New light on specialized XVI\textsuperscript{th} century construction techniques in the Low Countries

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The following paper briefly discusses two specific fields in construction in the 16\textsuperscript{th} century Low Countries, foundation techniques on the one hand, waterproof mortars and masonry on the other. Primary sources for these subjects are the writings of two late-16\textsuperscript{th}-century Netherlandish authors with great experience in these matters. Charles De Beste, a master-mason living in Bruges at the end of the 16\textsuperscript{th} century, passed on his knowledge in an extensive manuscript called \textit{Architectura}, conserved today at the Royal Library in Brussels (De Beste 1599; Van den Heuvel 1995). In this document, containing over 580 folios, the Fifth Book especially is of interest to those working in the field of construction history. This ‘\textit{Boeck 5 tracterende van Architecturen ofte Bauwinghe}’ manifestly refers to Vitruvius, but it also includes remarks and passages based on De Beste’s own practice and on the architectural context of late 16\textsuperscript{th}-century Bruges. Simon Stevin, Netherlandish scientist and engineer, was born in Bruges in 1548. He entered the service of Maurice of Orange at the end of the 16\textsuperscript{th} century, and taught at the first military academy in The Hague. Stevin was a very prolific writer; several of his writings on a variety of subjects were published during his lifetime, but also posthumously by his son (Van den Heuvel 1994). One specific manuscript, the so-called ‘\textit{Huysbou}’, is of particular interest to us. However, it was never published as such, and we only know it today through extensive references and quotations, included in the early 17\textsuperscript{th}-century journal of Isaac Beeckman² (De Waard 1942).

To complement the information offered by these treatises, contemporary building records and related documents for a variety of buildings have been taken into account as well.

FOUNDATION TECHNOLOGY

The Fifth book in the manuscript of Charles De Beste includes an entire chapter on foundations, ‘\textit{Van het legghen der fondamenten}’, providing us with a fine summary of the state of the art of foundation technology at the end of the 16\textsuperscript{th} century, at times with surprisingly great similarity to what Vitruvius wrote more than 1600 years earlier (Gwilt 1826, III; Vitruvius Pollio and Rose 1899, III).

De Beste states that as a rule, foundations have to be dug until good soil is reached, preferably going one foot deeper since the upper part of this good soil is generally of lesser quality. These foundation structures will have to be at least one third wider than the walls that will be erected on top (De Beste 1599, f° 343\textsuperscript{\textdegree}–344\textsuperscript{\textdegree}). De Beste strongly disagrees with building masters who disregard the shape of the building when planning the foundation structures. In this regard, de Beste refers to the belfry of Bruges, an 8-sided tower, which apparently has a square foundation system (De Beste 1599, f° 344\textsuperscript{\textdegree}).

Where good soil is not available at acceptable depths, builders will have to reach for other techniques: De Beste extensively describes a
procedure for pile-drilling, which was probably very common in Bruges. He suggests using oak, but alder or oleaster would do as well. These trees were to be cut to piles with a square section and a pointed head, their length being at least ten times their diameter. When necessary, a metal pin should be fixed at the head of the pile, for example when the soil is rich in cobbles stones. To improve the durability of the wood when sunk below ground, the surface of the piles could be burnt prior to drilling, a technique also mentioned by Vitruvius (Gwilt 1826, I: 5.3; Vitruvius Pollio and Rose 1899, I: 5.3). These piles would be placed closely against each other, the open spaces in between to be filled with ashes or charcoal. On top, massive oak planks would be fixed with copper nails, linking the piles together and providing a platform to start the foundation brickwork. This foundation technique is clearly illustrated by De Beste’s contemporary, the architect and military engineer Pierre Lepoiivre, in a drawing dated November 20, 1601, which shows the foundations of the (never to be built) north towers of the Arenberg Castle at Heverlee, then property of Charles II of Croÿ, duke of Aarschot (Duvosquel 1987, 76–79; Minnen 1993, 204–205 ill. 57). As an alternative for piles, De Beste describes sinking stones until good soil is reached, but he warns that stones tend to float up due to the high ground water pressure. Certain lime stones, however, seem to be less subject to this side effect, according to De Beste because they soak up the water.

The preserved building accounts for the construction of a new castle at Schoonhoven near Utrecht, some 150 km to the northeast of Bruges, give an even more accurate image of the practice of pile drilling in the Low Countries around 1525. The castle, commissioned by the emperor Charles V himself, was built by the well-known Netherlandish building master Rombout Keldermans the Younger (Leys 1987, 163–165). Prior to the start of foundation work, thorough research of the characteristics of the soil was executed. As to the pile drilling itself, beech and willow were used, with pointed heads to facilitate drilling. On top of these piles, a wooden ‘floor’ was constructed, on top of which the foundation brickwork was set. The foundation structures were made with a lime-trass mortar, which will be discussed later on.

De Beste’s overview also includes the technique of foundation pillars linked with arches, a technique
which was quite well-known in the middle ages, as remaining fragments of medieval city walls in Ghent, Brussels and Leuven still show today. According to De Beste, this was a very economical foundation technique: only the foundation pillars reached the depth where good soil could be found, the space in between the pillars was filled with rubble and sand, with an arch-shaped silhouette at the top, so that the arches linking each pair of pillars could be constructed without the use of centering. The irregular shape of these arches, visible on preserved examples, confirms this construction method.

Another paragraph in De Beste’s chapter on foundations deals with contemporary fortification technology: De Beste claims that the overall stability of curtain walls and the supporting buttresses would be increased if wooden planks were incorporated in the foundation structures. Again, he suggests using oak, burnt preventively on the surface or coated with tar. In view of the introduction of these wooden pieces, the bricks for the surrounding brickwork were not to be wet before bricklaying, and the mortar had to be based on lime from limestone.7 De Beste suggests that this part of construction was executed preferably in September, since this was the time when the ground water table was at its lowest. Traces of wooden reinforcements, or indeed of a complete wooden raft underneath the foundation walls, were found at Boussu castle, a work of the architect Jacques Du Broeucq for the imperial Master of Horse Jean de Hennin-Liétard, started in 1540 (De Jonge 1998a, 117). For special constructions such as towers, that are subject to relatively higher strains within the foundation masonry, De Beste suggests that every five layers, a diagonal layer would be incorporated, to improve the overall stability of the brickwork.8 This bond was found in Jülich (Germany, close to the Belgian and Dutch borders), during the restoration of the 16th-century citadel defences after World War II, the brickwork probably going back to the second half of the 16th century (Geleyns 1998).

VARIOUS USES OF TRASS

Trass, as mentioned in historical documents related to Netherlandish building practice, was a hydraulic binder of volcanic origin, similar to the puzzolani found in the south of Italy. The advantages of hydraulic mortars were known already in antiquity — Vitruvius mentioned ground stones or gravel as an additive to improve the properties of mortars: «If to river or sea sand, potsherds ground and passed through a sieve, in the proportion of one third part, be added, the mortar will be better for use». However, by adding a certain volcanic material, Vitruvius claimed that mortars could be obtained that were even more durable, mortars that could even set under water. He dedicates an entire chapter in his Second Book on building materials to what we know today as natural cements:


Figure 3
Two sketches taken from De Beste’s chapter on foundations. The drawing on the left refers to the specific diagonal bond, the drawing on the right clarifies De Beste’s suggestion to improve the connection between curtain walls and buttresses with wooden planks. (De Beste 1599, f° 345)
This was common knowledge in late 16th-century building practice in the Low Countries, as we can read in Charles De Beste's treatise. He discusses both regular mortars with added powder of ground roof tiles or ceramics, and hydraulic mortars. De Beste gives an almost literal translation of the passage found in Vitruvius, but adds that this 'puzzolan powder' described by Vitruvius cannot be found everywhere. However, there is a comparable material called trass stone, De Beste continues, which can be found in volcanic regions in nearby Germany, and which is a recent discovery according to him. This trass stone has to be ground and sifted carefully, after which 2 parts of trass can be mixed with 3 parts of good lime to make a hydraulic mortar (De Beste 1599, f° 338'-338').

In De Beste's own words, trass had been discovered 'fairly recently', which we should probably understand as 'dating from the 16th century'. This discovery runs parallel, in fact, to the introduction of several innovative solutions in the architecture of the Low Countries — the pile foundations at Schoonhoven are a good example of this. Even Thomas More included the following detail in his visionary Utopia of 1516, of a rather specific roof-rendering: «...Their roofs are flat, and on them they lay a sort of plaster, which costs very little, and yet is so tempered that it is not apt to take fire, and yet resists the weather more than lead» (More 1516, II: 'Of Their Towns, Particularly of Amaurot'). The pseudo-hydraulic mortars described higher, based on gravel and ground earthenware, however were already known in the southern Low Countries in late medieval times. For instance, in 1429–1430 repair works were executed in Mons, in the province of Hainaut, on the Tour Valencienne, a massive, round tower of the city wall. Apparently, there were problems of water infiltration that — as the source suggests — could be remedied with mortars with hydraulic properties (with ground roof tiles). Alain Salamagne even claims that this technique was gradually diffused in the north of Europe from the second half of the 15th century onwards, while it apparently was already quite common in the south of Europe at that time (Salamagne 2001, 81): it of course has antique roots.

Simon Stevin, who like De Beste originated from Bruges, refers to trass on a number of occasions, for various uses. As a general remark with regard to the properties of the material, Stevin writes that trass sets in water, provided that this water is not running constantly. Under water, setting apparently takes roughly six weeks, whereas under normal conditions, trass mortars take two weeks to set.

Obviously, the majority of Stevin's remarks on trass will relate to cellars, that part of the building where water often constitutes a constant and persistent problem. Stevin strongly favoured the construction of basements, provided that they were not moist (taking into account both ground water as well as rising damp) — otherwise, storing goods and food would be impossible, and the dampness would rise to the rooms overhead, which would strongly reduce living quality in that part of the house as well (Stevin 1650, 95–98). To meet this requirement, Stevin included a few construction techniques, the first based on trass mortar and sintered brick ('clinckaert'), ideally making up an impenetrable brickwork structure. Elsewhere, Stevin described more in detail a more specific procedure using trass: «To make basements in trass, one should lay a bed of sand first, followed by a bed of lime, on which 'dropsteen (?)' is to be laid in trass, seven stones high, with a fourfold isolating layer of trass. Stevin is well aware that cracks or holes in trass masonry are problematic, and offers two possible solutions. The first is a recipe for some sort of pap or slurry to close cracks in trass masonry, through which water would be dissipating; it is based on milk products. This is not a unique occurrence at that time: mortar based on Brussels cream cheese was thought to be especially fitting for grotto work, because it was resistant to the water sprayed by the automatons (De Jonge 2000, 92–93; 101 n. 25). In more urgent cases, with a higher ground water pressure for example, or when the first method proved to be unsuccessful, Stevin suggests constructing a pipe in trass brickwork against the fragment with the crack, high enough so that the ground water pressure can be compensated for by the level of the water inside the pipe (Stevin 1650, 95–98).

An alternative technique for areas with high ground water levels, though quite recent as Stevin admits, consists of wooden boards that are inserted in the ground, at least for the area that suffers from ground water. To resist the water, the planks are coated with tar and moss, «like caulking a ship» (Stevin 1650, 95–98).
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The use of trass in 16th-century construction to prevent water infiltration seems logical in the field of foundations and basements. Moreover, trass mortars also provided a good alternative for lead, as a covering for terraced roofs, and thus played an important role, it seems, in the introduction of large roof terraces and open-air galleries. These elements were important features of the innovative new architectural types of residential castles and prodigy houses, as will be explained by the examples of Mariemont (Hainaut) and Diest (Brabant) discussed below.

Work on the house at Mariemont, commissioned by Mary of Hungary, regent of the Low Countries, started in 1546. Together with its gardens, it was devastated by the French in 1554 already, and restored from 1555 till 1560 by its architect Jacques Du Broeucq. At the close of the 16th century, however, it had again fallen into disrepair; Albert of Habsburg, and the Infanta Isabella of Spain restored it again (1598-1620), adding the corner pavilions and several large wings to house their entourage (Wellens 1958-1961; Demeester 1978-1981). Nothing remains of it today.

As with the English prodigy houses, the architecture of Mariemont plays an important role in establishing the prestigious nature of the complex, aiming at a sensation of amazement and enchantment. In view of its role as backdrop for courtly events and hunting parties, the interaction between architecture and landscape was of paramount importance. This led to the creation of elaborate terraced gardens and parks, with belvederes and galleries serving as transitional spaces between the residence and its immediate surroundings (De Jonge 1998b).

Building accounts and iconography — although mainly 17th-century, these images accurately represent the 16th-century core — enable an accurate reconstruction of the original situation. The 16th-century house was a more or less cubic volume, measuring circa 19m on each side, but contrary to what later iconographical sources suggest, it initially did not have a sloping roof.18 This cube was placed in the exact centre of a water basin of 35m by 37m, construction of which was quite a technical achievement since it had had to be in part dug out of the steeply sloping hill on which the house was erected. This was the work of Guillaume Le Naing, master mason of Binche.19 On the southward and westward sides, impressive retaining walls can indeed be seen in the earliest views, the most accurate of which were painted by Jan Brueghel the Elder.20 Both the roof terrace and the water-retaining walls were at the time quite unusual, not in the least due to their scale. To secure a waterproof finish, the basin-walls and floor, including the basement walls of the castle on the inside of the basin, were covered with a dense clay, a technique which was well-known at the time from infrastructure works and hydraulics.21 The original roof terrace was covered with lead, possibly also with clay as an extra waterproof layer underneath.22 The roof terrace never proved to be completely waterproof, however, as can be deduced from the fact that in 1567, only a short time after the first repairs, it was covered with a sloping roof by Du Broeucq himself.

Figure 4
Digitally reworked image showing the putative 16th-century state. Jan Brueghel the Elder, ‘Mariemont seen from the south’. 1612, Dijon, Musée des Beaux Arts, Inv. nr. CA102.

A preserved builder’s estimate for the new residence in Diest commissioned by Henry III, count of Nassau, testifies to the fact that trass was a well-known additive already in the 1530’s — the estimate,
and the (lost) design to which it corresponds, presumably date from ca. 1530–1538. However, the castle was never executed. A reconstruction made by Bernhard Roosens (1983) shows a quadrangle, with two stories above the ground floor and the vaulted cellars, and with round staircase towers protruding at the angles. In front of each wing ran a portico on the courtyard-side, with a terraced roof. This design is closely related to similar noble residences dating from the first half of the 16th century, all with a regular square or rectangular plan and a portico in the courtyard (De Jonge 1998a, 161–187). Other examples are Henry III of Nassau’s castle at Breda, construction of which was started in 1536, and the palazzo in fortezza in Jülich, residence of William V, duke of Jülich-Kleve-Berg, started in 1549.

The arched gallery on ground floor level was vaulted with a trass-mortar. The document states explicitly that the roof of the gallery itself was also intended as a terrace or upper gallery: « . . . and on these (vaults), one shall go to access each of the rooms mentioned above . . . ».23 As to the roof of the wings, a finish based on trass and paving stones was intended as a first variant, the vaulting of the upper floor underneath also to be executed using a trass mortar.24 Combined with the summer house to be built on the roof, this would provide the perfect setting for banquets in good weather—the designer(s) even included the possibility to install a fishing pond on the roof.25 Using roofs for banquets was not so unusual in the world of English prodigy houses, as for example at Longleat; records discussing construction work around 1570 inform us that «Item all the staires to Ryse above the house and to be types, and IIII to have lytle staires wonne fro the rooфе so as they may as bancketting housses».26 Nevertheless, the designer(s) at Diest included an alternative solution for a sloping roof in the same document, which indicates that they were aware of the rather ambitious nature of their design, marking it as something still rather unusual in the Netherlandish building tradition.27

Isaac Beeckman’s ‘Journal’ includes remarks by Stevin, which offer a succinct overview of the problems inherent to terraced roofs such as these:

«The best roofs are achieved by using roof plastered with earth and trass, with stones on top. One without the other will not do».

Lead was a common solution for roofs, but had some disadvantages (Stevin 1650, 98–102): it was relatively expensive, it would expand considerably under warm weather, leading to gradual cracking. Also, lead would become so hot when exposed to direct sunlight, that it became almost impossible to walk there in summertime; obviously, this made the use of solid alternatives for flat roofs even more appealing. Stevin mentions in this regard that tiles, which were burnt in fire, withstand fire better than slates, lead or copper.29 On this point, the prodigy houses of the 16th century were technically vulnerable.
NOTES

ARAB RK  Algemeen Rijksarchief Brussel, Rekenkamer
ARADH  Algemeen Rijksarchief Den Haag
KUL AA  Katholieke Universiteit Leuven, Arenberg Archief

1. The authors would like to thank Charles van den Heuvel for allowing us to consult his notes and transcriptions of Simon Stevin’s texts.

2. Apparently, Beeckman met several times with the widow of Stevin in 1624, occasions upon which he had the chance to consult manuscripts and notes belonging to her late husband.

3. «Ende dese piloterijnghe sal gheschieden In dese manieren. Men sal nemen goeden Eecken houten daerm eenen pijlen af bereeden sal, te weteenv dat haecleider langde sal wesen 10 maal naer die diepte des diameters der seluer houten, Dese pilen die sullen viercant besleghe wese ende onder eere scerp, Ende soo waer keijachtighen grondt voor hande es, soo salmen aen die henden ijseren pinnen slaen, daer naer soo salmen desen pilen wat branden, dit nu aldus ghedaen mije ghebruijck ende ondere scelp, Ende zo salmen soo salmen die pilen dichte aan melckanderen. Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten ofte slaen met bijzondere Instrumenten van metaele daer toe ghemacht, deze pilen aldus Inne geheijt wesende, soo salmen die pilen dichte aan melckanderen Inne houten or...
viene à Mons et marchander de faire terrasse de tueilles mouillées sur la voussure de la grosse tour, se boitement valloir pouvoit contre les eaux sans trebattre." (Pierard 1981, 351)

13. «Tarrast versteent wel int water alst niet geduerich door en loopt, in ses weken; buijten t’water in veerthien dagen». Beeckman, I. Journal, p. 226, lines 1–2 (De Waard 1942).


15. «Om te stoppen een splete in tarrast, daer water door trebattre.» (Pierard 1981, 351)


17. «De tweede wijs is ontlanck t’Amsterdam int gebreyck gerocht alwaer seer leech lant zijnde, maken het deel onder water commende, van hout stoppen dat met ons en teer, en onderhoudent getijcken de schepen doet». A similar remark is included in Isaac Beeckman’s Journal, p. 231, lines 1–3 (De Waard 1942).

18. ARAB RK 27306, part II, 2nd account, f. 445v, 446v, 446r, 447v, 606v, 607v.


20. In particular Madrid, Museo del Prado, inv. n° 1434 (view from the south-west, 1611–1612); Dijon, Musée des Beaux-Arts, inv. n° CA102 (view from the north-west, 1611) ; and Munich, Alte Pinakothek, inv. n° 1893 (view from the south-west, 1611). (Ertl 1987, 157–163)


22. «. . . ende dat verwelsfel vander gaelderye zal liggen in tarras ende daer zalmen up gaen rond omme in elck vande voornoemden cameren om mijnhen here te dienen, . . . » taken from Raeminge van maecchen vanden huijse oft sloten van Diest, tempore comitis Henrici de Nassau. ARADH, Nassausche Domeinraad, 1st section, nr. 1076, f° 4r, paragraph 19 (Roosens 1983).

23. «. . . mids dese derde verdiepijnghe datse zal zijn . . . ende dat verwe1fsel vander gaelderye zal zijn in elck vande voornoemden cameren om mijnhen here te dienen» (Pierard 1981, 351)

24. «. . . mids dese derde verdiepijnghe dase zal zijn verwolven ende gheleyt in tyras, ende daer en zal gheen daak boven zijn, ende men zal den vloer int upperste paveren ook met tarrass, . . . ». Raeminge van maecchen vanden huijse oft sloten van Diest, tempore comitis Henrici de Nassau. ARADH, Nassausche Domeinraad, 1st section, nr. 1076, f° 4r, paragraph 15 (Roosens 1983).

25. Raeminge van maecchen vanden huijse oft sloten van Diest, tempore comitis Henrici de Nassau. ARADH, Nassausche Domeinraad, 1st section, nr. 1076, f° 4r, paragraph 22 (Roosens 1983).

26. Taken from the Records of the building of Longleat, II, 121 (Girouard 1983).

27. Raeminge van maecchen vanden huijse oft sloten van Diest, tempore comitis Henrici de Nassau. ARADH, Nassausche Domeinraad, 1st section, nr. 1076, f° 4r, paragraph 20 (Roosens 1983).


29. «. . . tegelen . . . welcke int vier gebacken zijnde. den brant connen verdragen beter dan leyen, loot of coper.» (Stevin 1650, 118–119).

Reference list


De Waard, C. 1942. Journal tenu par Isaac Beeckman de 1604 à 1634, t. II.


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