design of concrete mix was done for C_{30} but the results showed the average compressive strength to be 34.7N/mm^2. The results could have been close to 30N/mm^2 if the last reading for the compressive strength wasn't high. That error in reading could have been due to error in setting of UTM machine or else the cube which showed high compressive strength was casted much more effectively compared to other cubes. The test for compression of solid concrete blocks showed strength of 2.425N/mm^2. The results of compression test of ICF block showed strength of 6.2N/mm^2 . Compressive strength of ICF block was higher than the Solid Concrete block. This showed that ICF blocks are not only easy to install but it can be used to build strong and durable structures. The sound absorption test made on solid concrete block and ICF block rooms proves that the sound insulation level of room made by ICF blocks were higher than the room made of solid concrete blocks.

CONCLUSION

ICF building technology has decrease many construction cost, reduce the overall job completion time. Increase the safety of construction process and lower ongoing operational cost. ICF walls can bear substantial loads vertically and horizontally. The finished ICF structure is highly energy efficient, remarkably comfortable, quiet and very safe from extreme weather conditions. Middle East has to market this line of product to the consumer by telling about the significance and advantages of ICFs. As it structure is light, cost efficient, safer and strong. This research has increased my knowledge on adopting green building initiative. ICF Allows architects, owners and constructors to build light weight form structure. ICFs built strong, energy efficient, confortable and environment friendly home. The comparative study between two blocks proved that ICF block is superior to solid block mechanically as well as physically.

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