The Duke:
Mass Timber & Light Frame Hybrid

Presented by Forrest Bratton, P.E., SECB

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

The Duke: Project Team

Owner:

Harris Bay; Granite Bay, CA

Architect:

DesignTrait; Austin, TX

Structural Engineer:

WGI; Austin, TX

MEP Engineer:

AYS; Austin, TX

General Contractor:

Trinity Constructors; Pflugerville, TX

Mass Timber Supplier:

KLH US Holding Corp.; Portland, OR

The Duke: The Brief

Design and construct an *all-timber* 4-story mixed-use building in the heart of the fast-developing East Side of Austin, Texas

Considerations:

- Ground floor retail needs “open” floor plan, minimal walls
- Residential units to have maximal ceiling heights
- Timber structure to be exposed wherever possible
- High local familiarity with light-framed wood construction
- Mass timber desired as proof-of-concept, interest-generation

The Duke: Building Stats

Building Code:

- **2015 IBC**

Building Height:

- **4 stories, 57’-0” tall**

Building Area:

- **41,989 SF conditioned**
- **1,179 SF patios**

Construction Type

- **IV at 1st floor, VA above**
- **(could have been VA throughout)**

Occupancy:

- **Ground Floor: A-2, B, M (Food service, Business, Mercantile)**
- **Upper Floors: R-2 (Long-term Residential)**

The Duke: The Concept

Options considered during concept:

- Concrete Podium +
  - Heavy timber/Mass timber
  - Light-framed wood (traditional)
  - Light-framed wood + mass timber (hybrid)
- All heavy timber
- Timber “Podium” +
  - Light-framed wood (traditional)
  - Light-framed wood + mass timber (hybrid) ←←

The Duke: The Concept

Timber “Podium” + Light-framed wood + mass timber (hybrid)

Challenges

- Unfamiliar construction methods for local contractors
  - Accepted as part of process to develop proof-of-concept → more on this later
- Timber “podium” cannot provide 3-hour fire separation at Level 2
  - 1-hour rating sufficient for separation between occupancies, provided through char per NDS
  - NFPA 13 sprinklers must be provided at all levels
- Deeper structure required for Level 2 than comparable concrete
  - Maximum building height not a controlling criterion for project
  - Lower clear height between (typ. 33”) girders deemed acceptable
- Closer column spacing required than for concrete podium slab
  - Accepted because exposed timber viewed as a feature

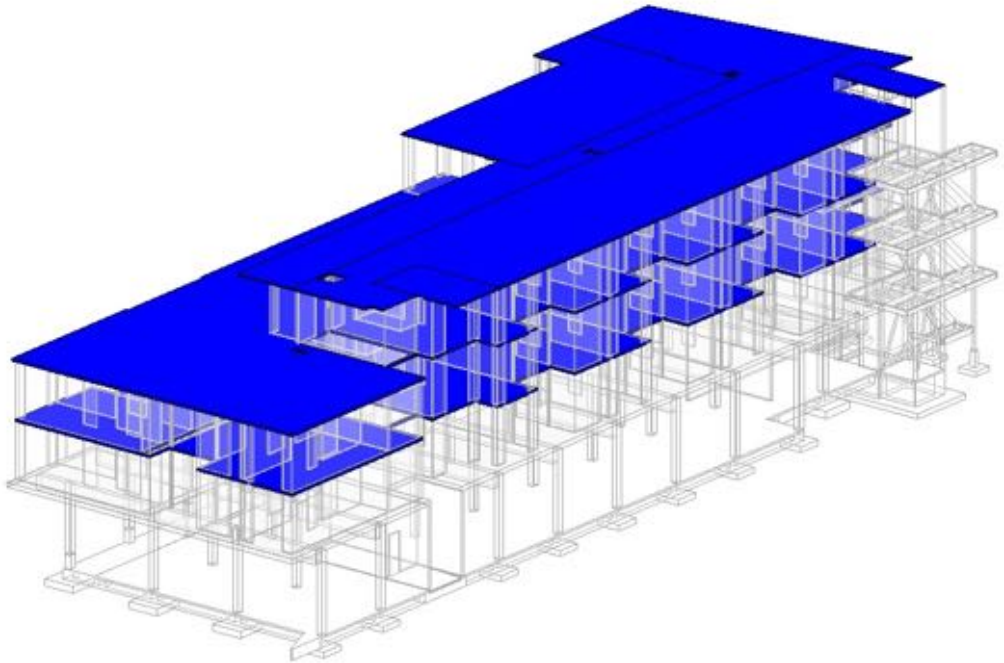
The Duke: The Concept

Timber “Podium” + Light-framed wood + mass timber (hybrid)

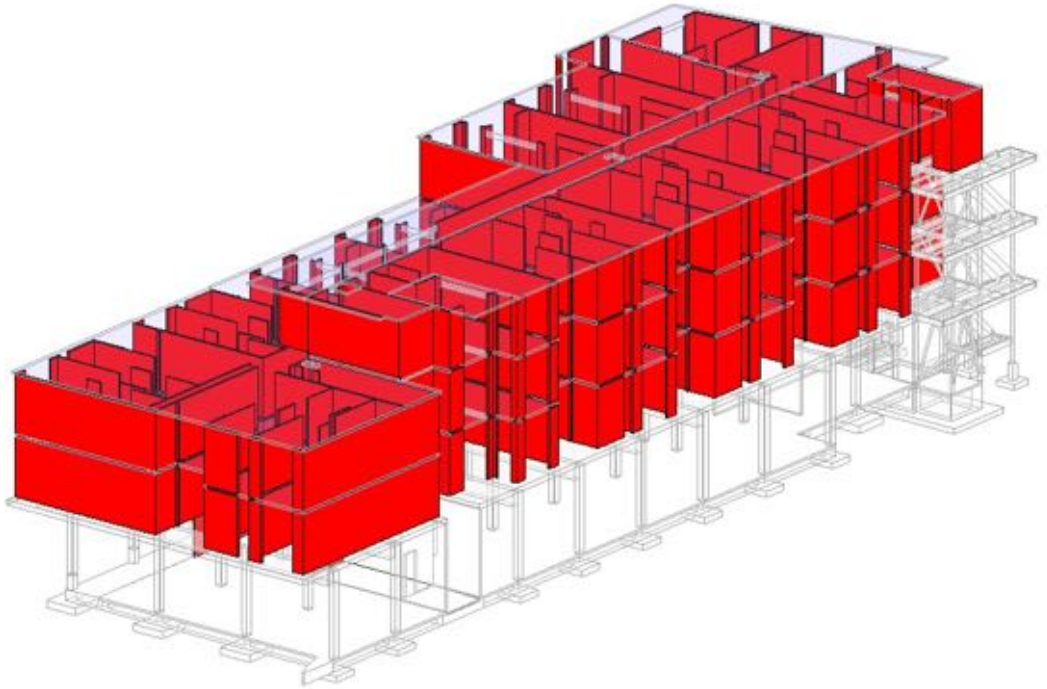
Advantages

- In keeping with all-timber brief, opportunity for added value
- Lighter than concrete podium options (foundation savings—clay subgrade)
- Faster to erect than cast-in-place concrete
- Optimizes use of wood fiber vs all-mass-timber option
- Flexible layout of residential units
- Walls can incorporate plumbing/electrical as with traditional wood-frame construction
- Fewer separate elements/connectors for lateral structural system

The Duke: Gravity Structure

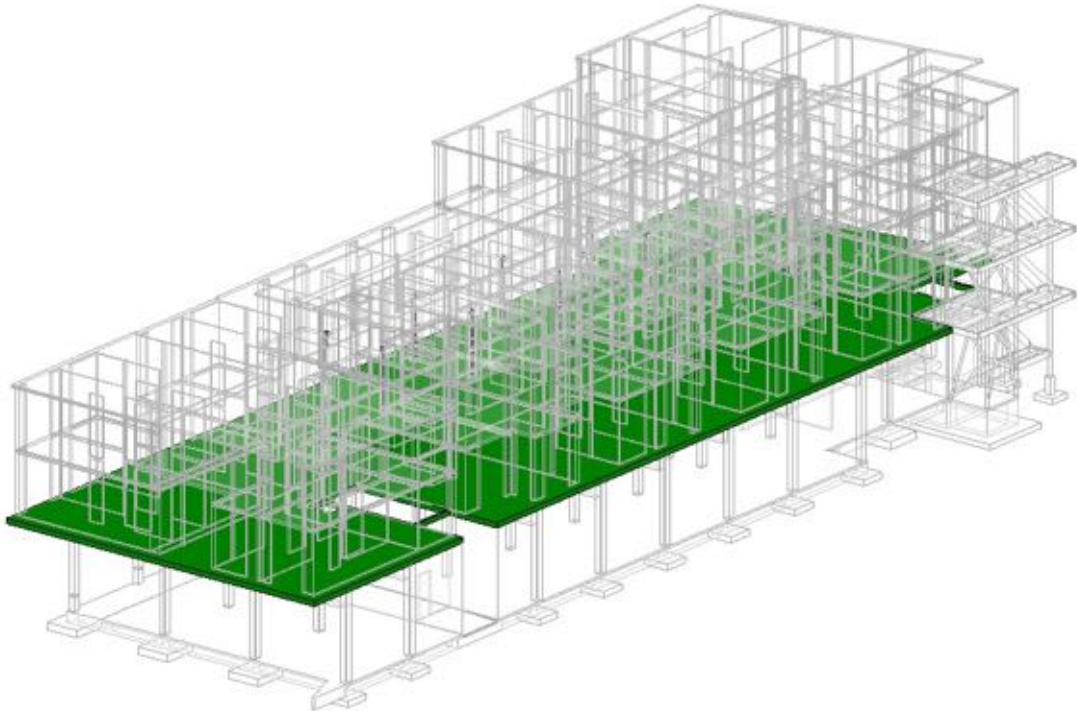


Upper CLT panels
(160mm floors, 120mm roof)

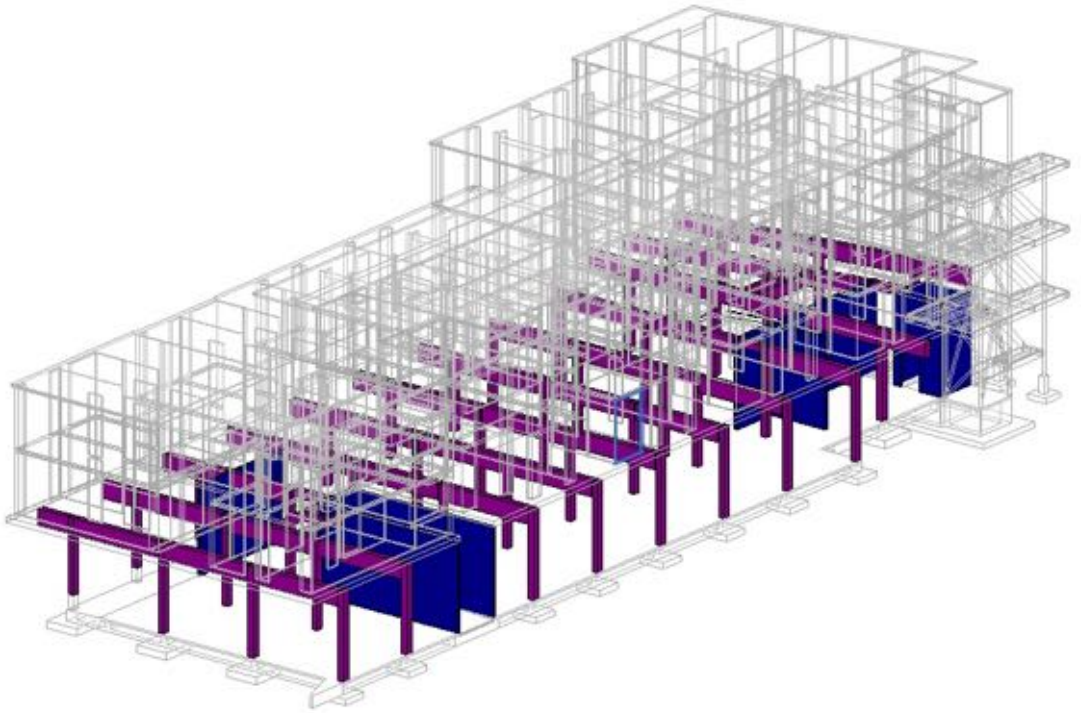


Light-framed wood walls
(Mix of 2x4 and 2x6)

The Duke: Gravity Structure

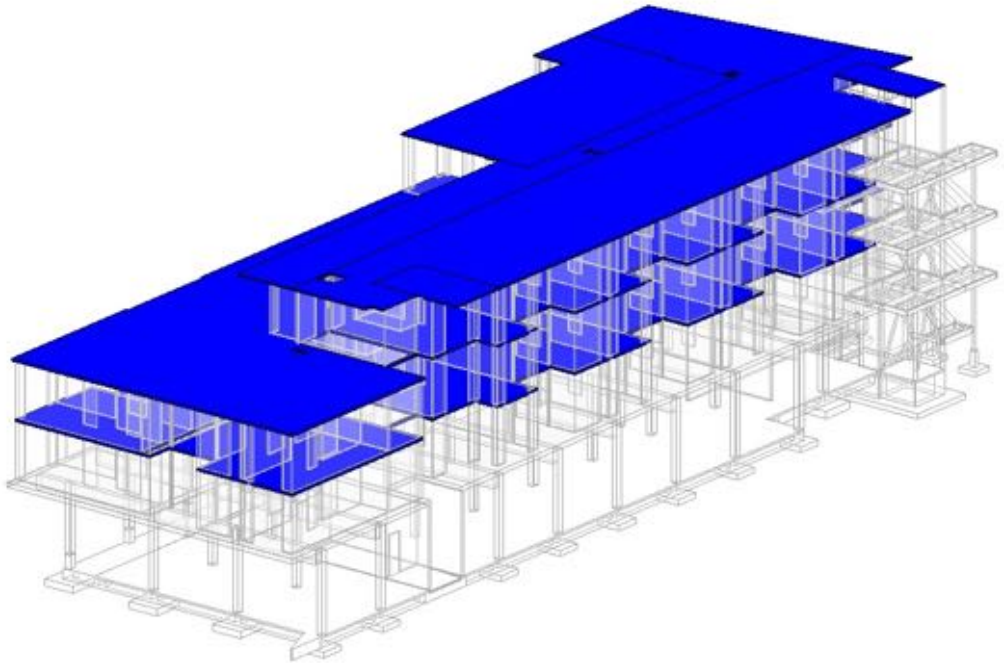


Level 2 CLT panels
(280mm “podium” floor)

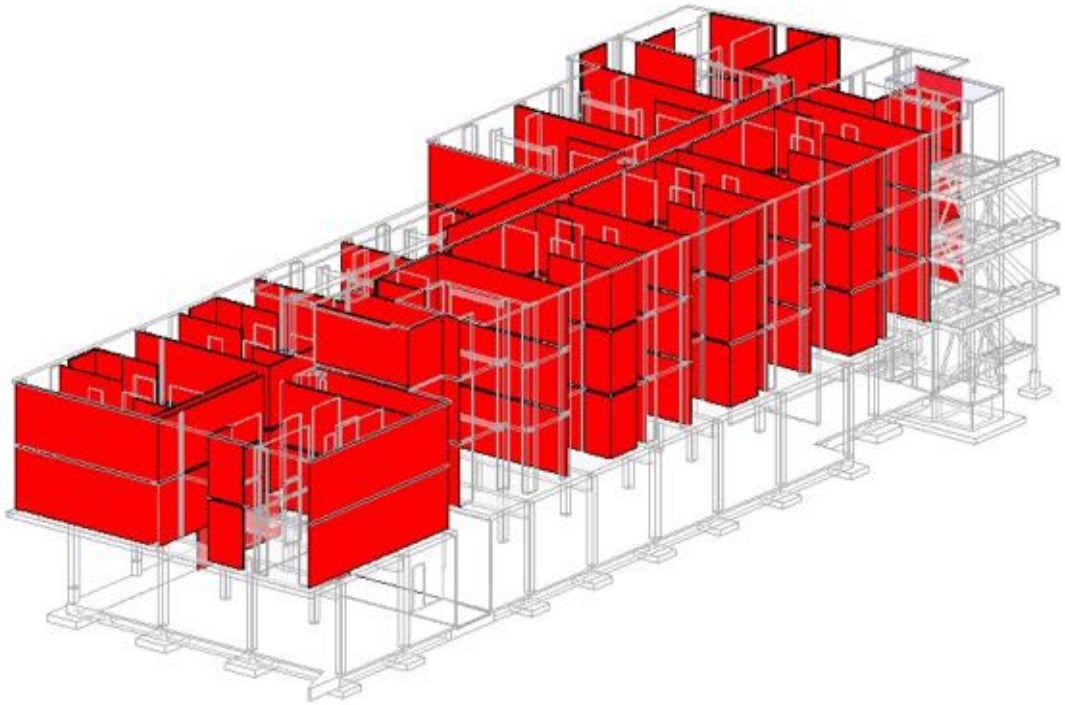


Glulam Girders & Columns
CLT walls (140mm, 200mm)

The Duke: Lateral Structure

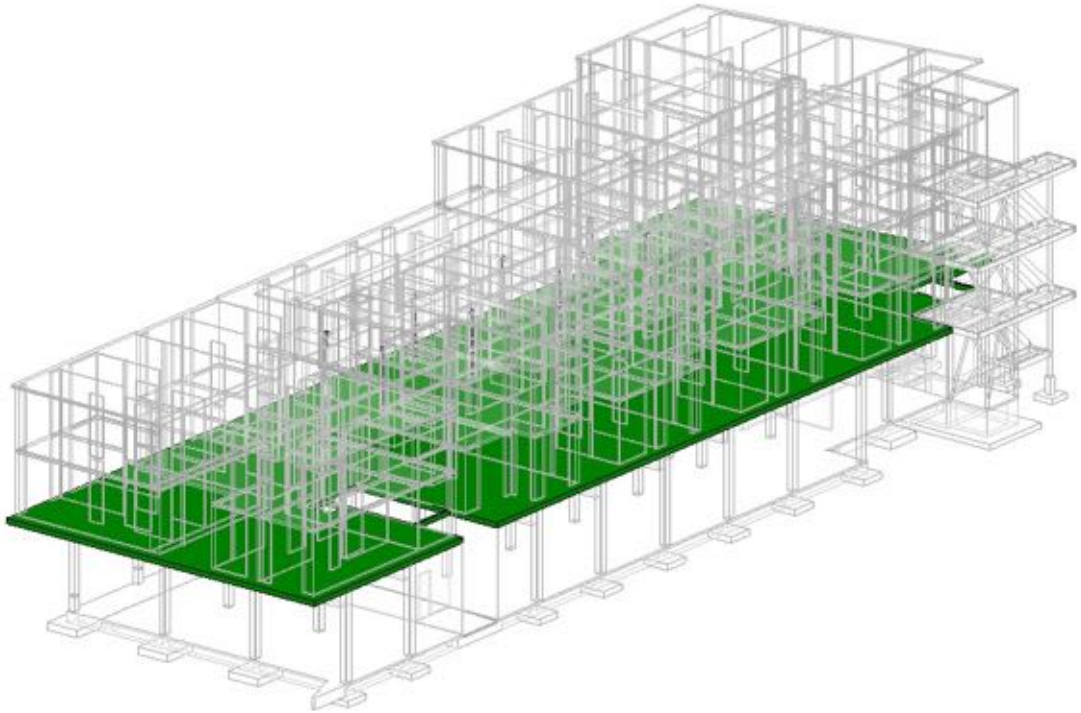


Upper CLT panel diaphragms
(160mm floors, 120mm roof)

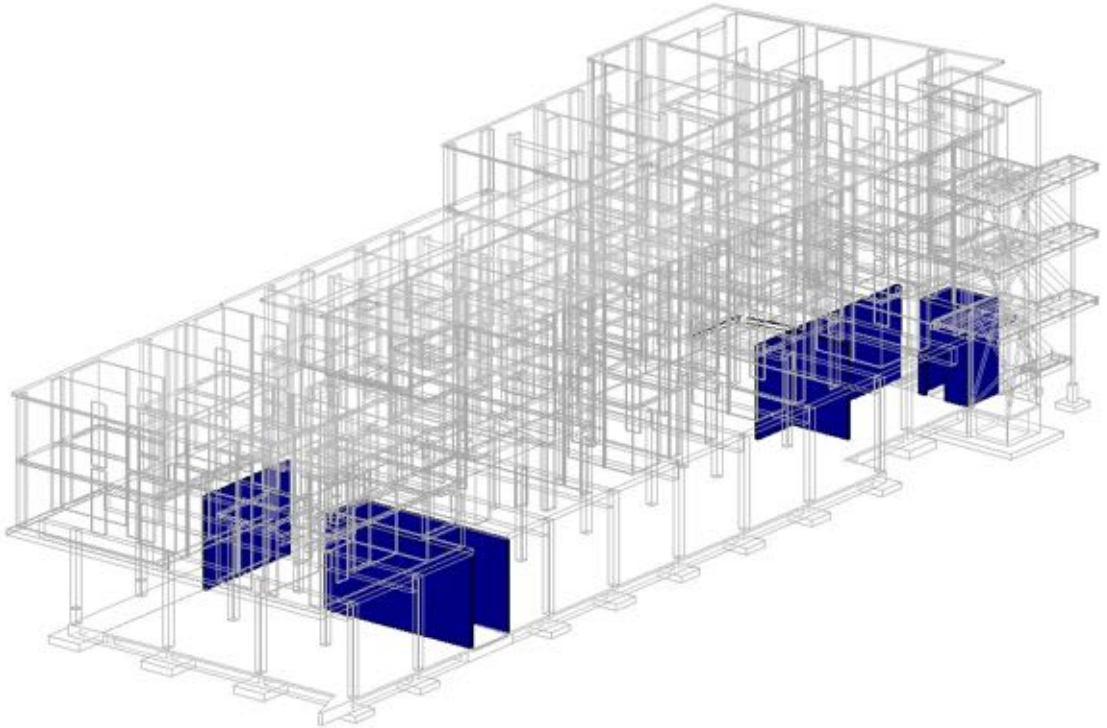


Light-framed wood shear walls
(Mix of wood panel and gypsum sheathing)

The Duke: Lateral Structure



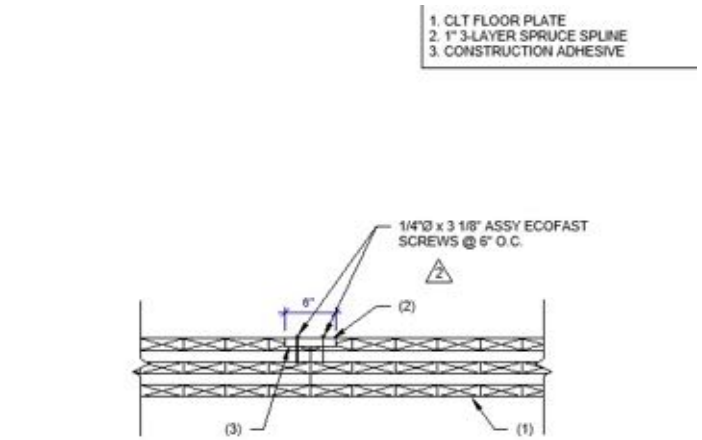
Level 2 CLT panels
(280mm “podium” floor)



CLT walls (140mm, 200mm)

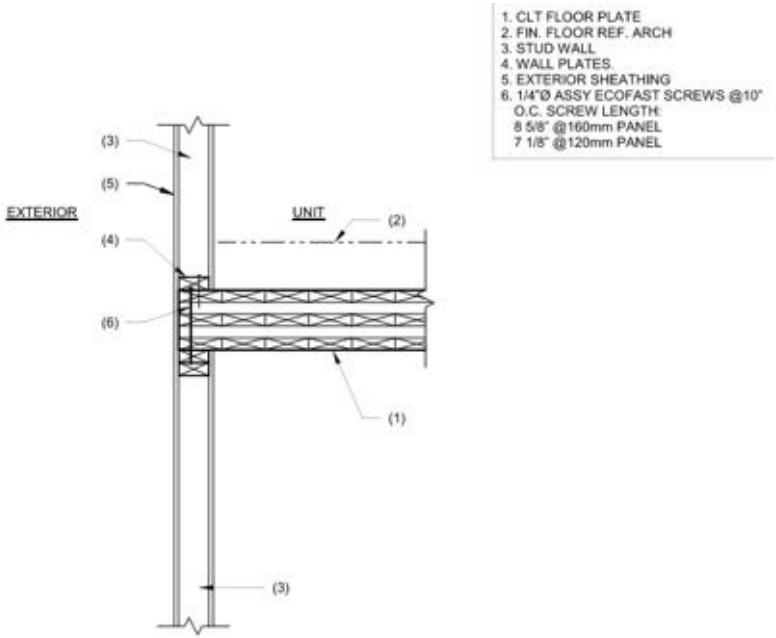
The Duke: Sample Details

Simple spline joints are used at upper-level panels.



TYPICAL DETAIL
CLT SPLINE CONNECTION LEVELS 3,4, AND ROOF
SCALE: 1" = 1'-0"

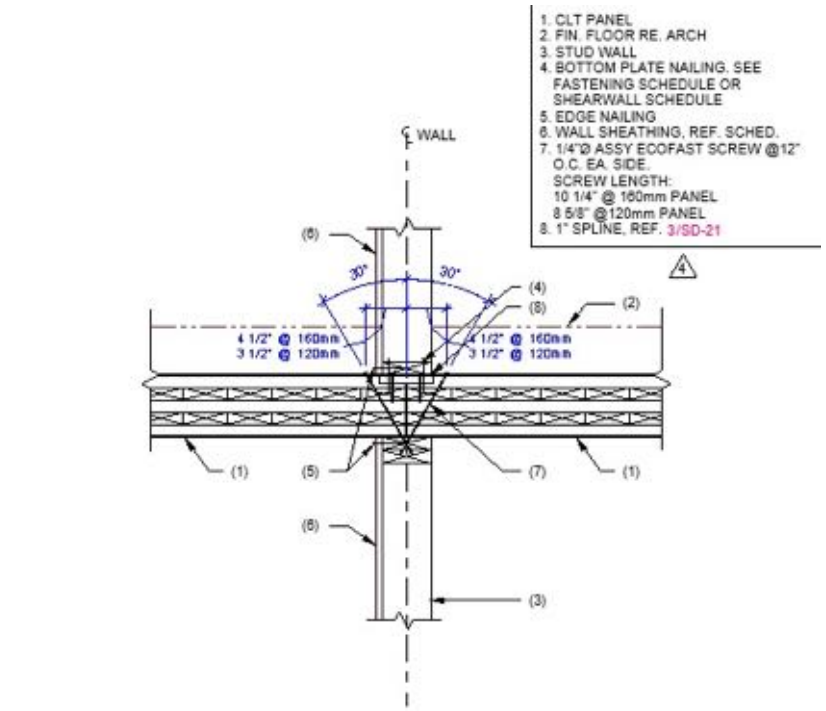
Screws installed from above connect through panels to walls below.



EXTERIOR FLOOR FRAME DETAILS
SCALE: 1" = 1'-0"

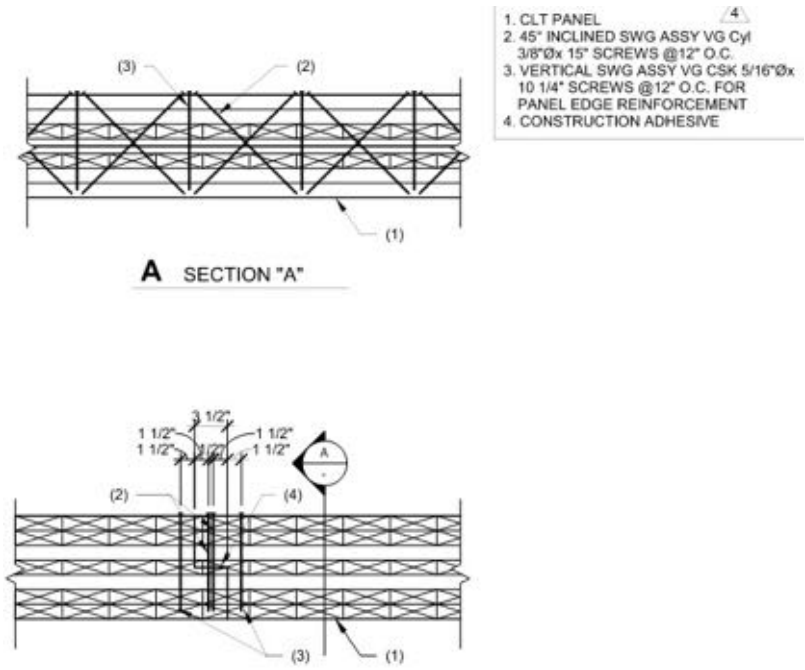
The Duke: Sample Details

Inclined screws are used for wall connections occurring at panel joints.



3 WALL AT JOINT IN CLT PANEL
SCALE: 1" = 1'-0"

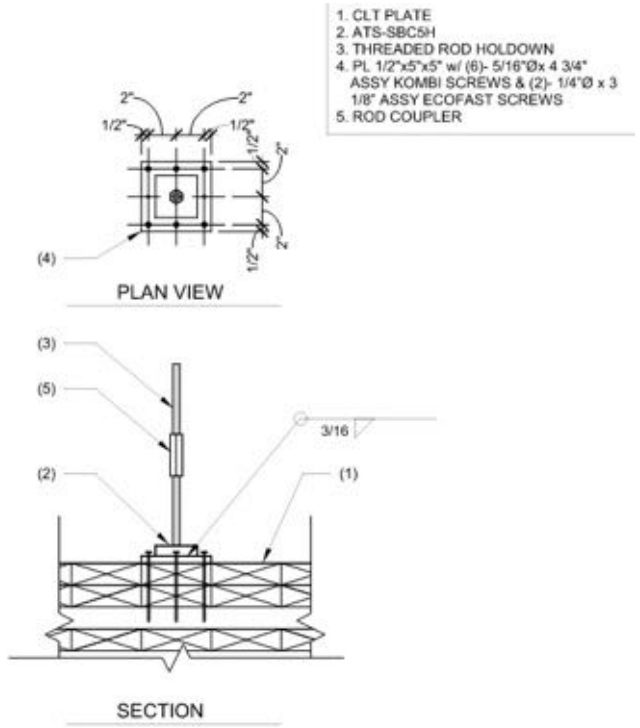
Half-lap joints with inclined screws at Level 2 provide better load-sharing and diaphragm stiffness.



LEVEL 2 PANEL HALF-LAP JOINT TYPICAL DETAIL
SCALE: 1" = 1'-0"

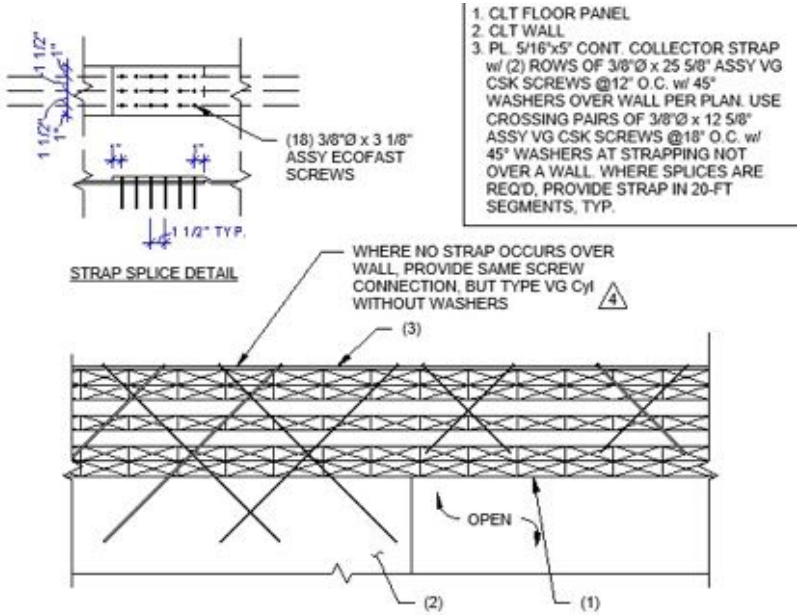
The Duke: Sample Details

Shear wall holdowns use screw plates welded to threaded rod base connectors.



TYPICAL DETAIL
ROD HOLDOWN CONNECTION AT CLT PLATE
SCALE: 1 1/2" = 1'-0"

Inclined screws fasten collector straps and attach Level 2 panels to CLT shear walls



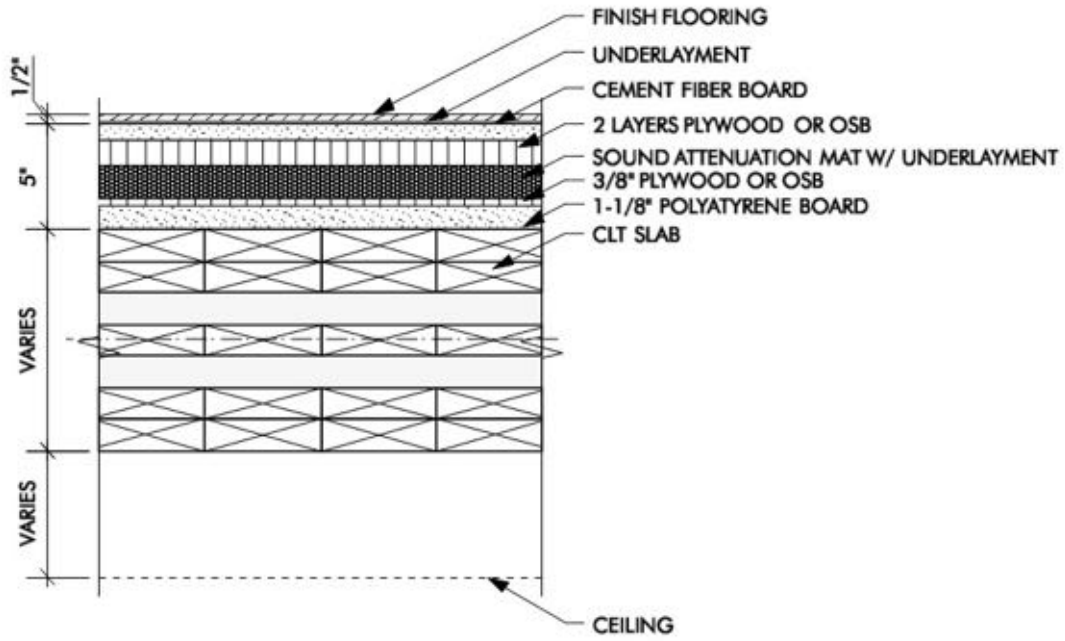
COLLECTOR STRAP AND CLT FLOOR PANEL
CONNECTION TO CLT SHEAR WALL TYPICAL DETAIL
SCALE: 1" = 1'-0"

The Duke: Special Considerations

- Fire separation between residential units with exposed CLT/timber
- Waterproofing CLT at exterior balconies
- Performance of CLT as diaphragm/shear wall
- Floor vibrations, especially across units
- Concentrated loads on CLT panels
- Acoustic performance of CLT floor

The Duke: Lessons Learned

Mass timber floors need sound attenuation, particularly between residential units.



TYPE 1 HORIZONTAL ASSEMBLY
N.T.S.

- Buildup over CLT to achieve minimum STC 55 and IIC 55 ratings with exposed timber panel ceilings.
- Poured underlayment avoided due to weight and potential schedule impact due to cure time.*
- Assembly was value-engineered during bidding, but viable alternative proved difficult to find.

*After start of construction, design team learned that GC would have preferred a poured topping for greater simplicity (but weight is still an issue).

The Duke: Lessons Learned

WoodWorks has a resource for acoustically-tested assemblies.

Acoustically-Tested Mass Timber Assemblies

Following is a list of mass timber assemblies that have been acoustically tested as of May 11, 2021. Sources are noted at the end of this document. For free technical assistance on any questions related to the acoustical design of mass timber assemblies, or free technical assistance related to any aspect of the design, engineering or construction of a commercial or multi-family wood building in the U.S., email help@woodworks.org or contact the WoodWorks Regional Director nearest you: http://www.woodworks.org/project-assistance

Contents:

The Duke: Lessons Learned

Poured toppings were too heavy to use for as a late alternative. (12 psf max)

19 psf

38 psf

No STC rating

Table 1 Continued: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed

WoodWorks

CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC[1]	IIC[1]	Source
CLT 5-ply (6.875")	4" concrete	Pliteq GenieMat™ FF16 (FF10 + FF06)	None	56	50	32
		Pliteq GenieMat™ FF20 (FF10 + FF10)		57	51	30
		Pliteq GenieMat™ FF23 (FF17 + FF06)		56	52	33
		Pliteq GenieMat™ FF25		57	50	2
			Eng Wood on GenieMat™ RST02	56	55	29
		Pliteq GenieMat™ FF31 (FF25 + FF06)	None	58	53	34
		Pliteq GenieMat™ FF50 (FF25 + FF25)		59	54	2
			Eng Wood on GenieMat™ RST02	58	59	5
CLT 5-ply (6.0")	2" gypsum	Keene ¾" Quiet Qurl® 075	LVT	-	54[6]	122
			LVT on 1" Platform L2		60[6]	121
		Keene 3/8" Quiet Qurl® 040	Underlayment on 5mm KeedeRoll MT Premium		58[6]	124
		5 mm Keene Step Soft Underlayment on Keene ¾" Quiet Qurl® 075	LVT	-	56[6]	123
	3" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	None	61	46	112
			LVT	-	61	113
			2 layers of ¼" USG Fiberock® on Kinetics® Soundmatt	61	59	114
			LVT on 2 layers of ¼" USG Fiberock® on Kinetics® Soundmatt	-	59	115
		Kinetics® Ultra Quiet SR with synthetic roofing felt	None	59	46	116
			LVT	-	58	117
			2 layers of ¼" USG Fiberock® on Kinetics® Soundmatt	61	58	118
			LVT on 2 layers of ¼" USG Fiberock® on Kinetics® Soundmatt	-	57	119
	4" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	None	61	52	120

The Duke: Lessons Learned

Only pre-drill plumbing penetrations where you are 100% sure you have it right.

- If coordinated early, it is easy to pre-core plumbing penetrations, BUT…
- If penetrations are located incorrectly, enlarging holes can be difficult. Cutting/coring also removes more of the structural member, which must be reanalyzed.
- Location/size information is likely communicated to manufacturer via CAD, which is atypical for a formal design deliverable. Scope appropriately, and consider liability implications.
- Contractor may prefer to drill/core all penetrations in field (may need special equipment; EOR must review layout)

The Duke: Lessons Learned

Communicate early to verify elevator can be installed as intended.

- Elevator installer may want entire shaft width open at first level for cab installation, BUT…
- If CLT wall is loadbearing - and a shear wall - then what? (door opening comparable to concrete shaft)
- Also consider guide rail bracket attachment – may be nonstandard

HOLD YOUR QUESTIONS!

This concludes The American Institute of Architects Continuing Education Systems Course

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