Progressive Wood Construction: The Evolution from Low-Rise to Tall Wood

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

As a structural building material, wood has been a staple in the US for hundreds of years. However, recent decades have seen a dramatic change in the type and scale of wood projects. As codes have evolved due to recognition of the fire and life safety, structural, and resilient capabilities of wood- construction, new doors have opened that allow larger and taller wood buildings. Concurrently, advances in the technology behind the production of wood products and components have led to the introduction and increased use of off-site construction and mass timber. This opening plenary will take attendees through the progression of wood construction—from light-frame low-rise, to mid-rise, to mass timber and tall wood. The audience will see the evolution of the design and construction processes and developments in technology applicable to wood products and buildings of all scales.

Learning Objectives

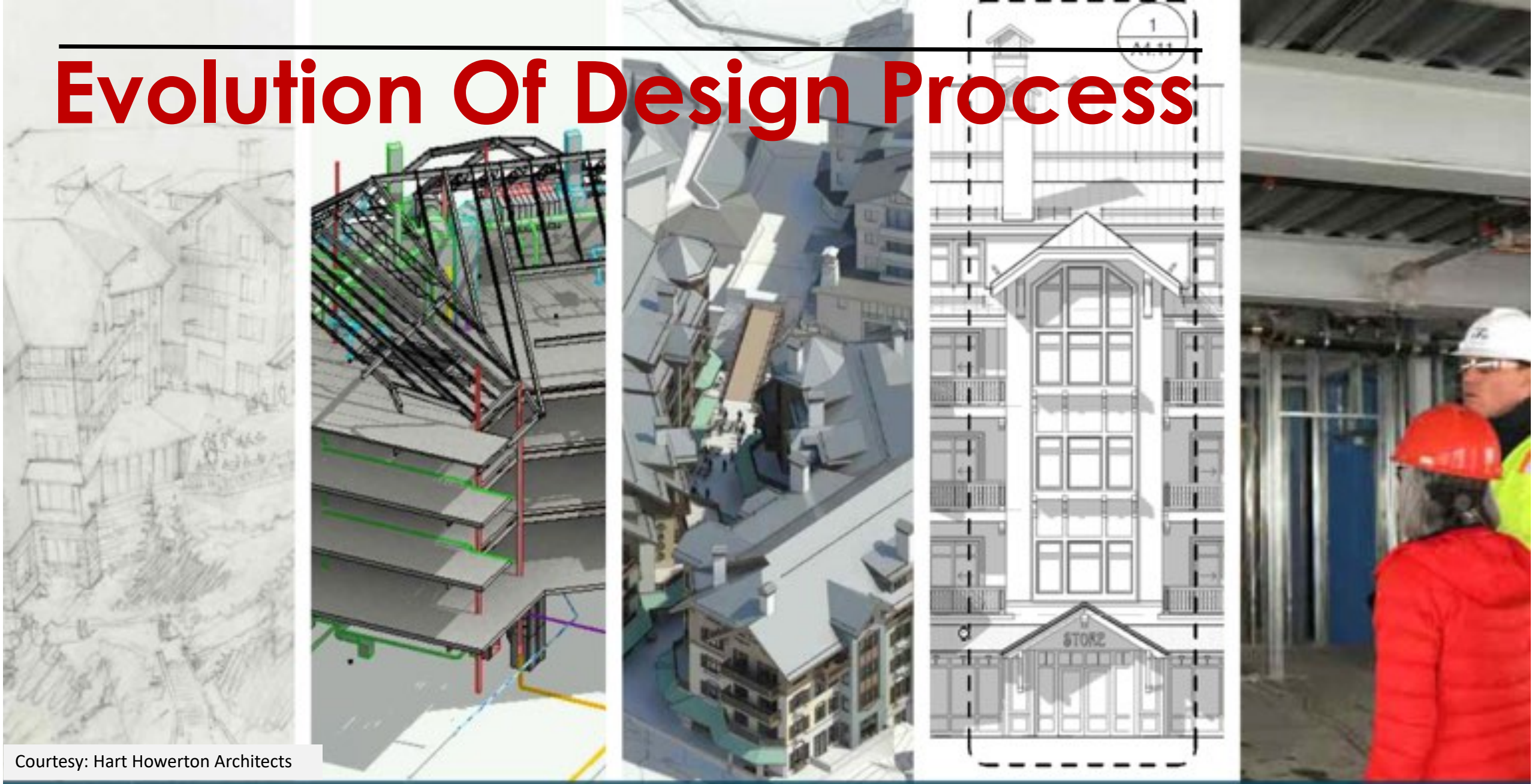
1. Advancement of design and modeling software.

2. Discuss advancements in prefabrication and modular techniques.

3. Recognize the various timber products available in the market.

4. Discuss the upcoming building code changes and the potential impact to the wood projects in the future.

Evolution Of Design Process



Courtesy: Hart Howerton Architects

LONG TRADITION OF TIMBER

Courtesy: Tom Bricker

GLACIER HOTEL | 1915

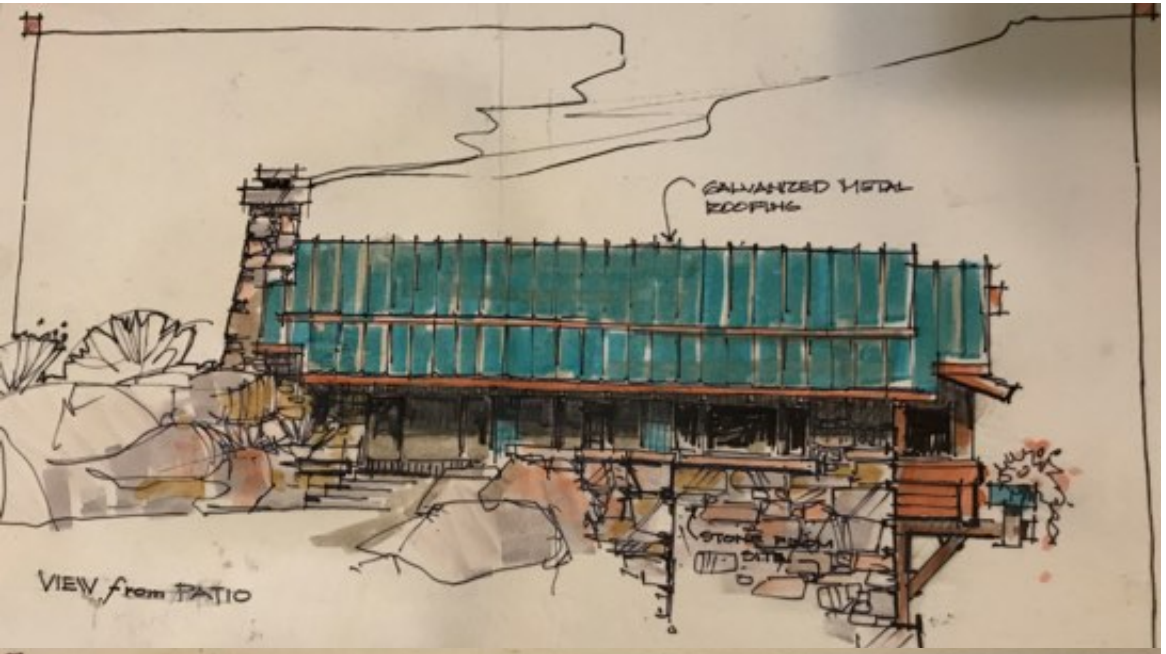
OLD FAITHFUL INN | 1904

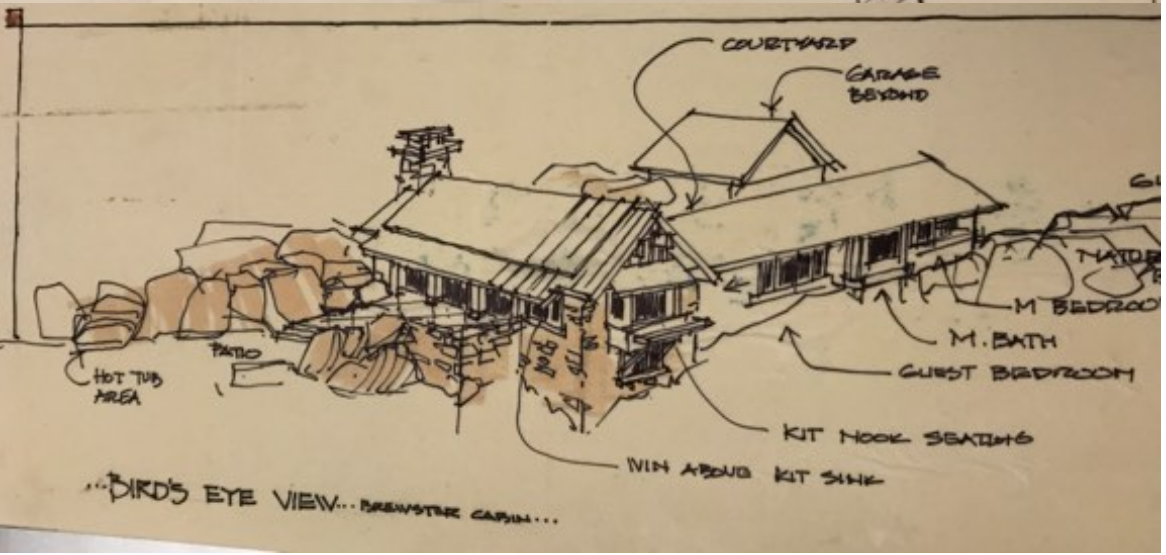
TRADITIONAL TIMBER

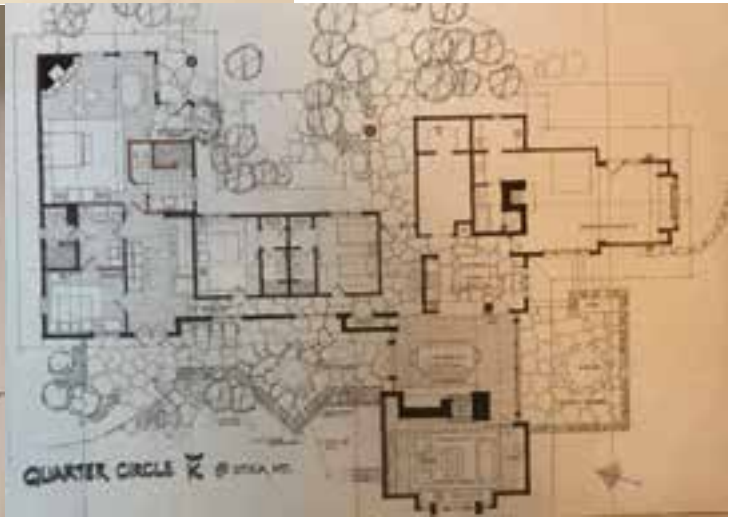
TRADITIONAL TIMBER

Design To Construction

Design To Construction







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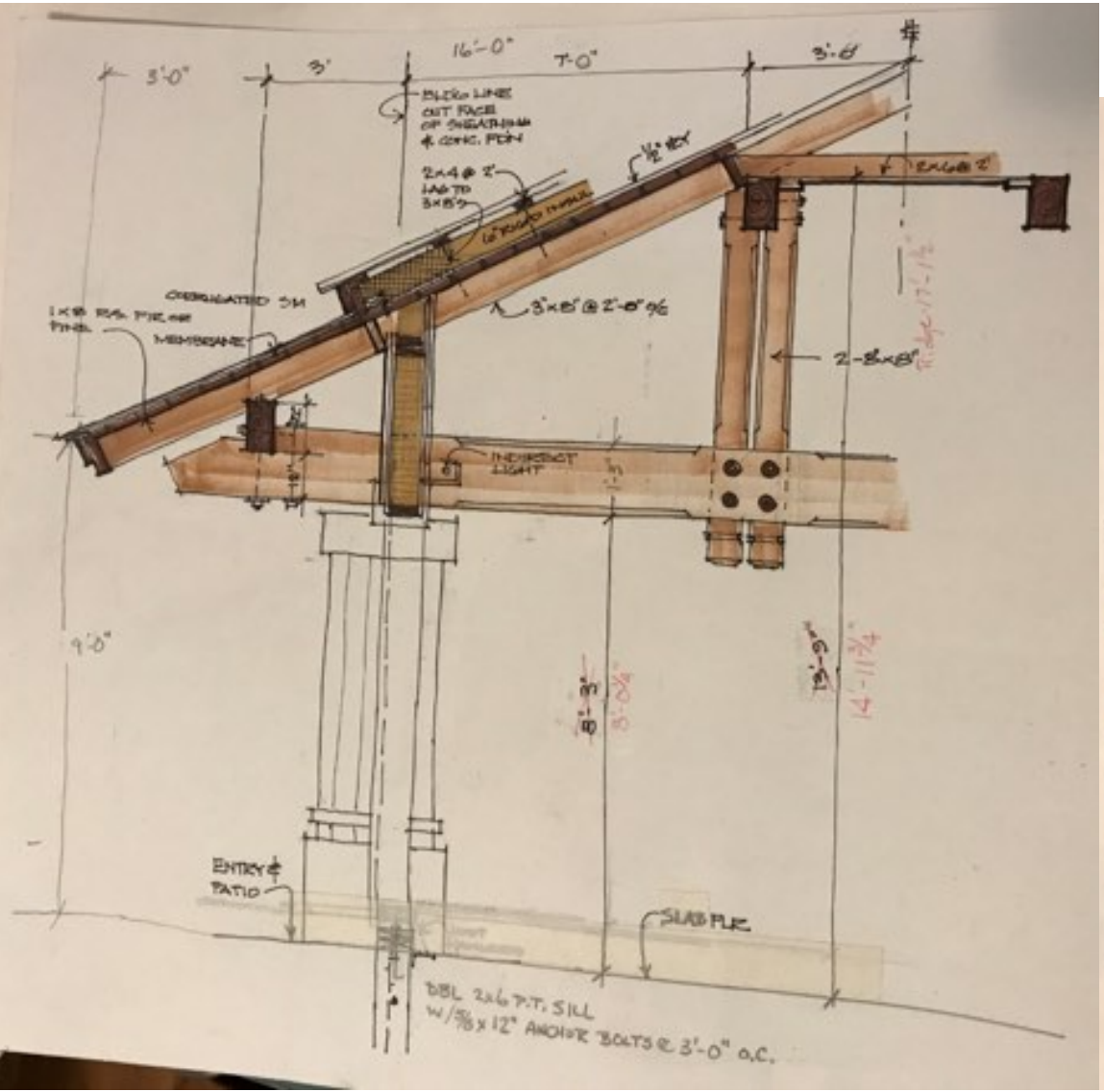
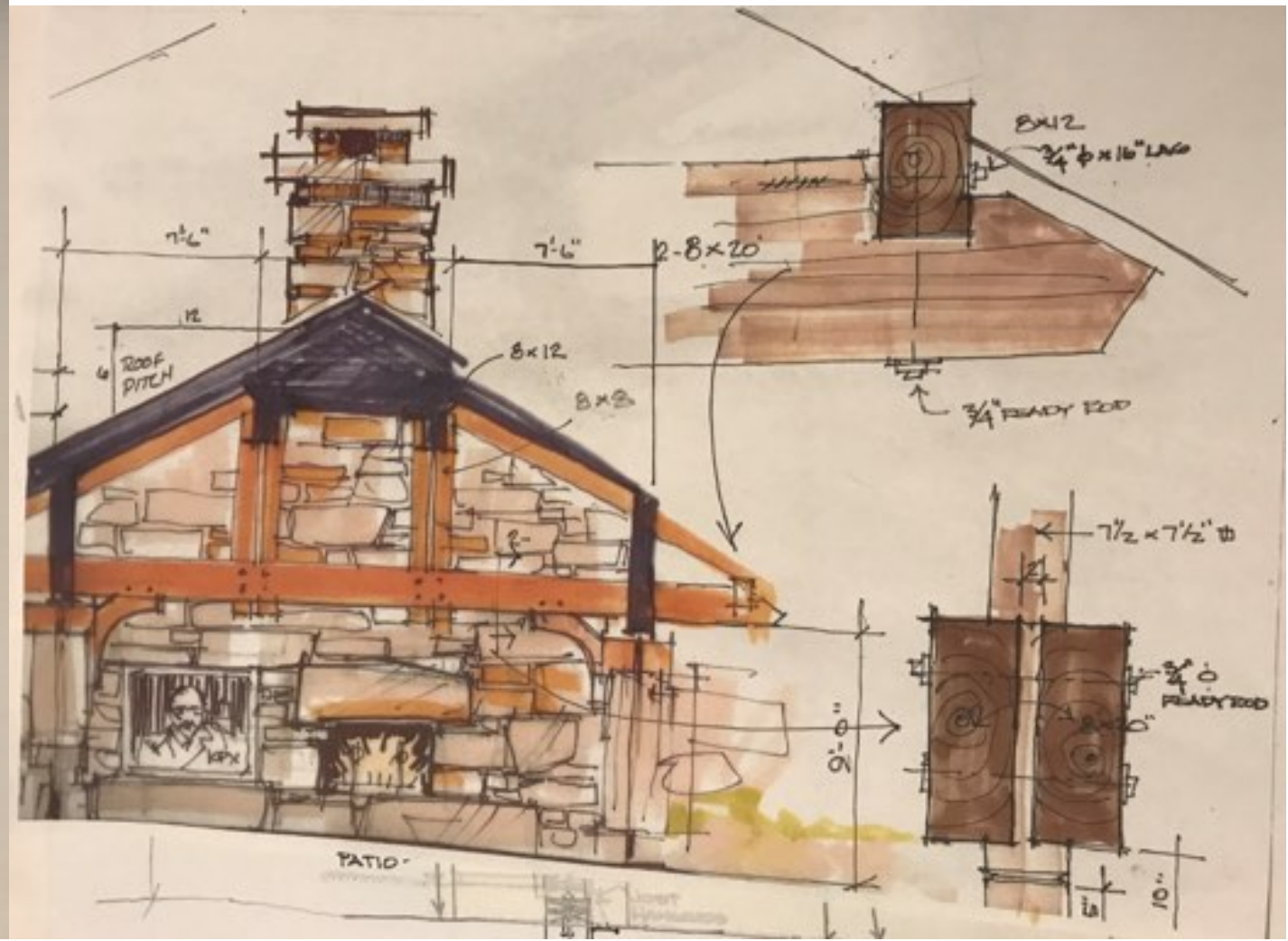
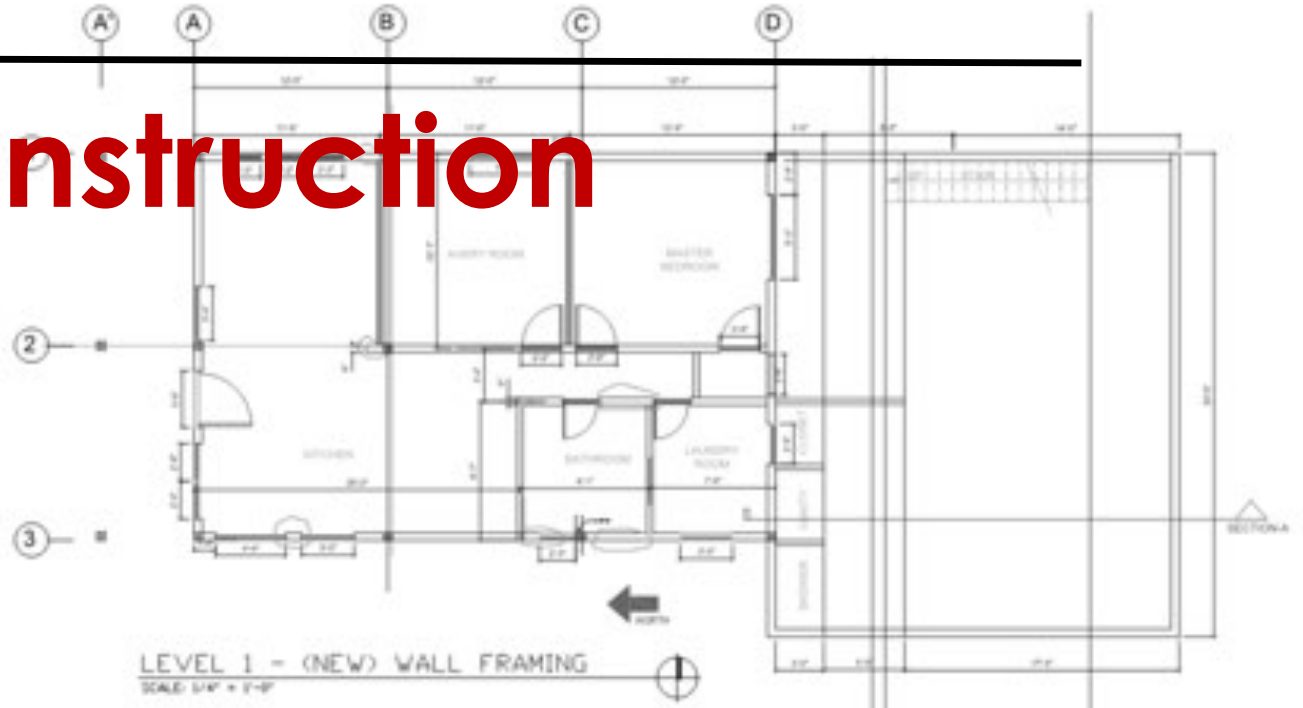
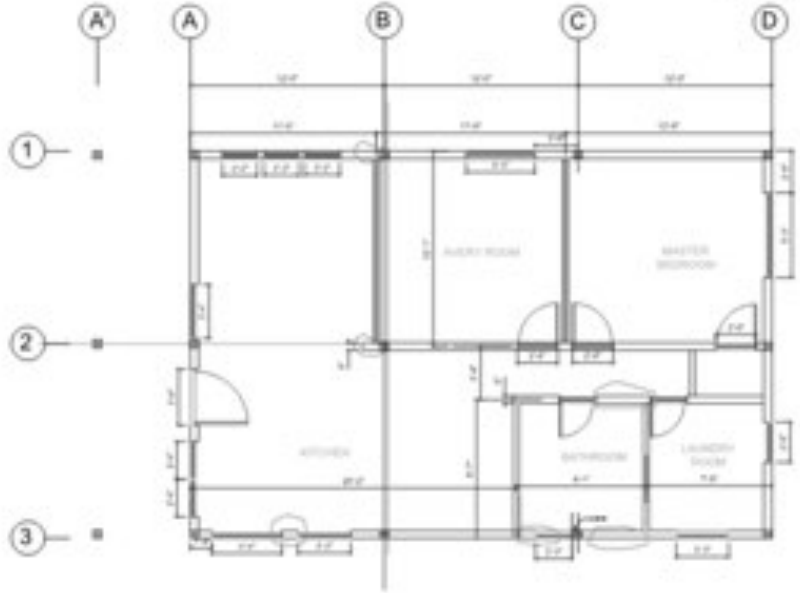




TRADITIONAL TIMBER

Design To Construction





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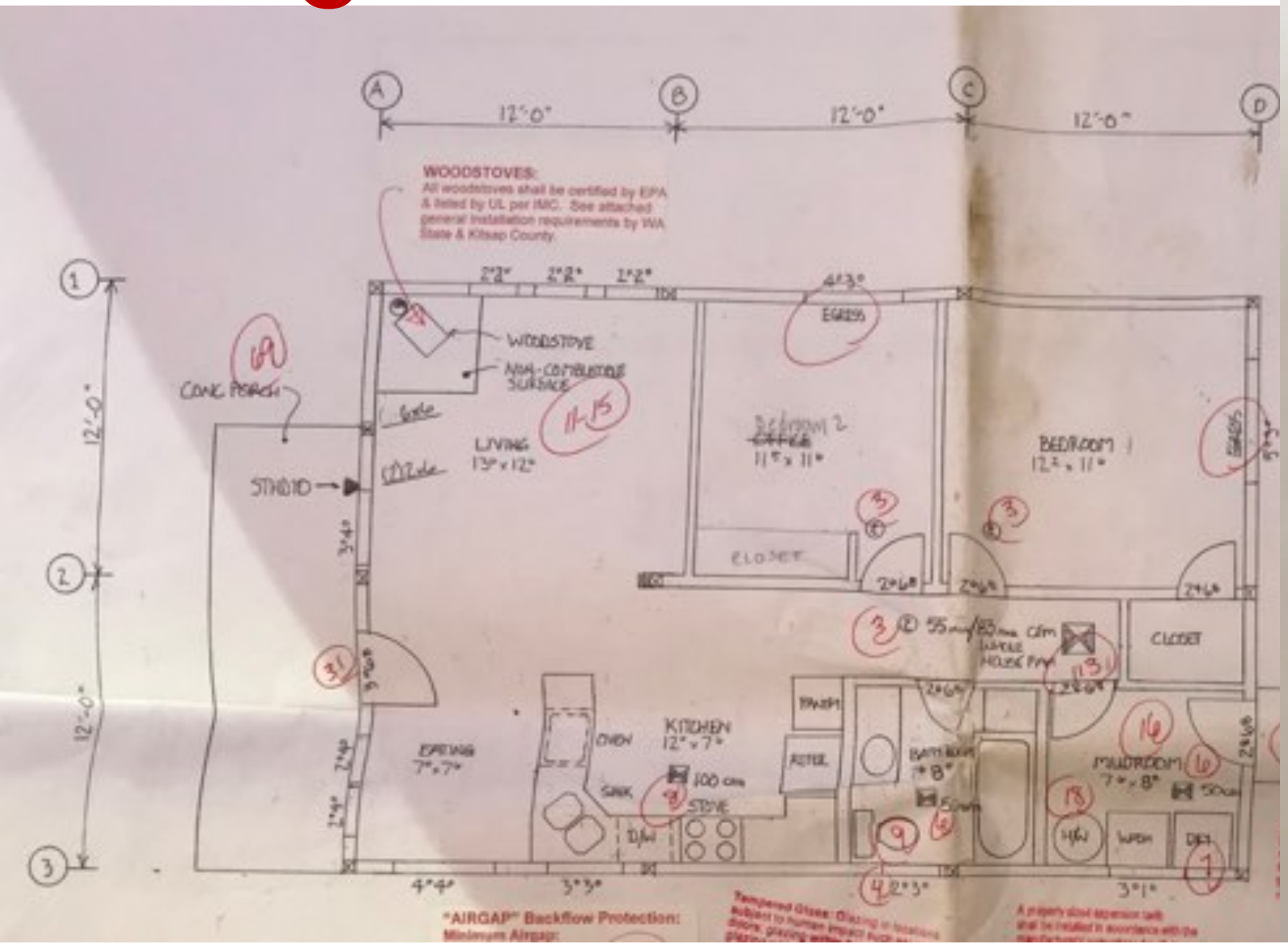
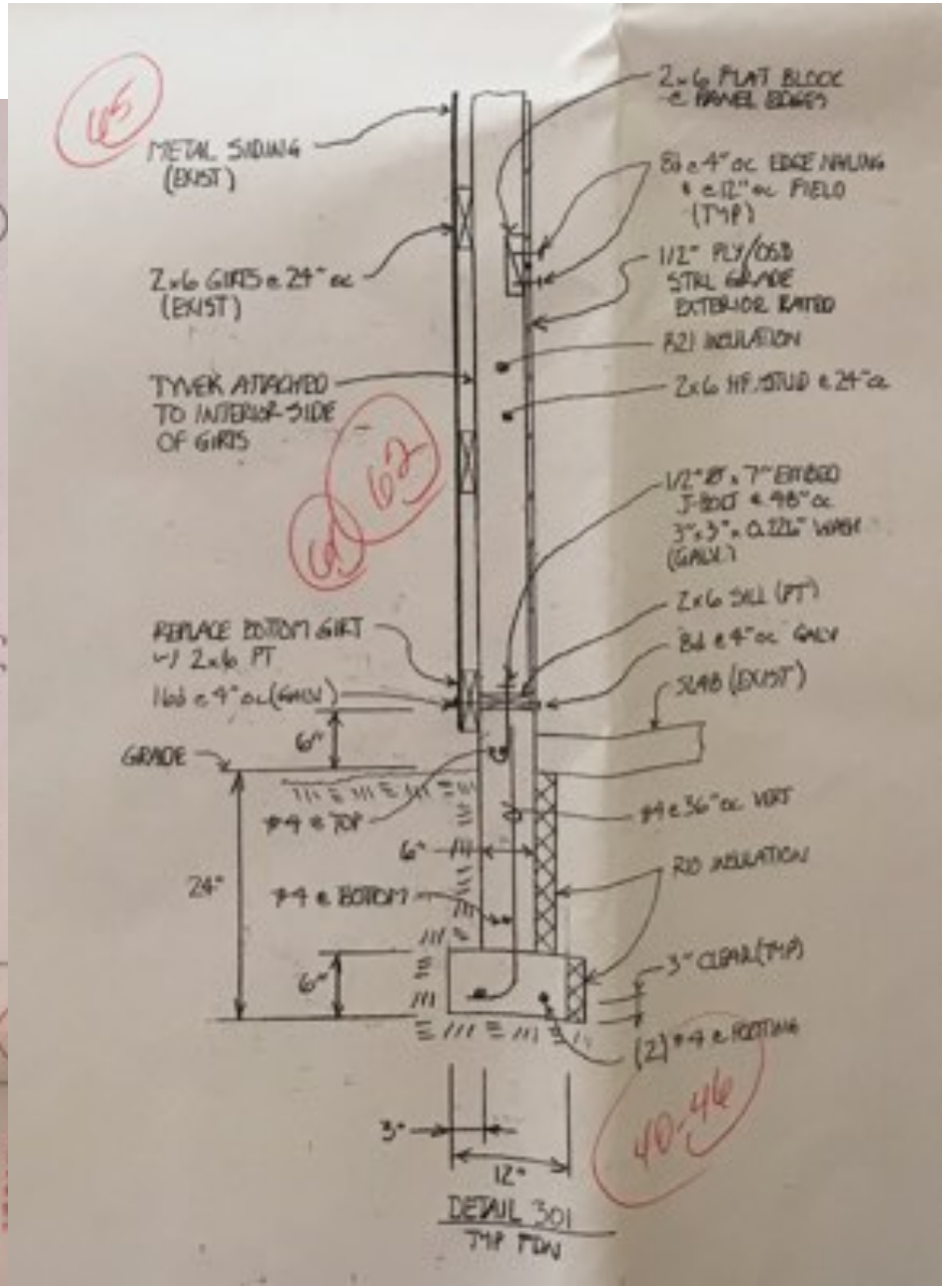




TIMBER WAS AND IS

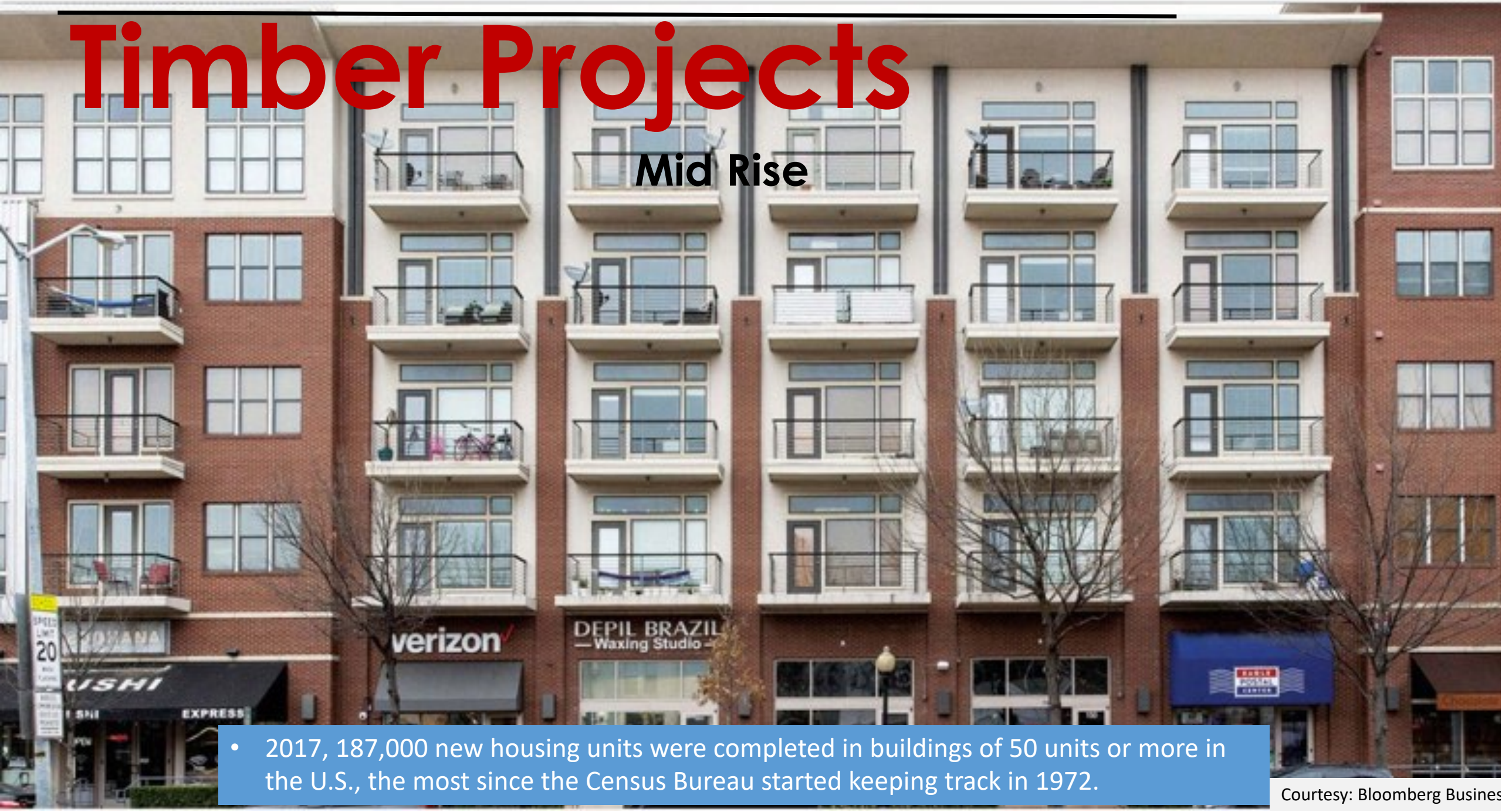
Courtesy: Interfor

Podium Construction

- 1970's saw (4) stories of timber over 1 story of concrete.
- 1996, Togawa Smith Martin Inc. used FRT lumber to complete (5) stories of timber over concrete.

Timber Projects

Mid Rise



- 2017, 187,000 new housing units were completed in buildings of 50 units or more in the U.S., the most since the Census Bureau started keeping track in 1972.

Courtesy: Bloomberg Busines

Wood Construction

Mid Rise

Courtesy: Mitch Doyle/Nibbi Brother General Contractors

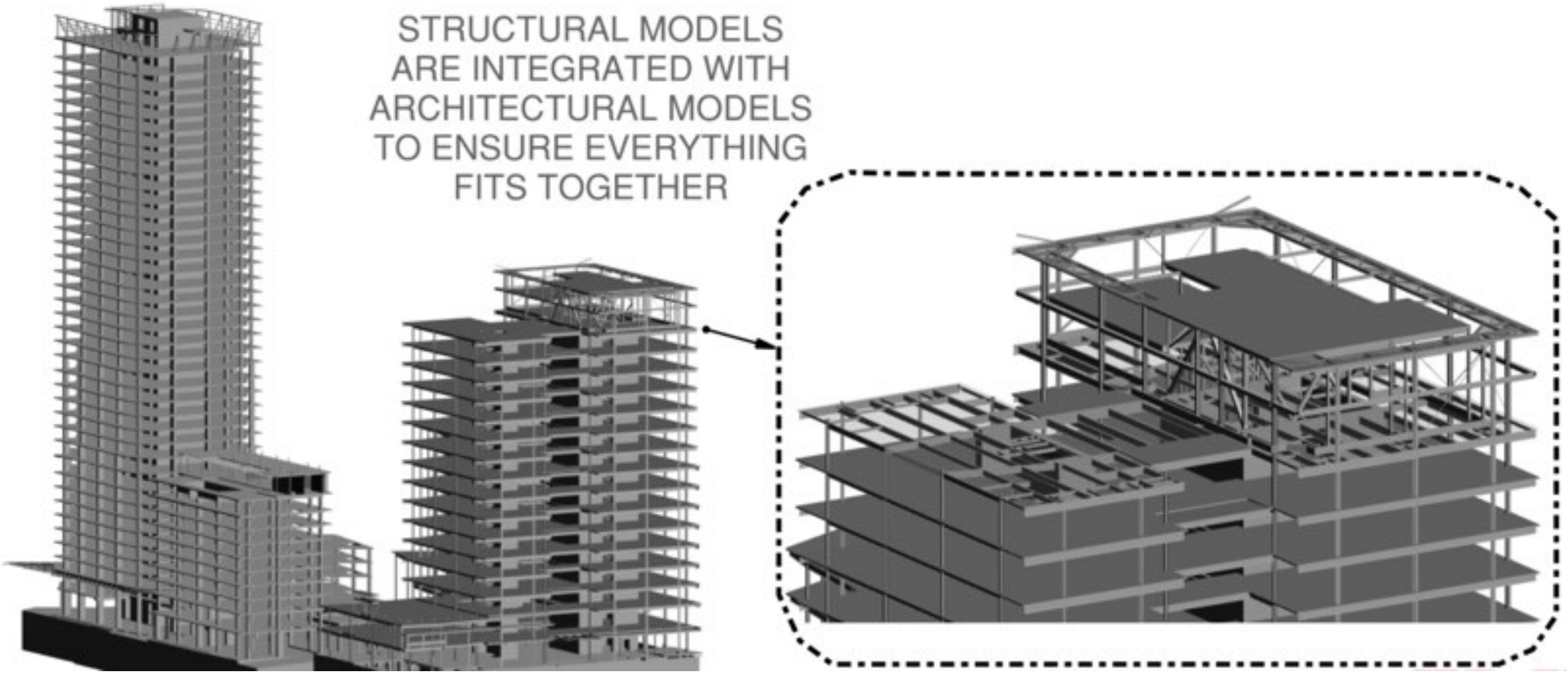
Wood Construction

Courtesy: Arch Daily-Fernanda Castro

Courtesy: Bruce Damonte

Pushing Design

Evolution Of Design Process



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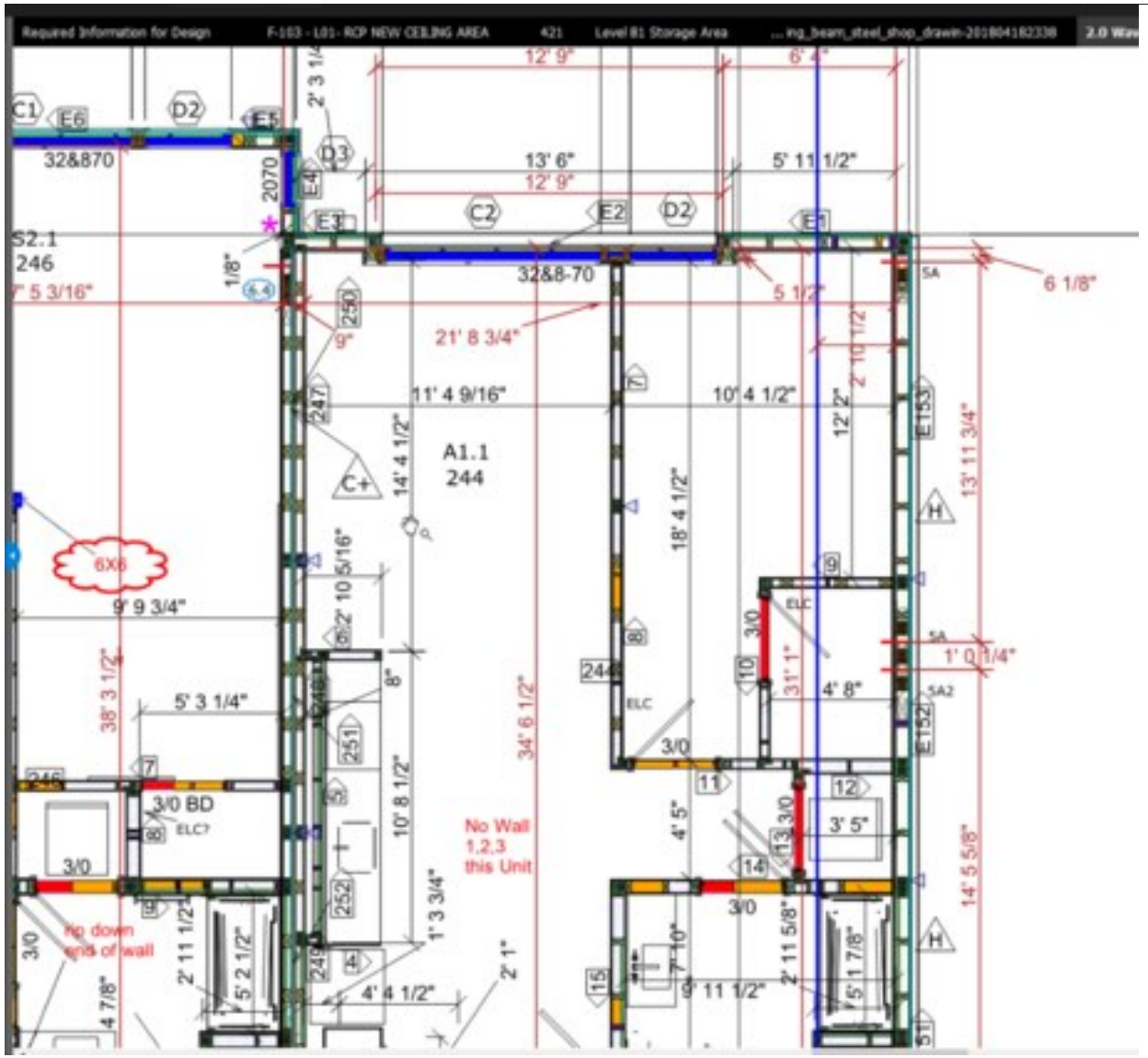
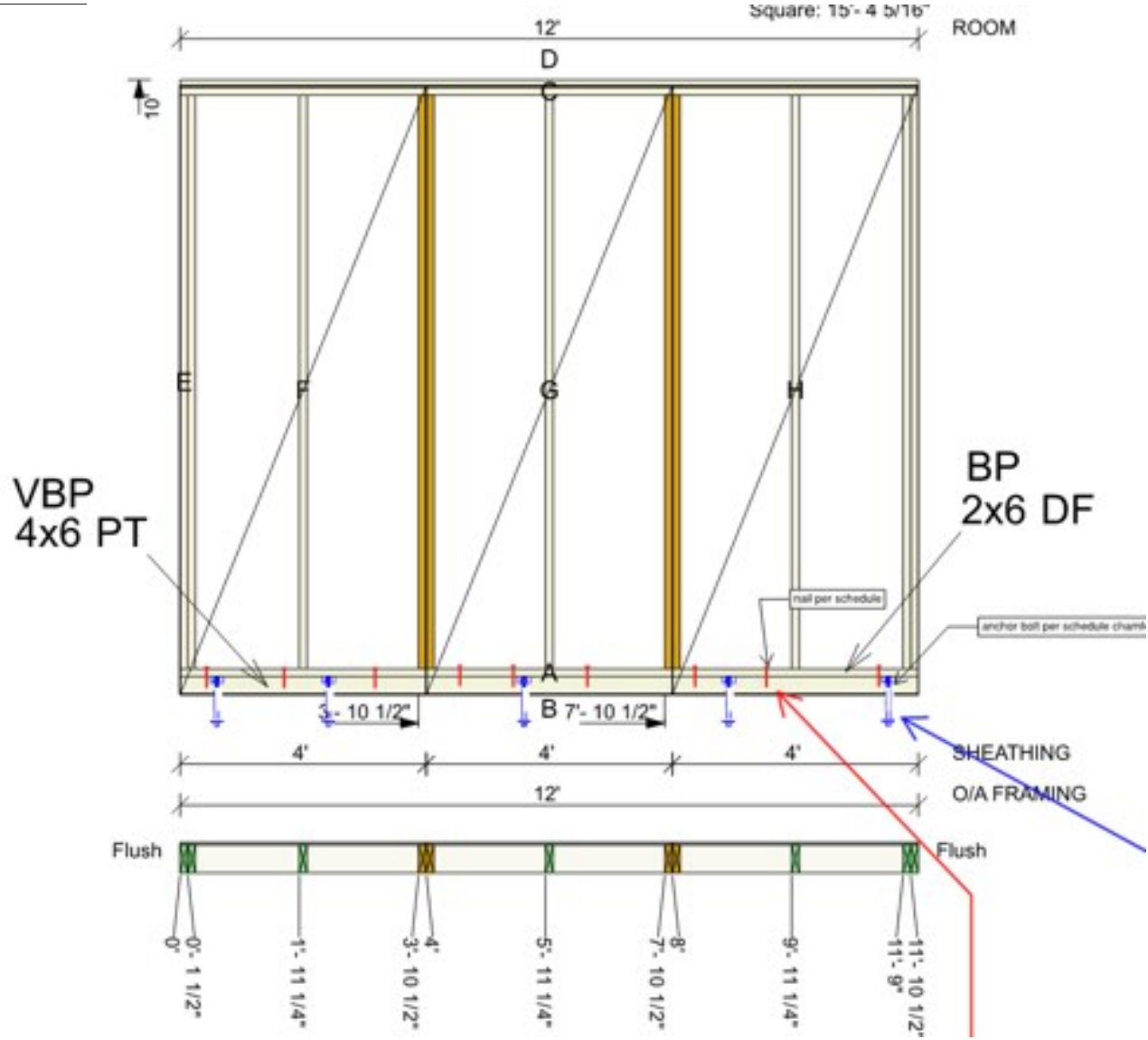
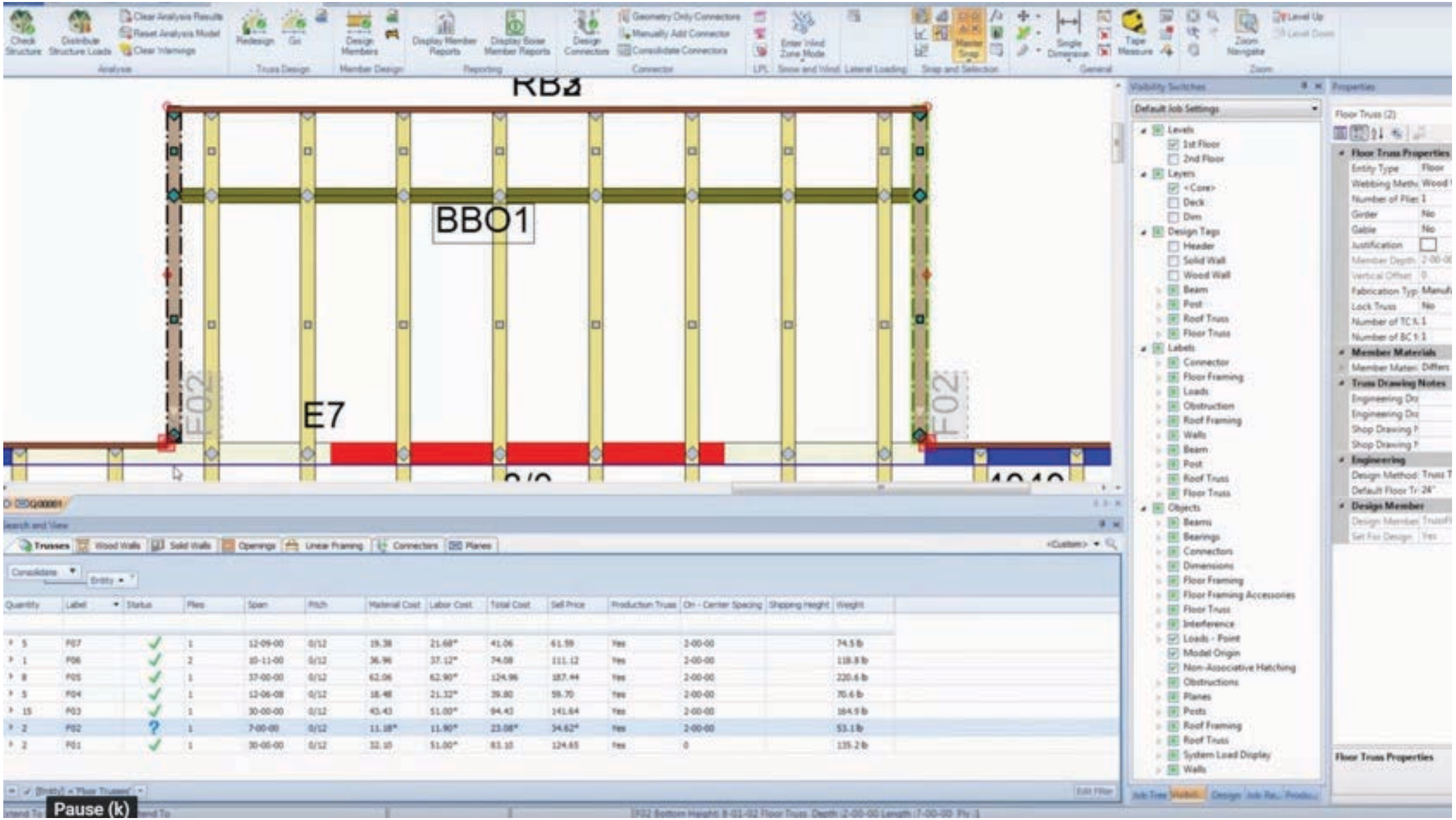
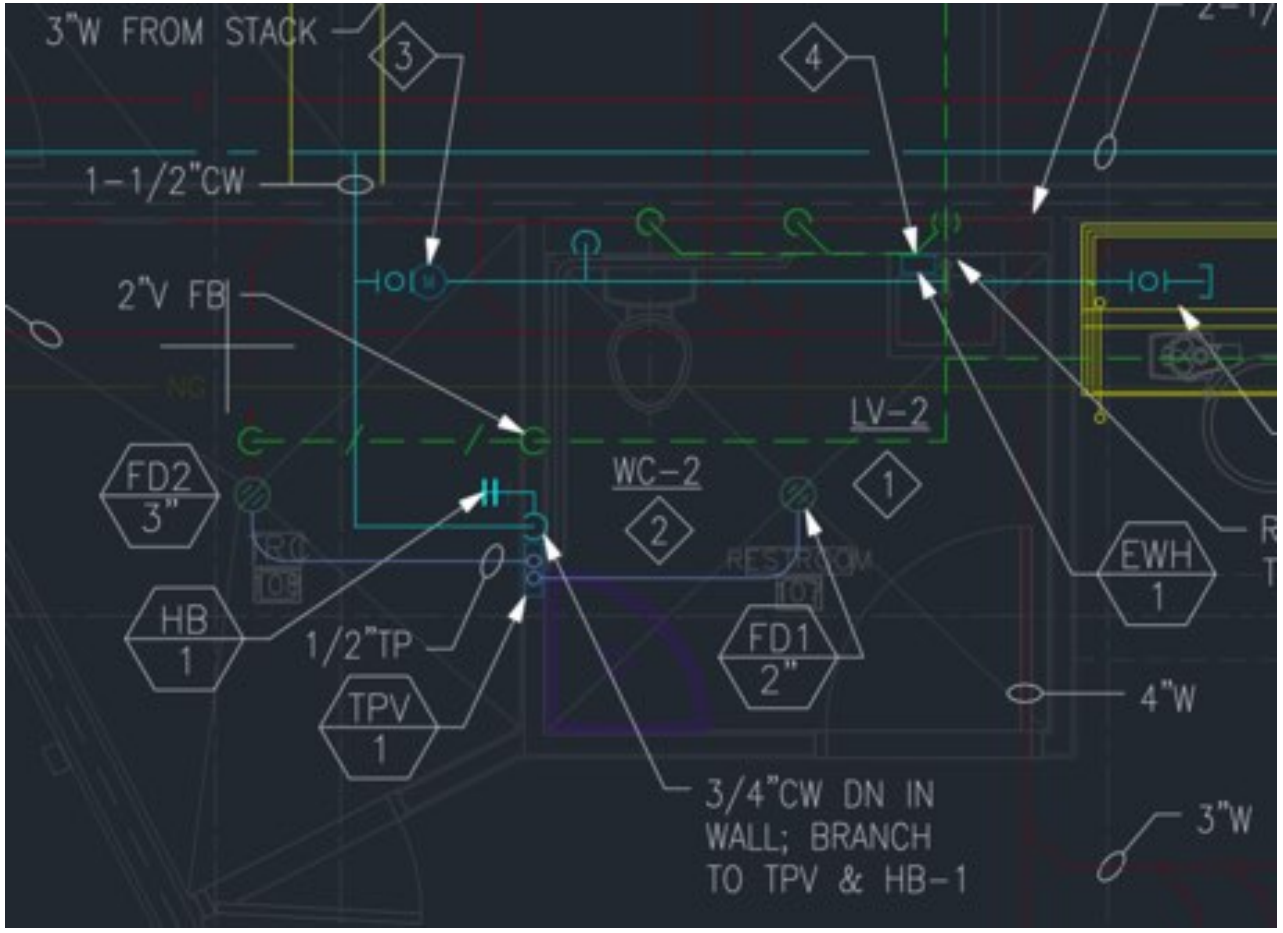
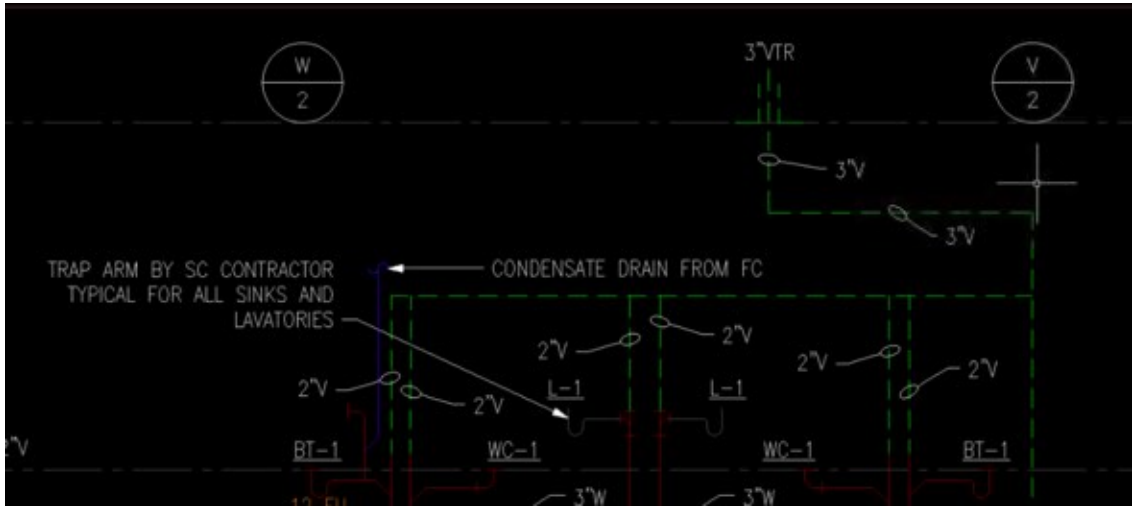


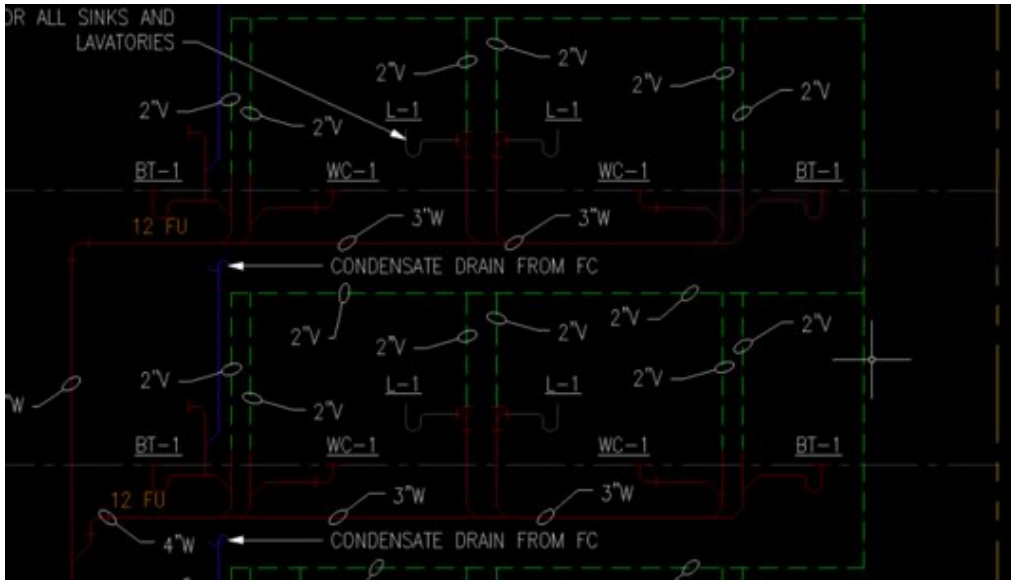



RB3
BBO1
E7
F02
F02
Pause (k)

Design To Construction

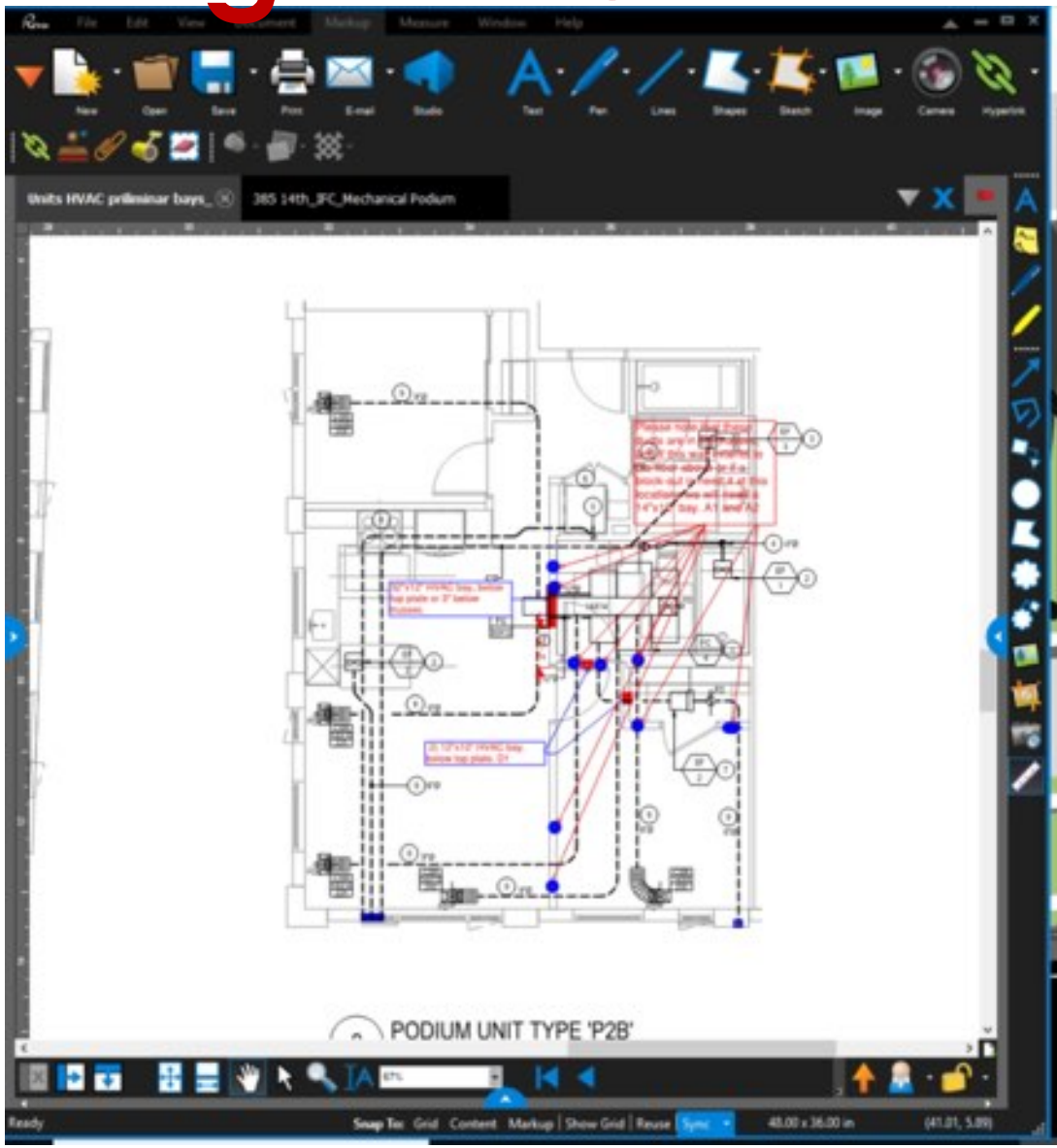






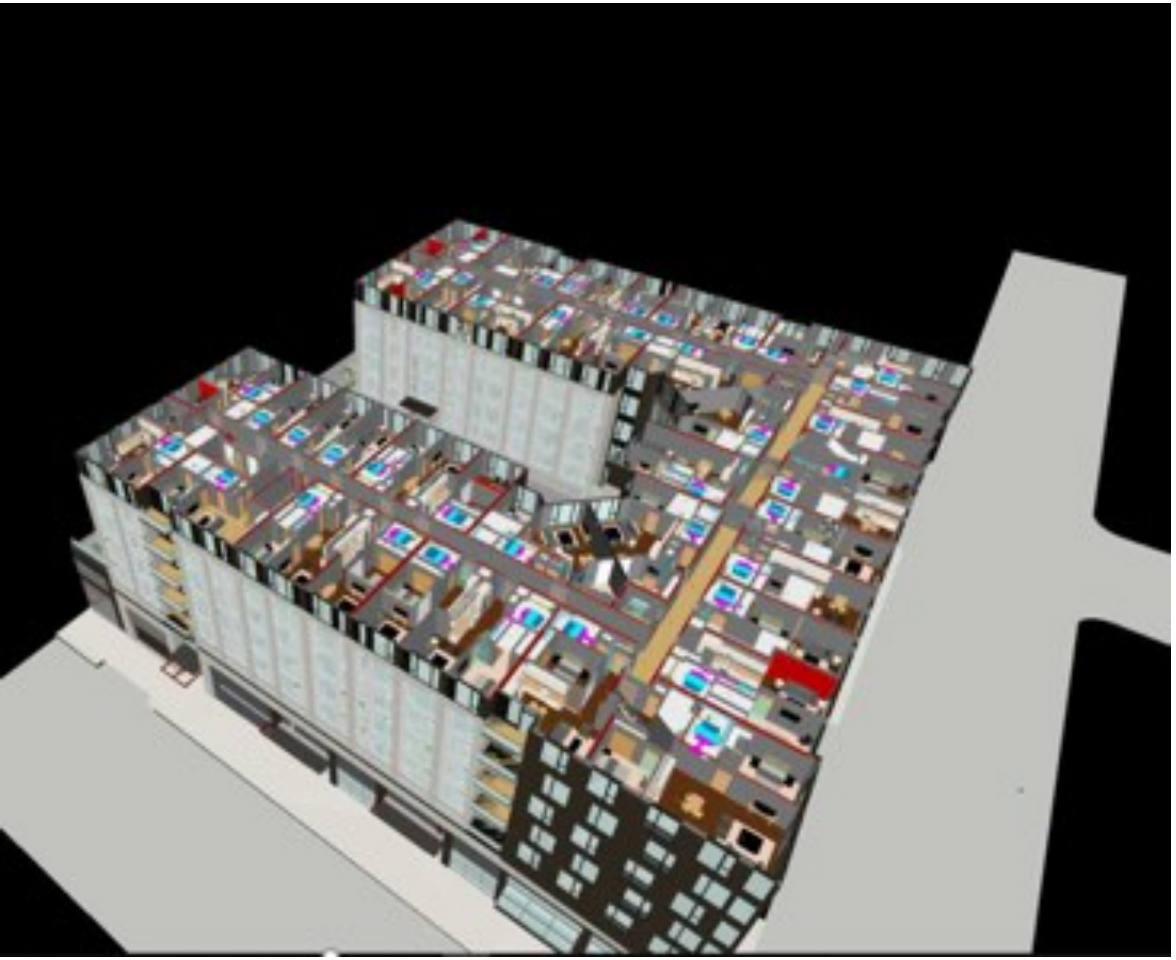
Wood Construction

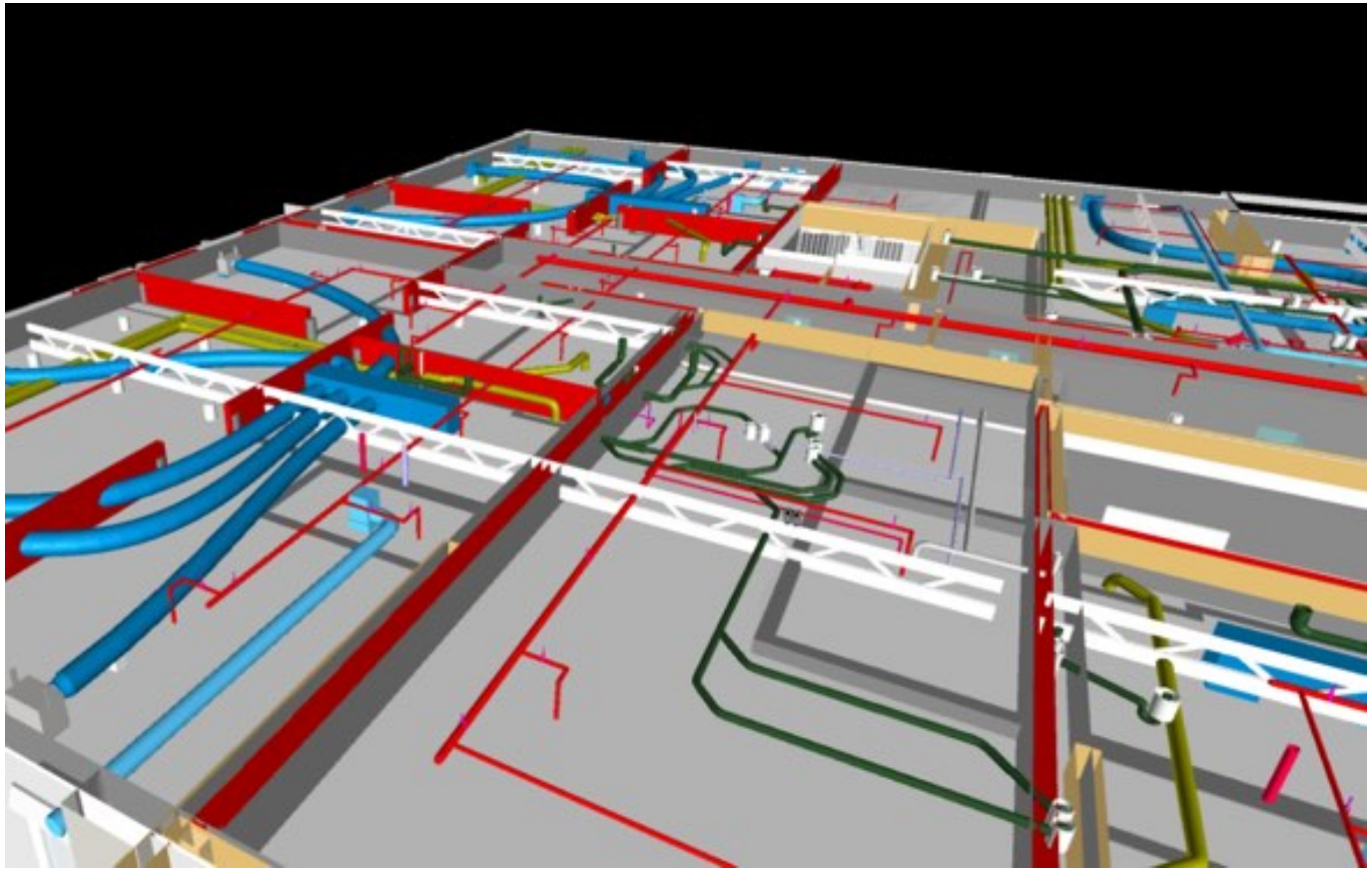
Design To Construction



MEP COORDINATION

- BIM & Revit coordination





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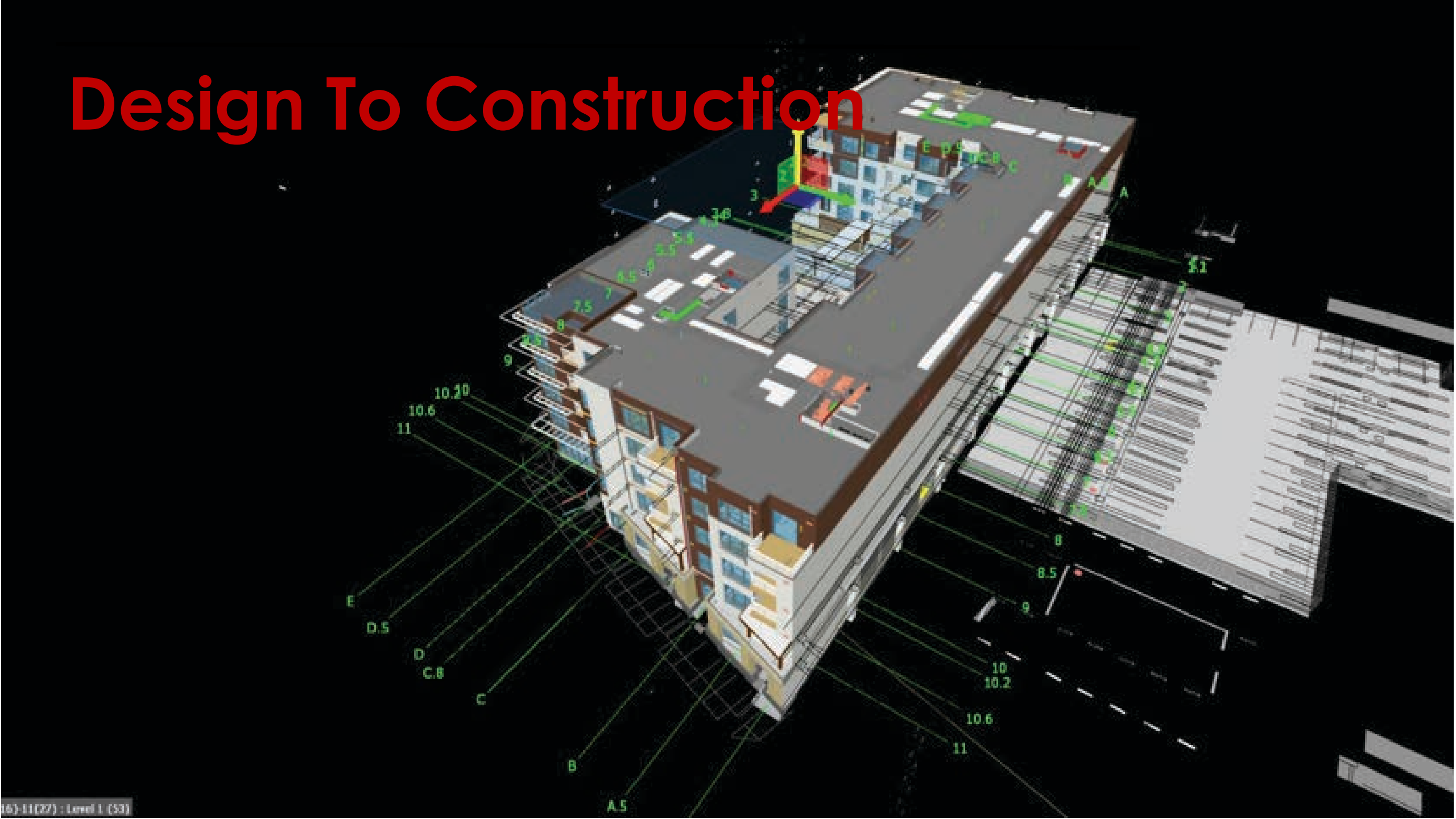
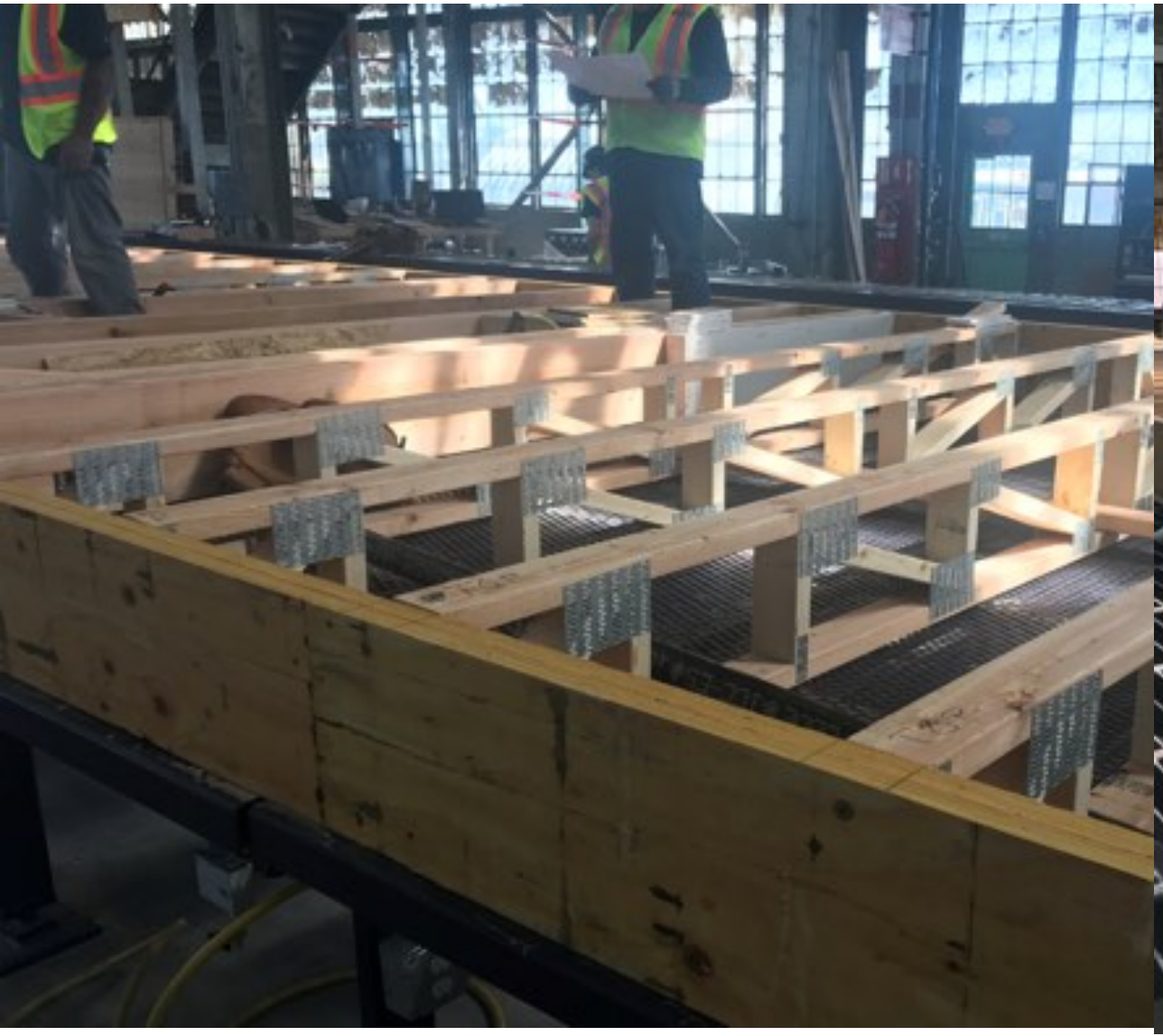
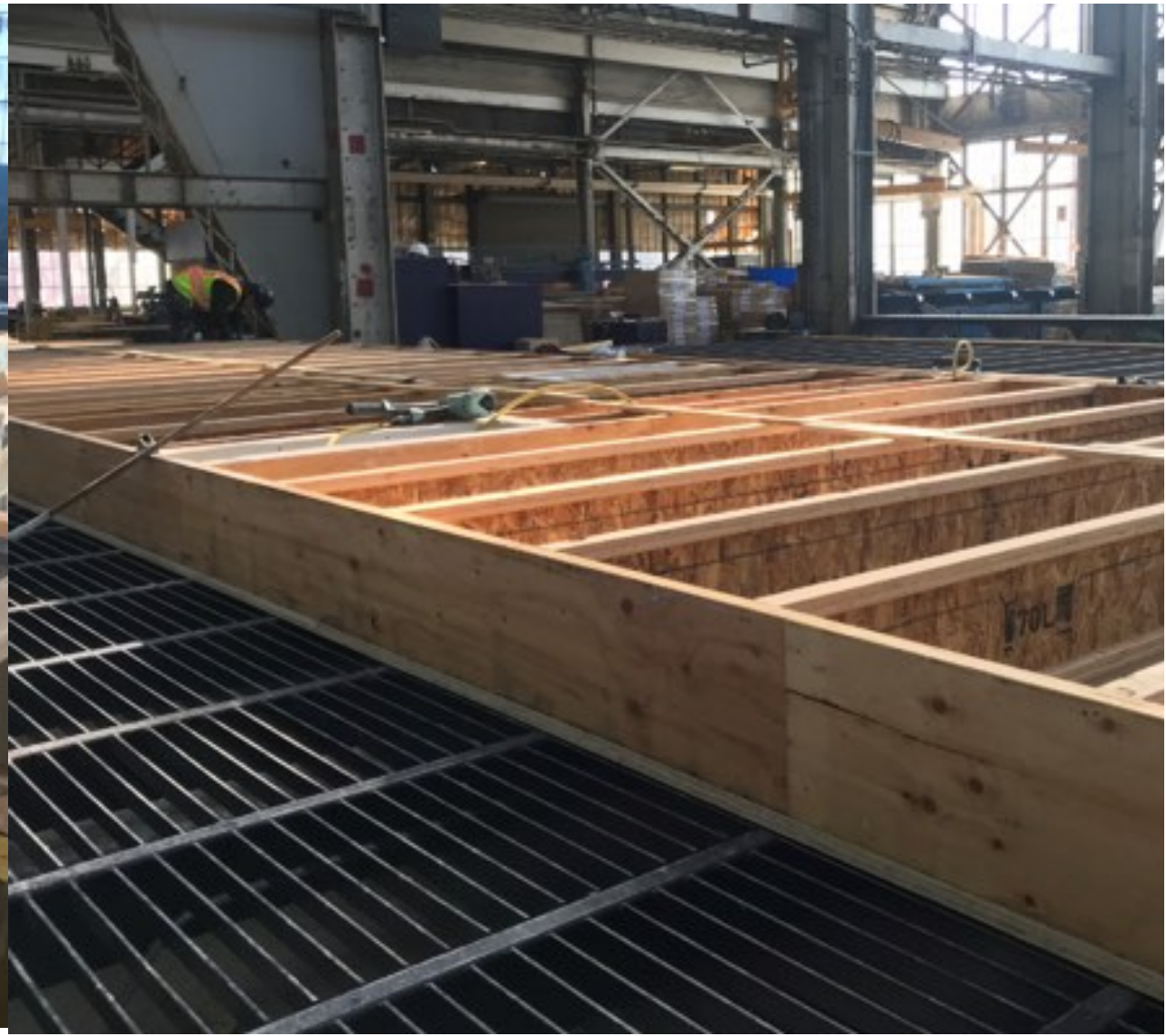
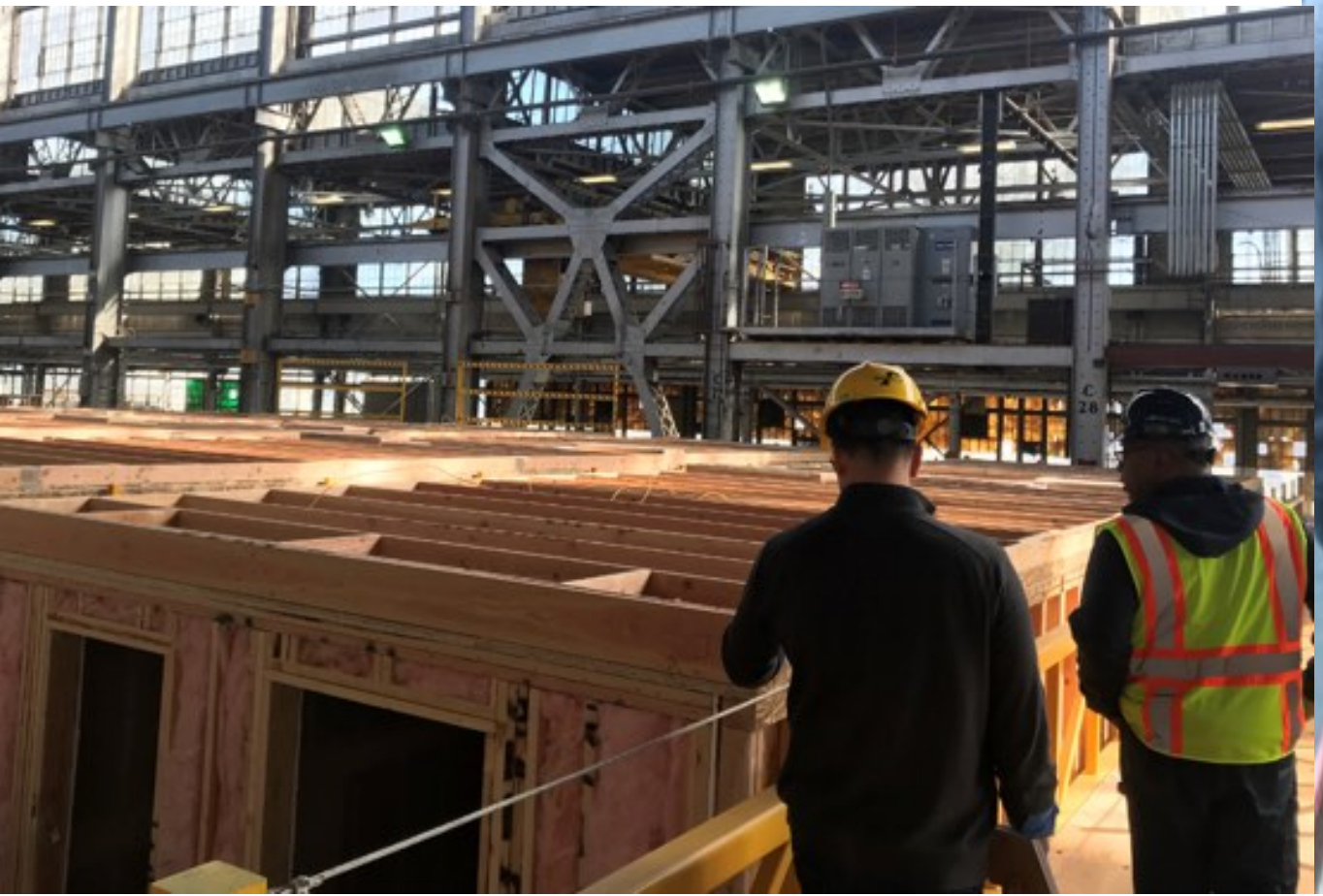


Factory Built Elements





Factory Built Elements

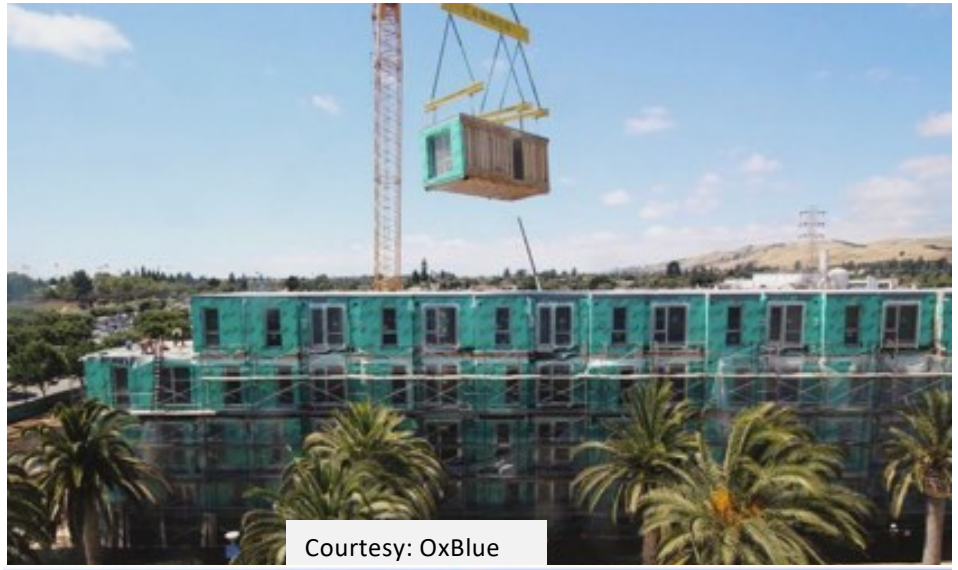


Factory Built Elements

Factory Built Elements

Wood Construction

Modular



Courtesy: OxBlue

Courtesy: Lowney

Courtesy: David Baker Architects

Courtesy: David Baker Architects

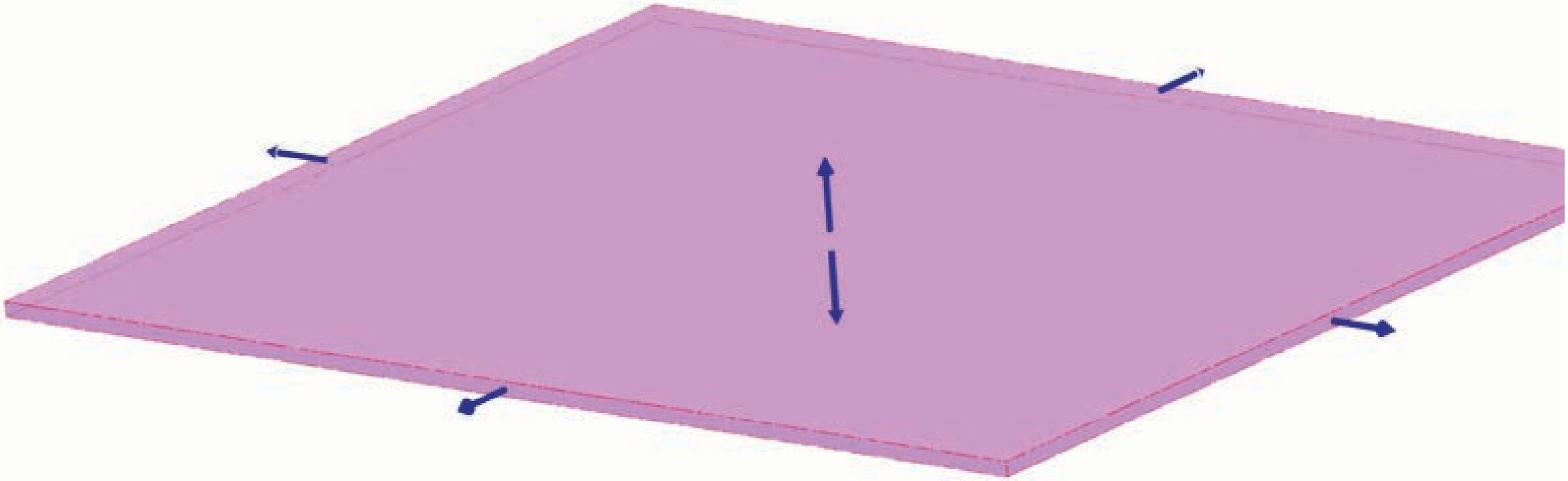
Factory Built Elements

MASS TIMBER

Courtesy: Michael Green Architects

Courtesy: Structurlam

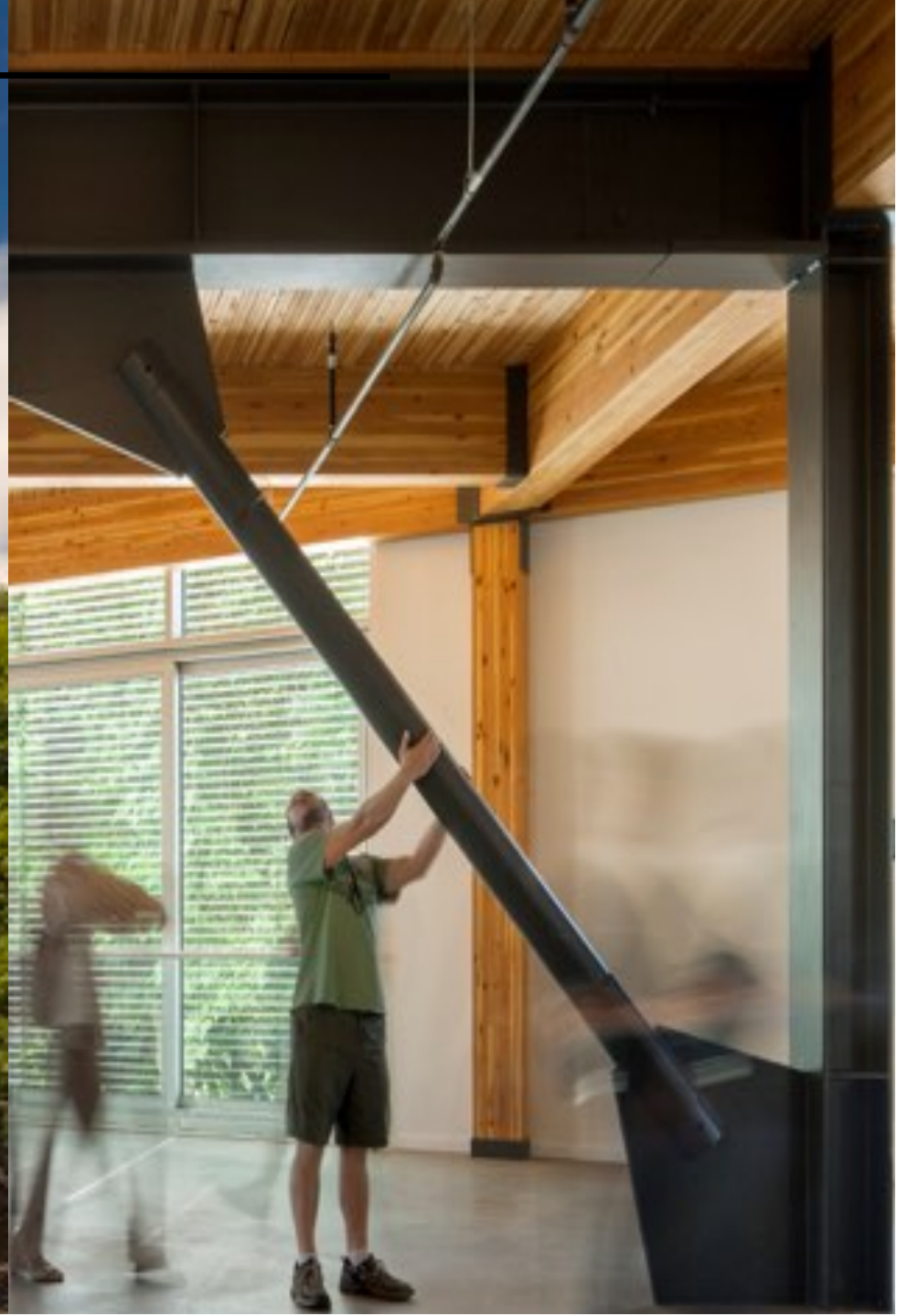
Courtesy: StructureCraft



MEP COORDINATION

MASS TIMBER

Courtesy: Bullitt Center Foundation



WHAT IS MASS TIMBER

PROJECT TYPE?

Courtesy: Think Wood

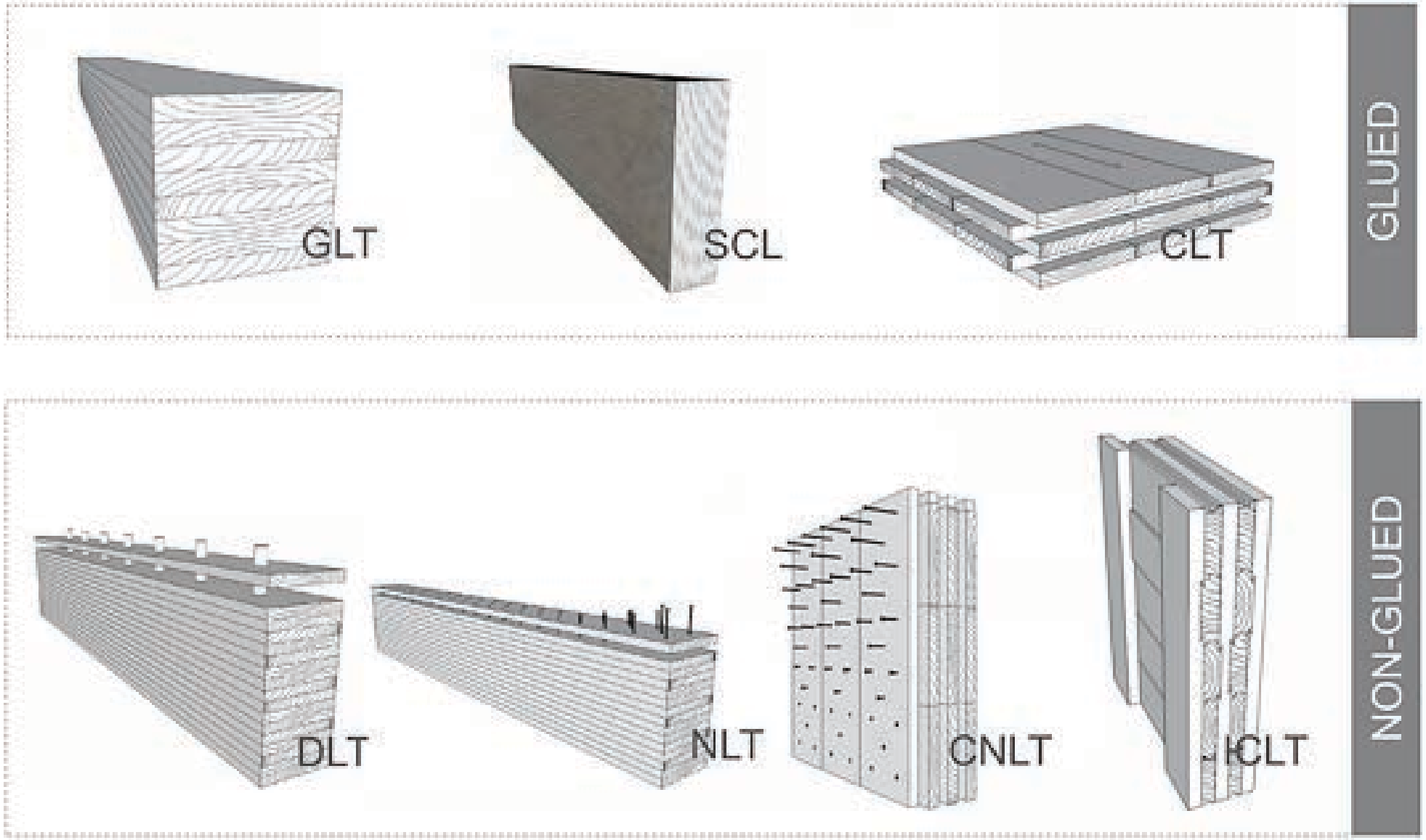
PRESENT DAY TIMBER

TABLE 601

FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A[d]	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls									
Exterior[e,f]	3	2	1	0	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1^1/_2$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

TYPES OF MASS TIMBER



Courtesy: University Of Utah

GLULAM

GLUE LAMINATED | BEAMS OR PANELS

LONG ONE WAY SPANNING CAPABILITIES

MINIMAL SHRINKAGE

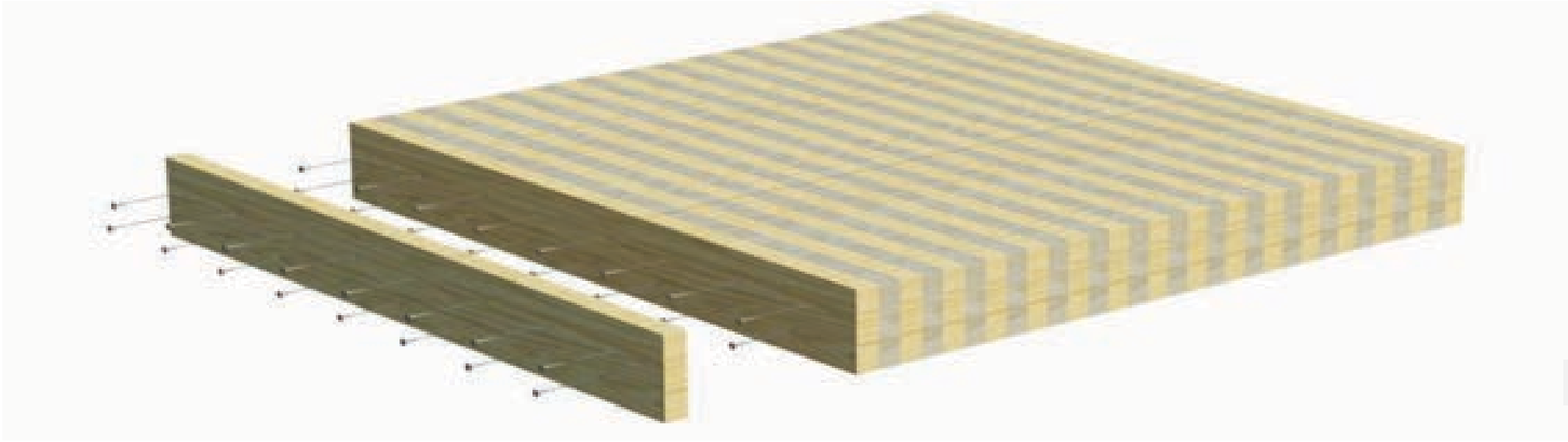
GLULAM

NLT | NAIL LAMINATED TIMBER

2x LUMBER WITH NAILS

SIMILAR PREFAB CAPABILITIES

SHRINKAGE NEEDS TO BE TAKEN INTO ACCOUNT



Courtesy: StructureCraft

NLT | NAIL LAMINATED TIMBER

DLT | DOWEL LAMINATED TIMBER

SOFTWOOD 2X LUMBER WITH HARDWOOD DOWELS

ENHANCED CNC CAPACITY VS NLT

-SHRINKAGE NEEDS TO BE TAKEN INTO ACCOUNT

Courtesy: StructureCraft

DLT | DOWEL LAMINATED TIMBER

Courtesy: StructureCraft

CLT | CROSS LAMINATED TIMBER

2X LUMBER LAMINATED IN ALTERNATING LAYERS

CROSS LAMINATIONS YIELD DIMENSIONAL STABILITY

LIMITED SHRINKAGE

MPP | MASS PLYWOOD PANEL

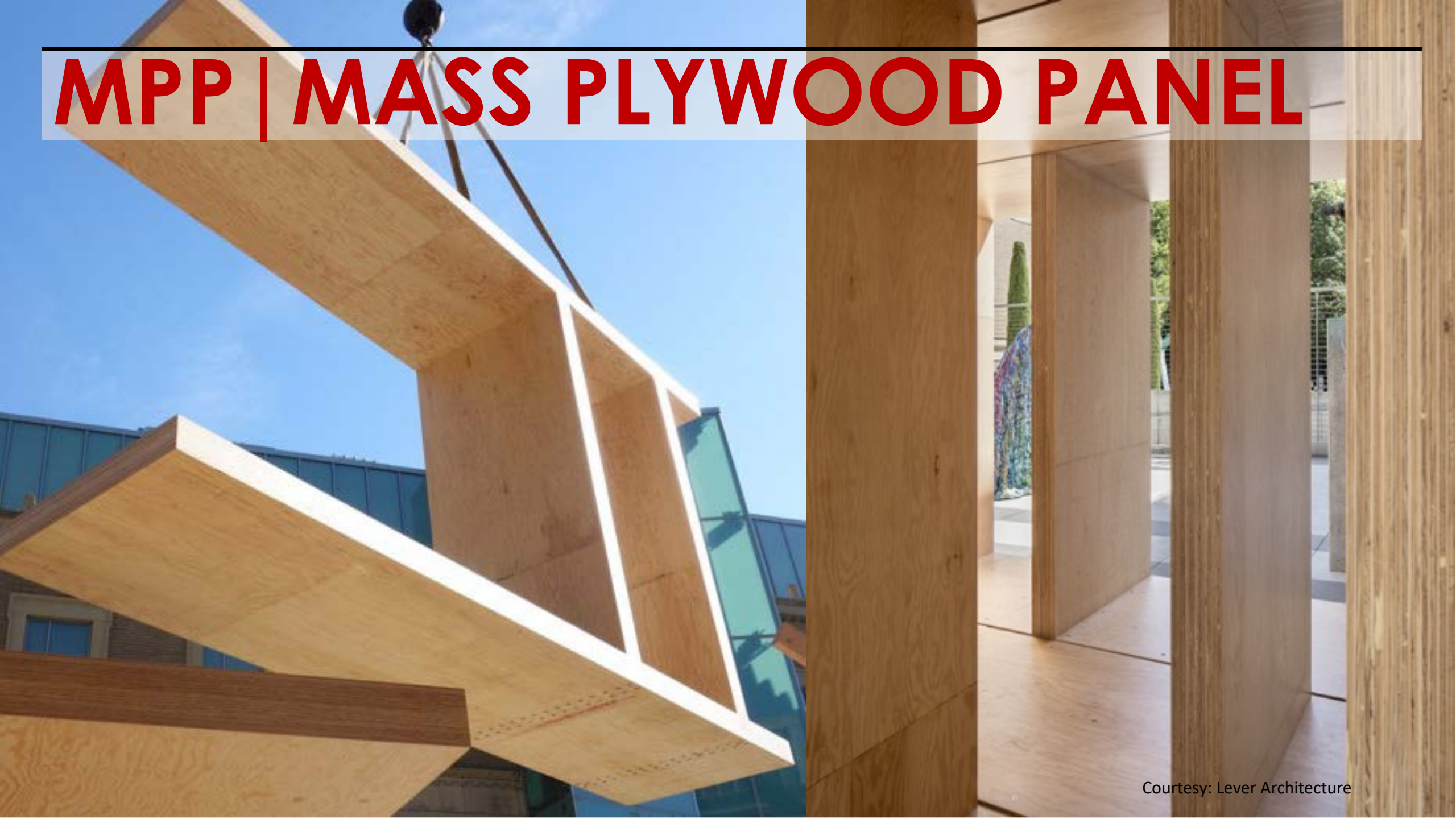
NUMEROUS LAYUP OPTIONS

PREFABRICATED CAPABILITIES

INCREASED STRUCTURAL CAPACITY

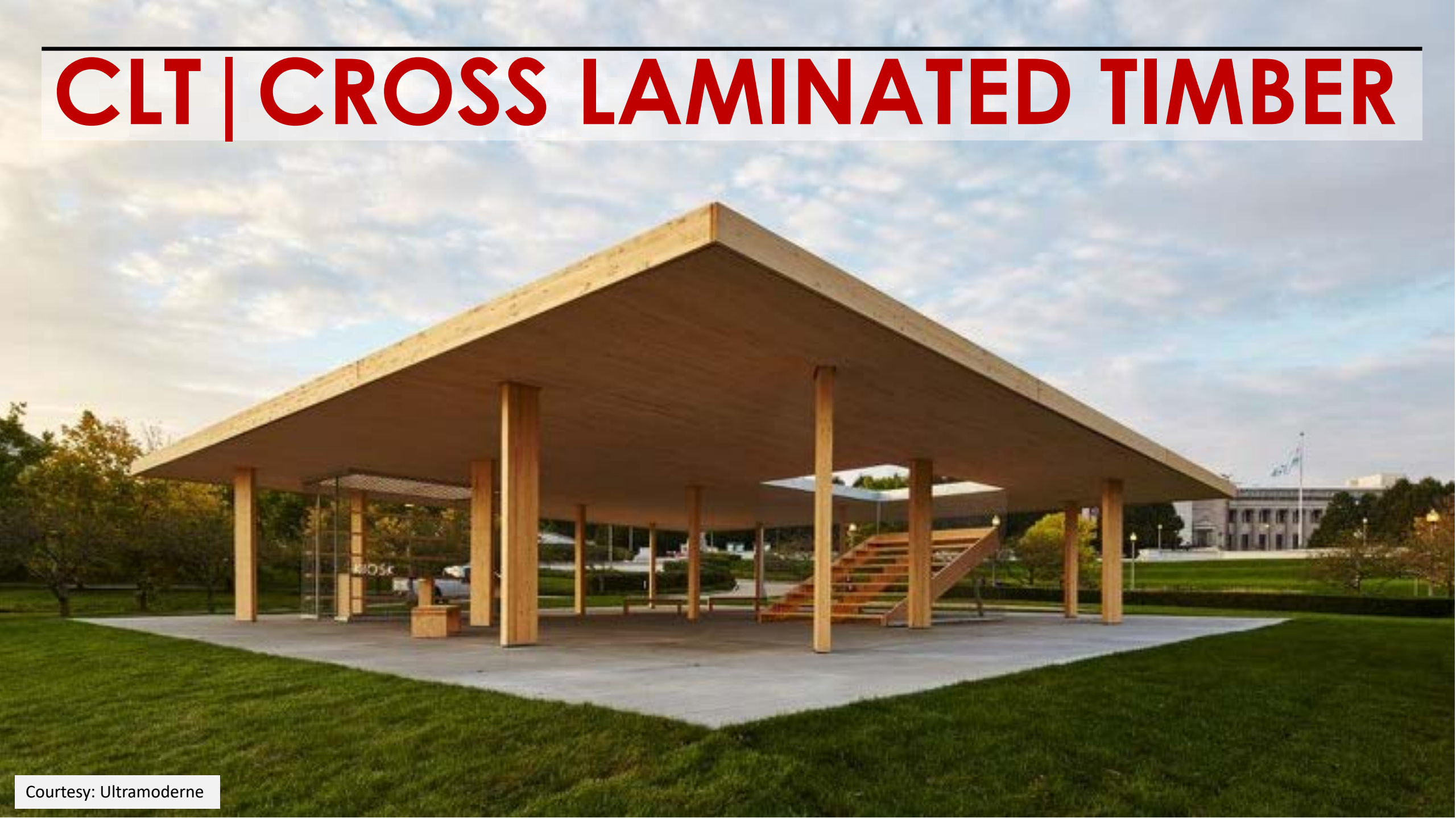
Courtesy: Freres Lumber & Lever Architecture

MPP | MASS PLYWOOD PANEL



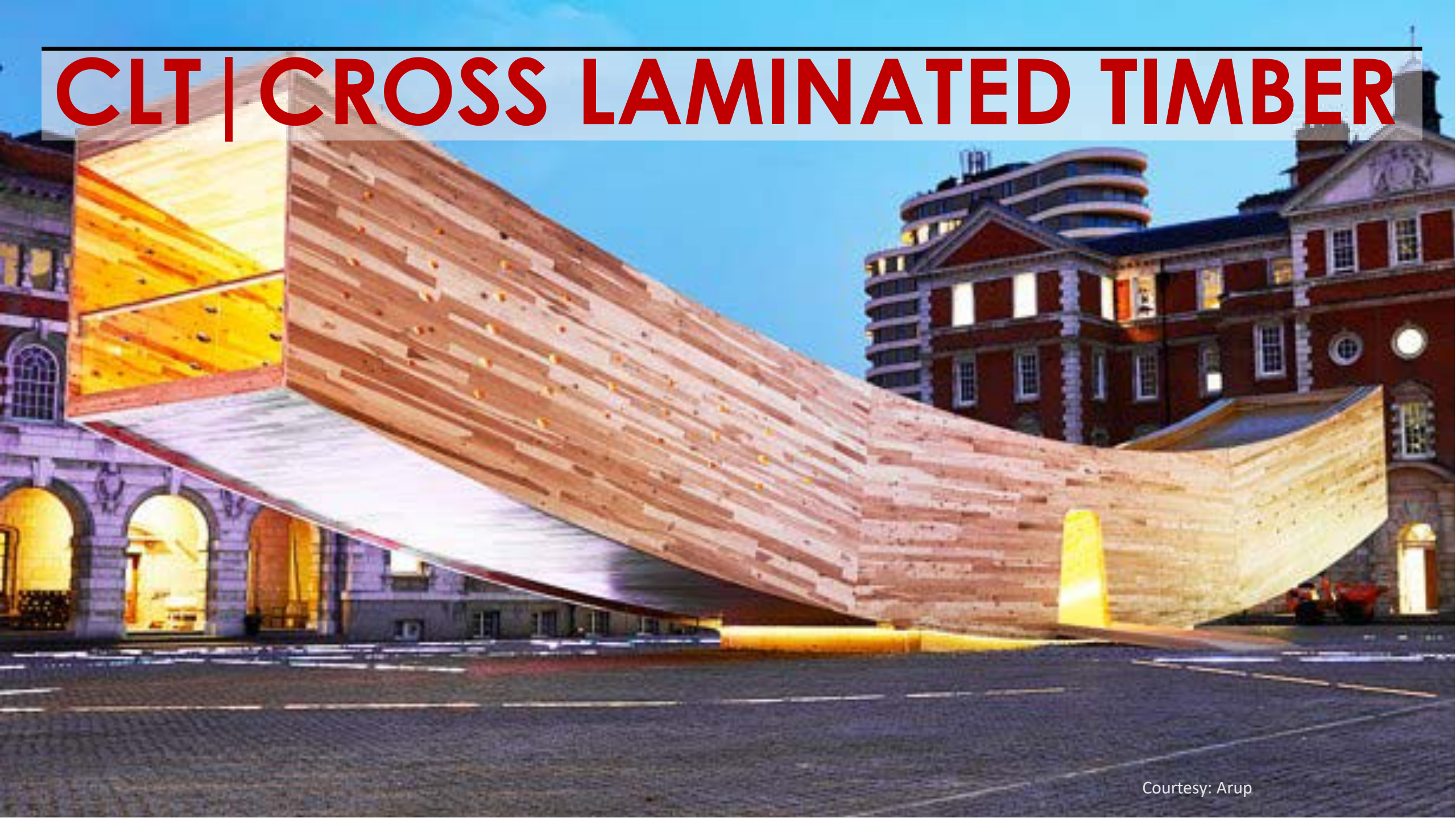
Courtesy: Lever Architecture

CLT | CROSS LAMINATED TIMBER



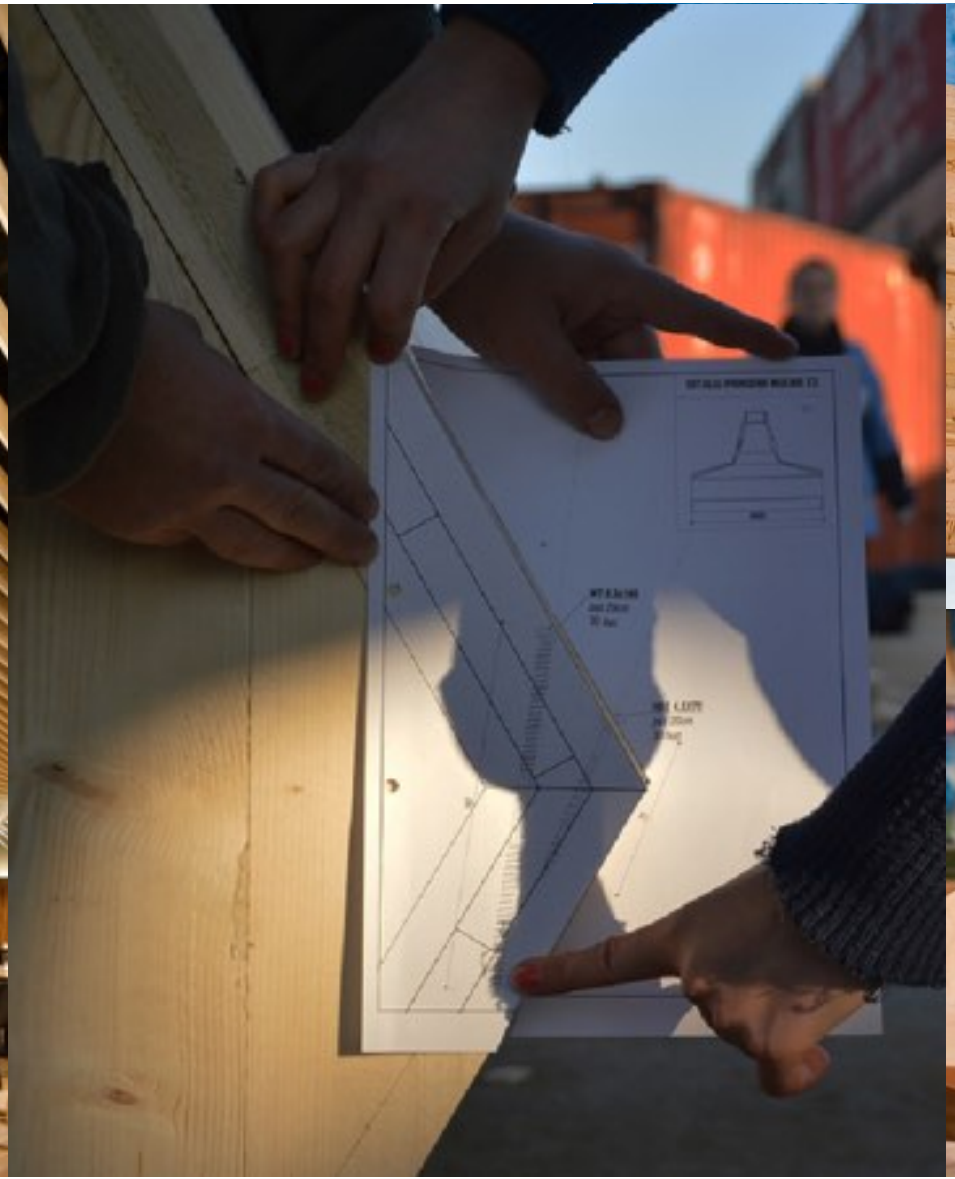
Courtesy: Ultramoderne

CLT | CROSS LAMINATED TIMBER



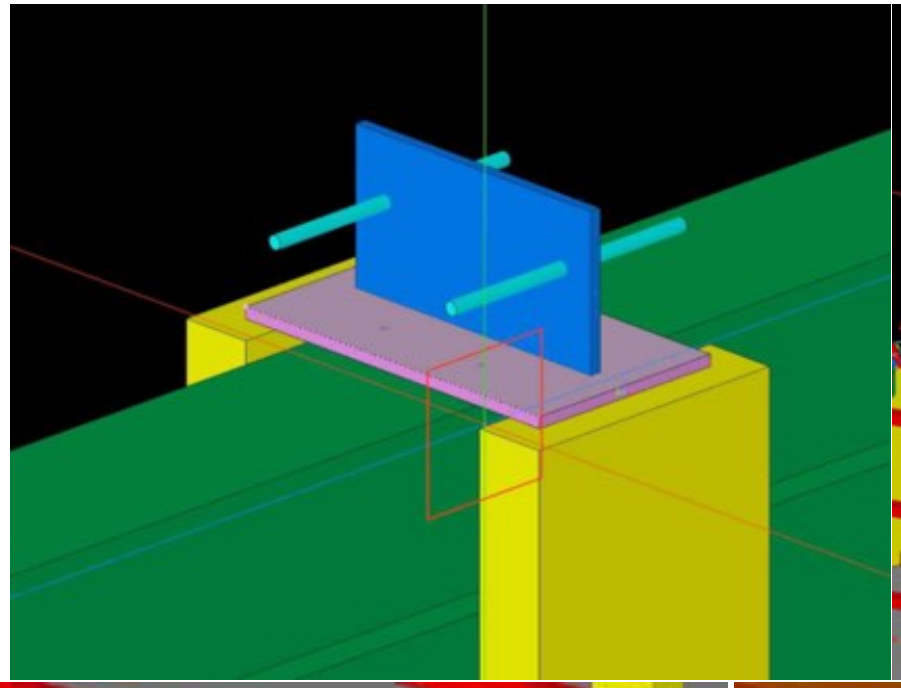
Courtesy: Arup

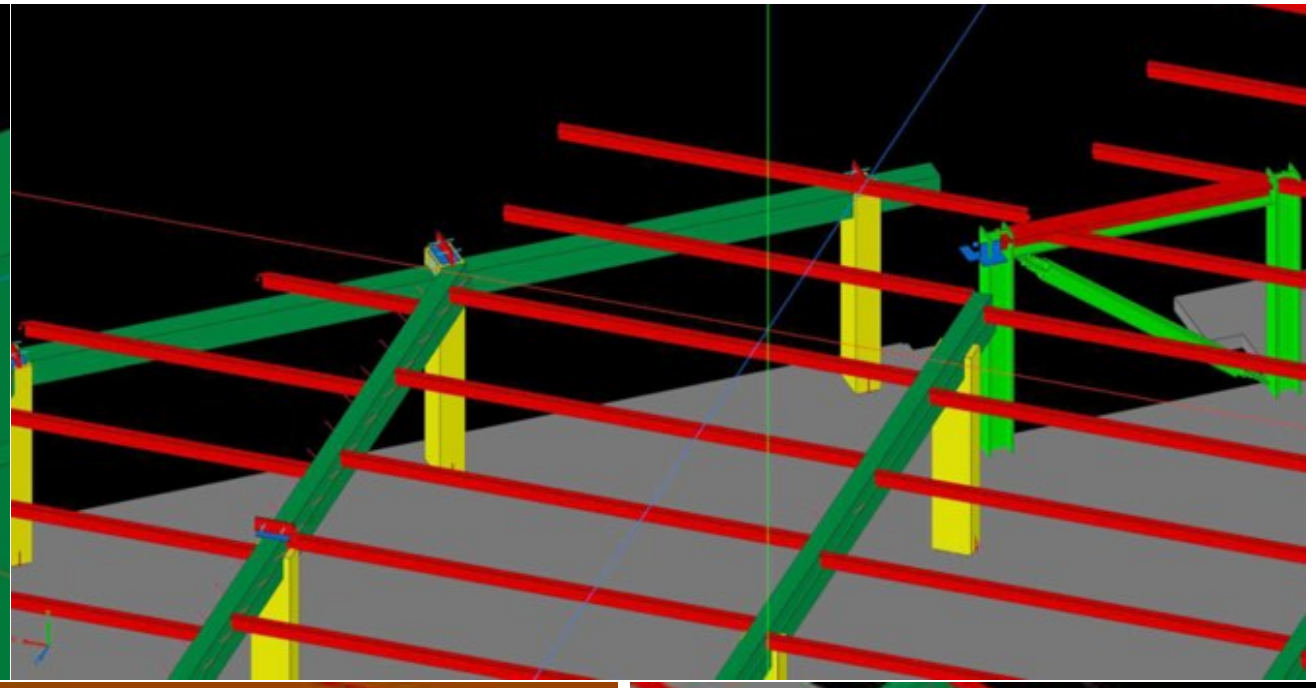
CNC FABRICATION

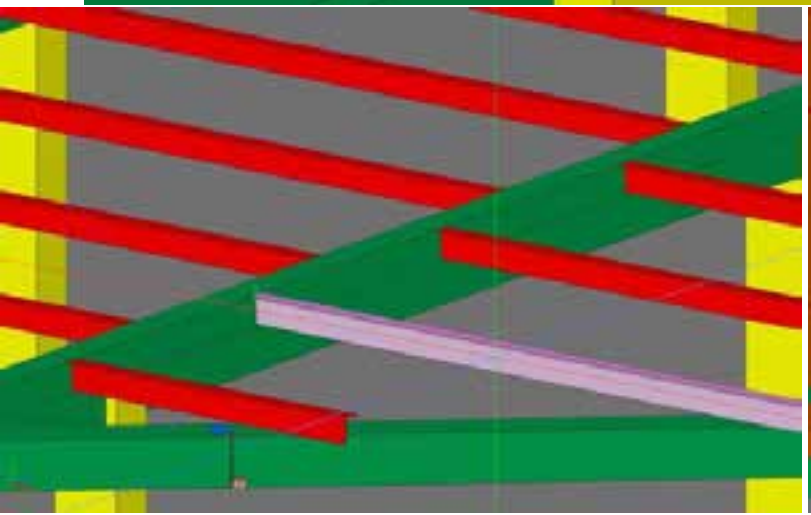


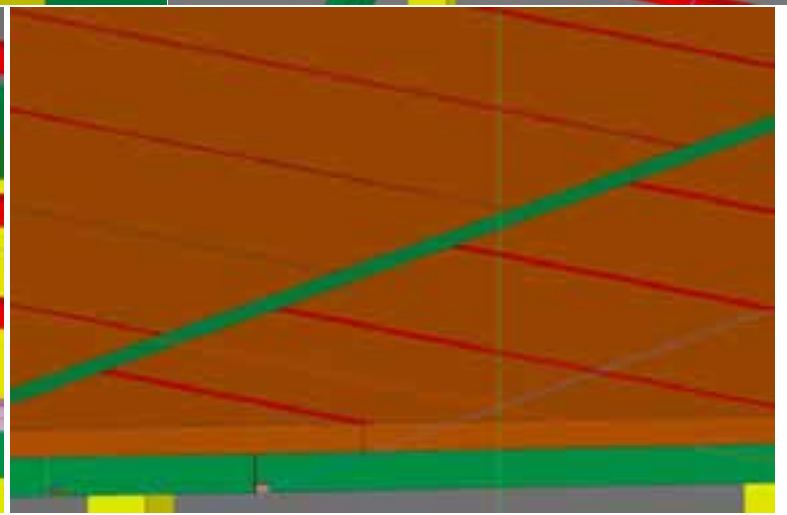
Courtesy: Smartlam

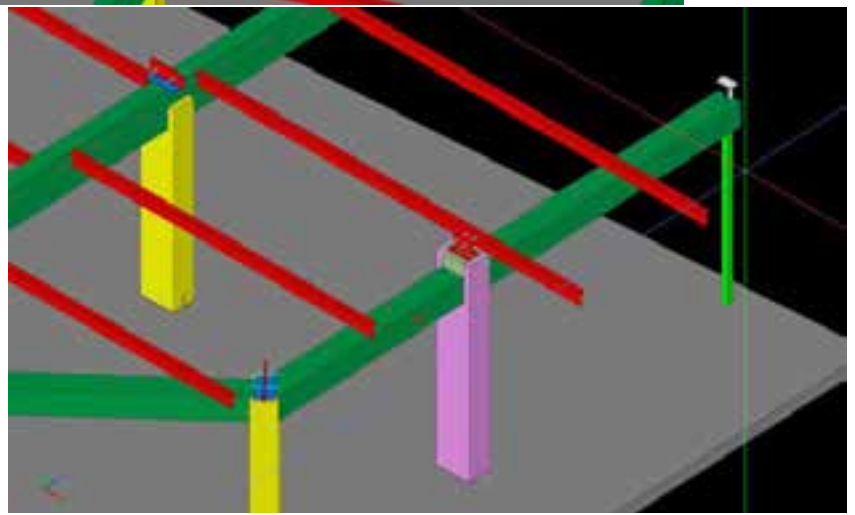
CNC FABRICATION











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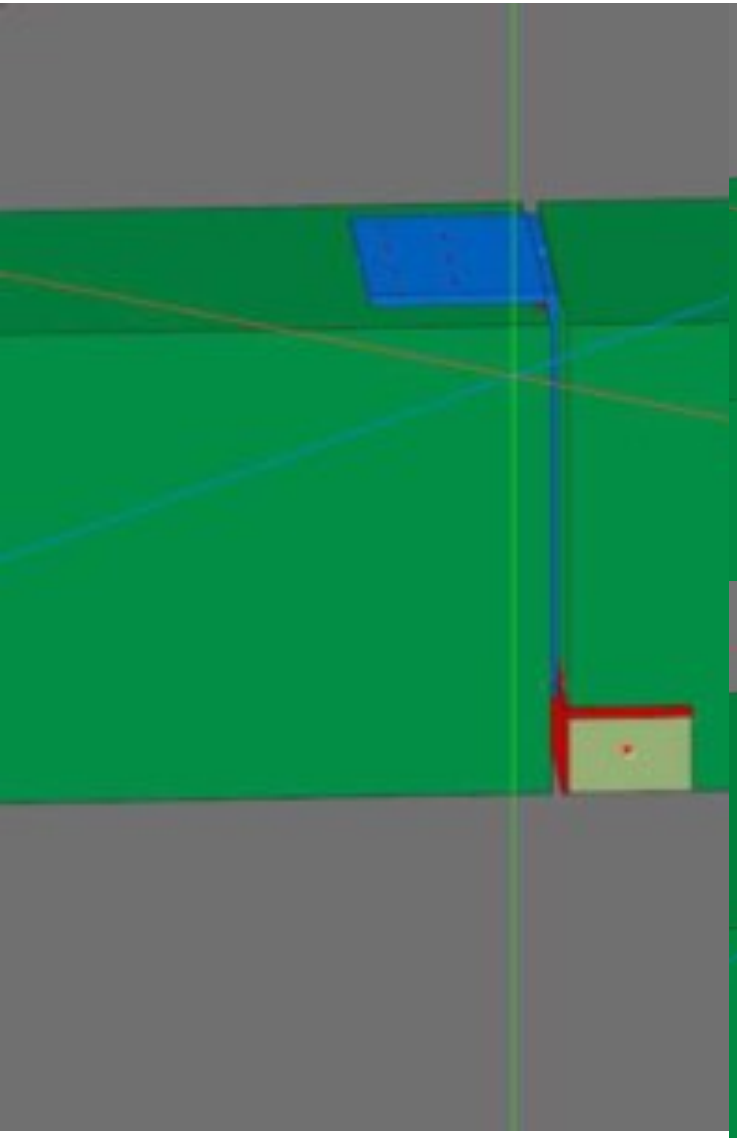
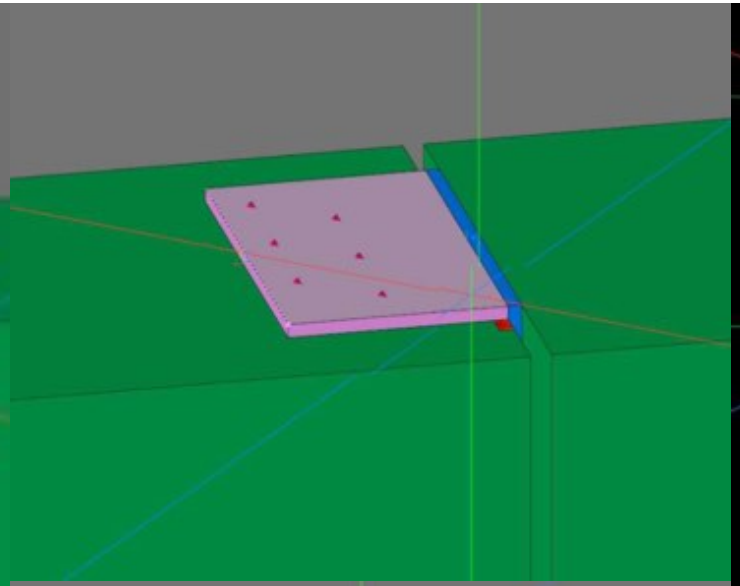
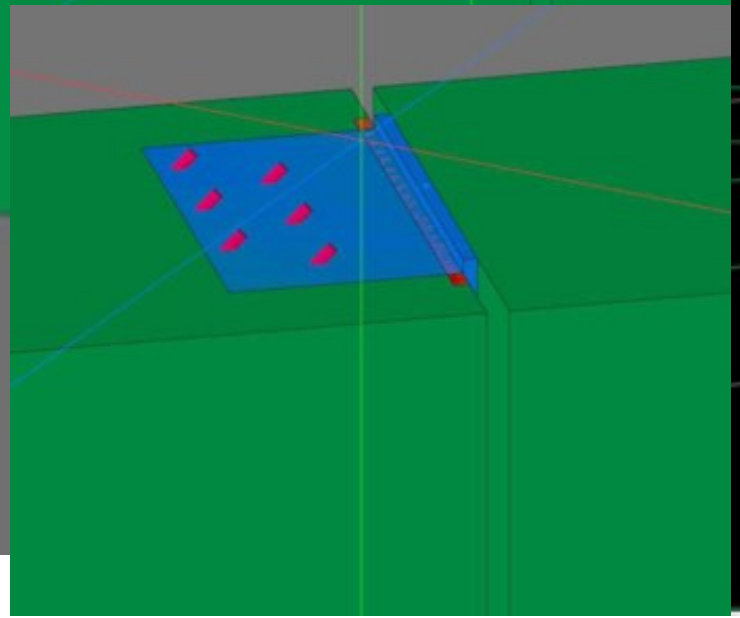
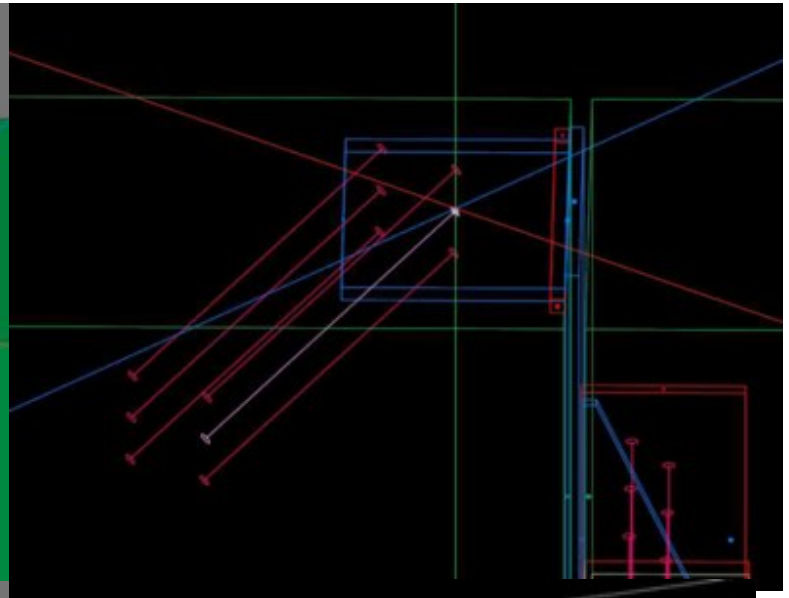
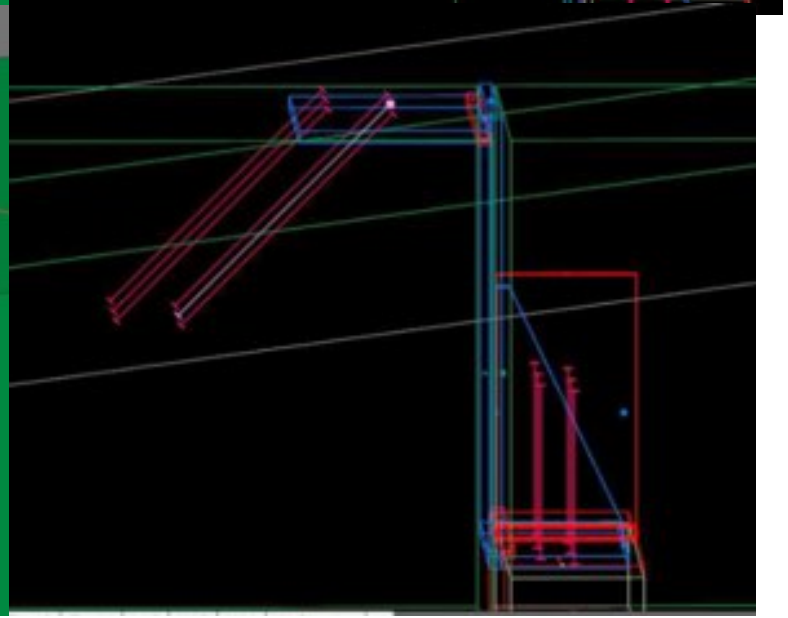










ACOUSTICS

LIMITED EXPERIENCE LEADS TO CONSERVATIVE DESIGN
FSTC RATINGS HAVE PROVEN TO BE HIGHER

STRUCTURALLY WHAT IS REQUIRED VS. ACOUSTIC REQUIREMENTS

Courtesy: UBC Media Relations

ACOUSTICS

Table 6

STC of CLT wall assemblies

Assembly Description from Top to Bottom (6.1)		STC
1	3-layer CLT panel of 3 3/4 in. ~ 4 1/2 in. (95 mm ~ 115 mm)	48 ~ 50
2	Mineral wool of about 1.18 in. (~ 30 mm)	
3	3-layer CLT panel of 3 3/4 in. ~ 4 1/2 in. (95 mm ~ 115 mm)	

Table 15

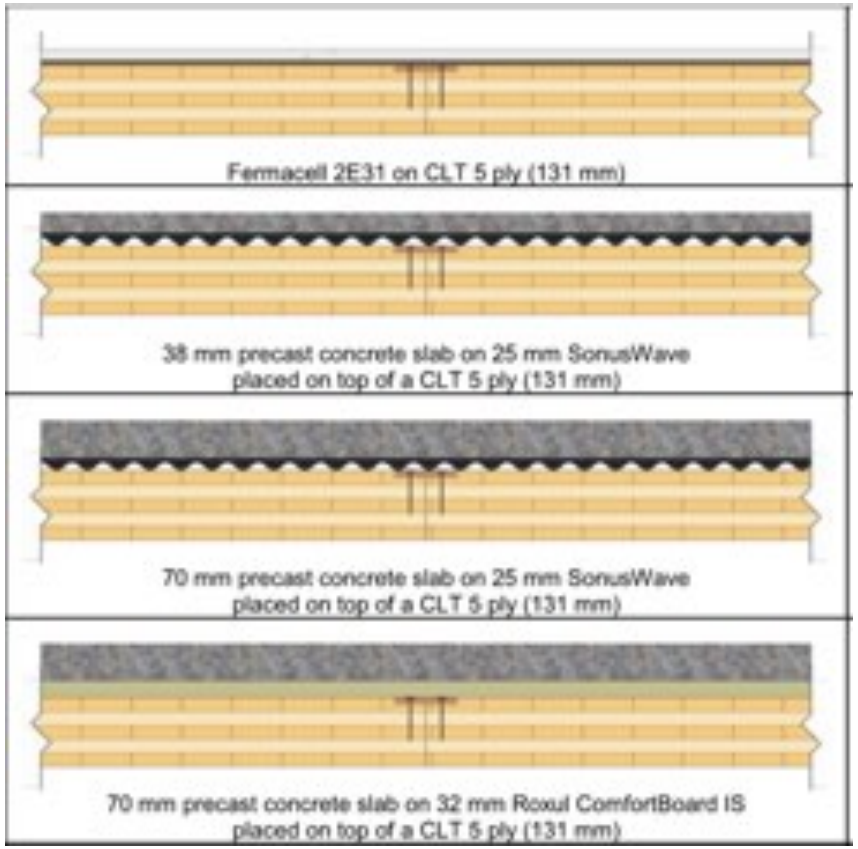
FSTC and FIIC of CLT floors with flooring and topping, wood exposed on ceiling side

Assembly Description from Top to Bottom (15.1)		FSTC	FIIC
1	About 2/5 in. (10 mm) carpet or floating flooring on 0.12 in. (3 mm) resilient underlayment (rubber mat, e.g. InsonoBois or similar; textured felt, e.g. Thermason HD or similar)	>45 Depending on the thickness of CLT, topping and flooring	>45 Depending on the thickness of CLT, topping and flooring, and the type of flooring, topping and underlayment
2	At least 5.12 lb./ft.^{2} (25 kg/m^2) dry topping, e.g. 0.8 in. (20 mm) Fermacell, cement fiberboard, Fibrerock or similar		
3	Resilient underlayment, e.g. 2/5 in. (10 mm) rubber mat (IsonoMat), 3/4 in. (18 mm) textured felt (Felt S-125), 1/2 in. (12 mm) low density wood fiberboard, or similar		
4	5-layer CLT of 6 7/8 in. (175 mm)		

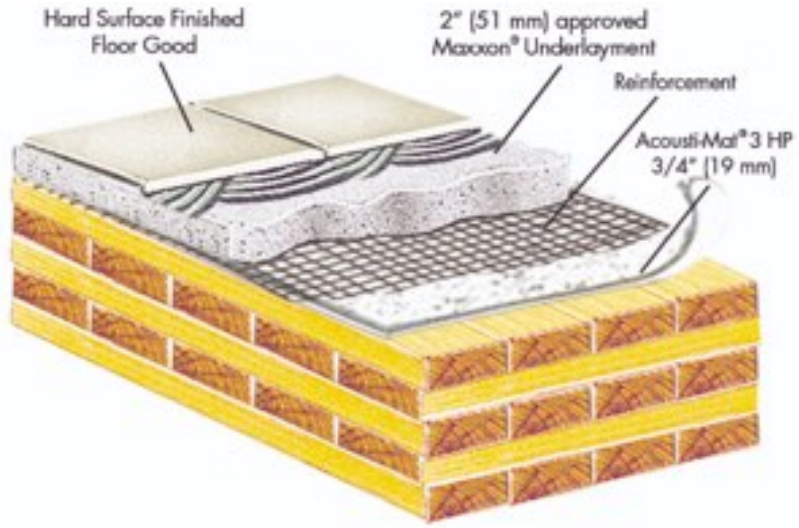
Images from CLT Handbook

ACOUSTICS

RECENT TESTING = ENHANCED ASSEMBLIES



Courtesy: AcoustiTech



Courtesy: Maxxon

AESTHETIC

- Aesthetics
- Cost

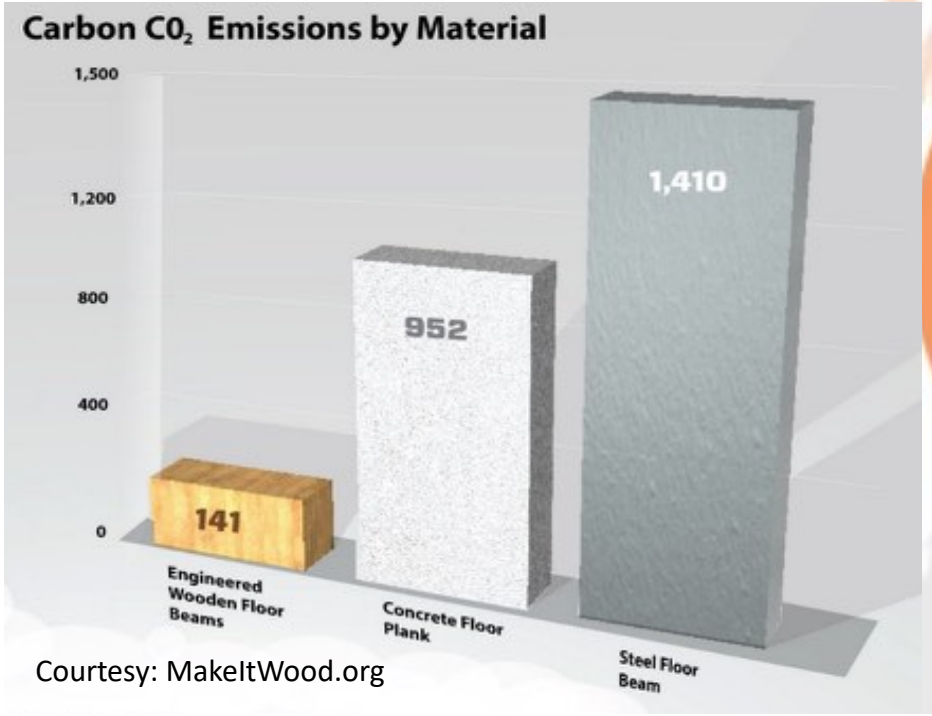
- Project Delivery
- Fire Requirements

Courtesy: Ramcet

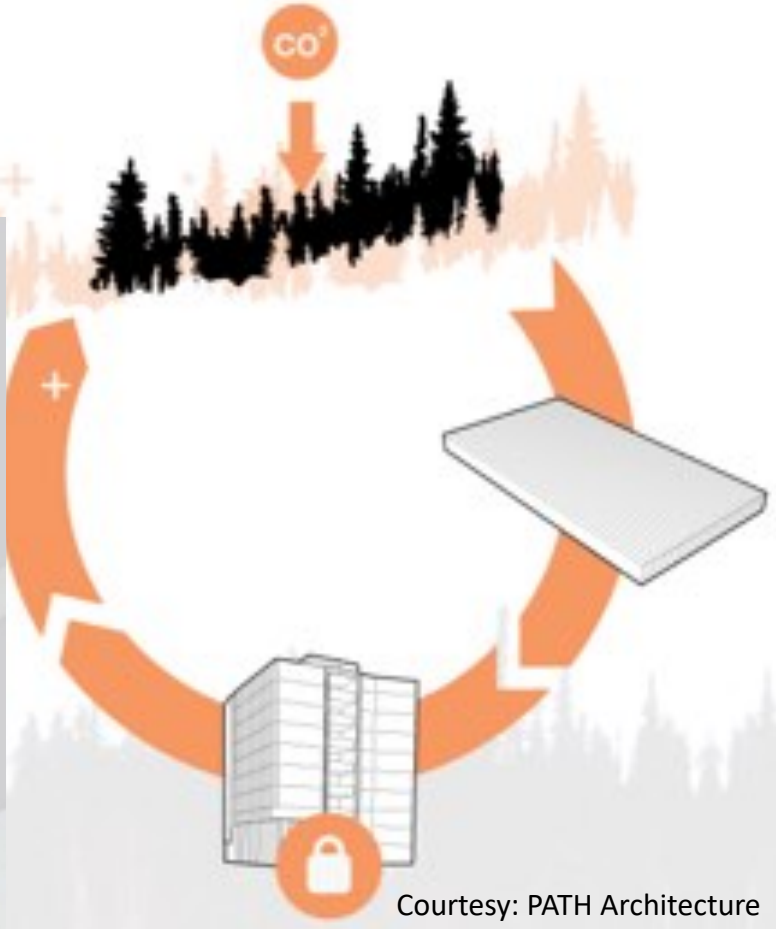
- Proprietary or Custom
- Hidden Connections

BENEFITS OF WOOD

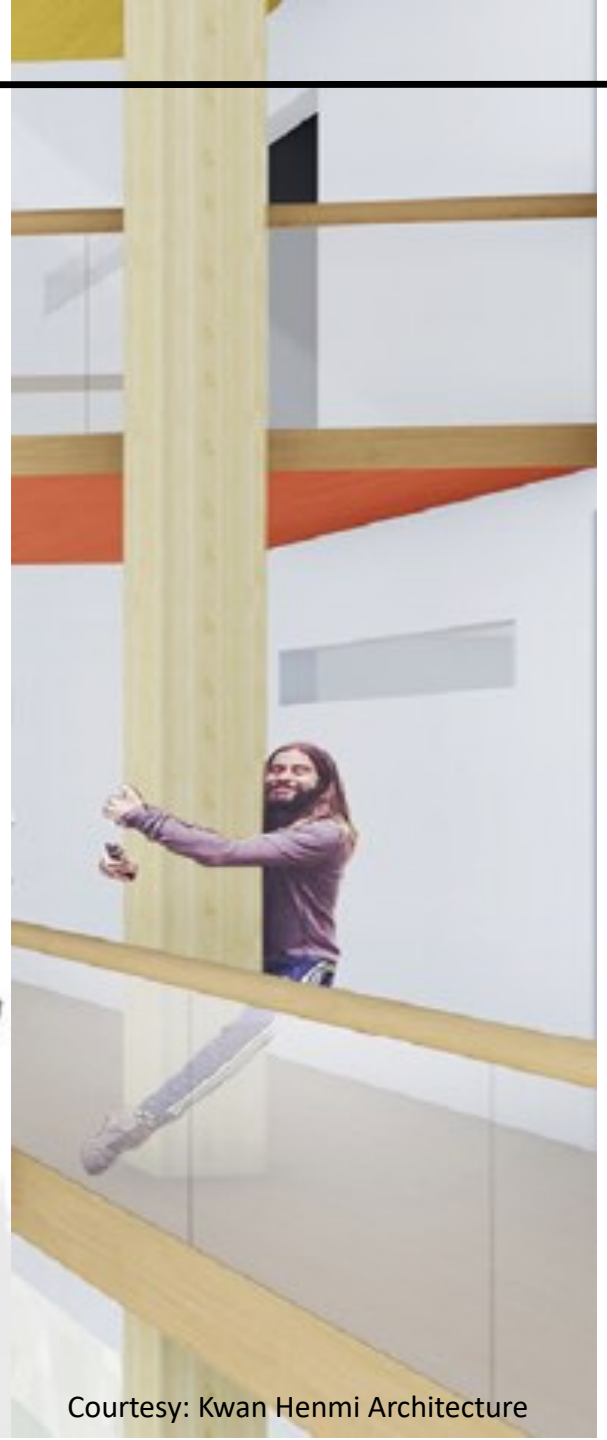
CARBON SEQUESTRATION
RENEWABLE RESOURCE
SUSTAINABILITY



Courtesy: MakeItWood.org



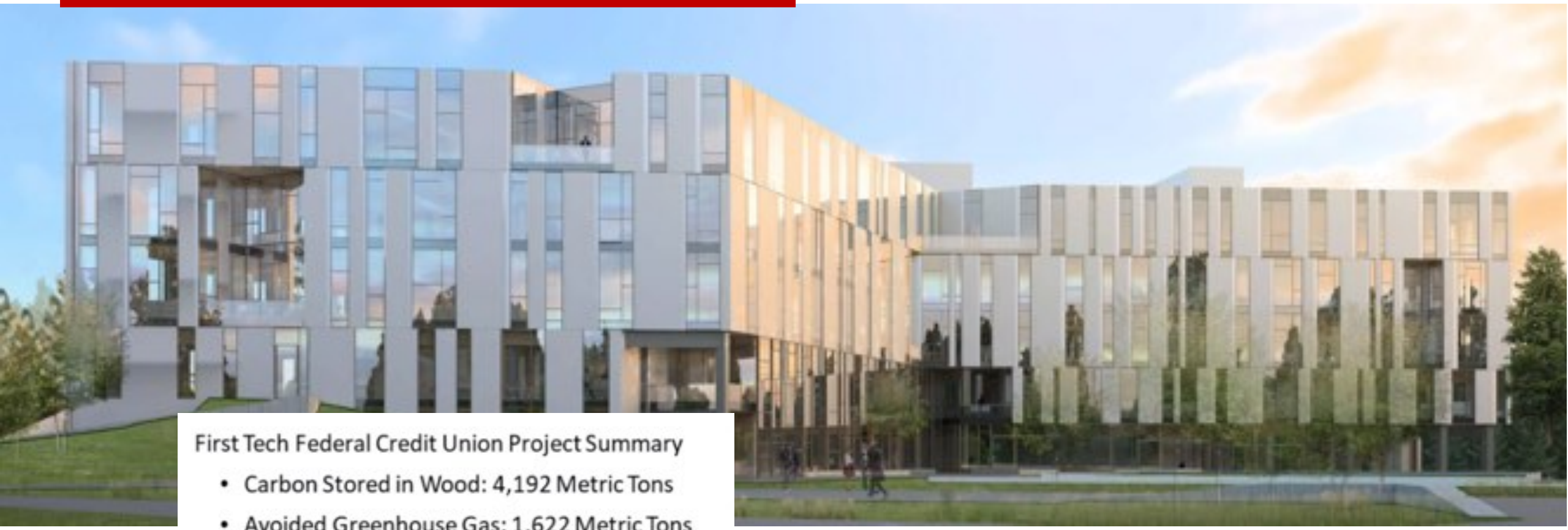
Courtesy: PATH Architecture



Courtesy: Kwan Henmi Architecture

BENEFITS OF WOOD

QUANTIFYING SUSTAINABILITY



First Tech Federal Credit Union Project Summary

- Carbon Stored in Wood: 4,192 Metric Tons
- Avoided Greenhouse Gas: 1,622 Metric Tons
- Equivalent to Removing 1,229 Cars for a Year
- **Time for Oregon to regrow wood used: 46 Min.**

Courtesy: Swinerton Builders

BENEFITS OF WOOD

QUANTIFYING BIOPHILIA

Lower blood pressure Ulrich *et al.* (1991), Parsons *et al.* (1998) ,Hartig *et al.* (2003)

Lower heart rate Laumann *et al.* (2003)

Faster recover from illness Ulrich (1984)

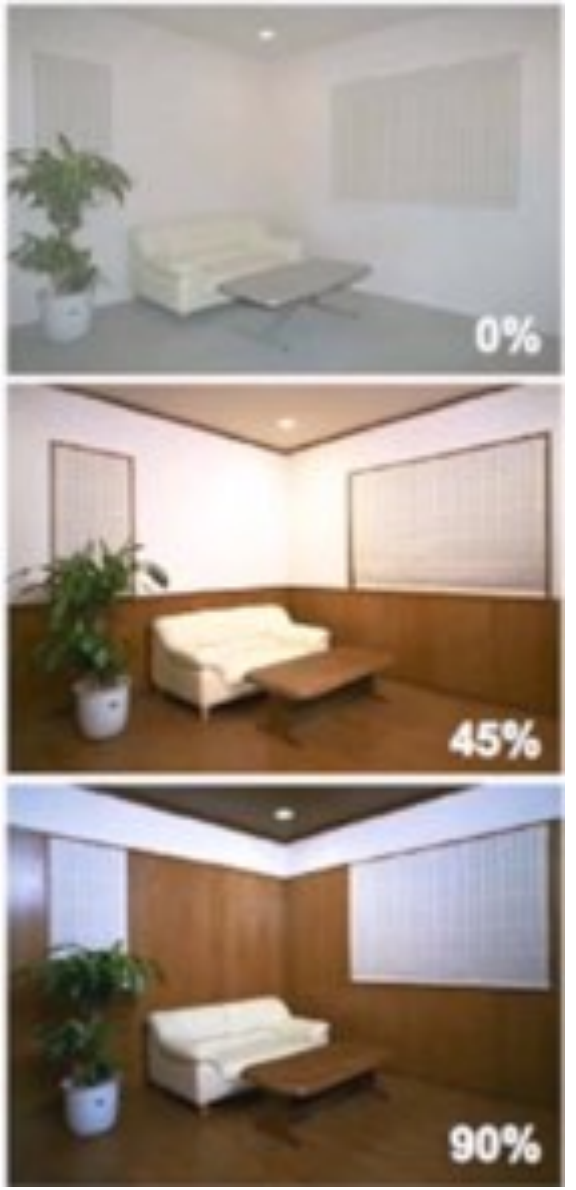
Lower pain perception Lohr and Pearson-Mimms, 2001

Better creative task performance Shibata and Suzuki, 2004

Better concentration task performance Hartig *et al.* (1991), Cimprich (1992)

Greater focused attention Tennessen and Cimprich (1995), Hartig *et al.* (2003)

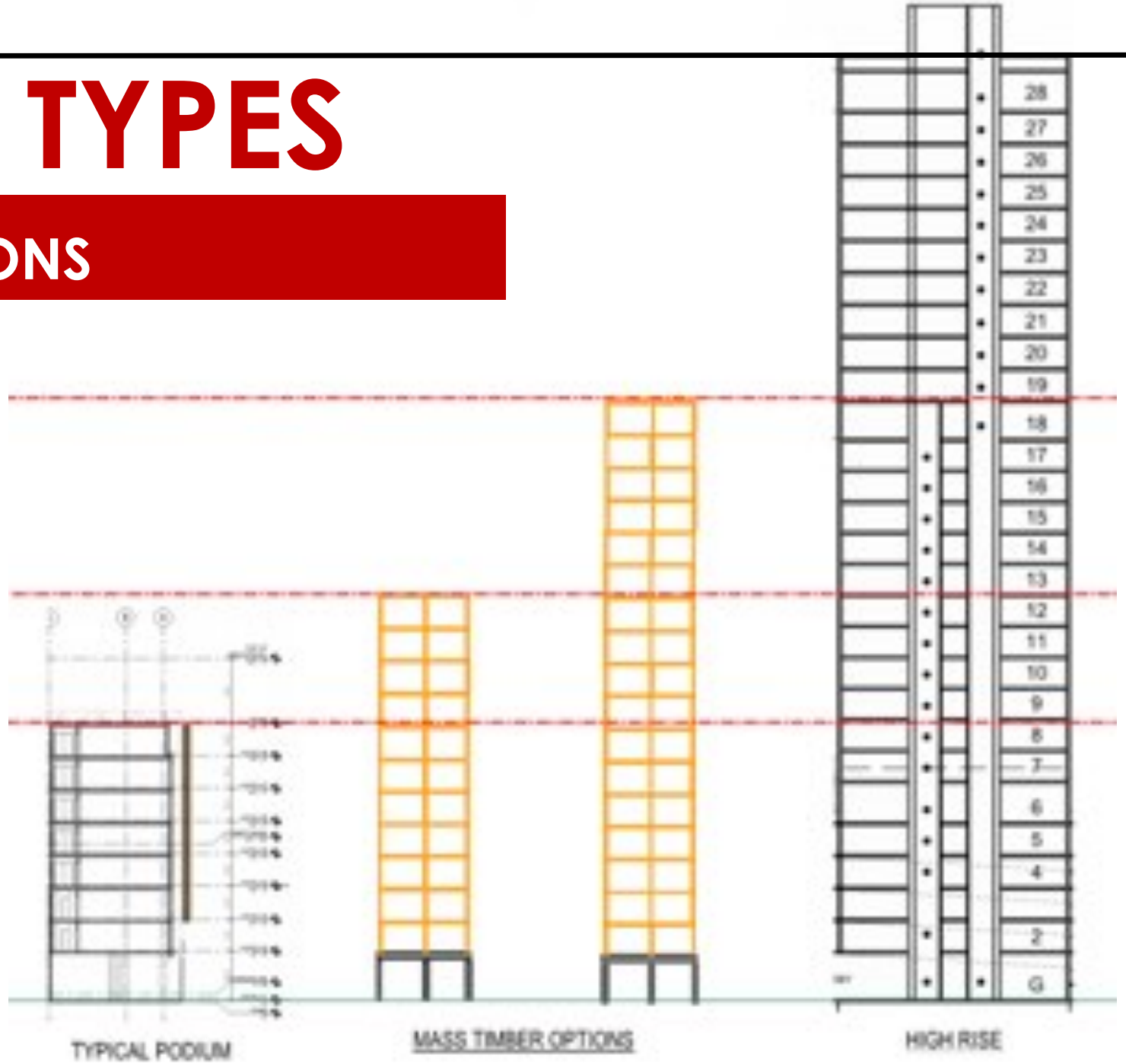
Lower aggression Kuo and Sullivan, 2001



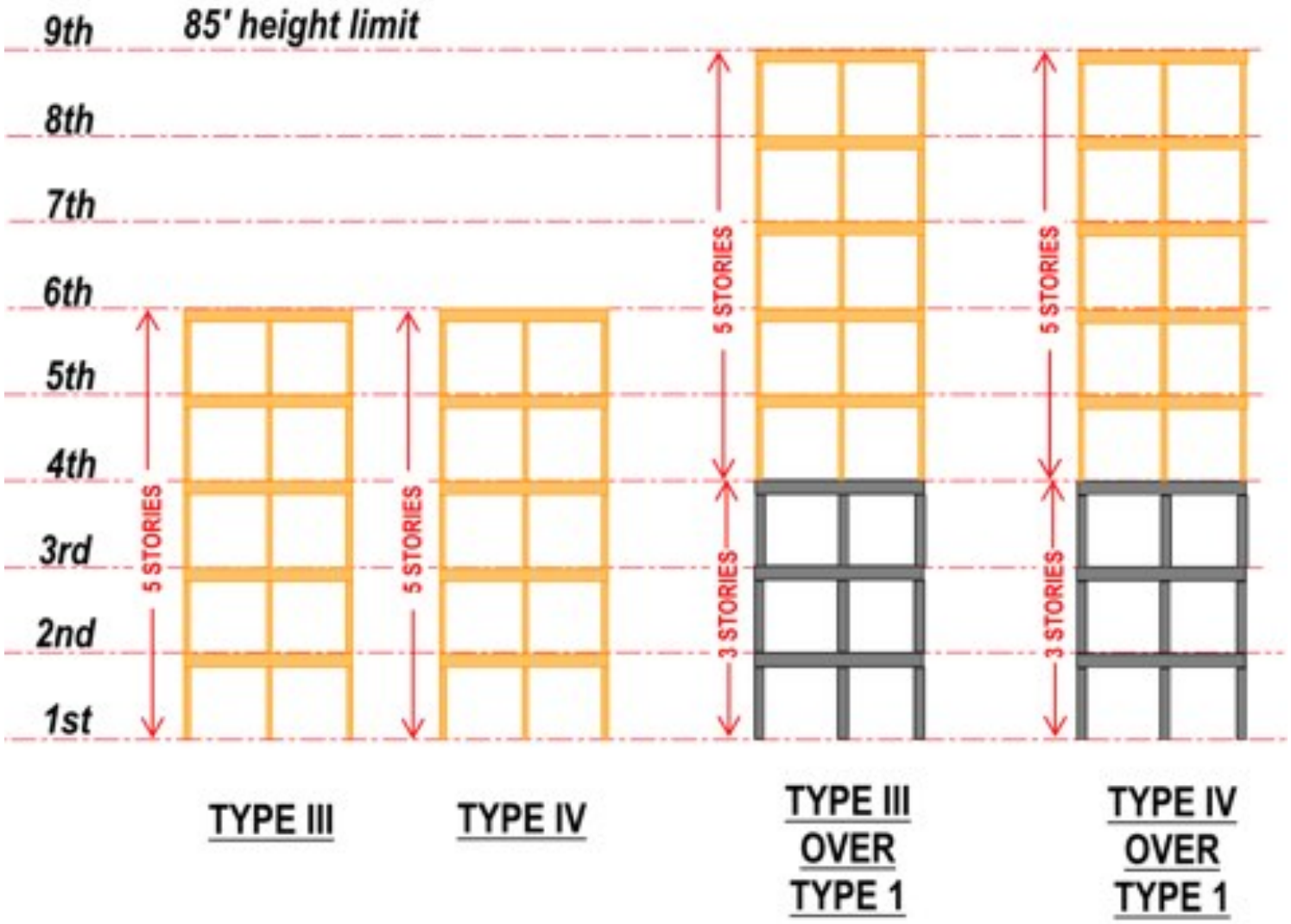
Credit: David Fell, FP innovations

PROJECT TYPES

MASS TIMBER OPTIONS



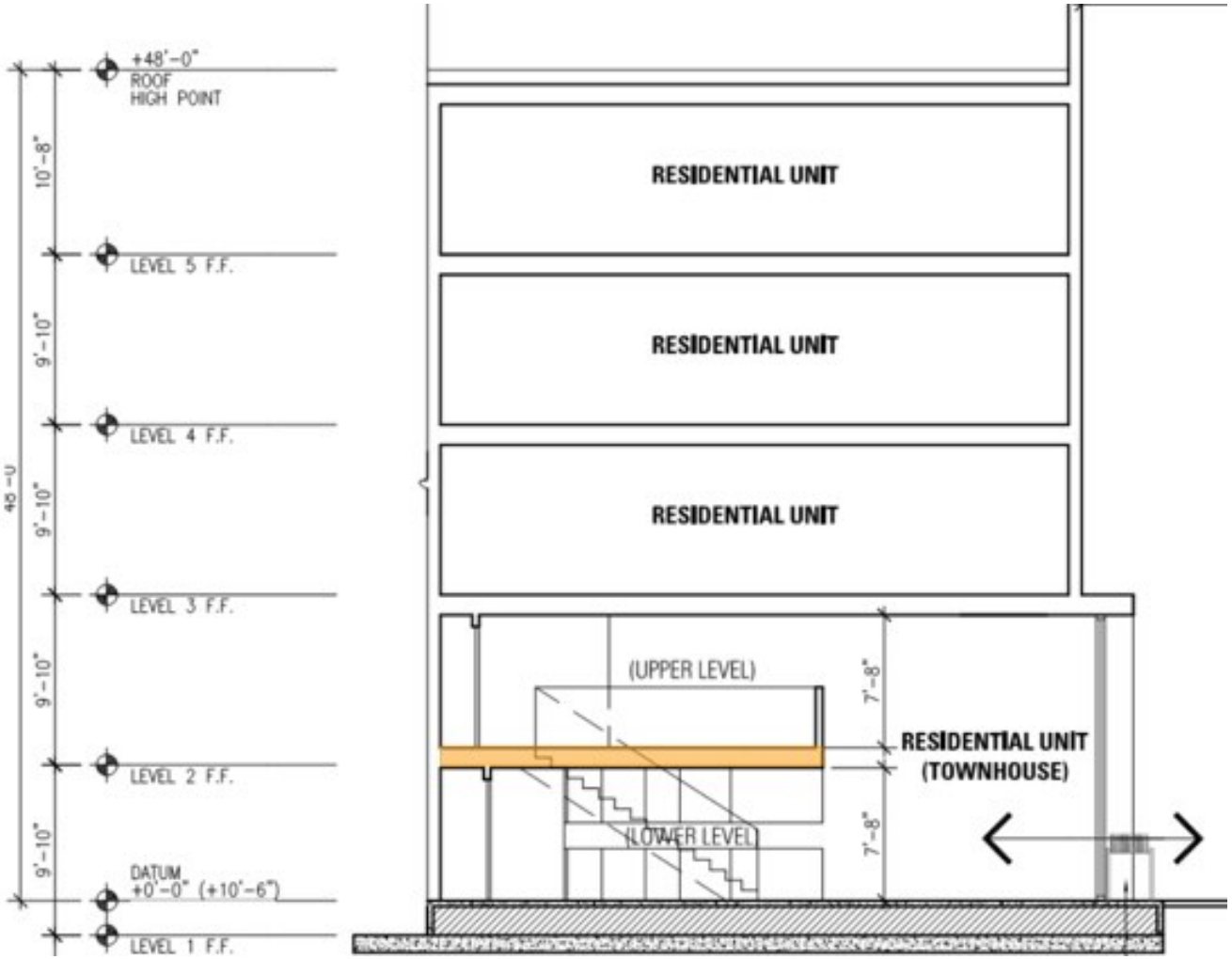
PROJECT TYPES

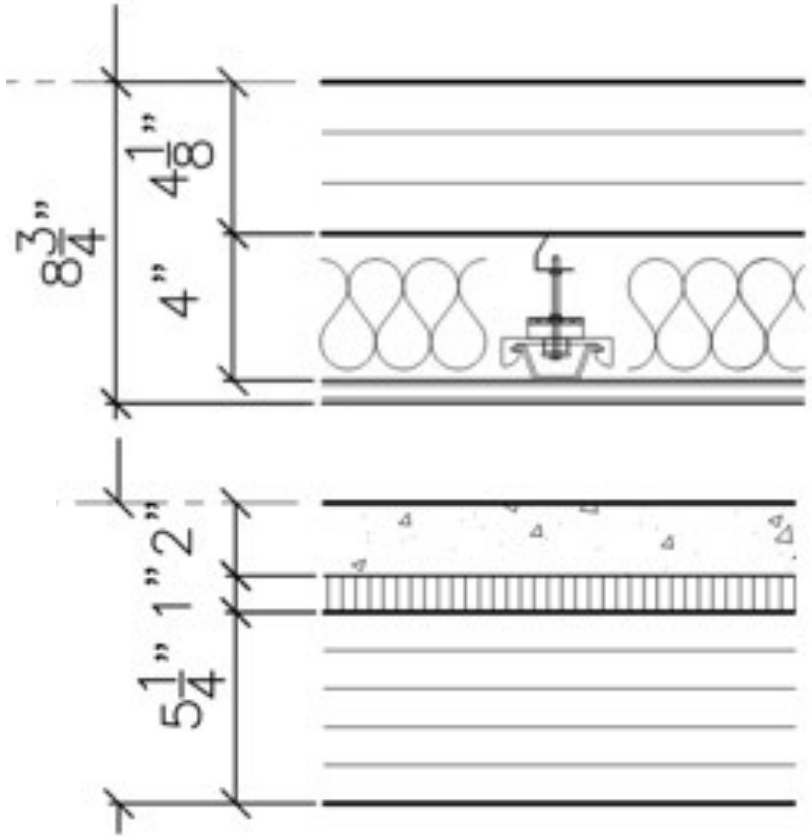


OPTIONS CURRENTLY AVAILABLE IN 2018 IBC

PROJECT TYPES

TYPE III & TYPE V





SPEED AND COST

Courtesy: Beacon Builders

SPEED AND COST

Courtesy: Beacon Builders

SPEED AND COST

FASTER CONSTRUCTION

SMALLER WORKING CREW

PREFABRICATED ELEMENTS

FEWER RFI'S IN THE FIELD

Courtesy: Structurlam

SPEED AND COST

Logistics of Labor

SUPPLY CHAIN

VAAGEN TIMBERS

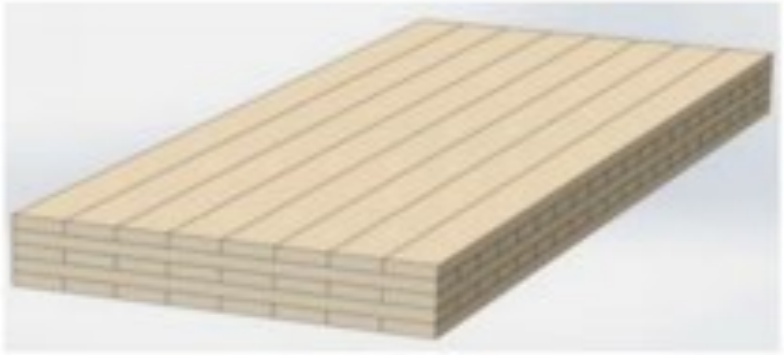
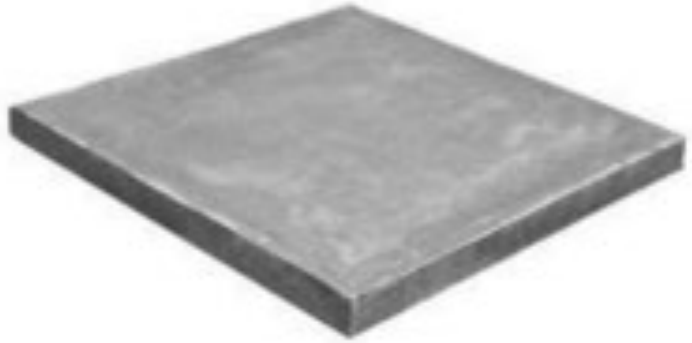
Freres LUMBER CO., INC.

KATERRA

STERLING

LignaTerra

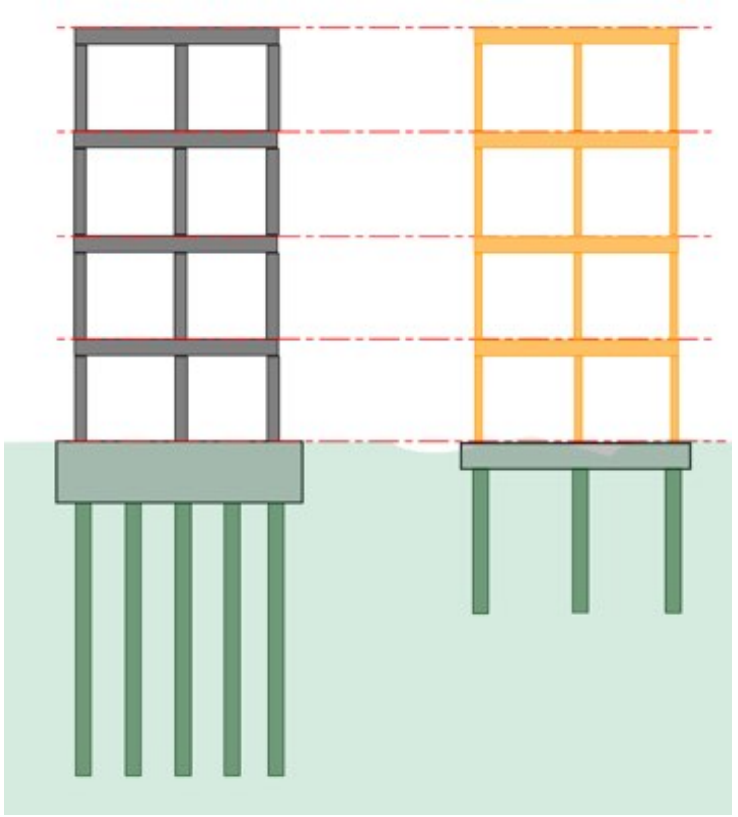
TYPES OF MASS TIMBER

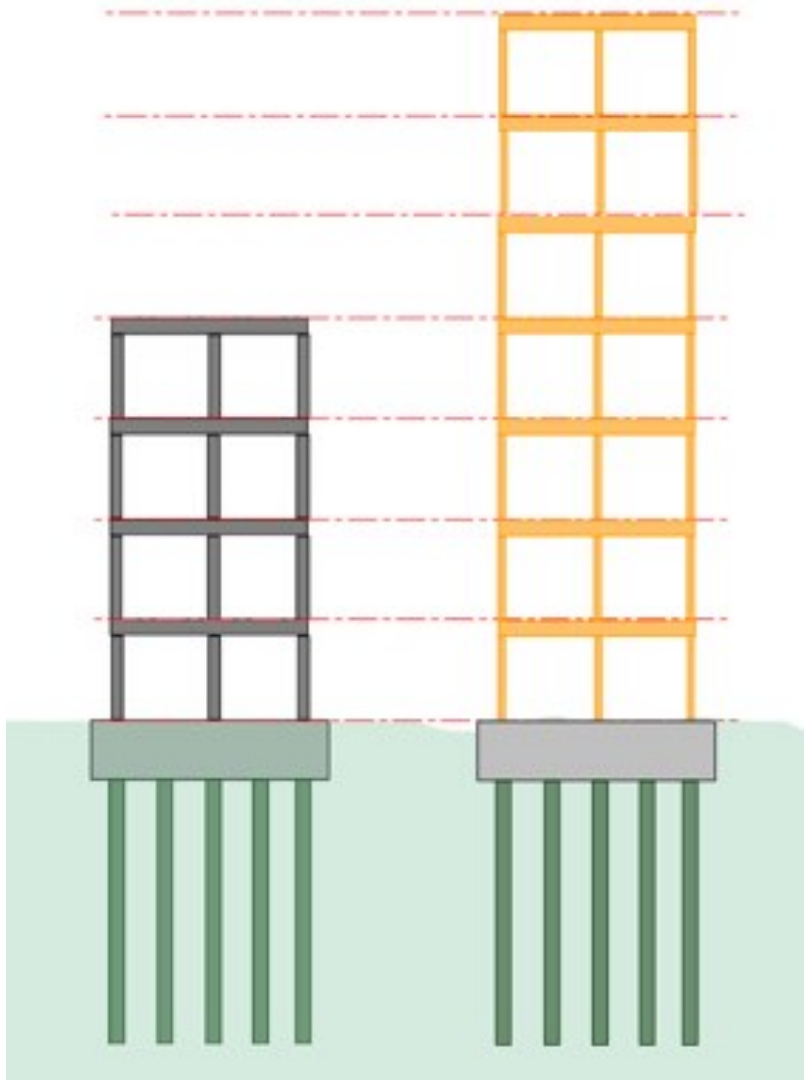
		
DESCRIPTION	5 PLY CLT PANEL	CONCRETE SLAB
THICKNESS	6.66"	6.66"
WEIGHT	17 PSF	84 PSF

SPEED AND COST

Raw Statics

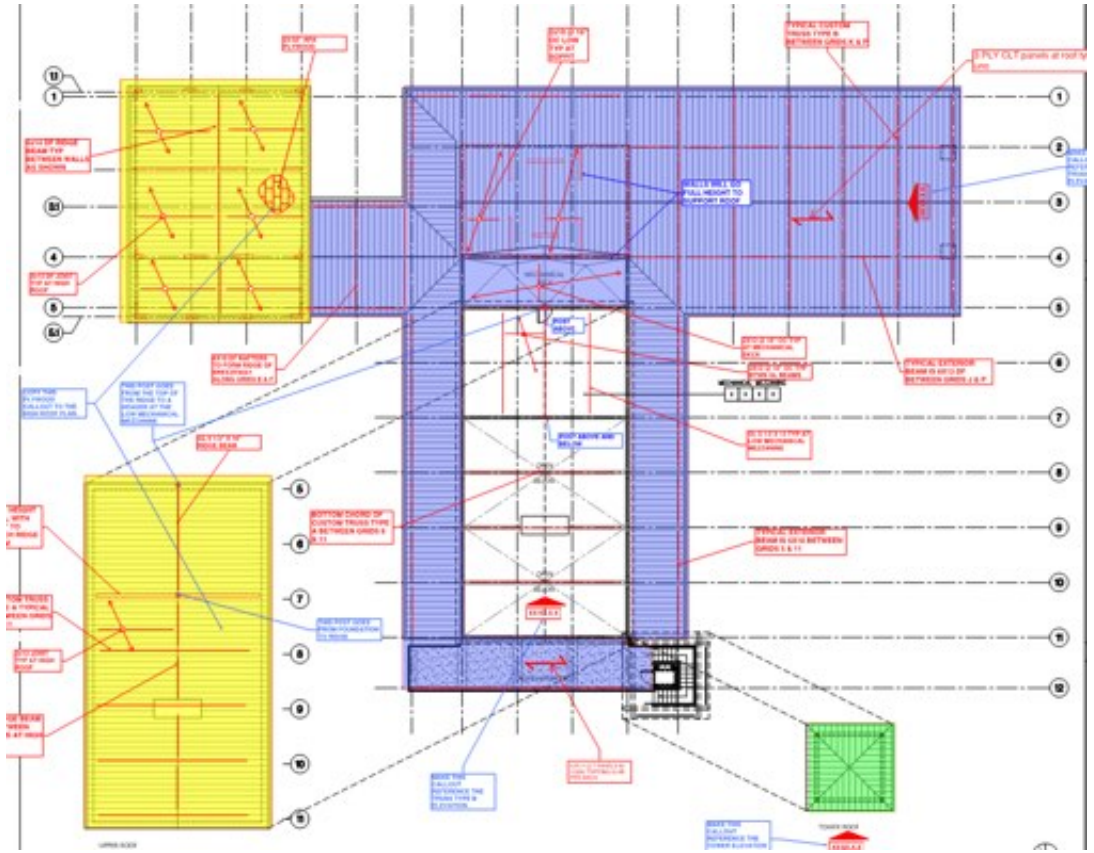
- Reduced Weight
- Foundations
- Seismic

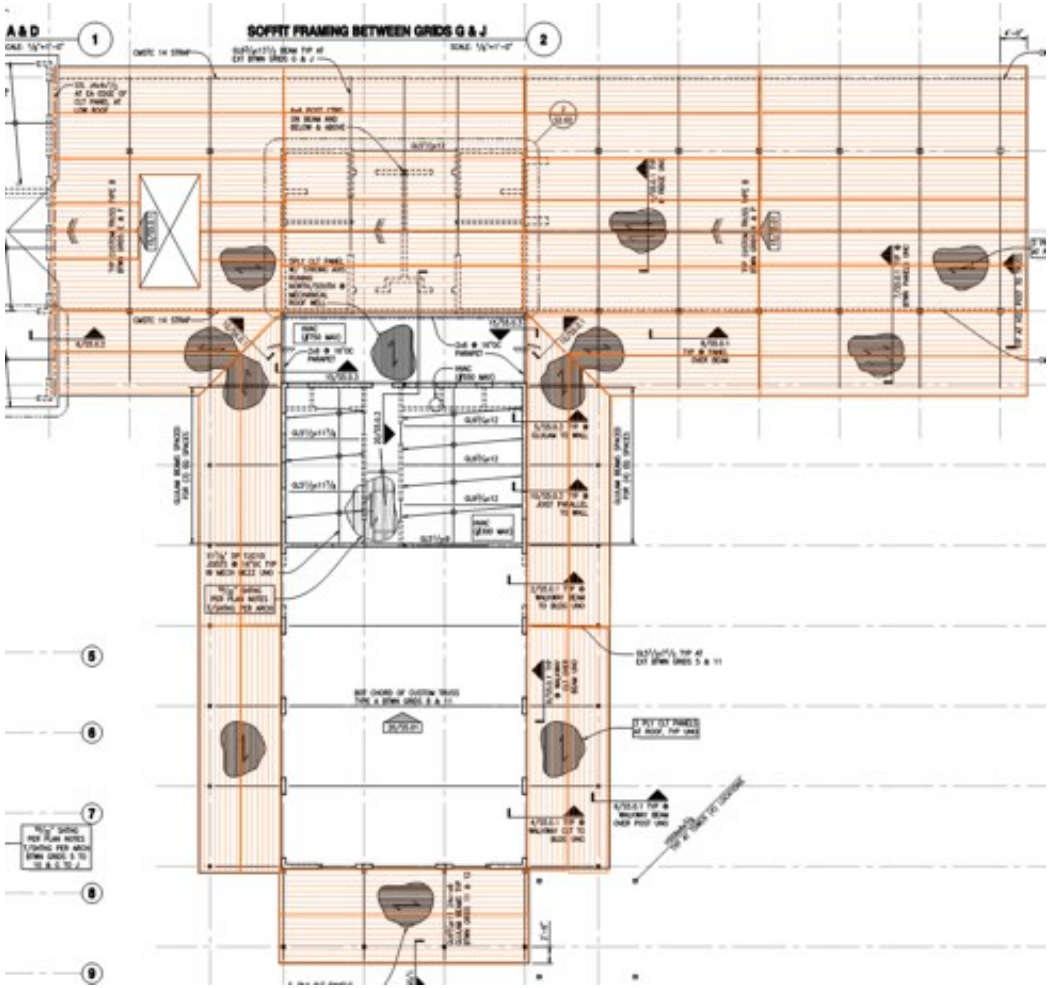




PROJECT TYPES

TYPE III & TYPE V

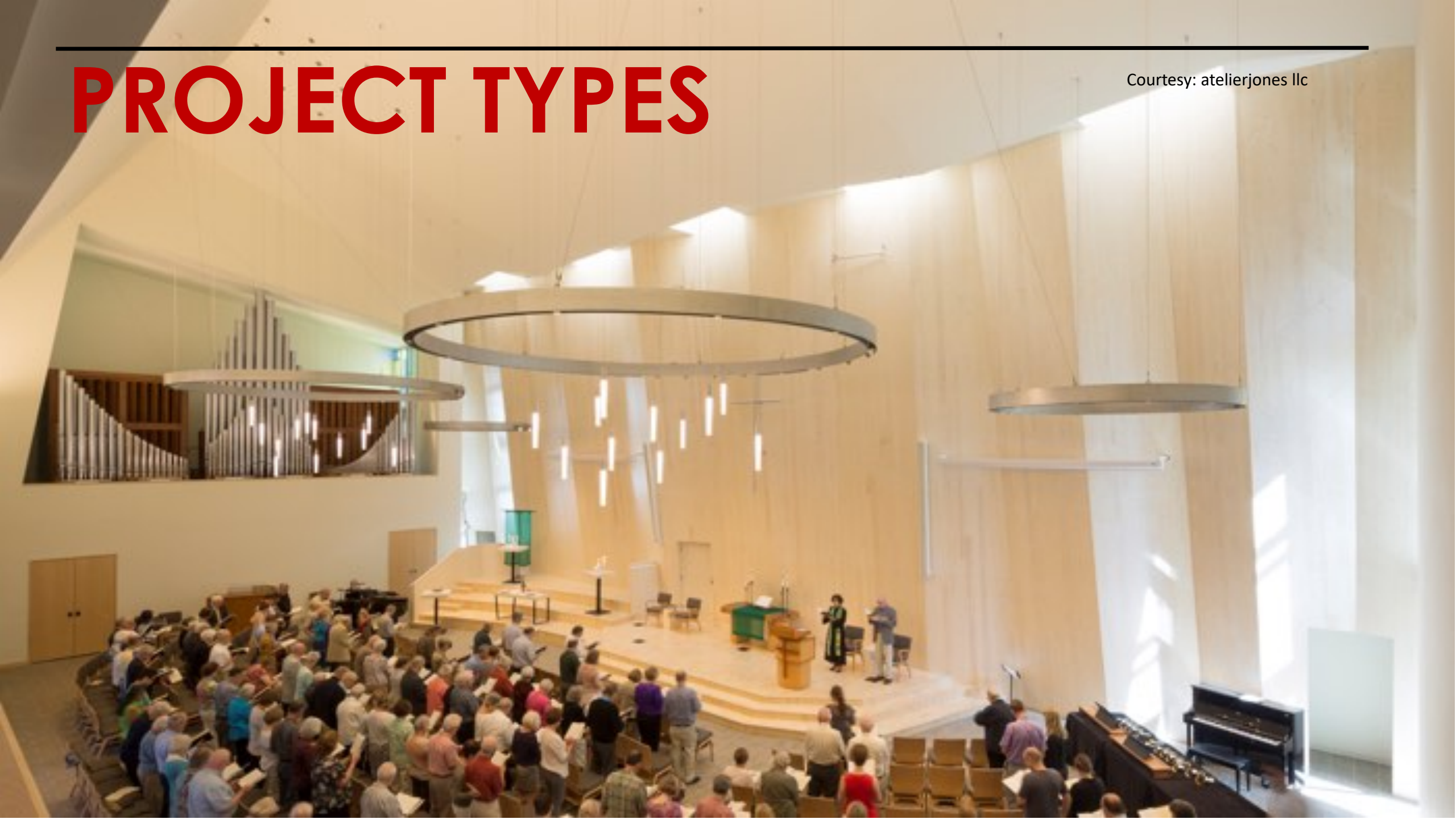




PROJECT TYPES

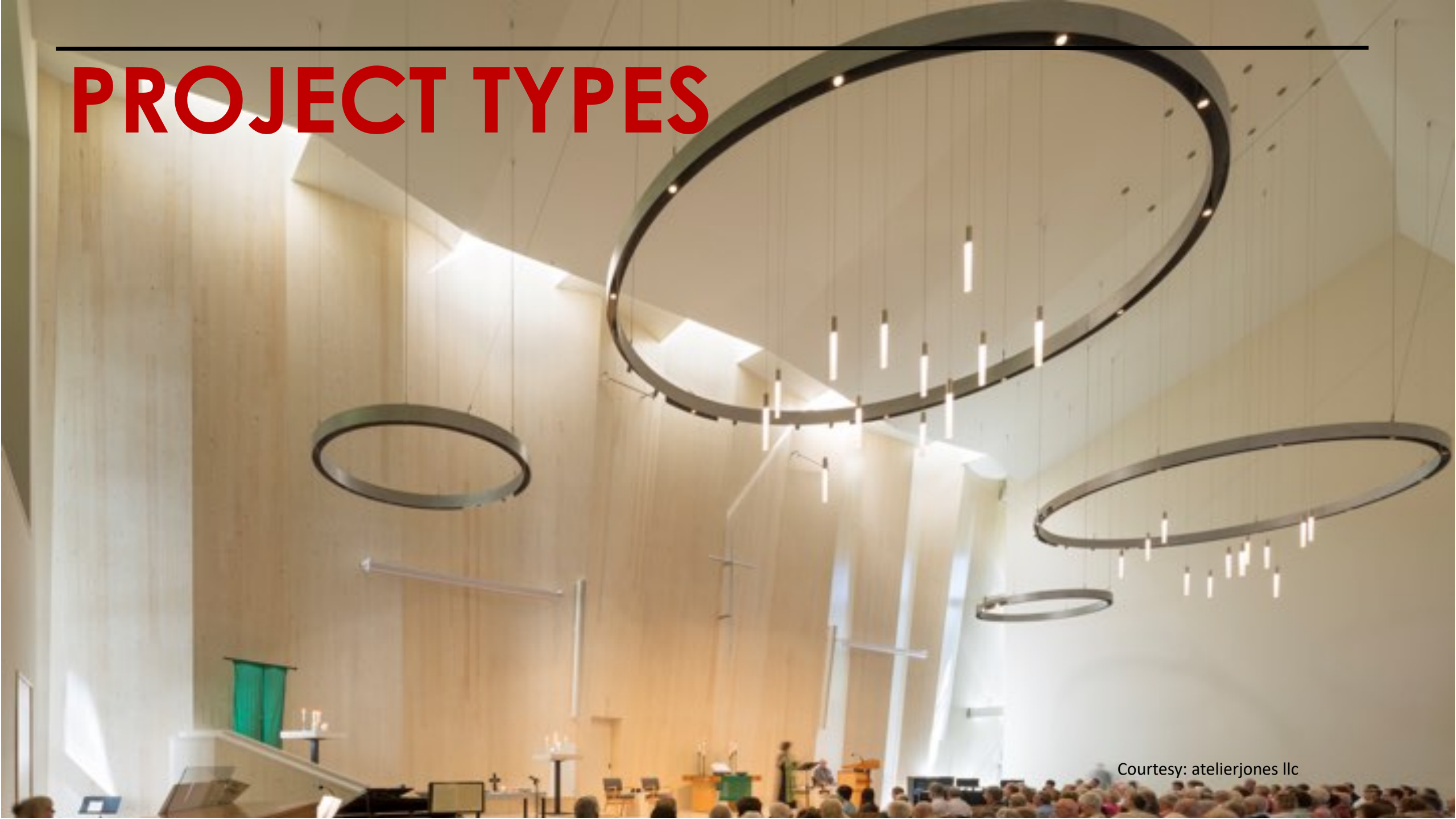
Courtesy: atelierjones llc

PROJECT TYPES



Courtesy: atelierjones llc

PROJECT TYPES



Courtesy: atelierjones llc

PROJECT TYPES

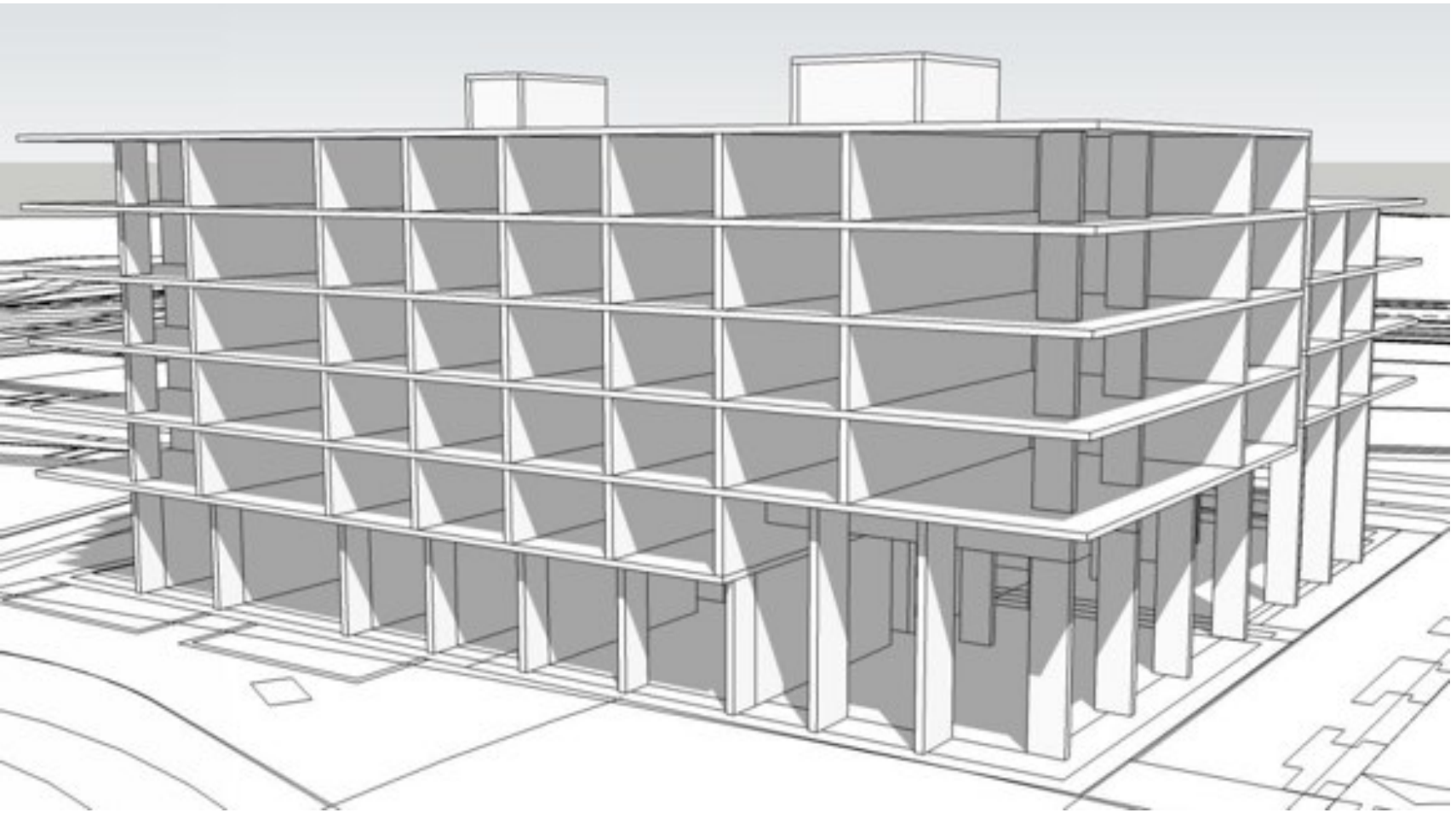
Courtesy: atelierjones llc

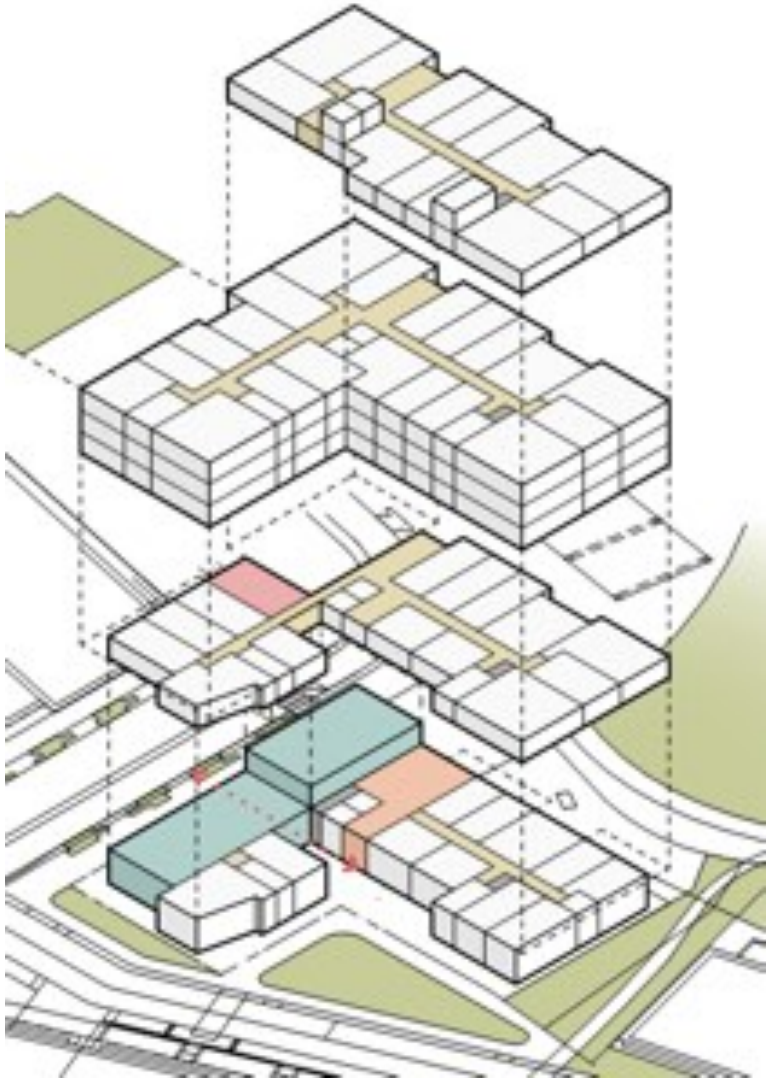
PROJECT TYPES

Courtesy: atelierjones llc

PROJECT TYPES

TYPE III & TYPE V HYBRIDS



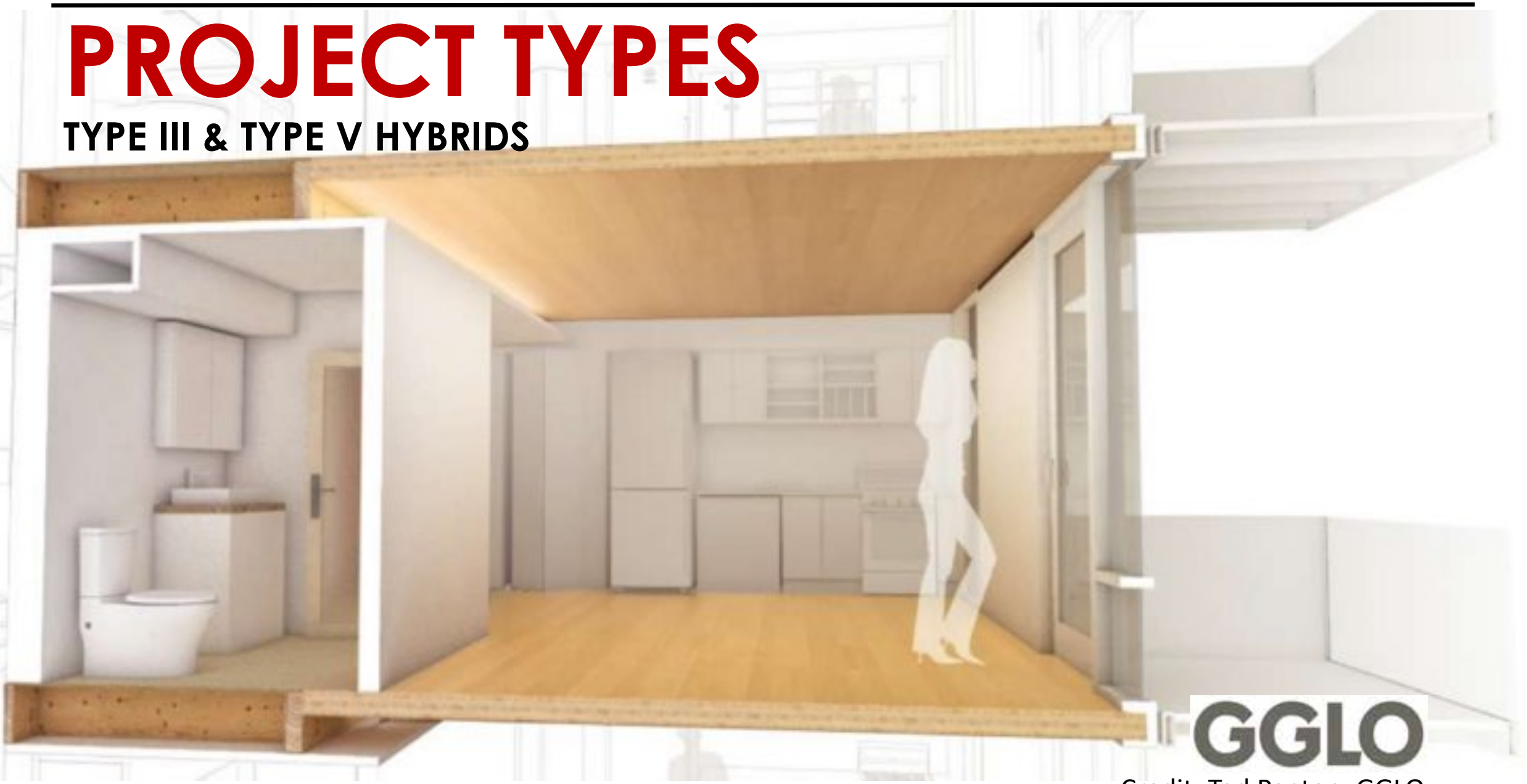


GGLO

Credit: Ted Panton, GGLO

PROJECT TYPES

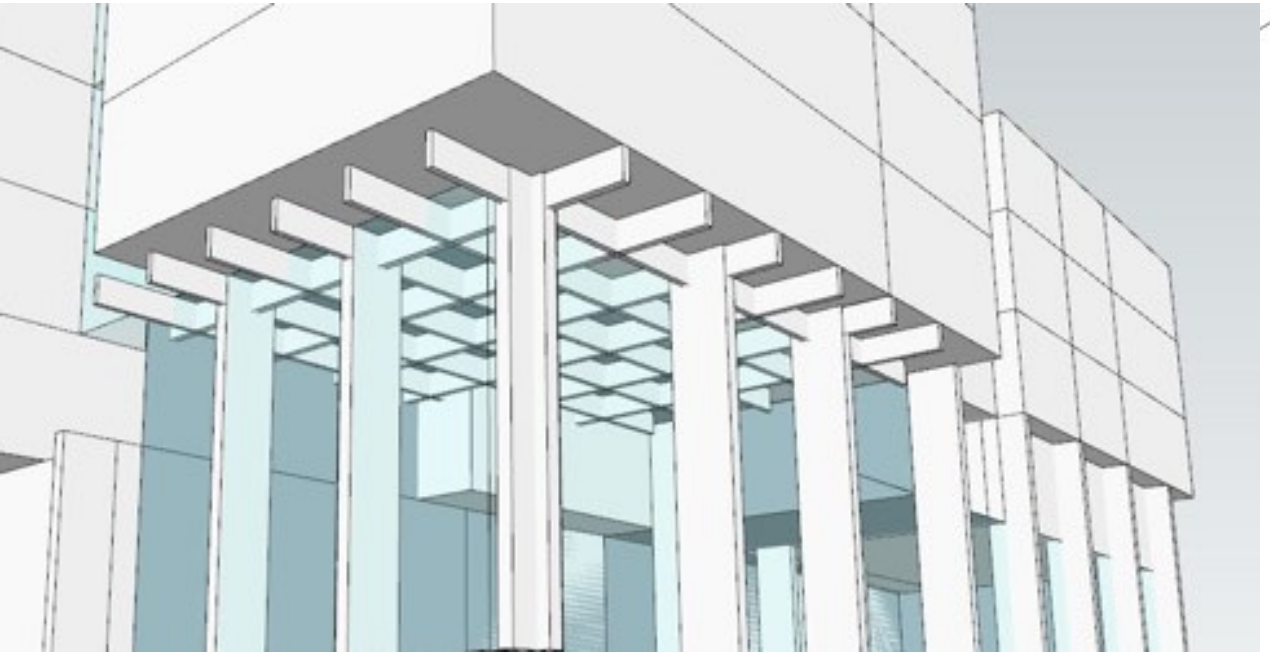
TYPE III & TYPE V HYBRIDS

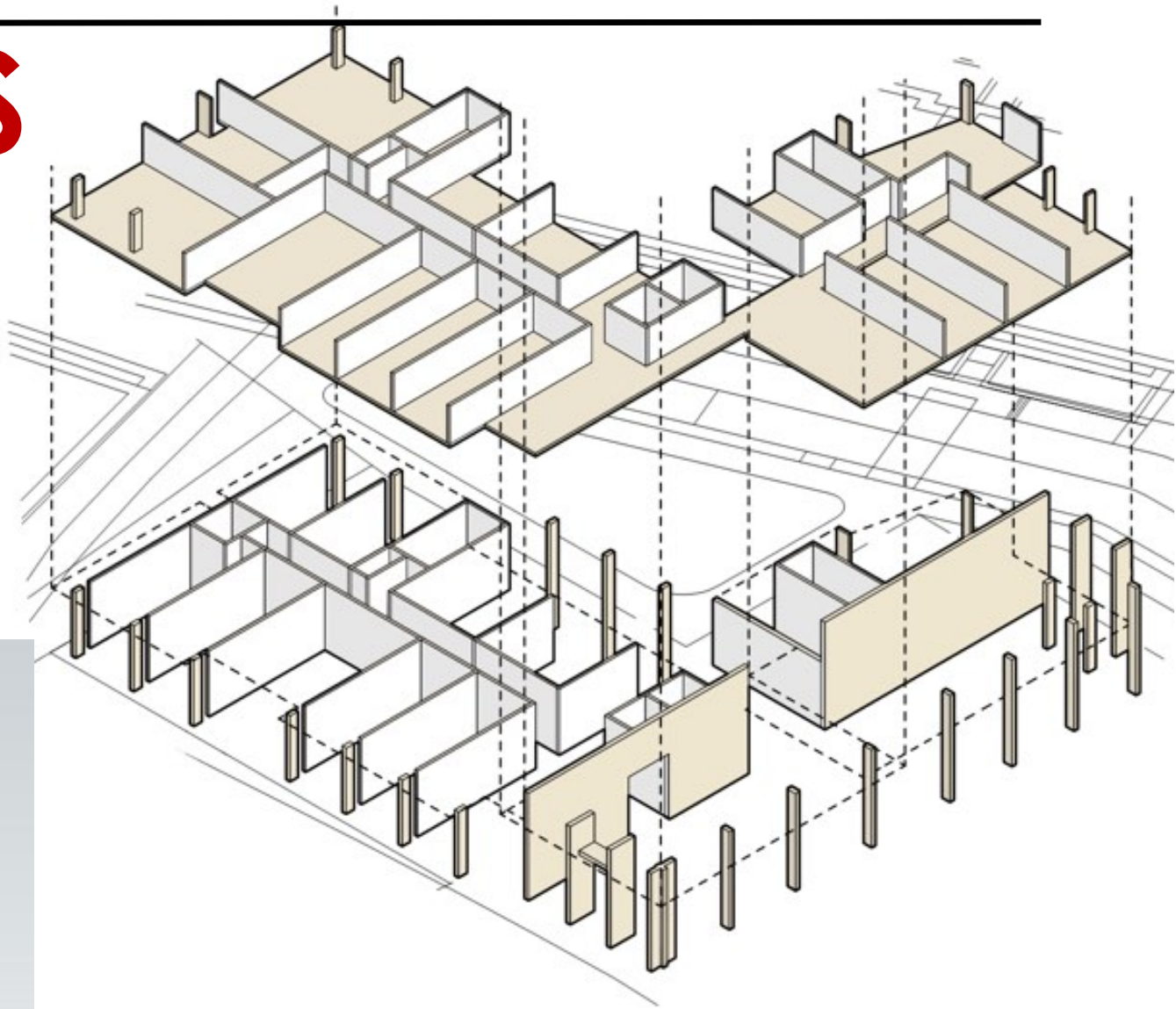


Credit: Ted Panton, GGLO

PROJECT TYPES

TYPE III & TYPE V HYBRIDS

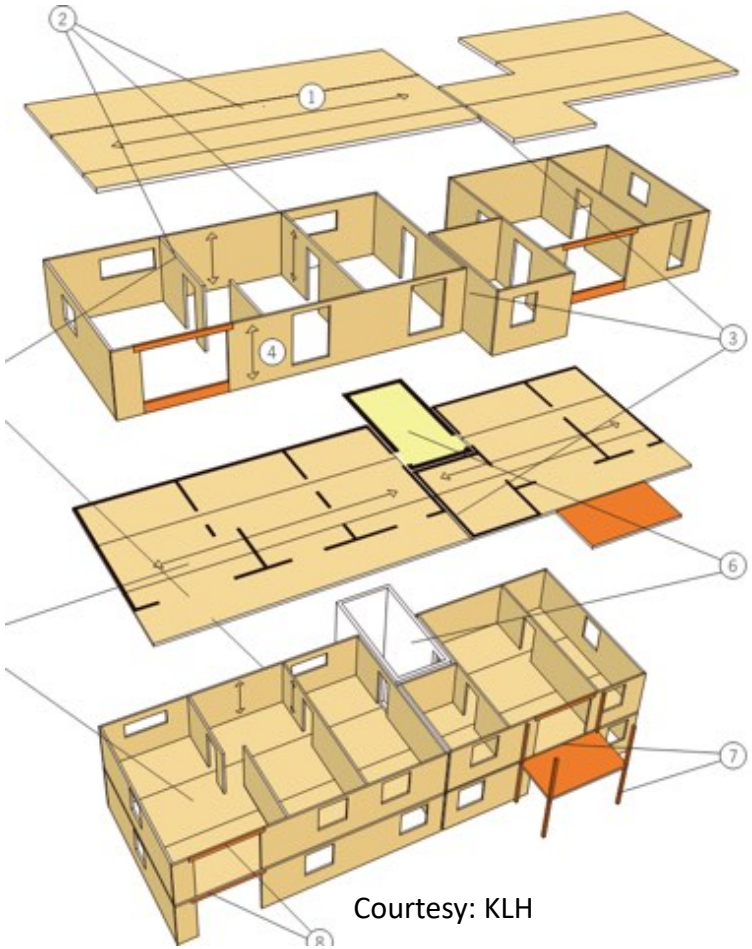




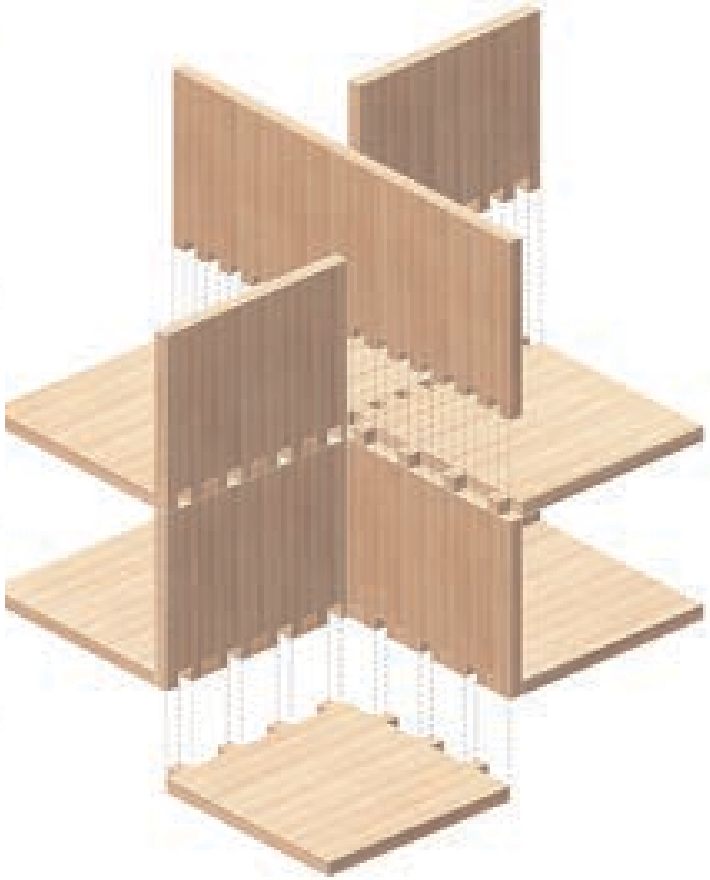
GGLO

Credit: Ted Panton, GGLO

PANELIZED SOLUTION



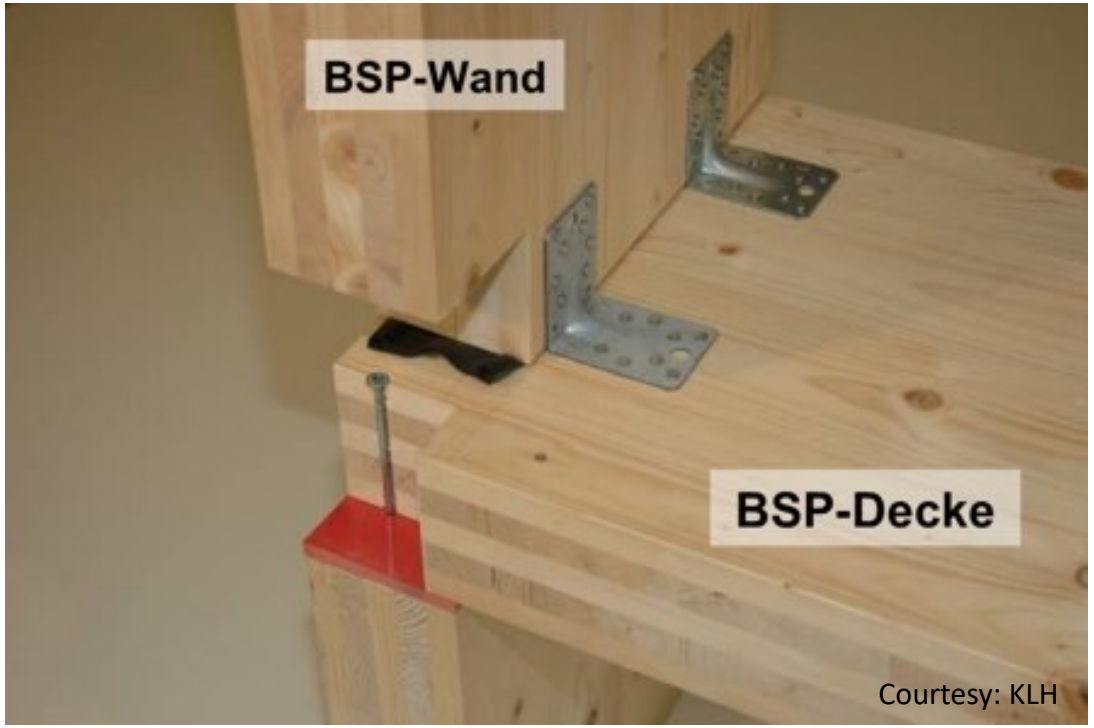
Courtesy: KLH



Courtesy: Waugh Thistleton

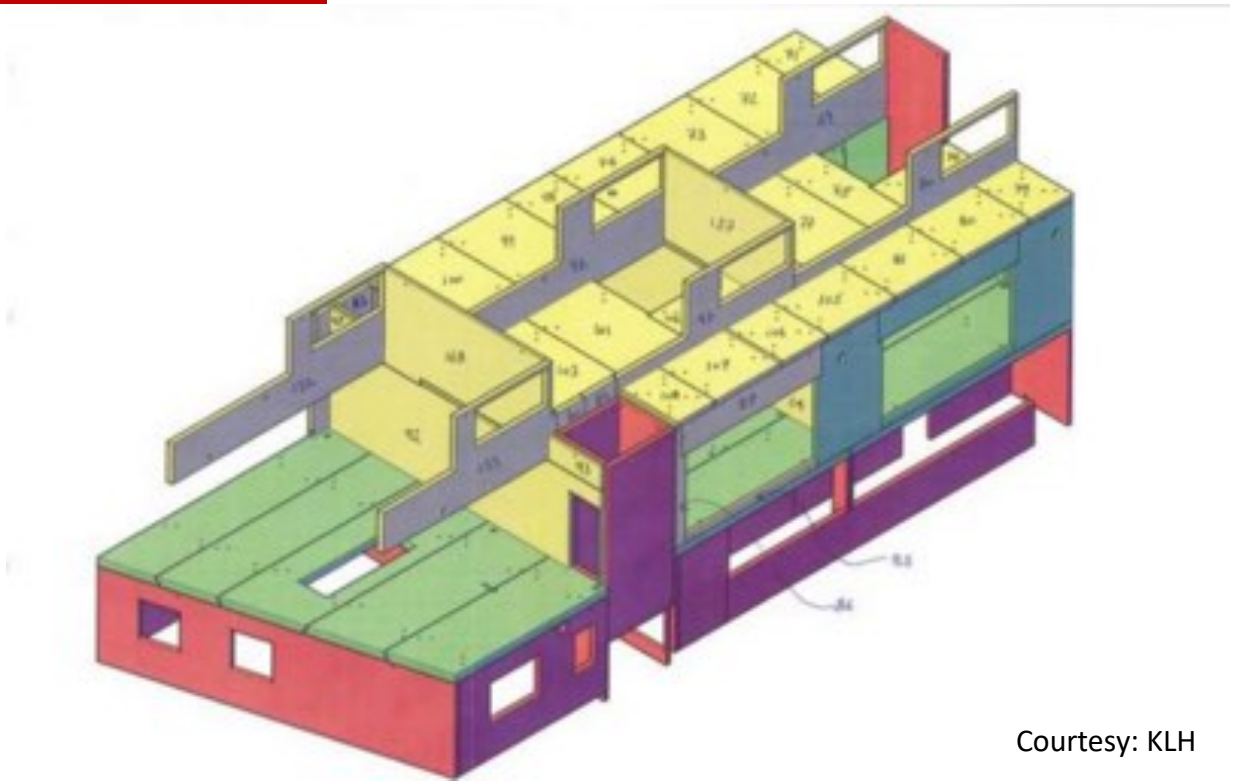
PANELIZED SOLUTION

PLATFORM FRAME



Courtesy: KLH

PLATFORM FRAMED



Courtesy: KLH

SEQUENCING => MORE SPEED

PANELIZED SOLUTION

HYBRID (PANELIZED/MODULAR) SOLUTION

PANELIZED SOLUTION

PANELIZED SOLUTION

ELEVATOR SHAFT

Credit: Smartlam

PROJECT TYPES

POST & BEAM SOLUTION

PROJECT TYPES

OFFICE

Credit: txbrewertc

PROJECT TYPES

OFFICE

Credit: vistekeng

Credit: Emily Hagen

PROJECT TYPES

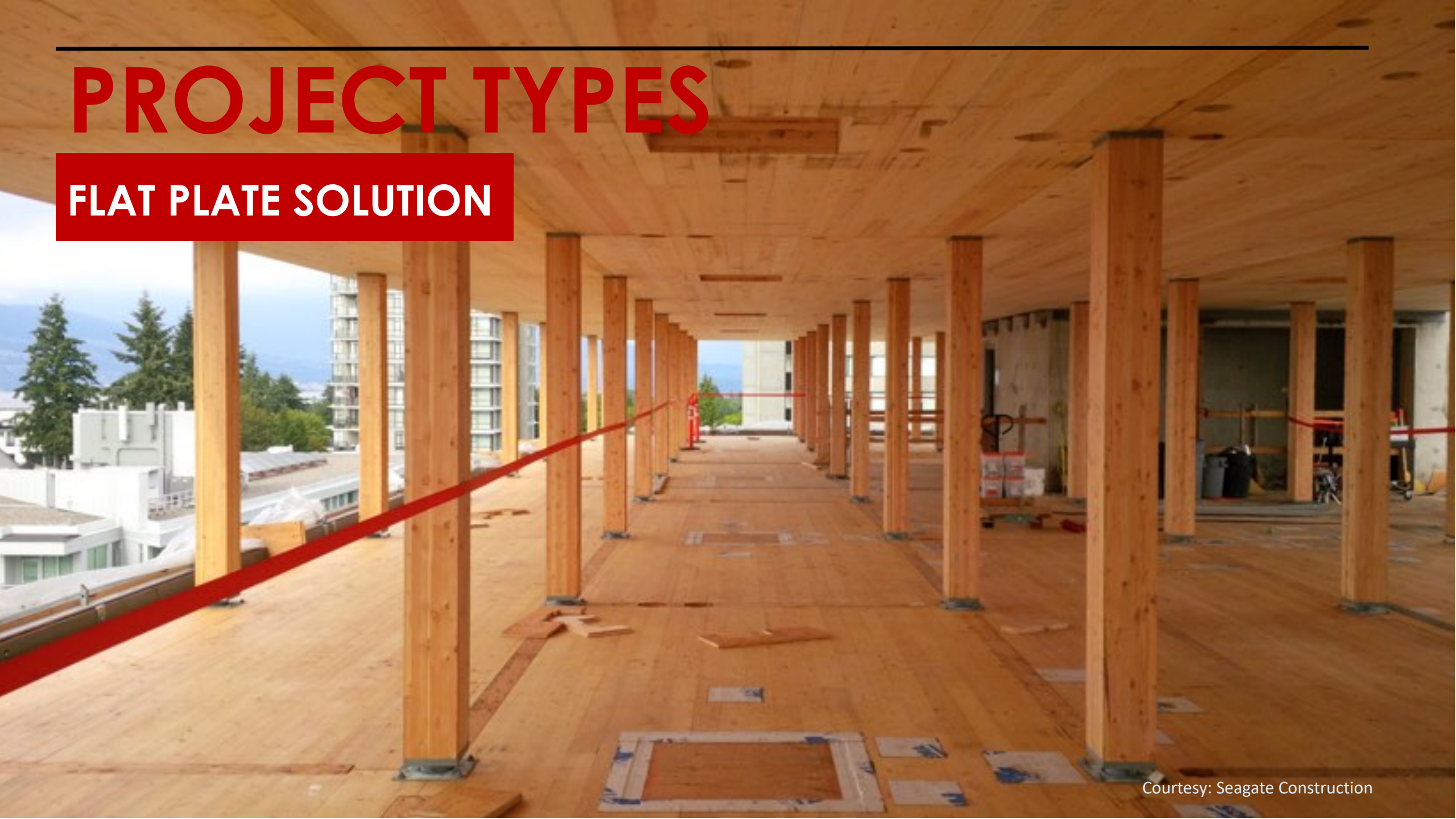
PROJECT TYPES

PROJECT TYPES

Credit: Trevor Acorn

PROJECT TYPES

FLAT PLATE SOLUTION



Courtesy: Seagate Construction

The Reality

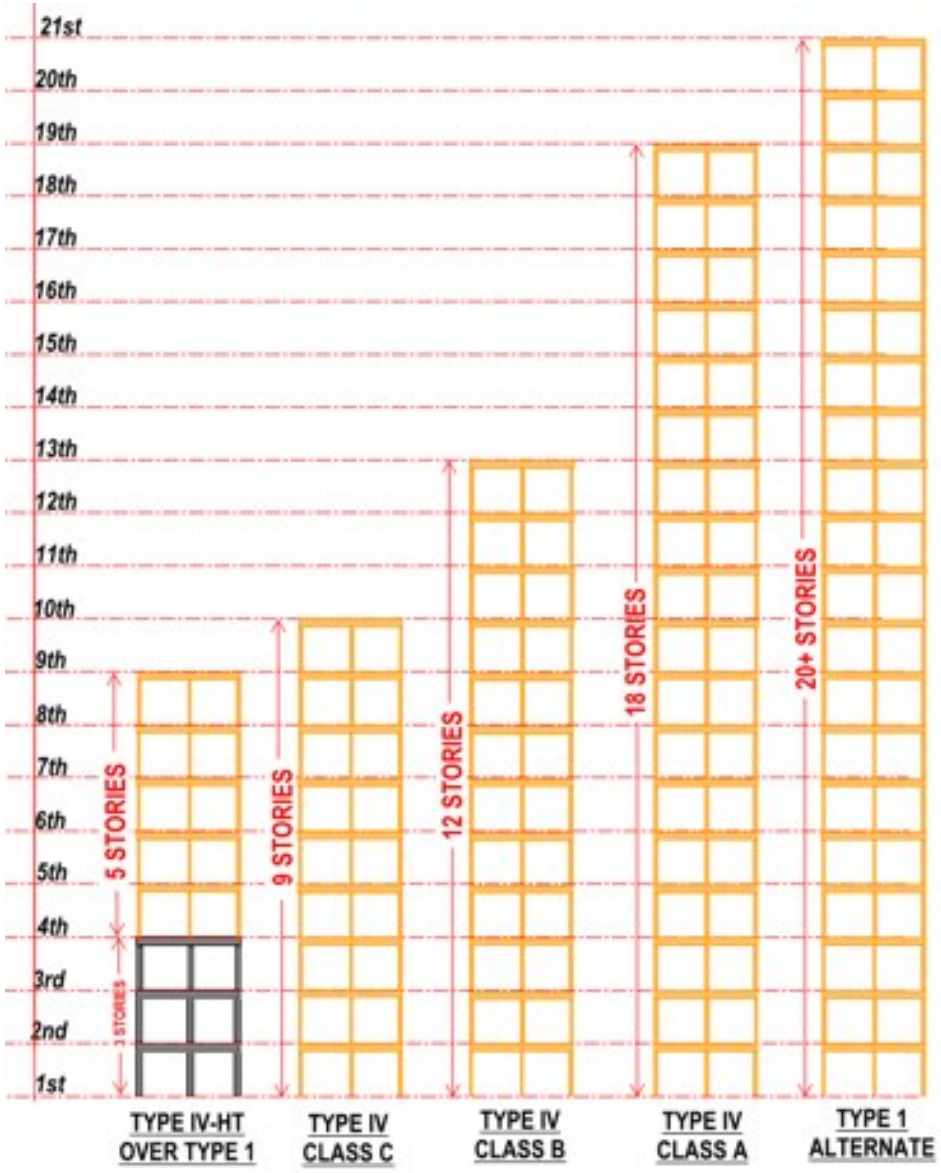
80% of multifamily buildings are built with timber

WHAT'S NEXT

Multi-family & podiums

Mass timber mid-rise

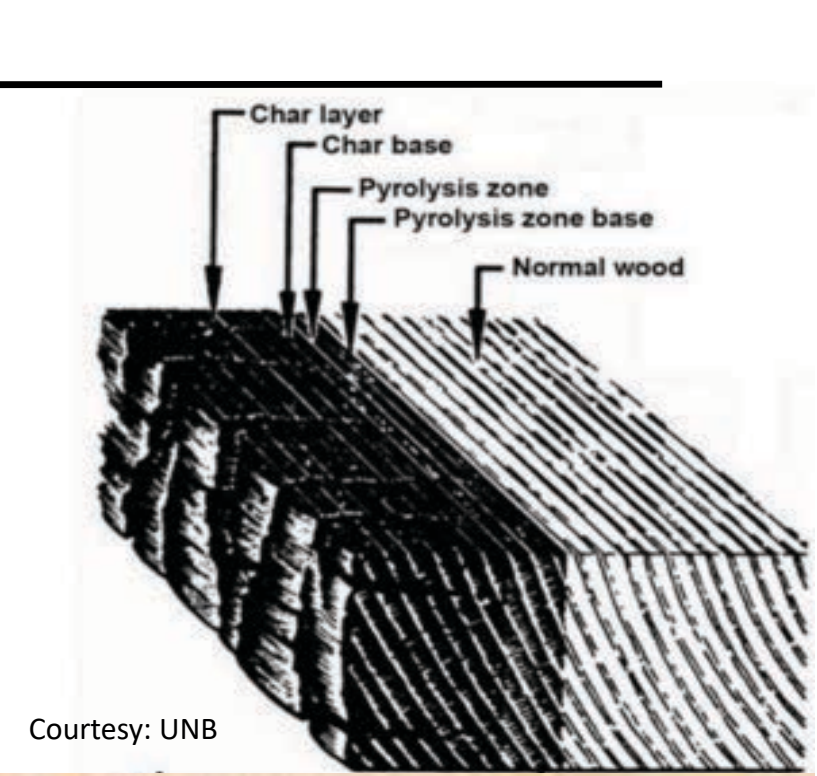
PROJECT TYPES



- UPCOMING OPTIONS IN 2021 IBC
- ALREADY ADOPTED IN OREGON

FIRE PROTECTION

Courtesy: CREE



Courtesy: UNB

Courtesy: Structure Magazir

FIRE

ASTM Fire tests for floors and walls

FIRE PROTECTION

Full scale state of the art tests

PROJECT TYPES

Type IVA, IVB, IVC = Post & Beam or Flat Plate solution

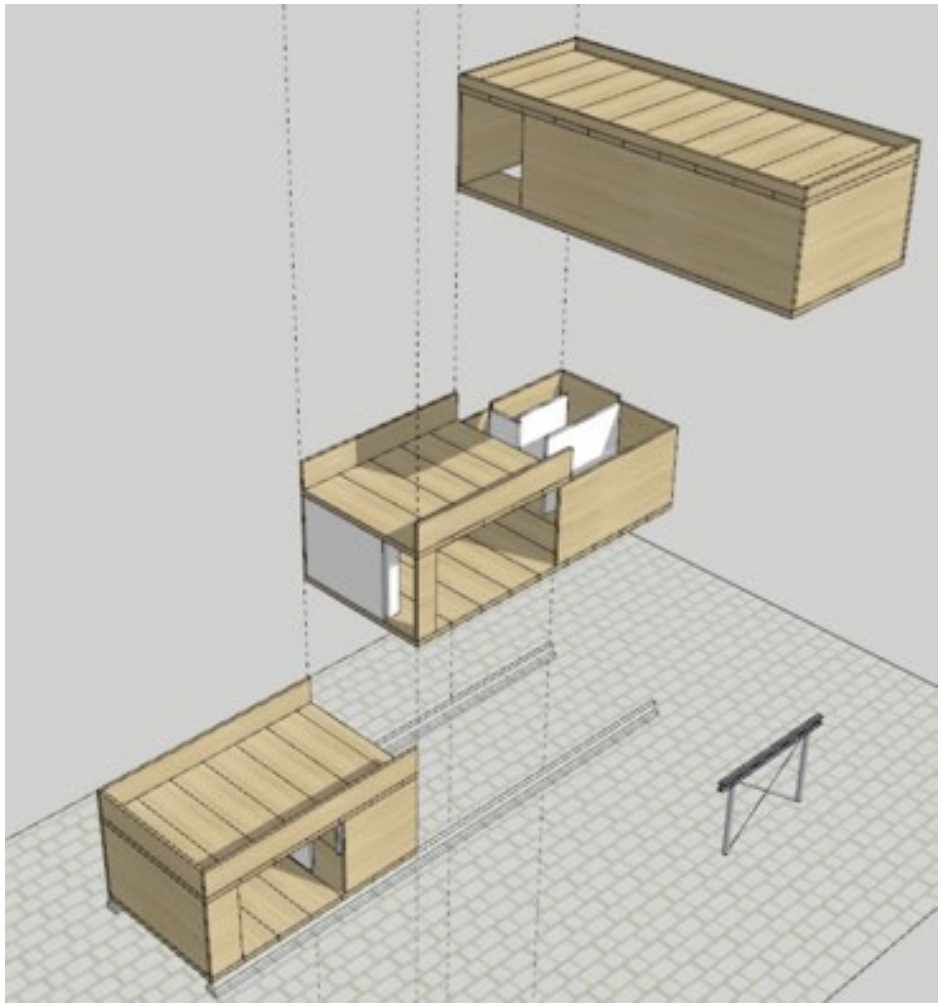
PROJECT TYPES

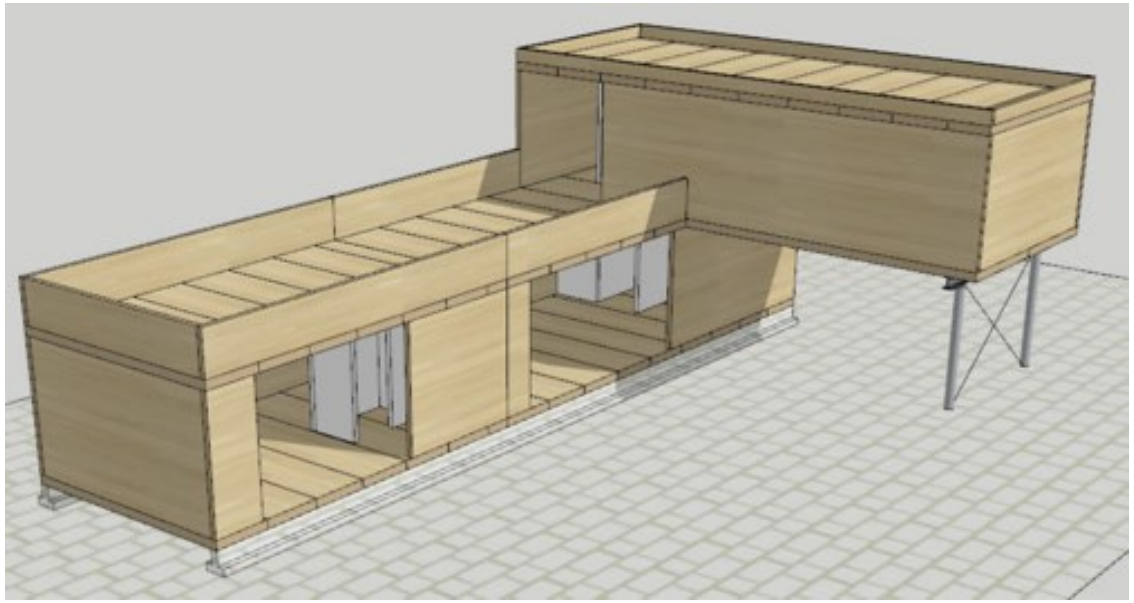
MODULAR

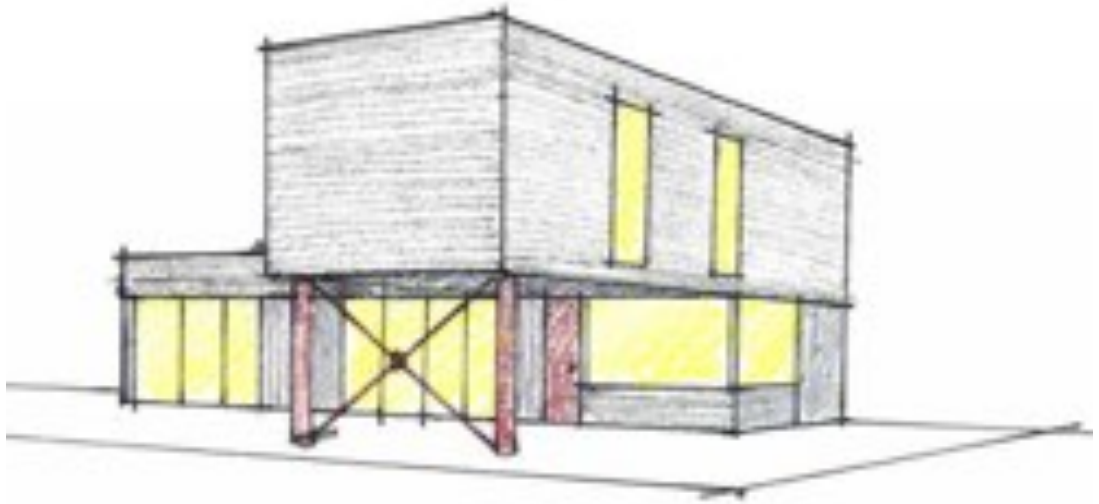
Blockhouse Research - ToolBox

PROJECT TYPES

MODULAR







Credit: Miller Hull

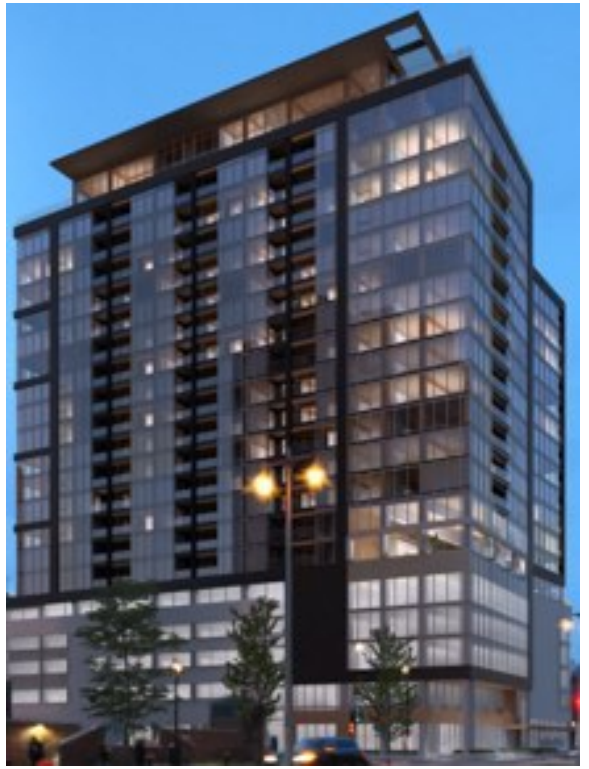
WHAT'S NEXT

5 STORY MASS TIMBER

8+ STORY MASS TIMBER

WHAT'S NEXT

Michael Green Architecture / Lotus Equity Group in Newark
11 story 500,000sf



Korb + Associates Architects 21 story 410,000

Council on Tall Buildings and Urban Habitats, 40 mass timber buildings over eight-stories tall are complete, planned or under construction. In 2008, there was only one such building worldwide.

21 such structures with a height of more than 50 metres will be completed by 2019

WHAT'S NEXT

How tall will we go?

Courtesy: International Beams

WHAT'S NEXT

19 story Canada

21 story Amsterdam

40 story Sweden

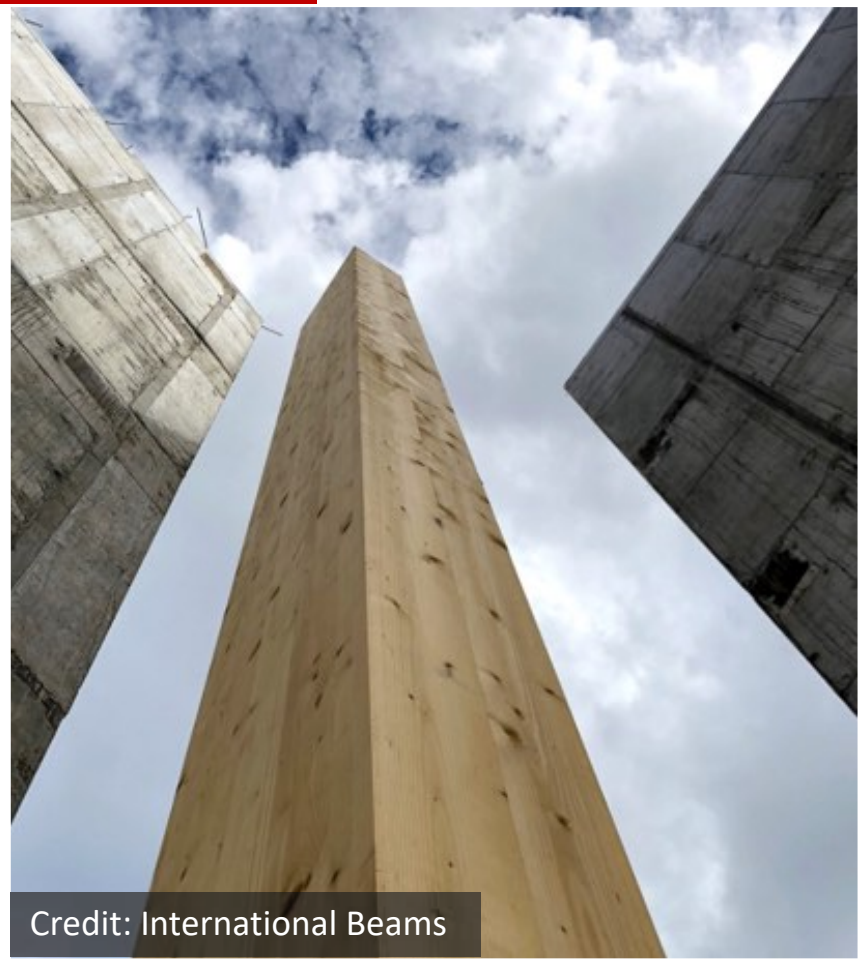
80 story in London

TIMBER COMPOSITES (HYBRID SYSTEMS)

INHERENT STIFFNESS | VIBRATION + SOUND

GREATER STRUCTURAL CAPACITIES

Credit: StructureCraft



Credit: International Beams

Credit: CREE

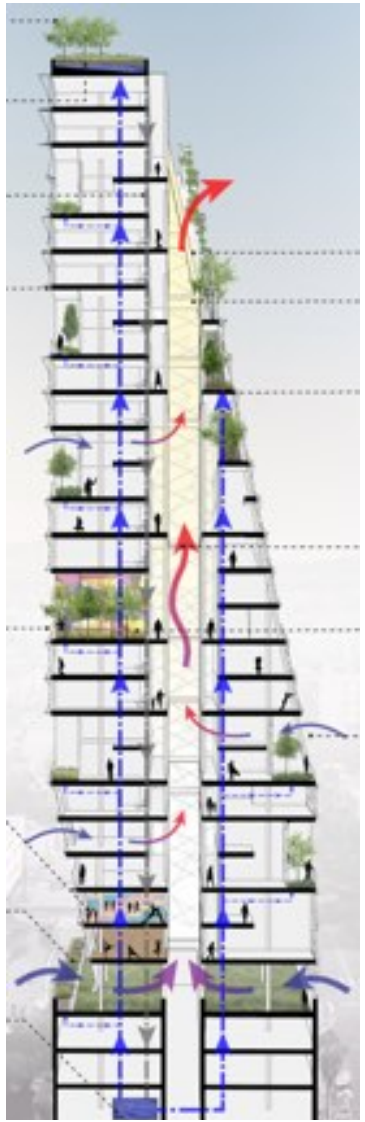
Building Make-up

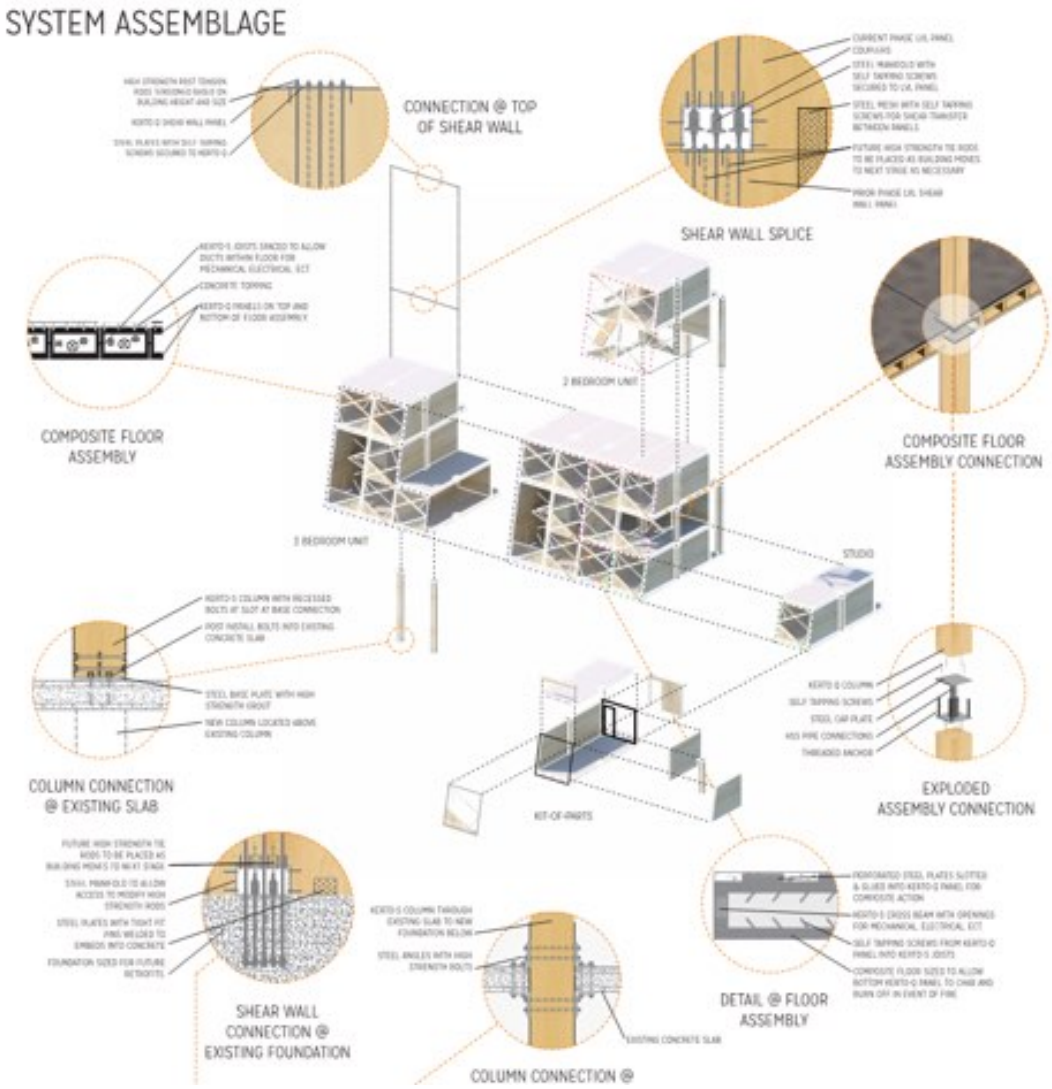
Concrete core or steel brace frame for lateral

Credit: StructureCraft

BEYOND

28 STORY PROOF OF CONCEPT
30 FOOT BAYS

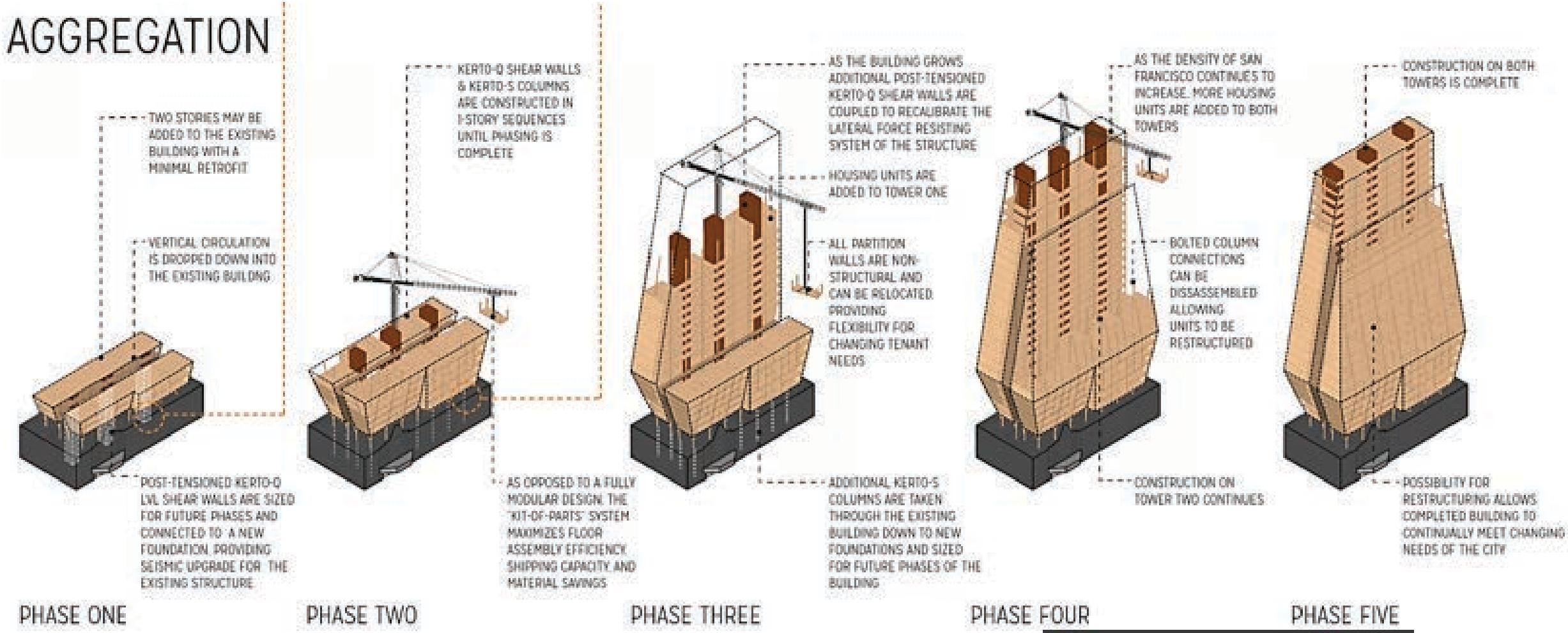




BEYOND

28 STORY PROOF OF CONCEPT
30 FOOT BAYS

AGGREGATION



DLR Group | KwanHenmi

DCI MASS TIMBER EXPERIENCE

35+ PROJECTS IN PAST 2 YEARS



















Mass Timber Projects In Design and Constructed in the US (March 2019)

545+ PROJECTS NATION WIDE

WoodWorks™
WOOD PRODUCTS COUNCIL

Stage	Mass Timber	# of Projects
Construction Started / Built	CLT	97
	NLT	7
	DLT	5
	Heavy Timber Decking	49
	Post & Beam	40
	Total	198
In Design	CLT	171
	NLT	21
	DLT	3
	Heavy Timber Decking	38
	Post & Beam	114
	Total	347
Grand Total		545

State	Stage		State	Stage	
AL	Construction Started / Built	2	MS	In Design	1
	In Design	8	MT	Construction Started / Built	6
AR	Construction Started / Built	3		In Design	4
	In Design	3	NC	Construction Started / Built	10
AZ	In Design	1		In Design	24
CA	Construction Started / Built	31	ND	In Design	1
	In Design	45	NE	Construction Started / Built	1
CO	Construction Started / Built	9		In Design	1
	In Design	8	NH	In Design	1
CT	Construction Started / Built	3	NJ	Construction Started / Built	1
	In Design	6		In Design	2
DC	Construction Started / Built	2	NM	Construction Started / Built	1
	In Design	3	NY	Construction Started / Built	5
DE	In Design	2		In Design	11
FL	Construction Started / Built	16	OH	Construction Started / Built	1
	In Design	12		In Design	3
GA	Construction Started / Built	1	OK	Construction Started / Built	1
	In Design	13		In Design	1
HI	In Design	2	OR	Construction Started / Built	17
IA	In Design	1		In Design	22
ID	Construction Started / Built	1	PA	Construction Started / Built	2
	In Design	2		In Design	2
IL	Construction Started / Built	4	RI	Construction Started / Built	2
	In Design	11	SC	Construction Started / Built	6
IN	Construction Started / Built	1		In Design	6
KS	In Design	2	TN	Construction Started / Built	3
KY	Construction Started / Built	1		In Design	3
	In Design	2	TX	Construction Started / Built	13
LA	In Design	1		In Design	30
MA	Construction Started / Built	16	UT	Construction Started / Built	1
	In Design	21		In Design	1
MD	Construction Started / Built	1	VA	Construction Started / Built	2
	In Design	7		In Design	10
ME	Construction Started / Built	1	VT	Construction Started / Built	1
	In Design	13		In Design	7
MI	Construction Started / Built	1	WA	Construction Started / Built	22
	In Design	4		In Design	28
MN	Construction Started / Built	1	WI	Construction Started / Built	3
	In Design	3		In Design	13
MO	Construction Started / Built	4	WV	Construction Started / Built	2
	In Design	5	WY	In Design	1

Considering mass timber for a project? Ask us anything.

For free project support, contact:
help@woodworks.org

SUMMARY

- What is mass timber
- Types of mass timber
- Benefits of timber
- Prefabrication & modular methods

QUESTIONS?

- Dean Lewis of DCI Engineers
- DLEWIS@DCI-ENGINEERS.COM
- (415) 638-8916