International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 8 (2015) pp. 21539-21548

http://www.ripublication.com

A Study On Heat Reduction Energy Efficiency Measures Through Sustainable Initiatives

Dr.N.S.Elangovan[1] and K.Venkatalakshmi[2]

[1]Head Of the Department, [2]Asst.Professor
[1,2]Department Of Civil Engineering.
Jerusalem College Of Engineering, Pallikarnai, Chennai-600100, TamilNadu.

Abstract

Various techniques are involved to reduce temperature inside the building. One of the methods used is thermal energy method. The thermal energy of the conventional bricks is found. Energy conservation can be done by using waste materials which also helps in reducing temperature effectively. This also helps in reducing the AC load inside a building which helps in cost saving. Materials like gypsum, copper slag, fly-ash are used which helps in conservation of resources. Energy conservation also helps in improvising the design of energy efficient buildings. Lack of proper quantification is one of the main drawbacks for not being popular. Blocks are casted using the waste materials mentioned above. The thermal energy is calculated for both conventional bricks and the blocks made out of waste materials. Later the results obtained are compared.

Keywords – Thermal energy, industrial waste materials, embodied energies, heatflow

I. INTRODUCTION

The thermal performance of a building refers to the process of modelling the energy transfer between a building and its surroundings. For a conditioned building, it estimates the heating and cooling load and hence, the sizing and selection of AC equipment can be correctly made. For a non-conditioned building, it calculates temperature variation inside the building over a specified time and helps one to estimate the duration of uncomfortable periods. These quantifications enable one to determine the effectiveness of the design of a building and help in evolving improved designs for realising energy efficient buildings with comfortable indoor conditions. The lack of proper quantification is one of the reasons why passive solar architecture is not popular among architects. Clients would like to know how much energy might be saved, or the temperature reduced to justify any additional expense or design change. Architects too need to know the relative performance of buildings to choose a suitable alternative.

Thus, knowledge of the methods of estimating the performance of buildings is essential to the design of passive solar buildings. In this chapter, we will discuss a simple method for estimating the thermal performance of a building and introduce a few simulation tools used for more accurate calculations. Various heat exchange processes are possible between a building and the external environment. Heat flows by conduction through various building elements such as walls, roof, ceiling, floor, etc. Heat transfer also takes place from different surfaces by convection and radiation. Besides, solar radiation is transmitted through transparent windows and is absorbed by the internal surfaces of the building. There may be evaporation of water resulting in a cooling effect. Heat is also added to the space due to the presence of human occupants and the use of lights and equipment’s.

To understand the process of heat conduction, convection and radiation occurring in a building, consider a wall having one surface exposed to solar radiation and the other surface facing a room. Of the total solar radiation incident on the outer surface of the wall, a part of it is reflected to the environment. The remaining part is absorbed by the wall and converted into heat energy. A part of the heat is again lost to the environment through convection and radiation from the wall’s outer surface. The remaining part is conducted into the wall; where it is partly stored − thereby raising the wall temperature − while the rest reaches the room’s interior surface. The inner surface transfers heat by convection and radiation to the room air, raising its temperature. Heat exchanges like these take place through opaque building elements such as walls and roofs. Additionally, mutual radiation exchanges between the inner surfaces of the building also occur (for example, between walls, or between a wall and roof). Such heat transfer processes affect the indoor temperature of a room consequently, the thermal comfort experienced by its occupants.

Thus, knowledge of the fundamentals of heat transfer and solar radiation would help in understanding the underlying processes that take place in a building and itsinteraction with the external environment.

II. HEAT TRANSFER

In this section, we discuss the basic concepts on conduction, convection, radiation and evaporation.

A. Conduction

Thermal conduction is the process of heat transfer from one part of a body at a higher temperature to another (or between bodies in direct contact) at a lower temperature. This happens with negligible movement of the molecules in the body, because the heat is transferred from one molecule to another in contact with it. Heat can be conducted through solids, liquids and gases. Some materials conduct more rapidly than others. For a given temperature difference, the higher the thermal conductivity of a material of fixed thickness and cross-sectional area, the greater is the quantity of heat transferred.

B. Convection

The convection is the transfer of heat from one part of a fluid (gas or liquid) to another part at a lower temperature by mixing of fluid particles. Heat transfer by convection takes place at the surfaces of walls, floors and roofs. Because of the temperature difference between the fluid and the contact surface, there is a density variation in the fluid, resulting in buoyancy. These results in heat exchange between the fluid and the surface and is known as free convection. However, if the motion of the fluid is due to external forces (such as wind), it is known as forced convection. These two processes could occur simultaneously. The numerical value of the heat transfer coefficient depends on the nature of heat flow, velocity of the fluid, physical properties of the fluid, and the surface orientation.

C. Radiation

Radiation is the heat transfer from a body by virtue of its temperature; it increases as temperature of the body increases. It does not require any material medium for propagation. When two or more bodies at different temperatures exchange heat by radiation, heat will be emitted, absorbed and reflected by each body. In case of buildings, external surfaces such as walls and roofs are always exposed to the atmosphere. It considers the fact that the atmosphere is not at a uniform temperature, and that the atmosphere radiates only in certain wavelengths. For building applications, usually convective and radiative heat transfer coefficients are combined to define surface heat transfer coefficient.

D. Evaporation

Evaporation generally refers to the removal of water by vaporisation from aqueous solutions of non-volatile substances. It takes place continuously at all temperatures and increases as the temperature is raised. Increase in the wind speed also causes increased rates of evaporation. The latent heat required for vaporisation is taken up partly from the surroundings and partly from the liquid itself. Evaporation thus causes cooling.

The rate of evaporation depends on:

- The temperature (rate of evaporation increases with increase in temperature)
- The area of the free surface of water (larger the surface exposed, greater is this rate)
- The wind (rate is faster when wind blows than when the air is still)
- The pressure (lower the external pressure, more rapid is the evaporation)

III. SOLAR RADIATION

A. Radiation on Tilted Surfaces

External surfaces of buildings receiving solar radiation are generally tilted, except for the flat roof, which is a horizontal surface. Consequently, it is required to estimate radiation on such surfaces from the data measured on a horizontal surface. Tilted surfaces receives three types of solar radiation, namely beam radiation directly from the sun, diffuse radiation coming from the sky dome, and reflected radiation due to neighbouring buildings and objects. The estimation of the last component is very complicated. However, its contribution is much less compared to the first two sources. Therefore, the reflected component from the surrounding ground surface is generally taken for simple calculations.

B. Shaded surface

If a surface is shaded, the radiation incident on it gets modified, and depending on the type of shading, its estimation becomes complicated. To illustrate, let us consider the simple case of a horizontal rectangular overhang on a wall. The height and width of the wall are H and W respectively, the depth of the overhang is P.

IV. OBJECTIVES

To study the building materials for the construction and analyse with relation to heat reduction.To simulate similar kind of building materials. To get the tested values of aerated building blocks using fly ash gypsum and copper slag (FaGCs).To compare the building materials and conventional bricks.To calculate the energy requirement for the aerated blocks and conventional bricks.

V. SCOPE:

To identify the building materials.To find the thermal conductivity.To determine the heat reduction inside the building due to less thermal conductivity.

VI. THERMO COUPLE

A thermocouple is a temperature-measuring device consisting of two dissimilar conductors that contact each other at one or more spots. It produces a voltage when the temperature of one of the spots differs from the reference temperature at other parts of the circuit. Thermocouples are a widely used type of temperature sensor for measurement and control, and can also convert a temperature gradient into electricity. Commercial thermocouples are inexpensive, interchangeable, are supplied with standard connectors, and can measure a wide range of temperatures. In contrast to most other methods of temperature measurement, thermocouples are self-powered and require no external form of excitation. The main limitation with thermocouples is accuracy; system errors of less than one degree Celsius (°C) can be difficult to achieve.

Any junction of dissimilar metals will produce an electric potential related to temperature. Thermocouples for practical measurement of temperature are junctions of specific alloys which have a predictable and repeatable relationship between temperature and voltage. Different alloys are used for different temperature ranges.

Properties such as resistance to corrosion may also be important when choosing a type of thermocouple. Where the measurement point is far from the measuring instrument, the intermediate connection can be made by extension wires which are less costly than the materials used to make the sensor. Thermocouples are usually standardized against a reference temperature of 0 degrees Celsius; practical instruments use electronic methods of cold-junction compensation to adjust for varying temperature at the instrument terminals. Electronic instruments can also compensate for the varying characteristics of the thermocouple, and so improve the precision and accuracy of measurements.

VII. METHODOLOGY

To construct a model room using conventional bricks and aerated blocks.To determine the thermal conductivity of the material using thermo couple instrument and to find the reading.To calculate energy requirement and compare the results.To determine the AC consumption for bricks model and aerated blocks model.Compare the results and find the efficient model

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VIII. AERATED BUILDING BLOCKS USING INDUSTRIAL WASTES

A. GENERAL

Building blocks are one of the most widely used conventional construction materials throughout the world since ancient times. The most basic building material for construction is the usual burnt clay brick. A significant quantity of fuel is utilized in making these bricks. Also, continuous removal of topsoil, in producing conventional bricks, creates environmental problems. However, nowadays conservation of natural resources and utilization of industrial by-products are considered to be very important issues. In India industrial by-products like fly ash-50 million tons, gypsum-5 million tons and copper slag- 24.6 million tons are produced each year which in India and causes serious storage and environmental problem. Also the Co_2 emission into atmosphere should be controlled to reduce the global warming. 6% Co_2 emission is from the cement industry which can be minimised by choosing a different binder material. Also natural resources can be replaced by industrial wastes like phosphor gypsum, fly ash and copper slag.

A feasibility study was undertaken on the production of fly ash–copper slag–gypsum-phosphorgypsum bricks in order to solve the problems of housing shortage and at the same time to build houses economically by utilizing industrial wastes. The main aim of this project is to minimize the problems of disposal and health hazards caused by the by-products like copper slag and fly ash to avoid the depletion of natural resources. Some of the industrial by-products have been successfully used in the construction industry for the production of bricks. Both fly ash and copper slag are the materials that are considered as a waste material which could have a promising future in construction industry as partial substitutes of either cement or aggregates. The unit weight, compressive strength, flexural strength, dimensional stability and water absorption of these bricks will be investigated. Tests will be conducted to study the influence of type of curing like hot water curing, ordinary water curing, room temperature curing and oven curing on the increase in strength and hardening of the bricks with time and compare with the normal bricks.

B. INDUSTRIAL BY-PRODUCTS

Various by-products are being released during most of the production. Considerable amount of phosphorgypsum, fly ash, and copper slag are being released in lakh of tonnes every year in India are dumped and used partially. These are polluting the environment and impel severe health hazards. These by-products are considered here for production of building blocks by which a part of problem may solve.

PHOSPHOGYPSUM

The production of phosphate fertilizers from phosphate bearing rock by reaction with sulphuric acid results in a residue of acidic calcium sulphate (phosphogypsum). This is a finely grained material, which is pumped out and stockpiled. With time, the material dries out and the acidic nature becomes reduced. .It is produced about 5.0 million tons per annum in India posing a serious problem of disposal and health hazards.

To eliminate pollution and health hazards, a proper and effective utilization of phosphor gypsum is required. Attempts have been made from time to time to find ways and means of utilization of phosphor gypsum. Currently not more than 10% of the bulk of phosphor gypsum produced in India is utilized in the manufacture of cement and ammonium sulphate fertilizer and soil amendment.

Fig 1 Phosphogypsum

COPPER SLAG

The copper is being produced from a copper concentrate containing around 30 - 35% of copper, iron and sulphur each along with around 12% of silica and 5% of calcium. While producing copper the anode, a slag with rich iron and moderate silica content is also generated or copper slag is a by-product created during the copper smelting and refining process. As refineries draw metal out of copper ore, they produce a large volume of non-metallic dust, soot, and rock. Collectively, these materials make up slag, which are stockpiled.

Fig 2 Copper Slag

FLY ASH

Of all the commercial energy sources, coal has been largely used in preferences to other. A vast quantity of coal is being burnt in thermal power plants for the purpose of power generation in addition to its use in other industries and railways. The utilization of coal on power generation results in production of huge quantities of fly ash, the particulate coal waste product of thermal power plants. Use of low grade coal and inferior model of electrostatic precipitator will result in a greater amount of fly ash which leads to environmental pollution.

Fig 3 Fly Ash

GYPSUM

Gypsum is an important construction material that has been used in the construction industry for thousands of years. Gypsum plaster, or plaster of Paris, is produced by heating gypsum to about 150 °C. When the dry plaster powder is mixed with water, it re-forms into gypsum. The setting of unmodified plaster starts about 10 minutes after mixing and is complete in about 45 minutes. It is evaporate mineral most commonly found in layered sedimentary deposits in association with halite, anhydrite, sulfur, calcite and dolomite.

Fig 4 Gypsum

IX. CONCLUSION

The thermal energy is the modelling energy between the buildings and the surroundings. The determination of thermal energy improves the design of the building and helps for energy efficient buildings with comfortable indoor conditions. This helps in energy conservation and conservation of natural resources. The blocks used instead of conventional bricks are made up of waste materials such as gypsum, copper slag, fly-ash and phosphogypsum. This will help in conservation of resources. The exact mix design is obtained and is casted. The thermal energy of these blocks is found by constructing a wall and finding out the values using thermo couple technique. The thermal energy is also calculated for conventional bricks by constructing a wall. The thermo couple instrument is used for taking temperature readings. To know whether the aerated blocks are efficient, comparisons of the results are made and the final result is obtained. With the usage of these waste materials energy can be saved immensely and the temperature can also be reduced. This leads to cost saving.

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