CORRIM UPDATE

New Research Provides More Proof of the Environmental Merits of Wood Products

Editor's Note: *This article draws heavily from "CORRIM: Life-Cycle Environmental Performance of Renewable Building Materials" in the June 2004 issue of the* Forest Products Journal *published by the Forest Products Society. The FPS article was co-authored by Bruce Lippke, president of CORRIM and director, Rural Technology Initiative, University of Washington; Jim Wilson, current vice president of CORRIM and a professor in the Dept. of Wood Science and Engineering, Oregon State University; John Perez-Garcia, associate professor in the College of Forest Resources, University of Washington; Jim Bowyer, former vice president of CORRIM and professor in the Dept. of Bio-Based Products, University of Minnesota; and Jamie Meil, vice president, ATHENA™ Sustainable Materials Institute, Canada.*

by Kathy Price-Robinson

The case for the environmental merits of wood products is getting a lot stronger thanks to the ongoing research of a consortium of university and industry research groups in the U.S. and Canada.

Known as CORRIM (Consortium for Research on Renewable Industrial Materials), the non-profit group recently issued a report—*Life-Cycle Environmental Performance of Renewable Building Materials in the Context of Residential Construction*—that shows with compelling scientific clarity that houses framed in wood are by most measures better for the environment than those built with steel or concrete.

For instance, data reveal that the global warming potential from building a wood-frame house in Minneapolis is 37,047 kg of net carbon dioxide emissions, compared to 46,826 kg for a comparable steel-frame house, or 26 percent less emissions for wood. (See **Table 1**) These emissions encompass the life cycle inventory (LCI) from the resource through manufacturing of products to construction of a residential structural shell.

Wood use also entails less global warming potential when compared with concrete as a building material. Carbon dioxide emissions for a wood-frame house in Atlanta are calculated at 21,367 kg compared to 28,004 kg calculated for a concrete frame house, or 31 percent less emissions for wood.

CORRIM was formed in 1996 to update and expand a 1976 landmark study by the National Academy of Science on the energy implications of producing and using renewable building materials. The newly formed group (sometimes referred to as CORRIM II) retained the same CORRIM name as the 1976 study, which was managed by a committee of scientists.

Over the past two decades, while environmental issues have dominated the national discussion on building materials, there had been no update of the 1976 CORRIM study, or extensions to include environmental issues not addressed in the original study.

For instance, the data gathered by the 1976 committee focused mainly on energy usage, which was the hot topic of the day. Back then, carbon emissions and resulting global warming potentials barely registered on the radar screen.

In its new incarnation, CORRIM set out to evaluate the environmental implications of wood, concrete and steel home construction, using internationally recognized protocols for measuring environmental impacts and based on five categories: embodied energy, global warming potential, air emission index, water emissions and solid waste. To perform these life cycle assessments (LCA), data was collected for structural wood products and processes, i.e., lumber, plywood, oriented strand board, laminated veneer lumber, I-joists, and glulam, and the wood resources that provided input logs to them.

The collection of the base data is referred to as a life cycle inventory (LCI), which is an accounting of all energy and, material inputs and emissions, solid waste, product and co-product outputs. Of significant value is that the data can serve as an environmental benchmark for managers to assess changes in products and processes, and can be used to meet environmental performance-based product standards and criteria.

The research resulted in a detailed database for assessment of the environmental impacts of products during each stage of manufacture and use. Opportunities to use this database are vast. According to a CORRIM purpose statement, "discussions that discourage the use of wood are made each day at all levels of industry and government. While many decisions may be motivated by a desire to protect the environment, individuals making these decisions may not consider the negative consequences associated with using non-wood substitutes.

"Consequences include the impacts that non-wood products can have on the environment," the statement continues, "and the impacts that management can have on forestland. The decision to avoid using wooden building materials may in fact be counterproductive to the intent. It is critical that a better information base of quantitative data regarding the environmental impacts of a variety of building products be developed. Decisions based on quantitative or scientific information will be needed to have a more positive effect on the environment and economy."

The Results

The full data from CORRIM's most recent findings, which constitute Phase I of a multi-phase study, can be found on the consortium's website at www.corrim.org. The findings are being compiled into a database that is intended to be updated to reflect changes in manufacturing or construction practices.

To study the use of various building materials, typical residential designs were used for each climate type: 1) a wood-frame design and a steel-frame design for the cold Minneapolis climate and 2) a wood-frame design and a concrete design for the hot and humid Atlanta climate. Based on analysis of the designs of the representative residential structures, 32 different wood and non-wood materials were found to be used. Additional materials were used in the generation and delivery of energy used in production processes. Environmental risk indices for water and air emissions, solid waste, and global warming potential were developed from the composite LCI data for all of the materials, energy, transportation and construction activities in building the house.

Table 1 shows that with two exceptions all of the environmental index measures had considerably lower environmental risk for the wood-frame designs in both Atlanta and Minneapolis compared to the non-wood-frame designs. The steel and wood designs produced similar amounts of solid waste in Minneapolis, and the concrete and wood designs produced similar water pollution impacts in Atlanta.

According to data presented in **Table 2**, the environmental indices for subassemblies such as "above-grade wall" showed larger percentage differences than for the buildings as a whole because the materials being compared (wood vs. steel and wood vs. concrete) made up a larger share of the subassemblies. The Minneapolis wood wall subassembly used less energy and produced less GWP than the steel wall subassembly that incorporated an outside layer of insulation to provide equivalent thermal properties. The Atlanta concrete wall subassembly was much worse in comparison to the wood subassembly because the concrete wall had to contain a wood frame in addition to the concrete in order to house insulation and its gypsum covering.

Another measure of environmental impact is to look at the difference in the fossil fuel related energy of a house when materials are substituted for existing ones. If you replace a wood frame with steel wall studs and floor joists you see how little energy is purchased for the wood house, partially because wood waste, a non-fossil fuel, is used to produce more than half of the energy needed for the wood processing. **Table 3** shows a reduction of only 7 GJ (gigajoule) by reducing the use of wood but a 128 GJ increase in energy needed for the substitution of steel and increased insulation, a 281 percent increase in energy for the materials being substituted.

Similarly if you replace wood walls by concrete in Atlanta they show only a 3 GJ reduction in the energy to produce the wood and a 63 GJ increase for the concrete, mortar and rebar, a 250 percent increase in energy for the substitute materials.

Space constraints prevent delineating all of the findings in this article. However, the report's highlights provide a persuasive scientific foundation for the defense of wood in the ongoing debate over the environmental merits of competing building materials. Several opportunities for environmental improvement related to management, process, and material substitution are noted in the Phase I report, including:

- Redesign of houses to use less fossil-fuel intensive products
- Redesign of houses to reduce energy use (both active and passive)
- Redesign of the codes that result in excessive use of wood, steel, and concrete
- Greater use of low-valued wood fiber for bioenergy
- Greater use of engineered products that utilize less desirable species
- Improved process efficiencies, such as in the boiler or dryer (including air-drying)
- Environmental pollution control improvements that consider LCI/LCA (life-cycle inventory/life-cycle assessment) impacts
- More intensive forest management
- Recycling of demolition wastes
- Increased product durability through improved products, construction designs, building practices, and maintenance of houses.

There may be internal tradeoffs between environmental burdens, with some rising while others fall. There may also be cost tradeoffs that need to take into consideration the time value of money when determining investments that can best improve performance.

Complex but Necessary Research

Evaluating the environmental impacts of wood as a building material is a complex endeavor, and must take into consideration different species of wood growing in various regions of the country and processed with assorted technologies into a vast array of products. And so it is incumbent on experts in wood technology—universities, institutes, and manufacturers, and other stakeholders—to fund and produce scientific data on environmental consequences of wood use. Flawed data or assumptions otherwise can be used to unfairly damage the reputation of wood among architects, engineers, builders, environmental protection and energy conservation analysts, and global environmental policy and trade specialists.

Like the early National Academy of Science study, CORRIM was organized around Technical Advisory Committees for each wood product and stage of processing in order to obtain the best possible internal scientific review prior to submitting the report to international experts for a final review. The initial research plan was reviewed by a Technical Steering Committee that included representatives from the EPA, DOE, US Forest Service, wood and non-wood industry associations, the American Institute of Architects, and non-government organizations. It was funded by a grant from DOE, membership dues from the participating institutions and several companies.

A CORRIM Interim Phase I Report (published in 2002) was professionally reviewed by Five Winds International of Toronto, an experienced LCI/LCA consulting company. They characterized the research as "solid" and their many recommendations for increasing clarity formed the initial action list for improvements in the final report. The final draft report was professionally reviewed with an assessment of its compliance with ISO standards relating to LCI/LCA by Environment and Development of Zurich. Their suggested list of modifications to increase transparency and compliance with ISO 14040 were incorporated by the report's 22 authors representing eight research institutions. The objective of developing scientifically credible data is at the heart of CORRIM's mission. The Phase I report was funded by a joint venture agreement with the US Forest Service Forest Products Laboratory and company contributions with matching contributions by the participating research institutions.

The need for scientifically credible data on the environmental impacts of wood use was also underscored several years ago during a meeting of the Intergovernmental Panel on Climate Change (IPCC) in Dakar, Senegal. As was reported in an article in this magazine by three CORRIM members a few years ago, "A group working to develop international guidelines for reducing carbon emissions announced that the IPCC default guideline to account for carbon in harvested wood is to assume that all carbon is emitted to the atmosphere at the time of harvest. This, it was explained, was based on the "simplifying assumption" that wood and paper are burned or decay at the same rate they are harvested. Were this assumption to be used in developing policy recommendations, the use of wood-based materials would clearly be a target for de-emphasis."

The data in the CORRIM study can be cited as powerful refutation of the oft-repeated claim that steel or concrete are better environmental choices. For instance, the LEED™ green building rating system developed by the U.S. Green Building Council penalizes wood unless it comes from FSC-certified forests. For members of the forest products industry who become members of USGBC and serve on committees that determine the criteria that earns a building a silver, gold or platinum LEED™ rating, the latest data from CORRIM research could be used to educate and persuade stakeholders that wood actually surpasses the environmental advantages of alternative building materials.

CORRIM is continuing environmental assessment to document the favorable performance of wood with a Phase 2 program designed to expand the regional, wood product, and residential construction end use coverage. The US Forest Service is providing substantial financial support for this new effort, with the expectation that others will step forward and support this needed effort. ■

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Table 1. — Environmental performance indices for residential construction.

	Wood frame	Steel frame	Difference	Steel vs. wood (% change)
Minneapolis house				
Embodied energy (GJ)	651	764	113	17%
Global warming potential (CO_2 kg)	37,047	46,826	9,779	26%
Air emission index (index scale)	8,566	9,729	1,163	14%
Water emission index (index scale)	17	70	53	312%
Solid waste (total kg)	13,766	13,641	-125	-0.9%
	Wood frame	**Concrete frame**	**Difference**	**Concrete vs. wood (% change)**
Atlanta house				
Embodied energy (GJ)	398	461	63	16%
Global warming potential (CO_2 kg)	21,367	28,004	6,637	31%
Air emission index (index scale)	4,893	6,007	1,114	23%
Water emission index (index scale)	7	7	0	0%
Solid waste (total kg)	7,442	11,269	3,827	51%

Table 2. — Environmental performance indices for above-grade wall designs.

	Wood frame	Steel frame	Difference	Steel vs. wood (% change)
Minneapolis house				
Embodied energy (GJ)	250	296	46	18%
Global warming potential (CO_2 kg)	13,009	17,262	4,253	33%
Air emission index (index scale)	3,820	4,222	402	11%
Water emission index (index scale)	3	29	26	867%
Solid waste (total kg)	3,496	3,181	-315	-9%
	Wood frame	**Concrete frame**	**Difference**	**Concrete vs. wood (% change)**
Atlanta house				
Embodied energy (GJ)	168	231	63	38%
Global warming potential (CO_2 kg)	8,345	14,982	6,637	80%
Air emission index (index scale)	2,313	3,373	1,060	46%
Water emission index (index scale)	2	2	0	0%
Solid waste (total kg)	2,325	6,152	3,827	164%

Table 3. — Energy for the products being substituted (GJ)

	Wood frame house	Steel frame house	Substituted products (difference)
Minneapolis house			
Wood products	17	10	-7
Insulation	13	37	24
Steel	13	117	104
Total	43	164	121 (281%)
	Wood frame house	**Concrete frame house**	**Substituted products (difference)**
Atlanta house			
Wood products	9	6	-3
Block and mortar	0	41	41
Rebar	15	37	22
Total	24	84	60 (250%)

CORRIM Research Institutions

University of Washington
Oregon State University
University of Minnesota
University of Idaho
Purdue University
Louisiana State University
Virginia Polytechnic Institute
North Carolina State University
Washington State University
Mississippi State University
FORINTEK (Canada)
APA—The Engineered Wood Association
Western Wood Products Association
ATHENA Sustainable Materials Institute (Canada)
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