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RELICS OF EXTREME LAND FRAGMENTATION IN BIAŁYSTOK

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RELIKTY SZACHOWNICY GRUNTOWEJ W BIAŁYMSTOKU

Abstract
Białystok, the capital of the Podlaskie region, N-E Poland, covers 102 km^2 and has *ca.* 293 000 inhabitants. In recent centuries the city has been incorporating its suburban villages. In effect, relics of village-like plot structures have been retained and immersed into the whole cadastral structure of the city. In the article, distribution of cadastral relics of extreme land fragmentation have been surveyed, based on two www GIS portals: http://gispodlasia.wrotapodlasia.pl and https://gisbialystok.pl. We extracted data about areas with extremely narrow and elongated plot structure, i.e. plots which are 1 to 20 m narrow while hundreds of meters long, sometimes of geometric proportions even as extreme as 1:600. About 50 areas with relics of extreme land fragmentation have been recognized, of which 15 areas seem to be essential for the city functional structure. Therefore, Białystok can be seen as an unique city in terms of its rural-derived structure with numerous remnants of extreme land frgmentation.

Streszczenie
Białystok to stolica województwa podlaskiego o zaludnieniu (w 2022 roku) 293.028 mieszkańców na obszarze 102 km^2. W przeszłości Białystok rósł, wchłaniając okoliczne wsie, czego pozostałością jest lokalnie zachowana specyficzna „wiejska" struktura podziałów gruntowych (katastralnych). Korzystając z internetowych portali udostępniających usługi informacji przestrzennej (w tym http://gispodlasia.wrotapodlasia.pl oraz https://gisbialystok.pl), rozpoznano jej relikty będące pozostałościami szachownicy gruntowej i przedstawiono w artykule ich lokalizację (rozkład przestrzenny) na obszarze miasta. Uwagę skupiono na obszarach pokrytych działkami geodezyjnymi węższymi niż 20 m, a długimi na kilkaset metrów, o proporcjach boków węższego do szerszego niekiedy sięgających nawet 1:600. Rozpoznano około 50 takich obszarów, z których 15 uznano za najbardziej istotne dla funkcjonowania miasta. Zatem Białystok wydaje się przestrzennym unikatem, wyróżniającym się obfitością reliktów szachownicy gruntowej.

Keywords: Białystok; land fragmentation; cadastral structure

Słowa kluczowe: Białystok; rozdrobnienie gruntów; szachownica gruntowa; struktura podziałów własnościowych

1. INTRODUCTION

The intermingling of overly fragmented plots of land belonging to different owners is known as "chequered lands"[1], with the word "chequered" in reference to a fragmented and mixed land structure having been in use sin-

[1] As early as the 19th century, a checkerboard (land) was defined by the dictionary as "a small piece of land, between similar pieces belonging to other owners: *We will exchange these chequerboards between us for others,* i.e. scattered here and there" [*Słownik…* 1861, p. 1612].

ce at least the 18th century[2]. The very phenomenon of excessive fragmentation and mixing of the land ownership structure as early as the 16th century[3] affected the landscape of the Polish lands, hampered the agricultural economy and indirectly generated multiple social effects.

In spite of In spite of land commassification, there are still quite a few remnants of the former land chequerboard in the eastern part of the country, although they are most often visible not in the landscape, but in the cadastral structure. Some relics of the land chequerboard are even preserved in urban areas. This article presents the issue of urban chequered land on the example of contemporary Bialystok: based on cadastral maps, its occurrence was determined, and then an attempt was made to make a preliminary diagnosis of the significance of chequered land on the city landscape and its influence on the development of Bialystok.

1.1. The concept of chequered land and its causes

Contemporary Polish authors of works on geography, agricultural economics and spatial planning define chequered land in various ways, usually taking as its distinguishing feature the fragmentation of land owned by one succession, often also the reduction of plots resulting from family divisions, their elongation (resulting from the accumulation of longitudinal divisions on the network of three-field divisions), and sometimes their mixing (cf. an outline of the issue in: [M. Dudzińska 2012]). Earlier authors included all of these distinctions together, and also mentioned (as an effect of the checkerboard or a manifestation of it) "the considerable remoteness of some of the fields from the house" [W. Kocent-Zieliński 1907, p. 3].

Land fragmentation was caused by inheritance divisions and ownership mixing by transactions such as sales, inheritance transfers, dowry transfers or donations. In addition, chequered plots around self-settled villages (such as noble hamlets) had a more chaotic structure and a faster increase in fragmentation than established ones, which was due to the spontaneity of settlement processes. Other reasons for the rapid fragmentation of the land structure were also pointed out, which were, however, more important in countries other than Poland [see: M. Dudzińska 2012, p. 48-49].

1.2. Chequered land as an agrarian and social problem

The chequered fragmentation of land was formerly seen as an impediment to rational farming (a view that has persisted to the present day), and as one of the factors, perhaps a key one, in holding back agrarian reform. In 1861 it was written: *"Forty parts (...) are enough for misfortune (...), and there are sometimes several hundred. (...) No progress (...) can take place in such a village. Crop rotation (...) [is] impossible, sowing in fallow fields is impossible, sowing of fodder crops is impossible. (...) The owner of the manor and his landowners have their hands tied and have to follow routine and custom (...) as to the time of sowing, harvesting and the type of seed. (...) Time is lost in moving from place to place in cultivation, and supervision is lost. (...) What I have said about chess in the field occurs [also] in meadows and woods, and in all of them disorder, damage and abuse"*. [J. Zawadzki 1861, p. 357].

In addition, land fragmentation remained an unresolved social problem for centuries, the subject of disputes between neighbors, court cases, cases in lower parliament and other legal forums (see footnote 2). Particularly troublesome was the fragmentation and mixing of the land ownership structure in the rural areas inhabited by small homestead nobility (for there it reached record proportions[4]) and in areas of mixed manorial, petty gentry and peasant ownership, where chequered land exacerbated old social problems and created new, so-

[2] Here, for example, among older documents there is information about the establishment in 1775 (probably by the Ordinary Seym of Warsaw) *„Commission for the exchange of chequers between the Kupis starosty (...) and the land estates Ponedel i Wysoki Dwór Wiłkomierz County"*. Two municipal judges were then sent from Troki and Wiłkomierz (today Ukmergė in the central-east Lithuania), *„who, having descended on the site, are to measure and inventory the chequered boards on both sides, (…) perpetually swap, (…) decree that the conversion be described and insured"* [*Volumina…* 1860, p. 425].

[3] In the 16th century, chequered land in the royal estates of the Grand Duchy of Lithuania (especially in the area of today's eastern Bialystok) was consolidated and re-measured within the agrarian reform „wołoczna pomiera". The principles of this reform were first set out in the Act *Korolewoje Jej Miłosti na wołoki w imieniach Jeje Miłosti w Wielikom Kniażstwie Litowskom...* of August 12, 1552, and subsequently extended in Act *na wołoki Hospodara Korola Jego Miłosti uwo wsiem Wielikom Kniażstwie Litowskom* of April 1, 1557. The amalgamations and reparcelling were mainly intended to raise income in the royal estates, nevertheless chequered land was perhaps the most important obstacle to this [see: Z. Ludkiewicz 1932, p. 36-37].

[4] The greatest fragmentation of land and its mixing was recorded in the hamlets of Łapy in Podlasie (corresponding to the present town of Łapy), and was described by Bohdan Zaborski [1926, p. 75]: *„In the village of Łapy Kołpaki, there is a farmer, one of many Łapińskis, who had his farm of several dozen hectares scattered over as many as 1,221 plots, not only in his village, but also in the other 11 other Łapy villages. In Łapy, farms consisting of 600-800 plots were common"*.

metimes unexpected ones[5]. Not surprisingly, the issues of land fragmentation and amalgamation in the context of broader agrarian reform (including the 'peasant question' a.k.a. the 'landlord question'), were being debated as early as the 19th century.

1.3. Terminological issues

In the former Polish geographical and agrarian economics literature, the issue of the land chequerboard was most often considered against the background of economic needs and methods of land consolidation, while landscape-visual aspects (shapes of plots, their visual role) were marginalised[6]. Besides, the very term "checkerboard", although well-established in Polish science, is misleading, because in our country there was a longitudinal (strip) fragmentation, which was a relic of earlier systems inherent in the three-field economy, subject to cyclical family divisions. Actual chequerboard in the geometric sense did not exist in our country.

Depending on the intensity of particular features of a chequerboard, its types were distinguished - e.g. Zdzisław Ludkiewicz [1932, p. 33-34] distinguished between "sprawled chequerboard" and "scattered chequerboard" (according to the morphology criterion), as well as between "internal chequerboard" and "external chequerboard" (the latter in the case of "confusion of land of a given village with manorial land, with land of neighbouring villages, etc."). Among the typologising terms, the following also appeared: "nuisance checkerboard", "malicious checkerboard", "harmful checkerboard", "high checkerboard" [W. Antoniak 1983, p. 10], "intricate checkerboard" [B. Zaborski 1926, p. 25].

In international literature, on the other hand, the English-language equivalent of the Polish term "szachownica gruntowa" is rarely used at all, usually only by Slavic authors and then in several variants, while non-Slavic authors describe chequered land with expressions indicating rather a fragmentation of plots or parcels of land (usually: „land fragmentation") rather than their chequered alternation. Interestingly, Russian-speaking authors used the word *cherezpolositsa* (*чересполосица*), indicating an alternation of elongated plots, as well as the words *dlinnopolosica* (*длиннополосица*) and *uzkopolosica* (*узкополосица*), indicating the elongation of very narrow plots of land, and occasionally the word *mnogopolosica* (*многополосица*), indicating the multiplication of plots of land.

1.4. Combating chequered land fragmentation

As already mentioned, the fragmentation and mixing of the land ownership structure assumed unprecedented proportions in areas inhabited by petty gentry, such as in western Podlasie, the Podlasie-Mazovia borderland and eastern and northern Mazovia. The greater the degree of fragmentation and mixing of the ownership structure of petty gentry or mixed land, the more difficult it was to attempt consolidation (which, after all, required the consent of all participants); in the Russian partition, however, by 1863 it was possible to consolidate and reparcel some peasant land on the occasion of the transition from serfdom to a rent economy [J. Rosłoniec 1928, p. 135]. In this way, 6704 villages and 1,638,235 hectares of land were consolidated and reparcelled there by 1863, while in the years 1863-1899 (after the enfranchisement of peasants) - 1,774 villages and 350,235 hectares of land [ibid., pp. 135-138]. The commassification and reparcelling of the land of the petty gentry, being more difficult, encountering resistance and impossible to carry out without social consensus, was spontaneously initiated by individual landowners, and by 1899 covered only a few dozen villages each in the former mławski, przasnyski and ciechanowski counties, and a few villages each in the szczuczyński and wysokomazowiecki counties; it did not develop in other

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[5] The nineteenth-century correspondent of the "Gazeta Rolnicza" and at the same time the owner of the Ryżki manor near Łuków, Józef Zawadzki, described the extent and various consequences of the fragmentation and mixing of manorial land (nevertheless less fragmented than the plots of homesteaded gentry), also pointing out effects such as in the following quote: *"The owner of a manor (...), when born in it, knows the location and boundaries of the chequers (...). (...) A new purchaser, on the other hand, often only has a few years to become familiar with them. (...) I give as an example the village of Radomyśl in the Siedlce district, in which the manor consists of a hundred and several dozen pieces, and there is only one servant (...) who knows their location"*. [J. Zawadzki 1861, p. 356-357]. Similar observations can also be found in Stanisław Rosłoniec's doctoral dissertation [1928, p. 142]: *"The average farm of a petty nobleman (...) lies in dozens, and sometimes a hundred and dozens and more plots very often scattered over the area of several villages; it happens that a nobleman does not know how to count his plots, that he cultivates someone else's field instead of his own, that he harvests from his neighbour's field and leaves it on his own"*.

[6] In this regard, the position of Władysław Biegajło [1957, p. 557], reducing the assessment of the visual-landscape aspects of land checkoffs in the then Bialystok Province to the economics of agricultural production: *"The chequered fields and the three-field system mean that farming does not take account of natural conditions (...) and therefore does not make adequate use of the existing conditions of the geographical environment. (...) The excessive fragmentation of fields results in a significant proportion of arable land (...) not participating in production during the year, (...) the strong dispersion of plots (...) results in a non-productive waste of time (...). The fragmentation of fields prevents the use of agricultural machinery"*.

areas populated by the descendants of small homestead gentry [see: M. Suchożebrski 1966].

It was not until the twentieth century that a breakthrough was achieved in terms of the social understanding of the economic necessity of the commutation and reparcelling of highly fragmented land, but at that time a new legal framework was already being created that favoured commutation and reparcelling actions even with the incomplete consent of the participants and regardless of whether the commutation concerned extremely fragmented formerly smallholder, peasant or mixed land. This legal framework was primarily comprised of the *Act of July, 31,1923 on land consolidation* (Dz. U. nr 92 z 1927, poz. 833 as subsequently amended), and then, after World War II, a Decree of the Council of Ministers of the Republic of Poland of 14 April 1948 *on adapting to the conditions created by the war the principles of the consolidation procedure provided for in the pre-war law* (Dz.U. 1948 nr 21 poz. 144) and the Decree of 16 August 1949 on land exchange (Dz. U. nr 48, poz. 367), and still later, the Act of 24 January 1968 *on land consolidation and exchange* (Dz. U. nr 3, poz. 13) and the Act of 26 March 1982 *on land consolidation and exchange* (Dz.U. 1982 nr 11 poz. 80). During their time in force, the majority of chequered areas were gradually consolidated, but nevertheless, at least in the eastern part of Poland, numerous areas of highly fragmented land still remained even after these actions of consolidation.

1.5. Chequerboard land as a scientific issue. Urban chequerboard

In the first half of the 20th century, land fragmentation became the subject of separate guidance studies [W. Kocent-Zieliński 1907], and soon also of scientific studies [Z. Ludkiewicz 1917], although a little earlier the term had already been used by historians of rural settlements (cf. an overview of the issue in: [B. Zaborski 1926, p. 11-16]). There were also studies published on land fragmentation in relation to selected areas, especially in north-eastern Poland [А. П. Эймонтъ 1909; S. Rosłoniec 1928]. This theme was continued in the second half of the 20th century by geographers: Wladyslaw Biegajlo [1957] described the struggle against land grading in the then Bialystok Province in historical terms up to the middle of the 20th century, while Wieslaw Antoniak [1983] in his doctoral dissertation described the course of land commassification in the same area in 1966-1975 and examined the impact of commassification on the state of agriculture.

On the other hand, the subject of the fragmentation of the urban land structure has not been addressed in depth in the past or in the more recent literature (other than one- or two-sentence mentions, as in e.g.: [Z. Ludkiewicz 1932, p. 34]), nor has the impact of urban land chequering on urban development been studied. And yet, the causal factors of the checkerboard, such as inheritance allotments, also existed in cities. Furthermore, the development of cities in the 19th and 20th centuries consisted, among other things, of their absorption of surrounding villages with their chequerboard land structure. Despite this, the town as an area of chequerboard land remains in scientific research a *terra incognita*.

Also in the study of the history of commassification and reparcelling (which, like the issue of checkerboard fragmentation as such, also remains within several disciplines and scientific specialities: settlement history, agricultural history, settlement geography, rural studies and rural planning, landscape architecture), the issue of combating checkerboard land in urban areas still remains a challenge.

1.6. Aims and methods

The directional aim of the article is therefore to address the issue of the urban land chequerboard and, in doing so, to identify the resulting scientific problems and suggest research needs.

It is not, however, the aim of this work to provide a comprehensive answer to questions about:

- the specificity of the causal factors of land fragmentation in former urban versus rural areas;
- the historical development of land fragmentation in individual towns;
- the impact of this land fragmentation on the development of historic towns;
- the impact of the remnants of the land chequerboard on the current structure of the cities as a whole (comparatively);
- the history of land consolidation activities within cities.

This is because these are broad issues, deserving separate studies, also requiring separate methodological approaches, literature reviews, etc. However, this article suggests the need to address them. On the other hand, complementing the directional objective outlined above is the intention to demonstrate the cultural relevance of the relics of the urban land chequerboard and, consequently, to justify the need for a discussion on the possibilities and needs for the protection of the relics of the land chequerboard.

The specific tasks include:

- finding cities with preserved land chequerboard relics in northeastern Poland;
- selecting a city for detailed research on the basis of the number of land chequerboard relics within

the city limits (Bialystok was selected after a reconnaissance survey);
- to investigate and describe the location of ground checkerboard relics in the selected city (Bialystok);
- to undertake a discussion of the possibilities and needs for protection of ground checkerboard relics in the selected city.

Methods of visual analysis of cadastral maps were used. Searching for cities with preserved remnants of the land chequerboard in northeastern Poland, cadastral maps from Geoportal (www.geoportal.gov.pl), and the Podlasie GIS web portal (http://gispodlasia.wrotapodlasia.pl/) were used.

The scope of the article has been limited to the size and shapes of parcels of land as features fixed in the cadastral structure and easily recognizable on GIS maps. Analysis of the ownership of parcels was omitted. Checkerboard relics were recognized as areas of strong elongation and density of plots (plots with widths of 1-20 meters and proportions of 1:50 or more elongated lengths were sought).

1.7. Research area

The preliminary research covered northeastern Poland as the region with the greatest former land fragmentation. Cadastral maps of towns in Podlaskie Voivodeship and adjacent parts of Mazowieckie and Warmian-Masurian Voivodeships, west of the Sokolow Podlaski - Zambrow - Elk line, and north of the Bug River were reviewed.

2. PRELIMINARY RESULTS

In the small towns of the study area, residual remnants of the land chequerboard were generally found, usually preserved along the river valleys cutting through the towns: most numerous and largest in Łapy along the Narew River valley, least numerous in Suwałki along the Black Hancza River valley, in Dąbrowa Białostocka and Drohiczyn, and absent altogether in Augustów, Gołdap, Olecko and Sejny. In Rajgród, chequered areas are few, located in the valley of the Jegrznia River, with some plots being unusually elongated and narrow: plot No. 923 (200404_4.0001.923) is 400 m long with a width varying from 1 to 2.5 m; there are also triangular plots in the shape of a very narrow wedge with dimensions of 427/427/3 m (nos. 936, 933, 929). In Goniadz, which lies on the Biebrza River, remnants of checkerboard land are more numerous along the small watercourse Czarna Struga, although examples of the narrowest checkerboard plots are preserved along the Biebrza: plots 130 and 249 (200801_4.0001.130 and 200801_4.0001.249) are 110 m long, but only a little over 1 m wide. In Ciechanowiec, there is also more fragmented land along a small tributary of the Nurt named Nitka than along the Nurt itself, but only a few plots are extremely elongated and narrow (plot 201302_4.0005.1361 is 148 m long with a width of just 2 m).

Not too many remnants of the land chequerboard are visible in the cadastral structure of cities and towns around Białystok (Choroszcz, Knyszyn, Czarna Białostocka, Wasilków, Supraśl, marginally in Gródek, Zabłudów and Sokolka). Sometimes, as in Mońki, the checkerboard structure remains only in the forest located within a given town. The situation is similar in Siemiatycze, but there the relics of the checkerboard remain in several parts of the town.

Slightly more remnants of the land chequerboard have been preserved by cities and towns in the western part of the study area, especially to the west and southwest of the aforementioned Lapy. Some of the plots have unusually elongated proportions: Wysokie Mazowieckie has plots within the municipal boundaries with a length of 744 m and a width of 3 m (no. 201301_1.0001.365, similarly 201301_1.0001.373) and with a length of 1283 m and a width of 5 m (no. 201301_1.0001.314). Sokolow Podlaski has preserved relics of the checkerboard throughout its structure, including some plots of land with exceptional elongation: plot no. 142901_1.0001.2009 measures 1.2x427 m, while in combination with its extension, i.e. plots 142901_1.0001.1992 and 142901_1.0001.1963 (of the same 1.2 m width), it is 695 m long. In turn, Łapy itself is literally surrounded by areas with a checkerboard of land, with land covered by a grid of extremely narrow and long plots preserved especially along the Narew River valley to the east of the built-up areas: some agricultural plots on the Narew River floodplain meadows have dimensions of 0.8x400 m (No. 200206_5.0009.1394) or 1.2x600 m (several plots), i.e., in the latter case, an area of about 0.07 ha with proportions like 1:500.

However, the greatest number of remnants of a checkerboard land structure have been found in Bialystok. Bialystok is unique in this regard, as the checkerboard land structure has been preserved in many places in almost all districts of the city, including near the central part of the city. Besides, Bialystok is the capital of the Podlaskie Voivodeship and the largest city in the region. (In 2022, the city had a population of 293,028 and an area of 102 square kilometers). In the eastern part of the country, only Bialystok and Lublin have more than 200,000 inhabitants, so - by way of comparison - the structure of Lublin's cadastral divisions was also examined (as an exception, since it lies

outside the study area adopted here), finding numerous relics of the checkerboard structure of land around the city with an almost complete lack of them within the main central part of Lublin. There are few exceptions: just over 2 meters long and almost a kilometer wide is plot no. 066301_1.0006.AR_3.24/10 measured together with its extensions 066301_1.0006.AR_3.24/9, 066301_1.0006.AR_3.24/8, 066301_1.0006.AR_3.24/20 and 066301_1.0006.AR_3.24/21 (parallel bordered by a similarly narrow and not much shorter plot 066301_1.0006.AR_3.25/16 with extensions (066301_1.0006.AR_3.25/15, 066301_1.0006.AR_3.25/14 and 066301_1.0006.AR_3.25/18). The above confirms the uniqueness of Bialystok (also in comparison with Lublin), as there is no other equally large city with such numerous and clear (in ownership divisions, but not necessarily in the visual landscape) remnants of extreme land fragmentation, where the narrowest plot is (as further described) only 20-30 cm wide with a length of several tens of meters, and many others are about a meter wide with a simultaneous length of several hundred meters (even over 700 meters).

2.1. Location of the relics of the land chequerboard in Bialystok

In the area of Bialystok within its administrative boundaries of 2021, there remain about 50 relics of the former land checkerboard, understood as areas where divisions of registered plots reveal the existence of many extremely elongated and narrow plots, with a width of 1-20 meters and proportions of the shorter to the longer side as 1:50 or more elongated (in extreme cases as 1:600). Of these areas, about 15 are large enough (some consist of several hundred elongated evidentiary plots) to affect the functioning of the city; these occur mainly in the western, northwestern and eastern parts of the city.

Fig. 1 shows the location of checkerboard land relics on a map of Bialystok. Fifteen main locations of checkerboard relics are marked, while a total of about 50 locations within the administrative boundaries of the city have been identified. The closest to the central part of the city (which is actually free of ground checkerboard) relics of the checkerboard are in the vicinity of Ks. M. Sopoćki Street (No. 4 in Fig. 1), Gen. W. Anders Street (No. 11) and Piastowska Street (No. 14). Closest to the historic center - about a kilometer to the southeast - are the extensive checkerboard areas on Piastowska Street.

Analyzing the occurrence of land chequerboard relics against the background of administrative division, the following areas abounding in chequerboard remains can be identified:

A. Several areas in the Skorupy settlement and the eastern part of the Wygoda settlement.
B. Several extensive areas in the northern and central parts of the Zawady settlement.
C. Several areas in the Lesna Dolina settlement.
D. Several areas at the junction of the Jaroszówka and Białostoczek settlements.

2.2. Sizes and shapes of plots of land chequerboard in Bialystok

The recognized very narrow plots were divided into the following groups: (a) plots up to 50 cm (sic!) wide; (b) plots 51-100 cm wide; (c) plots 101-300 cm wide; (d) plots 3-10 m wide; (e) plots 10-20 m wide.

The first categorization group is questionable: few plots have, for example, one end with a width of less than 50 cm, measurable within the limits of error, and only in the case of a few plots the measurement with the maximum accuracy available from the GIS service in the above-mentioned portals confirmed a width of no more than half a meter: for example, a variable width of 22 to 36 cm (sic!) and a cadastral area of 0.0051 hectares has plot number 2049/3 of the Starosielce P precinct, sheet number 25. This group was considered irrelevant for further consideration of the impact of land fragmentation on the structure and functioning of the city, but worthy of note as a curiosity. The second group, i.e. plots with a width of half to one meter, includes several cases, e.g. plot No. 372 within Pieczurki at 42 Pułku Piechoty Street with a cadastral area of 0.0378 ha., which according to publicly available measurement data, has a width of 0.9 m.

The third group is already very well represented, e.g. plot No. 228 of the Bialostoczek Pen. concession. has a variable width of 1.3 to 1.9 meters with a length of more than 710 meters; neighboring parcel No. 229 has a fixed width of 1.33 meters and a length of 701 meters; parcels No. 234 and 235 of the Starosielce Psn. precinct, sheet No. 7, have dimensions of (1.2 to 1.3m) x 540 meters, and so on. Adjacent plots of land No. 176/132, 176/130, 176/128, 176/126, 176/124, 176/146, 176/144 and 176/142 of the Białostoczek Psd. area. (Sheet 3), that is, a total of eight contiguous parcels, have a total width of 13.6 meters, which gives an average width of each parcel of land 1.7 meters and in the case of the Białostoczek P/n. concession. (sheet 6) an average width of no more than three meters was measured for as many as 26 adjacent narrow plots (plots 228 to 254).

The third and fourth groups also occur within compact areas of checkerboard land, often intermingled with narrower plots of land.

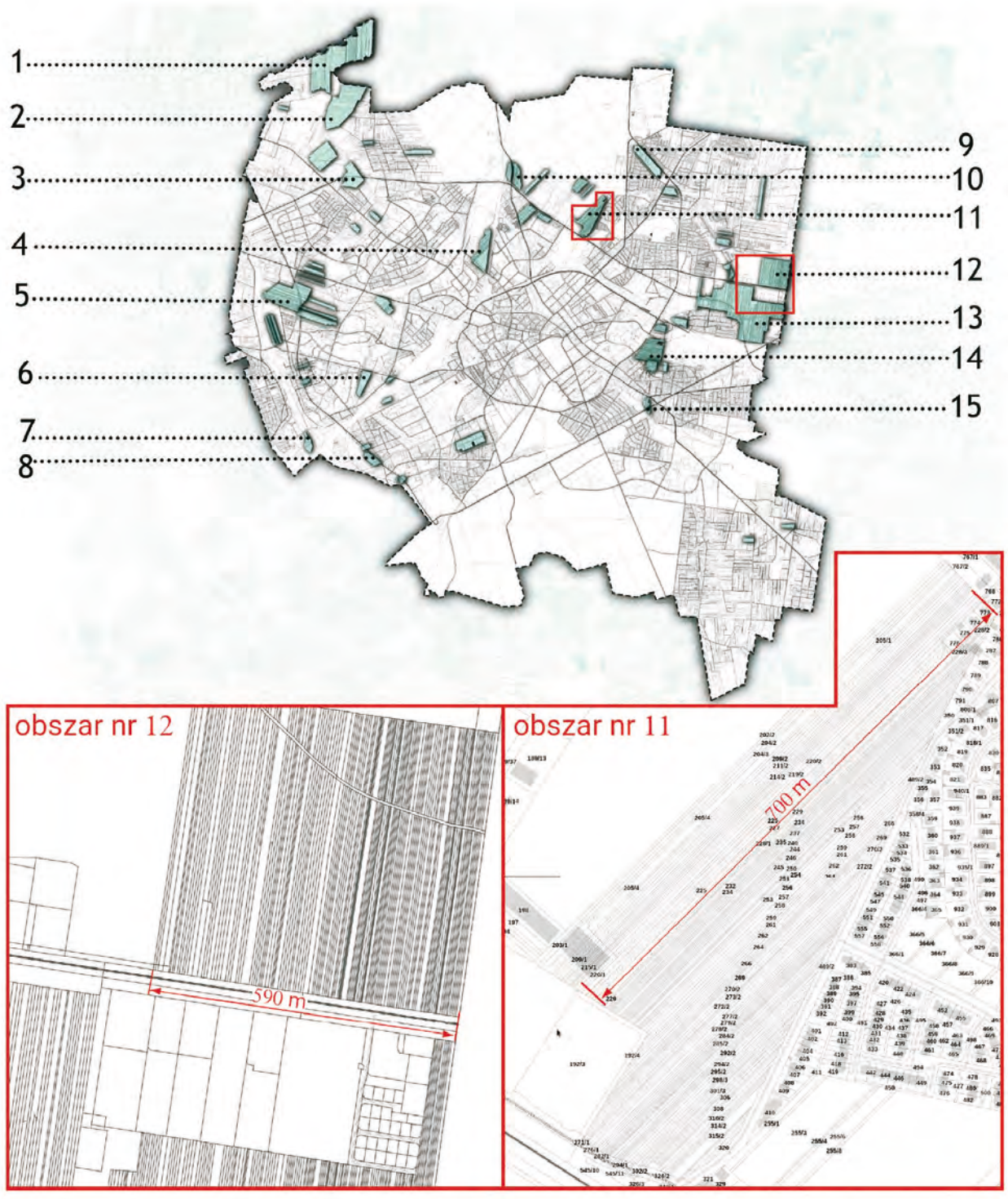

Fig. 1. Relics of extreme land fragmentation in Białystok (enlarged exemplary areas 11 and 12); source: http://bialystok.geoportal2.pl, the authors

2.3. Functions of the areas covered by the land chequerboard

Fig. 2 shows the current functional use of land checkerboard relics in Bialystok. Most of these areas are natural areas: former meadows that are now wastelands (they are often post-agricultural wastelands, as in the case of area No. 14 on Piastowska Street) or currently function as riverside meadows (areas in the Zawady estate on the northwestern outskirts of Bialystok, adjacent to the Supraśl River), or even forests (area No. 5 on the Leśna Dolina estate).

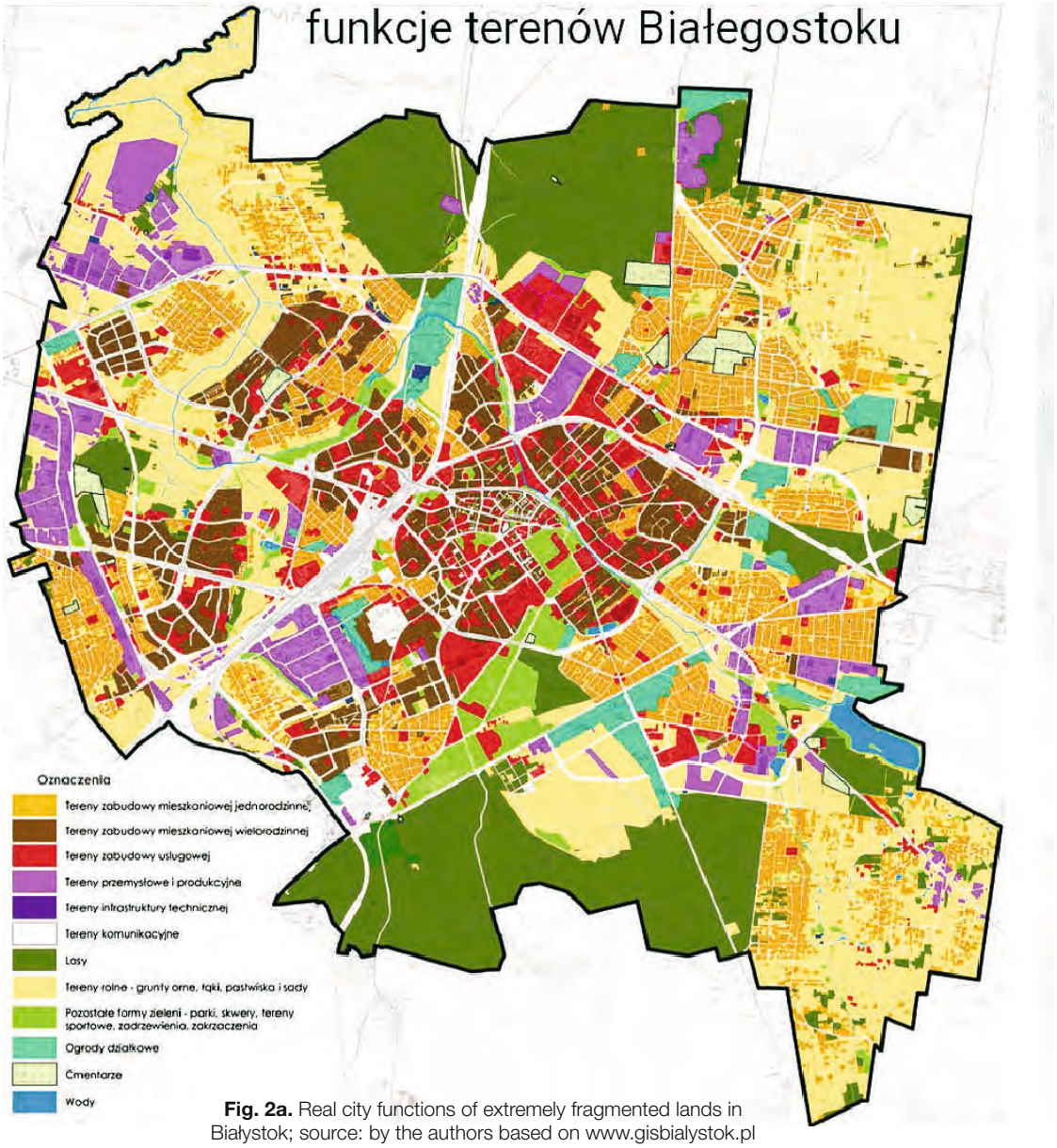

Fig. 2a. Real city functions of extremely fragmented lands in Białystok; source: by the authors based on www.gisbialystok.pl

Some of the areas covered by the land check are barriers to the city's development, acting as obstacles to investment. However, in some cases, buy-outs or expropriations have allowed investment use of such land (e.g. for multifamily housing).

3. INTERPRETATION AND DISCUSSION

If we look at the land chequerboard and its relics not from the old geographic-economic perspective, nor from the perspective of agrarian economics, but taking into account its multifaceted nature, i.e. also as a product of culture, an element of the landscape, a souvenir of the past, depending on the approach, the perception of this phenomenon changes to a positive one. Bialystok's elongated and very narrow land parcels, which are relics of the fragmentation of fields, and formerly absorbed by the growing city along with suburban villages, deserve a discussion about their cultural significance, perhaps even about the need and possibilities for their protection.

3.1. Bialystok's land chequerboard as a testimony to the rural past of the city's districts

Bialystok has a peculiar agglutinative spatial structure, for it received its modern shape as a result

Fig. 2b. Real city functions of extremely fragmented lands in Białystok; source: http://bialystok.geoportal2.pl, the authors

of the addition of numerous small villages. As a former private city and the residence of the Branicki family, Bialystok has grown over the centuries, absorbing neighboring villages, so that its current structure reflects the rural past of its neighborhoods. The annexations occurred successively in 1749, 1845 (parts of the villages of Białostoczek, Bojary and Piaski were annexed), 1877 (the remaining part of the village of Piaski was annexed), 1919 (the villages of Antoniuk, Białostoczek, Dojlidy, Dziesięciny, Marczuk were annexed, Ogrodniczki, Pieczurki, Skorupy, Starosielce, Słoboda, Wygoda, Wysoki Stoczek and Zacisze), 1954 (annexed were the villages of Bacieczki, Bacieczki-Kolonia, Korycin and parts of the land of the villages of Fasty, Ignatki, Klepacze, Krupniki, Zaścianki and Zawady), 1973 (among others the village of Bagnówka was annexed), 1980-1981, 2002 (the village of Zawady was annexed) and 2006 (Dojlidy Górne, Dojlidy Kolonia, Kolonia Halickie and Zagórki were annexed). Most of today's districts of Bialystok retained their characteristic structure even after incorporation into the city. In particular, in 1919 the villages were annexed without urban integration with the city, without changing their structure, without preparation - only to increase the percentage of Polish population within the city's administrative boundaries under the banner of the concept of creating a "Greater

Bialystok", and reduce the percentage of its Jewish population, which was then dominant[7]. Thus, villages with typically checkerboard layouts of accompanying fields and gardens, as well as fragmented structures of habitat plots, were incorporated into the city without change.

Relics of Bialystok's rural past are also fairly dense land divisions that are not remnants of the fragmentation of former farmland, but are left over from the structure of rural homesteads. They are visible in many neighborhoods in areas still built up with old single-family houses (and even barns in some places) – e.g., in Skorupy, Pieczurki, along English Street (until 2020), along Starosielce Street and others. In these areas, the fragmentation of plots is evident in the streetscape (narrow built-up plots are added to the streets) and the street-side width of the plots, rather than in their area, as the plots are generally not small. Smaller plots were found in the former Jewish neighborhoods of Chanajki and Shulchojt, but there the structure was almost completely rebuilt. Only here and there in the downtown area are relics of the former fragmentation preserved – e.g., plot number 1258/13 of the downtown area (on J. Pilsudski Avenue at the extension of Przejazd Street) has dimensions of 2x24 m; triangular plot 1258/5 has a length and width of about 5 m and an area of 14 m^2, etc. Fragmentation was also observed in the small-scale forms of old buildings, where in the past various extensions, sheds, porches and sheds were simply added sequentially.

3.2. Ground checkerboard as a visual component of the landscape of Bialystok

In none of the checkerboard-covered post-agricultural areas (former fields and meadows) is cadastral fragmentation any longer visible in the landscape, but exists only in the formal structure of the geodetic divisions, so it remains an administrative-geodetic abstraction.

On the other hand, cadastral divisions left over from the rural homestead structure are still visible in some areas built up with old houses with accompanying post-agricultural buildings. Locally they are very legible in the city landscape, easily discernible in the landscape of many city streets (e.g. Starosielce Street, Mohylowska Street, Nowowarszawska Street, Zaściańska Street, Pieczurki Street, Zawady Street).

A relic of the past and a scenic rarity is also the chequered structure of the plots and the remnants of the old buildings in the areas once inhabited by the Jewish poor - but not only in the former Jewish districts of Chanajki and Shulchojt, for Jews made up more than 70 per cent of the city's population at the turn of the 20th century and lived in all the districts of Bialystok. According to W. Wróbel [1989, p. 186] - at the beginning of the 20th century in Bialystok "there were several dozen synagogues, several yeshivot and synagogues" and often the buildings were densest around them. The peculiar structure and aesthetics of the narrow plots and old houses, sheds and extensions are disappearing today, but in many places they are still discernible and are also sometimes a topic of discussion among urban planners and architects: "Whole parts and quarters of the historic centre have disappeared, but many fragments of the pre-war urban fabric have survived in the structure of the entire inner city. (...) This fragmentary heritage, resembling pieces from a broken vessel, is still a difficult issue for urban planners today. A new urban layout has been created on top of the old one, still with elements of the old one, today already puzzling to the uninformed viewer of urban space." [M. Chodorowski, 201, p. 14].

3.3. Bialystok's land chequerboard as a rarity

Regarding the cultural value of the Bialystok land chequer relics, the elongation of the plots seems to be important. As already mentioned, a plot about 20 cm wide and at least a few plots 1.3 m wide with a length of more than 700 m were found in Bialystok, thus with proportions such as 1:500 and larger. Few relics of a land chequerboard with plots with proportions of shorter to longer side such as 1:500 and larger can still be found in the south-western part of the study area, especially in the western part of the Białystok district and in the Wysokie Mazowieckie district. The city of Bialystok with equally elongated plots is unique in that it has no similar counterpart. For although plots with proportions such as 1:500 and larger have been found in three cities: Białystok, Łapy and Sokołów Podlaski, only Białystok has them, as it were, built into its structure (in Łapy and Sokołów Podlaski the land chequerboard is located peripherally to urban development; moreover, these cities are small and have 15,283 and 19,231 inhabitants respectively as of 2021).

[7] In 1808, Jews made up 60% of Bialystok's population, while in 1895 - 76% (of the 62,996 residents of Bialystok, 47,783 were Jewish) [P. Wróbel 1989, p. 167]. Some (such as the portal *Wirtualny Sztetl (*https://sztetl.org.pl) even cite that over 82% of Bialystok's population was Jewish in the late nineteenth and early twentieth centuries (1895 and 1911), although this is disputed.

3.4. Conservation prospects

As mentioned, it is worth having a discussion about the needs and possibilities of protecting the relics of the land chequerboard, particularly in Bialystok. Most of these relics are actually unmanaged green areas, formally listed as wastelands and forests. This state of affairs suggests the possibility of leaving them as elements of urban greenery, with possible use as walking or allotment areas. However, in order for areas of chequered land to become actual evidence of former chequered fragmentation, visible in the visual landscape of the city, the visual markers of chequered fragmentation need to be restored. In the past, these were baulks, or unploughed ridges of farmland. The question of what will become of the contemporary visual traces of these dense chequered subdivisions is left open.

Architectural and urban planning literature includes descriptions of the use of landscape relics as 'identifying features of new areas' of urbanity. For example Lucyna Nyka [2012, p. 52] writes: "The drive to bring out the identifying features of new areas that result from the co-option of natural conditions is evident in Dutch cities such as Ypenburg, Dordrecht, Alkmaar or Hoogeveen, where suburban residential districts shaped on polders deliberately flooded with water are being developed. Natural ecological sequences in the form of green areas, waterways or topographical formations are used in strategies to merge new areas with existing ones. (...) Landscape is beginning to play the role of a glue connecting disconnected fragments of the city, allowing them to be perceived and composed as a whole".

CONCLUSIONS

The occurrence of the land chequerboard in Bialystok appears to be unique, perhaps even on a global scale. Formerly seen as a spatial problem, it deserves to be re-evaluated and assessed in terms of a memento of the past. Nowadays, relics of the checkerboard are only visible on cadastral layers on GIS maps, while the visual urban landscape completely masks the cadastral fragmentation and the density of divisions, as most areas of the checkerboard land are wastelands, some are forests and some have been bought up or taken over for major construction projects. So are not at least some of its urban relics worth preserving and protecting? Answering this question is beyond the scope of this article, but the question itself seems legitimate. Certainly a description of this phenomenon should find its place in the planning documents being developed, such as the city development strategy, the study of conditions and directions for spatial development, local development plans or the landscape study of the area with panoramic views, in agreement with the Provincial Conservator of Monuments.

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FOLK SCULPTOR WŁODZIMIERZ NAUMIUK – AS A CARPENTER

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LUDOWY RZEŹBIARZ WŁODZIMIERZ NAUMIUK JAKO CIEŚLA

Abstract
Włodzimierz Naumiuk is a recognized folk woodcarver and sculptor from Kaniuki, Podlaskie voivodeship, N-E Poland. He was "discovered" in the 1960s and invited for art exhibitions, and his sculptures were subjects of press notes, newspaper articles and also research works, including, among others, an extended paper by Jacek Wołowski, published in 1985 in "Polska Sztuka Ludowa". In this paper, some hitherto unknown aspects of Naumiuk's technical proficiency related to woodworking and carpentry are presented, with focus on his vernacular carpentry skills and knowledge. The objective of this work is to bridge the gap between Naumiuk's art and carpentry skills and knowledge, in order to place his art in a wider technology context. This work is based on personal interviews with Włodzimierz Naumiuk, on 05.04.2021, 03.09.2022 and 01.11.2022.

Streszczenie
Włodzimierz Naumiuk to ludowy rzeźbiarz i snycerz ze wsi Kaniuki w województwie podlaskim. „Odkryty" został w latach sześćdziesiątych XX w., później był zapraszany na wystawy, a jego rzeźby opisywano nie tylko w prasie regionalnej, ale też w piśmiennictwie naukowym, począwszy od poświęconego mu obszernego artykułu na łamach „Polskiej Sztuki Ludowej" z 1985 r., autorstwa Jacka Wołowskiego. W niniejszym artykule zaprezentowano wybrane aspekty warsztatowe pomijane w dotychczasowych opracowaniach poświęconych twórczości Włodzimierza Naumiuka, mianowicie jego warsztat ciesielski (znajomość tradycyjnej ciesiołki, jako że Naumiuk pracował też jako cieśla). Poznanie i opis aspektów ciesielsko-warsztatowych służyć ma lepszemu osadzeniu twórczości Włodzimierza Naumiuka w szerszym kontekście wiejskiego rzemiosła. Merytoryczną podstawą prezentowanych tu rozważań były wywiady z Włodzimierzem Naumiukiem, przeprowadzone w dniach 05.04.2021r., 03.09.2022r. i 01.11.2022r.

Keywords: Włodzimierz Naumiuk; vernacular carpentry; Podlasie

Słowa kluczowe: Włodzimierz Naumiuk; ciesielstwo ludowe; Podlasie

INTRODUCTION

Włodzimierz Naumiuk is a folk wood carver who lives in the Narew River Podlasie village of Kaniuki in the Zabłudów suburb of Białystok. In his work since the 1960s, he has been supported by ethnographers and folk art enthusiasts and invited to exhibitions, starting with a folk art exhibition in 1971 at Warsaw's "The House of The Peasant", where an exhibition of Włodzimierz Naumiuk's sculptures was shown against the backdrop of Bialystok's industrial landscape – and most recently his work was part of the EXPO 2020 World Exhibition in Dubai (which actually took place in 2021). In 2005, Włodzimierz Naumiuk was honoured with the Oskar Kolberg Award and the Gloria Artis Bronze Medal for Merit to Culture. His silhouette and works have been

described in scientific publications [J. Wołowski 1985; A. Naumiuk-Jakuc 2019] and many times in regional journalism.

The last half-century of Włodzimierz Naumiuk's sculptural oeuvre, crowned by the above-mentioned achievements, was preceded by a period when this artist, born in 1935, worked as a village carpenter (i.e. up to and including the 1960s). This fact alone is already worth noting, because the older generation of village carpenters knew the old (traditional, folk) woodworking techniques and the associated local customs. The experience and knowledge of such people is therefore worth commemorating, precisely because it includes knowledge of past traditions and customs of vernacular carpentry - which is, of course, cognitively valuable when such customs and technologies have not yet been known to science (in such a case, information obtained from folk carpenters representing the oldest generation has the value of cognitive novelty), but such information is also valuable even when it confirms the knowledge of folk woodworking techniques and related customs and traditions known in ethnography.

Aware of this state of affairs, a series of interviews were conducted with Włodzimierz Naumiuk in 2021 and 2022, asking the folk artist about his carpentry experience and relevant technological knowledge. The results were compiled in 2022 and are presented in this article. The interviews and the compilation of the results are a continuation of similar research from 2018-2019, which at that time resulted in an article on the role of Włodzimierz Naumiuk in the development of wooden architectural decoration of rural houses in villages located in the Upper Narew Valley [A. Naumiuk-Jakuc, 2019][1].

1. TRAINING IN CARPENTRY

"A professional begets a professional" - this statement, which W. Naumiuk quotes at the beginning of his stories, lies at the heart of the understanding of the carpentry profession. In the 1950s, when Wlodzimierz Naumiuk began his apprenticeship in this profession, both the local community and the working foremen paid special attention to the proper - professional - execution of commissioned work. As Naumiuk recalls, times were difficult, after the war the country was rebuilding, people often had problems obtaining material for construction - it took up to a dozen years: *"Those who were rich and had their own forest could buy wood immediately, but the poor collected it for years".* Consequently, people who were untrained or unsuited to the job were not allowed to work *(" ... but if you couldn't do it, if you didn't have the talent, what are you going to do with it ...").* The apprenticeship began by becoming an apprentice - an adept of a chosen master carpenter: *"The old carpenters would take apprentices - adepts - and their knowledge would be passed on at the construction site".* He started his apprenticeship at the age of 16, in winter, when carpentry was usually done, and he learned this at the beginning. He started working on site at the age of 18 (in the 1950s). At the very beginning, he *"planked the beam for the house"* - *"You had to plank the beam on two sides. You had to be able to wield the tool well. The carpenter paid a few pennies for his trousers, because they got very worn out during this work. That was my apprenticeship".*

The spectrum of basic and absolutely necessary carpentry skills had to involve a number of factors, including personal predispositions, i.e. precision, meticulousness, motor skills and physical fitness. Learning the carpentry tools and becoming proficient in their use was at the core of the apprenticeship. Each young apprentice had to be able to wield an axe well, sharpen it, position it well and make a good "hatchet" so that it would fit the owner's hand. The following were taught: cutting longitudinally, cutting material in half and even working with dykes. The youngest adept was entrusted with drilling holes with an auger. As Naumiuk points out, this was not hard work, depending not so much on the auger itself as on the skill of the doer. At the heart of the teaching was just the explanation, about the fact that the bores had to be made evenly. When making recesses, a line was drawn from the spirit level at the very beginning, which the student then stood on with the auger between his legs and spun it. At the beginning, it was checked how the novice was doing and comments were given: *"Well, maybe still the foreman: "right, left!"*, but he would not always stand by him - at first. And the poor young man was always reprimanded - he never drilled the hole straight, the master always grumbled that he had to quit. The hole drilled had to be straight. You set the tebel [a type of dowel], if the hole is crooked, then the tebel is also crooked later. With the second one, you scoop it and what - the beam gets knocked in. It was a very important thing.

[1] I concluded then, among other things: *"The numerous anecdotes not included here, recounted by Włodzimierz Naumiuk, and concerning (...) [among other things, the influence of social factors], indicate the need for further research into social needs as stimulators of artistic creativity and as a force indirectly shaping the unique landscape of the region's countryside."* [A. Naumiuk-Jakuc, 2019, p. 38]. In the present work, therefore, I return to the material omitted at the time, enriched by new oral information.

Fig. 1. The house built in 1960's by Wlodzimierz Naumiuk, Ryboly village; photo by the author, 2023

Fig. 2. The house built in 1960's by Wlodzimierz Naumiuk, Wojszki village; photo by the author, 2023

The making of the knots was done by the head foreman. These were the most visible parts of the buildings, whose bad binding was visible to the naked eye. For this reason, only journeymen who had been working for at least a year were taught to make them. An apprentice who had been studying for a year could only make the front (street-facing) coals under the supervision of the foreman. The second coal at the back of the building was made, under the supervision of an assigned worker (and sometimes also a foreman).

The carpenters had to be very physically fit. They walked around the dikes barefoot *("Like in a circus"*), fast and with various materials in their hands: *"The youngsters were almost like monkeys walking around, because it always feels, oh a beam like that, run over that beam and a hammer in your hands..."*. Sometimes ladders and scaffolding were also erected next to the building, but nevertheless it was necessary to be able to move smoothly on the walls. When asked why they worked barefoot, W. Naumiuk replies: *"Shoes, with shoes, what kind of shoes were there - rubber ones, it gets steamy, it's better barefoot, lighter. And they worked in shoes, why not, but it was not advisable. If someone could work in shoes, then in shoes (...)but it was not advisable and it was not observed, everyone as they wanted, but everyone knew that it was better like that [barefoot]."*

The work was usually completed after the roof was done and the gables were clad. Depending on the possibilities of the farmer, a house without windows and doors stood for a winter, sometimes a year or a year and a half: *"The doors and windows were boarded up and people didn't worry about anything happening. Then you still had to do the floor, the ceiling, sometimes you waited another year, sometimes people lived without a floor"*. Usually floors were done in the same house, but this was not the rule - *"sometimes it was other foremen, if we didn't have time. Sometimes the foreman would leave the young apprentices - do the floors, and us older ones, we would put up a new house"*.

2. CARPENTRY TOOLS AND OTHER TECHNICAL ASPECTS

During the interviews, the following information was obtained regarding the carpentry tools used by Włodzimierz Naumiuk and related to other technical aspects:

- Measures – „arszyny" (arshins)[2], folded into 4 parts, on which they measured in inches. In the words of Włodzimierz Naumiuk, the arszyn which he used was probably 73 cm long: *"In the beginning I didn't have a metre, only an arshin still. A folded beautiful arshin, the foreman always kept in sight for the girls to love, when he was young. Szeleszko* [neighbour] *carried a pencil behind his ear when he was about to get married - oh, what a fad it was, a man wanted to show off that he was worth something".* Naumiuk received an arshin when he started working on the construction site: *"I got the broken one, I don't know how much it served anyone else"*. When there were no measures, a strip was cut and the divisions were copied from others. Naumiuk recalls that in the first years after the war, tape measures did exist, but they were expensive, available only in the city, which was not easy to get to: *"There were no coaches, you had to walk to Bielsk, to Bialystok you would walk, basket, fish on your back - he went …".*
- Crosscut saw: W. Naumiuk recalls that when he started work, saws could not yet be bought. Therefore, old ones were sought and borrowed or bought back. The acquired saw was sharpened: *"The teeth were sharpened cool, someone there might not know how to sharpen, they might have messed up that saw, then you had to sharpen it, sit at that saw and the tinker's saw couldn't be picked up by anyone but the tinker.".*
- Axe: one of the most important tools of carpenters. It was either bought from the market or made by the local blacksmith: *„Łukow there was one, here was a blacksmith, he stayed after the war, a good blacksmith, here in the village. He would make an axe out of springs - a spring from a car or a train, but not every spring was suitable and the axe blade was made out of that spring, and there the shoe could be made out of something and he would weld it together, the handle had to be made exactly to his hand. Everyone was already fitting it to their own hand and everyone had an axe.".* The axe was sharpened on a "tochak" and a "toczydlo" made of sandstone (using water), which the foreman had to have. When the axe was slightly dull, files were used to sharpen it. The axe was also not given to anyone, it was highly respected and everyone had to have their own. W. Naumiuk said: *"And no axe either (...) some villager who doesn't know it will come and start chopping a tree on a stone, so what?*

[2] Arszyn – a former Russian unit of length, being the sum of the length of the cubit and the foot, varying between 71,11 – 81,5 cm.

Once on a tree, the second time on a stone. If someone doesn't know what an axe is and how to use it, (they say) - don't take the axe there, put it back, because you'll break it (...) Simple people don't know what it is, and you could shave with an axe, if they didn't have razors, they shaved with axes"[3].

- Hammer: this was used primarily for driving tees. Hammers of various weights were used: 8 kg, 10 kg, 12 kg (with the foreman where Włodzimierz Naumiuk worked, a 12 kg hammer was used). The hammer was of iron with a wooden handle. They were bought or rented from the blacksmith's.
- Teble (tibble, dowel): wooden "nails", made from the waste left over from cutting the dykes, from the same material from which the walls were erected, but *"...it was always looked at so that it would be healthier, so that it would have more resin in it, so that it would attract the wood better to itself, because it had to be tight".* Their ends were sharpened and the width had to correspond to the holes drilled: *"They were made with 4 angles, and then with 6 angles, because a round one doesn't pull the top dagger like that, it doesn't just pull it like that, and there had to be this 6-angled tebel, because that way it would be slippery and it would stand up, and that way you nail it with a hammer and it has to"*. The length of the tebels depended on the quality of the dowels, and ranged between 15 and 20 cm: *"Because it's from the bottom that one drills and from the top two beams after all".* The dowels had to be hammered in alignment, otherwise the dowels could stand out where the knots were tied, which had to be done precisely and tightly.
- Szlaga: a type of wooden hammer that was found on every construction site; made of hard wood, preferably oak, although pine slags were also used when no other was available. Szlags were made by hammering a handle (a long, metre-long one) into a wooden stump. The szlags were light, so they were good for driving an axe with, for driving tees they were not suitable: *"They were not used for the house, the hammer was"*.
- Augers: ordered from the village blacksmith. Inch augers were used for coals and one and a half inch augers for dikes. At the end of the auger, a handle was inserted into a circular hole to enable the tool to be turned. The depth of the holes drilled depended on the quality of the beams: *"If the beams were crooked then you had to auger deeper, he'd give up better later on, because that's how the tree froze, and if you gave more tebls, he'd better - they'd pull those tebls".*
- Key: made from an oblong piece of wood with a rectangular notch, the width of which corresponded to the dimensions of the dowels. The keys were placed on the dowels, pulled on both sides, straightening the dowel, at the same time the dowels were hammered in with a mallet.
- Hebel: or planer, used to straighten and level the surface of cut wood. Many types were used, both in carpentry and joinery work: *"These planers are different to make various forms, each planer has to be different. See what kind here* [on the inner door]*, filongi inserted, how to make it all with small hexagons".* The carpenters most often used the so-called trigger, or a long planer, *"Because short no, if you do short, you'll also make ripples in the tree".*
- Szpachle (paddles) - flat tools of small size used to pound moss between dildos. Moss, which at the time was the best insulator in buildings (linen bundles were also used, but Naumiuk states: *"Puffballs are worse, they weather and then the birds take it out for nests; the best way was moss laid when the dyl was not yet "struck"*. The paddles were used to press the insulation into the walls. After a while, the structure of the moss changed - it became very compact, did not let air through and did not spoil the wood.
- Reissmass: a wooden measuring tool consisting of two movable pieces, one of which terminated in me-toothed teeth. It was used to mark a selected length of wood without using a pencil.

3. CARPENTRY CUSTOMS AND RITUALS ASSOCIATED WITH HOUSE BUILDING

The rhythm of the calendar changes implied the necessity (custom) to perform different works at a certain time and in a certain order. Carpentry work was started in spring and carried out in such a way as to finish in winter, covering the house with a roof. Naumiuk states: *"Houses were not built all year round, they tried to build in such a way as to cover the house for the winter. The most important thing was to start in such a way as to finish for the winter."* In April,

[3] Anna Naumiuk – Włodzimierza Naumiuka's wife, added: „*Just like with your axes, no one can touch it*".

Fig. 3. The ax of Włodzimierz Naumiuk (from the collection of W. N.); photo by the author, 2023

Fig. 4. Augers of Wlodzimierz Naumiuk (from the collection of W. N.); photo by the author, 2023

Fig. 5. From the top: planer and reissmass of Wlodzimierz Naumiuk (from the collection of W. N.); photo by the author, 2023

carpentry work would start: *"As soon as the field was worked, from April onwards, potatoes planted in May, you could go do an additional job"*. May and June saw the start of construction. Work continued uninterrupted until August, when a fortnight's break was customary for the harvest. The building was to be completed before the onset of winter. In winter, the carpentry was done, the glazier (carpenters too) installed the glass panes. W. Naumiuk recalls: *"We were doing windows at the school in Soce, I was the one who glazed the windows there. The foreman went away, left me an "almaz" - a cutting knife, I puttyed and glazed". In the second spring after the building work began, doors and windows were put in".*

Fig. 6. The gable of the house with decorations made by Wlodzimierz Naumiuk in the 1960's, Ryboly village; photo by the author, 2023

They did not work on Sundays, and usually not on Saturdays either. However, the above should not be applied to the first years after the Second World War, as Naumiuk also emphasises: *"After the war nobody was looking, they were building on Sundays, because it was all destroyed. How are you not going to build, when children are sitting in cellars and you have to build a house? Who was looking... Superstition, maybe when there was debauchery, and in poverty there is no superstition."*

Significantly subject to the rhythm of the changes of the calendar year, carpentry work was in some ways linked to the traditions, or rituals, of a particular community. Among the rituals occurring Włodzimierz Naumiuk describes:

- Dowry

Naumiuk described issues related to the collection of wedding dowries. According to his information, the basic part of dowries at that time was material for building houses. When a girl was born into a family, "her father started to collect wood for the house to give her as dowry". The money people managed to put aside was spent on wood and even one dike or board each was bought and collected in this way. A short story introducing the essence of dowries at the time is presented by W. Naumiuk's wife, Anna Naumiuk: *"Aunt Olga was getting married, then they gave away the barn, and they themselves were without a barn for the rest of their lives. Such were the dowries".*

- Zakładziny (linings)

On the foundations laid, the host was asked to place a coin of his choice (it was not specified what kind of money it was to be) on the south or east side (the side on which icons were hung in the houses), so that there would be money in the house and that it would „not go out". At that time, the coals were also consecrated with holy water, and this action was usually performed by the eldest person in the family: *„– Grandma, go bless the house as the oldest", if there is a grandfather, he has blessed the coals we are building on"*. During linings, refreshments were only for the foremen, sometimes a neighbour or family member was invited. The real festivities only took place at the garlands.

There is another old superstition associated with the foundations - at the time of laying the foundations, young women and girls would not go out into the street: *„We used to ask the old grannies - Why? - and they laughed behind the cooker and didn't tell us. They said: - that's how it used to be, I didn't go either, the mothers would say; don't go out today, stay in today. The idea was that the foremen would make a maiden with child. And we laughed that it doesn't hurt to have one"*.

- Wiankowe (garland fest)

Wiankowe was celebrated lavishly, because, as recalls Włodzimierz Naumiuk – *It was the first moment where you could say you already had a home, it was almost a home".* Lots of people were invited to this personal feast of the farmers, including: neighbours, cousins and even people from other villages. The garland festival was also a moment of respite from the hard work of the foremen. On a daily basis, they did not allow themselves a break from their work: *„We didn't have time every day, people didn't come over to avoid disturbing us, we didn't get into conversations while we were working. When we were working, we did our job properly, no one came over, people just walked by and said, - God help us"*. Putting up the rafters meant garland ("garland" - a combination of a bouquet of flowers and a cross was nailed to the rafters: *„We nailed a garland with a cross - like on a house of prayer, like on an Orthodox church - and it was the house of life*", therefore, the work was planned so that the celebration, which usually took two days, would begin at the end of the week: *„ As we want to drink well, we tried to do it well, either on Friday and drinking on Saturday still"*. W. Naumiuk mentions: *„Everyone was in a hurry, then there was drinking all night and the next day and neighbors would come over"*. The time of celebration was also subject to an unwritten rule, namely, it depended on where the garland was nailed: if the garland was nailed on the second rafter and not on the first gable - the host brought two liters of alcohol, as on the third, three. W. Naumiuk mentions: *„The foreman* [said] *always: 'beat the garland on the fifth rafter! - five liters of vodka will be"*.

4. SOCIO-ECONOMIC CHANGES IN THE 1960s

During interviews, Włodzimierz Naumiuk emphasises the impact of the changes that gradually took place after the Second World War. He attributes the greatest importance to the changes in the 1960s. The electrification of the countryside, administrative restrictions and changes related to the migration of the population to the cities particularly stuck in his memory.

Electrification of the countryside

Electricity was brought to the village and the Kaniuki area relatively late. In the 1960s, sawmill workers, carpenters and joiners were still doing everything by hand. In 1963, Włodzimierz Naumiuk worked in electrification, in the 44th Brigade to bring electricity (led from Belarus) to Podlasie villages: including Budy, Postołowo, Szumaki, then the brigade also worked around Białystok. However, electricity was brought to Kaniuki even later, when Włodzimierz Naumiuk was no longer

working there (the electricity was set up there by his former brigade).

The possibility of using electricity, as Naumiuk points out, "relieved" the work of carpenters. Beams were now mostly cut in large sawmills (despite this, the sawmills still had a lot of work, although not as much as before: "They also had, well the rafters were nowhere to be bought, because that kind of material didn't sell, because they were thin trees, but they should have been cut down to the edge, and not at least one plane, so that they could nail the battens evenly". Electric lighting, however, benefited carpenters the most: *"And the light was more useful for the carpentry work, because you could already buy a smaller ball and the light was illuminating, but they were young boys with eyesight ..., but still the light gave a lot, it relieved, you could say, it relieved the work".* Soon, widely available mechanical circular saws - 'slicers' - were slowly 'taking away' the work of the sawmills. And although mechanical woodworking became easier and faster, Naumiuk emphasises: *"But a slicer could not replace the work of a sawmill, it was for cutting firewood, rails. For the house* [material]*, it was difficult from under the selvedge - because it's thick, it's hard to turn over."*.

Building houses and transporting them to cities

In the 1960s, obtaining planning permission became a necessity. The process was not easy: *"With the making of the project it was difficult: it was not given, it was delayed, well there was always some trouble.".* Consequently, attempts were made to somehow circumvent the arduous procedures. A loophole allowed a house to be built without the aforementioned permit, provided it was erected overnight: *„Once a man took the house to his yard at night, and by morning, by 8, by 9, as long as the offices were working and the rafters were standing, no one had the right to give any punishment. And at night they asked, right here, a team of peasants, they transported the house by carts."*

Włodzimierz Naumiuk was involved in the process of erecting and transporting houses to Białystok, of which a relatively large number were built in the 1960s compared to those erected in the "usual" way. The process of depopulation of the countryside, which began as people moved to the cities, necessitated a change in the mode and principles of the carpenters' work. Naumiuk recalls: *„At that time, we used to set up the whole house on stumps or stones (...). We would build a house somewhere in the backyard, mark the pieces, disassemble and transport them, to the building site (...). That's why the wooden pegs - the so-called "tebles" - were made loose, because like that, they were made tight, beaten with a heavy hammer"*. Given the hand-worked nature of the components for construction, which were rejoined together after transport, it became necessary to mark them: „*Because every beam as it ties into a dovetail is different. Otherwise it would be a mess, in a year's time the house wouldn't have been built".* The marks had to be invisible. They were made with a chisel, and each carpenter had his own way of applying them. Signs were placed according to the directions of the world. Roman numerals were used in particular, or letters or signs were added, i.e. a dot, two dots, crosses, etc. Each foreman had to know what the symbols were. Every foreman had to know what the symbols meant. From the information that Naumiuk has, it is known that this way of building was practised by foremen from Kaniuki and Ostrówek, and perhaps also from other surrounding villages. It is also known that Dojnowska Street in Białystok was built in this way at the time. It is worth adding to this topic the context of the construction of new buildings in the countryside in those years. Due to the relatively large distance from the larger cities, the law was not so respected in the countryside. If the neighbours had no objections to how a house was put up, there was nothing to prevent new buildings being erected freely: *„ Here people built normally (...) the village was always, it depended on the neighbours - the neighbour was silent, it was fine"*.

SUMMARY AND CONCLUSIONS

During interviews with the folk carpenter Włodzimierz Naumiuk on 05.04.2021, 03.09.2022 and 01.11.2022, complementing the 2018-2019 research, new reminiscence information was acquired about his experience in carpentry and the carpentry workshop, and - somewhat incidentally - also about ancient carpentry rituals. Włodzimierz Naumiuk stressed the importance of long-term and reliable training in carpentry under the guidance of an experienced foreman, a need that was somehow reinforced by a sense of responsibility for the outcome of the construction, as in a spoiled society, inadequate construction of a house could result in a tragedy for the owner, who lost the money he had accumulated over many years, and sometimes even his life's possessions. Consequently, the master builder, employing experienced workers and a few apprentices (journeymen), would oversee work assignments according to the experience and skills of each of his helpers. Simpler tasks, assigned to less experienced helpers (nevertheless requiring precision and care), included sawing the wood, planing it and drilling the holes for the tees (tenons), while journeymen were never entrusted with making carpentry locks themselves.

In Wlodzimierz Naumiuk's memories of the 1950s, the reminiscences reveal nuances which have been overlooked in previous studies on folk construction in the Białystok region: the gradual transition from the old Russian units of measurement (arshyns) to metric units, and the resulting necessity to replace measuring tools; the necessity to use worn-out or damaged tools due to the difficulty of acquiring such tools by relatively poor carpenters (although still wealthier than the general rural population), which also resulted in a respect for tools, especially the basic carpentry tool - the axe. It seems that some of the information given by Włodzimierz Naumiuk, e.g. that *„if they didn't have razors, they shaved with axes"*, are like the beginnings of a tool myth - they are probably not so much evidence of actual shaving with a sharp axe, but rather an echo of the publicity stories circulating in the carpentry circles of the time, extolling one's own skill in sharpening and using an axe at the expense of interlocutors (implying that one could not wield an axe so skillfully and subtly) and discouraging novices or competitors from using axes hastily. Yes, every farmer had an axe and everyone wielded it quite well, using it for instance to chop firewood, planing fence pegs, etc., but since this was the case, it made it all the more important for the technical elite – the carpenters - to circulate the opinion that they were exceptional when it came to the art of sharpening and using axes.

Some of the details from Włodzimierz Naumiuk's stories, when compared with similar information from ethnographic writing, attest to local variations in materials and technological solutions. Examples include information about teblocks, wooden pegs. Włodzimierz Naumiuk emphasises that they were always made of the same material as the beams and were given an octagonal cross-section. For comparison, Marian Pokropek and Tomasz Strączek [1993, p. 75] report that in villages from the Ciechanowiec area, which are about 60 km to the west of the village of Kaniuki *„The uprights were made of oak or resinous pine"*. Jerzy Czajkowski [1961, p. 159] states that in the villages of Nowoberezowo (15 km south-east of Kaniuki village) and Łuka (25 km east*) „instead of wooden dowels, the holes between the beams are filled with stone pebbles"*. Jerzy Cetera [p. 446 (reference 8)] wrote: *„The same dowels deposited in axe holes, used instead of dowels, were found in Usza Wielka commune of Klukowo"*, and also states that it was not until the 20th century that round or polygonal dowels, driven into holes drilled with an auger, began to be used throughout the Bialystok area because, as he writes, *„in the nineteenth century in the Bialystok Region, the auger was not a commonly used tool in folk building"*, therefore, until this type of tool became widespread, wooden tees of square cross-section were used, driven into holes cut with an axe.

Naumiuk's information on customs and rituals accompanying house building is very interesting. This information is fully in line with ethnographic knowledge, already quite abundant as far as the whole region is concerned (especially as far as house-building customs, considered to be the most primordial; see: [Pokropek, Strączek 1993, p. 70-73]). They prove the continuity of many customs up to the mid-20th century. Here, it is only worth comparing the information given by the interviewee - that "on the laid foundations a coin was asked to be placed by the host (...)" - with a record that is almost two hundred years older, namely with the information recorded in 1830 (but based on earlier research) by Lukasz Gołębiowski about the "Lithuanian peasant" (actually referring to as the North Belorussian people, not ethnic Lithuanians): *„The founding carpenter foreman puts a penny, a piece of bread, some honey and salt on the coals of the house from sunrise"* [Gołębiowski 1830, p. 50].

Thus, Włodzimierz Naumiuk, a folk carpenter and woodcarver from the Podlasie village of Kaniuki, revealed his knowledge of carpentry tools, techniques and customs acquired in his youth (in the 1950s and 1960s), which complements and confirms his knowledge from the literature on the subject, but also - importantly - shows the local specificity of the carpentry profession in a small village on the Narew river.

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Essays

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ENTRANCE TO THE FIELD OF CORDWOOD MASONRY

PRE-SCIENTIFIC OVERVIEW OF TECHNIQUE AND ASPECTS

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Abstract

Scattered information about cordwood masonry was gathered from different sources such as books, professional articles, popular articles and websites. Historical cordwood masonry construction techniques and newer cordwood masonry construction techniques were included. Current teachings of ecological construction practices were added, and private and professional individuals' knowledge. Three main cordwood wall types were evaluated and the wall type - single log with centered insulation space - was found to be optimal. Spruce *(Picea abies)* was identified as the best suited tree species in Norway. Mixing of clay based mortar was explained. Load bearing can be done with post framework, or the cordwood walls themselves can be load bearing. Solutions for stabilising corners were found. It is optional to clad the house or leave it unclad. Momentums for future scientific research were pointed out, such as finding thermal transmittance U (W/m2K) for woods and mortars, and understanding humidity transportation efficiency in different types of wood with/without cladding. Unanswered questions were set forth. This is a pre-scientific literature study.

Keywords: cordwood; masonry; kubbehus[1]; construction; technique

AIM AND OBJECTIVES

Aim

The purpose of this investigation is to look into historical and newer cordwood masonry construction techniques, show fitting ecological construction practices – as a preliminary and pre-scientific basis – from where scientific investigation can continue.

Objectives

- Find historical cordwood masonry techniques and practices that can have a place in future construction.
- Find newer cordwood masonry techniques and practices outside Norway that can be introduced to Norway.
- Give a base-categorisation of variations in historical and current cordwood masonry techniques.
- Pair cordwood masonry construction techniques with current ecological construction practices.
- Conclude with an optimal cordwood construction technique.
- Suggest further scientific research.

On a larger scale, continued investigation into cordwood masonry construction techniques can diversify current ecological construction by putting to use cordwood masonry in real life eco-construction projects.

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[1] *Kubbehus* is the Norwegian word for the English term *cordwood masonry house*.

INTRODUCTION

Cordwood masonry is the construction technique of building the walls of a construction with logs of wood and mortar. This technique has many variations in use of tree species, wooden log format, mortar and insulation spaces.

It is unknown how far back in time cordwood masonry dates, but historical constructions from the mid 1800s are found in USA and Canada [Roy 2003], Sweden [Hagman 2013] and Norway [SINTEF Byggforsk 2017]. Finland also has historical cordwood construction [SINTEF Byggforsk 2017].

In Sweden and Norway cordwood construction was built continuously at least from that time, and until the 1940s in Sweden [Hagman 2013], and the 1950s in Norway [SINTEF Byggforsk 2017b]. In this last phase of this historical cordwood construction in Sweden [Hagman 2013] and Norway [SINTEF Byggforsk 2017b] it was common to use cut offs from the wood industry such as planks and beams. Such houses were called *knubbehus* in Norway.

In the USA and Canada a revival of cordwood construction started in the 1970s, which led to a number of cordwood houses being built in those two countries over the years [Roy 2003], and they are still being built there today. This revival of cordwood construction did not reach Europe (just a few projects), so the majority of newer constructions of cordwood construction can only be found in the USA and Canada.

House construction in Norway today has become a technically complex and costly affair. The layman is dependent on professional builders and cannot hope to put so much of his own physical effort into building his own house. In addition acquiring a home requires parental financial assistance and decades of mortage.

This whole set-up of conditions must be said to be an odd occurence. If we give in to the belief that we are at peak technological know-how as nothing before during thousands of years, then surely we would have developed a way for everyone to manage to build their own house instead of incapacitating people. We would also have found a way to allow people to have a home without decades of debt.

Fig. 1. A cordwood masonry construction site; photo by: [Roy, 2017]

Fig. 2. This is the construction technique of cordwood masonry. Cordwood logs are placed in clay based mortar to build a wall; photo by: [Cordwood Construction, 2020]

Fig. 3. Barn of cordwood for animal keeping built in the historical period at the farm Risgjerdet in Oppdal in Norway, with logs that are 30 cm long (Stenby, 2021b). The logs seem to be reused from a previous log house, and there are horisontal planks or battens for stability sandwiched in between each layer of logs; photo by: [Hemmingsen & Stensen, 2021]

Fig. 4. Newer cordwood house in North America; photo by: [Flatau, n.d.b]

Homo sapiens is a species characterised by needing a shelter against the environment and being capable of constructing such a shelter in order to complete their life cycle of reproduction with raising of offspring. All so called primitive civilisations on Earth have solved this but the modern technological industrial society has not, in fact it has deregulated mankind away from having such ability to self manage their own biological life cycle.

That is what gives incentive to exploring natural construction techniques such as cordwood masonry. It is one of several construction techniques that are simple and effective, and can be used by the self builder. By looking around at ground level in the local environment and picking up the organic and abiotic construction elements that we discover, we find a new starting point and we progress in the challenge of building a home.

A very great point about organic construction techniques is also the state of the planet today. The natural world is continuously being degraded into disappearance by over exploitation of energy and resources. Natural construction techniques such as cordwood masonry significantly lowers the usage of energy and resources by omitting the technological industrial pathway for the construction materials that are to be used for the house. In fact, omitting the technological industrial pathway makes natural construction techniques severly outcompete any green labeled construction technique coming out of a technological industrial production line.

By going back to a man-in-nature stance and thereby finding local and natural construction materials, we not only manage to lower the costs and gain increased financial freedom - and lower our environmental impact drastically - but we also succeed in restoring mankind's biological life cycle by abling people to take care of it themselves. Nature in man is restored by resorting directly to nature, and man in nature is also further restored.

1. MATERIALS AND METHODS

This article is based on the study of other written sources:

- Books about cordwood masonry
    - *Cordwood Building: The State of the Art*, by Rob Roy in USA.
    - *Väggar av ved*, by Olle Hagman in Sweden.

- Investigation series from Byggforsk
    - Byggforsk SINTEF is a research institution in Norway. It produces reports with solutions and recommendations for the field of construction. The reports are intended for use as documentation in building permit applications. The solutions can progress beyond the current construction practices but are still within the regulations. Byggforsk also produces reports about historical construction techniques such as cordwood masonry.
- Current professional articles from
    - NIBIO – Norwegian Institute of Bioeconomy Research
    - Bygg og Bevar – ideal enterprise for maintenance and conservation of old constructions
    - Forskning.no – science news in Norway
- Private blog
    - Norsk Bygningskunst – a blog about common cultural crafts and crafts tradition.

2. RESULTS

2.1. The advantages of cordwood – diffusion openness and thermal mass

A tree, while it is alive, works to transport water from the ground via the roots and the trunk up and out to the leaves or needles. For this reason the tree trunk is designed to prevent water loss through the sides and to move water efficiently lengthwise inside the sapwood part of the trunk. This capacity still resides in the tree after it has been felled and cut into logs. In construction terms this means that wooden logs are open to diffusion, which means transportation of water molecules.

This gives interesting perspectives in eco-construction since the conscious intent in ecological construction is to try to use the materials by the capacities that they naturally provide.

The logs have the capability to move humidity through the wall and release it on the other side. When the humidity is higher on one side of the wall than the other, the logs absorb the humidity, move it and release it in the air on the other side of the wall where the humidity is lower. This helps to balance the humidity level inside the house, in complement with clay based mortar which has the same capability.

Apart from it's openness to diffusion, a cordwood wall with wood and mortar also has thermal mass. This means that it will retain heat and slowly release it during some time, making the indoor temperature more stable.

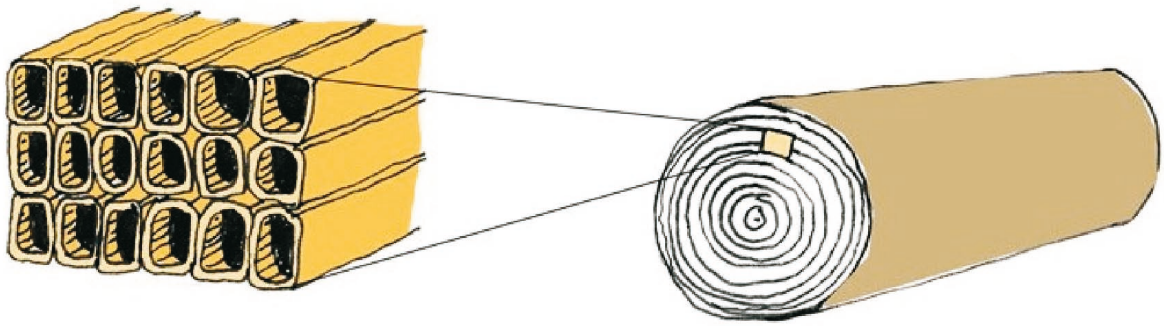


Fig. 5. The tree trunk is open to diffusion because of it's natural structure for water transportation; photo by: [Hemmingsen & Stensen, 2021]

2.2. The advantages of cordwood – economical advantage

There is an economical advantage in using cordwood. One thing is that the raw materials – wood logs and clay for the mortar – are not expensive. The other thing is that the self builder does the work of putting up the volume of the walls instead of paying a carpenter to do it. The self builder can cut down the trees in the forest himself with a chainsaw and bring the logs to an adequate place to dry, getting a good price on the logs. The local farmer who owns the forest probably has some patches of forest that are unprofitable for him to log by clear cutting, and he might be willing to sell those trees to the self builder at an even better price.

In Norway more or less one third of all agricultural land has clay-containing soil beneath it. Cities and towns have oftenly been built on top of old agricultural land. This makes clay-containing soil accessible both in the coun-

tryside and in urbanised areas. It is normal to see heaps of grey clay-containing soil at construction sites on farms and in cities. In urban and rural construction projects the clay-containing soil has to be deposited somewhere and is therefore an expenditure for the contruction project. This means that it can be possible to make a deal and obtain some clay-containing soil from such a construction project nearby.

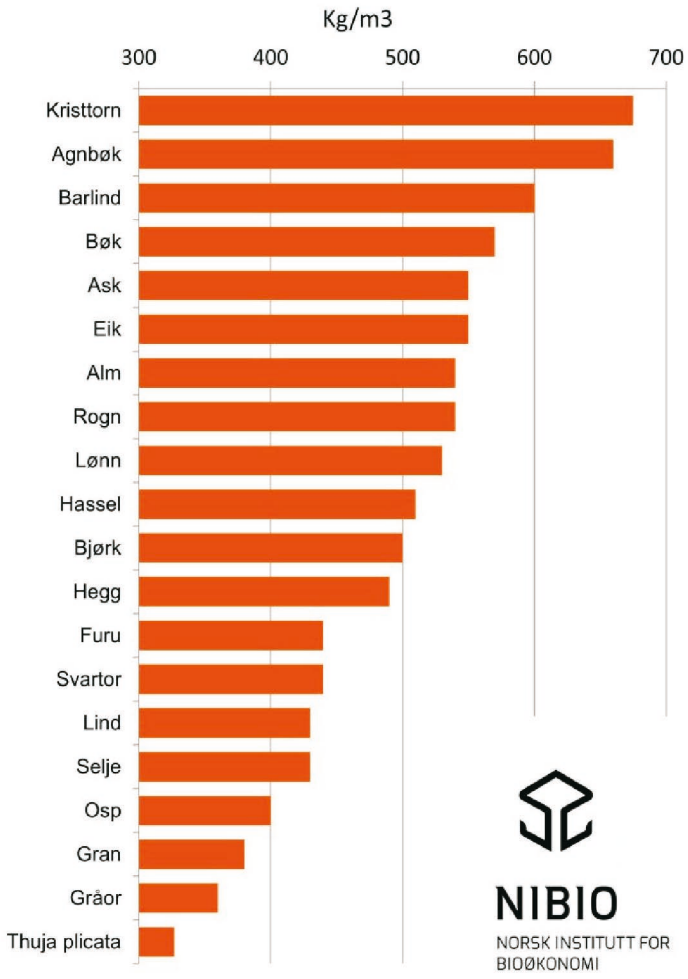
2.3. The cordwood logs – lighter versus heavier woods

Different tree species have wood with different qualities. When it comes to cordwood construction the wood should be light and airy. This is for two reasons. First, the lighter airier woods have better insulation values than heavier denser woods [Hagman 2013; p. 24, Roy 2003, p. 22]. Second, the lighter airier woods are more stable with less expansion and shrinkage in thickness when subject to changing levels of moisture [Hagman 2013, p. 24; Roy 2003, p. 22].

Heavier denser woods when dried have a much greater capability to expand in thickness when being re-hydrated [Roy 2003, p. 22; Stenby 2021). In cordwood masonry the logs are exposed to moisture when the wall is being built and each log is being put in moist mortar. This adding of water to a lot of denser heavier wood logs in the same wall has the capability to lift clear the top beam off the frame, push out the sides of the frame, and the cordwood wall itself can also come out inwards or outwards [Roy 2003, p. 21 – 22; Stenby 2021]. The expansion would be unstoppable [Roy 2003, p. 21].

2.4. The cordwood logs – tree species

Bar chart 1 [NIBIO 2019] The bar chart shows the specific weights of the wood of different Norwegian tree species.



Translations:
Birch = bjørk

Pine = furu

Aspen = osp
Spruce = gran

Source: NIBIO – Norwegian Institute of Bioeconomy Research

Historically speaking the tree species that have been used for cordwood construction in Norway are [SINTEF Byggforsk 2017]:

- spruce (*Picea abies*)
- aspen (*Populus tremula*)
- pine (*Pinus sylvestris*)
- birch (*Betula pubescens*)

Spruce, aspen and pine were most commonly used in cordwood houses [Stenby 2021].

2.5. The cordwood logs – debarking the trunks

Debarking must be done as soon as the tree has been felled. The space between the trunk and the bark is a favoured space for fungus and insects. Fungus is detrimental to human health and is not something to build into the walls of a house. The self builder who is logging forest himself should create the unflinchable habit of debarking each tree right after it has hit the ground. Fungus should be thought of as occurring immediatly after cutting the tree down, it occurs before the human eye can see it. There is no reason to let the trunks lie around for some days before taking off the bark.

Cutting a birch tree for example, during summer it takes just two-three weeks for fungus to completely infest the space between the trunk and the bark and this is very visible. During summer time there is a lot of sap underneath the bark which the fungus thrives on. Winter and early spring can be a better time for cutting trees.

2.6. The cordwood logs – cutting for drying

The logs should be cut to the correct length for the project before they are set to dry. Most of the moisture will leave the trunk through the cut endings, not so much through the side of the trunk. Therefore for efficient drying the trunks can be cut into logs of correct length. See the section 2.1. and Fig. 5 in particular.

2.7. The cordwood logs – splitting or not splitting?

Should the logs be split or left round and intact before drying? Both things will work for the cordwood wall. A cordwood wall with split logs will function, and a cordwood wall with intact round logs will function. Intact round logs will get more cracks, and some of them can be wide and deep and go all the way through the log lengthwise and connect the inside environment of the house with the outside environment. These bigger and deeper cracks can be filled with mortar so that they will not affect the functionality of the cordwood wall.

Fig. 6. Dried unsplit log where two major cracks have occured all the way into the center and continuing lengthwise in the trunk. There are also lots of smaller cracks in the log, 2015; photo by the author.

Splitting the logs through their center into several smaller logs is a way of not getting the larger cracks that run all the way through the logs [Roy 2003, p. 27]. It allows the tree rings to freely retract and become shorter. This can be understood by studying the drawings in Fig. 7.

During drying the growth rings in the logs will become shorter and retract. This means that something has to crack since the tree trunk is not so good at reducing its diameter correspondingly. A log can get smaller cracks spread out in the log, and they can get one or two larger cracks that go all the way into the center of the growth rings. These larger cracks can run all the way through the log lengthwise and thus create an opening between the outside and inside environment of the house. There can be variation depending on log size and tree species.

If the logs are split straight through the center before putting them to dry then the growth rings can freely retract and there will be no reason for creating so many cracks, in particular not the larger penetrating cracks, as this illustration points out.

Splitting or not splitting in the end can be a matter of personal aesthetical preference for the finished construction. If round logs are prefered then it just means that there will be some bigger cracks that have to be filled with mortar. If that is not an option then the logs must be split before drying.

Fig. 7. Wood drying process; source: [Roy, 2016, p. 28]

Fig. 8. Unsplit logs in cabin, photo by: [Cordwood Construction, 2013]

Fig. 9. Split logs in house; photo by: [Cordwood Construction, 2020].

2.8. The cordwood logs – size of logs

If some logs are of particularly big size, this means more movement in the wall at their local spots and bigger gaps can occur between the log and the mortar. These gaps can be filled with mortar afterwards.

The smaller the logs are the less movement they will produce and there will not be such big gaps. The same goes for split logs since they are also small.

2.9. The cordwood logs – drying of the logs

The logs should dry for a minimum of one year and can very well dry for two years. It can be attempted to dry them to 12% moisture content which is the value of straw bales dried in an industrial dryer. Moisture content can be measured by using a moisture meter which is an electronic device that does not cost much to buy.

The logs are best dried in a barn with protection against rain and snow. The logs should be set to dry in a well aired manner (not stacked so densly) and up from the floor with air underneath.

There must be entrance of new air into the barn so that there is exchange of air and humidity does not build up.

Follow the drying process of the logs. If some of the logs start developing a strange colour or if they are sensibly moist then act quickly to save the wood by giving more air to each log, or move them from the moist ground level of the barn to the dry second level etc.

2.10. Cordwood walls

There are basically three types of cordwood wall as shown in Fig. 10.

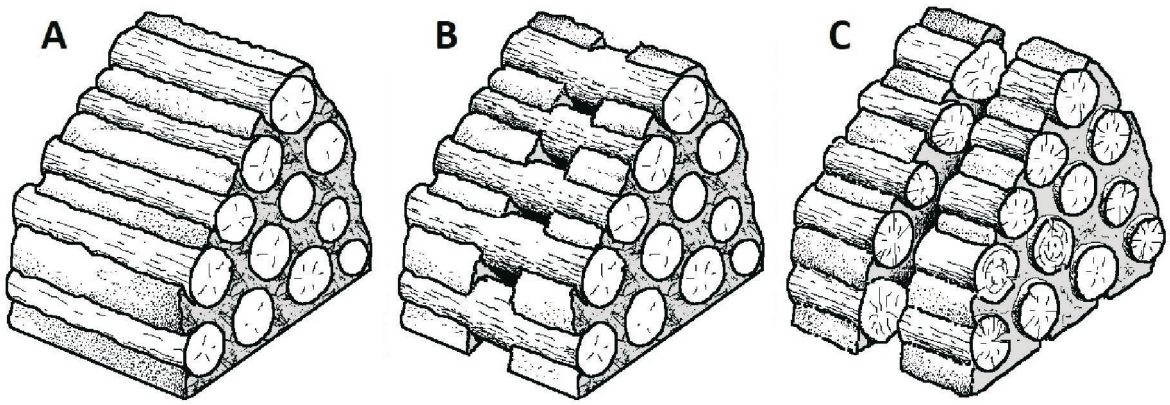


Fig. 10. A: Single wall with logs and mortar. B: Single wall with logs, mortar and insulation. C: Double wall with mid insulation layer; source: [Szewczyk, n.d., p. 10].

2.11. Cordwood walls – single wall – logs and mortar

The most basic cordwood wall construction is to simply put the logs in the mortar and build the wall with that technique. This is type A in Fig. 10.

Fig. 11. Construction technique of cordwood masonry in it's most basic form; photo by: [Kalamazoo College, 2014].

2.12. Cordwood walls – single wall – with insulation

The insulation capacity of the cordwood wall can be increased by exchanging some of the volume of mortar with volume of insulation. This is done by using mortar to support the logs in the end sections of the logs (interior and exterior parts of the wall) and the free space which remains in between is filled with insulation. This is type B in Fig. 10.

Fig. 12. Mortar is not being used along the entire length of the logs, so that a free space is made in the center. This is filled with insulation, here sawdust; photo by: [Flatau, n.d.d].

2.13. Cordwood walls – double wall – mid insulation layer

The most well insulated cordwood wall is the double wall technique. It is actually two separate cordwood walls with some room in between them for a layer of insulation. This is type C in Fig. 10.

In ecological construction it is sought to avoid the use of solutions such as oil based membranes and glass wools.

Ecological insulation can be wool mats, straw bales or straw insulation elements.

One advantage with the double wall technique is that the outer wall can be built during the warmer part of the year while the temperatures are not too cold for the mortar. When the winter part of the year is getting closer, the outer wall is completed and the house enclosed. The self builder can thus complete his work inside a heated house and put in place the insulation and the inner cordwood wall.

2.14. Exterior of cordwood walls

A cordwood wall can be clad or left unclad. Unclad is often chosen for the aesthetical expression. Clad on the other hand gives an outer appearance as a regular wooden house with wooden boards, or as a cement house if clay based plaster has been chosen. Clad or unclad will work well either way for a cordwood wall.

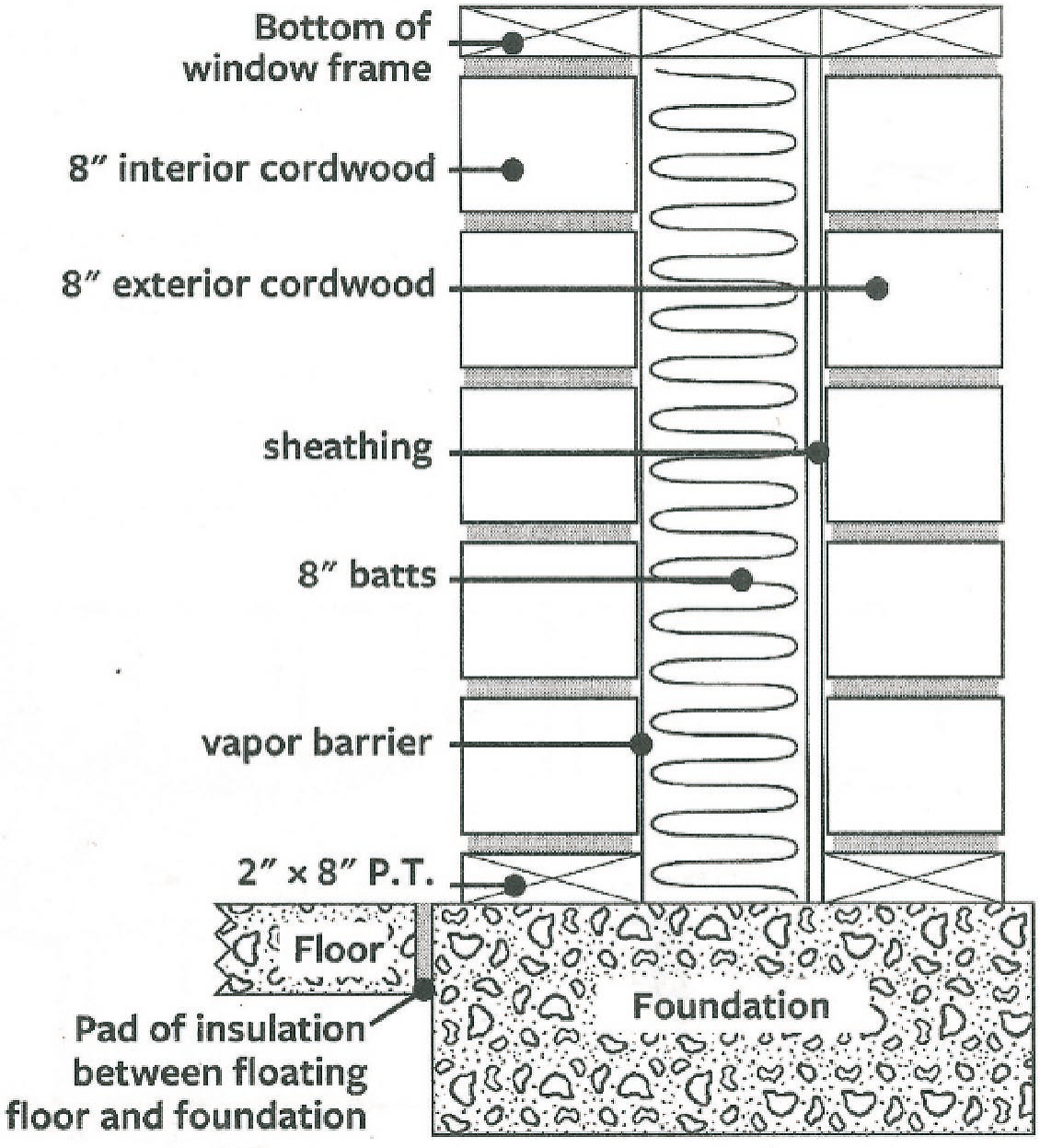


Fig. 13. This is the solution that has been used by Cliff Shockey in Canada; source: [Pichelman, n.d., p. 71].

2.15. Exterior of cordwood walls – unclad walls – log stacking

When the work has finally commenced and the walls are being built, then it is important that the exposed cordwood log endings are positioned with sufficient space in between them. They must not be in contact with each other or very near being in contact.

This is because if two wooden endings are touching or close to touching each other then liquid water can accumulate there. This will over time lead to rot or fungus in that part of the wood.

It is also worth noting that it is common among cordwood builders to let the logs stick out by 0,5 – 1,25 cm from the mortar part of the wall. This creates a visual effect that is attractive.

2.16. Exterior of cordwood walls – unclad walls – pointing

While the cordwood wall is being built with logs and mortar, it is also common to do something called “pointing”. By the use of a tool that has to be found or invented, for example a bent kitchen knife, the builders

apply pressure and movement against the mortar in between the log endings. This smoothens out the surface which makes the wall better looking, the exterior more water repellent and the interior less likely to collect dust particles.

2.17. Exterior of cordwood walls – clad walls

A cordwood house can be clad with wooden boards or clay based plaster. Cladding with clay based plaster seems to have a preserving effect on the wood.

The advantage of cladding is that it allows you to work faster when building the cordwood wall since you don't have to mind the aesthetical expression. The cordwood logs don't have to be placed so exact. In addition not having to do "pointing" is particularly time saving. A cladded wall is also easier to keep clean (O. Hagman 2022, pers.comm. e-mail 09.04.). See Fig. 17 where a clad cordwood wall has been opened, where the wood logs seem to have been a bit "thrown in". Obviously this made the work of building a lot more efficient.

2.18. Exterior of cordwood walls – clad walls - examples

Fig. 14. This cordwood house stands in Sweden. It was built in the 1870s or 1880s. It is clad with clay based plaster; photo by: [Hagman, 2016].

Fig. 15. A cordwood house located at Veset farm in Norway. It was built in the last part of the 1800s and is in use today as a house for living. It is clad with wooden boards like a regular Norwegian house. The cordwood wall can be seen in Fig. 16 and Fig. 17; photo by: [Nordbye, 2016].

2.19. The load bearing structure

A regular house has a load bearing framework that supports the entire house. Framework works fine for a cordwood house also. This entails that the cordwood with the mortar is used to fill in the frame sections of the house.

The advantage with load bearing framework is that the roof will be set up first, and this provides dry conditions for setting up the cordwood walls. The walls that are being built with mortar that needs to dry and the construction materials that need to be stored somewhere will be sheltered from rain. The self builder will be working under the shelter of a roof.

The other option is to build cordwood walls without framework. With such walls it is the cordwood and mortar that support the weight of the house. These are called load bearing walls, load bearing cordwood walls in this case. The self builder will have to think of solutions for keeping walls, materials and builders dry from rain.

2.20. The load bearing structure – historical load bearing frame in Norway

Fig. 16. A load bearing frame in a house that was built in the late 1800s in Norway. It stands at Veset farm and is still in use today as a house for living. The picture was taken during restoration. A closer look at the cordwood can be seen in Fig. 17. The finished result can be seen in Fig. 15; photo by: [Nordbye, 2004].

Fig. 17. A closeup of the wall in Fig. 16. The cordwood has horisontal battens in place in between each third row of logs for the most. This was done to give some stability to the cordwood and mortar filling of the wall; photo, by: [Nordbye, 2004].

2.21. The load bearing structure – newer load bearing frame in North America

Fig. 18. An example of a load bearing frame with roof, and afterwards the work of making the cordwood wall; photo by: [Flatau, n.d.].

2.22. The load bearing structure – historical load bearing cordwood walls in Norway

Historical cordwood constructions in Norway can have load bearing cordwood walls. They have horizontal battens in between the layers of logs, and the corners are made with logs in a 90 degree overlapping pattern.

The battens are placed in between each layer of logs. The battens are thinner than the walls, therefore there is one batten in the outward facing part of the wall and one batten in the inward facing part of the wall. The space in between the battens is mortar filled. See Fig. 20.

The corners of the constructions have logs placed on top of each other in an overlapping pattern of 90 degrees to contribute to good anchoring of the corners.

The structure as a whole is made to be as stable as possible. The battens stabilise the walls and so do the overlapping corner logs. The mortar part is made very thin between the wooden parts. In some instances (some constructions) there is so little mortar that wood rests directly on wood.

In the constructions where there is mortar between the parts of wood, then it is both the mortar and the wood that are bearing the structure.

In other instances where there is less mortar so that for the most part wood rests directly on wood and the mortar is just filling empty spaces, in these instances the wood alone can be said to be bearing the structure.

The advantage of using little mortar is that it becomes more efficient to build the house. Less masses of clay-containing soil to dig up and transport, and less mortar to mix. In short, the volume of mortar in the walls has to be elaborated much more by the builder, while the wood logs to a greater degree bring a premade volume to the walls as premade construction elements provided by nature.

It can also be added that less mortar means less usage of water, which means less movements in the wall [O. Hagman 2022, pers.comm. e-mail 09.04].

There is always a part of mortar separating the parts of wood however thin, so there is no continuous vertical wood on wood contact. In this case both the wood and the mortar are load bearing.

Fig. 19. A cordwood construction set up in Norway in 2008. The logs are reused wood from an older log house (lafteverk[2]) that had to be demolished. It is based on the historical cordwood construction technique in Norway. There are horisontal battens in between each layer of logs. The corners have logs placed on top of eachother in an overlapping pattern of 90 degrees; photo by: [Stenby, 2021].

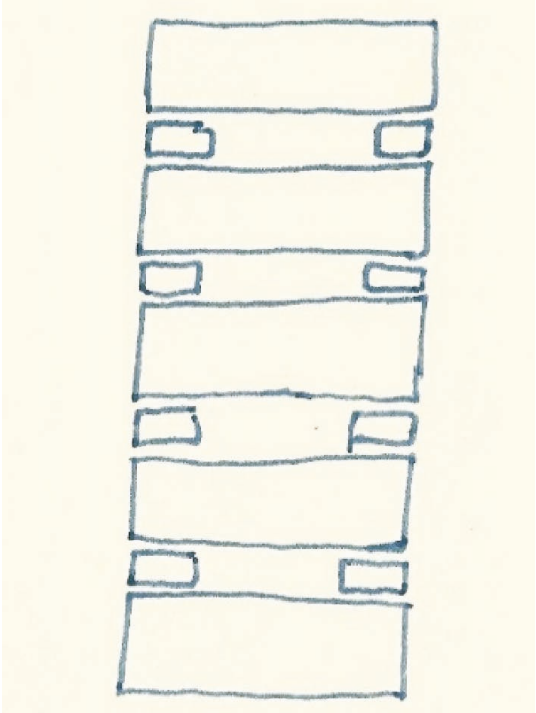


Fig. 20. A schematic drawing of the structure of the walls of the construction from 2008 in Norway in Fig. 19 and Fig. 21. The walls have horisontal battens in between each layer of logs. One batten in the outer part of the wall and one batten in the inner part of the wall. The space in between the battens is filled with mortar 2021; photo: by the author.

[2] *Lafteverk* is the Norwegian word for the construction technique of a log house.

Fig. 21. Closeup of the corner of the 2008-construction in Norway in Fig. 19. The corners have logs placed on top of eachother in an overlapping pattern of 90 degrees. There are battens in between each layer of logs. There is always a part of mortar separating the parts of wood; photo by: [Stenby, 2021].

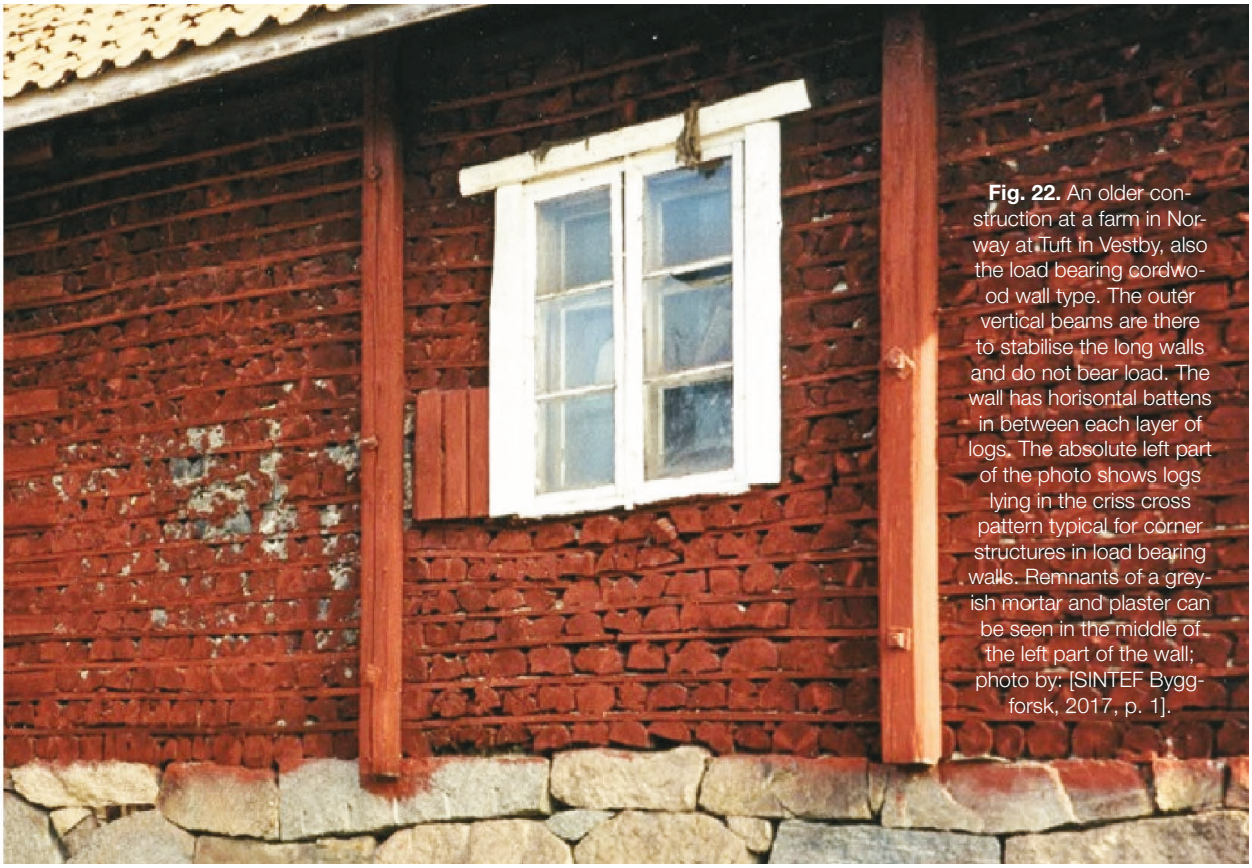


Fig. 22. An older construction at a farm in Norway at Tuft in Vestby, also the load bearing cordwood wall type. The outer vertical beams are there to stabilise the long walls and do not bear load. The wall has horisontal battens in between each layer of logs. The absolute left part of the photo shows logs lying in the criss cross pattern typical for corner structures in load bearing walls. Remnants of a greyish mortar and plaster can be seen in the middle of the left part of the wall; photo by: [SINTEF Byggforsk, 2017, p. 1].

Fig. 23. A closeup of the wall seen in Fig. 22. There is for the most part wood resting on wood, so there is continuous vertical wood on wood contact. In this case the wood can be said to be load bearing for the most part alone [SINTEF Byggforsk, 2017, p. 3].

2.23. The load bearing structure – newer load bearing cordwood walls in North America

The newer constructions in the USA and Canada (from the 1970s and onwards) seem to have a mortar that is based on Portland cement + lime as the binding agent, or solely a premade lime-mix as the binding agent.

The mortar part of the dried and finished cordwood walls based on these binding agents have more strength than clay based mortar can give. Such walls can be assumed to have the load bearing capability in the mortar part alone, not in the wood part. This seems to be confirmed by the prevalent theme about how to fill the gaps that occur between the wooden logs and the dried mortar due to schrinkage of one part or both. Since there are gaps then it seems to confirm that the mortar part is sturdy enough to bear the load alone.

Fig. 24. Two floors cordwood construction with load bearing walls in North America; photo by: [Roy, n.d.].

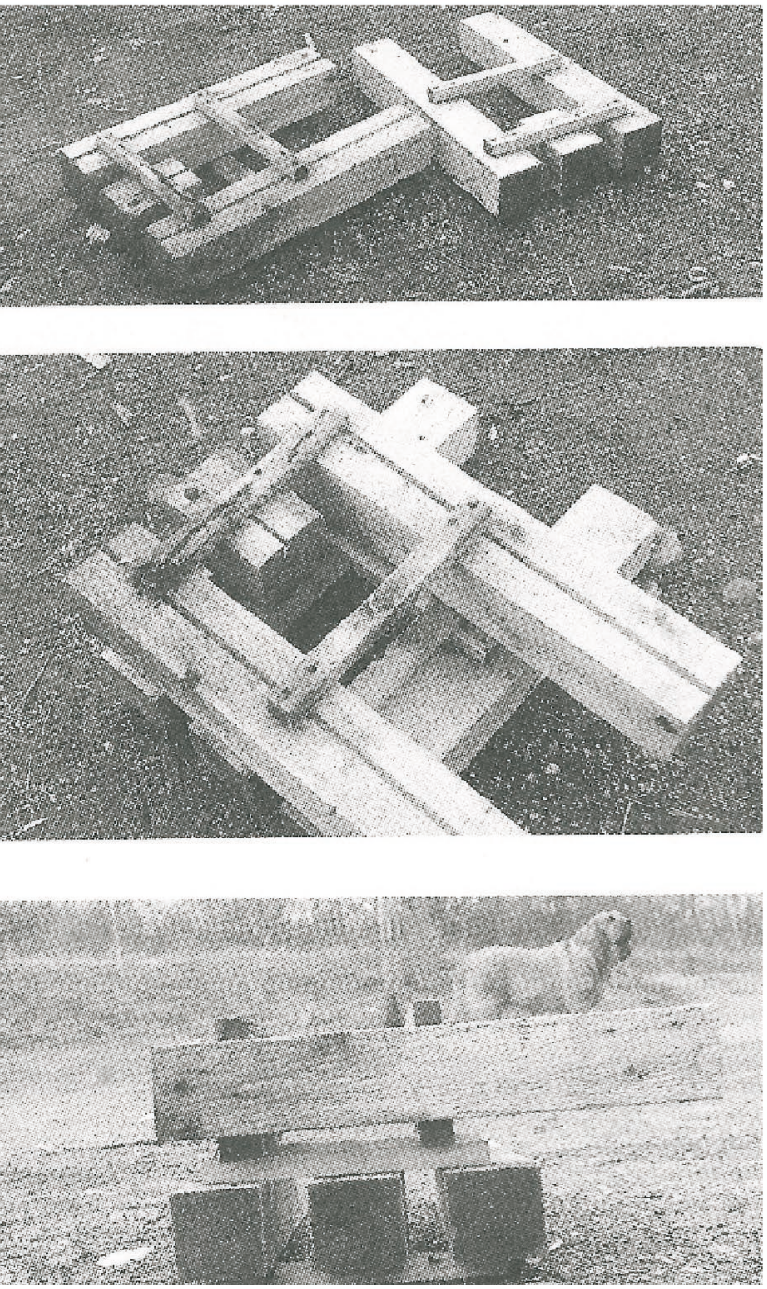


Fig. 25, 26 and 27. An overview of a type of a Lomax Corner unit to see the design and how they are stacked. The dimensions of the beams in thickness and length can be different for different projects, photos by: [Roy, 2003, p. 46]

2.24. The load bearing structure – corners

Regular cement houses can suffer from corners that have movement outwards, so that the corner tilts out and produces cracks going all the way from the ground to the roof. Cordwood houses experience the same forces acting upon the house, so that if there are no load bearing posts in the corners then the corners must be secured in some other way. The cordwood house must have secure corners that cannot tilt out and produce cracks.

This is done by anchoring the corners to the walls.

2.25. The load bearing structure – corners with horisontal battens

In the instance of cordwood walls with horisontal battens that run from corner to corner or to a window frame, the wall endings are secured to the rest of the wall. The horizontal battens stabilise the wall endings by anchoring them very well to the rest of the wall. It is important to criss cross the logs that make the corner so that the corners are unified. The battens and the criss crossing logs prevent the corners from tilting out and producing cracks.

See Fig. 19, Fig. 20 and Fig. 21 for examples.

See also Fig. 22, in the left corner of the photo where the corner structure can be seen.

2.26. The load bearing structure – Lomax Corner

Load bearing cordwood walls that have free stacking of logs in the mortar (no battens) must have the corners anchored in some other way. This is done by using a Lomax Corner.

The Lomax Corner is an anchored corner that consists of premade equal units that are stacked to make the corner. The units are made by the self builder at the construcion site and the measures are adapted to the needs of the construction project. It is a well tested, solid and time saving concept.

See the Fig. Fig. 25, 26 and 27. See also Fig. 28.

It is important to make all the units that are needed for the project at the same time. This saves time and gives an exact execution with reliable measures.

Important: There is a groove running lengthwise on one side of each square beam. This is made with a chain saw. It is for increasing the hold between the mortar and the wood, and it is very important.

Fig. 28. An example of Lomax Corner for securing corners. The units have one less batten in height than in the example in the black and white pictures designated Fig. 25, 26 and 27. They also have a central opening. This is the individual project variation; photo by: [Cordwood Construction, 2019].

It is recommended to stack them somewhat high first and fasten them, perhaps with vertical battens or boards nailed to the sides. This makes the rest of the work pass more efficiently.

2.27. The load bearing structure – anchoring of internal walls

This anchoring of the corners must also be done in internal corners where an internal dividing wall connects with an external wall. This will help interlock the entire house and make it a solid structure.

Fig. 29. Example of Lomax Corner type for anchoring also the internal corners (the nearer corner to the left in the picture); photo by: [Flatau, n.d.].

2.28. Mortar and plaster for cordwood – clay resources

The ideal for all ecological construction is to make use of local resources that have not passed through an industrial production process which uses energy and resources and involves longer distance transportation. Indeed also this gives a construction project a much nicer price for the self builder.

Clay is a good binding agent for mortar and plaster because clay has the ability to bind together other bodies such as silt, sand, gravel and fibers. This is what makes clay used as the binding agent in mortar with sand and straw.

In more or less one third of the agricultural land in Norway there are good clay resources. The soil profile has a marked transition between a brown and more organic top layer – and an underlying grey layer which has a higher content of clay. It is that grey, clay rich layer which is interesting for ecological construction. This clay-containing soil is commonly thought of as just clay and is known as blue clay (blåleire [3]) even though it is grey in colour.

Clay is defined as particles with a diameter below 0,002 mm and laminar in structural form, and the particles are of certain mineral origin. The Norwegian clay consists of a mixture of the minerals kaolin, illite and smectite, as well as crystalline quartz (Egge 2016).

Fig. 30. Dried Norwegian clay-containing soil, 2015; photo by the author

2.29. Mortar and plaster for cordwood – mortar ingredients

- straw 10 cm length
- clay-containing soil
- sand for construction
- water

(M. Aresta 2021, pers.comm. online conversation September)

The straw must come from bales that are dry and healthy, free of moisture and fungus.

The clay-containing soil is found locally.

[3] *Blíleire* is the Norwegian word for *blue clay*.

The sand must be construction sand, which means that the sand must be bought. Free sand found in nature or on the property will not suffice and will only result in a failed mortar. Sand grains need to have the right form so that the clay particles can get a large enough surface to connect to.

2.30. Mortar and plaster for cordwood – mortar ingredient functions

Sand is important in giving volume and load bearing capability to the mortar (M. Aresta 2021, pers.comm. online conversation September). The sand like the wooden logs do the job of bearing load in the wall.

Clay is the binding ingredient. It finds space in between the grains of sand and pulls on them, keeping them together. Without clay the sand would just "pulverise" and flow out like sand.

Straw reinforces the mortar by counteracting pull or push forces. Clay pulls hard enough together to produce cracks in the mortar, which is why we see clayish soil with cracks when the ground is dry. The load of the house will also exert force on the mortar. The straws extend in the mortar and counteract cracking movements.

2.31. Mortar and plaster for cordwood – mortar ingredient amounts

There is no exact recipe with the exact quantities. Making clay based mortar means using the local resources and see how they go together because the clay-containing soil, sand and straw are not standardised and will have local variation. The first thing to do is some experimenting and discover how different quantities of the different ingredients result.

These amounts are worth trying (M. Aresta 2021, pers.comm. online conversation September):

- 1 part straw
- 1 part clay-containing soil
- 2 parts sand

It is possible that the amount of straw can go up to 2 parts.

Just measure the parts by using a bucket as volume parts.

Mix in a cement blender with water.

How to know how much water to use? "*Take a ball out of the concrete mixer. It should be the size of a handball. Throw it straight and high up into the air using both hands and let it fall on the ground. The ball should hit the ground without falling apart and it should not make a splash. This is a dry mix.*" (M. Aresta 2021, pers.comm. online conversation September)

The purpose and functionality of this mortar is to fill out the space in between the logs and provide adequate foundation for the logs. This mortar is not meant for sticking to a vertical surface. It must not be added more water than making it possible to work with and raise the wall. The logs must not slide out because of a too watery mortar (M. Aresta 2021, pers.comm. online conversation September).

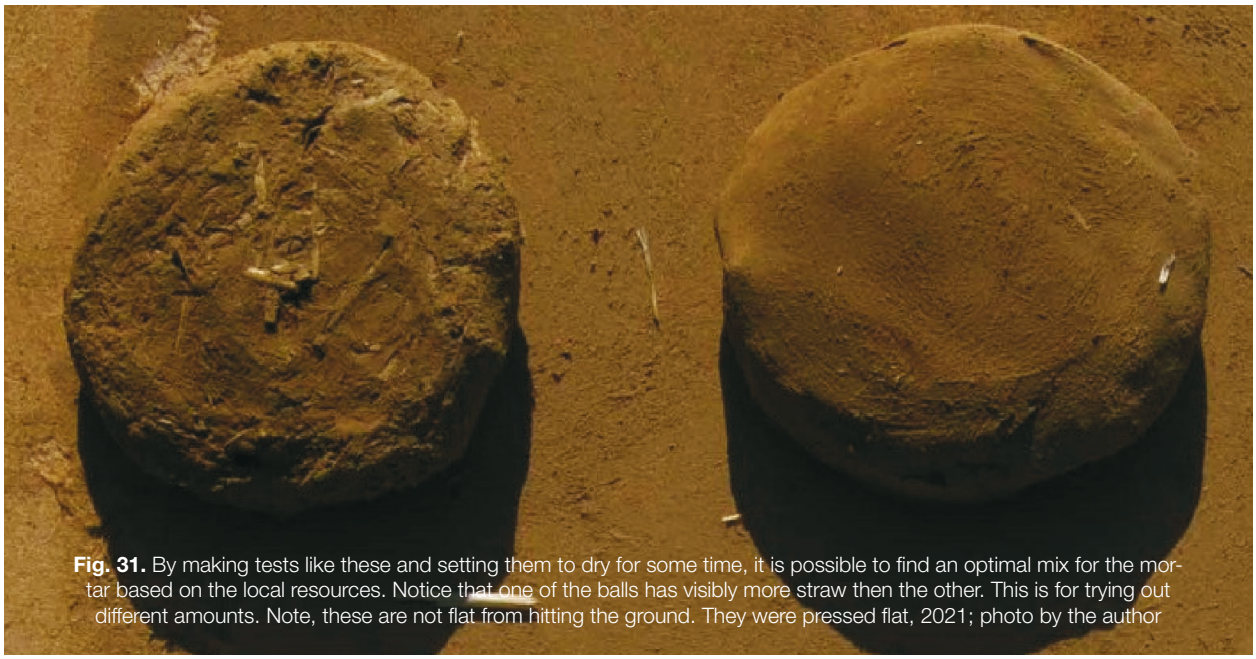


Fig. 31. By making tests like these and setting them to dry for some time, it is possible to find an optimal mix for the mortar based on the local resources. Notice that one of the balls has visibly more straw then the other. This is for trying out different amounts. Note, these are not flat from hitting the ground. They were pressed flat, 2021; photo by the author

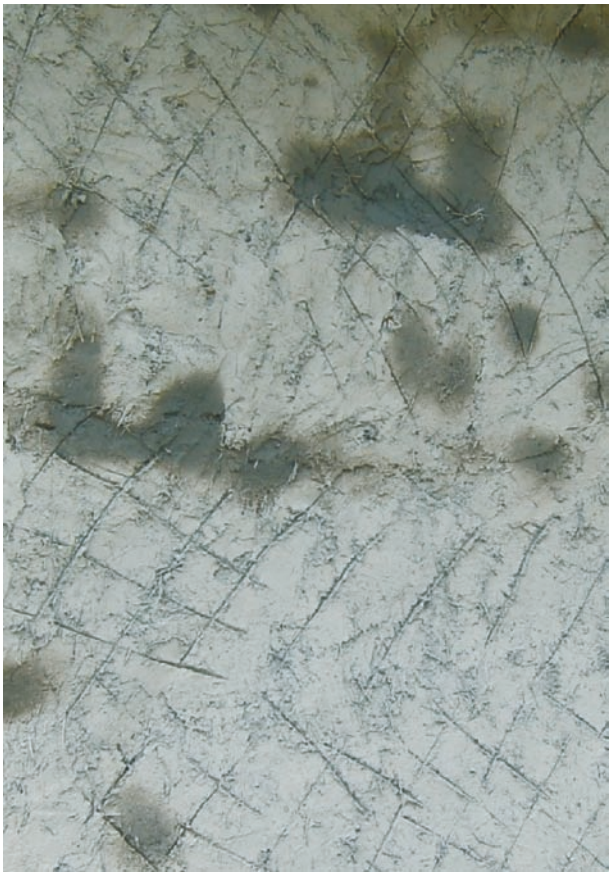


Fig. 32. Clay based mortar on a straw bale house. The mortar is naturally coarse and intentional cut marks have been made to make the coming plaster layer stick better, 2015; photo by the author

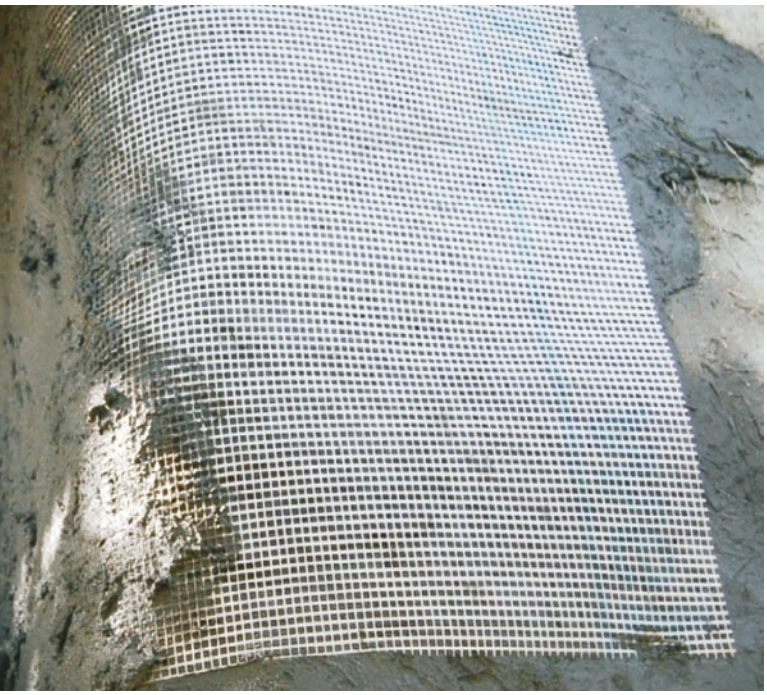


Fig. 33. Photo from straw bale house. Glass fiber mesh on first layer to give adherence to the next layer, 2015; photo by the author

2.32. Mortar and plaster for cordwood – mortar mix tests

It is also a good suggestion to build a test cordwood wall or a miniature house, even a year before the real walls are to be built, and see the result.

2.33. Mortar and plaster for cordwood – mortar mix test interpretations

Cracks in any mortar could mean that the clay has too much power since clay pulls things together. A solution could be less clay-containing soil or more straw.

Did the mortar dry in the sun? It could be that it cracked because of the direct sunlight. An experiment to dry the mortar in the shade can be done. If shade works then the mortar mix is fine and the cordwood walls should also be given shade while drying.

If the ball falls apart then there is not enough clay, or straw.

Experimentation is the solution.

2.34. Mortar and plaster for cordwood – plaster for cladding

The cladding consists of three layers;

Layer 1: Foundation

Layer 2: Coarse plaster

Layer 3: Fine plaster

Before the foundation can be put on, the wall must be prepared. First it must have an adherable surface structure. Second, a liquid clay-water mix must be sprayed on for connecting the foundation with the wall.

The steps of the process are elaborated below.

2.35. Mortar and plaster for cordwood – creating adherence on the wall

For anything to adhere to the wall then first the wall must be adherable. For this reason the wall must have or be given a rugged surface which serves as something to grab hold to for the next application.

The clay mortar in between the wooden logs should already have a coarse surface from when put in place. It could also help that it was intentionally made coarser and with markings for the layer of plaster to grab into.

The endings of the wooden logs should also be crude in their surface. This can be made by using a chain saw (M. Aresta 2021, pers.comm. online conversation September).

The endings of the wooden logs can also be fitted with nails that will give the plaster something to grab onto. The nails should be directed slightly upwards.

A mesh can also be fitted on the cordwood wall to give adherence to the plaster. It needs to be set in wet mortar, and at the same time nailed to the wooden logs.

It can be a mesh of jute fiber or other organic fiber that can be found. Some also use a glass fiber mesh.

2.36. Mortar and plaster for cordwood – clay-water mix

With rugged adherable surfaces on the cordwall wall, a clay-water mix is sprayed on. This mix is necessary for bridging the wall and the foundation. The surface is already sufficiently rugged, but there must still be a connection or a glue that binds the foundation to the rugged surfaces. This is what the clay-water-mix does. Without it, the foundation will fall off the wall.

It is made by dispensing the clay-containing soil in water in a barrel. A sifter can be used to prevent stones from entering the barrel. The barrel is left over night allowing the heavier earth particles to settle closer to the bottom, and the lighter clay particles will be found in a higher phase. The absolute top layer will be more water. All these phases are easily distinguishable. It is the clay rich phase in the middle that is to be extraced and used.

The purpose of this separation of phases is to extract and use the clay particles to the greatest degree and have the highest possible consentration of clay particles. Since clay particles have the ability to hold other elements together, then a clay rich layer sprayed onto the wall will tie the foundation to the wall.

See the making and application of clay-water mix in the figures 34, 35, 36 and 37.

Important: The clay-water mix must dry before the foundation layer is applied.

2.37. Mortar and plaster for cordwood – Layer 1: Foundation

The foundation is made out of long straw because of the need for long fibers. It should be very rich in fibers.

The other ingredient is clay (clay rich soil).

Of course, an amount of water is added.

Fiber gives structure and clay gives hold. This is a structural and holding layer. The purpose of this layer is to coat the wooden logs and prevent that they contract and that the next layer, the coarse plaster, loosens or cracks (M. Aresta 2021, pers.comm. online conversation September). This layer can also be used to even out irregularities on the wall surface and make the wall more even.

Fig. 34. Making of clay--water mix, 2021; photo by the author

Fig. 35. The propeller, 2021; photo by the author

Fig. 36. The right consistence of clay-water mix, 2021; photo by the author

Fig. 37. Spraying on the clay-water mix. In this case it is on straw bale but it serves as an example, 2021; photo by the author

Fig. 38. Clay and straw mix being made, 2021; photo by the author

Fig. 39. A finer plaster layer has been plastered onto a coarser layer. Still the finer layer can be worked even finer. This is ”blue clay” in Norway, 2014; photo by the author

Fig. 40. Experimentation with plaster mixes. The mix on the right has cracked because of the power of the clay to pull together. The mix on the left has the same amount of clay but it has been reinforced with straw. Straw counteracts the contracting of the clay and thus prevents cracking, 2021; photo by the author

There is no particular minimum or maximum thickness of this layer. This is simply a layer needed to apply the next layer.

The foundation has to dry before the next layer can be put on.

2.38. Mortar and plaster for cordwood – Layer 2: Coarse plaster

This is the main body of the two plastering layers with 2,5 cm thickness. The mix is the same as stated above for the mortar that was to put in between the cordwood, in the section 2.31. *Mortar and plaster for cordwood – mortar ingredient amounts*. The only difference might be more water so that it becomes more applicable on the wall.

2.39. Mortar and plaster for cordwood – Layer 3: Fine plaster

- 1 part clay (clay rich soil)
- 2 parts very fine sand
- 1 part dried horse manure (contains fibers worked by the horse's digestion)
- 4% sunflower oil or linen oil
- or also up to 10% paste (premade glue mass, made out of flour or starch boiled in water)
- water

This is a finer layer that will display a final smoother surface on the outside of the wall. This finer layer can be applied with some care and finer motions, and with a less crude tool. Of course the finer sand is part of what makes it a very fine surface, but the craftsman can also add smoothness by a careful execution and contribute in this way to the great result.

The thickness of the layer is not its purpose, the functionality of the layer is its purpose. Therefore, this layer should be used to smoothen things out and achieve a finer surface. If the coarse plaster has some uneveness then this finer plaster can be used to even that out.

2.40. Main structures – electrical wiring

In new houses today all electrical wiring is put inside the wooden walls in bendable tubes. The same principle applies to cordwood walls as long as there is internal insulation in the cordwood walls.

If the choice has been a cordwood wall without internal insulation then the electrical wiring can be put on the exposed indoor part of the wall.

Before starting the building of the house there must be a plan, a wiring diagram for all the electrical wires, connecting points, switches, fuse box etc. Every detail in the house's electrical set-up must be in the plan so that the cordwood walls can be built for that set-up and the tubes for the electrical wires can be built into the walls according to the plan.

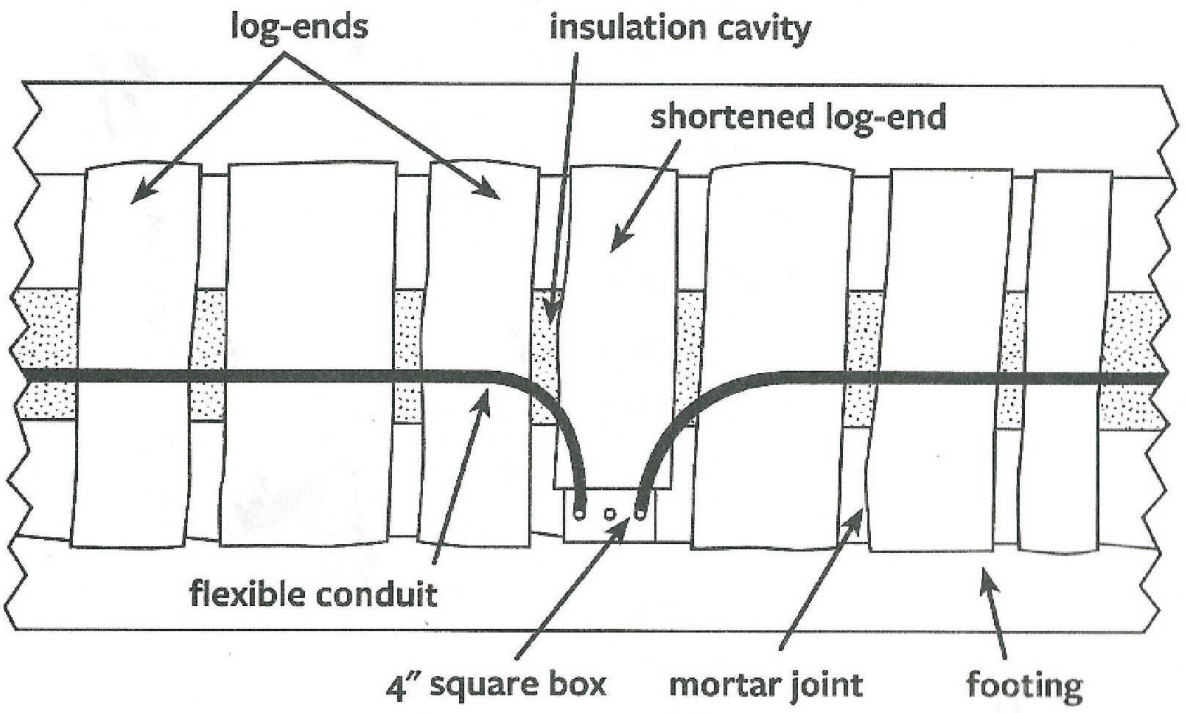


Fig. 41. Example of how electrical wiring can be built into the cordwood wall in the insulation part; source: [CoCoCo, n.d., p. 100].

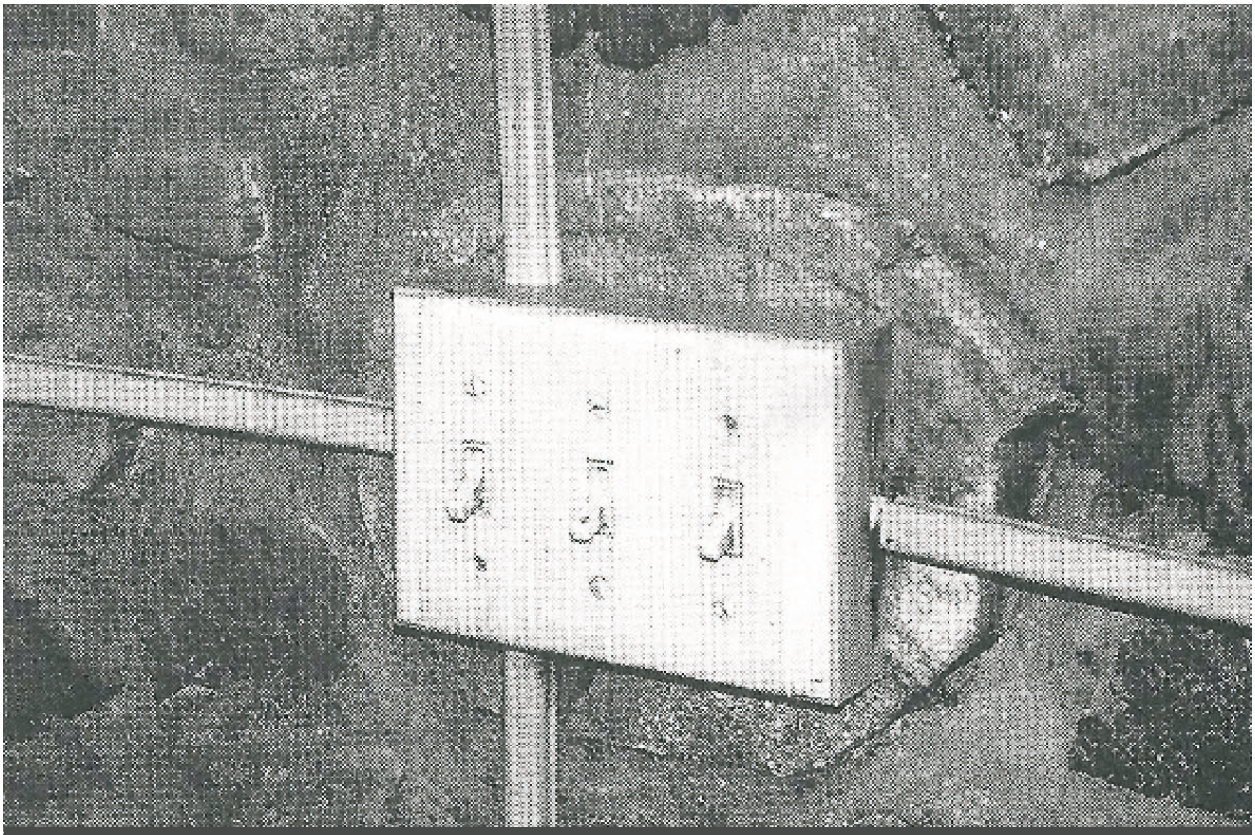


Fig. 42. An example of how electrical wiring and applications can be mounted on the exposed inside surface of the cordwood wall. The wires are protected in adequate tubing that can be mounted to the wood; photo by: [Roy, 2016, p. 101].

2.41. Main structures – foundation

The foundation for the entire construction can be a sole made of Portland cement. This is a common practice in Norway when building a house.

Up from the cement sole it would make an adequate solution to put a ring wall of bricks of 40 cm height. This is the minimum height from the ground that the cordwood wall must have at any point around the house. 40 cm is a height used for ecological constructions such as strawbale constructions in order to keep a sufficient distance from the humidity of the ground so that the walls will not suffer from moisture damage over the years.

The cordwood wall can rest on the 40 cm brick ring wall with an impermeable membrane in between the cordwood wall and the bricks. An example of a somewhat different solution can be seen in Fig. 43.

Fig. 43. The outside of a straw bale house, showing a sufficient height from the ground level of the sole of Portland cement. There is first a sole of Portland cement, then blocks and finally bricks. There is an impermeable membrane laid on top of the bricks, 2021; photo by the author

2.42. Main structures – roof

A cordwood house with exposed clay based mortar or plaster must be built with a roof that extends far enough out from the walls so that the cordwood walls do not recieve any direct rain. Over time, direct rain could wear away the mortar.

2.43. How big can the house be?

The size of a cordwood construction to set up for two persons should be no more than 110 m^2 [Roy, 2003, p. 186].

The time window for setting up a cordwood house is during the warm period of the year. The drying of the mortar must take place during the time when there is no night frost. Night temperatures below zero while there is still water in the mortar will cause frost damage in the form of expansion. The mortar needs some weeks to dry before frost nights set in during autumn.

Fig. 44. Cordwood house with large roof overhangs so that rain will not hit the mortar directly in any place. (There can also be seen a good ringwall up from the ground); photo by: [Flatau, n.d.].

For the integrity of the construction, and commonly for having a place to live in, it is important to be able to close the outer wall of the construction in good time before the winter. The construction must not have an open outer wall during winter.

It should not be underestimated how work intensive such a project can be. The work load is big enough to put a strain on a relationship and can very well result in a divorce. However with good enough planning and keeping the project within limits it will be a strengthening experience for a couple and a family. If 110 m^2 is too little then the house can be expanded during the years.

3. DISCUSSION

3.1. Techniques

The three cordwood wall types 1) single wall, 2) single wall with insulation, and 3) double wall technique, are three easy to build logical adaptations to building with cordwood and mortar. From the first and simplest technique of just a single wall of logs and mortar to the next of single wall with an insulation chamber, there is a natural step of adaptation and improvement ending in more complexity and better function. The double wall technique with an entire mid insulation section is yet another step in a natural evolution of the cordwood wall technique for improved insulation performance.

3.2. Techniques – characteristics

Type 1 single wall - gives an impression of being the most straight forward and easy wall to build for an unexperienced self builder. It must also be the most stable wall type of the three types due to the massiveness of the mortar and full log-length-thickness of the wall. Type 2 single wall with insulation – is less massive than Type 1 but still seems stable, and it has a better insulation value. Type 3 double wall technique – gives the impression of being the least stable wall because you would have to reduce the length of the logs, however it would get the best insulation value due to the uninterrupted centered insulation space.

3.3. Tree species

The historically used tree species in Norway show that there was a clear knowledge of which species to use. Spruce, aspen and pine were most used. Birch could also be used but it was less common. These are all lighter airier woods which provide better insulation and less expansion during construction. The newer cordwood construction in North America also prefers the use of lighter airier tree species.

3.4. Clad or unclad

Cordwood masonry results in wind proof walls in unclad state. The exposed end pieces of wood logs of the unclad cordwood walls have no particular problem with external humidity. Rain is not a problem with sufficient distance from the ground and a well extending roof. A cordwood house with exposed logs can last for a hundred years and still be in good condition.

Cladding gives the advantage of a faster execution because of not having to make the cordwood masonry aesthetically pleasing. Cladding with wood boards can be done during the cold season and cladding with clay based plaster can be done next warm season.

3.5. Load bearing

Cordwood functions well with a regular framework for houses as a load bearing structure. Of course, a load bearing framework has the great advantage of providing a roof which gives protection from rain and sun during the construction period of the cordwood walls. For this reason it is highly recommended.

Load bearing cordwood walls is a possibility. In particular the historical technique much present in Norway with horizontal battens put in between each layer of logs for stability, gives the impression of it being a quite stable construction. The same impression is given by Lomax Corners in other load bearing cordwood walls.

3.6. Execution

The wood and the clay-containing soil are unaltered natural resources and can have some natural variation, but as long as they are used correctly they will not be the reason for any unwanted results. The wood will work fine as long as it is dry enough and has not suffered any moisture damage during drying.

The mixing of mortar and plaster has more potential to produce a more variable result, and it is therefore important to try it out and get some experience before starting to build a house. There is much valuable experience in participating in courses and making some minor construction projects just to test things out in practice beforehand.

3.7. Unanswered questions – heavier denser woods

Might there be a third advantage to using light and airy woods instead of heavier denser woods? Reason one and two were stated to be better insulation and less expansion. Could there be a third factor – that heavier, denser woods might be less efficient at transporting humidity through the wall? The reason would simply be that higher specific weight means more wood and less air in the same volume of wood log, and thus the humidity will not have so much free space to move through.

3.8. Unanswered questions – birch bark

Birch bark is water proof. It has traditionally been used for roofing in Norway. Birch bark was laid first and then turf was laid. Greens would grow on top of it. The durability of the birch bark could easily be 70 - 100 years if all was done correctly.

This raises the question if using round unsplit logs of birch with the bark still intact on the logs would prevent the water in the mortar from reaching the logs during building of the cordwood wall. Would there be no swelling and expansion of the logs in the wall? Would there be less movement in the wall during construction than with the other lighter woods?

The problem with fungus beneath the bark can be avoided by felling the birch tree at the right time of the year.

3.9. Unanswered questions – clad vs unclad and transportation of humidity

Possibly the transportation of humidity from the inside environment of the house passes more efficient when the cordwood wall is not clad with clay based plaster. Possibly the transportation of humidity from the inside

environment of the house to the outside environment goes much less efficient as the log endings do not have free respiration.

Possibly cladding the cordwood wall with wood boards will also hamper the transportation of water molecules through the wooden logs. Wood placed sideways should transport water molecules slower than wood placed in accordance with its original lengthwise transportation route for water molecules.

3.10. Suggestions for further research

- Finding values for thermal transmittance U (W/m^{2}K) for the corwood wall. These values are for using in the building application by the self builder:
    - Values for different woods lengthwise.
    - Values for different mixes of clay based mortar.
- Do lighter, airier woods transport humidity more efficiently than heavier, denser woods because logs of heavier woods have more wood volume and less free space volume for movement of water molecules?
- Does intact birch bark on unsplit logs stop water in the mortar from entering the wooden log, and do such logs produce less movement in the wall than other lighter wood species without bark?
- Is humidity transported more efficiently through an unclad cordwood wall than a clad cordwood wall, due to the log endings being open and having free diffusion?
    - Diffusion through unclad logs.
    - Diffusion through logs clad with clay based plaster.
    - Diffusion through logs clad with wood boards.

CONCLUSIONS

Technique of recommendation – single wall with insulation

It is my recommendation to use technique number 2; single wall with insulation. This wall will be better insulated than the single wall that has no space for insulation. This technique is also easier to make stable than the double wall technique.

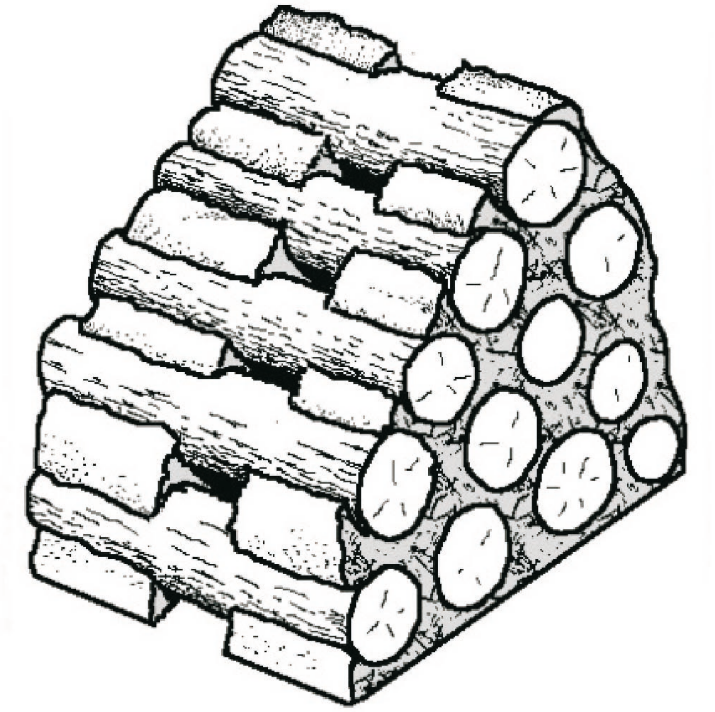


Fig. 45. Single wall with insulation; source: [Szewczyk, n.d., p. 10].

Recommended tree species

Spruce is the lightest and airiest among the historically used tree species in Norway and will yield the best of the desired prestations. Because of that I recommend it as the choice of wood for building a cordwood construction in Norway today.

Clad and unclad

Unclad can be a question of preferred aesthetical expression, while clad can be a preference of faster execution of the cordwood masonry. There are many old cordwood houses with clay based plaster cladding and wooden board cladding. Both options work fine. Cladding thus is optional.

Load bearing

Cordwood masonry works fine with load bearing framework, and cordwood masonry is capable of carrying load by itself when built properly. It is therefore a question of choice depending on the conditions one wishes to put into the project.

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Fig. 45. Jarosław Szewczyk (n.d.). *#3 Design and Build with Cordwood*. (Learn Building Impact Ø, 31 July – 27 August 2017, 2 Edition 2018). Östertälje: Architectural Environmental Strategies. Available from: https://indd.adobe.com/view/14fe3104-85ae-41d5-8fdc-a7458e25fc45 (Fetched: 26 September 2021).