CLT in the U.S.

Manufacturing and Applications

Presented by Quinn Guerrero

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Course Description

Architects around the world are using mass timber construction systems to build taller wood buildings, incorporate the aesthetic of exposed wood, or increase the amount of prefabrication on their projects. Many use cross-laminated timber (CLT) panels and glue-laminated timber (glulam) beams as the building structure, often as a carbon-friendly alternative to conventional materials such as steel, masonry and concrete. In this presentation by an Oregon-based CLT manufacturer, successful U.S. projects will be highlighted to demonstrate the variety of commercial and multi-family applications available for CLT under today's building codes. Topics will also include CLT manufacturing, benefits such as structural versatility, and potential future uses.

Learning Objectives

1. Identify CLT manufacturing processes and consider how CLT can be used under current building codes and standards.

2. Review completed CLT projects that demonstrate a range of applications and system configurations.

3. Discuss benefits of using CLT, including structural versatility, prefabrication, lighter carbon footprint, and reduced labor costs.

4. Highlight possibilities for the expanded use and application of CLT in larger and taller buildings.

Oregon Sawmill since 1951

Riddle Laminators opened 1967

Mass Timber Benefits

Sustainable	- reduced carbon footprint - energy efficient - renewable resource - minimal waste
Performance	- disaster resilient - good fire resistance - high performing acoustics - structural flexibility
Construction Efficiency	- approx. 75% lighter than concrete - reduced construction time - pre-fabricated & precise - small erection crews

Mass Timber – Horizontal Panels

NLT

CLT

GLT

DLT

composite

LVL

Im ages: Structurecraft

CLT– Common Layups

3-ply 3-layer

5-ply 5-layer

7-ply 7-layer

9-ply 9-layer

7-ply 5-layer

9-ply 7-layer

CLT

CLT

Engineered Timber – Frame

Glulam

PSL

LVL

LSL

Im ages: Structurecraft

Building Systems

Post & Beam

Light Frame

Mass Timber

CLT Possibilities– 2-way spanning roofs & floors

CLT Possibilities – Shaft Walls

Photo: Alex Schreyer

CLT Possibilities – Shearwalls

- Currently undergoing shake table testing
- R-values not yet published in codes

CLT – Shearwalls

CLT – Shearwalls & Floors

CLT – holes & notches

Early Involvement = success

- Design-Bid-Build Limitations
- Schedule is critical
- Early communication is key
  Design Team + Fabricator + Installer
- Involve the fabricator early so we can help realize your design dreams within budget and avoid value engineering later

CLT Prefabrication – CNC

CLT Prefabrication – CNC

- MEP openings
- Window & door openings
- Notches
- Shop installed connectors

Mass Timber– Steel Connectors

CLT Prefabrication – Connections

CLT Installation – Panel to beam connections

Photo: Myticon

Installation Training

- Invite new installers to the plant
- Truck loading & erection sequencing
- Proper care during installation and before closure

Delivering Success

- Early selection & involvement of supplier
- Regular communication
- Trained Installation Crew

CLT Cost Factors

- Thickness of panel/ number of laminations
- CNC time & complexity (for openings, penetrations, etc)
- Architectural finish or alternate grade/ species
- Shipping distance
- Special requirements

Keep CLT Costs in Check

- Use minimum thickness possible
  - Floors usually controlled by vibration
  - Fire rating requirements can effect thickness
- Minimize material waste
  - Keep in mind press sizes available
  - Selection of splice type effects % waste
  - Openings can be accommodated without cutting holes in panels
- Minimize factory CNC work
  - Consider field accommodation techniques for MEP
  - Openings can be accommodated without cutting holes in panels
- Use fabricator's standard product options including: species, grade & lay-up
- Always get the fabricator involved early in design process

CLT in Building Codes – 2015 & 2018 IBC

CLT permitted in various Types of Construction

	Type I	Type II	Type III	Type IV	Type V
CLT Floors			✓	✓	✓
CLT Roofs	✓ (1-hr or less FRR)	✓ (1-hr or less FRR)	✓	✓	✓
CLT interior walls			✓	✓	✓
CLT exterior walls				✓	✓

2021 IBC – Proposed Changes

Modernizing Type IV Heavy Timber for Tall Wood Buildings

Type of Construction	Max Height	# Stories	Exposed Mass Timber	Primary Frame FRR	Floor FRR	Stair Tower	Concealed Spaces
IV-HT	85 ft	4-6	fully exposed	HT (2021)	HT	Mass Timber	Permitted (2021)
IV-C	85 ft	4-9	fully exposed	2 hr	2 hr	Mass Timber	Permitted
IV-B	180 ft	6-12	partially exposed	2 hr	2 hr	Mass Timber	Permitted
IV-A	270 ft	9-18	fully protected	3 hr	2 hr	Noncombustible	Permitted

Courtesy of: American Wood Council

Fire Protection

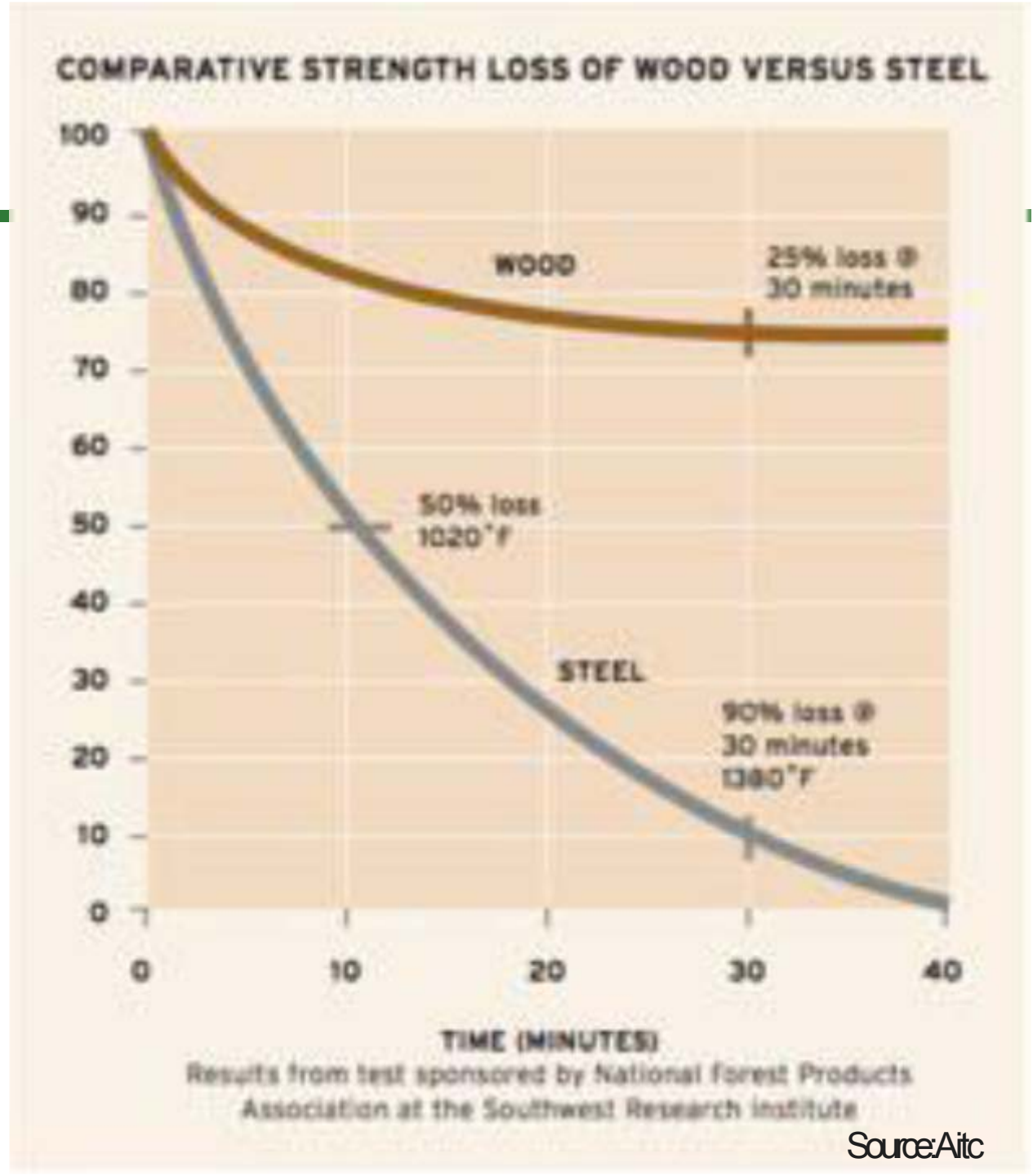
- Char layer provides protection
- Class A Fire Spread (highest rating)
- Building codes allow fire resistance to be calculated per the NDS (NDS Tech Report 10)

Fire Resistance Test – CLT Structural Floor

- Exposed 5-ply CLT w/ 2” gypcrete topping – passed 2 hour test (ASTM E119)
- Up to 3-hour rating possible w/ CLT

Fire – Wood vs Steel

- @ 30 minutes, steel loses 90% strength
- Wood only loses 25% strength



Source:Aitc

Locally Grown

- Support US Forest economy
- Revitalize rural communities

Sustainability

- Wood buildings store carbon (50% of dry wood weight is carbon)
- Wood buildings currently store 5.4 billion tons of carbon
- Lighter, higher precision, and faster construction time compared to concrete
- Sustainable forest management

Sonoma Academy

Janet Durgin Guild & Commons

Owner: Sonoma Academy

Architect: WRNS Studio

Structural Engineer: Mar Structural

General Contractor: XL Construction

Timber Supplier: DR Johnson

CNC Routing: DR Johnson

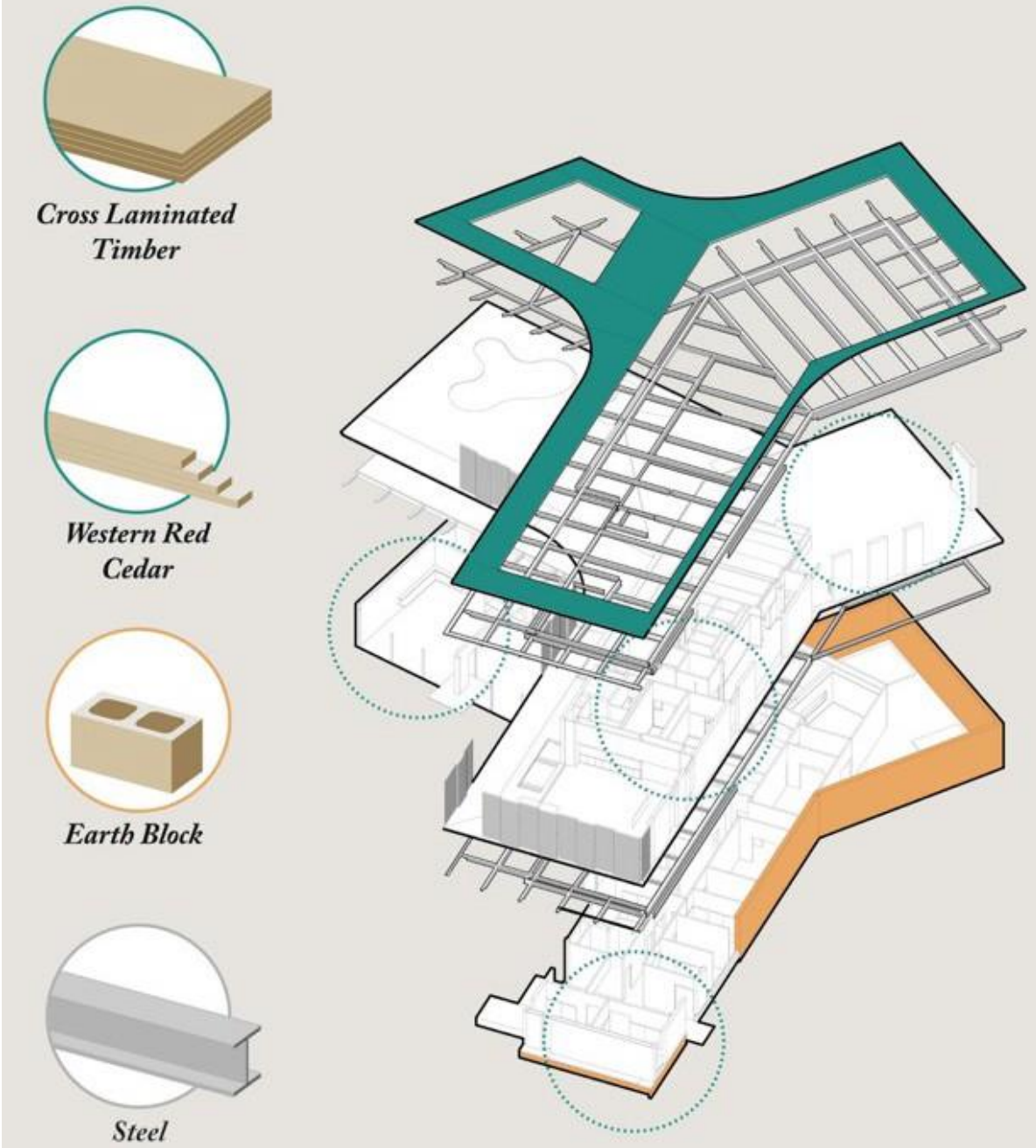
Location: Santa Rosa, California

Photo: Michael David Rose

Sonoma Academy

Sonoma Academy

- Hybrid CLT & steel roof
- CLT exposed at exterior
- Curving edges of CLT
- Reclaimed wood beams



Credit: W RN S Studio

Sonoma Academy – Roof

- CLT & steel hybrid
- Exposed CLT soffit

Sonoma Academy – CLT install

- Laydown area
- Small crew

Sonoma Academy – CLT curve

- Coordination between design team, steel and timber fabricators
- Tolerances

Photo: D R Johnson

Sonoma Academy – CLT to steel detail

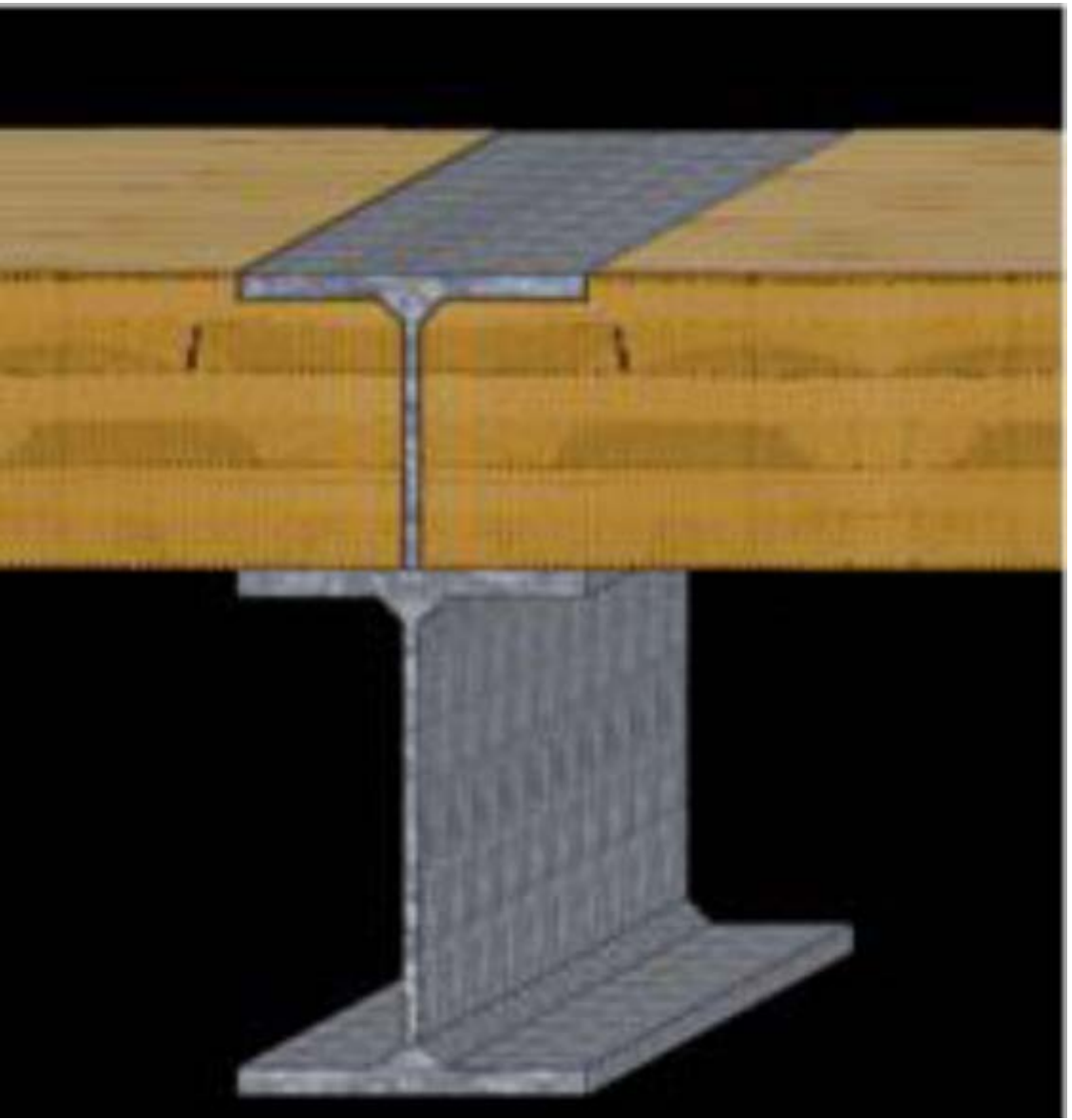


Photo: D R Johnson

Sonoma Academy

Sonoma Academy


Photo: Jerem y Bittermann


Photo: Celso Rojas

Albina Yard

Owner/ GC: Reworks

Architect: LEVER Architecture

Structural Engineer: KPFF

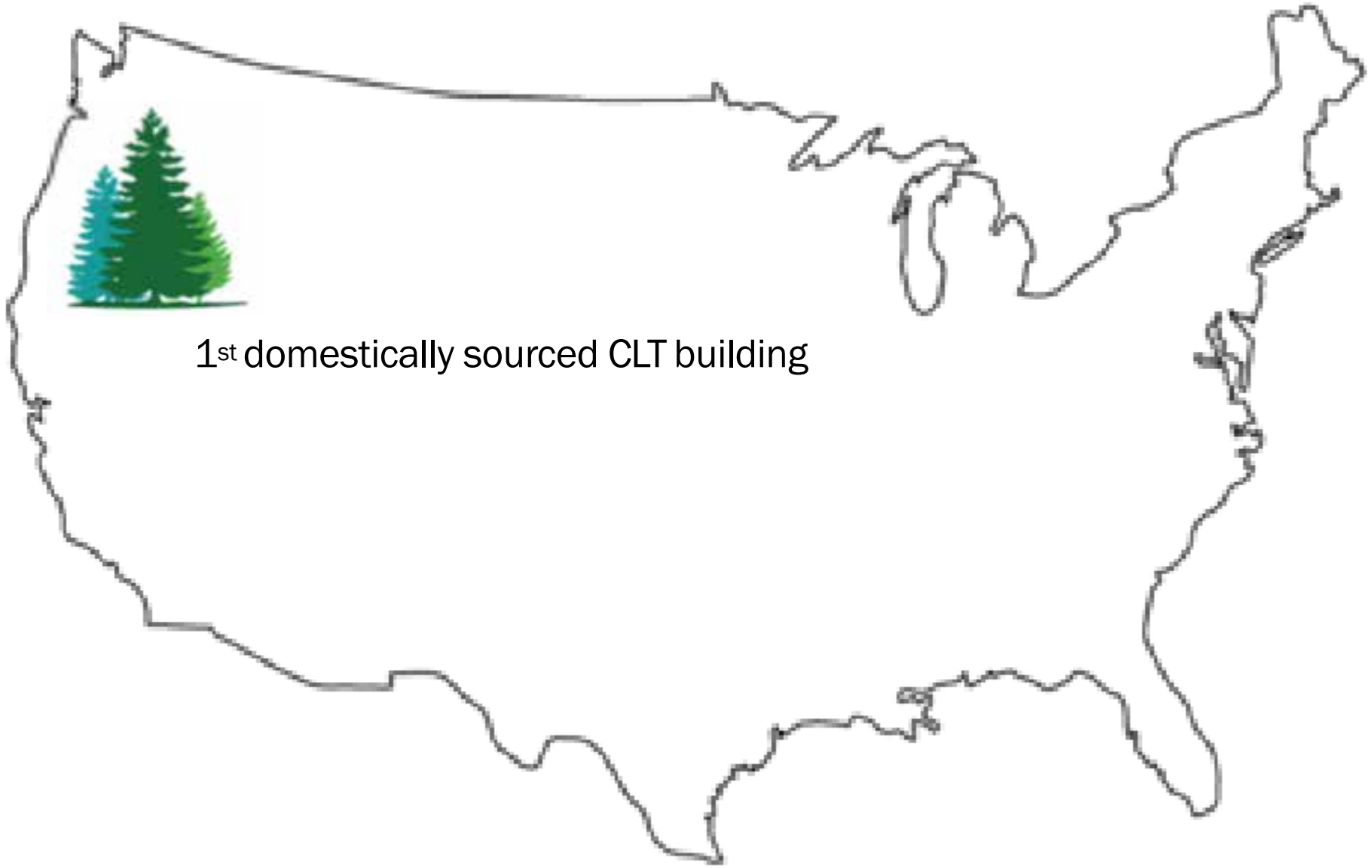
Timber Supplier: DR Johnson

CNC Routing: DR Johnson (CLT)
CutMyTimber (Glulam)

Project Support: WoodWorks

Photo: Lever Architecture

Albina Yard – First in the U.S.



1st domestically sourced CLT building

Albina Yard – First in the U.S.

1st CLT structural diaphragm

Albina Yard – Mass Timber

- CLT panels
  up to 10’ x 24’
- CLT cantilevers 4’
- Glue-laminated frame

Photo: Lever Architecture

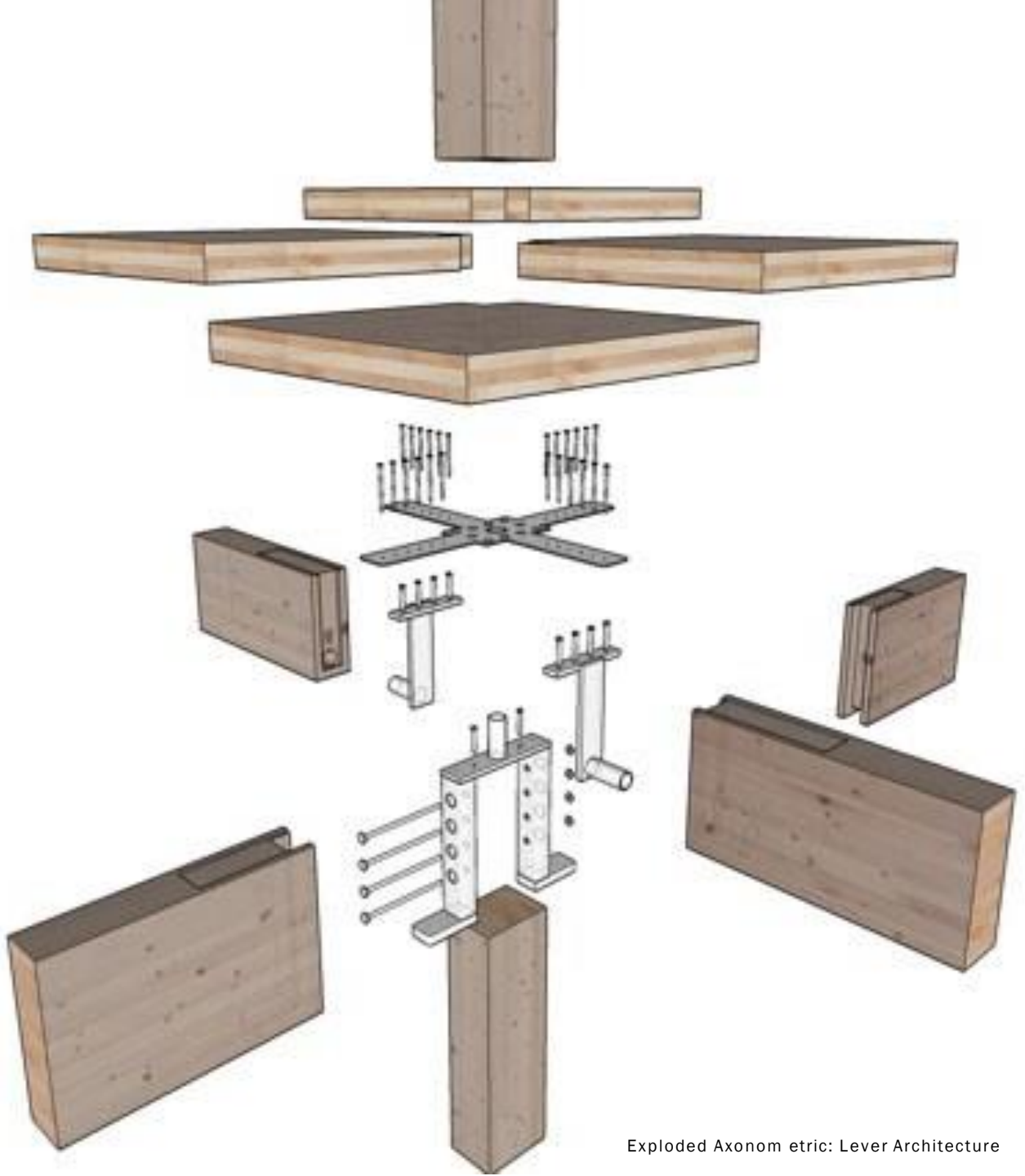
Albina Yard – CLT panels

- 3-ply CLT
- Fastened with long self-tapping screws

Photo: Lever Architecture

Albina Yard

- Concealed connections
- Tight tolerances



Exploded Axonom etric: Lever Architecture

Albina Yard – Digital Fabrication

- CNC routed
- Tight tolerances

Photo: WoodWorks

Albina Yard – Hundegger CNC

Albina Yard – Concealed Steel Connectors

Photo: Lever Architecture

Photo: Lever Architecture

Albina Yard – Hydraulic Press Bonding CLT layers

Albina Yard – DR Johnson's CLTtruck

Photo: Lever Architecture

Albina Yard – CLT erection

Albina Yard – 16,000 sf Office

Photo: Lever Architecture

Photo: Lever Architecture

Albina Yard – CLT Central Stair

Photo: Lever Architecture

Photo: Lever Architecture

Albina Yard – Illuminating the path for more CLT in the U.S.

Early involvement of GC & fabricators

Efficient panel layout

Coordinating all MEP penetrations before fabrication

Accurate BIM model

Tolerances between trades

GC to pre-plan everything

Extremely fast construction

Photo: Lever Architecture

Mass Timber – Future Applications

- Mid-rise commercial and multi-unit housing
- Modular construction
- Military buildings
- Buildings beyond 20 stories

Mass Timber – Blast Testing

Blast

After

Tall Wood - International

Credit: Rethink Wood

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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DR Johnson Wood Innovations

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