Traditional Building Materials of the Baltic Sea Region

Building Preservation and Maintenance in Practice

Surveys compiled during 2003

Baltic Sea States

Heritage Co-operation

Riksantikvarieämbetet

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Cover photos 1) Window glass in the old national archive, Sweden. Photo Rolf Helmers.
2) Plastering at Mälsåker manor, Sweden. Photo Hans Sandström.
3) Tarred wooden church on Ruhnu, Estonia. Photo Peeter Säre.
4) Brick wall on the St Johns church in Tartu, Estonia. Photo Peeter Säre.

This survey is compiled by the members of the working group Building Preservation and Maintenance in Practice within the Baltic Sea Heritage Co-operation. The aim has been to map traditional building materials to get an overview of the use, manufacturing and assets both in the past and present.

The most important aspect has been the study of similarities and differences between the countries to increase the possibilities of co-operation in matters of manufacturing and preservation of the materials.

The survey is published as a PDF-file on the web-site: http://balticheritage.raa.se
or linked from Council of the Baltic Sea States: http://www.cbss.st

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1:1

Contents

Historical background in the Baltic Sea region

The history of brick goes back to China, Egypt and Mesopotamia around two thousand years before Christ. Later the Roman Empire developed the knowledge of brick making and spread it around Europe with the expanding empire. The knowledge about brick reached the Baltic Sea area with the monasteries, as well as the knowledge of window glass manufacturing. The monks had a well-developed technique and manufactured brick with very high quality. Examples of churches built completely of brick during the 12th century still exist in the Baltic Sea area.

In time brick spread from the monasteries but was not economically accessible for others than the king, the church and the nobility until the 18th century. Due to the advantages with roof tiles in case of fire the use increased and tiled roofs became more common than buildings made of brick masonry. During the reformation the knowledge of brick production decreased as a result of the reduction of monasteries. Due to this the import of brick but even more tiles increased from foremost Holland and the northern German states. In a big part of the Baltic Sea states the knowledge of brick manufacturing would not reach its former level until the 19th century. With the expanding towns the demand for brick increased during the 19th century and with the industrialisation the techniques of manufacturing developed as well. The great extent of brick use led to the growth of large scaled brickworks that culminated the decades around year 1900. The time until today has been varying for the popularity of brick and the big majority of brickworks has disappeared, but the material is still important in the production of new buildings.

Traditional production

Back in history most of the brick was manufactured at the building site. Temporary kilns were built for burning the brick and demolished when the building was completed. The more large scaled manufacturers of brick and tiles were located near areas with easy reachable clay to prevent long transportation of the raw material on land. They were also located near navigable water to facilitate the transportation and export of the brick and tiles. Not until the introduction of the railroad brickworks were started on the countryside without necessary access to navigable water.

The process of brick manufacturing changed very little between the Middle Ages and the middle of the 19th century. Manufacturing by hand dominated the process and the extracted clay that was used came from local assets.

National and regional differences are evident in brick and tiles, for example a more yellow colour is significant for Denmark and the southern part of Sweden while the red

Brick wall from the 14th century with terracotta figures on the St Johns church in Tartu, Estonia. Photo Peeter Säre.

colour is most common in the other Baltic Sea states. The yellow colour comes from a higher level of lime in the raw material while the red colour comes from the level of iron oxide; a higher level gives a more reddish brick.

During the 19th century and its industrialisation manufacturing of brick grew more and more effective and more even in quality. The new brickworks with steam power and big kilns, so called ring kilns, produced even burned brick with a repeated and exact size, and the railroad secured transportation throughout the country. With the international exhibitions around the world during the late 19th century ideas and innovations spread which for example had the result that in first hand tiles of the same shape and size could be found in several countries.

In time the so-called tunnel kiln started replacing the ring kiln in the production of brick. The idea with the ring kiln, moving the fire around inside the kiln with the bricks placed along the sides, was shifted to keep the fire on the sides of a tunnel and move the brick through it. The tunnel kiln reduced a lot of the heavy work connected to the ring kiln and did also produce a very even burnt brick with almost no differences in colour. This method, which gives the highest quality of brick, became dominating during the 20th century but the brick is less suitable in restoration works due to its perfection.

Environmental aspects

Manufacturing and use of brick has small negative effects on the environment. The biggest effect is the air pollution connected to the burning process. Depending on what kind of fuel that is being used the level of polluting substances differs, the main problem concerns carbon oxide due to a dominating use of oil and coal. Though, the level is very low compared to the service life of the material. The service life is depending on various factors, it is extended for example if a lime mortar is used instead of a stronger mortar based on cement, this due to extended possibilities of recycling, significant for brick as building material.

Another inevitable consequence is that the clay pits affect and change the landscape. This is obvious at a look at the areas surrounding the big brickworks of today, and the effect of it will last for a long time forward.

The situation today

Today's manufacturing of brick and tiles is standardised and in a big extent concentrated to a few producers with a dominating part of the European market. The completely industrialised production with a modern and strictly controlled burning process gives even and uniform bricks. The traditional handmade brick with its more uneven surface both in colour and shape is in most cases manufactured by small-scale brickworks using traditional methods.

Modern production of brick and tiles exist in most of the Baltic Sea countries and traditionally handmade brick is manufactured by order in a number of the countries. In Denmark, Estonia and Sweden for example handmade brick is produced in such extent that it can be exported, which gives the possibility to cover the demand in countries where production of handmade brick does not exist today, like Finland.

Brick production today is not threatened due to environmental aspects. Modern industrially manufactured brick is used in a great extent in today's building construction and the material has a safe future. Even though it is carried out in a small scale handmade brick is produced at a number of places around the Baltic Sea today and the knowledge of manufacturing still exist in the region.

Denmark

Background

Brick has been the major building material in Denmark since monks and craftsmen brought the knowledge of burning clay to the country in the late 11th century.

Since the country is very poor of stone as natural found brick became very important as a substitute for wood and sun-dried clay. Natural stone is very sparsely found granite only on the island Bornholm in the Baltic Sea and as erratic boulders brought to the country through the Ice Ages. The limestone in the underground is quarried only at a few places and only for local use, as the amount is not enough to meet the demands countrywide.

Clay is usually easy found in most parts of the country and tileworks were built provisional as close as possible to the building site due to difficult transportation by land. It is quite common to find bricks and roofing tiles from North Schleswig and the Lübeck area as relatively far as Copenhagen. Roofing tiles often bear the tilework's signature stamp on the top of the tile.

The size of the bricks changes with age and producer. Medieval bricks are relatively large and have a length of 270–300 mm, width 120–140 mm and thickness 70–100 mm. The used clay came from just below the mould and gave red bricks. Those produced in North Schleswig were very thin, approximately 4 cm. The local clay gave yellow bricks.

Situation today

Until the 1950s there were hundreds of tileworks in Denmark but due to the industrialised building activity and thereby less demand for bricks, many of the works closed down. Those that are left are now industrialised to the extreme (bricks untouched by human hands) and specialised to produce either bricks or roofing tiles.

Some tileworks have recently experienced a renaissance due to the demand of facing concrete buildings with bricks and tile. For restoration and special tasks it is still possible to produce bricks of various size and colour. Only a couple of brickworks are able to satisfy the demand. One of them produces in a coal-fired plant.

The contemporary Danish standard brick is 230x110x55 mm. The rule is that the length is equivalent to the width plus one joint, to secure a durable bond in the brickwork.

Making brick with traditional methods. Sweden. Photo Olof Antell.

Institutions

- The periodical "Tegl", Lille Strandstræde 20 C, DK 1254, Copenhagen K.
  Web page: www.forlagettegl.dk (Links to various bodies related to production and advice concerning tiles.)
- Murerfagets Oplysningsråd, Lille Strandstræde 20 C, DK 1254, Copenhagen K., Phone: +45 33 32 22 30
- Teknologisk Institut, Murværk, Teglbækvej 20, DK 8361 Hasselager
  Web page: www.teknologisk.dk/byggeri
- Raadvad, Nordisk center for bevarelse af håndværk (Nordic Centre for Traditional Crafts)
  Web page: www.raadvad.dk

Literature

- Niels Holger Larsen, Bygningsarkæologiske Studier, 1986

Estonia

Background

Brick has been a major building material in southern Estonia since the Middle Ages. It was introduced after the Christianisation of the land in the 13th century. The first brickyard is mentioned at 1365 in Tallinn. More precise information about brick manufactories can be found since the end of the 16th century. Brickyards were widespread all over the land where those could have been found at every bigger town and manor. Still the brickyards were more concentrated to southern Estonia as in the northern and western Estonia (including the islands) the main building stone was the local limestone. During the 18th century new smaller brick proportions were introduced. Still the traditional proportions were used in smaller brickyards until Word War I. In the end of the 19th century bigger brick factories were established and small brickyards became more exceptional.

Situation today

Today it is possible to get bricks in all shapes and proportions from the Wienerberger factory at Aseri. Handmade bricks are also produced for the building conservation market. In Estonia, the main project where these bricks are used, is the restoration of St. John's Church in Tartu. Large quantities of the handmade bricks are exported.

Institutions

– Tallinn Technical University

Literature

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Finland

Background

Brick was used in mediaeval building construction in Finland mainly for gables, vaults, door and window openings and other architectural details. Production methods were in all probability imported from other Baltic States. Entire buildings were seldom constructed of brick except for churches and castles; good examples of early brick architecture are the early 14th century parts of Turku cathedral, the late 14th century parts of Hämeenlinna castle and the Hattula church. Brick constructions belonging to ruined mediaeval monasteries and town houses have also been found at excavations.

Construction of brick houses became more common in the towns during the 17th century. Tile roofs were favoured in order to prevent fires; curved tiles were imported from the Netherlands and Germany. The breakthrough of brick construction took place in the 19th century after the common building regulations for Finnish towns prohibited wooden houses higher than one storey. The dominance of brick as a building material for town houses lasted until the 1950s.

The remnants found at Hattula indicate that mediaeval brickworks were simple, about 5x5 m pits dug in the ground. A mediaeval brick had the average dimensions of 80x130x270 mm; the size of bricks increased to some extent by late Middle Ages. Special bricks for vaults, floors, roofs and stairways were made in various profiles and sizes.

The first public manufacture, a "brick hall" (fi. tiilisali) was established in Turku in 1556 and soon followed by similar kilns at Pori, Hämeenlinna and Viipuri. Private brickworks emerged in the 17th century, and the production got some economical significance. The size of the bricks got smaller (40x100x210 mm), but the production methods were not altered; new innovations were brought up in the 1700s, as the horse-driven blending machine (tiilirana) was introduced. Brick production was accelerated by the great fortification projects, which were started in the 1740s and continued for several decades. The average size of bricks in the 18th century was 55x120x230 mm.

The industrial revolution of the late 19th century brought along better transportation and new production methods. Mechanical fabrication and circular kilns were introduced at the end of the century. The building frames of town houses were mostly brick masonry; façade rendering was widely used because of the diverse quality of domestic bricks. Roof tiles and façade bricks were mostly imported; perforated bricks were used already in 1868. Brick dimensions were standardised in 1897 (75x130x 270 mm) and commonly acquired by 1917. The beginning of the 20th century was a period of active industrial production. The production of domestic roof tiles and perforated bricks was started.

Situation today

The last producers of hand-made bricks discontinued the manufacturing in 1994. Current restoration projects have to make use of recycled bricks or try to import bricks from neighbouring countries. Local brick suppliers have specialised on tiles, whereby finding standard bricks for masonry can be complicated and expensive. The National Board of Antiquities has kept an unofficial database of available recycled bricks for some time; lately private restoration centres have also picked up the subject.

Some educational projects aiming at a revival of traditional brick making skills have recently been launched. The deterioration mechanisms of bricks have been studied at an ambitious research project at the Suomenlinna fortress.

Institutions

– Restaurointitiiliprojekti (The Restoration Brick Project) c/o Rakennusrestaurointi Aki Sulonen, Nikkari Tuomisen tie 89/50, 39100 Hämeenkyrö. E-mail: aki.sulonen@lpkky.fi

Literature

– Kuokkanen – Leiponen: Suomen tiiliteollisuuden historia. ©Suomen tiiliteollisuusliitto r.y and Tiilikeskus. Helsinki 1981
– Leena Venhe: Irtaimet tiililöydöt. Article in Kuusiston linna, tutkimuksia 1985–1993. © The National Board of Antiquities. Turku 1994. ISBN 951-9075-75-5
– Leena Venhe: Laukon kattotiilimateriaali. Article in *Vesilahden Laukko, linna kartano, koti*. Archaeologica Medii Aevi Finlandiae IV. Turku 2000. ISBN 951-96801-1-X

Latvia

Background

Brick as material is used in the territory of Latvia since 13th century. There are many rich and easily accessible clay and limestone fields in Latvia, especially nearby big rivers. These fields have facilitated the production of brick and lime since the middle ages. Separate important buildings were built in brick – Dome and St.Peter's Churches in Riga, bergfrid of Turaida palace. Nevertheless, brick buildings were mostly constructed since 15th century (including St.Peter's Church in Riga).

During the 17th century production of bricks developed due to extensive building of new fortification constructions. There is information on brick import since 17th century (from Holstein, Lubeck, Gdansk, Amsterdam and other places).

In the beginning of 18th century the plague epidemic as well as destroyed forrests during the Northern War decreased brick production. The elimination of war consequeces lasted till the middle of the century. In the second half of 18th century brick became the dominant building material. The four biggest producers were two manufactures – Riga and Jelgava cities, and Unguri and Dole manor brickyards. Bricks from Ungurmuiža were exported also to Estonia.

In the beginning of 19th century brickyards could be found almost in every manor. Mostly these bricks were used for local manor needs, where possible – also for selling. In connection with the construction of Daugavpils fortress, the greatest brickyard developed there. During the 19th century brick production developed rapidly.

Situation today

Handmade bricks for restoration, produced after special order is supplied by "LODE" Ltd. Bricks are non-freezing in 50 cycles, unitmass – 1,99 g/cm3.

Institutions

- Rīgas Tehniskā Universitāte (Riga Institut of Technology)
- Silikātu materiālu institūts (Institute of Silicate Materials)
- Akmens materiālu konservācijas un restaurācijas centrs (Stone Material Conservation and Restoration Center), Āzenes street 14/24, Riga, LV-1048, Latvia
  Phone: +371-7-089140, Fax: +371-7-901460, E-mail: linda@ktf.rtu.lv

Literature

- Jenšs J. No Latvijas rūpniecības attīstības vēstures 18.gs. beigās – 1860.g. // Vēstures problēmas. V. Rīga. 1962.
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- Васильев Ю. О произиодстве и применении кирпича в Латвии // Из истории техники Латвииской ССР. 1. Рига. 1959.

Lithuania

Background

Brick have been used in Lithuania since the beginning of stone construction that started together with building of churches and state fortresses in the 13th century.

It was deduced that in the Great Duchy of Lithuania they produced porous and mechanically strong bricks during the 13th to the 16th century. In the 16th century, when brick production was expanding rapidly, their strength declined from 200–400 kg/cm² to 150 kg/cm² remained of such quality in later periods of Renaissance, Baroque and Classicism. In Vilnius region, due to clay composition, there are many yellow and flame-coloured bricks. It was found that there had been at least 150 different types of profile bricks and ceramics produced since the 13th century up to now.

Situation today

According to the requirements of Public Standard of Lithuania, modern simple ceramic bricks are produced of 250x120x65 mm and modular ones of 250x120x88 mm size. Measurement of restoration bricks also exist, they are as follows: T1: 290x135x 85 mm, T2: 260x125x65 mm and T3: 250x120x65 mm. Since old bricks were handmade, modern finishing bricks with even surface, used in restoration, scream out, especially in Gothic buildings. In many cases, stone restoration, when replacing it with ceramic bricks, destroys many materials of old substance and original lime grout.

Modern research methods allow analysing a historic brick and conditions of its surrounding environment and soiling perfectly. However, considering present economic situation, it is difficult to adapt equivalent substitute for it. The other issue is to what extent it is possible to apply modern concepts of construction expenses and desirable quality of production in restoration.

Institutions

– Vilnius Gediminas Technical University
– Kaunas University of Technology
– Institute of Civil Engineering and Architecture

Literature

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Poland

Background

Architectural landscape of Poland is divided into 'brick' north and 'stony' south. This partition issued from location lodes of sandstone and limestone in the south; they seldom occur to the north of Sudety Mountains and Little Poland Upland.

Archaeological findings and historical documents from Pomerania show that brick building was known and used in Princes of East Pomerania time (until 1294). Brick and stone were used together in the beginning; buildings of brick only were not built before the second half of the 13th century. The Church in the Cistercian Abbey in Kolbacz (West Pomerania), building started in 1210, is the first edifice from bricks purely.

The mendicant order (Dominican Friars and Grey Friars) has been contributed the growth of brick building in Poland in the 12th century.

Ordinary bricks and shaped bricks (decorated with mouldings or not) and ceramic plates was used already in the 13th century. Using two sorts of bricks, ordinary bricks and overburned bricks with a surface glazed and nearly black, had a special decorative effect used after the 13th century.

The size of the bricks in mid 14th century was around 300x150x110 mm.

Teutonic Knights had a share in the development of brick building in the northern areas of Poland. The Order created their own specific, independent and self-supporting artistic province in Prussia that had a natural connection to the second Teutonic colony in Livonia and Curlandia.

Bricks used for building the Teutonic castles were produced in brickyards close to the castles. One year's production at Malbork (Marienburg – where the worlds biggest brick castle in located) reached more than 200.000 bricks. For other castles bricks had to be bought from brickyards located near big towns. The ordinary size of these bricks was 320x150x90 mm. The oldest fragments of the medieval Teutonic cities Torun, Gdansk and Elblag show that they have been partially built of bricks as well. These kind of expensive buildings were built not only by the Order of Knights but also by bishops, religious orders and patriciate as well.

It is known that brickyards and lime kilns existed in Gdansk in the 14th century, for example the biggest brickyard in Poland at the time, producing 500.000 bricks per year. That amount is enough for 50–70 habitable rooms, i.e. a dozen or so imposing houses at the outmost.

In the 17th century the bricks had an average dimension of 310x150x90 mm. In the first half of the 18th century they were thinner, down to 50 mm thickness. In the second half of the 18th century the greater part had a dimension of 290x120x70 mm.

The 18th century suffered from permanent shortage of building materials, which led to alternative materials, shown e.g. in the Starost mansion-house (district Borzechowo, administrative district Starogard Gdanski) built of sundried bricks.

In the beginning of the 19th century most brickyards were provisional, but during the century permanent production and industrial production became more common. The tradition of provisional field brickyards did not disappear though, but existed still in Pomerania in the 1990s.

Situation today

Today brickyards in Poland make various ceramic products, for example brick of dimension 250x120x65 mm.

Institutions

– Instytut Zabytkoznawstwa i Konserwatorstwa, ul.Sienkiewicza 30/32, 87–100 Toruñ

Literature

– A. Arszyński, *Technika i organizacja budownictwa ceglanego w Prusach w końcu XIV i w I połowie XV wieku*, Wrocław 1970.
(Treat of essential problems of technology and system brick building in the State of Teutonic Knights)
– *Historia Kultury Materialnej Polski w zarysie*, t.III,IV,V, Wrocław-Warszawa-Kraków-Gdańsk 1978,1979

Sweden

Background

The first brick buildings are to be found in the southern parts of the country, in the region of Skåne. Some buildings remain from the 12th century. In coastal towns like Malmö, Ystad, Kalmar, Visby and Stockholm there are examples from the 16th century, reminding of the Hansa period. Typical for the baroque period (17th century) are the palaces of the high nobility, most of them around Stockholm. Local brickworks were organised close to the construction sites.

Industrial production of clay brick and tiles started in the 19th century. In the year 1915 Sweden had more than 500 brickworks. Around 1985 there were only 12 of them left.

Situation today

Most of the old production plants have disappeared and the great European manufacturing companies owns the remaining ones. Haga Tegelbruk, near Enköping, 100 km west of Stockholm, is the only one remaining of the modern brickworks. It belongs to the Wienerberger Group, with plants in many countries around the Baltic Sea. The Haga plant produces facing bricks. The one remaining producer of roofing tiles is part of the Lafarge-Tekkin group, with factories all over the world. At the Vittinge brickworks standard single and double tiles are produced through extrusion.

Two small producers of hand-made bricks are left – one in the region of Dalarna (Bältarbo) and one in Västergötland (Horns tegelbruk). They are both making bricks on demand but also roof tiles and floor paving.

Institutions

- MPI Mur och Puts Information AB, Box 1481, 621 25 Visby, Phone: +46 498 27 97 00
  Web page: www.mur.se
- Lund Institute of Technology, Division of Building Materials, Box 118, 221 00 Lund
  Phone: +46 46 222 72 00, Web page: www.byggnadsmaterial.lth.se
- SP – the Swedish National Research and Testing Institute, Building Technology, Box 857, 501 15 Borås
  Phone: +46 33 16 50 00, Web page: www.sp.se

Literature

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Historical background in the Baltic Sea region

It is known that lime has been used in building construction for thousands of years. The Romans had a well-developed knowledge about lime burning and use and with the empire that knowledge spread to Western Europe from where it later came to the Baltic Sea region with the monasteries. It was also the church foremost that used the knowledge of building lime in their constructions in the beginning. Later kings and high nobility started using lime when building their large scaled stone and brick palaces. Still in the early 19th century brick and lime constructions belonged to the well-situated part of the population. But the use and production of building lime increased during the 17th–19th century, and still during the first half of the 20th century lime dominated the market. After World War II cement took place as the dominating mortar and plaster material. With the extensive use of cement a lot of the knowledge of traditional lime burning and use was lost. Though, the late 20th century has shown an increasing interest for lime, foremost in restoration works, and today there is a small market for traditional building lime.

Traditional production

As with brick it was common to manufacture the building lime at the construction site. The lime for plaster was stored in pits for long periods before use, but the lime for mortar could be burnt and prepared just before use. It was common to use the same kiln for burning lime as used for burning the brick at the site, but the kilns in general varied from pits on the ground to big stone kilns for export production.

The choice of lime was in most cases decided by local assets, and in some regions hydraulic lime has been used for centuries. From the 19th century structures placed under water as well as masonry exposed to high levels of moisture were deliberately built or rendered with hydraulic lime due to better water resistance. To the larger areas air-cured, non-hydraulic lime was preferred.

Air-curing lime can be slaked both dry, as powder, and wet, as putty. The putty can be stored for years and it is known that wet slaked lime was frequently preferred for plastering works. Hydraulic lime can only be slaked dry or it will start hardening in contact with the remaining water. Today dry slaked lime, both hydraulic and non-hydraulic, is completely dominating due to the advantages in the handling of the product.

The production of lime today is concentrated to a few big producers of both lime and cement. The latest 150 years of communication development, foremost the railroad, has given the possibility to concentrate the production and distribution to a few places in the Baltic Sea region. The increasing use of cement after World War II has reduced the production and use of traditional building lime, but there are still a small number of existing producers around the Baltic Sea.

Environmental aspects

Lime manufacturing demands large amounts of energy. This has given great effects on the environment surrounding the lime kilns back in history when big forest areas was cut down to be used as fuel. Wood is not effective enough in a larger scale and today other fuels with a higher energy content is used. Instead the most obvious negative effect on the environment today is that digging for lime results in big ”wounds” in the

landscape, but there is also a considerable amount of carbon dioxide released in the burning process contributing to the air pollution.

Old lime mortar is possible to reuse as aggregate in new mortar. An air-cured mortar is also elastic and relatively soft. This is a great advantage when recycling for example brick because of the possibility to easily rinse the bricks from old mortar.

The situation today

Today's traditional manufacturing of building lime is carried out in a very small scale at a few places in the Baltic Sea region. For example is wet slaked lime for restoration manufactured in traditional lime kilns on the Swedish island Gotland and on Saaremaa, Estonia. The confidence in traditional building lime, especially for works of restoration, has increased during the last decades in the Nordic countries. In the other Baltic Sea countries cement mixed mortars and plasters are often dominating and the range of products is wide. The modern production of mortars and plasters is completely industrialised and concentrated to a few companies on European level.

Production of lime based products is not threatened due to environmental aspects. They are impossible to replace in many building constructions and that will secure the materials in the future. The traditional methods of production should not be threatened because of environmental aspects either and the knowledge about them still exists, even though it is limited.

Part of a brick wall from the 1920s with lime mortar in bed and cross joints and a coloured decorative joint at the surface. Sweden. Photo Ewa Sandström Malinowski.

Denmark

Background

Lime is so to say the foundation of the country and is generally easy accessible. You find it just below the mould and the clay that some places are only a few meters depth.

In few places you can find limestone in a quality that makes it possible to quarry it and cut the soft stone for direct use to build. That is the situation on Stevns, the peninsular south of Copenhagen. Due to the accessibility many rural buildings in this area are built of limestone. Literally you can dig it out of your own property. To protect the soft stone you plaster and whitewash the walls.

Lime is the basic material in mortar. For that purpose you heat the limestone (calcium carbonate, $CaCO_3$) to 1000°C and soak with water to a putty that must be stored in a lime pit for some years. The longer the better. Mortar with lime and sand mixed in a proportion of 1 to 3 gives a strong and tough mortar. When the lime react with the oxygene in the air the mortar sets. Clayey lime gives hydraulic mortar which sets without the influence of oxygene. On the island Bornholm there has been produced hydraulic mortar from a redish clayey limestone. This mortar has been used for plasterwork on some of the architect C. F. Hansen (1756–1845) in Copenhagen.

Situation today

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Institutions

– Raadvad, Nordic Centre for Traditional Crafts, Web page: www.raadvad.dk

Literature

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Estonia

Background

Limestone as a building material has been used already in the pre-historic times for dry-stone walls, but lime mortars were introduced as late as the 13th century by Germans and Scandinavians who came to Estonia as missionaries and crusaders to Christianise the land. The churches and castles were the first masonry buildings using local limestone and locally burnt and slaked lime. Since then the lime mortars and plasters were used consistently until the late 19th century when Portland cement and other binding media were introduced. The lime production and use declined rapidly and the techniques and crafts were forgotten surprisingly fast. Lime products have been reintroduced in conservation during the last twenty years, but with varying degree of success.

Situation today

Much effort has been put into recreating the whole production process of building lime in the last decades at Lümanda, Saaremaa. As earlier descriptions from Estonia do not exist, the 19th-century ones and knowledge from elsewhere were used to set up the process.

The limestone for burning is hand-quarried from a small quarry in an area which has been used for centuries. The lime is burnt in kilns just next to the quarry. As several 19th-century abandoned kilns have survived in the vicinity, the new lime kilns were built as replicas of these. The stones are packed into the kilns and burnt at the temperature of 1000–1200 °C for four to five days depending on the weather conditions, the quality of fire wood and exact size of the stones. The lime is "ready" when the flames at the top turn blue. The whole process of burning is empirical and has not been analysed.

After burning the lime is slaked in open pits for about two weeks. Water is gradually added for wet slaking, the excess water is drained through the wooden bottom of the pit. According to the tradition the lime should mature much longer (e.g. up to three years), but the effect has not been scientifically studied.

The mortars used in conservation are generally pure lime mortars with lime sand ratio 1:3–4. To gain greater porosity the mortars have to be mixed thoroughly. In a few cases crushed brick has been used as a hydraulic agent. Plasters are generally applied in three layers allowing the layers to dry inbetween. In case of very hot and sunny summers the surfaces have to be sprinkled with water before adding another layer. Applying and survival is difficult on large exposed surfaces.

Institutions

– Tallinn Technical University

Literature

–

Finland

Background

The art of building stone and brick masonry with lime mortar was most likely brought to Finland from Sweden in the 13th century in order to build castles and stone churches. The oldest masonry constructions built with lime mortar are dated to the last decades of the 13th century (the earliest building phases of Turku castle and cathedral and several churches on the Åland islands). Building activities were depending on commissioned master builders and bricklayers from other countries until a domestic tradition started in the early 15th century. Limewash dating back to the 14th century has been found in the mediaeval churches of Hammarland and Sund in Åland, in the churches of Pernaja, Pyhtää and Porvoo in the south-east of Finland. Fragments of limewashed renders have also been preserved in the mediaeval castles.

The historical methods of application and treatment of lime mortar and limewash resembled the techniques used in Sweden; specifically Finnish rendering techniques appeared first in the 20th century. Lime mortars or combinations of lime and cement dominated from late 19th century until the late 1950s. The use of prefabricated elements in construction weakened the building tradition as well as the bricklayer's skills and the apprentice training.

The limestone resources in Finland can roughly be divided into two main types: the calcite stone in the south-west, characterised by a crystalline composition, and the eastern dolomite limestone. Neither of these is known to have natural hydraulic qualities. Lime has been imported from Sweden and Estonia both as stone blocks and lime putty.

The earliest documents of lime quarries on the mainland are from 1329, concerning a donation of a mine in Kemiö to the building site of Turku Cathedral (mons cementi dicitur wlgariter Krakanes). On Åland islands the production required no quarrying because of the easily available limestone boulders on the ground. Lime was burnt in simple earthen kilns both by the state and private peasants, and the production method remained quite similar until the early 20th century. Industrial production was started almost parallel to the appearance of the first cement factories; cylindrical limekilns were used for the first time in Helsinki (1862) and Parainen (1872).

Situation today

A slight recovery in the late 20th century has brought more lime-based materials to production. Some research and development has been carried out both by industrial companies and research institutes. A relatively small marketing potential nonetheless hinders the development.

The level of knowledge and practical skills has been increasing. Rendering and constructing with lime is still not very common due to the discontinuation in the tradition. There is a demand for handicraft training, specialised contractors, easily available products and, finally, target-oriented research. Finding the resources for all this development requires a wider awareness, which most likely can be created only by producing information for builders and other professionals.

The education for bricklayers/masons does not include working with lime mortars or render. Updating education is given at some institutes, but the lack of traditional skills is a major problem.

Institutions

- Tampere University of Technology, Department of Civil Engineering, 03-3115 4804, Korkeakoulunkatu 5, PL 600, 33101 Tampere, Web page: www.tut.fi
- The National Board of Antiquities / Department of Monuments and Sites, Pl 169, 00511 Helsinki
  Web page: www.nba.fi, Phone: +358-9-40501, Fax: +358-9-4050 9420
- Governing Body of Suomenlinna, Suomenlinna C 40 FIN-00190 Helsinki,
  Phone: +358-9-41323300
  Fax: +358-9-41323280, E-mail: hoitokunta@suomenlinna.fi
- ICOMOS Finland / Stone Committee / Kati Winterhalter, Pellervontie 27 as.3 FIN-00610 Helsinki
- Optiroc Oy, Research and development. 010-442200, Web page: www.optiroc.fi
- Partek Industrial Museum, Skrabbölevägen, 21600 Parainen, Finland, 02-4581452
  Web page: www.wakkanet.fi/museer
- Tytyri Mine Museum, Tytyrinkatu, 08100 Lohja, Finland, Phone: +358-19-3694204 or 3694206
- Asiantuntijamestarit Oy, 09-7260077
- Rakennuskonsultointi Treuthardt, 09 – 737205, Tureida / Thorborg von Konow, Phone: + 358 9 346 3702. E-mail: Thorborg@saunalahti.fi

Literature

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- Mortars in historic buildings / New mortars in old masonry constructions. ©Technical Research Centre of Finland, research reports 341 and 342: Espoo 1985. ISBN 951-38-2265-6 / ISBN 951-38-2243-5
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Latvia

Background

Traces of building lime have been found in some of the oldest masonry buildings in Latvia from the second half of the 12th century. At the end of the same century the first buildings were constructed by craftsmen from Gotland using limestone and dolomite with lime mortar as binder.

In the middle of the 13th century the city Riga had its own lime kiln and the Livonian order established several limekilns that were in use periodically in Kurzeme. In 1226 a document was issued permitting everybody to burn lime and brick. The fortification wall surrounding Riga as well as the churches was built of local limestone, but for the construction of several dwelling houses limestone had to be imported from abroad.

In the 17th century lime production in Kurzeme was highly developed due to the dukes order to establish limekilns in "every possible place", especially near big rivers. At the most there were 25–30 limekilns and slaked lime was transported to Riga, and later also to Lithuania. Since the 17th century Kurzemes biggest limestone quarry is in Nigrande.

In the early 18th century lime production decreased due to a period of war, but with an increasing use of brick during the century the demand for lime products increased as well. Several limekilns maintained and existed until the 19th century, during which the main part of the lime production was used in the big cities. This factor determined the development of lime production areas. In Riga mainly dolomite was used obtained in the surroundings of river Daugava. In the 1860s building construction intensified in Riga and the demand for building lime increased greatly. Along with lime cement was beginning to be used as well, but it should last until the 20th century before it got used more widely on the countryside.

In 1939 there were 138 limekilns, from which 1/4 was out of function. "White" building lime, with a very high level of calcium carbonate, represented 9–15 % of the production. "Grey" building lime from dolomite represented the rest. "White" lime was produced in Nigrande and "grey" lime in Cesis.

It is known that gypsum was used in a limited amount for mortars during the 13–14th centuries. Together with lime and sand it results in a harder mortar. From the 13–19th century "grey" lime was used together with sand in relation 1:0,3–1,4 for thick mortar and 1:1,8–4,5 for lean mortar.

Situation today

Specific production of building lime for restoration works does not exist in Latvia today. Some companies produce "white" lime in limited amount depending on demand. In other cases lime is imported from Lithuania and Byelorussia.

Institutions

- Rīgas Tehniskā Universitāte (Riga Institut of Technology)
- Silikātu materiālu institūts (Institute of Silicate Materials)
- Akmens materiālu konservācijas un restaurācijas centrs (Stone Material Conservation and Restoration Center), Āzenes street 14/24, Rīga, LV-1048, Latvia, Phone: +371-7-089140, Fax: +371-7-901460. E-mail: linda@ktf.rtu.lv

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Plastering with lime at Mälsåker manor, Sweden. Photo Hans Sandström.

Lithuania

Background

During the first period of building construction with stone or brick, until the 15th century, mainly pure lime without hydraulic qualities was used. During the 15–16th centuries dolomite based building lime started dominating with the development of profane building construction. The dolomite lime was a cheaper alternative with poorer qualities than pure lime. In the 16th century, various additives were also used to get hydraulic lime; crumbs of ceramic brick, sand, slag of iron foundry, and ashes.

Situation today

Today it is required that non-hydraulic lime is used when restoring historical buildings. There are various numbers of mortars and plasters on the market of high quality but most of them are based on cement and not suitable for restoration works.

Today mortars for restoration works normally have lime-sand proportions of 1:3 or 1:2,5. Even though it is not stated the recommendations of WTA* is very often used in connection to restoration of buildings in Lithuania.

(*Wissenschaftlich Technische Arbeitsgemeintschaft für Bauwerkserhaltung und Denkmalpflege – scientific-technical labor association for cultural heritage and building conservation.)

Institutions

- Vilnius Gediminas Technical University
- Kaunas University of Technology
- Institute of Civil Engineering and Architecture

Literature

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Norway

Background

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Situation today

There are a number of producers of industrially manufactured building lime in Norway today. Traditionally manufactured lime is not produced.

Institutions

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Literature

– Riksantikvarens informasjon om kulturminner 3.1.1 Murverk: Kalkpussing
– NIKU oppdragsmelding 072 Kalk og kalkpussing
– Fortidsminneforeningen: Gode råd om mur og puss
– Byggforskserien: 770.111 Mørtler for rehabilitering av eldre murbygninger
– Skandinavisk Jurakalk: Bygningsbevaring (produktkatalog med oppskrifter)
– Riksantikvarens informasjon om kulturminner 3.1. Murverk: Kalking
– Byggforskserien 742.663 Utvendig maling på puss, tegl og betong – eldre bygninger

Poland

Background

The deposits of limestone that can be used for production of building lime are situated in the southern regions of Poland. Therefore the northern parts has always been depending on the southern assets.

During the Middle Ages the State of Teutonic Knights had to import limestone, mainly from the island Gotland.

In the former Duchy of West Pomerania the so-called Limely Mountain near Sepolno Male was a great lime quarry that many of the Pomeranian towns had a big interest in. Limestone from this area was used in buildings in Darlowo and Slupsk during the 15th and 16th centuries.

During the 16th century limekilns near Swiecie in east Pomerania was used for burning limestone from the surroundings of the river Vistula. Still in the middle of the 19th century building lime from this area was used, an example is the brick church in Chmielno in central Kashubia.

Between 1822–46 limekilns was used for the production of lime, but beginning in 1837 industries took over and lasted until 1891 in West Prussia. The production was not sufficient though and limestone had to be imported, mainly from Sweden.

Other areas of limestone that could be used in production of lime were in Kraków-Czestochowa Upland in the south of Poland as well as the Opole region in Silesia, Germany. The demand for lime products developed and a number of lime industries was started in these areas during the end of the 19th century. In time Opole became the main region for production of a number of building materials to Silesia and Prussia; cement, hydraulic lime and various kinds of bricks.

Situation today

The southern lime industries in Kielce, Radom, Piotrków, Lublin, Rejowiec (Little Poland) and in Silesia still supply the northern parts of Poland with lime products.

Institutions

- Instytut Zabytkoznawstwa i Konserwatorstwa
- Zakład Konserwacji Malarstwa i Rzeźby Polichromowanej.
- Uniwersytet im. Mikołaja Kopernika, ul. Gagarina 7, 87–100 Toruñ
  Phone: 0-56-61-14-621, E-mail: zkmirz@art.uni.torun.pl or brouba@art.uni.torun.pl

Literature

- A. Arszyński, *Technika i organizacja budownictwa ceglanego w Prusach w końcu XIV i w I połowie XV wieku*, Wrocław 1970. (Treat of essential problems of technology and system brick building in the State of Teutonic Knights)

Sweden

Background

The knowledge about lime for preparation of mortars and plasters was brought to the south of Sweden by the monasteries in the 11th century. Masonry from this period can still be found in Skåne (by then part of Denmark). Colonisation of the coast along the Baltic Sea brought lime as far as Luleå in the 16th century.

Still in the 19th century limestone was quarried in all parts of Sweden and a great variety of qualities were produced. Architects and builders knew which lime to choose for certain purposes. There was a very pure limestone, from the island Gotland, suitable for limewashing and for artist's work. There were less pure qualities with a large clay content often used in foundations and when the big canals were constructed.

Situation today

Since the 1970s lime products are being used again, for plastering and limewashing. There are ready mixed lime mortars and paints on the market – making it easy for the "ordinary" house owner. When ambitions are higher and the necessary craftsman's skills are at hand, it is recommended by the regional heritage authorities that mortars for plastering should be mixed on site – to fit with local traditions and materials.

The last producer of natural hydraulic lime in Sweden closed down in the 1950s. All production of dry slaked aerial lime (non-hydraulic) is concentrated to Optiroc, part of the Heidelberg Cement Group. Wet slaked aerial lime for conservation is produced in small-scaled kilns on the island Gotland. Different qualities of building lime are also imported from Denmark (Jurakalk), Germany (Sto), France (Lafarge and St. Astier) and Poland.

Efforts are also being made to produce "on site" limes in special kilns, close to building site. This will make it easier to prescribe a product, adjusted for the actual building (Läckö Castle, Palace of Borgholm (ruined) on the island of Öland).

Institutions

- SP – Swedish National Testing and Research Institute, Box 857, 501 15 Borås, Phone: +46 33 16 50 00
- MPI Mur och Puts Information AB, Box 1481, 621 25 Visby, Phone: +46 498 27 97 00 Web page: www.mur.se

Literature

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Historical background in the Baltic Sea region

The history of window glass manufacturing goes back to Syria the century before Christ and it has also been found parts of window glass during the excavations of Pompeii in ancient Italy. During time until the north European middle ages the knowledge about window glass manufacturing were kept in the monasteries, and with the christianisation of the Baltic Sea region the knowledge about window glass spread as well.

For a long time window glass was an exclusive product for a limited and wealthy part of the society. Not until the 18th century, but foremost the 19th century, window glass reached a wider market.

After being concentrated to the monasteries for a long time manufacturing of window glass was spread to private workshops during the 16th and 17th centuries. Window glass became a trade product and guild systems were established for glass blowers in the countries around the Baltic Sea. With the development of techniques the possibility of making more even glass grew with the size of the windows. The size was also depending on the use of wood instead of lead in the bars, something that became more and more used during the 18th century. The wooden barred windows are the most common old windows that you can find today.

Traditional production

The methods of manufacturing in a historical perspective are foremost the following three: crown glass, cylinder glass and sheet glass. Crown glass is first blown as a big bulb that is flatted and opened in one end. During rotation the opening expands and the former bulb becomes a flat disc. The glass disc is cut into rectangular pieces but allows only smaller panes which is characteristic for crown glass windows. This is also the oldest method used from the middle ages. The cylinder glass is first blown as a long cylinder from which the ends are cut off and then opened by a cut along the cylinder. The opened cylinder is flatted out and cut into panes. This method results in bigger and more even panes and became frequently used during the 18th century. Sheet glass was developed during the second decade of the 20th century. The melted glass is kept under rollers that drags the glass vertically upwards during cooling. This method results in considerably bigger and even more even panes, still not with the same perfection as today.

The quality of older window glass varies a lot. The pureness, or whiteness, necessary for mirror glass was not considered as important for windows, and that is obvious at a study of an old window. Often the glass has a green shade that is the result of contamination in the raw materials.

Environmental aspects

The production of window glass has small negative environmental effects and the raw materials are all natural with good assets, the process of manufacturing is highly energy intensive though. The possibility of recycling glass is good and the service life is long, which is useful in works of restoration. The material is also easy to maintain without any use of hazardous agents. The weakness of window glass is its fragility. Wrong handling or strain due to surrounding materials easily results in breaking the glass. Despite of this window glass have great economical credits except for a relatively high initial cost.

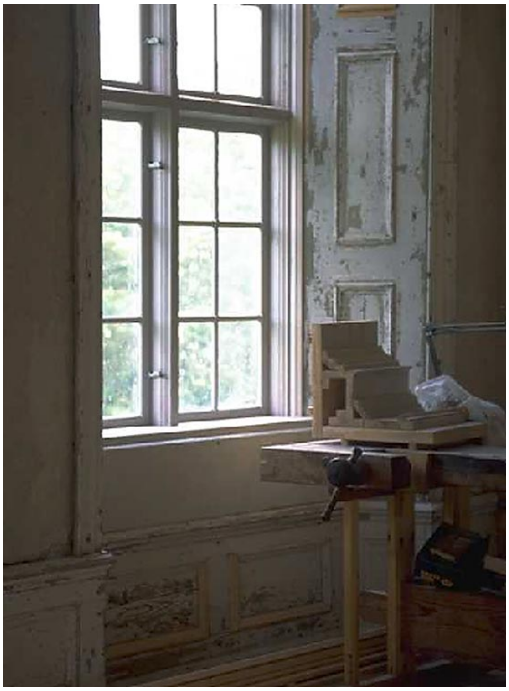
The situation today

The existing production of window glass around the Baltic Sea is, as mentioned, completely industrialised and of float glass-type. With this method the glass becomes very exact and without divergence in the surface. The old types of glass have a strong character, sometimes contain bubbles and are uneven in the surface. Together with the divergence in colour the old window glass has a completely different appearance than modern glass, which for these reasons is difficult to use in restoration works.

The need for traditionally manufactured window glass cannot be met by the production in the Baltic Sea region today. The small scale production that does exist in the region result in high prices and uneven assets. Instead old glass is recycled and new glass is imported from Central Europe, where drawn glass can be ordered for example in Germany and blown glass in France. The knowledge of crown- and cylinder glass manufacturing is also limited to only a few glassworks around the Baltic Sea, and that underlines the importance of supporting traditional window glass production both for building restoration as well as for keeping the knowledge of the methods.

Glass manufacturing is energy consuming but gives a product with a long service life. Together with good recycling possibilities window glass has few negative environmental effects.

Modern window glass has a prominent position in building construction today but the traditional techniques are severely neglected and the knowledge of manufacturing is highly limited in the region.



Reconstruction of 18th century windows with new cylinder glass imported from France. Mälsåker manor, Sweden. Photo Hans Sandström.

Estonia

Background

Window glass used in Estonia during the Middle Ages and the Early Modern period was imported from western Europe. The earliest known glass manufactory in Estonia was founded in the year 1628 at Hüti on the island of Hiiumaa (Dagö). The variety of glass products made in there included window glass as well. After almost forty productive years the manufacture was closed. From the end of the 18th century several glass manufactories were established which among the other products made also window glass. The year 1928 marks the beginning of using mechanical technology in mass production of widow glass.

Situation today

There are no enterprises in Estonia who produce hand made window class. It is possible to have it as a special order from the company Skankristall AS, which produces glass articles, but it is extremely expensive. The glass needed is imported.

Institutions

– Estonian Academy of Arts, Department of Glass Art

Literature

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Finland

Background

The use of window glass in residential buildings was not common in Finland until late 16th century. Mediaeval glass was imported mainly from Germany. The earliest dated fragments (around year 1300) are from the site of Koroinen church.

The first glassworks in Uusikaupunki, founded in 1681 by Gustaf Jung, had a short active period (1681–1685). More persistent glass production was started in mid-18th century (Åvik 1748).

Large glass panes (even 26" x 22") were preferred to a large number of small panes, and double windows were installed in order to keep buildings warmer.

Seven new glassworks were founded in Finland during the last decades of the 18th century (Mariedahl 1781,Tuorsniemi 1781, Olhava 1783, Inkere 1794, Nuutajärvi 1795, Liikola 1795 and Berga 1797).

Mechanical production was introduced for the first time in 1927 at Lahti glassworks.

The Fourcault machine production method was replaced with the Pittsburg method in 1969, and this in turn with the float method (Pilkington method) in 1986.

Situation today

Window glass for restoration is at the moment entirely imported. A long-term conservation project of the 17th century leaded windows of Askainen church is currently outlined by the National Board of Antiquities and the local parish.

Institutions

- The National Museum of Finland, Conservation Laboratory, Mannerheimintie 34, P.O.BOX 913, FIN-00101 Helsinki, Phone: +358 9 4050 9517, Fax: +358 9 4050 9500 E-mail: konservointi@nba.fi
- Suomen lasimuseo. The Finnish Glass Museum. Tehtaankatu 23, 11910 Riihimäki, Finland. Phone: +358-19-7417494, Fax: +358-19-7417555

Literature

In Finnish, English summary:

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- Liisa Seppänen: Is there evidence of Turku Cathedral's medieval glass paintings? Article in Aboa 2001 © Turku Provincial Museum. Turku 2002. ISBN 951-595-082-1

In Finnish:

- Kaila-Pietarila-Tomminen: Talo kautta aikojen, julkisivujen historiaa. © Rakentajain kustannus Oy. Helsinki 1987. ISBN 951-676-403-7
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Lithuania

Background

Glass crafts are mentioned in the Statute of Lithuania of 1529. In 1547 the first glass workshop was established in Vilnius.

Situation today

Nowadays engineers-technologists of glass manufacturing are qualified in Kaunas University of Technology. Glass is produced in two factories of Panevezys: "Panevezio stiklas" and highly quoted kinescope factory "Ekranas"; glass containers are manufactured in Kaunas factory "Aleksotas". There is a range of enterprises producing wooden windows in the country.

Institutions

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Literature

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Window from the 1880s with etched glass and casement with openable vent made of cast iron in the old National Archive, Sweden. Photo Rolf Helmers.

Norway

Background

”Norske Companiet” started in 1739 with exclusive rights to the natural assets in the country.

Nøstetangen glasswork 1714–1778
Aas-Jevnaker-Hadelands glasswork 1753/66 until today
Hurdal 1755–1895, taken over by Gjøvik 1805–1843
Biri 1765–1793
Jevne at Fåberg 1792–1832
Høvik 1855–1933
Drammen glasswork 1873 until today

The production has among other items included window glass, bottles, glasses, carafes, jars, candlesticks and pharmacy equipment.

Situation today

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Institutions
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Literature
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Poland

Background

The oldest glass membranes, used in the 14th century, had the form of rhombuses. In the middle of the 15th century small discs of crown glass were introduced. They remained in use until the end of the 18th century.

In the 16th and 17th century, membranes of hexagonal and octagonal panes were used. During the same period painted panes, so-called 'cabinet glass' became popular, usually with sacral or heraldic motifs. In the 17th century rectangular panes became dominating.

Along with the introduction of putty, around 1730 in Poland, wooden cross-window bars became frequently used.

In France Bernard Perrot introduced moulded and rolled glass in 1687. In Poland rolled glass manufacturing started in 1765.

Contemporary glass blowers that use the blown cylinder method are able to produce panes a size about 120x200 cm.

Situation today

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Institutions

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Sweden

Background

Glass for glazing was produced already in the 15th century in monasteries in Sweden. From the 18th century glazing was common in the towns and several glassworks were started. The peak for small manufacturers of glass was around 1890. Industrially produced glass took over from the 1920s.

Crown glass was produced and used until the middle of the 19th century. Production of blown cylinder glass went on until 1934 in one workshop. The last industries for drawn glass (Oxelösund and Emmaboda) were closed down in the 1970s.

Situation today

The only remaining producer of glass for glazing is Pilkington Floatglas AB in Halmstad. Production of float glass has been going on since 1976.

For restoration projects there are two alternatives: import from France or Germany and reuse of panes from demolished buildings. Blown glass is imported from France. Drawn glass is imported from Germany, where it is produced especially for restoration purposes.

Several distributors in Sweden take care of used glass. Sizes over 45x45 cm are rare.

The Rejmyre glassworks, 40 km north of Norrköping, have tried to start a new production of blown cylinder glass. Experiments are ongoing – the biggest problem seems to be the ”opening” of the cylinder on a flat surface.

Institutions

– Swedish Glass Museum, Box 102, 351 04 Vaxjö, Web page: www.smalandsmuseum.se

Literature

– Fönster – historik och råd vid fönsterrenovering, (History of windows – Manual of window renovation), RAÄ Rapport 1988:1, Stockholm 1988.

Historical background in the Baltic Sea region

Wood tar has been used as protection of ships and boats for several hundreds of years. It is known that tar was used in the Baltic Sea region during the Middle Ages, but the tradition is most likely older. As protection of buildings tar have been used on wooden roofs foremost, but it is presumed that the churches of the Middle Ages were protected like profane buildings later was protected with tar on the facades.

The manufacturing and export of wood tar had its breakthrough during the 16th century and became an important trade for the countries around the Baltic Sea during the 17th. Particularly Sweden (including Finland) exported in such extent that they reached a position of almost complete dominance on the market. Though, the biggest part of the production was orientated to the eastern half of the country (present Finland) that represented 2/3 of the production. With the extensive production of ships for warfare and expeditions during the 17th century the major buyers of tar was the naval nations around the Baltic Sea as well as England and Holland.

Sweden's great dominance in tar export was reduced during the 18th century when new countries came in to the market. It was mainly the British colonies in North America that started producing and exporting tar to Europe. Tar remained as an important trade in the Baltic Sea region until the beginning of the 20th century even though shipbuilding had gone from wood to steel but because the demand for wood products increased during the second half of the 19th century. With the new methods of manufacturing in the late 19th century and the increasing use of coal tar, the use of traditional pit tar decreased during the 20th century. Today the production and use only exist in a highly limited extent.

Traditional production

The methods of pit tar production has remained the same for a very long time, dry distillation by burning stumps in pits has been known at least since the Middle Ages. Tar from pinewood has been used for the protection of boats and buildings, but it is possible to extract tar from other species as well, for example birch used to impregnate leather.

The tar pit should be shallow with walls covered with shingle, birch-bark or lime stone on which the wood is placed radial leaning and aiming towards the centre of the pit. When the pile of wood is completed it will be spherical and from the centre the tar is led through a pipe to a cask. The pile is covered with turf and the wood is lit to smoulder for one or more days depending on the size of the pile. When the tar has been bottled in casks it is kept for some time for the polluting substances to come to the surface. With this method the wood is burnt up while later methods leaves it unburned. This is made in kilns in which the wood is "sweating" under high temperature without incineration. The method of kiln produced tar was developed during the late 19th century and became the dominating method during the early 20th century. Today's production of wood tar is mainly a by-product from industrial charcoal production.

The opinions on which kind of tar is the best are many as well as the opinions on the handling of the tar. A study of the opinions shows that the traditions are not quite the same around the Baltic Sea. As an example differ the recommendations concerning application of tar between Norway and Finland. The Norwegian recommendations say that the tar should be boiled before use while the Finnish recommendations say that it should not.

Environmental aspects

Wood tar has a complex chemical structure and will be slightly different from each occasion of production. Compared to coal tar it is not quite surveyed how harmful the different substances in wood tar are, and because of this wood tar is under supervision from the EU with a potential ban if it is found harmful. What is known is that wood tar should be used sparsely indoors and that it may contain allergenic substances.

Traditional production of pit tar is exclusively based on renewable materials and the tar has a long service life. The energy consumption is directly related to the quantity of tar that is produced, as the wood is both source and fuel. In the industrial production other fuels are used with varying environmental effects.

When new tar is used on a previously treated surface the old tar should remain, and wood that has been treated with wood tar can be burned in separate incineration facilities for energy recycling.

The situation today

Production of wood tar exists in a number of countries in the Baltic Sea region today, both industrially and traditionally. The industrially produced tar is a by-product in the production of charcoal. This tar is sold either as a pure tar or with anti-fungal agents, solvents or other additives. Though in a smaller scale the traditional manufacturing of wood tar covers a large part of the national needs in the region. In many of the countries it is prescribed that traditionally manufactured tar should be used when tarring wooden churches and roofs. Tar burning, both in pits and kilns, is carried out for example in Estonia, Finland, Norway, Poland and Sweden. It is also a popular attraction at summer festivals and in open-air museums. A wood tar project with Finland as leading part has been implemented with the aim to map the substances of the material and investigate their possible toxicity. Due to the uncertainty of toxic substances in wood tar it has come under supervision of the EU. A negative result of the investigations in the EU could lead to a complete ban of manufacturing and use of wood tar. A possible ban from the European Union is the biggest threat to a future use of wood tar.

The wooden church from 1643 on the island Ruhnu, Estonia, has always been entirely tarred. Photo Peeter Säre.

Estonia

Background

The data about the history of wood tar burning in Estonia is vague. It is not known exactly whether it was used during pre-historic era and when used then on how large scale, as the first information about tar dates from the Middle Ages when it was used in cog building. Plausibly tar use was more widespread and had already made its way to house building. During the centuries tar was used extensively from fisher boats to churches. On buildings it was mainly used on plank surfaces, which had to withstand the bad weather conditions. Frequently additives were used to improve certain qualities. The most common additive was linseed oil but in coastal regions seal fat was quite usual as well. The best example of such action is the seventeenth-century church on the island of Ruhnu (Runö), which is the oldest wooden church in Estonia.

More specific information about tar burning and using comes from the end of the 19th century when several small information guides were published. Until the middle of the 20th century wood tar burning and using was very common in Estonia. Even during the first decades of the Soviet occupation many collective farms had their own tar pits to produce wood tar for their need. Since the end of 1950s wood tar started to give way to the coal tar and soon the tradition of producing and using wood tar died out.

The renaissance of wood tar in Estonia began in the beginning of the 1990s when one farm in southeastern Estonia started to produce it. Soon a farm on Saaremaa (Ösel) followed their example. At the moment there are two farms in Estonia who burn wood tar.

Situation today

Since the revival of wood tar burning in the beginning of the 1990s tar has not regained its position as it used to be before the 1960s, except for conservation and restoration works as well as in boat building. The reason why wood tar is used primarily only in conservation of listed buildings and in tarring boats is the lack of wider knowledge and small number of wooden buildings needing such protection.

Institutions

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Literature

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Finland

Background

Wood tar was exported from Finland in small quantities already in the late 16th century. The increased shipbuilding in Europe created a wider market, and the production became a flourishing trade, which even had some strategic significance for the state. All the export was therefore submitted under the control of the Stockholm Tar Company. The military conflicts between Sweden and Russia in the 1720s disturbed the old tar production areas by the Saimaa and Päijänne lakes by cutting their connections to harbour towns. The Ostrobothnian area by the west coast now became the centre of production.

The forest resources of the Ostrobothnian district gradually decreased due to the timber-consuming nature of tar production. During the 19th century the tar-burning area gradually moved eastwards to the wildernesses of Kainuu province, which was to be the last major production district. A total amount of

50 000 barrels (6,5 million litres) of tar was brought annually to Oulu from Kainuu around 1900. Tar burning had a great influence on the cultural development of Ostrobothnia and Kainuu regions. The ”tar culture” included special forms of transportation especially on waterways and interaction between the merchants on the coast and the inland producers.

The international tar market was nevertheless already diminishing from the 1870s as tar was no longer needed for shipyards. At the same time new forms of forestry were taking over and sawing planks brought more profit with less labor. After World War I there was only a marginal amount of tar export left.

Tar burning survived throughout the 20thcentury, cherished by tradition enthusiasts and a couple of small-scale producers.

Situation today

Traditional tar burning has had a revival in the 1990s. In addition to domestic production (approximately 40 producers) there are about 30 professional small-scale tar-burners. Many summer festivals, especially in Kainuu region, have the burning of a tar pit as a main theme. The Kainuu Tar Project, started in 1997, has had a great influence on this revival and the beginning of an active heritage research.

There are several contractors specialised in repairing church roofs (and other traditional wooden constructions) that have the knowledge how to treat roofs with pit tar.

Institutions

– Esa Heikkinen, Osmonkatu 9, 87100 Kajaani, 08-6198 7215
– Panu Nykänen, Polyteekkarimuseo, Otaniemi, 09-4682126,
  E-mail: Panu.Nykanen@tky.hut.fi
– VTT, Technical Research Centre of Finland, Rakennus- ja yhdyskuntatekniikka,
  Puu- ja komposiittimateriaalit, fax 09-456 7027, Web page: www.vtt.fi

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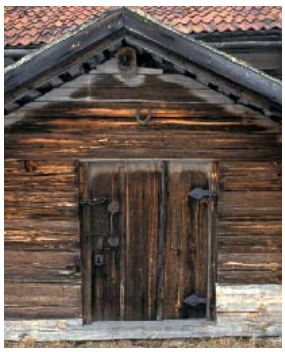
– Panu Kaila: Tar burning, article in *Monuments and Sites, Finland* (p.142). © The Finnish National Committee of ICOMOS. Helsinki 1999. ISBN 951-96602-4-0



Aged tarred gable with a clear patina. Ljusdal, Sweden. Photo Thomas Erenmalm

Norway

Background

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Situation today

About 20 persons, primarily older men, are involved in traditional production of wood tar in Norway today. "Fortidsminneforeningen" (The Society for the Preservation of Ancient Norwegian Monuments) distributes the tar mainly to the stave churches. The kiln production is documented by the use of the form "Information on tar production" that is filled out by the tar producers, and samples of the tar are controlled by NIKU (The Norwegian Institute for Cultural Heritage Research) prior to purchase by Fortidsminneforeningen. If distribution goes directly from the tar producer to the stave church the same requests for documentation and sample control applies. The private market can also buy tar when there are sufficient supplies.

Oppdal tjæreindustri A/S produces pine tar in retort, and sells pure tar products. The majority of the tar products on the market have additives such as solvents, drying oils, anti fungal agents, etc. This does not imply that these are poor products, only that they are inadequate for historic buildings.

Analysis and quality control is conducted by NIKU often in cooperation with the Chemical Institute at the University of Oslo.

Institutions

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Poland

Background

Already in the early Middle Ages the art of wood tar burning was known in Poland. An increase of the production took place in the 16th century and led to an expanding trade, mainly for boat and shipbuilding. A major part of the production was exported from harbours in Gdansk and Elblag. Tar production sites were, just as charcoal and potash, located in large forests near navigable rivers. The forests made sure about the raw material, rivers made it easy to transport the products. For example in Pomerania the big forest Tuchola's Woods delivered the products by horses and carts or by the rivers Wda or Brda (Vistula's confluents) to Gdansk.

Wood tar has been produced in Tuchola's Woods for a long time, confirmed by a survey of the land from 1565. Ten tar kilns were in use in the Swiecie district before the second Swedish war (1655–60), many of them leased by merchants from Gdansk.

Wood products such as tar, potash, birch tar and charcoal were of great importance next to grain as profitable export to West Europe from Gdansk.

Still in the 19th century tar was produced in the woods of Tuchola, and with tar workers from East Prussia kilns made of brick was introduced.

Along with the increasing use of coal tar during the last century the tradition of wood tar production has sunk into oblivion.

The use of wood tar has been verified. It has been used to protect wooden buildings, such as Pomeranian mansion and manor houses, to preserve carriages and to impregnate fishing net, but also in folk medicine.

Situation today

A minor quantity of wood tar is produced today in Bieszczady Mountains south-east of Poland. Production of wood tar as an example of former trades is demonstrated occasionally in some open-air museums (e.g. Tokarnia near Kielce and in Torun).

Institutions

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Sweden

Background

Tar for protection of wood and timber was exported from Sweden-Finland already during the 16th century. The shipyards used large quantities of tar and parts of the country were almost deforested. Before World War I more than 2,4 million kg of wood tar was exported each year and a majority of the tar was produced in small "valley" piles or stacks.

The quality of the tar is highly depending on the quality of wood. Stumps of pine-wood are the traditional, most economic and best raw material for building conservation purposes.

Situation today

Wood tar can be bought from several distributors. In the northern parts of Sweden it is still produced according to the traditional methods, mostly on small-scale family basis. There is also industrially made tar, in kilns, as a by-product in the production of charcoal.

The great quantities of wood tar are used for treatment of shingle roofs, which are common on churches and farm buildings. Specialised craftsmen, travelling around the country, are doing the job.

It is an open question whether the quality of traditionally produced tar differs from the industrially made.

Institutions/Producers/Distributors

- Claessons Trätjära, Järnmalmsgatan 5, 417 07 Göteborg (distributor of traditional pit tar). Web page: www.claessons.com
- Skogens Kol AB, Kilafors (producer of charcoal), Web page: www.skogens.net

Literature

- "Om träkolning" by Hilding Bergström and Gösta Wesslén, Stockholm 1922