Earth Tube Modelling

Earth tubes can provide a low tech solution to pre-heating or cooling an air supply resulting in reduced heating and cooling loads on the building plant. Earth tubes can form part of an entirely passive system where air is naturally induced through a supply pipe via buoyancy. Systems serving a single zone may also be fan assisted to ensure a set volume is achieved. Earth tubes can also be used to feed a main HVAC system prior to distribution.

All the scenarios mentioned above could be incorporated into a simulation using different techniques and modules within the <VE>.

In each instance I would begin by modelling both the building and the dimensions of the earth tube. I would ensure the template applied to the Earth tube has no heating or cooling profiles assigned to it.

To represent the Earth Tubes adjacency to the ground, a temperature profile should be assigned to each of the surfaces. This can be done in the Apache module of the software at the surface level of a zone. You need to be in adjacency mode which will allow you to query and edit the adjacency. As well as applying the correct adjacent temperature this will ensure there are no solar gains applied in the space.
Fully Passive System

A passive system where the Earth tube connects to a zone within a building can be modelled using Macroflo. Opening characteristics for louvers should be defined and assigned connecting the Earth Tube and room to outside.

To take into account friction losses associated with the duct corrections should be applied to the opening areas on the louvers. Details on this method can be found in the Macroflo calculation Methods document.

This type of analysis will model the air flow rate, direction and effect based on the driving forces at any particular instant.

Single zone – Fan assisted system

In this type of system a controlled volume of air can be supplied from the Earth tube to the occupied space. The volume of air being supplied to the occupied space should be applied to the Earth tube. This could be done using the room query facility. The air condition being applied to the earth tube should be set too “External Air”.

In the zone receiving air from the earth tube you will need to adjust the supply air condition. When this is set in Room Query you are given the option to specify that it is coming from an adjacent space and will list all the zones that share an adjacency.

Multi zone - Central plant supply
When Air is being supplied to multiple rooms via an earth tube, the tempered air supply can be represented using an absolute formula profile. The formula profile will take the temperature of the earth tube at a given moment and apply it as the room supply condition to the zones being served. As before an external air change rate should be applied to the earth tube that totals all the rooms being served.

When you create a formula profile that references a particular room you use a reference number that is linked to the zone you are interested in. This reference number is the position of the zone in the model on an integer scale (starting at 1). When you are in ModellT you will see that each zone is given a number indicating where it appears on the Model browser list. As the first zone on the list is 0 (not an integer) 1 should be added to establish the reference number.

<table>
<thead>
<tr>
<th>Number</th>
<th>Room Name</th>
<th>Room ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Vent</td>
<td>VENT0000</td>
</tr>
</tbody>
</table>

In this case the zone I want to reference is indicated as “5” in ModellT. To use this space in a formula profile I add 1 therefore my formula will take the form “ta(6)”. Ta indicates that I’m reading the room temperature and (6) indicates that it is from the 6th zone.

This profile should then be assigned as the supply air condition for all the rooms being served. I would define the air exchange as a Natural Ventilation air exchange. The reason for this is that if you describe it as an Auxiliary Ventilation air exchange it will place a heating or cooling load on the building plant to temper it to that condition.
These systems can also be represented using the ApacheHVAC module of the <VE> which requires a bit of experience in the package. This would allow air to be tempered further at the Central HVAC unit prior to being supplied to the building and still incorporate the benefit generated by the earth tubes.