odeh engineers

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Hybrid Mass Timber + Steel
RISD Quad

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board

Course Description

The Quad, a new 6-story residence hall on the campus of the Rhode Island School of Design, is the first major student housing project in New England to be constructed using a hybrid cross-laminated timber and steel structural system. In this presentation, the structural engineer will provide an overview of the project—from the process used to evaluate options for the superstructure and reasons why mass timber was chosen, to the resulting code path, and aspects of the design, such as fire-resistance and differential movement, that are unique to this type of structure. The use of integrated project delivery will also be discussed, highlighting the collaboration required between design team, fabricators and on-site installation in order to achieve the project's goals.

Learning Objectives

- Discuss code-complaint options for using hybrid mass timber structures in projects such as student residence halls.
- Highlight the evaluation criteria and ultimate reasons for choosing the structural system for the RISD Quad, with an emphasis on code-compliance, speed of construction and beauty.
- Explore aspects of design such as fire-resistance ratings and acoustic separation unique to hybrid timber and steel structures.
- Demonstrate the coordination efforts required between design team, fabricators and on-site installation in order to achieve the project's goals.

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

RISD Quad New Residence Hall

Key Project Challenges

- Schedule and speed
- Aggressive institution wide sustainability goals
- Adjacent concrete flat plate dormitories
- Design goal to create artist loft experience
- Interest in mass timber

Glued Laminated Timber

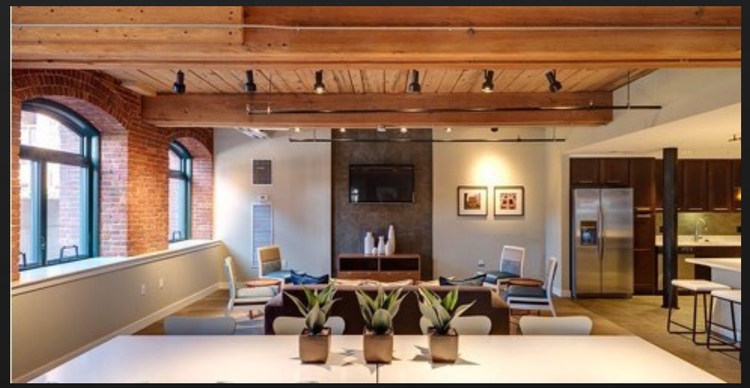
Structural Composite Lumber

Panelized Wood Products

Cross Laminated Timber

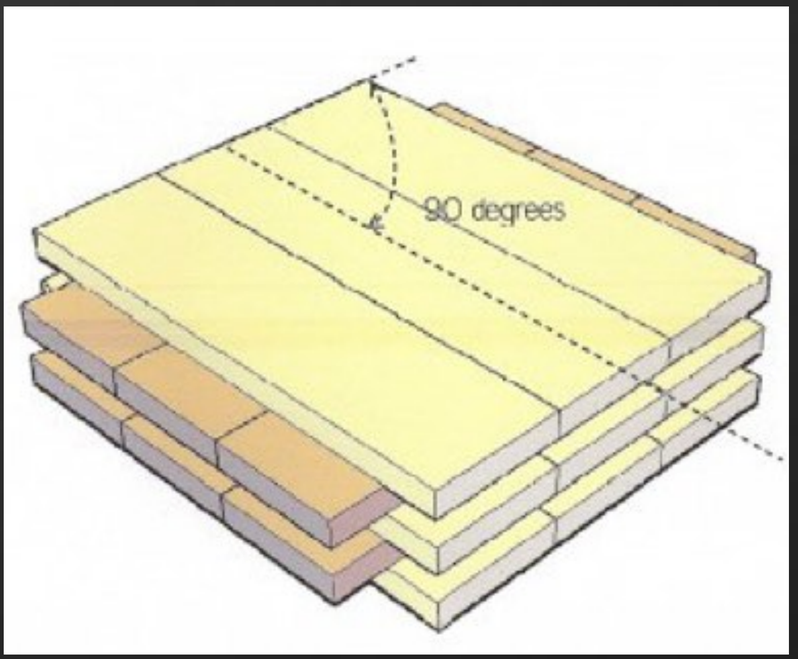
Dowel Laminated Timber

Solid Lumber



Cross Laminated Timber

- Made with sapling lumber
- Manufactured in up to 65’ lengths
- Two-way action possible
- Sequestered carbon



3 Ply ALT
4.125"
105mm

5 Ply ALT
6.875"
175mm

7 Ply ALT
9.625"
245mm

9 Ply ALT
12.375"
315mm

IBC2015 Construction Types

All heights assume NFPA 13 sprinkler system

Can use Mass Timber in ALL types

	Type 1 Noncombustible		Type 3 Noncombustible/ Combustible		Type 4 Heavy Timber	Type 5 Combustible	
Occupancy	A	B	A	B		A	B
A,B,R	None	180’	85’	75’	85’	70’	60’
A-2, A-3 A-4	None	12	4	4	4	3	2
B	None	12	6	4	6	4	3
R-2	None	12	5	5	5	4	3

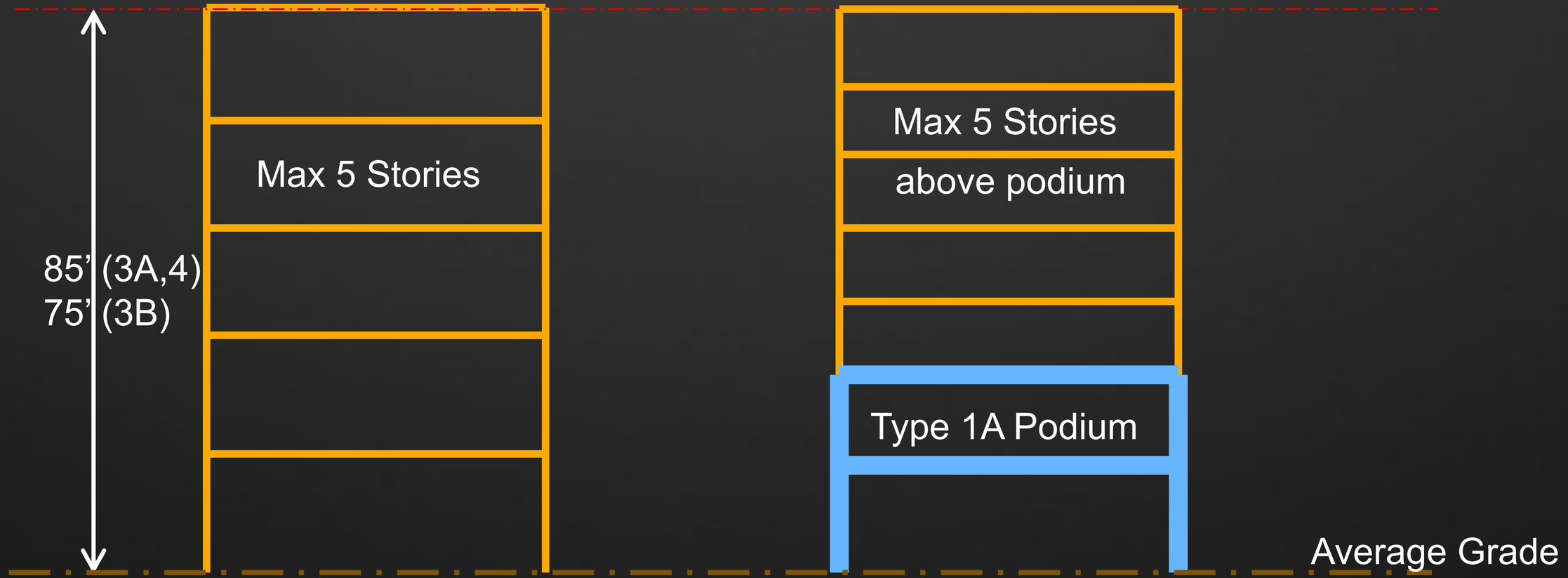
Height Limit

# of Stories

A: Interior structure fire rated

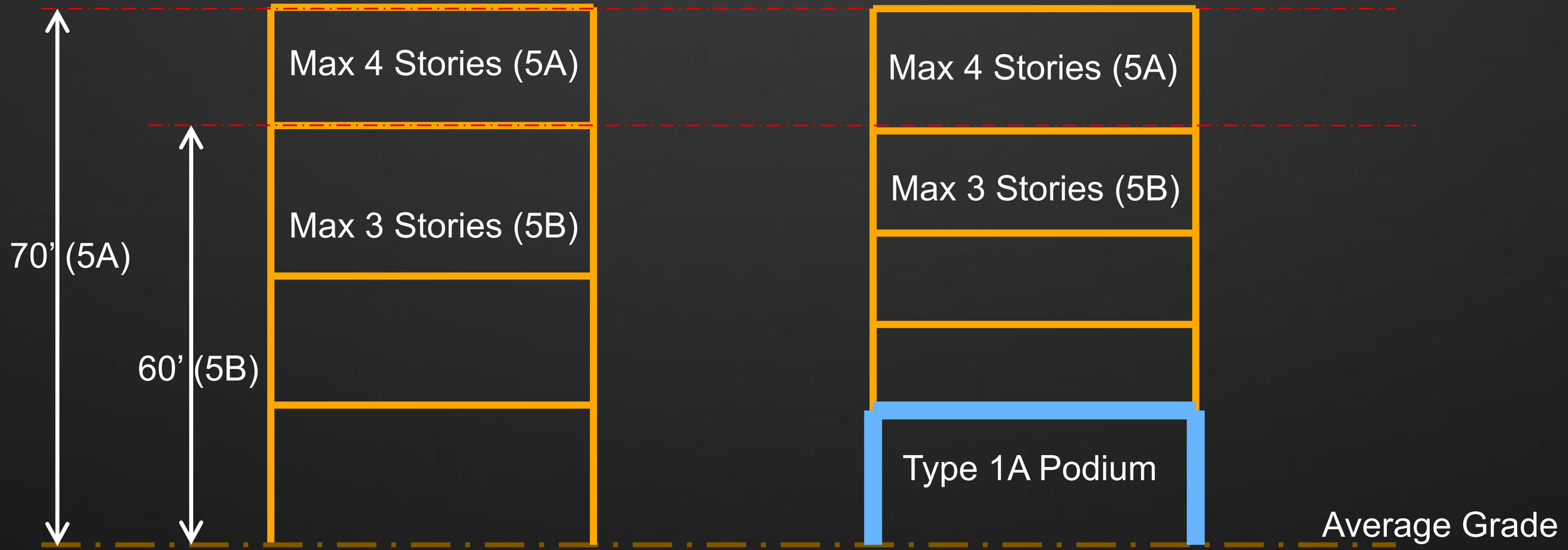
B: Interior mostly unrated

Height Limits – Type 3 and Type 4



Residential Dormitory (R-2)

Height Limits – Type 5



Residential Dormitory (R-2)

Minimum Heavy Timber Sizes (Type 4)

Member Type	Floor Framing	Roof Framing
Column	8x8	6x6
Beam	6x10	6” minimum thickness
Floor Deck (solid or glu-lam)	4” nominal	2” nominal
Cross laminated timber	4” actual	3” nominal

TABLE 602.4
WOOD MEMBER SIZE EQUIVALENCIES

MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NET SIZE		MINIMUM STRUCTURAL COMPOSITE LUMBER NET SIZE	
Width, inch	Depth, inch	Width, inch	Depth, inch	Width, inch	Depth, inch
8	8	$6^{3}/_{4}$	$8^{1}/_{4}$	7	$7^{1}/_{2}$
6	10	5	$10^{1}/_{2}$	$5^{1}/_{4}$	$9^{1}/_{2}$
6	8	5	$8^{1}/_{4}$	$5^{1}/_{4}$	$7^{1}/_{2}$
6	6	5	6	$5^{1}/_{4}$	$5^{1}/_{2}$
4	6	3	$6^{7}/_{8}$	$3^{1}/_{2}$	$5^{1}/_{2}$

IBC2021 Approved New Construction Types

Note: Limits assume sprinklers used

	Type 1 Noncombustible		Type 3 Noncombustible/ Combustible		Type 4 Heavy Timber New Types			
Occupancy	A	B	A	B	A	B	C	HT
A,B,R	Unlimited	180’	85’	75’	270’	180’	85’	85’
A-2, A-3, A-4	Unlimited	12	4	4	18	12	6	4
B	Unlimited	12	6	4	18	12	9	6
R-2	Unlimited	12	5	5	18	12	8	5

Height Limit

# of Stories

Type 1A podium can be used to extend story limit

IBC2021 Approved New Construction Types

Source: Tall Wood Buildings in the 2021 IBC – Woodworks
Credit: Susan Jones, atelierJones

All wood must be covered with fire resistant material

Some wood may be exposed, all wood must have rating

All wood may be exposed, but must have 2 hour rating

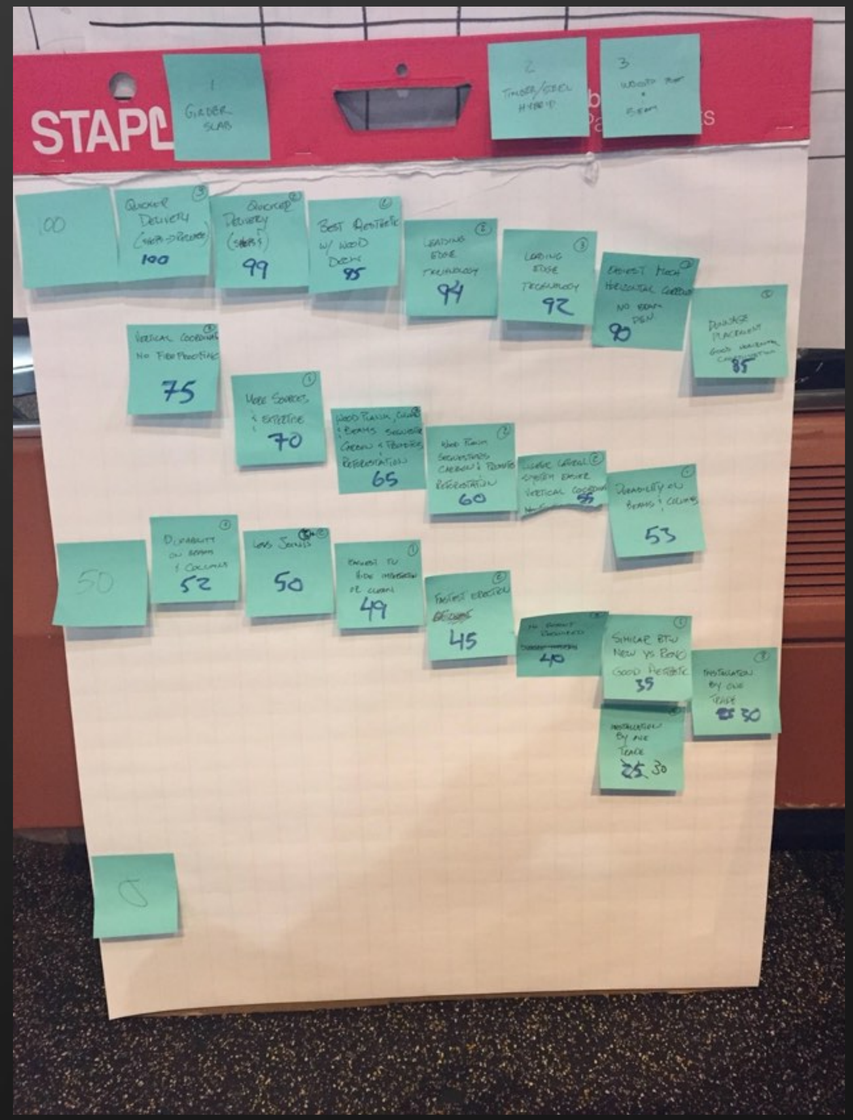
Choosing by Advantages

Options

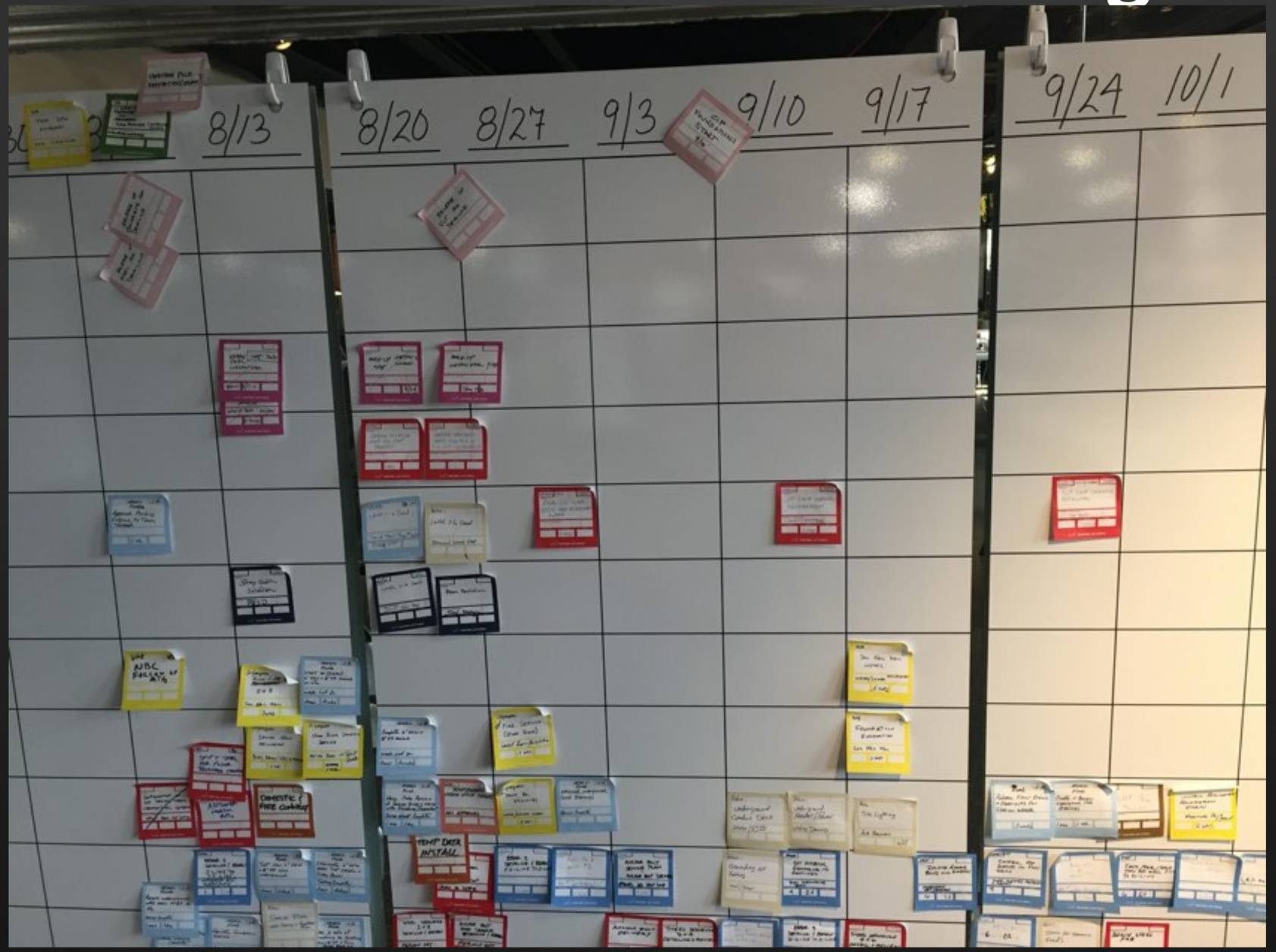
- Girder-slab (precast concrete with steel)
- All glued laminated timber frame and decking
- Steel-CLT hybrid

Key Factors

- Speed of construction
- Sustainability
- Aesthetic “look and feel”
- Cost
- Span and depth of members



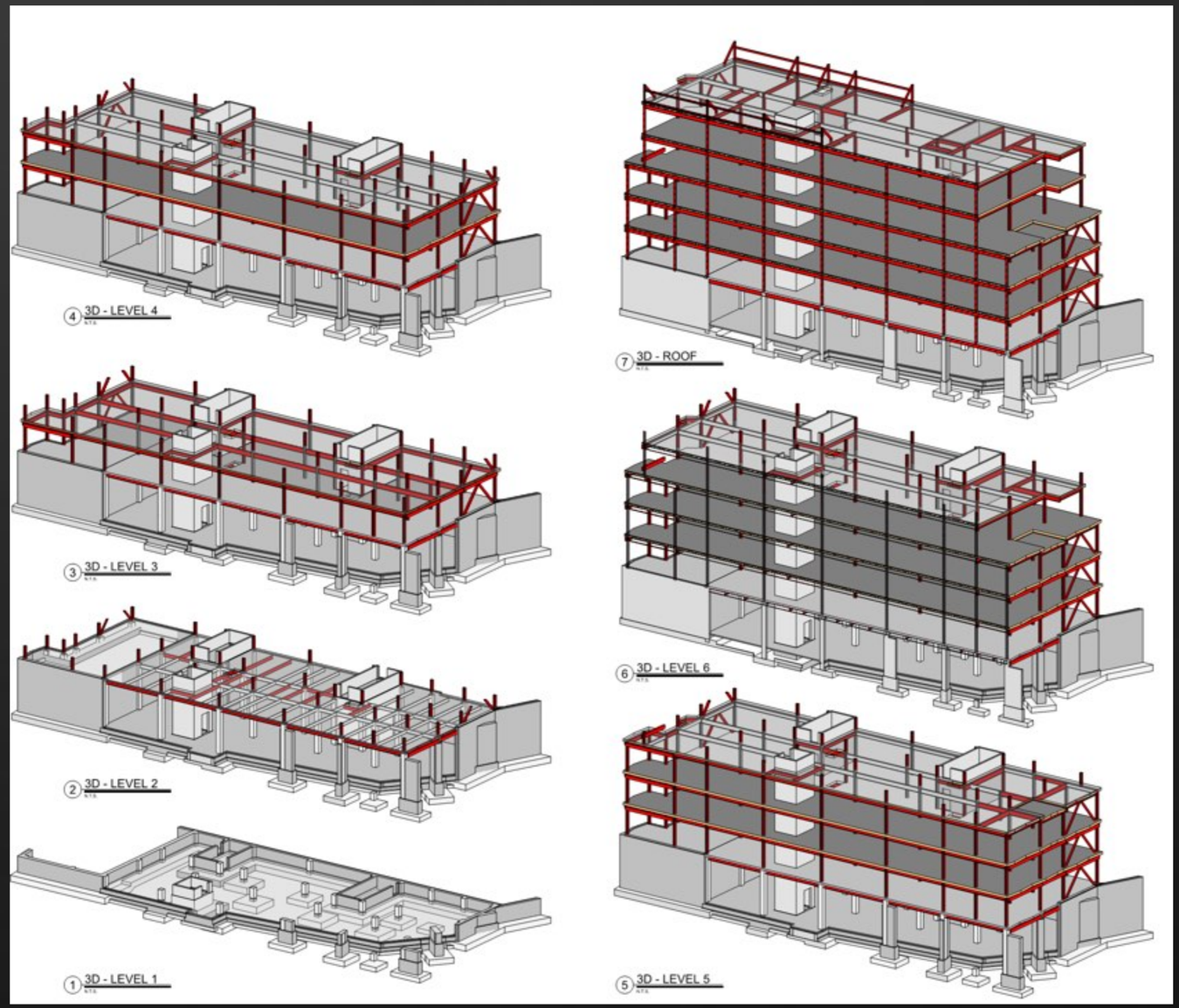
IPD – Pull Plan Scheduling



Overview: Hybrid CLT-Steel Construction

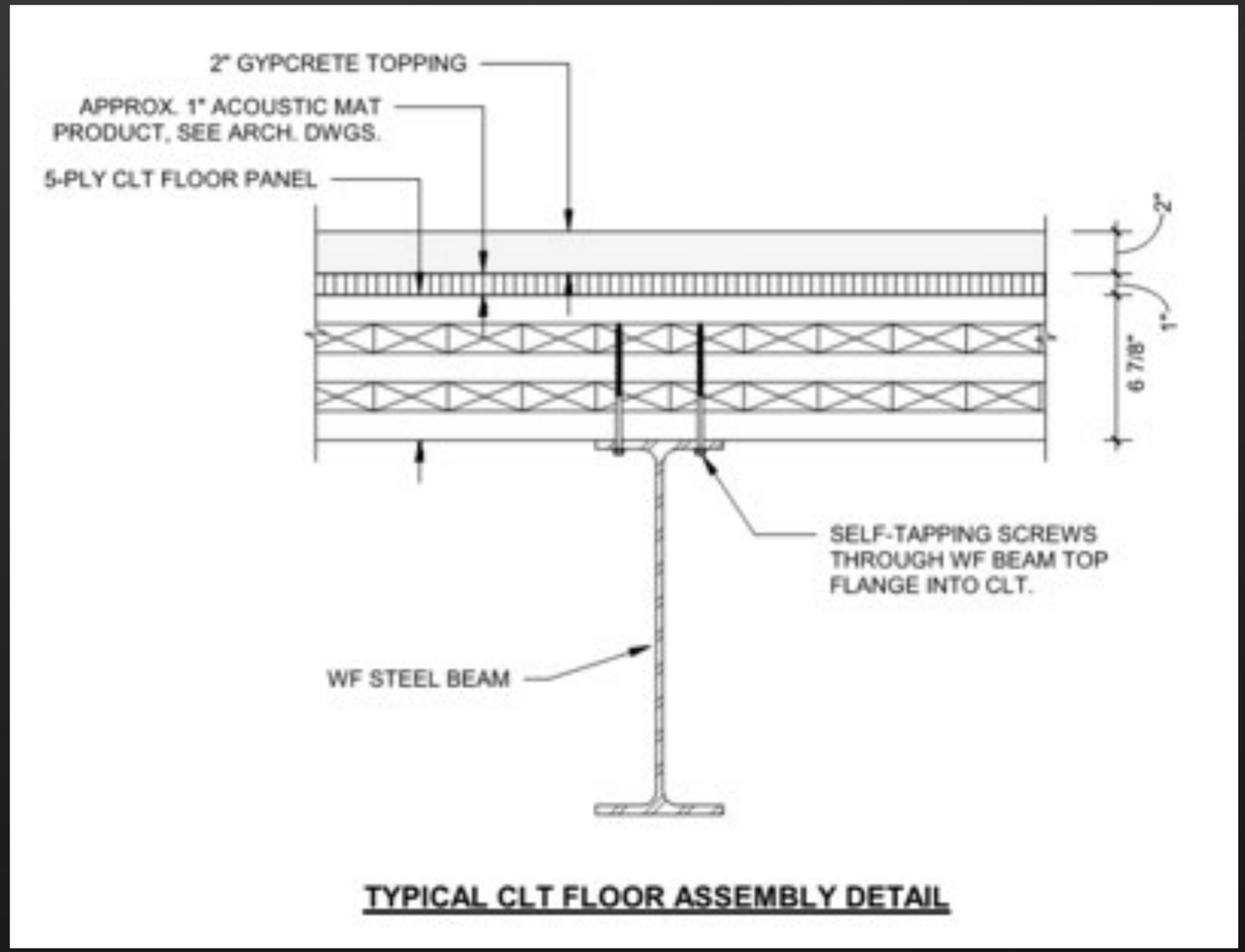
Features

- Steel frame with CLT slabs
- One-way CLT panels – entire building width
- Construction Type
  - Type 1A construction – Below Lvl 2
  - Type 3B construction – Above Lvl 2
- Exposed CLT ceilings
- Topping slab and acoustic isolation mat for sound isolation



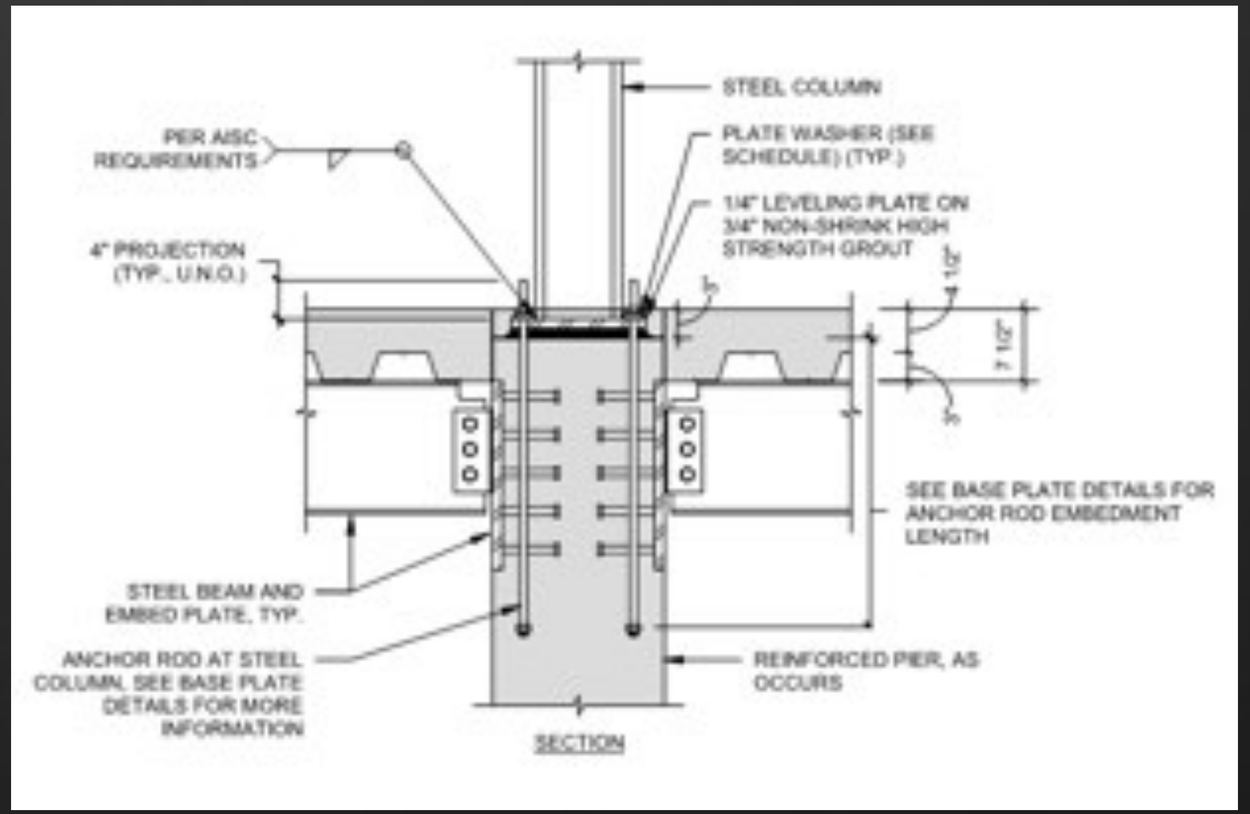
Floor Assembly – Acoustic Separation

- IBC 2015 Sound Transmission (1207)
  - Sound Transmission Class >= 50
  - Impact Insulation Class >=50
- Final Assembly (USG Products):
  - USG Levelrock SAM-N25 Ultra – Sound Attenuation Mat
  - USG Levelrock Sound Reduction Board
  - USG Levelrock 3500 Floor Underlayment (2” min thickness)



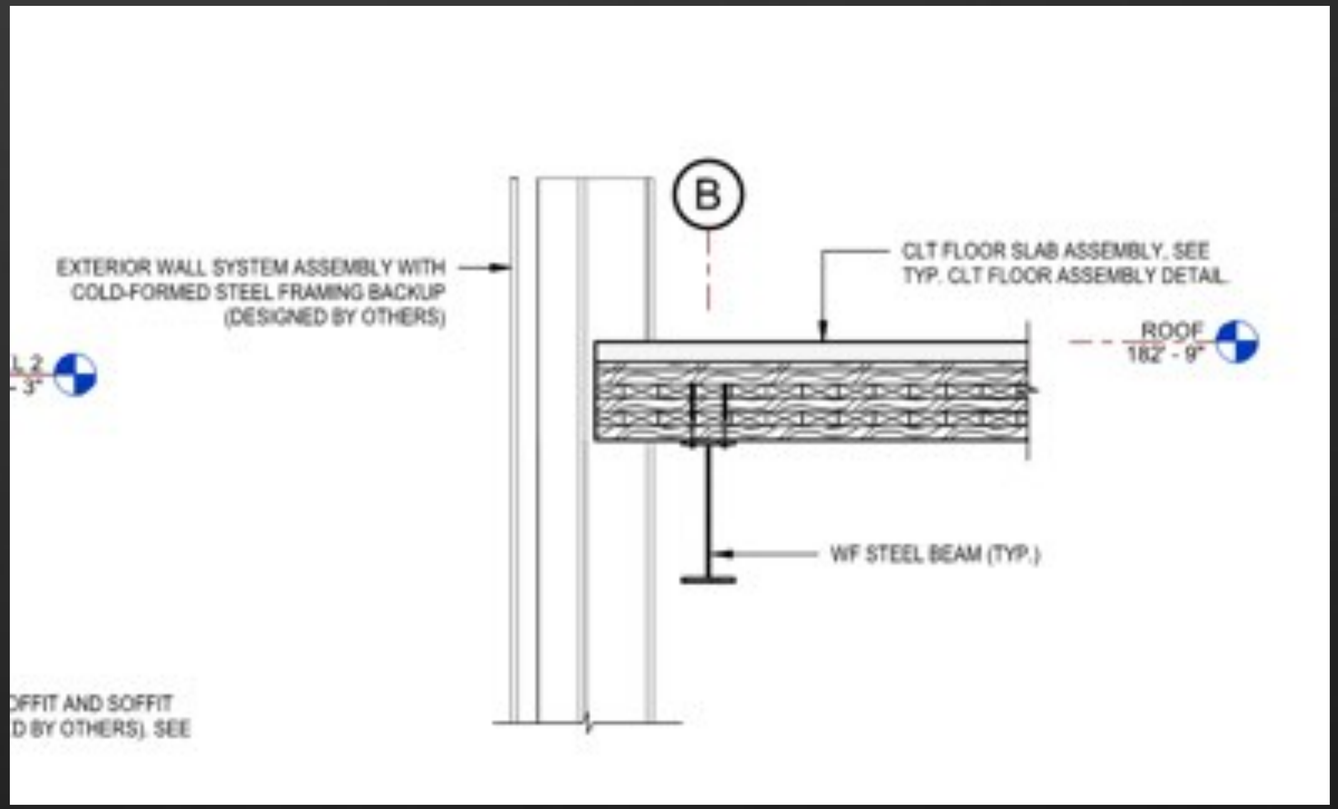
Fire Rating of Columns at Transition

- IBC 2015 Requirements (704.2)
  - Entire column protected for full height
  - Must extend to TOP of column
- Podium transition
  - 3 hour rating required
  - Extend piers to top of rated slab system



CLT in Exterior Wall Assembly

- IBC 2015 Requirements (602.4)
  - Allowed in walls with 2 hour rating or less
  - Must be protected on exterior surface




HOLE
HOLE

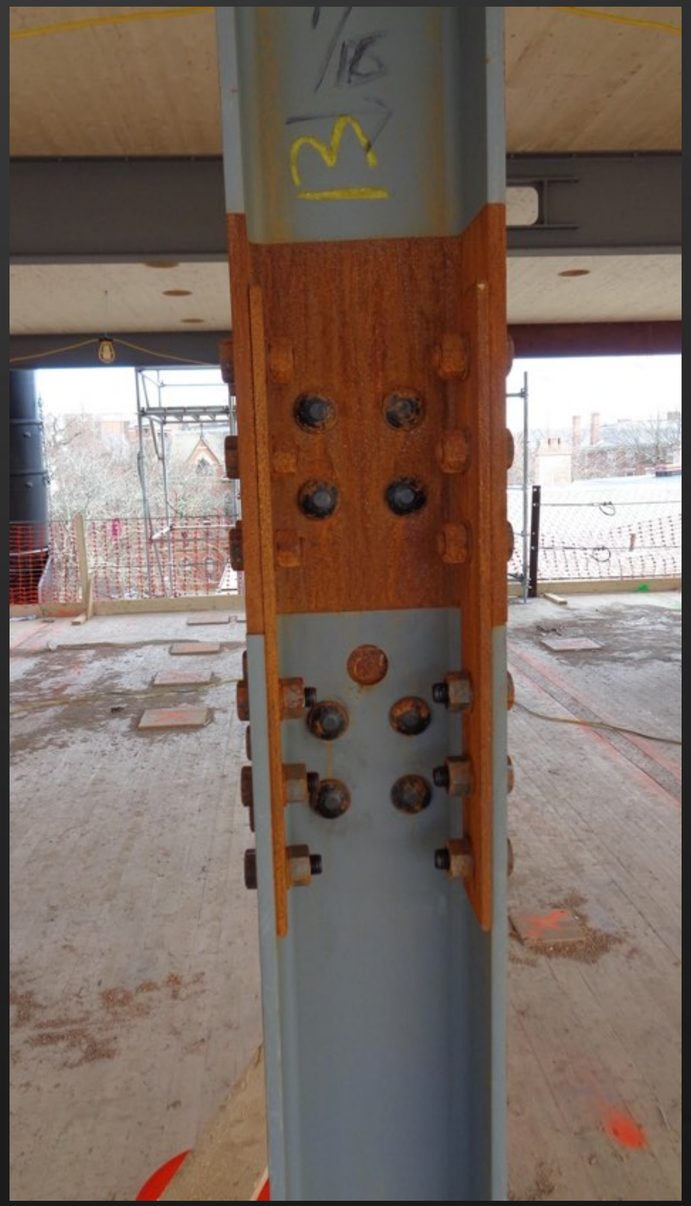
HOLE

Constructability Considerations

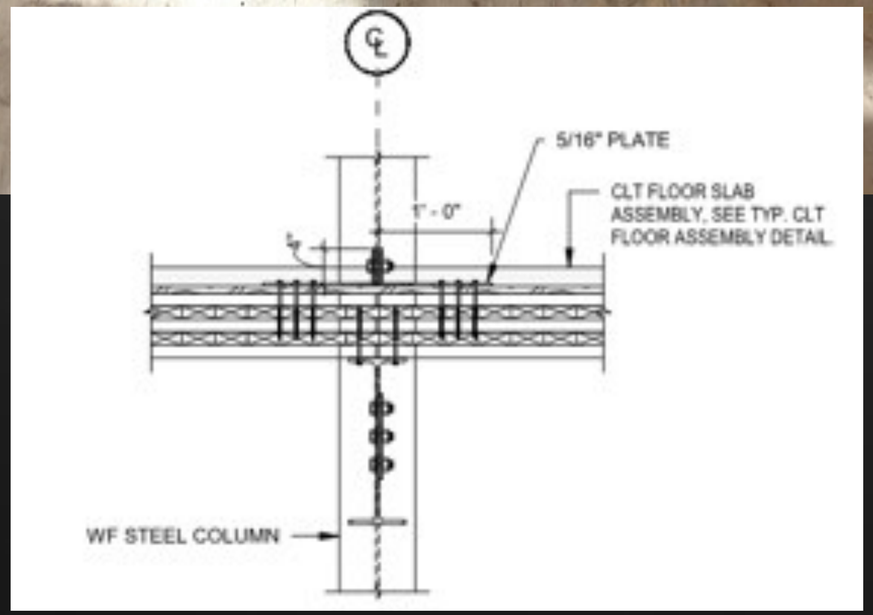
Key Issues

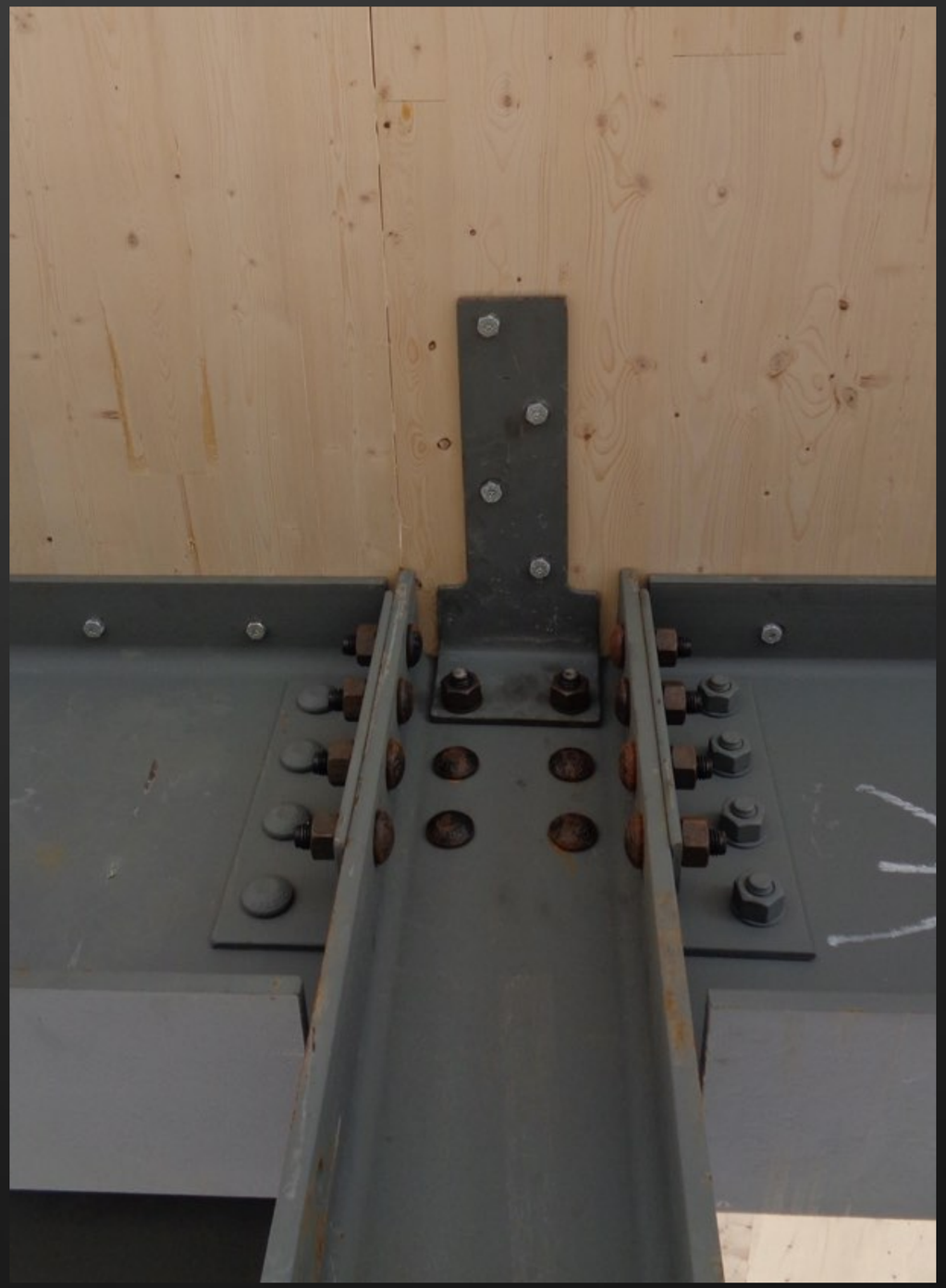
- Mix of trades – wood and steel erector
- Fasteners chosen for speed
- Most holes field drilled – simplifies coordination
- Diaphragm design using spline connectors

All field connections bolted



Weak Axis Column Bracing at Floors





Unframed openings in floors

Coordination of MEP systems

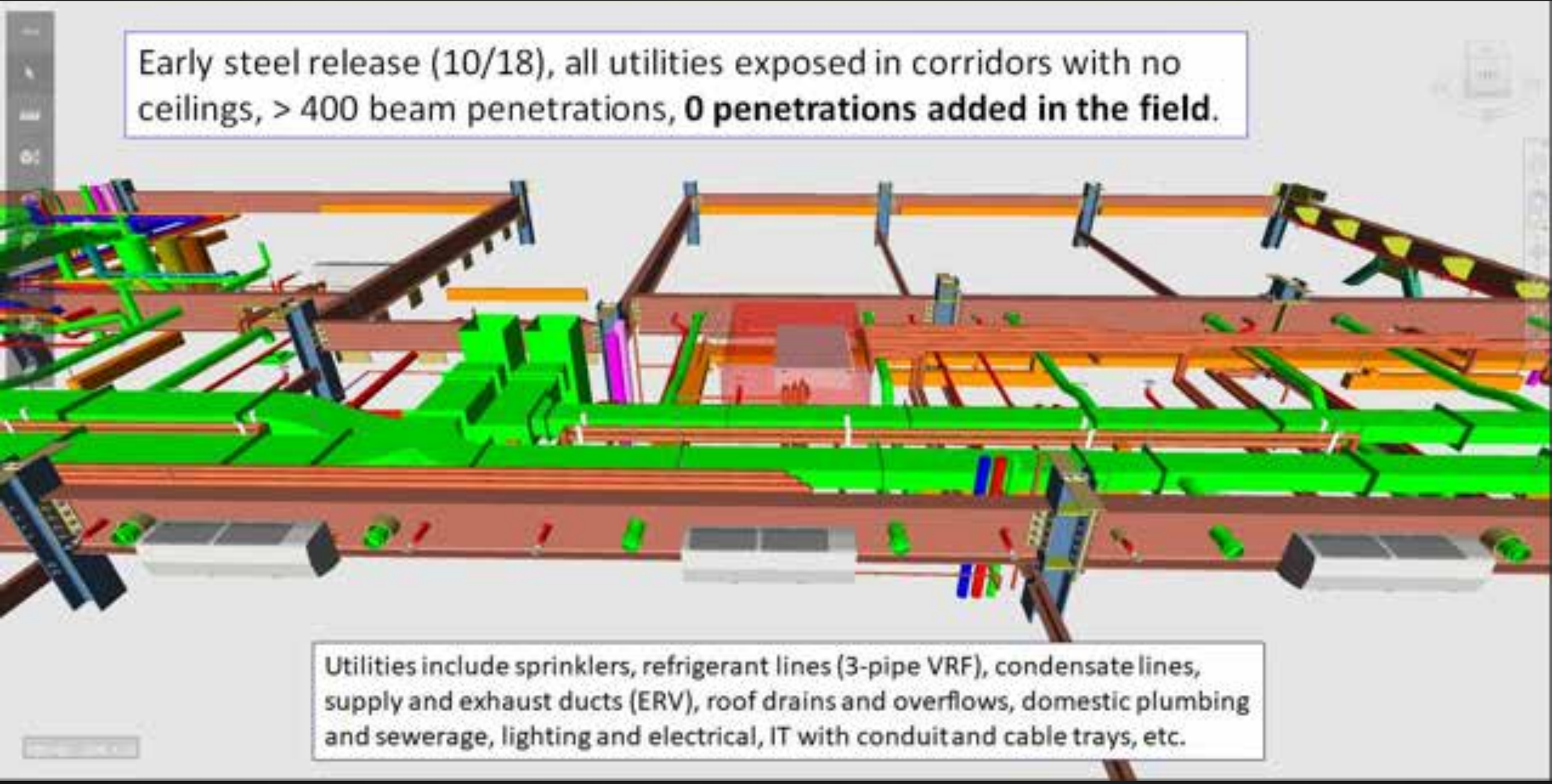
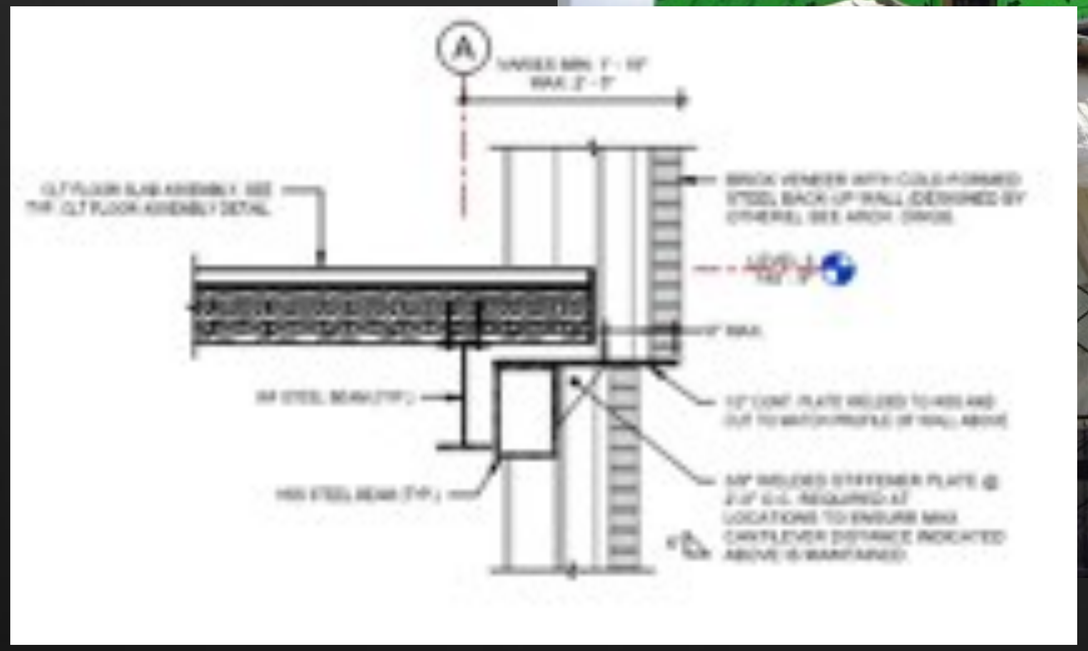


Image courtesy of Shawmut Design and Construction

Finished student bedrooms

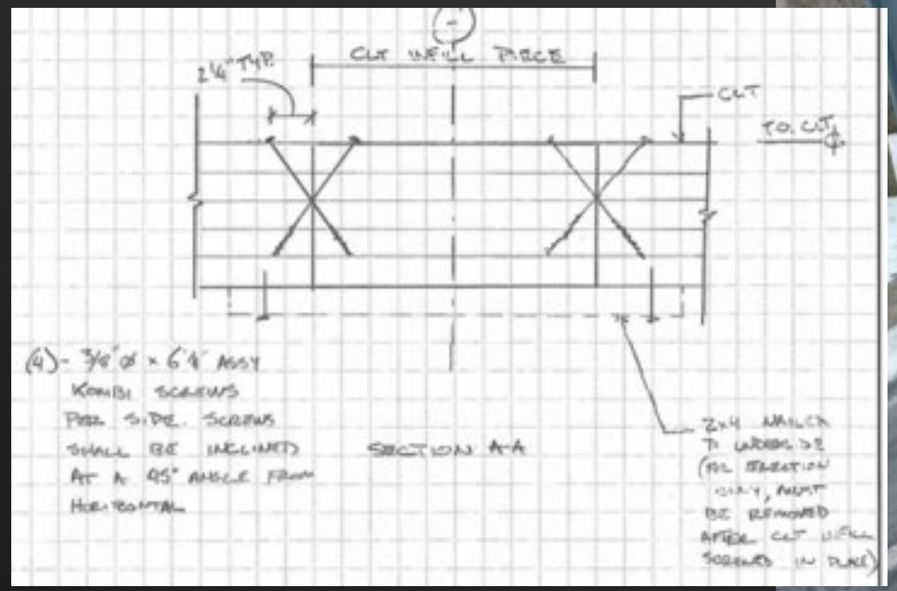
Exterior Skin Construction

Exterior Skin Construction



Exterior Skin Construction

Lessons Learned



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Questions?

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