

# The history of the mortars of Turku castle

Misa Nurminen, MSc Architecture

Mortar has been utilized in building construction for thousands of years<sup>1</sup>. The oldest preserved mortars are inherently culturally and historically valuable evidence. By studying them, information about both the history and culture of the buildings and their builders can be obtained. However, only limited written information about mortars and the traditions related to mortar production has remained to this day. As Von Konow notes, mortar recipes were not commonly documented, and masons closely guarded their craftsmanship as a well-kept secret<sup>2</sup>. My master's thesis, *Mortars of Turku Castle – The history and culturohistorical value of a building material*, explores the development of mortar production and lime burning in Finland. It takes a closer look on the mortars of Turku Castle, aiming to find out what written information about them has been preserved. Additionally, the thesis analyses the culturohistorical value of mortar. The thesis is written in Finnish and was published in November 2023 on the Senate Properties website and the digital publication archive of Tampere University. This article provides a summary of the essential content of the thesis, particularly regarding the history of mortars.

## Mortars in Finland

Mortar has been produced for thousands of years. In the Middle East, radiocarbon-dating has dated mortar findings to as early as 6000 BCE–10000 BCE. However, the use of lime mortar for masonry purposes only became widespread slightly before the beginning of the CE in ancient Greece.<sup>3</sup> The Greeks adopted the skill of mortar production from Phoenician sailors arriving from Asia Minor. The mastery of mortar production reached its zenith during the Roman Empire, spreading northwards to England and Germany. After the fall of the Roman Empire, mortar production declined until it was revived in the early medieval period, through the construction of churches. Initially, mortars were lumpy and poorly made from inadequately burnt lime. During the medieval era, lime began to be sifted and burnt more effectively, resulting in improved mortar quality.<sup>4</sup>

The exact time when the skill of mortar production spread to Finland is not known for certain. It likely arrived in the Nordic countries with the advent of Christianity when the first medieval stone churches began to be constructed<sup>5</sup>. Attempts to trace the origins of masonry and mortar usage have been made by determining the construction dates of the earliest brick buildings. However, a consensus on the precise timeframe has not been reached<sup>6</sup>. Archaeologist Tanja Ratilainen's doctoral dissertation outlines the development in dating masonry structures and summarizes the latest perspectives. According to her, researchers suggest that masonry construction began in Åland in the mid-1200s and in mainland in the early 1300s<sup>7</sup>. The earliest written evidence of lime burning dates back to 1329 when Turku Cathedral received a donation of limestone from Krakanäs.<sup>8</sup>

Information about the early days of mortar production primarily revolves around where lime was produced. Lime burning could only be practiced

in areas with limestone deposits, which are common in Southwest Finland<sup>9</sup>. Known major lime-burning locations in medieval times were Parainen and Lohja<sup>10</sup>. In addition to location, there is some knowledge of the methods used in lime burning. Lime burning has traditionally been a folk craft in Finland<sup>11</sup>. Peasants burned lime for their own use, for sale, and as a tax to be delivered to the crown<sup>12</sup>. Typically, Finnish peasants used earth kilns for lime burning<sup>13</sup>. An earth kiln is an approximately 8-meter-long and 5-meter-wide pit dug into a hillside, lined with clay and granite. When loading limestone into the kiln, vault-like channels are left between the rocks, into which whole tree trunks are inserted for burning. Filling the kiln usually took 10–12 days, and the actual burning process lasted 6–7 days. For the first few days, the kiln burned openly, after which its top was closed for the remainder of the time to retain heat. One medium-sized kiln produced approximately 70,000–80,000 litres of lime at a time. In the busiest kilns, lime burning was performed six or seven times a year.<sup>14</sup> However, there was considerable variation in kiln construction and burning times depending on the location<sup>15</sup>. This description is therefore approximate. Figure 3 shows an example of a Finnish earth kiln.



Picture 1: Lime kiln in Kainuu, Finland (Frosterus 1904).

## Mortars of Turku castle

The mortars of Turku Castle are interesting in the context of Finland. There is uncertainty about the construction date of Turku Castle, but it likely coincides with the time when mortar first started being used in Finland. According to Kupila and Uotila, considering other historical events, it seems probable that the construction of the castle began in the 1280s. At that time, the Kingdom of Sweden was divided into castle counties, and the Eastern Realm needed castles as administrative centres<sup>16</sup>. Due to the uncertainties in dating, it is not entirely ruled out that Turku Castle could be the first masonry building in mainland Finland<sup>17</sup>. Therefore, the mortars of Turku Castle represent a cross-section of the entire history of mortar production in Finland.

However, there is only limited information available about mortars. Details on the mortars of Turku Castle are scattered across various sources from different periods. The castle's account books contain old information whereas more detailed information is available in online archives from the last centuries. Next, I address the mortars divided into four periods.

### The Middle Ages 1280–1520

Turku Castle was continuously under construction during the first two centuries of its history<sup>18</sup>. Mortar was widely used, but no original written sources have remained. Information about medieval mortars, in general, is scarce and quite superficial. Therefore, what is known about the mortars of Turku Castle is limited to what can be inferred based on the general history and what has been revealed in later research.

During the medieval period, the common construction technique involved the use of cast-in-place masonry. The surfaces of thick walls were carefully masoned, while the central areas were filled with loose stones, mortar, and discarded bricks.<sup>19</sup> Finally, loose mortar was poured into the main area, flowing into the gaps between stones, filling the empty spaces, and binding the entire wall together<sup>20</sup>. The method was employed in both stone and brick walls, using lime mortar. The walls didn't require additional support and could stand on their own. The quality of medieval brickwork exceeds that of the following centuries in many buildings<sup>21</sup>. The mortars themselves were also generally high quality during the medieval period. The reason for this could be the use of lime burned in earth kilns. In earth kilns, temperature changes were slow, and the firing temperature was low, resulting in soft lime. Additives might have been used in mortars as well, but there is no research

information on the subject. According to literature, in the medieval period, various additives were used in mortars, including ash, oil, grease, and clay, which were available in Finland.<sup>22</sup>

Perhaps they were also used at Turku castle but there is no evidence. Only little is known specifically about the mortars of Turku castle. According to architect Eero Raatikainen, the medieval walls of the castle were pointed with flush mortar joints. The edges of natural stones were covered, but the bricks were completely visible<sup>23</sup>. Kronqvist states as well, that tight and neat joints were typical in the medieval walls of the castle<sup>24</sup>. Kronqvist and Raatikainen discuss exposed wall surfaces, but at some point, the walls of the castle were plastered. There is no consensus on the timeframe, but it seems that at the latest, by the end of the medieval period, Turku Castle was plastered. All literary references suggest that the plastering was done either in the preliminary stages of construction or by the latest in the 16th century<sup>25</sup>. Additionally, Perander et al. confirm that plastering was commonly done in the medieval period. At that time, it was customary to apply the mortar to the wall with a board.<sup>26</sup> It is therefore possible that Turku Castle was plastered already in the medieval period.

According to Gardberg, during the medieval period, masonry work at the castle was led by foreign masters. In the late 1200s, there may have been masons from Gotland working at Turku Castle.<sup>27</sup> From the vaults of the King's Hall, built in the late 1300s, Gardberg concluded that the expert builder had come from East Prussia<sup>28</sup>. And in the early 1400s, the master masons of the castle seemed to have come from Marienburg. This conclusion was based on the vault type of the Lord's Cellar, where the original medieval structures were still visible in 1993.<sup>29</sup>

The origin of the lime used in mortars is not certain, but estimates can be made. According to Kuokkanen, during the medieval period, lime was at least burned in Parainen, Kemiö, and Turku<sup>30</sup>. He argues that lime for Turku Castle was produced at the state lime kiln located in Turku<sup>31</sup>. There is no evidence that this lime kiln existed, and the topic raises conflicting opinions among experts. Ratilainen, who has inventoried lime-burning sites in the area, questions the claim of a state lime kiln, as she has not come across information about such a kiln. On the other hand, professor Savolainen finds it plausible<sup>32</sup>. In any case, the medieval lime-burning sites are located relatively close to the castle and based on their temporal existence and proximity, could have produced lime for the castle's mortars.

## The Beginning of the Modern Era 1520-1600

In the mid-1500s, Turku Castle became the centre of Finnish court life when Johan III, the son of Gustav Vasa, started his residence in the castle as the Duke of Finland. Masons were invited from Sweden to renovate the dark medieval castle.<sup>33</sup> Mortar was widely required in the construction projects that were conducted at the beginning of the modern era.

From this era, more is known about the origin and processing of mortars. The series of account books for Turku Castle starts in 1538, marking the earliest written source on the castle's history. The account books reveal the origin of lime brought to the castle and the names of the masons involved. Instead of the original account books, I reference Gardberg and Ruuth, who have studied them previously.

In 16th-century Finland, leading craftsmen were commonly from abroad, mostly from Sweden and Germany, but ordinary masons were Finnish<sup>34</sup>. In Turku, there were enough local workers, and in the early years of the century, local men were employed in the repairs of Turku Castle<sup>35</sup>. In the latter half of the 16th century, a group of Swedish professionals also worked at the castle<sup>36</sup>. Their work was led by the Swedish professional Staffan Mattsson<sup>37</sup>. In addition to journeymen and apprentices, head masons also needed other labourers in their work, who took care of the preparation of materials needed for mortar. This included lime mixers, whose task, for example, was to slake lime by pouring water over it.<sup>38</sup>

In addition to craftsmen, the account books provide extensive information about the origin and quantities of burnt lime. The account books of Turku Castle constitute the most complete surviving record of the history of lime burning in the entire country<sup>39</sup>. The account books reveal that lime was procured for the castle both through purchases and as tax<sup>40</sup>. To fund the construction of Turku Castle, a special tax was collected, enabling the execution of large-scale construction projects. Peasants paid the tax by supplying building materials, such as lime<sup>41</sup>.

More detailed quantities of lime deliveries can be examined in the digitized account books of the National Archives and in my master's thesis. During the early 1500s, lime primarily came from Åland, Parainen, and Livonia. Later, the significance of Åland and Livonia diminished, and the castle employed its own lime burner<sup>42</sup>. According to Gardberg's estimates, the most significant lime supplier throughout the early modern period was Parainen<sup>43</sup>. The lime suppliers, including many others, were located by the sea. Building materials were still commonly transported to the construction site by water, as was the practice in the Middle Ages<sup>44</sup>.

## The centuries of decay 1600-1880

A fire occurred in the main castle in 1614 and it symbolized the beginning of a new era for Turku Castle. After the fire roofs and floors were renewed, but the main castle remained in use as mere storage. Slow deterioration continued in the following centuries, and mostly demolition work was conducted in the main castle.<sup>45</sup> Repair and construction work was less extensive during the 17th and 18th centuries, leading to a decreased demand for mortar. According to Gardberg, it can be inferred from the account books that only minor maintenance work was conducted at the beginning of the 17th century. However, there is uncertainty regarding the years 1610–1630, as the account books from that period are missing.<sup>46</sup> Furthermore, from the 1630s onwards, the account books regarding mortar and lime remain entirely unexplored.

The lime suppliers are also unknown without information from the account books. Additionally, there is no information available about the destiny of the castle's own lime-burning facility. According to Kuokkanen, lime burning in Finland significantly declined in the 17th century, and state lime production decreased. It remains uncertain how long Turku Castle's own lime-burning operation continued.<sup>47</sup> So, the major construction projects at the castle concluded around the same time as the systemic issues affecting lime production began. Maybe the castle's own kiln was utilized for a longer duration as external suppliers decreased in number, or maybe it too ceased operation as the demand for lime diminished.

Little is known about the masons of Turku Castle because the account books have not been thoroughly examined. According to the last account books studied by Gardberg, the number of craftsmen at the castle decreased as construction work slowed down, and essential maintenance tasks were carried out by local men. Staffan Mattsson, who led the free masons at the castle, had died in 1599, and after him, there was only one mason at the castle who was assisted by locals as needed.<sup>48</sup>

In general, it can be said that the quality of mortars declined in the 17th century, and more binding agents were often used in the walls<sup>49</sup>. It is unclear if this also applies to Turku castle. Instead, it is known that colours were incorporated in the plasterwork at the castle. In 1974, a yellow-tinted plastered wall was discovered, believed to date back to 1770.<sup>50</sup> In addition, ochre-coloured plaster was revealed on the gate tower of the outer ward, presumed to date back to either the 1770s renovation or the early 1800s.<sup>51</sup> Mattinen and Raatikainen also believe that the plaster of Turku Castle was red in the 17th and 18th centuries and later turned yellow<sup>52</sup>.

## The Restoration Period 1880s – 2020s

A wave of restoration based on nationalism and admiration for the medieval era emerged in Europe. In Finland, Turku Castle and its natural stone walls inspired writers<sup>53</sup>. In the mid-1800s, there were public discussions expressing a desire for the restoration of the castle. Towards the end of the century, Turku City Historical Museum set the goal of returning the castle to its former appearance.<sup>54</sup> As a result of increasing interest in restoration, deepening understanding of the castles value, and better documentation, more detailed information about mortars has remained from this era. In the master's thesis, this period is divided in four chapters, in each of which the plasters are discussed in detail, including the raw materials and their origin, and the manufacturing, consistency and application of the mortars and plasters. In this article, the mortars from 1880s to present day are discussed more generally in this one chapter.

The most significant thing that separates the mortars of restoration period from those of the previous periods, is the raw material. Cement production began in 1856, and according to Perander, it is possible that it was used in demanding construction projects in Finland already by the late 1800s<sup>55</sup>. At Turku castle cement was utilized at the latest in the 1930s, as a mention found in a restoration report proves<sup>56</sup>. Also, during the first big restoration phase, the great restoration of the main castle in 1940s-1960s, both the rendering and pointing mortars underwent almost complete renewal. All the main castle's walls were repaired, and their mortars were replaced on both the exterior and interior.<sup>57</sup> The restoration mortar was a lime-cement mortar<sup>58</sup>.

In later repairs, various types of mortars have been experimented with and used in the castle. For instance, in the construction site protocol from 1979, it is mentioned that interior walls were repaired with masonry cement, and the patched areas were covered with lime and clay plaster<sup>59</sup>. In 1980, plastering was done using lime-cement mortar, and the surface layer was finished with clay plaster<sup>60</sup>. In 1980s, the facades of the bailey were plastered with lime-cement mortar (Picture 2)<sup>61</sup>.

## Conclusion

Turku castle consists of endless mortar and plaster layers, which are impossible to separate from each other. By studying the common history of mortars and their use at Turku castle, my master's thesis succeeded to create a rough picture about the mortars of Turku castle. Additionally, all available details on the specific mortars were collected to a chronological list, which is attached as an appendix to the original master's thesis. The results of my thesis provide valuable information on the history of the mortars of Turku castle. The information is useful in researching the castle's history and could also be used in the development of new repair mortars. However, many questions and unknown aspects remain and there still is further research potential.



Picture 2: The bailey gets a new plastering (Kotkas 1985).

The mortar recipes have changed many times, and they are still being developed. The recipes that are used nowadays are from 2016 and according to them, both hydraulic lime mortar and lime-cement mortar are used, depending on the targeted area.<sup>62</sup>

The lime used in mortars has also undergone major changes. According to Kauko Leiponen, lime production became industrialized in the early 20th century, and manufacturing shifted to factories. The lime produced in small-scale manufacturing had been of varying quality, but now the quality of lime began to be controlled.<sup>63</sup> During the great restoration, the mortar was still prepared on-site<sup>64</sup> and the cement was acquired from Parainen<sup>65</sup>. However, in the 1980s, Partek Oy delivered industrially manufactured lime to Turku castle<sup>66</sup>. Additionally, as we arrive to the 2000s, the geographical location of the raw material no longer plays the same role as before. Today, mortars are controlled by European standards<sup>67</sup> and it's clear that the industrialization and globalization have affected the mortar choices for Turku castle. In recent decades, mortars from various parts of Finland and even from abroad have been supplied to the castle<sup>68</sup>. This includes i.e. Sweden, France, and Germany<sup>69</sup>.

Something that has not changed, however, is the artisanry that is required in applying the actual mortar. The preparation and mixing of the mortar involve the use of electric tools, but the actual masonry is done by hand<sup>70</sup>.

## Endnotes

- <sup>1</sup> Carran et al. 2012, 117–119.
- <sup>2</sup> Perander et al. 1985, 13.
- <sup>3</sup> Carran et al. 2012, 117–119.
- <sup>4</sup> Perander et al. 1985, 12–13.
- <sup>5</sup> Ibid.
- <sup>6</sup> Nyström 1951, 15.
- <sup>7</sup> Ratilainen 2020, 47–68.
- <sup>8</sup> Ibid., 51, 57, 68.
- <sup>9</sup> Kuokkanen 1981, 46.
- <sup>10</sup> Talve 1965, 3.
- <sup>11</sup> Ibid.; Kuokkanen 1981, 46.
- <sup>12</sup> Suistoranta 1985, 45–46.
- <sup>13</sup> Talve 1965, 8–9.
- <sup>14</sup> Suistoranta 1985, 265–266.
- <sup>15</sup> Talve 1965, 8–14.
- <sup>16</sup> Kupila ja Uotila 2016, 9.
- <sup>17</sup> Ratilainen, videopuhelu 31.5.2023.
- <sup>18</sup> Kupila ja Uotila 2016, 10–16.
- <sup>19</sup> Perander et al. 1985, 14.
- <sup>20</sup> Hiekkänen 2003, 35–36.
- <sup>21</sup> Gardberg 1957, 30–31.
- <sup>22</sup> Perander et al. 1985, 26–28, 50.
- <sup>23</sup> Raatikainen 1990.
- <sup>24</sup> Kronqvist 1946, 13.
- <sup>25</sup> Mattinen ja Raatikainen 1990; Raatikainen 1990; Leppäniemi and Sonninen 2014, 14.
- <sup>26</sup> Perander et al. 1985, 15.
- <sup>27</sup> Gardberg 1957, 20–27.
- <sup>28</sup> Gardberg 1961, 8.
- <sup>29</sup> Gardberg 1993, 15.
- <sup>30</sup> Kuokkanen 1981, 94.
- <sup>31</sup> Rinne 1946, 10–11, according to *ibid.*, 47.
- <sup>32</sup> Ratilainen, video interview 31.5.2023; Savolainen, email to author 2.6.2023.
- <sup>33</sup> Gardberg 1961, 8–11.
- <sup>34</sup> Gardberg 1957, 20–31, 54–59.
- <sup>35</sup> Ruuth 1909, 122, 166.
- <sup>36</sup> Gardberg 1957, 49–50.
- <sup>37</sup> Nikula 1987, 377–378; Gardberg 1959, 502–503.
- <sup>38</sup> Nikula 1987, 378.
- <sup>39</sup> Kuokkanen 1981, 94.
- <sup>40</sup> Gardberg 1959, 185, 321, 393, 513–514, 552.
- <sup>41</sup> Suistoranta 1985, 45–46.
- <sup>42</sup> Gardberg 1959, 185, 187, 321.
- <sup>43</sup> Ibid., 552.
- <sup>44</sup> Kuokkanen 1981, 100.
- <sup>45</sup> Gardberg 1961, 11–13.
- <sup>46</sup> Gardberg 1959, 539.
- <sup>47</sup> Kuokkanen 1981, 97.
- <sup>48</sup> Gardberg 1959, 550.
- <sup>49</sup> Perander et al. 1985, 14–15.
- <sup>50</sup> Soiri 1974, 11.
- <sup>51</sup> Pietarila 1993, 63.
- <sup>52</sup> Mattinen ja Raatikainen 1990.
- <sup>53</sup> Nieminen 2023a, 145–146.
- <sup>54</sup> Ripatti 2011, 134–139.
- <sup>55</sup> Perander et al. 1985, 45.
- <sup>56</sup> Rinne 1932.
- <sup>57</sup> Leppäniemi ja Sonninen 2014, 9–11; Nieminen 2023b, 92, 166.
- <sup>58</sup> Leppäniemi ja Sonninen 2014, 10–11.
- <sup>59</sup> Turun linnan työryhmän pöytäkirja 5/79, 24.9.1979.
- <sup>60</sup> Raatikainen 1981b; Raatikainen 1981a.
- <sup>61</sup> Lehtonen ja Laaksonen 1982.
- <sup>62</sup> Leppäniemi 2016a; Leppäniemi 2016b; Turun linna rapauskorjaus 2007 työmaakokouspöytäkirjat, 2, 3 ja 4.
- <sup>63</sup> Leiponen 1981, 219, 342.
- <sup>64</sup> Turun linnan korjaustöiden valtuuskunnan pöytäkirja 1948:4, 27.10.1948.
- <sup>65</sup> Tähtinen 1946.
- <sup>66</sup> Lehtonen ja Laaksonen 1982.
- <sup>67</sup> Konow 2006, 16, 18.
- <sup>68</sup> Rakennustoimisto Lainio & Laivoranta oy 2008; Vilkanen 2007; Suna 1991; Lehtonen ja Laaksonen 1982.
- <sup>69</sup> Leppäniemi 2016a; Menchacatorre, email to author, 30.6.2023. Lauren, email to author 15.2.2023.
- <sup>70</sup> Hirviniemi, video interview 26.6.2023; Flink, email to author 13.7.2023.

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