Mass Timber Building Systems: Understanding the Options

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

Course Description

Mass timber represents a rapidly advancing technology that can be utilized as an alternative to steel and concrete to frame a variety of mid- and high-rise building types. This presentation provides an overview of available mass timber systems, with an emphasis on their advantages and unique design considerations. Topics will include connections and fasteners, which differ from those used in light-frame wood construction, including available options and code requirements. Practical design considerations with regard to project location, climate, material sourcing, weather and fire protection, as well as detailing for dimensional variability, will also be reviewed. Cost estimating will be discussed, as successful mass timber projects require a complete understanding of both the system itself and impact on trades.

Learning Objectives

1) Discuss mass timber products and building systems available to North American building designers

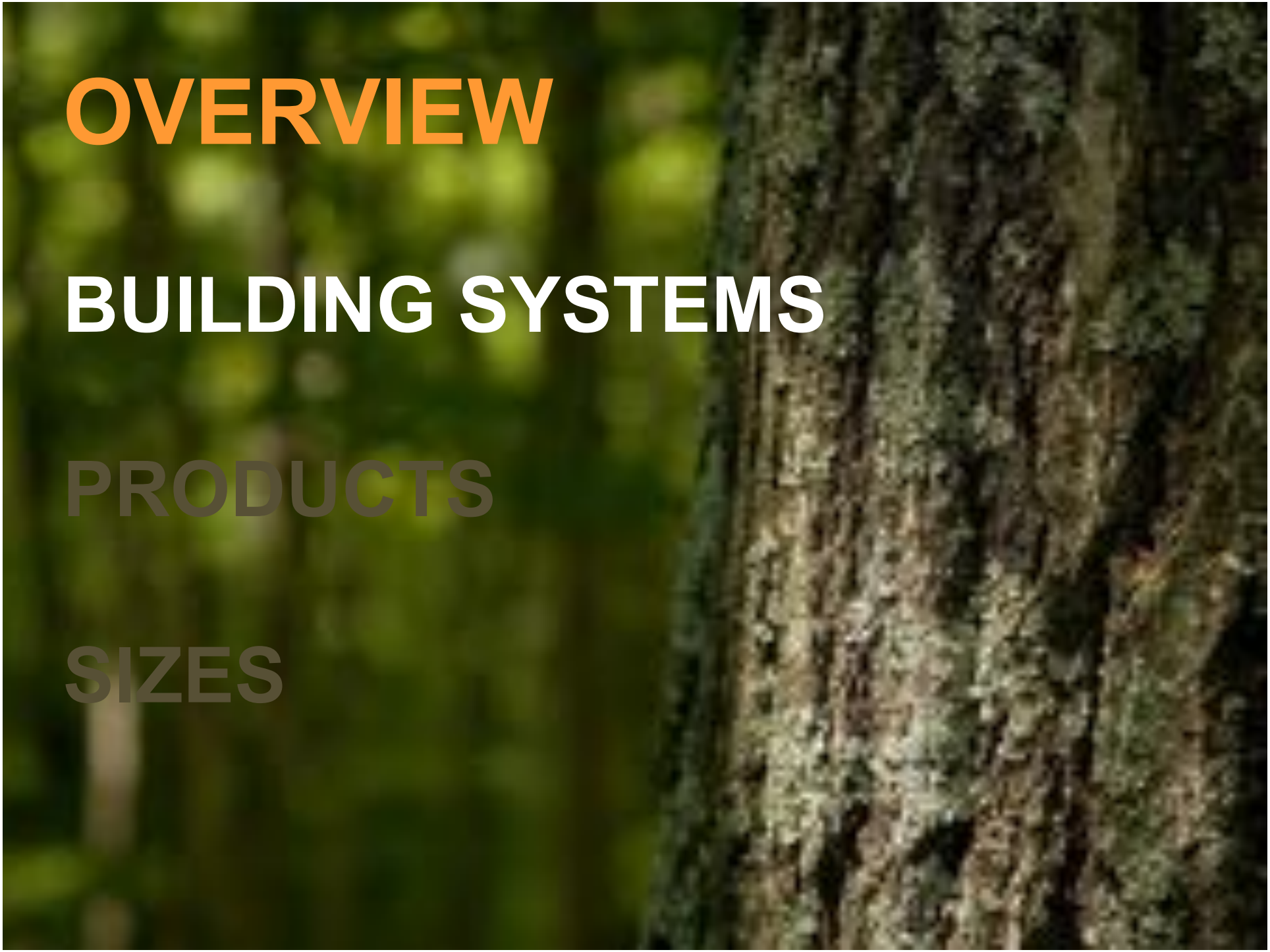
2) Compare properties and performance characteristics of mass timber products and review unique design considerations

3) Examine practical design considerations related to the use of mass timber systems with regard to project location and climate, material sourcing, detailing for dimensional variability, connections, and cost efficiency.

4) Evaluate mass timber cost estimating criteria and review cost data.


OVERVIEW
CONTEXT
DESIGN


OVERVIEW
BUILDING SYSTEMS
PRODUCTS
SIZES


OVERVIEW
BUILDING SYSTEMS
PRODUCTS
SIZES

LIGHT WOOD FRAME (STICK FRAME)

POST + BEAM
(WITH MASS TIMBER OR LIGHT WOOD FRAME FLOORS)

MASS TIMBER (100%)

LIGHT WOOD FRAME

POST + BEAM

MASS TIMBER

LIGHT WOOD FRAME

POST + BEAM

MASS TIMBER FLOORS
(AND SHEAR WALLS)

MASS TIMBER

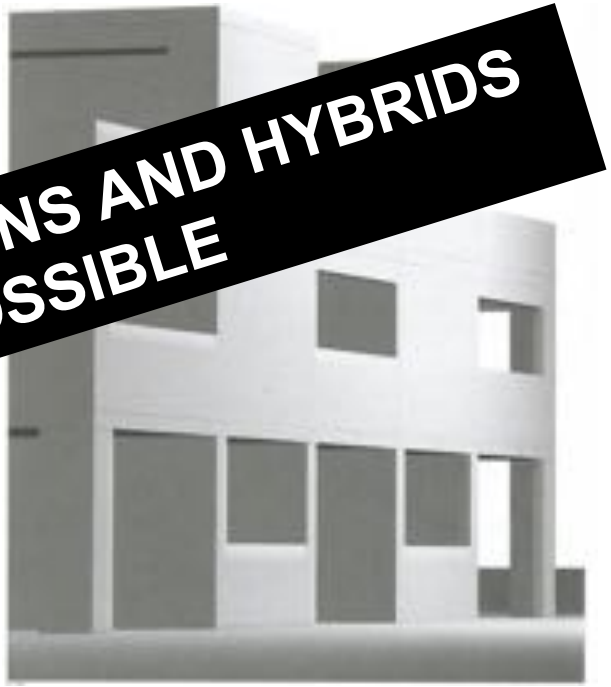
MASS TIMBER WALLS AND
FLOORS

LIGHT WOOD FRAME

POST + BEAM

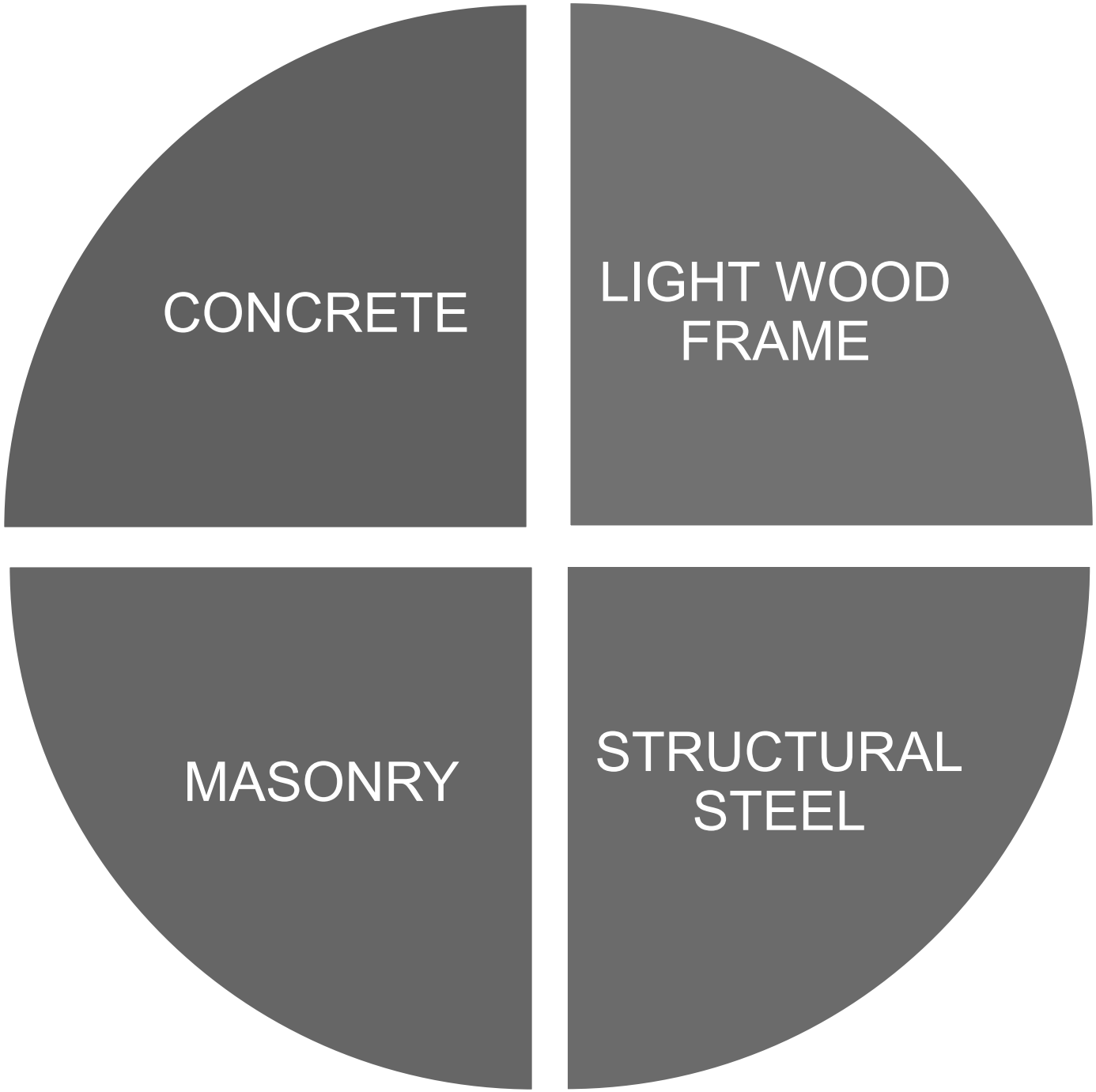
MASS TIMBER FLOORS
(AND SHEAR WALLS)

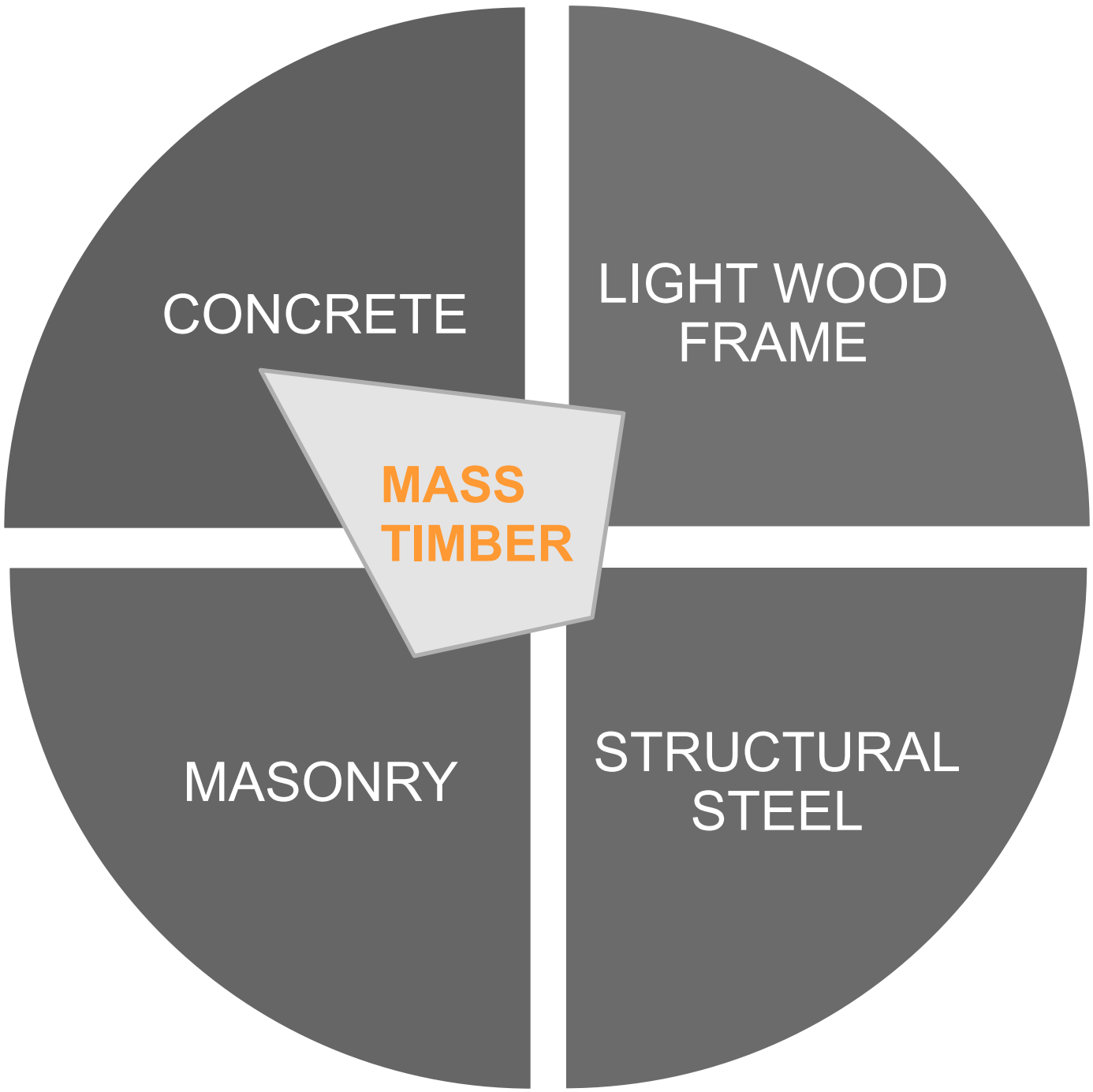
MASS TIMBER



MASS TIMBER WALLS AND
FLOORS

LOTS OF VARIATIONS AND HYBRIDS ARE POSSIBLE


CONCRETE
LIGHT WOOD FRAME
MASONRY
STRUCTURAL STEEL


CONCRETE
LIGHT WOOD FRAME
MASS TIMBER
MASONRY
STRUCTURAL STEEL


“MASS TIMBER CAN BE USED AS ALTERNATIVES TO CONCRETE, MASONRY AND STEEL IN MANY BUILDING TYPES”

SPEED

25%

COMPARED TO CONCRETE

CONSTRUCTION TRAFFIC

1:10

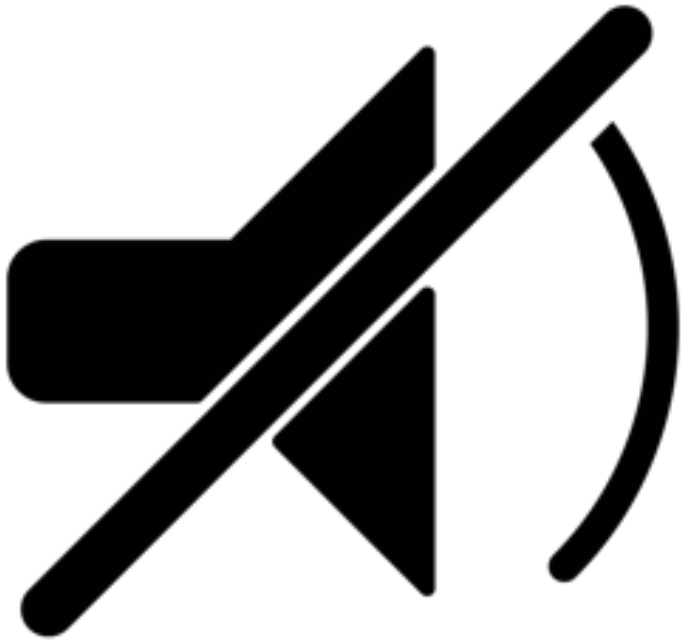
COMPARED TO CONCRETE

DECK LABOR

1:4

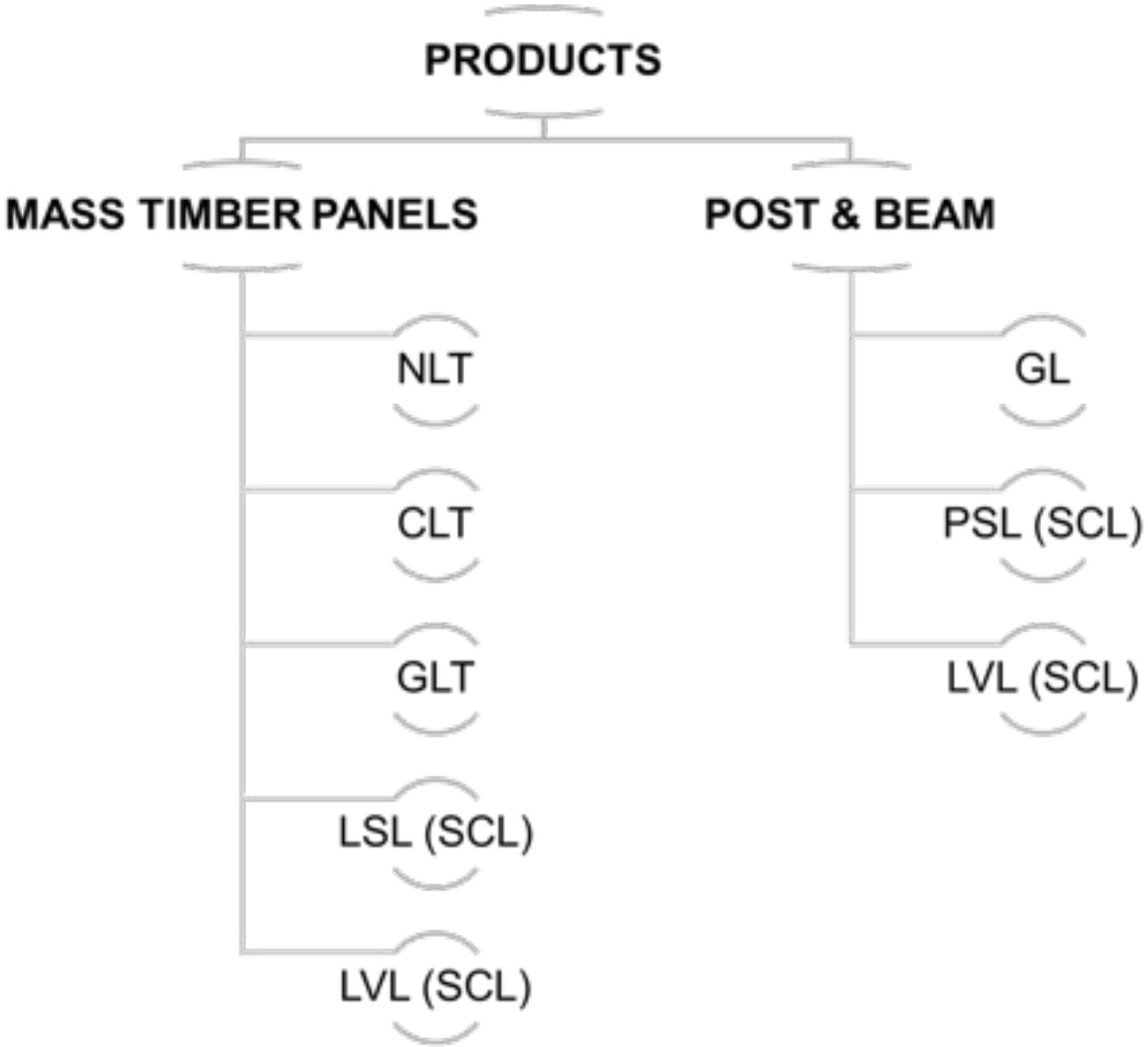
COMPARED TO CONCRETE

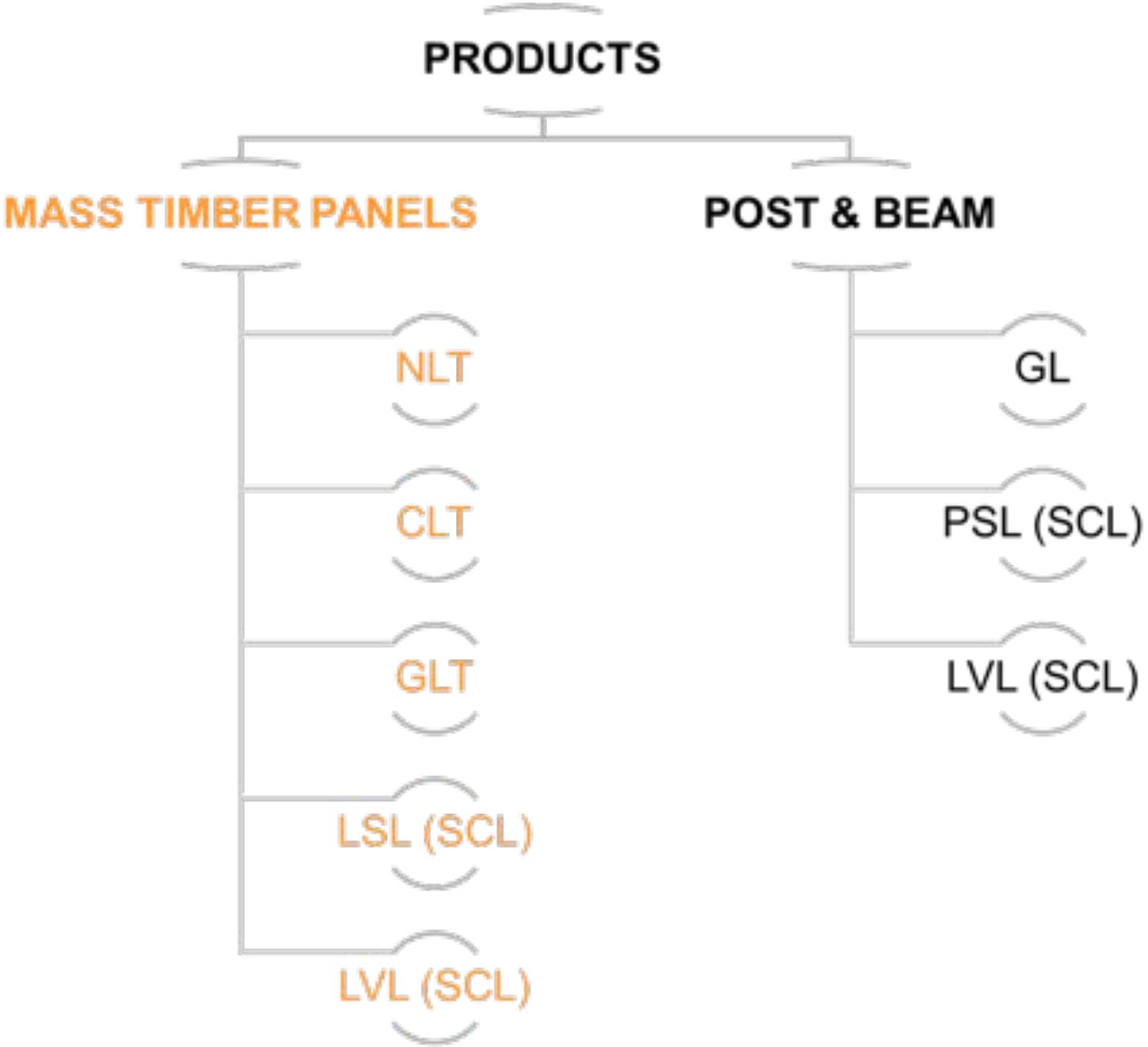
SITE NOISE



COMPARED TO CONCRETE


OVERVIEW
BUILDING SYSTEMS
PRODUCTS
SIZES


PRODUCTS
MASS TIMBER PANELS
POST & BEAM
NLT
CLT
GLT
LSL (SCL)
LVL (SCL)
GL
PSL (SCL)
LVL (SCL)


PRODUCTS
MASS TIMBER PANELS
POST & BEAM
NLT
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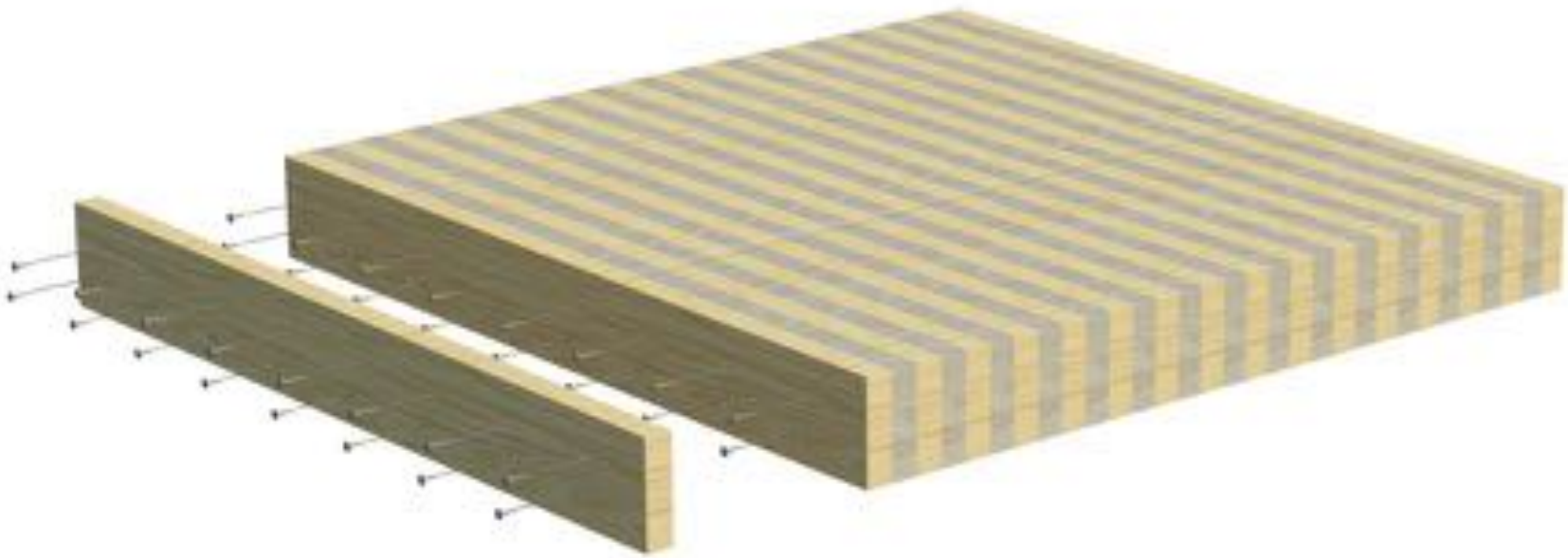
LSL (SCL)
LVL (SCL)
GL
PSL (SCL)
LVL (SCL)

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: S-P-F / Douglas Fir or any other
Floor, roof (and wall) with Plywood sheathing for lateral loads

NLT

Comments:

- Non-standardized panel system but base material covered with grading rules


SWL-2000LBS

NLT

Comments:

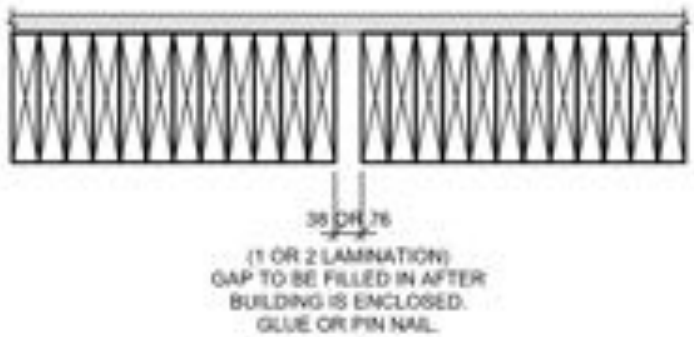
- Non-standardized panel system but base material covered with grading rules
- Specifications

NLT

Comments:

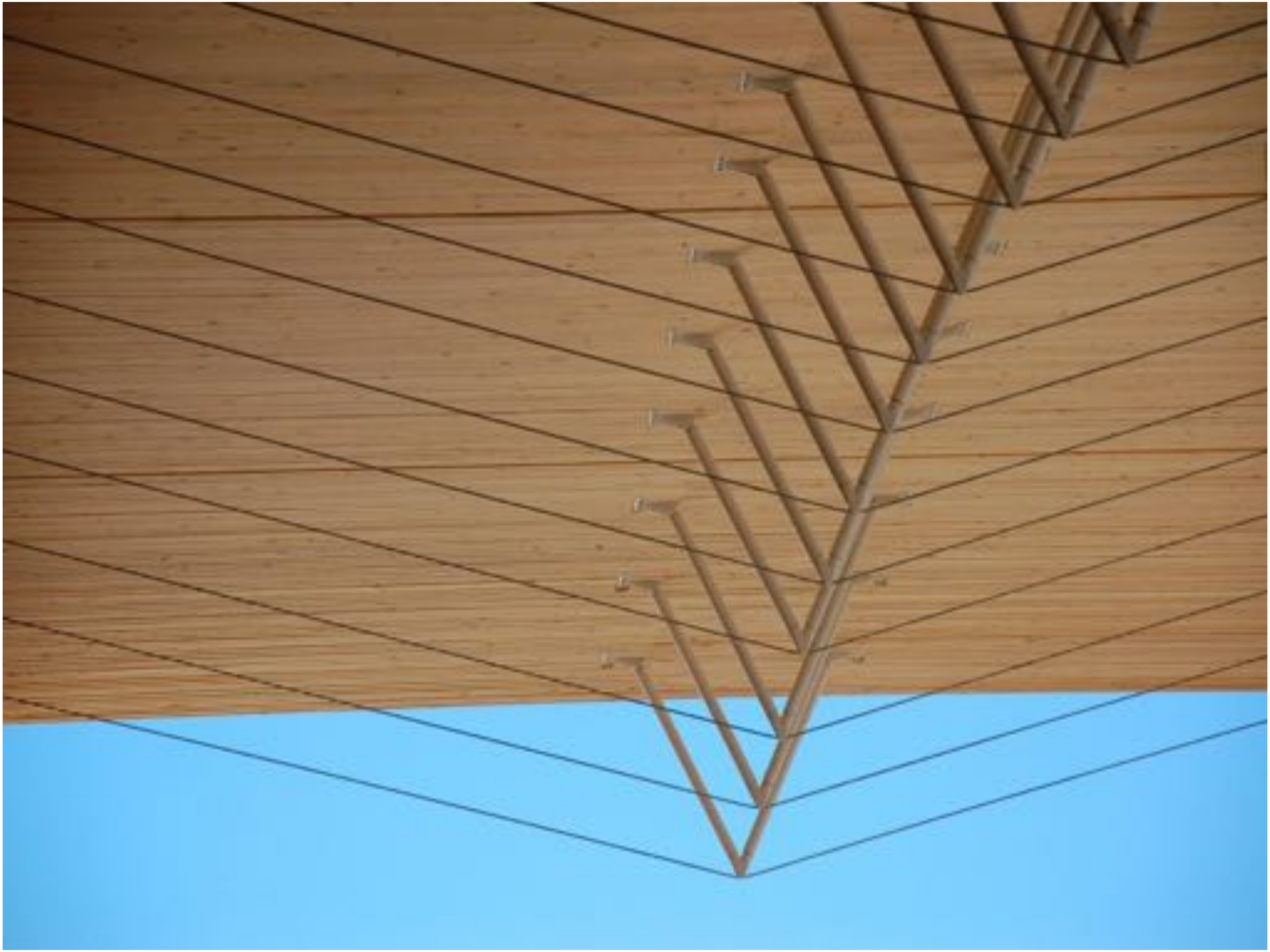
- Non-standardized panel system but base material covered with grading rules
- Specifications
- Requires care with regards to swelling / shrinkage perpendicular to grain

NLT



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

SAMUEL BRIGHOUSE ELEMENTARY, RICHMOND, BC



SFU UNIVERCITY CHILDCARE, BURNABY, BC

MOUNTAIN EQUIPMENT CO-OP, VANCOUVER, BC

GLT

Glue Laminated Timber

GLT

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

System: “glulam beams on edge”

Suppliers: any glulam supplier

Basic Info: S-P-F / D. Fir / Black Spruce / …
Adhesive: Phenol Resorcinol (black) or Melamine (clear)
Adhesive amount: 1% by weight
Floor, roof (and wall) with Plywood sheathing for lateral loads

GLT

Comments:

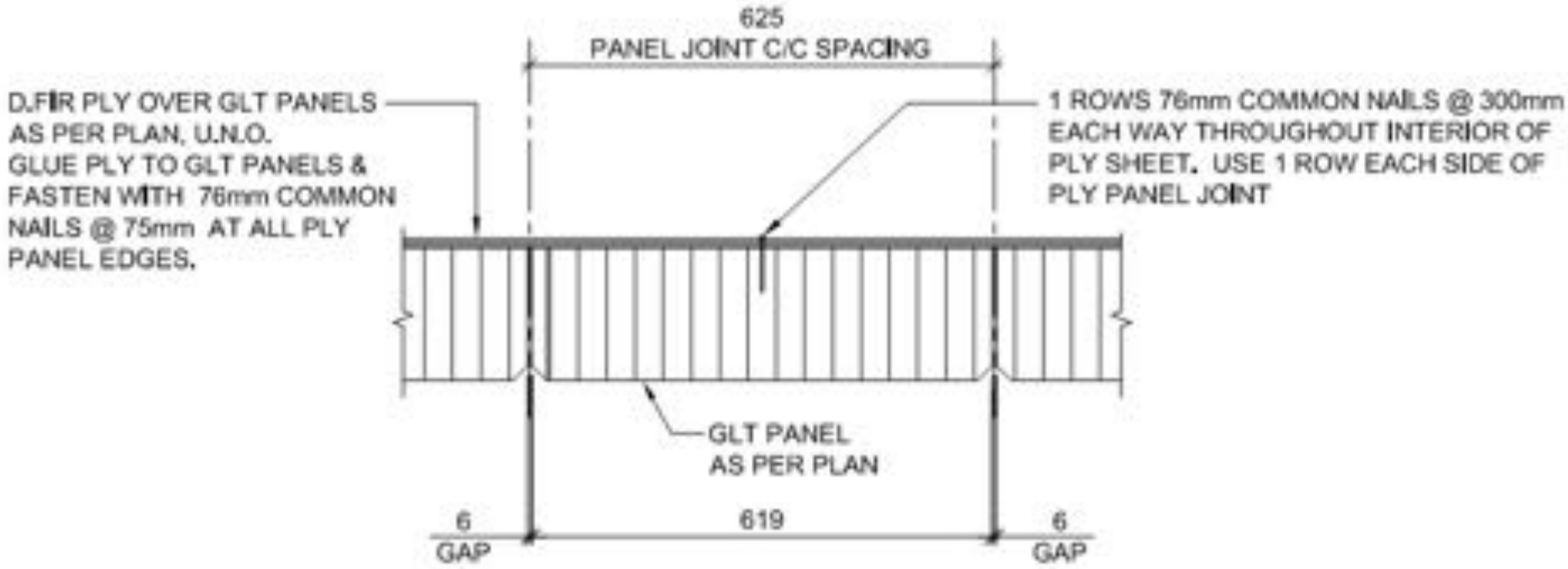
- Standardized product

GLT

Comments:

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

GLT

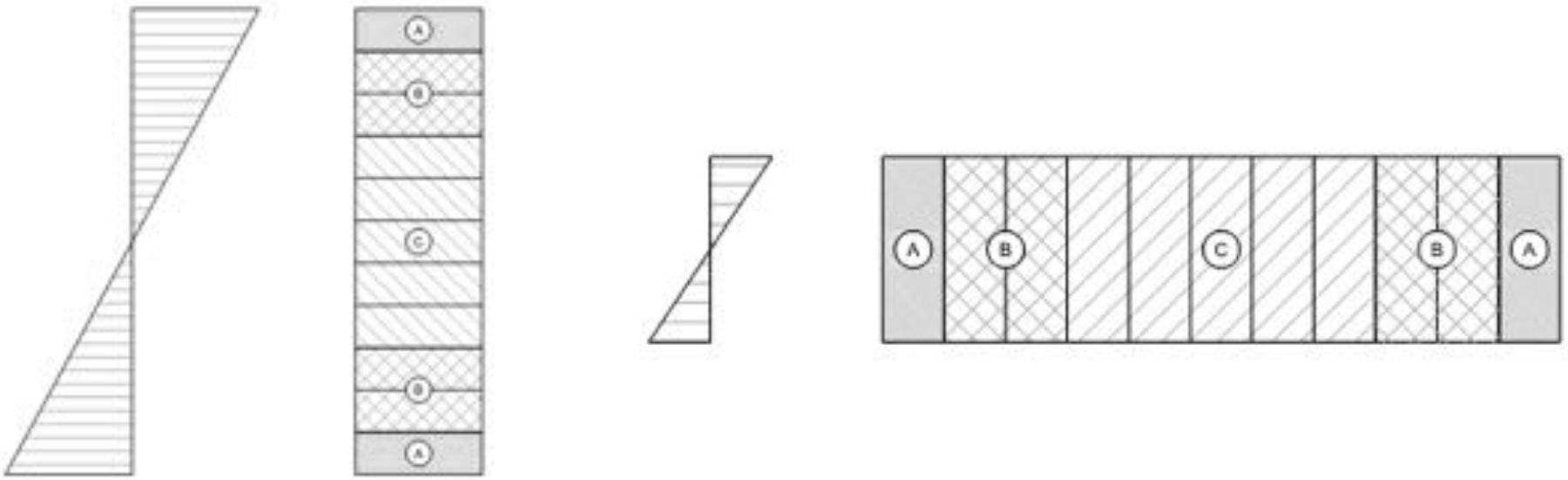

625
PANEL JOINT C/C SPACING
D.FIR PLY OVER GLT PANELS AS PER PLAN, U.N.O. GLUE PLY TO GLT PANELS & FASTEN WITH 76mm COMMON NAILS @ 75mm AT ALL PLY PANEL EDGES.
1 ROWS 76mm COMMON NAILS @ 300mm EACH WAY THROUGHOUT INTERIOR OF PLY SHEET. USE 1 ROW EACH SIDE OF PLY PANEL JOINT
GLT PANEL AS PER PLAN
6
GAP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

GLT

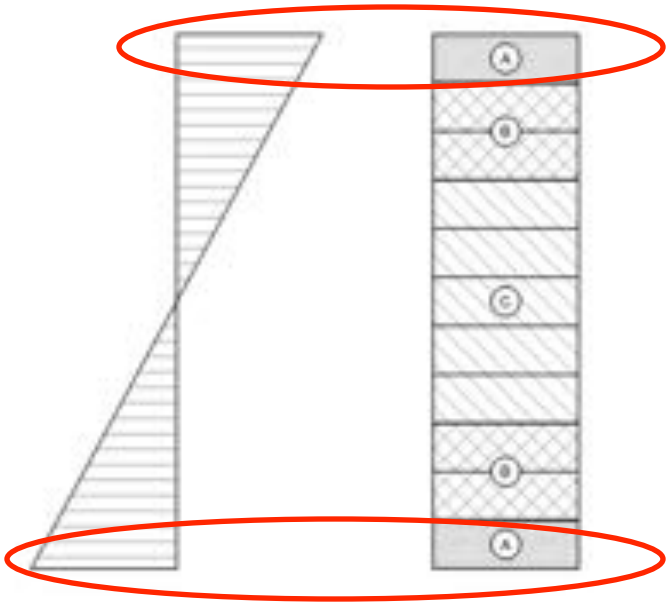
Comments:

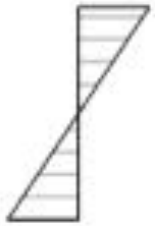
- Standardized product
- Requires care with regards to swelling / shrinkage perpendicular to grain
- Glulam beam ≠ GLT

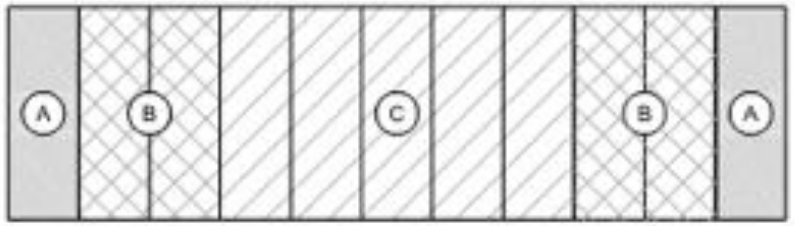
GLT



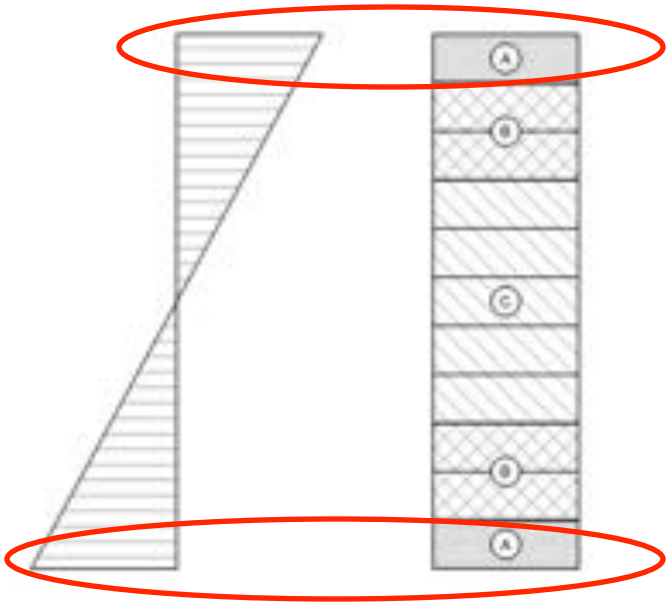
GLT

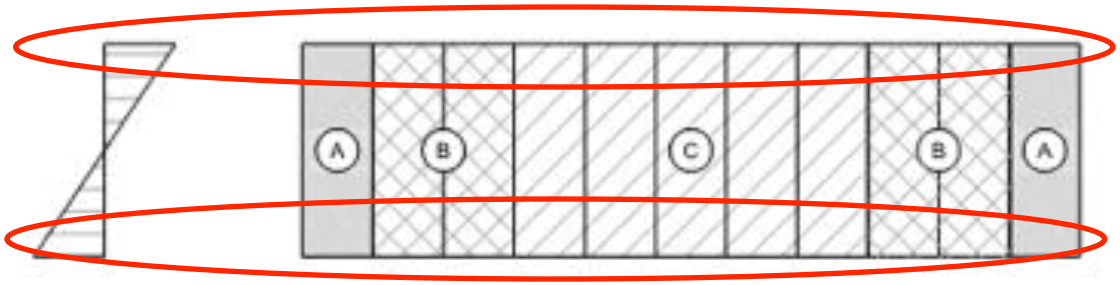






GLT





KIN CENTRE ARENA COMPLEX, PRINCE GEORGE, BC

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), DR Johnson (Riddle, OR), European Suppliers

Basic Info: S-P-F / Black Spruce / …
Adhesive: Polyurethane
Adhesive amount: 4% by weight
Floor, roof and wall with joints detailed for lateral loads

CLT

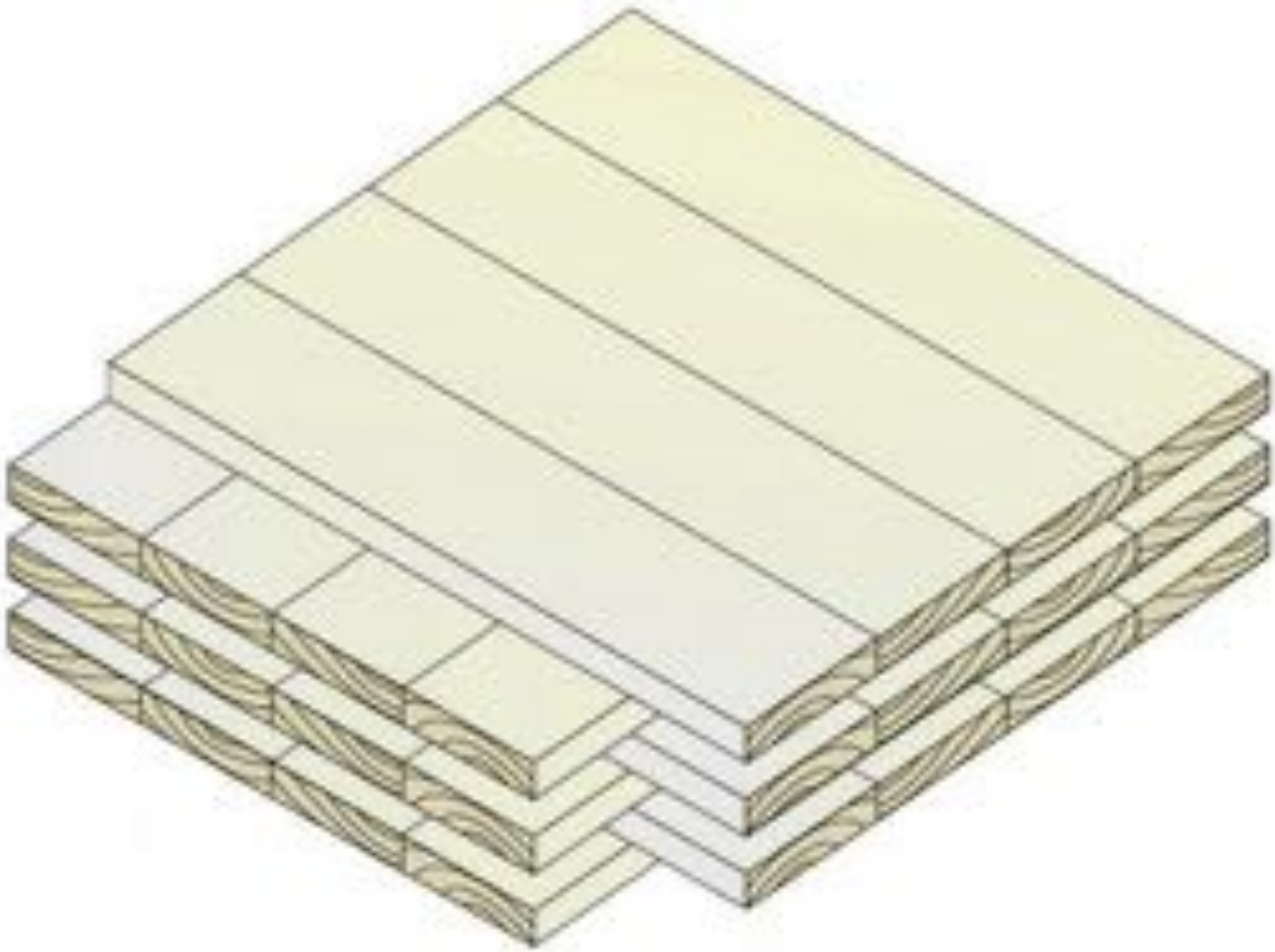
Comments:

- Standardized product

CLT

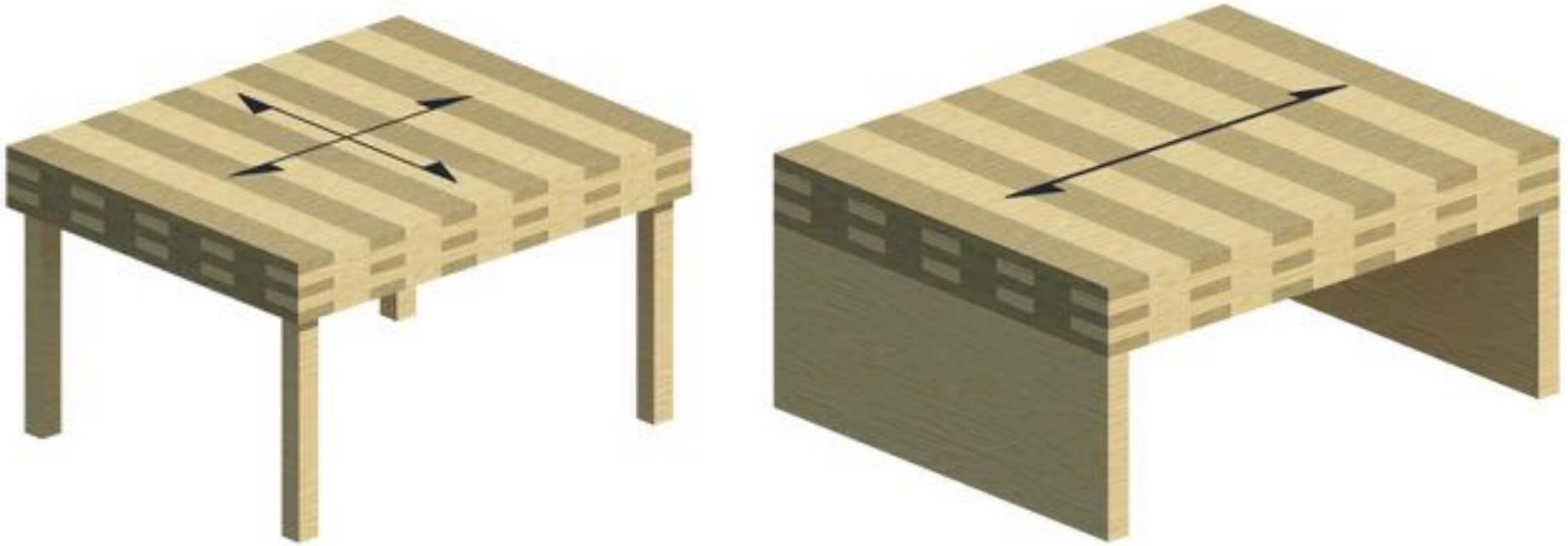
Comments:

- Standardized product
- Dimensionally very stable



Comments:

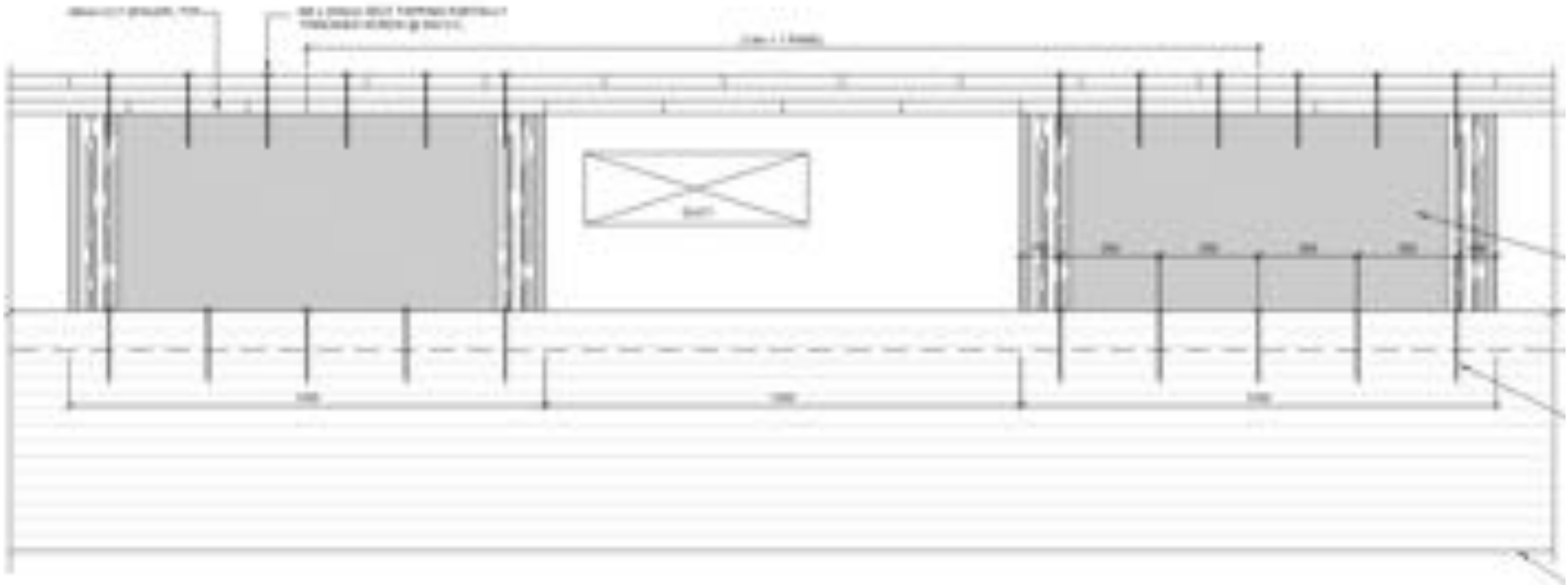
- Standardized product
- Dimensionally very stable
- Two directional span capabilities

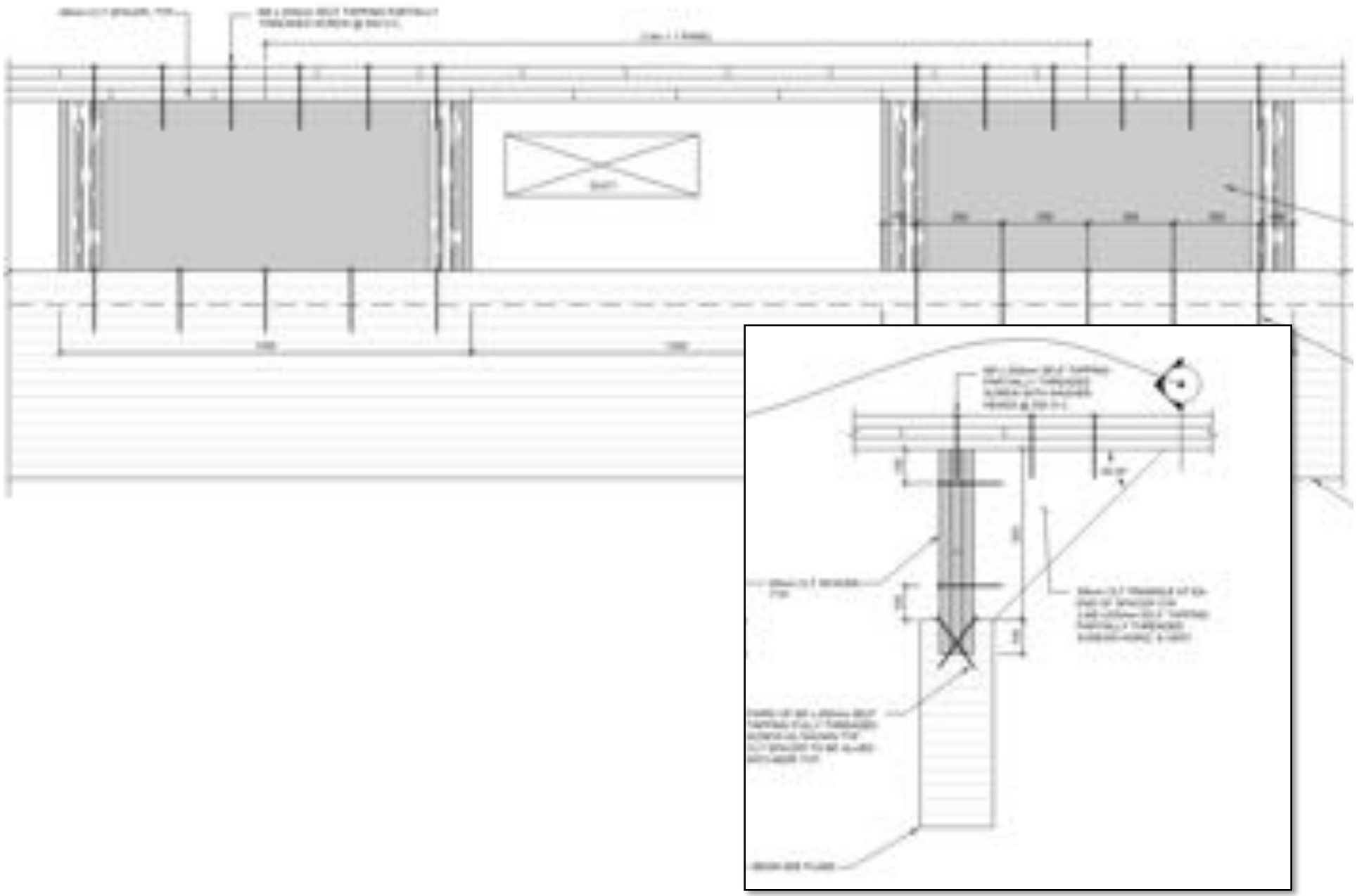


UHNBC LEARNING & DEVELOPMENT CENTRE, PRINCE GEORGE, BC


STERLING


CAUTION





UBC STUDENT RESIDENCE

SCL - LSL

Laminated Strand Lumber

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!)

LSL

Comments:

- Standardized product

LSL

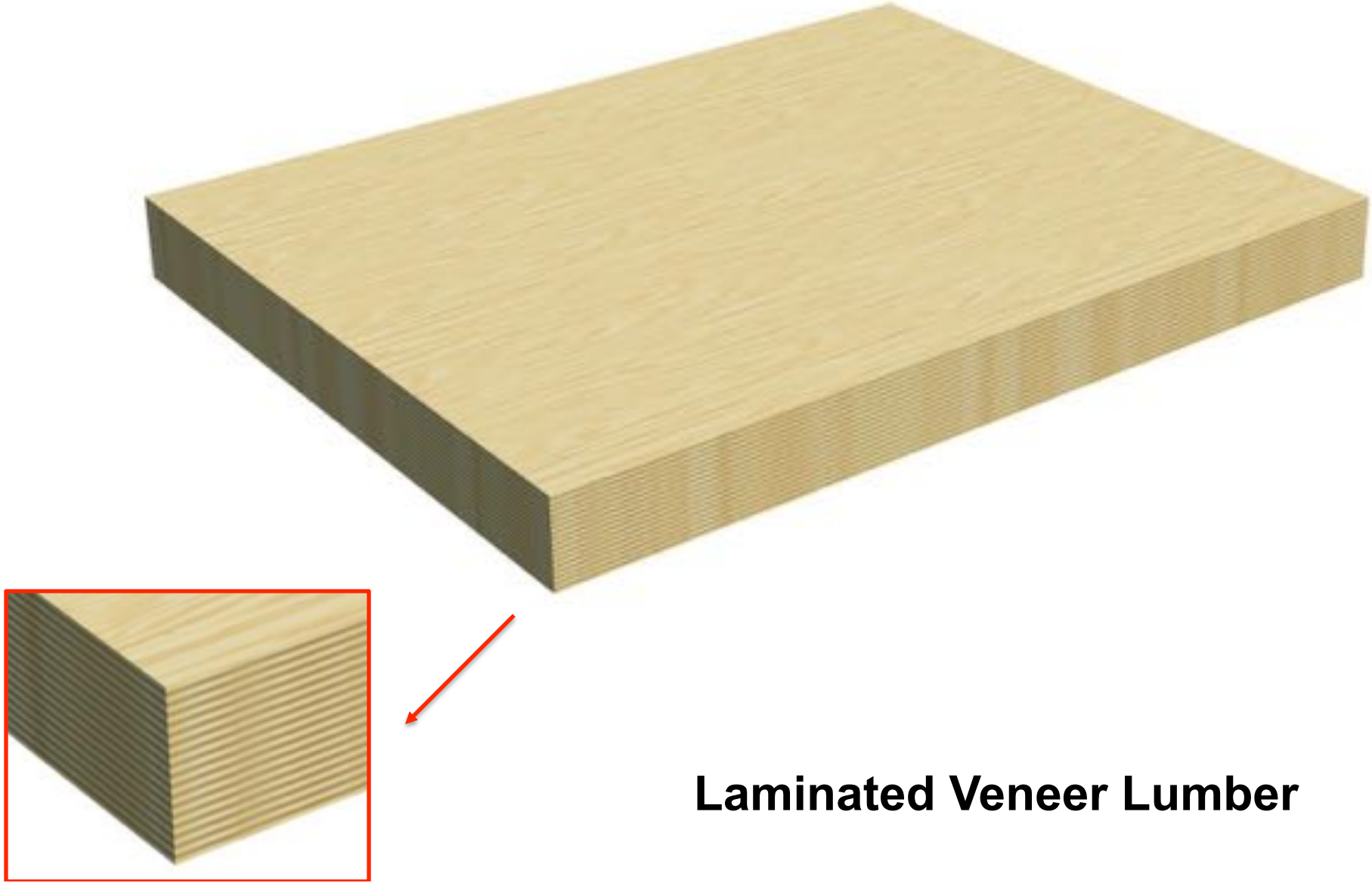
Comments:

- Standardized product
- Dimensionally stable in plan, sensitive to moisture in its thickness

GILMORE SKYTRAIN STATION, BURNABY, BC

FALSE CREEK COMMUNITY CENTRE, VANCOUVER, BC

SCL - LVL



Laminated Veneer Lumber

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!)

LVL

Comments:

- Standardized product

LVL

Comments:

- Standardized product
- Dimensionally stable in plan (can even add cross layers), sensitive to moisture in its thickness

PARASOL, SEVILLA, SPAIN

SCL - SECONDARY LAMINATED LVL

SECONDARY LAMINATED 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

SECONDARY LAMINATED LVL

Comments:

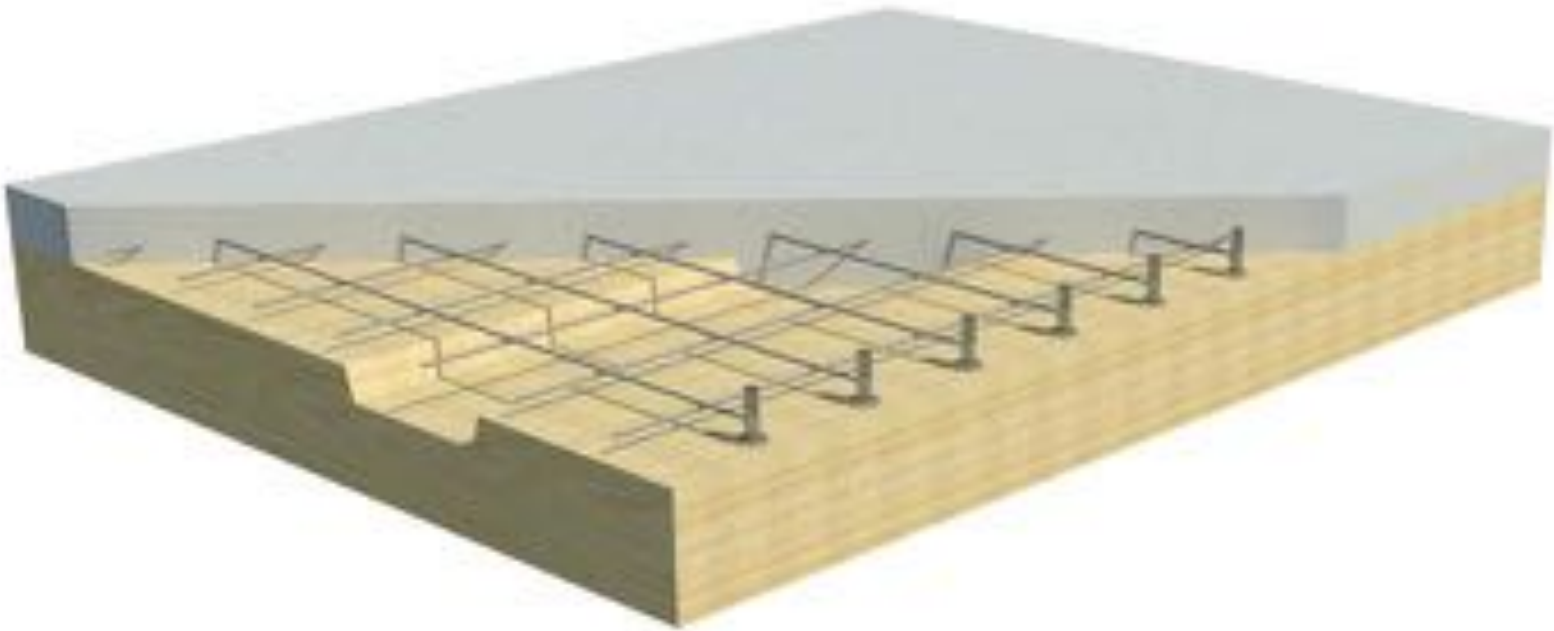
- Standardized product

SECONDARY LAMINATED LVL

Comments:

- Standardized product
- Dimensionally sensitive in plan, stable in its thickness. Requires care with regards to swelling / shrinkage perpendicular to grain

WCC



Wood – Concrete - Composite

WCC

Alternative Names: Timber – Concrete – Composite

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

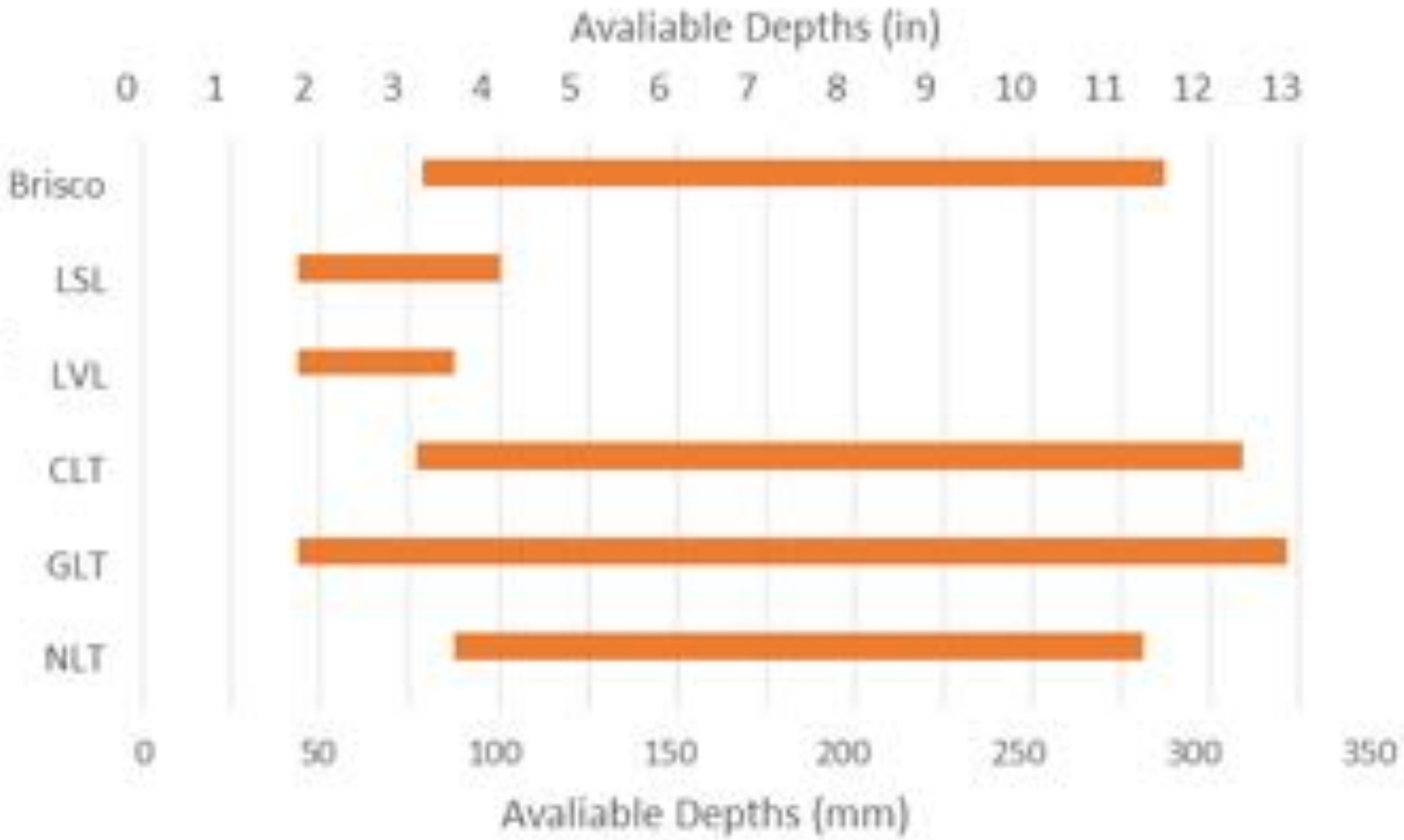
Base layer can be nearly any solid wood panel

Connector supplied by wood panel supplier or general contractor

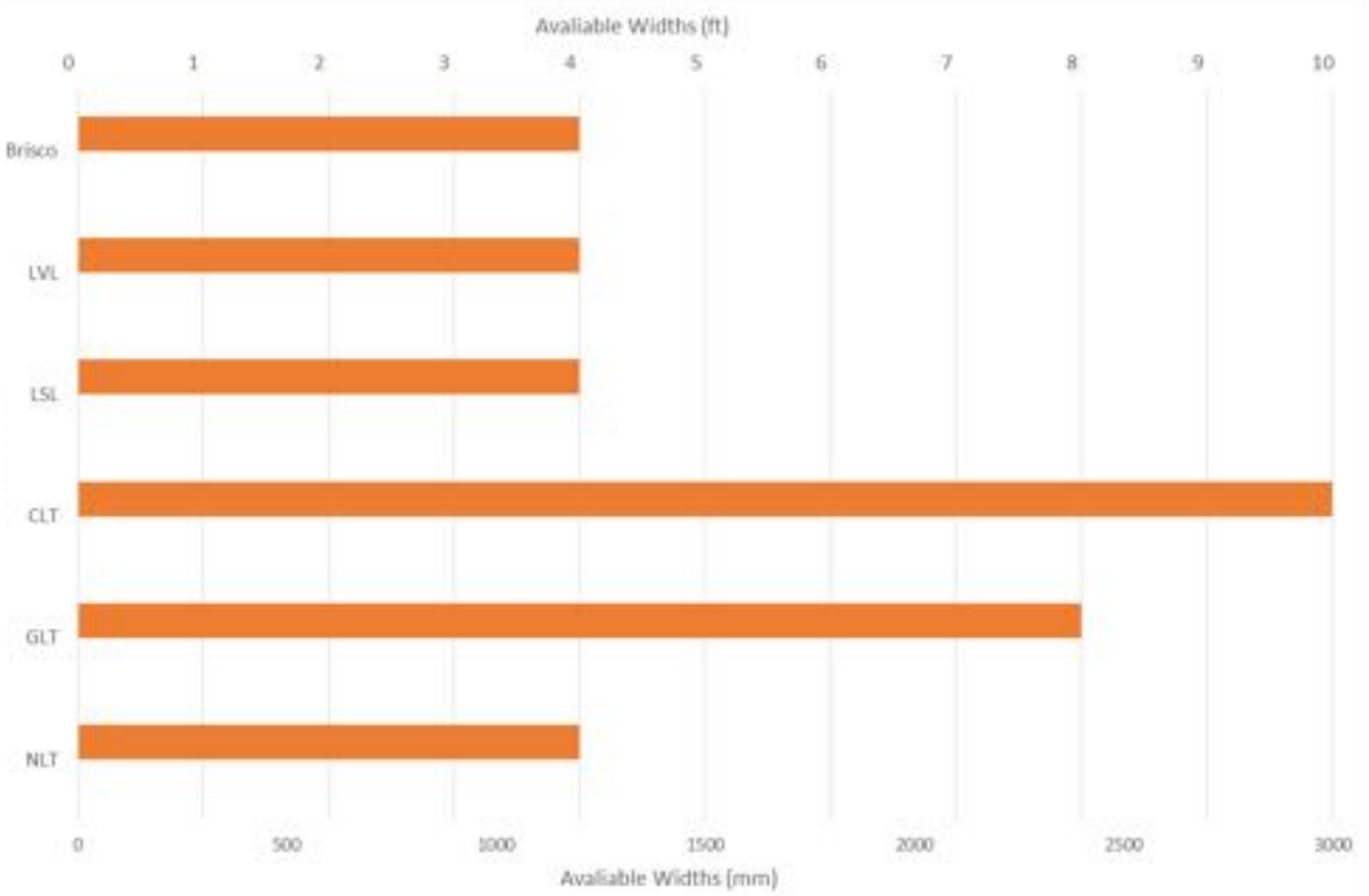
“Free”, stiff and strong diaphragm


OVERVIEW
BUILDING SYSTEMS
PRODUCTS
SIZES

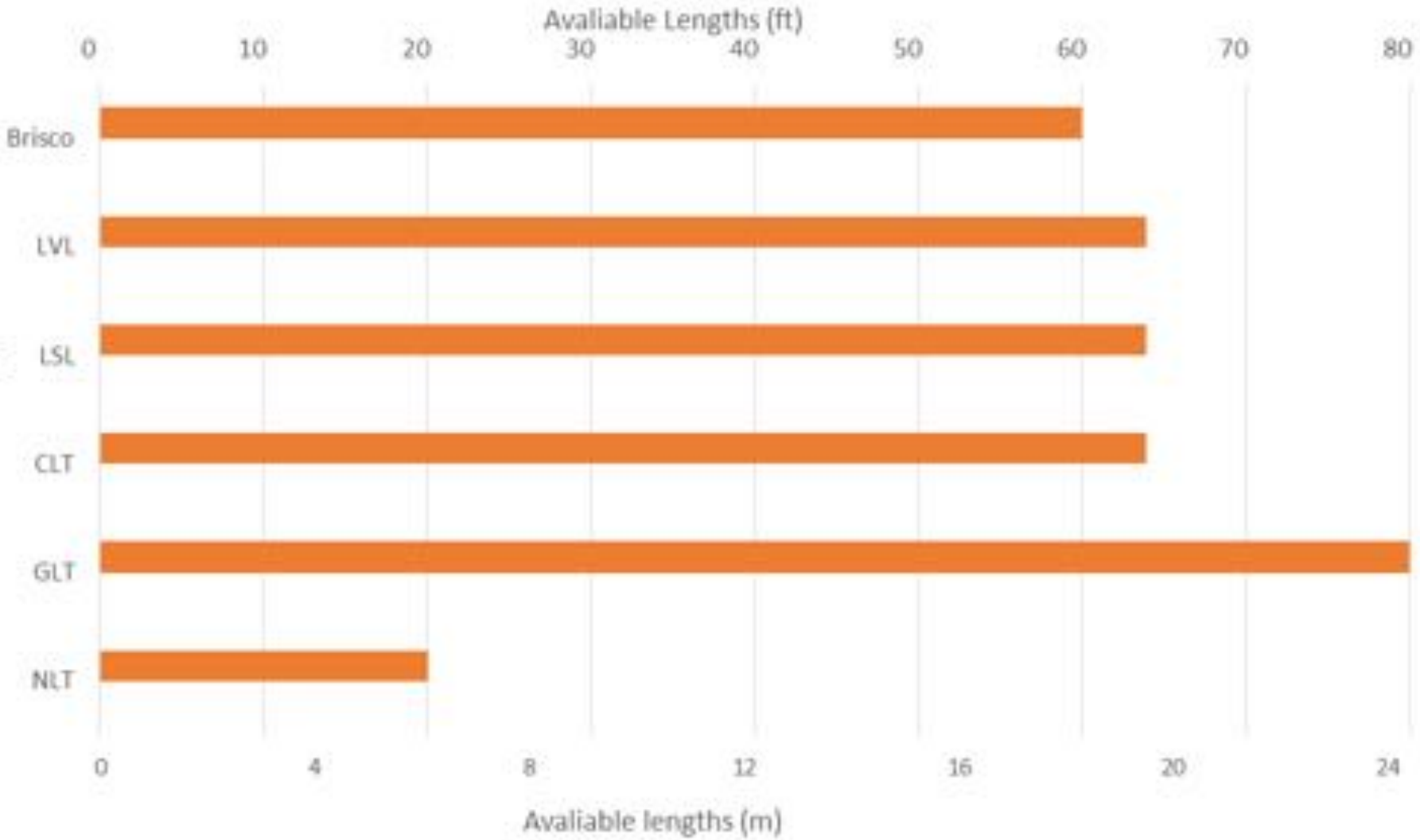
DEPTHS


Avaliable Depths (in)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Brisco
LSL
LVL
CLT
GLT
NLT
0
50
100
150
200
250
300
350
Avaliable Depths (mm)

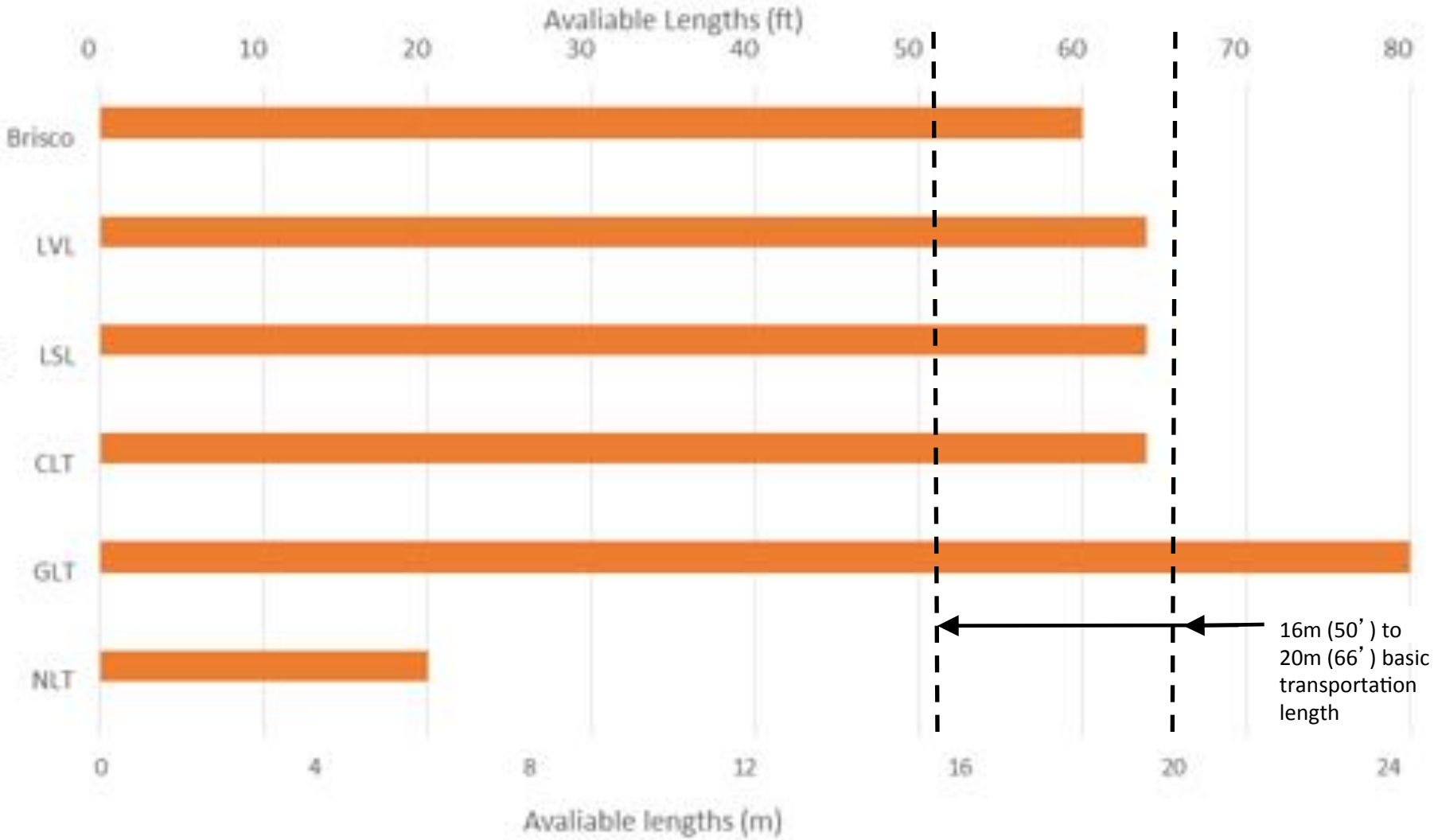
WIDTH


Avaliable Widths (ft)
0
1
2
3
4
5
6
7
8
9
10
Brisco
LVL
LSL
CLT
GLT
NLT
0
500
1000
1500
2000
2500
3000
Avaliable Widths (mm)

LENGTH


Avaliable Lengths (ft)
0
10
20
30
40
50
60
70
80
Brisco
LVL
LSL
CLT
GLT
NLT
0
4
8
12
16
20
24
Avaliable lengths (m)

LENGTH


Avaliable Lengths (ft)
0
10
20
30
40
50
60
70
80
Brisco
LVL
LSL
CLT
GLT
NLT
16m (50') to 20m (66') basic transportation length
0
4
8
12
16
20
24
Avaliable lengths (m)


OVERVIEW
CONTEXT
DESIGN

CONTEXT

THE SET OF CIRCUMSTANCES OR FACTS THAT SURROUND A PARTICULAR EVENT, SITUATION, ETC

CONTEXT

OR AS I LIKE TO CALL IT:

COLLECTING AND CONNECTING THE DOTS

COLLECTING THE DOTS…


CLIENT &
DESIGN TEAM

PROCUREMENT

FUNDING


PARTNER

SIZE OF A PROJECT


LOCATION


CLIMATE

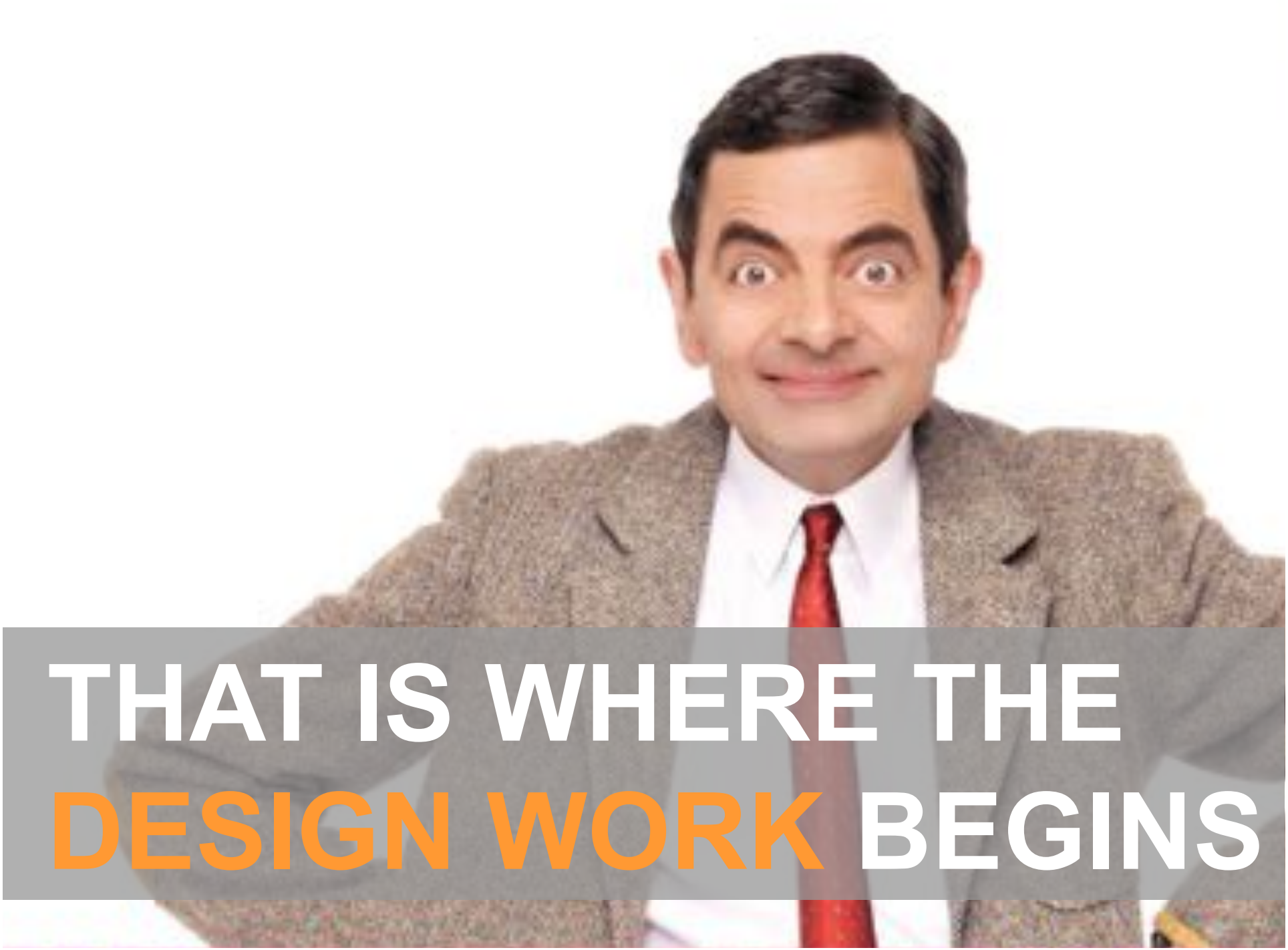
CAPACITY & CAPABILTY

AVAILABILTY


TOLERANCE

TOLERANCE

… CONNECTING THE DOTS


THAT IS WHERE THE
DESIGN WORK BEGINS


OVERVIEW
CONTEXT
DESIGN

DECIDE EARLY


“SYSTEM AND
MATERIAL
APPROPRIATE
DESIGN”

PRODUCT SIZES


FIRE

- In general, all products have a similar char rate

- In general, all products have a similar nominal char rate

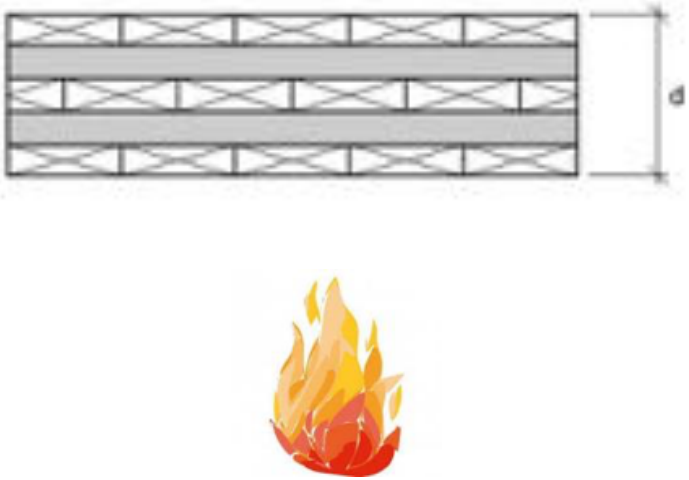
- Approximately 1 ½” – 1 ¾” / 60 minutes

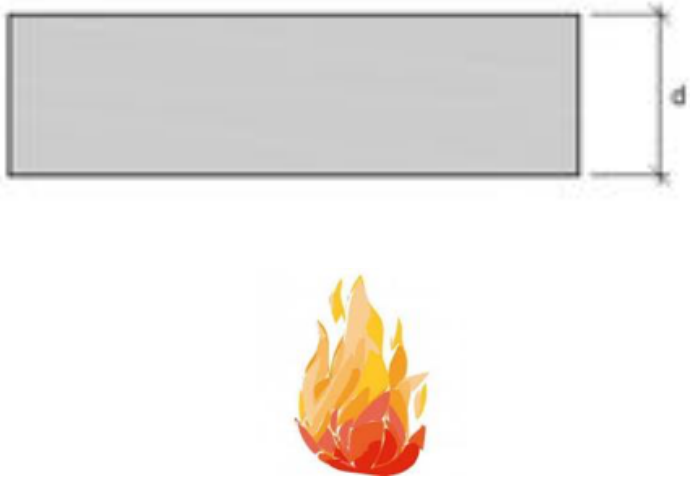
- In general, all products have a similar nominal char rate

- Approximately 1 ½" – 1 ¾" / 60 minutes

- 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


d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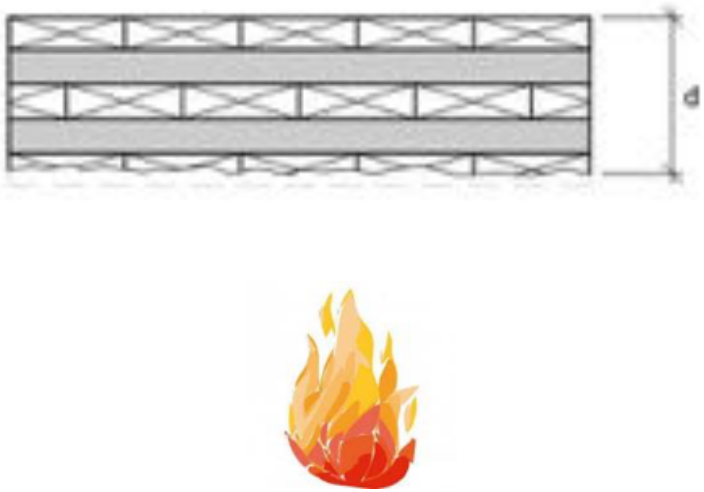
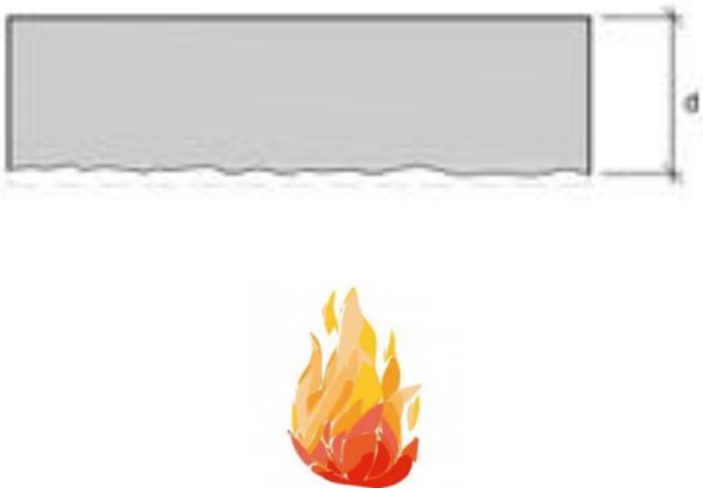
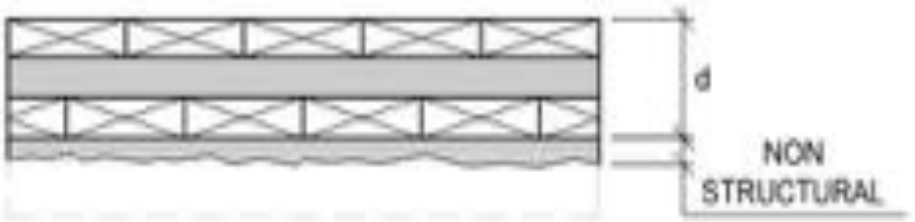

d


d


d
NON
STRUCTURAL


d

DEPTH

"DESIGN IS MOSTLY GOVERNED BY **DEFLECTION** (STIFFNESS) AND / OR **VIBRATION**"

20’ FLOOR SPAN 8” – 10”

16’ FLOOR SPAN 6” – 8”

12’ FLOOR SPAN 4” – 6”

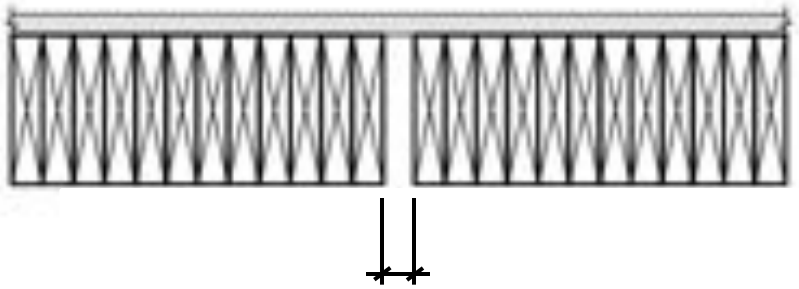
MOVEMENT

NLT, GLT

0.25% CHANGE IN DIMENSION FOR EACH **1%** CHANGE IN MOISTURE CONTENT

- 12% MC when installed
- 14% MC during construction
- 1 ¾” swelling in 30’

- 12% MC when installed
- 14% MC during construction
- 1 ¾” swelling in 30’

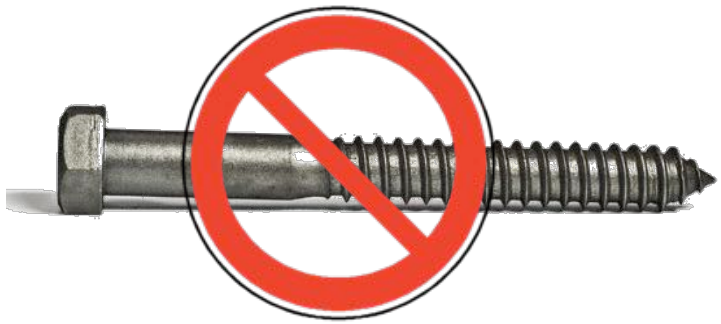


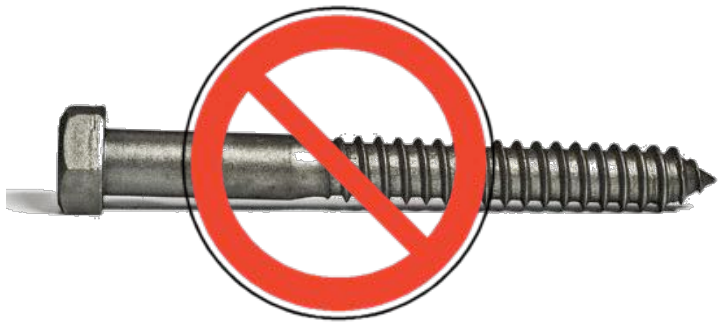
1 ½” @ 20’-0”
38mm @ 6m


WEATHER
PROTECTION
STRATEGY


CRANE
30 PICKS / DAY

CONNECTIONS

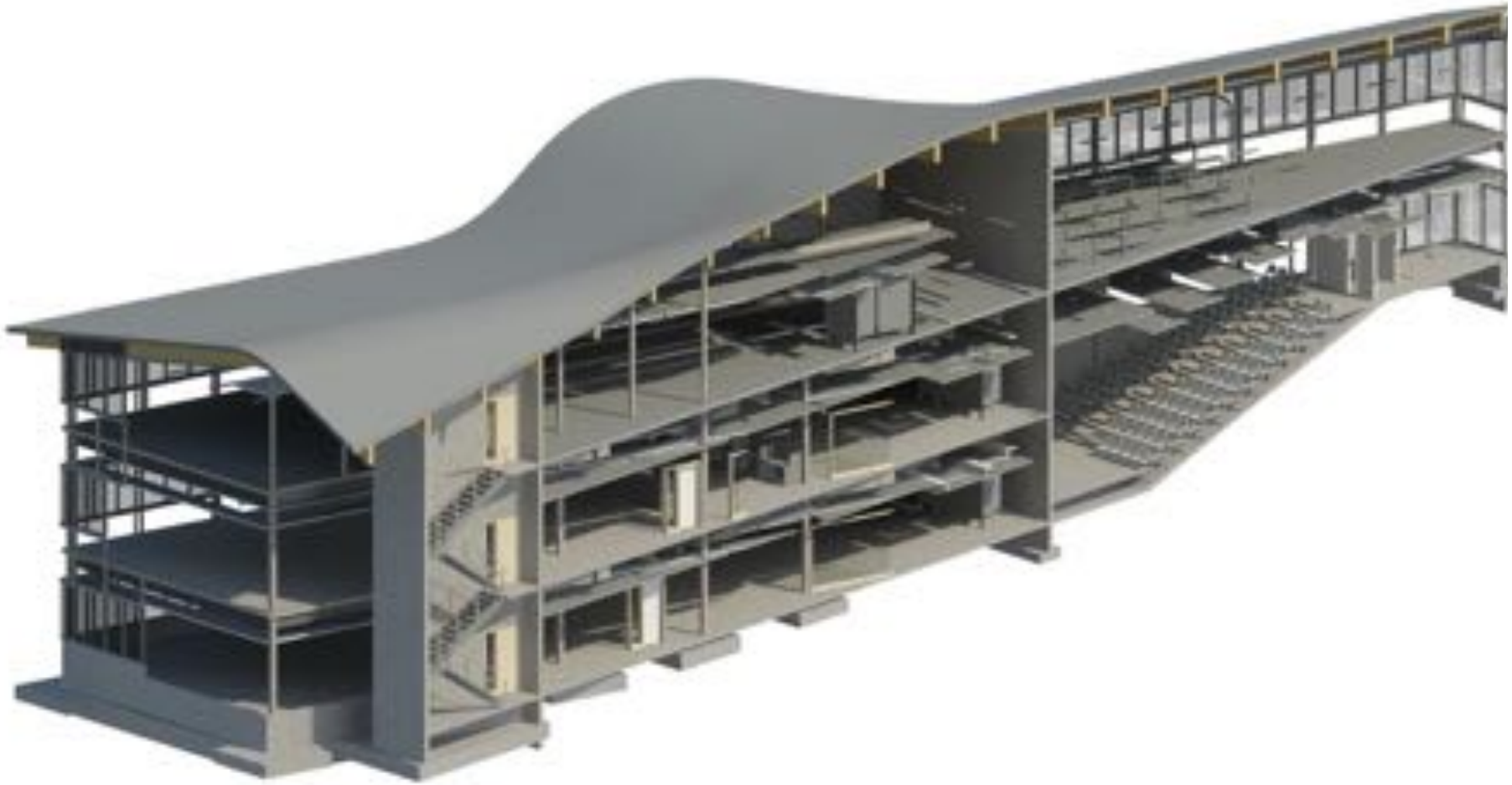




SECONDARY IMPACTS

… AKA COST DIFFERENCE TO OTHER BUILDING SYSTEMS

BIM



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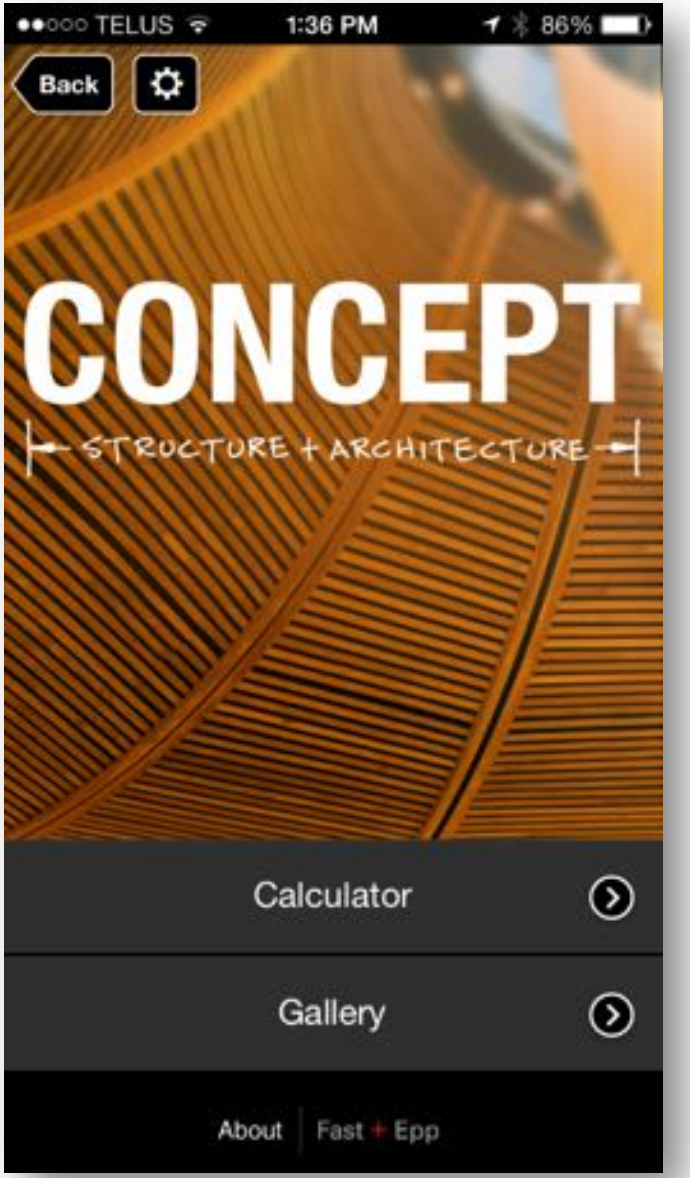
- Architectural 3-D models (REVIT) are not always compatible with fabrication models
- 3-D shop drawing model including connections

AUTODESK® REVIT®

≠

3D MANUFACTURING MODEL (3D-CAD/CAM)


KEEP
CALM;
THERE'S AN
APP
FOR THAT


TELUS
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Calculator
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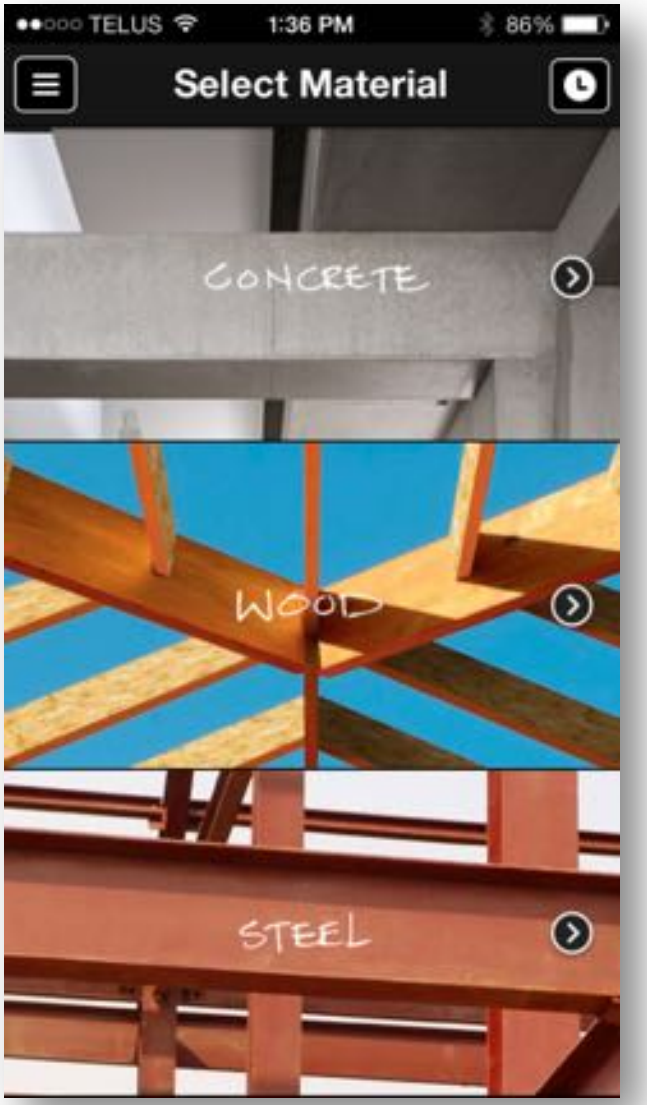
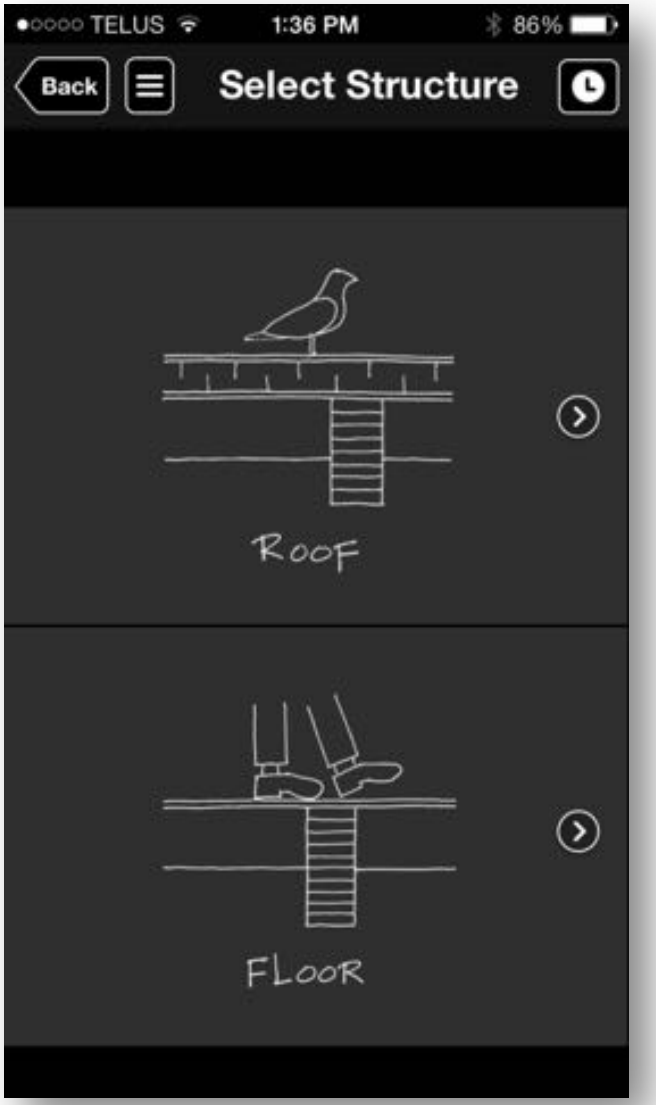
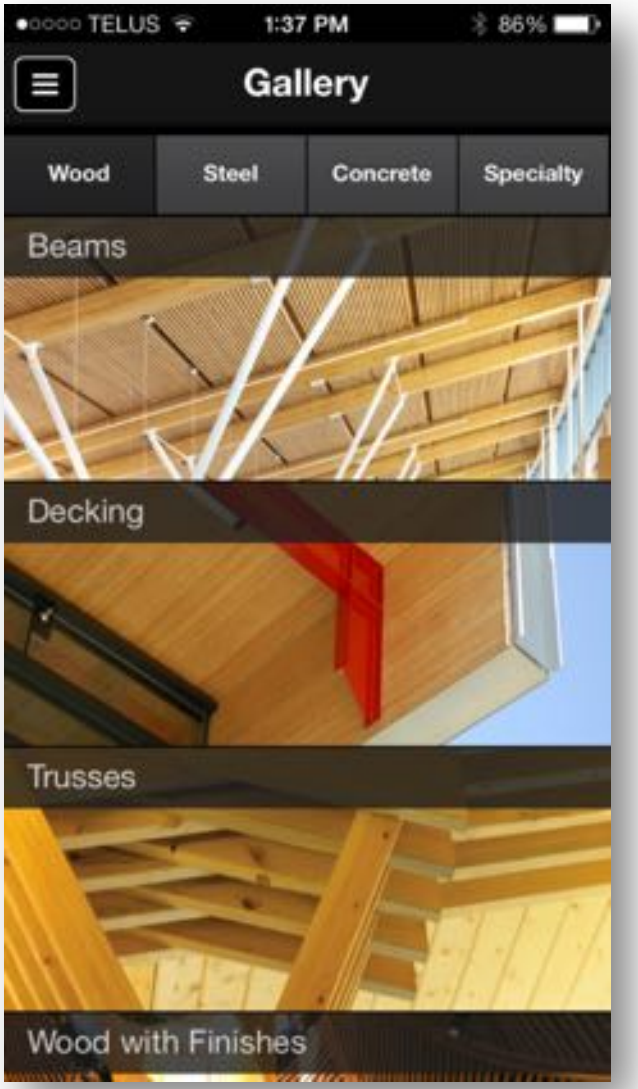
DEPTH CALCULATOR





MATERIAL GALLERY




“SYSTEM AND
MATERIAL
APPROPRIATE
DESIGN”

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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