Cooling by underground earth tubes

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ABSTRACT

It is a well notorious fact that if you get below the surface of the earth a few meters, the temperature tends to be constant and at 8 to 12 degrees, depending on latitude. So, it does not take an architect to appreciate that if you could move outside air through a buried pipe, you could alter its temperature and then move it into a house where it can warm or cool the home's interior.
Underground temperatures can be very beneficial in balancing the thermal comfort of the house. Normally we think more about the above ground temperatures and other climatic elements in designing a house for thermal comfort. One of the important problems which architect must thinking on when he start to create an efficient cooling system by using earth inertia is the amount of heat conducted and who widely it is diffused varies from one soil type to another. The moisture content of the soil is a major influence on conductivity and diffusivity, and accounts for large variations on how heat moves through the earth. Another problem is the sizing of the cooling system which must pass the living space area. The better design use and understanding of these elements and resolve the problems for create a naturally comfortable house. This method of cooling is cost effective, not damaging to the environment, and is a natural way to cool off. The air cools in the chamber overnight, and is circulated through the house during the heat of the day. Passive cooling is using natural building techniques for sustainable house design in indoor areas with extreme. It is important to understand that soils temperatures during the summer season at certain depths are considerably lower than ambient air temperature, thus providing an important source for dissipation of a houses excess heat. Conduction or convection can achieve heat dissipation to the ground. Earth sheltering achieves cooling by conduction where part of the building envelope is in direct contact with the soil. Totally underground spaces offer many additional advantages including protection from noise, dust, radiation and storms, limited air infiltration. The concept of earth cooling uses the thermal inertia of the earth to maintain internal temperatures below ambient in summer. This kind of energy is successful and efficient with employment air such element of transporting colt.

1. COOLIN BY UNDERGROUND EARTH TUBES

The subterranean world is actually only cooler in summer, when the surface is warmed by the sun. In winter, underground spots are relatively warmer because of their" thermal inertia". the cooling tubes system consist of long pipes buried underground with one end connected to the house and the other end to the outside. Hot exterior air is drawn through these pipes where it gives up some of its heat to the soil, which is at a much lower temperature at a depth of 3m to 4m below the surface. This cool air is then introduced into the house. Special problems associated with these systems are possible condensation of water within the pipes or evaporation of accumulated water and control of the system. The requirement of detailed data about the performance of such systems hinders the large-scale use of such systems.
In the 1980's, earth tubes approved a great deal of attention from architects and civil engineers, as an option or aid to conventional air conditioning. While the concept of routing air through underground tubes or chambers to achieve a cooling effect appears like a good proposal. Possibly a few hundred systems were constructed, but information on the practical application of the concept is imperfect. Cooling tubes are long, underground metal or plastic pipes through which air is drawn. The idea is that as the air travels through the pipes, it gives up some of its heat to the surrounding soil, entering the house as cooler air. This will occur only if the earth is at least several degrees cooler than the incoming air. (www.eren.doe.gov)
A cooling tube system uses either an open- or closed-loop design.
- In an open loop system, the outdoor air is drawn into the tubes and transported directly to the inside of the house. This system provides ventilation while optimistically cooling the house's interior.
- In a closed-loop system interior air circulates through the earth cooling tubes. A closed loop system is more efficient than an open loop design. It does not exchange air with the outside.

1.1. Tubes material

The main considerations in selecting tube material are cost, strength, corrosion resistance, and durability. Tubes made of aluminum, plastic, and other materials have been used. The selection of material has modest influence on thermal performance. PVC or polypropylene tubes perform almost as well as metal tubes.

1.2. Tube diameter

Optimum tube diameter varies widely with tube length, tube cost, flow velocity, and flow volumes. Diameters between 10-25 centimeters come into view to be most appropriate.

1.3. Tube location

Earth temperatures and, as a result, cooling tube performances vary considerably from sunny to shady location. The optimal situation is to build the house on a hill which rises 3 meters above its surrounding area. A channel can then be dug from the home, 3 meters down, and then horizontally until it reaches daylight. This horizontal section is placed on a small incline to the exterior, like a drain line. Mind must be taken that this flow line is absolutely controlled as we do not want pockets of water building up within the tube. Therefore, the flow line must be right on grade. This means the air can come into the tube, flow up the slight incline, and drop its condensation as it is travelling through the tube so the condensation drains out the tube's bottom portion. When there is humidity there will be a considerable amount of condensation. Obviously most houses are not built on 10-foot high hills, 30 meters from surrounding areas. Consequently, we need to consider how to put air tubes in flat land. We can place a tube 3 meters down and lay it horizontally for 30 meters, curved or straight, and then bring a riser back to the surface. The riser should have an upside down at its top so rain and debris cannot enter. And it should be screened so critters cannot use it as a back door into the house.

It is vital that the tube is sloped to a collection point. Water will run to this collection point where it must be removed. The collection point can be at either end of the tube or in the middle. It is left to the installer to decide its best location. Some tubes can all be drained to one collection point. This can be accomplished by simply installing cross-connecting the pipes with drain pipes. Drain pipes. The estimate tube diameter can be 10 centimetres. At the collection point, a sump pump can be installed which will automatically turn on and off, pumping the condensation out of the ground and sprinkling it on top.

1.4. Tube measurement lengthwise

There is no simple formula for determining the correct tube length in relation to the quantity of cooling preferred. Local soil conditions, soil moisture, tube depth, and other site-specific factors should be considered to determine the proper length.

2. EARTH TUBES TYPES

2.1. Vertical closed- loop.

In the vertical closed-loop ground heat exchanger, an air can circulated through preserved pipe loops covered in vertical bore holes.

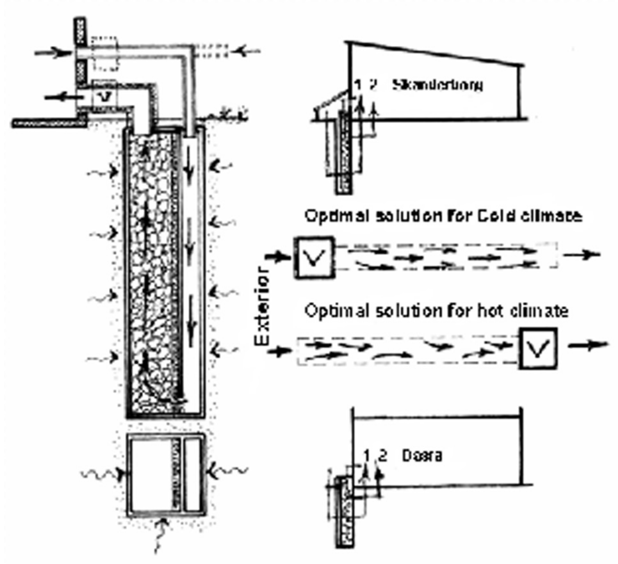

Figure 1: vertical closed lop

The bore holes are typically 45-60 meters deep. Heat is transferred, from the ground during the winter and to the ground during the summer. A vertical heat exchanger can be installed on smaller lots somewhat than the horizontal system.

2.2. Horizontal closed- loop.

In horizontal closed-loop ground heat exchanger, an air is circulated through sealed pipe loops buried horizontally, about 2 meters underground. During cold weather the pipe lops absorb heat from the earth and deliver it the house. In the summer the processes is reversed for air conditioning, and the system transfers the heat from the house to the ground.

The outer piping system is able to be either an open system or closed-loop.

- An open system takes advantage of the heat retained in an underground body of air. The air or water is drawn up through a well directly to the heat exchanger, where its heat is extracted. The air is discharged either to an above-ground body of air or water, such as a stream or pond, or back to the underground air or water body through a separate well.

- Closed-loop systems collect heat from the ground by meansofacontinuousloopofpipingburiedunderground.

3. GENERAL CONTEMPLATION OF COOLING TUBES

The devises of earth cooling tubes, take place by a vary system in size and form, some system have tubes in parallel terminating in a header, and some used a radial prototype collecting in a central sump (to make moisture removal easier), some were only a single tube. It is important to design the system so as to minimize the cost and maximize the benefits. The tube length over 10 m for example is inefficient. The conclusion say that; the small diameter tubes are more effective per unit than large tubes, the long tube is unnecessary, tubes should be placed as deeply as possible, closed loop systems are more effective than open loop systems, and the tube thermal resistance is unimportant the ground thermal resistance dominates. Pipes must be with wings to easier the energy transferred and the interior of pipes must have perforate obstacles to slow of the fluids speed circulation, for occurs the optimal exchange of energy between the air or water and the soil (earth).

The dark and humid atmosphere of the cooling tubes may be a breeding ground for odor-producing mold and fungi. Furthermore, condensation or ground water escape may accumulate in the tubes and encourage the growth of bacteria. Good construction and drainage could eliminate some of these problems. Insects and rodents may enter the tube inlet to deter potential intruders. The inlet ends of air pipes need to be screened for filtering. If we simply take 25 centimetres of window screen and put it over the end of a 25 centimetres air pipe, we will strain out most of the bugs, but we will also restrict most of the air flow. Air does not flow efficiently through a screened opening, particularly where the screen net size is small. Therefore we have to create a screen box, or a larger surface area for the screening. An area ten times as large as the area of the pipe should be provided. This allows the air to flow slowly through the screens and provides enough air for the pipe. A long roll of screening works very well. We must leave it up to the actual system designer to decide what is best for the situation.

4. COOLING BY PARALLEL SYSTEMS

4.1. Cooling by using a free Underground space

That means an open space which can be used also such a functional space (social space for family meeting, living, or with an auxiliary function).

It is necessary to appreciate that using of this space must be limited which means just in occasionally cases, because this space must be healthy so it must be isolate from all negative exterior agent such dust, pollute air, humidity, etc. At the same time this space must be tightly to the house interior or/and exterior, and the connection must be just through the terminals, which have air filters against, dust, bacteria, humidity, and ionizer effects. This space is partial contact with earth ground, just in the floors.

4.2. Cooling by using rock bed on underground spaces

This includes a layer of thermal mass such as rock bed, where is the earth temperature transferred from/ to the rock bed, in this time thermal mass become as source of cooling in summer season.

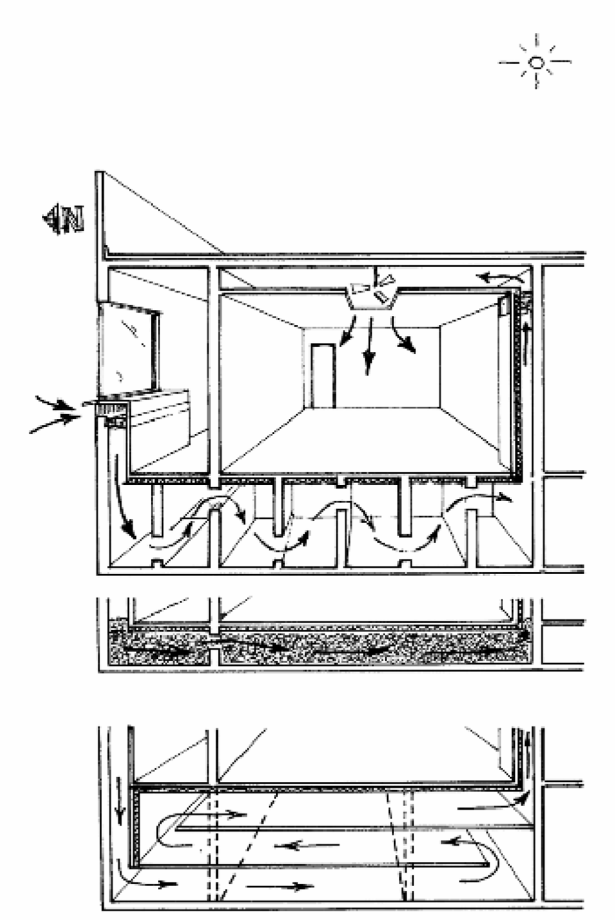

Figure 2: Different underground cooling systems

The cooling of Living spaces can occurs by radiation effect or by using of air such as cool transporter element, in which can be coordinate in corresponding of living space area and thermal mass cool capacity. For optimal working of system, we must take in evidence;

- velocity of airflow must correspond the thermal internal comfort
- airflow circulation must be tightly to the exterior
- existing of air filter such healthy element in both ter-

minals input/output
- easily to reparation and maintenance of the system

This system can be used in correspondences with other types of cooling, all such as an intelligent complex system.

5. CONCLUSIONS

Cooling tubes are a reasonably priced natural way to passively cool the air. Cooling tubes are long pipes placed underground through which air is drawn. As the air is drawn through the pipes it either cools the air or heats the air. It is usually used to cool and dehumidify hot outside air, but can also preheat cold outside air. The drawn air temperature will move towards the ground temperature where the tubes are located. There are a number of variables and design tradeoffs including:
- The average ground temperature of the site,
- Temperature extremes for the summer and the winter,
- Diameter and length of tubes,
- handling of condensation,
- Intake located in ravine/slope or in a dry well.

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