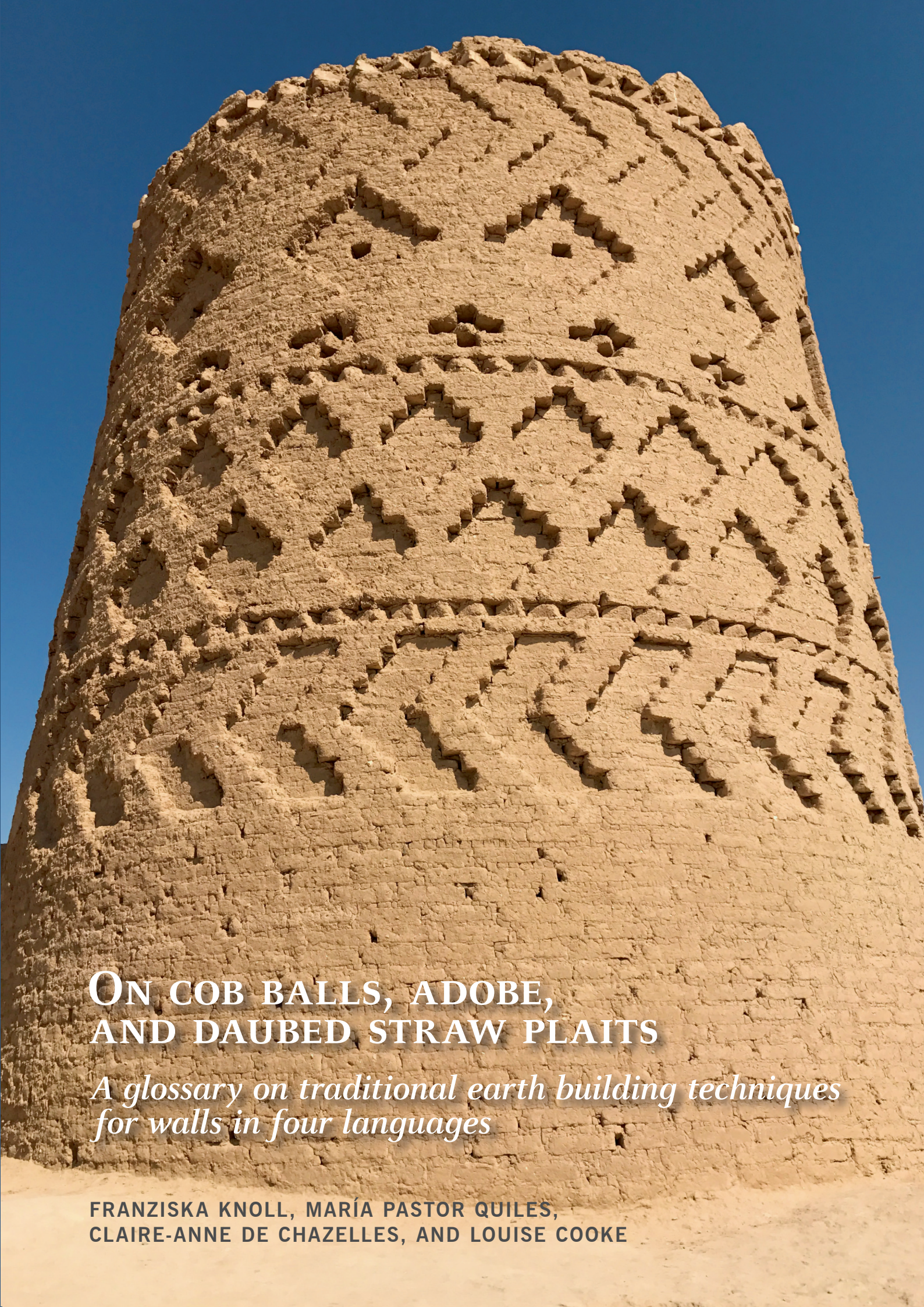

On cob balls, adobe, and daubed straw plaits

A glossary on traditional earth building techniques for walls in four languages

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Un glosario en cuatro idiomas de técnicas constructivas con tierra tradicionales

Sur les boules de bauge, l'adobe et les mèches de torchis torsadées
Un glossaire en quatre langues sur les techniques traditionnelles de construction des murs en terre

Von Lehmbroten, -ziegeln und -zöpfen
Ein viersprachiges Glossar der traditionellen Lehmbautechnik (Wände)

FRANZISKA KNOLL, MARÍA PASTOR QUILES, CLAIRE-ANNE DE CHAZELLES, AND LOUISE COOKE

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herausgegeben von
Harald Meller

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Cover front and back Narin Qal'eh (Narin Castle, pre-Islamic fortress), Meybod, Yazd Province (Iran).
Front Partly restored watchtower, built of adobe.
Back Enclosing wall, erected in »chineh« technique. The crenellations are covered with fired bricks.
(Photos: F. Knoll/H. Meller 2017)

Vorwort Herausgeber

Lehmziegelmauer im spätminoischen Palast von Malia, Kreta (Griechenland; Foto: F. Knoll 2019).

Im vergangenen Jahrhundert schien es im mitteleuropäischen Raum undenkbar, prähistorische Architektur befundnah im Aufgehenden zu rekonstruieren. Die Nachbauten basierten bisher in der Regel auf dem dokumentierten Grundriss, angezeigt durch Pfostengruben. Lehmfragmente, obwohl auf jeder heimischen Ausgrabung präsent, wurden – ganz anders als im mediterranen oder orientalischen Raum – als Quelle konsequent vernachlässigt; wohl auch deshalb, weil sie selten *in situ* angetroffen werden und oftmals als unansehnliche Bruchstücke in großer Anzahl die Siedlungsgruben füllen. Dass sich dieses Bild langsam zu wandeln beginnt, liegt auch an der Arbeit der vier Autorinnen, die sich hier zusammengeschlossen haben, um das vorliegende kleine Handbuch abzufassen.

Die Idee für dieses Werk wurde sozusagen aus der Not heraus geboren. María Pastor Quiles absolvierte für ihre Dissertation zu spanischen Lehmbauresten einen dreimonatigen Forschungsaufenthalt an unserer Institution bei Franziska Knoll, die seit fast einem Jahrzehnt architektonische Lehmfunde in Sachsen-Anhalt bearbeitet. Schnell stellte sich heraus, dass die deutschen Bezeichnungen verschiedener Baureste im Spanischen kein Äquivalent besitzen und englische Begriffe meist ebenso schwierig beliehen werden können. So erarbeiteten sie zusammen mit Claire-Anne de Chazelles und Louise Cooke die vorliegende Sammlung von Beispielen aus dem Lehmbau rund um den Globus. Diese beiden weiteren Archäologinnen sind seit Langem der Materie verhaftet. Erstere widmet sich in Frankreich und Marokko seit Jahrzehnten Lehmbauten und hat die »terre crue«-Tagungen mit initiiert. Letztere ist Mitglied des ICOMOS International Scientific Committee on Earthen Architectural Heritage und forscht neben Großbritannien schwerpunktmäßig in Mittelasien.

Die viersprachige Publikation ist ganz bewusst bildlastig gehalten. Mit archäologischen, historischen und modernen Fallstudien gelingt es dem Quartett, mehr als 50 verschiedene Lehmbaubegriffe anschaulich und knapp zu erläutern. In der Druckausgabe mag das Heft als Begleiter im Feld dienen, in der digitalen Version als Nachschlagewerk. Um möglichst viele Lehmbau-Interessierte bei der Klassifikation ihres Materials unterstützen zu können, wird Letztere als erste frei zugängliche Online-Publikation des Landesamtes für Denkmalpflege und Archäologie Sachsen-Anhalt abrufbar sein. Die Hoffnung ist, auf diese Weise die Grundlage für eine internationale und vergleichbare Datenbasis zu schaffen. Denn eine wirklich konsistente Interpretation des gebauten Raums kann nur gelingen, wenn alle Aspekte der Siedlungsforschung berücksichtigt werden; und dazu zählen neben dem Gebäudegrundriss und dem Hausinventar eben auch das Mobiliar (Einbauten) und bautechnische Aspekte.

Zuletzt ist den vier Autorinnen für ihre Initiative und vorliegendes Büchlein zu danken. Ebenso gebührt den zahlreichen Kolleginnen und Kollegen mein Dank, die dieses Vorhaben mit der Bereitstellung von eigenem Bildmaterial bereichert haben. Die finale Danksagung bleibt dem Redaktions- und Grafikteam des Landesamtes vorbehalten, das bei dieser unkonventionellen Publikation großartige Arbeit geleistet hat!

Harald Meller

Preface of the editor

Mud brick wall in the Late Minoan Palace of Malia, Crete (Greece; photo: F. Knoll 2019).

In the past century, it seemed unthinkable in central Europe to reconstruct above ground prehistoric architecture based on the archaeological features and architectural remains. To date, the replicas were usually based on the recorded ground plan indicated by post pits. Even though every local excavation unearths a number of clay fragments, they were consistently ignored as source – unlike in the Mediterranean or the Middle East –, perhaps owing to the fact that they are rarely found *in situ* and often fill the settlement pits as a mass of unattractive fragments. Due to the work of the four authors, who joined forces to draw up this compact handbook, this picture is slowly beginning to change.

The idea for this glossary was in a way born out of necessity. For her dissertation on earthen architectural remains from Spain, María Pastor Quiles conducted a three-month research stay at our institution with Franziska Knoll, who has been working on architectural clay fragments from Saxony-Anhalt for almost a decade. It quickly turned out that the German terms for various building remains have no Spanish equivalent and that it is mostly difficult to borrow the English terms. Thus, together with Claire-Anne de Chazelles and Louise Cooke, they established this collection of earth building examples from around the globe. Those two other archaeologists have long been concerned with this matter. The former applied herself to study earth buildings in France and Morocco for decades and took part in initiating the »terre crue« conferences. The latter is member of the ICOMOS International Scientific Committee on Earthen Architectural Heritage and predominately researches in Central Asia and Great Britain.

This publication in four languages deliberately uses a large number of images. By means of archaeological, historical, and contemporary case studies, the quartet succeeds in descriptively and concisely explaining more than 50 terms applied to earthen architecture. The print edition may serve as companion for fieldwork, while the digital version serves as reference book. In order to be able to support as many people interested in earth building as possible in the classification of their material, the digital version will be the first open access publication by the State Office for Heritage Management and Archaeology Saxony-Anhalt. Hereby, the hope is to create the basis for an international and comparable database, because a truly consistent interpretation of a built structure is only successful if all aspects of settlement research are considered. In addition to the building's ground plan and inventory, this includes furnishings (built-in fitments) and constructional aspects.

Finally, it remains to thank the four authors for their initiative and this booklet. I would also like to give thanks to the many colleagues who have enriched this project with the provision of private photo material. The final acknowledgments go to the editorial and graphic teams of the State Office for their excellent work on this unconventional publication!

Harald Meller

On cob balls, adobe, and daubed straw plaits

A glossary on traditional earth building techniques for walls in four languages

Franziska Knoll, María Pastor Quiles, Claire-Anne de Chazelles, and Louise Cooke

Archaeological research on earth building in the European context is, unfortunately, still in its early stages. The 2011 »Terra Europae Earthen Architecture in the European Union« project focused (with some exception) on the medieval, post-medieval, and modern uses of earth as a building material (Correia et al. 2011). Nevertheless, in recent years there has been increasing interest in the archaeological study and identification of earth constructions. An important range of publications on archaeological sites and their materiality highlight the presence of earth building remains, as the case studies presented in this article show. Some connect the archaeological evidence with contemporary vernacular building techniques, which are frequently similar to those implemented in the past and practised for centuries. It is from the realm of vernacular building that most of the terms applied to earthen architecture within archaeological contexts are selected. However, the names attributed to the different construction techniques and materials vary enormously according to region, building traditions, and language. As an example of this, humid cob balls in German are variously called »Lehmbatzen« (»mud blocks«) (1.1.2b), »Walzen« (cylinders), »Kuchen« (cakes), »Brote« (breads), or »Fladen« (»round flat cakes«), although they are produced and arranged in the same way.

The purpose of the glossary is therefore to raise awareness of the potential uses of earth as a building material in order for its archaeological identification and interpretation to be enhanced. The authors acknowledge the enormous variability of earth building techniques and that our current classification, terminology, and vocabulary is shaped by 21st century losses of traditional, vernacular heritage and is to some extent limited (e. g. the categories established through the ECVET Earth Building Units of Learning). The lost literacy of landscape has been explored by other scholars (Macfarlane 2015) and it is within this context the glossary has been conceived.

1. »Norms of use«

In order to help use the correct terminology for earth construction in archaeological contexts and facilitate research in this matter in other languages, we present a series of related and organised concepts, together with graphic examples of them.

This glossary approaches the topic of the study of earthen architecture from an archaeological standpoint structuring the different techniques and illustrating them. In so doing, with the data available, we present (where possible) an image of a recent example of a technique or building element, its aspect in an archaeological context, and a representation of its practical implementation. In this way, we try to contribute to the use of a more precise terminology for the archaeological remains of earthen architecture.

Certain construction techniques have been developed through time in some regions and cannot be found in others, given the relationship between earth building and the availability of raw materials, as well as the ways in which earth as a building material is adapted for use. These sorts of specific cases are indicated in a separate line. The same is applied to certain elements built with mud, not only for the construction of walls, but also for upper storeys, roofs, or floors.

When certain tools or instruments are used associated with a certain technique, namely the wooden frame of rammed earth, these are indicated as well.

After the terminology of earthen building techniques for erecting walls (I), we present a series of other related terms regarding the construction work (II).

2. A brief comment on the classification of the building techniques

From the realm of architecture, building techniques are differentiated by the distribution of the loads in a structure, considering load-bearing, massive earth wall buildings (1), and those techniques where the earth plays a non-bearing role (2). In the first classification, walls are built completely with earth, or together with other materials, but they support the weight of the roof. In the second case, earth is used as a filling in a load-bearing structure, generally made of wood or other fibrous materials.

2.1 Massive, load-bearing earth walls

Structures with massive earth walls can be built with humid, malleable earth or with techniques that employ already dried individual earth elements (cf. e. g. Aurenche et al. 2011, 14–17 or Perello 2015, Fig. 10).

In a humid state, earth as a construction material (simply a mixture of soil and water), with other substances that can be added, can be applied in layers (1.1) or compacted in a formwork (1.2). For example in cob building, different ways of arranging the humid earth can be distinguished: in individual units used for the layers, by shaping or directly modelling a narrow layer (1.1.1), with still humid earth units arranged one against the other (as »mud blocks« or »cob balls«, see 1.1.2), or the so-called piled or pitched-fork cob (»Weller«, »chineh«, »zabur«; see 1.1.4 [terminology after Piesbergen 2007, 26–29]).

In some parts of Africa, traditionally these earth layers are »teethed« or overlapping each other (1.1.4b). Whereas in the south-west of France, earth is sometimes layered into a wooden formwork (as it occurs in the widespread pisé technique but in this case with the manual compaction of the layers of earth; 1.1.4d). Nevertheless, both architectural traditions could be understood as piled cob layers.

Within these broader categories there are multiple local variations, e. g. a variant known predominantly in the German area are the so-called »Lehmzöpfe« (1.1.3). This technique uses bundles of long straw, which are daubed, twisted, and used to build.

Regarding rammed earth, the earthen material is used with a low degree of humidity and the variations are small concerning the execution (1.2). In this case, variability is observed in the earthen material chosen to be compacted and in the use of different substances or solid elements between layers, such as fired bricks, stones, or mortar, which are generally considered to increase the durability of the walls. A particular technique generates a mixed result, a technique that is somewhere between cob and rammed earth. For instance, in some regions of France, humid mud lumps of different forms are placed inside a wooden frame, although without the final compaction of rammed earth (1.1.4d). The use of wooden frames or planks as moulds in other earth building techniques (but without the compaction associated with rammed earth) should therefore be considered in the interpretation of archaeological findings.

A distinctive earth construction technique is the one that uses earth blocks cut and removed directly from the soil. In this technique no preparation of a mud mixture is involved, but only earth blocks, which can also be extracted from the surface and used with their vegetation (as turf/turves), or be blocks obtained in peat soils, used either before or after a drying process (1.4).

In the same way, earth block walls are considered load-bearing. The concept of unfired earth or mud bricks encompasses diverse types of unfired earth blocks generally constructed with regularly coursing and bonded together with mud mortar. Again there are substantial differences in the execution of this technique with extensive variation. Moulded bricks are widely spread (1.3.2). Hand-shaped mud bricks can have different morphologies (e. g. prismatic, conic, or elongated, see 1.3.1) and are considered older than those made in wooden moulds.

In addition, a special form of producing mud bricks is cutting them from a mass of humid earth. The humid earth mixture is spread with an even thickness and the blocks are cut from it in regular grids (1.3.3).

2.2 Mixed building techniques: non-bearing use of mud as construction material

The so-called mixed building techniques imply a constructive use of both earth and wood. The load-bearing function is performed by the wooden structure. Depending on the morphology of the wooden parts of a built structure, it can be distinguished between the half-timbered technique (2.2) and a post-and-beam construction or a load-bearing timber frame (2.1). The difference is mainly in the wall surface that is to be filled or closed. In half-timbered buildings, this surface is generally panels or frames of small dimensions, between horizontal or oblique wooden elements. In the post-and-beam construction, this surface is not subdivided in smaller panels, but the whole wall surface is to be filled, the space between the vertical posts and the upper beams.

In both types of construction with a wooden structure, similar materials are used as an infill, e. g. daubed sticks of small diameter. Earth construction with mud as a non-bearing element often consists of vertical wooden posts or stakes in combination with different plant or wooden materials and cob and plastered with daub.

The better known and mostly used building technique to fill wall spaces in a wooden frame construction is wattle and daub (2.1.1). An infill of the different frames of a half-timbered structure only with vertical or horizontal rods is also common (2.2.2), as well as the use of many smaller wooden elements for the whole filling of the space between posts and upper beams (2.1.2; 2.1.3). Again there is substantial variation.

In traditional half-timbered buildings, spread mainly over Germany and Alsace/France, the particular technique of »earth winding« can be applied (2.2.3). Here, as an infill for the frames, vertical timber stakes with long daubed straw wound around them are used.

Other earth building techniques more usually applied in load-bearing earth walls can also be used to fill the spaces in a wooden structure, such as mud bricks (1.3), or cob bricks or balls (2.2.4).

Other mixed building techniques are also variable, in relation to the availability of raw materials to be used for architectural purposes and the possibility of using them. For wattling vertical wooden sticks, reed bundles (2.1.5), or other vegetal materials, i. e. daubed plaits, can also be employed. Where wood is abundant, the space can be filled with laths, rods, or planks (2.1.6). Also in these cases, mud plaster is frequently used for the final coat.

Sobre bolas de barro, adobes y haces de vegetales y barro retorcidos

Un glosario en cuatro idiomas de técnicas constructivas con tierra tradicionales

Franziska Knoll, María Pastor Quiles, Claire-Anne de Chazelles, y Louise Cooke

La investigación arqueológica sobre la construcción con tierra en el ámbito europeo se encuentra todavía, por desgracia, en sus inicios. El proyecto »Terra Europae«, llevado a cabo en 2011, sobre la arquitectura de tierra en la Unión Europea se centró, salvo excepciones, en los usos de la tierra como material de construcción en época medieval, post-medieval y moderna (Correia et al. 2011). No obstante, el interés por la llamada arquitectura del barro ha crecido en los últimos años en el campo de la arqueología. Un buen número de publicaciones sobre excavaciones arqueológicas y presentaciones de los materiales de las mismas recogen la presencia de restos de construcción con tierra, como muestran los casos de estudio recogidos en este trabajo. A menudo estas evidencias son comparables con formas de edificar tradicionales, que en buena parte se han llevado a cabo de forma similar durante siglos. Del ámbito de la arquitectura tradicional procede también, generalmente, la terminología utilizada para describir estos materiales arqueológicos. No obstante, las denominaciones de las distintas técnicas y materiales varían en función de la región, las tradiciones constructivas y el idioma utilizados. Un ejemplo de ello es la denominación dada en el ámbito germanoparlante a la técnica de los »Lehmbatzen« (»bloques de barro« amasados) (1.1.2b), para los que el barro se dispone en estado húmedo. Éstos reciben nombres diferentes, como »Walzen« (cilindros), »Kuchen« (»pasteles«), »Brote« (panes) o »Fladen« (tortas), aunque se producen y ponen en obra de la misma manera.

El objetivo de este glosario es contribuir a mostrar los variados usos posibles de la tierra como material constructivo, para permitir su mejor identificación e interpretación desde la arqueología. Las autoras somos conscientes de la enorme variabilidad presente en las técnicas de construcción con tierra, así como del hecho de que las clasificaciones actuales y la terminología se basan en buena medida en el patrimonio vernáculo conservado hasta el presente siglo y se encuentran así, en cierto modo, limitadas (como muestran, por ejemplo, las categorías establecidas por las unidades ECVET de construcción con tierra, para la formación y certificación profesional europea).

1. »Normas de uso« del glosario

Con el objetivo de poder dar una denominación adecuada y de manera sencilla a los hallazgos arqueológicos de construcción con tierra y, así, facilitar la investigación en este campo en otros idiomas, hemos reunido y organizado una serie de conceptos, junto con ejemplos gráficos de ellos.

Este glosario enfoca así el tema de la construcción con tierra en arqueología estructurando las distintas técnicas e ilustrándolas. Para ello, en la medida en que ha sido posible con los datos a nuestra disposición, presentamos conjuntamente imágenes de un ejemplo reciente de una construcción con una determinada técnica, el correspondiente aspecto que puede presentar en contexto arqueológico y una representación de su ejecución. De este modo, esperamos contribuir a una adecuada denominación de los restos arqueológicos de construcción con tierra, no sólo mediante la presentación de la terminología acuñada, sino también de imágenes que la ejemplifiquen e ilustren.

Dada la relación de la construcción con tierra con la disponibilidad de materias primas que pueden utilizarse como materiales de construcción a nivel regional, se han ido desarrollando a lo largo del tiempo algunas técnicas determinadas en ciertas regiones, que no se encuentran en otras. Estos »casos particulares«, así como algunas denominaciones específicas, se indican en una línea en cursiva. Esto mismo se aplica a diferentes elementos construidos con barro, que no sólo pueden pertenecer a alzados, sino también a forjados de segundos pisos, cubiertas o pavimentos.

En los casos en que se utilizan determinadas herramientas o instrumentos de trabajo característicos de una determinada técnica, como el cajón de madera utilizado en la técnica del tapial, éstos aparecen marcados también.

Tras las denominaciones de las técnicas constructivas con tierra para alzados (I), en la tabla se recogen una serie de términos también asociados a la construcción con tierra (II).

2. Un breve comentario sobre la clasificación de las técnicas constructivas

Desde la arquitectura, las construcciones con tierra se diferencian, en primer lugar, según la distribución de las cargas en la edificación, entre las construcciones de muros de tierra maciza, portantes (1) y en las que el barro no realiza la función portante (2). En el primer caso, los muros se construyen en su totalidad con tierra o también con otros materiales asociados, y sobre ellos recae el peso de la cubierta. En el segundo caso, el barro no soporta las cargas de la edificación, sino que se utiliza como relleno o cerramiento de una estructura portante, generalmente hecha de madera.

2.1. Muros de tierra maciza y portantes

Las construcciones de muros de tierra maciza, con función portante, pueden edificarse con barro en estado húmedo, al que todavía se le puede dar forma, o con técnicas que emplean piezas de barro ya secas (cf. eg. Aurenche et al. 2011, 14–17 o Perello 2015, Fig. 10).

El barro utilizado como material de construcción, una mezcla de tierra, agua y diferentes sustancias que pueden añadirse a la mezcla, puede disponerse en estado húmedo aplicado en capas (1.1) o apisonado en un cajón (1.2). En la construcción con barro amasado, aplicado en sucesivas capas, pueden distinguirse otras diferenciaciones, en función de cómo se dispone el material para edificar: en capas individualizadas (formando paredes estrechas, modelado de forma directa; 1.1.1), con piezas de barro en estado húmedo dispuestas unas junto a otras (bloques o bolas de barro amasado; 1.1.2) o con barro apilado o lanzado con un instrumento (»Weller«, »chineh«, »zabur«; 1.1.4 [ver Piesbergen 2007, 26–29 para terminología]).

En algunas partes de África, las capas de barro amasado se disponen tradicionalmente apiladas unas sobre otras de una forma singular (1.1.4b). Por otro lado, en el suroeste de Francia, en algunos casos el barro amasado se pone en obra en el interior de un cajón de madera, como el utilizado en la conocida técnica del tapial (1.1.4d). No obstante, ambas tradiciones constructivas pueden seguir considerándose técnicas de barro amasado y apilado.

Una variante conocida en el ámbito germano son los llamados »Lehmzöpfe« (1.1.3). Esta técnica utiliza haces de materia vegetal de considerable longitud, a los que se añade barro y que son entonces retorcidos y utilizados para construir.

Respecto a la técnica del tapial, la tierra se aplica con un bajo grado de humedad para poder ser compactada. Las variaciones son escasas en lo referente a la ejecución (Punto 1.2). En este caso, la variabilidad se da en el material utilizado y apisonado o en el empleo de distintas sustancias o elementos sólidos entre las tongadas del encofrado, como ladrillos, piedras o mortero de cal, lo que aumenta la resistencia de los muros. Una aplicación particular del material crea formas mixtas, que pueden considerarse a medio camino entre las técnicas del barro amasado y del tapial. Por ejemplo, en algunas regiones de Francia se disponen bloques de barro amasado en estado húmedo, que pueden adoptar distintas formas, en un cajón de madera, aunque sin aplicárseles el apisonado final del tapial (1.1.4d). El posible empleo de cajones o tablas de madera en otras técnicas de construcción con barro amasado es, por lo tanto, algo que debería tenerse en cuenta a la hora de identificar las evidencias de técnicas constructivas con tierra en contextos arqueológicos.

Una técnica de construcción con tierra singular es la edificación mediante bloques cortados y extraídos directamente del suelo. En esta forma de construir no interviene ninguna mezcla antrópica de mortero de barro, sino bloques de tierra que también pueden provenir de la superficie del terreno y contener vegetación, o bloques extraídos de suelos de turba, empleados con o sin un secado previo (1.4).

Del mismo modo, también se consideran de muros portantes las edificaciones de adobe. Este concepto engloba formatos muy diversos de bloques de barro secados previamente a su uso, no cocidos y puestos en obra generalmente unidos con mortero. En la técnica del adobe pueden establecerse diferencias en el modo en el que se disponen estos bloques. Los adobes hechos con molde son ampliamente utilizados (1.3.2). Los adobes hechos a mano se consideran más antiguos que los fabricados con molde y pueden elaborarse con formas distintas (paralelepipédicas, cónicas, alargadas; 1.3.1).

Una forma, en cierto modo, especial de producir adobes, es el caso de los adobes »cortados«. En esta técnica, la mezcla de barro húmeda se extiende sobre una superficie con un grosor homogéneo y los bloques se fabrican recortando el barro en cuadrícula, generando formas regulares (1.3.3).

2.2. Técnicas mixtas: uso no portante de la tierra

Las llamadas técnicas mixtas suponen el empleo constructivo tanto de la tierra como de la madera. La función portante la realiza la estructura de madera. Consideramos que, según la forma de esta estructura, puede distinguirse entre la técnica del entramado (2.2) y la edificación mediante un esqueleto o armadura de madera (2.1). La diferencia se encuentra, sobre todo, en las dimensiones de la superficie del alzado que ha de cerrarse o rellenarse. En la técnica del entramado, la superficie a rellenar son generalmente marcos o bastidores de pequeñas dimensiones, delimitados por maderos horizontales u oblicuos. En el otro tipo de edificaciones con esqueleto de madera no se subdivide la superficie a rellenar en bastidores menores, sino que se rellena el espacio completo de la pared, enmarcada entre los postes verticales y las vigas horizontales.

En ambos tipos de construcción con estructura de madera se utilizan materiales similares a modo de relleno, como elementos lígneos de pequeño diámetro, manteados con mortero de barro. Generalmente, la construcción con tierra como elemento no portante consiste en el manteado de elementos de madera, unidos por diferentes combinaciones posibles de vegetales y barro y revestidos también con barro.

La técnica más conocida y utilizada para el cerramiento de superficies en edificaciones de estructura de madera es el bahareque o encestado (2.1.1), que emplea elementos de madera o distintos vegetales entrelazados y manteados con barro. También es frecuente el relleno de los bastidores de madera únicamente mediante algunos maderos verticales u horizontales (2.2.2), o cubriendo el espacio total restante entre postes y vigas mediante numerosos elementos de madera de menores dimensiones (2.1.2; 2.1.3).

En edificaciones tradicionales realizadas mediante la técnica del entramado se conoce el caso especial de los »rollos« o »rosquillas« de barro (2.2.3). En esta técnica se emplean, para el relleno de los bastidores, maderos dispuestos en vertical, en torno a los que previamente se ha enrollado paja, de considerable longitud, mezclada con barro.

Para los cerramientos pueden utilizarse asimismo otros materiales constructivos de barro que se emplean en muros portantes, como adobes (1.3) o bloques o bolas de amasado de barro, aplicados en estado húmedo (ver 2.2.4).

También en estas técnicas mixtas se dan numerosas variantes, en función de la disponibilidad de materias primas y de la posibilidad de utilizarlas como materiales de construcción. En los maderos verticales pueden entrelazarse haces de carrizo (2.1.5), o la superficie del alzado puede cerrarse con un panel de vegetales entrecruzados o trenzados y mantearse con barro. En casos de abundante disponibilidad de madera, el espacio entre postes puede cerrarse mediante el uso de listones o tablas de madera, o ramas (2.1.6). También en estos casos suele emplearse el barro para el revestimiento final.

Sur les boules de bauge, l'adobe et les mèches de torchis torsadées

Un glossaire en quatre langues sur les techniques traditionnelles de construction des murs en terre

Franziska Knoll, María Pastor Quiles, Claire-Anne de Chazelles, et Louise Cooke

La recherche archéologique sur la construction en terre est encore, malheureusement, à ses débuts en Europe. Le projet « Terra Europae » de 2011 sur l'architecture de terre dans l'Union européenne s'est concentré (à quelques exceptions près) sur les utilisations médiévales, post-médiévales et modernes de la terre comme matériau de construction (Correia et al. 2011). Néanmoins, un intérêt grandissant pour ce type de construction s'est manifesté au cours des dernières années et un grand nombre de publications concernant des sites archéologiques montre la présence de vestiges d'édifices bâtis en terre. Certains d'entre eux permettent de relier les évidences archéologiques à des techniques traditionnelles, souvent comparables en effet à celles utilisées dans le passé et pratiquées depuis des siècles. Beaucoup de termes appliqués aux restes archéologiques issus de bâtiments en terre sont empruntés au domaine de l'ethnologie et de l'architecture traditionnelle. Cependant, les noms des différentes techniques constructives et des différents matériaux varient selon les régions, les traditions locales et les langues. Un exemple en est donné par la dénomination en allemand des boules de bauge humides, les « Lehmbatzen » (« galettes ») (1.1.2b), qui sont nommées aussi bien « Walzen » (cylindres), « Kuchen » (gâteaux), « Brote » (pains) que « Fladen » (sorte de crêpes), bien qu'elles soient fabriquées et disposées de la même manière.

Le but du glossaire est donc de sensibiliser aux utilisations potentielles de la terre comme matériau de construction afin d'améliorer son identification et son interprétation archéologiques. Les auteures reconnaissent l'énorme variabilité des techniques de construction en terre et le fait que la classification actuelle, la terminologie et le vocabulaire sont tributaires du patrimoine vernaculaire traditionnel conservé au 21ème siècle et par conséquent, dans une certaine mesure, limités (comme le montrent, par exemple, les catégories établies par les ECVET, unités d'apprentissage de la construction en terre).

1. « Normes d'utilisation » du glossaire

En vue d'aider à trouver facilement le terme approprié, lors de la découverte de vestiges archéologiques de constructions en terre, et pour faciliter la recherche sur le sujet dans d'autres langues, nous présentons une série de concepts organisés et complétés par des exemples graphiques. Ce glossaire aborde l'étude des architectures de terre à partir de l'archéologie, en structurant les différentes techniques et en les illustrant. Pour cela, à partir des données disponibles, nous présentons l'image d'un exemple actuel d'une technique ou d'un élément de construction, ses aspects dans un contexte archéologique et une représentation de sa mise en œuvre. De cette manière, nous essayons de contribuer à une maîtrise plus précise des vestiges d'architecture en terre.

Certaines techniques ont été développées dans des régions au cours du temps et ne se trouvent pas dans d'autres, étant donnée la relation qui unit la construction en terre et la disponibilité des matériaux naturels. Ces cas spécifiques sont indiqués en caractères italiques sur une ligne séparée et, de la même façon, pour certains éléments en terre ne provenant pas seulement des murs mais d'étages supérieurs, de toits plats ou de pavements.

Quand certains outils sont associés à une technique en particulier, comme les coffrages en bois pour la terre damée, ils sont également indiqués.

Après la terminologie des techniques servant à construire les murs en terre (I), nous présentons une série d'autres termes relatifs au travail de construction (II).

2. Bref commentaire sur la classification des techniques de construction

Suivant les principes de l'architecture, les techniques constructives sont distinguées d'après la répartition des charges sur la structure, en considérant d'une part les murs porteurs entièrement en terre (1) et, d'autre part, ceux où la terre n'assume pas de rôle porteur (2). Dans le premier cas, les murs sont édifiés uniquement avec de la terre ou en l'associant avec d'autres matériaux, et ils supportent le poids de la toiture. Dans le second cas, la terre est employée comme garnissage d'une structure porteuse, généralement faite en bois.

2.1 Murs de terre porteurs

Les murs porteurs entièrement en terre peuvent être bâtis avec un matériau humide, malléable, ou selon des techniques employant des éléments individuels déjà séchés (cf. par ex. Aurenche et al. 2011, 14–17 ou Perello 2015, fig. 10).

À l'état humide, le matériau de construction – un mélange de terre, d'eau et autres substances éventuellement ajoutées – peut être utilisé par couches successives (1.1) ou compacté dans un coffrage (1.2). Dans la construction en bauge, on distingue différentes manières d'arranger la terre plastique : en unités individuelles, formant des lits façonnés ou modelés directement en couches minces (1.1.1), avec des éléments encore humides disposés les uns contre les autres (« blocs de bauge » ou « boules », « galettes », « mottes de terre », voir 1.1.2), ou bien selon le procédé de la bauge empilée et tassée à la fourche (« Weller », « chineh », « zabur » ; voir 1.14 [terminologie d'après Piesbergen 2007, 26–29]).

Dans certaines régions d'Afrique, traditionnellement, les couches de bauge sont superposées, chacune chevauchant ou emboîtant la précédente (1.1.4b), tandis que dans le Sud-Ouest de la France, la bauge est parfois mise en place dans des coffrages en bois, suivant la technique généralisée par le pisé (1.1.4d). Néanmoins, les deux traditions architecturales peuvent être classées comme de la bauge amassée ou empilée.

Une variante connue principalement dans l'aire germanique est désignée par l'expression « Lehmzöpfe » (1.1.3). Cette technique utilise pour construire des sortes de tortis ou torches faites de longues pailles, enrobées de terre plastique (torchis) et torsadées.

En ce qui concerne le pisé, la terre est toujours très peu humide afin de pouvoir être damée et l'exécution comporte peu de variantes (1.2). Dans son cas, la variabilité est observée à propos des matériaux choisis pour être compactés et dans l'emploi de différentes substances ou éléments solides entre les couches de terre, tels que des briques cuites, des pierres ou du mortier, destinés à accroître la durabilité des murs. Une technique particulière produit un résultat mixte, intermédiaire entre la bauge et le pisé (1.1.4d). L'utilisation de cadres en bois ou de planches en guise de moules, pour d'autres techniques que le pisé lui-même, est donc une possibilité à prendre en compte dans l'interprétation des découvertes archéologiques.

Un mode de construction particulier emploie des blocs de terre découpés, extraits directement du sol. Dans cette technique, le matériau impliqué n'est pas un mélange anthropique, ce sont des blocs de terre appelés « turf » qui peuvent être extraits de la surface du sol avec la végétation (mottes de gazon) ou taillés dans de la tourbe et employés avant ou après séchage (1.4).

De la même manière, les murs de brique crue sont également des structures porteuses. Le concept de brique crue englobe divers types de blocs séchés, non cuits, et assemblés avec un mortier de terre. Des différences existent pour cette technique dans la manière de disposer les éléments. Les briques moulées sont largement répandues (1.3.2), mais les briques modelées à la main sont considérées comme plus anciennes et peuvent adopter des formes variées (prismatique, conique, étirée, voir 1.3.1).

Une manière spéciale de produire des briques consiste à les découper dans de la terre à bâtir humide : celle-ci est étendue en couche d'épaisseur régulière, puis découpée selon un quadrillage régulier (1.3.3).

2.2 Techniques mixtes : utilisation de la terre plastique comme matériau de construction non porteur

Les techniques de construction dites mixtes impliquent l'utilisation conjointe de terre et de bois, la fonction porteuse étant assumée par la structure en bois. Nous considérons que, selon la morphologie de la partie en bois d'une structure bâtie, on doit distinguer la technique du pan de bois ou colombage (2.2) et la construction à poteaux et poutres ou à cadre de bois porteur (2.1). La différence tient principalement à la dimension des parties de mur devant être remplies ou fermées. Dans les bâtiments à pan de bois (ou à colombages), la surface du mur est généralement divisée en panneaux de petites dimensions par des pièces de bois horizontales ou obliques. Dans la construction à poteaux et poutres, les panneaux à remplir ne sont pas fractionnés : ils s'intercalent entre les poteaux verticaux que joignent une sablière basse et une sablière haute.

Dans les deux types de construction à structure de bois, des matériaux similaires servent au remplissage, par exemple des barreaux de petits diamètres enrobés de torchis. Quand la terre n'est pas l'élément porteur de la construction, la solution consiste souvent à dresser des poteaux verticaux qui sont combinés avec des planches ou d'autres pièces de bois et de la bauge et recouverts d'un revêtement de torchis.

La technique la mieux connue et la plus couramment employée pour remplir les vides d'une ossature en bois (hourdis) est le torchis sur clayonnage (2.1.1). Le remplissage d'une structure à pans de bois uniquement avec des baguettes verticales ou horizontales est également commun (2.2.2), de même que l'emploi de petits troncs ou de piquets qui occupent complètement l'espace entre les poteaux porteurs et les sablières (2.1.2 ; 2.1.3).

Dans l'architecture traditionnelle à colombages, un procédé particulier de « terre enroulée » peut être appliqué pour remplir les cadres (2.2.3). Dans ce cas-là, on se sert de poteaux verticaux autour desquels on enroule des longues pailles enrobées de torchis.

D'autres matériaux servant habituellement à faire des murs porteurs constituent parfois les hourdis, comme des briques crues (1.3) ou des pains de bauge (voir 2.2.4).

Des variantes existent également au sein de ces techniques mixtes, dépendant des matériaux bruts disponibles et susceptibles d'être utilisés dans un but architectural. En guise de clayonnages on peut trouver des bâtons verticaux, des roseaux (2.1.5) ou d'autres matériaux végétaux, comme par exemple les torches ou tresses enduites de torchis.

Lorsque le bois est abondant, les espaces sont quelquefois remplis avec des lattes, des baguettes ou même des planches (2.1.6). Dans tous ces cas aussi, un mortier de terre forme fréquemment le revêtement final.

Von Lehmbroten, -ziegeln und -zöpfen

Ein viersprachiges Glossar der traditionellen Lehmbautechnik (Wände)

Franziska Knoll, María Pastor Quiles, Claire-Anne de Chazelles und Louise Cooke

Die archäologische Bauforschung an Lehmbauten steht in Europa noch immer an ihrem Anfang. Der Erforschung von mittelalterlichen, neuzeitlichen und modernen Lehmbauten widmete sich beispielsweise das »Terra Europa« Projekt, getragen durch die Europäische Union (Correia et al. 2011). Nichtsdestotrotz ist das Interesse an Architekturfragmenten aus Lehm und Lehmbauten im archäologischen Kontext in den vergangenen Jahren erstarkt. Zahlreiche aktuelle Grabungsberichte und Materialvorlagen setzen sich mit den erhaltenen Lehmresten auseinander – wie die Beispiele im vorliegenden Band eindrucksvoll belegen –, oftmals mit Rückgriff auf Vergleiche aus dem traditionellen Hausbau, der teils über Jahrhunderte unverändert praktiziert wurde. Diesem Milieu sind in der Regel auch die Begriffe zur Beschreibung der archäologischen Befunde entnommen. Je nach Region, Bautradition und Sprache bzw. Dialekt variieren deshalb die Bezeichnungen. Dies veranschaulicht beispielsweise die Namensgebung der im deutschen als »Lehmbatzen« (1.1.2b) bezeichneten Nasslehmtechnik. Je nach Größe und Form werden diese auch als »Walzen«, »Kuchen«, »Brote« oder »Fladen« betitelt, sind aber in der gleichen Technik hergestellt und auch verlegt.

Ziel dieses Glossars ist die Sensibilisierung der europäischen Archäologie für den Lehmbau. Denn nur durch die Kenntnis der verschiedenen Bautechniken kann eine belastbare Interpretation und Rekonstruktion der im archäologischen Befund oftmals spärlichen Reste der Lehmarchitektur gelingen. Dabei muss klar sein, dass die Varianzbreite von Lehmbautechniken – bedingt durch die regionale Verfügbarkeit der Baustoffe und die aus ihrer Beschaffenheit resultierenden Verarbeitungsweisen – enorm ist. Gleichzeitig sollte man sich dessen bewusst sein, dass der weltweite Verlust der ländlichen Erdbau-Tradition seit dem vergangenen Jahrhundert unsere gegenwärtige Klassifizierung und Terminologie stark einschränkt (die ECVET hat hierzu in »Earth Building Units of Learning« Kategorien aufgestellt, die in vielen europäischen Sprachen abrufbar sind). R. Macfarlane (2015) hat dieses Phänomen für das Vokabular in Hinblick auf Landschaftsbezeichnungen beschrieben. Dieses Glossar sollte damit als aktuelle Bestandsaufnahme aus vorwiegend archäologischer Perspektive gelten und erhebt, dessen sind wir uns bewusst, auf ethnografischer oder baudenkmalpflegerischer Ebene keinen Anspruch auf Vollständigkeit.

1. »Benutzerhinweis«

Um eine einfache aber korrekte Ansprache der Funde und die Recherche in weiteren Sprachen zu erleichtern, haben wir zunächst für unsere eigene Forschung Begriffe, Techniken und Beispiele gesammelt.

Das vorliegende Glossar ist der Versuch, die verschiedenen Techniken strukturiert und reich bebildert zu bündeln. Dabei werden, soweit vorhanden, jeweils ein rezenter Bau, die technische Ausführung und der entsprechende archäologische Befund nebeneinandergestellt. So kann die Ansprache des Befundes im Idealfall nicht nur über die Terminologie, sondern objektiv über die Bildbeispiele erfolgen.

Da die Ausführung der Lehmbauten stark regional an das vorhandene Baumaterial gebunden ist, wurden im Laufe der Zeit in verschiedenen Gebieten spezielle Techniken etabliert, die andernorts keine Entsprechung finden. Solche »Sonderfälle« sind, wie auch spezielle Bezeichnungen, in einer eigenen Zeile vermerkt. Gleiches gilt für verschiedene Bauelemente aus Lehm, die nicht nur für Wände, sondern beispielsweise auch für Geschossdecken, Flachdächer oder Böden benutzt werden.

Sollten spezielle Werkzeuge für eine Technik charakteristisch sein, z. B. die Schalung für den Stampflehmbau, wurden diese separat aufgeführt.

Der Darstellung der Lehmbautechniken für Wände (I) folgt eine kleine Sammlung an termini, die im Zusammenhang mit der Bauausführung stehen (II).

2. Ein kurzer Kommentar zur Gliederung der Techniken

Architekten scheiden Lehmbauten zunächst rein nach Lastenverteilung in der Ausführung in Massiv- (1) oder Leichtlehm (2). Die erste Bautechnik sieht die Errichtung der Wände in Gänze aus Baulehm oder verwandten Stoffen vor, auf ihnen ruht die Dachlast. Wird Lehm als Leichtlehm verwendet, spielt er nicht die tragende Rolle, sondern dient einem Holzgerüst als Füllmaterial.

2.1. Massivlehm – tragende Wände

Massive Lehmbauten können in Nasslehmtechnik, also noch in feuchtem, verformbarem Zustand, oder trocken in Mauertechnik ausgeführt werden (vgl. hierzu auch Aurenche et al. 2011, 14–17 bzw. Perello 2015, Abb. 10).

Im nassen Zustand wird Baulehm, ein Gemisch aus anstehendem Lehm und verschiedensten Zusatzstoffen, entweder in Lagen angehäuft (= Lagenlehm, 1.1) oder in eine Schalung eingestampft (= Stampflehm/Pisé, 1.2). Der Lagenlehm kann einfach weiter untergliedert werden, je nach Schichtung der Nasslehmelemente zu einer Wand: Töpferlehm, dabei wird die dünne Wand ähnlich einem Gefäß aus Ton aufgebaut (1.1.1), gepackte Lagen (Batzen, Kugeln, Brote etc., 1.1.2) oder gehäufte Lagen (»Weller«, »Chineh«, »Zabur«; 1.1.4 [Terminologie nach Piesbergen 2007, 26–29]).

In der afrikanischen Bautradition sind verzahnte oder überlappende Lagen charakteristisch (1.1.4b). Wohingegen in einigen Gegenden im Südwesten Frankreichs der Lagenlehm in eine Schalung geschichtet wird, die wohl aus der weitverbreiteten Pisé-Technik übernommen wurde (1.1.4d). Beide Bauformen können den gehäuften Lagen zugerechnet werden.

Eine (bislang) vornehmlich deutsche Variante bilden die sog. »Lehmzöpfe« (1.1.3). Hier wird langes Stroh mit feuchtem Lehm vermengt und gedreht, um dann damit Mauern anzuhäufen.

Für die Stampflehmtechnik wird durchweg erdfeuchtes Substrat verwendet, in der Ausführung gibt es weniger Varianten (1.2). Hier liegt die Variabilität im verwendeten gestampften Material oder den Zwischenlagen zur Steigerung der Festigkeit, die aus Ziegeln, Steinchen oder verschiedenen Mörteln bestehen können. Eine Sonderstellung zwischen Lagen- und Stampflehmtechnik nehmen Mischformen ein. Für einige Regionen in Frankreich beispielsweise ist das Einbringen von nassen Baulehmstücken (verschiedenster Form) in eine hölzerne Schalung, jedoch ohne das finale Feststampfen, typisch (1.1.4d). Eine Verwendung von begrenzenden Holzpaneelen ist auch für andere Nasslehmtechniken denkbar und sollte daher im archäologischen Kontext ebenso bedacht werden.

Eine Variante des Nasslehmbaus ist die Errichtung von Wänden aus Blöcken, die direkt aus dem anstehenden Boden gestochen werden. Hier kommt kein aufbereiteter Baulehm zum Einsatz, stattdessen werden Lehm-/Erdblöcke, Gras- oder Torfsoden im noch feuchten oder bereits trockenen Zustand geschichtet (1.4).

Ebenfalls zu den massiven, tragenden Lehmwänden zählen Lehmziegel/Adobe-Konstruktionen. Unter diesem Überbegriff werden verschiedenste Ziegelformate zusammengefasst, die alle aus Baulehm bestehen, jedoch nicht gebrannt sind und trocken mit (Lehm-)Mörtel vermauert werden. Getrennt werden können die ungebrannten Lehmsteine zunächst nach ihrer Herstellungsweise. Die weltweit größte Verbreitung haben sicherlich die Formziegel (in eine Form gestrichen) erfahren (1.3.2). Älter sind handgeformte Ziegel, die in verschiedensten Formen (Quader, Kegel, Zigarren, etc.) gestaltet sein können (1.3.1).

Wieder eine Sonderform bilden »geschnittene« Lehmziegel. Hier wird die feuchte Baulehmmasse in gleichmäßiger Dicke ausgebreitet und – ähnlich dem Teig von Gebäckstücken – regelmäßig im Gitter durchschnitten bzw. -sägt (1.3.3).

2.2. Leichtlehm – Mischbauweise

Gemeint ist eine Mischung aus Holz- und Lehmkonstruktion. Tragend ist immer das hölzerne Gerüst. Die Form des Gerüsts kann in Fachwerk (2.2) und Rahmenbau (2.1) unterschieden werden. Der Unterschied ergibt sich in erster Linie aus dem Volumen der zu füllenden Wandfläche: Beim Fachwerkbau ist das die »Gefachfüllung«. Ein Gefache ist in der Regel ein kleines, oft quadratisches Feld der Wandoberfläche, das von horizontalen, vertikalen und/oder diagonalen Holzbalken gefasst wird. Der Rahmenbau verzichtet auf eine Unterteilung in kleine Gefache, hier wird die Wandfläche zwischen zwei Eckpfosten und dem Dach- oder Geschossbalken in Gänze gefüllt.

Für beide Holzskelette werden ähnliche Füllungen aus dünnen Holzelementen und Strohlehm verwendet. Verallgemeinert handelt es sich bei allen Leichtlehmvarianten um dünnere vertikale Hölzer (Staken), die mit verschiedensten Holz-Strohlehm-Kombinationen verbunden und verputzt werden.

Am populärsten ist sicherlich das Schließen der Wandfläche mittels Flechtwerk (2.1.1), das final mit Strohlehm verstrichen wird. Auch die Füllung des Holzrahmens nur mit horizontalen oder vertikalen Staken (2.2.2) oder im Rahmenbau mit gitterförmig darüber angebrachten Latten (2.1.2; 2.1.3) ist häufig anzutreffen.

Speziell im historischen Fachwerkbau kommen sog. Lehmwickel oder Wickelstaken als Wandfüllung (2.2.3) zum Einsatz. Hierfür werden die vertikalen Staken mit langem, in Lehm getränktem Stroh umwickelt und schließlich in die Gefache eingesetzt.

Außerdem werden auch Lehmbauteile für massive Lehmwände, beispielsweise Lehmsteine/-ziegel (1.3) oder nasse Lehmbatzen (1.1.2), zur Ausmauerung der Gefache verwendet (s. 2.2.4).

Auch in der Mischbauweise ist, bedingt durch die vor Ort verfügbaren und geeigneten Baustoffe, mit unzähligen Varianten zu rechnen. Anstelle der hölzernen Staken wird z. B. auf Schilfbündel zurückgegriffen, die schließlich mit Strohlehm dick verstrichen werden (2.1.5). Bei ausreichenden Holzressourcen konnte der Holzrahmen auch mit hölzernen Brettern oder eng stehenden dünnen Ästen geschlossen werden (2.1.6). Auch hier dient der Strohlehm final als Verputz und Isolierung.

I Earthen Building Techniques for Walls

	ENGLISH	ESPAÑOL	FRANÇAIS	DEUTSCH
1	**monolithic/massive earth** (load-bearing walls, massive walls)	**tierra maciza** (muros portantes)	**terre massive** (murs porteurs)	**Massivlehm** (tragende Wände)

Umbrella term, including every type of monolithic, load-bearing cob, or earth wall, erected in different techniques by piling or stacking wet earth units to form successive layers. Adobe/mud brick masonry, which is erected with sun-dried clay units, is among the massive earth construction. The difference is that dried adobe/mud bricks need no drying phase during the building process, but mud mortar is used to fix them.

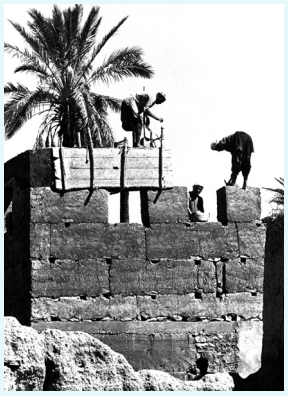
RECENT BUILDING

Remains of a cob wall in Wetzendorf, Saxony-Anhalt (Germany). Most of the cob is eroded and has been repaired with modern construction material. The top is overgrown with plants (photo: F. Knoll 2014).

ARCHAEOLOGICAL FIND

Deserted medieval village at Hohenrode, Saxony-Anhalt (Germany; 12th–14th century AD). Cross section through an eroded massive earthen wall above a stone base (Grimm 1939, Fig. 2.2).

TECHNIQUE – EXECUTION



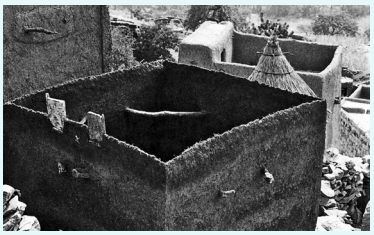
Building a wall with the rammed earth technique by using a mobile wooden frame in Touroug, Drâa-Tafilalt (Morocco; Striedter 1990, Fig. 8).

1.1	**cob**	**amasado**	**bauge**	**Lagenlehm** (ohne Schalung)

Umbrella term that includes all types of stacked earth constructions. The cob or earthen units are commonly laid or packed by hand without formwork.

1.1.1	**shaped earth**	**amasado, tierra modelada, modelado directo, manufactura directa, pared de mano** (Ecuador; Viñuales et al. 2003, 77)	**terre façonnée ou modelée, façonnage direct**	**Töpferlehm, Wulsttechnik**

The »shaped-earth-technique« can still be observed today in some African regions. Due to their apparent thinness, walls constructed by hand may not bear heavy loads. This technique is therefore often used to construct small, low-raised ancillary structures of various floor plans. For an overview on the technique, see e.g. Doat et al. 1979, 95–97. For more information, see Williams-Ellis/Eastwick-Field 1950 (1947); Historic England 2015; SPAB n.d.



Rectangular storage building of the Dogon people in Mali (Lauber 2011, 40). Locally termed »banco«, the thin walls reach a maximum diameter of 10 cm (see pictures in the right column).

Storage basin found at the Neolithic Tell Halula, middle Euphrates Valley (Syria; Molist 1996, 36 Fig. 8).

Left: Construction of a shaped earth wall in Togo, locally termed »banco« (Lauber 2011, 41).
Right: Rectangular storage building with very thin walls, Mali (photo: C.-A. de Chazelles 2008).

1.1.2	**packed or piled earthen units**	**amasado, barro apilado, a partir de unidades**	**bauge, terre empilée** (à partir d'unités)	**gepackter Lagenlehm aus Einheiten**

Depending on their size and shape, the earth or cob units are packed in successive layers. Various terms exist, e.g. small units are often called »cob balls«, whereas for the large irregular pieces the terms »lump« or »loaf« are common. If they are of oblong/cylindrical shape, the terms »roller« or »cob brick« are in use as well.

1.1.2a	**cob balls**	**bolas de barro**	**boules de terre**	**»Lehmkugeln«**

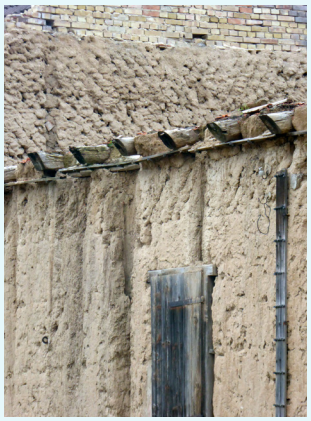
The detail of a wall in the ruins of the Kuaua Pueblo in Bernalillo, New Mexico (USA), shows that the irregular, hand-shaped lumps have been corded before drying (Mileto/Vegas 2018, 181 Fig. 4).

Cob balls with a high amount of long straw found at the El Argar (Early Bronze Age) settlement of Caramoro I, Elche, Alicante (Spain; Pastor Quiles et al. 2018, 87 Fig. 5).

Experimental construction of a wall by packing cob balls (Jallot/Wattez 2015, 11).

1.1.2b	**puddled mud blocks**, (»clay«) **lumps, cob bricks**	**bloques de barro amasado**	**galettes de terre** (A. Klein), **mottes**	**Lehmpatzen** oder **-batzen** (Süddeutschland)

Another archaeological example for piled cob or earth layers was uncovered at the Late Neolithic settlement of La Capoulière, Mauguio, Hérault (France). A wall »de mottes de terre de forme et de taille diverses« has been excavated and the shape of the »mottes de terre« was described as »pains« or »boules« (Gutherz et al. 2011, 343 Fig. 25).



Top: Derelict barn at Langeneichstädt, Saxony-Anhalt (Germany). The gable was erected by placing clay lumps, the walls of the building were erected in »Weller« (tooled cob)-construction (photo: F. Knoll 2017).

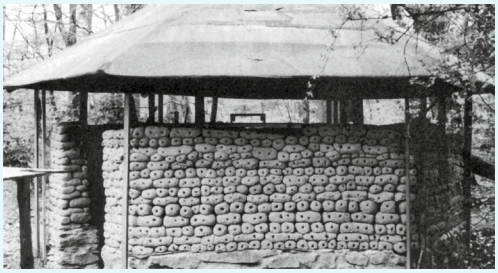
Bottom: Barn with walls made of irregular mud blocks near Rieumes, Haute-Garonne (France; Klein 2003, 433 Fig. 27).

Excavation at the El Argar (Early Bronze Age) site Caramoro I, Elche, Alicante (Spain). Remains of a cob lump wall found *in situ* (Pastor Quiles et al. 2018, 88 Fig. 7b).

Irish Cob Home Building Project Loughcrew, Hills, near Oldcastle, County Meath (Ireland). Erecting a cob wall by piling earth lumps. The surface is smoothed immediately after two layers have been finished.
Clip: <https://www.youtube.com/watch?v=SCnb9qF_0aI> (26.03.2020).

1.1.2c	**puddled mud blocks**, (»clay«) **lumps, cob bricks**	**panes de barro**	**pains, boudins de terre**	**Lehmbrote**

In the Czech Republic, the so-called »valky« (blocks of cylindrical shape) have been used to construct utility and storage buildings (Güntzel 1986, 396–397; Syrová/Syrový 2018, 235–236).



Top: Barn at Slup, Jihomoravský kraj (Czech Republic). The »valky« (cob bricks of cylindrical shape) have been laid in a herringbone pattern (Schäfer 2014, 2; see also Güntzel 1986, 369–370).
Bottom: Modern sheepfold in Dünne, North Rhine-Westphalia (Germany), built with »Dünner Lehmbroten« (»earthen breads« from Dünne, cf. right column; Minke 2017, 86 Fig. 8.3–2; Minke 2001, 91 Fig. 8.3–2).

No archaeological evidence to our knowledge at present.

Erecting a wall with so-called »Dünner Lehmbroten« (»earthen breads« from Dünne, North Rhine-Westphalia [Germany]). This technique was introduced by a German missionary in 1925 based on the example of African »wet clay techniques« (Minke 2017, 86 Fig. 8.3–3; Minke 2001, 90 Fig. 8.3–1; for details see also Schäfer 2014).

1.1.2d	**cut cob** or **cut earth blocks**	**bloques de barro cortados**	**pains de bauge découpés**	**geschnittene Lehmbatzen**

If the flattened and cut earth pieces are used wet they form a piled layer. Using them after drying means to build a brick or adobe wall (see 1.3.3).

The laying technique in the form of a herringbone pattern (*opus spicatum*; Klein 2003, 426 Fig. 16–17) is characteristic for the end of 16th/beginning of 17th century AD in Sariac-Magnoac, Hautes-Pyrénées (France).

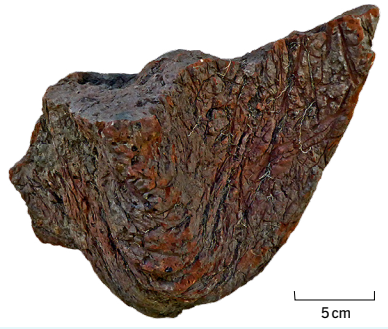
No archaeological evidence to our knowledge at present.

Lattes, Hérault (France), experimental workshop (photos: C.-A. de Chazelles 2009).
Top: The cob mixture was flattened and cut into irregular square pieces.
Bottom: The cut cob pieces are packed transversally to erect the wall.

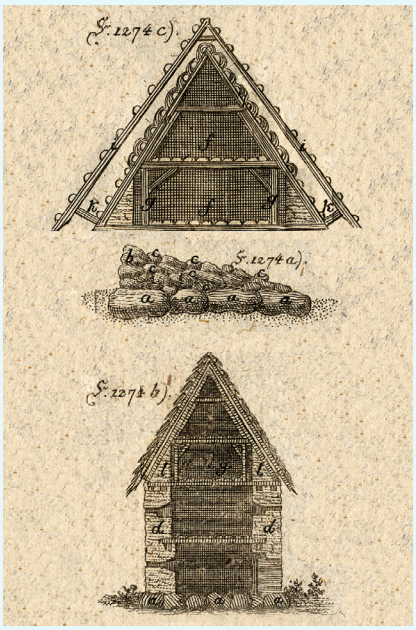
1.1.3	daubed straw knotted plaits	haces de vegetales y barro retorcidos	tortis ou torches de pailles enrobées de terre plastique	Lehmzöpfe, -kauten

Daubed straw knotted plaits consist of long straw, which is mixed with wet mud and plaited into a more or less cylindrical shape with the help of a tridentate fork. The plaits were used for building walls and as fire insulation of wooden roof structures. This technique was first described by D. J. G. Krünitz (1781, 317). A similar technique is known in Mexico for the building of granaries (Houben/Guillaud 1994, 176) using »tamales« (Van Lengen 1991, 186–187).

Top (detail) and bottom: Exterior wall of a dwelling in Angersdorf, near Halle (Saale), Saxony-Anhalt (Germany). The supposed plaits were piled into a wooden frame or against the exterior wall of the neighbouring building, which is now lost (discovered and photographed by M. Klamm, Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt).



Clay fragment found in the deserted medieval village of Stubbach near Steinau an der Straße, Hesse (Germany). The twisted shape of the straw impressions could indicate the use of plaits (photo: F. Knoll; editing: I. Staeves, Gelnhausen).



D. J. G. Krünitz describes how to produce and use »Lehmkauten« (daubed plaits): They have to be piled obliquely and still wet; finally they have to be slightly patted (Krünitz 1781, 323 Pl. 22 Fig. 1274; q. v. Knoll/Klamm 2015, 45–47 [© Univ. Trier]).

1.1.4	stacked cob	amasado, barro amontonado	terre empilée en place	gehäufter Lagenlehm

Contrary to piled cob layers, here the layers of cob are stacked by hand or by using tools like a pitchfork or a shovel. In addition, another technique can be observed: a kind of handmade cob (using no tools), that consists of thin layers made of cob units or continuously shaped earth.

1.1.4a	hand-stacked cob in thin layers	amasado en capas superpuestas	bauge litée	Lagenlehm aus dünnen Lagen (ohne Werkzeuge)

Wall of a medieval (14th century AD) building at Béziers, Hérault (France; photo: C.-A. de Chazelles 2005). The cob layers are separated by bands of heather (*Calluna vulgaris*, *Erica vulgaris*). This cob technique still exists today in Brittany, Belgium, and south-west France.

Top: »Bauge litée« at Saint-Pierre-les-Martigues, Bouches du Rhône (France), 5th century BC (Chausserie-Laprée/ de Chazelles 2003, 306 Fig. 11).

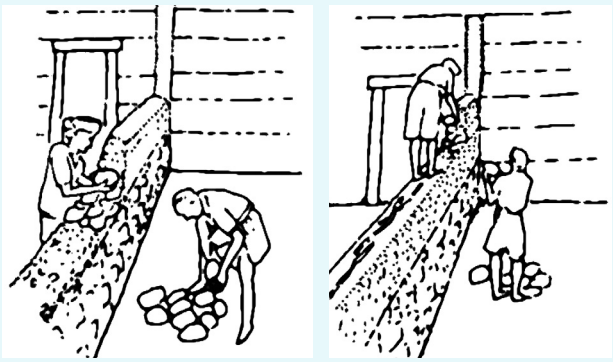
Bottom: Thin stacked cob layers were observed during the excavations in Lattes, Hérault (France), 5th BC (Roux 2003, 267 Fig. 8; see also Roux 2008, 109 Fig. 78.1–2). The technique is also evident in medieval contexts.

Lattes, Hérault (France): experimental workshop. Building of a wall using thin cob layers (lower part) and cob lumps (upper part; photo: C.-A. de Chazelles 2010).

1.1.4b	**hand-stacked cob units**	**amasado en unidades modeladas**	**bauge, bauge massive**	**Lagenlehm aus handgeformten Einheiten**

Tower building in the north of Yemen. The traditional earthen building technique is »zabur«; the layers are stacked similarly to the »chineh«-technique in Iran. Characteristic are the raised edges of the exterior walls to reinforce the »masonry« (Wright 1983, 131).

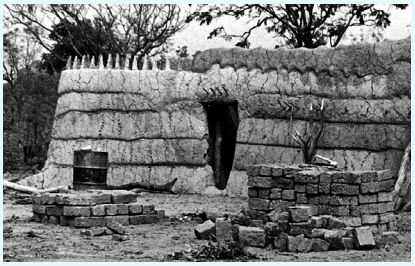
No archaeological evidence to our knowledge at present.



Schematic depiction of the erection of a »zabur«-wall in Yemen. Single earth lumps are rolled in the dust and stacked by hand. When the wall is finished, the individual units can no longer be distinguished (Wright 1985, Fig. 297).

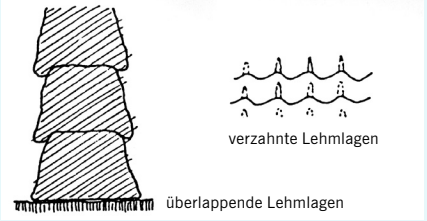
	overlapping (»toothed«) cob layers	**amasado en capas solapadas**	**terre empilée à assises emboîtées**	**überlappende** und **verzahnte Lagen**

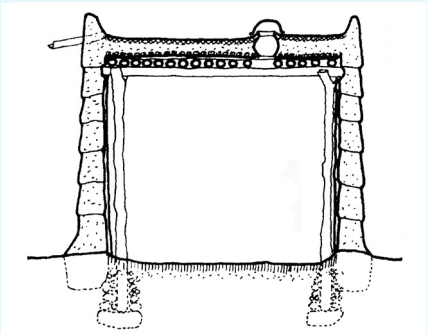
This building technique can be described as a mixture between piled and stacked cob layers. Single layers are interwoven or overlap the next layer to enhance the stability of the wall (see Fiedermutz-Laun 1983, 154 or Kéré 1995, 13 Fig. 3). The way the cob units are placed equates to the »zabur«-technique in Yemen.



Top: »Earthen castle« of the Lobi people in Burkina Faso. The single layers of the cob wall are notched. The peaked »teeth« are visible at the top of the building on the left side (Fiedermutz-Laun 1990, Fig 6).
Bottom: Remains of a royal palace of the Dahomey in Abomey, Zou Department (Benin), 17th/18th century AD, built in a similar technique (Randsborg/Merkyte 2013, 33 Fig. 4).

Foundation walls of a mosque (rotund wall) revealed during an excavation in Kasana, Upper West Region (Ghana; Randsborg/Merkyte 2013, 73 Fig. 32).





Top: Restoration of the royal palaces at Abomey, Zou Department (Benin). Cob is stacked in layers and consolidated by hand (photo: T. Joffroy © CRA-terre/Ensag, <http://whc.unesco.org/en/documents/129350> [26.03.2020]).
Centre: Schematic drawing of cob layers (Piesbergen 2007, 26 Fig. 5).
Bottom: Cross section of a building with overlapping layers in west Ghana (Minke 2017, 84 Fig. 8.2–4).

1.1.4c	**pitched-fork cob, tooled cob**	**amasado** (lanzado con herramienta)	**bauge, bauge massive, bauge à la fourche**	**Wellerlehm**

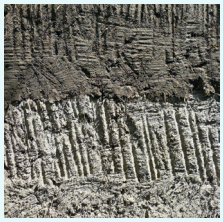
Top: Barn built around 1900 AD in Albersroda, Saxony-Anhalt (Germany). The single cob or »Weller«-layers were piled in opposite direction to increase the stability. This is why the wall surface appears to have an oversized herringbone pattern (photo: F. Knoll 2015).
Bottom: Remains of a »chineh«-wall in Meybod, Yazd Province (Iran). The cross section shows single cob units which were used to stack layers (photo: F. Knoll 2017).

Top: Roman wall built with cob on a high base, Aix-en-Provence, Bouches-du-Rhône (France; de Chazelles 2014, 212).
Centre: Detail of the material (de Chazelles 2014, 212).
Bottom: Excavated cob or placed earth wall, Abu Dhabi (photo: L. Cooke).

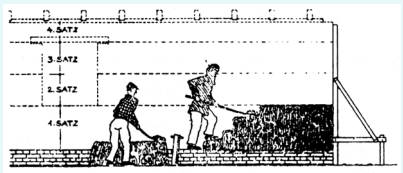
Top: Construction of a »Weller« (pitched-fork cob)-building in the 1920s in Eisleben, Saxony-Anhalt (Germany). The first »Satz« (layer of c. 1 m height) is stacked atop the stone foundation using pitchforks (Köster 1921, 40 Fig. 1).
Centre: »Chineh«-wall repair for conservation work, Uzbekistan (Cooke 2010, 62 Fig. 17).
Bottom: Two workers completing the third layer of a »chineh«-wall in Iran. They use a shovel to stack the cob units (Khalili 1986, 100 Fig. 3.22).

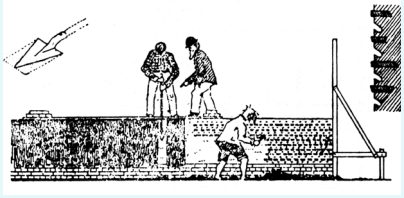
tools	**pitched fork; plain spade for trimming the walls**	**horca; laya, pala plana**	**fourche, paroir, bêche** (pour couper les murs)**; trique, bâton** (pour battre le mur humide)	**Mist-/Dunggabel** (Forke)**; flacher Spaten** (zum Abstechen der Mauern)

Exterior of a recent building in Manche (France). The facing of the cob wall was beaten with a »trique« (bludgeon) in order to limit cracking. The traces are called »triquage« (photo: C.-A. de Chazelles 2008).



Not an archaeological find, but an example of experimental archaeology: Lattes, Hérault (France).
Top: When the cob wall is still wet, it is first cut with a spade (»bêche«).
Detail: Then, a »bâton« (a kind of club) is used to beat the still wet surface. The strikes serve to »shrink« the cob (photos: C.-A. de Chazelles).





Top: Stacking cob on top of a »Weller«-wall by using a pitched fork (Niemeyer 1982, Pl. VIII.2).
Bottom: Trimming the finished layer of a »Weller«-wall by using an ordinary spade (Niemeyer 1982, Pl. VII.3).

1.1.4d	**cob built with forms, formwork cob**	**amasado de barro en cajón de madera, barro vertido** (Mexico; Guerrero/Boto de Matos 2013)	**bauge coffrée**	**Lagen-/Wellerlehm in Schalung**

The technique of »bauge coffrée« is found especially in the south-west of France and is still practised today, though rather rarely (Aurenche et al. 2011, 23; Klein 2003, 125–128). The archaeological evidence is scarce; the hypothesis for cob in a formwork is suggested by features of slight compaction observed by micromorphologists, especially near the faces of the walls (Roux/Cammas 2010, 278).

Farm at En Vidalot, Beaumont-de-Lomagne, Tarn-et-Garonne (France; 17th century AD), inner side of the wall. The imprints of the wooden formwork are still visible, as well as the single cob units used to erect the wall (Klein 2003, 422 Fig. 7).

Observations regarding this technique were made by C. Cammas in Lattes, Hérault (France): the regular shape of a cob wall indicated the use of a formwork.

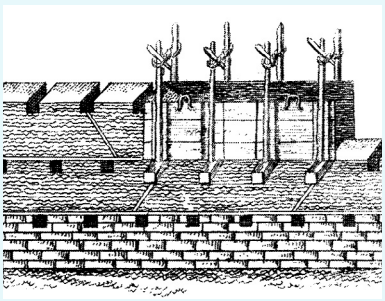
Lattes, Hérault (France), experimental workshop. Constructing a wall by packing cob layers into the wooden frame, separated by branches of heather (photos: C.-A. de Chazelles 2010).
Report of constructing a wall in »bauge coffrée« technique (Atelier alp 2013); watch the video clip: <https://www.youtube.com/watch?v=AgVueTeWLFQ> (26.03.2020).

1.2	**rammed earth** (compacted earth within formwork)	**tapial, tapia, paredes monolíticas** (Viñuales et al. 2003, 13)**, tierra apisonada**	**pisé, terre banchée, terre damée**	**Stampflehm**

Rammed earth construction makes use of moderately moist earth (with less than 10 % humidity) as otherwise it is not possible to compact the earth. Found in archaeological contexts in central and south Europe, in provincial Roman excavations (mentioned by several Roman authors [see de Chazelles 2016, 11–13]), as well as in northern Africa. Good impressions of entire Roman pisé buildings convey the reconstructed dwellings at Xanten (Colonia Ulpia Traiana), North Rhine-Westphalia (Germany): <http://www.apx.lvr.de/de/lvr_archaeologischer_park/rekonstruktionsbauten/roemische_wohnhaeuser/roemische_wohnhaeuser.html> (26.03.2020).

Top: Pisé wall of a ruinous building at Horticuela, Valencia (Spain; photo: M. Pastor Quiles 2015).
Left: Pisé-built dwelling at Steigra, Saxony-Anhalt (Germany). In this region, the single rammed layers are divided by roof tile fragments (photo: F. Knoll 2015).

Top: Remains of a Roman wall in Ampurias, Girona (Spain; photo: M. Pastor Quiles 2014).
Bottom: Part of the Alcázar of Pedro I, Carmona, Sevilla (Spain), erected in the 13th century AD (photo: F. Knoll 2017).



The pisé technique needs a wooden framework. This schematic drawing shows the construction of the second rammed earth layer with the aid of a small formwork, which has to be shifted several times. The putlog holes of the formwork remain inside the wall and can be filled with cob or brick fragments (Cointeraux 1803, Pl. 10.1).

tools	(wooden) **frame, mould, formwork; rammer; wooden crosspieces** (to bear the frame)	**cajón** (de madera)**, encofrado u horma; con pisón para apisonado manual; agujas** (para soportar el cajón)	**banche** (panneau de coffrage)**; pisoir, pison** ou **pisou** (pour compacter la terre)**; clés** (pour supporter les banches)	(hölzerne) **Verschalung; Stampfer** (hölzernes Werkzeug zum manuellen Verdichten)

Two construction workers in central Germany around 1920. To compact the earth, it is rammed into the wooden formwork with a wooden tool (Engelhardt 1919, 30 Fig. 13).

Rirha, Sidi Slimane Province (Morocco), Roman pisé wall on a stone base, 2nd century AD. The holes correspond to the wooden crosspieces (Roux/Cammas 2016, 113 Fig. 66).

Top: Formwork and »pisoir« at Lattes, Hérault (France), experimental workshop (photo: C.-A. de Chazelles 2008).
Bottom: Assemblage of an old wooden formwork. This mould was used for building construction in the region Midi-Pyrénées (France) until 1920 (Klein 2007, 163 Fig. 14).

1.3	**mud bricks, clay lumps, adobe**	**adobe**	**brique crue**	**Lehmziegel** (ungebrannt)**, Lehmsteine, Grünlinge, Lehmquader** (großes Format)**, Lehmpatzen** (selten für Lehmsteine mit Fasern)

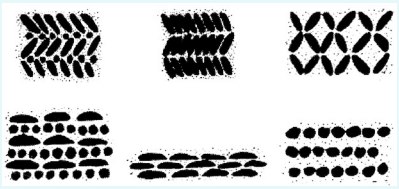
Mixed earth shaped by hand or cast into a wooden framework and left in the sun to dry. Adobe is used to build masonry. Mortar is needed to bind the adobes. For a brief overview on the development of adobe architecture from Mesopotamia to the Mediterranean, from the pre-ceramic Neolithic period (PPNB) to the Roman period, see de Chazelles 2011. For the origins of adobe masonry in the Near East see Sauvage 2009. For different types of adobe architecture in the ancient Near East see Hrouda 1983. See also Houben/Guillaud 1994.

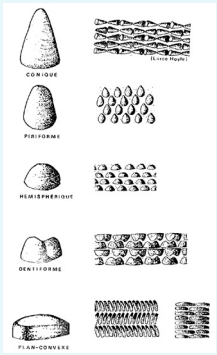
Adobe masonry basement of a recent dwelling in Kastaneri, Central Macedonia (Greece). The upper floor is built in half-timber with brick infill (photo: S. Mecca; Correia et al. 2011, 12).

Detail of an eroded adobe wall in the Achaemenid town of Persepolis, Shiraz (Iran). The visible adobe bricks measure c. 40 cm in length and are located east of the platform at the slope, where once the so-called »garrison quarters« were situated (photo: F. Knoll 2017; cf. Koch 2001, 74; 77 [map]).

Conventional production of adobe in a wooden two-piece mould in Yemen (Darles et al. 2011, 132 Fig. 23).

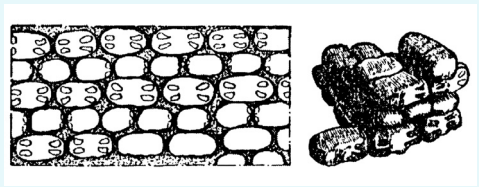
1.3.1	hand-shaped mud bricks, clay lumps, adobe	adobe modelado a mano	brique crue modelée	handgeformte Lehmziegel





Top: Masonry arrangement of different adobe shapes, West Africa (Haselberger 1964, 61 Fig. 21).

Left: Different types of hand-shaped adobe, classified by shape (Doat et al. 1979, 107).

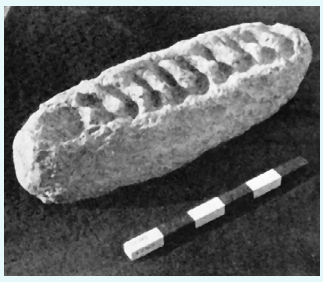


Top: Masonry pattern of hand-moulded adobe at the tell settlement of Tepe Sialk II, Esfahan (Iran), first half of the 5th millennium BC (Piesbergen 2007, 196).
Left: Hand-shaped adobe from the Neolithic Tal-i-Iblis, Kerman (Iran; Aurenche 1981, 61 Fig. 14).

Production of hand-shaped adobe at Figuig, Figuig Province (Morocco; Gentilleau 2011, 411 Fig. 9).

1.3.1a	cigar-shaped	en forma de cigarro	en forme de cigare	zigarrenförmig

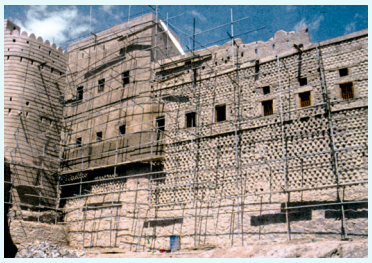
Wall built with hand-shaped, oblong adobe laid in herringbone pattern, Dogon people, Mali (Guillaud 2011, 44 Fig. 6).



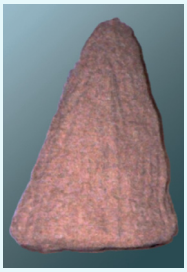
Left: Hand-shaped adobe from the pre-ceramic Neolithic (PPNB) settlement at Jericho, West Bank (Palestinian territories; Aurenche 1981, 61).
Right: Similar cigar-shaped adobe, dating to the so-called »Formative Period« (2150–1000 BC), Museum of Cerro Sechín, Ancash Region (Peru; Guillaud 2011, 43 Fig. 4).

Production of hand-shaped »curved« adobe, Dogon people, Mali (Lauber 2011, 41).

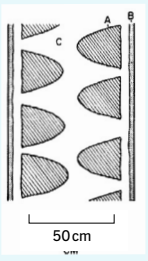
1.3.1b	conic	cónico	conique	konisch (Kegel)

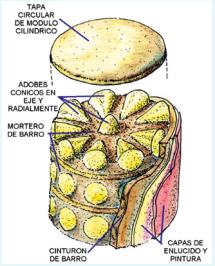


Ancient citadel at Bahla, Ad Dakhiliyah (Sultanate of Oman), during restoration works in 1995. The conical shaped adobe bricks, used for the right part of the building, were replaced by modern ones, which were created using a bucket as mould (Guillaud 2011, 47 Fig. 11).



Top: Hand-shaped conical adobe from the 2nd millennium BC, excavated at Huaca Lucía, Lambayeque (Peru; Chirinos/Zárate 2011, 65).
Left: Conical adobe of the same date, discovered at Cerro Sechín, Ancash Region (Peru; Guillaud 2011, 42 Fig. 3).



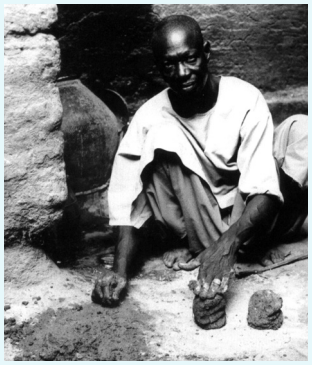


Top left: Production of so-called »tubali«, hand-shaped adobe of conical shape, northern Nigeria (Guillaud 2011, 45 Fig. 7).
Top right and bottom: Masonry techniques for the construction of walls and round pillars with conical adobe and earth mortar. Observed at Huaca Lucía, Lambayeque (Peru; Chirinos/Zárate 2011, 65).

1.3.1c	cylindric	cilíndrico	cylindrique	zylindrisch

Relicts of a plastered wall erected with cylindrical adobe at Djenné-Djenno, Mopti Region (Mali). A more recent wall consisting of rectangular adobe bricks can be seen in the background (photo: R. Risch, Univ. Autònoma de Barcelona).

Top (detail) and bottom: Rectilinear building in ancient Djenné, Mopti Region (Mali; 11th–14th century AD). Only the foundation walls are preserved. The detail (top) shows one wall seen from above. At least 4–5 rows of cylindrical adobe bricks form a wall with a width of about 40 cm (photos: R. Risch, Univ. Autònoma de Barcelona). In Mali this masonry technique emerged during the 8th/9th century AD and was very common until the 14th century, when ancient Djenné was abandoned (McIntosh 1995, 64–65).



Bere Yono, »maître-maçon« in Djenné, Mopti Region (Mali), fabricates the traditional cylindrical adobe, so-called »djenné-ferey« (photo: R. van Wendel de Joode 1989; Bedaux et al. 2003, 21).

1.3.1d	parallelepiped, rhomboid	paralelepípedo, romboidal	parallélépipédique, rhomboïdale	rhombenförmig

Gadachrili Gora, Kvemo Kartli (Georgia; 6th millennium BC). Bâtiment GAD3: circular, with a hearth inside, possible house built with flat parallelepiped bricks, on three courses laid with a yellow mortar (Baudouin et al. 2018, 59 Fig. 10; cf. Hamon et al. 2016).

1.3.2	**moulded mud bricks** (in moulds)	adobe hecho a molde	brique moulée	**Formziegel** (mit Holzmodel)

Dwelling (probably from the beginning of the 20th century) made of oversized adobe in Selben, Saxony (Germany; photo: F. Knoll 2017).

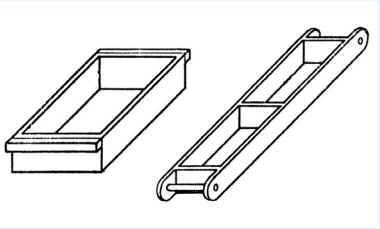
Left: Temple of Horus on Thoth Hill, Thebes, Upper Egypt (Egypt), 11th dynasty (2150–1990 BC; photo: M. Pastor Quiles 2009).
Right: Wall constructed of adobe (dark brown) and earthen mortar (light brown), excavated in Huaca del Oro, Lambayeque (Peru), c. 1000 AD (Chirinos/Zárate 2011, 90).

Serial production of adobe with large wooden moulds in New Mexico (United States of America; Oliver 2003, 248).

tools	moulds (wood, metal)	adobera, gradilla, molde, abancal, mecal, gavera (de madera o metal)	moules (de bois ou métal)	Formrahmen (Holz, Metall)

Left and Right: Traditional single and double moulds for mudbricks, Sardinia (photos: C.-A. de Chazelles 2009).

No archaeological evidence to our knowledge at present.

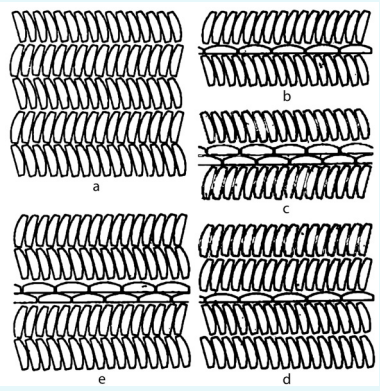


Single and double moulds for the production of adobe in Germany after World War II (Niemeyer 1982, Pl. V).

1.3.2a	plano-convex	plano-convexo	plano-convexe	plankonvex

Plano-convex adobe in Timbuktu, Tombouctou Region (Mali; photo: J. Dorsey, Mali Mud Bricks of Timbuktu, <http://www.africavernaculararchitecture.com/mali/> [26.03.2020]).

Top: Aruchlo, Kvemo Kartli (Georgia), Early Neolithic tell settlement from the 6th millennium BC. Adobe was used to build circular constructions (Hansen/Ullrich 2017, 218 Fig. 38).
Bottom: The burnt adobe shows an imprint of the rectangular mould. The average size measures 32 x 17 x 10 cm (Ioseliani 2017, 282 Fig. 2).



Different masonry techniques of plano-convex adobe, documented in Khafaje, Diyala (Iraq), c. 3200–2800 BC (Lloyd 1963, Fig. 11).

1.3.2b	rectangular	rectangular	rectangulaire	rechteckig

Residential house built in adobe masonry and decorated with stucco. Bad Kösen, Saxony-Anhalt (Germany; photo: M. Klamm 2012; see Knoll/Klamm 2015, 57).

Top: Adobe wall, Iron Age settlement in Martigues, Bouches-du-Rhône (France; 4th century BC; Roux/Chausserie-Laprée 2011, 225 Fig. 21).

Left: Adobe fragments from the Minoan Villa of Makrygialos, Ierapetra (Greece; photo: F. Knoll 2017).

Lattes, Hérault (France), experimental workshop. Fabrication of adobe with a single, rectangular mould (photo: C.-A. de Chazelles 2011).

1.3.2c	square	cuadrado	carrée	quadratisch

Decayed farmstead at Houbeh-Anbar, Esfahan (Iran; photo: F. Knoll 2017).

The defensive wall around the ancient town of Gela, Sicily (Italy), was erected during the second half of the 4th century BC. For the main part of the wall, square adobe (45 cm edge length) were used above an enormous limestone foundation (Pavini 2008, 95 Fig. 18; for adobe measurements see Di Stefano 2008, 83).

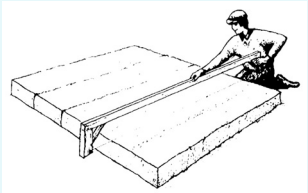
Top: Adobe production in Mexico. Mixed earth is poured into square-shaped wooded moulds (Khalili 1986, 83 Fig. 3.8).

Bottom: Very large square adobe for conservation repair, Turkmenistan (photo: L. Cooke).

1.3.3	cut mud bricks	adobe cortado	brique (de)coupée	geschnittene Ziegel

Detail of a wall built with cut adobe and covered with lime plaster, Cyprus (photo: C.-A. de Chazelles 2001).

Unburnt adobe masonry, excavated at the Neolithic settlement of Khirokitia, Larnaca District (Cyprus; Daune-Le Brun 2003, 156 Fig. 11).



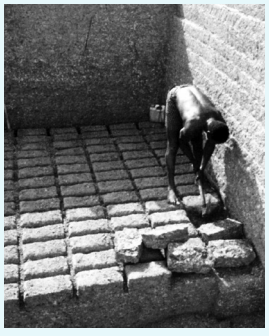
Top: Experimental production of Neolithic adobe in Cyprus. Although of irregular sizes, the bricks have sharp edges and show imprints of grass on the reverse. This led archaeologists to the interpretation of cut adobe, as is shown in the photo (Daune-Le Brun 2003, 156 Fig. 9).
Bottom: Cutting modern adobe in Arizona (United States of America; Doat et al. 1979, 120).

1.4	blocks cut from soil	bloques cortados directamente del suelo	blocs de terre découpés	Blöcke, direkt aus dem Boden entnommen

1.4.1	cut from a layer of mud, cut blocks	**terrón, tapetates** (Mexico), **cangahua, tepe** (Viñuales et al. 2003)	mottes/blocs découpés en carrière, mottes fraîches	Erd-/Lehmblock (abgestochen)

The simplest method to extract earthen blocks as building material by cutting them from soil is generally poorly testified in recent construction work. The quarrying of lateritic earth in Africa may serve as an example. Laterite (from the Latin word »later« = tile, because of its red colour) is formed in tropical regions. Due to high precipitation and temperature, iron as well as aluminium hydroxides and oxides accumulate, which leads to a development of this type of mineral or mineral earth. At the ancient complex of Angkor Wat, Siem Reap Province (Cambodia), laterite was used as building material. Laterite is, however, still in use today, e. g. in India. See cf. Houben/Guillaud 1994.

Angkor Wat, Siem Reap Province (Cambodia), laterite at the temple of Baphuon (photo: R. L. Pendleton, American Geographical Society Library Digital Photo Archive, <https://collections.lib.uwm.edu/digital/collection/ags-photo/id/11117/rec/9> [26.03.2020]).

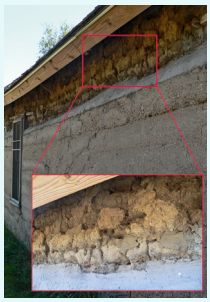


Laterite quarry in Burkina Faso. The highly weathered soil or minerals below are used in blocks as building material (Guillaud 2003, 197 Fig. 9).

1.4.2	sod	terrón con césped, césped, panes de hierba, tepe, tepa, cespedón, cespellón, chamba, champa (Viñuales et al. 2003, 75), tapín (Asturias, Spain)	mottes de terre, mottes de gazon, mottes engazonnées	(Gras-)Soden

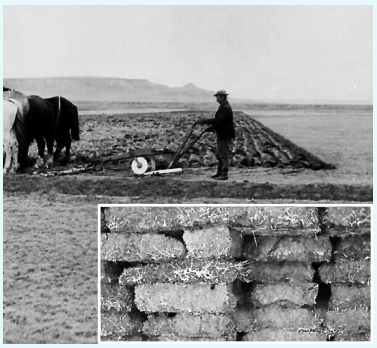
A sod is the grass with the soil (e.g. thicker, with more of the topsoil). Sod and turf are sometimes regarded as synonymous to name a cut block of soil with grass or a cut block of peat. Both are used to build in the same way.

Top: Round houses built of sod (»putucu«), Chipaya people, Andean highlands (Bolivia; Calla García 2007, Fig. 9).



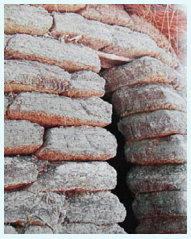
Bottom: Dowse Sod House in Custer County, Nebraska (United States of America). When the Great Plains were settled after the Homestead Act of 1862, sod construction rapidly became established as a quick and cheap building technique. Because of their dense root texture, especially buffalo grass (*Bouteloua dactyloides*) and slough grass (*Spartina pectinata*) were used (cf. Kampinen 2008; photo: Ammodramus, Dowse Sod House, own work, public domain, <https://commons.wikimedia.org/w/index.php?curid=11782231> [26.03.2020]).

Archaeological evidence: excavation results from West Heslerton Anglo-Saxon »Grubenhäuser« (Tipper 2004).



Top: Extraction of sods using a »grasshopper«-plough in the Great Plains (United States of America).

Bottom left: Traditional extraction of sod in South America (Castilla 2004, 2; see also Viñuales et al. 2003, 87).



Bottom right: Detail of a sod wall. The patches of sod were piled with the vegetated top facing downwards (Kampinen 2008, 52 Fig. 9; 55 Fig. 10).

1.4.3	cut peat, turf	bloques de turba	mottes ou blocs de tourbe	Torfsoden (gestochen)

Turf is the grass with the shallow soil and root mat (e.g. thinner, comprises the grass and root mat). Whereas peat is a fossil organic material that does not contain any grass. It is mostly cut for fuel, but in many cases cut for building purposes. Video clip: peat cutting in Holstein, northern Germany. Published by the Institut für den wissenschaftlichen Film (IWF) in 1970 (IWF, Torfstechen in Holstein, W 865, 1970, <https://doi.org/10.3203/IWF/W-865#t=28:51,28:57> [17.12.2018]). See also Historic Environment Scotland n.d.; Walker/McGregor 1996; Walker 2006.

Top: Turf house with gabled roof in Glaumbær, Skagafjörður (Iceland). Together with 13 others, this earth sheltered farmhouse was granted World Heritage Status in 2011 (photo: TommyBee, Turf roof of Glaumbær, Iceland, own work, public domain, <https://commons.wikimedia.org/wiki/File:Glaumbaer9.JPG#/media/File:Glaumbaer9.JPG> [26.03.2020]).

Bottom: Detail of a turf wall in Glaumbær. The pieces of turf are traditionally layed up in a herringbone pattern (photo: LeCardinal, Peat wall, Glaumbær, Iceland, own work, CC-BY-sa-3.0, <https://commons.wikimedia.org/wiki/File:LC_PeatWall.JPG#/media/File:LC_PeatWall.JPG> [26.03.2020]).

Vestervig, North Jutland (Denmark), house 11. The walls built of turves stand out dark against the plain surface of the excavation. Their margin is marked by the surrounding pebble-paved pathways. This settlement was occupied several times from the 1st to the 5th century AD – throughout all construction phases houses were built with sod material (Vebæk 1988, 30 Fig. 5; for more details see Kaul 1999).

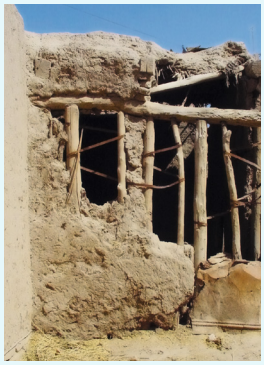
Cutting and piling peat for fuel use in Westhay, Somerset (United Kingdom), around 1900 AD (photo: A. E. Hasse, Peat stacks and cutting, public domain, <https://commons.wikimedia.org/wiki/File:Peat_stacks_and_cutting.JPG#/media/File:Peat_stacks_and_cutting.JPG> [26.03.2020]).

2	**mixed building technique** (mud as filling, non-load bearing)	**técnica mixta** (barro como relleno, no portante)	**techniques mixtes** (terre de garnissage, remplissage, terre non porteuse)	**Mischbauweise, Leichtlehm** (Baulehm als Füllung, nicht tragend)

Contrary to massive earthen buildings, mixed building structures are fitted with a wooden frame which bears the load of the roof and the upper floors. Cob, adobe, earth, and straw in combination with wooden scaffolds or sticks/stakes are used as infill of the wall areas.

2.1	**timber framing, post-and-beam construction, load-bearing wooden frame**	**esqueleto** o **estructura de madera**	**ossature en bois**	**Skelettbau-/Rahmenbauweise, Holzständerbau**

Instead of the walls being structured into several small panels, they are filled en bloc. The materials and techniques used correspond largely to those used for panel infills of younger half-timber frame constructions (see 2.1.1–2.1.4). Hardened fragments of mud plaster that once covered wooden wattle are doubtless the dominant archaeological evidence for this construction technique in prehistoric central Europe.



Left: Reconstructed Iron Age dwelling at the Federseemuseum Bad Buchau, Baden-Württemberg (Germany). Almost every archaeological architectural feature in Germany belongs to the »post construction« type (photo: M. Landolt, Ministère de la Culture France, 2011).
Right: Timber frame with earth infill, abandoned »sintch« building, Khiva, Xorazm Region (Uzbekistan; Cooke 2010, 64 Fig. 39).

Wooden remains of a round house of the Late Bronze Age, Must Farm, Peterborough, Cambridgeshire (United Kingdom; photo: <http://www.mustfarm.com> [19.12.2018]).

Experimental building of a structure with narrow base trenches for the posts (Gheorghiu 2013, 448 Fig. 1).

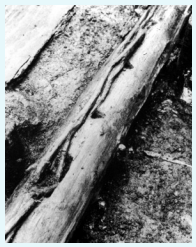
Ways to fill the spaces of the wooden frame

2.1.1	**hurdle, wattle covered with mud, wattle and daub**	**estructura mixta, encestado, bahareque, mantedo** (Sánchez García, 1999), **quincha, embarrado, estaqueo, pared francesa, estanteo** (Viñuales et al. 2003, 37), **vegetales entrelazados**	**clayonnage et torchis**	**Flechtwerk** (verschiedene Materialien) **mit Lehmputz**

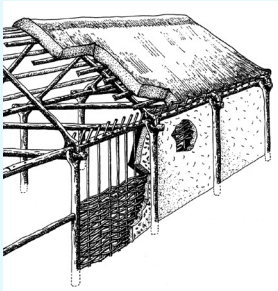
In South America, multiple terms exist for wattle and daub constructions. See Viñuales et al. 2003.

Top: Reconstruction of a structure with upright posts and wattle and daub walls in Stonehenge, Wiltshire (United Kingdom; photo: M. Pastor Quiles 2016).

Bottom: Wattle and daub wall in the Open Air Museum of Szentendre, Pest megye (Hungary; Vegas et al. 2011, 65).



Top left: Horizontal beam from c.1100 AD showing holes for vertical rods and wattle fragments. Trondheim, Trøndelag (Norway; Zimmermann 1998, 105 Fig. 66; 123).
Top right: A Neolithic wattle wall preserved in a humid environment, Lac de Chalain, Jura (France; Pétrequin et al. 1991, 46).
Bottom: Fragments of daub with imprints of a wattle panel with vertical sticks, Wennungen, Saxony-Anhalt (Germany; Knoll 2018, 47 Fig. 26).



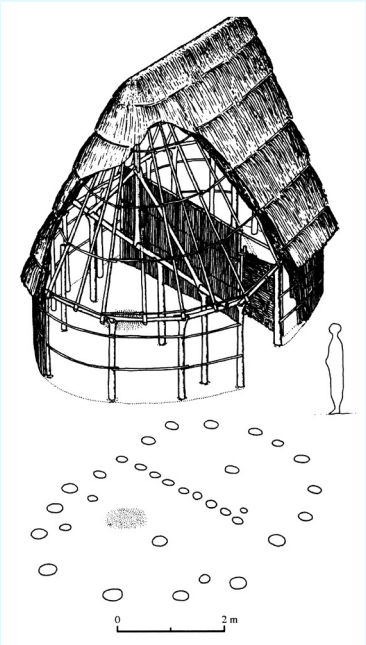
Graphic reconstruction of a building of the 19th century, constructed with posts and wattle and daub walls, Gullev, Viborg (Denmark; Zimmermann 1998, 38 Fig. 18).

2.1.2	**vertical rods, sticks, stakes, planks, posts**	**postes, varas, maderos verticales**	**poteaux verticaux**	**senkrechte Stakung**

Fragments of earthen plaster from an Early Iron Age settlement at Ragewitz, Leipzig district, Saxony (Germany), show impressions of parallel, thin round wooden elements (diameter: 8–10 cm; see Balfanz et al. 2019).

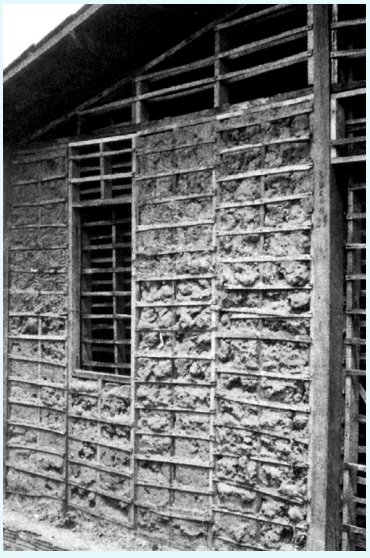
Top: United Republic of Tanzania. Thin wooden sticks are set into a foundation ditch in order to erect the walls (photo: F. Letterlé, Ministère de la Culture France, 2009). **Bottom:** Wall of a house in Yucatán (Mexico), built of vertical sticks covered with mud (Oliver 2003, 110).

Toppled and burnt wall structure from the Late Neolithic house 4 at Zagrebnice, Kakanj (Bosnia and Herzegovina; orthophoto; length c. 5 m). The hardened daub fragments have perfectly preserved the imprints of the wood construction, which was made of vertical rods or stakes each measuring c. 5–10 cm in diameter (Müller-Scheeßel/Hofmann 2013, 152 Fig. 12).



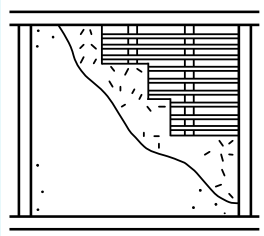
Graphic reconstruction of a Late Neolithic hut from Maccarese, Rome (Italy). As there were no fragments with imprints of daub, the building was reconstructed according to a local technique using wooden posts (Manfredini 2005, 469 Fig. 4).

2.1.3	**laths, battens; earth infill between two lath screens**	**travesaño, entramado** (Viñuales et al. 2003), **listones o varas horizontals, latas**	**lattes, lattis, barreaux, claies**	**Lattung** (horizontal)



Straw and mud (slipstraw) wall infill between two lath screens in Brasil (Minke 2017, 93 Fig. 49.4–2).

Building 4 at Joya de Cerén, La Libertad (El Salvador). The site was affected by a volcanic eruption in c. 600 AD. As a result, the settlement along with the walls of the structures, which were primarily built in »bahareque«, were well preserved (Shibata et al. 2012, 898 Fig. 6).



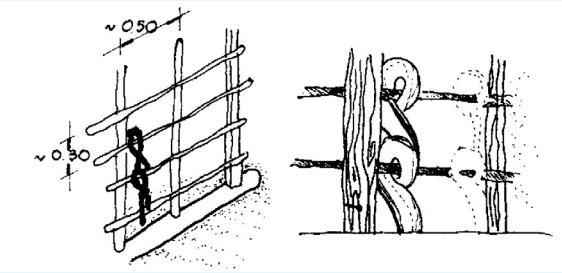
Wooden laths beneath earthen plaster (Volhard 2016, 35 Fig. 33f).

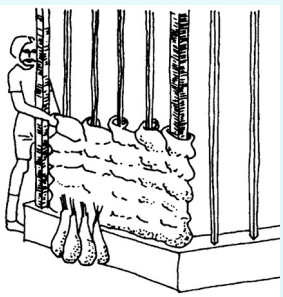
2.1.4	**clay lump infill, bottle-shaped bales of straw covered in clay**	**botella de barro, enchorizado** (Argentina)**, llunchi** (Ecuador; Viñuales et al. 2003, 76)**, relleno »a horcajadas«** (Proterra 2003, Fig. 37)	**bouteilles de terre, bourrage de terre et pailles**	**Lehmflaschen**

»Lehmflaschen« are described and recommended as timber frame filling in post-war German literature, but photos or drawings are non-existent (Niemeyer 1944, 76; Niemeyer 1982, 103; Minke 2001, 102; Minke 2017, 93). This technique is also widely spread in Latin American countries (Viñuales et al. 2003, 82; see also Urquijo 1969).

Top and bottom: Building with »enchorizado« in Valparaíso (Chile; photos: <http://phiesentierra.blogspot.de/2012/04/tecnicas-en-pared-con-tierra-cruda.html> [26.03.2020]).

No archaeological evidence to our knowledge at present.



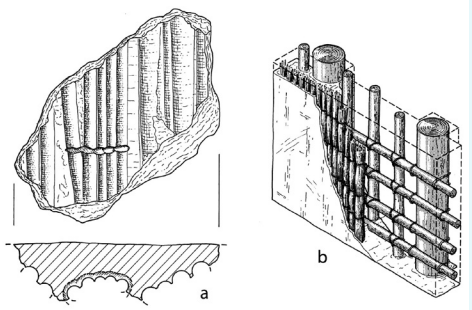


Production and arrangement of »Lehmflaschen« in a wall (top: Viñuales et al. 2003, 82; bottom: Minke 2017, 93 Fig. 9.5–3).

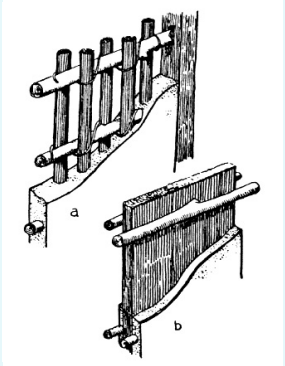
2.1.5	**reed/cane bundle or panel**	**haces o paneles de carrizo/cañas, cañizo**	**cannes, canisses, panneaux de roseaux, roseaux liés**	**Schilf-/Reetbündel oder -paneele**

The most commonly used canes are *Phragmites australis (Cav.) Steud.* and *Arundo donax* (in the Mediterranean region).

Decayed house at La Huerta Norte, Valencia (Spain). In the upper storey, long horizontal wall centre core cane reinforcements can be seen (photo: M. Pastor Quiles 2015).



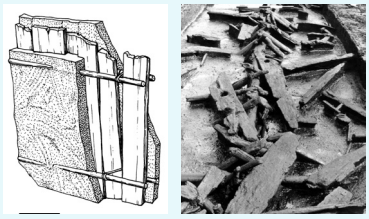
Top: Feudvar, Vojvodina (Republic of Serbia). By using the preserved imprints in a daub fragment as clue, the inner structure of a wall fitted with reed bundles was reconstructed (Hänsel/Medović1991, 73 Fig. 8).
Bottom: Replicas of Early Bronze Age daub fragments from Barca, Košice (Slovak Republic), with imprints of a reed panel (Kabát 1955, 611 Fig. 282).



Top: Applying mud to »Japanese« bamboo laths enclosed in a wooden frame (Fromme/Herz 2013, 134 Fig. 7–52b).
Bottom: Schematic drawings of a reed bale and a reed panel wall (Vela 2002, 183 after Davey 1964, 76).

2.1.6	timber planks	tablas de madera, listones	bois refendu, bois plat, planches	Spaltbohlen(wand), Bretter(wand)

Wall with clay-daubed sticks on the outside and timber planks on the inside, Salto du Jacuí, Rio Grande do Sul (Brasil; D'Avila 2006, 30 Fig. 2–8).



Top left: Typical wall construction of the Middle Neolithic Michelsberg Culture, Ammerbruch-Reusten, Baden-Württemberg (Germany; Schlichthele 1977, 109 Fig. 2).

Top right: Neolithic timber planks from Somerset Levels (United Kingdom; Coles 2006, 91 Fig. 1). **Bottom:** Daub fragment from a settlement pit in Wennungen, Saxony-Anhalt (Germany). The reverse shows the imprint of a wooden plank wall. The pattern of the split wood and the joint between the two planks are clearly visible (photo: F. Knoll).

Top: Sawing wood with a metal tool (Steen et al. 2003, 86). **Bottom:** Splitting wood (Petrequin et al. 1991, 31).

2.2	half-timbered, timber frame construction	entramado	pan de bois, colombages	Fachwerk

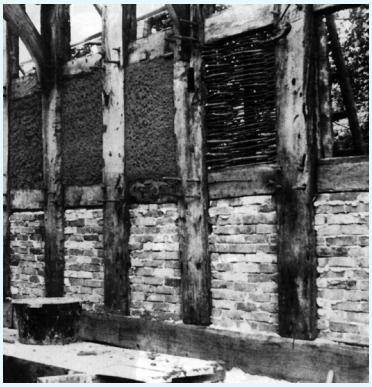
In Europe, especially in Germany, half-timbered constructions are attested to since c. 1200 AD. The oldest medieval German half-timbered house (»Hölle 11«) is situated at the northern fringe of the Harz mountains in Quedlinburg, Saxony-Anhalt (Germany), and dates to the second half of the 13th century (Henrich/Schmidt 2010). For more information, see Brunskill 1978.

Left: Wettin, Saxony-Anhalt (Germany), semi-abandoned half-timbered building with a porphyry rubble masonry basement. The three storeys are built half-timbered (photo: F. Knoll 2016).

Top: Half-timbered wall with fired brick infill, Winchester, Hampshire (United Kingdom; photo: M. Pastor Quiles 2016).

Ecomusée d'Alsace near Ungersheim, Haut-Rhin (France). Rebuilding of a timber frame on the ground (photo: C.-A. de Chazelles 2013).

	panel, frame (space between the timber frames) – **infill, filling**	**marco, panel, bastidor – plemento, relleno, cerramiento**	**hourdis, panneaux, remplissage**	**Gefache – Gefachfüllung/ Ausfachung**



Half-timbered wall with three vertical timbers in each frame and willow wattle infill panels, Emsland, Lower Saxony (Germany; Pressler 1994, 21).

Timber frame in a Roman *domus*, 1st century AD, Herculaneum, Campania (Italy). The panels are filled with stone masonry and covered with lime plaster (photo: C.-A. de Chazelles 2015).

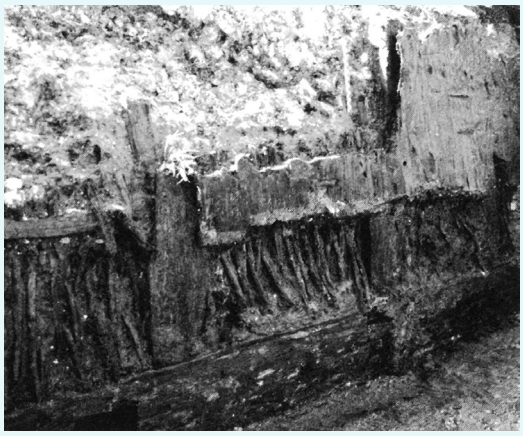
Quedlinburg, Saxony-Anhalt (Germany). Panel and infill made of sticks and mud become visible when the coat is not preserved (photo: M. Pastor Quiles 2017).

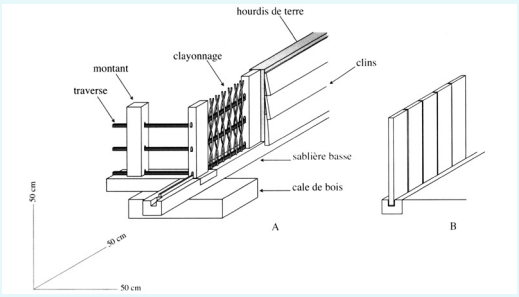
Ways to fill the panels

2.2.1 **cf. 2.1.1**	**hurdle, wattle, wattle and daub**	**estructura mixta, encestado, bahareque, manteado** (Sánchez García 1999), **quincha, embarrado, estaqueo, pared francesa, estanteo** (Viñuales et al. 2003), **vegetales entrelazados**	**clayonnage et torchis**	**Flechtwerk** (verschiedene Materialien) **mit Lehmputz**

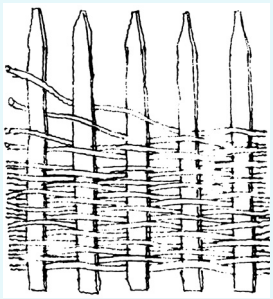
2.2.1a	**rod, stick**	**vara, rama, palo**	**latte, branche**	**Rute** (biegsamer dünner Ast)

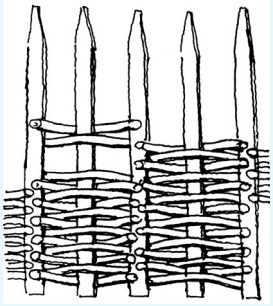
Top: Barn (19th century AD) in Estdorf, Lower Saxony (Germany). In the upper part, a broad-meshed wattle is coated with mud plaster. The lower part shows close-meshed wattle without plaster (Pressler 1994, 29).
Bottom: Thin wattle, covered with plaster. Ecomusée d'Alsace near Ungersheim, Haut-Rhin (France; photo: C.-A. de Chazelles 2013).





Wooden frame filling consisting of wattle and daub combined with planks, all covered with daub. Amiens, Somme (France), 30–50 AD (Gemehl/Buchez 2005, 215 Fig. 4).



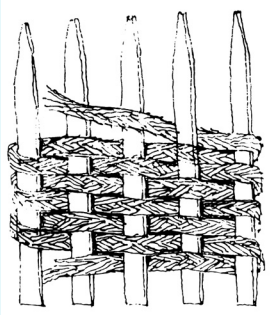


In half-timbered buildings, it is common to use closely set staves for wattling (top). A variant is the use of shorter, partially split branches, which are not very flexible, and thus can only be bent around one stave (bottom; Pressler 1994, 33).

2.2.1b	**daubed interlaced vegetal bands** (straw, grass, etc.)	**vegetales trenzados o entrecruzados en bandas** (paja, plantas, etc.) **trenzado de sogas o »antorchas«** (Proterra 2003, Fig. 34)	**vegetaux entrelacés** (paille, plantes, etc.)	**Zöpfe oder Bänder** (Stroh, Gras etc.)

Langeneichstädt, Saxony-Anhalt (Germany). Above the lintel of this barn, long daubed straw knotted bands were used for wattle weaving instead of twisted stakes that are usually more common in this region.
Left: Detail. **Right:** Overview.
(photos: F. Knoll 2017).

No archaeological evidence to our knowledge at present.

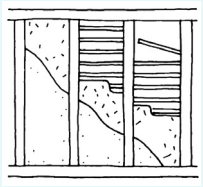


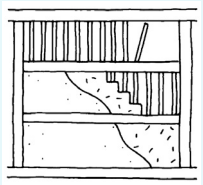
Occasionally, twisted or interlaced braids of vegetal materials (e.g., straw, grass) are used for the wattle and daub technique (Pressler 1994, 33).

2.2.2	sticks, stakes, planks, rods	estacas, horcones, maderos	piquets, potelets, palançons	Staken, Stakung

Left: Dieskau, Saxony-Anhalt (Germany). Farm building from 1797. Originally, the lower storey of this barn was built of cob, while the upper part was half-timbered. The square panels of the timber frame were filled with tightly packed, vertical sticks. Traces of several repairs of the last 200 years can be observed (photo: F. Knoll 2014).
Right: Daubed planks as vertical infill in the upper part of an internal wall in Abejuela, Teruel (Spain; photo: M. Pastor Quiles 2017).

No archaeological evidence to our knowledge at present.





Timber frame with horizontal (top) or vertical (bottom) plank infill (Volhard 2016, 35 Fig. 33c–d).

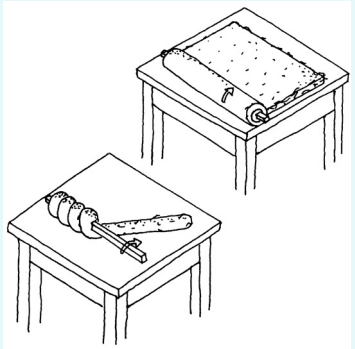
2.2.3	**»Lehmwickel«, earth winding** (straw and earth wound around a timber stake); **»dutch biscuits«** (Lewis 2018)	**rollos de barro** (Minke 2001, 101), **»rosquillas«** (SOSti-erra 2015), **»lulos«** (Chile; Proterra 2003, Fig. 29), **»trenzas«** (Van Lengen 1991)	**quenouilles, terre-paille enroulée autour de bâtons, torches** (Alsace)	**Lehmwickel, Wickelstaken, Wellerwickel**

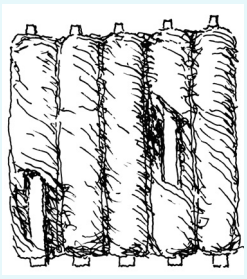
»Dutch biscuits« are evident in ceiling and wall constructions. This technique is especially spread across Germany and has been introduced to several countries by German immigrants (e. g., Australia, Hungary, and the United States of America). M. Lewis (2009; 2018, 13–14) assumes that the earliest evidence of »Lehmwickel« can be found in medieval buildings from north-west France.

Top left: Weathered »Lehmwickel« (»dutch biscuits«) at a decayed half-timbered house in Halle (Saale), Saxony-Anhalt (Germany; photo: F. Knoll 2017).
Top right: Half-timbered dwelling whose timber frames are filled in earth winding technique. Ecomusée d'Alsace near Ungersheim, Haut-Rhin (France; photo: C.-A. de Chazelles 2013).

Bottom: »Quenouilles« (wound earth) were commonly used as infill of the ceiling. They were covered with mud-straw plaster in a final step, just as it happened when they were used as wall infill. Ecomusée d'Alsace near Ungersheim, Haut-Rhin (France; photos: C.-A. de Chazelles 2013). This type of ceiling is also widely spread across Germany.

Not an archaeological, but an ethno-archaeological find: wrapped stake from a half-timbered house repair in Quedlinburg, Saxony-Anhalt (Germany; photo: M. Pastor Quiles 2017).



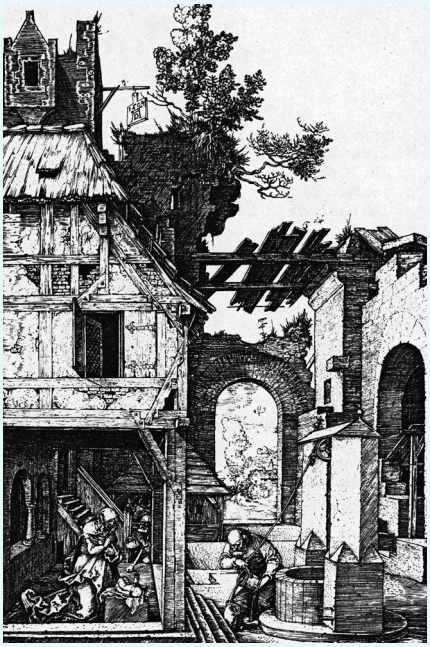


Top and centre: Production of earth windings and their placement in a wall (Minke 2017, 93 Fig. 9.5–1; 9.5–2).
Left: Schematic drawing of a tightly packed »Lehmwickel« infill (Pressler 1994, 33).

2.2.4	**infill with massive earthen elements like adobe or cob balls/clay lumps** (see above, 1.1.2 and 1.3; see also Mileto et al. 2011).

Top: Detail of a half-timbered barn. The panels were filled with adobe. Moivre, Marne (France; photo: C.-A. de Chazelles 2009).
Bottom: House with half-timbered upper storey in Mötzlich, Saxony-Anhalt (Germany), built in 1758. The timber framing was filled with mud bricks, whereas other parts were filled with vertical rods (photo: F. Knoll 2017).

No archaeological evidence to our knowledge at present.

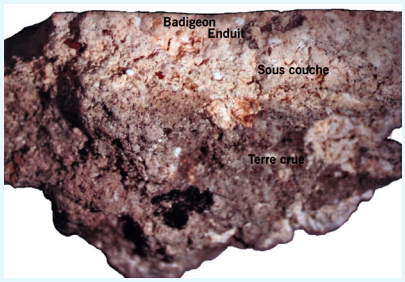


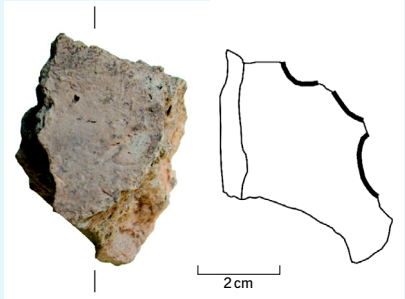
»The Nativity« by Albrecht Dürer, copper engraving, 1504. The stable as place of worship is depicted as a ruinous architecture with half-timbered upper storey, whereby the timber frames are filled with mud bricks (Binding et al. 1975, VI).

II Further (Technical) Terms for Parts and Finds of Earthen Walls

3	rendering			
3.1	(straw-clay) **plaster, render**	**enfoscado de mezcla de barro y paja, embarrado**	**corps d'enduit, sous couche**	**Lehmputz** (aus Strohlehm), **Verputz, Wandbewurf**

Top: Traditionally poured brick wall of palm-sized mud plaster in contrast to the modern mechanical spray-on technique (Fromme/Herz 2013, 83 Fig. 5–28; 5–29).
Bottom: Fresh straw-mud mixture for renovating the plaster, Yazd (Iran; photo: F. Knoll 2017).





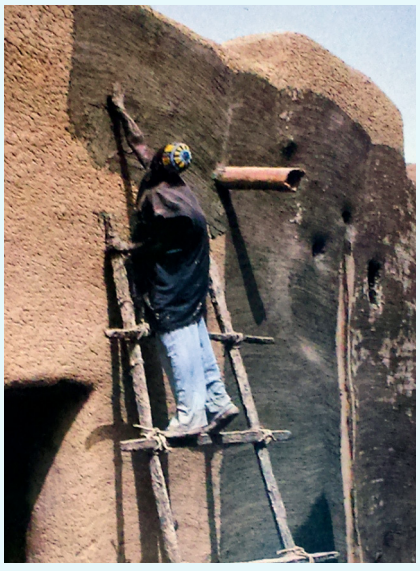
Top: Fragment of the defensive wall of Sidi Baba, Meknès Prefecture (Morocco), from the 17th century. In the cross section the following can be seen (from bottom to top): rammed earth core, plaster, and whitewash finish (Ajakane et al. 2007, 30 Fig. 10).
Bottom: Fragment of wattle and daub with imprints and mud render from the Bronze Age site of Cabezo Pardo, San Isidro/Granja de Rocamora, Alicante (Spain; Pastor Quiles 2014, 322 Fig. 8; see also Pastor Quiles 2017).

Top: Two craftsmen plastering with straw and mud in Yazd (Iran; photo: F. Knoll 2017).
Bottom: Plastering a wall with a mixture of mud and dung in Burkina Faso (Steen et al. 2003, 54).

3.2	**plaster, render, final/finishing/top coat** (see e.g. Allen/May 2003)	**enlucido, revestimiento, revoco, revoque, afinado, acabado**	**enduit, couche de finition, revêtement**	**Feinputz**

Two layers of final coat on a wall in Horticuela, Valencia (Spain; photo: M. Pastor Quiles 2016).

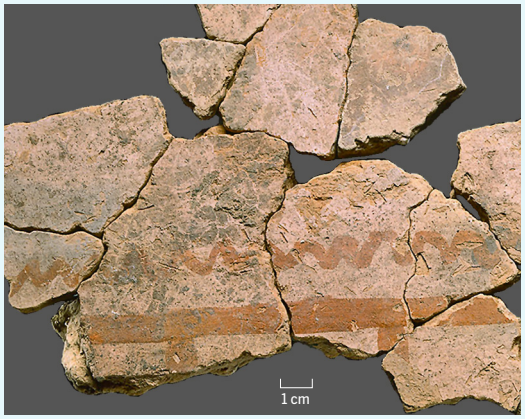
Fragment with ten layers of plaster and paint from Rottelsdorf, Saxony-Anhalt (Germany). The finely sifted mud plaster has a thickness of 1–2 mm and was mixed without organic components (Wunderlich/Kürbis 2001, 187; Knoll 2018, 79–82).



Adding a final coat to a construction in a deserted region (Bourgeois/Pelos 1983, Fig. 11).

3.3 paint, coat of paint | pintura, enlucido pintado | couche de peinture | Bemalung, farbiger Anstrich

Top: Wall with white and coloured paint, Arcos de las Salinas, Teruel (Spain; photo: M. Pastor Quiles 2017).
Bottom: Freshly plastered cob wall with white paint and a multicoloured pattern. Due to the mud underlay being composed of a small amount of organic material, the surface broke during the drying process and so the paint also cracked (photo: F. Knoll 2014).

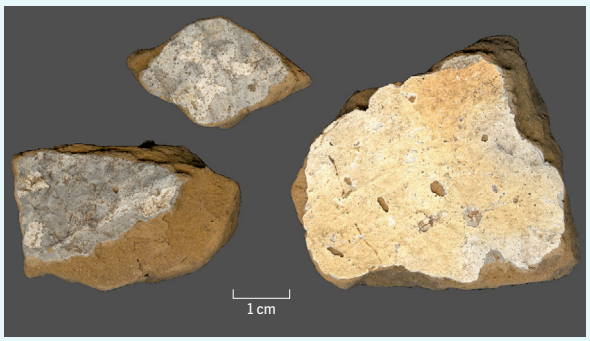


Top: Fragments of an Early Iron Age painted wattle and daub wall from Wennungen, Saxony-Anhalt (Germany; photo: J. Lipták, München; Knoll 2018, 474 Pl. 35,2).
Centre: Painted daub plaster fragment from Voldofte, Odense amt, Fyn (Denmark), dating to the Late Bronze Age. Different colours were applied to create this curved line (Knoll 2018, 510 Taf. 67,1).
Bottom: Iron Age wall painting fragment from Cortes de Navarra (Alto de la Cruz; Spain). The red chequered pattern decorated an adobe wall, plastered with mud and gypsum (Knoll 2018, 520 Taf. 77,1).

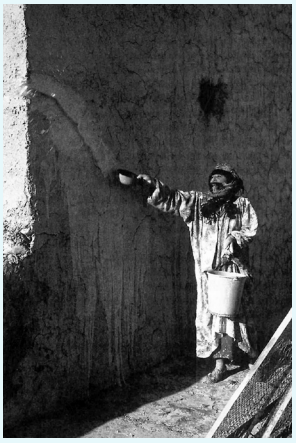
A Basotho woman painting a wall in South Africa (Van Wyk 1998, 84).

3.4 whitewash, lime paint | enlucido blanco, de cal, encalado | badigeon | **Tünche** (weiß, meist Kalk)

Remains of several whitewash layers on the outer wall of a »Weller«-built barn at a grange in Dieskau, Saxony-Anhalt (Germany; photo: F. Knoll 2015).



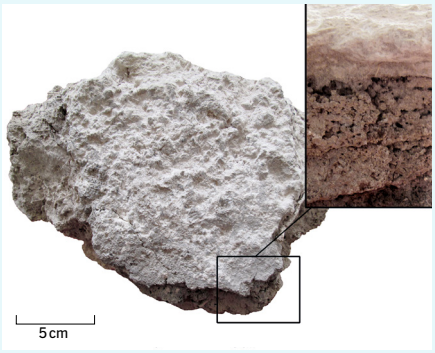
Mud-straw plaster fragments with whitewash finish. Found at the Late Bronze Age settlement of Hohenmölsen, Saxony-Anhalt (Germany; Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt Halle (Saale), Inv. HK 97:2440b; photo: F. Knoll).



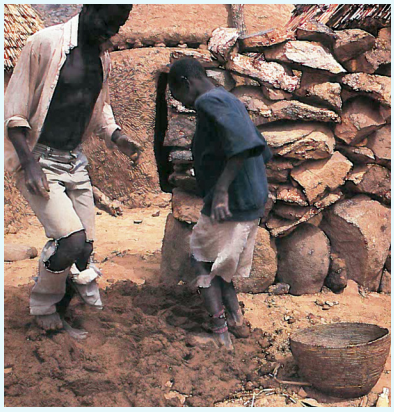
A Syrian woman is throwing chalk wash on the newly plastered walls of her house by using a small bowl (Pütt 2005, 243 Fig. 360).

4	mud earth as building material	tierra, barro como material de construcción	terre à bâtir	Baulehm

Detail of the surface of a cob wall, heavily affected by rain penetration. Jüdendorf, Saxony-Anhalt (Germany; photo: M. Pastor Quiles 2017).



Bronze Age earth building fragment, probably from the floor, showing multiple layers. Cabezo del Polovar, Villena, Alicante (Spain; Pastor Quiles 2016, 30 Fig. 6).

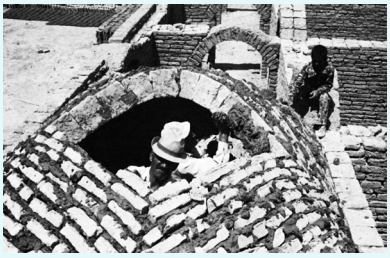


Mixing mud for construction in the Republic of Cameroon (Steen et al. 2003, 12).

5	mud mortar, earthen mortar	mortero de barro o de tierra	mortier de terre	Lehmmörtel

Mud mortar is frequently used for building stone walls, often in combination with lime mortar. In this example from Abejuela, Teruel (Spain), mud mortar is used with abundant straw (photo: M. Pastor Quiles 2017).

Plano-convex mud brick with remains of mud mortar from the Early Neolithic site of Aruchlo, Kvemo Kartli (Georgia; 6th millennium BC; Ioselani 2017, 283 Fig. 4a).

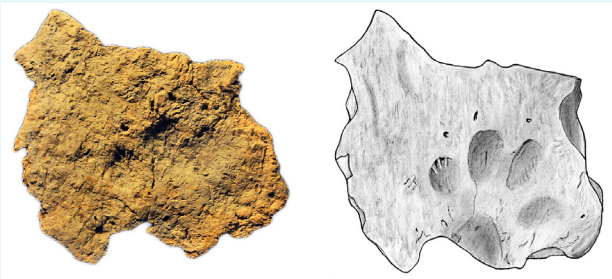


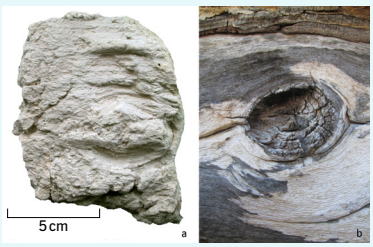
Building of a traditional dome with mud bricks in Iran. The thick mud mortar oozes out between the bricks (Khalili 1986, 117 Fig. 3.40). Video clip of the construction with mud bricks and mud mortar: <https://www.youtube.com/watch?v=RMrF28Gz4j8> (26.03.2020).

6	imprint	impronta	empreinte, négatif	Abdruck

When using mud for building purposes, imprints of the materials that were originally in contact with it are often preserved. The archaeological recovery and study of such building materials is crucial for the interpretation and reconstruction of buildings from the past.

Partially destroyed curved roof of an abandoned hermitage in Elda, Alicante (Spain) (photos: M. Pastor Quiles 2015). **Top:** Today the floor is covered in fragments of roofing material showing reed imprints. **Bottom:** The roof was made of plastered reed.





Top: Late Bronze Age daub fragment showing the imprint of a dog's paw. Wennungen, Saxony-Anhalt (Germany; Fröhlich 2012, 106 Fig. 1). **Bottom:** Daub fragment from the Copper Age site of Les Moreres, Crevillente, Alicante (Spain), featuring an imprint of a knothole (photo: M. Pastor Quiles).

Plastering the wattle. If the wall collapses, the mud plaster will show the imprints of the wattle on its reverse (Petrequin et al. 1991, 56).

6.1	tying, lacing	atadura, ligazón	ligature, lien, brêlage	Schnürung, Wickelung

Roof of a house in Hortichuela, Valencia (Spain). Hardened daub fragments with imprints of braided cord are evidence of a roof structure destroyed by fire (photo: M. Pastor Quiles 2016).

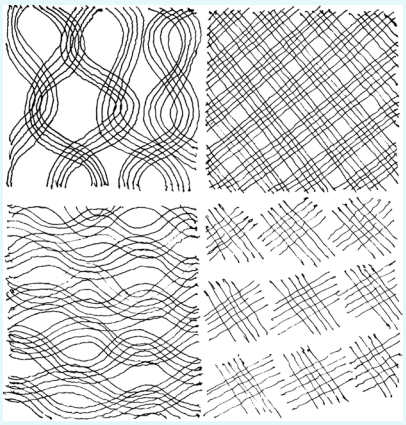
Top: Braided cord imprints in a daub building fragment from the Copper Age site of Les Moreres, Crevillente, Alicante (Spain; photo: M. Pastor Quiles).
Bottom: Daub fragment with cord imprint from the Neolithic site at Seilh, Haute-Garonne (France; photo: C.-A. de Chazelles 2013).

Cords are used for tying together wooden posts in the experimental building of a Neolithic post construction (Petrequin et al. 1991, 46).

6.2	incisions, plaster grooves	acanaladuras para fijar el revestimiento	rainures, stries d'accrochage (pour fixer le revêtement)	Putzritzung

Rhomboid motifs scratched into the plaster using a comb. The creation of surface scratches helps the exterior coat of plaster (partially spalled off, only visible on the very right of the image) to adhere to the scratch coat properly (Fromme/Herz 2013, 26 Fig. 2–46, after Volhard 2010).

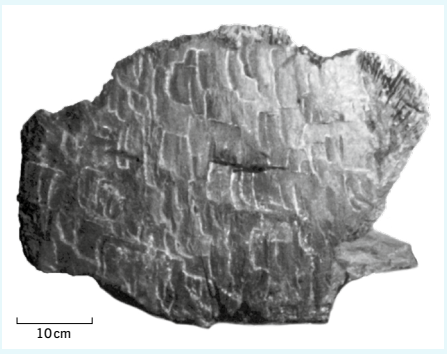
Fragment showing the positive imprint of a wavy line suggesting a plaster groove. Found in the apse of the Early Iron Age apsidal building of Mont Lassois, Côte-d'Or (France; Mötsch et al. 2008, 18 Fig. 9).

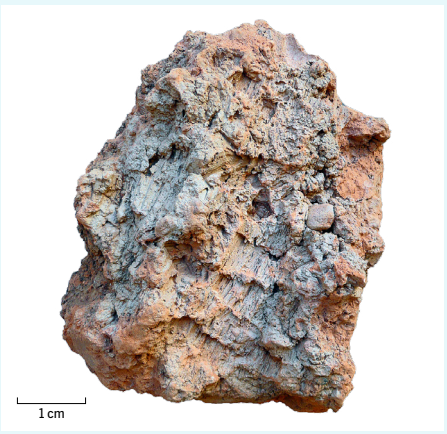


Different motifs of plaster grooves made with a five-tined comb (Pressler 1994, 42). Waves, crosses, or grid patterns were scratched into the plaster of traditional half-timbered buildings.

6.3	**preparation of the surface** (base coat) **for better plaster adhesion by hewing/pecking or by using a hatchet**	**incisión o picado de las superficies para fijar el revestimiento**	**impacts d'outil, piquetage**	**Vorbereitung des Untergrunds zur besseren Putzanhaftung durch Pickungen oder Anbeilen von Holz**

Top: This half-timbered building in Wettin, Saxony-Anhalt (Germany), shows several forms of surface preparation for a better adhesion of the plaster. Besides the plaster having been incised with various grooves, the panel beams were also hewn with a hatchet (photo: F. Knoll 2016).
Bottom: Hatchet marks in a window lintel. Arcos de las Salinas, Teruel (Spain; photo: M. Pastor Quiles 2017).





Top: Indentations at the bottom of a wooden post from a building of the Late Iron Age (proposed chronology: 136 BC) in Vittel, Vosges (France; Brénon et al. 2005, 187 Fig. 4). This post has not been incised for the purpose of an improved adhesion of a coat, but the marks would be very similar to those in this image.
Bottom: Burnt fragment of earthen architecture showing imprints of wood hewn with a hatchet. Neolithic settlement at Seilh, Haute-Garonne (France; photo: C.-A. de Chazelles 2013).

Two modern examples of plaster showing hatchet marks.
Top: Agost, Alicante (Spain; photo: M. Pastor Quiles 2015).
Bottom: Mallorca (Spain; photo: M. Pastor Quiles 2016).

6.4	**preparation of the surface** (base coat) **for better plaster adhesion by using plant material**	**elementos vegetales para fijar el revestimiento**	**éléments végétaux pour fixer le revêtement**	**Vorbereitung des Untergrunds zur besseren Putzanhaftung durch vegetabile Elemente**

Reed used to achieve a better plaster adhesion in a half-timbered building in Quedlinburg, Saxony-Anhalt (Germany; photo: M. Pastor Quiles 2017).

No archaeological evidence to our knowledge at present.

Cords twined/twisted around a wooden building element for an improved adhesion of the plaster. Aspe, Alicante (Spain; photo: M. Pastor Quiles 2015).

Entrance to a decayed farmstead at Houbeh-Anbar, Esfahan (Iran; photo: F.Knoll 2017).

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A collapsed mud brick wall next to a stone staircase in the Palace of Zakros, Crete (Greece, Late Minoan, c. 1600–1450 BC; photo: F. Knoll 2013).

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