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EXPERIMENTAL STUDY ON LIGHTWEIGHT POLYSTYRENE SANDWICH BLOCKS

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ABSTRACT

An Experimental study was conducted to investigate the compressive strength of lightweight polystyrene sandwich blocks. Eight blocks were subjected to compressive strength by using combination of cement, weld mesh, Thermocol and sand. Four blocks in single mesh and other four blocks in three web mesh with combination of M, V and U Pins. The test results of control block i.e. single mesh block without pin was compared with other specimen show that lightweight aggregate concrete blocks (400mm X 200mm X 100mm) offered higher compressive strength of 4.12MPa at 28 days. The density of foamed-concrete is found to be 1200 kg/m^3. Hence there is a reduction of dead load, faster building rates in construction and lower haulage and handling costs.

Keywords: lightweight polystyrene sandwich blocks, weld mesh, thermocol.

INTRODUCTION

Lightweight pre-fabricated sandwich structural elements in building construction is a growing trend in construction all over the world due to its high strength-to-weight ratio, reduced weight and good thermal insulation characteristics. Sandwich construction element consists of encasement of high performance material and a thick lightweight and low strength material as core. Ferro cement is regarded as highly versatile thin material possessing superior properties.

Sandwich composite structure possesses excellent flexural and shear properties. Their inherent lightweight characteristics make them ideal structural components where weight reduction is desirable. Thus structural sandwich blocks are becoming important elements in modern lightweight construction. In concrete construction, self-weight of structure it represents a very large proportion of the total load on the structures thus, reduction in the self-weight of the structures by adopting an appropriate approach results in the reduction of element cross-section, size of foundation and supporting elements there by reduced overall cost of the project.

The lightweight structural elements can be applied for construction of the buildings on soils with lower load-bearing capacity. Reduced self-weight of the structures using lightweight concrete reduces the risk of earthquake damages to the structures because the earth quake forces that will influence the civil engineering structures and buildings are proportional to the mass of the structures and building. Thus reducing the mass of the structure or building is of utmost importance to reduce their risk due to earthquake acceleration. Among the other advantages, its good thermal insulation due to the cellular thick core makes it an ideal external construction component. Some recent investigations suggest their excellent energy-absorbing characteristics under high-velocity impact loading conditions.

FERRO CEMENT

It been regarded as highly versatile construction material possessing unique properties of strength and serviceability. Its advantageous properties such as strength, toughness, water tightness, lightness, durability, fire resistance, and environmental stability cannot be matched by any other thin construction material.

As an alternative construction material, Ferro cement has not gained widespread acceptance in both developed countries in general and developing countries in particular. Its acceptance is hindered mainly due to its small thickness and labor intensive method of production. In order to cope with the problem of thickness, one of the options currently suggested is to develop Ferro cement sandwich elements. This technique provides not only the thickness but makes the sandwich element lightweight and good heat insulating. Sandwich block is a three-layer element comprising of two thin, flat facing plates of relatively higher strength material and between which a thick core of relatively lower strength and density is encased or it could consists of thin skin box of relatively higher strength material in-filled with relatively weaker and lower density material known as core. These have been used in the aerospace industry for many years and more recently they are being used as load bearing members in naval structures. Presently, it has gained attention to be used as an effective structural form in the building and construction industries.

Aerated concrete refers to concrete having excessive amounts of air voids. These air bubbles are created to reduce the density of the concrete and to make it lightweight, which provides good thermo-acoustic insulation too. However, aerated concrete, which is a porous material and classified as cellular construction material exhibits low compressive strength and high rate of water absorption. It can be used as a potential material for core in sandwich composite because of its relatively

more compressive strength compared to the traditional lightweight core materials like foam

MATERIAL TESTING AND MIX DESIGN

Methodology

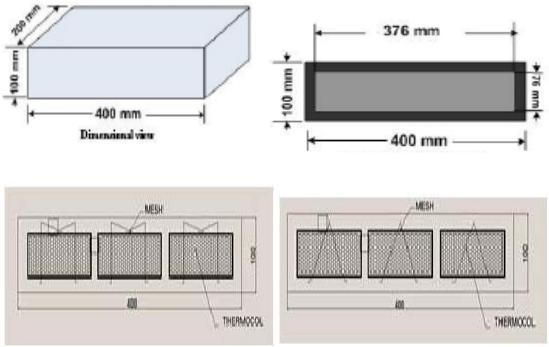
Ferro cement is a construction material composed of reinforced concrete and various layers of steel wire mesh, either electro-welded or hexagonal, distributed uniformly through a transversal section. Normally a mortar rich of cement, sand and water is used. This material is thin (10-35 mm width) and with high resistance and flexibility besides of being a low cost material. Ferro cement constructions present weight reduction compared to traditional building materials.

Blocks prepared and tested in this study for eight blocks and the Compressive strength measured and compared to Different types of shear connectors like,

Table-2.1. Specimen details.

S. No.	Specimen details	Index
1	Single Mesh Block	SM
2	Single Mesh With “V” Pin	SMV
3	Single Mesh With “M” Pin	SMM
4	Single Mesh With “U” Pin	SMU
5	Three Web Core Mesh	WM
6	Three Web Core With “V” Pin	WMV
7	Three Web Core With “M” Pin	WMM
8	Three Web Core With “U” Pin	WMU

Specimen (SM): Single Piece Thermocol of Size 375 mm x 175 mm x 750mmWrapped with Weld Me sh and Moulded



Specimen (WMM): Inserting ‘M’ Pin
Specimen (WMV): Inserting ‘V’ Pin

For mortar preparation in this study, Portland cement was used. Natural sand, clean and free from organic substances, sieved with sieve 2.38 was used. Average grain size was0.7 ± 0.145 mm. Water from the main distribution line in the region was taken to prepare the mixture. Thermocol used as thermal insulator filler in ferro cement blocks was bought in the local market.

Steps in Methodology

a) Allocation of raw materials like cement, Sand, Meshand Thermocol measuring as

b) per requirements.

c) Preparation of mortar is done with water cement ration of 0.45

d) The mould of size 400 x 200x 100 mm is made.

e) Thermocol is arranged as shown in Fig 3.1 to 3.7 for each type.

f) Casting of Blockswere done and kept for 1 day mould

g) Curing Of blocks in water is done after removing from mould

h) Checking compressive strength for particular 28th day.

MATERIALS

Cement

Ordinary Portland cement of 53 grades available in local market is used in the investigation. The cement has been tested for various proportion as per IS 4031-1988 and found to be confirming to various specifications of IS 12269-1987. The specific gravity was 3.14 and fineness was 3200cm^2/gm.

Fine aggregate

Natural river sand with fraction passing through 2.36 mm sieve was used and tested as per IS 2386(part 1)-1963. The fineness modulus of sand used is 2.83 with a specific gravity of 2.634.

Fine aggregates.

Testing procedure

To investigate the properties of the materials which are to be used for casting the specimens, various

laboratory tests were performed as per IS 2386:1963 and IS 383:1970. The results of the conducted tests are as follow

Sieve analysis of fine aggregate and the fineness modulus

Apparatus

Set of sieves ranging 40mm, 25mm, 20mm, 16mm, 12.5mm, 10mm, 6.3mm, 4.75mm, weighing balance, heating pan and 2.36mm, 1.18mm, 600µ, 300µ, 150µ stove

Table-2. Sieve analysis of fine aggregate.

Passing through IS sieve	Weight retained (gms)	Cumulative% retained	% Passing
4.75	42	4.2	95.8
2.36	96	13.8	86.2
1.18	413	55.1	44.9
0.6	287	83.8	16.2
0.3	138	97.6	2.4
0.15	20	99.6	0.4
Pan	4	100	0

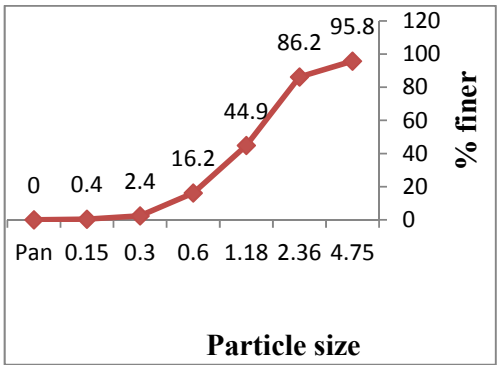


Figure-1. Sieve analysis of fine aggregate.

Fineness modulus fine aggregate

Total weight taken for sieve analysis
= 535 gm
Total Cumulative % Weight Retained on the pans
=273 gm
Fineness Modulus of Fine Aggregate = Total Cum % retained / 100= 283/ 100
= 2.83

Specific gravity

Specific gravity of aggregate is the ratio of its weight of an equal volume of water reference temperature -4ºC. Specific gravity of aggregate is useful for calculating void content in aggregate.

Specific gravity of Coarse Aggregate is = 2.634

Properties of cement

- Specific Gravity = 3.14
- Standard Consistency = 32%
- Initial Setting Time = 60 min
- Final setting time = 150 min

Table-3. Mix proportion of mortar.

S. No.	Materials	Quantities In Kg/M3	Proportion
1	Cement	350	1
2	Fine aggregate	700	2
3	Water-cement ratio	143.2	0.45

Specimen manufacturing details

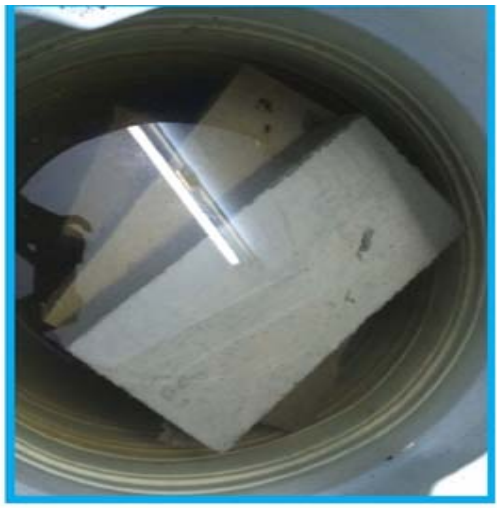
a) Preparing the reinforced wire meshes with the required block dimensions.

b) Preparing the steel mesh reinforcement for web

c) Arrange the rib shear connectors and attaching or fixing with the one side wire meshes.

d) The designed concrete is poured in the mold for the first layer. Placing the Thermocol or filler blocks material in place and above the first concrete layer.

e) The designed concrete is poured in the mold to full fill the mold and make the concrete cover with the required thickness



Casting specimen

EXPERIMENTAL RESULTS AND DISCUSSIONS

Compressive strength of blocks with results

Compressive strength of Sandwich for various types of connectors with cement and sand is determined on the 28 days for each sample. There were two samples for each test and the results would be taken as the average of these two.

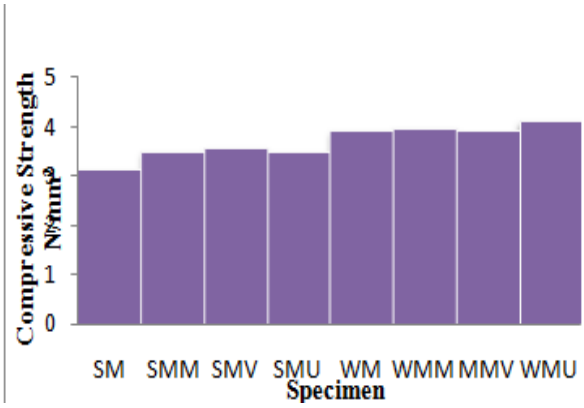


Figure-2. Compressive strength of sandwich blocks.

Table-4. Compressive strength of sandwich blocks.

S. No.	Details	Load (KN)	Compressive strength of concrete N/mm^2 28 days
1	Single Mesh (SM)	125	3.125
2	M - Pin mesh (SMM)	140	3.500
3	V - Pin Mesh (SMV)	142	3.550
4	U - Pin Mesh (SMU)	139	3.475
5	Three Web mesh (WM)	157	3.925
6	M - Pin web mesh (WMM)	159	3.975
7	V - Pin web Mesh (WMV)	156	3.900
8	U - Pin web Mesh (WMU)	165	4.125

Testing compressive strength of block

DISCUSSIONS

- The sandwich blocks are weight less and can used in construction as partition wall
- The M pin with mesh is 1.12 times compressive strength more than Single Mesh.
- The V pin with mesh is 1.13 times compressive strength more than Single Mesh.
- The U pin with mesh is 1.11 times compressive strength more than Single Mesh.
- Three web mesh is 1.25 times compressive strength more than Single Mesh.
- The M web mesh is 1.27 times compressive strength morethan Single Mesh.
- The V web mesh is 1.25 times compressive strength morethan Single Mesh.
- Three web mesh is 1.32 times compressive strength morethan Single Mesh.

CONCLUSIONS

- In order to make use of these building materials more efficiently and make people aware of its benefits, an organized technique is required to promote them. It is very important that people are aware of the benefits of using the substitutes for construction materials.

- According to various experts related to the real estate sector, the best environment friendly construction can be acquired through the usage of manufactured sand from stone quarries and brick substitutes. This will also avoid over-exploitation of natural resources like river sand and clay.

- Sandwich Blocks these days are being used in incredible projects taken up by business tycoons and real estate builders. It is also necessary that the government should start promoting these environment friendly construction substitutes to boost market acceptance.

- The government authorities have put a stop to the mining of sand due to environmental concerns but the manual operations in the sand mining have increased its prices. The sand prices have increased since the last few months and so are the brick prices due to climatic changes. Owing to all these reasons it is better that the usage of the Sandwich should be adopted.

REFERENCES

Brady. K.C. 2000. An Investigation into the Properties of Foamed Concrete. TRL Project Report PR/IS/99/00.

Brady. K.C and Greeno. M.J. 1997. Foamed Concrete: A Review of Materials, Methods of Production and Applications. TRL Project Report PR/CE/149/97.

Brady. K.C, Jones. M.R and Watts. G.R.A. 2001. Specification for Foamed Concrete, TRL Project Report PR/IS/40/01.

Byun. K.J, Song .H.W and Park. S.S. 2010. Development of Structural Lightweight Foamed Concrete Using Polymer Foam Agent. Department of Civil Engineering, Yonsei University, Korea.

Jones. M.R, Aikaterini McCarthy and Ravindra. K. Dhir. 2005. Concrete Technology Unit, Division of Civil Engineering University of Dundee.

MangalYadav. 2005. Mix Design Formulation of Foam Concrete. Feasibility Studies and Critical Appraisal of Application of Foam Concrete Blocks as Replacement to Burnt Clay Bricks.

Norazila Binti Kamarulzaman, 2010. University Malaysia Pahang.

Puttappa. C.G, Muthu. K.U and Raghavendra. H.S. 2008. Mechanical Properties of Foamed Concrete, MSR Institute of Technology, Bangalore.

Ramamurthy. K, Nambiar .E.K.K and IndusivaRanjani. G. 2009. A Classification Studies on Properties of Foam Concrete, Cement and Concrete Composites. 31(6).

Ravindra. K. Dhir. Moray. D. Newlands and Aikaterini McCarty. 2005. Use of Foamed Concrete in Construction, University of Dundee.