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A REVIEW ON APPLICATION AND PERFORMANCE OF EARTH AIR HEAT EXCHANGER

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Abstract - The temperature of earth at a certain depth about 2 to 3m the temperature of ground remains nearly constant throughout the year. This constant temperature is called the undisturbed temperature of earth which remains higher than the outside temperature in winter and lower than the outside temperature in summer. When ambient air is drawn through buried pipes, the air is cooled in summer and heated in winter, before it is used for ventilation. The earth air heat exchanger can fulfill in both purpose heating in winter and cooling in summer. This paper presents a review of air conditioner with ground coupled condenser that will be achieve the multi functions with decrease energy requirement on residential building. It is increasing the efficiency of residential air conditioning units. With the improvement of standard of living, air-conditioning has widely used. In this paper, recent research is investigated for air-conditioning systems and indoor air quality. The limitations in the existing research are summarized.

Index Terms— Earth to Air Heat Exchanger, Ambient Temperature, Air conditioning, ground couple.

I. INTRODUCTION

The energy consumption of buildings for heating and cooling purpose has significantly increased during the decades. Energy saving are of major concern everywhere is a particular challenge in desert climates. The desert climate can be classified as hot and arid and such condition exists in a number of areas throughout the world. In general most people feel comfortable when the temperature is between 20°C and 26°C and relative humidity is within the range of 40 to 60%.These condition are often achieved through the use of air conditioning. Air conditioning system is widely employed for the comfort of occupant as well as the industrial productions. It can be achieved effectively by vapour compression machines, but due to the depletion of ozone layer and global warming by using chlorofluorocarbons and the need to minimize high grade energy consumption various passive techniques are now a day's introduced, one such method is earth air heat exchanger. An earth air heat exchanger consist in one or more tubes lied under the ground in order to cool in summer or pre-heat in winter air to be supplied in a building. The physical phenomenon of earth air heat exchanger is simple: the ground temperature commonly higher than the outdoor air temperature in winter and lower in summer, so it makes the use of the earth convenient as warm or cold sink respectively.

Both of the above uses of earth air heat exchanger can contribute to reduction in energy consumption. Several researchers have described the earth-to-air heat exchangers (EAHE) coupled with buildings as an effective passive energy source for building space conditioning. An earth- to-air heat exchanger system suitably meets heating and cooling energy loads of a building. Its performance is based upon the seasonally varying inlet temperature, and the tunnel-wall temperature which further depends on the ground temperature. The performance of an EAHE system depends upon the temperature and moisture distribution in the ground, as well as on the surface conditions.

A. Working Principal of Earth to Air Heat Exchanger

The principle of using ground inertia for heating and cooling is not a new concept, but rather a modified concept that goes back to the Ancients. This technology has been used throughout history from the ancient Greeks and Persians in the preChristian era until recent history (Santamouris and Asimakopoulos, 1996). For instance the Italians in the middle Ages used caves, called colvoli, to precool/preheat the air before it entered the building. The system which is used nowadays consists of a matrix of buried pipes through which air is transported by a fan. In the summer the supply air to the building is cooled due to the fact that the ground temperature around the heat exchanger is lower than the ambient temperature. During the winter, when the ambient temperature is lower than the ground temperature the process is reversed and the air gets preheated.

B. Types of Earth to Air Heat Exchanger

There are two general types of ground heat exchangers: open and closed

- Open systems

In open systems, ambient air passes through tubes buried in the ground for preheating or pre-cooling and then the air is heated or cooled by a conventional air conditioning unit before entering the building. Figure 1 shows Earth Air Heat Exchanger Systems on Open loop mode.

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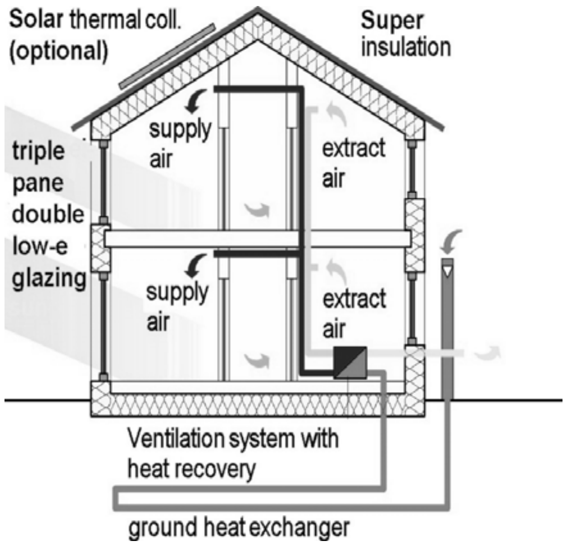

FIGURE 1.1: BASIC PRINCIPLE OF EAHE

- Closed systems

In this case heat exchangers are located underground, either in horizontal, vertical or oblique position, and a heat carrier medium is circulated within the heat exchanger, transferring the heat from the ground to a heat pump or vice versa. Figure 2 shows Earth Air Heat Exchanger Systems on close loop mode.

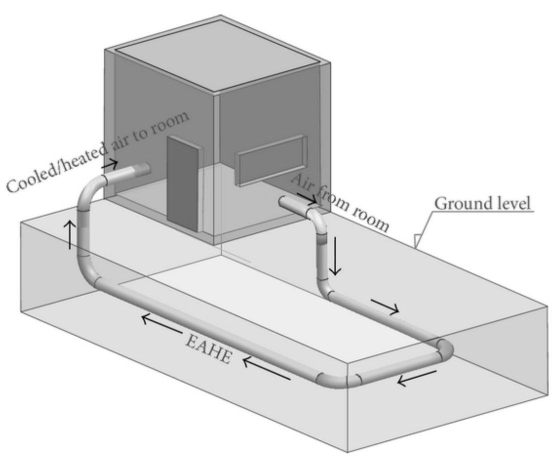

FIGURE 1.2: EAHE CLOSED LOOP MODE

II. Application and Performance :

The heat transfer to and from Earth tube heat exchanger system has been the subject of many theoretical and experimental investigations. By having a review on previous research papers published by many authors we can have an idea on how it works,

Sehli et al. proposed a one-dimensional numerical model to check the performance of EAHEs installed at different depths. It was concluded that EAHE systems alone are not sufficient to create thermal comfort, but can be used to reduce the energy demand in buildings in South Algeria, if used in combination with conventional airconditioning systems [3].

Ghosal et al. developed a simplified analytical model to study year around effectiveness of an EAHE coupled greenhouse located in New Delhi, India. They found the temperature of greenhouse air on average 6–7 °C more in winter and 3–4 °C less in summer than the same greenhouse when operating without EAHE [6].

Shukla et al. developed a thermal model for heating of greenhouse by using different combinations of inner thermal curtain, an earth–air heat exchanger, and geothermal heating. Bansal et al. investigated the performance analysis of EAHE for summer cooling in Jaipur, India. They discussed 23.42 m long EAHE at cooling mode in the range of 8.0–12.7 ◦C and 2–5 m/s flow rate for steel and PVC pipes. They showed performance of system is not significantly affected by the material of buried pipe instead it is greatly affected by the velocity of air fluid. They observed COP variation 1.9–2.9 for increasing the velocity 2–5 m/s [5].

Santamouris et al. investigated the impact of different ground surface boundary conditions on the efficiency of a single and a multiple parallel earth-to-air heat exchanger system. 5 Experimental Setup The experimental setup is an open loop flow system has been designed and fabricated to conduct experimental investigation on the temperature difference for inlet and exit section, heat transfer, coefficient of performance and fluid flow characteristics of a pipe in parallel connection. The experimental data are to be used to find the increase of cooling rate for the summer condition, heat transfer coefficient. The Earth Air Heat Exchanger in parallel connection as shown in fig comprises of horizontal pipe of 64 mm inner diameter with total length of 17 m .Three pipe each length of 3 m are connected in parallel connection, made up of GI pipes and buried at a depth of 1.5 m in a flat land with dry soil. The parallel connection of GI pipes is connected to common intake and exhaust manifold for air passage. Ambient air was sucked through the pipe by means of a centrifugal blower by a 3 phase, 2 hp, 230 V and 2800 rpm motor .The blower is used to suck the hot ambient air through the pipelines and delivered the cool air for required place. The air flow rate is required at desired rate by providing control valve. The mass flow rate of air through pipe is measured by orifice meter [1, 8, 9].

Michael Sivak et al. estimated that 24 of the top 50 metropolitan cities are in the developing world and are in warm climates. One city alone, Mumbai, has a cooling need equal to one quarter of the USA. It is predicted that by the end of the 21st century, the energy used for indoor cooling will be 40 times greater than it is today. This will cause the total CO2 emissions to rise from 0.8 Gt C in 2000 to 2.2 Gt C in 2100 [10].

III. Conclusion

After reviewing of pervious researches, motivated to proceed for this technology of air conditioner with ground coupled condenser decrease the energy requirement, cost of operation and one of the most global warming. This device can improve the overall performances of air conditioning system with lowest cost with low heat consumption. Coefficient of performance of air conditioning also improved.

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