Mass Timber:
Knowing Your Options

Presentation to the Architectural Institute of BC & the American Institute of Architects

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Fresh Thinking | Holistic Design

Fast + Epp | Vancouver • Edmonton • Frankfurt

Outline |

- Overview
- Design process + case studies
- Future
- Useful tools

Overview |

- Definition of Mass Timber
- Structural Building Systems
- Products
- Sizes and Design Characteristics
- Comparison

Mass timber construction uses large and ideally prefabricated wood for wall, floor, and roof construction. […] Because of their high strength and dimensional stability, they can be used as alternatives to concrete, masonry and steel in many building types.

- Quote from MassTimber.com

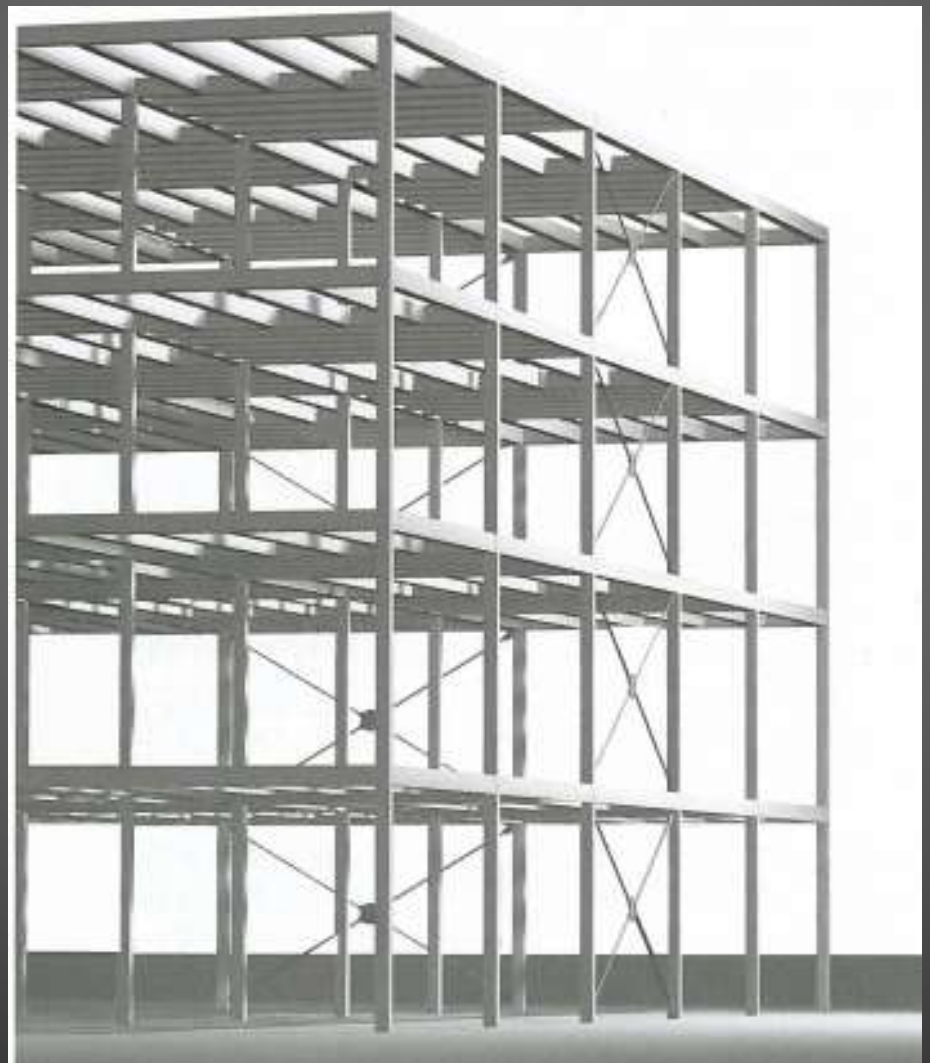
Overview | Building Systems

Building Systems |

Light Wood Frame (Stick Frame)

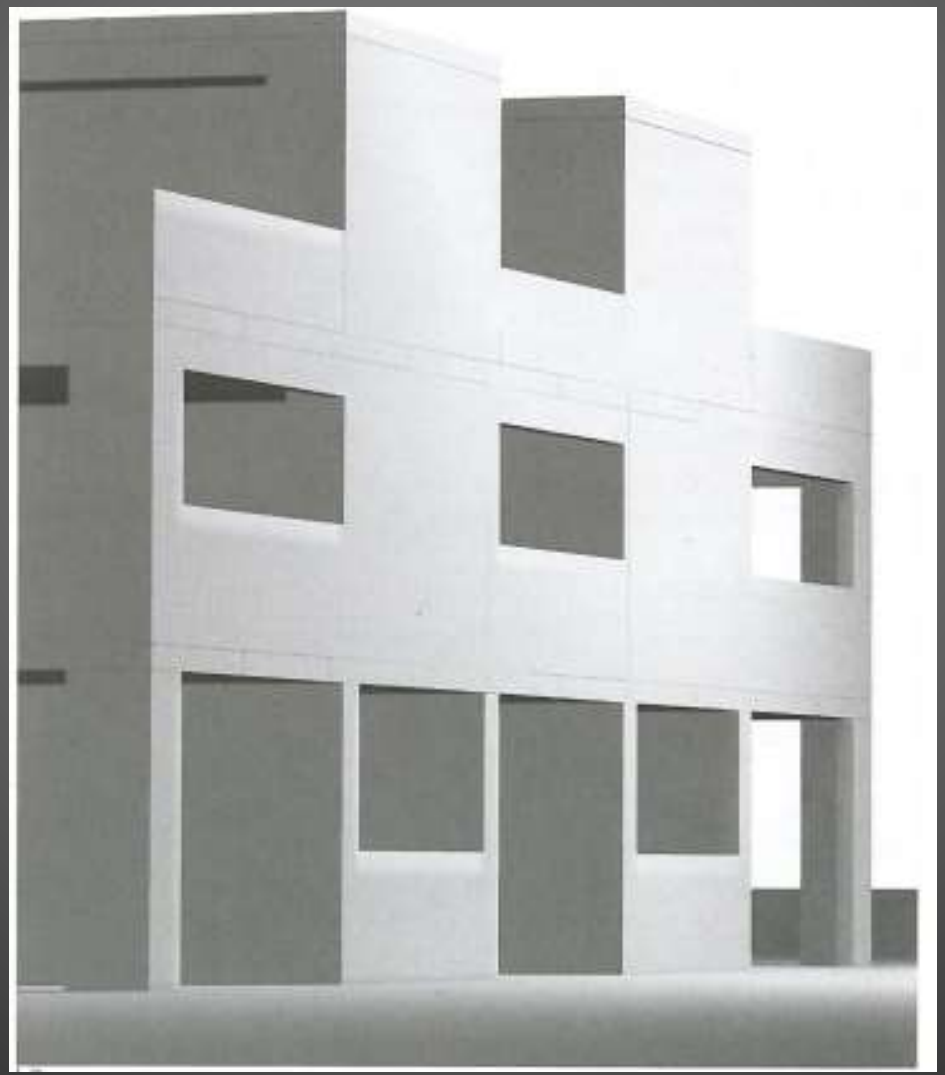
Building Systems |

Post + Beam (with Mass Timber or light wood frame floors)



Building Systems |

Mass Timber (100%)



Building Systems |

Light Wood Frame

Institutional

Post + Beam

Mass Timber Floors
(and Shearwalls)

Residential

Mass Timber (100%)

Mass Timber Walls and
Floors

Building Systems |

Light Wood Frame

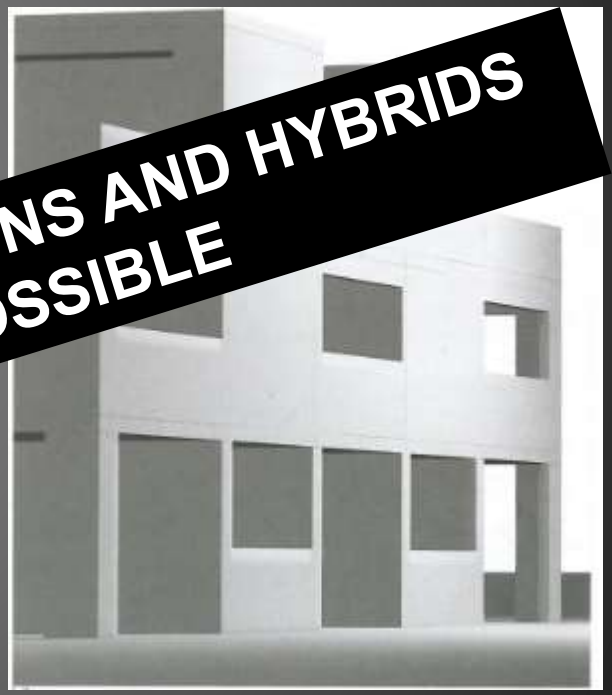
Institutional

Post + Beam

Mass Timber Floors
(and Shearwalls)

Residential

Mass Timber (100%)

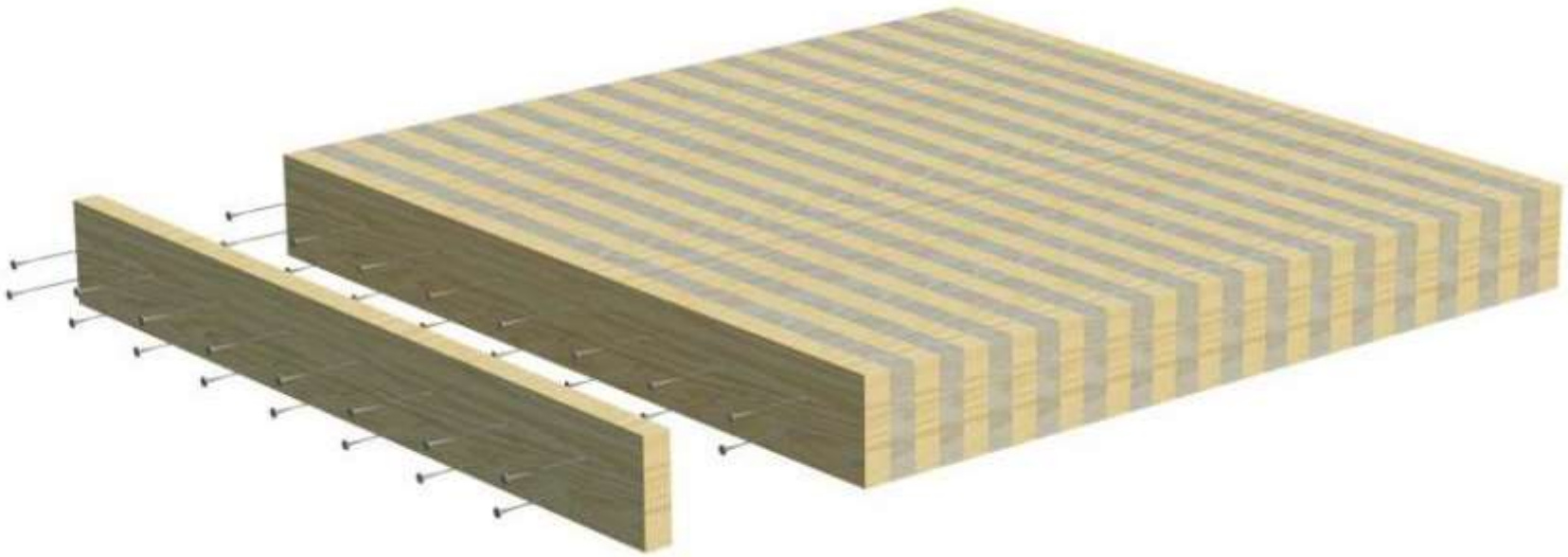


Mass Timber Walls and
Floors

LOTS OF VARIATIONS AND HYBRIDS ARE POSSIBLE

Overview | Products

Overview | NLT



Nail Laminated Timber

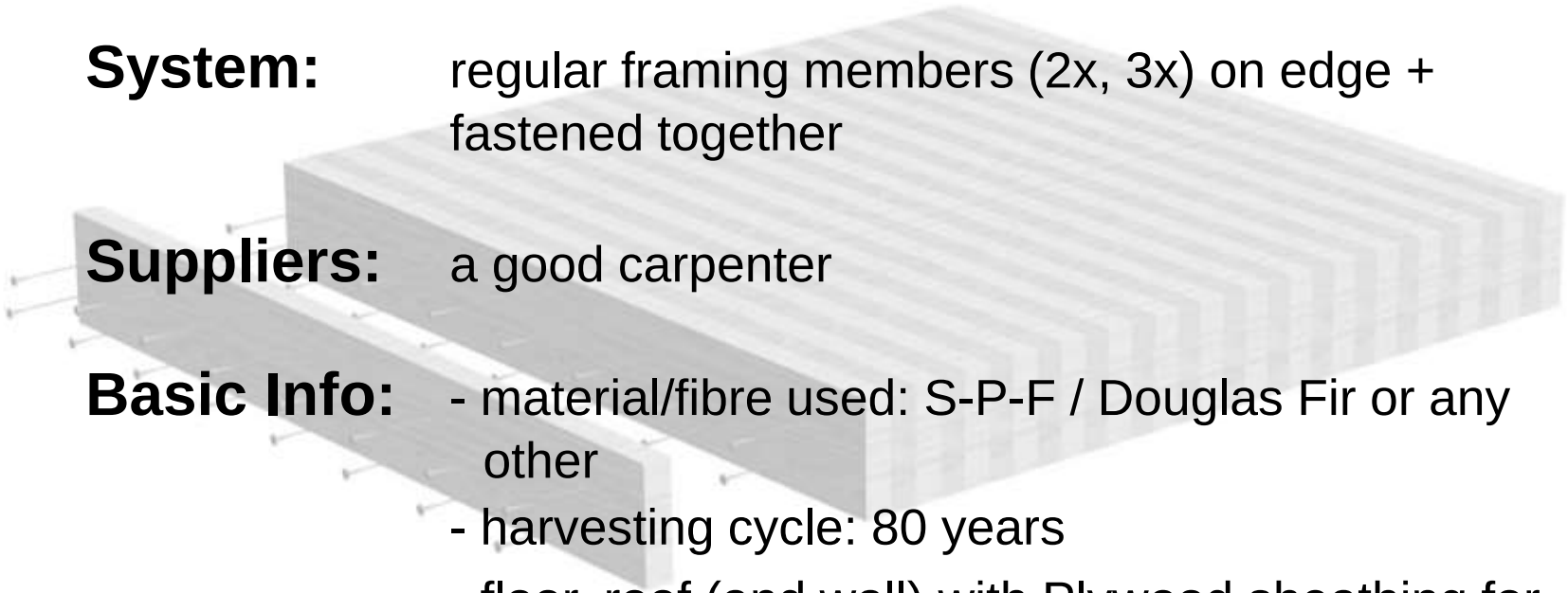
NLT |

Alternative Names: nailed timber, nail-up, edge-lam, brettstapel

System: regular framing members (2x, 3x) on edge + fastened together

Suppliers: a good carpenter

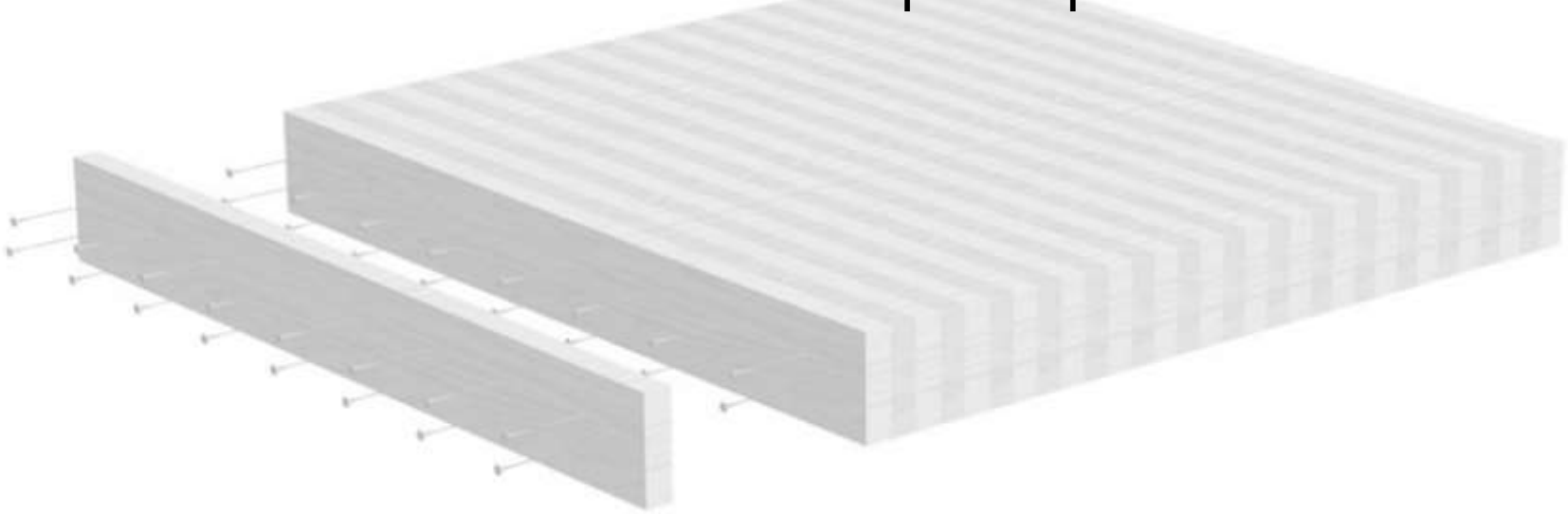
Basic Info:
- material/fibre used: S-P-F / Douglas Fir or any other
- harvesting cycle: 80 years
- floor, roof (and wall) with Plywood sheathing for lateral loads



NLT |

Comments:

- Non-standardized panel product



NLT |

Comments:

- Non-standardized panel product
  - base material covered with grading rules

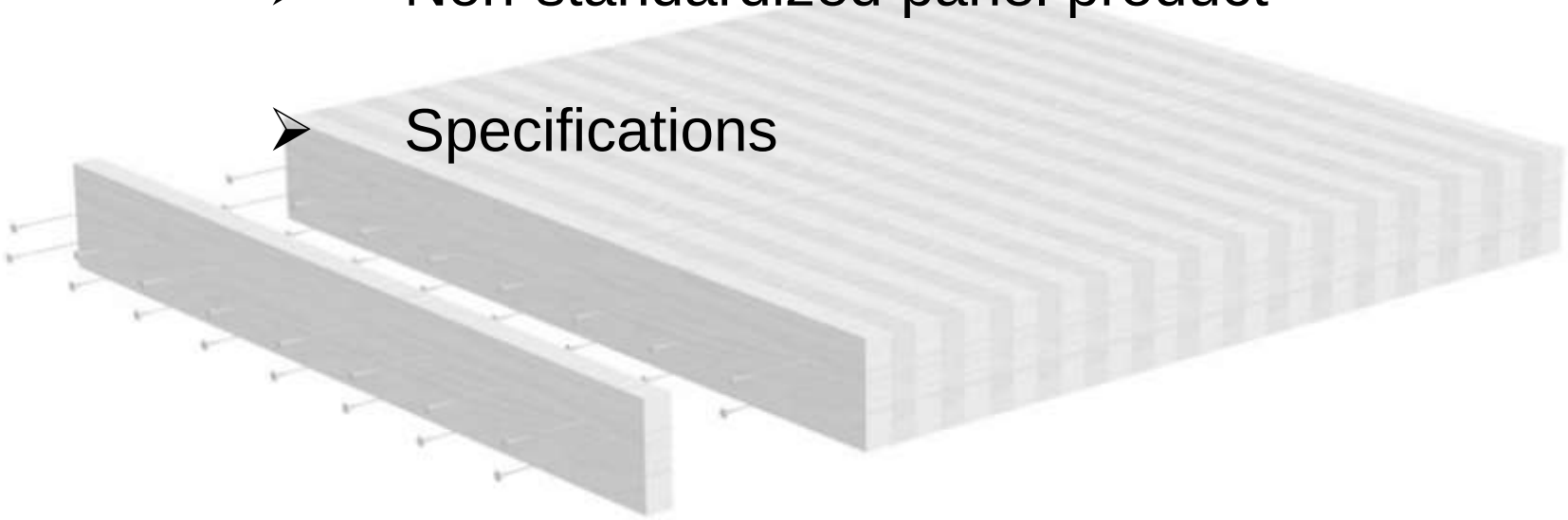
Courtesy of Nicola Log Works

Courtesy of Nicola Log Works

NLT |

Comments:

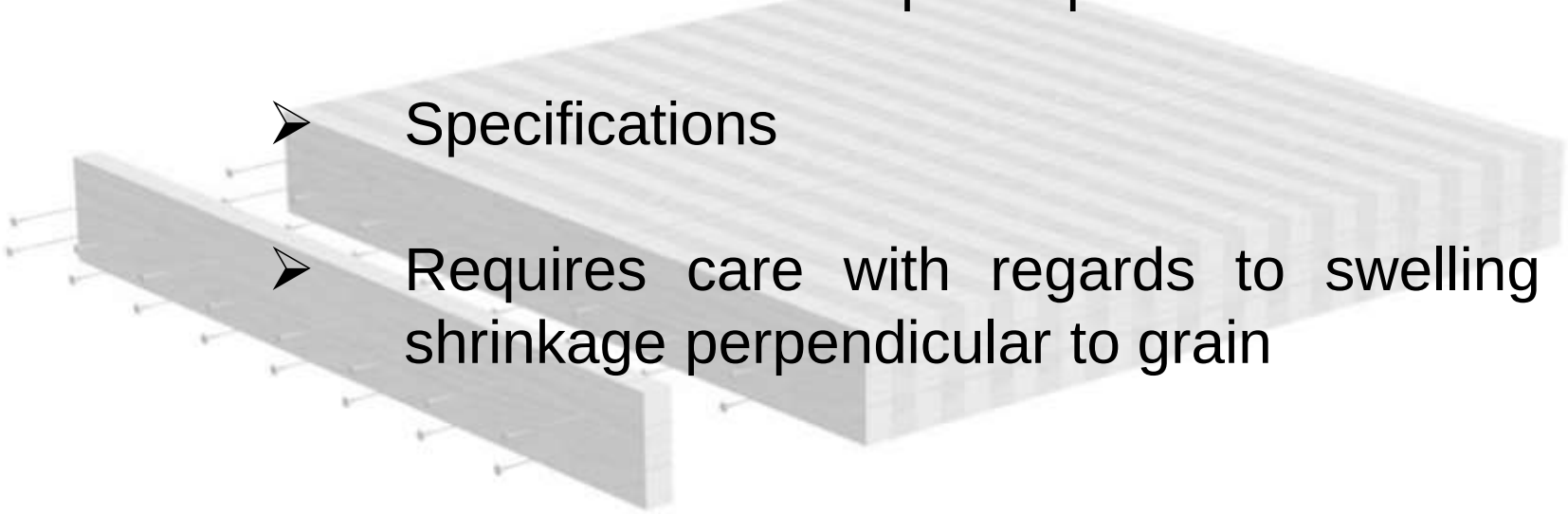
- Non-standardized panel product
- Specifications



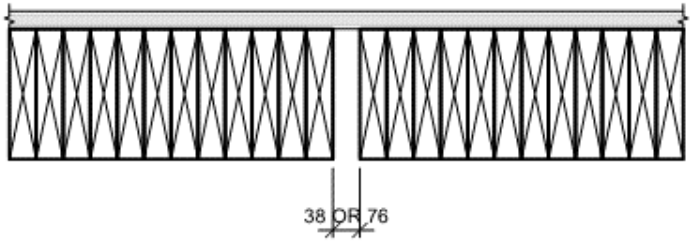
NLT |

Comments:

- Non-standardized panel product
- Specifications
- Requires care with regards to swelling / shrinkage perpendicular to grain



NLT |



2 / - SHRINKAGE / SWELLING GAP
TYP. GRIDS B, C, F AND G ONLY

NLT | Samuel Brighouse Elementary

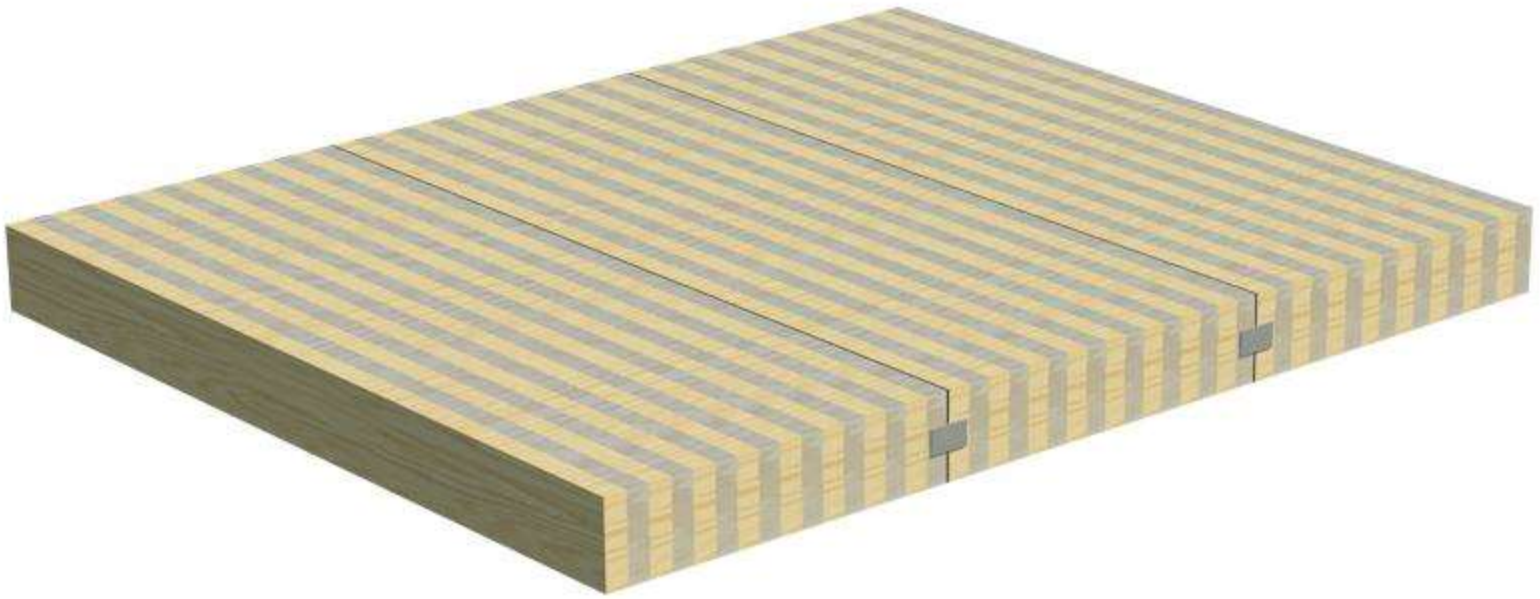
Perkins + Will Canada

NLT | SFU UniverCity Childcare

Hughes Condon Marler Architects

Overview | Products

Overview | GLT



Glue Laminated Timber

GLT |

Alternative Names: glued edge laminated timber, edge laminated timber, edge-lam

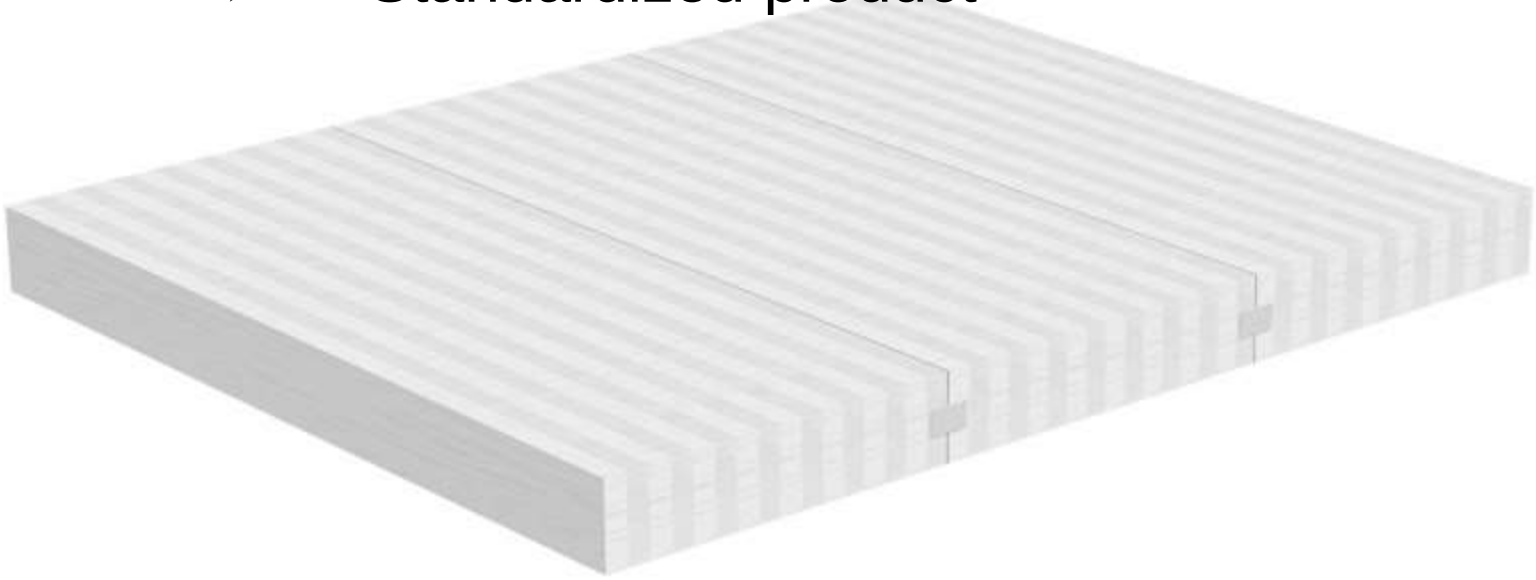
System: “glulam beams on edge”

Suppliers: Structurlam (Penticton), Western Archrib (Edmonton), Nordic (Montreal) or any other glulam supplier

Basic Info:
- material/fibre: S-P-F / D. Fir / Black Spruce / …
- harvesting cycle: 80 years
- adhesive: Phenol Resorcinol (black) or Melamine (clear)
- adhesive amount: 1% by weight
- floor, roof (and wall) with Plywood sheathing for lateral loads

Comments:

- Standardized product



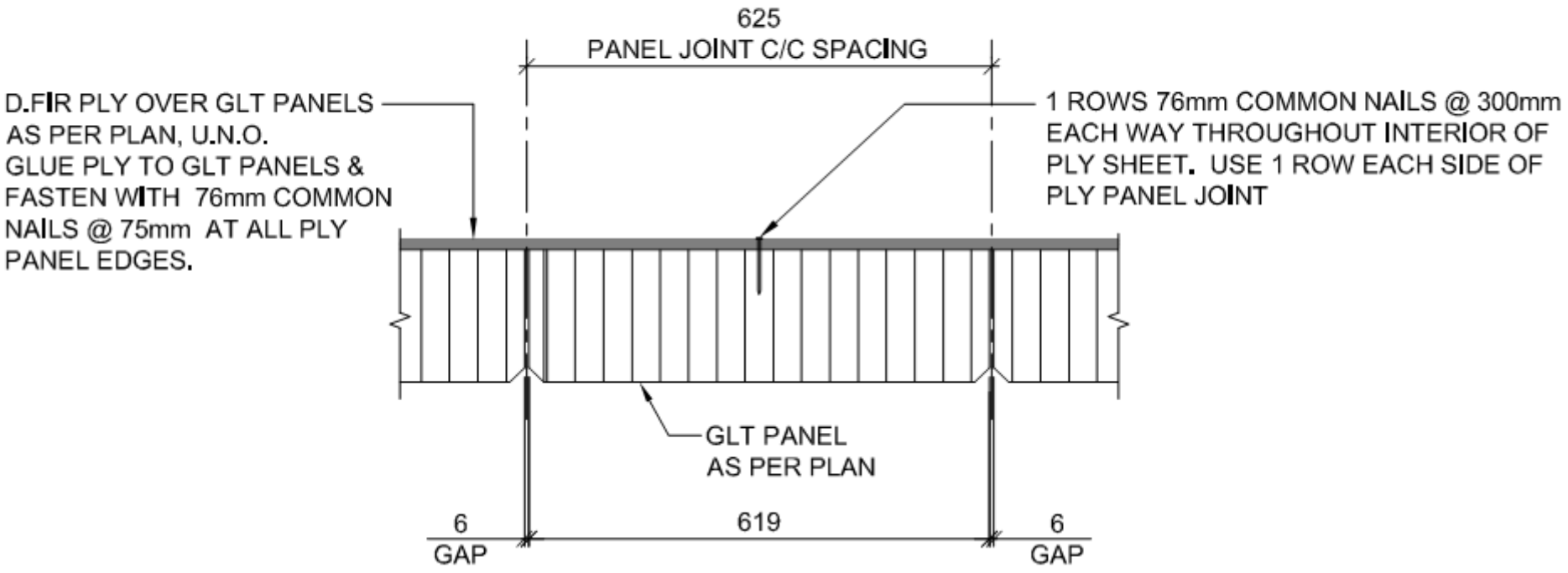
GLT |

GLT |

Comments:

- Standardized product
- Requires care with regards to swelling / shrinkage perpendicular to grain

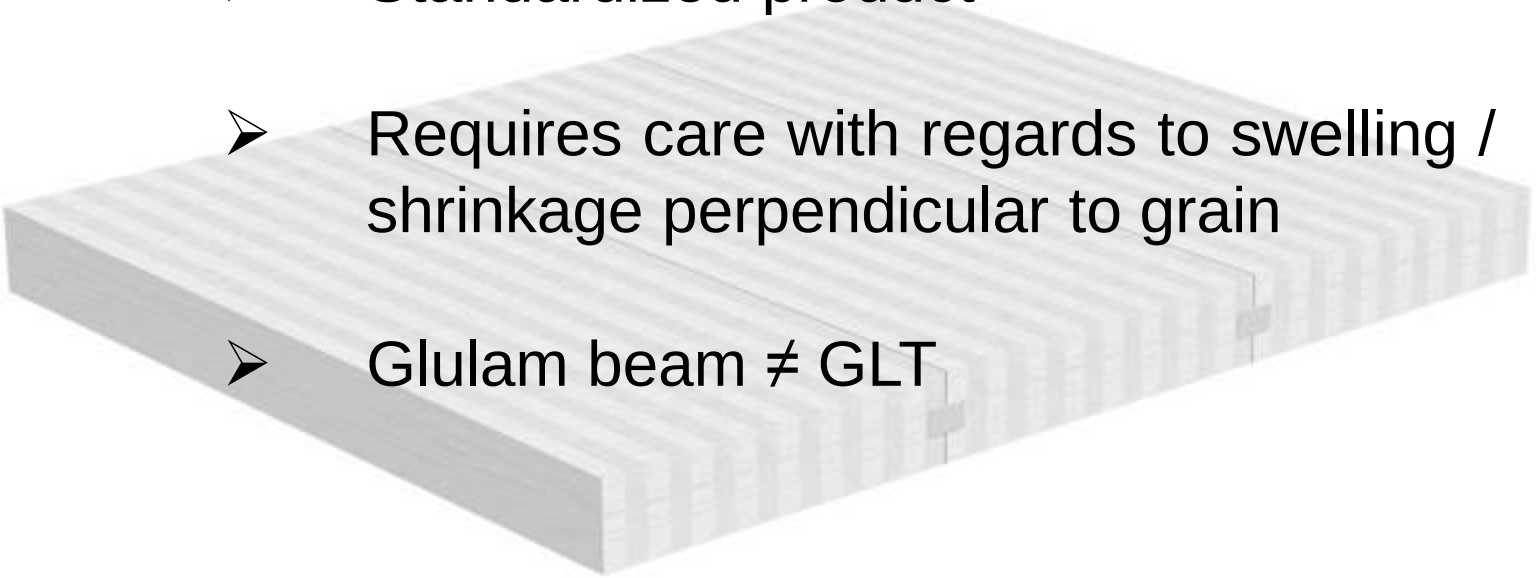
GLT |


625
PANEL JOINT C/C SPACING
D.FIR PLY OVER GLT PANELS AS PER PLAN, U.N.O. GLUE PLY TO GLT PANELS & FASTEN WITH 76mm COMMON NAILS @ 75mm AT ALL PLY PANEL EDGES.
1 ROWS 76mm COMMON NAILS @ 300mm EACH WAY THROUGHOUT INTERIOR OF PLY SHEET. USE 1 ROW EACH SIDE OF PLY PANEL JOINT
GLT PANEL AS PER PLAN
6
GAP
619
6
GAP

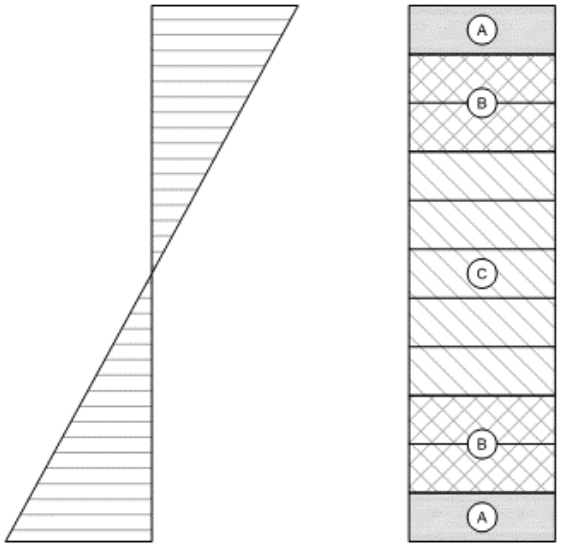
GLT |

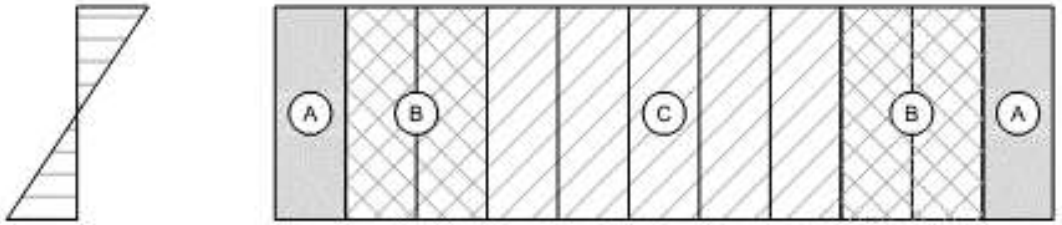
Comments:

- Standardized product
- Requires care with regards to swelling / shrinkage perpendicular to grain
- Glulam beam ≠ GLT

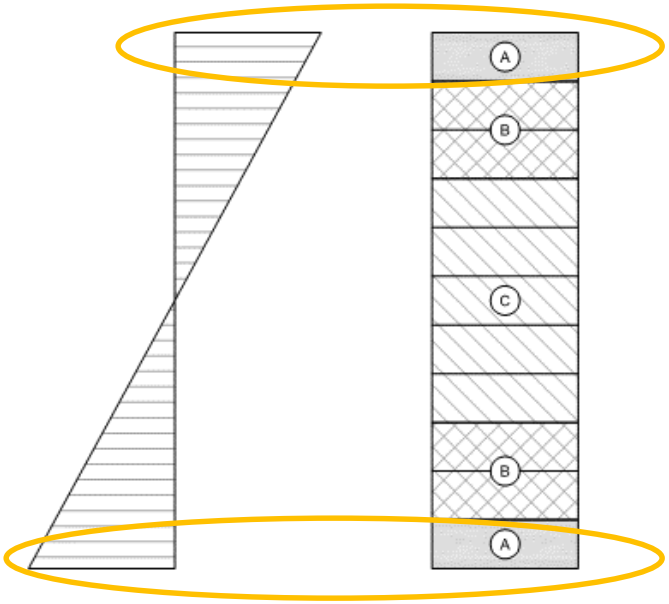


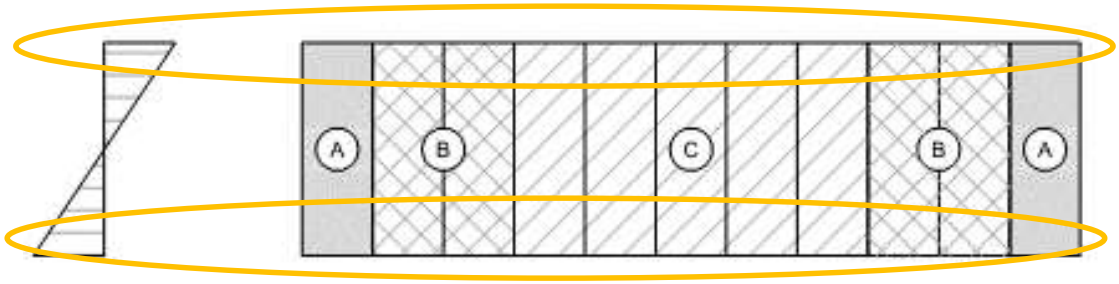
GLT |





GLT |





GLT | Slave Lake Government Centre

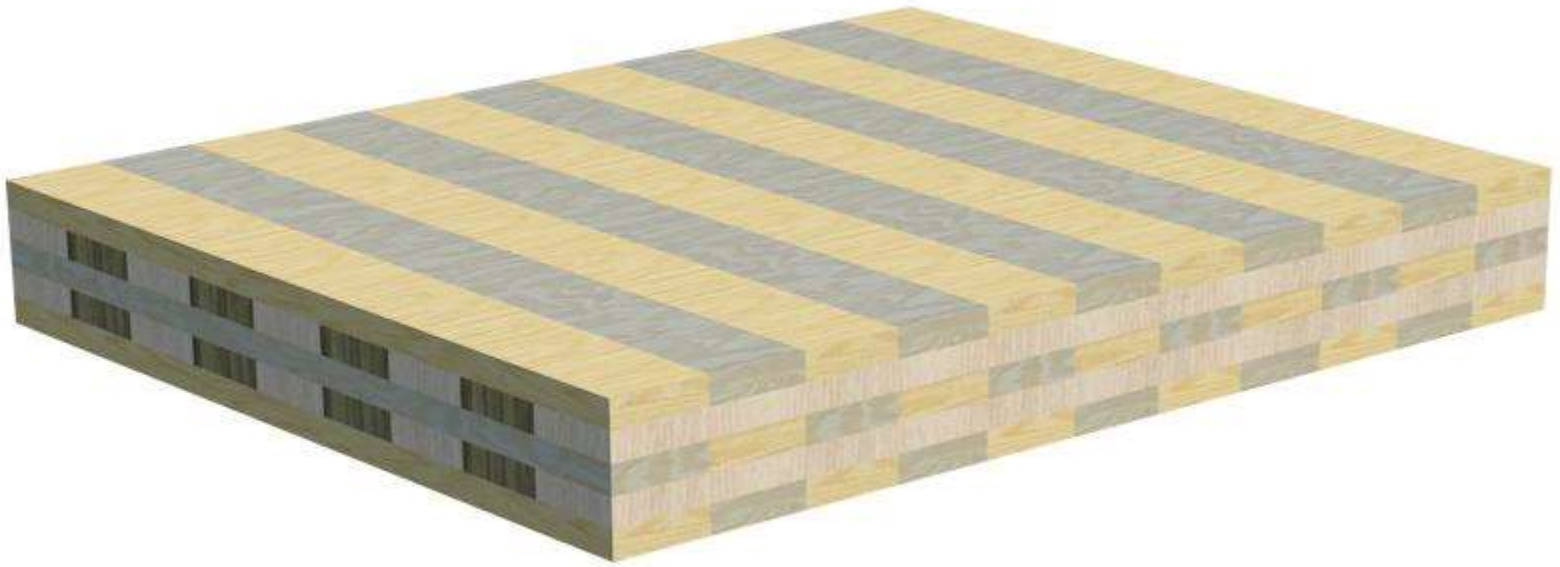
Manasc Isaac Architects

GLT | Kin Centre Arena Complex

PBK Architects

Overview | Products

Overview | CLT



Cross Laminated Timber

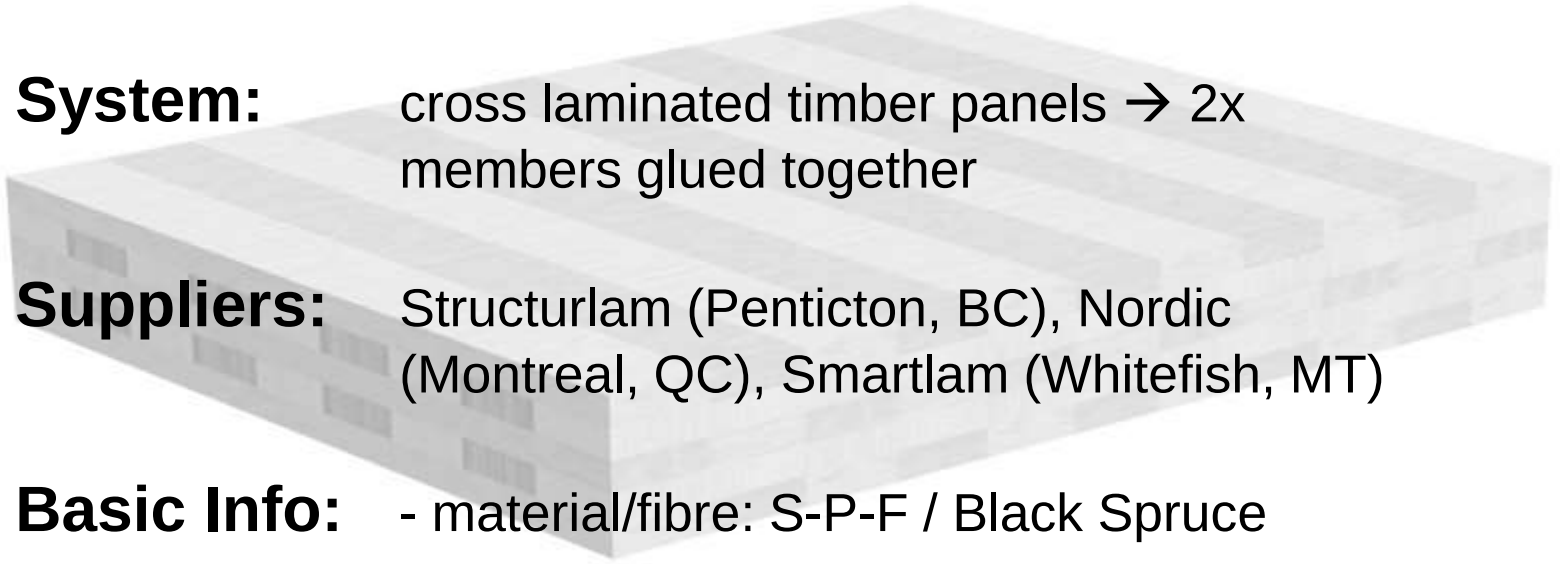
CLT |

Alternative Names: cross laminated timber, x-lam

System: cross laminated timber panels → 2x members glued together

Suppliers: Structurlam (Penticton, BC), Nordic (Montreal, QC), Smartlam (Whitefish, MT)

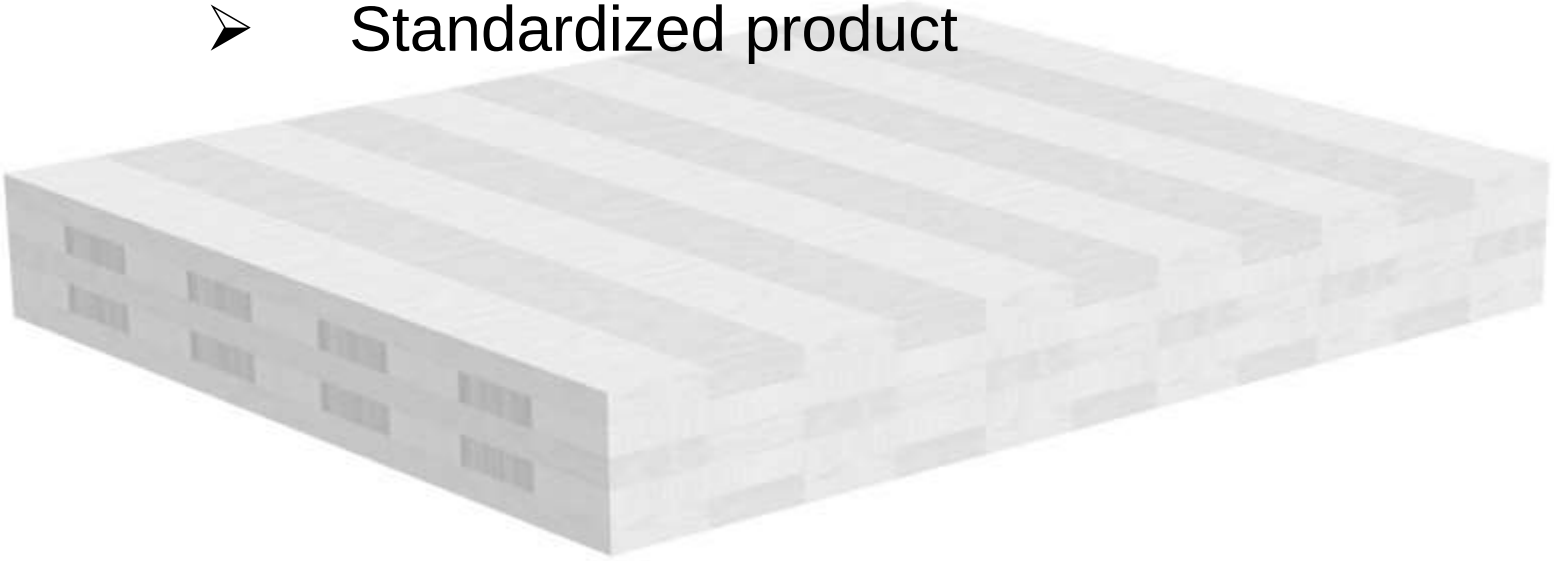
Basic Info:
- material/fibre: S-P-F / Black Spruce
- harvesting cycle: 80 to 100 years
- adhesive: Polyurethane
- adhesive amount: 4% by weight
- floor, roof and wall with joints detailed for lateral loads



CLT |

Comments:

- Standardized product



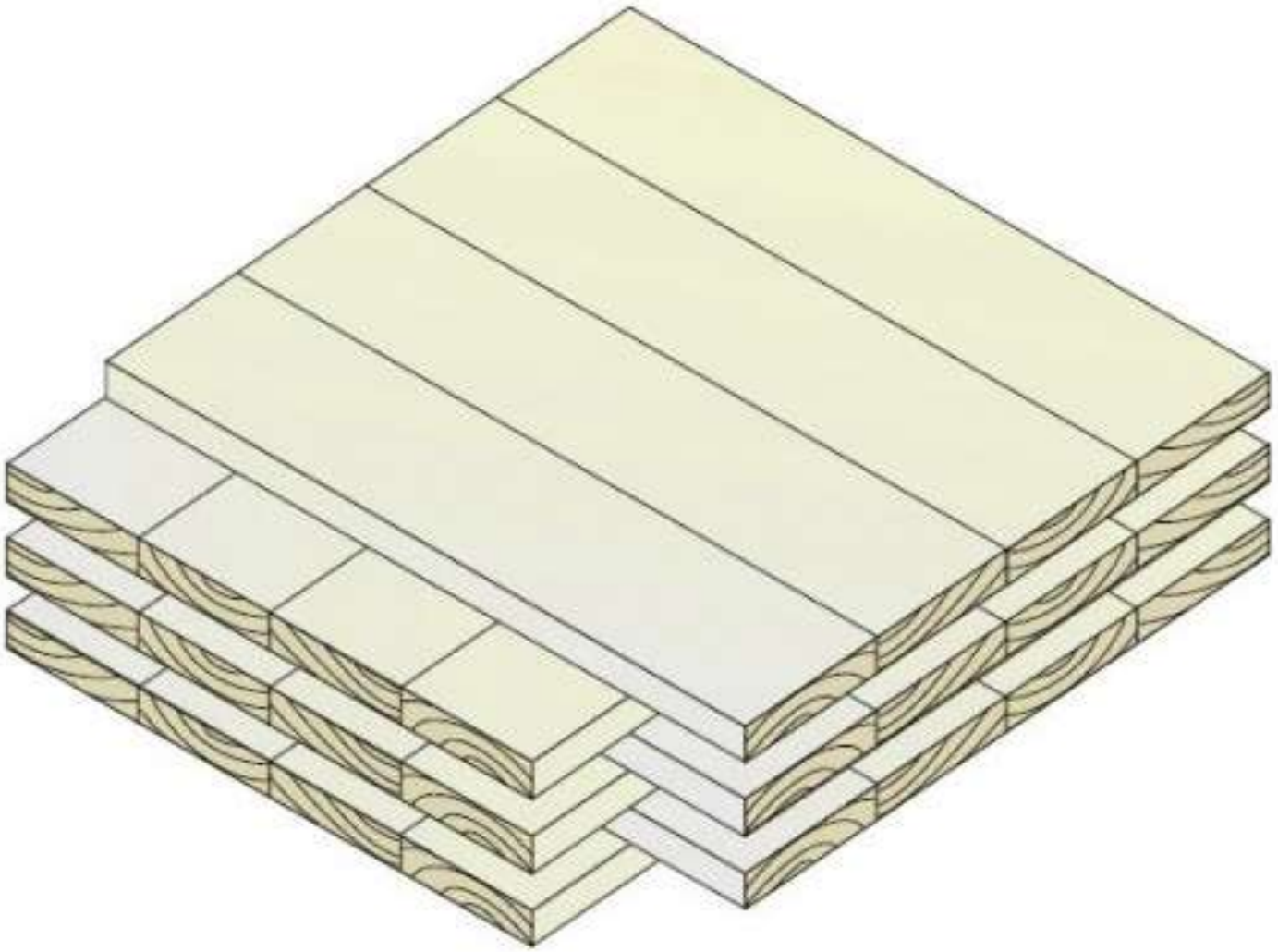
CLT |

CLT |

Comments:

- Standardized product
- Dimensionally very stable

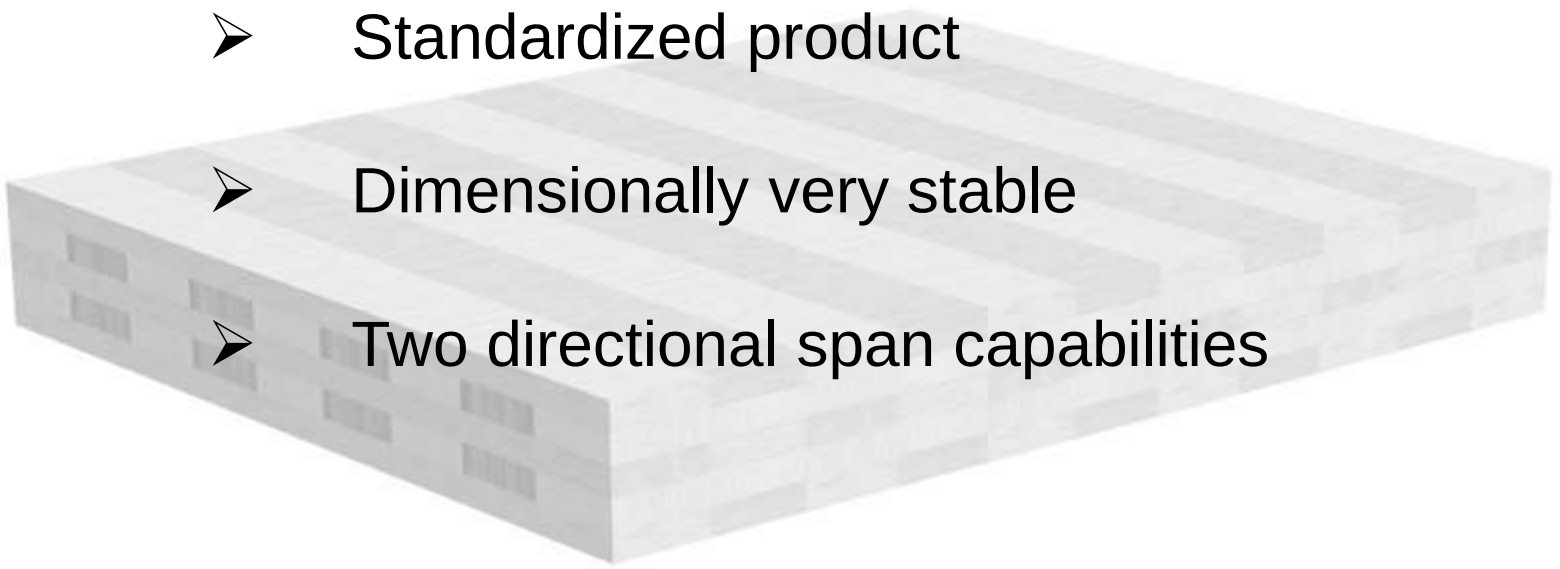
CLT |



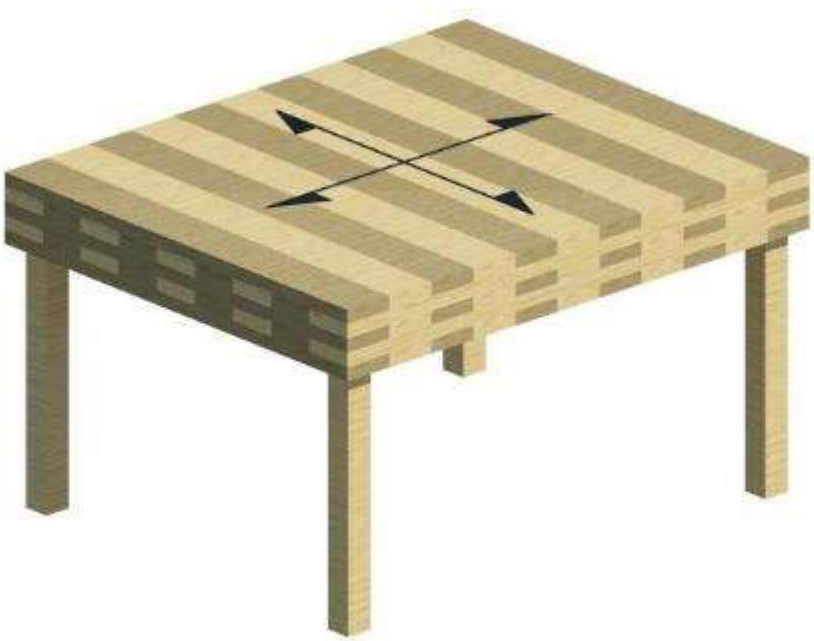
CLT |

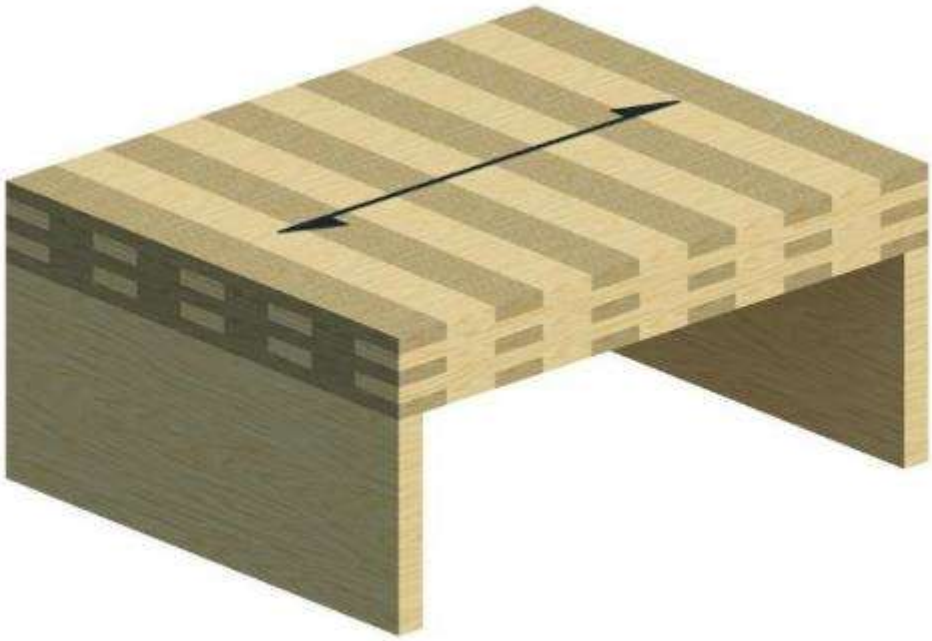
Comments:

- Standardized product
- Dimensionally very stable
- Two directional span capabilities



CLT |





CLT | Wayne Gretzky Centre

Courtesy of Structurlam Products

Courtesy of Structurlam Products

CLT | District 03

Courtesy of Nordic

Courtesy of Nordic

Overview | Products

Overview | Solid LSL

Laminated Strand Lumber

Solid LSL |

Alternative Names: n/a

System: laminated strand lumber (timber strands glued together)

Suppliers: *Weyerhauser, Louisiana Pacific,

Basic Info*:
- material/fibre: Aspen
- harvesting cycle: 60 to 70 years
- adhesive: MDI - Isocyante
- adhesive amount: 6% by weight
- floor, roof and wall with joints detailed for lateral loads (limited thicknesses!)

Solid LSL |

Comments:

- Standardized product

Solid LSL |

ANSI

APA

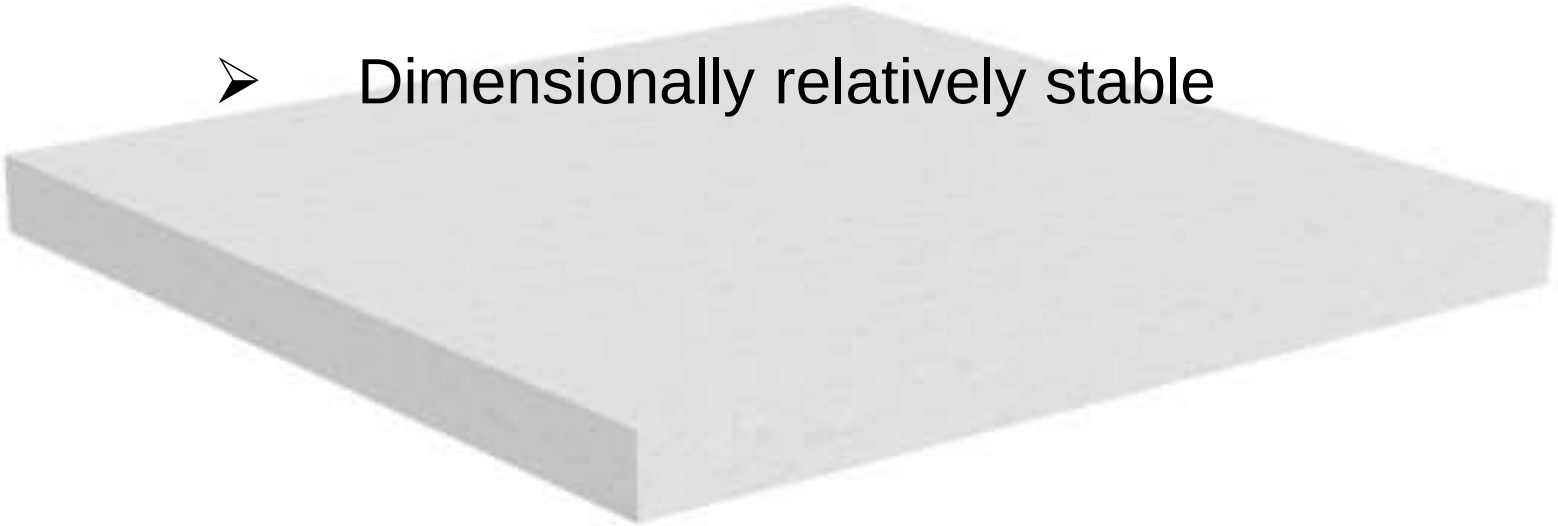
CCMC

Canadian Construction Materials Centre

Solid LSL |

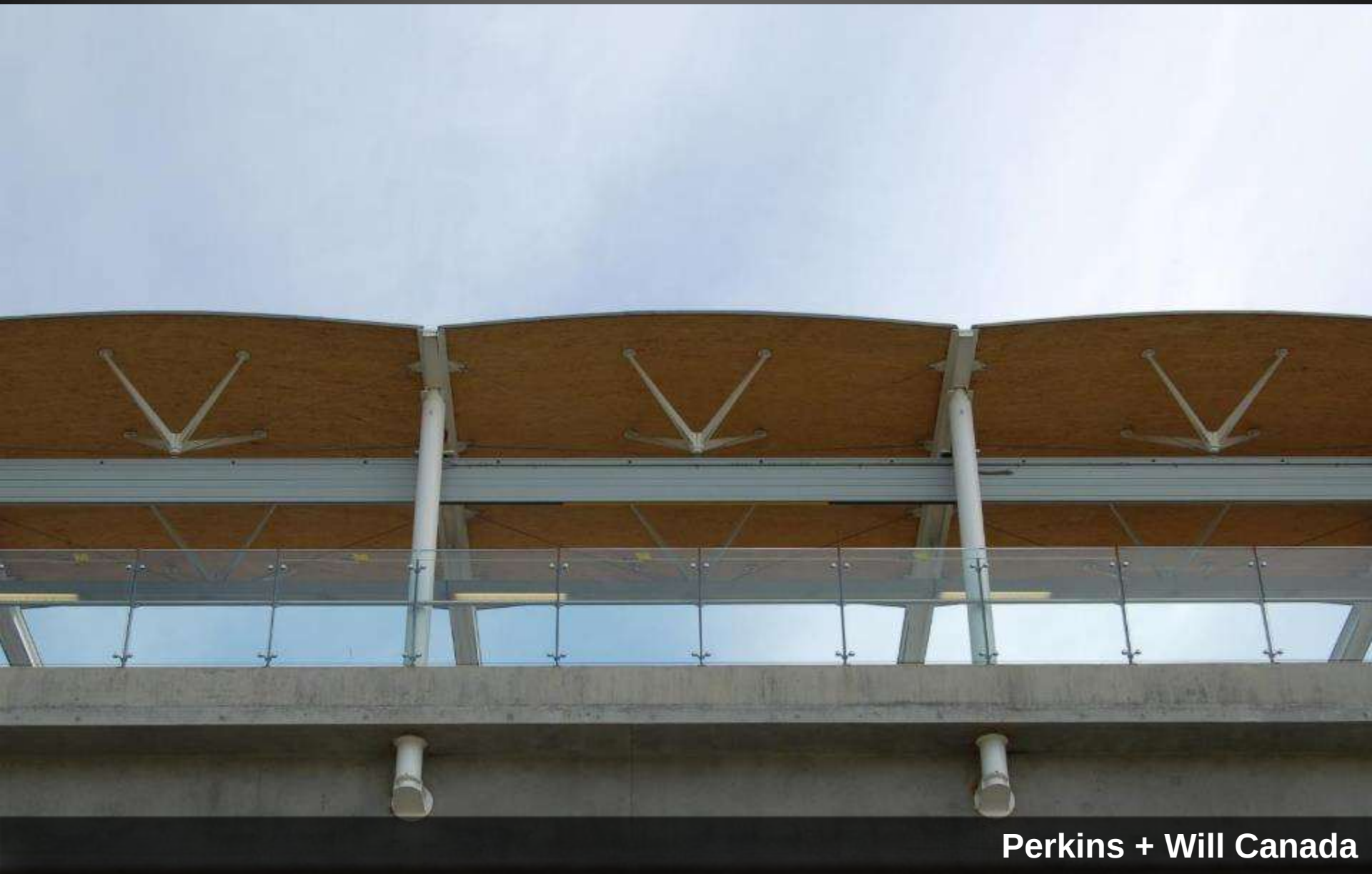
Comments:

- Standardized product
- Dimensionally relatively stable



Solid LSL |

Solid LSL | Gilmore SkyTrain Station



Perkins + Will Canada

Solid LSL | False Creek Community Centre

Henriquez + Partners Architects

Overview | Products

Overview | Solid LVL

Laminated Veneer Lumber

Solid LVL |

Alternative Names: Microlam, Versalam

System: laminated veneer lumber (veneers stacked & glued together)

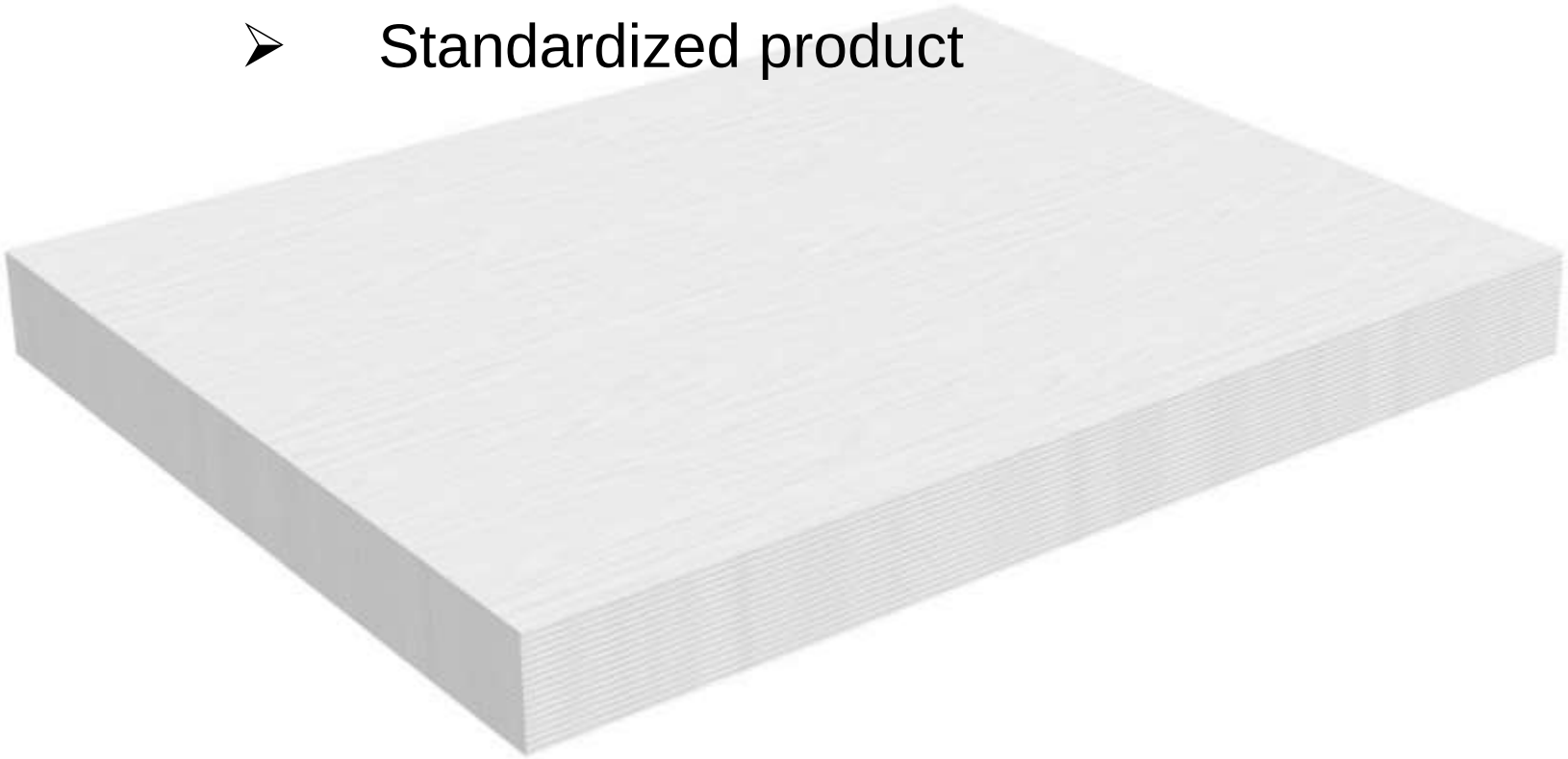
Suppliers: Louisianan Pacific*, Weyerhaeuser, Boise Cascade, West Fraser, Metsawood

Basic Info*:
- material/fibre: D. Fir
- harvesting cycle: 80 years
- adhesive: Phenol Formaldehyde
- adhesive amount: 7% by weight
- floor, roof and wall with joints detailed for lateral loads (limited thicknesses!)

Solid LVL |

Comments:

- Standardized product

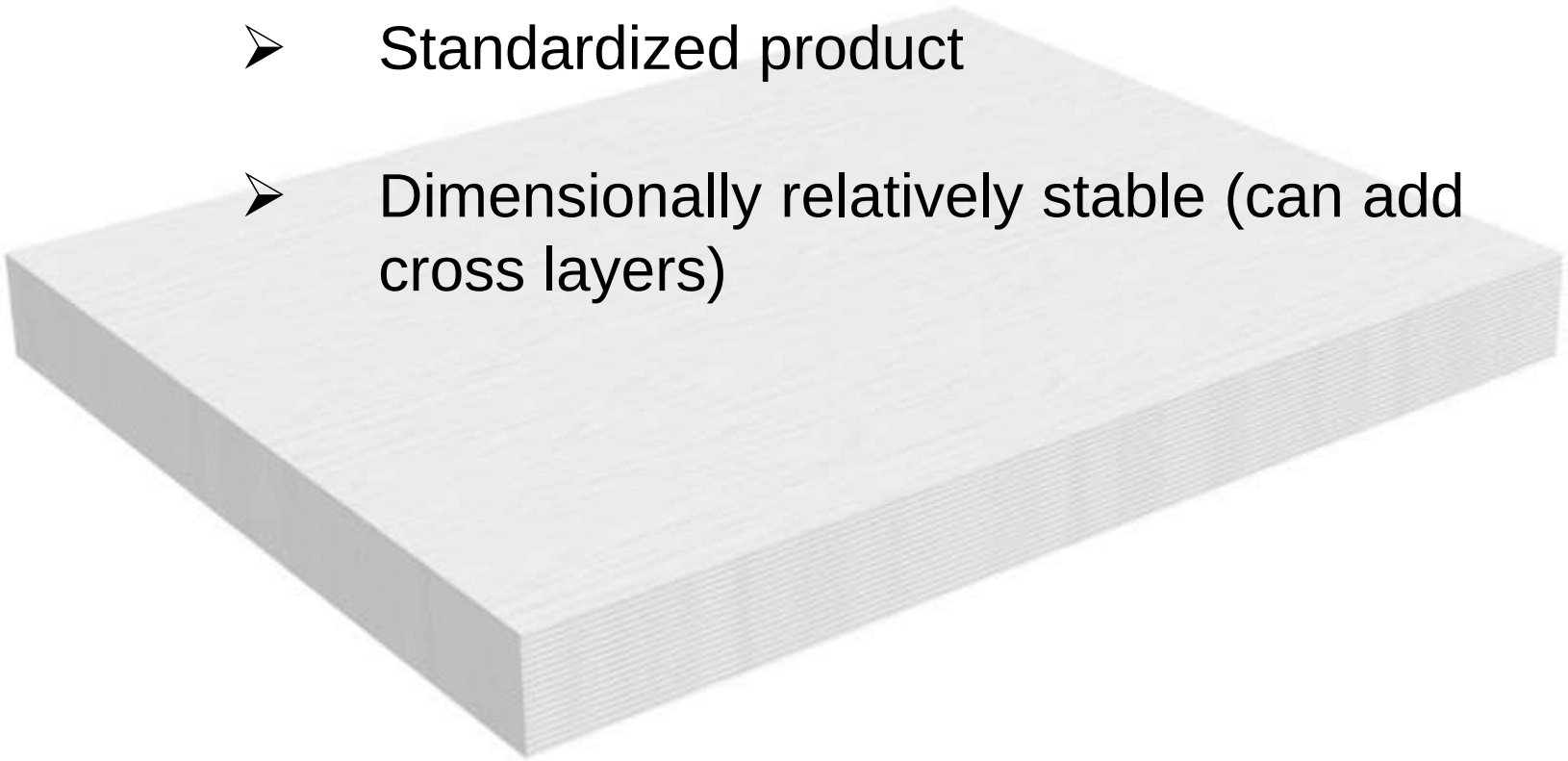


Solid LVL |

Solid LVL |

Comments:

- Standardized product
- Dimensionally relatively stable (can add cross layers)



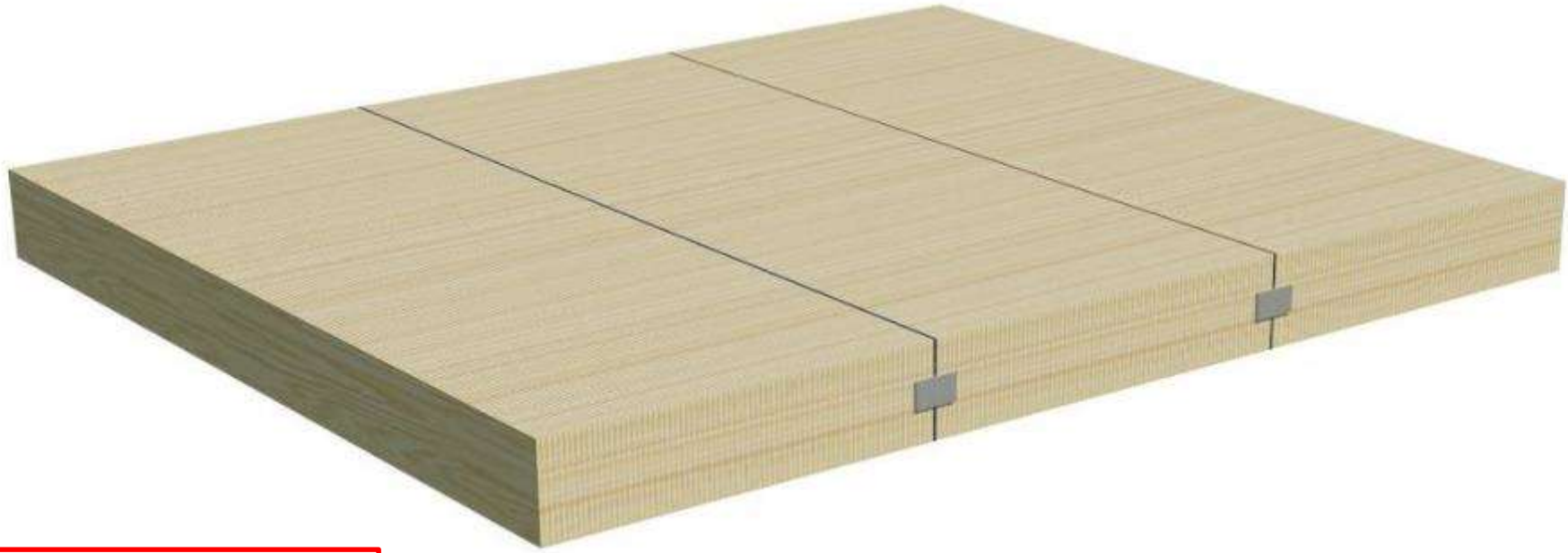
Solid LVL |

Solid LVL |

Solid LVL |

Overview | Products

Overview | Brisco Fine Line LVL



Laminated Veneer Lumber

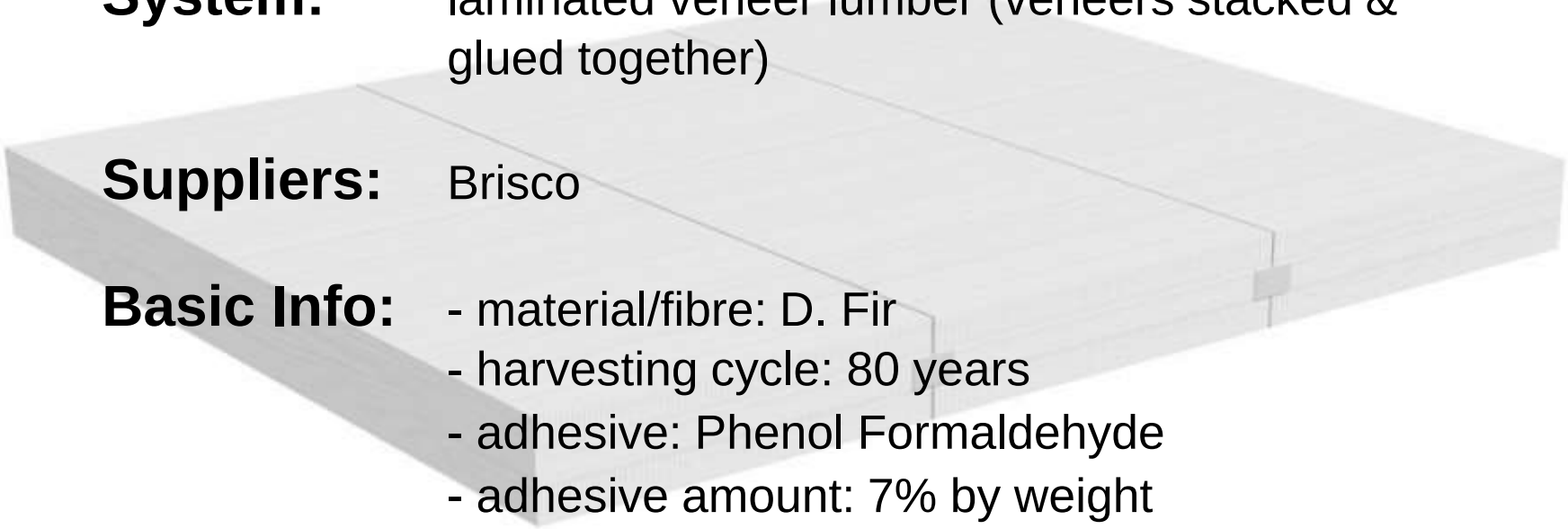
Brisco Fine Line LVL |

Alternative Names: N/A

System: laminated veneer lumber (veneers stacked & glued together)

Suppliers: Brisco

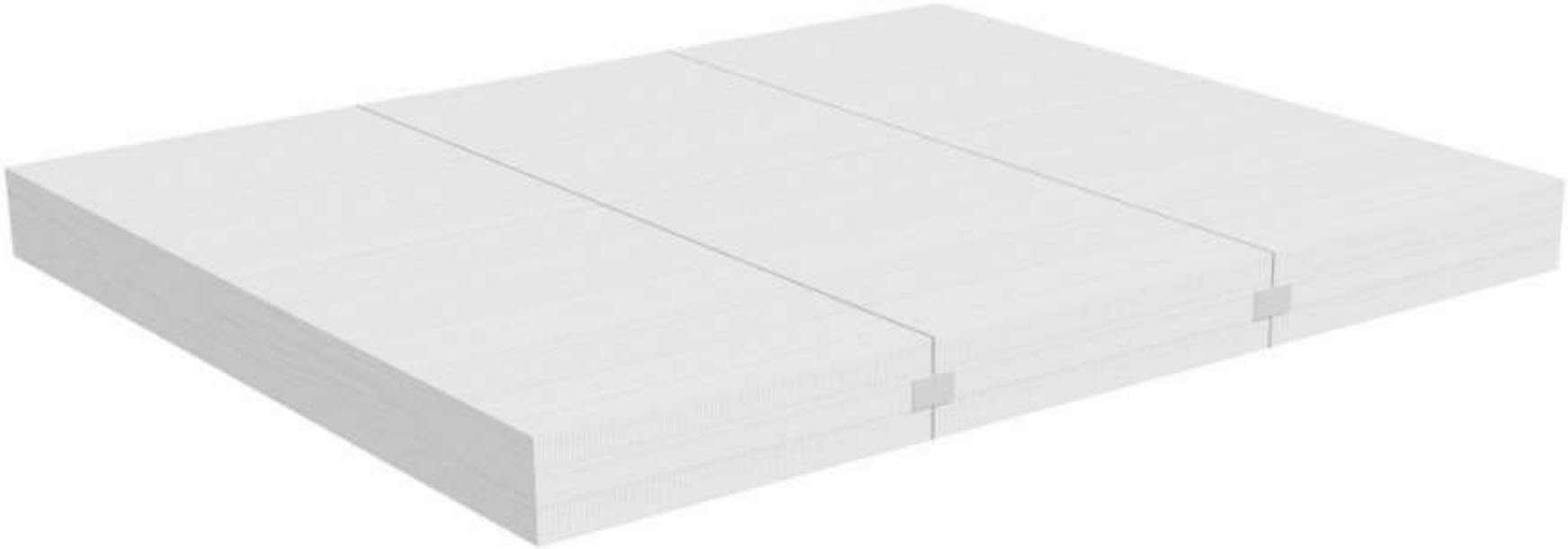
Basic Info:
- material/fibre: D. Fir
- harvesting cycle: 80 years
- adhesive: Phenol Formaldehyde
- adhesive amount: 7% by weight
- floor, roof and wall with joints detailed for lateral loads



Brisco Fine Line LVL |

Comments:

- Standardized product



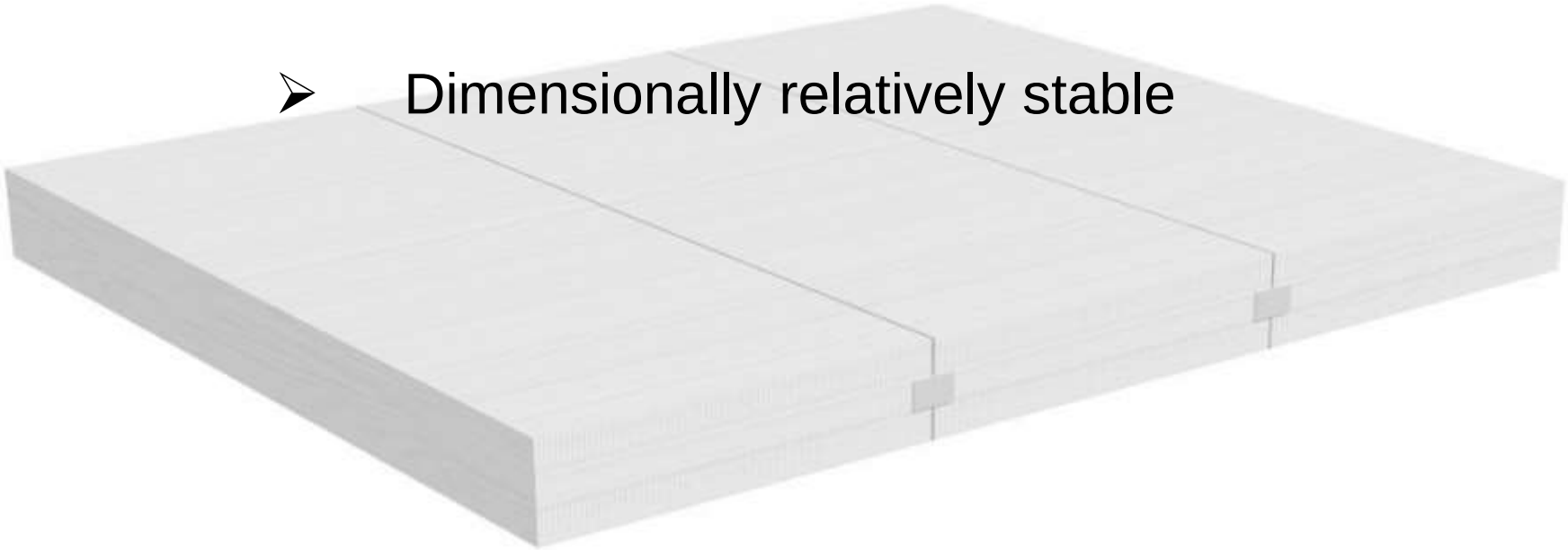
Brisco Fine Line LVL |

CCMC
Canadian Construction Materials Centre

Brisco Fine Line LVL |

Comments:

- Standardized product
- Dimensionally relatively stable



Brisco Fine Line LVL |

Courtesy of Brisco

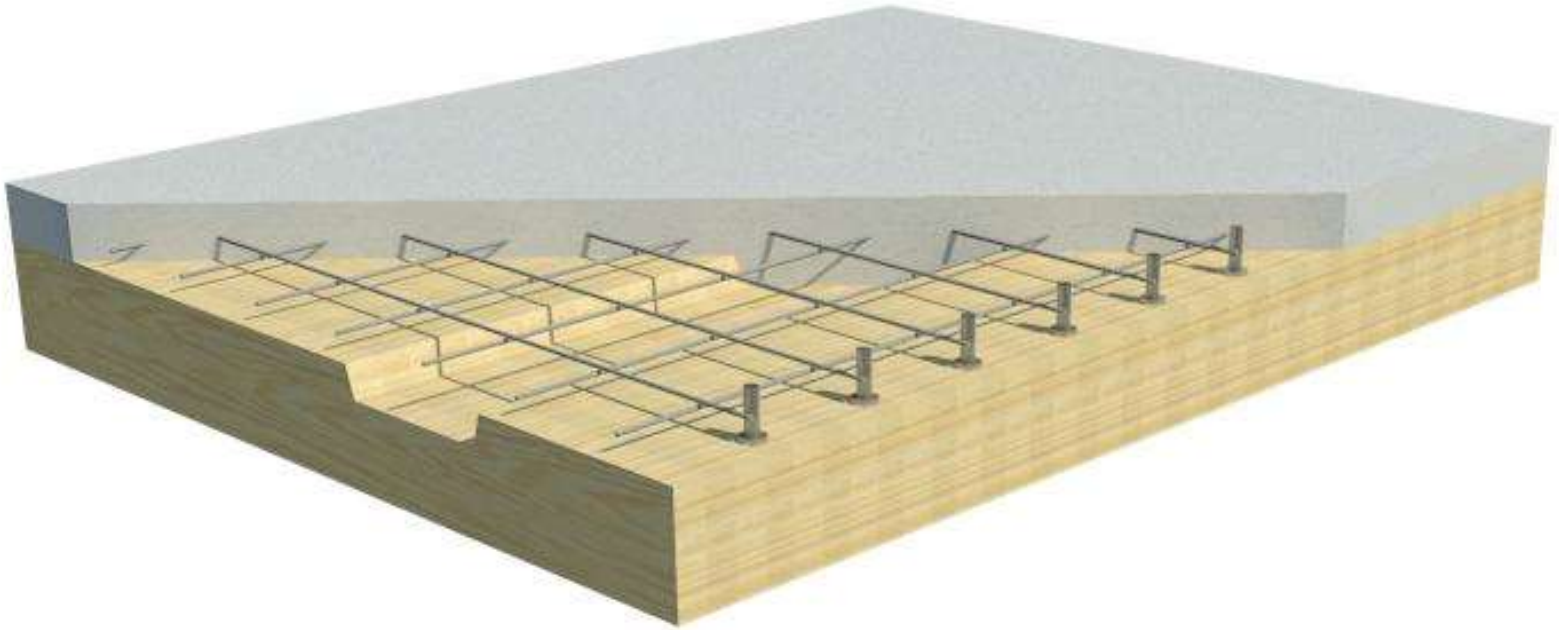
Courtesy of Brisco


Courtesy of Brisco

Courtesy of Brisco

Overview | Products

Overview | WCC



Wood – Concrete - Composite

WCC |

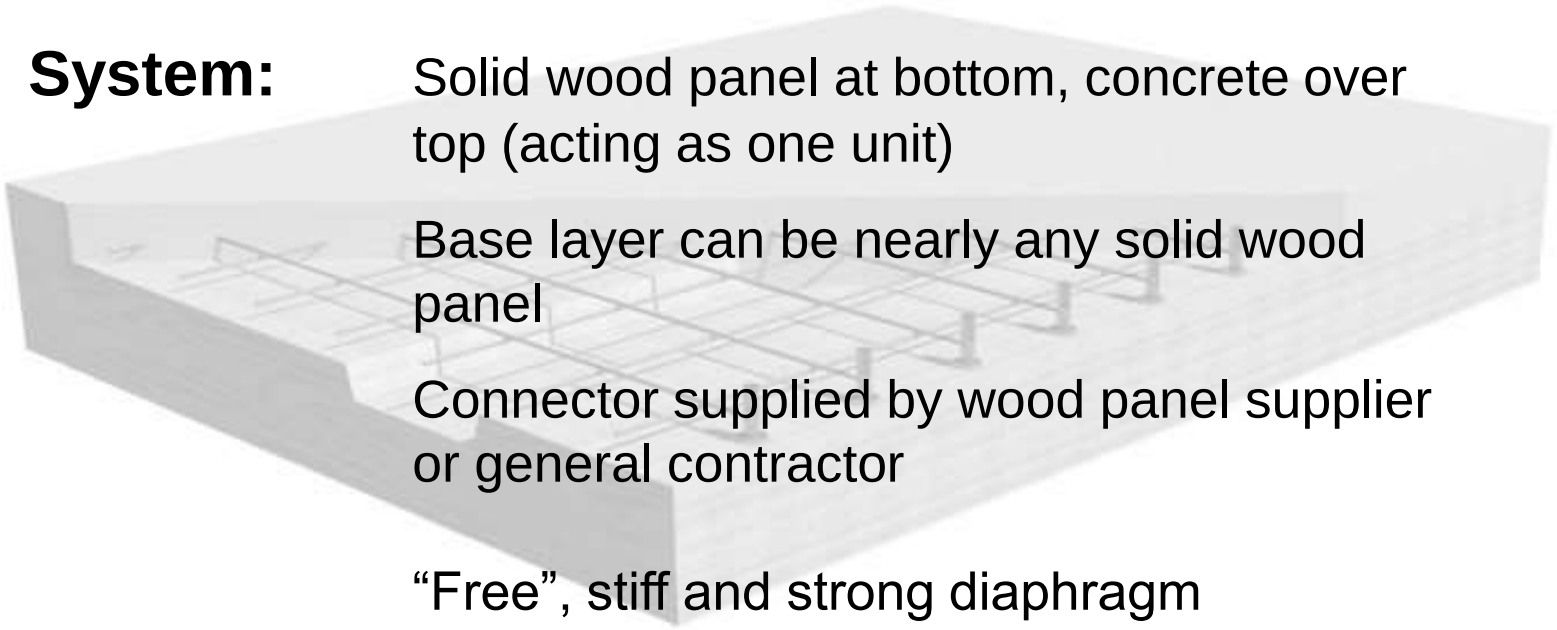
Alternative Names: Timber – Concrete – Composite

System: Solid wood panel at bottom, concrete over top (acting as one unit)

Base layer can be nearly any solid wood panel

Connector supplied by wood panel supplier or general contractor

“Free”, stiff and strong diaphragm

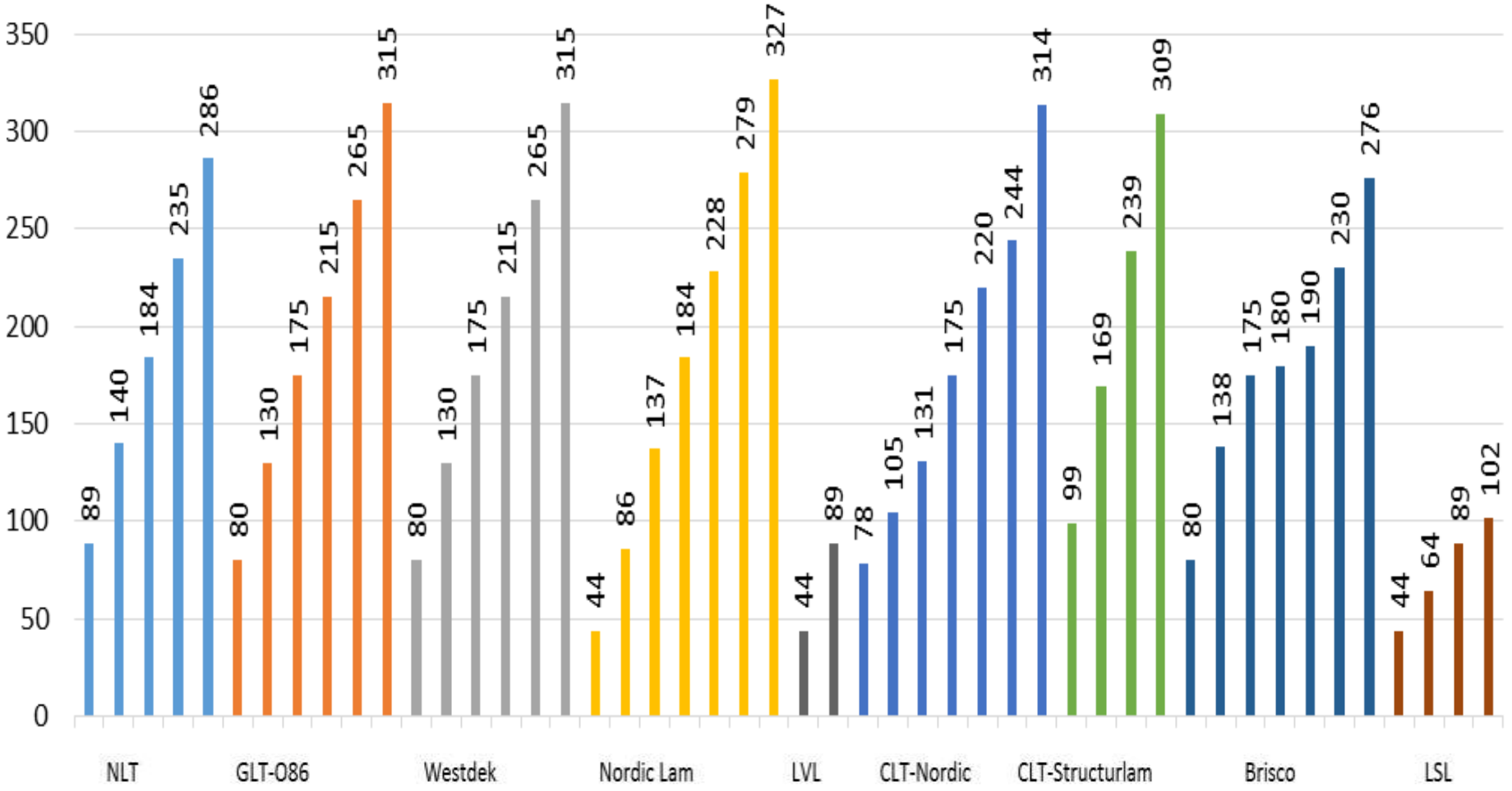


Overview | OTHERS

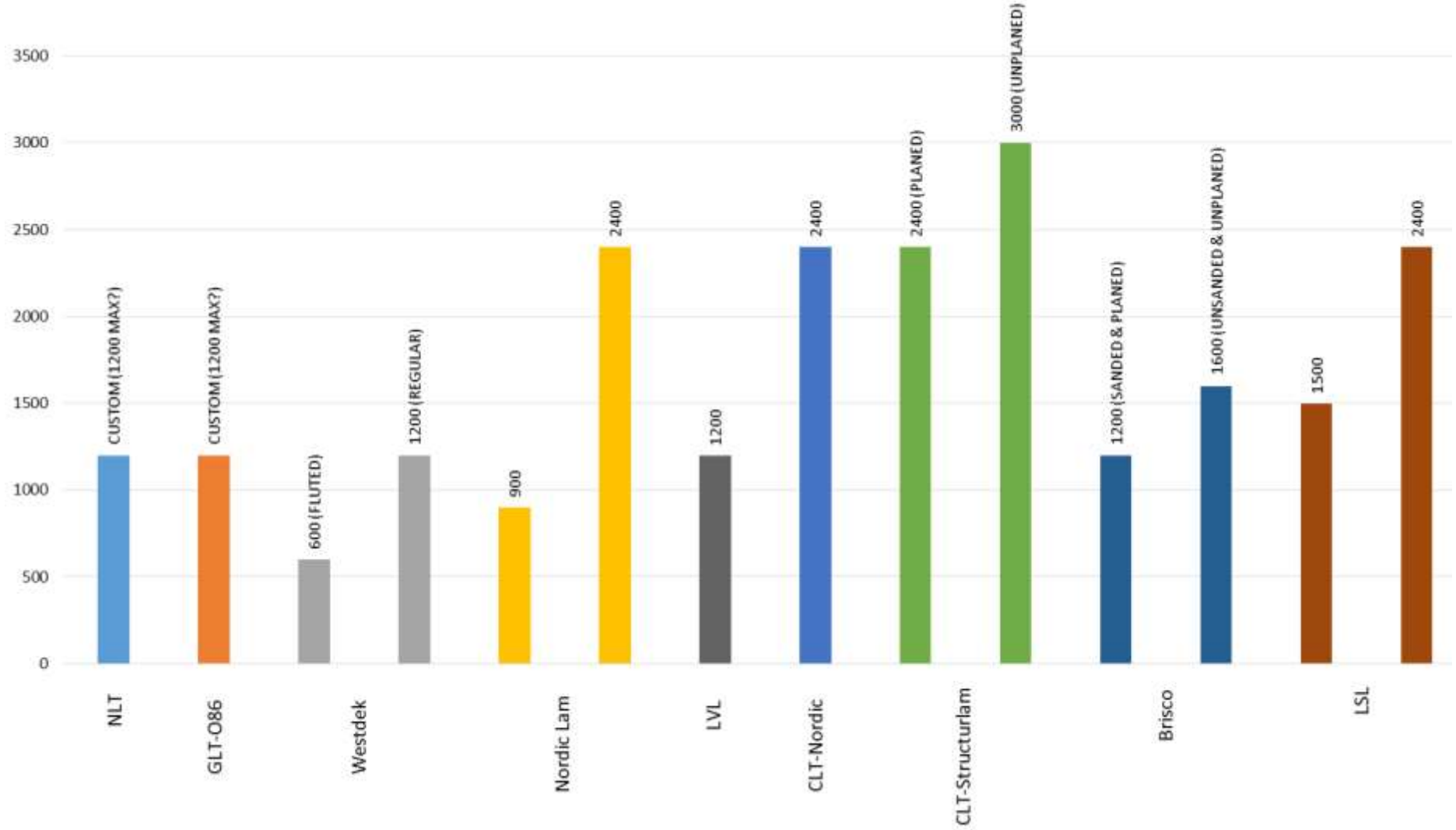
- PSL (Parallam)
- Solid Decking / T&G
- Logs

Sizes and Design Characteristics |

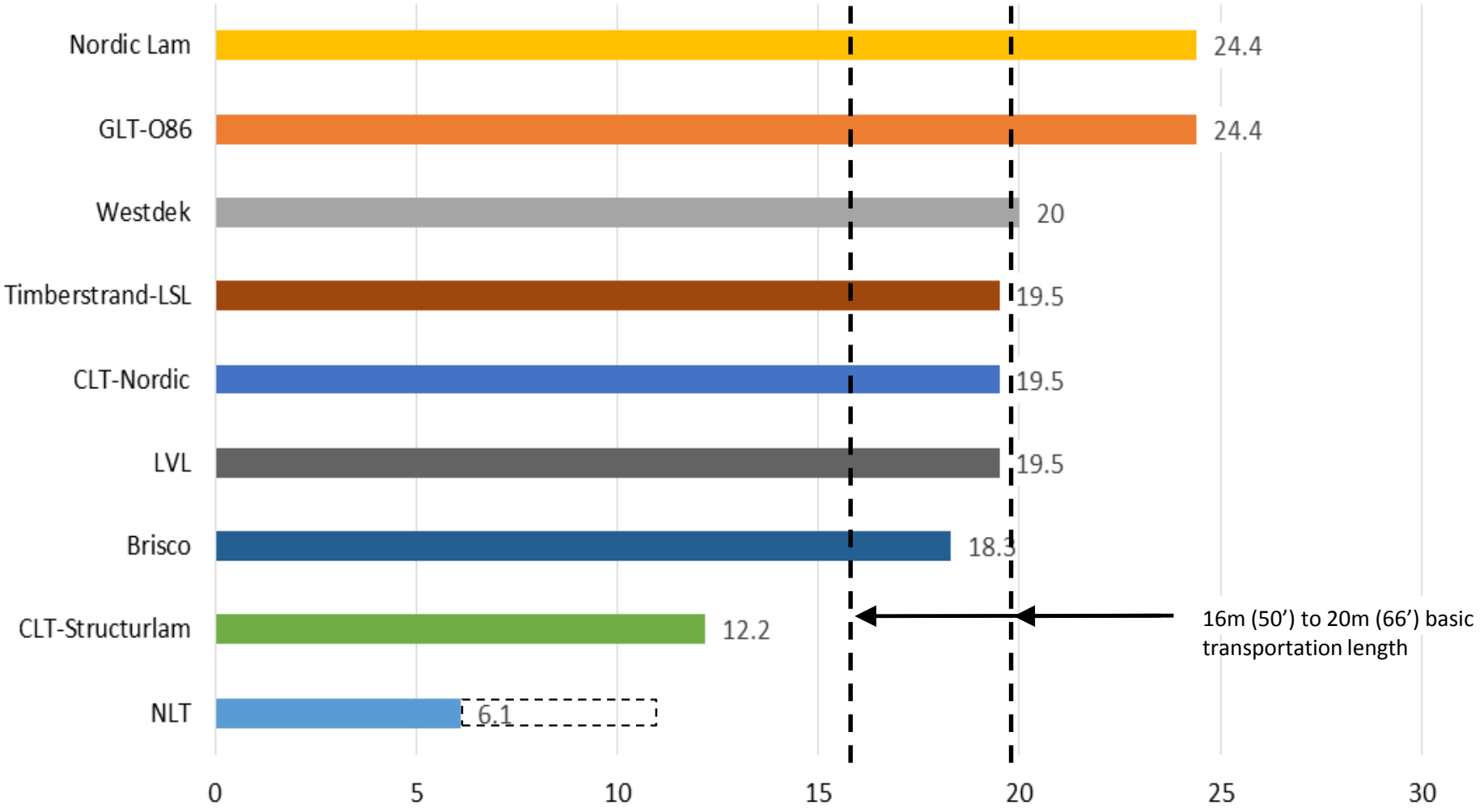
Sizes and Design Characteristics | Depth



Sizes and Design Characteristics | Width



Sizes and Design Characteristics | Length

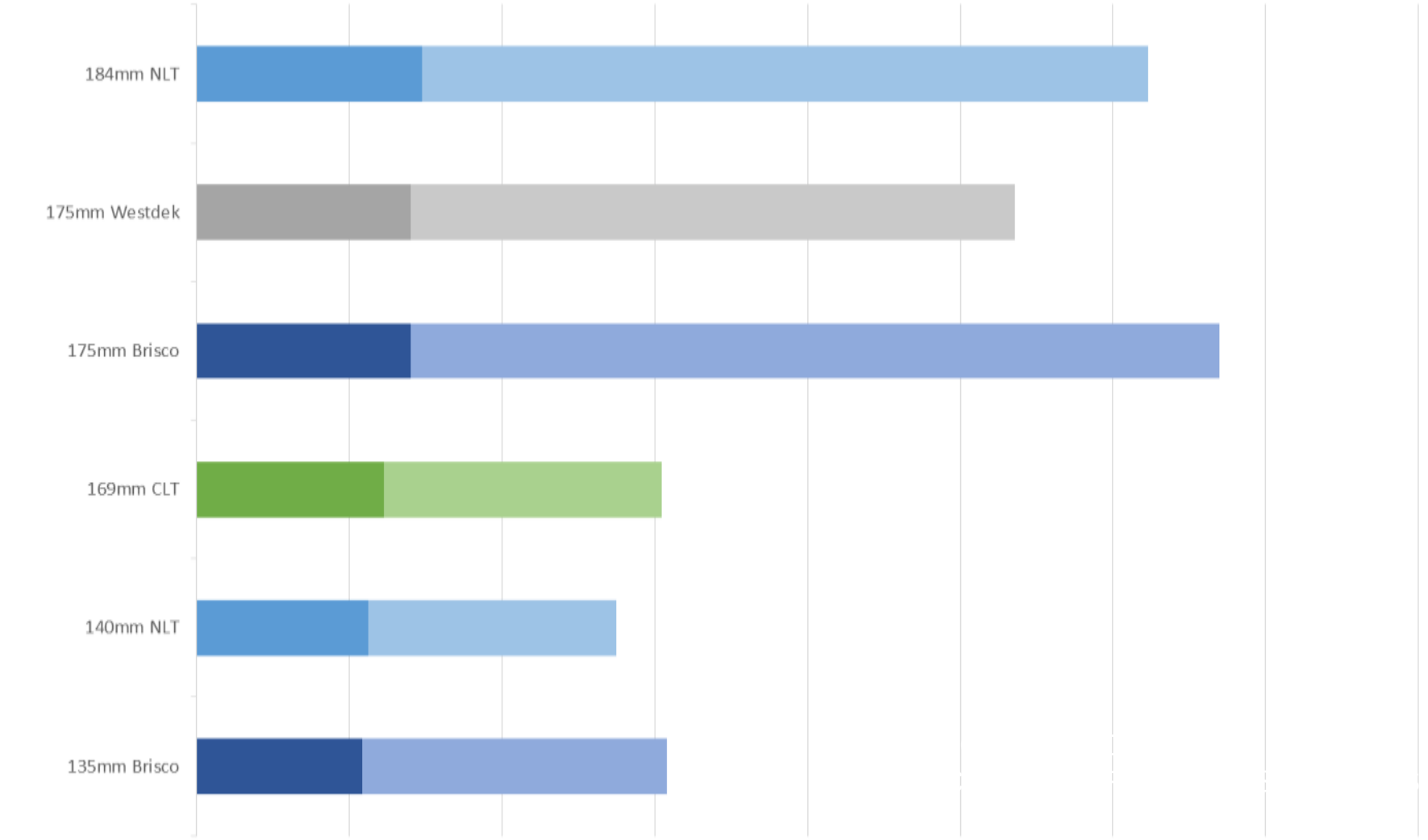


Comparison |

Comparison | Stiffness

Design is mostly governed by deflection (stiffness) and / or vibration

Stiffness |


184mm NLT
175mm Westdek
175mm Brisco
169mm CLT
140mm NLT
135mm Brisco

Comparison | Fire

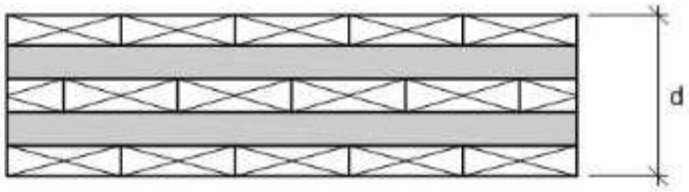
- In general, all products have a similar char rate
- Approximately 38mm – 44mm / 60 minutes

  - Check with Code Consultant

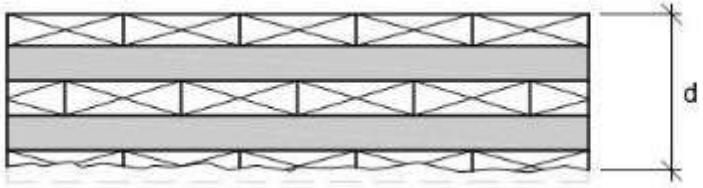
- Be careful with CLT if required rating is between 45 and 90 minutes

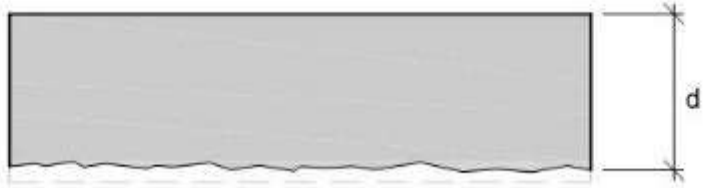
  - Most of the time it’s not a problem for panels with 5+ layers

Fire |

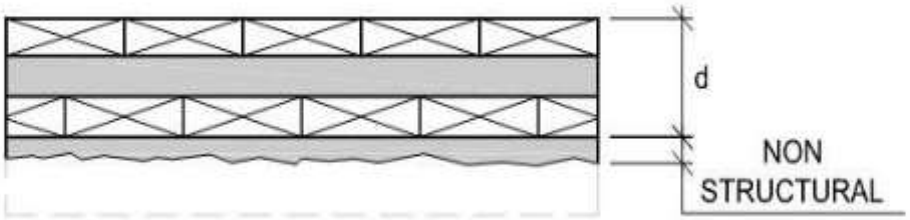


Fire |





Fire |



Practical Considerations |

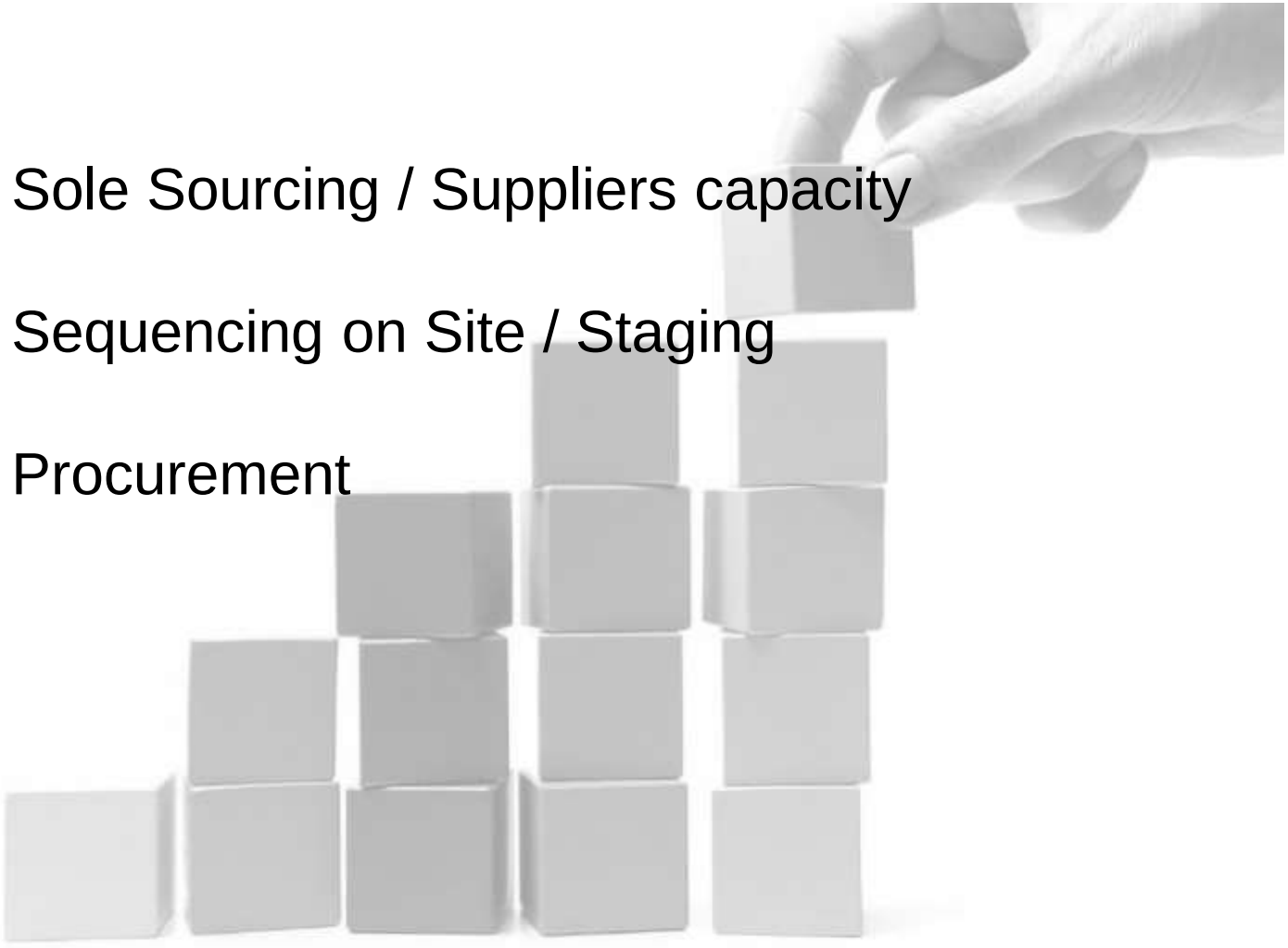
Practical Considerations | Location

Location |

- Local trades
- Distance to suppliers (LEED, Living Building Challenge)
- Dry vs. wet climate
- Funding
- Season of construction (winter prefab)

Practical Considerations | Size of a Project

Size of Project |



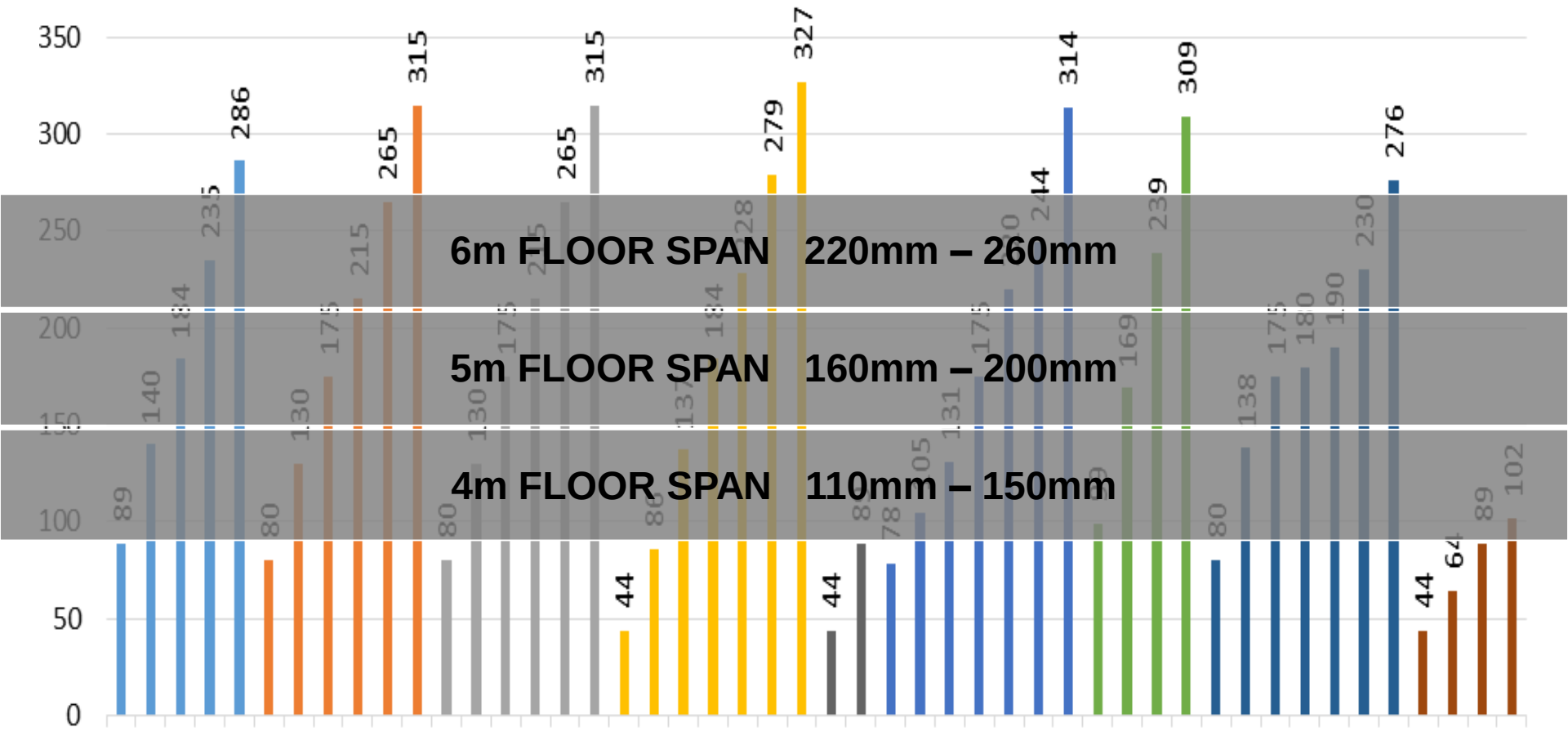
- Sole Sourcing / Suppliers capacity
- Sequencing on Site / Staging
- Procurement

Practical Considerations | Procurement

Procurement |

- Design - Bid - Build
- Construction Management
- Design Build
- ?

Depth |

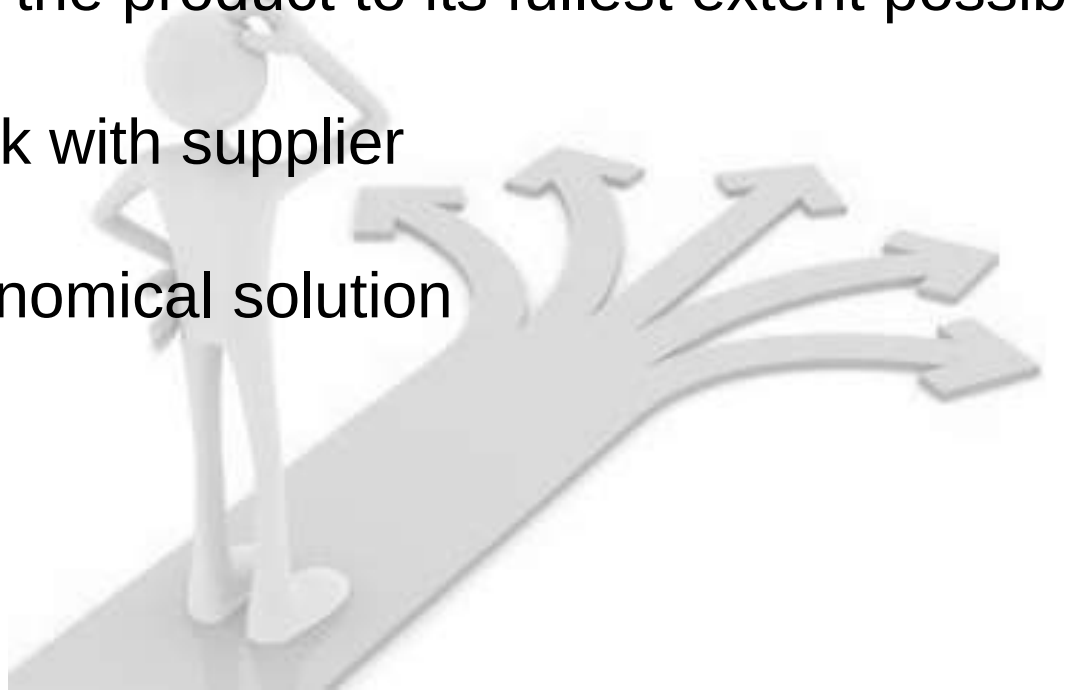


DEPTHS ACCOUNT FOR VIBRATION

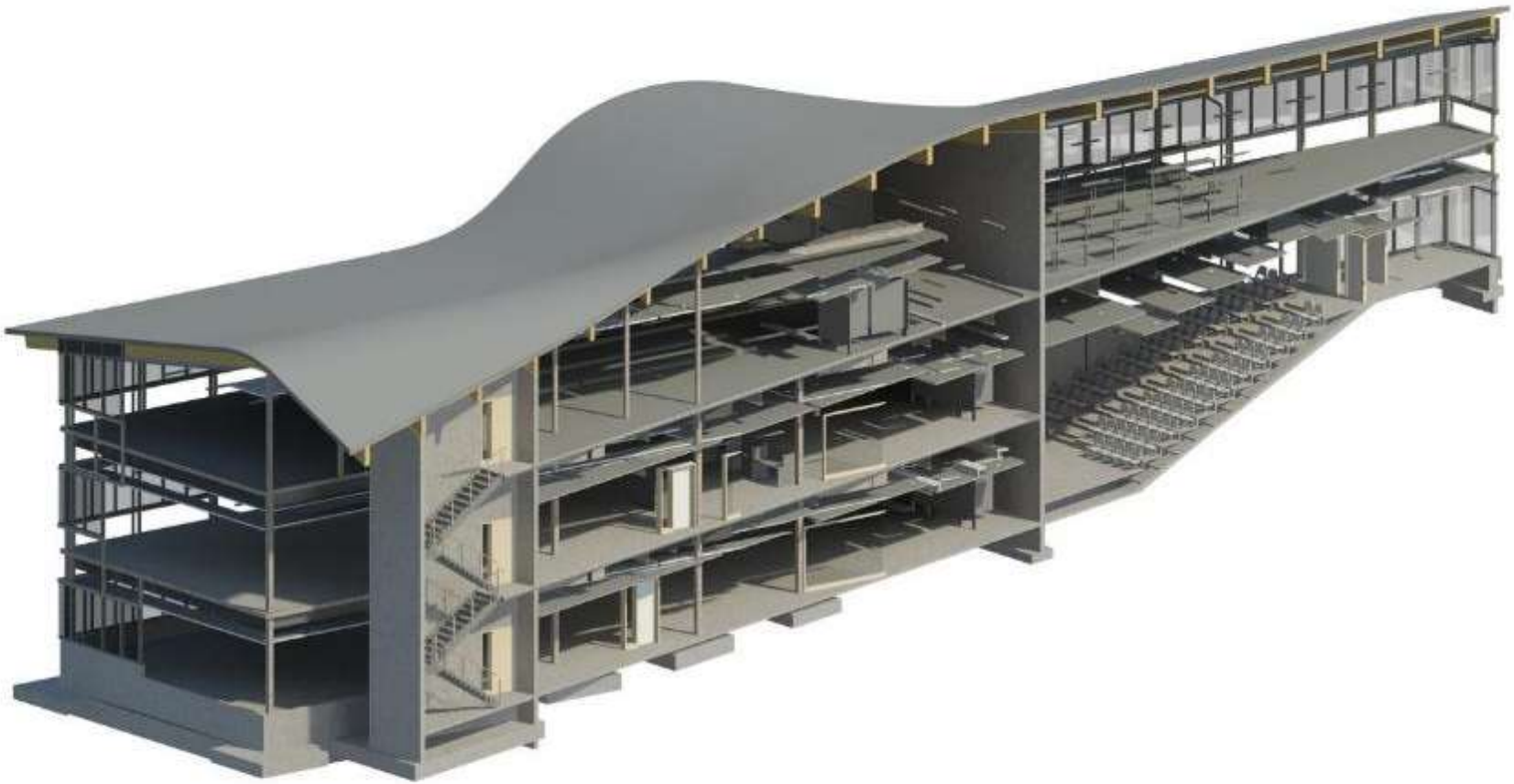
Practical Considerations | Decide Early

Decide Early |

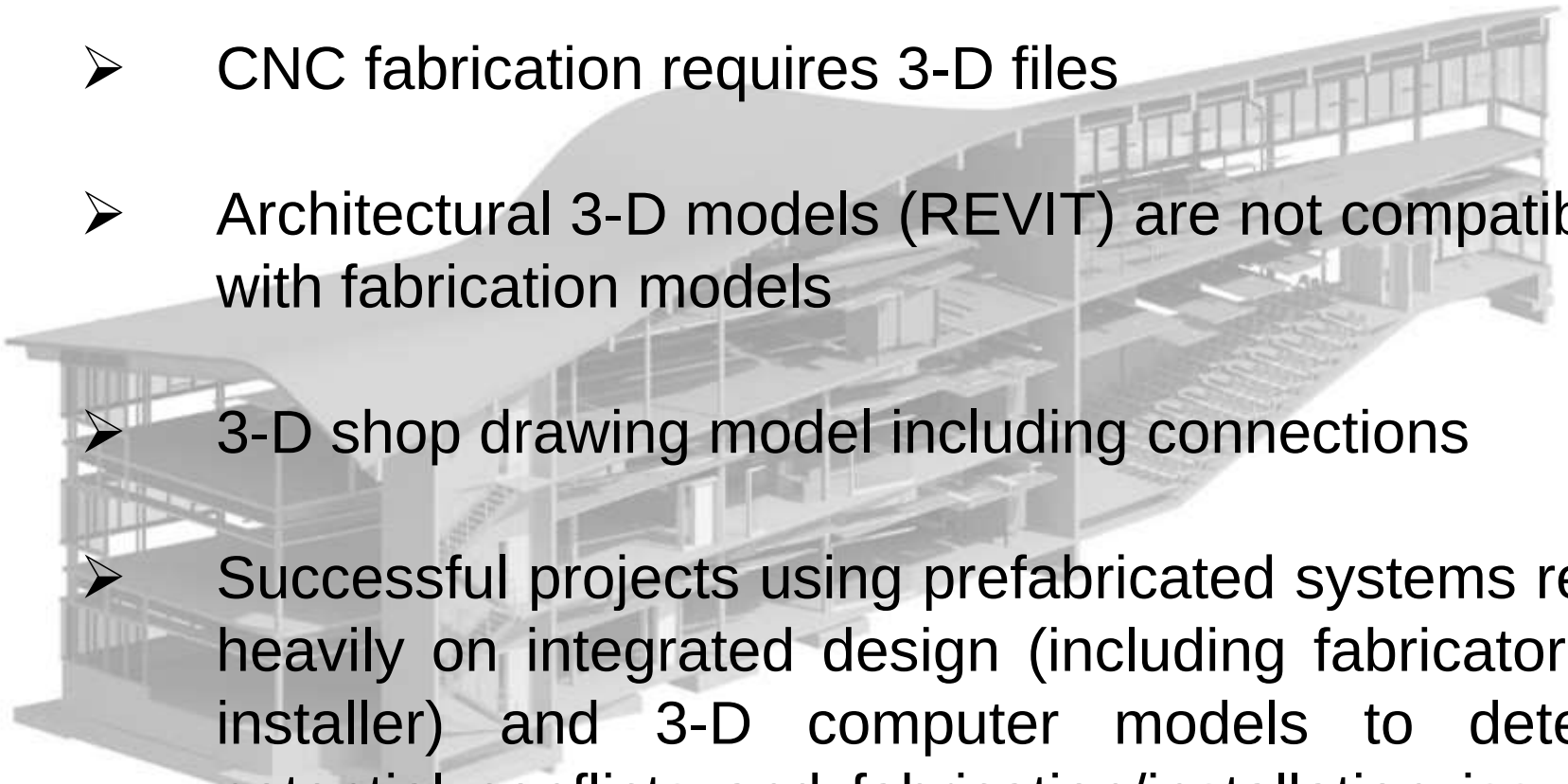
- Use the product to its fullest extent possible
- Work with supplier
- Economical solution



Practical Considerations | BIM

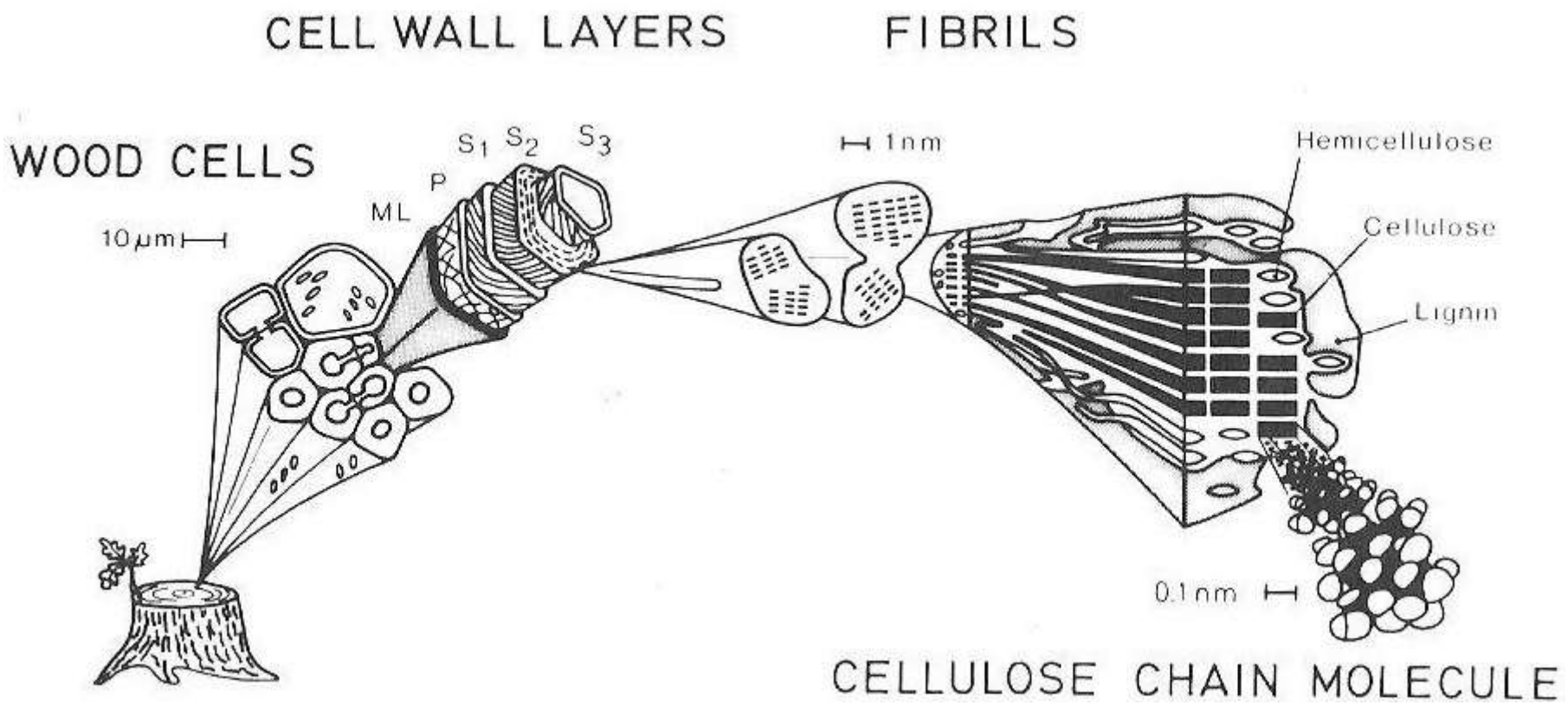


BIM |



- CNC fabrication requires 3-D files
- Architectural 3-D models (REVIT) are not compatible with fabrication models
- 3-D shop drawing model including connections
- Successful projects using prefabricated systems rely heavily on integrated design (including fabricator & installer) and 3-D computer models to detect potential conflicts and fabrication/installation issues early in the process

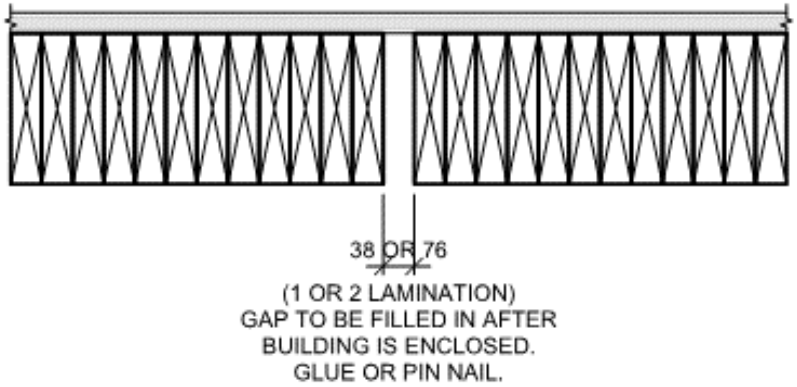
Practical Considerations | Movement



Practical Considerations | Movement

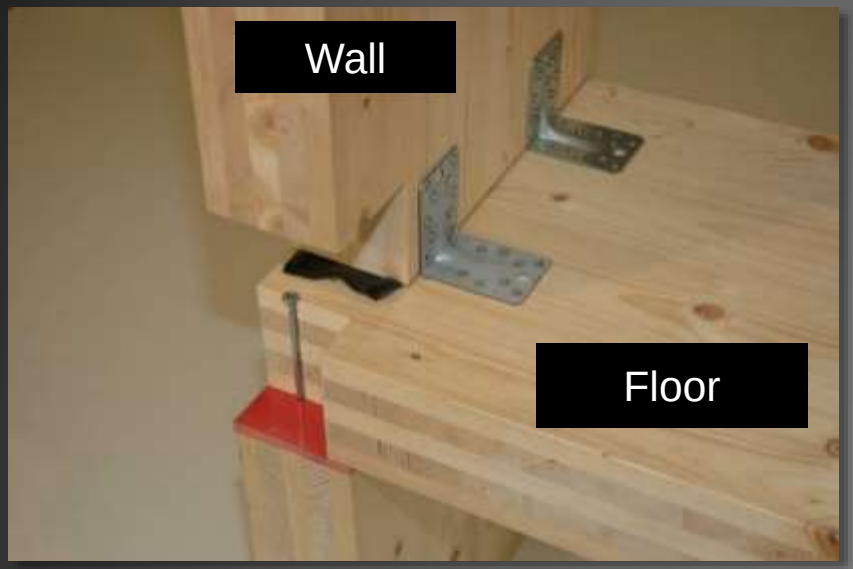
NLT, GLT:
0.25% change in dimension for each **1%** change in moisture content

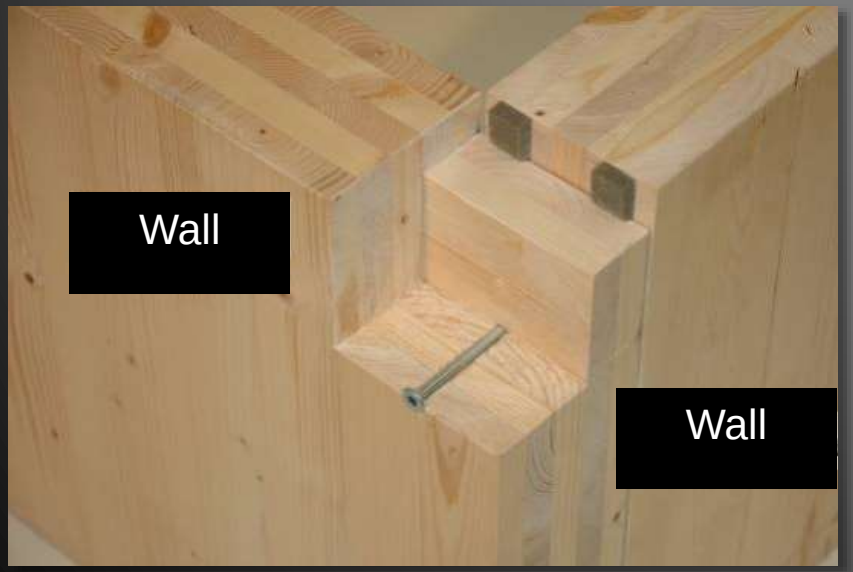
- 12%MC when installed
- 14%MC during construction
- 50mm swelling in 10m

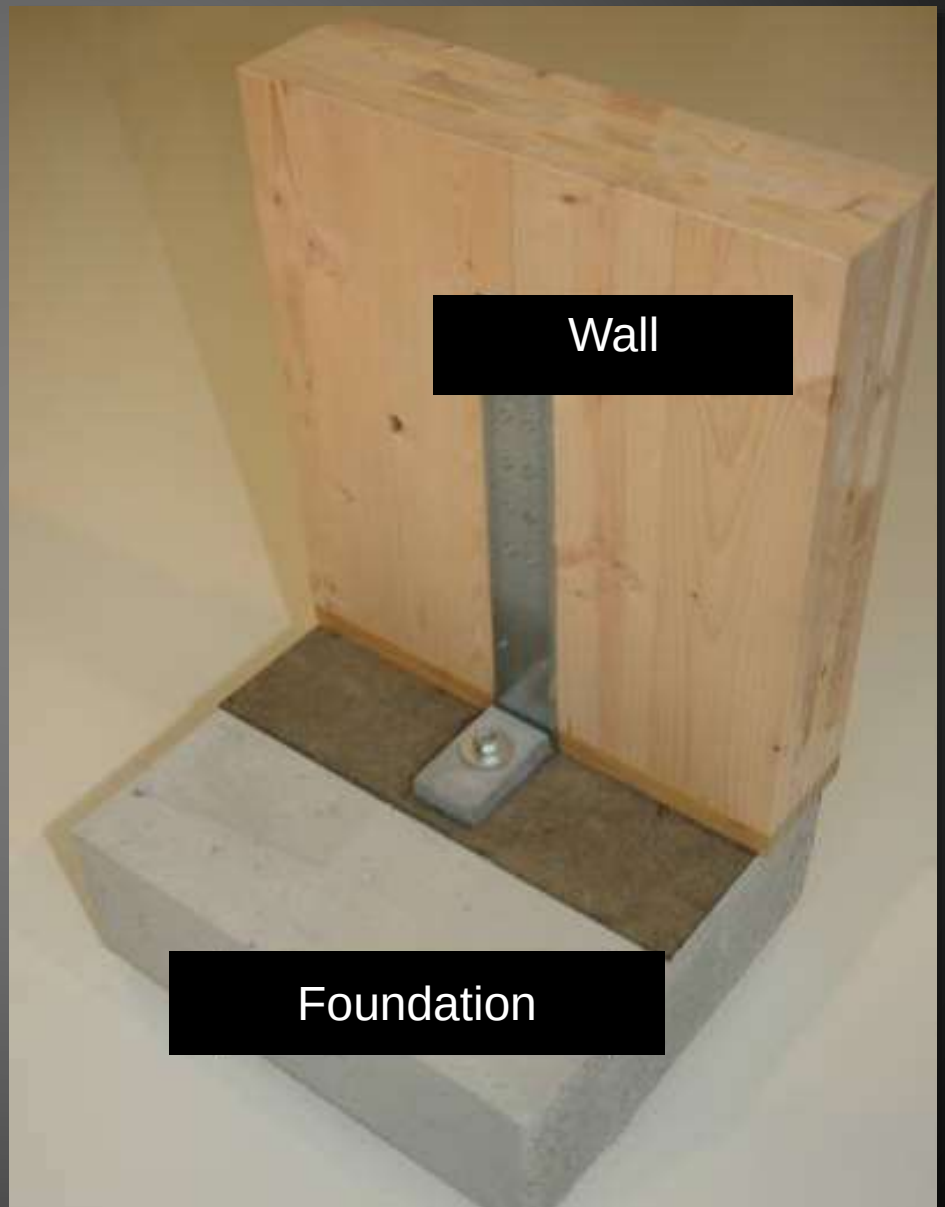


*38mm each 6m (1 ½” each 20’)

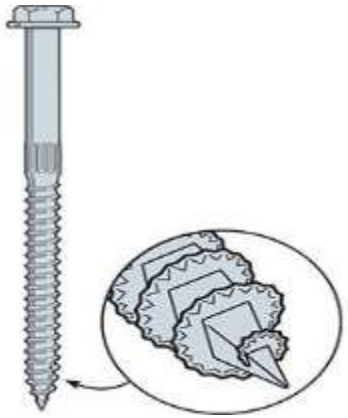
Practical Considerations | Connections







Practical Considerations | Connections



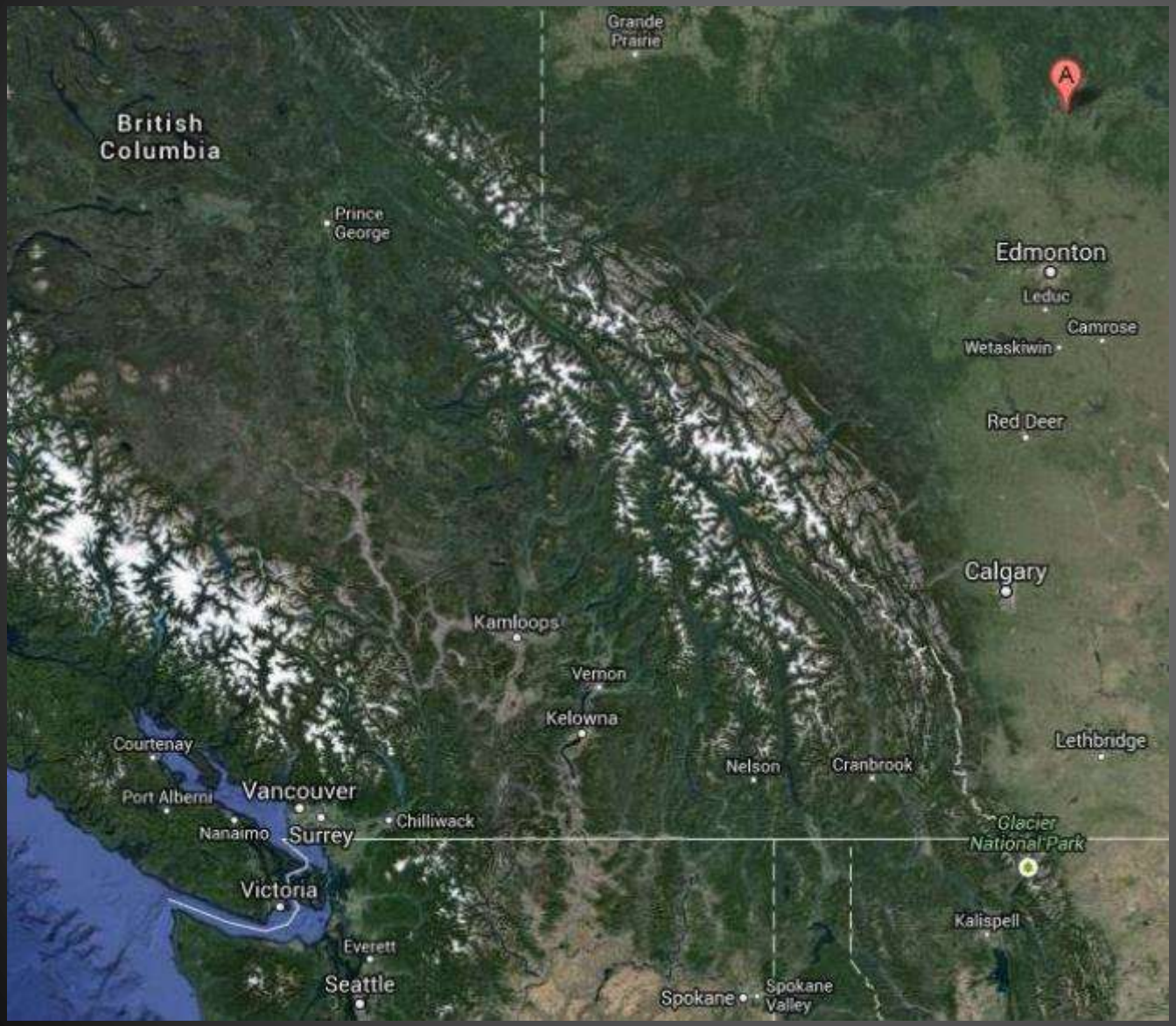
Practical Considerations | Connections

Galvanized or otherwise protected steel parts and fasteners to deal with moisture:

Mass Timber Design Process|

- Case studies as a means to introduce concepts, uses and challenges:
  - Case 1: Athabasca University Academic Research Ctr.
  - Case 2: Mountain Equipment Co-op Head Office

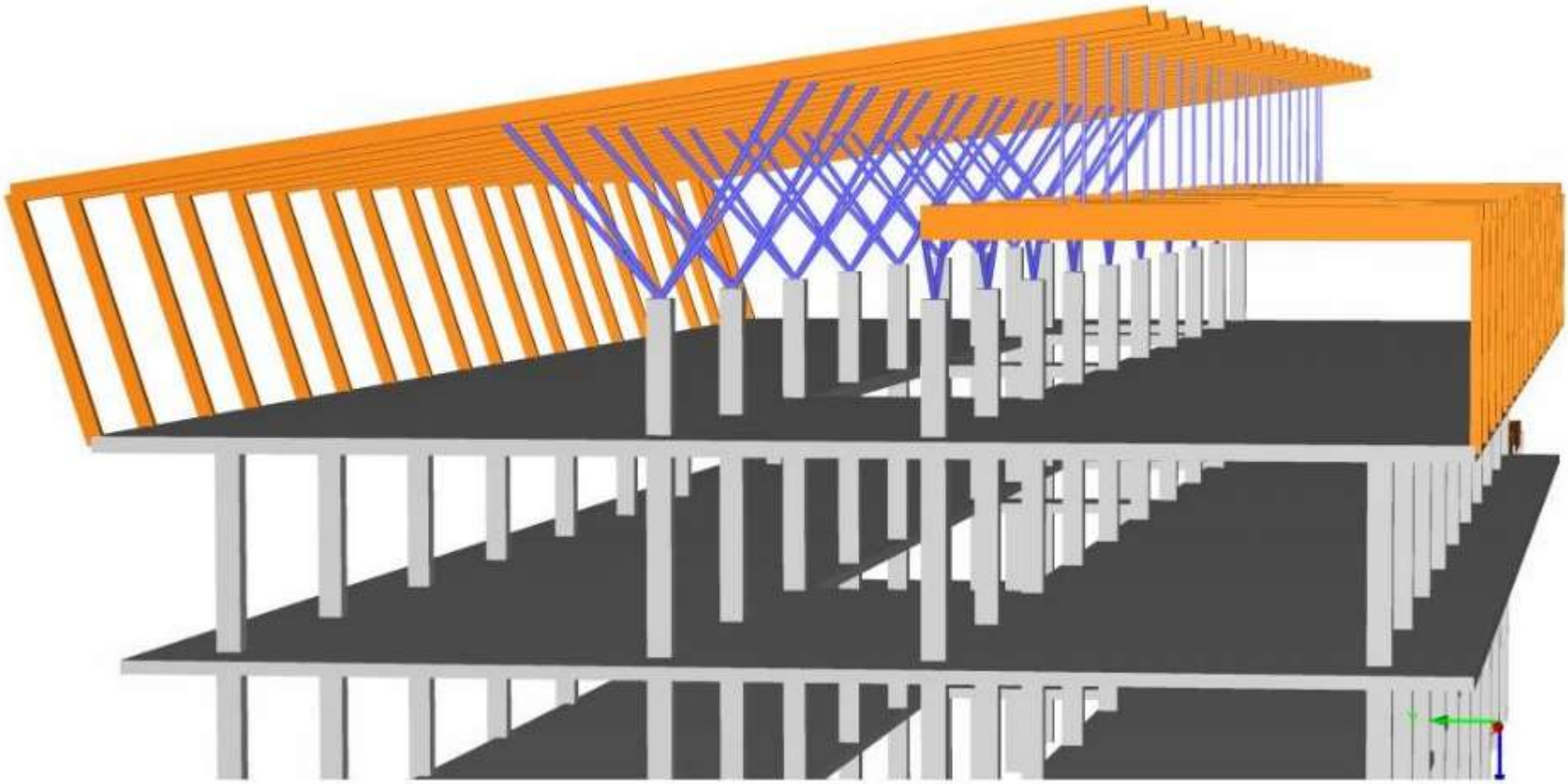
Case Study One | Athabasca University

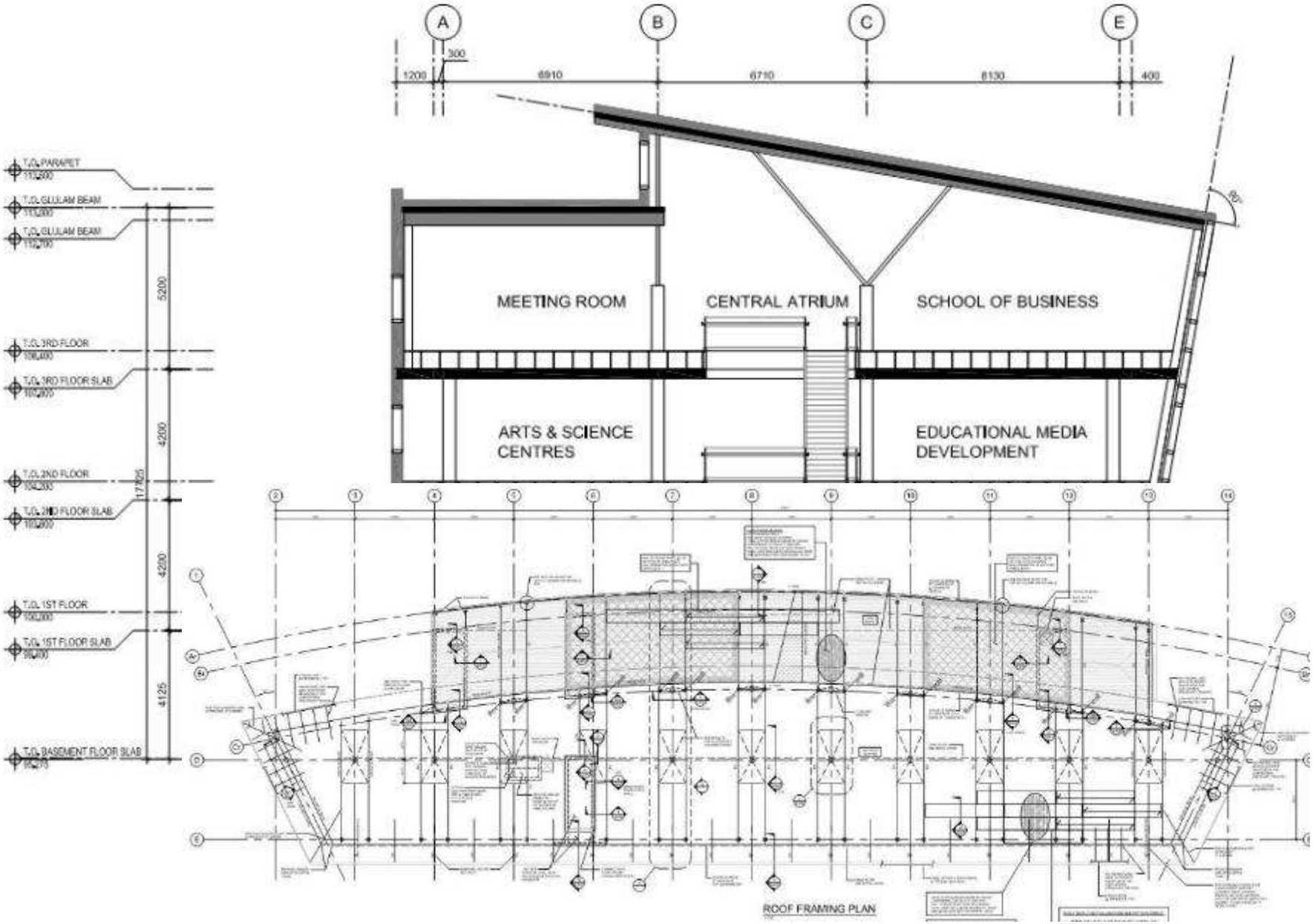


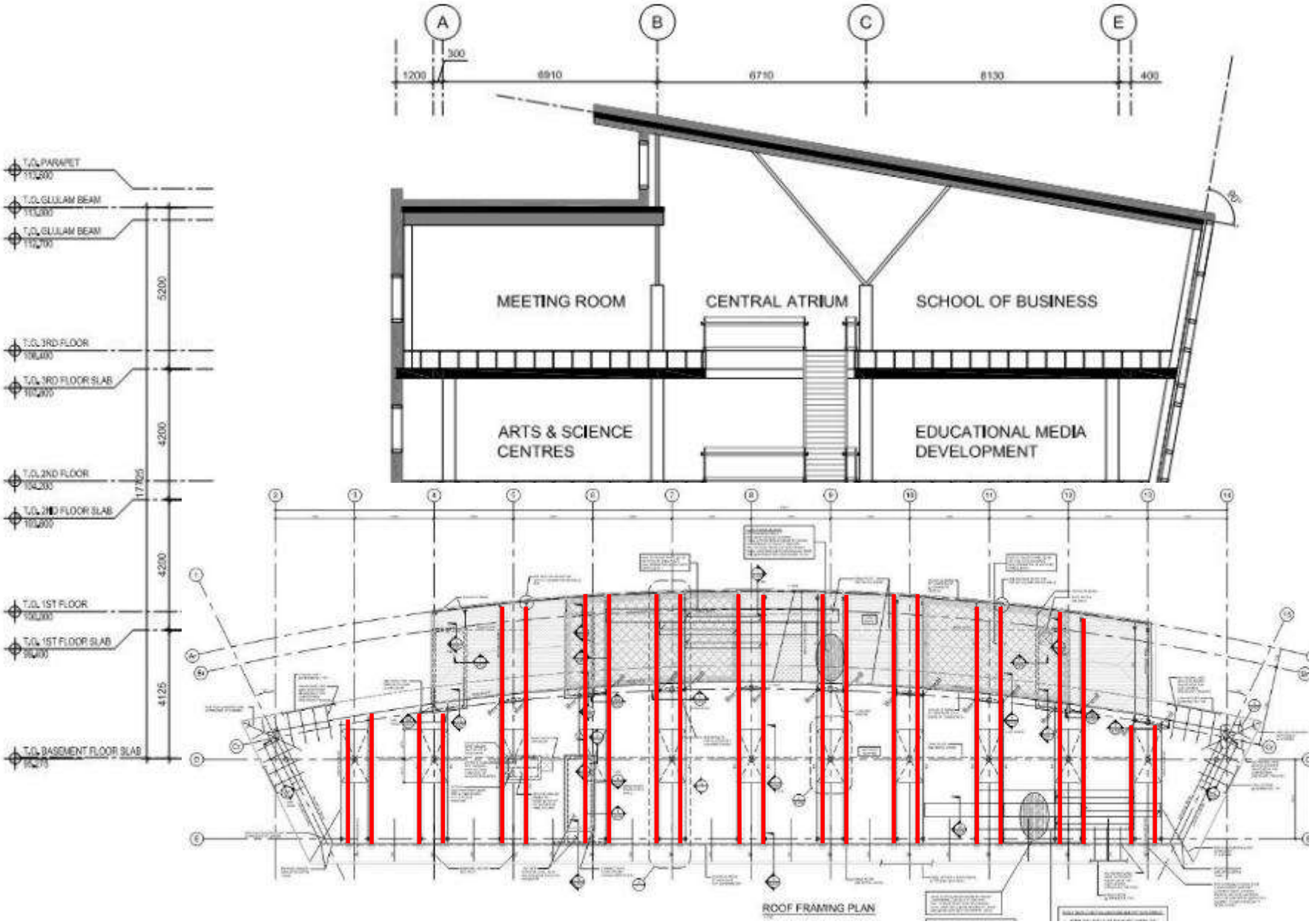
MANASC ISAAC

Athabasca University

Design |




A
B
C
E
1200
300
6910
6710
8130
400
MEETING ROOM
CENTRAL ATRIUM
SCHOOL OF BUSINESS
ARTS & SCIENCE CENTRES
EDUCATIONAL MEDIA DEVELOPMENT
T.O.L PARAPET
T.O.L GLULAM BEAM
T.O.L GLULAM BEAM
T.O.L 3RD FLOOR
T.O.L 3RD FLOOR SLAB
T.O.L 2ND FLOOR
T.O.L 2ND FLOOR SLAB
T.O.L 1ST FLOOR
T.O.L 1ST FLOOR SLAB
T.O.L BASEMENT FLOOR SLAB
5200
4200
4200
4125
ROOF FRAMING PLAN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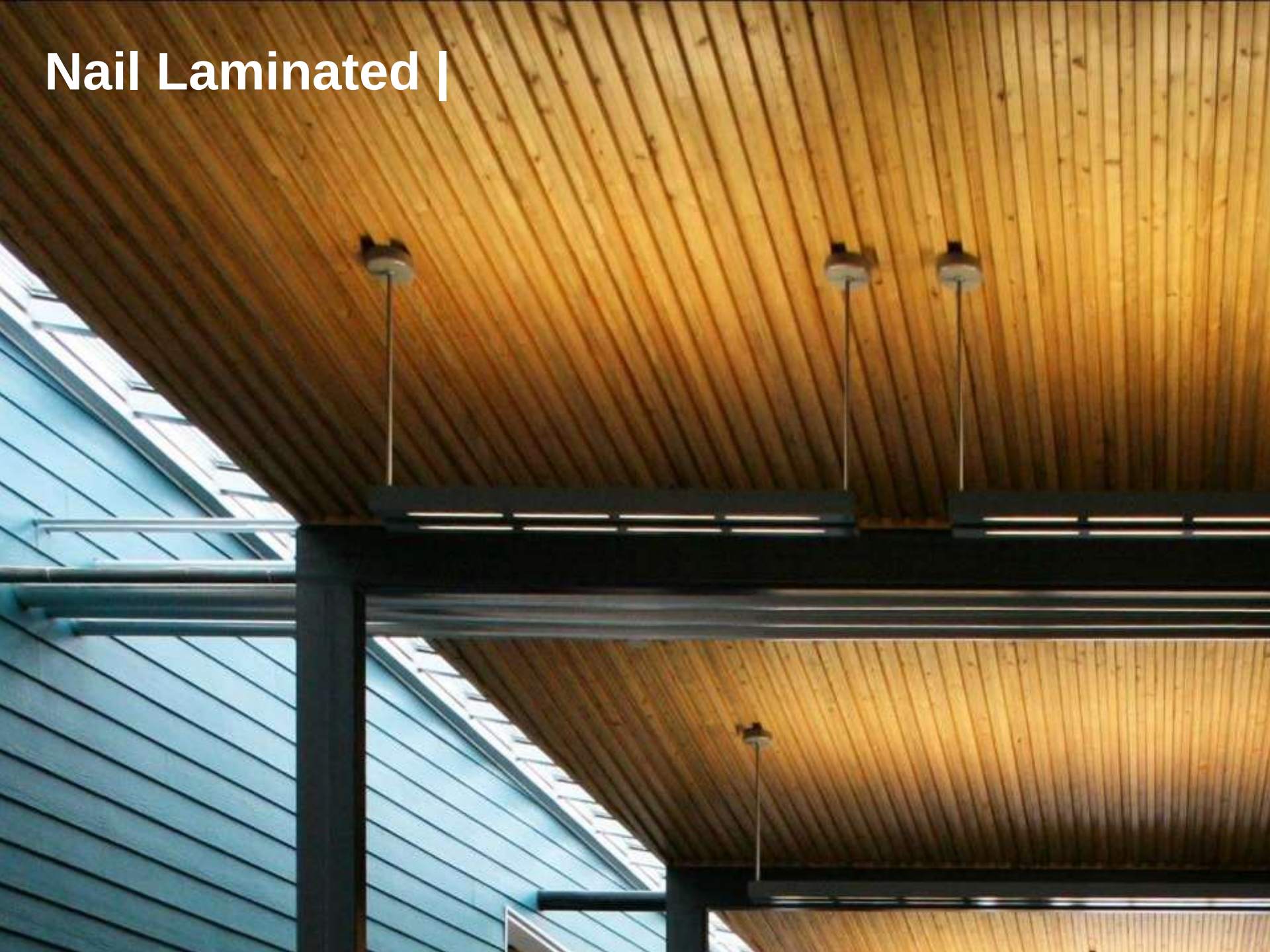
MEETING ROOM
CENTRAL ATRIUM
SCHOOL OF BUSINESS
ARTS & SCIENCE CENTRES
EDUCATIONAL MEDIA DEVELOPMENT
T.O.L PARAPET
T.O.L GLULAM BEAM
T.O.L GLULAM BEAM
T.O.L 3RD FLOOR
T.O.L 3RD FLOOR SLAB
T.O.L 2ND FLOOR
T.O.L 2ND FLOOR SLAB
T.O.L 1ST FLOOR
T.O.L 1ST FLOOR SLAB
T.O.L BASEMENT FLOOR SLAB
5200
4200
4200
4125
ROOF FRAMING PLAN

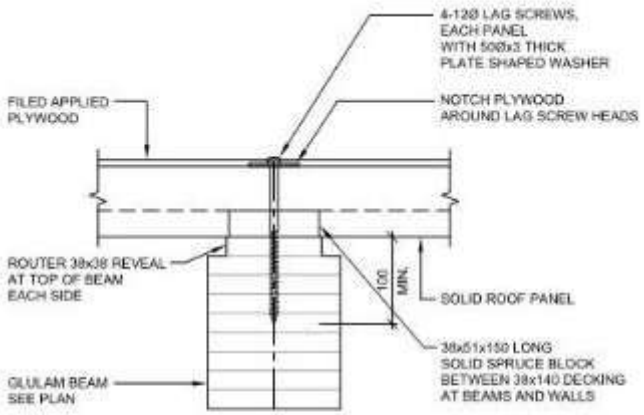



Nail Laminated |



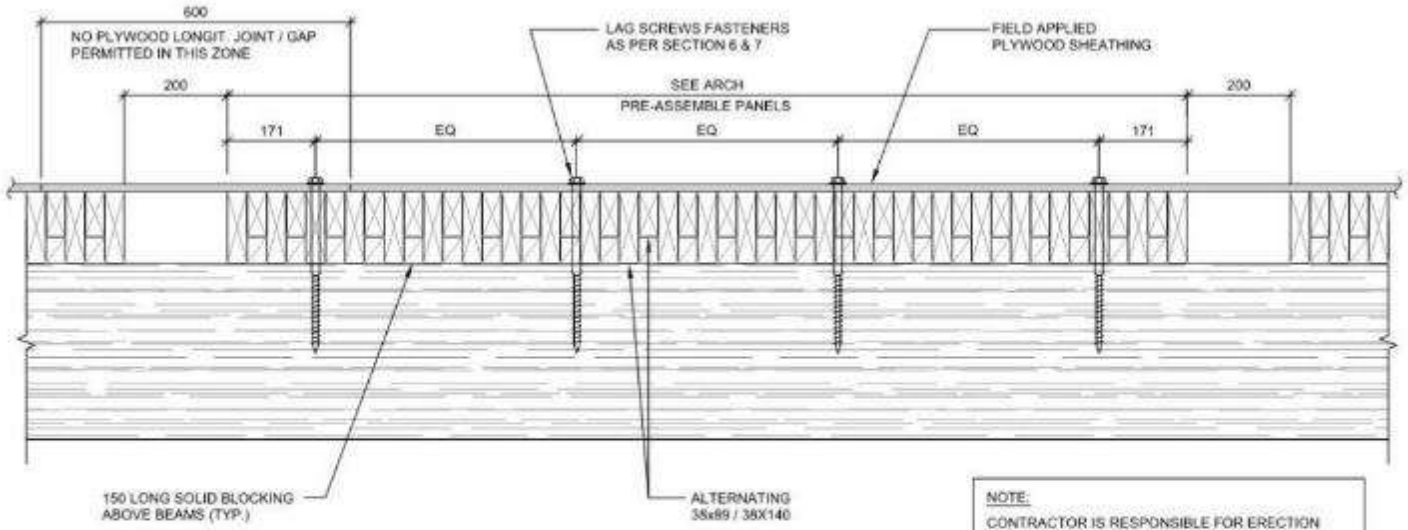
Nail Laminated |

- Standard & locally available
- Prefabrication
- Aesthetics
- Low-skilled labour
- Integrates mechanical & electrical systems



7 / - TYP. PANEL CONNECTION

1:10



NOTE:

CONTRACTOR IS RESPONSIBLE FOR ERECTION AND STABILITY OF PANELS DURING CONSTRUCTION. DISCUSS ERECTION PROCEDURE WITH ENGINEER PRIOR TO FABRICATION

A / S205 DETAIL

1:10

Tender & Construction |


SOPREMA
AVAPR

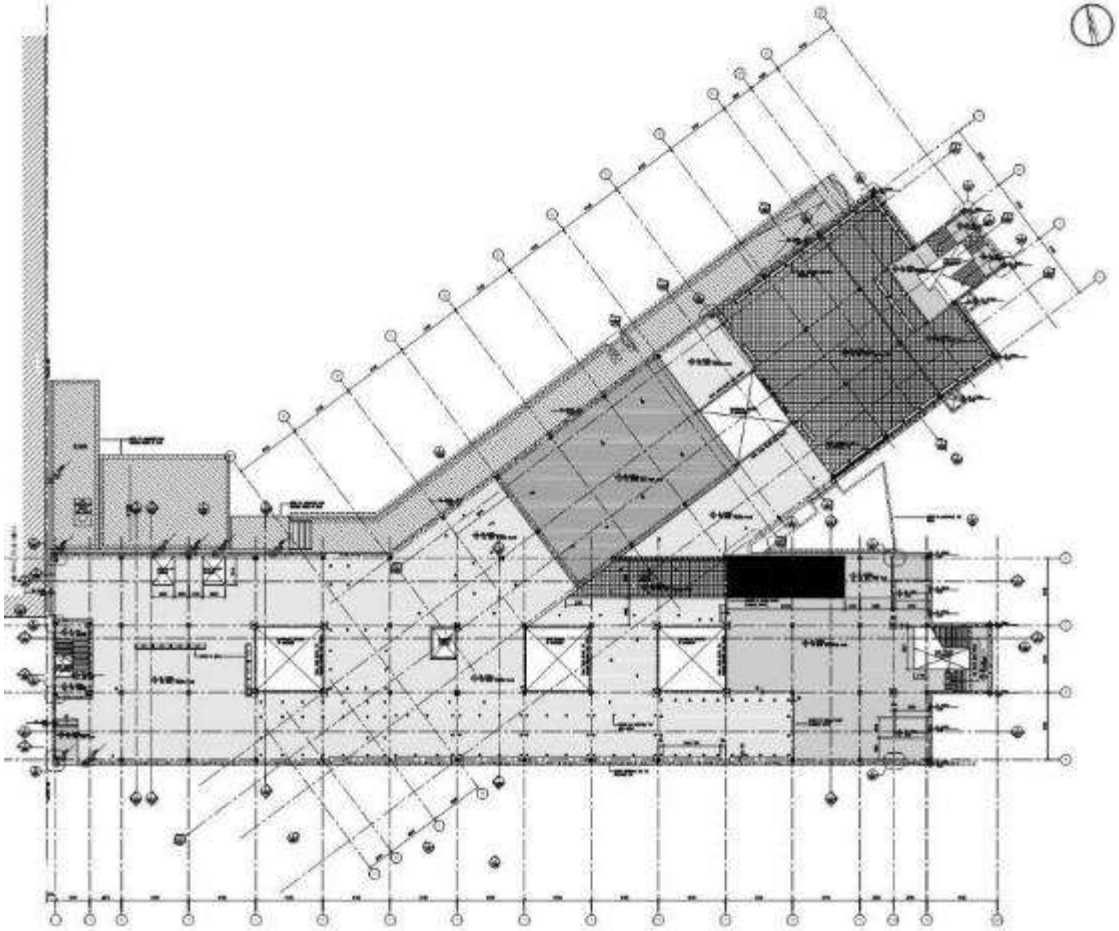

EXIT

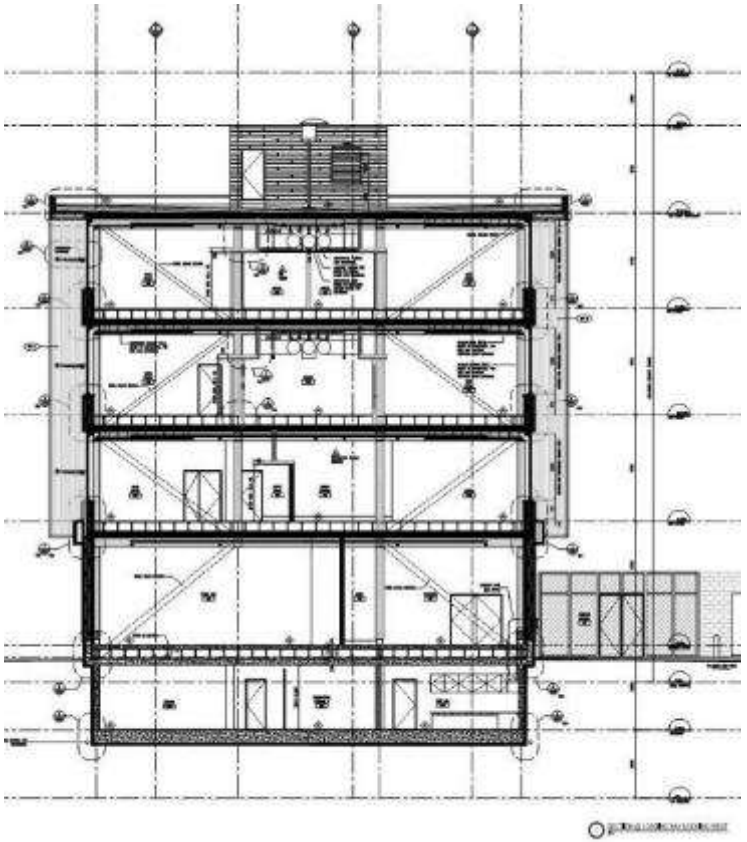
Case Study Two | Mountain Equipment Co-op

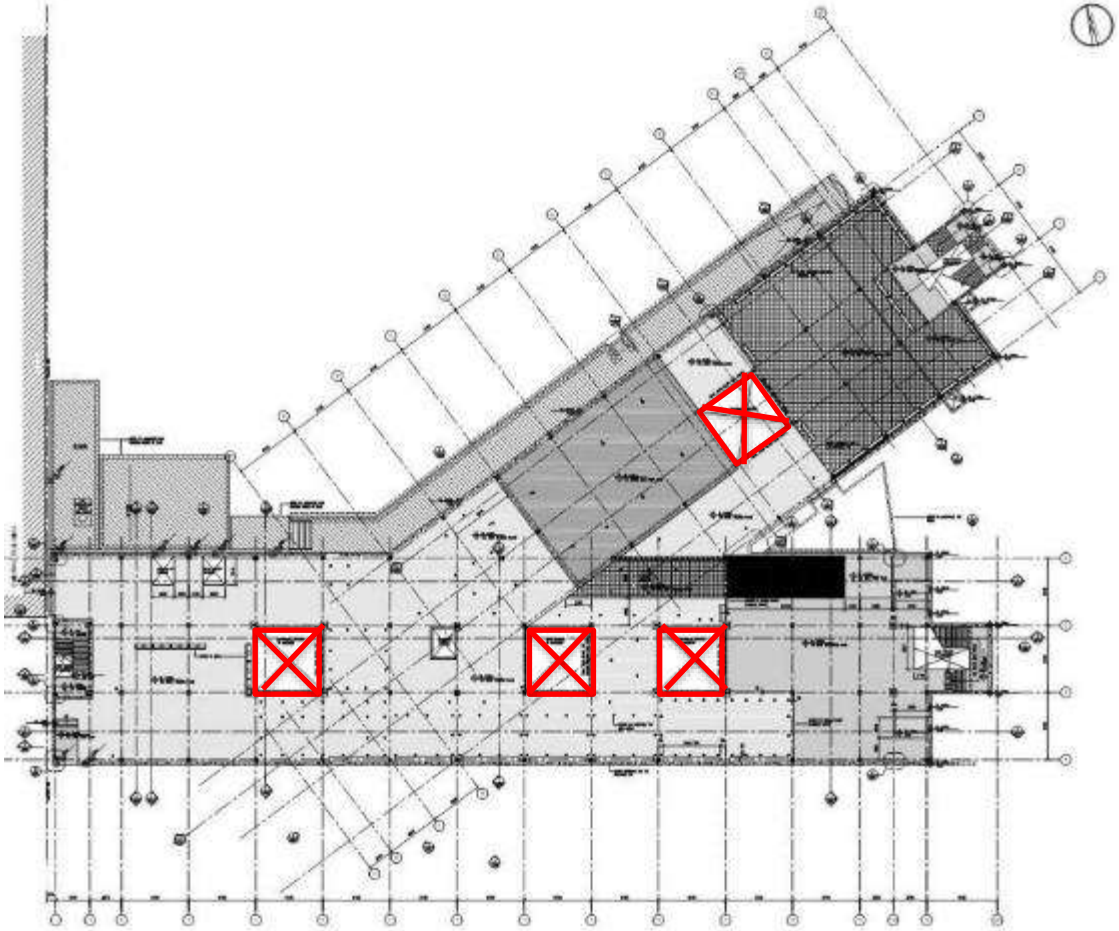

MOUNTAIN
EQUIPMENT
CO-OP

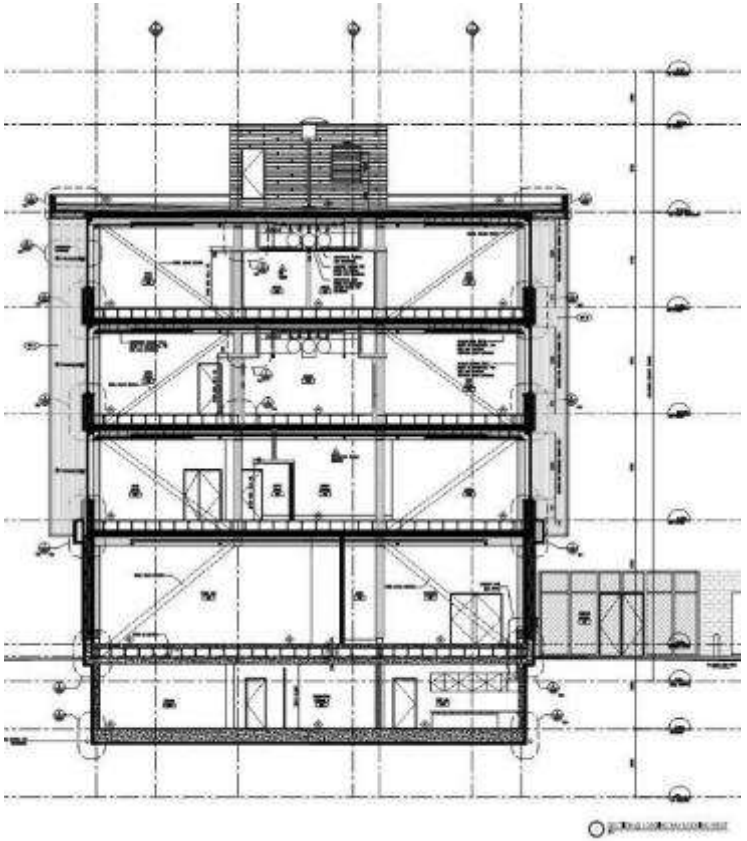

MOUNTAIN
EQUIPMENT
CO-OP
NOW OPEN

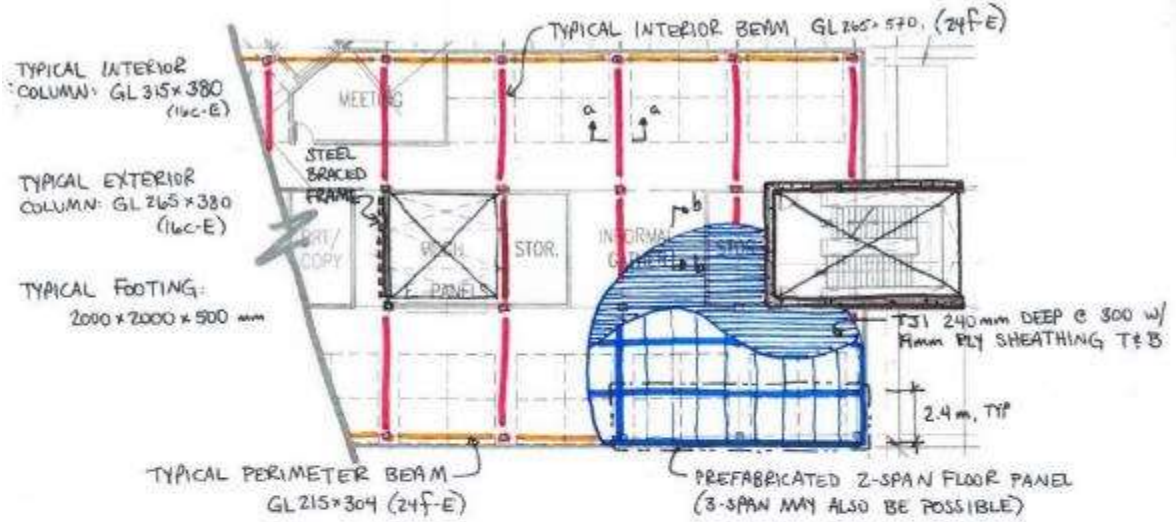
Design |

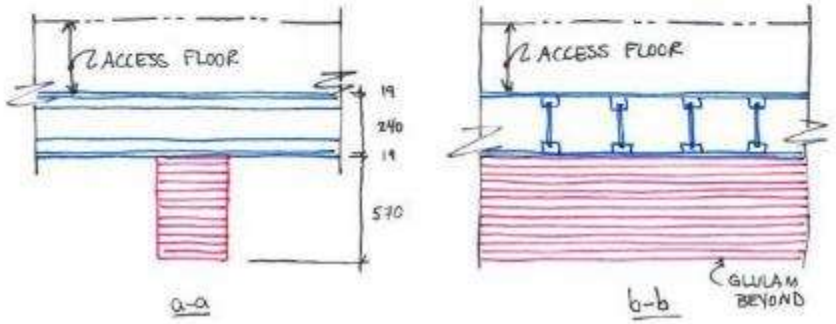


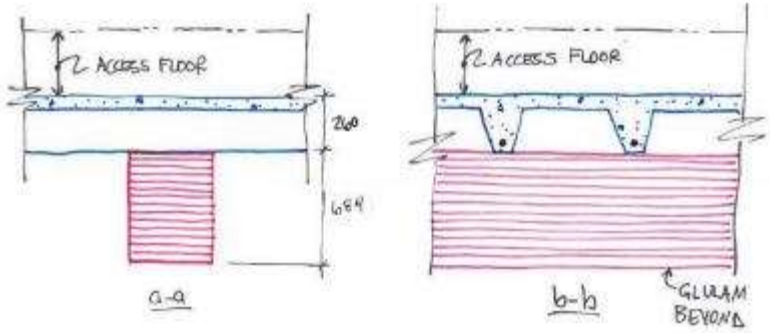




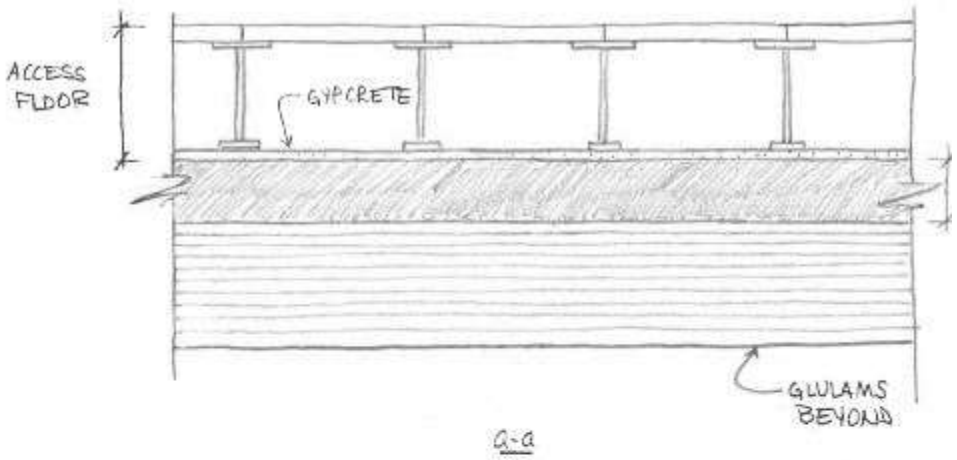




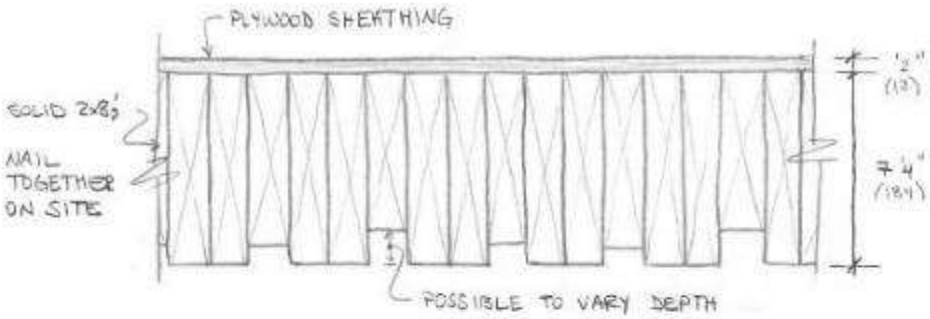




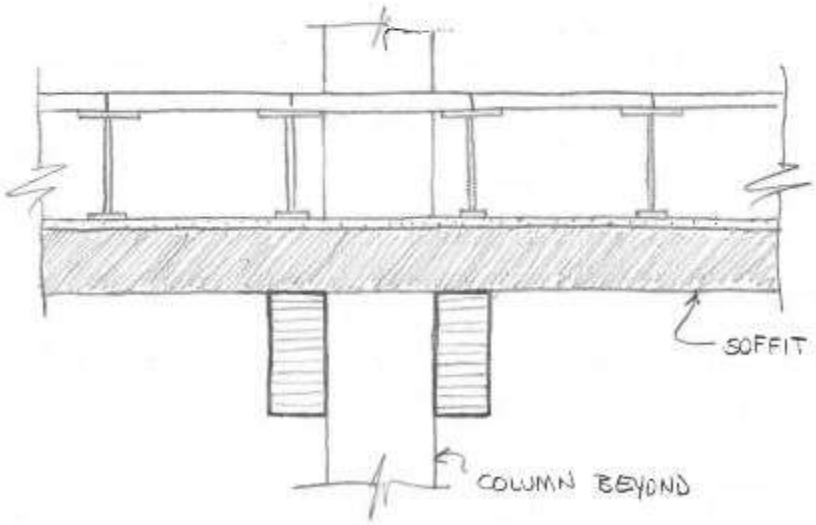
1778
MEC-HO
GLULAM/TJI FLOOR
F+E/TL
06 OCT 2011


ACCESS FLOOR
GYPCRETE
GLULAMS BEYOND

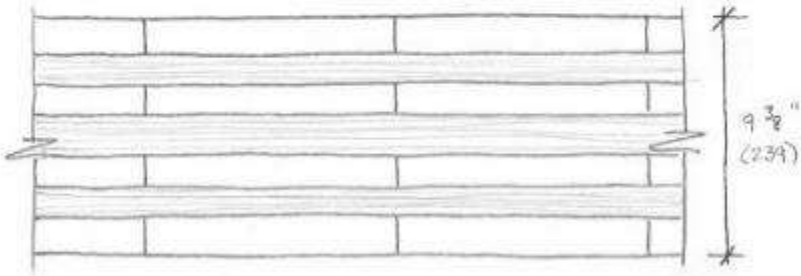
a-a


PLYWOOD SHEATHING
SOLID 2x8's
NAIL TOGETHER ON SITE
7 1/4" (184)
POSSIBLE TO VARY DEPTH

NLT

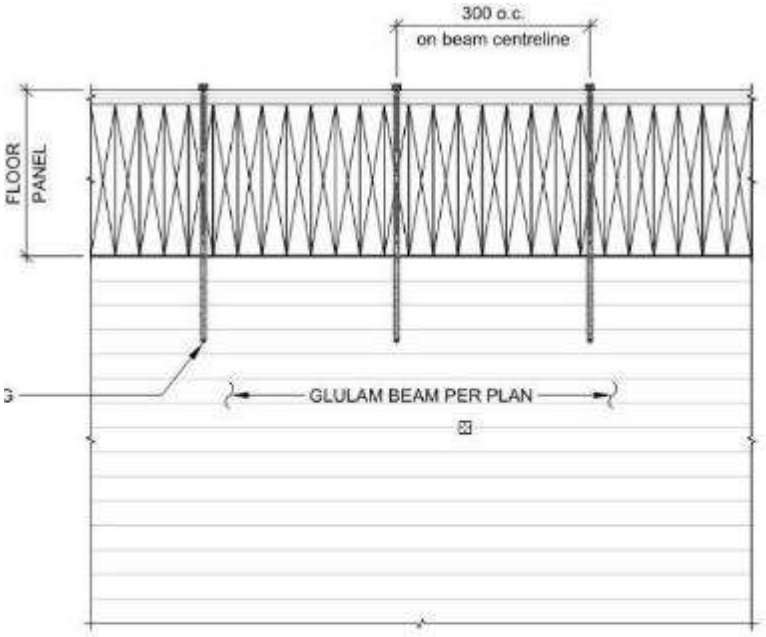

SOFFIT
COLUMN BEYOND

b-b


9 3/8" (239)

CLT

Tender |



7 / - TYP. CONNECTION - PANELS TO GLULAM BEAMS
1 : 10

- 2x8 solid wood NLT panels
- 2x10 panels at snow drift zones and green roof
- Random stack pattern for long span
- ½” plywood and topping
- One hour fire rating (including char reduction)

Construction |

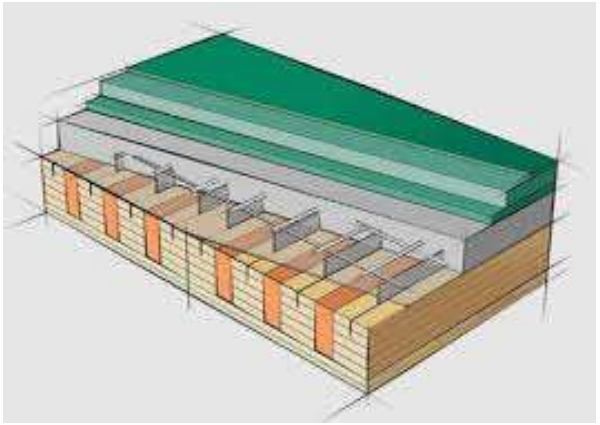

STOP
STOP

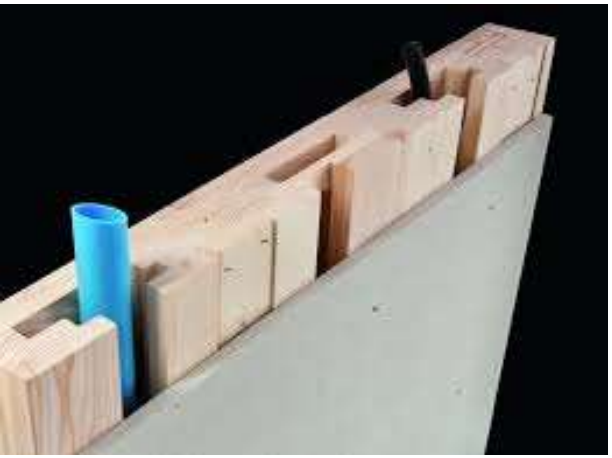

TRUSS


ALLIANCE TRUSS
ALLIANCE TRUSS
ALLIANCE TRUSS
ALLIANCE

The Future of Mass Timber |

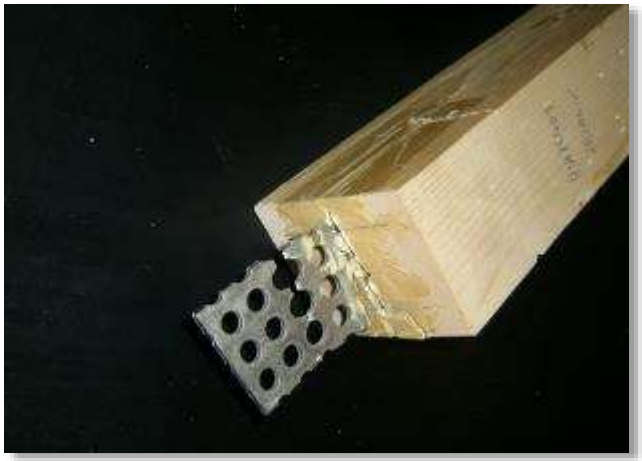
The Future | Innovative Products + Applications



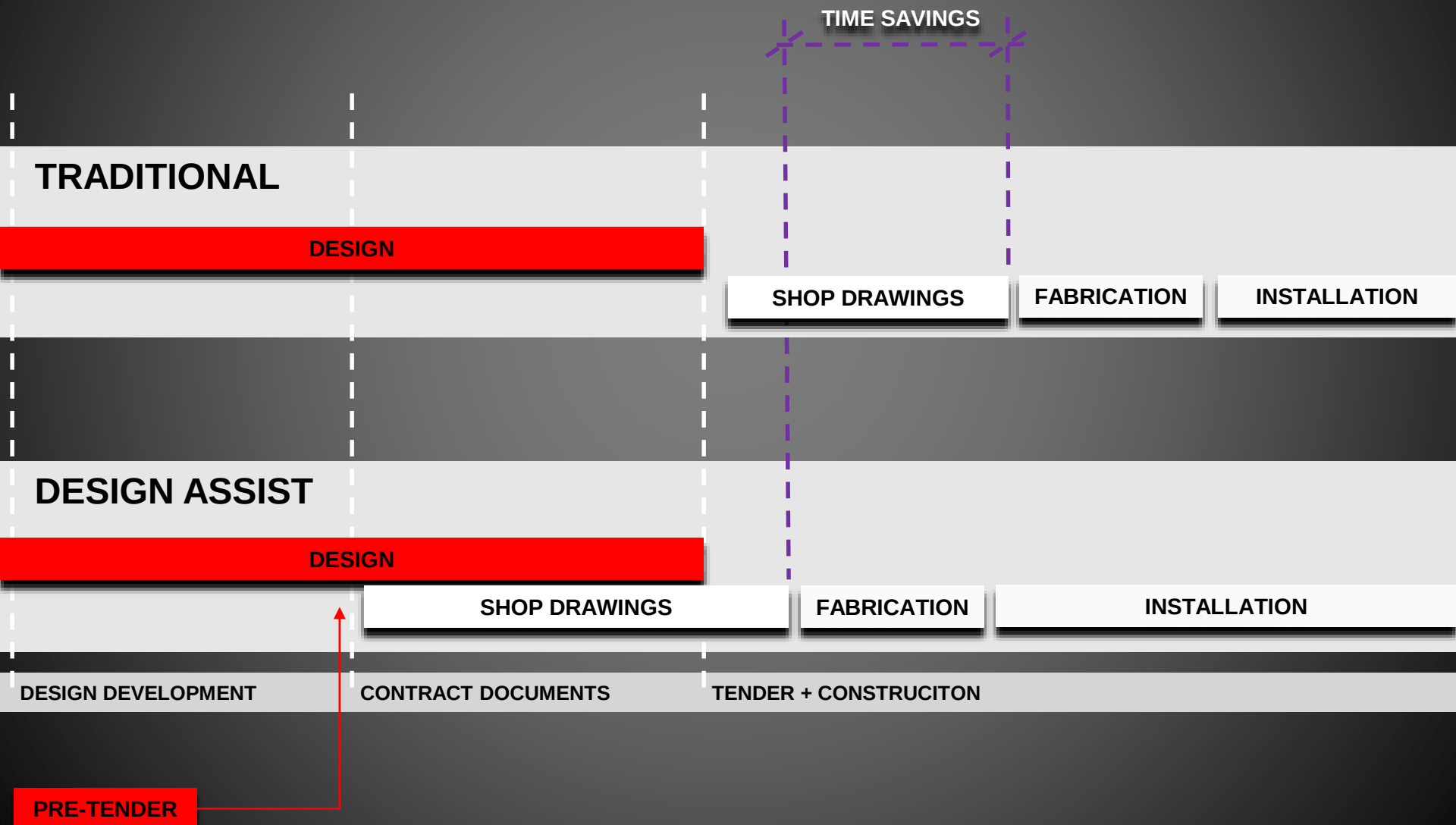


Passive House Institute

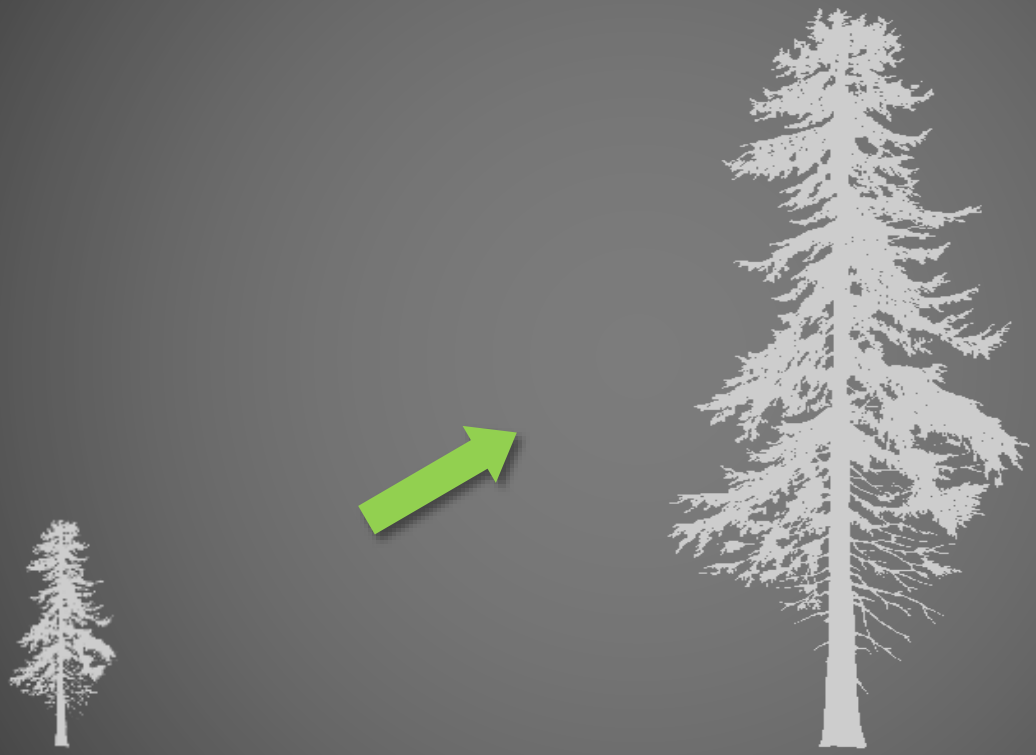
The Future | Innovative Products + Applications



The Future | Procurement

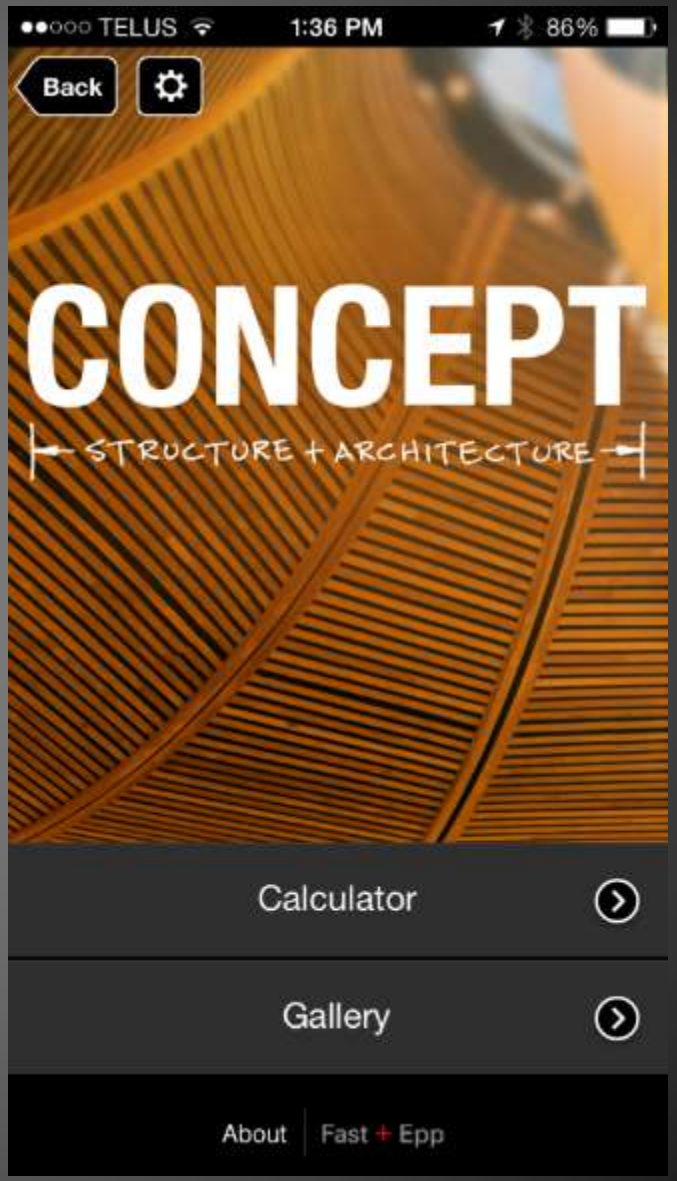


The Future | Tall(er) Wood Buildings

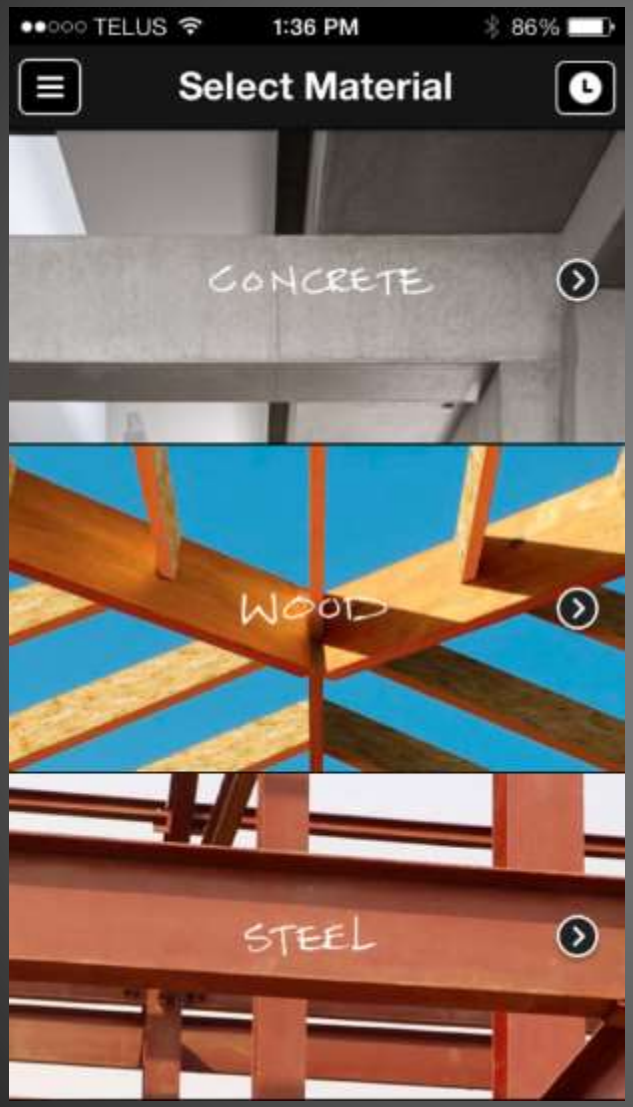


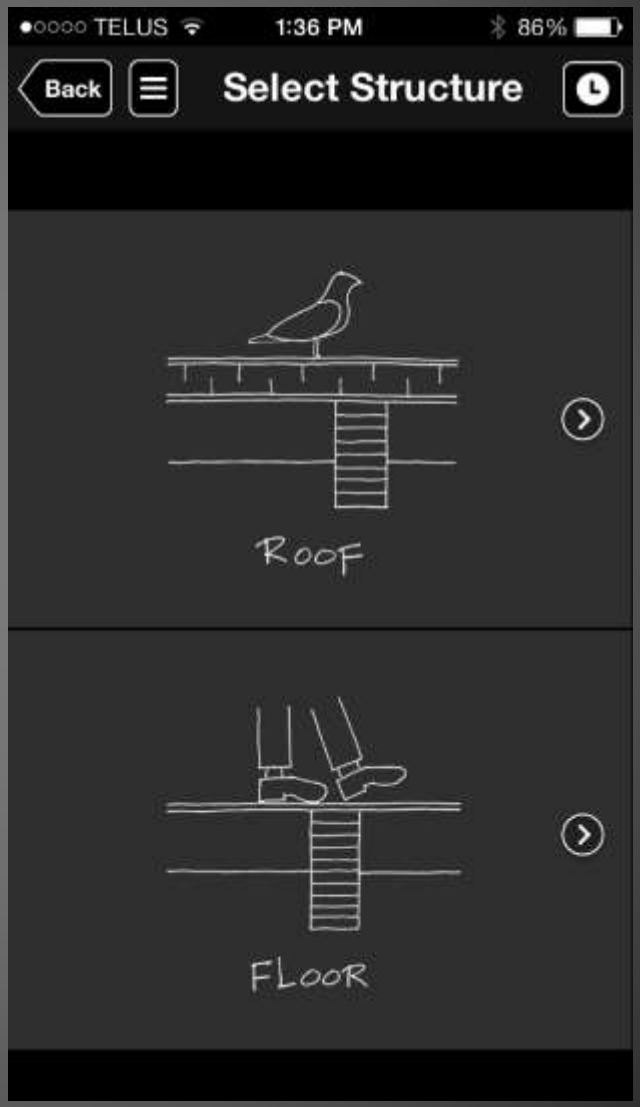
CONCEPT App

- Idea calculator for architects
- Member calculator
- Material gallery

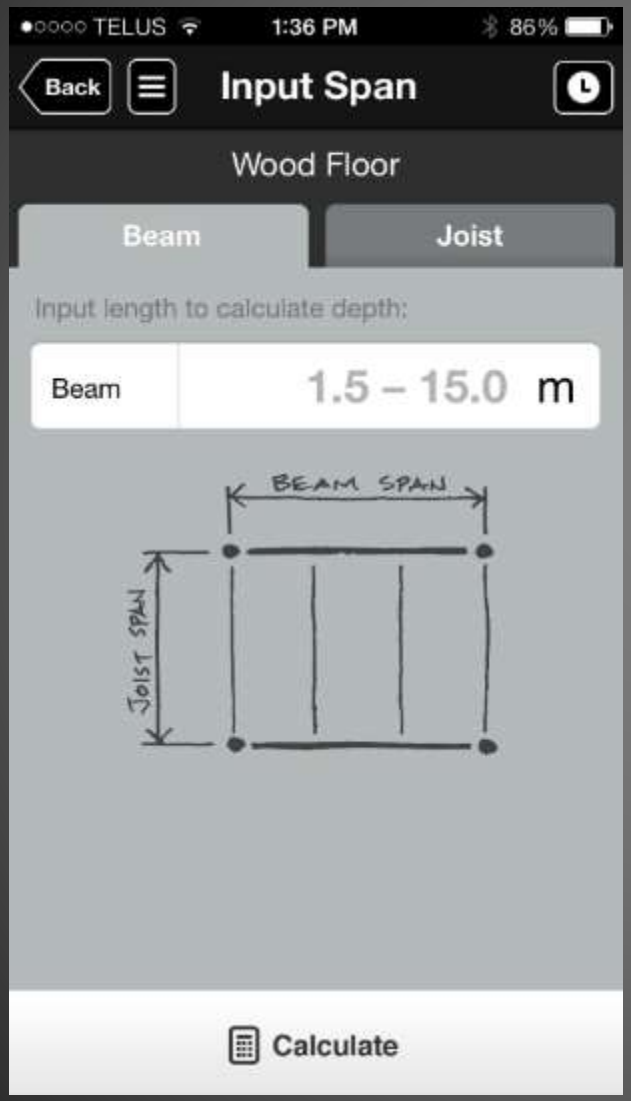


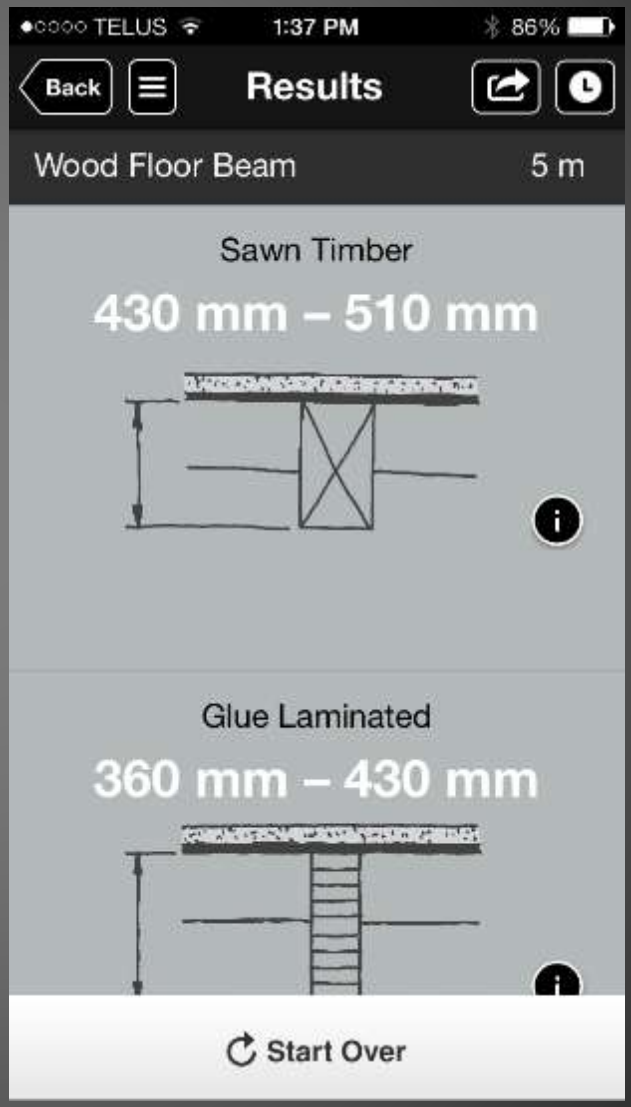
CONCEPT App | Depth Calculator



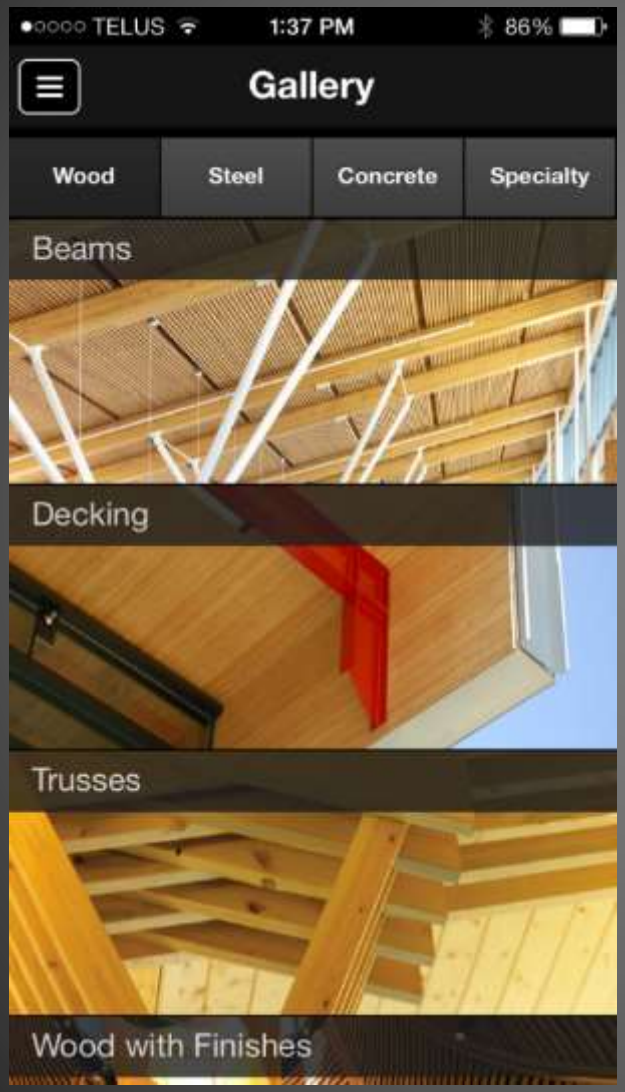


CONCEPT App | Depth Calculator Results

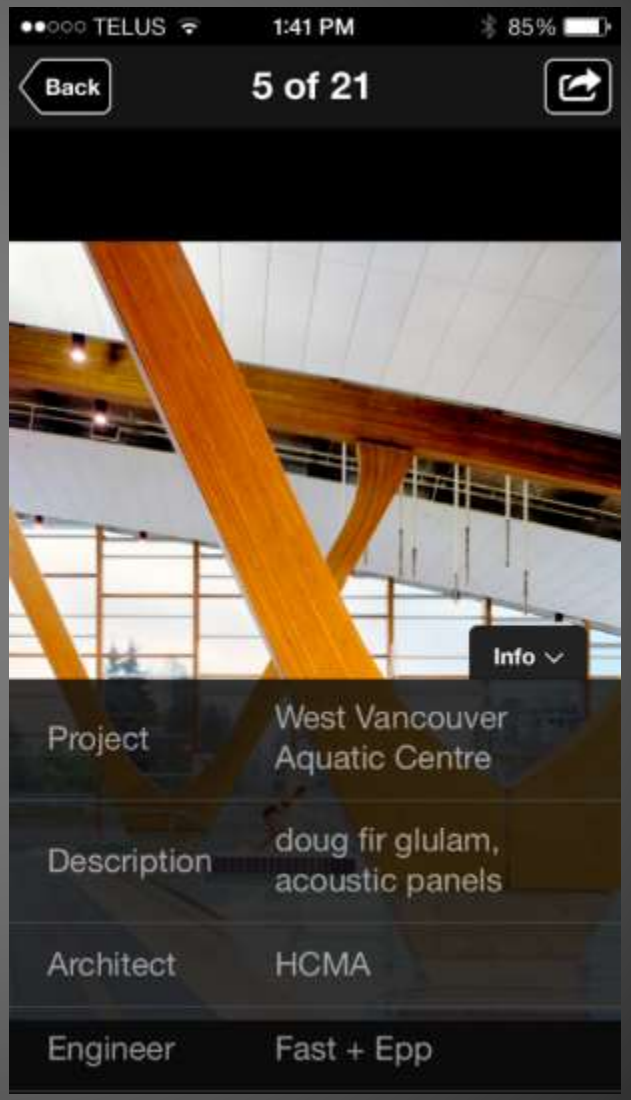




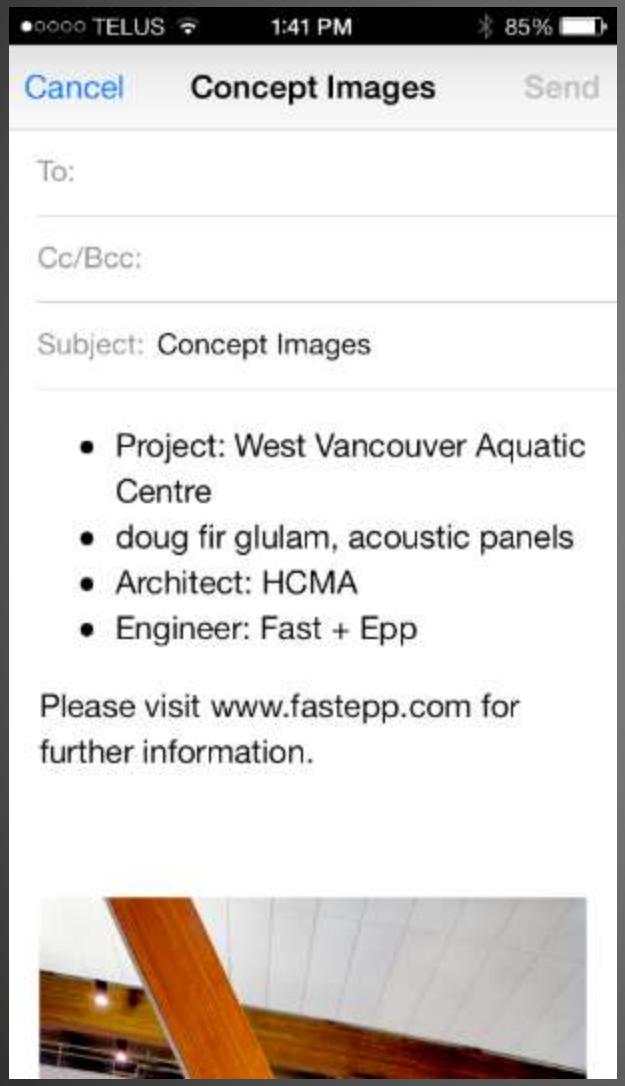
CONCEPT App | Material Gallery



CONCEPT App | Material Gallery



CONCEPT App |



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Thank You