SOLID WOOD PRODUCTS
GREEN MATERIALS OR THE BANE OF ENVIRONMENTAL SUSTAINABILITY?

DR. JIM BOWYER

DR. JEFF HOWE
ALISON LINDBURG
MATTHEW WENBAN-SMITH
KATHRYN FERNHOLZ

JULY 25, 2007

DOVETAIL PARTNERS, INC.

Solid Wood Products
Green Materials or the Bane of Environmental Sustainability?

Introduction

Environmentally preferable products are attracting great interest these days. After years of apparent indifference, people everywhere are beginning to ask questions about the products they buy, sell, and specify. Nowhere is this trend more apparent than in the architectural/building design and engineering community where "green building" guidelines and programs have become the hottest topic in years. Focused largely on energy efficiency and occupant health and safety, each of the green building programs (GBPs) also considers environmental attributes of building materials.

The environmentally preferable product lists of leading GBPs make interesting reading. Patterns quickly emerge, providing a roadmap of what is "in" and what is "out." Curiously, in several of the better known GBPs, lumber in virtually any form is "out." So too is plywood. Engineered wood products are "in," especially if certified as from a sustainable source, as are a myriad of products from steel to concrete.

Given the many positive environmental attributes of minimally processed wood, it is worth considering how materials such as lumber and plywood came to be on the "out" list and how these materials compare with those products that are "in." In this article, provisions of one of the nation's most rapidly growing GBPs – the Atlanta Earth Craft House program – is examined. While the focus here is on the Atlanta program, it is worth noting that several other popular GBPs have similar provisions.

Lumber and Plywood – Anything but Green?

Lumber and Plywood as Viewed by the Atlanta Earth Craft House Program

It isn't necessary to read between the lines of the Atlanta Earth Craft House program[1] to see that lumber or wood in or near solid form are considered environmentally inferior. For instance, while the use of FSC[2] certified lumber brings 3 green credits to a home builder, use of the following materials also results in credits, whether environmentally certified or not:

- Engineered floor framing (Min. 80%) **Engineered trusses, I-beams or non-wood**. (2 credits)
- Engineered roof framing (Min. 80%) **Engineered trusses, I-beams or non-wood**. (3 credits)
- Engineered wall framing. (Min. 25% of studs). Examples of acceptable material include **non-solid wood** such as laminated veneer lumber or finger-jointed studs. (1 credit)

---

[1] Although centered in Atlanta, Georgia, Earth Craft House program guidelines are now available for Climate Zones 2, 3, and 4, and for the Commonwealth of Virginia.
[2] Forest Stewardship Council (FSC), For more information: http://www.fscus.org

- Engineered wall framing. (Min. 80% of studs). Examples of acceptable material include **non-solid wood** such as laminated veneer lumber or finger-jointed studs. (2 credit)
- Engineered exterior trim (Min. 80%) including soffit, fascia, and trim made of **non-solid wood or non-wood material**. (1 credit)
- Beams (Min. 80%) are **steel, engineered wood, or trusses**. (1 credit)
- Structural headers (Min. 80%) are **steel or engineered wood**. (1 credit)
- **OSB** (not plywood) roof decking (1 credit)

Material Performance of Lumber vs. Engineered Wood Products

From a product property and performance standpoint, many of the products listed above are superior to lumber. The manufacture of engineered wood products (EWPs) involves breaking down wood into relatively small pieces (flakes, strands, veneers) and then reassembling the pieces into desired forms. A major advantage that comes from this process is that natural defects in wood are removed and/or dispersed, giving the finished product much more uniform properties than wood in its more natural solid form. This uniformity, in turn, means that a smaller safety factor can be used in engineering a structure when engineered products are used, allowing wider spacing of support members such as joists and, potentially, overall materials savings. Some engineered products that are substituted for solid wood, such as I-joists, use less wood raw material and in a form that is less bulky than solid wood, yielding savings in both raw material and shipping costs. EWPs also have more uniform moisture content, tend to stay straighter, and can be more easily treated with preservatives and fire retardants.

Environmental Performance of Lumber vs. Engineered Products

Although there are many significant design and performance advantages of engineered wood products, the operable question from the perspective of a green building program should presumably be whether engineered wood products offer *environmental* advantages when compared to wood in solid form. For some applications, the answer is clearly "no."

At a time when society increasingly recognizes the need for cost-effective technologies that capture energy from the sun, one of our most common building materials – lumber – is produced using solar energy. Moreover, wood in minimally processed form (lumber) can be produced using comparatively little additional energy inputs, with over one-half of the energy used typically met through combustion of woody biomass, such as bark and sawdust, arising from harvesting or from wood processing. The fact that considerable energy is derived from biomass translates to reduced fossil fuel use and significant reductions in release of CO_2 and other emissions related to fossil fuel combustion. *There is no other common construction material that comes anywhere near lumber in terms of energy efficiency in production.* This efficiency, in turn, means that emissions to air and water are also typically vastly lower when producing lumber than when producing functionally equivalent substitute products[3].

---

[3] For a comparison of air and water emissions associated with alternative framing materials, see the Dovetail Report: *Materials Selection in Framing: Is Steel Framing a Good Environmental Choice?* April 2007. Available at: http://www.dovetailinc.org/reports/pdf/DovetailMatSelFram0407bl.pdf

Thus, in applications where greater uniformity of strength doesn't translate into material savings, such as when engineered wall framing is substituted for lumber, it is not at all clear that the use of EWP is environmentally preferable. *In fact, a strong case can be made that exactly the opposite is true.* So why, then, are environmental credits awarded in the Earth Craft House program for use of EWP for wall framing, while specifically excluding credits for and thereby discouraging the use of solid wood? The answer possibly lies in two other attributes of EWP that are often cited as being environmentally advantageous:

- In the production of some EWPs a greater portion of the wood raw material winds up in the finished product than when making lumber.
- Some EWPs can be made from smaller trees than are used in lumber or plywood manufacture.

While these attributes do apply to some EWPs, it is important to recognize that these two attributes are not necessarily environmentally advantageous.

The fact that a greater portion of a log is utilized in the finished product when making EWPs than when making lumber may appear to be an obvious environmental advantage. But is it? Using a greater portion of the wood raw material is an advantage if lumber and the EWP used to replace it are of the same density, as is the case with laminated veneer lumber (LVL). However, oriented strand lumber (OSL) and parallel strand lumber (PSL), two principal EWPs, both have densities that are far higher than the wood from which they are made, and significantly higher than the solid wood framing members they are designed to replace (see Table 1)[4].

Table 1
Density of OSL in Relation to Density of:

Wood Raw Materials Used in Mfg	Solid-Sawn Douglas-fir*
1.6-1.9 x higher	1.3-1.6x higher

* A commonly used species for wood framing.

To illustrate the environmental impacts of higher density EWPs, let's look at the example of southern yellow pine. If southern yellow pine, a common raw material in the manufacture of OSL, is sawn into lumber, a cubic foot of wood in the form of round logs yields about 0.5 cubic feet of lumber (i.e. 50% of the volume of the log winds up as lumber), and 0.5 feet of "residue" that is used for such things as manufacturing paper and producing clean, non-fossil energy. If that same cubic foot is used in making OSL, the result is 0.44-0.53 cubic feet of "lumber" (even though 80-85% of the volume of the log winds up as engineered lumber) and only 0.15 cubic feet of residue that can be used for other purposes. *In other words, less material is available for other uses and has to be supplemented by additional wood harvesting, the use of fossil fuels or other means.*

[4] The increase in density is required to achieve adequate bending of the wood strands.

The fact that more of a log goes into the final product, described in some circles these days as a "no-brainer" environmental advantage, turns out to be, in fact, an environmental *disadvantage*.

The second attribute of EWPs that is often cited as an environmental advantage is that small trees rather than large trees can be used in producing structural members of large cross-section and length. This is certainly an advantage if, in fact, use of only small trees is a good idea from an environmental point of view. This point is discussed in the following section.

Small Trees or No Trees at All

Small Trees Only Please

The thinking behind the provisions of the "Resource Efficient Products" section of the Earth Craft House program that favors EWPs and other composite products is apparently based at least in part on the fact that small rather than large diameter trees can be used as raw materials in EWP manufacture. This preference also comes through strongly in other U.S. green building programs.

If green building program incentives imply that it is environmentally better to harvest only small diameter (young) trees rather than to harvest larger diameter (older) trees, the market signals sent to forest owners and managers are to:

- obtain wood for commercial use only through thinning of their forests while retaining older trees,
- convert their forests to rapid growth plantations, or
- harvest all trees at the youngest age possible.

Under this set of market drivers, from a commercial perspective the sensible thing to do would be to convert to a shorter rotation as soon as possible, and not wait for trees to get bigger and bigger to the point that they have no market. *In short, if the market only wants small trees, then only small trees will be produced.* Is this a sound environmental stance? A prioritization of material selection based on the rate of renewability of a material should be recognized as a "productivity" approach rather than environmental one. These two approaches are linked, and both are critically important, but they are different and should not be confused.

Two Ways of Managing a Forest

It is worth remembering that trees, like all living things, have a finite life span and that not all species have life spans that are the same length. Some trees living in a natural and healthy setting have life spans that average about the same number of years as humans. They emerge from seeds, grow vigorously when young, begin to slow down in middle age, and then decline appreciably in vigor in old age, often thinning at the top and experiencing increasing difficulty in warding off disease and other pathogens as the years go by. Eventually they die, or are harvested either by mankind or by nature.

An examination of harvest cycles in lodgepole pine, a commonly used species in wood framing, illustrates the point. Shown in Figure 1 is harvesting of lodgepole pine in Montana, where this species grows in extensive, mostly pure stands of this species alone (natural monocultures). As lodgepole pine is a pioneer species (meaning that it needs exposure to mineral soil and direct sunlight to thrive when young) it is harvested by clear cutting (Figure 2). Lodgepole pine stands are harvested when they reach merchantable size, when a stand shows signs of decline, or other indicators signal that the value and productively of a stand has reached its peak, typically at about 85 years of age.

Figure 1
Harvesting of Lodgepole Pine in Montana

Figure 2
Harvest of Lodgepole Pine by Clear-Cutting

Two years following harvest (Figure 3), grass and very small trees naturally occupy the harvest site without replanting or artificial seeding.

Figure 3
Typical Lodgepole Pine Harvest Site After Two Years

At ten years following harvest (Figure 4) many vigorous young trees typically occupy a harvest site, with seeds provided from the previous stand and from surrounding trees. At an age of about 85 years the stand is ready for harvest once again. This cycle provides a steady stream of solar-energy-produced raw materials for use by society.

Figure 4
Typical Lodgepole Pine Harvest Site After Ten Years

Contrast this scenario with a no-management regime as illustrated by Yellowstone National Park. Vast sections of Yellowstone are also populated by lodgepole pine, a species that has a natural lifespan of 100-120 years, and that is very prone to attack by the endemic mountain pine beetle, especially in advanced age. Year by year the beetles feast on dead, dying, and advanced-age trees. Then periodically, in cycles that have been going on for thousands of years, beetle populations rise from endemic to epidemic levels, taking out not only advanced-age, but younger trees as well. The result is natural forests that contain a considerable volume of standing dead trees (Figure 5). The presence of dead trees is accentuated by a 100-year history of aggressive fire suppression. A forest in this condition is a forest awaiting harvest of the type that visited the Greater Yellowstone in 1988 (Figure 6). Approximately 35% of the park burned in a catastrophic fire event over a several week period, releasing millions of tons of carbon dioxide, carbon monoxide, nitrogen oxides, mercury, and particulates in a spectacular show of nature.

Figure 5
Dead Standing Timber Typifies Lodgepole Pine Forests in Yellowstone and Throughout the Range of the Species

Figure 6
The Yellowstone Fire of 1988

The aftermath of the Yellowstone fire of 1988 left thousands upon thousands of acres of standing dead lodgepole pine, that in 1998 (10 years after the fire) had a new even-aged crop of lodgepole beneath (Figure 7). The new stand was established from seeds contained within cones opened by the heat of the fire. The new stand looks remarkably similar to that shown in Figure 4, except for the fact that dead standing trees are not visible in the harvested stand, with these having gone instead to the construction of a number of new homes.

Figure 7
Millions of Young Lodgepole Pine 10 Years After the 1988 Yellowstone Fire

Clearly, not all forests should be managed through clear cutting just as not all forests should be left vulnerable to insects and catastrophic fire. Each forest and each tree species offers unique management challenges and opportunities. Any simplified approach that attempts to reduce the diversity of nature to a simple rule of thumb, such as cutting small trees is better than cutting large trees, stifles a manager's ability to respect and nurture that diversity.

All of this begs the question: Is a green building strategy aimed at awarding use of products made of only small trees really a sound, environmentally preferable strategy? This line of thinking needs to be revisited.

The Bottom Line

In many uses engineered wood products have advantages over solid sawn lumber, including consistent product properties and improved material utilization. However, engineered products are likely to require more inputs (eg. energy, chemicals, and water) and generate more outputs in the form of effluents and air emissions in their processing. Thus EWPs are not automatically environmentally better than wood in solid form, and in some cases are demonstrably environmentally inferior. Steel, aluminum, plastic, and concrete products are likewise demonstrably inferior from an environmental point of view. Environmentally preferable product guidelines that place solid sawn lumber at the very bottom of the preference list should be seriously reconsidered, as should thinking underlying most of the nation's green building programs that are heavily biased against use of mature trees in wood products manufacture.

Though patently obvious, green building guidelines should actually point the way toward improved environmental performance, and not the reverse. Any prioritization of material selection based on the rate of renewability of a material should be recognized as a "productivity" approach rather than environmental one. These two approaches are linked, and both are critically important, but they are different and should not be confused. It is highly likely that core industrial practices and economic drivers will push improved productivity behaviors, and "green" guidelines are unnecessary to support their success. What is consistently required is environmental prioritization that brings productivity considerations into balance with environmental ones. The Earth Craft House program and many other current green building programs need to reconsider their material credit systems with this in mind.

This report was prepared by

DOVETAIL PARTNERS, INC.

Dovetail Partners is a 501(c)(3) nonprofit corporation that collaborates to develop unique concepts, systems, programs, and models to foster sustainable forestry and catalyze responsible trade and consumption.

FOR MORE INFORMATION OR TO REQUEST ADDITIONAL COPIES OF THIS REPORT, CONTACT US AT:

INFO@DOVETAILINC.ORG

WWW.DOVETAILINC.ORG

612-333-0430

This Dovetail Report is made possible through the generous support of the Surdna Foundation and additional individual donors.

DOVETAIL PARTNERS, INC.

528 Hennepin Ave, Suite 202
Minneapolis, MN 55403
Phone: 612-333-0430
Fax: 612-339-0432
www.dovetailinc.org