



PASSIVE DESIGN. THERMAL PROPERTIES

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Thermal properties

Heat transfer

- Thermal conductivity
- Resistance
- Transmittance

Heat storage

- Specific heat
- Thermal mass



Specific heat

Energy needed to increase one substance unit in one temperature unit (J/kg K)

Will depend on the difficulty to heat the material

The bigger specific heat, the bigger need of heat contribution

Mg requires 8 times more energy than Pb



Thermal mass

Ability of a material to absorb and retain heat.
Slow rate of heating and losing heat

It depends on:

Units in **J/kg**

- Density (the higher the better)
- Specific heat (the higher the better)
- Thermal conductivity (the smaller the better)

$$Q = C_{th}\Delta T$$

Q = Thermal energy

C_{th} = Thermal mass of the body (kappa value)

ΔT = Change in temperature



Thermal mass works by:

- absorbing heat when the sun radiates
- re-radiating it back as temperature drops

Passive design uses thermal mass to keep a more constant temperature inside

Materials with high thermal mass:

- Concrete
- Stone
- Brick
- Earth
- Water

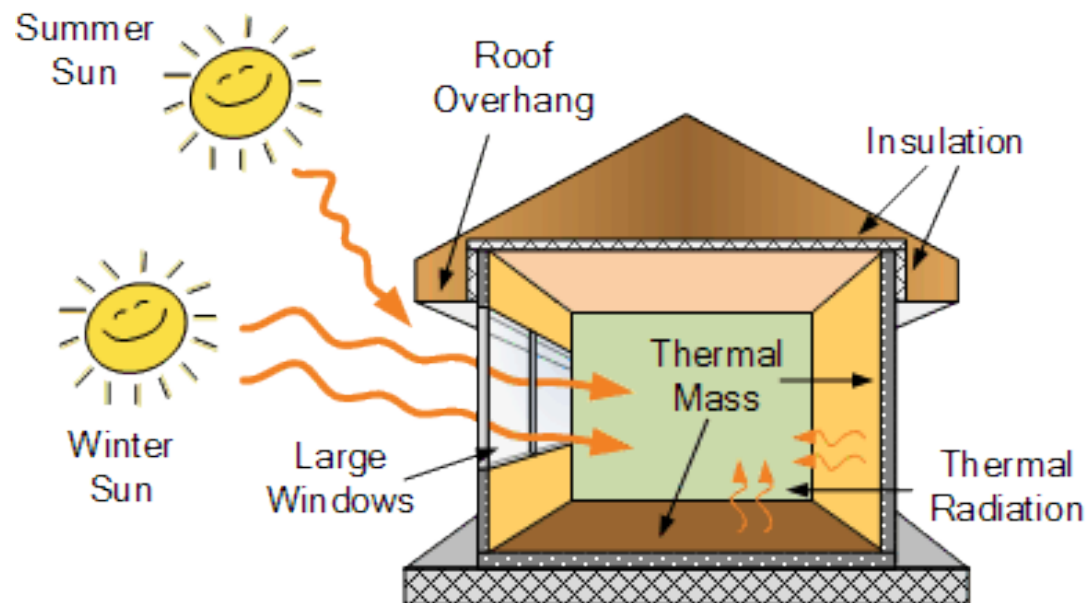
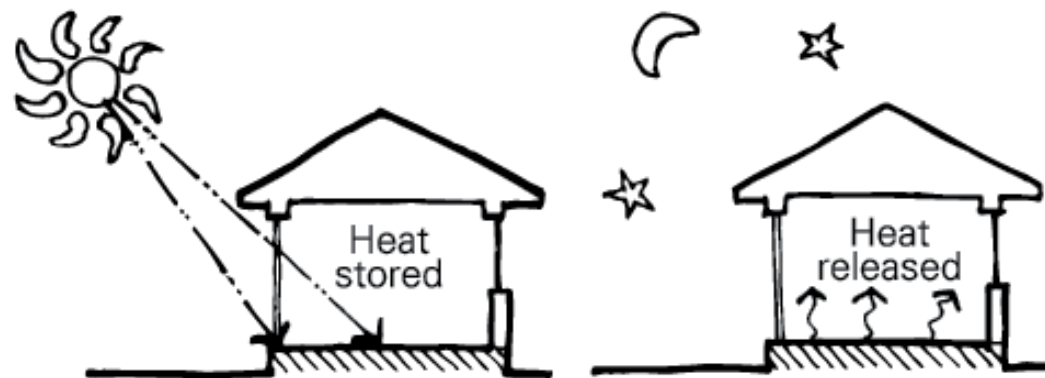
Low density materials are not good to work with thermal mass



Requirements for materials to work with thermal mass:

- High specific heat
- Big mass
- Low thermal conductivity
- Dark colours





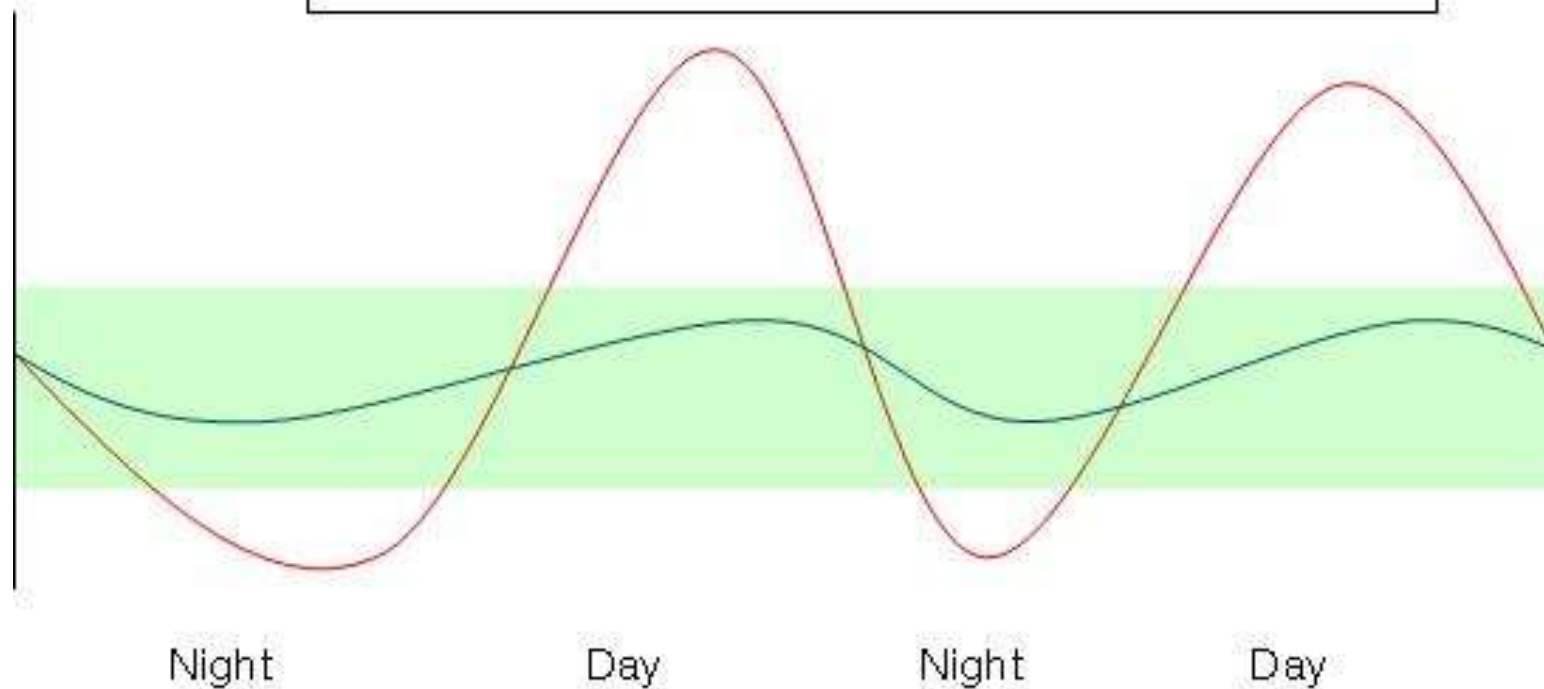


Internal Temperature

Uninsulated concrete

Insulated concrete with thermal mass effect

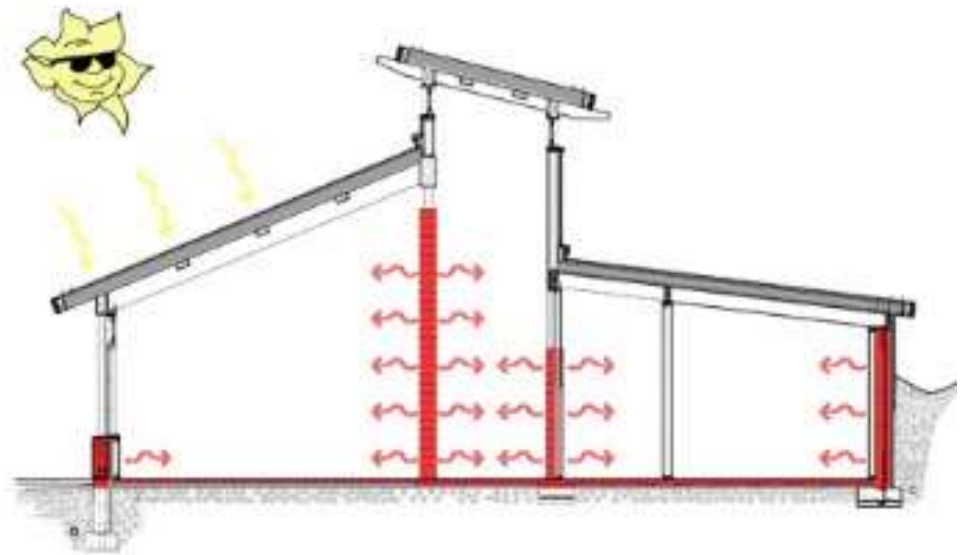
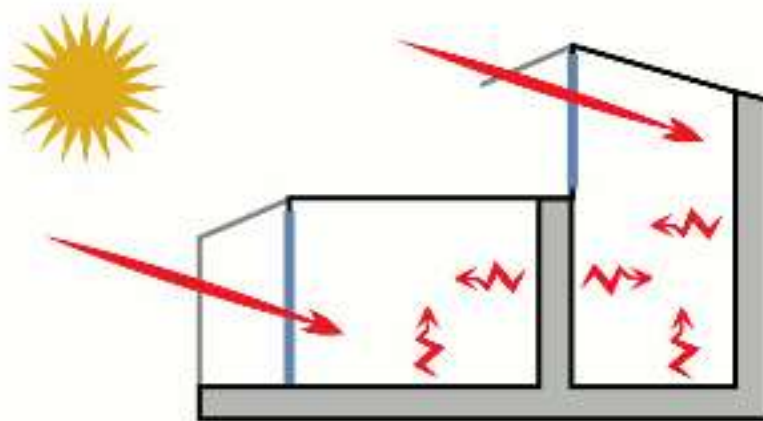
Comfort Zone



Effect of thermal mass on internal temperature over diurnal swings.



Internal thermal mass



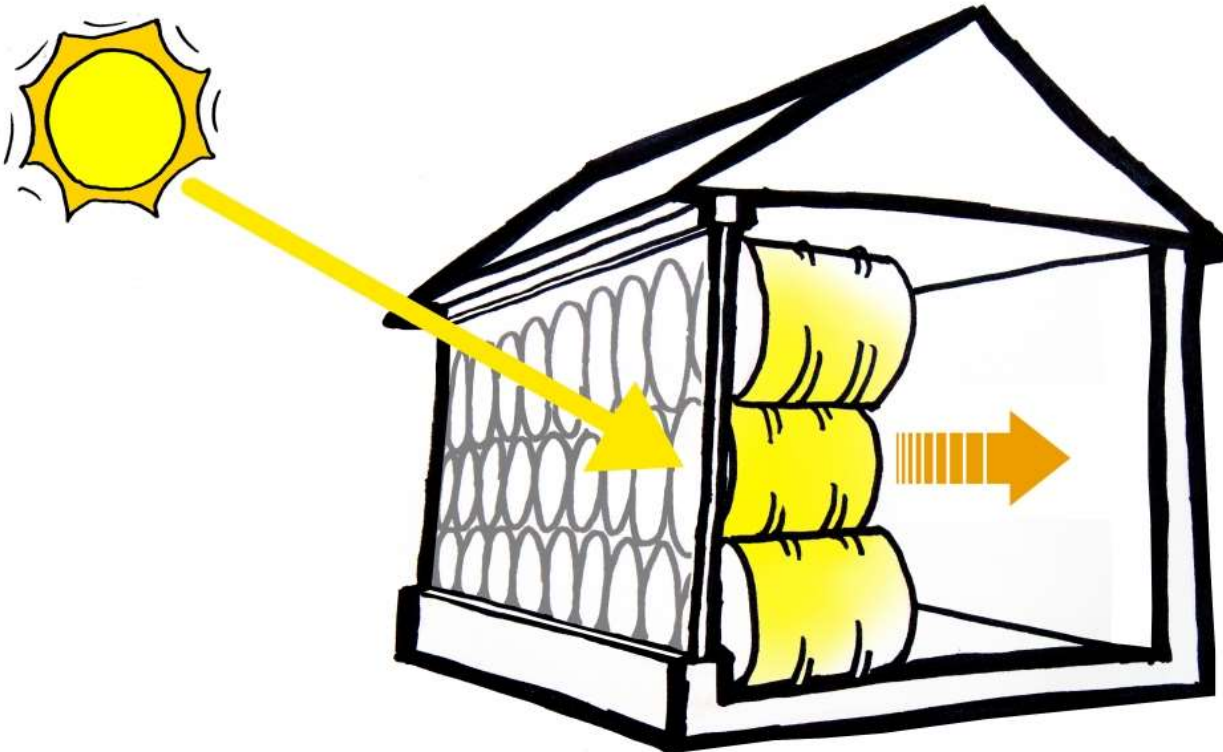


Internal thermal mass





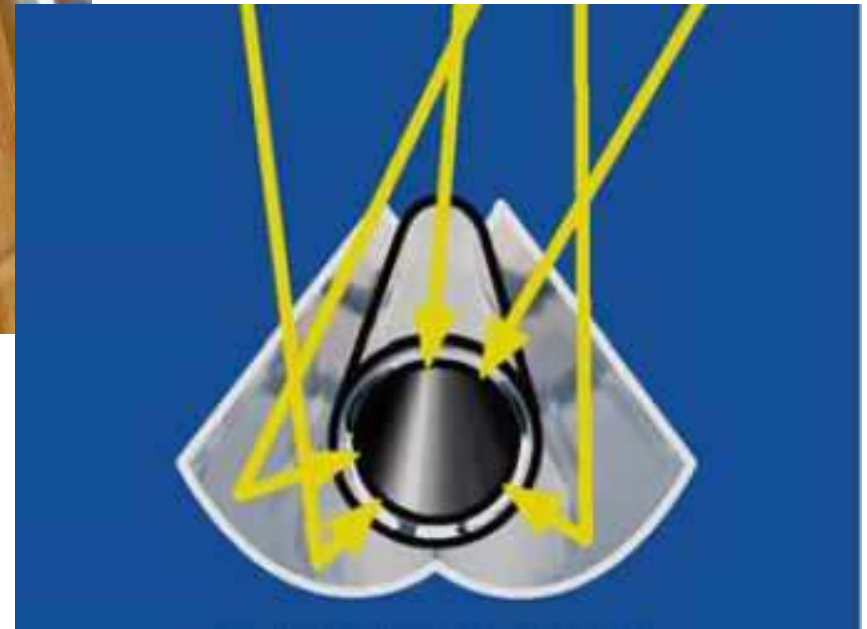
Water wall mass





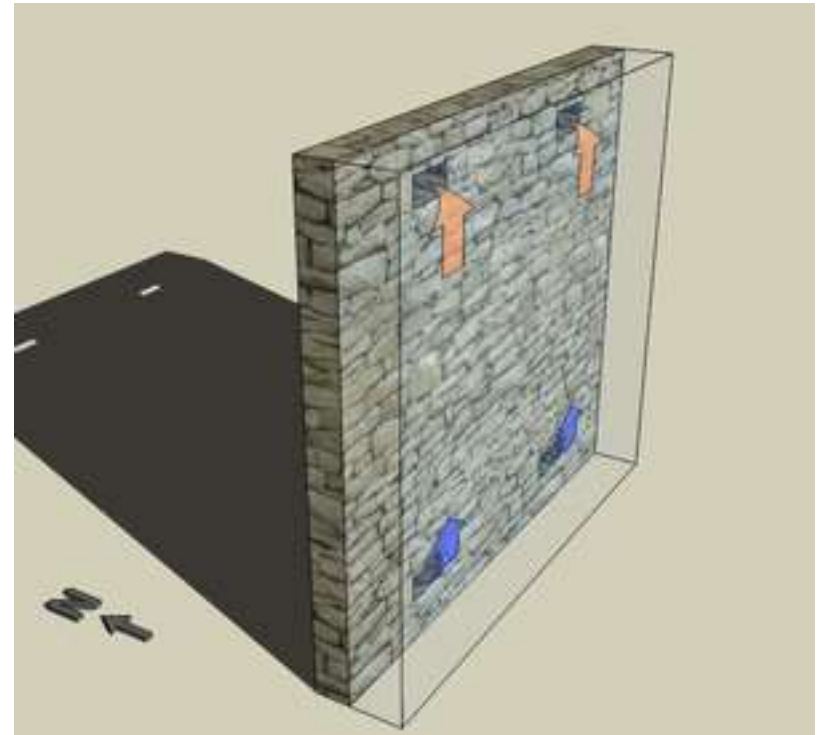
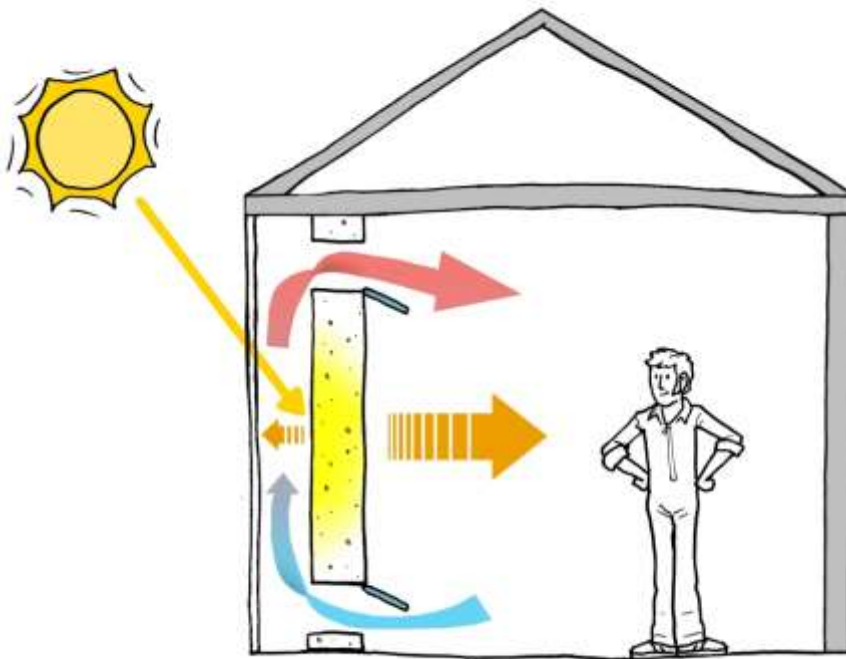
TECNOSOL

Heating solar system



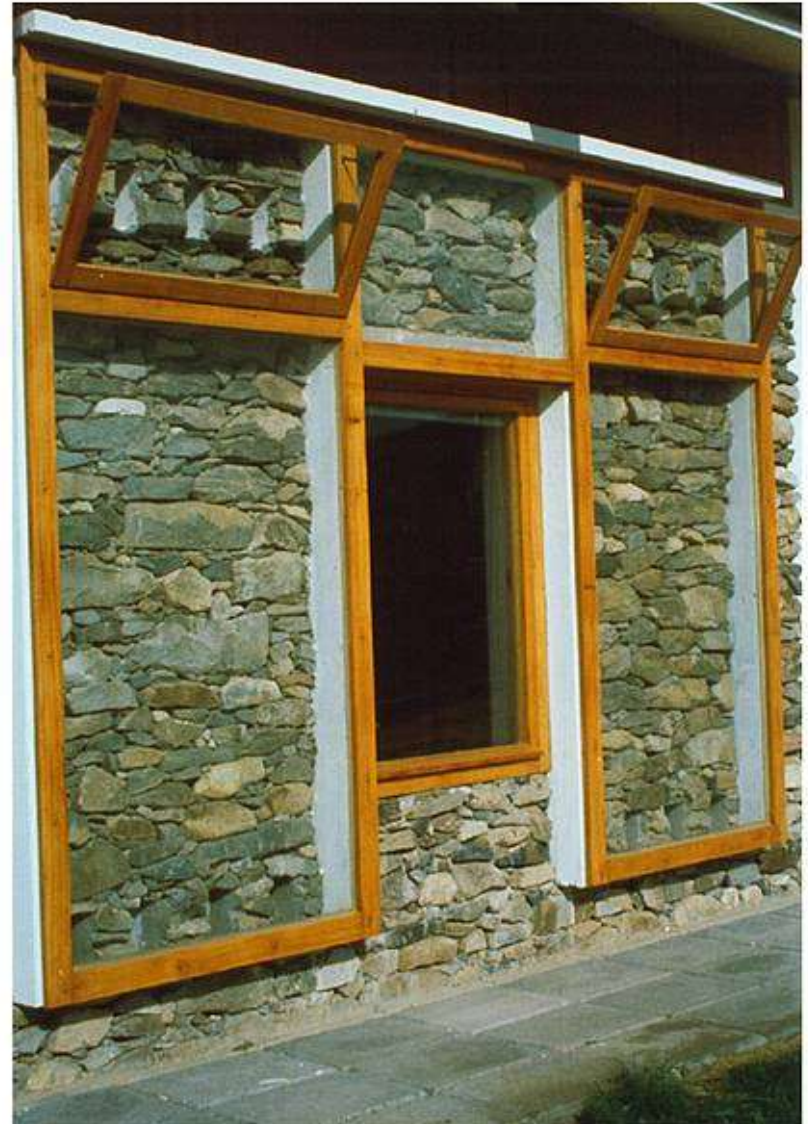


Trombe Wall system





Trombe Wall system



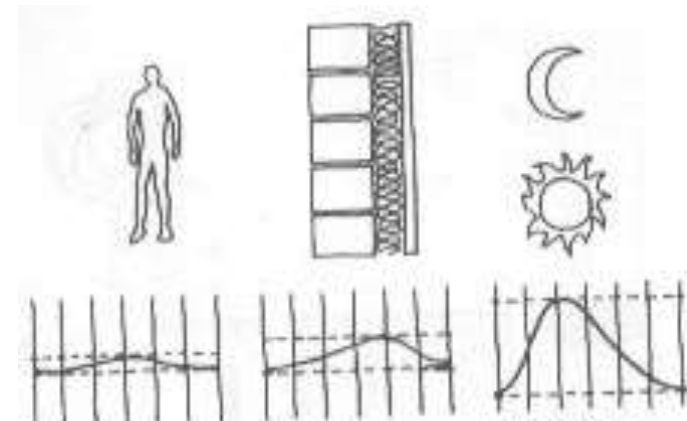
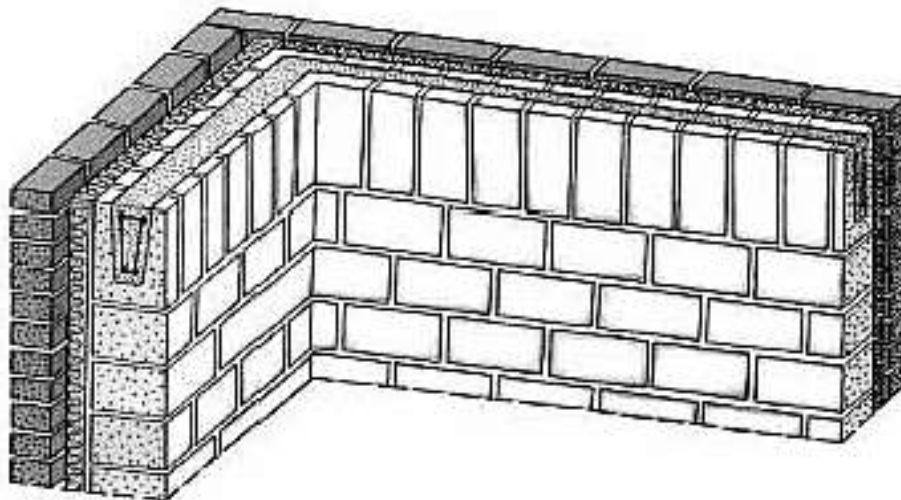


Trombe Wall system





How multilayer systems work with thermal mass

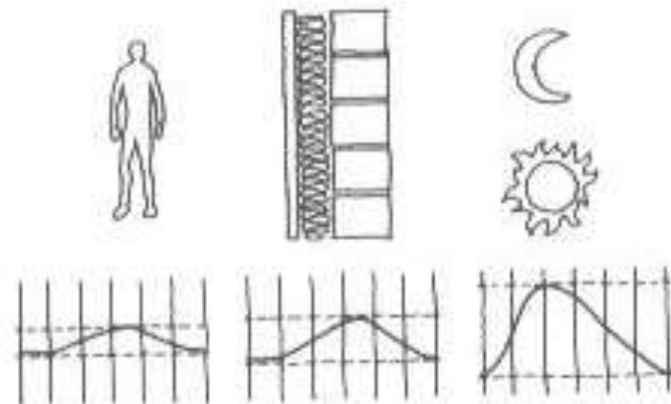


Interior

Wall

Exterior

Temperature changes in 24 hours



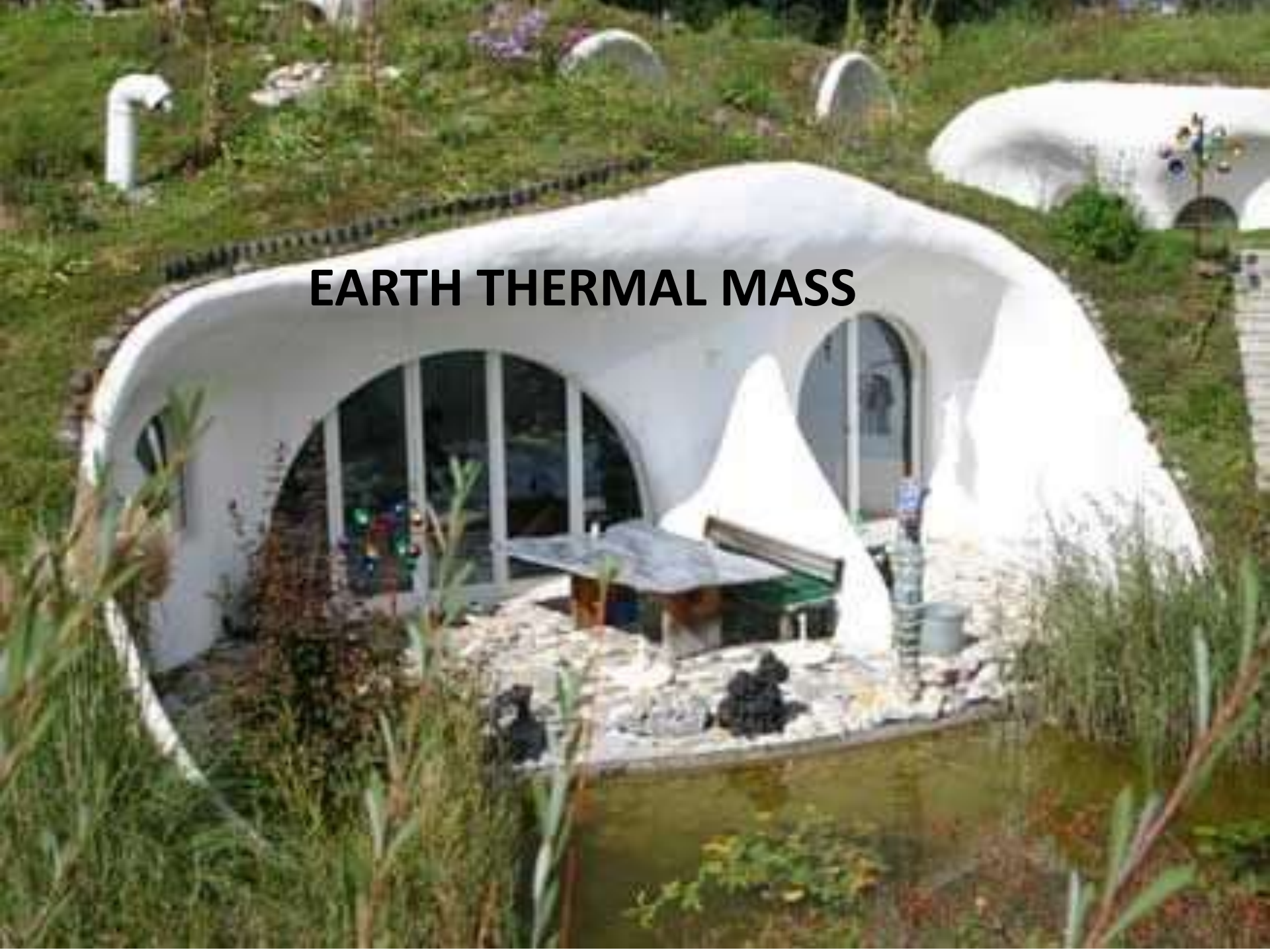
Interior

Wall

Exterior

Temperature changes in 24 hours

EARTH THERMAL MASS





Earth Thermal mass

Earth keeps a constant temperature during the whole year about 15 °C.

This temperature can be used in winter as well as in summer.





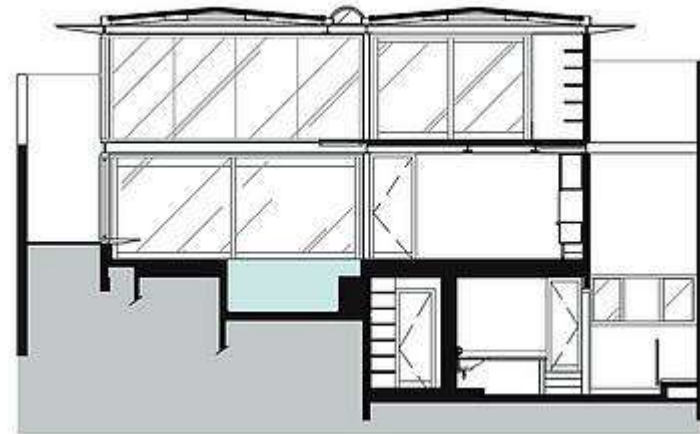
Earth Thermal mass



SOUTH
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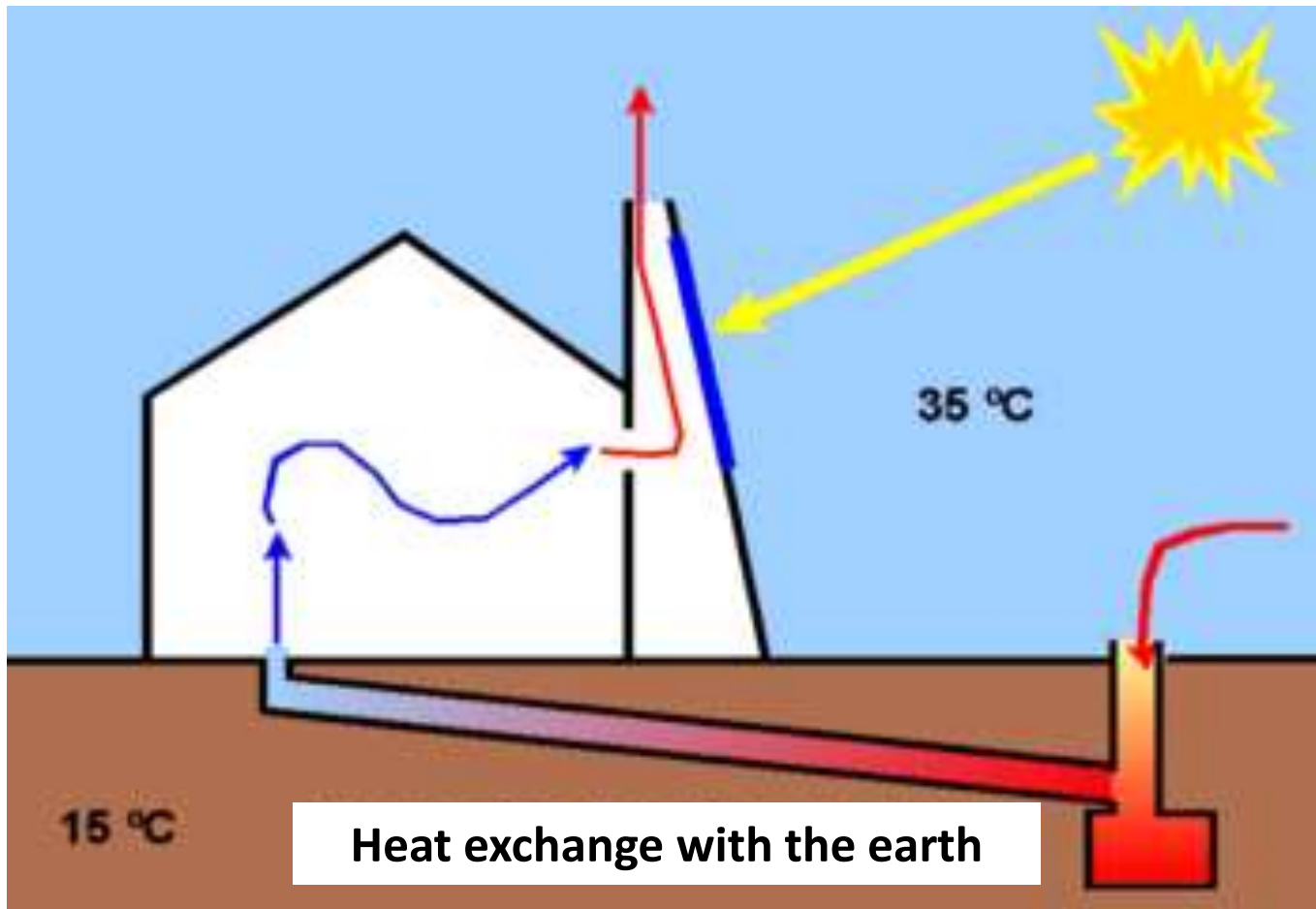
Earth Thermal mass



Constant temperature during all year



Earth Thermal mass





Exercise 1

What recommendations would you do for the construction of a dwelling so that it will work by thermal mass?

- **Materials**
- **Orientation**
- **Design**
- **Envelope**
- **Heating systems**