Building Physics as a Tool for Development of New Components: Roof Window

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PROJECT SONG

No risk

Min. surface temperature ($\theta_{SR,i}$; $f_{RS,i}$)

Solar radiation

Surface heat transfer ($h_{te} + h_{ce}$)

Sky radiation

Thermal coupling $\Sigma(\psi_W \cdot l_W)$

Surface heat transfer ($h_{ti} + h_{ci}$)

Convection in cavities

Thermal transmittance $U_w$

Passive solar gains ($g$)

Heating body power (alternatively)

$U_w \leq 0.8 \text{ W/(m}^2\text{K)}$
Introductory parametric studies

\[ U_w = \frac{A_g \cdot U_g + A_f \cdot U_f + \sum (\psi_g \cdot l_g)}{A_g + A_f} \]

\[ U_{w,\text{inst}} = 0.72 \text{ W/(m}^2\text{K)} \]

\[ U_w = 0.50 \text{ W/(m}^2\text{K)} \]
\( \lambda \approx 0.039\ \text{W/(m.K)} \)

\( U_w \approx 0.5\ \text{W/(m}^2\text{K}) \)

\( U_F \approx 0.6\ \text{W/(m}^2\text{K}) \)

\( U_g \approx 0.3\ \text{W/(m}^2\text{K}) \)
ROOF WINDOW – following steps

„two box solution“ for structural elements
Laminated veneer lumber (LVL) or plastic composite (glass fibers)
+ hardened polystyrene, both sides
U approx. 0.45 W/(m2.K) ???

Protected utility model
ROOF WINDOW: shading

Solar radiation

\[ \theta_{ae} \]

\[ \theta_{si,g} \]

\[ \theta_{ai} \]

\[ \theta_{sh} \]

\[ \theta_{sh} > \theta_{ae} \]

\[ \theta_{si,g} > \theta_{ai} \]
Protected utility model /Patent
Concluding remarks

Roof window (U 0.7 W/(m2.K)) ready for production
U 0.5 W/(m2K) reachable
Effects of thermal coupling relatively larger
Slanted lining OK
R&D continue
Focus on advanced construction and controlled shading
Open questions: how realistic are the surface heat transfer phenomena?
For building design: Compensation principles in $U_{\text{mean}}$ needed!
LCA (different scale) needed

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