Biogenic carbon accounting method for upstream forest & end-of-life scenarios: A regional approach

Applied Research Consortium Meeting  05.19.2022
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Agenda

01 RECAP
Regional EOL & Design Decisions

02 END-OF-LIFE
Bay Model Case Studies & EOL Emission Variations

03 NEXT STEPS
A0 Update & Next Steps
ARC 2.0 Fall & Winter Quarter

**Fall Q**
- Manufacturing
- Specified Forest Operation Factors
  - Harvest Intensity
  - Transportations

**Winter Q**
- End of life
  - Custom End of Life Scenarios (ARC 1.0)
  - Municipal/County data
  - Design decision on reusabilities (ARC 2.0)

**CRADLE TO GATE (EC3 / EPDS)**

**CRADLE TO GRAVE (LCA Software, TALLY)**

**PRODUCT STAGE**
- A0: forestry
- A1: raw material manufacturing & production supply
- A2: transport to site
- A3: construction & installation
- A4: use, maintenance, repair and replacement
- A5: deconstruction, waste processing, and disposal
- A6: operational energy & water
- B1-B5: Municipal/County data
- C1-4: Design decision on reusabilities (ARC 2.0)
- D: recovery, reuse and recycling
Regional Wood Waste Diversions

Lv 1 - National Average
- 2013 EPD
- 2020 EPD w/ biogenic storage
- Tally U.S. 2014 Municipal Solid Waste Report

Embodied Carbon only (fossil based)

Lv 2 - County Level
- King County 350,000 tons of clean wood

Lv 3 - Design Decisions
- Fed South

Cite from EPA, King County data
02 End-of-life

Spring Quarter Scope

Regional Waste Diversions

Deconstruction Potential in Common Practice

Regional End of Life Emissions

Cite from Rocky Mountain Institute floor assembly, ZGF
Wood Waste Data Diversions

End-of-life data for King, Pierce, and Yakima counties, along with national data. The graph shows the percentage of wood waste diversions for each category:

- Landfill
- Burn for Energy
- Recycling

King County: 5%
Pierce County: 1.65%
Yakima County: 100%

Cite from EPA, King County, Tally database.
Structural & Deconstruction Workshop

End of Life Discussion Meeting Series:

Chou Zhang, Research fellow with University of Washington Applied Research Consortium
Tomás Mendez Echenagucia, Ph.D., Assistant Professor, University of Washington
Jacob Dunn, ZGF
Marty Brennan, ZGF

Waste Specialists
Kinley Deller, King County Solid Waste Division
Alex Erzen, King County Solid Waste Division
Katie Kennedy: Waste Diversion Lead at Seattle Public Utilities
Theresa Blaine: Sustainable Materials Management Specialist at US EPA Region 10
Timonie Hood, Zero Waste & Green Building Coordinator, U.S. EPA Region 9
Christina Bjarvin, Master’s student at UW Environmental & Forest Sciences

Structural Engineering
Amie E. Sullivan, PE, SE, Principal, KPFF
Shana Kelley, PE, SE, Seattle Office Director of Sustainable Design, KPFF
Donald W. Davies, PE, SE, President, Magnusson Klemencic Associates
Morgan Brun, Design Engineer, Magnusson Klemencic Associates
Denis Blount, Associate Principal, Acoustics, Audiovisual, Theatre Consulting, CTS-D, Arup

Construction Specialists
Marc Chen, Skanska, Sustainability Manager
Laura Soma, GLY Sustainability Specialist

Deconstruction Specialists
David Bennick, Reuse Consulting Director of Building Deconstruction Institute, Owner of Re-Use Consulting
Noel Stout, Owner of Dedicated Deconstruction
Floor Assembly Bay Model Study

Assumptions:
- Location: Seattle
- Code: WA 2018 IBC
- Type: Office- B Occupancy
- Construction type: IV B, Fully Sprinklered
- 10 Floors @ 13’-6” Height
- Fire Rating: 2 HR. Primary Structural Frame & Floor; Design to Char
- Grid Size: 30’ x 30’
- 50 PSF Superimposed Dead Load
- 100 PSF Live Load
Factors Impact on De-constructability

Composite action

Fastener choice
(I.e. Screw / Bolt)

Seismic/ Lateral system

Acoustic & Fireproofing

Cite from AIA, VMTW, Pliteq
Common Mass Timber Floor Assembly Designs

Bay 1

- Gravity: Glulam beam & Column
- Lateral: CLT & topping slab with composite action
- Acoustic & Vibration: Topping slab

Cite from PAE, A. Shreyer
Common Mass Timber Floor Assembly Designs

Bay 2

- Gravity: Glulam beam & Column
- Lateral: CLT
- Acoustics & Vibration: Topping slab (w/o composite action)

Cite from AIA
Common Mass Timber Floor Assembly Designs

Bay 3

- **Gravity:** Steel beam (2-HR rating), 5-ply CLT
- **Lateral:** Concrete topping coupled to steel beam
- **Acoustic & Vibration:** Topping slab

Cite from Amie E. Sullivan, KPFF
Common Mass Timber Floor Assembly Designs

Bay 4

- **Gravity:** Glulam beam, column
- **Lateral:** NLT/DLT, concrete w/ composite action
- **Acoustic & Vibration:** Topping slab

Cite from Magnusson Klemencic Associates
Common Mass Timber Floor Assembly Designs

Bay 5

- **Gravity**: Composite double T Glulam & 5-ply CLT & precast concrete girders
- **Lateral**: Concrete slab / plywood
- **Acoustic & Vibration**: Topping slab (w/o composite action)

Cite from Amie E. Sullivan, KPFF
Bay 2 Regional End of Life Comparisons
(CLT Floor - 515.63 ft³)

King County
(5%-59%-36%)

Fed South & King
(77%-14%-9%)

Pierce County
(2%-73%-25%)

Cite from UpStream
Main Takeaway

- Design Decisions
- Data Set
- Wood End-of-Life
**Fall quarter**
- Forest Harvest Intensities
- Transportation Factors

**Winter quarter**
- Municipal/County waste diversion data
- Design decision impact on deconstruction and reuse
- Interviews with demo contractors
- UpStream Tool update

**Spring quarter**
- Regional waste diversions
- Bay model sensitivity studies
- CLF Forestry carbon methodology review
- Building Transparency openIMPACT development
- Final report
Thank you
# Common Mass Timber Floor Assembly

## Diagram

### Bay 1: Typical Concrete Composite
- **Connection Details**: [Diagram]
- **Gravity**: Glulam beam, column
- **Lateral**: CLT & topping slab with composite action
- **Acoustic & Vibration**: 3" Topping slab

### Bay 2: Non-Composite
- **Connection Details**: [Diagram]
- **Gravity**: Glulam beam, column
- **Lateral**: CLT
- **Acoustic & Vibration**: 3" Topping slab

### Bay 3: Steel & Mass Timber Hybrid
- **Connection Details**: [Diagram]
- **Gravity**: Steel beam (2-HR rating), 5-ply CLT
- **Lateral**: Concrete topping coupled to steel beam
- **Acoustic & Vibration**: 3" Topping slab

### Bay 4: DLT/NLT w/ Concrete
- **Connection Details**: [Diagram]
- **Gravity**: Glulam beam, column
- **Lateral**: NLT/CLT, concrete w/composite action
- **Acoustic & Vibration**: 3" Topping slab

### Bay 5: Double T Glulam Beams
- **Connection Details**: [Diagram]
- **Gravity**: Composite double T Glulam & 5-ply CLT, precast concrete grids
- **Lateral**: Concrete slab/plywood
- **Acoustic & Vibration**: 3" Topping slab (w/o composite action)