TECH SPEC

CLAY LUMP
WATTLE AND DAUB

EARTHA

East Anglia Earth Buildings Group

CLAY LUMP GENERAL PRINCIPLES

Clay with which clay-lump buildings in East Anglia are made is a Marl containing up to about 20% clay. This chalky boulder clay also contains chalk, sand and gravel.

Clay tends to shrink when dried because the moisture content is reduced.

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Applying cement renders on to clay-lump walls by using a metal armature fixed to the wall results in the render cracking which lets water in and condensation to form on the back of the render. This moisture is drawn to the base of the wall where it can accumulate in the clay, causing failure.

The strength of earth blocks:

The "characteristic unconfined compressive strength" is used by engineers in the design of masonry to calculate the ability of a wall to resist vertical loading. Earth blocks can have a crushing strength of between 0.5 &1.5 N/mm^2 depending on the earth mixture used and the amount of water used to produce them. A high clay content does not necessarily equate to a strong block. Local soils can have a clay content of between 20% and 30%. The strength of the block is usually increased significantly by the addition of coarse sharp sand to reduce the clay content to around 20%. Subsoil will contain a range of particle sizes ranging from gravel through sand; then silts to clays. Clay grains are smaller than 0.002mm. For more information please see technical papers "Soil Tests" & "Making Earth Blocks"

Interpreting the results of compressive tests on masonry units can be very misleading. It is important to distinguish between unit strength and characteristic strength. Unit strength refers to the masonry unit. Characteristic strength is the strength of the masonry formed from the blocks with the mortar acting together. To determine the characteristic strength, account needs to be taken of the strength of the mortar as well as the aspect ratio of the block. The characteristic strength of masonry is generally less than that of the units themselves. This is due to the weakening effect of the mortar and an adjustment of the units recorded compressive strength depending upon its aspect ratio when tested, unless tested with an aspect ratio of 2. (Height to least width)

Unconfined Compressive Strength

Units with a low aspect ratio will record higher compressive strengths than those with high ratios. If the material of the units is the same, then some distortion is being introduced into the results. This is because the platens of the testing machine restrain the top and bottom faces of the specimen against expansion and hence enhances its recorded strength. To obtain the true strength of a masonry unit, the specimen should be tested with an aspect ratio of 2. If earth mortar is used, having a similar composition to the blocks themselves, then the weakening effect of the mortar can be largely discounted and the characteristic strength of the masonry would be approximately equal to the mean strength of the masonry units tested with an aspect ratio of 2. At least 10 units should be tested and the characteristic strength used in design will be the strength below which the probability of a test result falling is not more than 5% of the unconfined mean strength of the sample. The more consistent the results of the 10 units tested, the nearer will be the characteristic strength to the mean strength of the units. If the units have a wide variation of strengths when tested, the characteristic strength could be considerably less than the mean strength of the units tested.

Flexural strength

Flexural strength is frequently ignored in design, but with earth blocks it is the flexural strength which will usually determine the thickness of an external wall rather than its compressive strength. The flexural strength is a measure of the walls ability to resist horizontal loading, usually wind load. A thin wall will have very limited resistance to horizontal loading and the limited flexural strength of earth walling is the reason why earth walls are usually quite thick compared with conventional masonry. The flexural strength of masonry is not easily determined. The British standard method is to test a completed wall in a laboratory and this would be extremely expensive. A more economical method is to test brick couplets using a device known as a bond wrench. Flexural strength is influenced by the strength of the mortar but more importantly, by the degree of adhesion achieved between the mortar and the block.

An earth block with a characteristic compressive strength of 0.8 N/mm^2 could produce a wall with a characteristic flexural strength of approximately 0.02 N/mm^2 depending upon the mortar used. This is very low compared to conventional masonry where flexural strengths of 0.1 N/mm^2 would be more normal.

However, research at Plymouth University found that a simple way of improving flexural strength by a factor of two or more is to incorporate hessian within the bed joint of an earth slurry mortar. With hessian as a bed joint reinforcement, a flexural strength of 0.06 N/mm^2 is attainable. This would enable wall thicknesses to be reduced so that they could be adequately insulated without the overall wall thickness becoming uneconomic. A similar result can be achieved by lining the moulds with hessian so that the block itself is hessian faced.

Thermal conductivity varies with density and with moisture content. Average density is about 1700kg/m^3(1.3 tons/yd3) which gives a K value of about 0.6 - 0.8 W/m^{2}k

Density can be reduced by increasing the amount of straw in the mixture or by adding expanded clay balls or expanded polystyrene.

All repairs to clay walls can be divided between "patch" and "cut out". Wet Clay shrinks as it dries and this shrinkage governs the size of a patch repair. Defects which are too large to be patched will have to be cut out and new or second hand clay-lumps fitted in.

The tendency of clay to shrink can be reduced by adding sharp sand or straw, crushed chalk or a mixture of any of these.

Much attention is given to the strength of the blocks, but very little to the mortar. The best mortar for earth block is an earth slurry mortar produced to the consistency of a stiff liquid. Course sharp sand should be added to the point where the dried mortar does not shrink and crack. A clay content of approximately 20% or less should be successful. The addition of hessian reinforcement in the bed joint will significantly improve the flexural strength of the wall. Other mortars are thick joint earth mortars or a lime mortar not stronger than 1:3 lime/sharp sand but these offer less adhesion than earth slurry and therefore less flexural strength. The lime used could be lime putty or an NHL2 hydraulic lime. Earth blocks should be dampened before being laid.

Clay-lumps for repairs can be made with clay salvaged from the works with more straw added and are made in a bottomless box-mould which is removed immediately.

A mixture of clay for render which has been successful is: 6 parts clay: 6 parts sharp sand: 2-4 parts straw chopped 50mm long.

New clay lump is becoming commerically available. Barley straw is preferred, however, finely chopped wheat straw is supplied by P.M. & B.J.Gooderham 01 953 888263 in 220kg bales only.

EARTHA

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'ONE HALF OF THE WORLDS POPULATION....
APPROXIMATELY 3 BILLION PEOPLE ON SIX CONTINENTS.... LIVES OR WORKS IN BUILDINGS CONSTRUCTED OF EARTH'

Bagged chopped straw for stables in small bales, 140 litre (17kg), is supplied to horse outfitters by Dixon Brothers 01359 259341.

Pet shops sell straw in smaller bales.

Suitable renders of lime or clay can be laid on a metal armature fixed to the wall if there is any doubt about the suitability of the background. Otherwise, direct rending is possible.

Waterproof paints must be avoided on clay walls. Limewash or brushing tar should be used.

Damp proof courses should not be required where there is a a plinth.

Advice regarding the repair and treatment of clay walls is available from a number of organisations:

The County and District Councils' Conservation Officers can usually give advice. This applies to: **Norfolk, Suffolk, Essex, Cambridgeshire, Hertfordshire, Bedfordshire, Northamptonshire, Lincolnshire and Leicestershire.**

The ICOMOS (International Committee on Monuments and Sites) U.K. Earth Structures Committee collates the work of the local organisations and is our formal contact with the international committee.
The Chairman is Linda Watson, 01 752 233608

The Devon Earth Building Association (DEBA) publishes leaflets and gives demonstrations and advice.
Contact Larry Keefe 01 626 864826

The East Midlands Earth Structures Society (EMESS) is based in Lincolnshire.
Contact: John Hurd 01 507 480626

The East Anglian Earth Buildings Group (EARTHA) organises demonstrations and practical days and provides information on its website: **www.eartha.org.uk**
Contact: Colin Williams, Membership Secretary and Treasurer, 27 Richmond Place, Lyng, Norwich, Norfolk NR9 5RF.
Email: colin@wckdesign.co.uk

The Hampshire Group is not formally organised.
Contact: Gordon Pearson 01 962 847923

The Harborough and Daventry Earth Society is based in Leicestershire.
Contact: Rosalind Willatts 01 858 821147

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EAST ANGLIAN WATTLE & DAUB

Wattle and daub panels may contain more archaeological information than the timber—frame. Where possible in repair, the panels should be refixed or the daub should be reconstituted and reused.

WATTLE

Any hardwood sticks that are straight can be used. Hazel, which is coppiced for thatchers is the most readily available. Willow and ash are easy to find in hedges and woodland.

Sticks should be 15—50 millimetres diameter and are better used fresh.

The horizontal sticks are called ledgers and are cleft or round and are either nailed to the outside face of the frame or sprung into pockets cut into the sides of the studs. If the walls are to be rendered on expanded metal lath then standard treated roofing batten can be fixed at 450 to 750 apart.

Split sweet chestnut may be better for between the studs.

The vertical sticks, the wattles, are cut to suit the height of the panels and are tied to the ledgers with any sort of string. Plastic baler twine indicates that the work is modern. The string is tied at one end of the ledger and wound round it so as to secure one wattle with each turn. It is tied at the other end of the ledger and can wind round one or more studs before being tied off if the wall is to be rendered.

Wattles should be spaced so an open hand will pass between them or so the spaces are the same width as the thickness of the wattles.

DAUB

Chalky—boulder clay subsoil is suitable and is easier to handle if it has been exposed to frost after it was dug.

Salvaged: clay—lump: shuttered clay walls, and clay renders as well as old daub can be broken up and reconstituted and used as the daub.

Basic daub is made of (by volume):

4—5 parts clay or salvaged material
1 part chopped straw
1 part cow muck (optional, it reduces the amount of water to mix required)

TIPS

Mixing with a pan mill is sometimes possible and may be an advantage on larger sites but they do make a mess.

Make mixing easier by adding extra water which can be taken up when the straw is added or the mixture is left over night. Nail loose panels of existing daub back to the frame.

JOIN EARTHA

As an EARTHA member, you will be added to the mailing list and receive details of events by post or email.
Subscription to the EARTHA mailing list is by a single payment of £10 for individuals and £20 for organisations.
If you would like a membership form, please email us at: info@eartha.org.uk

Or you can get a membership form online at **www.eartha.org.uk**

EARTHA, Colin Williams - 27 Richmond Place, Lyng, Norwich, Norfolk. NR9 5RF.

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