Roofing with Sod

Beneath the surface, it's not the same as it used to be

by David Easton

Sod has served as a roofing material throughout history and throughout the world. Sod covered the roofs of 14th-century Pawnee earth lodges, and it made up the walls and roofs of Scotch and Irish folk houses. But sod roofs are most deeply rooted in Scandinavia, where the climate fosters a thick and healthy turf. The traditional Scandinavian sod roof consisted of birchbark sheathing laid across poles running from ridge to wall, with blocks of turf cut from a nearby field and laid on the birchbark. The roofs leaked a bit, to be sure, but some of them lasted for centuries.

As a builder dedicated to the use of natural components, such as rammed-earth walls and soil-cement tile floors, I've been striving to develop a truly dependable sod roofing system. I think a living roof adds immeasurably to the ambience of a home. The first sod roof I built was almost as simple and as cheap as the traditional Scandinavian roof. Covering a small cabin on our ranch in the Sierra Nevada mountains of California, it consists of 30-lb. felt stapled over the roof boards, two layers of 6-mil polyethylene sheeting with asphalt emulsion between them and 4 in. of forest humus seeded with perennial rye. The roofing materials cost about 12 cents a sq. ft., and the labor was all ours. After nine years, the roof still doesn't leak much, but it does leak.

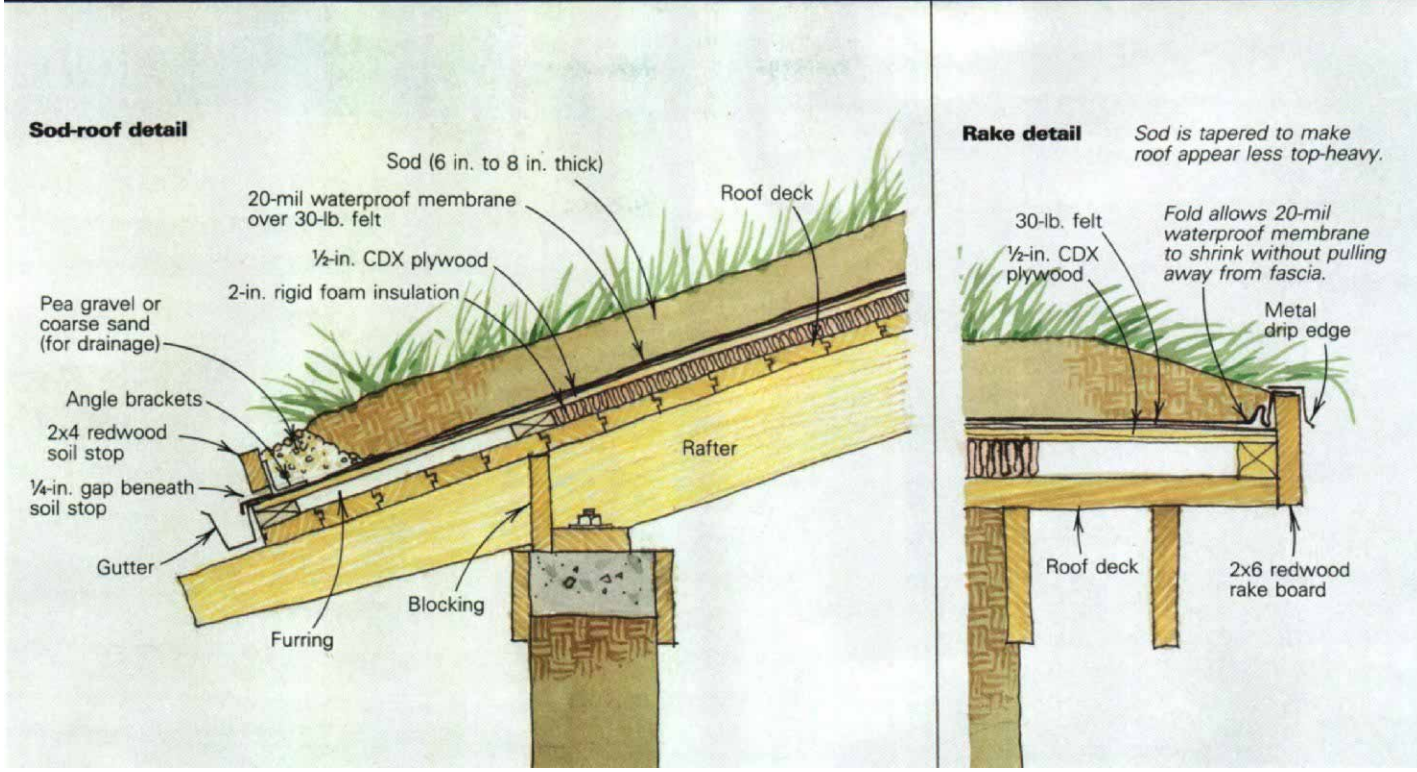
We even raised rabbits on that roof, and our wise old peahen outfoxed the foxes by nesting up there (photo below). The rabbits kept the grass mowed and fertilized, and every so often when one fell off the roof, right into the stew pot he went.

But there are more tangible advantages to a sod roof. Six or eight inches of healthy sod provide a pretty good thermal buffer, helping to keep a house cool in the summer and warm in the winter. One rammed-earth house I built in Calaveras County probably wouldn't have survived a recent brush fire if not for its sod roof. With the fire fast approaching, the owner mowed his roof and turned on the rooftop sprinklers. The fire swept right past the house, inflicting no damage.

For his sod, Easton uses either lightweight humus sowed with native grasses and wildflowers, or blocks of grass and soil cut from the fields and laid like bricks over the membrane. Left unmowed, Easton's own sod roof makes a hospitable home for his old peahen.

Of course, there are disadvantages to sod roofs, too. They're heavy, calling for stronger and more expensive roof timbers than do conventional roofs. There can also be extra maintenance involved, particularly if the roof is supposed to look well groomed. And if leaks develop, they can be a hassle to find. Unlike conventional roofs, where water runs downhill, 8-in. of soil can create enough hydrostatic pressure to force water upslope and through even the smallest of cracks.

I now have about a dozen sod roofs under my belt, and almost all the problems I've had with them have been due to faulty workmanship along rakes and eaves, and around chimneys, skylights and vent stacks. The hard-learned lesson is that you just can't be too careful, especially when you're burying a waterproof membrane beneath 8 in. of soil. My three most recent sod roofs have weathered for almost four years now, and all are performing as a good roof should. Though there are no guarantees that my sod roofs will last 20 years, I'm encouraged so far. As one who has seen his share of water pass *under* the membrane, I now feel qualified to offer some good tips on roofing with sod.



Roof-top anatomy—My state-of-the-art sod roof consists of (from bottom to top) the rafters and decking, 2-in. rigid-foam panels, ⅜-in. or ½-in. CDX plywood, a layer of 30-lb. felt, a 20-mil or thicker waterproof membrane, and 6-in. to 8-in. of soil (drawings above). I substitute furring strips for the insulation on the overhangs. A narrow band of gravel or sand promotes drainage along the eaves and around chimneys and skylights.

Every sod roof my crew and I have built sits on top of an open-beam gable structure—heavy timbers decked with 1½-in. T&G decking. But trusses or 2x rafters will work just as well, provided the roof is engineered to support the 100 lb. to 140 lb. per sq. ft. that 8 in. of soaking wet soil will weigh (if you live in snow country, you have to figure snow loads into the equation, too). *As* long as the roof framing can handle the weight, the building departments I've dealt with have had no problem with the use of sod as a roofing material.

Though traditional Scandinavian sod roofs are typically steep, we stick to a 6-in-12 pitch or under for our roofs (we prefer a 4-in-12 pitch). Sod bricks allow a steeper roof, but loose soil will creep downslope in a heavy downpour, at least until the grass roots have had a chance to knit the turf together. There's no real rule-of-thumb regarding roof types. I've seen sod installed over everything from flat roofs to complicated compound-curve roofs. If the sod will stay put on the roof, it will do the job.

A top-of-the-line sod roof isn't cheap. By the time you add up the cost of insulation, sheathing and waterproof membrane and factor in the labor, the total cost approaches that of a cedar-shingle roof. Factor in the hefty roof framing required (which we use anyway for aesthetic reasons), and a sod roof can cost double that of a shingle roof.

Insulation and sheathing—Once the roof is decked, the insulation is the first component of the sod roof to land on it (top photo, next page). Our early sod roofs had no insulation other than that provided by the sod itself. But I'm convinced that insulation would have been worth the cost, especially during cold, wet weather. We use Thermax polyurethane insulation (Celotex Corp., P. 0. Box 31602, Tampa, Fla. 33631) because polyurethane packs a lot of R-value into a small amount of space (R-16 for 2-in. thick panels). There is no need to insulate overhangs, so at the eaves and rakes we nail a 2-in. thick grid of scrap lumber to the deck, producing a flat nailing surface for the plywood sheathing. It takes longer to install this furring grid than to lay down rigid insulation instead, but it saves the cost of a few sheets of Thermax.

We lay the insulation from the ridge down, beveling the top edges of the ridge pieces for a snug fit. Each sheet is placed tightly against its neighbor and tacked down with a couple of 12d nails. We let the bottom course lap the eaves where it will and then fill in the leftover space with the furring grid.

Once the insulation and furring are in place, we sheathe the whole roof with plywood. Here we use 16d galvanized nails, which are long enough to pass through the plywood and insulation and to penetrate more than an inch into the roof deck. This time we work our way from the bottom of the roof to the top in order to offset the horizontal seams of the plywood and the insulation board (we also offset the vertical joints).

Not all our sod roofs have gutters, but when they do, we install them after the plywood is in place. We use 5-in. deep galvanized gutters, bending the backsides over at a right angle to form a 1-in. lip. The lip is then nailed securely to the edge of the roof with 16d galvanized nails. Bending the gutter like this shortens the effective depth of the trough, but it makes for a positive connection to the roof and allows us to wrap the waterproof membrane over the lip and into the gutter. Also, this raises the gutter so that its bottom edge is flush with or above the underside of the decking, allowing us to extend the rafter tails out beyond the gutters. If you like the look of exposed rafter tails as I do, this bend in the gutter is essential.

The drawback to bending the gutter is in dealing with that day in the distant future when the gutter needs to be replaced. Someone will have to lift up the membrane, yank out the old gutter and spike in a new one. If the budget allows you to use copper gutters, you won't have to leave instructions for installing a new gutter in your will.

Next come the rake boards, which retain the soil along the rakes. We use redwood 2x6s or 2x8s for this, but pressure-treated lumber works just as well. A 2x6 doesn't retain as much sod as a 2x8 does, but I prefer to use the slimmer boards and to taper the sod near the edges so the roof appears a little less top-heavy. We spike the rake boards to the ends of the decking with 20d galvanized spikes, aligning their bottom edges with the bottom of the roof decking.

Waterproofing—Before we install the waterproof membrane, we staple 30-lb. felt over the sheathing to protect the membrane from nail heads and wood splinters (bottom photo, next page). Courses lap a minimum of 3 in., and each course is cut long enough to turn up the sides of the rake boards (we're careful here to bend the felt at tight right angles). If there's a gutter, we lap the bottom course of felt over the bent section of the gutter and glue the felt to the gutter with mastic.

For the membrane itself, we use 20-mil chlorinated-polyethylene sheeting called

Drawings: Malcolm Wells

NobleSeal 220 (The Noble Company, 614 Monroe St., Grand Haven, Mich. 49417). Available in 5-ft. by 100-ft. rolls, it's commonly used for pond liners and for waterproofing under concrete slabs.

To install the membrane, we work our way from the eaves to the ridge (bottom left photo, facing page). Adjacent courses are lapped 4 in. to 6 in. and chemically fused with a brush-on sealant called Nobleweld (also available from The Noble Company), which permanently bonds the seams and prevents water and root penetration. We're extra careful with this part of the job because roots will penetrate even the smallest of openings in search of water and warmth. We position the first course so that the bottom edge overlaps the felt and either runs down the back of the gutter about two inches or, if there is no gutter, bends over the edge of the roof. Each course laps the tops of the rake boards on both ends, and the top course crests the ridge and drops down the opposite side of the roof. We staple the membrane only at the ends and along the top of each course, where the staples will be covered by the next course up.

Though the manufacturer claims that NobleSeal shrinks less than other membranes, a tightly stretched membrane will eventually shrink enough to pull away from the rake boards and cause leaks (naturally, we learned that the hard way). So now we cut the membrane for each course a few inches long and tuck an extra fold into it alongside the rake at both ends (top right drawing, previous page). As the membrane shrinks, it takes up this slack.

Vents, skylights and chimneys—Roof penetrations present special problems with sod roofs. In fact, we do our best to keep them to a minimum. For vent stacks, we use standard metal flanges with neoprene gaskets, which we nail on top of the felt, and cut round holes in the membrane to fit over the flanges. As an extra precaution, we fit a second piece of NobleSeal (about 2 ft. square) over the vent stack and glue it securely to the primary membrane with Nobleweld. We cut the hole in this piece slightly undersize so that the membrane stretches tightly around the flange. We use this same approach for stovepipes.

Because sod is substantially thicker than most other roof coverings, most skylights require a higher curb than usual to elevate them above the plane of the roof. We usually build a 2x12 redwood frame that slips down into the rough opening and projects about 7½ in. above the plywood sheathing, serving as both the finish trim on the interior and the curb on the roof. This curb requires careful and systematic flashing with four 12-in. wide strips of 30-lb. felt and four 18-in. wide strips of aluminum or galvanized-steel flashing (drawing, facing page).

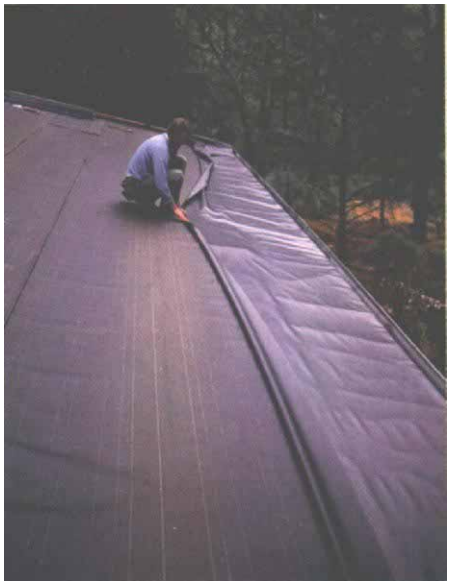
Flashing begins right after we install the 30-lb. felt over the entire roof, with the felt cut to fit snugly around the 2x12 frame. The

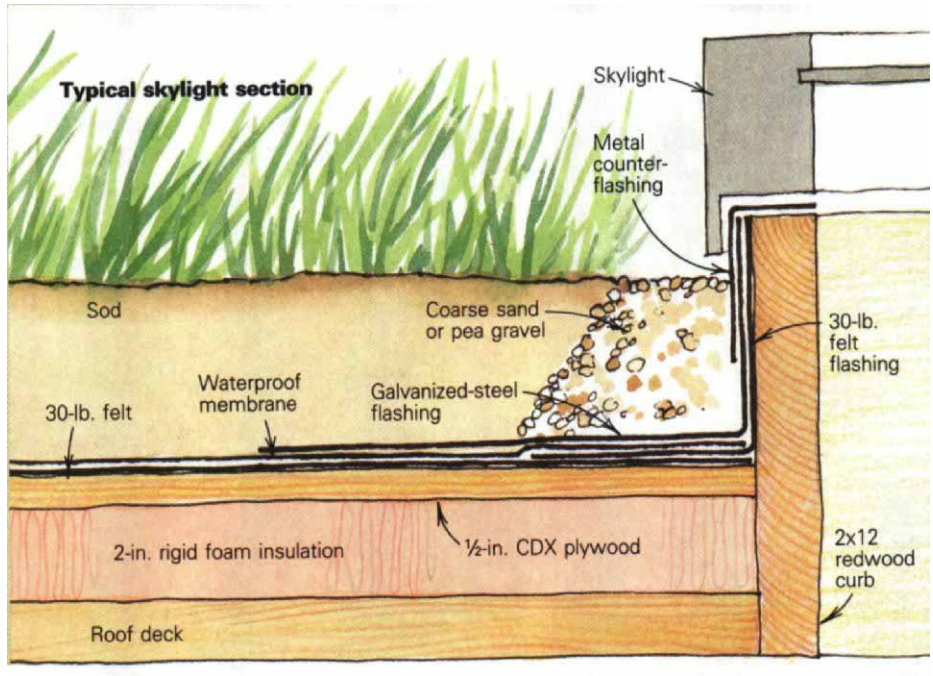
felt flashing is installed first. We start by cutting the first piece 12 in. longer than the width of the frame, folding it in half lengthwise and installing it against the bottom of the frame. At the corners of the frame, we carefully slice halfway through the flashing and wrap the ends around the corners, applying a healthy dab of mastic to prevent leaks. The two side pieces are cut, folded and installed the same way, with their bottoms lapping the ends of the bottom flashing. Again, we use a dab of mastic to prevent leakage. The top flashing matches the first piece and laps the tops of the side flashing.

Next, we install the waterproof membrane over the entire roof, cutting it for a close fit against the skylight frame, without turning up the sides (turning the membrane up prevents the final layer of flashing from lying flat). What we have at this stage is a roof covered in its entirety with both felt and the waterproof membrane, and the skylight curb flashed with strips of 30-lb. felt. The final step is for us to flash the skylight frame with the 18-in. wide strips of galvanized metal, using the same careful method described above. The bottom strip sits over the membrane, as do the side pieces, until they reach the top corners of the curb. Here, they tuck under the membrane through a neatly cut horizontal slit in the membrane. The top flashing also slips under the membrane and laps over the top corners of the side flashing.

Once again, we apply a generous dose of mastic where it's needed. This completes the primary flashing. Depending on how far down over the curb the skylight will sit, we sometimes install counterflashing—a 6-in. wide length of galvanized metal that's nailed

Sod-roof construction. **The roof structure for a sod roof has to be sturdy enough to support 6 in. to 8 in. of soaking wet soil (100 lb. to 140 lb. per sq. ft.). Once the roof is framed and decked, 2-in. thick polyurethane insulation is installed over the deck (top left photo). To save on insulation, Easton furs the overhangs with 2-in. thick scrap lumber. In the photo below left, the insulation is topped with CDX plywood, and 30-lb. felt is being stapled to the plywood to protect the waterproof membrane from plywood splinters and nail heads. The membrane is a 20-mil chlorinated-polyethylene sheeting commonly used for waterproofing concrete slabs. In the photo below, the membrane is being laid directly over the roofing felt, with adjacent courses lapped 4 in. to 6 in. and fused together with a brush-on glue. The ends of each course wrap over the tops of the rake boards and will be covered by metal drip-edges. To promote drainage, a narrow band of coarse sand is placed along the eaves (photo right) and around chimneys and skylights. Sand and sod are contained at the eaves by a redwood 2x4 fastened to the roof with galvanized angle brackets and screws. Because summers are dry in California, Easton typically installs rooftop sprinklers or drip-irrigation systems to keep the grass green and the house cool.**





to the top of the curb and bent down over the primary flashing.

Masonry chimneys are flashed the same way (the chimney is treated as a curb), except that they require the usual counterflashing embedded in the mortar joints.

Edge treatment—Once the roof is wrapped with the waterproof membrane, three steps remain before we start hauling up the topsoil. First, we fasten a 2x2 metal drip edge to the rake boards with 5d or 6d nails. This prevents water from working its way under the membrane and protects the edge of the membrane from the sun. Second, we install a redwood 2x4 on the roof along the eaves to retain the soil (top photo), holding the 2x4 ¼ in. above the membrane to allow drainage. The redwood is held fast with galvanized-metal angle brackets screwed to the roof, with big gobs of silicone caulk covering both the brackets and the screws. Finally, we place a narrow band of coarse sand or pea gravel along the edge of the 2x4 and around skylights and chimneys to promote quick runoff.

Topping it off—For soil, we use the best quality, lightest humus (loose, friable organic soil) we can gather at the building site, or we use the old Scandinavian trick of digging sod blocks and carrying up the grass and the soil together (we've tried this one a couple of times, but always have trouble finding grass thick enough to stay in one piece during transport).

Whichever method we use, getting the soil up on the roof is a chore. We've used conveyers, tractors, a backhoe, ramps and wheelbarrows, and even 5-gal. buckets. If we use loose soil, we rake it on the roof until it's smooth; then we sow it with native grasses and wildflowers. Sometimes we plant a few bulbs in it, too.

What about watering and mowing? Here in California, where the summers are dry, we always install sprinklers or drip irrigation systems on the roof. In addition to keeping the roof green and healthy, the water makes the roof work as an evaporative cooler, reducing the temperature in and around the house.

Most people I know who have sod roofs don't mow them. Rather, they let them grow wild and shaggy, building up humus and root mass over the years for increasingly better insulation (top photo, p. 78). Given enough time, the roof will look like it grew there. □

David Easton is a contractor and earthbuilder in Wilseyville, California. Photos by the author.