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Dense-Pack Cellulose
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Leak-Free Stucco Walls
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by Jonathan Tauer

Installing Dense-Pack Cellulose

This economical material both air-seals and insulates

I'm an insulation contractor in western Massachusetts. I specialize in loose-fill, damp-spray, and dense-pack cellulose. I also own a spray-foam truck that I bought a couple of years ago; I was hoping it would increase my efficiency if I no longer had to sub out the limited areas of spray foam that some cellulose projects called for. While I've sprayed quite a bit of foam, I'm now in the process of selling the foam rig. So many variables can affect the quality of the finished product — everything from how the equipment is calibrated to outdoor temperatures — that it's challenging stuff to get right. My crew and I also didn't like dealing with cleanup and were concerned about the possible health effects of working with the chemicals. But I've also found that with the right approach, many problem areas that are commonly spray-foamed — around band

joists, for instance — can be effectively insulated and air-sealed with dense-pack cellulose alone.

Cellulose has a lot of other things going for it. In dollars per unit of R-value, it's hands-down the most efficient insulating material there is. It's also highly fire-resistant and environmentally benign. It doesn't provide the sort of hermetically sealed air barrier you get with foam, but at atmospheric pressure it does stop the movement of air and moisture. We use it wherever we can. For those areas where only spray foam will do, we either use canned one-part foam or call in a local foam sub to spray it for us.

Figure 1. This truck (above) is equipped to install either damp-spray or dense-pack cellulose. The hopper that feeds material to the operator can be filled to the ceiling (right), providing enough material to last from 15 minutes to an hour, depending on the application.

Loose-Fill vs. Damp-Spray

The key piece of equipment needed to install cellulose is a box truck equipped with a powerful blower that mixes the fiber with air and distributes it through a hose that's typically 3 inches in diameter where it exits the truck. My company has two trucks, one of which is equipped with a large vacuum cleaner and a water tank for working with spray cellulose. We also have a van we use for doing prep work. Between the two trucks, we can blow more than 500 bags of insulation a day when everything is going well.

Cellulose comes in compact 30-pound bags. To prepare it for use, the material is unwrapped and tossed into a hopper in the back of the truck, where rotating paddles break it up from beneath. An auger feeds the finely shredded material to the blower (**see Figure 1**).

Loose-fill. Attics are most often insulated with loose-fill cellulose, which is blown directly onto the horizontal surface and built up evenly to the specified depth. This is about as straightforward as it gets, but there are a couple of points to keep in mind. First, depending on how it's blown, loose-fill cellulose can settle 10 percent or more, so it's important to compensate by applying a little extra material to begin with. We install attic depth markers every few feet so the building inspector and client can easily see the depth of the settled material. Loose-fill will finish settling within the first few days of installation.

While loose-fill has an R-value of about 3.5 per inch, it has less air-sealing ability than dense-pack does. A common mistake in retrofit applications is to blow cellulose directly onto a ceiling that's riddled with existing air leaks; afterward, it's very unlikely that anyone will go to the effort of finding and sealing those leaks. In retrofit applications, we make sure to air-seal the thermal envelope at the attic floor before applying more insulation. We look for any penetrations like chimneys, bath fans, and vent pipes, as well as interior parti-

tions or plumbing chases. It's easy to find air leaks when there's existing fiberglass in the attic, because the fiberglass will be stained with dirt filtered from the air that's passed through it over the years. To block larger openings, we use a one-part foam in an applicator gun, along with caulking, flashing, and scrap lumber or drywall. We cover can lights with Tenmat fire-rated light covers, which are easily air-sealed directly to the ceiling (tenmat-us.com). In new construction I always provide a separate line item in the estimate to cover any air-sealing work around rough openings or basement and attic penetrations.

Spray cellulose. Another application method, often called damp-spray, makes use of a fine mist of pressurized water to moisten the dry cellulose as it emerges from the hose. The surface on which it's sprayed is moistened at the same time, and the water causes the cellulose fibers to interlock, creating a bond that's strong enough to permit spraying onto vertical surfaces.

The damp cellulose is ordinarily sprayed to slightly beyond the full depth of the framing; because the material becomes even more strongly bonded as it dries, the excess is shaved off with rotary scrubbers soon after it's applied. As the scrubbed-off cellulose accumulates on the floor, it's vacuumed back into the truck and combined with fresh material for reuse. The adoption of high-pressure pumps has reduced the volume of water used and dramatically speeded drying time. Cellulose manufacturer National Fiber, for example, now provides a 24-hour drying-time warranty.

Like dense-pack, correctly applied spray cellulose is immune to settling. It's also easy to inspect, since any defects or missed areas are easily seen and repaired. It lets you get right down to spraying without a lot of prep work — you just tape plastic over the doors and windows, mask the electrical boxes, and you're ready to go.

The downside of spray cellulose is that

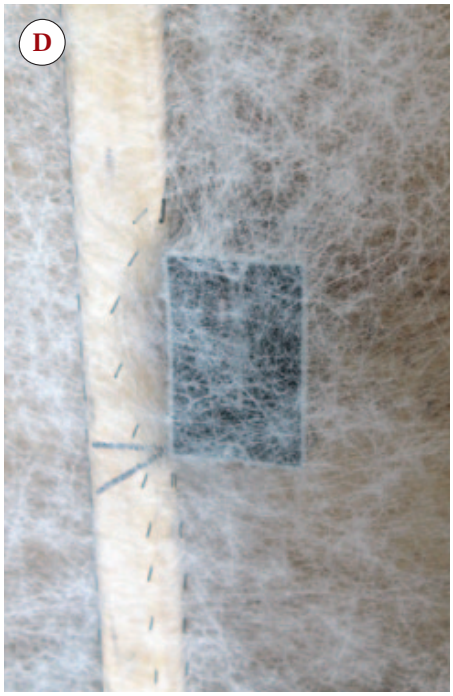

Figure 2. To minimize bulging of the cellulose between framing members, netting is stretched tight and fastened with a pneumatic upholstery stapler (A, B). The closely spaced fasteners are driven at an angle just beyond the outer edges of the faces of framing members. This "inset stapling" helps draw the material taut and prevents the cellulose from pushing beyond the framing (C). The tension of the netting against electrical boxes is enough to prevent them from filling with insulation when the cavities are packed; the netting will later be cut by the drywall crew (D).

it's messy. This isn't a big problem in commercial buildings with wide-open spaces, but on residential jobs you can easily lose more time to cleanup on the back end than you gain in reduced setup at the front end. Scrubbers can be difficult to use effectively in closets and other confined spaces. Areas that can't be scrubbed have to be scraped by hand, and with one person spraying, another scrubbing the overspray, and a third running the vacuum, just staying out of each other's way can be a challenge.

Finally, because the material that gets vacuumed off the floor goes right back on the walls, the site also has to be perfectly clean before you start and stay that way until you're done — no sawdust, wood scraps, bent nails, or other debris allowed.

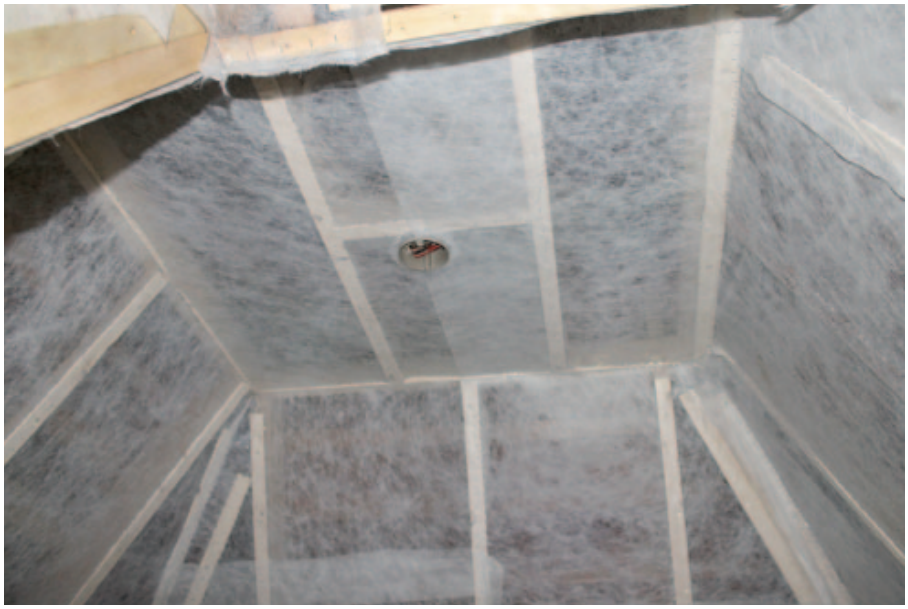

Figure 3. A skilled installer can snugly fit the netting around joists, collar ties, and other obstructions. As long as the material is tight and securely stapled, small gaps won't leak significant amounts of insulation as the cavities are blown full (right). In complex areas, like the peak of this Queen Anne tower (below), netted dense-pack can be a cost-effective alternative to spray foam.

Dense-Pack Basics

If you force enough loose-fill cellulose into a confined space under enough pressure, you end up with dense-pack — a firm, compact material that can't settle and is very resistant to air infiltration. It can be blown into closed framing cavities — the approach most often used in retrofits — or open ones that have been closed on one side with netting.

The obvious benefit to the closed-cavity method is that you can insulate an existing structure without gutting it first. On the other hand, progress is slowed by the need to seek out and fill every framing cavity, including oddly shaped or unexpected ones tucked behind blocking or diagonal braces. And because cellulose can't be packed into a space any faster than the air can escape, trying to force in too much material in too little time can yield a product that falls short of the required density of 3.5 to 4 pounds per cubic foot, or that bows out existing drywall or plaster.

Some installers will tell you they can dense-pack cavities that contain existing fiberglass, but I find that trying to do this always leaves some voids. When we have to deal with a previously insulated wall, we'll remove a 2-foot strip of drywall at the bottom or a strip of sheathing on the outside, pull out and discard the batts, then net the opening before blowing the empty cavities.

In new construction and gut retrofits, our preferred approach is to fasten netting over the entire frame and blow the cellulose behind the netting. Like damp-spray, this offers complete quality control, since the packed material can easily be seen and felt after installation. The permeable netting gives the air in the cavities an easy route of escape, making it possible to fill the cavities quickly.

Netting the Frame

Cellulose netting is a tough, lightweight, nonwoven fabric. It comes in long rolls of varying widths, and is fastened to the framing with staples. We use pneumatic upholstery staplers for this, which fire off staples at high speed for as long as the trigger is depressed.

After cutting a sheet of netting, stretching it tight, and tacking it in place, we "stitch" a continuous line of staples along each side of the framing members to prevent the insulation from forcing its way between the netting and the face of the framing and interfering with the drywall (**Figure 2, page 43**). This takes practice, because the spacing of the fasteners depends on how quickly the operator moves the stapler — too slow, and they'll be so close together that they'll create a line of weakness in the netting; too fast, and the spacing may be wide enough to allow some cellulose to leak between staples onto the face of the stud.

Open expanses of wall can be netted fairly quickly, but the work slows down when cathedral ceilings, collar ties, dormers, and other irregular areas are involved (**Figure 3**). On most jobs, it will take about twice as many man-hours to install the netting as it will to blow the cavities.

Blowing Wall Cavities

For most applications, the 3-inch hose from the truck is stepped down to 2 inches at the business end. Hoses as small as 1¼ inch can be used for narrow cavities (tighter cavities are filled with low-expanding one-part spray foam). The operator makes a small slit in the netting just big enough to provide an entry point for the sharply angled tip of the hose, which he pushes to the bottom of the cavity (**Figure 4**). A control box on a lanyard around the operator's neck contains a combination switch that operates the blower and the cellulose feed mechanism. When both are turned on, cellulose quickly begins flowing into the netted cavity.

Figure 4. Wall cavities are filled first from the bottom to the midpoint of the wall (A), then from the top back to the middle (B). After a cavity is filled, the operator uses a remote control (C) to momentarily turn off the blower, then quickly inserts the hose into the next cavity before switching it on again.

Figure 5. Filled cavities are compacted with an aluminum roller to avoid bulging drywall. A quick pass of the hand is enough to confirm that the insulation lies flush with the framing.

Figure 6. When filling rafter cavities, the usual insertion point is just above the top plate (above). The natural curvature of the longer hose required tends to direct the flow of insulation to one side of the cavity, so filling it uniformly requires a second pass with the curve facing the other way. The hose is visible behind the netting in the photo at right.

Judging when the correct density is reached is a matter of feel and isn't easy to describe, but if the pressure on the blower is set correctly, the flow of material begins to slow and the sound will change, alerting the operator to begin withdrawing the hose while keeping the cellulose flowing. Once the cavity has been halfway filled and the end of the hose is just inside the insertion hole, it's redirected upward, shoved to the top of the cavity, and then withdrawn as it fills from the top back to the middle.

When the cavity has been packed full all the way to the insertion point, the operator shuts off the blower, shoves the hose into the next cavity over, and repeats the process. There's no need to plug the entry holes in the netting; properly installed dense-pack is so compact it won't fall out on its own even if the netting is removed.

All of that happens fast, practically in one continuous motion. It has to, because if the hose is left in one place too long, the material inside it will begin to back up and bind together. An inexperienced or careless operator can pack the hose full all the way back to the truck, creating a mess that may take hours to clear.

You can tell when a cavity has been filled to the right density by feeling it through the netting with the palm of your hand. It should be solid but have some give to it, somewhat like a firm mattress. If everything has been done right, the netting shouldn't bulge noticeably beyond the framing. But some bulging is unavoidable, so each cavity has to be rolled flat with a heavy aluminum roller — a task we jokingly describe as the company fitness plan (**Figure 5, previous page**). A couple of quick passes up and down is usually all that's needed, but it adds up when you're talking about a whole house, especially if there are sloped or flat ceilings to deal with.

Rolling may seem like an afterthought, but it's something we take seriously. The one guy who can really hurt my business is the sub who comes on the job after I

leave. If the drywallers complain to the GC about having to flatten the insulation themselves, it makes us look bad. Worse, if they ignore slight bulges and just hang the drywall over them, the pressure exerted by the cellulose will eventually cause the fasteners to pop through the paper facing, especially with ½-inch-drywall. That makes us, the drywall crew, and the GC all look bad. Taking the time to roll the cellulose really flat saves trouble all around.

Working Overhead

Blowing a cathedral ceiling is similar to working on a tall wall, except that there's usually no way to start in the middle of the bay. The nozzle ordinarily goes in just above the plate and is pushed all the way to the peak, with work proceeding from the top down. If there's no ridge board at the peak, we'll push the nozzle high enough to let us blow material over the top and down the other side. This will fill the cavity most of the way, but we will still need to come into it again from the other side to "touch up" the density to the right level.

When the rafters are spaced 24 inches or more on-center, we make two passes along each cavity, because the natural curvature of the hose causes it to flop to one side, depositing more material there than on the back side of the curve. Once the hose has been withdrawn the length of that side, we twist it so the curve faces the other way and push it back to the peak, then pack the cavity to its final density (**Figure 6**).

It's generally cheaper to insulate a ceiling with loose-fill than it is to dense-pack it, but overhead rafter cavities are sometimes insulated for soundproofing, or if an attic will be floored to provide storage space. Gravity makes it more likely that the insulation will bulge beyond the framing in the ceiling, but it's difficult to use the roller overhead. To avoid putting any pressure on the ceiling drywall, we have the builder strap the ceiling after we've stapled netting to the undersides of the joists, but before we blow the cavities. That restrains the cellulose and ensures that any bulges that do form won't push out against the drywall.

Figure 7. A strip of netting between a top-plate nailer and the facing joist makes it possible to dense-pack this area of the band joist (top). Netting stapled between the joist ends is filled with cellulose to form insulating and air-sealing "pillows" (above).

Another benefit of dense-packing the ceiling is that it insulates and helps air-seal the band joist area at the same time. Even if we're not going to do the entire ceiling, we'll usually net and fill between the two outermost joists that run parallel to an outside wall (**Figure 7**). To insulate and air-seal the spaces between the joist ends, we'll often create "pillows" of material by folding and stapling netting into place before filling it with dense-pack. This requires some time-consuming origami, but it lets us do this part of the job on our own schedule with materials we already have available. It often means that we don't have to bring in a foam sub at all, which saves time and money in the end.

Jonathan Tauer *owns Cellu-Spray Insulation in Florence, Mass.*