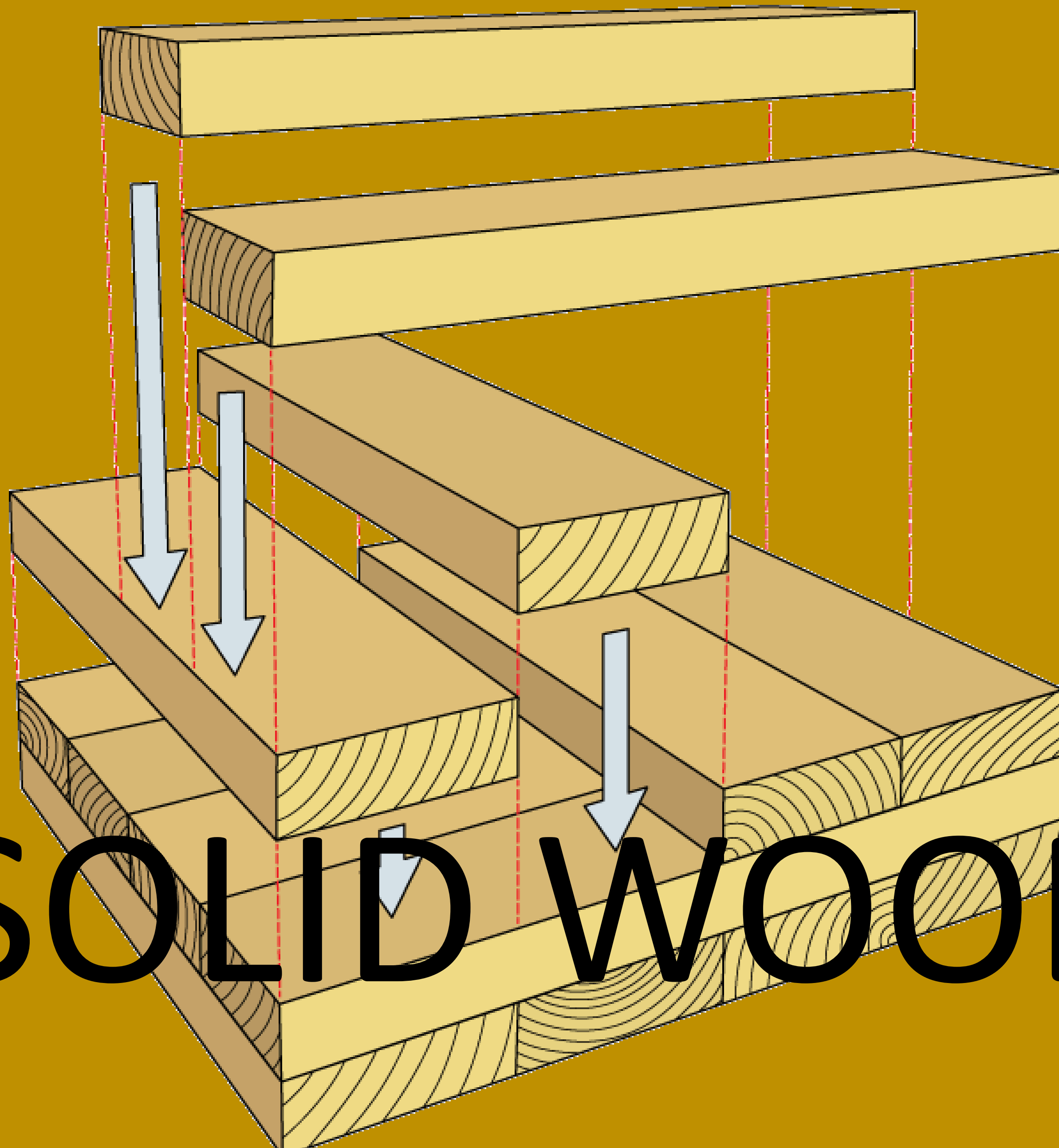


SOLID WOOD

Engineered Heavy Timber Types

Parallel strand lumber (PSL) is fabricated from long strands of veneer pressed and glued into standard dimensions and lengths. It has very consistent properties and high strength.

Laminated veneer lumber (LVL) is fabricated by laminating and gluing multiple veneers together in the same orientation. This enables long elements to be produced that have high strength in one direction.

Laminated strand lumber (LSL) is fabricated from flaked wood strands glued together in large billets. The length is limited only by standard shipping and trucking dimensions. LSL can be used for floors, walls and vertical members where large floor-to-floor heights are required.

Common types of engineered wood used in columns and beams, comprised of thinner pieces that are able to be made from newer growth trees.

Glue Laminated vs Cross Laminated Timber

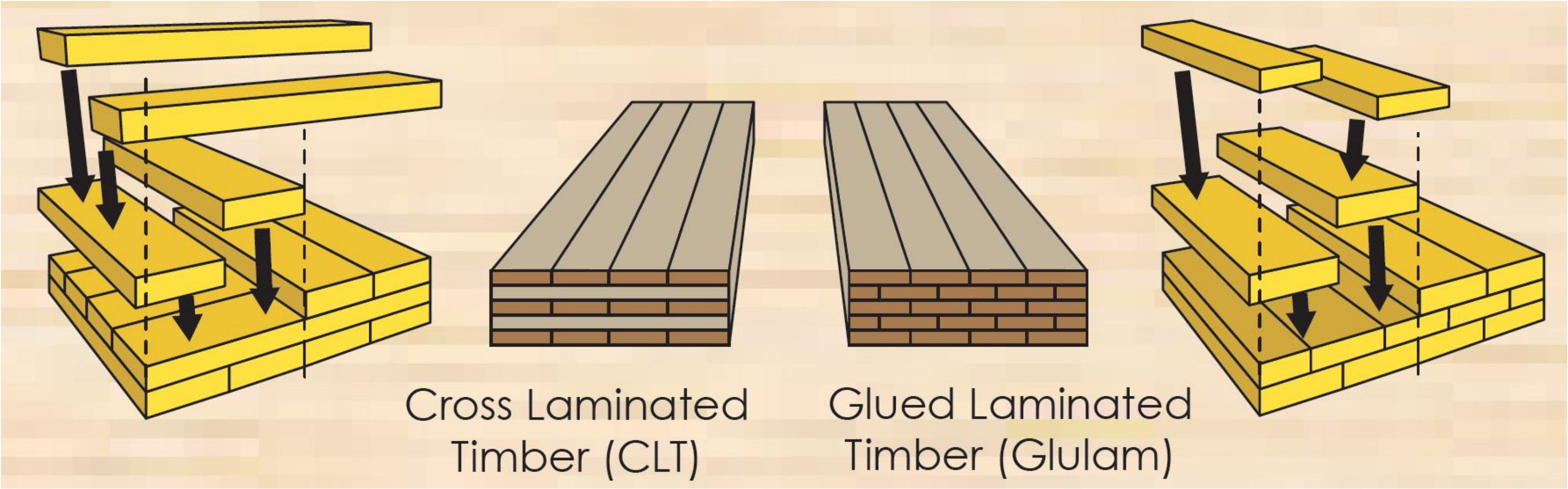
Glue-laminated timber (glulam) is fabricated by gluing individual pieces of dimensional lumber together to form columns, beams and headers.

Columns, Beams

Cross-laminated timber (CLT) is created by laminating dimensional lumber in layers that are perpendicular to one another. The resulting panels have two-way spanning capability, are dimensionally stable and are suitable for walls, roofs and floors.

Walls, Floors, Roofs

What is Cross Laminated Timber



CLT layers

As with normal “plywood” type materials, the number of layers is always odd.

CLT comes in 3 basic thicknesses

- 3 ply
- 5 ply
- 7 ply

The long direction of the pieces runs parallel to the span.

Fire issues

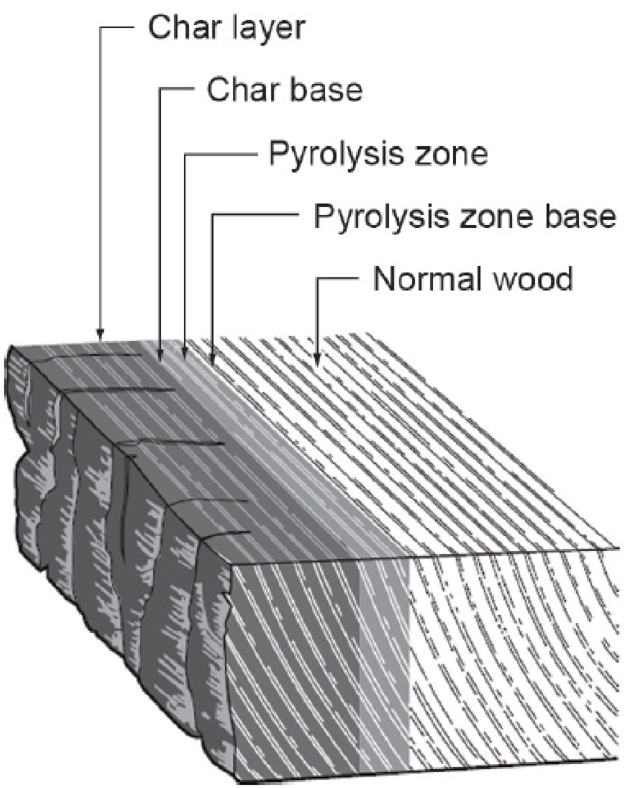


Figure 3.1. Formation of Char layer and pyrolysis zone in wood (one-dimensional) when exposed to high temperatures (CSA, 2011).

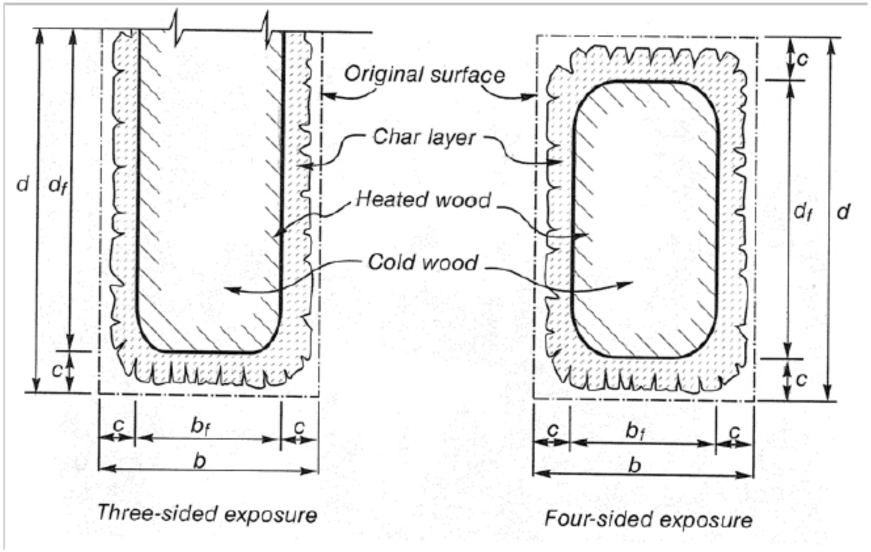


Figure 3.5. Illustration of wood beam or column exposed to fire with the char layer, heated wood layer and cool interior section indicated (Buchanan, 2001).

Large scale wood has better fire resistance than dimension lumber due to the development of a protective char layer.

Fire Resistance Strategies

FULLY EXPOSED

Structural wood elements	Type of Dimension	Minimum Dimensions (mm)
Wall, floor and roof assemblies with 1- sided fire exposure	thickness/ depth	136
Beams, columns and arches with 2-sided or 3-sided fire exposure	cross-section	248 x 248
Beams, columns and arches with 4-sided fire exposure	cross-section	336 x 336

Table 3.1. Summary of minimum dimensions of structural wood elements proposed for mass timber construction if left exposed (Craft, 2016).

GYPSUM COVERED

Structural wood elements	Type of Dimension	Minimum Dimensions (mm)
Wall, floor and roof assemblies with 1- sided fire exposure	thickness/ depth	96
Beams, columns and arches with 2-sided or 3-sided fire exposure	cross-section	192 x 192
Beams, columns and arches with 4-sided fire exposure	cross-section	224 x 224

Table 3.2. Summary of minimum dimensions of structural wood elements proposed for mass timber construction if encapsulated with 2 layers of 12.7 mm Type X gypsum board (Craft, 2016).

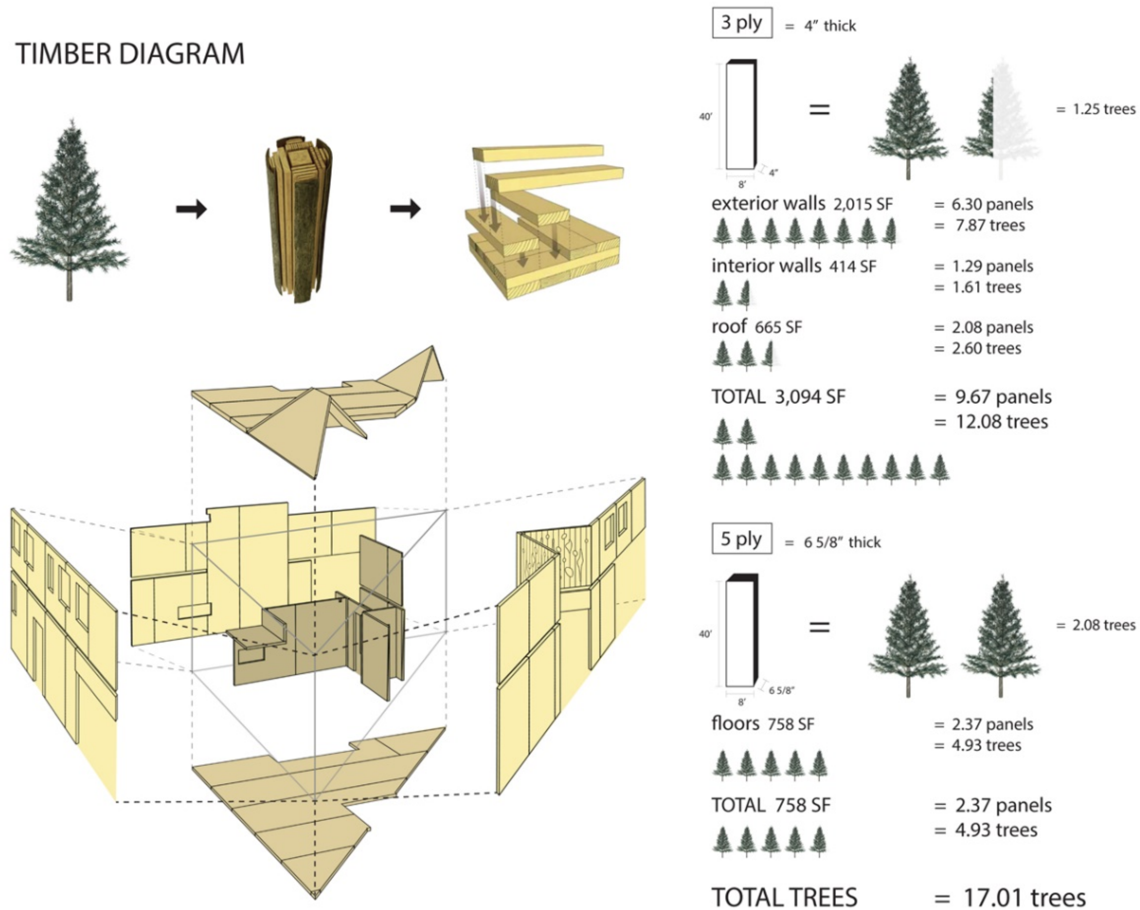
Fire resistance strategies

- At present there is a 6 storey limit to the height of commercial and institutional buildings out of heavy wood
- They must have a sprinkler (fire suppression) system
- Using composite construction (concrete) and cladding the wood with fire rated gypsum board, this can be increased (Brock Commons is 18 storeys)
- Surfaces can be treated with an intumescent coating to provide more than an hour of fire protection

Benefits of CLT

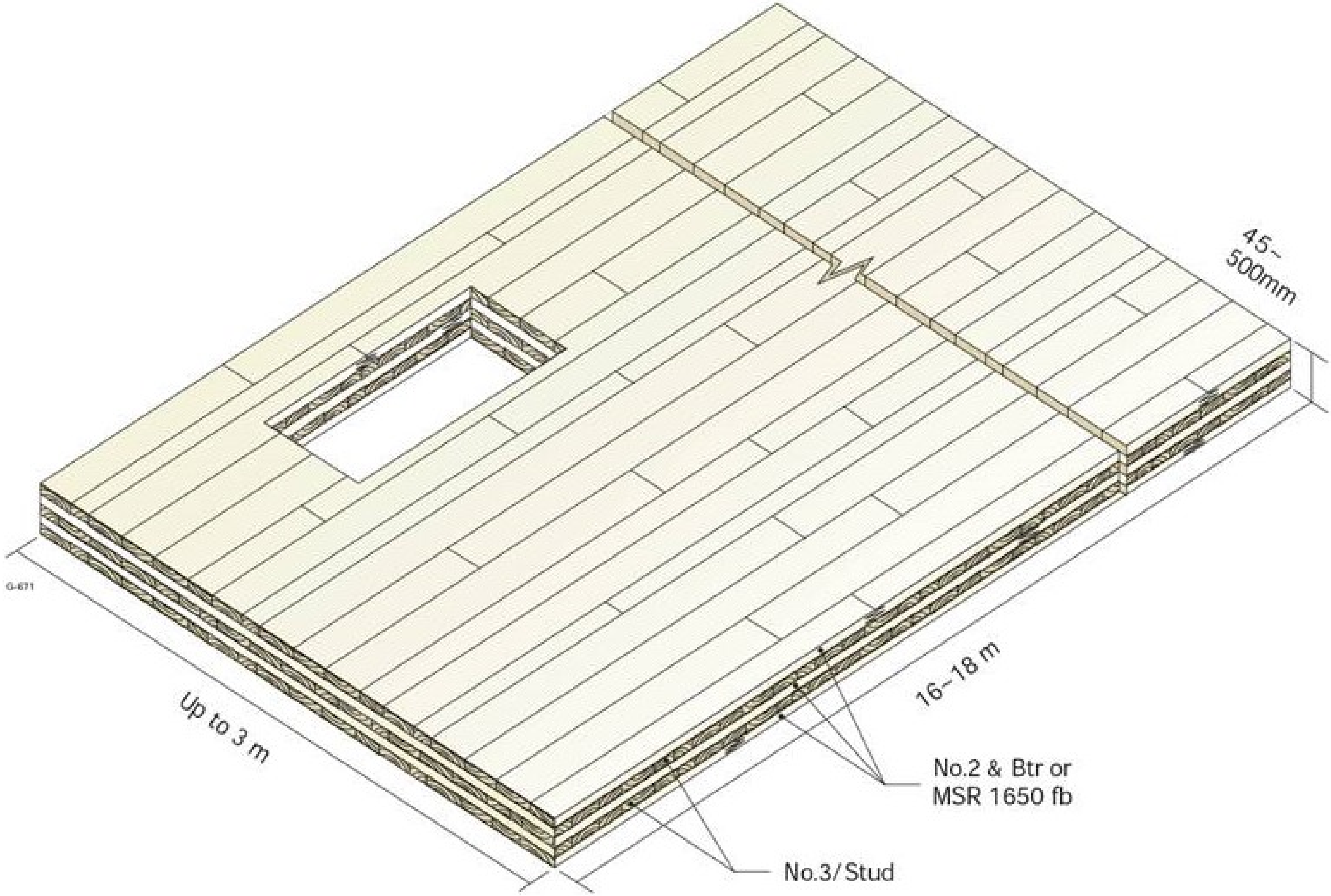
- positive CO_2 balance
- environmentally-friendly and sustainable construction method
- CLT is lighter than concrete or brick
- good insulating properties
- excellent fire safety characteristics
- short set-up time, easy to assemble and high level of prefabrication
- excellent structural properties and dry construction method
- earthquake-proof construction method

Use of wood

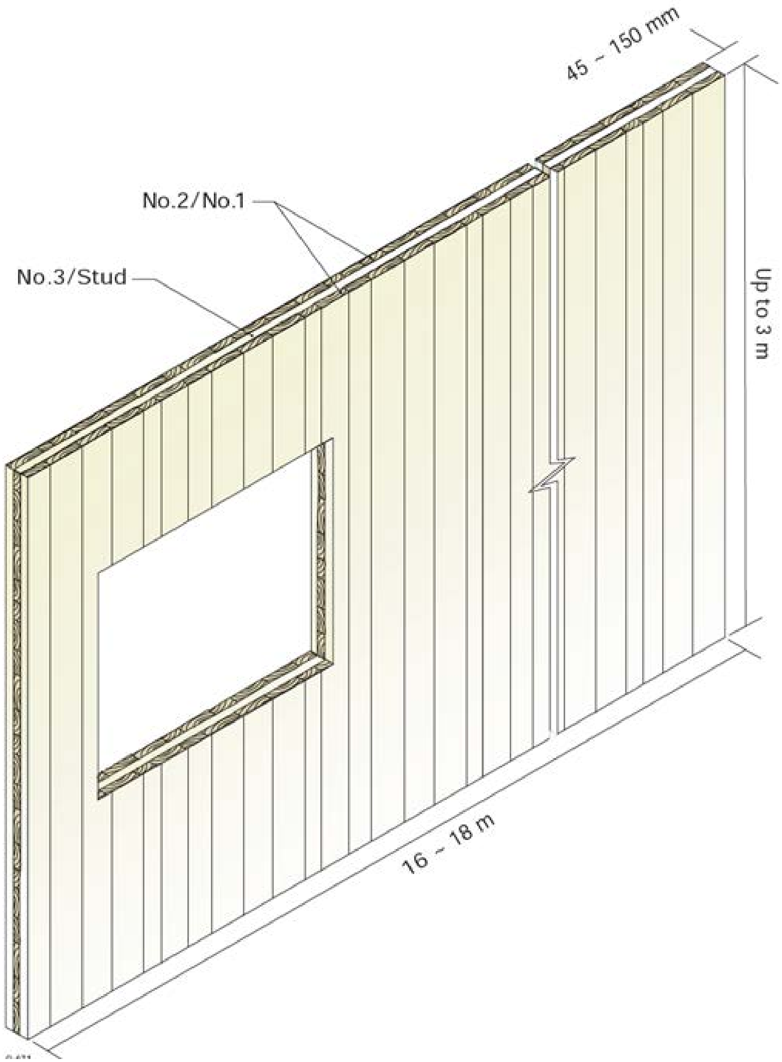


TIMBER DIAGRAM
3 ply
= 4" thick
40'
8'
4"
= 1.25 trees
exterior walls 2,015 SF
= 6.30 panels
= 7.87 trees
interior walls 414 SF
= 1.29 panels
= 1.61 trees
roof 665 SF
= 2.08 panels
= 2.60 trees
TOTAL 3,094 SF
= 9.67 panels
= 12.08 trees
5 ply
= 6 5/8" thick
40'
8'
6 5/8"
= 2.08 trees
floors 758 SF
= 2.37 panels
= 4.93 trees
TOTAL 758 SF
= 2.37 panels
= 4.93 trees
TOTAL TREES
= 17.01 trees

Floor system



Wall system



- 3 ply wall system.
- Note heights of up to 3m
- Note wall lengths of up to 18m
- Dimensions overall the same as for floor/ceiling slabs BUT the orientation of the wood is changed

Bearing wall system

It is possible to use large CLT panels to create a building with solid bearing walls and relatively clear span floors. Door and window openings usually cut out at the factory.

CLT wall systems

Solid CLT buildings

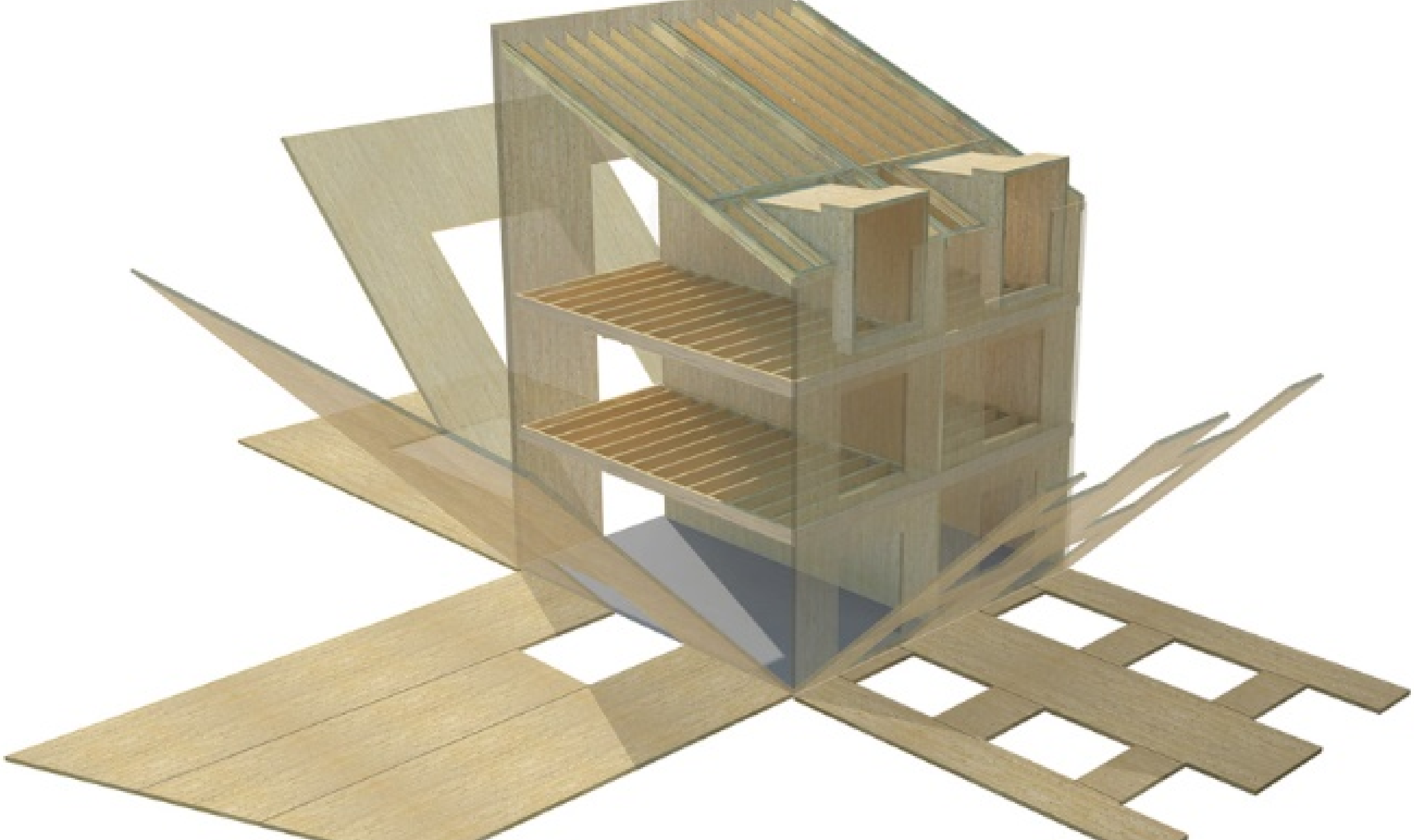
The decorative cut outs on the wall panels were done at the shop with precise CAD CAM cutting equipment.

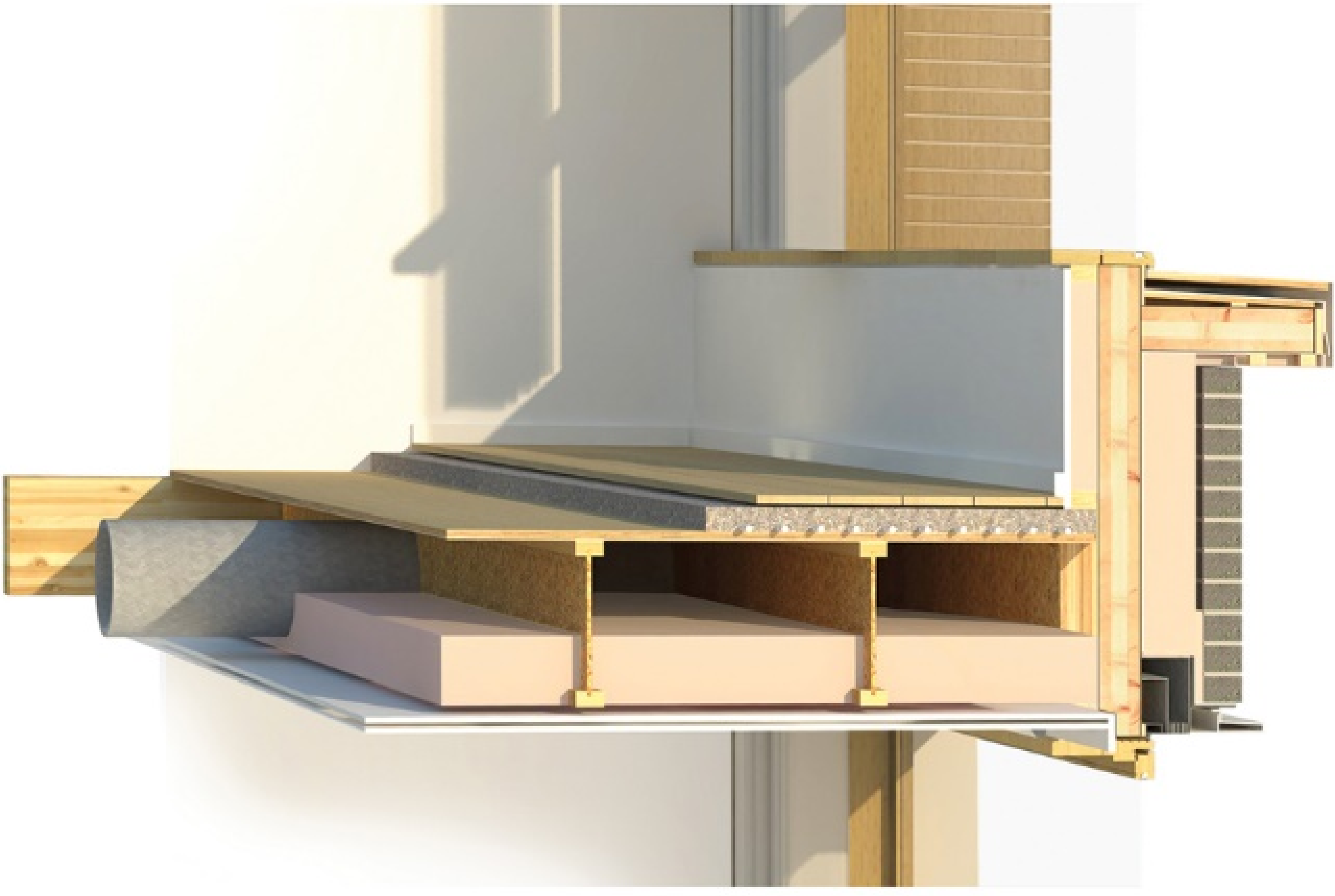
It is normal to have a slight round in the "corners" as sharp cut outs are rather difficult to achieve.

CLT wall systems

Ronald McDonald House, Vancouver

- By Michael Green Architecture
- Tilt up CLT slab strategy

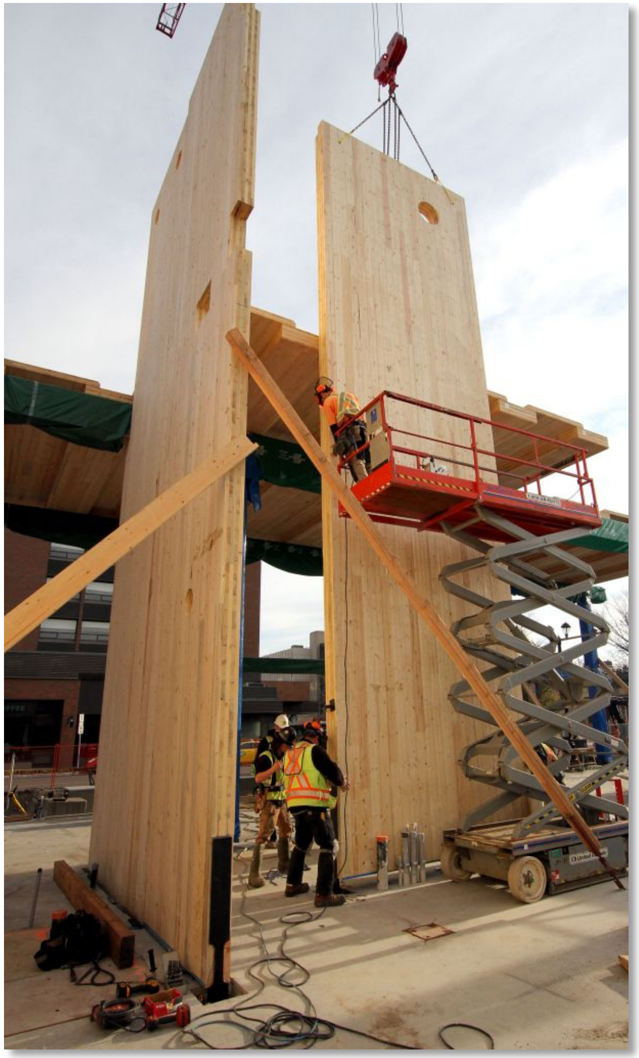




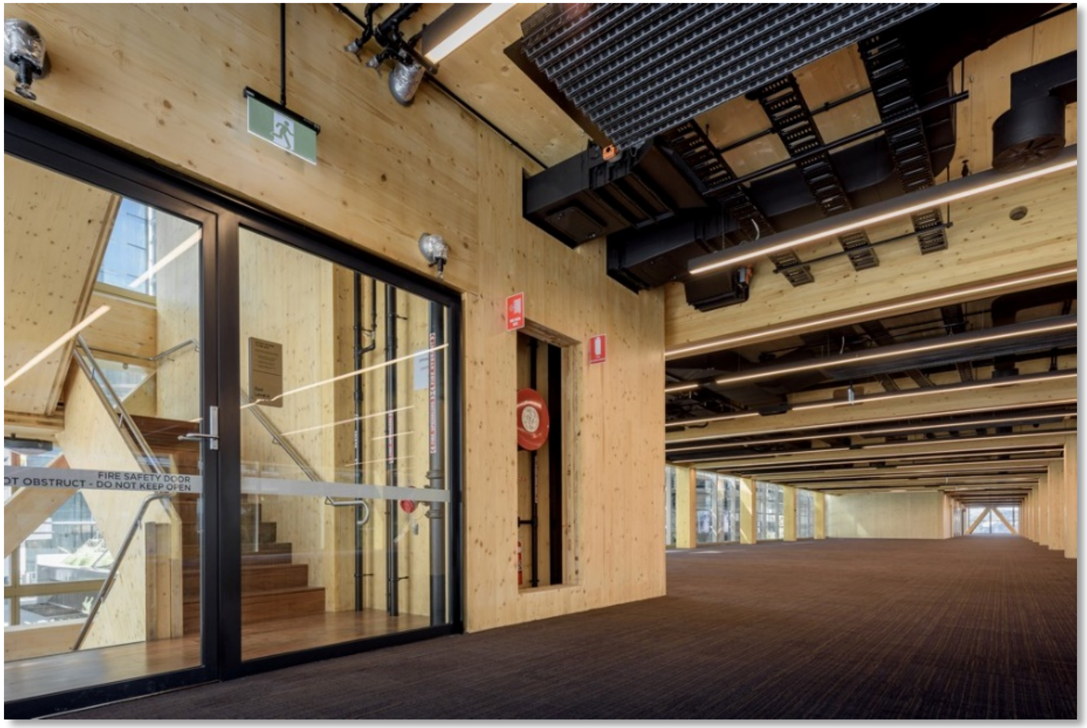
Need for stability

As the majority of the connectors used are equivalent to hinge connections (only able to transfer vertical and horizontal shear forces and NOT moment) it is necessary to add other materials, systems to stiffen the structure.

CLT – lateral stability



- Buildings need lateral stability
- For beam and column type buildings a core is often needed to stabilize
- Can be done with CLT panels to support the core (stairs, elevator shaft)



CLT – lateral stability

Very tall timber structures like Brock Commons use a reinforced concrete core as well as concrete toppings on the CLT floor slabs for stability. This is called COMPOSITE CONSTRUCTION.

CLT – lateral stability

Diagonal bracing or K bracing can also be used to add stability that is also expressive in the reading of the structure.

Fasteners – Megant system

Megant fastener system for beams

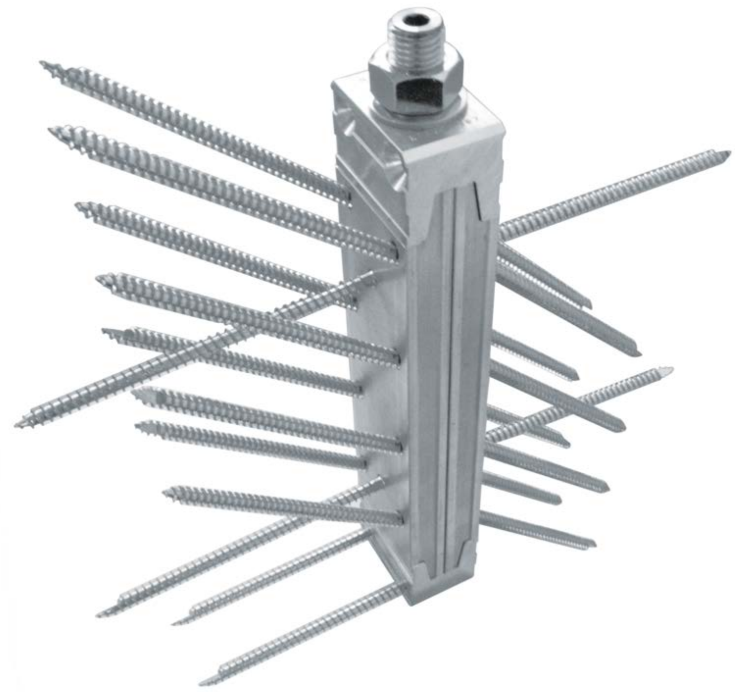
Fasteners – Megant system

No tilting when mounting!

Threaded rod with washers and hex nuts.

Profiled base plates made of aluminium with fastening holes at 45° and 90°.

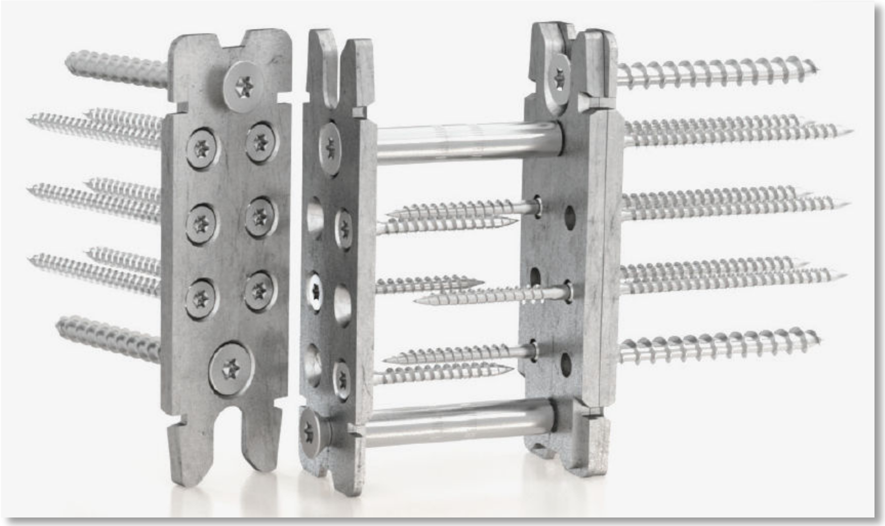
Conical clamping aluminium caps for closed joints in the connection area. Additional mounting holes for easy installation and high horizontal loads.



Fasteners – Megant system

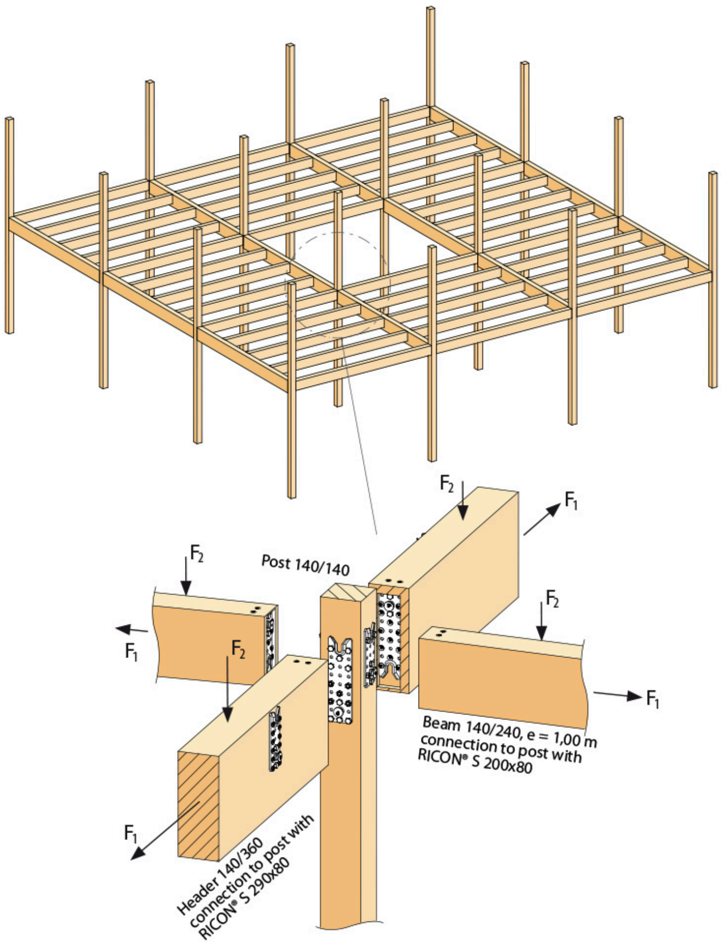
MEGANT® 290x60x40 | MEGANT® 405x60x40 | MEGANT® 520x60x40 | MEGANT® 290x100x40 | MEGANT® 405x100x40 | MEGANT® 520x100x40 | MEGANT® 280x150x50 | MEGANT® 430x150x50 | MEGANT® 550x150x50

Fasteners – Ricon system

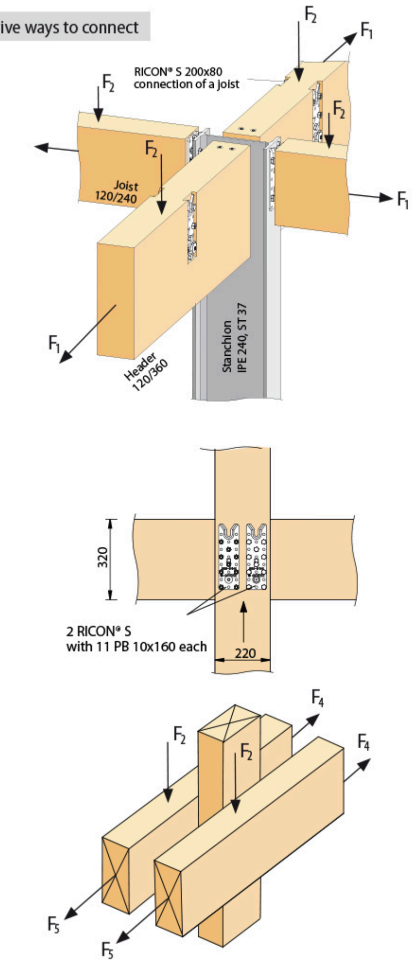


Fasteners – Ricon system

Ceiling of a timber frame construction



Alternative ways to connect



Steel connection

First node for dome

Fasteners – Ricon system

The John W Olver Design Building, UMASS Amherst

https://bct.eco.umass.edu/about-us/the-design-building-at-umass-amherst/

The John W Olver Design Building, UMASS Amherst

- At its core, the Design Building has a **contemporary, heavy-timber (“mass timber”) wood structure**, consisting of an exposed glulam frame (columns, beams, braces), cross-laminated timber (CLT) and concrete composite floors, and CLT shaft walls (for stairs, elevator, and mechanical shafts). It also features a three-story, folded, grand CLT stair in the atrium.
- The **wood-concrete composite floor** system.
- The 70,000 ft^3 of **wood** used in the Design Building **grew in just six minutes** (considering all of N. America’s forests). They also **removed (sequestered) 2,000 tons of carbon dioxide (CO_2) from the atmosphere** during growth, which is now permanently stored in the building. This is equivalent to taking 400 cars off the road for one year.

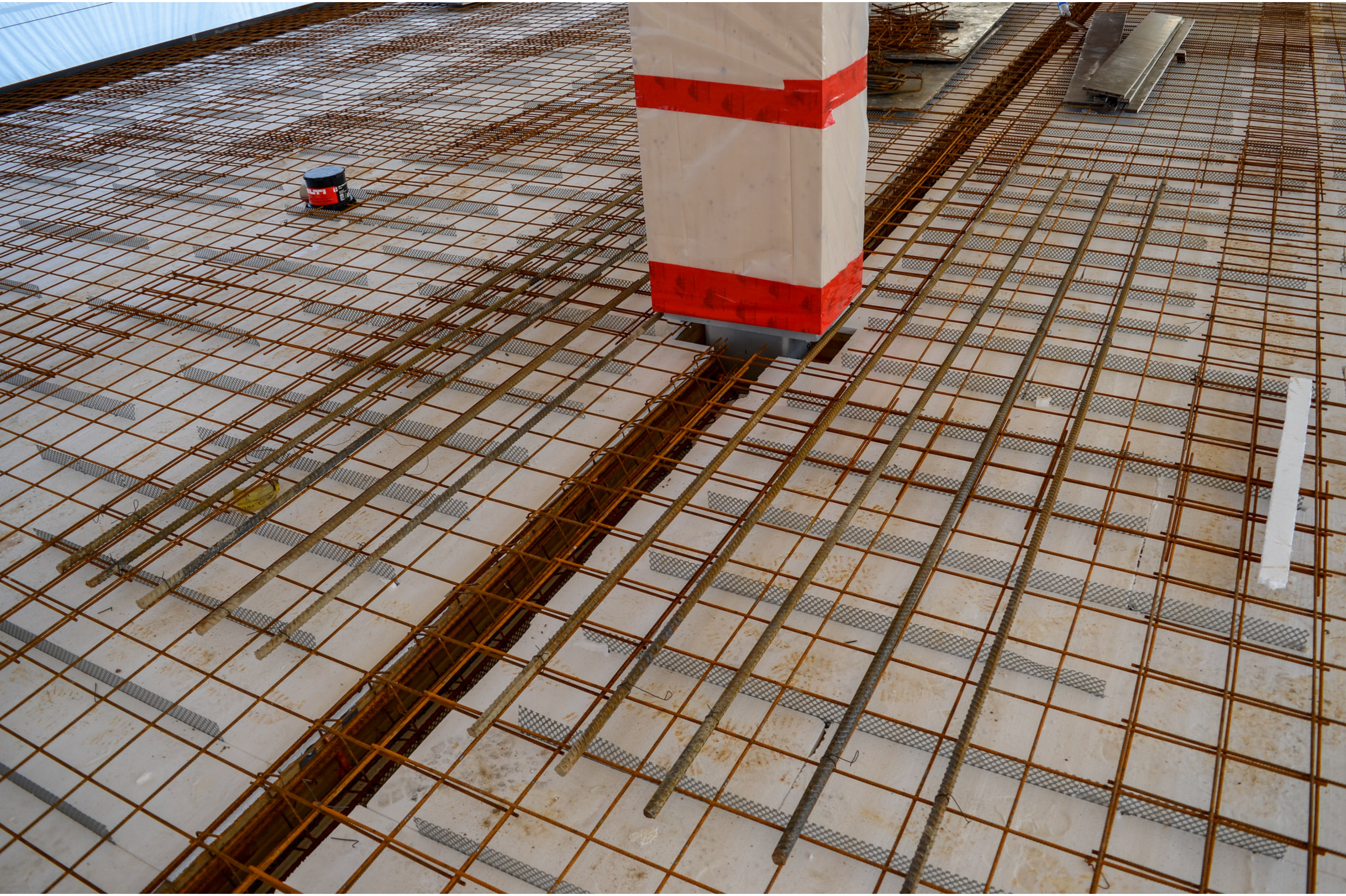
All photos of this building taken by Alex Schreyer.

UCAN
FASTENING PRODUCTS
HUSKY
019


5X302


United Rentals
009
005


H 11103 11_109 1138-035
3469LBS
H 11104 11_111 1138-036
ARCHI-5S 6 7/8 X 96-22
3469LBS
16005X0087



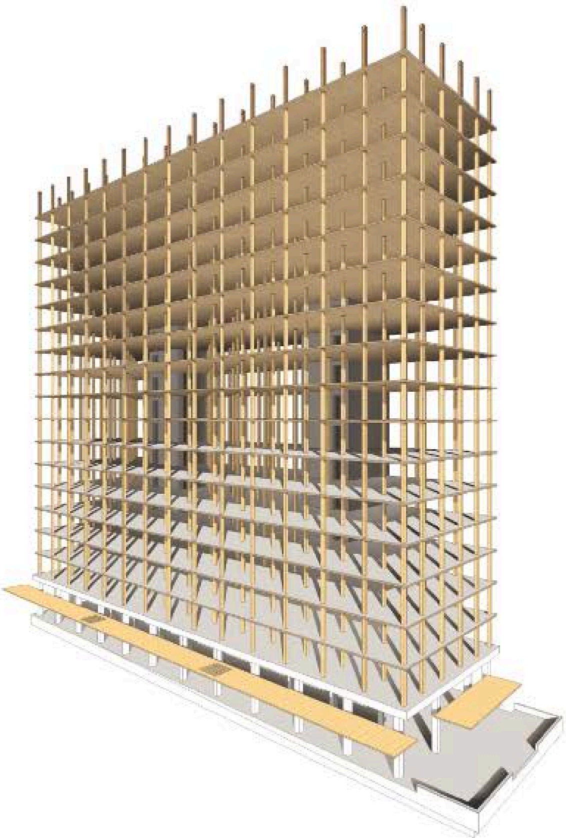

GP
DensGlass


GRACE

Brock Commons, UBC

Brock Commons

- 18 storeys
- **The mass timber frame was assembled in just over 9 weeks**
- With conventional materials, framing would have taken six to eight months, some three to four times longer. From start to finish, it took about two years to complete the project. In September 2017, over 400 students moved into Brock Commons Tallwood House, located on the campus of the University of British Columbia.
- **It's a hybrid, built of engineered mass timber and concrete**
- Engineered mass timber is made of layers of wood, connected by glue, nails or wooden dowels. It is incredibly strong, stable and rigid while remaining very lightweight. Concrete was used for the main floor and the two stairwells.



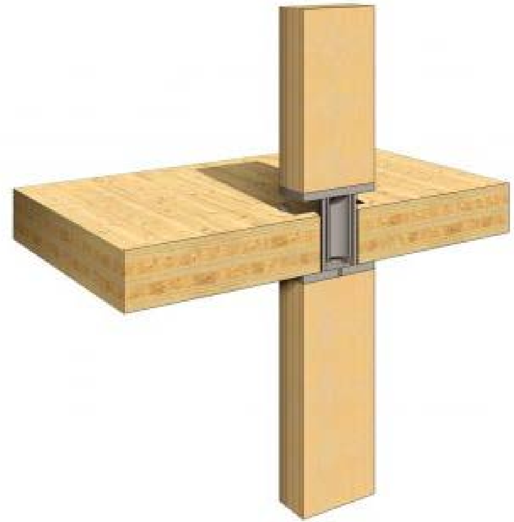
hybrid mass timber and concrete core structure

CLT floor slabs with glulam columns and steel connectors

partial encapsulation during construction

completed construction

northwest view



Now Renting


STRUCTURLAM
STRUCTURLAM


#10
#1


PRESTON RENTALS

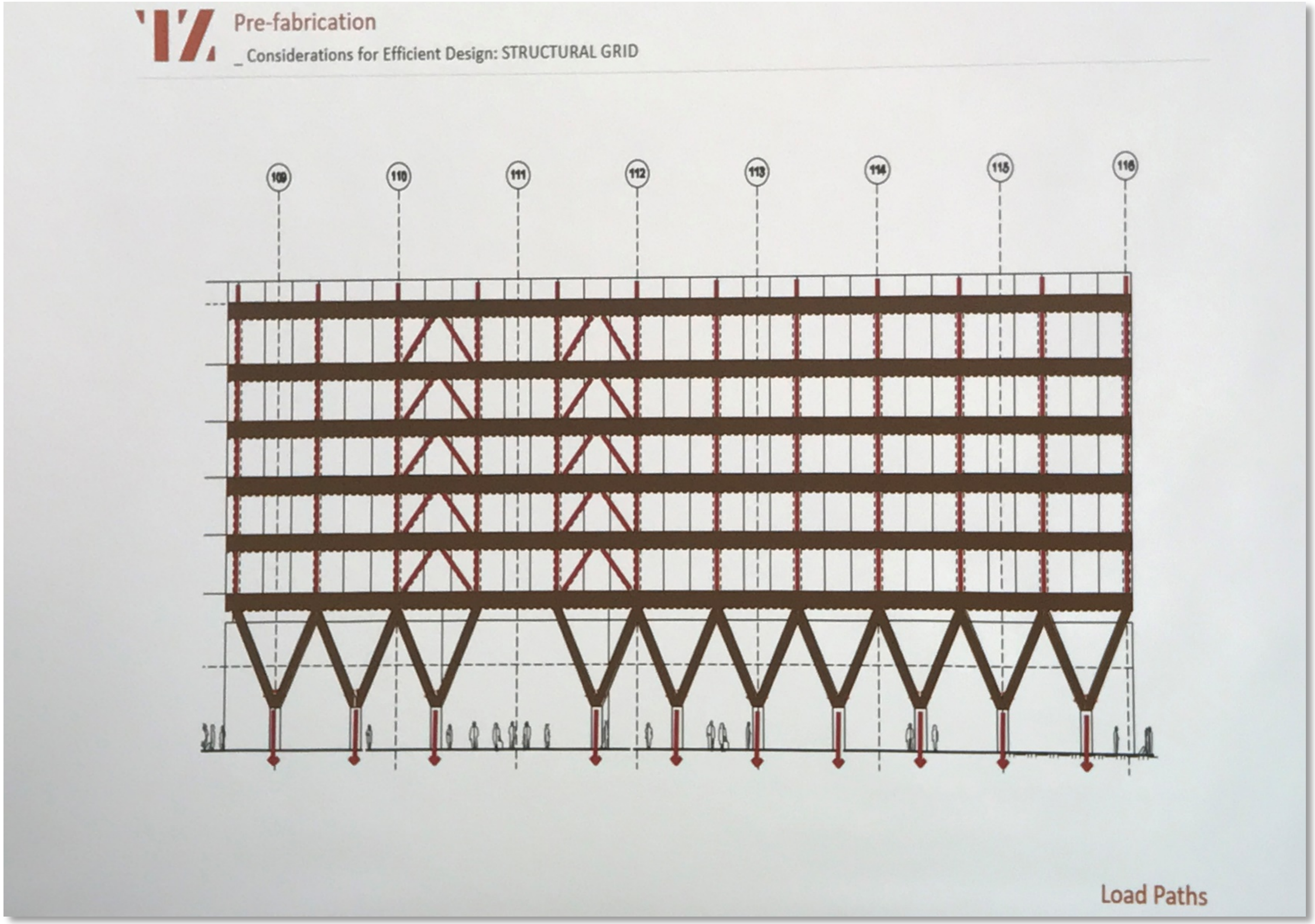
Because the building is so tall, the wood must all be encapsulated in gypsum board to meet the fire code.

International House, Sydney, Australia

International House, Sydney, Australia

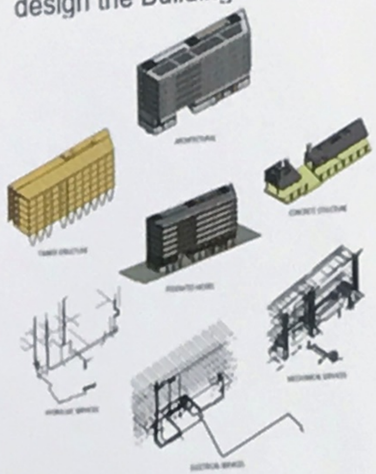
- The office building comprising 7 storeys with approx. 7,910 m^2 of space will be made from 950 m^3 of glued-laminated timber (glulam) and more than 2,000 m^3 of Cross Laminated Timber (CLT)
- Ground level constructed from concrete as termites are a big problem in Sydney
- Wood left exposed – building sprinklered

Section view



DESIGN PROCESS

DesignMake and Consultants design the Building in 3D



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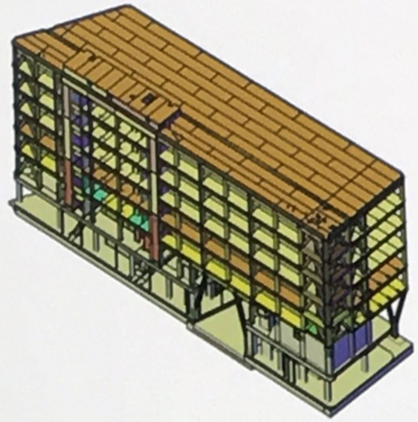
DesignMake produce manufacturing model and shop drawings



→

Supplier manufacture CLT "blanks" according to schedule.

↓

Manufacturers ship the timber "blanks" to DesignMake.

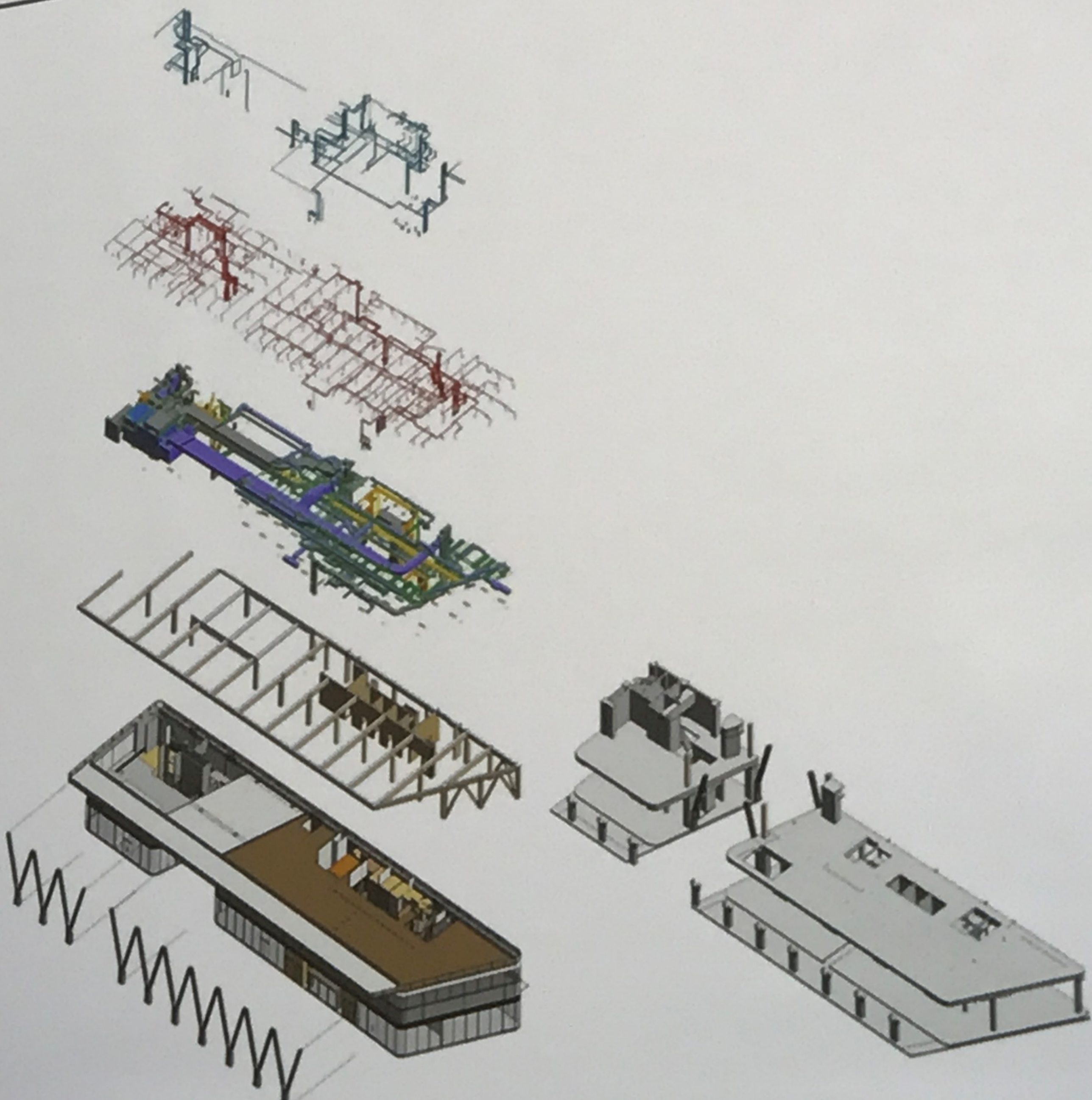
←

DesignMake process CLT and Supply to site.

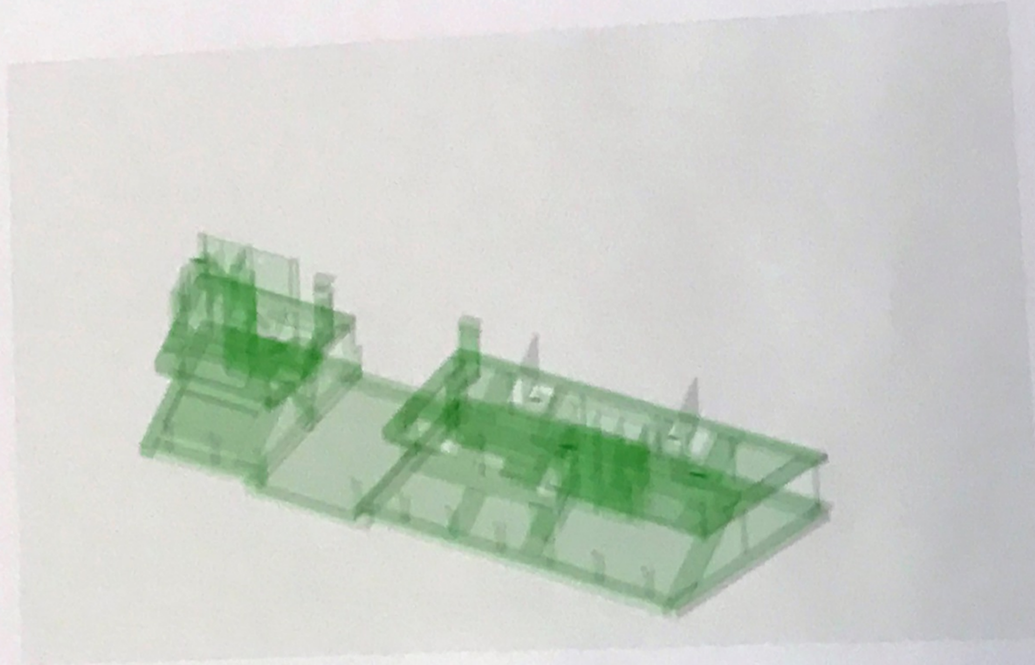
←

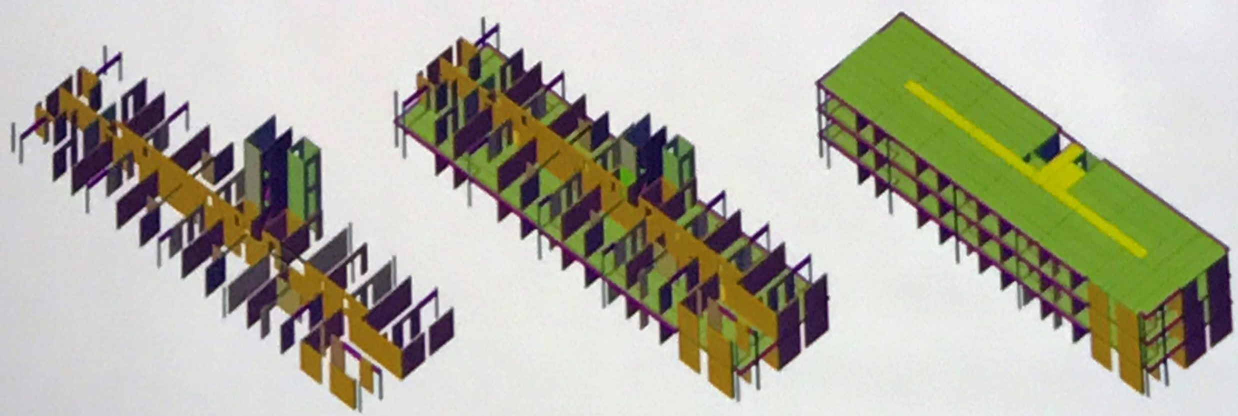
Installers put the building together

INTEGRATED DESIGN MODEL



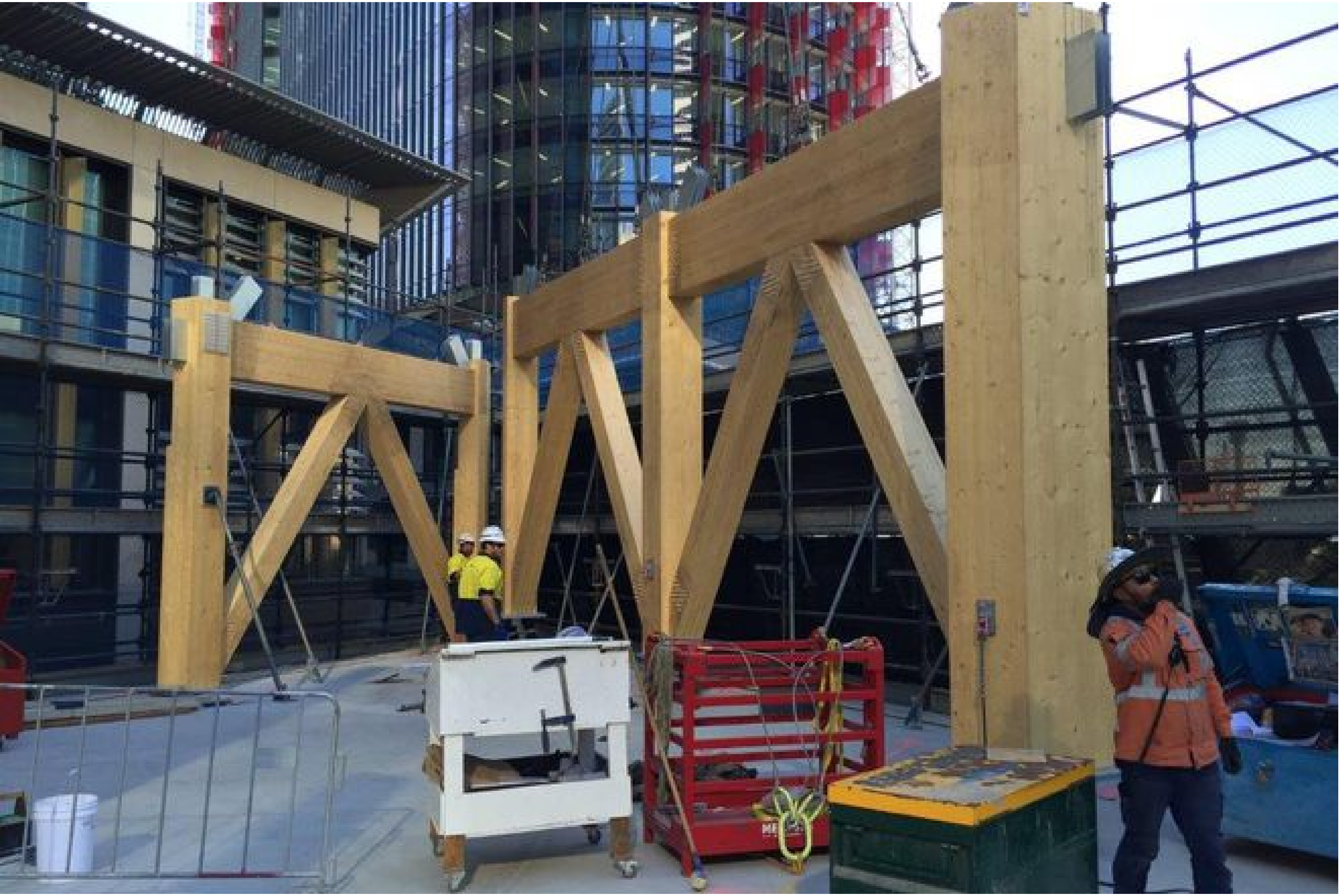
- Revit based 3d
- What You Design Is What You Get
- CAD to CAM
- Manufacture and CNC processing
- Construction methods incorporated






Megant fastening system used

Factory cut-outs to facilitate mechanical and electrical services installation on site.



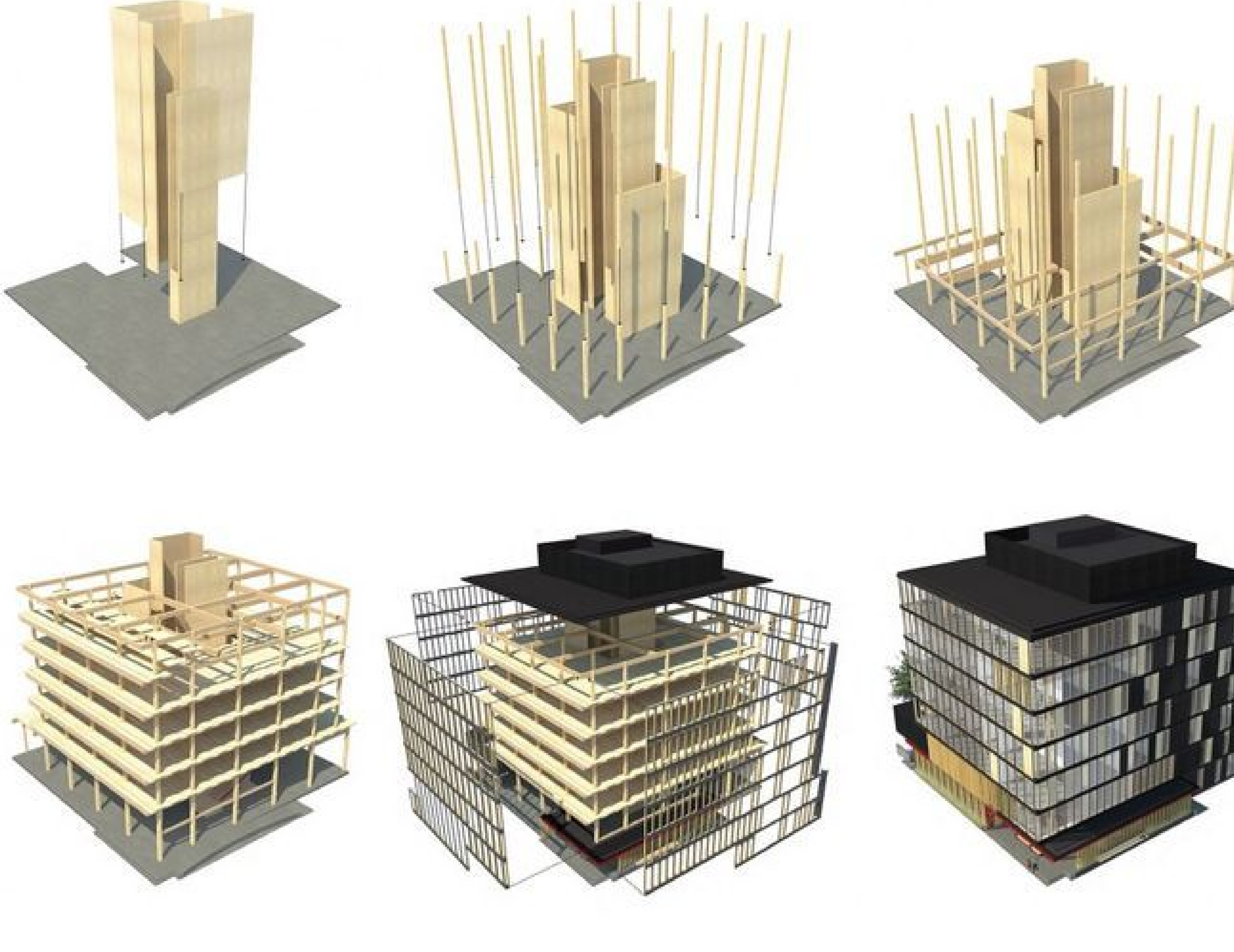
EXIT
FIRE EXTINGUISHER
A:B(E) POWDER
FIREX

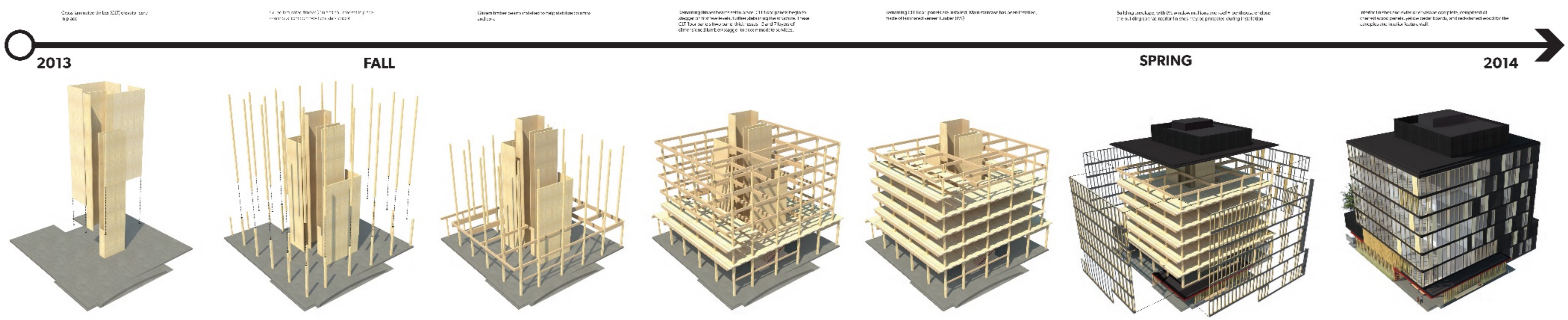

FIRE SAFETY DOOR
OT OBSTRUCT - DO NOT KEEP OPEN

Wood Innovation and Design Centre, Prince George, BC

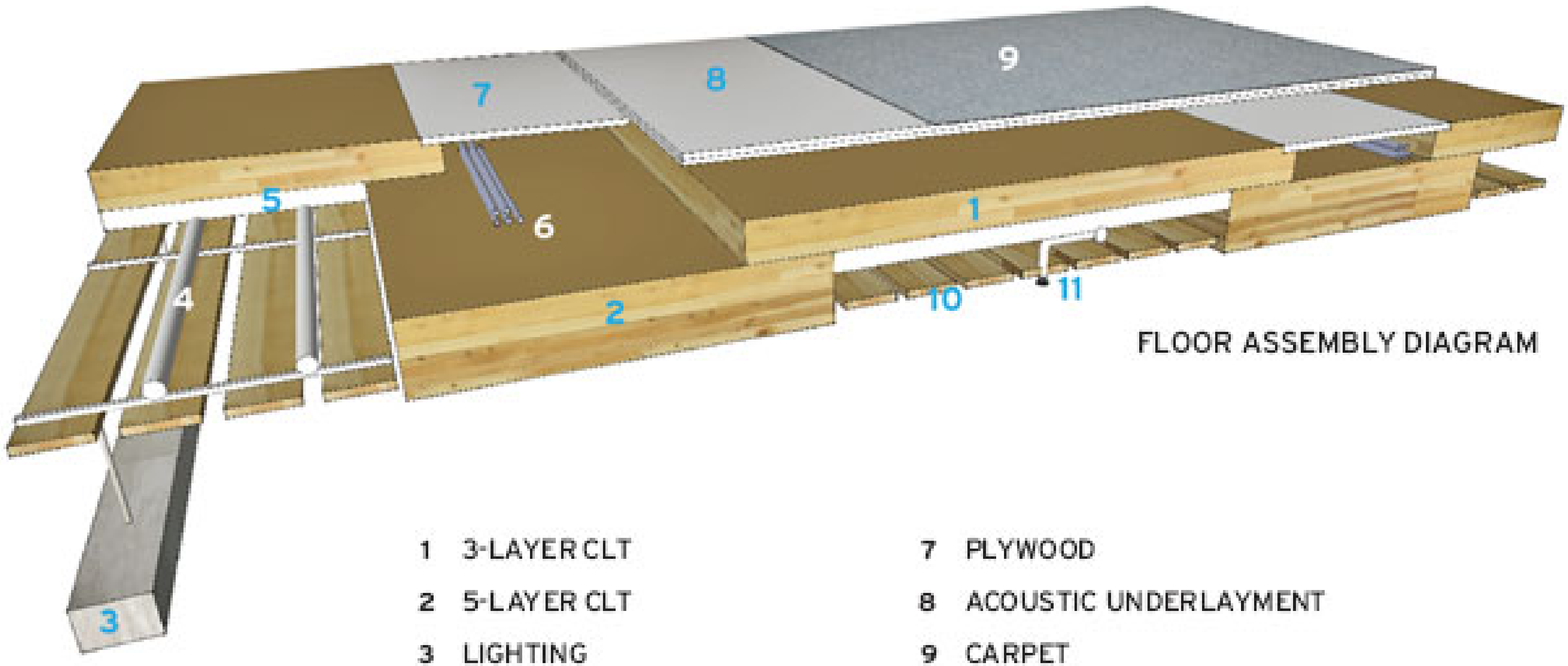
Project Facts

- Designed by Michael Green Architecture
- The Wood Innovation & Design Centre (WIDC) in downtown Prince George, British Columbia was completed in October 2014. The Centre utilizes a number of wood species and products from across the province such as Douglas-fir, western red cedar, hemlock, pine and spruce. The building incorporates a structural system that includes a variety of locally manufactured solid engineered wood products including cross laminated timber, glue laminated timber and laminated veneer lumber.
- At 97 feet- high (29.5 metres) with six floors and a mechanical penthouse, the WIDC is currently the tallest wood building in Prince George and the tallest contemporary wood building in North America.





CLT and glulam structures are able to be assembled very quickly!
Most of the preparation of the elements is done in the factory
The job site can be very clean as it is largely devoid of wet processes.



FLOOR ASSEMBLY DIAGRAM

1 3-LAYER CLT
2 5-LAYER CLT
3 LIGHTING
4 SERVICES IN CEILING TROUGH
5 ACOUSTIC INSULATION
6 SERVICES IN FLOOR TROUGH
7 PLYWOOD
8 ACOUSTIC UNDERLAYMENT
9 CARPET
10 WOOD SLATS
11 SPRINKLERS

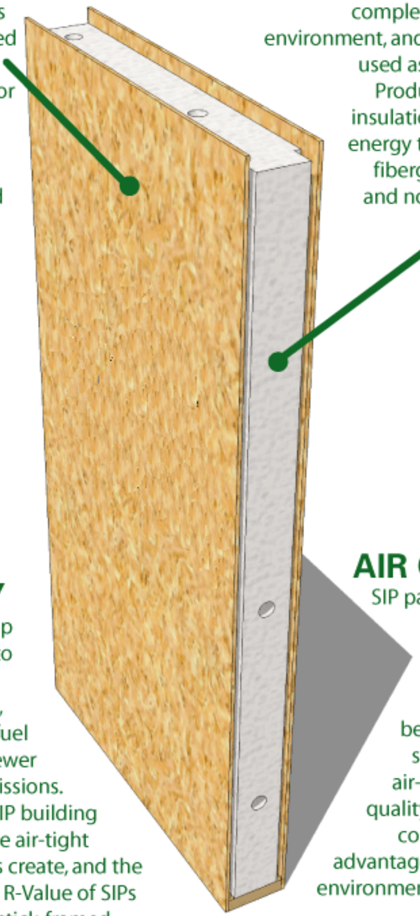
SIPS – Structural Insulated Panels

The entire building can be made from a type of sandwich panel that is insulated.

SIPS – Structural Insulated Panels

OSB is made from fast-growing, small-diameter trees that can be harvested from plantations, avoiding the need for cutting old-growth trees. Even the smallest scraps of wood can be turned into OSB, virtually eliminating waste.

EPS FOAM is a recyclable material that is completely inert in the environment, and is in fact often used as a soil additive. Producing EPS foam insulation requires less energy than producing fiberglass insulation, and no CFCs are used in the process.



ENERGY EFFICIENCY
SIP homes require up to 50% less energy to heat and cool than stick-framed homes, meaning less fossil fuel consumption and fewer greenhouse gas emissions. The efficiency of a SIP building is a result of both the air-tight envelope the panels create, and the substantially higher R-Value of SIPs when compared to stick-framed walls.

AIR QUALITY
SIP panels release no volatile organic compounds (VOCs). Furthermore, because SIP-built structures are so air-tight, indoor air quality can be closely controlled, a huge advantage for those with environmental or chemical allergies.

A method of building walls WITHOUT studs
Can use EPS (more sustainable) or XPS foam as insulation
Panel thickness varies from 140mm to close to 300mm.

SIPs insulation-value (R-value)

SIP Panel Thickness	10 cm	15 cm	21 cm	26 cm	31 cm
	4 1/2″	6 1/2″	8 1/4″	10 1/4″	12 1/4″
XPS	20	30	38	48	58
EPS	14	21	28	35	42

SIP thicknesses

SIP R-Values (Calculated R-Values)

SIP Panel Thickness	4 1/2"	6 1/2"	8 1/4"	10 1/4"	12 1/4"
EPS	14	21	28	35	42
XPS	20	30	38	48	58
Polyurethane	*	*	*	N/A	N/A

*R-values vary between SIP manufacturers slightly

If a higher R value is needed, the insulation should generally be place on the interior to prevent the OSB on the exterior from getting moisture trapped next to it which could cause rot.

Better idea to just specify a thicker panel.


(517)
486-4355
RIVERBEND
TIMBER
FRAMING

http://nbv.tid.al/post/building-a-home-with-sips-structural-insulated-panels

http://nbv.tid.al/post/building-a-home-with-sips-structural-insulated-panels

- A 38 x 140 (or whatever size matches the width of the SIP) is nailed to form the base plate.
- The SIP is lowered over

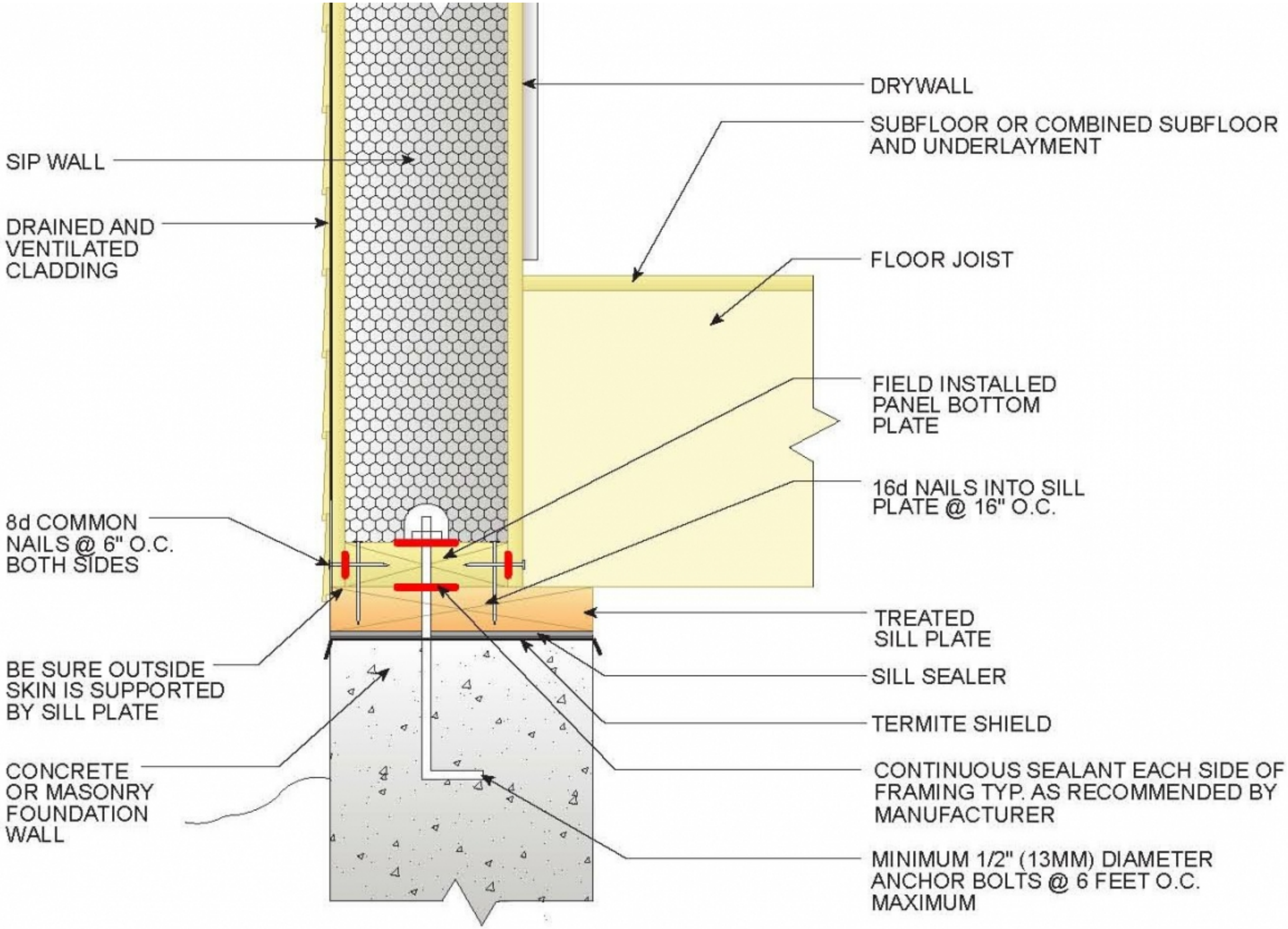
http://nbv.tid.al/post/building-a-home-with-sips-structural-insulated-panels

http://nbv.tid.al/post/building-a-home-with-sips-structural-insulated-panels

http://nbv.tid.al/post/building-a-home-with-sips-structural-insulated-panels

Wood stud inserted at the end of the panel as it turns the corner to facilitate adding the next panel and cladding.

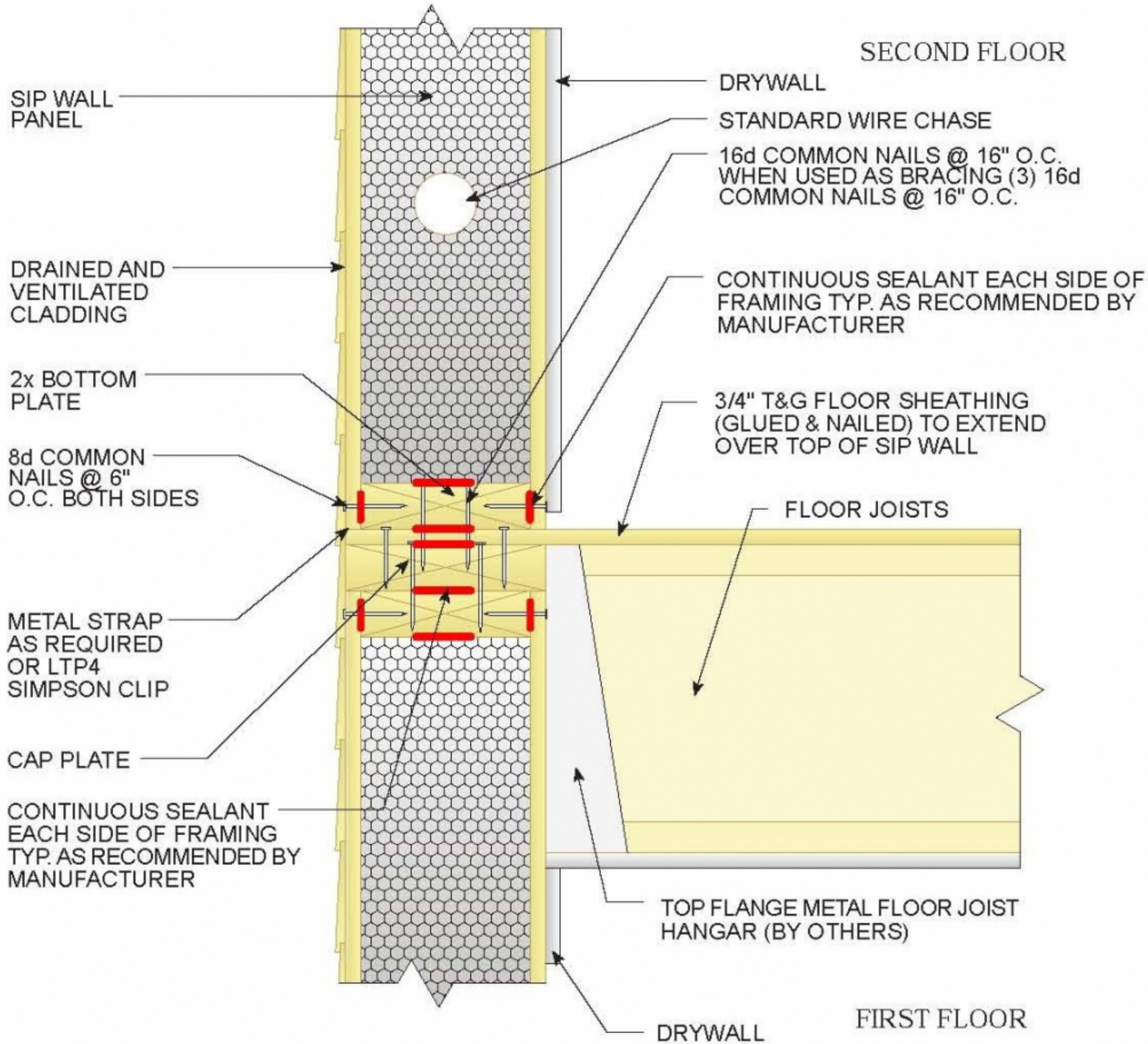
http://nbv.tid.al/post/building-a-home-with-sips-structural-insulated-panels



FOUNDATION CONNECTIONS

FOUNDATION CONNECTION DETAIL A

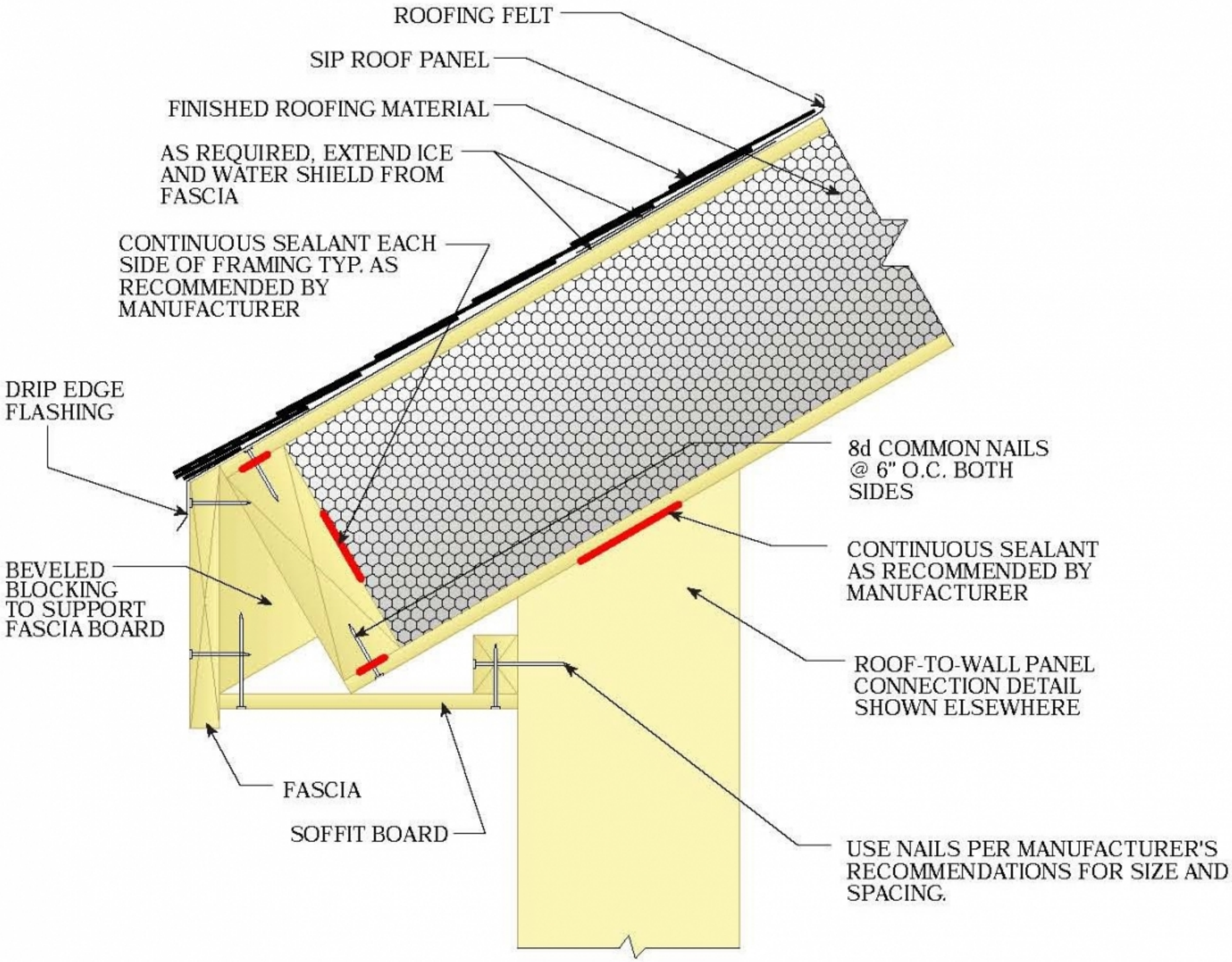
http://www.sips.org/technical-information/sips-construction-details



2ND FLOOR CONNECTION DETAILS

http://www.sips.org/technical-information/sips-construction-details

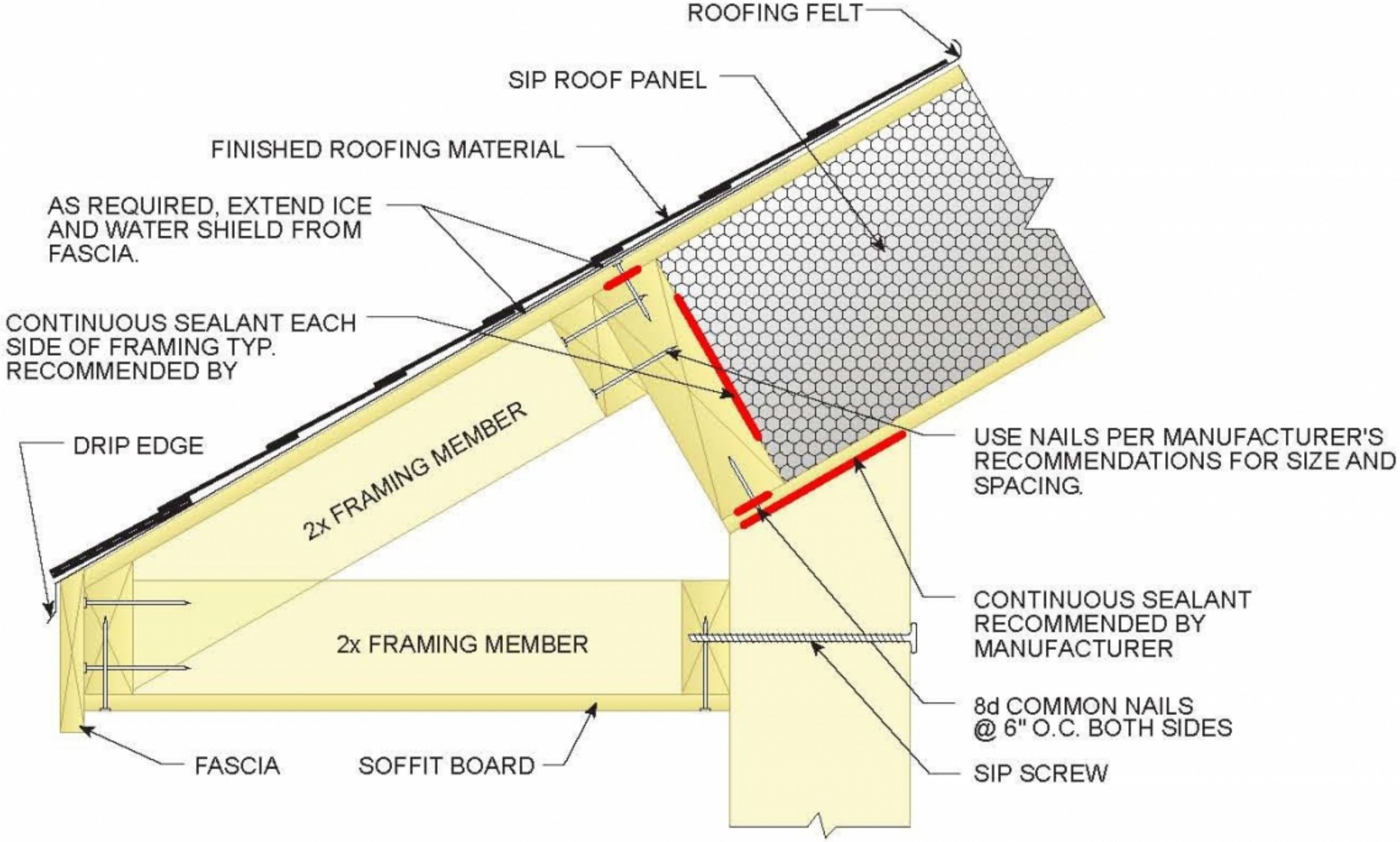
HANGING FLOOR



EAVES DETAILING

http://www.sips.org/technical-information/sips-construction-details

EAVES DETAIL D



EAVES DETAILING

EAVES DETAIL C

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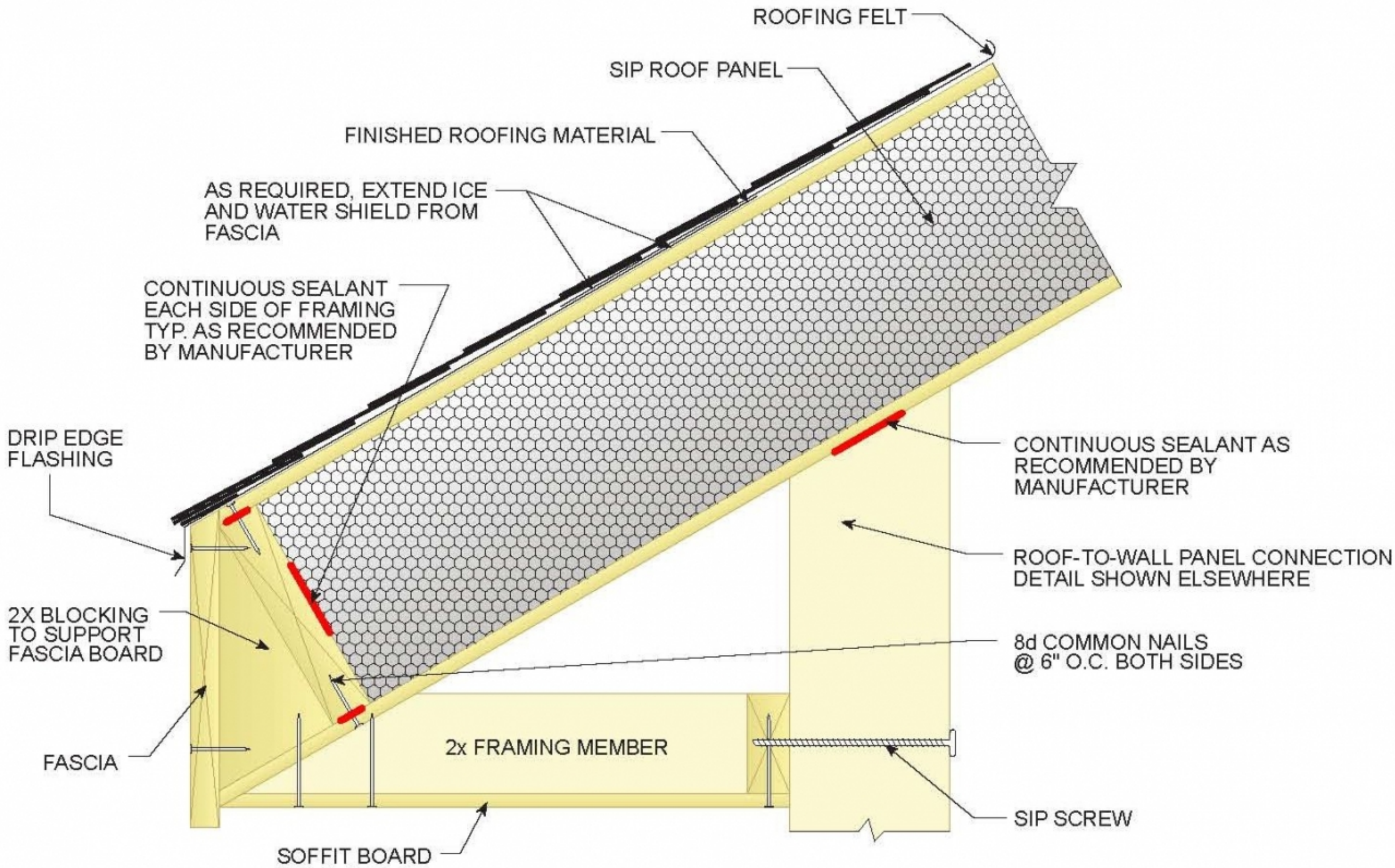

EAVES DETAILING

EAVES DETAIL B

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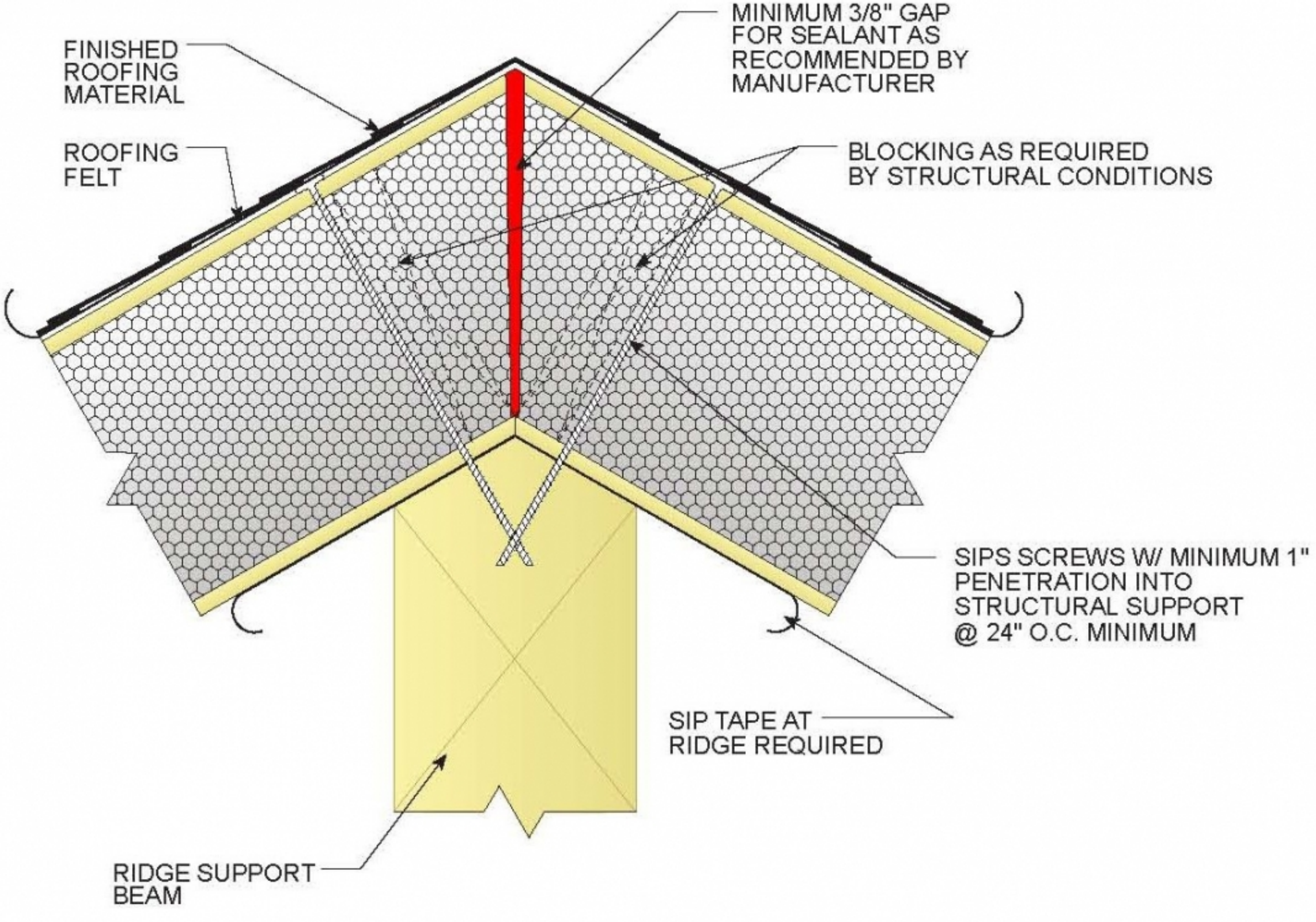
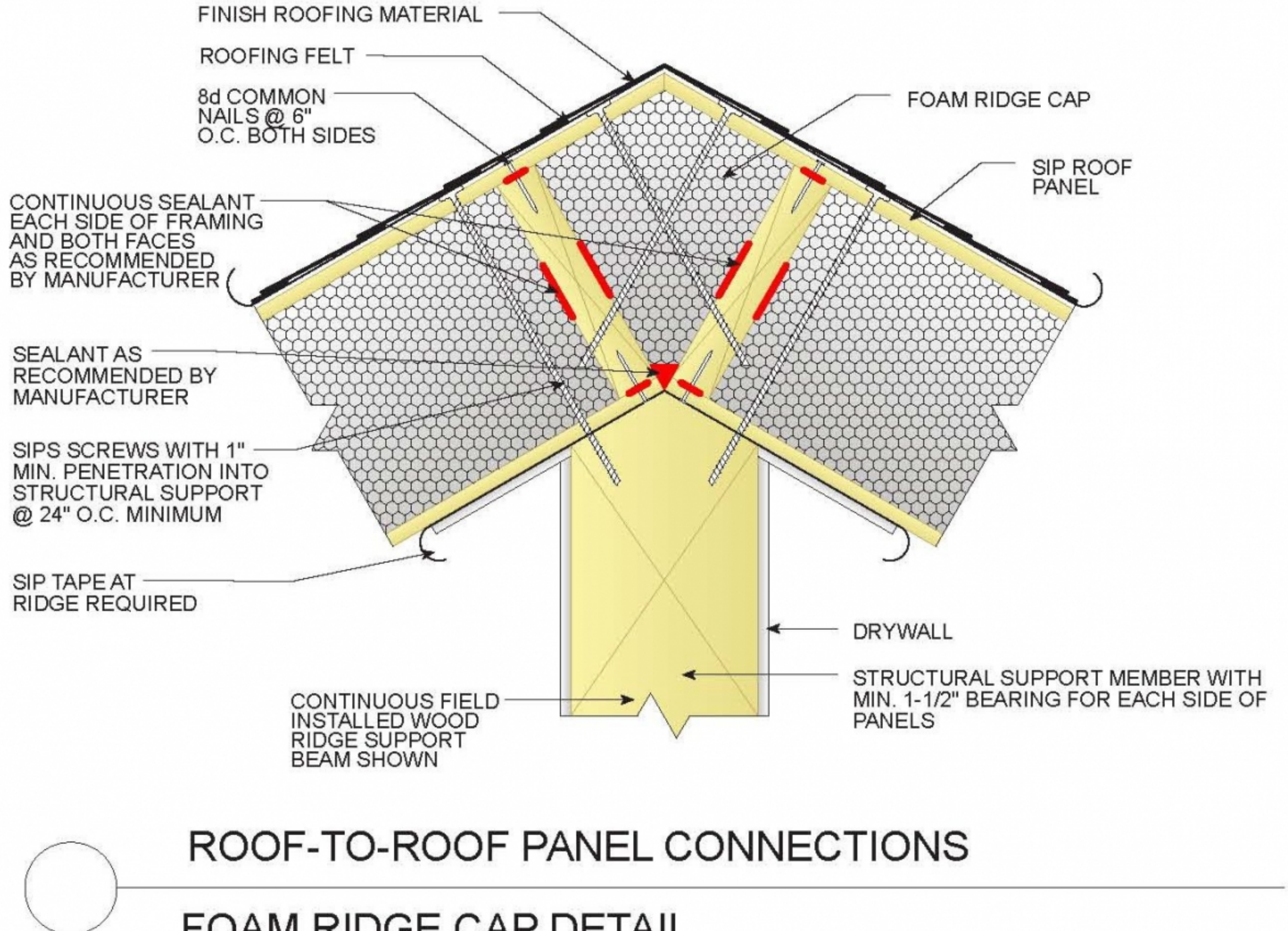


ROOF-TO-ROOF PANEL CONNECTIONS

BEVELED SIP RIDGE DETAIL

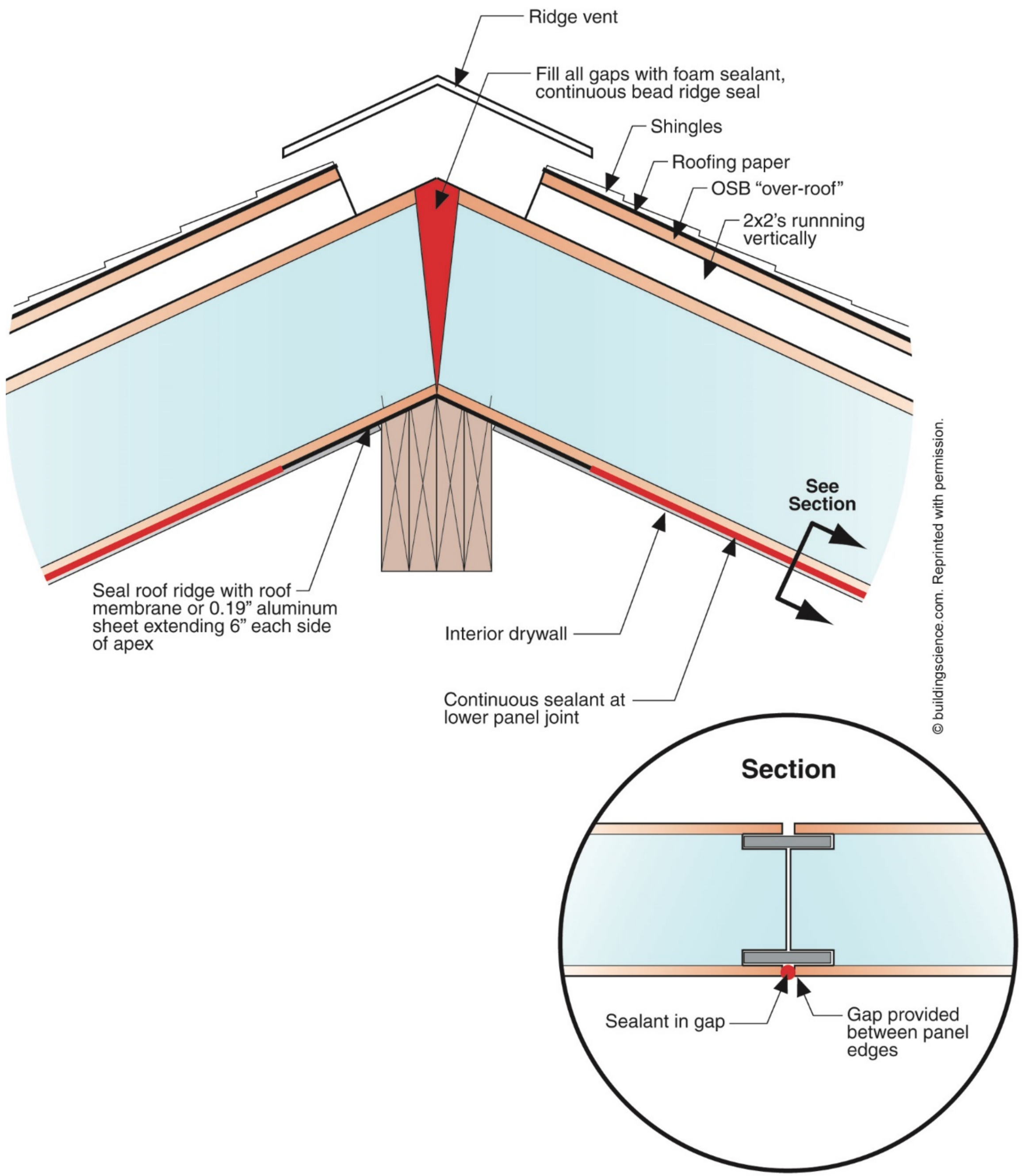
http://www.sips.org/technical-information/sips-construction-details



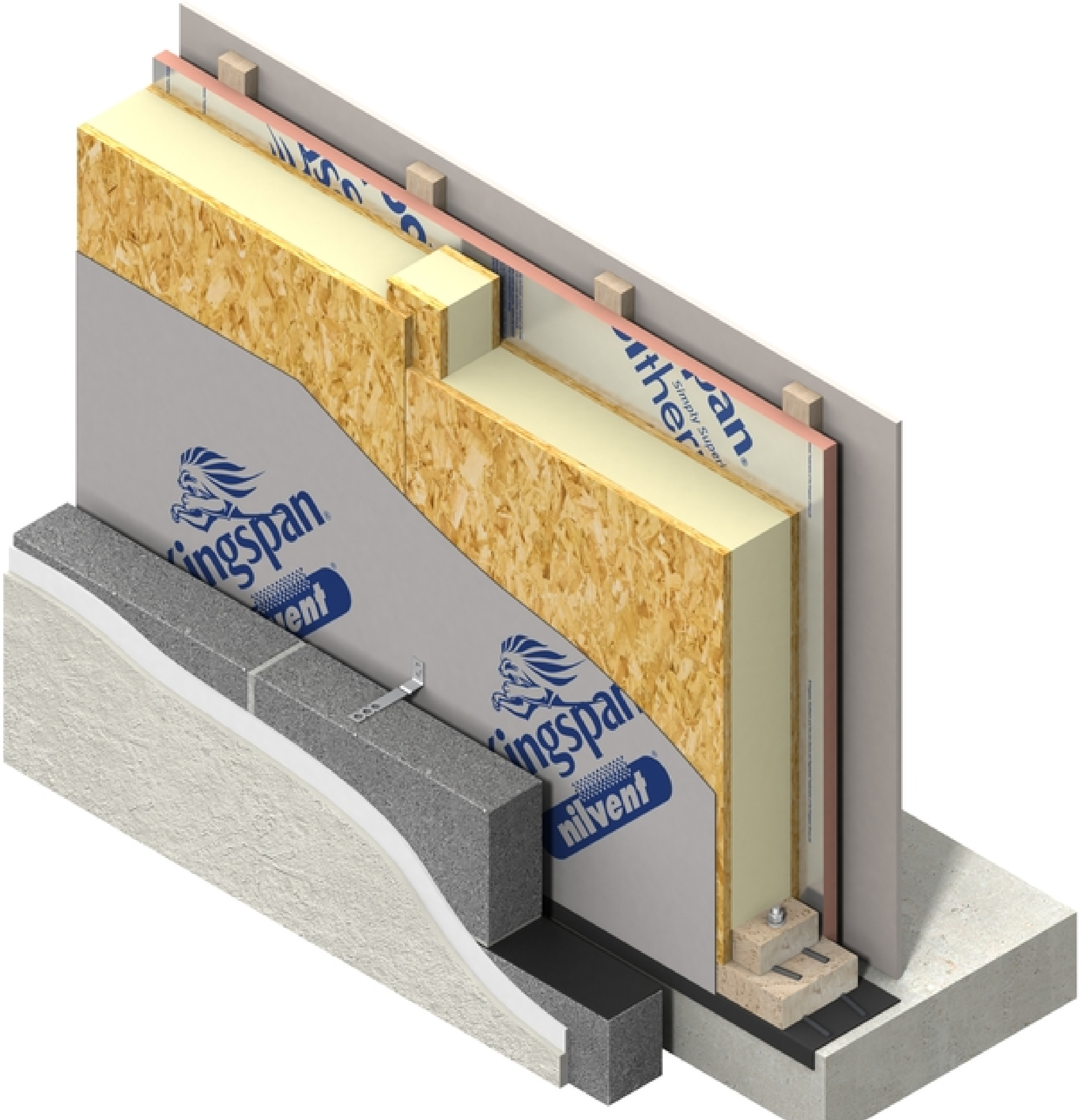
ROOF-TO-ROOF PANEL CONNECTIONS

FOAM RIDGE CAP DETAIL

http://www.sips.org/technical-information/sips-construction-details



http://www.greenbuildingadvisor.com/blogs/dept/qa-spotlight/how-make-sip-roof-better



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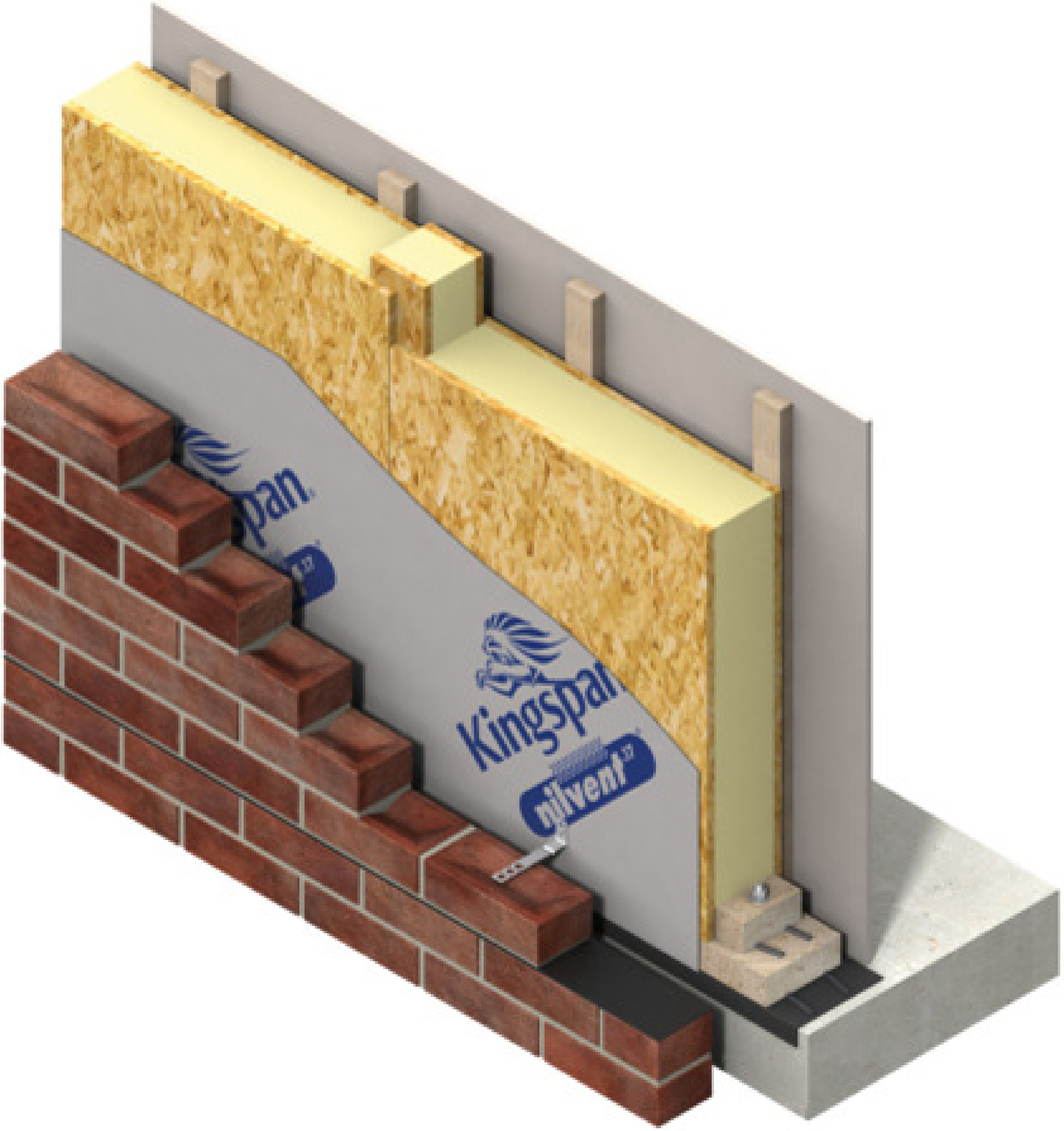

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