



Special Features of Energy Conservation in Historical Buildings



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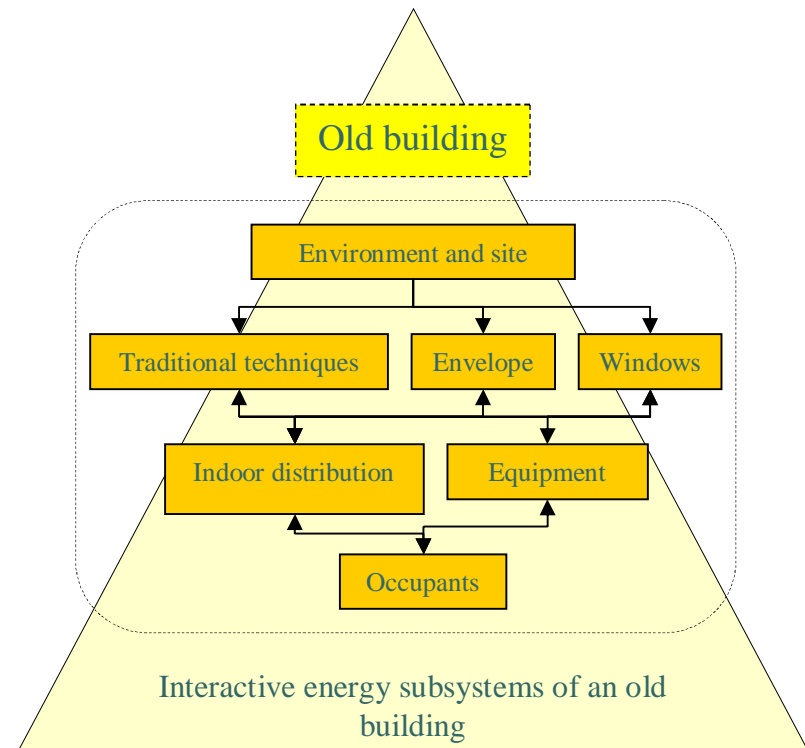
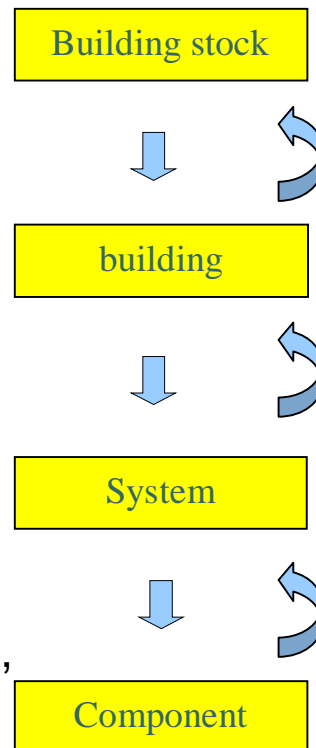
Government buildings

- Old buildings with historical and architectural characters
- 1/3 of existing building stock
- Diversity of old buildings before emergence of modern architectural movement
- After 1948: industrialized buildings, reproducible and standardized components



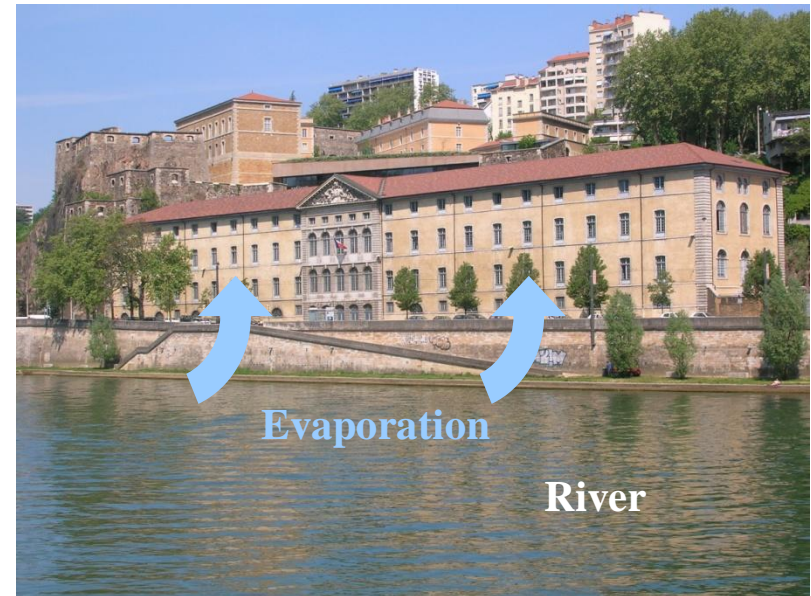
Building stock old & modern buildings

- In situ, multiple interactions between the building composed of a large diversity of heterogeneous elements linked together, and its environment
- Complexity of old building results from its design and its history: it is an opened system
- Holistic approach for understanding the complexity of energy behaviors of old buildings
- Subsystems: environment and site, indoor distribution, traditional building techniques, envelope, windows, equipment and occupants

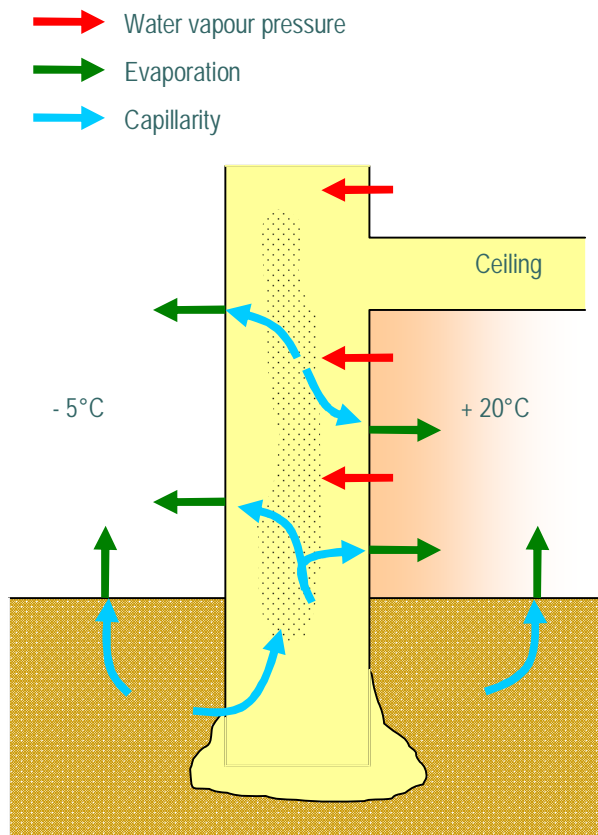


● ● ● | Environment and site

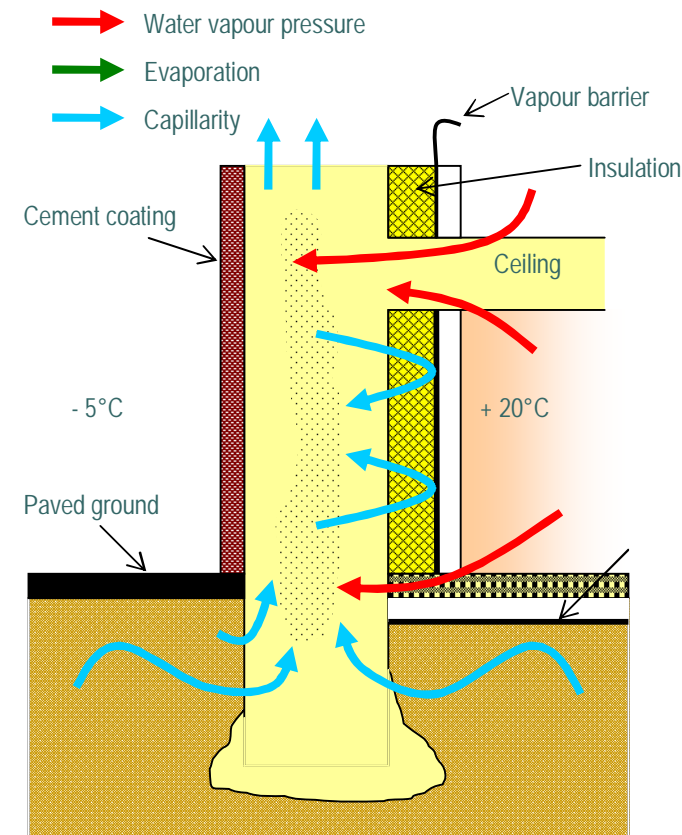
- Microclimate, close relief, solar masks, urban morphology...
- Essential thermal interaction between an old building and its environment
- Each retrofitting action taken on building's environment and site can lead to effects on energy performance: solar shadings, reflected radiation, potential of cooling night ventilation



Complexity of energy flows in old walls



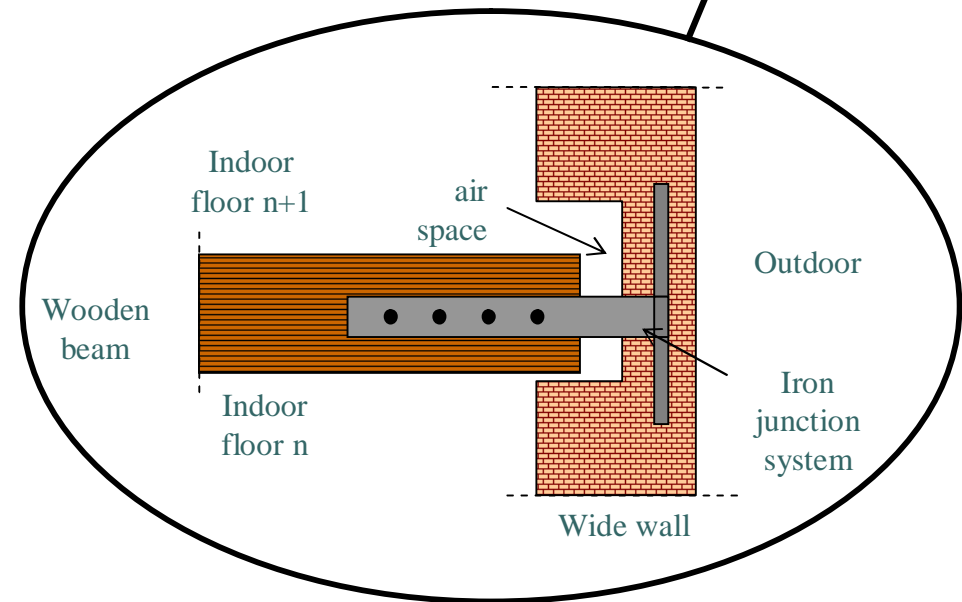
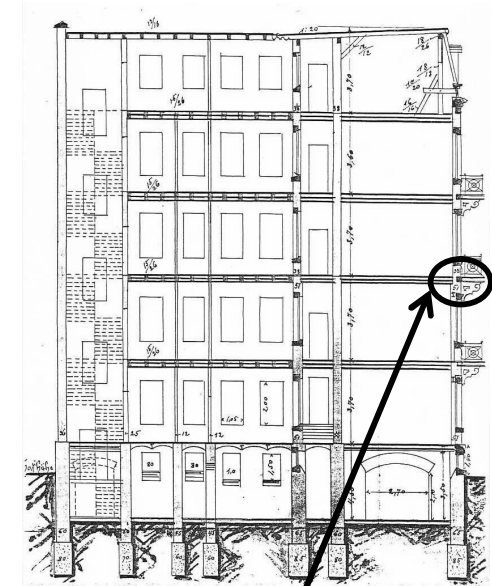
Before renovation



After renovation

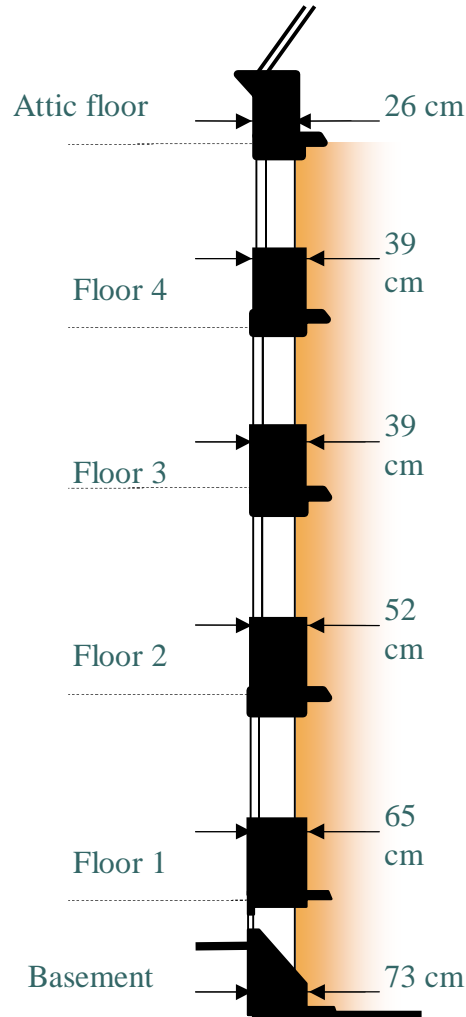
Traditional building techniques

- Compact buildings
- Heavy structures and different walls with strong thermal inertia distributed between facades and inside walls
- Composite materials in the old walls
- No thermal bridge



Envelope

- The use of local materials (unknown thermal conductivity) and several types of material in the same wall
- To protect the existing moisture barriers in old buildings
- To preserve different flows through the old walls (water – humidity regulation, air – natural ventilation)



● ● ● | Windows

- In old buildings, the significant function of a natural ventilation strategy
- To replace old windows by tight windows can cause disorders related to humidity flows and condensation
- Facades of old buildings cannot be modified because of historical and architectural constraints



● ● ● | Indoor distribution

- Interaction between an outside system and an inside system “indoor distribution”
- In old buildings: orientation of rooms (sunny side, cold side, winter and summer), of thermal buffer spaces, crossing rooms (air ventilation strategy)
- Old buildings have a whole coherence of the indoor air temperature distribution



● ● ● | Equipment and occupants

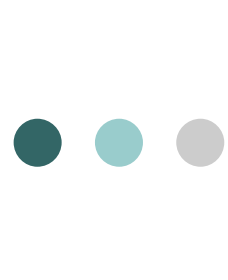
- Many old buildings do not have ventilation systems. They have natural ventilation.
- The heating systems are various and auxiliary heating systems are numerous
- Occupants influence energy performance by thermal adaptive behavior (seasons)





Differences Old & Modern

Old buildings	Modern buildings
Local materials with building design used over several centuries	Development of building systems according to new demographical, economical and industrial constraints
Location and orientation according to solar arc, winds and precipitations	No optimization of climatic constraints: location, orientation, openings, etc. Choices influenced by urban regulations
Indoor distribution with crossing rooms according uses Thermal buffer zones Specific optimized openings	Indoor distribution according general models in order to create spaces independent of local environment.
Materials which are very sensitive to water (variable U-Value) but with a good dimensional stability.	Industrial materials which are unaffected by water but which are sensitive to thermal dilatations.
Significant uses of plaster and superficial coatings allowing the absorption of air humidity without structural degradations (rooms without heating or cooling systems)	Few absorptive materials inside the building



Differences Old & Modern

Old buildings	Modern buildings
Heavy structural masonries with strong thermal inertia inside the facades and distribution walls	Identical and prefabricated walls with limited thickness
Different walls on the same floor according to uses (representative stones on the street side and wood on the courtyard side)	Similar, industrialized, horizontal and vertical walls
Different thickness of walls with their structural constraints according to the floors (reduced thickness for the higher floors)	Standardization of building design without differences between structural walls and facades.
Inside the old buildings, wooden floors well insulated with good energy performance	Solid concrete floors with heat transfer between different floor levels
Materials filling partitions and floors with hydrothermal regulation properties	Secondary materials with principally an esthetical role
Few thermal bridges in facades because of building design	Significant thermal bridges because the buildings techniques used jointed prefabricated elements



Recommendations

- To identify the traditional building techniques according to the age of old buildings
- To understand the thermal behaviour of the entire old building, with the active and passive measures
- To have a bioclimatic approach when considering the energy consumption
- To study at the same time the thermal behaviour of the building both in winter and in summer
- To consider that the more efficient energy savings are often in passive measures
- Not to create thermal bridges in old buildings where there are none
- Not to propose energy solutions which can cause structural degradations or indoor discomfort



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