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Modelling and Thermal Analysis of Medium Density Coir Composite Boards

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***Abstract*— Recent researches have led to the development of numerous natural fibre based composite materials with a variety of applications. Medium density coir boards (MDCB) prepared as per IS 15491 utilizes coir fibre and Phenol formaldehyde resin. The study investigates the possibility of substituting Phenol formaldehyde resin with cheaper Urea formaldehyde resin and to compare the temperature distribution of Medium density coir boards prepared with them using finite element modelling software ANSYS 14.5**

***Keywords*— FEM, MDCB, Temperature distribution, Thermal conductivity.**

I. INTRODUCTION

Composite materials possess numerous advantages like light weight and high strength to weight ratio over conventional materials like metals, wood etc.[1] Natural fibre reinforced composites or bio composites has finally started to become economically viable with improved technologies [4]. The forerunners in this race include coir fibre, jute, sisal, bagasse and many more [3].

The researches on coir composite boards were all focused towards the possibility of substituting wood or engineered wood products like plywood [8].Wood being an excellent insulator is widely used in applications utilizing this property [2]. This paper is an attempt to study the thermal conductivity and degree of insulation of MDCB while working with two different resins

Computer aided engineering tools like ANSYS 14.5 is the one of the successful Finite Element Modelling software and is selected as the medium for modelling and thermal analysis of medium density coir boards in this study.

II. METHODOLOGY

A. *Material selection*

Coir fibre is extracted from cocos nucifera largely cultivated in South-West Asia [9]. The strong, light weight, non-toxic and bio degradable characteristics of coir fibre enabled it an easy choice while the selection of reinforcement in the present study [3]. Phenol formaldehyde resin is selected as matrix material owing to the better fire retardation and good binding properties [5]. A possible substitute for Phenol formaldehyde resin is the cheaper Urea formaldehyde resin with similarity in its properties. The medium density coir board made of coir fibre with bonding agents either phenol formaldehyde or urea formaldehyde is selected for this study.

B. *Creating 3D models using ANSYS*

Element type solid 186 of ANSYS is used to carry out steady state analysis in this study [8]. Medium Density Fibre boards with three different thicknesses and two different resins were modelled using ANSYS. The dimensions of the board were 500mm X 500mm with thicknesses 25mm, 50mm and 75mm. Non-woven needled felt impregnated with Phenol formaldehyde resin forms a layer with approximately 1mm thickness. It is pressed to form laminated composite boards. The layer formation is shown in fig. 1 and fig. 2

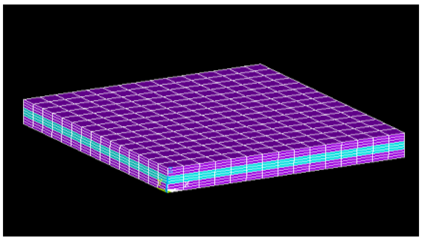

Fig.1. Coir and Phenol formaldehyde layer formation

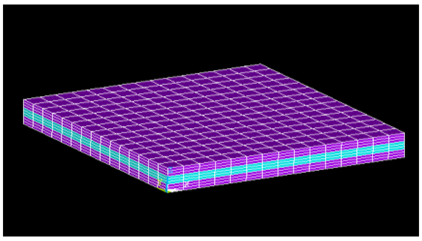

Fig.2. Coir and Urea formaldehyde layer formation

C. *Meshing*

The most suitable element type for layered composite in ANSYS is Solid 186[8]. Number of nodes and elements used are 512 and 225 respectively

D. *Boundary conditions*

The fig. 3 shows the boundary condition selected for analysis. An air flow temperature of 100˚C and 250˚C were applied at the top and bottom surfaces respectively and a heat transfer from higher temperature region to lower temperature region was initiated.

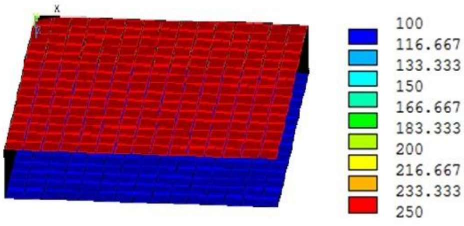

Fig.3.Bountary conditions

III. EXPERIMENTAL

A total of six models were developed with three different thicknesses each for MDCB utilizing urea formaldehyde and phenol formaldehyde resins. The temperature distributions across the thickness of the composite boards were analyzed using ANSYS.

PF 1 is medium density coir board composed of coir fibre and phenol formaldehyde with 25mm thickness and 500mm X 500mm length and breadth. The fig. 4 shows the temperature distribution across the thickness of the board. It is noted that a temperature of magnitude 4.403 ˚C is lost at bottom surface the same is gained at top surface.

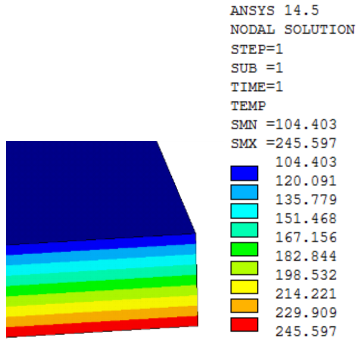

Fig. 4 Temperature distributions across the thickness of PF1

UF 1 is medium density coir board composed of coir fibre and urea formaldehyde with 25mm thickness and 500mmX500mm length and breadth. The fig. 5 shows the temperature distribution across the thickness of the board. A considerable temperature difference of 6.417˚C was recorded during the temperature distribution between top and bottom surfaces.

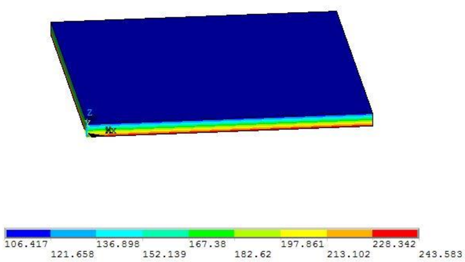

Fig. 5 Temperature distribution across the thickness of UF1

PF 2 is medium density coir board composed of coir fibre and phenol formaldehyde with 50mm thickness and 500mmX500mm length and breadth. The fig. 6 shows the temperature distribution across the thickness of the board. The corresponding temperature difference is of a magnitude of 2.213˚C.

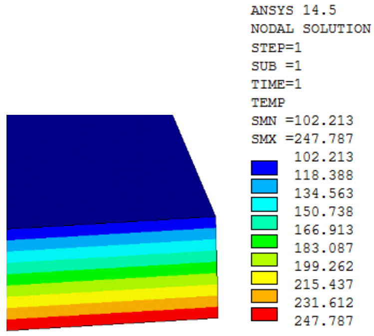

Fig. 6 Temperature distribution across the thickness of PF2

UF 2 is medium density coir board composed of coir fibre and urea formaldehyde with 50mm thickness and 500mmX500mm length and breadth. The fig. 7 shows the temperature distribution across the thickness of the board. A considerable temperature difference of 3.257˚C was recorded during the temperature distribution between top and bottom surfaces.

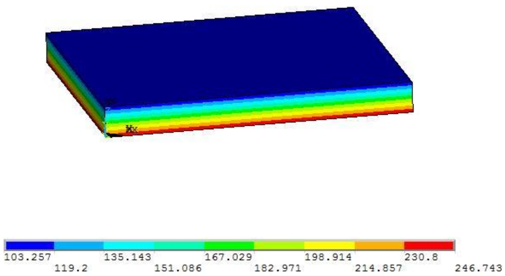

Fig. 7 Temperature distribution across the thickness of UF2

PF 3 is medium density coir board composed of coir fibre and phenol formaldehyde with 75mm thickness and 500mmX500mm length and breadth. The fig. 8 shows the temperature distribution across the thickness of the board. A temperature difference of 1.502˚C was observed during distribution across the two surfaces.

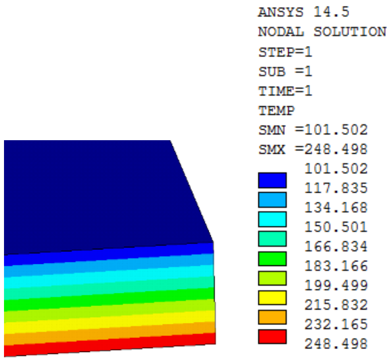

Fig. 8 Temperature distribution across the thickness of PF3

UF 3 is medium density coir board composed of coir fibre and urea formaldehyde with 75mm thickness and 500mmX500mm length and breadth. The fig. 9 shows the temperature distribution across the thickness of the board. A temperature difference of 1.225˚C was recorded between the top and bottom surfaces.

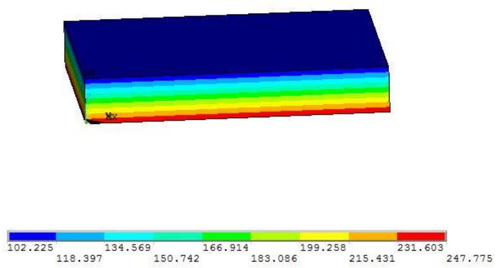

Fig. 9 Temperature distribution across the thickness of UF3

From the above results it is clear that change in temperature distribution is more for urea formaldehyde than phenol formaldehyde for same thickness. The thickness of the samples exhibited little effect on temperature distribution. Fig. 10 shows the relation between temperature drop and thickness for both the samples for entire range of thickness in consideration

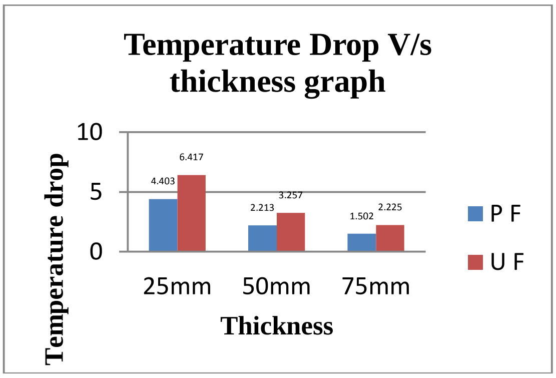

Fig. 10 Temperature drop v/s thickness graph

IV. CONCLUSIONS

a. The temperature distribution of three different thickness MDCBs are studied and it was observed that the change is temperature at top and bottom region decreases as number of layer increases.

b. More temperature drop is observed in board made of coir and urea formaldehyde than that of coir and phenol formaldehyde which indicates that board with phenol formaldehyde as resin is having more thermal conductivity. Thus boards of urea formaldehyde could possibility outperform board with phenol formaldehyde resin in insulation.

c. There is only a slight drop in temperature at bottom and top region as thickness changes, so it is concluded that the relative temperature drop of different models shows that thickness have less impact over the thermal performance of the boards

V.ACKNOWLEDGEMENT

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