

Restoration of Wooden Structures

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1. A short history of restoration in Finland today

1.1 General

As a nordic country Finland has a long tradition of wooden structures. Although we have well preserved graystone and brick buildings number of them is relatively low. Therefore focus in restauration is to treat wooden houses and in addition it has lately turned to treat modern architecture such as 1930's funkis style buildings and even to treat early 1960's precast concrete buildings. Public interest has lately been in problems of damaged concrete surfaces, in moisture and moulding problems of stuctures, in quality of air conditioning and specilally in use of ecological building materials as wood. Our building industry, official research and education of engineering has mostly concentrated in modern building technology. Public interest and the latest depression of construction has increased investments and contributions in renovation.



1. Pyhäniemi farmhouse

1.2 Main problems

In a case of restauration sometimes occurs that the new use for a building has been determined by developer before thorough investigations and estimations of technical suitability to its becoming use has been done. Too high standards may cause unnecessary measures in the point of view in protection of a historical monument. Modern airconditioning, heating and other installations brings out many changes for the frame of building. Handicapped must be noticed by making lifts. Surfaces must be done easily cleaned and cured. Climate conditions has to pay attention. Standardized snow load has doubled during this century and the effective loads for slabs may also need to be increased. Moisture coming from soil must be prevented. The permitted bendings of beams and slabs has to be

obayed. Acoustical features and fireproofing are usually demanded as in new constructions. The present damages in old structure are usually pretty easy to treat on a point of view strenght of old materials but there is a lack of knowledge in physical characteristics of old structures. On the other hand engineer designers responsibility to design safe and health structures and for more stuctures wich are easy to prepare leads often to oversize the structure dimensions. All this process causes measures witch badly correlate with tries to treat a historical monument well and tries to save its historical value.

2. Wooden cultural heritage in Finland

2.1 General

Wood construction in Finland has long traditions. Our cold climate calls for a need for heat-retaining structures. Because our country is filled with forests, it is only natural that buildings especially in the old times were been made of wood.

The know-how of wood construction came into our country along with migration. Although we thus got influences both from the East and West, a very strong and individual wood construction culture developed in Finland.

In Finnish forests, we have lots of conifers thanks to our climate. Softwood grows well up North, because there are not too many "wood enemies" to be found, such as insects and rot fungi. Softwood a building material conifers easily rot. That is why in Finland we don't have a single whole pre-medieval or even medieval building left. All those have either been destroyed in fires or rotted. However, various medieval wooden parts in stone churches' roof structures can be found, and also single relics in later building structures.

Very old building structures have been found, buried in conditions free from oxygen, such as swamps and clay soil. The interesting thing when researching wooden structures is the dating of them. In Finland we have got good results in the dendrochronolygy method. Compering the relative variation of the year-rings has been possible to determine the age back to thousands of years i a precision of one year or even of one season. Medieval wooden findings can nowadays be quite realiaibly dated. The oldest surviving wooden buildings found in Finland are from the sixteen hundreds. Among those there are modest timber churches, houses and outbuildings.



2. Loppi wooden church

Later, sturdier wooden churches and mansions entered the picture. With the development of farming and industry came the demand for bigger wooden buildings and establishments. Timber constructions were replaced by framework, and horizontal parts were more and more made as trussed frame.



3. Pyhäniemi farmhouse, wooden framework

The era of wood construction ended at around the beginning of the nineteen hundreds. Construction technique developed, and because of such reasons as fireprotection, stone buildings became more common. After this only small-houses had wooden structures in them. At first wood was the main material in intermediate floor and roof structures. Later it was concrete -- wooden structures were almost totally displaced by it. Today wood has gained in popularity again, and is used in very demanding constructions as well. Good results in other countries have inspired Finns too, to focus once again on wood construction. The ban on wooden apartment buildings was revoked in the 1990s. New wooden public buildings have also been built, such as Sibeliusstadi in Lahti and the bridge structures in Vihantasalmi. As we can see, progress in wood construction has been rapid over the last few years; the present advances have also been utilized in the restoration of historical buildings.

2.2 Restoration and repair in some wooden structures

2.2.1 Foundations

Wood has been used in foundations when the soil is poor at bearing. Usually, wooden structures were piles and timber foundations. As a result of the ice age there has been a very strong uplift, in some places even 1 m per 100 years. The level of groundwater has therefore lowered, thus rotting the wooden foundations. Also heavy construction activity in town centers has lowered the level of groundwater. The strengthening of wooden foundations is one of the biggest and most difficult rescue operations that a historical building can meet. Usually, wooden foundations must be replaced by concrete or steel structures.

Seldom the wooden foundations are even protected by regulating the level of groundwater. Downtown Helsinki there are still areas where the level of groundwater is maintained artificially.

2.2.2 Bottom floor

The oldest wooden base floors have been built on earth stones near the surface of the earth. The space under the floor is connected with the room, and only on the outside walls there is an earth covering functioning as thermal insulation -- a so called "soilbed". Floors were easy to open, and it was customary that when the lowest parts rotted, new ones were installed. "Soilbeds" can still be seen in museum buildings. It is very important, too, to preserve the "soilbed" even if the building were not heated any more. It also protects the foundations of the building against soil frost. "Soilbeds" are often replaced by light gravel.

Another traditional base floor type is a so called filled floor. They are thermal insulated and the under floor is designed to give an outward ventilation by openings in the basewall. Filling materials that were used were sod, moss, sand, brickwork-waste and sawdust. Filling sinks with time, so floors were often cold. In the winter people used to heap up snow against the outside walls in order to prevent nasty draught. The wood construction tradition continued in stone buildings as well. Often the bottom floor has been made by wood construction technique. Stone buildings are, however, so tight that the damage of wooden structures there is common.

2.2.3 Walls

In wooden buildings the walls are often timber. Normally timber walls are made lying. Timber wall is tight thanks to its own weight and load. Wood shrinks a lot radially. So the big problem with timber construction is the sinking of walls. Many tricks have been developed in order to control this sinking. Usually, in old buildings the whole sinking spare has been used up. Therefore, in old buildings there are damages caused by uneven sinking. Sometimes walls were made of vertical timber, especially if the building was meant to be coated. This was the case usually in urban houses. The most serious damages in wall structures are various kinds of water damages. They usually occur near fireproof walls. There the water from the roof easily gets inside structures. Sometimes can also damages caused by pests be found.

The changes made in wall structures in the course of history -- transferring of holes to different places and enlargements -- have caused the uneven division of loads resulting in sinking of walls.

Reparation of timber walls is usually fairly easy. Timber wall can be temporarily supported thus making it possible to replace certain parts with sound parts. Problems may arise if otherwise it were not necessary to tamper with covering. In that case the working technique has to be carefully planned as such that the original covering can be preserved as well as possible.

Today's thermal insulation standards require extra thermal insulation of the walls of such timber houses which are in active use. In Finland it is preferred to do this "extra insulation" on outside walls because in that way the massive wood remains intact on the warm side thus storing and balancing room temperature. It has also been learnt by experience that it doesn't pay to make a vapour barrier inside the structure. Air barrier paper is sufficient enough to guarantee airtightness because it allows steam to move through it. Outside walls should not be painted too thickly, and the work should be done with vapour permeability paints, oil paints etc. When plastic paints came into market, facades of many wooden houses (and stone houses too) were ruined by painting them with these wrong paints. There are still quarters in the field that don't understand the gravity of the matter, and many wooden houses are still painted with them.

2.2.4 Horizontal structures

Intermediate floors and upper floors are usually filled. Under the joists there is a lining boarding, sometimes plastering. The filling is construction-waste, sod and moss. In upper floors there are often layers of clay mortar or a brick as a fire preventive layer. Old intermediate floors are usually massive and oversized in view of their loads. Intermediate floors with filling are relatively fireproof, and in case of residential buildings, it is good that they are also fairly sound-proof. Dampness caused by water accidents is the main cause of damages in intermediate floors.

The dying down of joists as years go by causes aesthetical damage, as well as suffering of roof and wall coatings.

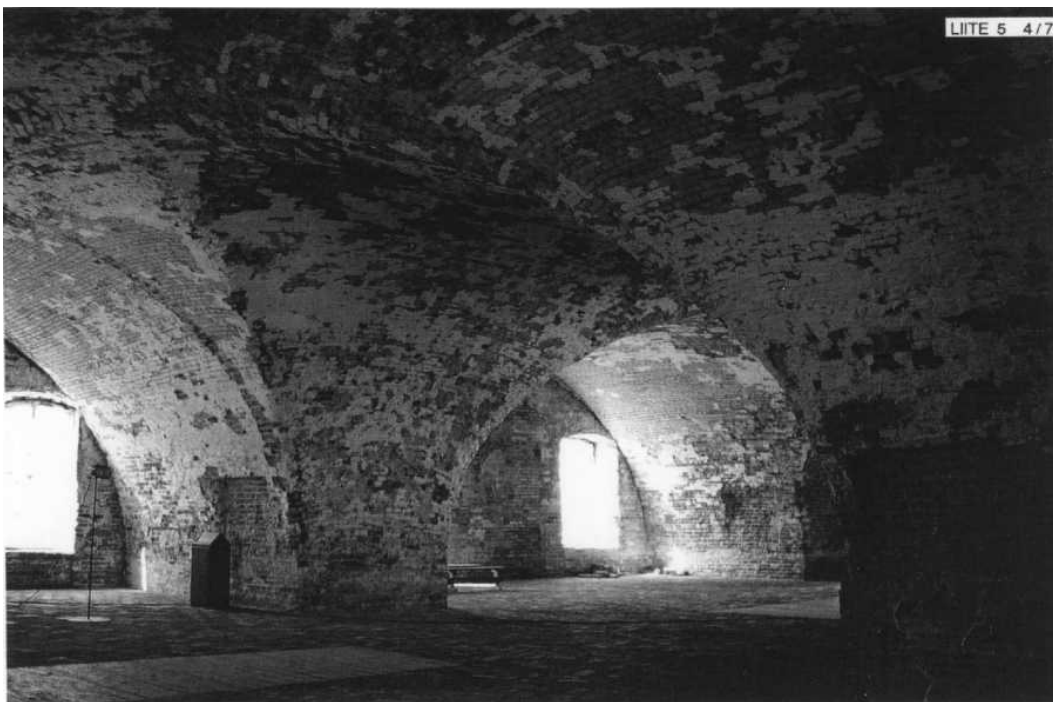
In restoration it is often necessary to change the filling material. When the load becomes lighter, it can happen that the wood gradually rises.

When we want to improve the thermal insulation of upper floor the same rules apply to them as to outside walls. Wooden structures in historical buildings should not be too compact. Vapour has to be able to move from the structures if necessary. Breathing structure is as a kind of bumper in case water accidents should occur, also giving time to consider reparation measures.

Trussed frames have been needed in big spans. Wooden structures have also proved to be very good when wanting to carry out different kinds of architectonic forms. The roof trusses of churches have been made of wood from the middleages on. In roof structures there are naturally many damages caused by leaks. They can be spotted easily, but sometimes the wood rots from the inside making it difficult to foresee its weakness. The heads of the joists of intermediate floors and roof are specially at risk. Roof leaks occur mainly around eaves and pipes. Damages are easy to repair if roofing is repaired at the same time. In other cases only the rotted structure is strenghtened. It may not be possible to totally remove the rotted wood. In the Finnish construction regulations the value of snowload has been raised many times in the 1900s. The estimation of loading capacity is important when the whole structure is restored or if major changes are made.

2.3 Cases

2.3.1 Suomalainen Tönnö von Fersen



4. Tönnö von Fersen, festival hall

Tönnö von Fersen is a building in Suomenlinna. Suomenlinna was built in the 18th and 19th century. The Swedes started the work, and when Finland was taken over by the Russians they continued. TvF is situated beside the fortress' dry dock. Originally there was the pumphouse of the dock powered by horses. Later on bakeries, warehouses and quarters, etc.

The building suffers from damages caused by dampness, and there is exceptionally deteriorated with salts. Deterioration has been studied for decades, and even now there is a

study going on financed by EU. The building has, however, been used all the time and its great vaulted storage space's renovation was completed in Suomenlinna Jubilee Year 1998, now serving as a festival hall. Because of antiquarian and acoustic reasons a wooden floor was installed. To install it inside the wet building was a challenge. Wooden floor was built on old brick floor. There was to be floor heating, too. To improve acoustics a layer of sand was installed. In addition to this the floor had to take in countless amounts of electric wires. For more a timber ruins in the middle of the floor had to be preserved. It had served as a hanger for the gear of the pump room below. Also, the height of the floor was not to rise too much. The trouble was that the wood might get too damp. One of the different options was the mechanical ventilation for the floor, but the risk in that was that then the bricks might get damaged because the brick construction had to dry.



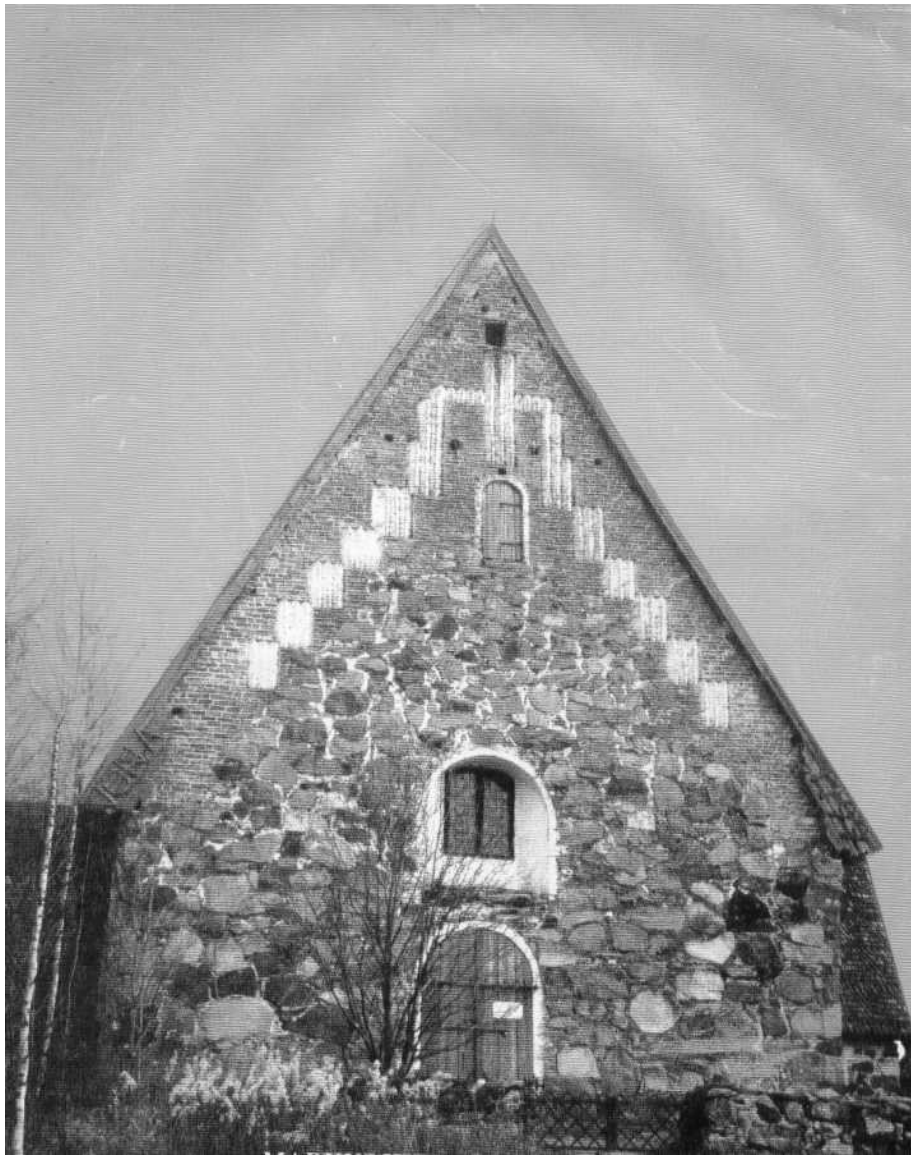
5. *Tenaille von Fersen, floor construction*

So the work was done so that the brick floor was covered with filterfabric. Above that the floor supporting rails were installed, and under them there was a neopren. In between came a layer of sand. Floor heating pipes were installed under the whole floor space. Between the supporting rails were mineralwool installed to deaden the echo. Finally, floor boards were installed. At first the floor was so dry that the boards had to be quite wide apart. When the structure got damper the floor tightened. A ventilation gap was left around the surrounding walls. The structure proved to be very good as far as acoustics were concerned, and today it's a popular place to have small classical concerts.

The dampness of the floor's underside has been controlled right from the beginning. Dampness has not reached critical levels. Floor heating dries the underside sufficiently. Now the salt studies have made it clear that the original idea of keeping the brick walls damp was wrong. This year the festival hall got extra radiators, and the building will probably dry by itself. The "woodenfloor worries" will soon be over.

2.3.2 Tyrvää church Tyrvää church

The medieval church of Tyrvää was burnt down by an arsonist in 1998 -- just when voluntary workers had completed their job with the shingle roof. It was decided that the church be rebuilt.



6. Tyrvää church

Roof trusses were reconstructed. The joints of the roof trusses were made with wood tenons. Their strength met today's norms in almost every case. Only in the critical joint on the wall where the horizontal loads are biggest, the wooden tenon was replaced by a steel bolt. The interior was to be reconstructed, too. It was a natural choice to follow the original construction style. And nails weren't to be used, either. All the wooden joints were to be designed according to old notching methods. Carpentry was made by voluntary pensioners. They have had all the necessary stamina and skill to make the demanding joints and to develop suitable solutions further. The realization is now on the homestretch. One of the most difficult parts has been the construction of the balcony's railing. The aesthetic demands of the railing and the ban to use nails have been a real challenge. The solution has been found. In a way "gunpowder has been invented anew".



7. Tyrvää church, under reconstruction



8. Tyrvää church, rebuild balcony



9. Tyrvää church, holes for joints



10. Tyrvää church, model for balcony fences

2.3.3 Suomenlinna artillery manege C 81



11. Artillery manege

When I surveyed the condition of Suomenlinna's manege C 81 almost ten years ago, I found alarming rot in the roof's lattice girders. The otherwise uninsulated roof structure had at some point been insulated by mineralwool jusa under the gutter area. Roof leaks and damperroof's condensation had got into the glass wool, and that's why the girders were rotting. The building served at that time as Suomenlinna's labour colony's warehouse, and it was not easy to find them a replacement quickly for the time of the reparation. At last such a place was completed in 2000.

The roof reparation was begun in January 2001. The work was done by the convict labour. After the starting difficulties the labour learned the right methods, and the project quickly progressed. Today all the 20 girders are repaired, and the building will soon get a new tin roof. Convict carpenters developed with the work into skillful restauration experts.



12. Artillery manege, rot examinations



13. Artillery manege, bad joint



14. Artillery manege, restauration in progress



15. Artillery manege, joints has strengthen



16. Artillery manege, restauration in progress