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London's earliest medieval roofing tiles: a comparative study

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SUMMARY

Roofing tiles were used in London from the 12th century and in early decades three systems were employed; they are here compared to suggest why peg tiles superseded their rivals to become the ubiquitous form of ceramic roof covering in later medieval London.

THE EARLIEST LONDON ROOFING TILES

Following a serious fire in London in the first year of King Stephen's reign (1135/6), the houses of a number of citizens were *spissis tegulis coopertam* or 'covered with thick tiles' (Riley (ed.) 1859, 329). In 1212 directions drawn up by the City's first mayor, Henry Fitzailwin,[1] recommended 'hard' roof coverings — wooden shingles, boards, ceramic tiles, lead, or plastered straw (*estra detorchiato*) — in place of flammable thatch (Bell 1938, 4; Salzman 1967, 223).[2] In 1245, legislation stipulated that tiles or shingles only should be used on houses in the principal thoroughfares of the City (Bell 1938, 4). Archaeological evidence confirms the 12th-century beginnings of ceramic roofing tiles in London and, moreover, demonstrates that in early decades — mid to late 12th and early 13th century — three different tile roofing systems were in use, employing four different tile forms, which have come to be known as *shouldered tiles, flanged* and *curved tiles* and *peg tiles*. (The earliest account of the different types, following their recognition in archaeological excavations, is Armitage *et al.* 1981; the best descriptive account is that in Betts 1990, 221–5; see also Betts 1997a, 66–8, which includes a consideration of more recent material; there is a useful summary account in Keily 1998, 27–30.)

Shouldered tiles (Fig. 1, No. 1) are essentially rectangular, but have a constriction in their upper third, forming a kind of neck; towards the top of this neck is a single circular hole or, more rarely, a pair of circular holes. Iron nails are occasionally still found in excavated examples, although wooden pegs, which are less likely to survive, may sometimes have been used. The tiles are thick and heavy and nailing would have made them more secure. **Flanged tiles** (Fig. 2, No. 2) are flat with a flange down each side; some are tapered so that they are wider at the top than at the bottom to facilitate the slight overlap down the roof slope, others are straight-sided. The tiles have a single circular nail- or peg-hole near the top. **Curved tiles** (Fig. 2, No. 3) are more or less segmental in section and also taper from bottom to top to permit overlapping; there is a single circular nail- or peg-hole towards the top. The flanged and curved tiles were used in combination in a single roofing system, the curved tiles covering the junctions between adjacent flanged tiles in the manner of Roman *tegulae* and *imbrices* (for Roman materials see Brodribb 1987, 5–27). Early **peg tiles** are also usually quite thick and have circular nail or peg holes near the top. Although peg tiles are usually rectangular, some of the earliest in London were slightly tapered from bottom to top in the form of an isosceles trapezium, the upper angles just a little over and the lower angles just a little under 90°; examples found to date have a single nail-hole. Pegs or nails were the usual means of fixing tiles in medieval London; only very occasionally were **nib tiles** used, far less often than in some other parts of the country. They have small lugs at the top of the under-face, which were hung over the roof battens.

The shouldered, flanged, and curved tiles, and *some* of the early peg tiles are in similar and very distinctive sandy fabrics, occasionally with an abundance of crushed shell, numbered 2272, 2273, and 3228 in the Museum of London Specialist Services ceramic building materials fabric collection; other medieval tiles are in various fabrics, of which the

Fig. 1. Some roofing tile types used in medieval London: No. 1 shouldered tile. Scale: 1:4.

most common are fabrics 2271 and 2586 (see Appendix 1 for fabric descriptions). The early tile types are orange-red or brown in colour and frequently show grey, reduced cores where oxygen has failed to reach their centres during firing. They also usually have a well-applied coat of lead glaze in dark green or brown. On the shouldered and peg tiles this is restricted to that part of the tile which would be visible in a completed roof — the lowest third or so of the upper face; flanged tiles too usually have the glaze limited to that part which was visible in the finished roof — the central strip of the upper face. Curved tiles, however, usually have the glaze restricted to the upper part of the outer (convex) curve, although the sides would also have been visible on a roof.

The similarity in fabrics of the shouldered, flanged and curved tiles, and of some of the peg tiles suggests manufacture from similar deposits of raw material; wasters recovered from Niblett Hall, Fleet Street indicate one place of manufacture (Betts 1997b, 122), although there may have been others. The date-range of the first three types appears to be the same — from about the mid-12th to the early decades of the 13th century. They are presumably the 'thick tiles' mentioned in 1135/6. There is less secure dating evidence for peg tiles in similar fabrics, although they are present soon after the other types and into the mid 13th century. At some time in the second half of the 12th century, peg tiles in other fabrics were also introduced, and these persisted throughout the Middle Ages and beyond.

By the late 13th century, perhaps as a result of increased demand and therefore of increased production, there may have been a falling-off in quality, for in 1284/5 it was directed that all roofing tiles in London should be *bien quyte et bien plumbe et de veil escauntilounn* ('well fired and well leaded, and of the old scantling': Riley (ed.) 1859, 288; cf. Latin version at 729: *Item quod tegulae sint bene arsae et bene plumbatae, et de veteri scantilone*). Riley was puzzled by the term 'leaded' (*plumbe, plumbatae*): '. . . for what purpose they [the tiles] were "leaded" is, perhaps, unknown' (Riley (ed.) 1861, 242, n. 2). Archaeological evidence leaves no doubt that 'leaded' means *lead-glazed*; 'scantling' may refer to the overall dimensions or, more probably, to the thickness alone. The insistence on good glazing perhaps reflects increased use of 'splash glaze', in which the glaze has the *appearance* of having been splashed onto the surface in a kind of spatter technique, although there were alternative ways of achieving this effect (see Newell 1995, 77–88 for this issue in connection with pottery). If, as seems likely, the glaze was regarded as protective rather than (or as well as) decorative, then tiles with splash glaze would be regarded as inferior products, and concern that they should be *bien plumbe* is understandable.

COMPARISON OF THE THREE SYSTEMS

In their comparative study of the different early tile forms in London, Armitage, Pearce and Vince suggest that all the types would have been fixed to the roof battens (which they call 'slats') by means of wooden pegs (Armitage *et al.* 1981, 359). Both wooden pegs and iron nails were employed for fixing roof tiles in the Middle Ages (for a useful brief discussion see Keily 1998, 32). The heavy early forms, however, may have been more secure if nailed rather than fixed with pegs. Despite their usual name, peg tiles too were quite frequently fixed with nails.

Each of the three roofing tile systems in early medieval London — shouldered tiles, flanged and curved tiles in combination, and peg tiles — had its own particular qualities and its advantages or disadvantages, which are examined further below.

Armitage *et al.* (1981, 362) estimated the weight of a peg tile at 1·3 kg, of a shouldered tile at 2·0 kg, and of a flanged and a curved tile at 3·3 kg and 1·6 kg respectively. These figures may be accepted as

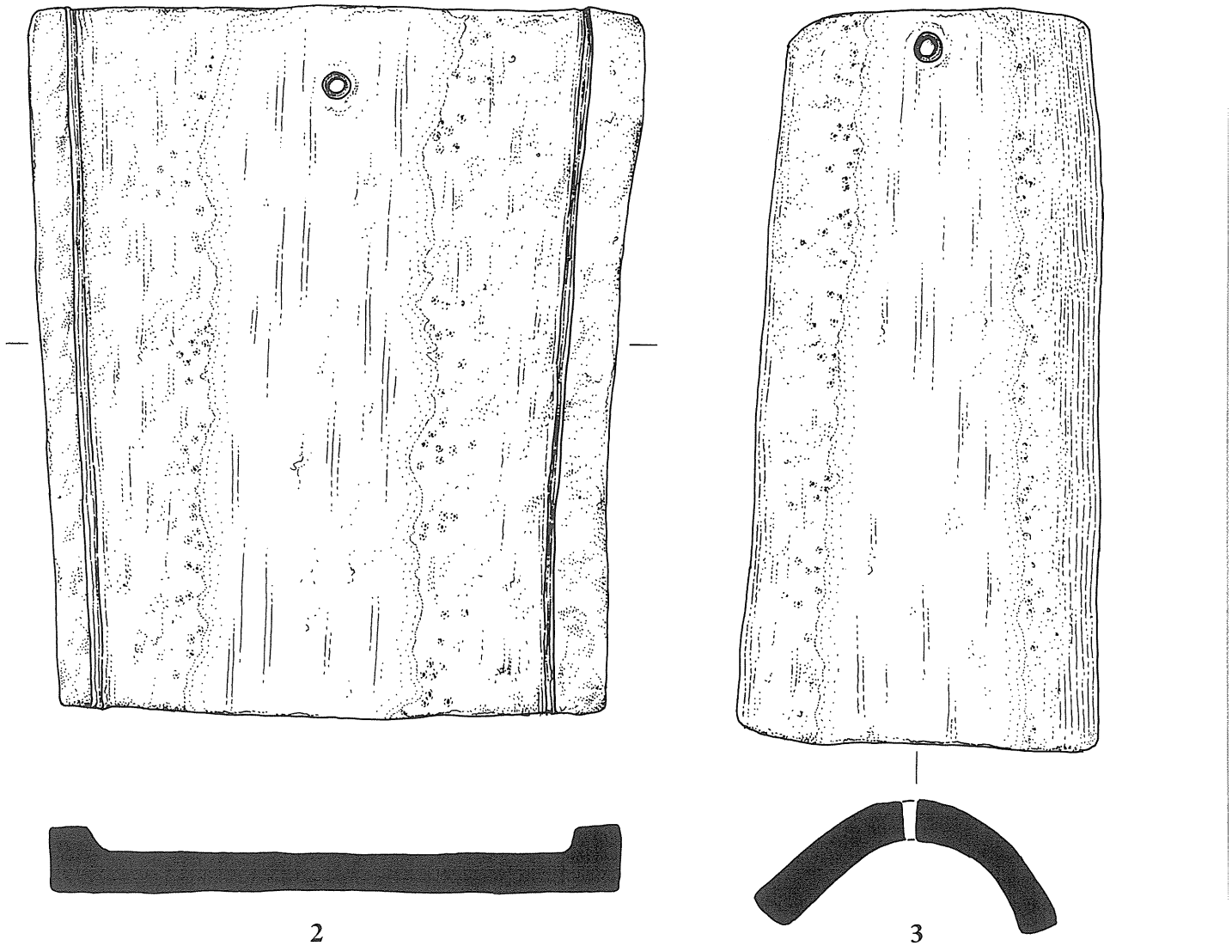

Fig. 2. Some roofing tile types used in medieval London: No. 2 flanged tile; No. 3 curved tile. Scale: 1:4.

typical values and are used here for further calculations, although individual tiles do, of course, vary in size and weight, sometimes quite markedly. They also gave the numbers of tiles required to cover a square metre of roofing, correctly stating that shouldered tiles would need to be laid with a two-thirds lap, but mistakenly claiming that *peg* tiles could be laid with only a *half* lap, an error followed in Cherry 1991 (194–5). Peg tiles too require a lap of two thirds in order to be weatherproof. The figure for the number of peg tiles required to cover a square metre therefore needs to be altered from 36 to 36 × 1·5 = 54; the other figures are acceptable, that is, 47 for shouldered tiles and 11 + 11 = 22 for flanged and curved tiles used together. The mistaken figure for peg tiles affects the estimation of the weight of a square metre of such roofing, which needs to be corrected from 46·8 kg to 46·8 × 1·5 = 70·2 kg; the figures given for the other kinds of roofing are acceptable (see Table 1). Clearly, therefore, a square metre of peg tile roofing would be significantly heavier than a square metre of flanged and curved tile roofing, though somewhat lighter than a square metre of shouldered tile roofing.

Comparison of roofing types also needs to take into account the *pitch* of the roof. Armitage *et al.* (1981, 362) assume that this is the same for each type. However, the minimum pitch for plain (peg or nib) tiles is 40°, and this would apply equally to shouldered tiles, in practice no more than a special type of peg tile. The flanged and curved tiles, on

Table 1. Estimated weight per square metre of different medieval roofing systems in London.

Tile type	Weight (kg/1m²)
Shouldered	94·0
Flanged + curved	53·9
Peg	70·2

the other hand, would permit a lower minimum pitch, down to 30° or even less: similar systems in Italy today have pitches of 'about 20° except where they cover a vault, as in churches, where a more usual [pitch] is about 30°' (Rook 1979, 295; cf. Schofield 1995, 96–7). A pitch of 30° is used here as the basis for further comparisons between the different roofing systems. The difference is significant, the *percentage* saving in area to be covered by dropping from a pitch of 40° to one of 30° being 11·54% (see Appendix 2). With a pitch as low as 20° the saving would be as much as 18·48%. It should be stressed too that a pitch of 40° for peg tiles, as used here, is a *minimum*; roofs were often of much steeper pitch. Harvey (1955, 45), for example, bases calculations on a pitch of 48°, and this would by no means be unusual: the percentage saving by dropping from such a pitch to one of only 30° is 22·74%.

Better data for comparison are obtained by calculating the number and weight of the different tile types required to cover differently pitched roofs for a specified *floor* area, here taken as 1m². The different weights (rounded up or down to whole numbers) are set out in Table 2 for ease of comparison (see Appendix 2 for the calculations on which these figures are based).

Table 2. The estimated weight of different roofing systems in medieval London per square metre of floor area.

Tile type	Pitch	Weight (kg/m² of floor area)
Shouldered	40°	124
Flanged + curved	30°	64
Peg	40°	92

Clearly, and somewhat surprisingly perhaps, it is the flanged and curved tiles which would weigh least. Even with a pitch of 40° the weight advantage lay with the flanged and curved tiles: the area of roof to be covered for 1 m² of floor area would be 1·31 m², the number of tiles required would be 14·5 (rounded up) of each type, and the overall weight would be 71·1 ≈ 71 kg. They would thus require a roof construction less robust than those needed by the other tile types. A further advantage lay in the fact that the roof covering required fewer battens than did the other types. Armitage *et al.* (1981, 362) give the figures for the spacing of battens in the different roofing systems as *c.* 300 mm for flanged and curved tiles, *c.* 110 mm for shouldered tiles, and *c.* 160 mm for peg tiles; but their last figure is again affected by the assumption that peg tiles could be laid with a lap of only one half. The correct figures should be *c.* 300 mm, *c.* 110 mm, and *c.* 107 mm respectively, increasing the advantage of the flanged and curved tiles in this respect. That advantage would indeed have been greater than even these corrected figures suggest since the lower pitch of a flanged and curved tile roof would result in still fewer battens being needed for a given *floor* area.

The *disadvantage* of the curved and flanged tiles, however, as Armitage *et al.* point out, is that they required 'considerable hand-finishing . . . in comparison with standard peg tiles': the sides of the flanged tiles would need to be bent upwards and the curved tiles would need to have their curvatures formed after demoulding. The latter task may have been done by pressing the newly demoulded tile over the upper leg (between thigh and knee) of the tilemaker, as sometimes seen in southern Europe today. Alternatively, a wooden 'saddle' may have been used. The first of these additional operations in particular — hand-forming of the flanges — would have added considerably to the time needed for making the tiles and therefore to the cost of manufacture. Even if the flanged tiles were made without post-moulding modification, in the manner suggested for Roman *tegulae* (Rook 1979, 298–301), manufacture would still have been an involved procedure — time-consuming, therefore, and costly. The laying of these unwieldy tiles on a roof would also have been a laborious undertaking. It is doubtless for these reasons that they passed out of use fairly early on. Perhaps too the flanged and curved tile system was poorly suited to the north European climate, as suggested in connection with examples from York, '. . . in damper northern climates moisture and detritus would collect in the channels encouraging the growth of vegetation' (Garside-Neville 1995, 34).

Armitage *et al.* (1981, 362) argue that shouldered tiles also required 'considerable hand-finishing'. But the narrowing at the neck would be built into the mould, so that such tiles would have required moulding only, with no post-moulding modification — apart from the formation of the peg/nail holes, which the other tile types required too. The reason for the disappearance of shouldered tiles, again quite early on, must lie not only in their cost (they used a good deal of raw material) but also in their need of a two-thirds lap combined with their high individual weight, and in the fact that they could not be laid at pitches below 40°, resulting in a very weighty roof covering — almost twice as heavy as a

roof using flanged and curved tiles at a pitch of 30°. This in its turn would have required an extremely robust timber roof construction for support. Their laying was probably less laborious than that of the flanged and curved tiles, but each unit is heavy and to that extent handling them would have been difficult. They must have been the least satisfactory method of roof tiling ever to be used in London — or elsewhere.

THE DOMINANCE OF PEG TILES

Peg tiles, although producing a roof heavier overall than flanged and curved tiles, were far simpler to manufacture and required less raw material. Their small size would have made them easier to handle than flanged and curved tiles or shouldered tiles, both at the yard during manufacture and by the tiler on the roof. Their principal advantage over the shouldered tiles, however, lay in the light weight (74%) of a peg tile roof compared with that of a shouldered tile roof. The future clearly lay with peg tiles, despite the fact that they required more battens for their fixing than either of their rivals, and it is hardly surprising that they persisted long after those rivals had disappeared. Peg tiles were also probably the cheapest to manufacture.

Nib tiles, perhaps a more serious alternative to peg tiles, required a degree of hand-finishing and would therefore have been more costly. In the 19th century, when nib tiles were again used, the nibs were formed in the mould, which had two small projections at its top; the flat lugs thus produced were turned up to form nibs by the boy who carried the tiles from the moulding bench to the drying ground (Dobson 1850, vol. 1, 107–8). In medieval times, however, the nibs seem always to have been formed by hand from lumps of clay at the tops of the tiles (Lewis 1987, 8). It may be for this reason that the nib tile industry in south-eastern England disappeared in the 14th century (Drury 1981, 131, where it is also pointed out that in a few areas, such as Southampton and the Severn Valley, nib tiles persisted beyond the 14th century). However, it is just possible that the industry was a fatality of the Black Death of 1348-9, as, for example, was the pottery industry of Hanley, Worcestershire (Le Patourel 1968, 108). In any case, although nib tiles were a common enough roof covering in adjoining Essex, they were hardly ever used in London: only very occasionally are they found in archaeological excavations there, for example, a few fragments from 250 Bishopsgate (Smith 1997). These tiles are, probably mistakenly, dated to the post-medieval period; their resemblance to a far larger assemblage from Stratford Langthorne Abbey, East London (originally Essex), now suggests a medieval (pre-mid-14th century) date (Smith, in prep.; see also Pringle 1998). Peg tiles formed the virtually ubiquitous roof covering in London from the 13th century down to the advent of Welsh slate in the later 18th and 19th centuries. Pantiles, introduced in the 17th century (Betts 1992, 76), were never a serious rival to them in the London area (*pace* Crowley 1997, 200).

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APPENDIX 1

Tile fabric descriptions

The following are brief descriptions of the fabric types used within the Museum of London Specialist Services and referred to in this paper:

2271 — red or orange-red, sometimes with grey (reduced) core; fine texture with little quartz, scatter of muscovite mica in certain tiles, with red iron oxide and calcium carbonate.

2272 — orange-red to light brown, commonly with a grey (reduced) core; sandy with common quartz, calcium carbonate, and much crushed shell.

2273 — as 2272 but with little or (more often) no crushed shell.

2586 — orange-red, sometimes with grey (reduced) core; fine clay matrix with varying amounts of quartz: sandy version of 2271.

3228 — light brown, sometimes with grey (reduced) core; otherwise as 2272 but with smaller quartz and with little or (more often) no crushed shell.

APPENDIX 2

Calculations of the number and weight of the different tile types required to cover differently pitched roofs for a specified *floor* area.

(i) The percentage saving in the area of roof to be covered by dropping from a steeper to a shallower pitch is given by the formula $\sigma = 100 - (100[\cos x \div \cos y])$, where σ is the percentage saving, x is the angle of the steeper pitch, and y is the angle of the shallower pitch. Thus, the percentage saving by dropping from a pitch of 40° to one of 30° = $100 - (100[\cos 40° \div \cos 30°]) = 11{\cdot}54\%$.

(ii) The area of roofing to be covered for a given floor area is obtained from the formula $a = f \div \cos x$, where a is the area of roofing, f is the floor area, and x is the angle of pitch. With a pitch of 40° and a floor area of 1 m^2, therefore, the area of roofing = $1 \div \cos 40° = 1{\cdot}31$ m^2, but with a pitch of 30° it is only $1 \div \cos 30° = 1{\cdot}15$ m^2. The number of shouldered tiles to cover 1m^2 of floor area (at a pitch of 40°) would thus be $47 \times 1{\cdot}31 = 62$ (rounded up) and their overall weight would be $62 \times 2{\cdot}0 = 124{\cdot}0$ kg. A roof of flanged and curved tiles to cover 1 m^2 of floor area (at a pitch of only 30°), on the other hand, would require only $11 \times 1{\cdot}15 = 13$ (rounded up) flanged tiles and the same number of curved tiles (thus 26 tiles in all); their overall weight would be $(13 \times 3{\cdot}3) + (13 \times 1{\cdot}6) = 63{\cdot}7 \approx 64$ kg. (With a pitch as low as 20° the roof area to cover a floor

area of 1 m^2 would be only 1·06 m^2; the number of tiles to cover that area would be only 12 (rounded up) of each type, and the overall weight of the tiles would be only 58·8 ≈ 59 kg.) Since, as previously noted, peg tiles require a two-thirds lap and to be laid at a minimum of 40°, it would take 54 × 1·31 = 71 (rounded up) tiles to cover a floor area of 1 m^2 (at 40° pitch); the overall weight would be 71 × 1·3 = 92·3 ≈ 92 kg.

Notes

1. The Tudor historian John Stow muddled the dates when he wrote that 'it was long since thought good policie in our Forefathers, wisely to prouide, namely in the yeare of Christ, 1189, . . . *Henry Fitzalwine* being then Mayor, that all men in this Citty should . . . couer [their houses] with slate or baked tyle' (Kingsford 1908, vol. 1, 83; this was followed too uncritically in Smith 1988, 9).
2. The document is normally understood as prescriptive, although H. T. Riley long ago pointed out that its terms 'do not appear to be obligatory on any point, except that . . . partition [that is, party] walls were to be built of stone . . .' (Riley, (ed.) 1859, xxx).

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Résumé

Les tuiles étaient utilisées à Londres à partir du XIIème siècle et pendant les premières décennies trois systèmes étaient utilisés; ceux -ci sont comparés dans ce papier, suggérant pourquoi les 'peg tiles' — tuiles plates perforées dans la partie supérieure permettant ainsi d'être fixées à la charpente par un clou — ont remplacé leurs concurrentes pour devenir la forme de couverture de toiture en céramique omniprésente à Londres ultérieurement pendant l'époque médiévale.

Zusammenfassung

Dachziegel werden in London vom 12. Jahrhundert an verwendet. In den frühen Jahrzehnten gab es drei Systeme, die hier verglichen werden, um herauszufinden, warum der Zapfenziegel seine Rivalen verdrängte und für die keramische Dachdeckung im spätmittelalterlichen London der überall verwendete Dachziegel wurde.