Low energy museum stores and archives

Poul Klenz Larsen, Tim Padfield.
The need of the objecs
Museum stores and archives are not for people
Museum stores and archives are not for people

- heat
- light
- air

humidity
Museum stores and archives are not for people

- heat
- light
- air

humidity
Zografu monastery, Greece
Heavily build limestone walls
Library more than 1000 years
No active climate control
Vælg layout
1. Højreklik uden for dit slide
2. Vælg et passende layout fra "drop ned" menuen
Vælg layout

1. Højreklik uden for dit slide
2. Vælg et passende layout fra "drop ned" menuen

0 – 30 °C
Vælg layout
1. Højreklik uden for dit slide
2. Vælg et passende layout fra "drop ned" menuen

17°C
Structure has large thermal inertia
1. Højreklik uden for dit slide
2. Vælg et passende layout fra "drop ned" menuen

50-80 %RF
Vælg layout

1. Højreklik uden for dit slide
2. Vælg et passende layout fra "drop ned" menuen

65%RF
Vælg layout

1. Højreklik uden for dit slide
2. Vælg et passende layout fra "drop ned" menuen

Open window
Closed window
Open window
Climate range, Zografu library
Royal Library, Copenhagen
Full HVAC for control of T and RH
Climate range, Royal library
Which climate range is best??

![Graph showing climate ranges for Zografu library and Royal library. The Zografu library is in a blue shaded area, while the Royal library is in a red shaded area. The graph has a grid with temperature on the x-axis and relative humidity on the y-axis.]
Main decay agent is hydrolysis
Rate of decay by hydrolysis
Equal decay rate

Graph showing the relationship between relative humidity and temperature.
Lines of equal decay rate
Temperature is important
Zografu library = Royal library
Zografu better than Royal library
Airplane shelter, heavy design
Air circulation ?
Temperature control

The heavy concrete structure has large thermal inertia.

The concrete absorbs heat during the day…
Temperature control

and release the heat during the night
Humidity control

Surplus of water vapor is removed by dehumidification

$AER = 0.05 \ h^{-1}$
Constant RH, variable T

Dehumidification stated
Climate with dehumidification

Temperature (°C)

Relative humidity (%)

6 kWh/m³

28 kWh/m³

0.05x

0.1x

0.2x

0.5x

1x

2x

4x

Værloge
TWPI 85

Royal Library
TWPI 45
Museum store, Ribe

Thermal insulation

No floor insulation
Vertical temperature gradient?
$T = 8 - 15^\circ \quad RH = 45 - 55\%$
Climate with temperature inertia and dehumidification
Climate with temperature inertia and dehumidification

- 6 kWh/m³
- 1.5 kWh/m³
- 28 kWh/m³

Temperature (°C)

Relative humidity (%)
Temperature control

The floor has no insulation
Heat flow to the ground keeps the temperature low in summer
Temperature control

The heat flow is opposite in winter. The ground keeps a moderate temperature.
Heat storage in the ground
Humidity control

Surplus of water vapor is removed by dehumidification

AER = 0.05 h⁻¹
Humidity control

Dehumidification mainly needed in summer.

Can be powered by photovoltaic elements

Solar panels needed on 8% of the roof area
Conclusion

Highly insulated walls and roof to moderate temperature variation imposed by outside climate.

Concrete floor without thermal insulation to allow heat storage in soil below.

Humidity control by dehumidification, powered by solar panels.

Block outside pollutants with low infiltration rate.

Air cleaning by recirculation with filters if needed.

No daylight allowed in stores. Artificial light by LED.