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Investigation of Natural Fiber Composite Material for Building Cooling System

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Abstract: ***The objective of this work is to develop a low cost composite natural fiber material for the application of improving the energy efficiency of building and also to improve the building cooling effect. This work involves investigation of the thermal properties of Natural fiber composite which is used to reduce heat transfer into the building. The selected three fibers namely (Sisal, Jute, Flax) are mixed with some certain ratio epoxy resin and hardener to prepare the composite panels. Composite materials have ability to absorb and store heat before releasing it. The thermal insulation composite panels (natural fiber) were produced and the composite material for the roof and wall which were experimentally determined the energy performance of the building application. An experimental investigation of the natural fiber composite panels were performed using heat flow meter to measure the thermal conductivity of composite materials.***

Keywords: Natural fiber, Insulation, Thermal conductivity, Energy efficiency

1. Introduction

The building sector has the world's total energy consumption due to the increasing demand for buildings. Several attempts have been made to improve energy efficiency in the building sector. To reduce carbon emission energy efficient building is one of the energy saving method of the energy demand utilization. Energy consumption in buildings is getting more importance as it represents a high amount of the global energy consumption. In fact, the panels are used for the construction, especially in walls, roof and ceilings. In order to energy consumption the present aims to enhance the thermo physical properties of the jute, sisal and flax fibers. Indeed the fibers are a naturals and renewable product with the thermo physical properties and chemical properties for the development of efficient insulating materials. It reduce energy consumption rate of the building and avoid environment effects.

The natural fiber composite panel in building contributes to reduce the size of air conditioning systems and the energy consumption. The periods of the thermal comfort could be extended without depending on mechanical air-conditioning systems. The application of innovative solutions can be a useful tool for the instead of existing buildings, reducing heat losses. Thermal properties of innovative insulating systems for buildings have been investigated. The application of innovative insulating systems composed of natural fibers can be good solution for the decreasing heat losses. Natural fiber combines ecological safety and many other properties, such as mechanical strength and thermal insulation characteristics. It is not a new material but its applications are surely innovative in many industrial fields, in particular for buildings, construction, and energy efficient. The present study focused on thermal characterization of insulating panels composed of three fibers (jute, sisal, flax). The three different natural fibers (sisal, jute, flax) panels for thickness 3mm, length 200mm and breadth 200mmwere investigated. The thermal conductivity was measured by a heat flow meter apparatus in PSG info tech at coimbatore.

2. State of art of natural fibers insulation panels

2.1 Materials and applications

Natural fiber (Sisal, Flax, Jute) are resistance to high temperature, strength and durability. It is suitable for applications requiring resistance against high temperature, insulation properties, durability, mechanical strength, low water absorption etc. In particular, natural fibers can be used for fire protective application it is also eco-friendly materials, characterized on easily recyclable when compared to other materials. The paper is focused on insulation three natural fiber composite panels as innovative materials for high energy efficiency in building as shown Figure1. The fibers used for the construction of the panels are recycled. These systems have high mechanical resistance, excellent thermal properties and good breathable properties.

Figure 1: Natural fiber insulating panels (Sisal, Flax, Jute)

2.2 Description of the samples

The three samples natural fibers were fabricated and the dimensions are length200mm, breadth 200mm, and thickness 3mm. The fabricated samples are to be used as roofs and walls.

3. Methodology

3.1 Thermal conductivity test

The hot plate apparatus establishes steady state one-dimensional heat flux through a test specimen between three parallel plates at constant temperature. Fourier's law for heat conduction is used to calculate thermal resistance and thermal conductance. The main equipment used in PSG techs coeindutech laboratory is the heat flow mater apparatus, which measures the steady state heat transfer through flat materials according to ASTM standard ISO 8301-91/1:1998. The sample is placed between three flat plates controlled to a specified at constant temperature. Thermocouples fixed in the plates are used to measure the temperature drop across the specimen and wireless thermal flux meter embedded in each plate is used to measure the heat flow through the specimen. The thermal conductivity (K in W/(m.K)) is calculated by means of the heat flux, the temperature difference across the specimens and the thickness of the specimens. The experimental set up is shown in Figure 2.

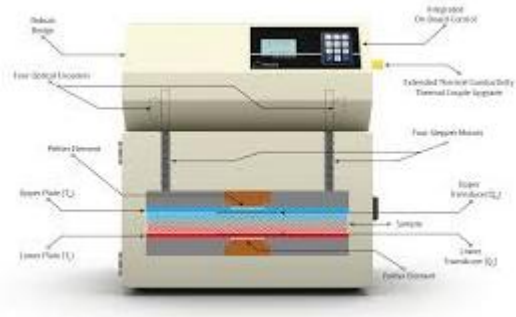

Figure 2: Heat flow meter apparatus

4. Result and discussion

4.1 Thermal performance

The low cost and natural available materials are selected to make panels for building cooling application. The samples jute, flax, sisal fiber panels were tested for thermal characterization by means of the heat flow meter apparatus and the thermal conductivity of the specimens was calculated. The obtained values are 0.08513, 0.079963, 0.078280, W/(m.K), respectively for samples Flax, Jute, Sisal fibers. The result of thermal conductivity analysis of three natural fibers composite panels are shown in Figure 3.

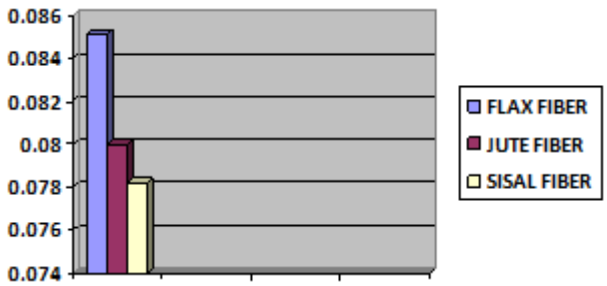

Figure3: Comparison of the thermal conductivity values

The thermal conductivity of the sisal natural fiber composite panels is lower than jute and flax fiber. This result confirms that sisal fiber can be considered as the specimen which has the best thermal properties for building cooling application.

5. Conclusions

Energy efficient insulating materials contribute in reducing the heat losses from buildings and allow energy and money saving for heating and cooling. The many innovative products emerged on market also thank to good mechanical (thermal) resistance properties. In this context, thermal properties of an innovative insulation system composed of the natural fibers (sisal, jute, flax) were investigated. The eco-friendly panel has a thermal conductivity included 0.078-0.085W/(m.K) range, lower than other panels. In the building application, the thermal transmittance of walls could be reduced using panels with very small thickness (3mm). Sisal fiber has low thermal conductivity value when compared to other (Jute, Flax) fibers.

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