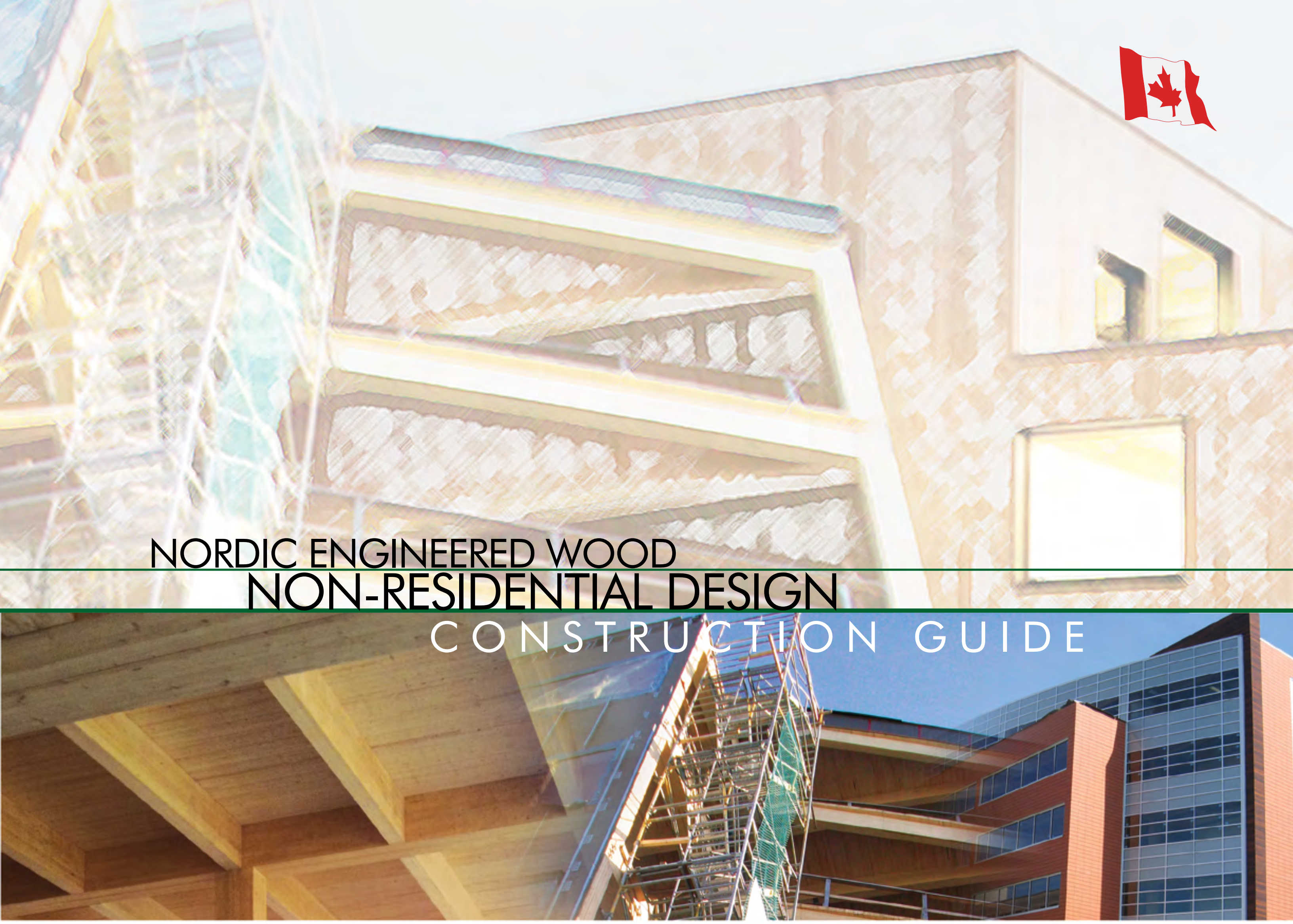


NORDIC ENGINEERED WOOD NON-RESIDENTIAL DESIGN
CONSTRUCTION GUIDE

NORDIC LAM™

NORDIC ENGINEERED WOOD

FSC-CERTIFIED PRODUCTS AVAILABLE

FSC www.fsc.org

The mark of responsible forestry

FSC® C011517

NORDIC
ENGINEERED WOOD

BRINGING NATURE'S RESOURCES HOME

Nordic Engineered Wood was founded in the year 2000 to develop and promote high quality wood products for use in residential and non-residential construction.

Our vision is built on the founding principles of reliable service, consistent quality, and responsible forestry practices. Chantiers Chibougamau Ltd (CCL) has achieved FSC certification, the international certification system dedicated to promoting responsible management of the forests, to ensure the long term viability of our precious natural resources.

With the addition of its third production line, CCL now boasts annual glulam production capacity in excess of 30,000 cubic meters.

Nordic Engineered Wood's goal is to provide the most consistent, high quality finished products available. Nordic Lam family of products illustrates our continued passion for building on tradition.

TABLE OF CONTENTS

THE ADVANTAGES
OF WOOD CONSTRUCTION

SUSTAINABLE

Wood is the only construction material that is 100% natural, renewable and recyclable. Because it sequesters carbon and can replace more energy-intensive and polluting materials like steel and concrete, choosing wood contributes to the fight against climate change. What's more, Nordic glued-laminated timber comes from forests with FSC Forest Management certification, which ensures that natural resources are protected.

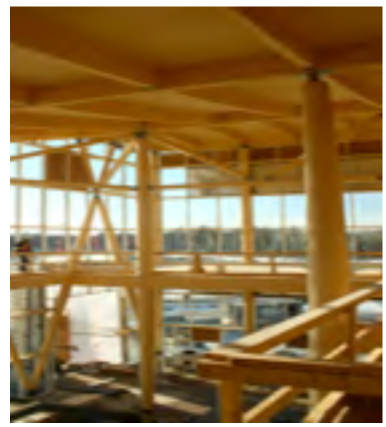
FSC www.fsc.org

The mark of responsible forestry

FSC® C011517

ARCHITECTURALLY INNOVATIVE

The architectural possibilities of glued-laminated timber are practically endless. Glulam members can be rectangular, circular, straight, curved, bent or double-tapered, and are perfectly suited for arches and portal frames as well as basic architectural forms. Moreover, the exceptional span lengths that can be achieved with the product allow for larger interior volumes. Glulam can also be combined with other construction materials such as glass, concrete and steel for one-of-a-kind projects.



RELIABLE

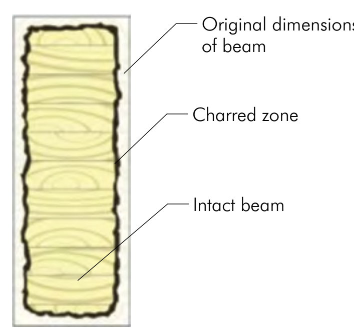
In addition to being visually appealing, glued-laminated timber is also the ideal structural choice for many applications due to its superior strength and durability. The mechanical performance of the laminations in glulam allow structures made from the material to support stress. These laminations are defect-free and arranged according to their mechanical strength in order to make the end product homogeneous and reliably strong. The exceptional strength-to-weight ratio of timber is another of glulam's many advantages.

FIRE RESISTANT

Fire resistance refers to the ability of a material to maintain its fire-separating function and structural strength when exposed to flames. High fire resistance improves a building's safety and enables evacuation. When mass timber burns, a layer of char forms at its surface and protects the unburned wood underneath, leaving its mechanical properties intact. Unlike in the case of many "non-combustible" building materials on the market today, the mechanical resistance of wood is largely unaffected by heat.

Mass timber behaves in a predictable manner when exposed to fire, allowing fire resistance to be determined during the design phase. Because glued-laminated timber has a proven char rate of 0.7 mm per minute, designers can specify minimum dimensions that will ensure that the mechanical performance of the timber can withstand exposure to fire, in accordance with the desired fire-resistance rating.

CROSS-SECTION OF A FIRE-EXPOSED TIMBER BEAM



For Chain of Custody FSC certification:
http://nordic.ca/en/documentation/technical-documents/ra-coc-004084

For Environmental Product Declaration:
http://nordic.ca/en/documentation/technical-documents/epd-nl

TECHNICAL
TOPICS

ENVIRO-LAM TECHNOLOGY

Engineered wood products use wood fibers extremely efficiently. By coupling its manufacturing expertise with special technology for processing small pieces of wood, CCL is able to utilize more fiber from each tree. Its exclusive ENVIRO-LAM technology maximizes resource efficiency by using smaller tree sections that cannot be processed using standard methods, such as crowns and side cuts.

The ENVIRO-LAM process respects our natural resources by using wood fiber to its full potential. The unique edge-gluing technology used in Nordic glued-laminated timber gives the material a distinctive appearance. And ENVIRO-LAM members, which are available in sizes of up to 327 mm wide x 2400 mm deep x 24.0 m long, offer greater dimensional stability than either traditional timber products or glulam made from larger tree sections. The unique look of the small blocks that make up ENVIRO-LAM products is a visual indication of our unwavering commitment to using wood fiber as efficiently, effectively and skillfully as possible.

HOMOGENEOUS LAYUP

Nordic Lam products are symmetrical in width and depth. Architectural-grade glulam is manufactured in a homogeneous layup and can be used for cantilevers, continuous spans, simple spans or compression and tension members, regardless of orientation. In addition, Nordic Lam conserves its strength properties whether used horizontally or vertically.

DIMENSIONAL CHANGES

Glued-laminated timber is less prone than standard timber and sawn lumber to dimensional changes in length, depth and width caused by moisture content fluctuation. Dimensional changes due to increased moisture content are generally temporary and may occur if the product is exposed to the elements during shipping, temporary storage or prolonged jobsite storage.

The unique process used to manufacture Nordic Lam products ensures a maximum tangential and radial shrinkage of 6% when moving from the fiber saturation point (30% moisture content) to an oven-dry state (0% moisture content). Longitudinal shrinkage under the same circumstances is a generally negligible 0.2%. For example, if the moisture content of a Nordic Lam member went from 12% to 14%, its dimensional change in depth and width would be equal to $\Delta d = 6\% \times (14 - 12)/30 = \pm 0.4\%$. Nordic Lam products are manufactured with a moisture content of 12%.

VISUAL
CHARACTERISTICS

APPEARANCE GRADES

Architectural: The appearance of choice in applications where members are exposed, because they have a smooth, attractive finish. Members may contain natural growth characteristics allowed in specific grades of laminating stock. Sides are surfaced true to specified dimensions, free from squeezed-out glue, and sanded smooth. Planing misses along laminations are patched with replacement stock. Wood inserts and filling are not required.

Industrial: Used for concealed applications, or where appearance is not of primary importance. Nordic Lam stock beams and columns are provided only in widths designed to fit flush with sawn lumber. This document does *not apply* to Nordic Lam products of industrial appearance grade. Consult Nordic for more information.

FINISHING TREATMENTS

Glulam structures resist time and span decades without damage. In specific applications, or when specified, treatments and finishes applied to the material during its manufacturing process provide increased resistance to biological agents that flourish in damp environments, such as in an aquatic complex.

Glulam timber is highly resistant to the action of many chemical agents, compared to other building materials. Therefore, it is as resistant to weak acids (acetic, oxalic, lactic acid) present in food-related environments and to basic environments including salt storage or where it may come into contact with seawater.

Architectural Appearance Grade

Industrial Appearance Grade

CHECKING

Glued-laminated timbers may develop seasoning checks as a normal function of the moisture stabilization process. The degree of checking that might occur in an individual member will depend on the combined effects of the initial moisture content, the seasonal conditions, handling and storage practices at job sites, and the in-service environment after the installation. The degree of checking in individual members will be influenced by the rate at which its moisture content changes from a moisture content level at the time of manufacture to its expected in-service level. When checks do occur, they are primarily an aesthetic concern and can be filled with an elastomeric filler.

Checking

For more information on wood checking:
http://www.apawood.org/pdfs/download_pdf.cfm?PDFFilename=managed/F450.pdf
http://www.apawood.org/pdfs/download_pdf.cfm?PDFFilename=managed/R475.pdf

SPECIFICATION
GUIDE

GLUED-LAMINATED CONSTRUCTION **SECTION 06 18 00**

SPEC NOTE: This Section includes only those items specific to Nordic glued-laminated timber (Nordic Lam).

1. GENERAL

- **References**
  - o Canadian Construction Material Centre (CCMC): CCMC's *Registry of Product Evaluations,* October 1st, 2000 On-line Edition (updated quarterly).
- **Information submittals**
  - o Certifications: Submit the material evaluation report listed in the *Registry of Product Evaluations* published by the CCMC at completion of fabrication.
- **Quality assurance**
  - o Qualifications:
    - Manufacture structural members in plant that is certified as meeting requirements of a certification agency accredited by the Standards Council of Canada.
    - Submit the material evaluation report listed in the *Registry of Product Evaluations* published by the CCMC at completion of fabrication.
    - Place, on members, the material evaluation report number listed in the *Registry of Product Evaluations* published by the CCMC indicating manufactured in certified plant.

2. PRODUCTS

- **Materials**
  - o Glued-laminated timber: Spruce-Pine-Fir FSC Certified, to the material evaluation report listed in the *Registry of Product Evaluations* published by CCMC.
- **Fabrication**
  - o Stress grade: bending, compression and/or tension members 24F-ES/NPG (beams, columns, and ties) and/or 20F-ES/CPG (decking), to the material evaluation report listed in the *Registry of Product Evaluations* published by the CCMC.
  - o Service grade: [Interior] [Exterior]
  - o Appearance grade: Architectural

3. EXECUTION

- **Erection**
  - o Erect glued-laminated decking in accordance with erection drawings issued for construction.
    - Install glued-laminated decking in a single- or multiple-span continuous pattern as indicated on the drawings (no controlled random pattern).
    - When possible, stagger end joints in adjacent elements over supports.
    - Nail decking to supports and adjacent courses as shown on the drawings. When the underside of the decking is to have an architecture appearance, particular care must be taken when nailing the decking to supports or to adjacent elements, and when nailing other miscellaneous framing to the wood decking, that nails do not penetrate through the full thickness of the decking.

For complete editable specification guide:
http://nordic.ca/en/documentation/technical-documents/t-s09

For CCMC evaluation report:
http://nordic.ca/en/documentation/technical-documents/13216

STANDARD
DIMENSIONS

NORDIC LAM 24F-ES/NPG
STANDARD DIMENSIONS

WIDTH (mm)						
44	86	137	184	228	279	327
DEPTHS (mm)						
70	127	*137*				
95	178	178	*184*			
121	222	222	222	228		
146	267	267	267	267	279	
171	318	318	318	318	318	327
197	362	362	362	362	362	362
222	406	406	406	406	406	406
248	457	457	457	457	457	457
273	502	502	502	502	502	502
298	546	546	546	546	546	546
324	597	597	597	597	597	597
349	641	641	641	641	641	641
375	686	686	686	686	686	686
400	737	737	737	737	737	737
425	781	781	781	781	781	781
451	826	826	826	826	826	826
	870	870	870	870	870	870
	921	921	921	921	921	921
	965	965	965	965	965	965
	1010	1010	1010	1010	1010	1010
		1054	1054	1054	1054	1054
		1105	1105	1105	1105	1105
		1149	1149	1149	1149	1149
		1194	1194	1194	1194	1194
		1245	1245	1245	1245	1245
		1289	1289	1289	1289	1289
		1334	1334	1334	1334	1334
		1384	1384	1384	1384	1384
		1429	1429	1429	1429	1429
		1473	1473	1473	1473	1473
		1524	1524	1524	1524	1524
		1568	1568	1568	1568	1568
		1613	1613	1613	1613	1613
			1664	1664	1664	1664
			1708	1708	1708	1708
			1753	1753	1753	1753
			1797	1797	1797	1797
			1848	1848	1848	1848
			1892	1892	1892	1892
			1937	1937	1937	1937
			1981	1981	1981	1981
			2032	2032	2032	2032
			2076	2076	2076	2076
			2121	2121	2121	2121
			2172	2172	2172	2172
				2216	2216	2216
				2261	2261	2261
				2311	2311	2311
				2356	2356	2356
				2400	2400	2400

NOTES:
1. Depth-to-width ratio shall be limited to 12:1.
2. Dimensions shown in black are the optimum dimensions for straight members (maximum length of 18.9 m).
3. Members of dimensions in light grey are fabricated using manual techniques (maximum length of 24.4 m).
4. Arched beams are available in dimensions up to 327 mm x 2400 mm x 24.0 m (width x depth x length).
5. Other dimensions are available on request; please contact Nordic.

SPECIFIED STRENGTHS AND DESIGN PROPERTIES [1,2,3,4]

APPLICATION	BEAMS AND COLUMNS	DECKING
APPEARANCE GRADE	ARCHITECTURAL	ARCHITECTURAL
STRESS GRADE	24F-ES/NPG	20F-ES/CPG
Bending about X-X or Y-Y axis		
Bending moment (F_b)[5]	30.7 MPa	25.6 MPa
Longitudinal shear (F_v)[6]	2.5 MPa	2.2 MPa
Compression perpendicular to grain (F_{cp})[7]	7.0 MPa	5.8 MPa
Shear-free modulus of elasticity (E)	13 100 MPa	13 100 MPa
Apparent modulus of elasticity ($E_{app.}$) [8]	12 400 MPa	12 400 MPa
Axially loaded		
Compression parallel to grain (F_c)	33.0 MPa	14.4 MPa
Tension parallel to grain (F_t)	20.4 MPa	10.2 MPa
Tension perpendicular to grain (F_{tp})	0.51 MPa	0.51 MPa
Modulus of elasticity (E_a)	13 100 MPa	13 100 MPa
Connections design		
Mean relative density (G)[10]	0,47	0,42
Characteristic density (ρ_k)[10]	430 kg/m³	385 kg/m³
Density (for member weight)	560 kg/m³	560 kg/m³

(1) Design of glulam members shall be in accordance to CSA O86-14 Standard. Annex B provides a design methodology for fire-resistance ratings.
(2) The tabulated values apply to members consisting of 4 or more laminations.
(3) The tabulated design values are for standard term duration of load. For other durations of load, see applicable design code (CSA O86-14, Clauses 5.3.2).
(4) The tabulated design values are for dry service conditions. For wet service conditions, multiply the tabulated values by the wet service condition factors, K_S (CSA O86-14, Clause 7.4.2).
(5) Nordic Lam 24F-ES/NPG and 20F-ES/CPG members are symmetrical throughout the depth and the width of the member (homogeneous layups). It should be noted that Clause 7.5.3 of CSA O86-14 is not applicable.
(6) The tabulated specified strengths in bending, F_b, shall be multiplied by a size factor, K_{Zbg}. The size factor formula is: $K_{Zbg} = (130/b)^{1/10}(610/d)^{1/10}(9100/L)^{1/10} \leq 1.3$, where b = net beam width (mm), d = beam depth (mm), and L = length of beam segment from point of zero moment to point of zero moment (mm).
(7) At the location of notches in rectangular members, the specified strength in shear, F_v, shall be adjusted per CSA O86-14, Clause 7.5.7.3 or 7.5.7.4, as applicable.
(8) The compression perpendicular to grain strength values, F_{cp}, shall be permitted to be adjusted by a size factor for bearing, K_{Zcp} CSA O86-14, Clause 7.5.9.2.
(9) The tabulated apparent E values already include a 5% shear deflection. For column stability calculations, E_{05} shall be determined by multiplying the tabulated apparent modulus of elasticity by 0.87.
(10) Mean relative density values for dowel-type fastener design in accordance to CSA O86-14, and characteristic density values for dowel-type fastener design in accordance to EN 1995-1-1.

* *Nordic Lam products are listed in CCMC Evaluation Report 13216-R and APA Product Report PR-L294C.*

For conventional glulam beam conversions table:
http://nordic.ca/en/documentation/technical-documents/t-s15

For the APA Product Report:
http://nordic.ca/en/documentation/technical-documents/apa-pr-l306c

To verify that the Decking Selection Tables are appropriate for the structure being designed, the following questions should be asked (the appropriate modification factor is given in brackets):

1. **Is load duration "standard" (K_D)?**
   K_D is a load duration factor. The tables are based on a standard term load (K_D = 1.0), which includes the effects of dead loads plus live loads due to use and occupancy, and snow loads. For other load durations, the tabulated values w_{FR} shall be multiplied by the appropriate factor permitted by the code.

2. **Is the service condition "dry" (K_S)?**
   K_S is a service condition factor. The tables are based on dry service conditions (K_S = 1.0). For wet service conditions, multiply the tabulated values by the following factors:
   K_{Sb} = 0.80 for w_{FR}
   K_{SE} = 0.90 for $w_{\Delta R}$

3. **Is the material free of incising and/or strength-reducing chemicals (K_T)?**
   K_T is a treatment factor. The tables are based on untreated timber (K_T = 1.0). For glued-laminated timber treated with fire-retardant or other potentially strength-reducing chemicals, strength and stiffness capacities shall be based on documented results of tests that shall take into account the effects of time, temperature, and moisture content. For preservative treatment, the treatment factor for unincised glued-laminated timber may be taken as unity.

4. **Is the width of the pieces 89 mm maximum (K_{Zbg})?**
   K_{Zbg} is a size factor in bending that is incorporated in the tables for a maximum thickness of 89 mm.

5. **Is the applicable specified live load deflection limit based on L/240?**
   The table L/240 is based on a deflection limit of span/240 under specified live load. Decking may also be checked for a deflection limit for specified total load. For other deflection limit, use L/180 or L/360 table or adjust the values proportionally.

6. **Is the decking laid in continuous spans?**
   The tables are based on continuous spans. For simple spans, multiply $w_{\Delta R}$ values by 0.76.

7. **Is the loading of a uniform nature?**
   The tables are based on uniform loads. In some applications, decking may have to be designed for a concentrated live load (as defined in article 4.1.5.9 of the 2010 NBCC) or other non-uniform loading. In these cases refer to CSA O86-14.

If the answer to any of those questions in no, refer to the description of modification factors above and make the necessary adjustments to the tabulated values. Otherwise, the Decking Selection Tables may be used directly. The selection tables provide the maximum uniform factored load w_{FR} and maximum uniform specified load $w_{\Delta R}$ that may be applied to a two- or more-span continuous decking to ensure that the design criteria are met. The tables do not consider any vibration criterion to limit the effects of floor vibrations.

Note: The tables are based on standard depths for bending on flat (loaded parallel to wide face of laminations). The panels self weight has not been considered in the calculation of loads (i.e. that it shall be included in the specified total load). The decking is available in widths of 203, 305 and 406 mm and lengths up to 18 m. Consult Nordic for other options.

DECKING

SELECTION TABLE

20F-ES/CPG

ULTIMATE LIMIT STATES – RESISTANCE

MAXIMUM FACTORED LOAD W_{FR} (kPa)

SPAN (m)	THICKNESS (mm)				
	38	44	54	64	89
1.0					
1.2					
1.4					
1.6	17.4				
1.8	13.8	18.7			
2.0	11.1	15.2			
2.2	9.21	12.5			
2.4	7.74	10.5	15.5		
2.6	6.60	8.98	13.2		
2.8	5.69	7.74	11.4	15.8	
3.0	4.95	6.74	9.94	13.8	
3.2	4.35	5.93	8.74	12.1	
3.4	3.86	5.25	7.74	10.7	
3.6	3.44	4.68	6.91	9.56	
3.8	3.09	4.20	6.20	8.58	16.8
4.0	2.79	3.79	5.59	7.74	15.2
4.2		3.44	5.07	7.02	13.8
4.4		3.14	4.62	6.40	12.5
4.6		2.87	4.23	5.85	11.5
4.8			3.88	5.38	10.5

FACTORED LOADS

SERVICEABILITY LIMIT STATES – L/240 DEFLECTION

MAXIMUM SPECIFIED LOAD $W_{\Delta R}$ (kPa)

SPAN (m)	THICKNESS (mm)				
	38	44	54	64	89
1.0					
1.2	13.9				
1.4	8.77	13.9			
1.6	5.87	9.33			
1.8	4.12	6.55	11.7		
2.0	3.01	4.77	8.55		
2.2	2.26	3.59	6.42	10.5	
2.4	1.74	2.76	4.95	8.06	
2.6	1.37	2.17	3.89	6.34	
2.8	1.10	1.74	3.12	5.07	
3.0		1.41	2.53	4.12	11.3
3.2		1.17	2.09	3.40	9.33
3.4		0.97	1.74	2.83	7.77
3.6			1.47	2.39	6.55
3.8			1.25	2.03	5.57
4.0			1.07	1.74	4.77
4.2				1.50	4.12
4.4				1.31	3.59
4.6				1.14	3.14
4.8				1.01	2.76

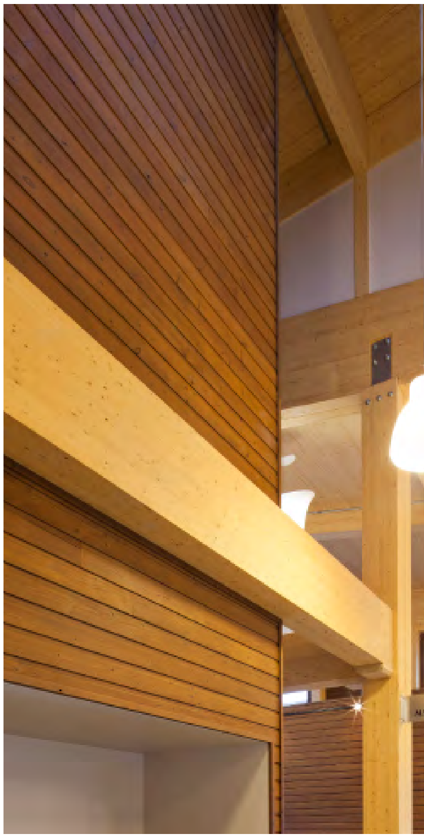
20F-ES/CPG

SERVICEABILITY LIMIT STATES – L/180 DEFLECTION
MAXIMUM SPECIFIED LOAD $W_{\Delta R}$ (kPa)

SPAN (m)	THICKNESS (mm)				
	38	44	54	64	89
1.0					
1.2					
1.4	11.7				
1.6	7.83	12.4			
1.8	5.50	8.73			
2.0	4.01	6.37	11.4		
2.2	3.01	4.78	8.56		
2.4	2.32	3.68	6.60	10.7	
2.6		2.90	5.19	8.45	
2.8		2.32	4.15	6.76	
3.0			3.38	5.50	
3.2			2.78	4.53	
3.4			2.32	3.78	10.4
3.6			1.95	3.18	8.73
3.8				2.71	7.42
4.0				2.32	6.37
4.2				2.00	5.50
4.4					4.78
4.6					4.19
4.8					3.68

SERVICEABILITY LIMIT STATES – L/360 DEFLECTION
MAXIMUM SPECIFIED LOAD $W_{\Delta R}$ (kPa)

SPAN (m)	THICKNESS (mm)				
	38	44	54	64	89
1.0	16.0				
1.2	9.28	14.7			
1.4	5.84	9.28			
1.6	3.91	6.22	11.1		
1.8	2.75	4.37	7.82	12.7	
2.0	2.00	3.18	5.70	9.28	
2.2	1.51	2.39	4.28	6.97	
2.4	1.16	1.84	3.30	5.37	
2.6		1.45	2.59	4.22	11.6
2.8		1.16	2.08	3.38	9.28
3.0		0.94	1.69	2.75	7.54
3.2			1.39	2.27	6.22
3.4			1.16	1.89	5.18
3.6			0.98	1.59	4.37
3.8				1.35	3.71
4.0				1.16	3.18
4.2				1.00	2.75
4.4					2.39
4.6					2.09
4.8					1.84



DECKING

EXAMPLE: **ROOF DECKING**

Roof decking

Specified dead load = 1.5 kPa (including panel self weight)
Specified snow load for strength calculations = 2.2 kPa
Specified snow load for serviceability calculations = 2.0 kPa
Purlin spacing (span) = 2.0 m
Dry service condition. untreated lumber
Deflection limitations: L/240 based on live load. L/180 based on total load
Double span pattern

Calculation

Factored load w_f = (1.25 x 1.5) + (1.5 x 2.2) = 5.18 kPa
Specified live load w_L = 2.0 kPa
Total specified load w = 1.5 + 2.0 = 3.5 kPa

From Decking Selection Tables. select 38 mm thickness:

w_{FR} = 11.1 kPa > 5.18 kPa	√	Table w_{FR}
$w_{\Delta R}$ = 3.01 kPa > 2.0 kPa for L/240 deflection (live load)	√	Table $w_{\Delta R}$. L/240 deflection
$w_{\Delta R}$ = 4.01 kPa > 3.5 kPa for L/180 deflection (total load)	√	Table $w_{\Delta R}$. L/180 deflection

Use 38 mm thick 20F-ES/CPG grade decking.

Note: Where decking is used to support roof loads' the maximum spans for decking may be limited by the NBCC roof point load requirements (refer to 2010 NBCC, article 4.1.5.9).

EXAMPLE: **FLOOR DECKING**

Floor decking

Specified dead load = 1.5 kPa (including panel self weight)
Specified live load = 1.9 kPa (residential use)
Purlin spacing (span) = 3.0 m
Dry service condition, untreated lumber
Deflection limitations: L/360 based on live load, L/240 based on total load
Double span pattern

Calculation

Factored load w_f = (1.25 x 1.5) + (1.5 x 1.9) = 4.73 kPa
Specified live load w_L = 1.9 kPa
Specified total load w = 1.5 + 1.9 = 3.4 kPa

From Decking Selection Tables, select 64 mm thickness:

w_{FR} = 13.8 kPa > 4.73 kPa	√	Table w_{FR}
$w_{\Delta R}$ = 2.75 kPa > 1.9 kPa for L/360 deflection (live load)	√	Table $w_{\Delta R}$, L/360 deflection
$w_{\Delta R}$ = 4.12 kPa > 3.4 kPa for L/240 deflection (total load)	√	Table $w_{\Delta R}$, L/240 deflection

Use 64 mm thick 20F-ES/CPG grade decking.

Note: A complete design shall include among other things the verification of a concentrated live load (if applicable), bearing resistance, effect of floor vibration, and fire safety requirements.

DIAPHRAGMS DESIGN

Decking may be used as diaphragms in conjunction with nailed shear panels using structural wood panels. The decking sub-structure may be considered as blocked framing, thus, provisions given by the CSA O86-09, Clause 11, may be used for specified shear strength calculation. Diaphragms sheathed with plywood or OSB may be used to resist shear due to lateral forces based on the shear strength specified in the table below.

Refer to CSA O86-09, Clause 9.5.6 for moment resistance of nailed diaphragms. Also, refer to CSA O86-09, Clauses 11.7 and 11.8 for deflection of diaphragms and seismic design considerations, respectively. Note that openings in the diaphragms alter the load path and require additional considerations.

FACTORED SHEAR RESISTANCES, V_{rs}, IN kN PER METRE LENGTH

DECKING THICKNESS (mm)	PANEL THICKNESS (mm)	COMMON WIRE NAIL		FACTORED SHEAR RESISTANCE, V_{rs} (kN/m)			
		DIAMETER (mm)	LENGTH (mm)	NAIL SPACING SCHEDULE (mm)			
				150/150	100/150	64/150	50*/75
38	n/a	n/a	n/a	Consult Nordic for more information.			
44	25.4	3.25	64	5.9	7.9	11.8	13.3
54	12.5	3.25	64	5.9	7.9	11.8	13.3
	15.5	3.25	64	--	7.9	11.8	13.3
	18.5	3.25	64	--	7.9	11.8	13.3
	25.4	3.66	76	--	14.8†	21.2†	--
64	12.5	3.25	64	5.9	7.9	11.8	13.3
	15.5	3.66	76	7.1	9.4	14.2	16.2
	18.5	3.66	76	--	14.8†	21.2†	--
	25.4	3.66	76	--	14.8†	21.2†	--
89	12.5	3.66	76	6.4	8.5	12.8	14.5
	15.5	3.66	76	7.1	9.4	14.2	16.2
	18.5	3.66	76	--	14.8†	21.2†	--
	25.4	3.66	76	--	14.8†	21.2†	--

** Nails spaced 50 mm on centre shall be staggered.*
† Two lines of fasteners shall be used.

NOTES:

1. Factored shear resistance, in kN/m; multiply by the dimension of diaphragm parallel to direction of load, in m.
2. The factored shear resistance is calculated as follows: $V_{rs} = \phi v_d K_D K_{SF} J_{sp} L_D$, where
   ϕ = 0.7
   v_d = specified shear strength for diaphragms (Table 9.5.2, CSA O86-09), kN/m
   J_{sp} = 0.9, species factor for framing material
   L_D = dimension of diaphragm parallel to direction of factored load, m
3. Nail spacing schedule refers to the nail spacing, in mm, at diaphragm boundaries (all cases) and at continuous panel edges parallel to load (cases 3 and 4), and the nail spacing, in mm, at other panel edges. In addition, a row of nails spaced 300 mm on centre shall be installed every 600 mm spacing along the length of decking. (See Figure 3.)
4. The tabulated values are based on dry service conditions (K_{SF} = 1.0) and short-term duration of load (K_D = 1.15), and apply to nailed shear panels using structural wood-based panels.
5. For diaphragms fabricated with power-driven nails, see CSA O86-09, Clause A.9.5.1 for an appropriate modification factor.
6. For construction sheathing OSB, the product specification shall also include a panel mark identifying an end-use rating.
7. Diaphragms shall be designed to resist shear stresses only and perimeter members shall be provided to resist axial forces resulting from the application of lateral design forces. Perimeter members shall be adequately interconnected at corner intersections and member joints shall be spliced adequately.

DIAPHRAGMS
CONSTRUCTION

Diaphragms using plywood or OSB shall be constructed with panels not less than 1200 × 2400 mm, except near boundaries and changes in framing, where up to two short or narrow panels may be used. Panels for diaphragms shall be arranged as indicated below. Nails shall be placed not less than 9 mm from the panel edge. Nails shall be firmly driven into framing members but shall not be over-driven more than 15% of the panel thickness. A gap of not less than 2 mm shall be left between wood-based panel sheets.

FIGURE 1
PANELS LAYOUT AND DETAILING

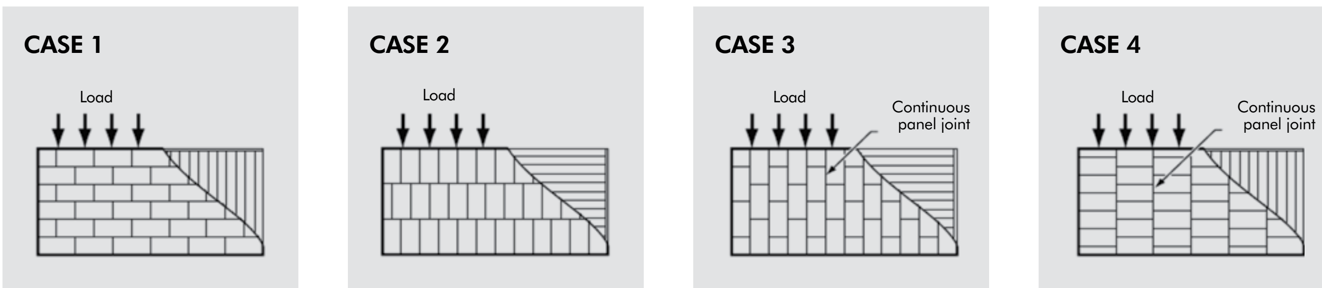
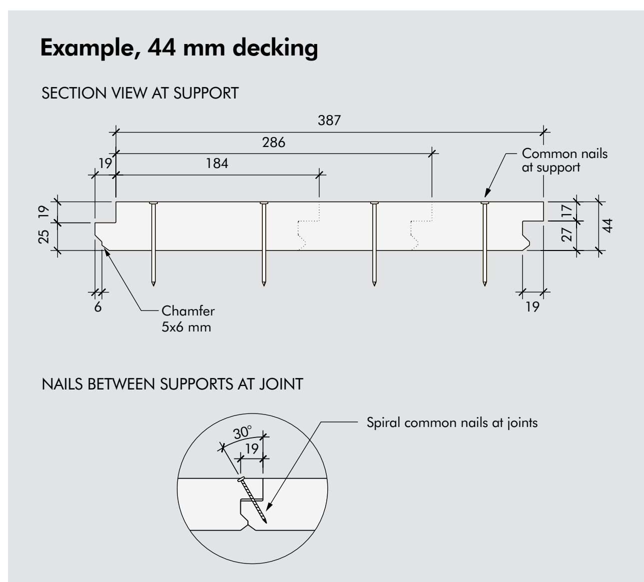


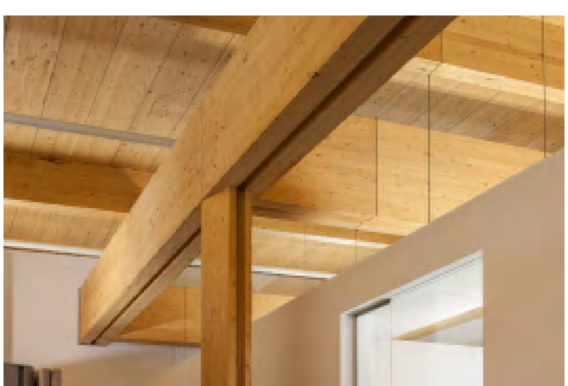
FIGURE 2
DECKING FASTENING SCHEDULE

DECKING FASTENING SCHEDULE			
DECKING THICKNESS (mm)	COMMON WIRE NAILS, AT SUPPORT (mm)		
	DIA. (in)	L (in)	SPACING (mm)
38	0.128	2-1/2	*By the designer*
44	0.144	3	
54	0.160	3-1/2	
64	0.192	4	
89	0.232	5	

NOTES:
1. Decking is available in widths of 203, 305, and 406 mm and lengths up to 18 m.
2. The covering widths are 184, 286, and 387 mm, respectively.

FIGURE 3
SHEATHING FASTENING SCHEDULE





EXAMPLE: **FLOOR DIAPHRAGM**

The floor has plywood sheathing on glulam decking. Case 3 (Figure 1) is appropriate for load in the N-S direction and Case 1 for the E-W direction. The uniformly distributed load on the diaphragm is 9.7 kN/m in both directions. The building dimensions are 30 m x 12 m as shown below. The loads are from wind forces.

Floor diaphragm

Factored wind load: $W_x = W_y = 9.7$ kN/m
Diaphragm dimensions: $l_x = 30$ m, $l_y = 12$m

1. Determine required decking thickness due to live loads due to use and occupancy, snow and permanent loads from Decking Selection Tables.
   → **A decking thickness of 64 mm is assumed (from the floor calculation example).**
2. The maximum diaphragm shear is:
   E-W: $V_{fx} = (w_x \times l_y) / (2 \times l_x) = (9.7 \times 12) / (2 \times 30) = 1.94$ kN/m
   N-S: $V_{fy} = (w_y \times l_x) / (2 \times l_y) = (9.7 \times 30) / (2 \times 12) = 12.13$ kN/m

Calculation / N-S Direction

3. Depending on the thickness of decking, select a sheathing panel thickness and nailing schedule with an equivalent or higher factored shear resistance, V_{rs}, than the factored shear load, V_f.
   → **Select a panel thickness of 15.5 mm and the nailing schedule "64/100" (i.e. 3 in. long x 3.66 mm diameter nails spaced at 64 mm o.c. at the diaphragm boundary and at continuous N-S panel edges, and 100 mm o.c. at all E-W panel edges):**
   $V_{rs} = 12.6$ kN/m $> V_{fy} = 12.13$ kN/m √ Factored shear resistances table
4. Examining the shear in the diaphragm along the length, as shown in the figure below, provides an opportunity to reduce the nail density.
   → **The table below summarize the edge nailing schedule requirements for different selected zones in the diaphragm. All interior nailing should be at 300 and 600 mm o.c. in accordance with footnote (2) in Table on page 14.**

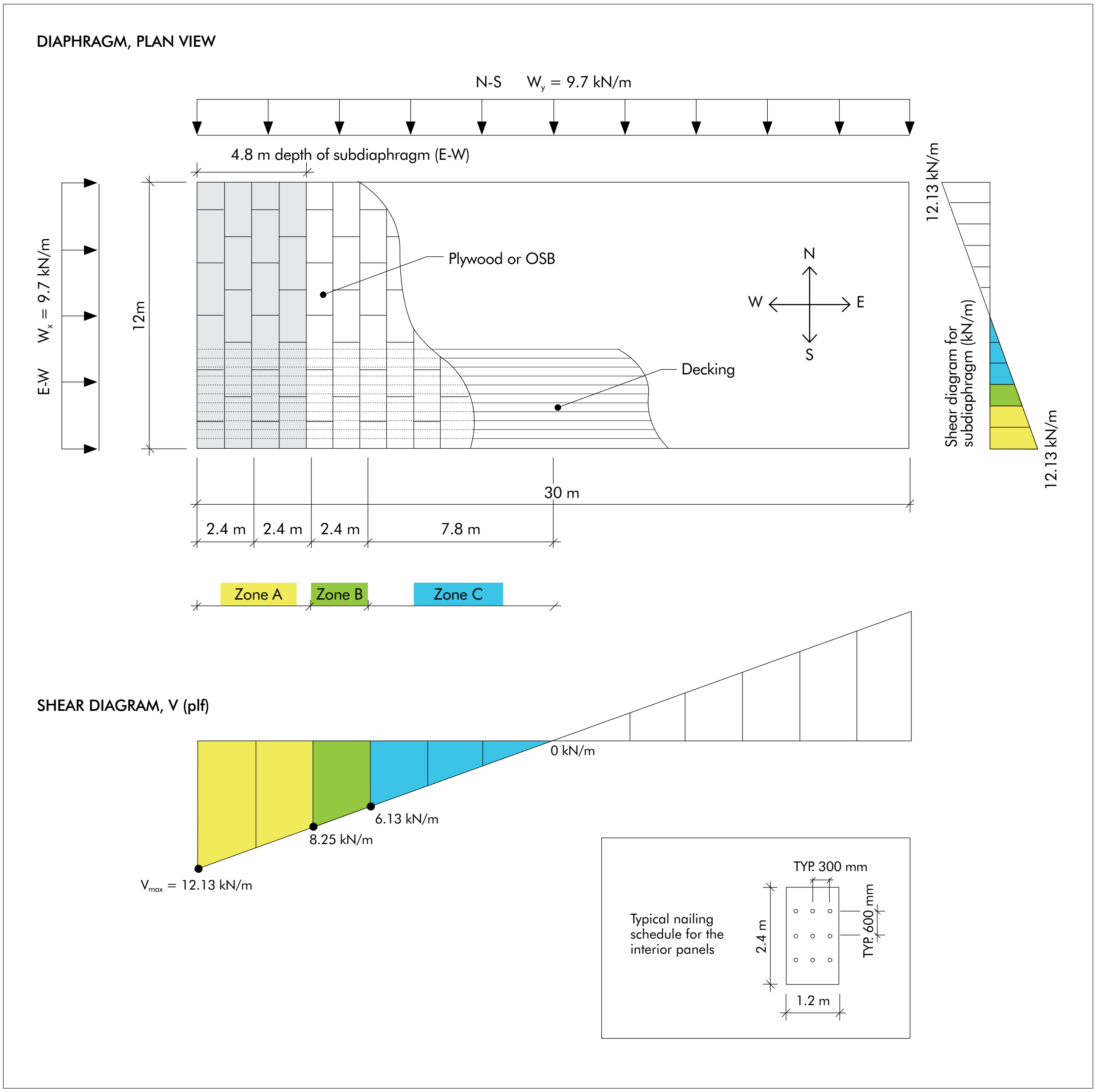
15.5 mm PLYWOOD SHEATHING WITH 3.66 mm COMMON WIRE NAILS

N-S Dir. / Load Case	Zone	N-S edge nailing, spacing (mm)	Other edges, spacing (mm)	Factored shear resistance (kN/m)	Factored shear load (kN/m)
Case 3	A	64	100	12.6	12.13
Case 3	B	100	150	8.4	8.25
Case 3	C	150	150	6.3	6.13

Calculation / E-W Direction

5. Assuming subdiaphragm with 2.5:1 aspect ratio:
   → **Depth = 12 m / 2.5 = 4.8 m (corresponds to edge of Zone A/Zone B)**
   → **Use Zone A resistance values. If sufficient, leave total diaphragm nailing schedule as is; if not, modify.**
6. The maximum shear load for Zone A:
   V_{max} (Zone A) = [9.7 kN/m x 12 m / 2] / 4.8 m = 12.13 kN/m
   V_r (Zone A) = 12.6 kN/m > 12.13 kN/m (thus, leave as it is)
7. Design of diaphragm perimeter members to resist axial forces is not shown in this example.

EXAMPLE: **FLOOR DIAPHRAGM** (continued)



To verify that the tabulated resistances and E_SI values are appropriate for the structure being designed, the following questions should be asked (the appropriate modification factor is given in brackets):

1. **Is load duration "standard" (K_D)?**
   K_D is a load duration factor. The tabulated resistances are based on a standard term load duration (K_D = 1.0), which includes the effects of dead loads plus live loads due to use and occupancy, and snow loads. For other load durations, the tabulated resistance values shall be multiplied by the appropriate factor permitted by the code.
2. **Is the service condition "dry" (K_S)?**
   K_S is a service condition factor. The tabulated values are based on dry service conditions (K_S = 1.0). For wet service conditions, multiply the tabulated values by the following factors:
   K_{Sb} = 0.80 for M'_r
   K_{Sv} = 0.87 for V_r and $W_rL^{0.18}$
   K_{SE} = 0.90 for E_SI
3. **Is the material free of incising and/or strength-reducing chemicals (K_T)?**
   K_T is a treatment factor. The tables are based on untreated timber (K_T = 1.0). For glued-laminated timber treated with fire-retardant or other potentially strength-reducing chemicals, strength and stiffness capacities shall be based on documented results of tests that shall take into account the effects of time, temperature, and moisture content. For preservative treatment, the treatment factor for unincised glued-laminated timber may be taken as unity.
4. **Does the construction provide lateral stability for the beam (K_L)?**
   K_L is a lateral stability factor. The tables are based on beams that are restrained against lateral displacement and rotation at their ends (K_L = 1.0). It is assumed that the compressive edge of the bending member is supported throughout its length by decking so as to provide a rigid diaphragm. If glulam lacks this restraint, then refer to Clause 7.5.6.4 of CSA O86-14 to modify the tabulated M'_r value.
5. **Is a size factor applicable (K_{Zbg})?**
   K_{Zbg} is a size factor for bending applied to glulam beams and is only applicable if it is less than the value of K_L. The values for M'_r in the Beam Selection Tables do not include K_{Zbg}. Values of K_{Zbg} shall be taken as:
   $(130/b)^{1/10}(610/d)^{1/10}(9100/L)^{1/10} \leq 1.3$
   where: b = net beam width (mm),
   d = beam depth (mm), and
   L = length of beam segment from point of zero moment to point of zero moment (mm).

6. **Is the beam free of notches (K_N)?**
   K_N is a notch factor. The tables are based on beams that are not notched (K_N = 1.0). If members are notched, refer to CSA O86-14, Clause 7.5.7.3 or 7.5.7.4, as applicable.
7. **For $W_rL^{0.18}$ only, is the beam simply supported and the loading uniformly distributed (C_V)?**
   C_V is a shear load coefficient. The tables are based on a simply supported beam with a uniformly distributed load (C_V = 3.69). If the beam is not simply supported or the loading is not uniformly distributed, select the appropriate C_V value from Clause 7.5.7.5 of CSA O86-14 and multiply the tabulated $W_rL^{0.18}$ value by $C_V/3.69$.

If the answer to any of these questions is no, refer to the description of modification factors above and make the necessary adjustments to tabulated resistances and E_SI values. Note that the M'_r values must be adjusted by the lesser of K_L or K_{Zbg}. Otherwise, the Beam Selection Tables may be used directly. The beams self weight has not been considered in the tables. Note that in certain cases the National Building Code permits a reduction in the loads due to use and occupancy depending upon the size of the tributary area (refer to Article 4.1.5.8 of the 2010 NBCC).

BEAMS
SELECTION TABLES
24F-ES/NPG

NORDIC LAM 24F-ES/NPG – RESISTANCES AND STIFFNESSES

DEPTH (mm)	86 mm				137 mm			
	M'_r kN-m	V_r kN	$W_rL^{0.18}$ kN-m$^{0.18}$	E_SI 10^9 N-mm^2	M'_r kN-m	V_r kN	$W_rL^{0.18}$ kN-m$^{0.18}$	E_SI 10^9 N-mm^2
127	6.39	14.4	86.4	182				
178	12.5	20.2	114	501	20.0	32.2	167	798
222	19.5	25.2	137	972	31.1	40.1	200	1549
267	28.2	30.3	159	1692	45.0	48.3	233	2695
318	40.0	36.1	183	2858	63.8	57.5	269	4552
362	51.9	41.1	204	4216	82.7	65.5	299	6716
406	65.3	46.1	224	5947	104	73.4	328	9474
457	82.7	51.9	247	8482	132	82.6	362	13 512
502	99.8	57.0	267	11 242	159	90.8	390	17 909
546	118	62.0	286	14 465	188	98.7	418	23 043
597	141	67.8	307	18 909	225	108	450	30 122
641	163	72.8	326	23 405	259	116	477	37 285
686	186	77.9	344	28 689	297	124	504	45 702
737	215	83.7	365	35 575	343	133	535	56 671
781	242	88.7	383	42 334	385	141	561	67 439
826	270	93.8	401	50 082	430	149	587	79 781
870	300	98.8	418	58 519	478	157	613	93 222
921	336	105	438	69 425	535	167	642	110 596
965	369	110	456	79 858	587	175	667	127 216
1010	404	115	473	91 559	644	183	693	145 856
1054					701	191	717	165 761
1105					770	200	746	191 006
1149					833	208	770	214 744
1194					899	216	795	240 976
1245					978	225	822	273 193
1289					1048	233	846	303 193
1334					1123	241	870	336 069
1384					1208	250	897	375 292
1429					1288	258	921	413 102
1473					1369	266	944	452 449
1524					1465	276	971	501 090
1568					1551	284	994	545 757
1613					1641	292	1017	594 106
1664								
1708								

NOTES:
1. V_r may only be used as a simplified check of shear capacity, if the beam volume is less than 2.0 m^3.
2. $W_rL^{0.18}$ may be used for beams of any volume to check shear capacity.
3. A complete design shall include the verifications of bearing resistance and fire safety requirements.
4. Dimensions shown in black are the optimum dimensions for straight beams (maximum length of 18.9 m).
5. Beams of dimensions in light grey are fabricated using manual techniques (maximum length of 24.4 m).
6. Other dimensions are available on request; please contact Nordic.

24F-ES/NPG

NORDIC LAM 24F-ES/NPG – RESISTANCES AND STIFFNESSES

DEPTH (mm)	184 mm				228 mm			
	M'_r kN-m	V_r kN	$W_rL^{0.18}$ kN-$m^{0.18}$	E_SI 10^9 N-mm^2	M'_r kN-m	V_r kN	$W_rL^{0.18}$ kN-$m^{0.18}$	E_SI 10^9 N-mm^2
222	41.8	53.9	255	2080	51.7	66.8	304	2578
267	60.4	64.8	296	3619	74.8	80.4	353	4484
318	85.7	77.2	342	6114	106	95.7	408	7576
362	111	87.9	380	9020	138	109	454	11 176
406	140	98.6	418	12 724	173	122	498	15 767
457	177	111	460	18 147	219	138	549	22 487
502	214	122	497	24 053	265	151	593	29 805
546	253	133	533	30 948	313	164	635	38 349
597	302	145	573	40 456	374	180	683	50 130
641	348	156	608	50 076	431	193	725	62 051
686	399	167	642	61 381	494	206	766	76 058
737	460	179	681	76 113	570	222	812	94 314
781	517	190	715	90 576	640	235	852	112 235
826	578	201	748	107 152	716	249	892	132 775
870	641	211	781	125 203	795	262	931	155 143
921	719	224	818	148 538	891	277	975	184 058
965	789	234	850	170 860	978	290	1013	211 718
1010	864	245	882	195 895	1071	304	1052	242 739
1054	941	256	914	222 628	1166	317	1089	275 865
1105	1035	268	950	256 534	1282	333	1132	317 879
1149	1119	279	981	288 415	1386	346	1169	357 384
1194	1208	290	1012	323 647	1497	359	1207	401 041
1245	1313	302	1047	366 916	1627	375	1249	454 656
1289	1408	313	1078	407 209	1744	388	1285	504 585
1334	1508	324	1108	451 363	1868	401	1321	559 297
1384	1623	336	1142	504 042	2011	417	1362	624 574
1429	1730	347	1173	554 824	2144	430	1398	687 499
1473	1838	358	1202	607 668	2278	443	1433	752 980
1524	1968	370	1236	672 997	2439	459	1474	833 931
1568	2083	381	1266	732 987	2581	472	1509	908 267
1613	2205	392	1295	797 924	2732	485	1544	988 732
1664	2346	404	1329	876 028	2907	501	1584	1 085 514
1708	2472	415	1357	947 375	3063	514	1618	1 173 921
1753	2604	426	1387	1 024 245	3226	528	1653	1 269 174
1797	2736	436	1415	1 103 323	3390	541	1687	1 367 161
1848	2894	449	1448	1 199 953	3586	556	1726	1 486 898
1892	3033	460	1476	1 287 721	3758	569	1760	1 595 654
1937	3179	470	1505	1 381 806	3939	583	1794	1 712 238
1981	3325	481	1533	1 478 127	4120	596	1828	1 831 592
2032	3499	494	1565	1 595 252	4335	612	1866	1 976 726
2076	3652	504	1593	1 701 141	4525	625	1899	2 107 936
2121	3812	515	1621	1 814 180	4723	638	1933	2 248 005
2172	3997	528	1653	1 948 219	4953	654	1971	2 414 097
2216					5156	667	2004	2 563 802
2261					5367	680	2037	2 723 184

NOTES:

1. V_r may only be used as a simplified check of shear capacity, if the beam volume is less than 2.0 m^3.
2. $W_rL^{0.18}$ may be used for beams of any volume to check shear capacity.
3. A complete design shall include the verifications of bearing resistance and fire safety requirements.
4. Dimensions shown in black are the optimum dimensions for straight beams (maximum length of 18.9 m).
5. Beams of dimensions in light grey are fabricated using manual techniques (maximum length of 24.4 m).
6. Other dimensions are available on request; please contact Nordic.

24F-ES/NPG

NORDIC LAM 24F-ES/NPG – RESISTANCES AND STIFFNESSES

DEPTH (mm)	279 mm				327 mm			
	M'_r kN-m	V_r kN	$W_r L^{0.18}$ kN-m$^{0.18}$	$E_S I$ 10^9 N-mm^2	M'_r kN-m	V_r kN	$W_r L^{0.18}$ kN-m$^{0.18}$	$E_S I$ 10^9 N-mm^2
318	130	117	481	9271				
362	168	133	535	13 676	197	156	610	16 029
406	212	150	588	19 294	248	175	670	22 613
457	268	168	648	27 517	314	197	738	32 251
502	324	185	700	36 472	379	217	797	42 746
546	383	201	750	46 927	449	236	854	55 000
597	458	220	807	61 343	537	258	919	71 897
641	528	236	855	75 931	619	277	974	88 994
686	605	253	904	93 072	709	296	1030	109 084
737	698	271	959	115 411	818	318	1092	135 267
781	784	288	1005	137 340	919	337	1145	160 969
826	877	304	1053	162 474	1027	357	1199	190 427
870	972	320	1098	189 846	1140	376	1251	222 508
921	1090	339	1151	225 229	1277	398	1311	263 978
965	1196	355	1196	259 076	1402	417	1362	303 648
1010	1311	372	1241	297 036	1536	436	1414	348 139
1054	1427	388	1285	337 572	1673	455	1464	395 649
1105	1569	407	1336	388 984	1839	477	1522	455 906
1149	1696	423	1380	437 325	1988	496	1572	512 564
1194	1832	440	1424	490 747	2147	515	1622	575 177
1245	1991	459	1474	556 356	2334	537	1678	652 073
1289	2135	475	1516	617 452	2502	556	1727	723 681
1334	2286	491	1559	684 403	2680	576	1776	802 150
1384	2461	510	1607	764 281	2884	597	1831	895 770
1429	2624	526	1650	841 281	3075	617	1879	986 018
1473	2788	542	1691	921 410	3267	636	1927	1 079 932
1524	2984	561	1739	1 020 468	3497	658	1981	1 196 033
1568	3159	577	1780	1 111 432	3702	677	2028	1 302 646
1613	3343	594	1822	1 209 895	3918	696	2075	1 418 049
1664	3557	613	1869	1 328 326	4170	718	2129	1 556 855
1708	3748	629	1910	1 436 509	4393	737	2175	1 683 650
1753	3948	646	1951	1 553 068	4627	757	2222	1 820 262
1797	4149	662	1991	1 672 973	4863	776	2268	1 960 796
1848	4388	681	2037	1 819 494	5143	798	2320	2 132 525
1892	4599	697	2077	1 952 576	5390	817	2366	2 288 504
1937	4821	713	2117	2 095 239	5650	836	2412	2 455 710
1981	5042	730	2157	2 241 290	5909	855	2456	2 626 888
2032	5305	748	2202	2 418 888	6218	877	2508	2 835 041
2076	5537	765	2241	2 579 447	6490	896	2553	3 023 223
2172	6061	800	2326	2 954 093	7104	938	2649	3 462 324
2216	6309	816	2364	3 137 285	7395	957	2693	3 677 032
2261	6568	833	2404	3 332 317	7698	976	2738	3 905 619
2311	6862	851	2447	3 558 316	8042	998	2787	4 170 499
2356	7132	868	2486	3 770 253	8358	1017	2832	4 418 899
2400	7400	884	2524	3 985 459	8674	1036	2875	4 671 130

NOTES:

1. V_r may only be used as a simplified check of shear capacity, if the beam volume is less than 2.0 m^3.
2. $W_r L^{0.18}$ may be used for beams of any volume to check shear capacity.
3. A complete design shall include the verifications of bearing resistance and fire safety requirements.
4. Dimensions shown in black are the optimum dimensions for straight beams (maximum length of 18.9 m).
5. Beams of dimensions in light grey are fabricated using manual techniques (maximum length of 24.4 m).
6. Other dimensions are available on request; please contact Nordic.

COLUMNS
AXIAL LOADS

To verify that the tabulated resistances are appropriate for the structure being designed, the following questions should be asked (the appropriate modification factor is given in brackets):

1. **Is load duration "standard" (K_D)?**
   K_D is a load duration factor. The tabulated resistances are based on a standard term load (K_D = 1.0), which includes the effects of dead loads plus live loads due to use and occupancy, and snow loads. For other load durations, the specified strength in compression parallel to grain, f_c, shall be multiplied by the appropriate factor permitted by the code.

2. **Is the service condition "dry" (K_S)?**
   K_S is a service condition factor. The tabulated values are based on dry service conditions (K_S = 1.0). For wet service conditions, multiply the specified strength in compression parallel to grain, f_c, by the following factor:
   K_{Sc} = 0.75 for f_c

3. **Is the material free of incising and/or strength-reducing chemicals (K_T)?**
   K_T is a treatment factor. The tables are based on untreated timber (K_T = 1.0). For glued-laminated timber treated with fire-retardant or other potentially strength-reducing chemicals, strength and stiffness capacities shall be based on documented results of tests that shall take into account the effects of time, temperature, and moisture content. For preservative treatment, the treatment factor for unincised glued-laminated timber may be taken as unity.

4. **Is the effective length factor, K_e, equal to 1.0 and the effective column length in the direction of buckling equal to the total column length?**

5. **Are the columns concentrically loaded?**

If the answer to any of these questions is no, the *Column Selection Tables* may not be used. Instead, calculate P_r from the formula given in CSA O86-14, Clause 7.5.8. Information on eccentrically loaded columns is provided in pages 26-27. Note that in certain cases the National Building Code of Canada permits a reduction in the loads due to use and occupancy depending upon the size of the tributary area (refer to Article 4.1.5.8 of the 2010 NBCC).

When the conditions of use do not meet the requirements above, the value of P_r given in the selection tables is not valid. Furthermore, the tabulated values cannot be adjusted by a factor that will apply throughout the entire unsupported length range. Therefore, P_r should be calculated from the CSA O86 standard.

Note: Since column design is an iterative process, the tables may be used to select a trial section. When designing a column with an effective length factor K_e other than 1.0 or 2.0, a preliminary section may be selected by using the table for K_e = 1.0 with L equal to the actual effective length K_eL. The preliminary section can then be checked using the design standard (note the difference between the estimated resistance and the actual resistance will not usually exceed 5%).

COLUMNS
SELECTION TABLES
24F-ES/NPG

FACTORED COMPRESSIVE LOAD RESISTANCES
COLUMN WIDTH – 137 mm

DEPTH	137 mm		178 mm		222 mm		267 mm	
L (m)	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN
2.0	390	390	573	506	739	621	891	732
2.5	324	324	509	414	682	507	840	600
3.0	257	257	439	328	621	402	787	478
3.5	199	199	372	255	557	314	730	374
4.0	154	154	310	197	493	244	671	291
4.5	119	119	256	153	431	190	611	227
5.0	93.0	93.0	211	120	374	149	551	178
5.5	73.4	73.4	173	94.8	322	118	493	141
6.0	58.6	58.6	143	75.9	276	94.2	439	113
6.5	47.4	47.4	119	61.4	237	76.3	389	91.5
7.0			99.3		204		344	
7.5			83.4		175		304	
8.0			70.6		151		268	
8.5			60.1		131		236	
9.0					114		209	
9.5					99.1		185	
10.0					86.8		164	
10.5					76.4		146	
11.0					67.4		130	
11.5							116	
12.0							104	
12.5							93.8	
13.0							84.5	
13.5								
14.0								

NOTES:
1. The tabulated compression resistances are based on simply axially loaded columns subjected to concentric end loads only (no eccentricity). P_{rx} is the factored resistance to buckling about the x-x (strong) axis. P_{ry} is the factored resistance to buckling about the y-y (weak) axis.
2. For L ≤ 2.0 m, use P_r for L = 2.0 m. Where P_r values are not given, the slenderness ratio exceeds 50 (maximum permitted).
3. A complete design shall include the verifications of bearing resistance and fire safety requirements.
4. L = unsupported length
5. Other dimensions are available on request; please contact Nordic.

24F-ES/NPG

FACTORED COMPRESSIVE LOAD RESISTANCES

COLUMN WIDTH – 184 mm

DEPTH	184 mm		222 mm		267 mm		318 mm	
L (m)	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN
2.0	778	778	958	918	1153	1081	1362	1261
2.5	695	695	885	822	1089	969	1300	1132
3.0	608	608	808	720	1021	850	1239	996
3.5	521	521	726	619	949	732	1176	859
4.0	440	440	644	524	874	621	1110	730
4.5	368	368	565	439	797	521	1041	614
5.0	306	306	491	366	721	435	970	514
5.5	254	254	425	304	647	363	897	429
6.0	212	212	366	253	577	303	826	358
6.5	177	177	314	212	513	253	756	300
7.0	148	148	270	178	454	213	689	252
7.5	125	125	233	150	402	180	626	213
8.0	106	106	201	128	355	153	567	181
8.5	90.6	90.6	174	109	314	131	513	155
9.0	77.8	77.8	152	93.6	278	112	463	133
9.5			132		246		418	
10.0			116		219		378	
10.5			102		195		341	
11.0			90.2		174		309	
11.5					155		279	
12.0					139		253	
12.5					125		230	
13.0					113		209	
13.5							190	
14.0							174	
14.5							159	
15.0							145	
15.5							133	
16.0								
16.5								

NOTES:

1. The tabulated compression resistances are based on simply axially loaded columns subjected to concentric end loads only (no eccentricity). P_{rx} is the factored resistance to buckling about the x-x (strong) axis. P_{ry} is the factored resistance to buckling about the y-y (weak) axis.
2. For L ≤ 2.0 m, use P_r for L = 2.0 m. Where P_r values are not given, the slenderness ratio exceeds 50 (maximum permitted).
3. A complete design shall include the verifications of bearing resistance and fire safety requirements.
4. L = unsupported length
5. Other dimensions are available on request; please contact Nordic.

24F-ES/NPG

FACTORED COMPRESSIVE LOAD RESISTANCES

COLUMN WIDTH – 228 mm

DEPTH	228 mm		267 mm		318 mm		362 mm	
L (m)	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN	P_{rx} kN	P_{ry} kN
2.0	1189	1189	1391	1365	1642	1591	1849	1782
2.5	1104	1104	1314	1269	1569	1480	1776	1659
3.0	1014	1014	1233	1166	1496	1362	1707	1528
3.5	918	918	1148	1058	1421	1238	1638	1390
4.0	821	821	1059	948	1342	1110	1566	1249
4.5	726	726	967	839	1260	985	1492	1109
5.0	637	637	876	737	1175	866	1414	976
5.5	554	554	788	642	1089	756	1334	853
6.0	480	480	704	557	1004	657	1252	742
6.5	416	416	627	483	920	570	1170	644
7.0	359	359	556	418	840	494	1089	559
7.5	311	311	492	362	764	428	1009	485
8.0	270	270	436	314	693	372	933	422
8.5	235	235	385	273	628	324	859	367
9.0	205	205	341	239	568	283	790	321
9.5	179	179	303	209	513	248	725	281
10.0	157	157	269	184	464	218	665	247
10.5	139	139	240	162	419	192	609	218
11.0	123	123	214	143	379	170	558	193
11.5			192		344		511	
12.0			172		312		468	
12.5			155		283		429	
13.0			140		258		394	
13.5					235		362	
14.0					214		332	
14.5					196		306	
15.0					180		282	
15.5					165		260	
16.0							240	
16.5							222	

NOTES:

1. The tabulated compression resistances are based on simply axially loaded columns subjected to concentric end loads only (no eccentricity). P_{rx} is the factored resistance to buckling about the x-x (strong) axis. P_{ry} is the factored resistance to buckling about the y-y (weak) axis.
2. For L ≤ 2.0 m, use P_r for L = 2.0 m. Where P_r values are not given, the slenderness ratio exceeds 50 (maximum permitted).
3. A complete design shall include the verifications of bearing resistance and fire safety requirements.
4. L = unsupported length
5. The values shown in grey are for dimensions fabricated using manual techniques.
6. Other dimensions are available on request; please contact Nordic.

COLUMNS
COMBINED LOADS

To verify that the tabulated resistances are appropriate for the structure being designed, the following questions should be asked (the appropriate modification factor is given in brackets):

1. **Is load duration "standard" (K_D)?**
   K_D is a load duration factor. The tabulated resistances are based on a standard term load (K_D = 1.0), which includes the effects of dead loads plus live loads due to use and occupancy, and snow loads. For other load durations, the specified strength in compression parallel to grain, f_c, shall be multiplied by the appropriate factor permitted by the code.

2. **Is the service condition "dry" (K_S)?**
   K_S is a service condition factor. The tabulated values are based on dry service conditions (K_S = 1.0). For wet service conditions, multiply the specified strength in compression parallel to grain, f_c, by the following factor:
   K_{Sc} = 0.75 for f_c

3. **Is the material free of incising and/or strength-reducing chemicals (K_T)?**
   K_T is a treatment factor. The tables are based on untreated timber (K_T = 1.0). For glued-laminated timber treated with fire-retardant or other potentially strength-reducing chemicals, strength and stiffness capacities shall be based on documented results of tests that shall take into account the effects of time, temperature, and moisture content. For preservative treatment, the treatment factor for unincised glued-laminated timber may be taken as unity.

4. **Is the effective length factor, K_e, equal to 1.0 and the effective column length in the direction of buckling equal to the total column length?**

If the answer to any of these questions is no, the *Column Selection Tables* may not be used. Instead, calculate P_r from the formula given in CSA O86-14, Clause 7.5.12. Note that in certain cases the National Building Code of Canada permits a reduction in the loads due to use and occupancy depending upon the size of the tributary area (refer to 4.1.5.8 of the 2010 NBCC).

DESIGN

Members subjected to combined bending and axial compressive loads must be designed to satisfy the strength interaction equation, as follows:

$(P_f/P_r)^2 + M_f/M_r\ [1\ /\ (1-P_f/P_E)] \leq 1.0$

where:

- P_f = factored compressive axial load
- P_r = factored compressive load resistance parallel to grain (refer to the *Column Selection Tables*, pages 22-25)
- M_f = factored bending moment
- M_r = factored bending moment resistance (refer to the *Beam Selection Tables,* pages 18-21)
- P_E = Euler buckling load in the plane of the applied moment
- $P_E = \pi^2\ 0.87\ E_SI\ /\ (K_eL)^2$ where E_SI is taken from the *Beam Selection Tables* (pages 18-21), K_e is the effective length factor, and L the unsupported length in the direction of the applied bending moment.

When checking the interaction equation, the compressive resistance P_r is calculated as if only the compressive loads were present. Therefore, it is always based on buckling in the weakest direction.

ECCENTRICALLY LOADED COMPRESSION MEMBERS

When a load is not applied in the center of the vertical axis of a compression member, the eccentricity will create a moment. At the location where the load is applied (typically the top of the column), there is no deflection and therefore the moment does not need to be amplified. The interaction equation takes the following form:

$(P_f/P_r)^2 + P_fe/M_r \leq 1.0$

where:

- e = load eccentricity, i.e. distance between the centre of the column and the centroid of the applied load

Midway between the location where the load is applied and the column support (typically mid-height of the column), the interaction equation takes the following form:

$(P_f/P_r)^2 + 1/2\ P_fe/M_r\ [1\ /\ (1-P_f/P_E)] \leq 1.0$

LATERAL RESTRAINT

In the case of members of rectangular section subjected to combined loads, the lateral stability factor, K_L, may be taken as unity when lateral support is provided at points of bearing to prevent lateral displacement and rotation, provided that the maximum depth-to-width ratio of the member does not exceed 4:1 if no additional intermediate support is provided, or, 5:1 if the member is held in line by purlins or tie rods (refer to CSA O86-14, Clause 6.5.4.2 for more details). Alternatively, K_L may be calculated in accordance with Clause 7.5.6.4 of CSA O86-14.

COLUMNS WITH SIDE BRACKETS

The 2015 NDS provides a design method that allows calculation of the actual bending stress if the eccentric load is applied by a bracket within the upper quarter of the length of the column, as follows. Assume that a bracket load, P, at a distance, e, from the center of the column, is replaced by the same load, P, centrally applied at the top of the column, plus a side (lateral) load, P_s, applied at midheight. Calculate P_s from the following formula:

$P_s = 3P\ e\ L_p\ /\ L^2$

where:

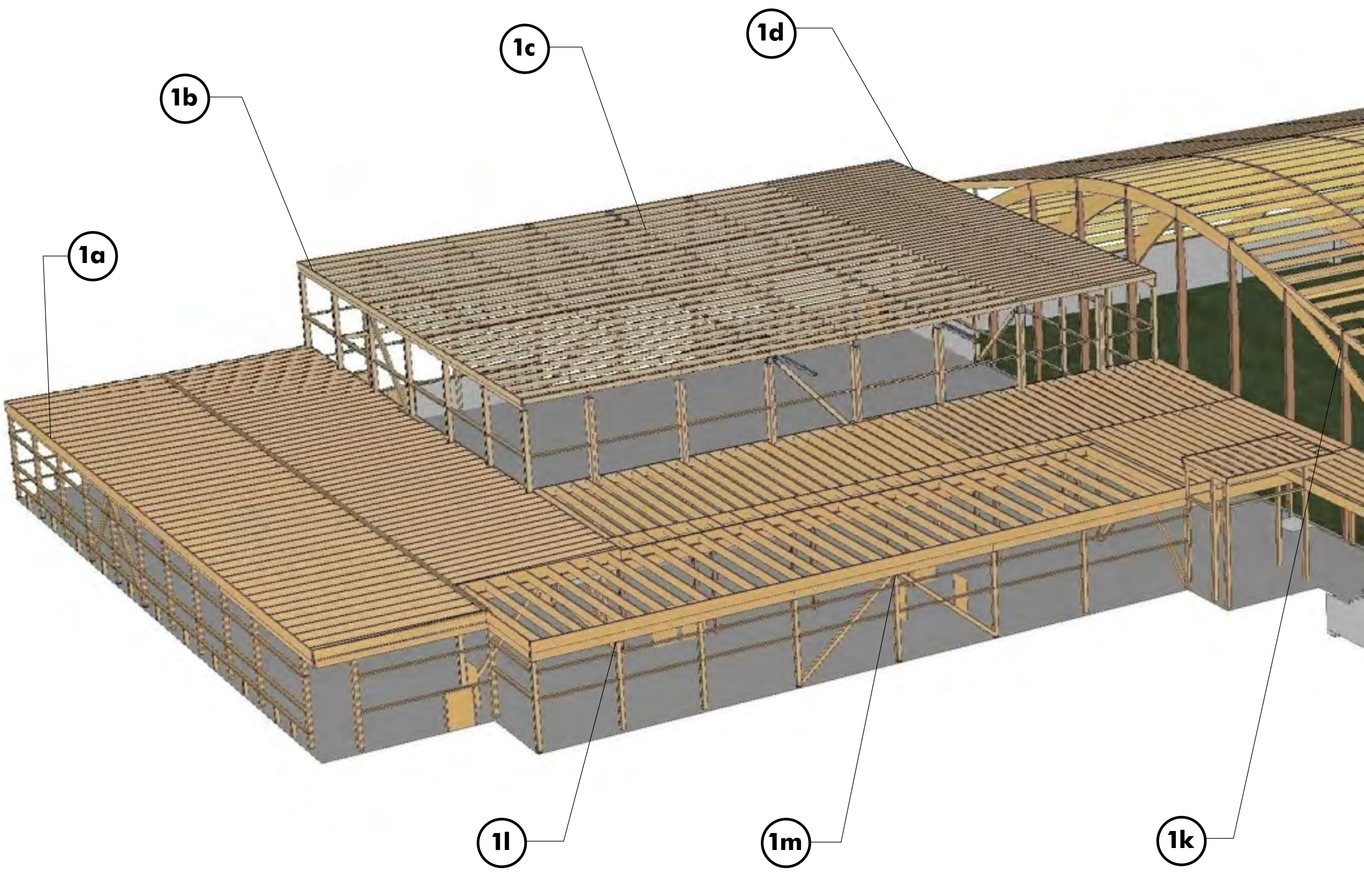
- P_s = assumed horizontal side load placed at center of height of column, kN
- P = actual load on bracket, kN
- e = horizontal distance from load on bracket to center of column, mm
- L_p = distance measured vertically from point of application of load on bracket to farther end of column, mm
- L = total length of column, mm

The assumed centrally applied load, P, shall be added to other concentric column loads, and the calculated side load, P_s, shall be used to determine the actual bending stress for use in the formula for concentric end and side loading.

CONNECTION
DETAILS

FIGURE 1
TYPICAL CONNECTION DETAILS

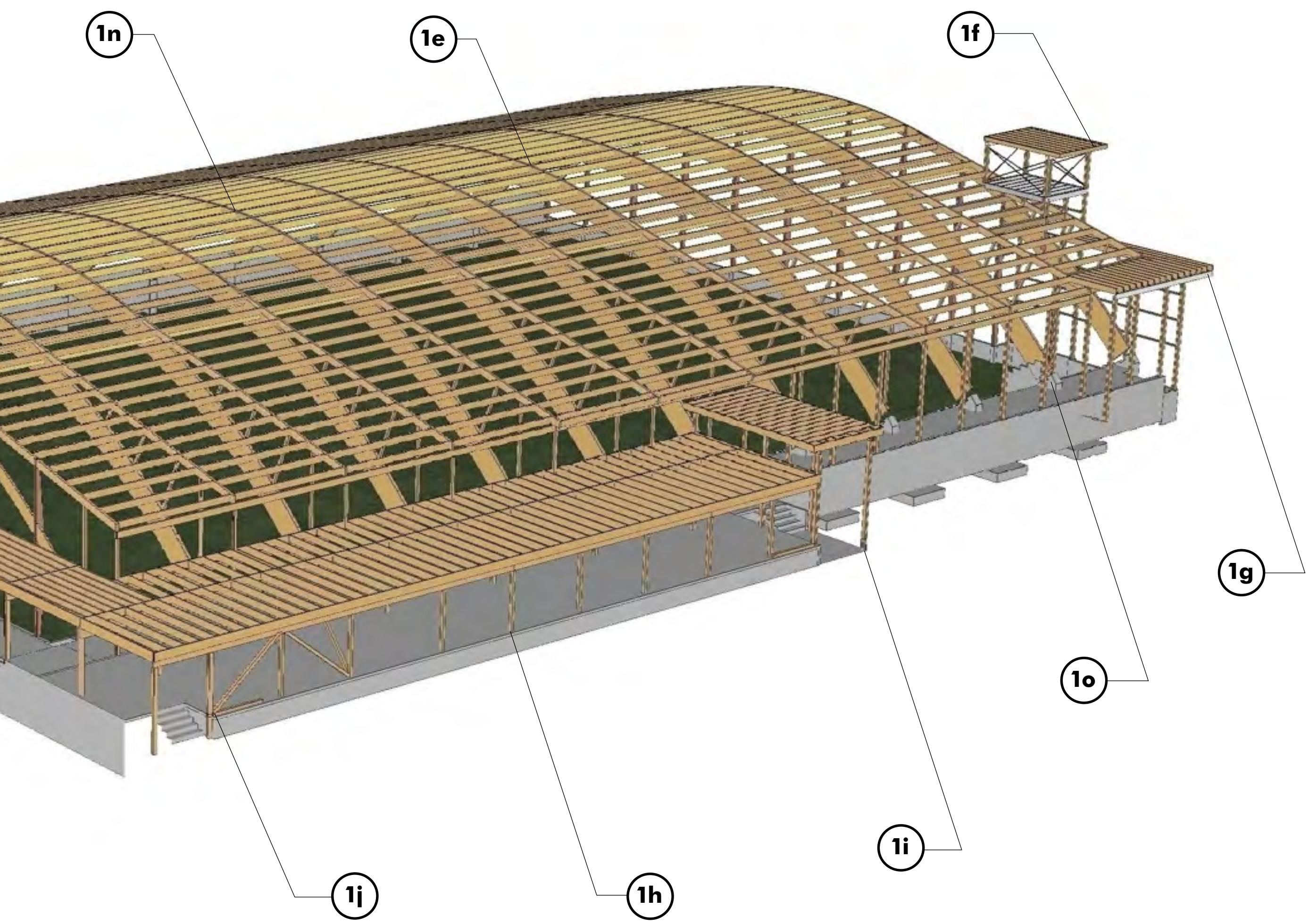
These typical details are intended as guides; therefore quantities of connectors are illustrative only and drawings shall not be scaled. Some framing requirements such as erection bracing and blocking members have been omitted for clarity.



Proper connections details are important to the structural performance and serviceability of any timber-framed structure. Careful consideration of moisture-related expansion and contraction characteristics of wood is essential in detailing glulam connections to prevent inducing tension perpendicular-to-grain stresses. It is also important to design connections to isolate all wood members from potential source of excessive moisture.

NOTES:

1. The details shown in Figure 1 are intended as guides. The final design shall include considerations for the specified resistances, end and edge distances, spacing between fasteners, dimensional changes, installation requirements, fire safety, among other things.
2. The factored resistances shown are based on standard term load duration and dry service conditions, and are given for informative purposes only; consult Nordic for more details.
3. When connectors and fastenings are used in wet service conditions, factored resistances shall be adjusted accordingly and additional precautions should be used to prevent moisture or free water being trapped.
4. Joint details should be avoided where shrinkage of the wood can lead to excessive tension perpendicular-to-grain stress.
5. Sufficient clearance must be provided between sides of steel connection hardware and wood members to permit installation.
6. Joints shall be assembled so that the surfaces are brought into close contact.
7. The details shown are considered to have a 15 minutes fire resistance rating. Greater fire resistance ratings may be possible.



While the details must address serviceability concerns associated with glulam connection detailing, it is important to emphasize that all connection details must effectively transfer the design loads imposed on the structure and that all designs be in accordance with accepted engineering practice. The following basic principles, if followed, will lead to efficient, durable and structurally sound connections.

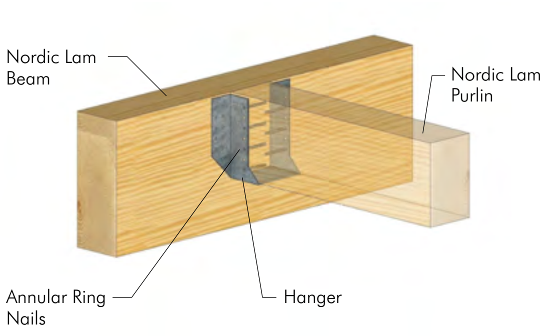
BASIC PRINCIPLES:

1. Transfer loads in compression bearing whenever possible.
2. Allow for dimensional changes in glulam due to potential in-service moisture cycling.
3. Avoid the use of details that induce tension perpendicular-to-grain stresses in a member.
4. Avoid moisture entrapment at connections.
5. Do not place glulam in direct contact with masonry or concrete.
6. Avoid eccentricity in joint details.
7. Minimize exposure of end grain.

Nordic connectors are manufactured in-house. Precision forming with manufacturing quality control provides dimensional accuracy and helps ensure proper bearing area and connection.

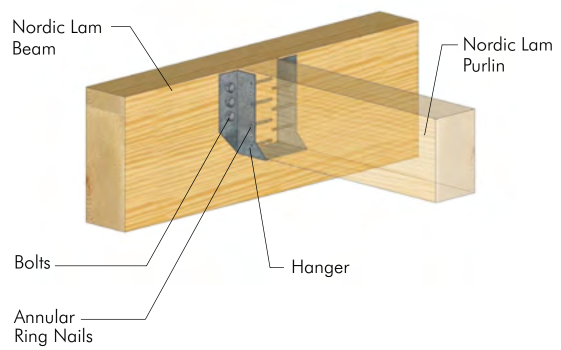
FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

1a HANGER WITH ANNULAR RING NAILS



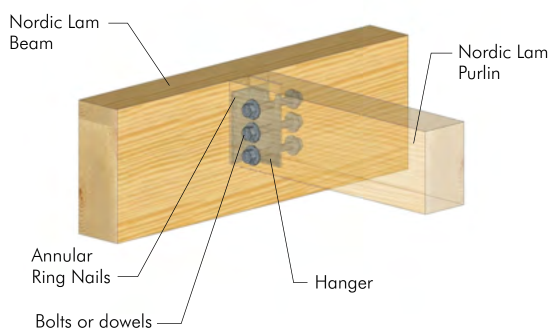
NOTES:
- Standard bent hangers, with annular ring nails; factored resistances up to 90 kN
- Flanges may be concealed for corner assemblies.

1b HANGER WITH BOLTS



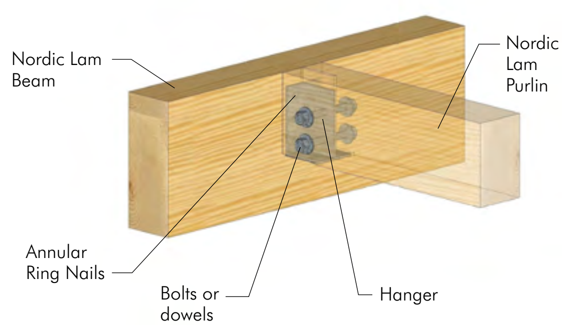
NOTE:
- Standard bent hangers, with bolts; factored resistances up to 90kN

1c HANGER WITH WEB IN SAW KERF



NOTES:
- The notch at the top of the plate facilitates the positioning of the purlin.
- Fastener through web may be concealed with wood plug in counter-bored hole.

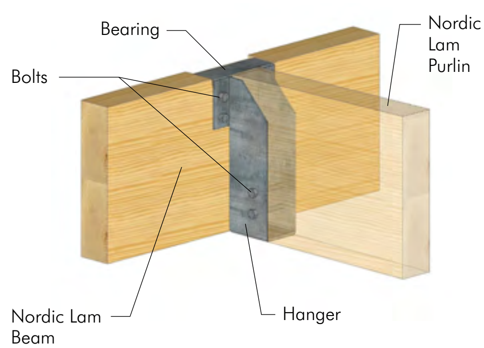
1d HANGER WITH WEB IN SAW KERF AND BEARING



NOTES:
- Factored resistances up to 90kN
- Fastener through web may be concealed with wood plug in counter-bored hole.

1e HIGH-CAPACITY HANGER

NOTES:
- High-capacity hangers are generally designed for factored resistances greater than 90 kN and/or to facilitate a particular geometry. Hangers may be face and/or top loaded.
- The height of the hanger brackets must be at least equal to 2/3 of the supported member.
- In this figure and similar details, fasteners should be located as close as practical to the bearing surface to minimize splitting due to shrinkage.

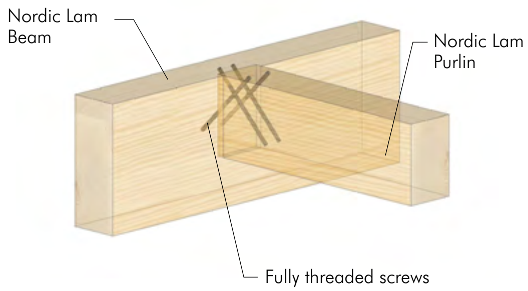


A QUALIFIED DESIGNER MUST ALWAYS EVALUATE EACH CONNECTION, INCLUDING WOOD MEMBERS LIMITATIONS.

FIGURE 1

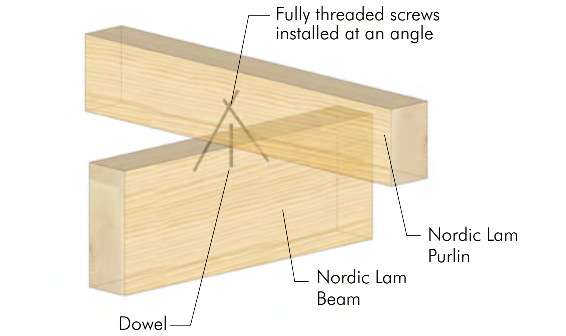
TYPICAL CONNECTION DETAILS (continued)

1f CONNECTION WITH SCREWS



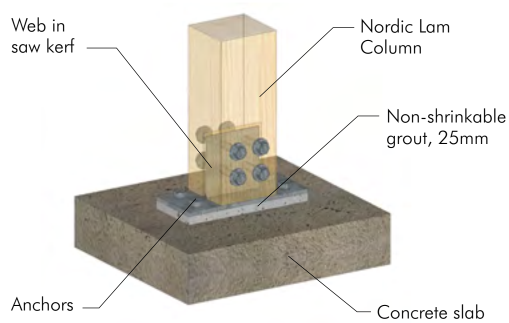
NOTES:
- Pre-drilling is not required with SFS WT-T type screws.
- Beam may be marked for purlins alignment.

1g CONNECTION WITH SCREWS AND DOWEL



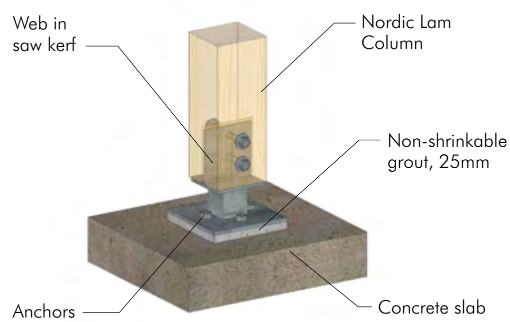
NOTES:
- Pre-drilling is not required with SFS WT-T type screws.
- The dowel, optional, is used for purlins alignment.

1h COLUMN BASE, SIMPLE



NOTES:
- Standard column base, simple
- The anchors and nuts may be located in holes counter-bored into the bottom of the column. This detail is used where the width of the connection must be minimised or appearance is important.

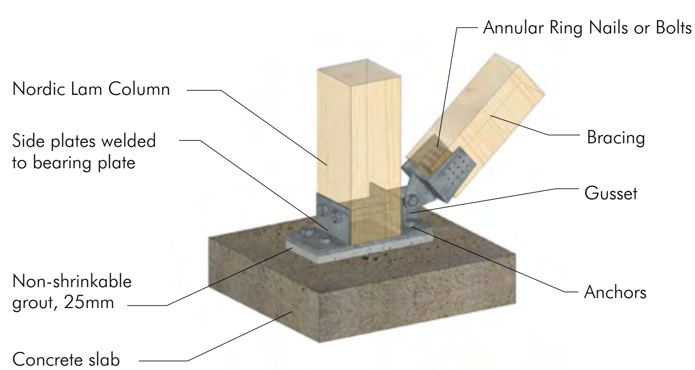
1i COLUMN BASE, DOUBLE



NOTES:
- Standard column base, double
- This type of assembly reduces the increase of moisture in the timber by capillarity (specifically for exterior applications).

1j COLUMN BASE WITH BRACING

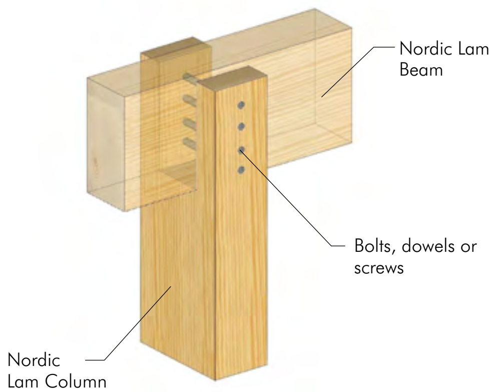
NOTE:
- Column bases should be elevated above the concrete floor level.



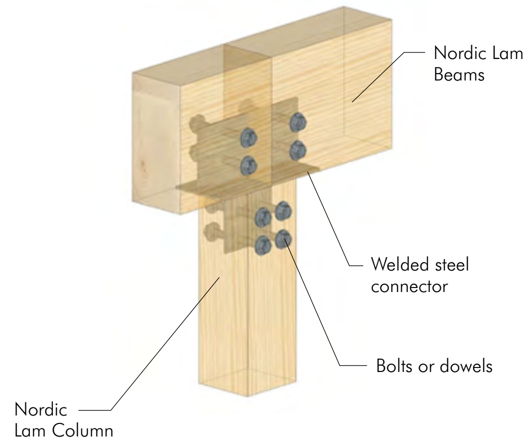
A QUALIFIED DESIGNER MUST ALWAYS EVALUATE EACH CONNECTION, INCLUDING WOOD MEMBERS LIMITATIONS.

FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

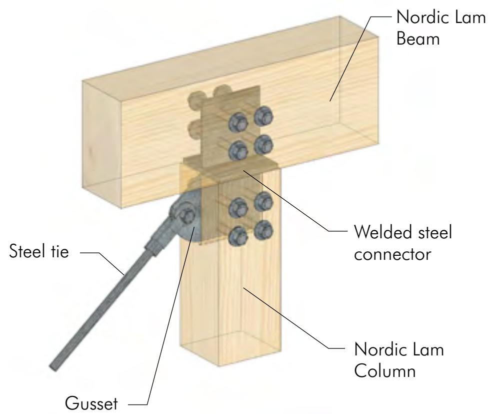
1k MORTISE COLUMN TOP



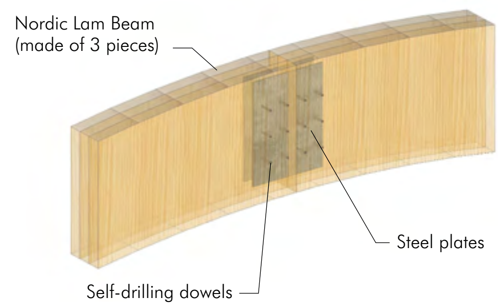
1l COLUMN TOP WITH CONNECTOR



1m COLUMN TOP WITH BRACING

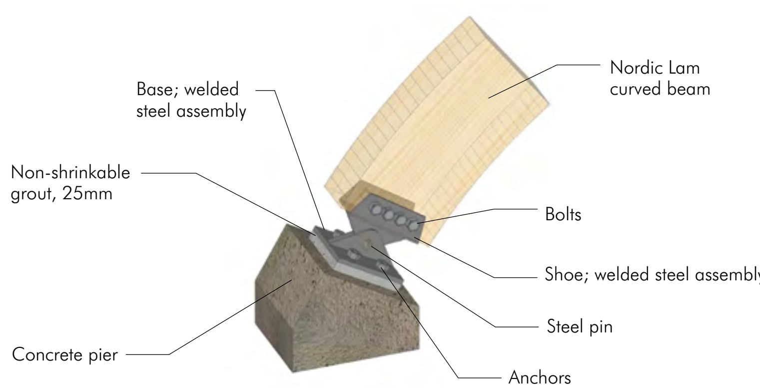


1n TRANSPORT SPLICE



NOTE:
- The self-drilling dowels are designed to drill both wood and steel.

1o BASE FOR ARCHES



NOTE:
- Arch bases should be elevated above the concrete floor level.

A QUALIFIED DESIGNER MUST ALWAYS EVALUATE EACH CONNECTION, INCLUDING WOOD MEMBERS LIMITATIONS.

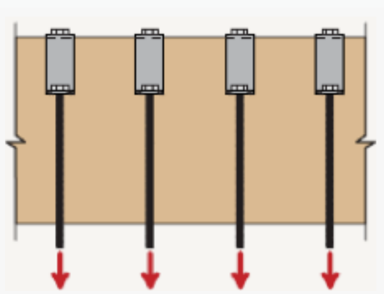
NOTICES

1. In addition to the moisture-induced tension-perpendicular-to-grain failures, similar failures can result from a number of different, incorrect connection details. Improper beam notching, eccentric loading and loading beams from the tension side can induce internal moments and tension perpendicular-to-grain stresses.
2. Field studies have shown that any metal connectors or parts of connectors that are placed in the "cold zone" of the building (that area outside of the building's insulation envelope) can become condensation points for ambient moisture. This moisture has ready access to the inside of the beam through fasteners and exposed end grain.

SUSPENDED LOADS

Heavy concentrated loads suspended from glued laminated timber beams should be resisted from the top of the member or at least above the neutral axis.

HEAVY CONCENTRATED LOADS SUSPENDED FROM BEAM



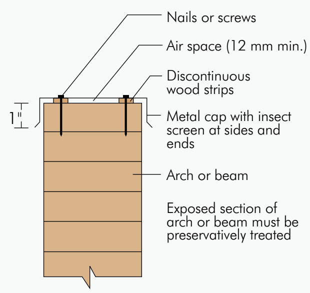
PROTECTION CONSIDERATIONS FOR OVERHANGS

Portion of beam extending outside of building should be covered or protected by metal cap and preservative treatment. Beam should be protected from direct exposure to weather by fascia. Roof should be sloped for drainage and designed to prevent ponding of water. Taper cut, to prevent end grain from absorbing water, should be sealed.

RECOMMENDED USE OF METAL CAPS

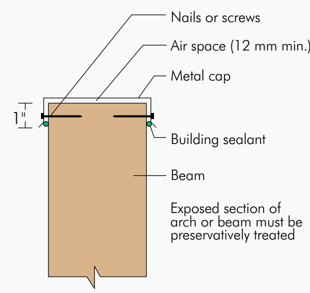
Cap or flashings are made of weatherproof metal. Nails or screws are weatherproof and heads are sealed with building sealant or neoprene washers.

TOP CAP FOR HORIZONTAL OR SLOPED MEMBERS



END VIEW

END CAP FOR EXPOSED BEAMS OR VERTICAL MEMBERS



SIDE OR CROSS-SECTION VIEW

INSPECTION AND TIGHTENING

Structures shall be inspected regularly at intervals not exceeding six months until it becomes apparent that further shrinkage of the wood will not be appreciable *(client's responsibility)*. At each inspection the fastenings shall be tightened sufficiently to bring the faces of the connected members into close contact without deformation.

ENGINEERING AND ARCHITECTURAL SERVICES

Nordic Engineered Wood offers a full range of architectural and engineering services to help our clients bring their wood construction projects to fruition.

Various architectural projects, including athletic facilities and office buildings, attest to the visual appeal and structural performance of glued-laminated timber. But glulam is also well-suited for projects where aesthetics are less of a priority, such as warehouses and industrial buildings. Nordic's range of products, which includes curved beams, purlins, decking and cross-laminated timber, provides effective solutions for many kinds of structures.

From the design to the completion of each wood structure and preassembled wall panel, Nordic works with a variety of competent construction teams to ensure that our clients' projects are finished on time and within budget.

SOFTWARE
NORDIC SIZER

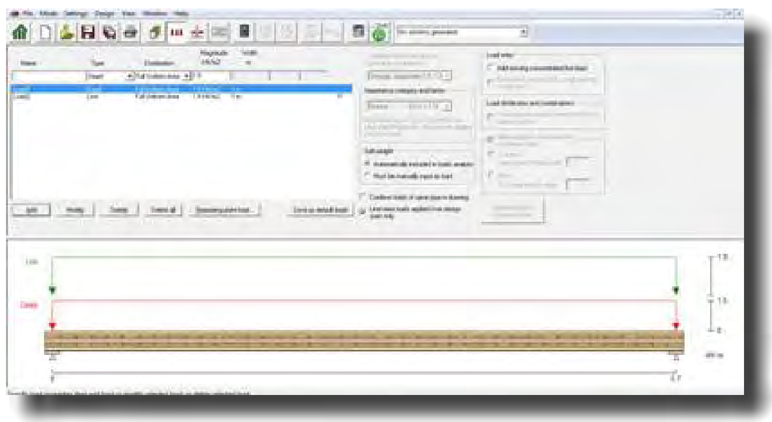
Nordic Sizer is a software program that can be used to design individual members (joists, beams, floor/roof slabs, studs, columns, wall panels) using the full range of engineered wood products: glued laminated timber, prefabricated wood I-joists, **glulam decking,** and cross-laminated timber.

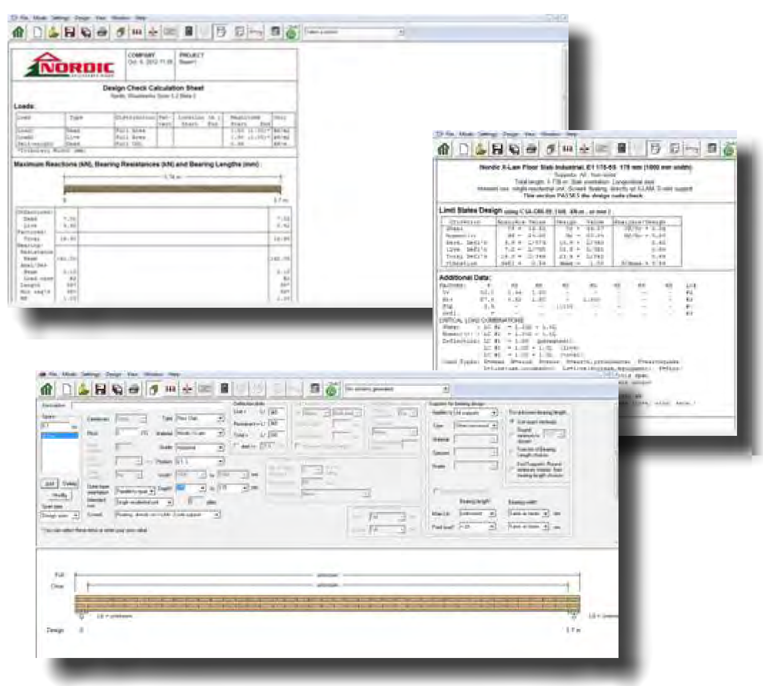
Users can analyze and verify simple or multiple span members for specified dead, live, snow and wind loads, as per **CSA O86-09 or -14,** and automatically patterns loads and checks all load combinations as per NBCC 2010. Joists and beams may be horizontal, sloped or have an oblique angle.

The user may also specify deflection limits, lateral bracing, end notches, web holes, built-up members, service conditions, and floor composition, the latter one for **vibration check**. Material, grade/series, width and thickness may all be specified as 'unknown' – a list of acceptable sections with all the combinations for a given span and loading arrangement will be generated.

Nordic Sizer can be used to analyze and designs columns, studs and wall panels in load-bearing applications; columns may be designed for combined bending and axial loads. The most recent feature is the **fire design** for massive timber. The designer may now design massive timber for fire resistance based on the NBCC 2010 and/or CSA O86-14, Annex B.

Nordic Sizer





http://nordic.ca/en/documentation/software

STORAGE
AND HANDLING

Nordic products must be stored properly and handled with care in order to ensure optimal performance. Unless otherwise indicated, the timber is protected with a sealer and wrapping before leaving the plant. Sealer is applied to the ends of members to protect against moisture penetration and checking. A layer of sealer must also be applied after trimming or cutting members at the jobsite. A surface sealer may be applied to the top, bottom and sides of members to increase resistance to soiling and moisture penetration and help control checking and grain raising. A penetrating sealer should be used if the members are to be stained or left exposed for a natural look.

Water-resistant wrapping is another way to protect members from soiling, checking and exposure to moisture during transit, storage and erection. Members can be individually wrapped, bundle wrapped or load wrapped. If the wrapping must be removed during erection in order to facilitate assembly, it is recommended to remove it fully rather than partially in order to avoid uneven discoloration due to sun exposure.

Glulam members are often loaded and nloaded using a forklift. For increased stability, members should be placed on the forks on their sides rather than bottom down. However, lifting an extra-long member on its side can cause it to flex excessively, increasing the risk of damage. Multiple forklifts must therefore be used with longer members. If a crane with slings is used for loading or unloading, adequate blocking must be placed between the sling and the member. Wooden skids or blocking should be used to protect corners, and glulam should only be lifted with non-marring slings. Using spreader bars can reduce the risk of damage when lifting extra-long members with a crane.

Glulam should be stored in a well-drained area of the jobsite and kept off the ground using rack systems or lumber blocking and skids. Members should remain wrapped in order to protect them from moisture, dirt, sunlight and scratches.

PORTFOLIO

PORTFOLIO

UQAC Arena
Chicoutimi, Que. (2009)

Captaincy of the marina
Roberval, Que. (2010)

Telus Stadium
Quebec, Que. (2012)

Parc Chauveau Soccer Complex
Quebec, Que. (2009)

SPECIFICATIONS
FOR LEED

INTRODUCTION

Nordic Lam is a black spruce structural glued laminated timber (glulam) manufactured in accordance with 24F-ES/NPG and 20F-ES/CPG layup combinations listed in CCMC evaluation report 13216-R and APA Product Report PR-L294C. Nordic Lam products are used as structural members and are manufactured in accordance with the in-plant manufacturing standards approved by APA. The adhesives used to manufacture the glulam products are exterior or limited-moisture exposure adhesives meeting the requirements of CSA O112.9 or CSA O112.10, respectively, and containing no added urea-formaldehyde. The laminating lumber is certified under Forest Stewardship Council Standard FSC-STD-40-004.

GREEN PRODUCTS

Nordic Lam glulam products listed above are qualified for green construction with points specified in Table 1, as independently verified by APA[1] as meeting pertinent criteria of the 2009 LEED Canada for New Construction and Major Renovations Standard.

TABLE 1
2009 LEED CANADA FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

Points that have been verified as eligible by APA[1]

	Section/Criteria	Eligible Points	Maximum Points
√	IEQ 4.4: Low Emitting Materials: Composite wood products used on the interior of the building (i.e., inside the weatherproofing system) must contain no added urea-formaldehyde resins	1	1

Eligible points that are conditional on construction location and application

	Section/Criteria	Eligible Points	Maximum Points
√	MR 5: Regional Materials: Use building materials or products that have been extracted, harvested, recovered and processed within 800 km of the final manufacturing site. Demonstrate that the final manufacturing site is within 800 km (2,400 km if shipped by rail or water) of the project site for these products for a minimum of 20% or 30%.	1 pt for 20% and 2 pts for 30%	1 pt for 20% and 2 pts for 30%
√	MR 7: Certified Wood: Use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's Principles and Criteria, for wood building components.	1	1

ADDITIONAL INFORMATION

- Nordic Lam is manufactured in the Chantiers Chibougamau Ltd (CCL) facility in Chibougamau, Quebec.
- CCL uses source materials, i.e. lumber, that have been extracted, harvested, recovered and processed within 800 km of the final manufacturing site. The mean harvesting distance is 100 km, and the farthest distance 240 km.
- Nordic Lam is made of 96% (by weight) of wood fibre; the other components include resins (no added urea-formaldehyde resins) and wax.
- LEED IEQ Credit 4.1, Low- emitting Materials: Adhesives and sealants - Not applicable
- LEED MR Credit 3, Materials Reuse - Not applicable

SUPPORTING DATA

- [1]APA Green Verification Reports GR-L294, Nordic Lam
- FSC SW-CW/FM-003874 Forest Management and SW-COC-CW-003885 Chain-of-Custody (CCL)
- FSC SW-COC-004084 Chain-of-Custody (Nordic)

ONE SMALL STEP FOR NORDIC

ONE GIANT STEP

FOR INDUSTRY

From its inception Nordic has strived to provide the most efficient wood products with the least environmental impacts. That's why Nordic, in its exclusive partnership with Chantiers Chibougamau Ltd., has become a leader in demanding well-managed forestry practices.

Back in 2000, Nordic was one of the first in North America to demand that the wood used in its products meet or exceed the ISO 14001 Standard. Continuing its ongoing commitment to responsible wood solutions, Nordic is proud to offer products that are certified by the Forest Stewardship Council, the international benchmark of well-managed forests.

What's in a logo?

With all the certification bodies out there, trying to do the right thing and buying responsibly produced products can be confusing. The FSC label makes it easy to make the right choice when buying wood products. This is what sets FSC apart:

Only FSC

- prohibits conversion of natural forests or other habitat around the world
- prohibits the use of highly hazardous pesticides around the world
- respects human rights with particular attention to indigenous peoples
- is the only forest ***certification system*** that is supported by all major environmental groups.
- identifies areas that need special protection (e.g. cultural or sacred sites, habitats of endangered animals or plants.

But most importantly only FSC reviews each certified operation ***at least*** once a year – and if they are found not to comply, the certificate is withdrawn.

> **"FSC has the highest environmental standard for forest management of any certification system in the world."**
>
> Monte Hummel
>
> *World Wildlife Fund, Canada*

Protecting nature's resources is everyone's responsibility; at Nordic we are doing our part.

Do yours.

FSC-Certified wood products are available. Consult your local distributor for details.

FSC
www.fsc.org

The mark of responsible forestry

FSC® C011517

www.nordicewp.com

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