SUSTAINABLE TRAILER FLOORING

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Different trailer flooring materials, including wood-based, aluminum, steel, and synthetic plastic floors, were evaluated in accordance with their durability and sustainability to our natural environment. Wood-based trailer flooring is an eco-friendly product. It is the most sustainable trailer flooring material compared with fossil fuel-intensive steel, aluminum, and plastics. It is renewable and recyclable. Oak, hard maple, and apitong are strong and durable hardwood species that are currently extensively used for trailer flooring. For manufacture, wood-based flooring is higher in energy efficiency and lower in carbon emission than steel, aluminum and plastics. Moreover, wood *per se* is a natural product that sequesters carbon. Accordingly, using more wood-based trailer flooring is effective to reduce global warming.

Keywords: Sustainability; Durability; Hardwood; Trailer flooring; Carbon emission; Embodied energy

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INTRODUCTION

Since the invention of semi trailers by August Fruehauf in the early twentieth century, trailer manufacturing has been a complete system, independent of the truck industry and plays a very important role in the North American modern transportation and delivery infrastructure. Primary commercial trailers are divided into dry vans, reefer vans, flatbeds, dumps, liquid tanks, heavy low-bed, and specialties. The dry vans usually account for around 65% of the total trailers produced each year.

Before the 1960s most of wood-based trailer flooring was built by the trailer manufacturers. Since the 1980s wood trailer flooring units have been gradually separated from trailer manufacturers and become an independent industry. In the early 1990s there were around twelve trailer flooring companies in the North American market. Due to high competition the number of companies has shrunk since the last economic slowdown in 2001. Havco Wood Products LLC, Rockland Flooring LLC, Prolam, and Wabash are currently the four largest trailer-flooring manufacturers in the North American market. Their total annual outputs account for approximately 95% of the market. Wood-based flooring is dominant in the dry van category.

The North American trailer flooring industry is entering a new era. Trailer flooring materials originally started from lumber and steel floors and now have grown to include laminated wood, aluminum, fiberglass-reinforced wood, fiberglass-reinforced plastics, and so on. All of these flooring materials concurrently exist in the market and compete with one another. The new generation flooring materials for truck trailers or containers should be stronger in mechanical properties, lighter in weight, and more durable for service (Bumgardner 2007). In order to meet these challenges, innovations of trailer flooring have taken place since the 1990s. The new trailer flooring materials should not be completely isolated from our natural environment. The industry and consumer should ask whether the new products are green (environmentally friendly) and sustainable. In this paper we will explore the answers to these questions through published facts and figures. The objectives of this paper are to evaluate the durability and sustainability of different trailer flooring materials in the North American market and promote the use of sustainable trailer flooring.

SUSTAINABILITY: THE BEST SOLUTION FOR ENVIRONMENTAL PROTECTION

Due to the pressure of public concern regarding global warming, a number of truck trailer flooring manufacturers have claimed that their trailer flooring products are “environmentally friendly”. For example, most of the plastics companies claim that their flooring products are “green” and advocate that using more plastic flooring will result in less felled trees and save more forests, thus resulting in a reduced greenhouse effect that causes global warming. Metal manufacturers also appeal to the public to use more steel and aluminum floors, which they claim can save more forests.

However, using “green” trailer flooring is not enough to protect our environment. Sustainability is the most effective solution to the global warming problem. What is sustainability? Sustainability is the capability of being sustained, which is a method of harvesting or using a resource so that the resource is not depleted or permanently damaged (Merriam-Webster 2008). It can also relate to a lifestyle involving the use of sustainable methods (Merriam-Webster 2008). As defined by the World Commission on Environment and Development (or the Brundtland Commission), sustainability is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED 1987). The concept of sustainability applies to all aspects of life on earth and is commonly defined within ecological, social and economic contexts. Ideally, sustainability development should reconcile the urgent needs of effective environmental protection and conservation of resources with economic development (Vis et al. 2008).

For the trailer flooring industry, sustainability is a process of “chain of custody”. It not only covers the production or processing of trailer flooring, but it also includes all steps of the life cycle of trailer flooring from raw materials to the end of its service life. The trailer flooring industry should minimize its impact to the environment and meet the sustainability assessment. More importantly, sustainability is a duty and commitment. We should make great effort to promote education on sustainability to our workers, suppliers, customers, and the public and frequently exchange sustainability information with them. For wood-based flooring, we should cooperate with our suppliers and tree farms to protect forest biodiversity, improve forest management to maintain high conservation value forests, and avoid any harvesting above sustainable levels. Furthermore, we must cooperate with our customers to promote reuse and recycling of trailer flooring after its lifetime and encourage its energy recovery to replace fossil-based fuel. Finally, the trailer flooring industry needs to balance social, environmental, and economic responsibilities on sustainability. Its driving force should meet social, environmental, and economic criteria on sustainability to promote a low carbon-emission economy and initiate innovations and improvement on trailer flooring by providing sustainable practices and solutions.

WOOD-BASED FLOORING VERSUS NON-WOOD MATERIALS IN SUSTAINABILITY

Durability and Its Environmental Impact

Table 1 compares the strength properties of wood flooring materials with steel, aluminum, and synthetic plastics. Among them, wood is the lightest flooring material, because it has the lowest specific gravity. It can compete with metal materials due to its high specific strength and modulus. Plastic materials have the lowest specific modulus

Table 1. Specific Modulus and Strength of Various Flooring Materials

Material	Specific gravity	Young's modulus (Msi)	Ultimate strength (Ksi)	Specific modulus ($Msi\text{-}in^3/lb$)	Specific strength ($ksi\text{-}in^3/lb$)
Steel [1]	7.8	30.00	94.00	106.5	333.6
Aluminum [1]	2.6	10.00	40.00	106.5	425.8
E-glass [1]	2.5	12.33	224.80	136.5	2489.0
Wood [2]					
Red oak	0.63	1.82	14.50	80.0	637.6
White oak	0.68	1.78	15.20	72.5	619.2
Hard maple	0.63	1.83	15.80	80.5	694.8
Keruing	0.69	2.07	19.90	83.1	799.0
Plastics [3, 4]					
HDPE	0.954	0.145	3.22	4.2	93.5
PP	0.905	0.197	6.14	6.0	187.9
PVC	1.38	0.268	11.41	5.4	229.1
Polyurethane (PUR)	1.44	0.110	4.49	2.1	86.4
E-glass/HDPE [3, 4]	1.50	2.21	23.40	40.8	432.2
E-glass/PUR [3, 4]	1.91	6.53	145.00	94.7	2103.2

1. Kaw 1997.
2. FPL 1999.
3. Matweb 2008 (http://www.matweb.com).
4. Strength properties of above plastic resins are the averages of commercial products in the market. The resin weight ratio of fiberglass-reinforced composite is 50% for HDPE and 24% for PUR, respectively.

and strength. Hence, they cannot be used alone as a flooring material, but can be reinforced with fiberglass. Fiberglass-reinforced HDPE composites have a lower specific strength and modulus than wood, while fiberglass-reinforced polyurethane composites are as stiff as steel in specific modulus and as strong as fiberglass in specific strength.

As mentioned above, wood is considered as a structural material because of its high specific strength. Oak and hard maple are the most durable domestic hardwood species for trailer flooring. For the above-ground applications, red oak and white oak normally last over twenty years, while the longevity of hard maple is fourteen years (Eslyn et al. 1985; Highley 1995). Due to heavy wearing by forklifts, the average lifetime of laminated oak and hard maple floors is estimated to be ten to twelve years. As a moderately resistant tropical hardwood, apitong is also a durable flooring material (Kukachka 1970). It has been reported that untreated apitong can last about five years for use as railway ties (Gerry 1952). All these hardwood species are biodegradable. Their biodegradation process would be accelerated in wet conditions or under the attacks of fungi, mildew molds, and termites (Eslyn et al. 1985; Highley 1995; FPL 1999).

Since oak is a ring-porous wood, it is coarser in texture than the diffuse porous woods of hard maple and apitong. Normally, white oak is denser than red oak, but hard maple is close to red oak in density (FPL 1999). Apitong is slightly denser than white oak. Oak, hard maple, and apitong have a flexural strength of around 15,000 psi, a specific gravity of around 0.65, and a hardness of around 1,300 lbs, respectively, which meets the requirements of trailer flooring materials on flexural strength, wearing resistance, and nailability (Haygreen and Bowyer 1994; FPL 1999).

The pores of the heartwood vessels in white oak are usually blocked by tyloses, which makes white oak impermeable, compared with red oak (Sander and Rosen 1985; Haygreen and Bowyer 1994). In addition, white oak contains a higher concentration of tannic acid than red oak (Fengel and Wegener 1984). Tannic acid is a polyphenol, which is an effective fungicide. Hence, white oak is more durable than red oak and hard maple (Sander and Rosen 1985). Apitong wood produces a lot of dammar (or damar) resin and apitonene (i.e., a sesquiterpene compound) within its fine texture (Kitao and Ikeda 1967). apitong wood also contains silica (Gerry 1952; Sander and Rosen 1985). Silica and the above extractives both help improve its water resistance and durability.

Steel is a strong and durable structural material and is recyclable. For manufacture, every ton of steel usually produces byproducts of 2.2 tons of carbon dioxide and 33 million-gallon water of pH 8.0 (i.e., alkaline), which has major impacts to air and leads to global warming and water pollution (Lawson 1996; Taylor and Van Langenberg 2003). Steel can be gradually decomposed under the natural environment. It is easily corroded or oxidized under wet conditions, which would significantly decrease its mechanical properties and durability.

Compared with steel, aluminum has a better corrosion resistance. In addition, it has lower specific gravity and higher specific strength than steel (Table 1). These advantages make it an ideal substituting material for steel. Similarly to steel, however, aluminum production results in a considerable amount of carbon dioxide and caustic red mud and sand byproducts, thus yielding a major impact to the natural environment (Taylor and Van Langenberg 2003). In addition, aluminum ore smelting plants, similarly to other metal smelters, are probable contributors to the level of acidity in the atmosphere, resulting from oxides of nitrogen and sulfur, components of smog and acid air (Roth et al. 1985). Aluminum can last over twenty years in the form of trailer flooring materials. It is recyclable and has a biodegradation life of 80 to 100 years.

Most synthetic plastics can be made from petroleum, natural gas, or coal, which are limited resources. They are normally non-structural materials. Thermoplastics such as HDPE, PP, and PVC are resistant to water. Polyurethane (PUR), a thermosetting polymer, also has excellent water resistance and durability (Forsdyke and Starr 2002). Synthetic plastic products usually contain additives that are harmful to human health and the environment (Lawson 1996). Moreover, they are resistant to decomposition in the natural environment. For example, thermoplastic bags can degrade within 10 to 20 years in outdoor conditions (Wikipedia 2009). However, they may not decompose even after 500 years under anaerobic biodegradation in a landfill. Accordingly, plastic products after their life cycle can have a negative impact upon our environment.

Carbon Emission

A number of tools have been used to evaluate the sustainability of various industrial materials or processes (Vis et al. 2008). Among them, the most common method of assessing a product's impact on the environment is the life cycle analysis (LCA) (Jönsson 1995; Taylor and Van Langenberg 2003; CEI-Bois 2004). LCA is commonly referred to as a "cradle-to-grave" assessment of a product.

According to ISO Standard 14040 (ISO 2006), LCA consists of the following four stages: 1) goal and scope definition, 2) life cycle inventory, 3) life cycle impact assessment, and 4) integration. During the *Goal and Scope* part of a LCA, the purpose, assumptions and boundaries of the process are normally defined. The *Life Cycle Inventory* (LCI) analysis phase of the LCA quantifies the material and energy inputs and environmental releases or emissions associated with the production process. The *Life Cycle Impact Assessment* takes the information from the LCI and evaluates the environmental burdens attributable to the substances released during the production process. This phase is designed to measure the total impact that this process has on the environment. Finally, major contributions and sensitive and uncertain factors are analyzed in the *Integration* phase, thus determining whether the ambitions from the goal and scope of the LCA can be met (Taylor and Van Langenberg 2003). Hence, LCA assesses the quantity of the environmental impact caused by the use of a product, and one tries to measure the impact at all stages of a product's life from raw materials to manufacture, transportation, use and final disposal or recycling.

Figure 1 presents the carbon flows of most wood products used for LCA. Wood logs as raw material for the wood industry are cut from forests. They are then directly produced in sawmills into lumber for building materials and other uses. The byproducts of sawmills, such as shavings, sawdust, and trim are used to manufacture hardboard, particleboard, or other panel materials through a panel factory. The wood wastes in the sawmill can also be used as fuel to displace fossil-fuel use. After a house is demolished, the wood wastes can be remanufactured into products or used as fuel for energy recovery. Wood fuels are considered neutral in terms of global warming impact, since the carbon dioxide emission of combustion can be absorbed and cleaned by the forests through the photosynthesis process to produce new trees and wood. Within such a closed loop, the impact of wood products on the environment is analyzed according to the above cradle-to-grave assessment. Sometimes, partial or specific LCAs such as "gate-to-gate", "cradle-to-gate" and "cradle-to-cradle" assessment are conducted for a specific scope of the researchers' studies or a certain process in the entire production chain (Wilson and Dancer 2005; Puettmann and Wilson 2005a).

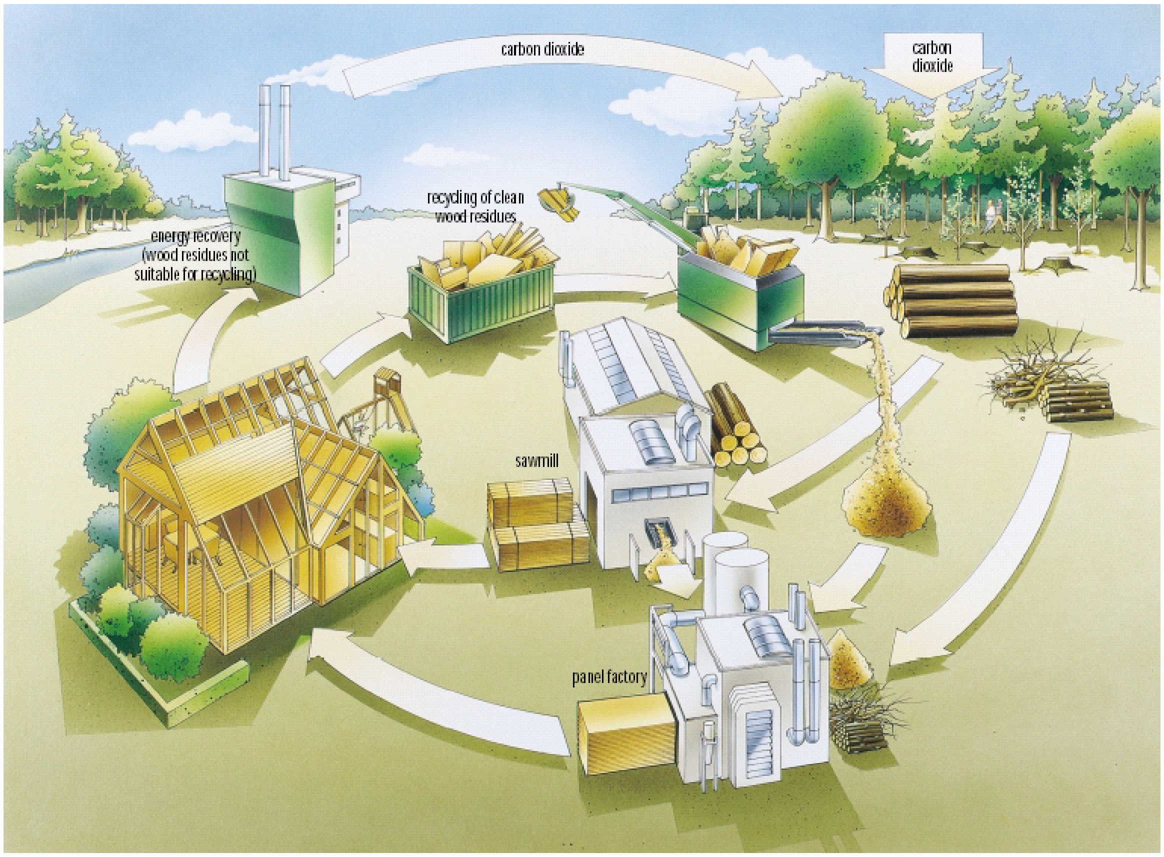


Figure 1. Schematic of the wood industry's carbon flows (Courtesy of European Confederation of Woodworking Industries)

Glulam is an engineered wood product, defined as glued-laminated timbers. Based on its applications, glulam is mainly divided into beam products and panel materials. The former has been extensively used as structural beams for flooring, roofs, and headers of buildings, telephone poles, electrical poles, and so on, while the latter can be applied as roof panels of houses and structural flooring for truck trailers.

There have been a number of publications on sustainability of various wood products by LCA (Richter and Sell 1992; Jönsson 1995; Scharai-Rad and Welling 2002; Lippke et al. 2004; Puettmann and Wilson 2005a; Wilson and Dancer 2005; Wilson and Sakimoto 2005; Rivela et al. 2006). This paper will consider in greater detail the sustainability of glulam beams, in comparison to that of wood trailer flooring.

Recently, Puettmann and Wilson (2005b) investigated the sustainability of glulam beam products by LCA. In their study, the glulam manufacturers were mainly divided into two regional locations in the United States: one was from the Pacific Northwest region, and the other from the Southeast region. The total annual glulam production in the year 2000 from these regions was 111 million board feet for the former region and 139 million board feet for the latter region. The production totals represented 31% and 39% of the total US glulam production for the Pacific Northwest and Southeast regions, respectively.

Most of the glulam manufacturers in these two regions use a similar process for glulam beam production. A typical glulam process includes lumber drying, trimming, finger- or end-jointing, planing, lamination, further planing or sanding, finishing, and shipping. The primary species used are Douglas fir, western larch, and Alaskan yellow cedar for the Pacific Northwest region and Southern pine species for the Southeast region. For glulam, melamine-urea-formadehyde (MUF) was used for finger-jointing of timbers, whilst phenol-resorcinol-formaldehyde (PRF) was applied for lamination of timber face bonding. The curing methods for adhesive bonding consisted of cold cure and radio frequency (RF) cure. The latter process is the most popular curing system for glulam production. The product yield of glulam was 81.5% for both regions. The major difference between these two regions in production emissions was for CO_2 fossil and CO_2 biomass. Glulam manufactures from the Pacific Northwest group used wood fuel as the major fuel source for wood drying and process energy, while in the Southeast group, manufacturers only used natural gas for process energy and did not use wood fuel, which generates CO_2 biomass emission (Puettmann and Wilson 2005b).

The primary air emissions in both groups were CO_2 (Table 2). In the Pacific Northwest region, total CO_2 emission per cubic foot of glulam was around 21 lbs, while for the Southeast region it was about 25 lbs. In production, however, the volatile organic compound (VOC) emission was negligible. Moreover, there were very low emissions of toxic gases such as methane (< 0.025 lb/ft^3), formaldehyde (< 0.00014 lb/ft^3), N_2O (< 0.00006 lb/ft^3), SO_2 (< 0.002 lb/ft^3), phenol (< 0.0009 lb/ft^3), and their derivatives per cubic foot of glulam products. For water emission, the biochemical oxygen demand (BOD) (< 0.0003 lb/ft^3), chemical oxygen demand (COD) (< 0.005 lb/ft^3) and Cl^- ion (< 0.006 lb/ft^3) levels were negligible. The dissolved solids in water weighed less than 0.1 pound per cubic foot of glulam for both regions. The solid wastes from the glulam products were also very low. They were less than 5 % in weight for the manufacturers in both regions (Puettmann and Wilson 2005b).

Figure 2 shows the carbon flow of glulam outputs in production. For each cubic meter of raw materials, 76% and 17% of the carbon was contained in the glulam products and byproduct, respectively, for the Pacific Northwest region, while for the Southeast region, 81% of total carbon output was contained in the product and 18% in the byproduct. As mentioned before, very little carbon was released as air emissions for the manufacturers in both groups (Fig. 2). Of 7% released as air emissions for the glulam manufacturers in the Pacific Northwest region, 97% was from the combustion of wood fuel used in on-site wood boilers. CO_2 emissions from wood fuel combustion are considered global warming-impact neutral according to the Environmental Protection Agency (EPA 2003).

Table 2. Air, Water, and Land Emissions for the Production of Glulam Timbers in the Pacific Northwest and Southeast Regions in the United States. [1]

	Pacific Northwest	Southeast
	$lb/1,000\ ft^3$	$lb/1,000\ ft^3$
Emission to air		
CO	112	120
Total CO_2	20,964	24,653
CO_2 (Biomass)	14,374	14,453
CO_2 (Fossil)	6,590	10,200
Methane	17	24
NMVOC	21	21
NO_x	41	54
SO_x	82	104
VOC	19	71
Total	21,295	25,170
Emission to water		
BOD	0.2250	0.2740
Cl^-	5	5
COD	3	4
Dissolved solids	108	105
Oil	2	2
Suspended solids	4	7
Total	122	123
Solid deposit		
Inorganic	43	-
Solid waste	1,070	1,230
Total	1,118	1,250

CO-carbon monoxide, CO_2-carbon dioxide, NMVOC- non-methane volatile organic compounds, VOC-volatile organic compound, BOD- Biochemical oxygen demand, Cl^--chlorine ion, and COD-Chemical oxygen demand. NO_x and SO_x-including N_2O and SO_2, respectively.

[1] The above table is edited from the data published by Puettmann and Wilson 2005b. Items of air and land emissions less than 5 $lb/1000\ ft^3$ are not included in this table.

Wood-based trailer flooring also has the lowest carbon emission compared with steel, aluminum, and PVC. The above data by Puettmann and Wilson (2005b) should be adjusted by the carbon storage effect of wood products. As shown in Table 3, the net carbon emission of wood-based trailer flooring was negative (-10 lb/ft^3). Hence, manufacture of wood trailer flooring has a neutral impact to the environment. However, steel, aluminum, and vinyl plastics all have very high carbon emissions to the environment. Steel has the highest carbon emission of 506 lb/ft^3, followed by aluminum (396 lb/ft^3) and PVC (158 lb/ft^3) (Buchanan 1993; Lawson 1996; Taylor and Van Langenberg 2003).

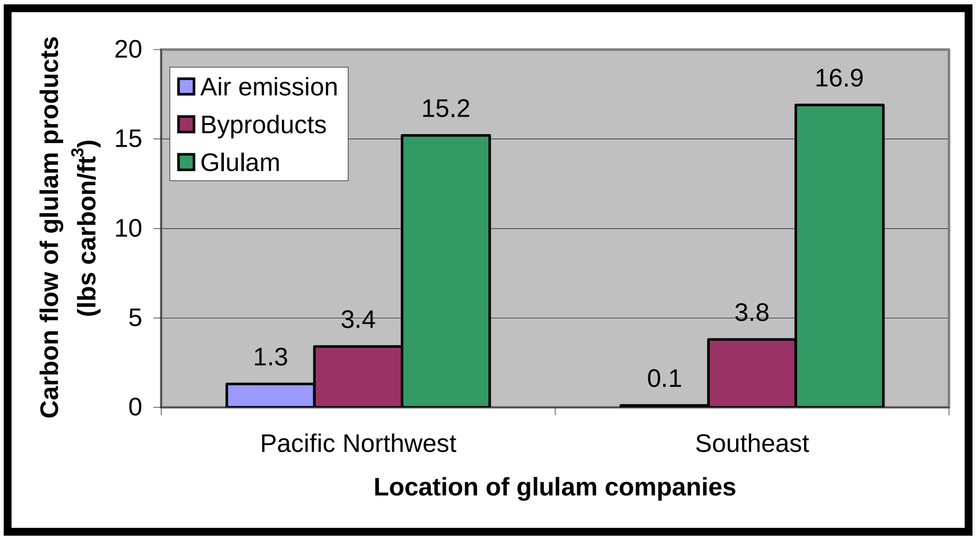


Figure 2. Carbon flow of glulam outputs (The above graph was plotted based on the published data by Puettmann and Wilson 2005b).

Table 3. Energy Requirement and Carbon Emission for Manufacture of Various Trailer Flooring Materials

Product	Net carbon emitted (lb/ft^3)	Energy (GJ/ft^3)
Glulam[1]	-10.49	0.13
Steel [1]	506.66	12.70
Aluminum [1]	396.49	10.26
PVC [2, 3]	157.92	2.05

[1] Buchanan 1993.
[2] Lawson 1996.
[3] Taylor and Van Langenberg 2003.

Embodied Energy

Embodied energy is usually defined as the energy consumed by all of the processes associated with the production of a trailer-flooring product, from the acquisition of raw materials to manufacture, transport, and product delivery (Milne 2008). In brief, embodied energy of trailer flooring is referred to its cradle-to-gate energy use. It is another useful index for sustainability evaluation of trailer flooring.

Like other glulam products, wood trailer flooring has a low energy requirement to manufacture and has the lowest embodied energy compared with steel, aluminum, and vinyl plastics (Table 3). In the above study reported by Puettmann and Wilson (2005b), the cumulative energy requirement for per cubic foot of glulam was 0.19 GJ for the Pacific Northwest region and 0.20 GJ for the Southeast region, respectively, which were higher than Buchanan's estimation (0.13 GJ/ft^3). As aforementioned, this is mainly due to Puettmann and Wilson's data being only calculated for manufacture, in which the energy recovery of wood products by substituting for fossil fuel-intensive materials was not considered. The feedstock energy value of wood products recovered at the end of their lifecycle can set off some energy requirement for their manufacture.

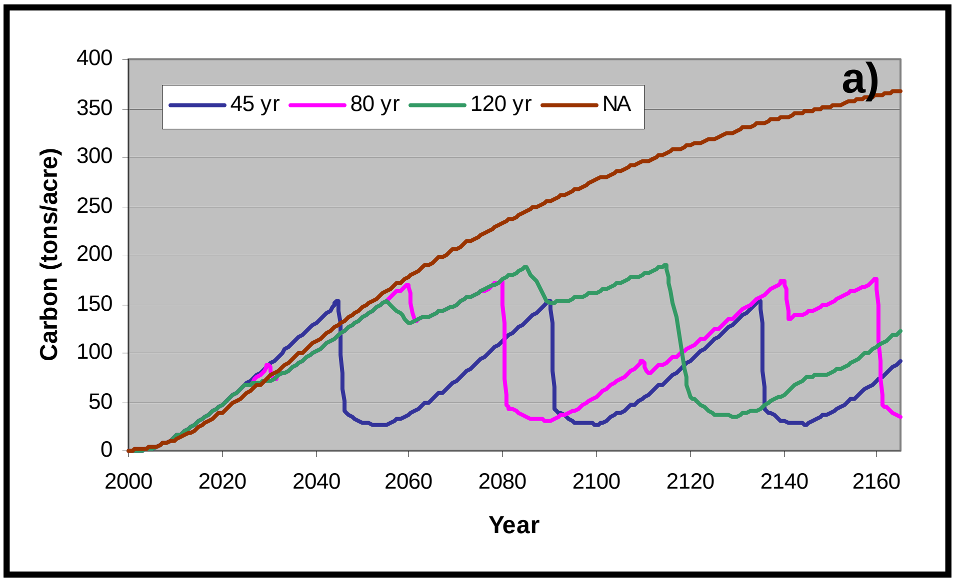
In contrast, steel has the highest energy consumption of 12.70 GJ/ft^3, followed by aluminum (10.26 GJ/ft^3). PVC, with an embodied energy of 2.05 GJ/ft^3, is still at least ten times higher in energy consumption than wood trailer flooring (Buchanan 1993; Lawson 1996; Taylor and Van Langenberg 2003).

Wood Trailer Flooring and Forests as Carbon Storage

Different from non-wood trailer flooring materials, wood trailer flooring is renewable and recyclable. Forests are the important renewable resource of wood trailer flooring. It has been estimated that through photosynthesis a tree can absorb the equivalent of 62 lbs of carbon dioxide for every cubic foot's growth and produce the equivalent of 45 lbs of oxygen (CEI-Bois 2007). Hence, forests sequester CO_2 in the atmosphere and transfer it as a form of carbon by photosynthesis. In the United States, forests are currently net carbon sinks, which sequester more carbon than they emit, because of the forest re-establishing itself on abandoned lands, suppression of wildfires, changes in timber harvesting practices, and increased growth of trees. It has been reported that in the United States (not including Alaska and Hawaii) the estimated total carbon stock by forest and harvested wood pools has increased from 4.62 to 4.94 billion tons carbon between 1990 and 2006 (EPA 2008). On the other hand, a considerable reduction in CO_2 emissions to the atmosphere can be obtained by using wood products instead of other materials. On average, the production of a cubic foot of wood results in about 175 lbs less CO_2 emission than the production of an equivalent amount of fossil fuel-intensive material such as steel, aluminum, or synthetic plastics. Hence, every cubic foot of wood products substituting for fossil fuel-intensive materials can reduce up to 231 lbs of CO_2 (Buchanan and Levine 1999).

Perez-Garcia and coworkers (2005) have recently investigated the influence of different harvesting scenarios on the carbon storage in forests. The harvest cycles were defined to be no action (no-harvesting), 45, 80, and 120 years, respectively. The harvested wood was converted into only lumber with a conversion efficiency of wood-to-lumber of 50%. The lumber was used for building materials as a long-term product with a service life of 80 years. It was assumed to decompose at the end of the useful life of a house. The remaining 50% of wood in the conversion went into pulp chips, sawdust, shavings, and bark, and all were considered as short-term products. Short-term products were assumed to decay within 10 years.

As shown in Figure 3a, no harvesting significantly increases the carbon storage of forests within 165 years, while all above harvesting rotations decrease the total amount of carbon in forest pools. However, harvesting forests would not significantly reduce the forest's carbon pool function, because wood products are carbon storage materials, as shown in Figure 2. This factor and the displacement of released carbon by substitution for concrete materials by wood products should be considered in the evaluation of the actual carbon storage during harvesting. Therefore, the compensation by wood products and concrete substitution actually made the 45-year rotation have higher carbon storage than no harvesting (Fig. 3b). The surplus of carbon is mainly ascribed to the substitution effect of wood products for fossil fuel-intensive materials.



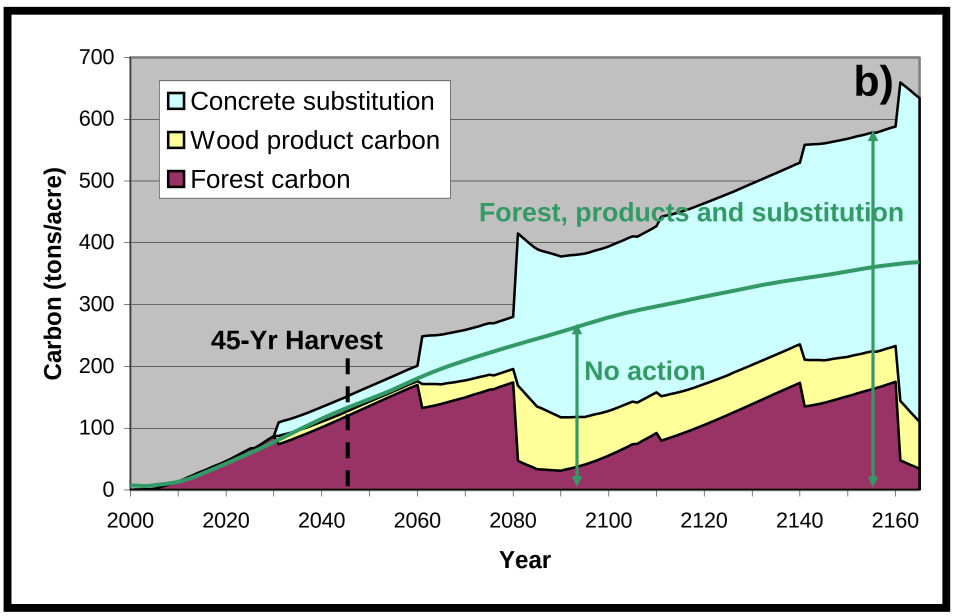


Figure 3. Carbon storage in forests and wood products. a) Carbon in forest pools for different harvesting rotations and b) carbon in the forest and product pools with concrete substitution for the 45-year rotation. 45 yr, 80 yr, 120 yr, and NA indicate 45 year-, 80 year-, and 120 year-rotations and no action (no harvesting), respectively (Adapted from Perez-Garcia et al. 2005).

Smith and coworkers (2004) have reported that the growing-stock volume of U.S. timberland has increased from 616 to 856 billion cubic feet between 1953 and 2002. Within it, the net growing-stock volume of U.S. hardwoods and softwoods has increased by 98% and 14%, respectively. Furthermore, other reports by Evans (1999) and by Woollons (2000) have also demonstrated that the productivity of subsequent rotations of most planted forests did not have a negative impact on their carbon sink effect. Accordingly, forest harvesting would not significantly impact global warming as long as an effective forest management system is used.

In summary, wood is clearly the most sustainable material compared with steel, aluminum, and synthetic plastics. Wood-based flooring is not only neutral in CO_2 emission and acts as carbon sinks, but also has the lowest embodied energy. By contrast, steel, aluminum, and synthetic plastics have a significant impact on global warming. Steel and aluminum can be recycled, while most of synthetic plastics cannot be naturally decomposed. Hence, all these non-wood materials are not sustainable to our environment.

SUSTAINABILITY CERTIFICATION IN TRAILER FLOORING INDUSTRY

Recently, a number of wood and wood composite companies have acquired or been acquiring sustainability certification of their products. Currently, there are many organizations accrediting sustainability certification for wood and wood products worldwide, including Sustainable Forestry Initiative (SFI) Organization, Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification Schemes (PEFC), and Canadian Standards Association (CSA) (Vis et al. 2008). FSC is the only forest certification system fully supported by most of the international environmental groups for sustainability of forestry. FSC is currently the only wood products certification system that is recognized by the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program.

FSC is an independent, not for profit, and non-government organization based in Bonn, Germany. Its mission is to support environmentally appropriate, socially beneficial, and economically viable management of the world's forests. There are a total of twenty global agencies working for FSC's certification. So far, there have been 276.8 million acre forests and 12,707 companies or organizations certified by FSC, which cover over 81 countries in the world. The annual value of FSC labeled sales is estimated at over 20 billion US dollars (FSC 2008). In the North American market, a total of 1,031 wood and wood composite companies have been certified by FSC for their products. Among them, the United States and Canada account for 75% and 20% FSC certificates, respectively. An FSC's certification is normally renewed every five years and an annual audit is required.

Similar to most of wood composite products, wood trailer flooring is also a sustainable wood product. However, there have been few certified sustainable trailer-flooring products in the North American market. Rockland Flooring LLC will cooperate with our lumber suppliers and trailer companies in this project and support certification for our sustainable flooring products.

CONCLUSIONS

Wood trailer flooring is an eco-friendly product. Wood is the most sustainable trailer flooring material compared with steel, aluminum, and synthetic plastics. It is renewable and recyclable. Oak, hard maple, and apitong are strong, durable species that are currently extensively used for trailer flooring. They store carbon that reduces global warming. Furthermore, selection of wood trailer flooring effectively displaces fossil fuel emission by substituting for non-wood flooring materials that utilize more fossil fuels in their manufacture. Wood wastes come from the manufacture of wood trailer flooring can be reused and recycled. Moreover, they can be used as biomass energy at the end of their service life to substitute for fossil fuels. To tackle global warming, it is recommended to use more wood trailer flooring!

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