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EXPERIMENTAL INVESTIGATION OF THERMOCRETE PANEL

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Abstract *- **This project is about Experimental investigation of Thermocrete Panel. The Thermocrete Panels is a reinforced concrete sandwich panel used for numerous building applications. The Thermocrete panel consists of a super-insulated core of rigid Thermocol (polystyrene) sheet between two engineered sheets of steel welded wire fabric mesh. A galvanized steel truss wire is pierced completely through the Polystyrene core at offset angles for superior strength and welded to each of the outer layer sheets steel welded wire fabric mesh. To complete the concrete structure, a special mix of shotcrete is applied to each side of the panel after installation in walls & roof of the building and trowel finished to produce a highly insulated energy efficient RCC building with a useful life of more than 50 years. The Thermocrete panels can be used for various building applications such as single storey, double storey & multi storey buildings. Thermocrete panels are also used in place of brick / c.c block masonry walls & metal framed walls. They are also used for floor systems, roofing structure, columns, beams, as well as in stairs and boundary walls.***

Key Words: Sandwich wall, Ferro cement, flexural strength compressive strength, EPS.

I. INTRODUCTION

The Thermocrete Panels is a reinforced concrete sandwich panel used for numerous building applications. The Thermocrete panel consists of a super-insulated core of rigid Expanded Polystyrene (EPS) Sandwiched between two engineered sheets of steel welded wire fabric mesh. A galvanized steel truss wire is pierced completely through the Polystyrene core at offset angles for superior strength and welded to each of the outer layer sheets steel welded wire fabric mesh. To complete the concrete structure, a special mix of shotcrete is applied to each side of the panel after installation in walls & roof of the building and trowel finished to produce a highly insulated energy efficient RCC building with a useful life of more than 50 years.

The Thermocrete panels can be used for various building applications such as single storey, double storey & multi storey buildings. Thermocrete panels are also used in place of brick / c.c block masonry walls & metal framed walls. They are also used for floor systems, roofing structure, columns, beams, as well as in stairs and boundary walls .Lightweight pre-fabricated sandwich structural element in building construction is a growing trend in construction industry. Sandwich construction element consists of cover of high performance material and a thick lightweight and low strength material as core. Ferrocement is regarded as highly versatile thin material possessing superior properties, thus suits its role as insulating and strength bearing cover. Thermocol (polystyrene) panel is a lightweight material which exhibits relatively higher insulation properties than the conventional core materials. It can be used as a potential material for core in sandwich composite because combine lightweight sandwich panel has more compressive strength compared to the traditional concrete wall panels.

II. LITERATURE REVIEW

Nahro Radi Husein et al., [2013] investigated the strength capability of lightweight web sandwich panel (LWSP) in terms of first crack load, load-deflection curve for flexural load with (one point loading and third point loading), module of rupture, ultimate flexural load, axial load- deformation curve and the failure mode. The unit weight of the LWSP's which have aerated concrete as a core is (1850-1950) Kg/m3 and the unit weight of the LWSP's which have thermocol as a core (1250-1300) Kg/m3]. Piyush Bhandari, Evaluating properties of lightweight sandwich wall panels in 2016, Department of Civil engineering, P.D.V.V.P College of Engineering, Ahmednagar.

Abhijit Mandlik- Expanded polystyrene (EPS) in 2013, Experimental investigation of engineering properties such as compressive strength, modulus of elasticity, drying shrinkage and creep, of expanded polystyrene (EPS) aggregate concrete varying in density. Cost of EPS is less compared to that of normal concrete. Increase in the EPS

beads content in concrete mixes reduces the compressive and tensile strength of concrete. All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished.

III. MATERIALS

A. Cement:

A Cement is a binder, a substance used for construction that set, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregate to produce concrete. Pozzolana such as fly ash is essentially a siliceous material which while in itself possessing little or no cementations properties will, in finely divided form and in presence of water, react with calcium hydroxide at ambient temperature to form compounds possessing cementations properties. Ordinary Portland Cement (OPC) of 'RAMCO CEMENT' brand was used during the study. The OPC used of grade 53 complied with the Type I Portland cement as in IS: 1489 Part (I):1991.

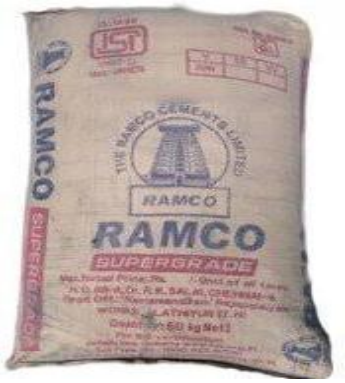


Fig 1 Cement-OPC

B. Fine aggregate

Sand is a naturally occurring granular materials composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textual class of soil. Fine aggregate are basically sands obtained from the land or the marine environment. Fine aggregate generally consist of natural sand or crushed stone. Aggregate passing through 4.75mm sieve was taken as shown in fig 2.

Fig 2 Fine aggregate

C. Coarse aggregate

Coarse aggregate is the portion of the concrete which is made up of the larger stones embedded in the mix. Concrete contains three ingredients; Water, cement, and aggregate. That aggregate is made of fine sand and coarse gravel. Coarse aggregate size is 12 mm.

Fig 3 Coarse aggregate

D. Water:

Water that is clean and free from injurious amounts of oils, acids, alkalis, Salt, Sugar, organic materials or other substances that may be deleterious to concrete is used.

E. Thermocol:

Polystyrene sheets having width 25mm were used as central core
Panel size: 90cmx30cmx10cm

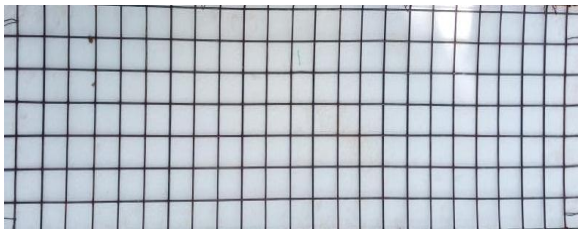


Fig.4 Thermocol with Wire Mesh

F. Wire Mesh:

Square welded wire mesh locally available in the market were used as the reinforcement in sandwich panel. The wire mesh having average diameter 0.2mm.

Fig. 5 Wire mesh

IV.TESTS DONE ON THERMOCRETE PANEL:

Different tests were performed on sandwich panels. Panels were prepared in Cube and beam mould. Panels size were 90x30x10 cm . It consisted of double layer of mesh on both sides of Thermocol core. This inner core was sandwiched between Ferro cement mortar of 1: 2 ratio. Physical and mechanical properties of Panels were determined and discussed to determine it use and adaptability.

1. Test on Materials

- Specific gravity of Sand
- Consistency of Cement
- Specific gravity of Cement
- Initial and Final setting time

2.Test on Specimen

- Flexural Strength Test

V. RESULTS AND DISCUSSION

Various tests were conducted on the sandwich panels to determine its properties.

FLEXURAL STRENGTH TEST:

Ferro cement specimens were tested in accordance with the applicable provision standard testing methods for flexural strength of Ferro cement, using a fixed supported slab. The flexural test under two point loading was conducted on the panels. During the testing loads and the corresponding deflection are noted down and are presented here in the forms of tables and graphs.

SET UP TESTING:

Fig 6 Panel during testing

1. Ultimate load and deflection for panel:

7 days	
Load KN	**Deflection mm**
9.2	0.3
11.9	0.8
12.8	1.6
14.2	2.1
11.2	2.4
9.8	2.7

Table 1: Flexural Strength Test

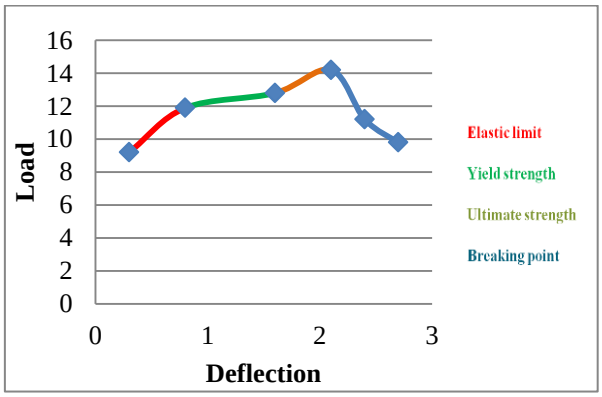
14 days	
Load KN	**Deflection mm**
9.7	0.2
11.6	0.7
14.5	2
16.4	3.8
14.7	6
12	7.2

Table 2: Flexural Strength Test

28 days			
Sample 1		Sample 2	
Load KN	**Deflection mm**	**Load KN**	**Deflection mm**
6.7	0.5	15.9	0.3
11.1	1.6	17.8	0.5
17.2	2	19.5	0.9
18.1	2.3	18	1.2
17.1	2.3	23.6	1.4
16.3	2.4	15.9	0.3

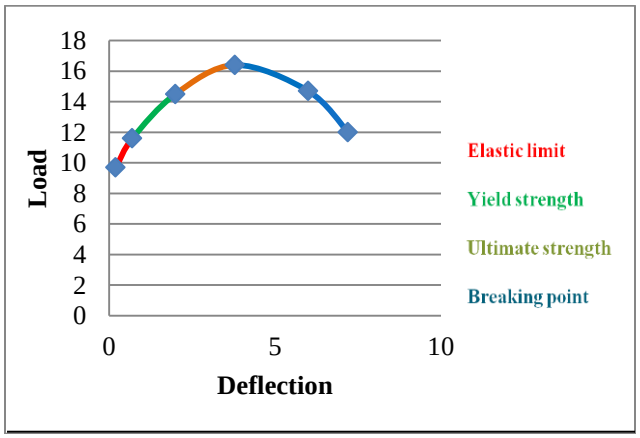
Table 3: Flexural Strength Test

2. Load vs Deflection graph



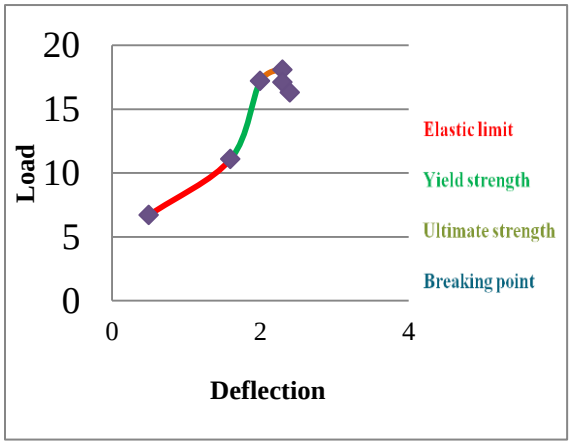
7 days

Graph 1: Load vs Deflection



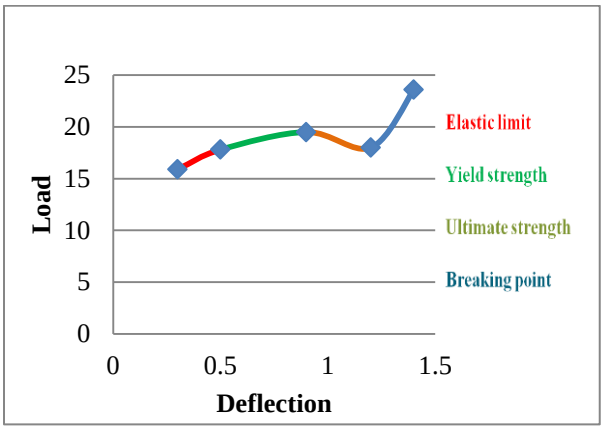
14 days

Graph 2: Load vs Deflection



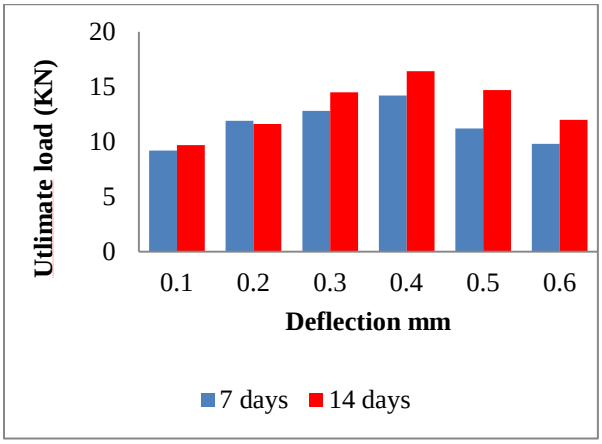
28 days Sample - 1

Graph 3: Load vs Deflection

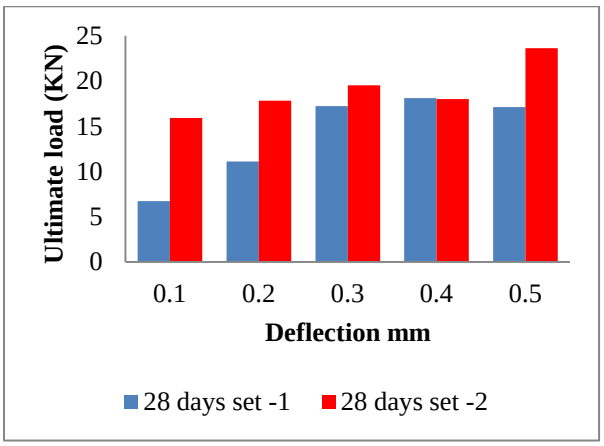


28 days Sample -2

Graph 4: Load vs Deflection



Ultimate load for 7 days & 14 days



Ultimate load for 28 days

SPECIFIC GRAVITY OF CEMENT(Sc):

Specific gravity is just a comparison between the weight of a volume of a particular material to the weight of the same volume of normally our nominal Mix design is based on the value of specific gravity of cement as 3.15. The value will change over time if the cement is exposed to various weather conditions. So it is essential to determine the specific gravity of cement before using it water at a specified temperature.

Empty Weight of Pycnometer (W1) = 52g
Weight of pycnometer + water (W2) = 161 g
Weight of pycnometer + kerosene (W3) = 138 g
Weight of pycnometer + kerosene +cement (W4) = 213 g
Weight of cement (W5) = 100 g

CALCULATION:

= (W3-W1)X(W2-W1)
=(138-52)X(161-52)
Specific gravity of coarse kerosene=0.79
= (W5*g)/(W5+W3-W4)20
=(100*0.79)/(100+138-213)
Specific gravity of cement=3.16

SPECIFIC GRAVITY OF FINE AGGREGATE (sfa):

The Sample was washed thoroughly to remove the fine particles and dust. The pycnometer is used for specific gravity test. The empty Weight of the pycnometer was taken as W1. Some amount of fine aggregate was placed in the pycnometer and weighed as W2. Sufficient water was added to make it saturated. The sample was stirred thoroughly for removing entrapped air. The pycnometer was filled with water and weighed as W3. It was emptied, cleaned well, filled with water and weighed as W4.
Specific gravity of fine aggregate is calculated from the formula = (W2-W1)/[(W4-W1)-(W3-W2)]

Empty weight of pycnometer(W1)=688.5g
Weight of pycnometer+dry sand(W2)=1157g
Weight of pycnometer +sand+water(W3)=1895.5g
Weight of pycnometer+water(W4)=1604g

CALCULATION:

=(W2-W1)/(W4-W1)-(W3-W2)

=(468.5)/(468.5)-(291.5)
Specific gravity of Fine Aggregate=2.64.

CONSISTENCY OF CEMENT:

The standard consistency of cement paste is defined as the Consistency which will permit the vicat plunger penetrate to a point 5 to 7mm from the bottom of the vicat mould.
Standard consistency(%)= (Weight of water added /Weight of cement) x 100
= (96/100) x 100
=32%

INITIAL AND FINAL SETTING OF CEMENT:

- Initial setting is that time period between the time water is added to cement and time at which 1mm square needle fails to penetrate the cement paste, placed in the vicat mould 5mm to 7mm from the bottom of the mould.
- Final setting time period between the time water is added to cement and the time at which 1mm needle.

Content	Time (minutes)
Initial setting time	36
Final setting time	570

VI . USES

THERMOCRETE combines the construction ease of concrete with the thermal insulation properties of EPS and can be used for a very wide range of application where lighter loads or thermal insulation or both are desired. Application includes:

- Flat RCC roofs
- Flat metal deck
- Green roofs
- Balconies and terraces
- Replacement of Brick
- Protection screed over waterproofing membrane

VII. ADVANTAGES

- Light weight (60% lighter then normal concrete)
- Can be moulded to any shape and slope
- Water resistant
- Lower w/c ratio – high compressive strengths
- Thermal – Insulating
- Easy to apply

VI. CONCLUSION

The paper mainly examines the properties of Thermocrete panels. Heat and cold transmission is reduced by 50% to-70% through the use of Thermocrete Panel and its superior sound insulation keeps each living space a quiet zone. By using our lightweight EPS core sandwiched with a galvanized mesh panel, construction system economize the use of materials and labor and offers economical option for construction of buildings that satisfies any physical and structural requirements.

Thermocrete Panel goes up so quickly, precisely and easily that fewer masons and other skilled workers are needed to get the job done. Thermocrete Panel is made of EPS foam and galvanized steel frame, so the system does not deplete forestry products. Furthermore, the high density expanded Polystyrene (EPS) thermal insulation core used in the panels contains no ozone damaging CFCs either in the manufacturing process or the end product. All the materials are also recyclable.

Thermocrete Panel construction system can easily be used toward a Leed certification of a passive building. Earlier completion means earlier occupancy. Fewer laborers and less equipment means a lower cost. Together, it means lower total capital investment and a quicker return on Investment (ROI).

Thermocrete Panel construction system structures require minimal long-term maintenance, especially in areas prone to termite infestation, extreme weather and temperature conditions. Summer heat, winter snow, heavy rains and high wind, nothing gets through Thermocrete Panel.

Structures built with Thermocrete Panel have experienced up to 50% -80% savings in electricity and gas consumption, made possible by the requirement of smaller and more efficient HVAC / heating and air conditioning systems due to lower heating & cooling loads. Smaller HVAC unit = cost reduction.
The Thermocrete Panel construction system is totally resistant to termites, insects, and rodents as well as to mold, mildew & fungi.

There are many documented instances where structures built with Thermocrete Panel have survived

the severest storms and other natural disasters. The Thermocrete Panel structures can withstand wind velocities of more than 200 miles/hour and endure earthquakes of 0.4 g Ground Acceleration or more than 7 on the Richter Scale.

Since the Thermocrete Panel construction system uses the traditional RCC construction materials that are Concrete and Steel along with an in-built thermal insulation core of high density Polystyrene, the finished buildings appear exactly similar to any other RCC / conventional building.

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