

# THE BAMBOO OPPORTUNITY

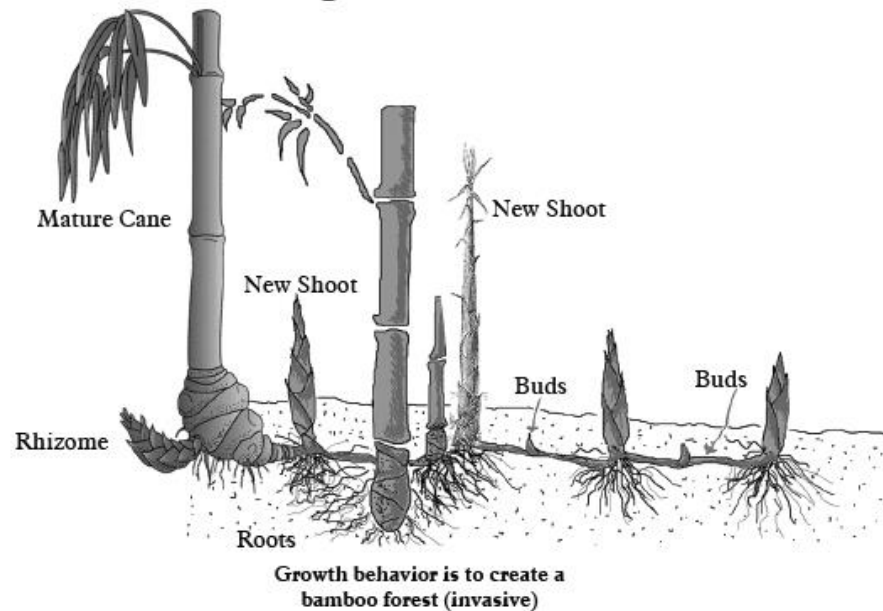
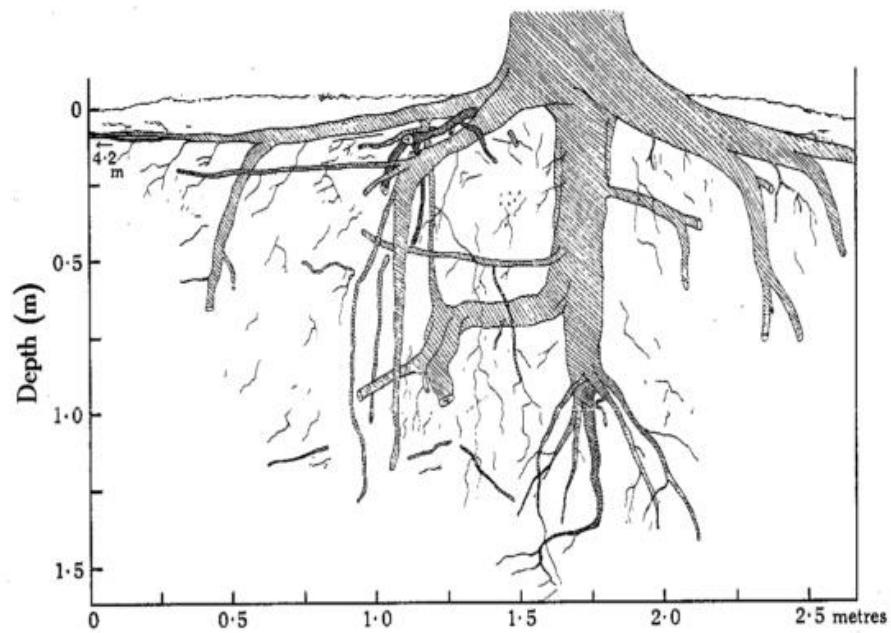
Fiber Optimized Engineering



## Growing the fibers faster



# It's in the Roots







# Hybrid



IN A WORLD OF UNLIMITED DEMAND BUT LIMITED  
RESOURCES

USE MATERIALS WHERE THEY ARE MOST EFFICIENT AND  
EACH DOES MORE THAN ONE JOB

A glowing hot steel beam is shown in a furnace, with a blue text box overlay in the center. The background is filled with the bright orange and yellow light of the furnace, and the steel beam is supported by dark metal blocks. The text "STEEL - TENSION" is written in white, outlined letters on the blue box.

STEEL  
- TENSION







CONCRETE  
- COMPRESSION

# Concrete Batch Tickets & EPD's

(Upstream sourcing disclosure beyond industry averages is greatly improving)



Hanley Wood Ready Mixed Concrete  
5600 N. River Rd.  
Rosemont, IL 60018  
773-824-2400

Driver's Information  
Mileage Return: 46.55 Start: 4:15  
Time Left Plant: 2:45 Arrived Job: 2:05  
End Pour: 3:55 Left Job: 4:05  
Arrived Plant: 4:25

IMPORTANT TERMS AND CONDITIONS  
Customer's delivery location and date are the customer's responsibility. This ticket is valid for the time and date specified. Any other use is void. The concrete batch is the property of the company and is not to be used for any other purpose. The company is not responsible for any damage or loss of material. The customer is responsible for the correct use of the concrete. No substitution will be made without the customer's written approval.

INSPECTED, APPROVED AND RECEIVED BY:  
*Joe Converse*  
(Operator)

NOTICE: Customer bears all responsibility for damage which might result from truck leaving the batch tickets.

NOTICE: Driver will not exit water unless customer is in the truck.

CAUTION: CONTACT WITH ANY PART OF BODY MAY BE HAZARDOUS. BRUSH OFF WITH WATER.

SOLD TO: Kan 'N Concrete Construction  
2564 Concrete Lane  
Chicago, IL 60625

SHIP TO: Joe Concrete, For  
823 East 94th St  
Chicago, IL 60623

DATE: 02/09/14 CUST. ACCT. # 600745 TRUCK# 0388

2.00 yd 4012 4000 psi #12 WINTER DELIVERY SPLIT LOAD CHARGE TOTAL COST 2.00 yd 35.0 wt

4.5 mi

BATCH: 1 START: 14:58 END: 14:28 BATCH TIME: 4 HR: 1

MATERIAL	DESIGN QTY	REQUIRED	BATCHED	WTR	4 HR: 1
#1	7708 lb	1480 lb	1480 lb	10	0.89
#2	1095 lb	2970 lb	3600 lb	30	0.84
SAND	2555 lb	6231 lb	6200 lb	-31	-0.50
GR# 111	584 lb	1128 lb	1140 lb	12	1.06
WTR	11.0 gal	24.4 gal	24.4 gal	0.0	0.0
WTRSD	3.00 gal	33.84 oz	34.00 oz	0.18	0.47
AIR	1.00 gal	11.84 oz	12.00 oz	0.18	1.264

LOAD TOTAL: 1932 lb DESIGN W/C: 0.459 WATER/CEMENT 0.48RT  
ACTUAL WATER: 41.8 gal TO ADD: 0.4 gal SLUMP: 4.00" WATER IN:  
ADJUST WATER: 0.0 gal/yard TEST WATER: 0.0 gal/yard

COMPANY: National Ready Mix  
15621 Ventura Boulevard, Suite 475  
Encino, CA 91436

PLANT: Irvine Plant  
16232 Construction Circle East  
Irvine, CA 92606

EPD PROGRAM OPERATOR: ASTM International  
100 Barr Harbor Drive  
West Conshohocken, PA 19428

DATE OF ISSUE: 11/29/2021 (valid for 5 years until 11/29/2026)

**NATIONAL READY MIX**  
ENVIRONMENTAL PRODUCT DECLARATION  
Mix S86001 • Irvine Plant

This Environmental Product Declaration (EPD) reports the impacts for 1 m<sup>3</sup> of ready mixed concrete mix, meeting the following specifications:

- ASTM C94: Ready-Mixed Concrete
- UNSPSC Code 30 111505: Ready Mix Concrete
- CSA A23.1(A23.2): Concrete Materials and Methods of Concrete Construction
- CSI Division 03-30-00: Cast-in-Place Concrete

**ENVIRONMENTAL IMPACTS**

**Declared Product:**  
Mix S86001 • Irvine Plant  
Description: AUGER CAST PILE  
Compressive strength: 5000 PSI at 28 days

**Declared Unit:** 1 m<sup>3</sup> of concrete

Heat Warming Potential (kg CO <sub>2</sub> e)	407
Acidification Potential (kg SO <sub>2</sub> e)	1.19
Eutrophication Potential (kg N <sub>2</sub> e)	0.17
Photochemical Oxidation Potential (kg O <sub>3</sub> e)	29.3
Abiotic Depletion, non-fossil (kg Sb-e)	1.11E-4
Abiotic Depletion, fossil (kg Sb-e)	2.621
Total Waste Disposed (kg)	2.50
Consumption of Freshwater (m <sup>3</sup> )	3.29

**Product Components:** natural aggregate (ASTM C33), Portland cement (ASTM C150), fly ash (ASTM C916), admixtures (ASTM C494), batch water (ASTM C1702)

Additional detail and impacts are reported on page three of this EPD

ISO 21930:2017 Sustainability in Building Construction—Environmental Declaration of Building Products: serves as the core PCR for Concrete, NSF International, February 2019 series as the sub-category PCR

Sub-category PCR review was conducted by Thomas P. Gloria • Industrial Ecology Consultants

Independent verification of the declaration, according to ISO 14025:2006:  Internal  external

Third party verifier Thomas P. Gloria (t.gloria@industrial-ecology.com) • Industrial Ecology Consultants

For additional explanatory material  
Manufacture Representative: John Halverson (jhalverson@nram.com)  
Software Tool: CustomCLARITY Suite, EPD Generator • Verification  
LCA & EPD Developer: Climate Earth (support@climateearth.com)



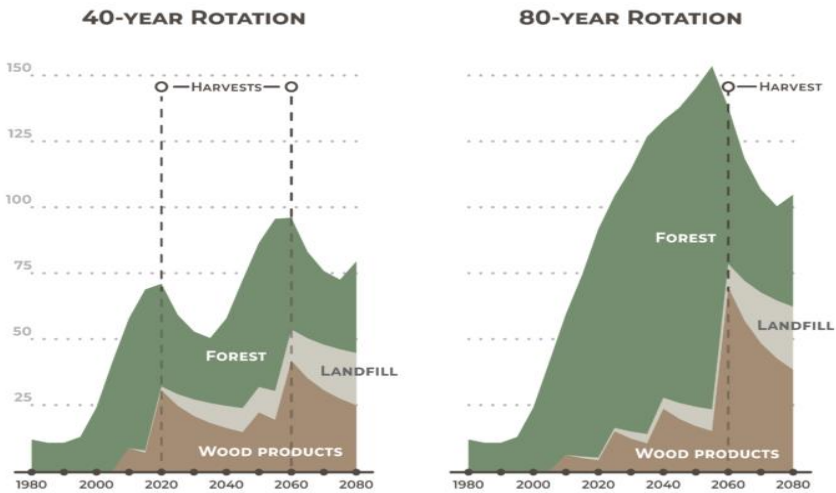


ENGINEERED FIBER MATERIALS  
- SURFACE AREA & BENDING

# Wood & EPD's

(Upstream sourcing doesn't differentiate across North American, all impacts are reported as carbon neutral)

Tons of carbon stored per acre (1980-2080)



## ENVIRONMENTAL PRODUCT DECLARATION



North American Softwood Lumber  
North American Structural and Architectural Wood Products



According to ISO 14025,  
EN 15804 and ISO 21930-2017

### 3.1. Life Cycle Impact Assessment Results

**Table 9. Impact Assessment Results for 1 m<sup>3</sup> of North American Softwood Lumber**

Impact	Total	A1	A2	A3
GWP <sub>100</sub> (kg CO <sub>2</sub> eq)	65.12	1		
GWP <sub>100</sub> (incl. biogenic carbon) (kg CO <sub>2</sub> eq)	65.12	(0.04)		
ODP (kg CFC-11 eq)	2.98E-06	5.9		
AP (kg SO <sub>2</sub> eq)	0.52			
EP (kg H <sub>2</sub> eq)	0.26			
POCP (kg Pb eq)	13.63	2		
ADP <sub>low</sub> (MJ LHV)	803.37	14		
Footnote for biogenic CO <sub>2</sub> (kg eq)	101.21	2		

\*G1 Results for GWP<sub>100</sub> include destination emissions but occur in information module A2 and C2SC G2

### 3.2. Life Cycle Inventory Results

**Table 10. Resource Use for 1 m<sup>3</sup> of North American Softwood Lumber**

Resource	Total	A1
RF <sub>100</sub> (M <sup>3</sup> LHV)	2,395.93	
RF <sub>10</sub> (M <sup>3</sup> LHV)	10,859.10	10,859
NRF <sub>100</sub> (M <sup>3</sup> LHV)	1,900.14	14
NRF <sub>10</sub> (M <sup>3</sup> LHV)	9.93	
SM (kg)	0.00	
RF <sub>10</sub> (M <sup>3</sup> LHV)	405.72	
NRF <sub>10</sub> (M <sup>3</sup> LHV)	0.00	
RE (M <sup>3</sup> LHV)	0.00	
FW (m <sup>3</sup> )	0.44	

**Table 11. Output Flows and Waste Components for 1 m<sup>3</sup> of North American Softwood Lumber**

Component	Total	A1
NH <sub>3</sub> (kg)	2.35E-03	0.46
NH <sub>4</sub> (kg)	0.06	1
H <sub>2</sub> SO <sub>4</sub> (m <sup>3</sup> )	2.7E-06	1.96
S <sub>2</sub> LHV (m <sup>3</sup> )	3.0E-03	2.46
CRU (kg)	0.00	0
MR (kg)	0.00	0
MER (kg)	0.00	0
EE (M <sup>3</sup> LHV)	0.00	0

## ENVIRONMENTAL PRODUCT DECLARATION NORTH AMERICAN SOFTWOOD LUMBER

AMERICAN WOOD COUNCIL,  
CANADIAN WOOD COUNCIL



The American Wood Council (AWC) and the Canadian Wood Council (CWC) are pleased to present this Environmental Product Declaration (EPD) for North American softwood lumber. The EPD includes Life Cycle Assessment (LCA) results for all processes up to the point that planed and dry lumber is packaged and ready for shipment at the manufacturer's log. The underlying LCA and the EPD were developed in compliance with ISO 14025:2008 and ISO 21930:2017 and have been verified under the U.S. Environmental EPD program.

The AWC and CWC represent wood product manufacturers across North America. The North American Forest product industry is a global leader of sustainably sourced wood products. This EPD reflects years of research and numerous sustainability initiatives on behalf of our members to continually improve the environmental footprint of North American wood products. We are pleased to present this document to show our progress.

Please follow our sustainability initiatives at [www.awc.org](http://www.awc.org) and [www.cwc.ca](http://www.cwc.ca).



## Environment

# Mass Timber Sourcing Disclosure (Questionnaire)

(Disclosure that rewards those “doing better”)



**1. APPENDIX: MASS TIMBER SUBCONTRACTOR RFP FOREST SOURCING DISCLOSURE QUESTIONNAIRE (3/29/2022)**

Responses to this questionnaire are to be collected by the project general contractor, accompanying the subcontractor bid submissions for the sourcing of a minimum of 90% of the structural mass timber to be used on the project. This information will be evaluated by the owner and/or the owners designated representatives (who may include a forestry consultant hired on behalf of the owner).

The questions are to assist in a comparative and competitive bid evaluation of the climate smart and ecological impact characteristics of the sourced timber. Chain of custody for the material shall be agreed to be provided, traceable back to the source forest(s) of origin. Documented third party verification of the chain of custody will be valued higher than self-declaration from the winning bidder at the time of material delivery to the owner, to verify to accuracy of the data provided.

Subcontractor bids should include a baseline bid that is the performance characteristics identified within the design and considered along with comparative subcontractor submitted climate smart and ecologically sensitive sourcing information include an alternative bid to the base bid which provides a sensitive material sourcing than the base bid. Provide any on a separate line item.

Each subcontractor's bid cost and climate smart and ecological the owner or owner's designated representatives using products FSC certified materials coming from FSC-certified forest.

Please share documentation for responses to the below questions likely prior to harvesting of the source logs for the project, of sourcing that will be committed to for the project, subject to the site. Sourcing substitutions may occur, subject to the owner's designated representatives, with the substitution time original bid submission for its climate smart and ecological

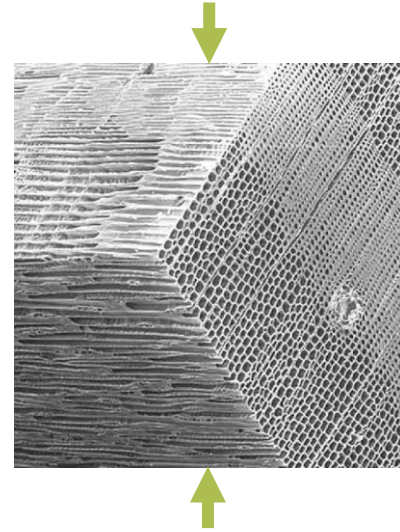
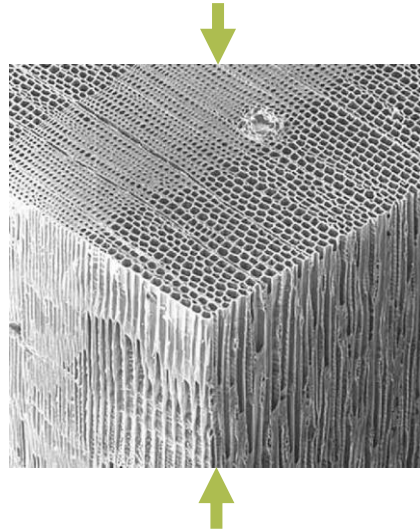
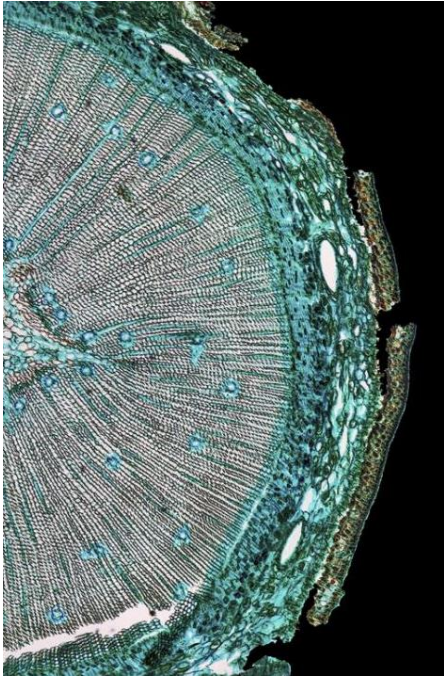
- 1) Is the timber being proposed for use on the project from operation, and/or is the material traceable to the source forest?
- 2) If source forest material certification is being provided, this material certification (FSC, SFI, PEFC, other)?
- 3) Can a third party developed source forest(s) specific re on the forest landscape(s) divided by the timber output consider a window of initial planting to final harvest, w than one forest is involved and segregation is not provided, using averaged yearly data for all of the material project is acceptable.

4) Additionally, please provide written answers and documentation for the following questions:

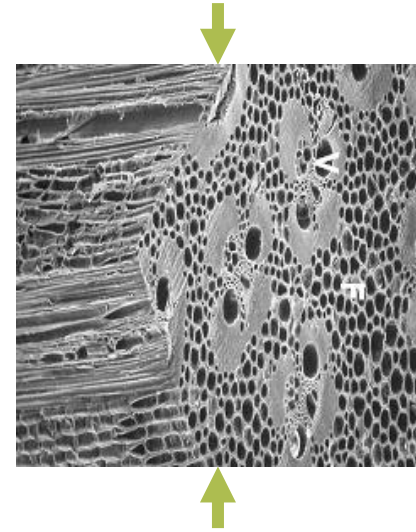
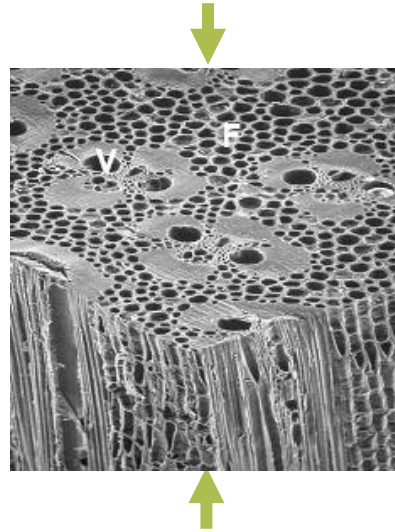
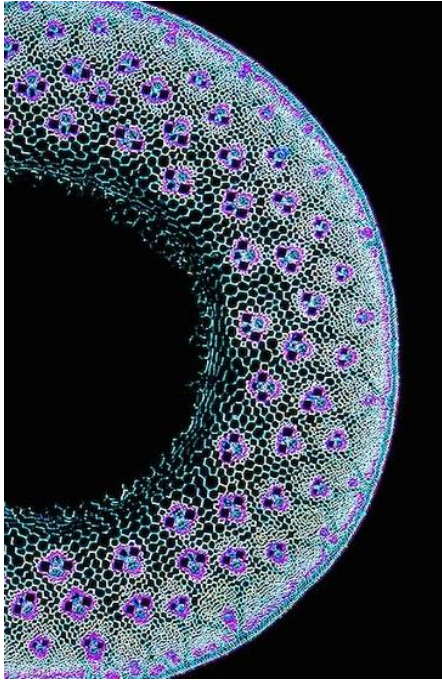
- a. What practices do the forest managers use to mitigate the impacts of climate change and increase resiliency for the forest ecosystems?
- b. Please characterize the silviculture used on the source forest(s) and share documentation of the source forest(s) forest management plan. Include stream buffers, the controls to protect soils and biodiversity, the controls to protect the habitat for any rare, threatened, or endangered plant or animal species that occur on the source forestlands, and the controls to prevent excessive soil erosion.
- c. What are the rotation lengths between final harvests at the source forest(s)? Do the forest managers use pre-commercial or commercial thinning to enhance forest quality?
- d. Confirm that no rare old-growth or forest conversion harvesting from prime, not previously logged forest lands will be included within the sourced material (unless such sourcing is from an ecologically restorative forest management plan that is attempting to maintain the values associated with the stand (e.g., removal of non-native species, conduct controlled burning, and thinning from below where restoration is appropriate).
- e. Please share documentation of the material sourcing control from the source forest(s) to the material delivery to the site. This shall include satellite photo images less than 5 years old, with GIS polygons identified, for the source forest(s) showing the forest management unit(s) where timber has been harvested for the project, and the year when harvesting has occurred.
- f. Has the source forest(s) been used to generate independently verified forest carbon credits? If so, please describe and provide documentation of the credit restrictions.
- g. What other characteristics do the source forest land(s) include that make their management climate smart and why?



# Fiber Density and Orientation Matters - Pine



# Fiber Density and Orientation Matters - Bamboo



**3 Layer CLT**



**5 Layer CLT**



**7 Layer CLT**

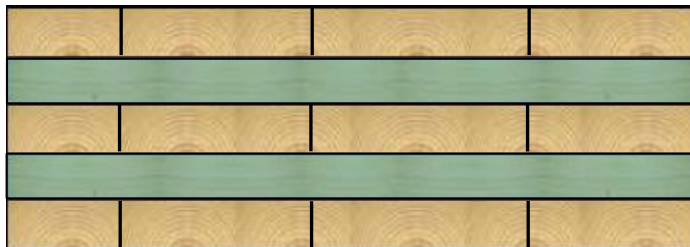




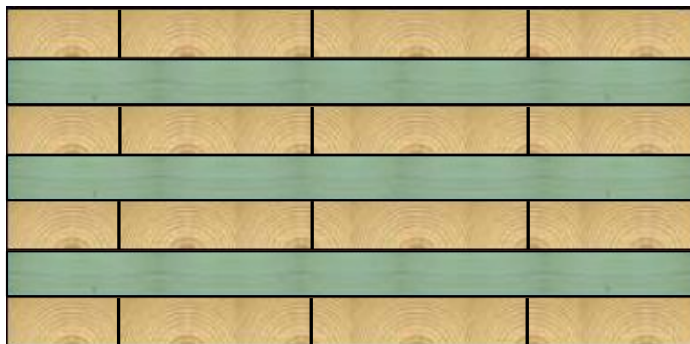
**3 Layer CLT**

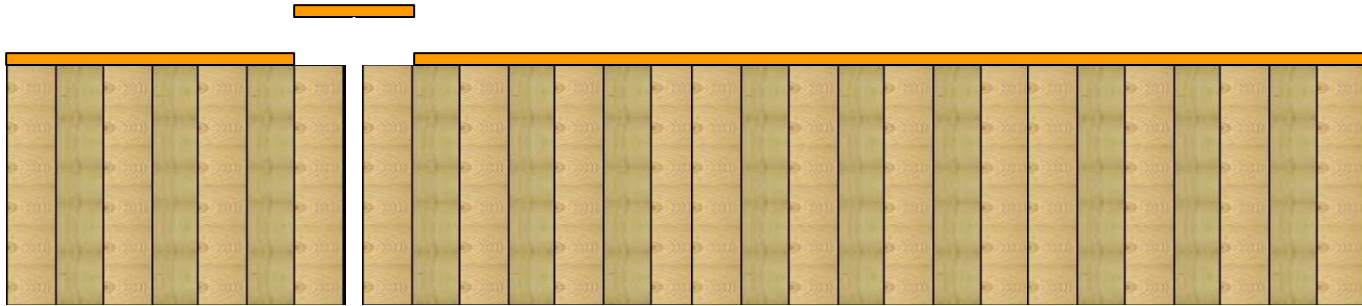


**5 Layer CLT**



**7 Layer CLT**





**Nail Laminated Timber (NLT)**



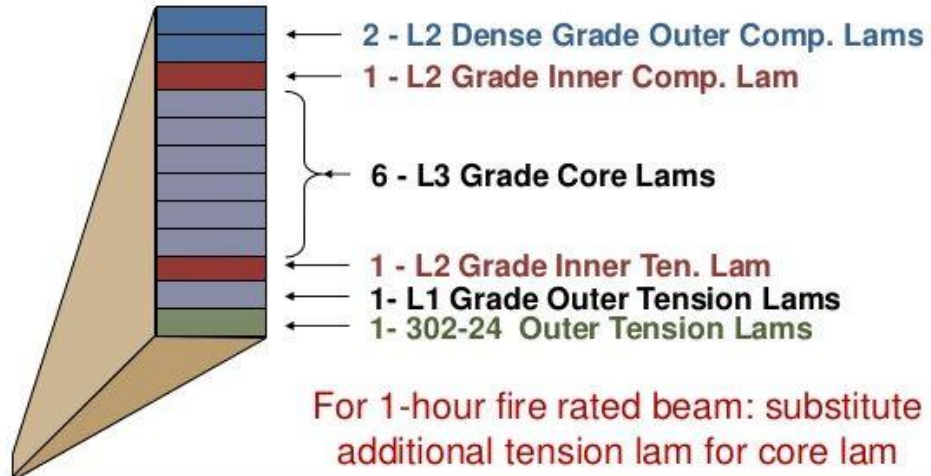




# GLU-LAM BEAMS

## Typical Glulam Beam Layup

### 24F-V4 Doug Fir (12 Lamination Example)



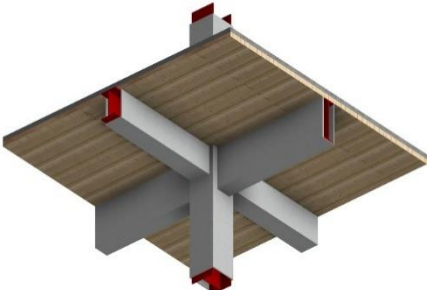
# MASS PLYWOOD PANELS



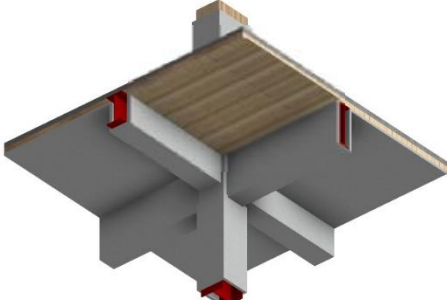




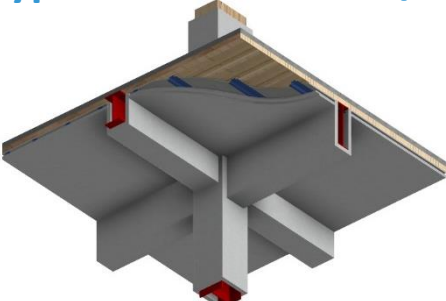
# CONCRETE SLAB ON BAMBOO DECK



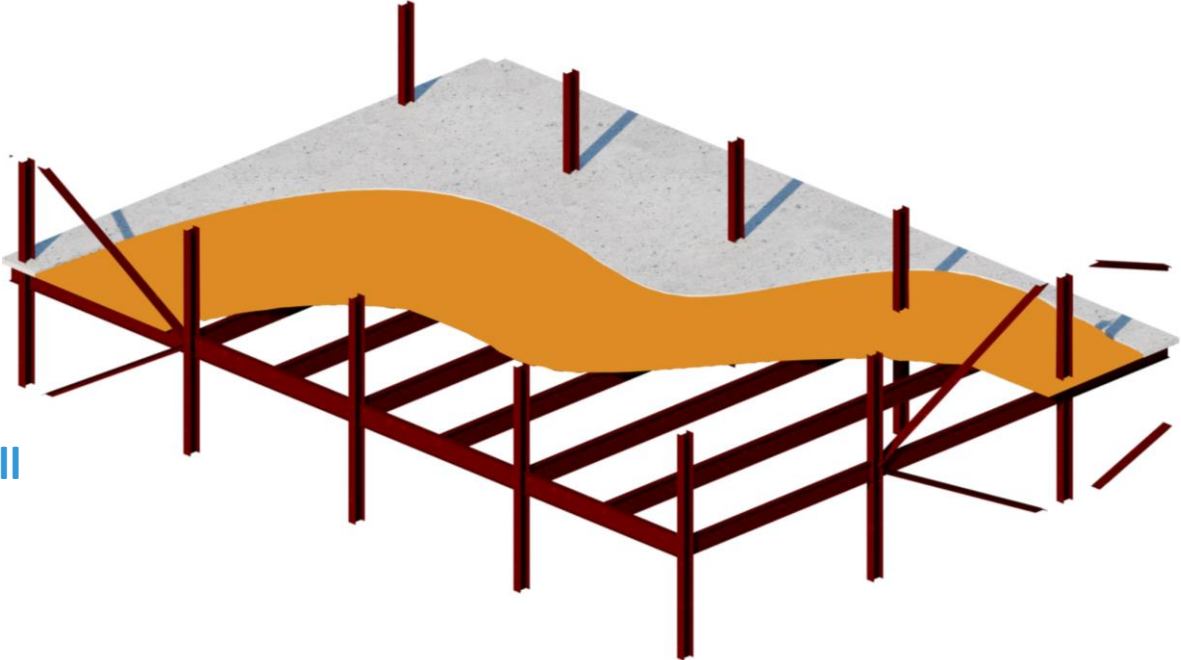
Type IV-C: 9 stories / 85' tall



Type IV-B: 12 stories / 120' tall



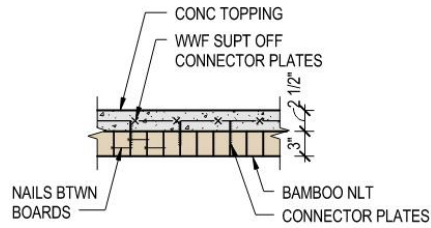
Type IV-C: 18 stories / 270' tall





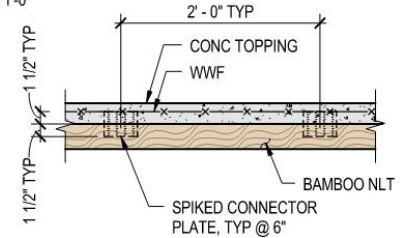






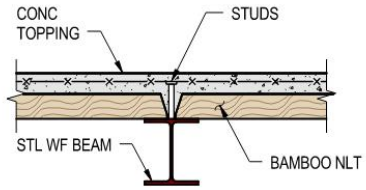
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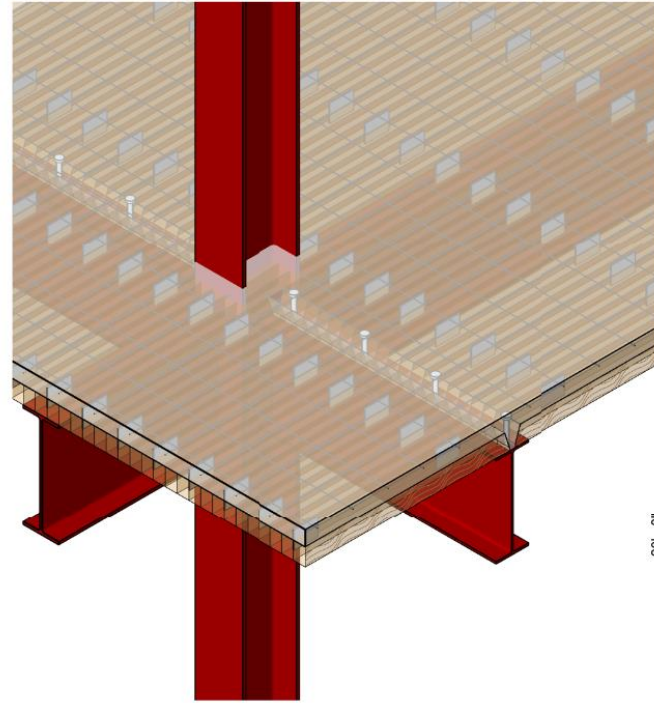
**SECTION B**

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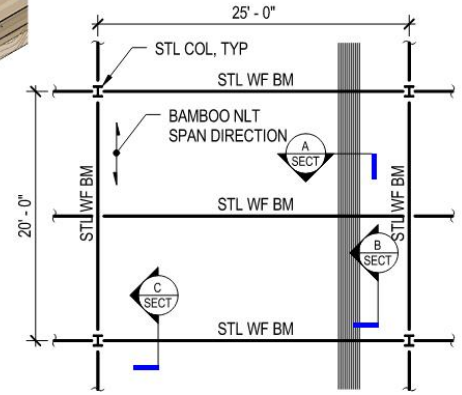


**SECTION C**

1" = 1'-0"



**AXONOMETRIC**



**NOTES:**

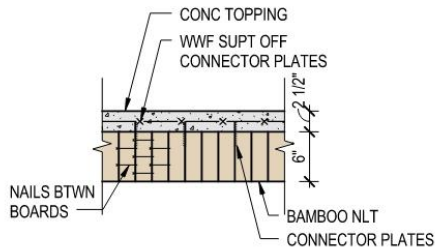
1. SIZES ARE FOR LIVE LOAD = 100 PSF AND BAY SIZE SHOWN. FRAMING CONCEPT IS SIMILAR FOR LARGER BAY SIZES.

**PLAN**

1/8" = 1'-0"

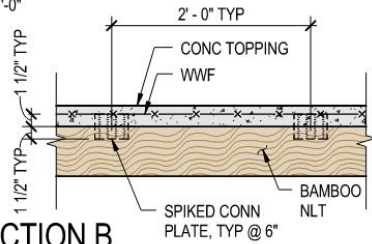
**BAMBOO NLT CONCRETE COMPOSITE SLAB - OPTION #1**





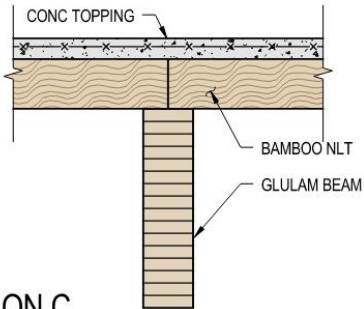
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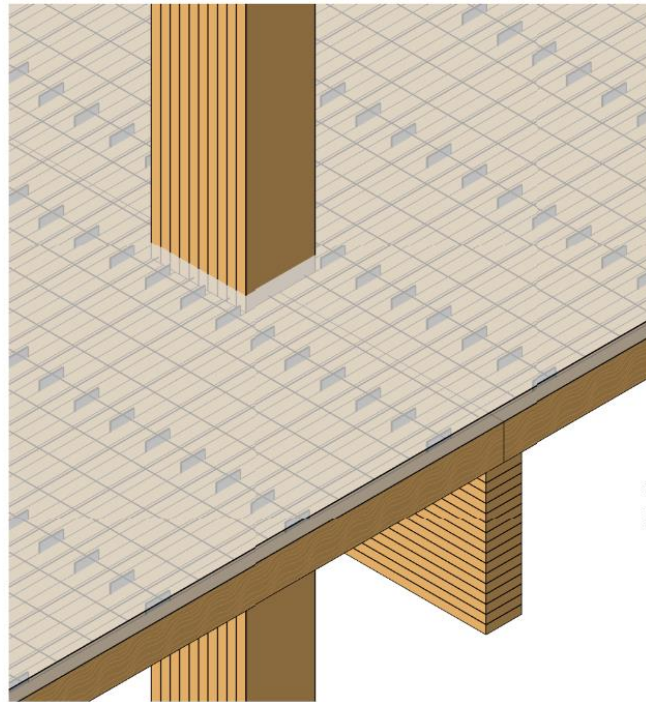
**SECTION B**

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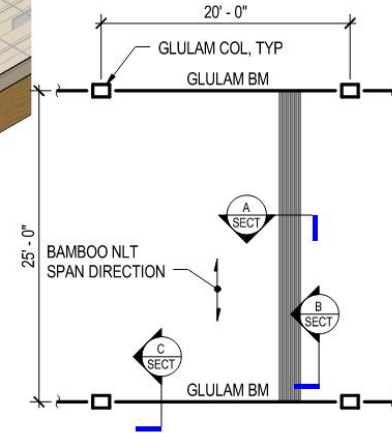


**SECTION C**

1" = 1'-0"



**AXONOMETRIC**



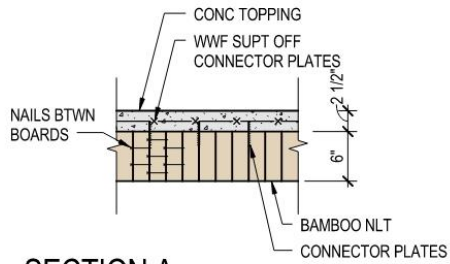
**NOTES:**

1. SIZES ARE FOR LIVE LOAD = 100 PSF AND BAY SIZE SHOWN. FRAMING CONCEPT IS SIMILAR FOR LARGER BAY SIZES.

**PLAN**

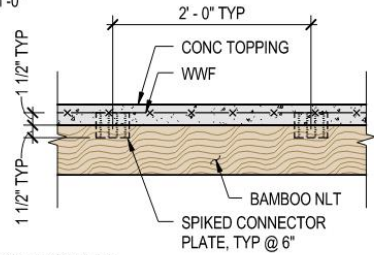
1/8" = 1'-0"

# BAMBOO NLT CONCRETE COMPOSITE SLAB - OPTION #2



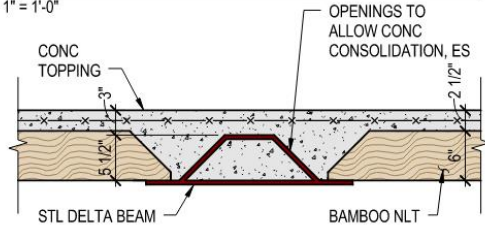
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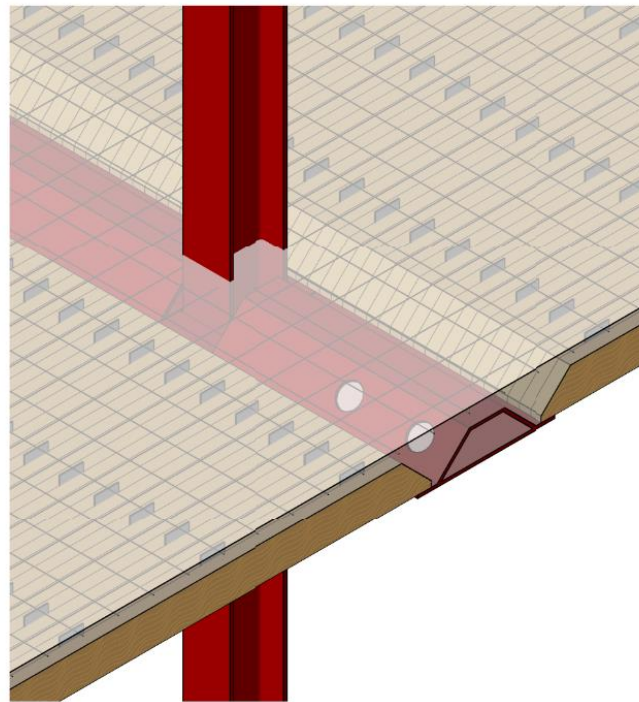
**SECTION B**

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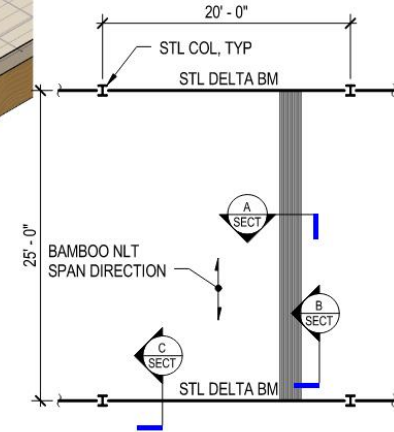


**SECTION C**

1" = 1'-0"



**AXONOMETRIC**



**NOTES:**

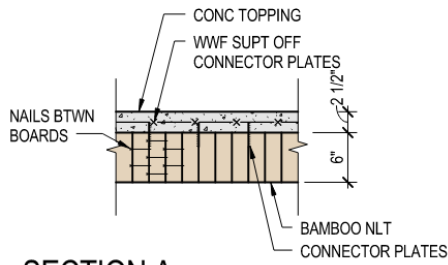
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**PLAN**

1/8" = 1'-0"

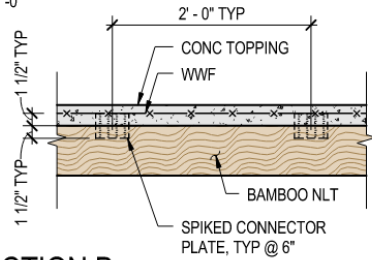
# BAMBOO NLT CONCRETE COMPOSITE SLAB - OPTION #3





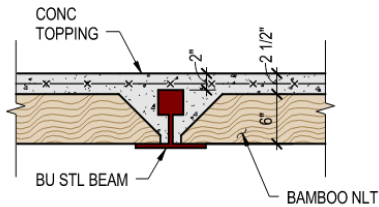
**SECTION A**

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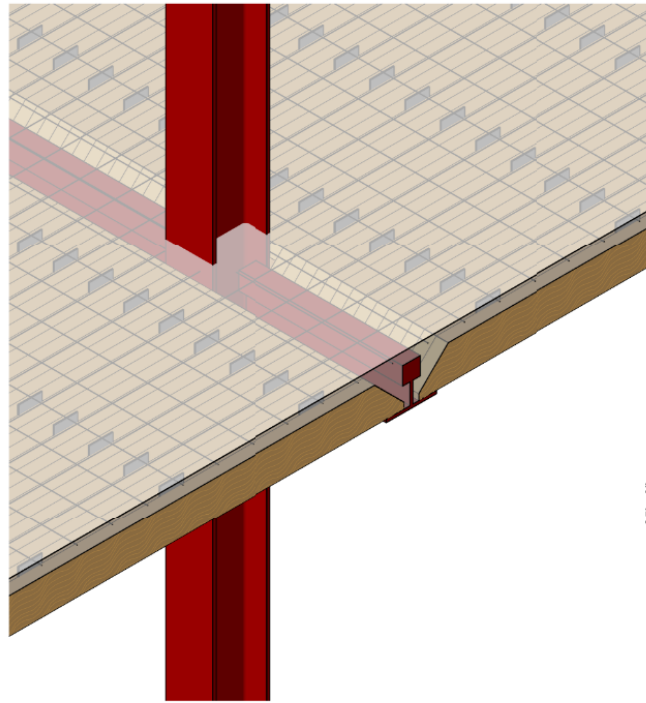
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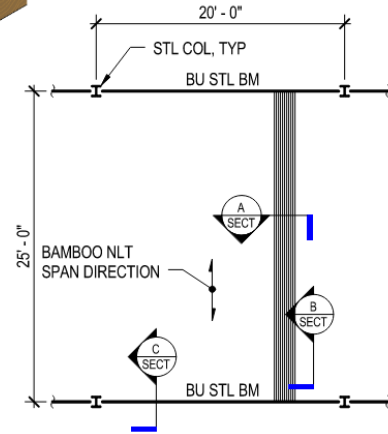


**SECTION C**

1" = 1'-0"



**AXONOMETRIC**



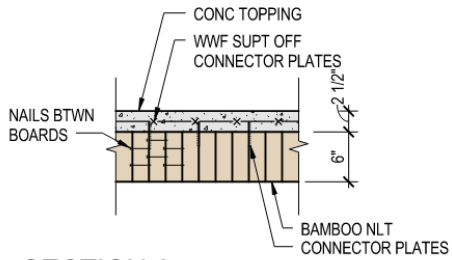
**NOTES:**

1. SIZES ARE FOR LIVE LOAD = 100 PSF AND BAY SIZE SHOWN. FRAMING CONCEPT IS SIMILAR FOR LARGER BAY SIZES.

**PLAN**

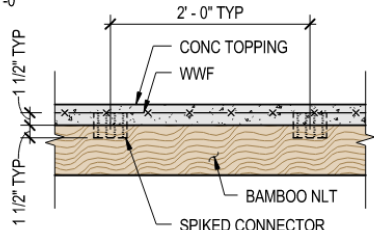
1/8" = 1'-0"

# BAMBOO NLT CONCRETE COMPOSITE SLAB - OPTION #4



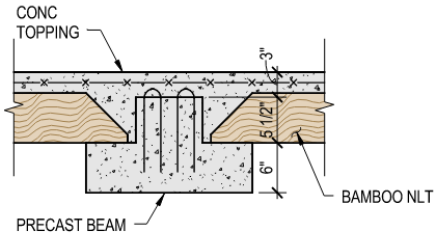
**SECTION A**

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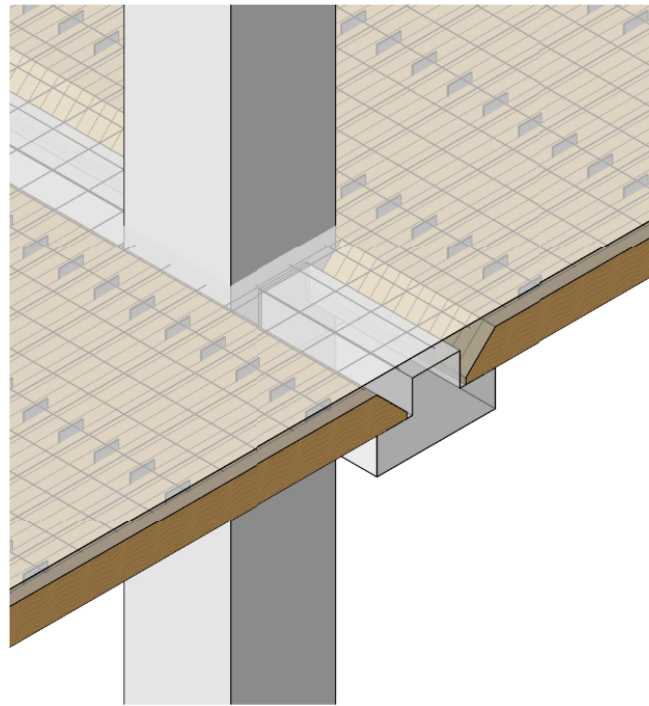
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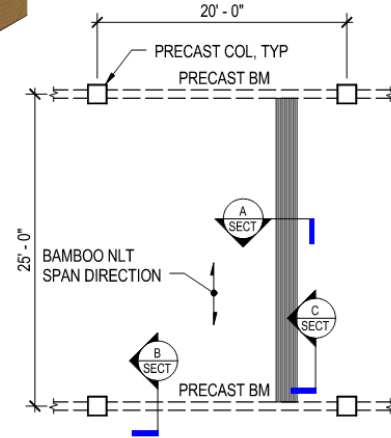


**SECTION C**

1" = 1'-0"



**AXONOMETRIC**



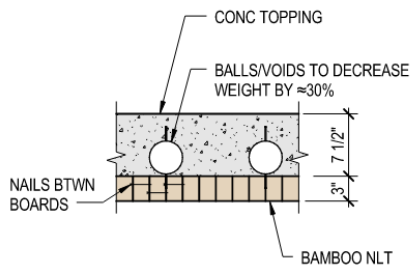
**NOTES:**

1. SIZES ARE FOR LIVE LOAD = 100 PSF AND BAY SIZE SHOWN. FRAMING CONCEPT IS SIMILAR FOR LARGER BAY SIZES.

**PLAN**

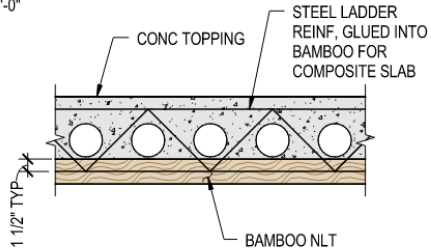
1/8" = 1'-0"

# BAMBOO NLT CONCRETE COMPOSITE SLAB - OPTION #5



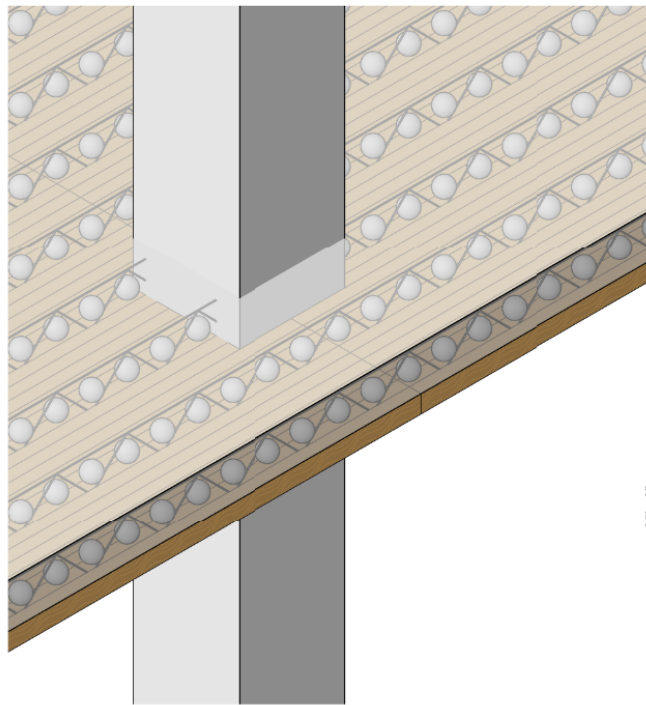
### SECTION A

1" = 1'-0"

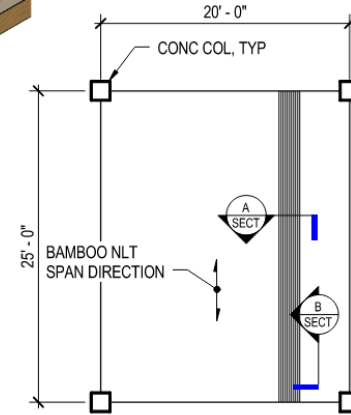


### SECTION B

1" = 1'-0"



### AXONOMETRIC



#### NOTES:

1. SIZES ARE FOR LIVE LOAD = 100 PSF AND BAY SIZE SHOWN. FRAMING CONCEPT IS SIMILAR FOR LARGER BAY SIZES.

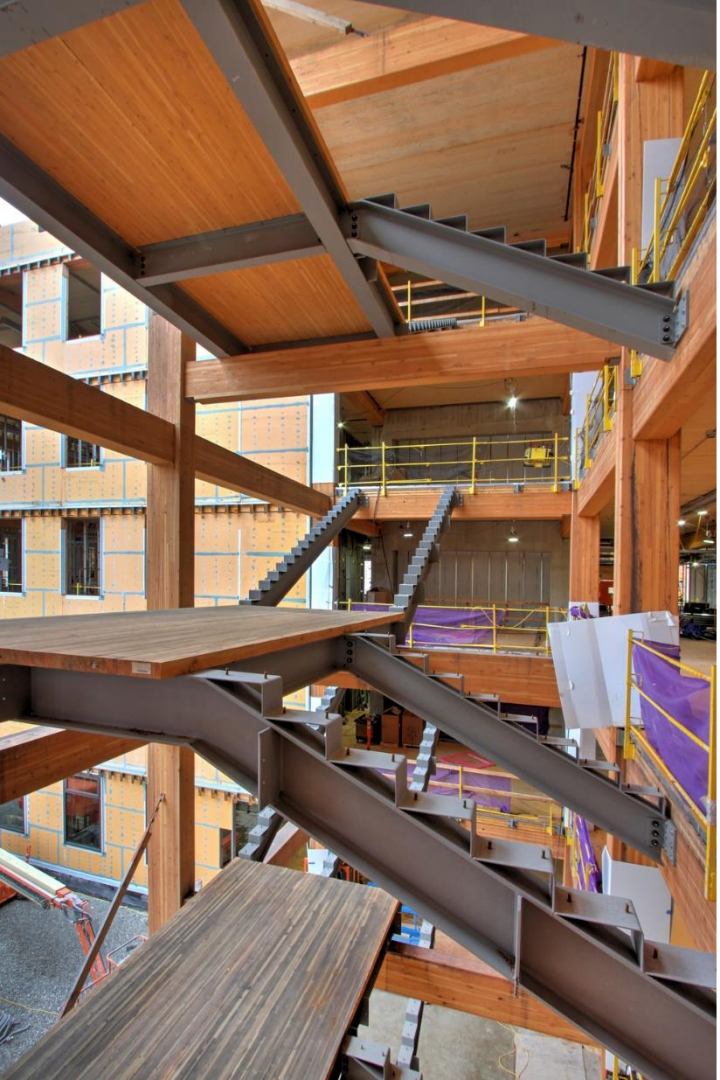
### PLAN

1/8" = 1'-0"

# BAMBOO NLT CONCRETE COMPOSITE SLAB - OPTION #6







# THE BAMBOO OPPORTUNITY

Fiber Optimized Engineering

