Understanding Mass Timber and Cold-Formed Steel Hybrid Construction

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Bunker Hill Housing Redevelopment – Stellata / Stantec / McNamara - Salvia / Leggat McCall Properties / Photo courtesy Stantec

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

AIA Approved Continuing Education

Course Description

This seminar explores the emerging hybrid construction method combining mass timber and cold-formed steel (CFS) to optimize structural performance and cost-effectiveness. We will examine structural, fire, and acoustic performance benefits, prefabrication advantages, and construction efficiencies. The presentation will also feature a detailed case study of the Bunker Hill Housing Redevelopment project in Boston, MA, showcasing a groundbreaking application of mass timber-CFS hybrid construction in an urban setting. Participants will gain insights into the design considerations, construction sequencing, benefits, and challenges associated with this hybrid structural system.

Learning Objectives

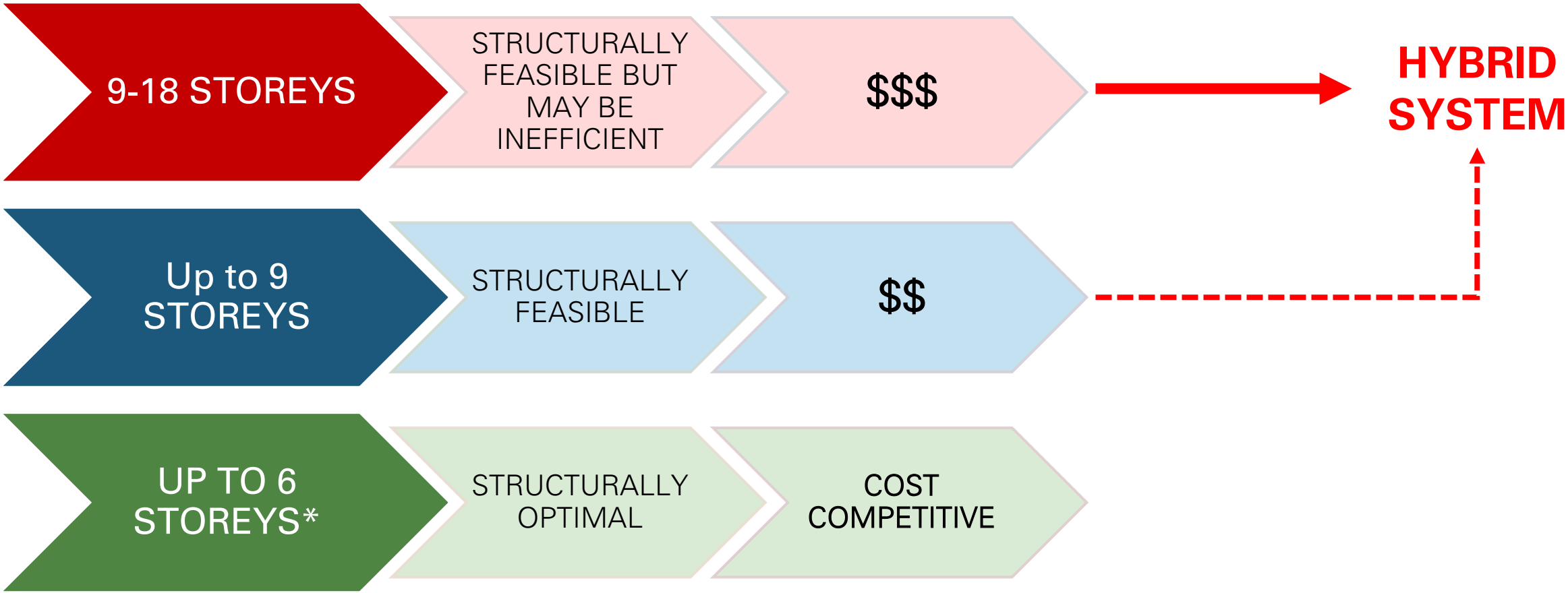
1. Assess the structural efficiency, fire safety, acoustic performance, and sustainability advantages of integrating cross-laminated timber (CLT) and cold-formed steel (CFS) in mid-rise buildings.

2. Examine how the thermal performance of mass timber and cold-formed steel contributes to energy-efficient building envelopes and reduces operational carbon.

3. Compare the cost-effectiveness of CLT-CFS hybrid construction with conventional building systems, focusing on material efficiency, labor savings, and lifecycle costs.

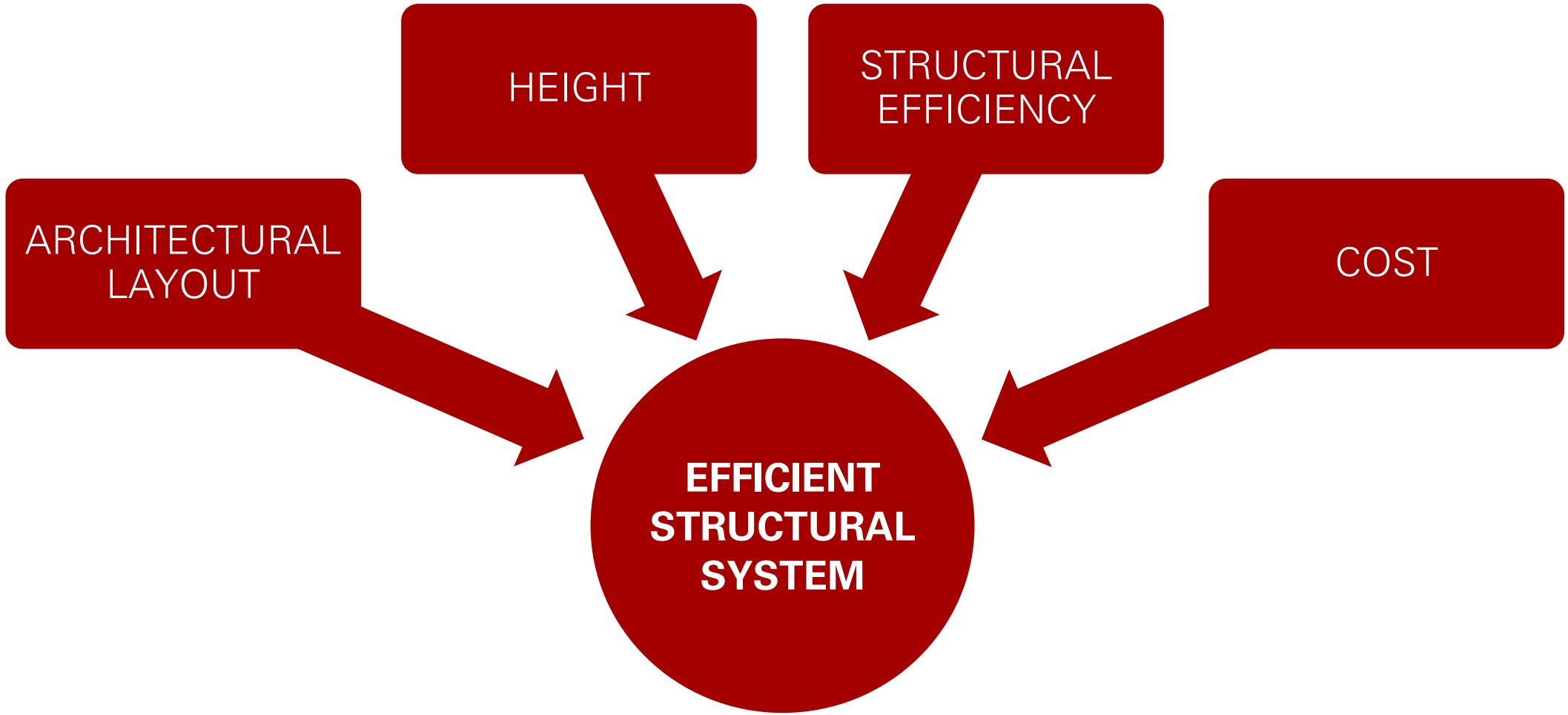
4. Explain the gravity and lateral load-resisting strategies of mass timber and CFS hybrid systems, including platform-type construction and connection detailing.

Wood Bearing Walls: WHEN ARE THEY VIABLE?

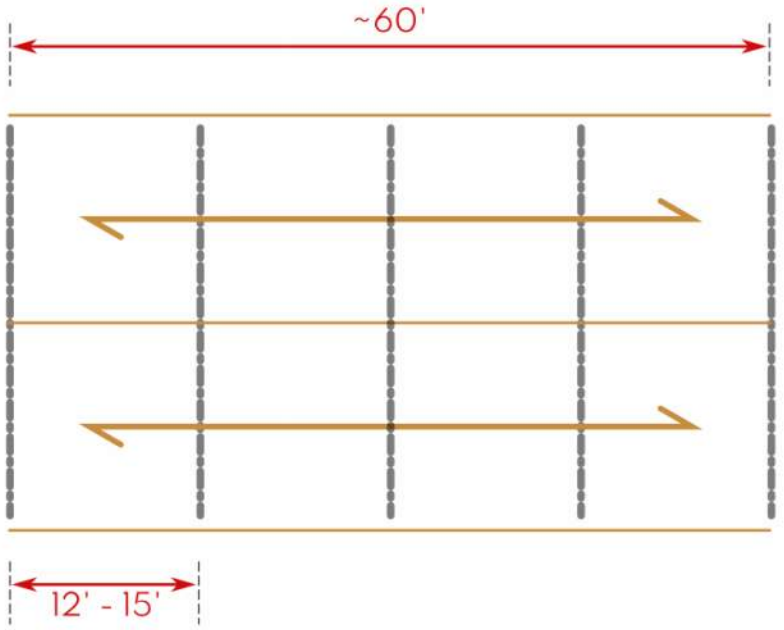


*UP TO 60FT SHEAR WALLS NO SPLICE

EFFICIENT SYSTEM

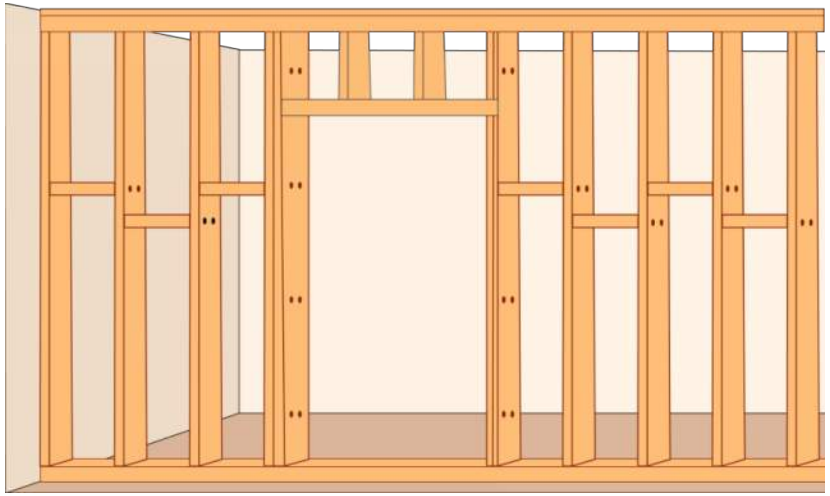


EFFICIENT LOAD BEARING WALL LAYOUT



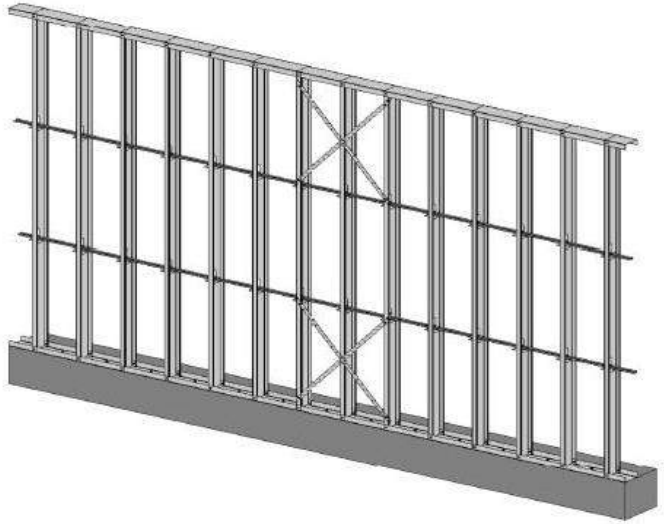
LOADBEARING WALL SYSTEMS : PLATFORM TYPE

LOADBEARING LIGHTWOOD FRAMING
≤ 5 STOREYS



LOADBEARING CLT PLATFORM-TYPE
UP TO 8-9 STOREYS

LOADBEARING CFS FRAMING
UP TO 18 STOREYS



EFFICIENT HYBRID SYSTEM FOR TALLWOOD– NEW APPROACH

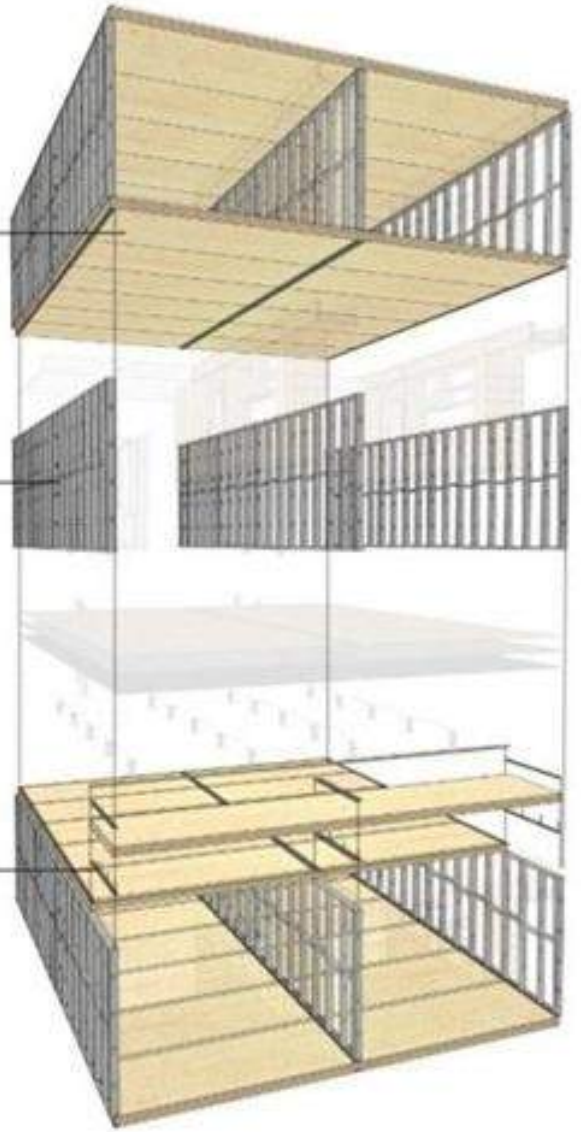
UP TO 18 STOREYS

CFS BEARING FRAME

+

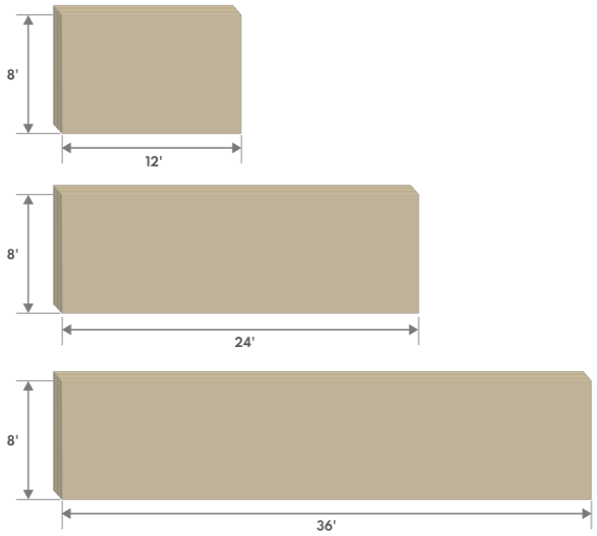
CLT PANELS

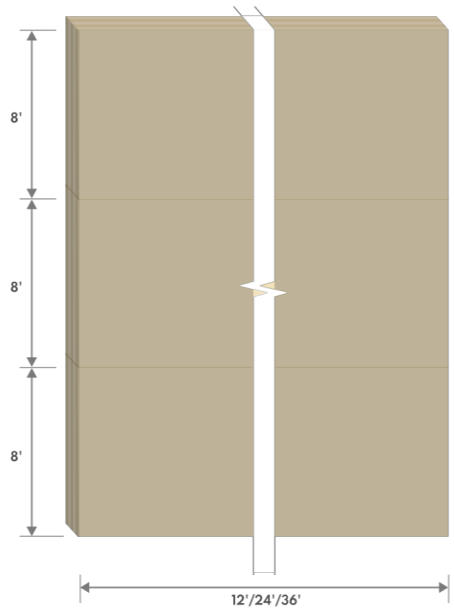
=

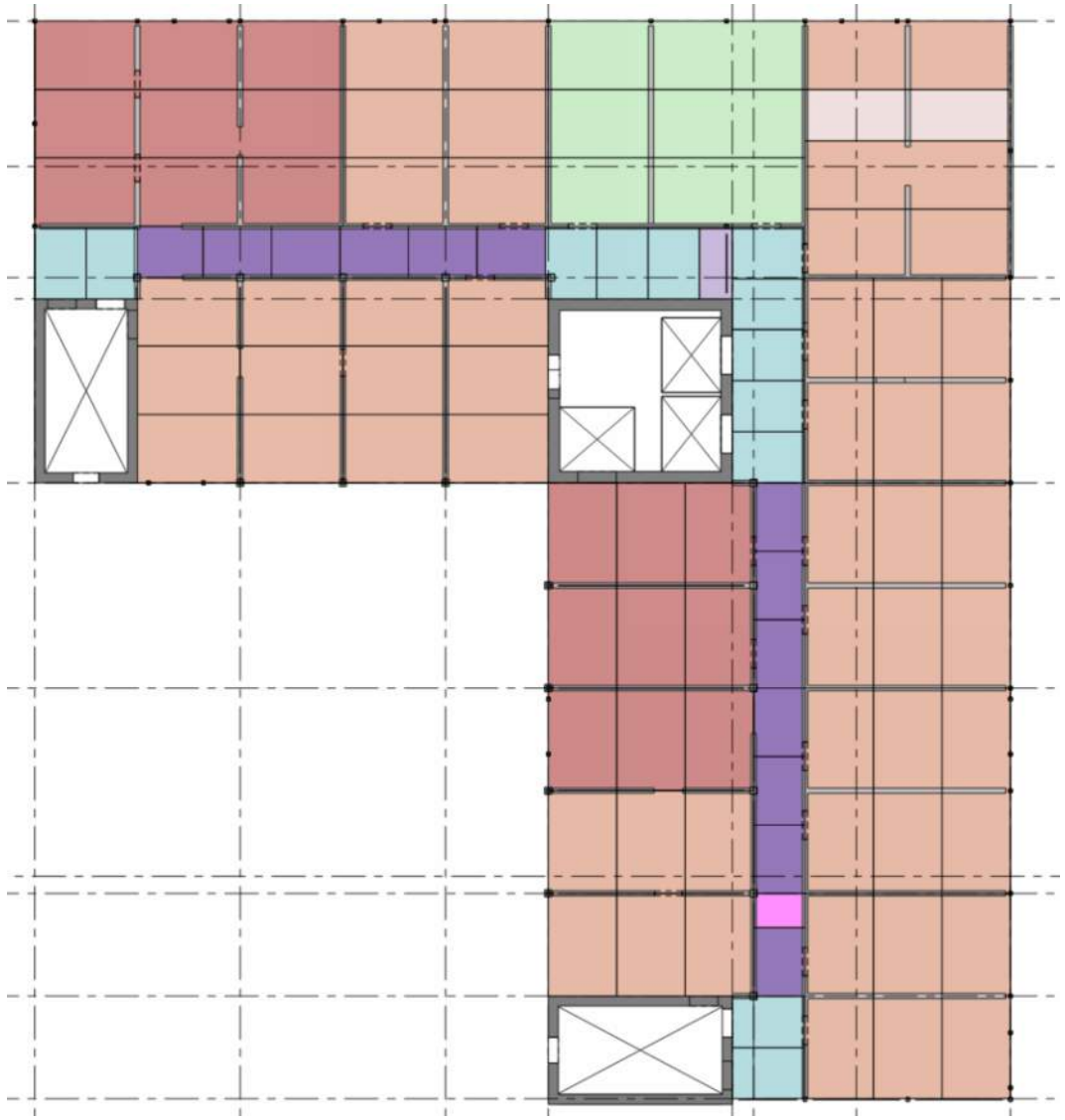


EFFICIENT GRAVITY SYSTEM
WHAT CREATES FORMS?

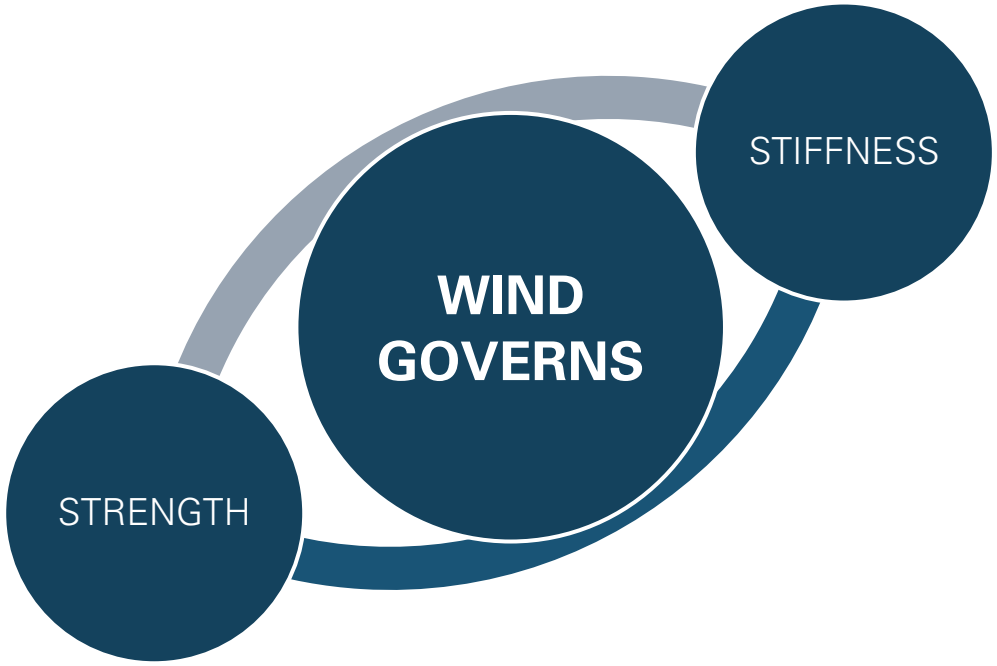
EFFICIENT STRUCTURAL LAYOUT
PANEL UTILISATION AND EFFICIENCY
TRANSPORTATION
SITE CONSTRAINTS



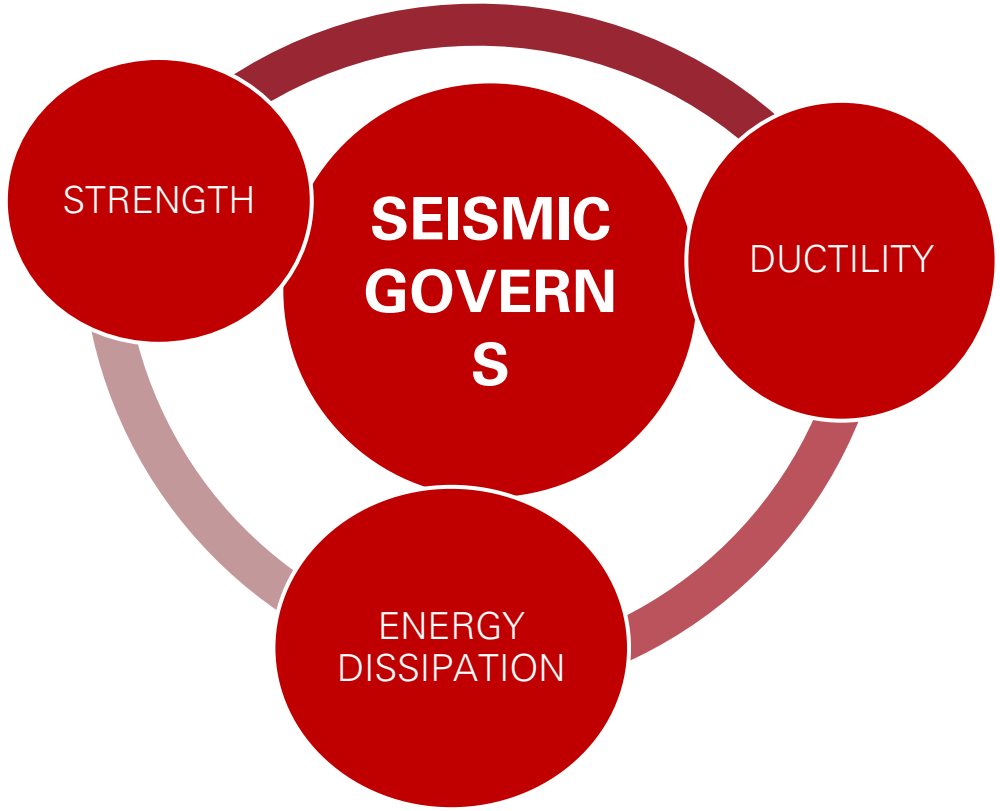




EFFICIENT LATERAL SYSTEM WHAT CREATES FORMS?



WOOD LLRS VIABLE UP TO~9 STOREY



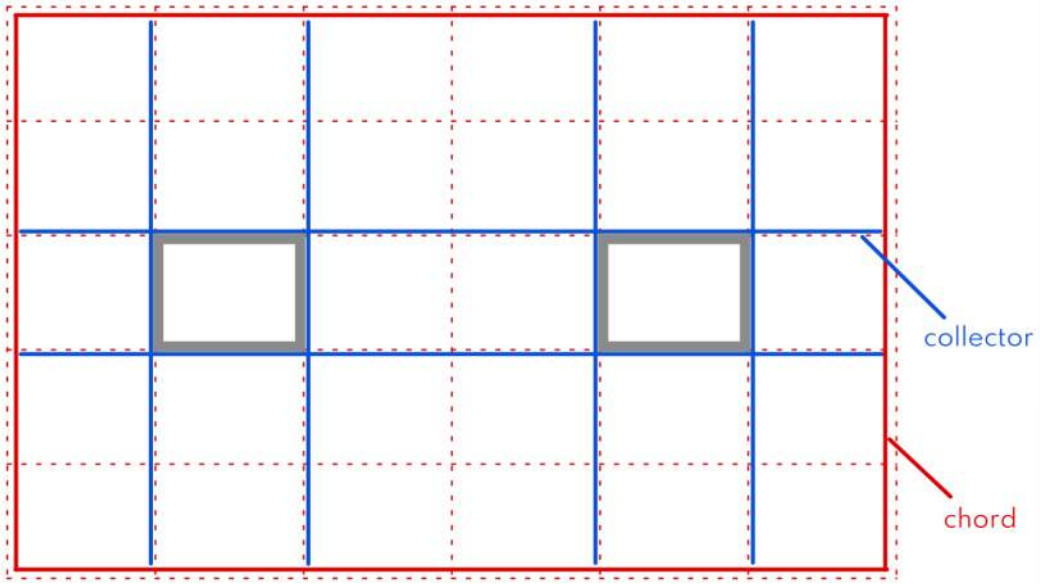
HYBRID LLRS REQUIRED

EFFICIENT LAYOUT – WHERE?

DIAPHRAGM CANTILEVER

20' - 24'

CONCRETE CORE/STEEL BRACES



→ *ELEVATION FLEXIBILITY*

SHEAR WALLS/BRACES

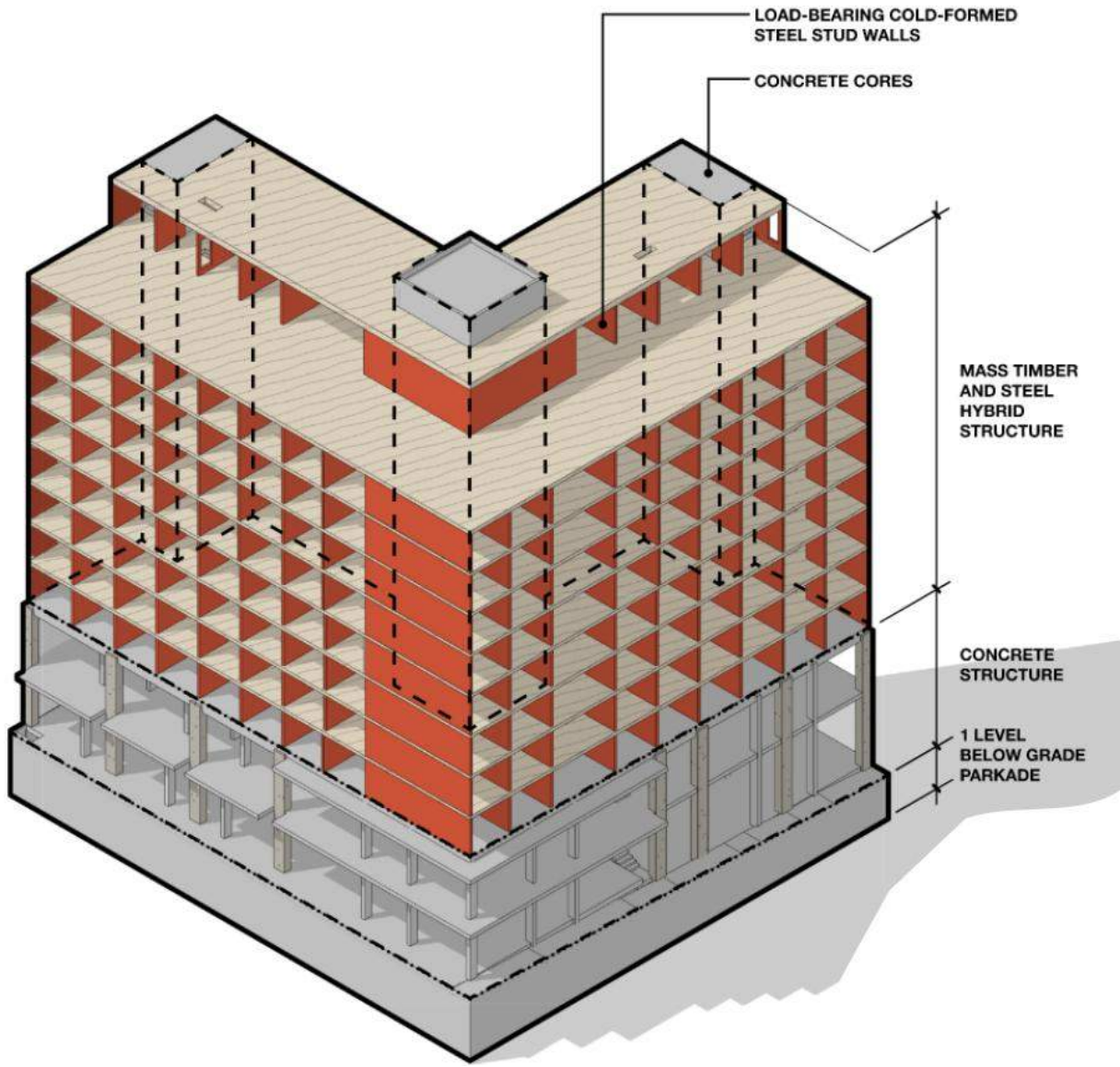
→ *PLAN LAYOUT FLEXIBILITY*

NEW APPROACH FOR TALL MID-RISE - MAC

CONCRETE PODIUM & CORE

PLATFORM TYPE CONSTRUCTION

- → CFS LOAD BEARING WALLS
- → CLT FLOOR PANELS



Credit – MA+HG ARCHITECTURE

PROJECT TEAM

Owner	Tomo Spaces
Architectural	MA+HG
Consulting Arch	Eskew+Dumez+Ripple
Structural	Timber Engineering
CP/Code	GHL Consultants
Mechanical	Rocky Point Engineering
Fire Suppression	Rocky Point Engineering
Electrical	Nemetz (S/A) & Associates
Landscape	Hapa Collaborative
Envelope/Energy	Evoke Buildings
Civil	Creus Engineering
Geotech	Geopacific Consultants
Acoustic	BLK Consultants
Heritage Consultant	Donald Luxton & Associates, John Atkin
Indigenous Consultant	snəw̓eyəɬ

Credit – MA+HG ARCHITECTURE

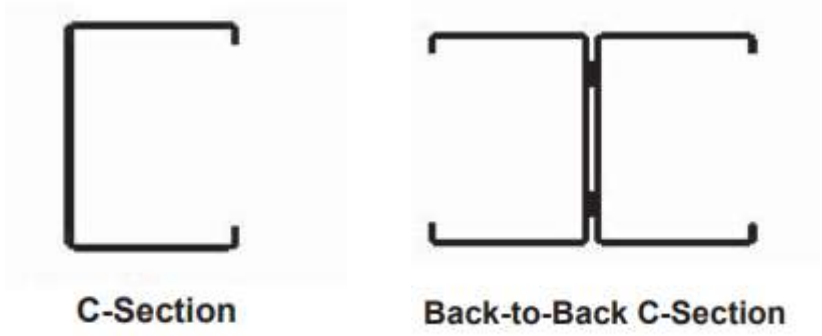
EFFICIENT HEIGHT < 8-9 STOREYS

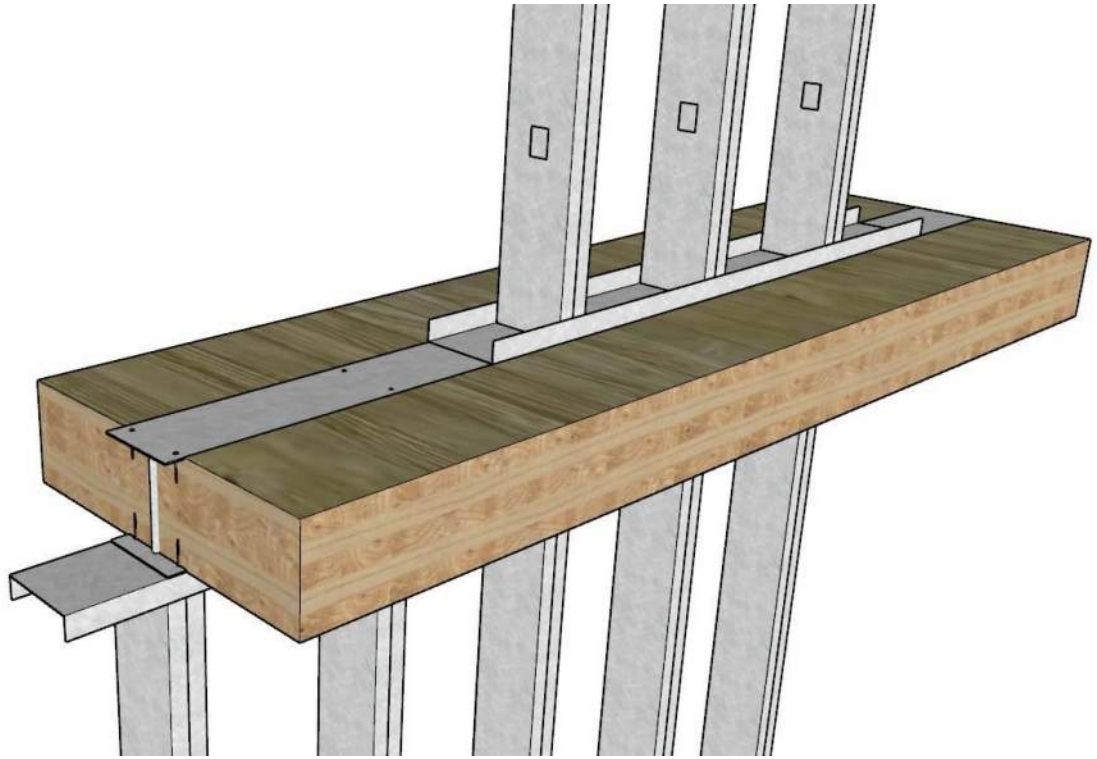
WALL SPACING – OPTIMISE LOADS ON WALLS

STUD SPACING – OPTIMISE LOADS ON STUDS

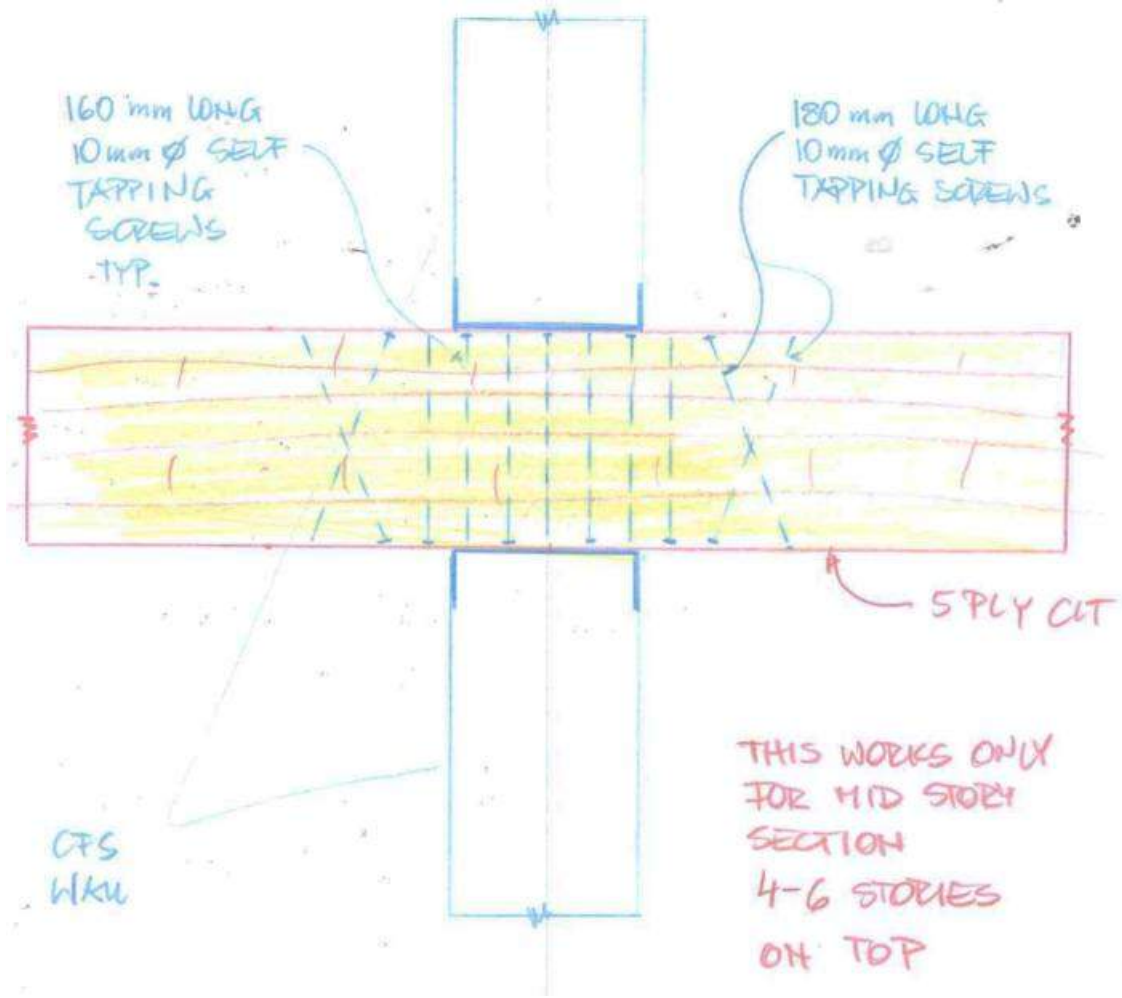
HEAVY STUDS AT LOWER LEVEL

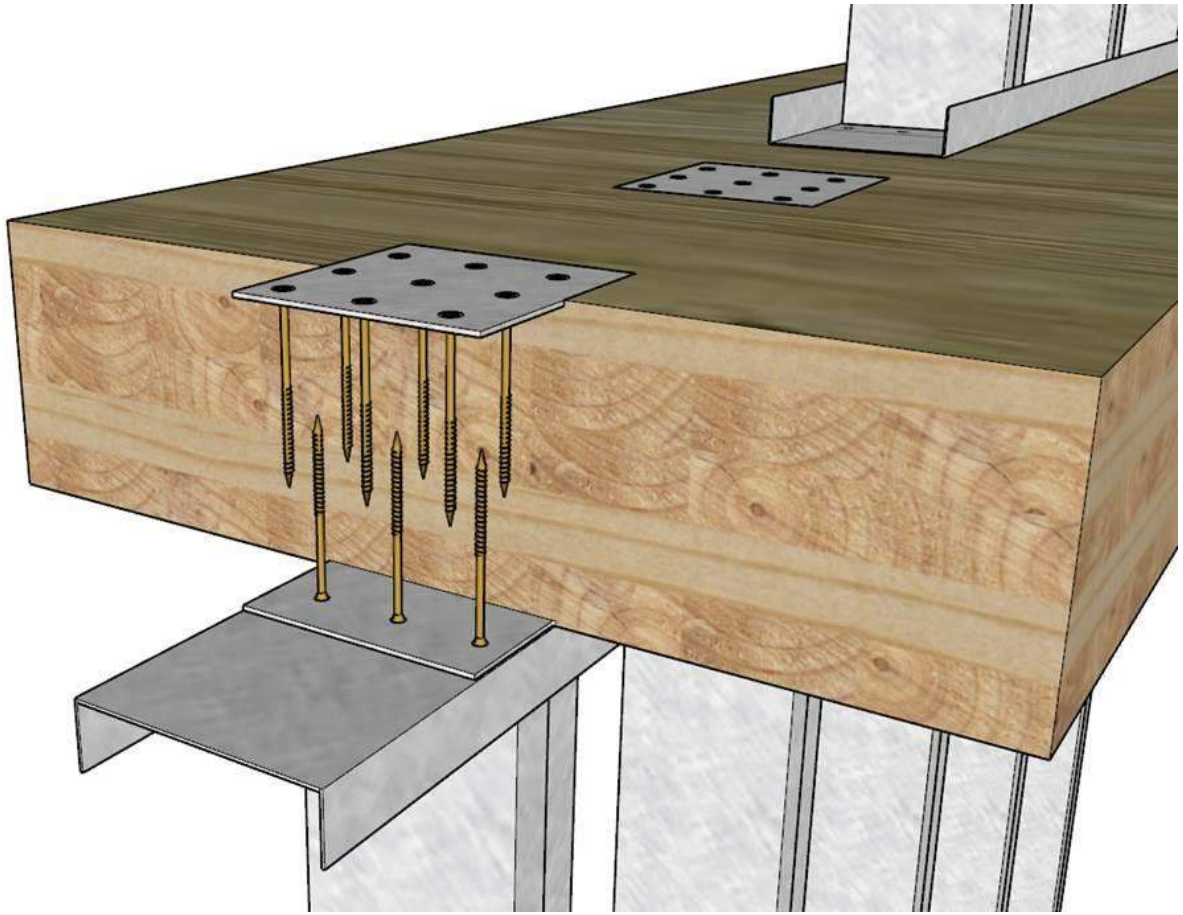
VERTICAL MOVEMENTS ISSUES



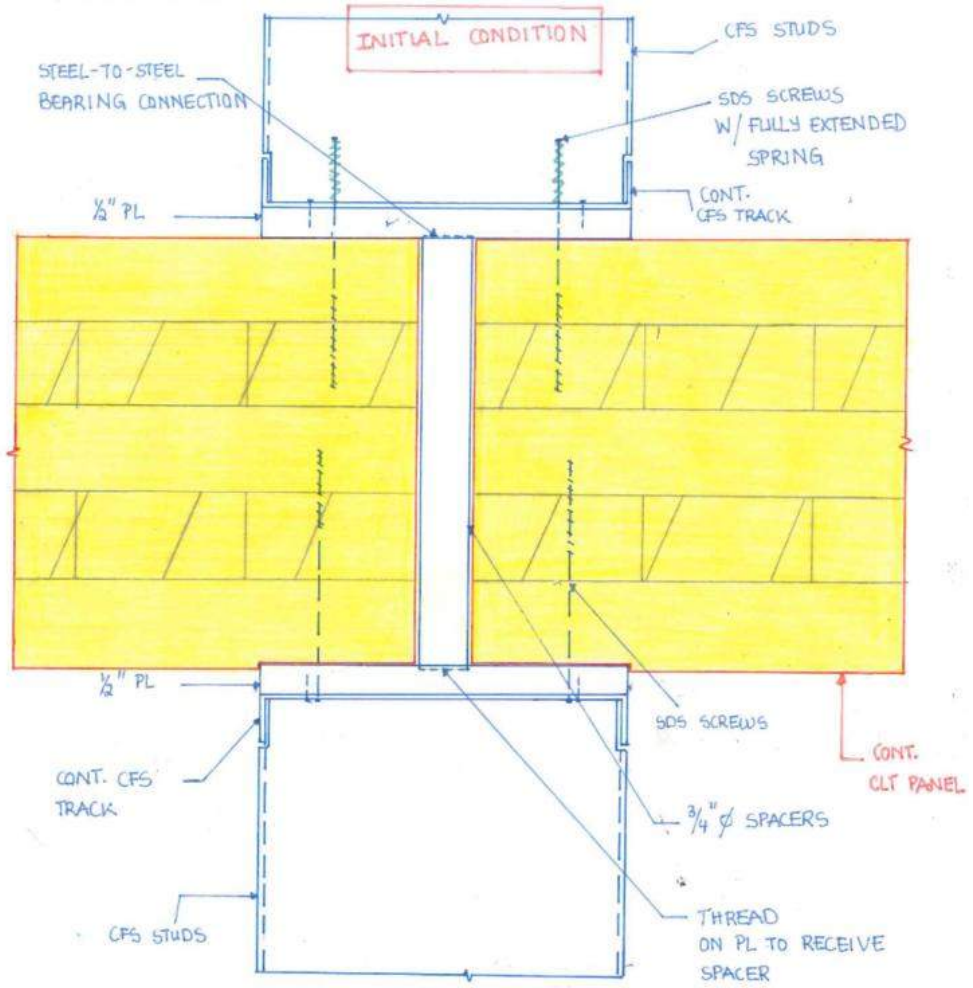


INITIAL CONCEPTS – SCREW REINFORCEMENTS

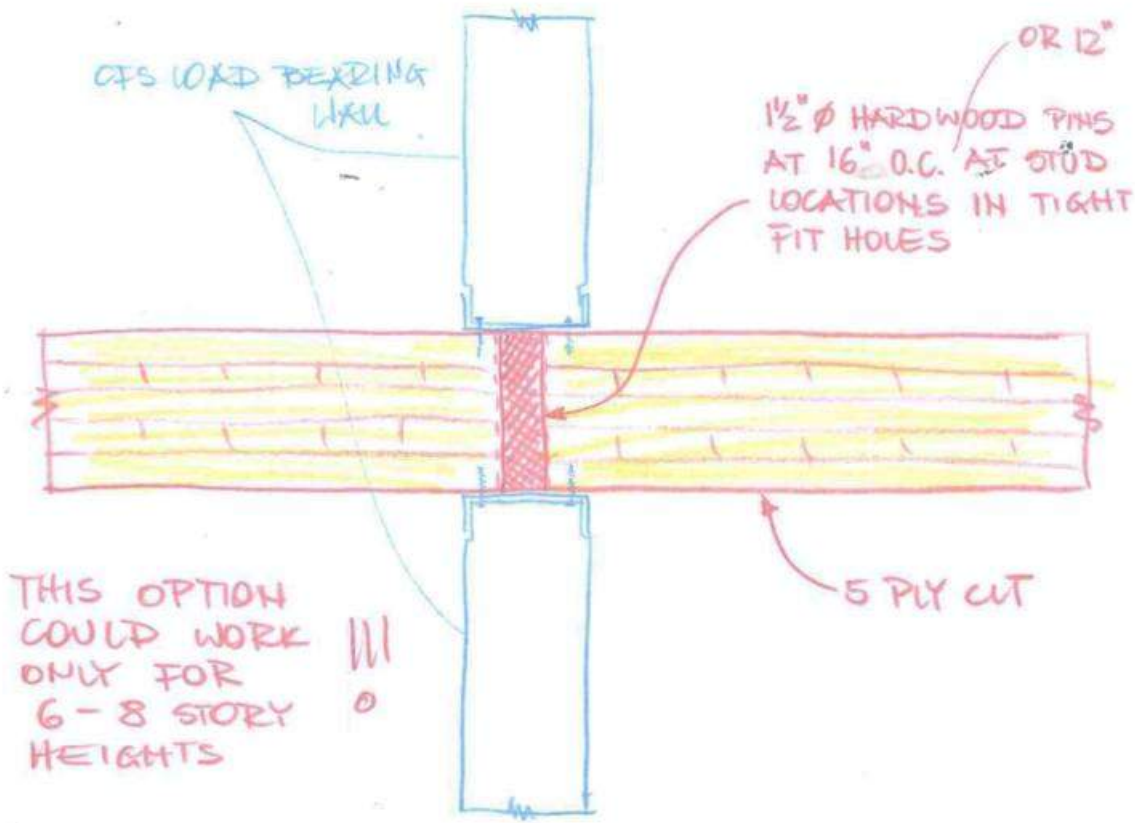




INITIAL CONCEPTS – DOWEL THROUGH CLT

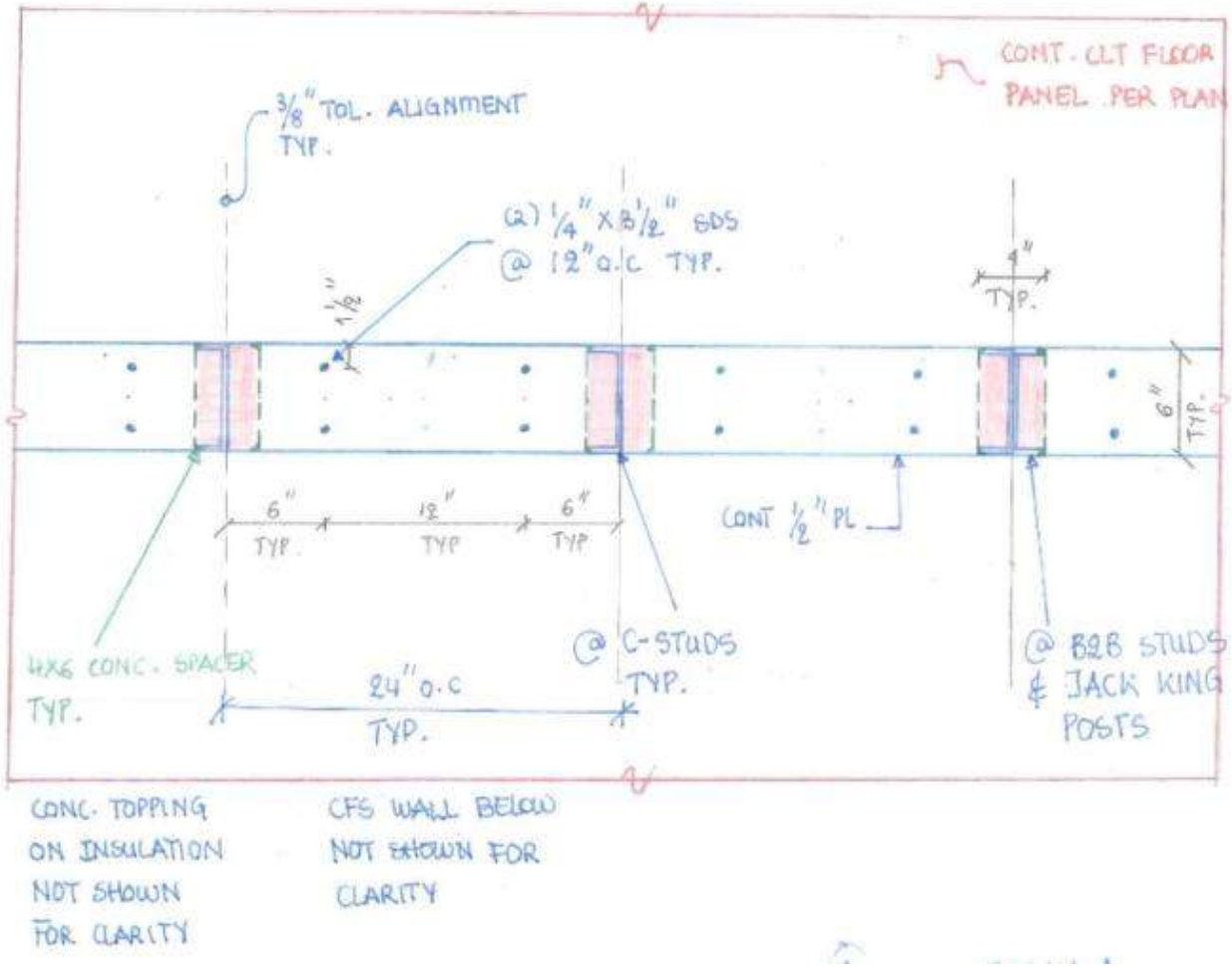


STEEL SPACERS (credit Katerra/Mercer)

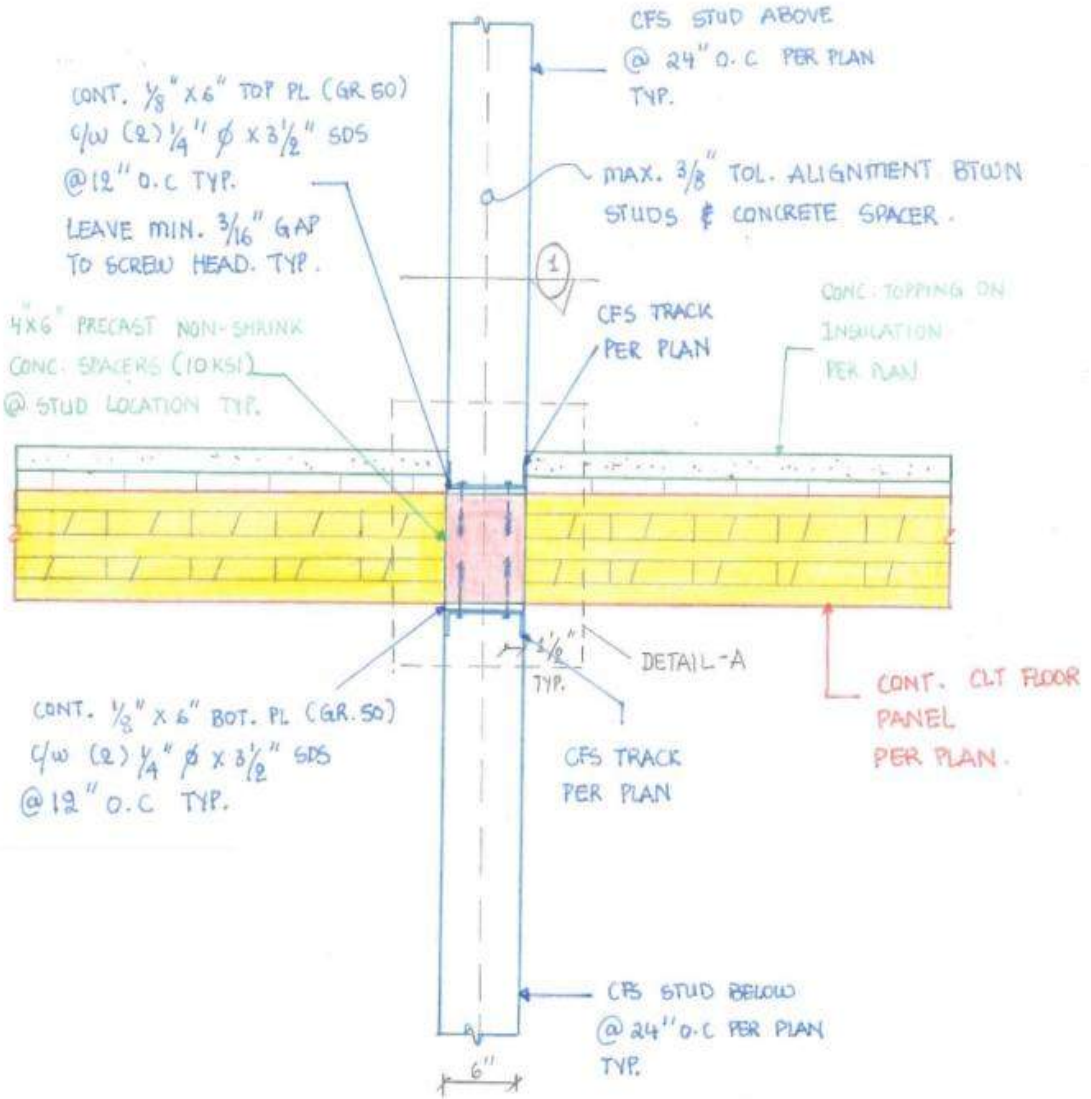


HARDWOOD WOOD SPACERS

CONCRETE SPACERS

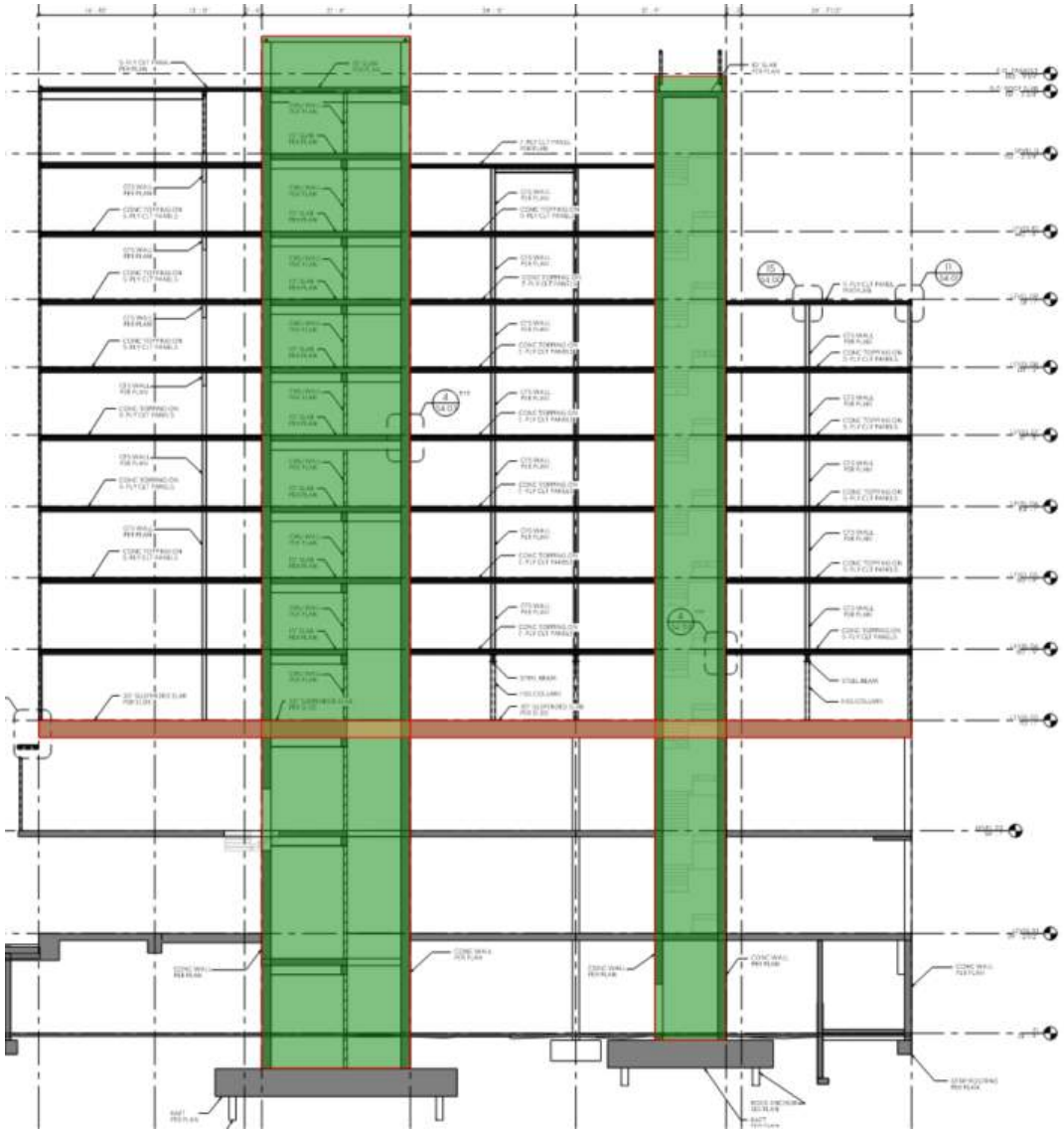


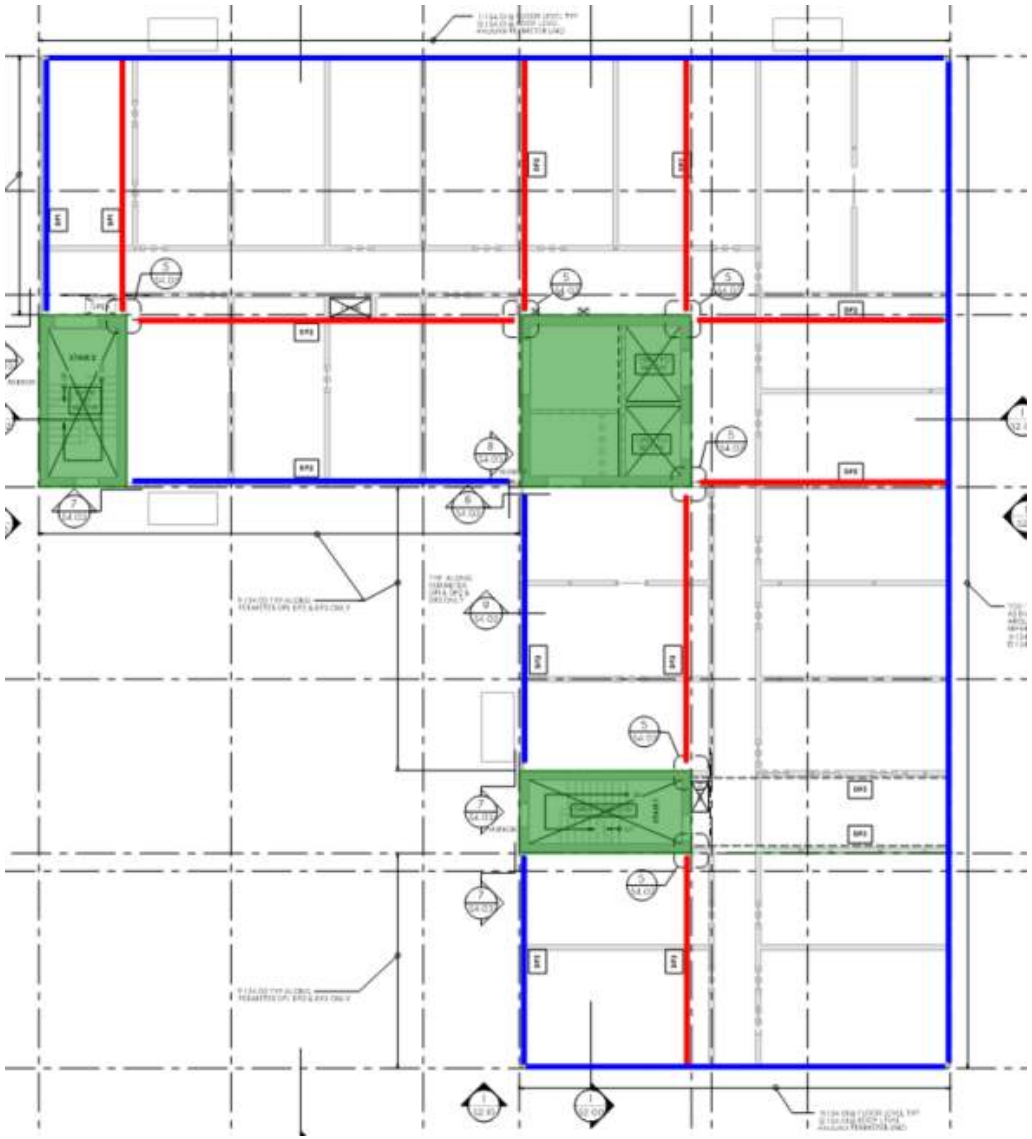
TOP VIEW



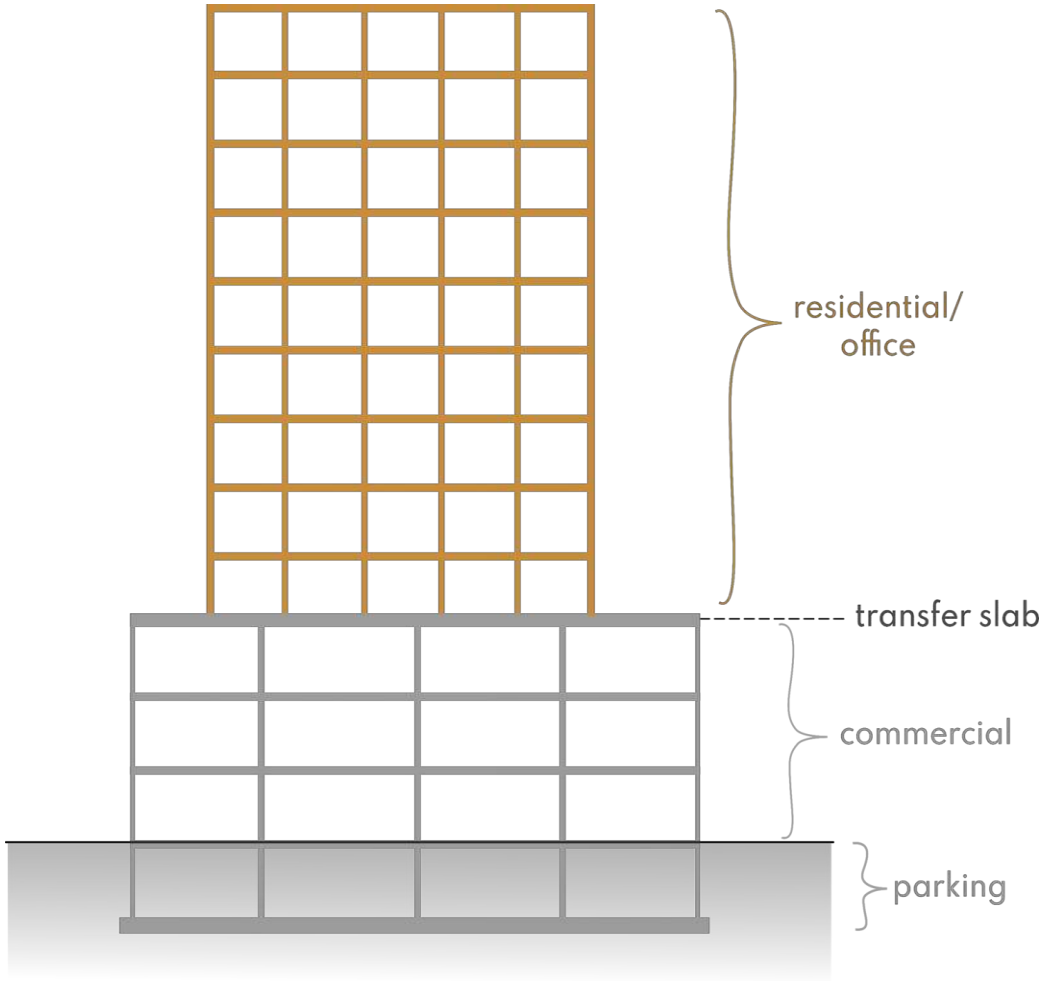
SECTION VIEW

SIMPLICITY + REGULARITY = EFFICIENCY

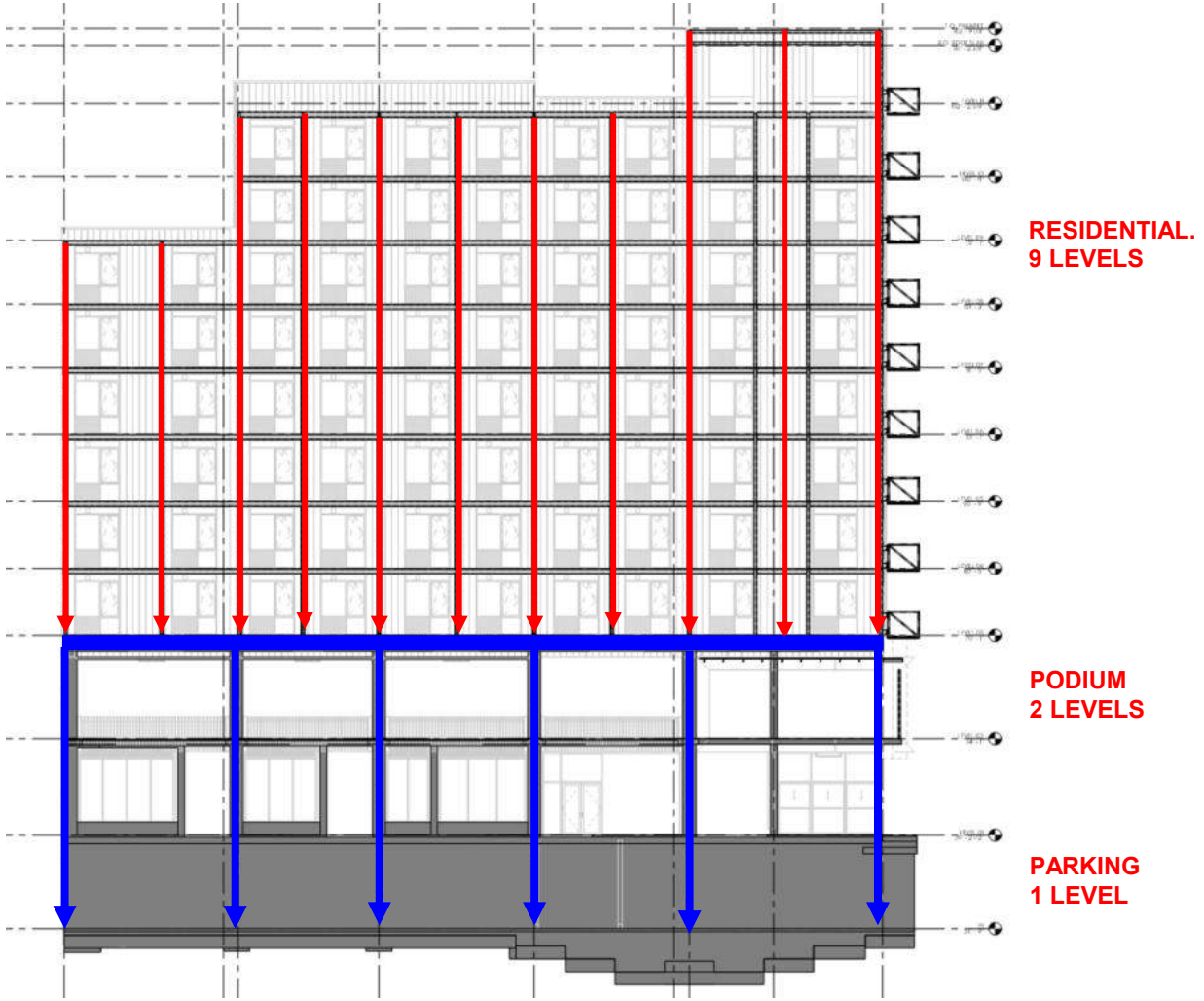




TRANSFER SLAB



PROACTIVE ADAPTATION



MODULAR TYPES FOR DIVERSE HOUSEHOLDS

CFS Walls

Credit – MA+HG ARCHITECTURE

FIRE PERFORMANCE

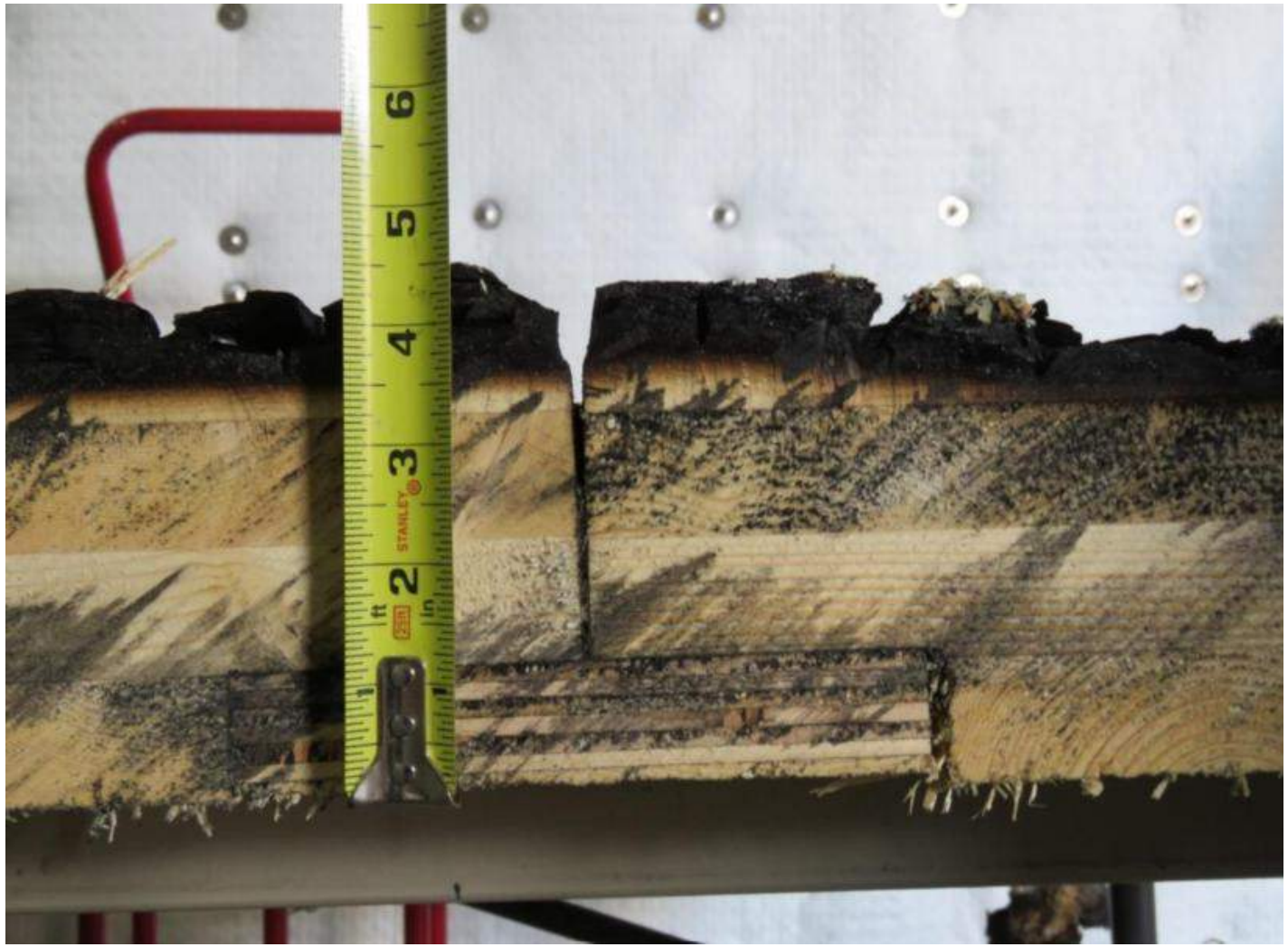
2H FRR

12’ SPAN – GRID SYSTEM

5PLY (175MM) V-GRADE CLT PANEL

DESIGN CHAR RATE
- 0.65mm/MIN

ALTERNATIVE SOLUTION
- AVAILABLE TESTS AND LITERATURE



Credit – Katerra /Mercer

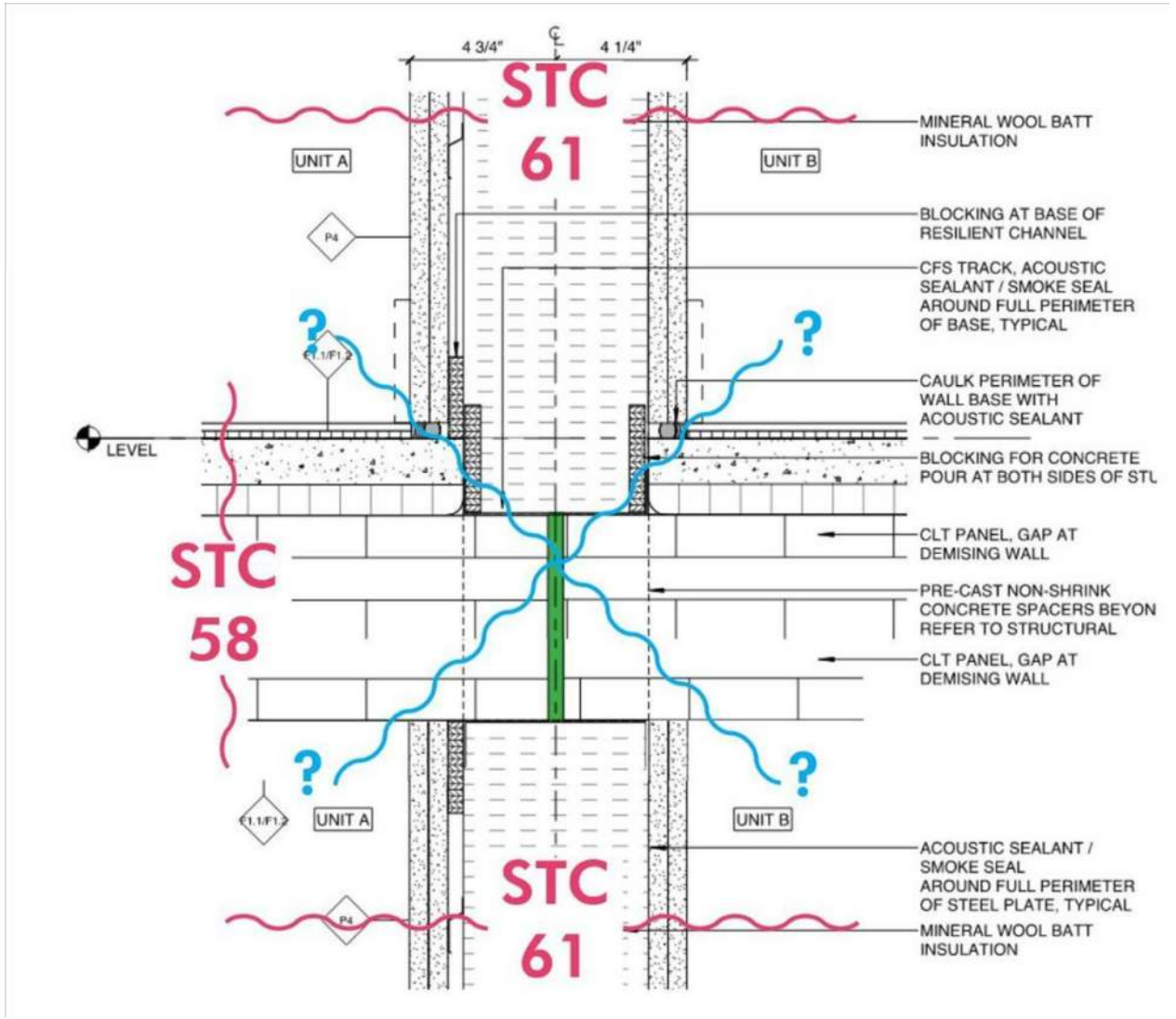
ACOUSTIC & VIBRATION PERFORMANCE

MAX. CLT SINGLE SPAN FOR 5PLY

MULTI-SPAN WHERE POSSIBLE

BREAK BETWEEN UNITS

PANEL LAYOUT



Credit – MA+HG ARCHITECTURE

TALL MID-RISE – 5 TO 9 STOREYS

SPACERS vs NO SPACERS?

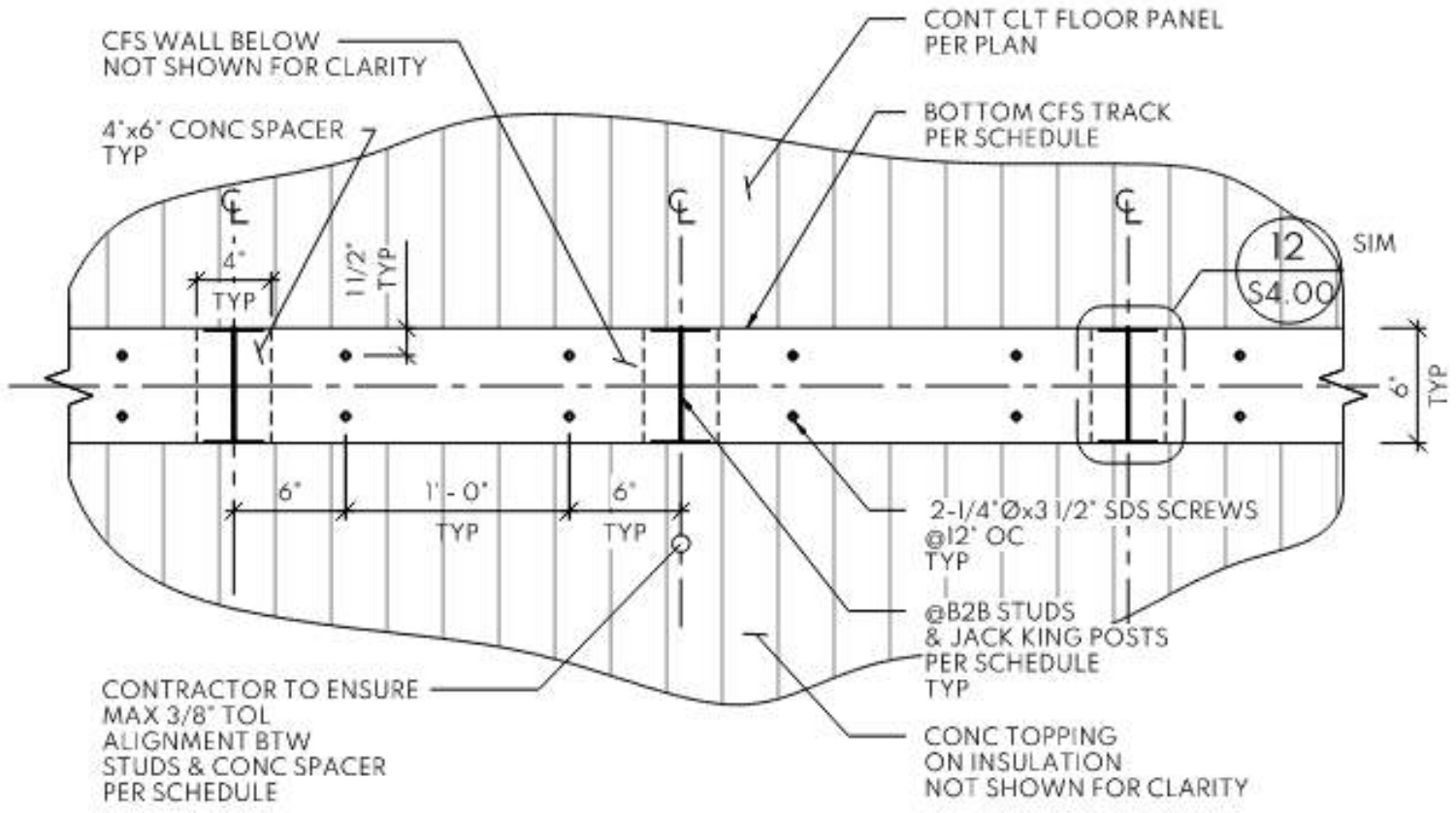
BACK TO BACK STUDS?

STUD SPACING?

SIZE OF CONCRETE SPACERS?

HSS POST/TRANSFER?

NUMBER OF TRADES?



Incorporating Mass Timber in Hybrid Structures

Bunker Hill Housing Redevelopment – Stellata

Development Vision

- To fast track the replacement of public housing units with pre-fabricated assemblies.
- To create a kit of parts model for sustainable urban design development.
- To be at the forefront of Sustainability with all buildings committed to Passive House prior to Energy Code updates.

Masterplan Program

- Residential, retail and community uses
- 15 Residential Buildings
- Replacement of 1,010 existing public housing units with the addition of market rate units
- Total of 2,699 units
- 37% affordable unit ratio
- 7 acres of open space
- 50,000 SF of retail space

Defining Design Targets

Rent-to-cost optimized product

- Limited unit, kitchen and bath types

Building forms and facades optimized for energy performance

- Early energy modeling to set design parameters

Structural system optimized for tall mid-rise (6-12+ stories)

Phase 1: Stellata

- 6 Story Building
- 120,000 Gross SF
- 102 units – 100% affordable
- Passive House
- Construction type: 2021 IBC IV-C

Partners

Design Team

Stantec
Copley Wolff
Lam Partners
McNAMARA·SALVIA
ACENTECH
integrated ecostrategy
HOWE ENGINEERS
Nitsch Engineering

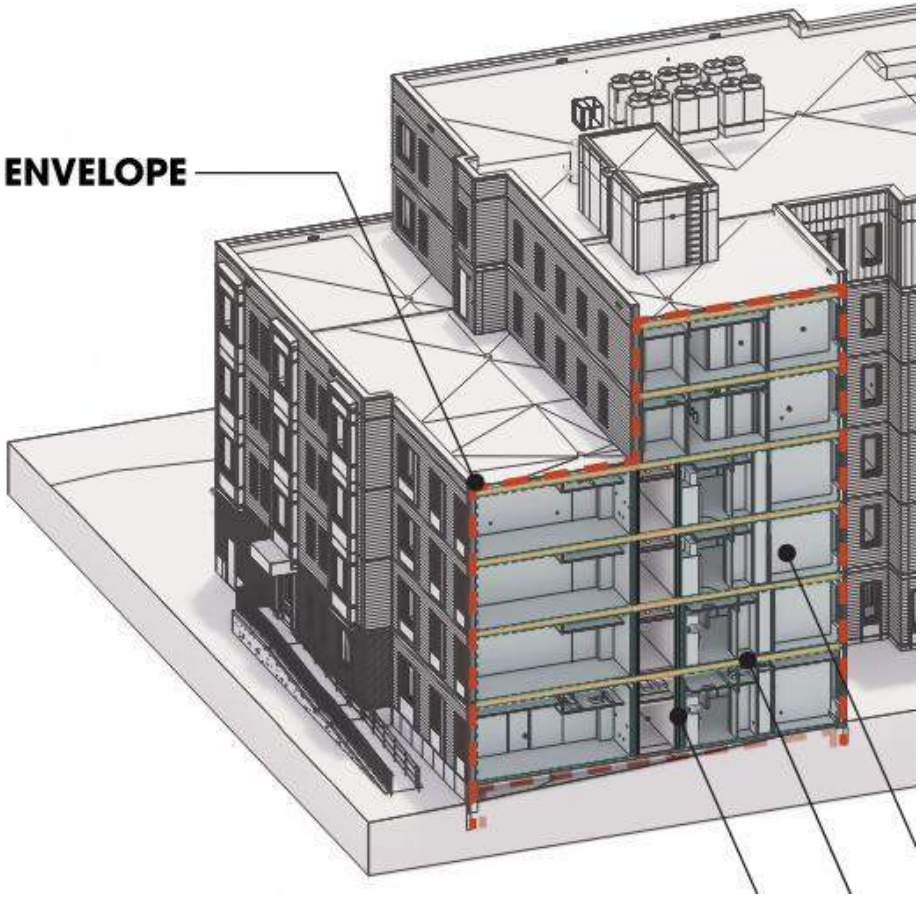
Construction Team

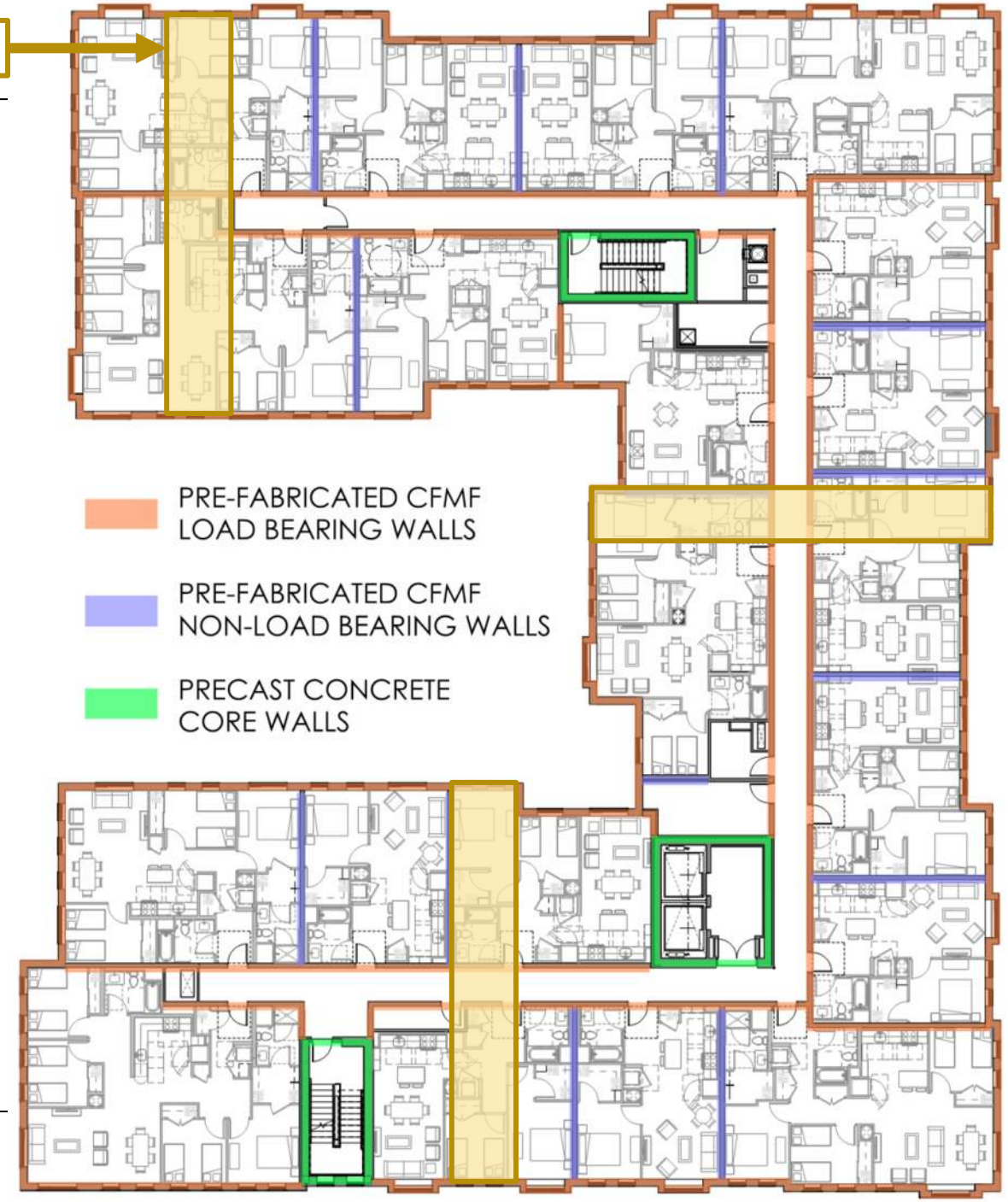
SUFFOLK

Passive House Team

- CPHC: PE Petersen Engineering
- CPHV: RDH BUILDING SCIENCE

Component Construction





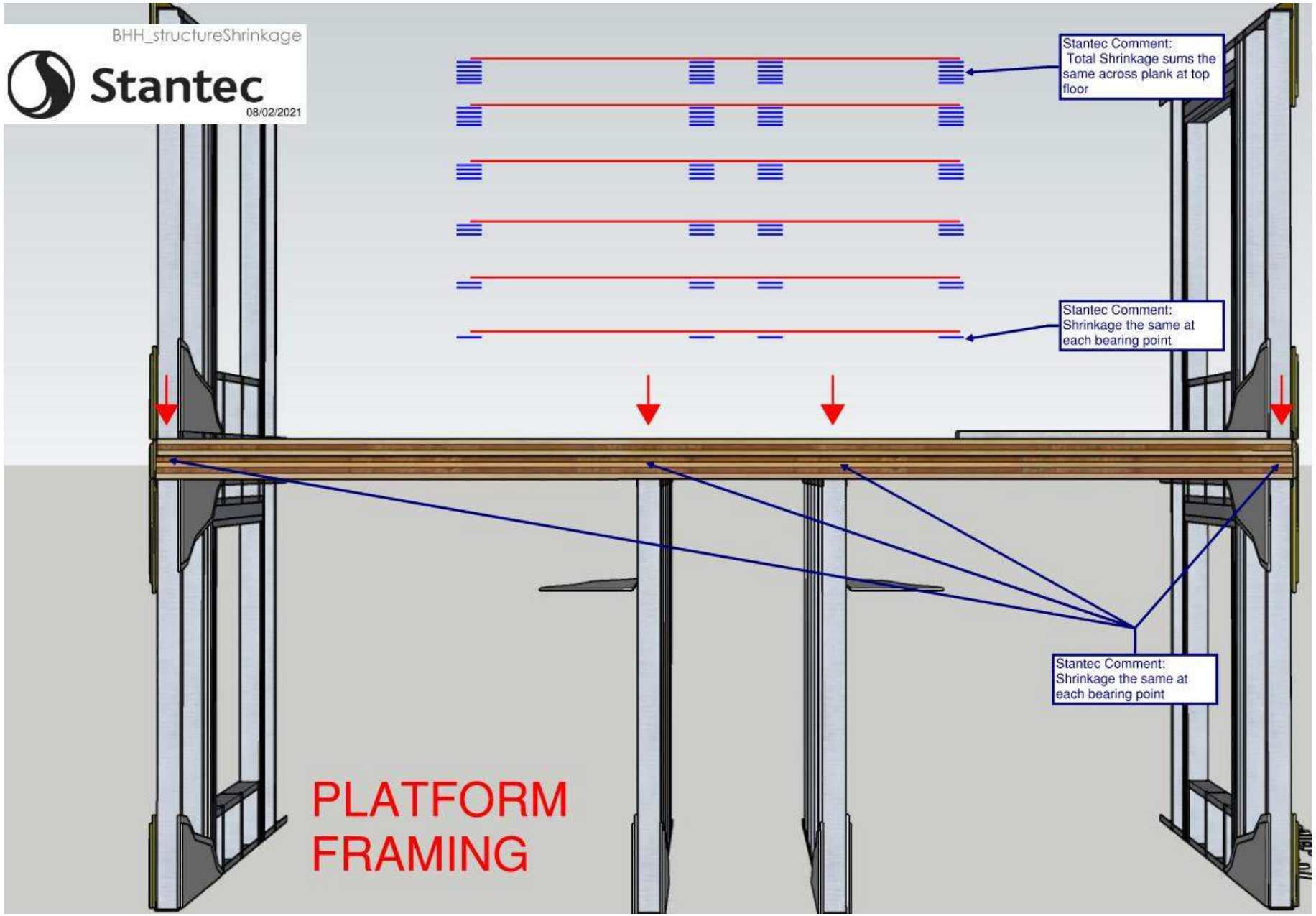
Leggat McCall PROPERTIES

COMPONENT CONSTRUCTION ANIMATION

Platform Framing

Building Cumulative Shrinkage

- 1” for 6 stories
- Shrinkage would remain the same at the perimeter and the center across a floor. This would then be cumulative as each successive level goes up, but remain constant per level

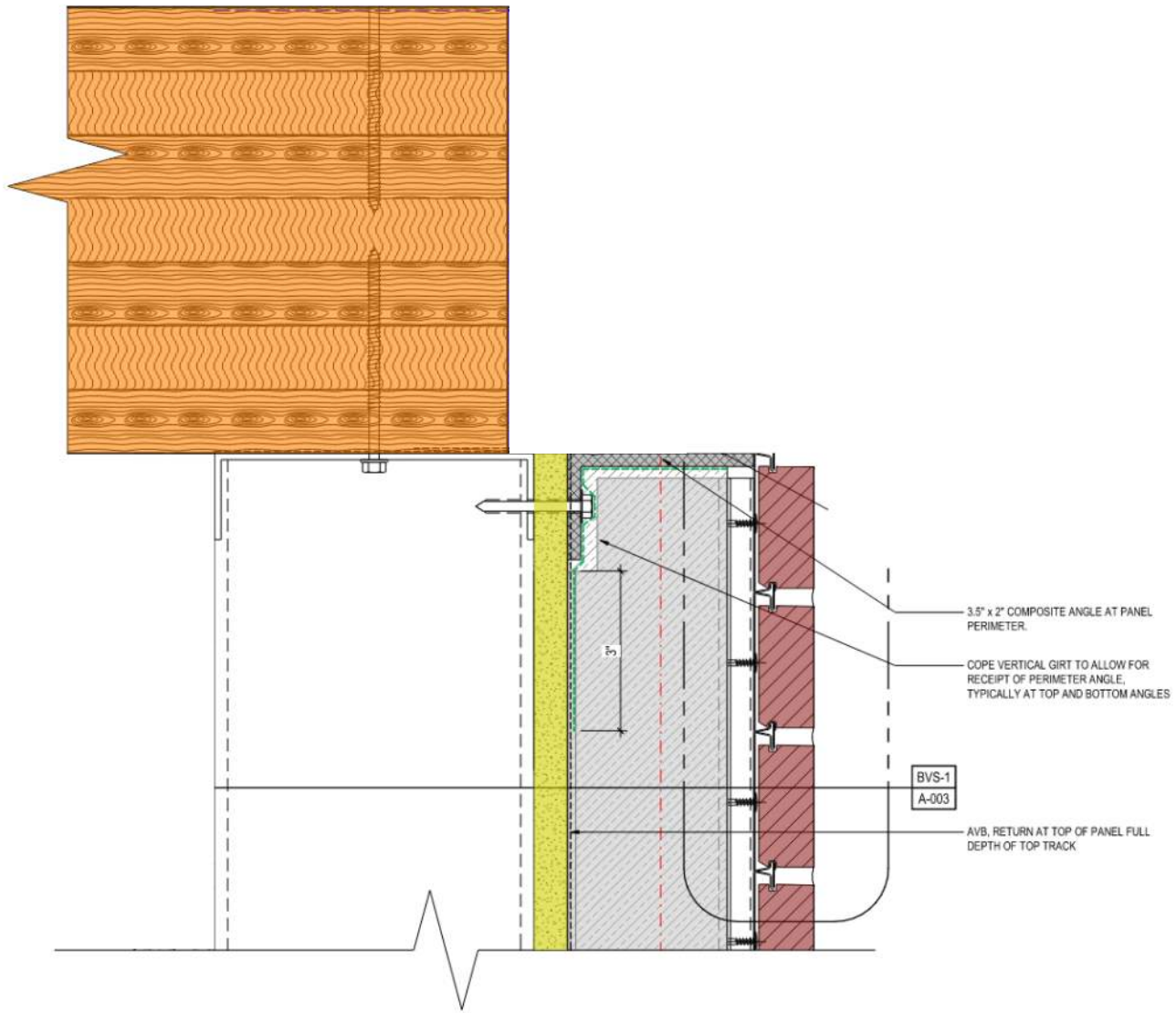


Edge of Slab Detail

Prefabricated exterior walls with cladding installed at the factory.

Construction Tolerance becomes a Key!

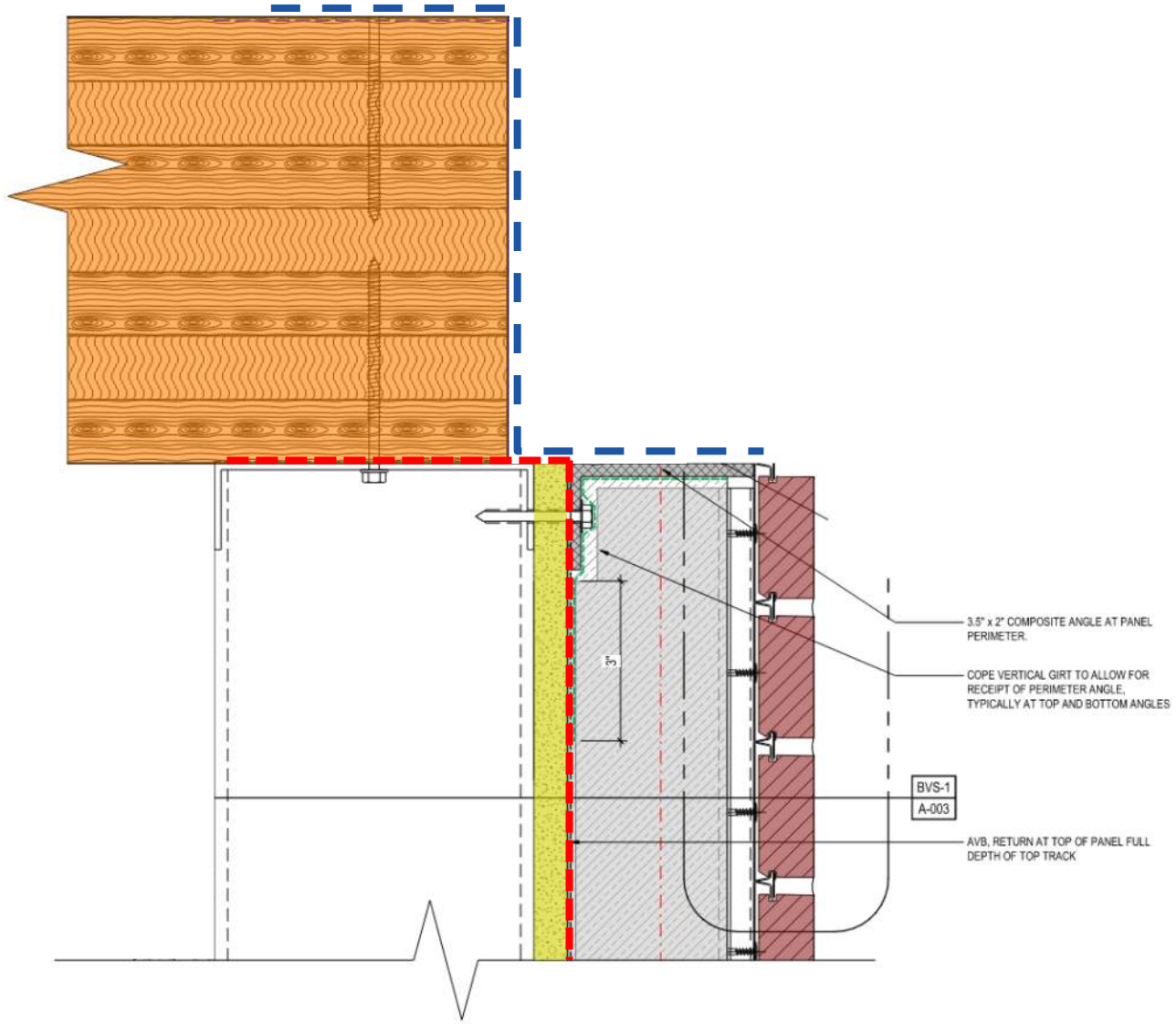
7 ply CLT (62’) gets hoist into place onto load bearing exterior and corridor walls.



New Constructability Approach

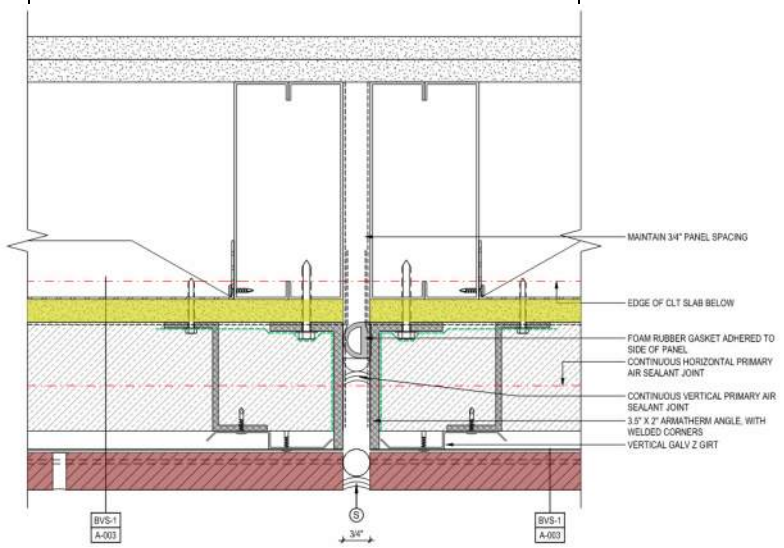
AVB layer dual purpose:

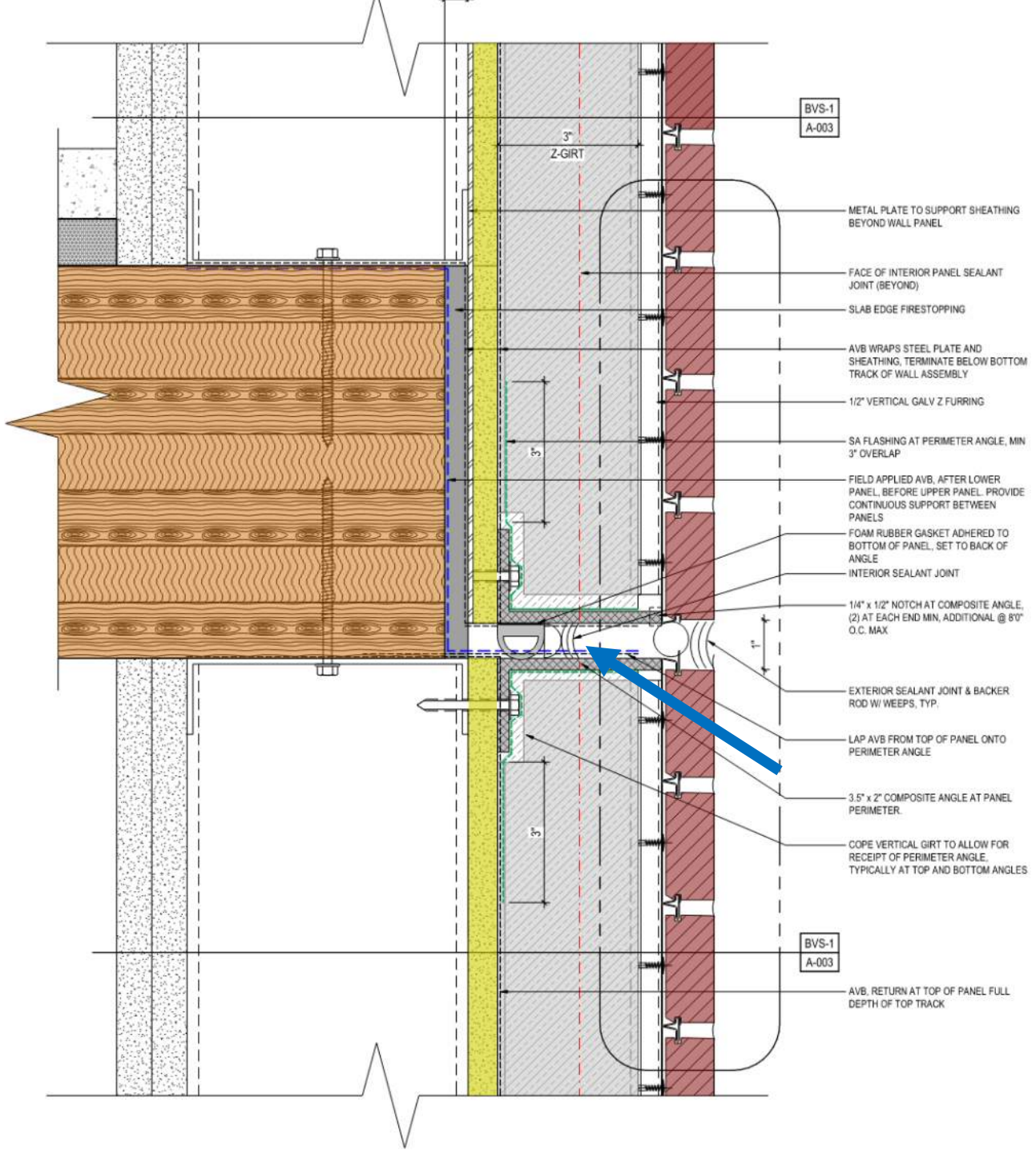
- CLT Moisture protection
- Air and water seal at the exterior wall panels 4-joint



New Constructability Approach

Tilt up panels with structure, sheathing, AVB, and cladding support installed.

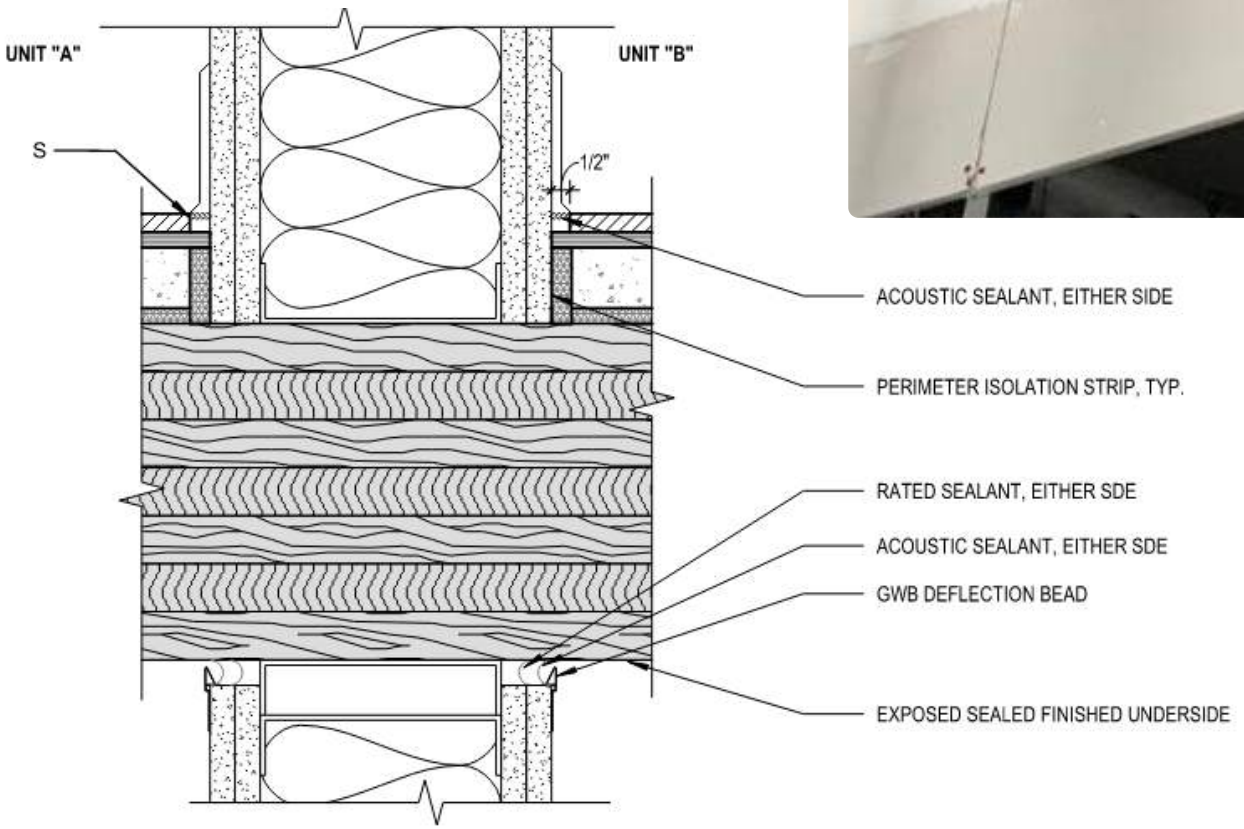




Deflection

Deflection bead at areas where demising wall met exposed CLT ceilings

App 5/8” deflection at floors and roof



Acoustics

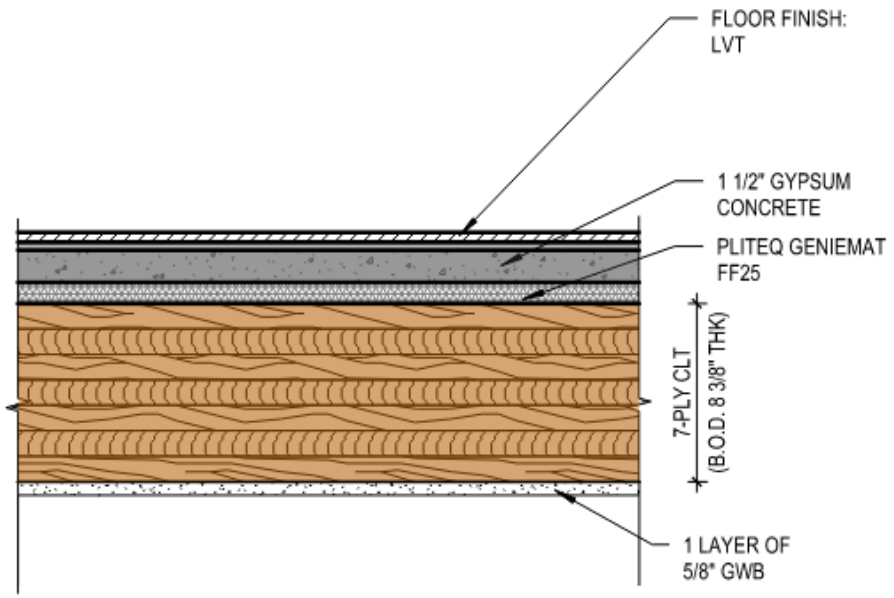
On the hunt for a tested assembly that will meet the project goals using 7-ply CLT

Lab Results:

STC 55 / IIC 50

Field Test Results:

STC: 57 / IIC: 49



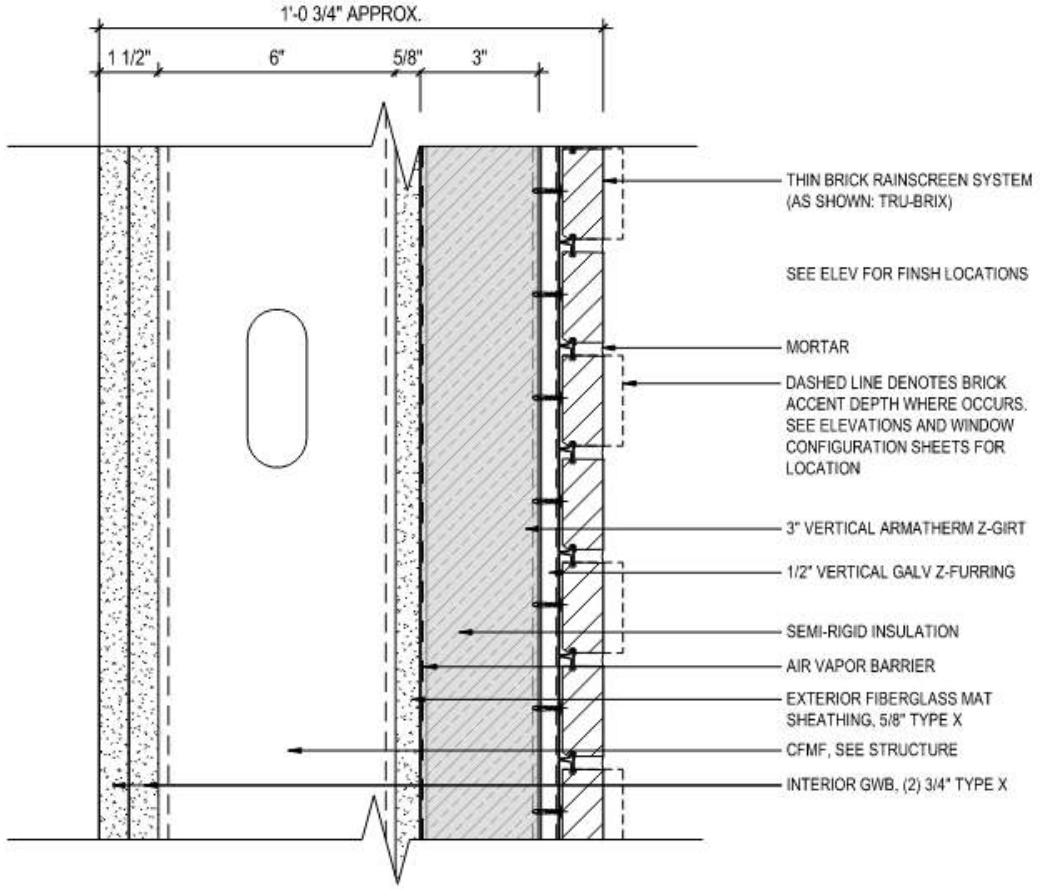
PENETRATIONS IN FLOOR:
1.FIRESTOP PENETRATIONS IN THE FLOOR.

MIN. STC 50
MIN. IIC 50

FLOOR TYPE	CLT FLOOR ASSEMBLY 2HR RATED (BASIS OF DESIGN)

Fire Rating

- 2HR rated exterior walls: UL 425
- 2021 Type IV-C: Variance at the time of permitting



2HR BEARING WALL : UL# - U425 R VALUE = 14

2 / A-301 **BVS-1 - BRICK VENEER SYSTEM - (REV)**

3" = 1'-0"

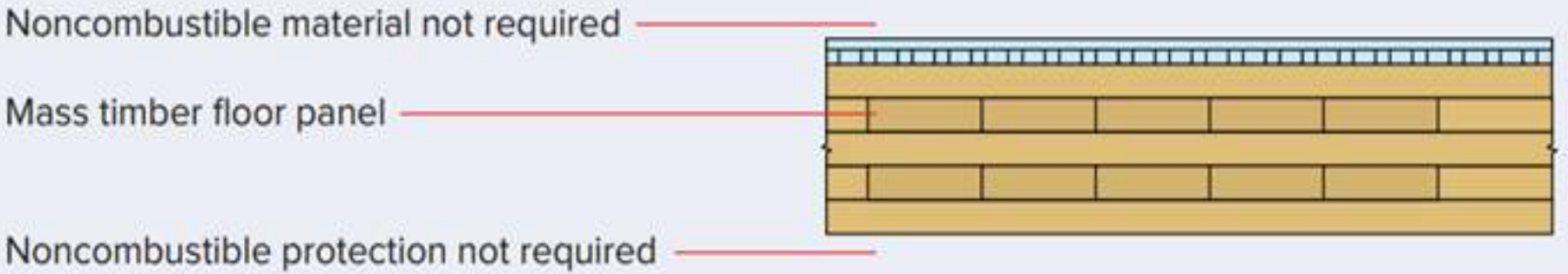
Concealed Spaces

Combustible material protection required in concealed spaces under 2021 IBC Type IV-C

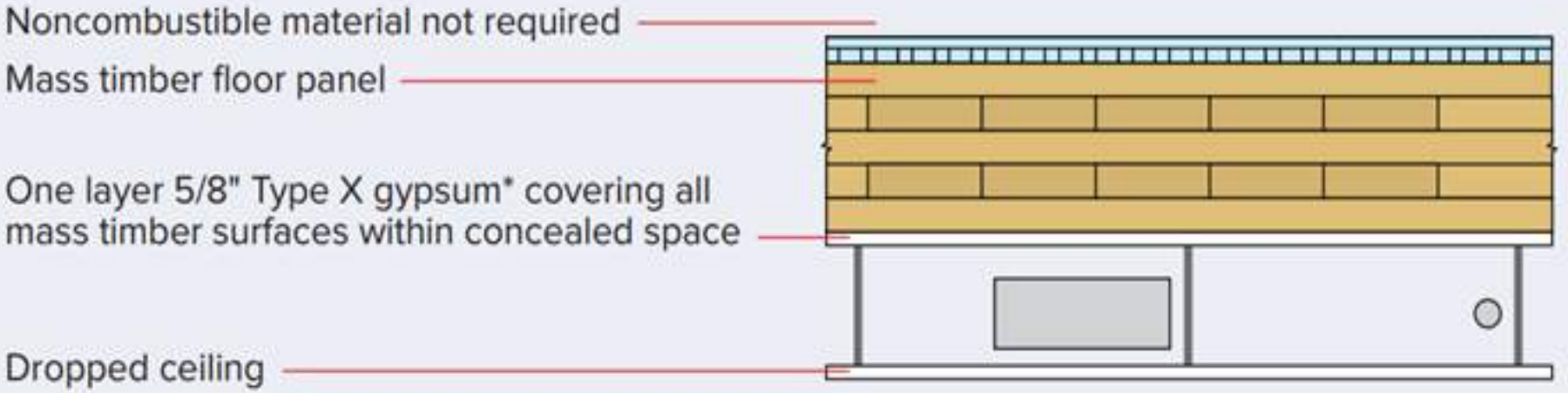
Taping and sealing of GWB joints, challenge with construction rain

CONCEALED SPACES: TYPE IV-C

Without Dropped Ceiling



With Dropped Ceiling



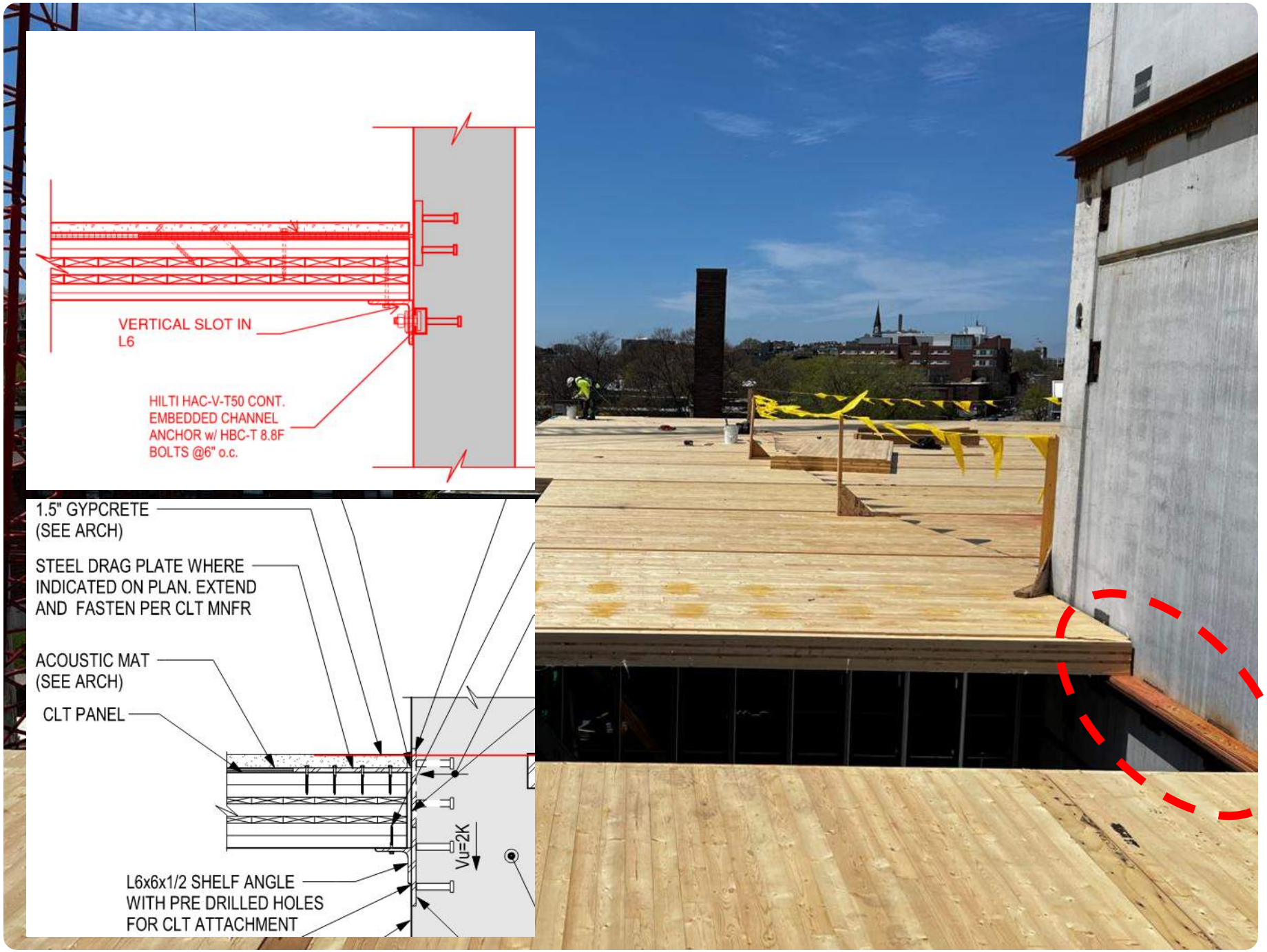
SOURCE: WOODWORKS

Challenge: Concealed Spaces

Combustible material protection required in concealed spaces under 2021 IBC Type IV-C

Lessons Learned

- Connection of CLT to precast concrete walls.



Lessons Learned

- Oversize door frame openings

Lessons Learned

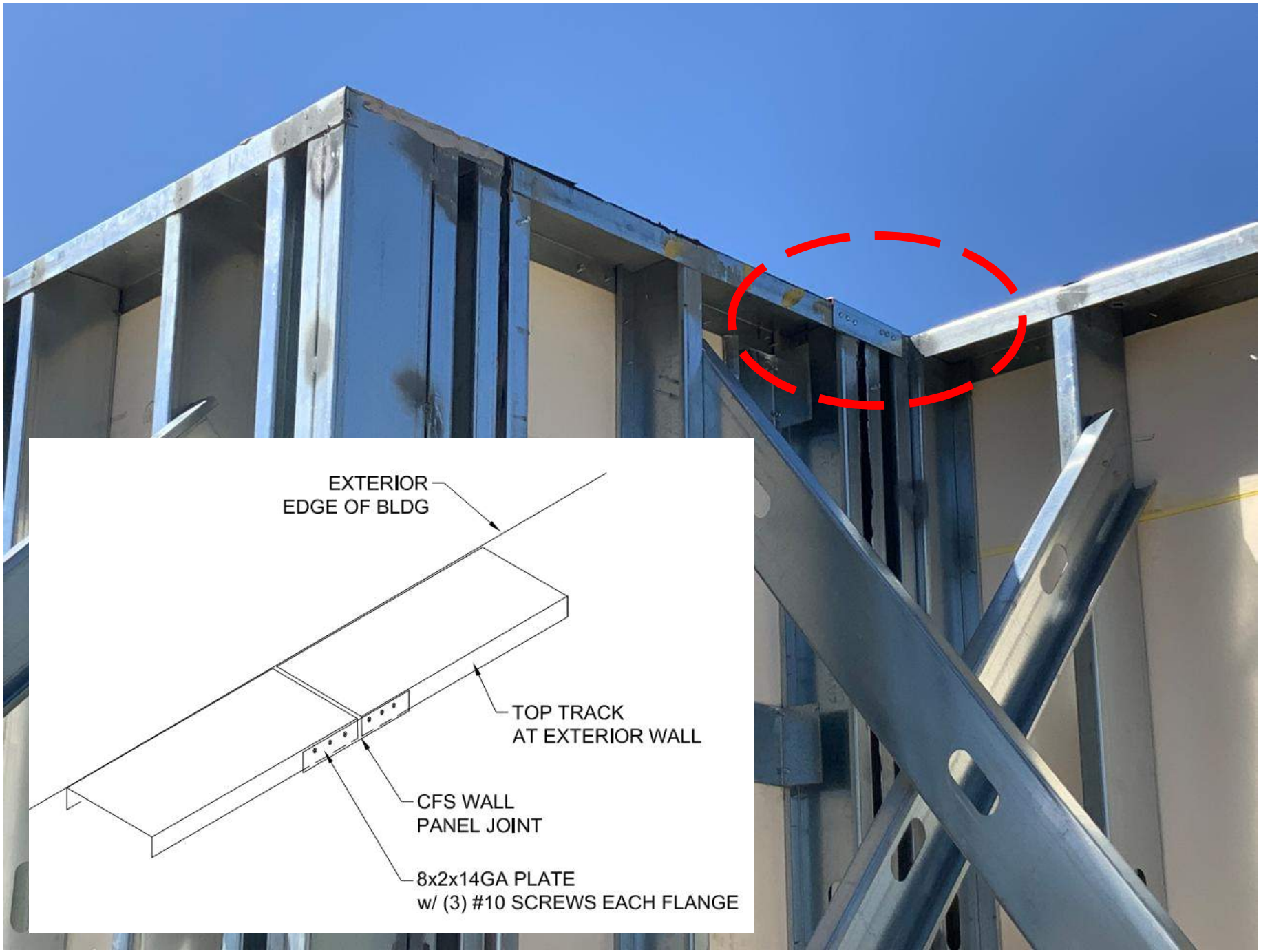
- Fastener heads, plates, stud packs
- Heavy studs for load bearing walls

Lessons Learned

- L-Shape plate at top of exterior wall panel, exposed.

Lessons Learned

- Exterior chord splice at panel joints at areas with exposed CLT.



Benefits

Decreased Construction Timeframe

- 7K SF floor structure per day
- 21K SF exterior walls in 6 days
- Building M beta test: 102 units, 16 months vs. 20+ mo.

On-site Labor Force Efficiency

- Erection by 6-man carpentry crew
- 20%+ Reduction of Onsite Labor Hours

Reduced Temporary Construction Items

- No construction hoist or operator – materials are preloaded during erection
- No exterior scaffolding – exterior walls glazed & finished
- No tower crane foundation
- Reduced winter weather mitigation

Benefits

CLT's single span across building

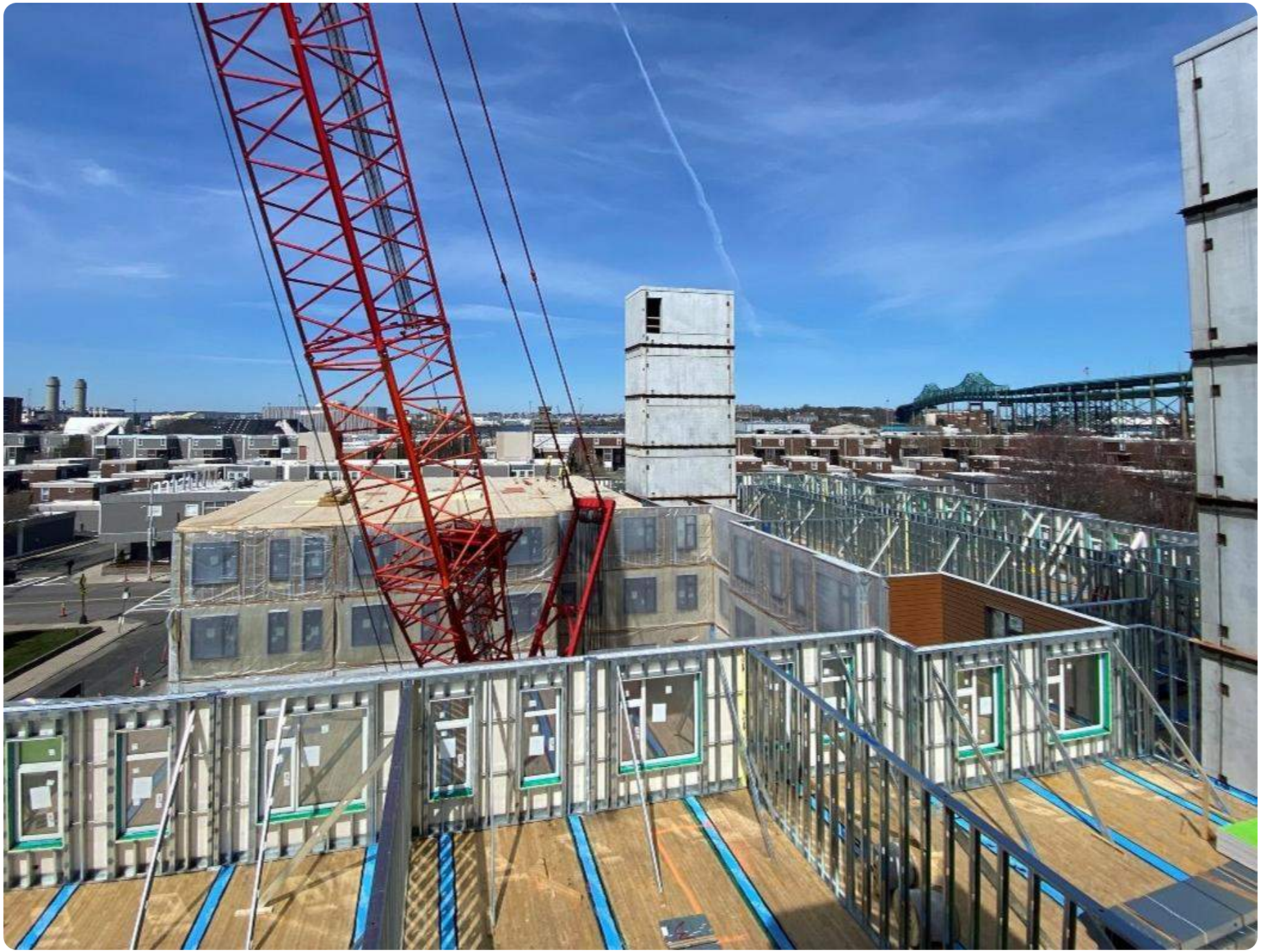
- Less crane picks – faster erection
- Maximizes fabrication efficiency

CLT's light weight

- Lower foundation impact

Fire Resistance

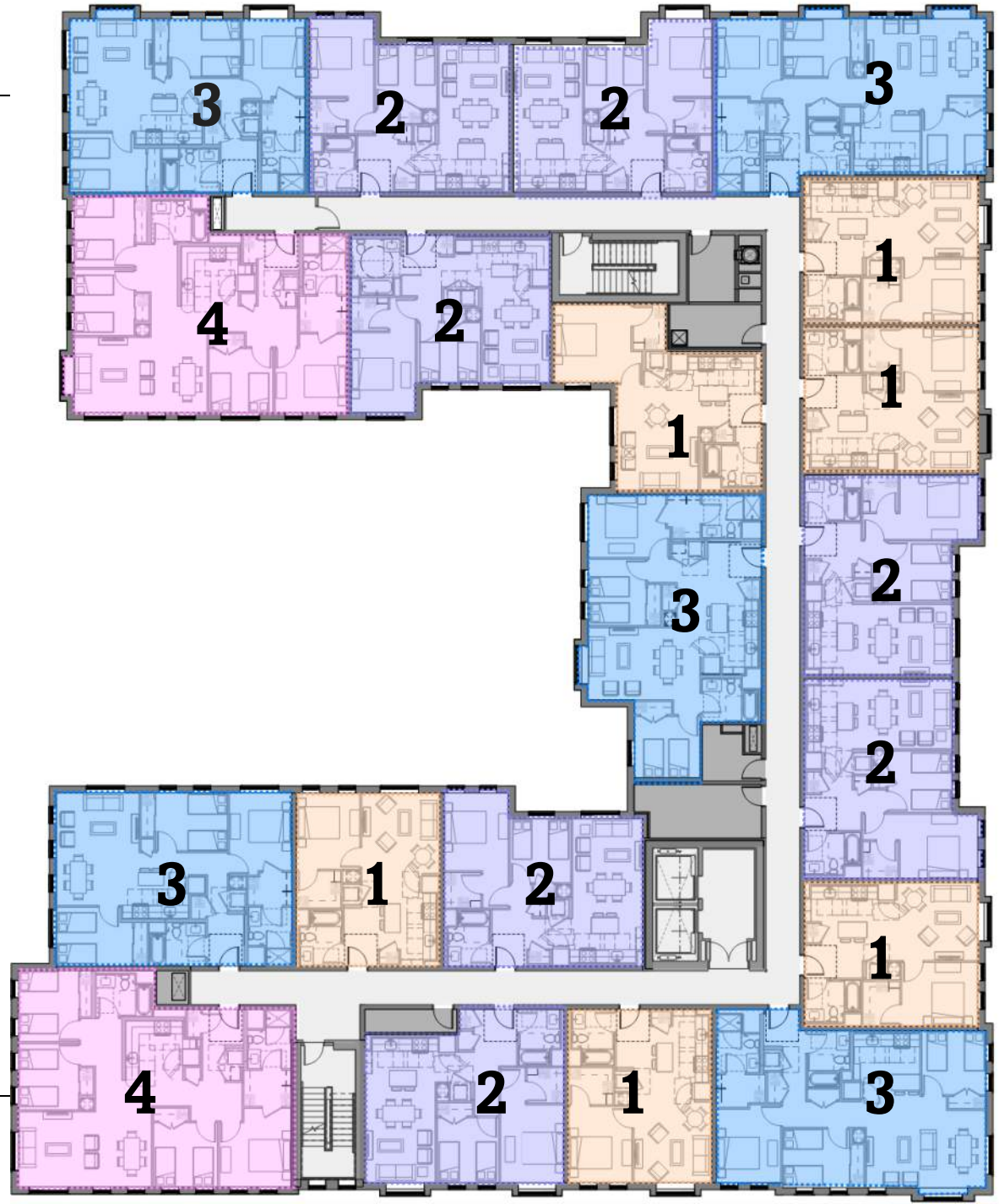
- Inherent 2HR fire resistance



Design Flexibility

Average Unit Size: 914 SF

Unit Type	%	Unit Size
1 Bedroom	32%	600 - 650 SF
2 Bedroom	35%	750 - 920 SF
3 Bedroom	23%	980 - 1,060 SF
4 Bedroom	10%	1,300 - 1,320 SF



Construction Progress

Interior Design

CLT Biophilia Effect

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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