Solar Passive Building - A Sustainable Building Design: An Experimental Investigation

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Abstract- Urban expansion in India is enormous and had created great pressure on natural resources, especially on land air and water. The main objective of this study is to reduce the embodied as well as operational energy in building and which would help to contribute to human development through passive buildings. This study involves examining the thermal properties of bison wall sheet based building as well as the conventional building materials in Dindigul district of Tamilnadu. The results of the study revealed that the thermal performance of the energy efficient bison wall buildings is almost nearer to the conventional building.

Keywords: Passive building, Thermal properties, bison wall sheet

I. INTRODUCTION

The world had seen the rise and fall of many civilizations. Each civilization had its own bench mark in providing shelter for its fellow human beings. Shelters which were made in those civilizations were made out of mud and earthen structures which were not harmful to the mother earth, and it is found that still one third of the earth population in the earth dwells in earthen structures [1]. As time passed away the modern civilization came into the scene and many advanced inventions came for usage in each and every field which has luxury as it's backbone. This scenario had reduced many works which were hectic to human beings and on the pessimistic side it crumbled the resources of the mother earth. The minimum burden to the mother earth is the crumbling of resources for the building materials. Green building is a design and construction practice that promotes the economic health and well being of family, the community and the environment. In green building, interior materials with low volatile organic compound emissions are used. For instance, in manufacturing 1Tonne of bricks 200 Kg of CO_2 and 143Kg of CO are released[2]. Solar passive design uses the existing natural features in the building and reduces the usage of natural resources artificially.

RENEWABLE ENERGY IN PASSIVE BUILDINGS:

Conservation and energy efficiency are the basic ideas incorporated in the present work. High performance building involves the use of low toxic paints and materials, energy efficient windows and lightings, recycled materials and locally produced sustainable materials.

Passive Solar Heating and Cooling:

It uses windows, walls, and floor to collect, store and distribute the sun heat in winter and rejects solar heat in summer.

NEED OF PASSIVE BUILDING& BISON WALL:

Passive buildings take the advantage of climate and maintain a comfortable temperature range. It eliminates the need for auxiliary heating and cooling, and reduces green house gas emissions.

Bison is both fire and moisture resistant and possesses and weather resistance. It can be employed for interior and exterior applications. It has no noxious content, saves time and labour, chemically stable with resistance to dilute chemicals.

Passive houses with south facing glazing are beneficial accompanied by substantial thermal mass to prevent overheating and to thermal energy[3].

A green building could be defined as a building which has a sustainable ability and has a minimum amount of adverse effects on the environment throughout the entire span of life[3]. This includes the phases of production, design of building materials and also demolition of any existing structure.

Thermal comfort is defined the condition which is satisfactory to our mind with respect to thermal environment[5].

There are several factors to be considered for deciding thermal comfort such as solar radiation, wind speed, air temperature, clothing level, psychological characteristics and relative humidity[6].

Equivalent Temperature is defined as that temperature either outdoor or indoor at which the heat balance of the body is maintained with core and skin temperature under the conditions being assessed[7].

In India it is expected that by 2030 the housing demand will be raised to 41 billion square meters and so the need for the basic building materials like cement would be increased upto 860 million tons and also in the case of steel the prime need will be upto 360million tons respectively[8].

II. MATRIALS AND METHODS

Solar passive lab building was made up of "Bison wall Sheet" at Rural Energy Centre at Gandhi gram Rural Institute. Data logger was used to record the temperature variations of the wall. Thermocouple wires were used to receive the temperature of the walls.

The main objective of the paper is to study the inner and outer temperature variations of the solar passive building made up of bison wall sheets with the help of thermocouple wires mounted on the inner and outer surface of the wall, and the variations of the temperature were recorded with the help of data logger. And the inferences were transformed as graphs and the results were interpreted and it is decided that the bison wall material is suited for the Dindigul region.

On the other hand, in order to record the temperature the northern wall of the passive buildings were taken for study since our country is located on the northern hemisphere of the earth, due to it the radiations which are incident will be higher on the northern direction and hence the northern wall is chosen for the study, and in order to cross check the variation of the temperature throughout the day the data logger is connected to the thermocouple welded wires. And the variation is recorded for every single minute of day and night. The variation of the temperature was taken for two days in order to get a clear picture of the variations in the temperature. The thermocouple was made by arc welding process in double strand wires. And those wires were mounted on the inner and outer walls of the passive building, finally after mounting the wires were connected to the channels of the data logger. The time interval for recording the variation in temperature was set for each and every minute for two consecutive days. The building has a length of 24m and it is divided into 6 equal bays. 3 bays were taken into account, they were designated as B_1,B_2 B_3 respectively and the inner and outer walls were designated as B_1I,B_2I,B_3I for the inner walls respectively on the other hand for the outer walls were designated as B_1O,B_2O,B_3O respectively. Three pairs of thermocouple wires were taken and mounted on the inner and outer walls of the lab building and the variations were recorded in the data logger and graphs were plotted and the inferences were derived from the same.

Fig.1.Solar Passive building at Rural energy center, GRI

III. RESULTS AND DISCUSSION

Succeeding the recording of data for two days, graphs were plotted for the variation of temperature with respect to time for the inner and outer walls. The comparisons were made in two phases. The inner and outer temperature variations were compared each and every wall taken for study. Then, the overall inner and outer variations for the 3 walls was plotted. The results were obtained from the graph and the following inferences were made.

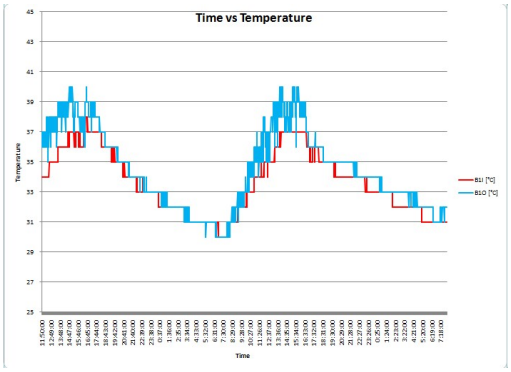

Fig.2. Inner and outer temperature variation of 1st bay.

The fig.2 compares the variation of the inner and outer surface temperature of the first bay wall taken into account. The graph shows that during the peak hour of solar radiation i.e. from 11.00a.m to 3.00 p.m, it was found that the outer surface temperature reached up to 40^0C, on the other hand the counterpart had only 37^0C. On further observation as time passed by 6.00p.m, the temperature on the outer wall was found to be 37^0C on the other hand the temperature absorbed by the inner walls were found to be 35^0C and there was a fall of 1^0C. The second day observation showed 30^0C by 6.00 demands there was a gradual increment of about 3^0C by 9.30 a.m and during peak hour by 12.00 p.m, the outer wall experienced about 40^0C; on the same time the inner wall absorbed a temperature of about 37^0c

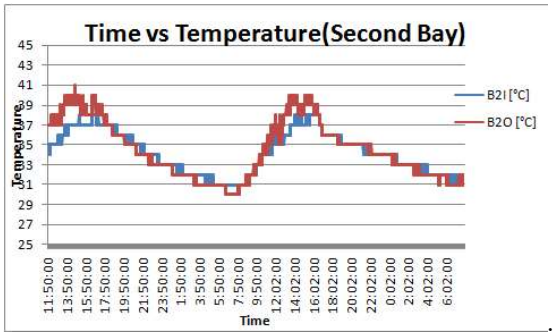

Fig.3.Variation of inner and outer temperatures of 2nd bay.

On analysis of the fig.3, it is evident that the temperature of the outer wall was high as compared to the inner wall on the peak noon time by 4^0C and as the sun goes to the dusk, both the inner and outer temperature was mutually same in the order of 35^0C. and on the second day the temperature difference was found to be in the order of 3^0C.

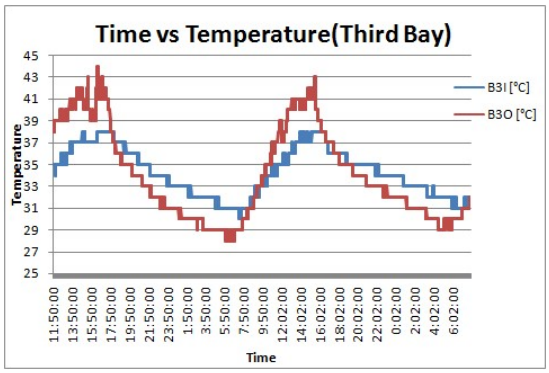

Fig.4.Variation of inner and outer temperature for 3rdbay.

On the analysis of third bay of the wall (fig. 4), the temperature difference on the outer face was found to raise by 41^0C,42^0C,43^0C by 1.30 p.m, 2.30p.m, and 3.30p.m respectively, while the inner wall had experienced about 37^0C and 38^0C , the difference being 4^0C. This graph shows a good variation in the temperature and this same scenario existed on the second day also.

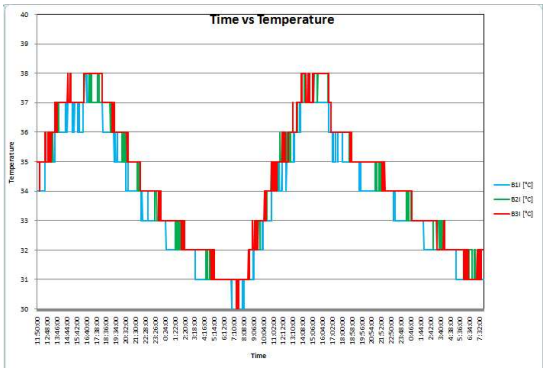

Fig.5.Variation of the inner temperature of the three bays.

The next analysis was the study of the temperature variation of the inner side of the entire wall(fig.5) and the results show that the third bay had absorbed lot of heat at 5 p.m in the evening on both the days, and the 1st bay had absorbed a lest amount of heat by 36^0C by evening at 3.00p.m and it was the same scenario found on the second day also. The inner temperature of the three bays was found to be same by 7.00 p.m and the temperature range was found to be 30^0C.

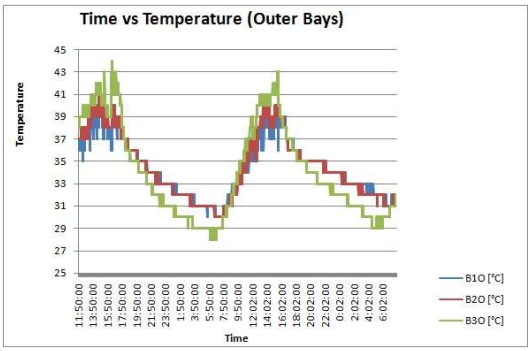

Fig.6.Temperature variation of the outer face of the three bays.

Fig.6 shows the variation of temperature of the entire bay on the outer face for the two days taken on account, and the graphical analysis communicates that the temperature during the peak hours raised from an order of 40^0C, 41^0C, 42^0C during the peak hour from 12.30 p.m to 2.30 p.m respectively. Similarly on the case of 2nd bay, the temperature had seen a raise of 39^0C and 40^0C respectively, and on the first bay the temperature raise was found to be in the range of 37^0C to 39^0C respectively. This scenario prevailed on the second day also.

IV. CONCLUSION

This paper made detailed investigation of bison wall building thermal performance. From the investigation it has been concluded that bison wall has almost similar thermal performance of the conventional wall and the thermal gradient is within 4°C. Further investigation is needed in different climatic zones and the thermal performance of the building.

V. ACKNOWLEDGEMENT

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