

ENERGY SAVING BY USING INSULATION

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ABSTRACT

The present work shows the importance of using thermal insulator for new construction walls. To decrease cooling and heating load, so the power consumption for air-conditioning equipment drop to more than 40% of that without insulation. The experimental work includes building of one models of (1X1X1) m width, length and height located at Aurangabad city, India. The model is set to be each wall faced south, east, north and west direction. The models built from brick (24cm), thermo-stone (20cm) and sandwich panel (5cm). Another type of insulation material was tested and compared with normal brick wall is styropor. The heat gain was calculated for all the above insulations compared with brick model. The results showed that the best model in energy saving is the sandwich type panel model with about 60% energy save, while the thermo-stone model gives 28% and outside styropor 46%.

General Terms: Q° : Heat dissipation rate. (w), A: Area (m^2), R: Thermal resistance ($m^2 \cdot ^\circ C/W$),

T : Time, Temperature (Sec, $^\circ C$), K: Thermal conductivity (W/m. $^\circ C$),

Key words: Thermal Insulation, Energy Saving by Insulation, Composite Insulation.

I. INTRODUCTION

India is located in the sub-tropical region hot and dry, which is dominated by desert climate. Where, the summer lasts for more than seven months. The sun shines during these months for long time (more than a 12hr / day), and the shadow temperature reaches more than ($45^\circ C$) so the external wall of models exposed to thermal waves and its strength proportion to the time [1]. The outside walls and roofs should be protected from radiation of the sun and the changing climatic conditions by an appropriate thermal insulation material. The radiation of sun is more than 780 watts/ m^2 on the horizontal surfaces in the summer season which leads to uncomfortable inside temperature. The cooling and heating equipment are considerably decreases in case of using thermal insulation materials which leads to save the consumption of electrical energy.

According to World Watch Institute Estimations, buildings are responsible for 40% of the total energy consumption worldwide with a greater percentage in the industrialized and urbanized countries (Graham [2], Oldewurtel et al., [3]). In Iraq, the building sector in Baghdad is responsible for 48% residential, 29% industrial, 13% offices, 6% commercial and 4% agricultural of energy consumption (Alsammarae, [4]). Most of the energy consumption in Iraq is for cooling and heating that require a great amount of energy loads as compared to lighting and other uses. Hasan [5] indicated that 69% of the annual energy use in houses in Baghdad consumes

for cooling by 42% and 26% goes for heating.

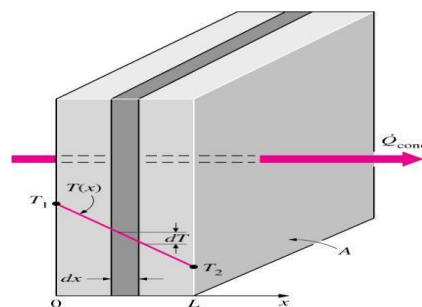
The thermal insulations are materials or composite of materials which used mainly to afford resistance to heat flow. Insulations are heterogeneous materials with low thermal conductivity, and they include air pocket. The purpose of using air is due to low thermal conductivities and availability of it.

II. OBJECTIVES OF THE RESEARCH

Saving the energy is done for the Indian buildings by using standard thermal insulation and new thermal insulation.

III. THEORITICAL EQUATIONS

The of heat conduction rate is directly proportional to the thermal conductivity, the temperature difference and the area of the wall, on the other hand its inversely proportional to the thickness of the wall.



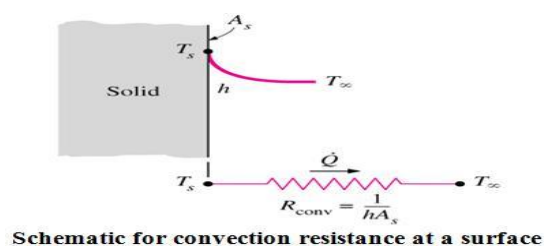
(3.1)

Schematic for convection and radiation resistances at a surface

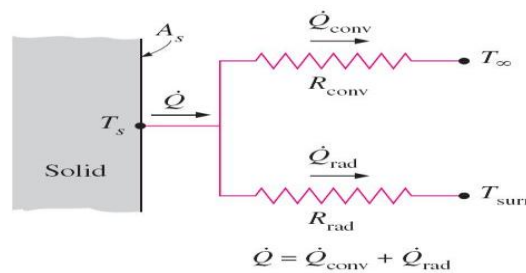
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(3.2)

Convection Resistance: Is the surface thermal resistance against heat convection.



Radiation Resistance: Is the surface thermal resistance against heat radiation.



IV. EXPERIMENTAL SET UP

4.1. Room Models

4.1.1. Brick Model

Two brick model (fig. 1&2) were constructed of (1*1*1 m) dimensions, one of them insulated with three type of insulation : polyurethane, polystyrene and NC, and the second model is kept without using insulation in order to compare it with the first model.



Figure (1) show the brick model

4.2.2 Thermo-Stone Room

Thermo-stone model walls consist of a thermo-stone block of dimension (60*20*20 cm) length, width and thickness respectively have been used with cement mortar as a binding agent. With considering the roof and the ground are constructed as mentioned above. The thermo-stone in the local market available with dimension (0.6 0.2 0.2m), and its cost is 9\$/m². The thermo-stone model has been used; The experiment done by comparing it with the brick model without insulation, as shown in photo (2) below:



Figure (2) shows the Thermo-stone & Brick model

4.2.3 Sandwich Panel Room

Its constructed from 5 cm thick sandwich panel, the four wall of (1*1 m length) fixed by using cubic iron frame shape, the panel plate jointed by using screws bolt on the frame . And all gaps are filled with polyurethane foam spray to avoid air leakage to the room. The sandwich panel in the local market is available in thickness 50 or 100 mm, with dimension (1 12m), and its cost is 16 \$/m². The sandwich panel model of 50 mm thickness, The experiment done by comparing it with the brick model without insulation, as shown in photo (3) below



Figure (3) show the sandwich panel & Brick model

4.2. INSTALLATIONS OF INSULATIONS AND THERMOCOUPLE

Thermal insulation is installed on the external wall of the model by using 1m² insulation materials with 5cm thickness fixed to model by adhesive tape and supporting by rope. The thermocouples distribution was For each model used 11 LM wires have installed to measure the temperature distribution over the model where 8 LM wires are installed in the two side of the walls(each side has 4 LM wires) of the model besides one LM wire in the center as well as two LM in both sides of the roof of the model. As insulation is attached to the model more 4 LM installed in outer surface.

4.3. MEASUREMENT DEVICE

Two devices are used in this study for measuring the parameters where Data logger device type lapjack U3 is used for measuring the temperature of the model. And an extension is used to increase the number of measuring point, while Solar power meter device type TES-1333/1333R is used for measuring the solar power during each day of experiment by put it on horizontal surface, then read the value directly on the models, the measuring unit w/m² is adjusting in this study.

5. RESULTS AND DISCUSIONS

Figure (5) shows the temperature variation of outside air temperature comparing with zone air temperature for sandwich model & for brick model, the temperature difference between $T_a - T_i$ increase for starting from morning to maximum value at 2 p.m. the value for brick model was 11 °C, while for sandwich panel at the

same time the difference reach to 15.5 °C, that means the insulated wall is better than commercial brick wall.

Figure (6) illustrates the temperature variation of outside air temperature comparing with zone air temperature for thermo-stone model & for brick model, the temperature difference between $T_a - T_i$ increase for starting from morning to evening.

Figure (7) represents the temperature variation of outside air temperature comparing with inside air temperature for outside cork model & for brick model, the temperature difference between $T_a - T_i$ increase for starting from morning to maximum value at 2 p.m. the value for brick model was 10 °C, while for outside cork at the same time the difference reach to 13 °C, that means the insulated wall is better than commercial brick wall.

Figure (8) represents the rate of heat gain in brick model and Thermo-stone model, The rate of heat gain in brick model increased rapidly from morning time to peak value with range (2-17 watt/m²), then decrease in afternoon duration to (2 watt/m²), while in insulated model the heat gain varied smoothly with rang (3-11 watt/m²).that the maximum value of the heat gain in the brick model is (17 watt/m²) at 1p.m., while the maximum value of the heat gain in the thermo-stone model is (11.36 watt/m²) at 2p.m., the saving energy percent is 33.17%.

Figure (9) illustrates that the maximum value of the heat gain in the brick model is (20 watt/m²) at 1 p.m., while the maximum value of the heat gain in the sandwich panel model is (6 watt/m²) at 2p.m., the saving energy percent is 70%.

Figure (10) shows the rate of heat gain in brick model and outside cork insulation model, The rate of heat gain in brick model increased rapidly from morning time to peak value with range (2-18 watt/m²), then decrease in afternoon duration to (1 watt/m²), while in insulated model the heat gain varied smoothly with rang (1-8 watt/m²).The maximum value of the heat gain in the brick model is (18 watt/m²) at 1 p.m., while the maximum value of the heat gain in the outside insulation cork model is (8 watt/m²) at 2p.m., the saving energy percent is 54.28%.

Figure (11) show the annual distribution of the heat gain in Wh/m² (by using Ecotect program), for sandwich panel and Brick model, from figure (5-30) it can be noticed that the average value of the heat gain during the experimental day (5 June) is

460 Wh/m², compared with a figure (14) at the same day the average value is 160 Wh/m².

Figure (12) show the annual distribution of the heat gain in Wh/m², for thermo-stone model, from figure (5-30) it can be noticed that the average value of the heat gain during the experimental day (3 June) is 440 Wh/m², compared with figure (13) at the same day the average value is 260 Wh/m².

Figure (13) show the annual distribution of the heat gain in Wh/m², for outside styropor and Brick model, from figure (5-30) it can be noticed that the average value of the heat gain during the experimental day (6 June) is 420 Wh/m², compared with figure (15) at the same day the average value is 210 Wh/m².

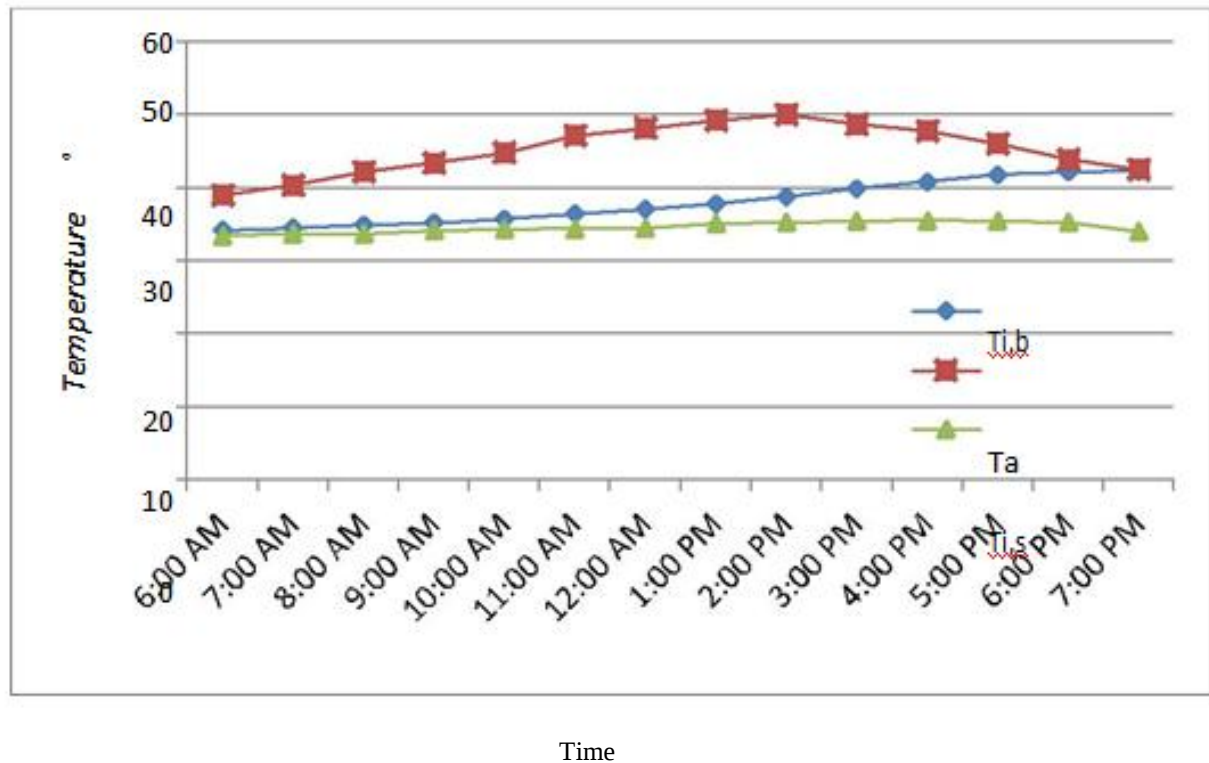


Figure (5) thermal behavior of rick and sandwich panel model wall

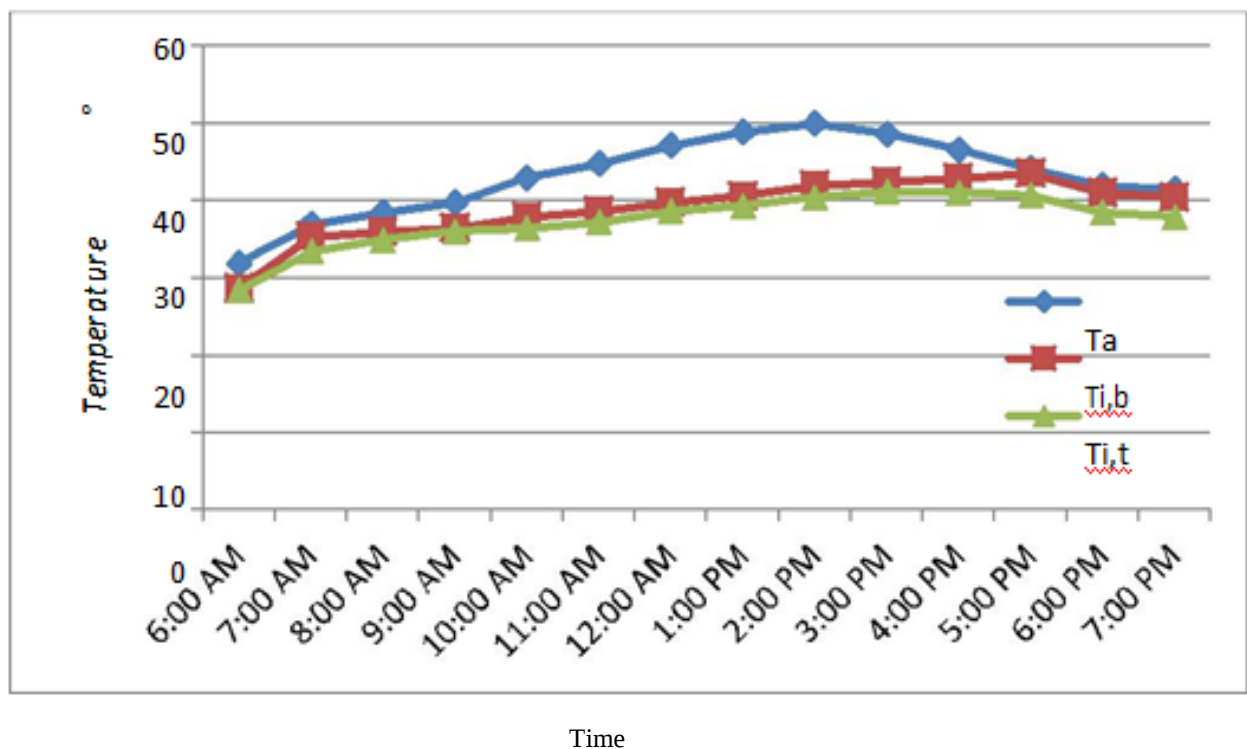


Figure (6) thermal behavior of brick and thermo stone model wall

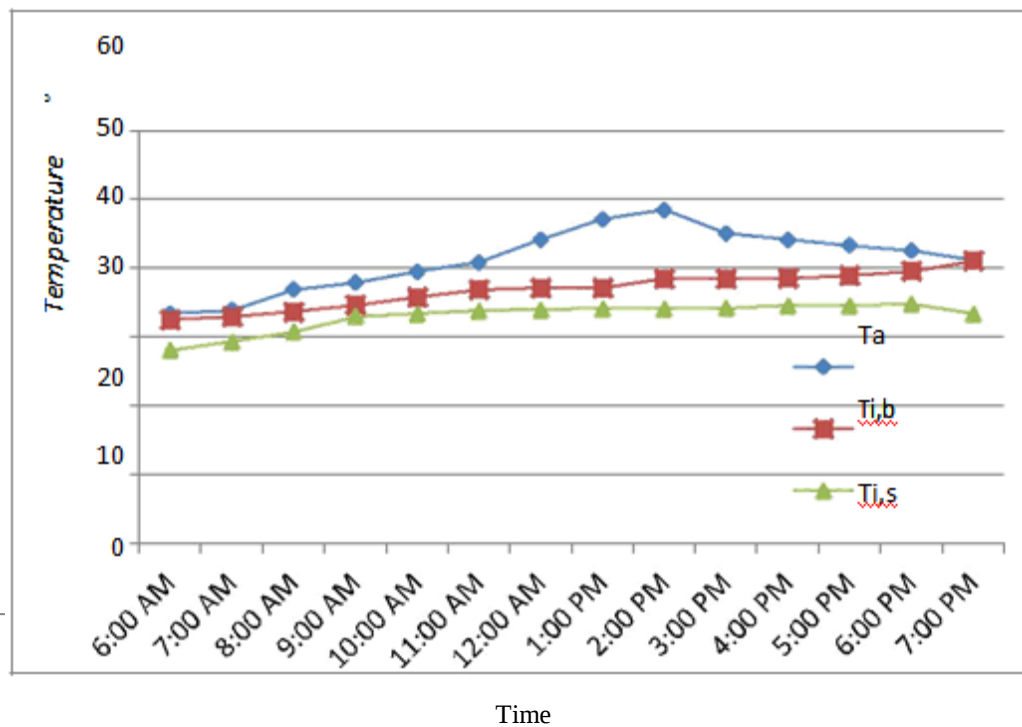


Figure (7) thermal behavior of brick and brick insulated outside by cork model wall.

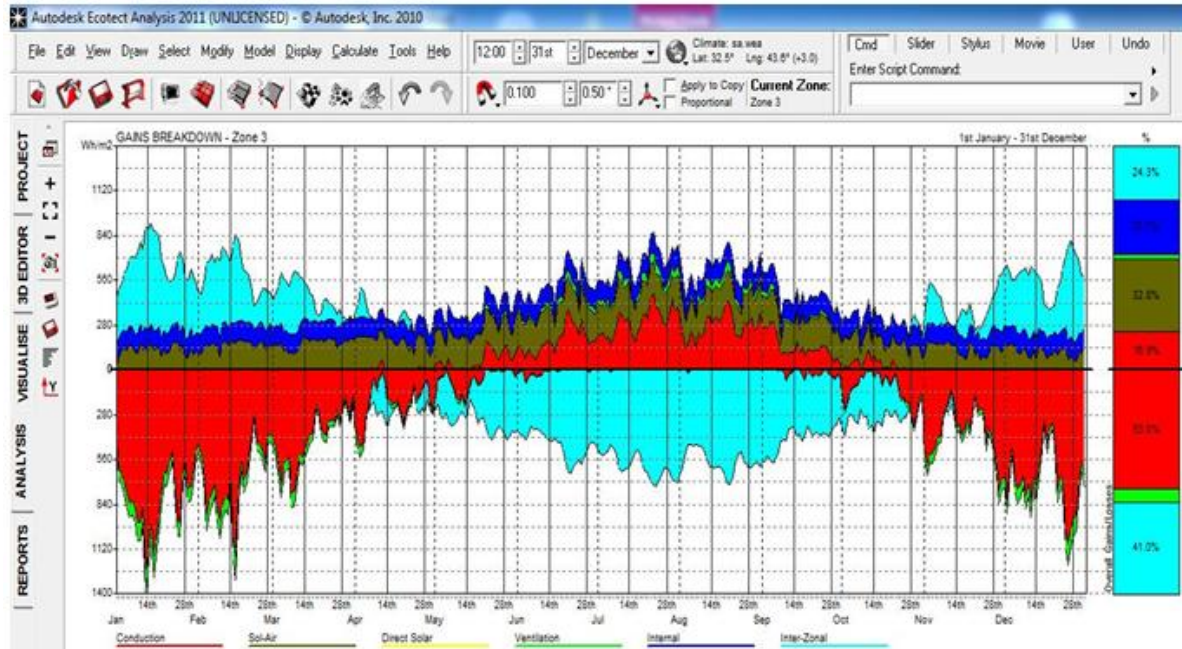


Figure (11) the heat gain distribution on brick model insulated with sandwich panel.

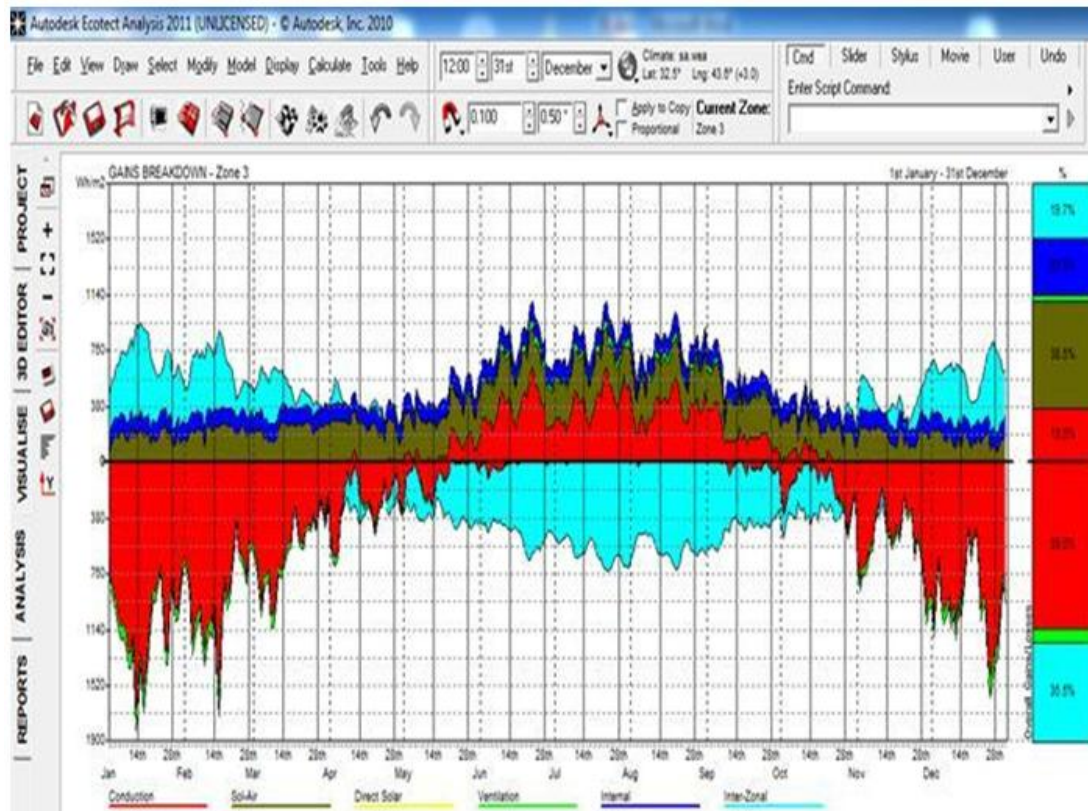


Figure (12) the heat gain distribution on brick model insulated with thermo-stone.

VI. CONCLUSIONS

The following comments could be concluded:-

- The insulated of south and west walls are more effective than that of northern and eastern walls.
- The best constructed walls to save energy were sandwich panel wall, then thermo-stone as compared to brick walls.
- The saving energy for experimentally tested insulation can be arranged from maximum value of saving as follow: 60% sandwich panel, thermo-stone model 30% and Outside styropor 51%.
- The higher initial cost of the constructed wall was brick wall, then sandwich panel wall and the cheaper one was thermo-stone wall.

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