A Parametric study of a metal sandwich VIP

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Year of construction

U-value, W/m²K outer walls, one family houses

CONTEXT

APPROACH

FIRST STEP

COST

PARAMETRIC STUDY

CONCLUSIONS
The Average Swedish one family house

Built in 1953
1,5 floors with a cellar
Wooden facade

\[ A_{\text{temp}} = 160 \text{ sqm} \]
\[ U_{\text{wall}} = 0.334 \text{ W/m}^2\text{k} \]
The Average Swedish Multi Family House

Built in 1959

3 floors with a cellar

Rendered or brick facade

$A_{\text{temp}} = 1426 \text{ sqm}$

17 apartments

$U_{\text{wall}} = 0.411 \text{ W/m}^2\text{k}$
VIP panel

Part of a prefab system
Systematic solutions for Refurbishment
Durability
Mechanical Resistance
(Core materials other than fumed silica)
Investigate the use of full metal VIPs
Active panels

**Focus on Thermal bridge**
Cost calculations
Period of 50 years
Panel size 600 by 1000 mm
Price of VIP is 1090 SEK per panel
Panel thickness of 30 mm
\( \lambda_{\text{center of core}} = 0.004 \, \text{W/(m·K)} \)
\( \psi_{\text{edge}} = 0.01 \, \text{W/(m·K)} \)
\( \lambda_{\text{traditional}} = 0.04 \, \text{W/(m·K)} \)
Price of traditional insulation is 1000 SEK/m³
Thermal bridge
Two dimensional calculation model

\[ T_a = 0^\circ C \]
\[ h_{si} = 25 \text{ W/(m}^2\text{K)} \]

\[ T_a = 20^\circ C \]
\[ h_{si} = 8 \text{ W/(m}^2\text{K)} \]

representative section, boundary conditions
Parameters

Material of the envelope
Thickness of cover
External insulation to break thermal bridge
Lengthening of the joint

The effect on the thermal edge loss
thermal conductivity of the cover

- thermal conductivity of joint = 100 W/(m*K)
- thermal conductivity of joint = 40 W/(m*K)
- thermal conductivity of joint = 20 W/(m*K)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_cover</td>
<td>0,05 mm</td>
</tr>
<tr>
<td>t_joint</td>
<td>0,05 mm</td>
</tr>
<tr>
<td>d_core</td>
<td>20 mm</td>
</tr>
<tr>
<td>λ_core</td>
<td>0,004 W/(m*K)</td>
</tr>
</tbody>
</table>
thickness of cover

- thermal conductivity of envelope = 20 W/(m*K)
- thermal conductivity of envelope = 40 W/(m*K)

\[ \psi, \text{W/(m*K)} \]

\[ t_{\text{joint}} = 0.05 \text{ mm} \]
\[ d_{\text{core}} = 20 \text{ mm} \]
\[ \lambda_{\text{core}} = 0.004 \text{ W/(m-K)} \]
outside thermal conductivity

- Thermal conductivity of envelope = 40 W/(m*K)
- Thermal conductivity of envelope = 20 W/(m*K)

![Diagram showing dimensions and thermal conductivity](image)

- $d_{outer} = 20$ mm
- $t_{cover} = 0.05$ mm
- $t_{joint} = 0.05$ mm
- $d_{core} = 20$ mm
- $\lambda_{core} = 0.004$ W/(m*K)
Altering the geometry of the joint

![Diagram of heat flow and barrier](image)

**FIG. 2:** With a serpentine edge the path for heat is prolonged with a smaller heat flow through the edge as the result.

From the Licentiate Thesis of T. Torsell,
edge length

- thermal conductivity of envelope = 40 W/(m*K)
- thermal conductivity of envelope = 20 W/(m*K)

![Diagram showing edge length and thermal conductivity](image)

- $t_{\text{cover}} = 0.05$ mm
- $t_{\text{joint}} = 0.05$ mm
- $d_{\text{core}} = 20$ mm
- $\lambda_{\text{core}} = 0.004$ W/(m·K)
Panel size

Thermal resistance, $R$, m$^2$K/W

Edge loss, $\psi$, Wm$^{-1}$K$^{-1}$

600mm x 1200 mm panel
900mm x 2400 mm panel
Reduce thermal loss

Low thermal conductivity of envelope, especially joint
Adjacent insulation beneficiary
Thickness of cover secondary
Longer edge, substantial reduction
All metal envelope of low conductivity metal such as stainless steel may provide a durable envelope. The cover of that envelope can be made more robust with little effect on the heat loss at the edges. Longer edges reduce edge loss