

# Mud Mortars in Masonry Construction – Malton, North Yorkshire

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## **Abstract**

This paper deals with the historic use of earth mortars in masonry construction and the appropriate conservation and repair of buildings in which these were common. It will examine their extensive use in Malton, North Yorkshire, where earth mortars were the material of choice for stonemasons and plasterers until the middle of the 18thC; as commonly in high status as lower status buildings. It will be demonstrated that earth mortars in masonry construction were very much more common and are much more widespread in the UK (and doubtless elsewhere) than has been generally understood or acknowledged and that this raises serious issues for the investigation and compatible, authentic conservation and repair of these buildings. The primary case study will be York House in Malton, a late C15 H-plan house of high status with subsequent significant alteration as a gentry house in both 1620 and 1694. This will be illustrated by our own practice during the conservation of this exceptionally significant building and by data produced from ongoing laboratory analysis of early mortars from within York House and beyond.

The use of mud mortars in the Middle-East, central Asia, and the south-western USA is well-documented. Traditions of solid wall earth building – in cob or rammed earth – also exist across Europe and the UK. In many parts of the world – such as the Yemen and Bhutan - there remains a live tradition of mud masonry. Elsewhere these traditions have been either lost to the methods or materials of modern building technology or are under threat of dilution and diminution. In the process, eminently sustainable and locally specific vernacular buildings of the past and of the future are being compromised and lost to polluting, damaging and generic materials and working practices.

Little documented is the extensive historical use of mud mortars in masonry structures in the UK. Where mud mortar is noted in this context, it tends to be ascribed to a mysterious leeching away of previously present lime binder, to the poverty of the builders or the scarcity of readily available limestone with which to make lime. The craft tradition of routinely using mud as a mortar when building with stone was long ago displaced in Britain and can be only interpreted and re-discovered today. Earthen building practices are identified in historic vernacular building across the UK [1], yet the one region apparently lacking in a coherent earthen building tradition has been Yorkshire.

Malton began its life as a significant Roman garrison town. It became an important Norman market centre, its economy dominated by the local Gilbertine

Priory, which seems to have generated considerable wealth, much of which was invested in construction in the town. The geology is predominantly oolitic limestone and calcareous sandstone in equal measure. The Romans quarried the limestone, and most of the older buildings in the town—many of them dating, at least in part, to the 12<sup>th</sup>/13<sup>th</sup> Century, are built with the same Malton oolitic limestone. The churches, all of them Norman/Early English, utilize a finer grain limestone, amenable to carving, quarried some 3 miles from the town at Hildenley. From the later medieval period onwards, the calcareous sandstone was used as much as the limestone by masons locally, along with the Hildenley limestone. There were lime-kilns just without the boundaries of the medieval borough, as well as ready river transport along the Derwent. Hildenley limestone was burned for mortar also and probably delivered a naturally hydraulic lime. Indeed our own burning of local limestones, producing authentic limes for use upon York House, confirms this. Both Hildenley and local oolitic limestones generate feebly hydraulic limes of appropriate impurity.



Figure 1: Malton in 1728. Almost all of the buildings shown will have been built using earth mortars. Most remain. All materials sourced or manufactured just without the boundaries of the town. Note thatched roofs, brick and tile works to left of picture. Vanbrugh and Hawksmoor's Castle Howard in distance.

Historically in Malton, and for all this abundance of eminently suitable limestone, until at least the mid 18thC, local masons were using mud mortars for bedding and plastering. Even early brickwork is laid in mud mortar. Mud bedding and jointing mortar is encountered on the outside faces of buildings across town and in surrounding rural areas, where lime mortar pointing has fallen or eroded away. Mud plasters are found within houses otherwise constructed using lime mortar. Furthermore, after the early C18, plastering displays a transitional style: lime begins to be added into quite 'earthy' aggregate; lime base coats are very rich in oxhair (some even having rye grass or straw additions) and are not keyed before the application of subsequent coats, as earth base coats were not locally before them. Finish coats are typically thicker than may be considered the norm for three-coat lime plastering, and contain ox-hair. At the same time, re-facings of some higher status buildings utilized lime mortars from the later C16 onwards, even when the wall they were refacing remained bedded in mud. All stone buildings that survive from this period, in town and country, were higher status buildings when constructed. They were the houses, shops and farms of the bourgeoisie.

Some, such as Ralph Eure's lost Prodigy House, of which only the gatehouse and former stables remain, were of exceptional grandeur.



Figure 2: subsequently extended 1604 gatehouse of Eure mansion, Malton, constructed using calcareous sandstone, earth mortars and plasters

York House is a high status gentry house set on a wide burgage plot just within the line of the former town wall. Probably built by the Gilbertine Priory, it later fell to the Eure family and was then the Malton residence of Sir William Strickland, who owned much of the town at the turn of the 17<sup>th</sup> and 18<sup>th</sup> centuries, among other East and North Yorkshire estates. The current appearance of the house is mostly a result of improvements made by Strickland after 1684. Its mud mortared walls clearly demonstrate that earth was a material of high and every status at this and earlier times – it was not a mortar of the poor.



Figure 3: S elevation, York House, Malton. Central range and windows introduced around 1690, using earth and 5% quicklime mortars and hay-rich earth plasters with limestone dust, quicklime and oxhair finish coats over.

Internally, buildings locally were then plastered with earth plaster, usually in a single coat up to 40 mm thick; a thinner, but typically 4-6mm thick, haired lime finish coat applied over, and limewashed. Earth plaster was always left 'off the float', with a smooth finish, rich in fines, even when it was intended as a scratch coat. Whilst a harder, lime rich surface is undesirable in a lime mortar, too much lime migrating, or having migrated to the outer face of the mortar, this is not such an issue with earth mortar, which does not 'set' as such, but dries, hardening as it does so. This said, the surface was commonly finished by 'opening up' the float for a final pass, leaving characteristic drag lines left by any hay or grit taken up by this motion. The only key that earth mortars seem to have offered were small shrinkage cracks and 'drag marks'. Although not evidenced on all historic earth mortars locally, initial shrinkage cracking of plaster

(of both earth and lime) seems to have been common and of little concern to the masons, so long as this represented a release of surface tension only, and did not announce detachment of the plaster from the substrate.

Reused earth plasters in York House shrank but remained well adhered to the stone wall behind. Our limestone- and lime-rich finish coats have crazed very slightly, much as did the original material they have sought to imitate. Neve [2], recording Sussex practice in 1726 records finish coats for lome plaster of 6 bushells of lime to 1 of hair, illustrating today the geographical spread of earth mortar use in England.



Figures 4 &5 earth mortars, York House

It should be noted that although many of the historic earth plasters do not contain organic matter, as many again do. This is always hay/rye grass and never straw. Trials with local subsoils have demonstrated that an earth that shrinks quite dramatically without the addition of hay, shrinks not at all when hay is added. Added hay was typically around 100mm long. Earth mortars and plasters in York House laid up around 1690 are the first to show any deliberate lime content. This is indicated by small inclusions of air-slaked lime, consistent with the addition of small quantities of quick-lime to the otherwise earth mortar. This may be around 5%, a commonly used volume in some modern earth plasters.

The later medieval version of the Customs and Privileges of the Burgesses of New Malton, quoted here from a hand-written copy of 1729, explicitly asserts that : “ *Fyrst, it was graunted to the forsayd Burgeses, a Wast, of ather syde of the Town of New Malton; that the Burgeses and thare successors, shall in the sayd Wastys, gett Stone, and fro thens, stone and Erd take and cary, to the Edyficacyon and Beyldyng, within the sayd Town; whensoever thay wyll, and als ofte as thay wyll, withowt Impedyment of any man,*”...this being the first of many liberties the burgesses “*and thayr Anteassors liberally hafe usyd before tyme; the qwhyche tyme is withowten Mans Membrance or mynde*”

At least 8 different ‘recipes’ of earth mortar have been visually identified, and whilst earth mortars throughout town are generally similar, they vary significantly from one building to another, suggestive of there being no consistent ‘recipe’.. Most buildings in town that have earth mortar also have undercrofts or cellars and the floors of these are usually of or upon the bedrock. It would seem likely, therefore, that much of the mortar used within each building was generated either

from pits around the town or else during the excavation of the overburden on site. Within these undercrofts, the mortar of the walls is earth; that of the segmental vaults above, lime mortar the aggregate of which is limestone, with no added siliceous material.



Figures 6 & 7: cross vault with earth mortared walls and lime mortared vault; 12thC ribbed vault with lime mortared ribs and earth mortared fill illustrating informed and deliberate mortar selections by stonemasons



The material would seem to be immediately sourced subsoil, therefore, occasionally improved by the addition of grass, straw and sometimes ox-hair as well, and sometimes containing twigs, pottery and bone. It is clearly a pragmatic but well-informed use over a long period of time. Investigation of sub-soils in the immediate vicinity of isolated rural houses locally with earth mortar within has shown obvious correlation between the character of both mortars and sub-soil, even when the sub-soil and plasters have been remarkably sandy and of apparently poor cohesion. Subsequent investigation seems to confirm this analysis.

It is clear from the particle distributions in the 15 samples studied (see graph below), that there is considerable variation in aggregate size groupings and in geological make-up. In all 15 samples the largest proportion of aggregates falls within the 63 to 15 micron group. Therefore 'fines' predominate in all samples and proportionally decrease toward the larger end.

There are, however, two main categories which likely reflect mortars and plasters (correlation still to be confirmed). The two groups comprise 1) Samples with higher proportions of coarse aggregate of predominantly of limestone or chalk 2) Samples which tend toward the fine end of the spectrum, mostly of silicate or degraded lime fine sands. In both groups samples appear to reflect natural soils rather than intentionally modified building soils. We consider, therefore, that the two groups reflect two different broad sources. It seems likely, given the location of the building in an alluvial valley that cuts through glacial boulder clay (overlying calcareous jurassic hard geology), that building earths were sourced from river sediments, and from boulder clay upland from the river. Further analysis may confirm that the finer of the two groups was sourced in the river valley, while the coarser group represents boulder clay sourcing.

The samples are heavy in clays and silts. All 15 contain between 50 and 60 percent clays and silts, clay representing typically 20 percent. Notably, modern

specifications for earthen building materials usually prescribe lower proportions of clay and silt content. The successful performance and longevity of these historic samples likely results, therefore, from the stable properties of the local clays and from the inherent flexibility of the material itself.

Our own intuitively designed earth plaster as used in York House comprised 4 parts clay-rich soil to 7 parts 'M' grade sharp sand. It has performed well and gained a toughness comparable to a high calcium lime plaster.

All new plastering in York House has been executed in a clayey sub-soil, sourced from just beyond the boundaries of the modern town, to which was added well-graded sharp sand until the mortar became workable and subsequent shrinkage manageable. Hay has been added during mixing and the mortar performed best when mixed to almost its liquid limit before application with steel floats. A lime finish coat is made with graded Portland stone dust and either putty or quicklime. (In the first case, the proportion of stone dust to lime was 2:1.) Significant quantities of goat hair were added.

The interior and exterior walls of York House have been limewashed once more, in colours known to have been used on the building in the past, primarily to defend the exterior from the effects of vehicle exhaust emissions.

Traditional methods locally have proved remarkably durable and long-lived and the materials have proved themselves eminently fit for purpose. They have delivered maximum breathability and vapour permeability, as well as ample flexibility to the structure. Compression has been maximised during the course of construction, stone-to-stone contact being not uncommon in places in the rubble-stone sections of the walls. For stone bedding, the mortars were clearly laid in a very sloppy and wet state – dismantling of walls shows the mortar beds to reflect every indentation of the stone. The joints were then 'dubbed out' with the same earth mortar in preparation for plastering – although the face was never made as fair as would have been necessary to receive lime plaster.

Historic lime pointing to the north wall of York House – the face of which seems to be a refacing from the later C16, bound with lime mortar, whilst the main body of the wall is bedded in mud – was relatively unusual for containing ox-hair – was this a considered response by the masons to the presence of mud in the wall? There is mounting evidence to suggest that the exterior walls of some, at least, of the stone buildings in Malton, including the high status York House, were treated in a similar way to the interiors, with a hair-rich lime finish coat over an earth base-coat. As typically in Malton, York house was faced on the outside with squared limestone ashlar (some of this likely recycled from Roman buildings locally) with rubblestone interior wyths. Stone walls constructed with mud mortar (typically 25" in section) display little or no deflection or separation cracking and mud-bound brickwork remains as sound as the day it was built. Except where the breathability of the walls has been compromised by the application of opc mortars inside or out, the walls are universally 'dry', they are never damp.

Earth plastering is specified in all situations where it exists or may be demonstrated to have done so, upon earth mortared walls. As in the past, the earth itself will be sourced locally and used with a minimum of necessary improvement. Associated lime finish coats are similarly informed by historic practice and

composition as well as upon specific analysis of examples found locally within each building. This steps back beyond more refined 19<sup>th</sup>C craft practice recorded in a number of contemporary manuals. Some evidence has been observed that exterior plastering with the same ‘system’ was common also, as late as 1690. We have yet to venture down this road, though external rendering is one of our chosen strategies when dealing with severely eroded and probably originally rendered facades within the town.



figure 8 N elevation, York House

From the evident quality of their workmanship, masons in Malton, at least, were highly skilled from the early medieval period onwards, with a deep understanding of their materials and of the principles of compatibility. Throughout the medieval period and at least until the beginning of the 18<sup>th</sup> century, these masons *chose* to use mud mortar in the majority of their work and the architectural documents of this choice remain not only for our everyday use throughout Malton and beyond, but also as platforms for our imagination and enquiry, and models for not only our current conservation practice but for sustainable, locally specific and culturally meaningful architecture of the future.



Figure 9 Old Malton Priory 12thC

Figure 10 mud-mortared limestone, Malton



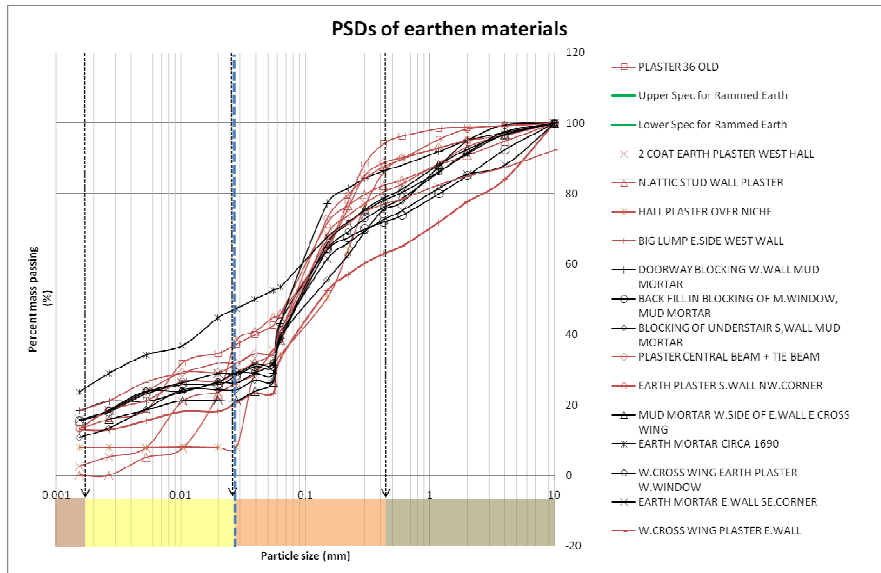


Figure 9 particle size distribution, sample mortars from York House and Malton. (Allen)

#### References.

This paper represents a significant development of an article published in the SPAB magazine, Cornerstone Vol 27 No 2 containing mainly new information, insights and data gathering.

- [1] Hurd J & Gourley B (2000) *Terra Britannica* English Heritage/ICOMOS James and James
- [2] Neve R (1726) *The City and Country Purchaser and Builder's Dictionary* Reprinted 1969 David and Charles London