Energy efficient climate control in museum stores

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Lightweight roof

Light weight concrete walls

Concrete floor (no insulation)

\[ \text{AER} = 0.07 \text{ h}^{-1} \]
Temperature control in summer

Heat gain from roof heats up the space

$T = 20 \, ^\circ\text{C}$

$\text{RH} = 70\%$

$20 - 25 \, ^\circ\text{C}$
Temperature control in winter

Heating

T = 0 °C
RF = 100%

5 -10 °C
Climate records for the interior over one year.
Humidity control in summer

Dehumidification in some periods

Dehumidifier

T = 20 °C
RH = 70%

20 – 25 °C

50-60 %RH
Humidity control in winter

Humidification in some periods

\[ T = 0 \, ^\circ C \]
\[ RF = 100\% \]

5 -10 °C
50 – 60 %RH
Climate records for the interior over one year.
New store for the Museum of cultural history in Ribe
Temperature control
The metal roof reflects the sun and prevents solar heating.

\[ AER = 0.03 \text{ h}^{-1} \]
Temperature control

The floor has no insulation

The ground below gives temperature stability on an annual cycle
Temperature gradient in February
Measured temperatures inside and outside
Ground temperature measured 2 m below surface
The climate records for one year in the Ribe store
The temperature is 8 – 16 °C
Humidity control

Surplus of water vapor is removed by dehumidification
The temperature is 10 – 16 °C and the RH is 55 – 60%
...except when the dehumidifier was turned off.
Dehumidification is always needed in summer.

The graph shows the relative humidity (RH) and temperature trends from 11/01 to 09/01, along with the energy used by the dehumidifier. The summer months are highlighted, showing a significant increase in the energy used due to the excess water outside.
Energy neutral store

Use the solar heating to run dehumidification
Passive climate control

Windows in roof let in heat from the sun in summer
The heat is released from the ground in winter
Computer simulation of empty store, AER = 0.1 h^{-1}
Unfired perforated clay bricks used for humidity buffer

45-55 %RF
<table>
<thead>
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<th>Location</th>
<th>Climate control</th>
<th>Energy consumpt (pr. year)</th>
<th>Temperature</th>
<th>Relative humidity</th>
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</thead>
<tbody>
<tr>
<td>Royal library, CPH</td>
<td>Full AC</td>
<td>30 kWh/m³</td>
<td>18-20°C</td>
<td>45-55%</td>
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<td>P-hal Oerholm</td>
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Humidity buffer capacity
Humidity buffer

Thermal capacity
Humidity buffer capacity

Thermal insulation

Air tightnessness

Thermal