Building Sustainable Bridges

What’s Important

Bill McEleny
Director
National Steel Bridge Alliance
ENVIRONMENTALISTS
Sustainable Development: “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”
Environmental Impact

- Global warming potential
  - (kg CO2 equivalent)
- Acidification potential
  - (mol H+ equivalent – air pollutants into acids)
- Eutrophication potential
  - (kg Nitrogen equivalent)
- Smog potential
  - (kg Nitrous Oxide equivalent)
- Non-renewable energy primary demand
  - (Mega-Joules)

A rational, quantified approach to determining specific environmental impacts (Webster 2004)
LCA Tools

ATHENA Impact *Estimator* and EcoCalculator

BEES – Building for Environmental and Economic Sustainability (National Institute of Standards and Technology)

Carnegie Mellon University’s Green Design Institute’s Economic Input-Output Life-Cycle Analysis Tool

GaBi Life Cycle Engineering Software and SoFi Software (Five Winds International and PE Americas)

U.S. LCI Database (National Renewable Energy Laboratory)

World Steel Association database
## LCA Carbon Footprint Numbers for Steel

<table>
<thead>
<tr>
<th>Source</th>
<th>Carbon Footprint (t/ton or CO₂/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEES/NIST</td>
<td>2.4 tons CO₂/ton</td>
</tr>
<tr>
<td>AISI average</td>
<td>1.4 t/t</td>
</tr>
<tr>
<td>World Steel</td>
<td>0.937 t/t</td>
</tr>
<tr>
<td>ATHENA</td>
<td>0.936 t/t</td>
</tr>
<tr>
<td>Five Winds</td>
<td>0.895 t/t</td>
</tr>
<tr>
<td>BCSA</td>
<td>0.762 t/t</td>
</tr>
<tr>
<td>AISC</td>
<td>0.73 t/t</td>
</tr>
<tr>
<td>SMA</td>
<td>0.62 t/t</td>
</tr>
</tbody>
</table>

We need better numbers!

*Estimates are not exact*
Compare - Two Buildings

• **Steel**
  Hospital Medical Office Building, Omaha
  151,910 sq. ft, five stories
  1,211 tons of steel and 5,814 cubic yards of concrete

• **Concrete**
  University Medical Research Center, Omaha
  280,000 sq. ft, eight stories
  1,941 tons of steel and 15,650 cubic yards of concrete
Compare - Two Buildings

- Included
  Material production, fabrication, construction, end-of-life deconstruction/landfill for the structural system

- Functional Unit
  One square foot of building space

- Criteria
  Global warming potential
  Acidification potential
  Eutrophication potential
  Smog potential
  Non-renewable energy primary demand

- Data
  GaBi LCI Database (Five Winds)
  Site-specific production data representative of current construction techniques
We need better numbers! Estimates are not exact.
Steel Construction is ‘Better’ By…

- Global warming potential  9%
- Acidification potential  8%
- Eutrophication potential  9%
- Smog potential  14%
- Non-renewable energy primary demand -1%
now

• 0.5 labor hours/ton
• 67% reduction in energy use (since 1980)
• 47% reduction in carbon footprint (since 1990); on track for 10% more by 2012
• 45% reduction in greenhouse gas emissions (since 1975)
• 40% higher strength (since 1990)
• EPA best performance recognition
SUSTAINABLE MATERIAL
Economic & Social Impact

Site Selection
existing routes, no virgin sites, no historic sites, footing & pier locations

Materials & Resources
reduce, reuse, recycle, recyclable; future use, demo/salvage, water use

Traffic / Alternative Transportation
transitways, HOV, pedestrians, bicycle, lane adaptability

Construction Activities
construction debris, erosion control, on-site energy use
electric arc furnace vs. basic oxygen furnace
RECYCLED CONTENT

93.3%
Highest recycled content of any material = 93.3%

Highest recycling rate of any material = 98%

Significant potential for material reuse

Not down-cycled or just recycled, but multi-cycled with no loss of functionality

A true cradle-to-cradle material!
Superior water resource management of a closed loop system with no external discharges
(requiring 70 gallons make-up water / ton of steel produced)
WATER USE

1 ton of steel = 70 gallons

1 lb. of steak = 1,857 gallons

1 glass of beer = 20 gallons
prefabricated bridges
JOB SITE IMPACT

prefabricated bridges
500 mile radius
LOCAL/REGIONAL SOURCES?
Transportation Options

Semi = 1 ton @ 150 miles/gallon
Rail = 1 ton @ 450 miles/gallon
Barge = 1 ton @ 675 miles/gallon
no touch / light touch
Mt. Si, King County, WA
no touch / light touch
FUTURE USE

re-use / modify / re-purpose
Cornell University, Ithaca, NY
reduce (thru long life)
127 Steel ‘Centurions’
Domestic wind power grew by 39% in 2009; it’s nearly 2% of total power use.

Domestic solar power has increased by 40% per year for last eight years.
AISC Member Fabricator
Hamilton Construction
Springfield, Oregon

74.3 KW Solar Electric System

Expected cost savings:
• $4,638 in first year
• $280,400 (with a 3% annual energy rate inflation) lifetime savings

Environmental savings:
• 2,000 tons of CO₂
• 6,000 trees planted
• 209,000 gallons of gasoline
WHAT CAN I DO?

Recognize sustainable design and construction is a growing market and movement

Engage in collaborative design with the full project supply chain

Avoid the “popular” issues – be analytical

Support the development of a balanced, consensus based standard for all construction materials in high-performance, green bridges

Operate in a sustainable manner

turn off the lights!
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