

Brickwork in Leiden: a Survey of Sixteenth and Seventeenth-Century Characteristics

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INTRODUCTION

Much has already been written about brickwork in general, but the subject recently regained interest as research by construction historians led to new discoveries and new insights. This article represents the results of recent research in the Dutch town of Leiden (fig. 1). It provides an overview of the bricks used, their history, and their specific use within Leiden relative to the general situation in the Netherlands. The scope of this article is limited to the period preceding the emergence of industrial products. The current state of affairs regarding the research of bricks is summarised in a table showing the development of brick sizes as used in historic buildings in Leiden. Brick sizes in this article are shown in centimetres as length x width x height followed by the 10-course height (10ch) including bed joints, e.g. 20 x 10 x 5, 10ch = 55). Finally, the article discusses the development of brickwork corner bonds in Leiden, with specific attention to some interesting phenomena in late sixteenth and seventeenth century corner bonds.



Figure 1. The location of Leiden in the west of the Netherlands.

BRICKS, A PRIMER

Throughout the Netherlands, apart from marl, glacier boulders, and bog ore, no natural stone is found that might be suitable for construction purposes. The Romans introduced bricks as a construction material to the region, and Roman fired clay products have been found in the Leiden area. However, as the Romans retreated from the Netherlands, the technique of brick-making disappeared with them, and most medieval buildings were constructed using perishable materials such as timber, loam, and thatch. For more substantial buildings, stone was imported, which in medieval times would have been tuff. Subsequently, alongside the use of expensive stone masonry, the redevelopment of bricks occurred. It is generally assumed that monastic orders, and the Cistercian and Norbertine orders in particular, reintroduced the skill of brick-making to our country (Berends 1989, p. 1). These bricks were manufactured from local clay deposits (Berends 1989, pp. 1-5).

Until recently, the approximate date of the general reintroduction of bricks in the Netherlands was put at some time in the second half of the twelfth century. However, the latest views of construction historians, based on the earliest reliable datings, rather point to a date around 1200. The bricks previously considered to be the earliest examples — a masonry tomb at de Benedictine Abbey of Egmond, dated shortly after 1136, and the foundation material of the abbey church of Klaarkamp, ca. 1165 — were considered by van der Hoeve and rejected with solid arguments (Hoeve 2005, pp. 125-138).

According to recent scientific views, not only the monastic orders, but the nobility also stimulated the reintroduction of brickwork (Holst 2005, pp. 11-3, and Trummer 2005, pp. 77-88). The bricks used in the tower of the Gravensteen in Leiden, which was most probably built by the count of Holland sometime around 1200, support this new view. A remarkable feature of the brickwork of the Gravensteen tower ($29/32 \times 14/14.5 \times 10/12$, $10ch = 110$) is the brick height of 10 to 12 cm, which is exceptional for the Netherlands. Perhaps these unusual bricks were imported, or manufactured locally by foreign brick-makers. The bricks or their makers could have come from the northeast of Germany, or the north of Italy (Holst 2005, pp. 12-3, and Schumann 2000, pp. 298-317) (**fig. 2**). Whatever the case, the use of bricks at that time was associated with the clergy and nobility.

A well-known example of the use of tuff as a construction material is Leiden castle, which has been dated to the middle of the twelfth century (Renaud 1974). Recent research by the author has shown that this date refers to the oldest phase of the circular wall, which was later encased in the current wall, part of which was built using bricks. Based on the size of the bricks used, the latter structure can probably be dated to about 1200.

LEIDEN AS A PRODUCTION CENTRE

The development of brick production around Leiden started at an early date. In the direct vicinity of Leiden, field kilns were located along the Oude Rijn river, using clay from the old river bed

(Hollestelle 1961, p. 112). A brick kiln is known to have existed here as early as 1283 (Staal 1986, p. 2). The main ingredient was locally cut clay, which was mixed with water and other additives, including sand. The colour of the end product depends on the raw materials and firing process. For example, clay rich in chalk will produce yellow bricks, whereas the presence of iron will result in red bricks. The old river clay cut from the bed of the Oude Rijn must have been rich in iron, since old bricks in Leiden are mostly red. The grey or black colour of some bricks is the result of an intentional reduction of the oxygen level during the firing process.



Figure 2. Gravensteen, Leiden; monk bond in the west wall, about 1200 (photograph by E. Orsel).

It was not until 1633 that a number of brick kiln owners around Leiden set up an association. The purpose of this cartel was to serve the interests of the owners through a mutual agreement to regulate production numbers. In addition to production, the agreement covered brick sizes and employment policies. In 1734 the association was elevated to the status of Rijnland brick-makers' guild, domiciled in Leiden (Hollestelle 1961, pp. 249-50).

Leiden bricks were a well-known export product during the fifteenth and sixteenth centuries, with destinations including Haarlem, Amsterdam, Enkhuizen, Amersfoort, and Harderwijk (Berends 1990, p. 76). On the other hand, Leiden also imported bricks, as can be seen from archive records for the Haarlemmerpoort from 1631, which state that “moppen ofte grooten backstien aen de vecht ofte leck ghebacken” (monastery-size or large bricks produced along the Vecht or Lek rivers) were used (Janse 1989, p. 1).

BRICK SIZES

During the period when bricks were being reintroduced in the Netherlands, probably about 1200, the sizes in which the new clay product was offered appear to have been matched to those of the tuff blocks in use at the time (Hoeve 2005, pp. 130-1). Consequently, early bricks are very large,

with a length of approximately 30 centimetres. In the Netherlands, such large bricks are often referred to as 'kloostermoppen' (monastery bricks), a name that became popular during the nineteenth century. The term is derived from the assumption that monastic orders reintroduced the art of brick-making in the Netherlands (Janse 1989, p. 1).

As the production process improved, brick sizes decreased, and regional differences started become apparent. Reducing the size of the bricks offered a number of advantages. The smaller bricks could be produced at a higher rate, they were of higher quality, were cheaper to make, easier to handle, and they were better suited to the construction of the thin walls of town houses (Hollestelle 1961, pp. 77-95). Leiden lies in the area in which brick sizes decreased most rapidly (Berends 1989, pp. 1-5). The reduction in size may well have been prompted by local statutes in which the use of fired products such as bricks and roof tiles was ordered for private buildings, since structures made of cheap, natural, soft materials such as timber, thatch, and straw formed a fire hazard. In addition to reducing the risk of fire, hard materials improved the appearance, and consequently the prestige, of the town. The Leiden statute of 1450 made the use of bricks compulsory for outside walls, as it did hard materials for roofs:

tsi woenhuyse, turfhuysen, schueren, loedzen off schoeten, sy syn groet of cleyn, hoge of lage die salmen maken mit stienen gevelen ende van stienen zijtwegen ende die salmen decken mit harden dake, tsi mit tegelen of leyen (dwellings, peat stores, barns, sheds, or partitions, be they large or small, high or low, shall be made with stone or brick facades and brick side walls, and they shall be covered with hard roofs, using either tiles or slates)

(Meischke 1969, p. 109).

Existing soft walls could only be repaired using stone or bricks (Meischke 1988, p. 240). In addition, the town subsidised hard roofing materials, initially flat tiles and slates, and later, pantiles (Meischke 1988, pp. 233-4). The result of these laws was that the demand for bricks increased. To keep up with demand, brick-makers had to improve their production process, and by making their bricks smaller, they could produce them faster and more cheaply (Hollestelle 1961, pp. 77-95).

In addition to making the use of bricks as a construction material compulsory, later town statutes also regulated brick sizes. The Leiden statute of 1527 for example, prescribes two standard sizes: 8 inches and 10 grains (1 grain = 1/12 inch) long, 4 inches and 4 grains wide, and 2 inches and 4 grains high for large bricks; 7 inches 8.33 grains long, 3 inches 9.5 grains wide, and 1 inch 10.75 grains high for small bricks (equal to 21.6 x 10.7 x 5.5 cm and 18.9 x 8.6 x 3.5 cm respectively) (Hollestelle 1961, p. 89). These sizes mostly match the standard moulds kept in the collection of the Lakenhal museum. These moulds, the date of manufacture of which is unknown, measure 23.1 x 11.3 x 6.1 cm and 20.1 x 9.9 x 5 cm. Taking into account the shrinkage that occurs during the drying and firing process, they would produce bricks matching the 1527 statute (Hollestelle 1961, pp. 83-9). The dimensions decreed by the authorities were minimum sizes, probably measured

before firing. At the time, smaller bricks were already in use, witness the bricks measuring 18-19 x 9-9.5 x 4-4.5 cm that were used in the naves of two Leiden churches, the Hoogland Church and the Church of St. Louis, both from the same period (Berends 1989, p. 4). Even so, other brick sizes were also being produced, as can be seen from the ‘large’ of ‘double’ bricks imported from Leiden in about 1550 to construct the fortifications at Harderwijk. These large bricks, with a length of approximately 27 cm, were probably produced to special order, since there is no evidence of their being used in the Leiden area during that period (Hollestelle 1961, p. 90).

Table 1. Brickwork, dated (d = dendrochronology)

Date	Length (cm)	Width (cm)	Height (cm)	10ch (cm)	Bond	Building, part
ca 1200	29/32	14/15.5	10/12	110	Monk	Gravensteen, tower
ca 1204	30/32	15/16	7.5/8.5	-	-	Leiden Castle
XIII a	34	17	8.5	-	-	no. 113, Breestraat, front cellar
XIII m	30.5/31.5	14.5/15.5	7/7.5	-	Flemish	no. 113, Breestraat, back cellar
ca. 1347 - 1355	20/22	9/9.5	4/5	-	-	Town wall at Koestraat
1366 ±6 (d)	19.5/20.5	9/10	4.5/5	54/57	-	no. 19, Breestraat
XIV c, ca. 1370	23/24	11/12	5/6	64-68	English	Hoogland church, tower
1385 ±6 (d)	23/24.5	11/12.5	5/6	65/67	-	no. 62, Hooigracht
1392	20/22	11/12	5/5.5	60-64	English	Hoogland church, nave
1392	23	11	5	-	English	Church of St. Peter, ambulatory
1393 ±6 (d)	22	10.5/11.5	5/5.5	61	Tudor (?)	no. 123, Breestraat
1402	21.5/22	9.5/10	5	61		no. 62, Breestraat, Walloon church
1412	22	11	5	-	English	Church of St. Peter, choir loft
1417-1428	19	9	4.5	-	English	Church of St. Peter, three-bay nave
1434 (d)	20.5/21	10/10.5	5/5.5	60/64	-	no. 15, Nieuwstraat
1450 (d)	19.5/20	...	4/4.5	-	-	no. 43, Rapenburg
1453-1473	19	9	4.5	-	English	Church of St. Peter, five-bay nave
1463	18.5/19	8.5/9	4.5/5	60	Tudor	Gravensteen, tower, heightening
1473 (d)	20	10	5	59-60	English	Hoogland church, ambulatory
1478 (d)	19.5/20	9.5/10	4.5/5	55-58		Hoogland church, choir loft
1490 (d)	19.5	9.5	4.5/5	53-57	English	Hoogland church, N and S transepts
ca. 1500	19	9	4.5	-	-	Church of St. Peter, transept, uncompl.
1539 (d)	18	9	4	-	-	Church of St. Peter, transepts
1544 (d)	18	9	4/4.5	50-52	-	Hoogland church, nave, uncompleted
1585 (d)	18/19.5	8/8.5/9	4/4.5	-	-	no. 166, Oude Rijn
1588 (d)	18/19	8.5/9	4/4.5	49	Tudor	no. 7, Vijfde Binnenvestgracht
1608	19	9	4.5/5	55	-	no. 14, Groenesteeg
1630	18.5/19.5	9/9.5	4	46.5	Tudor	no. 129, Rapenburg
1640	18.5	8.5/9	4.5	47.5	Tudor	no. 16, Papengracht
1645	18.5/19	8.5/9	4/4.5	48	Tudor	no. 13, Pieterskerkhof

Date	Length (cm)	Width (cm)	Height (cm)	10ch (cm)	Bond	Building, part
1645/1651	18	8.5/9	4/4.5	48	Tudor	no. 36, Rapenburg
1654	18.5	8.5/9	3.5/4	44.5	Tudor	no. 25, Rapenburg
1656	17.5/18	8	4	44.5	English	no. 45, Rapenburg
1660	18	8.5/9	4	46	Tudor	no. 82, Herengracht
1668/1670	17.5/18	8.5	4	44	Tudor	no. 8, Rapenburg
1683	17/18	8.5	4	45	Tudor	no. 21, Kloksteeg
1724	18	9	4	45	English	no. 12, Rapenburg
1727/28	20.5/21.5	10.5	4.5	47	English	no. 27, Rapenburg
1749	22/22.5	10.5	4	44	English	no. 65, Rapenburg
1749	20.5/21	10/10.5	4	44	Tudor	no. 24, Rapenburg
1751	21.5/22	10/10.5	4	46	English	no. 125, Breestraat
1752	20.5/21	10/10.5	4	45	English	no. 19, Rapenburg
1758	17/18	8/8.5	3.5/4	43	Tudor	no. 23, Rapenburg
1760	21	10/10.5	4	43.5	English	no. 67, Rapenburg
1768	21/21.5	11	4	41	English	no. 24, Breestraat
1772	18/19	9	4	47	English	no. 52, Oude Singel
1774	21/21.5	10/10.5	4	41.5	English	no. 17, Hooglandsekerkgracht
1790	18/18.5	8.5/9	4/4.5	41	Tudor	no. 12, Nieuwe Rijn 12
1791	20/20.5	10.5	4	45.5	English	no. 19, Breestraat
1808	18	8.5/9	4	44.5	Tudor	Nos. 19-29, Raamsteeg
1823	22/23.5	10/11.5	4	45	Tudor	no. 1, Pieterskerkstraat
1827	18	8.5/9	4	44	Tudor	nos. 7-121, Kaarsemakerstraat
1838	19.5/20	9.5/10	4	46	-	no. 106, Haarlemmerstraat
1852	18	8.5	4	49	Tudor	no. 38, Middelweg

As we have seen, the establishment in 1633 of the association of brick kiln owners, later to become the Rijnland brick-makers' guild, and the ensuing local production arrangements, led to even further regulation of brick sizes (Hollestelle 1969, pp. 249-50). The national government also decreed sets of dimensions. In 1645 the States of Holland issued a decree laying down the size of large bricks, Leiden bricks, and IJssel bricks (large bricks: 10 × 5 x 2.5 inches (26.2 x 13.1 x 6.5 cm), Leiden bricks: 7 x 3.5 x 1.5 inches (18.3 x 9.2 x 3.9 cm), and IJssel bricks: 6.5 x 3.25 x [?] inches (17 x 8.5 x [?] cm), Hollestelle 1961, pp. 249-54).

The research into the development of brick sizes in Leiden forms part of a general municipal construction history research effort (for previous regional and local research initiatives, see Steehouwer 2002, Berends 1989, and Ter Kuile 1937; due to the lack of an overall picture, the colour of the investigated samples will not be discussed here). A permanent item of recent municipal construction history research is the collection of information about brickwork walls, as a result of which a general current model can be presented (**table 1**). Hard dating using dendrochronological tests forms a particularly useful aid. The model must remain general in nature since, as the table clearly shows, there is no evidence of any consistent succession of size

reductions, different sizes being used concurrently throughout the period under review. This fact is supported by the 1527 Leiden statute, which prescribes two different standard sizes (Hollestelle 1969, p. 89). It is known that different sizes were also used concurrently in other towns (Berends 1989, p. 4).

Generally speaking it can be said that the larger sizes were used during the first half of the thirteenth century. In the course of the thirteenth century a slight reduction in size occurred (28-31.5 x 14.5-15.5 x 7-7.5, 10ch = [?]). A substantial reduction in brick sizes occurs during the fourteenth century (20-24.5 x 9.5-12.5 x 5-6, 10ch = 60-68). A striking occurrence is the use of very small and thin bricks in the town wall along the Koestraat, dating from ca. 1347-1355, and in the house at no. 19, Breestraat, dating from 1366 ±6 years (d). The brickwork along the Koestraat could be the result of later repairs, and the dendrochronological dating of the house may point to the later addition of brick walls to an earlier timber house. Brick sizes became slightly smaller still until about the middle of the fifteenth century (18.5-20 x 8.5-10 x 4-5, 10ch = 53-60). The ten-course heights appear to point to an additional development, decreasing as they do from approx. 60 cm in the first half of the fifteenth century to 53-55 cm in the second half.

Throughout the sixteenth century and the first half of the seventeenth century a relatively small brick size was used (18-19.5 x 8-9.5 x 4-5, 10ch = 49-55). In broad terms, this size matches the smaller brick size of the 1527 statute (18.9 x 8.6 x 3.5 cm, Hollestelle 1961, p. 89). After the middle of the seventeenth century bricks became a little smaller still (17-18.5 x 8.5-9 x 3.5-4, 10ch = 44-48), a standardisation process that ties in with the establishment of the association of brick kiln owners, later to become the brick-makers' guild, and the statute issued by the States of Holland in 1645.

After the first quarter of the eighteenth century, bricks tended to become longer and slightly wider, while retaining their original thickness (20-22.5 x 10-10.5 x 4-4.5, 10ch = 41-47). Of course, exceptions to the rule remain, such as the use at no. 23, Rapenburg of very small bricks (17-18 x 8-8.5 x 3.5-4, 10ch = 43). During the nineteenth century various brick sizes were used concurrently (18-22.5 x 8.5-11 x 4, 10ch = 44-49). Machine-produced bricks subsequently gained the upper hand, the 'waal' size (21.5 x 10.5 x 5.5, 10ch = 63) emerging as the most popular.

As recent construction history research shows, different brick sizes tended to be used concurrently, which makes it difficult to date buildings in Leiden based on the bricks used in their construction. Therefore, when investigating brickwork walls, in addition to brick sizes, the context, corner solutions, possible reuse, etc. must also be considered.

BRICK BONDS

A typical brick has dimensions with ratios for its long side (stretcher), short side (header), and thickness of approximately 4 : 2 : 1, i.e. the long side, or stretcher, is twice as long as the short side,

or header. This ratio follows from the need to be able to lay bricks in bond, i.e. forming particular structural patterns, which exist in many variations (Hoeve 2000, pp. 89–92) (**fig. 3**). In several types of bond, bricks are used that have been divided into quarter bricks, or closers, and three-quarter bricks, or three-quarter bats. The oldest bond types are the monk bond and the Flemish bond. The monk bond is characterised by alternating double stretchers and single headers per course. In the Netherlands, it is practically only found in the north, and mostly in walls constructed as rubble work, in which brick inner and outer leaves encase a concrete-like mixture of lime and rubble. Interestingly, the very early brickwork of the Gravensteen tower in Leiden, which lies a long way to the south, was also constructed using the monk bond (**fig. 2**). This early brick wall, which dates to approximately 1200, turned out to be rubble work.

Table 2. General development of brick sizes

Date	Length	Width	Height	10ch
First half of thirteenth century	29-34	14-17	7.5-12	...-110
Thirteenth century	28-31.5	14.5-15.5	7-7.5	...
Second half of fourteenth century	20-24.5	9.5-12.5	5-6	60-68
Fifteenth century	18.5-20	8.5-10	4-5	53-60
Sixteenth century and first half of seventeenth century	18-19.5	8-9.5	4-5	49-55
After middle of seventeenth century	17-18.5	8.5-9	3.5-4	44-48
After first quarter of eighteenth century	20-22.5	10-10.5	4-4.5	41-47
Nineteenth century	18-22.5	8.5-11	4	44-49
End of nineteenth and twentieth century	21.5	10.5	5.5	63

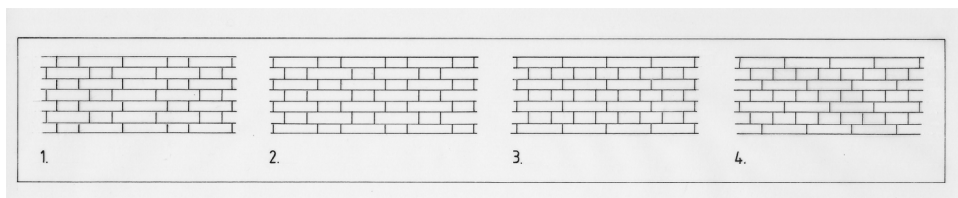


Figure 3. Brick bonds; 1: monk bond, 2: Flemish bond, 3: English bond, 4: Tudor bond (drawing by E. Orsel).

The Flemish bond is characterised by alternating headers and stretchers in each course. It is generally assumed that in the Netherlands the Flemish bond remained in use until approximately 1325 (Berends 1989, p. 3). In Leiden, locations where the Flemish bond has been found include the oldest dated brick wall of a recently excavated archeological site at the Steenshuur (Dolmans 2002, p. 271) and the cellar at no. 113, Breesstraat, which probably dates from the thirteenth century (**fig. 4**).



Figure 4. Excavation along the Steenschuur; Flemish bond (photograph by J. Dröge).

The monk and Flemish bonds were superseded by types of bond using alternating courses of headers and stretchers. Initially, the most commonly used bond was the English bond. About the middle of the sixteenth century the Tudor bond came into common use (Staal, 1986, p. 15). In Leiden however, the transition to Tudor bond occurred much earlier. An early example in Leiden is the section added to the top of the Gravensteen tower in 1463 (**fig. 5**). Part of the house at no. 123, Breestraat (1393 \pm 6 years, d), also seems to have been constructed using a bond similar to the Tudor bond, but this would appear to be a coincidence. In any case, the English bond remained in use, as demonstrated by sections of fifteenth century brickwork at the Hoogland Church and the Church of St. Peter, both built using English bond (**fig. 6**).

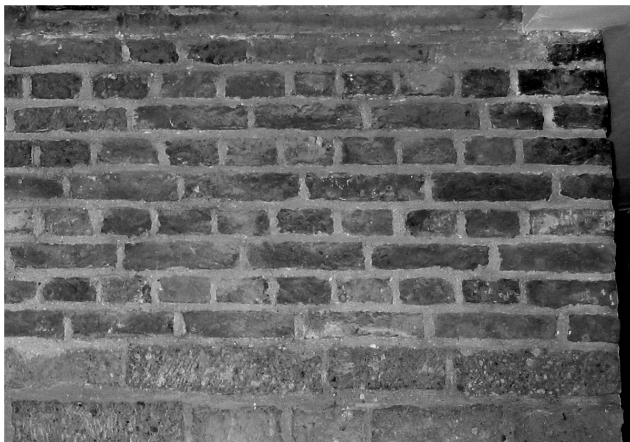


Figure 5. Gravensteen, Leiden; Tudor bond in the raised section that was added in 1463 (photograph by E. Orsel).

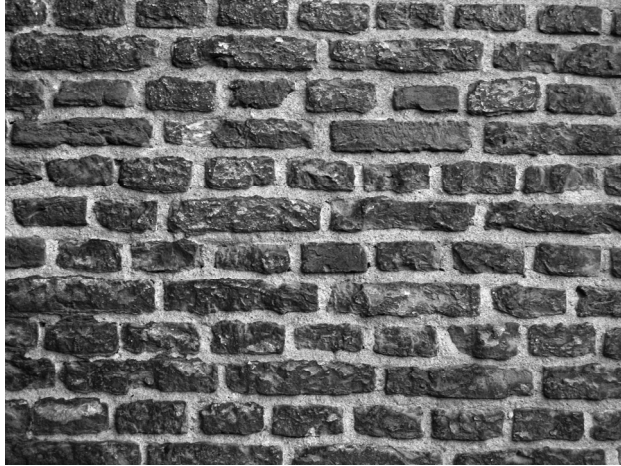


Figure 6. Church of St. Peter, Leiden; English bond at the north-west corner, 1453-1473 (photograph by E. Orsel).

The Tudor bond therefore dominated the scene in Leiden for a long time, albeit with a short interruption for the architecturally meticulous eighteenth-century facades which required the use of English bond. During the eighteenth century production process control improved to such an extent that high-quality bricks of consistent size could be produced in large quantities, allowing the construction of very smooth brickwork to be undertaken. This type of brickwork features very thin bed joints and practically non-existent vertical joints. In addition, builders appear to have had a preference for the English bond during this period. The regular bond, the thin joints, the very smooth bricks, and the high degree of bricklaying skills required, were all part of a conscious effort to create an aesthetically pleasing architecture for the most important facade of a building. Some batches of bricks appear to have been produced for specific projects, witness the various date bricks that have been found, for example at no. 19, Breestraat (1791), no. 8, Doelensteeg (1783), no. 52, Oude Singel (1772), no. 23, Rapenburg (1758), and no. 24, Rapenburg (1749) (**fig. 7**). The date and the name or initials of the principal were pressed into the wet clay before the bricks were fired. In some cases the bricks were even marked with scratched lines to enable them to be precisely aligned, as at no. 125, Breestraat, with an English bond dating from 1751 (Kamphuis 1996, pp. 78-9). This type of facade architecture reached its zenith in the eighteenth century. During the nineteenth century the Tudor bond reappeared in brickwork. Later in the nineteenth century, and later still in the twentieth century, machine-produced bricks came into common use, and a succession of schools of architecture gave rise to various experiments with new varieties of bricks and bonds, heralding the end of traditional brickwork.

CORNER BONDS

A significant detail of the various brickwork bonds is the way corner terminations are formed. It is generally assumed that in the Netherlands, until about the second quarter of the eighteenth century,

brickwork corners were constructed using a header and closer combination, whereas later three-quarter bats were used (Hoeve 2000, p. 90). Although three-quarter bats did appear sporadically during the Middle Ages, these occurrences tend to be isolated incidents, as at the Schierstins, Veenwouden, which dates from the thirteenth century (Staal 1986, p. 15). For the Tudor bond that dominated brickwork in Leiden, the usual corner construction involved the use of headers and closers, although in Leiden the three-quarter bat corner construction appeared much earlier than is assumed for the Netherlands as a whole, and the transition is much less marked. For instance, the Tudor bond brickwork of the addition to the Gravensteen tower, dating from 1463 and at no. 7, Vijfde Binnenvestgracht, dating from 1588, includes three-quarter bats at the facade corners (**fig. 8**). These would appear to be very early examples in the Netherlands of the consistent use of three-quarter bats in a Tudor bond. Throughout the seventeenth century the three-quarter bat construction even appears regularly alongside the header and closer solution, with early examples to be found at no. 9, Pieterskerkgracht, which dates from 1620, and at no. 129, Rapenburg, which dates from 1630 (**fig. 9**).



Figure 7. No. 19, Breestraat, Leiden; inscribed brick in the facade, 1791 (photograph by E. Orsel).



Figure 8. No. 7, Vijfde Binnenvestgracht, Leiden, 1588; three-quarter bat corner bond (photograph by E. Orsel).



Figure 9. No. 129, Rapenburg, Leiden, 1630; brickwork with closer corner bond and three-quarter bat bond at windows (photograph by E. Orsel).

The header and closer termination was used at the corners of facades, with three-quarter bats being used near windows. The reason for this practice can probably be found in the fact that during this period, influenced by the architectural treatises published as a result of the Renaissance, facades were designed to observe certain fixed proportions, while most of the architects came from the building trade (Haslinghuis 1997, pp. 373-5). An example to support this view is the facade brickwork of the courtyard houses at no. 21, Kloksteeg, dating from 1683 (figs. 10, 11). The courtyard is entered through a gatehouse in which the corner bonds of the architecturally important front and rear facades use either closers or three-quarter bats, the choice being determined by the design width of the doors and windows. The garden facades of the less significant courtyard houses all use closers. Therefore, the architecture of the gatehouse facades can be said to impose its rules on the brickwork, in consequence of which the bricklayers had to find suitable solutions for each corner bond. The result is an inconsistent use of corner bonds using both closers and three-quarter bats. The design of the garden facades of the houses is more traditional, with the brick size and the closer corner bond determining the position and dimensions of doors and windows.

The introduction of a consistent use of the three-quarter bat in Leiden may be connected with the influx of immigrants from the southern Netherlands after the town's relief from the Spanish siege in 1574. Among these immigrants, most of whom were fleeing before the Reformation, may have been a number of architects or brick-makers with a working knowledge of modern renaissance design methods and the use of the three-quarter bat termination, a notion also proposed by

Hollestelle (Hollestelle 1961, p. 247). Unfortunately, literature so far does not include an overview of such corner solutions, and inquiries from Belgian construction historians have so far failed to yield conclusive results).

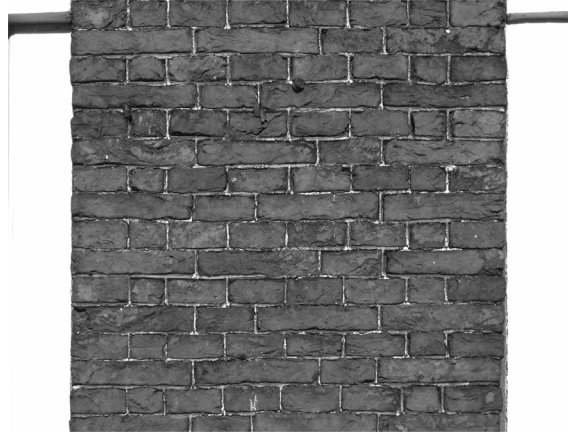


Figure 10. No. 21, Kloksteeg, Leiden, Pesijnhof, 1683; traditional brickwork with closer corner bond (photograph by E. Orsel).

In the middle of the eighteenth century, with no. 65, Rapenburg from 1749 as the earliest example, the closer termination starts to disappear (**fig. 12**). A late example of the use of a header-closer corner termination can be found at no. 12, Nieuwe Rijn, from 1790. As it is, window apertures and other terminations also demonstrate the use of other solutions, such as closers against the reveal, for example at no. 8, Rapenburg from 1668-1670, no. 25, Rapenburg from 1654, and no. 16, Papengracht from 1640 (the three-quarter bat solution also being in evidence). As the closer finally gave way to the three-quarter bat, the final stage in the development of brickwork corner bonds using traditionally manufactured bricks had been reached.

CONCLUSION

The redevelopment of the use of bricks as a building material in the Netherlands appears to begin sometime around 1200. As a locally manufactured product, bricks were a good alternative to stone, which was an imported, and therefore expensive, product. As bricks were also fire-resistant, their use was stimulated by the local authorities in various regulations, an early example of which is a Leiden statute from 1450 in which the use of brick or stone was made compulsory for facades.

The earliest bricks were very large, but brick sizes soon decreased as production rates went up and production costs went down. The quality also improved, and bricks became easier to handle, so they became better suited for constructing the thin walls of town houses. In addition, regulations issued by the authorities and mutual arrangements by brick manufacturers led to regulated, smaller brick

sizes. Based on the development of brick sizes, a rough date estimate can be given. For the town of Leiden, where the size reduction process took place relatively rapidly, the consistent collection of data from construction historical research has provided the basis for a tentative overview of the development of brick sizes (**table 2**). In addition to brick size, the type of bond and mortar used can provide an indication of age.



Figure 11. No. 21, Kloksteeg, Leiden, Pesijnhof, 1683; brickwork with closer and three-quarter bat corner bonds (photograph by E. Orsel).

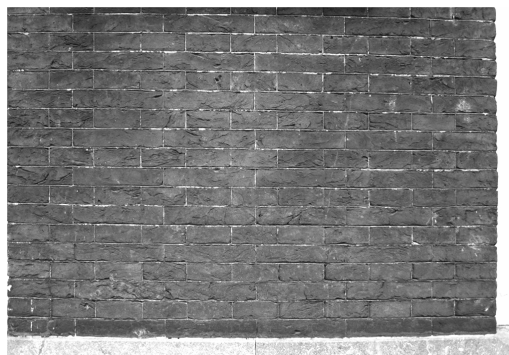


Figure 12. No. 65, Rapenburg, Leiden, 1749; three-quarter bat corner bond (photograph by E. Orsel).

In addition to a rapid reduction of brick sizes, Leiden buildings feature an unusual development of brick bonds. Around 1200 the monk bond, which does not normally occur in the region, prevails. The Flemish bond certainly occurs up to the middle of the thirteenth century. In the Netherlands as a whole, its use continues up to about 1325, when the Flemish bond is succeeded by the English bond. Use of the English bond continues at least until the late fifteenth century. Generally speaking, the English bond in the Netherlands is succeeded by the Tudor bond in about the middle of the sixteenth century. In Leiden however, the Tudor bond occurs as early as 1463, and it remains the dominant type of bond into the sixteenth century and later. On the other hand, the eighteenth century sees a revival of the English bond for facades requiring very smooth and precise brickwork. Another field in which Leiden is unusual is the development of the corner bond. The early rise of the three-quarter bat in Tudor bonds during the second half of the sixteenth century, as well as the concurrent use of closer and three-quarter bat terminations, are particularly striking features that can possibly be explained from the increasing popularity of treatises on novel architectural styles. Design rules determined the shape of the facade, and the bond simply followed.

Based on the above, construction historians can make a general identification of brickwork in Leiden. Based on context, size, bond, and mortar type, an indication of the age of a section of wall can be given, albeit with the proviso that different brick sizes tended to be used concurrently. Corner bonds and traces of later building activities such as additions and alterations are major factors that help determine a building's construction history.

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