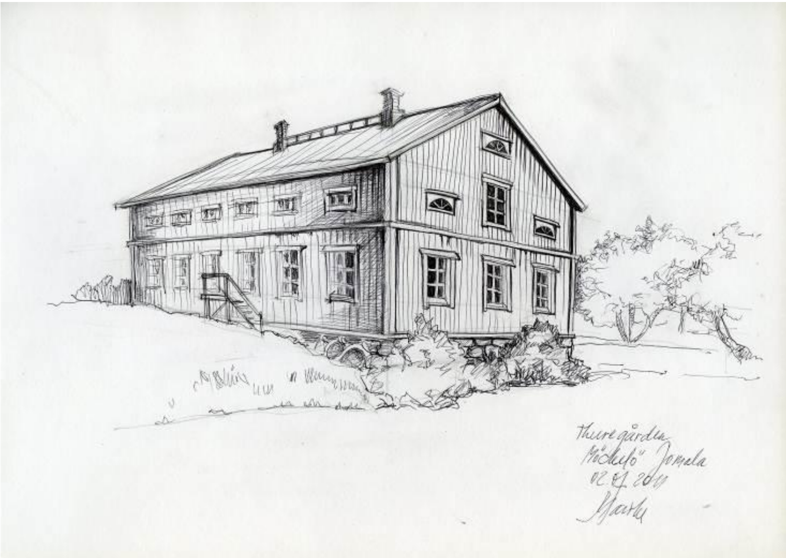
Inspections on Åland islands

Project Fungi and Beetles in Buildings on Islands of Baltic Sea (acronym FaBBi)



Tartu 2011

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OVERVIEW OF THE PROJECT FABBi

Aims:

The aim of this project is to prolong the durability of wooden buildings and structures on islands so that the historically valuable architectural heritage and properties of people are preserved. Several experts from Estonian, Swedish, Latvian and German universities take part in this project and their main aim is to work out an environment-friendly and sustainable methodology for the treatment of fungal and beetle damage in timber structures. At the same time, an example treatment will be performed in Ruhnu churches.

Partners:

- Estonian Open Air Museum – leading partner
- Gotland University
- Estonian Mycology Research Centre Foundation
- Estonian University of Life Sciences

Additional partners:

- Churches from Gotland
- National Heritage Board of Estonia
- Ruhnu Rural Municipality
- Gotland County Government
- Åland Museibyrån

Financed by: European Union and Central Baltic INTERREG IV A Programme

Duration of the project: 1 November 2010 - 31 October 2013.

ACTIVITIES

- Investigating and monitoring biodeteriorations (wood destroying fungi and insects) in wooden buildings or wooden-structure buildings; and developing environment-friendly methods for halting the spread of attacks. Up to 150 buildings are being investigated, 107 of which are located in Estonia.
- Monitoring wood damaging beetles in forests on Ruhnu, Kihnu and Vormsi Islands, finding relations between insects in buildings and in the forest, and between their population sizes.
- Organizing fieldwork on wooden cultural heritage on Kizhi Island.
- Publishing a handbook of wood destroying insects and fungi.
- Establishing a laboratory for investigating fungal and beetle damage in Estonia.
- Treating Ruhnu and Vormsi churches (or similar buildings) against the attacks of wood destroying insects and fungi, and the primary strengthening of constructions.
- Bringing top scientists, who study the durability of wood and conservation to Estonia and involving them in studies of Estonian historical buildings and wooden structures.
- Organizing 35 seminars and trainings for researchers from Estonia and Gotland, householders and other people interested.
- Making three educational films (fungal damage in houses, beetle damage in houses and treating timber structures in houses).

- Establishing a rural architecture research and training center. Drawing up renovation projects for Liberty Summer Manors on the territory of the Estonian Open Air Museum, planning a counseling center and exhibition.
- Organizing an international conference on the durability of wooden structures at the Estonian University of Life Sciences.
- Publishing a collection of conference articles.

INVESTIGATIONS ON ÅLAND ISLANDS

Cooperating with Åland Islands` Museum specialists – Carola Boman and Aino-Maria Niemelä – ten buildings were investigated on different Åland islands. We investigated churchs, open air museum buildings and private house in six municipalities (Föglö, Jomala, Kumlinge, Slatvik, Sottunga and Sund). Investigations were made in July 2011.

SPECIALISTS:

Kalle Pilt - project manager, civil engineer

Marko Teder - civil engineer

Ave Sadam - mycologist

Jane Oja - mycologist

Kristel Pau - specialist

EQUIPMENT:

Protimeter Moisture Measurement System

Wawetek Meterman TRH22

Digital camera Olympus E-3/ E-330

ZUIKO DIGITAL Wide-angle lens ED 7-14mm 1:4

ZUIKO DIGITAL Telephoto lens 50-200 mm 1:2.8-3.5

ZUIKO DIGITAL lens 14-54mm 1:2.8-3.5

Fiber optic borescope Olympus R080-063-045SW115-50

Light microscope Eclipse 50i (Nikon Corporation)

Stereomicroscope SMZ 800 (Nikon Corporation)

1. ENLISTED MARINE'S CROFT
JAN KARLSGÅRDEN OPEN AIR MUSEUM

Kastelholm, Sund

1.1. Exterior inspection

Date of inspection: 27th of June in 2011
Time of inspection: 10:05 to 11:40
Type of building: horizontal log building with existing socket.
Temperature: 17.6˚C
Relative humidity: 55.5%

The building is situated on a hump. Rainwater is poorly conducted away from the building. Although the rainwater system is incomplete (Fig. 1.), the placing of the building favours the drainage of the rainwater. On the other hand, due to the height of the socket, timber walls experience a severe water load (rainwater is splashing up from the ground taking along organic matter) (Fig. 2.). The height of the socket is too low, varies from 10 to 30 cm.

The roof seems to have some deformations in the load-bearing structures (Fig. 3.), but it cannot be inspected thoroughly due to the inaccessibility of the attic.

Fig. 1. The rainwater system is incomplete

Fig. 2. Loose or missing mortar between quarry stones of the socket

Fig. 3. The southern roof side undulates, which indicates deformations of the load-bearing structures

1.2. Interior inspection

Ground floor

Temperature: 17.3˚C (measured in room No. 4).
Relative humidity: 60.6% (measured in room No. 4).

The building has timber floors, which are ventilated with incitement holes in the socket only in the eastern part of the building (rooms No 1 and 4). Interior inspection revealed some old traces of water passages in rooms No. 3 and 4 (Appendix B).

Fig. 4. Traces of water passages in room No. 3

Fig. 5. Traces of water passages in room No. 4

Attic

The attic was inaccessible.

1.3. Insect and fungal damages

A few of the beetle damages were found outside, but most damages were inside the building. Precisely, all the wall constructions and handlooms in room No. 4. Walls and handlooms had massively attacked by the common furniture beetle (*Anobium punctatum*) (Fig. 6, 7, 8 and 9). Besides beetle exit holes we found holes on the floors, which were made by rodents.

We did not find any fungal damages from marine's craft.

Fig. 6. Bore dust on the damaged wall in the room No. 1


Fig. 7. Exit holes of the common furniture beetle on the wall


Fig. 8. Handlooms attacked by furniture beetle


Fig. 9. Bore dust all around handlooms, which indicates active attack

1.4. Summary and recommendations

In order to reduce the rainwater load to the exterior part of the walls, it would be necessary (if possible concerning the historical value) to install complete rainwater system. As there were traces of water passages and the southern roofside undulates, the attic should be inspected thoroughly. Although there were no visual traces of damages to the timber floors in room No 2 and 3, there should be made additional incitement holes to the socket in the western part of the building in order to assure the ventilation beneath.

2. DAIRY

King’s country estate in Kastelholm, Sund

Fig.1. Drawing of the dairy in King’s country estate in Kastelholm by Marike Laht

2.1 Exterior inspection

Date of inspection:	27th of June in 2011
Time of inspection:	12:45 to 14:25
Type of building:	horizontal log and timber frame (in room No. 3) building with existing socket
Temperature:	19.3˚C
Relative humidity:	53.5%

The building is situated on a slope. Rainwater system is complete, but rainwater is not conducted away from the building. Due to that, western side of the foundations can be under severe water load, when it is raining. There were also loose and missing mortar between quarrystones (Fig. 2) and in some places there are no quarrystones in the socket to bear the walls (Fig. 3). By reason of missing hydro-insulation between the socket and the walls (Fig. 4), quarrystones damp the logs, which lead to damages to the timber. The height of the socket is too low in some parts of the building (Appendix C).

Fig. 2. Loose and missing mortar between quarrystones of the socket

Fig. 3. Missing quarrystones in the socket

Fig. 4. There is a lack of hydro-insulation between the logs and quarrystoned socket

Some parts of walls have slanted out in the northern (Fig. 5) and southern (Fig. 6) sides of the building. There is also a severe UV-damage in the southern side of the building (Fig. 7).

Fig. 5. Wall slanted out

Fig. 6. Boarding and logs of wall have slanted out

Fig. 7. The southern side of logwalls have severe UV-damade

2.2 Interior inspection

Ground floor

Temperature:	18.7˚C (measured in room No. 5)
Relative humidity:	58.7% (measured in room No. 5)

The building has concrete (in rooms No. 3 to 8) and timber floors (in rooms No. 1 to 3) that are not ventilated with incitement holes in the socket; they are only partially ventilated with indoor air.

In room No. 6 the walls have loose and missing plaster, which indicates severe moisture damage (Fig. 8 and 9). In room No. 3 there has been already removed the lowest part of the damaged logged wall, but the problem consists in the absence of hydro-insulation – the socket is on a direct contact to the timber (quarrystones damps the timber element).


Fig. 8. Loose and missing plaster on the wall in room No. 6


Fig. 9. Loose and missing plaster on the wall in room No. 6

In room No. 8 the paint is peeling from the ceiling, which can indicate either to a water passage or a high humidity (Fig. 10). In room No. 2 there are some salt damages in the ceiling-beam (Fig. 11), this is due to the dairy, which was above the room.


Fig. 10. Peeling paint from the ceiling in room No. 8

Fig. 11. Salt damaged ceiling-beam in room No. 2

The walls of room No. 8 are partially covered with sheet metal that may condensate the logged walls behind (Fig. 12).

Fig. 12. Sheet metal covered walls in room No. 8

Attic

Near the chimney we identified ceiling-beam in bad condition (Fig. 13). The roof’s timber structure has a loose connection (Fig. 14), which needs to be fixed immediately.

Fig. 13. The ceiling-beam has signs of losing its strength (cracks in tensile zone)

Fig. 14. A loose connection of the roof's timber structure

2.3 Insect and fungal damages

Outside the building we found few places with old insect and fungal damages. Similar damages we identified also on the first floor. Precisely, insect and fungal damages were on the walls of room No. 4 and 6 (Fig. 15 and 16). We found old fungal damage on the floor constructions near the door had in room No. 3 (Fig. 17). Insect damages were made by Anobiidae beetles (*Xestobium ruffovillosum* and *Anobium punctatum*).

Fig. 15. Insect damages on the wall of room No. 4.

Fig. 16. Old fungal damages in room No. 6

Fig. 17. Old fungal damage in room No. 3

2.4 Summary and recommendations

Some parts of socket, that have missing quarrystones, should be remounted, in order to assure the load bearing to the walls. In order to assure the ventilation beneath the timber floors in room No. 1 to 3, additional incitement holes should be made to the socket in the southern part of the building. All the damaged logs in the socket area should be replaced.

The plaster on the wall between rooms 3 and 4 should be removed, because the logged wall beneath is damaged. In the attic the timber structures must be fixed (Fig. 13 and 14). The metal plates must be removed in room No. 2.

The northern and southern parts of logged walls have slanted out; hence those walls must be reinforced to prevent collapse of the building.

There should be monitored the activity of beetles.

3. SAINT MARIA'S CHURCH

Saltvik

Fig. 1. Drawing of Saint Maria's Church by Marike Laht

3.1. Exterior inspection

Date of inspection:	28th of June in 2011
Time of inspection:	10:00 to 11:55
Type of building:	masonry building without socket
Temperature:	23.3˚C
Relative humidity:	36.4%

The building is situated on a slope. The roof of the building is recently renovated. There is no rainwater system and rainwater is not conducted away from the building. Due to that foundation can be under severe water load, when it is raining (rainwater is splashing up from the ground taking along organic matter) (Fig. 2). The outreaching part of the walls (so-called fake socket) in the ground area are covered with biological organisms e.g. lichens and have moisture damages (Fig. 3) (Appendix D).

Fig. 2. Biodamages on the walls near the ground

Fig. 3. The outreaching part of the wall is bio- and moisture damaged

3.2. Interior inspection

Ground floor

Temperature: 18.6˚C (measured in the main hall)
Relative humidity: 58.7% (measured in the main hall)

The building has stone floors.

Belfry

There were a lot of birds' excrements (biodamage) on the timber elements (Fig. 4 and 5). Some load-bearing timber elements had traces of water passages, but the damage's extent was not severe (Fig. 6). There are also numerous cases, where the timber beams bear on the masonry walls without any hydro-insulation (Fig. 7).

Fig. 4. Timber elements covered with birds' excrements.

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Fig. 5. The whole floor is covered with birds' excrements and some elements of the timber floor are damaged

Fig. 6. Traces of old water damages and timber elements covered with birds' excrements

Fig. 7. Load-bearing timber element is unisolated with hydro-insulation - stonewall damps the timber, which may result in the reduction of shear strength

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3.3. Insects and fungal damages

The altar in this church had active insect damages. We identified bore dust inside the altar, mainly in the corners (Fig. 8 and 9). In the attic few timber elements had old insect damages caused by bark beetles (Fig. 10).

We did not find any fungal damages in the church.

Fig. 8. Bore dust inside the altar

Fig. 9. Closer view to the bore dust inside the altar

Fig. 10. Damages by the bark beetle

3.4. Summary and recommendations

In order to reduce the rainwater load to the exterior part of the walls, it would be necessary to install complete rainwater system. The outreaching parts (so-called fake sockets) should be covered with metal-sheets. The timber elements should be cleaned of birds' excrements in the belfry. Some of the floorboards should be replaced in the bell-tower (Fig. 5).

WORKER’S HOUSE

King’s country estate in Haga, Saltvik

Fig. 1. Drawing of worker’s house by Marike Laht

4.1. Exterior inspection

Date of inspection:	28th of June in 2011
Time of inspection:	10:00 to 11:55
Type of building:	plank timber building with socket
Temperature:	24.0˚C
Relative humidity:	47.0%

The building is situated on a slope, causing severe water and moisture loads to the eastern part of the foundation when raining. The rainwater system is malfunctioning, some pipes are corroded, detached and deformed (Fig. 2 and 3). The rainwater was conducted into a tank in the cellar. The doorstep has some biodamage, and is cracked probably due to the shrinkage or swelling of the ground soil (Fig. 4) (Appendix E).

Fig. 2. Corroded and malfunctioning rainwater pipe

Fig. 3. Corroded and malfunctioning rainwater pipe

Fig. 4. Cracked and biodamaged staircase

The paint of exterior walls has flaked off and the wall boarding has partially degraded (Fig. 5), eave-boardings are missing on the southern side (Fig. 6). The roof has some tiles missing, indicating to a severe water passages (Fig. 7 and 8). The basement stairs have no hatch, causing severe water load down to the basement (Fig. 9).

Fig. 5. The wall boarding has partially degraded and paint has flaked off

Fig. 6. Missing eave-boardings, paint has flaked off

Fig. 7. Some roofing tiles are missing and broken on the western side

Fig. 8. Some roofing tiles are missing and broken on the northern side

Fig. 9. The cellar’s stairway has no hatch, causing severe water load down to the basement. The stair steps and floor are covered mostly with mosses

4.2. Interior inspection

Basement

Temperature: 14.2˚C
Relative humidity: 86.3%

Due to the missing hatch of the basement, water load has caused severe bio and salt damage to the walls and ceiling and degradation of timber elements in the rooms (Fig. 10 to 14). There are also moisture and frost damages causing plaster to flake off (Fig. 15).

Fig. 10. The basement’s floor is covered with algae and the timber elements are degraded

Fig. 11. Salt damages in the ceiling

Fig. 12. Salt damages in the ceiling

Fig. 13. Degraded timber elements in sauna


Fig. 14. Degraded timber elements in sauna


Fig. 15. Moisture- and frost damage causing plaster to flake off

The southern side of the basement’s walls are with moisture and salt damage (Fig. 16). There are also a lot of old timber boards, should be removed.


Fig. 16. Moisture and salt damages on the walls of the southern part of the basement

Ground floor

Temperature: 20.5 ˚C
Relative humidity: 70.2%

The building has several water passages that have caused severe damages to the walls, ceilings and floors (Fig. 17 to 24). Water content of timber elements of kitchen floor was 53.6% and 18.6%.

Fig. 17. Severe water damages in the hall room

Fig. 18. Severe water damages in the hall room

Fig. 19. Severe water damages in the kitchen

Fig. 20. Severe water damage in the kitchen

Fig. 21. Severe water damages in the kitchen


Fig. 22. Severe water damages in the livingroom


Fig. 23. Severe water damages in the livingroom


Fig. 24. Severe water damages in the livingroom

Attic

The roof's timber structures and attic's timber floor have severe water damages; some of the timber boardings, purlin and posts have degraded (Fig. 25 to 29). The rooftiles are broken and covered with lichens (Fig. 30).

Fig. 25. Water leakages and degratation of timber elements in the roof structure

Fig. 26. Water leakages in the roof

Fig. 27. Waterdamage in the attic's northwest corner

Fig. 28. Severe water damages in the attic's floor

Fig. 29. Due to the water leakage, the rafter and the wind beam has degraded and lost its strength

Fig. 30. Many of the rooftiles are broken and covered with lichens

3.5. Insect and fungal damages

Outside of the building we did not discover any beetle damage. There were some fungal damages on the walls and some mosses and lichens grew on the rooftiles and staircases. Inside the building, we saw severe beetle attack on the timber wall of sauna (Fig. 31). There were severe fungal attacks on the floors, walls and on the ceilings on the first floor. All these damages are caused by the roof leakages. Mainly we found mycelium and fruitbodies of *Antrodia* species and also some mould fungi on the wallpapers (Fig. 32 to 34).

Fig. 31. Beetle attack on the timber of sauna wall

Fig.32. Fungal attack on the hall ceiling

Fig.33. Mycelium of *Antrodia* on the floor material in the hall


Fig. 34. Fruitbody of *Antrodia* species on the floorbeam

In the attic we found several beetle and fungal damages. Firstly, longhorn beetle (*Callidium violaceum*) had attacked the attic's roof timber (Fig 35). Also the upper part of the roof was damaged by Corticiaceae fungal species (Fig. 36). The floor beams had both the fungal and insect damages. Fungal damages were made by Antrodia species and Myxomycetes fungus and insect damages by anobiid beetle (Fig. 37 to 39).


Fig. 35. Longhorn beetle (*Callidium violaceum*) damage on roof's timber structure


Fig. 36. Fruitbodies of Corticiaceae species on the roof's timber structure

Fig.37. Fungal and beetle damages on the floorboards

Fig. 38. Fruitbodies of Myxomycetes fungus


Fig. 39. Beetle damages on the roof’s timber structure and fungal damage on the floorboards

3.6. Summary and recommendations

The most important is to repair the roof along with its timber structure to save the building structure from being completely collapsed. The roof’s degraded rafter and wind beam should be immediately replaced, because in winter with heavy snowloads it may loose its load-bearing strength. New balks with diffusion-layer should be set, when repairing the roof. And also the rainwater system must be fixed and replaced where necessary.

The exterior wall boarding should be taken off and tar paper removed, extra air-passage should be created beneath (Fig. 40). This will keep the exterior wall boarding breathable and possibility to try out throurghly. Beneath the air-passage should be wind-barrier layer with extra thermal insulation (that should be consulted according to the building regulations in Åland). Severely degraded timber elements inside the house must be replaced with new materials. All other fungal damaged timber elements with remained strength properties should be cleaned.

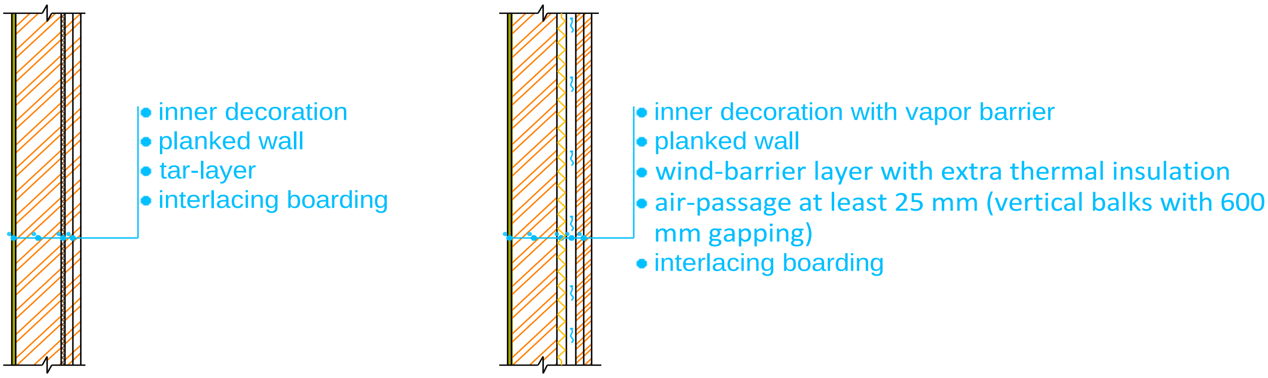

Fig. 40. Schematic drawings of wall structure. Existing structure – on the left; prospective structure – on the right

4. SOTTUNGA BELFRY

Sottunga

Fig.1. Drawing of Sottunga belfry by Marike Laht

5.1. Exterior inspection

Date of inspection:	29th of June in 2011
Time of inspection:	14:00 to 15:30
Type of building:	timber frame building with existing socket
Temperature:	24.3˚C
Relative humidity:	37.4%

The building is situated on a hump, causing water load to the southern side of the foundation (Appendix F). There is not any rainwater system and rainwater is not conducted away from the building. The socket is prevalently piled without any mortar (Fig. 2), allowing rainwater inflow.

Fig. 2. The socket is piled without any mortar allowing water to flow inside.

5.2. Interior inspection

Ground floor

Timber structures by the entrance are severly degraded; diagonal posts and roof's timberboarding are rotten (brown rot damage) (Fig. 3).

Fig. 3. Degraded diagonal posts and roof's timber boarding near the entrance

4.3. Insect and fungal damages

The northern and eastern parts of the interior walls were massively attacted by beetles. Mostly, were damaged boards and beams (Fig. 4 and 5). There was also some bore dust accumulated on the floor tiles under the structure. Unfortunately, we cannot be sure if this is still active damage.

Fig. 4. Bore dust and exit holes on the timber construction

Fig. 5. Beetle attack on the beam

Attic

Two diagonal corner posts in the eastern side of the bellfry have mechanical damages (presumably committed by birds) (Fig. 6 and 7).

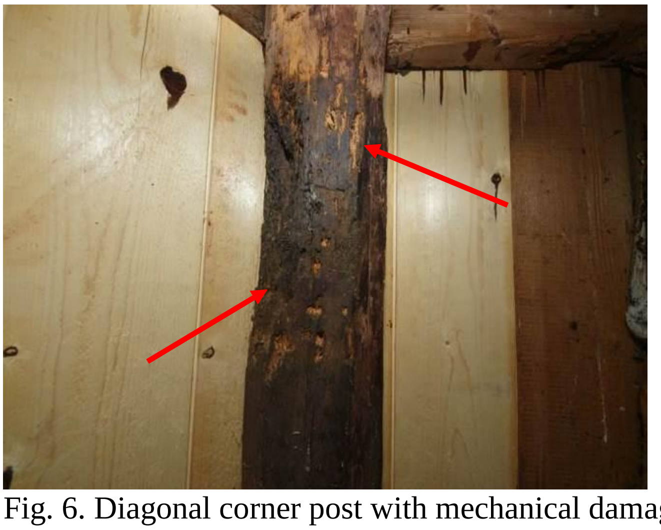

Fig. 6. Diagonal corner post with mechanical damages

Fig. 7. Diagonal corner post with mechanical damages

There were beams near the window and wall timber with severe beetle attack in the attic. Most of the timber was soft and friable (Fig. 8).

Fig. 8. Massive beetle attack on the beam

4.4. Summary and recommendations

In order to reduce the rainwater load to the building’s foundation and ground floor, it would be necessary to install complete rainwater system and set a waterbarrier to the southern part of the foundation. As there were traces of water passages, the roof should be inspected on a rainy day.

5. SOTTUNGA CHAPEL CHURCH

Sottunga

Fig. 1. Drawing of Sottunga Chapel Church by Marike Laht

6.1. Exterior inspection

Date of inspection:	29th of June in 2011
Time of inspection:	14:03 to 15:45
Type of building:	horizontal log building with existing socket
Temperature:	24.3 ˚C
Relative humidity:	37.4%

The building is situated on a hump. Therefore, water loads to the northern side of the foundation. There is not any rainwater system and rainwater is not conducted away from the building. The northern part of the socket is piled without any mortar (Fig. 2) and there were some loose and missing plaster on the southern part of the socket (Fig. 3) (Appendix G).

Fig. 2. The socket is too low and mortar between quarrystones is missing

Fig. 3. There is some loose and missing plaster on the socket

There is no hydro-insulation between the bearing floorbeams and stone foundation (Fig. 4). This causes constant damping to the bearing floorbeams and may result in their loss of strength. The water content of those timber elements were 25% and 40%. There were also useless timber elements (Fig. 5 to 6), which should be removed to prevent degradation.

Fig. 4. Missing hydro-insulation between the bearing floorbeams and stone foundation


Fig. 5. Useless timber elements


Fig. 6. Useless timber elements

The surrounding greenery is too close to the building especially in the eastern side of the building (near the entrance) (Fig. 7). Leaves gather to the roof and this favours biodegratation in future.


Fig. 7. Birch tree is too close to the building.

6.2. Interior inspection

Ground floor

Temperature:	21.3 ˚C (measured in the hall room)
Relative humidity:	53.7% (measured in the hall room)
Temperature:	20.3 ˚C (measured in the sacristry room)
Relative humidity:	54.5% (measured in the sacristry room)

The building has timber floors, which are ventilated with incitement holes in the socket only on the northern and southern sides. There are some traces of water passage on the eastern part of the ceiling in the hall room (Fig. 8).

Fig. 8. Traces of water passage on the eastern part of the ceiling in the hall room

Attic

There were some traces of water passages in the edges of roof's boarding (Fig. 9). We found some wasp's nests on the roof's ceiling (Fig. 9 and 10).

Fig. 9. Roof boarding has marks of water passages and wasp's nest


Fig. 10. Wasp's nests on the boarding

5.3. Insect and fungal damages

Longhorn beetles caused most of the beetle damages in this chapel church. Mostly were damaged hall room walls and bearing floor beams (Fig. 11 to 13).


Fig. 11. Bearing floor beam attacked by beetles

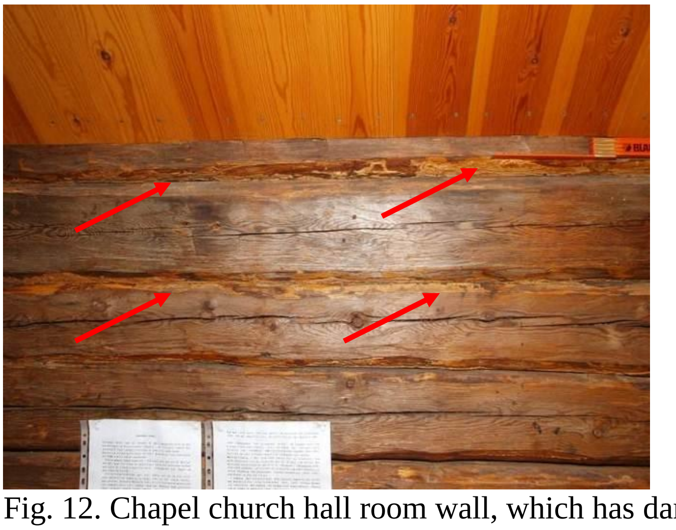
Fig. 12. Chapel church hall room wall, which has damages by bark and longhorn beetles

Fig. 13. Larvae tunnels on the surface of timber made by bark beetles

5.4. Summary and recommendations

In order to reduce the rainwater load to the northern part of the foundation and underground area, it would be necessary to install complete rainwater system. As there were some traces of water passages on the eastern part of the ceiling in the hall room, ceiling’s boarding should be detached and inspected. Although there were no severe visual traces of damages to the timber floors, there should be made additional incitement holes to the socket in the southern, eastern and western parts of the building in order to assure the ventilation beneath. Because the building is situated on a hump, it causes a severe water load to the northern side of the foundation when raining. Hence the water must be conducted away.

Between the bearing floorbeams and stone foundation a layer of hydro-insulation should be set. For this kind of repairment one should use lifting jacks to raise the floorbeams in order to set a tar layer between.

The wasp’s nests in the attic should be removed immediately. The main entrance’s roofing should be occasionally cleaned of the leaves of birch and other organic matter.

6. HERMAS MAIN BUILDING

Hermas Open Air Museum, Enklinge, Kumlinge

Fig.1. Drawing of Hermas Open Air Museum by Marike Laht

7.1. Exterior inspection

Date of inspection:	30th of June in 2011
Time of inspection:	13:10 to 15:30
Type of building:	horizontal log building with existing socket.
Temperature:	20.5 ˚C
Relative humidity:	68.7%
Temperature:	20˚C (in the underground area of the building)
Relative humidity:	75%

The building is situated on a hump, causing water load to the western side of the foundation and wall (Appendix H). The rainwater system is not complete and rainwater is not conducted away from the building (rainwater is splashing up from the ground taking along organic matter) (Fig. 2). The socket is piled mostly without any mortar (Fig. 3).

Fig. 2. Biodamages on the lower parts of the wall

Fig. 3. The socket is piled mostly without any mortar

The underground area is completely ventilated, keeping it less dampy. The load-bearing posts are not firmly set to the ground and joined to the floorbeams and there is a direct moisture connection from the ground (Fig. 4). There are also useless timber elements and drebis, which should be removed from there.

Fig. 4. The load-bearing posts are not firmly set to the ground and joined to the floorbeams, also direct moisture contact from the ground

There is no hydro-insulation between the bearing floorbeams and stone foundation (Fig. 5 to 7). This causes constant damping to the bearing floorbeams and may result in their loss of strength. The water content of timber element was 25%. There is also salt and bio damages on the floorboardings and –beams (Fig. 8) near the entrance of the underground area.


Fig. 5. Missing hydro-insulation between the bearing floorbeams and stone foundation


Fig. 6. Missing hydro-insulation between the bearing floorbeams and stone foundation


Fig. 7. Missing hydro-insulation and damped areas on floorbeams and foundation. Bio damages are on the floorbeam

Fig. 8. Salt and biodamages on the floorboards and –beams

7.2. Interior inspection

Ground floor

Temperature:	21.4 ˚C (measured in room No. 3)
Relative humidity:	63.6%
Temperature:	21.8 ˚C (measured in the attic)
Relative humidity:	64%

The building has timber floors, which are partially ventilated (rooms No. 1 and 2). Northern side of room No. 1 (wall and ceiling) has traces of water passage (Fig. 9). Due to the wallpaper the extent of damage to the bearing wall parts is unspecified. The underground area of room No. 3 is poorly ventilated; water content of timber flooring was 22% and 24%.

Fig. 9. Traces of water passage on the wall in the room No. 1

6.3. Insect and fungal damages

There were insect damages inside and outside the main building. First, the underground area floorbeams had attacks by the Deathwatch beetle (*Xestotobium rufovillosum*) (Fig. 10). There were some bore dust heaps, which indicates to active damage (Fig. 11). Also some floorbeams were found with old brown rot damages (Fig. 5).


Fig. 10. Damaged underground floorbeam


Fig. 11. Heaps of bore dust

Inside the main building we found many old insect attacks in the rooms on the first floor. Several rooms had anobiid beetles (*Anobium punctataum* and *Xestotobium rufovillosum*) attacts. First the hall ceiling, walls and the floor, secondly the Kammare room nothern side of the ceiling and thirdly the kitchen walls. On the first floor and in the attic most of the furniture had attacks by anobiid beetles (Fig. 12). In the attic the walls and ceiling were covered with beetles' emergence holes and there was also lot of bore dust, which indicate to massive attack (Fig. 13 and 14). It should be monitored to make sure is it old or active damage.

Fig. 12. Exit holes of anobiid beetles

Fig. 13. Bore dust in the attic wall

Fig. 14. Infested furniture in the attic

6.4. Summary and recommendations

In order to reduce the rainwater load to the northwestern side of the foundation and underground area, it would be necessary to install complete rainwater system. Because the building is situated on a hump, it causes a considerable water load to the western side of the foundation, when raining. Hence the water must be conducted away.

As there were some traces of water passages in the room No. 1, wall's wallpaper should be removed and inspected. Although there were no severe visual traces of damages to the timber floors, there should be made additional incitement holes to the socket in the eastern part of the building (below the room No. 3), in order to assure the ventilation beneath.

Between the bearing floorbeams and foundation and also between the bearing-posts and ground, a layer of hydro-insulation should be set. For this kind of repairment one should use lifting jacks to raise the floorbeams in order to set a tar layer between.

7. HERMAS SHED

Hermas Open Air Museum, Enklinge, Kumlinge

8.1. Exterior inspection

Date of inspection:	30th of June in 2011
Time of inspection:	14:55 to 15:50
Type of building:	horizontal log building.
Temperature:	20.5 ˚C
Relative humidity:	68.7%

The building is situated on a slope, causing water load to the northern side of the building and wall (Appendix I). There is not any rainwater system and rainwater is not conducted away from the building (rainwater is splashing up from the ground taking along organic matter). The building is situated on individually placed quarrystones (Fig. 1).

There is no hydro-insulation between the bearing logs and quarrystone (Fig. 1 and 2). This causes constant damping to the bearing logs. The logs of the walls have been hogged (Fig. 1 and 2).

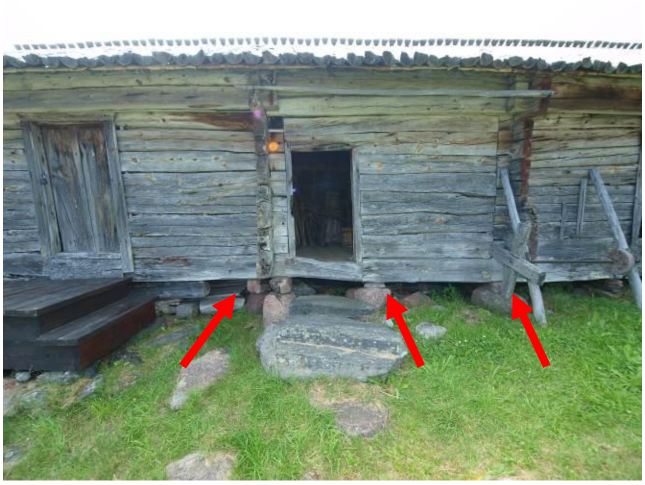

Fig.1. Missing hydro-insulation, hogged logs of the wall

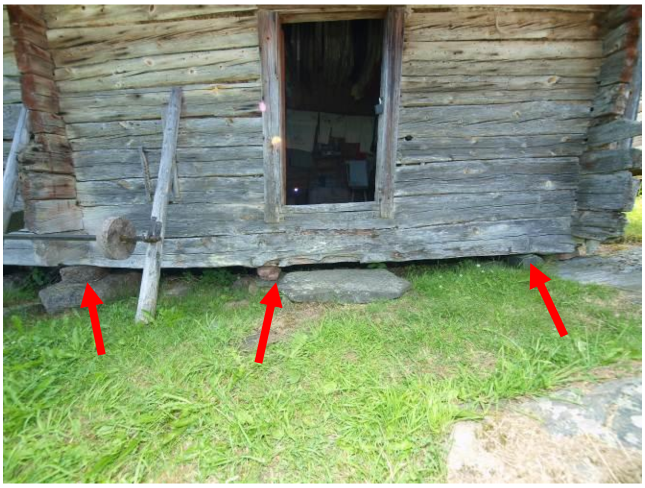

Fig. 2. Missing hydro-insulation, hogged logs of the wall

Lichens covered the northern side of the shed exterior wall panelling (Fig. 3). Also on the eastern side of the shed there were lichens growing.

Fig. 3. Lichens have covered the shed exterior wall panelling

8.2. Interior inspection

Ground floor

The building has timber floors, which are completely ventilated. However, water content of timber wall was measured 14% and timber flooring 21%.

7.3. Insect and fungal damages

Eastern and western side's exterior walls had insect damages. Inside the shed all walls had insect damages. We found bore dust on the walls and under the timber bars, which indicates that the damages are still active (Fig. 5 and 6). Damages were made by Deathwatch beetle (*Xestobium rufovillosum*). Besides active damages we found old insect damages on the floor of the room No. 2. Forementioned damages had been made by the Deathwatch beetle (*Xestobium rufovillosum*). The floor near the enternce to the room No. 3 was rotten, but this damage has been fixed (Fig. 4). Besides beetle exit holes we found holes on the floor of room No. 3, which were made by rodents (Fig. 7).

Fig. 4. Fixed floor near the entrance to room No. 3

Fig. 5. Bore dust under the timber bar and on the upper part of the walls

Fig. 6. Bore dust on the inside wall of the shed

Fig.7. Hole in the floor made by rodents

7.4. Summary and recommendations

Between the bearing logs of the walls and quarrystones a layer of hydro-insulation should be set. For this kind of repairment one should use lifting jacks to raise the logs in order to set a tar layer between. The logs of walls are not enough bracketed. Hence, some extra quarrystones should be set, to distribute the load of the walls.

8. THUREGÅRDEN

Village association house, Möckelö, Jomala

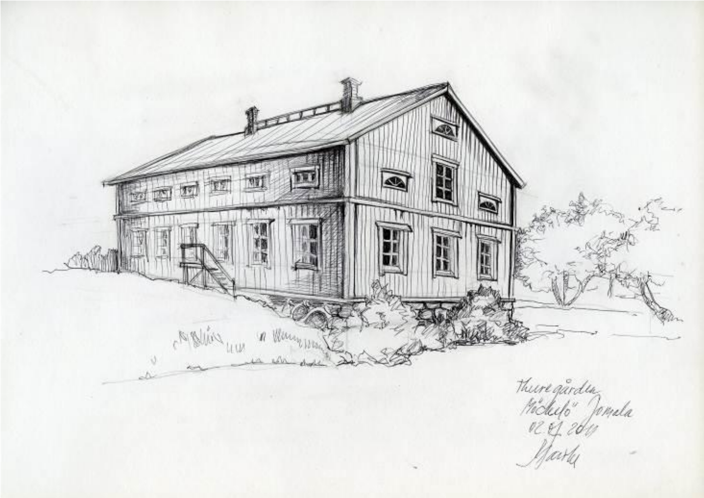

Fig.1. Drawing of Thuregården village association house by Marike Laht

9.1. Exterior inspection

Date of inspection:	1st of July in 2011
Time of inspection:	9:00 to 11:00
Type of building:	horizontal log building with existing socket.
Temperature:	22.2 ˚C
Relative humidity:	81.2%
Temperature:	18.2˚C (in the underground area of the building)
Relative humidity:	89.3%

The building is situated on a hump (Appendix J). The rainwater system is not complete and rainwater is not conducted away from the building (rainwater is splashing up from the ground taking along organic matter) (Fig. 2).

Fig.2. Piled socket partly without any mortar, biodamage on the socket

The socket is piled partly without any mortar (Fig. 2) and there are three ventilation holes, thus the underground area is ventilated, keeping it less dampy. The load-bearing posts are not firmly set to the ground and joined to the floorbeams and there is a direct moisture connection from the ground (Fig. 3 to 5). The water content of timber elements were measured 24% and 32%. There are also useless timber elements and drebis, which should be removed from there.

There is no hydro-insulation between the bearing floorbeams and stone foundation (Fig. 3 and 4). This causes constant damping to the bearing floorbeams and may result in their loss of strength.

Fig. 3. Missing hydro-insulation, unstable timber joints

Fig. 4. Missing hydro-insulation, unstable timber joints

Fig. 5. Missing hydro-insulation

9.2. Interior inspection

Ground floor

Temperature: 23.7 ˚C (measured in room No. 5)
Relative humidity: 70%

The building has timber floors, which are completely ventilated. Room's No. 1 ceiling has traces of water passage (Fig. 6).

Fig. 6. Traces of water passages

Attic (1st floor)

Temperature: 24.2 ˚C (measured in room No. 10)
Relative humidity: 63.9%

The roof's timber structure and attic's timber floor have some water damages; some of the timber balks and posts have degraded (Fig. 7 and 9). It is caused by the nails that have been striked through the metal sheet roofing. Some of the balks are spliced between the rafters (Fig.

10). One supporting post is detached from the wall and the wall structure is unstable (Fig. 11 and 12). There is also missing underlay covering that catches condensated water.

Fig. 7. Water passage in the metal roofing

Fig. 8. Traces of water passages, caused by the nails, that are striked through the metal sheet roofings

Fig. 9. Broken balk

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Fig. 10. The gap between the rafters is too big, a risk of hogging of balks


Fig. 11. Balks are spliced between the rafters


Fig. 12. Detached timber element

Fig. 13. Unstable timber structure

The attic's floor is inefficiently insulated with glass wool (Fig. 14). Due to the water passages in the roofing, the insulation gets wet and its thermal function decreases. Another issue is that the wool slabs must be placed tightly next to each other and covered with wind-barrier layer.

Fig. 14. Inefficient thermal insulation

8.3. Insect and fungal damages

We found few bark beetle attacts (Fig. 15), because of the use of unpeeled timber, in the cellar. Inside the house we found ants in room No. 3 (Fig. 16). It seems that walls in the southern side of this forementioned room are damages by ants. In the attic we found fungal and insect damages. Mainly, fungal damaged were walls under windows, due to leakage from these areas (Fig. 17). All the fungal damages were old. Besides rotten walls, we found lichens growth on the windowframe in the southeastern side (Fig. 18). In several walls in the attic we found insect attacts. The main damagers are longhorn beetles from family Cerambycidae (Fig. 19) and Anobiidae beetles (Fig. 20). We also found bark beetle attacts in the attic's timber structure.

Fig.15. Bark beetle attacks in the cellar

Fig.16. Ants on the floor of the room No. 3

Fig. 17. Old fungal damages on the wall under window in the room No. 15

Fig.18. Lichens growth on the windowframe

Fig. 19. Exit holes and bore dust on the wall in the attic

Fig. 20. Exit holes on the wall in the attic

8.4. Summary and recommendations

In order to reduce the rainwater load to the foundation and underground area, it would be necessary to install complete rainwater system. Because the building is situated on a hump, it causes a considerable water load to the western side of the foundation, when raining. Hence, the water must be conducted away.

Between the bearing floorbeams and foundation and also between the bearing-posts and quarrystones, a layer of hydro-insulation should be set. For this kind of repairment one should use lifting jacks to raise the floorbeams in order to set a tar layer between.

As there were some traces of water passages in the attic (nail holes in the metal roofing), some timber elements were degraded, broken or incorrectly spliced balks, the gap between some rafters were too big and missing of underlay covering of the roofing, the whole roof's structure should be renovated, in order eliminate problems with waterproofness and load-bearing structure.

9. PRIVATE HOUSE

Stentorpa, Föglö

Fig.1. Drawing of private house on Föglö by Marike Laht

10.1. Exterior inspection

Date of inspection:	1st of July in 2011
Time of inspection:	14:10 to 15:30
Type of building:	timber frame and horizontal log building with existing socket.
Temperature:	22 ˚C
Relative humidity:	77%
Temperature:	20.2˚C (in the underground area of the building)
Relative humidity:	77.2%

The building is situated on a hump (Appendix K). The rainwater system is not complete (indicating to porch, missing rainwater spouts) and rainwater is only partly conducted away from the building, causing water and moisture loads to the foundation when raining.

The old part of the building's socket is piled of quarrystones and the new part is casted in concrete. The underground area is divided into three rooms, cellarage no. 10 has no ventilation holes, cellarage no. 11 has two and cellarage no. 12 has two. Some of the existing ventilation holes were closed during the inspection (Fig. 2 and 3). For the time being the existing ventilation is ineffective, it keeps the cellarage's humidity high.

The load-bearing posts are not firmly set to the ground and joined to the floorbeams and there is a direct moisture load from the ground (Fig. 4). The water content of timber posts were measured 98% and for the ceiling beam 21%. There are also useless timber elements and debris, which should be removed from there.

There is also missing hydro-insulation between the bearing floorbeams and stone foundation in some areas (Fig. 5). This causes constant damping to the bearing floorbeams and may result in their loss of strength.

The basement's ceiling is partly inefficiently covered with wind and moisture barrier, which allows moisture absorption from the air (Fig. 5 and 6). The wool's thermal function decreases.

Fig. 2. Closed ventilation hole

Fig. 3. Closed ventilation hole

Fig. 4. Missing hydro-insulation, anobiidae beetles damage (in the basement)


Fig. 5. Missing hydro-insulation and there are gaps in the ceiling's covering layers (in the basement)


Fig. 6. Uncovered thermal insulation (in the basement)

10.2. Interior inspection

Ground floor

Temperature:	24.8 ˚C (measured in room No. 3)
Relative humidity:	67.7%

No building defects were found during the visual inspection.

1st floor

Temperature:	24.4 ˚C (measured in room No. 5)
Relative humidity:	67.3%

The balcony's door doesn't work properly (Fig. 7). The balcony's floor should be lower (approx. 10…15 cm) than the building's floor. This also helps to keep away severe moisture load to the timber boards and door during winter time.

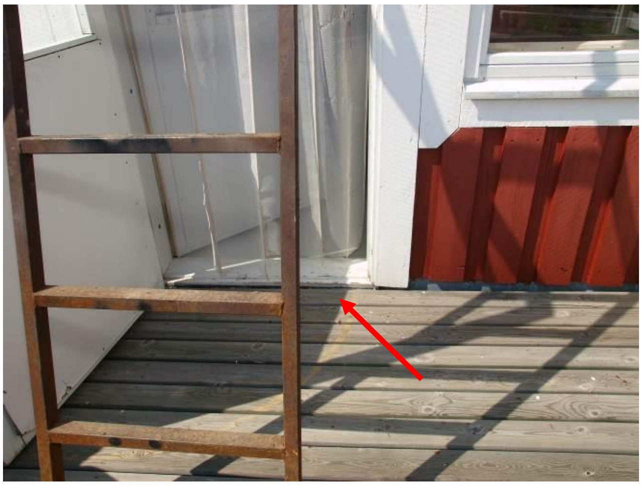


Fig. 7. The balcony's floor should be lower than the floor inside the building

Attic

We found some wasp's nests on the roof ceiling (Fig. 8).

Fig. 8. Wasp's nests in the attic

9.3. Insect and fungal damages

Southern side of the house exterior wall boarding was attacked by the Old House Borer (House Longhorn beetle; *Hylotrupes bajulus*) (Fig. 9). In the cellar, ceiling beam and load-bearing posts had Anobiidae beetles damages (Fig. 4). On the first floor, we found Old House Borer attacts in the living room window frame and in the floor (Fig. 10 and 11). Also some Old House Borer exit holes in the balcony's doorframe. All the attacts inside the building were in the southern side.

In the cellar we found fungal mycelium on timber elements, which had contact with the ground. Unfortunately, we could not identify growing fungal species. In the attic we found mould growth on the surface of the roof boarding (Fig. 12).

Fig. 9. Exit holes of the Old House Borer on the house exterior wall boarding

Fig. 10. Exit hole of the Old House Borer in the window frame

Fig. 11. Damages by the Old House Borer in the living room floor

Fig. 12. Moulds on the the surface of the roof boarding

9.4. Summary and recommendations

In order to reduce the rainwater load to the foundation and the basement, it would be necessary to install complete rainwater system.

Between the bearing floorbeams and foundation and also between the bearing-posts and quarrystones, a layer of hydro-insulation should be set. For this kind of repairment one should use lifting jacks to raise the floorbeams in order to set a tar layer between. All degraded timber elements (especially load-bearing posts) should be replaced. All useless timber elements and debris should be removed from the basement.

There is a need for some additional vents and the existing ones should be kept open, in order to ventilate the cellarage. The wind and moisture barrier should be set properly, in order to keep away moisture load to the thermal insulation in the cellar.

If possible the balcony's floor should be lowered (approx. 10…15 cm). This will help to keep away severe moisture load to the timber boards and door during winter time. The wasp's nests in the attic should be removed immediately.

DESCRIPTIONS OF IDENTIFIED TAXA

IDENTIFIED FUNGI

Genus: *Antrodia*

Four *Antrodia* species may be found indoor. Those species are: *Antrodia vaillantii*, *Antrodia sinuosa*, *Antrodia serialis* and *Antrodia xantha*.

Antrodia vaillantii occurs circumglobal in the coniferous forest zone and in Europe widely distributed, but rather rare in Fennoscandia. It is the most frequent fungus in British mines. In buildings we can find this species often under bathroom floors, by downpipes and in floor partitions above damp warm cellar. Likewise the space under staircases may be completely filled with a cottony mycelium. *A. vaillantii* demands a high temperature (optimum temperature 28 ˚C) and wood moisture content (between 35-55%).

Antrodia sinuosa is circumpolar in the boreal conifer zone, widespread in Europe, North America, East Asia, North Africa and Australia. This species is most often seen in roof constructions, e.g. unventilated roof spaces under asphalt roofing, and in built-up roofs, also in rafters and on external surfaces. Similarly with *A. vaillantii* this species also demands a high temperature (optimum temperature 28 ˚C) and wood moisture content (between 35-55%).

Antrodia serialis attacts logs and piles, causes heart rot in standing trees and occurs widespread, also in Himalaya and Africa, rarely in buildings, within the roof area, in cellars and under corridors.

Antrodia xantha occurs in Europe and North America on fallen stems, branches, stumps, in greenhouses, at windows, on timber in swimming pools and in flat roots.

In Central Europe, these fungi belong after Dry rot fungus, *Serpula lacrymans*, and together with the *Coniophora* cellar fungi to the most common indoor decay fungi.

Very often the attack can hardly be seen on the wood surface. Not until the fruitbody appears. Fruitbodies are resupinate, lightly coloured and with poors. The strands of these fungi remain white, velvety and flexible. Those species cause brown rot.

Family: Corticiaceae

Corticiaceae are responsible for active wood decay in houses, where they produce a typical fibrous white rot. Their fruiting bodies are thin, whitish, smooth, minutely granulose, warty or dentate patches, which are appressed to the substrate. In nature they are found on moist, dead, fallen branches and stumps, while in buildings they appear in protected areas in window joints and behind fascia board.

Class: Myxomycetes (slime moulds)

Fungal species from this class occur in builings under damp conditions, but do not break down timber.

IDENTIFIED BEETLES

Family: Anobiidae

Species of **Anobiidae** have been found, the most common of which are the common furniture beetle (*Anobium punctatum*) and the Deathwatch beetle (*Xestotobium rufovillosum*). These beetles have a cylinder body of 4–8 mm in length and they are dark brown, black or reddish in colour. The beetles do not feed; their function is to ensure reproduction and spread of the species. Larvae hatched from eggs damage wood in the course of their life cycle. The larval development takes 2–4 years, sometimes even up to 6 years. During the time, a larva makes holes of about 1 mm in diameter in wood. After the pupal stage, the beetle imago bores a round emergence hole with a diameter of 1–5 mm. The larvae need a temperature of at least 12°C and a wood moisture content of 12–30% to feed and grow. Several species of *Anobiidae* make rhythmic sounds as they knock their head against the walls inside their holes. These sounds also help male and female beetles locate each other inside wood.

Dampwood borer *(Hadrobergmus pertinax)*

Hadrobregmus pertinax is a species of woodboring beetle within the genus *Hadrobregmus* of the family Anobiidae. The adult is black, with yellow hairs at the back corners of its head, and is 4-5 mm long. The larva is white, about 5 mm long, and lives in decaying wood. The larval stage lasts many years. It is the most destructive insect of buildings in Finland, where it survives the long winters in below-freezing temperatures. Because the larva lives in in decaying wood, its presence indicates moisture damage. Resolution of the moisture problem will cause the beetle to leave.

Family: Cerambycidae

Cerambycidae are relatively large in size (usually taller than 20 mm), they have a slender body, which is commonly covered with hair, and very long antennae. The old-house borer is the species causing the most damage in buildings, with a larval stage of up to 12 years. Holes bored by its larvae are densely filled with frass and fecula. The emergence holes of beetle imago are oval in shape, with a size of 3x6 to 5x12 mm. The old-house borer only damage coniferous wood and likes higher temperatures (28–30°C is the most suitable). For this reason, the beetle prefers inhabiting ceiling beams, rafters, window frames and floors. Other species of *Cerambycidae*, for example the violet tanbark beetle, may also inhabit buildings, yet they are incapable of completing their life cycle or reproducing and thus pose no threat.

Longhorn beetle (*Callidium violaceum)*

Adults are 8-18 mm long, flattened. Pronotum and elytrae are metallic blue, violet or greenish. The ventral part of the body is dark brownish. The body is covered with dark hair. Eggs are elongated, oval, 1.6 mm long. Larvae are up to 26 mm long, flattened. Pupae are 9-17 mm long, white.

Adults are active from May through July. They are often observed on breeding materials. Females lay eggs in bark crevices. Larvae feed under the bark. Galleries are up to 15 wide and 2-3 mm deep, curved, with sharp margins, filled with frass and shredded bark and wood. At the end, galleries are widened up to 2-3 cm, where larva enter into wood up to 10 cm deep and construct pupal chambers. Adult emerge through the same hole as the larva entered the wood, and chew the exit hole of 6 x 2-3 mm in the bark. This species has one generation per one or two years, in dependence climatic conditions

House Longhorn beetle (*Hylotrupes bajulus*)

The house longhorn beetle (*Hylotrupes bajulus*) belongs to the longhorn beetle (*Cerambycidae*) family and is one of the most significant destroyers of coniferous timbers. Roof trusses, beams, floorboards, doors, stored wood or timber used outdoors all face a high risk of attack.

House longhorn beetles are between 8 an 25 mm long, blackish brown in colour and have two greyish white patches of hair on the wing covers. A further characteristic feature is the two shiny bumps on the neck shield. In the final stage, the larvae are 2 – 3 cm long and 4 – 6 mm thick, pale cream in colour and their bodies are made up of ring-shaped segments.

The actual wood destroyers are not the beetles themselves, but their larvae. The beetle’s life span is only a few weeks between June and August and during this time they do not destroy wood. Their only aim is to reproduce.

After mating, the females lay their eggs in fine cracks in the wood. Once the larvae hatch, they gnaw their way into the wood, where they live for 3 to 6 years (though even 15 years have been observed) and feed mainly on sapwood. At the end of this period, they pupate in the wood and metamorphose into adult house longhorn beetles. They then gnaw a hole in the thin outer surface and immediately search for a mating partner.

Bark beetles

Bark beetles are so-named because the best known species reproduce in the inner bark (living and dead phloem tissues) of trees.

Bark beetles often attack trees that are already weakened by disease, drought, smog, conspecific beetles or physical damage. Healthy trees may put up defenses by producing resin or latex, which may contain a number of insecticidal and fungicidal compounds that can kill or injure attacking insects, or simply immobilize and suffocate them with the sticky fluid. Under outbreak conditions, the sheer number of beetles can, however, overwhelm the tree's defenses, and the results can be disastrous for the lumber industry.

SUMMARY OF INSPECTIONS

The main problems are concerned with incomplete rainwater system that causes severe water and moisture loads to the building's foundation and basement. There is also a lack of hydro-insulation between timber elements and stones or concrete, especially load-bearing posts that are situated on the ground or stone without any tar layer between. The result is "fast-growing" degradation of timber element, which loses its strength properties.

Another issue is with the roofing, that has lost its waterproofness and there is a apsence of diffusion-layer (underlay covering). All moisture and water problems usually begin with it. Roof is the most important building structure and this should be the first thing to repair in renovation stages.

There are also problems with external timber walls that have moisture barrier in the outer side of the wall. This keeps (also ever-increasing) moisture load inside the wall structure. It may result in degradation of timber elements. The moisture barrier should be set inner side of the wall. That way moisture load is kept away from getting into the structure. Between the exterior wall boarding and wind-barrier layer should be air-passage (3 to 5 cm) that helps to try out the boarding.

MONITORING

After conducting the inspections and analysing the results, we have decided to monitor the Worker's House (King's country estate in Haga, Saltvik), Thuregården (Village association house, Möckelö, Jomala) and Hermas Main Building (Hermas Open Air Museum, Enklinge, Kumlinge).

Monitoring equipment

Logger is a two-channel electronic device measuring and logging temperature and relative humidity. Sticky trap is a folding card trap with glue pads inside to prevent the escape of insects (Fig. 1).

Fig. 1. Temperature and relative humidity logger (on the right), sticky trap (on the left)

There will be also one introductory poster for each building to put up. The introductory poster contains overview of the building, found damages and beetle species, monitoring equipment, info about the FaBBi project and its copartners.

Short instructions for monitoring

- The person monitoring participates in the first installation of temperature and relative humidity loggers and sticky traps in the building(s).
- 2-3 loggers and 10 sticky traps are installed in each building to be monitored depending on the size of the building. The sticky traps are placed near wooden structures, for example, on beams, beneath the altar, etc. The person inspecting determines the exact location of the loggers and sticky traps.
- All loggers and sticky traps are numbered; the numbers consist of the following parts:
  1) object number 2) measuring point number 3) month 4) year
  Example: 12 3 08 11 (object no. 12, measuring point no. 3, installed in August 2011)
- Objects are numbered by the person inspecting who also installs the loggers and sticky traps in all buildings to be monitored.
- During the first installation, the locations of the loggers are marked on a plan and also specified in the monitoring report.
- During the first installation, the area of the sticky traps within approximately one metre is cleaned of frass using a hand vacuum cleaner or brush. The area is marked on the building plan.
- Monitoring is performed once a month. During monitoring, the person monitoring:
  1) checks the loggers – whether they are in place and recording data (check the blinking of a red light bulb);
  2) collects the sticky traps and installs new ones. NB! New traps must be numbered!
  3) fills out the monitoring report by marking the numbers of collected traps, the numbers of new traps, and the date and time of replacing the traps;
  4) takes photos of the areas cleaned the last time and cleans the areas again. The numbers of the photos are marked on the plan.
  5) checks the condition of the poster notifying of the monitoring; if it is missing or defective, informs the Project Manager;
  6) posts the collected sticky traps in a box (NB! Do not open or fold the sticky traps) along with the filled out documents at the following address:
  Eesti Mükoloogia Uuringutekeskus SA
  Heina 7
  50604 Tartu;
  7) uploads the photos taken in the project FTP server or e-mails them at ave.sadam@fabbiproject.eu.
- In the laboratory, Ave Sadam indentifies the species of the wood-degrading beetles found in the traps as well as the number of other insects.
- All questions on monitoring may be addressed to Kalle Pilt at kalle.pilt@fabbiproject.eu or on +372 51 06 488, or to Ave Sadam at ave.sadam@fabbiproject.eu or on +372 50 82 385.

APPENDIXES

Appendix A Explanation of symbols and abbreviations

Hereafter are marked relevant symbols and abbreviations that are necessery to understand and follow the scope of damages on the plans of buildings and churches. On the plan on every corner outside of the building is indicated ground height compared to clean floor surface. Ground inclinations are indicated with arrows on the plan, one arrow on each side: toward building or away from building. Approximate ground inclination percentage is indicated beside the arrow.

___SE___ – beside wall (refers to damaged area on the wall)

____ P___ – floor damage

____ L___ – ceiling damage

K1 – number of damaged area

M – beetle damage

S – fungal damage

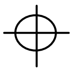
SO – salt damage

V – moisture damage

BK – bio damage (lichen, moss, alga)

V1 – measured water content of timber and wood-based material in damaged area

P1 – taken sample of fungal or beetle damage

 – ventilation hole

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K