Life Cycle Assessment of Shipping Container Floors
CONFORCE EKO-FLOR™ Flooring vs. Alternatives

1. Introduction

In cooperation with Covestro, CONFORCE has created EKO-FLOR™ flooring, a new type of container flooring that incorporates various types of fiber reinforcements and polyurethane resin materials from Covestro.

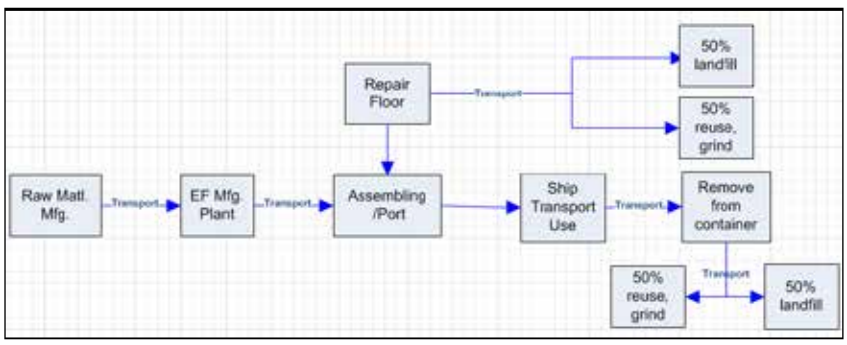
The materials and technology used to create EKO-FLOR™ flooring were designed to provide a floor with strength and durability. Since EKO-FLOR™ flooring is a non-porous fiber reinforced composite, the very nature of this material makes it stain resistant and breakage resistant. EKO-FLOR™ flooring is water resistant, does not de-laminate, cannot be infested with insects that may cause disease and damage buildings, and it is highly flame resistant. Moreover, it was realized that the lighter weight of EKO-FLOR™ flooring could have energy and environmental benefits associated with reduced fuel consumption on container ships and transport applications in general. A lighter weight also provides the possibility of adding more cargo weight up to the maximum payload equal to the standard maximum gross weight.

This study compares environmental impacts of most interest and relevance to the logistics community: Energy (net calorific value), Greenhouse Gases (GHGs) and also land occupation (land required for cultivation/manufacturing) associated with the entire life cycles of EKO-FLOR™ flooring, plywood and bamboo-wood.

2. Product Specifications

EKO-FLOR™ flooring has the same covered area per TEU as alternative wood/bamboo-wood floors (5.856m in length and 2.320m in width). The cross section area is an I-bar shape for EKO-FLOR™ flooring as shown in the figure below. For one piece of EKO-FLOR™ flooring, the width is 0.56648m. For one TEU, 4.1 pieces are required. EKO-FLOR™ flooring is engineered to have a weight of 250 kg per TEU with minimal variability.

3. LCA Study System Boundaries



Life Cycle Flow Diagram for EKO-FLOR™ Flooring

4. Functional Unit

The functional unit studied is the floor used in one TEU with the following weight specifications.

- EKO-FLOR™ flooring = 250 kg
- Plywood Floor = 304 kg
- Bamboo-wood Floor = 330 kg

5. Use Phase Assumptions

The table below shows the study's assumptions regarding floor service life, ship transportation distance and wood floor composition.

Items	Data	Source
Container floor lifetime	15-18 years	CONFORCE
Transportation distance	180,000-300,000 km/year	CONFORCE
Bamboo-Wood floor composition	70% bamboo-wood, 30% hardwood	KALMAR[1]

[1] KALMAR Industries, KALMAR around the world, 2006, No.1

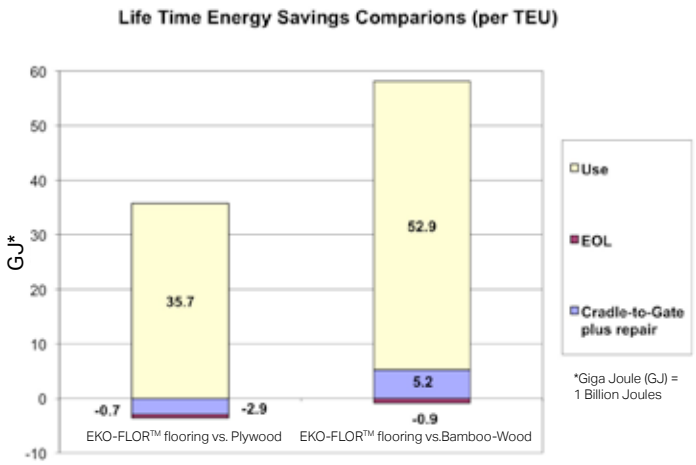
The average energy consumption and GHG emissions per metric ton cargo per km travelled was collected for two selected groups of the CMA-CGM fleet from shippingefficiency.org, as shown below.

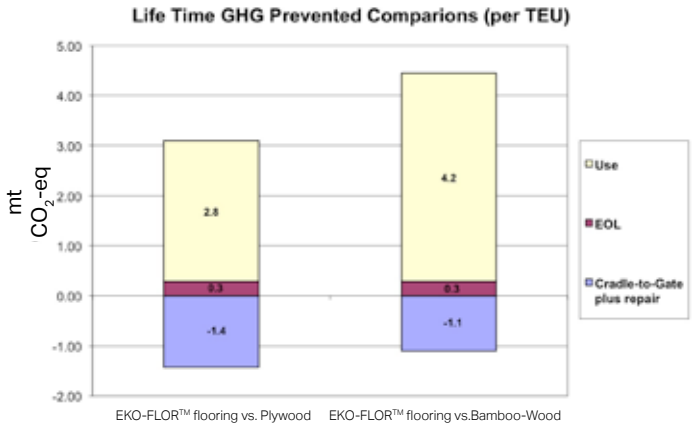
Nominal Capacity (TEUs)	Adjusted GWP factor (kg CO_2-eq /tonne/km)	Cradle-to-Gate Energy (MJ/tonne/km)
5,782	0.01493	0.1862
11,388	0.01072	0.1330

6. End-of-Life Options

Mass Fraction	EKO-FLOR™ flooring	Plywood/bamboo-wood
End-of-Life Options	50% landfill 50% recycled	80% landfill 20% burned to recover energy (50% energy recovery efficiency)

7. Life Cycle Impact Assessment Results





Cradle-to-EOL Comparisons (only for floor, 12,000 TEU ship)
(Top: Energy, Bottom: GHG)

Land Occupation

Floor Type	Land Occupied (m^2)	Ratio of Wood Flooring vs. EKO-FLOR™ flooring
EKO-FLOR™ flooring	8.090×10^4	-
Plywood floor	9.500×10^9	1.174×10^5
Bamboo/wood floor	3.725×10^9	4.604×10^4

Based on producing 250,000 TEU per year for 20 years

8. Conclusions

Based on the average life time and transportation distance scenario, for a 6,000 TEU ship, EKO-FLOR™ flooring saves 74.5 GJ/TEU vs. the bamboo/wood floor and 43.7 GJ/TEU vs. the plywood floor. The GHGs prevented by using EKO-FLOR™ flooring are 4.7 metric tons CO2-eq/TEU vs. the bamboo/wood floor and 2.6 metric tons CO2-eq/TEU vs. the plywood floor. The amount of energy saved is equal to 1,135 and 623 kg of heavy fuel oil, respectively (based on 4.16 mt CO2-eq/mt heavy fuel oil).

For a 12,000 TEU ship, EKO-FLOR™ flooring saves 57.2 GJ/TEU vs. the bamboo/wood floor and 32.1 GJ/TEU vs. the plywood floor. The GHGs prevented are 3.4 metric tons CO2-eq/TEU vs. the bamboo/wood floor and 1.7 metric tons CO2-eq/TEU vs. the plywood floor.

9. References

Carbon War Room, Methodology: Shippingefficiency.org – Efficiency Rating for Existing Ships, http://www.shippingefficiency.org/downloads/eedi-methodology.pdf, accessed May 17th, 2011.

Covestro LLC and CONFORCE International Inc,
Life Cycle Assessment of Shipping Container Floors EKO-FLOR™ Flooring vs. Alternatives, Feb, 2012

GaBi 4 Database, PE-International, 2011

KALMAR Industries, KALMAR around the world, 2006, No.1

Puettmann, M and et al., Cradle-to-Gate life –cycle inventory of US wood products production: CORRIM phase I and phase II products, Wood and Fiber Science, 2010, 42, suppl.1, 15 - 28

Vogtländer.J and et al., The sustainability of bamboo products for local and Western European applications. LCAs and land-use, Journal of Cleaner Production 2010, 18, 1260 – 1269