Straw
- The Next Great Building Material?

Straw, as a fibre, has been used as part of building materials for thousands of years. Today it is still being used in and outside Australia, and no huffing and puffing will harm it. ***By Annelie Wressmark:***

When the idea of building houses out of strawbales began gaining popularity about twenty years ago, you could hardly mention the idea without coming across jokes about the three little pigs. Today, hundreds of houses later, straw is being taken a little more seriously. Books on the subject are selling like hotcakes, and even code officials in some areas are accepting this building system.

Strawbale started as a poor man's material

Strawbale construction was first invented by homesteaders on the plains of Nebraska , USA in the late 1880s. The early settlers found that the soil and turf of the area was not suited to the construction of traditional houses and there was little timber for timber or log homes. With the invention of the hay press and hence the production of hay or straw bales, the homesteaders used bales, rendered for weather-proofing, as building blocks, to construct their homes.

As a form of cost-effective construction, many homes were built in the load-bearing "Nebraska style" and were fairly common on the Nebraska plain and adjacent areas. The expansion of the railway system made other materials, such as timber, available. These houses were seen as sign of wealth and the strawbale variety fell out of favour; they were seen to be "poor man's" homes.

It wasn't until the 1970s that strawbale construction was brought back to mainstream and was mentioned in the book "Shelter", a publication on alternative construction methods and materials. Shelter had a photo of an original Nebraska home and a paragraph about the history of the strawbale. Embraced by alternative design and building practitioners, there were a few attempts at this form of construction.

This article caught the attention of some designers and builders in California and Mexico in the '70s, but it was not until the 1980s that the permaculture movement in New South Wales became interested, and these enlightened people decided to explore strawbale construction.

Today strawbale is a re-introduced material

It was a learning curve for all and much work has been done since then to develop best practice construction methodology for successful outcomes. It is evident by the number of technical books that are now available.

Now that some of the earlier experimental strawbale houses have proved to be viable, the practice has spread around the world. In most States and Provinces in Canada and USA strawbale homes have been approved by local authorities and built by owner-builders or contractors. They have also been built in Mexico, China and Mongolia because of their low cost, using selfhelp by local people and in some cases with the help of the United Nations.

In Australia many strawbale houses have been built or are at various stages of design or construction; they are to be found in all States and Territories. There is even evidence that the South Australian Housing Trust constructed

several such houses at Gepps Cross in the 1950s, though they have been demolished now.

Bohdan Dorniak Architect has to date designed some 40 houses, additions, a winery, an eco village and artists' studios. Projects include both single and two storey structures; all projects are post- and beam-engineered structures built by owner builders and contractors.

Strawbale has a heap of benefits

Building Green notes that straw is appealing as a building material for several reasons: Firstly, straw is cheap in areas of grain production. Secondly, the price of timber is unpredictable, and some suggest future supplies may be limited. Thirdly, because straw is a waste material from grain production, its energy consumption is low. Fourthly, in many areas straw is still burned in fields, producing considerable air pollution.

Strawbales also have desirable acoustic properties, which makes them ideal for school buildings and music studios.

Basically, walls are built with "construction grade" bales and then rendering internally and externally with a selected render, such as earth, lime or cement to protect the walls from moisture penetration, fire and pest invasion. It is a simple technique and therefore has advantages for owner-builders, but it demands "sweat equity" from the owner-builder as the process is labour intensive.

Straw is a by product of the grain industry, be it wheat, rice, sugarcane, barley or any other grasses that can be baled into a tight bale. Growing straw is a combination of sun, water and soil, with some fossil fuel to sow, bale and transport the bales; it thus has relatively low energy embodiment and is sustainable.

Straw is readily available in South Australia and in the Eastern states and West Australia, but it is important to source good quality bales.

Strawbales are a versatile material as they are environmentally friendly and produce a healthy, non-toxic and low-allergenic environment.

Strawbale walls have a unique appearance, with thick walls and deep window sills. This appeals to many, along with the malleability of the building system.

Strawbale house on Hindmarsh Island. Photographer: Steve Rendoulis

Strawbale walls are relatively easy to manipulate and assemble, they are more forgiving than conventional materials, require fewer specialised tools and equipment and alterations are easily effected.

Strawbale construction encourages social development, building with friends and acquaintances and achieving results simply and quickly.

Surely it will burn nicely?

Concern about fire is often the first reaction to the idea of building with straw. However, while loose straw burns easily, once the straw is densely packed into bales it is remarkably fire resistant, as the tight packing severely limits the oxygen available for ignition. Also, the high silica content in straw of 3-14 per cent impedes fire: As it begins burning, a charred layer develops which insulates the inner straw. A rendered straw bale wall provides a 2.5 hour fire wall; it is like trying to burn a rendered telephone book.

Bohdan Dorniak and helpers had rendered strawbales fire-tested by the CSIRO in Sydney in 2002. The first stage of testing the rendered strawbale walls was conducted at the CSIRO Building, Construction and Engineering Division at North Ryde in Sydney on 25 July, 2002.

Three standard types of rendered strawbale were tested and the CSIRO found they performed satisfactorily. Standard size strawbales (950 x 450 x 400mm) were rendered in the three most popular renders: earthen, lime/sand and lime/sand/cement. The bales were subjected to a simulated bushfire front with a maximum heat intensity of 29kW/m2, which is an accepted standard under the current Bushfire Code AS 3959.

The main heat source was a gas-fired furnace which readily achieved the required heat intensity. None of the bales ignited and no visible cracks developed. After the standard test the bales were subjected to longer periods which did not cause further damage. For a third test, holes were drilled through the bales; there was no evidence that they would ignite under simulated bushfire conditions. The testing proved that rendered strawbales are suitable for wall construction in bushfire-prone areas.

The green factor

The average Australian house uses 39 per cent of its annual power consumption in heating and cooling. A strawbale house combined with good passive solar design should not require any artificial heating or cooling.

Colin Newton, owner-builder of the Newton House, says that one of the primary benefits of the system is the extremely high R—value of the walls, which exceeds building insulation requirements. The R—value of a material is its ability to resist heat flow. This is dependent upon the compactness of the straw, very compact bales having a lower R—value. Generally, a conventional timber frame wall insulated with fibre glass insulation will have an R—value of R 1.5 while the maximum that could be expected from mudbricks or rammed earth walls is around R1. Regular house walls have an insulation rating of R3.5, compared with the R10 of rendered strawbale walls.

In roof spaces R—values of R4.0 are now achievable with thick fibreglass or rockwool insulation batts and blankets. Conventionally-constructed walls and windows are still the weak link in achieving good insulation properties.

Another green plus is that strawbales do not produce any waste since any excess straw on site can be used in the gardens. If demolished, the straw bale home can be recycled back to the garden rather than adding to land fill. And because wheat and barley is grown annually in the Brisbane area it makes straw renewable, because straw is a byproduct of a basic food source. Therefore, the wall cost is approximately 20 per cent of the total cost of construction of a building. Final costing will vary depending on the detailing and type of render that you use on the wall.

Will it stand the time?

Straw bale houses are much more durable than expected. Houses dating back to the early 1900s are still standing in America. In fact, since straw is a natural fibre it can last many thousands of years under favourable conditions. Intact straw has been found in dry Egyptian tombs and buried in layers of frozen glacial ice. A straw bale wall is 300mm wider than a brick veneer wall system and once constructed, bale walls are very strong and stable. When tested, bale walls have withstood the equivalent of a wind of over 215 km/hr. They are strong enough even for two-storey load-bearing structures.

But straw will turn into compost - won't it?

The Ecobuild Network recognise that under typical conditions straw will slowly degrade as will all natural fibre materials such as wood, paper, cotton fabric, etc. The rate at which this happens is highly dependent on the conditions under which the straw is stored, primarily moisture content and temperature.

Straw is a potential food source for micro-organisms like fungi and bacteria. Under the right conditions this can be a primary mode of decomposition, a process similar to composting. The main contributors to decomposition are the nutrients contained in the straw, the availability of oxygen, the temperature and free moisture in the straw. With proper attention to moisture control, a

strawbale structure should last as long as a conventional wood-framed home.

While a bale of straw is almost 90 per cent air, the amount of oxygen within the bale will quickly be used up and replaced with carbon dioxide during active micro-organism respiration. If the diffusion of new oxygen into the bale is inhibited, as it would be by wall plaster, this will limit the rate of decomposition.

Temperature is an important parameter for micro-organism growth. Many fungi and bacteria cannot survive at temperatures below 10°C, so growth is not very active at low temperatures. In the range of 20-65°C the fungi and bacteria can thrive, each species having its own range and optimum temperature for growth. Above 65°C most species cannot survive and biological growth ceases.

Other potential risks that can be avoided

It is still unclear how appropriate strawbale construction is for high humidity and high precipitation climates. At the very least, extreme caution should be exercised when strawbale construction is used for walls with northern exposures in these types of climates.

Moisture is perhaps the biggest problem that faces building walls with strawbales. In conventional construction the external fabric of a building is generally waterproofed; this is not the case for rendered strawbale walls. If a vapour barrier is used on an external strawbale wall any water trapped in such a bale will not be able to evaporate and rotting of the bale will occur. Renders that are breathable will allow water vapour to dry out. There is documented evidence in Australia of water damage to an internal strawbale wall; over a period of several weeks, the wall dried out and was re-rendered without requiring demolition and rebuilding.

The use of a "toe up" will prevent moisture from running against the wall if any water is spilled on the floor. All walls should be built on a damp proof membrane, as with brick walls. Care in construction is important to keep moisture away from such areas as window sills, at junctions of different materials, at doors and particularly in bathroom and other wet areas. It is important also to ensure that tops of walls are fully sealed.

As straw is a cellulose material it is recommended that the moisture content of bales during and after construction should not be greater than 14 per cent. There are a number of commercially available

probes that measure moisture content but they must be calibrated for straw.

Straw is also naturally resistant to most termite species. Straw is the structural material that makes a plant stand up. This fibre structure is made up of cellulose strands bound in a matrix of hemicellulose and lignin. Some straws like rice have a significant amount of inorganic compounds like silica ash that serve as a structural or pest-resistant role for the plant. When the plant is harvested and dries, the fibre structure remains intact unless it is decomposed by biological or chemical mechanisms.

It is in the interest of all strawbale builders and homeowners to try to prevent such conditions. The strawbale walls should be covered with about 35mm of hard, earthen plaster both inside and outside, creating a very strong deterrent to unwelcome visitors. And unlike hay, the straw itself has no nutritional value once the seed head has been removed. ■