STRAWBALEHOUSE © Brian Waite

Designed in 1999 as my low energy, low carbon retirement home. I decided upon strawbales as the most sustainable, cost effective way of providing enough insulation, however I then needed to overcome the disadvantages, I perceived, strawbalehouses to suffer.

(1) Considered by most (particularly my wife) to be quaint but insubstantial and so inconsequential.
(2) Research indicated that moisture levels could be a worry in UK climate.
(3) Structural bales were not acceptable to me, as an engineer, so a simple but substantial, cost effective structure was needed with as little embodied energy as practical.

Whilst these problems set the parameters for my design, I was becoming aware that many others were interested in sustainability and conserving energy so the idea to supply a self-build kit home, particularly to help get first time buyers into home ownership, was born.

The Design;

To exploit the cost savings of mass production I have reduced the main structure down to a single curved "I" beam. Two are then paired together to form a bowed "A" frame (cruck) and then repeated at one bale length increments (1meter) for whatever length of building is required.

Complete structure

Second cruck going up

There is nothing simpler and stronger than an A frame and the bow is to allow a more viable upper floor. The bales rise seamlessly right up to the ridge thereby insulating the whole building in one go with no awkward change from vertical wall to horizontal ceiling (a structural and thermal weak spot). The result is a vaulted interior space totally free of structural restrictions that can be divided, or not, as the owner wishes.

The building can easily be added to as the family and/or finances grow.

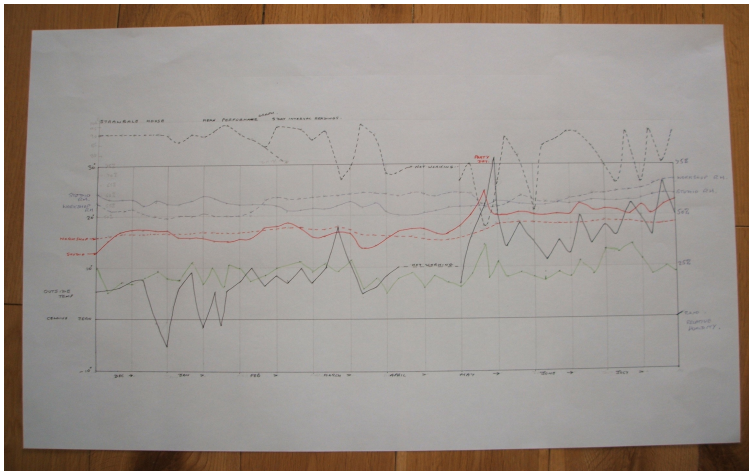
The crucks are set on a wall plate that sits upon a low plinth wall of local materials which can be varied in height to cope with sloping sites and alternative configurations – for instance at 900mm high it allows a 6 meter floor width on both levels. If an upstairs is not required then it can be reduced (for workshops, galleries etc.), however it must be high enough to keep the bales well clear of the splash-zone and accidental interior or exterior flooding.

Should an end elevation face South, I recommend the balcony over a porch arrangement as I have in my prototype. The recessed glazing reduces the mid-summer Sun penetration to zero yet the mid-

winter Sun reaches right through to the North wall for maximum solar gain. (see photos and drawings). Should the five bay dormer window be possible, and the buildings orientation suitable, the straight roof over the dormer (30 deg) is the size of a 4 KW PV array.
UK made, off the shelf, cambered clay tiles suit the building's curvature and, because they cover every bale, the building copes well with exposed locations. To tackle the moisture level worries (aim 2) I have exploited the pressure differentials at different heights to create a strong passive draught system that draws air over the, lime rendered, exterior of the bales. The result is moisture levels that are less than half those in other SBH's located in dryer parts of the UK – the dryer bales make them an even more effective insulant both for cold and heat. Because of the tile cover, chill factor has no part in the "U" calculations. The 380 bales in my prototype (110 M2 floor area) have captured about 3½ tons of carbon. ("U" = 0.104 watts/M2/deg C)

Aim (3) I haven't gone for the cheapest option of using bales structurally because I am sure that straw must lose some structural integrity over time which is certain to result in settlement that will transfer the roof loads onto the lime plaster/render – absolutely unacceptable to this engineer. Also it's been done many times so offers nothing new.

A simple multi-functional device (patent pending) supports each and every bale, thereby eliminating settlement; it also tilts each bale to precisely match the curvature of the wall/roof; it speeds erection of the structure and resists the natural outward thrust of the arch.
I was 68 years when I built my prototype (2010/11) with absolutely no assistance, other than the internal lime plastering, using only a £20 hand winch (see photos) and the most expensive item on site, apart from my wife, was the cement mixer - so definitely no heavy lifting gear needed.
Although the cruck beams are 7.3 meters long x 575mm deep, and capable of lifting a truck, they can be moved/carried by one person.
A 7 metre floor width option is also available - whilst still using the standard curved beam.
A Tee/L plan option has been designed, but takes away the basic simplicity, so is not yet off the drawing board.
I think by now most people are aware that strawbales are not a fire risk (in fact Australian and Texan fire reports actually recommend SBH's for bush-fire prone zones), neither are they a vermin sanctuary (behind 25mm of lime!) and they are definitely not short term.
In fact longevity is the best way of further diluting a building's carbon footprint so to that end, it's designed up to a quality rather than down to a price - cheap can be very expensive.
e.g. there are no nails - only stainless steel screws are used.
The low weight of the build and the width of footings, dictated by the width of the bales, means very low soil loading (37Kn/M2) which reduces the need for deep footings, in fact earth-ship type footings using old car tyres would be a viable option. 120 mph wind speed loadings have been included in the calculations that show the structure never exceeds 1/3 of normal working stress.
Heating: - After the lime plastering my prototype building needed drying out so two 200watt dehumidifiers were used, during daylight (from PV's), and their heat pump effect (latent heat and all that) was enough to keep the building at a constant and comfortable temperature (see data sheet below). However now the building is dry the dehumidifiers no longer release any heat so a fan heater (and immersion heater) as and when needed have been my only heat sources.
Theory says the building's heating requirement is 60 watts/degree C (The prototype is 110M2 floor area & a contained volume of 280M3) but the actual performance is indicating much better - probably because the theory calculations did not include solar gain (through glazing) and the straw being extra dry (<8%) performs better than expected. Also there is some experimental quadruple glazing but the building is certainly capable of "passive house" performance.
The water solar panels (under the balcony handrail) are connected to pipes within the ground floor slab and masonry stairs which together form a considerable thermal mass. However I have no data for this set up because they have only just been connected, I also don't have figures for the inclusion of a planned HRVU which my pension won't stretch to as yet.



Quadruple glazing with Winter and Summer options

Data sheet:- is a compilation of four electronic data loggers and a small weather station; solid black = outside temp.
dotted black = outside humidity. Solid red = upstairs studio temp. dotted red = downstairs workshop temp. Solid blue = studio r.h.
Dotted blue = workshop r.h. Green = dew point.
Note 1; Although treated and monitored as a separate house it is only part of my home with the upper floor serving as my drawing studio and guest accommodation over a wet-room/loo, entrance lobby, small kitchen and a workshop.
Note 2; The water solar panels are set nearly vertical to maximise winter solar gain, i.e. when it's needed.

I am experimenting with quadruple glazing on some of the windows, which utilises standard low emissivity, off the shelf (i.e. not imported & so easily replaced), double glazed units which provide a Summer (DG) setting and a Winter (quad G) option (photo).
To make the building control process easier I have gone for "type approval" so only site specific details will need to be cleared with BC on future builds.
The design is intended primarily for self-building either as an individual or collectively - indeed using self-build homes to self-build a community seems a good idea.
It is an immensely strong structure but my success in overcoming aim (1) is, of course, subjective. (at least my wife is converted – phew!) and only time will tell if straw insulation will make it into mainstream homes.

Nearly there - but keep it tidy – bales aren't a fire risk but loose straw is.

Winter Sun in 1st floor studio

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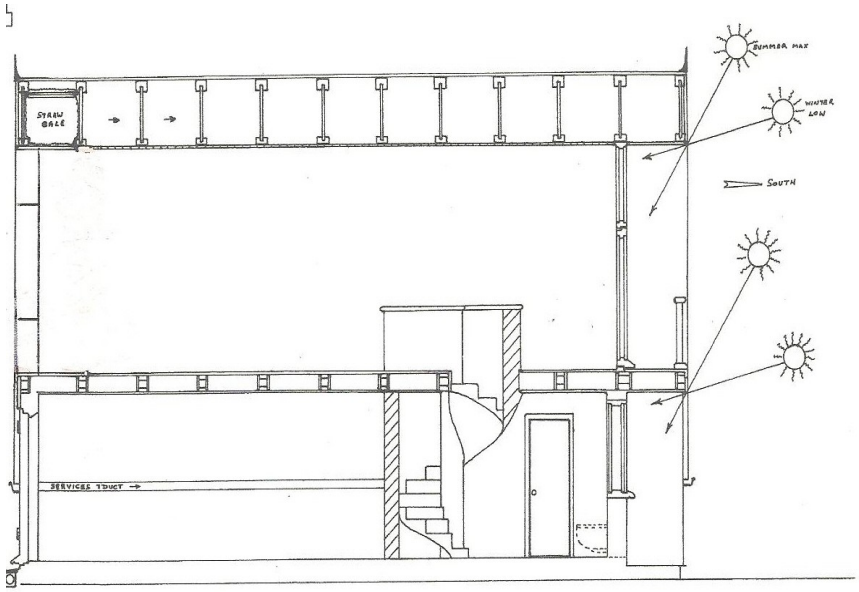
C.V. - Since an apprenticeship at Aston Martin Cars (1958 - 64), I have been a freelance design engineer designing all forms of vehicles from formula one race cars, rally cars, fun cars to electric vehicles (1972).
In 1979 I designed and patented the "Car Chair" system which enables the wheelchair-bound to drive (or be a passenger in) an unmodified mass produced car without having to leave their wheelchairs. It was a finalist in the Prince of Wales Industrial innovation award (1981) & The Duke of Edinburgh Industrial Award (1982) and was produced until 2008.
I retired in 1986 and became interested and involved with medieval buildings – the inspiration for my strawbalehouse.



Sectional side elevation is to show how to control the mid-winter & mid-summer Sun penetration by recessing the glazing both to the balcony and the ground floor.

The section also shows my personal choice of stairway.

Due to building line restrictions my prototype's balcony is lacking in useful depth so I suggest that it be cantilevered out for another meter at least and the ground floor be brought forward a section.
This would add 6M2 floor area to the downstairs but still control the Sun's penetration.

In this prototype building I have also tried a number of smaller innovations.

(1) Low cost quadruple glazing which the depth of the strawbale walls makes practical.
(2) The 20ft (6M) unsupported first floor is achieved with only 240mm deep "I" beams by bonding 18mm ply top and bottom. This arrangement means the ply is taking 90% of the load thereby giving a loaded floor deflection about 1/3 of that recommended without losing space to deep beams that would otherwise need to be 600mm. 23+ft (7M) floor width is also available.
(3) I have modernised the medieval method of scaffold by installing my take on the "putlog" whereby normal scaffolding is hung rather than supported from the ground.
(4) The frame's curvature and the use of T&G sarking boards makes permanent longitudinal wind bracing unnecessary.

It might be noticed that the buzzwords "eco" & "green" have not been mentioned – this is because I consider them a bandwagon that has come to mean double the price for half of the quality.

Summary of the main innovative features of strawbalehouse:

Elegant and simple "A" frame that is designed for mass production to reduce cost.
Single handed easy erection without needing heavy lifting hire.
Bales insulates walls and roof in one sweep.
Designed for strawbale insulation but any insulation is possible. An expanded polystyrene insulated option will soon be available offering 40% improved "U"
i.e. 400% better than UK building regulations requirements.
Vaulted interior completely free of obstructions.
Tiles cover every bale to give total weather protection.
Unique bale retaining system that eliminates settlement.
Passive draught system to ensure bales are kept dry.
Can be any length, is of variable height and easily added to at a later stage.
Extra width available and a Tee/L plan options to be made available later.