CO_2 Impact: Wood vs Concrete

Occasionally we're asked to address the question of which has more impact on CO_2 levels, the use of wood (deforestization) or concrete production. To address this question this analysis focuses mainly on the production of lumber vs. concrete, comparing the negative impact of harvesting a mature forest to build the walls of a 2,400 s.f. house versus the amount of CO_2 created in the production of enough cement to build the walls of the same house.

Building homes from wood has been the traditional method of building in the U.S. since the first settlers used it to build log cabins. However, domestic wood, once cheap and plentiful, has increased in price resulting in an increase in imported lumber. This increase in price and an unprecedented level of CO_2 being put into our atmosphere has caused the building industry to explore alternative and more responsible building materials. As we enter the 21st century, it's time to examine whether building with wood is serving our needs and whether it meets the requirements of reducing greenhouse gas emissions. Present day alternatives to wood include steel, aluminum, concrete, straw bales, just to name a few, but which ones are really sustainable? Metal construction is plagued with the inherent problem of thermal transmission, and straw has its engineering difficulties, not to mention longevity issues. By itself, concrete is a poor insulator, but when combined with recycled Styrofoam, as in RASTRA panels, the insulation value is greatly increased, helped further by the panel's thermal mass properties.

One of the chief concerns with concrete, or rather its primary ingredient cement, is the CO_2 released during its manufacture. Cement manufacturers are addressing this problem and attempting to reduce CO_2 emissions, but this will take some time. The substitution of two waste products, slag cement, produced during the reduction of iron ore to iron, and fly ash, a waste product of coal fired electric plants, can reduce the overall amount of CO_2 released into the atmosphere by displacing a percentage of the cement, but only slightly.

Wood, the most common construction material, suffers from several major disadvantages. Wood is subject to rot, mold, insects such as termites, and is very flammable. Best case, wood buildings last 50-100 years, and that usually requires replacement of deteriorated sections. Fire departments respond to 1.5 million home fires in the U.S. per year, many resulting in a complete loss. There is inherent waste in wood construction practices, as most lumber gets cut shorter after it arrives at the site. Of primary concern is that forests are cut down to produce lumber, and this reduces the quantity of trees, which are a major sequester of CO_2. Through photosynthesis, carbon dioxide is absorbed from the air, with the carbon being incorporated into sugars, starch and cellulose of the tree and oxygen released back into the air. The carbon is gradually incorporated into the soil of a normally decaying forest.

For a 2,400 square foot wood house, it takes approximately 750 cubic feet of wood to construct only the walls of the house, and requires 2.3 acres to produce that amount of wood. This 2.3 acres of mature forest would otherwise remove 11,818 lbs. of CO_2 per year from the atmosphere (5,200 lbs/acre).

By comparison, a 2,400 s.f. RASTRA house requires 23,558 lbs. of cement to construct only the walls. During the manufacture of the required amount of cement, 11,779 lbs. of CO_2 are released into the atmosphere – resulting in slight improvement at the end of the first year. However, RASTRA provides significant improvement from year 2 and beyond.

Another issue that is a factor is the area of disruption. Cement production is relatively localized to a few square miles of quarries and mills, whereas lumbering affects thousands of square miles of land and requires considerable energy be expended to clear and transport a forest and convert trees in to lumber. Lumbering decreases the biodiversity of forest; it creates erosion and pollution problems. It also enters into the problem of forest fires. Instead of allowing forest fires to occur as a natural function, forest managers prevent and put out fires, which robs the soils of the benefits of natural fertilization that occurs during burning.

This comparison does not take into account other factors of construction relating to sustainability, such as the fuel energy – even more if the lumber is imported. A cement house has a much longer service life than a wood frame house, lessening landfill burdens and creating the need to expend more energy to reconstruct the house. Europeans have traditionally built homes that last far longer than homes built in the U.S. The result is that with their reduced birthrates, the housing stock turnover is far less. This translates to a much lower percentage of GNP devoted to housing, 9% compared with over 12% in the U.S.

To build a 2,400 s.f. house requires 2.3 acres of mature forest which absorbs 11,818 lbs of CO_2 per year. Producing the 23,558 lbs. of cement required to build the same house with RASTRA produces virtually the same amount at 11,779 lbs. of CO_2. The CO_2 'payback' when building with RASTRA is one year. **Considering it takes 50 years for a new trees to mature, the 'ROI' from using RASTRA is 2,290% by the time the re-planted forest fully matures.**

	Wood	RASTRA
House Size	2,400 s.f.	2,400 s.f.
Lumber required to construct walls	750 c.f	-
Acres of mature forest harvested to construct walls	2.3	-
CO_2 removed per acre per year	5,200 lbs	-
CO_2 removed per year	11,818 lbs	-
Total oxygen not created per year	8,602 lbs	-
Cement used to construct walls	-	23,558 lbs
CO_2 produced per pound of cement	-	0.5 lbs
Total CO_2 produced	-	11,779 lbs
CO_2 Impact - Year 1	**11,818 lbs**	**11,779 lbs**

One can only conclude that concrete is a greener building material for building homes. The challenge is to learn and invent new methods and techniques for building with this material. As with automobiles, the technology of how we build things must change if we are to reduce man's footprint on this planet to the point of sustainability.

Assuming the 2.3 acres of forest is replanted, it is generally accepted that re-growth trees will take 50 years to mature. The following table provides a cumulative impact of wood vs. RASTRA in reducing CO_2 from the atmosphere over the 50-year growth cycle of a new forest. In addition, the table provides a conservative projected savings resulting from using less energy to heat and cool the home. **The net total result is that RASTRA outperforms wood by 506,927 lbs. over 50 years.**

Year	% Re-growth	Wood	RASTRA	Energy/CO_2 Savings*
1	-	11,818	11,779	-5,000
2	0.5	11,759	-	-5,000
3	1.0	11,700	-	-5,000
4	1.5	11,657	-	-5,000
5	2.0	11,582	-	-5,000
6	2.5	11,523	-	-5,000
7	3.5	11,404	-	-5,000
8	5.0	11,227	-	-5,000
9	7.0	10,991	-	-5,000
10	10	10,636	-	-5,000
11	13	10,282	-	-5,000
12	16	9,927	-	-5,000
13	18	9,691	-	-5,000
14	20	9,454	-	-5,000
15	22	9,218	-	-5,000
16	25	8,859	-	-5,000
17	29	8,387	-	-5,000
18	33	7,915	-	-5,000
19	37	7,433	-	-5,000
20	41	6,971	-	-5,000
21	45	6,499	-	-5,000
22	49	6,027	-	-5,000
23	53	5,555	-	-5,000
24	57	5,083	-	-5,000
25	61	4,611	-	-5,000
26	65	4,139	-	-5,000
27	69	3,667	-	-5,000
28	73	3,195	-	-5,000
29	77	2,723	-	-5,000
30	80	2,360	-	-5,000
31	81	2,242	-	-5,000
32	82	2,124	-	-5,000
33	83	2,006	-	-5,000
34	84	1,880	-	-5,000
35	85	1,770	-	-5,000
36	86	1,652	-	-5,000
37	87	1,534	-	-5,000
37	88	1,416	-	-5,000
39	89	1,298	-	-5,000
40	90	1,180	-	-5,000
41	91	1,062	-	-5,000
42	92	944	-	-5,000
43	93	826	-	-5,000
44	94	708	-	-5,000
45	95	590	-	-5,000
46	96	473	-	-5,000
47	97	354	-	-5,000
48	98	236	-	-5,000
49	99	118	-	-5,000
50	100	0	-	-5,000
Total		268,706 lbs.	11,779 lbs.	-250,000 lbs.

Concrete Is Sustainable, Durable — and Green

Concrete is one of the single most environmentally friendly construction products available. It offers stability, durability and design flexibility for the residential marketplace and environmental advantages through every stage of manufacturing and use. And it offers sustainability. Because old concrete can be recycled it can be reused almost indefinitely.

The following are concrete's primary environmental benefits:

Created From an Abundance of Raw Materials

Concrete draws upon some of the earth's most common and abundant minerals for its raw materials. Portland cement, which makes up about 12% of concrete, is manufactured from limestone, clay and sand. Sources of aggregates used to make concrete — sand gravel and crushed stone — are plentiful. In addition, aggregate can contain recycled materials such as slag, a by-product of steel manufacturing. Also, when using Portland cement, a portion of it can be replaced with fly ash, a by-product of coal-burning power plants, and similar materials.

Fuel to Produce Concrete Can Come From the Waste Stream

The process of making cement also can use recycled materials. High-energy wastes such as old tires can be used as fuel in the cement-making process. One million old tires can fuel a single cement kiln for a year — conserving fossil fuels and keeping old tires out of landfills. Other recycled waste used in the production of cement can include used motor oil, disposable diapers, industrial solvents and sludge.

Local Production Reduces Transportation Costs and Fuel

Cement and concrete supplies are highly local or regional. At least 60% of all concrete is produced within 100 miles of the construction site where it is used. Wood and steel products, on the other hand, typically have to be transported hundreds or, sometimes, a thousand miles or more to the job site.

Concrete's Thermal Mass Yields Energy Savings

The thermal mass of concrete buildings and homes reduces temperature swings — and can save owners energy year-round.

During the air-conditioning season, for instance, a concrete building generally only will require the cooling system to be in operation at night — during off-peak hours when electric companies can produce power more efficiently.

Also, many of today's concrete wall systems, such as insulating concrete forms (ICFs), combine the mass of concrete with foam insulation — creating an exterior wall envelope that through thermal mass, reduced air infiltration and increased R-value can reduce heating and cooling costs by as much as 40%.

Concrete Reduces Construction Waste Because Fewer Components Are Needed

Concrete construction requires fewer kinds of building products — such as sheathing and insulation —than wood-frame construction. Plus, concrete is created on an "as needed" basis, eliminating the waste inherent in sheet goods and dimensional products for framing.

Because fewer materials are needed, building with concrete puts less waste in landfills. And if replacement or demolition is required, old concrete can be ground up and reused as coarse aggregate or pavement sub-base material.

Concrete's Durability Can Weather Time and the Weather

Concrete does not rust, rot or burn, so housing stock built with concrete components such as wall systems can stand for generations.

Concrete is less susceptible to moisture damage and can generally "breathe" and dry — if the concrete structure is not too close to adjacent structures. Concrete driveways will far outlast their asphalt competitors, while items such as fiber-cement siding are much more durable than competing cladding materials. By simply outlasting other materials, concrete conserves energy and resources.

In addition, homes built with concrete also are more likely to withstand natural disasters such as hurricanes, tornados and fires than traditional wood-frame housing stock.

Concrete Homes Can Create a Healthier Indoor Environment

Concrete can promote a healthier indoor atmosphere because it is practically inert and requires no volatile organic-based preservatives.

The solid concrete walls in homes built with exterior concrete framing systems serve as a continuous barrier against air infiltration, which can greatly reduce the level of airborne dust and allergens when a fresh air exchanger and humidifier are used.

Concrete Homes Are Increasing in Popularity

From 1999 through 2005, the share of homes built with concrete walls increased from 5.9 to 17.9%. This increase not only measures a growing popularity in concrete homes, but a change in attitudes as well.

Not many years ago, the idea of building a concrete home generated blank stares among potential home owners or prompted questions about why anyone would want to do such a thing. Now, however, many consumers are aware of this type of construction, understand its benefits and want to know how much it will cost and where to find the nearest supplier or builder.

A combination of factors is driving these changes in perception and attitude — a rise in energy prices, an increase in the amount and destructiveness of natural disasters and the rise of the green building movement.

Aesthetically, the Depth of the Windowsill Tells the Tale

While growing in popularity, many people still have the mistaken perception that a concrete home looks more like a bunker or fallout shelter than a home.

Aesthetically, however, with most concrete wall systems in use today, it's difficult to drive down a street and pick out which home is concrete. Concrete home exteriors are finished with siding, stucco, brick and stone, just like wood-frame construction.

Also, like with wood-frame construction, the interior of a concrete home is finished with drywall, though with some systems such as precast concrete, interior walls are simply painted.

For both outdoor and indoor areas, decorative concrete is rapidly growing in popularity for all types of home construction. Traditional concrete flatwork can be stained, stamped, stenciled or polished to achieve a wide variety of patterns, colors and textures. Beautiful custom concrete countertops can achieve a similar range of styles.

So what's the primary aesthetic difference between concrete homes and wood-frame construction? Simply put, the walls of a concrete home are thicker. But the only way to tell the difference on a finished home is by the greater depth of the windowsill of a concrete home — which is a definite bonus in the eyes of many home owners.