1- Context of the study

This study is part of the RESIZED project. Designing new city districts and analyzing old ones from energy management point of view is a growing idea. In RESIZED project, this goal is divided into four different parts. Urban design, energy consumption, energy production and optimization. Simplified models are a strong tool for calculating energy consumption in buildings but their application in larger scale has not been investigated yet. Until now we have developed our method to make the building’s simplified model and in the second part, developing a district simplified model is under study in the RESIZED project.

2- Objectives

- Simplified models are strong tools for quantifying heating load and cooling load in buildings.
- Thermal networks provide a systematic way to develop equations for simple and complex models.
- Parameter identification of RC networks, provides a reliable model for energy management in building sector.

3- Model Schemes

Figure 1. Schematic simulated building in TRNSYS

Figure 2. Making the thermal network out TRNSYS

Table 1. Identified parameters for 4R2C model

<table>
<thead>
<tr>
<th>TRNSYS data</th>
<th>Q</th>
<th>720 h data</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>0.0144</td>
<td>0.00013</td>
</tr>
<tr>
<td>K2</td>
<td>0.0141</td>
<td>0.00166</td>
</tr>
<tr>
<td>K3</td>
<td>0.0007</td>
<td>0.00427</td>
</tr>
<tr>
<td>K4</td>
<td>0.5</td>
<td>Fix</td>
</tr>
<tr>
<td>C1</td>
<td>2425.9200</td>
<td>4516</td>
</tr>
<tr>
<td>C2</td>
<td>10248.0000</td>
<td>4516</td>
</tr>
</tbody>
</table>

Figure 3. Final thermal RC network for making a building model

4- System identification

- Using 1 month data for identification.
- Data extracted from TRNSYS software.
- More than 80% of fitness.

\[
\begin{align*}
C_1 \frac{dT_1}{dt} &= \frac{T_{in1}-T_1}{R_1} + \frac{T_{in2}-T_2}{R_2} + Q_{rad1} + \alpha Q_{rad2} \\
C_2 \frac{dT_2}{dt} &= \frac{T_{in2}-T_2}{R_3} + \frac{T_{rad2}}{R_4} + (1-\alpha)Q_{rad2} \\
Q_{heat} + Q_{ref} + Q_{vent} + \frac{V^\gamma T_{in}}{R_5} + \frac{V^\gamma T_{out}}{R_6} &= 0
\end{align*}
\]

Figure 4a. 4R2C model identification using 720 h data

Figure 4b. 4R2C model identification using 168 h data

5- Results

- Using identified parameters to simulate one year performance.
- The model is able to simulate building heating load with high accuracy.
- Mean square error is very low.

Figure 5. Simulated temperature for 1 year

Figure 6. Hourly error for 1 year data

Figure 7. Simulated heating load for 1 year

Figure 8. Hourly error for 1 year data

5- Conclusion

- The effectiveness of thermal networks to predict the heating load and indoor temperature in buildings is investigated.
- A “4R2C model” is used to simulate heating load and indoor temperature inside a building.
- The parameter identification has been done for 3 different sets of data (results from TRNSYS calculation).
- Data set (amount of information) can significantly impact on the accuracy of estimated parameters.
- The RC model trained with 1 month data can simulate heating load for one year accurately.

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