Mud brick

The ideal building material would be ‘borrowed’ from the environment and replaced after use. There would be little or no processing of the raw material and all the energy inputs would be directly, or indirectly, from the sun. This ideal material would also be cheap and would perform well thermally and acoustically. If used carefully, mud bricks come close to this ideal.

Basic mud bricks are made by mixing earth with water, placing the mixture into moulds and drying the bricks in the open air. Straw or other fibres that are strong in tension are often added to the bricks to help reduce cracking. Mud bricks are joined with a mud mortar and can be used to build walls, vaults and domes.

At its simplest, mud brick making places mud in moulds which, after initial drying, are removed to allow the bricks to dry slowly (not in direct sun). Moulds can be made from timber or metal — anything that can be shaped to provide the desired size for the bricks. Virtually all the energy input for mud brick construction is human labour (indirectly fuelled by the sun) and after a lifetime of use, the bricks break back down into the earth they came from.

The use of earth construction is well established in energy efficient housing. Despite the fact that most of the world’s buildings are made of earth and it is one of the oldest known building materials, much about its properties and potential remains undeveloped and poorly researched.

Performance summary

Appearance

The appearance of mud bricks reflects the materials they are made from. They are thus earthy, with their colour determined by the colour of clays and sands in the mix. Finished walls can range from a strong expression of the brick patterns to a smoothly continuous surface.

Structural capability

With thick enough walls, mud brick can create loadbearing structures up to several storeys high. Vaults and domes in mud brick prove that it can be used for many situations other than vertical walls. It may be employed as infill in a timber frame building or for loadbearing walls, although its compressive strength is relatively low. Typically, Australian mud brick structures are single or double storey. In the Yemen buildings eight storeys high and more have stood for centuries! (see Construction systems)
Mud brick walls can provide moderate to high thermal mass. For most Australian climatic conditions, as a rule of thumb, walls should be a minimum of 300mm thick to provide effective thermal mass. (see Thermal mass)

Contrary to popular belief mud bricks are not good insulators. Since they are extremely dense they lack the ability to trap air within their structure, the attribute of bulk insulation that allows it to resist the transfer of heat.

To achieve the levels of insulation needed for sustainable house construction and to achieve Building Code of Australia compliance across most of Australia, it is almost always necessary to add insulation linings to external mud brick walls. In some milder climate zones, where thermal insulation is less critical to the overall building performance, mud brick walls may not need additional insulation. (see Insulation)

One way of dealing with mud brick’s lack of insulation is to construct some or all of the outer walls with framed construction, and use mud brick for partition walls and as an internal ‘reverse brick veneer’ on some external walls. This approach allows the building to reach ‘lock-up’ very quickly and provides a protected space to make and dry the bricks.

Traditional earth buildings often used walls up to a metre thick: these would provide reasonable insulation and enormous mass to stabilise internal temperatures.

Sound insulation
A well-built mud brick wall has very good sound insulation properties. In fact, it can be almost equivalent to a monolithic masonry structure in its capacity for sound attenuation (see Noise control). Some modern mud brick homes use mud brick for external walls and light partition walls internally; it is more effective for thermal and acoustic performance to use mud brick for the partition walls and lightweight, well-insulated external walls.

Fire and vermin resistance
Since earth does not burn, and earth walls do not readily provide habitat for vermin, mud brick walls generally have excellent fire and vermin resistance.

Durability and moisture resistance
Mud brick walls are capable of providing structural support for centuries but they need protection from extreme weather (e.g. with deep eaves) or continuous maintenance: the ancient structures of the Yemen have been repaired continuously for the centuries they have been standing. Although some soils are very resistant to weathering, as a general rule mud brick needs protection from driving rain and should not be exposed to continuous high moisture.

Breathability and toxicity
Mud bricks make ‘breathable’ walls but some mud brick recipes include bitumen, which potentially results in some outgassing of hydrocarbons. Ideally earth should be used in, or as near as possible to, its natural state.

Environmental impacts
Mud bricks could have the lowest impact of all construction materials. Mud brick should not contain any organic matter — the bricks should be made from clays and sands and not include living soil. They require very little generated energy to manufacture, but large amounts of water. Their embodied energy content is potentially the lowest of all building materials but the use of additives such as cement, excessive transport and other mechanical energy use can increase the ‘delivered’ embodied energy of all earth construction. (see Embodied energy)

In a similar way, the greenhouse gas emissions associated with unfired mud bricks can (and should) be very low. To keep emissions to an absolute minimum, the consumption of fossil fuel and other combustion processes have to be avoided. If, say, 5% cement is added...
to a 300mm mud brick wall, it makes a fairly high energy/high emission building material, close to the embodied energy of a 125mm unreinforced concrete wall.

**Buildability, availability and cost**

Mud bricks are a forgiving medium well suited to owner builder construction. A number of proprietary mud brick makers and builders provide good information in Australia. A strong owner builder oriented network includes a broad based national organisation, the Earth Building Association of Australia (EBAA), which is a not-for-profit group ‘formed to promote the use of unfired earth as a building medium throughout Australia’.

Materials for making mud bricks are readily available in most areas and in some cases may be sourced directly from the building site.

Low costs in construction can only be effectively achieved by self-build, reducing the labour costs associated with the manufacture and/or laying of bricks. Commercially produced mud brick construction can be as expensive, or even more expensive, than brick veneer.

**Typical domestic construction**

**Construction process**

Mud brick wall construction has generally been the province of owner builders, but a large proportion of mud brick buildings are now constructed by, or with the help of, commercial builders. The potential for sourcing the main wall construction material from one’s own site, making the bricks, and building the walls can be very appealing as both an economic and lifestyle choice. The first stage of construction may be excavating the mud from the site.

The clay content of mud brick can range between 30% and 70% and overall earth content may also include silt, gravel and stones. There are a number of tests for suitability of the earth, and the approval process may require an erosion test. Before excavating for on-site mud, consider the site layout to minimise carrying and transport; ensure there is space to keep any topsoil separate for use on the garden.

Owner builders should recognise that mud brick making is a labour intensive activity. A house may require around 10,000 bricks, but a working couple making bricks in their spare time would be lucky to average a production rate of 200 a week. Mud brick moulds can be made from wood or metal. Bricks must dry evenly to avoid cracking and they should be covered to avoid direct sunlight and overly quick drying. A number of mud brick manufacturers cater to the market for people who do not have the time or resources to make their own.

A typical standard mud brick is 300–375mm long, 250–300mm wide and 125mm high, and can weigh up to 18kg — as much as a straw bale! Smaller brick sizes are recommended for owner building. Mud bricks can be made in a range of sizes and moulds and can be made in special shapes for fitting around structural elements and accommodating pipes and wires. Stabilised mud bricks may contain materials such as straw, cement or bitumen. (see *Straw bale*)

Although mud brick can be loadbearing, there is also widespread use of frames. The advantages are that a roof structure can be erected for weather protection for both mud brick making and construction. Disadvantages include the need to connect with and build around frame structures.

After the footings have been placed and the bricks are ready for laying, the building process is similar to that of any other masonry construction.
Materials

Mud brick

All structural design should be prepared by a competent person and may require preparation or checking by a qualified engineer. Qualified professionals, architects and designers have years of experience and access to intellectual property, and can save house builders time and money as well as help ensure environmental performance. All masonry construction has to comply with the Building Code of Australia and Australian Standards. For example, all masonry walls are required to have movement/expansion joints at specified intervals.

Footings

It is possible to make footings from rubble, but unconventional construction may make it harder to obtain building approvals and the usual method is to employ strip or raft concrete footings. A raft concrete slab can make a clean, flat surface for making mud bricks. A damp proof course must be laid between the footings and brick wall to prevent rising damp. A ‘splash course’ of fired bricks is advisable to prevent erosion of the lower course of mud bricks from heavy rain.

Frames

Mud bricks can be loadbearing but it is also usual Australian practice to build mud brick walls between timber or steel frames.

Loadbearing walls

Loadbearing mud brick wall construction requires particular attention to good bonding (avoiding continuous vertical joints) and ensuring stability by having returns on the walls that buttress them against sideways forces. Again, normal traditional masonry practice applies to the pattern in which bricks should be laid. It is possible to create arches, squinches and domes in mud brick; they have featured in adobe structures since time immemorial but are rare in modern buildings of this type.

Joints and connections

Mud bricks are laid on thick mortar beds that are essentially the same mix as the brick, but in its ‘muddy’ state. It is also common practice in the commercial mud brick industry to use a sand-cement mortar. Once dried, it can be difficult to distinguish between mortar bed and brick, and some adobe aesthetics exploit this ‘seamless’ appearance to create a monolithic effect. In loadbearing mud brick construction, roof structures bear on wall plates. In framed mud brick construction there may be timber or steel columns around which the mud brick walls are built. Considerable roof overhang is generally recommended to afford some protection to walls from driving rain. In more sheltered areas this requirement is less vital, but care must be taken to provide a good quality render and waterproofing finish (see ‘Finishes’ below).

Walls are laid in the traditional manner of masonry with string lines to provide a guide to vertical and horizontal alignments.

The mud mortar beds are normally quite thick and need to provide complete bedding for the bricks. Perpends are similarly thick (about 20–30mm). The intention is to produce a wall that is effectively monolithic, i.e. as if it were a single piece of material.

Fixings

Fixings to mud brick need to allow for the relatively poor ‘pull-out’ strength of the material. Strong fixings can be achieved by embedding dowels or plugs into a wall — the depth and type of which should be determined by reference to a skilled builder or engineer if the load carrying capacity of the fixing is critical.

Openings

Lintels can be in any structurally appropriate material, although timber is typically used. Beams and lintels can be formed from quite ‘rough and ready’ timber and readily blended into the mud brick construction. Mud bricks can be also be laid to form arches, particularly over small spans (less than a metre), and even domes, although this requires high levels of bricklaying skills as well as more stringent demands from engineering and approvals processes.
Finishes

After brushing to get a fairly even surface, the final finish is a mud slurry, typically completed by hand. This slurry may also be the final waterproofing coat (e.g. a mud and cow dung mix) or it may have a further clear coat of proprietary waterproofing material.

Linseed oil and turpentine can also be used as a final finish — and can be a very effective method of protecting walls susceptible to erosion. There is even the option of using the natural plastic of cellulose, processed by cattle, to create mud and manure slurry, although this is seldom employed in Australia. Finishes can range from rustic to smooth, with this flexibility of approach being one of the material’s many appealing qualities.

References and additional reading


Earth Building Association of Australia. www.ebaa.asn.au


Cob, wattle and daub, earth render

Cob is an ancient earth building technique of mixing earth, sand, gravel or pebbles and straw with a little water. It requires minimal construction skills and may be the world’s most common building material. Cob walls are built without formwork by placing lumps of the cob mix by hand to make massive walls, typically 450–600mm thick, built up in layers. Each layer needs to dry out sufficiently to support the next. It lends itself to making free-flowing sculptural forms.

This high thermal mass material has some insulation value. Cob building depends upon wall thickness for its structural and environmental performance. Cob is fireproof and can be used to make stoves, fireplaces and chimneys.

Cob walls require firm footings to avoid movement and cracking and to keep the base of the walls dry. They need to be whitewashed (lime and water) for weather protection.

Wattle and daub consists of panels of woven timber lattice set in timber frames. The wattle was traditionally made from wood coppiced from trees that would continually regenerate branches for future harvesting. The panels are daubed with a mud and straw mixture up to a thickness of 50–150mm. As with all earth constructions, wattle and daub walls need sealing against the weather with a breathable finish such as whitewash.

Earth render is fundamentally a mud or clay slurry that may be reinforced with straw or cow dung. It can be applied to mud brick or cob walls and can be used to render strawbale walls.

These very old techniques that date back to the earliest days of building are quite uncommon in the modern era. If you are contemplating using these methods it is worth checking out the growing number of websites and networks through which people exchange information and experience.

All earth walls benefit from being protected by wide, overhanging roofs that prevent driving rain from eroding their surface.

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