Cordwood CONSTRUCTION

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Adapted from *Cordwood Building: The State of the Art*

Cordwood masonry—the art of building a wall using log-ends laid within a mortar matrix—is an old building technique found in Europe, Canada, and the Upper Midwest. Today, cordwood buildings still offer many practical benefits to owner–builders, homeowners, and the environment. Unskilled owner–builders find working with cordwood to be relatively easy, and some find it less expensive to build with than conventional materials. Designed right, cordwood structures also can be energy efficient, providing effective insulation and significant thermal mass. Cordwood buildings can use lesser quality, small second-growth logs or even used building materials. And then there's the unique beauty of cordwood, which many people love!

Rob and Jaki Roy's Earthwood house in West Chazy, New York.

Cordwood Style

Cordwood easily incorporates into three structural styles: buildings with load-bearing curved walls, post-and-beam frames, and stackwall corners.

My wife Jaki and I built Earthwood, a round house that uses cordwood masonry as a load-bearing structure. A heavy earthen roof, which sometimes bears the additional weight of snow, sits on two full stories of cordwood masonry. This bears witness to cordwood's good compressive strength—its ability to withstand heavy loads without crushing.

Cordwood also is well suited for use as infill between posts in a post-and-beam or timber-framed structure. For building in earthquake-prone regions, using cordwood as infill in a post-and-beam structure is the only type of cordwood building I recommend.

Another cordwood building technique uses stackwall corners, which enable builders to make extremely thick cordwood walls of 24 inches (60 cm) or more. This method uses squared log-ends called *quoins*.

Stackwall corners consist of alternating corner pieces called *quoins* or Lomax corners.

Cordwood building suits a wide variety of skill levels and abilities. Here, Marjan Koleric, Earthwood Building School student and octogenarian finishes pointing a cordwood wall.

How Much Wood Is Enough?

For cordwood building, the best measure to work in is—no surprise—the cord. A full cord is a stack of wood that measures 4 feet tall by 4 feet wide by 8 feet long (1.2 x 1.2 x 2.4 m), or 128 cubic feet (3.6 m^3). But full cords and cubic feet confuse the issue of cordwood building. The calculations are easier and more accurate in "face cords." Face cords are also 4 feet high and 8 feet long. But the depth or thickness of the stack is whatever uniform length the wood is cut into—usually 12, 16, or 24 inches (30, 40, or 60 cm).

Your climate, the type of wood you choose, and the shape of the house you're building will determine how thick you'll need to make cordwood walls. Our upstate New York home's 16-inch-thick white cedar walls have an insulation value of about R-19 or a little better, which works well in our climate. In Canada and Alaska, 24-inch-thick walls are quite common. In the South, where the energy costs of cooling can equal or exceed heating costs, 12-inch-thick walls are adequate, but the thermal mass provided by thicker walls might also help to make the home even easier to cool. Homeowner George Adkisson tells me that the 12-inch-thick cordwood masonry walls of his home on the Gulf Coast of Texas reduce his air-conditioning costs to about half that of similarly sized, conventionally built homes in the area.

Choosing Cordwood

The best choices for cordwood building are woods that shrink and expand the least. Woods such as white cedar, larch (or tamarack), white pine, spruce, cottonwood, lodgepole pine, and quaking aspen are considered more stable woods for cordwood building. Red pine, Virginia cedar, and red cedar also have been used with success. These woods can be used fully dry, without serious expansion or shrinkage problems. Avoid using dense, heavy, fine-grained woods, which tend to both shrink and expand a lot.

In cordwood building, the problem that occurs most often is log-end shrinkage. While this problem can be irritating, inconvenient, and aesthetically unpleasing, it won't impact the building's structural integrity. However, wood expansion, while much more rare, can be a critical problem. In a curved cordwood wall, wood expansion will cause the wall to go out of plumb. Within a post-and-beam framework, the expanding wood can push corner posts out, no matter how they are fastened, and cause plate-beams to lift at the top of the cordwood wall. Stackwall corners, made of alternating quoins (or Lomax corners), will be pushed out in both directions by expanding cordwood.

Woods more prone to shrinkage are also the ones most prone to expansion. Hemlock is prone to great shrinkage. Hardwoods, such as oak, maple, birch, beech, and elm, as well as some dense Southern pines have potential expansion problems, particularly if they are dried too long before building.

Split or Round?

Whether you want to use round or split log-ends is generally an aesthetics issue. The main reasons for splitting wood are to accelerate the drying process, to eliminate the large "primary checks" seen in rounds, and to reduce the size of shrinkage gaps. Shrinkage is proportional, so the smaller the log-end, the smaller the shrinkage between wood and mortar. But smaller pieces require more handling of materials, and mixing more mortar too.

Beautiful cordwood walls can result from using all split wood, all rounds, or a combination of the two. The important thing is to maintain a consistent style, which means making a conscious effort to deplete the various sizes and shapes of log-ends in your stock at the same rate.

De-Barking

The space between the bark and the epidermal layers of the wood can trap moisture and provide habitat for fungi and bugs. De-barking remedies this potential problem. Almost any sharp or flat tool can serve as a peeling spud—an axe, pointed trowel, scraper, or even a flattened garden hoe. When de-barking is difficult, the tool of choice is a drawknife, a two-handled tool with a sharp blade edge. Using a drawknife—normally a killer of a job—is safer and easier with the long logs supported at a convenient height.

Goldec International Equipment manufactures a chain saw attachment for "barking wood," called a Log Wizard. This device adapts to both 3/8-inch and 0.325-inch-pitch chain, and allows your saw to be used for de-barking, post sharpening, or as a notcher–planer.

Figuring Face Cords

The area of a face cord's side is always 32 square feet (3 m^2)—this is the magic number to use in your calculations. From your building plans, figure the square footage of wall area that will be cordwood masonry. Subtract doors, windows, and heavy timber framing from the gross wall area to arrive at this figure.

For example, a house with a perimeter of 125 feet (38 m) and a wall height of 8 feet (2.4 m) has 1,000 square feet (93 m^2) of gross wall area. For this example, let's say the windows, doors, and post-and-beam frame make up 20 percent of the wall. (You can figure this accurately from your plans.) Subtracting 20 percent—200 square feet (19 m^2) in this case—leaves 800 square feet (74 m^2) of actual cordwood masonry. Now divide by the magic number—32 square feet—that gives, in this example, 25 face cords. You can safely discount 20 percent from this number, because the area of coverage increases by at least that much when the cords are restacked with mortar. So if you had 20 face cords cut to a length to match the thickness of your wall, you will have plenty of wood, and enough to reject misshapen pieces that you don't like or that are troublesome to use.

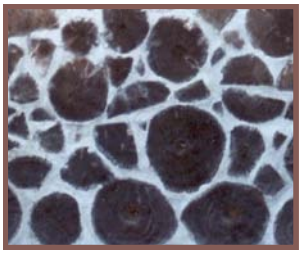
Cutting Cordwood

Most people use a chain saw to cut long logs into log-ends. Another good way to cut cordwood is with a large circular saw, typically 30 inches (76 cm) or so in diameter. These saws are commonly connected to a tractor's power take-off (PTO) by a belt. The long length of wood is set on a movable table tilted towards the saw, which cuts off the ends quickly with a nice, straight cut.

Cutting log-ends, by any means, must be considered a dangerous activity. Always use proper ear and head protection. Wear logger's safety chaps to protect your legs. Keep all

All rounds.

Splits and rounds.



All splits.

children, animals, and unnecessary people away from the cutting area. Before using any kind of cutting equipment with which you are unfamiliar, get training from an expert.

Drying Wood

With the more suitable woods, drying the wood a year or more usually causes no problems. A year's drying at log-end length will go a long way toward preventing shrinkage, and will help alleviate expansion problems. If you must use a denser species of wood, split the wood and dry it for about six weeks in good drying conditions. Although some shrinkage will still occur, most expansion will be curtailed.

Because wood dries ten times faster on end-grain than through the outer layers of the wood, the real drying will take place after longer logs are cut into their final log-end length. Split wood also dries faster than unsplit wood. Dry the wood in single ranks, keeping it off the ground by using wooden stringers or pallets. Cover only the top of the rank, not the sides. Covering the sides traps moisture, making conditions ripe for rot-producing fungi.

Putting It Together

At the Earthwood Building School in West Chazy, New York, we have refined a mortar mix that incorporates soaked sawdust to slow the mortar's initial set. Mortar that dries slowly will shrink less or not at all, which eliminates shrinkage cracks between log-ends. The sawdust should be passed through a 1/2-inch screen and immersed at least overnight in an open-topped 55-gallon drum or other soaking vessel.

This timber-frame building in British Columbia uses cordwood as infill.

Sturdy cordwood walls provide beauty inside and out.

"Suitable" sawdust, in our experience, is larger and less dense particles of softwood sawdust. White cedar, white and red pine, spruce, and even poplar sawdust works well. Oak and other dense hardwood sawdust has not proven to be successful. Hardwood sawdust doesn't hold and store the moisture the same way that the softer, lighter, softwood sawdust does, and mortar shrinkage is the result. In fact, hardwood sawdust seems to make the mortar more grainy, crumbly, and harder to use. If you cannot get suitable sawdust, use a commercially available cement retarder such as Daratard 17 or Plastiment (see Access).

Two mixes work well with suitable sawdust—Portland cement mix and masonry cement mix. The proportions given are equal parts by volume, not weight.

- Portland cement mix: 9 parts washed masonry sand, 3 parts soaked sawdust, 3 parts lime, 2 parts Portland cement
- Masonry cement mix: 9 parts washed masonry sand, 3 parts soaked sawdust, 3 parts masonry cement, 2 parts lime

Use washed masonry sand, not coarse-grained sand. The sawdust should be the softer, lighter type, already discussed. Portland cement, Type I or Type II, is full-strength cement. I've had good luck with Types M and N masonry cement. The lime is builder's lime, also known as Type S or hydrated lime.

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Step-By-Step Cordwood Construction

You will need strong, cloth-lined rubber gloves throughout the project, including during the mortar mixing process. Cementitious products, wet or dry, will eat nasty little holes in your hands that can be painful and take a long time to heal.

The first course of wood laid on top of the first layer of mortar.

Dry-mix the mortar materials in a wheelbarrow with an ordinary garden hoe until everything is a uniform color. Then make a little crater in the center of the mixture and add water. How much depends on how wet the sand and sawdust is. For the first batch of mortar, go easy on adding water, perhaps only a quart or two. Mix it in thoroughly and test the mixture by tossing a baseball-sized glob of mortar three feet in the air—one meter in Canada—and catch it in your gloved hand. If it shatters or crumbles, it is too dry. If it goes "sploot!" like a fresh cow pie, it is too wet. If it holds its shape, doesn't crack, and is plastic, it is just right. If the mortar is too dry, add more water, remix, and test again until it is right. If it's too wet, add more dry goods in the same proportions until it is right. You can leave out the wet sawdust if the mix is really soupy, or you'll never dry it out enough.

The second course of wood laid on top of the second course of mortar.

Bring the mortar to the site in the wheelbarrow. You can work out of the barrow or load up a metal or plastic mortar pan for convenient access to the "mud."

The foundation should be swept and dampened slightly. Several sizes of prepared log-ends should be within arm's reach. For discussion, we'll assume a 12-inch-thick wall. Picture that wall's footprint divided into thirds—a mortar and sawdust sandwich. We use MIM (mortar–insulation–mortar) sticks to help gauge this proportion. The MIM divisions are marked right on the stick, which can be a 12-inch-long piece of scrap board. Make two or three for your project.

The timesaving building mantra is: Mortar. Insulation. Wood. Using your gloved hands, grab a glob of mud and plunk it down on the foundation, about an inch thick. (If your MIM stick is made from 1-inch-thick material, it can double as a mortar depth-checker!) Keep adding more mud, extending the 4-inch-wide (10 cm) mortar bed for 3 or 4 feet (91–122 cm). Now do the same thing for the other parallel mortar bed.

Next, with a small, spouted bucket, pour in the lime-treated sawdust insulation up to the same level as the mortar.

Now grab a log-end and set it on the mortar, spanning the insulation. A slight, vibrating, back-and-forth motion is all that is needed to establish a suction bond to the mortar. (Later, this suction bond becomes a friction bond, which is the best you can hope for—no chemical bond between wood and mortar will occur.) The next log-end is placed beside the first, leaving about 1 inch between log-ends. Continue until all the mortar is covered.

Work laterally around the home, a course or two at a time, or in the case of cordwood panels within a post-and-beam frame, work three or four courses high at a time. Remember, avoid mixing up more wet mortar than you can comfortably use before it sets up.

The mantra doesn't change on the second course—put the mud down first, following the hills and valleys formed by the first course. Then add the sawdust. Use your gloved fingers and thumbs to pre-settle the sawdust in the spaces between log-ends. Bring the sawdust up to the level of the mud.

Now, select a log-end that has fits the shape defined by the previous mortar course. If you keep a variety of large and small log-ends nearby, choosing the right log-end will become easy with experience. Again, place it with a gentle, vibrating set. You don't have to pound it in, although sometimes a gentle tap with a small hammer is helpful. If the log-end doesn't seem to want to "sit," it is almost always because you've used too much sawdust, which is now trying to spring the log-end back up again. Remove a little sawdust and try again. The other possibility, although rare, is that an irregularity on one or both of the log-ends is getting in the way.

Leave about an inch of space between log-ends, so that you can work with your pointing knife. With cordwood masonry, pointing serves to maximize the friction bond between wood and mortar, as well as beautify the wall. Even a poorly laid wall can be salvaged with some good pointing. Good pointing also smooths the mortar, creating a more water-repellent exterior surface, and a less dusty interior wall. If the pointing is recessed slightly, and all the log-ends in the wall shrink, it will be easy to conduct a repair. Recessed pointing also looks better—the log-ends are the defining features of a cordwood wall, and having them "proud" of the mortar is what gives a pleasing surface texture.

You'll need a few pointing knives. Raid your local thrift stores or garage sales for nonserrated butter knives. I like the ones that are almost an inch wide, but it is good to have a variety. Bend the last inch of the knife to a 15- or 20-degree angle, so that you can get the business end in close to the work without your knuckles getting in the way.

First, "rough point" the wall, using just your gloved fingers. Remove excess mortar and catch it in your gloved hand. Then use your knife to press the excess mortar into any gaps. For the finished pointing, press quite stiffly with the knife blade, and draw the mortar out smooth, removing knife marks, if possible. How fussy you want to be is up to you, but be consistent. Above all, don't over-point— repeatedly going over the work will bring a lot of water to the surface, causing the mortar to crack within a few days.

Smoothing and pointing the mortar is the final step.

Don't forget to wash your gloves and tools, and cover the work for the night.

As mortars, these two mixes are very similar in terms of hardness, strength, workability, and smoothness. The main difference is color. The Portland mix tends to be lighter and more of a green-gray shade; the masonry mix usually is a blue-gray color.

Mortars mix well in a wheelbarrow. Add the dry ingredients to the barrow by the shovelful. Following the series below will help ensure a uniform mixture. For the Portland mix, combine:

- 3 shovelfuls sand, 1 shovelful sawdust, 1 shovelful lime, 1 shovelful Portland
- 3 shovelfuls sand, 1 shovelful sawdust, 1 shovelful lime, 1 shovelful Portland
- 3 shovelfuls sand, 1 shovelful sawdust, 1 shovelful lime

With the masonry mix, a good cadence for adding material is:

- 3 shovelfuls sand, 1 shovelful sawdust, 1 shovelful masonry, 1 shovelful lime
- 3 shovelfuls sand, 1 shovelful sawdust, 1 shovelful masonry, 1 shovelful lime
- 3 shovelfuls sand, 1 shovelful sawdust, 1 shovelful masonry

The numbers in these mixes refer to equal parts by volume, so always use the same size shovel and load it the same way each time. Reserve a separate shovel of the same size for the soaked sawdust—and keep this wet shovel out of the dry cementitious materials.

What about Rot?

Within a cordwood wall, fungi have access to nutrients and air, but not moisture—the third ingredient they need to thrive. The exposed log-ends are permeable along their end-grain and readily release any moisture. To further diminish the chance of wood rot, follow these four easy strategies:

- Start the cordwood masonry at least 4 inches (10 cm) above grade, on a good foundation made from concrete, cement blocks, earth bags, or stones. In wet climates, increase this to 12 inches.
- Design ample roof overhangs: 16-inch overhangs are good, but 24-inch overhangs or more are even better.
- Keep adjacent log-ends from touching each other. Prevent log-ends from contacting the surrounding post-and-beam frames.
- Build only with de-barked, dry log-ends. Reject wood that shows any sign of existing rot or deterioration.

The Importance of Insulation

A cordwood wall derives its resistance to heat flow from the insulated space between the inner and outer mortar joints. If this space is uninsulated, the house will be very difficult to heat.

Several insulation options exist. Fiberglass is a readily available material, but it can be nasty to work with (gets in the eyes and lungs); it has a high embodied energy; and, if it mats down with moisture, it may not fluff back again. Vermiculite, perlite, and other loose-fill insulation work quite well, but can be costly. Using shredded beadboard insulation, made out of expanded polystyrene beads, may seem like a good way to recycle this material, but it is virtually impossible to direct it into a wall cavity. The little beads stick to the mortar, your gloves, your clothes—they go everywhere, it seems, but where you want them. And the slightest wind causes an insulation disaster.

Sawdust is cheap, makes use of a "waste" material, and has an insulation value of about R-3 per inch, about the same as fiberglass. And it's easy to pour into the space with soup cans or small buckets. To retard against vermin, mix builder's lime into the sawdust at a ratio of twelve parts sawdust to one part lime. An additional benefit to adding lime is that if the wall takes on moisture, the lime will set up with the sawdust in the wall, forming a kind of rigid insulation.

Cordwood Basics & Beyond

Now that you have the basic background on cordwood, start experimenting! Small cordwood structures are fairly straightforward and easy to build, and cordwood easily lends itself to whimsical structures—from children's playhouses to potting sheds. For more details on building with cordwood, read *Cordwood Building: The State of the Art* or consider attending a workshop for hands-on experience (see Access).

Access

Rob Roy, Earthwood Building School, 366 Murtagh Hill Rd., West Chazy, NY 12992 • 518-493-7744 • robandjaki@yahoo.com • www.cordwoodmasonry.com • Rob Roy has written thirteen books about alternative building techniques, including five about cordwood masonry.

Continental Cordwood Conference in Merrill, Wisconsin, July 30 & 31, 2005. Lectures & demonstrations by Rob Roy, Alan Stankevitz (see *HP105*), Jack Henstridge, Cliff Shockey & others. Tour cordwood homes. For info, go to www.daycreek.com, e-mail organizer Richard Flatau at flato@aol.com or call him at 715-536-3195. Registration: US$100 for an individual, US$180 per couple.

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Sika Corp., 30800 Stephenson Hwy., Madison Heights, MI 48071 • 248-577-0020 • Fax: 248-577-0810 • sikainfo@sika-corp.com • www.sikausa.com • Plastiment cement admixture

Grace Construction Products, 62 Whittemore Ave., Cambridge, MA 02140 • 617-876-1400 • Fax: 617-234-7548 • concrete@grace.com • www.graceconstruction.com • Daratard 17 cement admixture

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