MAX-CORE CLT

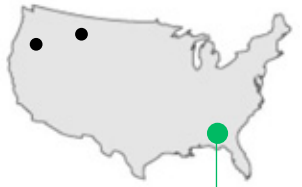
INTERNATIONAL BEAMS

Cross Laminated Timber (CLT) Manufacturing in the Southeast U.S.

Steve Lieberman, PE

INTERNATIONAL BEAMS

2017



DOTHAN, AL

X-LAM USA

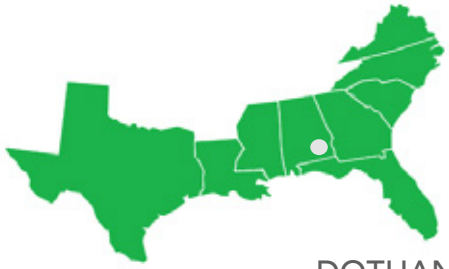
MAX-CORE

CLT
GLULAM

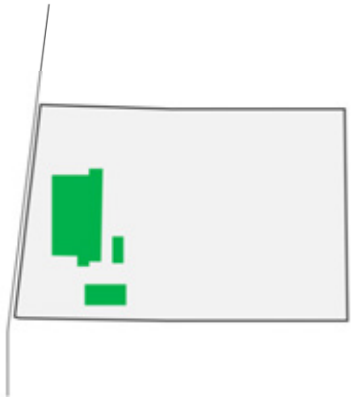
- In business for 22 years
- Two existing mills
- Manufacturer of solid flange wood I-joists

X-LAM USA

MASS TIMBER SOLUTIONS COMPLEX



DOTHAN, AL



Building Size: 227,400 sq/ft
Land Size: 84 acres

Economy

$13 Billion
Annual Industry

Lumber Supply

22.9 Million
Acres of Forest

Transport Access

Railroad
U.S. Highways
Port

Industry

650 Forest Product
Companies

Energy costs

Lower 25%
Nationally

Workforce

47,000 Employed
Skilled Labor Force

- Alabama is No. 7 nationally in lumber production and No. 8 in wood panel production
- Forestry is Alabama ’s second largest manufacturing industry, ranking No. 1 in the U.S. in pulp production and No. 3 in paper production.

MAX-CORE CLT

KLH PARTNERSHIP

KLH®

- Pioneers of CLT
- Global suppliers of CLT
- In business for 20 years
- Austria/UK/Portland

MAX-CORE CLT

SUPPORT

CLEMSON
WOOD UTILIZATION + DESIGN INSTITUTE

AMERICAN WOOD COUNCIL

AUBURN
UNIVERSITY

USDA

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Forest Products Laboratory

WoodWorks™
WOOD PRODUCTS COUNCIL

APA
THE ENGINEERED WOOD ASSOCIATION

WHAT IS CROSS LAMINATED TIMBER?

MAX-CORE CLT

HISTORY

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HISTORY

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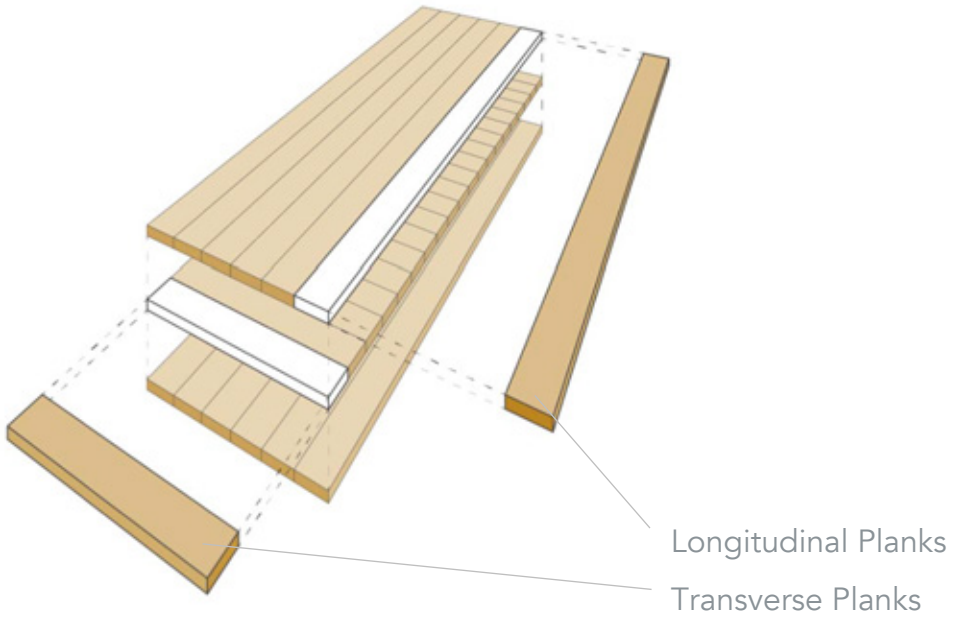
HISTORY

Pyramidenkogel tower, Austria

MAX-CORE CLT

CROSS LAMINATED TIMBER



X-LAM USA will be the first manufacturers of structural Southern Yellow Pine CLT.

SYP is one of the strongest species of lumber approved for CLT per the PRG-320.

RAW MATERIAL SPECIFICATIONS

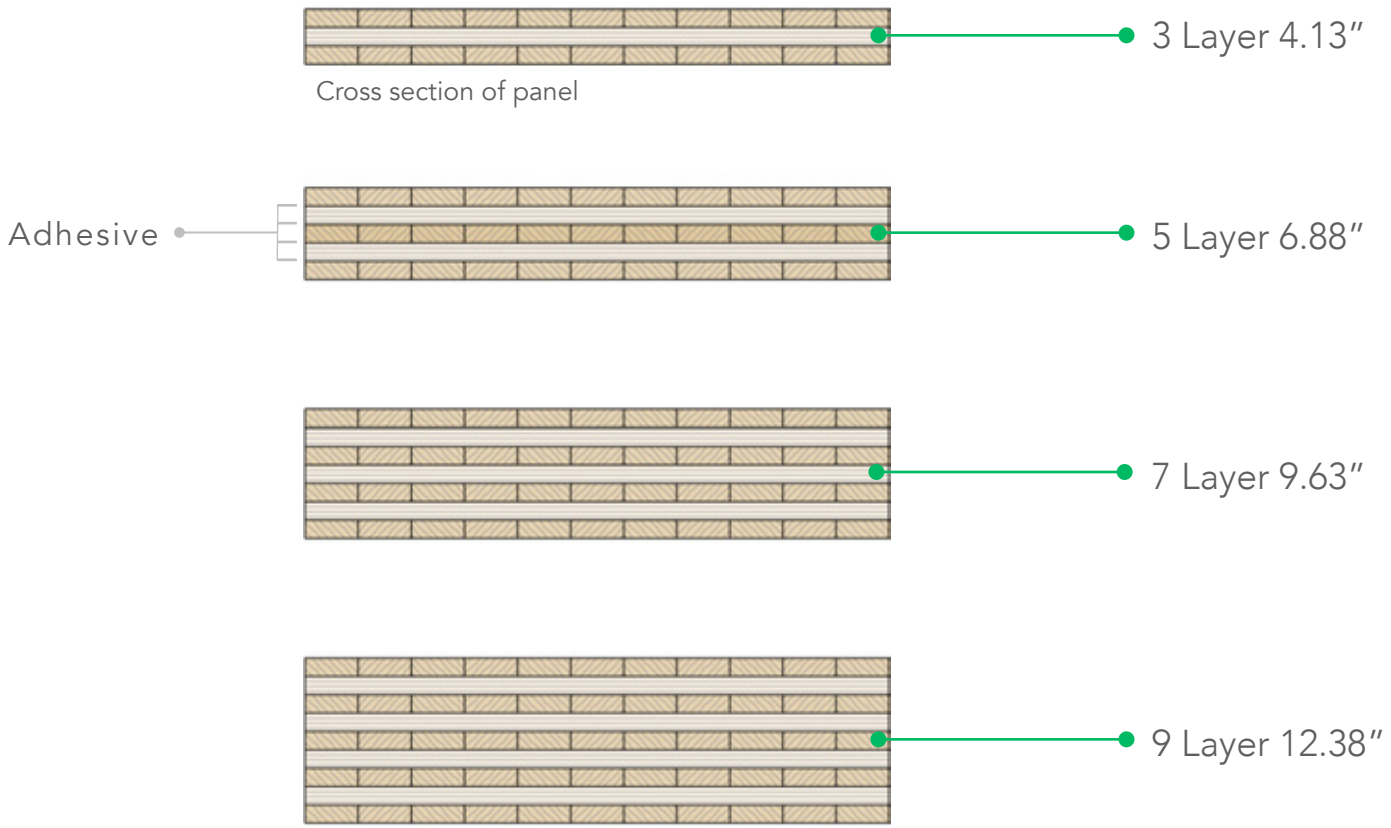
Wood species:	Southern Yellow Pine	
Wood moisture:	12	%
Width max/min	12/3.35	inch
Thickness max/min	3/0.8	Inch
Length max/min	16/8	feet

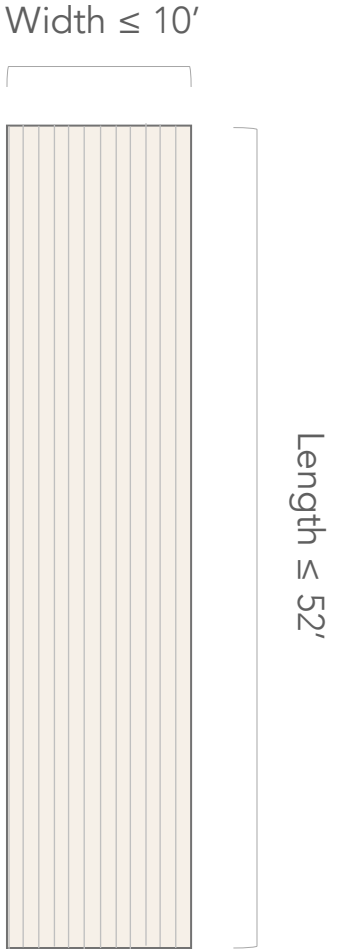
CLT SPECIFICATIONS

Max Width	10 feet
Max thickness	12 inches
Max Length	52 feet
Number of layers	3/5/7/9

MAX-CORE CLT

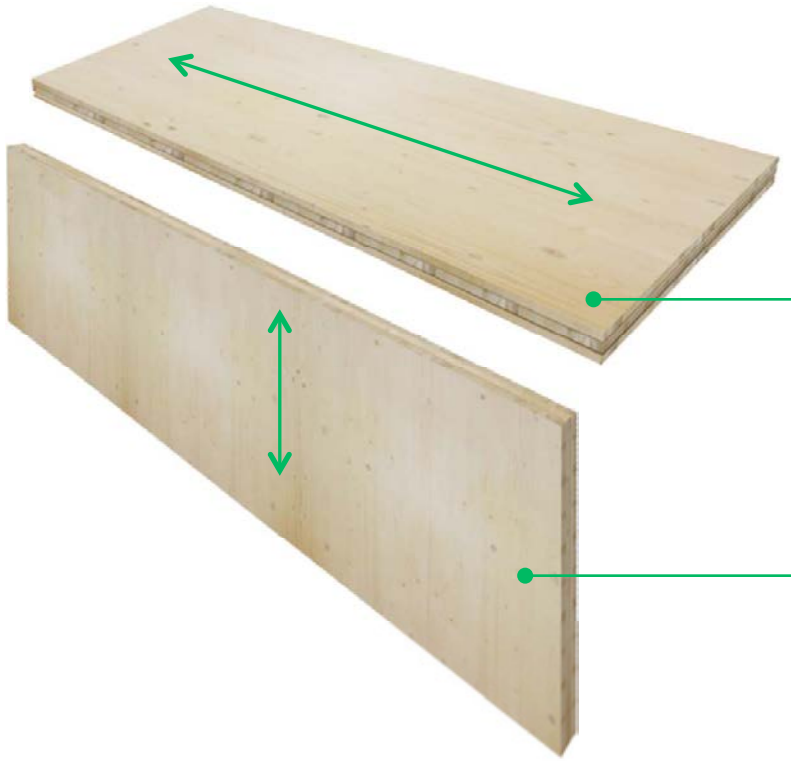
CROSS LAMINATED TIMBER





MAX-CORE CLT

CROSS LAMINATED TIMBER



CLT SPECIFICATIONS

Panel Types	TL / TT
Finishes	Domestic Visual (DVQ)
	Industrial Visual (IVQ)
	Non-Visual Quality (NVQ)

Panels for floors/ceilings: **TL** (**T**op layers **L**ongitudinal)

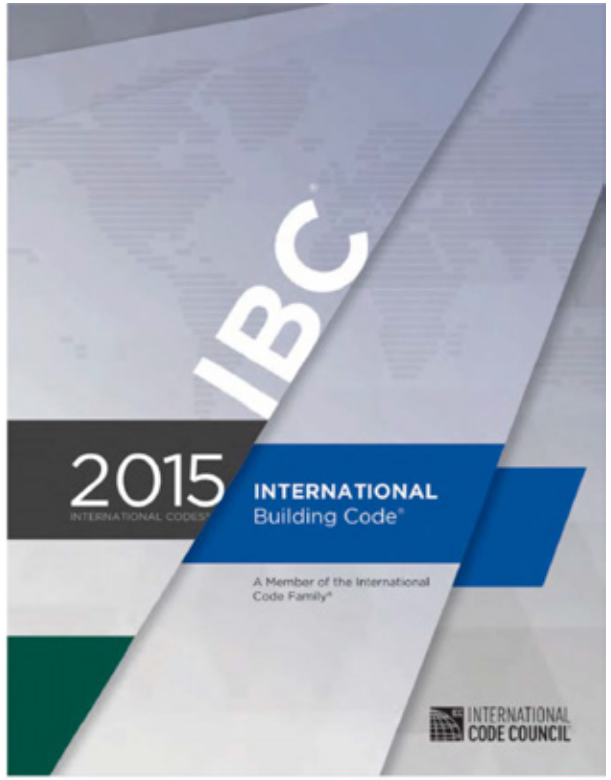
Panels for walls: **TT** (**T**op layers **T**ransverses)

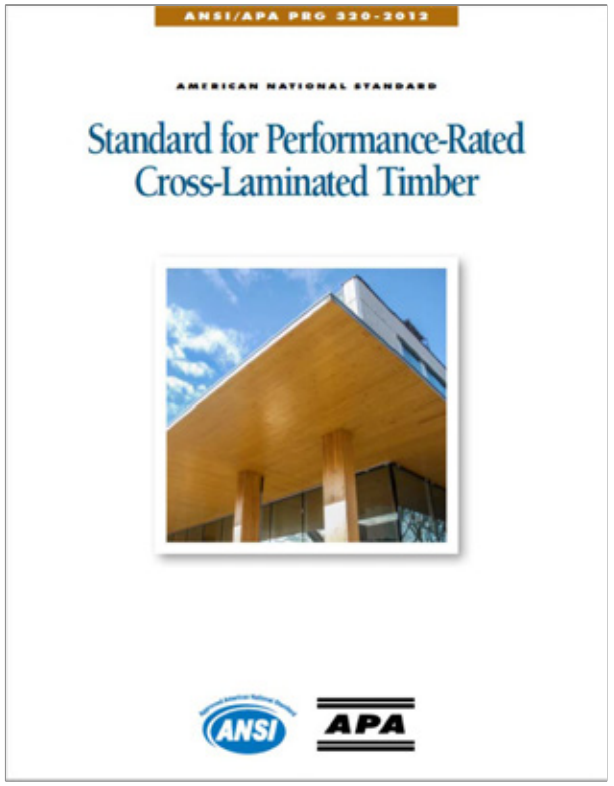
5 MYTHS ASSOCIATED WITH CLT

MAX-CORE CLT

FIVE MYTHS ABOUT CLT

MYTH 1: "CLT IS NOT IN THE BUILDING CODE"

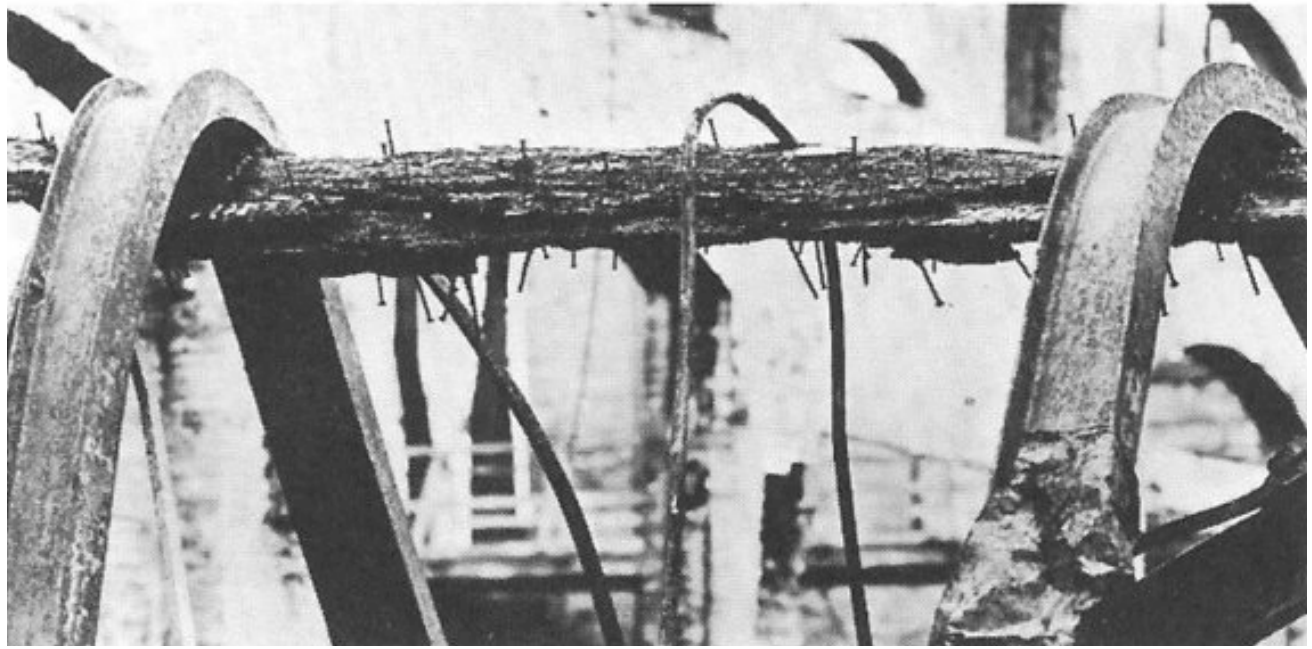




MAX-CORE CLT

FIVE MYTHS ABOUT CLT

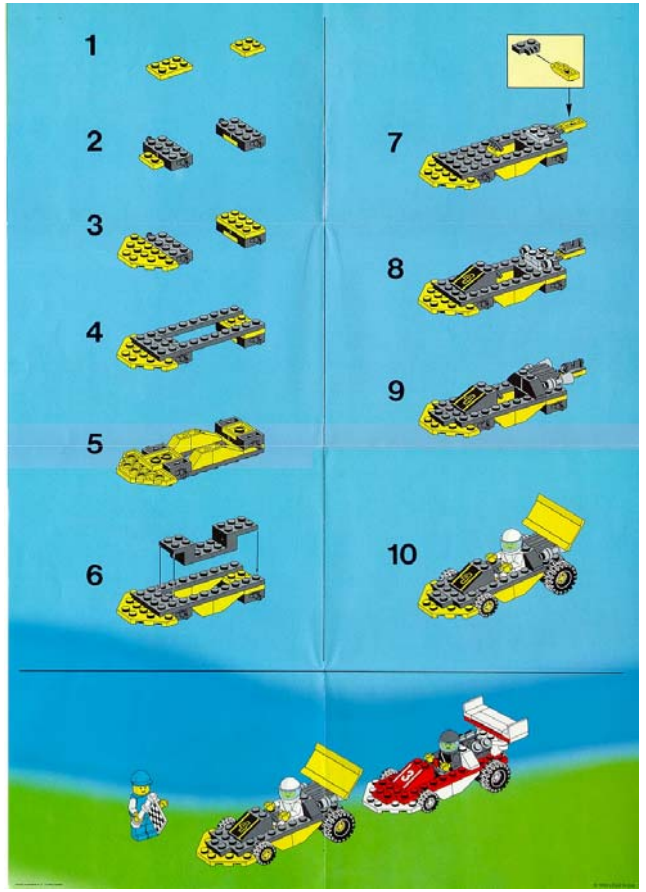
MYTH 2: "CLT IS MADE OF WOOD AND, THERFORE, EASILY CATCHES ON FIRE"

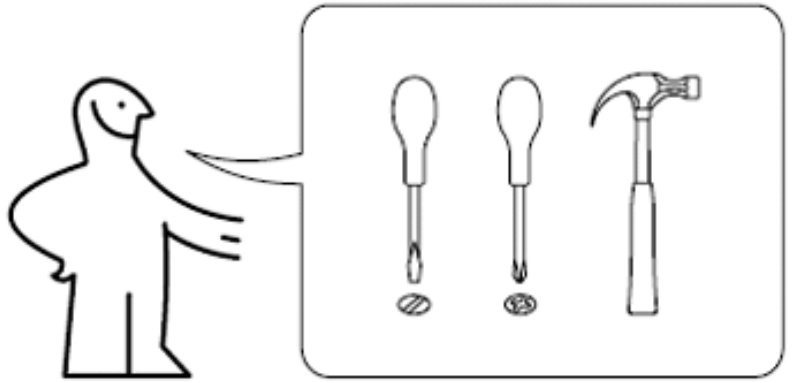


MAX-CORE CLT

FIVE MYTHS ABOUT CLT

MYTH 3: "YOU HAVE TO BRING IN A SPECIALIZED CREW TO INSTALL CLT"

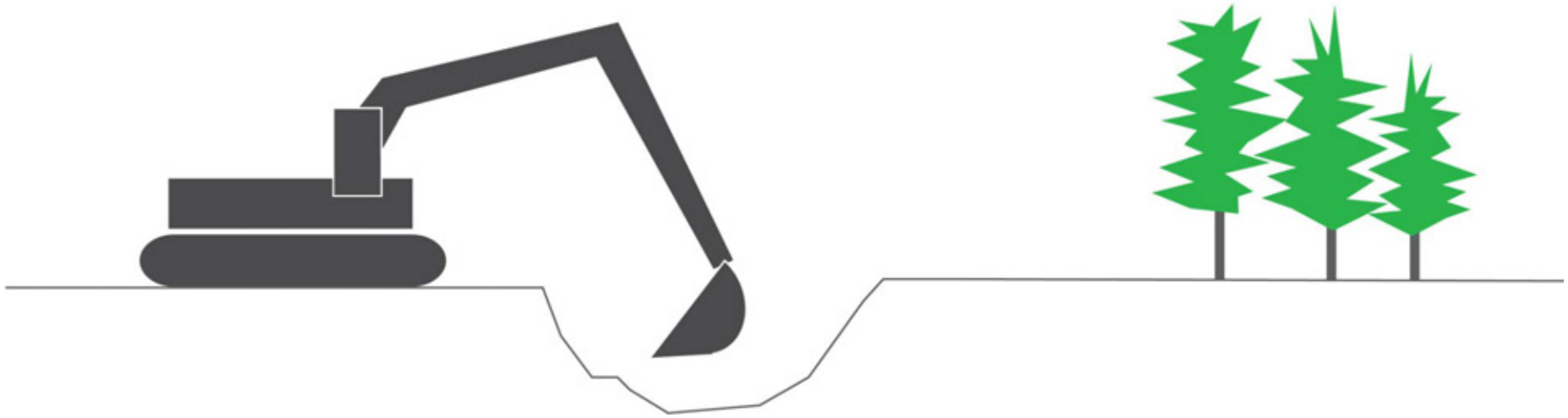




MAX-CORE CLT

FIVE MYTHS ABOUT CLT

MYTH 4: “CLT IS BAD FOR THE ENVIRONMENT SINCE TREES MUST BE CUT DOWN”



MAX-CORE CLT

FIVE MYTHS ABOUT CLT

MYTH 5: "CLT IS EXPENSIVE"

CLT PROCESS

MAX-CORE CLT
DESIGN PROCESS

Think CLT at the conception phase

- Requires substantial front end planning and collaboration between architects, engineers and developers to consider the following:
    - CNC precision
    - Mechanical, Electrical and Plumbing
    - Envelope
    - Connections
    - Transportation
    - Assembly
- Preplanning will save time and money during construction

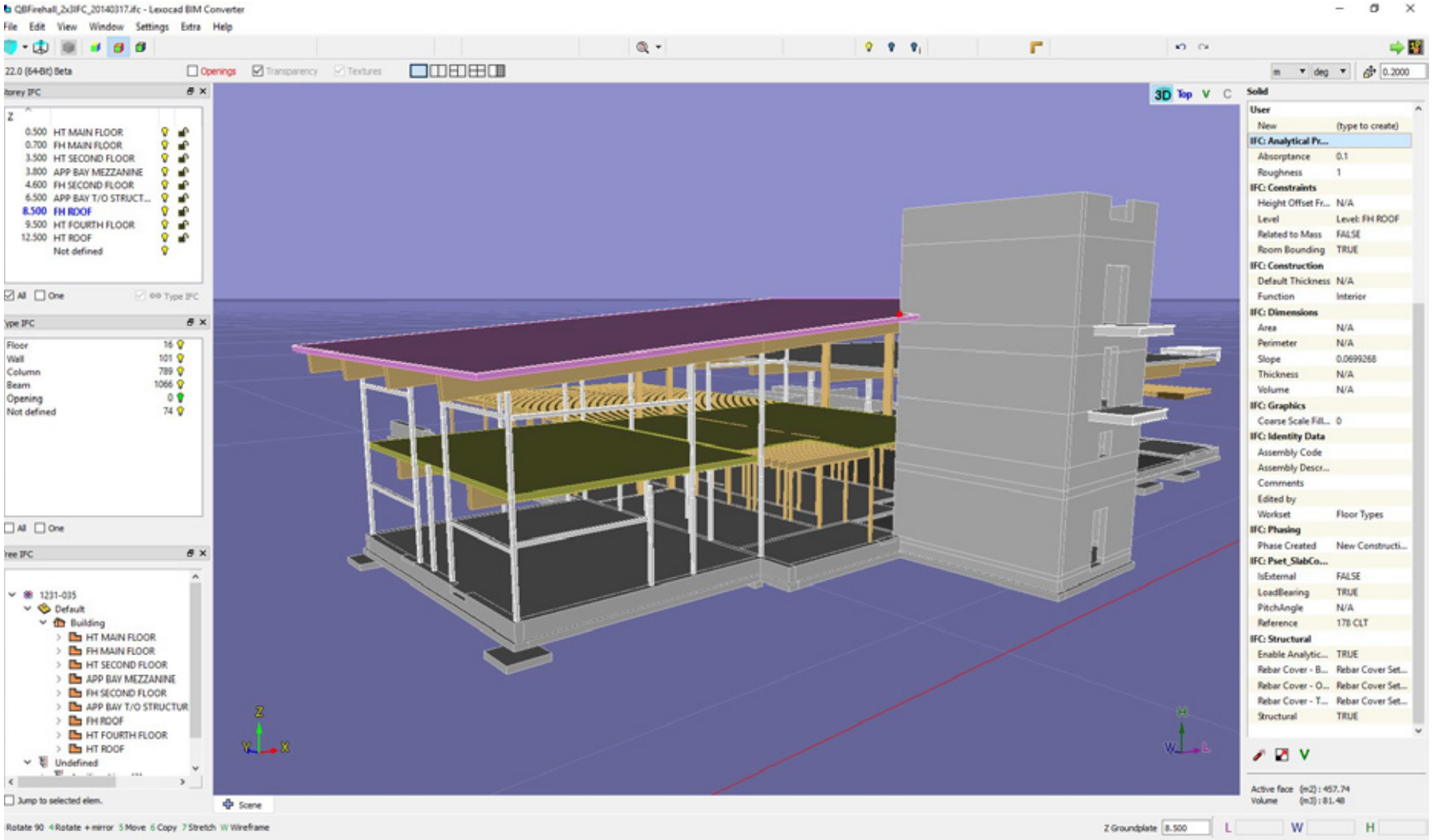
AUTODESK® REVIT®

cadwork®

MAX-CORE CLT

DESIGN PROCESS Import

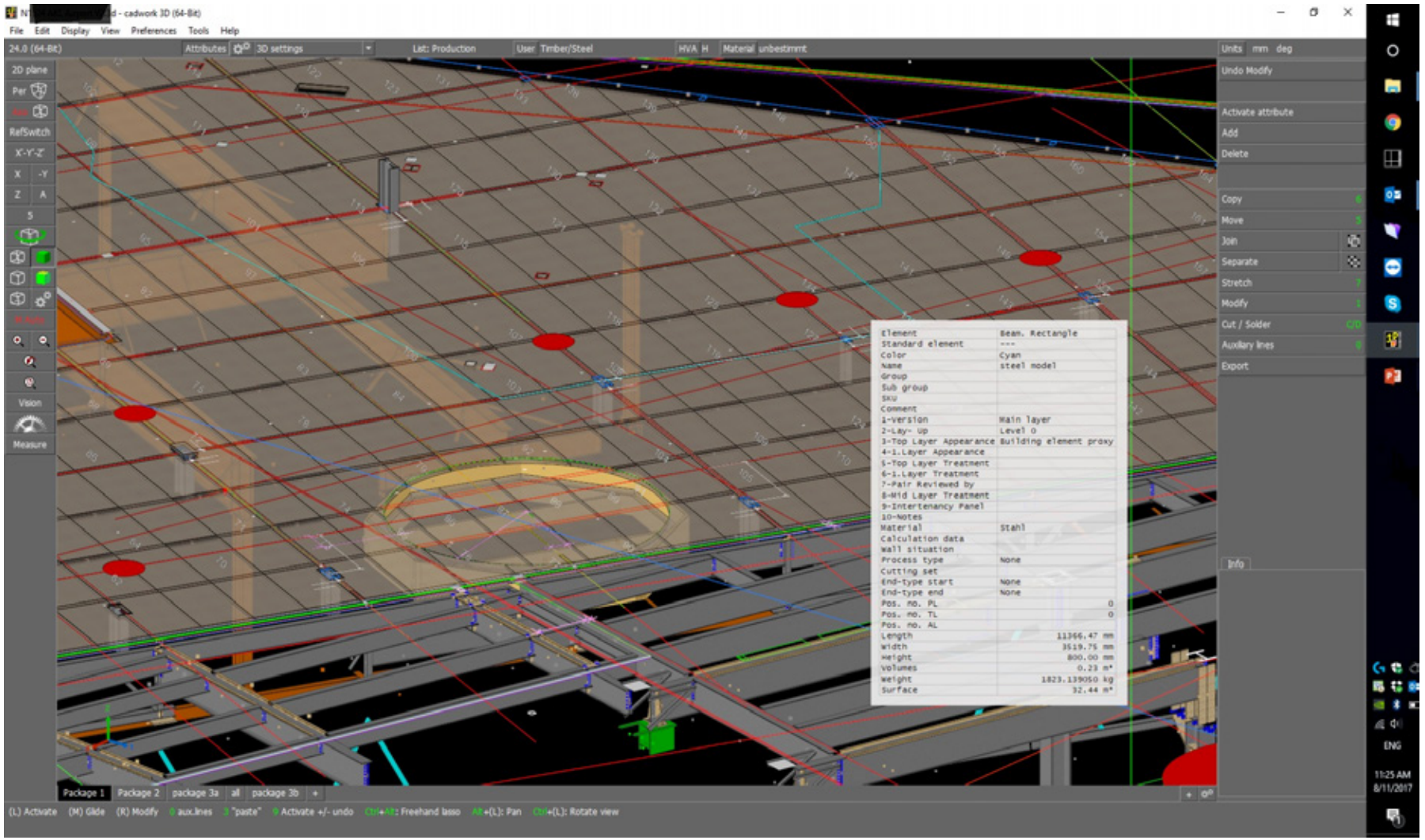
cadwork®



MAX-CORE CLT

DESIGN PROCESS Draw

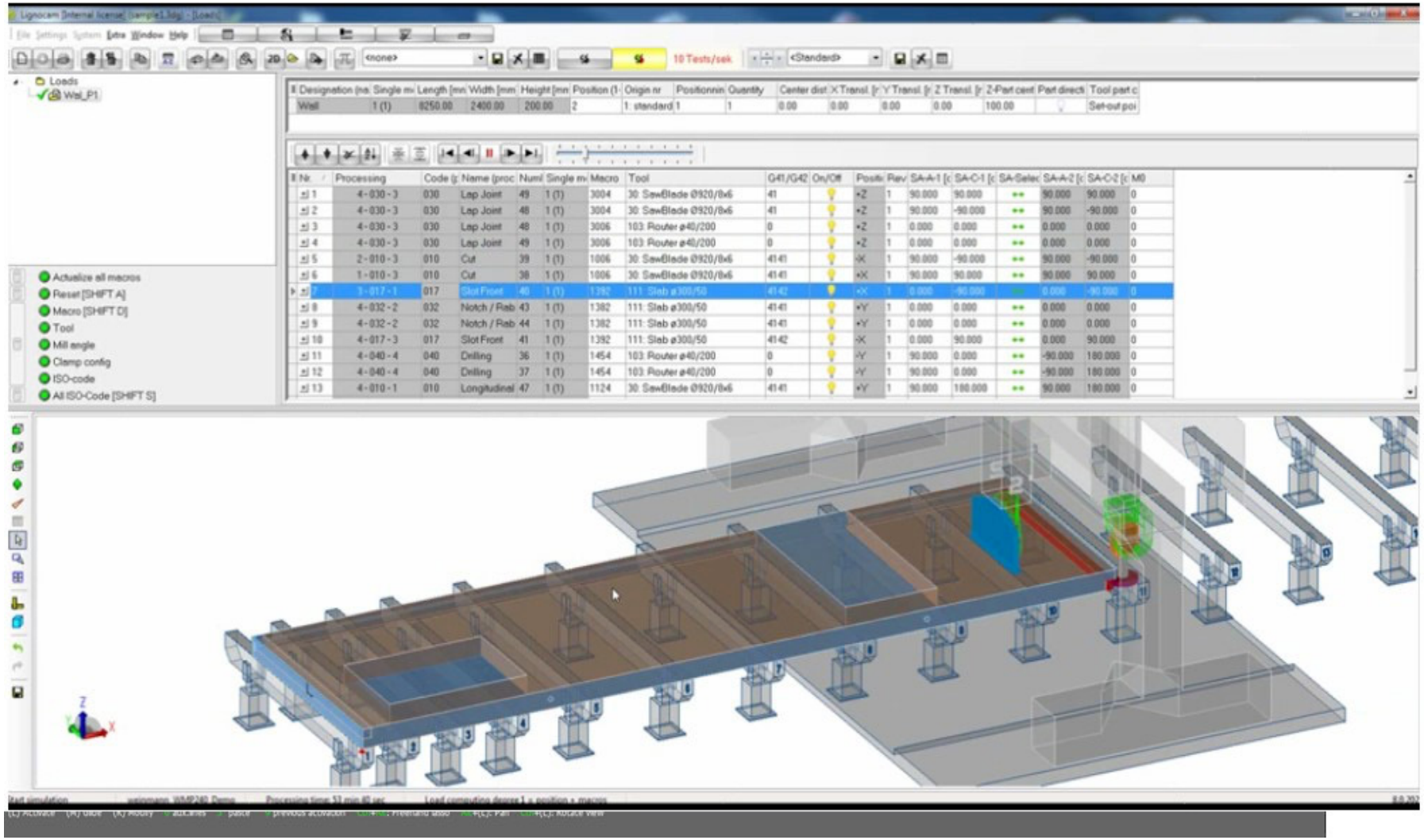
cadwork®



MAX-CORE CLT

DESIGN PROCESS Export to CNC

cadwork®



MAX-CORE CLT
MANUFACTURING

Digital Fabrication and CLT

CLT Manufacturing is automated through Computer Numerical Controlled (CNC) machines. This enables:

- Mass customization
- Accuracy/Precision
- Fully automated
- Extremely tight tolerances of walls, floors, openings for windows, doors and service channels.

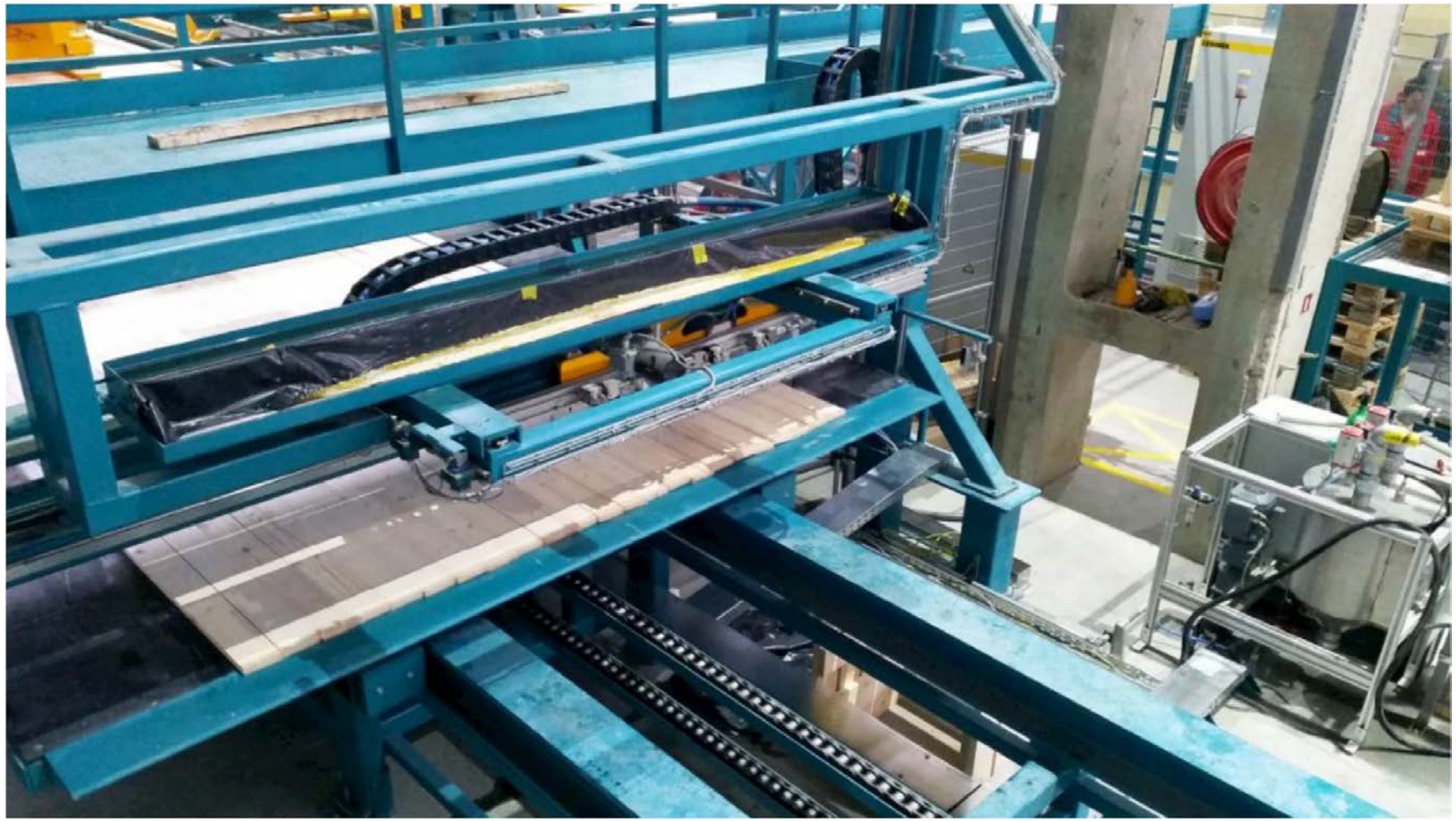
Photos courtesy of KLH

MAX-CORE CLT

MANUFACTURING Layup

MAX-CORE CLT

MANUFACTURING Gluing

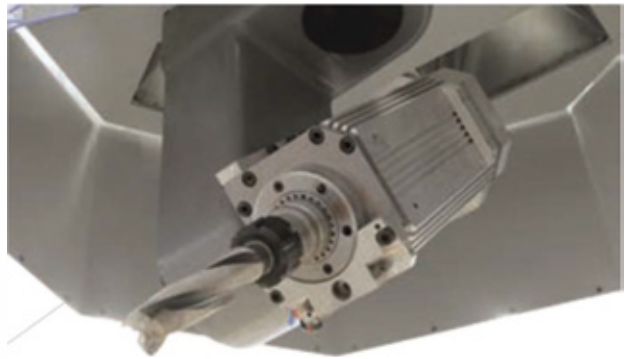


MAX-CORE CLT

MANUFACTURING Press

MAX-CORE CLT

MANUFACTURING CNC



MAX-CORE CLT

MANUFACTURING

Photos courtesy of KLH

MAX-CORE CLT

TRANSPORTATION/ASSEMBLY

"Rolling Process" through factory. Technical work is accomplished offsite by machine:

- Enables just-in-time (JIT) delivery to job site
- Panels are lifted by crane and set immediately
- Fast assembly is a main attribute of CLT
  - Assembly and sequencing arranged during preplanning
  - Outputs of 1,000 to 8,000 SF/day can be achieved with 2-8 man crew plus 1-2 crane operators

Photos courtesy of KLH

MAX-CORE CLT

TRANSPORTATION/ASSEMBLY

Platform construction is typical of CLT buildings.

- Safer for construction crew
  - CLT floor panel virtually impenetrable
  - Less scaffolding
  - Lower insurance
- Floors bellow can immediately be finished
- CLT cores rise swiftly
- Construction can proceed year-round and is not inhibited by weather.

UBC Brock Commons, Vancouver. Structurlam

MAX-CORE CLT

ASSEMBLY/SAFETY

Reduced waste, safe and clean site

- Less demanding of skilled construction trades like steel and concrete.
- Less waste due to prefabrication
- Cleaner site due to JIT delivery
- Less site disturbance
    - Quick, quiet, and requires less space
    - Ideal for urban and hard to reach sites

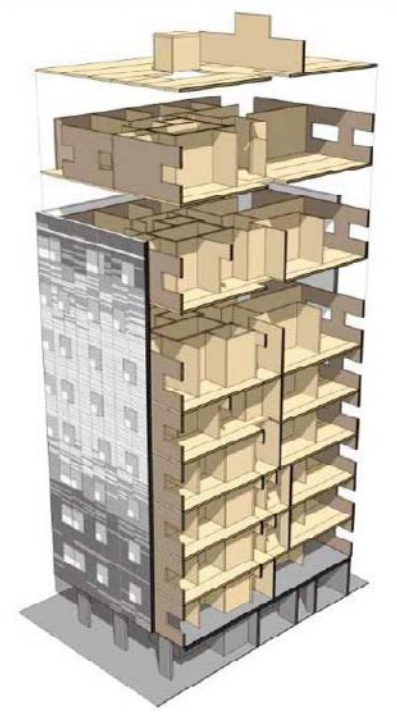
Forte Building, Australia. KLH

MAX-CORE CLT

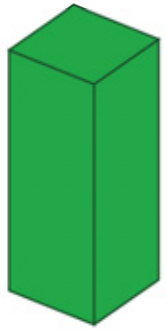
ENVIRONMENTAL ADVANTAGES

MAX-CORE CLT

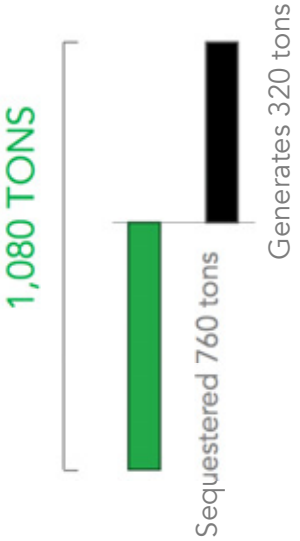
ENVIRONMENTAL ADVANTAGES

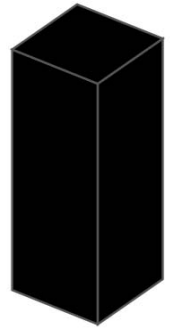


STADTHOUSE MURRAY GROVE
Architect: Waugh Thistleton
Location: London, UK



CLT/Mass Timber





Steel/Concrete

1,080 TONS CO^2 =  1,615 Cars driven for 1 year

OR  Enough energy to operate a home for 803 years

MAX-CORE CLT

FIRE RESISTANCE

CLT/Mass Timber is inherently fire resistant.

- Additional layering of timber can act as fire protection, establishing a char-layer that insulates the structural section.

Photo courtesy of FPInnovations

MAX-CORE CLT

FIRE RESISTANCE

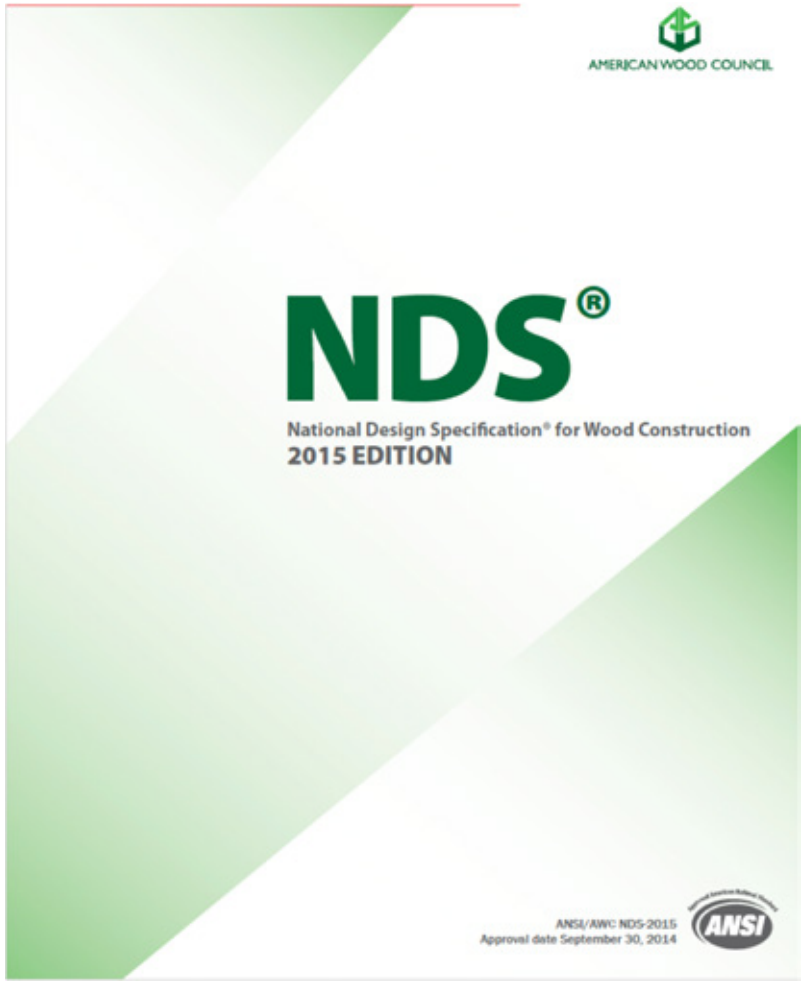
Fire resistance of Mass Timber is well researched and documented

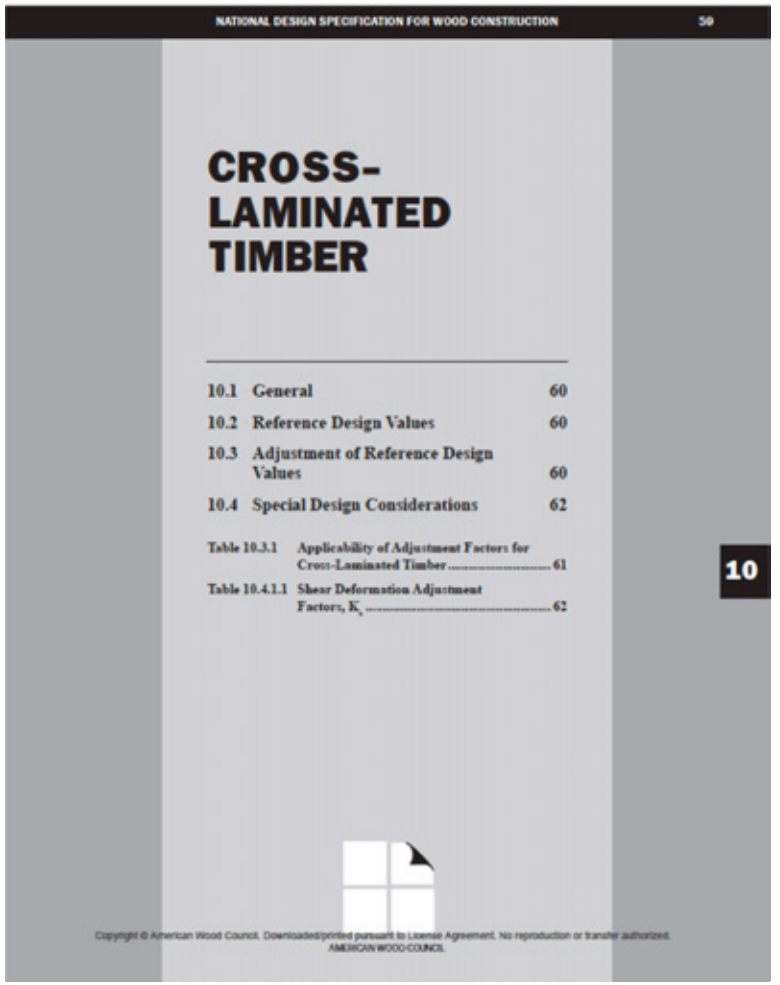
- Well known characteristics and methodology for determining fire resistance up to 2 hours.
  - US CLT Handbook
  - 2015 NDS
  - IBC 721
- U.S. Forest Products Laboratory has conducted recent fire tests with positive results

Photo courtesy of USDA

MAX-CORE CLT

FIRE RESISTANCE





MAX-CORE CLT

FIRE RESISTANCE

Table 16.2.1B Effective Char Depths (for CLT with β_n=1.5in./hr.)

Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

MAX-CORE CLT
CASE STUDY

CANDLEWOOD SUITES, Redstone Arsenal, Alabama

PAL PORTFOLIO	TYPICAL*	CLT	DIFFERENCE
Gross SF	54,891	62,688	+14%
Average # of Employees	18 (Peak 26)	10 (Peak 11)	-43%
Structural Duration (days)	123	78	-37%
Structural Man Hours	14,735	8,203	-44%
Structural Production Rate	460 SF/Day	803 SF/Day	+75%
Overall Schedule	15 months	12 months	-20%

Lendlease

Lendlease

Economic

- 37% Faster
- Cost Neutral to Metal Stud

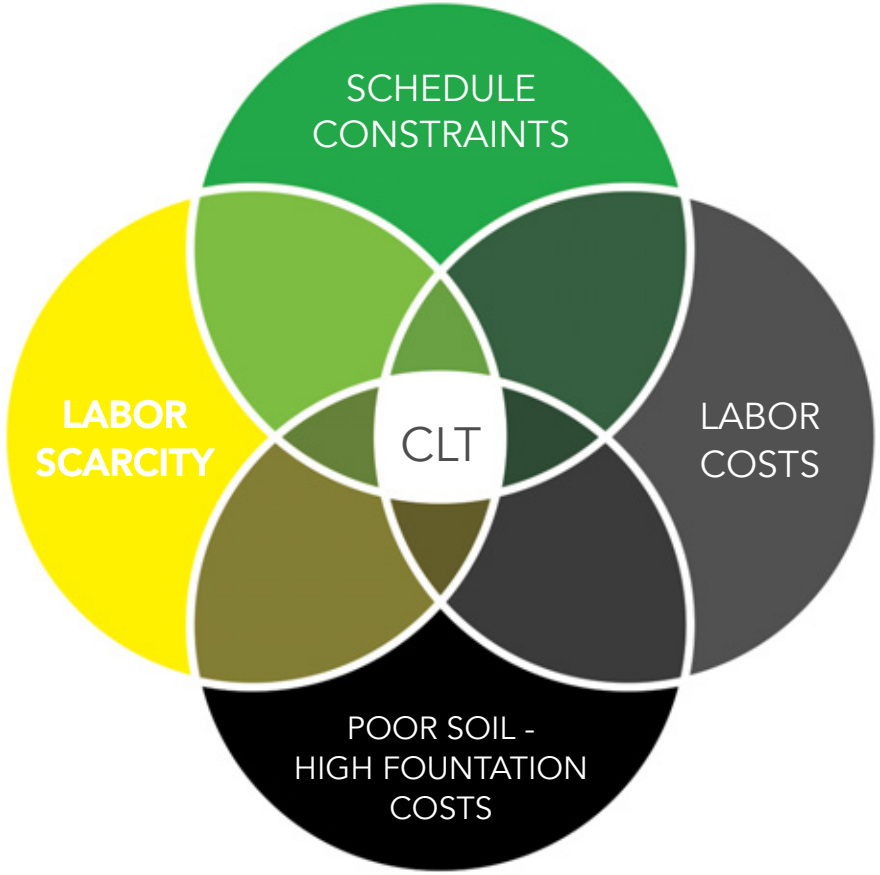
Environmental

- 31% more efficent
- 1,656 tons carbon sequestered

MAX-CORE CLT

INDUSTRY ADVANTAGE

Choosing cross-laminated timber becomes superior to conventional materials when a project experiences at least three of these constraints.



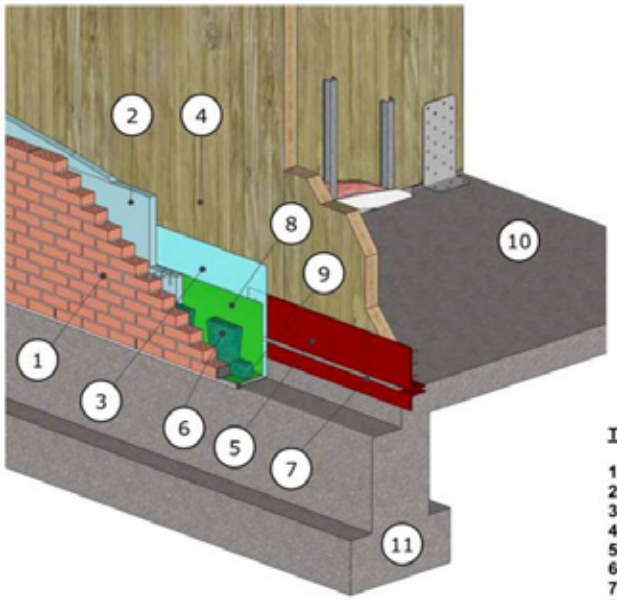
Pricing considerations:

- No shoring, no form work
- Smaller foundations
- Reduced waste management
- Finished surfaces
- Faster construction process
- Schedule (e.g. no curing, waiting time: 20%-30%)

CLT JOINTS & CONNECTORS

MAX-CORE CLT

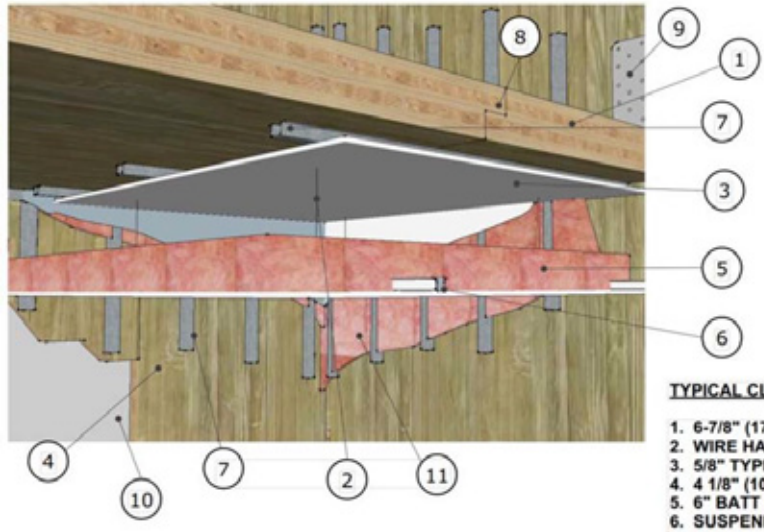
Assemblies



A01 Exterior CLT Wall
scale: 3/4" = 1'-0"

TYPICAL CLT EXTERIOR WALL ASSEMBLY

1. BRICK VENEER
2. 2" INSULATION BOARD
3. VAPOR BARRIER
4. 4 1/8" (105mm) CROSS LAMINATED TIMBER PANEL
5. STEEL SILL PLATE ASSEMBLY
6. MORTAR NET
7. NON-SHRINK DRY PACK GROUT
8. FLASHING
9. TERMITE SHIELD
10. FLOOR SLAB
11. FOUNDATION



A03 Interior CLT Floor / Ceiling
scale: 3/4" = 1'-0"

TYPICAL CLT INTERIOR FLOOR CEILING ASSEMBLY

1. 6-7/8" (175 mm) CLT FLOOR PANEL
2. WIRE HANGERS
3. 5/8" TYPE "X" GYPSUM BOARD
4. 4 1/8" (105mm) CLT WALL PANEL
5. 6" BATT INSULATION
6. SUSPENDED CEILING SYSTEM
7. 1-5/8" METAL FURRING
8. HALF LAP OR SPLINED PANEL JOINT
9. CONNECTION BRACKET
10. 5/8" TYPE "X" GYPSUM BOARD
11. ROCK WOOL INSULATION

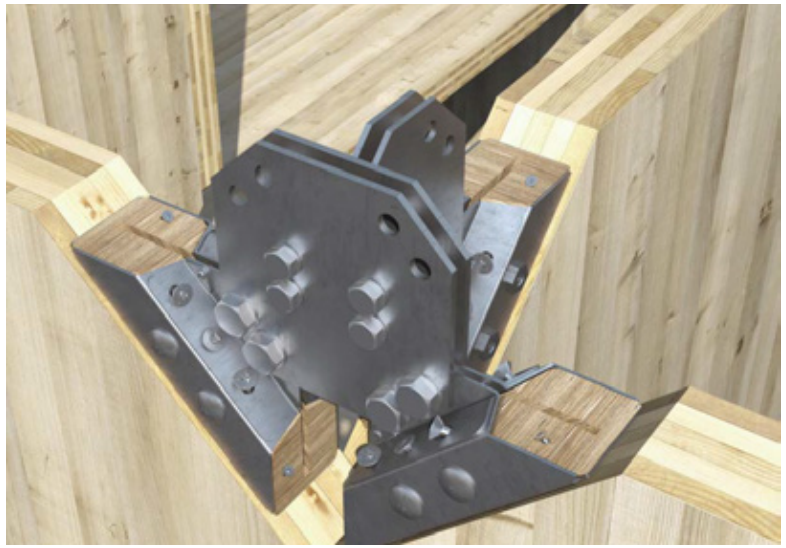
60 IIC DESIGN
72 IIC ACHIEVED VIA FIELD TESTING

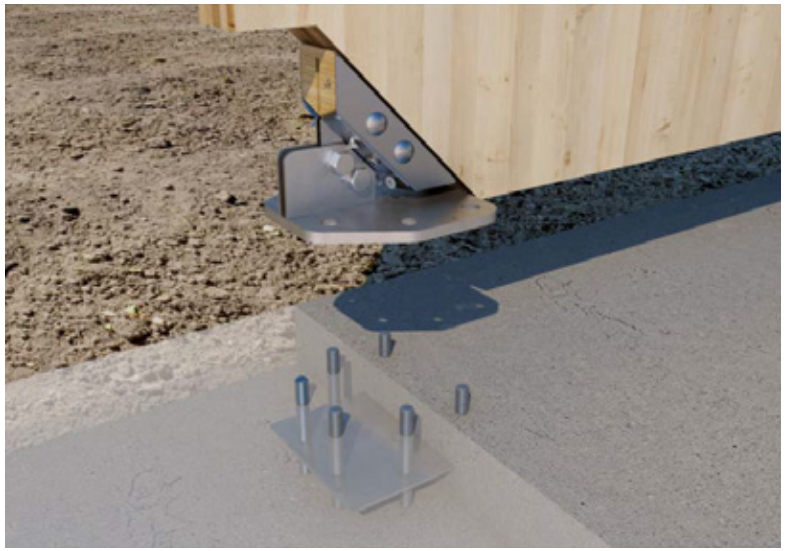
55 STC DESIGN
61 STC TESTED

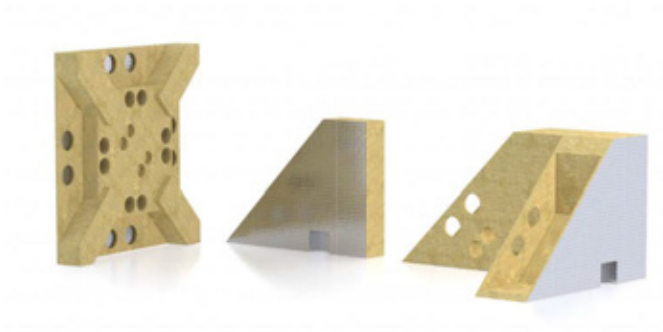
MAX-CORE CLT

CONNECTION Specialty

Rothoblaas X-RAD System





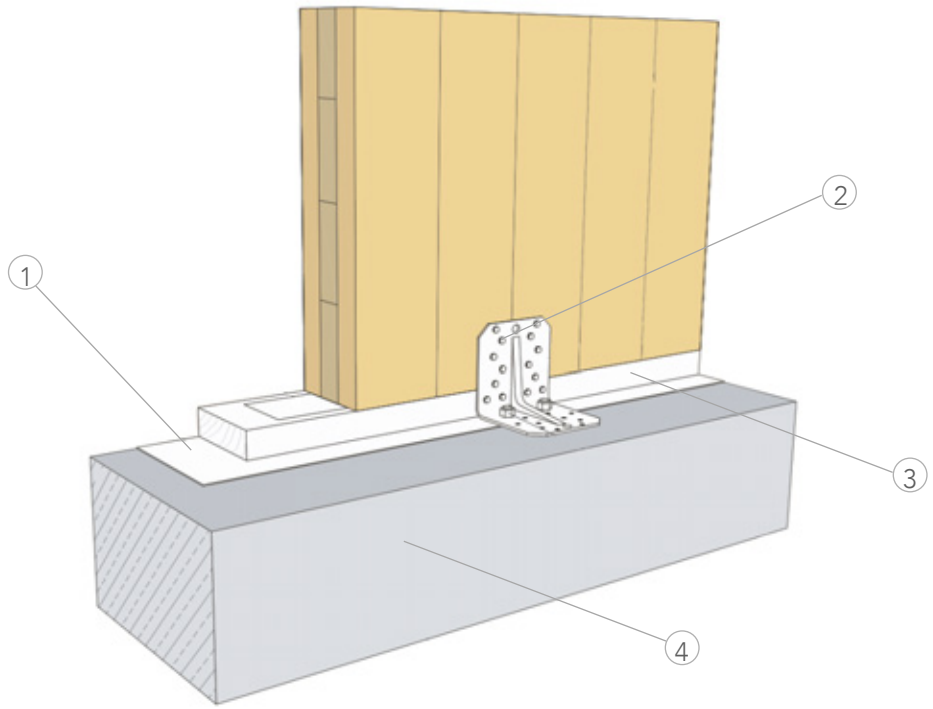


Images courtesy of Rothoblaas

MAX-CORE CLT

CONNECTION

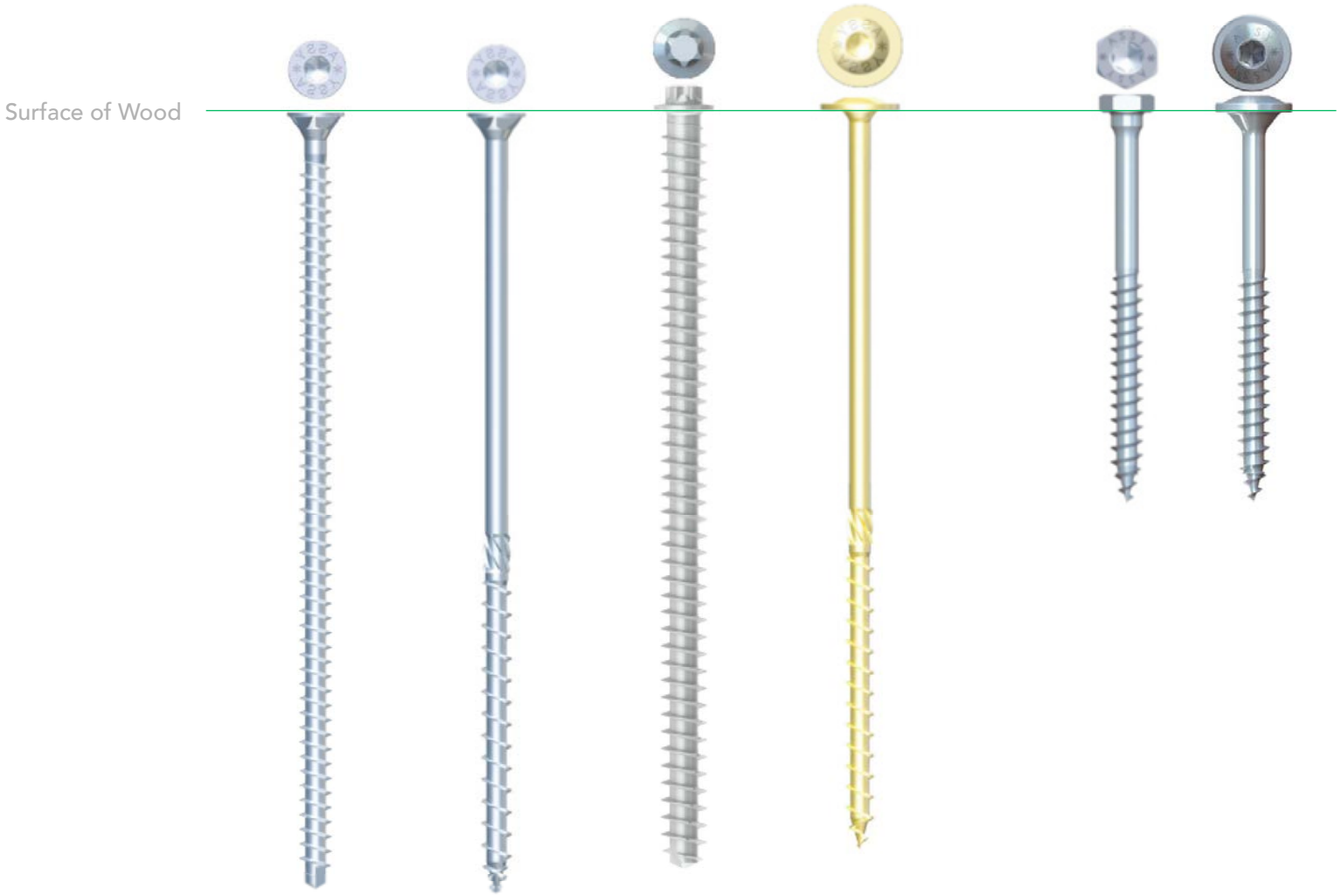
WALL-CONCRETE CONNECTION



1. Moisture barrier
2. Angle bracket for shear and tensile forces
3. Pressure treated sill plate
4. Concrete component (wall ceiling, concrete slab)

MAX-CORE CLT

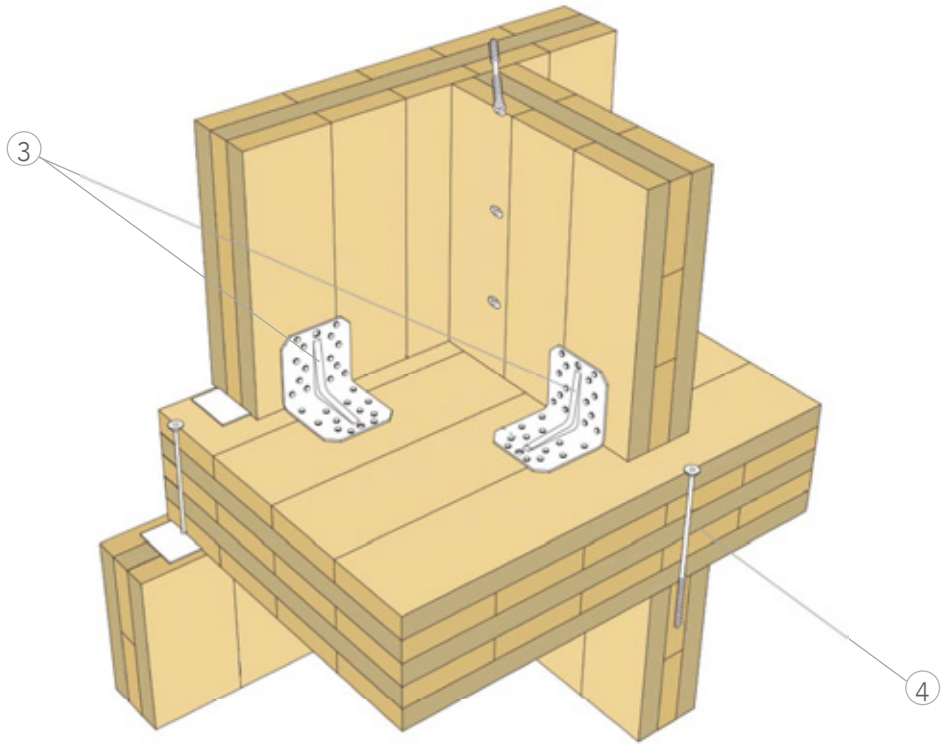
CONNECTION Screw Types



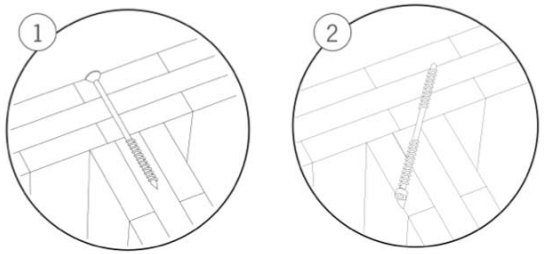
MAX-CORE CLT

CONNECTION

INTERIOR/EXTERIOR WALL, CEILING



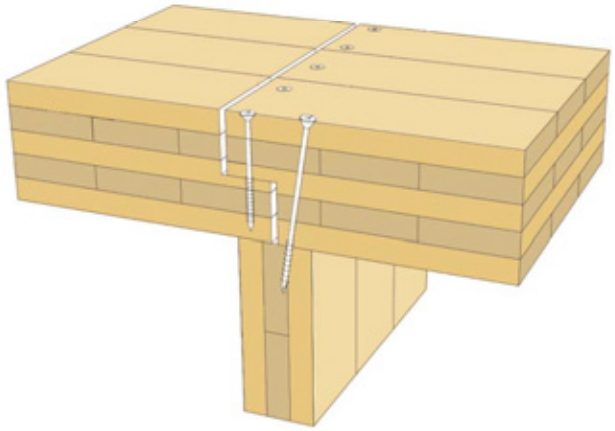
1. Screw connection from the outside
2. Screw connection from the inside
3. Shear force transmission along the joint and tension anchorage
4. Screw connection of ceiling with walls



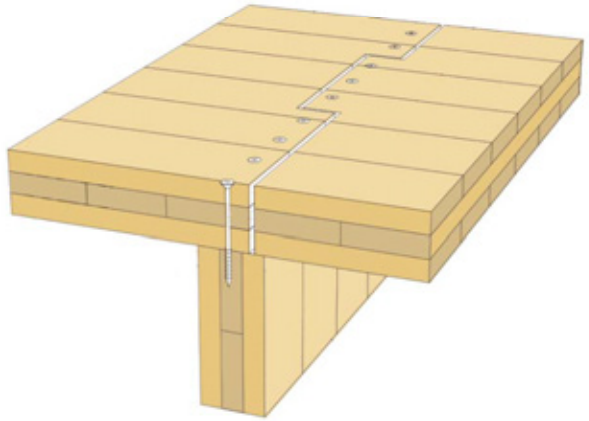
MAX-CORE CLT

CONNECTION Screws

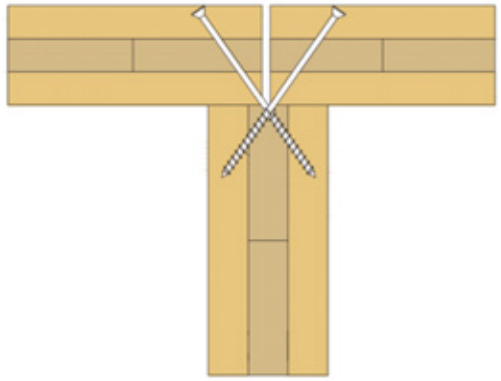
CEILING JOINT ON WALL



1. Half lap joint on a wall



2. Notched joint on a wall

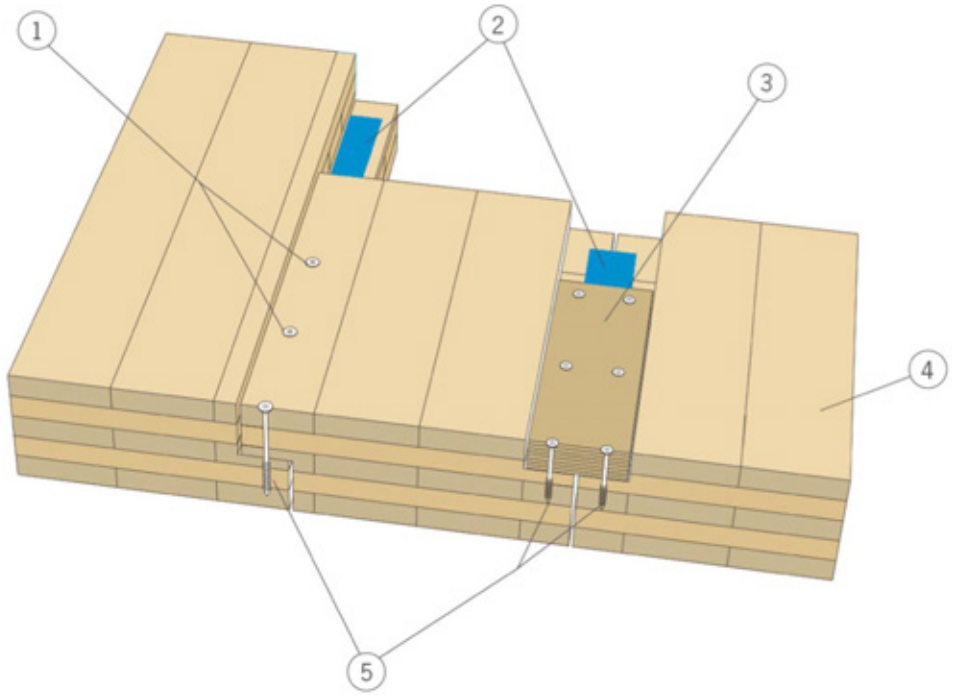


3. Butt joint on a wall

MAX-CORE CLT

CONNECTION Screws

CEILING JOINT

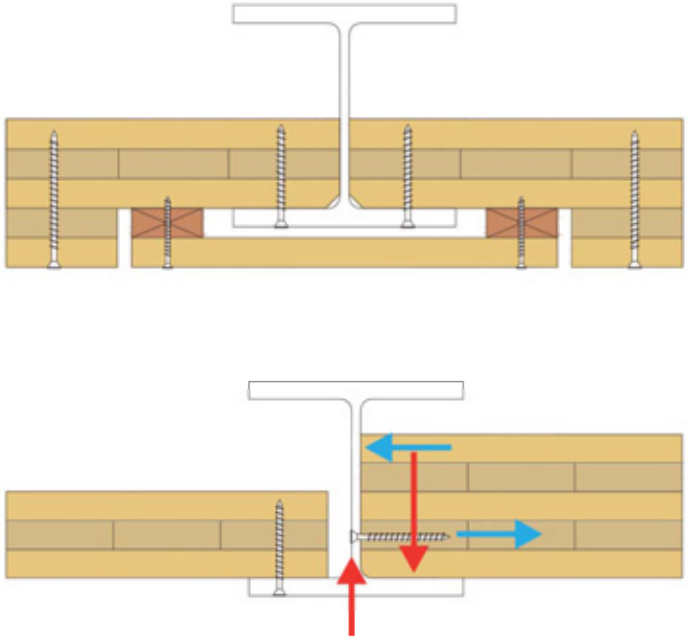


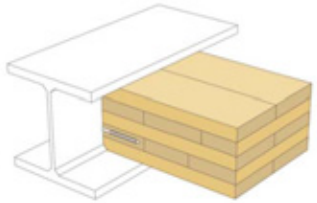
1. Connection for shear transmission in the direction of the joint
2. Joint tape, if air tightness is required for fire protection
3. Plywood spline plate
4. Ceiling Panel
5. Type, diameter and distance of screw according to static requirements

MAX-CORE CLT

CONNECTION Specialty

CEILING, ROOF TO WIDE FLANGE BEAM



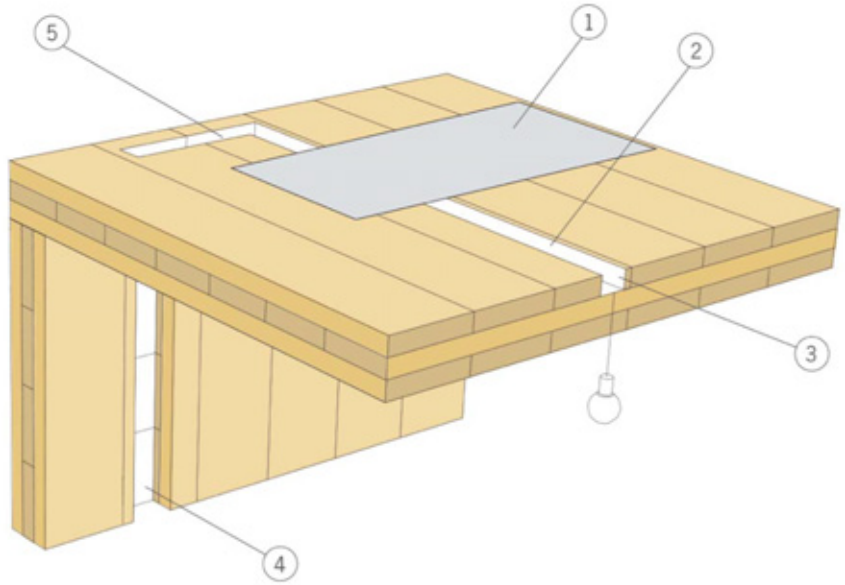


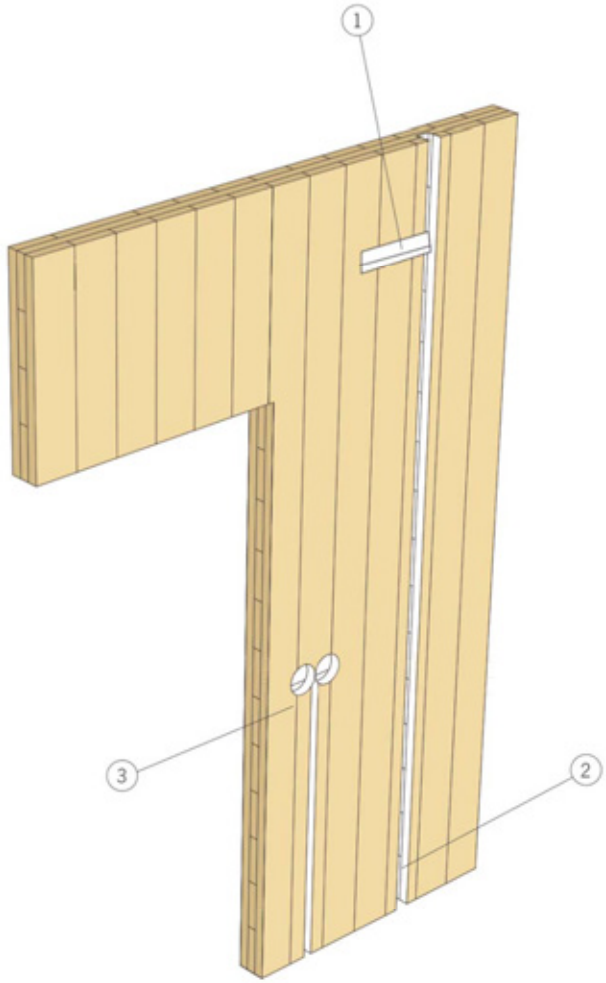
Notes

1. Panel placed on lower flange
2. Connections with fully threaded or partially threaded screws are possible

MAX-CORE CLT

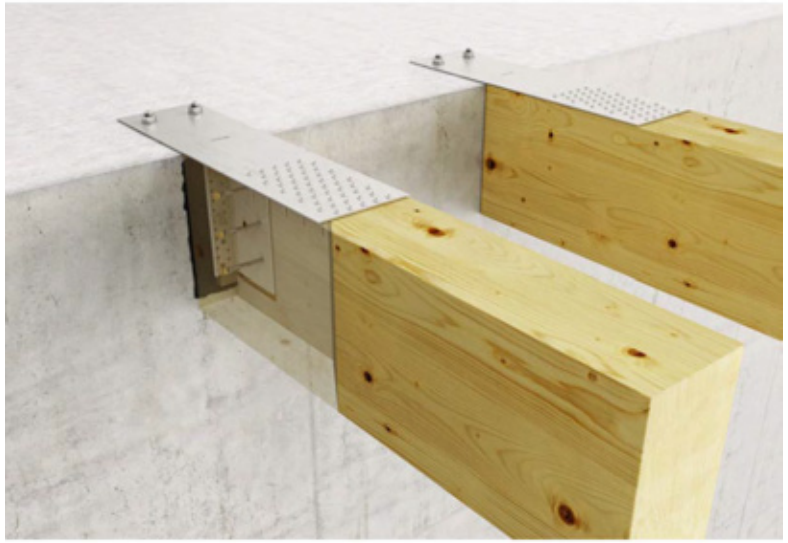
CNC ROUTING





MAX-CORE CLT

CONNECTION Specialty



MAX-CORE CLT

CONNECTION Lifting

CLT construction utilizes a variety of single use and reusable connections for panel assembly.

David Murakami Wood

Image courtesy of KLH

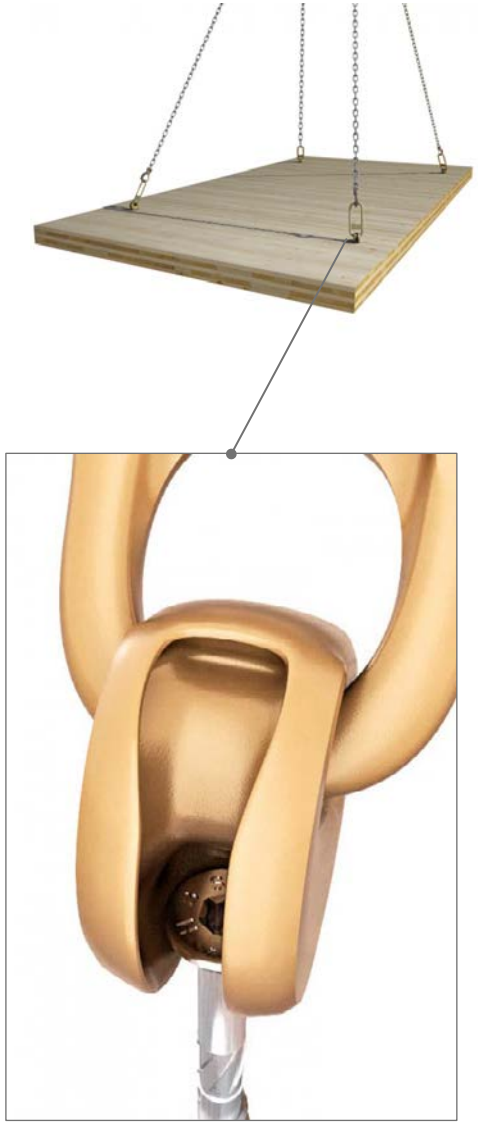
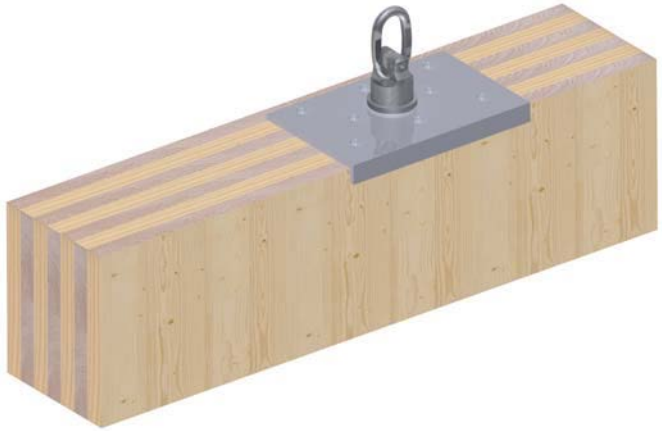


Image courtesy of Rothoblaas

MAX-CORE CLT

CONNECTION Lifting



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CONNECTION Lifting

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ASSEMBLY TOOL KIT

Fig. 16 – Hammer drill

Fig. 17 – Drill

Fig. 18 – Cordless drill

Fig. 25 – Hammer

Fig. 26 – Auger bits

Fig. 27 – Hole cutters

Fig. 19 – Chainsaw

Fig. 20 – Circular hand saw

Fig. 21 – Groove cutter

Fig. 28 – Forstner bits

Fig. 29 – Bits

Fig. 30 – Chalk line

Fig. 22 – Planer

Fig. 23 – Grinder

Fig. 24 – Sledgehammer

Fig. 31 – Levelling rod

Fig. 32 – Angle

Fig. 33 – Rachet beam tensioner

EXAMPLE PROJECTS

BROCK COMMONS

UNIVERSITY OF BRITISH COLUMBIA

18-STOREY HYBRID MASS TIMBER
STUDENT RESIDENCE

WOOD CONSTRUCTION:

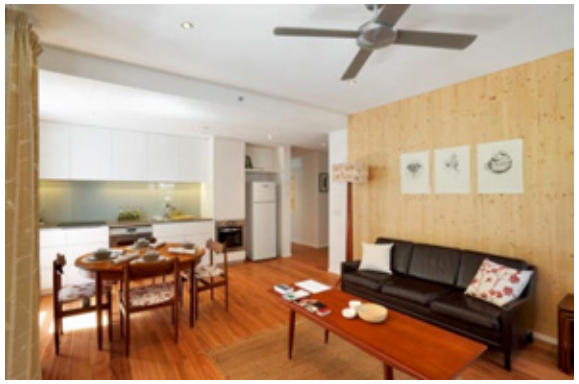
—

START

Arbora Condos | 434 Units | Montreal, Quebec | Provencher_Roy Architects

Stadhouse Murray Grove| 9-storey Apartment Building| UK | Waugh Thistleton

Forte Living | 10 Stories| Melbourne, AUS | Lendlease



Murau Brewery Logistic Hall | Graz, Austria | KLH

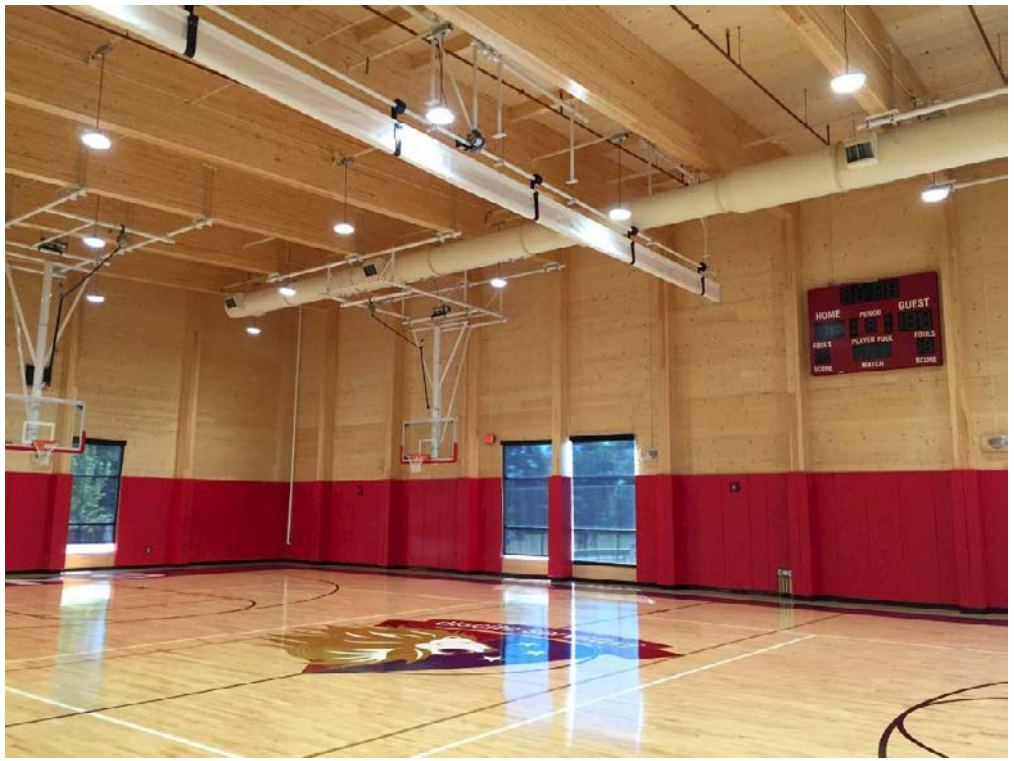
Photos courtesy of KLH

Photos courtesy of KLH

MAX-CORE CLT

A SMARTER BUILDING

- Durable and long lasting when properly designed and planned
- Higher strength to weight ratio than steel and concrete
- Natural material
  - Aesthetic quality (tangible - higher rent)
  - Moisture management
- Prefabricated solid panels
  - Negligible air infiltration
  - Significantly more efficient
- Healthy indoor environment
  - consisting of wood and non-toxic adhesive



Washington Latin School, Washington D.C. KLH

MAX-CORE CLT

KEY ADVANTAGES

CLT is creating a paradigm shift within the building industry, it is much more than a new building material.

- Environmentally sustainable material
- Lightweight construction
- Fast erection time
- Extremely accurate panels and openings
- Maximum architectural freedom
- Reduced site traffic and waste
- Safer construction site
- Simplistic assembly process
- Fire resistant
- Versatility
- Inherent aesthetic quality

Hermann Kaufmann Austria

X-LAM USA

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QUESTIONS?

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