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Hygrothermal response of highly insulated timber frame walls with an exterior air barrier system: laboratory investigation

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Tendency towards low-energy-buildings, makes light-weight constructions more and more popular also in countries with masonry tradition.



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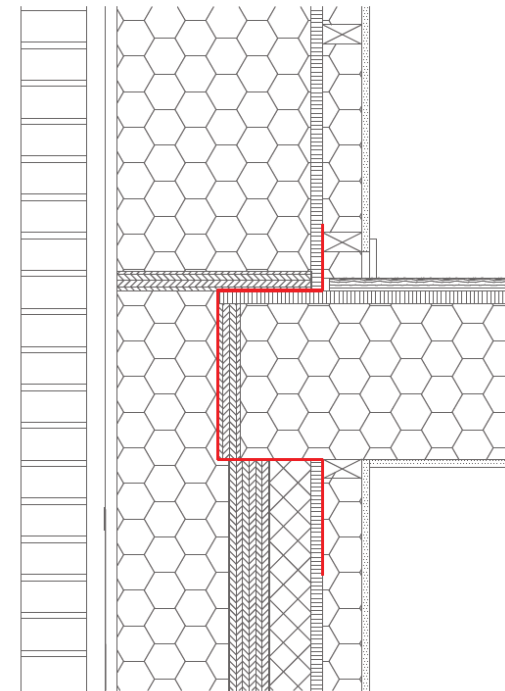
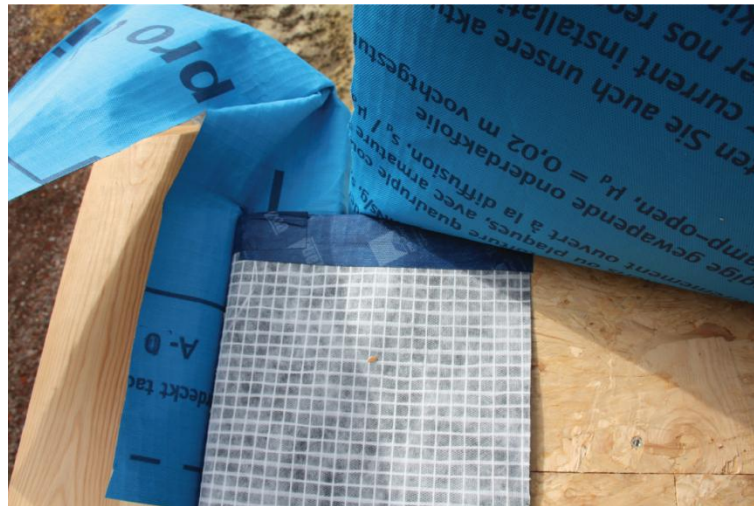
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Complex details of interior air barriers



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Case Study: exterior air barrier



Langmans, J., Klein, R., De Paepe M., Roels, S. (2010). Potential of wind barriers to assure airtightness of wood-frame low energy constructions. *Energy and Buildings*, 42 (12), 2376-2385.



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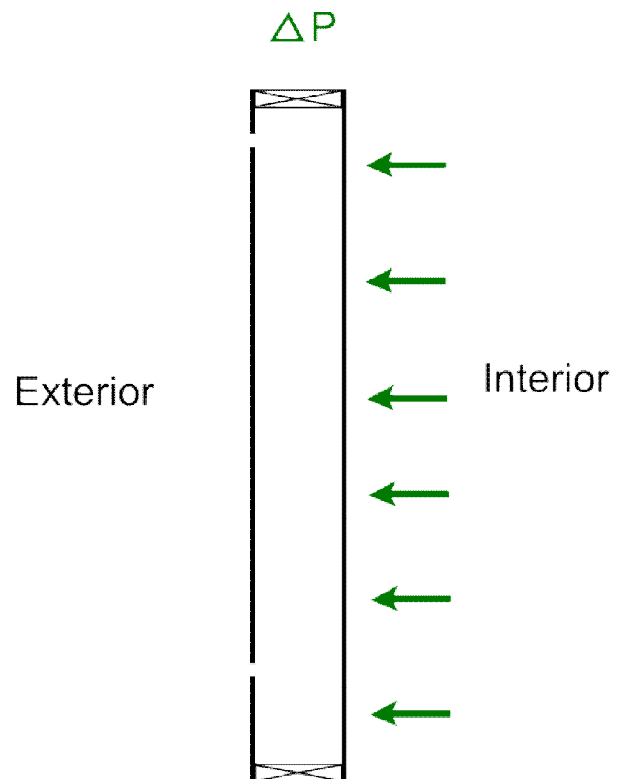
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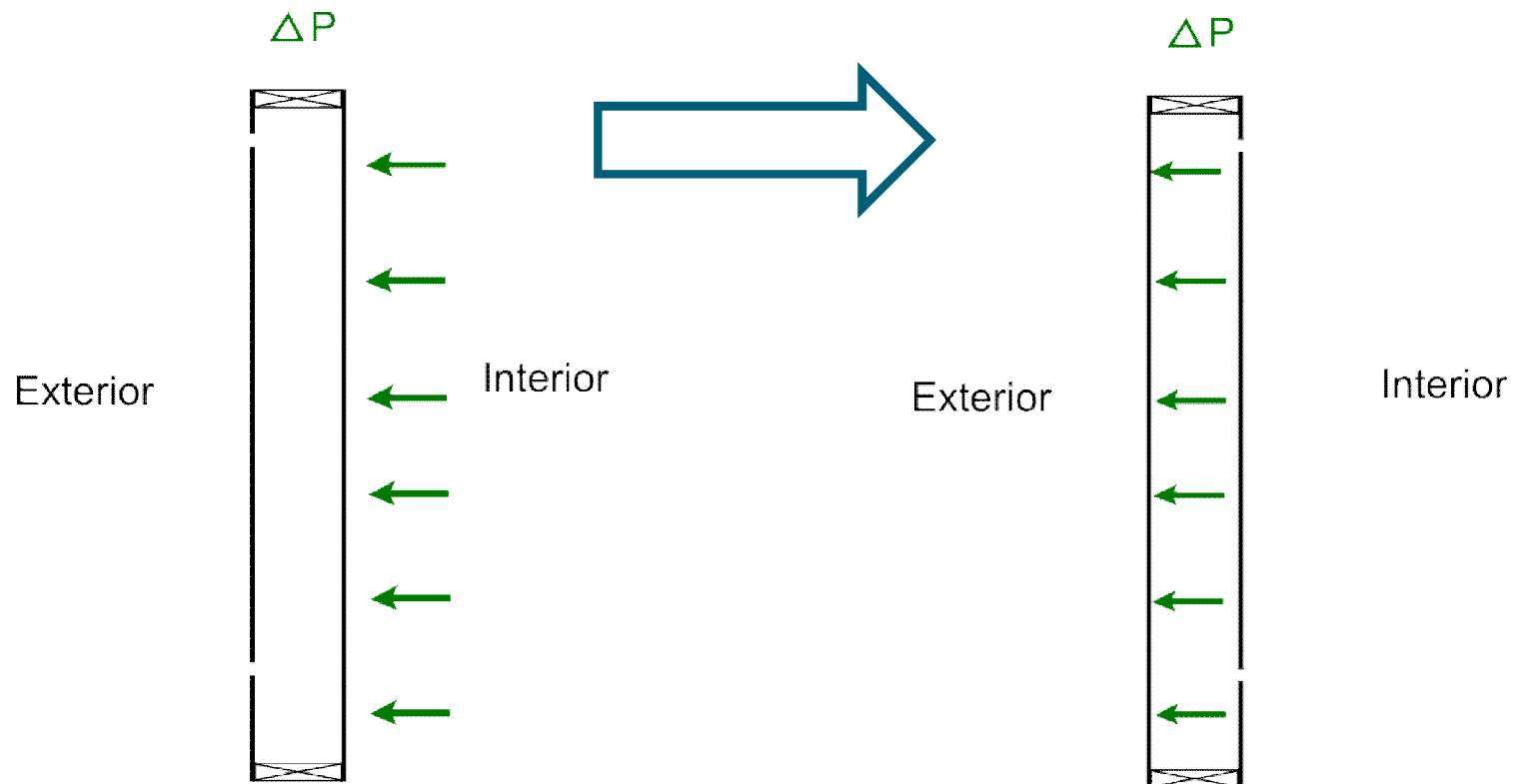
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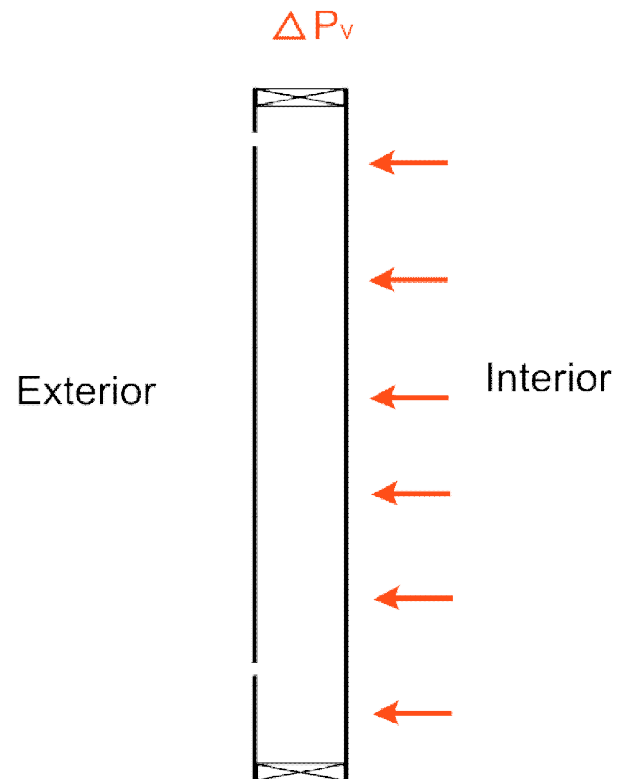
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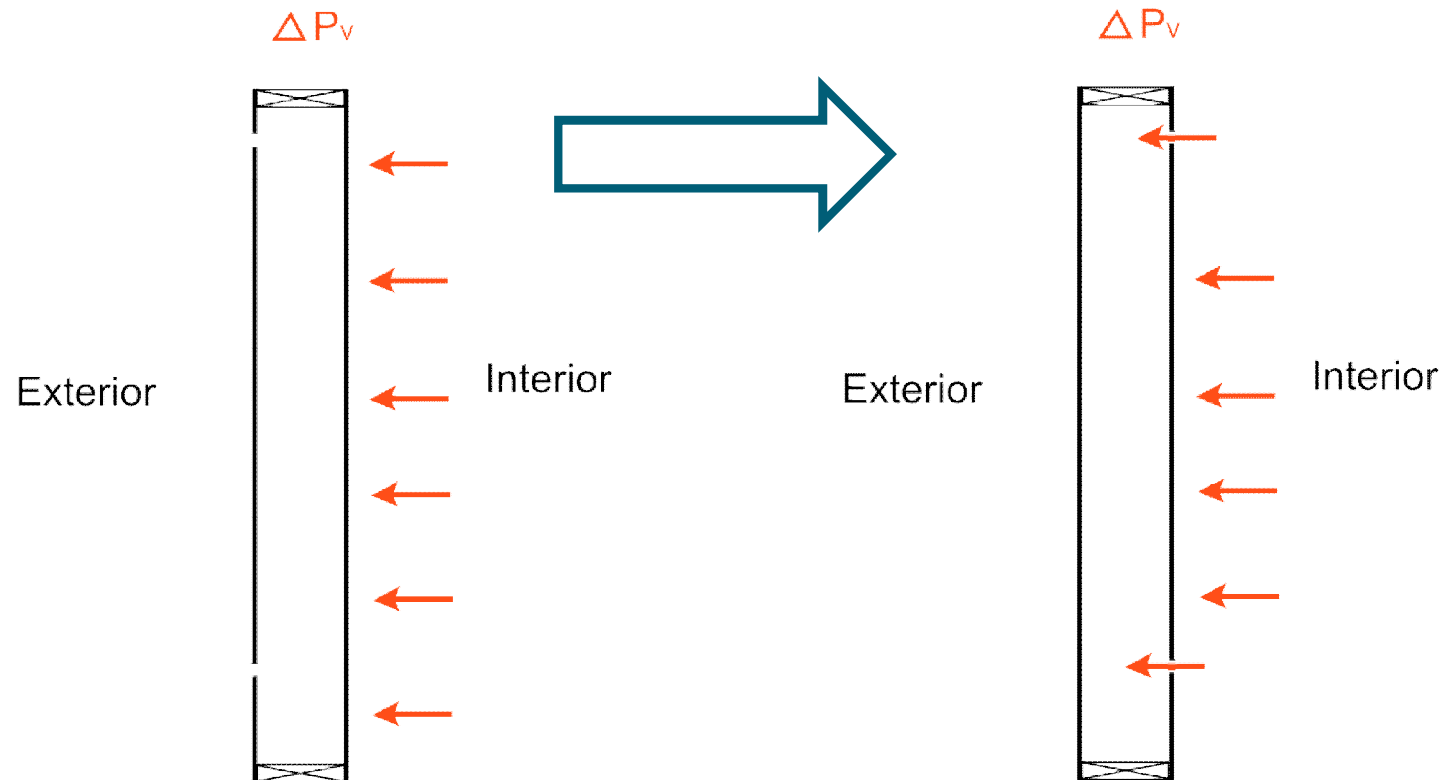
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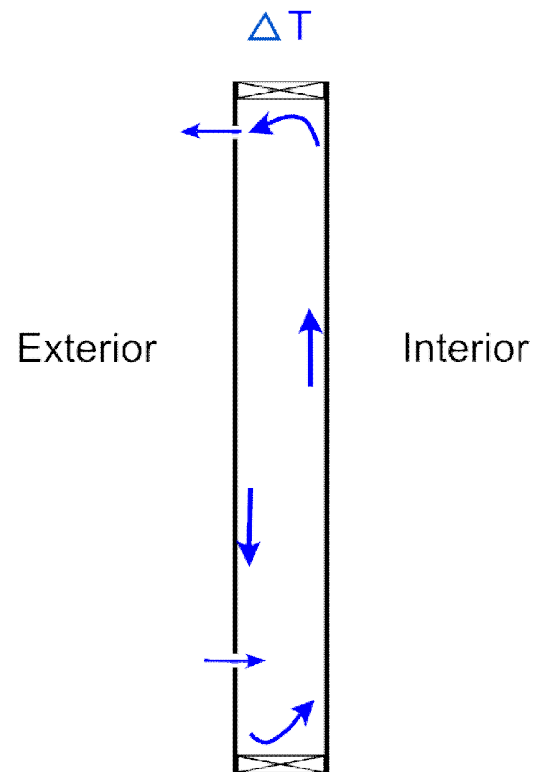
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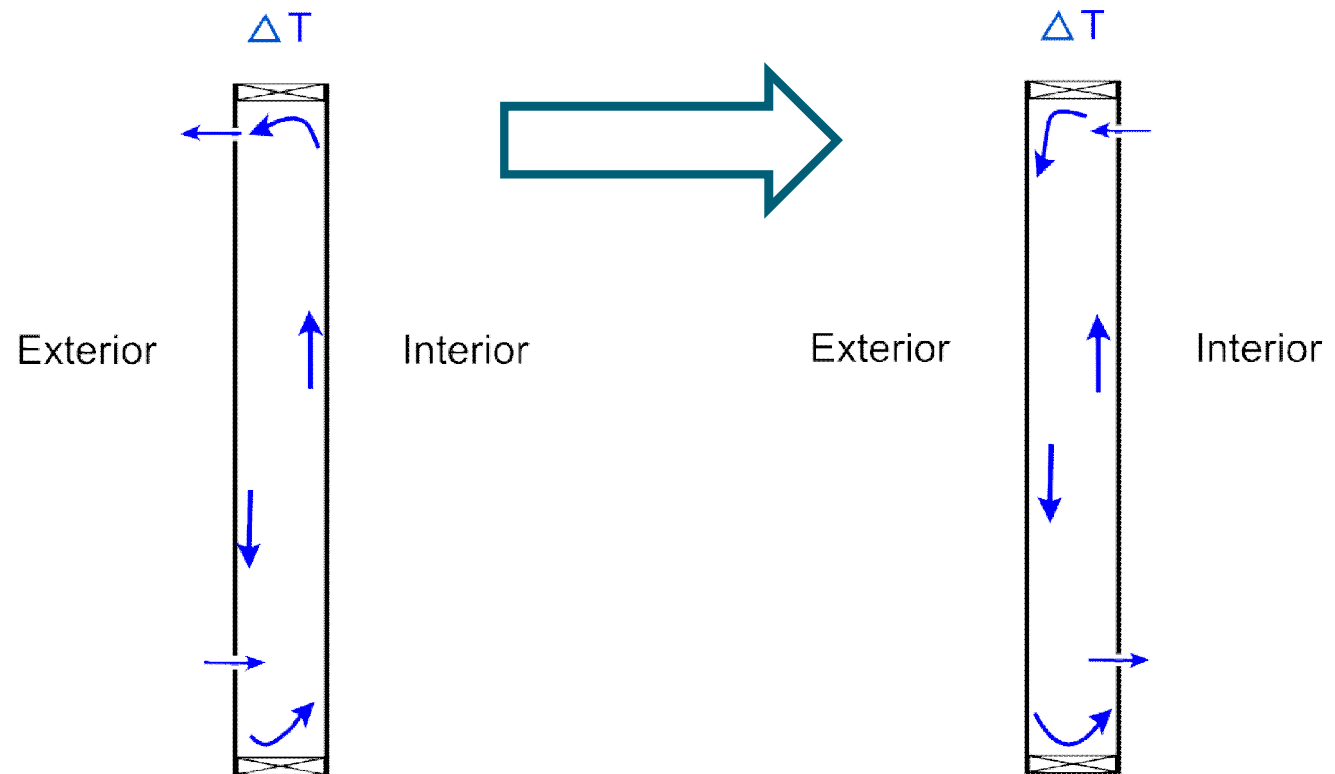
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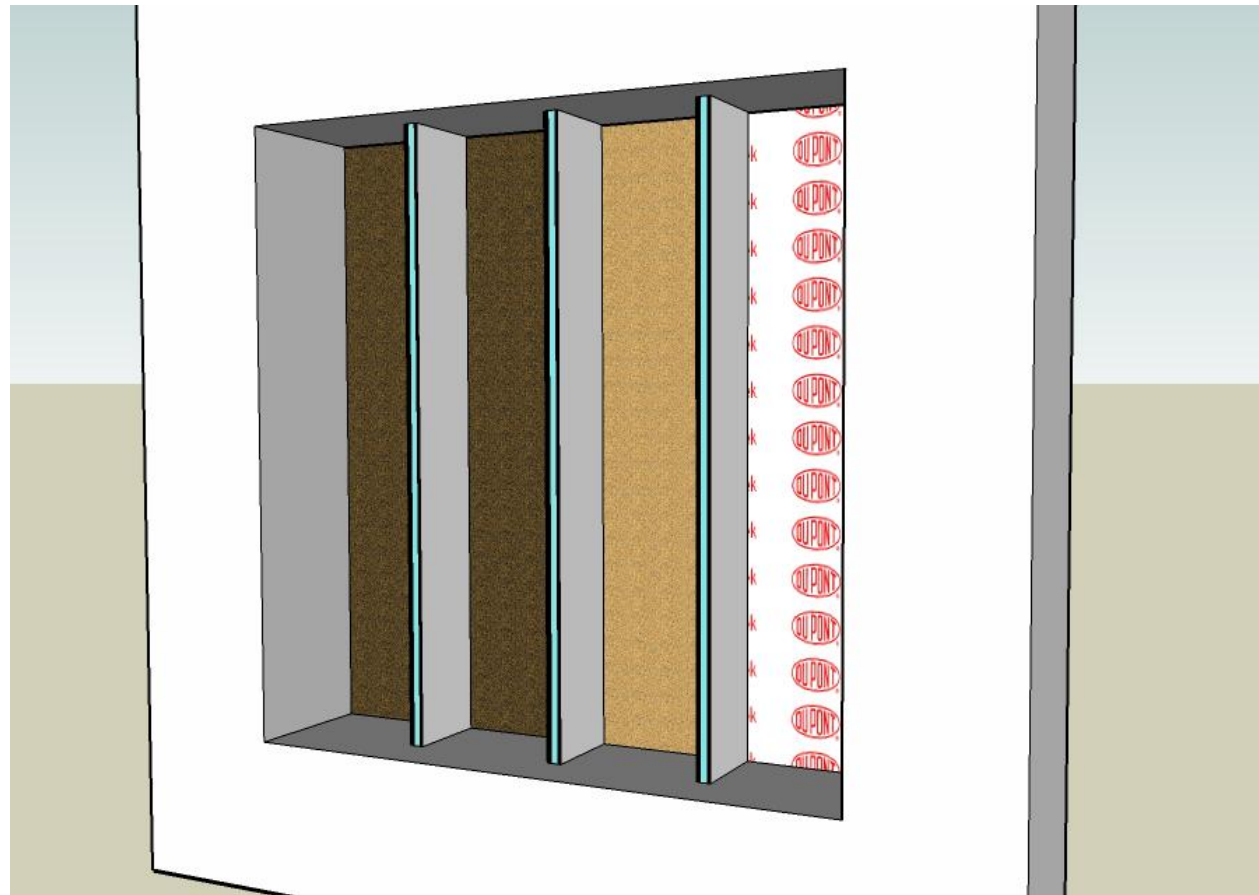
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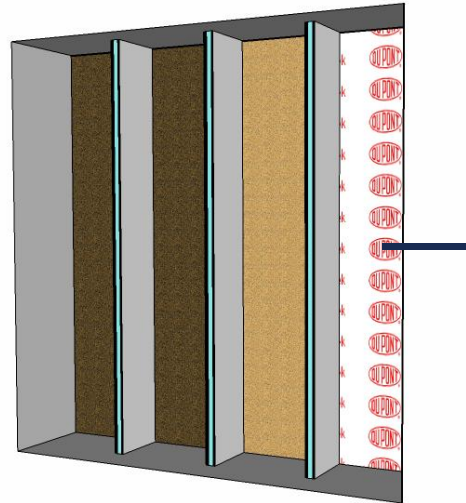
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Air barrier	Ka (m ³ /m ² /h/Pa)	R (m ² K/W)	buffering
Foil	<0.001	-	No



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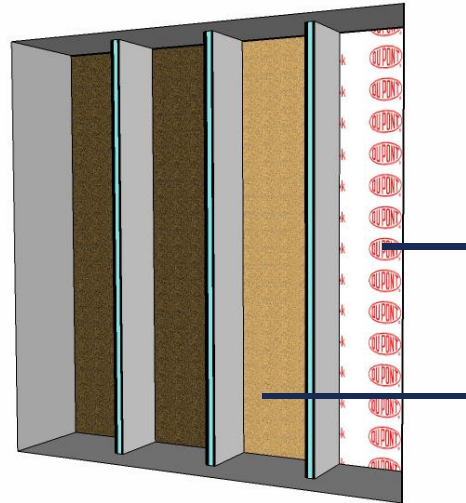
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Air barrier	Ka (m ³ /m ² /h/Pa)	R (m ² K/W)	buffering
Foil	<0.001	-	No
AIFB (FB1)	0.13	0.36	Yes



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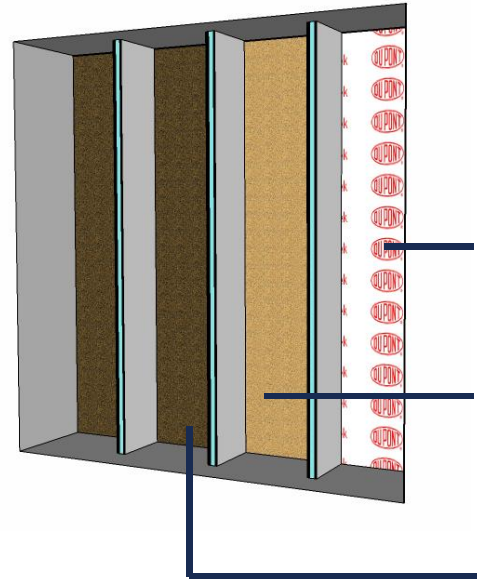
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Air barrier	Ka (m ³ /m ² /h/Pa)	R (m ² K/W)	buffering
Foil	<0.001	-	No
AIFB (FB)	0.13	0.36	Yes
AIFB with coating (FB2)	0.005	0.36	Yes



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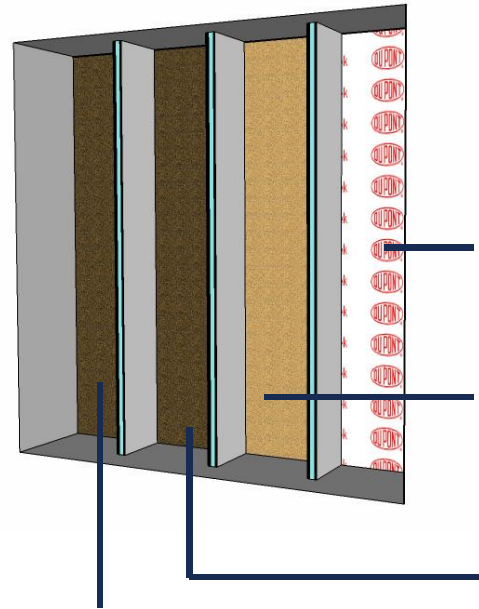
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Reference wall

Air barrier	Ka (m ³ /m ² /h/Pa)	R (m ² K/W)	buffering
Foil	<0.001	-	No
AIFB (FB1)	0.13	0.36	Yes
AIFB with coating (FB2)	0.005	0.36	Yes



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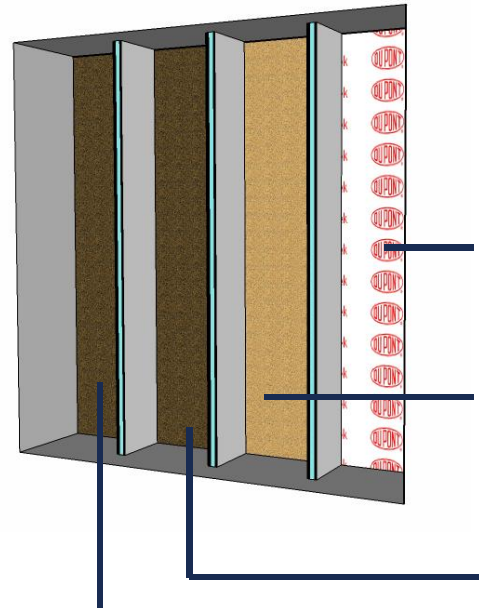
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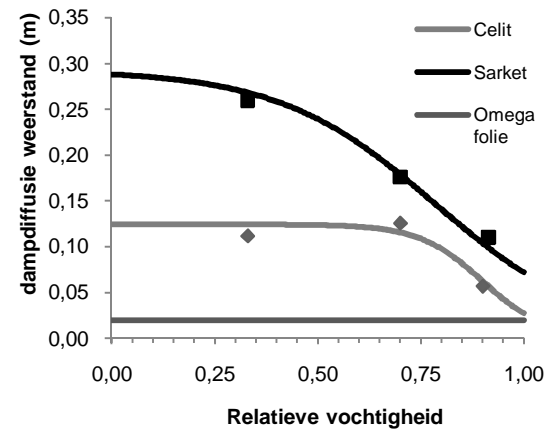
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Reference wall

Air barrier	Ka (m ³ /m ² /h/Pa)	R (m ² K/W)	buffering
Foil	<0.001	-	No
AIFB (FB1)	0.13	0.36	Yes
AIFB with coating (FB2)	0.005	0.36	Yes



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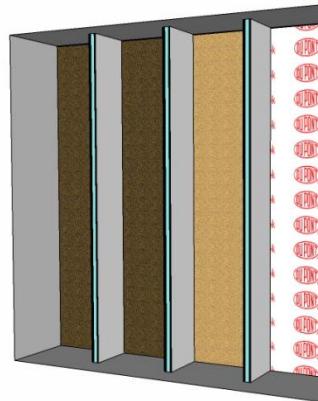
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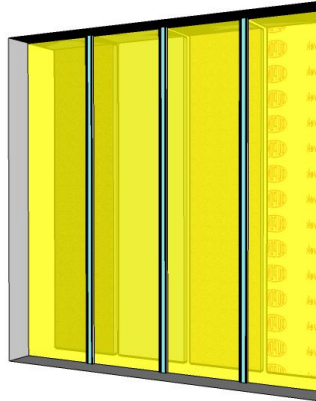
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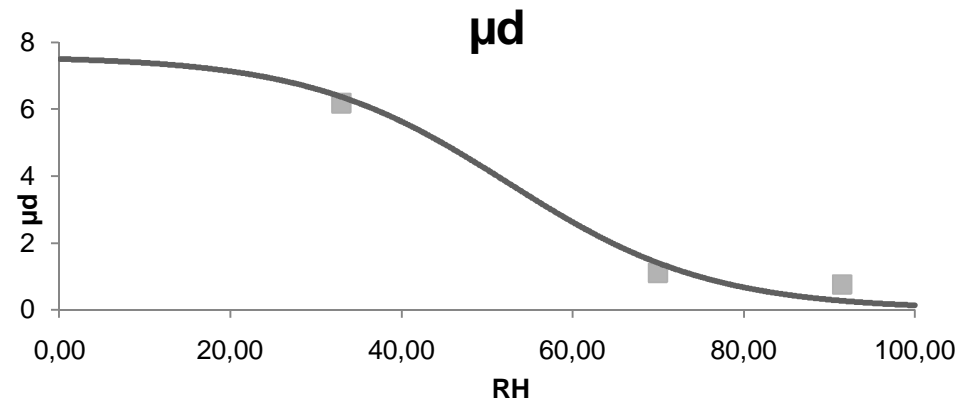
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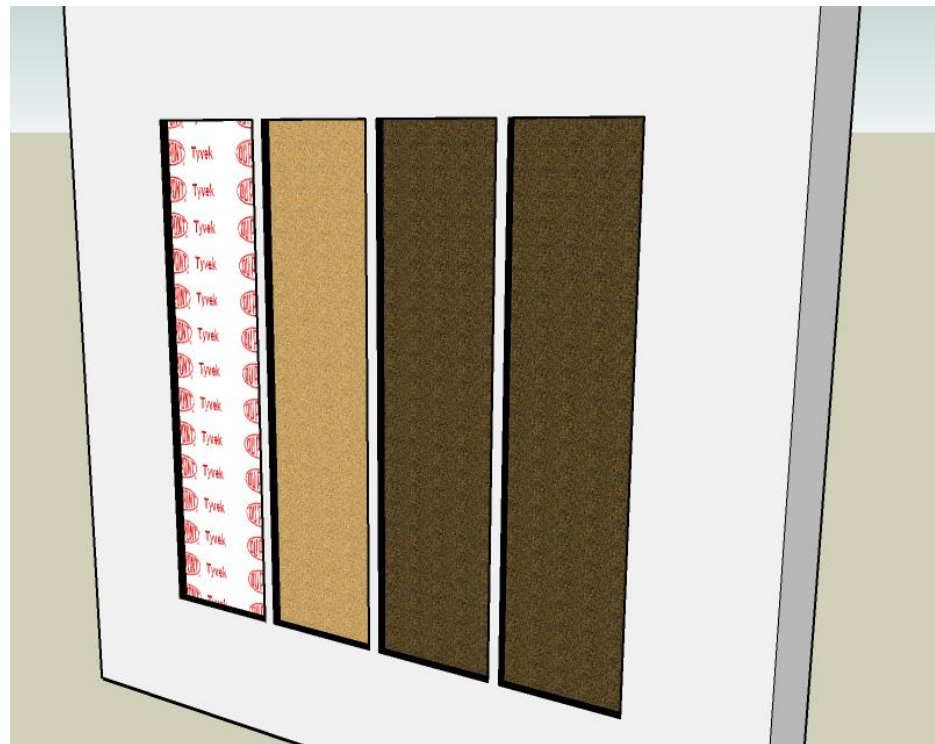
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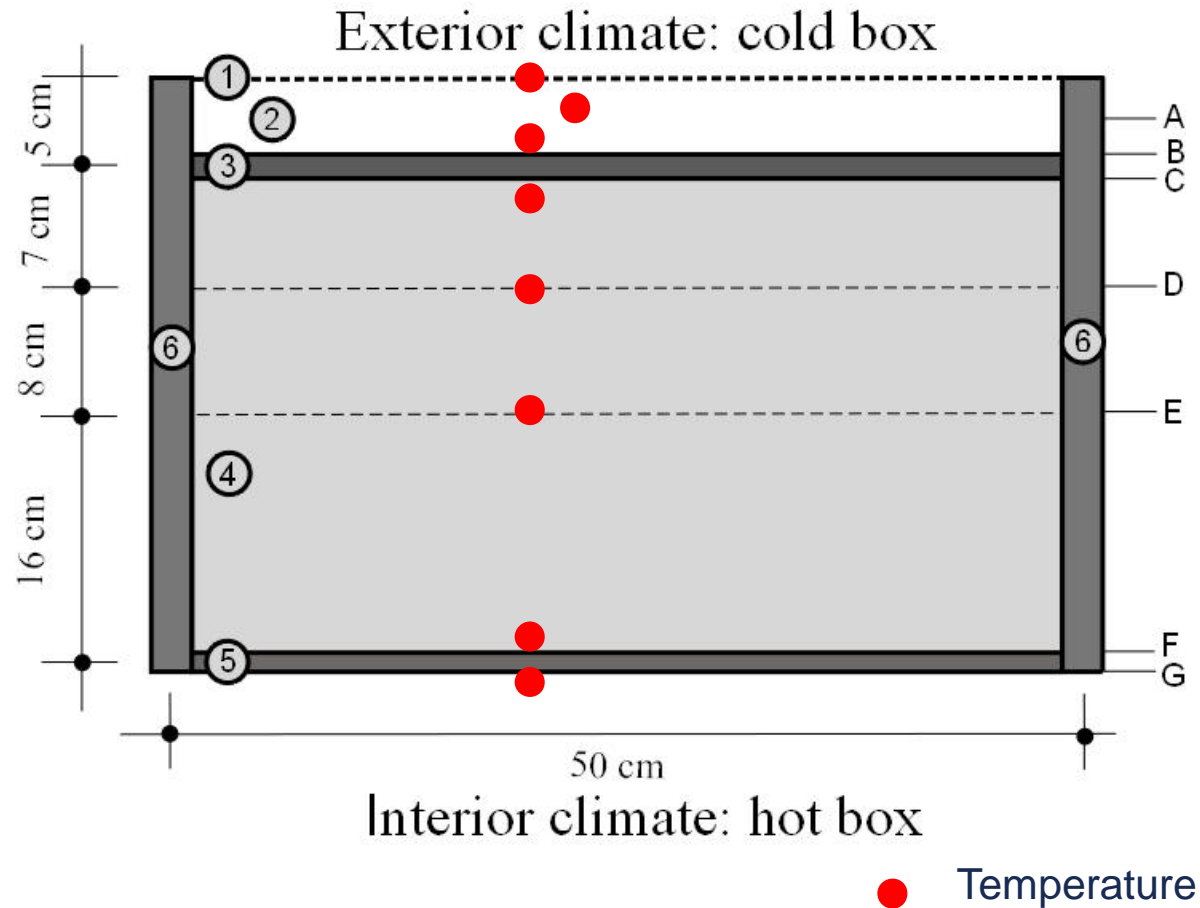
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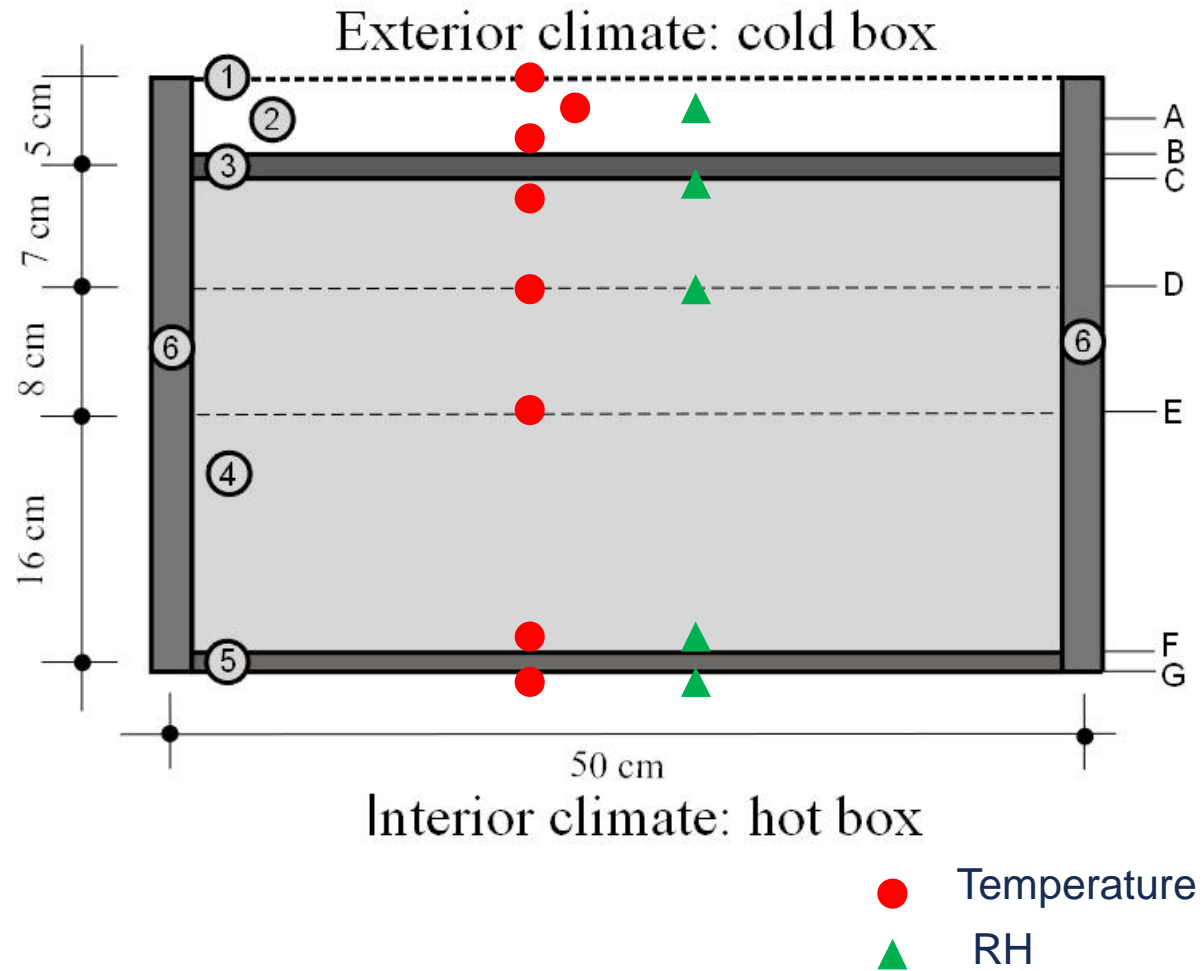
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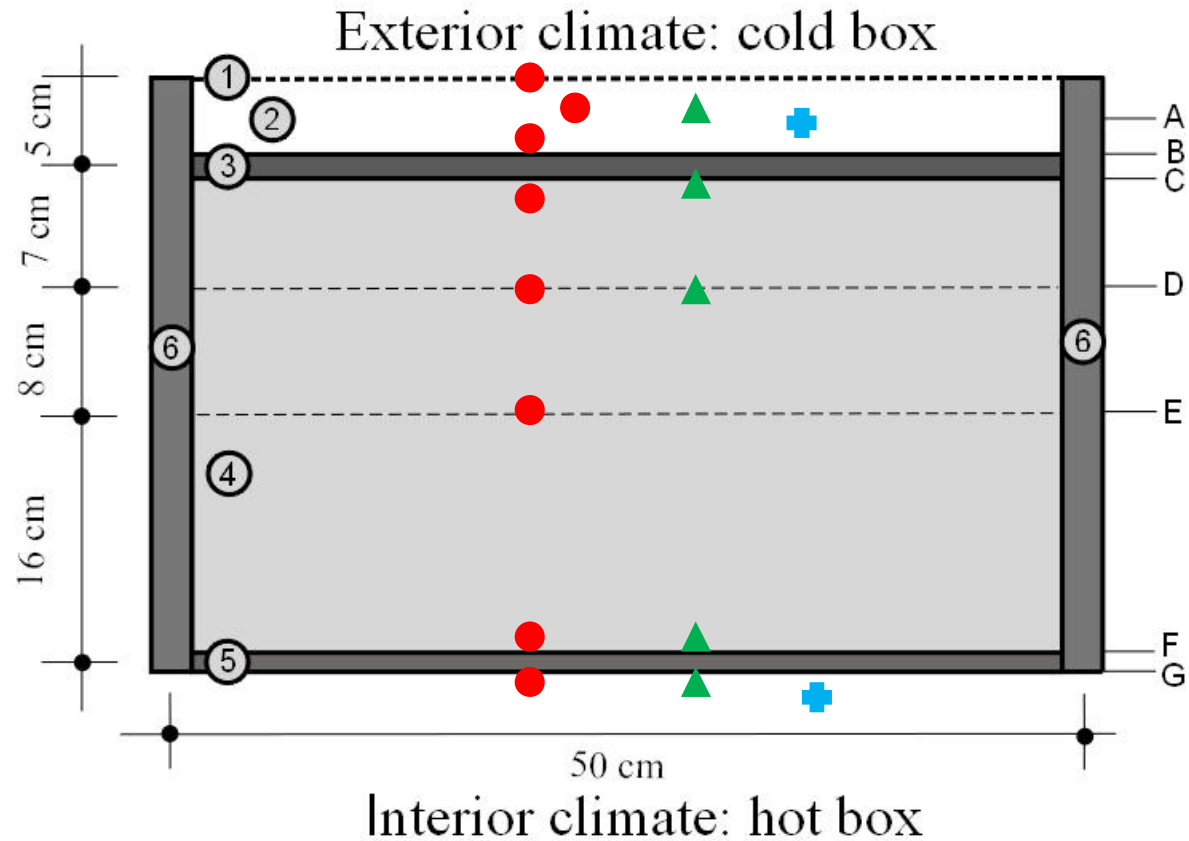
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- Temperature
- ▲ RH
- + Air pressure



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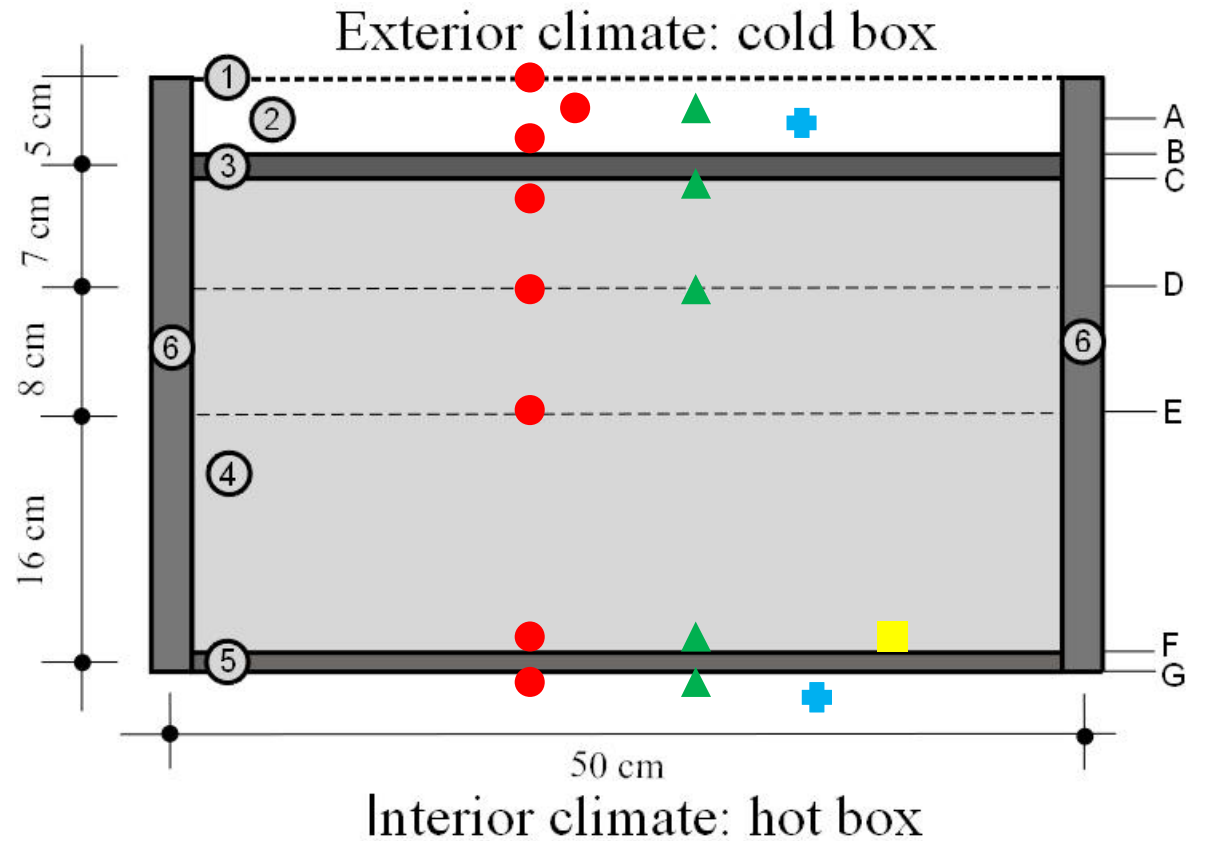
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- Temperature
- ▲ RH
- + Air Pressure
- Heat Flux



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- **Boundary conditions**
 - $T_{in} = 20^{\circ}\text{C}$ and $T_{ex} = 3^{\circ}\text{C}$
 - $RH_{in} = 54\%$ and $RH_{ex} = 86\%$
- **3 steps**
 1. Intact interior and exterior sheathing
 2. Openings in interior sheathing (top/bottom)
 3. Total pressure difference



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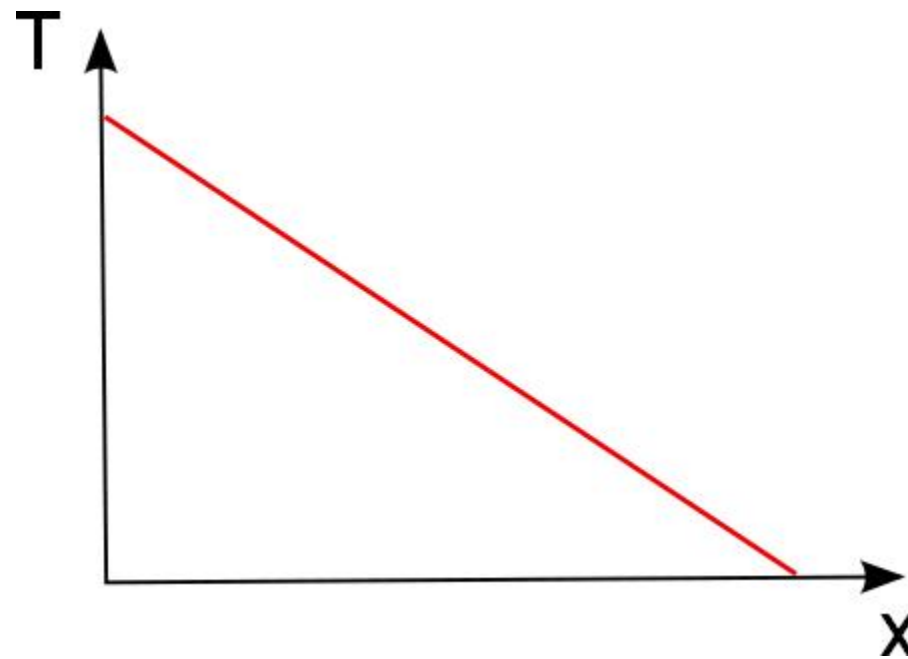
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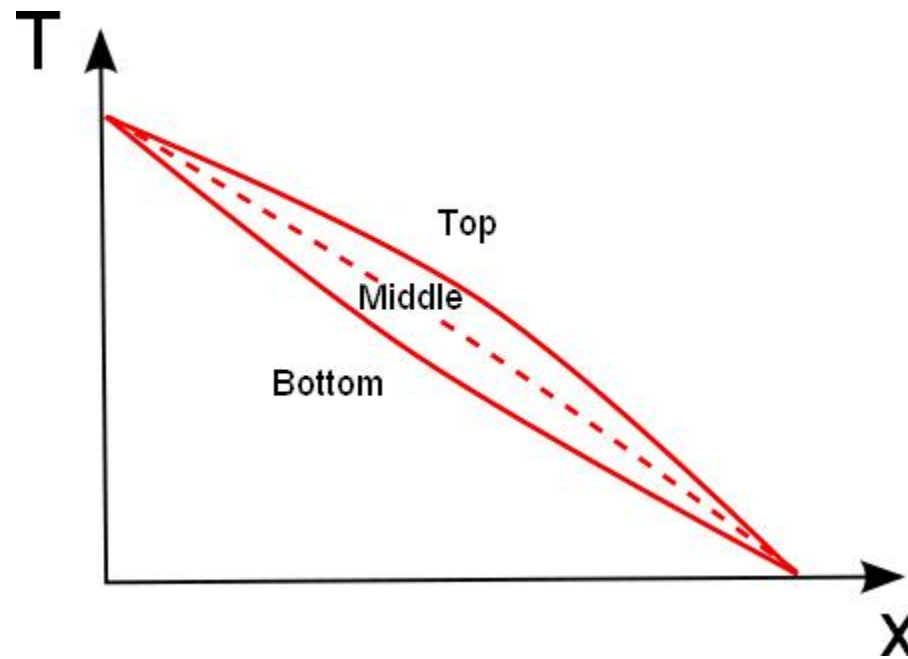
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2 steps

1. Intact interior and exterior sheathing



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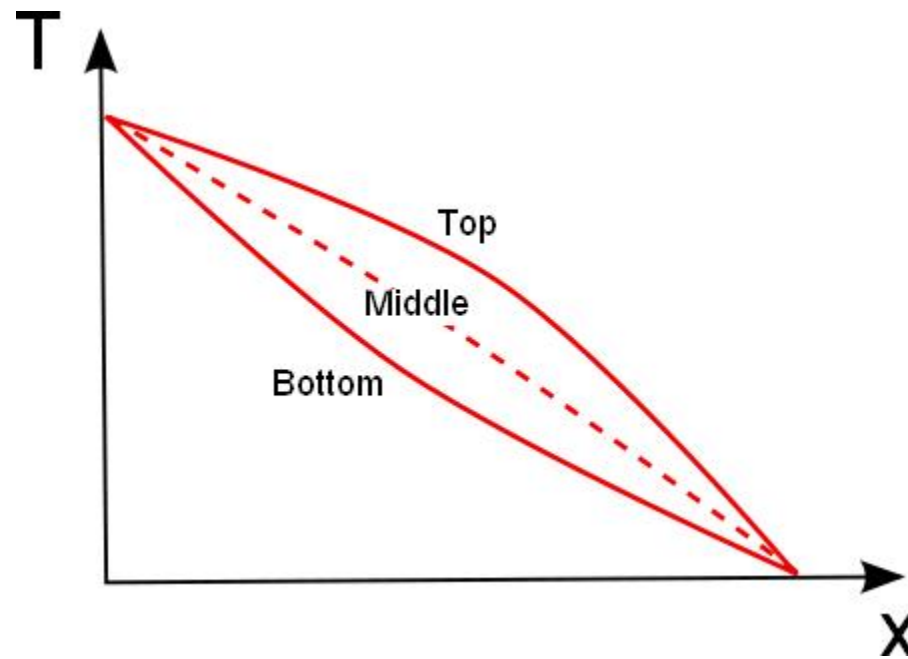
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2 steps

1. Intact interior and exterior sheathing
2. Openings in interior sheathing (top/bottom)



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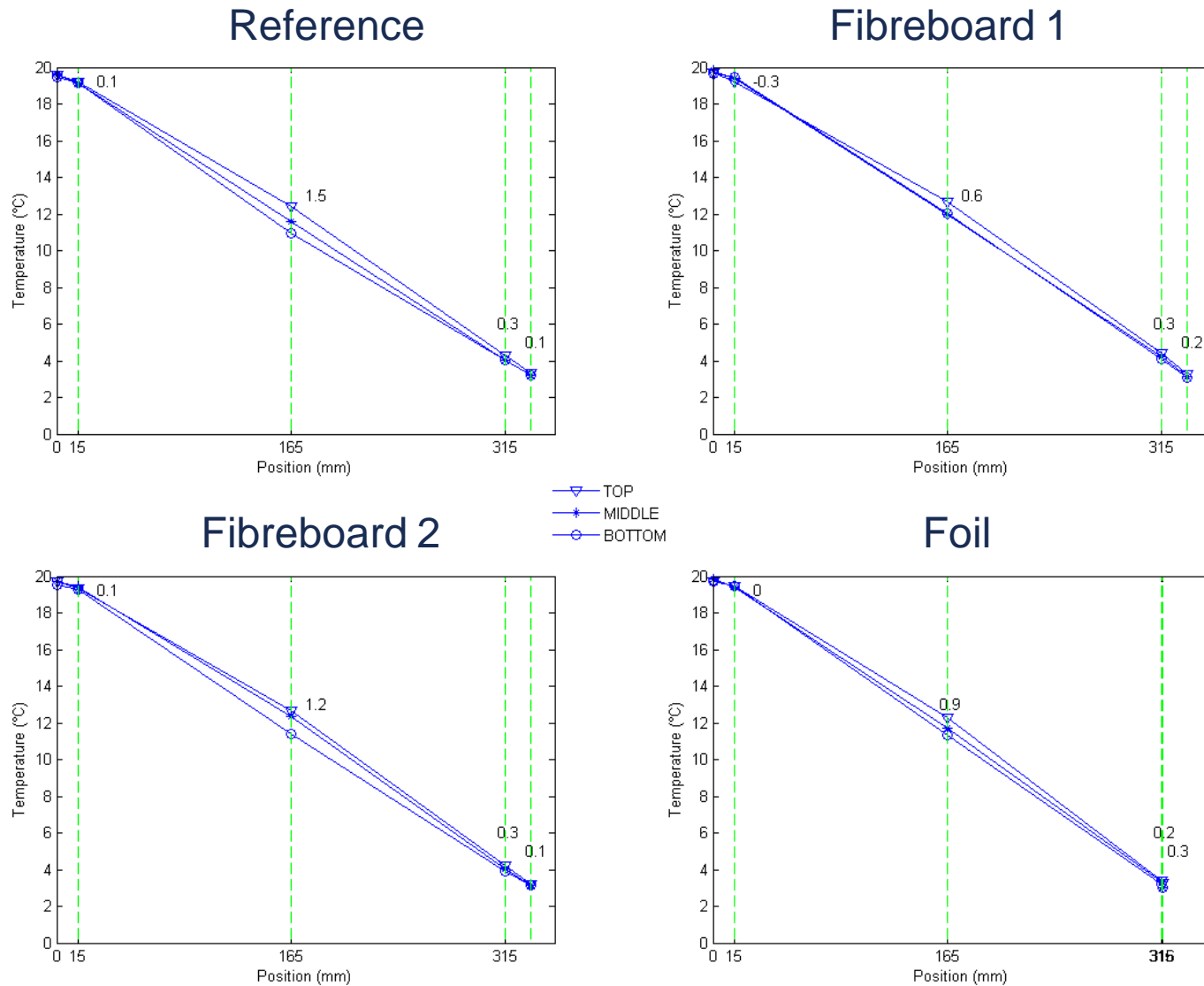
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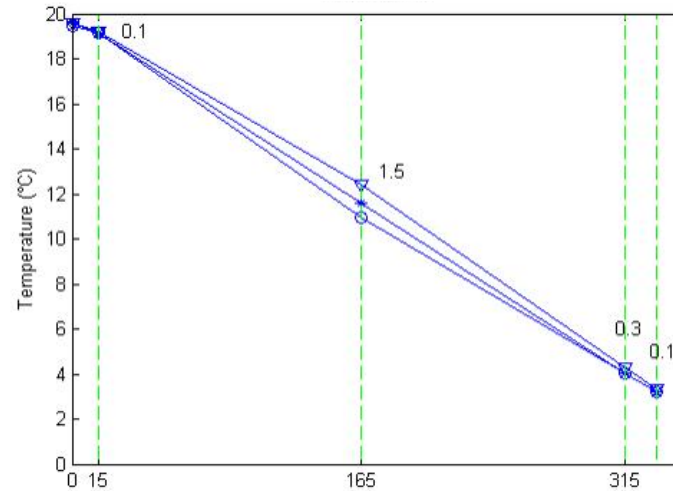
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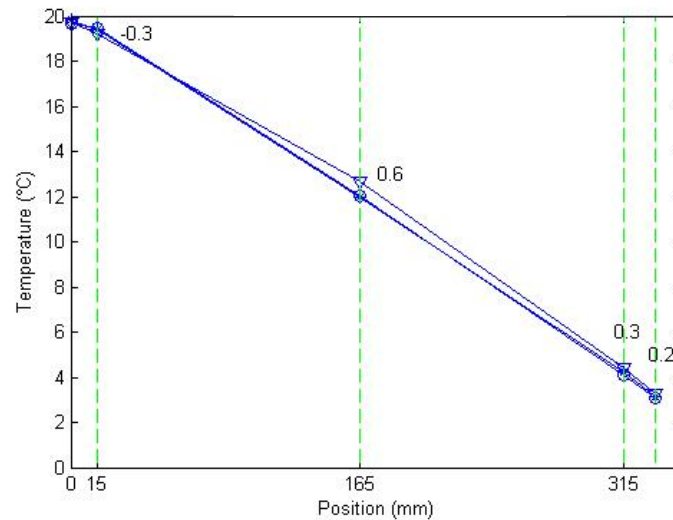
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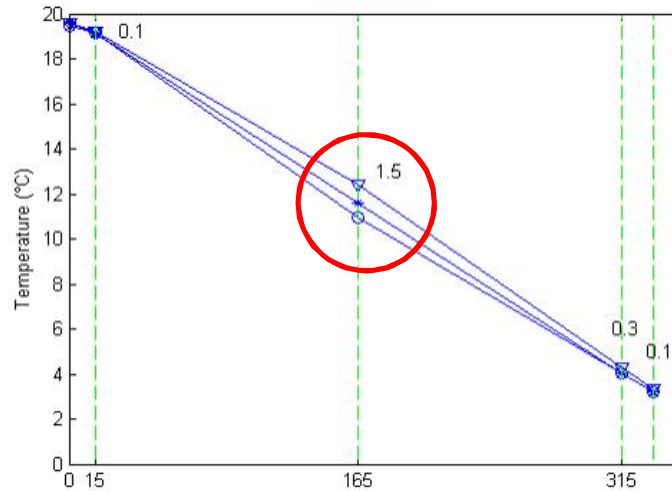
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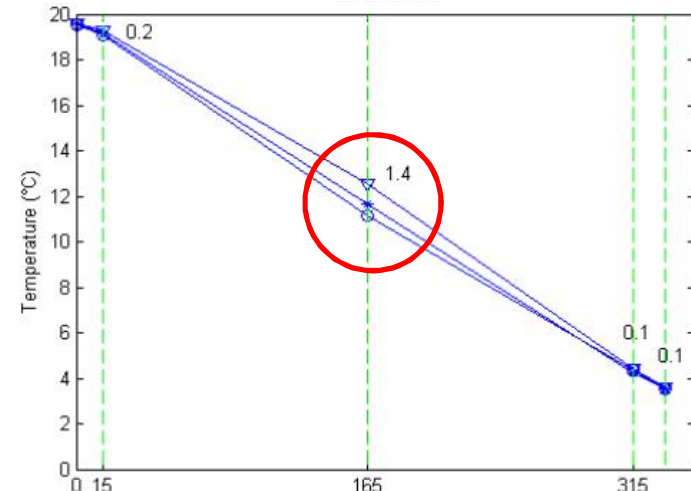
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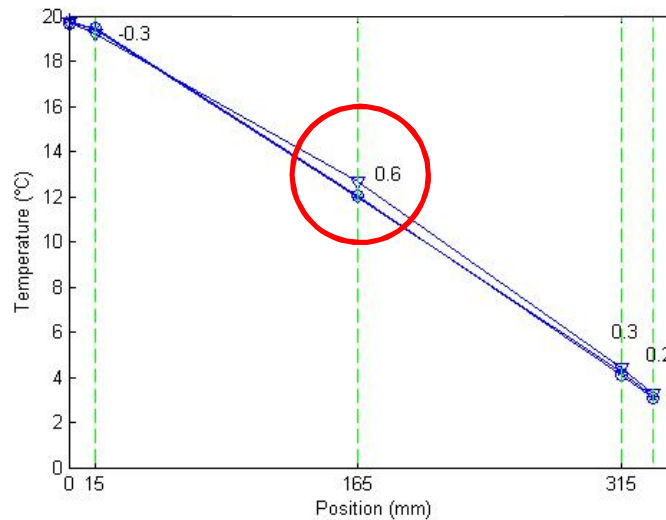
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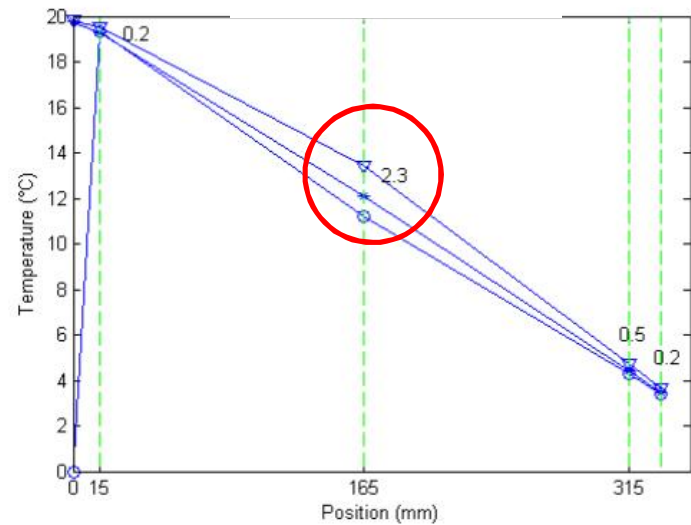
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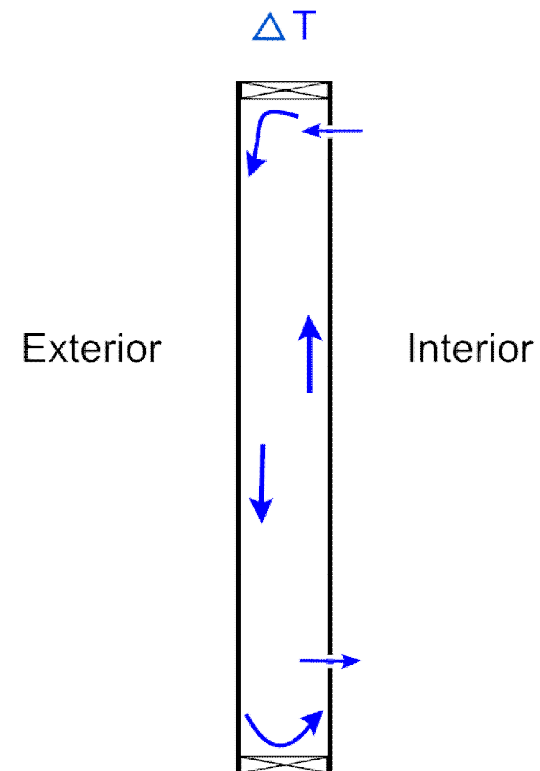
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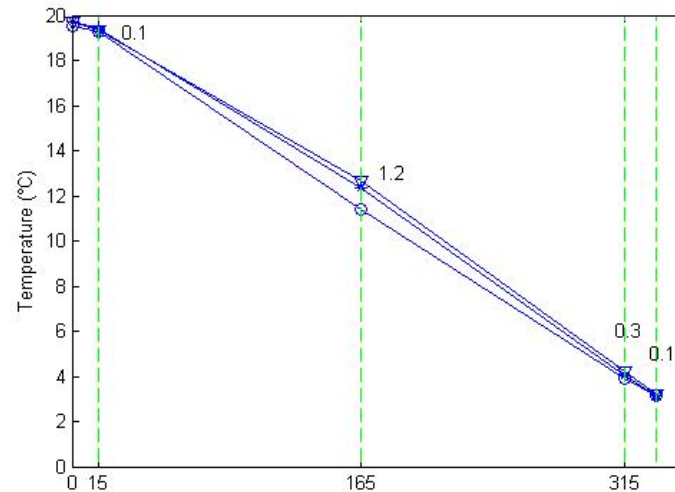
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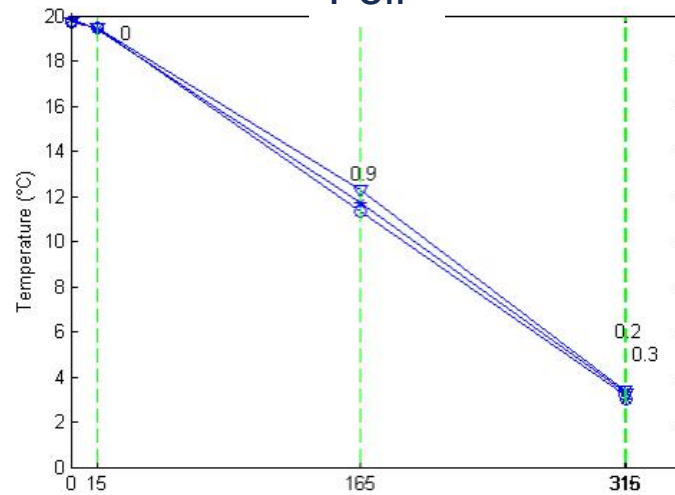
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Foil



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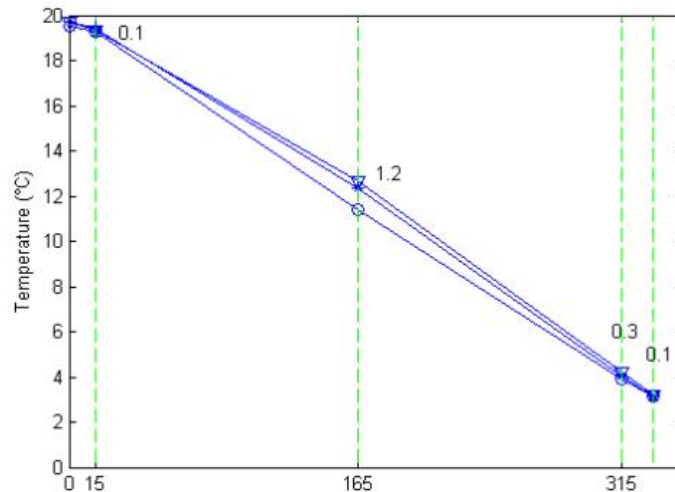
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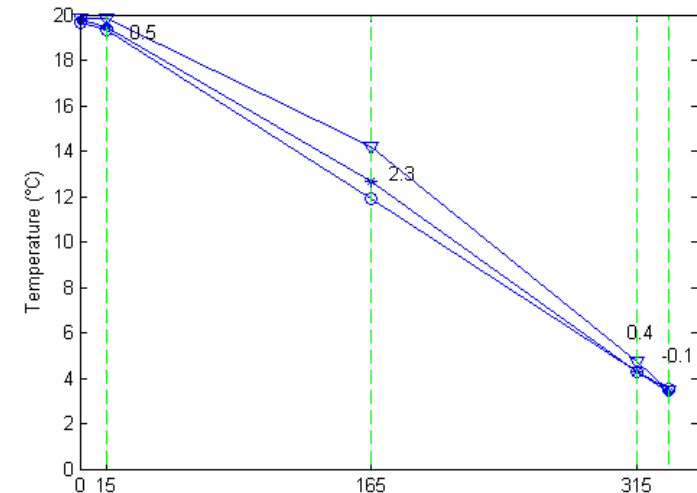
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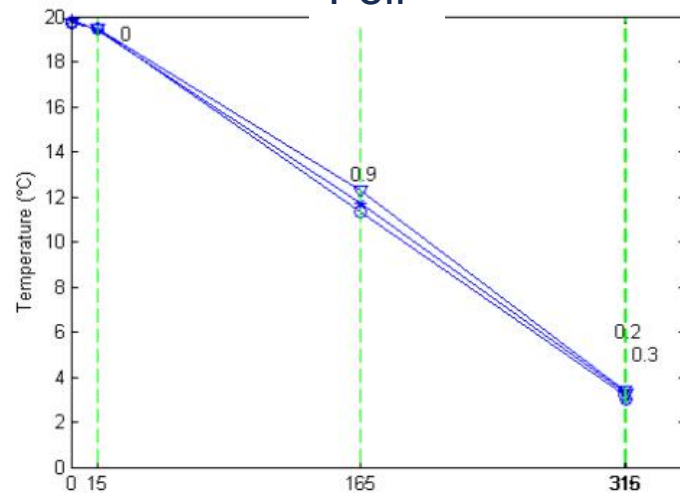
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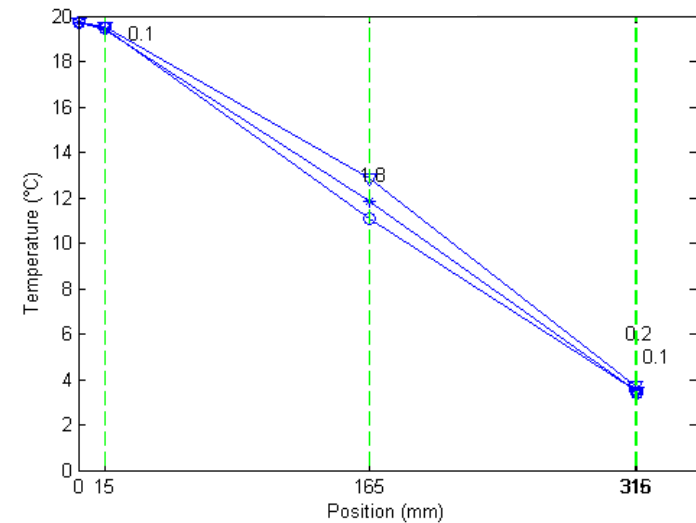
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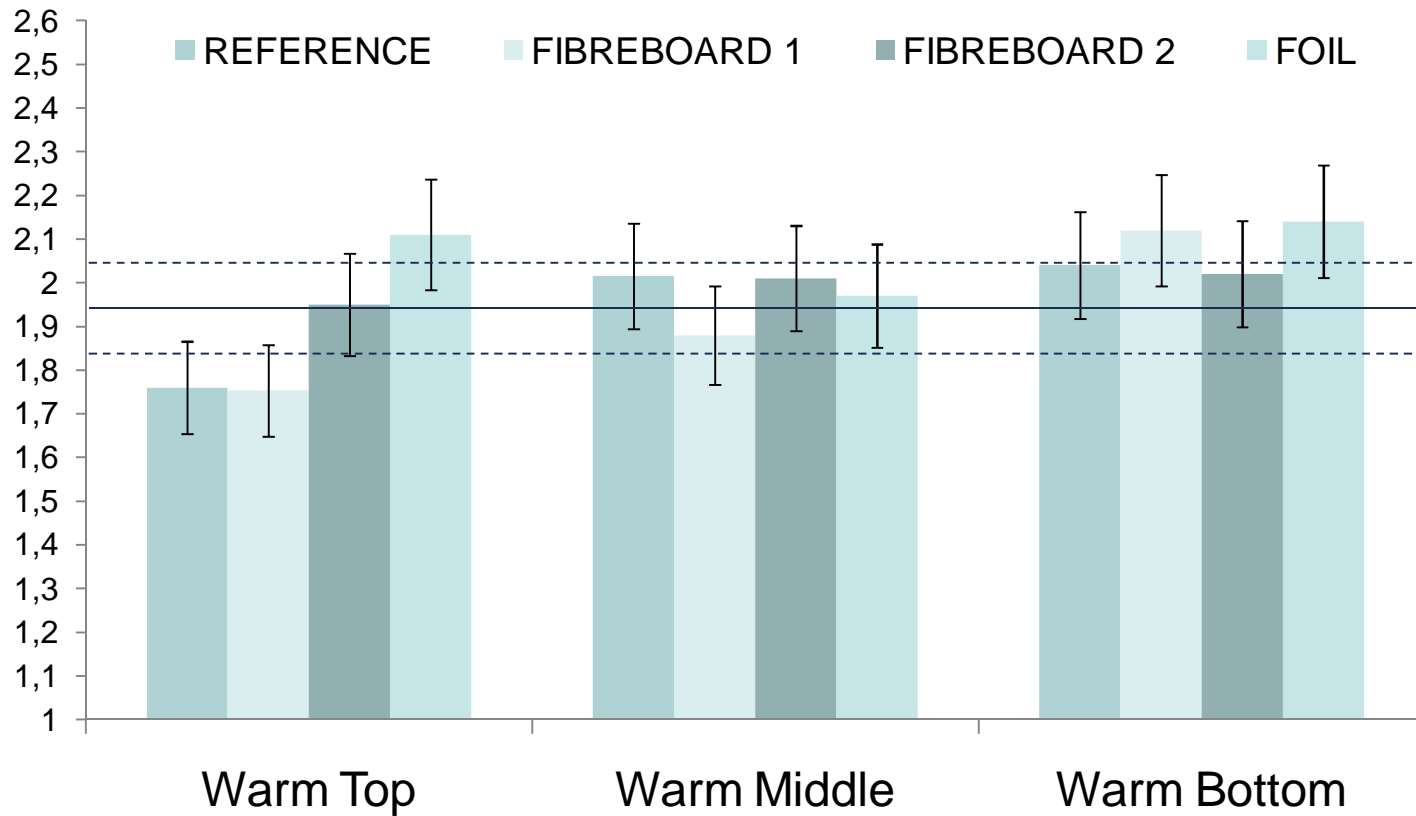


Foil



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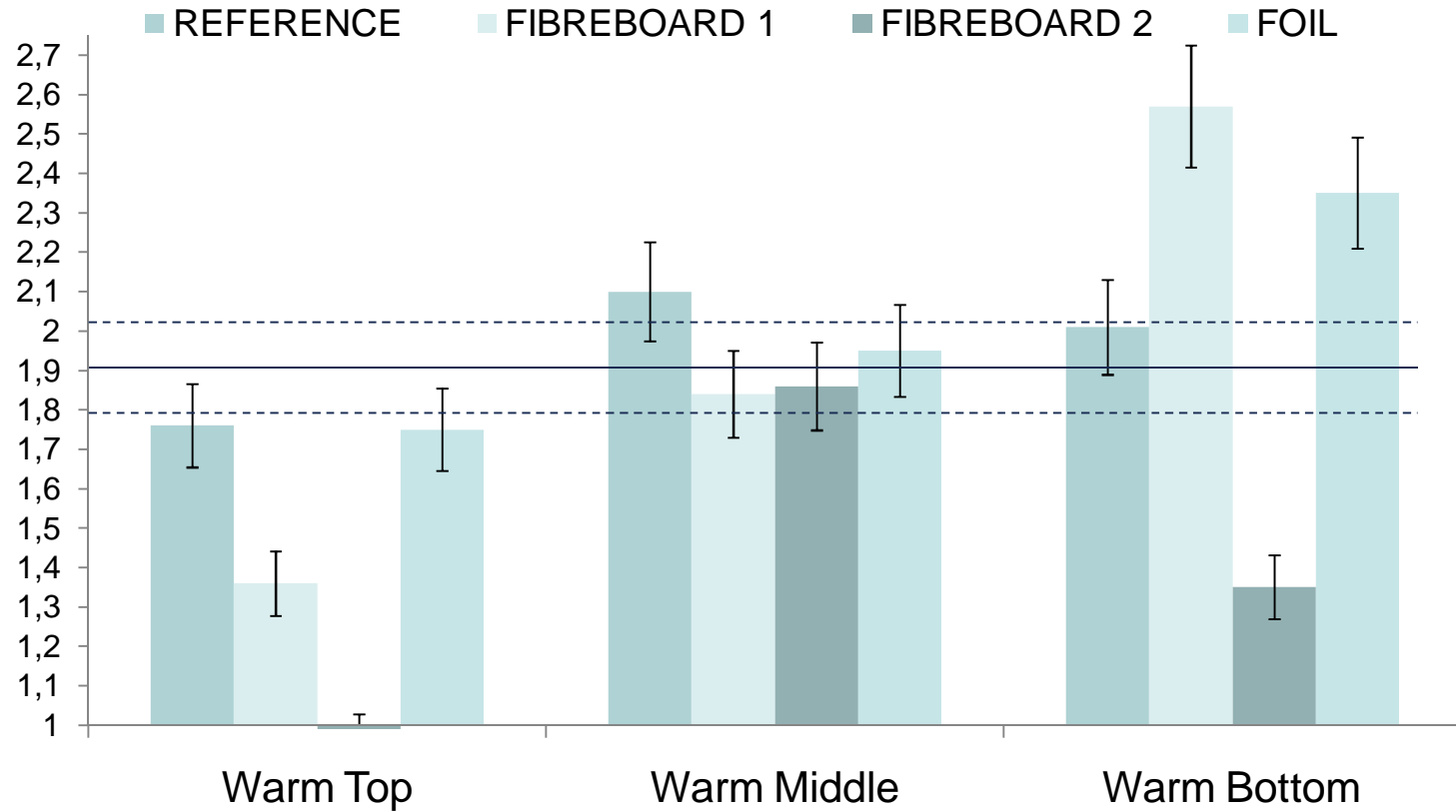
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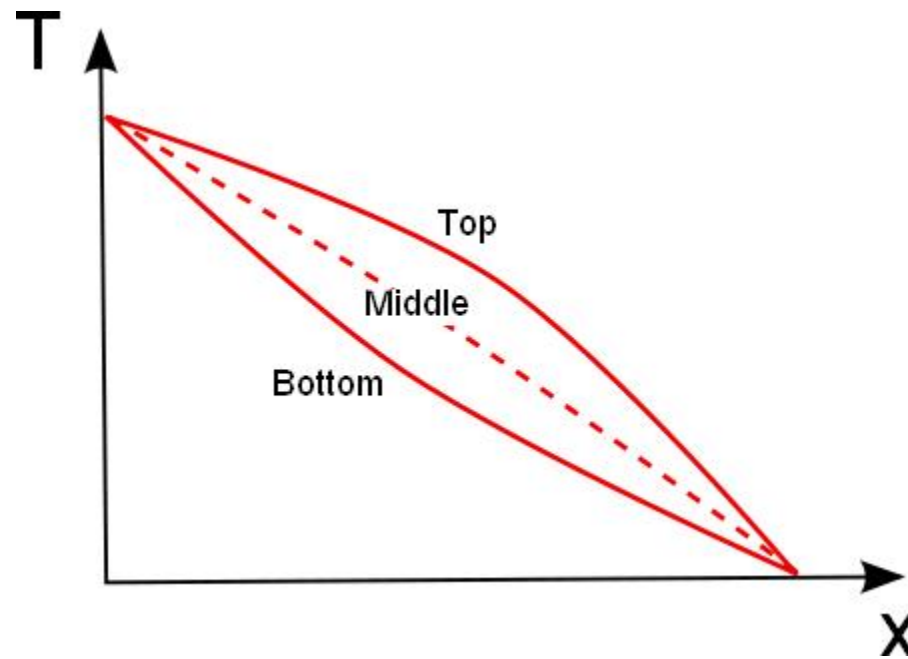
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3 steps

1. Intact interior and exterior sheathing
2. Openings in interior sheathing (top/bottom)



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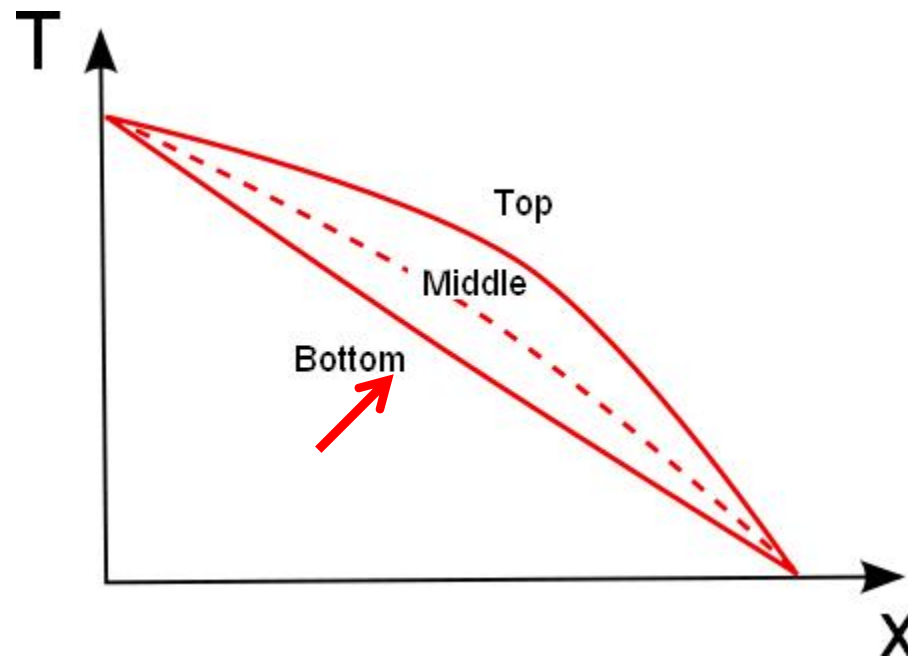
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3 steps

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2. Openings in interior sheathing (top/bottom)
 - +/- 3 Pa over pressure (ventilation in cold box)



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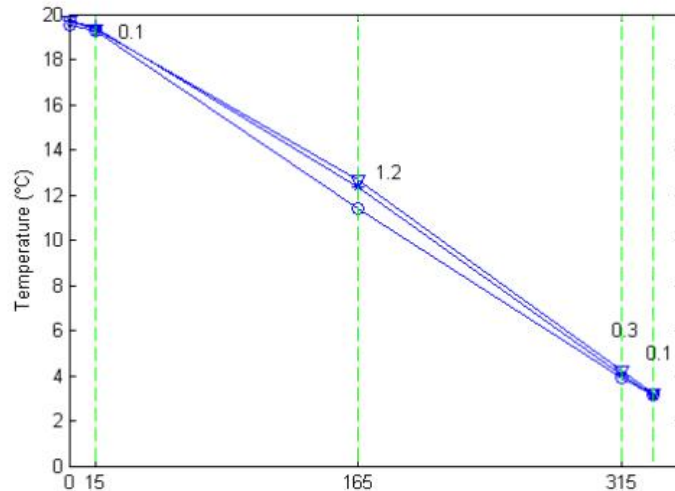
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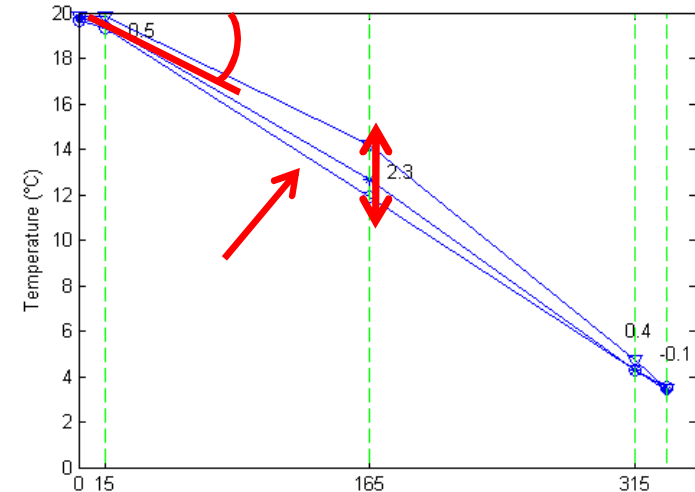
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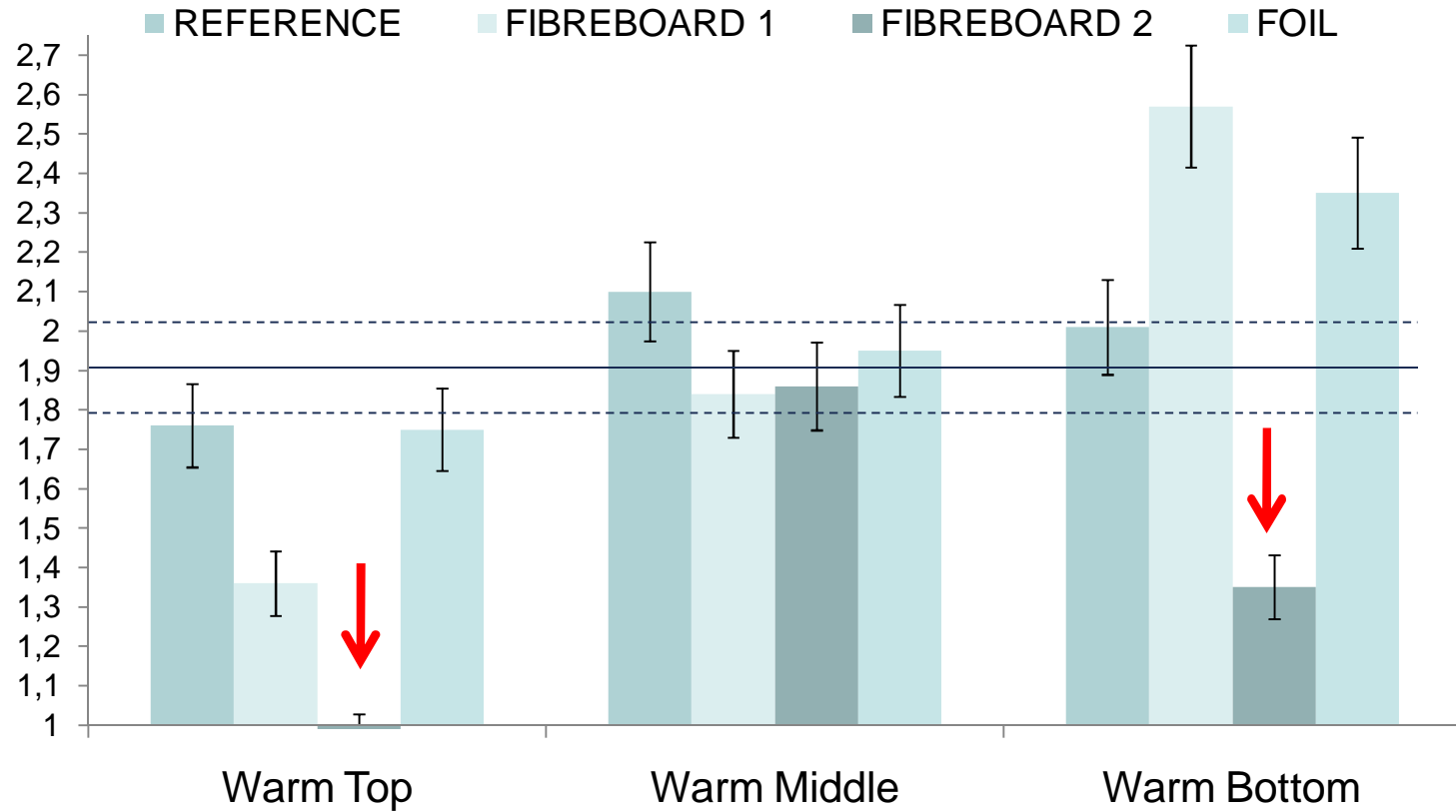
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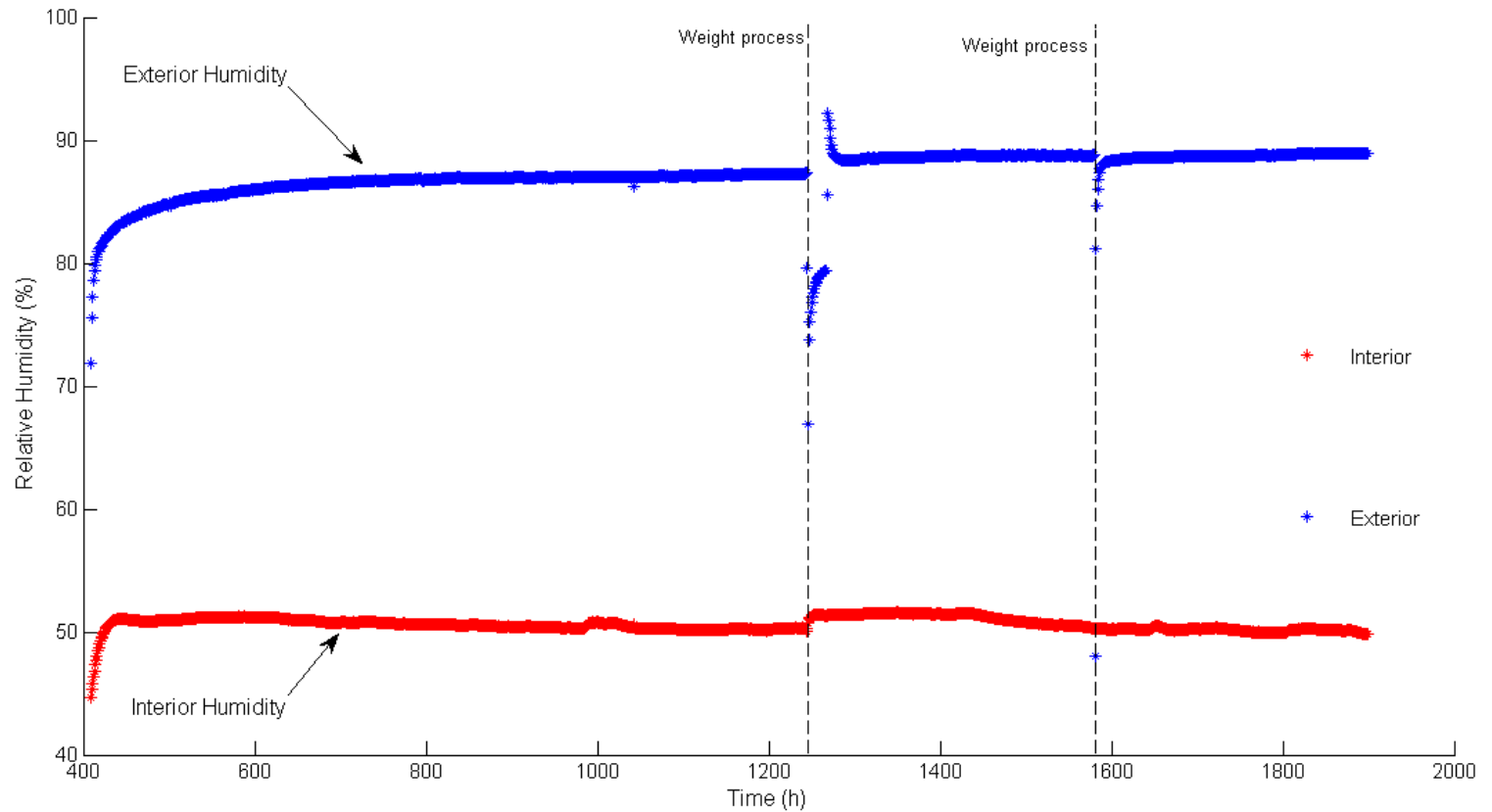
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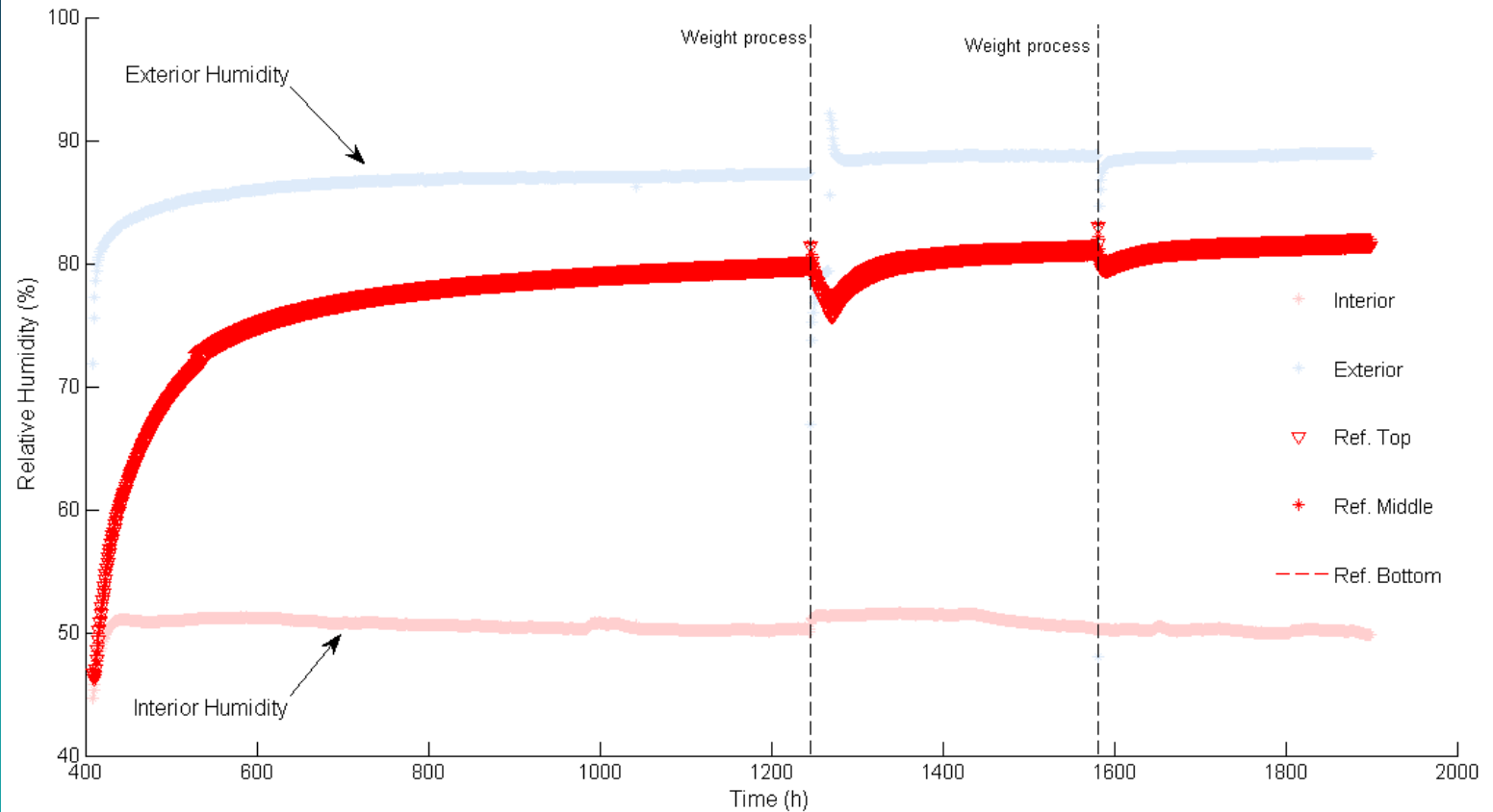
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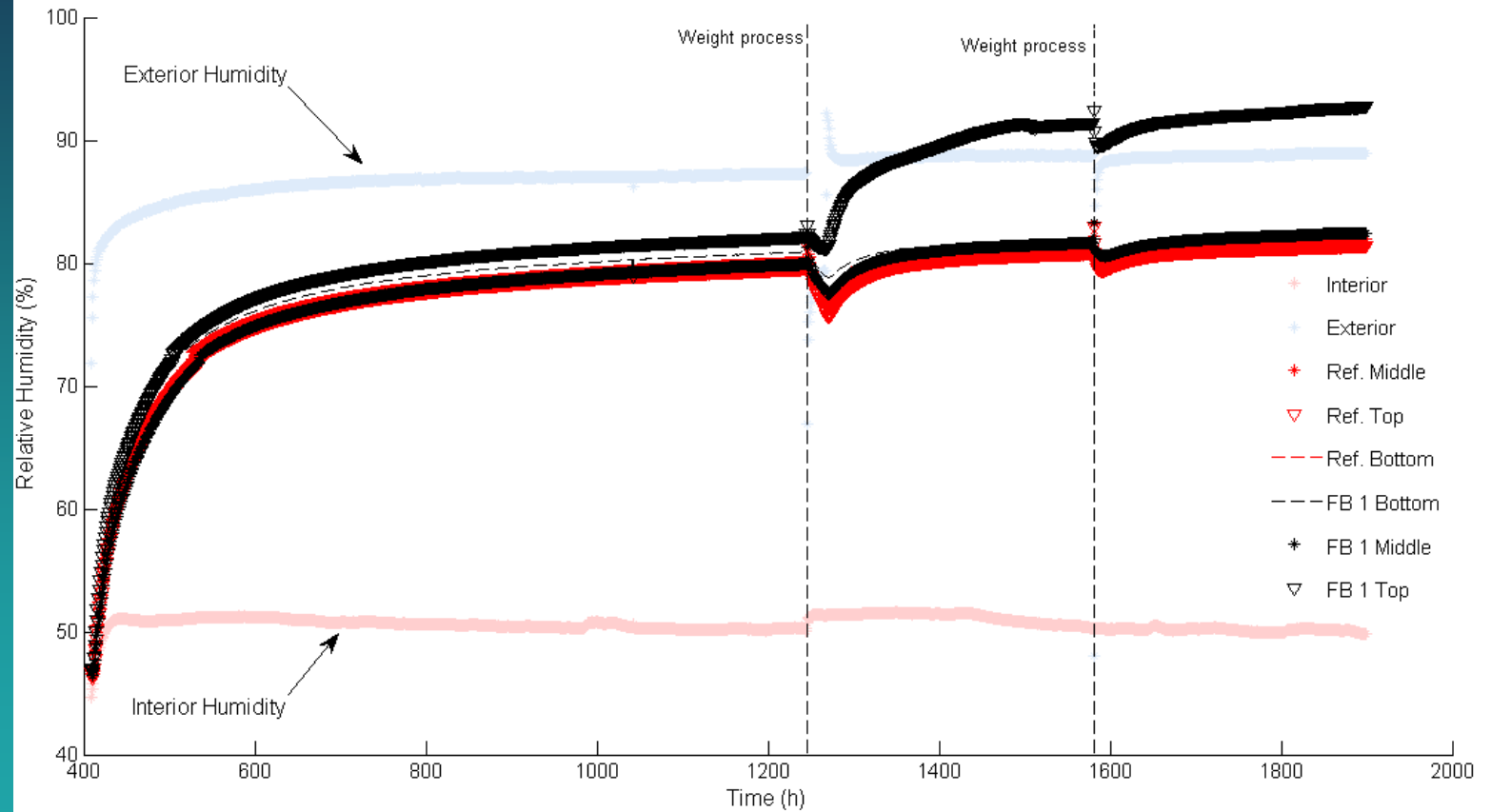
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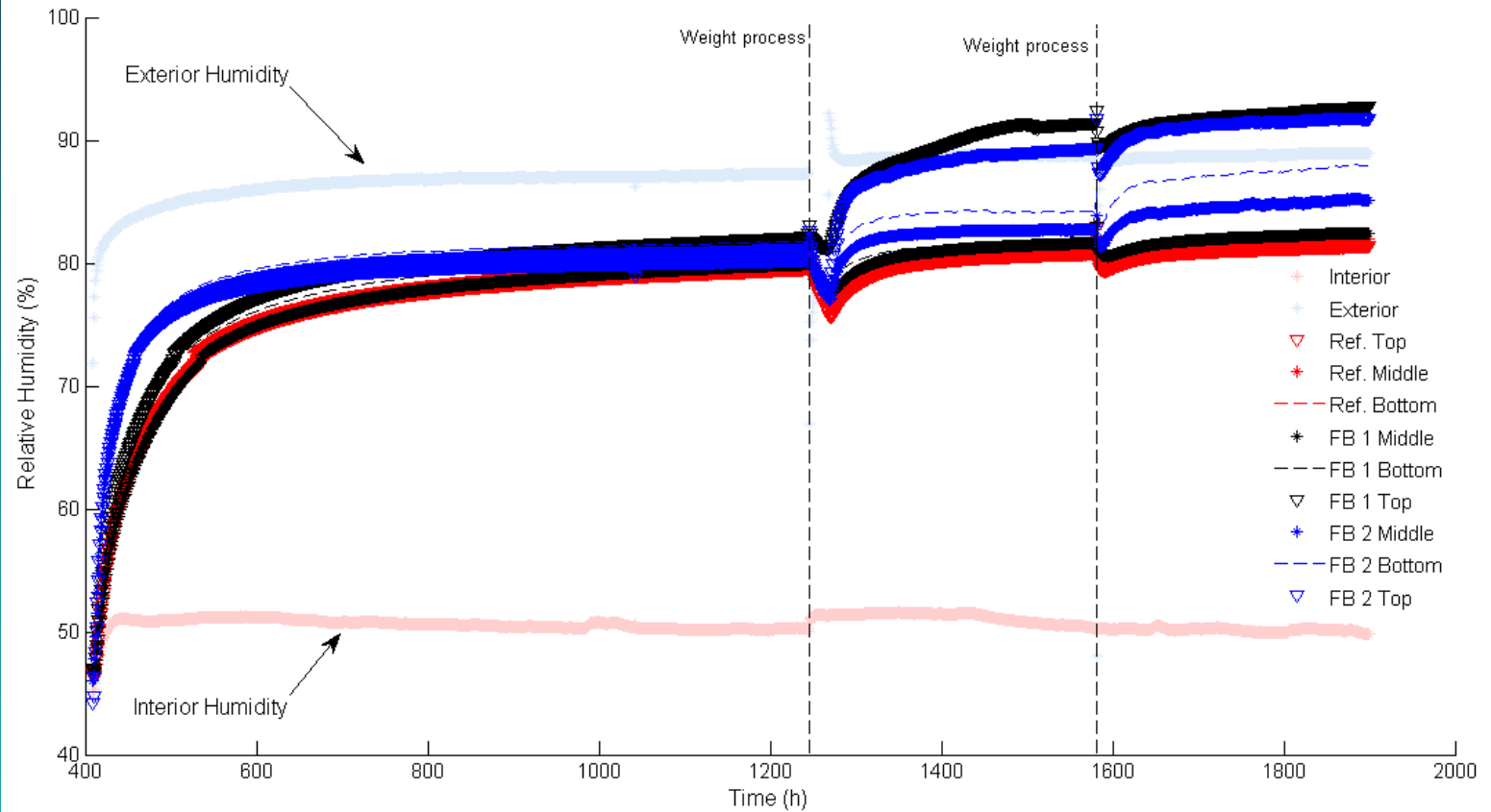
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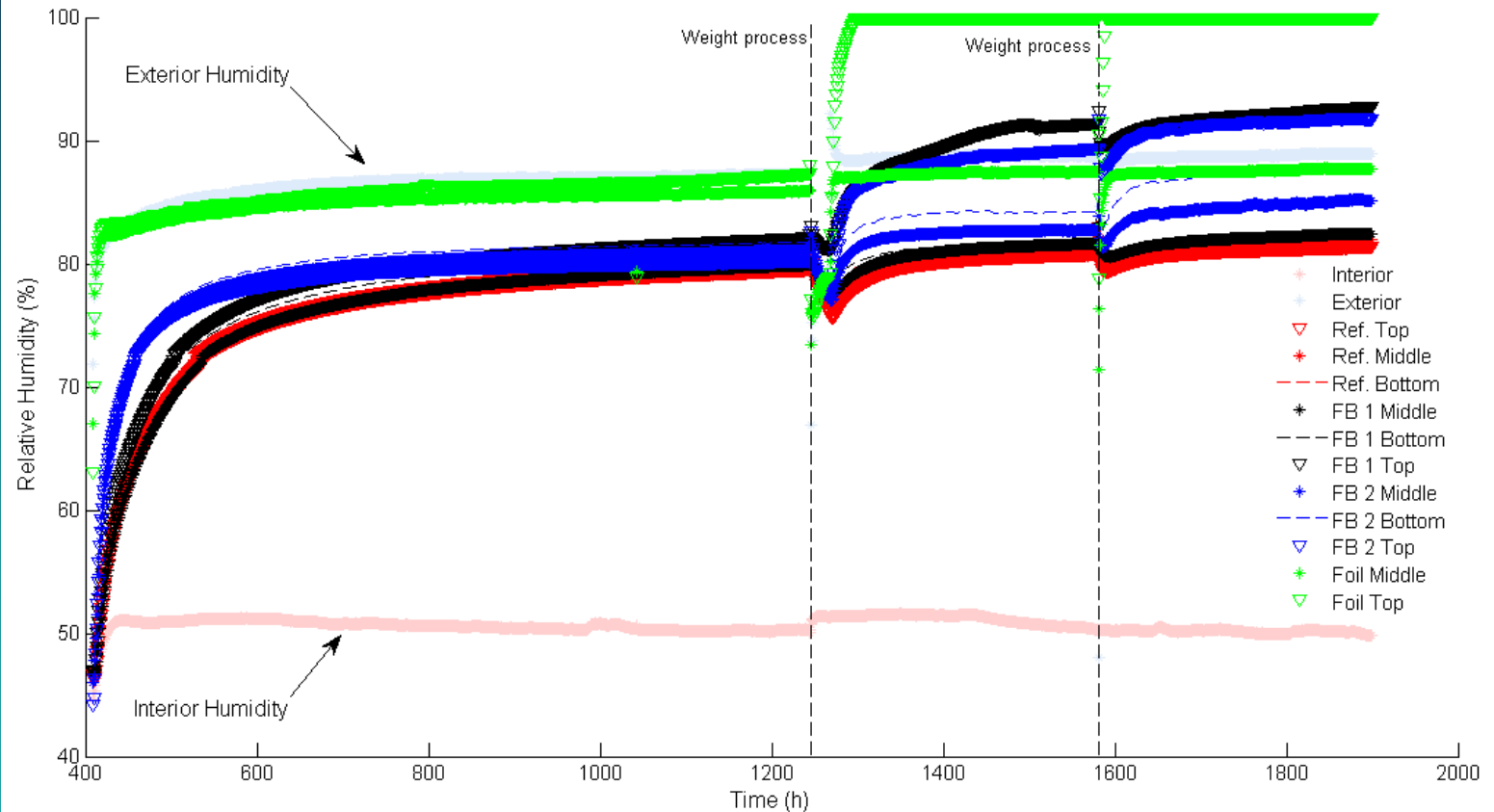
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- Preliminary results of hygrothermal impact of exterior air barrier are given
- Small effect of natural convection in mineral wool if placed carefully
- Interior openings increase the moisture load at the top position
- Exterior air barriers without thermal resistance and moisture buffer immediately shows condensation
- Valuable set of validation data for HAM-models



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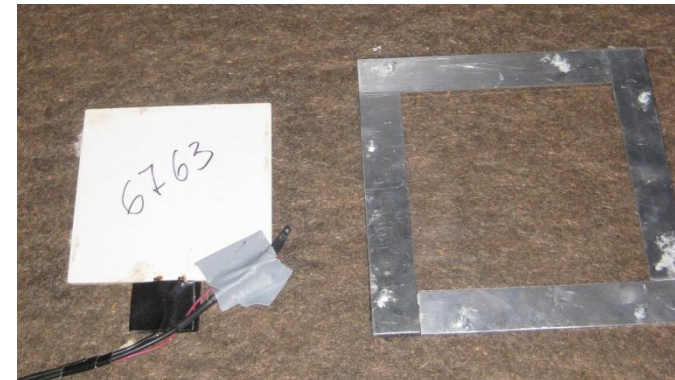
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Problems in first test round (2010)

- 3 layers of insulation: gaps in between + uncertain position of sensors
- Very small air leakage dominated the system
 - Weight samples
 - sensors
- Flux sensors on cold side: condensation
- Condensation on boundary of weight samples



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Changes in second test (2011)

- Two insulation layers (2x16cm in cavity of 30 cm)
- Only flux sensors on interior sheathing
- New design weight monsters
- Smoke test: extra sealing of exterior sheathing



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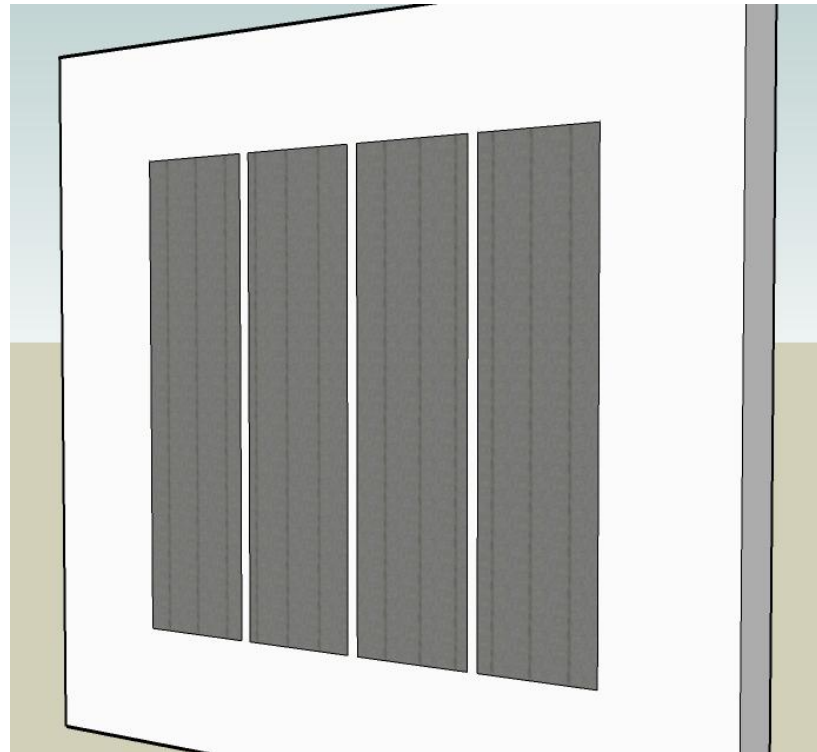
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