Building Energy Investigation: Understanding Our Buildings From An Energy Perspective

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Introduction

2050 Climate Change Act: Reducing greenhouse gas emission by 80-95%

Building are the largest energy users, accounting for 25-40% of the total energy demand (Mayer et al 2014)

Buildings are designed based on
• Safety
• Economy
• SUSTAINABILITY
Motivation

With the climate change and effect of fossil fuels, buildings are required to reduce their energy consumption (CO2 emission). Therefore, buildings are designed as low energy or zero energy buildings using smart energy systems. A low energy building with both passive and active energy measures was not performing as expected.
Methodology Framework

Infrared Thermography Analysis Using MATLAB

Do they match?

Yes: Determine Psi-values and New U-Values

No: Re-Calibrate

Numerical Analysis Using ANSYS

Computer Simulation

Sensor Monitoring

Do they match?

Yes: Simulate model using future weather data

No: Re-Calibrate

Energy Modelling Using DesignBuilder

Effect of Thermal Bridging

Input Values into Energy model

Determine the effect of unwanted heat loss/gain

End

Risk of Overheating Assessment

End
Case-Study

- Location: Clifton, Nottingham
- Facility: Sports changing facility
- Dimension: 468m² floor area
- Equipment:
  - Boilers
  - Radiators
  - Heat recovery unit

United Kingdom
Nottingham Trent University, Clifton Campus
Sports Centre
DesignBuilder Model of the Clubhouse
Thermography of Case Study

- Cracks creating heat sinks
- Pipes becoming radiators
- Mortars joints cooling the lounge
Numerical Analysis
Comparison between numerical and thermography analysis
What is the Effect of the Thermal Bridge

<table>
<thead>
<tr>
<th>Thermal Bridge Location</th>
<th>U-Value</th>
<th>New U-Value</th>
<th>Psi-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal bridge created by Steel frame</td>
<td>0.32</td>
<td>0.52</td>
<td>0.256</td>
</tr>
<tr>
<td>Thermal bridge created by junction</td>
<td>0.32</td>
<td>0.32</td>
<td>0.678</td>
</tr>
</tbody>
</table>
Energy Simulation of Case Study

- DesignBuilder Software
- Whole building modelling
- Results validated with data from temperature and humidity sensors
Effect of Thermal Bridge on Gas Consumption

- 15% increase in gas consumption during winter
- 5% increase in gas consumption during summer
- Influence of hot water pipe left on during the holidays to avoid frosting
Overheating Risk

- Using TM52 the risk of overheating was assessed
- Future weather data (from Prometheus Project) was used to predict the performance
Conclusion

• Unwanted energy gains and losses (thermal bridges) affect the energy performance of buildings. *Therefore to have the optimal use of our smart energy systems, thermal bridges have to be eradicated!!*

• There is substantial risk to overheat in the future. *Therefore smart energy systems (cooling systems) have to be incorporated in a way to reduce the risk of overheating*
Thank you

Any Question?

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