Calculation of Additional Thermal Resistance Provided by Polystyrene Pods Under a Concrete Floor Slab

by

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The concrete slab/pod system considered consists of an 80 mm thick top layer of concrete with 305 mm high concrete edge beams and a grid of internal concrete beams. The spaces between the beams are occupied by 225 mm high polystyrene pods consisting of a 50 mm thick top layer of polystyrene and an array of polystyrene legs 175 mm high and 25 mm wide (perimeter legs are 35 mm wide), forming 36 air voids.

This report gives an estimate of the additional thermal resistance provided by this system compared to a conventional 100 mm concrete slab-on-ground floor.

As requested by the client, calculations were done for three combinations of edge beam and internal beam widths, as shown in Table 1.

Table 1. Dimensions of the three cases considered

Case	Edge beam width (mm)	Internal beam width (mm)	Slab length (mm)	Slab width (mm)	Slab area (m^2)
1	300	110	2089	1130	236.1
2	270	100	2067	1115	230.5
3	110	110	2051	1091	223.8

All cases contain 153 (17 x 9) foam pods.

The following material properties and assumptions were used:

- Thermal conductivity of concrete: 1.4 W/m.K.

- Thermal conductivity of polystyrene: 0.0375 W/m.K (as supplied in the client fax of 10 February 2004).

- Thermal resistance of air voids: 0.17 m2.K/W (assumes a still air space and is the mean of the heat flow up and heat flow down resistances).

- Thermal resistance of ground itself- 1.8 m2.K/W. This is based on the case I floor area of 236.1m 2 , and an assumed soil conductivity of 1.4 W/m.K (cases 2 and 3 give the same result to one decimal place). This resistance was calculated using the author's mathematical model of slab-on-ground heat flow. The actual value used is not critical as we are interested in the difference between the pod system and a conventional raft slab, both of which rest on the ground.

- The slab was assumed to be carpeted. The carpet thermal resistance was assumed to be 0.2 m2 K/W. Again, this value is not critical for the reason given above.

- Resistance of surface air film above carpet: 0.12 m2.K/W.

To estimate the overall thermal resistance of systems such as this, the usual approach is to calculate upper and lower limits for the total thermal resistance of the air film+carpet+slab+pod+ground system, which take into account the thermal resistances and areas of each of the components.. The estimated thermal resistance is then taken to be

the mean of the upper and lower limits. This approach works well when the upper and lower limits are not too different. Because of the large differences between the thermal conductivities of the concrete and the

polystyrene, the upper and lower limits in this case will differ considerably. This reduces accuracy, but is unavoidable.

For each case, the proportions of concrete, air voids and polystyrene legs is given in Table 2.

Table 2. Proportions of each material as a % of the surface area

Case	Concrete beams	Polystyrene legs	Air voids
1	23.0	24.5	52.5
2	21.1	25.1	53.8
3	18.8	25.8	55.4

The results are given in Table 3. Because of the uncertainties involved, they have been rounded to one decimal place.

Table 3. Additional thermal resistance provided by the polystyrene pods, compared to a 100 mm raft slab.

Case	Additional thermal resistance (2.K/W) m_v
1	0.9
2	1.0
3	1.0