Earth and Clay Plastering

A rough guide

Samantha Saville and Stephen Saville

October 2012

www.FloweringElbow.org

Intro

For straw bale construction, clay plaster is a fairly common choice for the internal walls, but if you modify the technique appropriately, it can also be used on other wall types: insulating aerated blocks, wood boards, reed matting[1]. These pages are based around our experiences of plastering the two strawbale walls of the FE workshop, both inside and out, with local clay (check out this post for our straw back-story), but should be worth a look for people considering plastering other wall types. There is lots of useful clay plastering books, blogs, and forum information out there, and many many ways to go about this, none of them necessarily right or wrong. We're sharing our attempted meld of the most useful advice we found, and our own mistakes and successes while learning on the job.

The 'system' we used was: 'slip coat' – first coat – dry – re-wet and slip – second coat – dry – re-wet – third coat – polish/sponge – dry – vacuum brush – apply finishes (wall glaze inside/lime wash out). If that didn't make much sense, keep with it, read on and all will become clear...

Some people don't bother with a slip coat and just wet the wall, some people do an 'all purpose' first coat that binds to, and levels the walls, and follow it up with a finish coat. It will very much depend on what the surface is like that you're plastering onto (known as 'the grounds') the techniques you use, and the kind of effect your trying to create with the plaster.

[1] Stone, concrete and clinker do not provide good grounds for clay plaster, because they are so hard and dense the clay has difficulty keying into the surface. It is *possible* if mechanical fixings, such as a wire mesh or similar is used to provide a key.

1: Before you start

Is earth plaster/render the thing to go for?

There are many well known and tested benefits to using earth plasters, both in terms of building performance and eco-cred. Lets just have a quick look through some:

- Earthen plaster is non-toxic and typically uses 'naturally' occurring ingredients.
- It is highly hygroscopic – will regulate humidity at around 60% (a very comfortable human dwelling environment).
- Is thermally massive and will help regulate temperatures
- Is breathable (vapour permeable) and thus compatible with other natural building materials, especially strawbale, cob and rammed earth constructions[2].
- Involves little energy in production, depending on where you source the earth from.
- Is fun to work with and relatively 'forgiving' (at least during application, if used inappropriately, it can fail completely).
- Can be very cheap
- Is easy to safely dispose of in the ground, or possibly re-use, depending on ingredients.
- Can produce a wide range of beautiful and individual finishes.

There are some other factors to take into account though:
Clay plaster done not deal well with water, if you splash a load of it on untreated clay plaster, it absorbs it and goes soggy and soft. Thus it is less suitable for exterior renders without some serious water protection design engineering, such as rainscreen cladding, extended roof overhangs and other weather protecting coatings.

If you are going to use earth dug on-site you will need to do lots of testing of the soil available ti devise appropriate recipes for each plastering layer. The time for this needs factoring in.

Using free, on-site earth like we did means lots of labour – digging, sifting, testing, mixing.

Tools and finishing products specifically designed for clay plastering are available, but not very widely, mail order and research is needed. Though, there aren't too many tools and products needed really.

Some questions to ask yourself:

Lets just run through some common questions to do with clay plaster, worth asking yourself before starting any project:

What are the main reasons for using clay?
Are alternatives worth considering (alternatives are *always* worth considering!)? This GreenSpec page has an excellent summary of the properties, suitable situations and

[2] This has nothing to do with 'air tightness', which in construction, is a term referring to the leakage of air through the buildings envelope (ie. chilly drafts).

environmental considerations for all the major plastering options, though it may slightly undersell gypsum plaster. If sourced from “flue-gas desulphurisation” (FGD) of power station emissions, this is arguably made from a waste product that performs well and has little wrong with it - it certainly doesn’t have the ‘pure untarnished by industrial processes’ feel to it that clay *can* have (if you dig it yourself), but is worth considering (possibly used as a mix with clay for final coats).

Will you buy-in the materials or dig your own? If buying the plaster mixes, this can become expensive especially if you have a large area to cover, but it will drastically reduce the time and labour involved, and will probably require less testing. One the flipside, you may not learn as much, and will also lose out on some of the fun of taking a raw material all the way through to a finished product.

What time of year will you be plastering? The plaster will take a good while to dry - several weeks for the thicker base coats. In temperate climate such as the UK, attempting this is winter would be a lot like madness, drying times would be *very* long so mould would be a real problem, and you would be in major ‘fail from frost’ territory.

Have you got plenty of energy and enthusiastic friends to support and help out? This is a serious consideration if you are going the whole hog and testing, harvesting, mixing and applying the plaster yourself - but depends on the scale of the area to be plastered and if you are willing to pay for labour.

Are you up for learning as you go or will you need prior training/ experience to feel confident enough to get started? The low budget option for training would be to find volunteer opportunities on other people’s projects to gain experience, or you could invest in training (see resources).
Have you got the time? Did we mention it takes a long time already? As a rough indication we started soil testing at the end of April and are painting on finishes mid-September. Ok so we haven’t been JUST doing the plastering all the time, there have been many days off and work on other things, but a lot of that has happened whilst waiting for coats of plaster to dry. Having working parties takes a fair amount of organising and preparation, but you can get large areas done pretty quickly this way (and spread the fun and skills around a bit). We had a couple of these, otherwise it was mainly one or two of us plastering.

A common approach is to use local earth, if appropriate for the base coats, which are bulky and won’t show on the final finish and then buy in the final coat mix, with there being lots of colour and effect options and higher chance of it looking like the text book pictures!

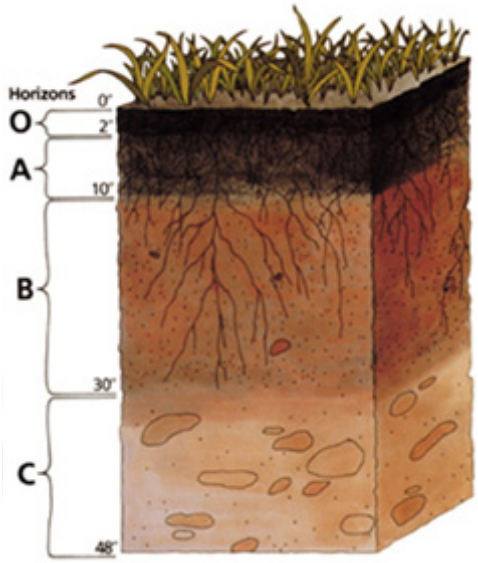
We don’t want to put anyone off clay, many of its weaknesses; like the fact you must keep rain off it, are also its strengths; it is hygroscopic and provides a very pleasant, healthy environment.

Step 2: Soil testing

The aim here need not be a full scale scientific soil composition worked out, but to find out if you have earth that will be suitable for the application. Mainly, we need to see if there is enough clay in there. It isn’t as simple as aiming for a specific % of clay as there are many types, which have differing strengths and properties.

There are lots of tests and the more you handle different soils and play around with them in different forms, the more of an idea you will get for clay content and whether you have found some stuff worthy of taking forward to the next stage – plaster mix testing.

When soil testing be sure that you have dug below the organic and top soil layers (O and A) to the sub-soil (B). This will not smell 'soily', won't be populated with loads of roots or worms and should look pretty different from the humus top layer.



http://soils.usda.gov/education/resources/lessons/profile/profile.jpg

Keep careful note of where the samples came from and the results etc. Try out several locations. Soil types can vary over very short distances, so if you have found some good stuff, it is worth checking that the area will provide enough for the project.

Good signs to look out for when digging:

- The spade creates a shiny surface.
- Cracked ground or water pooling can indicate a clay rich area.
- Observe how rocky the soil is – excessively rocky/ shaley areas will be harder to dig and you'll have to do more digging and sifting to get the amount of earth you need- avoid if possible!.

There are lots of different tests you can do, these were our favourite ones:

The jar test

This is good for getting a feel for clay content and the amount of sand and gravel present. Take out any big stones and rocks, then fill the jar a quarter full with the sample soil. Top it up almost all the way with water, adding a teaspoon of salt gives clearer results but isn't strictly necessary. Shake the jar thoroughly for a good 3 minutes then leave on a flat surface.

The sand will drop to the bottom within a minute or so, you can mark a line on the jar at that point. The water will still be murky with the suspended clay sediment. Leave it for 24 hours and then return – by then most of the clay should have dropped out and you can see how much clay is in the mix compared to sand. There is the 'iffy' aspect of silt with this test, which is difficult to spot – it is a layer between the sand and clay.

The sausage/worm and splat tests
These are fun to play around with and good to get a feel for how well earth will perform as a binder, or how sticky the clay is.

Wet the earth so it sticks together, but not so much you can squeeze water out if it. For the sausage/worm test, roll it into a sausage shape and see if it will stay together and you can hold it up by one end. If you can roll it into a worm 3 mm diameter or less and it still stay together, this indicates really high clay content.

The 'splat' or drop test is similar. This time make your wetted sample into a ball the size of your hand. Drop it from shoulder height onto a hard surface. If it stays together, likely there is a fair amount of clay in the soil. You can also try hurling the balls at a concrete block wall, if it sticks great! Low clay content balls would not survive that test either.

This is an excellent video of these two tests: http://www.youtube.com/watch?v=hh211b8b5FE

The 'biscuit' test
This one is good for testing the strength of the earth and seeing what kind of colour it dries to (not an instant result one though). Again start with wetted clay and mould it into a flattened ball about 1cm thick. Cut a disc/ biscuit shape for each sample (making them all the same size using a mould/ cutter will help with comparisons later). Wait for them to dry out completely (several days). If there is a fair amount of clay in the earth, it is likely the biscuits will have shrunk a little when dried and cracks will have appeared. You can then test for compressive strength by trying to crush the biscuit by pressing the centre between thumb and one finger. If the earth is very sandy or silty it isn't likely to hold, if there is good clay content, it should feel pretty strong.

We found the combination of these tests meant we were confident there was enough clay in the earth to move on to the next stage...

Step 3: Plaster testing for the first coat

So the basic ingredients of clay plaster are:

- Earth with clay present
- Sand
- Fibres: We used chopped straw. Other possibilities for fibres (we haven't tested any of these though, only read about them): coconut fibres, animal hair, flax, dry pine or larch needles, horse manure.
- Clean water

There are additives you might consider using as well, which we'll go into later. The first coat is for making a strong bond between the straw and the plaster. So, we want a clay rich mix as clay is the sticky binder. Being clay rich the plaster will crack, but that's ok, so long as the plaster overall has a good bond to the straw. Cracks at this stage can provide a 'key' for subsequent coats, so can actually be a desirable for a strongly bonded plaster.

Most advice suggests you test things out on a decent area of the wall, like half a metre square. That way the straw is compressed as well. We decided that we didn't want to go through pulling the plaster off the bales again and wanted to get a rough idea before actually putting it on the walls, so we used a spare bale. This worked in that it gave us a rough idea of the ratios of clay to sand and straw.

After waiting for that test to dry, we opted for a 1:1 earth/straw mix for the first coat. It ended up cracking a little more than we expected, from looking at the test bale. In hindsight, testing a larger area on the wall and seeing how it dried first might have meant we added more sand to the mix, but really you don't need to worry too much for the first coat, if it bonds well to the straw, all's good.

Again, like the soil testing, keep a good record of which mix is which and how it was made, so you can repeat the one you want easily!

Possible additives to consider:

Let's get the smelly one out of the way first - manure/ dung. Many swear by using this in the mix, it is both sticky and contains some small fibres, both useful properties. It doesn't smell when dried either. It can also be used to improve water resistance, apparently 10-15% volume of cow manure has been shown to prove itself - so worth considering if doing external clay render. We didn't have a ready supply of cow manure, though we could have gotten some horse poo, we were happy with the mix as it was and happy to keep the plaster mix non-smelly and relatively inert :)

Wheat paste - this could be useful if you have a 'weak' clay or lower clay content earth as it will up the stickiness levels. It can also make the plaster more durable and harder.

Sawdust - can, and has been used in combination with sand as a binder/aggregate. This was a bit experimental for us - we couldn't find anything but superficial references to its effects on the mix. The type of wood the sawdust is produced from must govern its properties to some degree.

Step 4: Prepare the walls

Assuming we are talking strawbale walls, they will need trimming – it is worth trying to get them as straight as you can before starting, and making any rounded edges and contours you want. We found a chainsaw was good for getting rid of large chunks and a hedge cutter for getting a good overall straight finish. We've seen people using angle grinders with a wood carving attachment, and super sharp hand shears too. We saved the straw from the trimming for mixing in the plaster later along with other saved up straw from the building process, the stuff goes everywhere, so worth collecting it as you go.

The usual advice is to stuff all the gaps and holes with straw before starting, which we did. However, to a large extent we found they came loose again when we starting slapping on the slip coat. Hence we ended up dipping wadges of straw in slip as we came across the holes and gaps when doing the first coat.

Install services like electric wires and sockets:

Wire up the electrics, it is easier now than making lots of holes in your lovely plaster work later. Electricians apparently tend to draw a blank and/or do a poor job here because they are unaccustomed to straw bale construction. A few tips for your electrician may be:

* Use the horizontal joint lines of the bales to route cables - a smooth ended stick can be used to push the cable a few inches into the wall.
* For vertical cable runs cut a groove with the chainsaw, and again, just carefully press the cable in there.
* Insist they use generous cable sizes, so there isn't a problem with overheating of cables embedded in the straw.

Sockets and Light Switches:

It’s a good idea to install the back boxes for sockets and switches before you put on your first coat. they want to be mounted in the straw so they stick out about one inch, so the finished plaster comes flush. In our climate (UK) we think it is sensible to try and minimise the amount of metal in the wall, which could potentially form a cold surface that condensation can form on, and crate dampness in the wall (bad!). Thus, we used plastic dry lining boxes, for light switches and sockets in the straw bale wall.

Install the dry lining boxes into the wall by cutting out a little rectangle with the chainsaw for the box itself, then plunge cut the saw in about ¾ the way through (make sure you are not going to cut any bale strings!) in the middle of you rectangle. This plunge cut ‘self seals’ when you retract the saw, but forms a guide hole for a timber wedge, which you can hammer in. The dry lining box can then be nestled into the rectangle and screwed to the timber wedge. This should then all be reasonably firm in the wall and adjusted to the correct level.

To maintain the excellent fire resistance of the wall, the area behind the back box should be pre-coated in thick clay slip, making the area immediately behind the socket (where there will be no plaster), much more fireproof.

You can also cut neat holes, after the event, in the finished plaster, using a multi-tool, exactly as you would in plasterboard, like so:

This second way of doing it, still requires the cable to be routed properly prior to plastering, and is slightly more fiddly (dry lining boxes are not generally designed for super thick plaster) and a little less secure because they are not ‘plastered in’.

Prep Timber

For any surfaces that aren’t straw, such as timber frame work, you’ll need to provide a ‘key’ for to help the plaster stick. We covered the timber up-rights with jute scrim, aka burlap or hessian webbing. We used stainless steel staples to attach it, standard steel is likely to corrode badly during the clay drying time. There were also a number of areas where timber needed covering up but wasn’t at the same level as the rest of the straw wall. We used ‘wood wool’ to bulk these areas out and provide a key for the plaster at the same time. All this will depend a lot on the construction and how you want it to look afterwards though. (You can find a little advantages and disadvantages of wood wool pondering in this post).

Step 5: Gather equipment and prepare resources

So, if you are using earth from onsite, it will need sifting. For the first and second coats this doesn't have to be super fine, through a 1 to 1.5cm mesh is adequate. We made a 'riddler' for large volumes from an old rabbit cage. The earth was easier to riddle when it had dried out a bit but hadn't had the chance to go rock solid (then it needs hammering to break up the clumps). We started out using secondary hand riddlers to get it down to a finer grade, but found that this wasn't really necessary for the first two coats, so long as you didn't have ultra sensitive feet tramping the plaster (*wetsuit boots are excellent*!).

Source in the sand, again for the first coats it doesn't need to be super fine, builders sand is ok.

Prepare the fibres. If using straw this needs to be chopped up, which is actually pretty time consuming/ heavy on tools that aren't really designed for that use. We found an electric grass strimmer in a very large plastic tub works best, but watch out for the vents getting clogged and motor overheating!

Figure out how you are going to mix the plaster. It's possible to hire a special paddle mixing machine, which might be worth it for big quantities. We constructed a mixing pit using 4 bales to make the sides and a tarpaulin to contain the material in the middle hole. We had a lot of fun stomping together the plaster mixes, especially when friends were involved, but it requires energy and enthusiasm for sure and music helps a lot!

Buckets, trugs, wheel barrows and similar are really useful for carting batches of plaster and ingredients around. The number you need will depend on how many people you are likely to have plastering at once. Also having a consistent designated ‘measuring bucket’ thats kept clean, helped us keep track of ratios of ingredients in each batch.

A hose with mist attachment and quality pump action hand misters are really useful for wetting and re-wetting walls and well as cleaning up tools, hands, etc.

Consider how you’ll apply each type of plaster. We found a big masonry brush or soft dust pan brush good for applying the slip coat. Hands were the preferred method for the first scratch coat, with thin gloves to protect from poking straws in nails. The second coat we used hands again, but in hindsight would have combined that with a large long darby plastering trowel and maybe even a big spirit level: this would have made for flatter walls. For the third coat we used standard plastering trowel and hawk (little flat bit of something to hold the plaster on, we just had scraps of ply, or you can buy them). Near the end we needed to replace one of our trowels and bought a good quality large trowel – 355mm x 120mm (14” x 4 ¾”), which we got on well with and was loads quicker for big areas, with a smaller one still useful for fiddly bits. For finishing we used sponges (small washing up ones were fine) and small circles of damp proof course plastic for polishing. A ‘polishing stone’ sounds like it would also have been worth a try, and if you’re lucky enough to have straight walls by the final coat, a plastic trowel would be great for this.

You will need ladders and/or scaffolding to safely reach all the areas that need plastering.

If you’re plastering an area with surroundings that matter, it is worth contemplating the likelihood of mud getting everywhere and taking preventative measures first. We put boards down at the

base of the walls where possible which helped to an extent, but we're still cleaning up now. If you can treating any timber frames etc in the area first with varnish/ paint/ oil before you start is a good idea – those areas have been a lot easier to clean than those which we didn't. You could go whole hog and cover up everything, though remember this is a long process!

Step 6: Get set, go! Slip and plaster mixing in general

Slip

For the slip, you want a nice thick creamy clay and water mix. We found if you simply added water to sifted clay and stirred it up/ used a paint mixing attachment, it was still very lumpy and lots of the clay hadn't soaked in. So, soaking the clay in a paste for a few hours/ overnight then diluting a bit more gives a better result. Given the wet summer we had, we noticed on our second clay harvest that there was some pretty slip-like goo sitting in the fields already, having had horses trampling on it in untold amounts of rain. We were able to slice off the top soil and use the sludge directly as slip - perfect.

Mixing plaster

We honestly tried shovels and all sorts to mix it up, but using the feet, either barefoot or with something like wet-suit booties is by far the easiest, most effective way, combined with flipping and turning the mix using the tarpaulin, to combine the ingredients. Get a few people in the pit with some decent tunes and soon everyone will be enjoying squelching around in the mud. It's easiest to see and hear for yourselves rather than describe in words! So we made some videos, which are on this blog post: http://www.floweringelbow.org/2012/workshop/plastering-the-straw/

The clay needs a while to soak in the water and fully plastisise. We started out by mixing just the clay and water together then leaving it to soak for 4 hours or overnight and then mixing in the fibres later on. We streamlined the process later so we mixed it all together and then let it sit before putting it on the wall.

Adding all the dry ingredients first (earth, chopped straw, sand) and mixing, then adding a good amount of water to get the mix going, then adding a little as needed is how we approached it. It's easier to add a bit more water if the mix is too dry than try and rectify a sloppy mix.

Only mix as much plaster as your pit (and stompers) can handle and that you can apply in the day/ next day – though the clay element of the plaster can be revived, the fibres can make it a bit smelly and start harbouring moulds etc if you leave it more than a couple of days. We found our little pit was just about right for batches of five 12-litre-buckets of earth with the accompanying 5 buckets of chopped straw and water.

The aim with the mixing is to get the fibres and clay combined well and evenly in a sticky consistency that keeps together. We declared the mix ready when it all held together in a big 'sausage' in the tarp' and it appeared to be evenly mixed. It's worth experimenting with how wet you like the mix for getting onto the straw.

Step 7: First coat application

If possible, it would be a good idea to start plastering in the least visible areas first, as it is likely you'll get better at it as you go.

Getting the slip coat well worked into the straw is the first step – you can use gloved hands, but we found massaging it in with masonry brushes and dust pan brushes worked better. either way, It kinda goes everywhere, be warned!

We started our first plastering party getting a load of people applying slip, but if the weather is good and especially if you're not undercover, it will dry out quickly, so having the slip applied a little ahead of the plaster works best.

Then, when the slip is wet and sticky, work the plaster into the wall aiming for about 1cm thickness. We found grabbing a big handful and slapping it onto the wall hard, using the heal of the hand to force it up and into the bales, prodding it right in with fingers and then smoothing in and over (with wet/ slip coated hands) after was our method of choice.

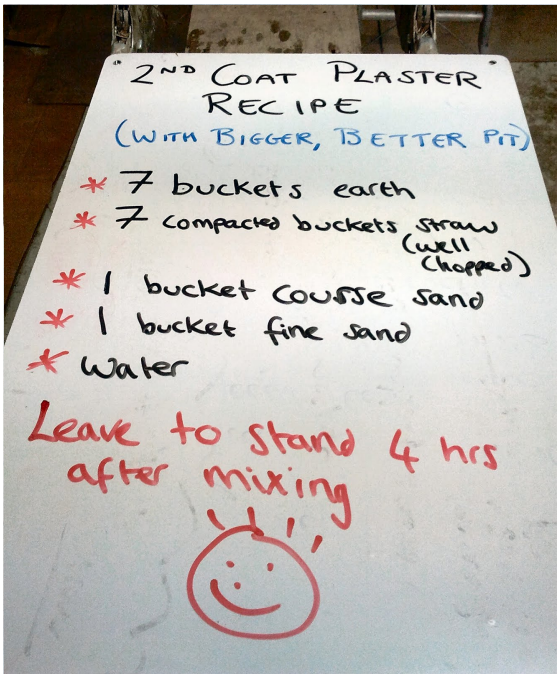
Although this layer will end up cracked and bumpy etc, it is worth trying to smooth it over as you go and try to get it as straight as you can without building up the first layer too thickly.
When you're done, sit back and wait/ get on with other things, while it dries. We had to wait about 6 weeks, but this summer was WET. Whilst it was drying some mould patches appeared, especially on exposed straw and in areas where there was low air circulation (corners). We vacuumed these off and when the wall was drier - they didn't (and by all account don't usually) persist, so don't panic too much if this happens. We also started to use a fan to help dry these patches – although this can mean slightly more cracking, that wasn't a problem for the first two coats.

Another thing to look out for: if you're using straw as the fibre in the plaster mix: you will probably start growing mini wheat plantations on the walls unless they dry out very quickly. Again, nothing to panic about. We quite enjoyed some zen wall-weeding while waiting for the walls to dry out and again, once the moisture has gone any seedlings you haven't weeded away will die off.

Step 8: Second coat testing

This coat is the main shaping and straightening out coat. We still want plenty of clay to bind it all together and make it sticky, but we don't want it to crack and shrink as much. So we have plenty of fibres again, and this time more sand, without it being too crumbly.

The results from the first round of testing might have given some useful clues as to possible ratios to try for the second coat. For comparison our mix was thus:



The sand could have been 2 buckets of the same sand, just we had two types to use up! We chopped the straw a lot smaller this time, and because we were measuring by volume, this effectively meant we had a lot more fibres in the mix.

for the second coat we did a nice big test patch on the wall itself so we could properly see how it adhered to the first coat - though, better to do this in a non-prominent patch as it is hard (not impossible though) to join dry and wet plaster together: even when re-wetting lots, it's tricky. Or it might be better just to chip this off and start again (but if you can do that easily once it is dry the second coat's adhesion is seriously suspect). Make sure you wet the wall well and then apply slip, as you would for the second coat generally, for the test patch.

Step 9: Second coat mixing and application

We used exactly the same method for mixing the plaster, though with a bigger mixing pit, so we could make bigger batches and have more people in the pit.

We wetted down the walls with a mister attachment and hose, repeating when the moisture gets sucked away by the dry clay and then applying slip just before the plaster to have double security of the first and second coats bonding. There should be plenty of cracks and poking out bits of straw to create mechanical bonds as well.

During this coat we went jute scrim/ burlap crazy! We had quite a number of big cracks, particularly around the timber framing and joins of bales, so we filled them in, adding extra straw if really big and used slip to glue patches of burlap to them and then plastered over, the cracks weren't a problem when the second coat dried, so it must have worked! We also wrapped burlap over some of the corners of the walls where there might be more likelihood of damage and high traffic, using slip as a glue. We mainly did this after applying the second coat, but in some areas we had jute scrim sandwiches with the second coat as the filling.

This coat is for shaping the walls. We used our hands to apply it, this time, the focus was not on working it in, and pushing, but putting the energy into smoothing and building the shapes. Again,

we tried not to do layers that were really thick in one go. We're quite happy with the results but in hindsight, using a long derby float at this stage with spirit level checks would have helped get a flatter result, if you're into that kind of thing.

We were going for simple walls with a few curved reveals, but with clay plastering there are lots of possibilities to get creative and make interesting shapes. This is the time to do any sculpting etc, using extra straw/ fibres to build up the shapes.

You can score the plaster with a knife to help the final finish coat bond to the second coat, which is easier done when the plaster isn't dry, but not slick with surface water either. We did this on the inside coat and didn't bother on the outside. Our finish coat seemed plenty sticky enough either way, so the scoring may have been a waste of time, but it isn't too big a task if you want extra peace of mind.

Same applies in terms of drying out, we went through more wheat and mould growing :)

Step 10: Finish coat plaster testing

The third coat of plaster is a bit of a different beast. For this layer, we are aiming for a thin skim of a few millimetres that doesn't crack or crumble at all, and a surface texture and appearance that we're happy with when it dries. Avoiding mould at this last stage is a good idea too as it can stain the plaster. It still needs to stick to the wall and have reasonable strength, so clay and fibres are involved, and much more sand. It is also a much wetter consistency, or ours was, to help spread it on thin. This is the realm of the plasterers' trowel! Plastering with a trowel is surprisingly tiring and blisters/ calluses aren't unheard of.

As this was nothing like the first two coats, we did lots and lots of testing in a much closer to scientific manner!

Our final mix was:

- 1 part earth
- 1.5 parts sand
- ¼ part hair
- 200g borax
- Water

There are lots of things to consider here – you might add pigments to the plaster itself to create the finish effect, you might add some sparkly bits like mica, you could get some posh coloured sand or crushed marble, all of which you'll want to test out. While you're at it, you can test the different options for finishing you are thinking about (paint, colour wash, glaze/ sealer).

You might also want to experiment with application methods/ finishing techniques. The main choice is between a polished, smooth almost marble like finish, or a sponged, textured finish. Different mixes will look and perform differently under different treatment here. We decided that the extra strength and wear-resistance of the polished finish appealed for the internal walls and we'd save our energy on the external walls and sponge that.

Polishing was VERY hard work, see the next step for notes on this!

A word on the ingredients:

Clay/ earth – this time you want this as finely screened as possible, lumps and gravel will be awkward when trowelling on and can make for bumps in the plaster. We ended up spending extra time milling and sifting our earth this time round, it was worth the effort to get a smoother mix.

Sand – We got 'plasterer's sand' from the builders merchant, which is apparently the finest they sold. Well, it wasn't that fine really, not like sand-dune fine, but it did the job ok. You might want to investigate specialist suppliers – though if not local, delivery will make this extra expensive, but the effects created might be worth it.

Fibres - You may or may not need / want fibres, some people use very finely chopped straw which looks pretty as golden flecks, but we were done with clogging up the strimmer and weeding walls! Others use animal hair or synthethic fibres which you can buy or perhaps find locally. After some searching and asking around, it seemed the easiest and cheapest option for us was to get some hair from the barbers shops, which it seems is otherwise thrown away. This is better than from unisex or women's salons because men's hair tends to be shorter, and for this, short fibres are what we want. A little goes a long way. One big bag full form one barber was more than enough for all of our final coat.

Borax – This might not be necessary in your situation and previous experience with how the wall dried for the other coats will be a good indication. As we had a little mould on the other coats, we wanted to take action to prevent mould on the final coat, the tests showed this amount was effective, though we didn't test without, and it may not have been necessary. Maybe you don't need as much, but we didn't have the patience to test out the mould threshold level for borax. There are some health concerns about using this, but no solid evidence and until recently it was touted as a natural cleaning product, so we weren't too concerned.

Let the test patches dry thoroughly before assessing the results and look closely for crack levels. Interestingly, we found that the mix we tried with no hair at all was crack central, adding just a little hair really turned the mixture into something quite different. Perhaps this was a unique phenomenon with the kind of clay and sand we were using, perhaps not! Maybe if we'd added more sand this would have been overcome, but we were willing to go with the magical properties of hair. We tested out adding pigments to both the plaster and the glaze, but in the end decided we liked the natural colour the plaster dried to the best.

Step 11: Third coat mixing and application

This time we used a big barrel-off-cut for the mixing (which was easier than a wheelbarrow) as the mixture is more liquid like. We found that adding some water to the earth, sand and borax

then mixing as you would cement with a spade worked quite well to combine these ingredients roughly. You need to be careful of adding too much water at once, there is a fine turning point between too dry, just right and too wet it seemed to us. You'll get a feel for it when making test batches.

Then we added the hair and a little more water and got stuck in there with hands. It took a fair amount of mixing to get the hair evenly distributed and non clumpy. The first time round we tried things like food mixers, but they didn't seem to help much, fun though, and the plaster did look like an interesting version of coffee cake mixture!

Again we left the plaster for a few hours to let it plasticize and gave another stir before use.

Like the other coats, the wall needs to be wetted down before adding new plaster to help it bond together. The undercoat will tend to suck in the moisture and so wetting will probably need repeating regularly. We were a little worried that a few patches of mould were still around so we also treated them with borax solution before plastering over them, which seems to have done the job.

Given you are likely to keep hosing the wall, we found it a good approach to start at the top so you don't keep wetting the newly applied plaster. Again we got better at it towards the end, so start where it matters least if you can.

To apply we got a load of plaster on the hawk (we were just using squarish scraps of plywood for these) using the trowel. Then push the plaster from the hawk onto and up the wall with the trowel using mainly smooth long vertical strokes. Try and keep a wet edge and minimise the edges exposed when you need to take a break, taking special care to give them a good wetting when starting up again.

As mentioned in the equipment step we found late on, that a big trowel was much quicker and nice to use for large straight forward areas and smaller ones worked well for more fiddly, curvy bits.

It's easy to get carried away, but you'll need to stop every now and again to either polish or sponge what you've already done, it is much easier to do this way that to re-wet and re-work, though this is possible if you need to.

Polishing

We used small circular pieces of damp proof course to massage the clay - smoothing out the trowel marks and closing up the gaps between particles. This is best done when the plaster no longer has surface water showing and isn't soft to touch, but is still workable. Hard to describe, 'leathery' some people call it, but it will be relatively easy to polish if you get the timing right. If it is too wet, you won't get a shiny surface, but a sort of sandy one, if too dry you'll know because you really need to put some elbow grease into it to get it to do anything at all! If it's too dry, you can use a hand mister to try and get it back to the sweet polishing spot, or over a large area, use the hose mister.

One tricky thing is that the plaster will dry at different rates in different spots depending on thickness and the substrate, so judging the timing is tricky.

After the event we heard of using polishing 'stones', this might have been the easier and more effective, we don't know.
As it was, this was hand-hurtingly tiring, so much so, we decided not all of the internal walls needed polishing and we switched to sponging for one of them...

Sponging

Again, easier to do if you time it right, though the window of opportunity is much larger with sponging. We used dampened washing up sponges to gently even out the trowel marks and smooth it over. This creates a rougher, sandy, rustic kind of look.

Then the final waiting game for that to dry before applying a finish. It takes much less time for this coat to dry as it's so much thinner. Meanwhile we found we had a large amount of clearing up to do, mud, mud, mud!

Step 12: Finishing

This is where things can really start to diverge here, many choices and looks to consider. Perhaps the most important thing to bear in mind when thinking about finishes is maintaining the important qualities of the clay plaster that led you to decide to go down this path. 'Breathability' might well have been one of them, in which case you'll not want to be sealing up the walls behind lots of oils and non-breathable products for instance.

If you've put effort/ money/ resources into making the finish plaster coat look special, it's doubtful you want to go covering it up with paint. In which case something that can harden up the plaster, protect it and prevent dusting would be good. There are a few products out there (see resources) which can do just that without impeding much on breathability. We used a single coat of Earthborn Wall Glaze diluted with 3 parts water on the interior. For the sponged section we then topped it with another coat of undiluted glaze too. We tried this on a patch of the polished wall, but thought that looked a bit too shiney. We're pretty happy with how the glaze has hardened up the plaster, provided a water resistant layer and stopped any dusting.

If you want to have a painted finish inside, that is pretty easy, there are many natural paints out there these days, including clay paint and limewash can be used inside as well.

If you have outside clay plaster it might well be covered up with weatherscreens etc. It will likely need some protection, and the wall glaze products are specifically for indoor use only. Hence, we are going for limewash on our 'ambiguously outside sections', it's relatively cheap and has been used in the past on cob buildings etc. Plus it will brighten up our semi-outside area and protect it from the dampness.

Another option in this case is silicate paint, there are a few products out there. We've seen some sob-stories which put us off somewhat (http://bristolgreenhouse.co.uk/site/render.html), but also we found these products were quite a lot more expensive than limewash, which for something that might not work, we weren't willing to go for. If you had reason to believe this might be the way forward, perhaps tester pots would be the answer here. The environmental credentials of silicate products versus lime (less energy intensive production and less nasty to deal with) certainly make it worth pursuing if you can.

INSERT LIME WASH PICoff phone

Time scale

(starting april)
Month 1 - Week 1 Soil testing. Possibly needing a week for samples to dry
Week 2 - Narrow down results and harvest enough for test plaster mixes. Test plaster mixes

Week 3 - Await plaster mix results (could harvest big batches of earth if the right area has been identified at soil testing stage)
Week 4 - Await plaster test results (could be drying out and sifting earth, gathering materials)

Month 2 (test bale/ wall probably not dry yet, so time scale shifts forwards if so)
Week 1 Decide on plaster mix/ go back to testing more. If decided get started! Mixing plaster and slip and application. Times for this very dependant on number of people and size of area!
Week 2 1st coat mixing and applying continued
Week 3 - Wait for 1st coat plaster to dry
Week 4 - Wait for 1st coat to dry

Month 3 - If there are any areas dry/ using a test bale you could start testing for second coat, but this might be jumping the gun.
Week 1 - waiting for plaster to dry
Week 2 - waiting for plaster to dry
Week 3 - waiting for plaster to dry ,possibly testing second coat if first is dry
Week 4 - awaiting second coat results (might need to gather more earth and process)

Month 4
Week 1 - awaiting second coat testing results
Week 2 -If results are in, get started mixing and applying second coat
Week 3 -Mixing and applying second coat
Week 4 - Wait for second coat to dry

Month 5
Week 1 - wait for second coat to dry
Week 2 - wait for second coat to dry (can be gathering equipment and resources for final coat)
Week 3 - final coat testing and waiting for results
Week 4 - test finishes and effects, begin third coat plastering

Month 6
Week 1 - final coat plastering cont.
Week 2 - Wait for final coat to dry
Week 3 - Apply finishes

Rough costings:

This will totally depend on what tools etc you have already, what finishes used etc. But this is what we think it cost in money terms

Tarpauilin with no holes for the pit: 14.99
Sand (1 ton bag) £30
Plastic polishing float £6
Earthborn glaze about £20 a tin x 2 = £40
Limewash £18 20 litre tub x 2 = £36
Large plastering trowel = £18
Food and drink for volunteers about £100
Extra dust pan brush = £1

Total estimate: £265.99

Resources for Clay plastering

http://www.floweringelbow.org: Our blog! If you have any questions or comments please please ask below or on the relevant pages. As well as this set of pages, we made number of blog posts dealing with different clay plastering issues as we went along. The latest one deals with the fire resistance testing of the straw bale, clay plaster combo, but there are others too- have a graze…

http://www.buildnaturally.com/EDucate/Articles/ClayPlaster.htm: Good low down with background of properties, application, and breakdown of each coat. Within the same website, there is some stuff on soil testing.

http://www.buildnaturally.com/EDucate/Articles/Cob.htm#soiltesting and some detailed blog posts of each coat of plaster, including a soil testing video.

http://buildnaturally.blogspot.co.uk/ Nice details on the different coats of plaster.

http://www.greenspec.co.uk/plaster-and-render.php Green Spec pros and cons of different plastering systems

Borax concerns, someone who has looked into it fairly thoroughly. http://www.crunchybetty.com/getting-to-the-bottom-of-borax-is-it-safe-or-not

Videos
http://www.youtube.com/watch?v=K-SX3lm6gu8 - A good one to demonstrate mixing and talking through some additives.

http://www.youtube.com/watch?NR=1&v=8RIAHPKKf5Y&feature=endscreen&noredirect=1 - Part 2, application.

Courses for clay plastering (UK)
Centre for Alternative Technology (CAT) www.cat.org.uk/shortcourses
Clay Works http://www.clay-works.com/blog/clay-plaster-training/

Books
Jones, B (2009) Building with Straw Bales: A practical guide for the UK and Ireland 2nd ed, Green Books: The first edition of this book is very handy generally if straw bale building and has a chapter on plastering and rendering which is a good foundation. The second edition is a little more detailed and more up to date.

Guelberth, CR and Chiras, D (2003) The Natural Plaster Book: Earth, Lime and Gypsum Plasters for Natural Homes, New Society Publishers. Not used this book, but comes recommended if you aren't so keen on internet resources.

Disclaimer

We spent a lot of time putting this document together, we hope you find it useful. It is based on our own experiences and research, but mud has a fantastic capacity to surprise people, us included. There are many different kinds of clay, soil, weather condition, straw possibilities. Many of which we probably can not foresee. In other words, we hope this document will help to give you ideas. but If it all goes wrong... Let us know, but don't blame us. Happy mud splatting!

Contact

We welcome any feedback.
Arrange to come and visit our on-going workshop in Mid-Wales. Chat about straw bale construction, and clay plaster... Please contact us on our blog www.floweringelbow.org.