

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

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

Building Systems



Post & Beam



Light Frame



Mass Timber

CLT Possibilities— 2-way spanning roofs & floors



Photo: Tom Harris

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



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				✓	✓

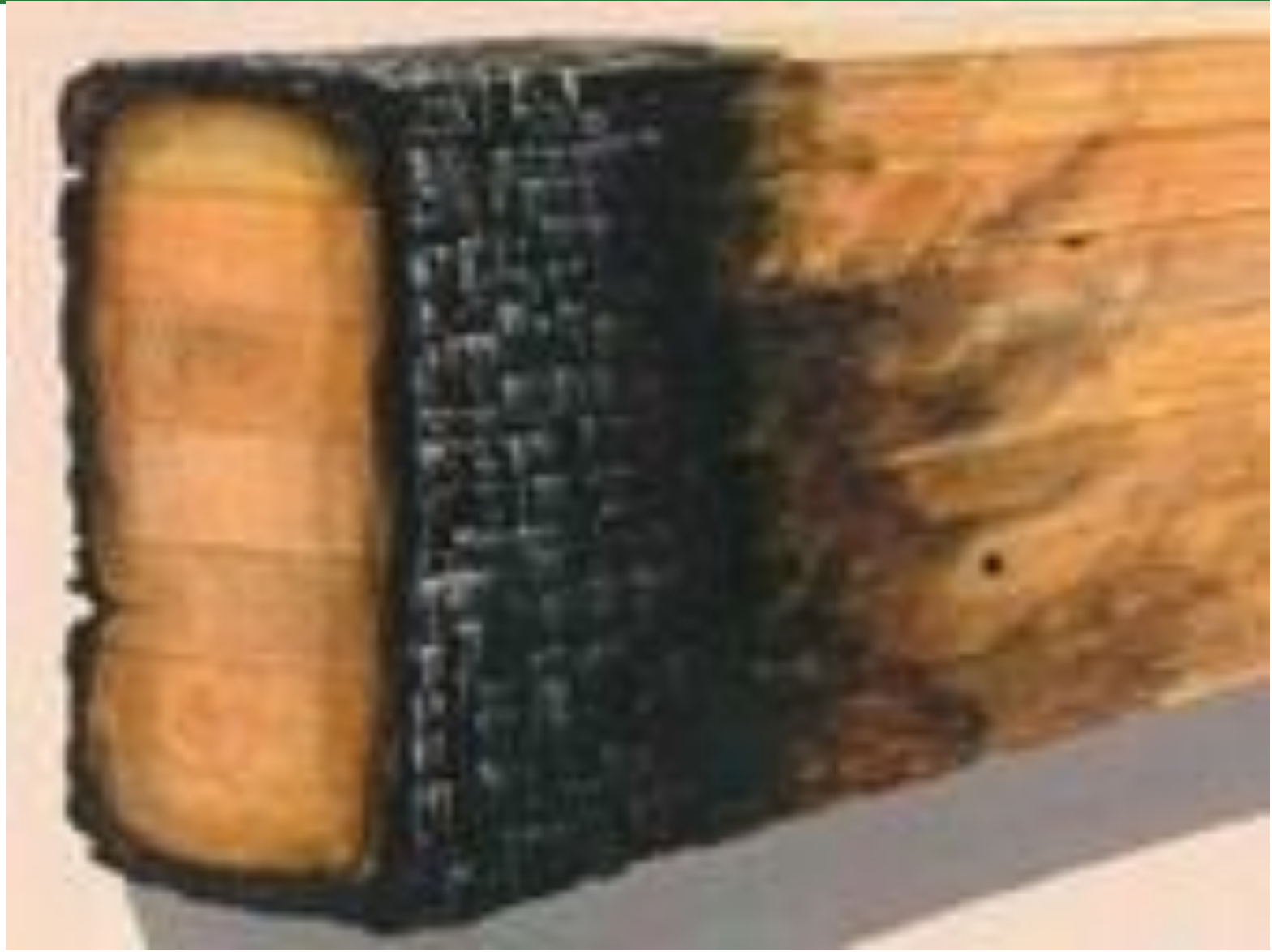
2021 IBC – Proposed Changes

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

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

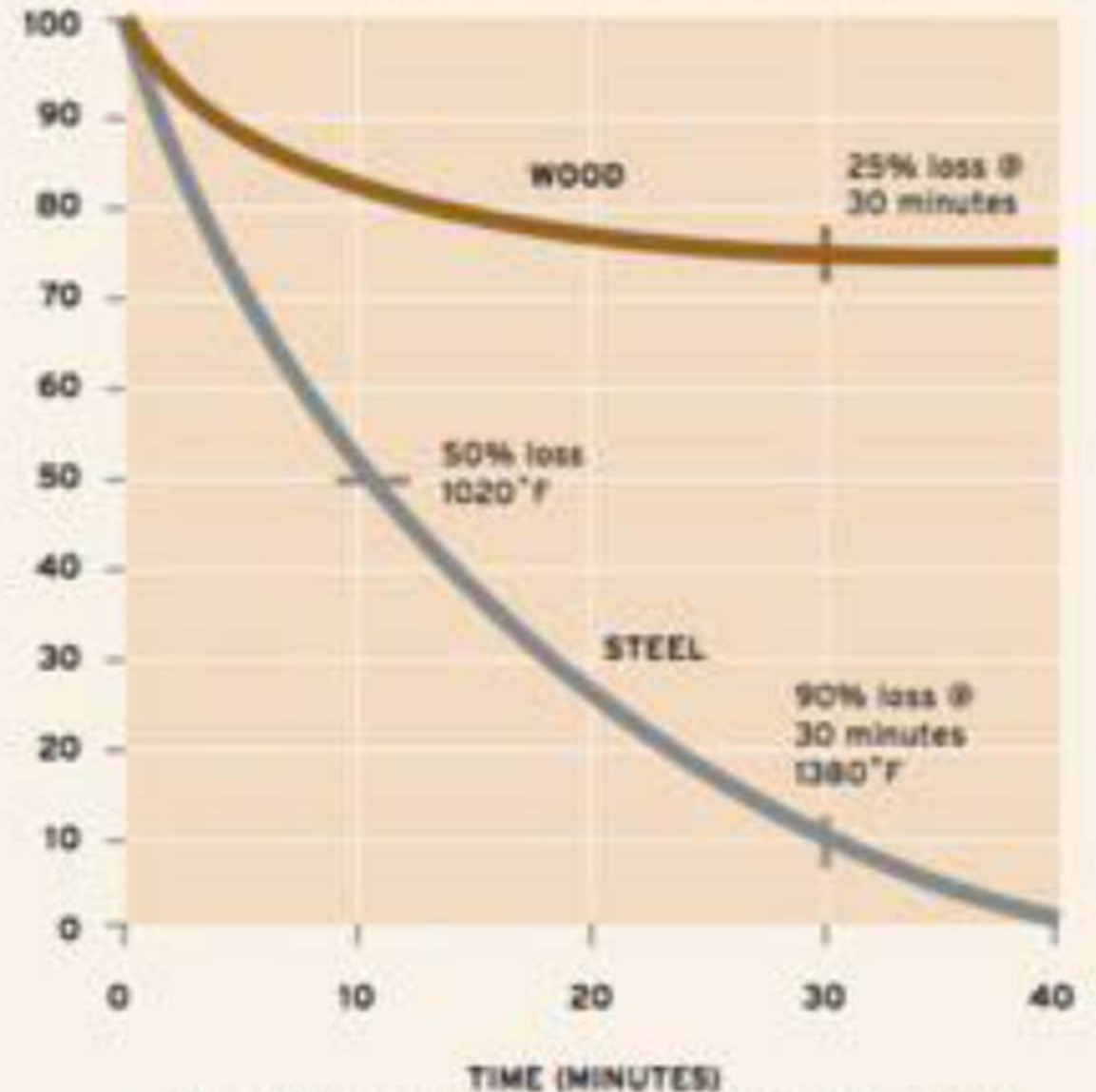


Fire – Wood vs Steel

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



COMPARATIVE STRENGTH LOSS OF WOOD VERSUS STEEL



Results from test sponsored by National Forest Products Association at the Southwest Research Institute

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



*Cross Laminated
Timber*



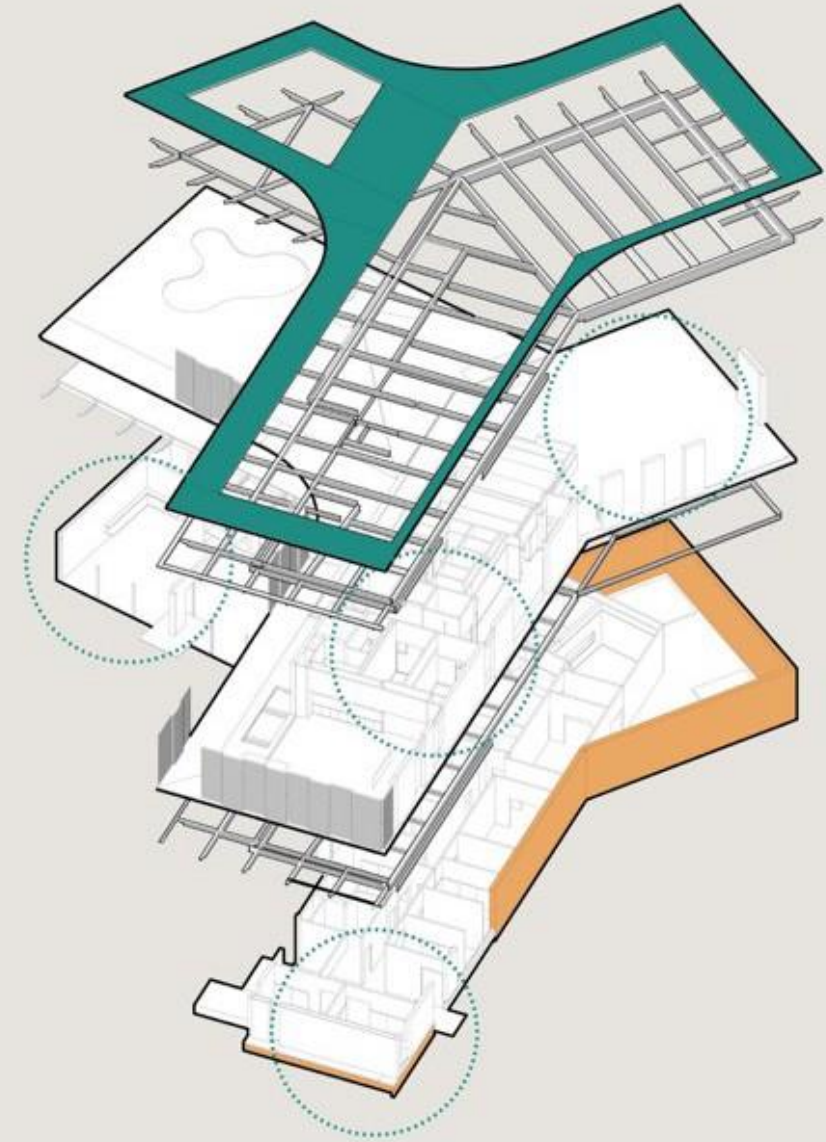
*Western Red
Cedar*



Earth Block



Steel



Sonoma Academy – Roof

- CLT & steel hybrid
- Exposed CLT soffit



Sonoma Academy – CLT install

- Laydown area
- Small crew

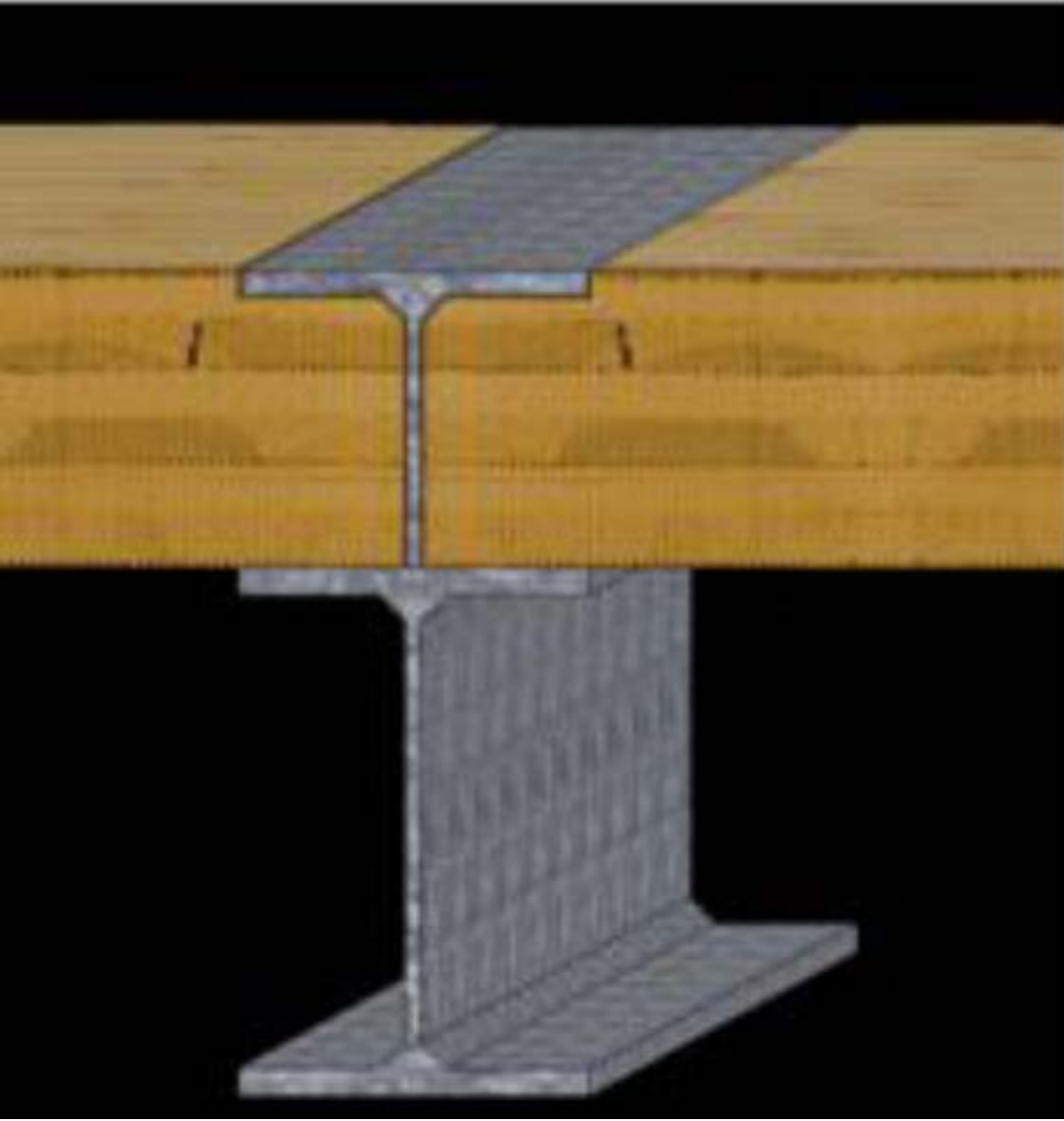


Sonoma Academy – CLTcurve

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



Sonoma Academy – CLT to steel detail



Sonoma Academy



Photo: Celso Rojas

Sonoma Academy



Photo: Jeremy 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.



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

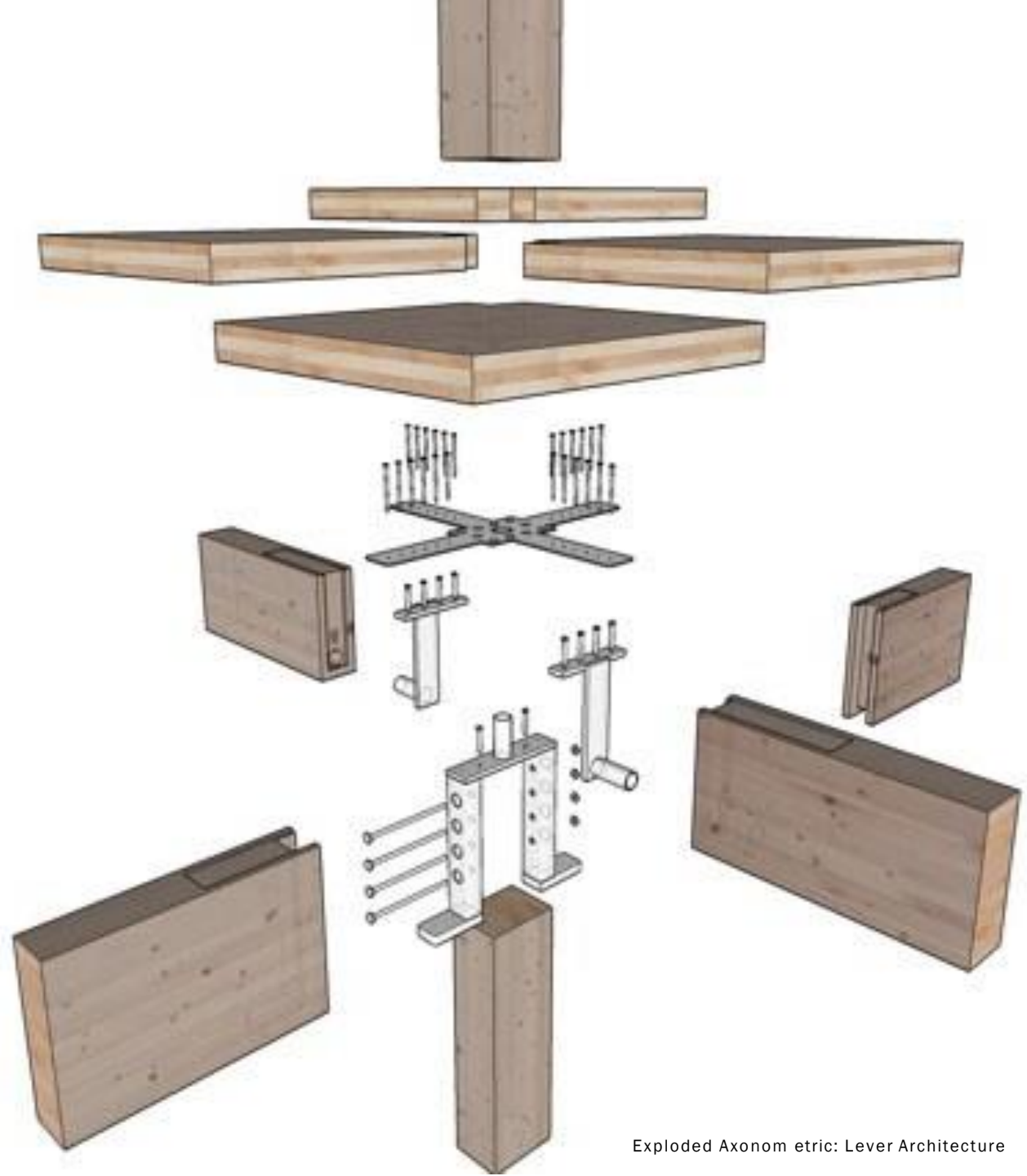
Albina Yard – CLT panels

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



Albina Yard

- Concealed connections
- Tight tolerances



Albina Yard – Digital Fabrication

- CNC routed
- Tight tolerances



Albina Yard – Hundegger CNC



Photo: Lever Architecture

Albina Yard – Concealed Steel Connectors



Photo: Lever Architecture



Photo: Lever Architecture

Albina Yard – Hydraulic Press Bonding CLT layers



Photo: Lever Architecture

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



Murray Grove

London, United Kingdom
8 Stories
2009



Forté

Melbourne, Australia
10 Stories
2012



TREET

Bergen, Norway
14 Stories
2015



Brock Commons

Vancouver, Canada
18 Stories
2017



HoHo

Vienna, Austria
24 Stories
2017

QUESTIONS?

This concludes The American Institute
of Architects Continuing Education
Systems Course

Quinn Guerrero

DR Johnson Wood Innovations

QuinnG@DRJLumber.com

