

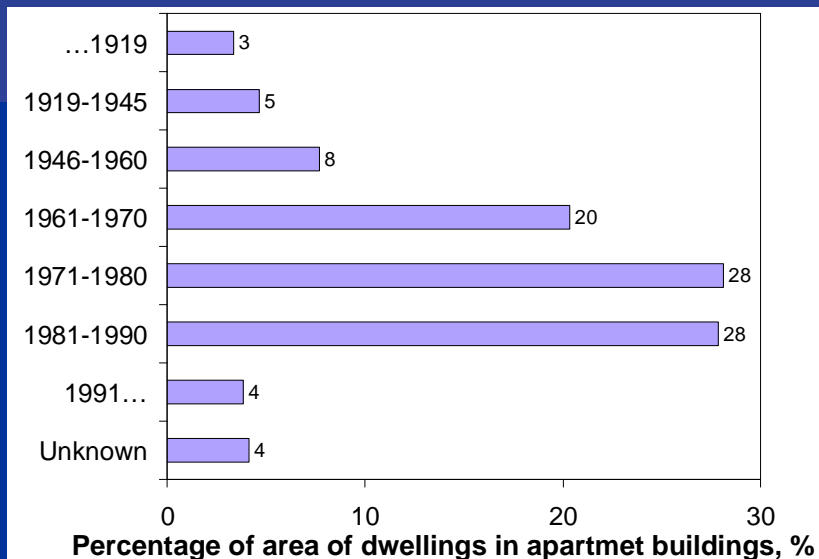
Research principles and renovation demand of old brick apartment buildings in Estonia

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Situation of housing in Estonia

- 71% of population lives in apartment buildings, 20%: in detached- or in terraced house, 9%: in farmhouses;
- Brick is one of the main structural material;



- Today the end of the **designed service life** of these older buildings is close;
- Typically each occupant is owner of the apartment → building;
- Milieu valuable areas (urban environment).

Service life of buildings / Performance criteria

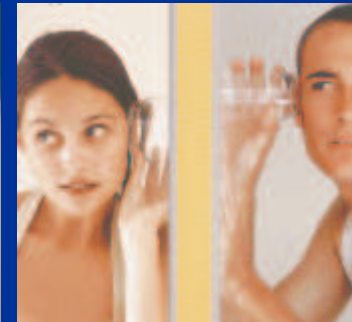
■ Service life

- Quality and properties of components and building materials;
- Design level;
- Work execution level;
- Indoor environment;
- Outdoor environment;
- In-use conditions;
- Maintenance level;

■ Performance criteria:

6 essential requirements (CPD)

- Mechanical resistance and stability;
- Safety in case of fire;
- Hygiene, safe to health and environment;
- Safety in use;
- Protection against noise;
- Energy performance

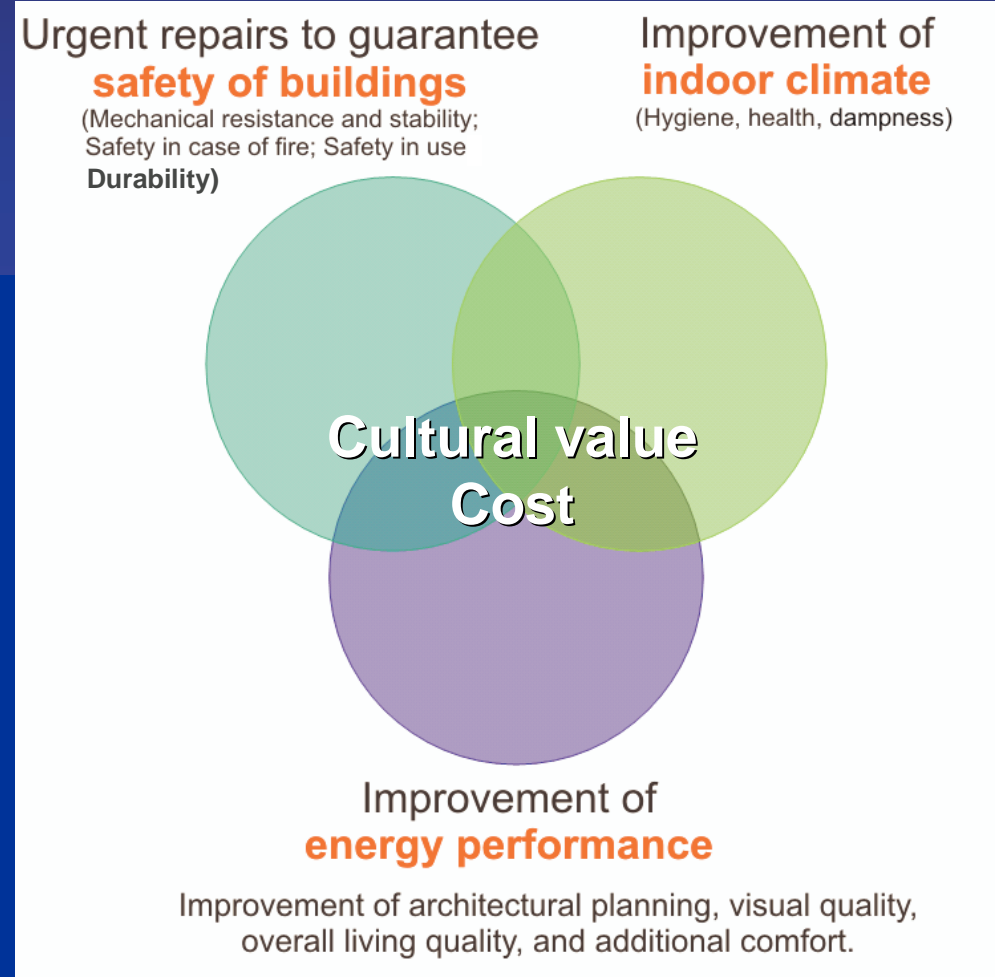


The needs for renovation

■ Typical aspects:

1. **safety** of building, **durability**;
2. **healthy** indoor climate;
3. **energy** performance + living & visual **quality**

■ Renovation and reducing energy consumption of historical buildings need to be done without losing their cultural value and identity.



The areas of research

■ Different areas of research

- Values: historical, cultural, architectural (milieu valuable areas);
- Structures: mechanical resistance and stability, durability, degradation of materials and components;
- Building physics, energy performance, and indoor climate;
- Technical systems: heating, ventilation, water, sewerage, electricity, etc.;
- Background information of the building (actual drawings of the building; earlier damages, previous investigations, interviews, risk assessment);

■ Scale of the research

- Case study (concerns one certain building or problem)
- Large scale study (concerns certain type of buildings or problems)

The aim of investigation

■ Investigation of the degradations

- exists of the degradations
- extent of the degradations
- grade of the degradations

■ Reasons of the degradations

- detection of faults in design and construction
- change of loading or alterations to a load-bearing member
- change in thermal or moisture conditions

■ Renovation solutions

- Values;
- Structures;
- Building physics, energy performance, and indoor climate;
- Technical systems.

Renovation demand of old brick apartment buildings in Estonia

- National research project: *“Technical condition and service life of Estonian brick apartment buildings”* 2009-2010
 - The main objectives:
 - Survey of technical condition typical brick apartment buildings;
 - Investigate the indoor climate and energy performance of buildings;
 - Determine the main demands of renovations of old brick apartment buildings.
 - Characterization of studied brick apartment buildings:
 - 30 buildings, constructed between 1940 and 1990, 4-9 storey;
 - From each building one to three apartments were selected to the indoor climate and building physics studies (50 apartments);
 - All the buildings and apartments studied were in private ownership.
 - The research was financed by Credit and Export Guarantee Fund KredEx and Tallinn University of Technology

Research

- Investigation of building envelope
 - survey of technical conditions of the constructions (walls, floors, roofs, balconies)



Research

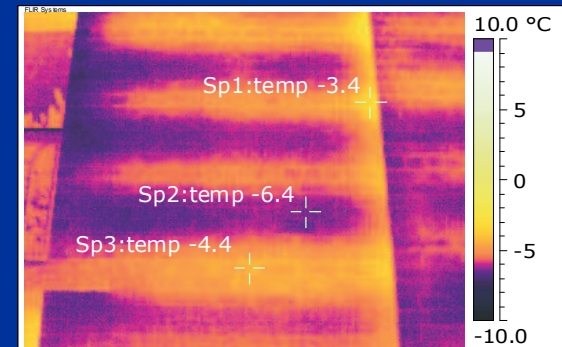
- **Investigation of building envelope**
 - survey of technical conditions of the constructions (walls, floors, roofs, balconies)
 - frost resistance of the facades



Research

■ Investigation of building envelope

- survey of technical conditions of the constructions (walls, floors, roofs, balconies)
- frost resistance of the facades
- thermal transmittance and thermal bridges of building envelope
- air tightness of building envelope



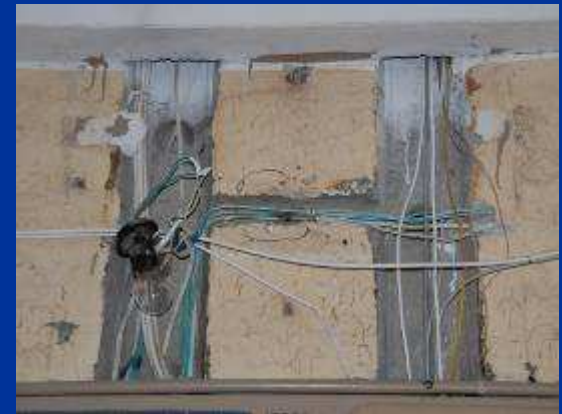
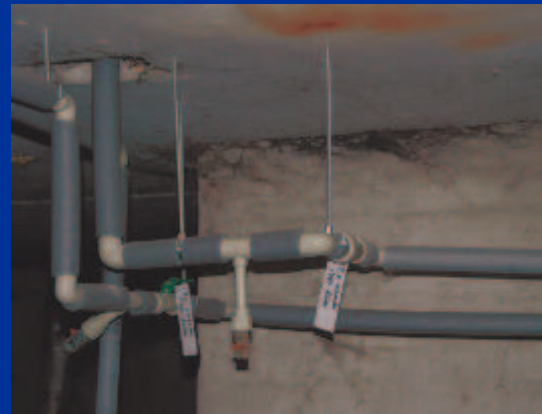
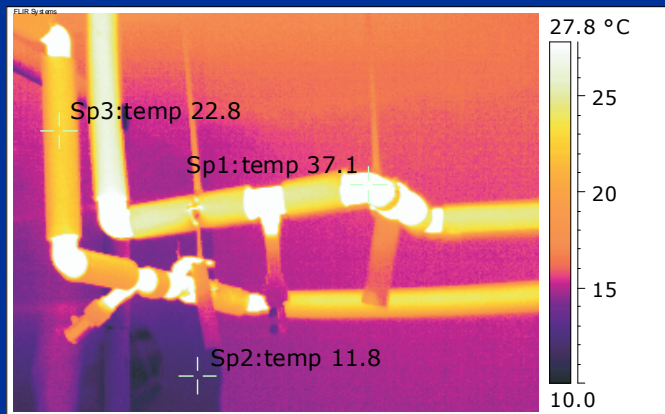
Research

- Investigation of building envelope;
- **Indoor climate, hygrothermal conditions**
 - indoor temperature and relative humidity over one year per hour interval
 - indoor CO₂, performance of ventilation
 - microbiological contamination on surfaces of building and indoor air



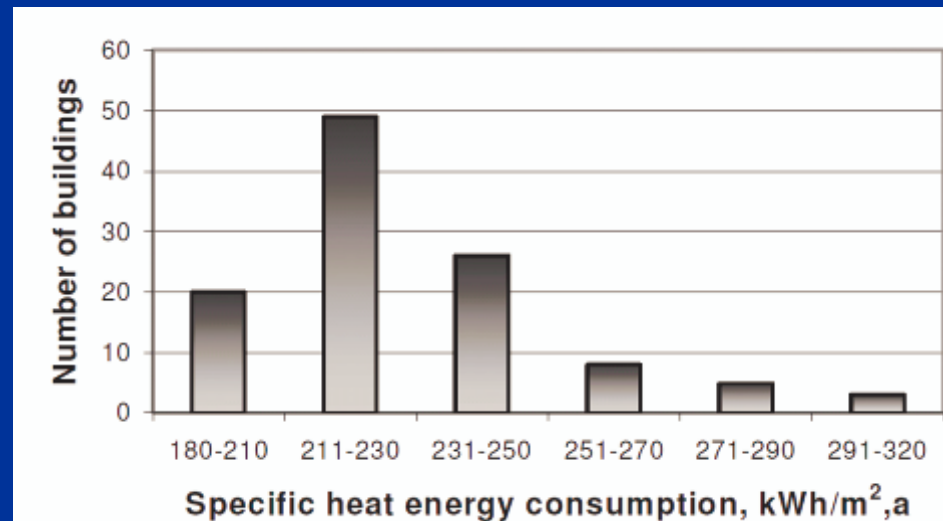
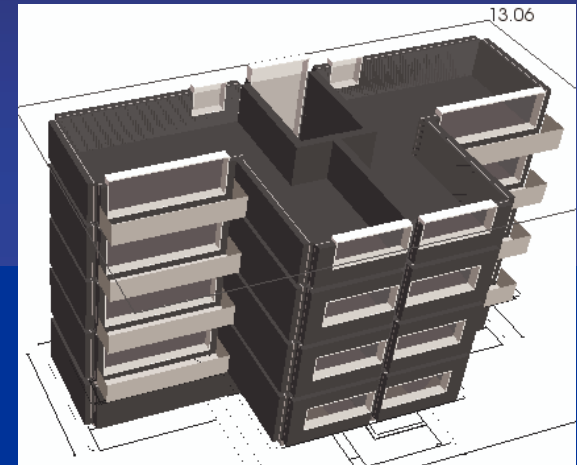
Research

- Investigation of building envelope;
- Indoor climate, hygrothermal conditions
- **Conditions of building technical systems**



Research

- Investigation of building envelope;
- Indoor climate, hygrothermal conditions
- Conditions of HVAC systems
- **Measurement and simulation of energy use**

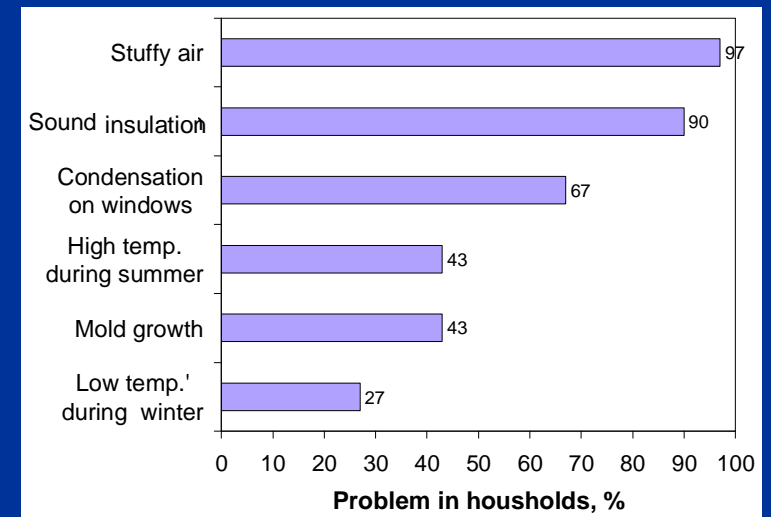
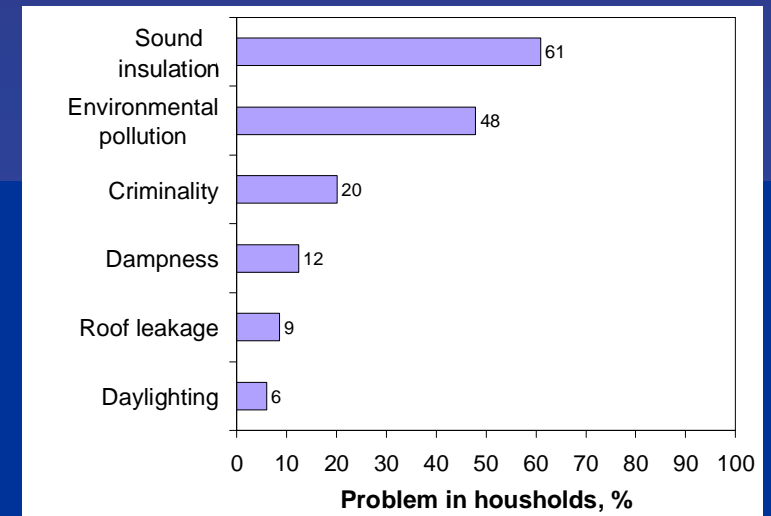


Research

- Investigation of building envelope;
- Indoor climate, hygrothermal conditions
- Conditions of HVAC systems
- Measurement and simulation of energy use
- **Questionnaire for occupants**

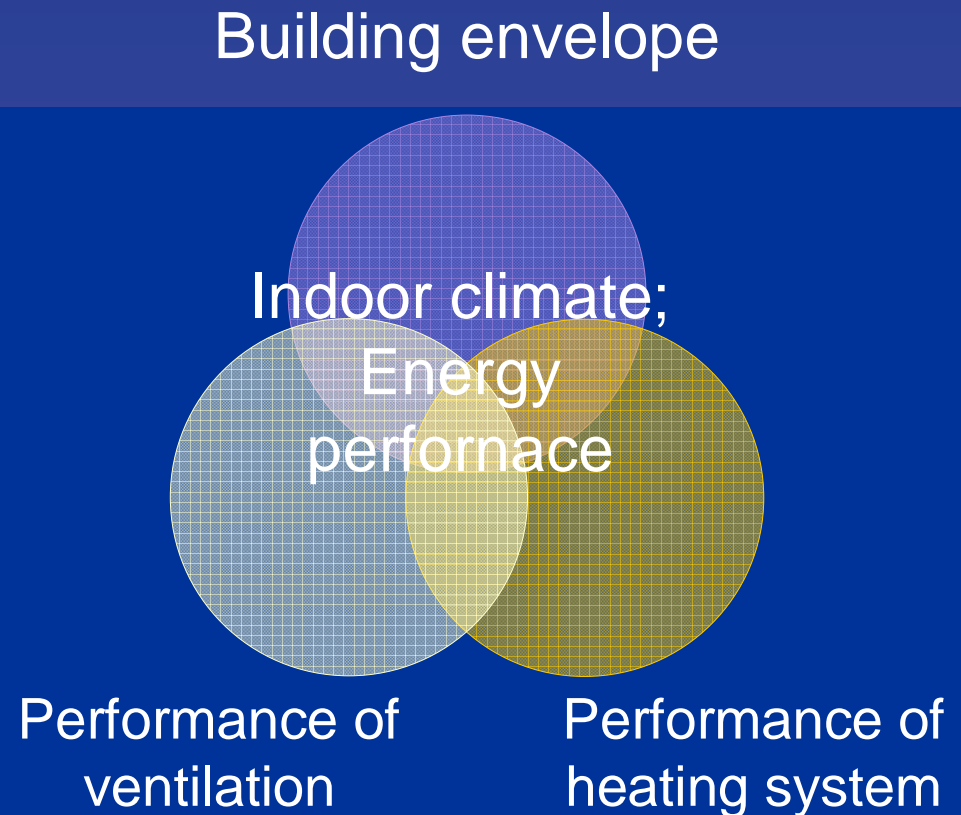
The main problems in general

- Mechanical resistance and stability are not the main problems
- The main technical problems are in the field of:
 - indoor climate,
 - building physics,
 - HVAC systems,
 - energy efficiency.
- Old dwellings need improvement to meet today's requirements in a:
 - healthy indoor climate, thermal comfort,
 - energy performance,
 - functional / architectural,
 - constructional / technical.



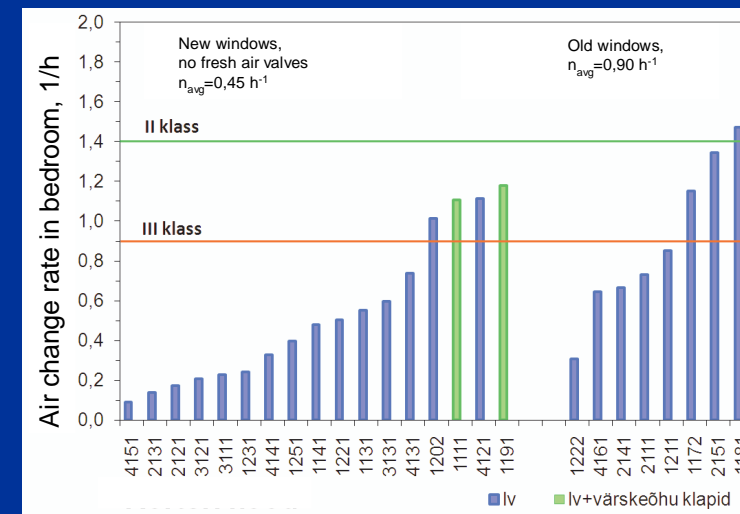
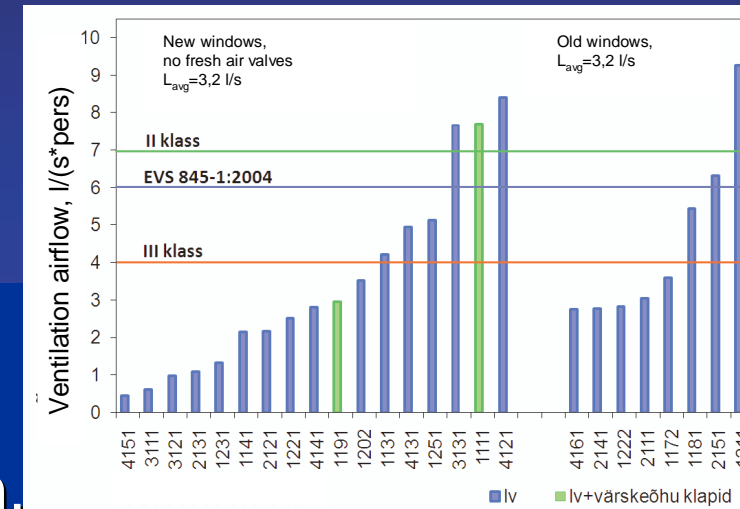
The main needs for renovation

- Improvement of indoor climate and energy performance of buildings in cold climate:
 - performance of building envelope;
 - performance of ventilation;
 - performance of heating systems.



Ventilation

- Typical problems of existing systems:
 - natural ventilation (passive stack, window):
 - low air change,
 - low indoor air quality,
 - high moisture load,
 - no heat recovery: large energy consumption,
 - impossible to regulate air flows,
 - air inflow from stack (wind),
 - air tightness of old ventilation channels,
 - the replacement of windows without renovation of ventilation:
 - smaller leakage rate,
 - more airtight building envelope.



Ventilation

■ Challenges for renovation:

■ mechanical exhaust ventilation with fresh air inlets:

- thermal comfort during winter (fresh air inlets with radiators)
- energy performance (exhaust air heat pump → domestic hot water)
- air tightness of old ventilation channels
- not suitable for combined ventilation channels

Ventilation

- Challenges for renovation:
 - mechanical exhaust ventilation
 - **balanced ventilation with room units:**
 - where to put room units: a little space,
 - problems with sound pressure levels,
 - where to put air channels: rooms height 2.5m,
 - air flow in apartment through existing doors

Ventilation

■ Challenges for renovation:

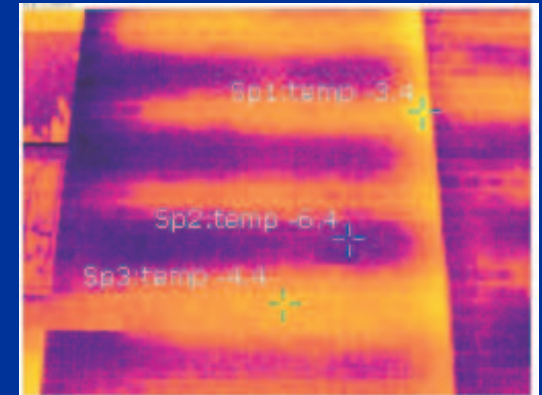
- mechanical exhaust ventilation
- balanced ventilation with room units
- **acceptance of occupants:**
 - how to motivate occupants for changes: “I do not want new tubes and noisy equipment in my apartment”
 - renovation works in apartments, change of internal doors?
 - cost-effective solutions are needed,
 - understanding about the importance of ventilation (customer, occupants): example-renovation without changes in ventilation: bad indoor climate

Thermal envelope

■ Existing problems:

■ **high thermal transmittance:**

- external walls $0.5\text{--}1.2 \text{ W}/(\text{m}^2\cdot\text{K})$,
- roof-ceilings $0.7\text{--}1.0 \text{ W}/(\text{m}^2\cdot\text{K})$,
- windows $2\text{--}3 \text{ W}/(\text{m}^2\cdot\text{K})$.



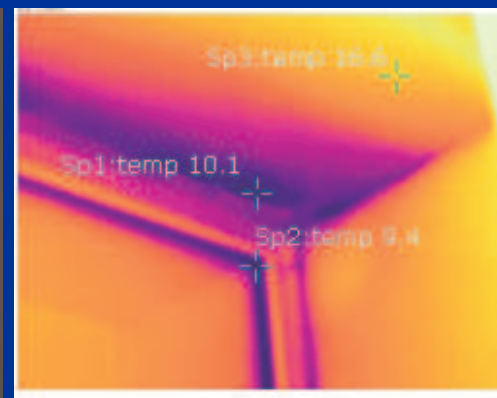
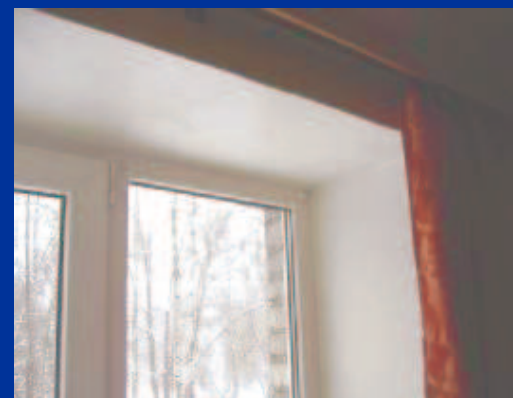
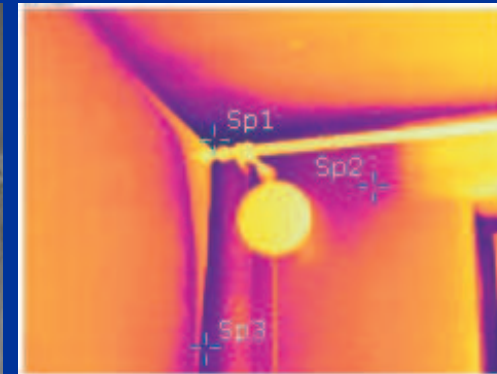
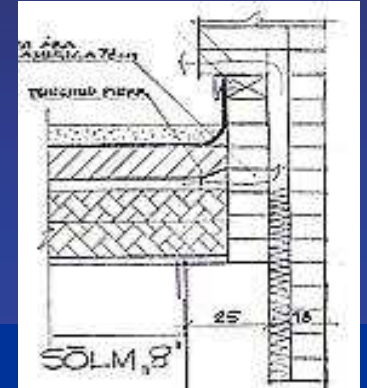
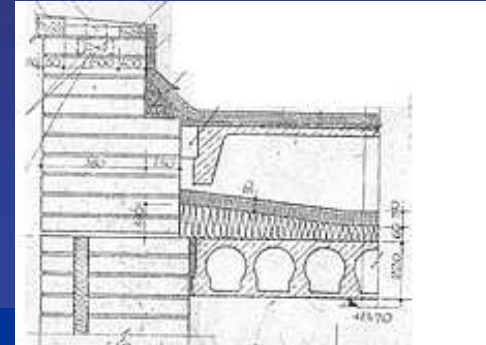
Thermal envelope

■ Existing problems:

- **high thermal transmittance**
- **serious thermal bridges:**
a large problem especially in
old apartment buildings

mould growth and surface condensation
on the internal surfaces of thermal bridges
is unavoidable without:

- lowering thermal transmittance,
- lowering internal humidity loads.



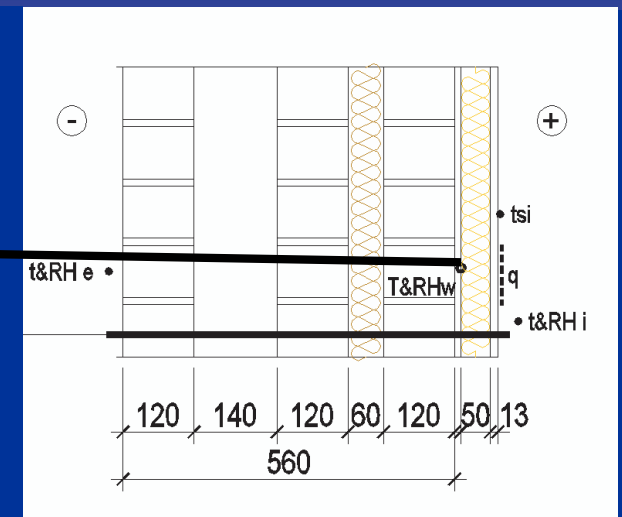
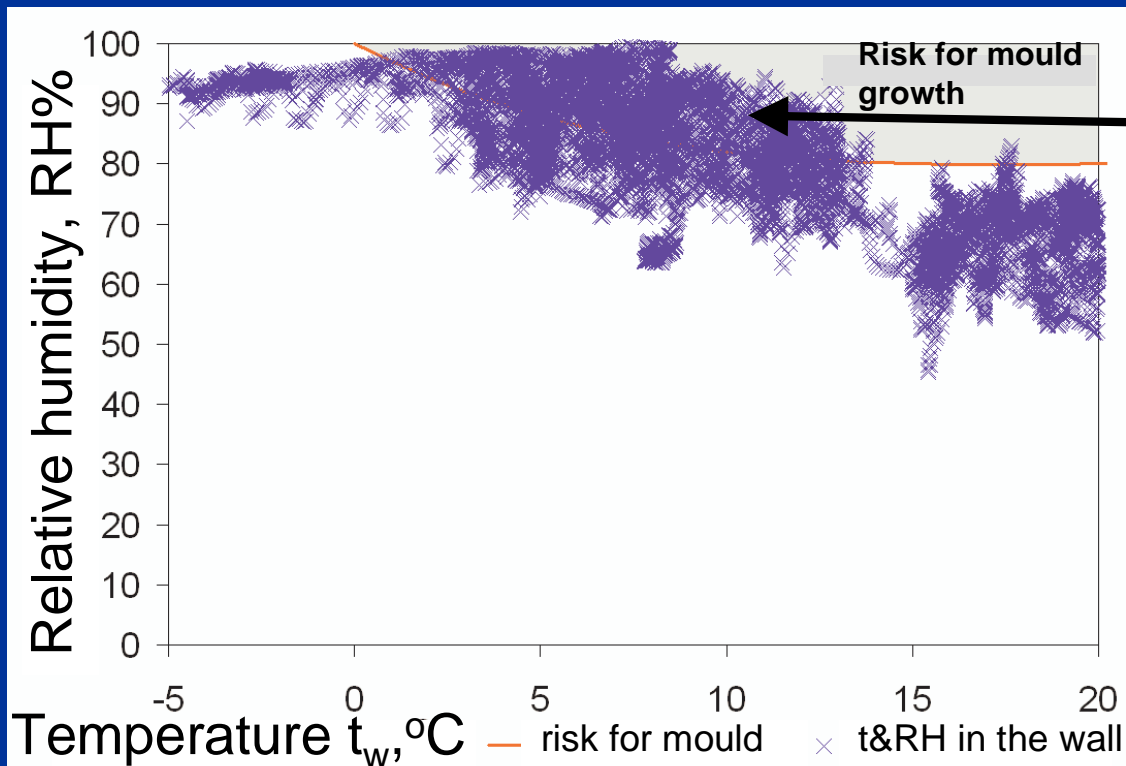
Thermal envelope

- Existing problems:
 - **high thermal transmittance:**
 - **serious thermal bridges:**
also big problem in old apartment buildings already additionally insulated (windows)
 - **low frost resistance:**
a need to protect facade,
 - **carbonization of concrete,**
 - it is economically reasonable to make the additional thermal insulation for walls and roofs (strong pressure).
 - cultural value should be preserved



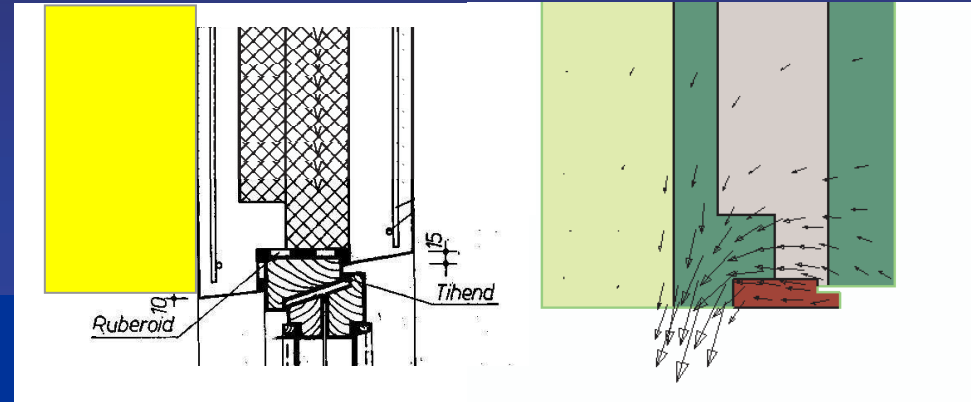
Thermal envelope

- Internal thermal insulation is risky solution in cold climate: mould growth and condensation in the wall on the old wall surface



Thermal envelope

- Typical problems with the additional insulation:
 - **Windows:** old or new, on its original place
 - thermal bridge in connection of wall and window
 - visually bad solution



Thermal envelope

- Typical problems with the additional insulation:
 - **Windows:** old or new, on its original place
 - **Low quality:** air space between old wall and new insulation;



Thermal envelope

- Typical problems with the additional insulation:
 - **Windows**: old or new, on its original
 - **Low quality**: air space between old wall and new insulation;
 - **Loggias**: thermal bridges, mould



Thermal envelope

- Typical problems with the additional insulation:
 - **Windows**: old or new, on its original
 - **Low quality**: air space between old wall and new insulation;
 - **Loggias**: thermal bridges, mould
 - Drying out of **constructional moisture**



Thermal envelope

- Typical problems with the additional insulation:
 - **Windows**: old or new, on its original
 - **Low quality**: air space between old wall and new insulation;
 - **Loggias**: thermal bridges, mould
 - Drying out of **constructional moisture**
 - **Complex renovation** (ventilation + building envelope + heating systems) is not common: mould after insulation (ventilation was not renovated)



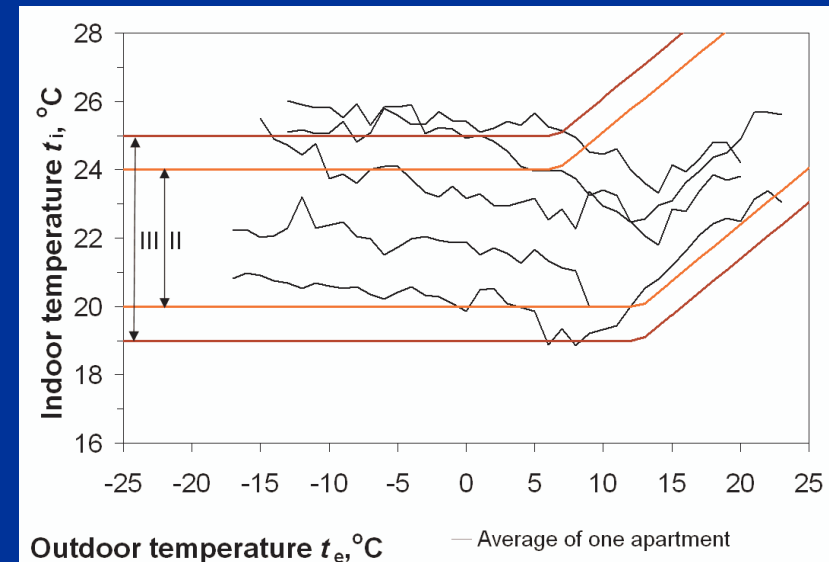
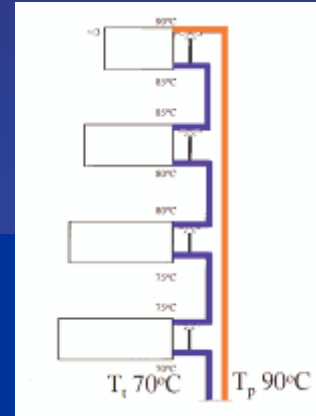
Heating systems

■ Typical solution:

- one-pipe heat distribution system;
- no room thermostats on radiators;

■ Typical problems:

- incorrect control curve of the temperature of the supply water of the heating system,
- incorrect water flow rate of the risers of the heating system,
- lack of direct room temperature control,
- difficulties to balance the one-pipe heat distribution system,
- lack of maintenance and improper modifications of the heating and ventilation systems.



Conclusion

- There exists the need to renovate old brick buildings:
 - to lengthen the service life of building;
 - to provide healthy indoor climate;
 - to lower the energy consumption of buildings (pressure from occupants and from EU (20/20/20));
 - to ensure mechanical resistance and stability.
- During renovation of historical buildings we face different problems compared to new buildings;
- During renovation of historical buildings the identity should be preserved;
- There is a need for different renovation solutions where all presented aspects are taken into account;
- Example renovations with good practice, including monitoring and actual performance reports, are needed.