Field investigation of unventilated cold attics

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Ventilated cold attic

- Traditional method in Norway
Unventilated cold attics

Cold, ventilated attic

Advantages:
• reduced risk of fire spreading through the attic
• no snow blows into the attic

Underroof with low vapor resistance allows drying of built-in moisture ($S_d$ value max. 0.5 m)
Field investigation

- 6 wood construction houses
- investigation performed January – March
- buildings located in south-east of Norway
- monthly mean outside temperatures -8.4 °C to -11.3 °C which is 3.8 – 6.2 °C below normal
Field investigation – Case 1

- cold attic with fink trusses
- extension on both sides of house with flat roof
- no trapdoor to attic
- no ventilation system in living space
- bathroom fan is often out of order
Field investigation – Case 1

- condensed water on underroof in attic
- condensation/ice at eaves in attic
- leakage in bedroom (at the border of pitched/flat roof)
- 16 weight-% moisture in trusses in attic
- condensation on windows
- 50 % relative humidity and 18 °C in room below attic
- no air leakage from rooms below or from outside into attic (the wall between the flats is not controlled for air leakages)
- outdoor temperature 1 °C
Field investigation – Case 2

- cold attic with fink trusses
- extension on both side of house with flat roof
- trapdoor to attic
- insufficient ventilation in living space
Field investigation – Case 2

- condensed water on underroof in attic
- ice at the eaves of the attic
- leakage in bedroom (at the border of pitched/flat roof)
- 18 weight-% moisture in trusses in attic
- 35 % relative humidity and 19 °C in room below attic
- no air leakage from rooms below (the wall between the flats is not controlled for air leakages), from outside or through trapdoor into attic
- outdoor temperature 1 °C
Field investigation – Case 3

- cold attic with rafters
- trapdoor to attic
Field investigation – Case 3

- rime on lower part of underroof in attic
- rime and condensation reported along the whole underroof in the period before the investigation
- 13 weight-% moisture 50 mm inside the ridge beam
- no air leakage from rooms below, from outside or from trapdoor into attic
Field investigation – Case 4

- simple attic truss
- unventilated cold space above tie beams
- building under erection
Field investigation – Case 4

- leakage from external wall at entrance to house
- rime observed along the whole underroof in attic
- rime on underroof in roof above bedroom
- 13 weight-% moisture in laminated wood girder and 27 weight-% in furring strip in attic
- 40 % relative humidity and 20 °C in room below attic
- no ventilation in building
- no large air leakages from rooms below
- outdoor temperature -7.5 °C
Field investigation – Case 5

- simple attic truss
- unventilated cold space above tie beams
Field investigation – Case 5

- rime on underroof in attic
- 18 weight-% moisture in upper part of truss
- 15 weight-% in middle of truss
- no air leakage from rooms below, from outside or through trapdoor into attic
Field investigation – Case 6

• simple attic truss
• unventilated cold space above tie beams
• one dormer at each roof surface
• building under erection
Field investigation – Case 6

- rime and condensation water on underroof in attic
- 26 weight-% moisture in top of truss
- 54 % relative humidity and 19 °C in room below attic
- no air leakage from rooms below at time of inspection in attic
- reported previous air leakages through trapdoor
- observed air leakages around ventilation tube in dormer
- outdoor temperature 1 °C
Cause of damage – properties of underroof?

- moisture level in wood materials may be up to 20 weight-%
- high vapor resistance of the underroof reduces drying of the wood
- consequence: condensation or rime on the underroof

- the underroofs in the investigated buildings: low vapor resistance, $S_d$ value 0.014 – 0.25 m
- not the cause of damage
Cause of damage – wet wood materials? (1/2)

- no tradition for weather protected building in Norway
- wood materials have limited ability of natural drying in autumn/winter
- if mounting moisture and air barriers before the construction is dried to an acceptable level (15 weight-% for wood), a too high amount of moisture may be built in
  - excess moisture may be deposited on the surfaces
  - leakages in the rooms below when the rime and ice melt
  - rime may alter the properties of the underroof (increase vapor resistance)
Cause of damage – wet wood materials? (2/2)

- the wood constructions in four of the six buildings had high moisture content
- indication on too high moisture content in the wood materials under erection
- normally most of the built-in moisture will dry up within one year
Cause of damage – internal air leakages?

- air leakages between the heated parts of the building and the cold attic \(\rightarrow\) warm moist air will be cooled down in attic
- the relative humidity of the air above saturation \(\rightarrow\) excess water deposits on surfaces
- In building 6: previous air leakages from rooms below
- In the other buildings: no substantial air leakages
Cause of damage – water leakages from outside?

- rime and condensation water has been observed over a large area
- water leakages are usually concentrated
- no other symptoms indicated water leakage
### Cause of damage

<table>
<thead>
<tr>
<th>Building</th>
<th>Cause of damage</th>
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<tbody>
<tr>
<td>1</td>
<td>High built-in moisture, secondary also air leakages from the ground through wall between flats</td>
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<tr>
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<tr>
<td>3</td>
<td>High built-in moisture</td>
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<td>4</td>
<td>Primary high built-in moisture, secondary also air leakages</td>
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<tr>
<td>5</td>
<td>High built-in moisture</td>
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<tr>
<td>6</td>
<td>Combination of high built-in moisture and air leakages through trapdoor and ventilation tube</td>
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Built in moisture in attics

Single family house, ground floor area 90 m²

- 5 m³ wood materials are found in the attic (2500 kg at a density of 500 kg/m³)
- Wood materials drying from 20 weight-% to 15 weight-%
- 125 litre excess water are to be transported through the underroof
Conclusions (1/2)

- Built-in moisture was the main cause of the damage in the invested buildings. Internal air leakages increased the problems in some buildings.
- The principle with unventilated cold attics is a less robust construction method than ventilated attics.
- In periods with extensive natural drying some condensation may be deposited on the underroof.
- If the wood materials have high moisture content and the external climate is cold over a longer period, there is a risk of moisture damage.
- Drying time can be reduced by ventilating the attic during erection; another solution is to use dehumidifier.
• Underroofs which have the ability to absorb a minimum of 0.5 kg/m$^2$ moisture should be recommended if the $S_d$ value is above 0.1 m

• Installation of moisture barriers (with tight joints) immediately after the insulation is set up will increase the robustness

• Underroofs with vapor resistance below 0.1 m will increase the robustness

• It is important to control the moisture level; use wood materials with low moisture content combined with weather protected building