Potential influence of the heating demand by choice of thermal mass and comfort interval

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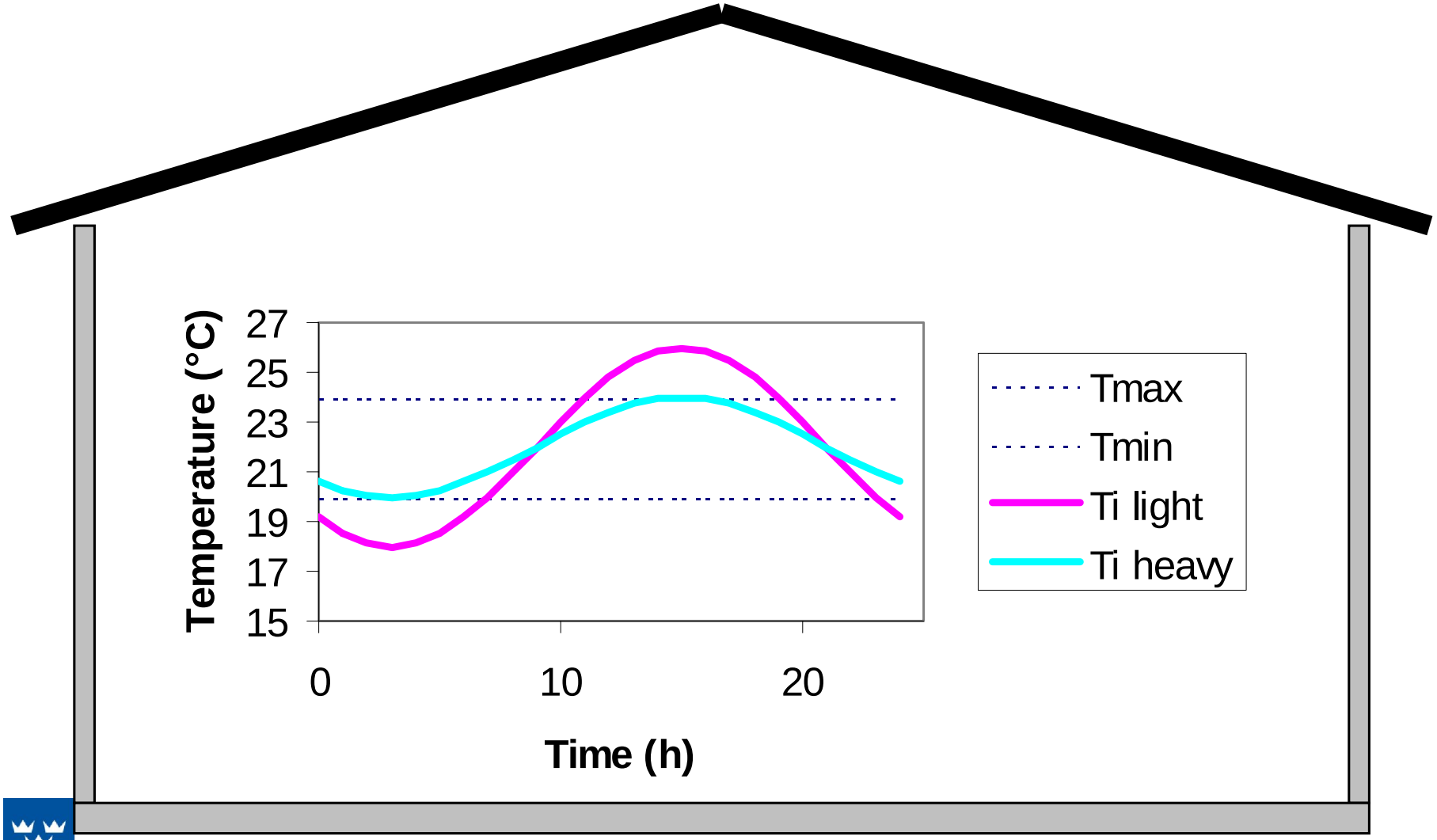
Periodic heat storage in a building structure

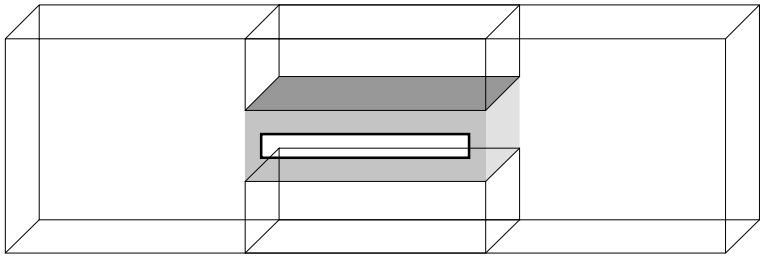


Case study

Apartment or office

Floor area 150 m^2

Air exchange rate 0.5 h^{-1}



IBPT, International Building Physics Toolbox

	Area (m^2)	U-value ($W/m^2 \cdot K$)
Window	26	1.9
Exterior wall	52	0.162
Interior walls + roof + floor	358	no heat transfer

Choice of building material and structure thickness

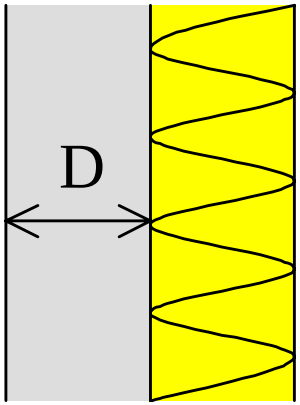
28 different material combinations (4 x 7)

thickness 0.025 – 0.30 m

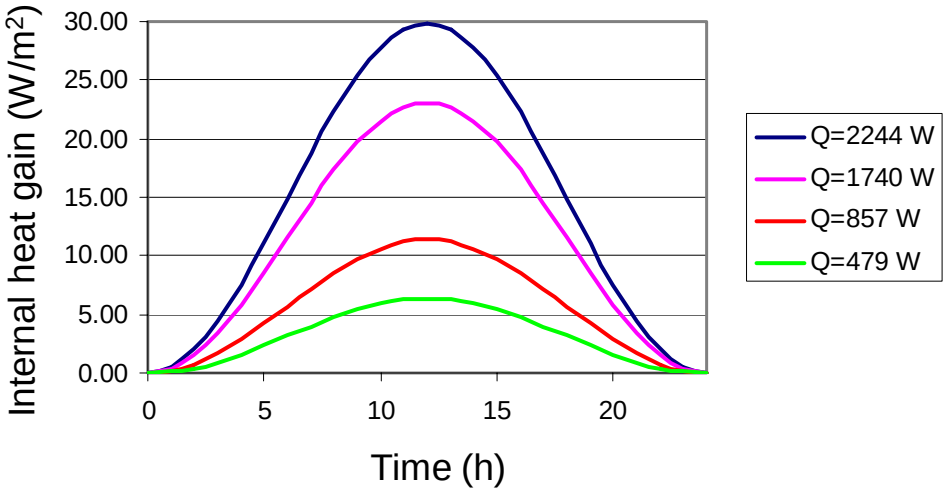
Thermal effusivity

$$b = \sqrt{\lambda \cdot \rho \cdot c} \ \left(\mathrm{W}\sqrt{\mathrm{s}}/\mathrm{m}^2\mathrm{K}\right)$$

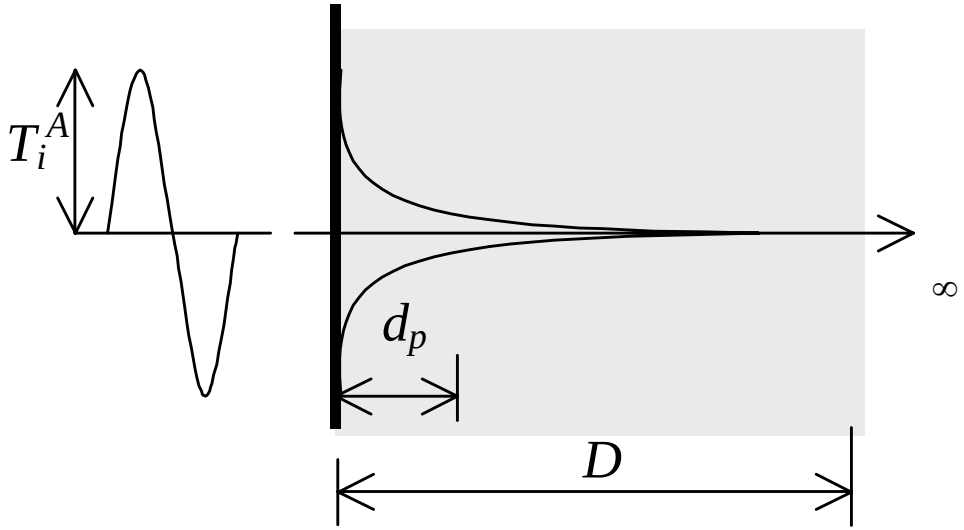
Exterior wall



Internal heat gain



Periodic penetration depth (sinusiodal)

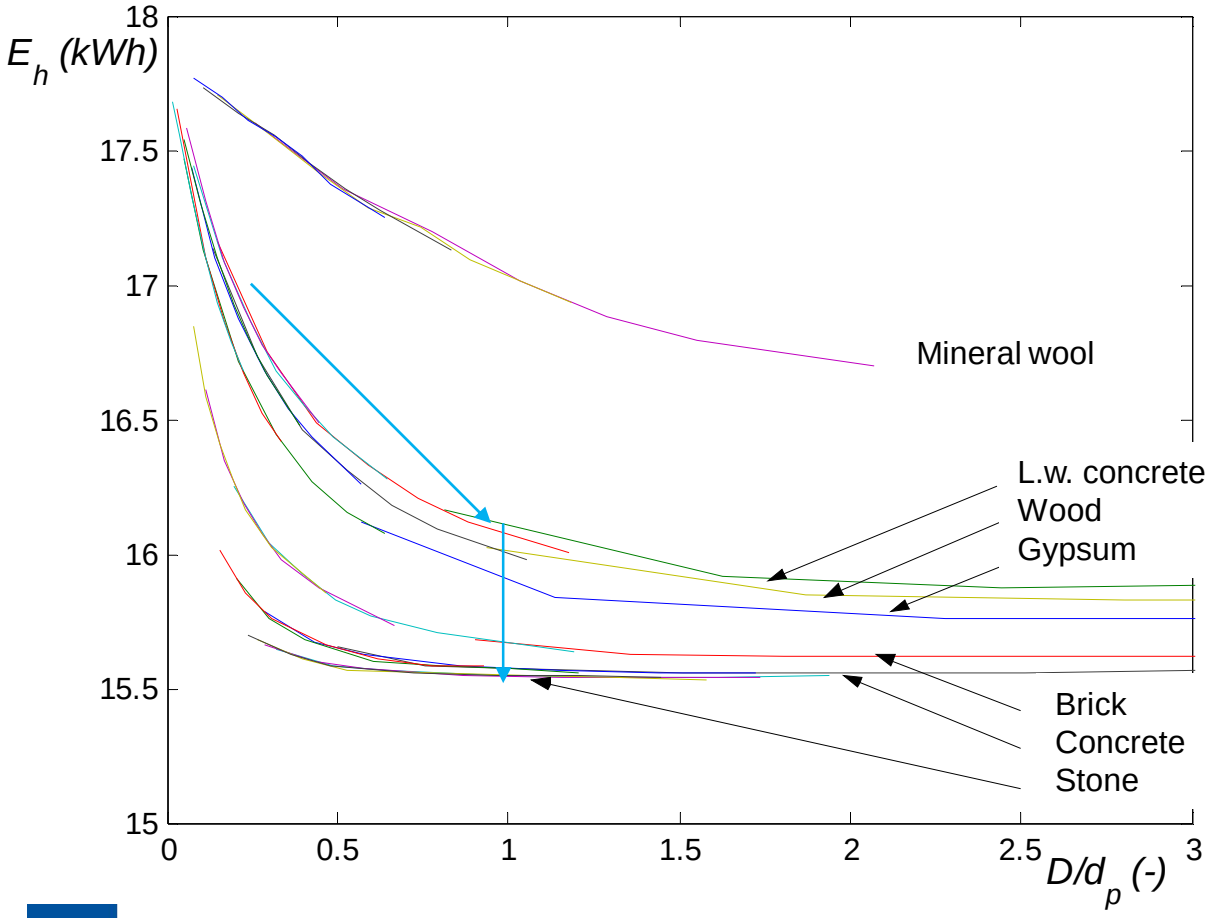


$$d_p = \sqrt{\frac{\lambda}{\rho \cdot c} \cdot \frac{t_p}{\pi}}$$

λ	thermal conductivity
$\rho \cdot c$	volumetric heat capacity
t_p	time period (24 h)

Material	d_p (m)
Stone	0.21
Concrete	0.15
Brick	0.11
L.w. concrete	0.09
Gypsum	0.09
Wood	0.07
Mineral wool	0.16

Heating demand for an apartment



Internal gain (residence)

0 – 11.4 W/m^2

Comfort interval

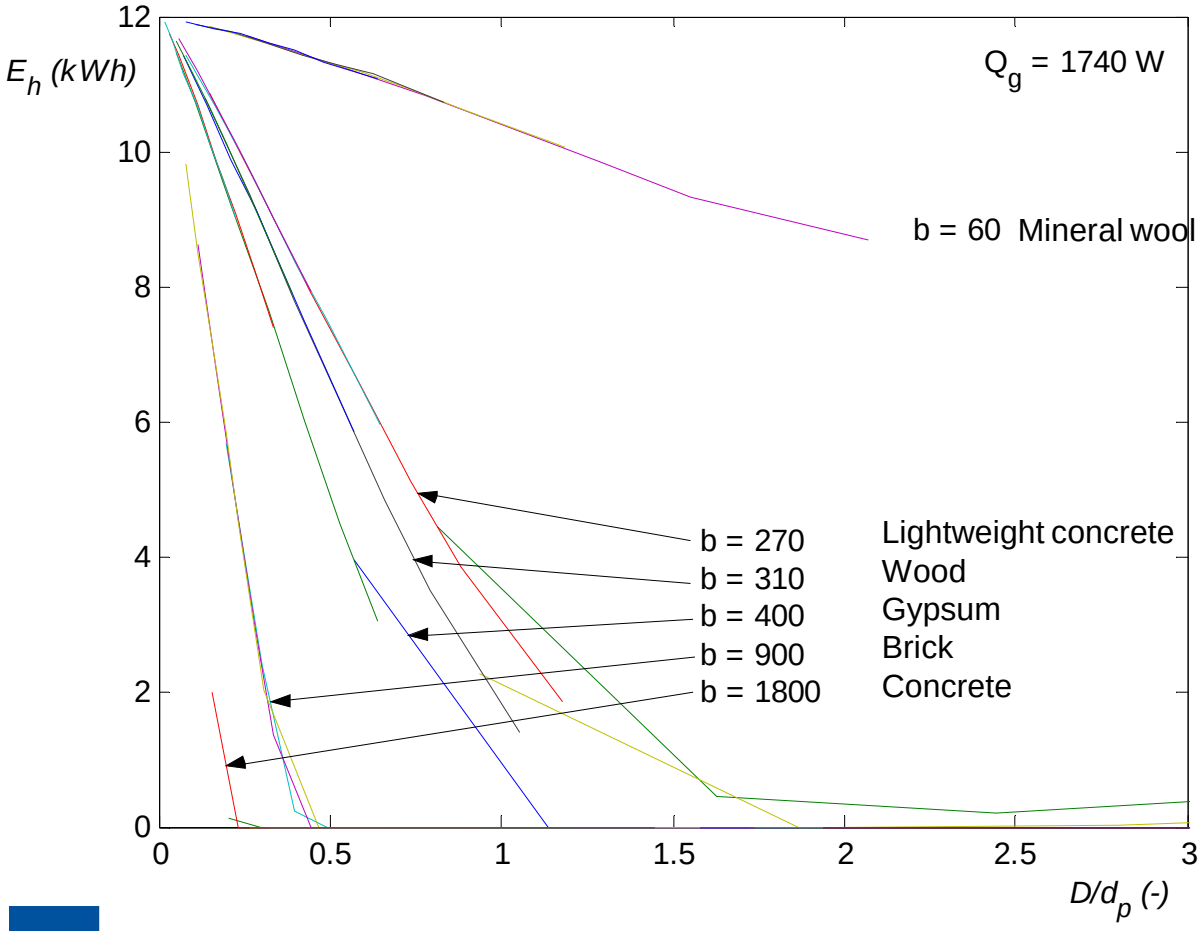
T_i = 20 – 24 °C

Change of material: 3%

Triple thickness: 3%

Material	b
Mineral wool	60
Wood	310
Brick	900
Concrete	1800

Heating demand of an office



Internal gain (office)

0 – 23.1 W/m^2

Comfort interval

T_i = 20 – 24 °C

Conclusions

- The thermal effusivity is an important parameter for periodic heat storage
- The optimal thickness of the interior structure of a building is close to the periodic penetration depth of that specific material (periodic heat storage)
- The energy saved by heat storage is relatively small in residential buildings with a normal amount of insulation