ASPI
APPALACHIA
SCIENCE IN THE PUBLIC INTEREST
Route 5, Box 423 Livingston, KY 40445

CORDWOOD BUILDINGS

ASPI Technical Series

INTRODUCTION

No one knows who first built a stackwood or cordwood log building (CWB) back in the hazy past, but some of these structures have withstood the elements in northern Greece for at least a thousand years. Northern Europe has a sizeable number of such buildings and the construction zone extends into Siberia and the frigid climates of Canada. This author saw one such structure used in Saskatchewan Province. It requires very little fuel wood to heat the building, even though outside temperatures reach as low as 40° below zero (Fahrenheit) –– yet it is most comfortable in winter.

Why so few CWB's in non–frigid parts of the world? Maybe the lack of accessible, long–lasting supplies of wood has something to do with it. Granted, there is a loss of insulating ability in the end direction of wood as opposed to laying materials lengthwise, but this is compensated for by using thicker logs and cradling insulation within the interior of the CWB walls. Curiously, the insulating ability of a cordwood wall is actually far superior to that of a conventional log building. A 16 inch thick cordwood wall would have an insulating value of R–16, or a factor of resistance to heat loss of R–1 per inch of wood. Unfortunately, many do not want novel ideas for building and thus refrain from this CWB approach to low–cost housing, although CWB's have several advantages. Where building codes may restrict or impede the construction of cordwood houses, the technique can still be used for garages, workshops, studios, storage sheds, barns, or other buildings.

Parts of the world build for hot summers and other parts for cold winters, but in a temperate zone band, building spaces experience both hot and cold temperatures –– and few structures serve both extremes better than CWB's. Furthermore, these are "solar" buildings which have captured the sun's rays in the form of wood, a renewable resource and do not take as much maintenance and care as do more conventional solar houses.

ADVANTAGES

* Saves fuel in both summer and winter. ASPI's CWB uses only about one cord of firewood a year. Therefore, extra wood required for initial construction can be recovered as fuel savings in less than one decade.

* Very low cost. On a per square foot basis this is one of the most economic houses to build, in areas where plentiful wood supplies are present.

* Uses recycled materials. The short length of each cordwood log (12–16inches) allows use of scrap wood and log ends.

* Extremely attractive. Virtually all who see these buildings comment on their aesthetically pleasing lines, rustic charm and character.

* Easy to construct. Full–length logs are heavy and cumbersome, difficult to transport, and need draft animals or machinery and several people for construction. A CWB can be built by a single person with moderate stamina and strength. Care is the only special skill required.

* Easy to maintain. The CWB needs an application of linseed oil on the log ends every two or so years and one or two repointings (filling the masonry joints with mortar, and smoothing with a spoon) as the walls season.

* Low fire–hazard. It is almost impossible to burn down the walls of a CWB. The roof may burn out, but the walls are protected by the surrounding cement from doing more than singeing under ordinary circumstances.

ASPI's CORDWOOD BUILDING

This 1000–square foot building is made from 16 inch lengths of White oak cut from already down timber on U.S. Forest Service land about a mile from this site. The structure was erected in 1983 and has served as the ASPI office since 1985. It is cool in summer and warm in winter, using little cooling energy in summer or heating in winter. The cordwood building cost less than $8,000 for materials, or $8.00 per square foot.

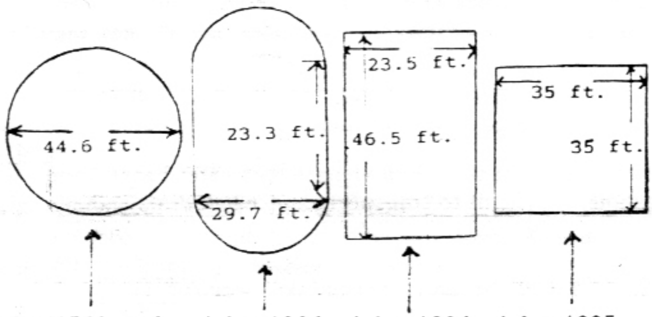
HOW TO BUILD A CWB

The classic books by Robert L. Roy (references 2 and 3) describe the construction of a CWB in great detail. For the sake of emphasis, we will review some of the steps:

Choosing the Site

Site selection is important for the total comfort, lifetime, and economy of the building. Remember, having a southern exposure is most important for including passive design considerations. Building on a shaded hillside away from the prevailing wind but with winter exposure to the sun is ideal. However, very few locations fit all one's expectations. In level areas in suburbs or sub–divisions, one might be highly restricted as to what can be done–– as important for CWB's as for other kinds of housing. Often, wind barriers can be constructed with the proper types of evergreens (hemlocks, white pines, blue spruce, etc.) that can cut winter space–heating losses.

INTERNAL AREAS OF VARIOUS BUILDING SHAPES



I.A.=1562 sq.ft. I.A.=1384 I.A.=1094 I.A.=1225

Each figure has a perimeter of 140 feet.

Selecting the Design

CWB's come in a variety of building designs, (e.g., post–and–beam, stack wall, curved––round or oblong). As Roy points out, a 120–running foot wall building could have a variety of internal areas so the selection of shape has much to do with building material economy. One should remember that curved wall buildings require some novel ways of economizing interior space because of the customary shape of commonly purchased furniture and appliances.

Economy of building materials is not the only design consideration. One must remember that curved walls are far less difficult to construct, but the roofs are somewhat harder to design and build. However, the self–supporting nature of the curved walls, along with the fact that log ends need not be as uniform in size as is necessary for the angled corners of stackwall buildings are significant factors to be considered. A post–and–beam structure is beautiful but takes far more time to construct if individual mortising is performed. The technique is an art and the resulting handiwork could last for centuries.

Choosing and Preparing Wood

The type of wood one selects for the CWB is most important. The typical type of wood in northern climates is Eastern red cedar (Juniperus virginiana), which is known for its durability and resistance to rotting. Where plentiful, this is an ideal CWB construction material because many of the trees are of small girth and make good logs.

For its CWB ASPI used White oak (Quercus alba), which is the most common tree of the central Appalachian climax forest. The U.S. Forest Service had clear cut a number of acres of its nearby land because of '74 tornado damage; this wood was dried and cut for our building after being deadened for three years. Another common tree, the Yellow poplar or Tulip tree (Liriodendron tulipfera), has been known to remain solid and sturdy in two–hundred year–old log cabins.

The selected trees are cut into double lengths for drying. (Walls may be 12 or 16 inches thick; thus the lengths could be 24 or 32 inches). The cordwood is placed on stovewood type ricks and allowed to dry. Cutting in winter before the sap rises reduces drying time required. At a minimum, wood should be cut, split, stacked and dried out of the weather for at least one year prior to construction. Pieces of tin roof over the rick will keep rainwater from adding moisture during the drying period.

Timing is important in removing bark from the logs and will vary with different types of wood. Common sense and some knowledge of timber will help to determine when your variety of logs can be stripped of bark most easily. For some logs peeling is best done when the trees are freshly cut, while the bark on others is more easily cut away after they are seasoned and thoroughly dry (sometimes six months or more depending on when cut).

It is better to split larger logs (above 10 inches diameter) for faster drying, and to prevent checking starring or cracking after the wall is laid. This last factor is mostly an appearance problem because the cracked logs can easily be caulked during an annual inspection. In addition fewer logs are needed in construction when large logs are split into several individual segments, each to be used as small logs.

TOOLS TO USE FOR THE CWB CONSTRUCTION

Foundation tools (pick, spades, etc.)
Chainsaw for wood cutting
Axe and hatchet (or peeling spud) for debarking
Splitting maul or go–devil
  (or sledge hammer with splitting wedges)
Masonry mixing tools and container
Tarp for covering wet walls
Trowel & pointing tools
  (a large spoon is sufficient)
Hammer, saws, drills, square, level
Caulking gun and caulk
Painting equipment.

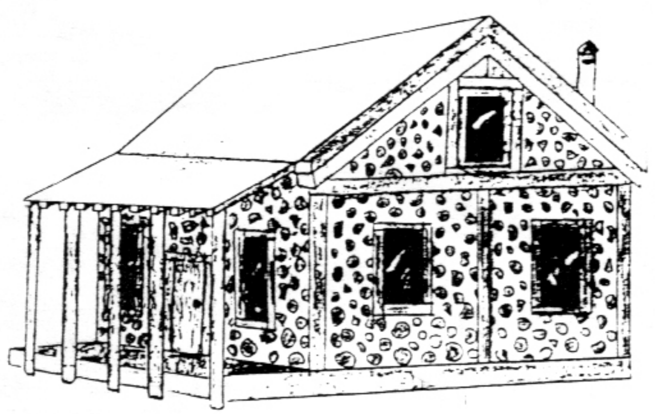
Wood Protection

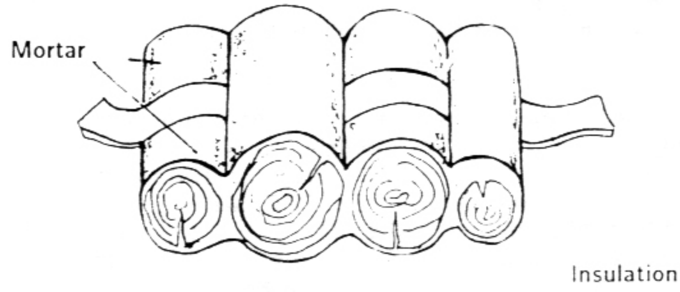
A masonry or slab concrete floor will retard the action of termites and other wood–eating insects. Precautions taken for preserving and preventing such damage in other houses apply here. Stacking of the cordwood should begin at least 12 –18 inches above the grade, with rocks, block, or other masonry forming the foundation. Aluminum flashing should be applied between the masonry foundation and the cordwood with ample caulking and sealing to prevent air infiltration. The first course of stacked wood should be treated with Thompson's Water Seal brand Water Proofing Formula or other non–toxic wood preservative to deter insects and prevent rot from splash action, which results from normal rainfall and runoff from the roof. Due to the removal of many toxic wood preservatives from the market, wood preservation is more difficult for the do–it–yourselfer. We suggest raw linseed oil as a good CWB preservative. The discontinuous nature of the cemented individual logs makes it more difficult for termite damage to occur in CWB houses.

Cementing Mixture Composition

There is no firm mixing composition of the masonry materials due to the amount of shrinkage still to occur, the type of wood used, the weather conditions of the construction period, the time length allowed for drying the cement, and the weather conditions of the first year curing time. Because slower drying time is necessary to prevent severe shrinkage and breaking away from the wood, some sawdust is inserted into the masonry mixture. In the ASPI building a composition of almost equal sand and sawdust was used. The resulting cement wall is soft and will easily crumble for a year or so –– and no nails or excess hammering should occur to shake up the wall in any fashion. A Brixment/yellow sand mix which is so helpful in tuck–pointing (See MAINTAINING THE CORDWOOD BUILDING) could be used in the log laying process as well.

If you are using a type of wood that has no previous CWB history, a helpful procedure for gaining hands–on experience is to build a smaller free–standing storage building in the model of the anticipated house, and see how well the various masonry types hold up after recording conditions at each of the sides during and after construction. Use the mixture of the best–preserved side.





Insulating the Walls

The CWB at ASPI was built using insulation scrap that was free for the cost of hauling. Check at local lumber yards and building supply outlets for free or low–cost fiberglass, rock wool or foam insulation scraps. Shredded and fire–proof (boron treated) newsprint and other cellulose materials also prove good insulating materials. There is a need for a thermal–break between exterior and interior mortar to prevent excessive heat loss. (The outer and inner masonry walls should not be connected and the space between should be about one–third the width of the wall.) See diagram. The more insulation between the mortar joints, the greater the overall efficiency of the building.

At the top of the building's walls some space will exist between the last row of logs and the plate holding the roof. This can be plugged with scrap insulation, by using a trowel to firm the material into place and protected with masonry both on the exterior and interior.

NOTE: In warmer climates heat gain, rather than loss may be the more serious problem.

Pointing Practices

Veteran builders know the value of tuck–pointing the walls, but this is a step many amateurs will omit or consider superfluous. If inexperienced, talk to a builder before beginning the masonry process to understand the importance of this operation. It firms the walls and adds to the life of the materials. Since sawdust is inserted in most mixtures, and this dries very slowly, additional pointing can be done the second day, the second week and even after a month in many climates.

Finishing the CWB

The completion of the house follows standard practice. Interior walls, plumbing, electrical work, roofing and chimney are done in the usual manner. One should remember that a curve–walled building may require some special fitting and more scrap wood. We would suggest making a regular rectangular roof of hip or gable design, for it takes the same amount of wood and adds overhangs to the ends for weather protection. In any case, a minimum eave or roof overhang of 30 inches will protect the exterior walls from weather damage, and will also help to shade the building to prevent overheating during the hot summer months.

MAINTAINING THE CORDWOOD BUILDING

Even though the CWB is built to last for centuries some maintenance is necessary.

* Walls will normally require repointing with some cementing material mix. We strongly suggest a mix of yellow sand and masonry cement (We used BRIXMENT brand type–N Coplary Cement, ESSROC Materials, Inc. Speed, IN 47172), recommended by expert log cabin builder, Albert Baldwin of Pittsburg, Kentucky. For the ASPI house this material has proven to be excellent. It sticks very well to the wood and will not develop cracks provided hammering and violent vibrations do not occur.

* The wood surface should be re–coated with linseed oil depending on the amount of weathering. The inside surface of the log ends can last for four or five years between applications, but parts of the outside should be done every other year. The applications should be quite light and the linseed oil should not be allowed to touch the mortar, so apply with a small paint brush.

* At times larger logs will "star" or check. If this is severe apply a caulking material to match the color of the logs.

* If ample overhangs have not been built, any re–roofing of the house should take this into consideration. Porches and other protective roofing can also help preserve the logs. Guttering is more difficult but not impossible with rounded varieties.

* Use a water sealer on the bottom layer of logs if moisture becomes a problem. Thompson's Water Seal brand Water Proofing Formula works well.

* Often wasps and other stinging insects are attracted to log buildings and periodically throughout the warmer months an effort should be made to remove the nests and gathering places. Kerosene is an excellent low–toxic substance for such extermination operations. Sealing cracks at the top of the highest layer and between the plate and roofing area will discourage many of these insects.

* When attaching items such as pictures to walls on the interior, be extremely careful about hammering nails into the wood. Thumb tacks or other low vibration attaching devices are preferable.

* Doors and window frames and other parts of the building will require the same maintenance due any housing.

TYPICALCOST (Labor not included.)

Small CWB Cabin 20 X 20 feet Total 400 square feet

Cement, sand	$ 120
Chain saw fuel	30
Four windows	240
Two doors (galvanized steel)	200
Roof –500 square feet (shingles, plywood, tar paper, nails)	300
Guttering, downspout	100
Floor (concrete, rebar) plus foundation	440
Paint, caulking	50
Insulation	120
Rafters (local cut)	150
Sheeting (sheet rock) for ceiling	160
Electric outlet, box, wiring	200
Plumbing and pipes	120
Vents	20
Stove pipe	50
Flashing	40
Miscellaneous hardware	100
TOTAL	$ 2400

$ 6.00/ square foot

IF ...

If we had to do it again we would –

* Build the house in an open space due to moisture problems. However, ASPI sites are extremely limited;

* Insert glass bottles into the walls for beauty and light;

* Split all logs of more than eight inches in diameter, due to difficulty in placement and starring (cracking) on standing;

* Build a gabled roof over the building;

* Conduct more workshops as part of the building procedure;

* Put vertical log supports every 12 feet ––to prevent possible severe earthquake damage;

* Add two skylights to the attic area;

* Insert several more windows.

REFERENCES:

1 Square, David, "Poor Man's Architecture," Harrowsmith #15 (1978), pp. 84–91.

2 Robert L. Roy, HOW TO BUILD LOG–END HOUSES, Drake Publishers, New York, 1977.

3 Robert L. Roy, CORDWOOD MASONRY HOUSES: A PRACTICALGUIDE FOR THE OWNER–BUILDER,Sterling Publishing Company, New York, 1982.

Editor: Al Fritsch, S.J.
Technical Editor: Paul Gallimore
Design and Layout: Robyn Arnold