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nordic.ca



Formation Principes de Conception et Calcul d'Assemblages pour des Structures en Poteaux-Poutres

Simon Gallagher

ORGANIZATION

BUILDING SINCE 1961

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EXPERIENCE COLLABORATIONS

CLIENTS

DESIGN TEAMS

GENERAL CONTRACTORS

R+D PARTNERS

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Plan de la formation

- Description
- Matériau bois
 - Naturel
 - Anisotrope
 - Parallèle et perpendiculaire au fil
 - Hygroscopique
 - Retrait
 - Résistance mécanique
 - Feu
- Connecteur
 - 'Ancien'
 - Goujon/Boulon/Clous
 - Vis
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 - Oublis commun
- Detail Typique
- Connecteur propriétaire

Description

- Dans un premier temps, nous couvrirons les notions de base du bois massif (Glulam, CLT) et son comportement structurel. Par la suite, nous examinerons comment ces caractéristiques guident la bonne conception des assemblages de structures en bois massif.

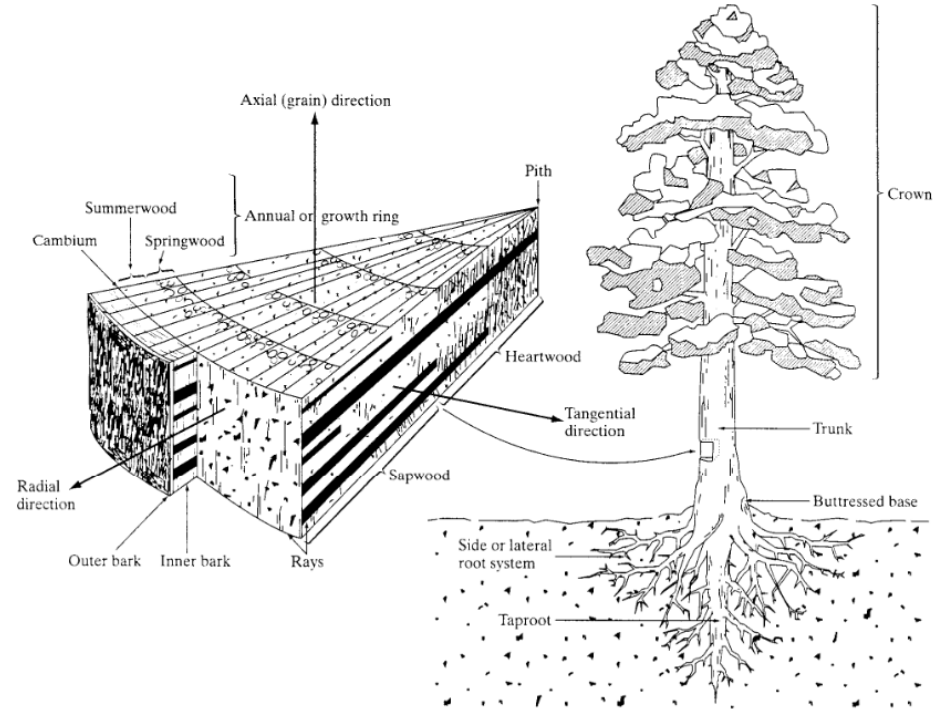
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Matériau Bois

Naturel

- Anisotrope
- Hygroscopique



Science and Technology of Civil Engineering Materials

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Matériau Bois

Anisotrope

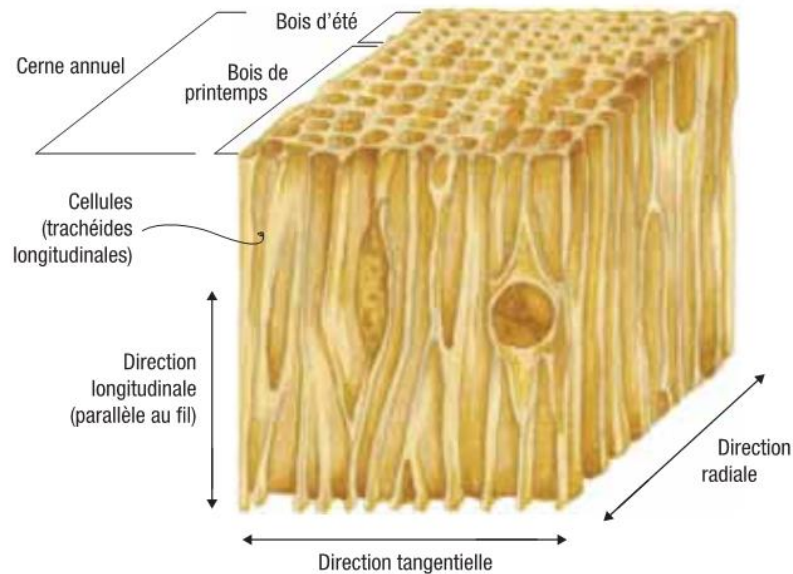
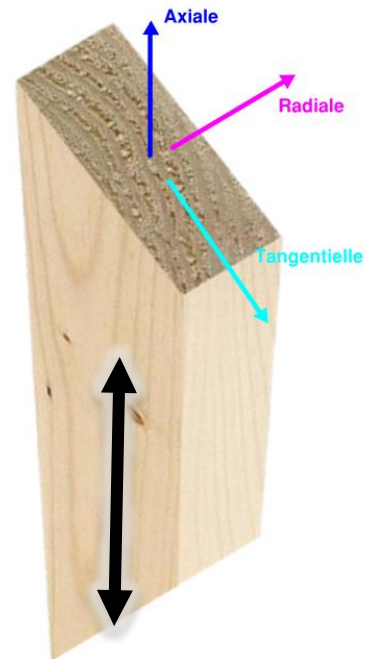
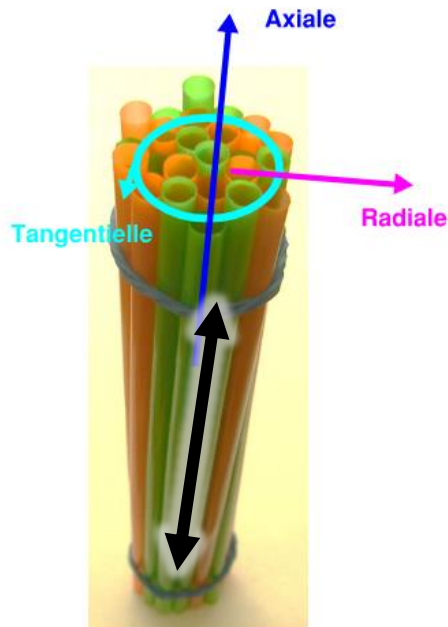
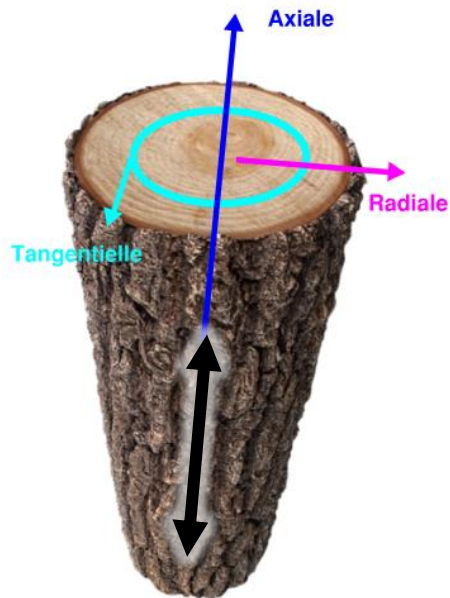


FIGURE 3 • Structure microscopique d'un bois résineux

Cecobois

Matériau Bois

Anisotrope

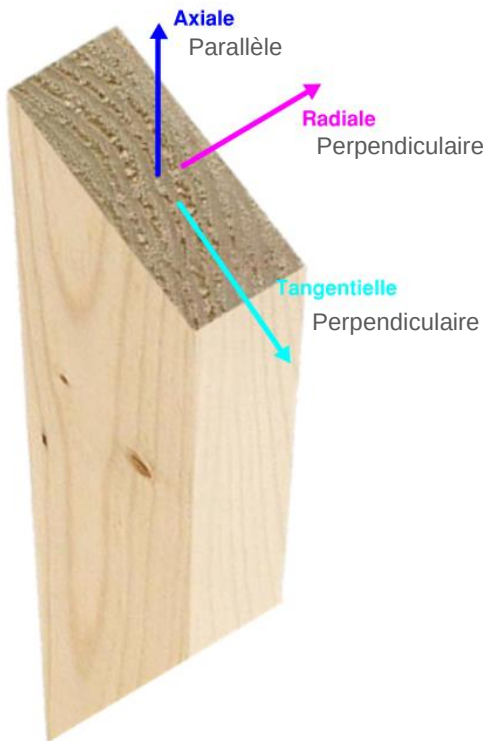


Orientation de la fibre ou du grain

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Matériau Bois

Parallèle et Perpendiculaire au fil



Axiale

= Parallèle au fil

Tangentielle

= Perpendiculaire au fil

Radiale

= Perpendiculaire au fil

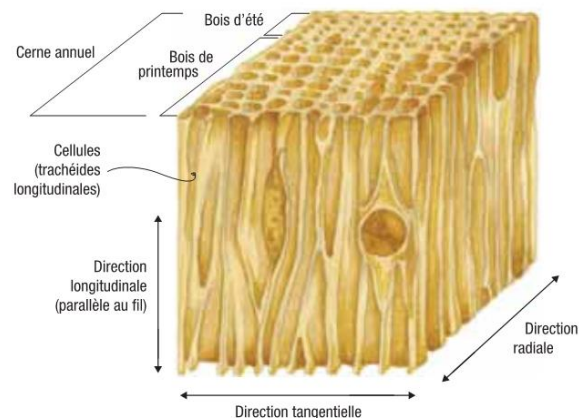


FIGURE 3 • Structure microscopique d'un bois résineux
Cecobois

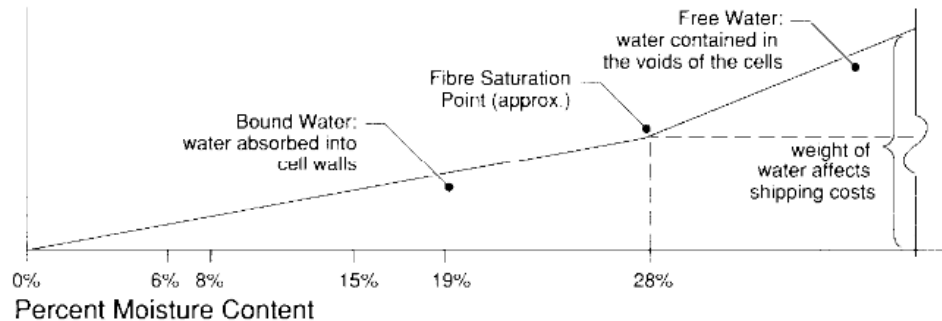
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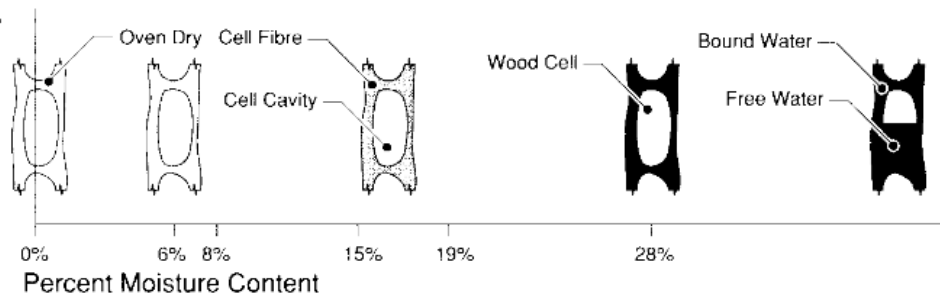
Matériau Bois

Hygroscopique

Moisture Content of Wood



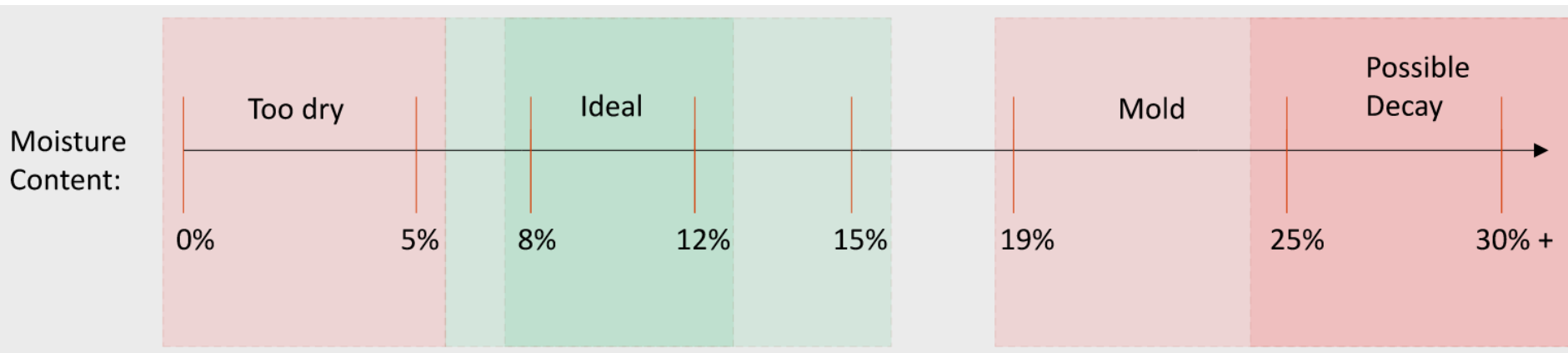
Wood Cell Moisture



CWC

Matériau Bois

Hygroscopique



Wood Water Relations, Evan Schmidts,
TallWood Design Institute

Matériau Bois

Hygroscopique

ASHRAE:

Intérieur

Température:

68.5 à 80.5 °F

Humidité relative

30% à 60%

Table 3-4. Moisture content of wood in equilibrium with stated temperature and relative humidity

Temperature		Moisture content (%) at various relative humidity values																		
(°C)	(°F)	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
-1.1	(30)	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3
4.4	(40)	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.3	13.5	14.9	16.5	18.5	21.0	24.3
10.0	(50)	1.4	2.6	3.6	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.2	12.3	13.4	14.8	16.4	18.4	20.9	24.3
15.6	(60)	1.3	2.5	3.6	4.6	5.4	6.2	7.0	7.8	8.6	9.4	10.2	11.1	12.1	13.3	14.6	16.2	18.2	20.7	24.1
21.1	(70)	1.3	2.5	3.5	4.5	5.4	6.2	6.9	7.7	8.5	9.2	10.1	11.0	12.0	13.1	14.4	16.0	17.9	20.5	23.9
26.7	(80)	1.3	2.4	3.5	4.4	5.3	6.1	6.8	7.6	8.3	9.1	9.9	10.8	11.7	12.9	14.2	15.7	17.7	20.2	23.6
32.2	(90)	1.2	2.3	3.4	4.3	5.1	5.9	6.7	7.4	8.1	8.9	9.7	10.5	11.5	12.6	13.9	15.4	17.3	19.8	23.3
37.8	(100)	1.2	2.3	3.3	4.2	5.0	5.8	6.5	7.2	7.9	8.7	9.5	10.3	11.2	12.3	13.6	15.1	17.0	19.5	22.9
43.3	(110)	1.1	2.2	3.2	4.0	4.9	5.6	6.3	7.0	7.7	8.4	9.2	10.0	11.0	12.0	13.2	14.7	16.6	19.1	22.4
48.9	(120)	1.1	2.1	3.0	3.9	4.7	5.4	6.1	6.8	7.5	8.2	8.9	9.7	10.6	11.7	12.9	14.4	16.2	18.6	22.0
54.4	(130)	1.0	2.0	2.9	3.7	4.5	5.2	5.9	6.6	7.2	7.9	8.7	9.4	10.3	11.3	12.5	14.0	15.8	18.2	21.5
60.0	(140)	0.9	1.9	2.8	3.6	4.3	5.0	5.7	6.3	7.0	7.7	8.4	9.1	10.0	11.0	12.1	13.6	15.3	17.7	21.0
65.6	(150)	0.9	1.8	2.6	3.4	4.1	4.8	5.5	6.1	6.7	7.4	8.1	8.8	9.7	10.6	11.8	13.1	14.9	17.2	20.4
71.1	(160)	0.8	1.6	2.4	3.2	3.9	4.6	5.2	5.8	6.4	7.1	7.8	8.5	9.3	10.3	11.4	12.7	14.4	16.7	19.9
76.7	(170)	0.7	1.5	2.3	3.0	3.7	4.3	4.9	5.6	6.2	6.8	7.4	8.2	9.0	9.9	11.0	12.3	14.0	16.2	19.3
82.2	(180)	0.7	1.4	2.1	2.8	3.5	4.1	4.7	5.3	5.9	6.5	7.1	7.8	8.6	9.5	10.5	11.8	13.5	15.7	18.7
87.8	(190)	0.6	1.3	1.9	2.6	3.2	3.8	4.4	5.0	5.5	6.1	6.8	7.5	8.2	9.1	10.1	11.4	13.0	15.1	18.1
93.3	(200)	0.5	1.1	1.7	2.4	3.0	3.5	4.1	4.6	5.2	5.8	6.4	7.1	7.8	8.7	9.7	10.9	12.5	14.6	17.5
98.9	(210)	0.5	1.0	1.6	2.1	2.7	3.2	3.8	4.3	4.9	5.4	6.0	6.7	7.4	8.3	9.2	10.4	12.0	14.0	16.9
104.4	(220)	0.4	0.9	1.4	1.9	2.4	2.9	3.4	3.9	4.5	5.0	5.6	6.3	7.0	7.8	8.8	9.9			
110.0	(230)	0.3	0.8	1.2	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.3	6.0	6.7						
115.6	(240)	0.3	0.6	0.9	1.3	1.7	2.1	2.6	3.1	3.5	4.1	4.6								
121.1	(250)	0.2	0.4	0.7	1.0	1.3	1.7	2.1	2.5	2.9										
126.7	(260)	0.2	0.3	0.5	0.7	0.9	1.1	1.4												
132.2	(270)	0.1	0.1	0.2	0.3	0.4	0.4													

Wood Handbook

Matériau Bois

Hygroscopique

Teneur en Humidité d'Équilibre

Location		Average (%)	Winter (%)	Summer (%)
West coast	Indoors	10 – 11	8	12
	Outdoors under cover	15 – 16	18	13
Prairies	Indoors	6 – 7	5	8
	Outdoors under cover	11 – 12	12	10
Central Canada	Indoors	7 – 8	5	10
	Outdoors under cover	13 – 14	17	10
East coast	Indoors	8 – 9	7	10
	Outdoors under cover	14 – 15	19	12

CWC

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Matériau Bois

Retrait

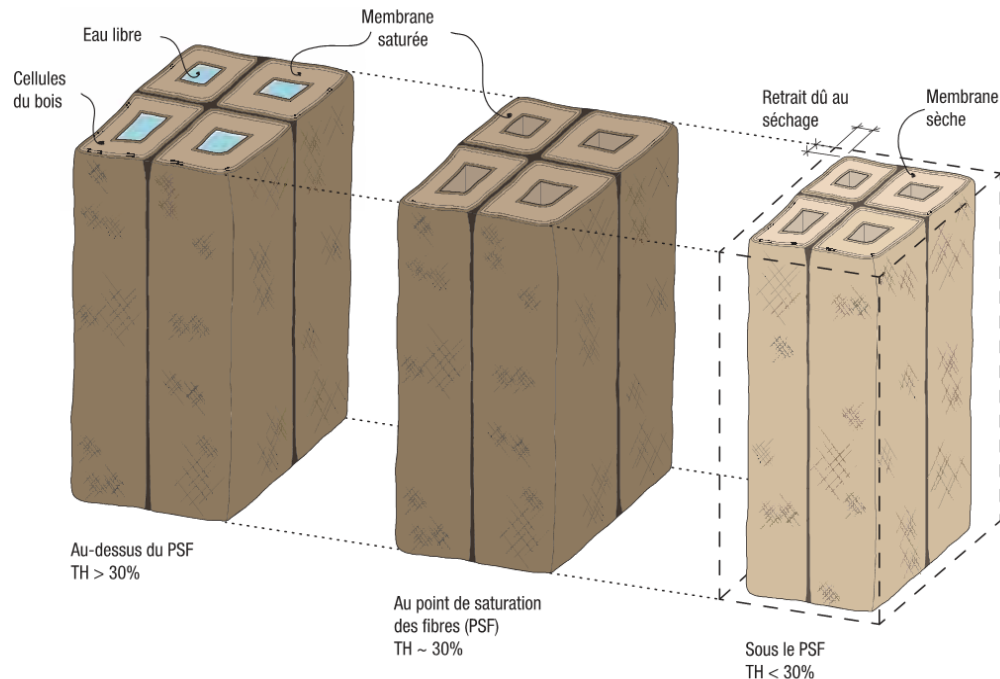
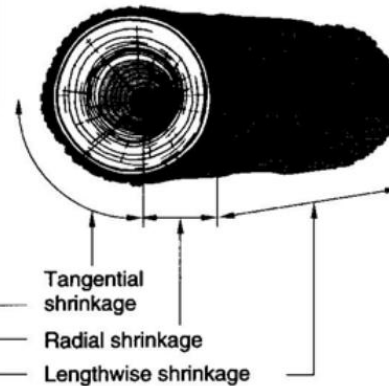
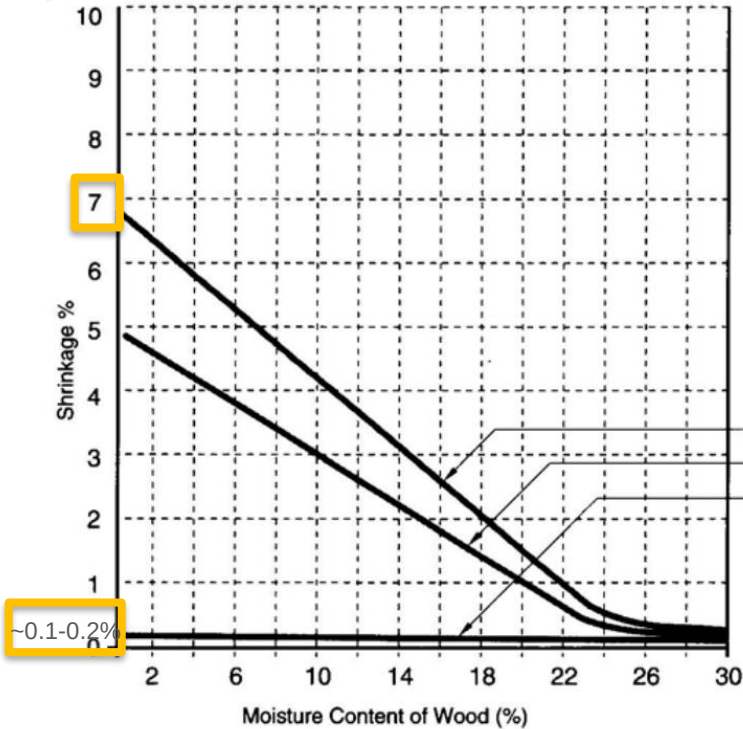


FIGURE 10 • Influence de la teneur en humidité sur les changements dimensionnels du bois

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Retrait



$$R = D \times M \times C$$

R = Retrait

D = Dimension

M = Changement de Teneur en humidité

C = 0.002 Perpendiculaire au grain
0.00005 Parallèle au grain

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Retrait

ANSI 117-2020 - Glulam

C3.1 Moisture Content

Moisture content shall not exceed 16%.

PRG 320-2019 - CLT

6.1.5 Moisture content

The moisture content of the laminations at the time of CLT manufacturing shall be typically $12 \pm 3\%$ and $8 \pm 3\%$, for lumber and SCL laminations, respectively. Lower

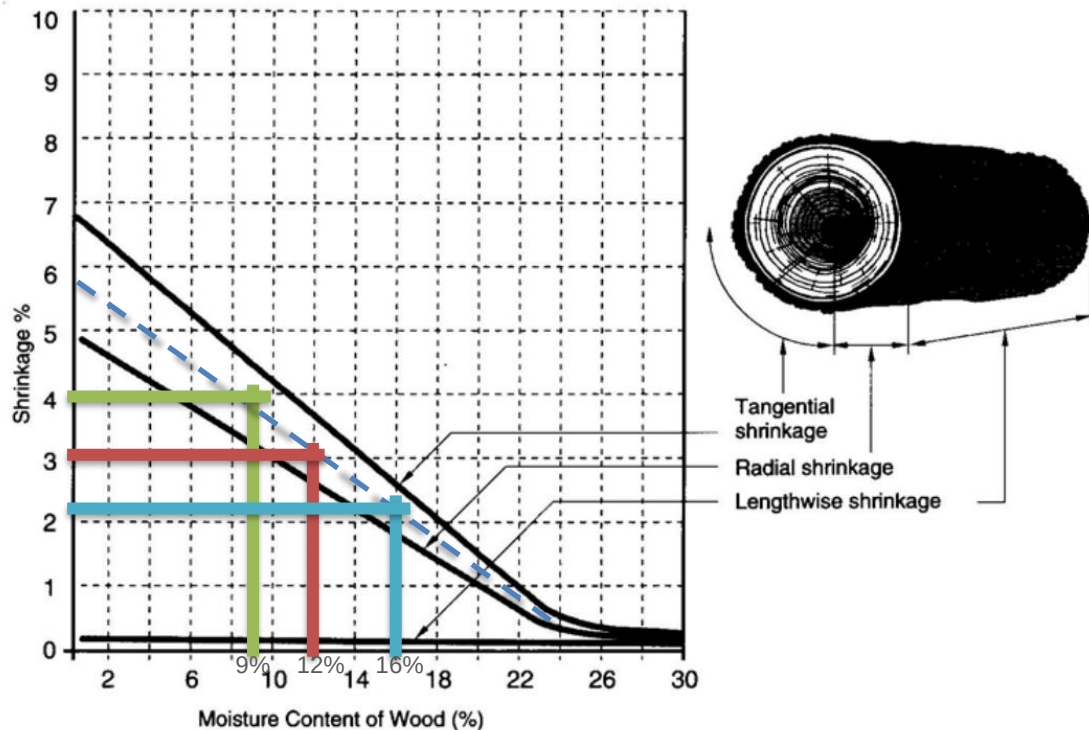
Fabriqué à $\pm 12\%$

$\pm 16\%$ Transport et Chantier

Équilibre $\pm 9\%$

Matériau Bois

Retrait



Teneur en Humidité

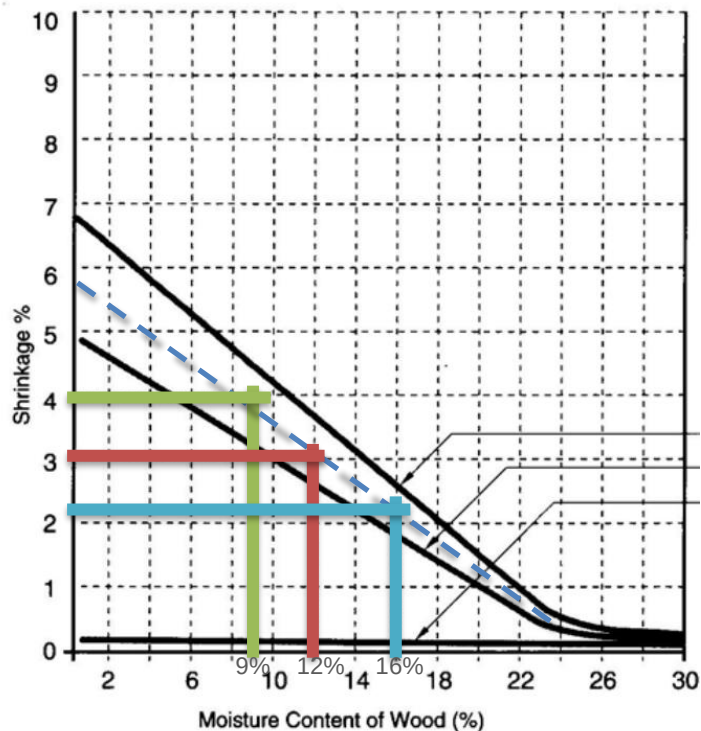
12% → 16% → 9 %

Retrait (%)

3% → 2% → 4%

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Retrait



Teneur en Humidité

12% → 16% → 9 %

Retrait (%)

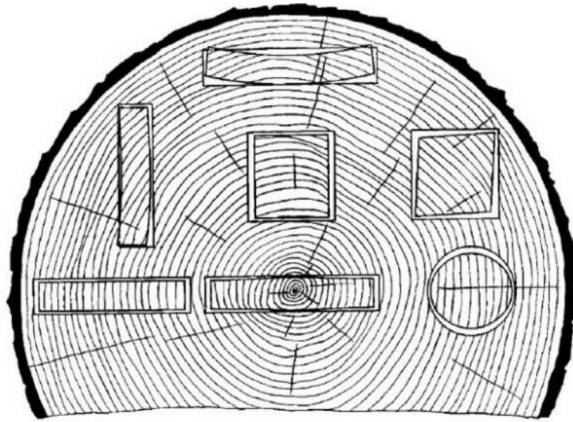
3% → 2% → 4%

Morceau qui commence
à 100 mm

~100 mm → 101 mm → 99 mm

Matériau Bois

Retrait



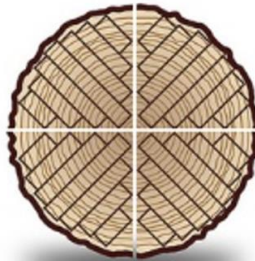
CWC

PLAIN SAWN

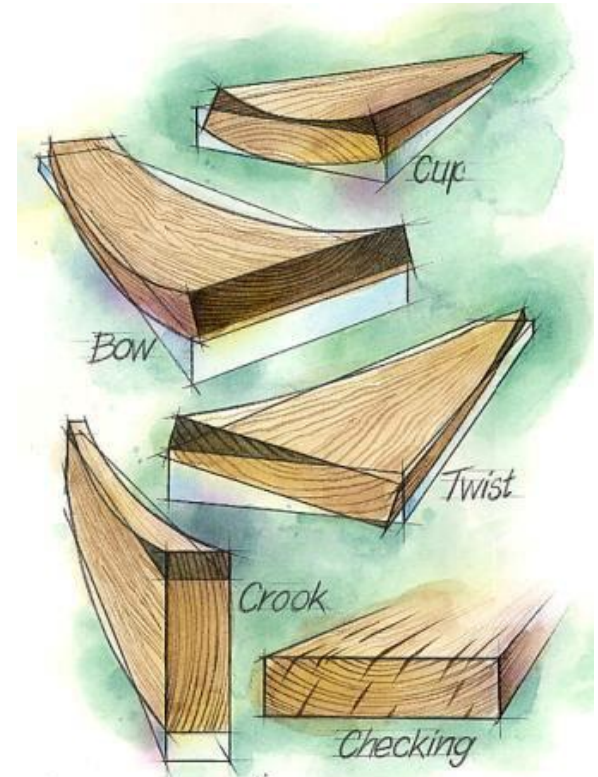
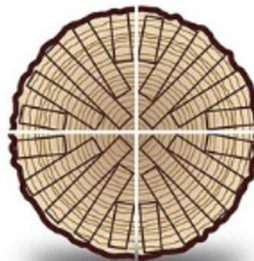


v3-usa.com

QUARTER SAWN



RIFT SAWN



woodandshop.com

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Matériau Bois

Retrait



Glulam

Retrait 2 directions



CLT

Retrait 1 direction

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SCOTTISH PERSPECTIVE: ICCROM 17th International Course on Stone Conservation: Tuesday 31st May 2011; Carrara (scottishlimecentre.blogspot.com)



Granite Quarry In Aswan Egypt: Two Unfinished Obelisks - [Hidden Inca Tours](http://HiddenIncaTours.com)

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Matériau Bois

Résistance mécanique

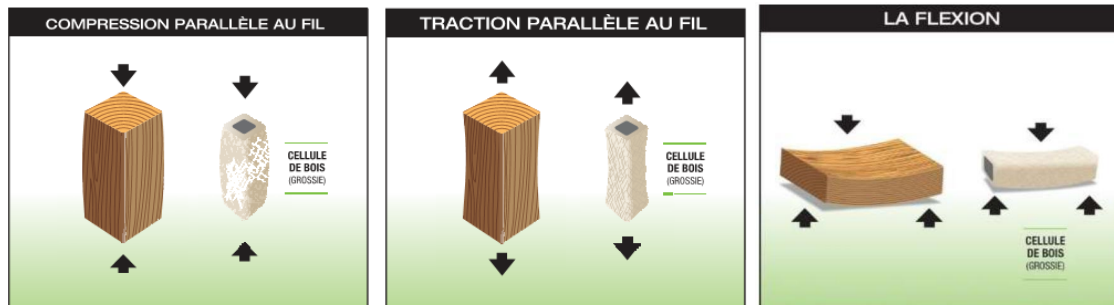


FIGURE 4 • Efforts exercés parallèlement au fil

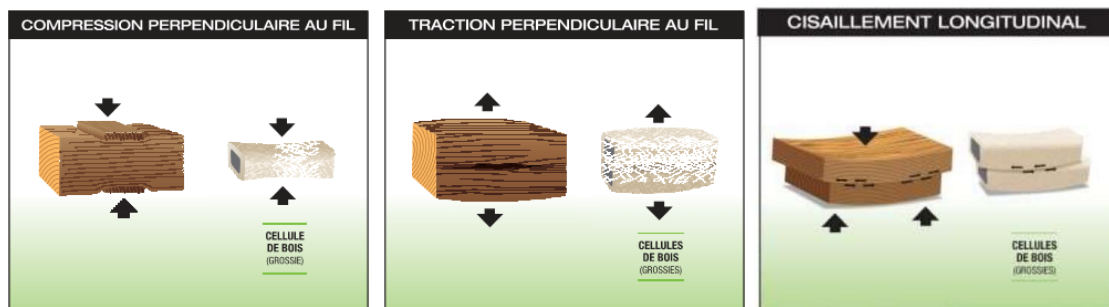
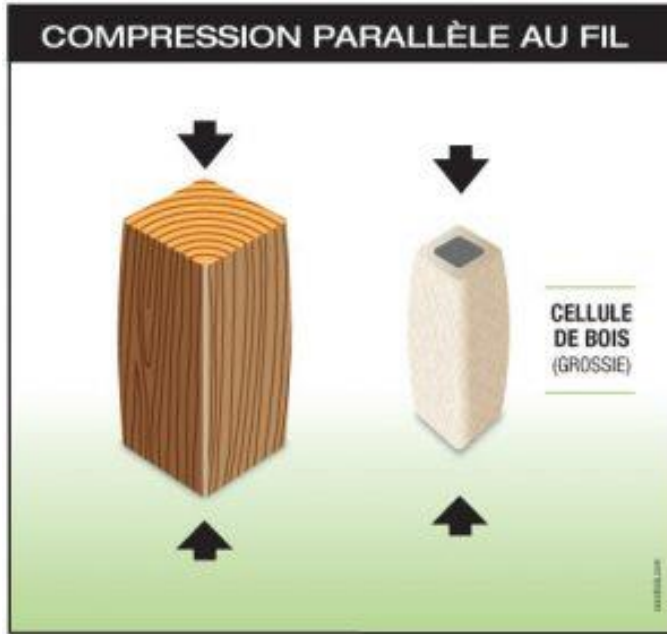


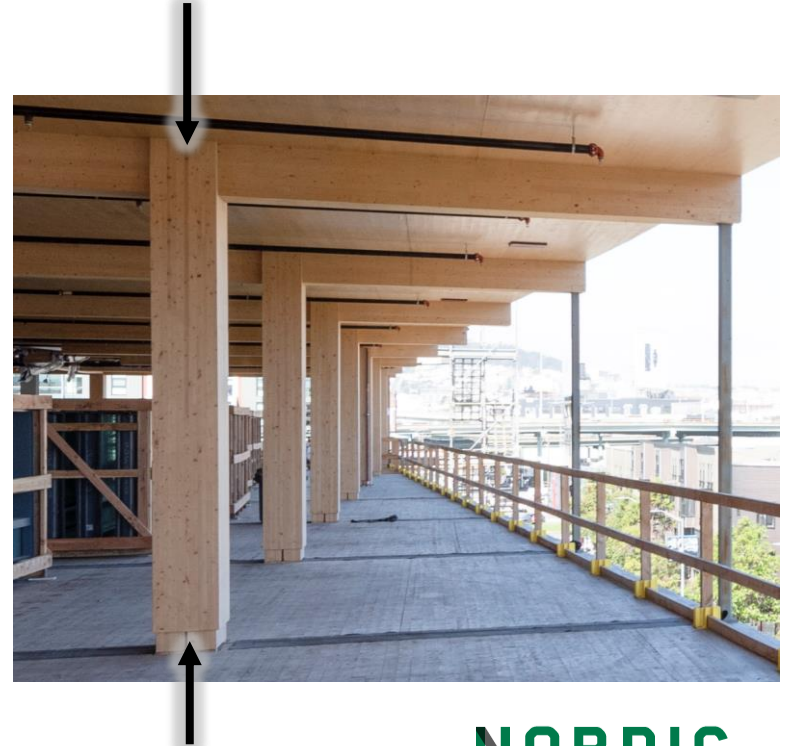
FIGURE 5 • Efforts exercés perpendiculairement au fil
Cecobois

Matériau Bois

Résistance mécanique



Cecobois

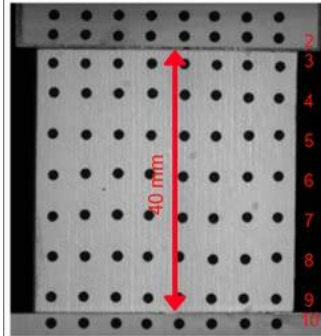


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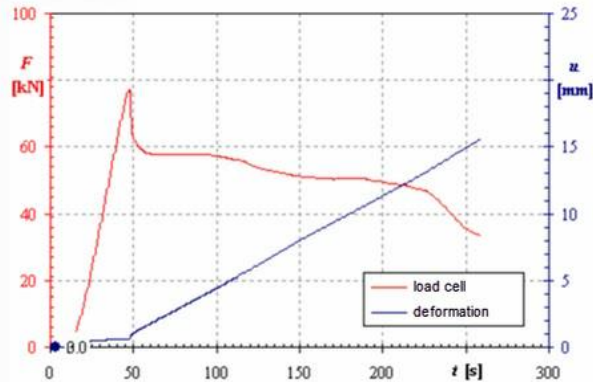
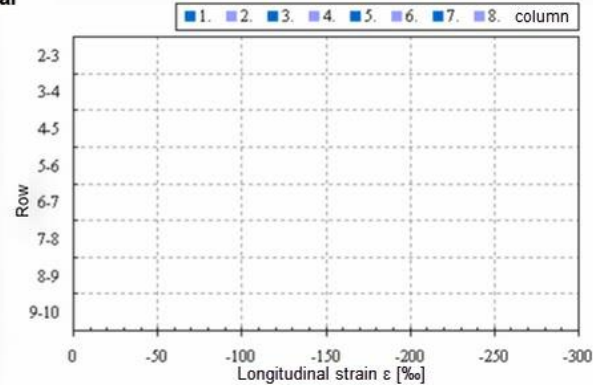
Matériau Bois

Résistance mécanique

Failure compression longitudinal



© Prof.-Dr. Steffen Franke



Matériau Bois

Résistance mécanique



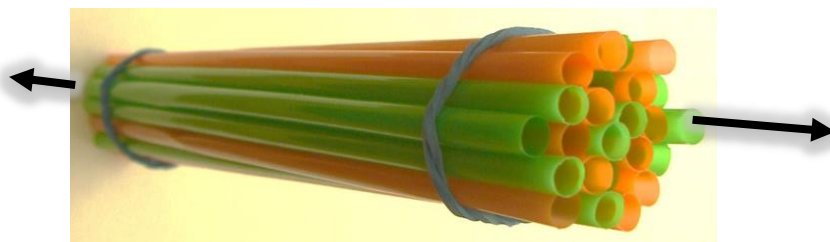
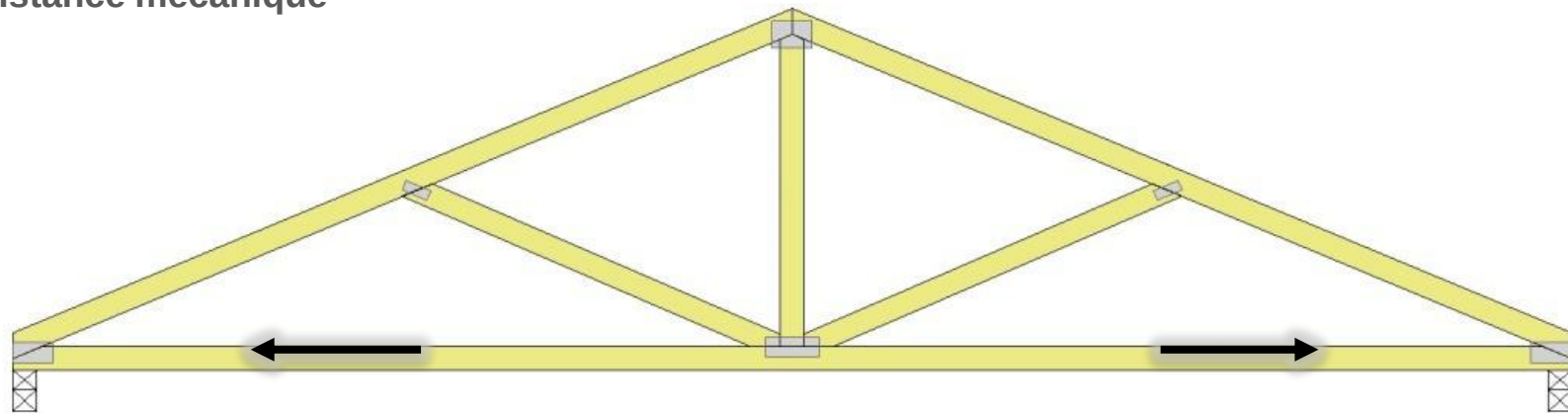
Cecobois



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Matériau Bois

Résistance mécanique



Matériau Bois

Résistance mécanique



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Résistance mécanique



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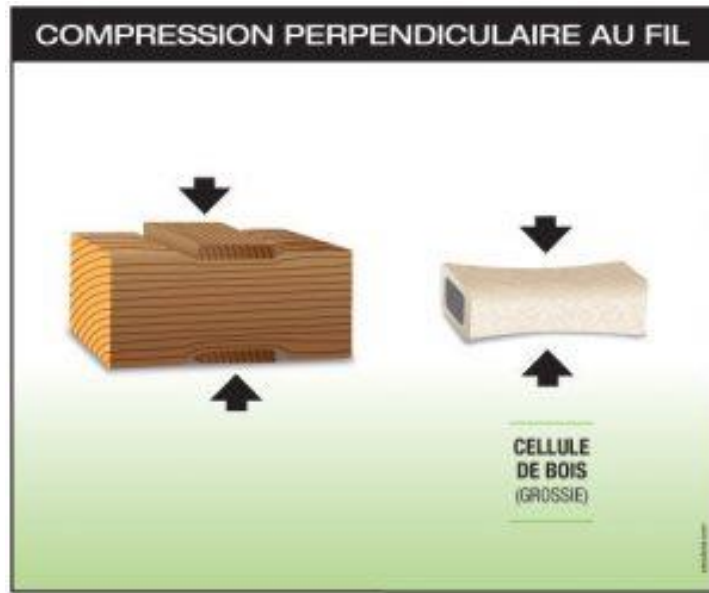


Cinematic Visualization of Failure Mechanisms in
Timber Structures 2010, Dietsch

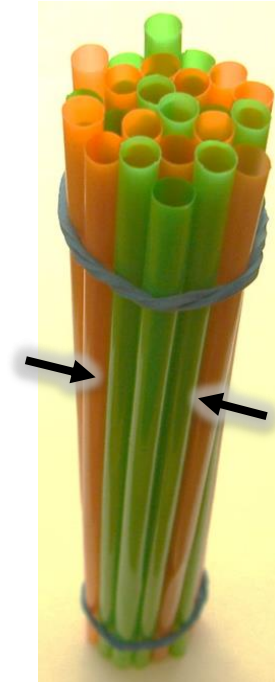
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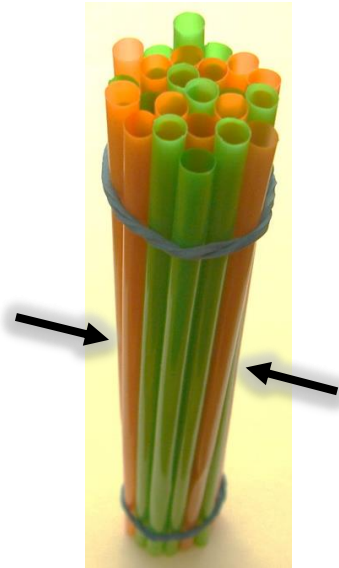
Cecobois



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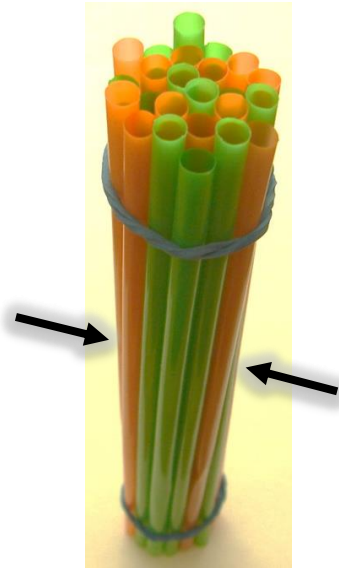
Matériau Bois

Résistance Mécanique



Matériau Bois

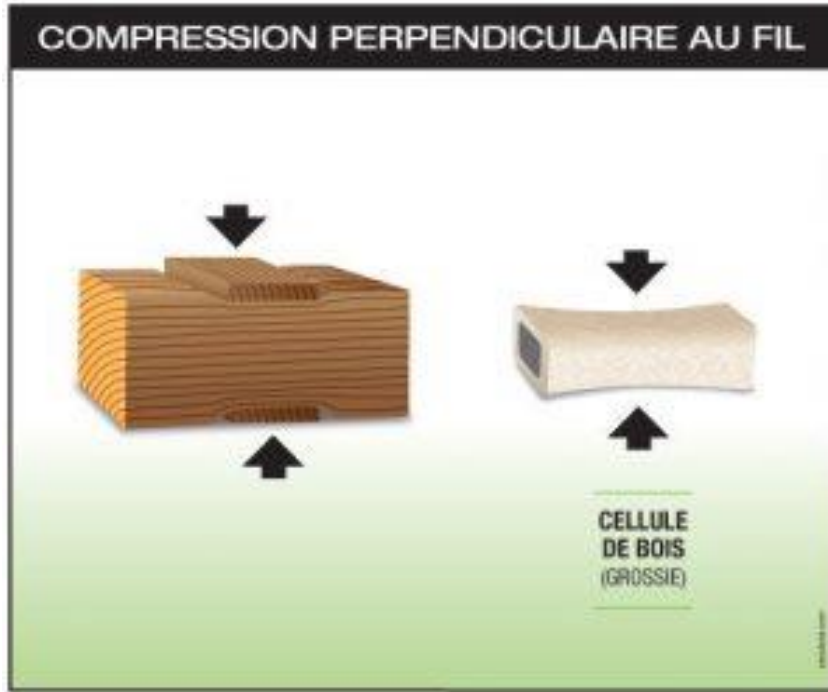
Résistance Mécanique



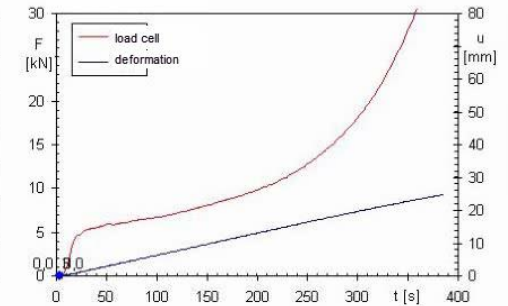
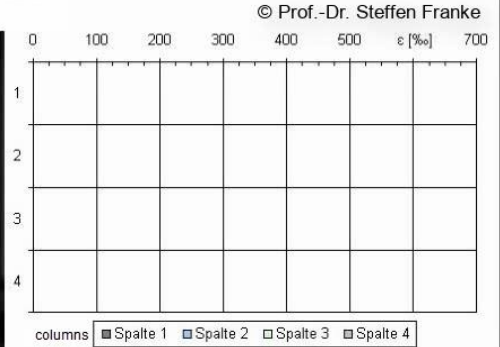
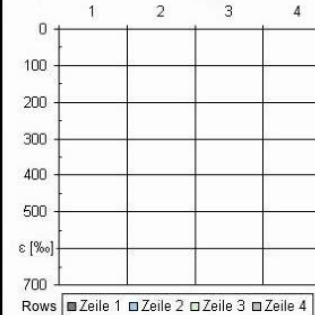
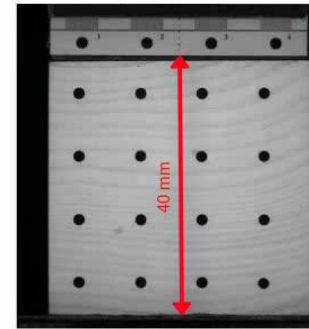
Dealing with a wooden porch that buckles when it rains - The Washington Post

Matériau Bois

Résistance Mécanique

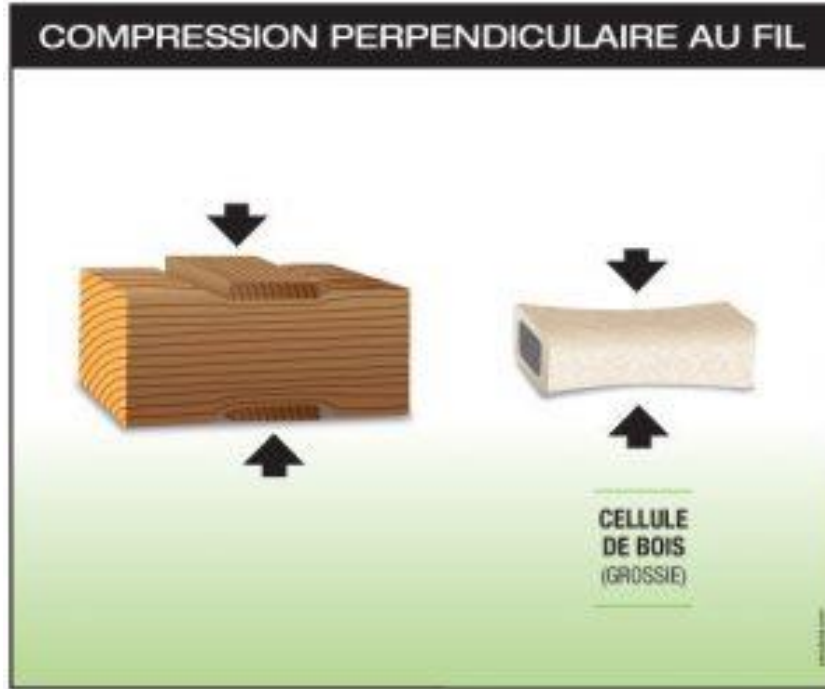


Failure compression radial

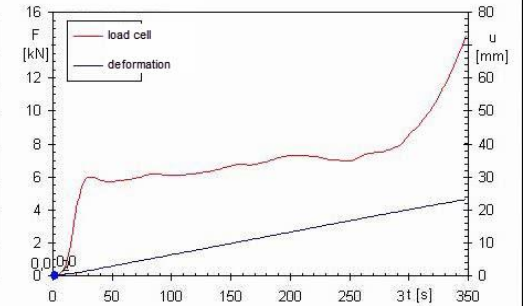
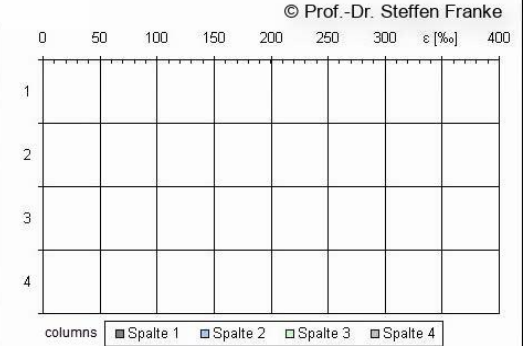
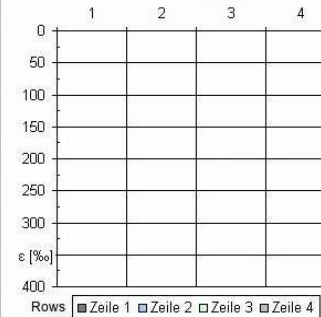
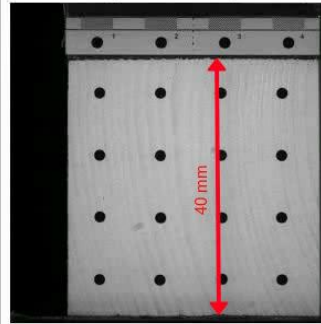


Matériau Bois

Résistance Mécanique

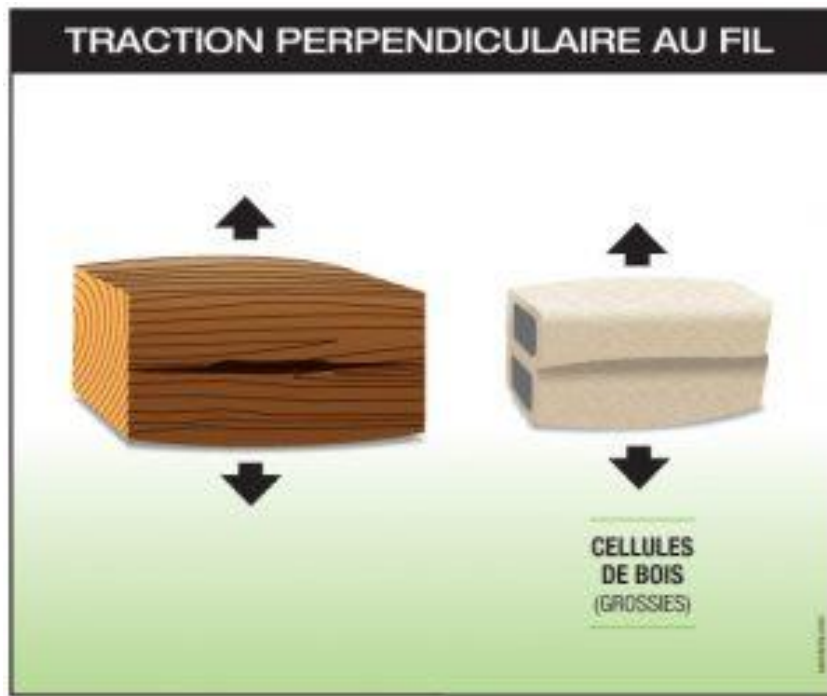


Failure compression tangential

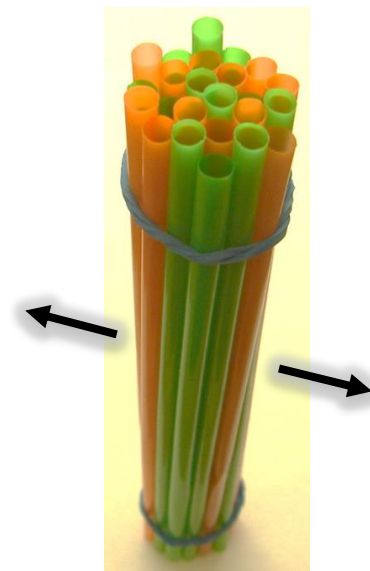


Matériau Bois

Résistance Mécanique



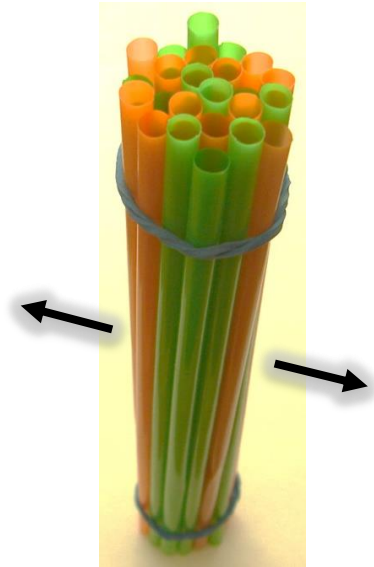
A éviter!



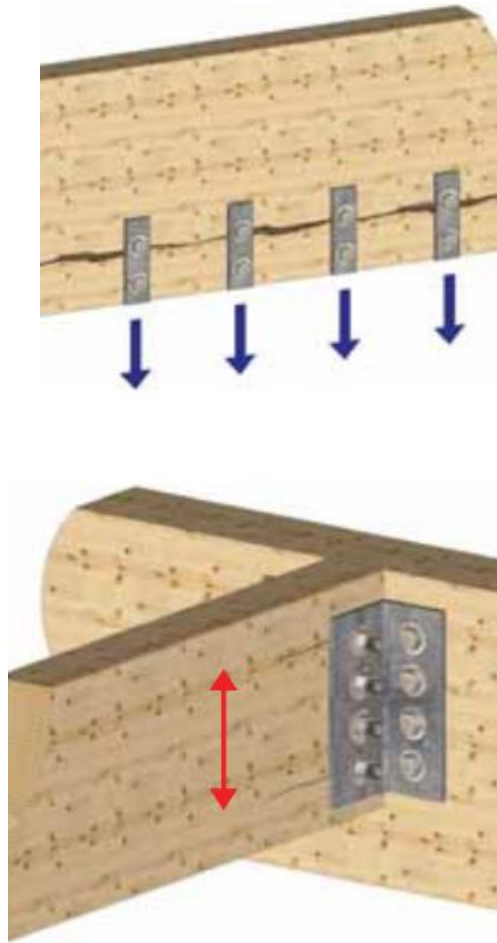
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STRUCTURES

Matériau Bois

Résistance Mécanique



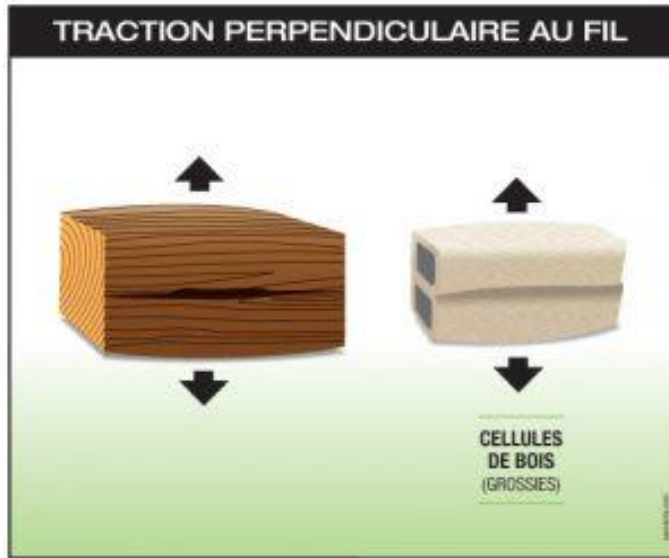
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Matériau Bois

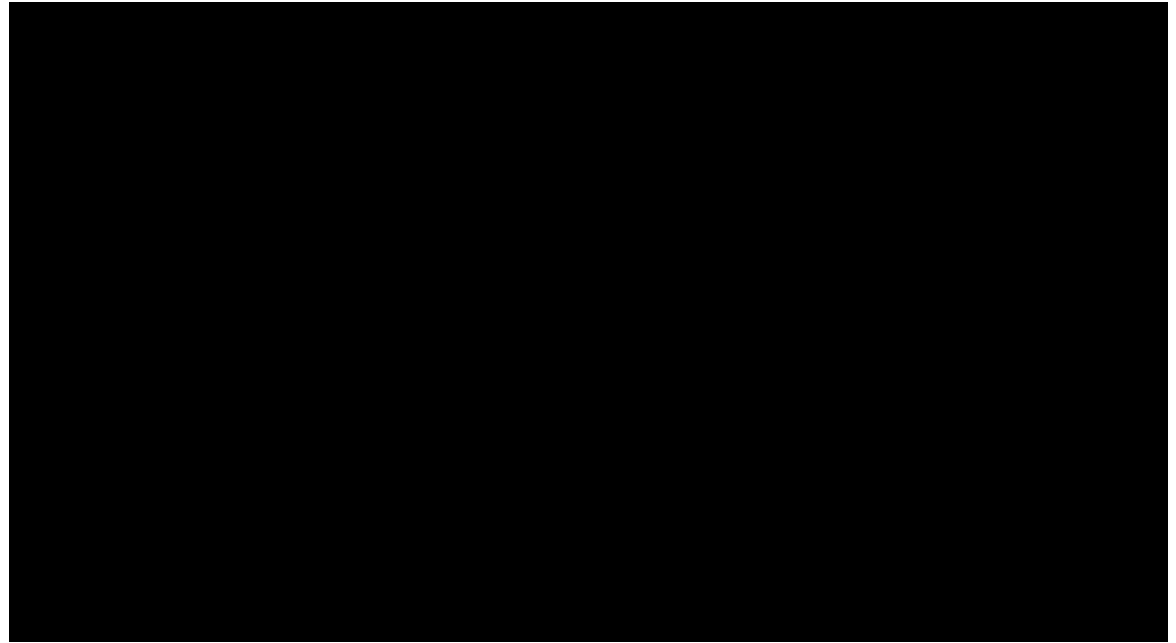
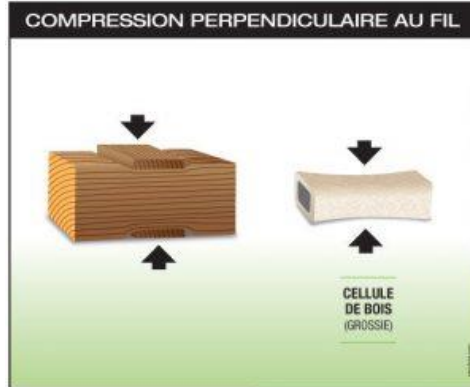
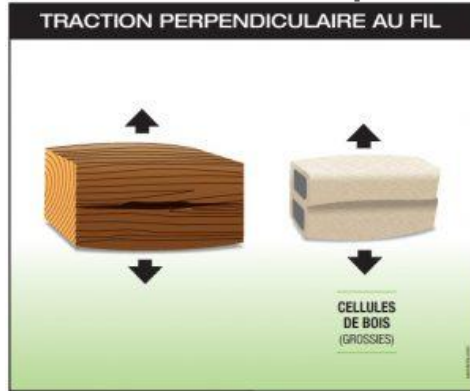
Résistance Mécanique



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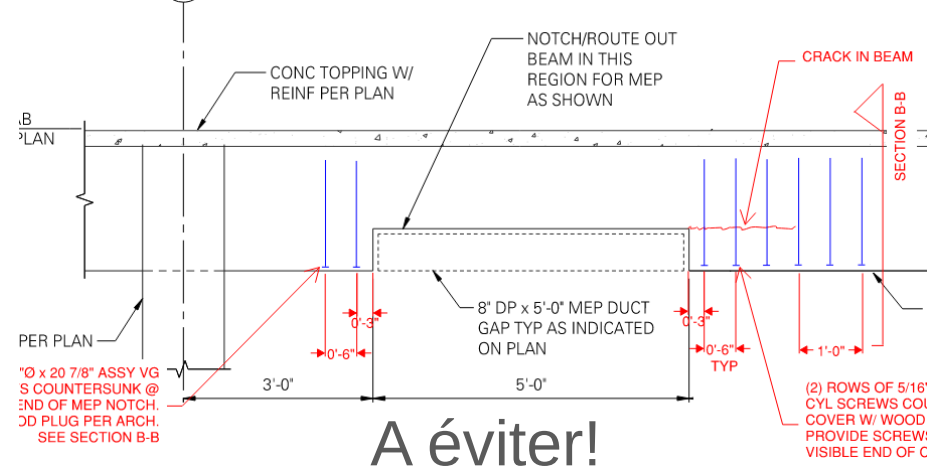
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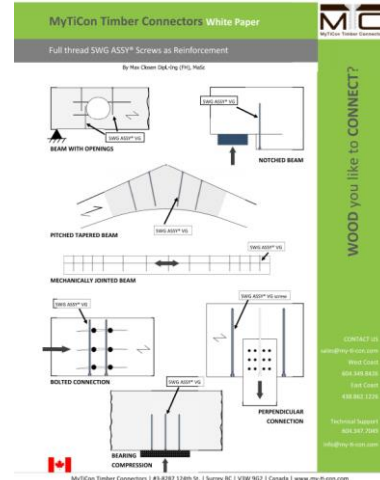


Matériau Bois

Résistance Mécanique



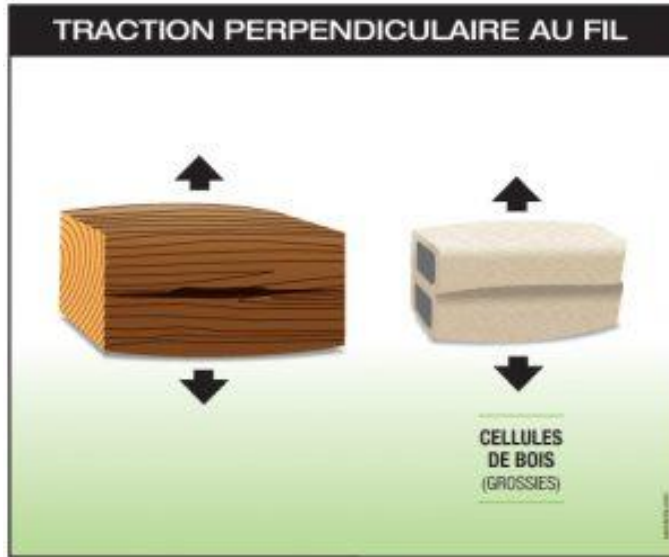
<https://mtcsolutions.com/resource/timber-reinforcement-guide/>



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Matériau Bois

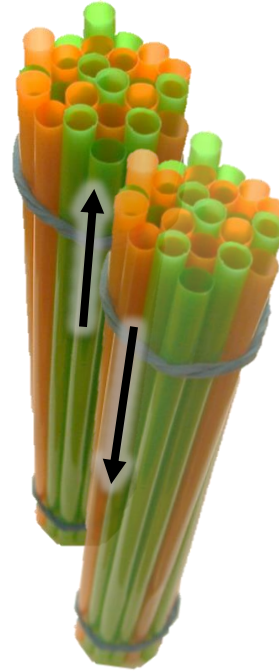
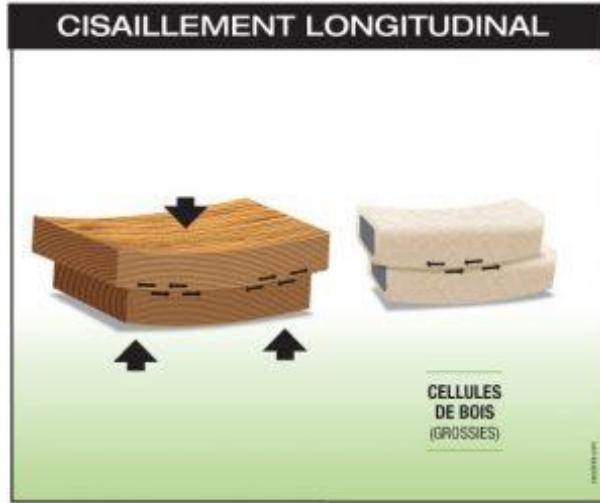
Résistance Mécanique



A éviter!

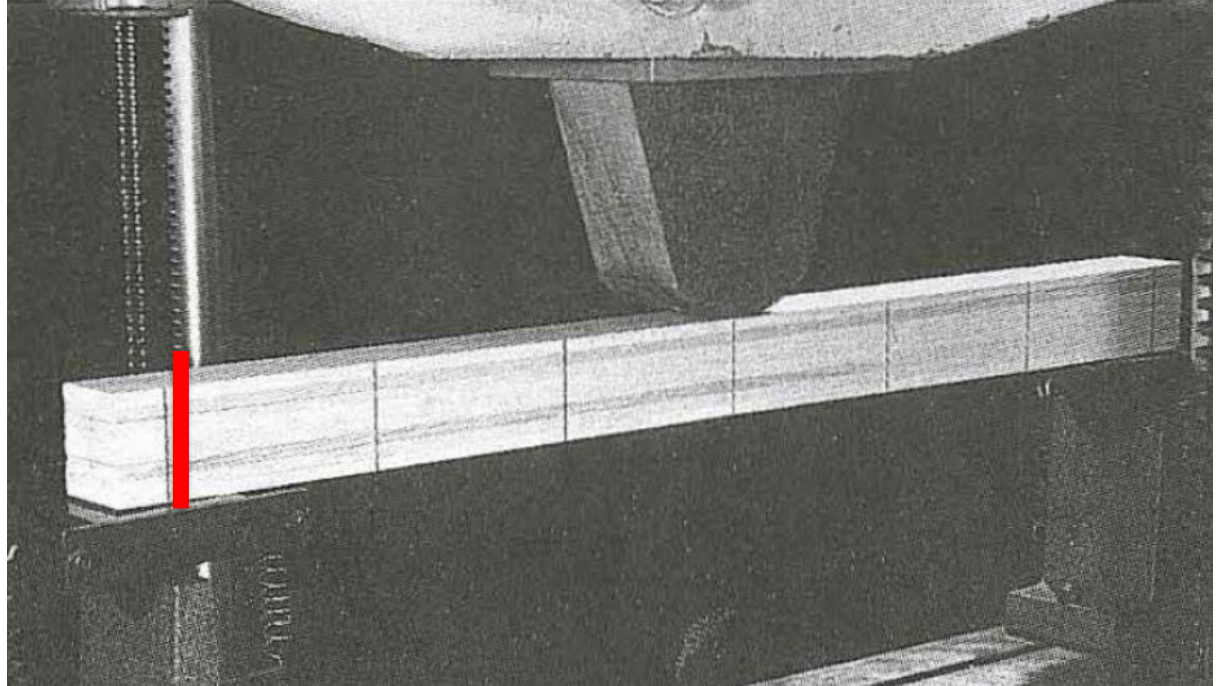
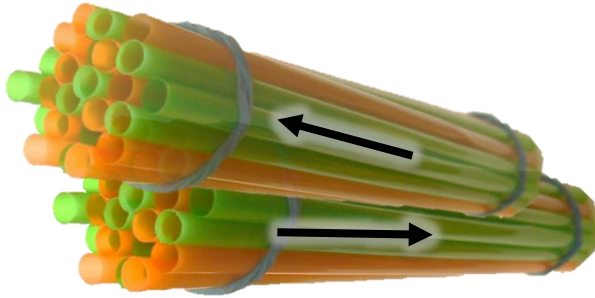
Matériau Bois

Résistance Mécanique



Matériau Bois

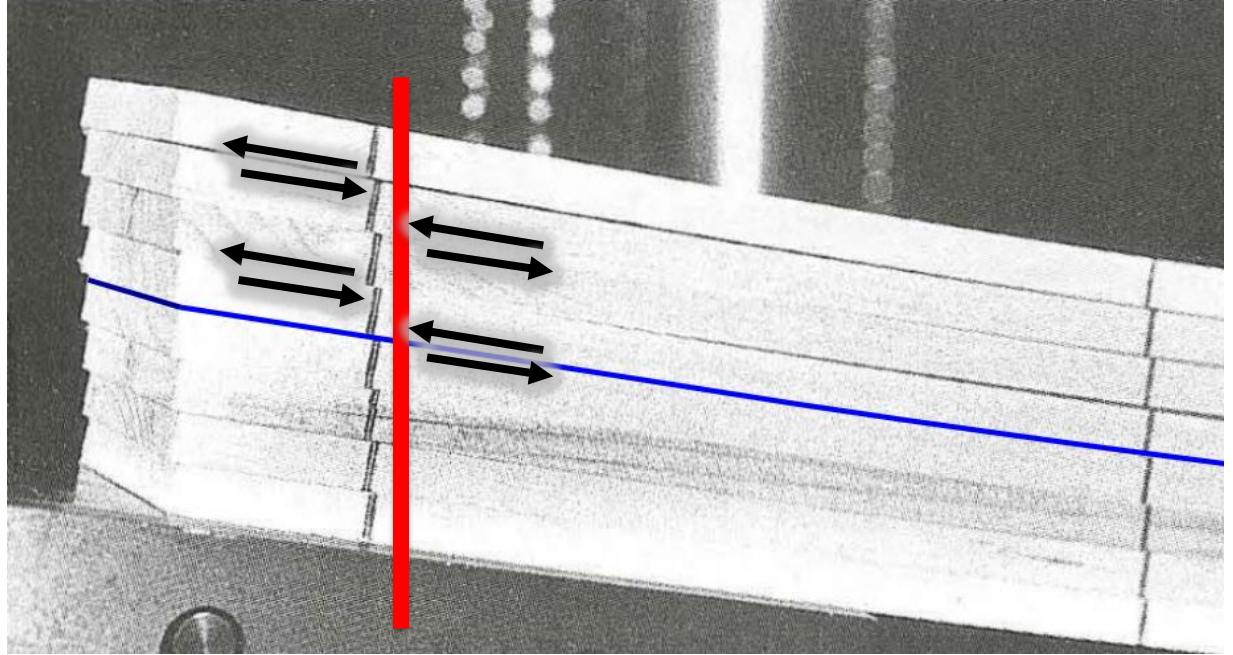
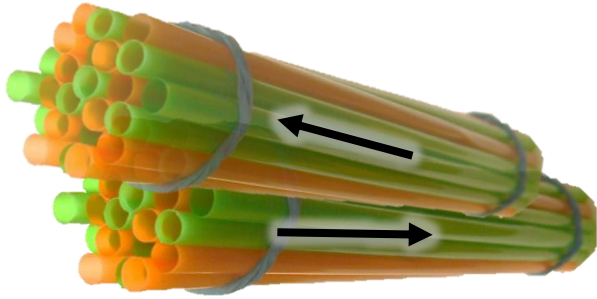
Résistance Mécanique



Cinematic Visualization of Failure Mechanisms in
Timber Structures 2010, Dietsch

Matériau Bois

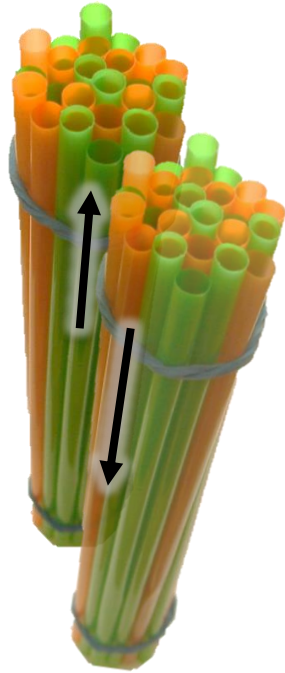
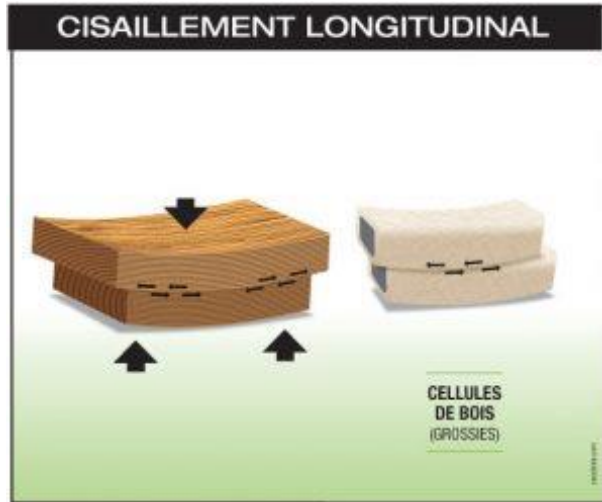
Résistance Mécanique



Cinematic Visualization of Failure Mechanisms in
Timber Structures 2010, Dietsch

Matériau Bois

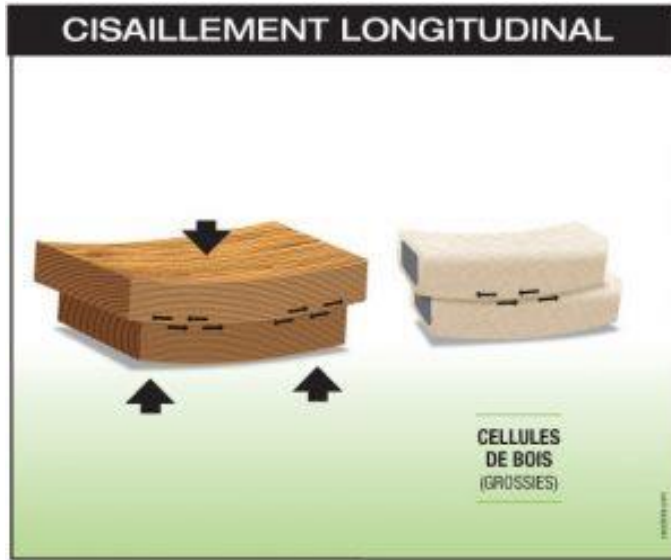
Résistance Mécanique



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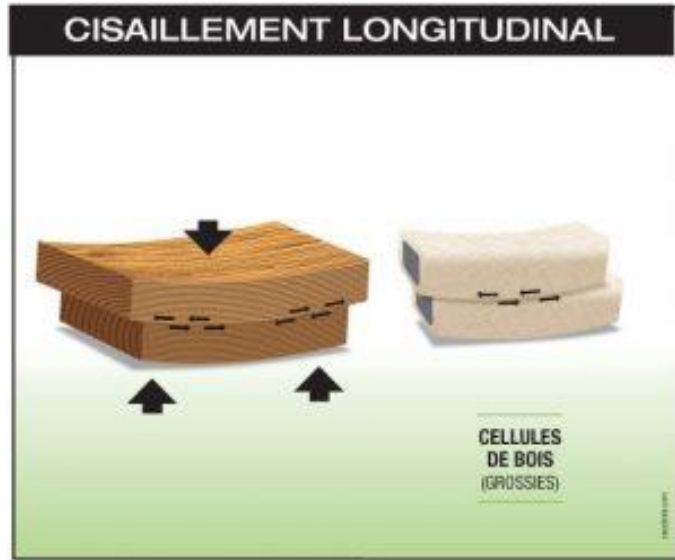
Résistance Mécanique

Torsion



Matériau Bois

Résistance Mécanique



Torsion

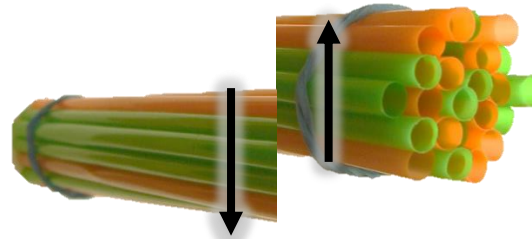


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Matériau Bois

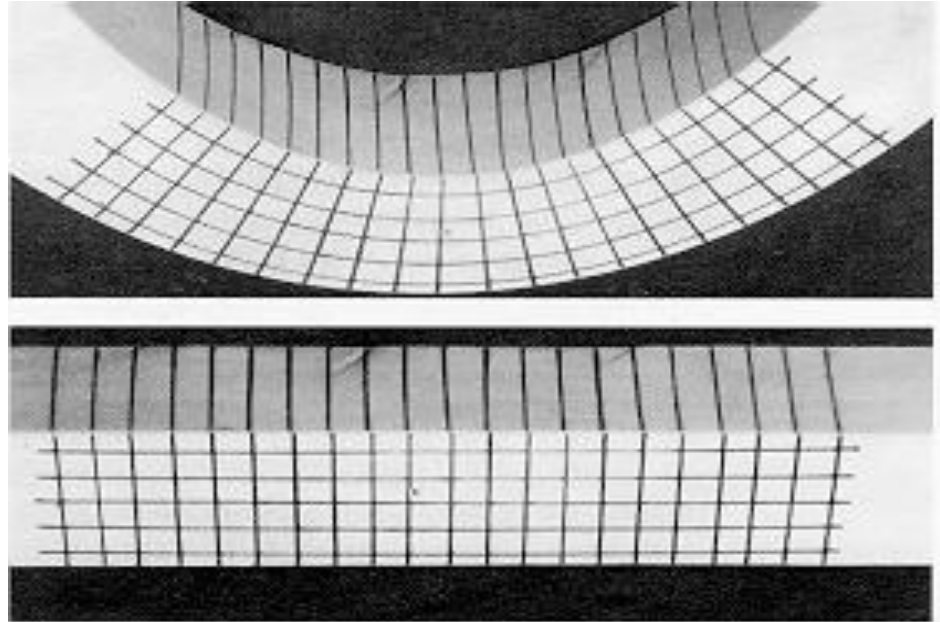
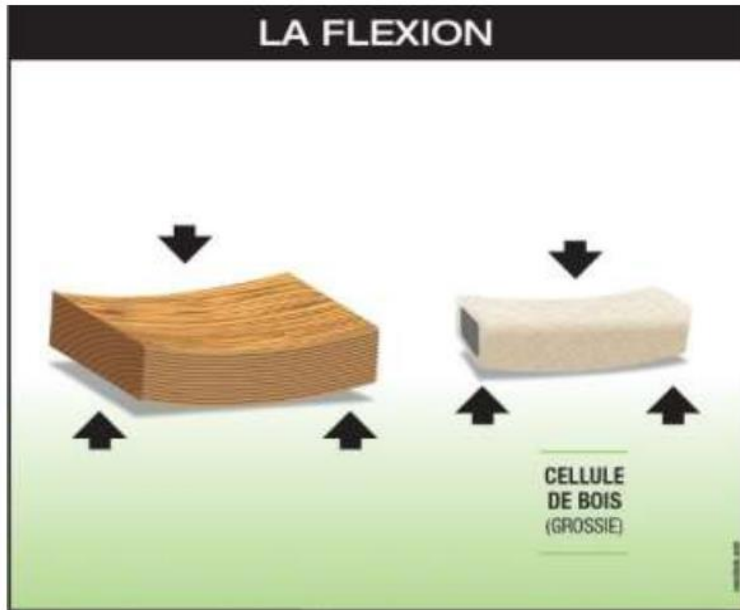
Résistance Mécanique

Cisaillement
perpendiculaire
au fil



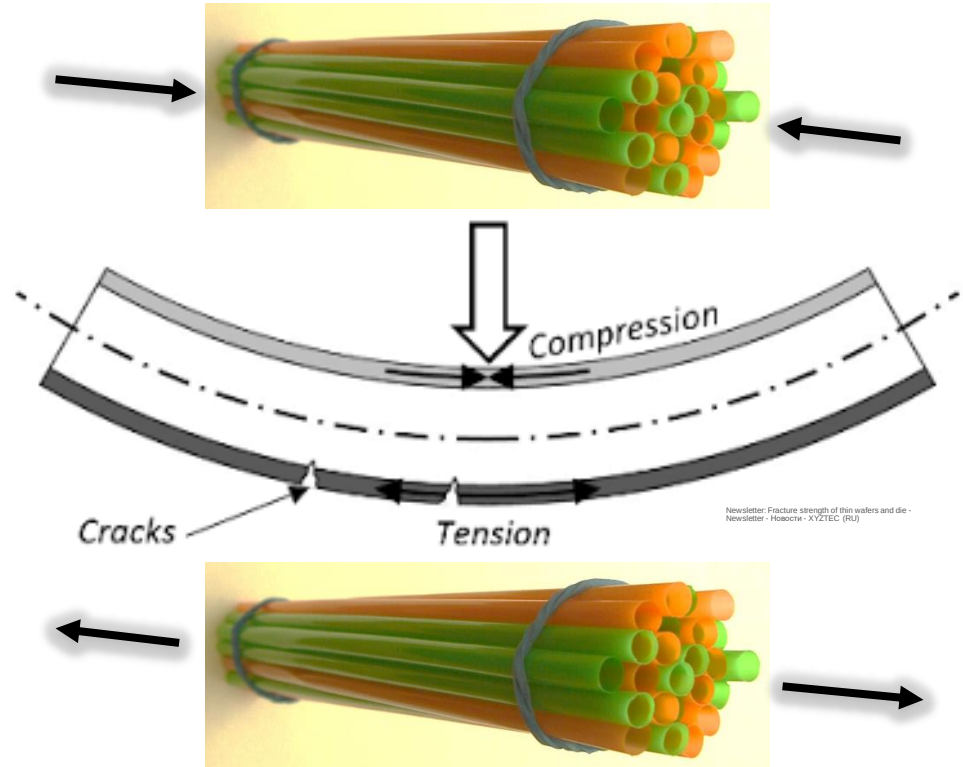
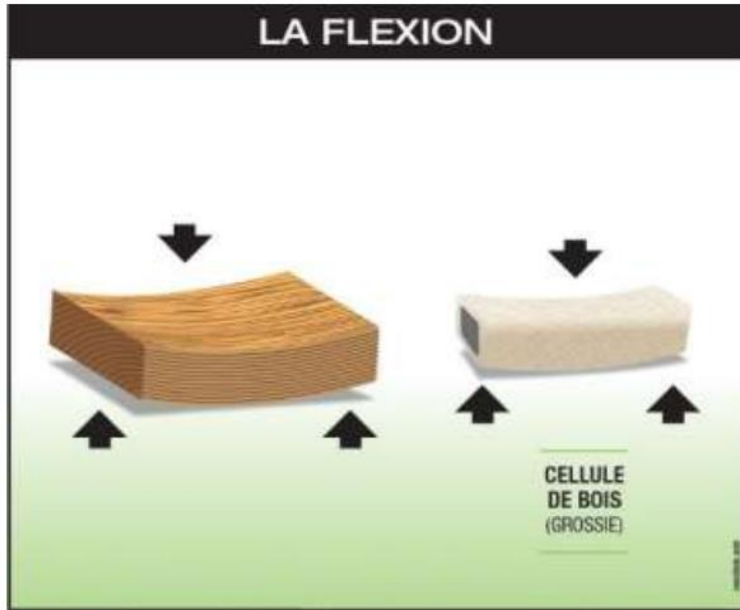
Matériau Bois

Résistance Mécanique



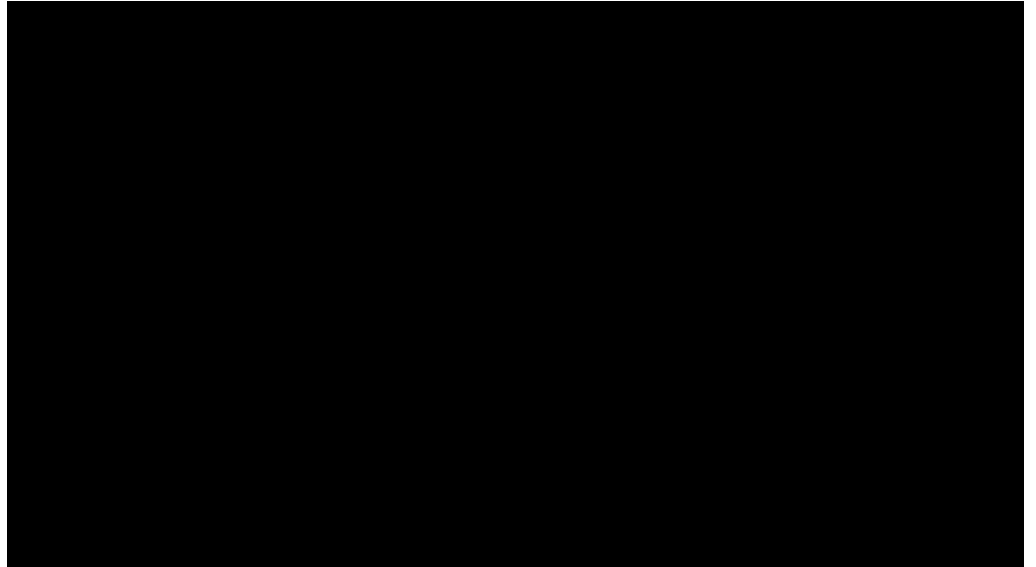
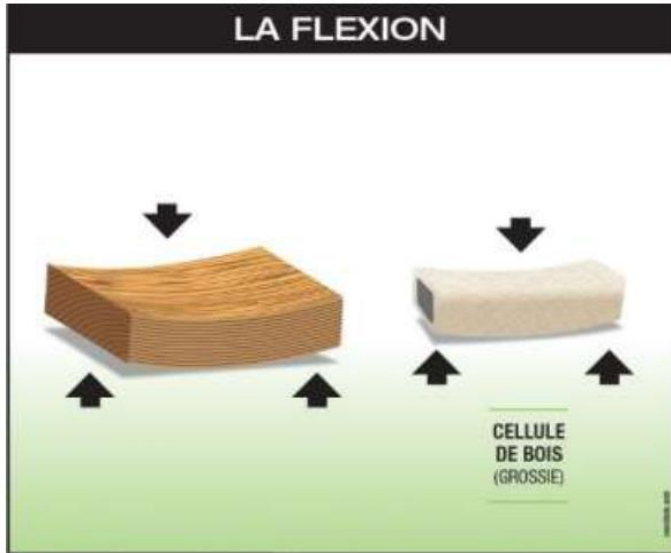
Matériau Bois

Résistance Mécanique



Matériau Bois

Résistance Mécanique

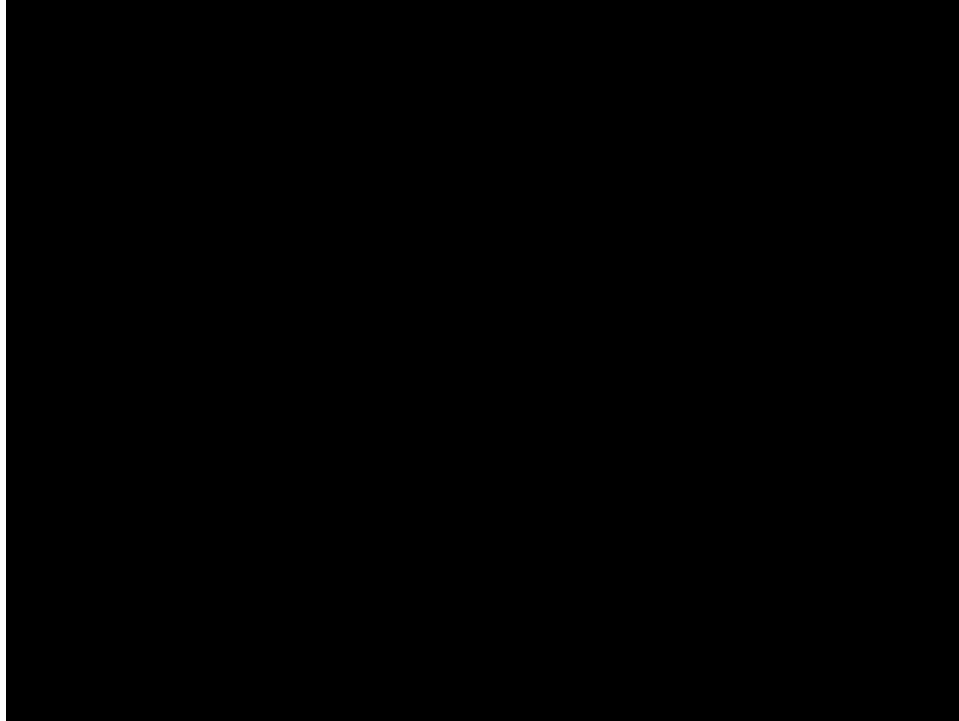


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Matériau Bois

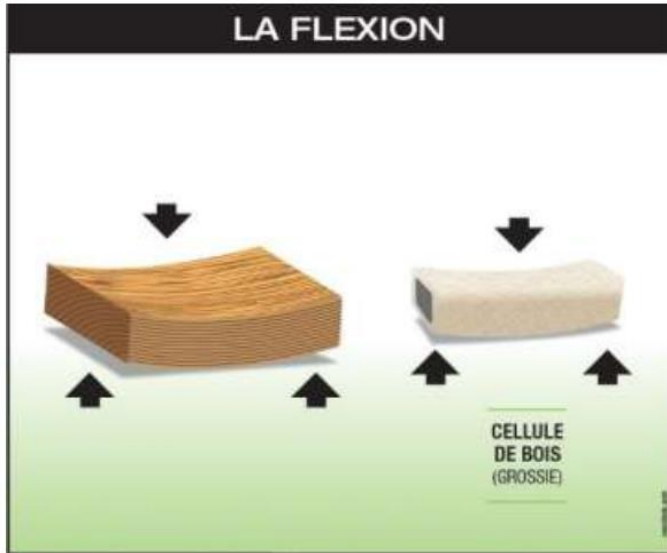
Résistance Mécanique



<https://www.youtube.com/watch?v=thd01MjOTeA>

Matériau Bois

Résistance Mécanique



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STRUCTURES

Matériau Bois

Résistance Mécanique

Propriétés du Bois

• Tension (Parallèle)	20.4 MPa
• Tension (Perpendiculaire)	0.51 MPa
• Compression (Parallèle)	33.0 MPa
• Compression (Perpendiculaire)	7.5 MPa
• Cisaillement (Parallèle)	2.5 MPa
• Cisaillement (Perpendiculaire)	N/A
• Flexion	30.7 MPa

Matériau Bois

Résistance Mécanique

Propriétés du Bois

- Compression (Parallèle) 33.0 MPa
- Flexion 30.7 MPa



NORDIC
STRUCTURES

Plan de la formation

- Description
- Matériau bois
 - Naturel
 - Anisotrope
 - Parallèle et perpendiculaire au fil
 - Hygroscopique
 - Retrait
 - Résistance mécanique
 - **Feu**
- Connecteur
 - 'Ancien'
 - Goujon/Boulon/Clous
 - Vis
- Conception
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 - Durabilité
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 - Tolerance Bois vs. Acier-Beton
 - Oublis commun
- Detail Typique
- Connecteur propriétaire

Matériau Bois

Feu



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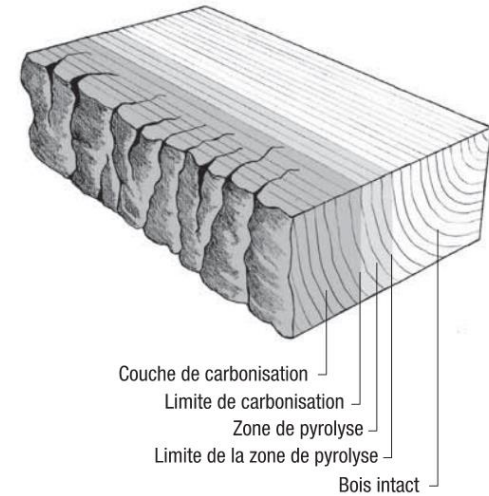


FIGURE 7 • Couche de carbonisation

Source ; adaptée de CSA O177

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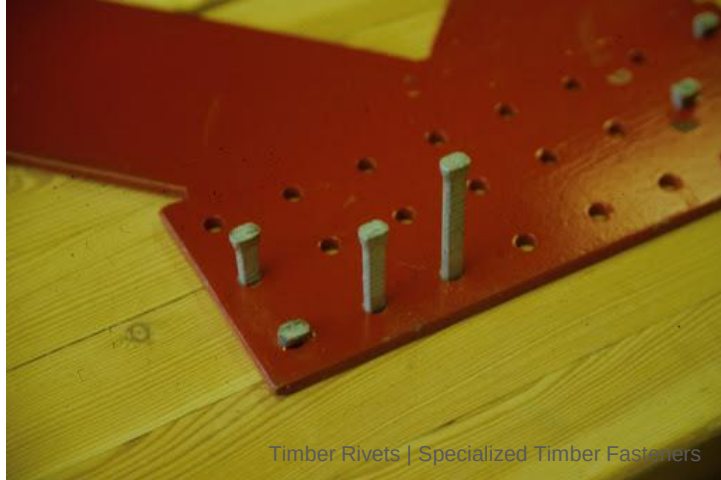
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STRUCTURES

Plan de la formation

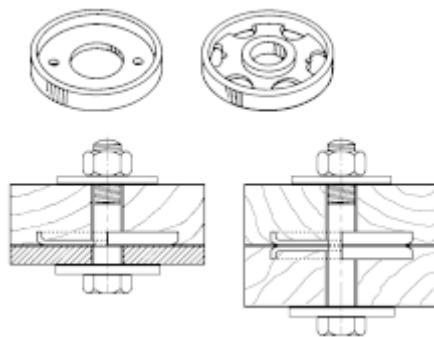
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3/4" x 10" Plated Lag Screw (dhcsupplies.com)



Timber Rivets | Specialized Timber Fasteners



Connectors and metal plate fasteners for structural timber (catimakasi.com)



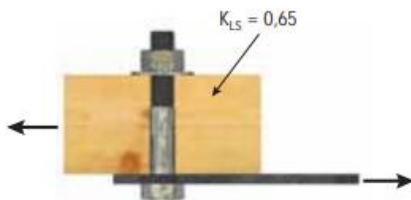
Shear Plates and Split Rings | Specialized Timber Fasteners

Plan de la formation

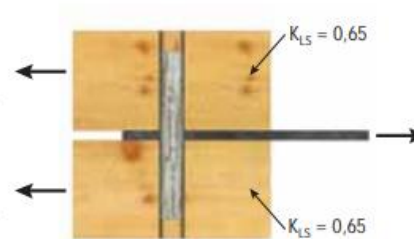
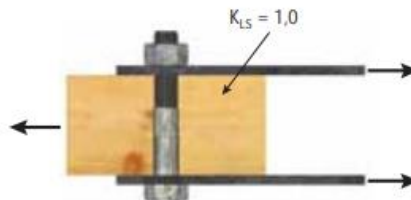
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- Connecteur propriétaire

Connecteur

Goujon/Boulon/Clous



Cecobois



NORDIC
STRUCTURES

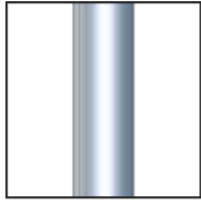
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- Detail Typique
- Connecteur propriétaire

Connecteur

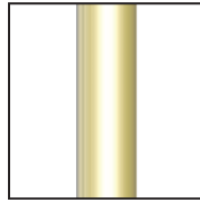
Vis

Carbon Steel



Zinc and Blue Passivated
Surface Coating

MTC Solutions

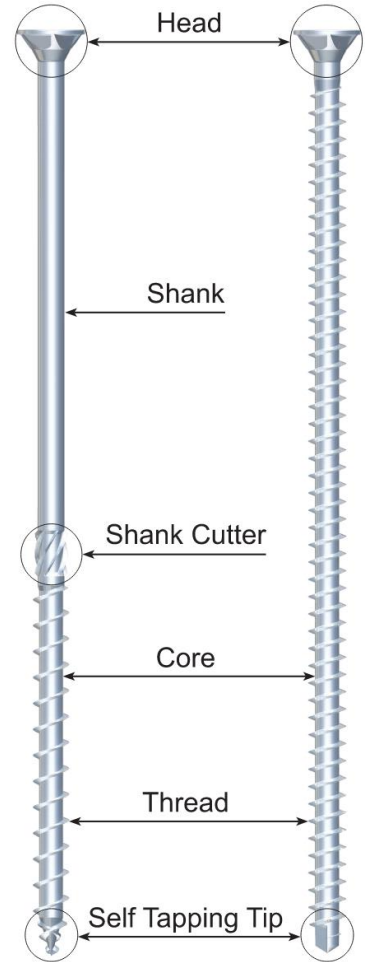


Yellow Chromate Surface
Coating

Stainless Steel



A2 Stainless Steel



Connecteur

Vis



MTC Solutions

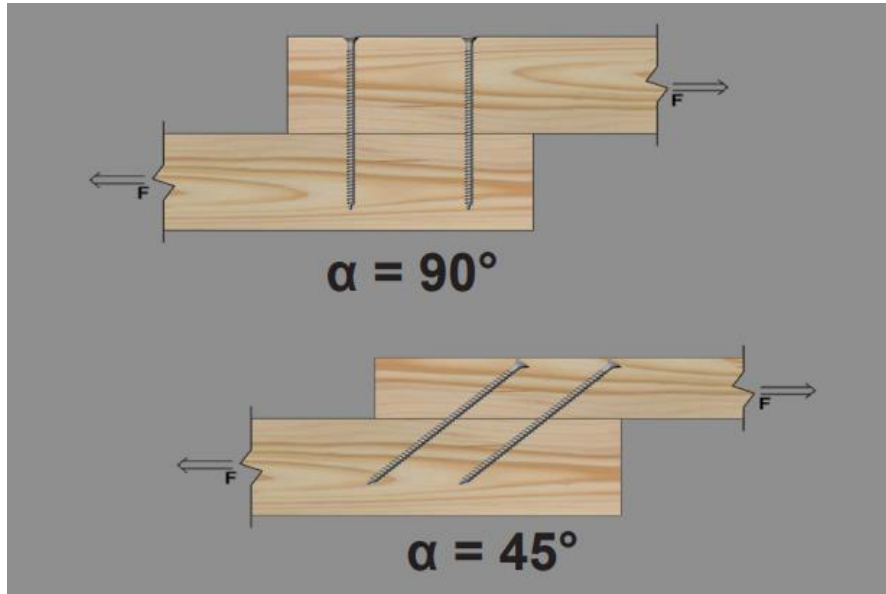
Diamètre (mm): 6, 8, 10, 12, 14

Longueur (mm): 60 - 1500

NORDIC
STRUCTURES

Connecteur

Vis



MTC Solutions

Table FR.4.2, Basic Factored Lateral Strength R
Wood Side Member

Fastener	Side Member Thickness	Minimum Fastener Penetration into Main Member	Basic Factored L		
			G=0.35		
mm	mm	mm	$N'_{c,II}$	$N'_{c,III}$	$N'_{c,T}$
6 x 100	38	56	585	453	299
6 x 120	51	63	620	485	363
6 x 140	70	64	620	485	410

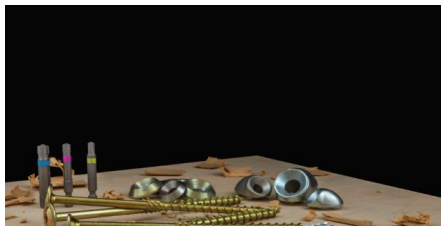
Table FR.4.3, Basic Factored Lateral Strength
Threaded Fasteners with Wood Side Member

Fastener	Side Member Thickness	Minimum Main Member Thickness	Basic Factored Late
			G = 0.35
mm	mm	mm	$N'_{t,II}$
6 x 120	38	43	1,102
6 x 160	51	58	1,479
6 x 180	64	60	1,712

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Connecteur

Vis



Structural Screw Design Guide



MyTiCon Timber Connectors
www.myticon.com | 1.866.899.4090 | info@myticon.com
© 2017 by MyTiCon Timber Connectors December 20, 2017

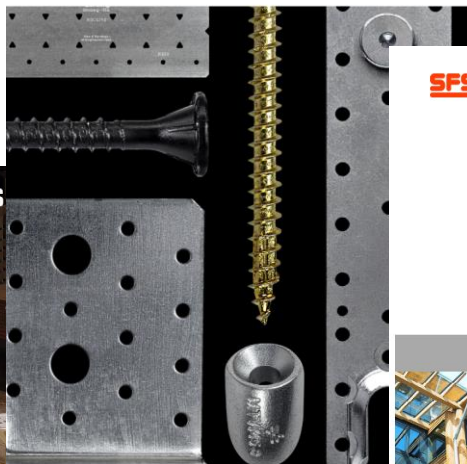
VIS ET CONNECTEURS POUR BOIS

CHARPENTERIE, STRUCTURES
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Connectors & Fasteners for Mass Timber Construction

C-C-MASSTIMBER20 | (800) 999-5099 | strongtie.com



SFS intec

Inspiring versatility and performance
the WT fastening system for cost-
durable joints in structural timber



PRODUCT CATALOGUE

07/2018



NORDIC STRUCTURES

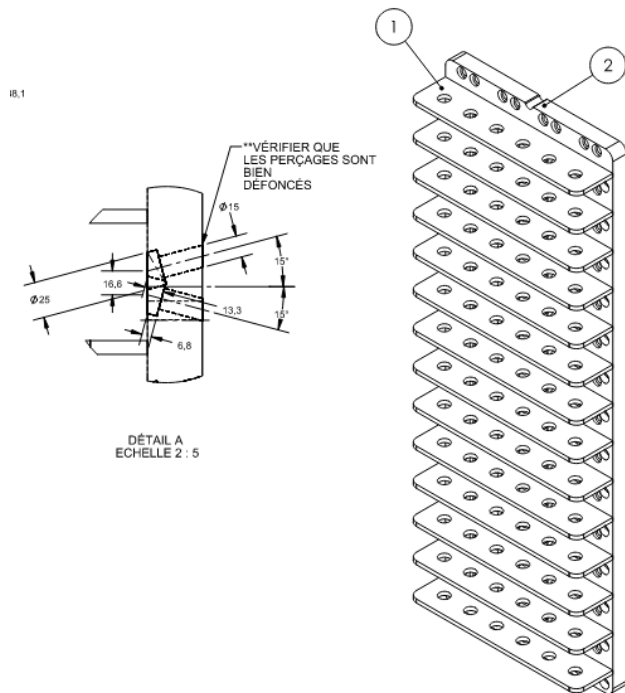






Connecteur

Vis



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STRUCTURES



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Conception

Feu



Thinkwood.com

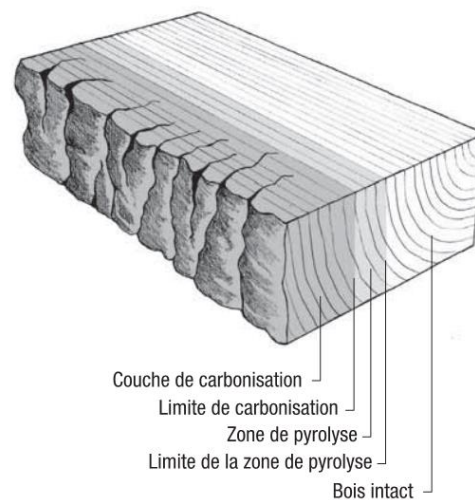


FIGURE 7 • Couche de carbonisation

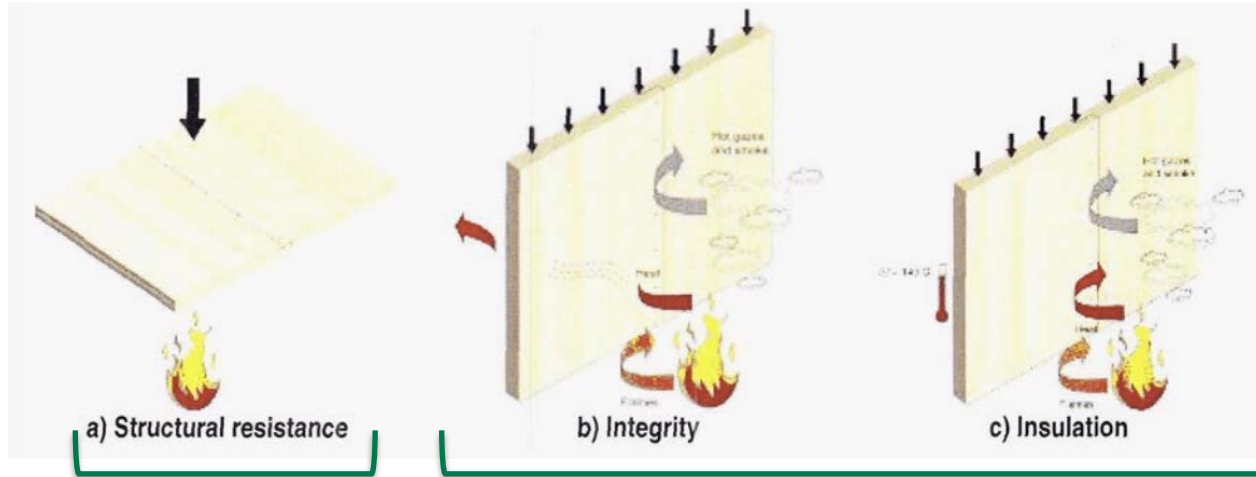
Source ; adaptée de CSA O177

cecobois.com

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STRUCTURES

Conception

Feu



Fonction structurale
(visée par l'annexe B)

Fonction de séparation
(pas visée par l'annexe B)

Conception

Feu

Lamellé-collé

2 méthodes valides

Lamellé-croisé

CLT

1 méthode valide

Annexe B – O86

De O86-2014, Mise à jour #2 – Sept 2017

Calcul

Calcul

Annexe D.2 – CCQ

Prescriptif

Conception

Feu

Annexe B (informative)

Résistance au feu des éléments en bois de grande section transversale



Quelles charges utiliser?

B.1.4

La méthodologie présentée à l'annexe B est une approche d'ingénierie destinée à prédire la résistance au feu structurale des éléments en bois de grande section transversale soumis à l'essai de résistance au feu selon la CAN/ULC-S101. La méthode d'essai exige que les éléments porteurs mis à l'essai supportent une charge représentant la pleine charge spécifiée ou une condition de charge réduite. Pour le calcul du degré de résistance au feu selon la méthodologie présentée à l'annexe B, les charges spécifiées dues à la gravité sont utilisées (c.-à-d., $D + L$).

Conception

Feu

Annexes
Résistance
sectionnelles



Quel

B.1.4
La résistance au feu structurelle selon la charge de résistance sont u

4.1.6.2.

Charge spécifiée due à la neige

(Voir la note A-4.1.6.2.)

1) La charge spécifiée, S , due à l'accumulation de la neige et de la pluie qui l'accompagne sur un toit ou sur toute autre partie d'un bâtiment doit être calculée à l'aide de la formule :

$$S = [I_s S_s (C_b C_w C_e C_a) + S_r]$$

où

- I_s = coefficient de risque de la charge due à la neige, décrit au tableau 4.1.6.2.-A;
- S_s = charge de neige au sol susceptible d'être égalée ou dépassée une fois en 50 ans, en kPa, déterminée conformément à la sous-section 1.1.3.;
- C_b = coefficient de base de charge de neige sur le toit du paragraphe 2);
- C_w = coefficient d'exposition au vent des paragraphes 3) et 4);
- C_e = coefficient de pente des paragraphes 5), 6) et 7);
- C_a = coefficient d'accumulation du paragraphe 8); et
- S_r = charge correspondante due à la pluie susceptible d'être égalée ou dépassée une fois en 50 ans, en kPa, déterminée conformément à la sous-section 1.1.3., mais sans dépasser $S_s(C_b C_w C_e C_a)$.

résistance au
force au feu
supportent une
calcul du degré
s à la gravité

Conception

Feu

B.3.2 Coefficient de résistance, ϕ

Le coefficient de résistance, ϕ , doit être de 1,0.

Tableau B.3.9

Coefficients de correction pour le calcul de la résistance au feu, K_{fi}

Produit	K_{fi}
Gros bois d'œuvre et platelage en madriers	1,5
Bois lamellé-collé	1,35
Bois de charpente composite	1,25
Bois lamellé-croisé	
— Classe de contraintes V1-V2	1,5
— Classe de contraintes E1-E3	1,25

Note : Le coefficient de correction pour le calcul de la résistance au feu, K_{fi} , convertit la résistance prévue en résistance moyenne.

Conception

Feu

Tableau B.4.2

Vitesses de combustion de calcul pour le bois et les produits à base de bois, mm/min

	β_o	β_n
Gros bois d'œuvre et platelage en madriers	0,65	0,80
Bois lamellé-collé	0,65	0,70
Bois de charpente composite	0,65*	0,70*
Bois lamellé-croisé	0,65	0,80

*Ces valeurs s'appliquent uniquement aux produits de bois de charpente composite à base de bois.

B.5.1 Épaisseur de la couche de résistance nulle

■ ■ ■

$$x_t = \left(\frac{t}{20} \right) \times 7 \quad (\text{pour } t < 20)$$

$$x_t = 7 \quad (\text{pour } t \geq 20)$$

où

t = durée d'exposition au feu, min

Conception

Feu

- **B.3.3 Coefficient de durée d'application de la charge, K_D**
- doit être déterminé en se basant sur la section transversale réduite,

B.3.7 Élancement, C_C

B.3.8 Coefficient d'élancement, K_C

B.3.6 Coefficient de stabilité latérale, K_L



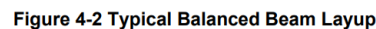
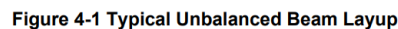
B.6.4 Module d'élasticité

- en se basant sur les dimensions de la section transversale d'origine.

B.3.5 Coefficient de dimensions, K_Z

Feu

TECHNICAL REPORT NO. 10					
Unrated	1-hr Fire Resistance Rating	1-1/2 and 2-hr Fire Resistance Rating	Unrated	1-hr Fire Resistance Rating	1-1/2 and 2-hr Fire Resistance Rating
Outer Compression	Outer Compression	Outer Compression	Outer Tension	Outer Tension	Outer Tension
Inner Compression	Inner Compression	Inner Compression	Inner Tension	Outer Tension	Outer Tension
Core	Core	Core	Inner Tension	Inner Tension	Outer Tension
Core	Core	Core	Core	Inner Tension	Inner Tension
Core	Core	Core	Core	Core	Core
Core	Core	Inner Tension	Core	Core	Inner Tension
Core	Inner Tension	Inner Tension	Core	Inner Tension	Inner Tension
Inner Tension	Inner Tension	Outer Tension	Inner Tension	Inner Tension	Outer Tension
Inner Tension	Outer Tension	Outer Tension	Inner Tension	Outer Tension	Outer Tension



Conception

Feu

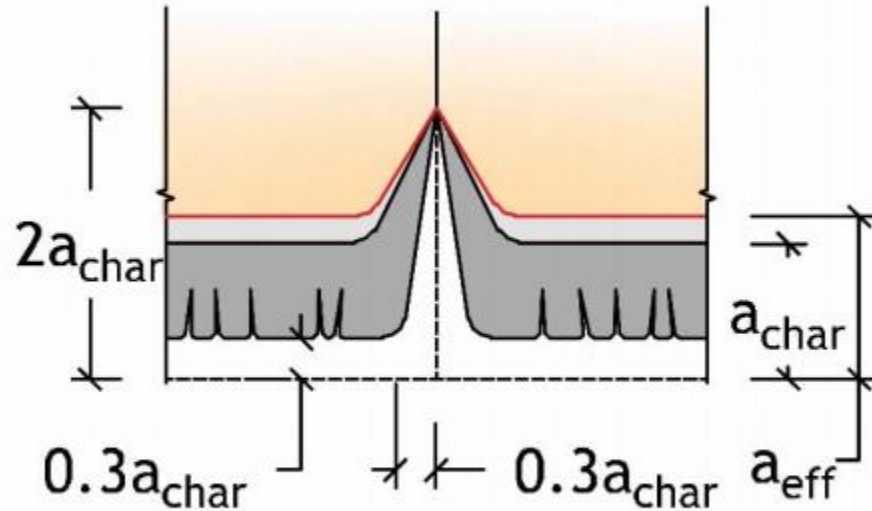
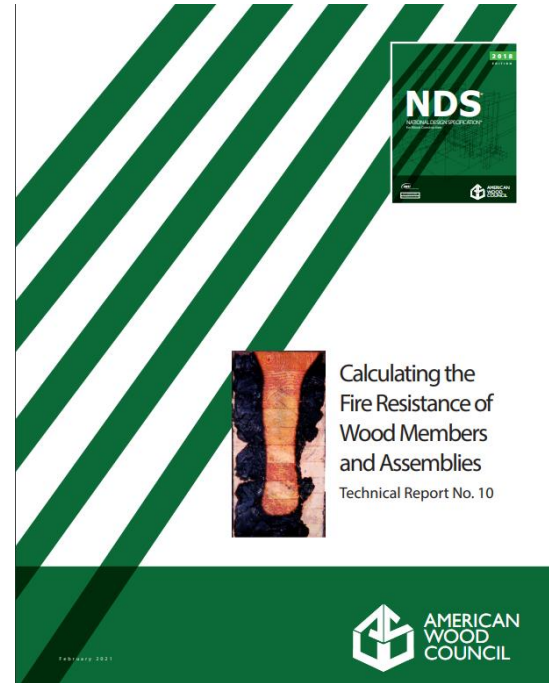


Figure 1-5. Char contraction at abutting wood members that are unbonded

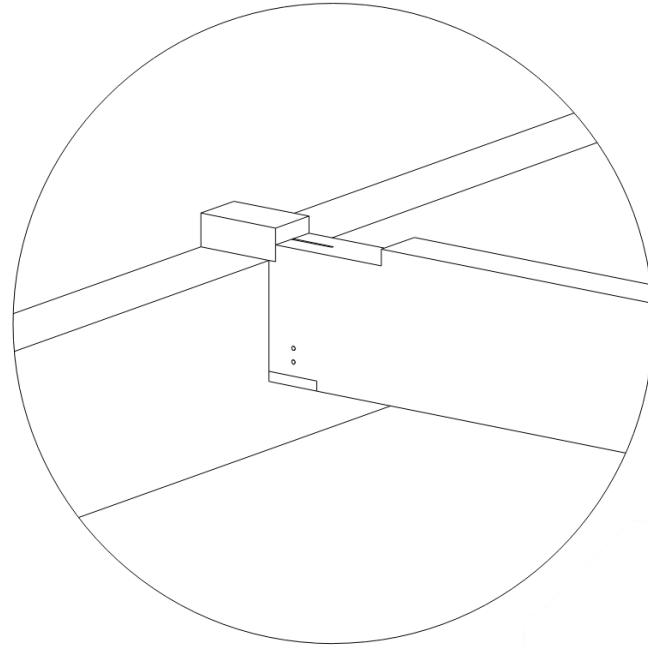
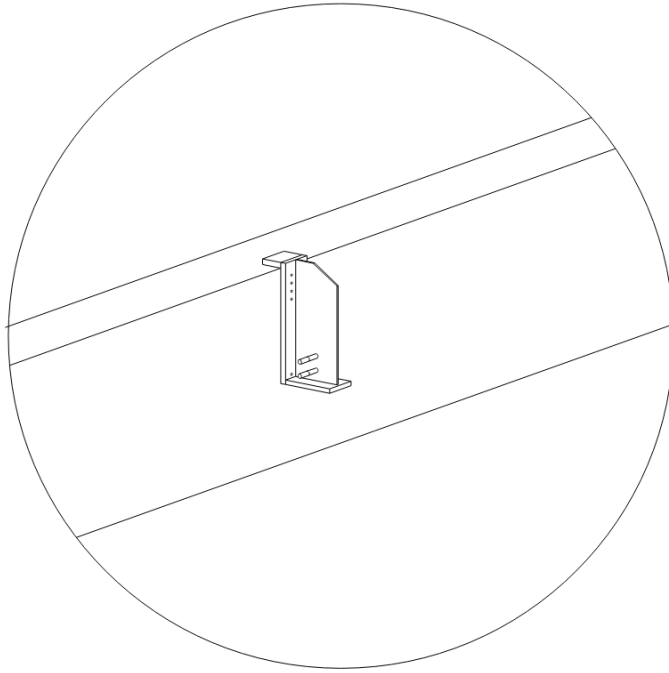


TR 10 - Calculating the Fire Resistance of Wood Members and Assemblies (awc.org)

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STRUCTURES

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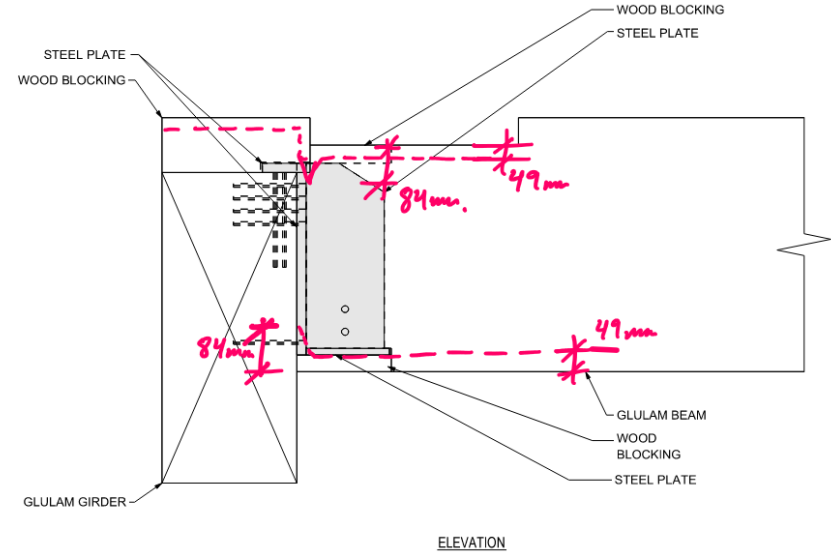
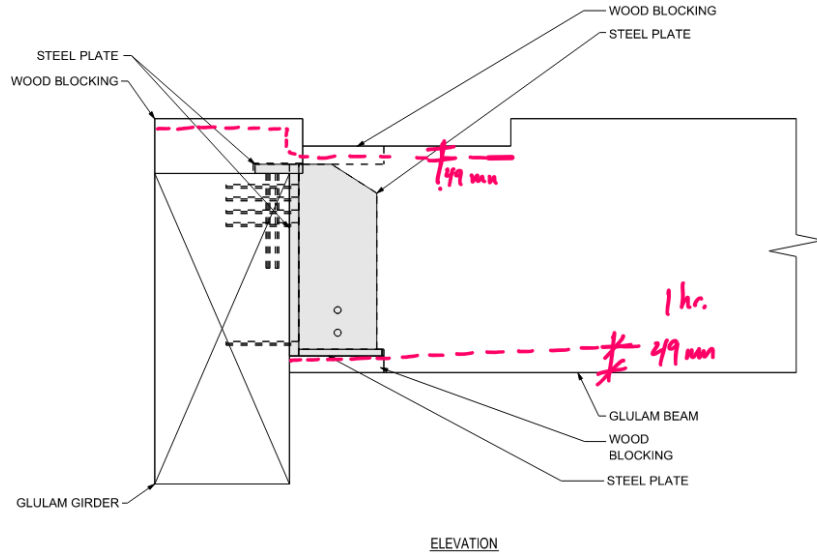
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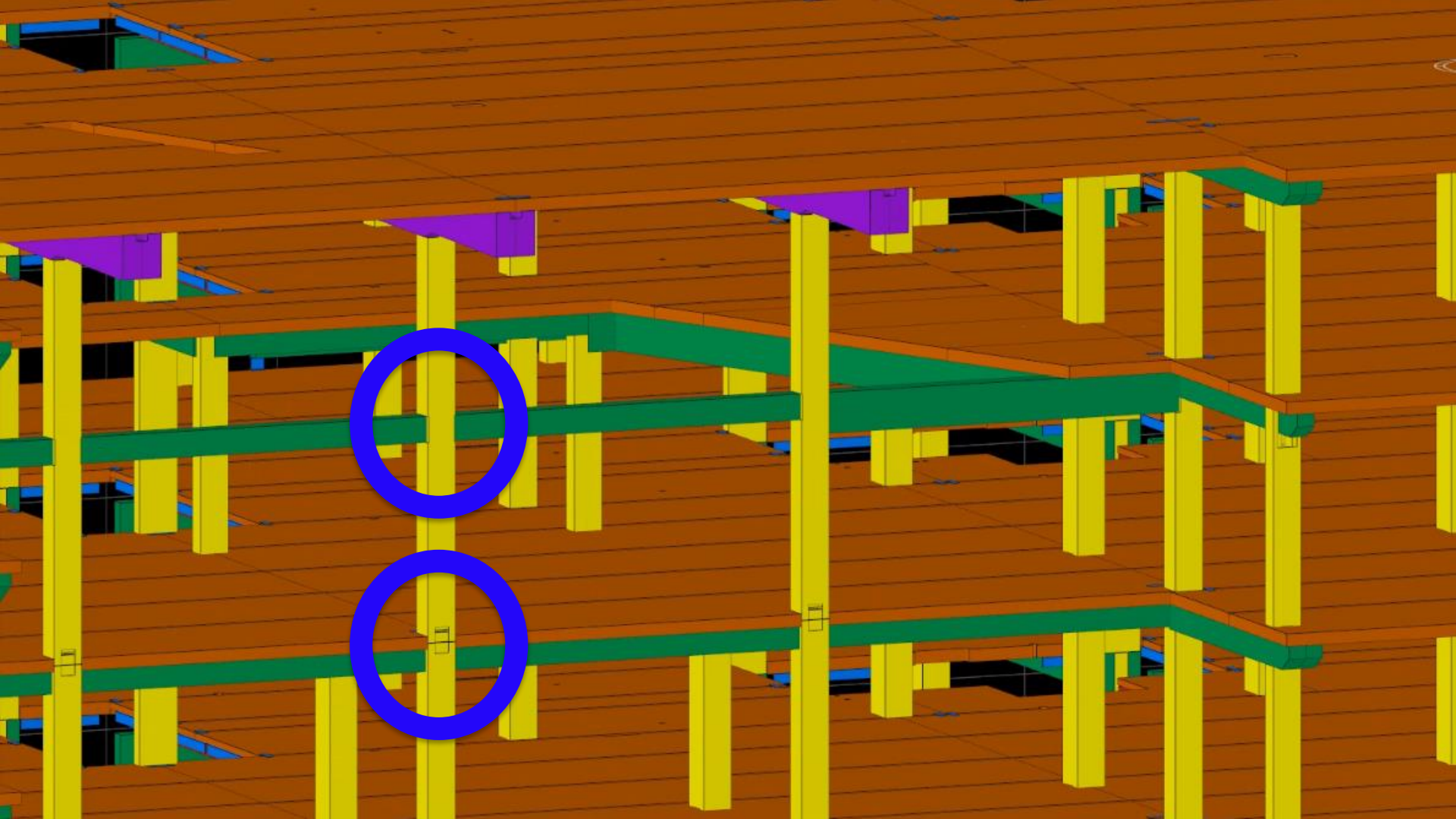


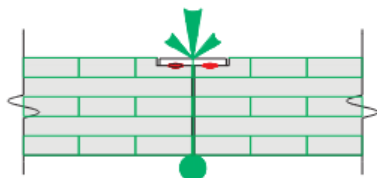
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Feu







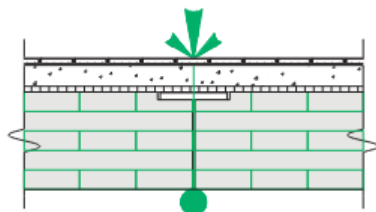
FF2.2

ASTM E119 – Separating Function ^(a)

89-3s	1.0 h
105-3s	1.5 h
143-5s	2.0 h
175-5s	2.0 h
197-7s	2.0 h
213-7l	2.0 h
244-7s	2.0 h
244-7l	2.0 h
Nordic X-Lam	2.0 h

a) The separating function addresses the integrity and thermal insulation criteria, as specified in ASTM E119, Refer to Chapter 3 and to the Nordic X-Lam Technical Guide (NS-GT6) for the structural fire resistance criterion.

- PLYWOOD SPLINE
- FIRESTOP SEALANT
- NORDIC X-LAM



FF2.3

ASTM E119 – Separating Function ^(a)

89-3s	1.5 h
105-3s	2.0 h
143-5s	2.0 h
175-5s	2.0 h
197-7s	2.0 h
213-7l	2.0 h
244-7s	2.0 h
244-7l	2.0 h
Nordic X-Lam	2.0 h

a) The separating function addresses the integrity and thermal insulation criteria, as specified in ASTM E119, Refer to Chapter 3 and to the Nordic X-Lam Technical Guide (NS-GT6) for the structural fire resistance criterion.

- FLOORING AND/OR CONCRETE TOPPING (UP TO THE DESIGNER)
- PLYWOOD SPLINE
- NORDIC X-LAM

Conception

Feu



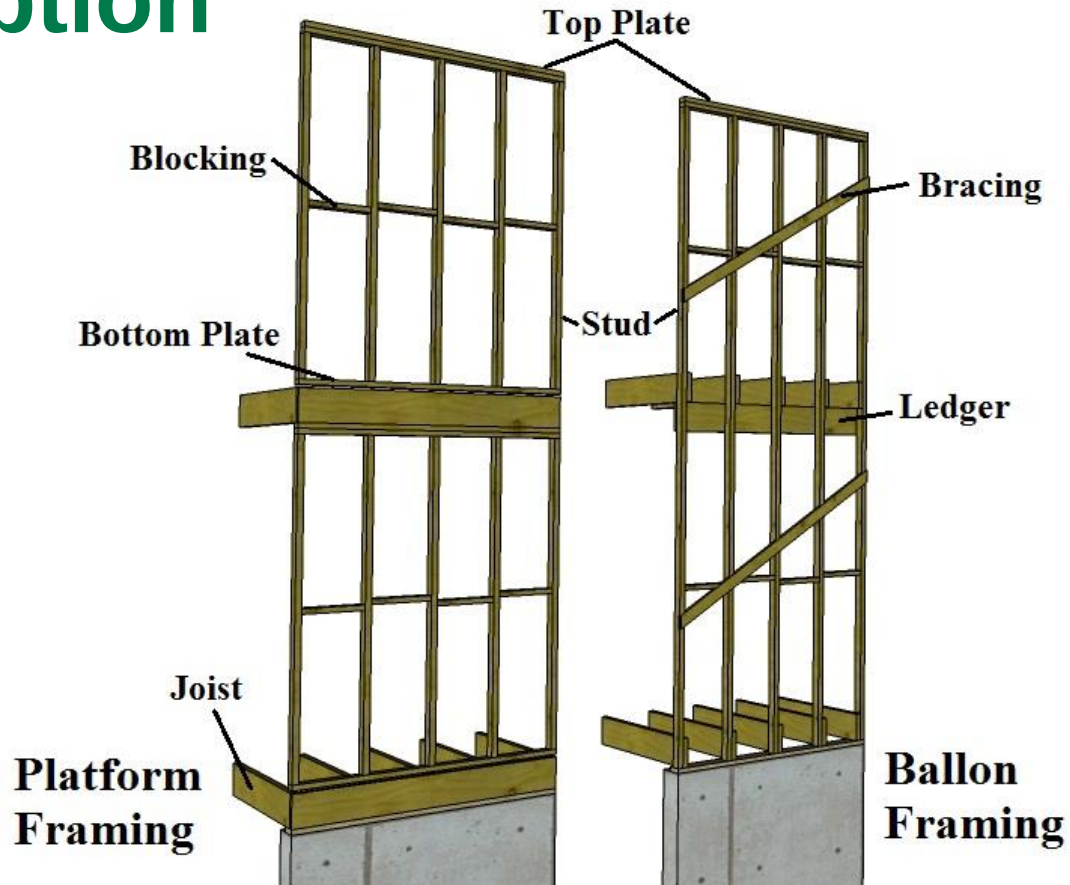
NORDIC
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 - Tolerance Bois vs. Acier-Beton
 - Oublis commun
- Detail Typique
- Connecteur propriétaire

Conception

Retrait



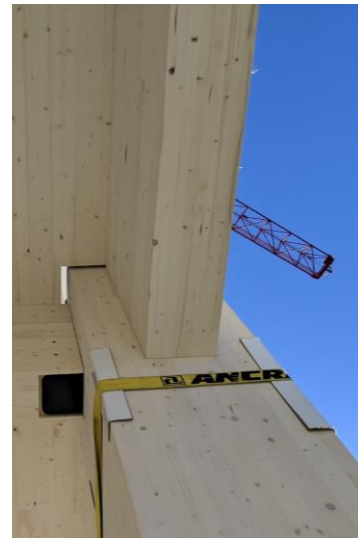
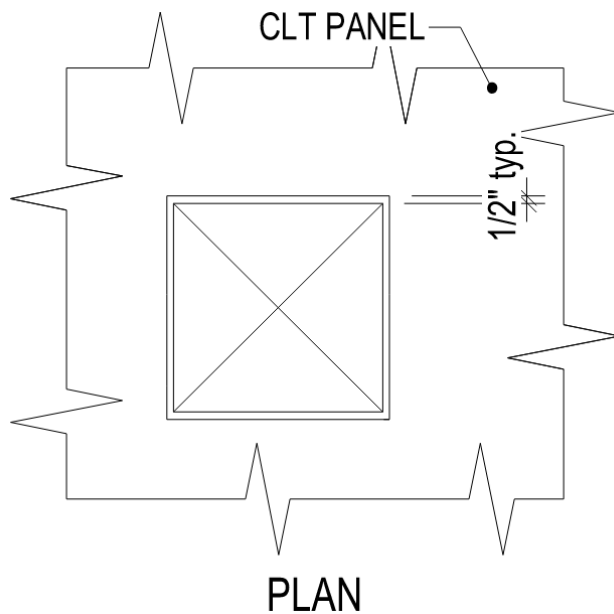
electrical - how to route cable in wall -
Home Improvement Stack Exchange

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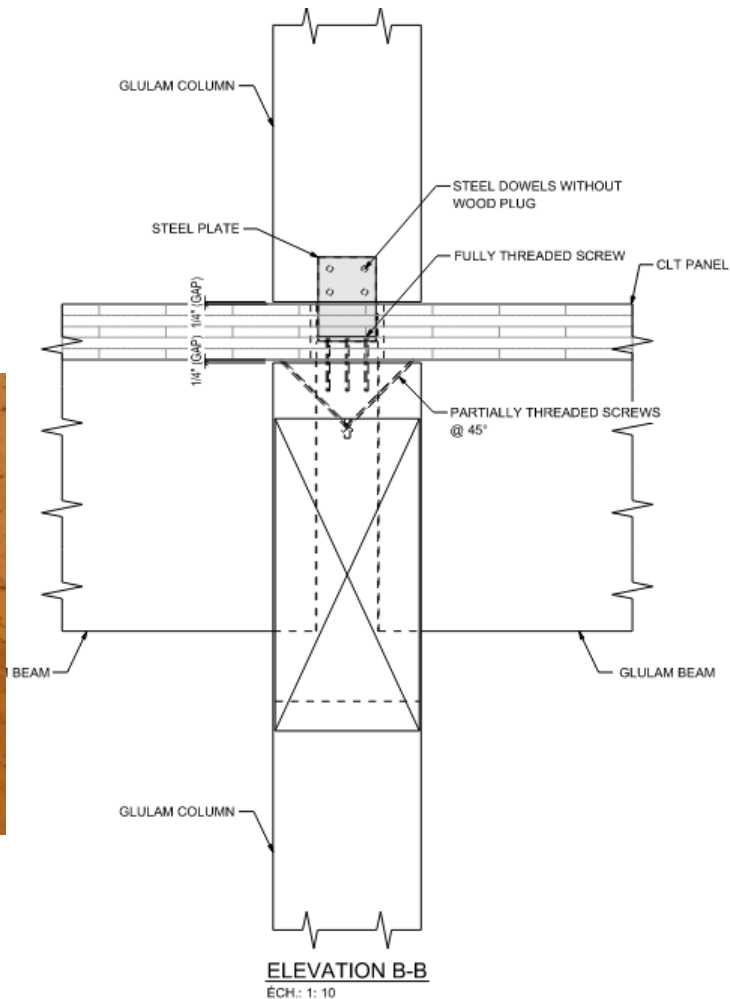
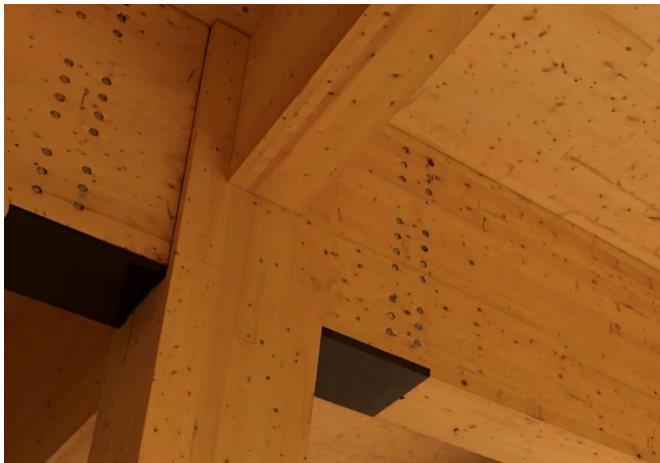
Retrait

Oubli Commun



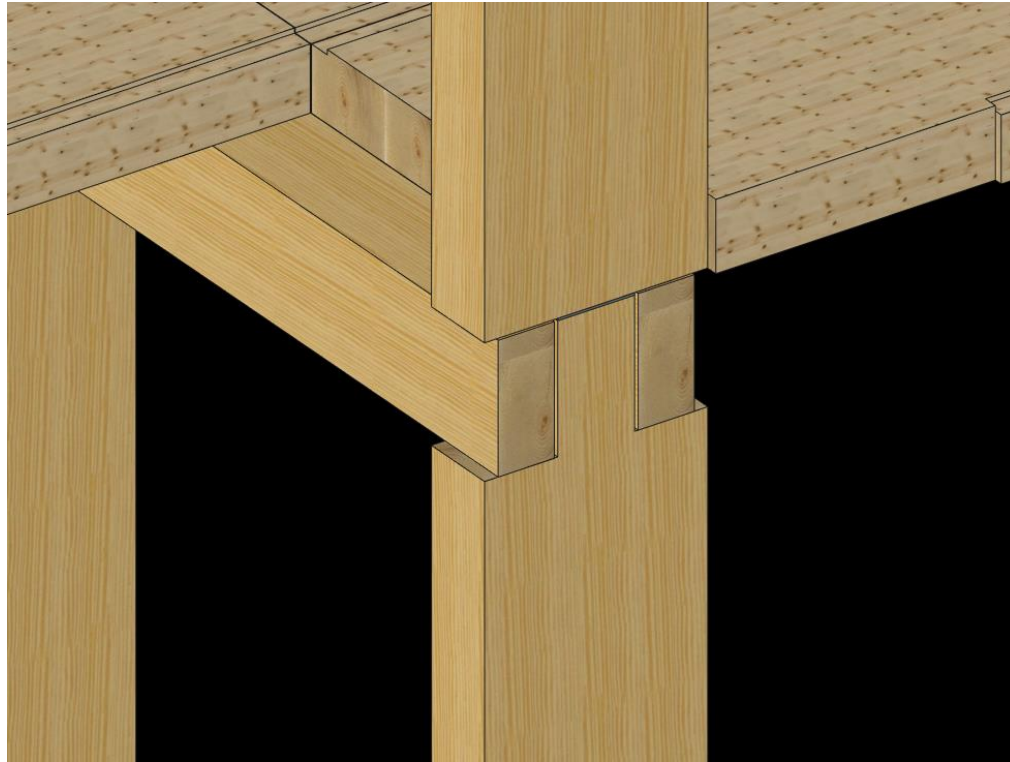
Conception

Retrait



Conception

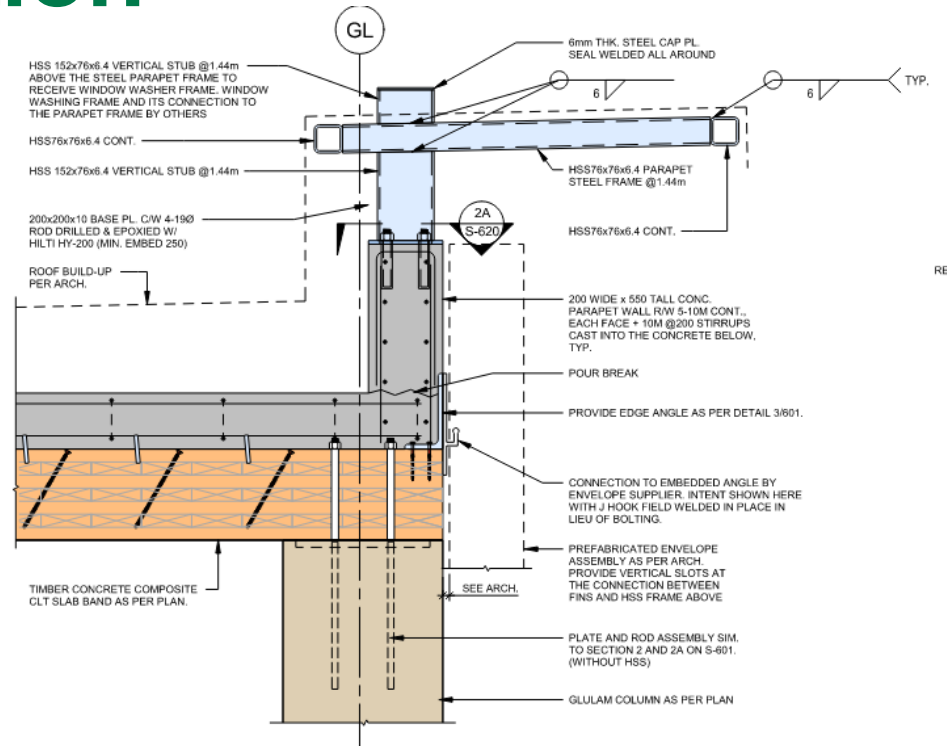
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NORDIC
STRUCTURES

Conception

Retrait



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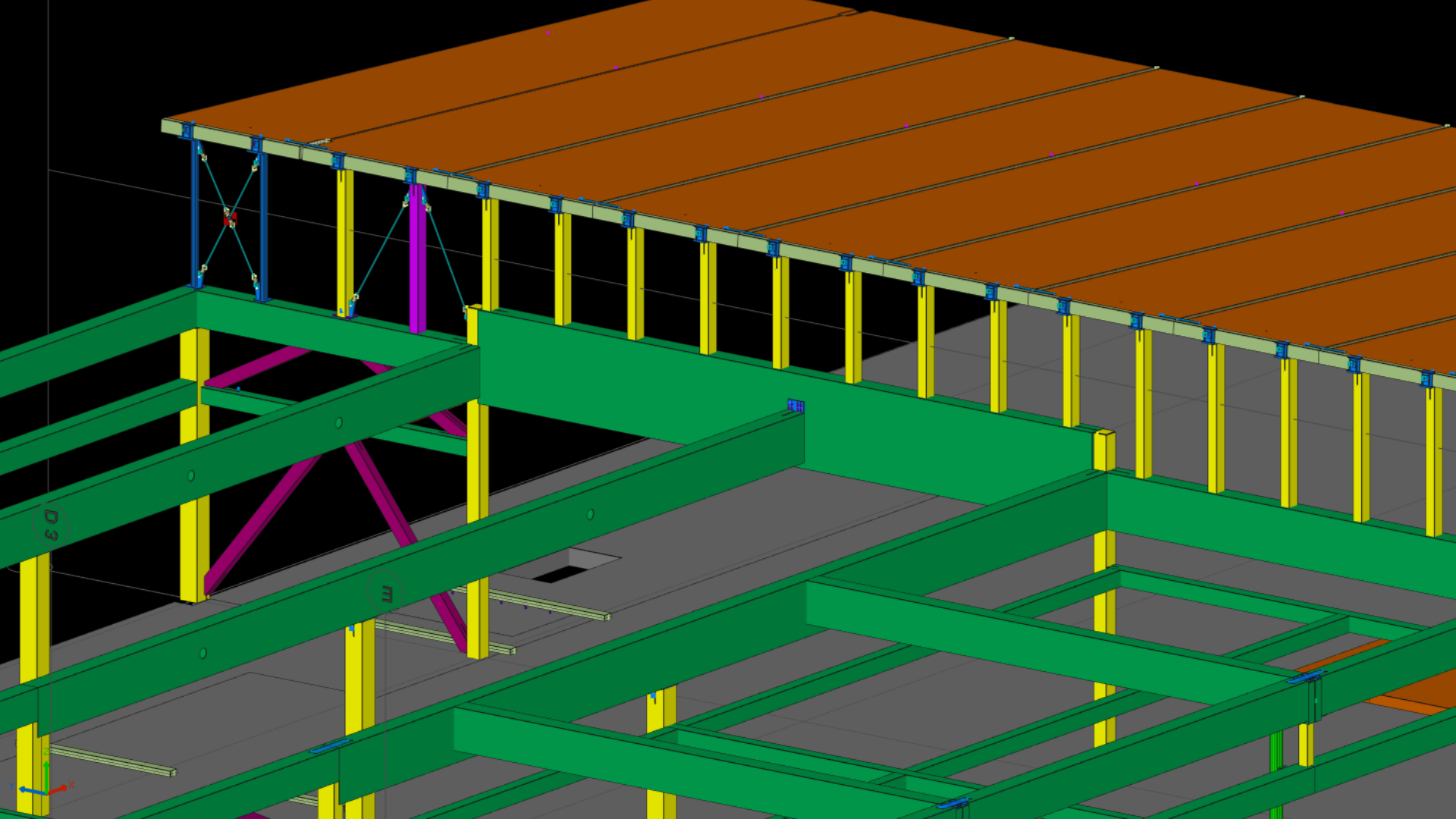
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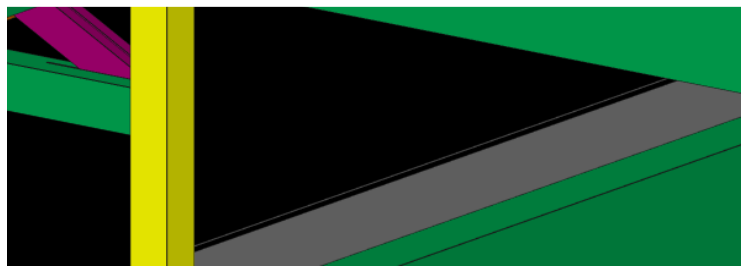
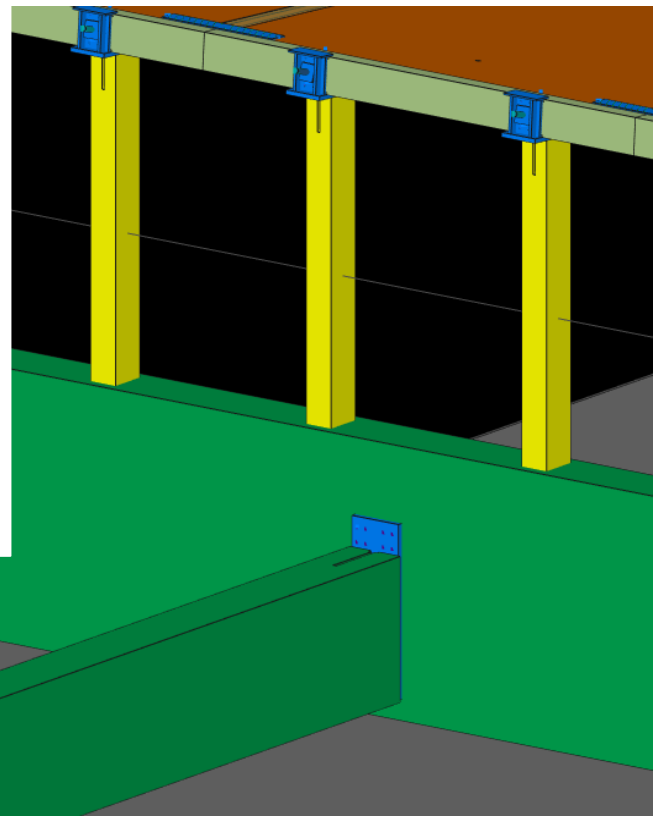
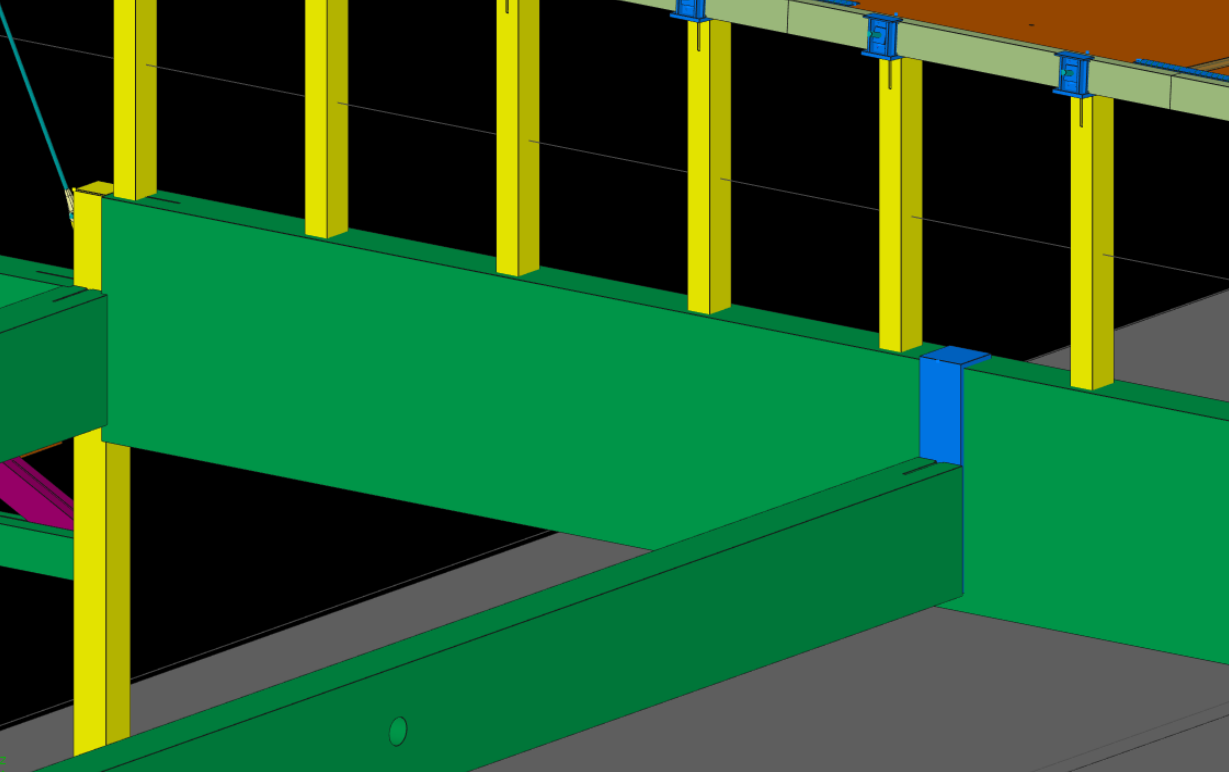
2 SECTION
S-209 1:10

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STRUCTURES





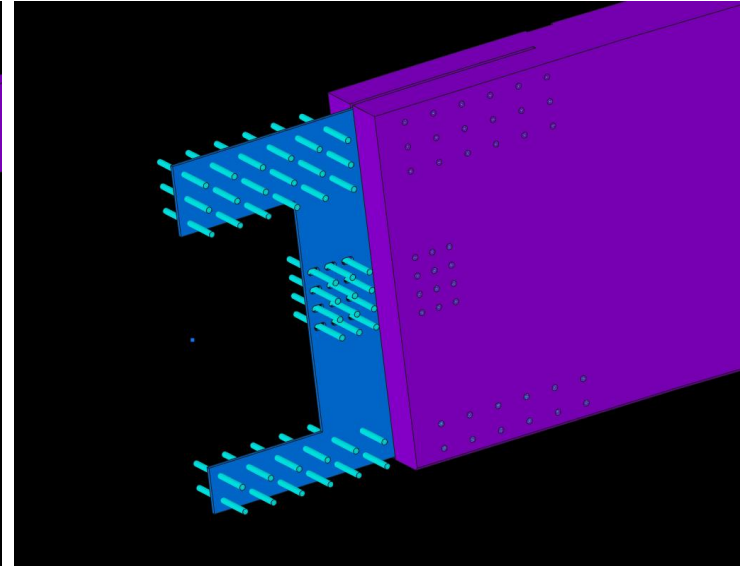
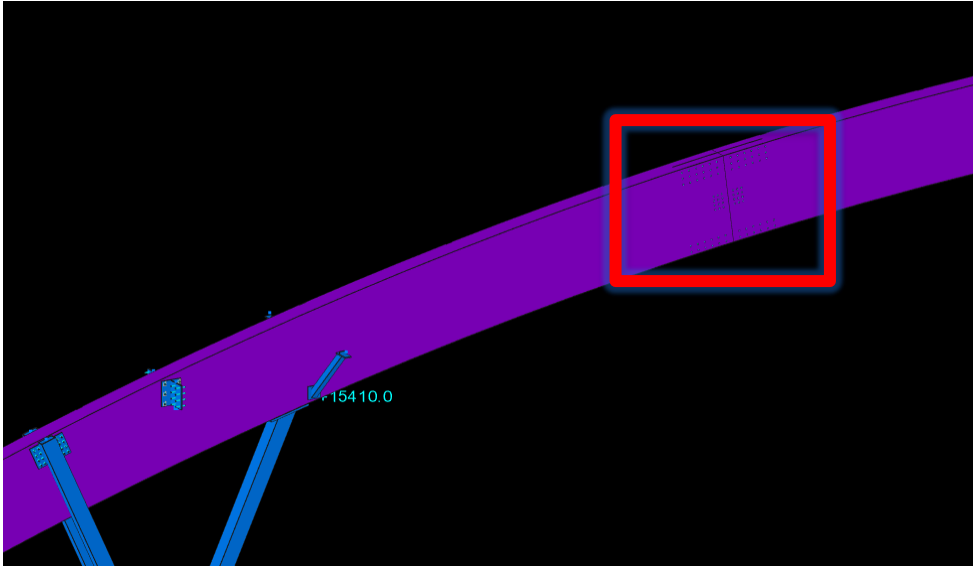






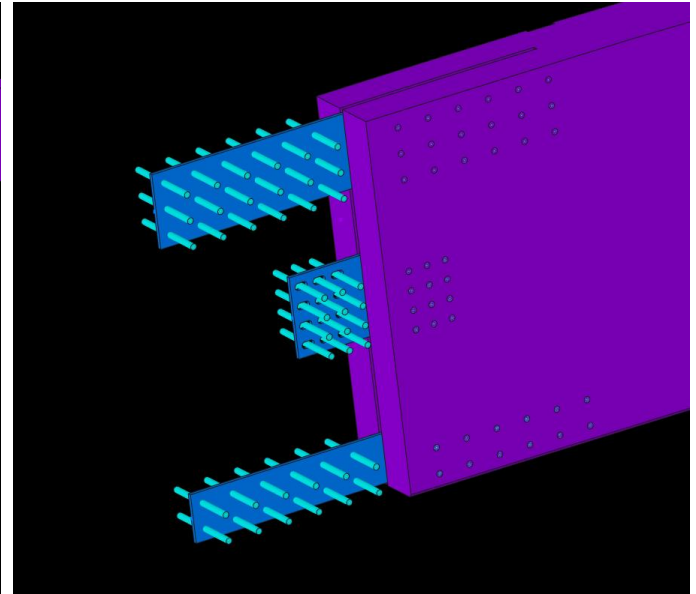
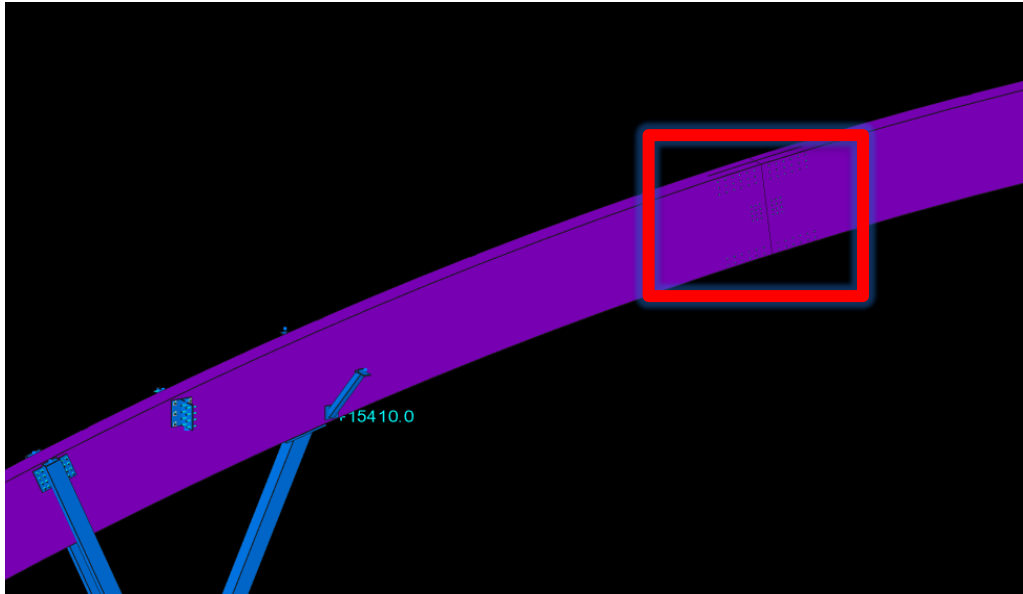
Conception

Retrait



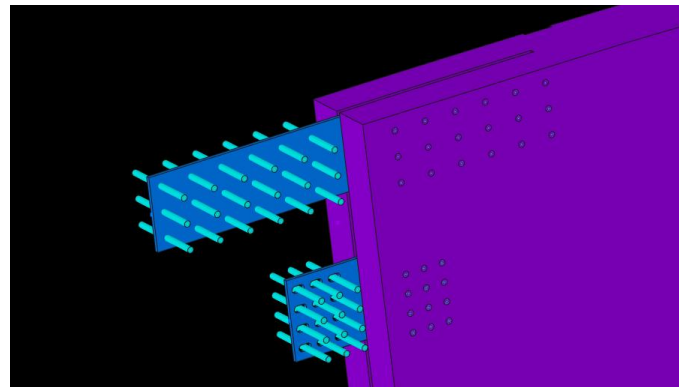
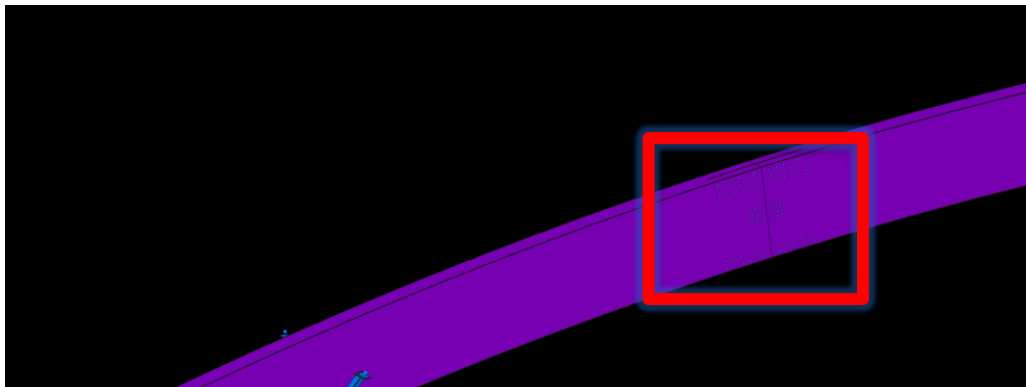
Conception

Retrait



Conception

Retrait

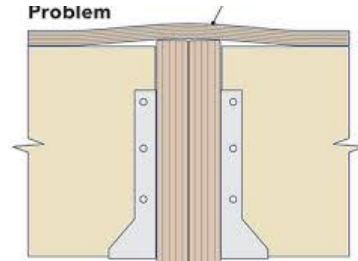


12.4.3.3 Distance maximale perpendiculaire au fil

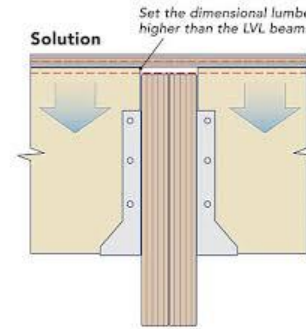
À l'exception des assemblages dans les panneaux en bois lamellé-croisé, on ne doit pas poser les files des boulons dans une même plaque métallique d'un couvre-joint lorsque l'espacement des deux files extérieures dépasse 125 mm.

Conception

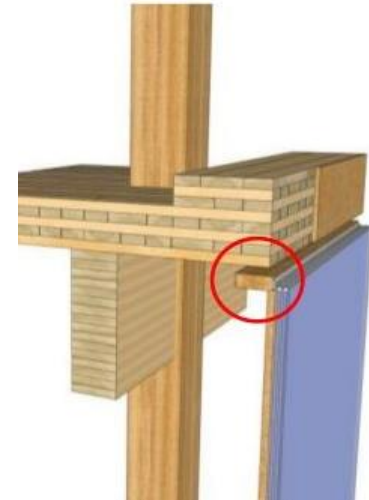
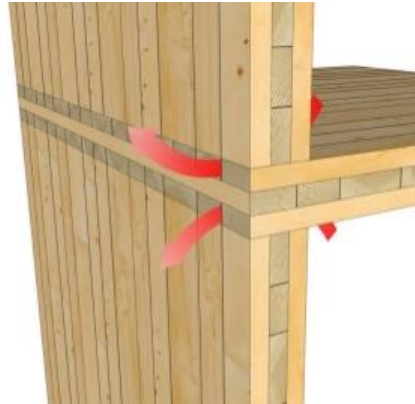
Retrait



Mathscinotes.com



RDH

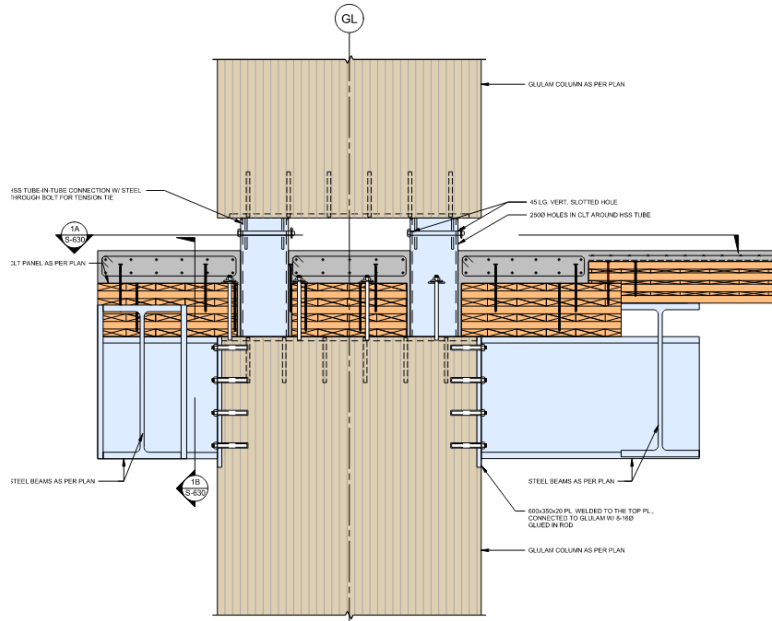


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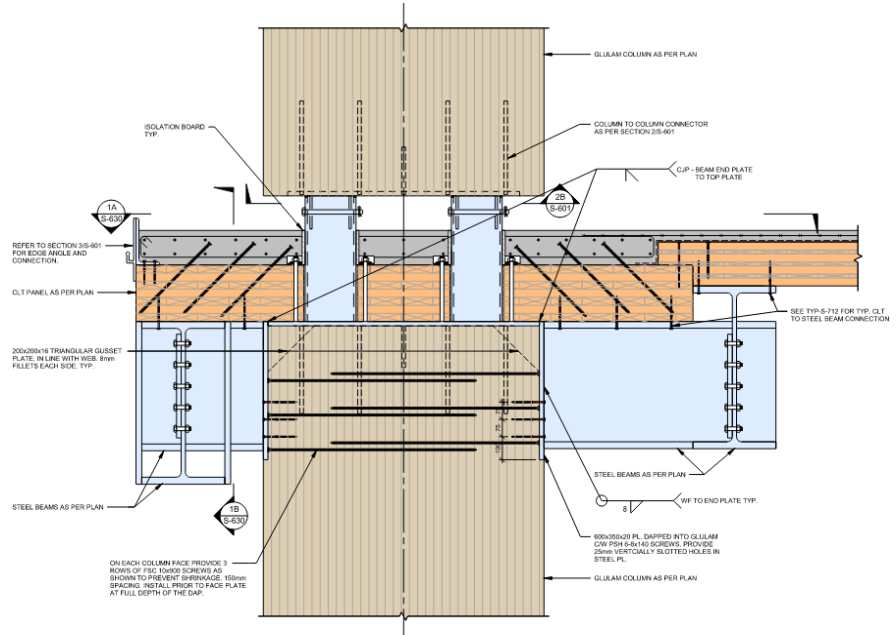
NORDIC
STRUCTURES

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Retrait



1 SECTION
S-203 1:10



1 SECTION
S-203 1:10

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NORDIC
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- Detail Typique
- Connecteur propriétaire



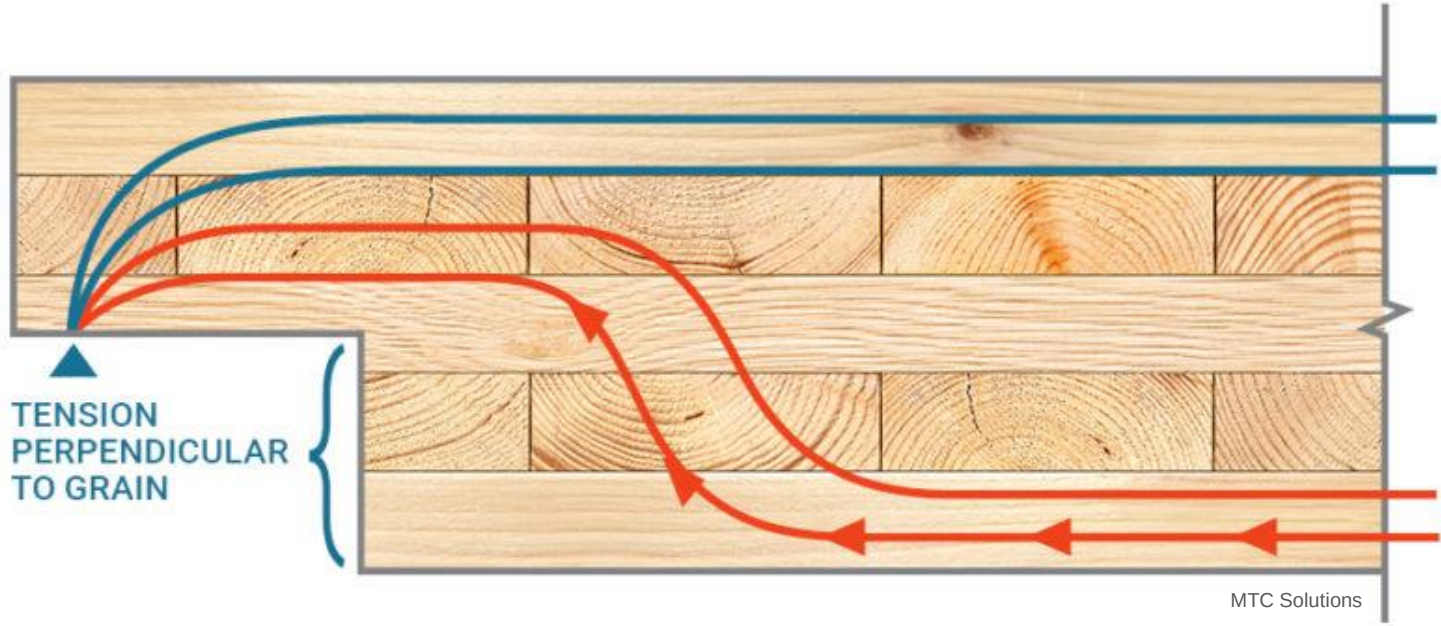


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Conception

Traction Perpendiculaire au fil



Conception

Traction Perpendiculaire au fil



Conception

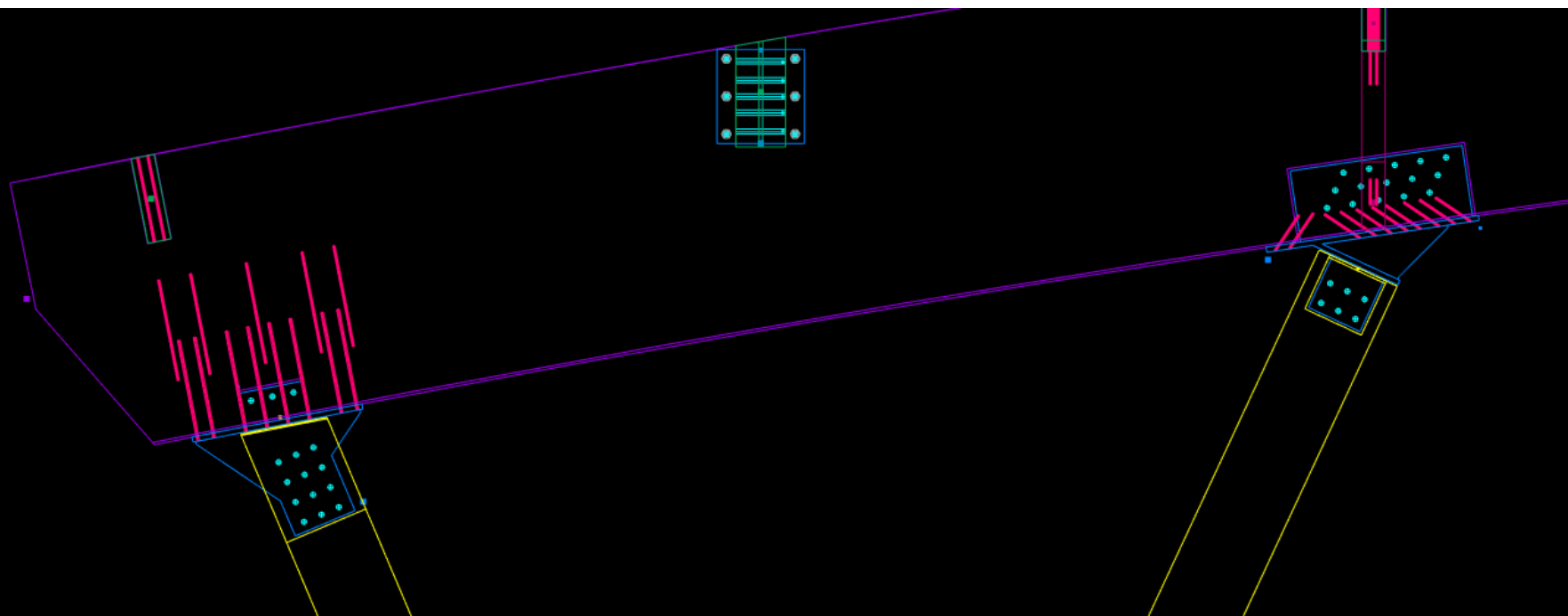
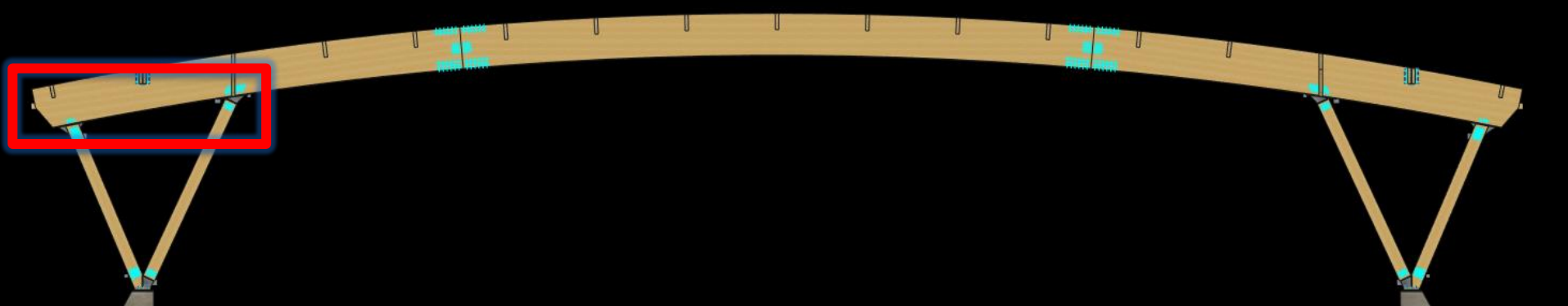
Traction Perpendiculaire au fil

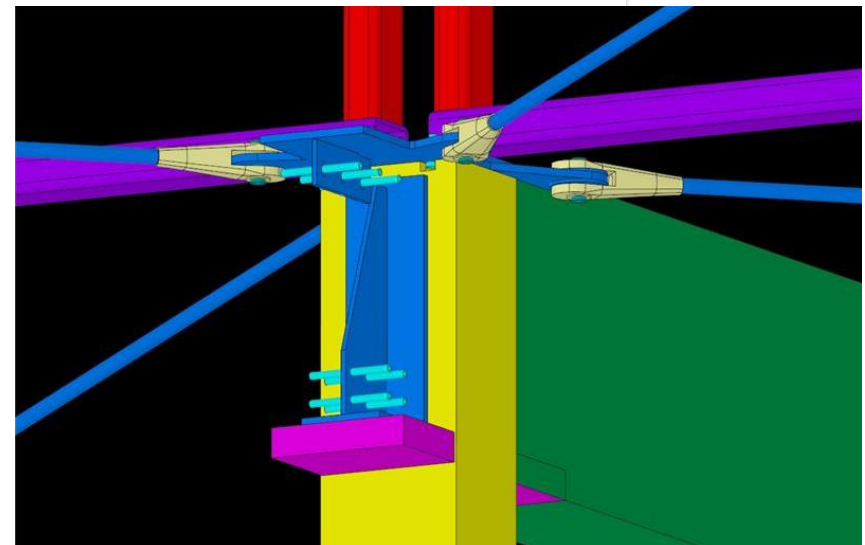
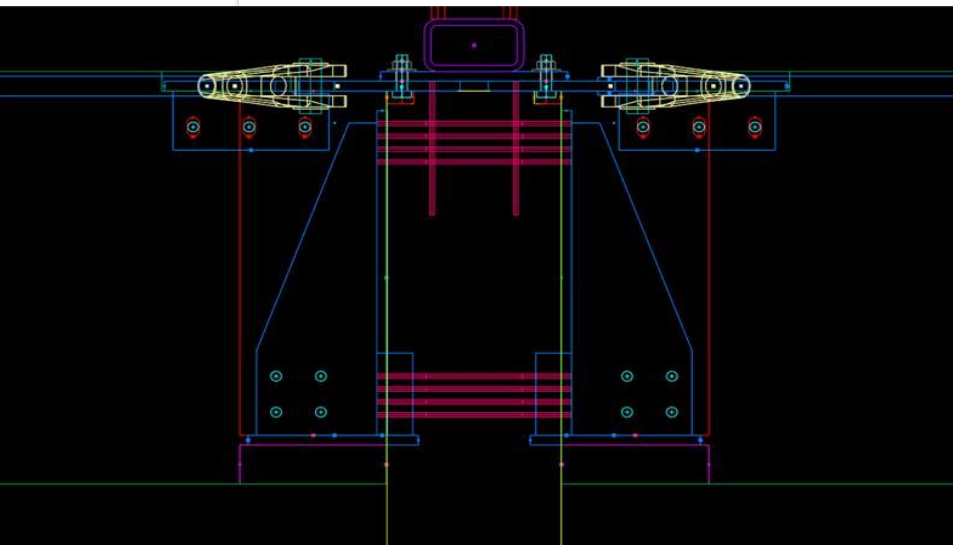
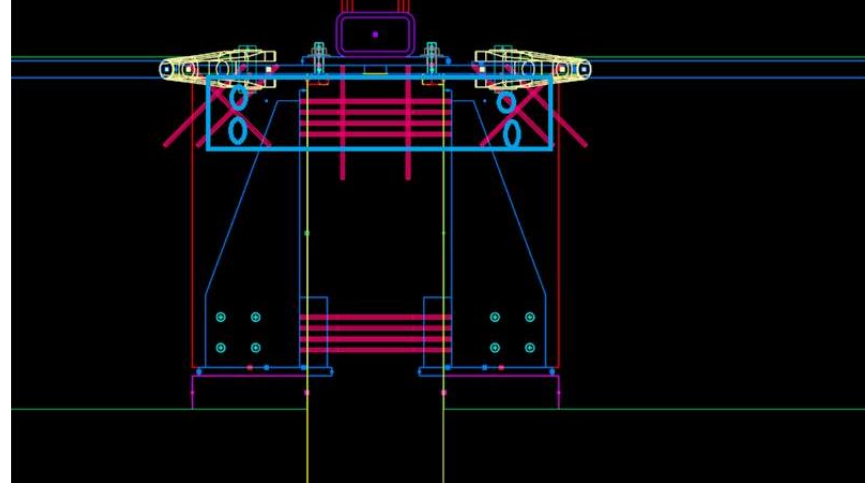
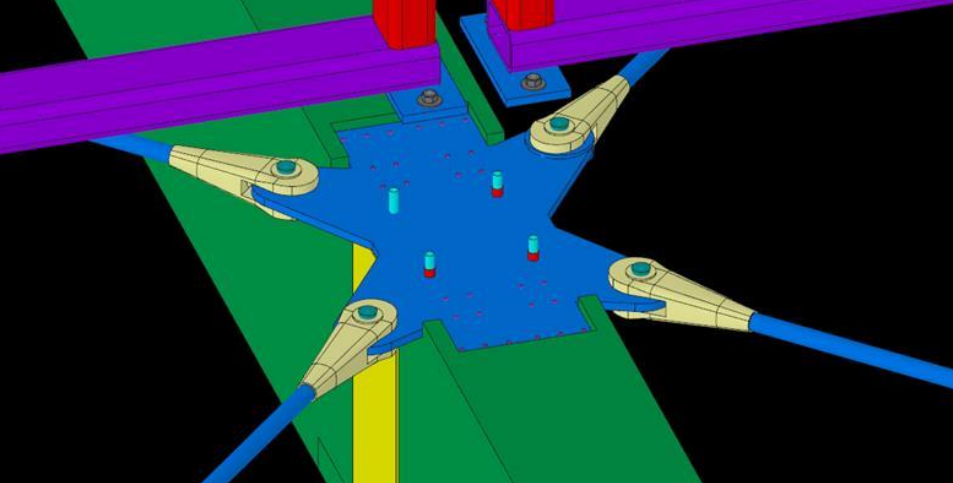


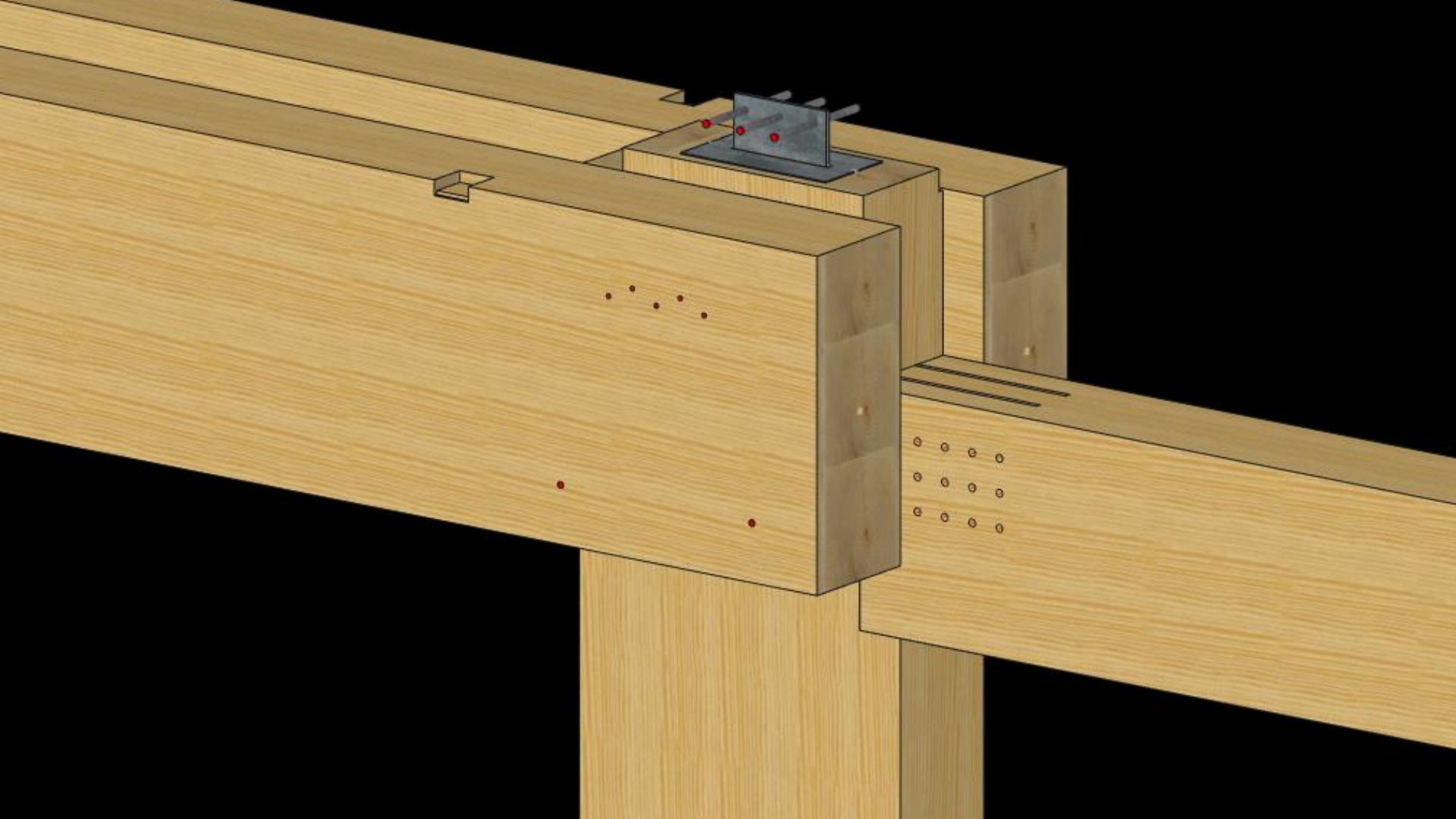
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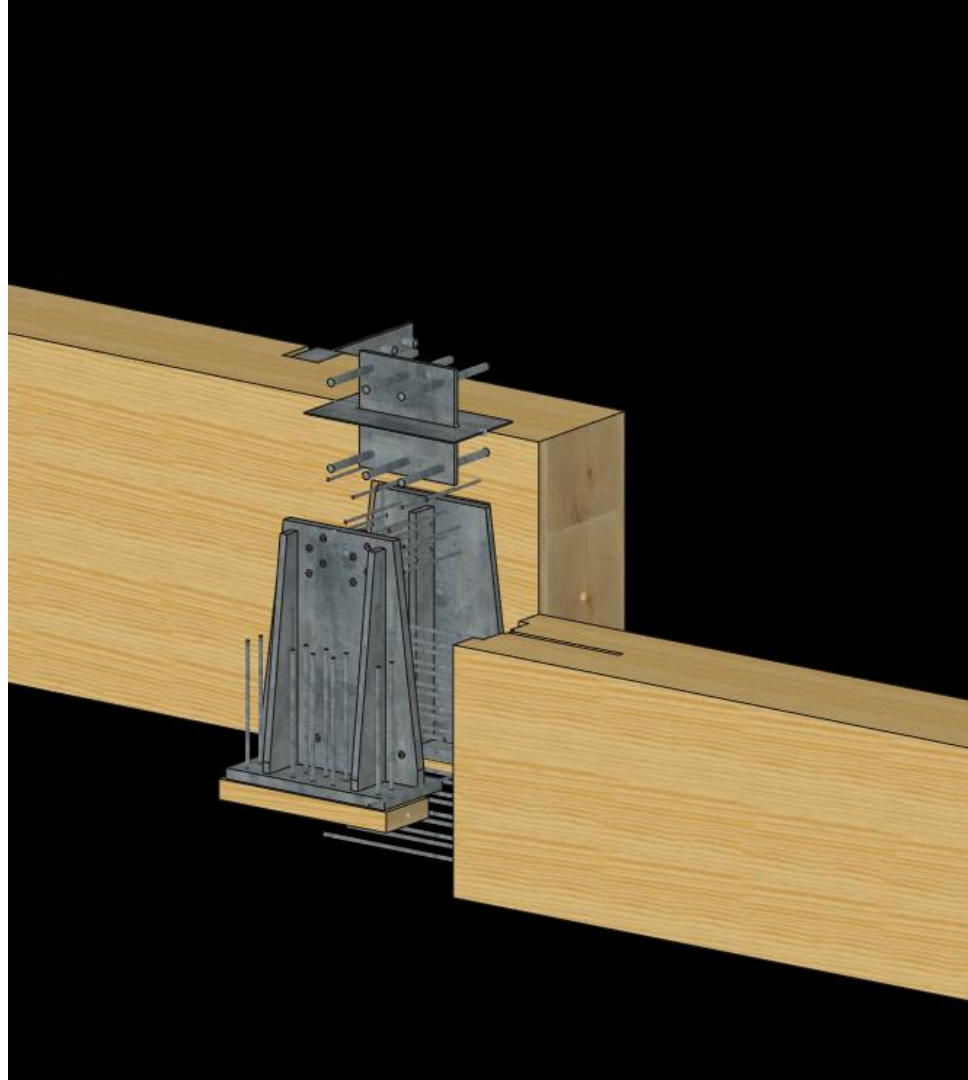
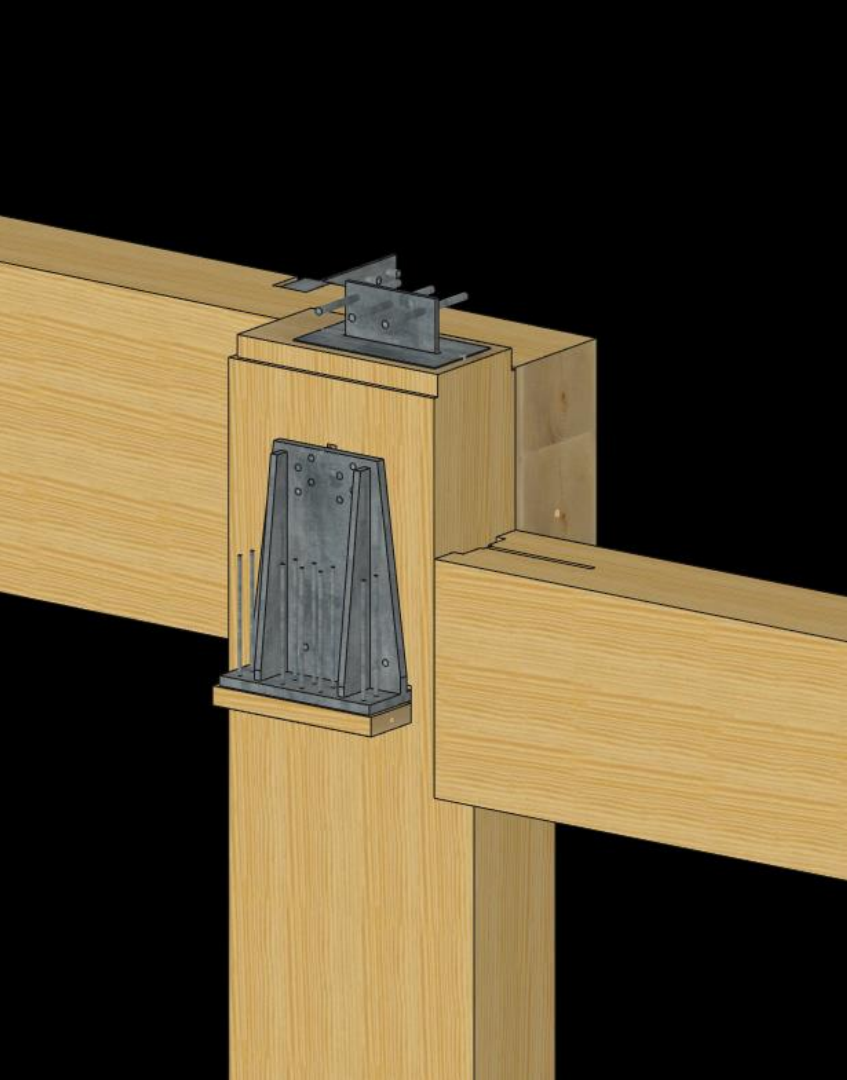
NORDIC
STRUCTURES

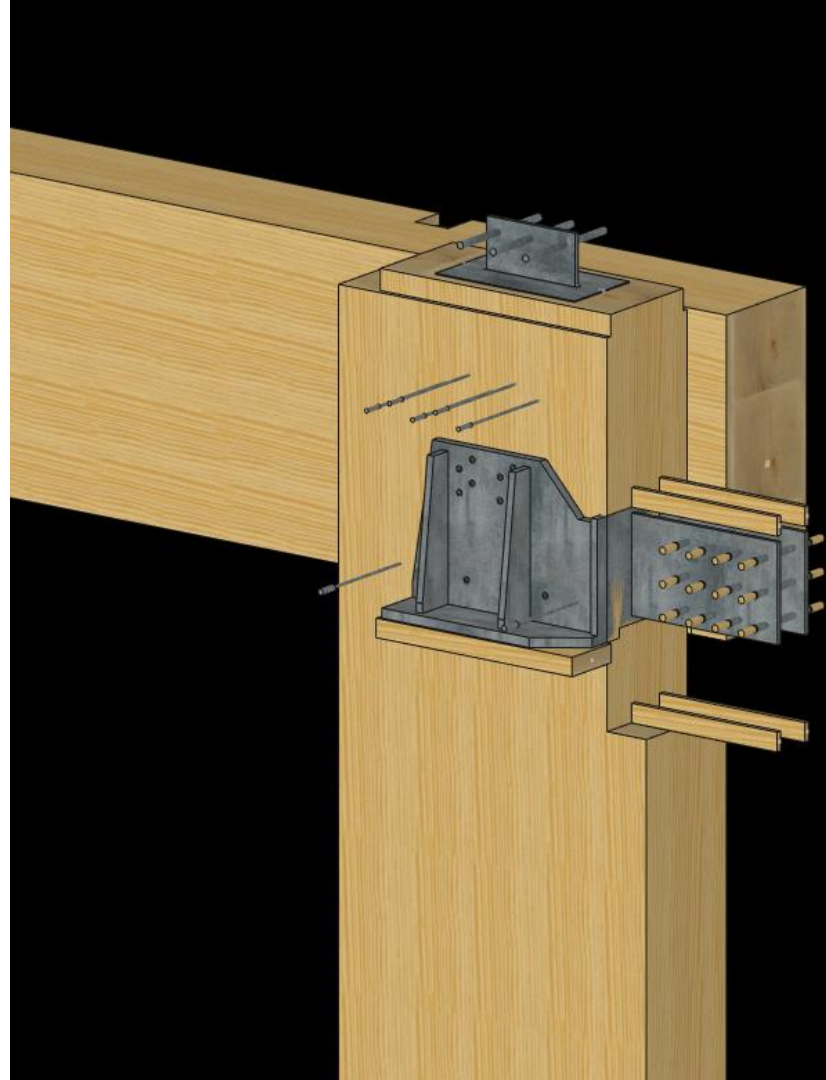
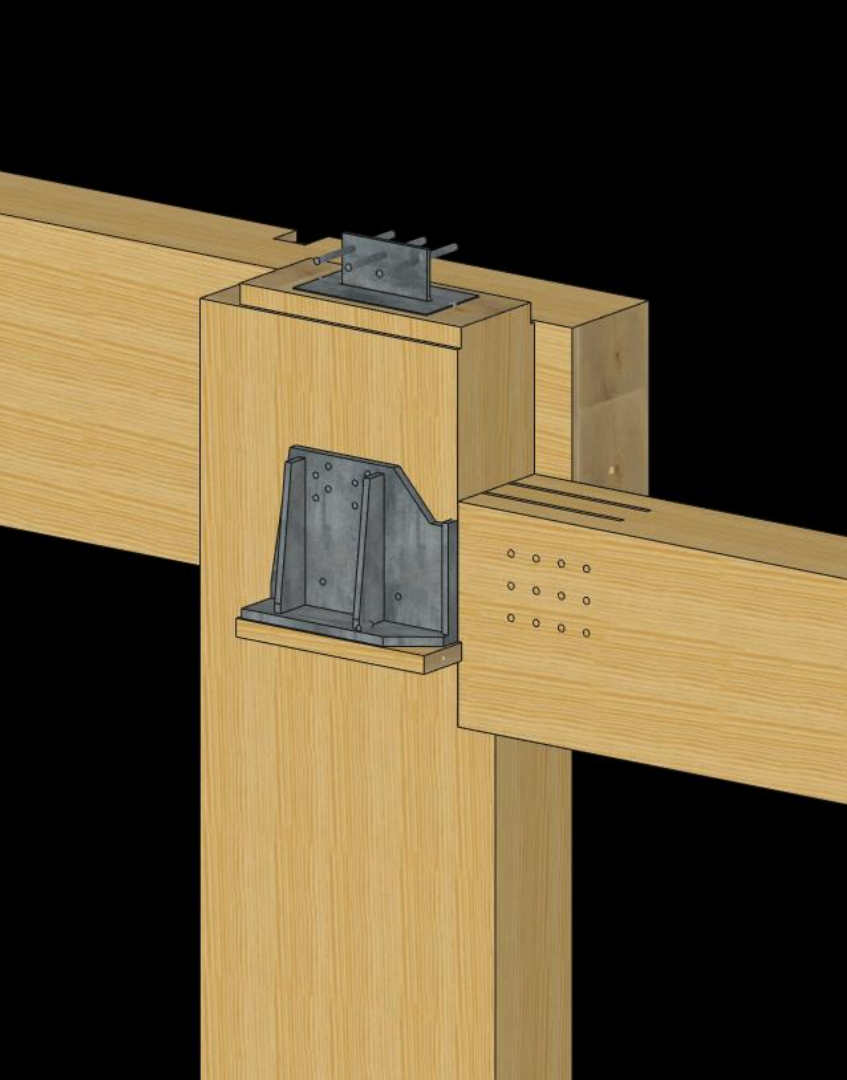








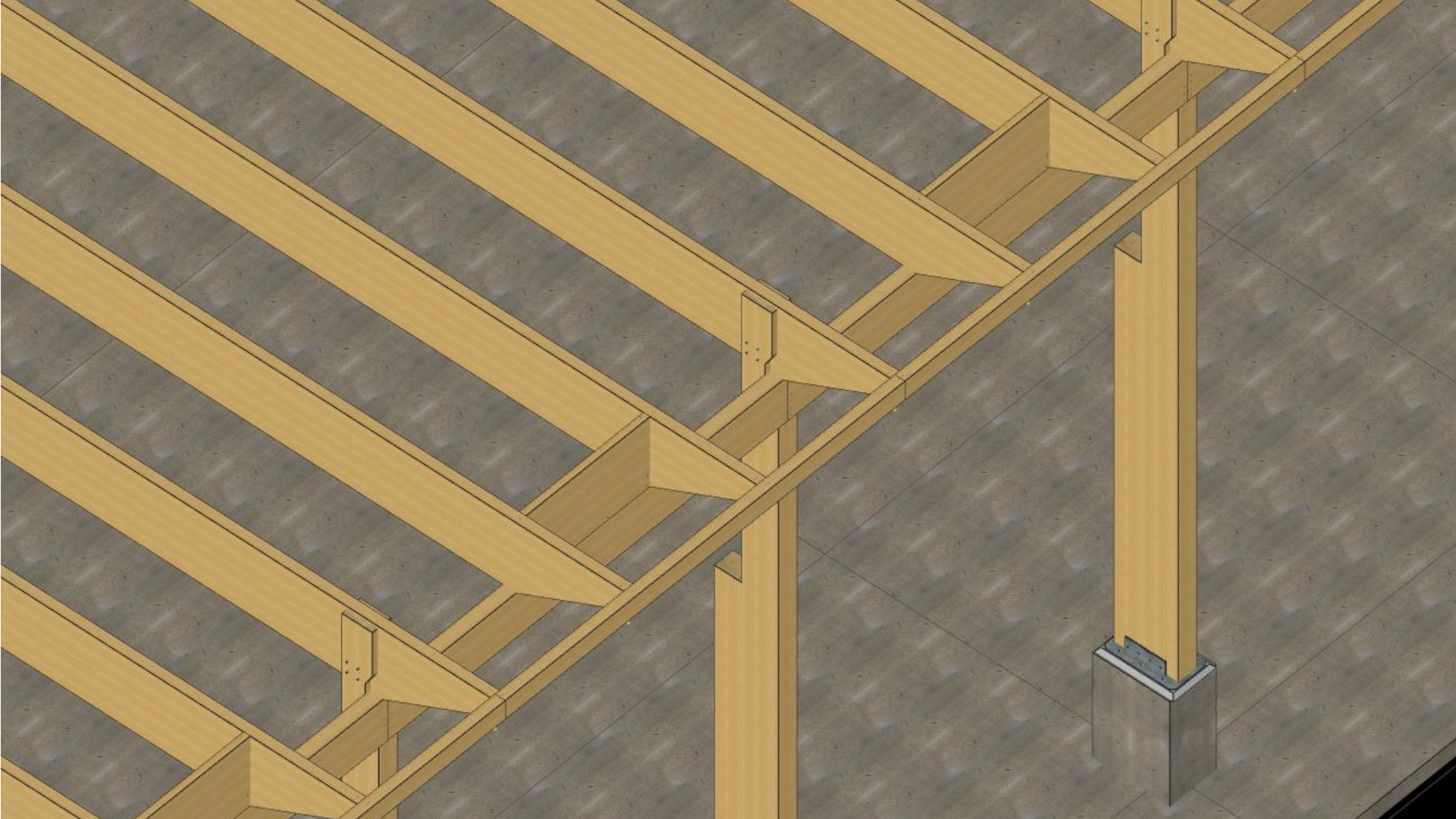




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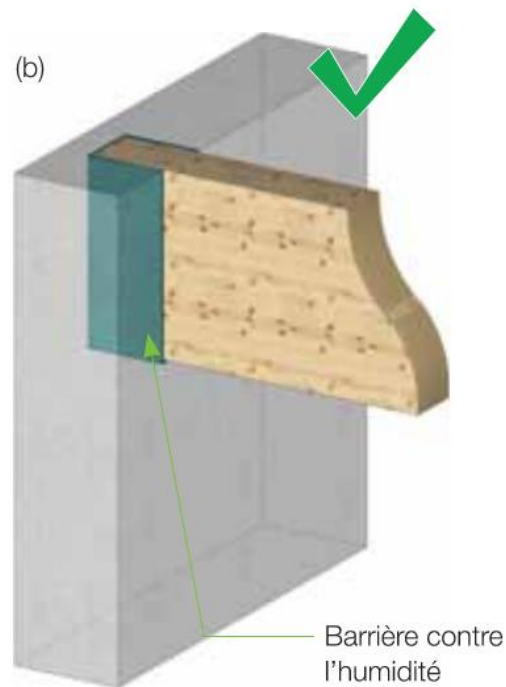
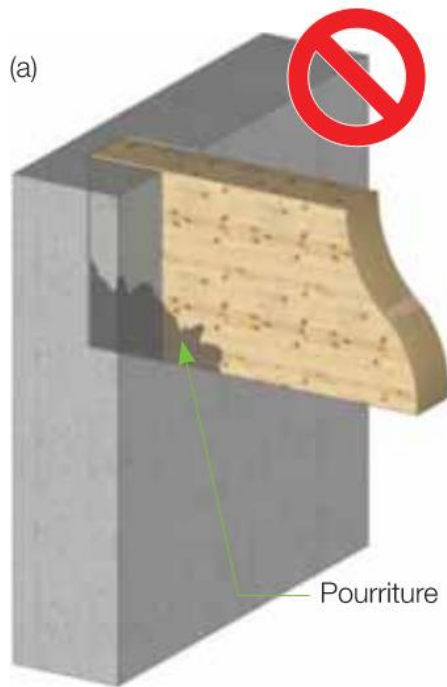
Durabilité



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Conception

Durabilité



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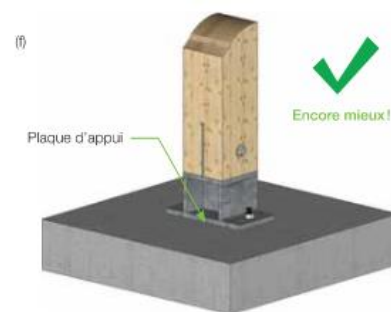
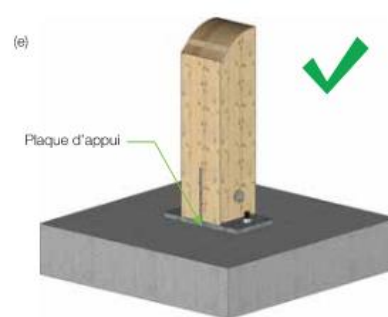
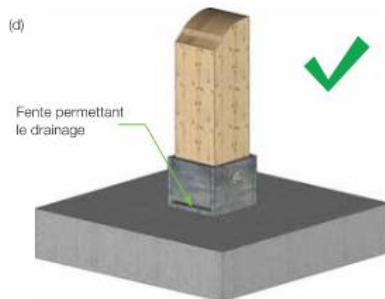
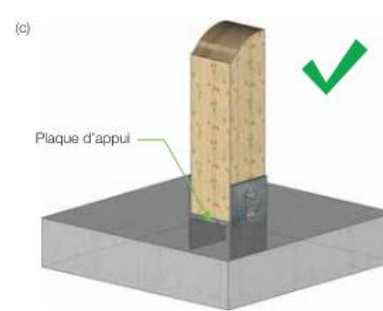
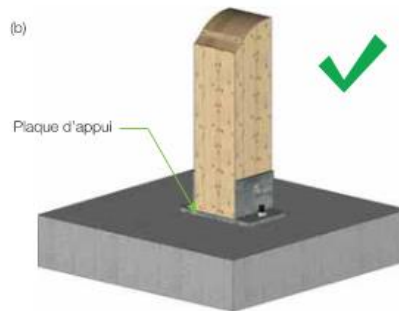
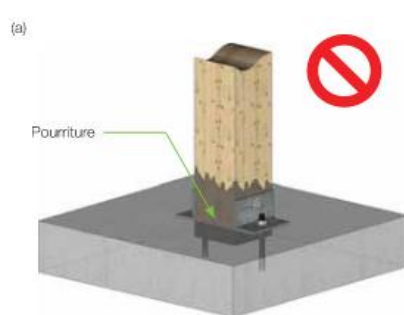
Durabilité



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Durabilité





How to anchor post to concrete | HowToSpecialist -
How to Build, Step by Step DIY Plans

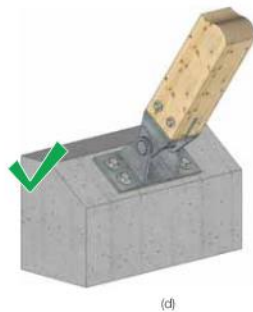
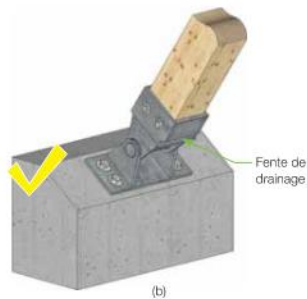


Octagon Post & Beam - Cedar Forest
Products



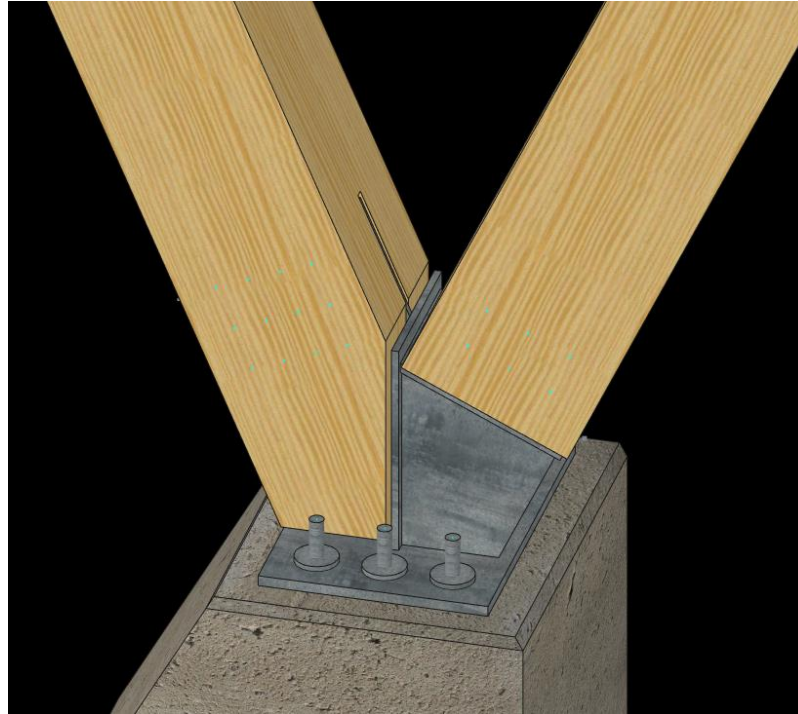
Conception

Durabilité



Conception

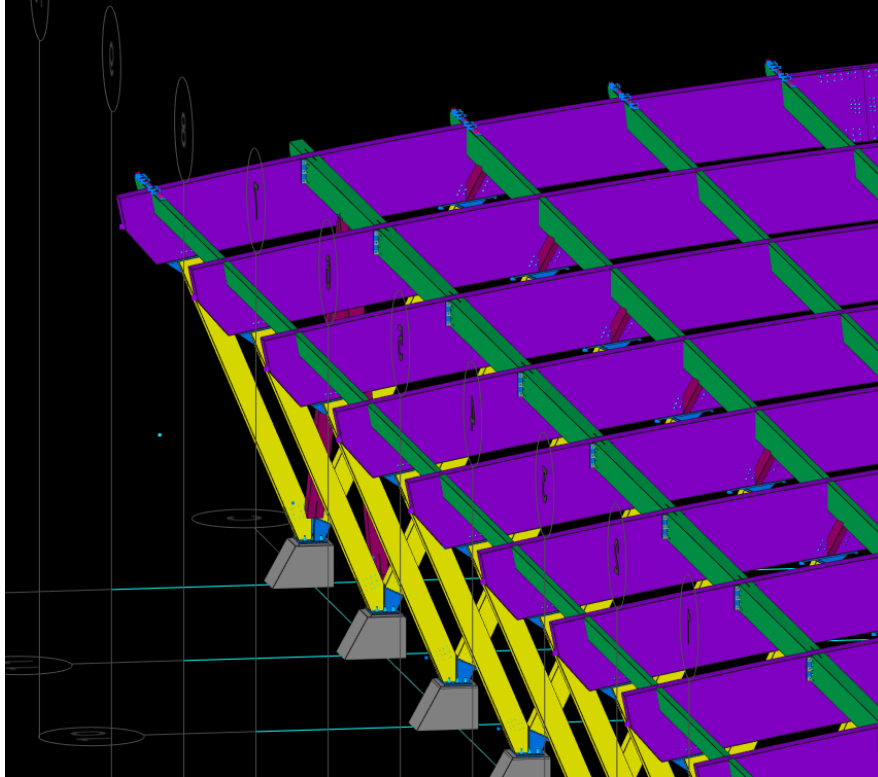
Durabilité



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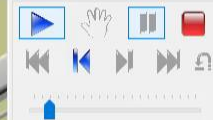
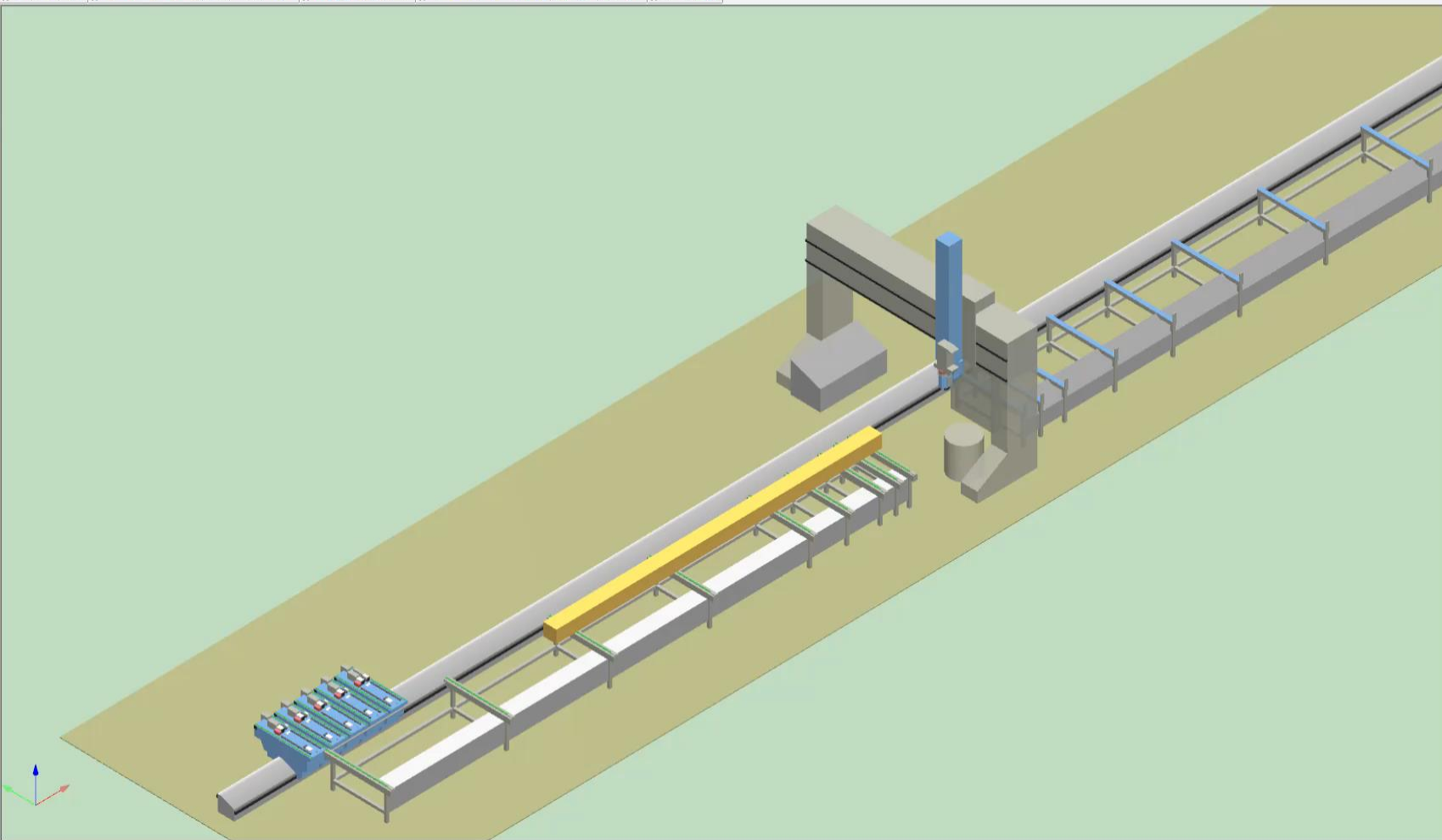
Durabilité



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Plan de la formation

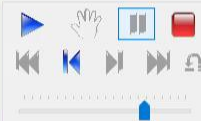
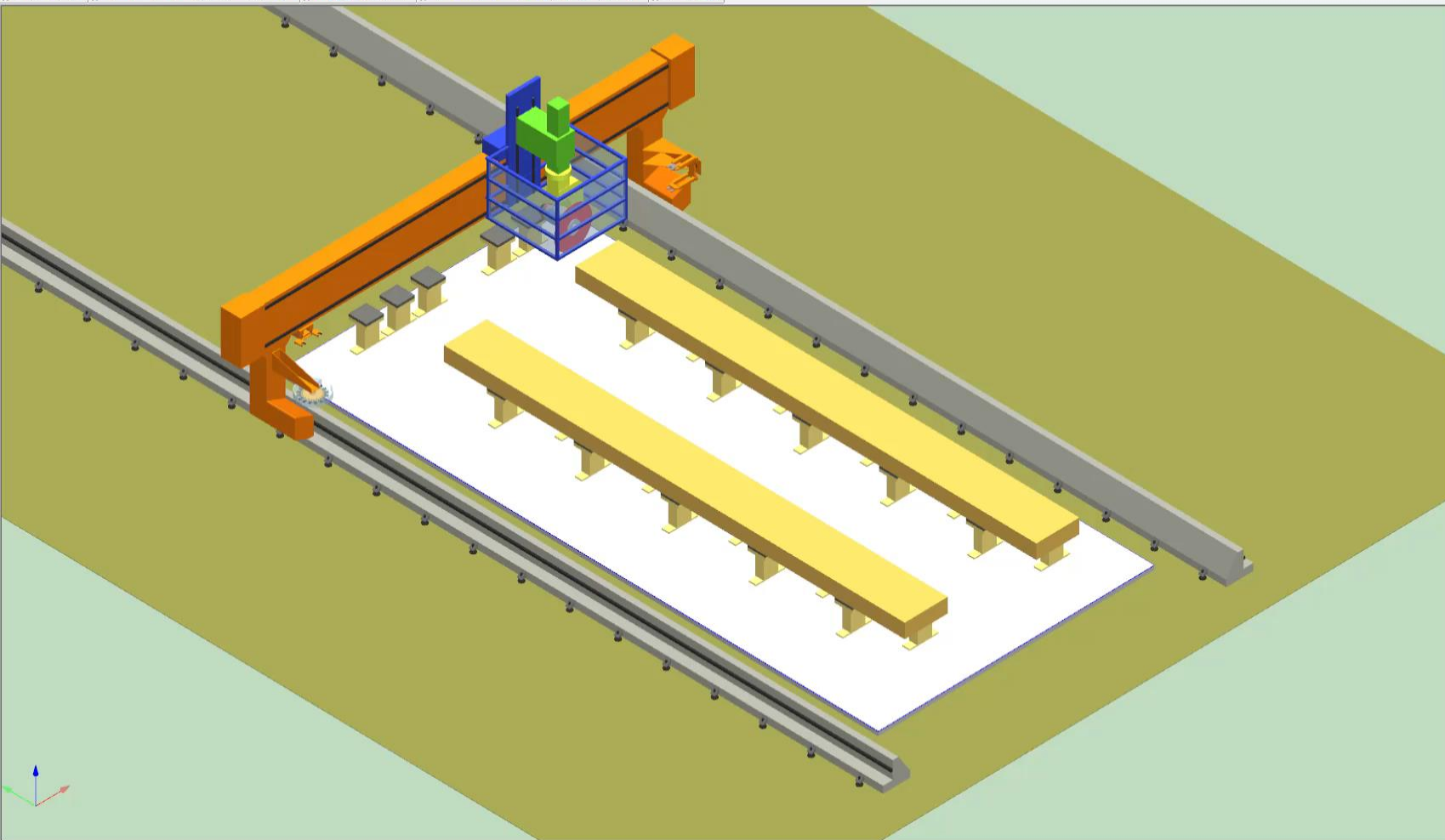
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Usin.	
Outil	
Descr.	
Speed	
Feed (V	0.0
X	15089.000
U	15689.000
P	16289.000
Q	16889.000
A	17489.000
Y	0.000
Z	0.000
C	0.00
B	0.00

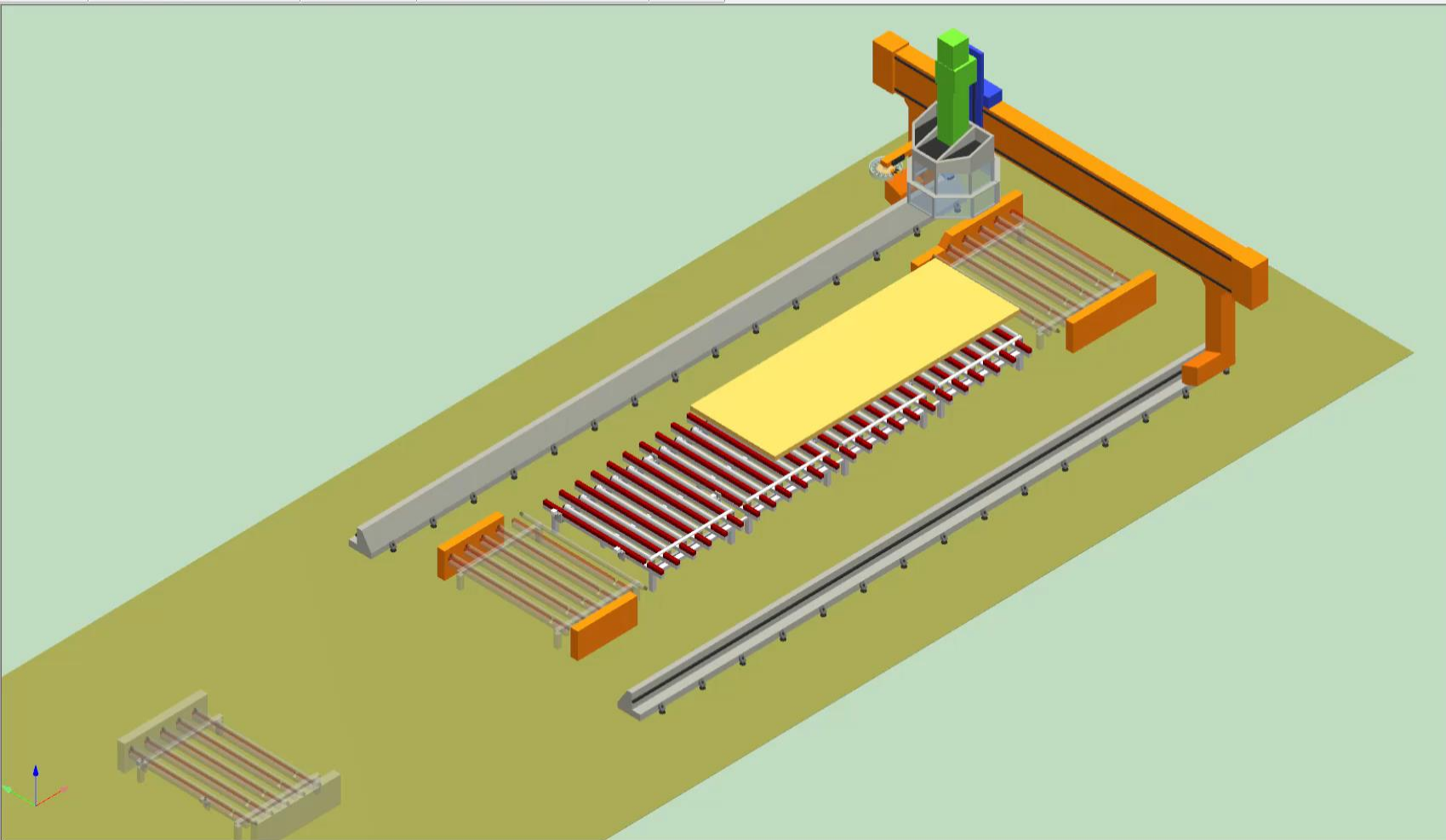






Usin.	1011A,Lame800_4
Outil	T20
Descr.	Lame d800
Speed	1700.0
Feed (V	Rapide
X	-1704.999
Y	-30185.730
Z	-173.428
C	-90.00
B	-90.00





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Usin.	
Outil	
Descr.	
Speed	
Feed (V)	Rapide

X	0.000
Y	0.000
Z	0.000
C	0.00
B	0.00



Conception

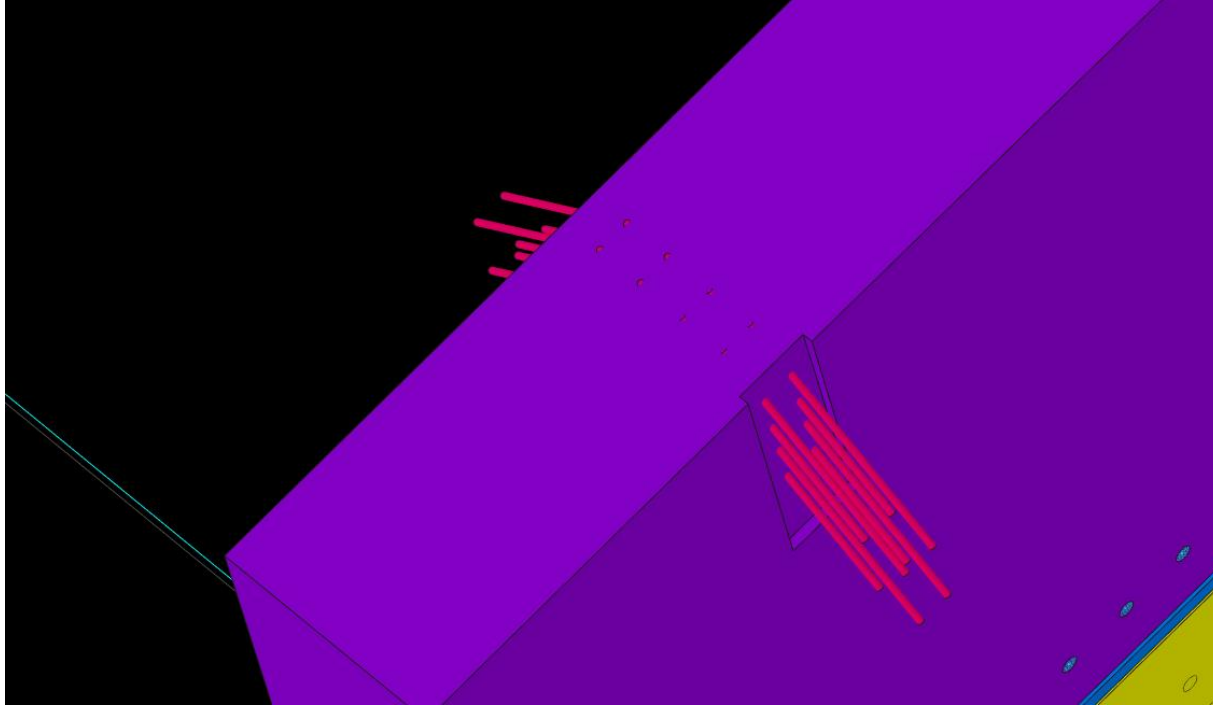
Fabrication/Usinage/CNC



NORDIC
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Conception

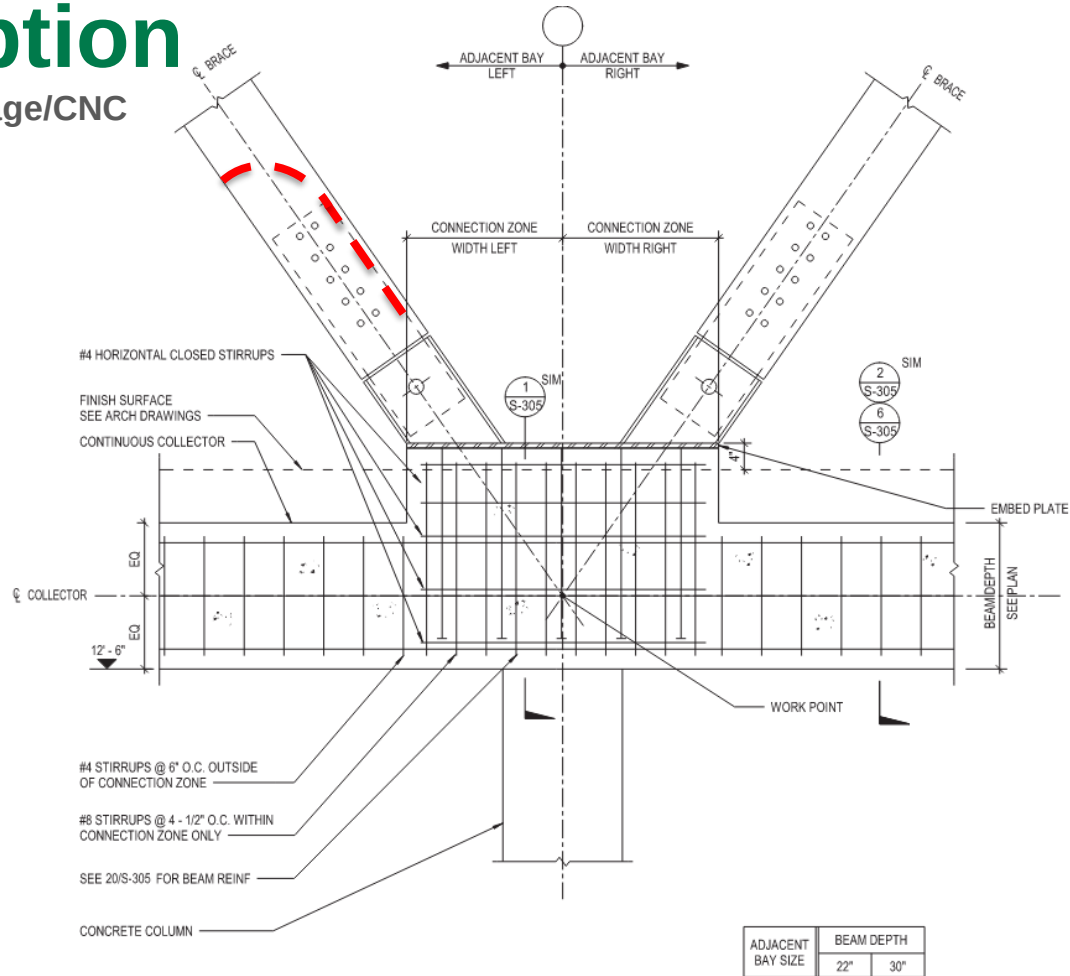
Fabrication/Usinage/CNC



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Conception

Fabrication/Usinage/CNC



NORDIC
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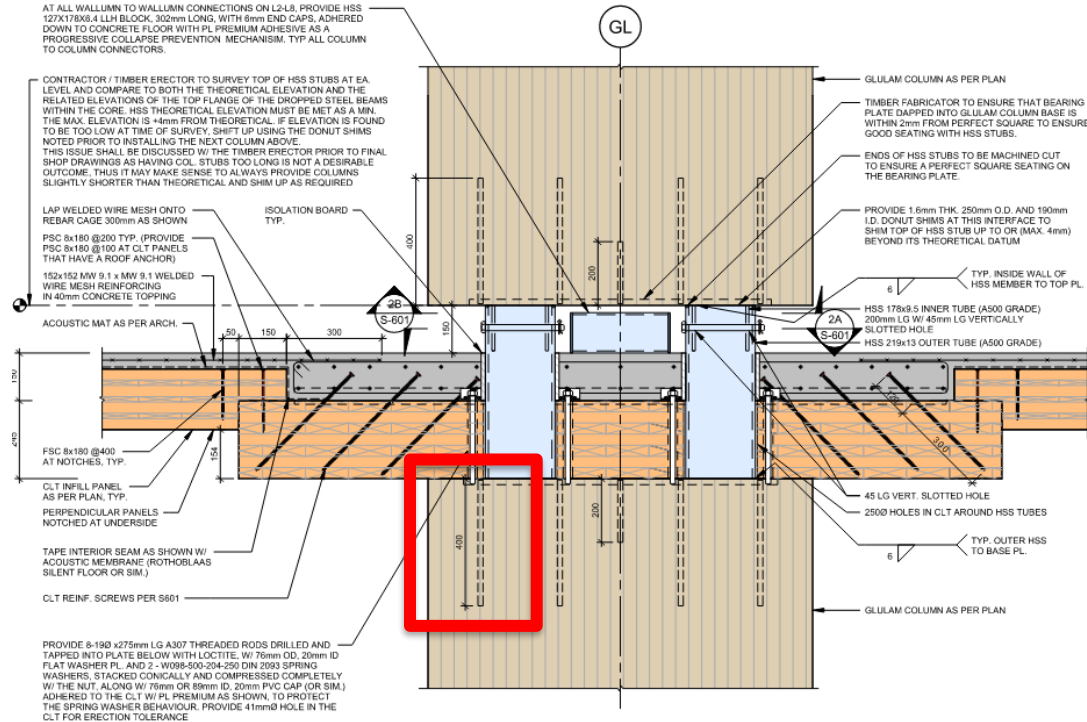
Fabrication/Usinage/CNC



NORDIC
STRUCTURES

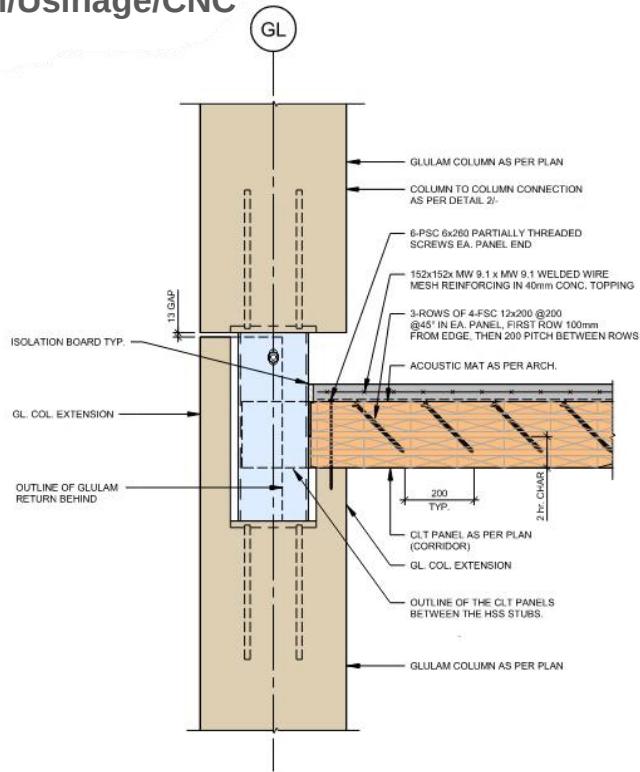
Conception

Fabrication/Usinage/CNC



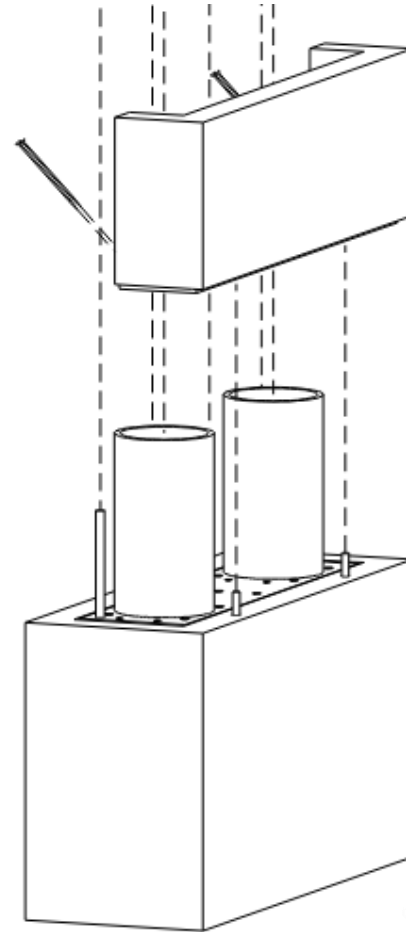
Conception

Fabrication/Usinage/CNC



Fast+Epp

1 SECTION
S-202 1:10



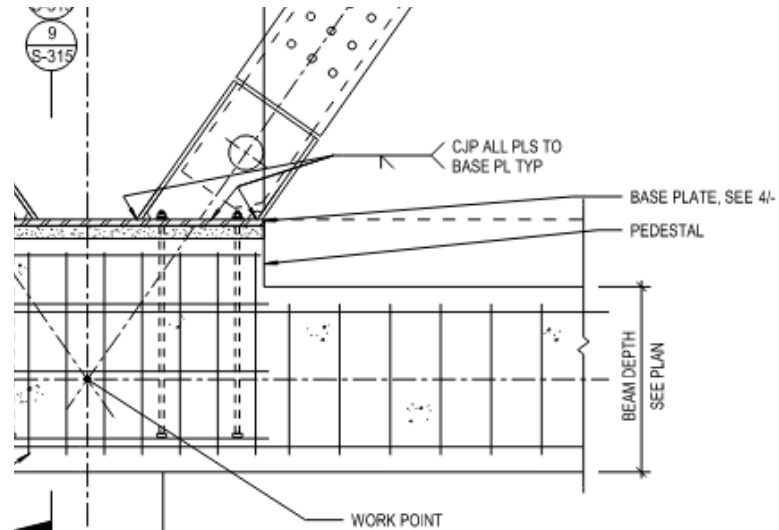
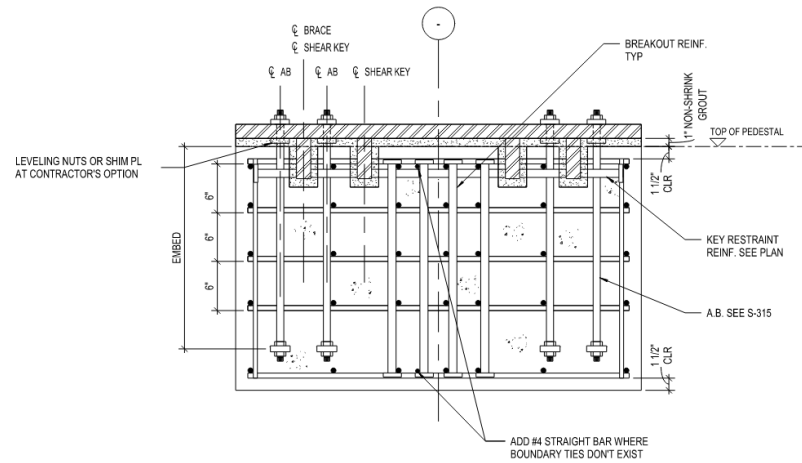
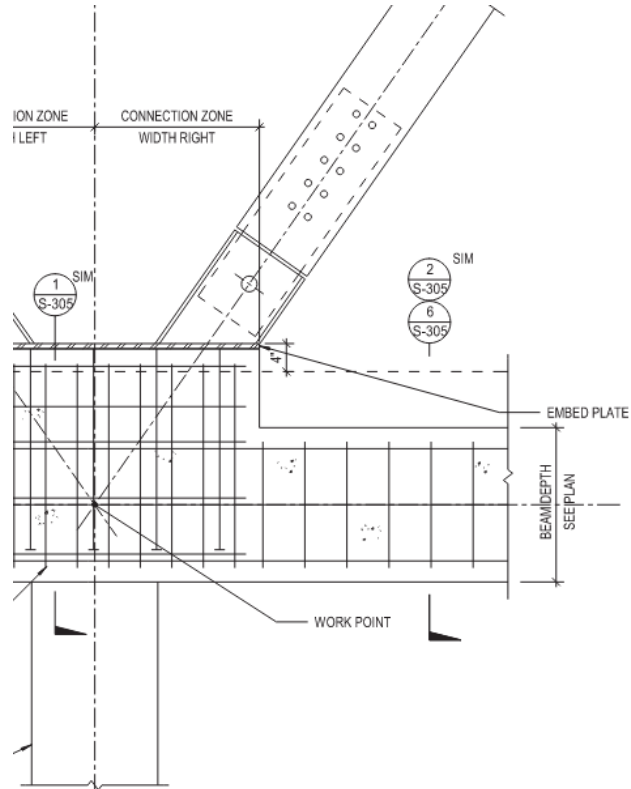
NORDIC
STRUCTURES

Plan de la formation

- Description
- Matériau bois
 - Naturel
 - Anisotrope
 - Parallèle et perpendiculaire au fil
 - Hygroscopique
 - Retrait
 - Résistance mécanique
 - Feu
- Connecteur
 - 'Ancien'
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 - Durabilité
 - Fabrication/Usinage/CNC
 - **Tolerance Bois vs. Acier-Beton**
 - Oublis commun
- Detail Typique
- Connecteur propriétaire

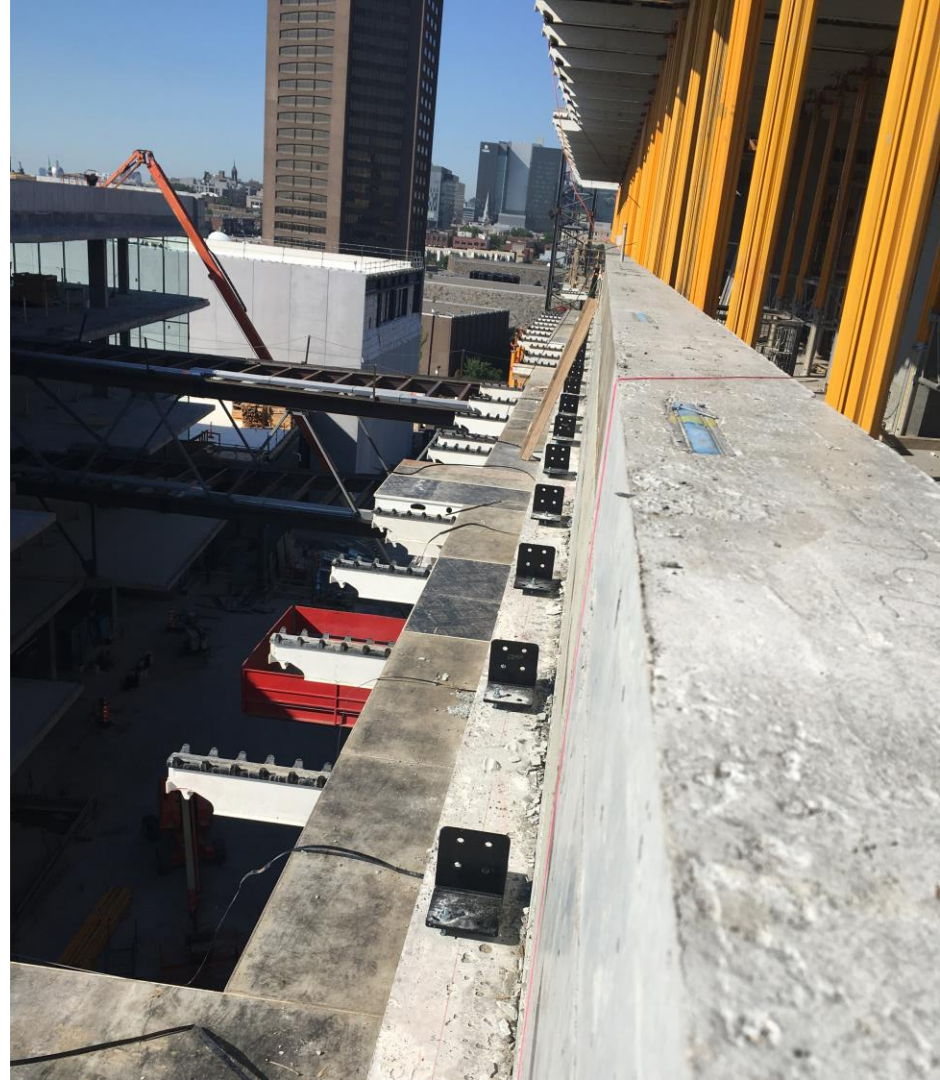
Conception

Tolérance

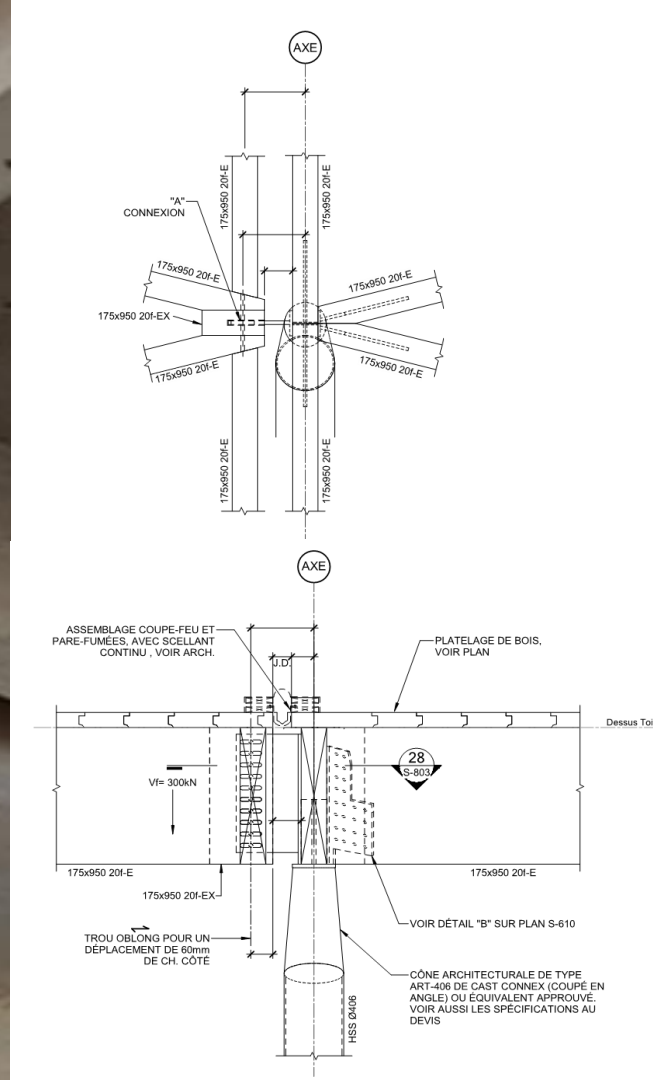
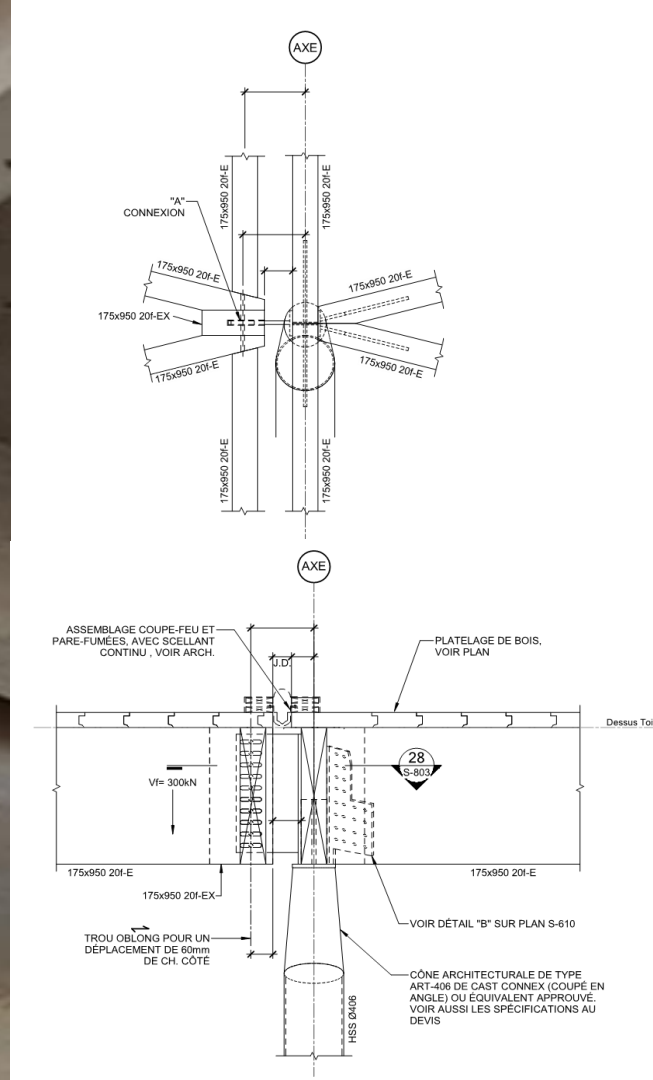






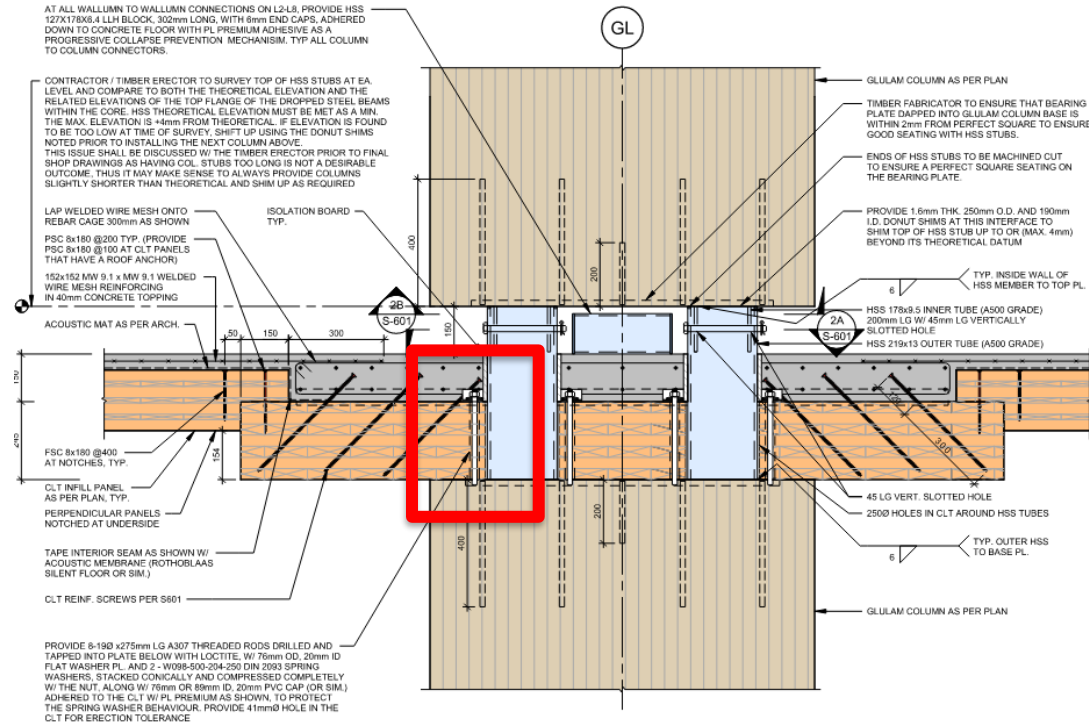






Conception

Tolérance



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Conception

Oublis Commun

244-7l

244-7s

Conception

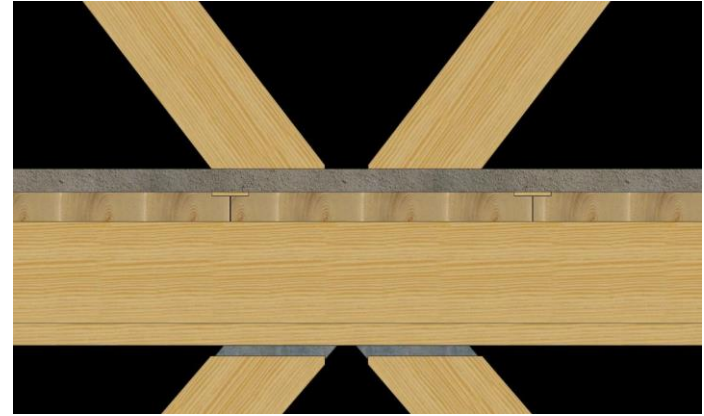
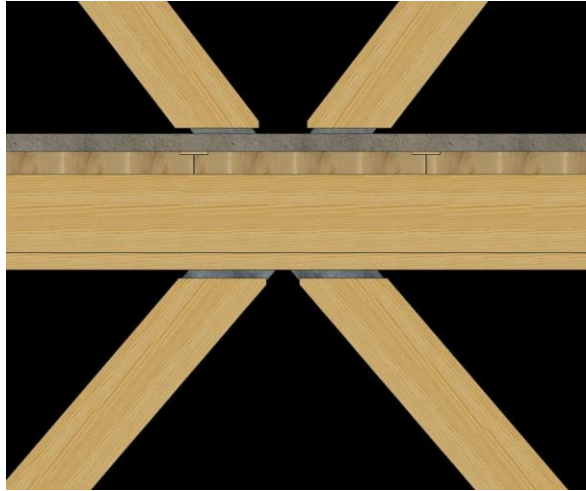
Oublis Commun



NORDIC
STRUCTURES

Conception

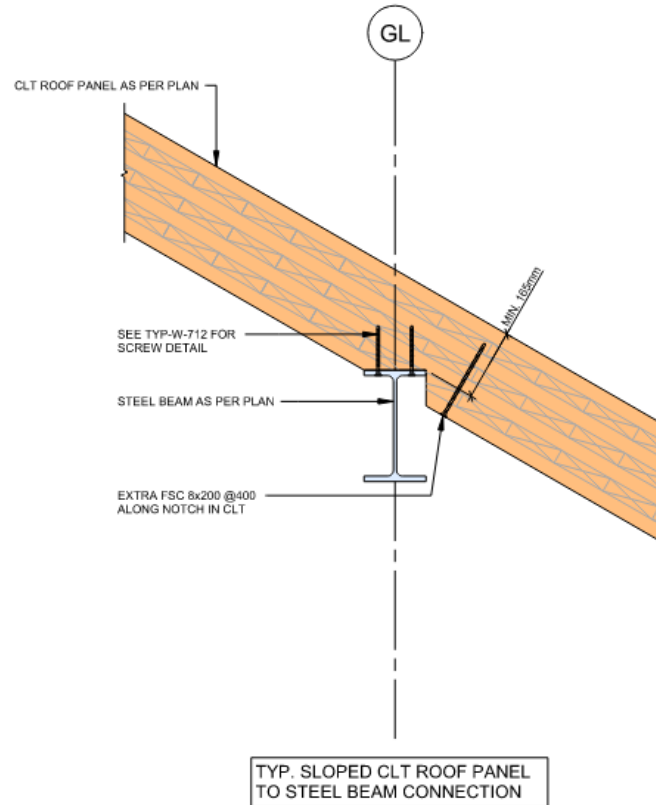
Oublis Commun



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STRUCTURES

Conception

Oublis Commun

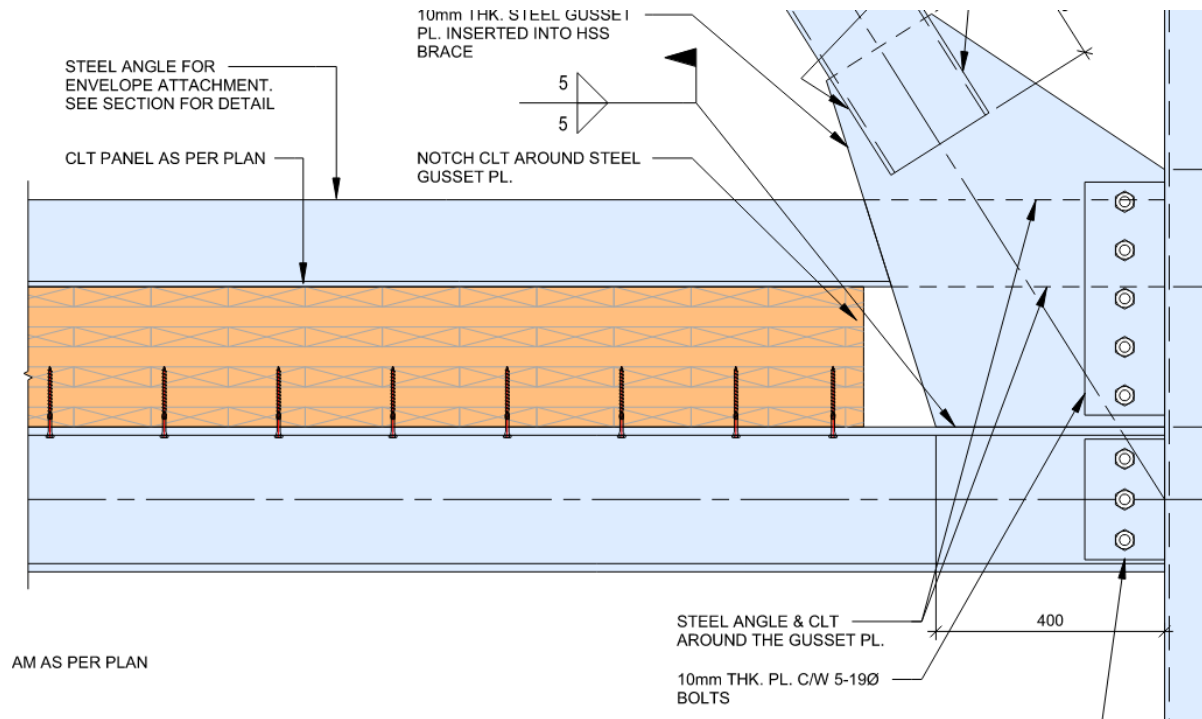
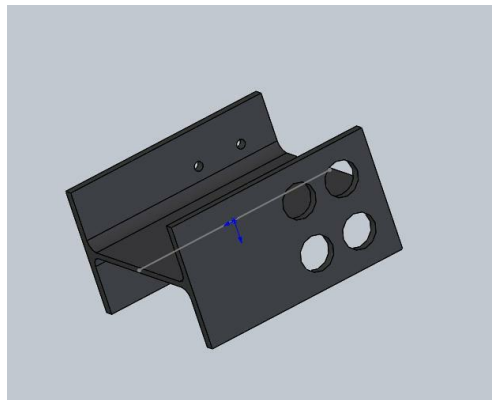


6 SECTION
S-211 1 : 10

NORDIC
STRUCTURES

Conception

Oublis Commun



NORDIC
STRUCTURES

Conception

Oublis Commun

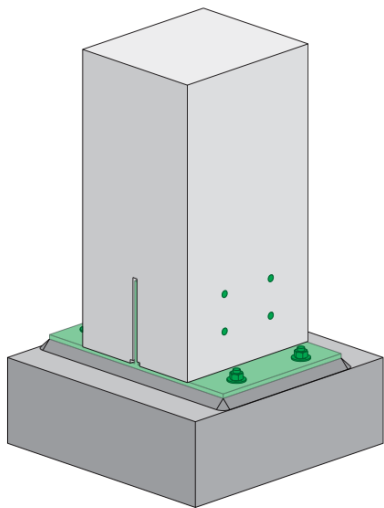
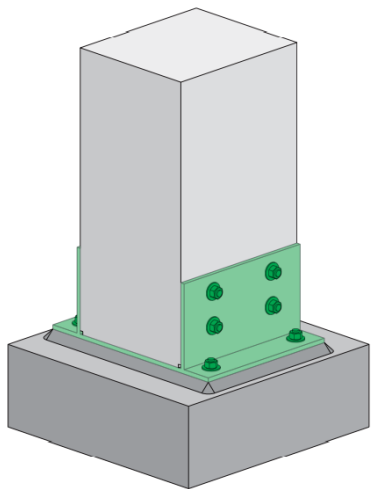


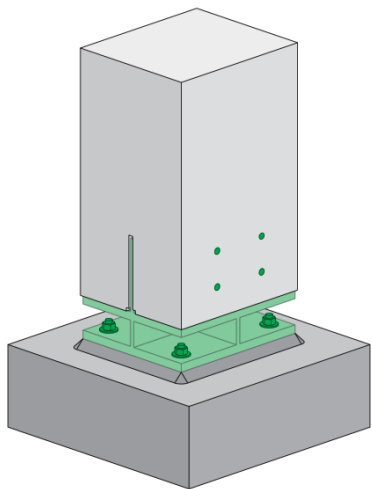
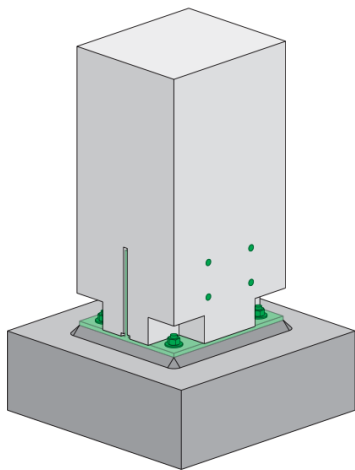
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STRUCTURES

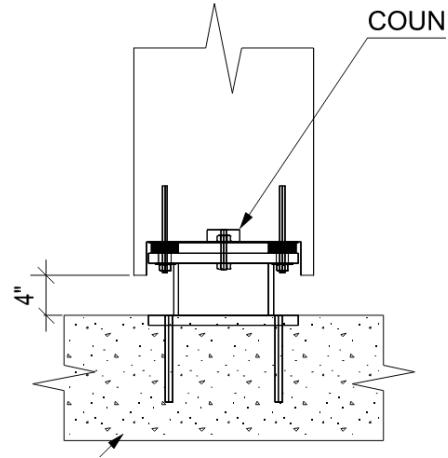
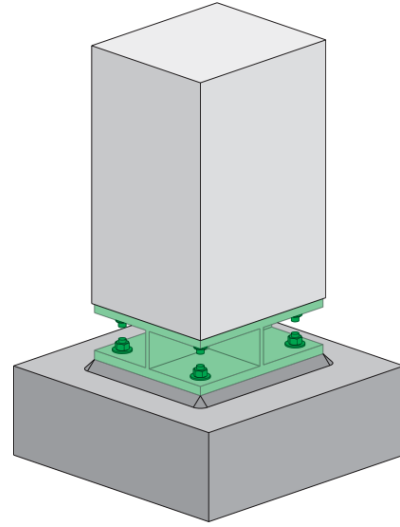
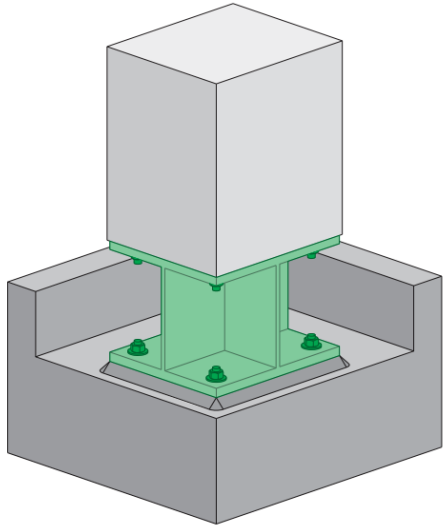


Plan de la formation

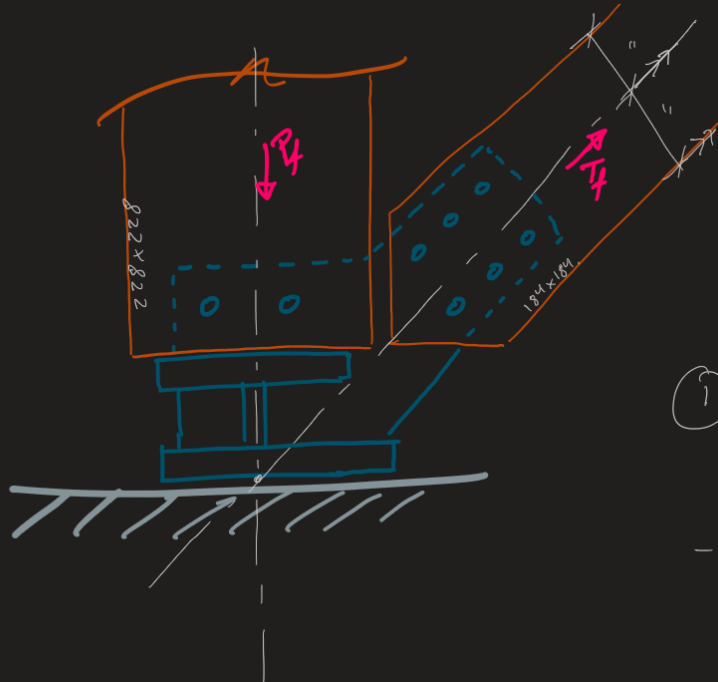
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Détail Typique



Hypothèse.

$DRF = 2 \text{ hr.}$

$T_4 = 120 \text{ kN.}$

$P_4 = 30 \text{ kN.}$

① Vérification effort de traction.

O86. 12.4 - Goujon.

- détermine t .

$$\frac{184 - 15 \text{ mm}}{2} = 84 \text{ mm.} \quad \text{USE } 80 \text{ mm.}$$

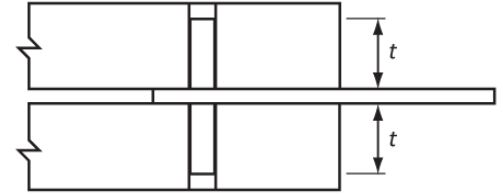
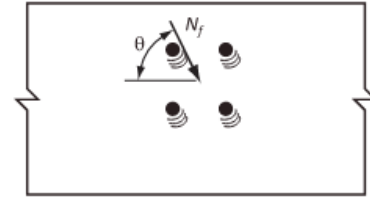
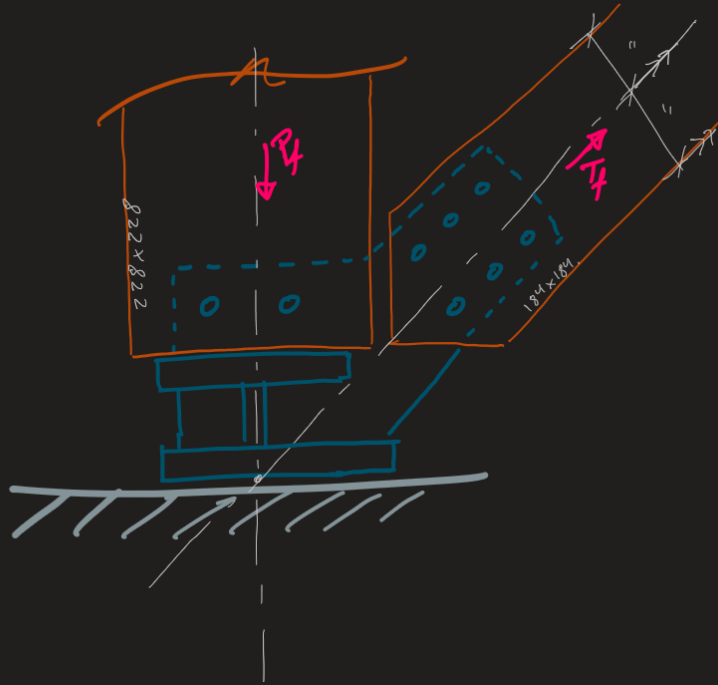


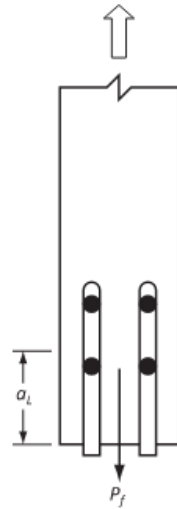
Figure 12.4.2.2
Épaisseur des éléments en bois

- Modes de ruptures possibles.

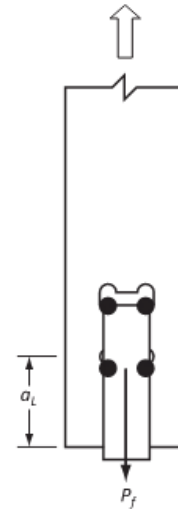


Rupture ductile

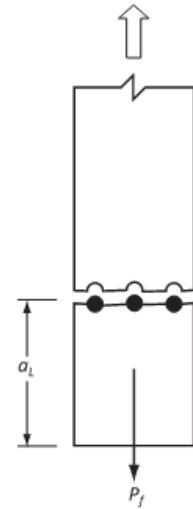
a) Toutes directions de charge



Cisaillement de file



Déchirement de groupe



Traction nette

12.4.4.3.1 Généralités

La résistance latérale ductile pondérée, N_r , d'un groupe d'attaches dans un assemblage, due à la rupture ductile, est fonction du nombre de plans de cisaillement de l'assemblage ; elle doit être supérieure à N_f

$$N_r = \phi_y n_u n_s n_f$$

où

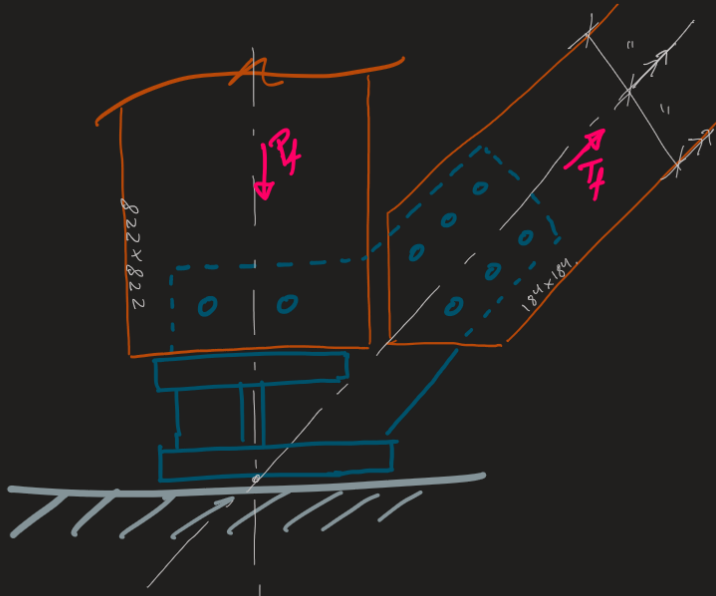
ϕ_y = coefficient de résistance à la rupture ductile

= 0,8

n_u = résistance latérale ductile unitaire, N (l'article 12.4.4.3.2)

n_s = nombre de plans de cisaillement dans l'assemblage

n_f = nombre d'attaches dans l'assemblage

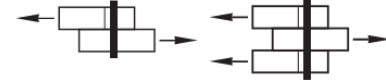


a) Equation Johansen.

12.4.4.3.2 Résistance latérale ductile unitaire

La résistance latérale ductile unitaire, n_u (par plan de cisaillement), doit être la valeur moindre calculée à l'aide des formules a) à g). Pour les assemblages à deux éléments, seules les formules a), b) et d) à g) doivent être considérées. Pour les assemblages à trois éléments, seules les formules a), c), d) et g) doivent être considérées.

a) $f_t d_f t_1$



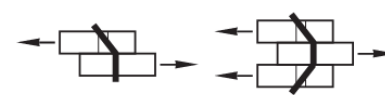
b) $f_2 d_f t_2$



c) $\frac{1}{2} f_2 d_f t_2$



d) $f_t d_f^2 \left(\sqrt{\frac{1}{6} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1} + \frac{1}{5} \frac{t_1}{d_f}} \right)$



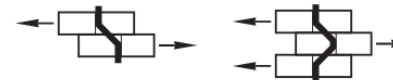
e) $f_1 d_f^2 \left(\sqrt{\frac{1}{6} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1} + \frac{1}{5} \frac{t_2}{d_f}} \right)$



f) $f_t d_f^2 \frac{1}{5} \left(\frac{t_1}{d_f} + \frac{f_2}{f_1} \frac{t_2}{d_f} \right)$



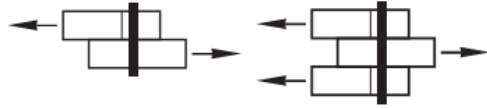
g) $f_1 d_f^2 \sqrt{\frac{2}{3} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1}}$



12.4.4.3.2 Résistance latérale ductile unitaire

La résistance latérale ductile unitaire, n_u (par plan de cisaillement), doit être la valeur moindre calculée à l'aide des formules a) à g). Pour les assemblages à deux éléments, seules les formules a), b) et d) à g) doivent être considérées. Pour les assemblages à trois éléments, seules les formules a), c), d) et g) doivent être considérées.

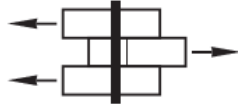
a) $f_1 d_f t_1$



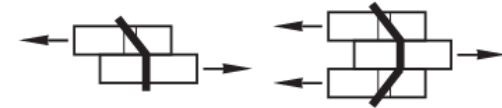
b) $f_2 d_f t_2$



c) $\frac{1}{2} f_2 d_f t_2$



d) $f_1 d_f^2 \left(\sqrt{\frac{1}{6} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1} + \frac{1}{5} \frac{t_1}{d_f}} \right)$



e) $f_1 d_f^2 \left(\sqrt{\frac{1}{6} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1} + \frac{1}{5} \frac{t_2}{d_f}} \right)$



f) $f_1 d_f^2 \frac{1}{5} \left(\frac{t_1}{d_f} + \frac{f_2}{f_1} \frac{t_2}{d_f} \right)$



g) $f_1 d_f^2 \sqrt{\frac{2}{3} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1}}$



$$f_1 = 50 \text{ G} (1 - 0.01 d_F) J_x \times K_D \times K_{SF} \times K_T$$

$$d_F = 19 \text{ mm.}$$

$$J_x = 1.0 \text{ (pas CLT)}$$

$$G = 0.47$$

$$K_D = 1.15$$

$$f_1 = 21.9 \text{ MPa}$$

$$f_2 = K_{sp} (\phi_{acier} / \phi_y) f_u$$

$$f_u = 450 \text{ MPa} \quad (350 \text{ W})$$

$$\phi_{acier} = 0.8$$

$$\phi_y = 0.8$$

$$K_{sp} = 3.0$$

$$f_2 = 1350 \text{ MPa}$$

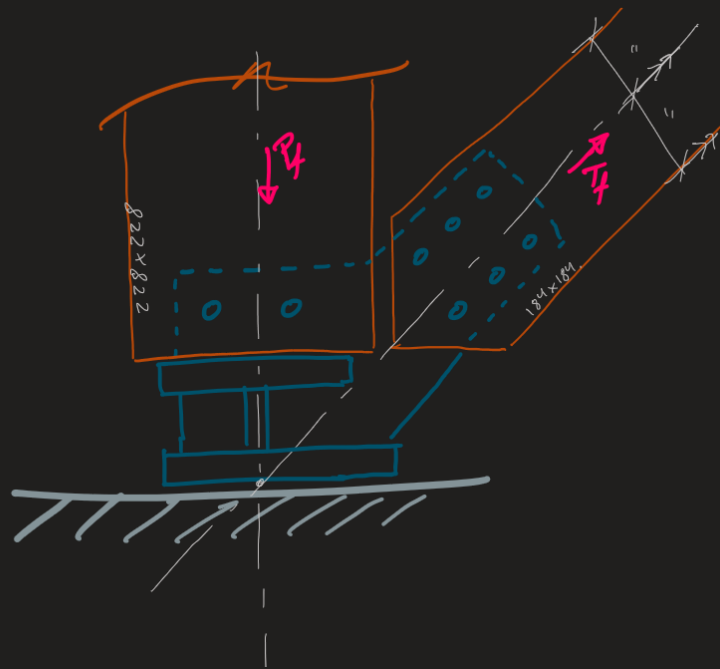
$$f_y = \frac{f_{ym} + f_{um}}{2}$$

goujon 300W.

$$= \frac{300 + 450}{2} = 375 \text{ MPa}$$

BOIS.

equation pour effort + parallel.



$$a) 33 \text{ kN}$$

$$c) 162 \text{ kN}$$

$$d) 20 \text{ kN.}$$

$$g) 26 \text{ kN.}$$

12.4.4.3.2 Résistance latérale ductile unitaire

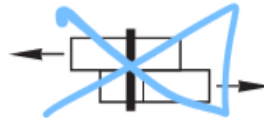
La résistance latérale ductile unitaire, n_u (par plan de cisaillement), doit être la valeur moindre calculée à l'aide des formules a) à g). Pour les assemblages à deux éléments, seules les formules a), b) et d) à g) doivent être considérées. Pour les assemblages à trois éléments, seules les formules a), c), d) et g) doivent être considérées.

$$a) f_1 d_f t_1$$

$$21.9 \times 19 \times 80$$



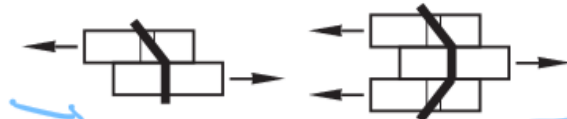
$$b) f_2 d_f t_2$$



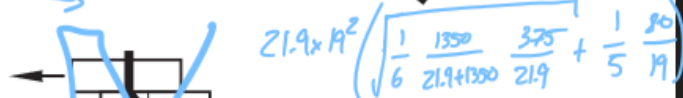
$$c) \frac{1}{2} f_2 d_f t_2 \quad \frac{1}{2} \times 1350 \times 19 \times 12.7$$



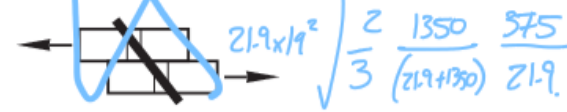
$$d) f_1 d_f^2 \left(\sqrt{\frac{1}{6} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1} + \frac{1}{5} \frac{t_1}{d_f}} \right)$$



$$e) f_1 d_f^2 \left(\sqrt{\frac{1}{6} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1} + \frac{1}{5} \frac{t_2}{d_f}} \right)$$



$$f) f_1 d_f^2 \frac{1}{5} \left(\frac{t_1}{d_f} + \frac{f_2}{f_1} \frac{t_2}{d_f} \right)$$

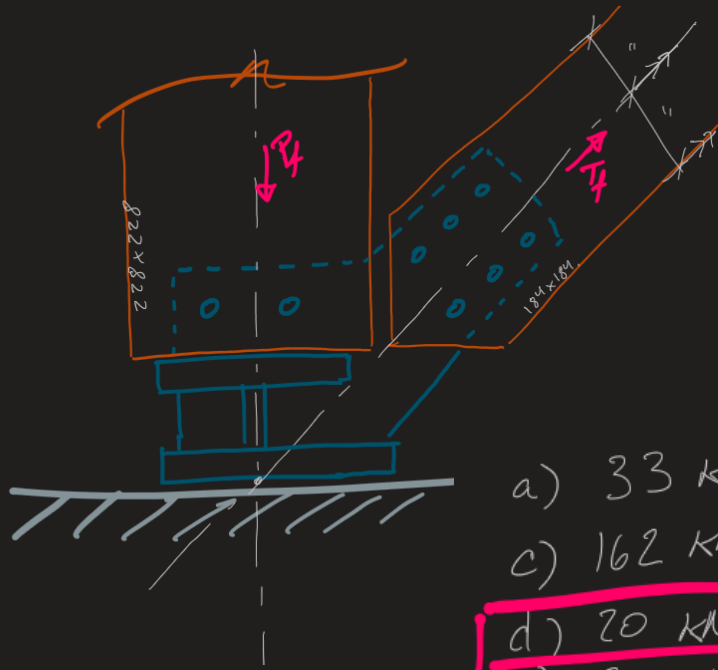


$$g) f_1 d_f^2 \sqrt{\frac{2}{3} \frac{f_2}{(f_1 + f_2)} \frac{f_y}{f_1}}$$



$$21.9 \times 19^2 \left(\sqrt{\frac{1}{6} \frac{1350}{21.9 + 1350} \frac{375}{21.9} + \frac{1}{5} \frac{80}{19}} \right)$$

$$21.9 \times 19^2 \sqrt{\frac{2}{3} \frac{1350}{(21.9 + 1350)} \frac{375}{21.9}}$$



- a) 33 kN
c) 162 kN
d) 20 kN.
g) 26 kN.

12.4.4.3.1 Généralités

La résistance latérale ductile pondérée, N_r , d'un groupe d'attaches dans un assemblage, due à la rupture ductile, est fonction du nombre de plans de cisaillement de l'assemblage ; elle doit être supérieure à N_r ,

$$N_r = \phi_y n_u n_s n_f$$

où
 ϕ_y = coefficient de résistance à la rupture ductile
= 0,8

n_u = résistance latérale ductile unitaire, N (l'article 12.4.4.3.2)

n_s = nombre de plans de cisaillement dans l'assemblage

n_f = nombre d'attaches dans l'assemblage

$$N_r = \phi_y n_u n_s n_f$$

$$\phi = 0.8$$

$$n_s = 2$$

$$n_u = 20 \text{ kN}$$

$$N_r \geq 120 \text{ kN.}$$

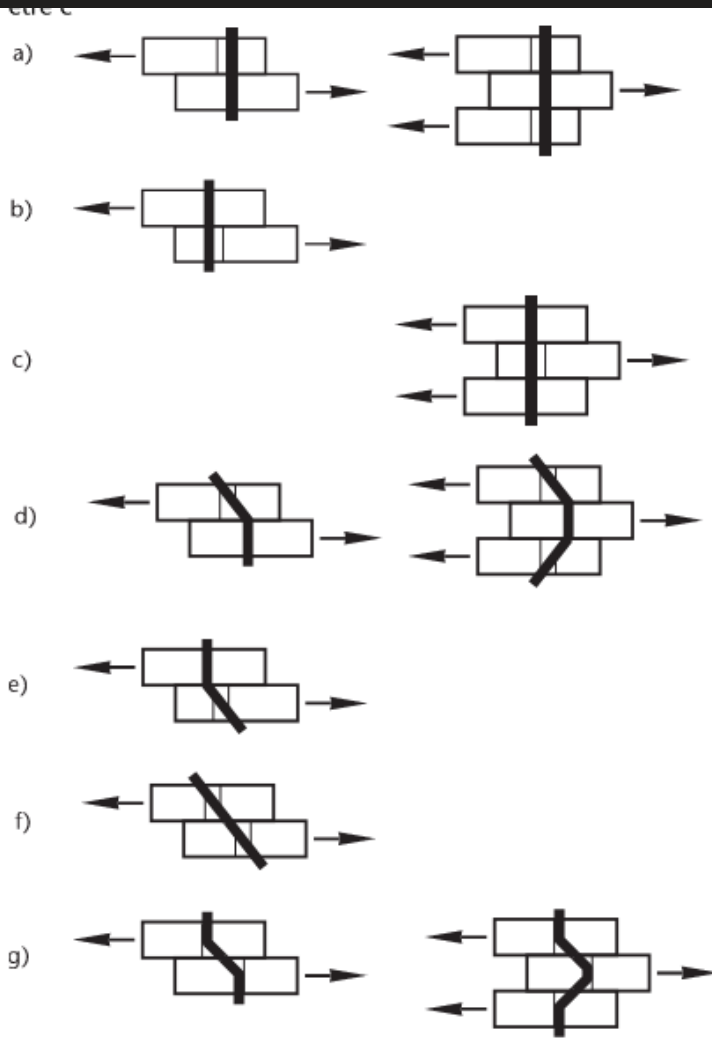
$$n_f \geq \frac{120 \text{ kN}}{0.8 \times 20 \text{ kN} \times 2} = 3.75$$

$$\underline{n_f = 4}$$

★ pour favoriser le mode (g) → $d_f \downarrow$
 $t_f \uparrow$

Calcul de la capacité réel.

$$N_n = 0.8 \times 20 \times 2 \times 4 = 128 \text{ kN.}$$



$$N_R = \phi_y n_u n_s n_f$$

$$\phi = 0.8$$

$$n_s = 2$$

$$n_u = 20 \text{ kN}$$

$$N_R \geq 120 \text{ kN}$$

$$n_f \geq \frac{120 \text{ kN}}{0.8 \times 20 \text{ kN} \times 2} = 3.75$$

$$\underline{n_f = 4}$$

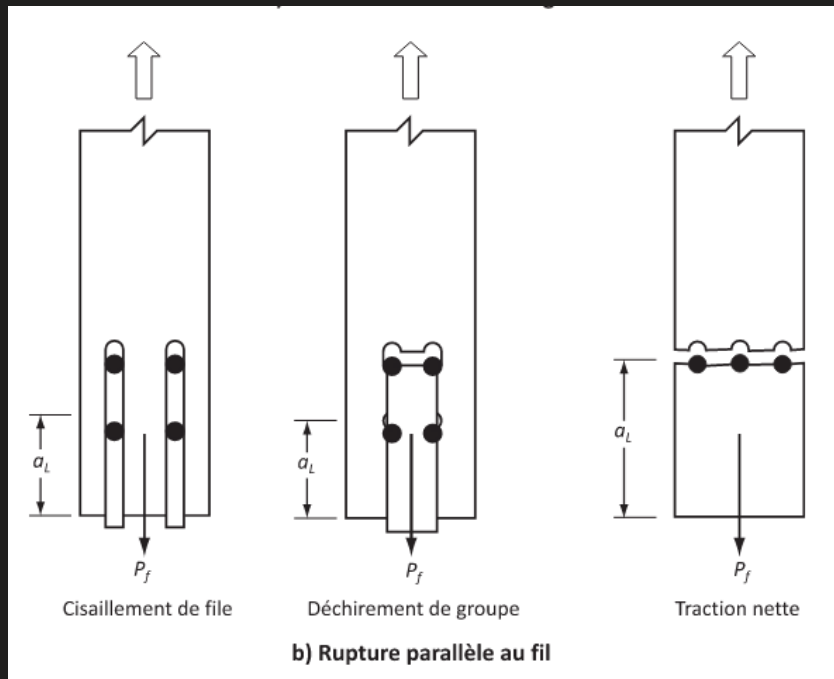
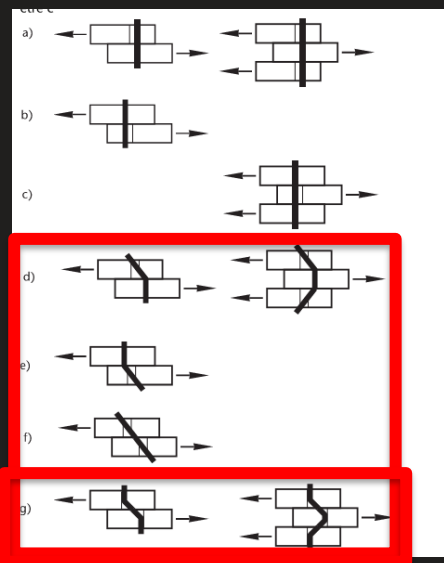
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 $t_f \uparrow$

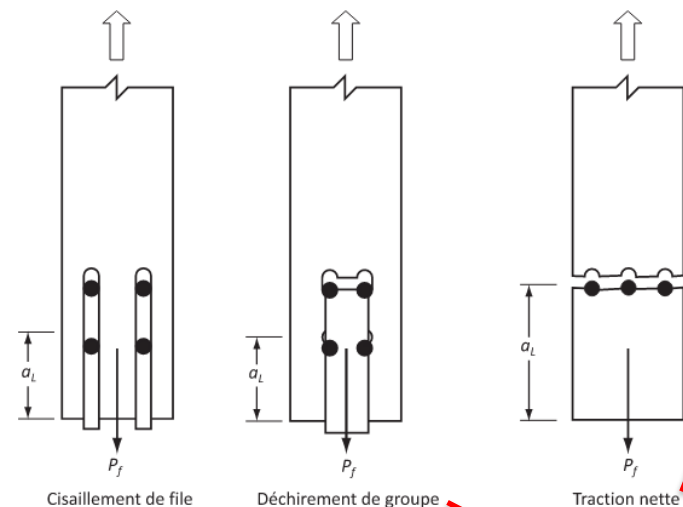
Calcul de la capacité réel.

$$N_R = 0.8 \times 20 \times 2 \times 4 = 128 \text{ kN}$$

Structures en bois conformes à la norme CSA O86					
Mur travaillant en cisaillement					
Murs travaillant en cisaillement cloués : panneaux dérivés du bois	3,0	1,7	NL	NL	
Mur travaillant en cisaillement : combinaison de panneaux dérivés du bois et de plaques de plâtre	2,0	1,7	NL	NL	
Ossature contreventée ou résistant aux moments, avec assemblages ductiles					
Ductilité moyenne	2,0	1,5	NL	NL	
Ductilité restreinte	1,5	1,5	NL	NL	
SFRS en bois ou en plâtre autre que ceux définis ci-dessus	1,0	1,0	15	15	

b) Modes de ruptures fragiles.
overstrength. de combien?





b) Rupture parallèle au fil

12.4.4.6 Résistance à la traction nette

12.4.4.6.1 Généralités

La résistance totale pondérée à la traction nette d'éléments en bois chargés parallèlement au fil, dans la zone d'un groupe d'attaches, doit être calculée comme suit :

$$T_{NrT} = \sum T_{Nri}$$

Le terme T_{Nri} de l'élément i dans la zone d'un groupe d'attaches doit être déterminé selon l'article 6.5.9 pour le bois de sciage et selon l'article 7.5.11 pour le bois lamellé-collé.

12.4.4.6.2 Aire déduite

L'aire de la section déduite de la section brute ne doit pas dépasser 25 % de la section brute de l'élément.

12.4.4.5 Résistance au déchirement de groupe parallèle au fil

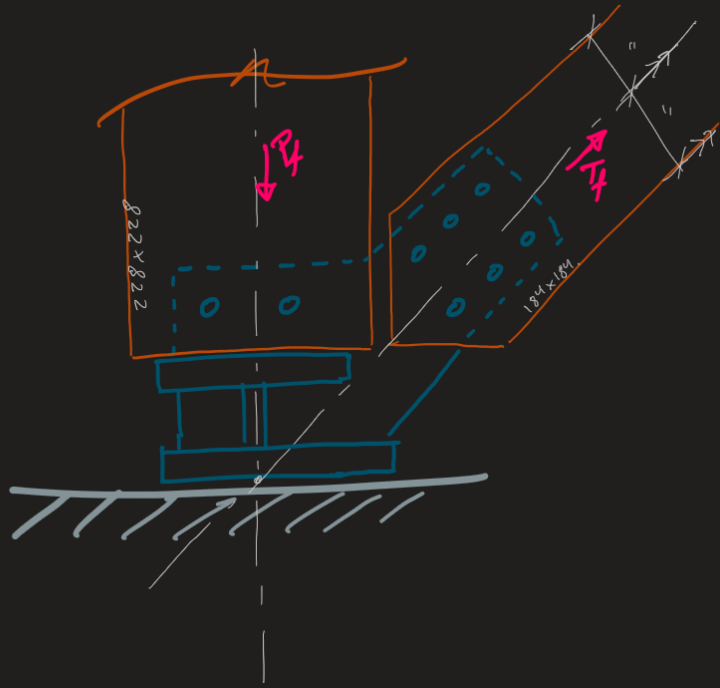
La résistance totale pondérée au déchirement de groupe d'un assemblage doit être calculée comme la somme des résistances pondérées au déchirement de groupe des éléments en bois qui résistent à la charge, comme suit :

$$PG_{rT} = \sum (PG_{ri})$$

Δ 12.4.4.4 Résistance au cisaillement de file parallèle au fil

La résistance totale pondérée au cisaillement d'un assemblage doit être calculée comme la somme des résistances pondérées au cisaillement de file des éléments en bois qui résistent à la charge, comme suit :

$$PR_{rT} = \sum (PR_{ri})$$



c) acier en traction.

d) acier en compression.

longueur de flambement à considérer?

- centre de goujon?
- dernier goujon?
- extrémité du bois?

K à considérer?

2 Compression.

7.5.8.4.2

La résistance pondérée à la compression parallèle au fil, P_r , doit être déterminée comme suit :

$$P_r = \phi F_c A K_{zcg} K_C$$

$$\phi = 0.8$$

$$F_c = f_c (K_D K_S K_T K_H)$$

$$= 33 \text{ MPa} (1.15 \times 1 \times 1)$$

$$K_{zcg} = 0.68 (Z)^{-0.13} \leq 1.0$$

$$Z = \text{volume (m}^3\text{)}$$

$$K_{zcg} = 1.0$$

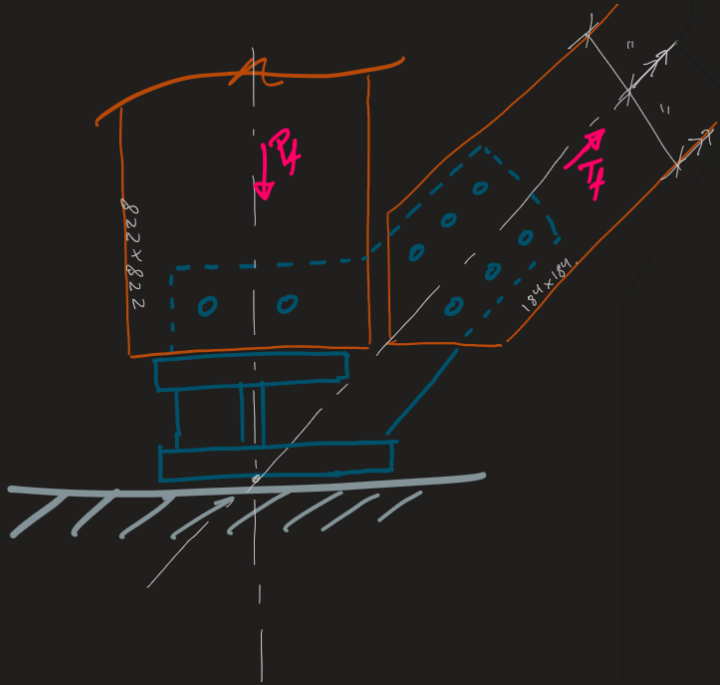
$$K_C = \text{coefficient d'élanement}$$

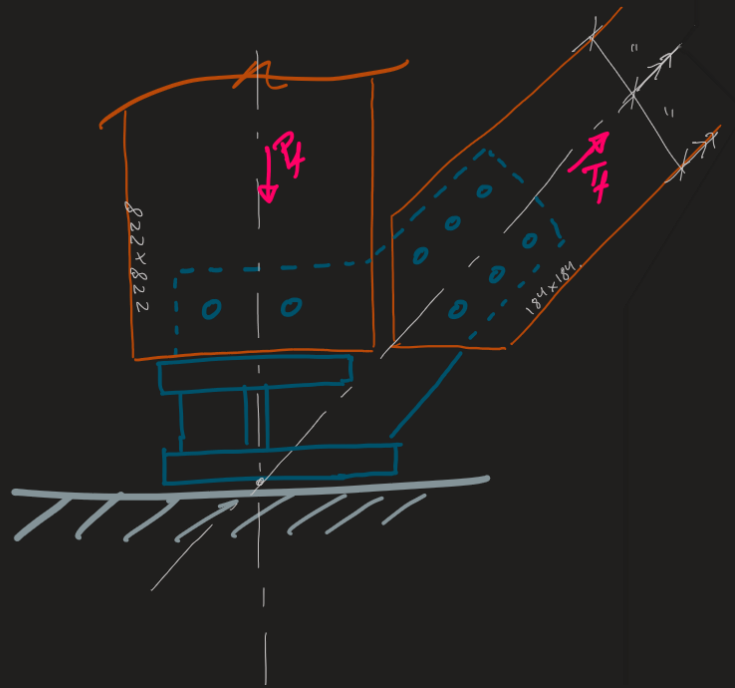
$$= 1.0$$

$$P_r \geq 30 \text{ kN.}$$

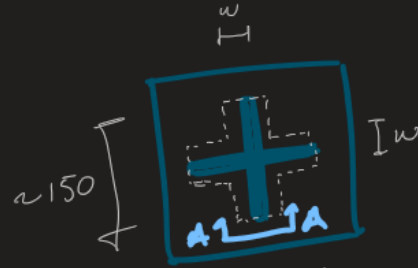
$$A \geq \frac{200}{0.8 \times 33 \times 1.15 \times 1.0 \times 1.0}$$

$$A \geq \underline{6588 \text{ mm}^2}$$





- Vérification 'top plate'



$$L = 150 \times 2 = 300 \text{ mm}$$

$$\frac{A}{L} = w = \frac{6588}{300} = 22 \text{ mm.}$$

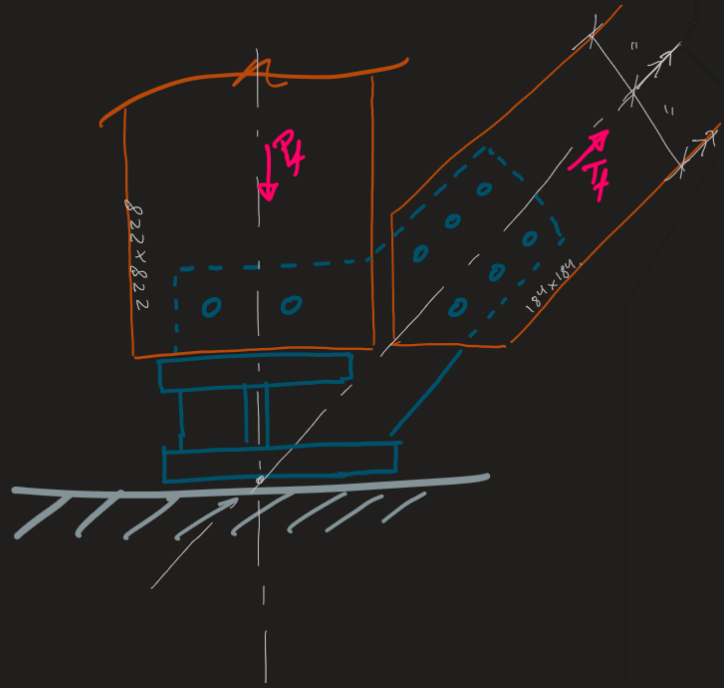


A-A

Vérification en flexion.



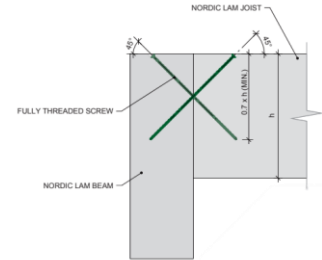
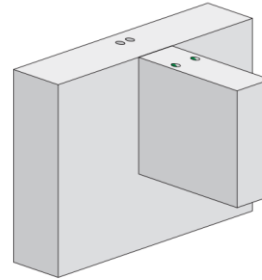
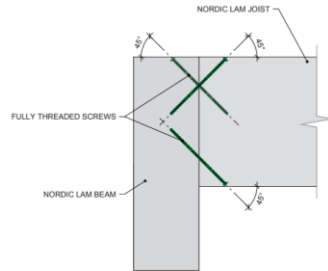
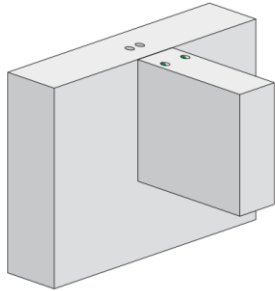
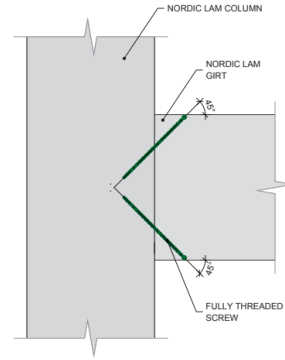
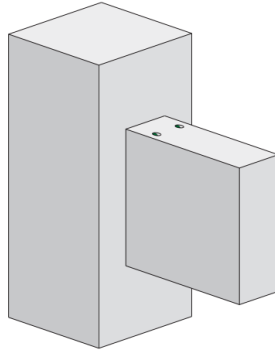
Autres hypothèse possible.

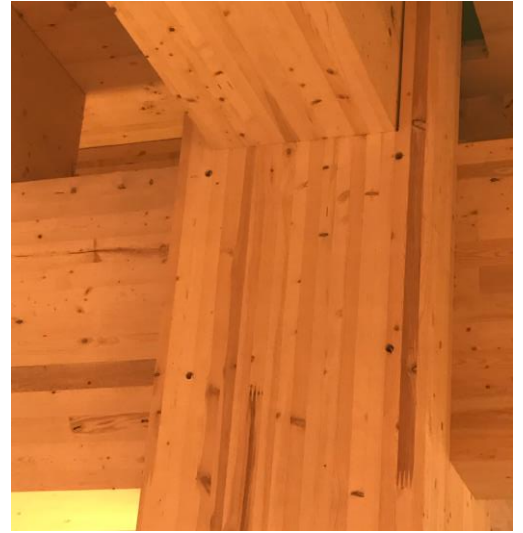


- Vérification de la croix en compression.
- Système dans l'autre direction.
- ancrage
 - cisaillement
 - traction.
- compression béton.

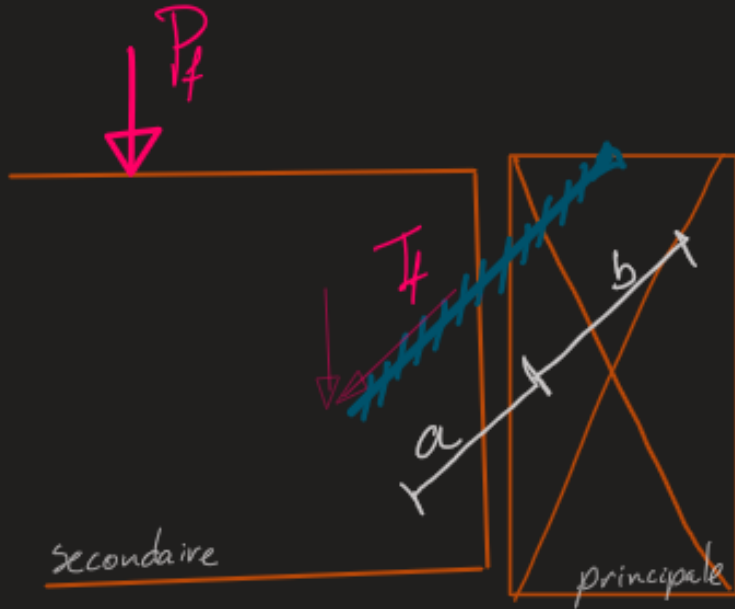
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Détail Typique





Détail Typique



Vis à 45 deg.

Trouver longueur de filetage nécessaire
Si $P_f = 10 \text{ kN}$ & $G = 0.42$ & $\phi = 8 \text{ mm}$

① Trouver effort de traction dans le vis

$$T_f = \frac{P_f}{\sin(45)} = 14.2 \text{ kN.}$$

② longueur a requise

$$P_{rw} = P'_{rw,90} \cdot R_{\alpha} \cdot L_{ef} \cdot n_F \cdot J' \cdot K'$$

$P'_{rw,90} = 61 \text{ N/mm}$ [Table FR.1.1]

$R_{\alpha} = 0.857$ [Table FR.1.2]

$L_{ef} = a'$

$J' = 1.0$

$K' = 1.0$

$P_{rw} \geq 14.2 \text{ kN}$

$n_F a' \geq \frac{14.2 \text{ kN} \times \frac{1000 \text{ N}}{1 \text{ kN}}}{\frac{61 \text{ N}}{\text{mm}} \times 0.857 \times 1.0 \times 1.0}$

$n_F a' \geq 272 \text{ mm}$

Si $n = 2$

$n_F = n^{0.9}$

$a' \geq \frac{272}{2^{0.9}}$

$a' \geq 146 \text{ mm}$

③ longueur b requise

$P'_{rw,90} = 61 \text{ N/mm}$

$R_{\alpha} = 1.0$

$L_{ef} = b'$

$J' = 1.0$

$K' = 1.0$

$P_{rw} \geq 14.2 \text{ kN}$

$n_F b' \geq 233 \text{ mm}$

Si $n = 2$

$b' \geq \frac{233}{2^{0.9}}$

$b' \geq 125 \text{ mm}$

ASSY® Withdrawal Design (P_{rw})

Table FR.1.1, ASSY® Unit Factored Withdrawal Resistance with Angle to Grain of 90° ($P'_{rw,90}$)

Major Diameter (d)		Unit Factored Withdrawal Resistance with Angle to Grain of 90° ($P'_{rw,90}$)				
		N/mm				
in.	[mm]	G = 0.35	G = 0.42	G = 0.49	PSL (G = 0.50)	G = 0.55
1/4"	[6]	32	46	60	35	76
5/16"	[8]	42	61	80	47	101
3/8"	[10]	53	76	100	59	126
1/2"	[12]	63	91	120	70	151
9/16"	[14]	74	107	140	82	176

Note: see notes under the table FR.1.2.

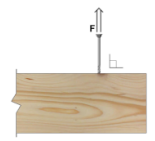


Table FR.1.2, ASSY® Angle to Grain Reduction Factor for Withdrawal at an angle of α° (R_{α})

tens	ones								
	9°	8°	7°	6°	5°	4°	3°	2°	1°
9°					N/A				
8°	1.000	1.000	0.999	0.998	0.997	0.996	0.995	0.994	0.992
7°	0.988	0.986	0.983	0.981	0.978	0.975	0.972	0.969	0.966
6°	0.959	0.955	0.952	0.948	0.944	0.940	0.936	0.932	0.927
5°	0.919	0.914	0.910	0.906	0.901	0.897	0.892	0.888	0.879
4°	0.875	0.870	0.866	0.861	0.857	0.853	0.849	0.845	0.836
3°	0.832	0.829	0.825	0.821	0.817	0.814	0.810	0.807	0.800

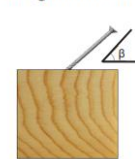
R_{α} Angle to grain reduction factor for withdrawal, given in FR.1.2

- Angle to grain (α) between 90° and 30°: Can be subjected to long term loading $J_E = 1.0$
- Angle to grain (α) between 30° and 15°: Can be subjected to short term loading only; $J_E = 0.75$ or 0.67
- Angle to grain (α) between 15° and 0°: Should not be loaded

Withdrawal angle to the grain is 90°



Withdrawal angle to the grain is 90°



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STRUCTURES

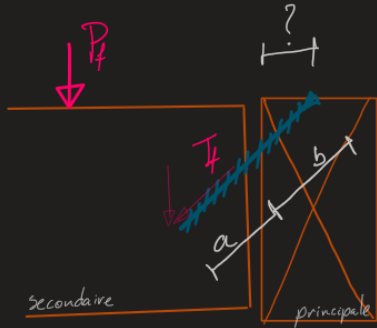
Détail Typique

④ Choisir CSK, $D = 8 \times L = 300$.

$$L_{\text{eff}} = L_{\text{thread}} - L_{\text{Tip}}$$

$$= 283 - 8 = 275 \text{ mm} > 271 \text{ mm} \therefore \text{OK} \checkmark$$

⑤ Position de la vis.



$$a = a' + L_{\text{Tip}} = 146 + 8$$

$$= 154$$

$$b = 300 - a = 146 \text{ mm.}$$

$$? = 146 \sin 45 = 103 \text{ mm}$$

Countersunk Head

Drill bit tip

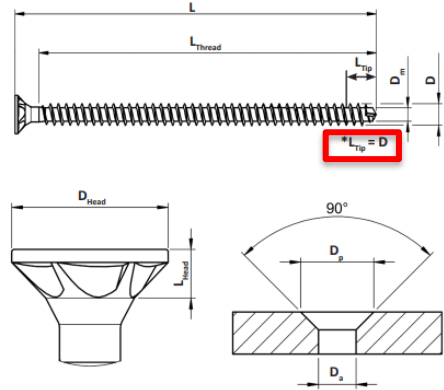
Self-tapping

Fully Threaded

Diameters: 5/16", 3/8", 1/2"

Wood/Wood, Wood/Steel,
Wood/Concrete

Code Approved: ICC, CCMC
& LARR



Item#	Box size	D	L	L _{thread}	D _{head}	D _m	D _p	D _a	L _{head}	Bit
#	pieces	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	
14080080000	75		3-1/8 [80]	2-1/2 [61]						AW 40
14080120000	75		4-3/4 [120]	4 [103]						
14080140000	75		5-1/2 [140]	4-7/8 [123]						
14080160000	75		6-1/4 [160]	5-5/8 [143]						
14080180000	75		7-1/8 [180]	6-3/8 [163]						
14080200000	75	5/16 [8]	7-7/8 [200]	7-1/4 [183]	0.591 [15]	0.196 [5]	0.748 [19]	0.354 [9]	0.181 [4.6]	
14080220000	75		8-5/8 [220]	8 [203]						
14080240000	75		9-1/2 [240]	8-3/4 [223]						
14080260000	75		10-1/4 [260]	9-5/8 [243]						
14080280000	75		11 [280]	10-3/8 [263]						
14080300000	75		11-7/8 [300]	11-1/8 [283]						

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Détail Typique

Did you know?

Inclined fully threaded screws can be arranged as symmetrical screw crosses, engaging the withdrawal strength of both screws. For each screw cross, one screw carries the load in tension, while the other screw carries the load in compression. Both screws can be assumed to contribute equally to the connection strength.



Timber Requirements for Non Pre-drilled Self-Tapping Fasteners

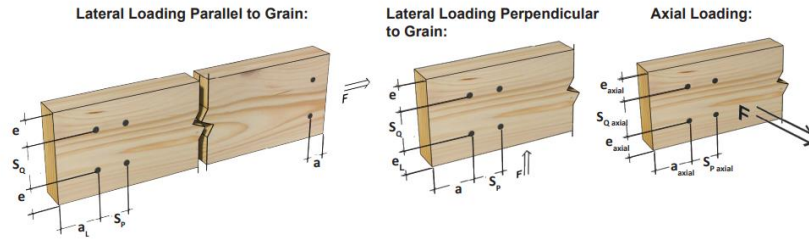
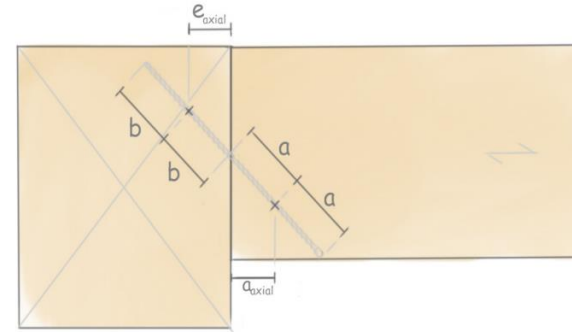
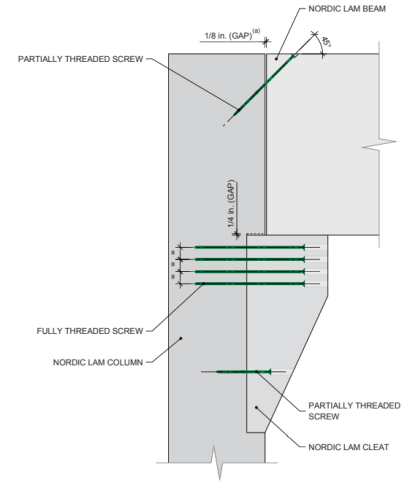
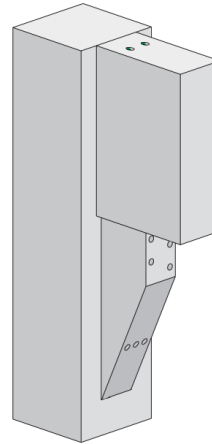
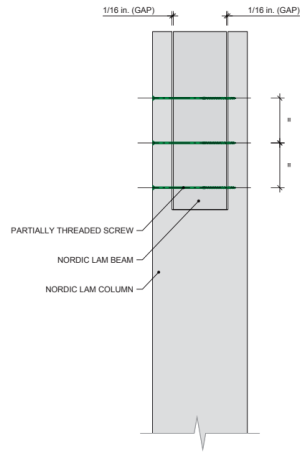
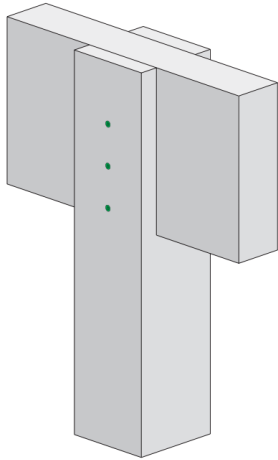
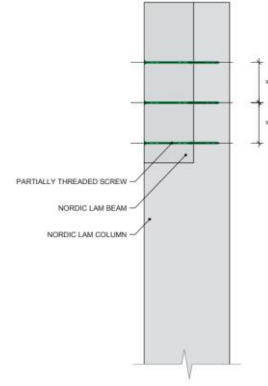
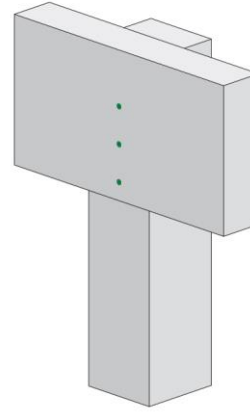
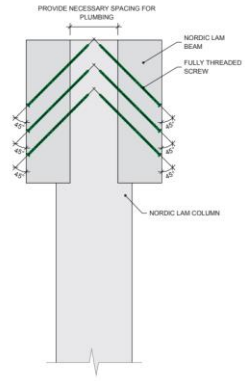
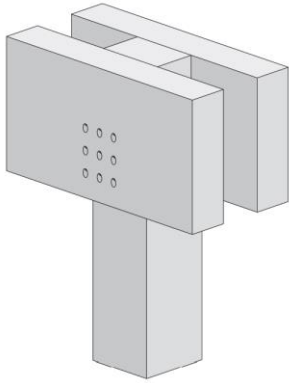


Table S.1.1, Timber Connection Geometry Requirements without Pre-drilling

		End Distance			Edge Distance			Spacing Parallel to Grain		Spacing Perpendicular to Grain	
		a_L	a	a_{axial}	e_L	e	e_{axial}	S_p	$S_{p_{axial}}$	S_a	$S_{a_{axial}}$
Partial Thread	$SG \leq 0.42$	15 d	10 d	10 d	10 d	5 d	5 d	12 d	12 d	5 d	5 d
	$0.42 < SG \leq 0.55$	20 d	15 d	15 d	12 d	7 d	7 d	15 d	15 d	7 d	7 d
	D-Fir	30 d	22.5 d	22.5 d	12 d	7 d	7 d	22.5 d	22.5 d	7 d	7 d
Full Thread	$SG \leq 0.42$	12 d	7 d	5 d	7 d	3 d	3 d	5 d	5 d	3 d	2.5 d
	$0.42 < SG \leq 0.55$	12 d	7 d	5 d	7 d	3 d	3 d	5 d	5 d	3 d	2.5 d
	D-Fir	18 d	10.5 d	7.5 d	7 d	3 d	3 d	7.5 d	7.5 d	3 d	2.5 d

- Notes:
1. In accordance with CCMC 13677-R.
 2. Tabulated values above are intended to prevent splitting in wood. If splitting be observed, a design professional must be consulted immediately.
 3. Within a row, fasteners may be staggered up to 2 d to further reduce the potential for splitting, with d = major diameter of the fastener.
 4. All connection design must meet all the relevant requirements of the Notes to the Designer section.







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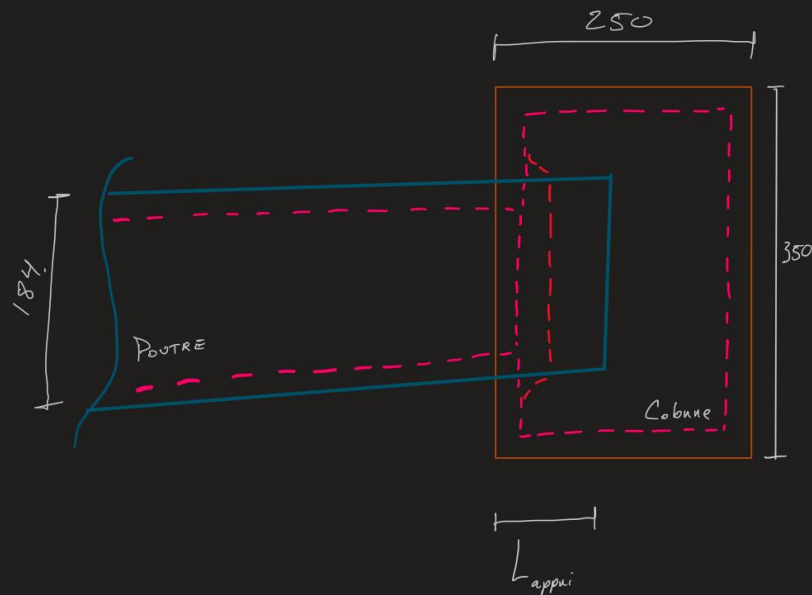


NORDIC
STRUCTURES



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Détail Typique



Poutre en Appui sur Colonne.

Une heure au feu

$$D_2 = 25 \text{ kN}$$

$$L_2 = 40 \text{ kN}$$

GL 24F-ES/NPG.

Ⓐ Calcul L_{appui} requis 'froid'

① Déterminer la charge

$$P_f = 1.25D + 1.5L \\ = 91.25 \text{ kN}$$

Ⓑ Calcul L_{appui} requis 'chaud'

① Déterminer la charge.

$$P_f = D + L \quad [B.1.4] \\ = 65 \text{ kN}$$

Détail Typique

$$\textcircled{2} \underline{\underline{F_{cp}}} < F_c$$

$$Q_k = \phi F_{cp} A_b K_B K_{Zcp} \quad [086-7.5.9.2]$$

$$\phi = 0.8$$

$$F_{cp} = f_{cp} (K_D K_{Zcp} K_T)$$

$$K_D = 1.0 = K_{Zcp} = K_T$$

$$K_B = 1.0 \quad [6.5.7.5]$$

$$K_{Zcp} = 1.15 \quad [6.5.7.4]$$

$$f_{cp} = 7.5 \text{ MPa}$$

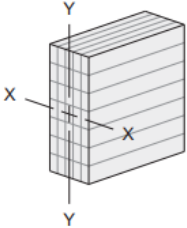
$$A_b = L_{appai} \times 184 \text{ mm}$$

$$91.25 \text{ kN} = 0.8 \times 7.5 (1 \times 1 \times 1) \times L_{appai} \times 184 \text{ mm} \times 1 \times 1.15$$

$$L_{appai} = 72 \text{ mm}$$

Nordic Lam+ – Design Properties

Nordic Lam+ – Design Properties

Application	Beams and columns
	
Axonometry	
Appearance grade ^(a)	Architectural
Stress grade	24F-ES/NPG
Available thicknesses	-
Bending about X-X axis	
Bending moment, f_{bx} ^(b)	30.7 MPa
Longitudinal shear, f_{vx} ^(c)	2.5 MPa
Compression perpendicular to grain, f_{cpx} ^(d)	7.5 MPa
Shear-free modulus of elasticity, E_x	13 100 MPa
Apparent modulus of elasticity, $E_{x,app}$ ^(e)	12 400 MPa
Bending about Y-Y axis	
Bending moment, f_{by} ^(b)	30.7 MPa
Longitudinal shear, f_{vy} ^(c)	2.5 MPa
Compression perpendicular to grain, f_{cpy} ^(d)	7.5 MPa
Shear-free modulus of elasticity, E_y	13 100 MPa
Apparent modulus of elasticity, $E_{y,app}$ ^(e)	12 400 MPa
Axially loaded	
Compression parallel to grain, f_c	33.0 MPa
Tension parallel to grain, f_t	20.4 MPa
Tension perpendicular to grain, f_{tp}	0.51 MPa
Modulus of elasticity, E_a	13 100 MPa
Connection design	
Mean relative density, G ^(f)	0.47 -
Characteristic density, ρ_k ^(g)	430 kg/m ³
Density (for member weight), ρ ^(h)	560 kg/m ³

Détail Typique

$$\textcircled{2} \underline{F_{cp}} < F_c$$

$$Q_k = \phi F_{cp} A_b K_B K_{zcp}. \quad [086-7.5.9.2]$$

$$\phi = 0.8$$

$$F_{cp} = f_{cp} (K_D K_{s_p} K_T)$$

$$K_D = 1.0 = K_{s_p} = K_T$$

$$K_B = 1.0 \quad [6.5.7.5]$$

$$K_{zcp} = 1.15 \quad [6.5.7.4]$$

$$f_{cp} = 7.5 \text{ MPa}$$

$$A_b = L_{appui} \times 184 \text{ mm}$$

$$91.25 \text{ kN} = 0.8 \times 7.5 (1 \times 1 \times 1) \times L_{appui} \times 184 \text{ mm} \times 1 \times 1.15$$

$$L_{appui} = 72 \text{ mm}$$

6.5.7.5 Coefficient de longueur d'appui, K_B

Si les longueurs d'appui ou les diamètres des rondelles sont inférieurs à 150 mm, les résistances prévues à la compression perpendiculaire au fil peuvent être multipliées par le coefficient de longueur d'appui, K_B , conformément au tableau 6.5.7.5, sous réserve

- a) qu'aucune partie de la surface d'appui ne se trouve à moins de 75 mm de l'extrémité de l'élément ; et
- b) que les surfaces d'appui ne se trouvent pas aux endroits soumis à de fortes contraintes de flexion.

Tableau 6.5.7.5
Coefficient de longueur d'appui, K_B

Longueur d'appui (parallèle au fil) ou diamètre de la rondelle, mm	Coefficient de correction, K_B
12,5 ou moins	1,75
25,0	1,38
38,0	1,25
50,0	1,19
75,0	1,13
100,0	1,10
150,0 ou plus	1,00

Détail Typique

$$\textcircled{2} \underline{\underline{F_{cp}}} < F_c$$

$$Q_K = \phi F_{cp} A_D K_B K_{Zcp}. \quad [086-7.5.9.2]$$

$$\phi = 0.8$$

$$F_{cp} = f_{cp} (K_D K_{sp} K_T)$$

$$K_D = 1.0 = K_{sp} = K_T$$

$$K_B = 1.0 \quad [6.5.7.5]$$

$$K_{Zcp} = 1.15 \quad [6.5.7.4]$$

$$f_{cp} = 7.5 \text{ MPa}$$

$$A_D = L_{appui} \times 184 \text{ mm}$$

$$91.25 \text{ kW} = 0.8 \times 7.5 (1 \times 1 \times 1) \times L_{appui} \times 184 \text{ mm} \times 1 \times 1.15$$

$$L_{appui} = 72 \text{ mm}$$

6.5.7.4 Coefficient de dimensions pour l'appui, K_{Zcp}

Si la largeur d'un élément (dimension perpendiculaire au sens d'application de la charge) est supérieure à la hauteur de l'élément (dimension parallèle au sens d'application de la charge), la résistance prévue en compression perpendiculaire au fil peut être multipliée par un coefficient de dimensions pour l'appui, K_{Zcp} , conformément au tableau 6.5.7.4.

Tableau 6.5.7.4
Coefficient de dimensions pour l'appui, K_{Zcp}

Rapport largeur/hauteur de l'élément*	K_{Zcp}
1,0 ou moins	1,00
2,0 ou plus	1,15

*On peut déterminer les rapports intermédiaires par interpolation.

K_{Zcp} = coefficient de dimensions pour l'appui, où la hauteur correspond à l'épaisseur de la lamelle (l'article 6.5.7.4)

Détail Typique

② Longueur de Poutre Brûlée

$$t = 60 \text{ min}$$

$$\beta_n = 0.7 \quad [\text{B.4.2}]$$

$$\alpha_t = 7 \quad [\text{B.5.1}]$$

$$\begin{aligned} c_{\text{char}} &= \beta_n t + \alpha_t \\ &= 49 \text{ mm} \end{aligned}$$

Longueur résiduelle

$$b_r = 184 - 2 \times 49 = 86 \text{ mm.}$$

③ Q_R

$$Q_R = \phi F_{cp} A_b K_B K_{zcp}$$

$$\phi = 1.0 \quad [\text{B.3.2}]$$

$$K_b = 1.15 \quad [\text{B.3.3}]$$

$$K_{fi} = 1.35 \quad [\text{B.3.9}]$$

$$K_{scp} = K_T = 1.0$$

$$K_B = 1.0$$

$$K_{zcp} = 1.15$$

$$f_{cp} = 7.5 \text{ MPa}$$

$$65 \text{ kN} = 1.0 \times 7.5 (1.15 \times 1 \times 1 \times 1.35) \times L_{\text{appui}_{\text{res}}} \times 86 \text{ mm} \times 1 \times 1.15$$

$$L_{\text{appui}_{\text{res}}} = 56 \text{ mm.}$$

Détail Typique

④ 'Rajout' Colonne Brûlée

- Sans tenir compte de la TR-10

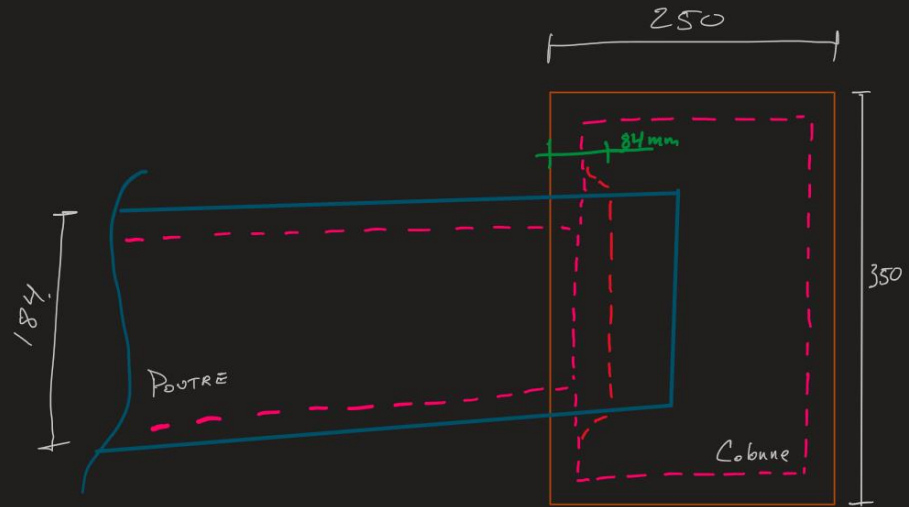
$$char = 49 \text{ mm.}$$

$$L_{appui} = 56 + 49 = 105 \text{ mm}$$

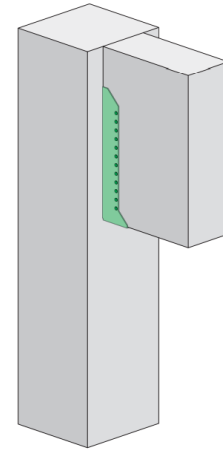
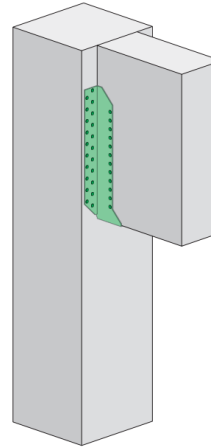
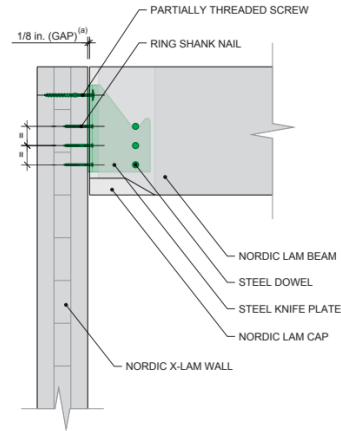
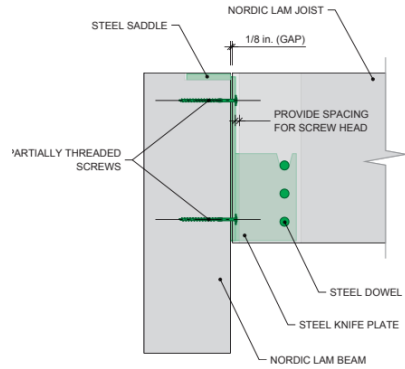
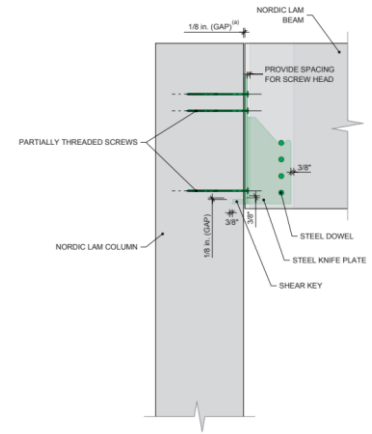
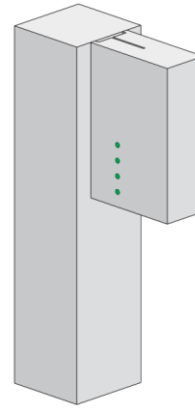
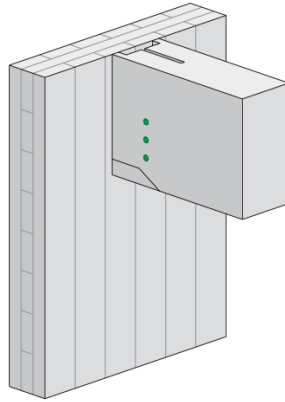
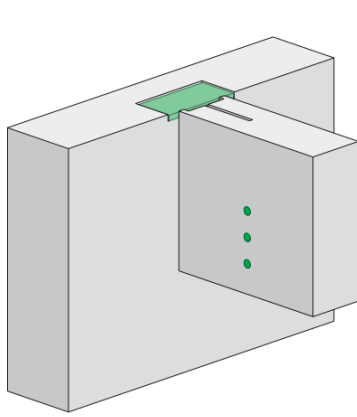
- Avec "char contraction" de la TR-10.

$$\begin{aligned} char &= \beta_n t \times 2 \\ &= (0.7 \times 60) \times 2 \\ &= 84 \text{ mm.} \end{aligned}$$

$$L_{appui} = 56 + 84 = 140 \text{ mm}$$



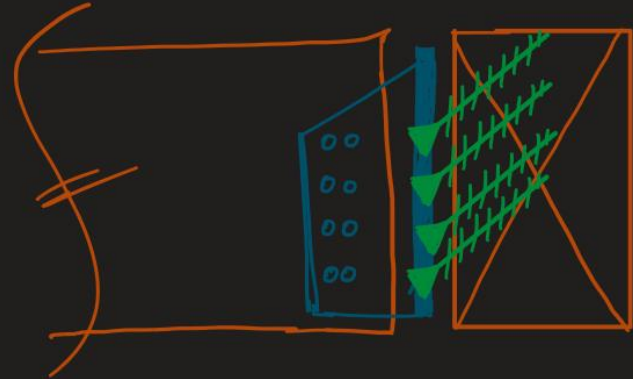
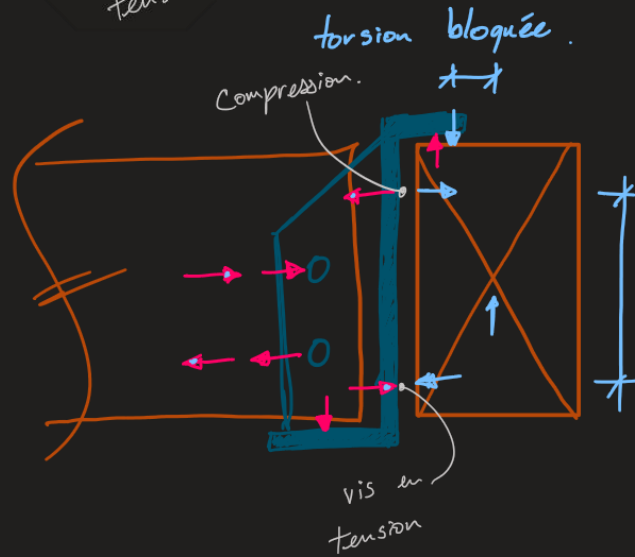
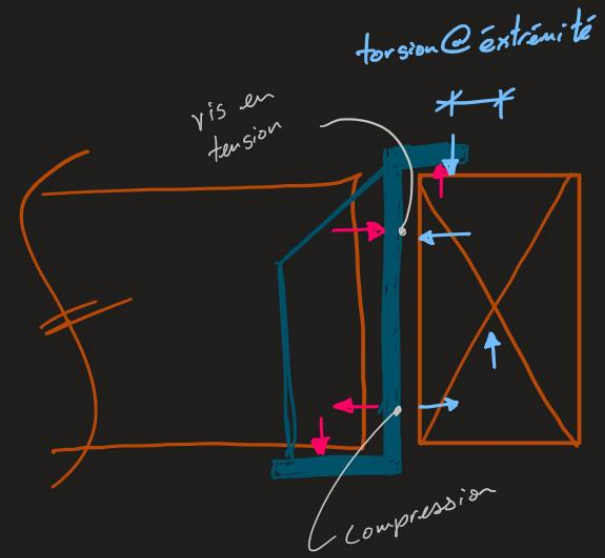
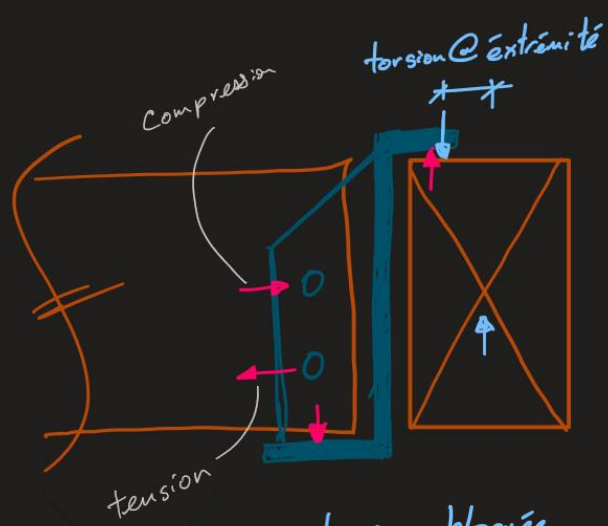
$$\begin{aligned} L_{appui} &= \begin{matrix} \text{froid} = 72 \text{ mm} \\ \text{chaud} = 105 \text{ mm} \\ \text{TR-10} = 140 \text{ mm} \end{matrix} \end{aligned}$$

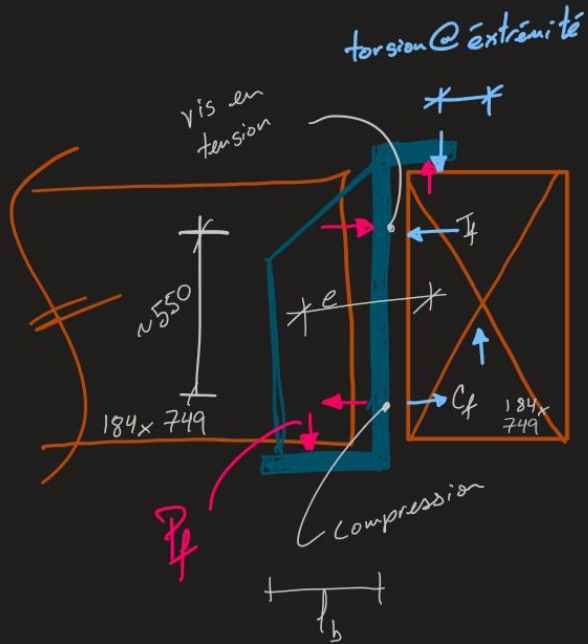












$$P/4 = 100 \text{ kW}$$

$$DRF = 0 \text{ hr.}$$

① Aire d'appui requis

$$Q_R = \Phi F_{cp} A_b K_B K_{Zcp}$$

$$A_b \geq \frac{100 \text{ kW}}{0.8 \times 7.5 \text{ MPa} \times 1 \times 1.15}$$

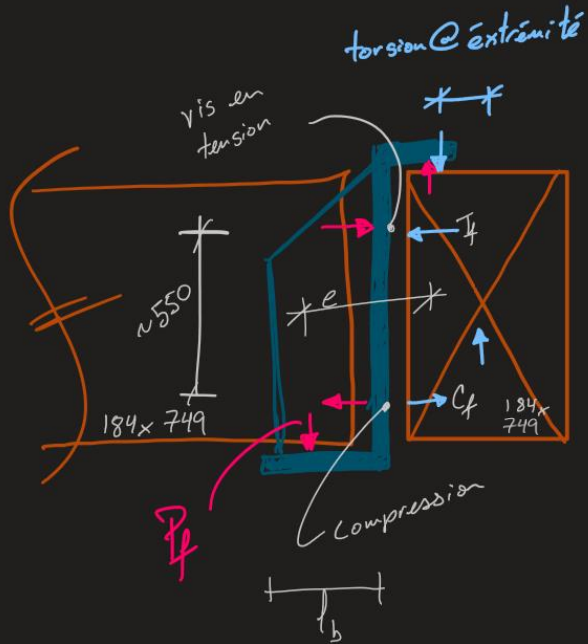
$$A_b \geq 14\,493 \text{ mm}^2$$

appui bas.

$$l_b = \frac{14\,493}{(184 - 15 \text{ mm})} = 86 \text{ mm}$$

appui haut

$$l_h = \frac{14\,493 \text{ mm}^2}{184 \text{ mm}} = 79 \text{ mm}$$



② Equilibre dans étrier.

$$e = \frac{b + h}{2} + \sim 25 \text{ mm.}$$

$$= 108 \text{ mm.}$$

$$M = 100 \text{ kN} \times 0.108 \text{ m}$$

$$= 10.8 \text{ kNm}$$

$$T_f = C_f = \frac{10.8 \text{ kNm}}{0.55 \text{ m}} = 20 \text{ kN.}$$

③ Vis en traction.

Assy CSK $\phi = 8$

$$G = 0.47 \text{ (0.42)}$$

$$P_{rw,10} = 61 \text{ N/mm} \quad [\text{FR 1.1}]$$

$$P_{rw} = P_{rw,10} \cdot R_\alpha \cdot L_{ef} \cdot n_F \cdot J' \cdot K' \geq 20 \text{ kN.}$$

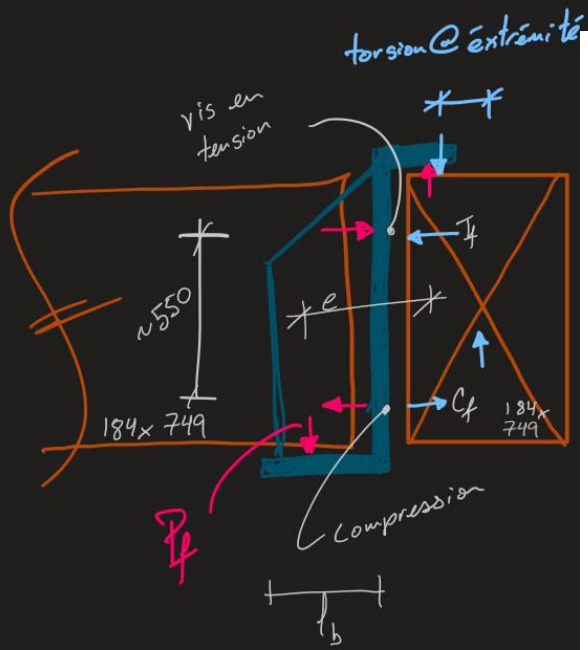
$$R_\alpha = J' = K' = 1.0$$

$$L_{ef} \cdot n_F \geq \frac{20 \text{ kN}}{\frac{61 \text{ N}}{\text{mm}} \times 1 \cdot 1 \cdot 1}$$

$$L_{ef} = \frac{328 \text{ mm}}{n^{0.9}}$$

$$\text{si } n = 4 \Rightarrow L_{ef} = 94 \text{ mm.}$$

$$4 \times \phi = 8 \times L = 140 \text{ mm.}$$



Countersunk Head

Drill bit tip

Self-tapping

Fully Threaded

Diameters: 5/16", 3/8", 1/2"

Wood/Wood, Wood/Steel, Wood/Concrete

Code Approved: ICC, CCMC & LARR

Item#	Box size	D	L	L _{thread}	D _{head}	D _{in}	D _o	D _a	L _{thread}	Bit
#	pieces	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	
14080080000	75		3-1/8 [80]	2-1/2 [61]						
14080120000	75		4-3/4 [120]	4 [103]						
14080140000	75		5-1/2 [140]	4-7/8 [123]						
14080160000	75		6-1/4 [160]	5-5/8 [143]						
14080180000	75		7-1/8 [180]	6-3/8 [163]						
14080200000	75	5/16 [8]	7-7/8 [200]	7-1/4 [183]	0.591 [15]	0.196 [5]	0.748 [19]	0.354 [9]	0.181 [4.6]	AW 40
14080220000	75		8-5/8 [220]	8 [203]						
14080240000	75		9-1/2 [240]	8-3/4 [223]						
14080260000	75		10-1/4 [260]	9-5/8 [243]						
14080280000	75		11 [280]	10-3/8 [263]						
14080300000	75		11-7/8 [300]	11-1/8 [283]						

③ Vis en traction.

Assy CSK $\phi=8$

$G=0.47$ (0.42)

$P_{rw,10} = 61 \text{ N/mm}$ [FR 1.1]

$$P_{rw} = P_{rw,10} \cdot R_{\alpha} \cdot L_{ef} \cdot n_F \cdot J' \cdot K' \geq 20 \text{ kN}$$

$$R_{\alpha} = J' = K' = 1.0$$

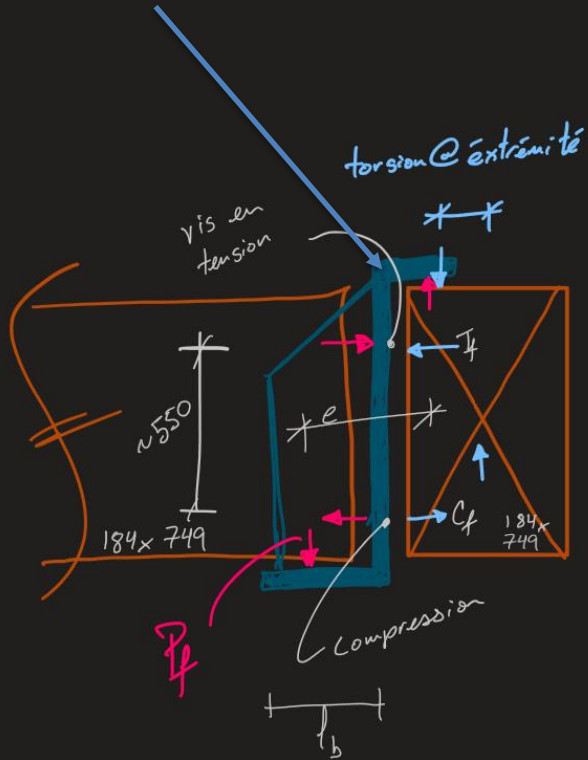
$$L_{ef} \cdot n_F \geq \frac{20 \text{ kN}}{\frac{61 \text{ N}}{\text{mm}} \times 1 \cdot 1 \cdot 1}$$

$$L_{ef} = \frac{328 \text{ mm}}{n^{0.9}}$$

si $n=4 \Rightarrow L_{ef} = 94 \text{ mm}$.

$$4 \times \phi = 8 \times L = 140 \text{ mm}$$

Soudure?



④ Compression "axiale"

$$Q_R = \phi F_{cp} A_b K_B K_{Zcp}$$

⑤ Vérification épaisseur "casquette"

$$M_R = \phi F_y S \quad [S16]$$

$$\phi = 0.8$$

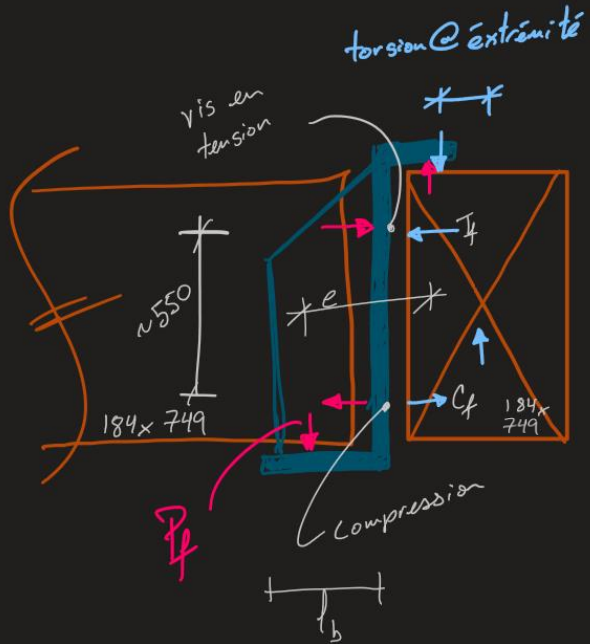
$$F_y = 350 \text{ MPa}$$

$$S = \frac{bh^2}{6}$$

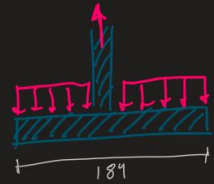
$$M_f = 100 \text{ kN} \times \frac{79 \text{ mm}}{2} = 3.95 \text{ kNm}$$

$$\sqrt{h^2} = \sqrt{\frac{M_f \times 6 \times 10^6}{\phi \times F_y \times b}} = h$$

$$h = \sqrt{\frac{3.95 \times 6 \times 10^6}{0.8 \times 350 \times 184}} = 20 \text{ mm}$$



⑥ Vérification épaisseur "appui bas"



$$M_f = \frac{PL}{8}$$

$$= \frac{100 \times 184}{8}$$

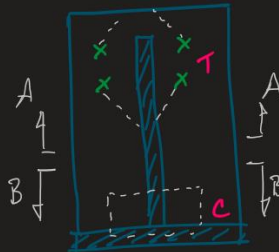
$$= 2.3 \text{ kNm}$$

$$t_{\text{req}} = \sqrt{\frac{2.3 \times 6 \times 10^6}{0.9 \times 350 \times 86}} = 23 \text{ mm}$$

⑦ Vérification 'knife plate'

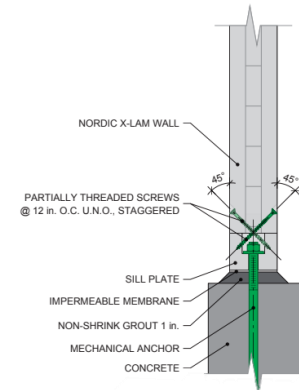
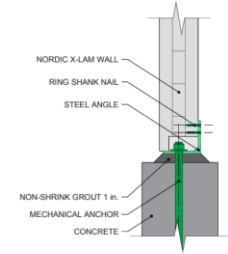
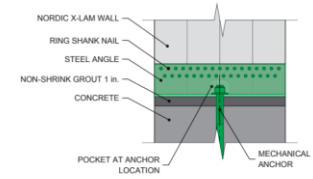
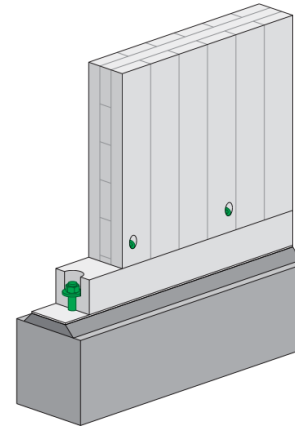
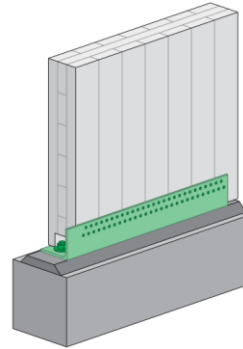
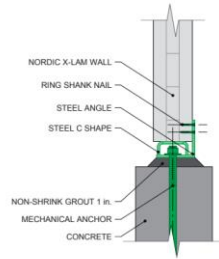
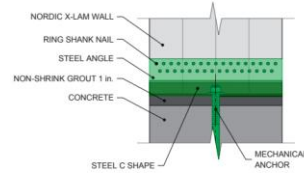
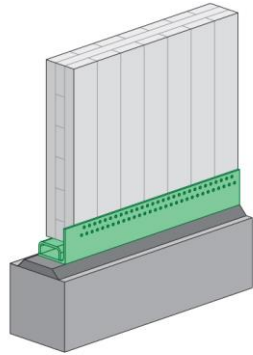


⑧ Vérification 'back plate'



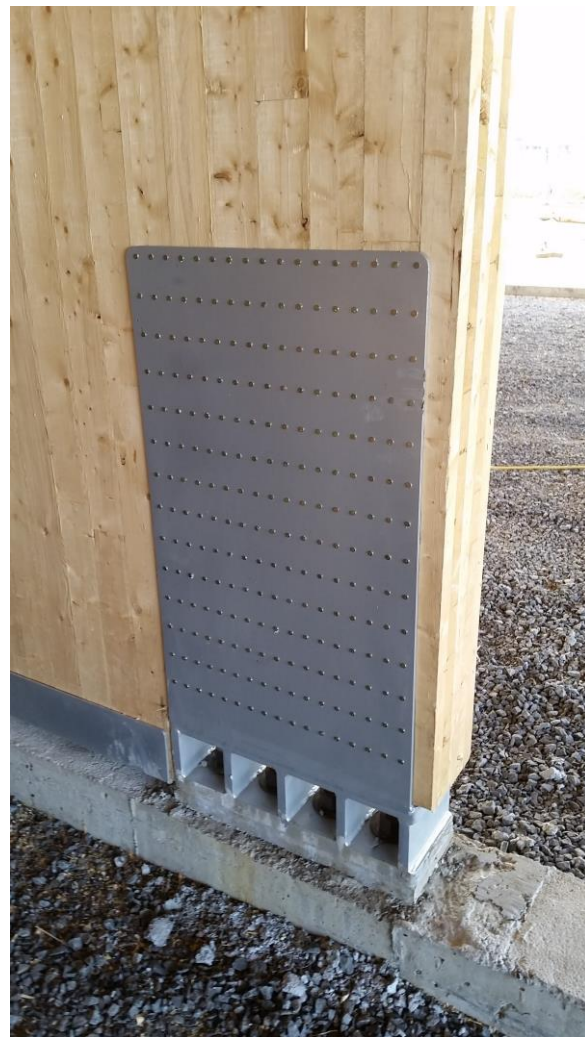
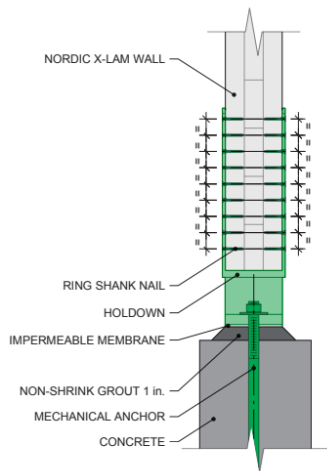
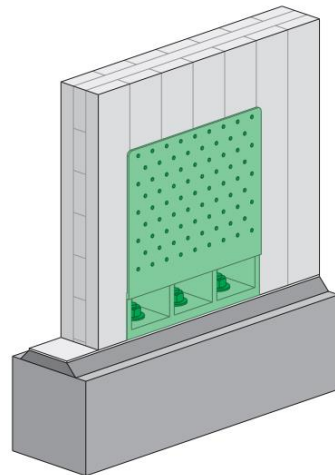
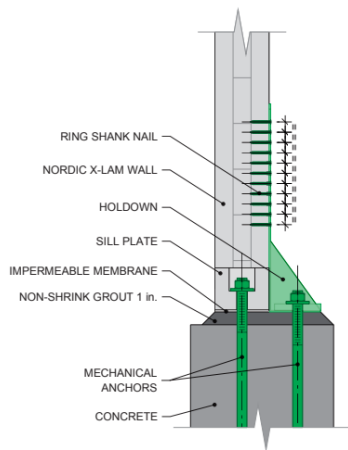
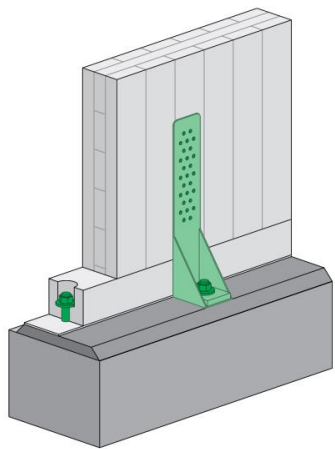


Détail Typique



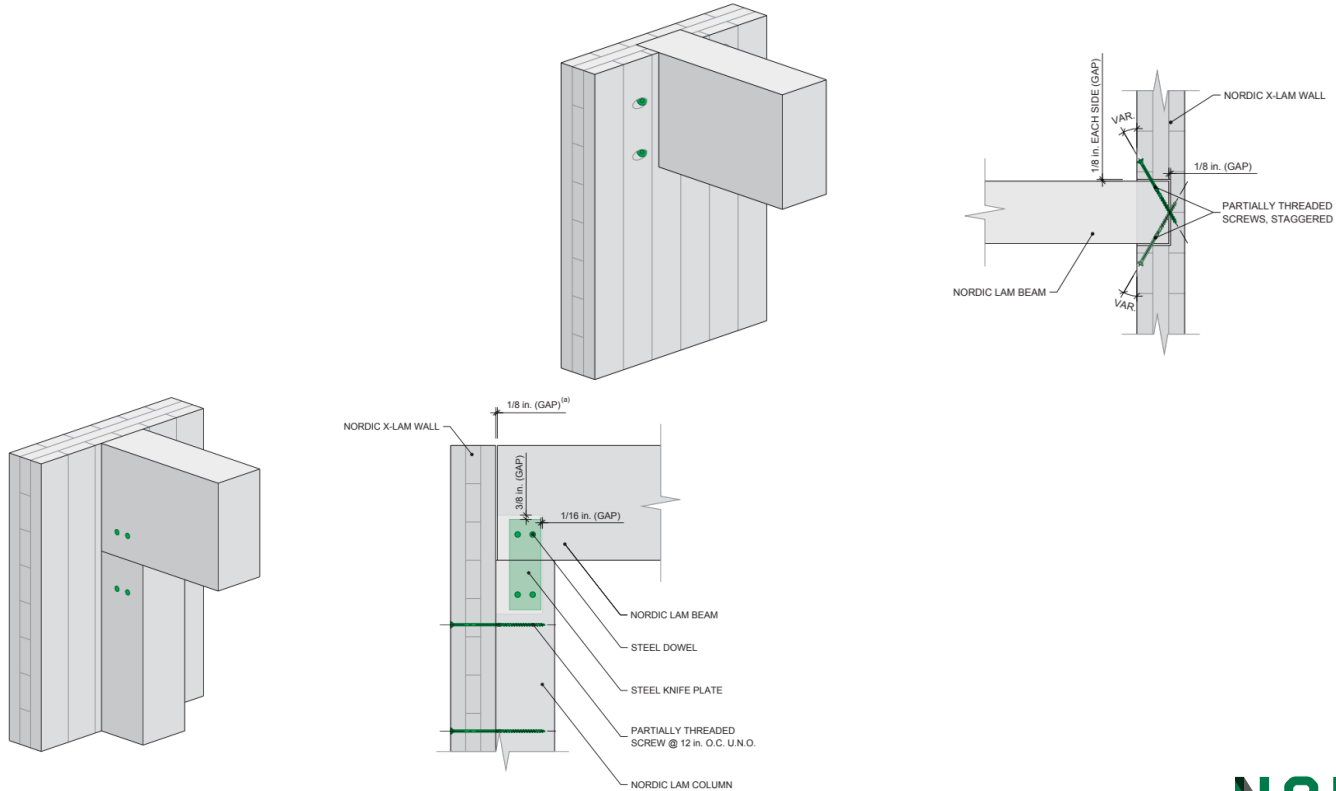
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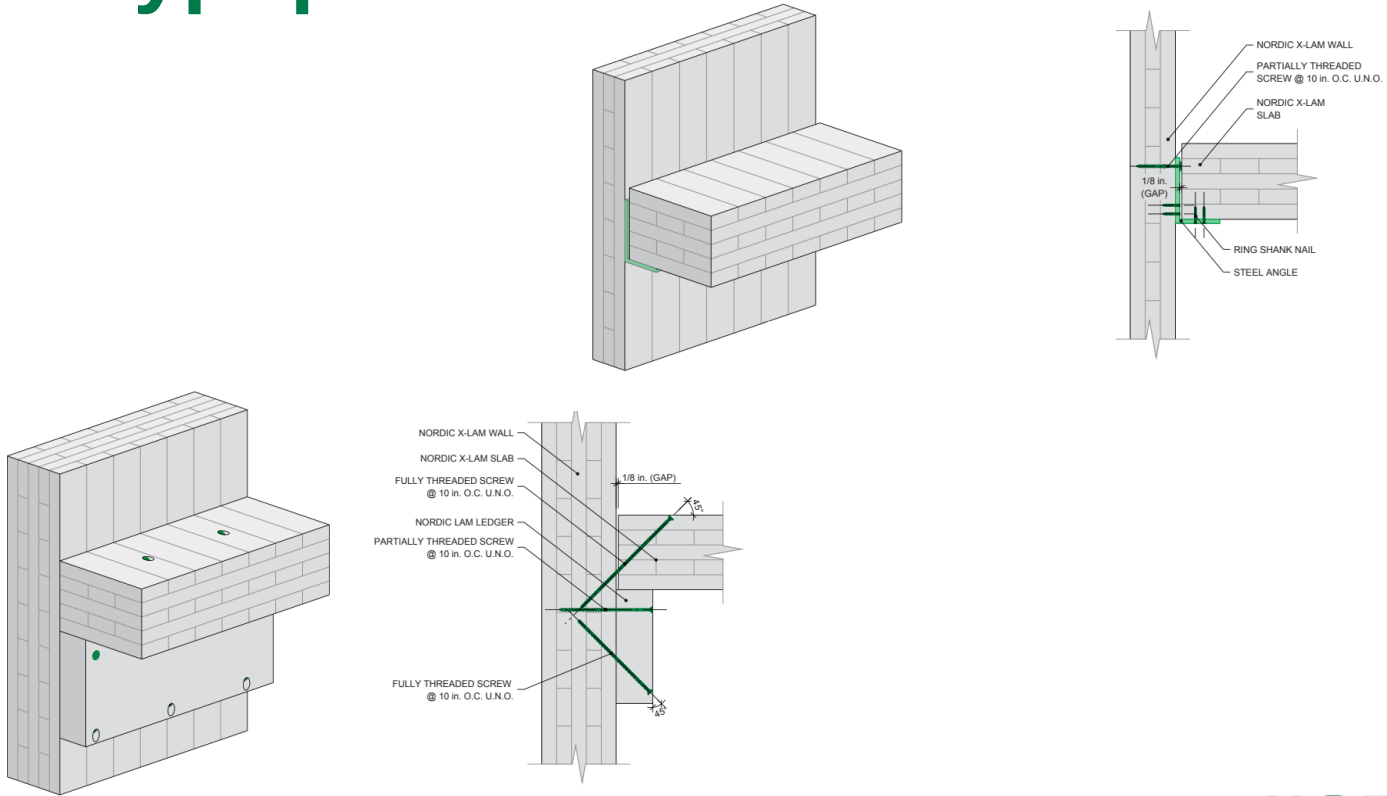


Détail Typique





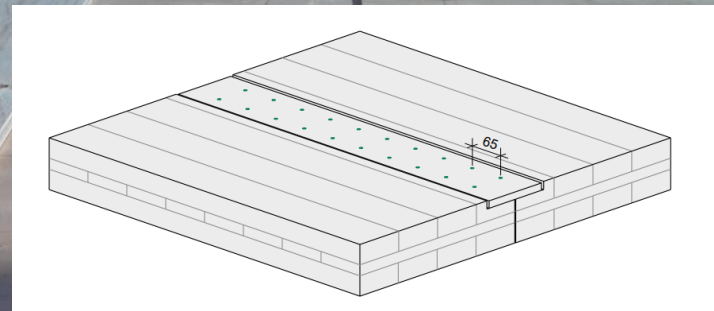
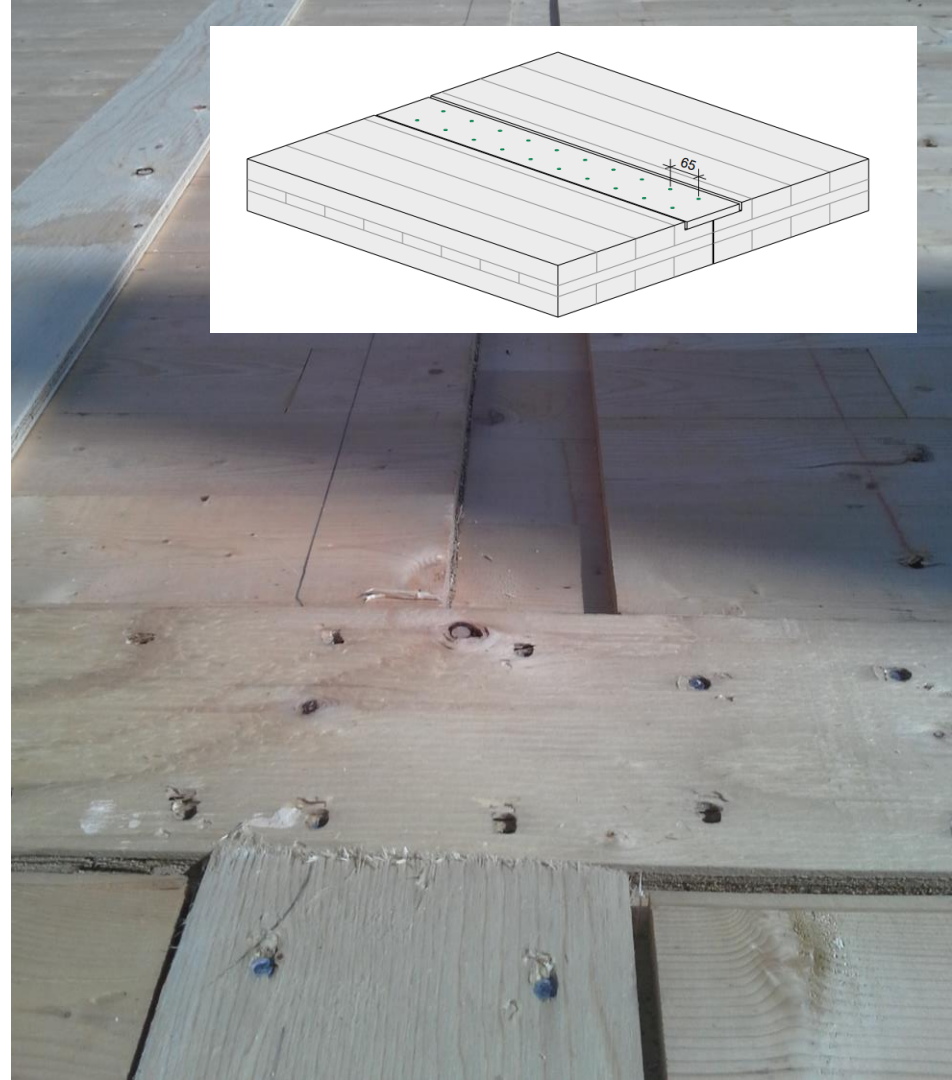
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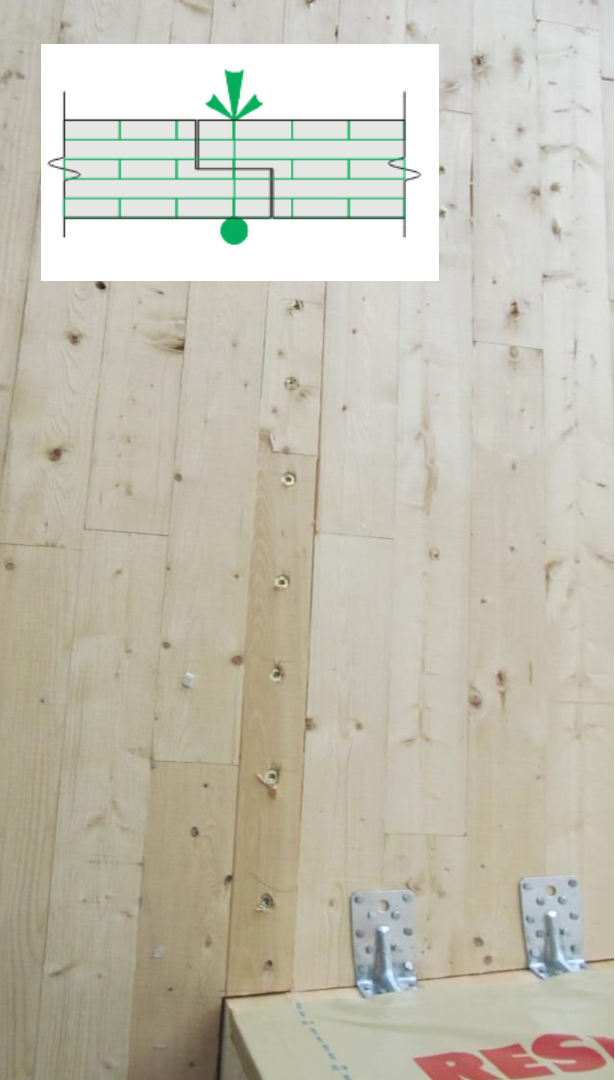
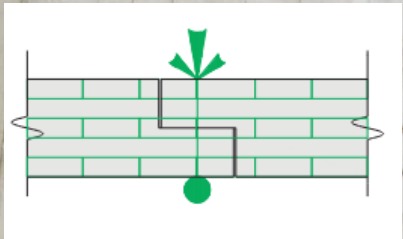


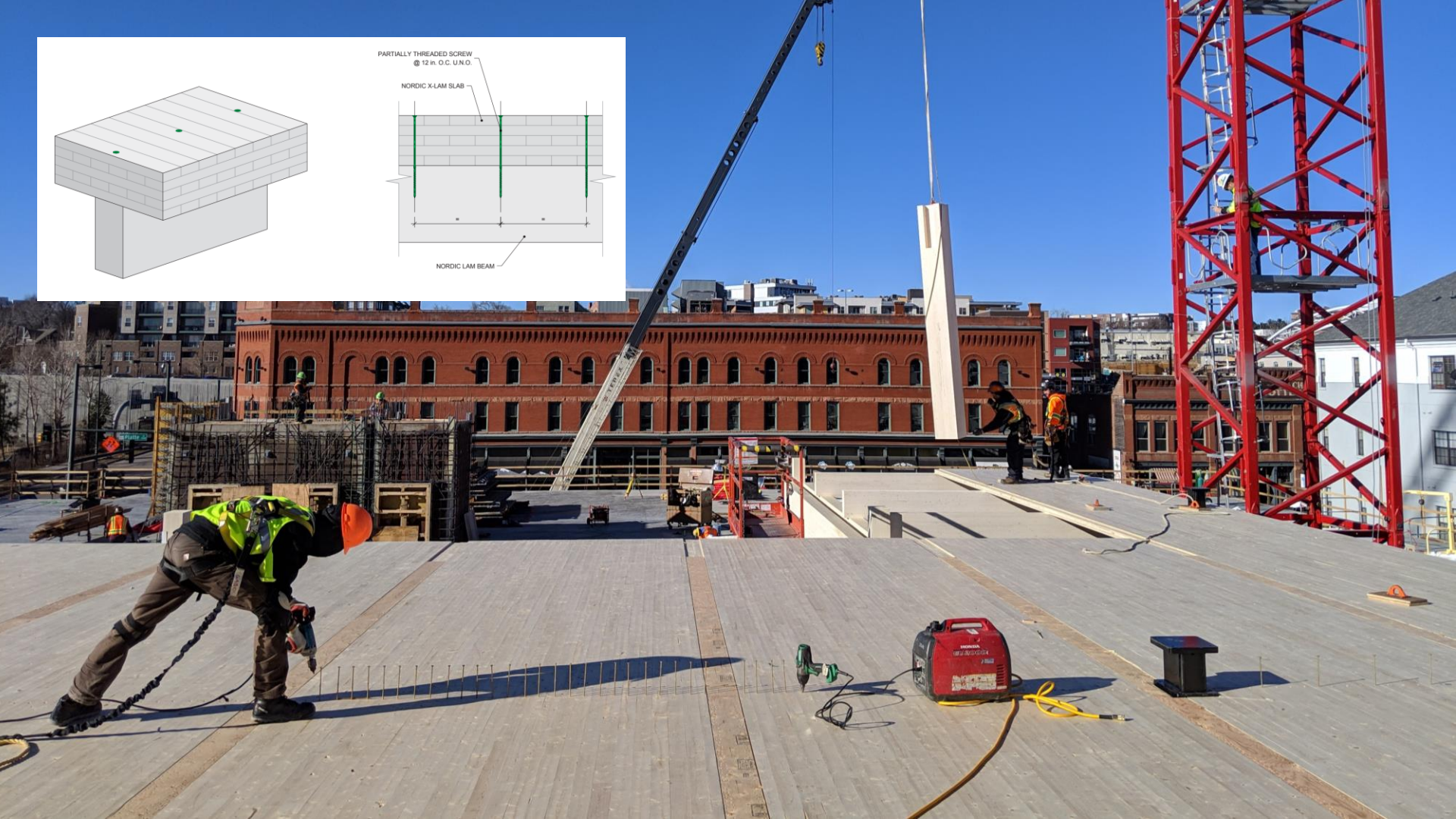
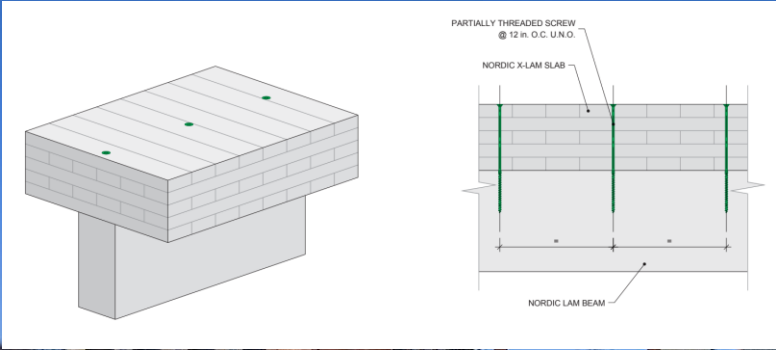




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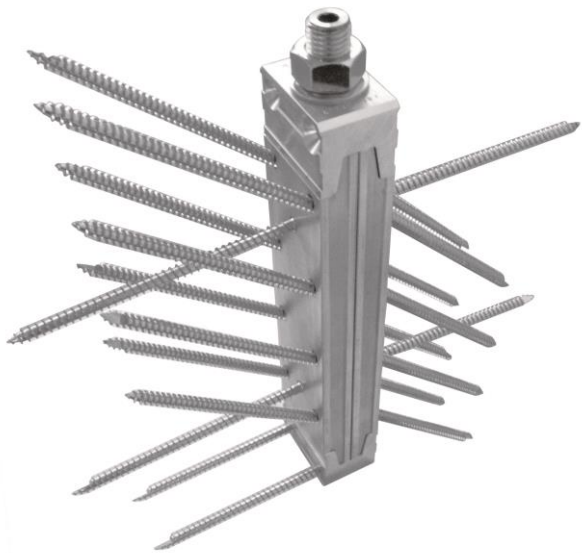




Plan de la formation

- Description
- Matériau bois
 - Naturel
 - Anisotrope
 - Parallèle et perpendiculaire au fil
 - Hygroscopique
 - Retrait
 - Résistance mécanique
 - Feu
- Connecteur
 - 'Ancien'
 - Goujon/Boulon/Clous
 - Vis
- Conception
 - Feu
 - Retrait
 - Gonflement
 - Traction perpendiculaire au fil
 - Stabilité
 - Durabilité
 - Fabrication/Usinage/CNC
 - Tolerance Bois vs. Acier-Beton
 - Oublis commun
- Detail Typique
- Connecteur propriétaire

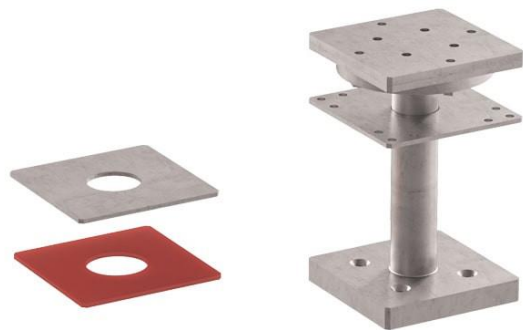




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Merci

Simon Gallagher, ing., M. Sc. A.

Chef d'équipe | *Team Leader*

D 514-871-5621 T 514-871-8526 x 8041 C 514-609-1280

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100-1100, av. des Canadiens-de-Montréal, Montréal (Québec) H3B 2S2

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