Strength and Elastic Properties of Aerated Concrete Blocks (ACBs)

T M Prakash, Dr. B G Naresh kumar and Dr. Karisiddappa

***Abstract*—**These Aerated concrete block is a type of masonry unit manufactured by precast technique. Aerated concrete is produced by the mixing of Portland cement, sand, water and pre-formed stable foam. The foam is produced with the help of a foam generator by using foaming agent. In this experimental study the feasibility of using aerated concrete block as an alternative to the conventional masonry units has been investigated. The preliminary studies focused estimating physical, strength and elastic properties of Aerated concrete block units. These included Initial rate of absorption, density test, water absorption test etc. The compressive strength, modulus of elasticity and the flexural strength of the units were obtained. There is scanty information on the physical, strength and elastic properties of Aerated concrete blocks. The present investigation has endeavored to study all such properties. Having obtained the results, it would now be interesting and useful to compare the results with that of conventional masonry units.

***Keywords*—**Aerated concrete block, modulus of elasticity, water absorption, wet compressive strength.

I. Introduction

THE quest for finding a light weight material as a replacement for conventional masonry units has been there since nearly three decades. In India, over the past two decades a significant time has been utilized for making attempts to promote Aerated concrete blocks (ACB) as an alternative to the conventional masonry units. Simultaneously, there has been a very significant change in the replacement of burnt clay bricks by concrete masonry units. It appears that the usage of Aerated concrete block masonry may become more common in the coming years. Many structures, not only in urban and semi-urban regions, but also in rural regions of India have started using concrete masonry units in place of the traditional bricks. The use of Aerated concrete blocks as a load-bearing masonry unit, at present, is very much limited, in the Indian context. Only recently in a very few reinforced concrete framed buildings, Aerated concrete block masonry is used in place of conventional masonry in-fill. It is in this context that the present research work finds its back ground. Conventional concrete made with natural aggregate originating from hard rock has a high density that lies within the range of 2200 to 2600Kg/m^3 and represents a large proportion of the dead load on a structure. The British standard, BS 8110: Part 2: 1985 classifies that lightweight concrete is one with a density of 2000Kg/ m^3 or less.

T M Prakash is Associate Professor, Dept. of Civil Engg., P E S College of Engineering, Mandya, Karnataka, India. tmprakash.1964@gmail.com Mobile No. +91 9448824956

Dr. B G Naresh kumar is Principal, Maharaja Institute of Technology Mysore, S R Patna Tq., Mandya District, Karnataka, India. nareshgowda58 @gmail.com +91 9620228021

Dr. Karisiddappa is Principal, Government Engineering College, Hassan, Karnataka, India. karisiddappamce@yahoo.com

II. Relative Advantages Of ACBs Over Conventional Masonry Units

- ACB combines insulation and structural capability in one material for walls, floors, and roofs. Its light weight/cellular properties make it easy to cut, shape size and accept nails and screws readily, and allow it to be routed to create chases for electrical conduits and small-diameter plumbing runs.
- Fire resistance is excellent, it is noncombustible, it will not burn or give off toxic fumes.
- ACB units are precisely shaped and conform to tight tolerances. Due of the high dimensional accuracy, the blocks can be laid with very thin mortar joints. 10 mm mortar joint is standard compared to nearly 25-35 mm for normal concrete blocks. Again, because of high dimensional accuracy, the blocks being of almost perfect size and shape, plastering can be reduced from the normal 25-40 mm thickness to less than 10mm. In most cases, it can be completely eliminated outside by just giving a waterproof coating.
- ACB blocks weigh lesser, the dead load is lesser on the structure and hence the structure can be designed more efficiently for a lower load.
- On an average, a mason lays about 300-400 bricks a day. A professionally trained mason can lay up to 600 bricks a day. A similar work output for conventional solid concrete block masonry is equivalent to about 40 solid concrete blocks a day. On the other hand, when the unit weigh reduces, the output is enhanced by at least 40%.

III. Tests On Aerated Concrete Blocks

Here an attempt has been made to compile the information on the absorption characteristics, wet compressive strength and density of aerated concrete blocks. The recommendation as given by IS: 2185-1979 (part 1) [1] was followed for carrying out the tests.

A. Initial rate of absorption

Initial rate of absorption test was conducted, as per ASTM

C– 67 [2]. The specimen was kept in a tray containing distilled water up to a depth of 25 mm from the bottom of the tray for 1 min. Later, the specimen was removed from the tray and weighed, thus the initial rate of absorption is obtained. The average IRA for ACB is found to be 2.28 kg/m^2/min. It is within the permissible limits similarly to that for IRA of bricks specified in BIS codal provisions.

B. Dry density

This test was carried out on blocks samples collected randomly in and around Bangalore City. *IS:* 2185-1979 (Part I) [1], specifications were followed to conduct this test. The average block density of ACB is found to be 612.10 kg/m^3. It is very low as compared to other masonry units.

C. Water absorption

The blocks were tested in accordance with the procedure laid down in *IS*: 2185:1979 (Part I) [1]. Water absorption for blocks should not be greater than 20% by weight up to class 12.5 as per *IS*: 1077-1992[3] specifications. The average water absorption of ACB is found to be 23.66%. This is very high when compared with any other masonry unit. This is also not permissible as per the codal provisions.

D. Wet compressive strength

The compressive strength of the block is the main contributing factor for the strength of masonry. The test was done according to the specifications laid in *IS:* 3495-1992 [4] and *IS:* 1077-1992 [3].The average wet compressive strength of ACB is found to be 3.75 MPa. The compressive strength is indicative of the minimum acceptable value.

E. Flexural strength test

This test was conducted as per the guidelines, given in the reference Dayaratnam [5]. The test specimen was placed centrally on two roller supports and load was applied through another roller, taking care not to cause local failure. The transverse load was applied at a uniform rate not exceeding 300 N/min through the central roller. The individual breaking load was recorded and flexural strength was calculated, using pure bending equation. The average flexural strength is found to be 0.53 MPa. It can be concluded that there is increase in flexural strength even though there is reduction in compressive strength.

F. Stress strain characteristics of aerated concrete blocks

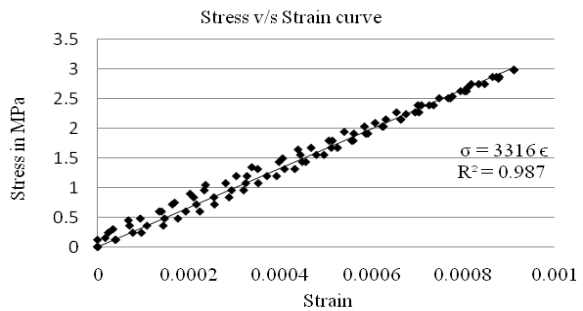

Fig. 1 Stress-strain plot for ACB blocks

Strain measurements were carried out on the block specimens with a uni-axial compressive load applied parallel to its length in a 600kN *UTM*. Steel plates were placed on the specimens to facilitate uniform compression. The strains were measured using a demountable mechanical strain gauge of 100 mm gauge length. The relative deformation of the studs mounted on the specimen was measured using a digital dial gauge of least count 0.001mm. The stress strain values were computed and a best fit graph was plotted to obtain the modulus of elasticity of the block specimens. Figure 1shows the best fit curve obtained from the test conducted on several specimens. It is however comparable to that of moderate strength conventional concrete blocks.The modulus of elasticity of ACB is found to be 3316 MPa.

IV. Summary Of Results And Discussions

As mentioned earlier, there has been rather scanty information on the physical, strength and elastic properties of ACB. The present investigation has endeavored to study all such properties. Very recently Mangala Keshava [6] has carried out an extensive study on the strength and elastic properties of a variety of masonry available in and around Bangalore (South India). The results quoted by author [6] have been used to compare with the investigations carried out in the present study.

A. Initial Rate of Absorption (IRA)

Fig. 2 gives a similar comparison of IRA values of a variety of blocks. Here the IRA values of ACB units are within the range of conventional blocks.

Legend:

ACB: Aerated Concrete Block, TMB: Table moulded brick, WCB: Wire cut brick

SCB: Solid concrete block (150mm and 200mm thick)

HCB: Hollow concrete block (150mm thick)

SMB: Stabilized mud blocks, 8% cement (143mm thick)

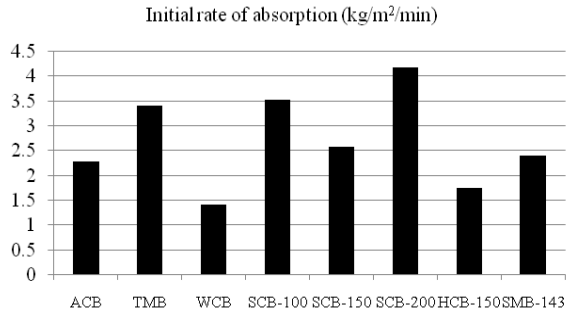

Fig. 2 Comparison of ira values of different types of units

B. Block Density:

Fig. 3 gives a comparison of the block density of a variety of masonry units. It is quite apparent that ACB has the least density when compared to any other type of unit

C. Water Absorption

Fig. 4 gives a comparison of water absorption of a variety of units. ACB units perform rather badly in this parameter. The

water absorption is extremely high, indeed more than what the IS code specify[12].

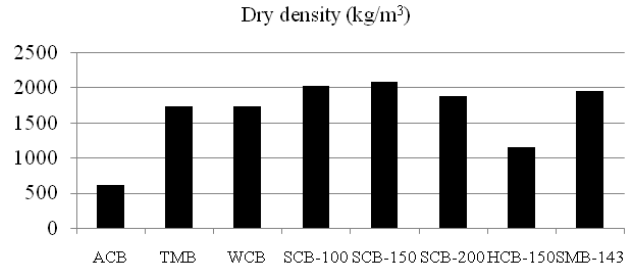

Fig. 3 Comparison of dry density of different types of units

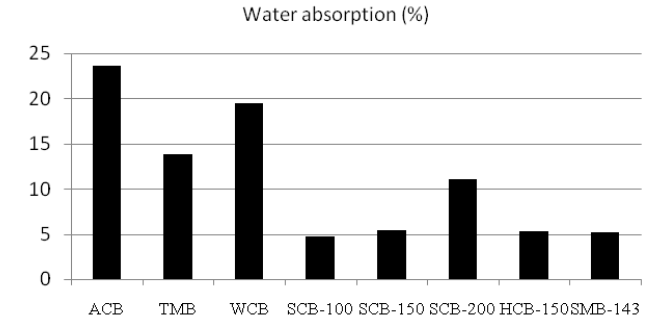

Fig. 4 Comparison of water absorption of different types of units

D. Wet Compressive Strength

A comparison for compressive strength is presented in Figure 5. It can be noted that, here again, the performance of ACB is not favorable.

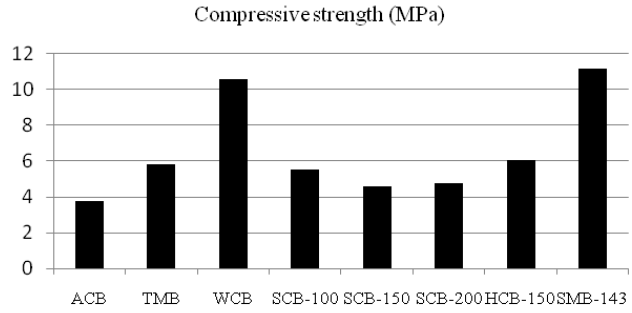

Fig 5: Comparison of wet compressive strength of different types of units

E. Modulus of Elasticity

It is extremely interesting to note from Figure 6 that, although the compressive strength is low, the modulus of elasticity is very high compared to the common table moulded bricks.

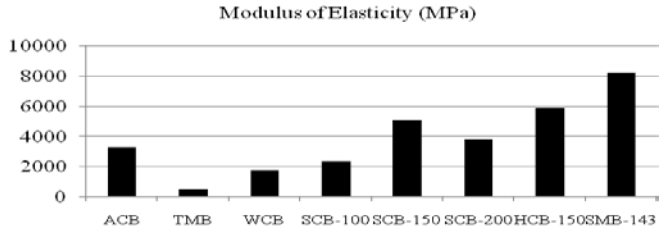

Fig. 6 Comparison of modulus of elasticity of different types of units

F. Flexural Strength

Here also, the flexural strength of ACB units are favourable for structural purposes. Figure 7 shows the comparison of flexural strength and suggestive of the benefit of ACB as compared to table moulded bricks. However, it is here that hollow and solid concrete blocks perform much better.

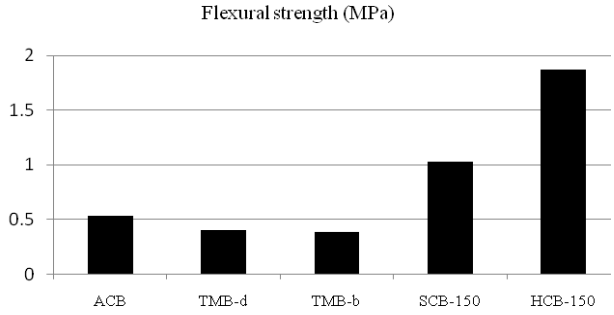

Fig. 7 Comparison of flexural strength of different types of units

V. CONCLUDING REMARKS

1. Solid concrete blocks possess more initial rate of absorption since they are generally manufactured using bigger sized fine aggregates and thus tend to have more pores. These pores may enhance the capillary action and thus leading to higher Initial rate of absorption. On the other hand Aerated concrete blocks possesses fine discontinuous pores and blocks the movement of water through the body and therefore is seen to possess low Initial rate of absorption values.
2. Aerated concrete block has the least density when compared to any other type of masonry unit. Indeed the extremely low density is extremely favorable to structures due to the great reduction in self weight and thus may result in lower structural costs.
3. The water absorption is extremely high, indeed more than what the IS code specify. This aspect is detrimental to the performance in terms of durability. Perhaps there is a need for the manufacturers to look into this aspect in great detail; otherwise the low density benefit will be offset by the unwanted need to protect it by water ingression.
4. Aerated concrete block units has the least compressive strength when compared to any other type of masonry unit. It is not favorable.
5. It is extremely interesting to note that, although the compressive strength is low, the modulus of elasticity is very high compared to the common table moulded bricks and Solid concrete blocks. This may find special benefit in the limiting deflection due to lateral loads.
6. The flexural strength of Aerated concrete block units is favorable for structural purposes. Flexural strength is suggestive of the benefit of Aerated concrete block as compared to table moulded bricks. However, it is here that hollow and solid concrete blocks perform much better.

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