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KAUNAS UNIVERSITY OF TECHNOLOGY
INSTITUTE OF ARCHITECTURE AND CONSTRUCTION

Determination of specific thermal output of floor heating module

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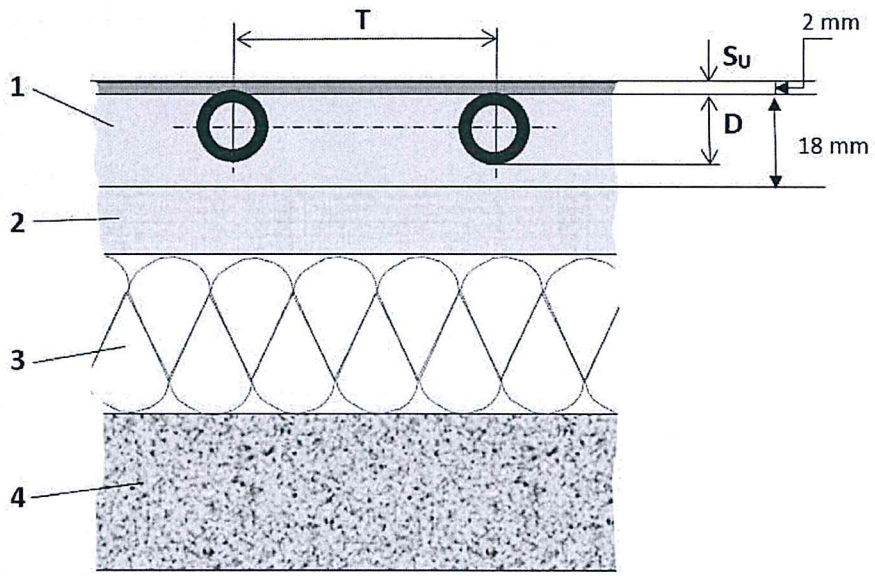
Kaunas 2021

Test according to LST EN 1264-2:2008+A1:2012. Water based surface embedded heating and cooling systems – part2: Floor heating: Prove methods for the determination of the thermal output calculation and test methods.

1. Testing equipment of floor heating module:

- thermocouple wire: Omega grade A (copper-constantan) – TT-T-20 with 30 x 30 mm copper foil on the ends;
- formula used for conversion from measured emf (mV) to temperature (°C): ϑ= -0,00021076007400736*(mV)^6 + 0,00320020841764401*(mV)^5 - 0,0169579561768329*(mV)^4 + 0,0621054811630694*(mV)^3 - 0,71596265180415*(mV)^2 + 25,8530292787711*(mV);
- Ice point reference: Omega Ice Point Cell;
- Multimeter: HP 34401A;
- Heat flux sensor: type PU 4.3, serial number PU 4.3.0121, calibration value at 20°C – 6.2 (W/(m^2.mV)), maximum temperature 90 °C, thermal conductivity 0.25 (W/(m.K)), accuracy of calibration 5 (%); Institute of applied physiscs TPD TNO-TH;
- Electic instantaneous water heater: Kospel EPS2 – 5.5R, electrical power 5.5 (kW).

2. Floor heating module:



1 – screed - weight bearing and thermal diffusion layer, thickness 20 mm:
fermacell self-leveling gypsum compound 2mm thickness,
fermacell gypsum fiber board 18mm thickness.

2 – OSB plate, thickness 18mm;

3 – thermal insulating layer (Rockwool boards), total thickness 130mm;

4 – concrete structural base.

Outside diameter of pipe D = 12,0 mm;

Spacing between pipes o.c. T = 100 mm;

Table 1. Results of floor heating module test measurements (5 minutes average) – emf (mV)

ϑ_i	$\vartheta_{F,m}$	ϑ_V	ϑ_R	q
0,8707715	0,5508784	0,5063433	0,5062856	-3,532467
0,8424551	0,5514215	0,5040168	0,5053472	-3,30211
0,7398971	0,5496778	0,5101383	0,513418	-2,287992
0,774872	0,7799661	0,793281	0,7871448	0,4801946
0,8156662	0,9159656	0,9663895	0,9609794	2,31121
0,7818371	1,063147	1,159586	1,127835	5,206295
0,831608	1,511554	1,745718	1,6677891	12,55497
0,829342	1,653034	1,94045	1,842521	15,26329

Table 2. Results of floor heating module test measurements – temperatures (°C)

ϑ_i	$\vartheta_{F,m}$	ϑ_V	ϑ_R	ϑ_H	$\vartheta_H-\vartheta_{F,m}$	$\Delta\vartheta_H$	$\vartheta_{F,m}-\vartheta_i$	q
22,00	14,03	12,91	12,91	12,91	-1,12	-9,09	-7,97	-21,90
21,30	14,05	12,86	12,89	12,87	-1,18	-8,43	-7,25	-20,47
18,76	14,00	13,01	13,09	13,05	-0,95	-5,71	-4,75	-14,19
19,63	19,75	20,08	19,93	20,01	0,25	0,38	0,13	2,98
20,64	23,12	24,36	24,23	24,29	1,18	3,65	2,48	14,33
19,80	26,73	29,09	28,31	28,70	1,97	8,90	6,93	32,28
21,03	37,59	43,17	41,32	42,24	4,65	21,21	16,56	77,84
20,98	40,97	47,76	45,46	46,61	5,64	25,63	19,99	94,63

Where:

q – specific thermal output, W/m^2;

ϑ_i – (standard) indoor room temperature, °C;

$\vartheta_{F,m}$ – average floor surface temperature, °C;

ϑ_H – average heating medium temperature, °C;

$\Delta\vartheta_H$ – temperature difference between average heating medium and room temperatures, °C;

($\vartheta_{F,m}$ - ϑ_i) – average temperature difference between floor surface and indoor room, °C;

ϑ_V – heating medium inlet temperature, °C;

ϑ_R – heating medium outlet temperature, °C.

Table 3. Measurement results for drawing of graphs

$(\vartheta_{F,m}-\vartheta_i)$, K	$\Delta\vartheta_H$, K	q, W/m^2
-7,97	-9,09	-21,90
-7,25	-8,43	-20,47
-4,75	-5,71	-14,19
0,13	0,38	2,98
2,48	3,65	14,33
6,93	8,90	32,28
16,56	21,21	77,84
19,99	25,63	94,63

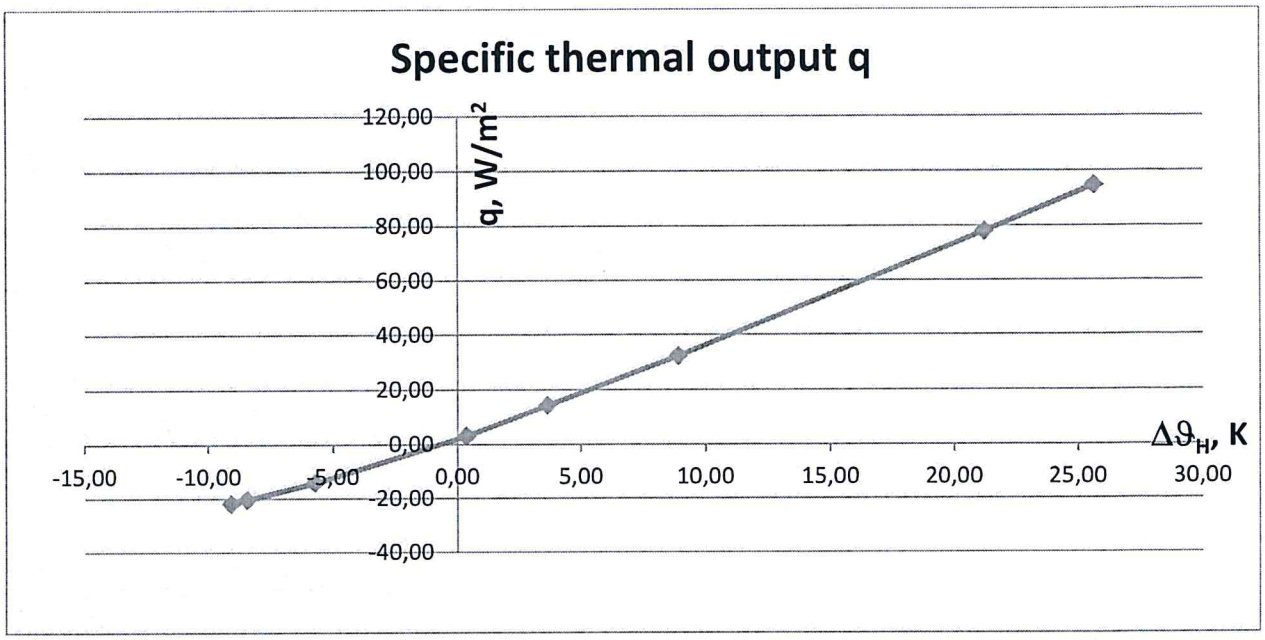


Fig. 1. Dependence of specific thermal output q from temperature difference between average heating medium and indoor room.

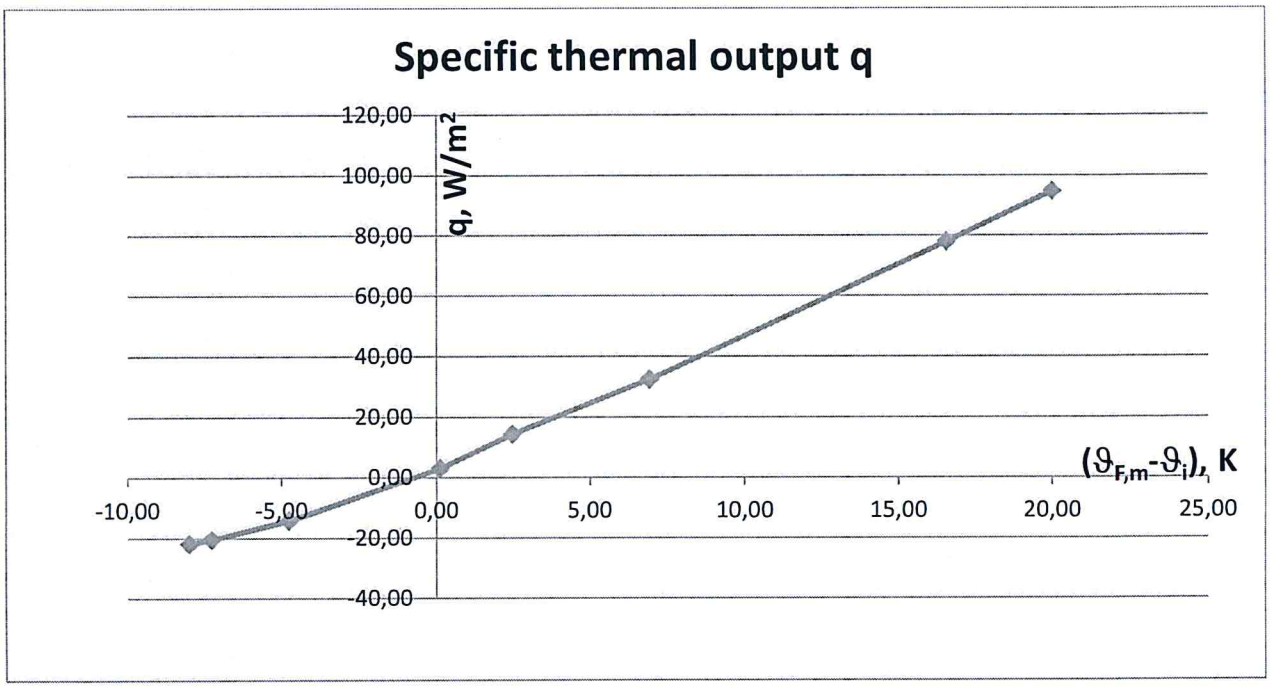


Fig. 2. Dependence of specific thermal output q from temperature difference between average floor surface and indoor room.

Table 4. Derived values of average cooling temperatures from test data in floor cooling regime

Standard	Values from test			Derived values	
ϑ_i, °C	$(\vartheta_{F,m}-\vartheta_i)$, K	$\Delta\vartheta_C$, K	q_C, W/m²	ϑ_C, °C	$\vartheta_{F,m}$, °C
24	-7,97	-9,09	-21,90	14,91≈ 15*	16,03 ≈ 16*
24	-7,25	-8,43	-20,47	15,57≈ 16	16,75 ≈ 17
24	-4,75	-5,71	-14,19	18,29≈ 18	19,25 ≈ 19
24	0,13	0,38	2,98	24,38≈ 24	24,13 ≈ 24

Note: * the limit (minimal) surface temperatures for floor cooling.

$$\vartheta_H = \vartheta_i + \Delta\vartheta_H; \text{ and } \vartheta_{F,m} = \vartheta_i + (\vartheta_{F,m}-\vartheta_i) .$$

q_C – specific thermal output of cooling surface, W/m²;

ϑ_i – (standard) indoor room temperature, °C;

$\vartheta_{F,m}$ – average floor surface temperature, °C;

ϑ_C – average cooling medium temperature, °C;

$\Delta\vartheta_C$ – temperature difference between average cooling medium and room temperatures, °C.

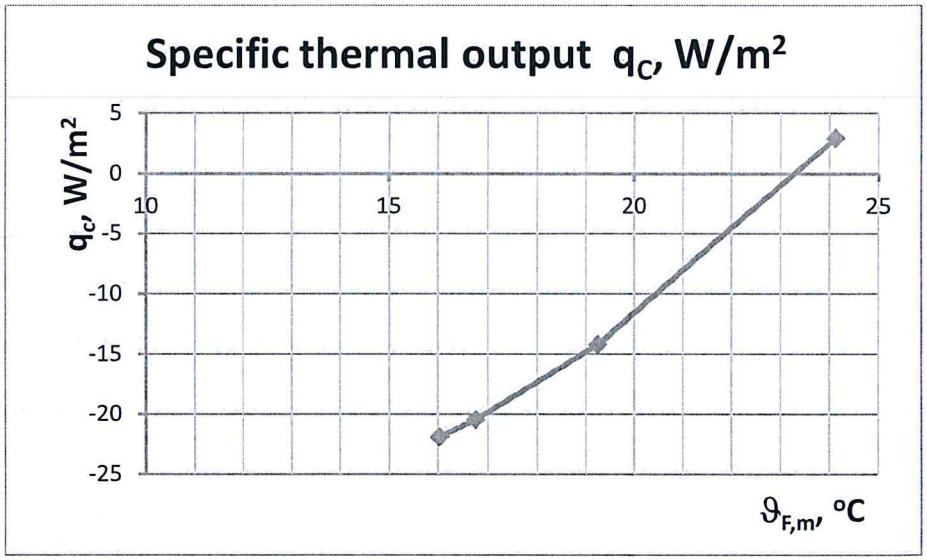


Fig. 3. Dependence of specific thermal cooling output q_C from average floor surface temperature $\vartheta_{F,m}$.

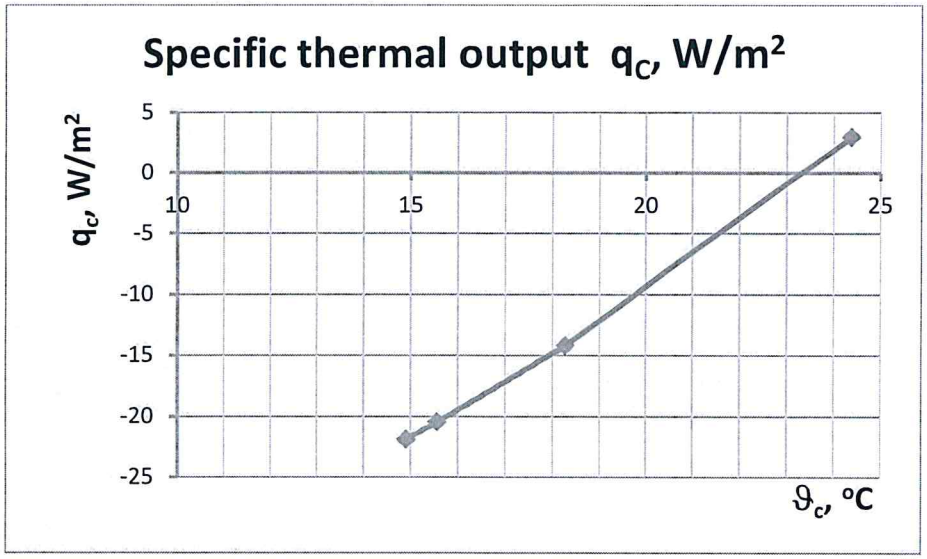


Fig. 4. Dependence of specific thermal cooling output $\mathbf{q_C}$ from average cooling medium temperature ϑ_C.