Shelter in North-Central Indiana: The Owner-Builder

An Honors Thesis

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By

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Abstract

Across the history of pioneers and settlers in America, building and creating shelter was one of the prime concerns. In the modern housing market, most people think of “building” a house by hiring a contractor and crew. There is a growing trend, however, towards owner-built green building methods, also called alternative building. These alternative methods include straw bale, rammed earth, and cordwood construction. In the straw bale method, bales are used in place of lumber, and then plastered on both the interior and exterior. Rammed earth is a process of using particular blends of clay and sand compacted tightly to form thick, monolithic walls. Cordwood construction uses short lengths of log mortared together in a similar fashion to bricks. All three of these methods have been successfully built and written about in recent years. In this paper, I discuss the strengths and weaknesses of each method and come to a conclusion on which method my research proves to be the most feasible in North-Central Indiana.

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Finally, without my husband, this paper would not be what it is today— to my grammatical hero, Dan Stephens.
Shelter in North-Central Indiana: The Owner-Builder

Across the history of pioneers and settlers, building and creating shelter was one of the prime concerns. In the modern housing market, most people think of “building” a house by hiring a contractor and crew. The goal of this paper is to explore a growing trend towards true owner-builder structures, and discover the most well suited method for North-Central Indiana. I will briefly look at the advantages and disadvantages of several methods, and then focus attention to one method that, through research, has come to light as being both feasible in Indiana’s climate and aesthetically pleasing.

To discuss the climate and particulars of the environment in North-Central Indiana, USA is to talk about water in all its forms. The geologic record tells us that the glaciers scraped Indiana flat, advancing rapidly and then melting in place over many centuries (Bleuer). Parts of North-Central Indiana were once swampy lowland now called the Limberlost, ¹ which was drained in 1913. What remained after is clay-heavy top and sub-soils² that still hold moisture to an extreme, for all the drainage efforts. In addition to ancient glacier activity and surface water, the climate itself is an ever-changing system. Heavy, drenching rains in the spring, summer thunderstorms, ice, snow, and rainstorms in the fall and winter are common.

¹ The Limberlost, once a swamp that covered most of current day Jay and Adams counties and 13,000 acres, is now limited to the 440-acre Loblolly Marsh, 106-acre bird sanctuary and 112-acre Wabash River Rainbow Bend Park.
² http://soils.usda.gov/survey/online_surveys/indiana/
North-Central Indiana experiences 40 inches of annual rainfall, and the clay soil forces most of it to either shed via drainage or form standing surface water (Iclimate.org). Flooding, from minor basement water to major waterways, is a concern during heavy and/or rapid rainfall. Although Indiana is far North enough to experience severe winter temperatures, the flat land and plains-like nature of the plant life creates hot and humid summers with scattered and sometimes limited shade. Together, the climate and environmental considerations create the framework from which I will be discussing popular owner-builder methods.

In Nebraska Style straw bale construction, straw bales are stacked in brick-like formation on the foundation, compressed, and the roof is built directly on the bales. The bales require a finish coat both inside and out to protect and strengthen the structure. Some straw bale builders cover the exterior with siding; others choose to use an earth plaster or cement-based plaster. Either method is proven to be adequate. Some reinforcement such as bars or ties are added in strategic locations to ensure stability. If the straw bales are well protected from moisture, insects, and other damage, straw bale construction is a stable, well insulated, and natural building method (King 134). Although this is a simplified description, the benefit of the straw bale house is the insulation gained by utilizing a lightweight and airy material, quick and simple construction, and low cost.

The clear advantage of this method is that it utilizes a waste-stream product from local farmers, straw bales.\(^3\) Straw, a waste product from grain production, is baled and stored and can often be procured for a relatively low cost. Another advantage of straw

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\(^3\) It is important to distinguish between hay bales and straw bales. Hay is cut and baled grass, used for animal feed. It contains seeds, additional moisture, and is sometimes unpredictable in its content. Straw, however, is a by product of grain production. After the grain is removed from the plant, what is left is the stalk, which is baled and called straw.
bale building is the speed of construction. Once the prep work is complete, straw bales can be set up and ready for adobe or finish work in a relatively short amount of time.

Several disadvantages of building with straw bales are clear to me. First, the building material is very susceptible to moisture. In North-Central Indiana, the climate is unpredictable at best and often very wet, as discussed previously. Speed of construction is an advantage that has some drawbacks. Prep work and designing the foundation takes time, and the finish work to protect the bales is also time-consuming. Bale assembly can be quick but, once in place, the race begins to get the bales sealed against the weather before it rains. And even after construction the question of moisture remains. The rain can penetrate and cause mold that is not visible. Mold can also be an issue if the walls are built without precautions to breathe and dry out quickly.\(^4\) Although detailing and vigilance on the part of the builder can curb some of these issues, Indiana has too much water and unpredictable weather to make this building method completely viable.

Using a particular blend of soils, rammed or compacted earth in forms creates monolithic and aesthetically pleasing walls when the forms are taken away. The aesthetic quality of a rammed earth wall with striations and banding from the layers is beautiful (Easton 151). And the walls are massive, effectively storing and radiating heat unlike most other methods—creating a “thermal flywheel” (Easton 34). The particular advantages of rammed earth depend on location and availability of soil. Clearly, one can always find subsoil, but rammed earth relies on a specific ratio of clay-type soil to sand-type soils. The formula used by David Easton in his book “The Rammed-Earth House” is 70% sand to 30% clay (91). If the location of your site does not have these exact soils

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\(^4\) Paul Lacinski and Michael Bergeron recommend vapor-permeable materials wherever possible, especially on the exterior in cold climates (Lacinski, Preface).
then the soil must be brought in from other locations, increasing cost and decreasing the major advantage of this building method, its low material cost.

The disadvantages of rammed earth make this method strongly unadvisable; some disadvantages are specific to Indiana. First, the walls must be constructed using formwork. In many cases, the formwork itself will cost more than the soil, because the formwork should resist the force applied to the soil to compact it and therefore must be very strong. Another concern is that rammed earth cannot readily incorporate insulation. In the cold wintertime, the walls will act as heat conductors, “wicking” heat out of the structure. The best location for a rammed-earth house is the American Southwest, where the sun can heat the walls during the day—and the walls can heat the house during the night (Easton 34). This principle is the same as in traditional adobe houses in the Southwest.

Another disadvantage of the rammed earth procedure is that it cannot handle the amount of rainfall Indiana receives. A downpour that wets the walls can erode the surface, and repeated over time this can prove disastrous. In the Southwest, it would take many years for a house to be in danger. In Indiana and much of the Midwest, rain in all seasons is the norm, with over 40 inches of annual rainfall, compared to Arizona’s approximately 7 inches (Iclimiate.org). Easton discusses cement additives for soil mixes as a bonding agent that solidifies and stabilizes the wall and can reduce the erosive effect that water can have (Easton 98-101). Adding a cement based product significantly increases the cost and toxicity of the building method.

Cordwood masonry is the method of using short logs of specific length, called log ends, laid up in mortar transversely to form a wall. The log ends are exposed both inside
and out and no additional finish is required for the completed wall. One usually sees
cordwood construction in the American Northeast, Upper Midwest, and Canada.
However, the methods and innovations used in cordwood construction are applicable to
any climate that experiences seasonal changes. The method itself is adaptable, with
variables such as wall depth, that relate to the particular climate. Rob Roy is an innovator
and one of the foremost cordwood masonry developers. He discusses in his book
*Cordwood Building: The State of the Art* the problems he and his wife Jaki encountered
about how to size cordwood walls for the climate in which you live.\(^5\)

The history of cordwood varies from source to source, but two cultures remain in
close contention for the honor of developing cordwood construction. The first is the
Scandinavian tradition, which lays claim to several structures over one hundred years old
(Roy 8). This claim makes sense, as the northern European culture has very harsh winters
and is also heavily forested with boreal forests. These two factors and the short building
season may have led to using cordwood, especially in areas where logging was
happening. Logging creates some by-product, also called log ends, which very well may
have been the inspiration for cordwood and the reason we call cordwood’s building
material a log end as well.

The other tradition of cordwood appears across the pond, in Canada and the
Northern United States (Roy, Cordwood Building, 4). Again, we see very cold and harsh
winters and an abundance of building material in its living state, trees. There is, in my
mind, no need to debate the history of cordwood. As it stands now, cordwood is a proven
method of building a low-cost, efficient shelter.

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\(^5\) In Rob Roy’s early home the wall depth was an insufficient 9”. In Upstate New York the winters can be
cold and harsh, and heating the cabin took 7 full cords of firewood each winter (Roy, 15).
An illustration of the particular benefits of cordwood masonry as a type of construction will follow in the next paragraphs. For one, cordwood is a unique combination of common and readily available local materials. In colder climates, hard and softwood forests are proliferate, indicating that a method of construction that utilizes those materials would be preferable. Historically, log cabins are the method most used in these locations. Cordwood itself is a variation on a log cabin, although a more flexible method. While log cabins are usually made of large, long, straight logs, cordwood can use logs that would otherwise not be suitable to building a log cabin, i.e., those pieces that are too short, irregularly shaped, bowed, or warped. Therefore, while log cabin builders are clearing the forest of its mature, straight trees, some cordwood builders have built houses only of the wood they cleared to place the house, leaving the forest or wood source more intact (Roy, Cordwood Building, Introduction).

A second benefit of cordwood construction is the assembly. With small sections of log and a wheelbarrow of mortar, even a small child can help to build (Roy, Cordwood Building, 176). The materials are not so heavy that crews of strong men are required. In fact, both genders, the older generations, and children can all participate. This decreases the total cost of the structure quite significantly. As the house is being built, the mortar can be mixed as needed in small batches, so construction can happen as time is available.

There is a direct correlation between the length of the logs (and ultimately the depth of the wall) and thermal performance, or R-value. Therefore, in colder climes one would find cordwood homes with a much deeper wall dimension and in warmer climes a

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6 The final cost of a structure reflects material costs and labor costs. Labor costs include paying another person or crew to build in your place. This can quickly ramp up the cost of a house when skilled workers are involved.
shallower dimension.\textsuperscript{7} Cordwood walls are usually given an R-value of about R-24. This number varies with the species of wood used and the particulars of wood-to-mortar ratio in the wall, but as a general statement R-24 is the average (The Complete Cordwood DVD). This is sufficient in terms of insulation, but this number does not reflect the thermal mass of the wall (Roy, Cordwood Building, 219). In typical stick-frame construction, R-values are increased by building with lightweight materials that are designed to give high R-values, such as batt insulation made of fiberglass. The 2 x 4 studs and cladding are also skinny, small, and lightweight materials. Although stick framed houses can claim a high R-value, there is very little thermal mass involved because of these lightweight materials. Cordwood, a heavy solid wall with an air cavity filled with insulation, has a large thermal mass. The benefit of having thermal mass is twofold. First, the more massive the structure, the more energy that can be stored within those walls.

Second, thermal mass can act as a heat sink or as a “blanket” to balance the temperature inside the house during very hot or very cold days. This leads to more even temperature throughout the house, as well as protection against dramatic and short-lived spikes in temperature (Roy, Cordwood Building, 101).

Cordwood has the added benefit of being load bearing. The walls can easily support a roofing system, and in Rob Roy’s case, he uses living green roofs that are very heavy and usually require a sturdy structure to support (Roy, Cordwood Building, 18). Cordwood is intrinsically stable by design, so this is not a problem. Another way to build a cordwood house would be to frame the house with locally harvested timbers, get the roof on, and then enjoy the cover from sun and rain while you infill the walls with cordwood. Many people have experienced both benefits to great success.

\textsuperscript{7} Shallower, in this sense, refers to not less than 8” deep.
Cordwood builders are often the type of people who readily reuse, repurpose, or salvage materials for their structure. Although the same could be true for traditional stick-built homes, cordwood builders tend to greatly reduce the cost of their house through several methods. The first, as mentioned before, is the owner contributes the vast majority of labor needed for construction. Immediately the cost of the house is reduced by a significant amount. If the logs are harvested right from the land that the house is placed on then the savings will increase. Other ingenious builders have utilized old telephone poles as a source for building material; these are just a few of the many options available to the frugal builder.

Another savings benefit of building with cordwood is the general lack of traditionally manufactured building materials. For example, insulation for a stick-built home comes in rolls of varying but standard widths, for use in the walls, floor, or roof. Another example is the wood itself. Kiln dried and planed to standard sizes, dimensional lumber comes from oft-unknown sources. These materials carry both a high embodied energy in manufacture and transport, but also very quickly increase the cost of a house.

Cordwood is also conducive to customization and nontraditional shapes. Many cordwood builders design and build round homes, because the circle is the most efficient shape ratio of skin surface to interior square footage (Roy, Cordwood Building, 189). This translates into less labor for more livable space. Owner-builders also have the freedom to design for their specific needs and preferences. Many unique and interesting houses have resulted from this customization (Roy, Stoneview, 142).

Some of the disadvantages of cordwood are that cordwood is labor intensive. Unlike a stick frame house, the walls are massive and monolithic in some regard. This
means that the builders must build up the walls one log end at a time. The mortar should be mixed on-site, in small batches as the walls are laid up. Cordwood is time-consuming; Rob Roy, in his book “Stoneview: How to build an eco-friendly little Guesthouse,” claims he can construct 24 square feet of cordwood in an 8-hour day working alone (187). Roy also says that when his wife and he work together, the work they can achieve is slightly more than twice what a single person can achieve, because one person can focus on laying up log ends and the other can be mixing new mortar and smoothing the already applied mortar.

Another disadvantage of cordwood can be worked with, but should not be discounted— the innate differences between wood and mortar (Snell, 299). Mortar will not readily bond to wood because of their different compositions. This means that cordwood as a whole relies on more of a “friction” bond between the wood and mortar than an actual chemical bond. This is important because the masonry can separate under certain conditions. If the wood is not completely dry when constructed, the wood could shrink and gaps might appear. Incorrect selection of wood type can also cause shrinking and expanding, which can cause cracks, gaps, and in extreme cases can cause the wall to fail. Small gapping can be remedied fairly easily with PermaChink©, a log cabin compound for sealing gaps or other silicon-based sealant products (Roy, Cordwood Building, 95). However, excessive cracking is a sign of structural weakness, and the wall should be considered unsafe (Snell, 298).

Some innovators in the cordwood field have experimented with a mixture of cob in place of the traditional mortar described above. Cob is a mixture of clay, sand, and binding material, typically straw. The cob is easy to work with and dries very firm
depending on the particular mix. In place of the cementitious mortar, the cob has shown early promise of being reliable and easier to mold (Roy, Cordwood Building, 130).

Despite the various disadvantages of cordwood, the advantages of the method are highly attractive. Cordwood is a low-cost building method which lends itself to adaptation, customization, and creative sourcing for materials. Time-consuming though it may be, cordwood is no different in that regard than Straw Bale or Rammed Earth. In truth, a builder cannot expect to build a house without great time input no matter the method. Anything worth doing takes time—in life and in building shelter. A clear advantage over straw bale building is the cordwood method has only one step and requires no plastering or finish work once the wall is constructed. The rammed earth method falls far behind cordwood in the aspect of insulation and climate protection in North-Central Indiana specifically.

The majority of this paper has focused on cordwood for good reason. In research and common sense, cordwood becomes the clear leader in alternative building methods particularly in North-Central Indiana. This is not to claim that cordwood is a perfect method or will appeal to everyone. Aesthetic judgments are a personal choice and will be left to the reader. This paper has set out to illustrate and examine various owner-builder methods and to determine a method well-suited for North-Central Indiana. In conclusion, cordwood construction has several advantages in the Indiana climate and appears to be the method that has the durability, comfort, and beauty to last in Indiana.
Photo Gallery

Image used with permission from www.daycreek.com.

A round cordwood house called Daycreek.

Image from www.MotherEarthNews.com

A Straw Bale House by Lilker Hecht Design Studio with Stones Throw Design.
A Rammed Earth House, Photo by Robert Peck

www.naturalhomemagazine.com

http://igs.indiana.edu/Geology


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