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Thermal Conductivity Of Fibre Filled With Ferrocement Sandwich Panels

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ABSTRACT

This study reviews the construction process of Ferrocement sandwich panels as non-load bearing units of buildings. The cast-in-situ construction process, on a small scale pilot project including materials and the steps of workmanship will be explored in this paper. The sandwich panels consisted of two thin Ferro cement layers reinforced with palm and sugarcane fibre. Steel wires were used to tie the two layers of iron meshes together. A total of 1m^2 sandwich panel was casted. The proposed panels are lighter in weight relative to the conventional brick walls. This kind of lightweight construction process would lead the construction industries for having a green and earthquake resilient environment. Two Different Layers will be used in our project the one was Palm fibre with ferrocement panel and sugarcane fibre With Ferrocement Panel of 150mm Thickness. In this study thermal conductivity measures used by the sandwich panels, the temperature will be noted by every 30mins intervel.

Keywords: Thermal Conductivity, Fibre, Ferrocement, Sandwich Panels

1. INTRODUCTION

Improving mortar strength using available local materials is an effective way of overcoming the problem of low strength and failure in building construction as well as integrating indigenous knowledge in industrial sector. Flow ability of mortar gave it an added advantage over concrete when inaccessibility comes into pictures in cases like congested reinforcement, narrow cracks or fissures and rehabilitation of structures. Self Compacting Mortar (SCM) easiness of application and improved mechanical advantages makes it preferable in repair works. Moreover, mortar plays a vital role in the workability properties of Self Compacting Concrete (SCC) therefore improvement on the properties of SCM will also bring about improvement in SCC. 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. Aerated concrete is a cellular lightweight material which exhibits relatively higher strength than the conventional core materials. 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 panels are becoming important elements in modern lightweight construction. In concrete construction, self-weight of structure it self represents a very large proportion of the total load on the structures.

Ferrocement has 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, ferrocement 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 ferrocement sandwich elements. This technique provides not 2 only the thickness but makes the sandwich element lightweight and good heat insulating. Sandwich panel 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. Natural fiber reinforcement increases biodegradability, reduces cost and decreases environmental pollution and hazards. Recently many types of natural fibers have been investigated for use in plastics including palm, flax, hemp, jute, straw, wood, rice husk, wheat, barley, oats, rye, bam-boo, sugarcane, grass reeds, kenaf, ramie, sisal, coir, banana fiber etc. Among these fibers, palm fiber is one of the particular interests because palm fiber (Palmyra Palm) grows plenty in Bangladesh and all over the world and composites made of palm fibers have moderate tensile and flexural properties compared with other natural fibers Palm fiber would be a good reinforcing agent in ABS and will be a good area of research. With the addition of palm fiber in ABS, polymeric matrix could change the mechanical and physical properties of the composites. Therefore, the mechanical (tensile strength, flexural stress, micro hardness, Leeb's rebound hardness) and physical (bulk density & water absorption) properties were measured in the palm fiber reinforced ABS composites in this study.Dividing ends of the middle hard part of the leaves were hammered. Hard part of the leaves was immersed in water for 20 days to rotten. Rotten materials were cleaned and fiber were then separated and dried under sun light. After that fiber was kept at 100˚C for 24 hours for partial removal of moisture.

1.1 Significance Of The Study

The development of lightweight, industrialized and sustainable construction techniques in India is a need of the day. The prevailing construction trend involves Reinforced Cement Concrete and burnt brick as infill walls which are heavy in weight. Ferro cement structural elements are known as lightweight, high performance composite material which can replace the conventional heavy materials. This research and its findings will encourage the use of the new approach to produce lightweight composite wall elements. The study, surely, is a step forward in the right direction to achieve quality
Products. The current project is able

- To produce a new potential structural composite, that is an integration of Ferro cement and expanded polystyrene for modular housing and building system which can be developed and marketed nationally and internationally.
- To develop a novel method of light weight construction resulting in a cost effective production.
- To help solve the housing problem of low and middle income earners.

1.2 Aim And Objectives Of The Study

The main aim of this research investigation is to manufacture and study the behaviour and properties of ferrocement encased aerated concrete sandwich wall elements.
Towards achieving the above mentioned aim, the related objectives associated
Were identified as follows:

1. To investigate the minimum flow value (flow table) of cement mortar capable to be poured during the casting of thin ferrocement encasement.
2. To establish the optimum high workability and high performance mortar. This pertained to the compressive strength, strength development, unit weight, curing regime, water absorption and ISAT (permeability) as parameters of study
3. To study the behaviour of ferrocement encased mortar sandwich specimens.
   This part of study was focused on, to optimize the various variables; in compression as principal testing and thermal conductivity testing.. The variables investigated were, type and number of wire mesh layers, overall unit weight, core dimensions (core-encasement volumetric ratio) to achieve lightweight sandwich, and the encasement direction (parallel or perpendicular to the loading direction) effective in terms of compressive strength.A variety of specimens of standard size of blocks and were cast and tested.
4. To investigate the behavior of ferrocement encased lightweight aerated Mortar wall elements of relatively large size particularly in compression with additional thermal conductivity tests.

2.METHODOLOGY

Figure.1 shows the methodology followed in this study

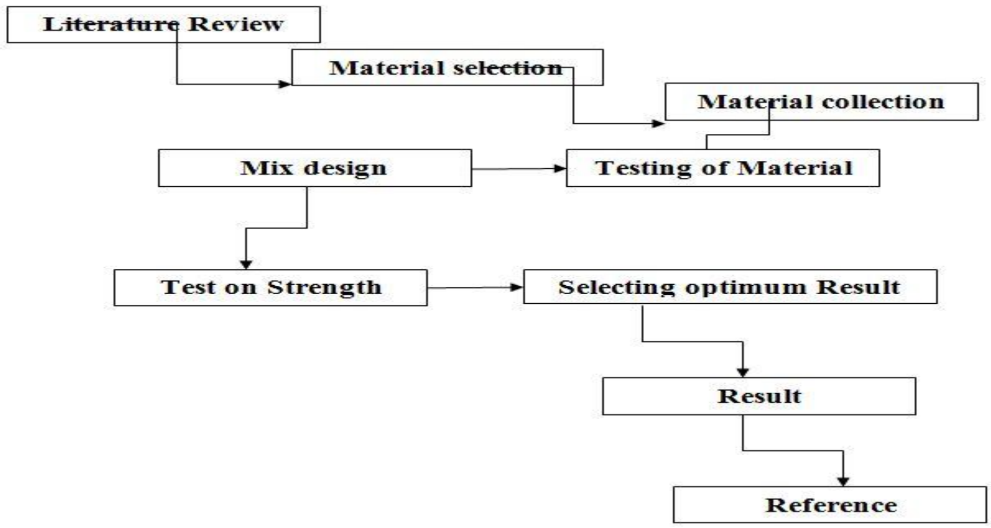

Figure.1 Methodology

3. SANDWICH STRUCTURAL PANELS

3.1 Introduction

A sandwich panel is a three-layer element, comprising two thin, flat facing plates of high-strength material and between which a thick lightweight core of low average strength is attached. Figure presents a few types of sandwich panel elements. Such sandwich structures have gained widespread acceptance within the aerospace, naval/marine, automotive and general transportation industries as an excellent way to obtain extremely lightweight components and structures with very high bending stiffness, high strength and high buckling resistance.

3.2 Precast Concrete Sandwich Panels

PCSP consists of two layers of concrete called wythes separated by a thick, lightweight and very low strength core layer. The concrete wythes are connected to each other by concrete webs, steel connectors or the combination of the two, called as shear connectors. PCSP with shear truss connectors is typically fabricated of two concrete wythes tied together with truss-shaped shear connectors equally spaced along the length of the panel as depicted in Figure, while Figure 2 shows the PCSP, where the wythes are connected by webs.

The first prefabricated panels were of non-composite type and consisted of a structural wythe (layer) and a non-structural wythe separated by a layer of insulation, whereas composite type panels were manufactured later.

In addition, it has been demonstrated time and again that during flexural loading be static or cyclic, core (foam cores) basically controls the failure of the sandwich structures. Interfacial delaminating in a sandwich panel represents a severe defect that affects the overall integrity and safety of the structure. It typically begins as a delamination crack at the core–skin interface near the loading point, advances towards the support along the sub-interface Russo and kinks into the core.

Figure shows the interfacial delamination between core and wythes. Thus, in any event, it is clear that the delamination at the sub-interface region and the shear strength of the core in essence dictate the performance of the sandwich composites under flexure. Sandwich structures with compliant/soft core materials (foam etc) are notoriously sensitive to failure by the application of concentrated loads, at points or lines of support, and due to localized bending effects induced in the vicinity of points of geometric and material discontinuities. The reason for this is that, although sandwich structures are well suited for the transfer of overall bending and shearing loads, localized shearing and bending effects, as mentioned above, induce severe transverse (vertical) normal and interfacial shear stresses.

Ferrocement is a thin laminated structural composite and its advantageous properties such as its versatility of application, strength, toughness, lightness, water tightness, durability, fire resistance and environmental stability cannot be matched by another thin construction material.

3.3 Ferrocement

3.3.1 Introduction
"Ferrocement is a type of thin wall reinforced concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small diameter wire mesh; the mesh may be made of metallic or other suitable materials".

3.3.2 Constituents Of Ferrocement
Ferrocement is defined as being made of cement-based mortar mix and steel wire mesh reinforcement. However, a broader definition of ferrocement includes the use of skeletal steel in addition to the mesh system.

3.3.3 Mortar Mix
The hydraulic cement mortar mix consists of Portland cement, fine aggregate (sand), water and various admixtures as per the requirement. The materials should satisfy standards similar to those used for quality reinforced concrete construction, with particular attention paid to the type of application.

3.3.4 Wire Mesh Reinforcement
Steel wire meshes are considered the primary mesh reinforcement. This include the various types of the shape; square woven or welded meshes, chicken(hexagonal/aviary) wire mesh, expanded metal mesh lath etc. Except for expanded metal mesh, generally all the meshes are used galvanized.(Figure.2)

3.3.5 Skeletal Steel
Skeletal steel used in ferrocement is in form of welded fabric as a grid of steel rods, strands of small diameters. Skeletal reinforcement is needed to form the shape of the structure to be built; around mesh layers are attached. Skeletal steel is only used when the thickness of the ferrocement element allows.

3.3.6 Impact Resistance
Resistance to impact is often measured by the amount of energy absorbed during the impact loading. Reports attesting to the favourable characteristics of ferrocement in collisions between boats or with the rocks are numerous. Ferrocement is very adequate to resist the impact, due to its higher ability of absorbing impact energy as compared with the conventional reinforced concrete, and the damage is localized at the impact zone. Ferrocement wall panels could resist blast load effectively, and posses high deformability. Ferrocement walls of 20 mm thickness exhibited higher blast resistance capabilities then the 100 mm thick conventional plastered brick and block masonry walls.

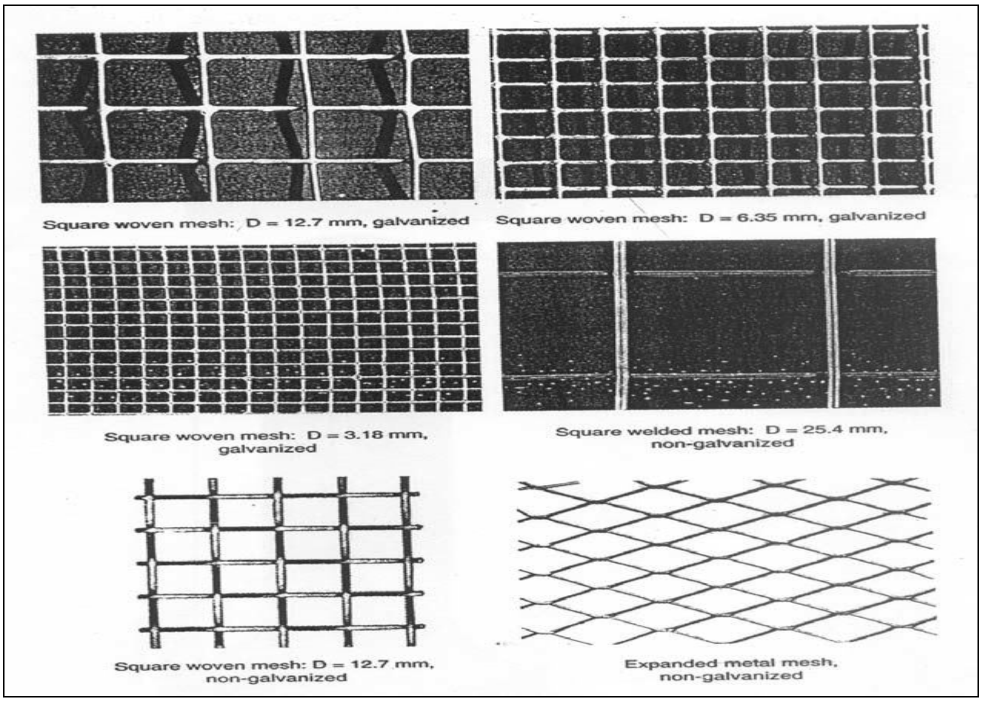

Figure. 2 Typical Steel Meshes Used In Ferrocement

3.3.7 Durability

Durability can be defined as the resistance to deterioration of properties when the ferrocement composite is subjected to various loading and environmental exposures. Although the measures required to ensure durability in conventionally reinforced concrete also apply to ferrocement, two other factors which affect durability are unique to ferrocement,

(a) The cover of mortar to the mesh reinforcement is small and consequently it is relatively easy for corrosive liquids to reach the reinforcement.

(ii) The surface area of the reinforcement is unusually high; so that area of contact over which corrosion can take place, and the resulting rate of corrosion are potentially high.

3.3.8 Thermal/Sound Conductivity

Thermal conductivity in ferrocement increases with the increase in volume fraction of reinforcement. However, it is significant when mesh layers are placed along the direction of heat flow. This rarely exists in ferrocement structures because in the conventional form of ferrocement construction, the mesh layers are arranged normal to the anticipated direction of heat flow. However, it is believed that, the ferrocement has high thermal and sound conducting properties due to its small thickness of section. This could be addressed by providing a cavity insulation or infilling the cavity with low conductivity materials, when ferrocement elements are produced in hollow sections.

3.4 Construction Process

3.4.1 Preparation Of Mesh

At first, the length and height of the wall were measured. The opening was cleared from the measurement and mesh was cut accordingly. Two sets of meshes were prepared as per the measurement. Necessary splices were provided where there was a joint with columns and beams. The lap length was considered as minimum as three inches.

3.4.1 Strengthening /Confinement

Ferrocement is useful for repair of concrete structures. It can restore the durability of structures which may undergo distress due to aggressive environments causing the corrosion of embedded reinforcement.Its application as overlays on masonry walls can increase its total load capacity, tension and shear strength. It also provides the ductility, and. cracking control. The application of ferrocement overlays is potential option in the situations where high performance of the walls is required.

A significant enhancement in stiffness, strength, and durability can be achieved Under compression when concrete is confined with various degree of ferrocement confinement. Compressive strength enhancement of the order of 20 to 30% was achieved by ferrocement confinement. Ferrocement jacketing of RC columns is a feasible technique to prevent their shear failure and to provide the ductility when loaded in compression. It enhances the stiffness, strength, energy dissipation, and ductility significantly, where, the mode of failure changed from brittle shear failure to ductile flexural failure.

3.4.2 Ferrocement In Sandwich Construction

A very little information is available regarding the application of ferrocement in sandwich elements especially members under compression. Ferrocement when used as middle plate in a sandwich panel prevented cracking and disintegration of the middle. Plate when subjected to a hard lateral impact. The behaviour of sandwich panels under low velocity impacts. Showed large permanent deformations in the steel cover plates but no fracture. Middle plates of normal and high strength concrete cracked into pieces under this kind of impact but the introduction of a ferrocement layer to the middle plate reduced the steel strains and also prevented disintegration of the middle plate.

Ferrocement skins of a bolted sandwich panels tested exhibited a significant increase in the punching shear strength when compared with a corresponding single skin. The increase in upper skin strength was greater than that of the lower skin which was of the order of 221% and 119% for the upper and lower skins respectively under punching.

The possible uses of composite materials in infrastructure related applications is an area of active research now a days and autoclaved aerated concrete is a proven building material that will become much more widely used for both residential and commercial construction. It is also important that the building material be cost effective, energy efficient, and available throughout the world.

3.5 Applications Of Ferrocement

In its role as a thin reinforced concrete product and as a laminated cement-based composite, ferrocement can be used in numerous applications. These applications can be classified in three major categories; marine applications, terrestrial applications, and repair and strengthening applications.

4.MATERIAL USED

4.1. Concrete
Concrete is a composite material that consists of a cement paste within which various sizes of fine and course aggregates are embedded. It contains some amount of entrapped air and may contain purposely-entrained air by the use of air-entraining admixtures. Various types of chemical admixtures and/or finely divided mineral admixtures are frequently used in the production of concrete to improve or alter its properties or to obtain a more economical concrete.

4.2. Concrete Making Materials

4.2 .1 Cement
Cement is a generic term that can apply to all binders. There is a wide variety of cements that are used to some extent in the construction and building industries, or to solve special problems. The chemical composition of these cements can be quite diverse, but by far the greatest amount of concrete used today is made with Portland cements.

4.2.3 Fine Aggregate
The sand which was locally available and passing through 4.75mm IS sieve is used. The specific gravity of fine aggregate was 2.60. Locally available river sand conforming to Grading zone I of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.
Fine aggregate" is defined as material that will pass a No. 4 sieve and will, for the most part, be retained on a No. 200 sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

4.3 Water
Water is a key ingredient in the manufacture of concrete. It is also material on its own right. Understanding its properties is helpful in gaining and understanding of its effects on concrete and other building materials. Although water is an important ingredient of concrete little needs to be written about water quality, since it has little to do with the quality of the concrete. However mixing water can cause problems by introducing impurities that have detrimental effects on concrete quality. Although satisfactory strength development is of primary concern, impurities contained in the mix water may also affect setting times, drying shrinkage, or durability, or they may cause efflorescence. The water used for experiments was potable water. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. It should be free from organic matter and the pH value should be between 6 to 7.

4.4 Palm Fibre

4.4.1 Extraction Of Fibers
The extraction of fibers involves the retting process followed by decorticating. The stems of toddy palm were cut at their base and immersed in a water-retting tank for two weeks. Then they are removed, The fibers were stripped from the stalks by hand, washed and dried in the sun. After drying, any extraneous matter that may still be adhering to them was removed .then the fibers are treated with 5% aqueous NAOH solution.(Figure.3)

4.4.2 Density Of Fibers
The density of fibers is measured by the gravimetric method. In general the density of natural fibers is depend on the process of extraction , algae of plant, moisture present in the fiber, soil condition in which the plant has grown , and similar factors. The density of toddy palm fiber is (1007.87 kg/m3).

4.4.3 Specific Heat Capacity Measurement
Specific heat capacity is one of the most important thermodynamic properties of the engineering materials. The specific heat capacity of samples was measured using differential scanning calorimeter (TA Instruments, Model no, Q20) at a heating rate of 20°c/min.

4.5 Sugarcane Fiber
Sugar cane is used due to its properties as a natural filler reinforcement that has played an important role in enhancing the composites performance. By combining sugar cane with tapioca starch that acts as a matrix, it will give many advantages to the environment. This is due to the advantages of renewability, low density, and high specific strength as well as biodegradable and recyclable at a very reasonable cost. Besides, it is expected to give the benefit to the environment due to non-degradable waste of plastic food packaging caused by uncontrolled solid waste disposal.

The fibers outstanding properties such as high specific strength and stiffness, impact resistance, flexibility, and modulus make them an attractive alternative over the traditional materials. Specifically, towards the properties of sugar cane fiber cellulose, which includes good specific strengths and modulus, economical viability, low density and low weight that make them a promising reinforcement of choice by the industry.


Figure.3 Palm Fibre


Figure.4 Sugarcane Fiber

5.MATERIAL CHARACTERISTICS

5.1 Cement

All through the experimental study, Ordinary Portland Cement conforming to IS: 8112 -1989, was used. The physical and mechanical properties of the cement used are shown in Table 1.

Table.1 Properties of Cement

Physical property	Results
Fineness	2946 cm2/gm.
Normal Consistency	30%
Vicat initial setting time (minutes)	64
Vicat final setting time (minutes)	192
Specific gravity	3.10
Compressive strength at 3-days	23.86 MPa
Compressive strength at 7-days	37.01 MPa
Compressive strength at 28-days	45.73 MPa

5.1.1 Physical Properties

Portland cements are commonly characterized by their physical properties for quality control purposes. Their physical properties can be used to classify and compare Portland cements. The challenge in physical property characterization is to develop physical tests that can satisfactorily characterize key parameters.

5.1.2 The Physical Properties Of Cement

- Setting Time
- Soundness
- Fineness
- Strength

6.1.3 Setting Time

- Cement paste setting time is affected by a number of items including: cement fineness, water-cement ratio, chemical content (especially gypsum content) and admixtures.
- Setting tests are used to characterize how a particular cement paste sets.

- For construction purposes, the initial set must not be too soon and the final set must not be too late. Normally, two setting times are defined: Initial set. Occurs when the paste begins to stiffen considerably.
- Final set. Occurs when the cement has hardened to the point at which it can sustain some load. Setting is mainly caused by C3A and C3S and results in temperature rise in the cement paste.
- False set :No heat is evolved in a false set and the concrete can be re-mixed without adding water Occures due to the conversion of unhydreous/semihydrous gypsum to hydrous gypsum(CaSO4.2H2O)
- Flash Set: is due to absence of Gypsum. Specifically used for under water repair.

5.1.4 Soundness

- When referring to Portland cement, "soundness" refers to the ability of a hardened cement paste to retain its volume after setting without delayed expansion.
- This expansion is caused by excessive amounts of free lime (CaO) or magnesia (MgO). Most Portland cement specifications limit magnesia content and expansion.
- The cement paste should not undergo large changes in volume after it has set.
- However, when excessive amounts of free CaO or MgO are present in the cement, these oxides can slowly hydrate and cause expansion of the hardened cement paste.
- Soundness is defined as the volume stability of the cement paste.

5.1.5 Fineness

- Fineness or particle size of Portland cement affects Hydration rate and thus the rate of strength gain.
- The smaller the particle size, the greater the surface area-to-volume ratio, and thus, the more area available for water-cement interaction per unit volume.

5.2 Palm Fibre

Figure.5. shows the Palm fibre.

5.2.1thermal Diffusivity

The physical significance of thermal diffusivity is associated with propagation of heat in to the medium during changes of temperature with time, the smaller the thermal diffusivity the more time required for heat to generate the solid thermal diffusivity (α) is a function of thermal conductivity (k) and specific heat capacity (Cp) can be calculated from the relation given below and the results are presented in the Table. 2

$$\alpha = K / \rho . Cp$$

Table:2 Thermal Properties Of Palm Fibre

Temperature (°C)	Thermal conductivity (W/M.K)	Specific heat capacity (KJ/KG.K)	Thermal diffusivity x 10^{-5} (m^2/ sec)
30	0.142	1.029	5.3678
60	0.157	2.354	6.322
120	0.160	2.710	5.857

Figure.5 Oil Palm Fibre

5.3 SUGARCANE FIBRE

The bagasse is an important by-product of the sugar cane industry and most of it is used to produce steam and electricity in a co-generation plant at the ethanol plant. After the bagasse combustion, a new by –product is the Sugar Cane Bagasse Ash (SCBA). It consists mainly of silica (SiO2), which indicates its potential as mineral admixture for use in concrete. The results of this research program indicated that SCBA can be used as a pozzolana and substitute cement. Since durability is a very important issue for implementing new construction materials, in this Thesis, the results of tests of sulphate attack on concrete cubes made with SCBA. These tests indicated that SCBA improves the durability of a reference.The fibers outstanding properties such as high specific strength and stiffness, impact resistance, flexibility, and modulus make them an attractive alternative over the traditional materials. Specifically, towards the properties of sugar cane fiber cellulose, which includes good specific strengths and modulus, economical viability, low density and low weight that make them a promising reinforcement of choice by the industry. Thus, natural fiber, like sugarcane, that can be used as a replacement to the conventional fiber since the global environmental issues, have led renews interest in the development of bio-based industrial products. Table.3 shows the Properties Of Sugarcane Fibre.

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Table.3 Properties Of Sugarcane Fibre

COMPOSITION OF SUGARCANE FIBRE	COMPONENT MASS%
SiO_2	78.34
Al_2	8.55
Fe_2O_3	3.61
CaO	2.15
Na_2O	0.12
K_2O	3.46
MnO	0.13
TiO_2	0.50
BaO	<0.16
P_2O_5	1.07
LOSS OF IGNITION	0.42

6.TESTING PROCEDURE

6.1 Compression Test

Compressive strength is the major test done during this study. Three types of specimens were tested under compression; cubes, blocks and wall elements. The cubes and block specimens were tested using TONIPAK 300 compressive testing machine of capacity 3000 KN installed in the structures and materials laboratory, FKA UTM. The tests were conducted as per the specifications of ASTM C109-02 and EN 679 at the prescribed age of the testing. Before conducting the test, all the specimens were checked for any kind of deformation such as broken edges and cracks. Then the specimens were placed at the center of the cleaned platens of the machine followed by the application of gradual and Without shock loading. The rate of loading was maintained at a constant value 0.3 KN/mm^2 per second until the failure of the specimens. During test, the visible cracking and the failure mode were monitored carefully and the load corresponding to first visible crack and the ultimate failure were recorded.

6.2 Thermal Radiation

Thermal conductivity of concrete were obtained by fitting with temperature response curve predicted, experimental temperature response data for mixes M-1. Sample analytical fit with measured temperature response data of specimen for the time interval between 2 ~ 5 hours. The variation of thermal conductivity with Time can be expressed in Table.4 and Table.5 . Thermal conductivity obtained based on above described method for three Mixes. The variation of thermal conductivity with time can be expressed as nonlinear curve. It can be seen that the thermal conductivity of OPC concrete follows a unique pattern irrespective of the mix proportions, where it remains constant up to hours and starts to increase up to a maximum value in the range which is fairly in good agreement with values proposed by previous studies for hardened concrete. The thermal conductivity and the specific heat measurements were performed using a device based on the transient plane source method. It enables measurement of thermal conductivity range at least 0.01-500 W/m K° and can be used for measuring various kinds of materials. The technique of the transient plane source uses two identical samples, between which enters a sensor. The choice of a suitable sensor size is importance to maximize sample penetration.

7.TEST RESULTS &PHOTOS

7.1 Thermal Conductivity Measurements On Ferro Cement Panels Filled With Fibres

Thermal conductivity measurements of panels used in this study were carried out on a homemade hot plate conductivimeter. In its basics, this apparatus is a box one side open, in which heat is generated by means of an electric heating system. The walls of the box are thermally isolated with a ceramic fibre material. It is worth to mention that if the specimen is a laminar compound, contains porous or voids where heat can be transferred by convection, radiation and/or conduction then k, is the apparent thermal conductivity of the specimen. For thermal conductivity determination, panel walls are mounted on the open side and closing the box completely. A constant heat flow of 100W was supplied to the specimen of area 1 m2 through a controlled power supply .four located in the hot face and four in the cold face of the panel wall to determine the thermal conductivity. Four testing replicates were carried out on each panel wall in this study. Temperature measurements were taken every 30 min for a period of 4h. Registered temperatures from the four sensors in the hot side and four sensors in the cold side were plotted and only the range of steady state was taken to get the mean temperature of that sensor. The same procedure was taken for the four sensors in the cold side. During the test, temperature values were registered every 10 min. It is important to mention that registered values used to determine thermal conductivity of the material tested correspond to the steady state.

7.2 Thermal Conductivity For Palm Fibre and Thermal Conductivity For Sugarcane Fibre

Thermal Conductivity For Palm Fibre given in Table.4 and Thermal Conductivity For Sugarcane Fibre given in Table. 5

Table. 4 Thermal Conductivity For Palm Fibre

S.No	Time (min)	Temperature (°c)	Difference δT
1	0	31.4	-
2	30	32.2	0.8
3	60	34.9	3.5
4	120	36.4	5
5	240	39.2	7.8

Table. 5 Thermal Conductivity For Sugarcane Fibre

S.No	Time (min)	Temperature (°c)	Difference δT
1	0	32.2	-
2	30	33.8	1.6
3	60	35.2	3
4	120	37.9	5.7
5	240	39.9	7.7

7.4 Photos

Photos given in Figure6. To Figure 12 shows preparation of Ferrocement sandwich panels

Figure.6 Fibres (Sugarcane &Palm Fibre)

Figure.7 Placing

Figure. 8 Finishing Stage

Figure.9 Ferrocement Slab

Figure. 10 First Layer Of Mortar

Figure.11 Mortar Placing Above The Palm Fibre

Figure. 12 Mortar Placing Above The Palm Fibre

8.CONCLUSION

- Ferrocement sandwich panels show good potential for use in several construction applications as reflected by their relatively high ultimate and serviceability loads, crack resistance control, high ductility,and remarkable energy absorption.
- Irrespective of the type of the core material, the developed ferrocement cored and sandwich panels are lighter in weight when compared to conventional reinforced concrete construction of same thickness.
- For the same thickness, ferrocement panels reinforced with welded wire mesh exhibited higher ultimate load in flexural than that reinforced with expanded and woven steel mesh. However,steel type did not seem to have much effect in compressive strength.
- For the same core material, ultimate load, ductility ratio, energy absorption, and deflection were all increased when increasing the volume fraction in flexural panels. However, this did not have much effect for the compression loading.
- The ferrocement cored panels yielded the highest strength, for both flexural and axial loadings, followed by the light weight brick core panels.
- Commercial plasticizer can be used to augment the workability of the mortar mix and to reduce the water content thus enhancing the mortar strength.
- Precast wall panel can be made in the factory and it can be transported to the site to fix.
- For precast panel, standard sized panel can be made and there should be groove on each panel to fix with the other.

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