ECN Materials Focus Group
“Materially Important” Speaker Series:
Steel and Embodied Carbon
Agenda:

• Welcome and CLF Overview
• Speaker Intros
• Speaker Presentations
• Attendee Question and Answer
• Wrap up

Note: This webinar will be recorded and posted as an educational resource on the CLF website.
Speakers:

Luke A. Johnson, SE, PE  
Senior Steel Solutions Center Advisor  
American Institute of Steel Construction (AISC)

Pat Jablonski, PE  
Environmental Manager  
Nucor Steel Seattle, Inc.

Ben H. Klingenstein, P.E., S.E., LEED AP  
Senior Associate  
Magnusson Klemencic Associates (MKA)
What is an Ideal, Sustainable Building Material?
Sustainable
Fabricated with Minimal Waste
Erected with Minimal Waste
Recoverable and Reusable
High Recycled Content & Recovery Rate
Gentle on the Environment
Cradle-to-Cradle Life Cycle of Structural Steel

Structural Steel Mill

- Scrap Processing
- Fabrication
- Construction and Erection
- Building Operation
- Deconstruction
- Scrap Collection
### Construction & Demolition Debris in the USA

(Units in Thousand Tons)

<table>
<thead>
<tr>
<th>Material</th>
<th>During Construction</th>
<th>Demolition</th>
<th>Total</th>
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<tbody>
<tr>
<td>Concrete</td>
<td>19,939</td>
<td>21,689</td>
<td>23,081</td>
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<tr>
<td>Wood Products</td>
<td>2,691</td>
<td>2,842</td>
<td>2,860</td>
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<tr>
<td>Drywall &amp; Plasters</td>
<td>2,788</td>
<td>2,431</td>
<td>2,490</td>
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<tr>
<td>Steel</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brick &amp; Clay Tile</td>
<td>232</td>
<td>252</td>
<td>258</td>
</tr>
<tr>
<td>Asphalt Shingles</td>
<td>866</td>
<td>498</td>
<td>850</td>
</tr>
<tr>
<td>Asphalt Concrete</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>26,516</strong></td>
<td><strong>27,712</strong></td>
<td><strong>29,540</strong></td>
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</table>

**Construction & Demolition Debris in the USA**

Construction & Demolition Debris in the USA

Environmental Product Declaration (EPD)
Transparency Across Multiple Impacts

aiisc.org/EPD
<table>
<thead>
<tr>
<th>Product</th>
<th>Impact Category</th>
<th>Units</th>
<th>Produced in China</th>
<th>Produced in the US</th>
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<tbody>
<tr>
<td>Hot-Rolled Structural Sections</td>
<td>GWP-100</td>
<td>Tons CO2eq/ton</td>
<td>2.94</td>
<td>0.98</td>
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</table>
Nucor – Sedalia, Missouri
EVRAZ – Pueblo, Colorado
SSAB AB – Montpelier, Iowa
Structural Steel - Sustainability

- Domestically produced and fabricated structural steel is a sustainable building material.

- Sourcing domestically produced and fabricated structural steel will provide some of the lowest carbon footprint steel in the world.

- Domestic structural steel contains 93% recycled content on average, and 98% of all structural steel is recovered at the end of a structure’s useful life.

- The steel industry is always looking for new innovations and ways to provide cleaner, more sustainable steel.
Luke A. Johnson, SE, PE
312.670.5434
johnson@aisc.org
Steel and Embodied Carbon

Patrick Jablonski, PE
Environmental Manager
Nucor Steel Seattle, Inc.
Nucor Steel Seattle, Inc. – The Important Part

- Largest recycler in the State of Washington
- 315 Teammates that earn an average salary of $90K and have unprecedented job security for our industry.
- Electricity provided by Seattle City Light, carbon neutral since 2005
- Proud to have some of the best energy efficiency and GWP numbers in the world.
- Support the great community in which we live.
Steel – An Old Material that Continues to Get Better

• Steel is infinitely recyclable and is the most recycled material in the world.

• The steel industry has reduced its energy consumption by over 60% in the last 50 years.

• The domestic steel industry has reduced its GHG emissions by 37% since 1990.
Steel Making Processes

Blast Furnace- Basic Oxygen Furnace (Integrated) Steel Plant

Electric Arc Furnace (Minimill) Steel Plant
EAF Steel Making Technology – Smaller Footprint

- Recycles scrap steel

- Roughly 20% of energy intensity of BF-BOF

- Majority of energy is from electricity vs 90% of BF-BOF energy comes from directly from coal

- Direct CO2e emissions are roughly 1/3 that of BF-BOF
BF-BOF vs EAF Steelmaking

2018 Steel Production (Million Tonnes)

- EU
- Russia
- US
- China
- India
- Japan
- S Korea

BF-BOF Production
EAF Production
Nucor Steel Seattle, Inc.

- Located in W Seattle since 1905

- Produces mostly rebar
  - Grade 40 – Grade 100
  - #3 - #18 Bar (& metric equivalents)

- Also produces channel, angle, and flats – All 6” and smaller

- Regionally, Nucor also has Harris Rebar fabrication facilities in Tacoma, Puyallup, Auburn, Lake Stevens, Burbank (Tri-Cities), and Portland that mostly use product from the Seattle mill.
Nucor Steel Seattle, Inc. EPD

- Covers all of our products.
- Significant effort to produce
- GWP of .499 tonne CO2e, roughly 50-60% of domestic rebar average.
  - GWP of Rebar for European with mix of EAF and BF-BOF 1.23 tonne CO2e.
  - GWP of BF-BOF plate from European mill 1.9 tonne CO2e.
- Surprises and changes during and after the process?
What’s Next

• Nucor continuing to work towards minimizing our footprint.

• Nucor plans to continue to work with ECN and others in an effort to reduce the carbon content of the built environment.

• Nucor is in the process of producing EPDs for our other products and divisions.
The Engineer’s Role

- We cannot control the carbon content (or carbon footprint) of the materials we specify
- We can control how much is used...
  - ...but at times, cost considerations will prevail
The Engineer’s Role – Material Selection

Material specifications & grades
The Engineer’s Role – Material Selection

Structural shape selection

https://www.aisc.org/steelavailability/
### The Engineer’s Role – Material Selection

#### Structural shape selection

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The Engineer’s Role – “Good” Design

- Be a good designer...
  - Select efficient framing layouts / “right size” column bays
    - Reduces beam weight and piece counts
  - “Right size” member depths
    - Reduces beam weight
  - Minimize transfers
    - Reduces beam weight
The Engineer’s Role – “Good” Design

- ...but also understand the design process!
  - Select efficient framing layouts
    - Ensure column locations, slab edges/openings, etc. support this
  - “Right size” member depths
    - Ensure the structural “sandwich” is defined and vetted
  - Minimize transfers
    - Ensure column locations, slab edges/openings, etc. support this
- Stake your claim early!
The Engineer’s Role – “Good” Design
The Engineer’s Role – “Good” Design

- Smart rebar detailing
  - Select bar lengths to reduce waste
  - Be aggressive about staggering bars
  - Use lap splices and development lengths appropriately
- Use couplers (where appropriate)
The Engineer’s Role – Design Optimization

- Extract information on load and displacement of each optimizable element
- Remove the element that contributes the least to the overall structural stiffness
- Analyze
The Engineer’s Role – Design Optimization
The Engineer’s Role – Question the Status Quo

Asymmetric floor framing
The Engineer’s Role – Question the Status Quo

Asymmetric floor framing
The Engineer’s Role – Question the Status Quo

Asymmetric floor framing

W24x55 (controlled by vibration)
BUW24x40 alternative design
The Engineer’s Role – Question the Status Quo

Controlling floor vibrations

<table>
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<tr>
<th>FLOOR LOAD / VIBRATION REDUCTION SCHEME</th>
<th>BEAM FRAMING PER FLOOR</th>
<th>BEAM &amp; COLUMN FRAMING PER FLOOR</th>
<th>SLAB ON METAL DECK PER FLOOR</th>
<th>CALCULATED FLOOR ACCELERATION</th>
<th>ESTIMATE OF COST</th>
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<tr>
<td></td>
<td>STEEL WEIGHT (LBS)</td>
<td>WEIGHT DELTA (LBS)</td>
<td>STEEL WEIGHT (LBS)</td>
<td>WEIGHT DELTA (LBS)</td>
<td>CONC VOLUME (YD³)</td>
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* THE ESTIMATED COSTS ARE BASED ON THE FOLLOWING ASSUMED MATERIAL UNIT RATES: CONCRETE @ $100/CU. YD STEEL @ $2000/TON
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