Canada Wood
Produits de bois canadien

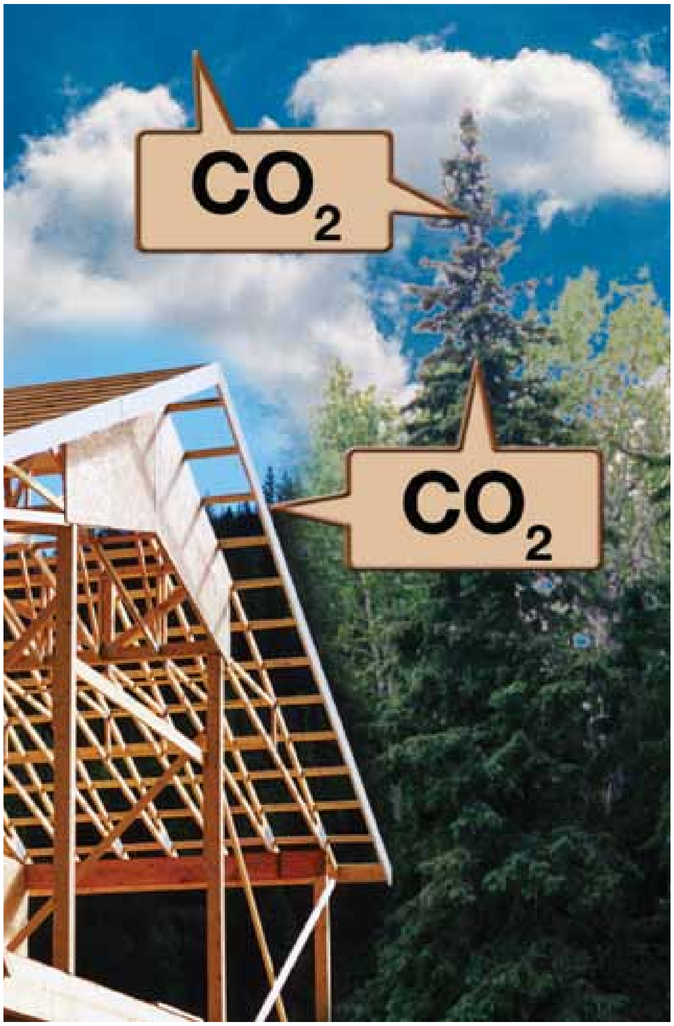
Sustainability and Life Cycle Analysis

for Residential Buildings

INTERNATIONAL

Building series NO. 4

Introduction



Environmental awareness in building design, construction and operation is stronger than ever. But how can we meet the world's rapidly growing need for buildings and still be environmentally responsible?

Although construction is never fully benign for the environment, designers and builders can make choices to minimize the impact. Wood plays an important part in sustainable design, as shown by scientific analysis.

PHOTO 1: Wood framing achieves a comparatively minimal environmental footprint due to the relatively clean and low-energy manufacturing processes for wood construction products. In addition, continuous renewal of the forest paired with use of wood for long-lived products like houses and furniture helps mitigate the current imbalance in the earth's carbon cycle leading to global warming.

Environmental Impact of Product Selection

Buildings stress the planet in several ways. Depletion of natural resources, ecosystem disruption, air and water pollution, and generation of waste are just some of the undesirable side effects of building construction and operation. Many design decisions have an influence on a building's environmental footprint – but it can be difficult for an environmentally-conscious designer to wade through the confusing mass of "green" information.

Choosing construction products based on environmental impact requires an analysis process called life-cycle assessment (LCA). This is the internationally-accepted method for quantifying the total environmental effects associated with products: extraction of raw resources; product manufacture and transportation; product installation, use, and maintenance in a building; and ultimate disposal or reuse . This rigorous cradle-to-cradle calculation gives the only true picture of a product's environmental profile.

LCA is not yet incorporated in most current tools used to guide environmentally-conscious design decisions, such as various published "green product" directories, or the LEED™ rating system. In those cases, a subjective list of products or design strategies is supplied without scientific rationale – and it is likely that some of the recommendations sound better than they really are. Only non-biased LCA analysis, following international standard procedures, can help a designer make wise environmental choices.

LCA Tools

Until recently, the only software tools available for sustainable design were energy performance simulators. A rising interest in life-cycle assessment – and the emergence of several easy-to-use LCA tools – means designers can now take a more complete look at environmental impact. As with energy simulation, the use of LCA tools requires some investment by the designer in understanding the complexities of the subject.

A typical LCA analysis would quantify the impact of design decisions across a varying set of environmental characterisation measures, usually including energy and raw material use, global warming potential, photochemical smog formation potential, acidification potential, ozone depletion potential, eutrophication potential and solid waste produced.

The designer needs some knowledge of these environmental factors in order to interpret the LCA results. In addition, a designer needs to choose the right tool; LCA tools vary in their scope, geographic relevance, data transparency and data quality. But the resulting confidence in environmentally-sound product selections is well worth a designer's LCA preparation time.

Several tools exist for various world regions; the ATHENA™ Environmental Impact Estimator is the only North American software for life-cycle assessment of whole buildings.

Wood's Environmental Profile

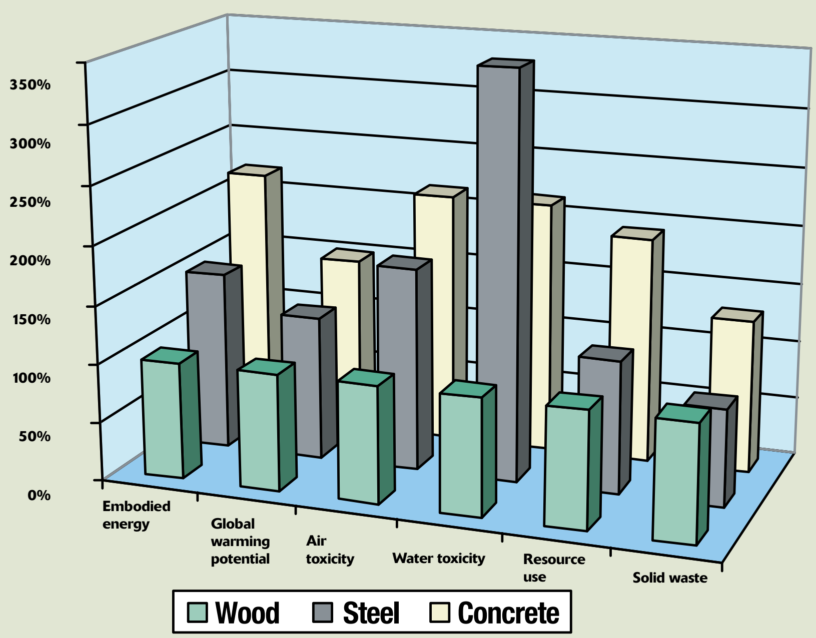
As a structural material, wood competes with various building systems that use steel or concrete. How does wood measure environmentally against those other two materials? Because wood is uniquely characterised as renewable and easily transformable into standard construction products, we might expect wood to demonstrate a favourable environmental profile compared to competing materials.

Embodied Energy vs. Operating Energy

Energy use and associated greenhouse gas emissions (due to combustion of fossil fuels) are typically considered the most important environmental effects of a building. Buildings are substantial energy consumers with long lifetimes, thus we're usually most concerned about energy and emissions due to operation of the building.

Energy consumed during product manufacturing and construction (embodied energy of the building) and the associated emissions are typically far smaller than operating energy – except in an energy-efficient building. As average operating energy for buildings goes down, the embodied portion of the equation goes up. Energy isn't the only important embodied effect. Some environmental impacts, such as toxic releases to water, are almost entirely a function of product manufacturing. Wood construction products typically score well in all embodied effects.

FIGURE 1: Environmental Impacts of Housing Types



Environmental impact relative to a typical wood-frame home (the 100% baseline) is shown for an equivalent house in light-gauge steel and an equivalent in insulated concrete forms. Data addresses the life-cycle portion from resource extraction through construction and does not include environmental impacts of building occupancy and demolition.

Recycled vs. Renewed

Recyclability and recycled content are important, especially for products made out of non-renewable resources. Recycling helps reduce landfill burdens, reduce the effects of resource extraction and can, in some cases, reduce a product's embodied energy. However, recycling doesn't necessarily result in reduced total environmental impact.

Most guidelines for green design presume that all recycled-content products are environmentally preferable over their virgin-content alternatives. Such a determination cannot be made in the absence of a standard life-cycle assessment for each product. Indeed, a recent study for the National Institute of Standards and Technology (NIST) evaluating the LEED™ rating system, discovered that points awarded for recycled content are invalidated by life-cycle assessment. For example, a virgin-content product using renewable materials may well be the better environmental choice than one with recycled content.

The study notes that steel in particular may be inappropriately advantaged in the credit structure of LEED™, which favours high-cost materials with inherent recycled content. The study uses LCA to quantify the disproportionate value awarded to steel, especially compared to recycled concrete. Other LCA studies demonstrate that steel is not environmentally preferable to wood. Steel making, even with high rates of recycled content, remains one of the most energy-intensive industries.

What About the Forest?

Canada's status as a world leader in responsible forestry provides peace of mind to users of Canadian wood products. Canada has maintained its vast forests (10% of the world's forest cover) while also providing a large portion of the world's wood products. Canada has almost 92% of its original forest cover, more than any other country. Canada also has the world's largest area of forest land protected from harvesting.

Nearly all forests in Canada are publicly-owned, which means they are highly regulated according to the full range of values associated with a forest. These regulations not only dictate the volume of wood that can be harvested but also how quickly those sites must be regenerated, the use of buffer zones along waterways to prevent erosion and maintain water quality, the preservation of specific wildlife habitats, the involvement of local stakeholders, and much more. Canada harvests less than one-half of 1% of its commercial forest area each year, or one-quarter of 1% of its total forest area. Canada's foresters and biologists are caretakers of entire ecosystems, with high priority given to the maintenance of biodiversity.

Largely due to climate, trees in most regions of Canada grow slowly – many would be called "old-growth," although this is a term without universal definition. Concerns about old-growth are well-intentioned but often misguided. The health and value of a forest ecosystem cannot be measured simply by age of its trees. Natural forests are in constant states of renewal – today's trees replace the ones before them, and so on. In all commercial forests across the country, forest managers are responsible for maintaining a good distribution of older and younger stands, as trees of all ages have important roles to play in sustaining biodiversity.

Another misunderstood aspect of silviculture is clear-cutting. The appearance of a fresh clear-cut, while unsightly to untrained eyes, is no indicator of the ecological impact of logging. Harvesting methods are carefully selected depending on the tree species, the soil and terrain, wildlife habitat and the conditions needed to renew a healthy forest. In forestry operations around the world, the environmental footprint of harvesting techniques is frequently challenged, leading to constant improvements as new knowledge about forest sustainability is developed.

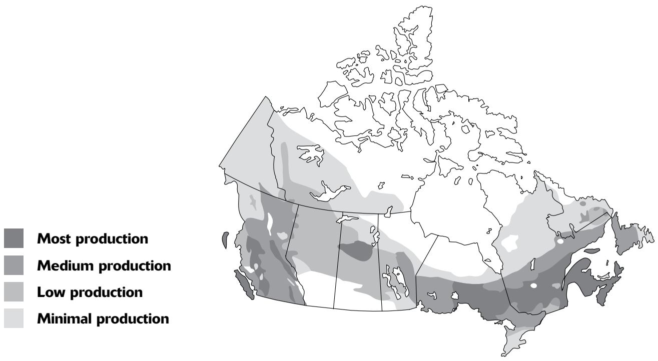


PHOTO 2 : Canada is a world leader in sustainable forest management.

With some of the strictest regulations on forest renewal, Canada is at no risk of deforestation. Still, some wood users are concerned about the state of forests around the world, and they may seek assurances that wood products come from certified forests. Certification is about providing evidence, through third-party independent verification, that forest management meets economic, social and environmental criteria. Certification also involves a commitment to continual improvement in forest management practices. So far, no other structural materials are expected to demonstrate this level of accountability.

A substantial proportion of Canada's forests have undergone certification under one of the forestry-specific standards, or registration under the general International Organization for Standardization (ISO) 14001 standard for environmental management. Standards such as those established by the Canadian Standards Association (CSA), the Sustainable Forestry Initiative (SFI) and the Forest Stewardship Council (FSC) vary in approach but all have the same objective – to promote sustainable forest management. Canada has been one of the most proactive countries in the world in its promotion of certification as a means to demonstrate forest stewardship. But neither certification standards nor chain-of-custody audits are an indicator of full environmental impact of wood products – only LCA analysis provides a comprehensive environmental picture.

Canada's responsible forest stewardship helps offset deforestation in other parts of the world. And the widespread use of wood as a construction material also has global warming benefits by sequestering some of the CO_2 those trees have absorbed. A typical 216 square meter wood-frame house is holding 28.5 tonnes of carbon dioxide. This is equivalent to seven years of emissions from a small, light-duty car.

Forestry and Climate Change

Atmospheric carbon dioxide (CO_2) is currently the most important contributor to the greenhouse effect and climate change. Trees capture CO_2 from the atmosphere by photo-synthesis. In forests, the carbon thus captured is sequestered in living trees, in the litter and in soils. Forests also lose carbon to the atmosphere through the decomposition of their litter and fallen trees, and through forest fires. Forests, and man's impact on their extent, growth and use, play an important role in global warming.

A young, actively growing forest removes more CO_2 from the atmosphere than it releases through respiration and decay – it's a carbon sink. An old, stagnating forest has a low rate of growth and may be releasing as much CO_2 to the atmosphere as it absorbs. This forest is carbon-neutral, but contains a much larger stock of carbon than the younger forest. A large disturbance, such as an insect infestation or especially a fire, turns a forest into a net source of carbon to the atmosphere. In such cases, the older the forest, the more carbon is released.

Forests hold more carbon per unit area than almost any other type of land cover. Over the past century, deforestation – conversion of forests to farmland or other uses – has produced over one-third of all man-made CO_2 emissions. Current deforestation, mostly from tropical regions, still accounts for about 20% of all anthropogenic CO_2 emissions. Clearly, the maintenance of a productive forest is an attractive alternative to deforestation from a climate change and environmental perspective.

The development of an industrial forestry base and the sustainable management of forest resources have several benefits to climate change. Forest management provides an economic incentive against deforestation. Production of solid wood products results in the storage of a portion of the trees' carbon in another long-term storage medium (a house or furniture, for example). Forest regeneration ensures that the carbon-absorbing role of the forest is preserved. Energy generation from wood residues reduces the need for fossil fuels. Sustainable forestry is thus regarded as a simple and highly cost-effective way to mitigate the greenhouse gas emissions of other industries, especially in countries where large scale deforestation is an issue.

PHOTO 3: Most of Canada's wood products come from sustainably-managed forests.

Room for Improvement

Wood's low-impact environmental profile has been demonstrated, but what about the role of wood construction products in the 3Rs of conservation? The low cost of lumber generally doesn't provide a strong financial incentive for conservation, but this may be changing.

Reduce

Standard practice for residential wood framing is less efficient than it could be. Common examples are structural members oversized for their loads, window and door openings not optimally aligned with the framing module, and unnecessary framing elements. An increased up-front investment in architectural and engineering time, along with the use of structurally efficient elements like trusses, can result in net savings to the builder and a significant reduction in wood materials used. "Advanced framing" has begun to catch the interest of builders.

At the manufacturing end, numerous technological innovations that get more product out of each log continue to emerge. For example, improvements in sawmilling have reduced wood waste dramatically. Kiln-drying optimisation has cut back on the energy used to produce dry lumber. And engineered wood products are widely recognised as highly efficient in use of material while additionally incorporating wood residuals recovered from the manufacturing process as well as wood from fast-growing and under-utilised tree species.

Recycle

Building-related construction and demolition waste is a substantial load on waste management systems, and recovery is a challenge for all materials. Estimates based on 1996 data indicate a total of 136 million tons of building debris are generated in the United States each year, 25% of which is recovered for recycling while 75% is either combusted or sent to landfill.

Wood recovery for recycling is improving with a rapid growth in the number of companies processing recovered wood in recent years. Wood waste can be re-manufactured into high-value composite products like medium density fiberboard (MDF), finger-joined lumber and wood/plastic composite lumber. Some wood users may not realise that these wood products often contain a high degree of recycled content. Wood waste is also chipped into mulch, animal bedding, and other low-grade uses, or burned as useful fuel.

Wood recovery at the industrial end is good – wood product manufacturers capture 94% of their wood waste. However, wood recovery from the municipal waste stream and the construction and demolition waste stream is less effective. Of the solid wood in municipal waste, 5% is recycled or composted, 26% is burned for energy recovery, and 69% is sent to landfills. About two-thirds of that landfilled wood is estimated to be suitable for recovery.

Similarly, construction waste wood has good potential for recovery improvement. About 75% of this wood is still available for recovery; 25% is already recovered, burned or is not usable. Construction waste presents good recovery opportunities because the material is generally clean and easy to separate.

Demolition waste is more difficult – potentially recoverable materials are highly mixed and possibly contaminated with other materials. Only 34% of demolition wood waste is estimated as still available for recovery; 66% is already used, burned, or – most frequently – considered unusable. Standard demolition techniques break up and mix building products too much for cost-effective recovery. One solution is "deconstruction" – selectively dismantling a building in order to carefully remove re-usable or recyclable products.

Re-use

Wood can be reclaimed from decommissioned buildings and re-used directly, a niche activity which is increasing due to strong market interest in salvaged large-dimension timbers. In addition, there is a large and as-yet relatively untapped store of standard lumber in the ageing North American residential housing stock. But widespread recovery will require that the deconstruction and wood re-grading process becomes easier and more financially attractive.

Life Cycle Analysis - A Case Study

The battle cry "Save the planet" grows louder daily. In response, builders, architects and homebuyers in ever increasing numbers seek construction materials and methods that are gentle to the earth.

Specific concerns include the thinning ozone layer, depletion of natural resources, and air and water pollution. These issues must be addressed by professionals in the construction industry in order to satisfy their own social consciences — as well as home buyers' concerns.

Indeed, initiatives such as the Kyoto Agreement, which require countries to reduce greenhouse gas emissions, may lead to outright regulation of materials used.

PHOTO 4: Life cycle analysis shows that wood products are a good environmental choice.

With so many decisions to make about selecting building materials, it is important to have methods for arriving at sound conclusions. The Canadian Wood Council commissioned a case study by the ATHENA™ Sustainable Materials Institute to compare the environmental impact of constructing a house using wood framing, sheet metal framing, and concrete.

ATHENA™ used life-cycle analysis, an evolving process for assessing environmental effects at all stages of a product's life including resource procurement, manufacturing, on-site construction, building service life and de-commissioning at the end of the useful life of a building.

The case study explains the environmental consequences of the main residential building materials. And, like the independent findings of BRE reported in the internet story (see page 14), it shows that, all factors considered, wood products are a good environmental choice.

To any construction professional interested in a healthy planet, the findings are more than relevant, they are imperative reading.

How the Comparison was Done

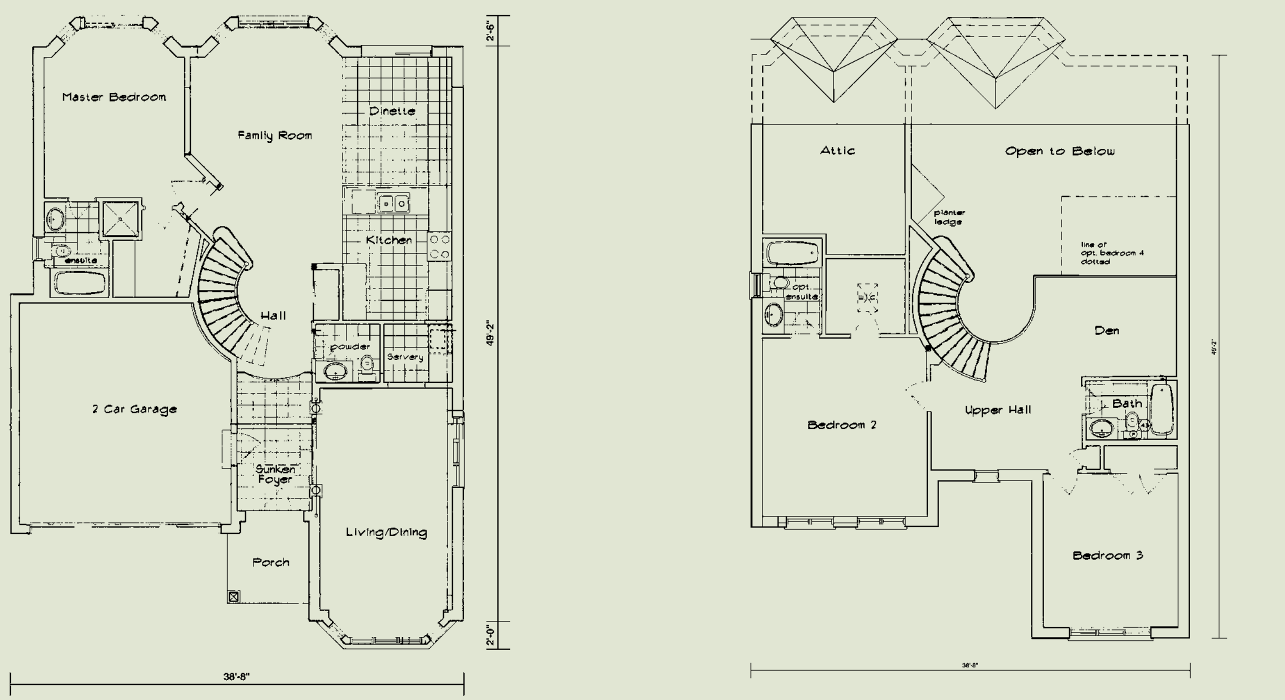
The Toronto firm Gabor + Popper Architects was engaged by the Canadian Wood Council to identify a house design and select building materials and techniques currently common for wood, sheet metal, and concrete residential construction.

The house selected for the study is a 216 square meter single-family home (shown right) designed for the Toronto, Ontario market, but deemed typical of many houses existing or planned in North America (see Figure 2).

All quantity estimates and assumptions were verified for accuracy and fairness of comparison by Morrison Hershfield, a consulting company specializing in building systems.

FIGURE 2: Floor Plan

Main Level **Upper Level**



Assumptions

Scope

Since the main purpose of the study was to compare the environmental effects of the wood, sheet metal, and concrete structure and envelope, elements common to all three designs (for examples, windows, cladding, and finishes) were not included in the comparison.

Roof Framing

Because sheet metal and concrete roof-framing methods are not readily available or in common use, the decision was made to use wood trusses for all three designs to reflect current building practices without unduly exaggerating the case against sheet metal and concrete.

Level of Insulation

The ICF system for the concrete house is both the concrete formwork and the permanent insulation. Because the concrete insulation extends down to the basement floor, the decision was made to provide basement insulation for the wood and sheet metal houses. The wood and concrete houses are considered equal in terms of thermal insulation (overall RSI value of 3.0). The sheet metal house has a lower overall RSI value of 2.2.

Applicability

The model and databases are based on Canadian practices for manufacturing, transportation, construction, and post-use.

Although ATHENA™ is based on Canadian information, comparisons based on the model should have rough applicability to North America. The model house used for this report is based on data for Toronto.

Wood House – Figure 3

The following design decisions were made for the wood house:

- Basement exterior wall vapour barrier included with use of fiberglass batt insulation,
- Interior walls are 38 x 89 mm wood studs @ 600 mm o/c,
- Wood I-joist webs are 9.5 mm OSB and flange is 38 x 64 mm lumber, and
- Perforated polyethylene sheet was substituted for building paper on the exterior walls inside the brick cladding.

Sheet Metal House – Figure 4

The following design decisions were made for the sheet metal house:

- Basement exterior wall vapour barrier included with use of fiberglass batt insulation,
- Exterior above grade walls finished in 15.9 mm gypsum to provide racking strength, modeled additional 3.2 mm thickness in envelope material component group,
- Interior walls are 0.46 mm thick sheet metal studs @ 600 mm o/c,
- Rigid insulation on above grade walls is extruded polystyrene (XPS), and
- No building paper is required behind brick cladding.

Concrete House – Figure 5

The following design decisions were made for the concrete house:

- Foundation footing width as per Ontario Building Code for above grade concrete structures,
- Above grade ICF exterior-wall interiors finished with 15.9 mm gypsum,
- Roof rafter framing at garage, porch and bays is wood,
- 10M rebar 915 mm long reinforcement around window openings,
- 10 – 600 mm stirrups at each stirruped opening,
- Substituted polyethylene for polypropylene in form ties for ICF system, and
- ICF made of expanded polystyrene (EPS).

Materials

The three houses are considered equal in terms of meeting code requirements. The wood and concrete houses are considered equal in terms of thermal insulation.

The wood house (Figure 3) is framed with lumber and wood I-joists; the sheet metal house (Figure 4) has light frame steel for its structure; and the concrete house (Figure 5) uses insulated concrete forms (ICF) and a Hambro floor system, a composite floor system that combines open-web steel joists with a concrete slab. Note for the figures: Items with a star (*) bullet are common to all three houses and were not included in the life cycle comparison.

While other floor systems can be used for a concrete house, the Hambro system was recommended by design professionals as the most appropriate method for the present case. Because ATHENA™ did not contain information for the ICF and Hambro systems, Morrison Hershfield developed the material estimates for both systems and ATHENA™ assessed the on-site construction and transportation environmental effects to develop complete life-cycle profiles.

FIGURE 3: Wood House Cross-section

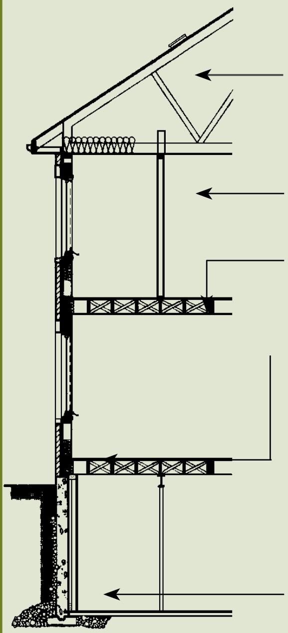


FIGURE 4: Sheet Metal House Cross-section

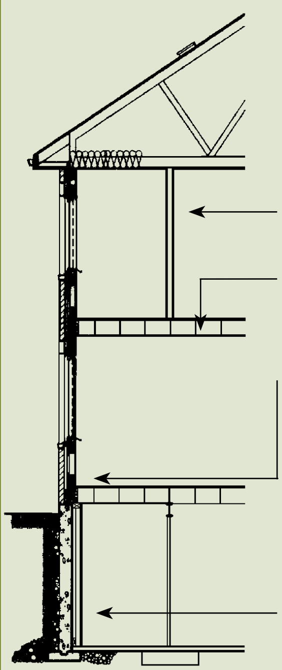
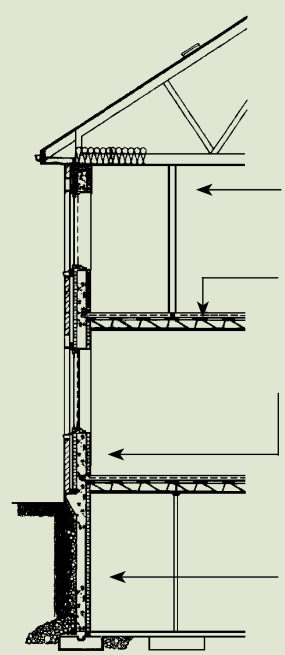


FIGURE 5: Concrete House Cross-section



Results

The results for comparing the environmental effects of a wood house, sheet metal house, and concrete house are shown in Table 1.

The Embodied Energy (Figure 6) for the wood house is 53% less than sheet metal and 120% less than concrete.

For Global Warming Potential (Figure 7), wood is 23% lower than sheet metal and 50% lower than concrete.

The Air Toxicity Index (Figure 8) for the wood house is 74% less than sheet metal and 115% less than concrete.

The Water Toxicity Index (Figure 9) for the wood house is 247% less than sheet metal and 114% less than concrete.

The Weighted Resource Use (Figure 10) is 14% less than sheet metal and 93% less than concrete.

Solid Waste generation (Figure 11) , which is the weight in kilograms of construction waste, was lowest for sheet metal. The wood house is 21% higher and for concrete, 58% higher.

Review of Table 1 and Figures 6 to 11 show the wood-frame house is significantly easier on the environment for five of the six key measures. The environmental advantage of wood construction would further increase if the sheet metal and concrete houses did not have a wood roof.

FIGURE 6: Embodied Energy

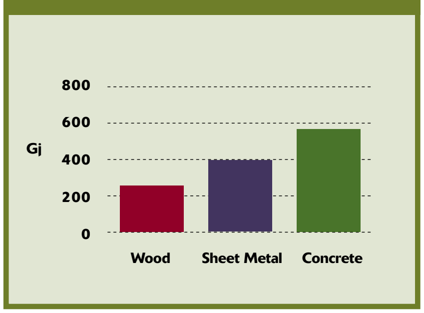


FIGURE 7: Global Warning Potential

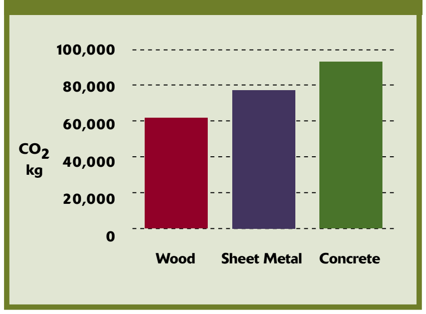


FIGURE 8: Air Toxicity

FIGURE 9: Water Toxicity

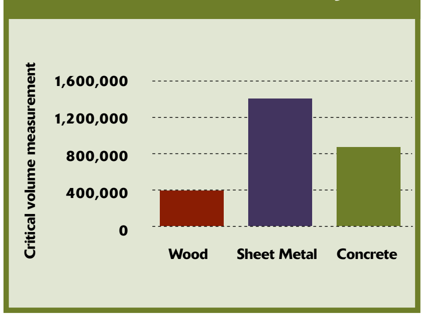


FIGURE 10: Weighted Resource Use

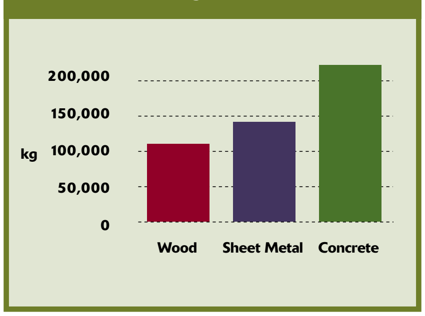


FIGURE 11: Solid Waste Use

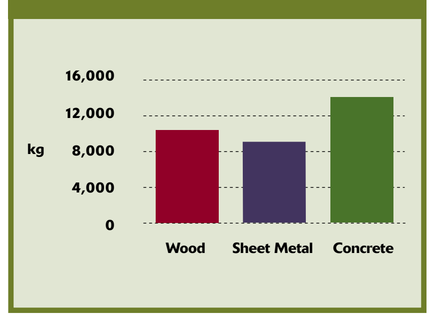


TABLE 1: Environmental Measures Results Summary

	Wood	Sheet Metal	Concrete
Embodied Energy Gj			
Foundations	17	17	10
Walls	85	118	102
Floors	54	102	108
Columns and Beams	57	44	87
Envelope	41	90	246
Extra Basic Material	<1	18	9
Total	**255**	**389**	**562**
Global Warming Potential Equivalent CO_2 kg			
Foundations	6,160	6,160	3,436
Walls	25,599	31,263	33,009
Floors	8,785	17,294	27,441
Column & Beams	8,688	6,929	15,099
Envelope	12,831	12,309	13,941
Extra Basic Material	120	2,498	647
Total	**62,183**	**76,453**	**93,573**
Air Toxicity **Critical volume measurement**			
Foundations	331	331	237
Walls	1,242	2,183	1,791
Floors	474	1,604	1,340
Column & Beams	784	617	2,068
Envelope	372	653	1,497
Extra Basic Material	33	240	38
Total	**3,236**	**5,628**	**6,971**
Water Toxicity **Critical volume measurement**			
Foundations	1,110	1,110	1,120
Walls	1,933	494,440	90,900
Floors	40,280	281,320	192,530
Column & Beams	363,640	617,310	555,300
Envelope	204	154	739
Extra Basic Material	620	19,450	35,600
Total	**407,787**	**1,413,784**	**876,189**
Weighted Resource Use kg			
Foundations	23,629	23,629	9,679
Walls	79,796	83,046	133,713
Floors	8,371	15,096	55,272
Column & Beams	6,705	5,187	10,239
Envelope	3,162	8,893	23,929
Extra Basic Material	141	2,650	2,164
Total	**121,804**	**138,501**	**234,996**
Solid Wastes kg			
Foundations	894	894	485
Walls	6,099	4,837	7,082
Floors	2,239	1,382	3,735
Columns & Beams	736	569	1,172
Envelope	752	999	996
Extra Basic Material	26	216	586
Total	**10,746**	**8,897**	**14,056**

Notes:

1. Foundations include all concrete walls and strip and column footings.
2. Walls include all structural framing, sheathing (where stipulated) and fasteners for both partition and exterior load-bearing walls but exclude gypsum wallboard, EPS ICF and ties, and rigid insulation.
3. Floors includes all framing materials, hangers (where required), bracing, stiffeners, sheathing (where required) and fasteners.
4. Column & Beams includes all beams and posts.
5. Envelope includes gypsum wallboard, rigid and fiberglass insulation, EPS ICF, polyethylene form ties, and air and vapour barriers where required.
6. Extra Basic Materials includes any additional wood, steel and concrete materials that are not part of a discrete assembly.

Timber Tops LCA Study

FROM MILLER FREEMAN UK LTD

Timber has come out tops in an investigation into the environmental profiles of building materials carried out by the Building Research Establishment (BRE).

The study, 'Environmental Profiles of Building Materials, Components and Buildings', is one of the first substantive exercises undertaken by a major independent research body into the highly complex area of life cycle assessment (LCA).

Timber scored highly in the 13 environmental impacts studied — from climate change, pollution to air and water, waste disposal, and transport pollution and congestion.

Timber is the only building material to have a positive impact on the environment, with trees' ability to absorb carbon dioxide and emit oxygen.

BRE spokesperson Jane Anderson said different industries had different sets of rules for LCA so the study tried to work with them to create a level playing field. Timber came out very well as it is renewable and does not require a great deal of energy for processing.

BRE is the United Kingdom's leading centre of expertise in buildings, construction, and the prevention and control of fire. (www.bre.co.uk)

At the time of the 1999 Life Cycle study:

1. The environmental impact estimator software could only simulate the environmental implications of structural systems and, hence, all the building envelope components were assessed as side calculations in an Excel R spreadsheet using life cycle inventory (LCI) data that had not been entered in the software,

2. The study included a very preliminary quantity take-off for insulated concrete forms – a key assembly in the concrete design,

3. At the completion of the 1999 study it was also noted that the effective R-value of the wall envelope systems was different for the three designs and, at the time, budget constraints precluded an analysis of the effects of these varying R-values on the results, and

4. All common elements (e.g. cladding, windows, roofing, etc.) shared among the three designs were excluded from the analysis to underscore the differences across the three design scenarios.

Note: A 2004 study commissioned by the Canadian Wood Council addresses all the aforementioned deficiencies and, hence, provides a more thorough environmental assessment of the three alternative material designs (structure and envelope).

Conclusion

Wood works extremely well as a framing material and a as a friend of the environment.

The Environmental Building News reported it when the magazine printed, "When originating from well managed forests, wood products are a good environmental choice."

In fact, Canada is a recognized leader in forest management practices, as demonstrated by its implementation of the Canadian Standards Association CAN/CSA Z808 Sustainable Forest Management System, a third-party audited process.

The study contracted to the ATHENA™ Sustainable Material Institute confirms the findings of the well-respected British research firm BRE, as reported in the internet story. The manufacturing of wood construction products releases fewer contaminants into the world's supply of water and air than other framing materials. In addition, it consumes fewer natural resources.

Using the ATHENA™ Life Cycle Assessment model to assess the environmental effects of using wood, sheet metal and concrete for residential construction, shows wood has the lowest impact.

PHOTO 5: The manufacturing of wood products uses fewer resources and is less polluting than other materials.

References

This document presents information originally published in the Canadian Wood Council's Wood the Renewable Resource Bulletin No.5 entitled, "Life Cycle Analysis for Residential Buildings" © 1999, and the publication "Sustainable Design and Wood" © 2003 produced by Forintek Canada Corp., the Canada Mortgage and Housing Corporation, the Canadian Wood Council, and the Forest Products Association of Canada.

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