

May 2005

Resource



Engineering & Technology for a Sustainable World

Building Houses of Straw

The Compaction Problem

**Iowa State's Ag Engineering
Celebrates 100 Years**

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Vol. 12 No.4

May 2005

FEATURES

7 Houses of Straw

When author David Bainbridge attended his first straw-bale-building workshop in 1989, he thought building with bales would take at least 20 years to catch on. "I never anticipated how quickly it would spread around the world," he says. "The advantages of straw bales are now well understood in the building trades. And where grain is grown, bales can be cost competitive with conventional construction."

9 The Compaction Problem

The "show me" state – a Missouri nickname made popular by native skeptic President Harry Truman – is the proving ground for a soil strength profile sensor. It *shows* measurements of soil strength at five depths in the soil profile, *shows* penetration resistance, and thereby enables generation of a soil strength map, which in turn *shows* compaction differences. Need convincing? Read on as Ken Sudduth shows off the Missouri-made SSPS.

11 Environmental Technology

Like a Cinderella story, the new Valley View plant is turning "necessary-expense" waste management into an attractive, moneymaking operation. The plant operates without treatment lagoons, eliminates the land application of nutrients, and captures greenhouse gases and converts them to clean-burning fuel, says Dave Townsend. For Crystal Peak and hog producers, it's a dream come true.

13 Teaching Safety

Agricultural safety is taught not caught. But Gary Roberson concentrates on upgrades that "catch on" in bio and ag engineering and technology programs reaching classroom as well as distance education students and more.



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ON THE COVER



"Straw, the waste material left after grains such as wheat and rice are harvested, is usually baled by machine behind a tractor, but it can be made into bundles or bales by hand for building – a building that will last forever," says David Bainbridge. Shown under construction in 1995, the AIA Design Merit Award Claiborne and Churchill winery sailed through the magnitude 6.5 San Simeon earthquake without cracking, even though barrels were overturned. (Photo by the author)



Iowa State's Ag Engineering Celebrates 100 Years

- 15 The invention of the large round hay baler and the incorporation of women in agricultural engineering are just part of the 100-year history of Iowa State's Department of Agricultural and Biosystems Engineering.

Houses of Straw

Building solid and environmentally conscious foundations

David A. Bainbridge

As straw bales become increasingly popular as material for building homes, outbuildings, and commercial and industrial buildings, they also provide interesting new opportunities for agricultural engineers. This “all American” technology was born on the treeless plains of Nebraska but has spread around the world. Many people are straw-bale-building enthusiasts because the structures are very quiet, energy-efficient, strong, durable, attractive, and fire-resistant. Combining straw bales, insulation value (U.S. R-30 to 40), solar orientation, and climate-adapted design features can create very comfortable and extremely efficient buildings. In Mongolia, straw-bale buildings have reduced energy use by 80 percent. They are also “friendly” to build, as families and communities often work together to create their own homes.

“You can huff and puff ... ”

Contrary to the Big Bad Wolf’s thinking, straw bales *can* be used structurally. Tests have demonstrated much greater strength than initially expected. Straw bales are more commonly used as infill for wood, timber, concrete, or steel-framed buildings. But bales can be used like big bricks with a running-bond pattern. Fairly tight curves in walls can be created when the bales are bent. After the walls are stacked, they are usually reinforced on both sides with 5- x 5-cm (2- x 2-in.) wire mesh (the current preference) pinned together with bamboo or rebar, or reinforced with vertical canes or bamboo tied between the inside and the outside — a low-cost method developed in Mexico.

“ ... but you can’t blow it down”

Bale-wall bases are typically kept dry with a pressure-treated wood frame filled with pea gravel. The plate is



Wall installation at the Santa Clarita, Calif., bus facility. (Photo by Rick Green, who grew the rice straw bales and supervised the installation)



The bale wall is trimmed before plastering at a Santa Clarita, Calif. bus facility. (Photo by Rick Green)

often a wood-box beam or concrete-bond beam. Load-bearing walls are typically precompressed with tensioned wire or poly strapping running from the foundation over the plate to reduce settling. Walls may be plastered with lime, earth, or cement plasters. The current preference is for a breathable wall. Designs include wide eaves and careful detailing of windows and doors to help keep rain out of the walls. Well designed and built, straw-bale edifices will last forever, with several in the 70- to 100-year-old range in Nebraska.

Versatility

Straw-bale construction has been used primarily for new homes, schools, and wineries. However, it makes sense for office buildings and commercial spaces, and it is a natural for barns and utility buildings. (My work with straw bales actually began on a long-ago consultancy request for more energy-efficient housing for pigs.) Straw bales have also been used to provide retrofit insulation for existing homes to great effect and could be used to retrofit buildings of all kinds. Ideal for use in garages and workshops, straw bales also suit hangars in cold and hot climates. Some work has also been done in using straw-bale walls for emergency housing and as sound control walls for freeways. They also make excellent thermal shelters for water tanks.

Early adopters

Most of the early straw bale work has been in single-family custom homes, with costs ranging from \$1.50/0.1 m² (1 ft²) in Mexico to more than \$200/0.1 m² (1 ft²) for high-end homes in the United States. Construction costs

are usually about half the cost of adobe and about the same or only slightly higher than conventional wood frame construction. Straw bale construction boasts two to three times the wall thermal efficiency, much better fire safety, superb sound control, and increased comfort and security. Straw bales are much cheaper than adobe and have become common in high-end estate construction, especially for those who want the look of adobe at lower cost and with better performance.

The Real Goods Store and Solar Living Center in Hopland, Calif. was the first significant commercial building. Wineries continue to be very receptive to straw-bale construction, and excellent examples now exist for both tasting rooms and production facilities around the world. The Ridge Winery recently added a 1,672 m² (18,000 ft²) straw-bale production facility in Healdsburg, Calif. Monica's Winery, near Geelong in Victoria, Australia, built by John Glassford and Susan Wingate-Pierce, used big bales struc-



At Tree of Life Nursery the pole and roof were put up first, allowing the wall construction to proceed safely as a potential rainfall threatened.

turally (5 layers = 4.5-m (15-ft) walls). A number of schools have been built, including Waldorf School near Carbondale, Colo. This 557-m² (6,000-ft²) school was built on time and under budget by volunteers and contractors. Heating costs were reduced 60 percent. A 1,858 m² (20,000 ft²) bus building, now under construction in Santa Clarita, Calif., is the first big step in building government facilities. In Norway, a three-story straw-bale café is underway near Oslo.

Although no big office buildings have risen from the ground yet, it won't be long. Discussions this year have taken place with builders contemplating projects in the 4,645-m² (50,000-ft²) range. A straw-bale subdivision may be in the works for the California desert, and it may be surmised that within a decade we will be seeing 100,000-ft²-and-up straw-bale buildings. As straw-bale building becomes more commercially acceptable, the demand for uniform and structurally

approved bales will offer new opportunities for agricultural engineers and equipment designers. New balers, designed to make smaller and more perfect bales, may offer a new opportunity in sales for equipment manufacturers.

To learn more about straw bale buildings ...

There are many books on straw bale construction, but *The Last Straw* (the International Journal of Straw Bale and Natural Building) remains the best resource. Several straw building associations also have newsletters. *Natural Home* magazine regularly features straw bale homes (www.naturallhomemagazine.com), as do many other home and design magazines. To contact one of the major straw-bale suppliers and straw-bale contractors, visit Rick Green at www.benchmarkdevelopmentco.com/.

... or attend a straw bale workshop

The best way to experience bale building is to attend a workshop, now offered year-round by straw-bale building schools and organizations. Children are usually welcome and encouraged to attend. Mud plasters and straw are fun for everyone. Contact Bill and Athena Steen at the Canelo Project (www.caneloproject.com) for an elucidating presentation. The Solar Living Center also has a regular workshop series (www.solarliving.org), and workshops around the world can be found through *The Last Straw*. **R**

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Straw bale seed processing and storage building, San Diego Wild Animal Park, Escondido, Calif., reflects environmental consciousness in more ways than one.