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Application of Geothermal Cooling Techniques to Improve Thermal Conditions of a Residential Building

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Abstract: **This paper gives a general description of passive cooling system of building by using ground as a heat exchanger. The temperature of earth below 1 m depth from ground surface does not have sudden change due to variation in temperature on ground surface. These daily variations are effective up to a depth of 0.5 meter approximately from ground. Beyond 0.5m (approximately) this variations are less effective because of high thermal inertia of soil. By considering these effects of earth temperature the building may be ventilated naturally and can maintain a comfortable climate in it. In previous case studies the air circulation is worked out by providing PVC pipe line around the building and through this pipe air is collected and circulated in the building for passive cooling. The temperature difference between atmospheric outer temperature and inner temperature which would be observed that is from 1.5° C to 2.5 ° C. This project utilizes less area and results in more fruitful outcomes with respect to passive cooling.**

Keywords**: Passive Cooling; water; air heat exchanger; PVC pipes; ground cooling.**

I. INTRODUCTION

The last two decade has witnessed a severe energy crisis in developing countries particularly during summer season primarily due to cooling load requirements of buildings. The energy expenditure in building is quite high and is expected to further increase because of improving standards of life and increasing world population. Air conditioning use has increasingly penetrated the market during the last few years and greatly contributes in the upsurge of absolute energy utilization.

According to the World watch organization, buildings consume about 40% of the world's energy production.

To minimize the consumption of energy on cooling of a building, getting maximum cooling effect and to reduce the cost of construction for passive cooling, optimizing area utilization and improving cooling effect should be priority. This is worked out by providing PVC pipe line in such way that the one end which is open at outer face of plinth wall and the other end is open in room.

II. LITERATURE REVIEW

Miroslaw Zakowski, Beata Sadowska[1](2011) has done computer simulation in their study to analyze the thermal performance of earth tube. For investigation purpose, they have used two parallel buried pipes which are 110 mm in diameter and 10 m long connected to ground air connector. They have tested air temperature in four places at exit from earth tube outlet at north side of room, outdoor temperature and beat exchanger outlet. Final results of this study shown that earth tube is energy saving solution. They have succeeded to educe the temperature in building by 2 to 3 degree.

Girja Sharan [2](2007) has discussed about advantages and disadvantages of earth tube ventilation system. He has used 50 m long and 10 cm in diameter pipe in Ahmadabad to check the results. He has used blower to move air at 3 m depth. He checked performance each month for full year. He has found that in May it could cool the air by amount from 40.8 to 27.2 degree. He has concluded that by increasing length of pipe improves the performance of the ventilation system.

Ken Rust[3](2011) has summarized the results on study on residential earth to air exchanger and their applicability on Canadian climate. He has concluded that earth tube may have benefits when used under the right condition and right condition and right place.

Vujas Bansal, Rohit Mishra[4](2010) have developed model to predict thermal performance and cooling capacity of earth-air-pipe heat exchanger. They have implemented for experimental investigation in Ajmer. They have used 13.42 m long pipe at 3 m depth in soil and got cooling range of 8 to 12 degree for flow velocity 2-5 m/s. They have also investigated on steel and PVC pipe. It has shown that performance is not significantly affected by material of the buried pipe.

P. S. Ghemmaghami, M.Mahmoudi Qazwin [5] (2005) In this study the results of a research on form of wind towers. Wind tower is an architectural element in traditional architecture of Iran. This analysis demonstrates wind towers characteristics with emphasis on their morphology.

A. K. Faghih and M. N. Bahadori [6] (2009)

Wind pressure coefficients were determined experimentally an various points on a 1/10 scale model of domed roof. Tests were run in a boundary layer wind tunnel. The wind tunnel employed was originally an aeronautical one, modified to produce the wind velocity profile generally found in small cities.

Mohammad Arif Kamal [7] (2012) In this paper several passive cooling techniques were reviewed and discussed with reference to their design implications and architectural interventions. The continuing increase of energy consumption of air conditioning suggests a more profound examination o the urban environment and the impact on buildings as well as to an extended application of passive cooling techniques.

III. METHODOLOGY

For experimental analysis we considered a general building plan (2BHK) having outer dimensions 10.4m X 8.0 m with plinth height 1.5m.

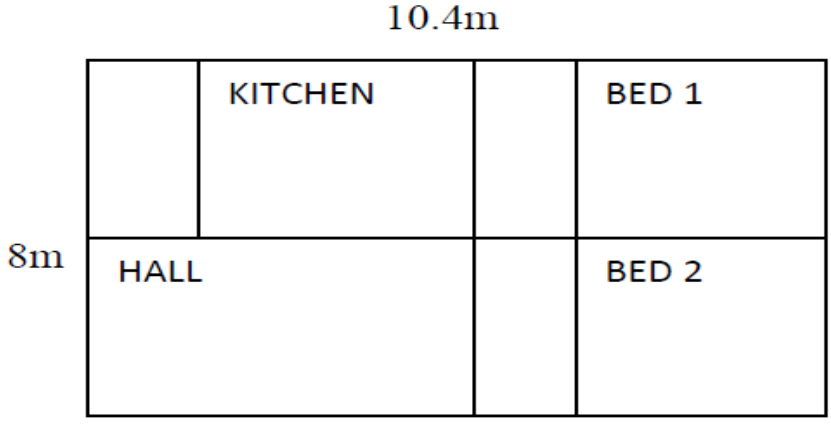

Fig. 01

By considering the above dimensions, we made four models by waterproof, air tight and thermal resistance material with a proportion 1:10. The models sizes were 105cm X 80cm X 20 cm.

These models were filled with soft murum up to a height of 15 cm. and PVC pipes and fan were used to transfer air through them.

Pipes used for this model were of 12.5mm and 25mm of diameter and fan with output of 35CFM.

Fig. 03

The temperature detector sensors were fixed to modes for measuring the External air temperature and the air temperature of air at the inner end of pipes. The readings were examined for three days in the month of April and May. The readings were taken at 2hrs interval.

IV. RESULTS

The observed reading as shown in Table No – 01.

Table No. 01

Date- 29/4/2014 No 01					
Time	External	0.5 Inch	1.0 Inch	1.5 Inch	2.0 Inch
9.00	31.00	28.80	29.60	27.60	25.50
11.00	35.40	31.20	30.10	29.40	26.60
1.00	35.50	34.10	30.50	29.10	26.90
3.00	39.10	36.00	31.10	29.20	27.70
5.00	33.80	36.00	31.50	29.70	28.70

Table No. 02

Date- 30/4/2014 No 02					
Time	External	0.5 Inch	1.0 Inch	1.5 Inch	2.0 Inch
9.00	31.10	29.20	29.60	27.70	25.30
11.00	33.80	31.80	29.40	27.00	26.10
1.00	35.20	35.00	29.90	27.80	27.90
3.00	37.50	36.20	30.50	28.20	28.10
5.00	33.20	36.10	31.20	28.60	28.90

V. CONCLUSION

In experimental analysis we have used PVC pipes the soft murum as a heat exchanger, which reduces the temperature of air. It is found that with increase in the pipe diameter the cooling effect increases.

Results show that using this method the interior temperature can be reduced up to 10 degree, which will reduce the cooling load of the building.

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