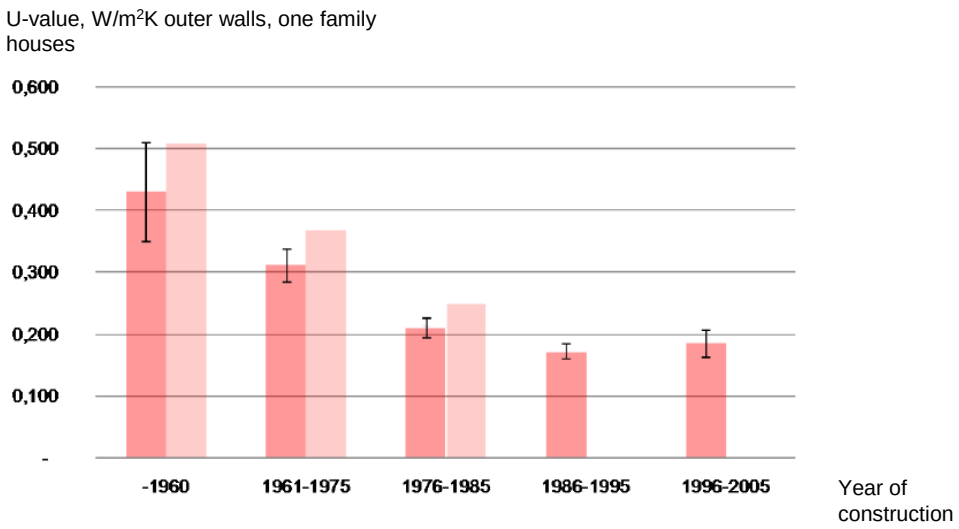
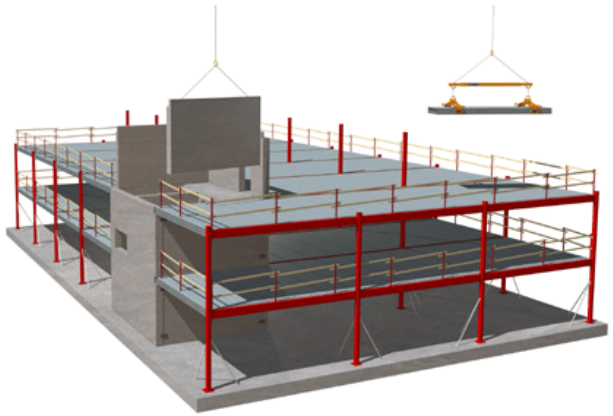
A Parametric study of a metal sandwich VIP

Kjartan Gudmundsson, PhD.

dept of Civil and Architectural Engineering. KTH, Stockholm


U-value, W/m²K outer walls, one family houses
0,600
0,500
0,400
0,300
0,200
0,100
-
-1960
1961-1975
1976-1985
1986-1995
1996-2005
Year of construction

www.norrlandstrahus.se



www.contiga.se

The Average Swedish one family house

Built in 1953

1,5 floors with a cellar

Wooden facade

A_{temp} = 160 sqm

U_{wall} = 0,334 W/m^{2}k

Foto: Conny Fridh/Johnér

The Average Swedish Multi Family House

Built in 1959

3 floors with a cellar

Rendered or brick facade

A_{temp} = 1426 sqm

17 apartments

U_{wall} = 0,411 W/m^{2}k

Foto Niklas Almesjö/Bildarkivet.se

VIP panel

Part of a prefab system

Systematic solutions for Refurbishment

Durability

Mechanical Resistance

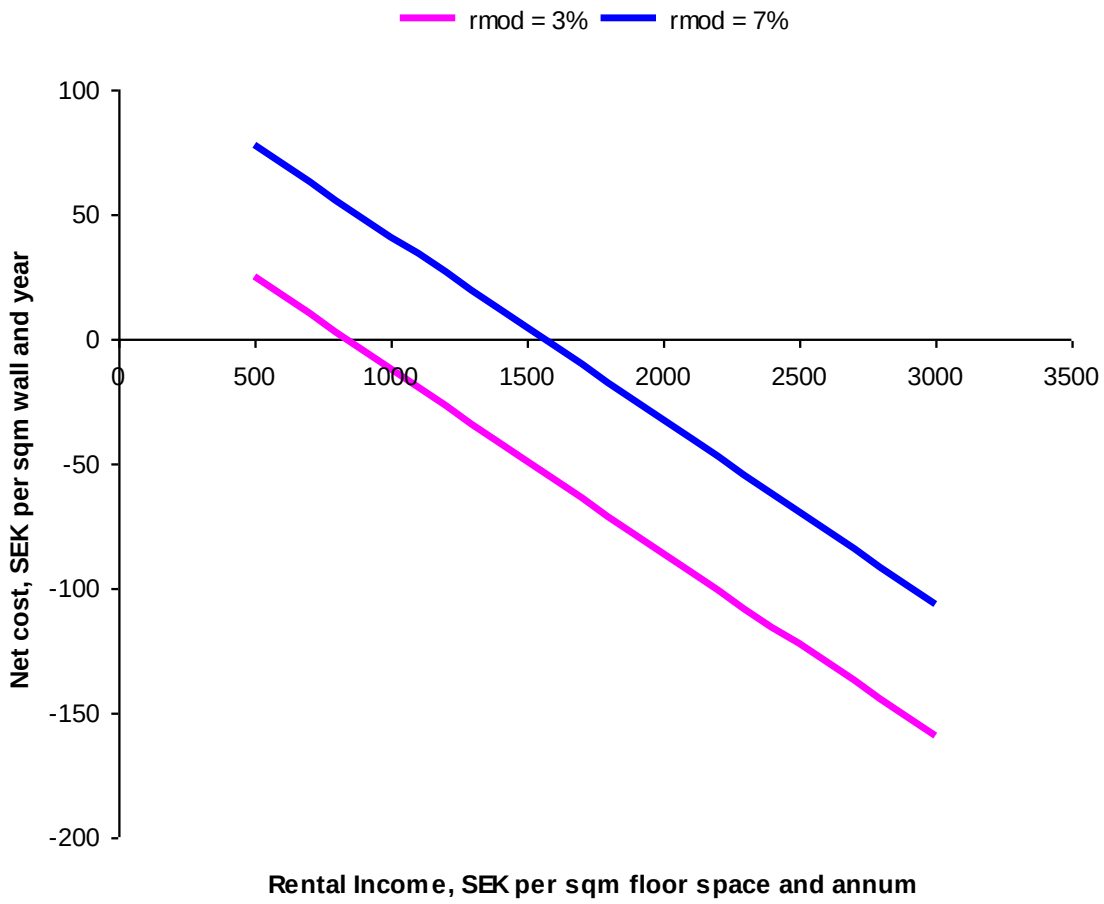
(Core materials other than fumed silica)

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

$\lambda_{centerofcore}$ = 0,004 W/(m·K)

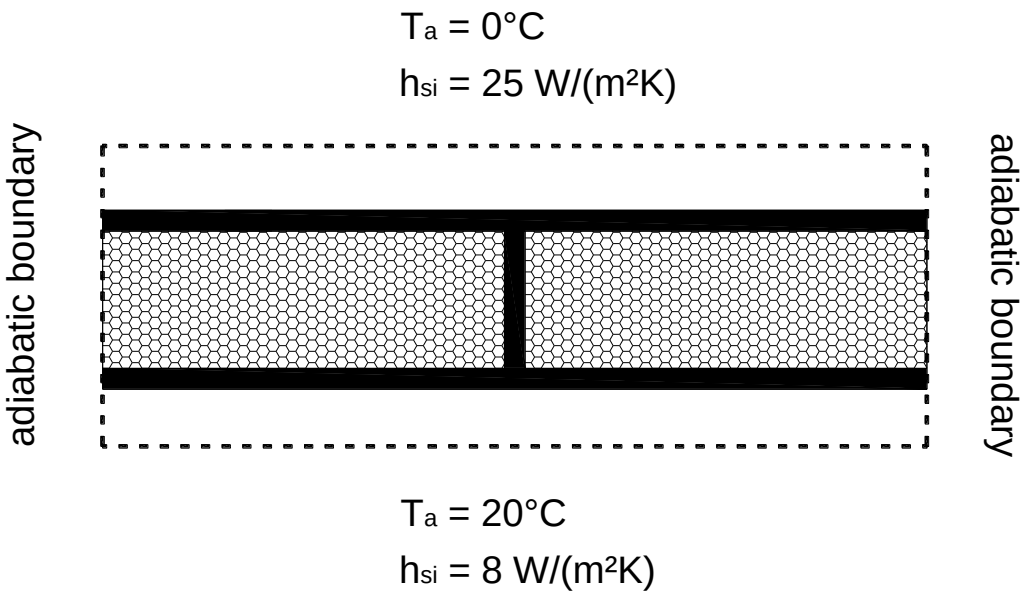
ψ_{edge} = 0,01 W/(m·K)

$\lambda_{traditional}$ = 0,04 W/(m·K)

Price of traditional insulation is 1000 SEK/m^3

Thermal bridge

Two dimensional calculation model



representative section, boundary conditions

Calculated with COMSOL Multiphysics, finite element program

Parameters

Material of the envelope

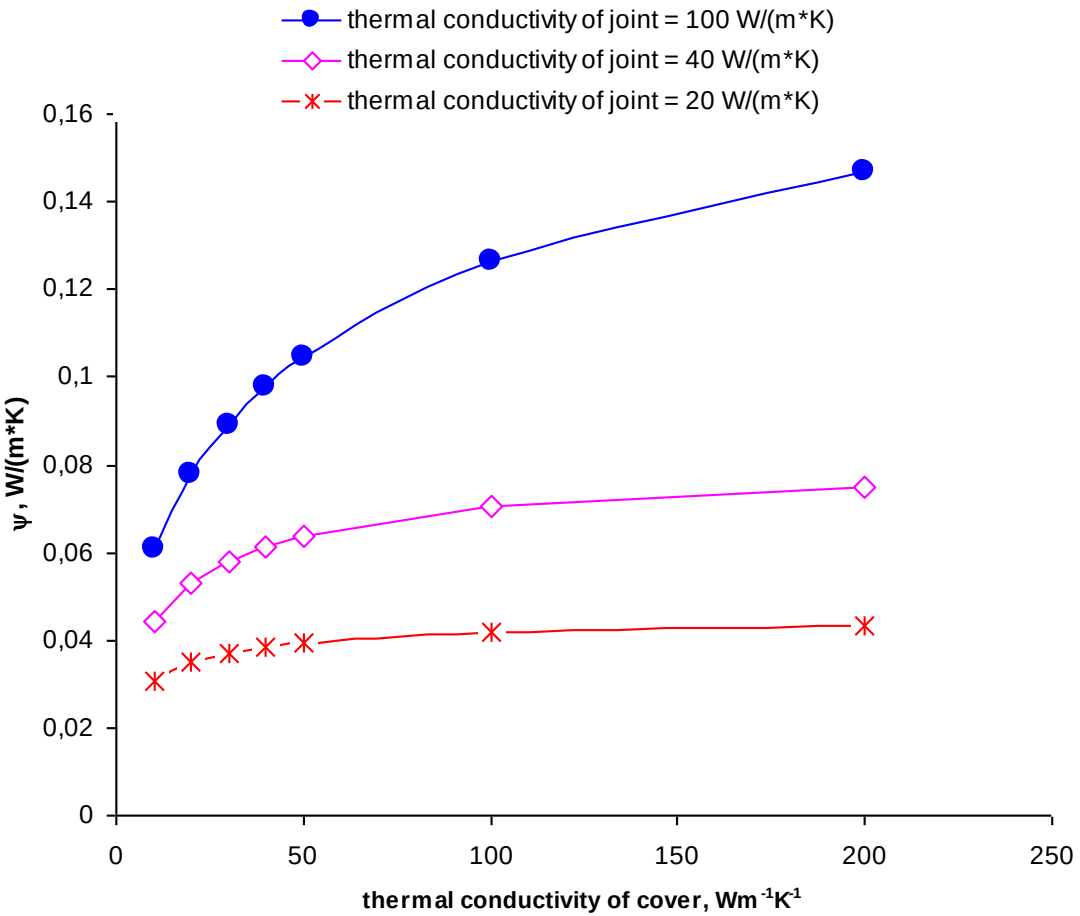
Thickness of cover

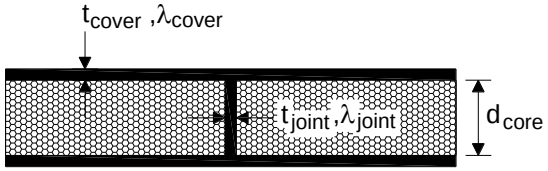
External insulation to break thermal bridge

Lengthening of the joint

The effect on the thermal edge loss

thermal conductivity of the cover





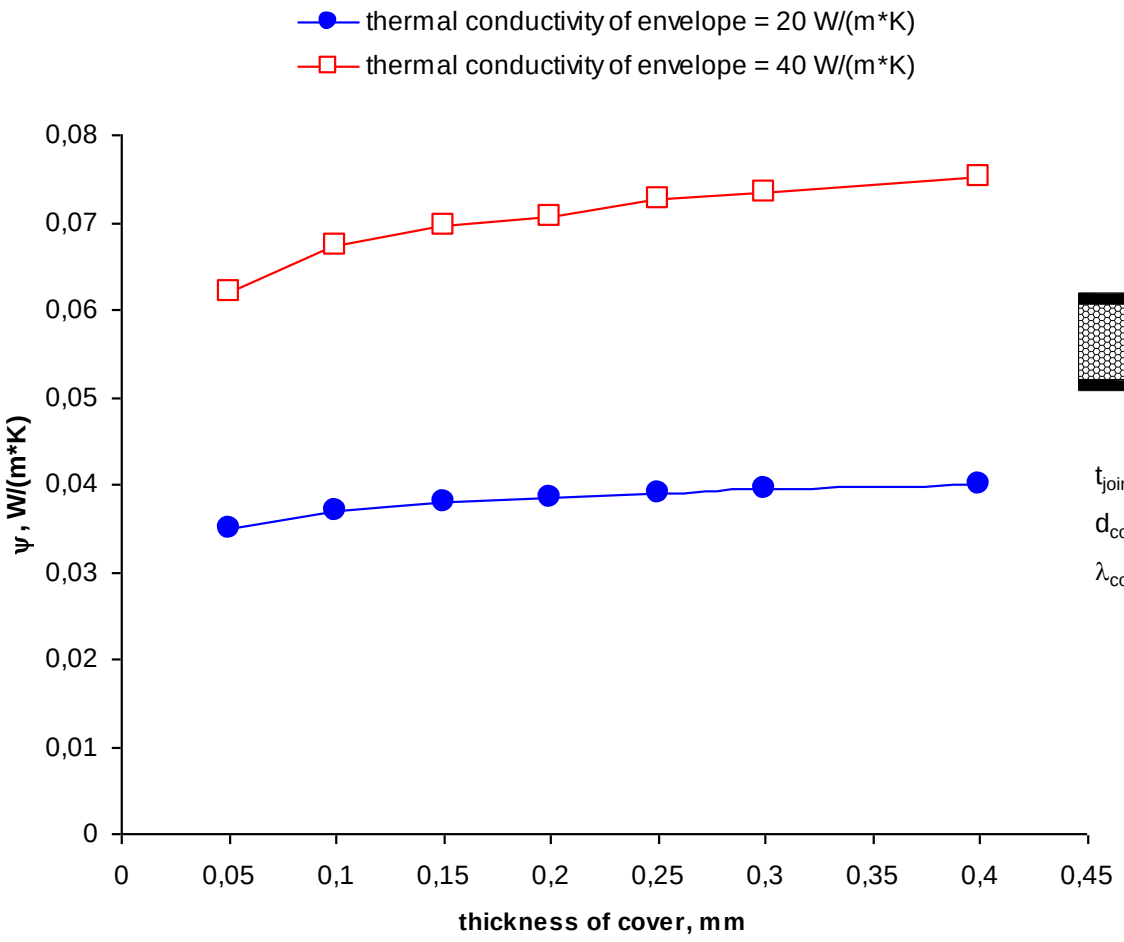
t_{cover} = 0,05 mm

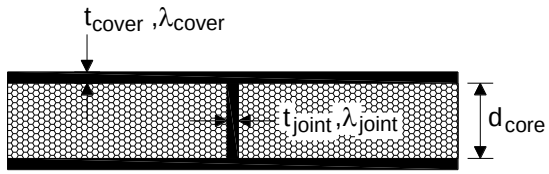
t_{joint} = 0,05 mm

d_{core} = 20 mm

λ_{core} = 0,004 W/(m·K)

thickness of cover



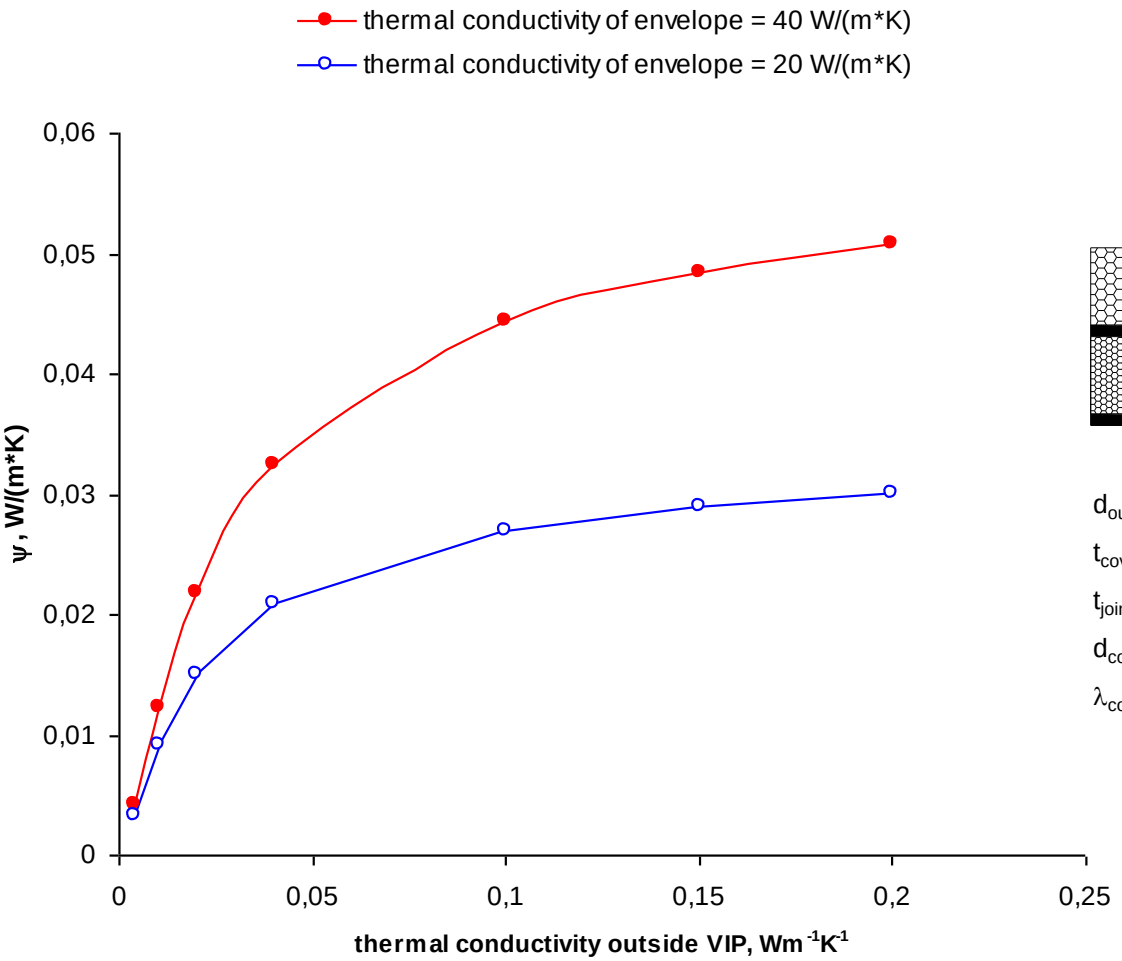


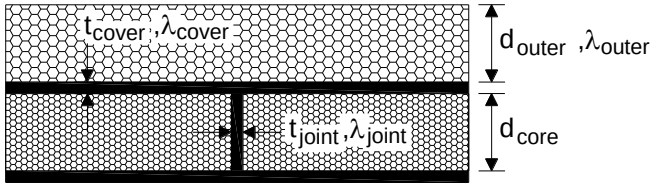
t_{joint} = 0,05 mm

d_{core} = 20 mm

λ_{core} = 0,004 W/(m·K)

outside thermal conductivity





d_{outer} = 20 mm

t_{cover} = 0,05 mm

t_{joint} = 0,05 mm

d_{core} = 20 mm

λ_{core} = 0,004 W/(m·K)

Altering the geometry of the joint

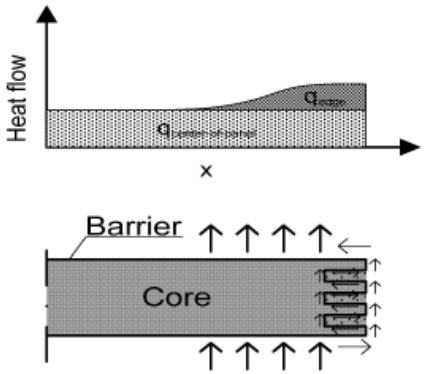
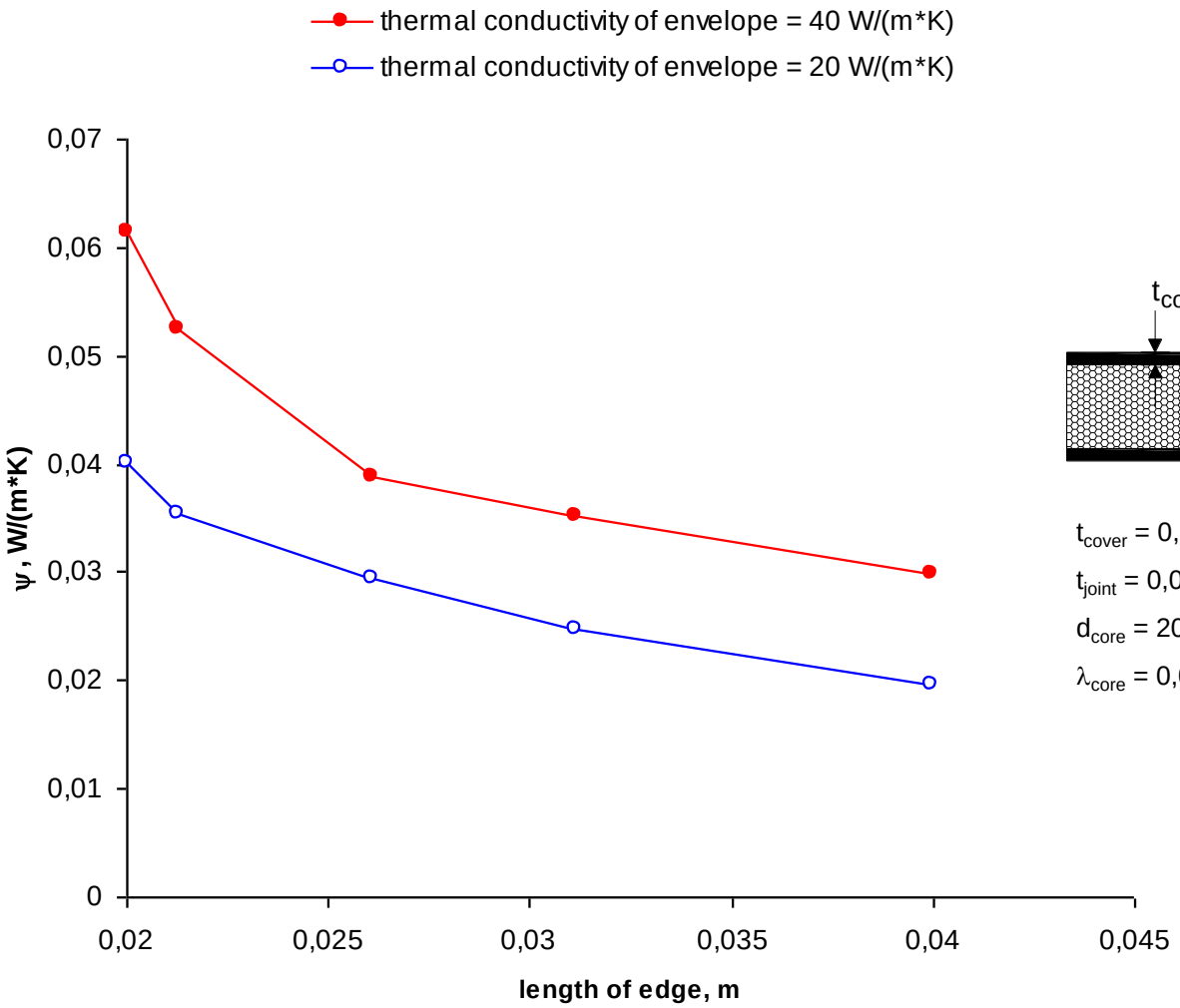


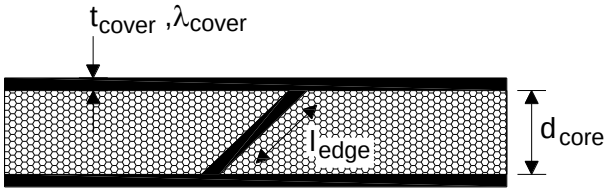
FIG. 2: With a serpentine edge the path for heat is prolonged with a smaller heat flow through the edge as the result.

Barrier type	Ψ_{edge} W/(m · K)
Serpentine 5 slots, depth 30 mm[1] thickness of steel 0.1 mm	0.015
Serpentine > 15 slots, depth 30 mm[1]	<0.010

From the Licentiate Thesis of T.Torsell,

edge length





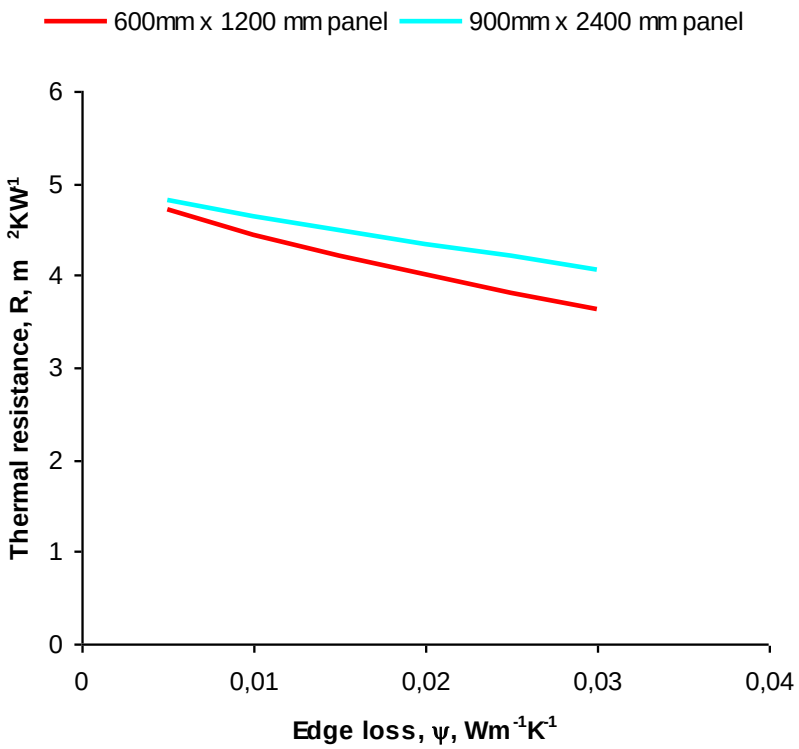
t_{cover} = 0,05 mm

t_{joint} = 0,05 mm

d_{core} = 20 mm

λ_{core} = 0,004 W/(m·K)

Panel size


600mm x 1200 mm panel
900mm x 2400 mm panel
Thermal resistance, R, m ²KW⁻¹
6
5
4
3
2
1
0
0
0,01
0,02
0,03
0,04
Edge loss, ψ, Wm⁻¹K⁻¹

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