TYPE 529: IN GROUND RADIANT SLAB

PARAMETERS

Parameter Number	Name	Unit	Typical Value	Comment
1	Slab length	m	10.0	The length of the slab in the x-direction.
2	Slab width	m	10.0	The width of the slab in the y-direction.
3	Slab depth	m	0.10	The depth of the slab in the z-direction.
4	Nodes Along Length (Nx_adj)	-	3	The number of nodes located along the length of the slab.
5	Nodes Beyond Length (Nx_ext)	-	6	The number of nodes located along the x-direction and beyond the edges of the slab.
6	Nodes Along Width (Ny_adj)	-	5	The number of nodes located along the width of the slab.
7	Nodes Beyond Width (Ny_ext)	-	4	The number of nodes located along the y-direction and beyond the edges of the slab.
8	Depth Nodes (Nz_ext)	-	4	The number of nodes located along the z-direction and beneath the bottom surface of the slab.
9	Mean surface temperature	C	10.0	The mean (average) surface temperature of undisturbed soil.
10	Amplitude of Surface Temperature	ΔC	5.0	The amplitude of the surface temperature of undisturbed soil over the course of a year.
11	Day of Minimum Surface Temperature	Day	36	The day of the year at which the minimum undisturbed surface temperature occurs.
12	Soil conductivity	kJ/h.m.K	8.722	The thermal conductivity of the soil.
13	Soil density	kg/m3	3200.0	The density of the soil.
14	Soil specific heat	kJ/kg.K	0.84	The specific heat of the soil.
15	Surface emissivity	-	0.9	The emissivity of the soil surface beyond the edges of the slab.
16	Surface absorptance	-	0.6	The absorptance of the soil surface beyond the edges of the slab to solar radiation.
17	Insulated nodal depth	-	1	The number of nodes in the depth direction for which the perimeter of the slab is insulated (including the slab node).

18	R-Value of Perimeter Insulation	h.m2.K/kJ	0.0	The resistance to heat transfer (R-value) for the material used to insulate the perimeter of the slab in the depth direction.
19	R-Value of Bottom Insulation	h.m2.K/kJ	0.0	The resistance to heat transfer (R-value) for the material used to insulate the bottom of the slab from the soil.
20	Side boundary heat transfer	-	1	Setting this value greater than zero allows the soil nodes to interact thermally with the soil beyond the boundary in the x and y directions.
21	Bottom boundary heat transfer	-	1	Setting this value greater than zero allows the soil nodes to interact thermally with the soil beyond the boundary in the depth (z) direction.
22	Logical Unit for Output File	-	11	The logical unit that has been ASSIGNed to the file which will contain the temperatures of all nodes (soil, slab, pipe and far-field); to be printed at the very end of the simulation. Set this value less than 0 to turn-off the auto-print feature. Logical units must be unique integers greater than 10 in TRNSYS.
23	Logical Unit for Input File	-	12	The logical unit which has been ASSIGNed to the file which contains the temperatures of all nodes (soil, slab, pipe and far-field) at the very beginning of the simulation. Set this value less than 0 to turn-off the import feature. Setting this value less than zero will cause the model to calculate the initial soil temperatures based on a correlation (Kasuda). Logical units must be unique integers greater than 10 in TRNSYS.
24	Surface mode	-	1	The mode for the surface temperatures of the near-field and far-field soil: 1: Use an Energy Balance on the Soil Surface to Calculate the Surface Temperature. Conduction effects will impose this boundary conditions on all nodes below the surface node. 2: Use the Surface Temperature, as Calculated by the Kasuda Correlation, to Set the Surface Temperature. In the near-field, conduction effects will impose this boundary conditions on all nodes below the surface node. In the far-field, the temperature of all nodes will be set with the Kasuda correlation. 3: Use the User-Supplied Surface Temperature. Conduction effects will impose this boundary conditions on all nodes below the surface node.
25 to 24 + Par 4	Length of soil node - Dx(i)	-	0.1	The length of the nodes (x-direction) starting at the slab boundary and proceeding towards the far-field (assumed to be symmetric).
25 + Par 4 to 24 + Par 4 + Par 6	Width of soil node - Dy(j)	-	0.1	The width of the nodes (y-direction) starting at the slab boundary and proceeding towards the far-field (assumed to be symmetric).

25 + Par 4 + Par 6 to 24 + Par 4 + Par 6 + Par 7	Depth of soil node - Dz(k)	-	0.1	The depth of the nodes (z-direction) starting at the slab boundary and proceeding down towards the far-field.
NPAR = 24 + Par 4 + Par 6 + Par 7				
NPAR+1	Slab conductivity	kJ/h.m.K	8.722	The thermal conductivity of the slab.
NPAR+2	Slab density	kg/m3	3200.0	The density of the slab.
NPAR+3	Slab specific heat	kJ/kg.K	0.84	The specific heat of the slab.
NPAR+4	Slab surface emissivity	-	0.9	The emissivity of the slab surface. Setting this value to zero effectively causes the radiative exchange between the slab surface and the zone interior surfaces to be neglected.
NPAR+5	Slab surface absorptance	-	0.6	The absorptance of the slab surface to incident radiation. Setting this value to zero effectively causes the radiative exchange between the slab surface and the zone interior surfaces to be neglected.
NPAR+6	Initial slab temperature	C	20.0	The temperature of the slab, pipes, and fluid at the beginning of the simulation.
NPAR+7	Contact Resistance Between Pipe and Soil	h.m2.K/kJ	0.0	The resistance to heat transfer (R-value) from the outer pipe surface to the center of the soil/slab node.
NPAR+8	Number of Buried Pipes	-	1	The number of different pipes that are contained within the soil/slab boundary. For each pipe the user must specify the inlet fluid conditions and the pipe layout through the storage volume.
Cycle	Number of Pipe Nodes	-	9	The number of nodes that this pipe will be divided into along the flow direction. Each node is assumed to be of uniform temperature and fluid conduction in the axial direction is not accounted for. This parameter is cycled with the number of pipes (Par (NPAR+8)).
Cycle	Logical Unit for Pipe Layout	-	13	The logical unit which has been ASSIGNed to the file which contains the pipe layout information for this pipe. The file must contain one line for each pipe node and provide the fraction of total pipe length for this node and the x, y, and z coordinates of the soil/slab node in which this pipe node is contained. Logical units must be unique integers greater than 10 in TRNSYS. This parameter is cycled with the number of pipes (Par (NPAR+8)).
Cycle	Length of Pipe	m	75.0	The total length of this pipe. This parameter is cycled with the number of pipes (Par (NPAR+8)).
MPAR = NPAR + 3 * Number of Buried Pipes (Par(NPAR+8))				

MPAR+1	Pipe conductivity	kJ/h.m.K	1.4	The thermal conductivity of the pipe material.
MPAR+2	Pipe density	kg/m3	1200.0	The density of the pipe material.
MPAR+3	Pipe specific heat	kJ/kg.K	0.65	The specific heat of the pipe material.
MPAR+4	Pipe outer diameter	m	0.033	The outer diameter of the pipe.
MPAR+5	Pipe inner diameter	m	0.027	The inner diameter of the pipe.
MPAR+6	Fluid specific heat	kJ/kg.K	4.19	The specific heat of the fluid flowing through the pipes.
MPAR+7	Fluid density	kg/m3	1000.0	The density of the fluid flowing through the pipes.
MPAR+8	Fluid conductivity	kJ/h.m.K	6.23	The thermal conductivity of the fluid flowing through the pipes.
MPAR+9	Fluid viscosity	kg.h/m	3.06	The viscosity of the fluid flowing through the pipes.

INPUTS

Input Number	Name	Unit	Typical Value	Comment
1	Ambient temperature	C	20.0	The dry-bulb temperature of the ambient air (in contact with the near and far-field soil).
2	Sky temperature	C	10.0	The temperature of the sky for radiative exchange calculations with the soil surface.
3	Incident solar radiation	kJ/h.m2	0.0	The solar radiation (beam + diffuse) incident upon the soil surface.
4	Outer convection coefficient	kJ/h.m2.K	25.0	The convective heat transfer coefficient between the soil surface and the ambient air.
5	Zone temperature	C	20.0	The dry-bulb temperature of the zone air (in contact with the surface of the slab).
6	Surroundings temperature	C	20.0	The temperature of the surroundings for radiative exchange calculations with the slab surface.
7	Incident radiation	kJ/h.m2	0.0	The total radiation (lights, solar etc.) incident upon the slab surface.
8	Inner convection coefficient	kJ/h.m2.K	15.0	The convective heat transfer coefficient between the slab surface and the zone air.

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Cycle	Fluid inlet temperature	C	30.0	The temperature of the fluid entering the specified pipe. These two inputs are cycled with the number of pipes (PAR (NPAR+8)).
	Fluid flow rate	kg/h	0.0	The flow rate of the fluid entering the specified pipe. These two inputs are cycled with the number of pipes (PAR (NPAR+8)).
9 + 2 * Number of Pipes	Near/far-field surface temperature	C	10.0	The temperature of the near-field and far-field soil surface. This input is only used if Parameter 24 = 3

OUTPUTS

Output Number	Name	Unit	Comment
1	Slab surface temperature	C	The temperature of the top surface of the slab (the surface in contact with the zone air).
2	Slab heat transfer rate	kJ/h	The rate at which heat is transferred from the slab into the zone.
3	Bottom boundary heat transfer rate	kJ/h	The rate at which heat is transferred from the soil in the near-field to the soil in the far-field through the bottom boundary of the storage.
4	Top boundary heat transfer rate	kJ/h	The rate at which heat is transferred from the soil in the near-field to the ambient through the top boundary (surface) of the storage.
5	Side boundary heat transfer rate	kJ/h	The rate at which heat is transferred from the soil in the near-field to the soil in the far-field through the side boundary of the storage.
6	Heat storage rate	kJ/h	The rate at which heat is being stored in the soil.
7	Pipe heat transfer rate	kJ/h	The rate at which heat is being transferred from the fluid in the pipes to the slab/soil nodes.
8	Near-field surface temperature	C	The average temperature of the soil surface in the near-field.
9	Long-term average surface temperature	C	The average temperature of the soil surface in the near-field if predicted by the Kasuda correlation.
10	Deep earth temperature	C	The temperature of the soil located just beneath the bottom boundary of the storage.
11	Far-field surface temperature	C	The average temperature of the soil surface in the far-field.
12	Energy balance error	%	The error in the energy balance for the entire storage volume expressed as a percentage.

Cycle	Fluid outlet temperature	C	The temperature of the fluid exiting the specified pipe. These two outputs are cycled with the number of pipes (Par (NPAR+8)).
	Fluid flow rate	kg/h	The flow rate of the fluid exiting the specified pipe. These two outputs are cycled with the number of pipes (Par (NPAR+8)).