EXPERIMENTAL INVESTIGATION OF ENGINEERING PROPERTIES OF HOLLOW CONCRETE BLOCKS USING BASALT FIBRE

PRIYAVADHANI S[1], NALIN PANDIYAN T[2], NARESH J[2], SIVARAMAN K[2], THAMIZH VANAN K M[2]

[1]Assistant professor, Dept. of Civil Engg, S.A. Engineering College, Avadi, Chennai, Tamilnadu
[2]UG Student, Dept. of Civil Engineering, S.A. Engineering College, Avadi, Chennai, Tamilnadu

---

ABSTRACT: The objective is to investigate the engineering properties of hollow blocks using basalt fibre. This project involves material collection, testing of material, casting of hollow blocks, testing of hollow blocks. The ultimate target of this project is to overcome the crack induced in walls by using basalt fibre in hollow blocks. Usually the property of the fiber is strengthening. For the preparation of hollow block for that optimum value basalt fibre of length 12mm are added as 0.5%, 1% and 1.5% to volume of cement. In this research, the effect of inclusion of basalt fibre on the compressive strength of hollow block was studied. The main aim of the investigation program is to find the optimum value of fibre content and also the impact of addition of fibre on the compressive strength of hollow concrete blocks. The hollow concrete block samples were tested for compressive strength after 28 days of curing period and a notable increase in compressive strength is observed for all the percentage addition of fibre when compared with the hollow concrete block without fibre. In addition to that, hollow block wall is constructed and NDT test was done. This project thesis explains the study in detail.

1. INTRODUCTION

Construction industry has undergone a fast change in the last century particularly with the advancement of different types of concrete. In the beginning of the civilization, Fibres have been used to toughen bricks and pottery. Initially, it was suggested that the cracking strain of brittle matrices, such as cement paste mortar and concrete, could be significantly increased by using closely spaced fibres. The experimental studies showed that the stress at which a brittle matrix will crack can be slightly increased by using high modulus fibres but, in general, the cracking strain of the matrix remains unaltered. Concrete with the increase of technology has undergone several changes not in its composition, but also in its performance and applications. Concrete is the most widely used construction material.

Hollow concrete blocks are substitutes for conventional bricks and stones in building construction. They are lighter than bricks, easier to place and also confer economics in foundation cost and consumption of cement. In comparison to conventional bricks, they offer the advantages of uniform quality, faster speed of construction, lower labour involvement and longer durability. In view of these advantages, hollow concrete blocks are being increasingly used in construction activities.

Generally the fibre has a property of strengthening. In summer season due to heat there is an appearance crack formation brick masonry heavy structures. The ultimate target of this project is to overcome the crack induced in walls by using basalt fibre in hollow blocks. Because of the modification in the mix, the block gets a positive sign on the durability aspects. These new alternatives of improve in the macro texture of the hollow block surface, resulting in an increased friction between aggregate and cement.

For synthetic fibre it has been enables that the early age micro cracking. This enables the bonding between surface of fine aggregate and cement materials. The compressive strength in the hollow blocks were increased proportionately with the increase in the percentage of fibre.

Fibres work as primary reinforcement in thin products in which conventional reinforcing bars cannot be used. In these applications, the fibres act to increase both the strength and the toughness of the composite. Fibres are added to control cracking induced by humidity or temperature variations and in these applications, they work as secondary reinforcement. They have been tried as reinforcement for Cement matrices in developing countries mainly to produce low-cost thin elements for use in housing schemes.

1.1 OBJECTIVES OF THE PROJECT

- ✓ To determine the mechanical properties of the hollow blocks using basalt fibre.
- ✓ To investigate the cracking resistance of the hollow blocks.
- ✓ To verify the ability of fibre induced hollow blocks to retain or improve the load bearing, cracking resistance and hydrophobic property of hollow blocks.

1.2 SCOPE OF THE PROJECT

a) The ultimate target of the project is to determine whether the basalt fibre reinforced hollow block has more strength than the nominal one.

b) To improve the Load bearing characteristics of the hollow blocks using basalt fibre.

c) In order to enhance the bonding property of the hollow blocks.

2. BASALT FIBRE

Basalt fibre is a relative newcomer to fibre reinforced polymers (FRPs) and structural composites. It has a similar chemical composition as glass fibre but has better strength characteristics, and unlike most glass fibres is highly resistant to alkaline, acidic and salt attack making it a good candidate for concrete, bridge and shoreline structures Compared to carbon and aramid fibre, it has the features of wider application temperature range -452°F to 1,200° F(269 C to +650° C), higher oxidation resistance, higher radiation resistance, higher compression strength, and higher shear strength. (Note that application temperatures of FRPs are limited by the glass transition temperature of the matrix, which is lower than the application temperature of the fibres.

Producing fibres from basalt was researched during the cold war by the old Soviet Union and limited commercial research and production was done in the U.S. during the same period. Made from volcanic rock basalt is tough, stronger than steel and has a higher tensile strength. Much lighter than steel, 89% percent in fact! One man can easily lift a 100 meter 328 foot coil of 10 mm basalt rebar. Basalt rebar is naturally resistant to alkali, rust and acids.

Fig. 1.1- basalt fibre

3. MATERIAL TESTING

3.1 CEMENT

Cements used in construction are usually in organic, often lime or calcium silicate based, and can be characterized as being either hydraulic or non-hydraulic and depending upon the ability of the cement to set in the presence of concrete (hydraulic and non-hydraulic lime plaster). Ordinary Portland cement (OPC) is the most important type of cement.

Table 3.1 cement properties

MATERIAL USED	TEST DESCRIPTION	RESULT
cement	Fineness	**2.42%**
	Consistency	**6mm**
	Initial Setting time	**35mins**
	Final setting time	**10hrs**
	Specific gravity	**3.15**

3.2COARSE AGGREGATE

Coarse aggregate have an integral part of many construction applications, sometimes used in their own, such as granular base placed under a slab or pavement, or as a component in a mixture, such as asphalt or concrete mixtures. These are important constituents of concrete. This give body to the concrete, in reduces the shrinkage and effect economy. This occupies major volume of concrete.

Table 3.2 aggregate properties

MATERIAL USED	TEST DESCRIPTION	RESULT
coarse aggregate	Impact test	**22.5%**
	specific gravity	**2.76**
	Fineness modulus	**5.74%**
	Bulk density	**1631.53kg/m³**

3.3 FINE AGGREGATE

Fine aggregate generally consists of manufactured sand with most particles passing through 3/8 inch sieve. Fine aggregate is manufactured sand which has been washed and sieved to remove particles larger than 5mm. The code to be referred to understand the specification for fine aggregate is IS: 383:1970.

Table 3.3 M sand properties

MATERIAL USED	TEST DESCRIPTION	RESULT
fine aggregate	Water absorption	**13.80%**
	Silt content	**12.5**
	Specific gravity	**2.65**
	Bulk density	**1828.33 kg/m³**
	Fineness modulus	**2.73**

4. MECHANICAL BEHAVIOUR OF CONCRETE

4.1 DETERMINATION OF BLOCK DENSITY

Three blocks shall be dried to constant mass in a suitable oven heated to approximately 1000C. After cooling the blocks to room temperature, the dimensions of each block shall be measured in centimeters to the nearest millimeter and the overall volume computed in cubic centimeters.

Density in kg/m³ = Mass of block in kg/Mass of block in cm² * 10⁶

Table 4.1 block density

% FIBRE	BLOCK DENSITY	BLOCK GRADE
Nominal block	1406.25	**B**
0.5%	1467.5	**B**
1.0%	1527.5	**A**
1.5%	1562.5	**A**

4.2 DETERMINATION OF WATER ABSORPTION

Three full size blocks shall be completely immersed in clean water at room temperature for 24 hours. The blocks shall then be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth, the saturated and surface dry blocks immediately weighed. After weighing all blocks shall be dried in a ventilated oven at 100 to 1150C for not less than 24 hours and until two successive weighing at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

Absorption, percent = (A-B)/B * 100

Where, A=wet mass of unit in kg.

B = dry mass of unit in kg.

Table 4.2 water absorption

% FIBRE	WATER ABSORPTION %
Nominal block	**4.30**
0.5%	**3.23**
1.0%	**1.96**
1.5%	**2.52**

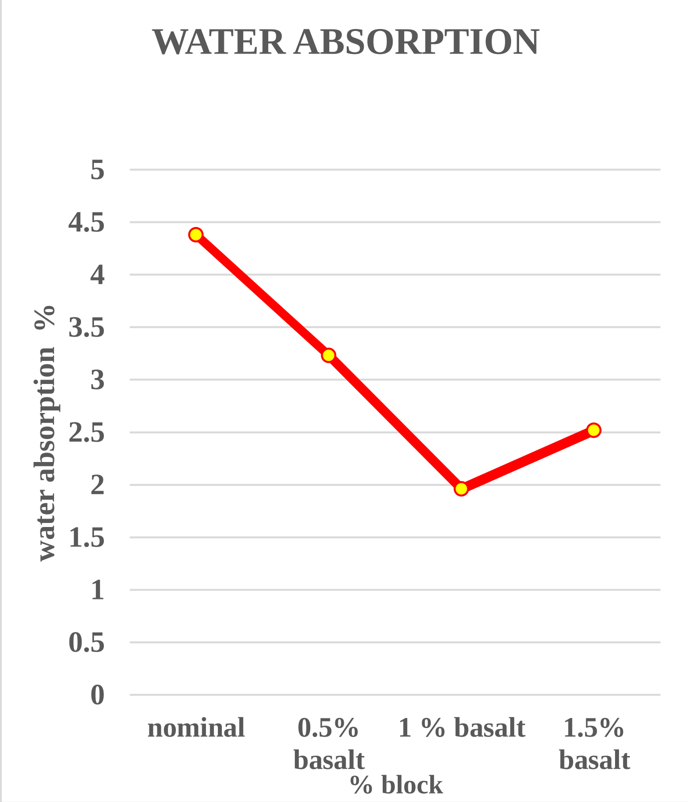

Fig 4.2 water absorption

4.3 AVERAGE COMPRESSIVE STRENGTH

Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. Compressive strength of the concrete is calculated from the failure load divided by the cross sectional area resisting the load and reported in units or megapascals in SI units.

Compressive strength $= \frac{max.compressive\ load}{cross\ sectional\ area}$

TESTING BLOCKS FOR COMPRESSIVE STRENGTH

Table 4.3 compressive strength in 7thday

% FIBRE	COMPRESSIVE STRENGTH IN N/ mm²
Nominal block	**4.38**
0.5%	**5.28**
1.0%	**5.77**
1.5%	**4.98**

The compressive strength of the hollow block is calculated by means of testing subjected to uniform loading in compression testing machine.

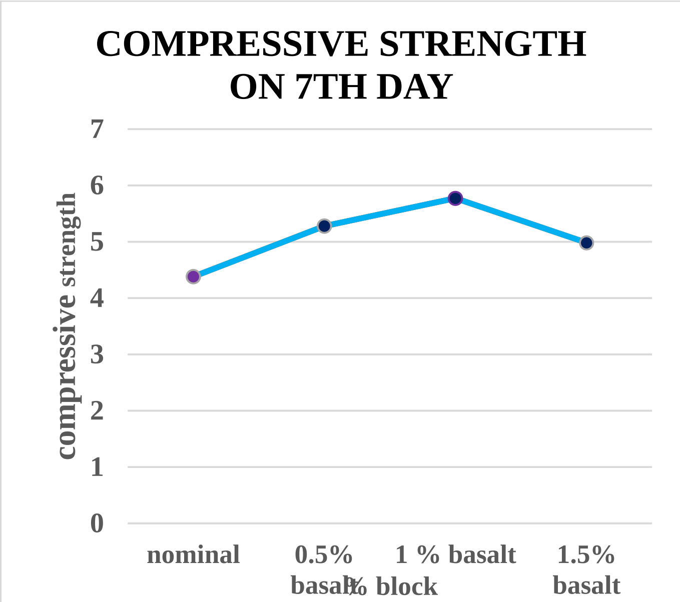

Fig 4.3 compressive strength in 7th day

Table 4.31compressive strength in 28th day

% FIBRE	COMPRESSIVE STRENGTH IN N/ mm²
Nominal block	5.50
0.5%	6.78
1.0%	7.98
1.5%	6.00

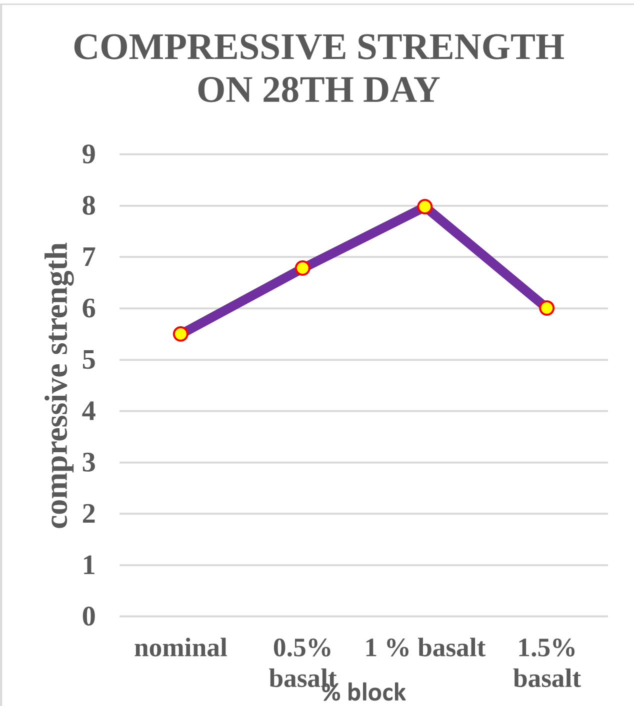

Fig 4.31compressive strength on 28th day

4.4 DETERMINATION OF CRACKING RESISTANCE OF HOLLOW BLOCK WALL

The hollow block of respective dimension 400 X 200X 100 mm is casted with concerned proportions of basalt fibre. The 1% basalt fibre added block is made to form a wall of 1m height to inspect a cracking resistance of the wall. The cracking resistance to the environmental loads is inspected by rebound hammer test. The operation of rebound hammer is shown in the fig.1. When the plunger of rebound hammer is pressed against the surface of hollow block wall, a spring controlled mass with a constant energy is made to hit block surface to rebound back. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This measured value is designated as Rebound Number (rebound index). A block with low strength and low stiffness will absorb more energy to yield in a lower rebound value.

Table 4.4 Estimated compressive strength

Sl.no	Mix details	Rebound number	Estimate compressive strength
1	Basalt (1.0%)/ fibre 1.0m x1.0m	12 ,14, 18, 16 ,14, 16, 12, 18, 14, 16, 16, 14, 12, 16, 18, 14, 16, 18, 12, 10, 14, 10, 12, 16, 14, 14, 12, 16, 12, 12, 10, 12, 16, 14, 18, 16	13 N/sq.m
		Average rebound number-14	

4.5 EXAMINATION OF CHEMICAL RESISTANCE OF HOLLOW BLOCK USING SULPHURIC ACID

The atmosphere of the world has carries many gases like priceless oxygen, carbon dioxide, hydrogen, nitrogen etc… due to the pollution of earth by industries and many other considering parameters. Its leads to contamination of atmospheric air. The hollow block is mainly used for the purpose of construction of partition wall and the compound walls. When the compound wall hollow block is exposed to the earth polluted atmosphere or if it is located near any industrial zone. Definitely the atmospheric chemical attack will be takes place on the hollow block. Because of the gaseous deposit of sulphuric acid on pores of hollow block, it will create the impact on texture of hollow block.

The absorption of chemical attack of sulphuric acid on hollow block and reactions occurred while soaking for the well-defined period of 24 hours in the open hot weathered environment was done. As the result of this, there is the absorption in change of weight because of acid absorption. And there in an approximated change of 40% in appearance and texture of the hollow block as expected.

Fig 4.51 blocks soaked in sulphuric acid

Fig 4.52 Acid attacked block

5. RESULT AND DISCUSSION

From reference to the results that we got from the above experimental project, its shows that the addition of basalt fibre will increase the resistance of the hollow block to the externally applied load. Initially, the nominal block of mix 1:3:5 is selected and the casting is done with respect to the additional percentage of fibres calculated. Then the blocks are allowed for concerned period of curing by water and atmospheric mist in casting yard. Then the blocks are subjected for block density, water absorption and followed by compression testing on respective 7th and 28th days. The compression test average result shows that the 1% basalt fibre added block gets expected additional strength on both 7th and 28th days. By the block density results, it's under goes grade A block type.

6. CONCLUSION

The ultimate goal of this concerned project is to promote sustainable development in building materials which is currently undergoing in popular usage in the field of construction. From the research carried out, the mentioned expected goal is achieved by increasing the strength of nominal hollow block by using adoptable percentage of economically available basalt fibre by using trial and error method. Finally with reference to the results, it is proved that by adding 1% basalt fibre, the ultimate compression strength is achieved for respective testing on concerned days of curing. The cracking resistance of the hollow block is computed by casting a hollow block wall up to adoptable height and width and rebound hammer test is carried out and the graphical value respect to rebound number is obtained. It is concluded that using 1% of basalt fibre in hollow block is economically, environmentally and technically sustainable as reference to this experimental thesis.

7. REFERENCES

1. Sittati musalamah, Rectifa rio And Ririt aprilin sumarsono "Comparative study on proportion of Hollow concrete block to its compressive strength " on International journal of advances in Mechanical and Civil Engineering.Volume-3,Issue-2,Apr-2016.
2. Sarath P, Pradeep P, Shemy And S Babu "Experimental investigation on the performance of interlocking concrete hollow block strengthened with steel fibre" on International Journal for Research in Applied Science & Engineering and Technology. Vol. 3, Issue X, October 2015.
3. Sathes kumar H ,Tamilrasan K, Sathiskumar N,Shirpy thangam saranya And Vaisnavi "Strength and Analysis of basalt fibre in concrete" on International Journal of ChemTech Research Vol. 10, No.8, pp 376-381, 2017
4. Ramadevi K , Chithra R And Rajesh B "Experimental study on strength properties of concrete with different aspect ratios of basalt fibre " on Informational Journal of Civil Engineering and Thechnology Vol.8 , Issue 9 , Sep 2017 , pp.629-637
5. Naga suresh M And Prafulla devi K "Experimental Investigation on Mechanical properties of basalt fibre reinforced concrete with partially replacement of cement with fly ash " on International Journal of Science, Engineering and Technology Research. Vol. 6, Issue 5, May 2017
6. Gore ketan R, Suhasini And M.Kulkarni "The Performance of Basalt fibre in high strength concrete " on Journal of Information, Knowledge and Research in Civil Engineering
7. Suchita hirde And Sagar shelar "Effect of basalt fibre on strength of cement concrete" on International Journal current Engineering and Technology. Vol. 7 , NO 2, Apr 2017.