Plastering strawbale buildings

Straw is a vapour-permeable material: it allows the imperceptible passage of moisture vapour and air through it. If it is sealed by a waterproofing material, it may eventually start to rot. It needs good ventilation around it to stay healthy. In practical terms, this means that anything used to weatherproof or decorate the straw must not impede this breathable nature. The ideal finishes for straw are traditional lime-based plasters or renders or natural clay plasters, since these are also breathable materials, painted with limewash or breathable paints. Both lime and clay are humidity regulators, and help to keep indoor air quality healthy. Apart from them being vapour permeable, another reason we use lime and clay is that they are flexible – vastly more so than cement or gypsum, which are classed as rigid materials. Straw and flexible foundations require flexible plasters to go with them: this ensures durability over time, as all buildings move if they stand for many years, and we don't want them to crack! Finally, a third reason for using lime and clay is that they are sustainable, natural materials that are part of a harmonious cycle in nature, and can go back to nature harmlessly at any point in their life; clay even more so than lime.

Preparing for plastering

This sounds like a fairly innocuous job but can be one of the hardest and most frustrating, depending on the aesthetic finish you require and the quality of your bales. You've done your best to keep the walls straight, you've used the best-quality bales you can find, and you've compressed the walls and put the floors and roof on. Now you need to trim the walls so that you get as flat a surface as possible without all that hairy straw sticking out. This reduces surface area so that you use far less plaster than you would otherwise; it also reduces the risk of flame spread across the surface of the wall while the building is more vulnerable before plastering. Good tools to use for trimming are a garden strimmer, sharp hedge cutters or clippers, a chainsaw (be careful!) or a crocodile saw. The corners and around windows are usually the only places where strings are exposed, so take extra care here not to break them. (Although, as with everything in straw bale building, there's always a way round it – just carefully tie string extensions to each end and then retie the string.) It's amazing how transformed the building looks once you've given it a really good haircut!

Strengthening up round windows and doors

Pay good attention to the shapes you've created around doors and windows. If you had good tight bales then you should be able to shape these with your tools and also provide a sound surface on which to put your first coat of plaster. If not, you'll need to add something to the bales in order to make a good key for the plaster. One way to do this is to make a mix of long straw and lime- (or clay)-rich plaster, and starting at the bottom of the opening work your way up the window or door reveals, building out the edge until you have the required shape. You'll have to leave this a day or so until it becomes hard enough to apply your second coat of plaster. Another option is to use vertical reed matting, fastened tightly into the straw by sewing through from the inside to the outside, or pinning into the straw using barbed hazel pins. You can then apply your first coat of plaster on to the matting. Variations of these two methods can be used above windows and doors, around alcoves and niches, and so on.

Clay plasters

Although these types of plaster are very common in parts of Europe, Scandinavia, the USA, the Middle East and Africa, they are not so well known in the UK and Ireland. Knowledge of their use was almost lost, although we do still have many fine examples of older buildings with a clay mortar binding the bricks or stones together. And of course, our rich heritage of cob buildings, built entirely of clay subsoil, are testament to the durability of clay as a building material. In the last 20 or so years, the use of clay for cob building and plasters has seen a revival of interest as people have come to appreciate its quality and advantages, in much the same way as they have come to appreciate straw, and the two materials work very well in combination.

Clay is the finest particle of earth, created by different types of erosion and ultimately made from the weathering of the mountains. When rocks are subjected to wind, rain, ice and heat they will erode, both in a physical sense and through chemical erosion. Big rocks are broken up into smaller pieces, and in descending order of size we know them as rocks, gravel, sand, silt and clay. Clay and silt can often be difficult to distinguish but there is one very big difference between them, which is that clay particles are extremely cohesive whereas silt particles are not.

Testing clays

In this part of the world, pretty much any type of clay that you find can be used for plastering, usually with the addition of some sand and fibre. If you're pretty sure you've got a clay subsoil, you still need to test it by making up different mixes of clay, sand and fibre, until you can decide what the optimum mix is for your plaster.
To be usable, clay or clay subsoil needs to be either very wet or very dry. In the UK and Irish climate it's almost always somewhere in the middle – which means that making your own plasters, renders and cob is going to be hard and time-consuming if you just dig the clay up from your back garden. It can be mixed from wet or dry clay, or bought (wet or dry) from a manufacturer.

Using clay plasters on straw

Clay is often used for internal walls, but would not generally be used on the outside as a finish except in sheltered positions, or where you have a veranda, because rain would erode it fairly quickly. Prepare your straw walls for plaster first, using a long straw mix where necessary then apply the first coat of clay.

First coat (key coat)

This is a slurry made from pure (or almost pure) clay. Mix up the clay at least 24 hours before you want to use it to make sure it has absorbed all the water it needs to and is really nice and sticky. Dry clay can just be put in a tub with water and mixed using a hand-held plaster mixer; claggy clay should be broken up into small lumps and may need to be soaked for a while before it can be mixed. Often it will need mixing a bit, leaving to soak, then mixing again before it is all a uniform thickness. This clay slurry should have the consistency of thick cream. (Lovely on your hands!) Apply it by hand (with or without gloves; it's not toxic) direct to the straw, rubbing well in so that all the straw is covered. It's rather like massaging the straw. You're not trying to hide the straw with this coat, only to provide a good key – something for the next coat to hang on to.

Second coat (body, base or backing coat)
Wet the first coat down so it is a bit sticky again before adding the second coat, but don't wash it off! This is the coat you made your tests for, so mix up lots of it and call all your friends in, as the work is a lot of fun. The mix should have lots of finely chopped straw in it to give it tensile strength and stop it cracking. You can use a fairly gritty sand, with 4mm (1/6") or even 6mm (1/4") maximum sized grains as long as it is sharp and well graded (has a good range of sizes in it). Use this coat to even out any undulations: you can apply it quite thickly, 25-30mm (1-1¼"), and should try to get a flat surface. All this work can be done by hand, but using tools will give a flatter finish. It's best not to use a steel trowel too much as it can draw the clay out of the mix and leave the surface dusty. A wooden or plastic float is best, used to rub the plaster well in. If you're not experienced at plastering and you want a flat surface, now is the time to bring in a professional plasterer, as it does take skill and years of practice to be able to make a flat wall. However, if you're happy with an organic look, then just do the best you can. At least with clay it won't dry before you've had time to really play with it, move it around, and flatten it out.

Finish coat (top coat)
It's not always necessary to apply a final coat. If you're happy with the finish on your body coat you can simply rub it up with a sponge the next day, or smooth it off with a wooden float, or rub it up with a small round stone. There are lots of different finishes and textures you can add to your plaster, but this is not the place to go into them. It's really beneficial and a lot of fun to go on a course and play and practice with everything that's possible before you make your final decisions about your own plaster. If you do use a final coat then choose a fine sand to give a smoother finish.

Decoration
You can choose from a range of clay pigments to make coloured plasters that won't need further decoration, but if you do want to paint the plaster then limewashes (see Chapter 11) are perfect, giving a variegated hue and plenty of natural colours. There are also clay paints, and other breathable paints in many colours. It's important to use vapour-permeable paints and finishes to keep the plaster (and straw behind) healthy. To protect outside surfaces from the weather it is necessary to use several coats of limewash, but to protect against driving rain something more is needed. There are many practices from the past and from other countries that have been used, such as adding 1 per cent linseed oil to the final coat of limewash to give it a bit of extra durability. In Arizona they add small amounts of cactus juice to it for the same reason Once you get hooked on clay you'll discover all sorts of interesting facts about it.

Professional use of clay plasters

Clay is not yet a mainstream plastering material in the UK, but it is growing in popularity. Many professional plasterers are adding clay work to their list of skills and becoming familiar with its properties, and some FE colleges are offering clay plastering as an option. It won't be long now before we have a more widespread take-up of clay and clay products throughout the construction industry, as more people become aware of the need to use sustainable materials, and of exactly what this means.

Clay plasters work brilliantly well, people feel happy working with them because they are truly natural, and they make sense as a material. You can see where you've been; there's no time pressure as they dry quite slowly; you can play around with them, make different textures, shapes and colours; there's no waste as anything that is dropped or dries out can just be remixed with water; and they're not harmful so you can work without protective clothing, as long as you don't mind being spattered with clay!

We use them because they are natural, non-toxic, beautiful, cheap, come from the Earth and go back to the Earth. They regulate humidity in the air (unless you're stuck in an airtight room with a drying source of heat, e.g. radiators!) at pretty much the optimum level for human health. They prevent condensation, deal very well with humid conditions, and help generate that cosy, genial ambience that is associated with straw bale houses.

Lime Plasters

Limestone and lime burning

The raw material for all lime mortars and renders is naturally occurring limestone, shells or coral, which is calcium carbonate ($CaCO_3$). It is made into lime putty by a relatively simple process. Traditionally, the limestone is placed in a specially built kiln (sometimes a pit or a heap) and layered with fuel such as coal or brush and burnt for about 12 hours. At the end of the burning process, whitish lumps or powder is left, this is called calcium oxide, 'lump lime' or 'quicklime', it is very reactive and can be dangerous: it MUST be kept dry as it reacts very quickly with water – even the water in the air or the moisture in your skin – to form calcium hydroxide, which is the first step to reversing the process back to calcium carbonate again. Just as making quicklime needed heat, the reverse process PRODUCES heat. **For this reason, never add water to quicklime. Always do it the other way round and add quicklime to water, or it could explode!**

Quicklime plus water gives us . . . lime putty!

Protective clothing, goggles and a mask should be worn when working with quicklime. Alternatively, lime putty can be ordered from a supplier, ready-made in airtight sacks or tubs.

How to use lime render and plaster on straw

The internal and external faces of the straw walls should be given a very short haircut –trimmed down to a neat finish. All the long, hairy, unkempt bits of straw should be removed.
The reasons for this are:

- to reduce the amount of plaster required by reducing the surface area
- to even out any large undulations in the surface of the wall
- to minimise flame spread over the surface of the bales, in the event of a fire before plastering.

There is no need to wrap the straw in stucco or chicken wire first, as many cement-rendered buildings in the USA have been. This is totally unnecessary and a waste of time! Both lime and clay stick extremely well to the straw, particularly if applied by hand or sprayer.

The lime plaster or render should be beaten and worked to a stiff consistency, so sticky that it can be held upside-down on a trowel. There should be no need to add water to it, as this would increase the risk of shrinkage cracks.

The first key (or scratch) coat on to straw is usually lime-rich to make it stickier, often a 2:1 sand:lime mix. The next two coats of plaster and render contain chopped fibres such as straw or hemp, well distributed throughout the mix, to give it much greater strength – in the same way that straw is used in mud plaster to give it tensile strength.

For straw bale walls, it's usually best to apply the first coat of lime by hand (with gloves, as it's caustic!) because it's more fun, and because the straw tends to flick the stuff back at you if you try to use something like a float. It is not a good idea to use a steel float on a lime render, as this polishes up the surface and closes up the texture, thus preventing humid air from penetrating into the body of the render.

It needs to be well rubbed in, to get a good key (join) between the straw and the lime. It's important to encourage the render to cure (go off) from the inside out, not to let the outside skin carbonate too fast: the way this is done is to keep the whole thing MOIST (not wet). The surface should not be allowed to dry out; it will naturally take two to seven days before two-coat render feels hard. The first coat should be as thin as possible, leaving stubbly bits of straw sticking out, and will probably be ready for the second coat on the next day, unless there are pockets of thicker mix in places. A rule of thumb, literally, is to put the second coat on when the first is hard enough that you cannot push your thumb into it. Wet the walls down with a mister, not a hosepipe, before putting the second coat on, and work it well in, either with hands again or a wooden float. Keep the render or plaster damp by misting it, unless you have ideal drizzling weather! It is often not necessary to do much misting inside for a plaster as the wind and sun don't dry the internal air in the same way as they do outside. Keep going over the wall with a wooden float, rubbing in the mix and misting it. **It is probable that lime renders on straw bale walls will carbonate to a greater depth than on stonework, because the straw itself is breathable, and so the back as well as the surface of the render has access to the air.** Usually lime coats are limited to 10-12mm (3/8-1/2"), as on most surfaces a greater depth would not carbonate fully, but we think this can be increased on straw.

Aftercare for lime renders

Over the next few days, protect the render from direct sunlight, driving rain, forceful wind and frost. Often this can be done by hanging sacking from scaffolding, and keeping it moist to create a humid atmosphere close to the lime. The render will probably crack, and needs to be reworked several times over the next few days to squeeze and compress the sand particles together, before the surface hardens. The cracks are caused by shrinkage as the excess water in the mix evaporates. The aim is to compress all the render so that there are no air spaces left. The misting is not to add water to the render, but to make sure that carbon dioxide can be carried into the thickness of the layer via the medium of water. It needs to be protected from frost for about three months, so exterior lime renders should only be applied between the end of April and mid September, unless the local micro-climate is frost-free for longer.

Internal plasters can be applied at any time of year as frost is unlikely to attack them inside. However, no render or plaster will carbonate if the temperature drops below 8 degrees Celsius,

and although this will not damage the render/plaster, it will mean that it takes longer than the usual three months to carbonate. Internal walls, plastered in winter in an unheated house can still be soft to the touch three months later. This then begs the question, would it have been more sensible to wait till spring?

Limewash and decorating

Limewash is made from lime putty, diluted with water. It is very thin and watery, and should be applied in many thin coats, left to dry overnight each time, but it's much quicker to apply than ordinary paint because of this wateriness. Putting it on too thick can make the surface powdery. Applying limewash to the building once it's been plasteredor rendered should be seen as part of the plastering process. If there are any tiny cracks left in the finished plaster, the limewash will seal these up. Over time, lime plasters have a self-healing effect. Any cracks that do appear tend to close up as the lime carbonates, because the calcium carbonate molecule is bigger than the calcium hydroxide one.

Externally, walls that take a lot of weather, usually the south-west side, should have about five coats of limewash to protect them. The rest of the building may need only three, although the more coats you apply initially the better the weatherproofing will be. How frequently the walls need re-coating will depend on the weather. The sheltered side may need limewashing again only every five years, whereas other parts may need to be done more often. In England there was a tradition to limewash houses on May Day each year. Natural pigments can be added to the limewash, giving a large range of beautiful colours with a visual quality that is quite different from modern vinyl paints. Limewashes are more variegated; less stark and uniform. Lovely!

Active silicate paints

These are waterglass natural mineral paints that bond with the silica (sand) in the plaster or render and are an alternative to the limewashes. It's very important to use an *active* silicate paint, and to make sure that it does not contain any synthetics (good examples are Beeck and some of the Keim products), otherwise the paint will not be vapour permeable. These paints differ from the limewashes in that the colours are uniform, not variegated, but they also provide much better weather protection and durability and are recommended for exposed buildings, or those where regular maintenance may be a problem, as they do not need to be reapplied for about 15 years, unless you get fed up with the colour!

Maintenance of lime renders and plasters

As long as a lime render is regularly lime washed, or has had mineral paint applied, there should be no other need for maintenance, unless something else is causing problems e.g. a broken gutter or an overgrown garden. Otherwise it behaves much like straw; let it breathe, and it will take care of itself. Lime renders should be limewashed every 2 or 3 years at first, and it may need to be once a year on the most exposed wall, but as time goes on the need for this is reduced as the render becomes stronger, more like the limestone that it came from, and limewashing becomes a surface decoration rather than a protection.

If you do need to patch in a section of render for any reason, take out any loose material, dampen down the surface of the hole, and apply fresh render in thin layers no more than 12mm thick, working well into the sides. The patch will adhere well to the rest of the render because it's all the same stuff. Limewash over the top when done. Old render can be pounded up and used as well as/instead of sand for aggregate in a new mix.