YORK ARCHAEOLOGICAL TRUST

A GUIDE TO CERAMIC BUILDING MATERIALS

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CONTENTS

Plates

Cover: A medieval ceramic spit-support from the St Leonard's excavations, York

Abbreviations

CBM Ceramic building material

YAT York Archaeological Trust

1 INTRODUCTION

The following document is a reference guide to the forms of ceramic building material (CBM) held in the collections of York Archaeological Trust (YAT). It is intended as an aid for excavation staff, to enable the easy identification of CBM recovered from excavations in the city. Only the types of CBM currently held within the YAT collections are described below, any forms that have been found elsewhere in Britain that are absent in York (such as medieval shouldered tiles) are not therefore described here.

CBM is one of the most commonly occurring artefacts recovered from excavations in York, and indeed from urban excavations elsewhere in Britain. At the time of writing YAT had excavated a total of 42.8 tons of CBM, of which approximately 8 tons was of Roman date, 32.8 tons was medieval or post-medieval in date and two tons was of modern date. The relative lack of modern CBM is a reflection of excavation practice in the 1970s and 1980s when such material was rarely retained.

The CBM excavated by YAT has been recorded to a standard methodology (McComish 2014) whereby each sherd is recorded in detail, but only a representative sample is retained from each excavation. The retained portion typically amounts to 20% of the volume of material excavated from each site. The detailed recording of the entire collection has enabled YAT to state with precision exactly which forms of CBM have been recovered from across the city.

It should be remembered that CBM is often badly fragmented when excavated, which is due to its post-depositional history. Taking the Roman material as an example, over 60% of the CBM is so badly shattered that its original form is impossible to determine, and despite in excess of 36,000 Romans sherds being recorded, only 158 sherds have complete surviving length measurements, 246 sherds have complete surviving breadth measurements, and just 145 tiles have both a complete surviving length and breadth. This severe fragmentation is because most of the Roman CBM originated from deeply stratified urban sites, where the Roman buildings had collapsed or been robbed, with the resultant tile being constantly re-deposited and broken into ever smaller sherds.

2 METHODOLOGY

This report comprises a description of each form of CBM on a period-by-period basis, but it should be noted that for the medieval and post-medieval periods there is considerable overlap in the forms of CBM used. A brief overview of the material from each period is also given. The text used in the descriptions of the Roman forms is taken from McComish (2012), while the descriptions of the post-Roman material were written specifically for this report.

Data on the number of examples of any particular form present was extracted from YAT's internal database (called IADB) in the week starting 2nd August 2015. These figures will inevitably change as ever more CBM is recorded and added to the dataset.

All the examples illustrated in the text are from YAT's collections unless otherwise stated. In some cases, the material held by YAT is too fragmentary to give a clear indication of the original appearance of an individual form, an alternative photograph of the form in question has been provided in such cases (these photographs are from the private collection of J.M. McComish).

3 ROMAN CERAMIC BUILDING MATERIAL (LATE 1ST TO 4TH CENTURY AD)

The use of ceramics for building purposes was introduced to Britain by the Romans. CBM was produced in Britain within twenty years of Claudius' invasion, the earliest evidence of production being a kiln dating to AD 50-60 at Colchester, while the earliest known stamped tiles dating to the reign of Nero, AD 54-68, are from Silchester and a nearby site at Little London (Greenaway 1981, 290). The precise date at which tile production commenced in York is uncertain (McComish 2012, 86), but it was clearly shortly after the foundation of the fortress *c.* AD 71. Legionnary kilns for the production of both pottery and CBM were located to the south-east of the fortress in York, and CBM was produced by both the Legionns stationed in York (the Legionn IX, which was based in York from AD 71 to *c.* AD 120, and the Legionn VI which was in York from *c.* AD120 to the end of the Roman occupation). There are also a small number of civilian tile stamps known from York, but the location of the associated kiln/kilns is unknown. The date at which CBM production ceased in Britain is more difficult to determine, but in the case of York there is little evidence of production after the mid-third century (ibid., 48).

In theory Roman bricks were made to standardised sizes based on divisions of a Roman foot. In practice, however, sizes often vary from the ideal, largely due to shrinkage of the clay during firing. Roman bricks (bessalis, bipedalis, opus spicatum, parietalis pedalis, Lydion and sesquipedalis) were made on sanded work benches using appropriately sized open-bottomed sanded moulds, known as formers, giving rise to sand on the sides and bases of the bricks, and sometimes to lips of clay around the bottom of the tiles where clay had been squeezed between the former and the work bench (Betts 1985, 158). Sometimes the sanded undersides have drag-lines from wires which were used to separate the tile from the workbench (ibid., 162). The method of manufacture for the more specialised tiles is discussed in the relevant sections of text below.

Roman material was often stamped by the manufacturer, and in the case of Britain that includes the Roman army, the Roman navy, municipalities and civilian manufacturers. Known stamps are published by Collingwood and Wright (1992 and 1993) and their numbering system for recording such stamps should always be followed.

Roman material may also have signature marks; these do not comprise names or text, but rather take the form of simple designs drawn by the person making the tile while the clay was still wet. Signatures were usually drawn with the fingers (Warry 2006, 91), though nationally a few signatures are known which were drawn with a stick, a comb, or incised with a knife (Brodribb 1989, 102). The function of these marks is unclear, and it has been suggested that they could represent trade-marks, or were designed to denote grades of differing quality tile (ibid., 104). It has also been suggested that the signatures were designed to indicate which tiles were to be stamped by the overseer (McWhirr and Viner 1978, 364).

Tiles with graffiti are known from many sites across Britain; text based graffiti include information relating to tile manufacture, personal names, presumably of the tile maker, lists of names, and examples where tile makers seem to be practising writing the alphabet (Collingwood and Wright 1993, 92-159). There are also some which are pictorial, such as the drawing of a pharos on a tile in the collections of the British Museum (Brodribb 1982, 299).

Examples have been found within the YAT collection of both inscribed numerals, and random lines.

Some forms known from elsewhere in Britain are absent in YATs collections, notably bipedalis and sesquipedalis tiles (descriptions of these forms can be found in Brodribb 1989, 41-2).

3.1 Antefix

Antefix tiles typically comprise a decorated vertical panel of triangular or pentagonal shape, though two are known from Caerleon with a rounded top, and they have a lug or a semi-circular flange on the reverse designed to fit into the open end of either the lowest-most course of imbrices on a roof or into the gable-end of the ridge-tiles (Brodribb 1989, 29-31). Antefix tiles have sanded decorated surfaces showing that they were made in sanded moulds rather than being stamped (Betts 1985, 161).

The majority of antefix tiles in Britain are decorated with human masks, though several other designs are known (Toynbee 1964, 428-31 and illustrations XCVIII and XCIX). Ten published examples from York, all on pentagonal panels, depict a vine leaf with grapes, gorgon heads (two examples), a female head with a stylised headdress, a second design of female head (six examples) and a man fishing (RCHM 1962, 114 and Plates 38-39).

Antefix tiles are rare, with only four examples are known from YAT's excavations, the most complete example being from excavations at 37 Gillygate.

Plate 1 Antefix from excavations at 37 Gillygate, York.

3.2 Bessalis

Bessales (pl.) are the smallest size of Roman brick, with dimensions of eight Roman inches square, that is 197mm² in size. Bessales are usually square in plan, though circular examples are known from twenty-three sites in Britain (Brodribb 1989, 35), and octagonal examples are known from Silchester (Williams 1971, 181). Bessales were principally used to form the columns or *pilae* of hypocausts, though they were also used for other purposes, such as bonding courses within walls, for flooring and in arches (Brodribb 1989, 34). When used in *pilae* they usually rested upon a larger basal pedalis brick, as in the caldarium in the Legionnary baths suite in York (RCHM 1962, 42), or at Heslington East, York (Plate 2).

Brodribb's (1989, 34) measurement of 608 bessales across Britain produced a size range of 170-235mm in size, with an average size of 198mm², conforming very closely to eight Roman inches. Betts (1985, 176) showed that examples from York were on average 220 x 210mm in size making them larger than the national average size. The examples in YAT's collections range from 178-245mm in size. Both circular and square forms have been recovered on YAT's excavations, but the overwhelming majority are square in shape.

Plate 2 Base of a hypocaust *pila* at Heslington East, York.

The uppermost two tiles are bessales. Scale unit 0.1m.

3.3 Chimney

There are a small number of objects described variously in reports as chimney pots or finials. Typically these take the form of tapering cylinders pierced by tiers of vents. The vents are separated on the external surface by horizontal flanges of clay, which are often notched or finger-impressed (Lowther 1976, 36-7). Examples where the chimney is integral to a ridge tile are known from Norton in East Yorkshire (ibid., 36), from Silchester, and from both the Rhine and Danube regions (Blagg 1979, 279). A further example within the Yorkshire Museum collections has a flange at the base suggesting that it was also integral to a ridge tile (RCHM 1962, 114, Plate 38).

The majority of objects described as chimneys or finials in archaeological reports are free standing pots, which typically have a conical top, though examples are known from Verulamium and Chalk which are open at the top (Lowther 1976, 37). There is no conclusive evidence to prove that such objects were used on roofs, indeed they could only be used on the ridge line of a building if it was capped with flat tegulae with a central hole over which the pot could be set, or to cap columns of box flue tiles within a wall (Brodribb 1989, 31-2). Alternative uses which have been suggested for these free standing pots are as ventilators, finials or as covers for either lamps or burning aromatics (ibid., 32).

Only a handful of sherds from Roman chimneys have been excavated by YAT and none of these are of sufficient size or quality to be worthy of illustration here.

Plate 3 A chimney on a reconstructed Roman roof at South Shields, South Tyneside.

3.4 Flue

Flue tiles were used to conduct heated air through buildings. Two differing forms are known, half-box flue tiles and box flue tiles, but the latter are by far the most commonly occurring. Both types of flue tile were used to line the interior elevations of heated rooms, thereby enabling hot air to circulate through the walls from the hypocaust below.

Plate 4 Box flue tiles lining the walls of the forum baths at Ostia, Italy.

Half-box tiles, *tegula hamatae* (Rook 2002, 14), are rectangular, with a flange on each longer side, the middle portion of the flange is cutaway, with the cutaway portion usually being half the length of the tile (Brodribb 1989, 67). The non-flanged face usually has incised keying in a diamond pattern, though nationally some combed examples are known (ibid., 67).

Box flues (*tubuli*) are hollow rectangular or square cross-sectioned tiles, with sanded interior surfaces, and they have vents in two opposing sides, while the other two sides are usually keyed. The keying can be incised, finger drawn, combed, or relief-patterned. There is no standard size for box flue tiles nationally (ibid., 74). Box flues were made by wrapping a slab of clay around a sanded former then joining the edges of the clay together with a single seam, and the vents were cut out after the tile was removed from the former (Rudling et al. 1986, 204).

Plate 5 A box flue tile from York.

3.5 Imbrex

Imbrices (pl.) are roof tiles which take the form of hollow half cylinders that taper inwards at the top. Imbrices were principally used to cover the junction between tegulae on a roof, with the wider basal end of one imbrex overlapping the narrower upper end of the adjacent imbrex, and they were mortared into place to ensure a sealed joint (Betts 1985, 143). Imbrices were probably also used along the ridge-line of buildings, where they would be held in place by mortar (see Plate 6). Imbrices were put to other uses: placed upside-down they could be used as drains, as at Verulamium (Brodribb 1989, 26) and St Anthony's Hall, York (G. Dean pers. comm.); at Rockbourne pairs of imbrices placed vertically were used as flues instead of box-tiles; imbrices were also used to form the ridge-lines on a group of tile-lined tombs in York (RCHM 1962, Plate 28).

Nationally imbrices range in length from 360-510mm, with average breadths from 130-220mm and in thickness from 14-30mm (Brodribb 1989, 26), while imbrices previously recorded in York are more variable ranging from 290-506mm in length, 162-232 in breadth at the basal end of the tile and 10-35mm in thickness (Betts 1985, 172-4; McComish 2012, 173). Some imbrices are notably thicker at the basal end and it has been suggested that this was to accommodate antefix tiles at the eaves (ibid., 145).

Imbrices were made using a trapezoidal slab of clay, which was either inverted over a suitably sized convex former, or the slab of clay was placed into a concave former; examples of the two types of manufacture are known from Beauport Park and Piddington respectively (Warry 2006, 37).

Because of their cross-sectional shape imbrices are particularly vulnerable to breakage, and for this reason there are no complete surviving examples within YAT's collections.

Plate 6 A reconstructed Roman roof of imbrices and teguale at South Shields, South Tyneside.

The imbrices form ridges on the sides of the roof and are used to cap the ridge-line of the building.

3.6 Lydion

Lydions were the only rectangular bricks used by the Romans, and they measured 1 x 1.5 Roman feet in size, equating to 297 x 444mm in size. Lydions were used in flooring, as bonding courses within walls and as the bases and/or caps for hypocaust pilae (Brodribb 1989, 40).

A national survey of 314 Lydion bricks from Britain showed that they ranged from 335-480mm in length, with the average length being 403mm, the breadths ranged from 230-310mm, with an average breadth of 280mm, and the thicknesses ranged from 25-70mm with an average of 41mm (ibid., 40).

Two sizes of Lydion bricks have previously been recorded in York, the first group averaging 360 x 290 x 50mm in size, and the second group 440 x 280 x 60mm in size (Betts 1985, 178). Both these earlier surveys recorded examples that were far smaller than the Roman standard size, showing that there was considerable variation in the dimensions of Lydion bricks.

Examples from YAT's collections range from 386 x 410mm in length, 270-290mm in breadth and 29-62mm in thickness (ibid., 178; McComish 2012, 180).

Plate 7 Lydion with graffito, from 16-22 Coppergate, York.

3.7 Non-standard shapes

A small number of sherds recovered from YAT's excavations are in non-standardised forms. There are 21 such sherds and they come from seven sites across York (McComish 2012, 184). These sherds probably represent bricks made as one-offs for specific purposes.

Plate 8 An 'L' shaped brick from excavations at1-9 Micklegate, York.

3.8 *Opus Spicatum*

The term *opus spicatum*, coined by the late first century Roman architect Vitruvius, refers to small bricks laid on their stretchers in an arrangement resembling the ears of wheat, but the pattern would now be described as herringbone (Ward 1999, 43). There was no standard size for such bricks, and nationally they range from 70-155mm in length, 30-90mm in width and 20-60mm in thickness (Brodribb 1989, 52).

Very few examples are known from YAT's collections, and none have complete surviving measurements.

Plate 9 Opus spicatum in the Mithraeum of the Circus Maximus, Rome.

3.9 Parietalis

There is evidence that some walls were lined with tiles called parietalis which were then plastered over (ibid., 58). Parietalis are identified by holes or notches in the sides of the tiles designed to carry nails or cramps for fixing the tiles to the walls, together with keying on one face to aid the adhesion of plaster.

Thirty examples of such tiles from eighteen sites across Britain were recorded in a national survey of Roman tile but only five of these were complete (ibid., 58-9).

No complete parietalis bricks are known from previous studies in York, but it has been suggested that brick sherds 30-40mm thick with pronounced keying on the upper surface probably represent parietalis (Betts 1985, 181).

Plate 10 An unstratified parietalis brick from the YAT collections.

The tile has combed keying on the upper surface, and a notch on the side to accommodate a nail or clamp for fixing it to a wall.

3.10 Pedalis

A pedalis was a brick that measured one Roman foot square, that is 295.7mm² (ibid., 176). Pedales (pl.) were principally used as the base and capping tiles for hypocaust *pilae* columns (Brodribb 1989, 36), as at the Legionnary bath-house in St Sampson's Square, York (RCHM 1962, 62 and Plate 18), but they were also used in ovens such as at the Ebor Brewery site, York, and in hearths with examples known at Blake Street in York (Betts 1985, 175, 178), Pevensey, Watercrook and at Newport on the Isle of Wight (Brodribb 1989, 37).

Pedales are uncommon finds, a survey of Roman tiles from Britain recorded 200 complete examples with an average size of 281mm square, a thickness range of 25-70mm and an average thickness of 46mm, and these sizes are smaller than the Roman standard for such tiles (ibid., 36). Previously recorded examples from York have an average size of 305mm square (Betts 1985, 178).

Examples in YAT's collections measure 275mm broad and 35mm thick, 262mm broad and 37mm thick, 260mm broad and 32mm thick, and 305mm² and 62mm thick (McComish 2012, 198).

Plate 11 Pedalis forming the basal bricks of hypocaust *pilae* at Heslington East, York.

Scale unit 0.1m.

3.11 Pipe

Roman ceramic pipes were made in a variety of shapes and sizes reflecting the various uses to which they were put, including as down-flow pipes for upstairs latrines (Adam 1994, 261-2), for moving water into, around and out of buildings, for drainage beneath roads, as conduits for aqueducts, as chimneys associated with wall heating systems (Brodribb 1989, 84-7), and for use in vaults in order to reduce the weight of the roof (Mason 1990, 220-21). Vaulting pipes are termed *tubuli lingulati* (ibid., 220). The method of manufacture for such pipes is debated, it has been suggested that the deep internal corrugations seen on examples from York indicate formation by coiling (Whitwell 1976, 41 and 43), but similar internal ridges on pipes from Chester are seen as indicative of the pipes being thrown on a wheel (Mason 1990, 220).

A variety of pipe forms were used within York, Brodribb (1989, 85-7) records a hexagonal cross-sectioned pipe, a pipe with a junction outlet and a pipe with a flared end. Lawton (1993, 7) recorded the presence of two types of pipe at a kiln site at Apple Tree Farm, Heworth, 3km north-east of the fortress, the first type were thin walled pipes tapering to smooth blank rims, while the second type were in excess of 250mm long and had circular or triangular perforations up to 40 x 70mm in size. The perforated types were heat damaged on the interior surfaces, suggesting that they had been used to distribute hot gasses within a kiln. Betts also recorded vaulting pipes in York that resembled a syringe shape, the neck of one pipe slotting into the base of the adjoining pipe, but none were complete (Betts 1985, 182). Tiles of this type were present on the YAT excavations at 12-18 Swinegate (Plates 12-13).

Plate 12 Roman pipe from excavations at 12-18 Swinegate.

Plate 13 Pipe necks from excavations at 12-18 Swinegate.

3.12 Roman brick

The term Roman brick is used for all sherds which are too fragmentary for the original form to be determined. Roman brick sherds must have originated from a mixture of all the various forms of tile, excluding imbrices or flue tiles, both of which are distinctive enough to recognise even among severely fragmented material. Sherds classified as Roman brick accounts for approximately 60% of the Roman CBM from YAT's excavations.

Plate 14 Roman brick with incised numerals, from excavations at the Bedern, York.

Plate 15 Roman brick with graffito, from excavations at Wellington Row, York.

3.13 Tegula

Tegulae are roofing tiles which are usually rectangular in shape, though some taper inwards slightly toward the base of the tile; they have flanges on the upper face along each of the longer sides, there is a lower cutaway on the underside of the tile beneath the basal end of each flange, and an upper cutaway on the upper surface at the upper most end of each flange (Betts 1985, 143). The upper and lower cutaways of adjacent tiles overlapped when fitted on the roof. The arrangement of tegulae in columns on a roof facilitated repair work as it was easy to replace a single column of damaged tiles, while leaving the rest of the roof intact (Warry 2006, 104).

The average size for tegulae in Britain is 430 x 330mm with external flanges of 50mm in height, though tegulae range from 310 x 270mm to 570 x 480mm in size (Brodribb 1989, 12, 142). Tegulae are usually 20mm thick but examples are known from Heddington, Ickham and Slonk Hill which are 9mm, 14mm and 18mm thick respectively (ibid., 13).

A previous survey of complete tegulae in York divided the tiles into three groups on the basis of their size (Betts 1985, 168): the Group A tegulae were the largest ranging from 485-547 x 365-412mm in size, and these had both Legion IX and Legion VI stamps; the Group B tegulae were slightly smaller ranging from 523-555 x 345-362mm in size, and had only Legion VI stamps suggesting that they were of later date than the Group A tegulae.; the Group C tegulae were the smallest ranging from 372-393 x 291-328mm in size and were unstamped, these could be of military or civilian manufacture, though the presence of Legion VI stamped tiles of similar size at York Minster suggests the former.

Plate 16 Upper portion of a tegula from excavations at 12-18 Swinegate, York.

This example has a full surviving breadth, two upper cut-aways and dog's paw-prints.

Most tegulae were manufactured using a four-sided bottomless mould which was sanded, and used on a sanded workbench. Blocks for the lower cutaways could either be integral to the mould, or fixed onto the workbench in the correct position, thereby holding the mould in place during manufacture. Alternatively lower cutaways could be knife cut. Clay would be thrown into the mould and punched into the corners, and the hands would then be run along the flanges to smooth them, often creating a noticeable finger-groove adjacent to the flange. The upper cutaway would then be cut with either a wire or knife, and the surface of the tile sponged down to improve surface strength. Five sided moulds with retractable sides also seem to have been used (Warry 2006, 7-32).

Tiles were then stacked or laid on the ground to dry, and sometimes animals walked across the drying tiles leaving footprints (Plate 16). A tenth of military produced tiles have hob-nail boot impressions on the upper surface, but similar marks are relatively rare on civilian tiles, and while this may suggest that the civilians were more careful not to walk over drying tiles, a more likely explanation is that the officer in charge could have been testing the hardness of the tiles, to determine if they were ready for firing (ibid., 16). Once the tiles were sufficiently dry they were fired.

Plate 17 Upper and reverse sides of portion of a tegula from excavations at 12-18 Swinegate, York. This example has a complete surviving length with both and upper and lower cut-away.

3.14 Tegula Mammata

Tegula mammata are tiles with clay nibs on one face. It is possible that such tiles developed as a response to the problems of damp. Their use was recommended by Vitruvius in his chapter devoted to the insulation of wall facings in damp places, and the basement rooms of the house of Livy and the *domus Tiberiana,* on the Palatine in Rome, have walls lined with tegulae mammatae, possibly to counter rising damp (Adam 1994, 269).

Such tiles are rarely seen *in situ*, at Beauport Park tegula mammatae were used in the floor with the mammatae facing down to anchor the tile into the mortar below (Brodribb 1979, 146). It has also been suggested that tegula mammata could have been used in kilns to provide space for air to circulate during the firing process (ibid., 147). The tegulae mammata were manufactured in the same way as other bricks, with the mammatae being pressed onto the upper smoothed surface.

Only four examples are present in YAT's collections, all of which are very badly shattered, with the nibs being broken off in each case.

Plate 18 Tegula mammata from excavations at St Leonard's Hospital, York.

3.15 Tessera

Tesserae (pl.) are small square or rectangular pieces of differing coloured stone, tile or glass, used in mosaic floors. There were three kinds of mosaic flooring, *opus tessellatum* comprising simple geometric patterns, more elaborate patterns called *opus musivium*, and *opus vermiculatum*, which was the finest quality mosaics made using exceptionally small tesserae that were of sufficient quality to imitate paintings (Johnson 1995, 8; Adam 1994, 234).

The size of tesserae varied dependent upon the quality of the floor, with examples from mosaics in Britain ranging from 4-12.5mm square in size, while those in coarser tessellated pavements ranged from 12-38mm in size and these were often somewhat irregular in shape (McComish 2012, 244).

The ceramic tesserae in YAT's collections range from 17-38mm in length, 12-31mm in breadth and from 13-27mm in thickness. The size coupled with the slightly irregular shape of many of the sherds suggests that they were from tessellated pavements rather than mosaics. YAT's collections also include numerous examples of similarly sized micaceous sandstone tesserae.

Plate 19 Tessera from excavation at St Maurice's Road, York

Plate 20 A mosaic panel depicting a horse from Qasr Libya, Libya.

4 MEDIEVAL CERAMIC BUILDING MATERIAL (*c.* AD 410 TO 1540)

The Anglo-Saxons had no tradition of building in stone/CBM when they migrated into Britain during the 5th century, and as a consequence the production of CBM ceased for several centuries. Following the adoption of Christianity from the late 6th century onwards the construction of churches began, and these were often built of re-used stone and CBM quarried from Roman ruins. For example, Ealdred the Abbot of St Albans destroyed the ruins of Verulamium putting aside whole bricks and stones for use in his church (Salzman 1997, 140).

There is some evidence of limited CBM production in the later Anglo-Saxon period; plain flat roof tiles have been found on some sites in East Anglia which bear no resemblance to Roman roofing forms, and it is probable that tilers had established an industry for manufacturing such tiles in East Anglia and possibly Middlesex by the late 10th century, though no tilery of this date has been located (Eames 1992, 5). Decorated floor tiles known as polychrome relief tiles were produced in the 11th century, but these are exceptionally rare, and production of such tiles ceased with the Norman Conquest.

The Normans introduced the production and use of curved and flanged ceramic roof tiles, which were based on Roman tegulae and imbrices. This curved and flanged style of roofing was replaced from the 13th century by flat tiles which gradually became more common and remained in use throughout the remainder of the medieval period. Such roofing tiles were used in conjunction with ridge tiles, which were definitely in production by the 13th century, possibly earlier (ibid., 6). Ridge tiles could be decorated with elaborate crests.

Floor tiles were produced from the 13th century onwards; these came in a variety of styles (see 4.5, 4.9 and 4.13 below) but these were always associated with high status sites.

The earliest production and use of brick in England is in East Anglia in the 13th century, but elsewhere in England bricks used prior to the first quarter of the 14th century seem to have been imported from the Low Countries (Salzman 1997, 140). For example, 202,500 Flemish bricks were imported in 1278 for works at the Tower of London (ibid., 140). The use of brick gradually spread across the southern and eastern counties of England throughout the medieval period, but at this stage it was a high status building material being used on buildings such as Thornton Abbey gateway, Lincolnshire *c*. 1382, North Bar, Beverley, Yorkshire *c.* 1409, Tattershall Castle, Lincolnshire *c.* 1434-5, Gainsborough Old Hall Lincolnshire *c.* 1470, and Wainfleet School, Lincolnshire *c.* 1484 (Brunskill 1997, 118-129).

4.1 Brick (14th to 16th century)

While there are examples of late 12th and 13th century bricks in Essex and Suffolk, brick manufacture elsewhere in England was rare prior to the 14th century (ibid., 116 and 129; Salzman 1997, 140). The earliest definite reference to the manufacture of brick in England dates to 1335 for use at Ely, while for York it is in 1353 (Salzman 1997, 141). Evidence from standing buildings confirms that the use of brick starts in York in the 14th century (Betts 1985, 388). During the 14th and 15th centuries brick was primarily used for high status buildings such as the Merchant Taylors Hall, York, dating to *c.* 1400 (RCHM 1981, 88). Its use gradually spread to lower status buildings, where it was particularly in demand for fireplaces and chimneys. It was also used for infilling timber framing (RCHM 1981, lxiii).

In the case of York medieval bricks were made using sanded formers on sanded workbenches, the basal bed, headers and stretchers of such bricks area therefore sanded. The surplus clay was then removed from the top of the mould with either with a stick known as a strike, or with a cutting-wire on a bow. The upper surface was then wiped smooth. Sometimes when the brick had been removed from the former, the former was then used to push down the edges of the brick resulting in indented borders. Medieval bricks in York range from 247-292mm in length, 115-155mm in breadth and are 45-50mm thick (Betts 1985, 455-7).

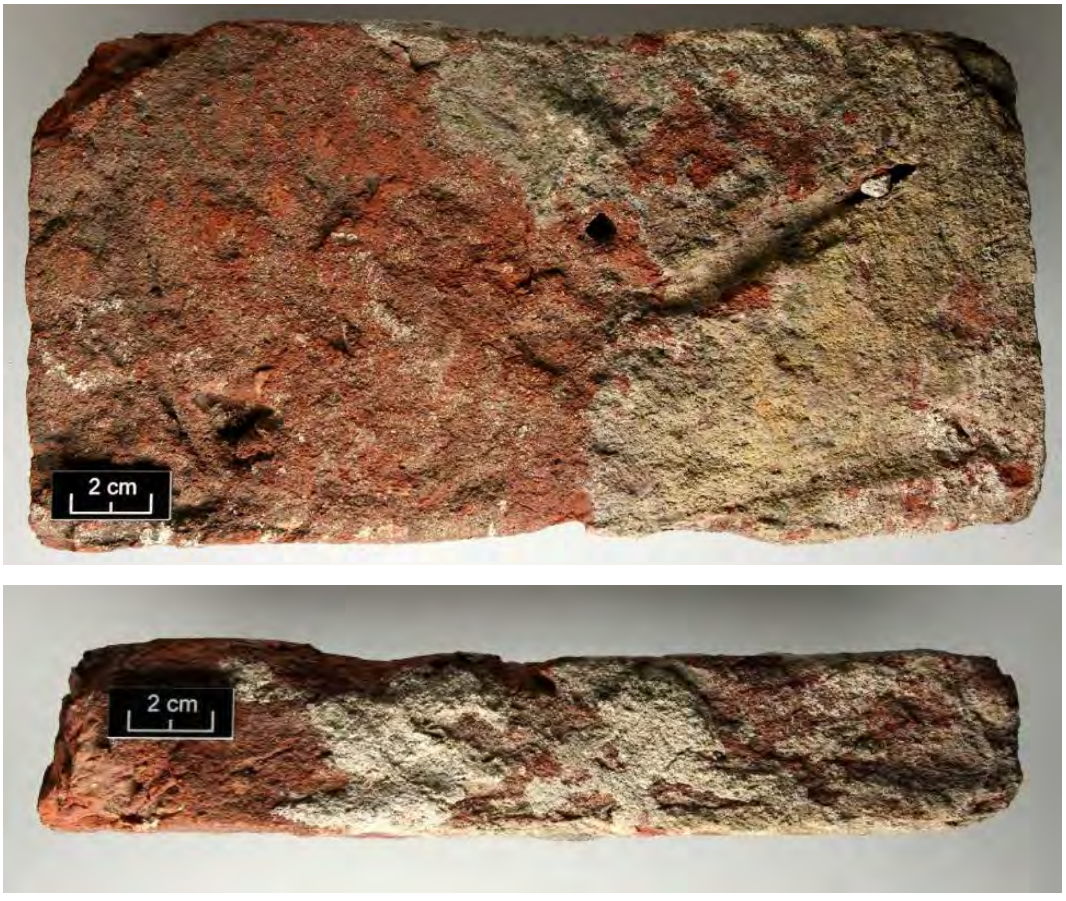

Plate 21 The basal bed and one stretcher of a medieval brick from the St Leonard's Hospital excavations, York.

4.2 Ceramic spit supports

Ceramic supports for the iron bars of cooking spits are known from a number of sites in both Britain and the Netherlands (Heidinga and Smink 1982; Drury 1985, 459-61; Redknap 1992, 45; Evans and Verhaeghe 1998-9, 93). Ceramic spit-supports are relatively rare objects (though this could be due to a failure to recognise such objects within archaeological material). Ceramic spit-supports would only have been capable of carrying the weight of small animals, such as fowl, or small joints of meat.

Examples from York were from the St Leonard's Hospital and the Bedern sites both of which were associated with ecclesiastical use, while an example from Hungate could have originated from the nearby Carmelite Friary. This may suggest that such objects were from higher status sites, rather than from smaller domestic settings.

Ceramic spit-supports were made in a variety of shapes, but most were tapering blocks with notches on the top edge, and they are sometimes decorated with incised or stamped patterns (Drury 1985, 460).

The dating of spit-supports is currently difficult; none have been found *in situ*, and too few examples have currently been identified to enable any kind of typology to be determined. Heidinga and Smink suggest a range from the 13-16th centuries for the examples in the Netherlands, with the majority of fragments being of 14-15th century date (Heidinga and Smink 1982, 73).

Plate 22 Ceramic spit support from the St Leonard's Hospital excavations, York.

This example has notches on the top and one side to accommodate the spit-bar, and is decorated with a small circular stamped design possibly depicting a bird on three sides and small impressed circles and lines on the remaining side.

4.3 Chimney-pots and louvers

Ceramic chimney-pots are generally assumed to have been introduced into England in the later middle ages (Dunning 1961, 78). Nationally examples in a variety of styles are known, ranging from simple pots, open at the bottom and closed at the top, pierced by holes, to extremely elaborate examples such as that from Great Easton, Essex (ibid., 75); in general elaborate forms are referred to as louvers in publications. The many and varied designs for such items are summarised in Hurman and Nenk (2000).

Given their shape and position on a roof, these objects were vulnerable to breakage, and relatively few examples are therefore known archaeologically. It should be noted that individual sherds of such objects when badly shattered could easily be mistaken for sherds of pottery.

The examples in YATs collections comprise a small number of badly shattered sherds.

Plate 23 A replica medieval louver on the roof of Barley Hall, York.

This is of similar design to an excavated medieval example from Great Easton, Essex.

4.4 Curved and flange tiles (late 11th to early 13th century)

The earliest form of medieval ceramic roofing tile seen in York is curved and flanged tile. This type of roofing system was derived from Roman roofing tiles (tegulae and imbrices), and was in use from the late 11th to the early 13th centuries (Lewis 1987, 6). There are some differences between the Roman and medieval tiles: curved and flanged tiles are much smaller than Roman roof tiles; secondly curved and flanged tiles usually have a nail hole at the upper end to secure the tile to the roof, whereas nail holes are relatively rare on tegulae, especially prior to AD 200 (Warry 2006, 103; McComish 2012, 84); thirdly the flanged tiles lack the upper and lower cutaways seen on tegulae. In addition, curved and flanged tiles are often glazed, or partially glazed, with examples known from Southampton and London (Platt and Coleman Smith 1975, 190). Re-used glazed flanged tiles are visible in the fireback of Scarborough Castle keep. Tiles of this type are comparatively rare and are thought to have been associated with high status sites such as churches or manor houses.

In the case of curved tiles a slab of clay was made in a sanded former on a sanded bench (resulting in sanded bases and edges) and the resultant slab of clay was placed, sanded side down, on a suitably shaped mould and pierced by a peg hole. Flanged tiles seem to have been made by throwing clay into sanded formers placed on a sanded workbench, and then smoothing the upper surface. Some flange tiles have a ridge of clay along the top outside edge of the flange where the clay has lipped over the top of the mould, while other flanges have clearly been trimmed or smoothed after removal from the mould.

The curved tiles within YAT's collections range in length from 324-369mm in length, 105-184mm in breadth and from 11-20mm in thickness. The flanged tiles range from 325-357mm in length, 211-220mm in breadth and 12-28mm in thickness with flanges 21-38mm high.

Plate 24 Curved file from excavations at the Ambulance Station, Haymarket Car Park, York, and flanged tile from excavations at 16-22 Coppergate, York.

4.5 Decorated floor tiles (mid 13th to 16th century)

Such tiles are always from high status sites, usually religious sites, but some examples are known from secular buildings. Nationally there are many different forms of decorated medieval floor tiles, including monochrome relief tiles, line-impressed tiles, *opus sectile* tiles, *sgraffiato* tiles and several forms of two-coloured decorated floor tiles, a description of these various forms together with the process of manufacture is given in Eames (1992). The manufacture of decorated floor tiles ceased in the later 16th century due to changes in fashion (Betts 1985, 534).

As all the examples in the YAT collections are two-coloured inlaid tiles, the method of manufacture described below relates specifically to this form of tile. A tile was cut from a slab of clay using a template. The tile was allowed to dry to a leather-hard stage at which point the upper surface was stamped, creating a series of indentations on the upper surface of the tile. These indentations were then infilled with cream coloured-clay and the upper surface was trimmed with a wire to create a crisp design. The tile was then dipped in clear glaze and fired creating a cream design on a brown background.

The examples in YAT's collections date from the 14th-16th centuries and include tiles manufactured both within Yorkshire, and tiles imported from the Midlands.

Plate 25 A selection of decorated floor tiles from the St Leonard's Hospital excavations, York.

The upper left, upper right and lower right images are Huby/Percy tiles (Stopford 2005, 238 and 240), the lower left image is a Nottinghamshire tile (Stopford 2005, 195).

4.6 Hip tiles (13th to 16th century)

Hip tiles are narrower at the top than the base, they are curving in cross-section, and they have a centrally placed peg-hole near the top of the tile. Hip tiles were designed to cover the junction of two sides of a hipped roof.

As with other curving forms of roof tile (imbrices and curved tiles) these tiles are very prone to breakage. As a result no complete examples are present in the YAT collections. Examples in York occur in 13th century and later contexts.

Plate 26 Hip tiles on the roof of Layer Marney Tower, Essex, which was built c. 1520

Plate 27 Hip tiles from the Hungate excavations, York

4.7 Mosaic floor tile (c. AD 1220-1270)

Plain mosaic floor tiles are small tiles in a variety of shapes. Each tile was glazed with a single colour, but when laid in a floor, tiles of different colours were alternated to create geometric patterns. These tiles are particularly associated with the Cistercians, and were made between c. 1220-1270 (Stopford 2005, 10). Very few tiles of this type have been excavated by YAT in York, but this is hardly surprising given that such tiles are generally associated with rural monastic sites.

The tiles are of very high quality, and they were made by cutting shapes from a slab of clay, using templates. They sometimes have a single key in the base, and small numbers of such tiles were also decorated with stamped designs. Tiles can be coloured with a cream slip and clear glaze to create a yellow colour, or they can have green or dark-brown to black glaze.

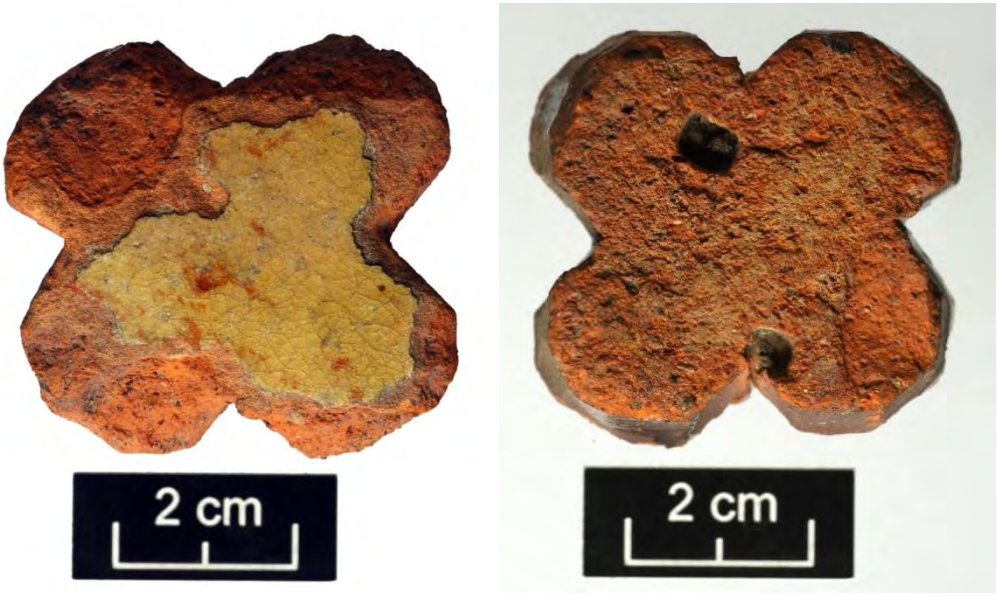

Plate 28 The upper and basal surface of a mosaic floor tile from the St Leonard's Hospital site, York.

Plate 29 Mosaic floor tiles at Byland Abbey, North Yorkshire.

4.8 Nib tiles (late 12th century onwards)

Nib tiles were used to cover the sloping surfaces of a roof, and were fixed to a roof by a projecting nib of clay which hooked over the roof battens. Nib tiles came into use from the second half of the 12th century (Lewis 1987, 7-8) but they were largely replaced by peg tiles in the 13th century.

Nib tiles were made in open sided moulds on a sanded work-bench. The nibs were added to the slabs of moulded clay in one of two ways, the first type were made by pressing one or two lumps of clay pushed onto the sanded basal surface of the tile, and this form dates from the latter half of the 12th century (ibid., 7). An alternative form of manufacture was to pull up part of the surface of the tile while the tile was wet and bend it over to form a nib, which resulted in the nib being on the smoothed frontal surface of the tile; this form seems to be slightly later dating from the 13th century onwards, and it has been suggested that as these nibs were easier to manufacture they represent an adaption to large-scale production (ibid., 8).

Nib tiles are relatively rare in York; a search of the YAT database revealed just 361 examples from 52 sites across the city. The nib tiles in YAT's collections range in size from 310-322mm long, 165-212mm wide and they are typically 13-17mm thick.

Plate 30 Nib tiles from the Hungate excavations, York.

The left hand image has two separate nibs of clay pushed onto the back of the tile, the right hand image has an extremely small central nib folded over from the top of the tile.

4.9 Peg tile (13th to 16th century)

Peg tiles were used to cover the sloping surfaces of a roof and were pierced by a hole to accommodate a wooden peg or an iron nail which fixed the tile to the roof. Nationally, most tiles have a single peg hole, but examples with two peg holes are known (Lewis 1987, 7; Betts 1990, 222).

Peg tiles are known in London in late 12th century deposits (Betts 1990, 223), but do not seem to have become widespread until the mid-13th century (Lewis 1987, 7). They remained in use until the 16th century. The dimensions and quality of these tiles were confirmed by a statute of 1477, from the reign of Edward IV (Betts 1985, 441), how thoroughly this was enforced is another matter. The method of manufacture for such tiles is described in 4.12 below. The peg hole would be punched through from front to back while the tile was still wet using any suitable implement, resulting in a variety of peg holes shapes, sometimes the handle of the punch leaves an impression around the peg hole on the front surface of the tile. The upper surface of the tile was wiped smooth with a cloth, and in some cases smoothed with the fingers.

The peg tiles in YAT's collections range in size from 280-357mm long, 163-234mm wide and they are typically 13-17mm thick.

Plate 31 Peg tiles from the St Leonard's Hospital excavations, York.

Showing a dog's paw print (left hand image), and pronounced finger smoothing lines and indented borders (right hand image).

4.10 Plain tile

The term 'plain tile' is used for flat roof tile sherds which are too badly broken to determine the original method of fixing the tile to the roof. Such sherds could represent portions of flanged, nib or peg tiles. Owing to the uncertainty of their form these tiles could be of any date from the late 11thcentury to the 16th century, but given the relative proportions of flanged, nib or peg tiles overall it is probable that most were from peg tiles originally.

Plain tiles (and therefore nib and peg tiles) were made using a sanded wooden former on a sanded work bench (Betts 1985, 401). The clay was thrown into the former and pressed into the corners, after which any excess clay was removed, either with a wooden tool called a strike or with a wire resembling a cheese-wire (ibid., 400). The upper surface of the tile was then smoothed, either by wiping with a cloth or somewhat more crudely with the fingers. Smoothing was usually parallel to the long sides of the tile, but some tiles exhibit smoothing lines in multiple directions. The tile was then removed from the former, and the edges of the former were then sometimes used to press down the edges of the upper surface of the tile resulting in indented borders.

The tile would then be lifted off the bench and moved elsewhere to dry before being fired. Tiles could either be laid on the ground to dry or placed in open sided sheds called hack-steads (Cherry 2001, 190). That some tiles were laid directly on the ground can be seen by grass or straw marks on the reverse sides, by the footprints of animals which have walked across the tiles, and by rain or hail stone marks on the upper surfaces. Some roofing tiles were decorated with glaze (ibid., 191).

The tiles were stacked into up-draught kilns and firstly heated to around 200°C to thoroughly dry the tiles, and then to around 1000°C to fully fire the tiles and to ensure that any glazes fused successfully to the tile-surfaces (Eames 1992, 16). The firing of kilns was normally carried out in the summer (Betts 1985, 406). Although nationally wood was the normal fuel for kilns, turves seem to have been used as fuel in both Hull and York (ibid., 405).

It is clear from documentary sources that from at least 1327-1458 roof tiles were far more expensive in York than elsewhere in England, and that the price only fell to levels similar to other parts of the country in the early 16th century (Salzman 1997, 229-30). It was suggested by Salzman that the difference in price might be a reflection of the use of larger tiles in York. There is a statue dating to 1477, which stipulated that roof tiles should be 10½ x 6¼ x ½ inches (267 x 159 x 13mm) in size (ibid., 230). Assuming this size is a reflection of the customary manufactured tile sizes in the south of England, there is certainly a notable difference between the dimensions in the statute and those in the YAT collections. The surviving lengths on the YAT tiles were 13-90mm longer than the statue measurement, and 4-75mm broader. This discrepancy in size between the statue and the YAT tiles implies that the traditional size of tiles in York was larger than those made elsewhere in the country. This would seem to confirm Salzman's suggestion regarding the price of the York tiles reflecting a greater size.

4.11 Plain-glazed floor tiles (14th to 16th century)

Plain-glazed floor tiles were in use from the 14th century. It is known from documentary sources that such tiles were imported from the Low Countries, but they were also manufactured in England (Stopford 2005, 217-9). Plain-glazed floor tiles range in size considerably with examples from Northern England varying from 101mm to 280mm across ibid., 215). They were cheaper to manufacture than decorated tiles, but they remained luxury items associated with high status sites.

The tiles were cut from a slab of clay using a template. In some cases four or five tiny nail holes will be visible in the upper surface of the tile, one near each corner and one centrally; these nails were used to hold the template in place during the cutting process. The upper surface of the tile was coloured using either a cream slip and a clear glaze to create a yellow colour, or with glazes that range from green, to brown and black in colour. The colours were alternated when laid in floors to create patterns such as a chequer-board design, as seen in the surviving example in the Consistory Court of York Minster (ibid., 214).

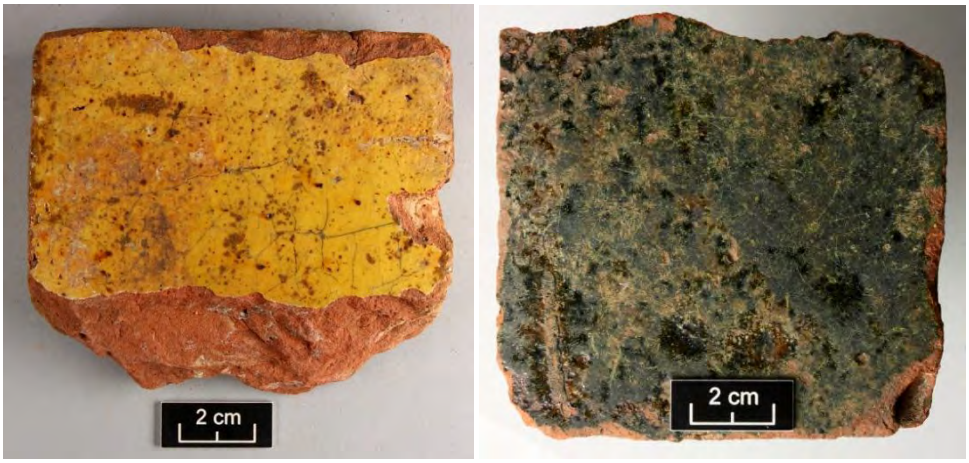

Plate 32 Plain glazed floor tiles from the St Leonard's Hospital excavations, York.

Plate 33 A replica plain-glazed tile floor in Barley Hall, York.

This floor is based the results of excavation at the site (known as Coffee Yard).

4.12 Polychrome relief tiles (mid 10th to mid-11th century)

Polychrome relief tiles date from the mid-10th to late 11th century, pre-dating the Norman Conquest (Keen 1993, 80; Betts 1996, 19). Polychrome relief tiles are exceptionally rare nationally, with examples known from Canterbury, Coventry, Peterborough, St Alban's Abbey, St Edmund's Abbey, Westminster Abbey, Winchester and York (Keen 1993, 67). In the case of York tiles of this type are particularly associated with the church of All Saint's Pavement (ibid.).

The design on these tiles takes the form of small cells separated by thin ridges of clay, with two or more differently coloured glazes used in the various cells of the design (ibid., 78). The designs usually take the form of geometrical patterns, though some depict round-headed arches and zoomorphic designs (ibid., 73). Some, though not all, of these tiles have flanges on the back; the backs of the tiles are sometimes stabbed, and some of the tiles have chamfered edges on the reverse. These tiles could have been made either in moulds, with the design carved in intaglio, or by stamping a decorated mould into the upper surface of a tile (ibid., 78).

Plate 34 Polychrome relief tile from the excavations at 16-22 Coppergate, York.

4.13 Ridge and crested ridge tiles (13th-16th century)

Ridge tiles were designed to cover the ridge-line of a roof. They are semi-circular in cross-section, some being decorated with crests along the apex. The earliest archaeological and documentary evidence for ridge tiles dates to the 13th century (Cherry 2001, 195). A statute dating to 1477 stipulated that ridge tiles should be 13½ x 6¼ inches in size (340mm x 140mm).

Ridge tiles could be decorated by crests of varying sizes and shapes. Examples from Leicester included a variety of looped shapes, equilateral triangles and right angled triangles (Allin 1981, 56-58), the latter forming terminal crests. Four methods of attaching crests to ridge tiles were recorded at Leicester: crests which were dowelled through; crests smeared onto the surface of the tile; or by adding a clay mound, peak or tube onto the tile then pressing this up from beneath; applying a strip of clay along the tile which was then knife cut (Allin 1981, 53).

The crests in York were made by adding a strip of clay along the top of the tile, while still wet, which was then knife-cut into a variety of shapes, or in some cases by pinching clay up from the surface of the tile to create low rectangular crests. In the case of York 289 crested tile sherds have been recorded, (but in most cases the crests had broken off). The commonest shape for crests in York is a row of inverted equilateral triangle shapes, but small numbers of rectangular crests, trapezium shaped crests and wave shaped crests have also been found.

Plate 35 A crested ridge tile from excavations at 16-22 Coppergate, York

4.14 Valley tiles (13th-16th century)

Valley tiles have a concave upper and basal surface, with a peg hole near the top of the tile. They are used to cover the valley on a roof, i.e. the point where roof surfaces at right angles to one another meet.

As with other curving forms of roof tile, valley tiles are vulnerable to breakage. No complete examples are present in the YAT collections, it is therefore impossible to determine typical dimensions for this form of tile.

Plate 36 Valley tile sherd from the Hungate excavations, York.

5 POST-MEDIEVAL CERAMIC BUILDING MATERIAL (AD 1540-1850)

There is considerable overlap between the forms of CBM used in the medieval and post-medieval periods. In the case of York, peg tiles remained the dominant method of roofing until the 17th century, and such peg tiles are indistinguishable from medieval examples (Betts 1985, 535). Ridge tiles, hip tiles and valley tiles continued to be manufactured and used throughout the post-medieval period, and again it is impossible to distinguish between medieval and post-medieval examples. There were some changes, however, from the 17th century onwards pan tiles became the dominant form of roof tile in eastern England. Pavers were introduced for flooring. In the case of brick there was a change in overall size and the method of manufacture. Some forms went out of use due to changes in fashion, notably inlaid floor tiles.

In the 17th century brickwork became more widespread (Brunskill 1997, 140), especially in London, which was largely rebuilt in brick following the Great Fire in 1666. The coronation of William and Mary II in 1689 led to a fashion for all things Dutch, including the use of bricks for buildings and tin-glazed tiles for decoration. There were an increasing number of building acts during the Georgian period to regulate building construction, such as the 1774 Building Act which was drafted by leading architects to control the standard of building and fire-proofing nationwide (Yorke 2007, 40-1). Many of the improvements brought in by the Act were cancelled out by the extension of the 1696 window tax to all houses with seven or more windows in 1766, to houses with six windows or more in 1784 (Parissien 1995, 28). The brick tax of 1784 acted as a break on the development of brick architecture (Parissien 1995, 28).

There were some changes in the methods of production in the post-medieval period. Many bricks were fired in clamps, whereby unbaked bricks were stacked with fuel under or among them. The fuel was then lit to fire the bricks, but the results could be somewhat uneven, with some bricks being overfired and others underfired. In the 17th century Scotch kilns developed, some of which are still in use today because, despite their fuel inefficiency, they produce beautifully coloured bricks (Hammond 2001, 22). Brick kilns in the 18th to early 19th centuries increasingly used coal as fuel rather than wood, enabling firing at higher temperatures and the production of a greater range of brick colours (Parissien 1995, 22-4). Horse powered pugmills which chopped the clay, knead it and then extrude it were probably invented in the late 17th century by the Dutch, but they did not come into general use for brickmaking in Britain until the late 18th century (Hammond 2001, 5; Brunskill 1997, 22). The early 19th century saw the start of the process of industrialisation which affected the brick-making industry; from 1820-1850 patents were taken out on 109 brickmaking machines (Hammond 2001, 14). In 1841 and 1843 James Gibbs and Thomas Ainslie patented multi chamber kilns (Hammond 2001, 23).

5.1 Pan (17th century onwards)

Pan tiles are rectangular in shape with rounded corners, they have a shallow S shaped cross-section, and they are fixed to the roof using a nib on the reverse side of the tile.

Pan tiles were imported into England in considerable numbers from the Netherlands from the 16th century onwards. It has been estimated that 363,000 such tiles were imported into England in 1695 alone (Lucas 1998, 75). The design of the tiles was rapidly copied by English manufacturers. A patent for the manufacture of pan tiles was granted to William Westby by Charles I in 1636 (Neave 1991, 94). From the 17th century onwards the use of pan tiles became widespread in the eastern counties of England, including Yorkshire, almost eclipsing the use of flat roofing tiles.

These tiles were made in moulds placed over a block or stock-table, both of which were coated with very fine sand, and there was a depression in the top edge of the block that produced the nib on the underside of the tile (Betts 1985, 535-7). The tile was then placed in a second mould and 'washed-down' to obtain its characteristic curving shape (ibid., 537). After partially drying it could be beaten back into shape if any warping had occurred while drying; the tile was then fired (ibid., 537).

There is considerable variation in the size of pan tiles in the YAT collections, ranging from 232-375mm in length and 124-275mm in breadth with the thicknesses generally being in the range of 14-18mm.

Plate 37 A pan tile from excavation at Hungate, York.

5.2 Paver

Pavers are square tiles used for flooring. Few such tiles are present in the YAT collections making it difficult to accurately determine either typical sizes or the date range for the form.

The examples in the YAT collections vary in size considerably, ranging from 212-230mm^2 and 17-74mm in thickness.

Plate 38 A paver from the Hungate excavations, York.

5.3 Post-medieval brick (16th-late 18th century)

During the 16th century in York there was a gradual change from the use of sanded moulds to that of wetted moulds, a technique called slop-moulding (Betts 1985, 534). Slop moulded brick had to be dried for longer periods before firing than bricks made in sanded moulds (ibid., 535). Many post-medieval bricks have linear marks on the base which seem to be from turning the bricks over during drying.

Post medieval bricks in York range from 212-238mm in length and 103-126mm in breadth and 51-64mm thick (ibid., 541-5).

Plate 39 The upper bed, lower bed and one stretcher of a post-medieval brick from the excavations at St Leonard's Hospital, York.

A turning mark is visible on the central image.

5.4 Bricks from 1784-1850

The Brick Tax was introduced in 1784 and remained in place, though with some amendments until 1850 (Brunskill 1997, 38). The tax was initially levied per 1000 bricks irrespective of size, and to get round the tax manufacturers started producing thicker bricks, usually around three inches (76mm) thick. This increase in thickness was particularly noticeable in Northern England, the Midlands, South Wales and Scotland (ibid., 38). In 1784 Joseph Wilkes of Measham, Leicestershire, introduced double sized bricks 235 x 110 x 110mm in size as a way round the brick tax, these were known as 'Wilke's gobs' or 'jumbies' (Chapman 2008, 9-10; Hammond 2001, 30). To counter this in 1803 the Brick Tax was amended, with a double duty being placed on bricks with a volume of 150 cubic inches or greater (Brunskill 1997, 38).

From the late 18th century a raised block or 'lack' was sometimes fixed to the work bench which had an upstanding central area, the former for the brick was then placed around the lack and filled with clay. Once removed from the former the brick would have an indentation or 'frog' in one bed (ibid., 24).

Examples of bricks of this date in the YAT collections range from 201-295mm long, 102-123mm in breadth and 64-94mm thick. Other than their size, such bricks are indistinguishable from post-medieval bricks described in 5.3 above.

Plate 40 A brick relating to the period of the Brick Tax, from the Hungate excavations, York.

5.5 Field drains (late 18th century onwards)

From the late 18th century ceramic drains were used to improve drainage on agricultural land. These drains could take the form of ridge-tiles, or be in the shape of a horse-shoe, and these tiles were often laid on flat tiles to prevent them sinking into the bottom of a specially dug drainage–trench (Harvey 1976, 21). Later examples have a built-in base-plate. From 1784-1850 there was a tax on tiles, but an Act of Parliament of 1826 specifically exempted filed drains from this tax, provided that they were stamped with the word 'drain' (ibid., 23).

At first field drains were manufactured by hand making them too expensive for many farmers (ibid., 21). Hand-made cylindrical pipes came into use in the early 19th century (ibid., 22). By the 1830s simple machines had been introduced in Bedfordshire that produced agricultural drains like macaronies (Muthesius 1982, 28), reducing the price by half and allowing widespread adoption.

Plate 41 Horse-shoe drains (lengthways and end-on) from Heslington East, York.

Plate 42 Circular cross-sectioned field drain from Heslington East, York

5.6 Floor tiles

In the case of churches, the Gothic Revival style led to a revival of interest in medieval inlaid-tile designs, many of which were copied for new church floors. Although based on medieval designs these tiles were manufactured in a different way, being moulded rather than stamped; usually a screw-press was used to force clay onto a plaster mould set in a metal frame, the resultant impressions being filled with clay slip which was allowed to dry, the surface of the tile was then scraped level giving a very sharply defined pattern, which was further dried then fired. In some cases the tile was then glazed and re-fired (Graves 2002, 113-5). While early examples of such tiles were two-coloured like their medieval predecessors, multi-coloured tiles were soon developed, leading to richly coloured floors. The architect A. W. N. Pugin in particular used floor such tiles to great effect in public buildings, such as the new House of Lords which opened in 1847 (ibid., 116).

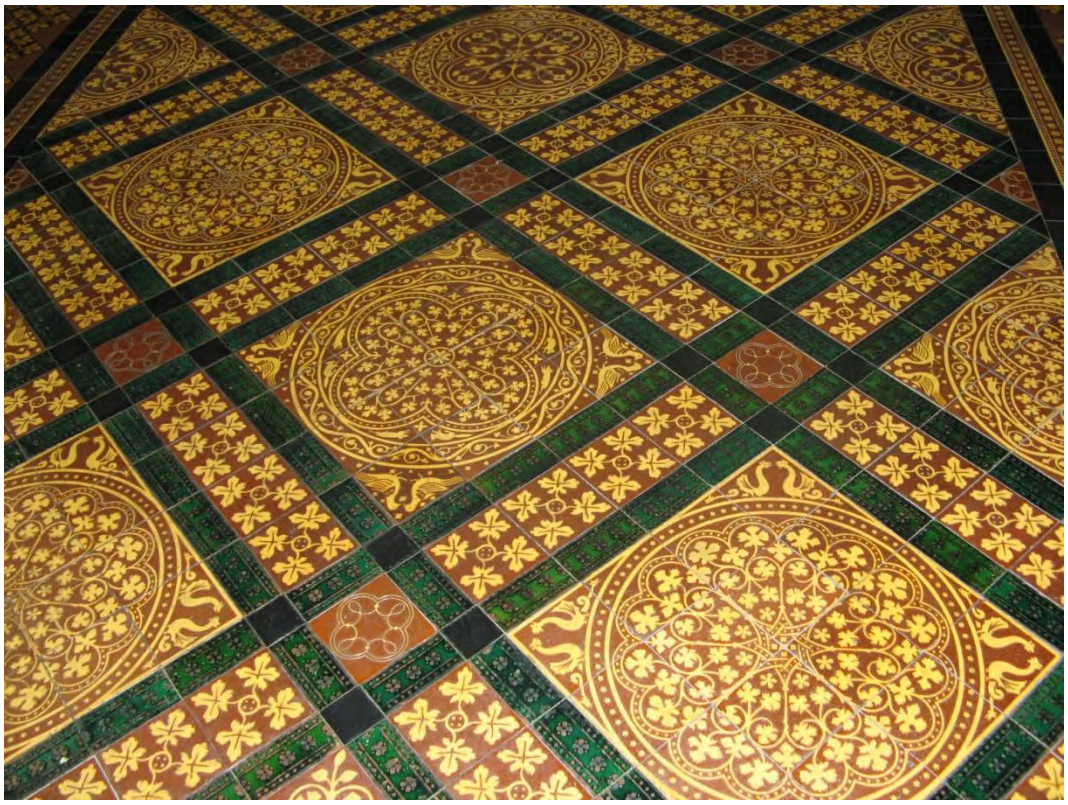

Plate 43 Nineteenth century tiles in Ashbourne church, Derbyshire

5.7 Tin glazed tiles

Tin glazed tiles were introduced into Northern Europe from the Netherlands in the 16th century (ibid., 70). The manufacture of such tiles was centred on Delft, in South Holland, with the term Delftware coming into general use as a description for any blue and white pottery or tiles irrespective of the place of manufacture. Tin glazed tile manufacture began in England from *c.* 1636, but the industry went into sharp decline from the 1750s, with production in Britain ceasing in 1840 (Archer 1997, 9-10).

These tiles were not floor tiles, rather they were designed for use on elevations such as walls or stoves.

The method of manufacture is detailed in Betts (1985, 537-8) and is summarised here. Tin-glazed tiles were made from very pale cream or white clays. Suitable clay was thoroughly mixed then flattened by hand or rolled out like pastry before being cut into squares. Some tiles have nail holes on the upper surface showing that the template was fixed onto the surface of the clay before cutting. The blank tiles were then places in a sanded moulding frame and rolled again to obtain a uniform thickness. The blank tiles were fired twice, once before the application of the pattern and once afterwards. The pattern, usually in blue, could be made by covering the area to be left white and sprinkling, sponging or tapping a pigment-powder over the tile, or by painting the design onto the tile.

Only 29 sherds of tin glazed tiles have been recorded from YAT's excavations, only one complete breadth survived which was 136mm broad, and the tiles range from 9-18mm in thickness.

Plate 44 Tin glazed tile from the Hungate excavations, York.

6 MODERN CERAMIC BUILDING MATERIAL (1850 OR LATER)

Rapid urban growth created a huge demand for CBM which could not be met by hand-made production alone. Machinery for the manufacture of CBM continued to develop. Extrusion machines were invented to make wire-cut bricks, with one such machine being displayed at the Great Exhibition of 1851 (Hammond 2001, 14). The introduction of the Hoffmann kiln in 1859 was of particular importance allowing larger numbers of bricks to be fired quickly, cheaply and evenly (Muthesius 1982, 28). By 1860 continuous extrusion machines had been developed for brick and pipe production (Hammond 2001, 14). Accrington bricks were made from 1860 whereby almost dry clay was crushed and pressed to create bricks of exceptional strength (Muthesius 1982, 213). In the late 19th century steam shovels and dragline extractors were developed enabling exploitation of deeper clays for brick manufacture (Brunskill 1997, 21). By the 1870s a single brick making machine could produce 10,000 bricks in a day, and by 1900 this had increased to 60,000 bricks a day (Muthesius 1982, 28). In 1904 Dean and Hethrington of Accrington Lancashire patented the Staffordshire kiln to burn blue bricks (Hammond 2001, 23). From 1904 onwards new Fletton bricks appeared leading to a massive drop in price, but also to overproduction and a slump (Muthesius 1982, 28). This decline in brickmaking is seen in the fact that some engineering forms stopped manufacturing brick-making machines around this time, for example Edward Page & Co of Bedford stopped building such machinery by 1914 (Hurst and Kennet 2011, 23). Many brick companies closed during the blackout of World War II and never reopened (Brunskill 1990, 182).

The post-war period saw a massive increase in building, and those brick-makers who had survived prospered and produced staggering number of bricks in the 1950s; the London Brick Company alone produced 16 million bricks a day in this decade, and even as late as the 1980s this company was still the largest brick manufacturing company in the world (Hanson, 2007).

It is worth noting that despite all the technical advances in manufacture, the production of hand-made bricks has never died out completely (Hammond 2001, 31).

The array of products produced by the modern CBM industry is vast, including bricks, drains, floor tiles, malting bricks, pipes, roof ties, terracotta and wall tiles. The variety of forms available can be illustrated by the case of chimney pots; the catalogue of the National Clayware Federation for 1964 listed five hundred different varieties of chimney pot (Fletcher 1994, 54). A selection of these modern forms of CBM is shown below.

6.1 Machine made bricks

From the mid-19th century brick-making became increasingly mechanised. Numerous machines were invented for the preparation of clay and the moulding of bricks. In addition, new types of drying tunnels and kilns were introduced which increased productivity greatly. Bricks could be produced in a variety of clays giving a wide range of colours, and fireclay was also used to produce the heat-resistant bricks needed by industry. Bricks could also be glazed for both decorative and functional reasons.

Wire-cut bricks were produced by forcing clay through a die until a block of the necessary dimensions could be cut off using a wire. Wire cut bricks could also be perforated if an appropriate die was used (Brunskill 1997, 25). Wire cut bricks are still in production. Machines for the pressing of bricks were invented in the mid-late 19th century, creating bricks of uniform sizes and an infinite number of precise shapes. In addition, moulding enabled the imprinting of bricks with maker's stamps, the production of perforated bricks and of bricks with deep frogs on one or two beds. Both the perforations and deep frogs helped to reduce the volume of clay needed, reducing the cost of raw materials (ibid., 25).

The creation of the British Standards Institution led to bricks being manufactured in a number of standard sizes; BS 657 from 1936 specified bricks should be 8¾ by 4 3/16 and 2 or 2⅝ inches in size; BS3921 of 1965 specified 8⅝ by 4½ by 2⅝ inches; while BS 3921 of 1969 specified 215mm by 102.5mm by 65mm in size (ibid., 39).

The machine-made bricks in YAT's collections range from 113-310mm long, 100-179mm broad and 25-110mm thick, many being specially shaped. Numerous makers' stamps are present, showing that bricks were made locally but were also imported into York from elsewhere in Yorkshire, from the Midlands and from southern Scotland.

Plate 45 The upper bed and one stretcher of a modern brick from the St Leonard's Hospital excavations bearing the marker's stamp of the London Brick Company

6.2 Drain pipes and sewer pipes

Machine moulded drain pipes are known from the mid-19th century, these come in a variety of sizes, and usually have a wider collar at one end. The narrow end of the pipe slots into the collar of the adjacent pipe segment. These sometimes have maker's stamps.

Rapid urban growth in the late 18th and 19th centuries created problems with the removal of sewage. Until the mid-nineteenth century main sewers and individual house drains were built of brick and there were constant problems of seepage (Cruickshank and Burton 1990, 91). In 1846 Henry Doulton found a more durable solution and began making impervious, salt glazed earthenware pipes at his pottery in Lambeth (Wedd 2007, 12). Sewer pipes of this type could be easily assembled but the joints had to be carefully sealed with cement (Muthesius 1982, 58). The network of such sewers spread across the country during the 19th century, often in response to public health acts and local bye-laws.

Plate 46 A machine made drain pipe and salt-glazed sewer pipes from the Hungate excavations, York.

6.3 Duct

Machine-made caps for electricity cables appear in the 20th century. These are designed to lock together to produce a continuous cover, and are always clearly marked to warn of the danger below.

Plate 47 The upper and basal surfaces of a machine-made electricity duct. Form the Hungate excavations, York.

6.4 Field drains (1850s century onwards)

In 1846 the Public Money Drainage Act was passed to encourage drainage and an increase in the useable area of arable land. This aimed to increase food production to cope with the massive growth in the population. This act coupled with the machine manufacture of pipes which had begun in the 1840s and led to a massive increase in drainage (Bridges 2003, 5; Harvey 1976, 22). By 1880 2-3 million acres of land had been drained, one twelfth of all agricultural land (Harvey 1976, 22). Many farmers said that pipes were the most profitable crop they ever planted (Harvey 1976, 22).

Extruded field drains come in a variety of shapes, from circular to circular with a flat base, to almost square in cross-section with a circular bore as in Plate 46.

Plate 48 Field drain from excavations at Heslington East, York.

6.5 Floor tiles

The mass-production of floor tiles which came with the industrial revolution led to the widespread use of floor tiles in domestic architecture. Such tiles had the advantage of being very durable and easy to clean, with the added bonus that they could also be highly decorative (Austwick 1980, 38); plain quarry tiles in red or dark grey were popular for utilitarian areas such as kitchens, while hallways could be decorated with patterned tiles in a variety of colours.

Mass-produced tiles often have maker's stamps on the reverse, and/or indentations or keys to aid with the keying of mortar.

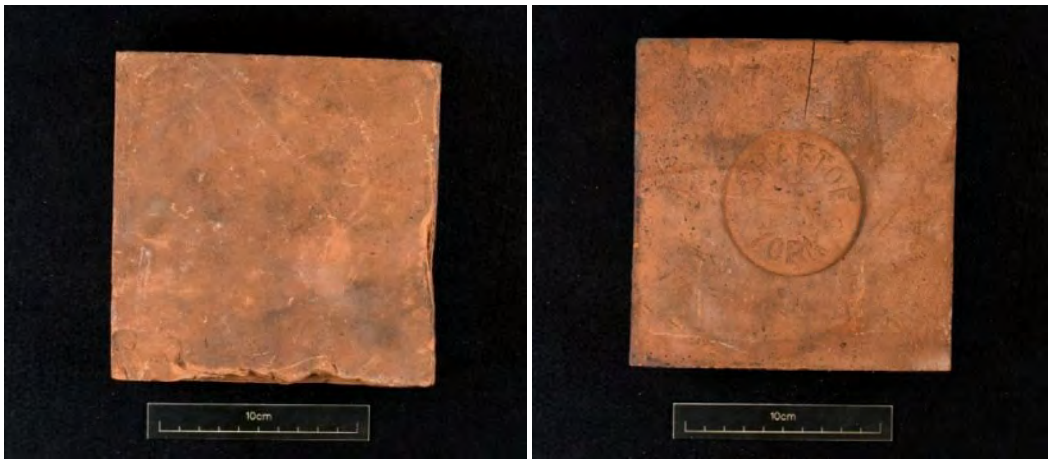

Plate 49 A red quarry tile made by Shaftoe's of York, from the Hungate excavations, York.

Plate 50 Small Victorian floor tiles (front and reverse) from the Hungate excavations, York.

6.6 Malting bricks

Machine made malting bricks were manufactured from the mid-19th century onwards, for use in the floors of maltings and corn dryers. Malting bricks are very distinctive, having deep cells on the underside, each of which is perforated on the upper surface by up to 12 small holes 2-3mm in diameter, and some have salt-glazed upper surfaces (Crew 2004, 4). Numerous differing types of malting brick have been recorded and classified by the shape and pattern of the cells on the underside, and the number of perforations per cell (ibid., 4).

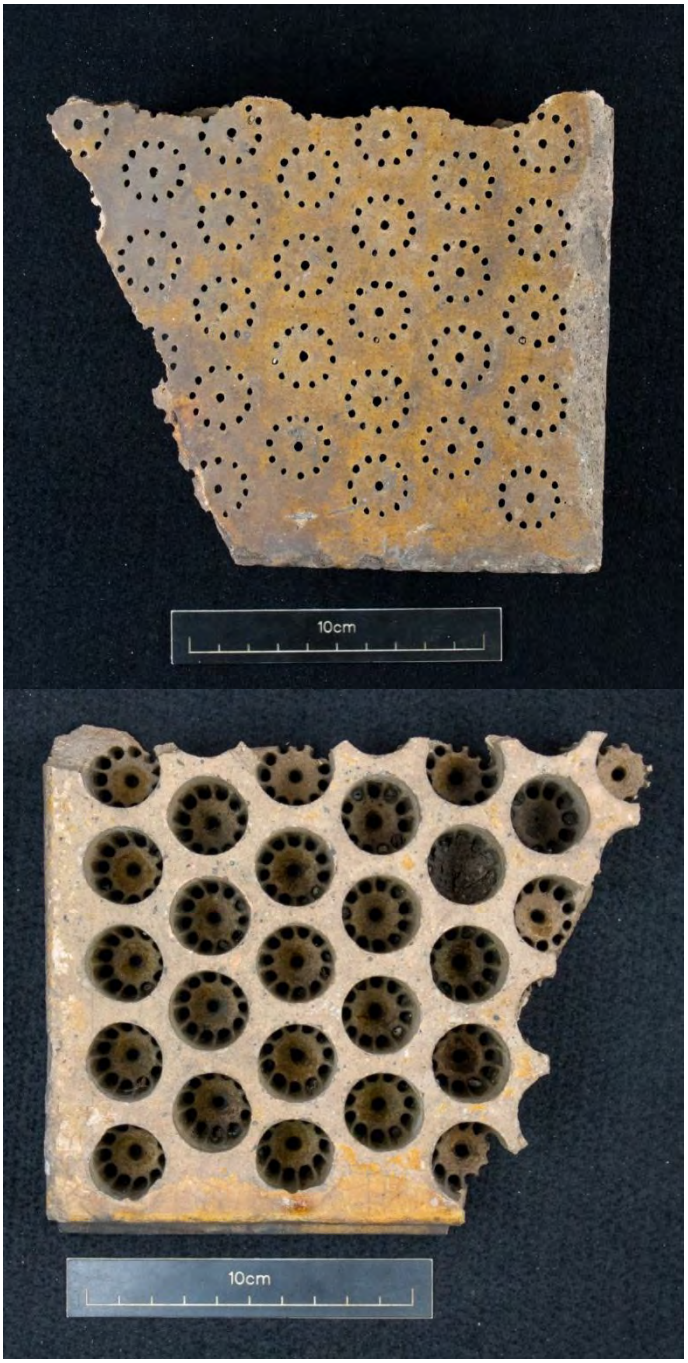

Plate 51 Malting brick from the Clementhorpe Maltings, York.

6.7 Sanitary wares

Many mass-produced salt-glazed wares were associated with sanitation. Among the more interesting excavated by YAT was a toilet block behind a row of small working-class houses at Hungate, York. The toilets were of a type known as a 'slop water' closet, which had a lop-sided pivoting bucket set inside a larger ceramic tank, this bucket would empty automatically when full, thereby filling the larger ceramic tank. This larger tank was connected to a horizontal pipe which ran beneath the toilets, to flush them. The Hungate toilet block had a row five toilets, with two slop-water tanks, one at each end of the row of toilets, and it was shared by eleven households. The small size of the two tipper tanks within this system could not possibly have provided adequate flushing to clear out the sewage create by eleven households, and it must have been highly unsanitary. These items were manufactured by Duckett's of Burnley, who took patents out on such systems 1898 and 1913 (McComish 2008, 21).

Plate 52 A slop-water toiled bucket from the Hungate excavations, York.

6.8 Wall tile

Glazed wall tiles became widespread in the Victorian period, being durable, easy to clean and ideal for certain forms of public buildings, such as the white tiles on the walls of many London Underground stations (Dillon 1985, 11), or the tiles used to line the walls of butcher's shops, the walls of domestic bathrooms and kitchens.

A wide variety of different techniques were used to decorate such tiles including heavy moulding to create raised designs, the use of differently coloured glazes on a single tile, incised decoration, barbotine (a hand painting method based on oil painting), hand-painting, transfer printing, and the use of metallic and lustre decoration (Austwick 1980, 28- 37).

Such tiles are usually thin, those in YAT's collections being 4-16mm thick, with pale cream or white fabrics.

Plate 53 Modern wall tiles from the Hungate excavations, York.

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