BY TED CUSHMAN

Fighting Climate Change With Straw Panels

Buildings are a major source of carbon dioxide pollution on planet Earth. Recognizing that fact, some builders are working to lower the energy use, and thus the carbon output, of the homes they build. But there's a wrinkle: The CO_2 and other greenhouse gases emitted in the construction of a high-performance building can exceed the carbon footprint of the home's operation (especially in the near term).

However, that depends on the materials and methods used to construct the house. By using materials that capture and store carbon, builders can actually remove CO_2 from the atmosphere and sequester it in the home for the lifetime of the building. That's the approach Vermont-based New Frameworks Natural Design Build took for a recent project in Leyden, Mass. The company made the home's walls with an innovative structural insulated panel composed mostly of straw. The straw absorbs carbon dioxide from the atmosphere as it grows; when it's harvested and buried in a building, that carbon is locked up.

Every project uses energy to build, whatever the materials, and each project has to be evaluated individually, says New Frameworks founder Ace McArleton. But he says, "The calculations that have been done on a general basis about straw being used in the walls of a building is that it sinks so much carbon and stores so much carbon that the net offset gives us a huge leg up—more than any other material that we have out there."

New Frameworks is experienced in building straw-bale homes on site. But now the company is pioneering a different approach: integrating straw bales into a panelized system that the crew can fabricate in the shop, then set in a day or two on site. The method is inspired by European firms EcoCocon and ModCell. McArleton says, "As usual, the Europeans are ahead of the curve from us on these things: They're doing beautiful commercial buildings and giant office parks with straw-bale panels."

New Frameworks also learned from the work of Chris Magwood and his Ontario, Canada-based organization, the Endeavour Centre. Magwood, author of *Essential Pre-Fab Straw Bale Construction, The Complete Step-by-Step Guide*, brought New Frameworks some essential methods gleaned from a Canadian straw-bale-panel company started by one of his Endeavour Centre students. Armed with that knowledge, New Frameworks invested in basic equipment and started to build panels.

Jackson Mills, project lead for the Leyden house, explains the process. "It started with individual cut sheets for each panel from the design office," he says, "so every panel had its own design page. And we precut all the lumber and sheathing, and we had

The crew sets straw panels on site **(1)** in Leyden, Mass. In the shop, panels are assembled in a steel frame and packed with straw bales **(2)**, then moved onto another work table **(3)** for installation of Gutex insulation and Intello vapor barrier.

Photos courtesy New Frameworks

Panel assembly takes place on tables at a convenient working height **(4)**. This panel has Gutex fiberboard insulation, rainscreen strapping, and corner protection applied. Above, a closeup of the panel in cross section **(5)**.

two assembly tables. One of those tables had a machined template, a kind of little cage that we built the frame inside of, to make sure that there was as little variation as possible. When we built the frame inside of that, it made sure that the frame was exact. After we built the frame, we installed the bales. Then we pulled out that panel [and moved it] onto the second assembly table. We trimmed the straw to make sure that it was exactly flush with the framing, and then installed the sheathing; and on the same table on top of the sheathing, we installed the Gutex fiberboard (we used Gutex Multitherm 60). And then it was strapping for the rainscreen on top of that, corner protection, and then we flipped it, shaved the bales down again flush with the framing, and then attached the Intello, which we used as the air barrier. And then corner protection on top of that."

Including the Gutex fiberboard, each panel weighed about 500 pounds, says Mills. In the shop, the crew was able to roll the panels around on the assembly tables, and move and stack them using a rented forklift. On site, the crew set the panels using a telehandler.

Panels have a clear-wall R-value of about R-40, says Mills. To create a continuous air and vapor control layer, the crew taped the Intello smart vapor retarder on the inside face of each panel to the adjacent panel on site when they set it. On the outboard face of the panels, the Gutex fiberboard forms the building's drainage plane, and strapping outboard of that creates the air space for a rainscreen siding application.

Although New Frameworks is a design-build general contractor in Vermont, handling jobs from concept to completion, for this Massachusetts job its only function was to deliver and set the wall panels. The builder then set trusses for the roof and installed windows and doors to dry in the building. "They were able to roll up onto the site and say, 'Whoa, there wasn't a house here two days ago, and now there is,'" says McArleton, "'and I just put the roof on, and now all I have to do is side on the outside and put the windows and doors in, and then do the inside finishes.'" Intello on the underside of the trusses was taped to the Intello coming up the walls to create a continuous air control layer. The attic was insulated with blown cellulose.

Wiring on the inside of the house runs in a service cavity built with 2x2s, says Mills. Penetrations, where needed, are cut with a hole saw. "We entertained the idea of pre-installing conduit for all penetrations, but that would really require knowing down to the

Panels are set on site using telehandler forklifts. Above, a corner has been assembled from two panels on site **(6)**. The completed walls of the house sit ready for roof trusses **(7)**.

inch where the plumber or electrician or whoever was going to put the penetrations, so we decided against doing it ahead of time," says Mills. "But when they do have the penetrations mapped out, they'll hole-saw it and install the conduit, and gasket and tape to the Intello on the interior, and prime and flash tape to the Gutex on the exterior."

Although this project is not a certified Passive House, the air-tightness goal is the Passive House standard of 0.6 ACH50.

The house is unusual, but McArleton says there was no difficulty with the local building department. "We have a fair amount of experience working with building inspectors in different municipalities because of the straw bales that we build with anyway on site," he says. "And what we've found is that because straw is in the International Building Code and has fire testing—there's an ASTM fire rating for it—we've moved out of the time where it's this super wacky thing. It's more acceptable to building inspectors overall. Really, it is cellulose insulation in a different form. So it's not actually much of a big deal, we find, to most inspectors. And we are able to provide the ASTM testing if needed and also the IBC if needed, but we haven't had an issue with that."

One challenge on site, says Mills, is the need for a dead-level sill plate. "We built the panels to such exacting standards that the transitions and connections between them are really tight," he says, "so if your sill plate is out of level, then the connections won't be tight. They would be off kilter to each other. It's a double sill plate, meaning one to the interior and one to the exterior, because of the thickness of the wall. And they have to be level in both directions. We had to do some work to level the sills."

With one house under its belt, New Frameworks is ready for more. "We're a full design-build company," says McArleton, "so as we're working with owners and clients looking at potential projects, we now have this as an option to offer. Our goal as a company is to try to do at least one to two a year if we can for the next few years, just to get ourselves feeling like we've worked out the kinks. And then it's a question for us of how much volume we would be interested in doing, and what that would mean for us to scale up to a larger production facility. That is still an open question for us. But we feel so dedicated to this idea taking off in the marketplace that we are excited to do it for our own projects, and then beyond that, help others to take this idea and run with it."

Ted Cushman is a senior editor at JLC.