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Energy gain in a cold season using mat insulation in different material buildings

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ABSTRACT

This paper describes how to measure conductivity of a new insulator. Mat is made up of Agave plans which are now produced in Iran; it can be used in walls of buildings to reduce energy loss in cold season. In this work the thermal conductivity for mat is to be 0.06949 J/s.m°c and also from temperature gradient curve it was found that the temperature changes uniformly with thickness of the mat. Finally the difference of the energy gain in the concrete buildings with & without the mat was estimated to be 12.285×10³ kcal and with and without in the brick chamber was calculated to be 1.956x10³ kcal in the cold season in Tehran.

Keywords: Temperature gradient, Mat, Thermal conductivity, Concrete building.

INTRODUCTION

Prior to World War II in the 1940s, coal and wood were important. As we begin the new century the challenges we face as building designers increase daily. In criticism of energy due to the increasing oil and energy price, the main consumption of energy is usually used in residential and commercial buildings. One side of energy conservation is energy efficiency. The addition to insulation to the outside walls of a house means that the same inside temperature can be maintained with less fuel to the furnace. The largest amount of household energy use in all countries is for space heating. Nevertheless, many well-designed houses have been built that require no separate heating system. They are heated adequately by existing internal sources of heat energy such a lights and cooking stoves. The paths of heat loss for a typical conventionally insulated house are 5% through ceilings 20% through, 17% though frame walls, 1%through basement floor, 20% through basement walls, 3% through door, 38%through cracks in walls, windows, and doors. As a general rule, 30 to 40 % of the total heat loss is by this convective process. Up until about 20 years ago, homes in many areas of Iran were commonly built without insulation in wall space. It was a feature that the prospective home buyer could not see and for the most part did not care about. In a typical house, infiltration of outside air is sufficient to

account for a complete change of air in a house about once per hour. This effect can account for a third of the total heat loss. The cold air comes in, the warm air goes out. Much of this air exchange occurs around doors and windows, or through leaky siding, and other cracks in the structure. Insulation reduces heat loss from conduction process. Mat is made up of plant fibers which are produced in many countries in the world. Both sisal and henequen come from the leaves of species of Agave (Agavaceae). Sislana has sharp spines on the ends of its leaves that have been used by native people as needles. The provision of both the fiber and a sewing utensil gave rise to the common name needle and thread plant. Today the fibers are used for sacking, mat, and teabags and as reinforcements for materials such as rubber. Fibers are removed from Agave species in the same way. The outer, mature leaves are cut at the base, to the factory, and fed between rollers that squeeze out most of the water and turn the soft tissues into an amorphous mush that is scraped away from the fibers. The fibers are then washed and hung in the sun to dry. They can be dyed or used directly since they are naturally a creamy white if properly washed and dried.[1]. This work tries to consider mat as one of the desirable insulator.

Instrumentation

In order to find the thermal conductivity for mat, the insulation chamber of dimensions $0.75\times0.6\times1m^3$ was made in Shahed University, physics department which consists of three thermometers in which the heat flows through the mat and plywood from the warmer inside to cooler outside (both regions are inside the chamber). The area of the insulation is $0.75\times0.60\ m^2$, thickness of 0.076m and of 0.01m thick plywood Table1

Fig.1 A piece of mat

Table1.The dimensions of the insulation chamber

Ma Materials	Dimensions	
Area		Thickness
Chamber	0.7*0.6m²	1m (height)
Mat	0.7*0.6m²	0.076m
Plywood	0.7*0.6m²	0.01m

Fig2.The insulation chamber and temperature controller

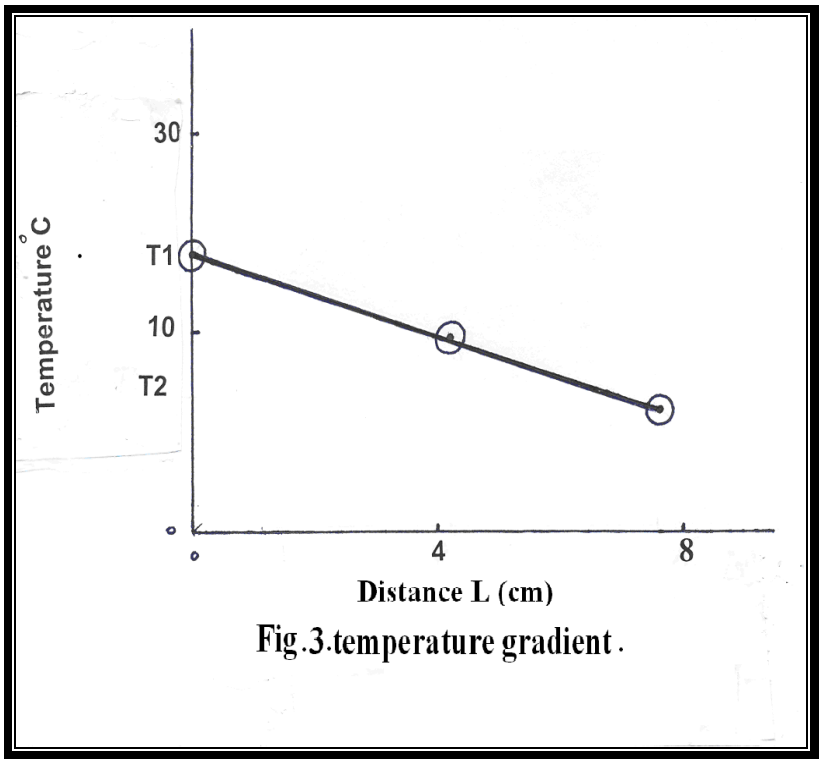

Fig.3.temperature gradient.

Fig4. Concrete chamber with the mat

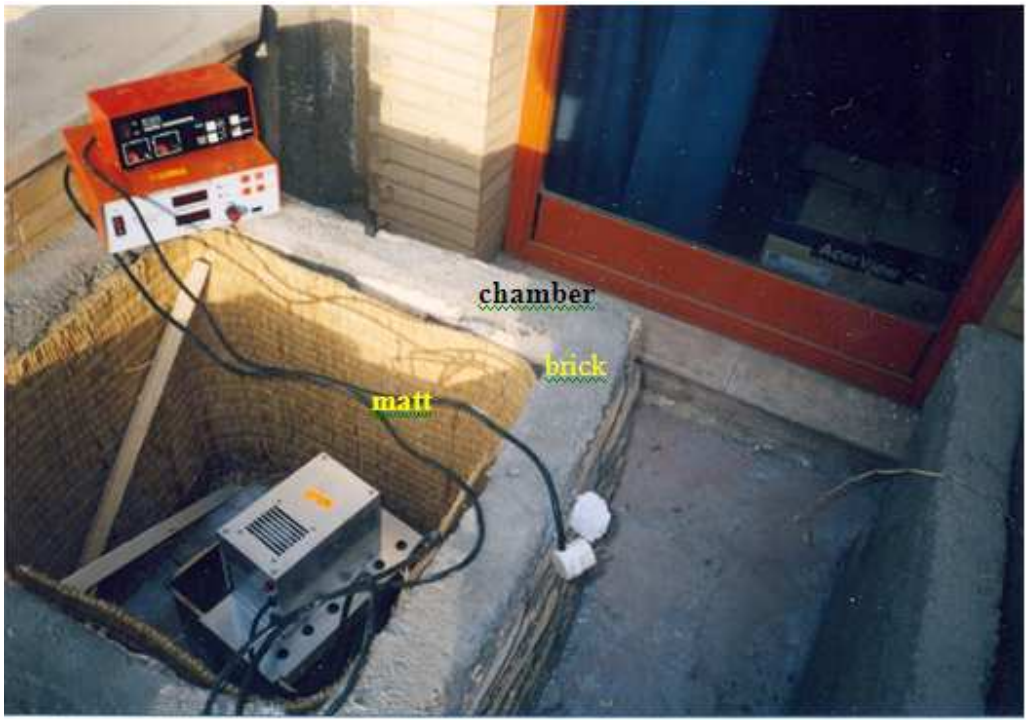

Fig.5 Brick chamber with the mat

Inside the chamber blacken and outside of it whiten to avoid penetrating heat into the chamber from outside fig.1. A temperature controller used to control temperature. This system has been

constructed from the following difference parts: 1) water container, 2) set of pump, heater and fan, 3) digital thermometer, 4) temperature sensor and 5) digital timer this system has been located on the insulation chamber fig.1. Four chambers made up of two concrete chambers and of two brick chambers on the veranda of physics Department, all of them with thickness of 10cm, area of walls are 64×62 cm², one of them without the mat and other with the mat with thickness of 0.0261 cm. Figure 4 shows the concrete chamber covered with the mat and the temperature controller and Fig.5 shows a brick chamber with mat.

Measurements

Twenty observations have been taken in
different days and the average temperature at inside the chamber shown by temperature controller to be 37°C, the interface temperature to be30.4 °C while the temperature at outside surface to be 29.6°C. The thermal conductivity [2-3] is given by

$$Q=\frac{KAt\Delta T}{L}$$

Where Q the number of J/s.m°c, Δt is the temperature difference between the ends of the insulation material and K is the thermal conductivity of mat, L is the thickness of insulation, cross-sectional area is A and t is the time in hours. From the temperature gradient along mat, the temperature drops per unit length is constant fig.3 [4].In fact we used in our calculations thermal conductivity of plywood to be 0.08 J/s.m.c .The energy gain for one cold season in Tehran is given by [5]:

$$Q=\frac{24(hr)\times A(m^2)\times(\deg days)}{R(hr.m^2.^\circ C/J)}$$

Where $R=\frac{1}{K}$, Q is for the number of degree days for 150 days and every day nine hours observations have been taken, it was found that the difference of energy gain between two concrete chambers with and without mat to be 12.285×10³kcal.

CONCLUSION

By using mat in concrete chamber for 150 days 12.285x10³ kcal was estimated and by using mat in brick chamber for 150 days1.956x10³ kcal was estimated. The measured thermal insulation of mat proved to be more desirable comparing with thermal insulation of wood. From temperature gradient, the temperature falls uniformly along its length from T1 to T2, and the data points are arrayed in linear fashion. So the heat energy per second reaching the cooler end is less than that energy per second which flows from the hot end. On this basis, it is concluded that for reducing the energy consumption such as coal,natural gas, oil and etc, to the lowest level, mat can be considered as the best choice. It is cheaper as compared to other insulators; it is available everywhere and can be used easily. It has no side effect at all.

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