# Validation of the block HeatTranser2Ground_ISO13370 with results of PHPP

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**Version of Model, Carnot, Matlab and Operation system**

HeatTransfer2Ground_ISO13370 (V 1.11),

git-Carnot/Master (SHA-1:03c96ba5140e84c782678723259229afdc6c6ccd)

Matlab R2022b, Windows 10 (19045.2728)

**Complete path of the block in the Carnot Library**

carnot/Basic/Heat_Transfer/HeatTransfer2Ground_ISO13370

# 1 Data used for validation

The verification uses monthly data, calculated by PHPP with the same inputs and parameters.

# 2 Description of the model

## 2.1 Block

The model is an update of the existing ground loss calculation for buildings. Instead of Simulink blocks the calculation is done by a “Matlab Function Block” for better readability. A calculation mode for “unheated basement” and “heated basement” was added.


The comparison of the new and the old model is not part of this report. This can be done using the verification script included in Carnot-Toolbox, where results of the current model are compared to reference simulation result.

## 2.2 Model File

| | |
|---|---|
| *groundlossPHPP.mat:* | *Validation results from PHPP* |
| *...\verification\iso13370_Validation.m:* | *Running simulation and calculate results.* |
| *...\verification\validation_iso_ground.slx:* | *Simulation file for model.* |

# 3 Results

There are two limitations to the validation.

1. PHPP does calculation on a monthly basis. The time shift of minimum outside temperature in the Carnot-Toolbox model is given in seconds of the year. This time shift must be estimated, to best fit PHPP results.
2. PHPP uses a fixed value for internal temperature. The effect of fluctuations of the internal temperature cannot be validated. Differences regarding this effect between the Carnot-Toolbox model and ISO13370 can be observed. The work done in Task44 A38 (validation of simple house), already concluded that the Carnot model is the correct implementation.

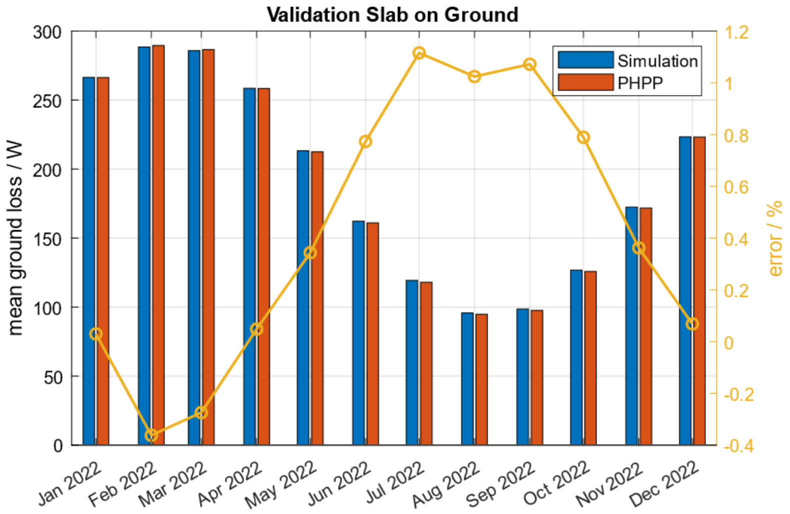
Maximum error of monthly mean heat transfer power:

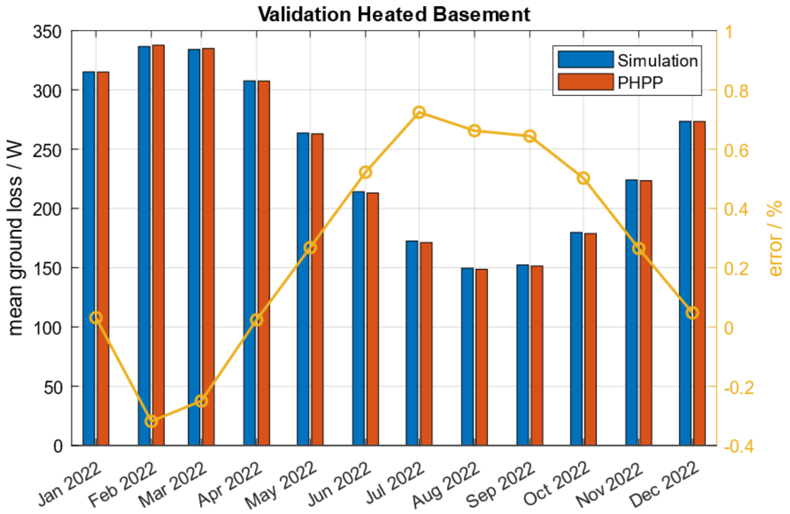
| | |
|---|---|
| Slab on ground | 1.18% |
| Heated basement | 0.72% |
| Unheated basement | 0.56% |

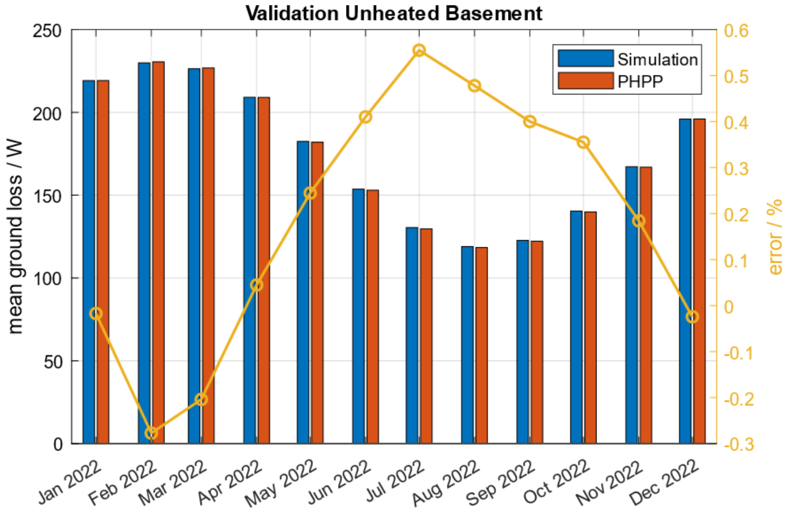
Maximum error occurs in summer for all three models.

**Input Data:**

| Variable Name | Symbol | Value | Unit |
|---|---|---|---|
| time shift | $\tau$ | 348*3600 | sec |
| mean inside temperature | $\bar{\theta}_{in}$ | 20 | $℃$ |
| mean outside temperature | $\bar{\theta}_e$ | 10.4 | $℃$ |
| annual amplitude of $\bar{\theta}_{in}$ | $\Delta\theta_i$ | 0 | $K$ |
| annual amplitude of $\bar{\theta}_e$ | $\Delta\theta_e$ | 11 | $K$ |
| length of slab | $L$ | 15 | $m$ |
| width of slab | $W$ | 9 | $m$ |
| level of 1st floor above ground | $hb$ | 0.5 | $m$ |
| level of basement below ground | $z$ | 2 | $m$ |
| density ground | $\rho_{gr}$ | 2500 | $kg/m^3$ |
| heat capacity ground | $cp_{gr}$ | 800 | $J/(kg.K)$ |
| conductivity ground | $\lambda_{gr}$ | 2.0 | $w/(m.K)$ |
| avg. thickness of walls | $d_{we}$ | 0.4 | $m$ |
| *total heat transfer* | | | |
| slab | $U_{fs}$ | 0.183 | $W/(m^2.K)$ |
| floor/basement | $U_w$ | 0.15 | $W/(m^2.K)$ |
| wall above ground | $U_{fk}$ | 0.5 | $W/(m^2.K)$ |
| wall below ground | $U_{wk}$ | 0.08 | $W/(m^2.K)$ |
| thermal transmittance junctions | $\Psi_{wf}$ | 0 | $W/(m.K)$ |
| ventilation rate | $n$ | 0.2 | $m^3/h$ |


Validation Slab on Ground
mean ground loss / W
error / %
Simulation
PHPP
0
50
100
150
200
250
300
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
Jul 2022
Aug 2022
Sep 2022
Oct 2022
Nov 2022
Dec 2022


Validation Heated Basement
mean ground loss / W
error / %
Simulation
PHPP
0
50
100
150
200
250
300
350
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
Jul 2022
Aug 2022
Sep 2022
Oct 2022
Nov 2022
Dec 2022


Validation Unheated Basement
mean ground loss / W
error / %
Simulation
PHPP
0
50
100
150
200
250
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
Jul 2022
Aug 2022
Sep 2022
Oct 2022
Nov 2022
Dec 2022

# 4 Literature

[1] EN ISO 13370:2018-02

[2] M. Y. Haller, R. Dott, J. Ruschenburg, F. Ochs, und J. Bony, „A technical report of subtask C Report C1 Part A“, S. 23.

[3] R. Dott, M. Y. Haller, J. Ruschenburg, F. Ochs, und J. Bony, „A technical report of subtask C Report C1 Part B“, Part B, S. 40.