Infrared measurements on a ventilated cladding

Surface temperature measurements
Heat transfer calculation through the insulated part of the envelope

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Experimental set up

- 20m²
- 50m³
- 142 Sensors
- Vapour and heat production
- + wheather station

Diagram showing:
- Particle board
- Cellulose wadding
- Rain screen
- Gypsum board
- Air gap
- Sensors
- Wooden cladding

indoor
outdoor

Thickness (mm)
Aim of this study

Test house ➔ Compare different envelope types
1D- HAM model Validation

Errors on heat transfers around the cladding

Measurements on a wall in summer
Evaluate bi-dimensional effects
IR technique

Infrared radiation measurements:

\[ J = \varepsilon \cdot \sigma \cdot T_{Tar}^4 + (1 - \varepsilon) \cdot \sigma \cdot T_{Surr}^4 \]

- \( T_{Surr} \): aluminium foil
- \( \varepsilon \): black tape
- \( T_{Tar} \)
Weather conditions – 30/06

Solar loads (W/m²)

- Direct (Vertical)
- Direct (Horizontal)

Temperature (°C)

IR Measurements

600 700 800

300 400 500

200 300 400

100 200 300

0 100 200 300

4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00

35

33

31

29

27

25

23

21

19

17

4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00

Hour
Southern side – 9h40

<table>
<thead>
<tr>
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<th>Exposed</th>
<th>Shaded</th>
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</thead>
<tbody>
<tr>
<td>Air Temp (°C)</td>
<td>22.8</td>
<td></td>
</tr>
<tr>
<td>Cladding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Temp (°C)</td>
<td>27.6</td>
<td>27.5</td>
</tr>
<tr>
<td>Max Temp (°C)</td>
<td>28.5</td>
<td>27.9</td>
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Wall temperature is 1°C homogenous
Southern side – 11h40
### South wall – 13h40

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<tbody>
<tr>
<td>Air Temp (°C)</td>
<td>29.7</td>
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<tr>
<td>Mean Temp (°C)</td>
<td>46.2</td>
<td>39.1</td>
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<tr>
<td>Max Temp (°C)</td>
<td>47.6</td>
<td>43.4</td>
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</table>

Solar loads 280 W/m²

$\Delta T$ with air

$[9.4 ; 16.5]$ °C
Weather conditions – 07/07

IR Measurements

Solar Loads (W/m²)

- Direct (Vertical)
- Direct (Horizontal)

T_Air (°C)

Hour

4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00
Eastern wall – 6h to 16h

Results plotted for few relative heights (H=3.81 m)

No shaded part

Solar loads > 600 W/m²

\[ \Delta T \text{ with air} \]

[28 ; 36 ]°C
Toward simulations

IR measurements

75% of the cladding is 3°C homogeneous

Temperature distribution on the rain screen?

Computational work
Toward simulations

IR Measurements

Position of thermal sensors

$T_{\text{air outdoor}}$  $T_{\text{air indoor}}$

$T_{\text{IR}}$

Calculated nodes

Boundary

Rain screen
Temperature distribution

One-dimensionnal wall model
Enhanced model

44 IR measurements
=> 44 superimposed one-dimensional models

[Diagram showing IR measurements and temperature models labeled T_{IR} 1, 2, 3, T_{air gap} 1, 2, 3, and T_{Air indoor}, with 1D wall model n°1, 2, 3.]
Fitting air gap coefficients

Increasing air speed in the air gap from 0.1 to 0.3 m/s

On the cladding

On the rain screen
Temperature distribution

Widely spread from 0 to 2.5m

σ > 3°C
(8h00 to 13h20)

Rain screen temperature is not homogeneous
Conclusion

IR measurements
\( \Delta T \) with air:
- [9.4; 16.5]°C on southern side
- [28; 36]°C on eastern side

Heat transfer calculation
Bi-dimensional effect through the air gap
Rain screen temperature is not homogenous

Outlook
Comparison with CFD simulations
Enhancing modelling
Thank you for your attention