

Brickwork-Related Innovations in the Seventeenth and Eighteenth Century

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In the course of the nineteenth century admiration arose for the old, national architecture, initially picturesquely depicted and later documented and copied down to the smallest detail. Romanticism nourished the ardent wish to fathom the medieval soul, to revive that sublime architecture with all the knowledge available. Although neo-Gothic buildings are often protected as listed buildings nowadays, no one would mistake neo-Gothic buildings for medieval ones. The limited wear and tear, the lack of patina, the use of machine-manufactured bricks and tiles are self-evident. In the nineteenth century the bricklaying of vaults had to be reinvented. The vacuum between the reformation and the revival of the Catholic part of the population had become an unbridgeable gap. In retrospect, the nineteenth-century appreciation of the Middle Ages often shows selectivity and ignorance. In nineteenth-century appreciation of pure materials plaster was omitted from most new construction until far into the twentieth century. During restorations of truly medieval buildings in the nineteenth and twentieth century the plaster coats, including possible wall paintings, just as old floors and roof constructions, were cleared away unnoticed. Bricklaying in exposed brick with struck mortar joints remained fashionable, as well as a sign of 'traditional' workmanship. Pure exposed building materials were preferred: timber acquired a transparent or wood-coloured finishing, the specific brick surface was allowed to be eye-catching, just as that of natural stone, which, in an unmedieval way, was provided with a drafted cross-pattern. Actually a new, contemporary style developed, the beauty of which was projected onto the past with retrospective effect. The new approach was also inspired by the nineteenth-century invention of the superior binder: Portland cement. To this very day large quantities of Portland cement are used for the restoration of old brickwork, both for the masonry and the pointing. In the form of cut pointing a 'traditionally sound' variant was developed, which was considered harder, finer and more efficient than the less striking, flush pointing or lightly brushed old lime pointing. Due to these kinds of views entire square miles of historical brickwork were destroyed forever, as will be illustrated later on. Within half a century, between 1875 and 1925, an absolute break with the past took place. What happened to the *Arts et metiers* in the nineteenth century?

THE GUILDS

Under the influence of the French Revolution the guilds were permanently abolished in the Netherlands in 1808 by virtue of the constitution of 1798 (Batavian Republic). Thus the citizenship-related system of training in practice, quality guarantee, but also protection and collective care disappeared. Particularly in the sixteenth century the spheres of activity of the various specialisms

were defined. Around the middle of that century a few trials took place in Utrecht and Kampen, which illustrate that theoreticians or craftsmen from other occupational groups than the masons/bricklayers meanwhile occupied themselves with designing buildings. In the Netherlands this trend continued in the seventeenth century when the term *architect* was first used, a profession that could also be practised by, for example, a painter or a carpenter, such as Jacob van Campen and Arend van 's-Gravensande. They studied Vitruvius and the drawn interpretations of this classical handwriting, which by then was available in printed form. This does not only manifest their admiration for the form language of Antiquity, but above all their wish to grasp the underlying proportions. Already in the Middle Ages a pair of compasses was a symbol of mastery. God the Father as creator of the universe was depicted with compasses, just as in later times a craftsman, who was thereby indicated to have a profound command of mathematics. In a quarrel between two cabinetmakers in Kampen Colijn de Nole witnessed in 1543: “And because they were arguing about art, the aforesaid master Vrederick said that he would hang out the golden compasses to show thereby that he was master and superior to all others” (De Vries 2001, p. 75).

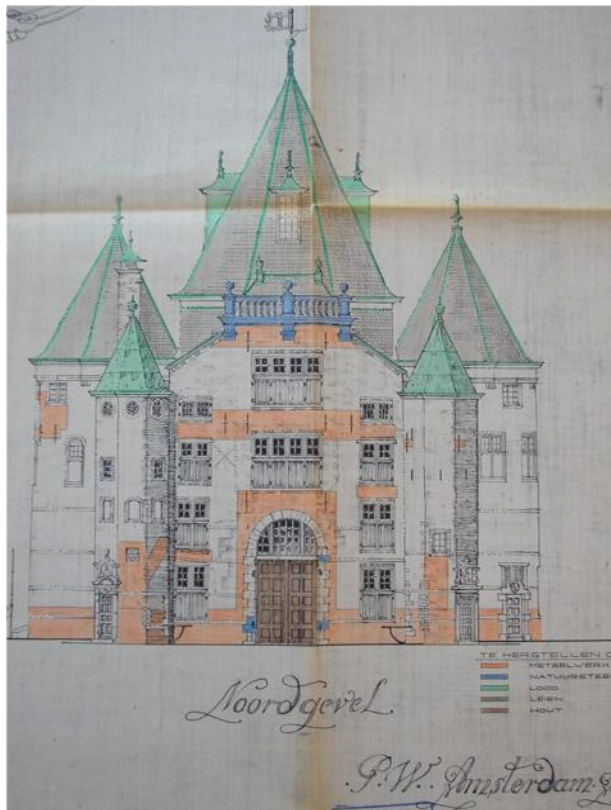


Figure 1. North side of the Amsterdam Waag (weighhouse) with entrance turrets to the guildrooms (Gemeente Werken Amsterdam 1942)

Freemasonry also uses compasses (and square) as symbols of the ideal lodges founded in the course of the eighteenth century. The order is said to go back to medieval rituals related to the trade of (free) mason. Social cohesion, working at the world and at yourself are factors playing a role within the guilds. It is remarkable that the abolition of the guilds more or less coincided with the rise of the ideally and abstractly functioning freemasonry. On other fronts, too, we see that in the nineteenth century the craftsman was definitely overruled by the theoretician. Is this just a coincidence or do any other factors play a part?

Since 1617 the guild of the Amsterdam masons and bricklayers had held its meetings on the first floor of the refurbished St. Anthonispoort, which then acquired the function of the new weighhouse 'De Waag' (fig.1).



Figure 2. Entrance of the guildhall for the bricklayers, stonemasons, slaters and pumpmakers in the northeast tower, sandstone 1617

The northeast staircase tower gave entrance to it. The door is framed with Bentheim sandstone with in relief the tools of the four guilds united here, notably the bricklayers, masons, slaters and pumpmakers (fig.2).

From three to five every Monday the surveyors of the guilds met in this room (Kurpershoek 1994, p. 24). On the first floor the masons had two rooms, with above them a small attic room under the

steeple of the staircase tower. Income and payments were handled through a cash desk, a *bosse*, for which the dean of the guild and the four surveyors each kept a key and which was thus supervised jointly. The dominant position of the bricklayers appears from the composition of the guild leadership in 1662: “... a dean being a master bricklayer, with two surveyors, also being master bricklayers, [...] notably three master bricklayers, one master mason and one person functioning as master for the slaters and pummakers, so acting as master for both trades” (GA ms 366-1339 and 366-1342).

No one could join the guild unless he was a citizen and had prepared a masterpiece, for which he paid 13 guilders plus additional costs, among other things for inspection of the masterpiece and a ‘certificate’ in the form of the accompanying medallion and the testimonial, 63.13 guilders in all (GA ms 366-1342 and 366-1338).

Preparing the masterpiece appears to have been relatively cheap in Amsterdam, compared to other towns. In Leeuwarden, for instance, apart from the cost of material, the amount was fixed at 180 *carolusgulden* for citizens and Dfl. 200 for non-citizens. (Mud 1988, p. 84).

The content of the masterpiece of the pummakers is described (GA ms 366-1338). End seventeenth century the masterpiece of the Amsterdam masons is also described: “That after this no one will be allowed to enter the masons’ guild, or be accepted, until they have made a Ionic column with capital and base, to be inspected by the surveyors, from one piece of marble or other stone, as ordered by the surveyors” (GA ms 366-1343).

Several of these small columns can be seen in the staircase tower on the first floor, but the Ionic capitals seem to have been made separately and from another type of natural stone. Because of daily occurring misunderstandings and irregularities in 1691 a time limit was set for the preparation of the masterpiece (GA ms 366-1343, p. 5). From now on, no one could work at the masterpiece longer than: “A plumber for the period of fourteen days; a slater for the period of three weeks; a mason for the period of one month; and a bricklayer for the period of six weeks” (GA ms 366-1343). From this we may conclude that the bricklayer’s masterpiece took most time and may therefore have been regarded as the most difficult. However, there is no information on the nature of the masons’ or the slaters’ masterpiece in the available archives. Fortunately, both inside and outside the Amsterdam weighhouse dozens of extraordinary pieces of brickwork are to be found, which we are going to look at first; later we discover a description and an explanation in another source after all.

THE AMSTERDAM WEIGHHOUSE AND THE MASONS’ MASTERPIECES

Once we are inside the weighhouse, a winding stair leads to the small room of the guild servants on the first floor (Scheltema 1874, p. 306). Above the stair handrail we see a row of niches and windows of gauged brickwork, several of which are also visible on the outside (**fig.3**).



Figure 3. Masterpieces in the northeast tower of the Amsterdam weighhouse

The room of the guild servants also contains masterpieces of fair-face brickwork and is covered by a stucco ceiling, signed *H. Husly 1753*. This is the anteroom of the actual guild room (Scheltema 1874, p. 307), where windows give a view of the former canal (*Gelderse kade*); the other side wall is covered with masons' masterpieces (**fig.4**).

The passageways in the end walls are surrounded by gauged brickwork, and next to the entrance to the large northwest tower there is a natural-stone mantelpiece. There is a description of the layout and furnishing which in 1874 was still more or less intact (Scheltema 1874).

That it does concern masterpieces here is confirmed in a manual from 1777 on *Architectura of Bouw-Konst* by an Amsterdam teacher of mathematics and architecture, Adrianus Erzey. Here it is explained that "the masterpieces of the bricklayers also fall under the category 'twisted', this 'twisted' actually is like a certain opening in a flat wall, (either round, oval or square, etc.), not rectangular but slanting to one side or the other" (Erzey 1777, pp. 106-107).

The pointing or joints between the bricks had to run tidily to one point, but the connecting surfaces had varying shapes, and "moulds or boards" were made of them "according to which the workman has to prepare the bricks". The first assignment is to draw the figure of a twisted circle, arch, square, and the like, and to define the shape of the moulds or boards mathematically. "The aforesaid description shows that this procedure mainly concerns masons and bricklayers, although the

carpenters are not completely excluded, for besides having their twisted stairs and roofs to work at ... the moulds (or boards), mentioned above, are also made by carpenters” (Erzey 1777, p. 107).

Nine examples are illustrated and discussed, several of which “being communal masterpieces” are present in “the upper room of the weighhouse” (**fig.5**).



Figure 4. Meeting room of the guild on the first floor of the Amsterdam weigh-house

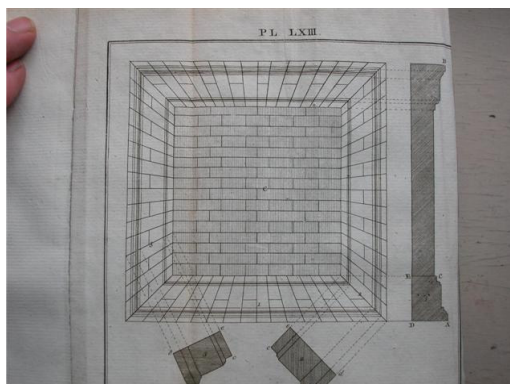


Figure 5. Masterpiece in brick (Erzey 1777, plate 63)

Some can also be executed in larger blocks of natural stone “however, these can also be made of brick, and are then again masons’ masterpieces” (Erzey 1777, p. 109). A window in the form of an oval or an elongated circle has an inside and outside, “which is one of the ordinary masons’ masterpieces, several of which can be seen on the outside of the aforesaid weighhouse and are usually beautifully worked on the inside and outside, and the insides are decorated with a quarter-round profile (or other profile), and therefore it is often assigned to two persons as a masterpiece” (fig.6) (Erzey 1777, p. 110).

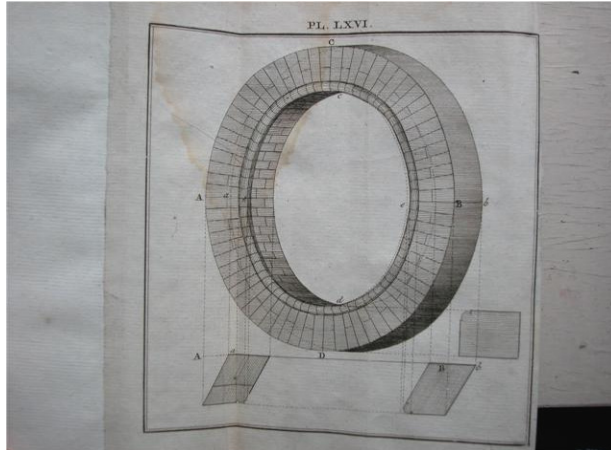


Figure 6. Oval masterpiece in brick (Erzey 1777, plate 66)

In a recent English article a review is given of gauged brickwork with applications in Italy, Great Britain, the Netherlands, in particular the Amsterdam weighhouse, and Flanders, where they occurred earlier (Lynch and Watt 1998, pp. 52-66). The phenomenon coincides with the Renaissance and according to the English authors it is especially a craftsman’s assignment, being the “ultimate expression of the skill of the master bricklayer” (Lynch and Watt 1998, p. 52). Adrianus Erzey must have seen the execution of the Amsterdam masterpieces with his own eyes. Apart from the making of moulds by a carpenter, the execution of the brickwork is unfortunately not further defined, probably because it was a matter of course and subordinate to the drawing assignment and mathematical assignment preceding it.

As a number of masterpieces, mostly on the inside of the staircase tower, are in an alarming state of dilapidation, architecture students of Delft University of Technology and Rob van Hees of TNO (Netherlands Organisation for Applied Scientific Research) have taken a good look at the brickwork again. The dilapidation has been going on for quite a while and manifests itself in dropped-out bricks, cracking and pulverisation of the soft bricks (Scheltema 1874, p. 310 and Van den Klooster 1995, pp. 12-13). It is visible that the extremely narrow lime pointing – it is just a matter of a few millimetres – remain equally narrow at the back (fig.7).

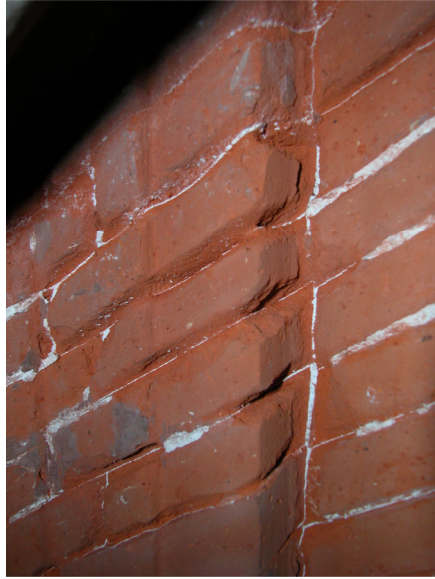


Figure 7. Dilapidation along the narrow pointing of a masterpiece

In other words, the bricks have parallel joint faces. Where these visibly connect with an interior angle, it is noticeable from the side surfaces that the bricks have been rubbed away 3 to 5 millimetres (**fig.8**).



Figure 8. Gauged surfaces of a masterpiece in the guild's meeting room

This must also have happened to the front surfaces, which is confirmed by the places that could evidently not be reached very well, for less material has been removed there (**fig.9**).



Figure 9. Vertical grooves on bricks in a corner above the banisters

Here remnants of grooves can be seen on the bricks, a kind of rough char finishing, in the terminology of natural-stone treatment. These grooves do not run vertically across more courses, from which we can conclude that they have not been applied to an already built brick wall surface, but have been fired into the individual bricks in advance.

In the depot of the municipal monuments and historic buildings department in Dordrecht there is a set of small bricks with grooved surfaces. Only after having seen the remnants of grooves on the Amsterdam masterpieces did it become clear that specially prepared bricks were involved here, meant to be rubbed later. The bricks could not be fired hotter than approximately 900° C because otherwise a sintered surface would develop, which made rubbing more difficult (Lynch and Watt 1998, p. 56). It is not certain if a stone plane was used for this or if the bricks were, for instance, rubbed with sand and water. What is clear, however, is that the presence of grooves had a number of advantages for the construction: once the brickwork had been completed fewer bricks needed to be rubbed away, a possible 'post-firing surface' can be broken more easily, it is easier to remove the grindings through the grooves and a smooth and even surface develops, because the groove serves as an indication for the measure of the layer to be rubbed away. It is not known whether bricks with grooves were always the starting point for gauged brickwork.

BRICKS, GAUGED AND WITH GROOVES

Just as with natural stone there are various types of finishing for the surface of bricks. Hand-moulded bricks are usually sanded at the sides, recognizable by a rough surface with grains of sand. Hatches or grooves may also have been applied. A first, rough distinction may be possible. The question thereby is whether these hatches developed after firing the bricks, or if they were applied to the green-clay brick in advance. Moreover, the phenomena appear to be much older than the seventeenth or eighteenth century we are discussing here. E.H. ter Kuile concluded in connection with the late fourteenth-century sections of the Pieterskerk in Leiden that “The brickwork of the ambulatory and sacristy has been cut flat” (Ter Kuile 1944, p. 65). It is not quite clear whether this had already been done during construction or, for instance, during the restoration in the early twentieth century. For it is conceivable that the wall section was given the desired roughness before plastering it, but also that it concerned a correction of a surface which emerged more or less damaged underneath the plasterwork. Fired bricks could certainly be cut into. This appears to be the case, for instance, in the profiled gutter board above the choir of the Broerenkerk in Zwolle (1466-82) which – just as natural stone – is provided with a mason’s mark (De Vries 1989, pp. 23-25). In the nave (1492-1500) of the same church, both on the reveals of the windows and on the outer corners of the buttresses, specially moulded (unsanded/cut) bricks are noticeable, which are slightly lighter in colour than the other brickwork. The same phenomenon can be observed on the outer corners of the northern staircase towers of the Amsterdam weighhouse – St. Anthonispoort (1488) (fig.10).

Nevertheless these bricks appear to be just as well-fired as ordinary bricks. We also know such bricks from one of the outer corners on the auditorium/refectory of the *Broeders des Gemeenen Levens* (Brothers of Communal Life) behind Praubstraat in Zwolle, where the date 1497 had been inscribed on the green-clay brick. Optically this method is reminiscent of corner bonds for which natural stone was used in combination with bricks, as for instance in the Brabant Gothic style. Older is the combination of corner blocks and rubble-work in between. The method may have to do with the aesthetic need for evenly finished demarcations, but also with the technical necessity to make a corner or side sturdier, which may have played a part in the construction of solid or hollow Romanesque walls.

Grooves or hatches on bricks have hardly been listed systematically in the Netherlands. Recently a publication appeared on medieval brick churches in North Germany, in which it is convincingly proved that the hatches were not applied for structural reasons (Zahn 1995, p. 30). The author, Matthias Zahn, has good reason to reject assumptions such as ‘reducing surface tensions during the firing’, or ‘grip for the benefit of colour or plaster’. Just as the grooves, colour was only used for special sections, notably to suggest a kind of precise brickwork, or to effect uniformity, or camouflage perpend joints. In places where natural stone and brick were used side by side, the same effect as the char finishing can be achieved with the hatches on the bricks (Zahn 2005, pp. 31-32).

The hatches may have been applied to the green-clay brick with a piece of wood, a comb with teeth or a wire saw, or cut into the bricks later, as referred to before. The article invariably starts from the idea of a deliberate aesthetic effect and not from any technical reason. Consequently, this seems to be inconsistent with the application of the (much more recent) grooves that we came upon as (unintentional) remnants of the rubbing process. Another reason, which is rather of a practical, technical nature, seems to be adjustment of ‘ordinary’, rectangular bricks in order to realise oblique angles. In that case the hatches only occur on one side, while the other side is sanded. In the Middle Ages this was customary for the springing of funnel-shaped or profiled openings. Returning to the period under discussion, a good example is to be found in Leiden. For a slanting town plan requires adjustment of all the individual bricks forming the corners of the building. Such corners are abundantly present in the Zeilpoort in Leiden (1667- ’69); as twisted passages in the brickwork were opted for– for military-strategic reasons – these special cornerstones were necessary. Invariably only one side of such bricks was adjusted. It is not clear yet whether it concerns bricks shaped like that in advance or cut to the required shape later. In the same gate there are arches in which some springing stones have grooves, arranged in patterns and unmistakably applied before firing (**fig.11**). Considering their dark, fired colour they were not intended to be rubbed.



Figure 10. Rubbed corner stones in the northeast tower (1488) with a few gauged masterpieces (17-eighteenth century)

In a number of other situations vertical grooves occur, which do not run on across the entire wall surface but were connected to individual bricks and applied before firing. Various seventeenth-

century instances are known in Leiden, where all the bricks in the wall surface show such grooves and one in Haarlem dating from 1756, where only the stretchers and three-quarters against the window openings have them (Regentenkamer Leprozenhuis). The question is whether it here concerns bricks with imitation char finishing or brickwork that still had to be rubbed. For the time being we opt for the former, which may be confirmed or rejected by carrying out hardness measurements.



Figure 11. Zijlpoort Leiden (1667-'69) prepared bricks with grooves and hatches at the inside of the gate

A brick that was deliberately fired less hard was indeed meant to be rubbed after the bricklaying. Compared to 'normal' bricks these can be recognized by their lighter, orange-red colour. Yet another possibility presents itself: the above-mentioned meter to measure the hardness of the pointing, which we have not used yet in connection with this question, however. There may be a third (optical) characteristic for recognizing softly fired bricks meant to be rubbed and that is the dilapidation as a result of frost and salt damage with the passage of time. Many of the Amsterdam masterpieces appear to have suffered from it, but also several gates of gauged brickwork found elsewhere (arch next to 4 Springweg, Utrecht, for example) (**fig.12**).

Several gates and façades of gauged brickwork, however, seem to have endured the ravages of time perfectly well. Is the quality of the bricks in the façade of the Van der Perrehuys in Middelburg (1765) so much better or does it also have to do with the capacity to prepare harder bricks, like the cornerstones referred to above?

In his *De re aedificatoria* (1452) Leon Battista Alberti recommends to perform the rubbing on wet green-clay bricks, but it is even better to do this when they have just been taken out of the brick kiln

and are still hot (Gabrielli 2005, p. 55). Not only in Italy was gauged or hatched brickwork particularly used around openings. In the Netherlands it was part of the classicist, austere brick architecture of the seventeenth century. At that time the arrangement of the openings in the façade became a new, compositional, and hence theoretical assignment, states the Leiden building historian Edwin Orsel. Before that time the layout was the result of craftsman's anticipation, i.e. the position of the openings was a logical multiple of whole stretchers and headers. Closers in the header courses (usually) determined the 'fastening' at these openings. In the last quarter of the seventeenth century three-quarters also appear besides (queen) closers and soon a whole repertory of 'tricks' to give the brickwork in the sections between the openings an orderly appearance. In 1996 Jan Kamphuis called the slightly broader header 'smuggle header' (Kamphuis, 1996). Around this time Christiaan de Jong graduated at Delft University of Technology with a much more extensive research into similar phenomena in the towns of Delft and Leiden.



Figure 12. Arch next to 4 Springweg Utrecht, dilapidated gauged brickwork

After 1700 the assignment of 'filling in' and arranging the brickwork harmoniously against and along the openings was probably one of the most difficult jobs in practice. The bricklayers did not do much else anymore. After all, the straight crown mouldings on these austere façades were made by carpenters. While Amsterdam bricklayers still had to prove themselves by plotting out and making a gauged-brickwork masterpiece, in Leeuwarden in the eighteenth century another requirement had to be met: "The bricklayers had to draw a façade with a specific surface division, in which a window frame had been included and where various bonds had to be applied. The practical part of the masterpiece consisted of raising the upper part of the façade" (Mud 1998, p. 82). In Leeuwarden these masterpieces were executed in the town orphanage, which received a compensation for this.

THE IDEAL IMAGE

Besides being used as a masterpiece, from the seventeenth century onwards gauged brickwork also occurs elsewhere in façades, exterior walls, gates, stretchers above windows and the like, although not on a large scale because it probably concerned a very laborious and expensive method. The largest-scale application is the previously mentioned concave (Baroque) façade of the Van der Perrehuis in Middelburg (1765). Gauged brickwork probably reflected the highest ideal of perfectly and precisely executed masonry, such as that of the masterpiece. The ideal is a smooth and even wall surface, mathematically precise, built in Tudor bond or English bond with the pointing as narrow as possible. With used, selected bricks in combination with fine, pure lime mortar that had probably been sifted in advance or had been rotting for a long time, so that the bricklaying was more like glueing. The pointing is not “struck”, nor has it been applied separately and consists of flush mortar, at most brushed away diagonally. In technique and appearance the best built façades approach this intended perfection of gauged, mathematically precise brickwork. Particularly in the West Netherlands several examples are still to be found of unrubbed yet perfectly built brick façades, but these are threatened by sandblasting, cutting out and re-pointing, which are nearly always done in the wrong way. The intentions of the old bricklayers are easier to understand when we look at gauged brickwork more closely and respect old pointing as much as possible. Apart from the surface treatments referred to above, varying hardness, colours, pointing and bonds, there are a few other phenomena which should be mentioned briefly here. They have to do with the same striving for perfection and mathematical purity. Sometimes bricks have false joints, intended to suggest the end of a brick, but actually just a groove filled with mortar. In the left part of 7a Vijfde Binnenvestgracht in Leiden (approx. 1590) there are brick-sized basket arches with sandstone keystones. Apart from the fact that here and there vertical grooves seem to have been made in the surface, every other stretcher a groove was applied in order to suggest alternating stretchers and headers. However, the two arches only consist of stretchers on their sides, which is the more striking because in most false joints there is no sign of mortar anymore. This also occurs in some of the masterpieces in the Amsterdam weighhouse, also because these are not ‘deeper’ than half a brick. The bricklayer of 15 Koningsstraat in Amersfoort (approx. 1685) still placed closers in the header courses against the outer corners of the façade, but looking more closely we notice three-quarters against the reveals of the openings. Apparently – as more often in the second half of the seventeenth century – (queen) closers seem to stand directly against the jambs. However, this effect is caused by vertical false joints in three-quarters, which ‘betray themselves’ because the pointing mortar has fallen out (**fig.13**).

A more recent example is Huis der Boede in Koudekerke from approximately 1728. The foundations of pilasters projecting half a brick show three-quarters in the header courses with false joints, as if closers had been used there. Higher up in these (narrowed) pilasters, however, three-quarters were included in the stretcher courses unconcealed.

We may also point out scratched lines that seem to confirm the mathematical purity of the brickwork and may have been used as an aid for the execution of the brickwork. Janse already

recognized them on the exterior walls of Mauritshuis in The Hague (Janse 1980, p. 36), but good examples can also be found in Leiden. The façade of 12 Nieuwe Rijn, for example, dates from 1790 and contains both short ‘marking’ scratches (**fig.14**) on several stretchers and continuing vertical scratch lines, half a brick next to the window openings. Apparently one of them was slanting and was corrected by means of a cross.



Figure 13. False vertical pointing on three-quarter bricks near an edge in the façade of 15 Koningsstraat Amersfoort (ca. 1685)



Figure 14. Leiden, façade of 12 Nieuwe Rijn, stretch with marking scratches

Finally, a special effect could be given to the surface of a brick by mixing little balls of yellow and red clay to a certain extent, since the aim was not to obtain a homogeneous mixture but rather a kind of flaming pattern. On the sanded side of a brick such an effect cannot be seen, and therefore these bricks were ‘opened up’, cut to shape before firing, in order to make it visible. This technique is already found in early bricks in North Germany (Zahn 2005, pp. 33-34). In the Netherlands we also know it from seventeenth/eighteenth- century earthenware floor tiles, probably used to try and imitate marble. What is special is that there are also façades – only the lower fronts – with similar bricks, for instance, those of 5 Oude Rijn in Leiden and 17-19 Plompstorengracht in Utrecht (fig.15).

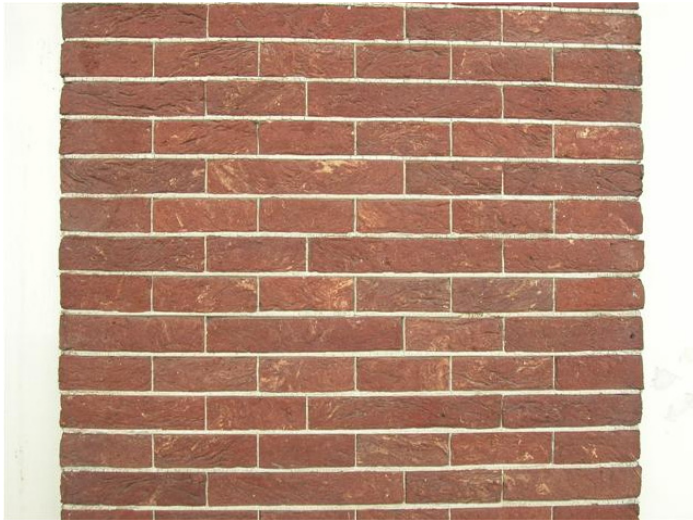


Figure 15. Utrecht, 17-19 Plompstorengracht. Rubbed façade with marbling bricks

FINAL CONCLUSION

All this came to an end in the nineteenth century. The abolition of the guilds in 1808 put a final stop to the requirements set by the trade units themselves. Gauged brickwork had become a thing of the past, although carefully executed, ‘ordinary’ fair-face brickwork continued to be made. A permanent break with the past came with the arrival of machine-made moulded bricks, and in particular with the use of Portland cement, which entailed a completely different method of bricklaying with broader pointing. Wire-cut bricks, on the other hand, sometimes seem to link up with the ideal of the smoothest gauged brickwork. In restorations the so-called cut pointing is usually applied to camouflage too widely cut joints or brickwork with irregular bricks. It is a twentieth-century restoration practice, which has little to do with the historical starting point and is therefore undesirable in the conservation of monuments and historic buildings (although this sounds paradoxical in the face of reality).

In the Middle Ages and the subsequent period there were a range of possibilities to create special brickwork. This was probably also possible because in those days the 'finishing phase' took considerably longer than became customary more recently through the use of Portland cement.

It is remarkable that certain minute effects with respect to the surface of medieval brickwork occurred simultaneously in Northern and Southern Europe; people knew what was going on in the world, in spite of the fact that the production of brick was a local affair. In working with brick clamps a direct relation between bricklayer and brickmaker is obvious. Nevertheless this cooperation must have continued up to and including the eighteenth century, when the brick kilns supplied the bricklayers with various special-dimension bricks. In spite of the arrival of architects in the seventeenth century, the greater part of the architectonic commissions were still realised by bosses or masters who made both the design and the building (Krabbe 1998). The application of the Antiquity-oriented order books led to a higher level of abstraction with the aid of mathematics and arithmetic.

With the Enlightenment in the second half of the eighteenth century theoretical knowledge is no longer a secret of master builders, but shared by a bourgeois elite with good taste, thus profiling themselves as connoisseurs and enthusiasts. Although Adrianus Erzey shows practicable examples, his explanation is largely theoretical. The order book of Scamozzi was translated and elucidated by Symon Bosboom and later adapted and made suitable for the building trade by Caspar Philips and Jacobus Houthuisen, engraver-land surveyor and master carpenter respectively, who recommend themselves on the title page as members of the Mathematical Society (Philips and Houthuisen 1821). The concise manual of Leendert van Heusden, which is nevertheless useful for the full range of the building trade, entitled *Handleiding tot de burgerlijke bouwkunde* (manual for civil architecture), was published by the Dutch Society for Public Advancement in 1833. This manual filled the lack of knowledge still common among building workers and the guilds. The societies and academies were often private, local organisations, comparable to associations for the improvement of good taste and the edification of the people in a more general sense. The foundation of the Association for the Advancement of Architecture in 1842 and their journal *Bouwkundige Bijdragen* (architectural contributions) can be regarded as the start of collective exchange of knowledge for architects in the modern sense of the word. Two years later technical schools started to be established, and the school for engineers, established in Delft in 1805, provided day-time education from 1843 onwards, was promoted to Polytechnic in 1864 and given university status as University of Technology in 1905. It took a considerable part of the nineteenth century before a state-acknowledged system of technical education had been set up, in which through various levels of education a complete separation between theory and practice was realised. Within the field of architecture Van Heusden distinguishes civil architecture, military architecture and hydraulic engineering and subsequently states: "Civil architecture is usually divided into two large main sections, notably: common or ordinary architecture and fine or elevated architecture, of which the former teaches one how and in what way houses and dwellings can be built in an easy and

sustainable way, while elevated or higher architecture in addition provides the principal rules to give such buildings as much beauty, splendour and magnificence as possible” (Van Heusden 1833, p.7).

Nevertheless, Van Heusden considered it unnecessary to include drawings of the five ‘elevated’ orders of architecture in his manual, because this had already been done elsewhere. Erzey preceded him in 1777 with the presentation of the basic principles of geometry, in combination with assignments to make pieces of work oneself. These manuals are modern to such an extent that the reasoned control and active application of the classical orders are pushed into the background and replaced by pure mathematics. This eventually paved the way for modern architecture, after numerous other, possibly practicable orders had first passed in review, which in the second half of the nineteenth century were no longer fully understood.

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