ECOLOGICALLY RESPONSIBLE WOOD BUILDING

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Wood is one of the world's primary building materials, particularly in North America and other naturally wooded regions. Further, in those regions and — thanks to globalization — increasingly elsewhere as well, wood plays a leading role in residential and other low-rise building types. With increasing demand pressure and increasing public concern about the preservation of the world's remaining natural forests, it is imperative that we examine how we can build wood buildings in more ecologically responsible ways.

Isn't Wood "Green"? Isn't it a Renewable Resource?

Notwithstanding lumber companies' claims that they are growing more trees than ever, natural forest ecosystems continue to be lost at alarming rates. In British Columbia, for example, forests are being clearcut at the rate of one acre every 66 seconds; lost along with them are an incalculable wealth of biological, economic, spiritual, scenic, and recreational resources. Plantation tree farming, while it may be able to produce many of the wood products that our society requires, cannot replace these forest systems in all their richness and diversity; nor do plantations perform all of the ecological services of the lost natural ecosystems. *Wood* is renewable; natural forests, however, take hundreds to thousands of years to renew in all their biological complexity.

At issue are two trends: rates of consumption are exceeding the rate of renewal of natural forests, and conventional forestry does not in fact seek to renew natural forests but instead typically converts natural forest to monoculture plantations or other uses such as agriculture. Also at issue is the liquidation of forests of particular ecological significance, among them the remaining unentered roadless areas of the United States and the coastal rainforests of the Pacific Northwest which, here in the Western U.S., supply much of our building lumber.

These issues form the basis for three strategic fronts in the effort to shift the building industry to more sustainable wood use practices. We must reduce demand for wood overall. We must demand wood from sustainably managed sources. And we must actively avoid wood that comes from ecologically significant source forests.

This paper presents opportunities for building professionals to implement these strategies in their design and construction practices. The focus of these ideas is on structural wood (lumber and panels) in residential and residential-scale applications, because structural lumber represents 86 percent, by volume, of all the wood in an average wood-framed house — and residential building represents the single largest use of wood worldwide.

Reducing Demand for Wood

Strategies to reduce demand for wood include reducing building size; accommodating future adaptation and disassembly; optimum value engineering; using inherently efficient wood products; using reclaimed wood; and reducing construction waste. Alternative building systems, such as rammed earth and straw-bale construction, also offer significant opportunities to reduce wood use.

While some of the measures discussed in this paper, and most of the studies and statistics cited, relate to single-family houses, the home style of choice for most of North America, it is important to note that multifamily residential structures are significantly more resource-efficient than single-family homes, using 28 percent less structural wood per square foot of floor area. Thus multifamily housing should be considered wherever feasible.

Designing and building for durability is also crucial. If the useful life of an average home is assumed to be about 30 years, the length of the typical U.S. home mortgage loan, prolonging the life of that home by 10 years through good design and building practices would effectively reduce the wood (and other material) demand associated with the occupants of that home by one-fourth.

Reducing Home Size

In 1963, the median new U.S. home was 1,365 square feet and housed 3.2 people. By 1991, the median new U.S. home had grown a whopping 44 percent, to 1,966 square feet. At the same time, average household size had decreased to 2.6 people. The area per person increased 77 percent, from 427 to 756 square feet. For the last several years, average new home size has hovered between 2,000 and 2,100 square feet.

Historical data also indicate that wood use increases disproportionately as house size increases — that is, larger houses use more wood per square foot than small houses. Therefore, reducing home size will not only reduce overall wood consumption, it will reduce the rate of consumption per housing unit. It will also reduce the consumption of other materials, as well as energy demands, and thus is beneficial on several environmental fronts. Reducing home size also reduces costs.

Accommodating Future Adaptation and Disassembly

Roughly half of all residential construction activity is in remodeling and rehabilitation. There is a high probability that a home will be remodeled during its useful life. And despite the great strides that have been made in the area of construction and demolition salvage and waste recycling, most framing lumber still has only one life as solid wood; at best, it may achieve a second "use" as fuel or mulch, doing nothing to "close the loop" of recycling and thus reduce the demand for new construction lumber.

Builders who have attempted to reuse framing lumber cite the generally poor quality of small dimension lumber (2x4, 2x6) as a primary obstacle — it cracks and splits when nailed. The principal barrier to reuse of larger dimension pieces is fastening: denailing is very time-consuming and, in most labor markets, prohibitively costly; and floor joists are often glued to sheathing, making them nearly impossible to remove intact.

These problems suggest a variety of solutions. First, the use of small dimension lumber and/or lumber of poor quality should be avoided. While market conditions may make it difficult, if not impossible, to find high-quality, reasonably priced framing stock, for the next several years at least the supply of high-quality, *large* dimension lumber in many parts of North America should be quite plentiful, as hundreds of U.S. military bases converting to civilian use begin to implement deconstruction programs.

Many traditional heavy timber framers rely on reclaimed timbers for their buildings, as new large-dimension lumber of good quality has become increasingly hard to find. Heavy timber and other approaches to post-and-beam framing are worthwhile options to consider for an additional reason: the inherent flexibility of the post-and-beam framework lends itself readily to adaptation and remodeling, and its non-load-bearing infill panels can be made of non-wood materials (e.g., straw-core panels), wood-efficient products (e.g., stressed-skin panels), or smaller-dimension and fewer studs (2x3 @ 24" o.c.).

Building to facilitate the eventual salvaging of large-dimension headers, joists, rafters, girders, beams, and columns requires installing them with removable fasteners (i.e., screws and bolts), rather than nails, and avoiding the use of adhesives wherever possible.

Optimum Value Engineering

Optimum value engineering (OVE) refers to a set of practices that have been developed to cut costs by reducing the amount of materials used in construction. At its core, OVE is about designing and engineering a structure for materials efficiency. It encompasses a range of specific building techniques, as well as some broad design principles. First among those principles is simplicity: simpler shapes and volumes are easier to build and enclose more space with less material. Another principle is designing with the characteristics of the materials in mind; an example is designing using a one- or two-foot module, which is the basis for most building materials in North America. (For example, most sheet goods are 4 by 8 feet; most lumber comes in 2-foot length increments.) Close collaboration among members of the design team is a key to success with OVE.

Specific OVE building techniques include 24-inch-on-center framing; aligning wall, floor, and roof framing and using a single top plate; designing headers for specific loading conditions; aligning openings with stud spacing; and eliminating unnecessary framing at intersections. The most cost-effective of these, increasing spacing to 24 inches, can save as much as 840 board feet of framing lumber in a single house. Combining a variety of OVE design and building techniques might save as much as 40 percent, or more than 7,000 board feet of lumber per house.

Using Inherently Efficient Wood Products

Trusses, stressed-skin insulating-core panels (SIPs), and engineered wood products such as I-joists, laminated veneer lumber, and parallel strand lumber all use wood fiber far more efficiently than solid lumber does. That is, they use less wood to carry the same structural loads. In addition, they typically provide other performance benefits, such as longer spans, greater dimensional stability, and superior insulation; individual attributes vary for different products. Unfortunately, there are outstanding concerns about some of these products that should also be considered in a comprehensive evaluation of environmental impacts. These include higher embodied energy levels, toxicity of adhesives, ozone-depleting effects of insulating materials, and damaging forestry practices. However, they unquestionably can reduce wood use.

The Wood Truss Council of America built two identical demonstration houses, one stick-framed and the other using trusses. The truss house used 26 percent less wood than its stick-framed counterpart. Most of the wood savings (79 percent) was due to the use of roof trusses; the remainder (21 percent) was due to the use of floor trusses.

In a study performed at the University of Oregon, a house built with SIPs was compared with a stick-framed house. The SIP house was found to use nearly 50 percent less wood — 2,880 vs. 5,600 board feet — in the building envelope. Even allowing for the larger-than-normal framing (2x8 studs, 2x10 floor joists, and 2x12 rafters) used in the stick house to make the two houses equivalent in insulating value, substantial wood savings can be attributed to the use of SIPs.

While no comprehensive study has evaluated the wood-reducing effect of using engineered wood joists, beams, etc., the impact can be estimated by looking at a simple substitution. Replacing 2x8 roof rafters and ceiling joists on a hypothetical 1,012-square-foot roof (23-foot span) with manufactured I-joists would save 672 board feet of lumber, an 18 percent reduction in the wood used in the roof. Savings in other applications have been claimed as high as 50 percent.

Using Reclaimed Lumber

Reclaimed wood refers to lumber that is somehow recovered or salvaged for reuse. Much reclaimed wood is salvaged from abandoned buildings, many of them in decommissioned lumber mills and on military bases converting to civilian use. Other reclaimed wood comes from logs that were submerged in a river or lake and only recently brought to the surface to be put into commercial use, or from logs long ago felled and abandoned in timber regions. In the U.S. there are a significant number of small, regionally based businesses specializing in reclaimed wood from unique local sources.

Leaders in the reclaimed wood field believe that, while reclaimed wood is a finite source, there is for now a significant supply base that can help supply building needs while we reduce demand and reshape the wood products industry in a more sustainable mold. According to Erica Carpenter, co-founder of Jefferson Recycled Woodworks in McCloud, California, "For at least the next ten years, the reclaimed lumber market will be strong." Smart Wood's Rediscovered Wood Program brochure estimates that billions of board feet of reusable wood exist across the U.S. and Canada alone.

Substituting reclaimed lumber for new lumber is a reasonably straightforward proposition. While it does not, strictly speaking, reduce consumption, it does reduce demand for new wood. One million board feet of reusable lumber can offset the need to harvest 1,000 acres of forest. Like the FSC-certified wood market (see below), the reclaimed wood market has supply limitations that sometimes necessitate substitution or redesign to accommodate the characteristics of locally available supply.

Using Alternative Systems

Wall systems such as rammed earth, adobe, straw-panel, and straw-bale construction are increasingly being used as "green" alternatives to stick framing. The materials are typically obtained from local sources and are low in embodied energy (unlike steel and concrete which, while touted by their industries as green options, generally have other high environmental costs, such as inferior thermal performance). Roughly one-third of the wood in a house is in the walls, and nearly all of that can be replaced with these alternative materials. Alternative materials and systems are less often used in place of wood-framed roof and floor systems, but are sometimes appropriate in horizontal applications.

Reducing Construction Waste

Construction waste reduction programs feature materials sorting, reuse, recycling, donation or give-away, and deconstruction. The success of construction waste programs relies on good planning as well as availability of alternatives to disposal (salvage yards, materials exchanges, etc.) and secondary markets (recyclers); if there are sufficient outlets for scrap wood, none needs to end up in a landfill. Programs typically target a variety of solid wastes in addition to wood, including drywall, cardboard, rubble, metals, and plastics.

Materials sorting is the most important component of a waste program from the perspective of reducing wood demand; if offcuts are sorted and set to one side where they can be readily found for appropriate uses (blocking, cripples, etc.), less wood will be needed on the job. The National Association of Home Builders Research Center, in an OVE study, correlated wood waste with “material cost efficiency,” or the cost of wood per square foot of floor area. This study showed a clear pattern of lower costs associated with less waste.

Eliminating waste starts with baseline assumptions; if the builder uses a high waste factor in take-offs and materials ordering, the excess material will be brought to the job site — and used. Care should be taken in estimating, and the lowest feasible waste factor should be used.

Creating Demand for Sustainably Harvested Wood

The vast majority of the international environmental community has endorsed the forest management standards of the Forest Stewardship Council (FSC). Wood products bearing FSC certification are acknowledged by the Natural Resources Defense Council (NRDC), Greenpeace, World Wildlife Fund, and numerous other non-profits worldwide as passing the litmus test for sustainable forest management. FSC is the *only* organization that provides environmentally credible oversight to ensure that the wood certified by its accreditees does, in fact, come from sustainably managed forests.

FSC-certified wood products are increasingly available in North America and throughout the world. However, they still represent a minuscule fraction of the total wood product market, and there are limitations to quantities, species, and grades available in any given local market.

Nevertheless, specifying and purchasing FSC-certified lumber is to date the most effective tool for redirecting demand to sustainable sources. In many cases, where a particular species and grade of FSC-certified wood is not available in a given market, a suitable FSC-certified substitute may be available.

FSC-certified wood products buyers' groups have been established to assist building professionals and others with the specification and use of FSC-certified products. In North America, the Certified Forest Products Council (www.certifiedwood.org) provides these and related services. Information on buyers' groups outside North America and other relevant information is available through the Forest Stewardship Council (www.fsc.org).

Avoiding Purchases of Wood From Endangered Sources

A number of environmental organizations, spearheaded by the World Resources Institute, are currently engaged in an effort to identify and map ecologically significant forest land areas throughout North America. Once complete, this database will be available to the public to assist in the identification of suppliers of wood from those lands, and thus eliminate wood from endangered ecosystems from their supply chains. NRDC, in concert with major U.S. home builders, is now developing a supply chain audit model that will enable builders and other major purchasers to identify and eliminate purchases of wood from endangered forests. This effort is the first of its kind and will be replicated throughout the country as more and more companies respond to their customers' values and priorities by enacting forest-friendly procurement policies.

Costs and Incentives

Many of the materials and strategies described in this paper can save builders money. (More information on costs is found in *Efficient Wood Use in Residential Construction*, Edminster and Yassa, 1998). Most others are cost-neutral or cost only slightly more than conventional construction. In return, they afford the designer, builder, and/or homeowner the satisfaction of knowing they have built an environmentally responsible structure. Further, market research has demonstrated an increasing interest among consumers in making environmentally responsible purchases; and, in many cases, buyers are willing to pay extra for the assurance that they have, in fact, bought a "green" product.

Because of the increasing consumer appeal of "green label" products and programs, dozens of green building rating systems have begun to spring up across the U.S., starting with the City of Austin's Green Builder Program, which won a sustainability award at the Rio Earth Summit. These programs, some of them developed by home builders' associations and others by state or municipal agencies, typically allow the builder to display a rating logo on advertising materials and signage. Some also offer additional incentives to green builders, such as priority processing of building permits.

The U.S. Green Building Council has developed a national green building rating system, Leadership in Energy and Environmental Design (LEED). To date, LEED has been implemented for use with commercial and institutional buildings. Additional system components are currently under development for homes, commercial interiors, and ongoing commercial building operations. LEED has been far more successful than anticipated by the U.S. Green Building Council, and already has been adopted and customized by a number of cities, including San Jose, California, Portland, Oregon, and Seattle, Washington, as the standard for construction of public buildings. Green building rating systems, including LEED, typically address multiple aspects of responsible wood use, lending increasing force to the scrutiny of wood-use practices as a measure of ecologically responsible building.

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