Reducing Construction's Environmental Footprint with Modular / Prefabricated Systems.

TOTAL = **MATERIALS** + **TRANSIT** + **PROCESS**

- **MATERIALS**: 1.67x Waste Reduction
- **TRANSIT**: 16.0x Less Employee Travel Miles
- **PROCESS**: 2.5x Less Waste Generated

MATERIALS

1) **Material Consumption / Waste**
2) **Solid Waste Generation**

FACT: The United States Environmental Protection Agency (EPA) estimates that a total of 135,000,000 tons of debris is sent to landfills annually by construction projects.

Efficient Material Usage in the Factory Setting.

Modular and prefabricated buildings are largely constructed off-site in an enclosed and modern production facility. Trades work year-round in specialized areas and can take advantage of the latest in construction technology such as accurate framing jigs and overhead lift systems.

The Modular Building Institute (MBI) found that: "Prefabrication makes it possible to optimize construction materials purchases and usage while minimizing on-site waste and offering a higher quality product to the buyer. Bulk materials are delivered to the manufacturing facility where they are stored in a protected environment safe from theft and exposure to the environmental conditions of a job site."

A 2008 University of Michigan Center for Sustainable Studies "Life Cycle Analysis" comparing modular and conventional construction approaches found significant improvements in efficiency of material usage through use of modular / prefab construction methodology.

The two charts to the right show the findings from this study comparing material consumption and percentage waste and solid waste generation for modular and conventional construction case scenarios.

Material Consumption / Waste

48,539#
Modular Material Consumption

1,414# (3%)
Modular Waste (%age of total)

49,482#
Conventional Material Consumption

2,356# (5%)
Conventional Waste (%age of total)

Solid Waste Generation

641 kg
Modular Construction / Fabrication

1,220 kg
Modular Material

1,861 kg
Total Modular Solid Waste

1,630 kg
Conventional Construction

1,130 kg
Conventional Material

2,760 kg
Total Conventional Solid Waste

TRANSIT

1) Supply Chain Miles Traveled
2) Transit Energy Consumption

Efficient Material Usage in the Factory Setting.

The overall carbon footprint of the building is partially determined by travel distances (and resultant emissions) for both all components in the material supply chain and also the employees performing work on the facility.

In a modular approach, employees are retained full-time and work a regular schedule at the production facility. As such, they live in the surrounding area and commute each day to work. The modular supply chain utilizes suppliers and material manufacturers located around the production facility, where materials are regularly delivered to a central location. The assembled modules are then shipped to the final project location.

A conventional construction project is assembled at the site, with a variable location. All contractors and labor drive from their varied home locations to the site of the project (which may be a significant distance that is commuted twice per day throughout the duration of the project). Similarly, materials must all be shipped to the project site, where workers will assemble the building over a period of months or years.

Average Supply Chain Miles

6,394 miles
Supply Chain Miles (Modular)

31,500 miles
Supply Chain Miles (Conventional)

Total Transportation Energy

20.9 GJ (0.2%)
Modular Transportation Energy (%age of total)

29.7 GJ (0.3%)
Conventional Transport. Energy (%age of total)

PROCESS

1) Lifecycle Global Warming Potential

Construction / Fabrication Energy Use

The lifecycle energy consumption figures from the University of Michigan study factor in several items.

For modular construction, this includes the total emission which is presented as the global warming potential (or CO2 equivalent). Typically this would incorporate the building use phase, but to compare only processes this is omitted. It includes raw material extraction, material production, and modular unit fabrication. It also includes material and employee transportation and the delivery of the modular units to the site.

The conventional construction process includes raw material extraction, material production, and construction along with material and employee transportation.

Lifecycle Greenhouse Gas Emis.

11,000 kg CO_2
Modular Construction Emissions

20,900 kg CO_2
Conventional Const. Emissions

1,397 kg CO_2
Modular Transportation Emissions

2,150 kg CO_2
Conventional Trans. Emissions

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