PRACTICAL GUIDE

Measures for heat loss prevention in historical buildings, using the experience of the Baltic and Scandinavian States

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A guide for "The Measures for Thermal Loss Prevention in Historical Buildings, Based on the Experience of the Baltic and Scandinavian States"

Introduction

Nowadays historical buildings and landscapes of historical towns and cities are treated as special and maintainable values for our future. However, everyday life has slightly changed nowadays. Presently, the requirements for comfort are not the same as they used to be hundred and even more years ago. During a couple of centuries, the overall situation in the field of environmental context has also changed. At the present time, a special attention is given to various aspects, including an effective usage of the resources and the energy. On the world scale and in Europe, a current issue is the energy efficiency of buildings, and the building owners are encouraged to take various measures, in order to use less energy consumption, but still live even more comfortably.

To balance landscapes of historical towns and cities and the preservation of certain historical buildings for future generations with the energy efficiency improvement, it is necessary to explain possible approaches, ideas, activities and conclusions based on already implemented examples. In order to offer some approaches for a building host how to renovate directly his/ her building, this guide publication offers a wide international view in various Baltic and Scandinavian States – in Latvia, Estonia, Lithuania, Sweden and Norway. These countries have quite similar climatic weather conditions, so it is possible to consider various approaches, various ideas on equal basis thereof. However, these countries have different laws and regulations, socially economic circumstances, the history of the preservation of culturally historical heritage and the people's understanding about it. In the Baltic and Scandinavian States, there are unified world guidelines for heritage preservation and the European Union regulations, suggestions and recommendations in various fields, including in the field of conservation of the cultural-historical heritage and the energy efficiency.

This edition – a practical guide – is useful for owners, building managers, residents, designers of historical buildings, and other interested people. It encourages to search for an individual approach, thinking about various opportunities and types of life in historical buildings. Inspired by different examples of increasing the energy efficiency in historical buildings, it is possible to make well-considered, responsible, provident and farsighted decisions, thinking not only about the improvement of present everyday life, but also about an old building, which is also – a historical heritage – preservation for future generations.

The guide summarizes the problems which are concerned on increasing the energy efficiency in maintainable historical buildings, and to render various ideas and approaches, based on the Baltic and Scandinavian states. Mainly, all writings and publications have a common idea that the residents shall adapt to an old building, respecting it, using appropriate correspondent materials, in order to prolong and maintain the historical story of a building for the future. However, simultaneously, the energy saving measures shall be implemented, by restoring the worn-out elements and items and adding modern day materials for the improvement and increase of the energy efficiency, which physical characteristics would be compatible with those materials which were used during a building construction. Every building might have such values which are prescribed as maintainable for preservation and protectable, or also such values which a life-wise owner of an old building has defined as maintainable values which should be preserved, despite that a building might not even have a protection status.

This material discusses several important issues – how to preserve the energy in an old building, why it is necessary to use traditional construction materials, what the typical problems are appearing when a building is adjusted for modern-day necessities, the best possible methods for historical building insulation. The material includes recommendations for thermal loss prevention, introduces various insulation materials for buildings and their special characteristics, discusses the issue about a necessity for additional insulation for floors, windows, attic and roof. The material comprises also practical examples for historical building preservation, accepting the decisions taken and the practical solutions.

When reading these articles on diverse approaches, ideas and recommendations, may all the renovators of old buildings find some motion and vision, how to improve the energy efficiency in their own buildings, at the same time maintaining the uniqueness of a building!

The architect Ms Jana Jakobsone *[Latvian: Jākobsone]*

SAVING ENERGY WITHOUT LOSING HISTORIC VALUE AND CHARACTER

Reducing energy consumption and greenhouse gas emissions is a challenge that needs to be embraced by all parts of the society, in all countries. Governments across the world have approved policies and standards regarding energy consumption, for example when it comes to the heating of new and existing buildings.

The continued use of older buildings is an important part of a sustainable future. The existing buildings are built up by energy that is already invested, in contrary to new buildings which require reinvestment of resources with additional greenhouse gas emissions.

Saving energy and at the same time preserving heritage values can be perceived as a complex challenge. This article aims to sum up some of the most sustainable solutions for lowering energy consumption in historic buildings. It is mainly written as a guidance addressed to owners of residential houses built before the 1950's, but most of the advices apply to buildings of all types and ages. It has been written to help prevent conflicts between energy efficiency requirements and the conservation of historic and traditionally constructed buildings.

Since building traditions can differ markedly between regions and countries, the suggestions in this text have a general character.

GENERAL PRINCIPLES OF IMPROVING A BUILDING OF HISTORIC INTEREST

The principle of minimal intervention is crucial to an owner of a historic building. This means that existing fabric should be repaired rather than replaced, and additions of different sorts should be reversible. When it comes to comfort in an older house, it means that a compromise between the improvement of the building and the preservation of historic values is needed.

Innovation in the field of building science is moving fast and new materials and solutions, sometimes compatible with maintaining historic features, emerges every now and then. The ageing of new materials and appliances can be very hard to predict, and the level of sustainability is sometimes uncertain. Untried modern elements are not generally recommended in traditional buildings since the experience tells us that the best materials are the ones that will last, that are possible to maintain and repair. Combining curiosity with some skepticism is probably the best attitude when it comes to novelties in building science. A new kind of element that so far seems to be well-functioning in traditional buildings is for instance modern hygroscopic insulation materials, made by different natural fibers. Remember to document alterations. The information will be useful to both you and the owners to come.

When needed, always seek advice from your local restoration architect or built heritage expert when it's time to make energy conservation improvements.

SUMMARY

Our most important general advice is to make a plan of improvements and maintenance instead of rushing into renovation, and, most importantly, to prioritize small and simple measures regarding energy saving actions. Making your house more airtight has shown to be one of the most profitable ways to lower your energy bill when it comes to traditional buildings. Renovating and weather stripping the windows is a good investment, whereas replacing the existing windows with new ones is both expensive and will damage the appearance of the house.

Extensive changes such as investing in new energy systems will not only be expensive, they are also likely to affect the whole building in a profound way, more or less controlled. This can lead to changed humidity levels in the building, and can therefore potentially cause damage. Sticking to the simpler measures and enhancing the existing equipment will instead in most cases be beneficial both to your economy and to the overall health of your house.

Never hesitate to ask for advice, and to use skillful professionals both when it comes to planning the works and implementing them. Unconsidered measures can damage a building and may be difficult to undo. Ask your local council for recommendations.

GET TO KNOW YOUR BUILDING FIRST – DON'T RUSH

All buildings are unique and need individual solutions adapted to their specific construction and usage. This is particularly valid for traditional buildings. There are simply no standard solutions that work for every building. Therefore, knowing how your house works is necessary before any actions are taken. So the first recommendation is to take it easy! You might want to start off by changing windows and doors, or replace your heating system to a more modern one. It's possible that you might save a lot of energy, but the investment is likely to become expensive and it will probably take your whole lifetime or even longer to earn back these investments. So instead, consider this working order:

- Find out as much as possible about the history of the building, how it was built originally and how/if it has been developed through the years.
- Assess the condition of both the building envelope and the technical building systems. Using expertise is to be recommended.
- Spend time trying to understand the building and define how comfortable it is when it comes to air flow, temperature and humidity for example. Understand why and how heat is lost. Ask yourself these questions:

How does air and moist move throughout the seasons of the year, and how do you perceive different rooms? Which parts of the house do you use regularly and which rooms do you use less?

Try to wait a year before you execute any works, by then you have experienced the changes during all four seasons. Gather as much information about your house as possible during this year, both how it works and its history - it will be of great use for you further on.

RELATION TO THE ENVIRONMENT

Identical houses in different landscapes and climates are likely to behave differently and therefore require different actions. Investigate how the building relates to its environment. How is it exposed to wind and sun? Is it sheltered by trees or hills, for example? Question the possibility to modify the microclimate around the building. Using vegetation to create shelter can actually reduce heat loss by up to 15%.[1]

Outbuildings and walls can also be used as protective shields, both for the main house and the outdoor recreation and working areas.

Using vegetation to shelter houses from wind is an old tradition. It is an efficient way to reduce heat loss significantly. Photo: Marie Odenbring Widmark

PLAN YOUR ACTIONS

So, let's assume you've documented flaws and advantages in your house for a while. Now it's time to choose *which measures to take, in which order and when*, preferably a long-term plan extending over several years. A good plan implies actions well adapted to each other, meaning for example that your heating system will be dimensioned to last for ages, not just present conditions. A plan will decrease the risk of costly surprises and help you to reduce your carbon footprint.

When making this plan, the historic value and characteristics of the house has to be taken into careful consideration. All interventions have to be performed with respect to the elements that constitute the historic value of the house, and all measures that will damage these elements should be avoided. What has to be preserved and what can be changed, if necessary? Contact your local authorities to find out if the building is listed and/or situated in a conservation area, and which regulations you need to pay attention to. Some actions need permission, when the historic and architectural values are high. Furthermore, it could be useful to know the legal demands on energy saving where you live, but keep in mind that historic buildings normally should be exempt from the demands of energy efficiency that apply on modern buildings. Your local municipality will be able to answer these questions, and hopefully also recommend local craftsmen with experience from working with traditional buildings.

[1] Energy efficiency in traditional buildings. P 11.

Planning the general maintenance can be highly recommended since it is of great importance to the wellbeing of a building in the long term. Included in the concept of general maintenance is for example: making sure that the ground slopes away from the buildings, regularly taking down vegetation that grows close to the house, cleaning the gutters especially when autumn turns into winter. Spend some time thinking about the intended future use of the building. A house used in summer time only, for example, will not require the same comfort as a house used all year round.

BEFORE UPGRADING - PRIORITIZE MAINTENANCE

Make sure to attend to damages before you start draught proofing or insulation projects. Damp penetration of walls for example needs to be properly addressed – what is the reason for excess moisture? Are the gutters leaking, are the window frames poorly fitted, what's the condition of the drainage system in the ground? Moisture tends to reduce any material's ability to insulate. Simply put - houses need to be dry in order to get better thermal efficiency. Therefore, inspect all parts and make sure they work properly and are well maintained before you go ahead with energy-saving activities.

ALWAYS BEGIN WITH EASY MEASURES

There are quite a few things you can do that requires neither grand interventions nor expensive investments. In fact, the greatest cost benefits can arise from the simplest of improvements. Several of them are based on just recognizing your habits and changing them.

- Turn down the thermostats slightly, a degree or two
- Heat unused or seldom-used rooms less
- Keep the doors to such rooms closed
- Use energy-efficient light bulbs or LED-lights
- Install low flow shower heads and faucet aerators
- Place fridges and freezers in cooler rooms where they will consume less electricity
- Close shutters and curtains at night
- Fit smart meters to provide information on electricity usage
- Use daylight for lighting rather than artificial lighting[2]

Remember that uncomplicated measures like these will save a considerable amount of energy without affecting the structure or appearance of a building. If you combine several of them, the multiplier effect is likely to surprise you.

MAKE YOUR BUILDING MORE AIRTIGHT

Research has shown that the main energy saving potential deals with air tightness, when it comes to historic buildings.[3] The key is to find the balance between comfortable indoor climate without drafts but with sufficient air flow. Taking control of the rate of ventilation, and the uncomfortable feeling of draughts, can be done easily with draught-proofing strips. When the windows are tight, the effects of cold downdraught drops, leading the radiator system to work with lower temperatures.

The strips come in various sizes and materials: rubber tubes, hemp or wool for example. When sealing double glazed windows, the strips must be mounted along the inner frames and not the external ones, in order to prevent condensation.

According to science, the main energy saving potential deals with air tightness when it comes to historic buildings. Sealing windows is a cheap and simple solution that will have significant effect on the energy bill. The strips comes in various materials, sizes and shapes. Cords made of wool is an example of a product that is flexible and repels water. Photo: Carina Carlsson

Every action that involves making your house more airtight has to be accompanied by measures improving the ventilation, in order to prevent high humidity levels indoors. In many cases, easy actions like investing in new vents will be sufficient.

Another, more extensive kind of leakage minimization can be performed in the distance between wall and window frame or wall-to-wall junctions, preferably when it is time to refurbish walls on the inside or outside. Expanding foam fillers cannot be recommended here since it is an example of a modern material whose decay is not well known. It is also sprayed in blindly, which means that the installer has no control over the expansion of the foam. It might also cause problems with rot in adjacent wooden material or plaster in the future, in case of leakage. Instead, using hygroscopic materials that can absorb and release excess dampness from time to time, just like the surrounding traditional materials, is to prefer when it is time to seal the spaces around windows, doors and corners.

When refurbishing a timbered structure on the outside, replacing (or adding) an external wind barrier will enhance the airtightness of the house significantly. It needs to carefully cover all gaps around doors, windows and corners. This is a cost-effective measure that will not influence the appearance of the building, especially if the siding can be gently removed and mounted again afterwards.

REPAIR AND MAINTAIN THE WINDOWS

First and foremost - always remember that there are much more cost-effective ways to save energy than to replace your windows with new ones. Only about 10-15 % of the total energy consumption is lost through the windows, therefore - improving other parts is a lot more efficient.[4] When considering new windows also take the energy required to produce the new windows into account, and the environmental cost connected to their future disposal of waste. Another important detail is the future for the new windows: it might not be possible to repair them at all, if the frames are made of plastic, for instance.

The wood used for making windows 50 or 100 years or even longer ago were of much greater quality than today. This is due to lumber being farmed quickly today, which results in wood with much lower resistance towards rot. Furthermore, the quality of the workmanship is also far superior to that found in mass-produced modern windows.

The cost of repairing and maintaining old windows is less than purchasing new ones, especially if you consider the extra expenses that are not always mentioned by the contractors. Repairing windows is also a craft possible to learn for everyone. It is not difficult to make them look and work much better, additionally – they will automatically become tighter and more energy-efficient as a bonus. After renovation, your old windows may become nearly as efficient as brand new ones. And they will definitely outlast modern replacements.

In some cases, exchanging the inner glass to a more modern pane or triple pane packages with more effective U-values, could be a good option. It will save some energy but it will however take quite some time to count in the profit. Also note that high-tech glass will let in less light into the rooms, and packages get punctuated in time and condensated water will therefore appear between the panes.

There are many reasons to save and renovate old windows instead of replacing them: economical, aesthetical and environmental, to mention some of them. With the help from a skilled craftsman, they can be improved in different ways without impact on the character. Or take a course and learn how to renovate them yourself. Photo: Ulrika Lindh

[2] Most of these tips are gathered from Energy Efficiency in Traditional Buildings. p 26.
[3] Improving the Energy Efficiency of Historic Buildings. p 89
[4] Energy Efficiency in Traditional Buildings. p 39. This percentage can vary depending on the amount and size of the windows, and the microclimate around the building, for example.

ADDING AN INNER WINDOW FRAME

Instead of replacing original single glazed casements, upgrading them to double glazed windows with an extra frame on the inside will be a good investment. It will cut the heating costs significantly and result in a more comfortable and quiet house. At the same time the original appearance and fabric can be preserved to a high extent. Make sure that the proportions and the details of the inner frame is equivalent to the existing ones. Also – the inner frames should be sealed to the interior and the outer frames should be ventilated to prevent condensation.

Before investing in double glazing, take into consideration how the house is used. Sometimes it is more appropriate to leave single glazed windows as they are and use any existing shutters or curtains instead, especially if the historic and architectural values are very high.

THE ART OF HEATING AND VENTILATING

As mentioned before – it is essential to renovate and implement changes to a building first, if needed, and change the heating system afterwards. As an example: homes are often overheated as a result of drafts, therefore sealing leakages around windows and doors is necessary before making any major adjustments to the heating system. Otherwise you might end up with a system that is not dimensioned to the new circumstances inside. Also, remind yourself to begin with easy measures first, like asking yourself it you really need the same temperature in all of your rooms.

Draft is part of the natural ventilation system without fans that traditionally was used in all older houses. It is, to describe it in a simple manner, the consequence of warmer air rising in the building during the heating season, causing a lower pressure in the base of the building which leads to a draft of cold air through cracks and leaks in the structure in order to balance the pressure. This flow of air through the building envelope makes the structure dry and healthy but uncomfortable, unfortunately. Mitigating drafts will naturally result in a decreasing flow of fresh air into the building, which can lead to a risk of high humidity levels. Therefore, the lack of draft will need to be compensated somehow, at least if a building is used to live or work in. Opening new intake air vents in the outer walls will normally be sufficient when a building is stack ventilated the traditional way.

Needless to say, when a building is equipped with central heating: the boiler and its efficiency is directly related to the energy expenses and carbon footprint. Before you consider a complete change of heating system, begin with examining your existing system: Does it work properly or is it in need for maintenance or improvement? Can it be optimized or upgraded without huge investments? A lack of servicing might result in malfunction and expensive energy bills.

When is a complete change of heating system or heat source necessary? Well, it depends on how effective it is, the fuel used, how the building is used and its historic and architectural value. When the heat generated is based on combustion of fossil fuels, or costly options such as electric heating, you certainly have arguments to consider changes. Investigate available heating systems in your area. Find out if people are satisfied with the different kinds of systems, how much work they will imply for you and how much money you will save. Make sure to only consider systems that are compatible with the construction of your house.

In some cases, completing an existing heating system with an air convector or solar thermal heating can be a good option. They might however be problematic from an aesthetical point of view, both indoors and outdoors, and the installation process may include perforation of valuable building material. Ask for advice when it comes to the placement of devices like these in an environment of historical interest. Remember that the exterior devices do not necessarily need to be mounted directly onto the building in question, or not even close. With some imagination they can be hidden somewhere in a smart way in the proximities, for example underneath a set of stairs. Solar panels can be placed on the roofs of outbuildings in order to save the historic character of the main building.

A HOT CHIMNEY IS A GOOD INSURANCE

Continuing the use of the chimney, and keeping it hot as often as possible is very beneficial to an older building. It will ensure a natural draft, and the radiant heat will keep both the cellar or crawling space and the attic dry. It simply contributes fundamentally to a healthy house. A complementary heat source therefore needs to be studied carefully, since it might affect the rate at which you heat up the chimney.

Make sure that the lining in the chimney is intact. Cracks will cause leakage of noxious gases, and the draft characteristics will become less efficient. When repair is needed – try to avoid the modern solution where a metal pipe is installed in the flue. This modern technique might seem like a simple and cheap option, but instead it is to be regarded as risky when it comes to buildings of age. It is likely to slowly harm the building since a consequence is a colder chimney and a lowered rate of radiated heat. The drying-effect becomes reduced, and neither the chimney, the attic nor walls for example will be dehydrated like before. In the long-term, this may lead to costly damages.

TO INSULATE AND NOT TO INSULATE

The following is to be regarded as a short introduction to insulation, a field of knowledge that is rather complicated since alterations in insulation thickness will affect both temperature and humidity levels in a building. The issue of vapor moving through a structure needs to be carefully addressed, especially when insulation layers are changed in some way. Different kinds of insulation need to be combined with different kinds of moisture barriers. Seek guidance to find out what suits your specific building and its properties. As always when it comes to historic buildings, contracting experienced professionals is to be recommended.

To sum up our view on insulation in historic buildings – adding extra insulation in the attic (to a certain extent) will be a good investment that will save energy without affecting the appearance of the building. You will also gain from insulating the ground floor if it is very cold, but other easier measures should in general be prioritized. Insulation of walls on the inside or outside is very rarely appropriate for traditional buildings, and should be avoided in most cases for many reasons.

Traditionally, many kinds of materials were used as insulation, differing from region to region. Materials like for example dirt or peat do not necessarily have good insulation properties and can be replaced at the time of insulation improvements, preferably with materials of a hygroscopic nature that will adapt well to fluctuating moisture levels during the year.

In recent years, several types of building insulation materials with low environmental impact have emerged. Insulation made of flax is one of those - a light, durable material with hygroscopic properties. Photo: Jonas Ulfsfält

INSULATION OF ATTIC AND ROOF

If the insulation of the roof is insufficient or has become packed during the years, upgrading the insulation layer can be a very cost-effective operation. An important bonus is that it will not affect the appearance of the building. Provided that the existing insulation is dry and similar materials are used, new insulation can easily be added on top. Before the insulation is upgraded, remember that necessary repair works regarding leaks for instance needs to be completed.

Avoiding too much insulation is crucial. Too thick layers will result in a colder attic leading to a high risk of damage like fungal decay or insect attacks, due to unwanted moisture effects. According to research, 20 - 30 cm in total is enough. [5] In order to avoid microbial growth, the relative humidity needs to be lowered. This can be done through slightly limiting the intake of fresh air in the attic, according to science.[6] Ensuring that the temperature in the attic is higher than that of the outdoor is very important. Since an insulation project affects the environment in the attic notably, make sure to supervise the space during the following year. Investing in a device that measures both temperature and humidity is therefore highly recommended.

[5] Johnson, Magnus. P 17.
[6] Samuelson, Ingemar. 1995. Fuktbalans i kalla vindsutrymmen. SP Rapport 1995:6. P 25.

IMPROVING THE FLOOR

Collapsed insulation material in the first floor joists will result in a cold and uncomfortable floor. Adding insulation here can be a good idea, but we suggest that you prioritize easier measures first. Just like in the attic, one should be careful not to add too much insulation. With more insulation the crawl space will be colder, leading to higher relative humidity levels which in turn increase the risk of microbial growth in the foundation. As mentioned before – the crawl space is more likely to stay dry when the chimney is regularly used. Make sure to mark old floor boards carefully when improving the insulation in the first floor joists, and put them back in the same order as before.

AVOID INSULATION OF WALLS

Insulation of walls is for many reasons very rarely appropriate for traditional buildings. One of the paramount reasons to avoid actions like these is that a very limited percentage of the total energy consumption is lost through walls, since hot air moves upwards and not sideways. Taking other actions will both be cheaper and save more energy. Insulation of walls is measure that will take a lifetime to count in, or even longer.

Any addition on the inside will interfere with historic finishes and reduce the size of the room. Furthermore, it will also require relocation of radiators and all electrical installations. Most importantly - supplementary insulation on the inside of brick walls or plastered façades will result in a colder surface and lead to an increasing risk of frost damage[7].

External insulation of walls affect the exterior appearance of the building significantly, and should simply be avoided completely, with very few exceptions.

The only kind of construction where insulation of walls possibly can be recommended - when it comes to buildings of historic interest - is buildings with wood-frame walls.

ABOUT AUTHOR

Carina Carlsson studied the bachelor programme Integrated Conservation of Built Environments at The University of Gothenburg in Sweden 1997-2000. Her master thesis investigated the protection of historic interiors. Before that, she took courses in for example environmental psychology at The Lund University in 1995-1997. She works as a BUILT HERITAGE EXPERT at Region Västra Götaland since 2001. During 2000 and 2001 she spent a year as a conservation trainee at Sevenoaks District Council in England.

Carina works in different ways with information and communication regarding the built heritage, for example in courses, publications and social media. Her field of knowledge ranges over the history and maintenance of various types of buildings and settings, for example churches and cemeteries, modern architecture in general, agrarian buildings and landscapes. In 2015 she published a report on the changes of the built heritage during the postmodern era in four areas in the western parts of Sweden, "40 years later – about the change of the built environment, and built heritage surveys in the rear-view mirror".

Currently, she produces an exhibition regarding the effects of climate change on historic buildings and settings.

THIS CHAPTER IS BASED ON THE FOLLOWING PUBLICATIONS:

European Standard EN 16883 Conservation of cultural heritage - Guidelines for improving the energy performance of historic buildings

Improving the Energy Efficiency of Historic Buildings A handbook of best practice examples, technical solutions and research projects. Co2ol Bricks 2013.

Energy Efficiency and Historic Buildings Application of Part L of the Building Regulations to Historic and Traditionally Constructed Buildings. Historic England 2017.

Energy efficiency in traditional buildings. Government of Ireland 2010.

Löfgren, E., Hansson, P. (eds). The Energy Book. A guide to improving energy efficiency for house owners. EnergibokenEnergieffektivisering för småhusägare. Svenska byggnadsvårdsföreningen 2011.

Johnson, M. Careful renovation of an older house – to lower energy consumption without damaging the house.Varsam renovering av ett äldre hus – Att sänka energiförbrukningen utan att skada huset. Chalmers tekniska högskola. 2007

Samuelson, I. Humidity balance in cold attics. Fuktbalans i kalla vindsutrymmen. SP Rapport 1995:6.

[7] Improving the Energy Efficiency of Historic Buildings. A handbook of best practice examples, technical solutions and research projects. P 20.

THE PEARLS OF KULDIGA TOWN – HISTORIC WOODEN-FRAME LOG BUILDINGS – MEASURES FOR HEAT LOSS PREVENTION

Kuldiga is a small town in Latvia – it is a historical town where large importance is shown for identification, conservation and reinvigorating the cultural and historical heritage. The old town of Kuldiga in the ancient valley of Venta is included in the Latvian national list of the UNESCO, evaluating its medieval-type territorial planning, the complex of historic buildings, maintaining traditions and the nature value – the ancient valley of the river Venta, the wonderful waterfall "Ventas Rumba", the river Aleksupite (Latvian: Alekšupīte) – as a complex.

Kuldiga offers to see the renovation processes in relevance with heat loss prevention measures in its former old town hall – which is a remarkable wooden building and an architectural monument. There is a large number of wooden houses in Kuldiga that shall be applied to modern-day life requirements, though preserving its special characteristics. To improve the energy efficiency – it has been a big challenge for the designers of the project – as they had to find and foresee the measures which shall be taken in the field of energy efficiency in a historic building where seemingly nothing could be done. There values all around that shall be preserved, external wooden log walls, internal – historic wall plastering and paintings on them. Among the values which should be preserved, there are also the building construction, structure, frameworks, the parts of wooden building joinery, separate elements and parts of the interior. Solutions were found after evaluation of the current situation and in renovation using the traditional materials which were historically used during the building's construction, combining them with compatible and relevant modern-day materials. The accomplished target – there are comfortable and cosy living conditions created for people also in a historic building, preserving its values and reducing the financial expenditures.

THE BUILDING DATA:

Function	The public building – the building for maintaining traditions and the tourism information centre
The year of construction	17th, 18th century, the year of 1806
Rebuilding	The building had suffered from several fire occasions and was renovated in the middle of 19th century, partly rebuilt in the decade of 1970's
Material	Granite and dolomite stone rudiments, walls – wooden logs, (roof) frameworks – wooden with clay stuffing, roofing – roofing clay tiles, wooden building joinery – doors, windows, details and parts
Architects	There have been several architects participating in the building renovation
The number of floors	Basement, the ground floor. The attic floor was built in
Type of heating	The central heating system from the town heating system network was built in 1973, renewed and partly rebuilt in 2015. The heating providers – the cast iron radiators – were not changed
Developer. Year. The contracting entity	The complex renovation project which was realized in 2015 by the team – the public contracting entity, the designers' office and the construction company. The insulation, renovation project

THE LOCATION AND MEANING

The historical wooden frame log house is located in the historic centre of Kuldiga town (the national significance monument of culture and urban construction) and in the heart of Kuldiga town, in the bank of the picturesque river Aleksupite (Alekšupīte) (Picture 1). In 17th century, the new Town Hall became the central place of the town life, and it has maintained its importance also nowadays, as the current town hall is located on the southern side of it.

The building has gained its current outlook in the result of several rebuilding processes. Initially the building was built in the 17th century, and later it was rebuilt for several times. The building is placed on a masonry wall cap and downstairs under the building there is a basement with vaults, where historically a prison of Kuldiga was located for some time. The massive pitched roof with partly truncated roof corners provide to the building its outlook characteristic to Kuldiga urban construction. The outlooks of the classically symmetrical facades are still preserved which was built in the beginning of the 19th century.[2] The building is very important object for its citizens who actively involved in discussions on the building renovation and specially asked the local authority to preserve the building's wooden walls without wall renderings (the walls were covered with renderings in the 30s of the 20th century) and leave them darkly pitched, which, by the point of view of the citizens, are some of the Kuldiga town symbols.

The location of the historic building in the central part of the old town of Kuldiga – on the second town hall square – as it is still nowadays[1]

The building in the beginning of the 20th century – with wall rendering on the wooden log house walls[3] *and the building after the renovation – in 2016*

THE CULTURAL AND HISTORICAL SIGNIFICANCE

The building was necessary to renovate because of its bad technical conditions, and after a year of restoration work it has become as an example of the ancient wooden building renovation possibilities in old towns. The building is a significant example of wooden architecture which shall be maintained and protected as the state importance cultural – architectural – monument. The building is open to the public, so, in order to be possible for visitors to get to know the

[1] Mr Gustovskis, A., 2017, photo fixation, available in the digital archive of Kuldiga District Council
[2] Mr Krastiņš, J., Ms Eniņa, A., Kuldiga. Architecture and Urban Construction. The architecture of Kuldiga: public buildings. Kudiga: Kuldiga District Council. 2014. Pages 380, 381.
[3] Ms Veinberga K., Mr Zviedrāns J., The Architectural and Artistic Research of a Building. Kuldiga. 2014., Page 10

traditions of a typical wooden building construction of the beginning of the 19th century, the historical planning of the premises and enfilade on the both floors of the building, as well as one of the two historical mantel chimneys, and the building constructions, building parts and wall paintings characteristic to the century were uncovered. The original and historical constructions and building parts are preserved and maintained as much as possible. The building was partly rebuilt in the seventies of the 20th century, with that time understanding of a cultural monument restoration. Last rebuilding and renovation works of the town hall were accomplished in 2015, by carefully evaluating the importance and influence of every layering, not only in the culturally historical but also in the technical field, and supplementing with the necessary new elements.

THE DATA RESEARCH OF THE ENERGY EFFICIENCY OF THE BUILDING

Research works. There was a technical inspection of a building and a report developed which showed that, after the building was exposed, the condition of the current thermal insulation should be repeatedly evaluated; when exposing the building, it was decided to dismantle all the former materials of the thermal insulation – fibrolite boards, sawdust with lime, sandy-clay filling in wooden frameworks, rock wool over the pipes. There was also exercised an architectural and art inventory of the building. In conformity with these documental instructions and conclusions, the maintainable and renewable values of the building were prescribed, as well as the technical condition of those values. This was also as a basis for the building renovation conception and, consequently, also for the heat loss prevention measure planning and their implementation. As the building is considered to be an architectural monument, the regulations do not require to perform some certain mandatory measures if they might be damaging to the preservation of the building values. Though the contracting entity has mentioned to the designer that such measures should be considered. In the project, the complexity of the measures is scheduled and its calculated energy efficiency assessment shows that after the reconstruction the building will be correspondent to the level of the average consumption of the respective type of the building.[4] Also the recommendations published by the State Inspection for Heritage Protection (Latvian: "Valsts kultūras pieminekļu aizsardzības inspekcijas (VKPAI)") of Latvia on the improvement of the historical building energy efficiency show that "(..) In order to implement the measures of improvement of the energy efficiency in cultural and historical buildings, there is a necessity of a careful, professional approach with a tendency to a succession and continuity. First of all, the surveillance of the building should be performed and the places for a possible heat loss should be found out and inspected, understanding the building and its value thereof. Then, carefully treating the protectable and maintainable cultural and historical values, there should be developed a complex of measures necessary to be taken for energy saving."[5]

REGULATIONS AND THE IMPLEMENTED DEROGATIONS FROM THE REGULATIONS

The laws and regulations valid in the Republic of Latvia prescribe the permissible indicators of a building energy efficiency. Some of such regulations are, for example "The Law on the Energy Performance of Buildings" (Latvian: "Ēku energoefektivitātes likums") (valid from 2009) and the Latvian construction standards "Thermotechnics of Building Envelopes" (Latvian: "Ēku norobežojošo konstrukciju siltumtehnika") (valid from 2003). The main target of these normative acts and regulations is to promote a rational usage of energy resources and improve energy efficiency of buildings. The requirements prescribed by the regulations are concerned with current buildings and new buildings, but this law requirements shall not be applicable to the buildings that are *"(..) cultural heritage monuments or in which are placed some cultural heritage monuments, or if a building is in a territory of a cultural heritage monument, if the law enforcement might be damaging to the protection and maintenance of such cultural heritage monument or if its cultural and historical value and significance might be reduced."*[6] Nevertheless, "In an architectural monument restauration, the State Inspection for Heritage Protection (Latvian: "Valsts kultūras pieminekļu aizsardzības inspekcijas (VKPAI)") may permit some alternative measures or derogations from the requirements of these construction standards, if the fulfilment of the respective requirements might be damaging to the maintenance and protection of a cultural heritage monument or if its cultural and historical value and significance might be reduced."[7] When evaluating the influence of a historical building towards the environment, the suggestion in calculation models is to examine and assess the respectively current materials, cultural and historical heritage, social and ecological values, not only the energy value, so mentioned Mr Dzintars Heinsbergs,

[4] Technical project documentation. Kuldiga. 2015. Availabe in the archive of the construction board of Kuldiga District Council.

[5] Improvement of the Energy Efficiency in a Historical Building. Recommendations of the State Inspection for Heritage Protection – recommendations Nr. 2011-3. Available online: http://mantojums.lv/media/uploads/dokumenti/vkpai_rekomendacijas/rekomendacijas_energoefektivitatei_29039011.doc.pdf

[6] "The Law on the Energy Performance of Buildings". Available online: https://likumi.lv/doc.php?id=253635

[7] "Thermotechnics of Building Envelopes". Available online: https://likumi.lv/ta/id/275015-noteikumi-par-latvijas-buvnormativu-lbn-002-15-eku-norobezojoso-konstrukciju-siltumtehnika-

the architect of Kuldiga District Council, who has actively participated in restauration work of this building. In every historical town or city, there are also their own local normative acts and regulations – building regulations which prescribe requirements for building renovation. Kuldiga District Building Regulations prescribe that a historical building is "a building which was built until the year of 1940 (..) and it is not permitted to use outer or external insulation for such a building (..)"[8]

But in the recommendations published by the State Inspection for Heritage Protection of Latvia (Latvian: "Valsts kultūras pieminekļu aizsardzības inspekcijas (VKPAI)") concerning a building energy efficiency improvement, it is mentioned, in its turn, that "(..) In all the Europe, constantly more and more importance is given to the building energy efficiency, which affects also historical buildings. From all the volume of construction, approximately 3% of construction are considered to be buildings with significant cultural and historical values which are affected by the requirements for cultural heritage maintenance and protection. One method how to reduce the energy consumption in a building is an insulation. Integration of new and effective thermal insulation materials in building envelopes (in outer or external walls and upper floor flameworks) is connected with physical changes made to such constructions. As the thermal insulation must be one of the outer layers of a building envelope or separating constructions, the insulation inevitably affects an architectural surface finish of a building facade. But it is a significant maintainable value in many historical buildings. Only in very rare occasions, it is permitted to insulate culturally, historically and architecturally significant building outer facades, because the heritage value of a historical building are not only the form, shape or colour of its outer surface, but also a substance, a construction example, original decors and historical surface patina. If it is not impossible to insulate walls of a historical building or to change wooden joinery products of a building – windows and doors – then it is advisable to implement all other possible measures for energy efficiency without external wall insulation or window, door replacement." [9]

THE STRATEGY FOR HEAT LOSS PREVENTION MEASURES IN THE BUILDING

This building was modified and recovered from a historical building which had no energy efficiency measures applied to a historical building with increased energy efficiency. External walls on their outer layer are not possible to be insulated, nor the inner walls – because the building is a culture monument which is open to public and its walls render significant information and tell us about diverse materials, traditions, crafts and styles used in various periods of time.

In order to improve the energy efficiency in this building, the following targets were determined:

1. maintain the air and moisture permeability of the building envelope (or the outer and inner separating constructions), by using appropriate traditional materials – historically used during the building construction and being ecological – which are renewable materials and contain comparatively small amount of some chemical additives;
2. ensure maximum prevention of some openings or cracks in the building envelope (separating constructions) by the help of traditional/ ecological sealing materials;
3. insulate the separating constructions of the building envelope which do not affect the visual outlook and the protectable and maintainable values of the building, using ecological materials.

There were inspected systems, separating constructions of the building envelope, and, consequently, the conclusion was made that they are frost-resistant, and the following program of activities was accepted:

1. gravitation ventilation system – to be improved and to ensure regulation;
2. windows – to restore, densify, but maintain aeration, glazing – with reflectance;
3. exterior doors – produce new doors and densify them;
4. the attic framework – to be densified and insulated;
5. walls – to be densified;
6. building rudiments – to be densified.

The thermal heat loss prevention of the building was examined by various aspects and in every aspect, it was tried to find the best solutions to improve the present situation of the building, simultaneously maintaining the defined protected and maintainable values of the building.

The heat loss prevention measures in this historical wooden building shall be implemented in such parts of the building:

1. for gaps in the building envelope separating constructions – using by the method of convection. The solution – to densify the gaps in the building envelope separating constructions;
2. the construction elements of the building envelope separating constructions – by the help of the thermal permeability of the material. The solution – to reduce the thermal permeability of the construction elements of the building envelope separating constructions (W/M2k), using materials with less thermal permeability;
3. the glazing of the building envelope separating constructions – by the method of rays. The solution – to use the surface finish with heat-reflective coating on the glazing parts of the building envelope separating constructions.[10]

Further in the text – in the descriptions of construction processes – the measures for heat loss prevention are grouped and described in such structure – describing them by these 3 groups.

THE PROCESS OF IMPLEMENTING THE CONSTRUCTION MEASURES

In order to prevent the heat loss mentioned in the previous point, the following activities were performed:

The type of the heat loss prevention – to densify the gaps on the building envelope separating constructions

The walls of the wooden log house

The gaps in wooden log walls were densified externally by the traditional method – the gaps were carefully caulked with flax staple fibres (linen) which were drenched in wood pitch (Picture 5). This mixture of staple fibres and wood pitch is flexible and durable, as wood is a material which swells and dries out. In the biggest gaps in wood, there are applied and inserted some wood parts from a historical, regained wood material and there are some replacements placed, though evaluating the wood species, age and wood fibre orientation or directions. A good material for thermal insulation is lime mortar plastering on a board of wooden splints. The masters tried to preserve the plastering where it was possible (Picture 6 and Picture 7). In other areas in the interior, there was applied new lime mortar plastering and renderings on a board of wooden splints.

The walls before restauration.
The restored walls – caulked, afterwards pitched wooden log-house walls

The preserved current and newly formed lime mortar plastering

[8] The territorial planning of Kuldiga District Council. Territorial usage and construction regulations. 2013. Available online: http://www.kuldiga.lv/userfiles/files/Kuldigas_Novada_TIAN_2012_6_1_red.pdf

[9] Improving the energy efficiency in the historical buildings. Recommendations of the State Inspection for Heritage Protection – recommendations Nr. 2011-3. Available online: http://mantojums.lv/media/uploads/dokumenti/vkpai_rekomendacijas/rekomendacijas_energoefektivitatei_29039011.doc.pdf

[10] Mr Heinsbergs Dz., The heat loss prevention in historical building. Presentation available in the digitall archive of Kuldiga District construction board.

WOODEN WINDOWS

The windows have a significant role in the overall architectural image of a building: "Window are an important part of a historical building architecture. They are among the most attracting facade elements, and like a mirror of technical possibilities of a certain style and period of time likewise. It is necessary to try to maintain and preserve every window original, by carefully treating, renovating and restoring them. Window replacement should be admissible only in such occasions when the prevention of damaged parts noticeably and extremely exceeds the costs of a new, high quality and the same material window manufacture and replacement costs. As a compromise, it is admissible to replace the interior window frame. The original external window frames must be preserved as much as possible. The window replacement must be coordinated with the overall project of a building facade." [11]

The problems with historical, old windows, also in this particular building, are related to regular untidiness of the windows and only in rare occasions concerned with construction failures and manufacturing quality. In order to make the old windows to be more thermal energy-saving, the main two tasks must be implemented: to examine window glass fixation and to obturate or seal the windows. In the windows produced till the 60s of the 20th century, the glass was mainly caulked, but in the second part of the 20th century, in its turn, there appeared a tradition to fix the window glasses with laths conversely to the previous tradition to caulk.

In this building, the windows were manufactured during the process of renovation – in the second part of the 20th century – that is, in 1973, the window glasses were fixed with laths. It was cheaper, but less economical. When humidity and moisture get beyond a lath, the glass bedding rifle was damaged and through such gaps the air-flow got in.12

Firstly, the current windows, their density were examined and evaluated, and there was a decision to

The restorable window with the applicable sealing parts in it – rubber sealing gums and the window glazing with a putty appliance in the external sashes[12]

[11] Improving the historical building energy efficiency. Recommendations of the State Inspection for Heritage Protection – recommendations Nr. 2011-3. Available online: http://mantojums.lv/media/uploads/dokumenti/vkpai_rekomendacijas/rekomendacijas_energoefektivitatei_29039011.doc.pdf

[12] Technical project documentation. Kuldiga. 2015. Available in the archive of Kuldiga District Construction Board.

restore the external window sashes (manufactured in 1973) with a caulked window but produce new internal window sashes by introducing an innovation – to use a reflective glazing, which was not possible historically. It is discussed in more details in Chapter 7.3. The second place where the cold air-flow could come into the building, are gaps between the window sashes and their frames, and in order to prevent this – there were gaskets moulded (a rubber sealing contour) in the window sashes – cushion rubber of capron. It is possible also for inhabitants to purchase glued cushion gum rubbers for household necessities, but a more sustainable solution is to mold the gum, which is a more complicated, more expensive process though, as it must be performed by a craftsperson. For **historic-type chamfered windows and box-type or lined** windows, the rubber sealing contours are often embedded in the inner sash block. In order to ensure the best fixage density, it is necessary to individually evaluate the size of every rubber sealing for every window separately, to ensure that the density and compactness is enough for every window individually, not standardised and the same for all windows of the building. It is necessary to place an adequate rubber sealing cushion gum in the appropriate necessary thickness and length, with especially careful attention to corner connections, in order to prevent heat loss as much as possible. The third place where the most heat loss appears (visually observable), is the window frame fastenings in the wall, as the fibre tows were used as the only material, sealed on the surface. Traditionally before using them, the fibre tows were soaked in gypsum and then the tows gained more density. In such situation, they not only drain the moisture, but also accumulate it. Outside the wooden log house here, it was not possible to apply a plastering or wall rendering in such technique as it is done for masonry buildings – the wall rendering was applied only in the interior where it is not flexible enough, which caused heat loss in this place. Probably the fibre tows should have been sealed more closely or chose modern-day materials which could be visually covered with window frame but would fulfil its function more effectively.

The window block application in various material walls with the supplements – flax tows[13]

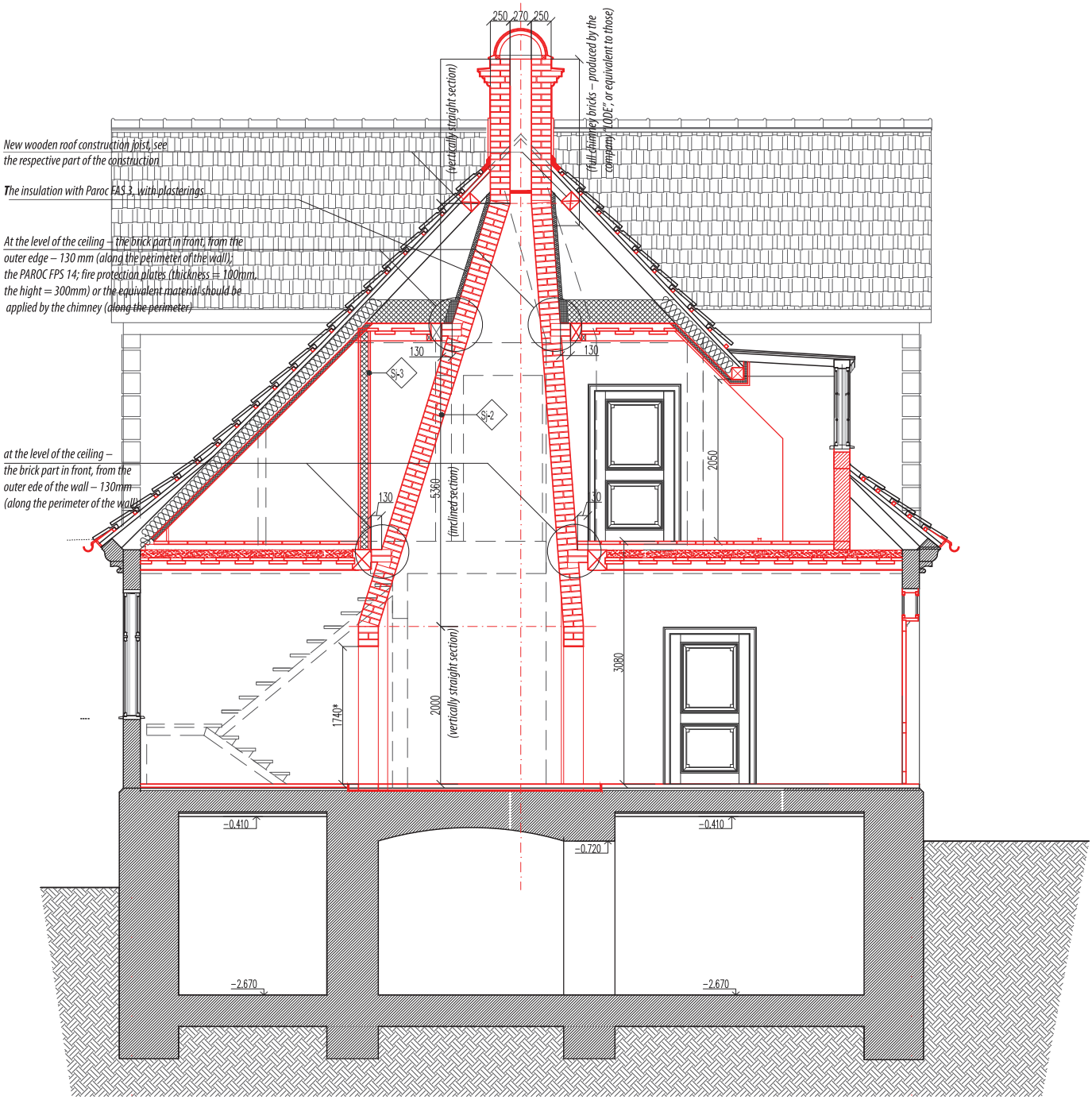
[13] The electronic archive of the photo fixation of Kuldiga District Council.

WOODEN DOORS

The sealing for doors – the rubber applications were put similarly in the door ails, though the profile of the rubber sealing gums is different. With the traditionally manufactured wood panel doors, the sealing is a huge challenge, as historically porches and staircases were not ensured with heating, therefore the heat loss prevention measures were not necessary. The heat loss does not derive from unheated premises. But in order to use a building as effectively as possible, the solution is preserved which was introduced in 1973 – the porches are ensured with heating and the doors are newly manufactured – traditional, with moulded rubber cushion gums. Such type of doors is a place for the heat loss.

MANTEL CHIMNEYS

A mantel chimney or a shell chimney, also called as "the great chimney" is a big chimney arising throughout all the building's height and is more narrow at the upper edge – as a type of funnel.

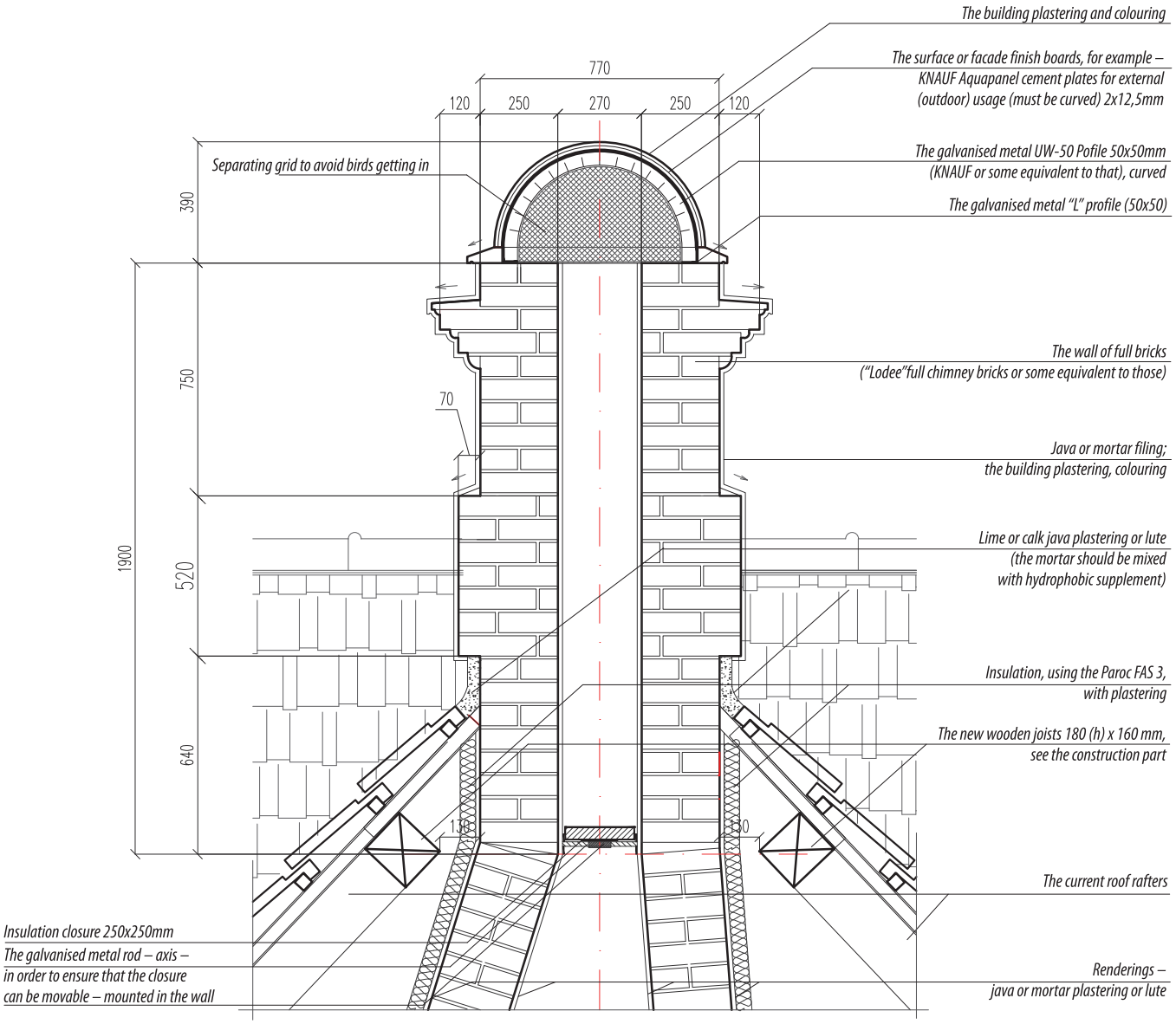


[14] Mr Krastiņš J., Ms Eniņa A., Kuldiga. Architecture and Urban Construction. Architecture of Kuldiga: the public buildings. Kuldiga: Kuldiga District Council. Kuldīgas novada pašvaldība. 2014. Pages 380, 381.

That was a typical planning of publicly open houses historically in Kuldiga, and often it was similar also to dwelling houses. The mantel chimney was planned in the centre of the building – and the rooms for work or living were placed around that type of chimney. The scheme for such planning with a kitchen in the centre of a dwelling house or a publicly open house remained till the end of the 19th century. In the former town hall, the mantel chimney is near the hallway which led to two rooms in both edges of the building[14].

In general such type of planning with a mantel chimney in the centre of a building and a mantel chimney as a structure itself – have stilled remained in several private houses. But in the houses open to public, in its turn, it was not possible to see the mantel chimney which was typical in Kuldiga, until the restoration of this building. That is why it was very important to restore this chimney, simultaneously ensuring that there will be no heat loss through this chimney.

The mantel chimney was built by craftspeople, according to the traditions, but also that the premises built in it would be functional as building premises – for exhibitions, etc. It was necessary to ensure sealing – a hatch which could be lifted if fire and food was made there, as for the chimney was built historically. There is a solution of sealed hatch which can be lifted, and that ensures also heat loss prevention.



The mantel chimney which is renovated (red coloured) and The mantel chimney outlining and the expected density – insulated roof hatch, sealed roof coverings near the mantel chimney[15]

[15] Technical project documentation. Kuldiga. 2015. Available in the archive of Kuldiga District Council Construction Board.

THE BASEMENT AND THE RUDIMENT

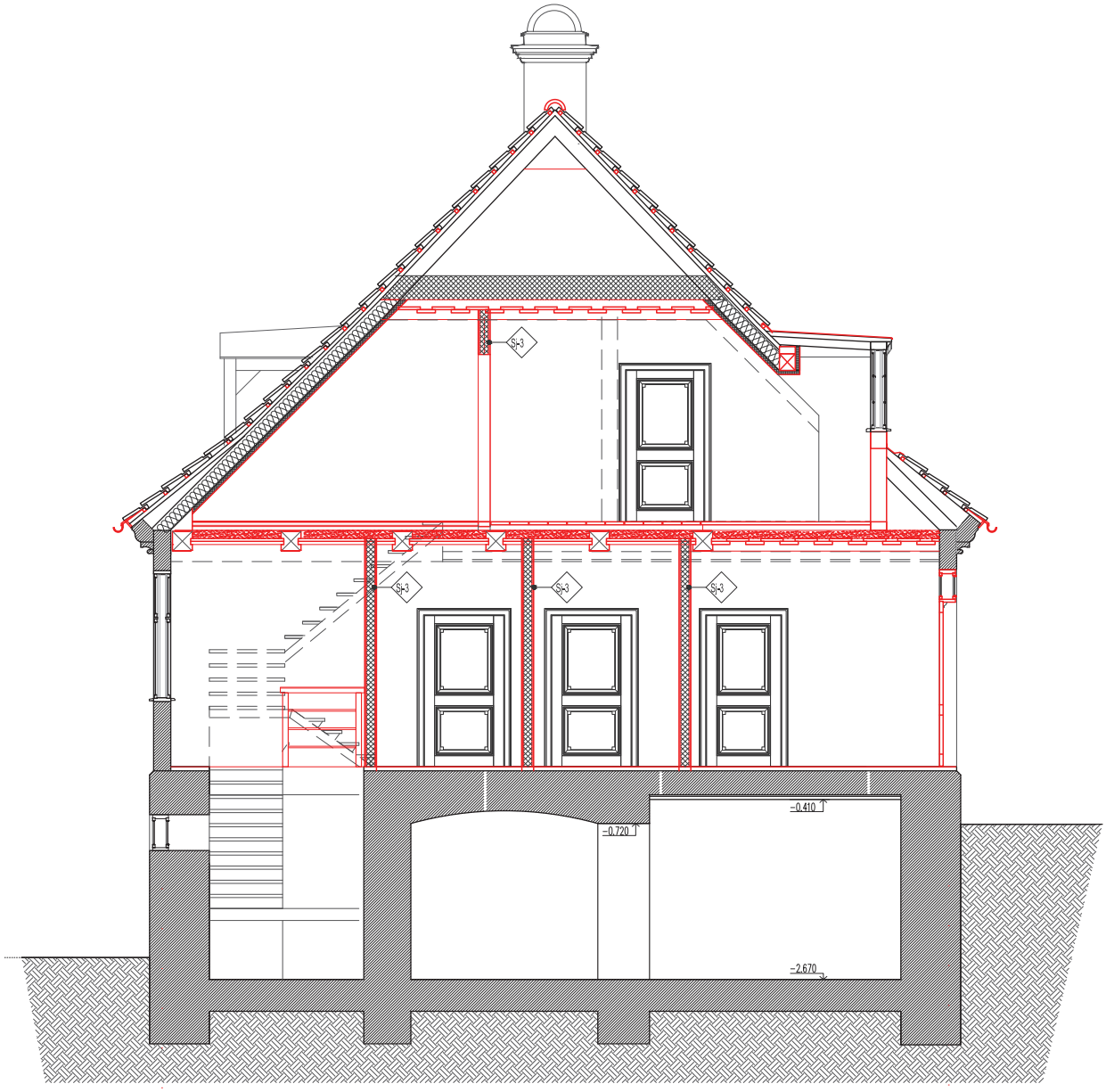
The building has its basement heated – there is a café in the basement premises. The local authority renovated only those premises which are in its possession, but the rented premises for the private company was not renovated, as the financial resources for this project were limited. During the building renovation, the solutions were implemented only till the level of the basement covering.

The Method 2 for the heat loss prevention – reduction of thermal transmittance (W/M2k) of the construction elements of the building envelope (separating constructions), using insulation materials.

The insulation materials in a historical building should be applicable only accordingly to a specialist's – an architect's – suggestion, because all solutions should be discussed as a complexity – application of new materials and restoration of the current ones.

CEILING

In the attic, the clay was used a material for thermal insulation, which was dismantled and repeatedly inserted back in the building after the constructions were strengthened. The clay coverings have not only isolating role, but it is also of high density and quite heavy, which



The drawing of the building reconstruction – on the edge – the changed coverings among the current bearing structures and the ceiling boards which are insulated. [16]

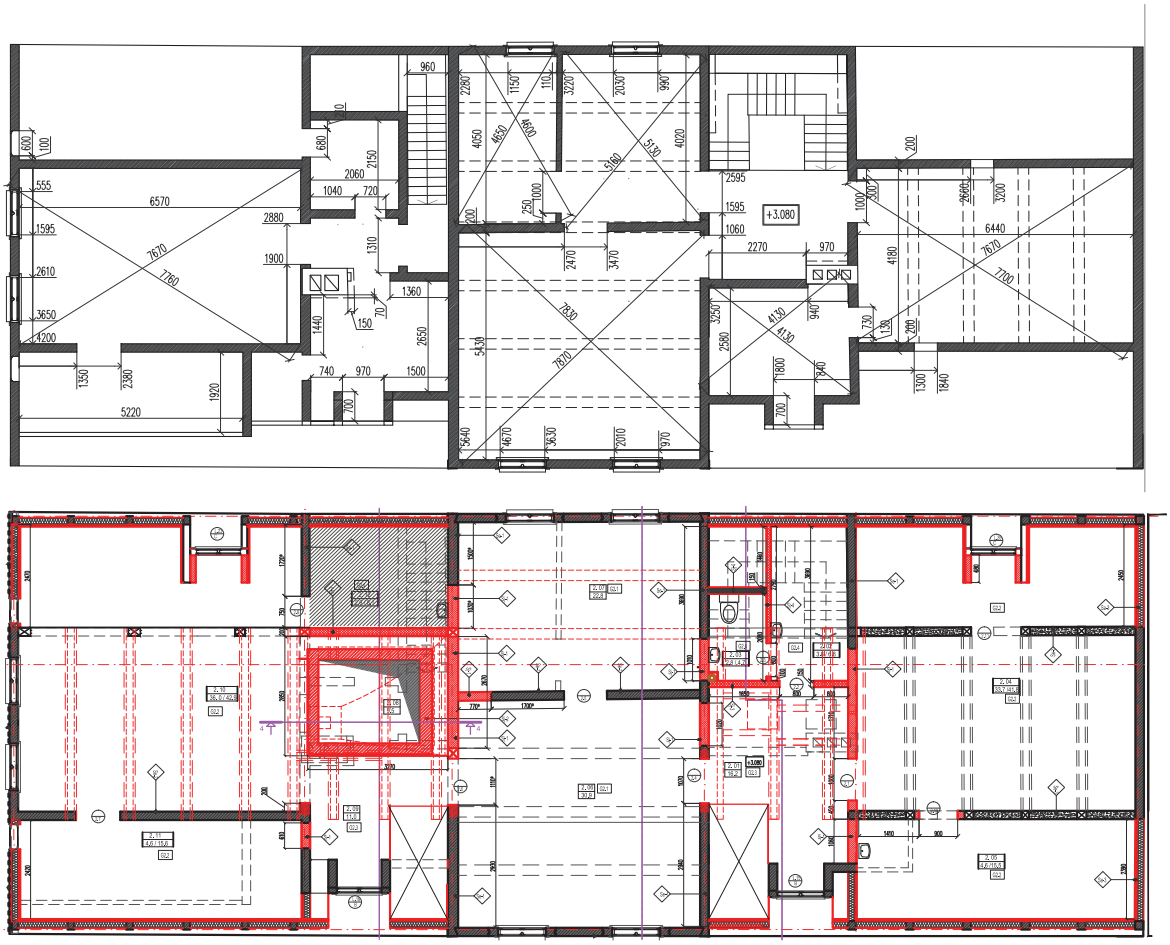
[16] Technical project documentation. Kuldiga. 2015. Available in the archive of Kuldiga District Council Construction Board.

tightens the building constructions as it was done historically. If it was dismantled constantly, then the gaps in constructions might increase due to the load changes. When coverings are insulated, it is very important to pay a particular attention to the ventilation system in a roof. During the project, there was a material of sand and exclay inserted in the ceiling, but later all the construction project participators agreed to renew the clay filling.

The removed and repeatedly laid clay covering

THE ROOF

The type of roof insulation and usage was changed. The previously cold roof porches are intended to be used for the building functions, therefore the roof board was insulated – the whole upper floor was re-built. The historically warm rooms were in the center of the roof floor, enclosed with filled framework walls (wood and brick) or wooden package walls, which in the Soviet times were renovated and insulated with fibrolite, in some places dismantled, in other places the openings were opened, and the roof plate was insulated, simultaneously ensuring the roof ventilation, as the cold porches and the upper floor premises no longer filled this function as it was previously. During the renovation process, there was created a roof construction which is insulated and possible to ventilate. Under the roofing tiles, the humidity draining ensured. The solutions are made with modern-day, compatible materials – wood fiber boards, the fibrolite, the ecowool for construction (dry wool – in the thickness of 300mm), steam diffusion film.



The planning of upper floor premises (till the cold roof porches) – on the left side – before the reconstruction, and on the right side – after the reconstruction (with built-in and insulated porches of the building – the current constructions and materials – in the black colour – and the new ones in the red colour) [17]

[17] Technical project documentation. Kuldiga. 2015. Available in the archive of Kuldiga District Council Construction Board.

Before the renovation. The renovated and reconstructed premises in the end of the 20th century – in 1973[18]

The renovation processes. The cold porches and their construction

And their dismantled materials which were used in 1973 for reconstruction, including the fibrolite boards

After the rebuilding reconstruction. The cold porches incorporated with the heated and usable premises

After the rebuilding renovation. The cold porches partly incorporated with the heated premises – with some openings in the filled framework walls, in order to ensure more lighting from the built-in roof parts

[18] Electronic archive of photo fixations of Kuldigas District Council.

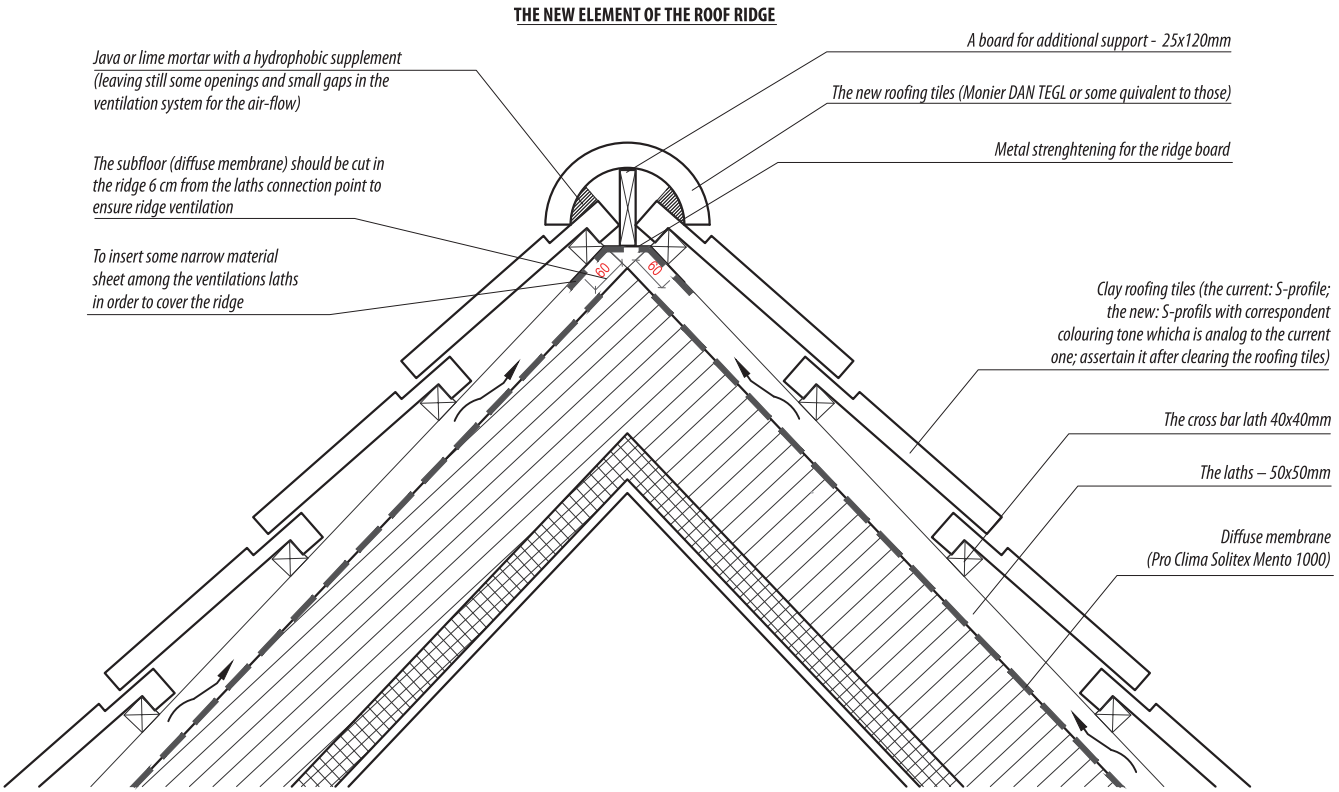
After the rebuilding renovation. There is a rendering on the fibrolite boards – as a solution which is still open for discussions, especially in a historical building where after the reconstruction the building still sinks a bit more into the ground, and there are some cracks revealed among the [19] boards, and consequently also in the rendering coverage of the wall. It is advisable to cover such interior rendering with some wood boards, where there would be no visible cracks

On the roof – diffusion film – under the cover – clay roof tiles

The insulation of roof board with wood fiber boards

There are a steam barrier, laths and fibrolite layer placed above the wood fiber boards, afterwards the layer of the lime mortar rendering

[19] The electronic archive of photo fixations of Kuldiga (Kuldīga) District Council.



Roof with a ventilation system. The current constructions and the applicable additional materials, their characteristics, to develop an insulated roof with a ventilation system. A drawing among the project materials[20]

The Method 3 for the heat loss prevention – apply heat-reflecting materials on the glazing part surfaces of the building envelope (separating constructions) In the inner sash of the windows, there is a heat reflective glass applied (colloquially called as selective, thermal insulating one, etc.) in the thickness of 4 mm. It is easily applicable in the current wooden window frames and it has a special role with inner window sashes as this type of glass reflects heat. The heat reflective glazing was applied in the inner window sashes because of its good quality characteristics – the reflection of the building's thermal insulation in the interior, and also because of the surrounding situation – its glazing and the glass surface texture, which is not typical for wooden log-house architecture solutions of the 19th century. It was decided to use the current 2mm wavy glass in the outer window sashes, as it was in the moment of window manufacturing, and to put a new identical glass in those places were the previously mentioned type is not possible.

THE SPECIALISTS INVOLVED

As this building – the former town hall of Kuldiga – simultaneously is both a very significant wooden house and a publicly open building, a large team of various specialists was invited to participate in the process of this building renovation, in order to develop an example of a traditional building renovation and to ensure the best quality solutions as possible. In everyday situations – for renovation of residential buildings and heat loss prevention – these issues are advised to be initially started to discuss with a practicing architect who would invite the necessary specialists for cooperation if there might be a need for specific calculations, more detailing or because of the legislation regulations.

In the renovation process of the respective building – the former town hall of Kuldiga – generally there were cooperating various specialists, and every specialist performed their tasks and individual responsibilities of their own specialized profile field. The research work, the project designing, the project management, the construction work. The manager and the contracting entity of the construction project ensured the common solutions, the collateral work among the specialists, assessment of various aspects and balancing the interests in the process of the project designing.

[20] Technical project documentation. Kuldiga. 2015. Available in the archive of Kuldiga District Council Construction Board.

The research work before the project – the technical research was concluded by a building engineer, and the architecturally artistic inventory – by an architect. During the project stage – the temporary energy certificate was developed by an independent expert in the field, the construction project was developed by the project designer team of engineers and architects. Other project designers were examining if the project solutions are being correspondent to the law regulations and the requirements of the contracting entity. The project was coordinated among the involved parties of the state and local municipality institutions, the construction board and the contracting entity. The municipality specialists also participated actively – such as architects, restaurateurs/ restorers and project managers. The restauration work was led by a professional builder and a restaurateur/ restorer. It was supervised by a team of the authors, the representatives of the contracting entity and the construction supervisor – the construction engineer.

THE OPINIONS

As the building is a public-type one, it is constantly open to public and it is no possible to maintain some special kind of schedule for usage. Correspondent to the information provided by the building users, in the field of the energy efficiency previously before its renovation the building premises had very unequal and unstable temperature in the interior in separate rooms – it was too hot in the office premises, and comparably cold common areas of the building premises. After the renovation, the temperature is equalized among the office premises and the common area premises of the building – the temperature is even and there is a reduction in the sum of the bills for the heating, although it is equally warm in all rooms and premises – that is, there are more square meters to be ensured with heating (including the restored second floor cocklofts (spaces directly under the roof). According to the information provided by the building users, there are no consistence failures in the building constructions or construction parts throughout the building, which could be possibly disturbing to the work conditions as it had been previously when it was impossible to organize a work place near any window in the building. However, the user points out that after the building renovation the air is too dry in the interior and it requires additional air humidifiers during the heating season.

THE CONCLUSIONS AND LESSONS-TO-LEARN FOR THE FUTURE

As an idea:

- If using only the traditional materials – which were historically used during the construction of the building – and changing the traditional usage of the premises of the building (renovating the cold cocklofts (spaces directly under the roof), providing the heating for the previously cold porches and including them among the premises with heating), it is not possible to ensure the improvement of the build energy efficiency. There is a possibility to use modern-day, though compatible materials for the heat loss prevention (densifying, heat reflection). An example of this could be that in the occasions when it is not enough to use only the traditional – historically used – materials for preventing the heat loss through the windows, it is advisable to apply them with modern rubber sealing parts or heat reflecting window glasses.
- For the restaurateurs/ restorers of historical buildings, it is necessary to have some additional knowledge of not only traditional solutions for the building renovation, but also modern-day material usage in a historical-type building. Because nowadays the buildings are often rebuilt etc in the way which slightly changes the way of the building usage, or traditions; consequently, it is necessary to implement compatible and modern improvements by the help of materials. Or another possibility is to attract to this field of energy efficiency certain specialists, having correspondent knowledge and qualification.
  There is a necessity to have a clearly defined conception not only for the renovation of the building to be heated, but also for the heat loss prevention measures.

In the project designing:

- Every such type of a project needs a detailed information and selection of all the materials not only in the sections of restoration and constructions, but also in this – heat loss prevention – the field of energy efficiency.
- Much attention must be paid to the selection or choice and the analysis of the possible solutions for the engineering systems. Already at the stage of the project design, the developed assemblies or subassemblies must be in such amount and such level of detail, to

manage all further thermally technical calculations, choice of engineering systems and construction works as precisely and accurately as possible.

- For the complex project realization, the competent people were asked to participate in specific issues of the energy efficiency – in the analysis of thermal bridges, as well as for finding solutions for sealing the building envelopes (separating constructions), technical parameters of thermal insulation materials, and the specialists experienced in the analysis of the complex energy consumption in a building;
- The quality control principles of the construction work and the achievable indicators are clearly defined;
- An example for the necessary detalization – a reasonable and effective choice of the reflection percentage and type of the surface coating of the applicable window glass. It is necessary to assess the measures which should be taken in the process of the glass implementation and evaluate if a method by mechanically clearing the putty appliance (with a razor-blade) do not affect the qualities of the selective coating. The putty is applied and afterwards the remains of the putty rendering and a colour are mechanically cleared, possibly damaging the glazing thereof. It is possible to take off the putty rendering also by dry chalk if the putty has not dried yet. If the soft selective coating is resistant to a mechanical action (this is important to clarify, because the window restoration processes include the same activities. To clarify and ask the selective glazing producers also how the glass might or might not react if being mixed with the linseed oil. It is necessary to find out also what coatings might be suggested for such conditions and what the indicators might be. What we should know about the selective glazing – its implementation and application, mechanical resistance, coating and its thickness, type, technical indicators.

During the construction work:

- Changes to the project might be evaluated in various aspects, also in this – energy efficiency – field, and they must be confirmed by a specialist who evaluates the material not separately, but by interconnections with other planned solutions.
- In the stage of a building construction, the regular tests on the quality control are managed, for example, a test on the air permeability of a building (BlowerDoor), in order to identify and prevent the identified imperfections in time.

The author is grateful for the participation and consultations during the article developing process: the building physicist Mr Andris Vulans (Andris Vulāns).

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VAMBOLA STREET 1, TARTU

Function	Family house
The year of construction	1920 II half
Rebuilding	2017
Material	Log
Architects	Engineers from Novarc
The number of floors	2
Type of heating	Stoves, air to water heat pump, ground floor has floor heating, II floor has cast iron radiators
Developer. Year. The contracting entity	Private owner

This article is aiming to broaden the discussion in the context of a lifecycle and energy efficiency of buildings. As the aim of the EU Energy Efficiency Directive is to reduce the CO2 emission on a state level, a building's cultural heritage must be considered as a resource.

Life cycle studies suggest that demolition and new construction causes larger carbon footprints than those resulting from reuse of urban resources.[1]

In short-term as well as long-term perspective sustainable renovation of historic buildings at heritage sites is more environmental friendly than replacement with new ones.[2] As the aim of the EU Energy Efficiency Directive is to reduce the CO2 emission on a state level, a building's cultural heritage must be considered as a resource.

The revisions in national legislations brought about by the Energy Performance in Buildings Directive (EPBD) are changing the design and environmental properties of new buildings and the premises for use and reuse. Urban heritage resources that are not upgraded may in turn become less competitive in the market and vulnerable to detrimental effects of development forces. Following the demands for improved energy efficiency too rigidly, may however cause serious harm to sensitive historical and architectural characteristics, as well as to physical building properties, unless custom designed and gentle approaches are applied.[3]

Estonia is among the countries with a high intensity of energy consumption with the primary energy use per gross domestic product (GDP) unit considerably higher than in more economically developed countries.[4] According to the EU Energy Efficiency Directive Estonia is aiming to reduce energy consumption of buildings and has validated minimum requirements to improve energy efficiency. Improvement of the energy efficiency of houses is endowed through Kredex Foundation, by which the funds are directed to reconstruction of houses to achieve the minimum requirements of energy efficiency. The minimum requirements of energy efficiency are not applicable at heritage conservation areas, heritage conservation objects and milieu protection areas.

[1] https://www.raa.se/app/uploads/2013/05/SuHiTo-Project-Report-Eng.pdf
[2] http://www.renoveeri.net/sites/default/files/Srikjuhendveebi.pdf
[3] https://www.raa.se/app/uploads/2013/05/SuHiTo-Project-Report-Eng.pdf
[4] http://www.kredex.ee/energiatohususest/energiatohusus/videod/

The case study building of this article is situated in historic build-up area Tammelinn in Tartu, Estonia. Until 2017 the area was part of a milieu protection area (local protection) but according to the most recent Comprehensive Plan of Tartu the area has been excluded from the milieu protection area. Therefore there are no restrictions by law to consider the historical value of the building. Following the original architectural solutions is recommended even if the building is not part of a milieu protection area, imitation materials are prohibited.

Considering the heritage value of the building at a renovation is up to good will and awareness of the owner. National policy inclines towards buildings' energy efficiency, most of all executed by adding insulation to the outer perimeter, replacing windows as well as developing of ventilation and heating systems.

1 VAMBOLA STREET, TARTU

The building in question is situated in Tammelinn, which is one of the first garden-cities designed according to the modern garden-city principles. The characteristics of the Tammelinn plan are large plots with plentiful green plantation and low building density. The original size and shape of the plots in the area is well preserved. Houses are located slightly remote of the street line. The building in 1 Vambola Street is a typical Tammelinn house with the characteristically designed plot. The house is situated in the district between Maarjamõisa and Tartu Mill production building. The main characteristics of the area are cob buildings build in the 1920's. In 1920's-1930's clay as building material was taken widely into use also in urban architecture. It was greatly encouraged by the favorable state policy.

Street view Vambola 1 after renovation. Photo: J.Laineste

[From 1922, 41 year housing loans were given to build fire resistant buildings, for wooden buildings olny for 29 years (RT 1922, 70: 297–299). Also, by The Settlers' Housing Loan Act passed in 1925, a loan given to build of fire proof materials was in rate of 80% and for wooden buildings only 60% (RT 1925, 109/110: 595–596). (By Lutsepp 2016, p 130)].[5]

The house has been built in the second half of the 1920's, the exact date is not known. In 1932-2016 the house has been kept by one family, therefore it is well maintained and preserved. The ownership was changed in 2016, two years directly before that the building had been uninhabited. The main structures of the building were in average condition, the roof needed a replacement. The renovation took place in 2016-2017. The terms of reference for the renovation were to minimize the heating costs and prospective maintenance costs considering the restraint building budget and cultural-historical essence.

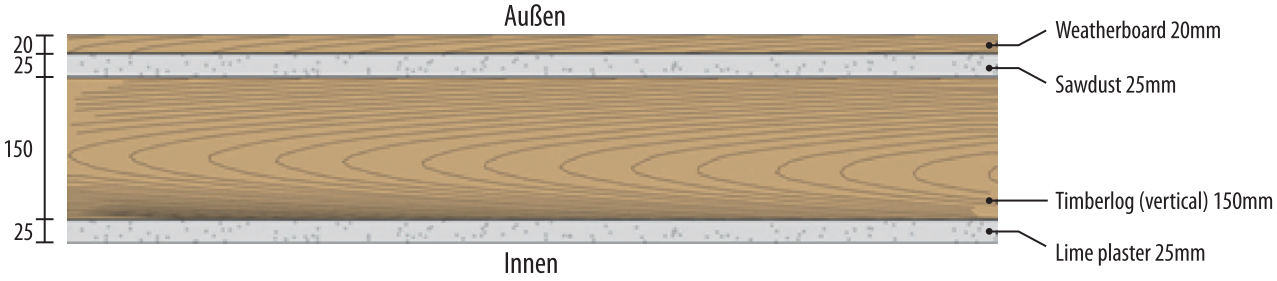
The project plan of renovation was made by Novarc engineering firm, the design process only lasted for two weeks. The process was complicated due to the designers not residing locally and visiting the site only once. HVAC/WC were designed by different contractors, the project was managed by the owner, many decisions were made quickly on the spot. The whole renovation project is described in the blog run by the owner during the building process.

The blog can be found http://1vambola.blogspot.com.ee/2016/07/proloog.html.

[5] Tominga, 2017

OUTSIDE STRUCTURE

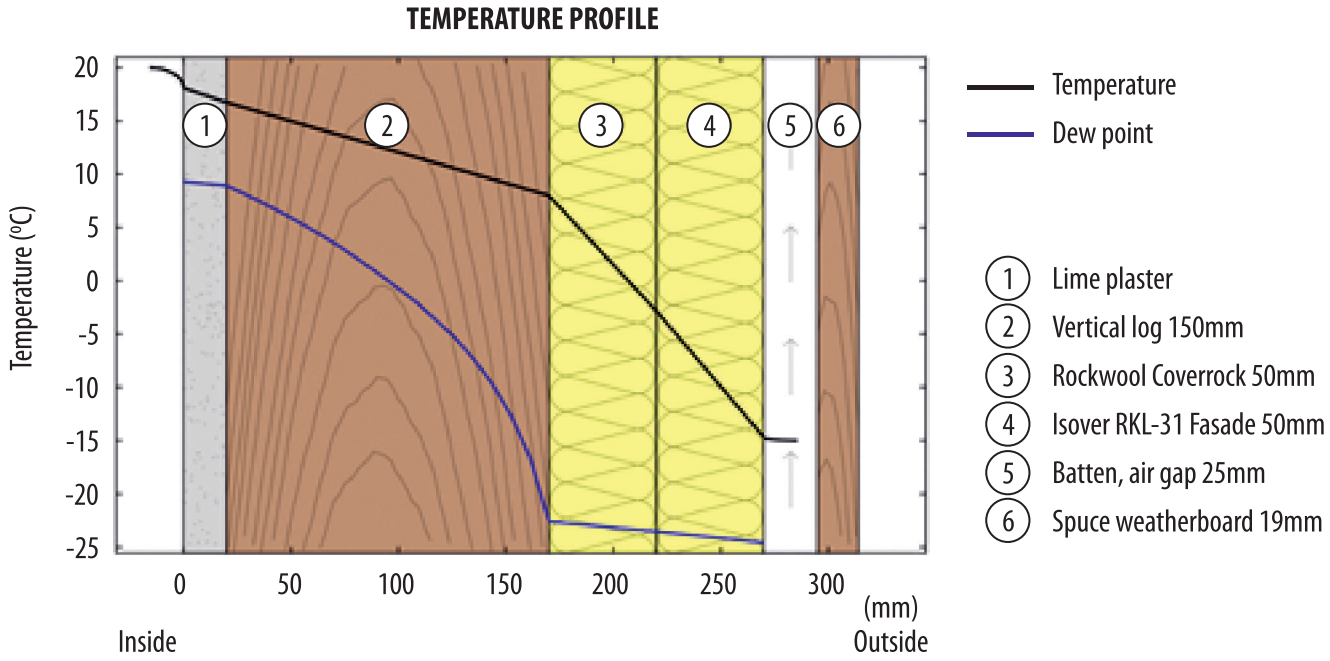
The building has a vertical timber log structure, a few logs needed to be replaced, log gaps needed to be towed, but in general the state of the logs was good. The original structure was as following: 20 mm weatherboard, sawdust, 150 mm vertical timber log, ca 30 mm lime plaster on a reed mat. Lime plaster was preserved and modified.



Drawing 1, original wall section [6]

The original weatherboard was replaced, also the details like window borders, saw-cut gable boards, as a carpenter found no point in renovation of these. That was a compromise where the owner took into account the professional opinion. In a long term perspective we can evaluate if the decision to replace the wooden details is justified. The walls were tightened with tow, the outer wall was insulated with 50 cm mineral wool and mineralwool panel RKL 31, which also works as wind barrier board. Board connections were taped. The board was followed by batten, air gap and new spruce cladding, for which original-like profile, so called Nõmme profile, was used. The cladding was painted with linseed oil paint of which the base and first layer were added in production and top layer added on the site.

The thermal conductivity of the original wall structure was calculated to be U=0,52-0,67 (www.vuuk.ee and U-wert). After tightening the walls with tow and adding the extra layers of insulation the calculated result was U=0,23. According to the energy efficiency minimum requirements the U-value of a dwelling wall must be the range of 0,12...0,22 W/(m^{2}K). Considering the heritage value of the house and the restriction related to it, the result is good.



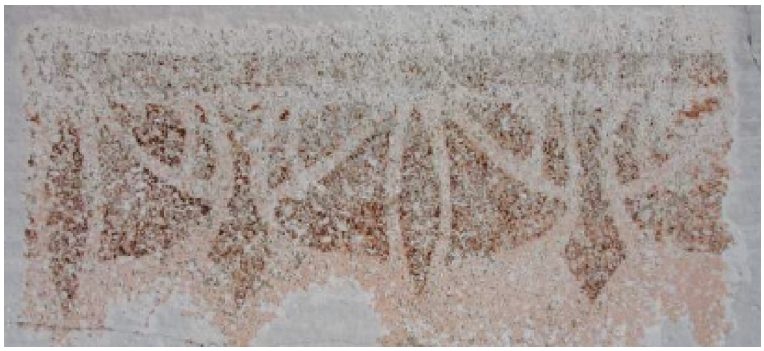
Drawing 2, Wall structure after renovation [7]

[6] http://1vambola.blogspot.com.ee/2016/07/proloog.html
[7] http://1vambola.blogspot.com.ee/2016/

In the interior finish the lime plaster was preserved and modified. A vapor barrier was installed in the bathroom, where the outer wall structure was resolved differently from the rest of the house. A 50 mm hard rock wool was put on the outside of the logs, which was plastered (wind barrier) and covered with batten and weatherboard.

Additionally to the plaster modifications in the interior finish the coved ceiling were added to the ground floor ceiling. That was a constructive solution to ensure air circulation and to enhance insulation to avoid possibility of cold bridges as the plastering layer is thin. Coved ceiling corners help to avoid the possible issue of heat loss. The particularity of the case of 1 Vambola Street it is that historically there were no coved ceiling in the building, although it is common in the houses of the era.

In the interior finish of the building there were numerous mural paintings. The paintings were documented in an evaluation of the finishing layers. 11 mural paintings were found in the room. The restoration work of the paintings is still in progress.



Mural paintings[8] *photos by Ribelus*

FOUNDATION AND FLOORS

The floors on the ground floor were historically ventilated underneath, the floors were cold, the beams and the floor planks were largely rotted. Ventilation ports of a ventilated floor should be closed in winter and summer time, usually that is not done and the result is rotten structures and cold floor. It was not possible to preserve the original floor at the ground floor. The floor was insulated with XPS board, concrete and floor heating were installed. The first floor floors were preserved, furbished and oiled. The attic space mid-ceiling was insulated with ca 400 mm bulk wool - cellulose fiber wool. Partial heat loss under the eaves shown in the thermographic image indicates the bulk wool has not spread everywhere and the warm air coming from beneath finds its way out. The building has a concrete socle which was not insulated during the renovation. In the basement various fungi were found and identified in The Estonian Mycology Research Centre. Control measures were taken and new floor structure was made unpropitious for fungi.

[8] Ribelus, 2017

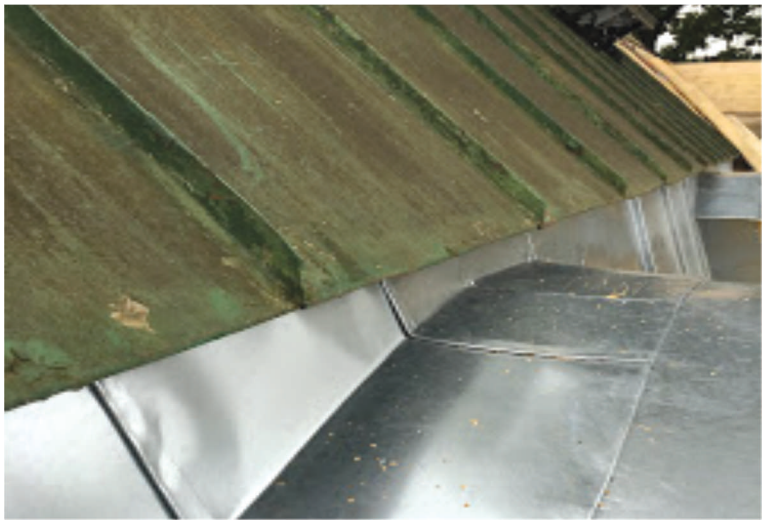
ROOF

The roof covering was depreciated; the roof underlayer was partly missing. The old roof was removed and a new roof underlayer was build. The roof covering was replaced with hand-rolled zinc roof sheets. Just a couple of firms can provide hand-rolled metal roofs in South-Estonia, often pre-rolled sheets are used. At the Vambola street house historically the roof had been hand-rolled and the new one was made the same way. To prolong the life-cycle of the roof the metal sheets will be painted with linseed oil paint in a few years (after the zinc layer has abrased). Some of the funnels of the rainwater system were preservable, the rest were replicated.

Old roof underlayer. Photos: J.Laineste

WINDOWS AND DOORS

The building has more than 30 windows. The initial intention was to restore the windows, but it was impossible to find a firm to do all the windows at a time, it was decided to engage different restorers. A problem occurred as each restorer has a different 'hand-writing' and schedule. As a result it was decided to order new windows. The windows are with double glazed pack in wooden frames. The outer frame is a rebated frame, which is unconventional in Estonia, only a couple of other houses in the area have the same. A rebated outer frame is not a perfect solution as the ventilation between two frames is retarded and causes the problem of condensation. As the building historically had rebated frames outside, the replicas were made.



Replaced roof covering

The windows have a glasspack inside, are puttied and painted with linseed oil paint.

A couple of details were changed: the outer frame have new hinges as no one had the skills to attach the old hinges to the new mantel frames, and the upper frame is attached with contemporary holder instead of the original tommy bar. The cremones and inner hinges were restored and painted with Tikkurila Lin (linseed paint). Some of the extraneous windows (8 pcs) have been restored as an example, but there are close to 30 new windows. Exterior doors were replaced with replicas. The new doors are thicker (7 cm) than the old ones and with seals. The doors and windows were mounted with montage foam. Due to the extended outer dimension of the building the new windows were fitted to the outer plain of the house.

House after renovation. Photo: J.Laineste

HEATING AND VENTILATION

The heating system of the building is renovated. There were 9 stoves and a cooker of which one was a soviet-time tiled stove. This stove was preserved, one tiled main stove was renovated and 7 were demolished as they were not restorable. The heating system is a air-to-water heat pump. On the ground floor there is floor heating and on the first floor cast iron radiators, additionally there is heat recovery ventilation system. The main heating source are the stoves, the heat pump is supplementary.

THERMOGRAPHY

To evaluate the result of the renovation a thermographic images were taken and analyzed by energy auditor Tõnu Jõesaar from Renoveerimisabi LLC. The complete energy auditing was not possible as the building has been in use only for a few months. The aim of the thermographic examination was to evaluate the thermal tightness of the building to detect possible air leaks, thermal defects and constructive cold bridges, which may affect the thermal resistance of the building.

During the examination the following remarks were made:

- The outer vertical timber log structure walls are well insulated and tightened. The thermal transmission valued by the difference of the inner layer of the outer wall and the room temperature is in the range of 0,25-0,3 W/(m2 ·K).
- During the examining cold bridges caused by the untightened structures were not found.
- The jointing of the inner frame of the wooden windows is not providing even air tightness.
- Single layered exterior doors are not thermo-proof. It is recommended to use double-layered exterior doors.
- The coved ceiling reduce the influence of the cold bridge of the joints and the cold bridge temperature index in the areas is >0,8.
- During the outside examining it is notable the socle is the structure with the highest outer surface temperature, which is caused by the heat loss through the socle.
- To decide about expediency and possible extent of insulating the socle it is recommended to have model calculations made.

SUMMARY AND CONCLUSIONS:

The dwelling sector in Estonia is aiming to raise the energy efficiency by insulation, not taking into consideration the environmental burden (footprint) of the work and materials used in insulation and renovation. The building and the renovation process are not seen as an integrated whole from the life-cycle theory point of view, according to which every existing house is a resource and each additional material has a footprint. The national policy favors insulating the buildings, giving credit on favorable conditions to the owners to improve insulation, if certain energy efficiency requirements are met. The general context of the energy saving policy is reduction of the CO2 emission.

The aim of the renovation works at 1 Vambola Street was to optimize maintenance costs, taking into account the historic value of the building. The owner evaluated the time of the design period to be very short (2 weeks). An old house needs time and knowledge therefore time and patience are needed for the design period. In this case the owner of the historic building has awareness above average and whose aim was to possibly preserve the materials fitting in the era. A problem was to find qualified restorers, who would have undertaken this relatively large scale job in a reasonable time frame. That is one of the greatest bottlenecks of renovation sphere. Often restoration as the service is unfavored compared to ordering a replica because a reliable crafter cannot be found. A few qualified restorers are engaged and the waiting period for services is a half a year at least. In the case study the aim to save energy in the future maintenance has been achieved without blemishing the historic value or the appearance of the house. The owner was searching the relevant information and was open to suggestions. There is no package of sustainable renovation information and consultations available. In a municipality qualified consultants are needed for similar projects as heritage conservation license is not required to design similar houses. In the current situation available information about possibilities to renovate old houses there at preserving the heritage value might not find its way to a landlord.

The owner had no obligation to follow the requirements of an object of heritage value. For common people the value of old houses has increased in recent years and they care to preserve the heritage. In general the awareness has risen; still there is a lot to be done. Especially there is lack of restorers and qualified designers.

CONCLUSION IN THE CONTEXT OF ENERGY EFFICIENCY OF VAMBOLA 1:

- The main energy saving effect was achieved by insulating the building envelope and installing the heat recovery ventilation system. Environmental friendly materials, like cellulose fiber wool, hemp, lamb's wool and flax wool, should be favored for insulating an historic building. Heat retention of a building can be considerably improved by tightening the logs that is one of the most important stages in renovation. Flax tow should, montage foam is not permitted as wood is changing and montage foam is not sufficiently flexible to secure the tightness of the structure in long term.
- The heating system was optimized; stoves remained the main heating source being endorsed by a air water heat pump.
- Thermal efficiency of the windows was improved by adding glass pack and seals to the inner frame and the outer glass were puttied as it secures better air tightness than batten. Mantel frame on the outside is a characteristic of the house. In case of a historic building restoration should always be in favor of replacing or in case of new details traditional materials and solutions should be used, glass pack and seals are permitted. Windows and doors should be mounted and tightened with flax tow and flax felt.
- Thermal efficiency of the doors can be improved by using a double framed door.
- Thermographic analysis revealed that the socle is warm i.e. there is a leak of warm air also by the eave. The severity of the leak will be investigated further.

1 Vambola Street is a positive example today of how to renovate an historic building in order to achieve energy saving at the maintenance while respecting and valuing the traditional and historic materials and building methods.

ABOUT AUTHOR

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Contributors:
Jaak Laineste – owner of Vambola 1
Tõnu Jõesaar energy auditor, RenoveerimisAbi OÜ

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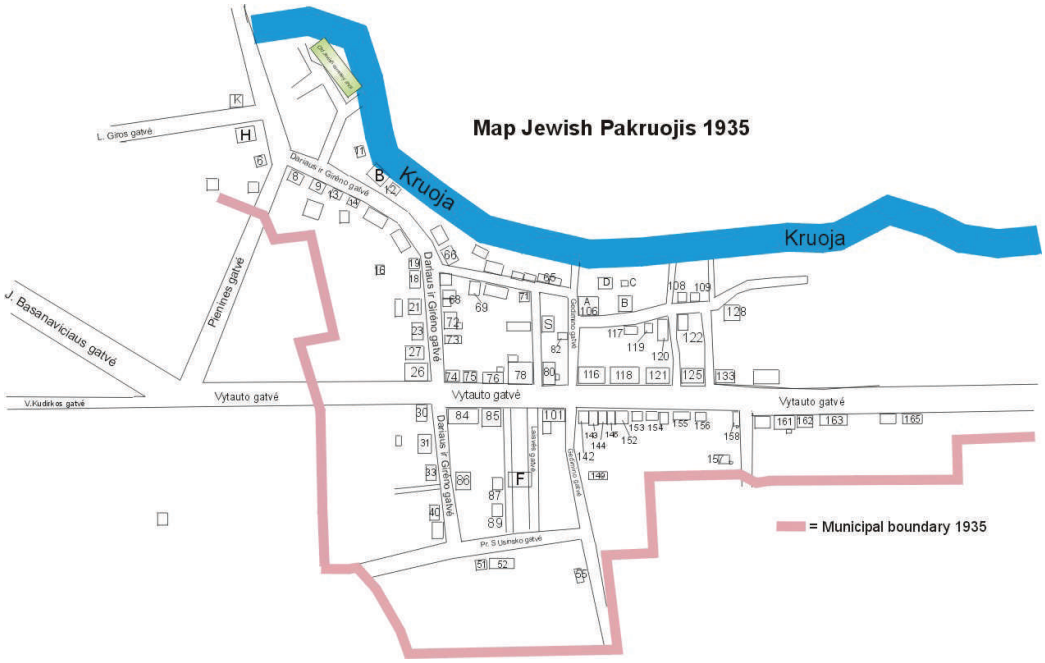
WOODEN SYNAGOGUE IN PAKRUOJIS TOWN

Function	The public building – the Children's Literature Sector of Juozas Paukštelis Public Library of Municipality
The year of construction	1801
Rebuilding	The building was renovated in the end of 19th century, then repaired in 1920, rebuilt 1954 to the cinema, had suffered from several fire occasions and finally restored in 2017
Material	Foundation - stone masonry, walls – wooden logs, roof wooden framework, covering– spruce shingles, wooden building joinery – doors, windows, details and parts
Architects	The builders are unknown 2017 restoration architect Rimas Valeckas
The number of floors	The ground floor and balcony (women part)
Type of heating	The central heating system from the town. The heating providers – the contemporary iron radiators
Developer. Year. The contracting entity	The complex renovation/restoration project which was realized in 2017 by the private company "Šiltas namas" ("Warm house")
	The complex renovation/restoration project which was realized in 2015-2017 by the private company "Šiltas namas" ("Warm house")

There is a story of an exceptional heritage site with Jewish Synagogue, telling us local history of small Pakruojis Town in Northern Lithuania. The town was first mentioned in 1531 with some taverns/inns and market place. In the Pakruojis inventory 1647 we can find 34 houses, in which 29 there were inns. The Jews in Pakruojis began to develop after the wars, fires, plague and famine in the beginning of XVIII century. A shortage of local inhabitants was successfully completed by Jewish people who have noticeably activated the economic life of the town. Substantial changes in urban structure took place then Synagogue complex appeared in a densely built-up area on the bank of Kruoja river. In the 1940s in the expanded Pakruojis there were already about 2,500 inhabitants (1,000 Jews)[1]



1935 Map of Jewish Pakruojis (in: http://www.shtetliks.jewishgen.org/pakruojis/walk/maps/overallmap2.htm)

This unique heritage - the oldest wooden synagogue still existing in Lithuania had to be saved. Thirst of all the synagogue was proposed to be moved to the Open Air museum. But due to its high volume it did not suit the small scale of the museum town's space. After few fires and almost definitively lost of historical building was finally determined to handle it on the spot. Synagogues - this is not only a reflection of the Jewish spiritual and material heritage, but also an integral part of the cultural heritage of Lithuania, therefore every initiative was welcome in order to preserve the examples of this unique architecture. The Jewish community agreed to adapt the building to the needs of society. In 2014 the contract was signed (by the Ministry of Culture, Central Project Management Agency and Pakruojis District Municipality) for the project "Management and application of the Pakruojis Jewish synagogue building for cultural and public use". The fully-restored building was decided to be adapted for the activities of the Juozas Paukštelis Public Library of Municipality - it should establish the Children's Literature Sector. Besides the main use/function of the library the well-kept building should be of great interest to tourists as well to commemorate the remembrance of the local Jews. It was necessary to think how to reach a sensory experience, because it is more effective than lectures, lessons or other routine methods that do not cause emotions.

Synagogue in Pakruojis town, exterior and interior.
Photo Stasys Vaitkus, 1937 (Šiauliai Aušros Muzeum)

Project issues started with a lot of discussions:

- how properly to treat the historical wooden building (to keep historical cultural values);
- how suitable to renovate old house and adopt it to modern needs (match the old with the new one);
- how to achieve economical, energy efficient and environmentally friendly building effect.

The main focus was on preserving cultural historical value of the synagogue. During the preparation of the project lot of discussions were held with representatives of the Lithuanian Jewish community, the Department of Cultural Heritage, the Universities and the different specialists of wooden architecture.

HISTORICAL CULTURAL VALUE OF THE SYNAGOGUE

To extend the life of a wooden building, we are always faced with the questions - what and how to protect? Value, its identification, preservation and dissemination is the fundamental dimension of the essence of heritage protection and first step in our job.

Wooden synagogues are the significant part of Lithuanian wooden heritage. They appeared in Lithuania in the second half of 17 the century and in a hundred years they spread in many cities and towns of Lithuania (about 200). Unlike churches, the synagogues were located in densely neighborhoods surrounded by dwellings. It was allowed to build a synagogue with at least 80 Jewish homes. The synagogue was the spiritual, cultural, economic and political center of the Jewish community. Their purpose was three: religious ceremonies, studies and community meetings. Quite often, as in Pakruojis, they were built near water and consisted of a complex of buildings (four-building complex): prayer houses, ritual slaughterhouses, and baths. The most commonly used were cold (summer) and warm (winter) synagogues. Due to the specifics of liturgy, their plan was little evolved during long period. Almost all they were destroyed during the war and postwar years. Till now, only a few poor condition, not functioning wooden synagogues have survived.

Synagogue in Pakruojis town - the oldest wooden synagogue still existing in Lithuania, erected in 1801 (former note on the inner door), in the Baroque and Classicist epochs. It was a "summer" (unheated) synagogue. At the end of XIX century it was repaired and repainted by a local Jew (later he emigrated to America). Most likely, at this time he painted the train on the gallery of women. Then was made special metal smith work templates 40 x 40 mm (to reduce the force of the parachute), wallpapering works.

In the pictures of 1938 we can see very rich interior: bima and altar fragment, balcony based on the columns, openwork fencing and other details. It can be seen that the windows of the synagogue were small, eight glasses, completed with segmental lintels and surrounded by plane boards. The lower ones decorated with simple carved ornament. At the main side (north-east) facade was an enclosed porch.

The shapes of the synagogues reflected the features of the prevailing styles and elements of Lithuanian ethnic architecture. At the time when the Pakruojis synagogue was being built, classicism was spreading in Lithuania, but Pakruojis synagogue forms still reveal features of Baroque style and characteristic features of Lithuanian ethnographic architecture. The basis of ethnic architecture has led to harmonious proportions of the synagogue, modest wall and window decoration, the nature of the primitive interior painting. The influence of Baroque was shown by a high two-tier roof and curved openings, in the interior - an ornament of artistic forms of altar, the composition of which can be seen in similarities with the altar of Baroque churches. Classical style also left its trace: there are no twin windows, a porch appeared, and inside it - a frieze decorated in the original elements. The sacred purpose of the building was given by the characteristic Jewish symbols: hexagram - hexagonal star of David or the Decalogue - two twisted plates with ten commandments of God. Inside the walls and ceiling vaults were distinctively decorated. The drawings include deer, lion, tiger, eagle, camel, leviathan, stuck their tail, birds, trees, flowers, train. The symbols typical of Jewish art were combined with elements of the decor, depicting traditional plants and birds of Lithuanian homesteads. Within the synagogue, the goal was to create a closed model of the Jewish world, but here the links with Lithuanian ethnic culture are inevitably avoided. The photographs show very valuable interior fragments and the main objects of the liturgy - altar and bima carved from wood and painted. It is said that the altar master was a not a local, homeless very poor Jew. He worked for a long time, was maintained by local Jews and received a small salary for his work[2].

Bima and an aron-codec fragment in the Pakruojis Synagogue.
Photo Chackelis-Lemchenas, 1938 (SAM)

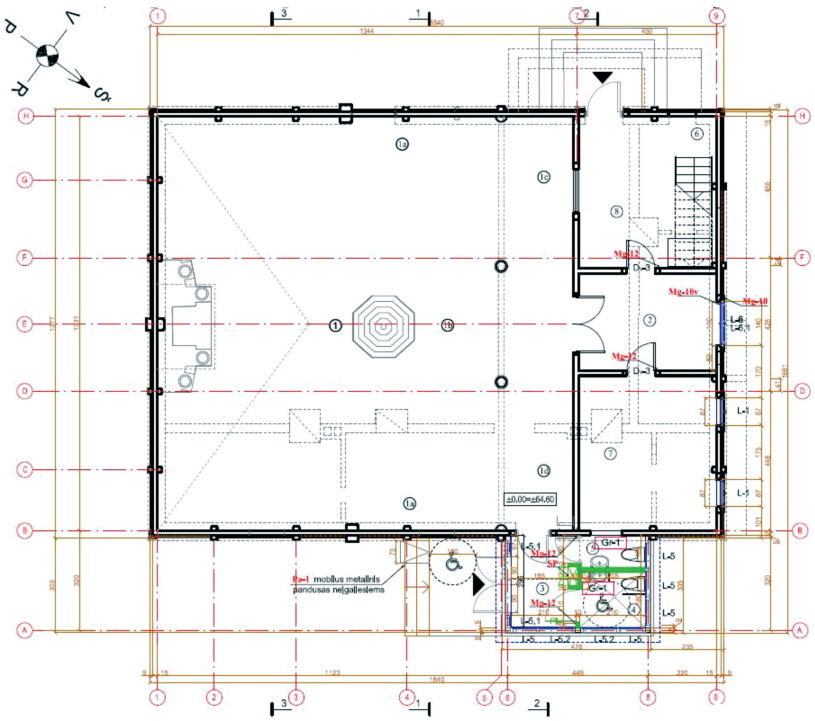
1941 - 1954 building was not used. Later the synagogue was converted into a cinema and house of culture. Internal plan has been changed, all partitions and vaulted ceilings were dismantled, windows and some doors covered by planks. Inside, new walls were built up / laid, flat wooden ceilings, concrete floors, new doors, two stone chimneys arranged and the roof covered with a slate. Facades were planked, the inner side of the walls were insulated with sawdust and shavings. When the new cultural house was built in Pakruojis in 1971, the former synagogue building was converted into a sports hall, a warehouse, and later stood empty. Since 1992 the synagogue was included in the Cultural Heritage Register. During a fire in 2009 the half of the building was burned down. After this disaster, it was concerned about the preservation of the building. At the expense of the Cultural Heritage Department, a roof was covered in 2010, an emergency condition was liquidated and building was provisionally preserved.

Until the beginning of the restoration in 2014, the following values (valuable properties) have survived: a monumental volume covered with a high two-tiered roof (the main volume was authentic missing the porch at the entrance); the foundation of the stone; the walls visually split up with vertical fasteners (trimmed with horizontal boards); authentic window and door openings, workpiece remnants, massive profiled roofing cornices, roof construction and metal stamps. Following the performed architectural, wood and polychrome studies, specialists have offered specific design solutions, as well as discussed the planning of the interior premises of the synagogue.

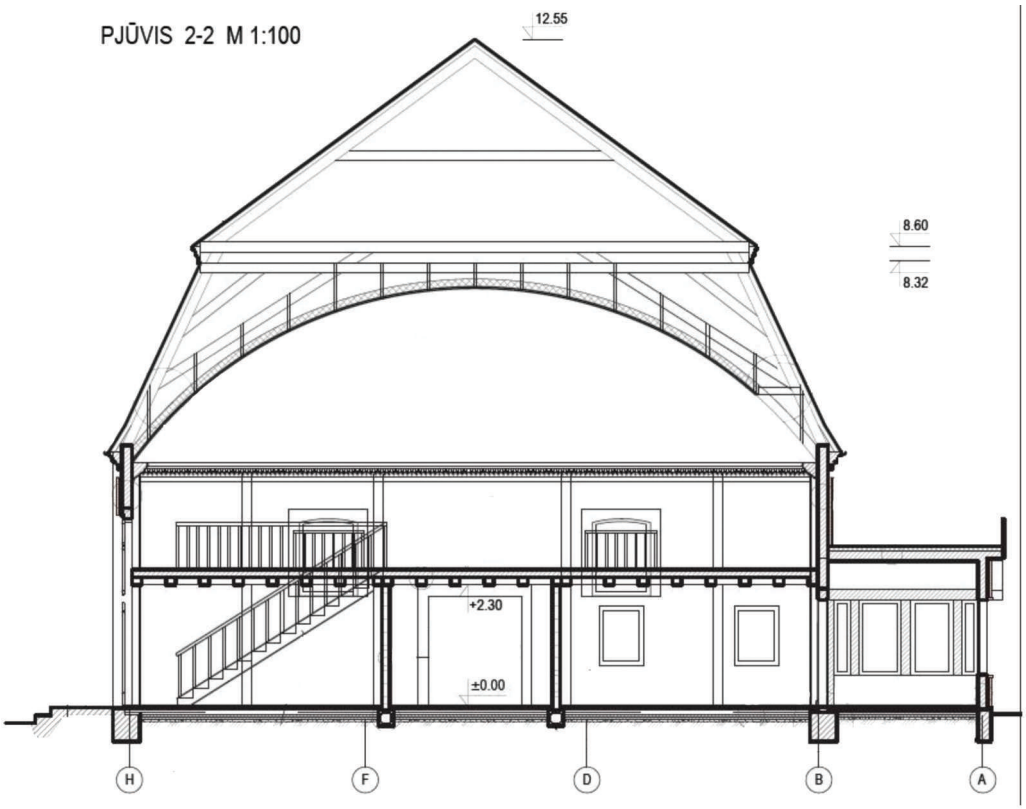
Cleaned the inside of the synagogue before restoration work 2016 (photo M. Veliulis)

ADAPTATION/ARRANGEMENT AND EFFICIENT USE

Pakruojis synagogue is 16 meters long and 12 meters wide. Only the authentic volume of building and expressive two slots roof were partly survived. The interior was extremely gorgeous / magnificent, unfortunately totally destroyed. The foundation – simple stone masonry 30 – 40 cm dig up to the earth, walls – log construction made of hewn beams/logs (15-18 cm width), reinforced by vertical ties. Earlier it was a summer synagogue, not heated. The application of the new purpose first of all required to solve the issues of thermal insulation (walls, roof and foundation) also operation / maintenance throughout the whole year. The proposals for arrangement of this building also included reconstruction of internal layout/plan, restoration of log walls and women's balcony, installation of wooden floors, heating system an engineering unit (in the restored porch). The key issue was how to warm/insulate the synagogue with the least possible damage to the building's authenticity. The specialists offered various options and propositions; there were many discussions and disputes.



Restored plan and section of synagogue 2015 (architect R.Valeckas)



The project architect proposed to heat/insulate the restored vault and the walls of the building from the outside. In this case it was necessary to widen/broaden the stone masonry foundation, and leave the gap at the top of the walls (without additional insulation layer), so that the cornice had not be hidden. Inside, only restored surfaces would remain. Another suggestion was from the project construction technician who proposed to insulate walls from the inside. The main argument of this decision was not to damage authentic external architecture, as the interior was totally lost. It was recognized that this option was not favorable for walls because of the threat of moisture. Some of specialist had an opinion not to insulate walls wholly and to use the building only on warm period during the summer time.

Others architects have suggested an alternative solutions – to install a glass capsule, a heated structure inside the building. This option would allow the exposition of the building without changing construction and without damaging its structures. There would not be rotting walls threat. The representative of the Jewish Community emphasized the importance to find out which option (from the outside or from inside) would guarantee a better durability of the building. It was still difficult to decide which option was most appropriate. The administrators much feared that prolonged consideration of technical design solutions caused a high risk for successful project implementation. After a long discussion, experts from Norway were contacted who provided such answers:

"There are no set rules regarding insulation from the outside or inside – but mostly it is done from the outside (especially on churches in Norway) because it is simpler. Judging from the photos, the interior seems to be quite decorative. If this is the case it should be protected. One photo shows a pile of new planks which seem to be meant to re-panel the exterior of building. If this is the case, it would be a simple matter to put the insulation down under the new paneling. It is also possible to put down a thin layer of draught-proofing which is very effective. My colleague commented on the fact that if the exterior panel is removed and a layer of insulation/draught-proofing put underneath, the vertical beams which are visible on the exterior walls should be kept to maintain the visual aspect of the building" (2016.04.11)

"Another expert doesn't have much to add to the answer given before; as in any restoration project, this is a matter of choice and balancing those choices according to the priorities of the user. The synagogue was built for summer use only, if it is to be used all year round and be comfortable, then some insulation will be necessary. Much heat can be retained through draught-proofing as described before. As the draught-proofing is thinner than thick insulation material it is less intrusive. It seems from the photos that much of the exterior paneling is already falling away or is loose, so exterior insulation would be fairly simple. In order to retain the interior decoration and wallpaper, proofing from the inside seems out of the question as much of the integrity and interest of the building would be lost" (2016.04.25).

Then cleaning works started in the synagogue the new valuable qualities/artefacts were clarified: profiled fasteners with carved details inside and outside the object, authentic wallpapers, five painted boards from the vaulting and profile cut of the balcony. Preservation of these valuable properties was not foreseen in the current technical project. So warming up of the synagogue from the inside would destroy valuable pieces of the nineteenth century. This discovery helped to decide on external insulation: 5 cm wood fiber covered with 3 cm board.

There was some discussion about roofing of the synagogue. The district municipality wanted to cover it with a tin, because the wooden covering requires maintenance and is not durable. However, the Department of Cultural Heritage did not agree and insisted on covering with wooden shingles. There was chosen a special type of spruce shingles jointed with one side.

Windows, door installation variants have not been considered, there was no talk of any special traditional technologies, although all this greatly affects the visual efficiency of the restored building. Windows were redesigned taking into account the history of window's geometry and pattern splitting and respecting the type of window, but without the use of traditional glazing technology (the window glazing was embedded using wooden laths instead of traditional linseed putty techniques). Thus, the split nature of window sashes has come out more solid than the original. Doors are re-made, presumably respecting the geometry and type of historic doors, using modern fittings[3]

Profile cut of the balcony, damaged fasteners of the walls and board from the vaulting 2017

THE SPECIFIC APPROACH TO THE PROTECTION OF WOODEN HERITAGE

In the synagogue management project, all works were divided into repair, conservation, restoration, and accident prevention. All works related to traditional technologies were included in the restoration work: replacement, changing, fixing, implantation of wooden constructions, manufacture of new doors and windows, balcony, etc. In the opinion of masters, some works are not being implemented technologically properly, but their opinions do not provide for the views of the heritage management law. This problem is faced in all objects of wooden heritage.

The Convention on the Protection of the Intangible Heritage[4] distinguishes the traditional crafts which are recognized as essential for the management of the wooden architectural heritage[5]. Crafts, old traditional technologies, once a part of traditional lifestyle, now are becoming objects of cultural heritage. The essence of authenticity is living tradition, the knowledge of local building methods, materials, constructions and their practical application. Buildings using short-term materials (wood, straw, clay) should be treated differently than masonry. In order to maintain the authenticity of a wooden heritage, the use of traditional building materials, techniques and crafts is

essential for repair, restoration, adaptation and restoration work. However, the traditional knowledge and skills of the masterpiece/craftsmanship require much more time than the restoration of material heritage. The cheapest cost winning the contest/ competition builders are not able qualitatively to work with wooden objects of heritage, no skillful masters. And architects also do not know the subtleties of the restoration of wooden heritage.

Builders are using modern advanced tools to make work faster. Efforts to do everything very quickly do not leave any time to know the object and material, and the use of increasingly advanced tools threatens to lose the quality of the item and to break away from the genuine relationship with the material. The more productive the tool, the greater the abstraction: things overlap/ assimilate, lose peculiarity and developer's/creator`s style [6]. The ignorance and neglect of old building technologies often results in the loss of historical information along/together with the value of the object. So each restored object is a peculiar/particular experiment of architects and builders, more or less successful.

The project was in touch with traditional technologies. During the training course 4 chaplains were curved according to the authentic samples/examples found in the synagogue. While boarding the synagogue from the outside they were destroyed (trimmed) and only fragments remained inside. Seminar was much devoted to the technological processes of wood restoration, there were discussions about prosthetic technologies, wood structure and properties, wood decoration and preparation for painting works, subtleties of restoration of various woodwork and carving secrets, but this did not affect/influenced the working restorers. True, all defects remained hidden after decoration/finishing, everything looks very nice and convincingly. Maybe we should not even talk about defects and mistakes, but let`s think how these restoration works will be appreciated by future generations 50 or 100 years later... The restoration works of the synagogue were entrusted to one of the most famous restorers in the country. It was restored the exterior of the synagogue, made the building's engineering networks, internal premises.

Restoration of wooden wall: implants and partial change of logs 2017 (photo M. Veliulis)

Restoration of wooden wall: implants and partial change of logs 2017 (photo M. Veliulis)

Inappropriate restoration of window frames 2017

They also succeeded in restoring one of the greatest values of the synagogue - the interior wall painting. Drawings of the walls and vaults were reproduced by the pictures, and the restoration and restoration works of the wallpaper - according to the remains of their fragments. But unforeseen defects here have also occurred. The vault planks are drying, creating gaps between the planks, making the thermal insulation foil visible. As the shrinking of planks might continue, it is desirable to consider ways to avoid this optical defect.

SOME RELEVANT REMARKS AND RECOMMENDATIONS OF THE EXPERTS

„It is understandable the joy/pleasure of the local community and cultural staff to see the building that has been abandoned for many years has finally made a significant cultural life and can be gathered together, visited by guests and tourists. Selected design and execution decisions can be seen as compromise, not quite appropriate for this important historic object. Although the project emphasizes that the valuable properties of a building have been preserved, it is obvious that this does not correspond to reality, because when the building is warmed up from the outside, its volume and openings have changed"[7]

¨The external form and overview, including its texture and color, are largely authentic. Especially, this can be seen on the elements of the original construction, the foundation of the building, the conservation of the original areas of the building and the excellent traditional roof texture. It is very good that the outside of the building and façades respect all the essential details and textures, with the exception of the modern interpretation of the window linseed oil putty.

It would be highly desirable for owners, after the completition of all building works, to be informed and provided with detailed instructions on all necessary inspections, care and repair work and a set of measures, for example, the identification of the presence of moisture damage to the outdoor wooden building elements, the annual cleaning of roof drains, façades, immediate damage to the fault, etc. maintenance and maintenance works, tools, and practices. It is the best warranty for the sustainability of works and investments done.

Spruce shingle roof covering 2017.(photo M. Veliulis)

Wall insulation and boarding of the sinagogue 2017 (photo M. Veliulis)

Wall insulation and boarding of the sinagogue 2017 (photo M. Veliulis)

It would have been desirable to increase the proportion and consistency of retained original components in renewable (restoration, renovation, reconstruction) objects as a conceptual priority for the preservation of authenticity. It would be recommended to involve a larger share of the local inhabitants in the project preparation, document creation and realization process.

Actions that could significantly improve the effectiveness of architectural heritage conservation projects, the quality of construction work, a more calm construction process and the sustainability of results: shortening of the "paper phase" deadlines; research, designing and constructing timetables to enable them to be carried out without hesitation; the start of construction according to the seasonality of the construction work; assessment of the timetables of restoration technologies in common graphics; necessary seasonal conditions for observing restoration technologies; observance of deadlines for high-quality wood preparation (cutting times, selection of specific conditions, drying and preparation times etc.) required for restoration work; providing disappearing crafts and craftsmanship opportunities for permanent practice; the need for a craft inheritance program; co-ordination of programs for the preservation of craft-related professions with neighboring countries[8].

New painted interior, 2017 (photo Mindaugas Veliulis)

The synagogue before restoration

INSTEAD OF SUMMARY:

After reviewing a large number of duplicate/repetitive documents, projects and meeting reports, I think it is necessary to speak not only about energy efficiency in old houses with historical value but also about effectiveness of our personal human energy (time, excess paper production) that we vaste/spend for abnormally stretched out bureaucracy.

The synagogue after restoration 2017.

ABOUT AUTHOR

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Professional - scientific activity: I work in the University and Museum, carrying out/ implementing studies on traditional vernacular architecture, doing the measurements, assessment, monitoring, documentation (transfer and restoration) of wooden buildings. I teach students modules related to ethnic culture and heritage, participate in research programs, various projects.

Field of interest: architectural history, ethnic architecture, wooden architecture and constructions, traditional / special technologies, heritage protection, reconstruction, renovation, restoration of historical houses, education science, museology.

Membership: ICOM, ICOMOS member, Member of the Woodworkers Association, Member of the Adult Education Association, a member of Rumsiskes Community.

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[4] *Nematerialaus paveldo apsaugos konvencija* (in: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=248105&p_query=&p_tr2=)

[5] Masonry and wooden structures are vanishing differently: masonry is usually supplemented with new parts or new upper décor layers, while wood changes with the replacement of parts that are structurally important, sometimes essential. These differences between the stone and wooden heritage are of particular importance not only in the formation of heritage conservation attitude, but also in the theory of heritage protection, namely the concept of authenticity (Jarulaitienė G. *Tradicinių dailidystės technologijų ir medinio paveldo apsauga*. Magistro baigiamasis darbas. Vilnius, 2006, p. 38–39.)

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KORPLAINE in the Unesco World Heritage site Old Rauma, Finland

Keeping a balance between modernization and conservation when interfering a historically valuable timber frame building in order to gain energy savings.

Function	Private. Office of architecture
The year of construction	The first part in 1865, extended in 1900
Rebuilding	Modifications in 1876, 1904, 1908, 2002
Material	Groundwork in stone, a log frame, roofing partly felt, partly plate sheet
Architects	Original architect unknown. Modifications in the early 20th century by Arvi Forsman. Architect for the recent renovation Timo Tuomola
The number of floors	One floor and an attic
Type of heating	Wood ovens and nowadays an electric heater in addition
Developer. Year. The contracting entity	The developer of the project is the owner, architect Timo Tuomola. The project was started in 2002 and is still ongoing

ENWALLA PROPERTY AND KORPLAINE

The building of my case study is situated in the northern part of the wooden town of Old Rauma, in the Enwalla property. The property carrying the name Enwalla existed already in the 17th century, as it was mentioned by name in a town master plan made by Volter Högman. The present main residential building of the property was built parallel to the street Pohjankatu in the early 19th century. (1)

The target building Korplaine is situated in the northern part of the wooden town of Old Rauma in the Enwalla property. City of Rauma.
2 Situation plan of Korplaine by Timo Tuomola 2002

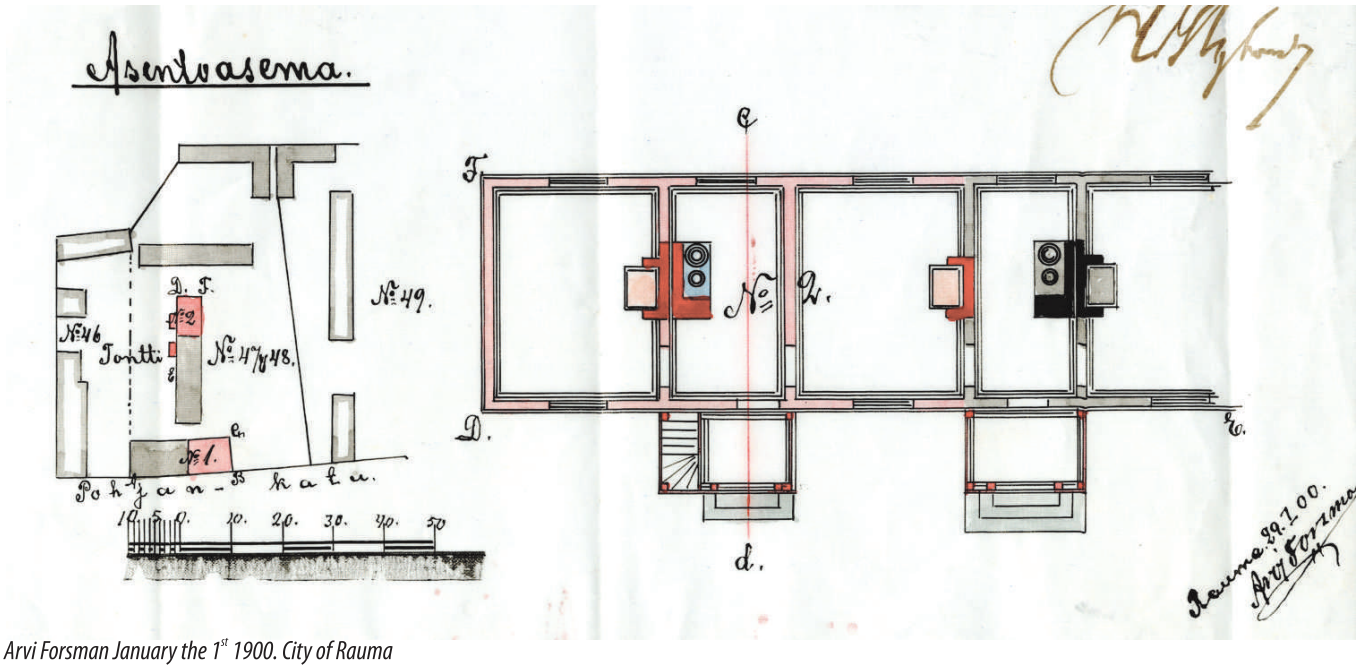
The subject of our study, originally a secondary residential building of the property is situated in the inner court yard of Enwalla perpendicular to the street. The present owner calls the building *Korplaine* referring to the period of time where the property was actually two separate properties, the other one named Korplaine. From now on I will use the name Korplaine meaning the subject of this study.

According to the old fire insurance documents[1] Korplaine was originally built in 1865 when the property was owned by a merchant Lars Borgström.

The subject of our study, Korplaine, first had a simple unpanelled timber frame which was painted with red ochre paint and the roof was covered with boards. The building measures are 25 cubits in length (14.9 m), 7 cubits in width (4.2 m) and 10 cubits in height (5.9 m).

Aerial photo from north-west. City of Rauma

The building originally had two bedrooms, a hall, one room reserved for baking and an entry hall situated inside the main timber frame all in one floor. In addition there were an external vestibule and a covered staircase attached to the frame. The attic has always been an uninsulated, open space. The building was originally heated with eight ovens.



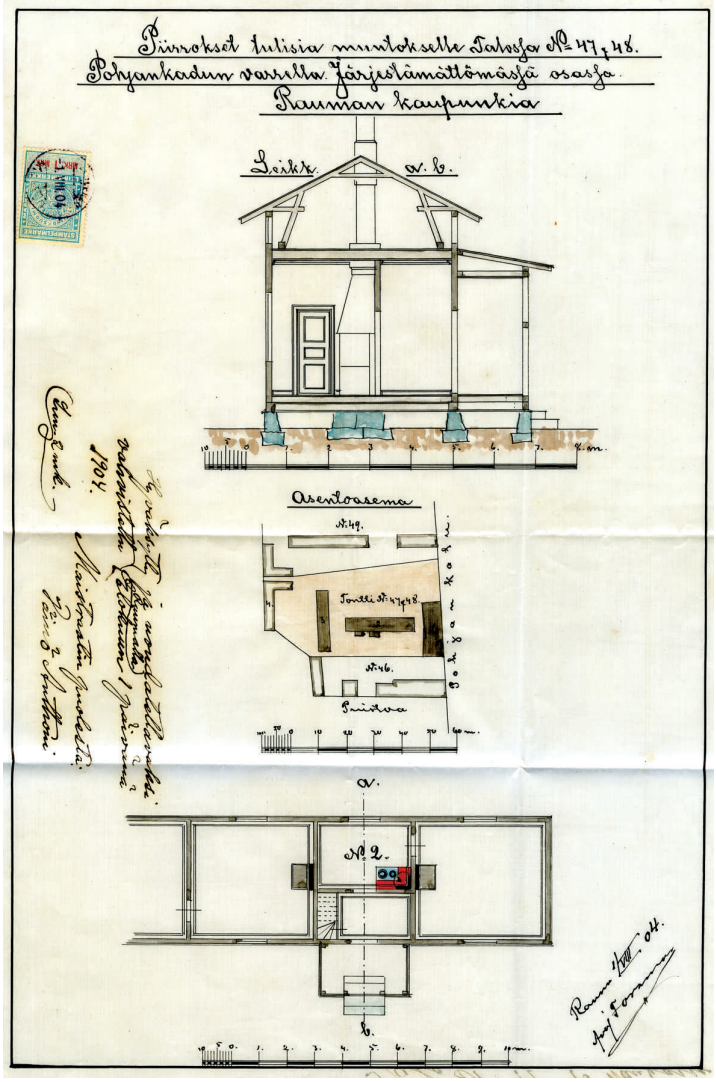
Arvi Forsman January the 1st 1900. City of Rauma

In 1876 the owner of the property, Högman, made some modifications to the layout of the building. The building was now half way cladded and entirely painted with red ochre. The bakery was modified to a hall and one of the two bedrooms was converted to a kitchen.

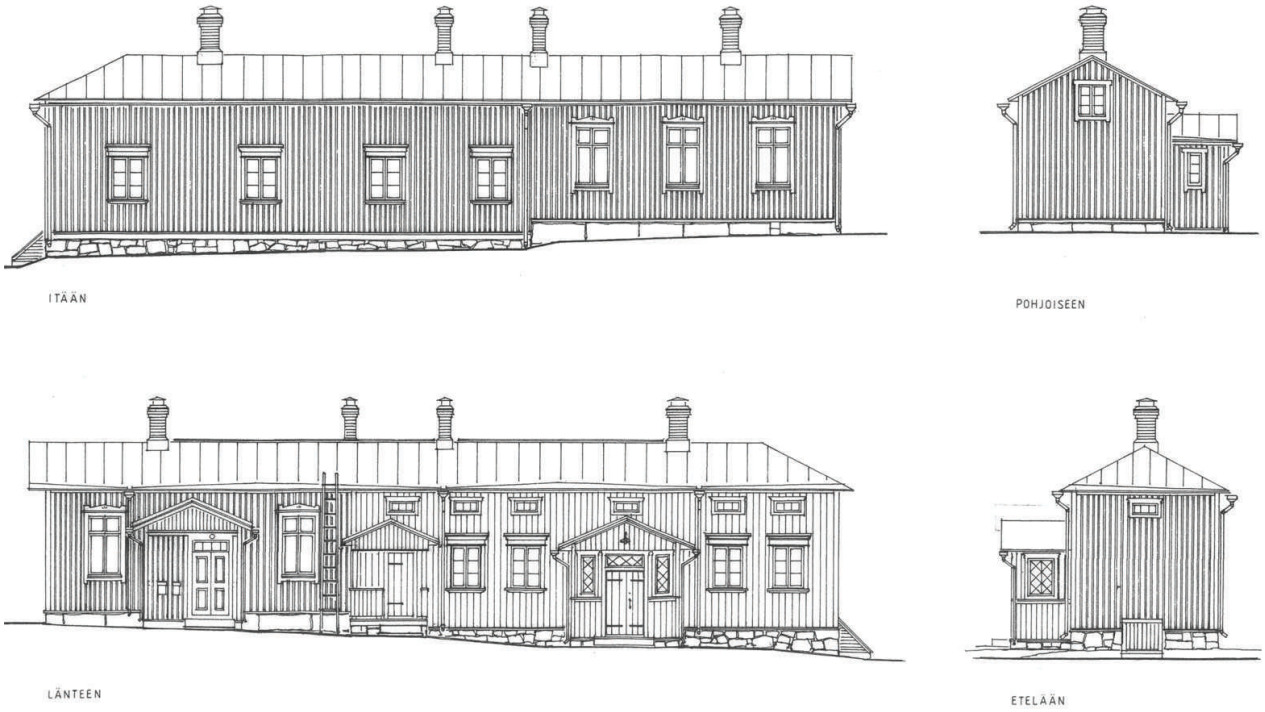
The original designer of Korplaine or other buildings situated in the Enwalla property are not known, but there is a modification drawing signed by Arvi Forsman in January 29th 1900, which concerns an extention of Korplaine by some new rooms, a kitchen and porches. Four years later, in August the 1st 1904, Forsman signed a modification concerning the ovens of the building

[1] Old fire insurance documents which exist in Old Rauma from the year 1834 on are copied on micro films and are kept in the Rauma Museum. They give detailed information about the buildings' year of construction and modifications, windows, doors, fireplaces and even tapestry.

The present owner family of the Enwalla property lives in the main residential building which stands parallel to Pohjankatu street. The very original part of Korplaine now houses the owner's agency of architecture since 2010 and is renovated to be energy saving, comfortable to reside, yet according to the conserving principles. The building is heated mainly with wooden ovens and extra heat during the very cold seasons is gained from electric radiators. The most northern rooms of the building are still under conservation.



Arvi Forsman 1904. City of Rauma



Facades of the building 2002, Timo Tuomola.

RAUMA TOWN

Rauma is a municipality of ca. 40 000 inhabitants on the west coast of Finland. Rauma got its town privileges on April the 17th 1442 and is nowadays known for its paper and maritime industry, lace and its well preserved wooden town center Old Rauma, which is a UNESCO World Heritage site since 1991. (2)

Old Rauma is one of the oldest harbors' in Finland. Built around a Franciscan monastery, where the mid-15th-century Holy Cross Church still stands, it is an outstanding example of an old Nordic city constructed in wood. Although ravaged by fire in the late 17th century, it has preserved its ancient vernacular architectural heritage (3).

Enwalla property and Korplaine as one of its buildings make part of this valuable entity. Old Rauma is composed altogether of some 600 buildings constructed almost uniquely of wood, most of which are privately owned. The site covers an area of 29 ha. Old Rauma is both a commercial and a residential center. The town plan structure of Rauma has been maintained since the medieval period, including the irregular street network, city blocks, plots of land and courtyards. The buildings are mainly one storey tall, and date back between the 18th and 19th centuries, while some cellars remain from earlier houses. The residential houses are typically placed along the street, and outbuildings such as former animal sheds and granaries are built around narrow courtyards. (3)

As we can see, Korplaine, due to its location and direction in the courtyard makes is a somewhat peculiar example of a residential building.

STATUS OF PROTECTION

The current detailed plan of the Old Rauma area dates from 1981 and is thus partially out of date. In 2016 a building prohibition was put in force to cover the whole area of Old Rauma whilst the new component masterplan and a detailed plan are both bending. The prohibition is restricted to apply to such interventions which normally would only require a construction permit. The building prohibition aims to prevent any conflicts between the possible interventions and the goals of the detailed plan in development.

Old Rauma is inscripted as a UNESCO World heritage site based on two criteria:

Criterion (iv): The town of Old Rauma constitutes one of the best preserved and most expansive examples of northern European architecture and urbanism.

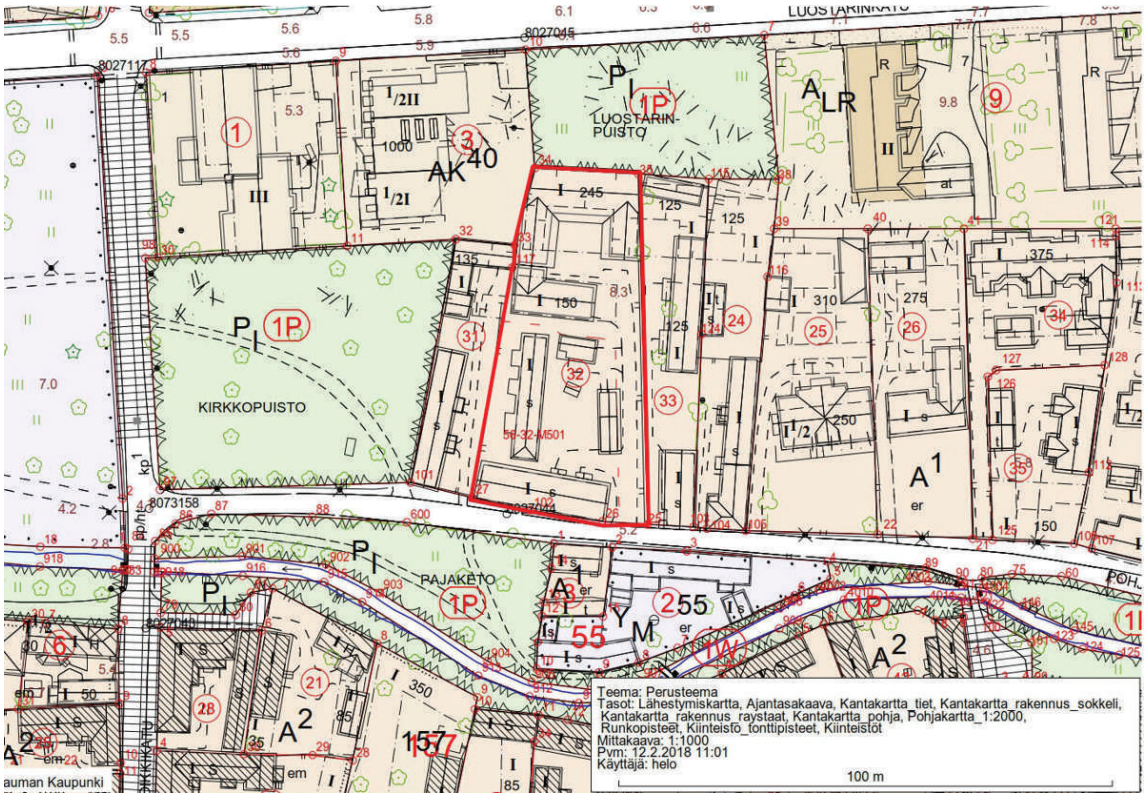
Criterion (v): Old Rauma is an outstanding example of a Nordic city constructed in wood, and acts as a witness to the history of traditional settlements in northern Europe.

'Old Rauma includes all elements necessary to express its Outstanding Universal Value, namely the entire urban area dating back to between the 17th and 19th centuries, when the town expanded to the west. The town includes all elements that contribute to its integrity: the street network, city blocks, plots of land, as well as the buildings themselves. The historic fabric of the city has been built over centuries, forming different historic layers. The historic houses, courtyards, fences and gates, as well as the traditional street pavements, form a homogenous urban entity.' *(4)*

The outstanding universal values of the Old Rauma area apply to the area as a whole but also to each individual building as such. This means that the originality of the building shall not be violated with any intervention what so ever.

In the valid detailed plan (City of Rauma 1981) our target building Korplaine is designated to be preserved. According to the planning instruction of its specification S_2 the building has historical value or has an important role in preserving the townscape. The building may not be dismantled without imperative reasons. The modifications and repairs in the building must be suitable to the building entity as well as to its environment. (5)

[2] S = This is the veritable specification given in the Detailed plan concerning intervention appropriate to the building



Extract of the detailed plan from 1981. City of Rauma

APPLICABLE REGULATIONS

The Ministry of environment in Finland has issued a decree concerning the improvement of the buildings energy efficiency in the course of repairs and modifications.

Anyhow the degree is not fully applied to the edifices with historical value and which are protected, and when one can consider that to fully apply the degree would deteriorate the protected building parts or its overall aesthetics or function.

ORIGINAL STRUCTURE – STARTING POINT TO THE CONSERVATION PROJECT

The last renovation process was started by the present owner in 2002. The description on this chapter follows the notes made by the architect Tuomola in the early phase of the project. (7)

The premises of Korplaine are built in two phases. The southern part of the house is built in 1865 in empire style and the additional length towards the north was added in 1900. These two phases are clearly visible, and there are a lot of the original structures left from the both. In the early 20th century the external vestibules were heightened hence to make the roof of the vestibules continue directly from the main roof.

The building's timber frame continues up to the roof and consists of even today very steady and large scale timber. The overall materials and the handprint of the original carpenters are of a high quality.

The main entrance on the west side of the building was originally enclosed and its shape is still visible in the inner parts of the timbers in the attic. The enclosure has contained windows already in the early phases of the buildings history and there is no evidence that they would have been replaced.

The secondary entrance to the building was originally made through the northern gable. There has probably been a small porch through which one could reach the bakery. There are no clear marks of a vestibule on the structure in that part of the building, but it is possible that there has been some kind of a pentice over the door. Above the porch in the attic level there has supposedly been a storage space. The access to the storage was through a hatch on the gable.

The facade cladding has been changed completely at least once in the buildings history before the year 2002. The original solid cladding parts are to be found in the upper parts of the vestibules.

Inside the building the original architectural components like paneled doors and their moldings are mostly preserved. The windows in the hall and in the attic were well enough preserved to be conserved in the project which started in 2002. The roof is out of jointed plate sheds, built on top of an older felt covering.

ESTHETICS

The appearance of the building in the starting point of the conservation project in 2002 tells about the era where it was divided in three modest lodgings. The external vestibules leading to each apartment are relatively large scale, which generates an almost a rowhouse-like identity to the edifice. The original classic morphology of the building has dispersed, but is still clearly to be sensed in the southern part of the whole.

TECHNICAL CONDITION

The building has been uninhabited and thus cold from the end of 1980s and therefore partly in a bad condition in the time its conservation process started in 2002. Only the roof and the chimneys had been kept in order. Still the chimneys above the roof line were dismantled and remade. The lowest timber was at many places buried under the ground and decayed badly. In addition rain water had clustered under the building due to the shape of the ground which had accelerated the decay.

The lower parts of the external vestibules were badly decayed and fallen down. The middle parts of the roof have had a leak and the ceiling had fallen down. Also the flooring at this part of the edifice was decayed. The original tile stoves had been taken down and replaced with plate stoves, from which a part was in a condition to be conserved. There was no running water in the building, but there was electricity.

Korplaine in 1979. Timo Tuomola

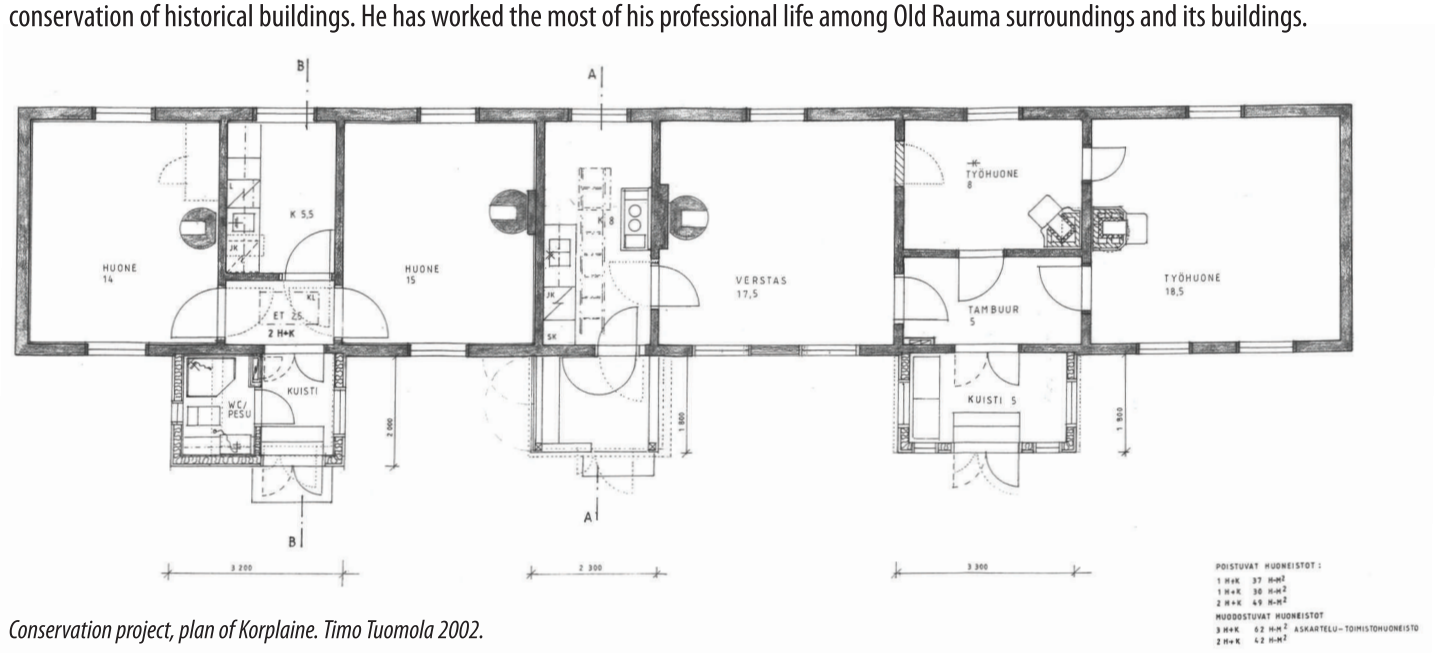
Korplaine in 1997. Timo Tuomola

Korplaine in the winter 2018. Hanna Elo

RENOVATION PROCESS

The principle in the renovation process was safeguarding the buildings historical value and at the same time improving its energy efficiency with modest and simple methods. The owner and the architect of Korplaine put most of the historical value of the edifice to the original log frame and architectural components like windows and doors among their moldings. In his project he wanted to highlight these parts and make them visible also when approaching the premises from the street side. At the start of the renovation process the soil was removed from around the building and its groundwork, and the rainwater was led into the storm drain.

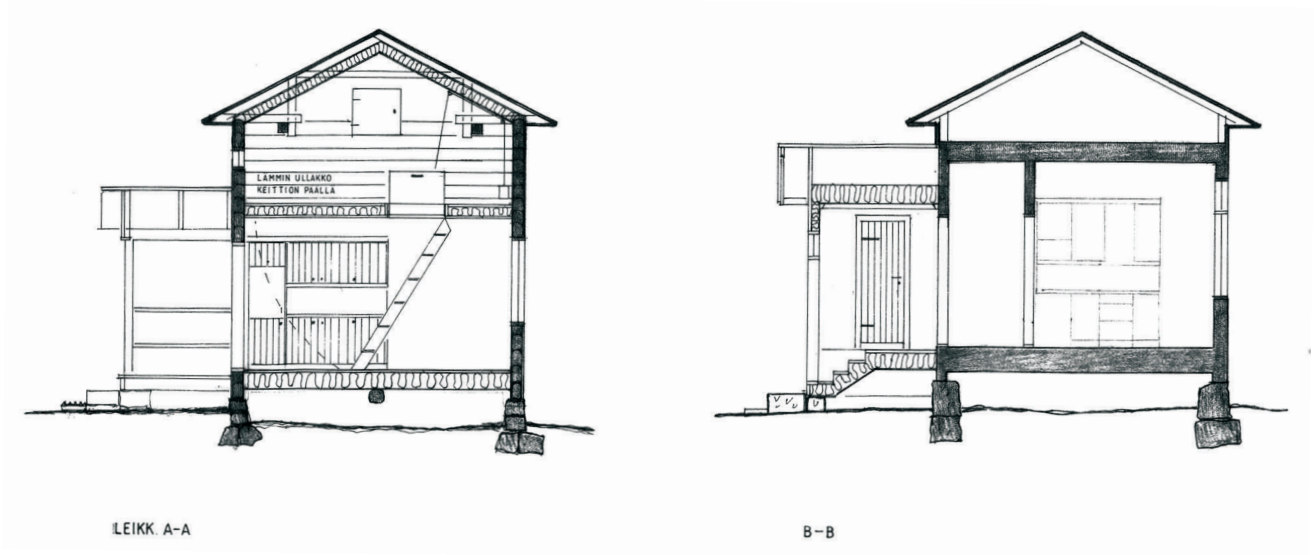
The design of the interventions is principally made by the property owner Timo Tuomola, who is an architect, specialized in renovation and conservation of historical buildings. He has worked the most of his professional life among Old Rauma surroundings and its buildings.



Conservation project, plan of Korplaine. Timo Tuomola 2002.

ETHICS AND AIM (7)

The very aim of the project when it started was to enhance the targets two most marked construction phases meaning firstly the very original empire building from the 1865 and the historicism styled extension constructed in 1900. This principle was endorsed by the need to deploy two separate functions under the same roof. The older part of the building was to be converted into a working space, aiming to house the architecture office of the owner. The younger part was to live further as a two-room apartment.



Conservation project, sections. Timo Tuomola 2002. Warm attic on top of the kitchen

NEW STRUCTURES

Procedure on the facades

The remaining original plane cladding was discovered in the western façade and left visible. The decayed areas were replaces with similar tongue-and-groove board.

The newly built external vestibule was covered with a plane board as well. Other parts of the building were cladded with simple vertical boards and laths were added to line their joints. The whole of the facades was covered with traditional cooked ochre paint, brown on the older empire part of the edifice and red on the extension. The windows, their moldings and the door moldings were painted white with linseed oil paint. The roof and the gutters were painted black.

In the external vestibules adjacent to the older empire part of the building the roofs are covered with felt. By contrast the vestibule serving as an entrance to the extension from 1900, there is a plate sheet roof.

Procedure inside

The flooring was only partly entirely opened. Most of the flooring was quite well preserved. It was possible simply to remove the decayed parts and patch them with sound material. At places where the floor was dismantled, the structure was repaired at required extent, but the old moss insulation was left at its place where possible. Underneath the old floor structure wood fibre insulation was added as to double the thickness of insulant. The accent was put to a careful sealing of the joints between the floor and wall structures in order to prevent uncontrolled air leakage.

The walls were insulated from the inside with doubled wood fiber board. There was no additional framework done in order to straighten the walls. The outside was left without additional insulation in order to prevent the windows from subsiding from their original position according to the facade surface.

There are double windows with standard windowpanes in every light. In addition the windows were sealed with a special liner again to prevent unnecessary air leakage.

Autumn 2007. Timo Tuomola.

Spring 2008. Timo Tuomola.

Summer 2008. Timo Tuomola.

The ceiling insulation was thickened with around 300 mm layer wood fiber plates installed onto the existing moss layer of which the thickness varied from 200 to 300 mm. The external vestibule's framework was insulated with 150 mm of wood fiber blown directly on the frame. These half warm vestibules are an effective method in saving energy by preventing heat loss in the winter time. In the kitchen, of which the vestibule is unenclosed there is a double front door.

Overall the materials used were kept homogeneous and natural, meaning wood, wood fiber insulation and for example plastic free construction papers. This enables the new and old material to work in conjunction preventing problems due to humidity or fissures.

THE REACHED RESULTS IN ENERGY SAVINGS AND COMFORT

The building is still principally heated with wood. Additional heating during the coldest periods is provided with radiators. In the winter time only those rooms that are used are heated, and the doors to the rest of the rooms are kept closed.

The owner and user of the building, architect Timo Tuomola is content with the results of the renovation process so far. The energy efficiency such as air leakage of the edifice has not been measured, but Tuomola tells that the air of the building is fresh, the fireplaces give pleasant warmth and the overall ambiance of the building is as unique as only in a historical building can be. The floors are still relatively chilly, but Tuomola sees it more as a feature of the building than a problem.

As the building is orientated its long sides to east and west, the light conditions inside are very agreeable. The house is never too warm in the summertime, and also collects well warmth from the sun in the winter time.

The only negative side in this is, that at certain time of the year during forenoons the sun shines in a low angle directly inside the office impairing visibility when working with computer. Therefore Tuomola has planned to install some sort of sunshades outside the windows at the eastern side of the building.

Summer 2008. Timo Tuomola.

The apartment in the northern end of the building is still under construction in winter 2018. The old floor construction is in these rooms replaced with a new one. The walls are insulated with two layers of wood fiber board. Photos in 2018 Hanna Elo

The external vestibule's framework was insulated with 150 mm of wood fiber blown directly on the frame. Photo in 2018, Hanna Elo

The area of the building in use now is around 120 square meters. Wood needed annually to its heating is around 3 cubics. In addition electricity is needed around 10 000 kWh.

CONCLUSIONS

In a best case a historical building is an allegory telling a tale of it's past, answering to our questions if only we are capable of asking. In Korplaine-case Tuomola began planning the renovation and made the first interventions in 2002. While the last part of the building is still to be finished in 2018. Anyhow the building is constantly in use and serves well its users. In conservation, like in so many other things, one should keep in mind the importance of the process itself, let the building tell how it should be handled and not necessarily set a firm goal in the very beginning. A rush never brings good or lasting results.

One of the principals one must bear in mind when discussing energy efficiency is, that the more modifiable and thus the longer-lived the building is, the more energy saving it's whole lifecycle will end up being.

The working methods in conservation should be based on our four senses, and kept as simple as possible just like our target building. Also, less is more when it comes to amount and size of interventions. This has been the way during the renovation in Korplaine. Only the necessary was done. During the whole process the history and different phases of the edifice were kept in mind. The aim was to facilitate the visibility and readability of both the original components and of the latter interventions. Time has been used to think and think over again. Being flexible and mindful has given a result which ensures Korplaine to live another hundred years further.

ABOUT AUTHOR

Hanna Elo has a degree in architecture (2007 Helsinki University of Technology). She studied her major in history of architecture and wooden structures in École d'architecture de Paris – Belleville (EAPB), France (2004-2006). In 2016 she was accepted to take part to the International Course on Wood Conservation Technology (ICTWC) Norwegian University of science and technology (NTNU) / Trondheim – Oslo.
Elo currently works as a **City planning Architect** for the City of Rauma where her work consists of zoning planning and consulting restoration of the UNESCO world heritage site of Old Rauma wooden town. She also has her own architectural practice since 2013. From 2009 until 2012 she was working as a **Regional Artist of Architecture** in the Arts Council of Satakunta, Finland. Before that she has been working as an **Architect** in numerous architectural offices mostly in the field of building conservation. Elo has researched the history of the Vuojoki mansion in Eurajoki and a study concerning the historical orangeri of the mansion has been published by Vuojoki Foundation.

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THE OLD "TELEGRAPH STATION", REBUILT AFTER FIRE

ABOUT DRØBAK

Drøbak is an old town, situated by the seaside of the Oslofjord, 30 kilometres south of Oslo, the capital city of Norway. From about 1650 to 1850, Drøbak was an important harbour/port for Oslo, especially in wintertime when the fjord between Drøbak and Oslo was frozen. Rich merchants from Oslo built houses and trading facilities, and they shaped the town. The town prospered on export of wooden boards and square axed timber from about year 1650 to about 1850. The customs station for the region was also situated here at the narrowest place in the fjord. From 1850-1900, ice from lakes was exported from Drøbak area to most of coastal Europe and England. The very rich period from 1680- 1810 gave Drøbak the big collection of wooden buildings, with horizontal logs as the main construction. The old town with its "self grown" roads and wooden buildings has been a protected area since 1978, and listed on a national list by the Directorate of Cultural Heritage Norway.

As Drøbak is situated close to Oslo, many people want to live here while they have their work in Oslo. This has made a pressure on the old houses when new owners want more space, more comfort and extensions. The building sections in the municipality, the county and the Directorate of Cultural Heritage Norway are the authorities on different levels, which process applications within the protected area. Since 1978 the regulations have mostly applied to the exterior of the buildings. The last 20 years the interior is also very important to protect and register, because here we will find tapestry, wall paintings, mouldings and boards from early periods under newer layers.

THE BUILDING DATA

Function	In origin a private house for merchants. From 1917- 1970 the National Telegraph station were the owners, and installed telephones and telegraph in the first floor. In the ground floor was installed a café. From 1921-1957 the local mail office was situated here, and from 1971-1982 a liquor store was there. From 1984-2015 a restaurant have used the whole building. From 1984 the attic was changed and built as an apartment. The building almost burnt down in November 2015. Since then the building has been rebuilt and will open as a restaurant in the autumn of 2018
The year of construction	The ground floor constructions are made of three sections, where the oldest is from early 1700. The building got the size and hip roof construction about 1780-90
Rebuilding	The building was almost untouched until 1917, and has changed windows 4 times and wall boards 3 times. There was a big change in 1917 to art-Nouveau-style, and a new change in 1984, when it got an old-style façade, new windows and it was insulated. The attic was changed and insulated to be an apartment
Material	The foundation were made new of concrete in the 1930s. The main wall construction is made of horizontal logs of spruce. Two smaller sections are made of framework. The hip roof construction is made of horizontal round logs of spruce. Roof tiles made of clay
Architects	There have been several participating crafters, consultants and one architect in the planning and rebuilding process
The number of floors	Basement, ground floor, first floor and attic
Type of heating	Outside 3 holes are drilled in the ground, each one 200 meters deep, to get heat from the ground connected with pumps to a circulation system. The liquid is pumped through a heat exchanger in the energy central. From here waterborne heating tubes are spread in the floors, and air ventilation systems are spread to all rooms in the buildings and sent back again
Developer. Year. The contracting entity	The project was started a week after the fire in November 2015, and is still running. The plan to finish autumn 2018. The team: the private owner, the insurance company, the main contractor, architect and advisor Per-Willy Faergestad

THE OLD "TELEGRAPH STATION"

The building was built in the richest period of the town. Only five of this type of construction were built in Drøbak from 1750-1800, and now three are left.

The building is situated in the main street in town, close to the marked place, and is very important for an holistic street facade and for the town. The very complete collection of these wooden houses in Drøbak is important nationally as well as internationally.

The telegraph station with hip roof construction is in the center of this photo from 1951. The main street in town is in front . 100 meter to the left is the marked place

A painting from 1880 shows the main street and the building is behind the horse. At that time the building was almost untouched and had windows in Empire-style and original boards outside

This picture shows how the building looked like just before the fire. This facade was built up in 1984

On November 8th, 2015, the old Telegraph building, a two story timber house, almost burnt down in the protected area Drøbak old town.

The building with hip roof construction got the size and style about 1790, at the time when Drøbak was an expanding town with trade of timber and boards to Europe. Two sections on ground level was older than 1790. The roof construction and the 1st floor were almost totally damaged by the fire. However, the rooms on ground floor were almost intact, with original boards, ceilings, mouldings and hand printed tapestry, never found in Norway before! In addition, the building was very valuable for the town, and had an important position in the main street. It was quickly decided to rebuild the building. Akershus Restoration Centre was elected as responsible advisor during the whole rebuilding process, with undersigned person (PWF) as advisor. The building was measured, levelled and numbered, and taken carefully down before summer 2016. During summer and autumn 2017 most of the building was restored, and placed back on the foundation. The roof construction was rebuilt on top of the restored wooden walls the first week of December 2017.

This was a great day for the town and all people involved! The building construction is back in town almost similar as when it was new, more than 200 years ago! The walls are made of spruce logs, and so is the roof construction; all as a handmade copy of the original. About 40-50% of the logs are original. In January 2018 all kinds of work with: floors, inside/outside walls, ceilings and roof started, and will continue until autumn 2018. When completed, the building will have restaurants in two floors and an apartment in the attic.

This photo was taken during the work in 1984, and we can see the main part to the left with log walls, and the frame work section to the right. A painted window on the wall in the framework section, to give balance in the facade, is visible in first floor to the right

A sad view down in the fire plot, where the roof construction has burnt and fallen down on first floor. Pretty horrible chaos! The whole building was close to collapse!

The facades after the fire and the disassembly had started

THE DATA RESEARCH OF THE ENERGY EFFICIENCY OF THE BUILDING

As the building was completely taken carefully down, restored and rebuilt, we had the possibility to construct and use modern new energy systems and fit this into the old construction, as all the floors were made with double crossed floor joists. All energy efficiency measures are based on knowledge and science on this theme in Norway. Based on drawings and accurate descriptions of how to build a good construction in addition to the old construction.

THE APPLICABLE REGULATIONS

Several laws and regulations in Norway will put claim on how to insulate and to prescribe the permissible indicators of energy efficiency. When rebuilding an old house there is a possibility to apply for dispensation from these claims. This is especially true and is important for authentic facades and the proportions of the building. The floors and the roof will often follow the claims and be fully insulated inside the building.

THE STRATEGY FOR HEAT LOSS PREVENTION MEASURES IN THE BUILDING

In 1984 the building was insulated for the first time, outside the walls, in the attic/roof construction (new apartment), and it got new windows. It was used Rockwool mineral fibres as insulation at that time. The strategy for the heat loss prevention measures in this building, is a combination of old insulation materials and new materials. When the building was rebuilt, the main part of the original building had spruce logs in the walls with 7“ thickness, and moss (Hylocomium splendens) were put in between the logs, as tradition.

On the 5th. of December 2017 the whole building was back in town, risen up from the ash! The roof construction contains of 850 meters of round logs. In front is the roof of the new kitchen under construction. The kitchen will be moved outside the old building

Inside the attic before the ceiling is put on top of the logs

In between the logs we put wet moss (Hylocomium splendens) as tradition. This is absolutely the best material for this purpose, and is used all over Norway, Sweden and Latvia. The roof insulation will be put in a rafter construction on top of the ceiling

The traditional timber wall is a combination of insulation and wind stopper. The log section is about 4/5 of the building with living rooms. In the southern part of the building there was originally a cold section with framework construction and gateway with trespassing for horse and wagon. Outside the façade is made of rebated boards only.

THE PROCESS OF IMPLEMENTING THE CONSTRUCTION MEASURES

A. Outside the 7" thick timber walls it will be insulated with 10-15 cm of paper/cellulose fibres. One rom will be plastered with a mix of clay and straw directly on the timber wall, as it was earlier. We will reuse the original plaster, by mixing it with water.
B. All windows are new. They will be made traditionally of pine heartwood, as a copy of the earliest windows (8-10 panes in each frame). The inner panes will have a thickness of 10 mm, to minimize noise from the restaurant to neighbours, and will also have energy saving surface with heat reflecting coating.
C. All doors will be made new in traditional construction, with addition of rubber sealing strip. The panels will be made better, as two parts and insulated in between.
D. All floors and the roof construction will be insulated with paper/cellulose fibres, which will be blown into the construction between a layer of wind stoppers (special paper). These fibres are very similar to the old material, and have almost the same hydroscopic trait as wood.
E. About 80-90% of all heat is taken care of through energy saving with air ventilation systems. The investment for such a system is paid down in 20-30 years, depending on prices in the energy marked.
F. The roof construction with horizontal logs is visible from inside of the apartment, and the insulation will be put in a construction above the ceiling.

On top of insulation is a wind stopper. Outside the wind stopper is an 2" wide opening for ventilation. On top is red clay tile.

Inside the attic/ apartment after the ceiling has been fastend

Inside to rooms in ground floor, where we see original ceilings and log walls. The ceiling joists and part of the walls had to be made new

Another room in the ground floor where original ceilings is restored. The floor thickness is about 40 cm, with double crossed floor joist. Technical instalations will fit in between, and the rest will be filled up with cellulose fiber insulation

THE SPECIALISTS INVOLVED

From the very beginning, just after the fire in November 2015, the owner, the insurance company, the municipality, the Directorate of Cultural Heritage Norway, a contractor, an architect and Akershus Restoration Centre were hired to discuss what to do. It was decided to take the building carefully down and rebuild it.

The reasons were:

1. The importance of the building for the town.
2. It is prohibited to demolish old buildings in the old town centre.
3. The owner wanted to rebuild, instead of making a new building.

After the clearing of floors, the building was levelled and all parts of the construction, boards, mouldings, tapestry were marked. In each story there was more than 500 long or short logs in the construction. A company, specialists in this kind of work, dismantled all what were reusable, and started the long process to rebuild each story, with use of old and new materials. In the ground floor about 70% of the logs were reusable. In the first floor only 20% was reusable, and in the roof construction all logs were to be made new. For the roof construction, we only had 6 logs from one corner left after the fire. We were lucky to have a similar roof construction of the same age 300 meters away in town. This construction was used as a model.

During the excavations and dismantling, under layers of newer materials, we found some original boards on the walls and in the ceilings. We found mouldings and tapestry, especially in the ground floor, with different e xpressions in each room. We also found out how the first facade looked like.

Inside the big hall in first floor, where almost all logs are new. These walls will be visible in the restaurant for several years, until the logs have been comressed and shrinked

The roof insulation will be put in a rafter construction on top of the ceiling

The owner wanted to recreate the rooms as they were originally, so we made catalogues for our findings in each room. Several courses have been arranged for crafters and other involved, where we made different profile planes for boards and mouldings. All boards and mouldings in the interior will be hand planed with tools similar to those, which were used in the 1790s. Together with an interior architect the owner now decide the expression in each room, combined with our findings and the use of the rooms in the future.

Before the building was returned and rebuilt at the property, they built an energy central situated underground in the backyard. Outside this, they drilled 3 holes in the ground, each one 200 meters deep, to get heat from the ground connected with pumps to a circulation system. The liquid is pumped through a heat exchanger in the energy central. From here waterborne heating tubes are spread in the floors, and air ventilation systems are spread to all rooms in the buildings and sent back again.

THE OPINIONS

All people involved and the users look forward and are curious to see how the restored building will look like when finished. The local newspaper and many magazines have written about the process several times, which is quite comprehensive and unique. For the town, for the street and for crafters and other involved, this process has been very important and given back lots of knowledge about the original interior, the exterior and the use of the building. During a workshop arranged in 2016, 23 crafters participated and made copies of profiled rebated boards, which will be attached to the wall together with some original similar boards. 4 crafters from Kuldiga, Latvia, participated in this workshop. In June 2018, the Directorate of Cultural Heritage Norway and Akershus Restoration Centre will arrange a three days international seminar on wood conservation with this building as a case, with 20 participants from 15 counties will participate.

THE CONCLUSIONS, BENEFITS AND LESSONS-TO-LEARN FOR THE FUTURE

It will always be a tragedy for an old town to lose an old building like this. Fire in towns with wooden houses, built close to each other is an overhanging danger. We can be careful and do very much to prevent fire, but when it starts burning, the fire will often be difficult to stop, because of many openings between layers in the constructions. The municipality, the Directorate of Cultural Heritage Norway and the local fire station have done very much to prevent fire, with alarm systems directly connected to the fire station. Extra control of electrical installations also has high priority. Inside the building the timber walls will be visible in many rooms for some years, because of shrinkage when the logs dry, and heavy weighs from roof construction will press the logs together. Some rooms in the ground floor, where the logs are original, will have original boards, panels and tapestry put back. There is almost no shrinkage in these old logs.

During a total restoration like this, there will always be some details to be lost. The registrations, with photos and drawings are very important from the beginning, during the rebuilding process, and as documentation for the future. Pieces of original boards, mouldings, tapestry, clay plaster which are left overs, should be marked and packed well and stored at the local museum or restoration centre. We use these pieces in our education of crafters, architects and planners.

The restoration process is not finished. Lots of work is still to be done, outside and inside. In such a process changes will also be done, especially with all new technical installations and new claims. It has been quite challenging for all involved persons in this project, where old and new constructions, materials and technical installations shall meet and fit to each other. Most of new installations are invisible; hidden in the floors, inside columns or behind panels, and the ventilation is noiseless.

Every old house has hidden securities. The use of materials and the use of tools are patterns, which are very important to discover before a restoration process starts. Knowledge about former craftsmanship and understanding of the production process is a supposition for a successful result.

Per-Willy Faergestad,
Senior advisor,
Akershus Restoration Center Drøbak
MiA- Museums in Akershus county

ABOUT AUTHOR

Per-Willy Faergestad is educated as a master craftsman with cultural heritage wooden buildings as speciality. He is also educated building engineer(BSc). He had his own company for more than 20 years, before he started educating of crafters and other involved in heritage buildings. Since 2007 he has made education plans for traditional craft in Norway, which now has been formalized even up to university level (NTNU, Tronheim). Since 2008 he has established a restoration centre in Drøbak, which now is responsible for the whole Akershus county area, with advice and courses for crafters, architects and house owners. Akershus Restoration Centre Drøbak has five employees, and work closely to the Directorate of Cultural Heritage Norway. The restoration centres in Drøbak and Kuldiga have cooperated since 2008.

All photos are taken by the author, except pic no 1.





PRACTICAL GUIDE

Measures for heat loss prevention in historical buildings, using the experience of the Baltic and Scandinavian States