Deterioration of building envelope of wooden apartment buildings built before 1940 based on external survey

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Introduction

- Wood was the main structural building material until WW II.
- Many of the historic listed buildings and areas are in bad conditions and need thorough and ongoing renovation.
- A lack of local guidelines aimed at increasing durability and energy-efficiency as well to longer the service life of monumental building or milieu valuable districts;



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- Many of the historic listed buildings and areas are in bad conditions and need thorough and ongoing renovation.
- A lack of local guidelines aimed at increasing durability and energy-efficiency as well to longer the service life of monumental building or milieu valuable districts;
- This study concentrates on the:
  - investigation of technical conditions of the external side of the building envelope (roof, facades, windows, foundations etc.) of old wooden apartment buildings;
  - moisture-related problems mainly.

Methods

- Studied buildings
  - 4 towns
  - private ownership
  - 1-4 stories
  - built <1940
  - external wall
    - hor. log
    - vert. log
    - timber-frame
  - external surface:
    - wooden gladding (73%)
    - plastering (27%)

Methods

- Studied buildings
- The survey
  - External survey: 133 buildings;
  - External + internal survey: 29 buildings;
  - Special questionnaire
    (in beginning two researchers, later more);
    - Foundation wall: dimensions, material, condition of the rendering, windows, causes of defects;
    - Facade: material, decorations, condition, windows, doors, maximum thickness of additional thermal insulation;
    - Rainwater drainage systems: existence of the components, condition;
    - Roof: material, leaks, condition;
    - Chimney: existence of the components, condition;
    - Recommendations: required tasks to be attended and timeframe.

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- The survey
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  - Special questionnaire
    (in beginning two researchers, later more);
  - Samples from possibly damaged areas;

Methods

- Studied buildings
- The survey
- Classification for technical condition

0 – failure/dangerous situation, very severe damage:
needs immediate renovation;

1 – bad, severe damage:
needs renovation during 1 year;

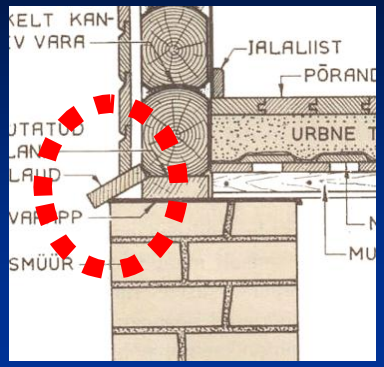
2 – satisfactory, moderate damage:
renovation recommended within 3-5 years;

3 – good, slight damage:
maintenance recommended within 5 years;

4 – very good, very slight and small damage:
may need maintenance within 10 years;

5 – excellent, no visible damage, new structure in good condition, correct performance.

Foundation's board →



Results: roof

- Typical problems:
  - Leaking of roof:
    - corrosion of metal,
    - cracking of the roof-boards,
    - loose or missing roofing tiles.
    - bushings;
  - Flora on the roof
    (prevents water drainage;
    50 % of stone and asbestos-cement roofs suffered from growth of moss or plants);
  - Lack of maintenance;



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  - Lack of maintenance;
  - Low thermal resistance;

Type of roofing material	Standing seam sheet metal	Asbestos-cement board	Corrugated sheet metal	Stone roofing
Percentage of roofing materials (note: several materials could be present on a roof simultaneously)	54 %	35%	15%	9%
Average category of the technical condition	Good (cat. 3)	Satisfactory (cat. 2)	Very good (cat. 4)	Good (cat. 3)
Roofs in bad or dangerous condition, (cat. 0 and 1)	3 %	4 %	0 %	0 %
Roofs requiring replacement within 3 years (cat. 2)	13 %	35 %	0 %	25 %
Roofs requiring replacement within 10 years	33%	48%	0%	17%

Results: rainwater drainage systems

- 72% of rainwater drainage systems were defective:
  - non vandal-proof lower sections of the drainage pipes
  - water reached foundation wall and external wall,
  - construction errors (pipes connected in the wrong order),
  - growth of flora and low maintenance.






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	Rainwater flow to the external wall or foundation wall	Defects and discontinuance of rainwater systems	Clogging of the rainwater systems
Of all rainwater drainage systems	62 %	44 %	29 %
Of renovated rainwater drainage systems	40 %	21 %	14 %

Results: facades

- Main areas of damages:
  - above foundation wall: 48%
  - around eaves: 30%
  - near drainage system: 26%
  - near corners: 21%
  - around canopies: 11%
  - near trees and vegetation: 9%
  - around windows: 8%
  - near cables with wrong slope






Results: foundations

- Main damages:
  - excess moisture (chipping of paint, destroyed mortar, bricks and limestone): 58%
  - algae as an indicator of moist surface: 57%
  - different settlement of foundation: 32%
  - high level of the ground surface: 8%

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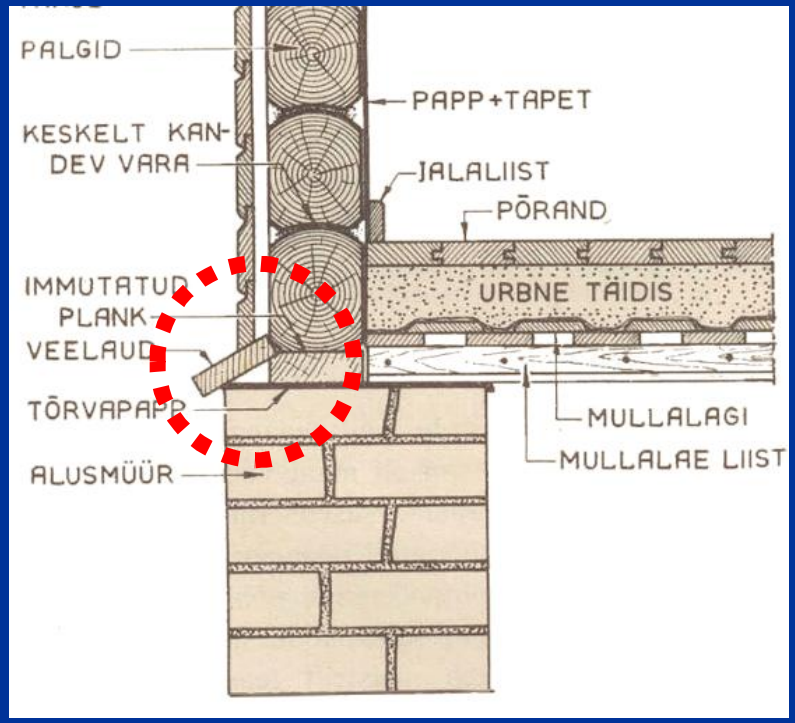
  - high level of the ground surface: 8%
- Reasons for the wetting of the foundation:
  - rainwater downpipe: 35%
  - vegetation: 22%
  - missing or broken gutter: 20%
  - water sprays from the street: 14%
  - flows down the wall: 14%
  - wrong street's slope: 13%

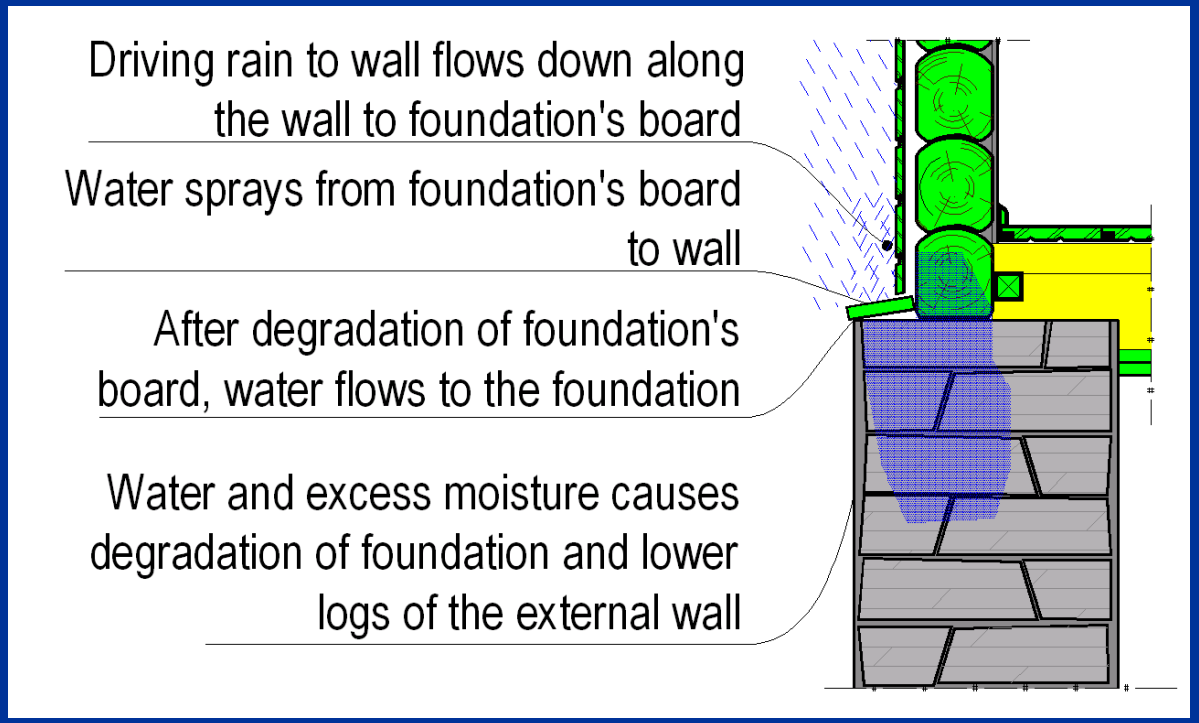
Results: facade + foundations

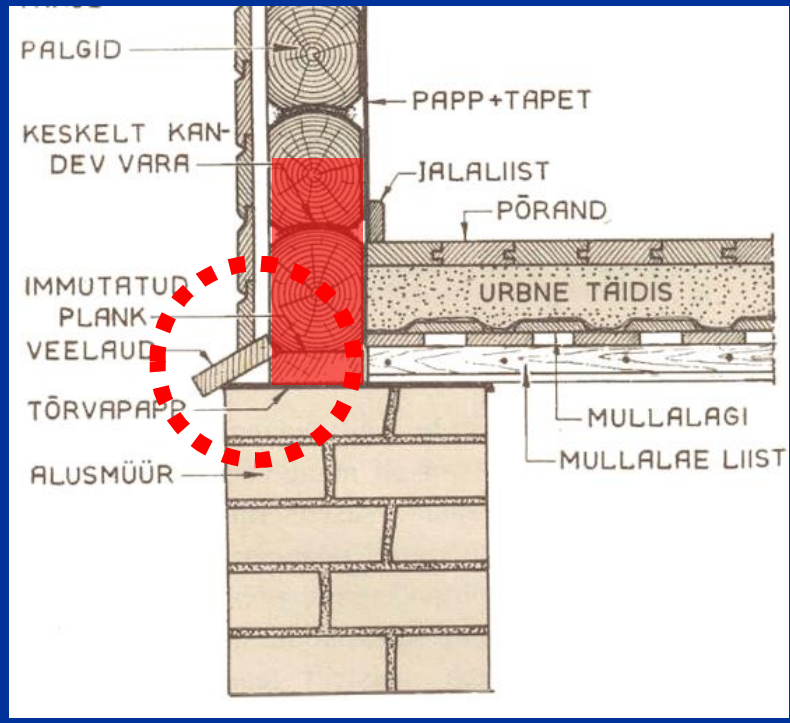
- Typical area for damage:
  the rows first of the log of the external wall;



Results: facade + foundations

- Typical area for damage:
  the rows first of the log of the external wall;
- In renovation of buildings, the Heritage Board requires original solution
  (despite that was partly guilty on degradation);



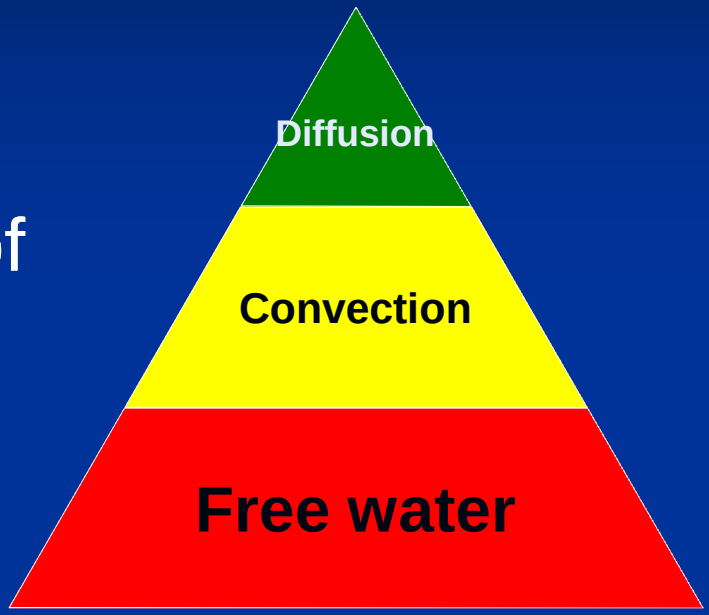


Results: rot damages

- 27% of wooden samples had rot damages:
  - brown rot: 20%,
  - soft rot: 5%,
  - white rot: 2%.
- Rot damage was determined in 63% of buildings (10/16).
- Main areas for rot damages:
  - the first log row of the external wall,
  - roofing construction,
  - floor beams in crawl space.

Conclusions

- Wood is not very moisture-tolerant and brings easily all mistakes out;
- The most critical factor in degradation of wooden buildings was free water;
- Nevertheless, in many cases designers still concentrate mainly on vapour diffusion;



Causes for moisture damages

- Required renovation within 10 years:

New cladding	New roofing	Foundation wall renovation	New windows	At least 3 of the previous combined
37%	52%	71%	17%	23%