Strawbale Wall Raising

Preparation

Before laying the first bale, make sure that everything has been prepared that can be, that all the carpentry is made and on site or is ready to be delivered – including the wall plates, floor joists, insulation, roof trusses, windows and doors, etc. When you begin with the straw you need to be able to build the walls, keep them protected from bad weather and put the floors and roof in place as fast as possible. It's always good to plan and prepare well.

The foundations need to be completed, with a base plate or structural box beam on top (depending on your choice of foundation) with pre-drilled noggins or cross pieces (dwangs in Scotland) to take hazel stubs, and insulation between the timbers of the plate. You need to think about how the walls are going to be compressed if you are using pre-compression techniques, and make sure you have made provision for this. If you are using structural door frames they should be fixed securely to the foundations or base plate before the straw is laid, and any fixing posts for windows and doors also need to be in place. Window boxes, as an alternative, are built into the walls as they go up and are pinned through the base with hazel. For load-bearing buildings, it is useful to place temporary braces at corners and along long lengths of wall to provide a guide to keep everything vertical.

Building

The first course of bales must be placed slowly and carefully, as these provide the template from which the walls will emerge. It is important to make sure that the bale is placed centrally on the base plate, lining up with the outside edge of the timber, and securely pinned by hazel stubs. You must follow the bale plan accurately, or you might end up with only a half-bale space left in the middle of the wall (which is structurally unsound) as different teams set off from different corners!

Bales go together like giant bricks, a second-course bale straddling equally the joint between two lower bales. Work from fixed points into the centre of each wall; place the corner bales first, and those beside any fixing posts. Make sure that corners are vertical and don't move as more central bales are placed. Use a spirit level or corner guides! Bales need to be hand picked to ensure a snug, not over-tight fit.

There are usually some small gaps at the joints between bales, even after the most careful dressing and customising, and these must be stuffed (but not over-stuffed) with straw after every course of bales before beginning the next. And, finally, there is no substitute for climbing on to the bales and jumping hard between the strings! This helps with compression (bales) and depression (humans).
Remember to stay calm, work together, and be aware of what other teams are doing on their sections of wall.

Pinning

We usually use hazel for this job because it grows in long straight sticks that can be coppiced from the stump every five to seven years without killing the tree. Sweet chestnut can also be used: the choice depends on which part of the country you are in and which tree is most common. What we're after is a tree that has some flexibility but not too much (willow is too flexible), grows straight, can be harvested regularly, is durable and relatively cheap; so other trees could be OK too. Hazel has been used since the Stone Age for building, so we're pretty

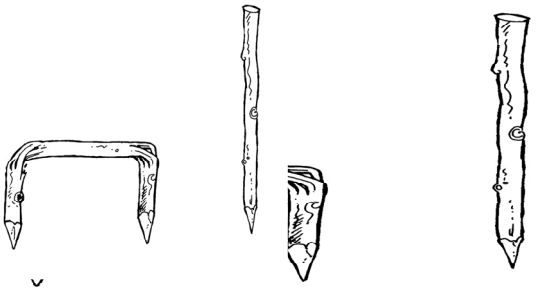
sure of its qualities! Think about wattle-and-daub panels – they are mostly made with hazel or sweet chestnut wattles and have lasted rather a long time.

Stubs

These are short lengths of hazel that are fixed into holes in cross noggins of the base plate, to secure the first course of bales. The holes are usually 32mm (1¼") in diameter and the hazel is 350mm (14") long by 32-38mm (1¼-1½") diameter. It's important that the hazel is long enough to only embale the first bale and not stick out above it, for obvious rather important health and safety reasons. It should be whittled at the fatter end so that the natural but irregular hazel fits tightly by friction into the regular drilled hole. Two stubs are used per bale, placed centrally, one-third of the way along each bale. It should be possible to see the bale plan by the location of noggins and hazel stubs in the base plate. Once made, the stubs should not be placed until directly before placing the bale on to them, to avoid vampire-type injuries. Stubs are also used like giant wallplugs before plastering, knocked into the centre of a bale wherever you want fixings for sockets, radiators, kitchen cabinets, etc.

Staples

We used to use hazel staples at every radical change of direction, such as at corners, or at delicate points such as where the bales go above windows and need attaching to their neighbours. Nowadays this is done only if the building requires it, such as when the bales are a little less than perfect, or the design needs a bit more



made from 1m (3' 3") lengths of ') in diameter, by splitting the fibres ımer at the point where you want t breaking – and then twisting and used by basket makers and is very ɔ make sure that you have split the you twist and bend and don't just

Internal pinning

Once the walls are four bales high, they need to be pinned with lengths of hazel. Again, sometimes we don't use these pins at all, but they do help a lot for self-build when people are not too familiar with bale building. Also, they give the wall integrity, so that each bale acts together with the others instead of independently, and this can be very important when building in areas with lots of wind (engineers call this high wind loading). The pins are as long as the height of four bales, less 50mm (2"), which is 1.35m (4' 6"), and they should be 38-50mm (1½-2") in diameter, straight, sharpened at the narrow end and without excessive knobbles. There are two pins per bale (dividing the bales into equal thirds), driven down through the centre of the bales to overlap with the hazel stubs that stand up from the foundations. The same length pins are used on the sixth course (unless there is no seventh, in which case they go through the wall plate instead), building up a series of overlapping pins throughout the wall system. The walls of a single or ground floor are usually either six or seven bales high, depending on the design of the foundations and the type of floor installed. First floors are generally from three to six bales high, but can be higher. The same pins but slightly less in diameter are used to pin the wall plate down to the straw. Use a template hole beforehand to make sure that each pin will actually fit through the hole drilled in the wall plate.

Pinning windows and doors
Underneath or above windows you may need to use shorter pins, as there are usually less than four bales at this point. Window and door frames can be pinned in sideways to the bales, but only after all settlement has stopped (or the settlement might snap the pins). If you are using fixing posts instead of box frames this won't be necessary.

Pinning for frame designs
All of the above techniques may need to be used for frame methods, as the bales must be stabilised somehow before plastering. However, often the frame prevents the use of pins as there is a beam or a roof over the straw such that pins cannot be inserted. In this case, other methods need to be used. These include fastening some sort of mesh to the posts and pushing the bales tight against it. In the US this may be chicken wire but we strongly advise against using metal on the straw and in the render or plaster. The mesh can also be fibreglass but preferably would be large mesh (8mm squares) hessian/jute.

External pinning for frames
Here the pins run from base plate to the wall plate in one continuous piece. (Remember to trim the straw ready for plastering before the pins are put in position – it makes the task of trimming quicker and easier). The pins are placed externally to the straw, again two per bale, inside and outside the wall, four per bale in total, e.g. about 350mm apart and opposite each other. Grooves are cut into the straw with a tool such as the claw on a hammer, so that the pins are flush with the straw. Pairs of pins on either side of the wall are tied together through the straw at each course of bales with baling twine, and are fixed to the base and wall plates with screws or nails. The pins are covered with hessian to provide a key for the plaster, either before or after placement, and can either be hazel, chestnut, etc. or sawn softwood. This is also a good method if you have really poor-quality bales but want to use them anyway . . .

Buildings with a frame
You'll need all of the above skills and knowledge to work successfully to infill your frame with straw. Ideally, you will have designed your frame to fit the bales, rather than the other way round.

Depending on the type of frame construction, frames can be built off-site and then assembled once the foundation is finished, or built in situ. All framing, including temporary bracing and propping, is done before the straw is placed. The roof is also constructed, with membrane and battens to provide waterproof shelter, leaving the final roof covering until the straw is in position.

Bales are laid using the methods described above, on to a timber base plate using hazel stubs. They are also pinned where possible internally, and externally where not. Usually, bales will be notched around posts so as to make sure walls are airtight and strong, but a particular problem in frame buildings that have not been designed with the straw in mind is that posts are too large or in the wrong position to be notched into the bales. In this case, hessian about 200mm (8") wide by 600mm (2') long can be attached to the posts and laid into every course of bales to provide friction that will prevent the bales from sliding beside the posts in high winds.
Bales in infill designs can also be laid on edge. They are harder to stack up vertically, and can't be notched very easily because the strings are in the way, but it reduces wall width by 100mm (4"). Altering the orientation has almost no effect on the insulation value.

Design tips for using straw

- Raise the first course of bales up from the ground by at least 300mm (12"), preferably 450mm (18"); put a 450mm (18") overhang on the roof to protect the walls from rain, and you won't go far wrong. 'A good hat and a good pair of boots' – just like cob buildings!
- Distribute the loads as evenly as possible around the whole building. Never use point loads.
- The roof weight must be placed on the centre of the walls, not on one edge or another.
- The key to durability with a straw bale house, as with any other, lies in good design and detailing, quality work, and maintenance when necessary throughout the building's life.
- Avoid using metal in the walls if at all possible – and if it's not possible to avoid using it, wrap it in hessian or something similar, since it is a cold material and may encourage warm, moisture-laden air from the inside of the house to condense on it.
- Load-bearing houses are subject to settlement as the straw compresses under the weight of the floors and roof. Allowance for this must be designed in by leaving settlement gaps above doors and windows, even when using pre-compressive methods.