

MASS TIMBER IN K-12 SCHOOLS

**From forestry through manufacturing, design,
engineering and construction**

Joe Mayo, AIA LEED AP
Mahlum Architects

Russ Vaagen
Vaagen Timbers

Emily Everett, AIA
Mahlum Architects

Josh Reed
Hoffman Construction

Jason Whitney, PE, SE
Coughlin Porter Lundeen

MASS TIMBER?



GIANT CEDAR
SOURCE: WASHINGTON STATE DIGITAL ARCHIVES



PHOTOS: VAAGEN TIMBERS





PHOTO: MAHLUM

New Mass Timber (MT) Construction Types

Existing MT Construction Types

Type IV-A

18-story max

9-story Group E

Type IV-B

12-story max

6-story Group E

Type IV-C

9-story max

4-story Group E

Type IV-HT

Don't forget!

4-story Group E

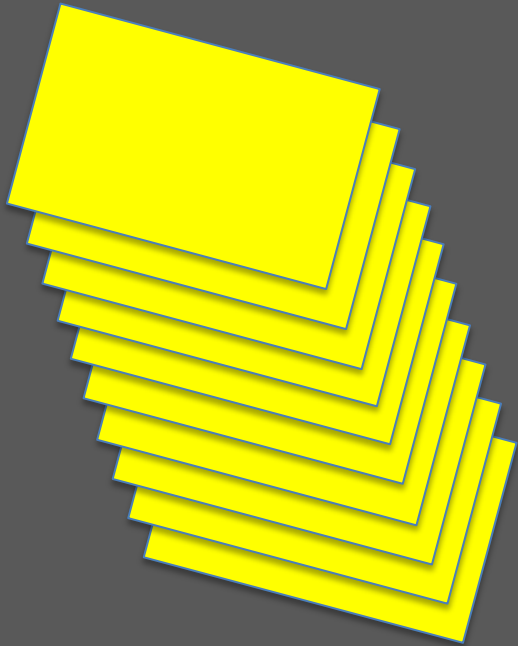




PHOTO: NIK @ UNSPLASH



PHOTO: MAHLUM



PHOTO: JOEL-JASMIN-FORESTBIRD

Introductions



Russ Vaagen
Vaagen Timbers



Jason Whitney, PE, SE
Coughlin Porter Lundeen



Josh Reed
Hoffman Construction



Emily Everett, AIA
Mahlum Architects



Joe Mayo, AIA LEED AP
Mahlum Architects

Q1: Does using mass timber mean that we'll need to cut down all of our forests?

What role can mass timber play to actually enhance forest health in the region?



PHOTO: SEATTLE TIMES

WWW.SEATTLETIMES.COM/SEATTLE-NEWS/WILDFIRE-NEWS-UPDATES-SEPTEMBER-11-WHAT-TO-KNOW-TODAY-ABOUT-THE-DESTRUCTIVE-FIRES-IN-WASHINGTON-STATE-AND-ON-THE-WEST-COAST/



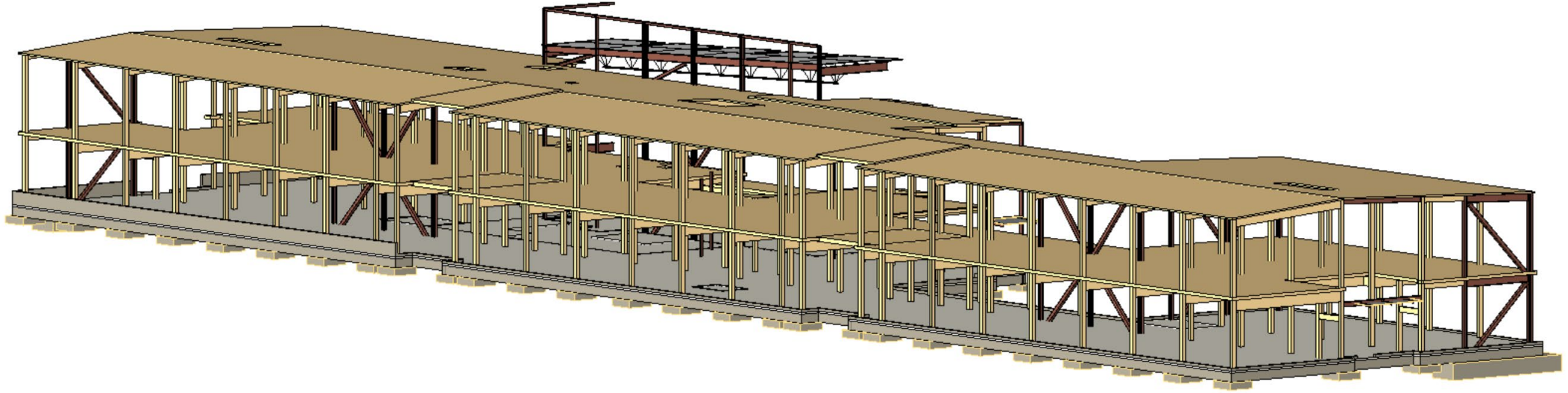






Q2: How different is mass timber from conventional materials we might use to design and build schools?

Efficient Mass Timber Structures



Construction Type

Floor/Roof Panel Thickness

Column Spacing

Lightweight Floor Toppings

Repetitive/Regular

Proper Vertical Lateral System Selection

Efficient Mass Timber Structures

Design for Competitive Bidding

Layout Framing to optimize panels common across multiple manufacturers

Panels utilizing 1-3/8" laminations
4-1/8" thickness for 3-ply
6-7/8" thickness for 5-ply

Visually graded instead of Machine graded



3-alt



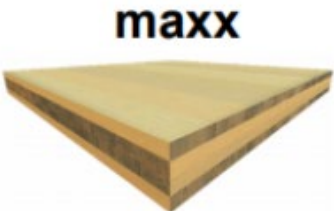
5-alt



7-alt



9-alt



4-maxx



5-maxx

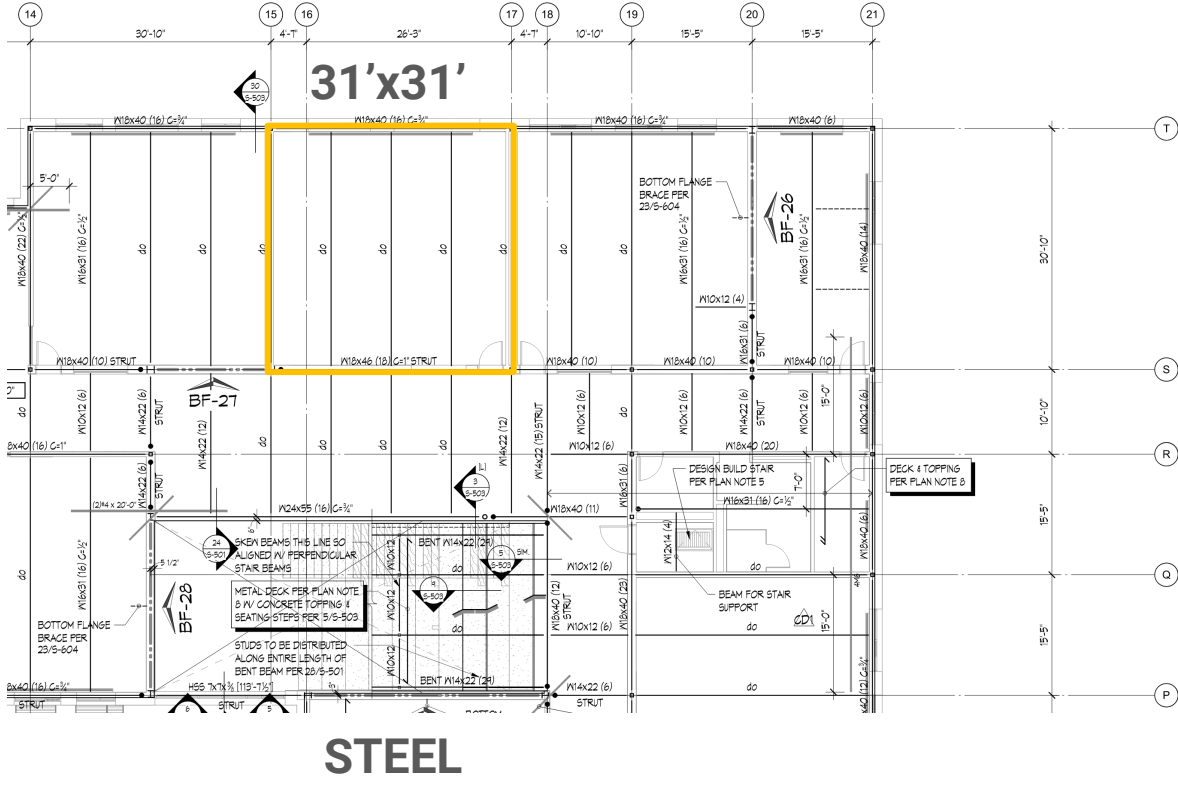
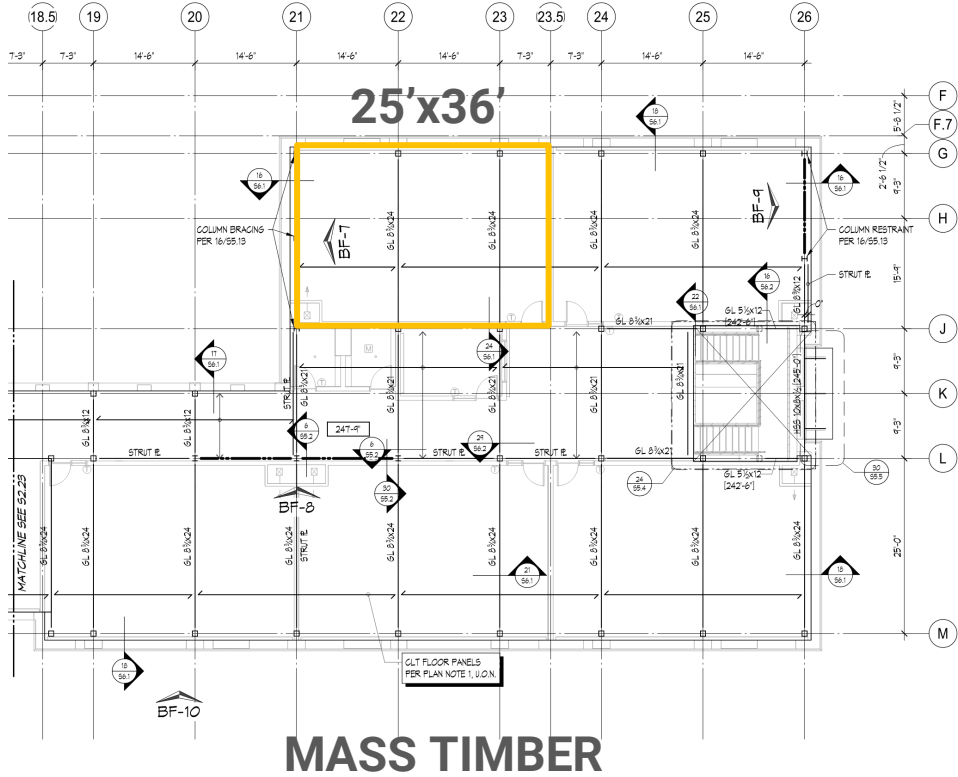


7-maxx



9-maxx

Classroom Sizes – Column Bays



Q3: Architecturally, what are the advantages of mass timber? Do these schools feel different?

14 Patterns of Biophilic Design

NATURE IN THE SPACE

1. Visual Connection with Nature

A view to elements of nature, living systems and natural processes.

2. Non-Visual Connection with Nature

Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

3. Non-Rhythmic Sensory Stimuli

Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.

4. Thermal & Airflow

Variability Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.

5. Presence of Water

A condition that enhances the experience of a place through the seeing, hearing or touching of water.

6. Dynamic & Diffuse Light

Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.

7. Connection with Natural Systems

Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem

NATURAL ANALOGUES

8. Biomorphic Forms & Patterns

Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.

9. Material Connection with Nature

Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place.

10. Complexity & Order

Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.

NATURE OF THE SPACE

11. Prospect

An unimpeded view over a distance for surveillance and planning.

12. Refuge

A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

13. Mystery

The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

14. Risk/Peril

An identifiable threat coupled with a reliable safeguard.

14 Patterns of Biophilic Design

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Health Benefits of Building with Wood

Cutting Boards of Plastic and Wood Contaminated Experimentally with Bacteria

Nese O Ak^{1,2}, Dean O Cliver^{1,3}, Charles W Kaspar¹

Affiliations + expand

PMID: 31113021 DOI: [10.4315/0362-028X-57.1.16](https://doi.org/10.4315/0362-028X-57.1.16)

Abstract

The microbiology of Plastic and wooden cutting boards was studied, regarding cross-contamination of foods in home kitchens. New and used Plastic (four polymers plus hard rubber) and wood (nine hardwoods) cutting boards were cut into 5-cm squares ("blocks"). *Escherichia coli* (two nonpathogenic strains plus type O157:H7), *Listeria innocua*, *L. monocytogenes*, or *Salmonella typhimurium* was applied to the 25-cm² block surface in nutrient broth or chicken juice and recovered by soaking the surface in nutrient broth or pressing the block onto nutrient agar, within 3-10 min or up to ca. 12 h later. Bacteria inoculated onto Plastic blocks were readily recovered for minutes to hours and would multiply if held overnight. Recoveries from wooden blocks were generally less than those from plastic blocks, regardless of new or used status; differences increased with holding time. Clean wood blocks usually absorbed the inoculum completely within 3-10 min. If these fluids contained 10³-10⁴ CFU of bacteria likely to come from raw meat or poultry, the bacteria generally could not be recovered after entering the wood. If $\geq 10^6$ CFU were applied, bacteria might be recovered from wood after 12 h at room temperature and high humidity, but numbers were reduced by at least 98%, and often more than 99.9%. Mineral oil treatment of the wood surface had little effect on the microbiological findings. These results do not support the often-heard assertion that Plastic cutting boards are more sanitary than wood.

Physiological effects of wood on humans: a review

Harumi Ikei^{1,2} · Chorong Song¹ · Yoshifumi Miyazaki¹

Summary of the physiological effects of stimulation by wood and wooden materials

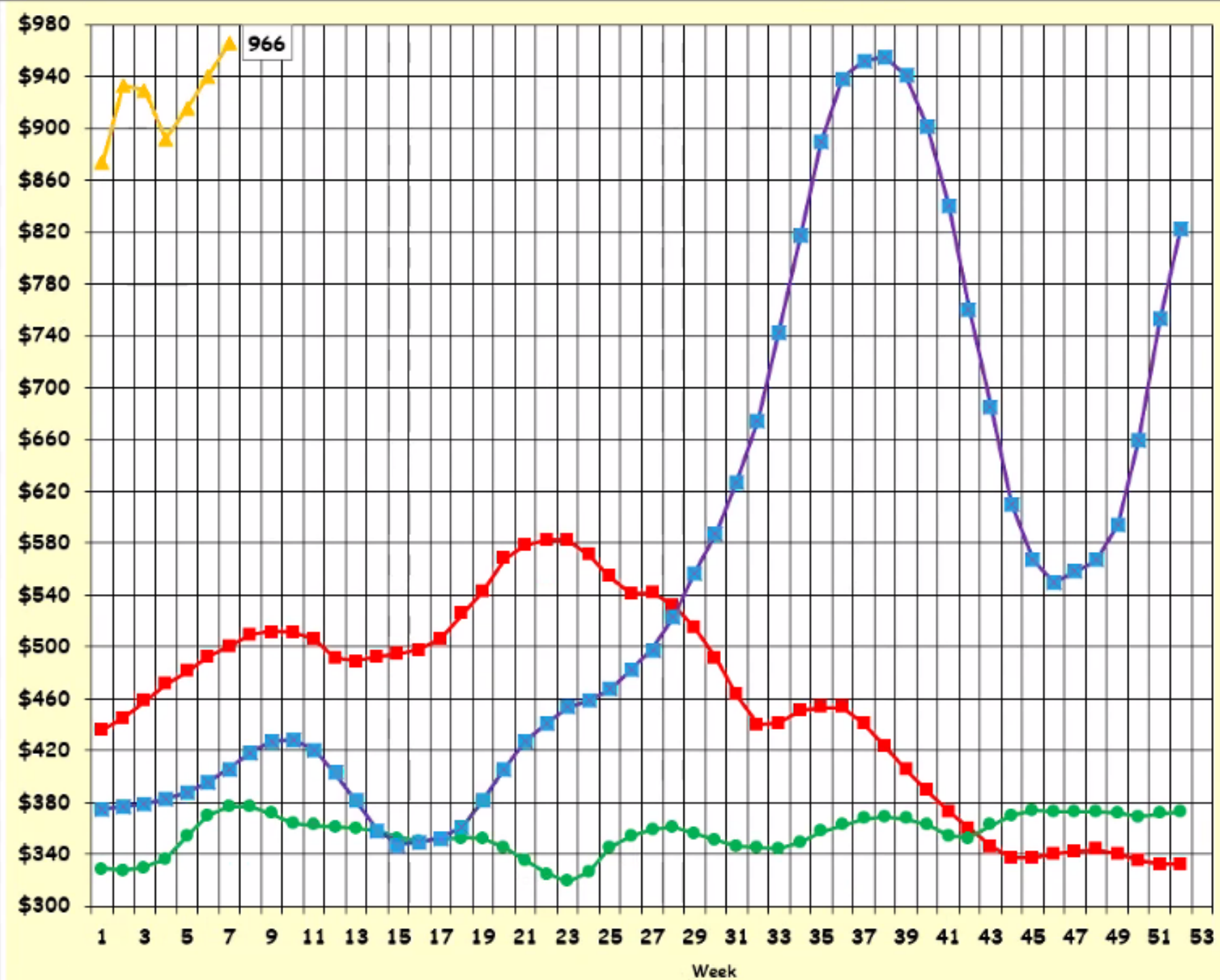
This review has described scientific reports that elucidated the physiological effects of wood-derived stimulation. Throughout, these reports showed that olfactory, visual, tactile, and auditory stimulation involving wood-derived materials induced physiological relaxation such as reduction of brain activity, enhancement of parasympathetic nervous activity, and inhibition of sympathetic nervous activity, as well as decreased blood pressure, heart rate, and stress hormone level.

Lakeridge Middle School

Lake Oswego School District



Q4: I think we've all heard the price of lumber is fluctuating. How will that effect the ability to deliver mass timber schools cost-effectively?



Q5: When talking about cost, how can we use design to be more efficient and therefore affordable?

Optimization – Fiber Efficiency

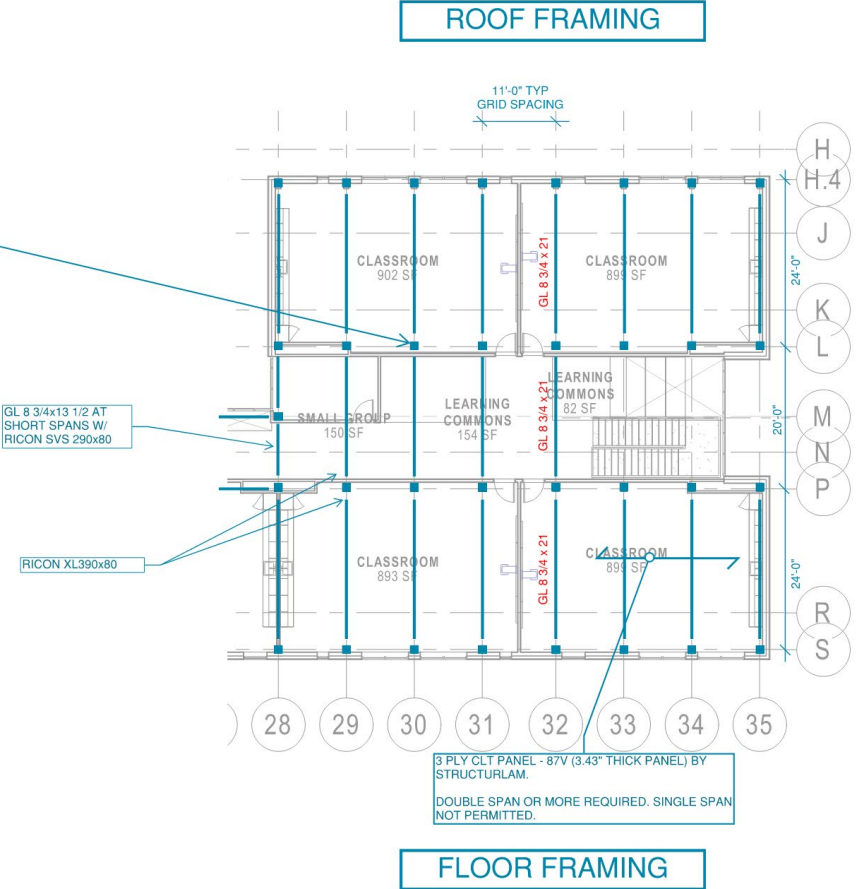
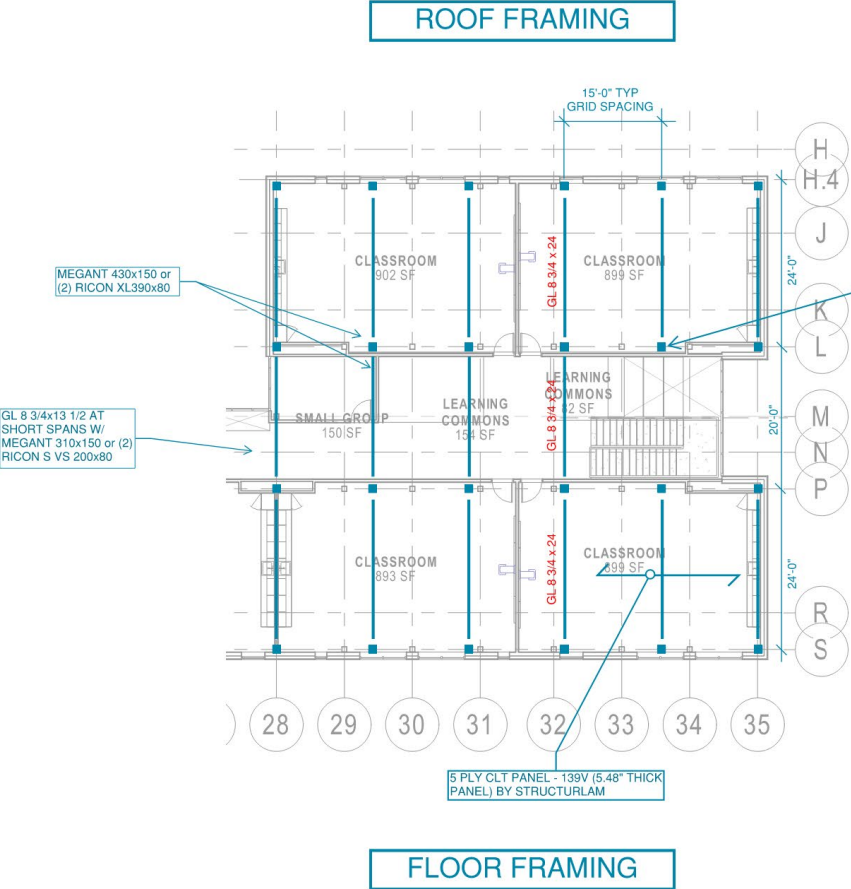
Measure of cubic feet of
wood volume divided by
square feet of floor/roof area

Values 0.6-0.8 typically
efficient

>1.0 Likely inefficient and
expensive



Optimization – Piece Count



Q6: Is the devil really in the details? Are there specific considerations on the detail level for mass timber versus steel or concrete?

Proprietary Hardware

Concealed Beam Connectors

Consider Cost and
Erection Tolerance

Mass Timber Screws

Self Tapping vs. Predrill

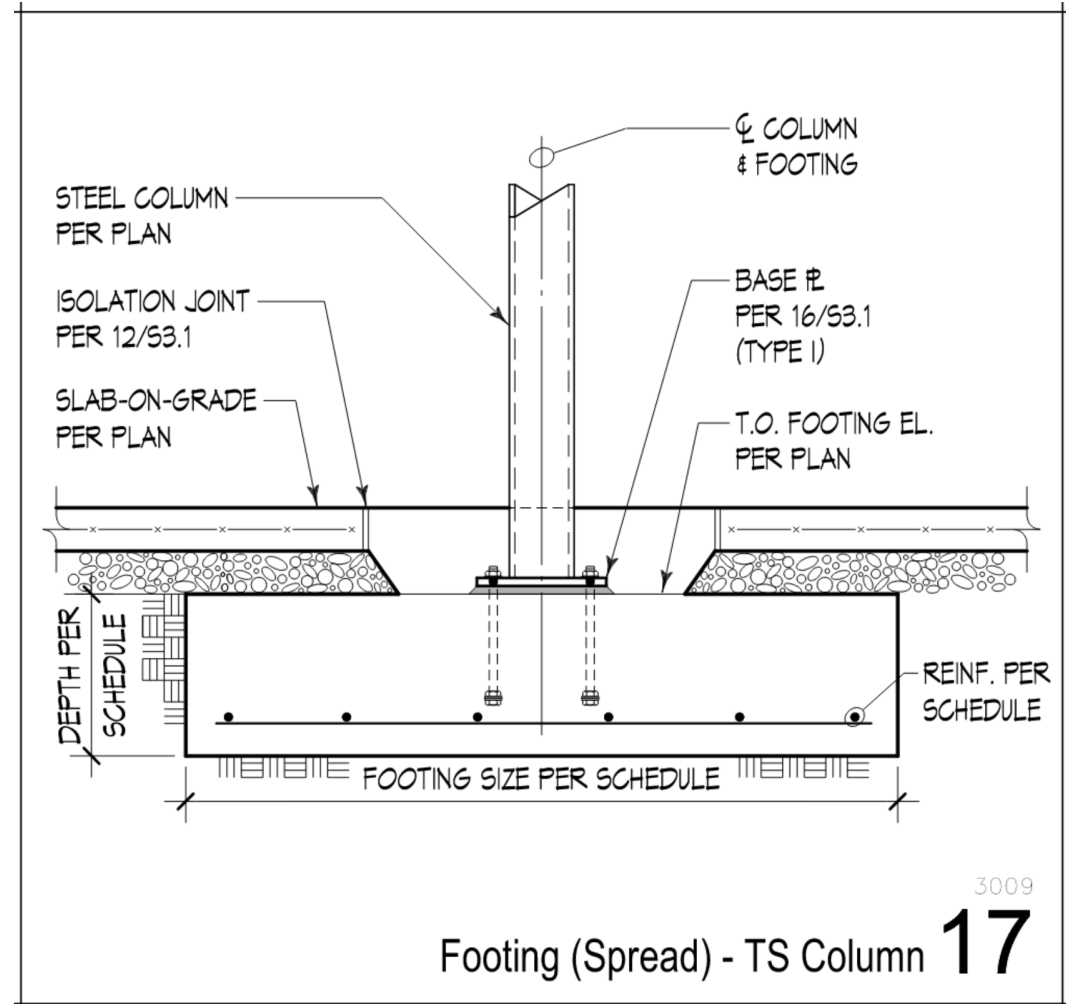
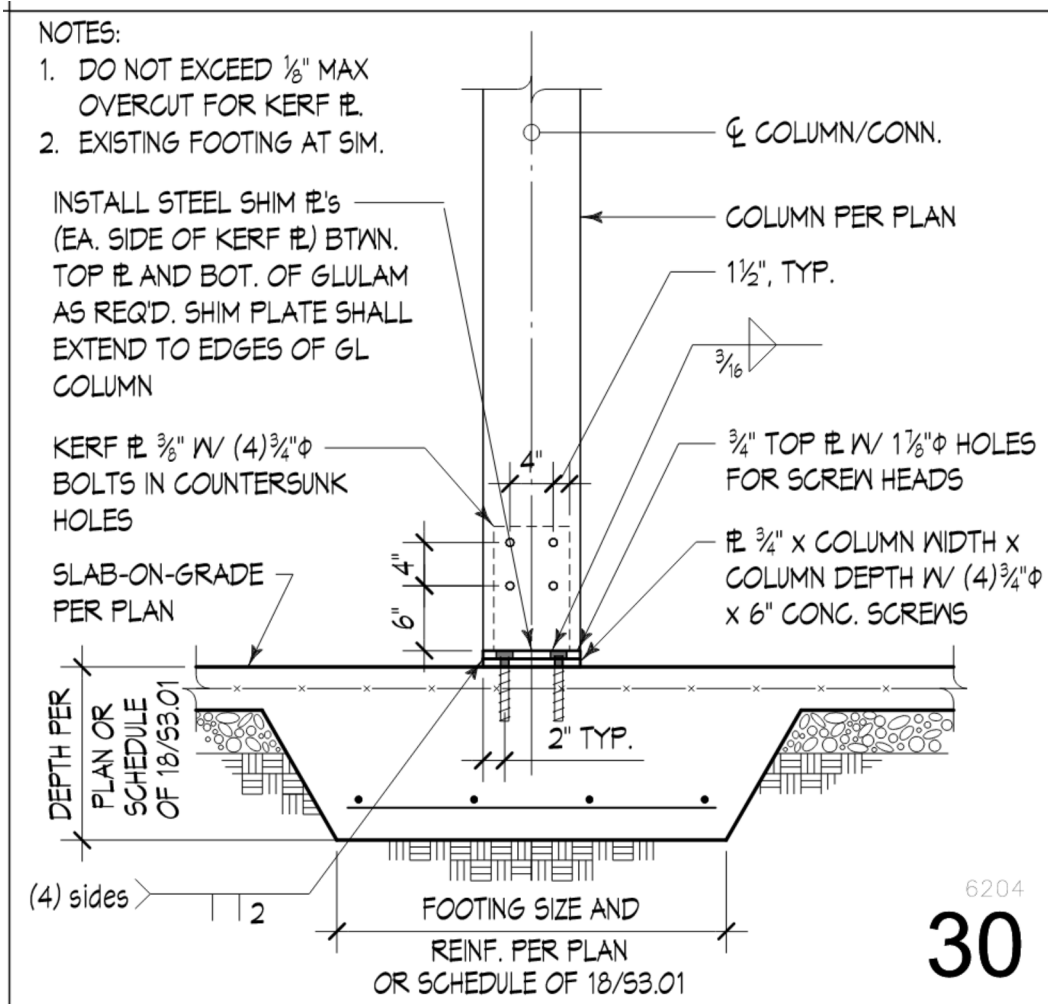
Partially and Fully Threaded
Options

Find Opportunities to Use
Cheaper Fasteners

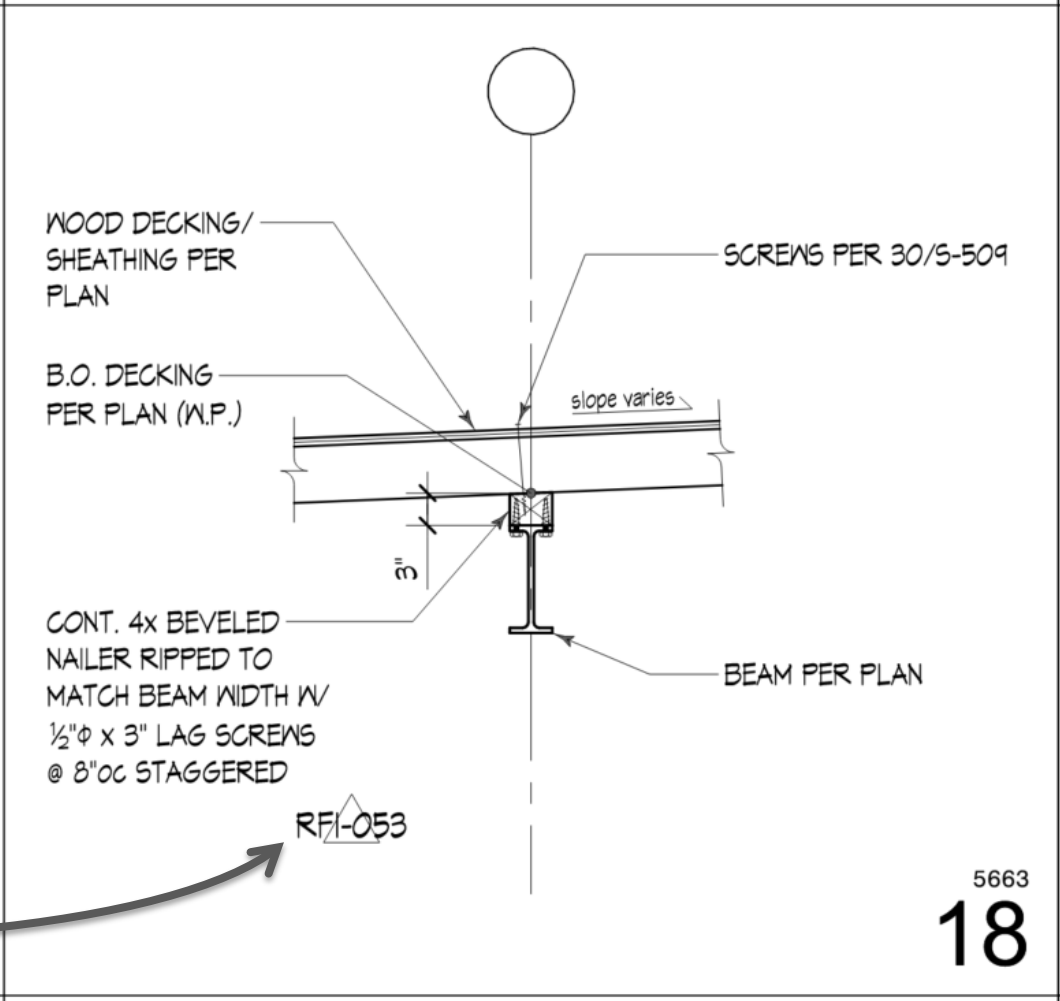
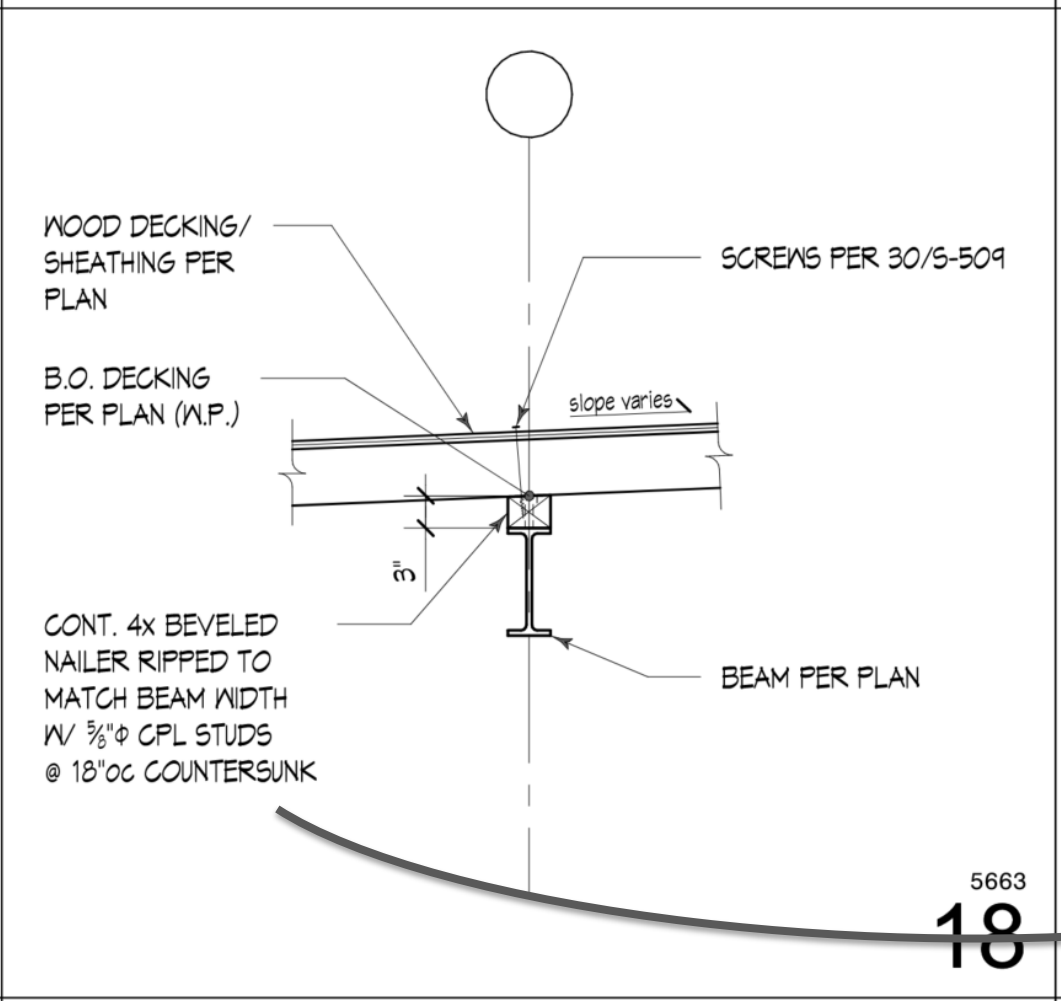


Source: MyTiCon

Column Bases and Connections

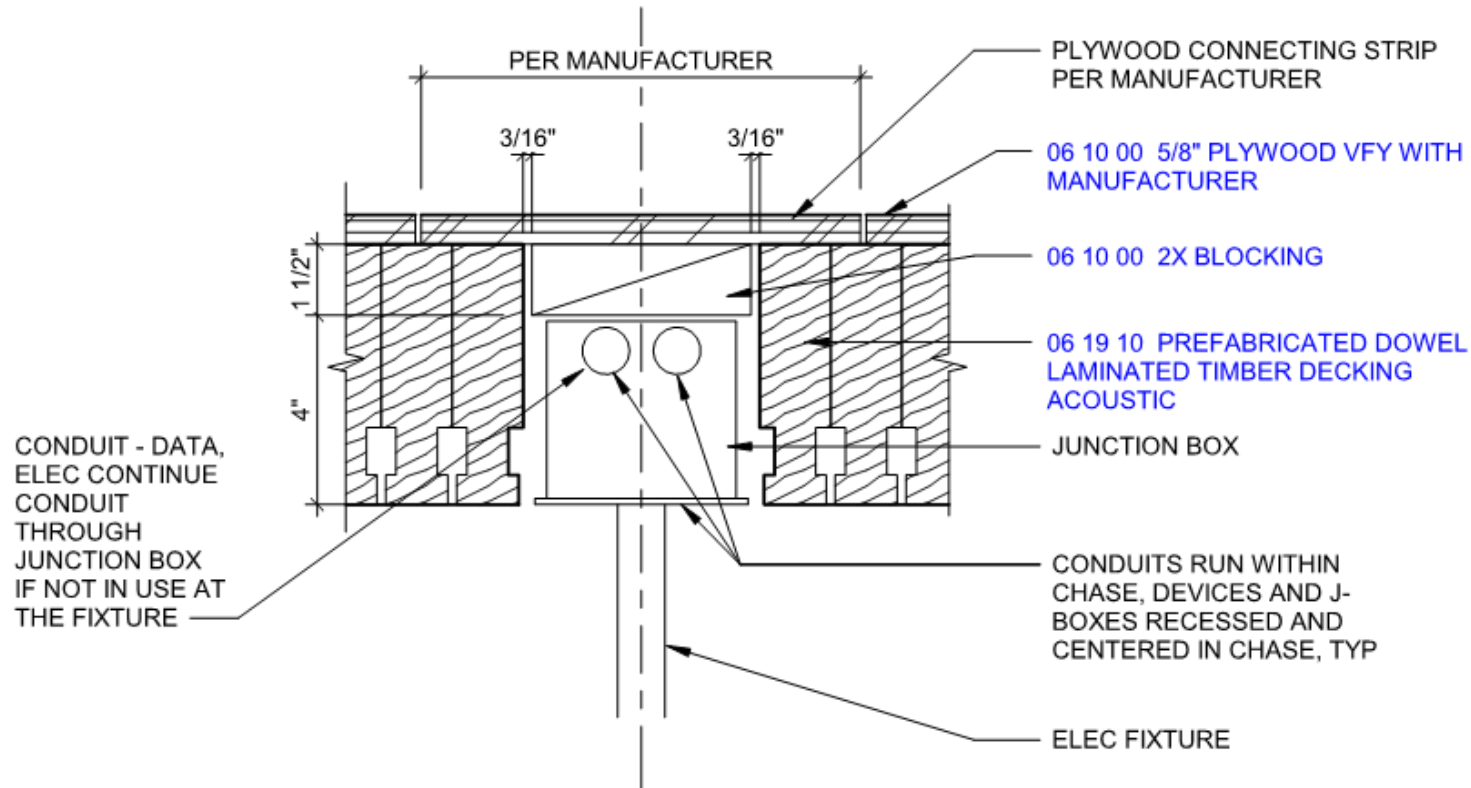


Steel and Wood Contractor Coordination

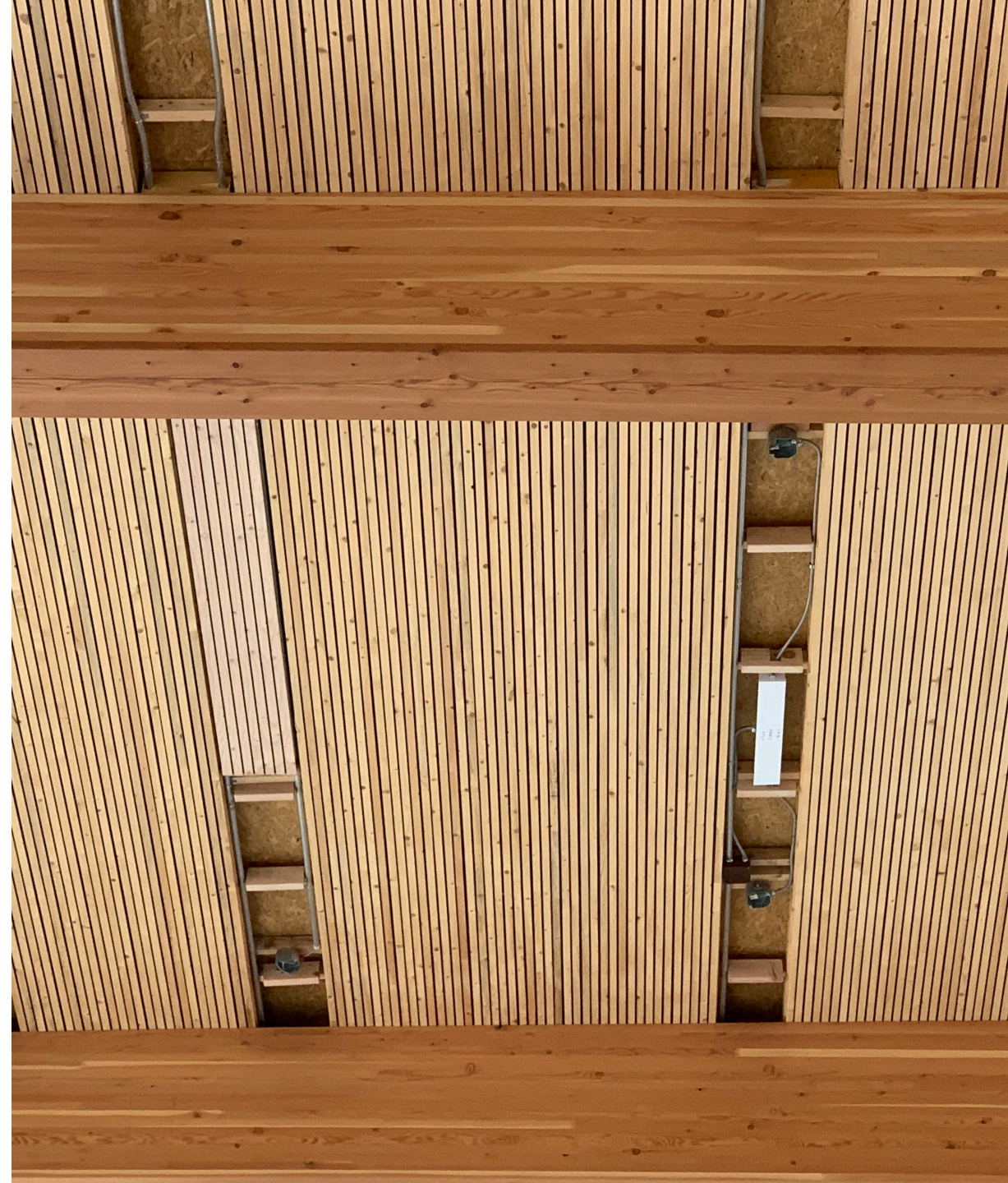
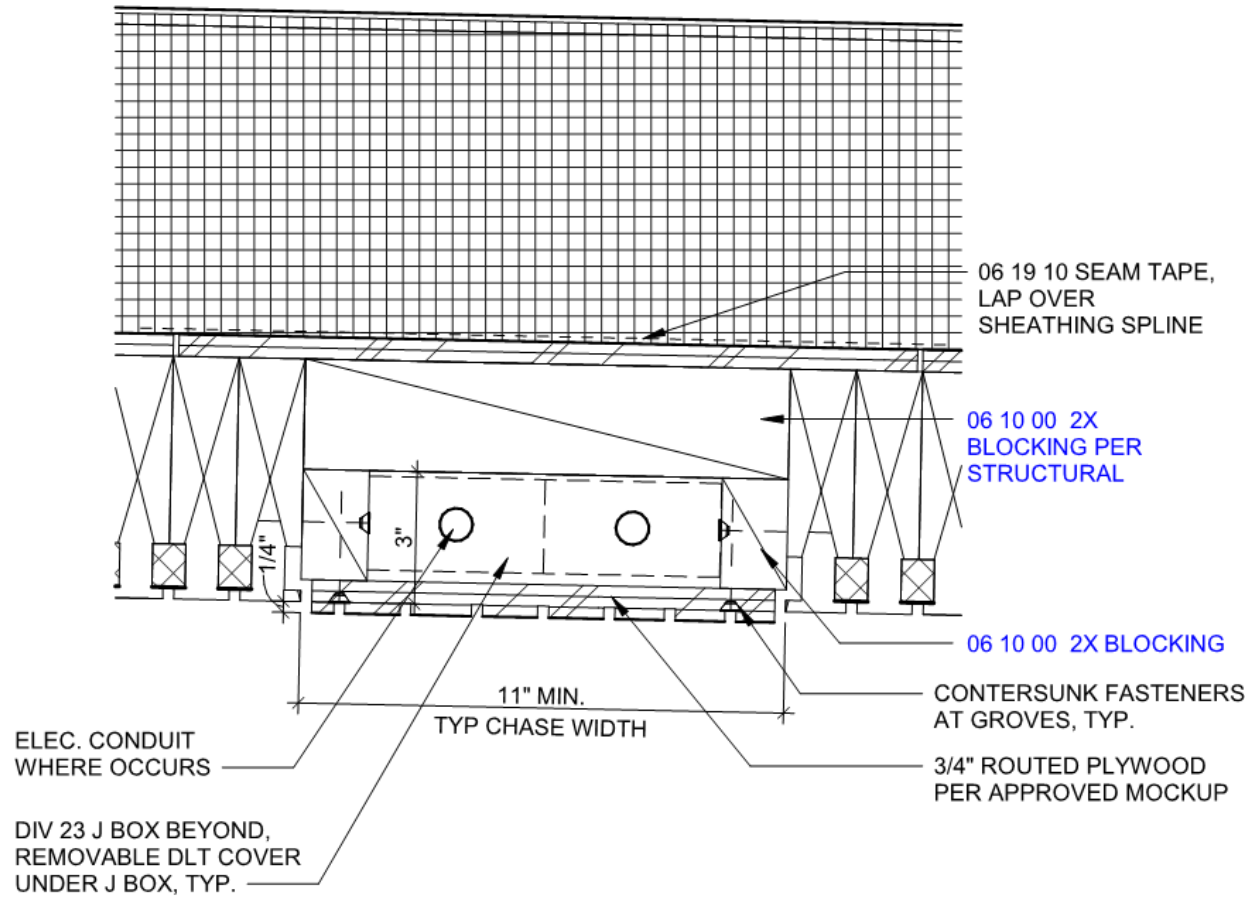


Q7: With these solid panels, where do you run electrical and other services?

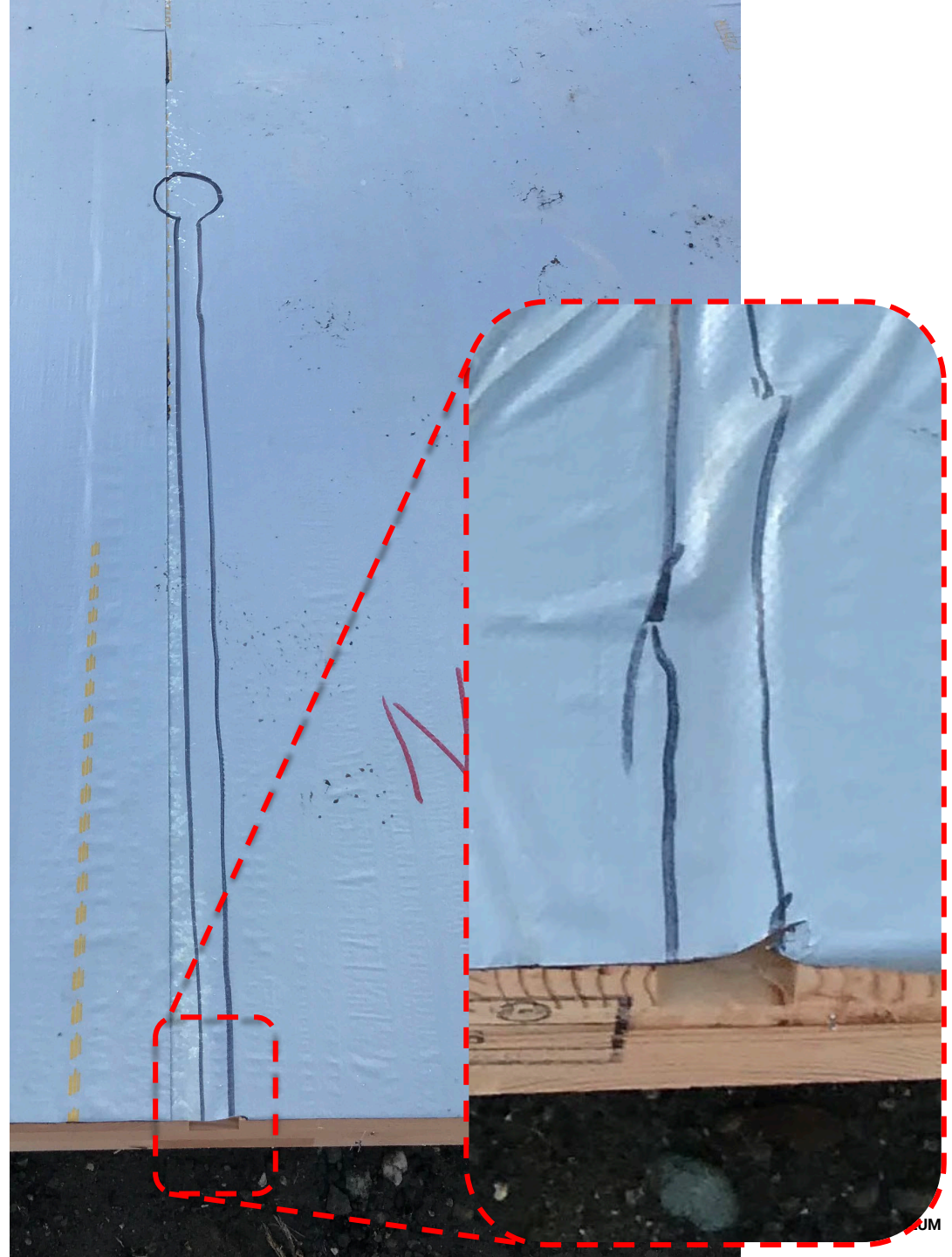
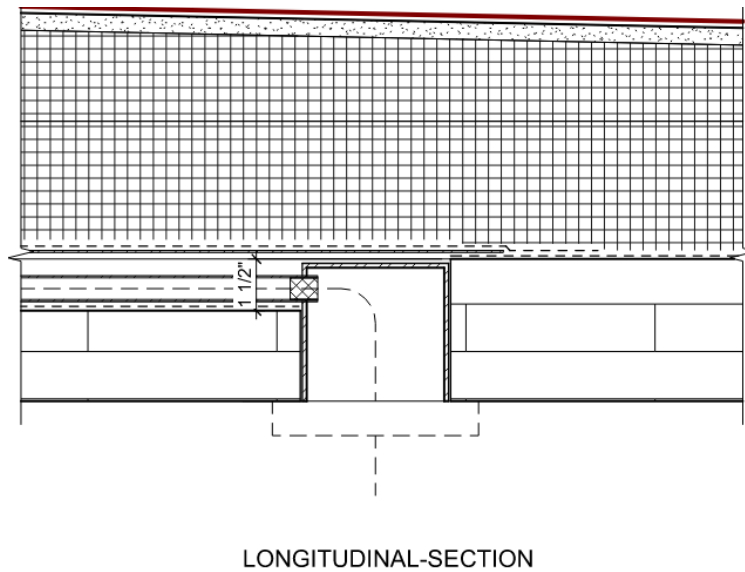
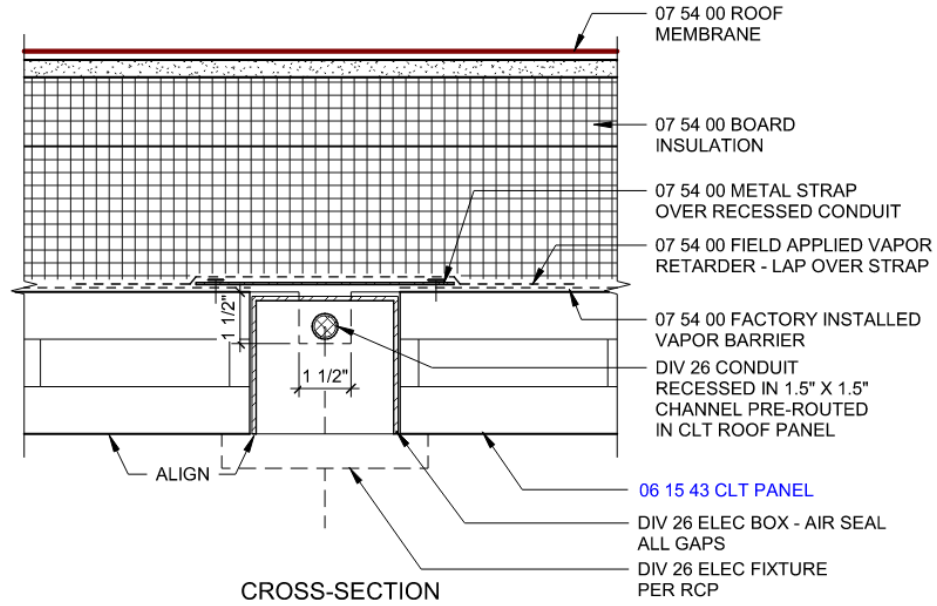
Conduit Pathway – Lakeridge Middle School



Conduit Pathway – Kellogg Middle School



Conduit Pathway – Capitol Campus Childcare





RECESSED ELECTRICAL BOX DURING CONSTRUCTION
PHOTO: MAHLUM



FINISHED CLASSROOM
PHOTO: WALSH CONSTRUCTION



PHOTOS: MAHLUM







Q8: Have there been any delays related to jurisdictional approvals?

Jurisdictional Approvals – Code Alternates

Code Alternates or Alternate Means and Methods (AMM)

Engage Jurisdiction Early – Involve as Design Partner

COUGHLINPORTERLUNDEEN
STRUCTURAL CIVIL SEISMIC ENGINEERING

Project Record

DATE	June 10, 2021	FROM	Jason Whitney PE, SE
TO	Katie Pond Huttenball & Oremus Architecture	PROJECT	New Renton Elementary School
CC	NA	CPL PROJECT #	S200390-06
RE	New Renton Elementary School – Code Alternate Proposal	# PAGES	3
ATTACHMENTS	NA		

COMMENTS

New Renton Elementary School – Code Alternate Proposal

The proposed structure for the new Renton Elementary School consists of two primary framing systems of wood and steel framing. The wood framed portion of the building consists of Cross Laminated Timber (CLT) panels fastened down to glulam post and beam framing. The CLT panels will be topped with an acoustic mat and non-structural gypcrete topping. Resistance to seismic induced forces utilize the CLT panels, in combination with the panel-to-panel spline connections and metal straps to resolve chord forces, to span to reinforced Concrete Masonry Unit (CMU) shear walls. Refer to figures 1 (surface spline) and 2 (chord strap) for example details of the panel connection components.

CLT has been used for decades as a building material primarily in Canada and Europe but is relatively new to the Pacific Northwest in comparison. However, many local projects have been completed that have incorporated CLT as a primary structural component, a number of which our company has designed as Engineer of Record in a manner similar to what we are proposing for the New Renton Elementary project.

Because of the relative infancy of CLT in the United States, the formal adoption of CLT and other Mass Timber products are only partially included in our current editions of the Building Codes (eg. IBC, NDS). More comprehensive provisions have already been written and will be included in future editions of the code.

Specifically, although the 2018 IBC permits the use of CLT, it does not specifically address the use of CLT as a seismic diaphragm. Section 2305 permits the use of wood frame diaphragms designed and constructed in accordance with AWC NDS SDPWS (the material specific code for wood design). Design guidance for CLT as diaphragms are not yet incorporated into the current edition of the NDS codes; however, the draft version of the 2021 SDPWS document (currently available online at <https://awc.org/codes-standards/publications/sdpws-2021>) has incorporated a new section 4.5 CROSS LAMINATED TIMBER (CLT) DIAPHRAGMS. Refer to figure 3 for the updated provisions.

Therefore, we are requesting approval from the City of Renton's building official to allow for CLT to be used as the seismic diaphragm strictly following the code provisions published in the 2021 version of the NDS SDPWS.

Please let us know if there are any questions or further documentation needed to approve our proposal.

End of project record.

801 SECOND AVENUE, SUITE 900 SEATTLE, WA 98104 / P 206.343.0460 / cplinc.com



City of Seattle
Department of Construction and Inspections

www.seattle.gov/sdci

700 Fifth Ave, Suite 2000, P.O. Box 34019, Seattle, WA 98124-4019

Phone: 206-684-8850

Code Modification or Alternate Request

Q9: What are the schedule implications to using mass timber? Is there a time advantage to mass timber?

Schedule Considerations

Collaborate early with manufacturer

Procurement process and optimization for agnostic design solutions to allow for multiple bidders

Understand Special Inspections

WOOD FRAME OBSERVATIONS REPORT

MAYES TESTING ENGINEERS

- Terracon member

Report Number: M7181970.0078

Service Date: 09/27/19

Report Date: 10/01/19

20225 Cedar Valley Rd Ste 110
Lynnwood, WA 98036-6365
425-742-9360

Client

Shoreline WA School District
Attn: Dan Stevens
18560 1st Ave NE
Shoreline, WA 98155-2148

Project

Shoreline SD Kellogg MS Replacement
16045 25th Ave NE
Shoreline, WA

Project No.: M7181970

Permit No.: COM19-0056

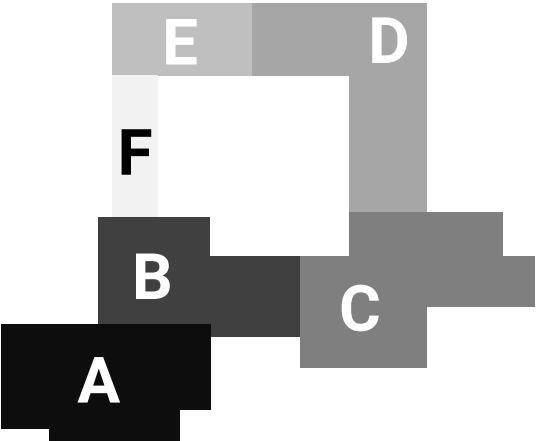
Samples: N/A

Weather: Occasional showers

Inspected diaphragm sheathing nailing pattern and SWG screws on roof, grid lines F to H / 14.7 to 21, per details and schedule, 27/S-509. Nails and screws were found to be per these details and Mayes Testing Engineers understands these joints will now be taped.

To the best of our knowledge, the items inspected today are in conformance with approved plans and specifications.

Schedule

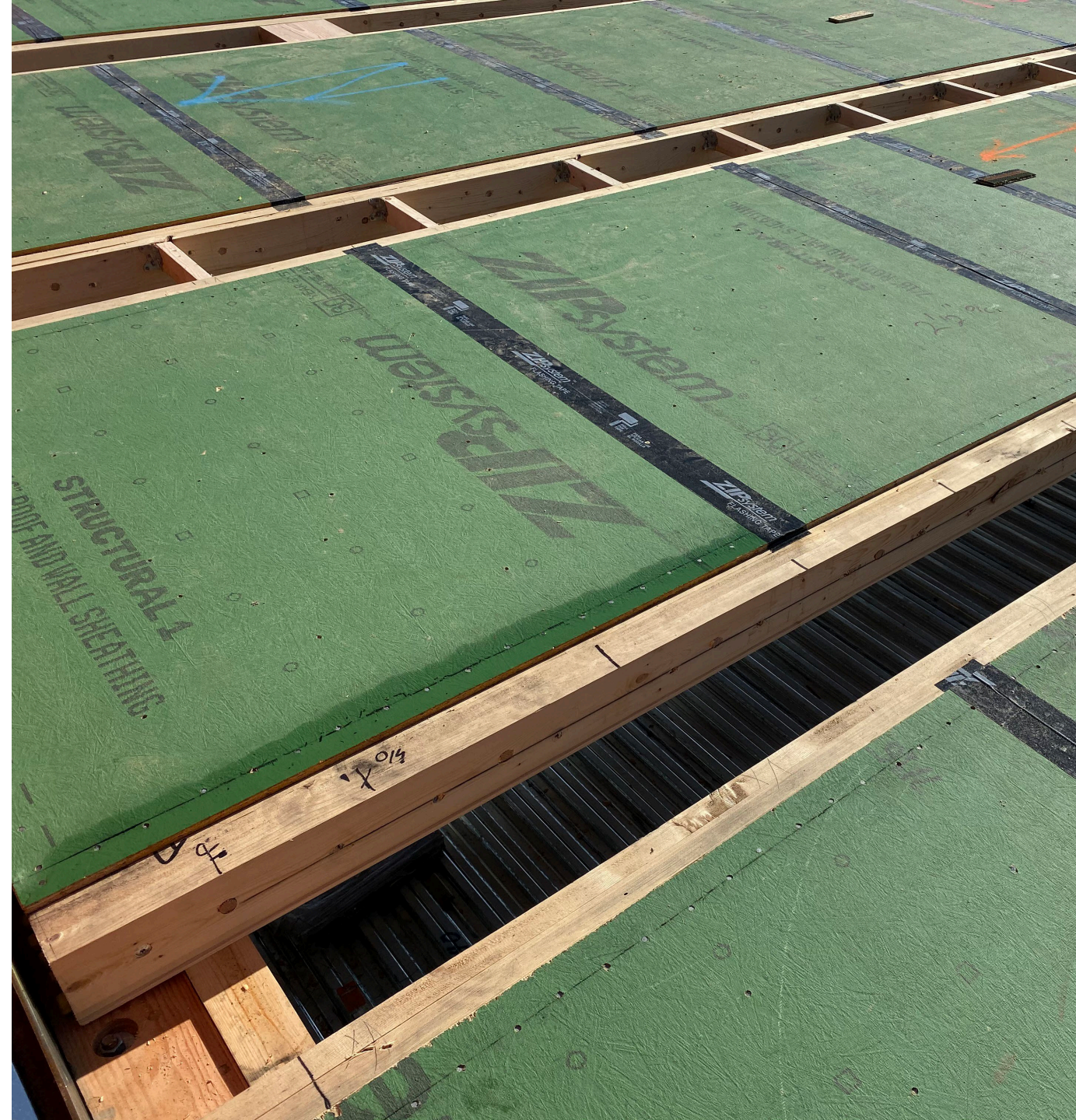


STRUCTURE
AS FINISH

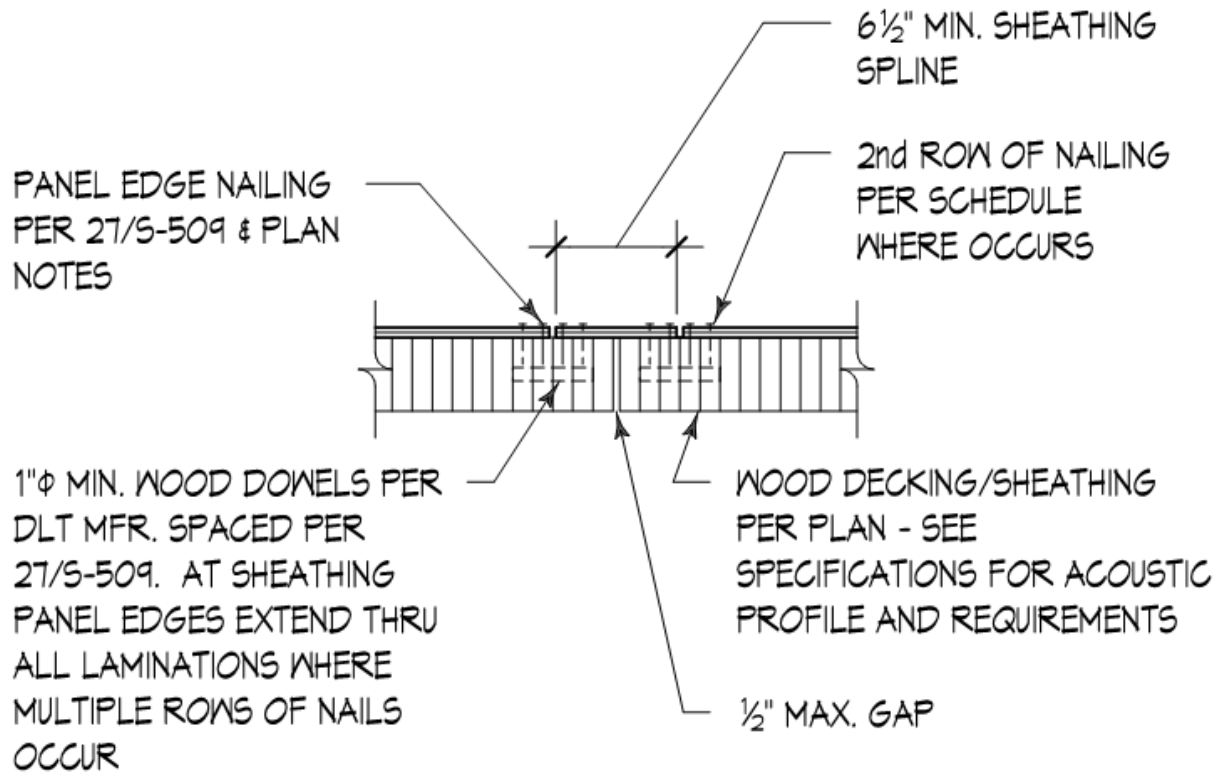
Activity	Duration	Start	Finish	2019							2020	
				Jul	Aug	Sep	Oct	Nov	Dec	Jan		
Zone A – Erect Structure	10	23-Jul-19	05-Aug-19		■							
Zone A – Paint	5	13-Dec-19	19-Dec-19								■	
Zone A – Ceiling Grid	10	20-Dec-19	06-Jan-20									■
Zone B/C – Erect Glulam/DLT	15	13-Aug-19	03-Sep-19		■							
Zone F – Erect Glulam/DLT	10	16-Oct-19	29-Oct-19				■					



04 September 2019



NOTE:
LAMINATION ORIENTATION ONLY
SHOWN THIS DETAIL FOR CLARITY



DLT DECKING SPLICE



Kellogg Middle School

First Acoustic DLT Installation in the U.S.

Completed 2020

At-a-Glance

Location:
Shoreline, Washington

Area:
152,000 SF (separated into two buildings)

Height:
2-stories (~45' tall)

Occupancy:
E

Construction:
Type IIB





Kellogg Middle School

Shoreline School District





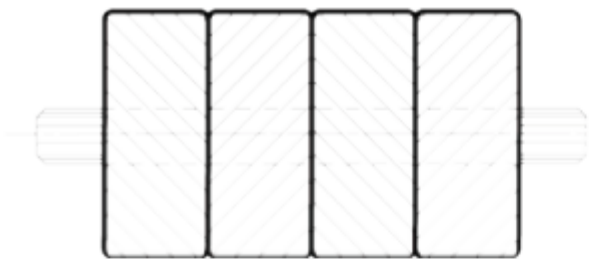


Q10: Can mass timber be left exposed?
Are there other architectural considerations?



PHOTO: MAHLUM

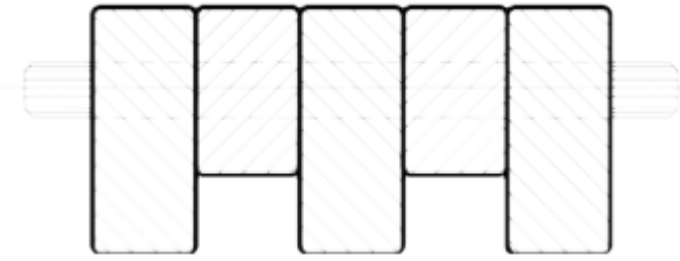
Dowel Laminated Timber (DLT)



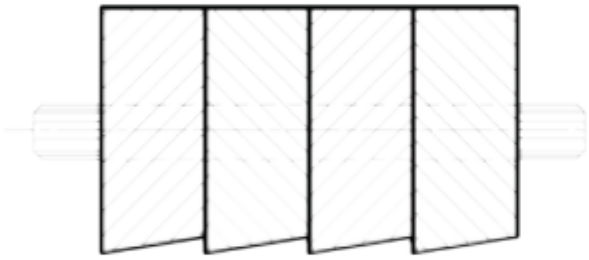
Factory Edge



Square Edge



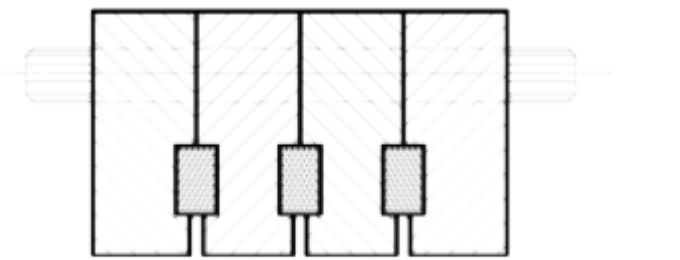
Fluted



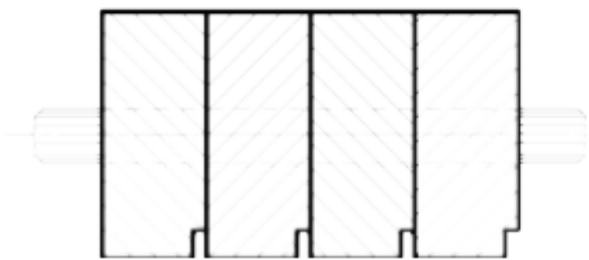
Sawtooth



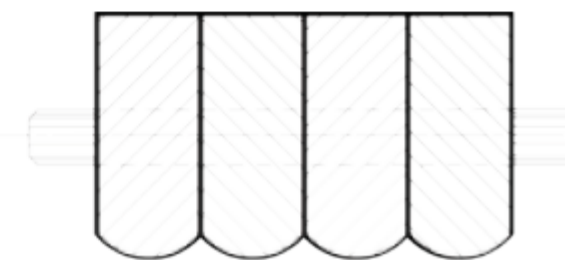
Chamfer



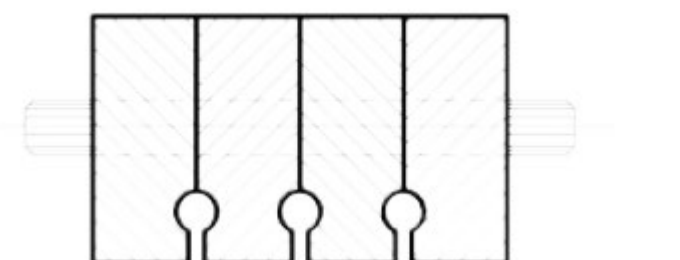
Acoustic Square



Kerf

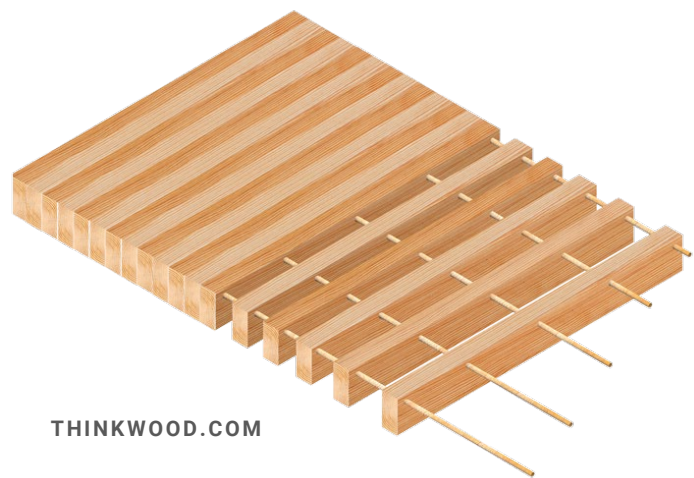


Bullnose



Acoustic Round

NRC = 0.70



THINKWOOD.COM



IMAGE: MAHLUM



WOOD AESTHETIC

Roof/Ceiling Assembly	Materials	Unit Costs	Assembly Cost
Acoustic DLT (NRC 0.7) + Glulam Beams	DLT (2x6 SPF) Deck Glulam Beams	\$27.50/sf \$14.25/bf	\$930,000
CLT + Glulam Beams + Acoustic Cloud Ceiling	CLT Deck Glulam Beams Acoustic Cloud Ceiling	\$11.00/sf \$14.25/bf \$8.00/sf	\$1,103,000
Metal Deck + Steel Joists + Acoustic Cloud Ceiling + Wood Ceiling	1.5" Metal Deck Steel Joists Acoustic Perf Metal Panel	\$4.00/sf \$5,250/ton \$45.00/sf	\$1,203,300







Q11: I understand that mass timber may hold some digital fabrication advantages that could benefit construction. Can you explain?

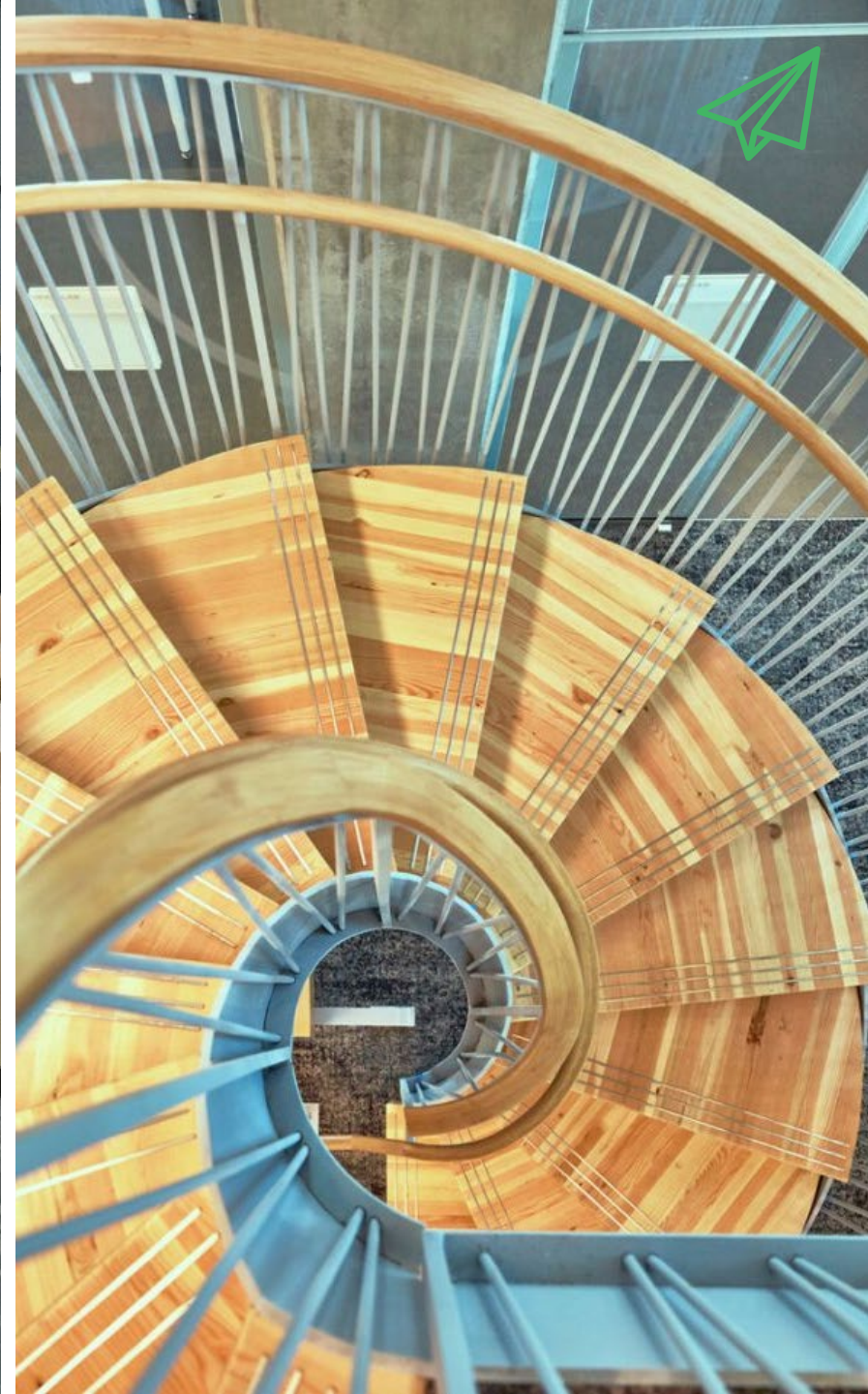






IMAGE: MAHLUM

Q12: With more and more digital fabrication, are there any exciting new mass timber opportunities that many might not be aware of?

Lakeridge Middle School

WholeTrees

Completed 2020

Branching Column: 2973

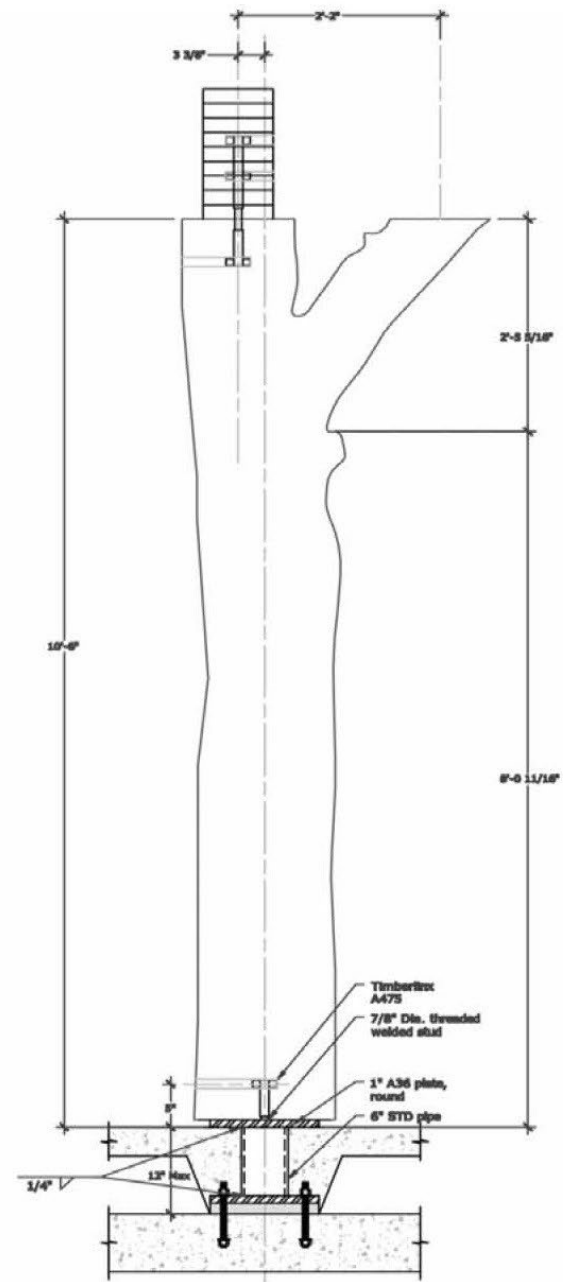
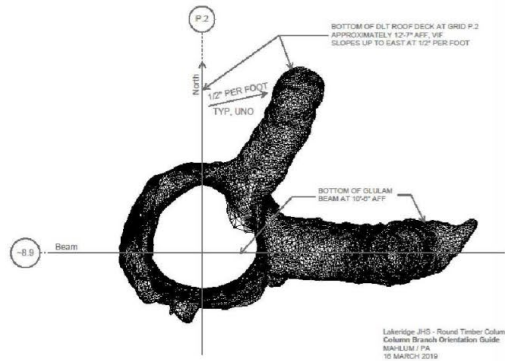


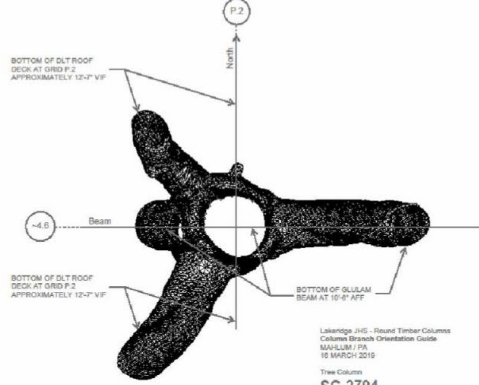




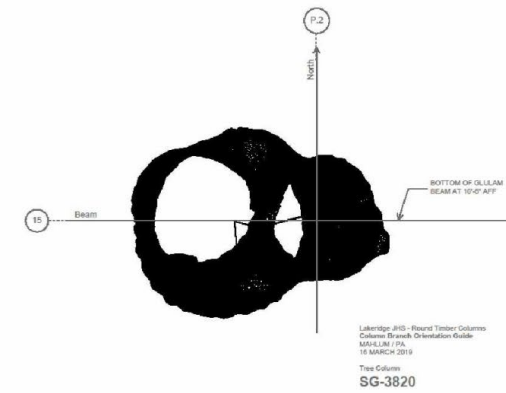
IMAGE: WHOLETREES



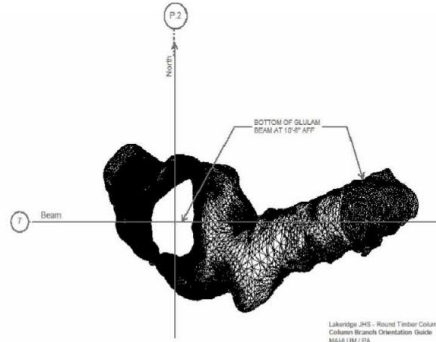
Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
SG-2793



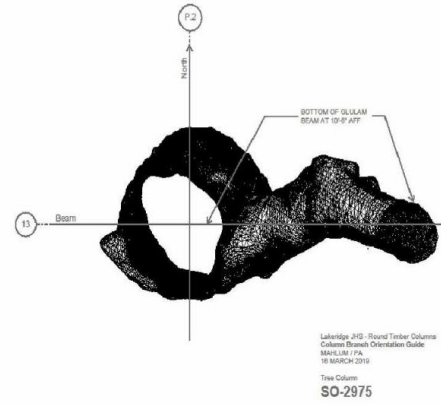
Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
SG-2794



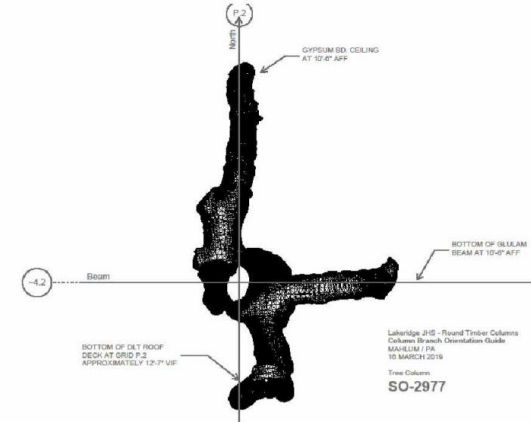
Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
SG-3820



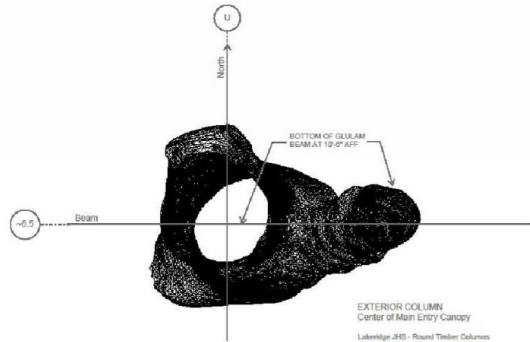
Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
SO-2973



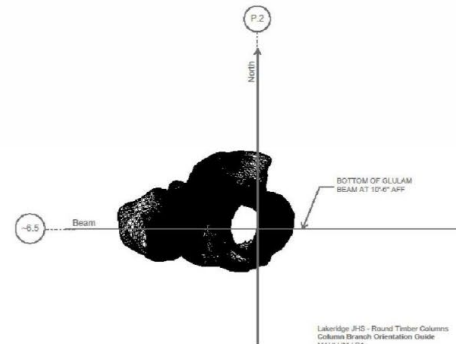
Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
SO-2975



Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
SO-2977



EXTERIOR COLUMN
Center of Main Entry Canopy
Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
WO-3454-Y



Lakeridge JHS - Round Timber Columns
Column Branch Orientation Guide
MAHLEIM / PA
18 MARCH 2019
Tree Column
WO-3455-B

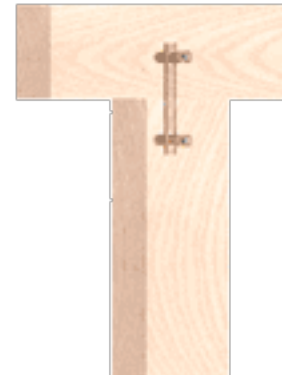
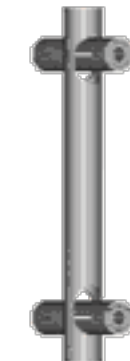
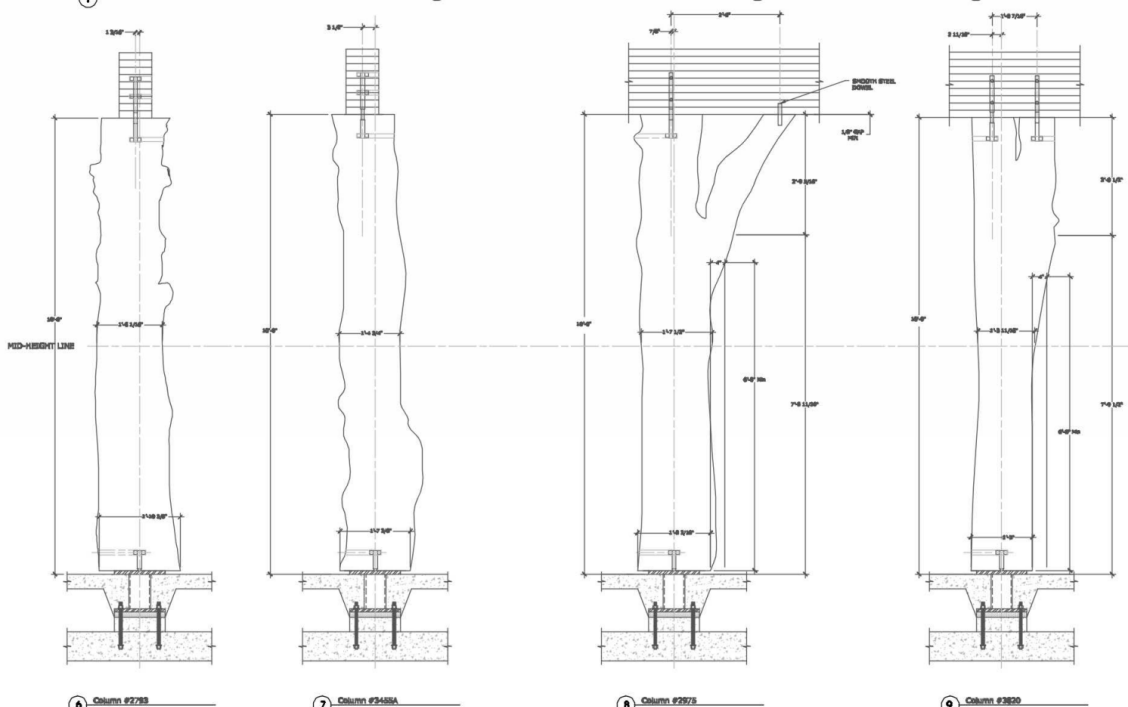
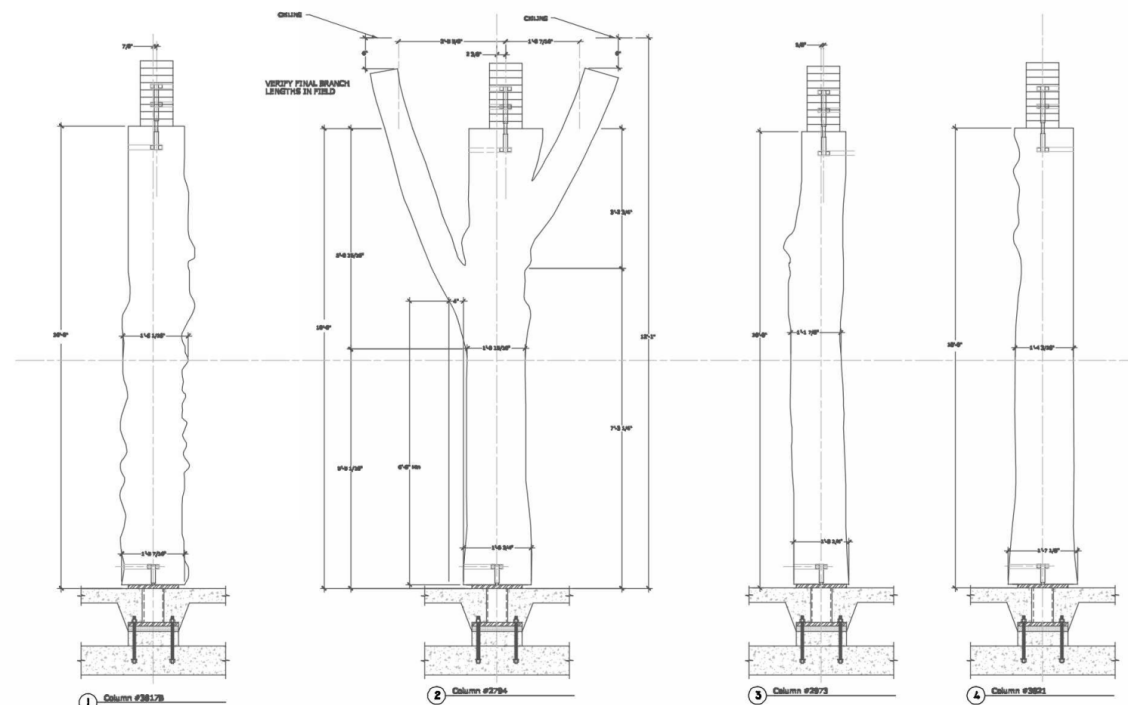
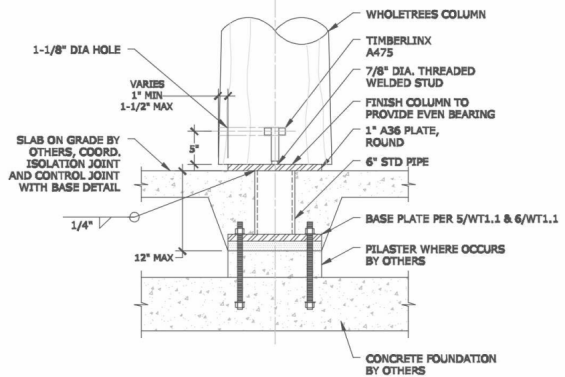
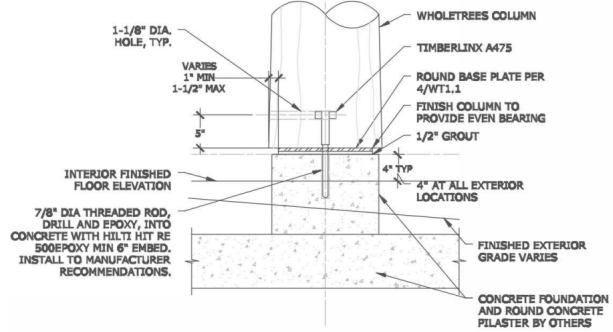
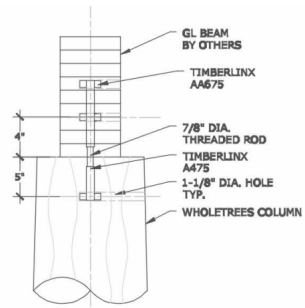


IMAGE: WHOLETREES/KPFF SEATTLE

IMAGE: TIMBERLINX



Thank You!

“The CLT wood adds a natural finish and a more authentic environment. Not institutional at all.”

CLT Classroom User

“It still has that new car smell! Actually, the structure itself is doing just great...It is a great, nice building and is showing no signs of wear and tear a portable would be showing after a year of use.”

CLT Classroom User

“[The best thing about the CLT classrooms are] the materials used to create the buildings.”

CLT Classroom User

“I’m glad I can go to school here... it’s happy, bright and warm.”

Lakeridge Middle School Student

Thank You!

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