WoodWorks® SOFTWARE FOR WOOD DESIGN

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Wood Solutions Fair

woodWORKS! Program of the Canadian Wood Council

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This course is registered with

Course Description

WoodWorks® Design Office is a structural engineering software package that has been developed over the past fifteen years by the CWC for professionals who specify wood structural components and connections in accordance with the NBC and CSA O86. This session will focus on the capabilities of Sizer and Connections, and will be of interest to all design professionals interested in learning how to use WoodWorks® to specify or confirm the capacity of wood beams, joists, columns, studs, steel beams, and fasteners such as lags, wood screws, bolts, rivets, nails, and shear plates. Concise explanations, including recent updates to conform to CSA O86-14 will be supplemented with software demonstrations.

Learning Objectives

At the end of the this course, participants will be able to:

Key learning points:

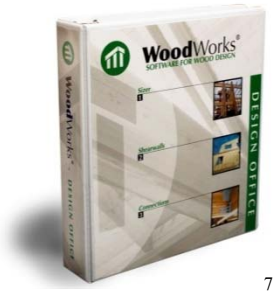
- How to design structural wood elements (beams, joists, walls, columns) for gravity loads using WoodWorks® Sizer.
- How to design wood-to-wood, wood-to-steel, and wood-to-concrete connections using WoodWorks®.
- How to construct whole building models for gravity load design of structural wood elements.
- Overview of technical changes between CSA O86-09 and -14.

The Canadian Wood Council represents the Canadian wood products industry through a national federation of Associations:

Canadian Wood Council / Conseil canadien du bois

www.cwc.ca

CWC produces and communicates technical information to architects, engineers, builders, and other designers on how to use wood in buildings from a structural, fire, and sustainability design perspective.



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Design Office
SIZER | SHEARWALLS | CONNECTIONS

WoodWorks®
SOFTWARE FOR WOOD DESIGN

SIZER
Gravity Design
- Concept mode
- Beam mode
- Column mode

DATABASE EDITOR
Add proprietary products

SHEARWALLS
Lateral Design (Wind and Seismic)

CONNECTIONS
Fasteners

CDN Standard

Electronic copy of CSA O86 included with purchase of Design Office suite ($205 value)

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WoodWorks® SOFTWARE FOR WOOD DESIGN

- **PART 1: *Sizer, Connections*: An overview and demonstration with updates to CSA O86-14**
- ***PART 2: Analysis and design for wind and seismic loads using Shearwalls with updates to CSA O86-14***

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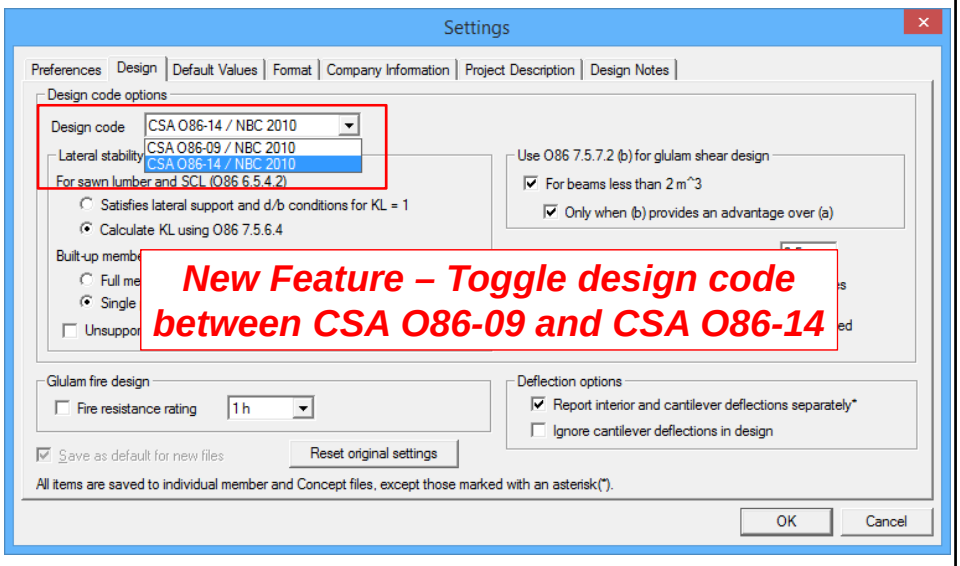
SIZER



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NBC Part 4 vs. NBC Part 9

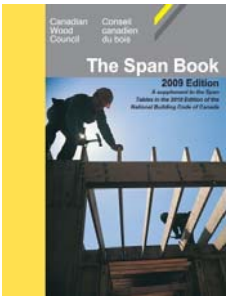
Part 4:

- Engineered Design
- CSA O86

WoodWorks Software Follows a Part 4 Design

Part 9:

- Prescriptive Design
- Span Tables in Appendix



Additional Construction Factors, Guidance Provided in CWC "Span Book" (Available through CWC Webstore)

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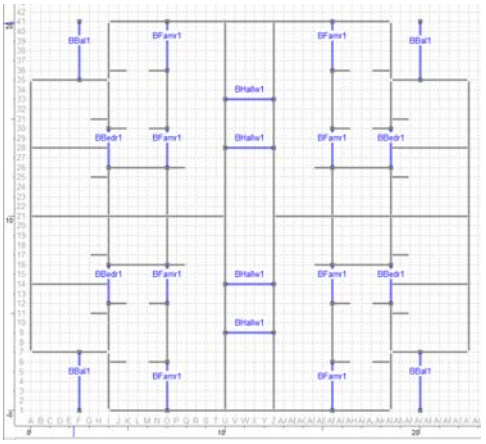

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SIZER-Concept

WoodWorks® SOFTWARE FOR WOOD DESIGN

- **Preliminary Gravity Load Design Tool**
  - Capable of modelling **Columns**, **Walls**, **Beams** and **Joists**
  - Can input line, area or point loads
  - Models can be up to 6 storeys in height
  - Automatically distributes and transfer loads from the top storey to bottom storey
  - Can produce material lists for costing

Joist Group	Material	Joist Area	Max. Length	Pcs.	Ttl Len.	Sfc. Area
Roof_Jst1	Lumber	j136	1.50	6	9.0	4.5
	S-P-F	j137	2.00	2	4.0	2.0
	No.1/No.2	j138	1.50	2	3.0	1.5
	38.0 x 38.0	j139	3.50	6	21.0	10.5
		j140	1.50	2	3.0	1.5
		j141	2.00	2	4.0	2.0
		j142	2.00	2	4.0	2.0
		j143	1.50	2	3.0	1.5
		j144	1.50	2	3.0	1.5
		j145	2.00	2	4.0	2.0
		j146	1.50	6	9.0	4.5

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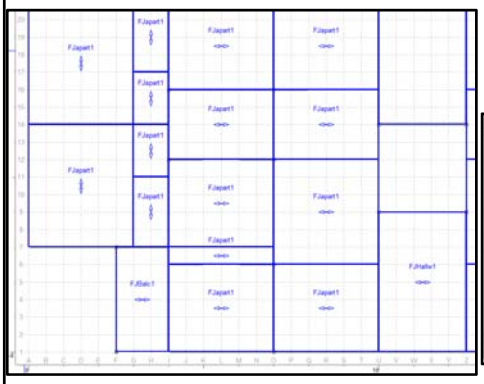
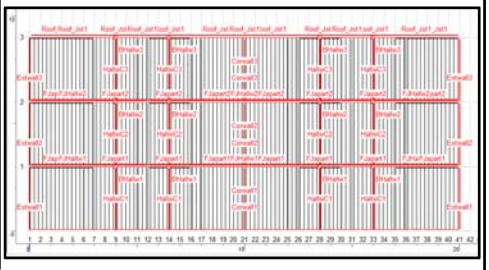
SIZER-Concept

WoodWorks® SOFTWARE FOR WOOD DESIGN

Plan View



Elevation View



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SIZER-Concept

WoodWorks® SOFTWARE FOR WOOD DESIGN

- **Concept Mode Design Assumptions**
  - Columns and Walls are pinned at both ends
  - Combined (Axial and lateral) load cannot be applied
  - No Bearing Design
  - No Pattern Loading
  - Cannot define eccentric loading
  - Beam fully supported at top edge

Refine Design by transferring members into Beam or Column Mode

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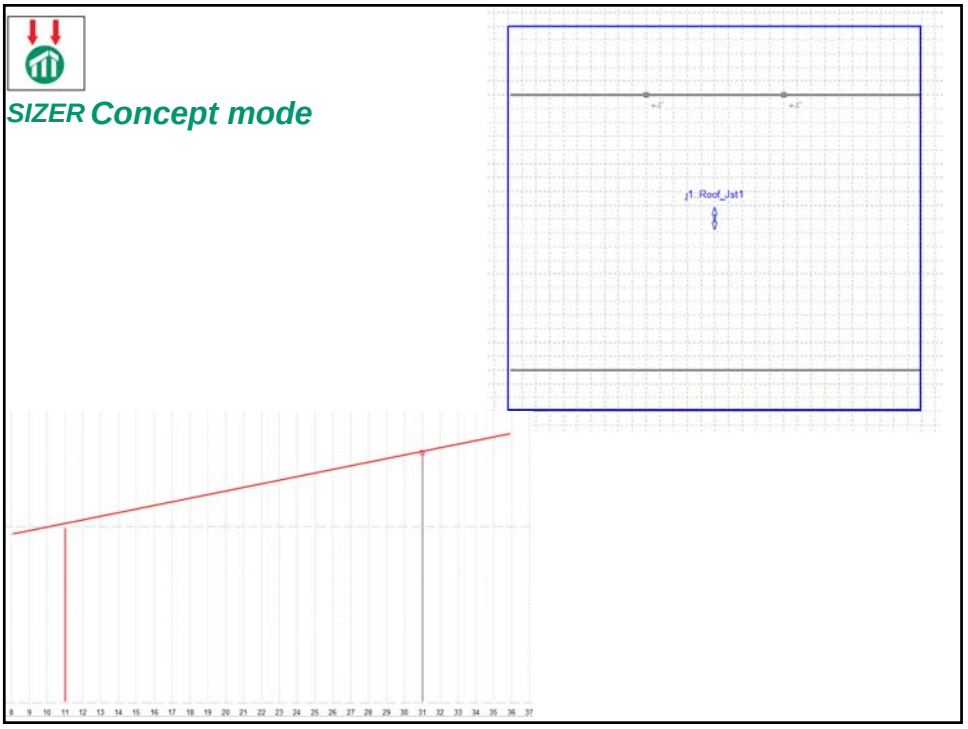
SIZER Concept mode



Concept Mode Demo

Design Office
SIZER | SHEARWALLS | CONNECTIONS

WoodWorks®
SOFTWARE FOR WOOD DESIGN

SIZER
Gravity Design
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  - Beam mode
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Add proprietary products

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CONNECTIONS
Fasteners

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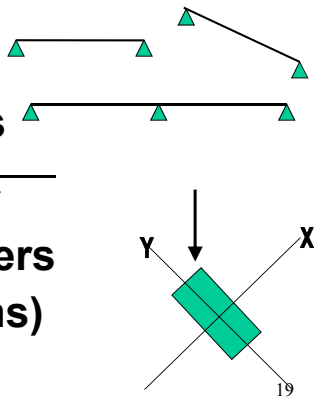
SIZER-Beam

WoodWorks® SOFTWARE FOR WOOD DESIGN

Detailed Design of Beams, Joists, Rafters

- Simply Supported
- Multi-Span Continuous
- Cantilevers
- Biaxial bending members (such as oblique purlins)



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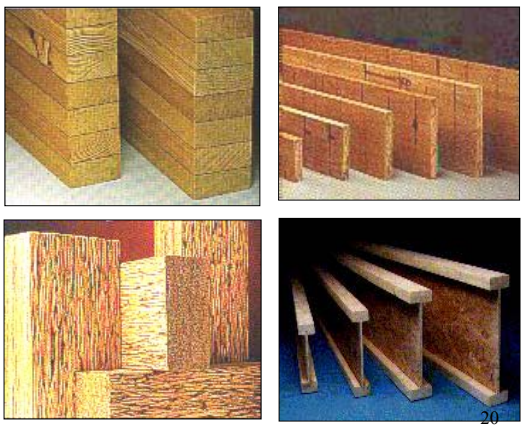
Wood Materials

- Lumber, Timber, Rough Sawn Timber
- Built-up lumber
- Glulam



- *PSL, LVL, LSL*
- *Wood I-Joists*

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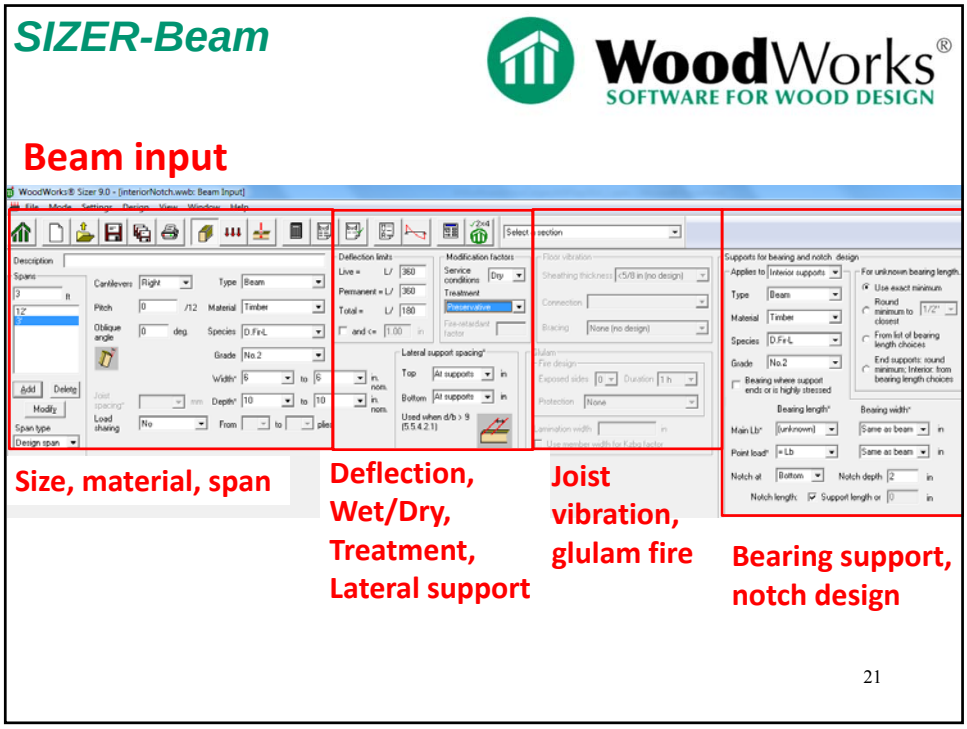
SIZER-Beam
WoodWorks®
SOFTWARE FOR WOOD DESIGN
Beam input
Size, material, span
Deflection, Wet/Dry, Treatment, Lateral support
Joist vibration, glulam fire
Bearing support, notch design
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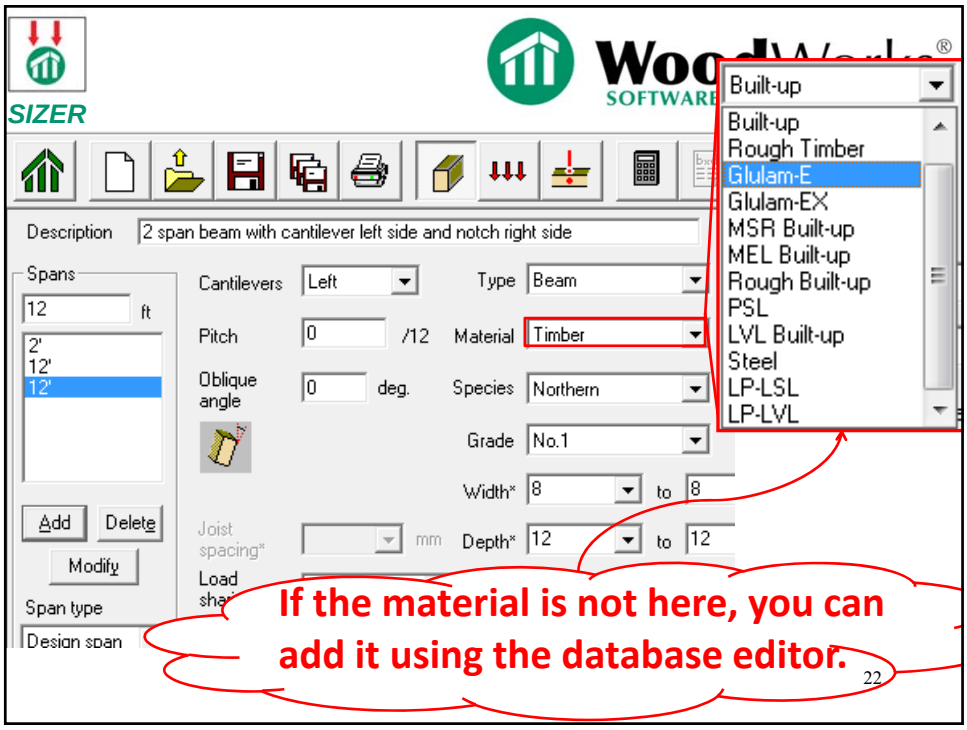
SIZER
Description
2 span beam with cantilever left side and notch right side
Spans
12 ft
2'
12'
12'
Add
Delete
Modify
Span type
Design span
Cantilevers
Left
Type
Beam
Pitch
0
/12
Material
Timber
Oblique angle
0
deg.
Species
Northern
Grade
No.1
Width*
8
to
8
Joist spacing*
mm
Depth*
12
to
12
Built-up
Built-up
Rough Timber
Glulam-E
Glulam-EX
MSR Built-up
MEL Built-up
Rough Built-up
PSL
LVL Built-up
Steel
LP-LSL
LP-LVL
If the material is not here, you can add it using the database editor.
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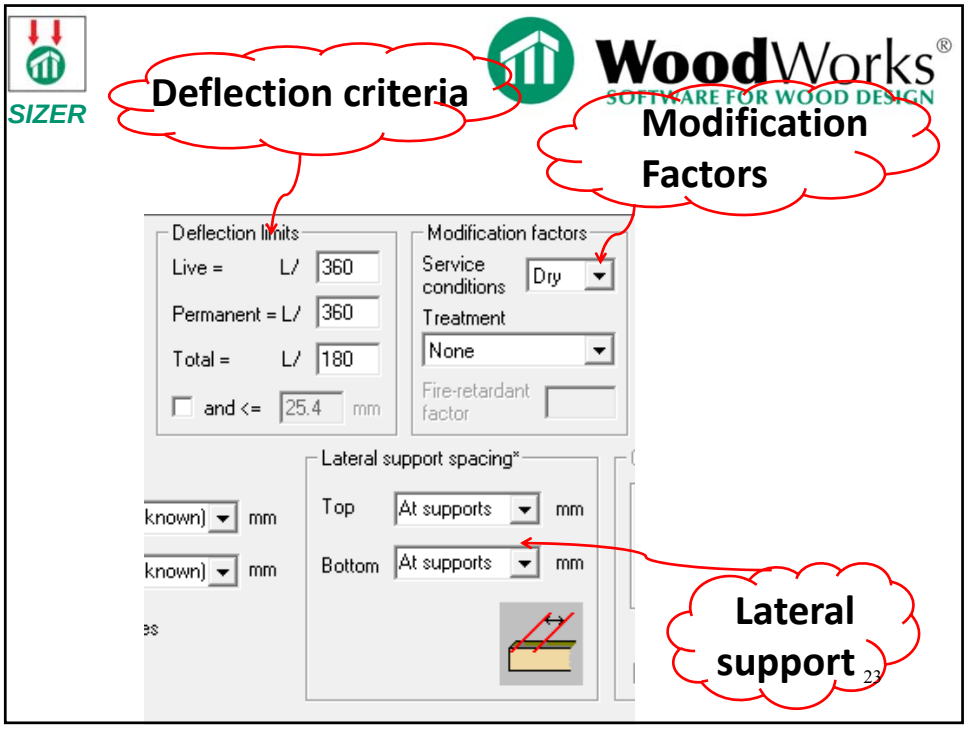
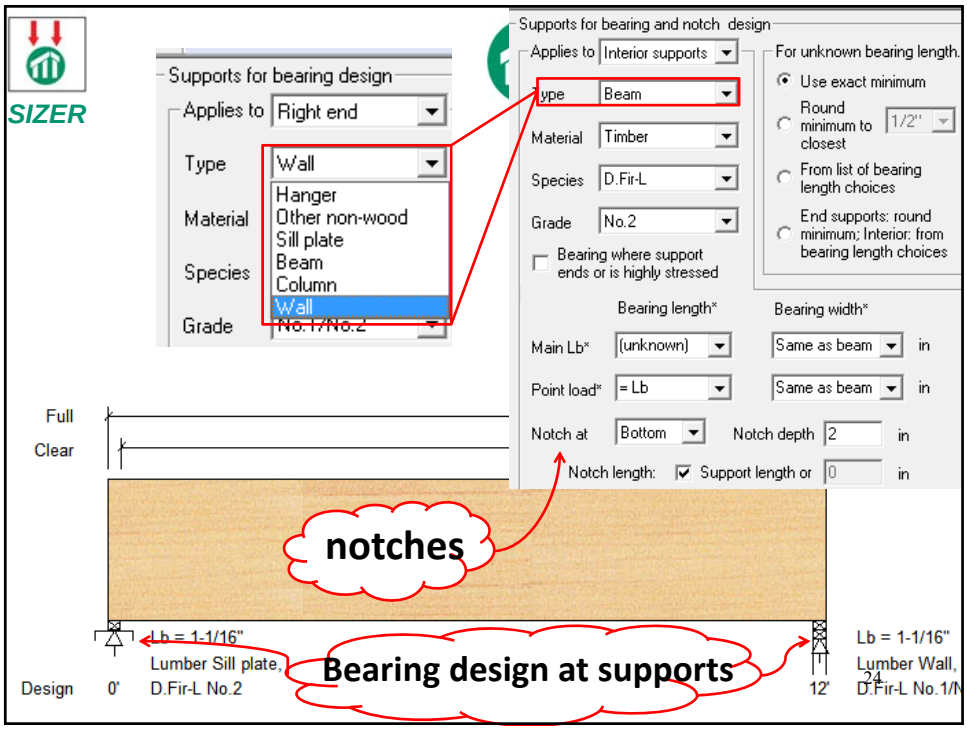

SIZER
Deflection criteria
WoodWorks®
SOFTWARE FOR WOOD DESIGN
Modification Factors
Deflection limits
Live = L/ 360
Permanent = L/ 360
Total = L/ 180
and <= 25.4 mm
Modification factors
Service conditions Dry
Treatment
None
Fire-retardant factor
Lateral support spacing*
Top At supports mm
Bottom At supports mm
Lateral support
23


SIZER
Supports for bearing design
Applies to Right end
Type Wall
Material
Species
Grade
Hanger
Other non-wood
Sill plate
Beam
Column
Wall
Supports for bearing and notch design
Applies to Interior supports
Type Beam
Material Timber
Species D.Fir-L
Grade No.2
Bearing where support ends or is highly stressed
For unknown bearing length
Use exact minimum
Round minimum to closest 1/2"
From list of bearing length choices
End supports: round minimum; Interior: from bearing length choices
Bearing length*
Bearing width*
Main Lb* (unknown) Same as beam in
Point load* = Lb Same as beam in
Notch at Bottom Notch depth 2 in
Notch length: Support length or 0 in
Full
Clear
notches
Lb = 1-1/16"
Lumber Sill plate, D.Fir-L No.2
Bearing design at supports
Lb = 1-1/16"
Lumber Wall, D.Fir-L No.1/N
Design
0'
12'
24

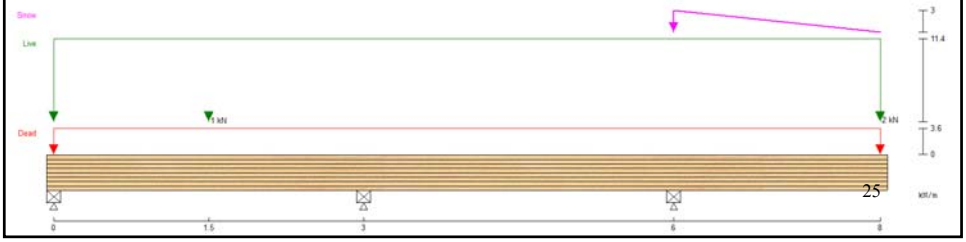
Load type:

Dead
Live
Snow
Wind
Earthquake
Soil
Storage equipment
Controlled fluids

Distribution:

Line
Partial Line
Area
Partial Area
Triangular
Trapezoidal
Point
Repeating point
Applied moment
Moving concentrated

Name	Type	Distribution	Magnitude (kN/m) max.		Location from left (m) zero at	max. at	Pattern loading
	Snow	Triangular	3		8	6	P
Load1	Dead	Full Uniform Area	0.6 kN/m2	6 m			
Load2	Live	Full Uniform Area	1.9 kN/m2	6 m			P
Load3	Live	Point Load	1 kN		1.5 m		P
Load4	Live	Point Load	2 kN		8 m		P
Load5	Snow	Triangular	3 kN/m		8 m	6 m	P



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SIZER-Beam

Design Check

Analysis results intuitively summarized

Force vs. Resistance and Deflection using CSA-O86-09:

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear (b)	Vf @d = 30.67	Vr = 47.88	kN	
Shear (a)	Wf = 177.76	Vr = 308.17	kN	Wf/Vr = 0.58
Moment(+)	Mf = 24.22	Mr = 50.88	kN-m	Mf/Mr = 0.48
Moment(-)	Mf = 50.69	Mr = 50.61	kN-m	Mf/Mr = 1.00
Deflection:				
Interior Perm	0.2 = <L/999	8.3 = L/360	mm	0.03
Live	-1.2 = <L/999	8.3 = L/360	mm	0.15
Total	-1.4 = <L/999	16.7 = L/180	mm	0.08
Cantil. Perm	1.3 = <L/999	11.1 = L/180	mm	0.12
Live	6.4 = L/311	11.1 = L/180	mm	0.58
Total	7.7 = L/258	22.2 = L/90	mm	0.35

Additional Data:

FACTORS:	f/E(MPa)	KD	KH	KZ	KL	KT	KS	KN	Cv	LC#
Fv	1.8	1.00	1.00	1.000	-	1.00	1.00	-	7.455	#4
Fb+	25.6	1.00	1.00	1.000	0.510	1.00	1.00	-	-	#14
Fb-	19.2	1.00	1.00	1.000	0.676	1.00	1.00	-	-	#4
Fcp	5.8	-	-	1.150	-	1.00	1.00	-	-	#-
Es	10300	-	-	-	-	1.00	1.00	-	-	#14

CRITICAL LOAD COMBINATIONS:

Shear : LC #4 = 1.25D + 1.5L + (1.0)0.5S
Moment(+) : LC #14 = 1.25D + 1.5L (pattern: L_L)
Moment(-) : LC #4 = 1.25D + 1.5L + (1.0)0.5S

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Beam Mode Demo

SIZER - CSA O86-14 Updates

Ultimate Limit States Load Combinations

► **Design Provisions in O86-09 (Clause 4.2.4.1)**

Case	Principal loads*	Companion loads
1	1.4*D*	—
2	(1.25*D*† or 0.9*D*) + 1.5*L*‡	0.5*S*§ or 0.4*W*
3	(1.25*D*† or 0.9*D*) + 1.5*S*	0.5*L*§** or 0.4*W*
4	(1.25*D*† or 0.9*D*) + 1.4*W*	0.5*L*** or 0.5*S*
5	1.0*D* + 1.0*E*	0.5*L*§** + 0.25*S*§

***The companion load factor of 0.5 for a live load (L) shall be increased to 1.0 for storage occupancies, equipment areas, and service rooms.*

► **Design Provisions in O86-14 (Clause 5.2.4.1)**

Case	Principal loads*	Companion loads
1	1.4*D*	—
2	(1.25*D*† or 0.9*D*) + 1.5*L*‡	1.0*S*§ or
3	(1.25*D*† or 0.9*D*) + 1.5*S*	1.0*L*§** or
4	(1.25*D*† or 0.9*D*) + 1.4*W*	0.5*L*** or 0.5*S*
5	1.0*D* + 1.0*E*	0.5*L*§** + 0.25*S*§

NEW

***The companion load factor for a live load (L) shall be increased by 0.5 for storage occupancies, equipment areas, and service rooms.*

SIZER - CSA O86-14 Updates

ULS Load Combinations – Design Example

3.6 m design span, 3-ply 2x12, D.Fir-L SS, lintel beam

Supporting DL = 0.5 kPa, interior occupancy LL = 1.9 kPa, exterior SL = 3.4 kPa, all loads with 2 m tributary length

Bearing length = 76 mm on two jack studs

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SIZER - CSA O86-14 Updates

ULS Load Combinations – Design Example

- **Design using O86-09 ULS load combinations**

1.25D + (1.0)1.5S + 0.5L

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	Vf @d = 21.28	Vr = 40.89	kN	Vf/Vr = 0.52
Moment (+)	Mf = 22.61	Mr = 25.39	kN-m	Mf/Mr = 0.89

Beam	0.55
Support	0.27

- **Design using O86-14 ULS load combinations**

1.25D + (1.0)1.5S + 1.0L

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	Vf @d = 24.01	Vr = 40.89	kN	Vf/Vr = 0.59
Moment (+)	Mf = 25.59	Mr = 25.39	kN-m	Mf/Mr = 1.01

Beam	0.62
Support	0.31

~14% increase in ULS critical response (load/resistance)

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SIZER - CSA O86-14 Updates

Glulam Size Factor (K_{Zbg}) for Moment Resistance

► **Design Provisions in O86-09 (Clause 6.5.6.5.1)**

$$M_{r1} = \varphi F_b S K_x K_{Zbg}$$

$$M_{r2} = \varphi F_b S K_x K_L$$

$$K_{Zbg} = 1.03(BL)^{-0.18} \leq 1.0$$

where

B = beam width (for single-piece laminations) or the width of widest piece (for multiple-piece laminations), m

L = length of beam segment from point of zero moment to point of zero moment, m

► **Design Provisions in O86-14 (Clause 7.5.6.5.1)**

NEW

$$M_{r1} = \varphi F_b S K_x K_{Zbg}$$

$$M_{r2} = \varphi F_b S K_x K_L$$

$$K_{Zbg} = \left(\frac{130}{b}\right)^{\frac{1}{10}} \left(\frac{610}{d}\right)^{\frac{1}{10}} \left(\frac{9100}{L}\right)^{\frac{1}{10}} \leq 1.3$$

where

b = beam width (for single-piece laminations) or the width of widest piece (for multiple-piece laminations), mm

d = beam depth, mm

L = length of beam segment from point of zero moment to point of zero moment, mm

Note: *For beams with one or more points of inflection (i.e., multi-span beams and cantilevered beams), the size factor is calculated for each beam segment. The moment resistance for each beam segment, as modified by the appropriate size factor, is then compared to the maximum factored moment within that segment.*

SIZER - CSA O86-14 Updates

Glulam Size Factor (K_{Zbg}) – Design Example

215 x 722 mm, 8 m simply supported:

O86-09 → K_{Zbg} = 1.00

O86-14 → K_{Zbg} = 0.994

315 x 2128 mm, 8 m simply supported:

O86-09 → K_{Zbg} = 0.965

O86-14 → K_{Zbg} = 0.865

- **Deep beams (d > 700 mm), O86-14 usually more conservative → K_{Zbg} & M_{r1} reduced up to 10%**

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SIZER - CSA O86-14 Updates

Glulam Shear Resistance (Gross Section)

► **Design Provisions in O86-09 (Clause 6.5.7.2)**

$$V_r = \phi F_v 0.48 A_g K_N C_V Z^{-0.18} \geq W_f$$ *Any beam volume*

$$V_r = \phi F_v \frac{2A_g}{3} K_N$$ *2 m³ or less*

► **Design Provisions in O86-14 (Clause 7.5.7.2)**

$$W_r = \phi F_v 0.48 A_g C_V Z^{-0.18} \geq W_f$$

$$V_r = \phi F_v \frac{2A_g}{3}$$

No change to shear resistance of gross section (at locations other than end notches, K_N = 1.0)

SIZER - CSA O86-14 Updates

Glulam Shear Resistance at Compression Side Notches

► **Design Provisions in O86-09 (Clause 6.5.7.2)**

$$V_r = \phi F_v 0.48 A_g K_N C_V Z^{-0.18} \geq W_f$$

$$V_r = \phi F_v \frac{2A_g}{3} K_N$$

for $e > d$: $K_N = 1 - \frac{d_n}{d}$

for $e < d$: $K_N = 1 - \frac{d_n e}{d(d - d_n)}$

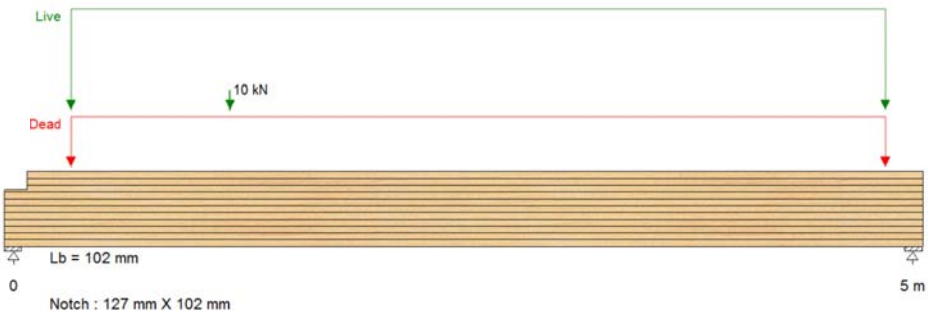
► **Design Provisions in O86-14 (Clause 7.5.7.3)**

for $e_c > d$: $V_r = \phi F_v \frac{2A_n}{3} = \phi F_v \frac{2A_g}{3}\left(1 - \frac{d_n}{d}\right)$

for $e_c < d$: $V_r = \phi F_v \frac{2A_g}{3}\left(1 - \frac{d_n e_c}{d(d - d_n)}\right)$

SIZER - CSA O86-14 Updates

Glulam Compression Side Notches – Design Example



5.0 m design span, 130 x 418 mm, Glulam 20f-E,

Spruce-Pine, Notch length = 127 mm,

Notch depth = 102 mm, Bearing length = 102 mm

Beam volume = 0.27 m^3 < 2 m^3

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SIZER - CSA O86-14 Updates

Glulam Compression Side Notches – Design Example

- **Design using O86-09:**

KN

Notch 1: dn = 102 mm ec = 25 mm 0.981

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear (b)	Vf @d = 58.17	Vr = 55.96	kN	
Shear (a)	Wf = 122.71	Vr = 179.27	kN	Wf/Vr = 0.68

Shear Vr: O86 6.5.7.2.1 (a) used; Wf = sum of all loads.

~~$V_r = \phi F_v 0.48 A_g K_N C_v Z^{-0.18} \geq W_f$~~

- **Design using O86-14:**

Notch 1: dn = 102 mm ec = 25 mm

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear 7.5.7.3b	Vf @d = 58.17	Vr = 55.96	kN	Vf/Vr = 1.04
Shear 7.5.7.2a	Wf = 122.71	Wr = 182.80	kN	

Shear Vr: O86 7.5.7.3(b) used $V_r = \phi F_v \frac{2A_g}{3}\left(1 - \frac{d_n e_c}{d(d-d_n)}\right)$

SIZER - CSA O86-14 Updates

Glulam Shear Resistance at Tension Side Notches

► **Design Provisions in O86-09 (Clause 6.5.7.2)**

$$V_r = \phi F_v 0.48 A_g K_N C_V Z^{-0.18} \geq W_f$$

$$V_r = \phi F_v \frac{2A_g}{3} K_N$$

$$K_N = \left(1 - \frac{d_n}{d}\right)^2$$

► **Design Provisions in O86-14 (Clause 7.5.7.4.2)**

NEW

$$F_r = \phi F_f A_g K_N$$

$$F_f = f_f (K_D K_H K_{Stp} K_T)$$

$$f_f = 2.5\, b_{eff}^{-0.2}$$

$$f_f \geq 0.9 \text{ MPa}$$

$$K_N = \left[0.006d\left(1.6\left(\frac{1}{\alpha} - 1\right) + \eta^2\left(\frac{1}{\alpha^3} - 1\right)\right)\right]^{-\frac{1}{2}}$$

SIZER - CSA O86-14 Updates

Glulam Shear Resistance at End Notches

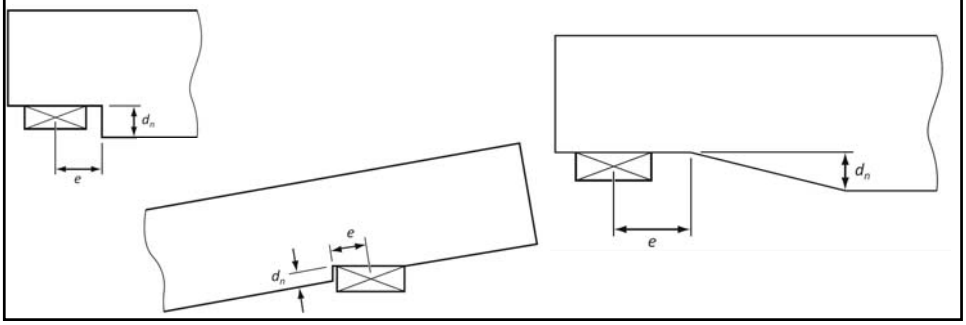
► **O86-14 Compression Side Notches (Clause 7.5.7.3)**

e_c = length of notch, mm, from inner edge of closest support to farthest edge of notch

d_n = depth of notch, mm (which shall not exceed $0.25d$)

► **O86-14 Tension Side Notches (Clause 7.5.7.4.2)**

e = length of notch measured parallel to the member axis, mm, from the centre of the nearest support to re-entrant corner of notch



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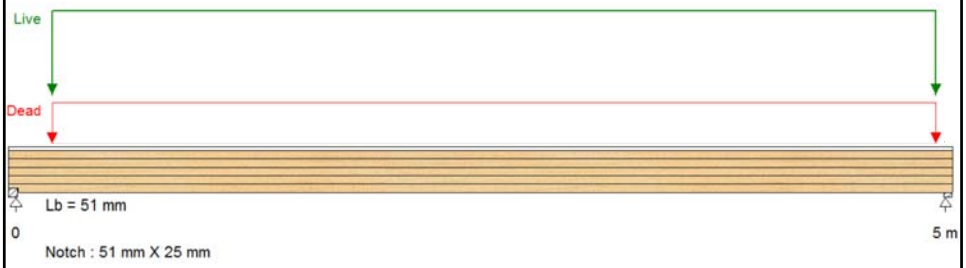
Glulam Tension Side Notches – Design Example



Short Notch: e < d

5.0 m design span, 80 x 228 mm, Glulam 24f-E,

D.Fir-L, Notch length = 51 mm,

Notch depth = 25 mm, Bearing length = 51 mm

Beam volume = 0.1 m³ < 2 m³

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Glulam Tension Side Notches – Design Example

► **Design using O86-09:**

Notch 1: dn = 25 mm KN 0.793

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear (b)	Vf @d = 9.97	Vr = 17.35	kN	
Shear (a)	Wf = 21.80	Vr = 68.54	kN	Wf/Vr = 0.32

Shear Vr: O86 6.5.7.2.1 (a) used; Wf = sum of all loads.

$V_r = \phi F_v 0.48 A_g K_N C_v Z^{-0.18} \geq W_f$

► **Design using O86-14:**

Notch 1: dn = 25 mm e = 11 mm $F_r = \phi F_f A_g K_N$

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear 7.5.7.2b	Vf @d = 9.97	Vr = 21.89	kN	Vf/Vr = 0.46
Shear 7.5.7.2a	Wf = 21.80	Wr = 86.46	kN	Wf/Wr = 0.25
Shear 7.5.7.4.2	Vf = 10.90	Fr = 32.83	kN	Vf/Fr = 0.33

FACTORS:	f/E (MPa)	KD	KH	KZ	KL	KT	KS	KN	Cv
Fv	2.0	1.00	1.00	1.000	-	1.00	1.00	-	3.565
Ff	1.0	1.00	1.00	1.000	-	1.00	1.00	1.922	-

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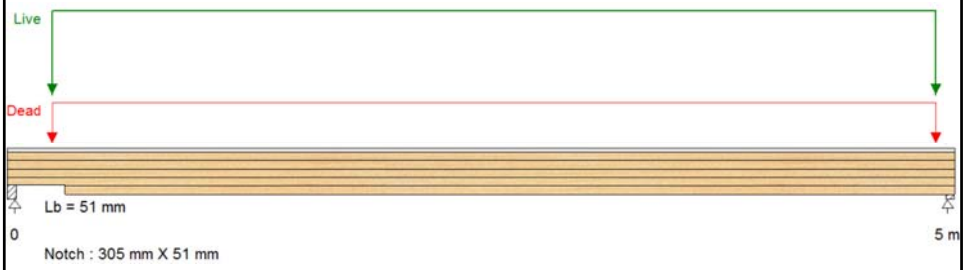
Glulam Tension Side Notches – Design Example



Long Notch: e > d

5.0 m design span, 80 x 228 mm, Glulam 24f-E,

D.Fir-L, Notch length = 305 mm,

Notch depth = 51 mm, Bearing length = 51 mm

Beam volume = 0.1 m³ < 2 m³

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Glulam Tension Side Notches – Design Example

- **Design using O86-09:**

Notch 1: dn = 51 mm KN 0.603

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear (b)	Vf @d = 10.08	Vr = 13.19	kN	
Shear (a)	Wf = 21.80	Vr = 52.10	kN	Wf/Vr = 0.42

Shear Vr: O86 6.5.7.2.1 (a) used; Wf = sum of all loads.

$V_r = \phi F_v 0.48 A_g K_N C_v Z^{-0.18} \geq W_f$

- **Design using O86-14:**

Notch 1: dn = 51 mm e = 265 mm $F_r = \phi F_f A_g K_N$

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear 7.5.7.2b	Vf @d = 10.08	Vr = 16.99	kN	Vf/Vr = 0.59
Shear 7.5.7.2a	Wf = 21.80	Wr = 67.12	kN	Wf/Wr = 0.32
Shear 7.5.7.4.2	Vf = 10.90	Fr = 10.35	kN	Vf/Fr = 1.05

FACTORS:	f/E(MPa)	KD	KH	KZ	KL	KT	KS	KN	Cv
Fv	2.0	1.00	1.00	1.000	-	1.00	1.00	-	3.565
Ff	1.0	1.00	1.00	1.000	-	1.00	1.00	0.606	-

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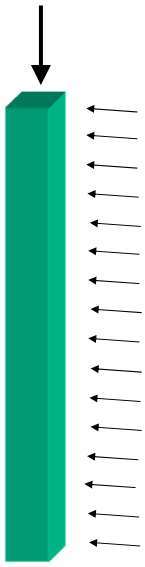
- Columns & Walls
- Eccentric loading
- Compression & Tension
- Axial / Lateral Loads
- Fixed or Pinned



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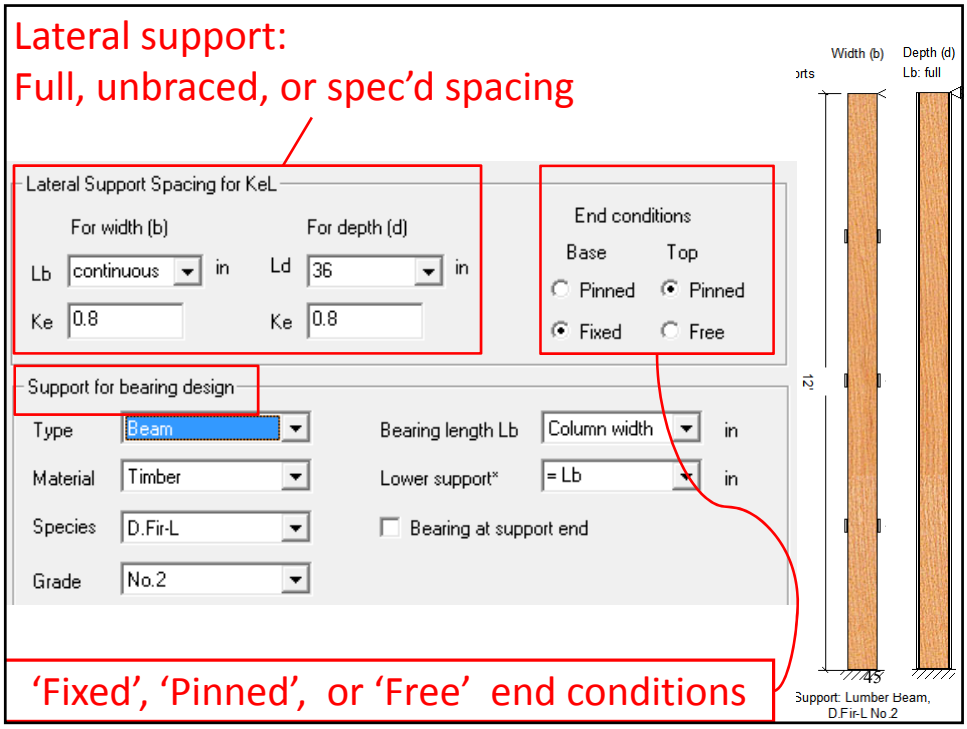
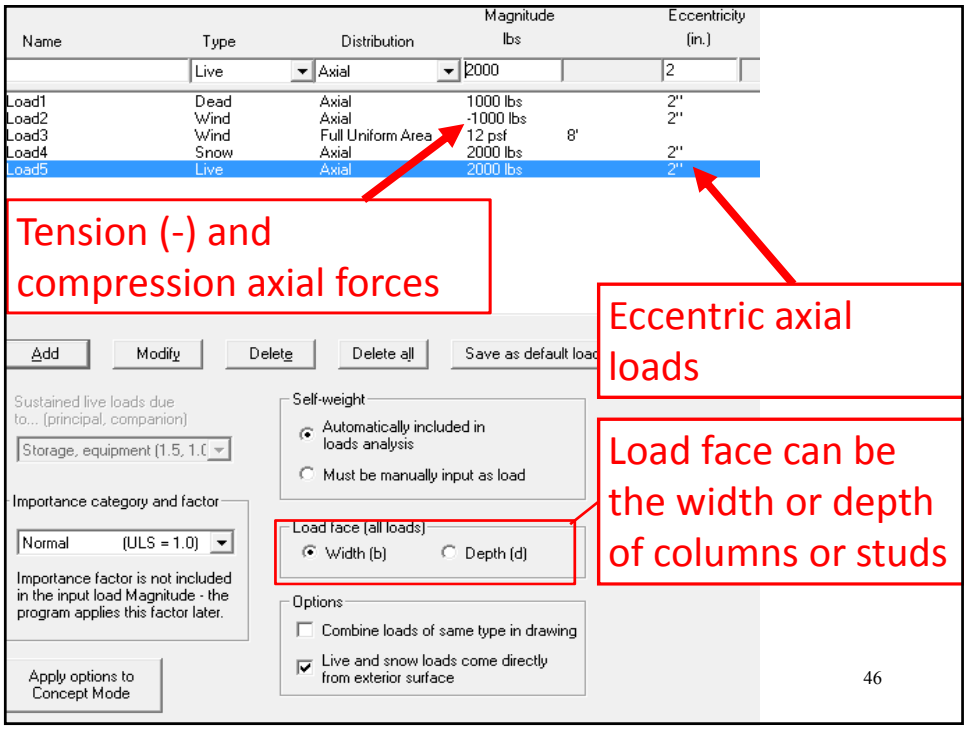

Lateral support:
Full, unbraced, or spec'd spacing
Lateral Support Spacing for KeL
For width (b)
For depth (d)
Lb continuous in
Ld 36 in
Ke 0.8
Ke 0.8
End conditions
Base
Top
Pinned
Pinned
Fixed
Free
Support for bearing design
Type Beam
Material Timber
Species D.Fir-L
Grade No.2
Bearing length Lb Column width in
Lower support* = Lb in
Bearing at support end
'Fixed', 'Pinned', or 'Free' end conditions
Width (b)
Depth (d)
Lb: full
12'
Support: Lumber Beam, D.Fir-L No.2


Name
Type
Distribution
Magnitude lbs
Eccentricity (in.)
Live
Axial
2000
2
Load1 Dead Axial 1000 lbs 2"
Load2 Wind Axial -1000 lbs 2"
Load3 Wind Full Uniform Area 12 psf 8'
Load4 Snow Axial 2000 lbs 2"
Load5 Live Axial 2000 lbs 2"
Tension (-) and compression axial forces
Eccentric axial loads
Add
Modify
Delete
Delete all
Save as default load
Sustained live loads due to... (principal, companion)
Storage, equipment (1.5, 1.0
Importance category and factor
Normal (ULS = 1.0)
Importance factor is not included in the input load Magnitude - the program applies this factor later.
Self-weight
Automatically included in loads analysis
Must be manually input as load
Load face (all loads)
Width (b)
Depth (d)
Load face can be the width or depth of columns or studs
Options
Combine loads of same type in drawing
Live and snow loads come directly from exterior surface
Apply options to Concept Mode
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- **Column mode**

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Fasteners

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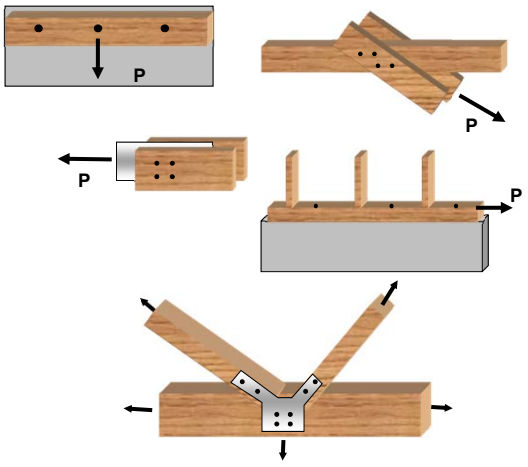
CONNECTIONS

- **Single and Double shear connections**
- **Wood to wood, concrete or steel**
- **Beam to Column, Beam to Beam, Column to base**



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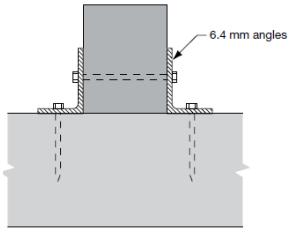
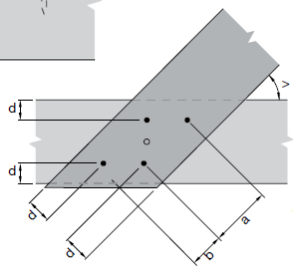
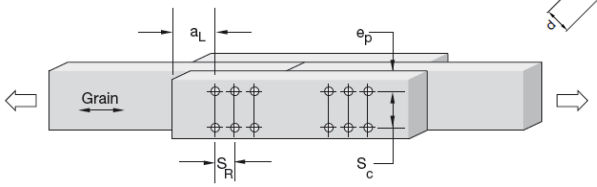
CONNECTIONS

Types of Connectors

- Shear Plates
- Bolts
- Lag Screws
- Wood Screws
- Nails
- Timber Rivets







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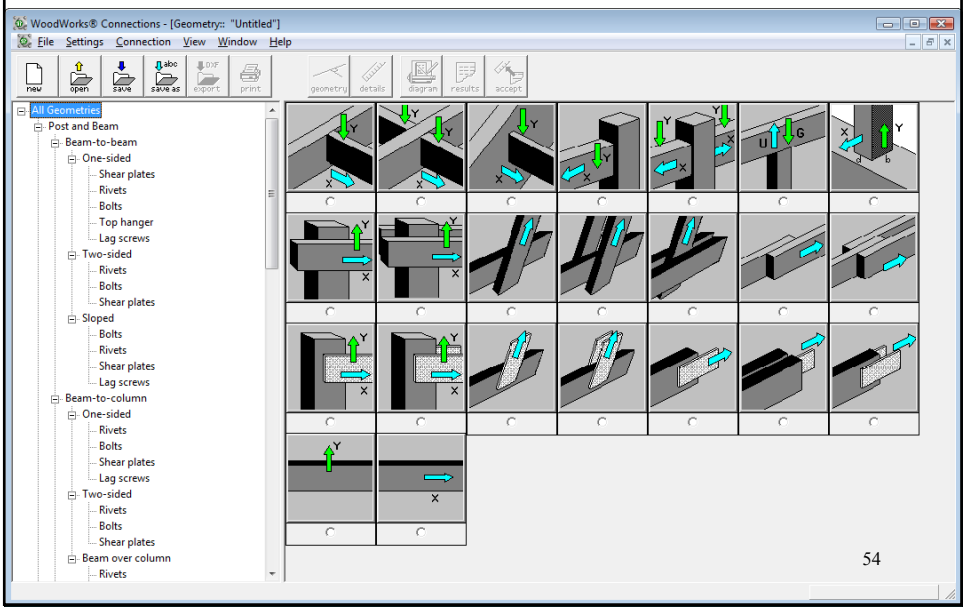
CONNECTIONS

Connections and associated Fasteners on first screen



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CONNECTIONS - CSA O86-14 Changes

Withdrawal Resistance of Lag Screws

- Design Provisions in O86-09 (Clause 10.6.5)

$$P_{rw} = \phi Y_w L_t n_F J_E$$

$$Y_w = y_w (K_D K_{SF} K_T)$$

Table 10.6.5.1
Basic withdrawal resistance for lag screws, y_w, N/mm

Species group	Shank diameter, in								
	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
Douglas Fir-Larch	74	97	120	140	170	200	240	280	310
Hem-Fir	37	55	70	86	100	130	150	180	200
Spruce-Pine-Fir	31	42	61	75	91	120	140	170	190
Northern Species	27	42	58	70	84	110	130	150	180

- Design Provisions in O86-14 (Clause 12.6.5)

$$P_{rw} = \phi Y_w L_t n_F J_E$$

$$Y_w = y_w (K_D K_{SF} K_T)$$

$$= 59\, d_F^{0.82}\, G^{1.77}$$

Basic withdrawal resistance based on the diameter of the fastener and the density of the wood product(s)

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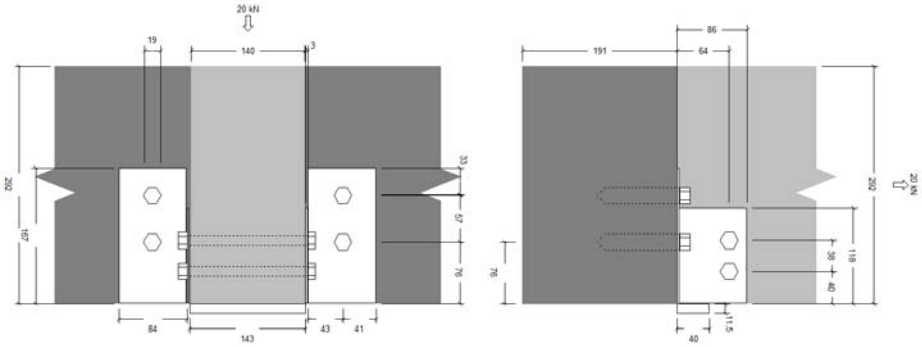
CONNECTIONS - CSA O86-14 Changes

Withdrawal Resistance of Lag Screws – Design Example



Four - ¾ in diameter, 4 in long Lag Screws
Fastening a Steel hanger to a
Solid Sawn D.Fir-L, No.2, 191 mm x 292 mm Beam,
Loaded with 20 kN in Withdrawal

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CONNECTIONS - CSA O86-14 Changes

Withdrawal Resistance of Lag Screws

► Design using O86-09 (Clause 10.6.5)

```
Design Results using CSA O86-09:
   Face Plates:
      Factored load:              Qf =  20.00 kN
      Effective shear resistance: Vr =  25.22 kN  Ratio: 0.79 (10.2.1.4)
      Effective depth:            de =    133 mm
      Strength resistance:        Qr =  23.86 kN  Ratio: 0.84 (10.6.6.1.1(b))
      Withdrawal load:           Pfw =  20.00 kN
      Withdrawal resistance:     Prw =  34.71 kN  Ratio: 0.58 (10.6.5)
```

► Design using O86-14 (Clause 12.6.5)

```
Design Results using CSA O86-14:
   Face Plates:
      Factored load:              Qf =  20.00 kN
      Effective shear resistance: Vr =  25.22 kN  Ratio: 0.79 (12.2.1.4)
      Effective depth:            de =    133 mm
      Strength resistance:        Qr =  23.86 kN  Ratio: 0.84 (12.6.6.1.1(b))
      Withdrawal load:           Pfw =  20.00 kN
      Withdrawal resistance:     Prw =  27.06 kN  Ratio: 0.74 (12.6.5)
```

CONNECTIONS - CSA O86-14 Changes

Lag Screws Yield Strength

► Design Provisions in O86-09 (Clause 10.6.5)

f_y = lag screw yield strength, MPa
= 480 MPa for 1/4 in diameter lag screws
= 410 MPa for 5/16 in diameter lag screws
= 310 MPa for 3/8 in or greater diameter lag screws

► Design Provisions in O86-14 (Clause 12.6.5)

f_y = lag screw yield strength, MPa
= 310 MPa for lag screws meeting SAE J429 Grade 1

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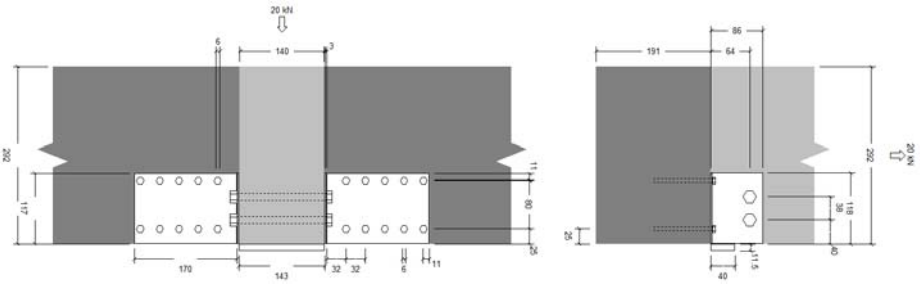
CONNECTIONS - CSA O86-14 Changes

Lateral Resistance of Lag Screws – Design Example



Sixteen – ¼ in diameter, 4 in long Lag Screws
Fastening a Steel hanger to a
Solid Sawn D.Fir-L, No.2, 191 mm x 292 mm Beam,
Loaded Laterally with 20 kN

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CONNECTIONS - CSA O86-14 Changes

Lateral Resistance of Lag Screws – Design Example

► **Design using O86-09 (Clause 10.6.5)**

Unit lateral strength resistance (10.6.6.1.2) (kN):

a	b	c	d	e	f	g
28.72	3.66	-	6.89	110.56	6.48	2.28

► **Design using O86-14 (Clause 12.6.5)**

Unit lateral strength resistance (12.6.6.1.2) (kN):

a	b	c	d	e	f	g
28.72	3.66	-	6.66	110.33	6.48	1.84

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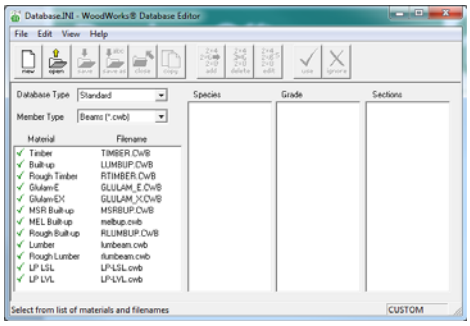

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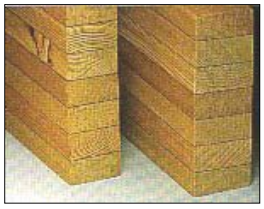
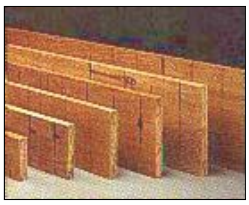
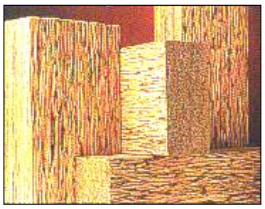
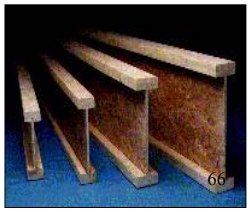
DATABASE

Two data bases: Standard and Custom

- **Lumber, Timber, Rough Sawn Timber**
- **Multi-ply lumber**
- **Glulam**
- **PSL, LVL, LSL**
- **Wood I-Joists**

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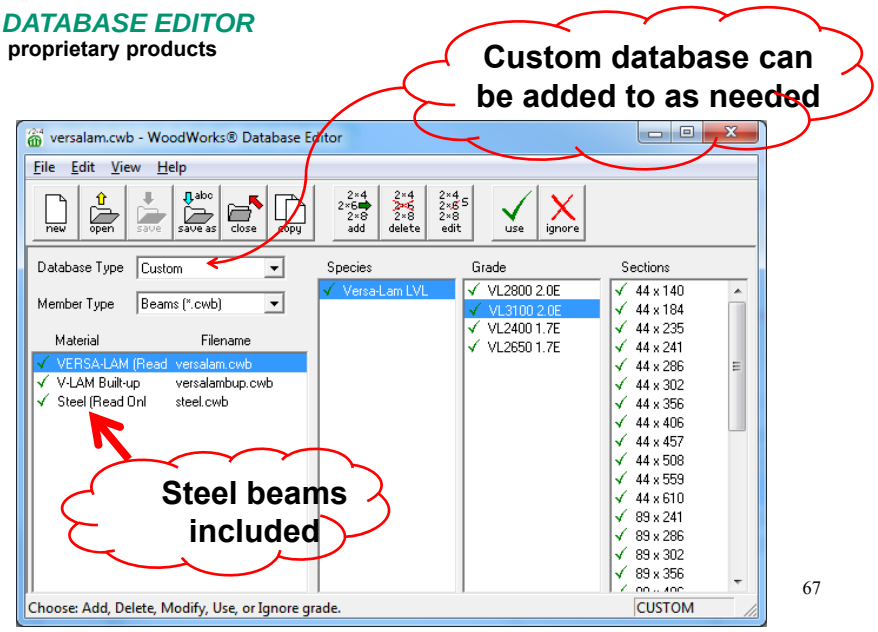

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western archrib structural wood systems — Canada

NORDIC STRUCTURES — Canada and US

Alliance TruTrus — US

WEB JOIST Inspired by Integrity — US

GLOBAL LVL — Canada

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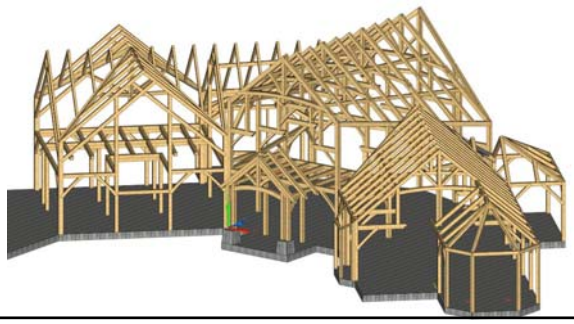

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3. **See 'Help' menu for more detailed engineering information and assumptions**

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Kevin Rocchi, M.A.Sc., E.I.T. & Adam Robertson, M.A.Sc., P.Eng.

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