WoodWorks®
SOFTWARE FOR WOOD DESIGN

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support@woodworks-software.com

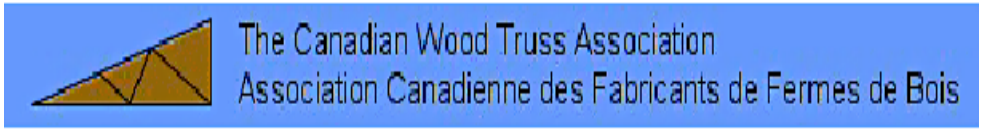
March 25th 2015

Halifax

Copyright Materials

Canadian Wood Council / Conseil canadien du bois

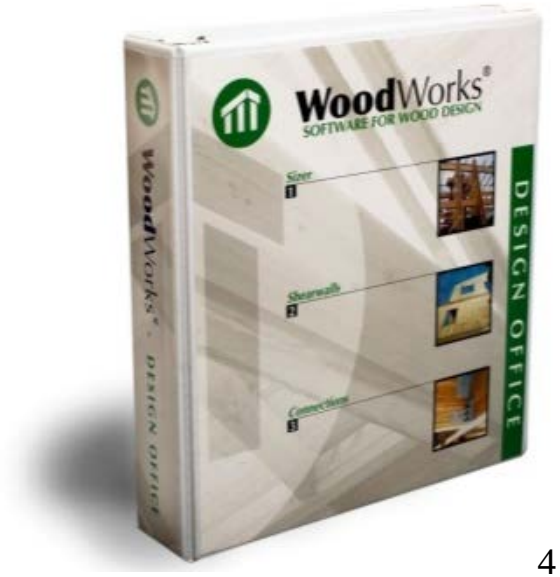
The Canadian Wood Council represents the Canadian wood products industry through a national federation of Associations:



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.



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

FREE

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

Design Office 9 comes with free upgrade to the O86-14

- **PART 1: An Overview and Demonstration of WoodWorks Sizer**

- **PART 2: An Overview and Demonstration of WoodWorks Shearwalls**

NBC Part 4 vs. NBC Part 9

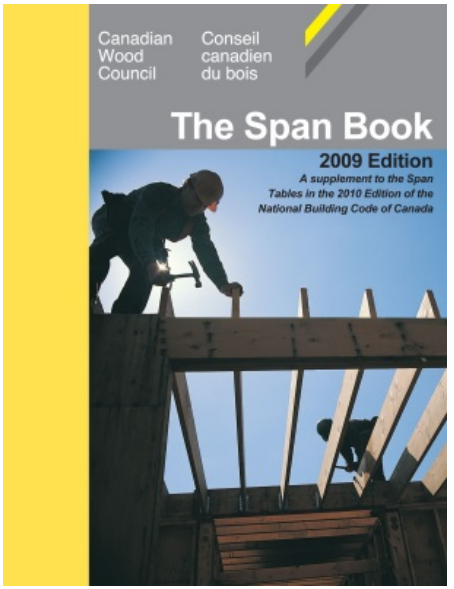
Part 4:

- 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)

SIZER
Gravity Design

Concept mode
- **Beam mode**
- **Column mode**

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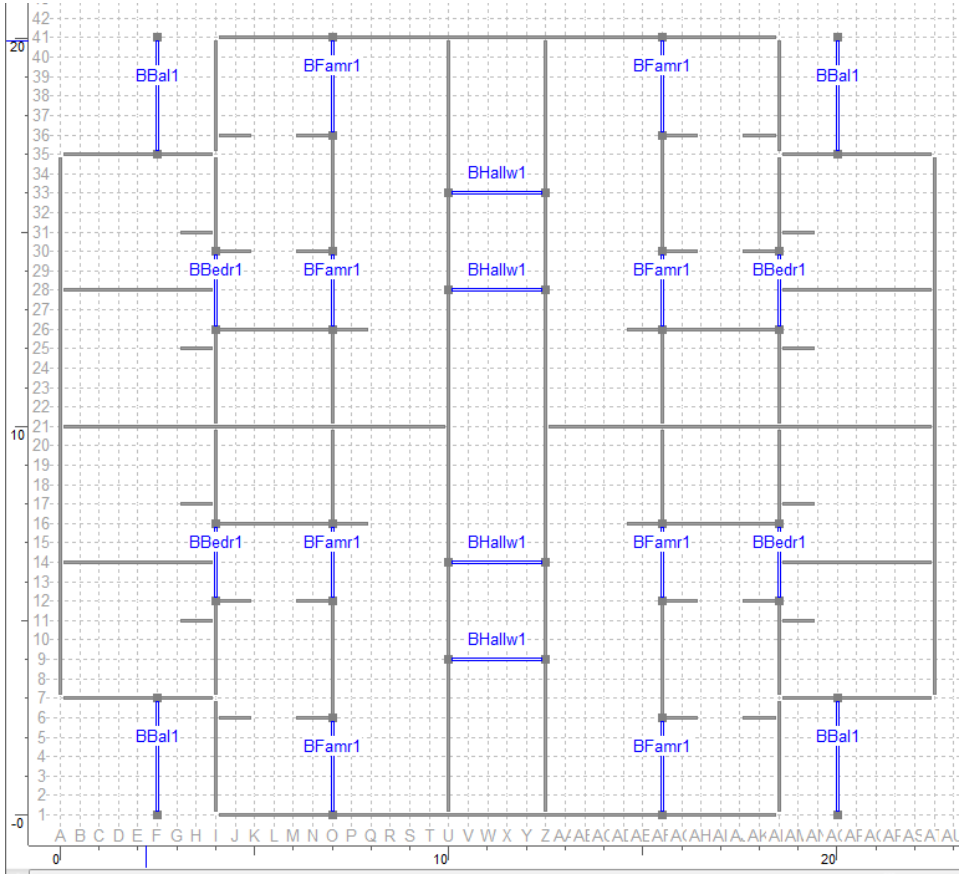


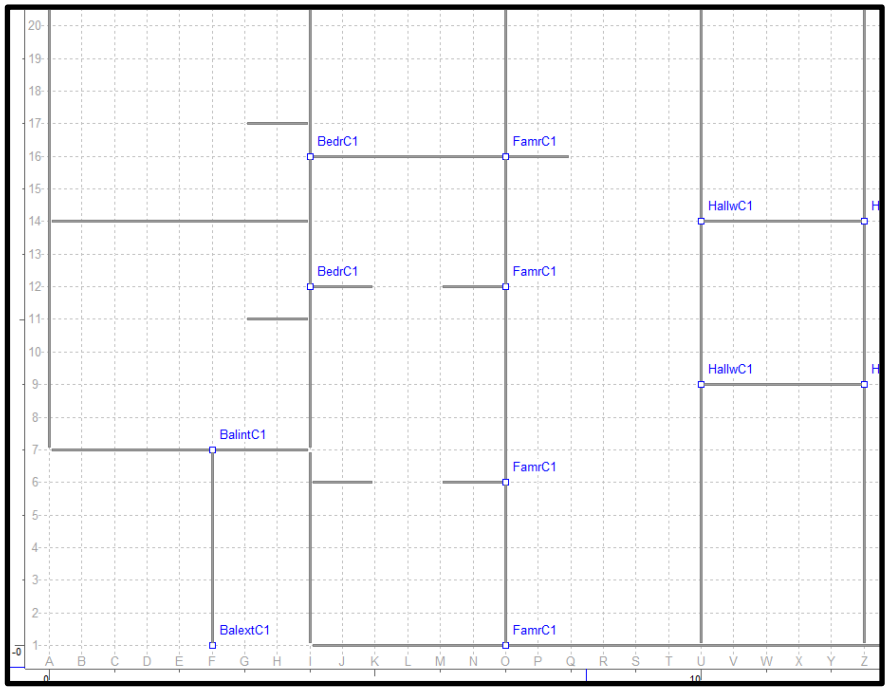
WoodWorks® SOFTWARE FOR WOOD DESIGN

- **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

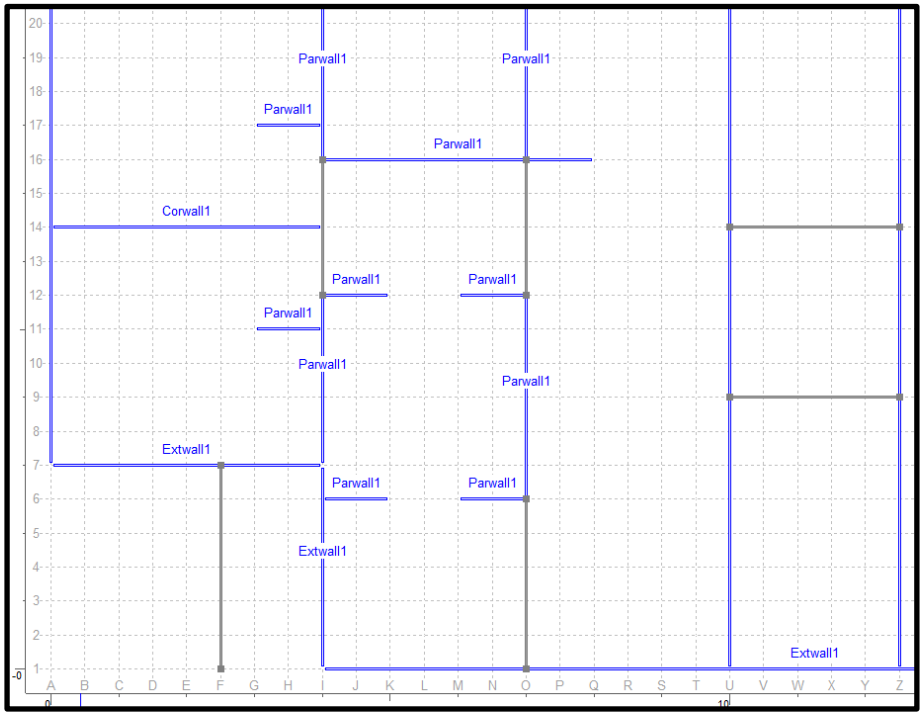
Joist Group	Material	Joist Area	Max. Length	Pcs.	Ttl Len.	Sfc. Area
Roof_Jst1	Lumber	j136	1.50	6	9.0	4.5
	S-P-F	j137	2.00	2	4.0	2.0
	No.1/No.2	j138	1.50	2	3.0	1.5
	38.0 x 38.0	j139	3.50	6	21.0	10.5
		j140	1.50	2	3.0	1.5
		j141	2.00	2	4.0	2.0
		j142	2.00	2	4.0	2.0
		j143	1.50	2	3.0	1.5
		j144	1.50	2	3.0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

WoodWorks® SOFTWARE FOR WOOD DESIGN

Column View

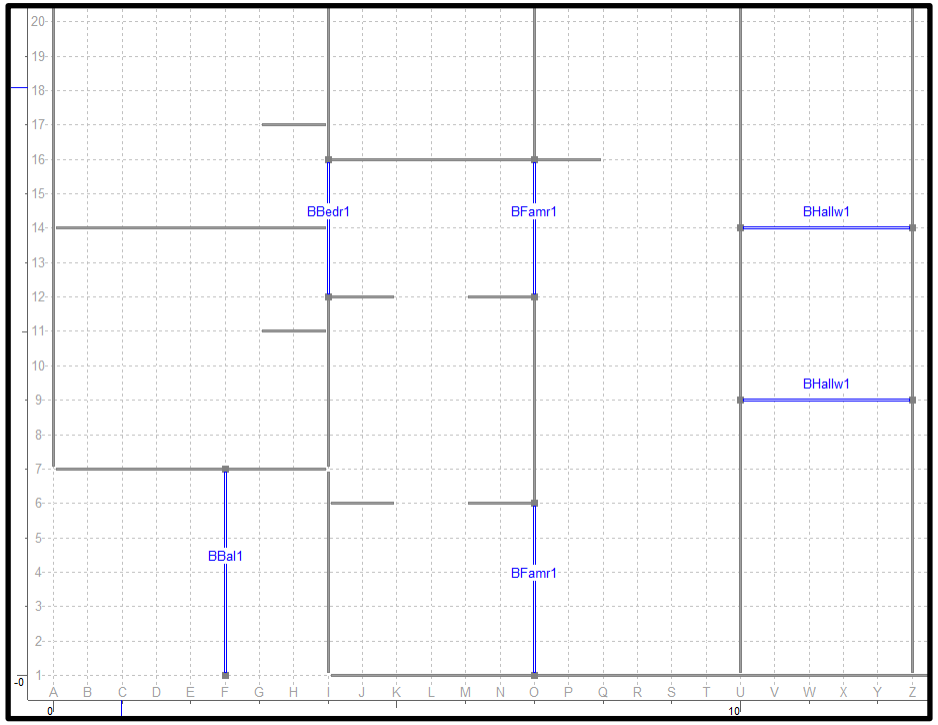


Wall View

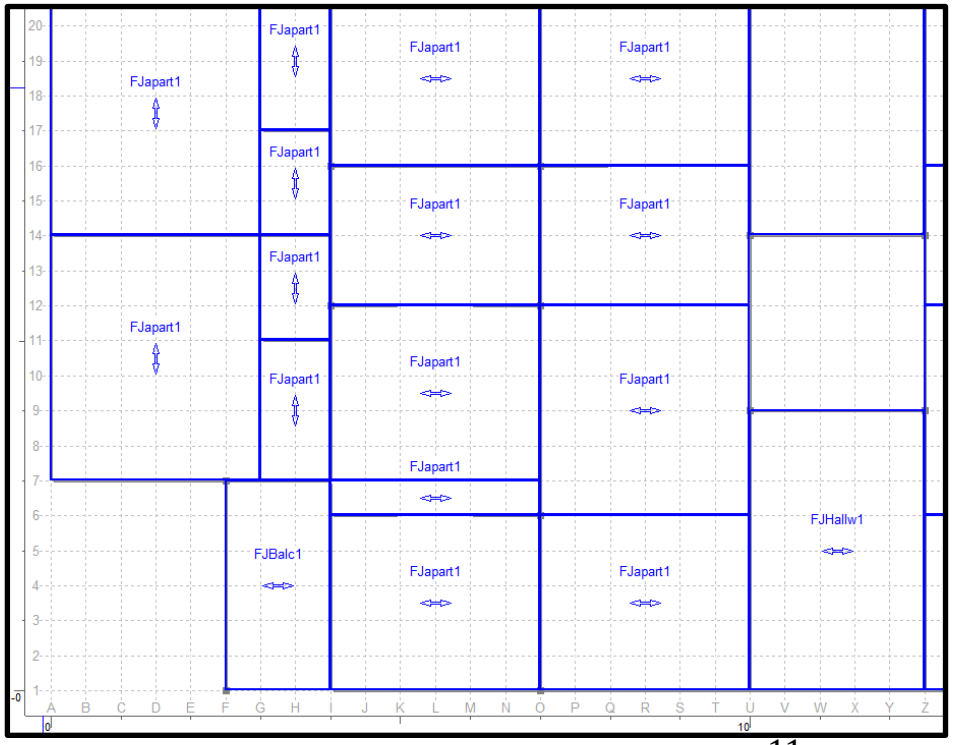


WoodWorks® SOFTWARE FOR WOOD DESIGN

Beam View



Joist View



WoodWorks®
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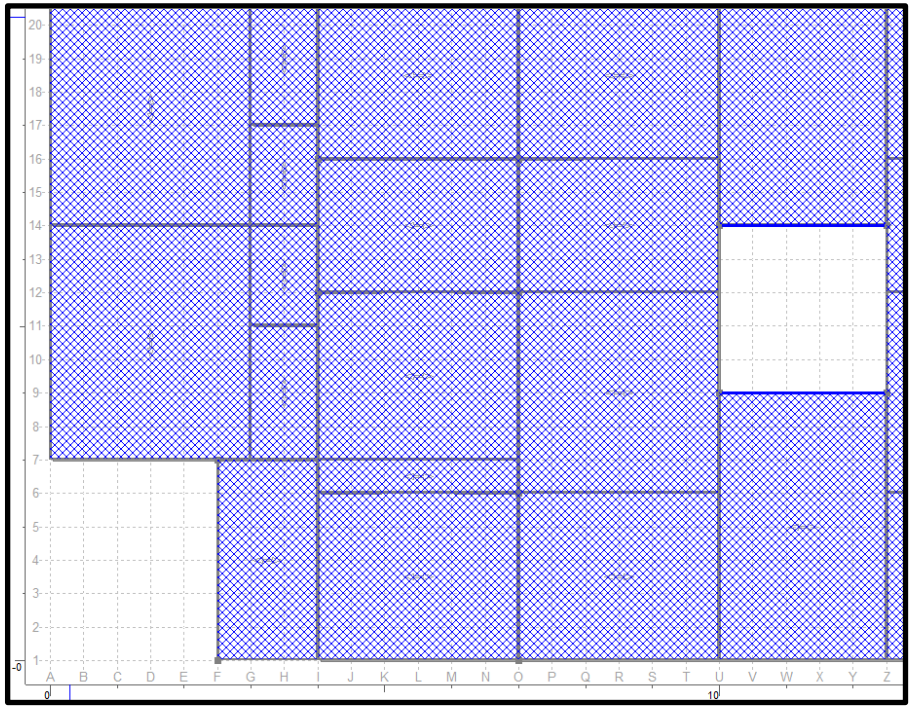
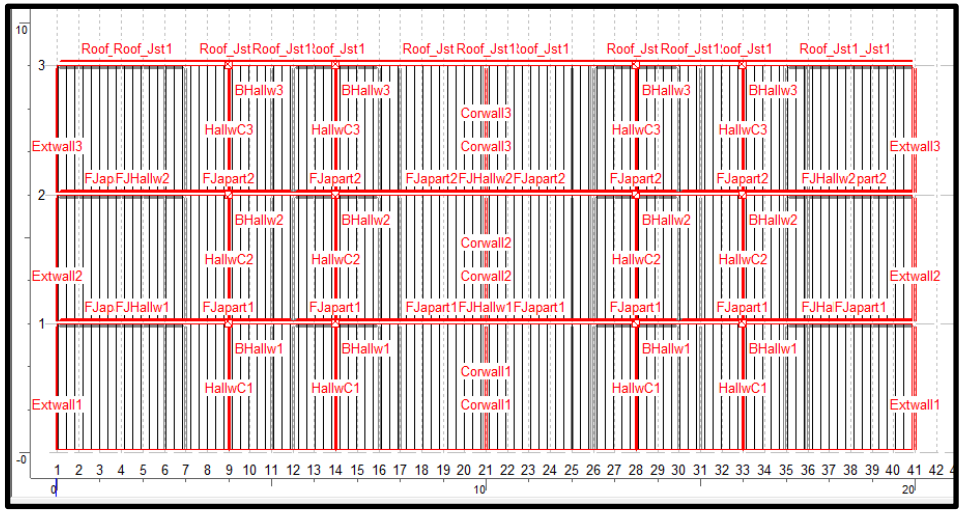
Loads View



Elevation View



WoodWorks® SOFTWARE FOR WOOD DESIGN

Design Results

W o o d W o r k s S I Z E R - Software for Wood Design

3_storey_building_v2 Sizer 9.2 17 Mar,2015 15:41

COMPANY	PROJECT
	3 Storey Apartment
	Ottawa Ontario
	Mr. WoodWorks
	JobNumber01

RESULTS by GROUP - CSA-O86-09

SUGGESTED SECTIONS by GROUP for LEVEL 3 - ROOF

Roof_Jst1	Lumber	S-P-F	No.1/No.2	38x38 @600
BBedr3	Built-up	S-P-F	No.1/No.2	38x38
BFamr3	Built-up	S-P-F	No.1/No.2	38x64
BHallw3	Built-up	S-P-F	No.1/No.2	38x38
BBal3	Timber	Northern	No.1	140x140
BedrC3	Built-up	S-P-F	No.1/No.2	38x89
FamrC3	Built-up	S-P-F	No.1/No.2	38x89
HallwC3	Built-up	S-P-F	No.1/No.2	38x89
BalextC3	Built-up	S-P-F	No.1/No.2	2- 38x89
BalintC3	Built-up	S-P-F	No.1/No.2	38x89
Extwall3	Lumber	S-P-F	No.1/No.2	38x89 @400
Parwall3	Lumber	S-P-F	No.1/No.2	38x89 @400
Corwall3	Lumber	S-P-F	No.1/No.2	38x89 @400

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

SIZER
Gravity Design

Concept mode

Beam mode

Column mode

DATABASE EDITOR
Add proprietary products

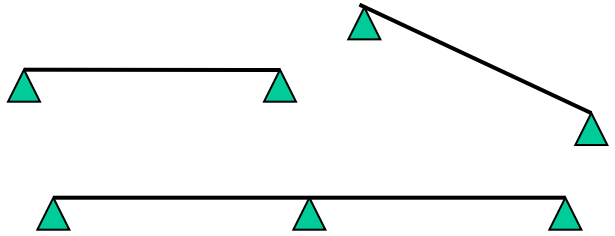
SHEARWALLS
Lateral Design (Wind and Seismic)

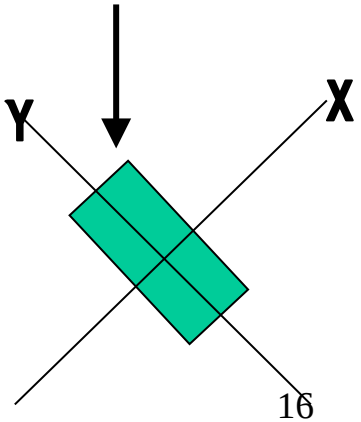
CONNECTIONS
Fasteners

WoodWorks®
SOFTWARE FOR WOOD DESIGN

Detailed Design of Beams, Joists, Rafters

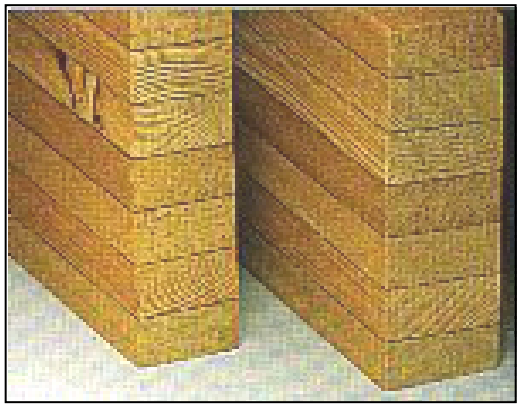
- **Simply Supported**
- **Multi-Span Continuous**
- **Cantilevers**
- **Biaxial bending members (such as oblique purlins)**



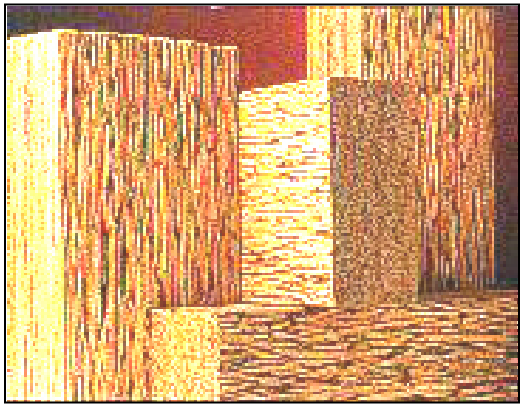


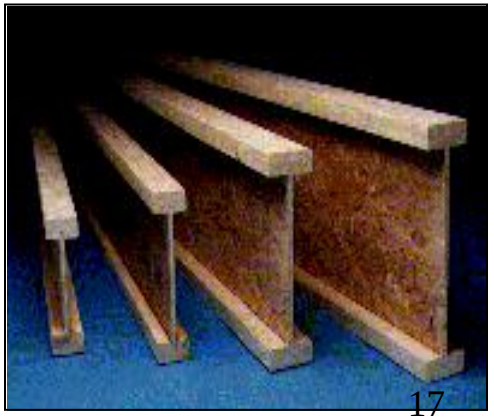
Wood Materials

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



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

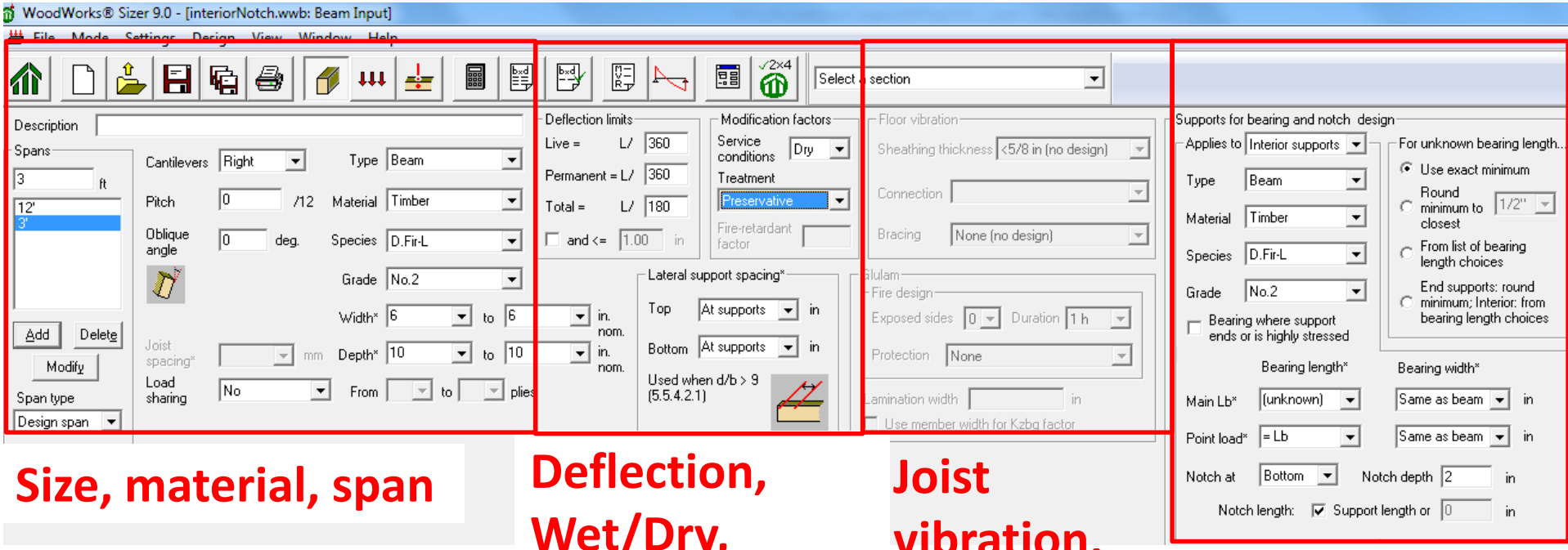




SIZER-Beam

WoodWorks® SOFTWARE FOR WOOD DESIGN

Beam input

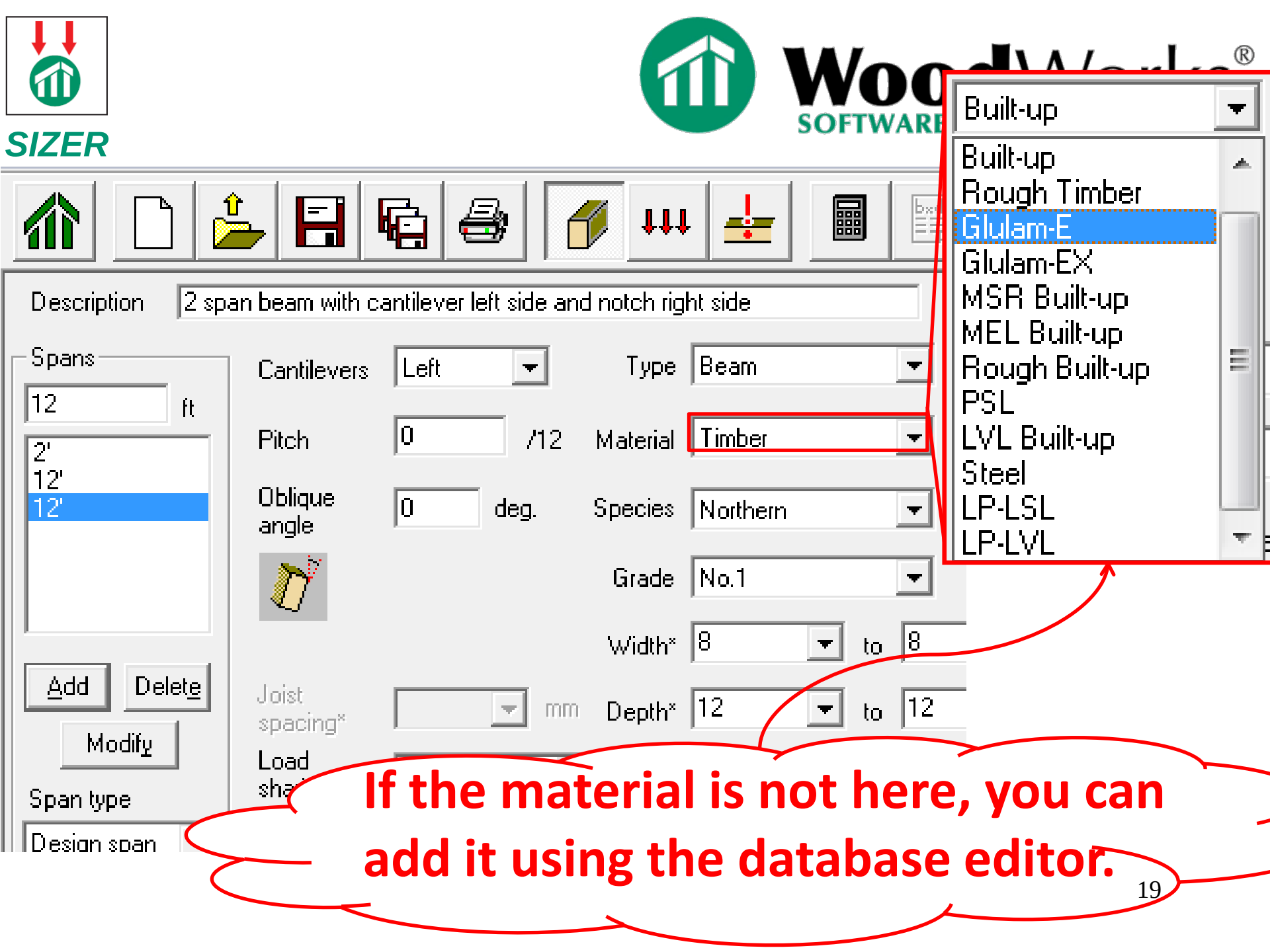


Size, material, span

Deflection, Wet/Dry, Treatment, Lateral support

Joist vibration, glulam fire

Bearing support, notch design

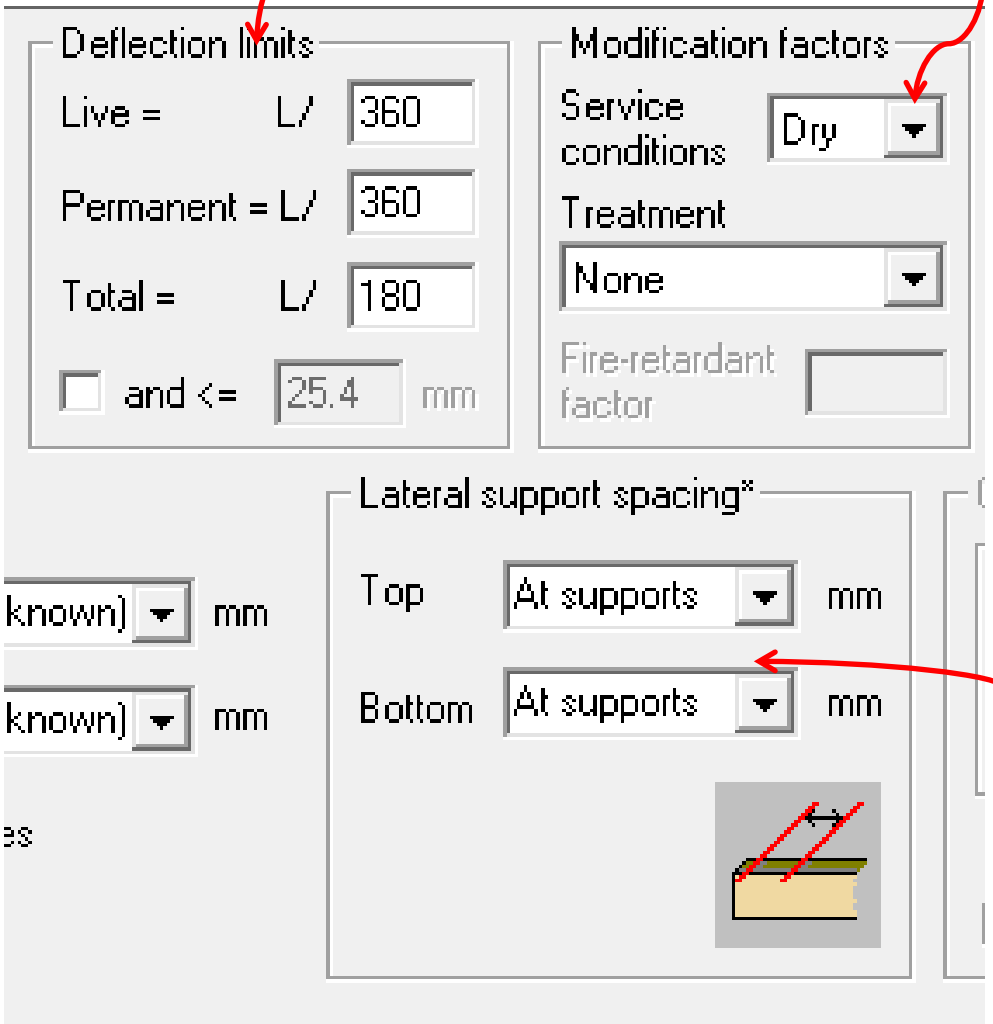

SIZER
Description
2 span beam with cantilever left side and notch right side
Spans
12
ft
2'
12'
12'
Add
Delete
Modify
Span type
Design span
Cantilevers
Left
Type
Beam
Pitch
0
/12
Material
Timber
Oblique angle
0
deg.
Species
Northern
Grade
No.1
Width*
8
to
8
Joist spacing*
mm
Depth*
12
to
12
Load
Built-up
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.

SIZER

WoodWorks® SOFTWARE FOR WOOD DESIGN

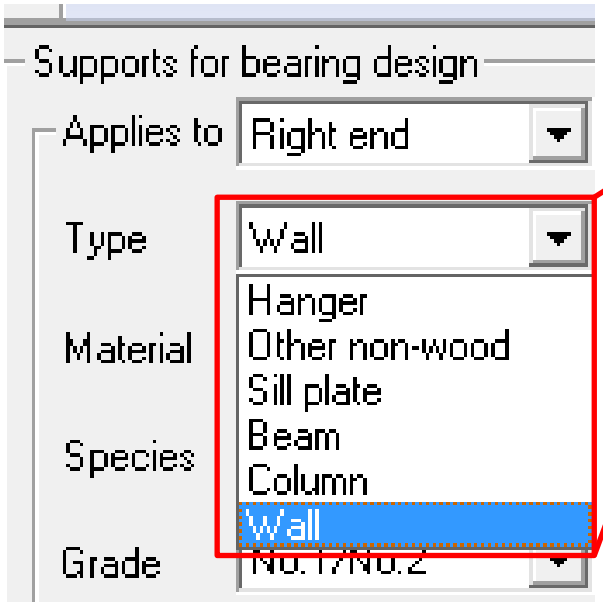
Deflection criteria

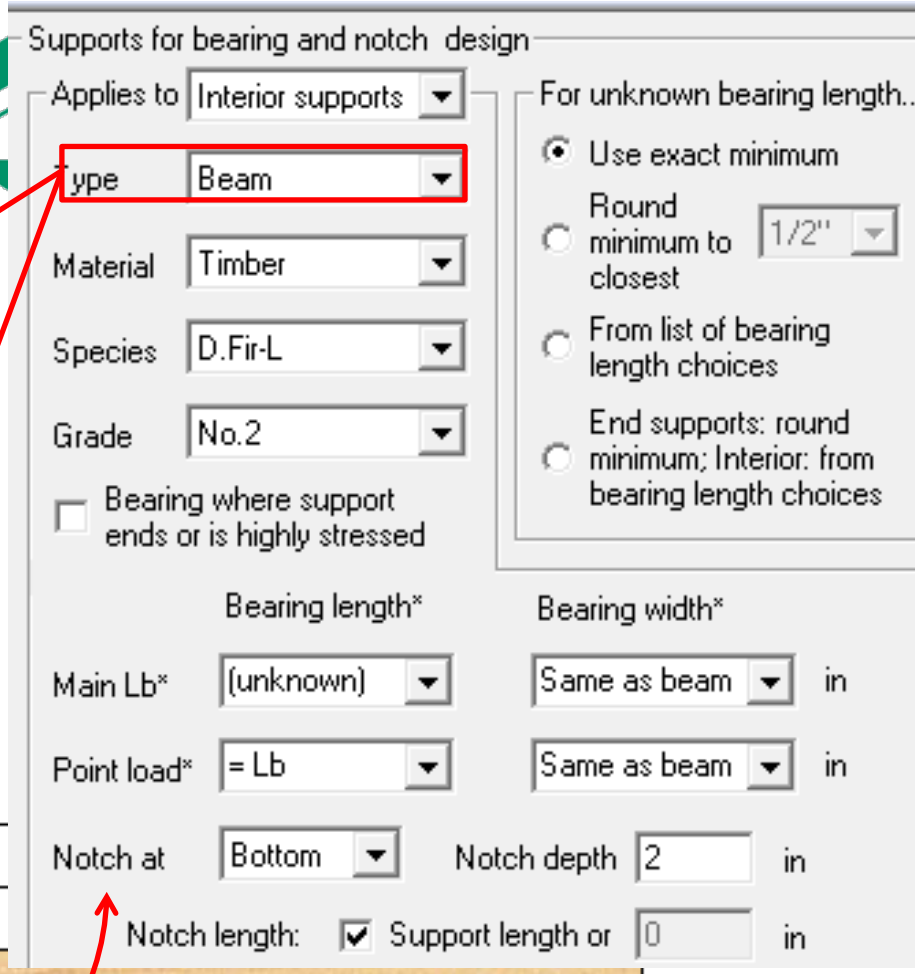
Modification Factors

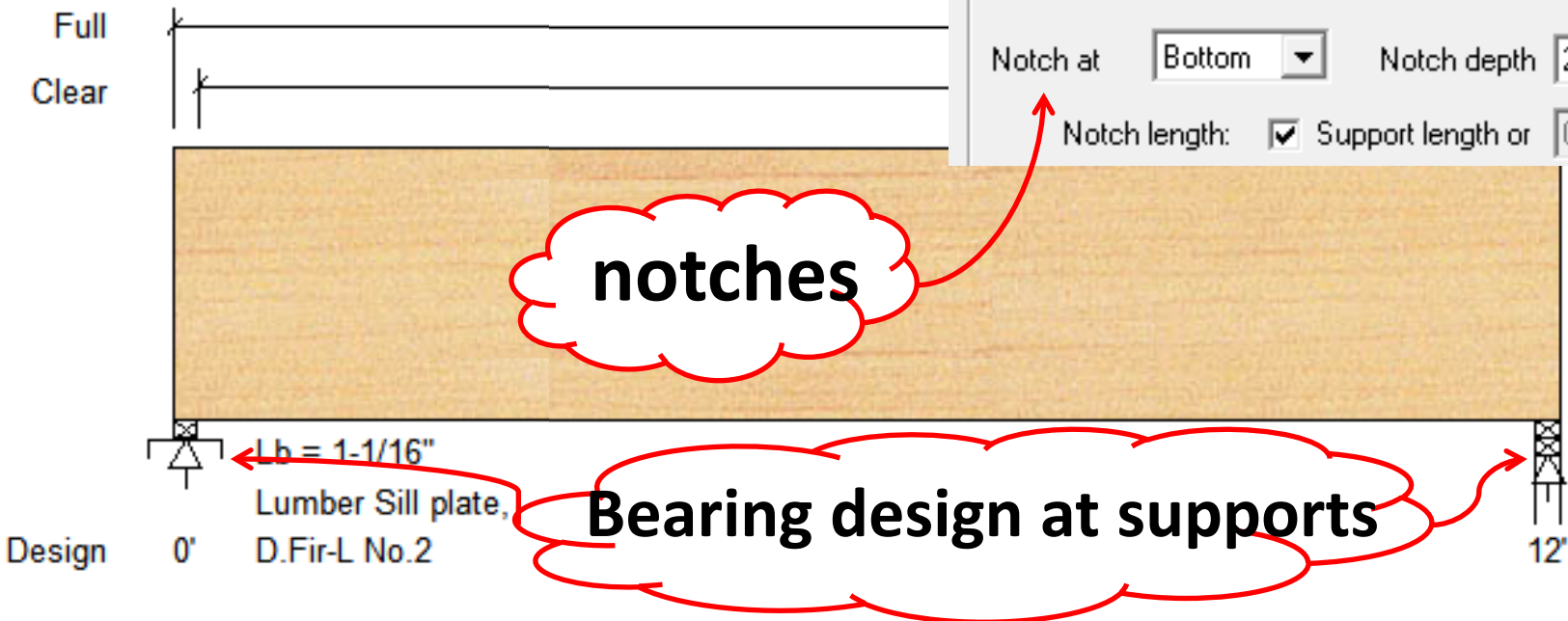


Lateral support

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
Design
0'
Bearing design at supports
Lb = 1-1/16"
Lumber Wall,
D.Fir-L No.1/N
12'

Load type:

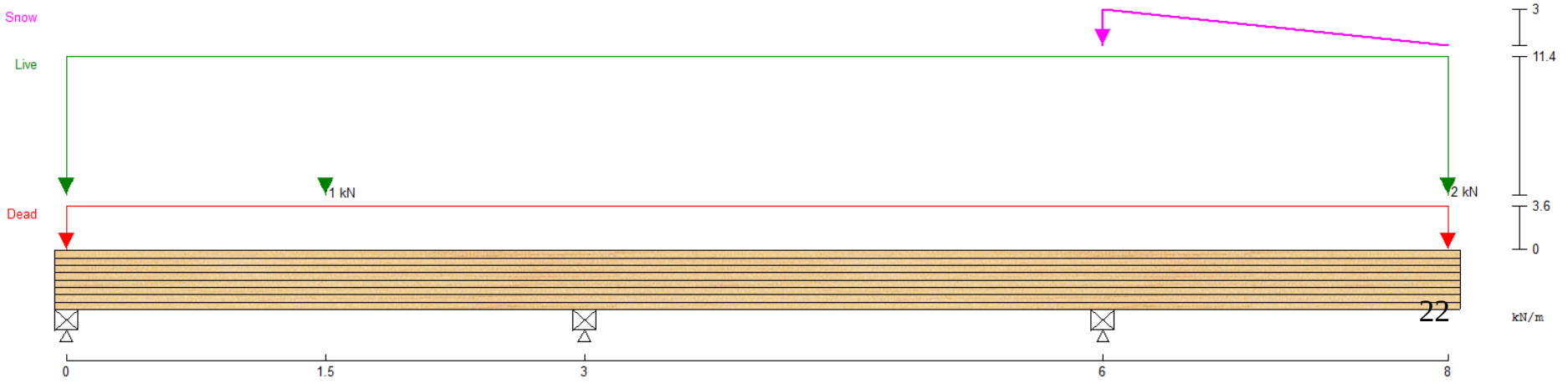
Dead
Live
Snow
Wind
Earthquake
Soil

Storage equipment
Controlled fluids

Distribution:

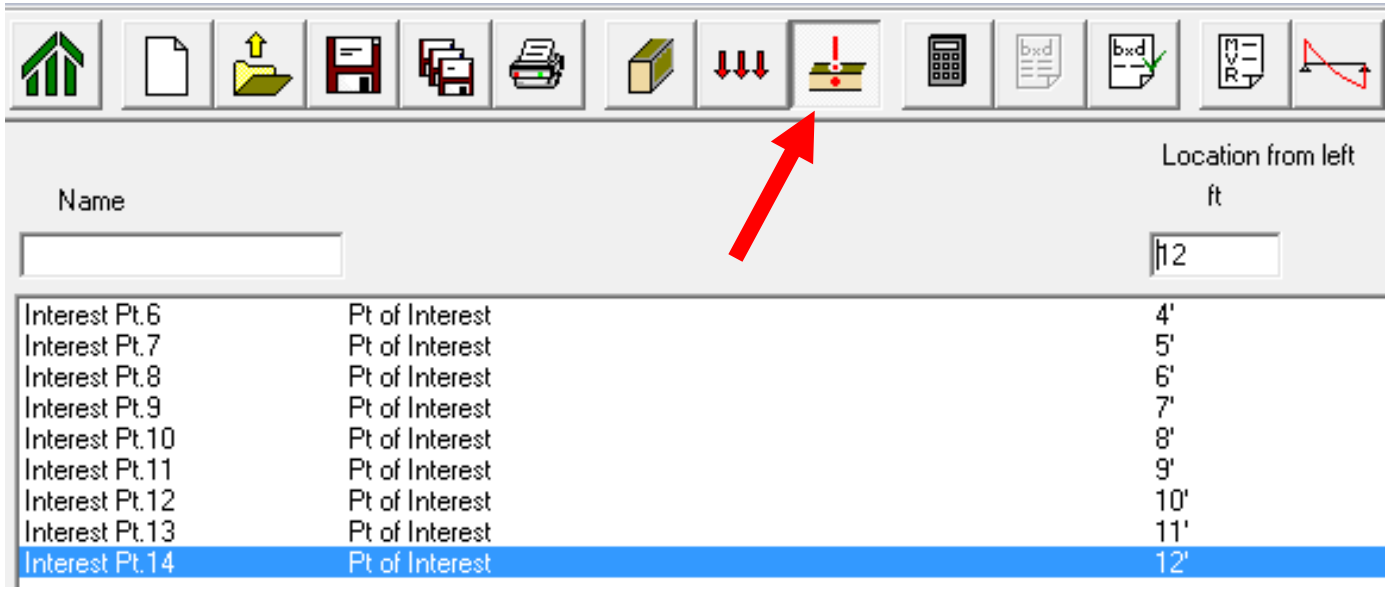
Line
Partial Line
Area
Partial Area
Triangular
Trapezoidal
Point
Repeating point
Applied moment
Moving concentrated

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

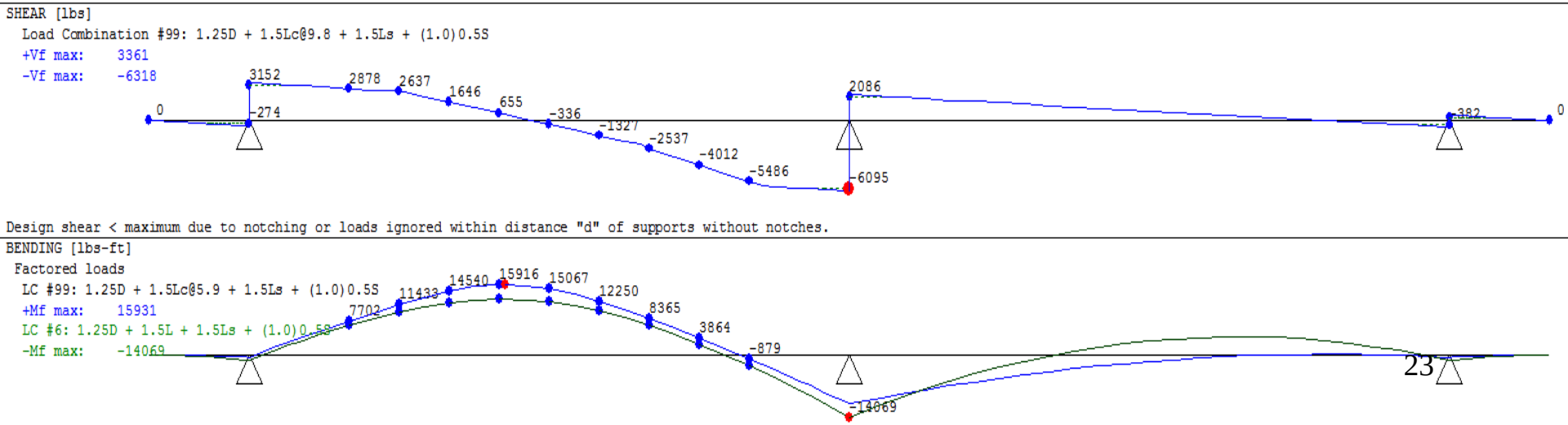


SIZER-Beam

Points of Interest



Shear and moment at user-defined locations



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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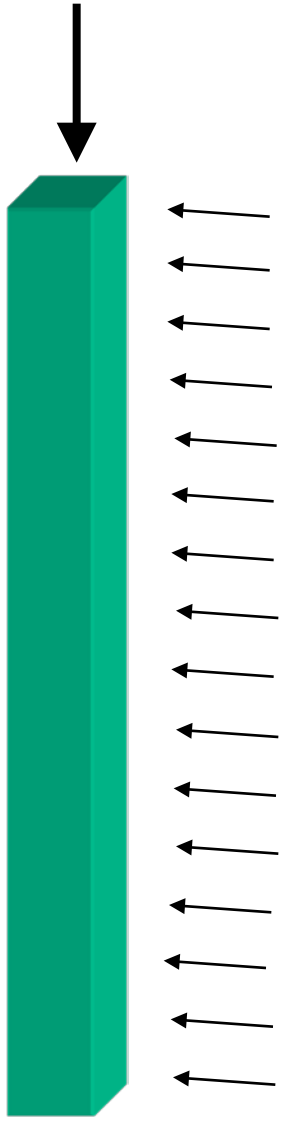
Lateral Design (Wind and Seismic)

CONNECTIONS
Fasteners

SIZER-Column

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



Lateral support:
Full, unbraced, or spec'd spacing

Lateral Support Spacing for KeL

For width (b)

Lb: continuous in

Ke: 0.8

For depth (d)

Ld: 36 in

Ke: 0.8

End conditions

Base	Top
○ Pinned	◉ Pinned
◉ Fixed	○ Free

Support for bearing design

Type: Beam

Material: Timber

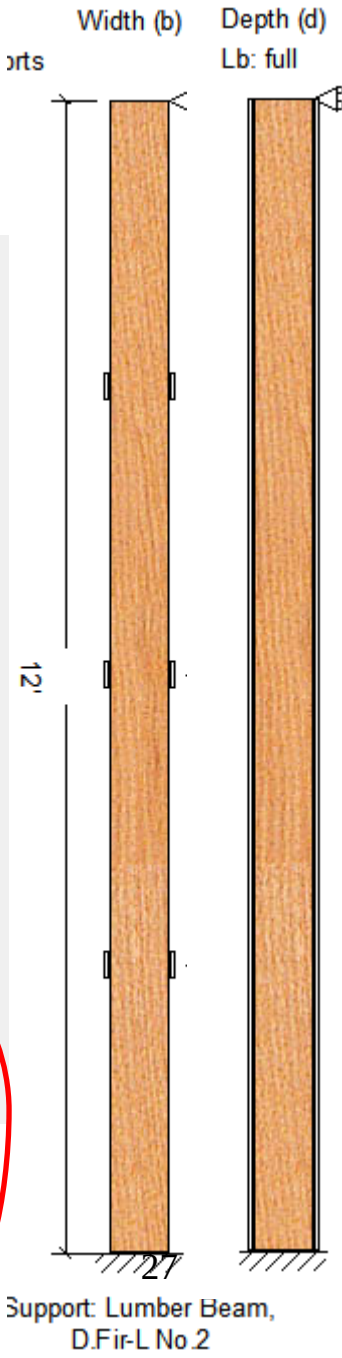
Species: D.Fir-L

Grade: No.2

Bearing length Lb: Column width in

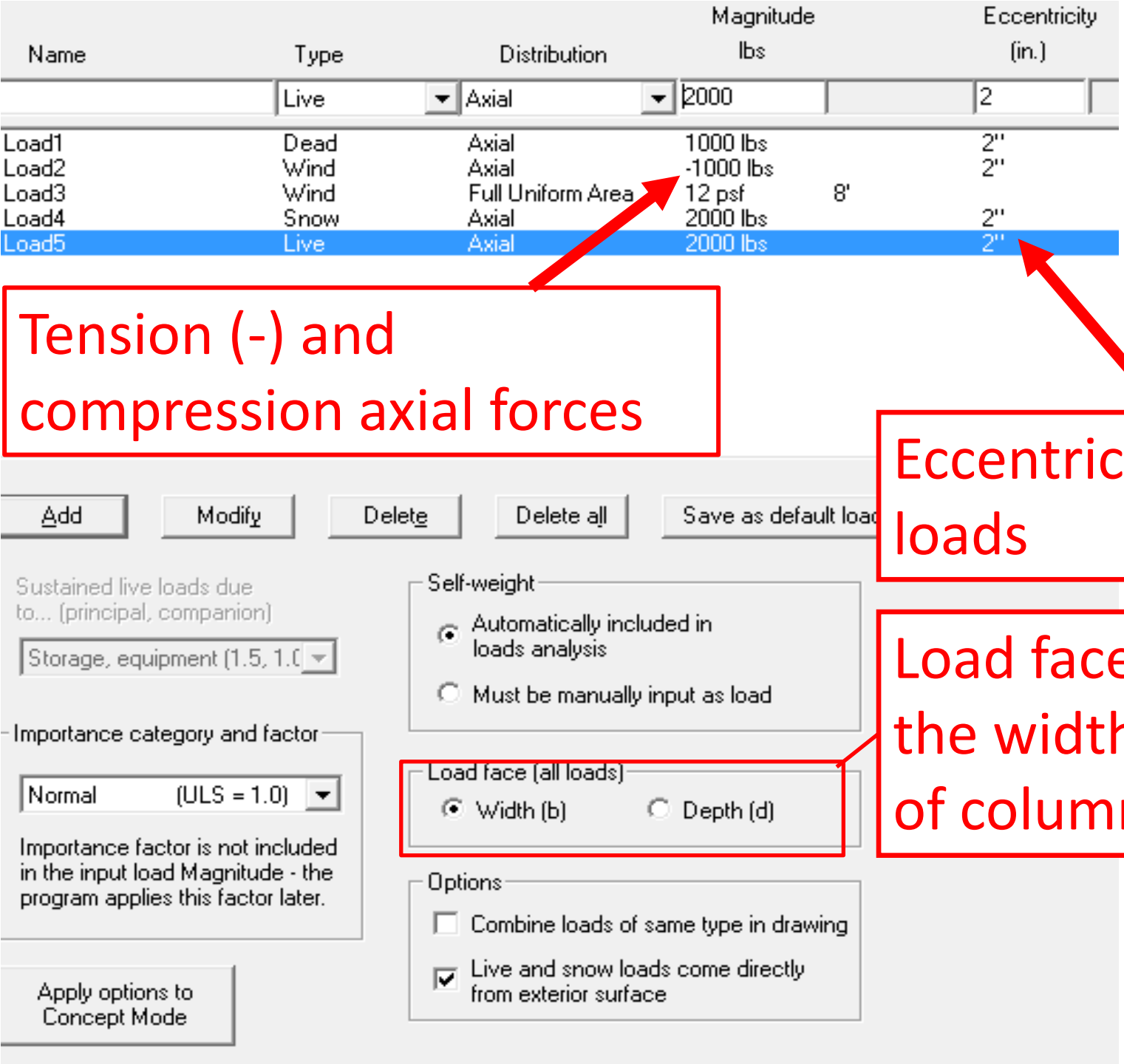
Lower support*: = Lb in

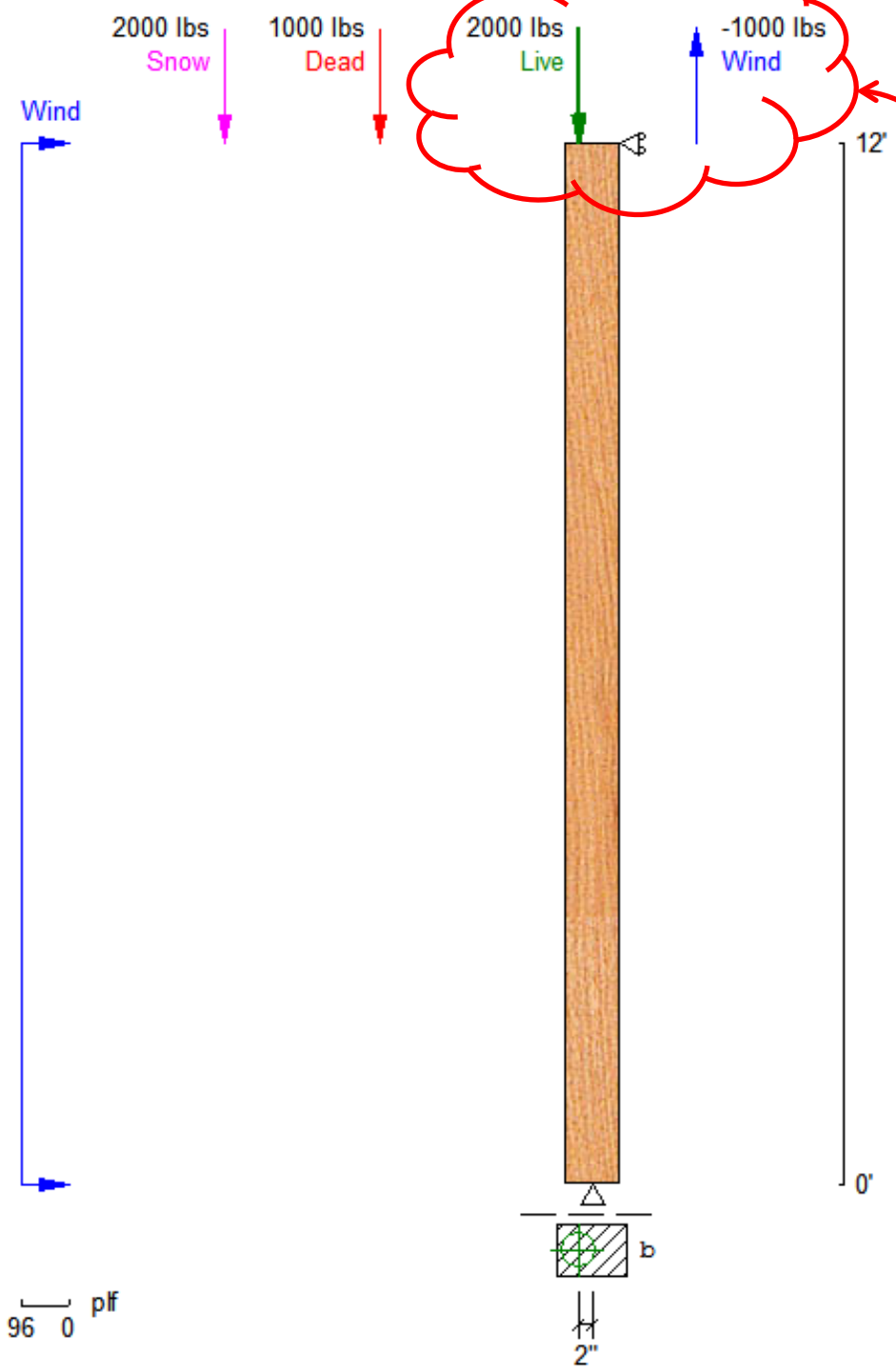
☐ Bearing at support end



Support: Lumber Beam, D.Fir-L No.2

'Fixed', 'Pinned', or 'Free' end conditions


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
Self-weight
Automatically included in loads analysis
Must be manually input as load
Importance category and factor
Normal (ULS = 1.0)
Importance factor is not included in the input load Magnitude - the program applies this factor later.
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



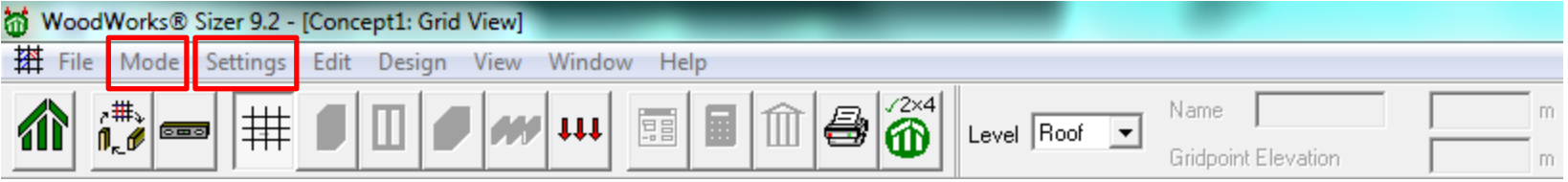
Tension (-) and compression axial forces

Getting to Know WoodWorks Sizer:

Step-by-Step Demo

March 25, 2015

Adam Robertson, M.A.Sc., P.Eng.
Technical Support
support@woodworks-software.com
1.800.844.1275

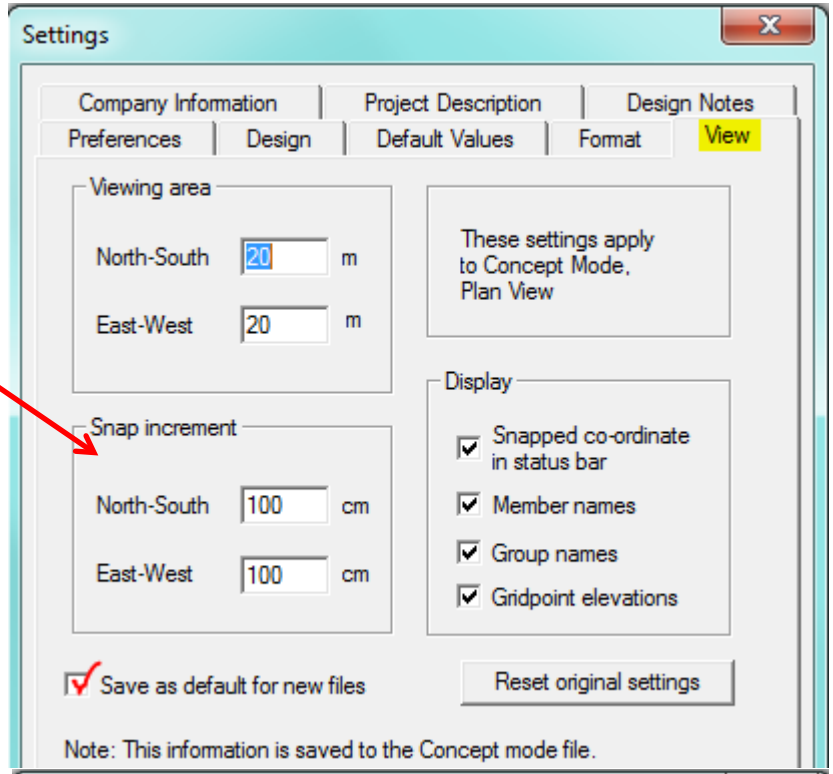


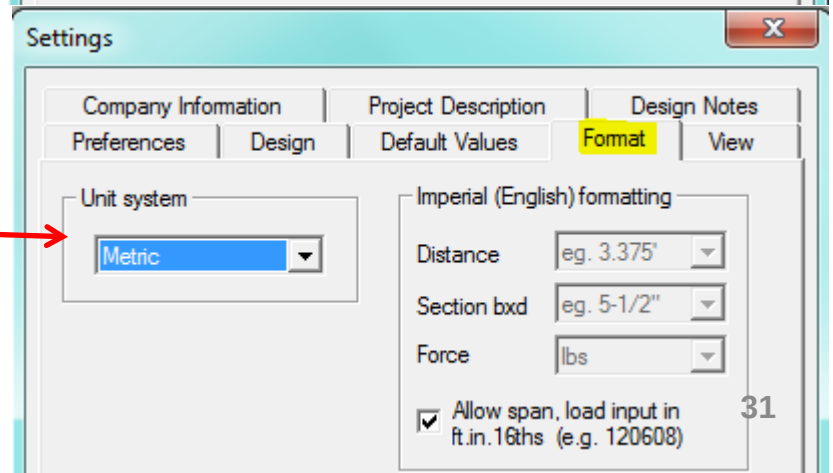
WoodWorks® SOFTWARE FOR WOOD DESIGN

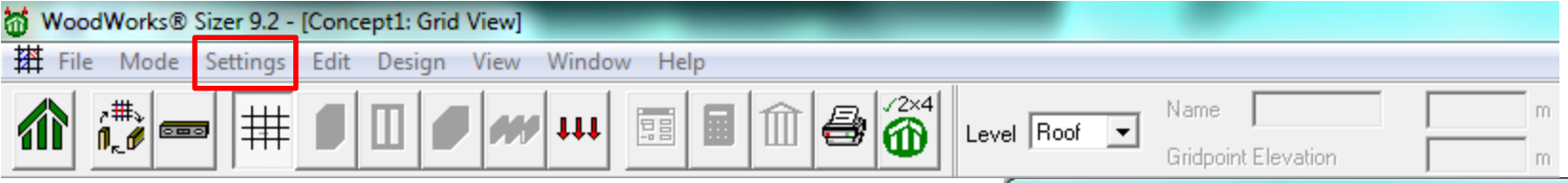
Settings

- Adjust snap increment to a 1 x 1 m grid (*member lengths must be multiples of snap increment*)

- Ability to change unit system in the "Settings" -> "Format" tab

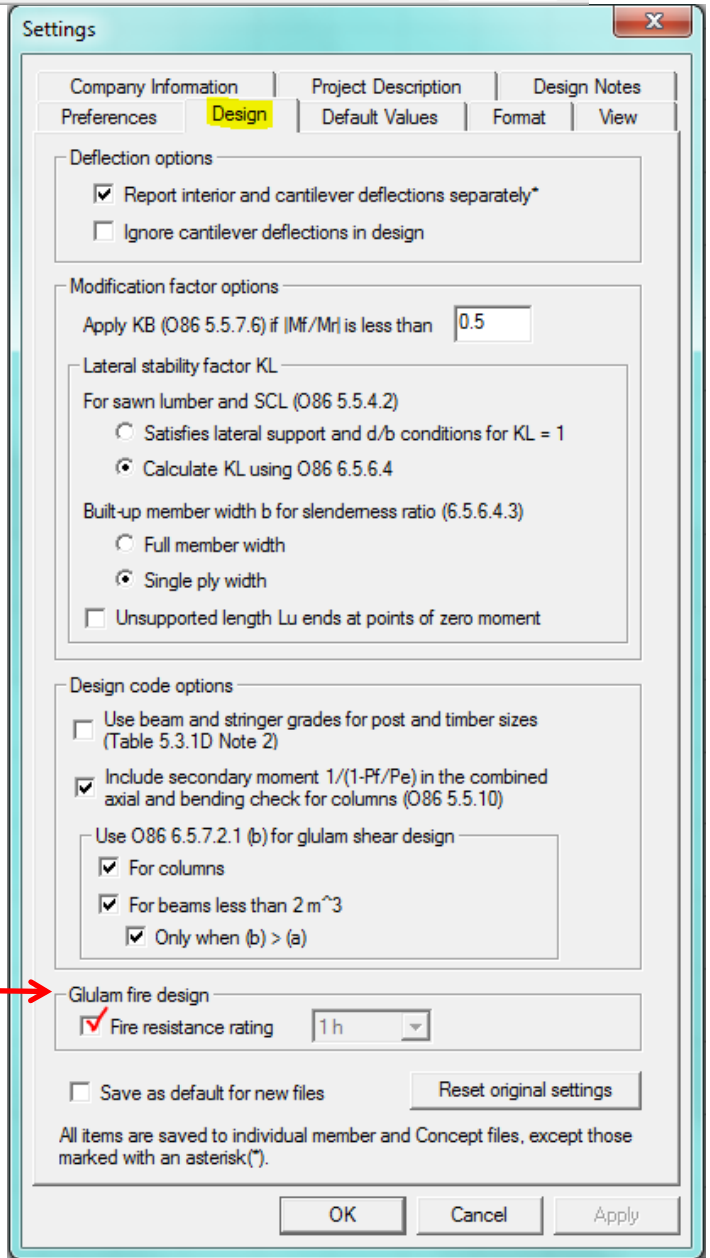


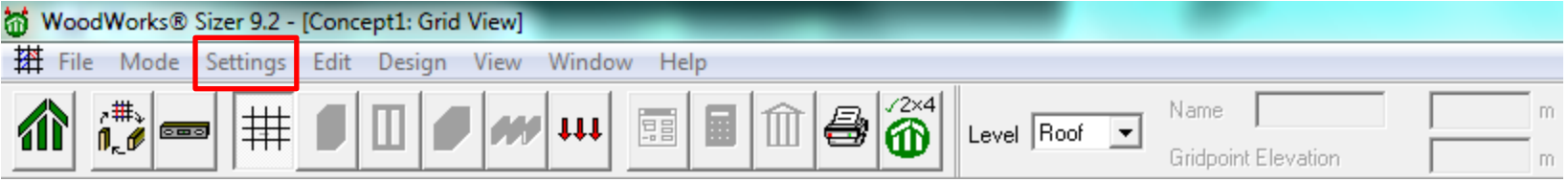




Design Settings

- Ability to modify specific design assumptions
- CSA O86 references provided
- Activate glulam fire design





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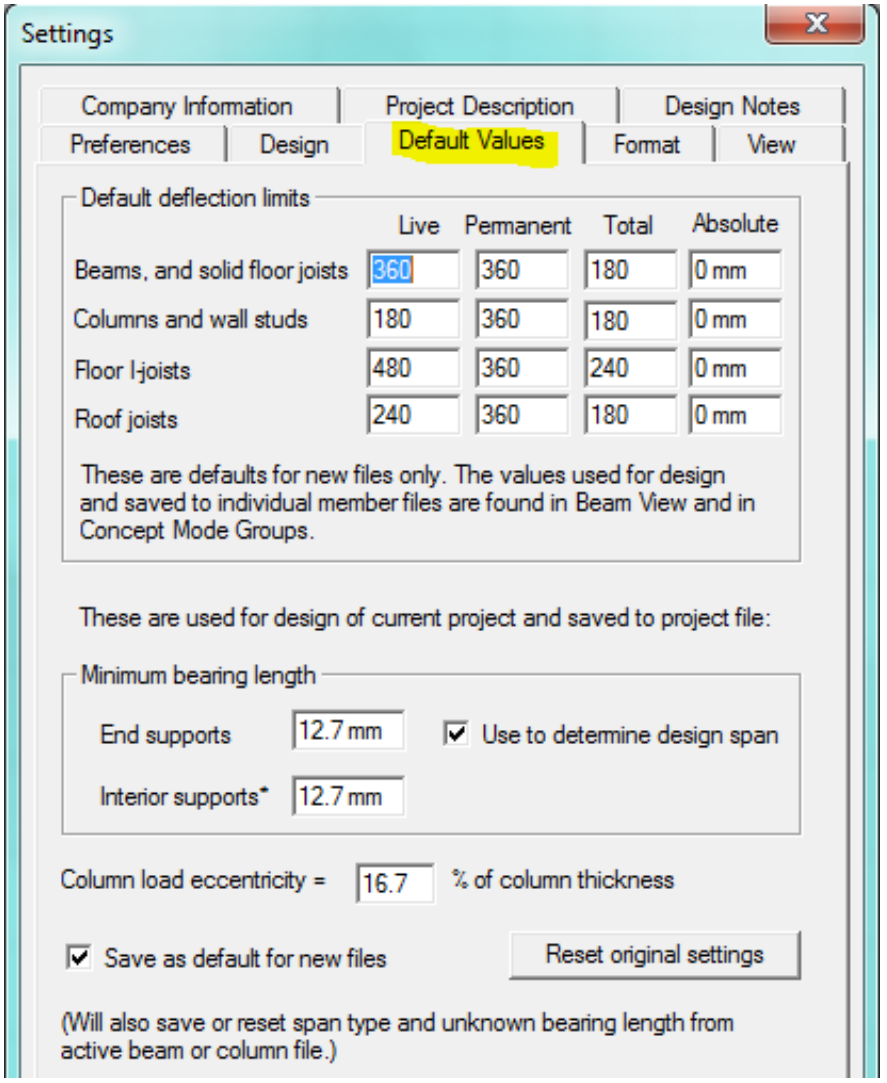
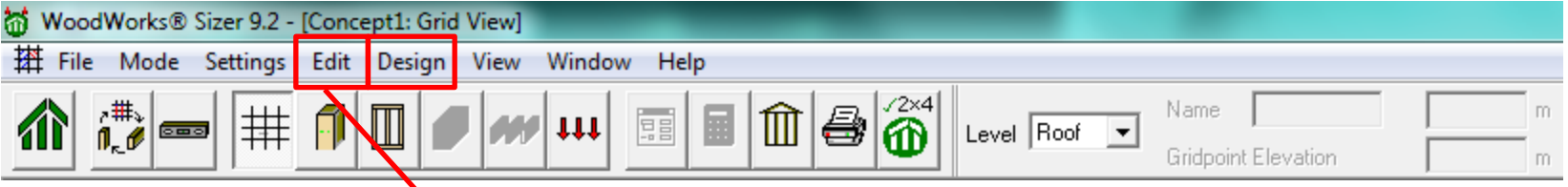
Default Values

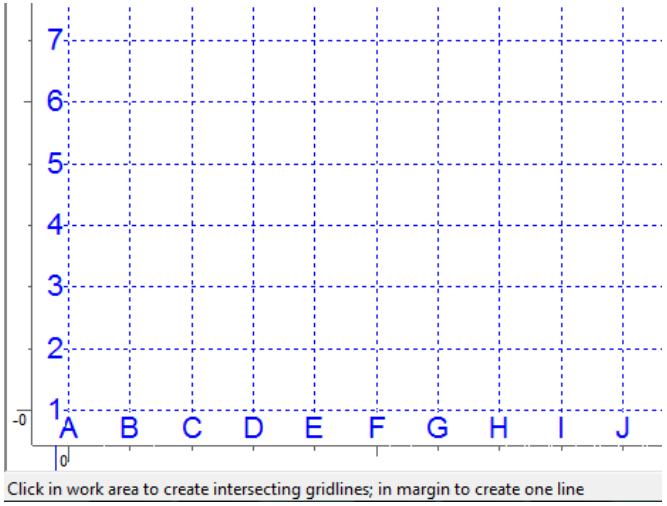
- Modify deflection limits
- Modify bearing lengths
- Modify default column load eccentricity

- Some toggles only apply to beam or column mode





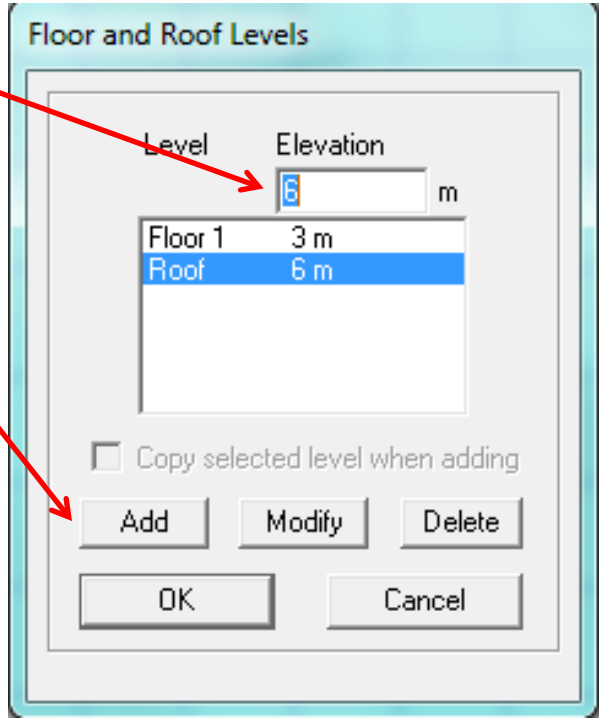
- Edit -> Generate Grid



Define Levels

- Define roof level at 6 m elevation & press “Add”

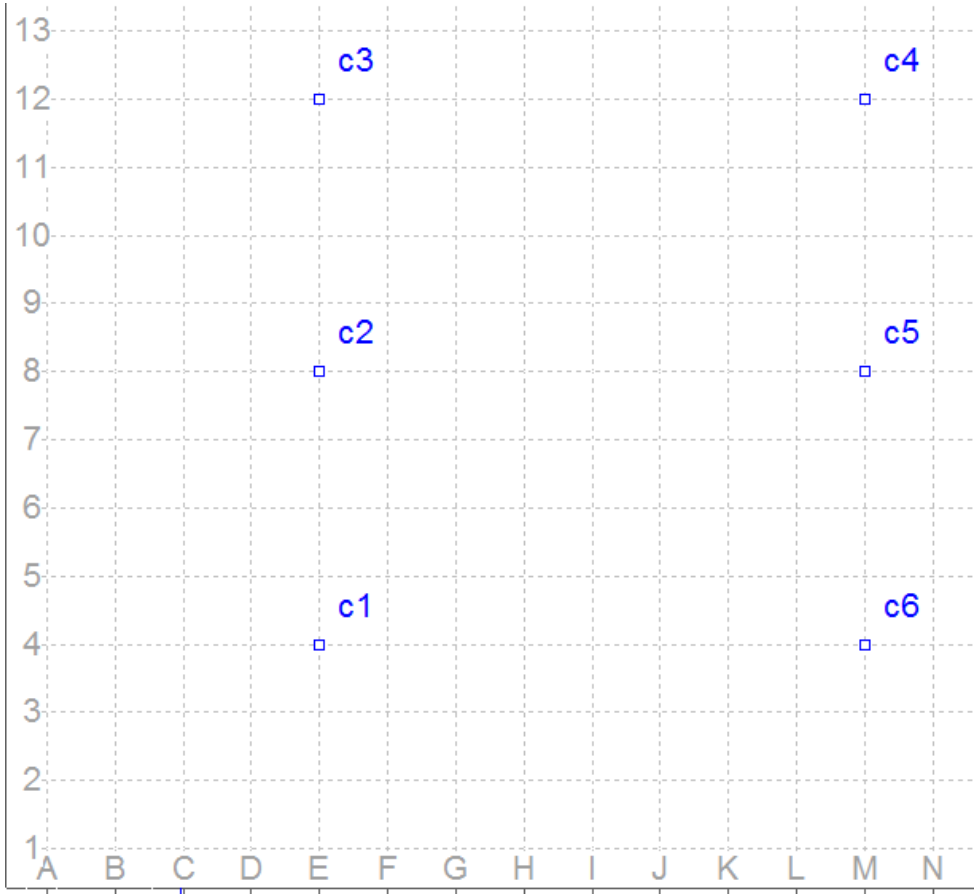
- Software is capable of designing up to six-storeys in height

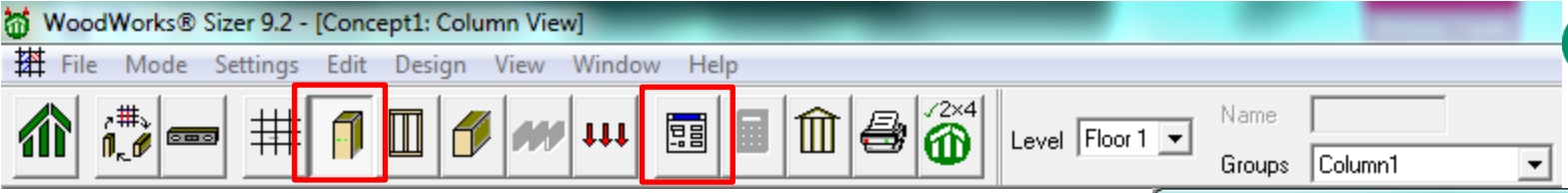


Floor 1 Column Layout

- Layout the columns on Floor 1: Six columns in two N-S lines with N-S spacing of 4 m & E-W spacing of 8 m

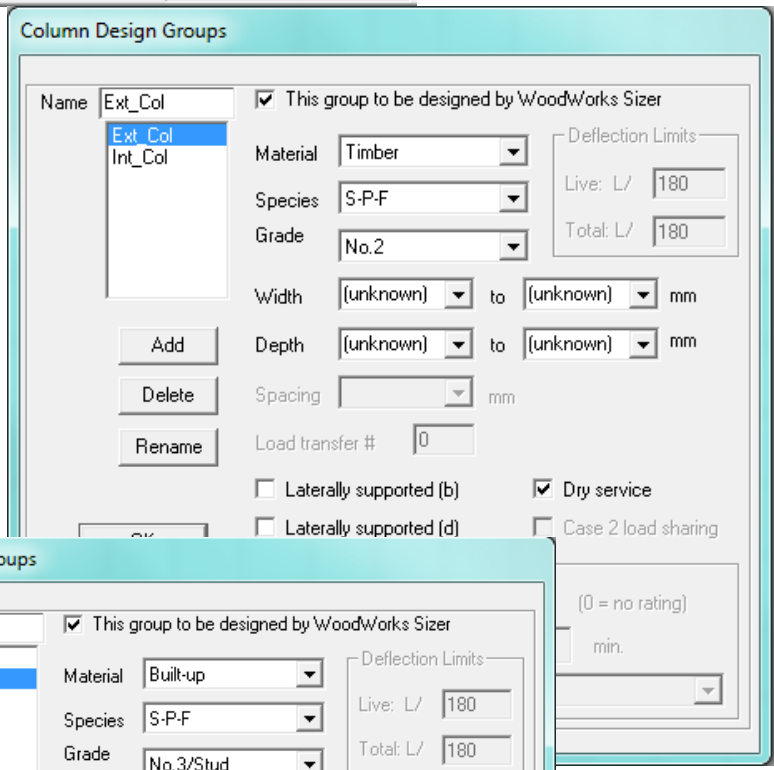
- Columns and other elements can be deleted by clicking on them (highlight red) & pressing the "Delete" key

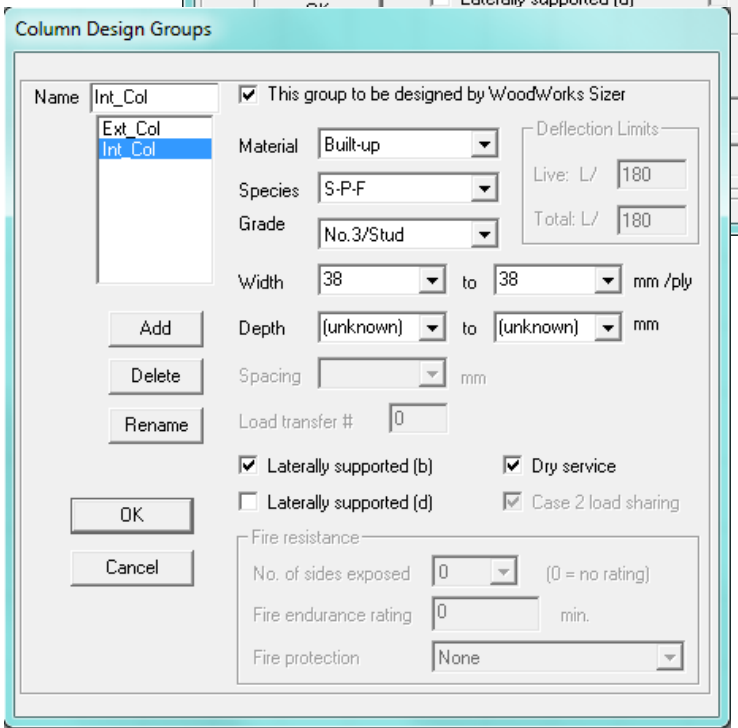




Column Design Groups

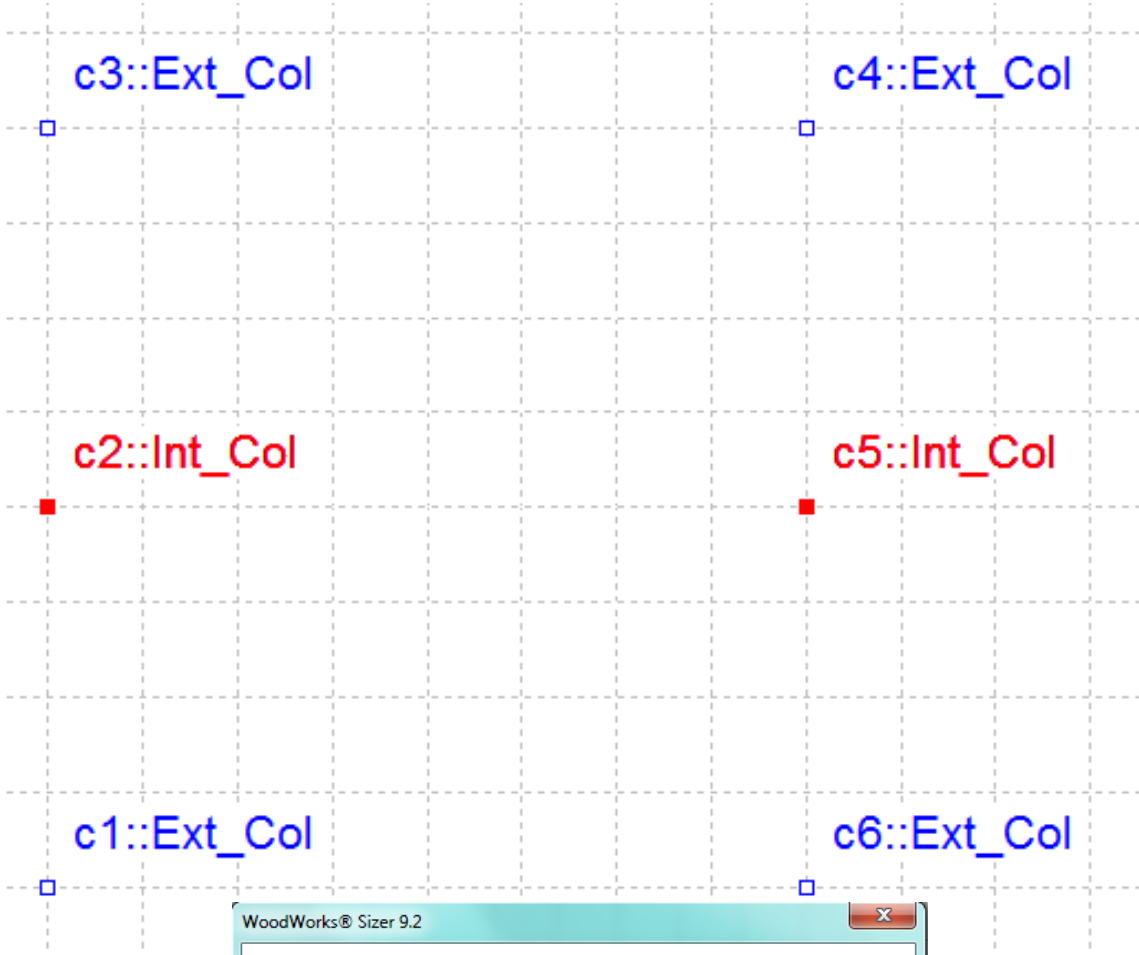
- Purpose is to group members with similar loading
- Software designs for the worst case member in each design group
- Create design groups for:
  - Exterior Columns (Ext_Col)
  - Interior Columns (Int_Col)

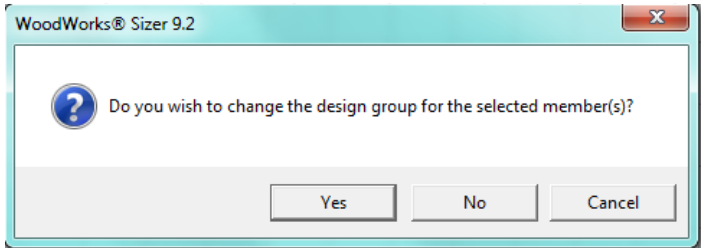


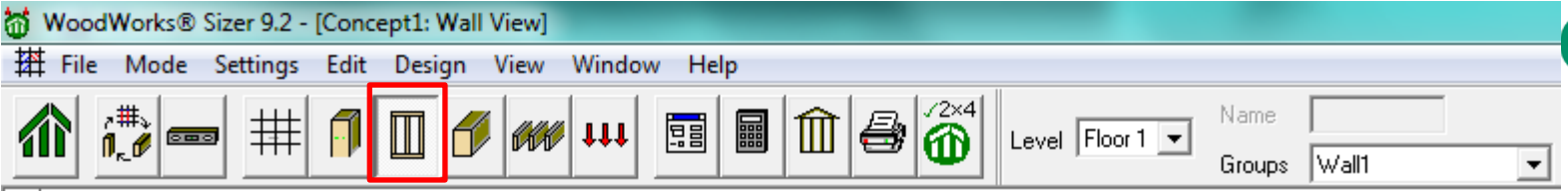


Floor 1 Column Layout

- Hold the Ctrl key to highlight multiple columns
- Change the column design group using the “Groups” pull-down menu on the top toolbar



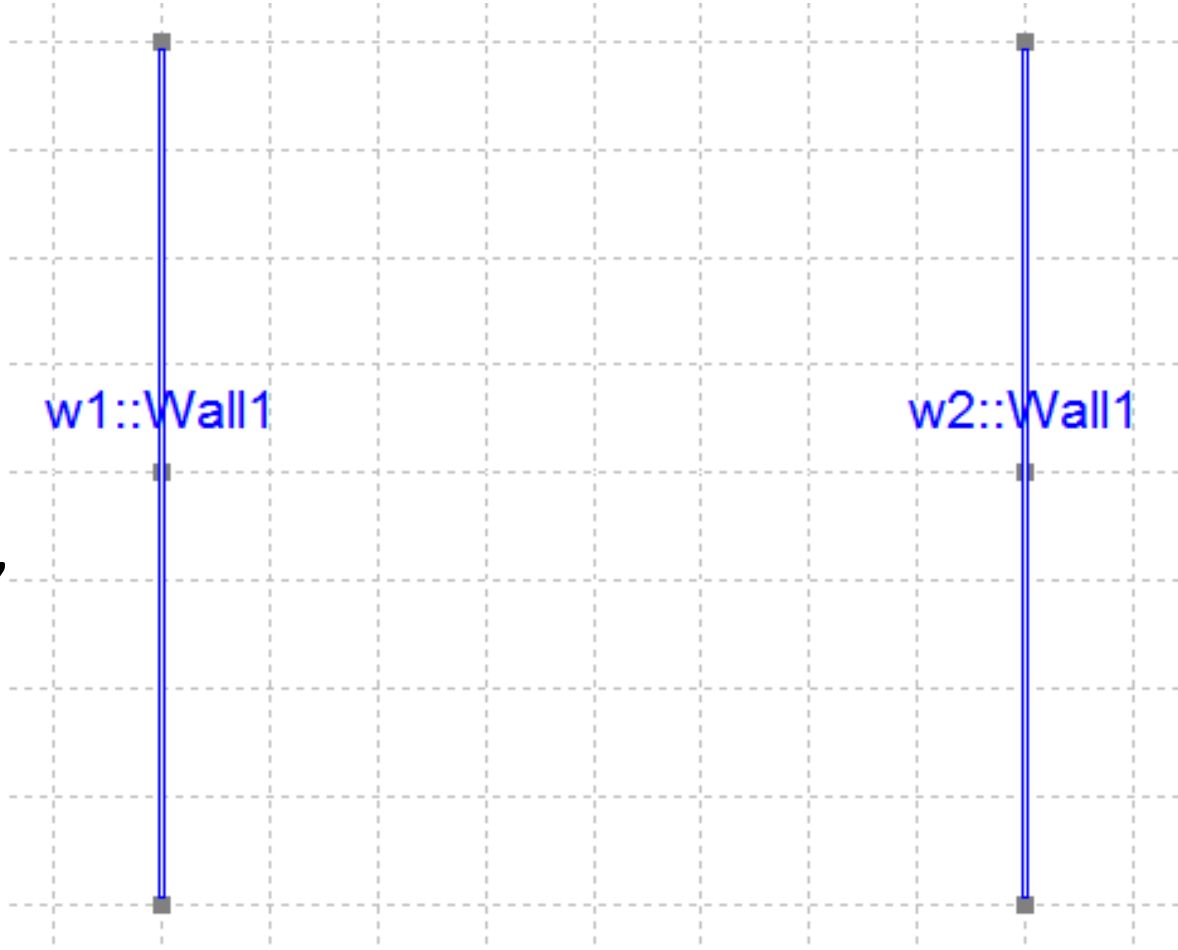


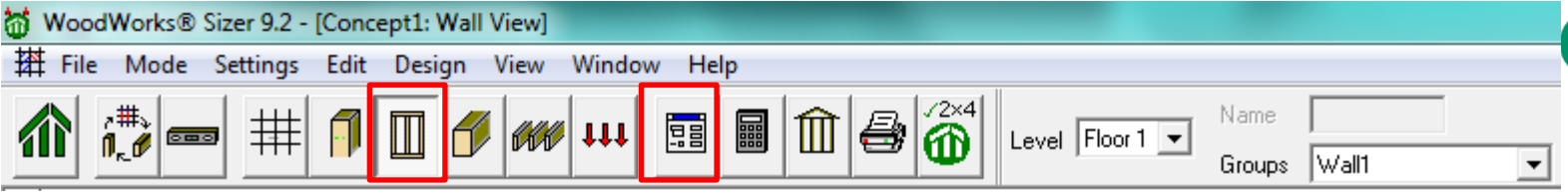


Floor 1 Wall Layout

- Draw two parallel walls between the N-S column lines

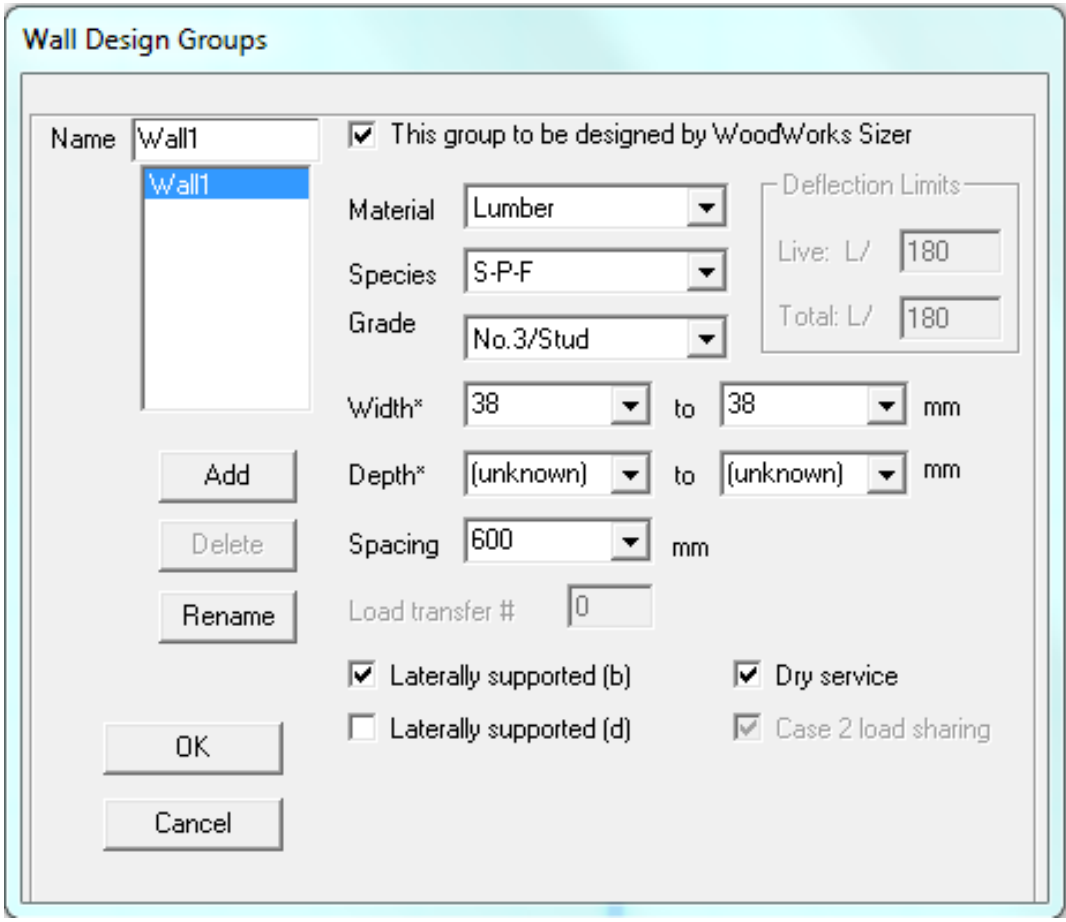
- Left click and hold, then drag the wall & release the mouse button





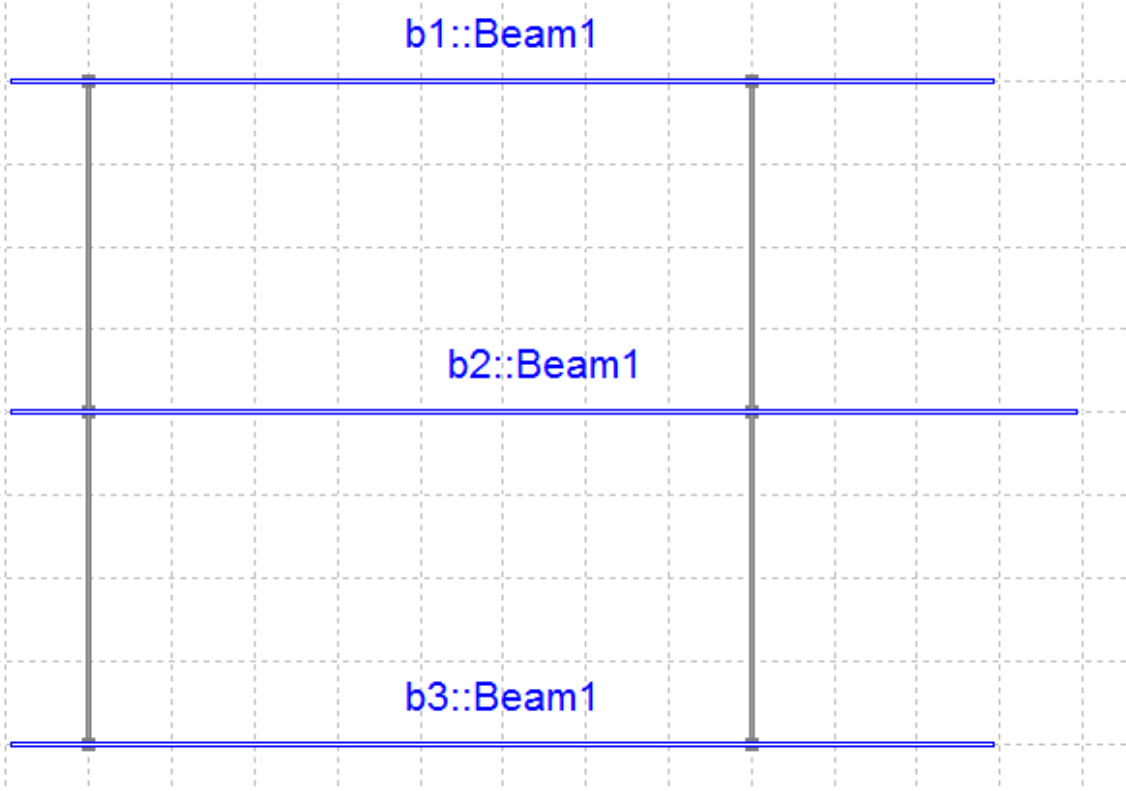
Wall Design Group

- Design groups are a global setting
- Do not need to specify new design groups for each level
- Although, it is possible to specify different design groups on each level



Floor 1 Beam Layout

- Left click & hold over gridpoint, then drag the wall & release the mouse button

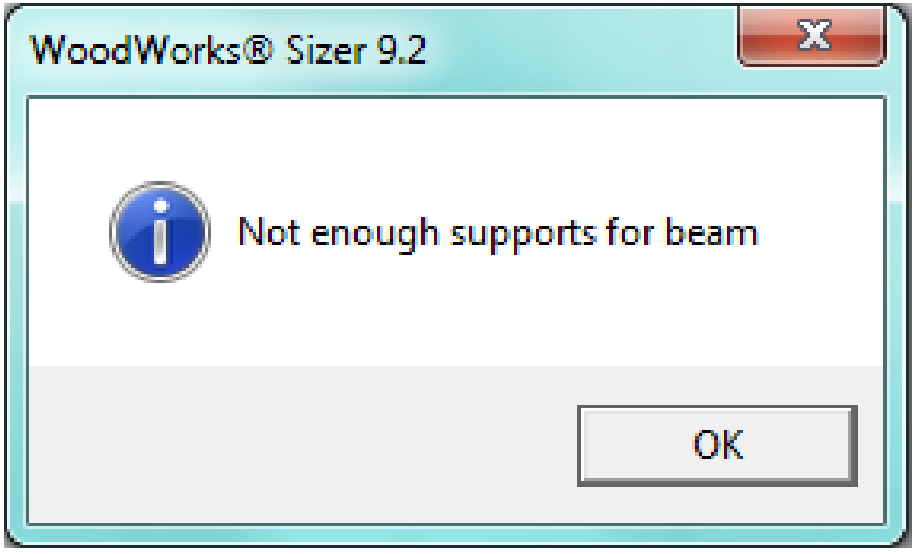


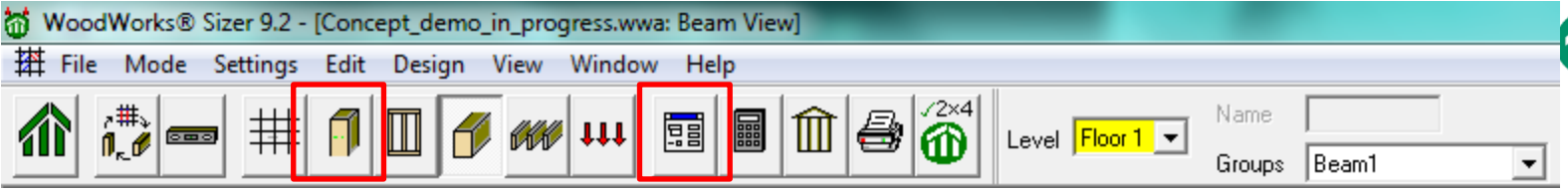
- 1 m west cantilever
- 3 m east cantilever for edge beams
- 4 m east cantilever for centre beam

Floor 1 Beam Layout

- Beam can be supported by columns or other beams on the same level

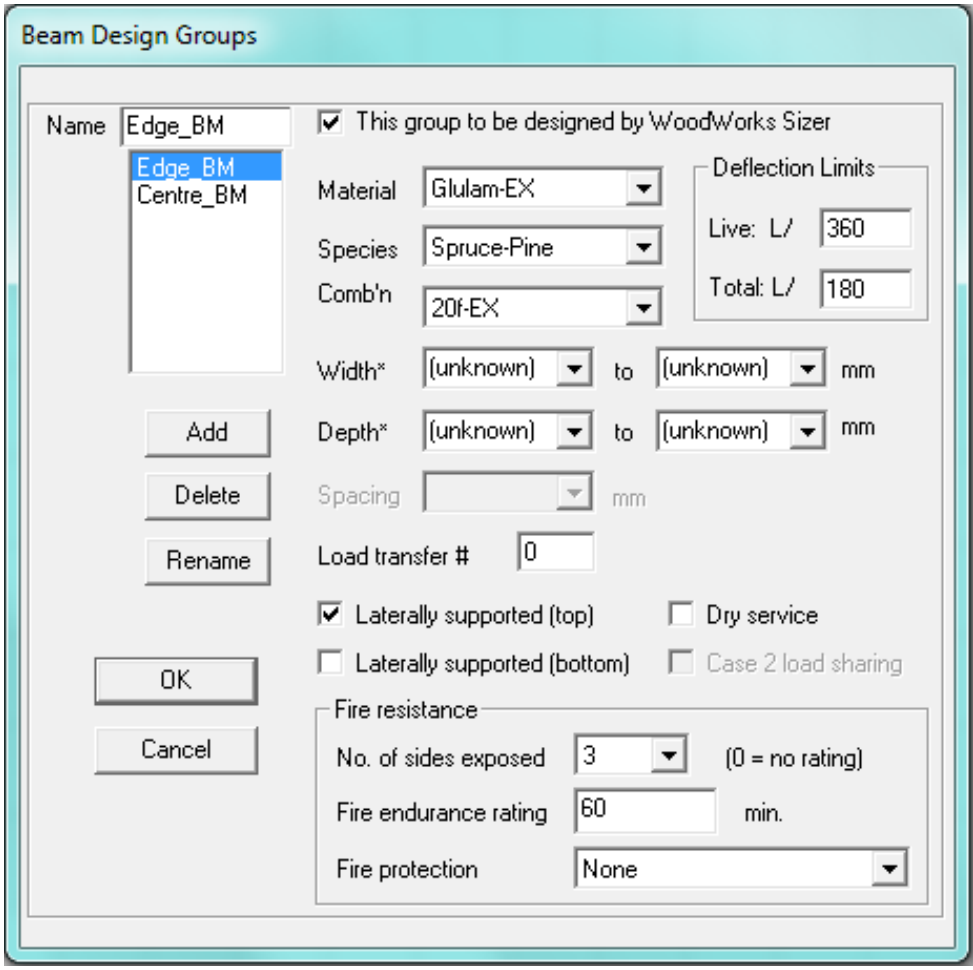
- Beams cannot be supported by walls (*must define a column within a wall to support beam*)

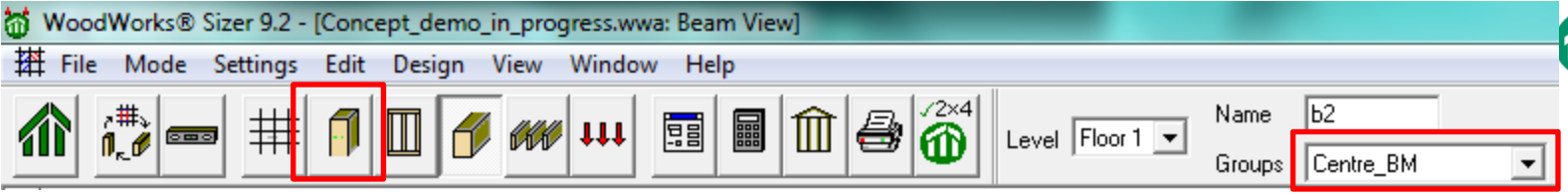




Beam Design Groups

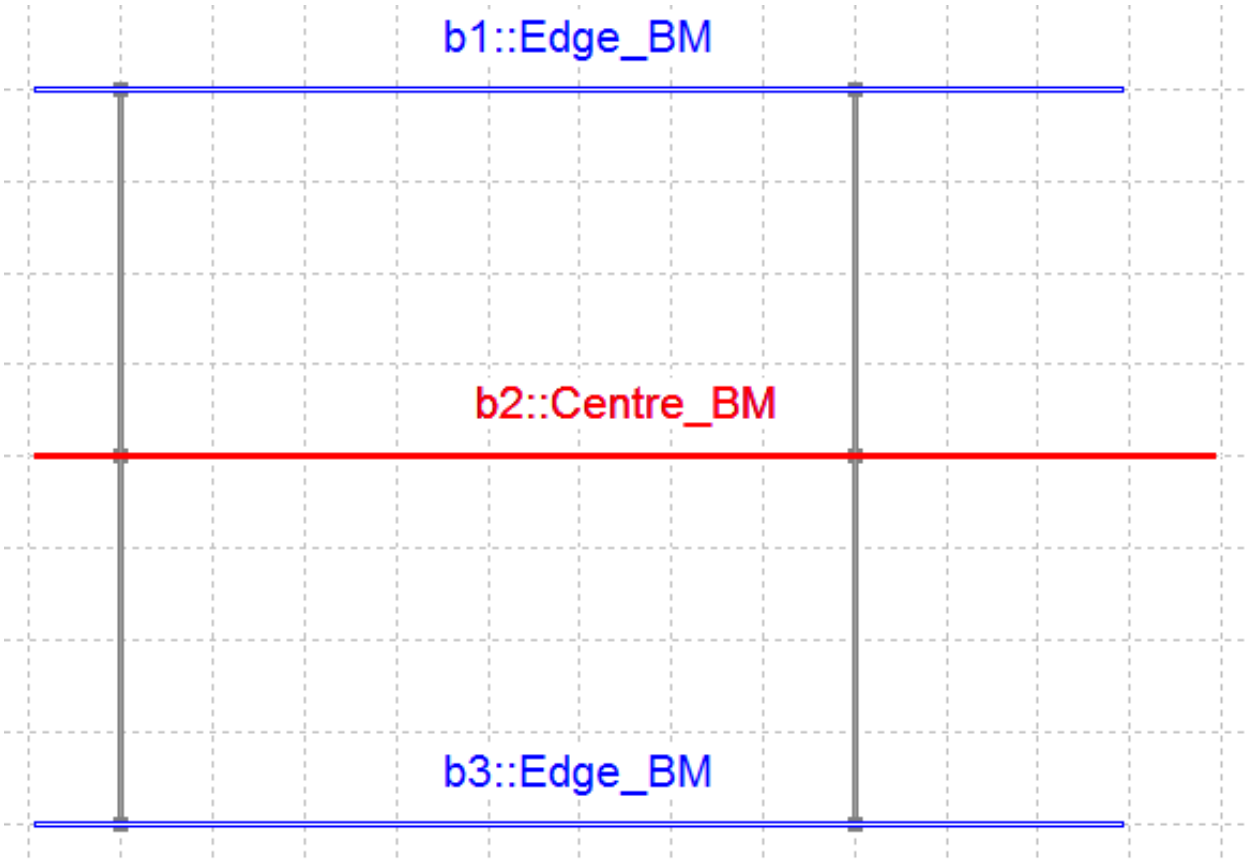
- Define “Edge_BM” and “Centre_BM” design groups
- Glulam-EX
- Spruce-Pine
- Width & Depth unknown
- Laterally supported by floor joists
- Exterior exposure on cantilevers

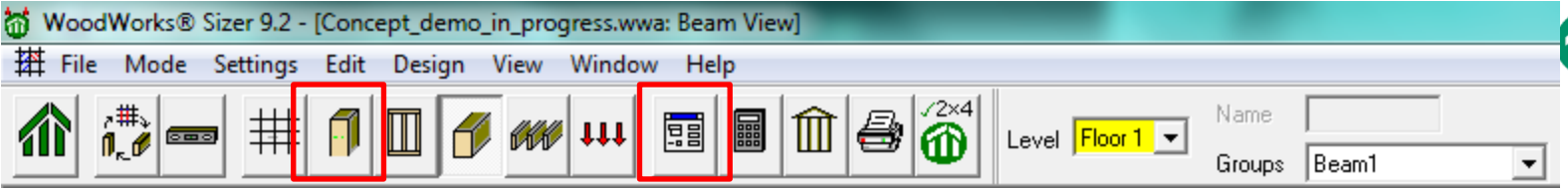




Floor 1 Beam Layout

- Highlight the beam, then change the beam design group using the "Groups" pull-down menu on the top toolbar

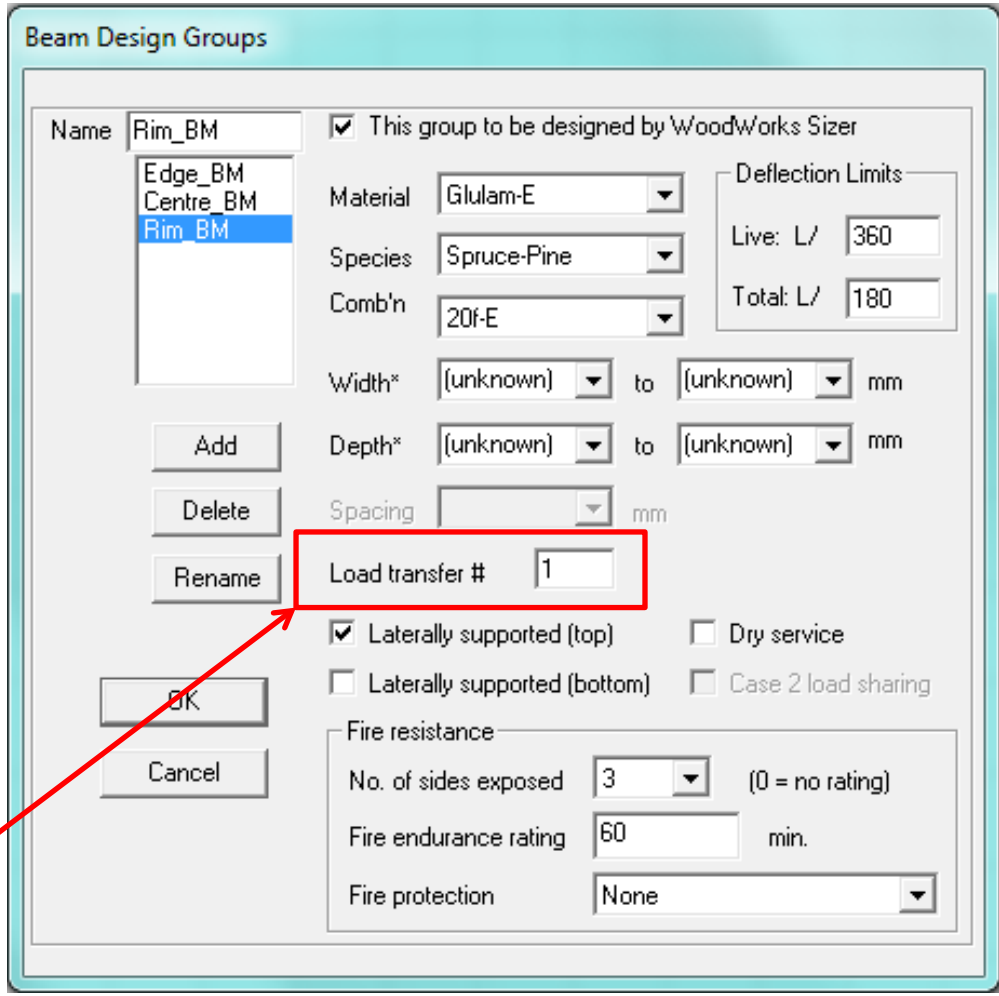


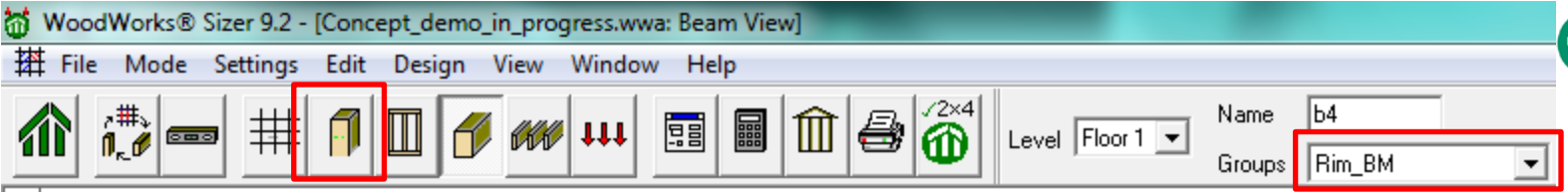


WoodWorks® SOFTWARE FOR WOOD DESIGN

Beam Design Groups

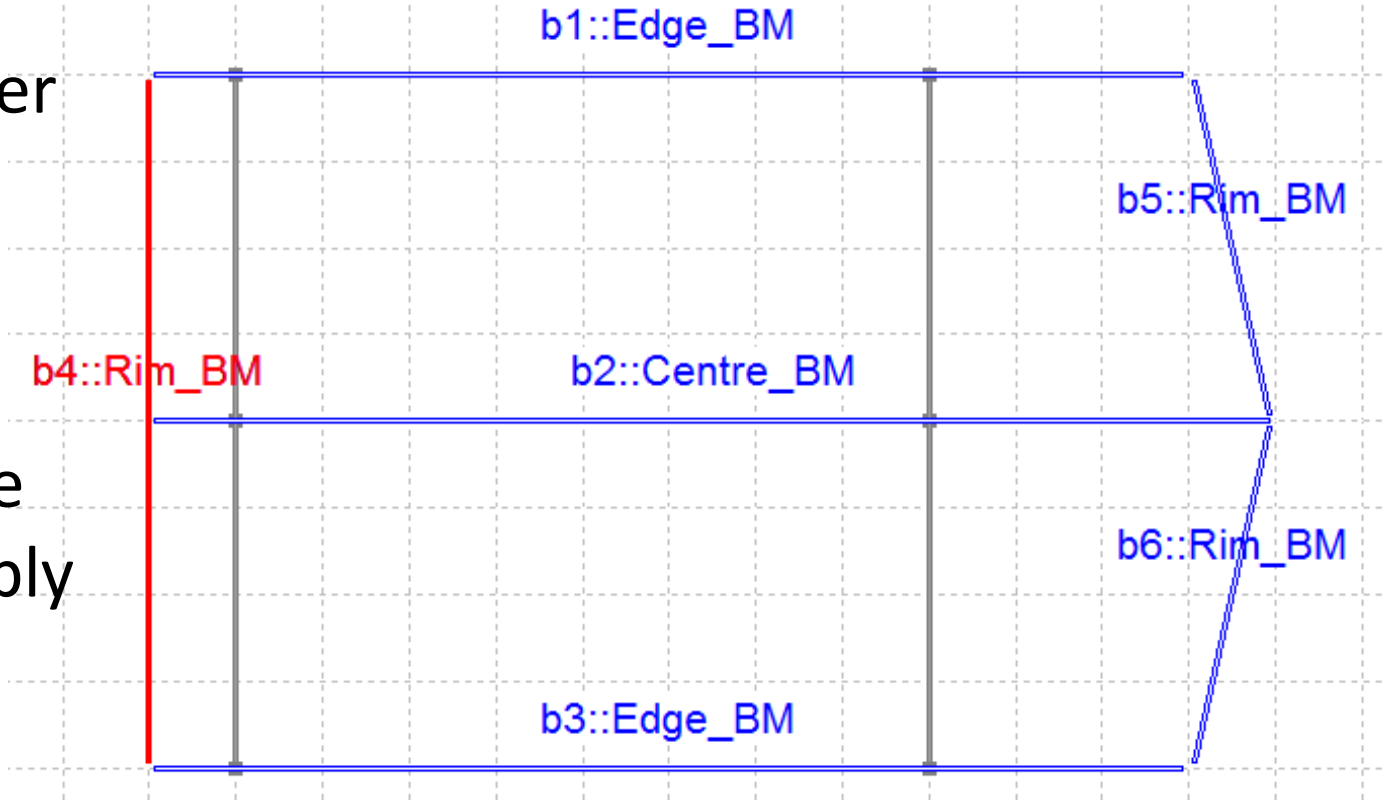
- Define “Rim_BM” design group
- Glulam-E
- Spruce-Pine
- Width & Depth unknown
- Laterally supported by floor joists
- Exterior exposure on cantilevers
- Load transfer # = 1

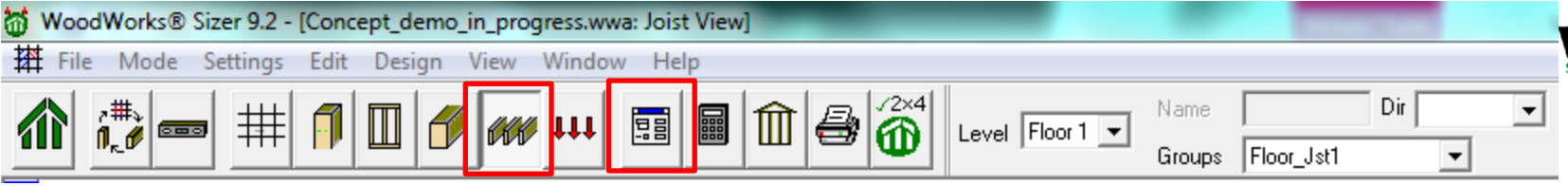




Floor 1 Final Beam Layout

- West beam is continuous over cantilever supports
- East beams are skewed & simply supported

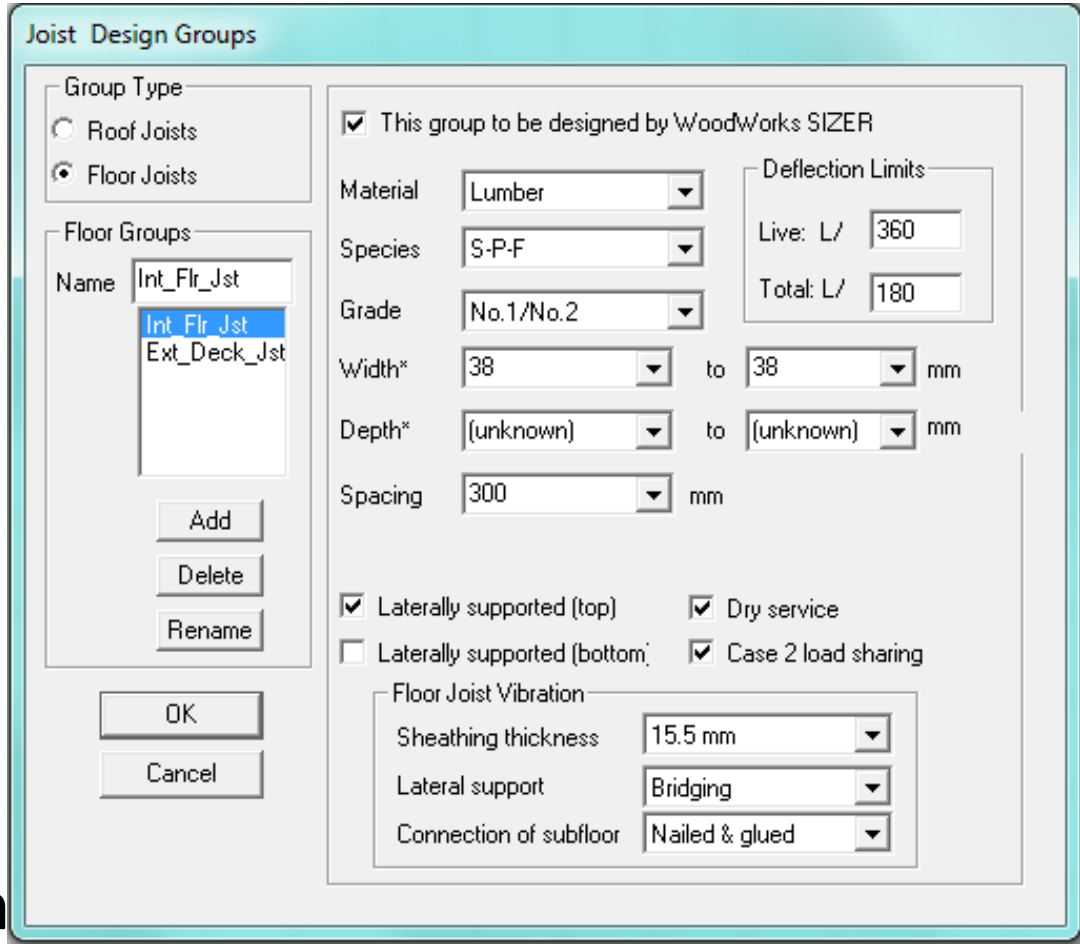


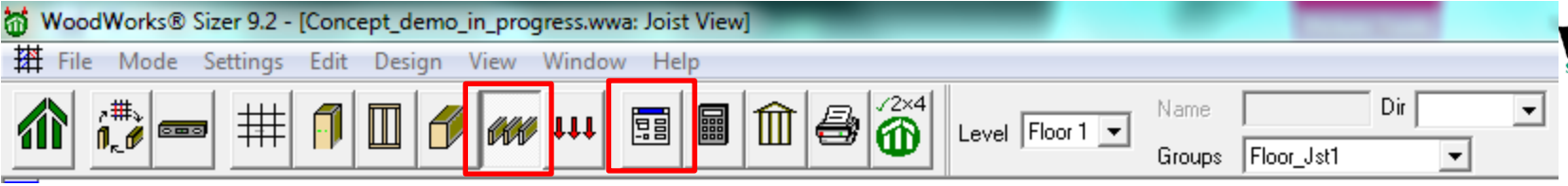


WoodWorks® SOFTWARE FOR WOOD DESIGN

Joist Design Groups

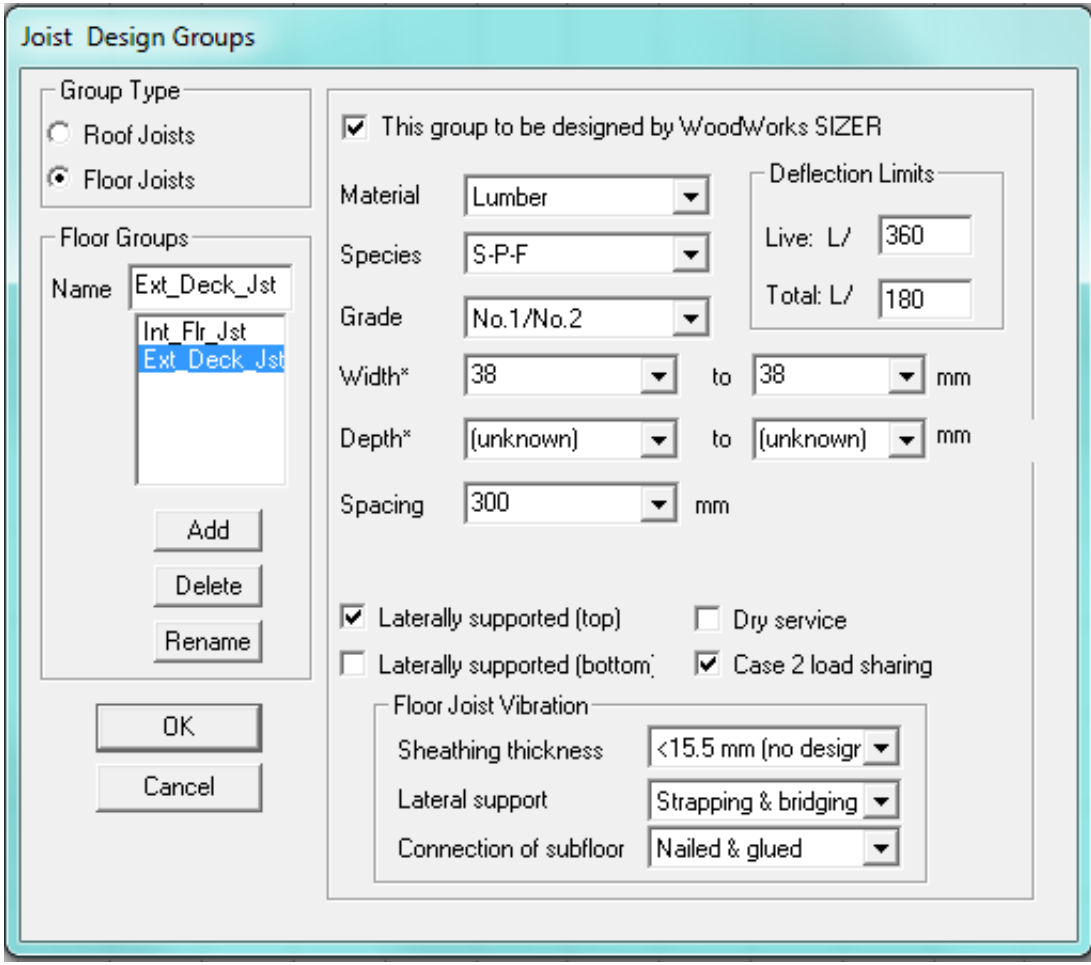
- Define “Int_Flr_Jst” design group
- Lumber
- S-P-F
- No.1/No.2
- 38 mm width
- Unknown depth
- 300 mm joist spacing with bridging
- Overlaid with 15.5 mm sheathing (nailed & glued)

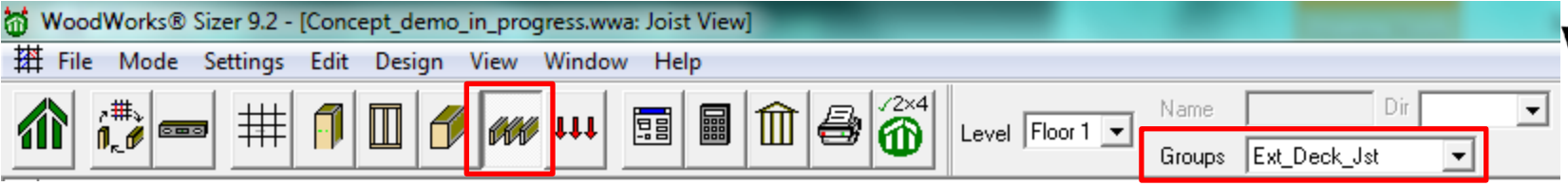




Joist Design Groups

- Define “Ext_Deck_Jst” design group
- Lumber
- S-P-F
- No.1/No.2
- 38 mm width
- Unknown depth
- 300 mm joist spacing
- Overlaid with 38 x 140 mm pressure treated

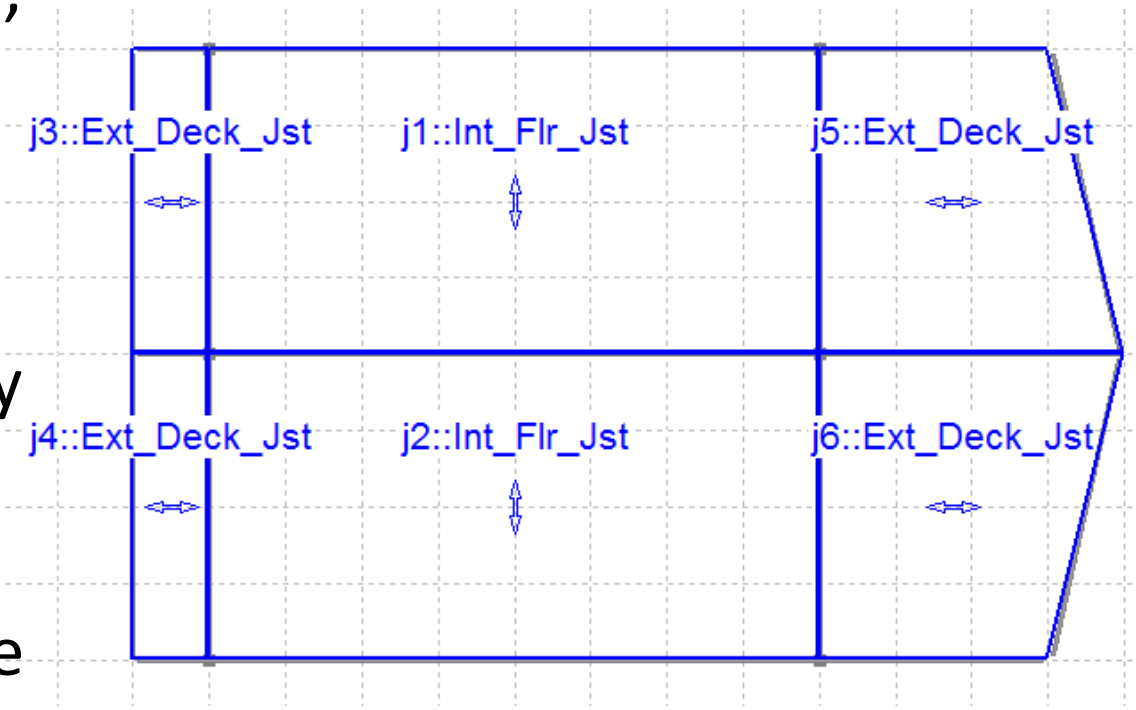


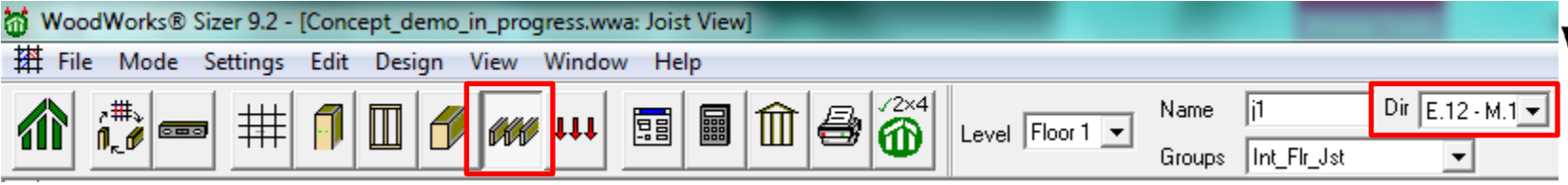


Floor 1 Joist Layout

- Click & release on a corner of the joist area, then click & release on the next corner, etc.

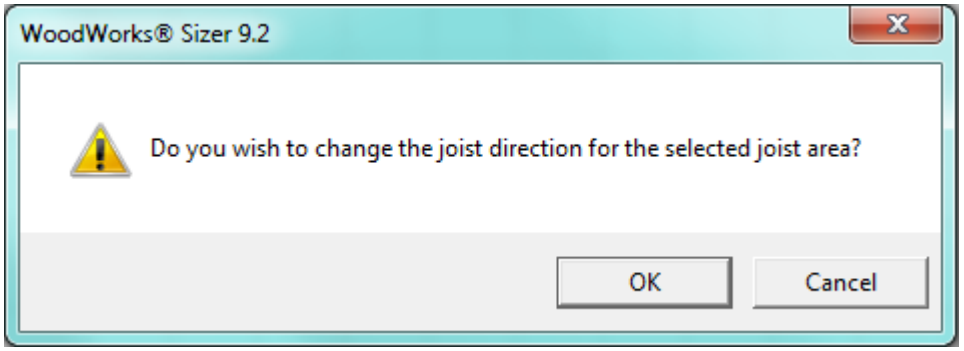
- Joists will automatically span in shortest direction, unless they are unsupported in one direction

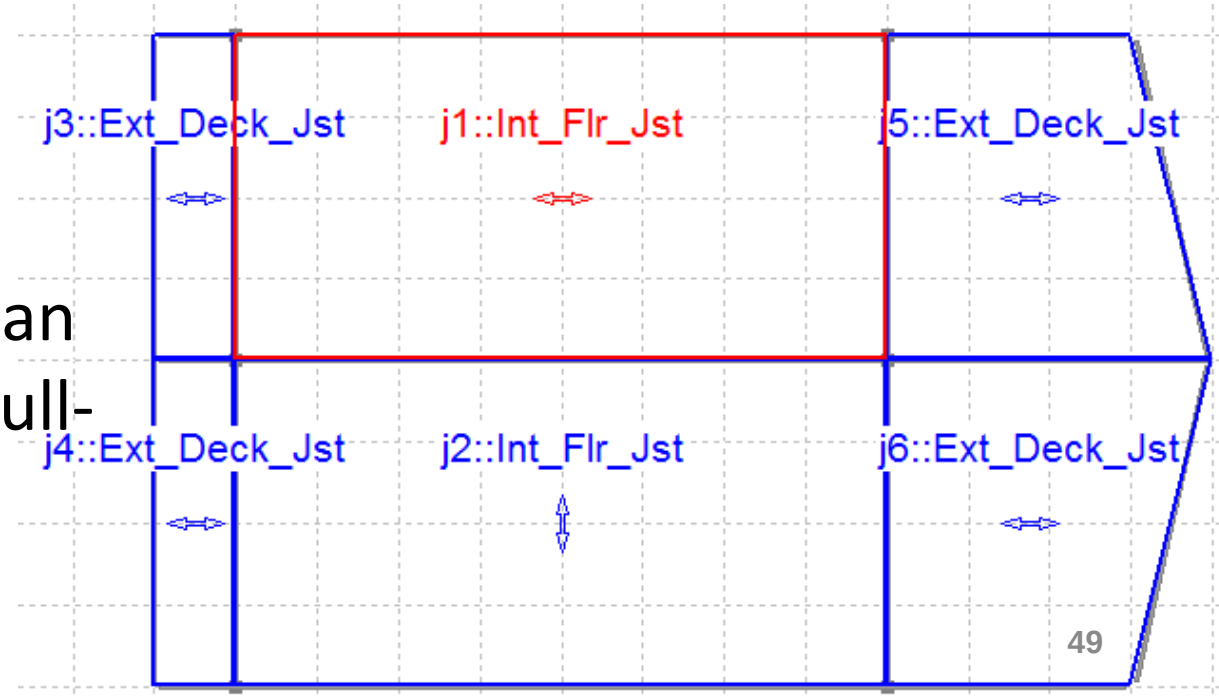


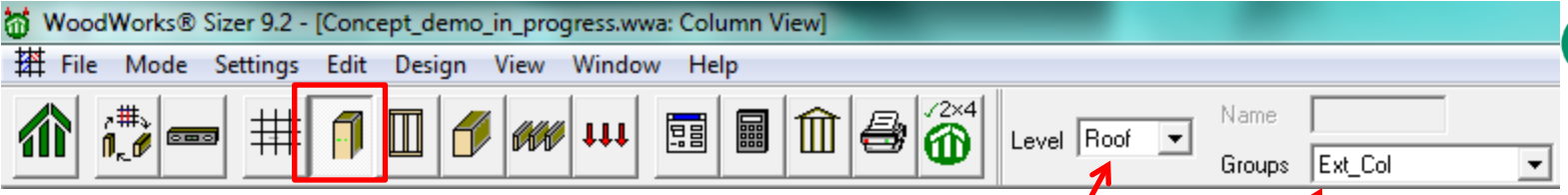


Floor 1 Joist Layout

- To change span direction of Int_Flr_Jst:
- Press Esc button to enable selection of joist area
- Click on a joist area (highlight red)
- Choose the other span direction from the pull-down menu

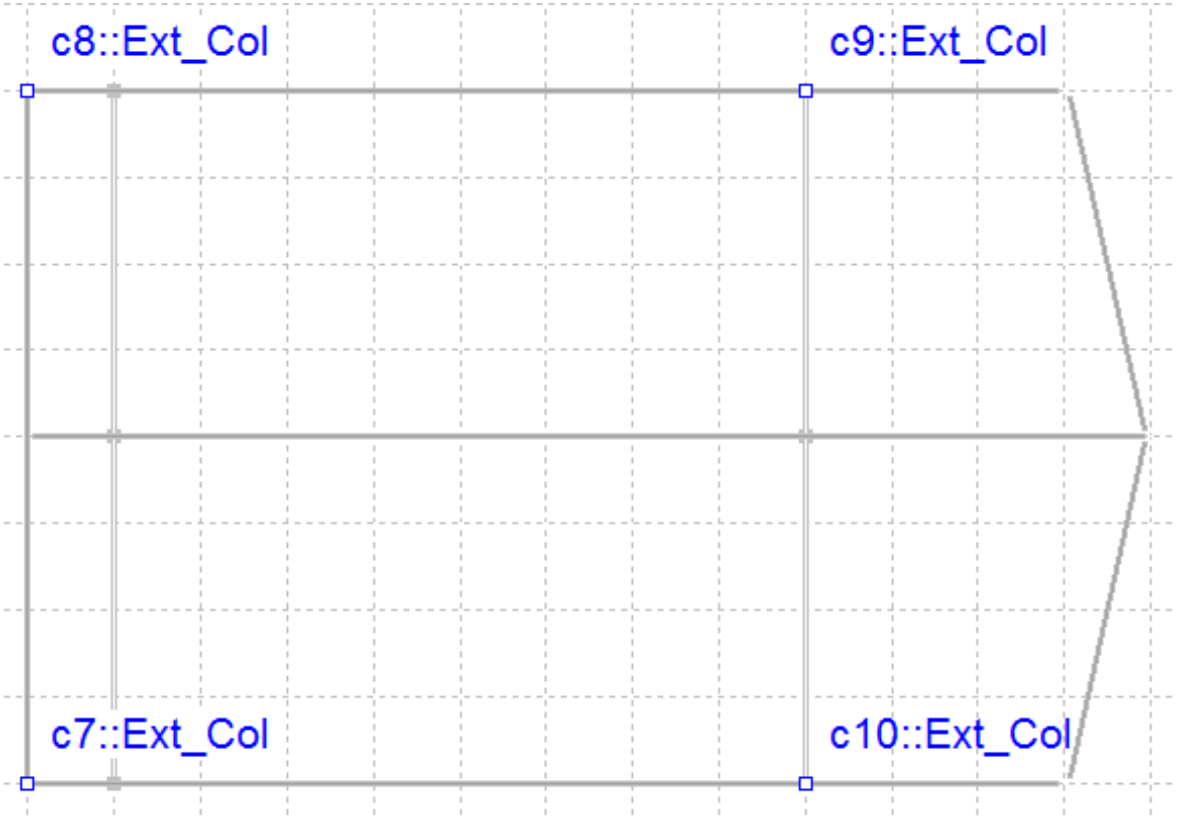


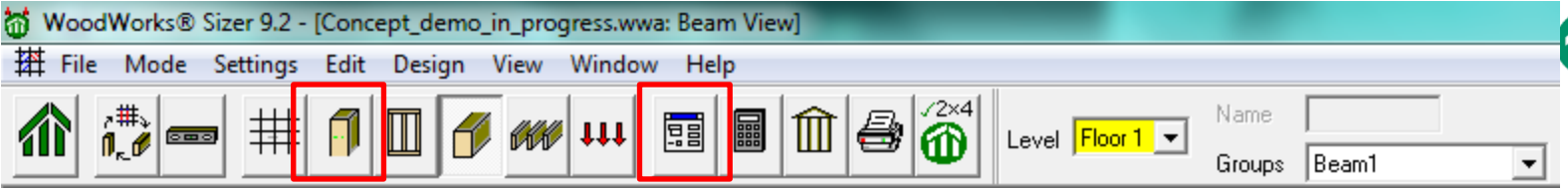




Roof Column Layout

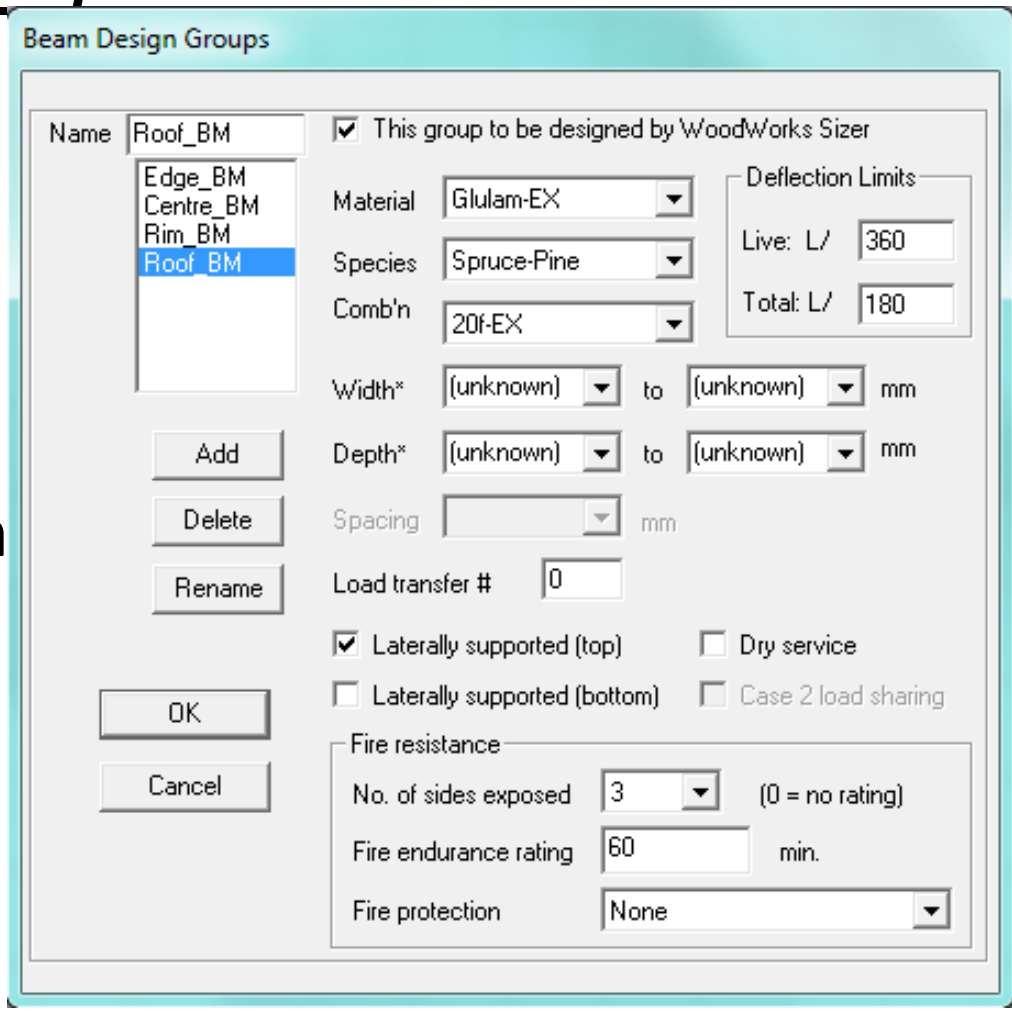
- Column layout on Roof level ("Ext_Col" design group):
  - Two west columns supported by the edge beam cantilever
  - Two east columns over columns below

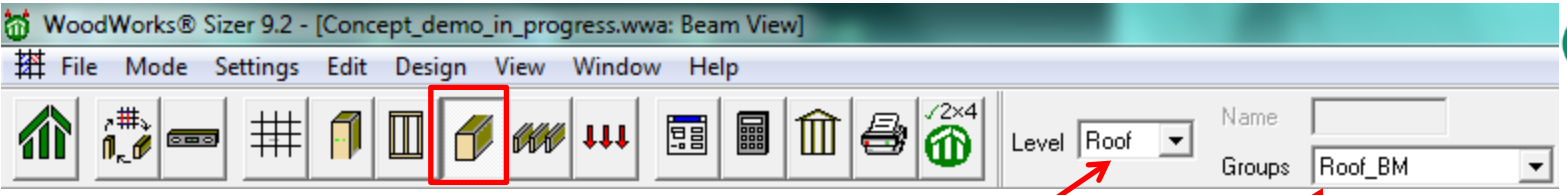




Beam Design Groups

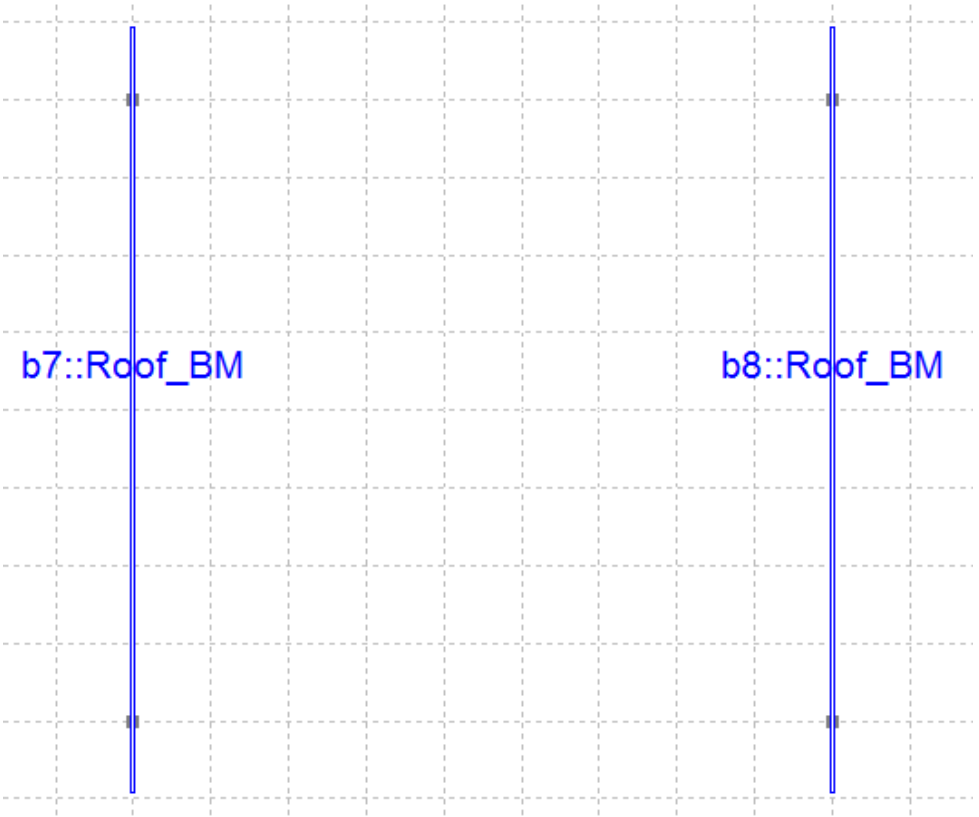
- Define “Roof_BM” design group
- Glulam-EX
- Spruce-Pine
- Width & Depth unknown
- Laterally supported by roof joists
- Exterior exposure on cantilevers

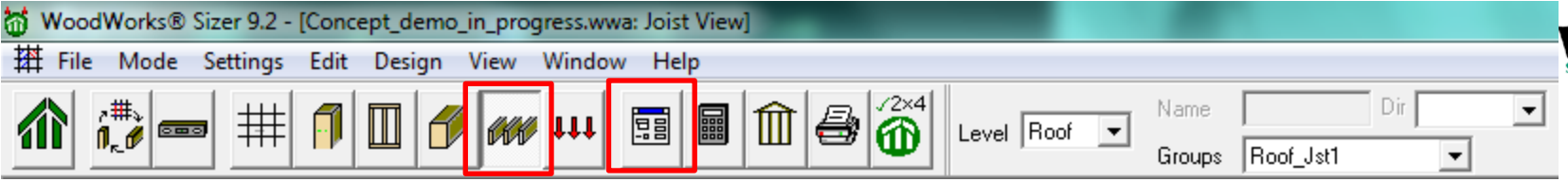




Roof Beam Layout

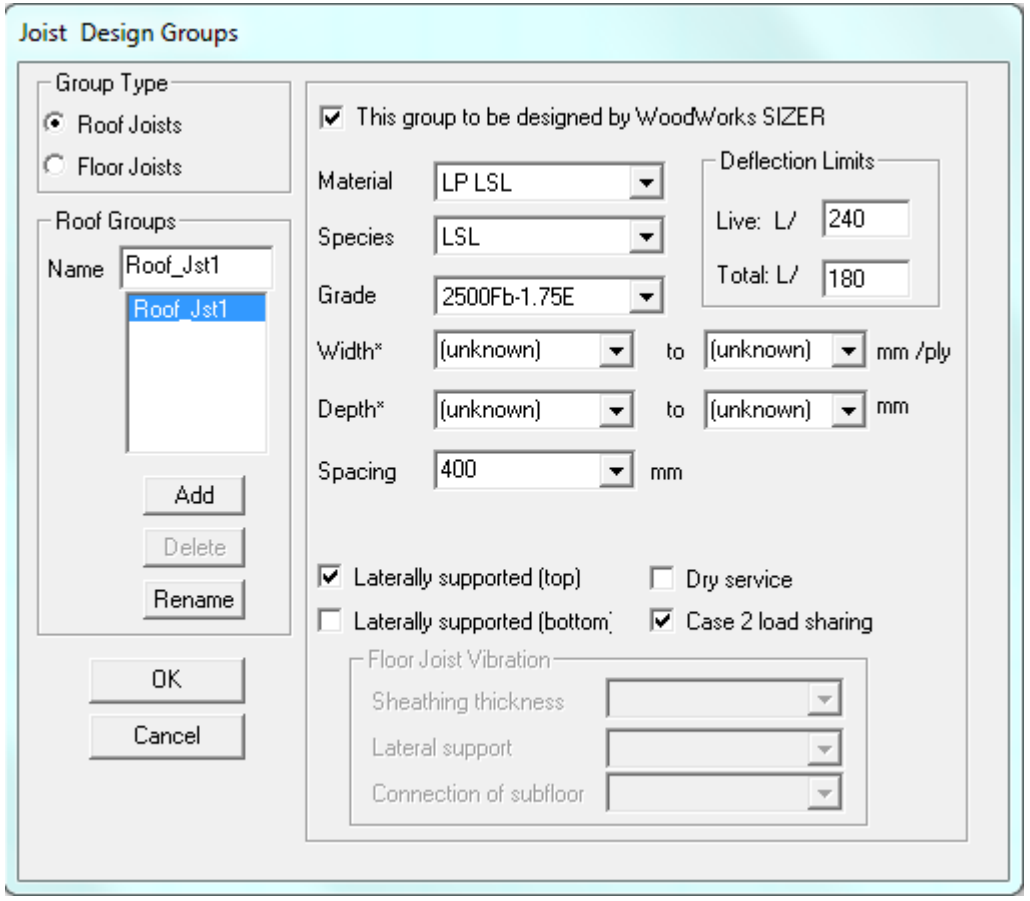
- Beam layout on Roof level ("Roof_BM" design group):
  - Two beams spanning N-S over the columns
  - Each with a 1 m cantilever at both ends

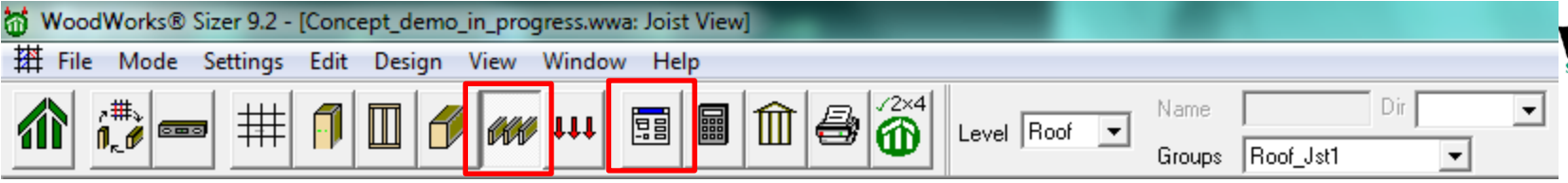




Joist Design Groups

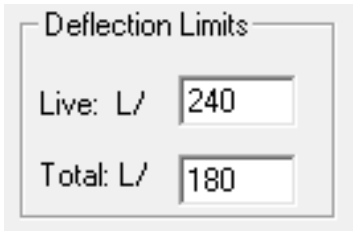
- LP LSL
- 2500Fb-1.75E grade
- Unknown width and depth
- 400 mm spacing
- Overlaid with roof sheathing



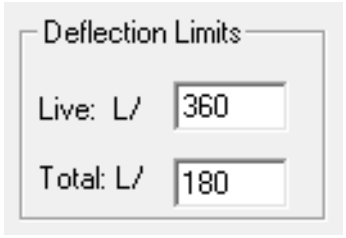


Joist Design Groups

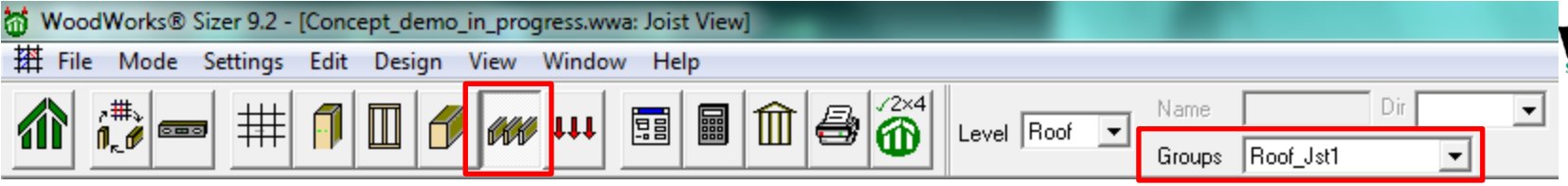
- Design of roof joists and floor joists is the same, except:
  - Less stringent live load deflection limits for roof joists



vs.



  - No vibration design required for roof joists



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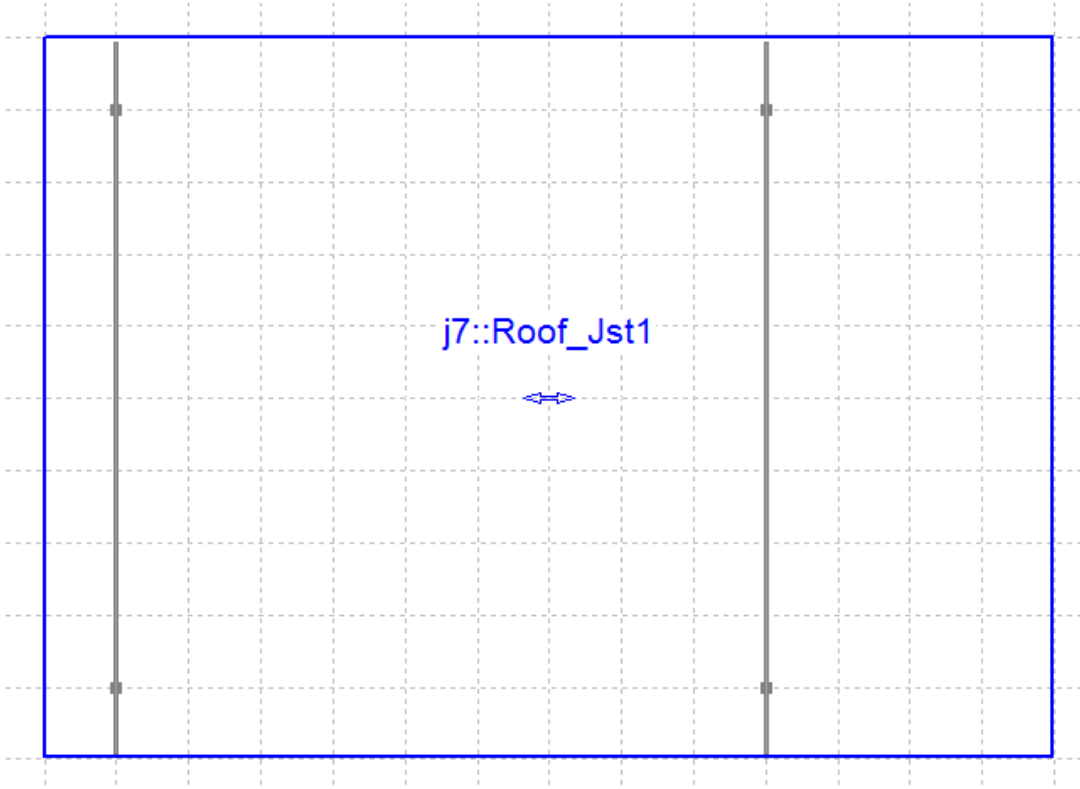
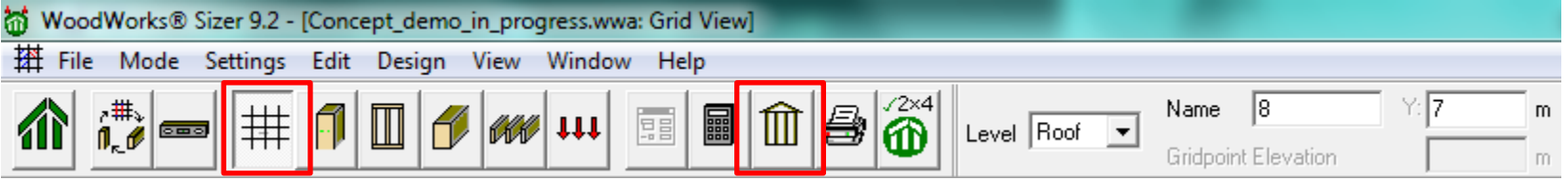
Roof Joist Layout

- Click & release on a corner of the joist area, then click & release on the next corner, etc.

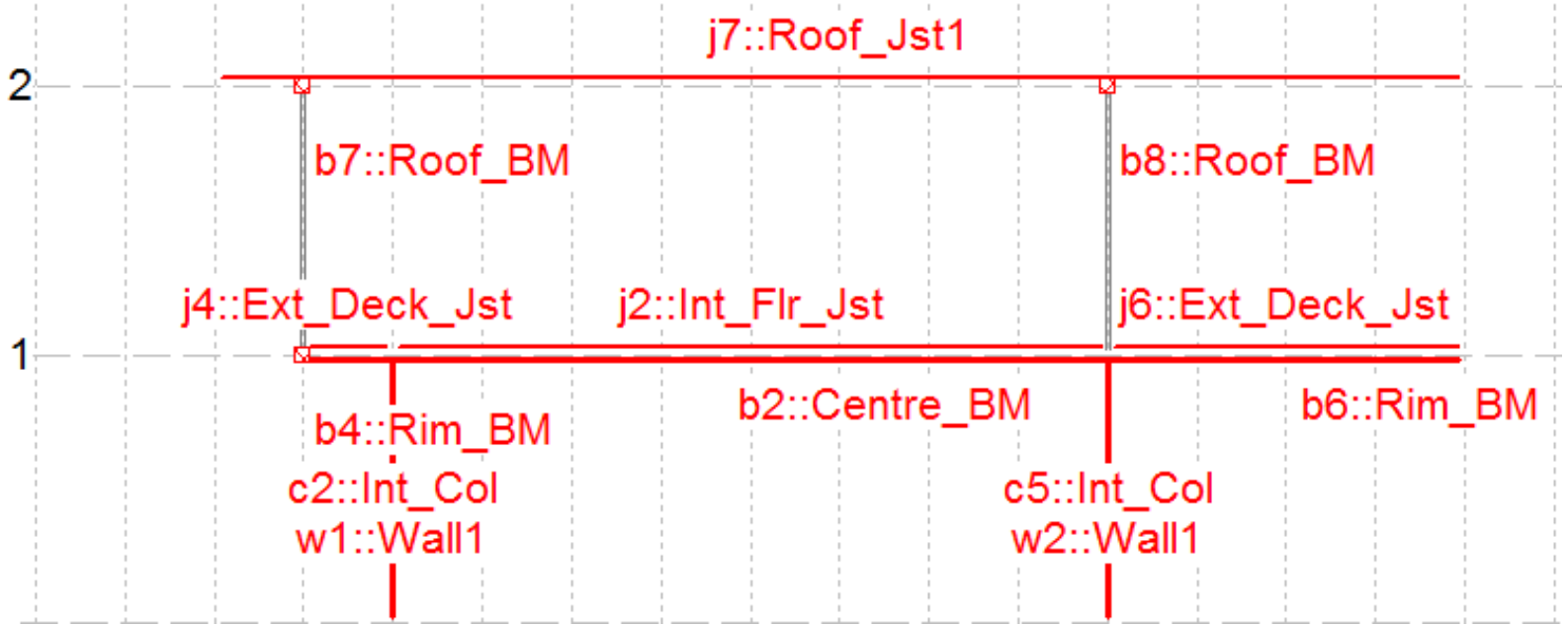
- Cantilever joists 1 m to the west and 4 m to the east

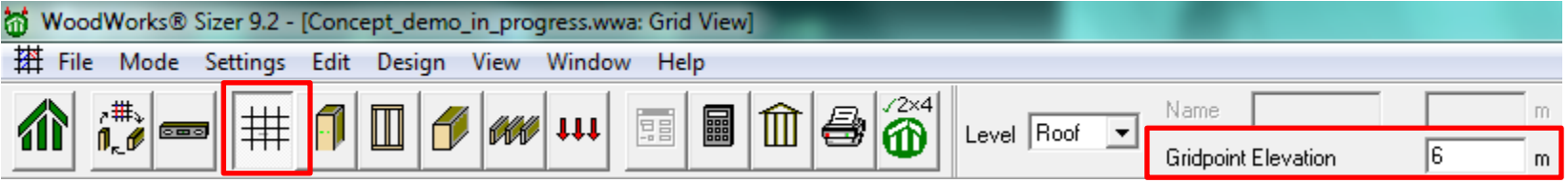




Cut a Section (Elevation View)

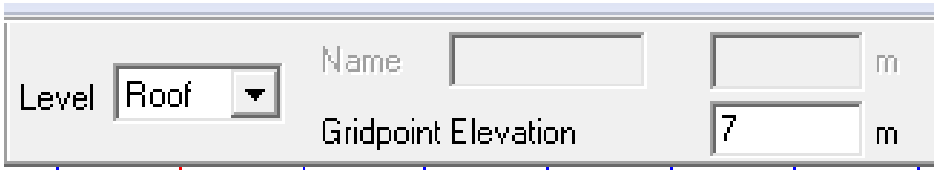
- Select an E-W gridline (highlighted red)
- Press the “Elevation View” button on the top toolbar

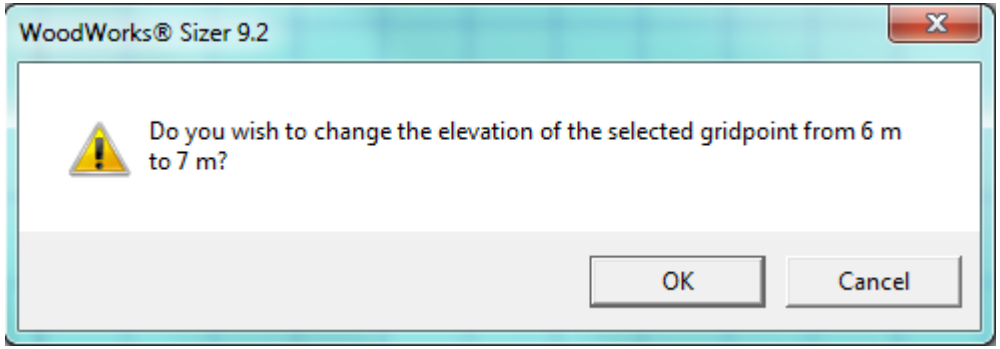




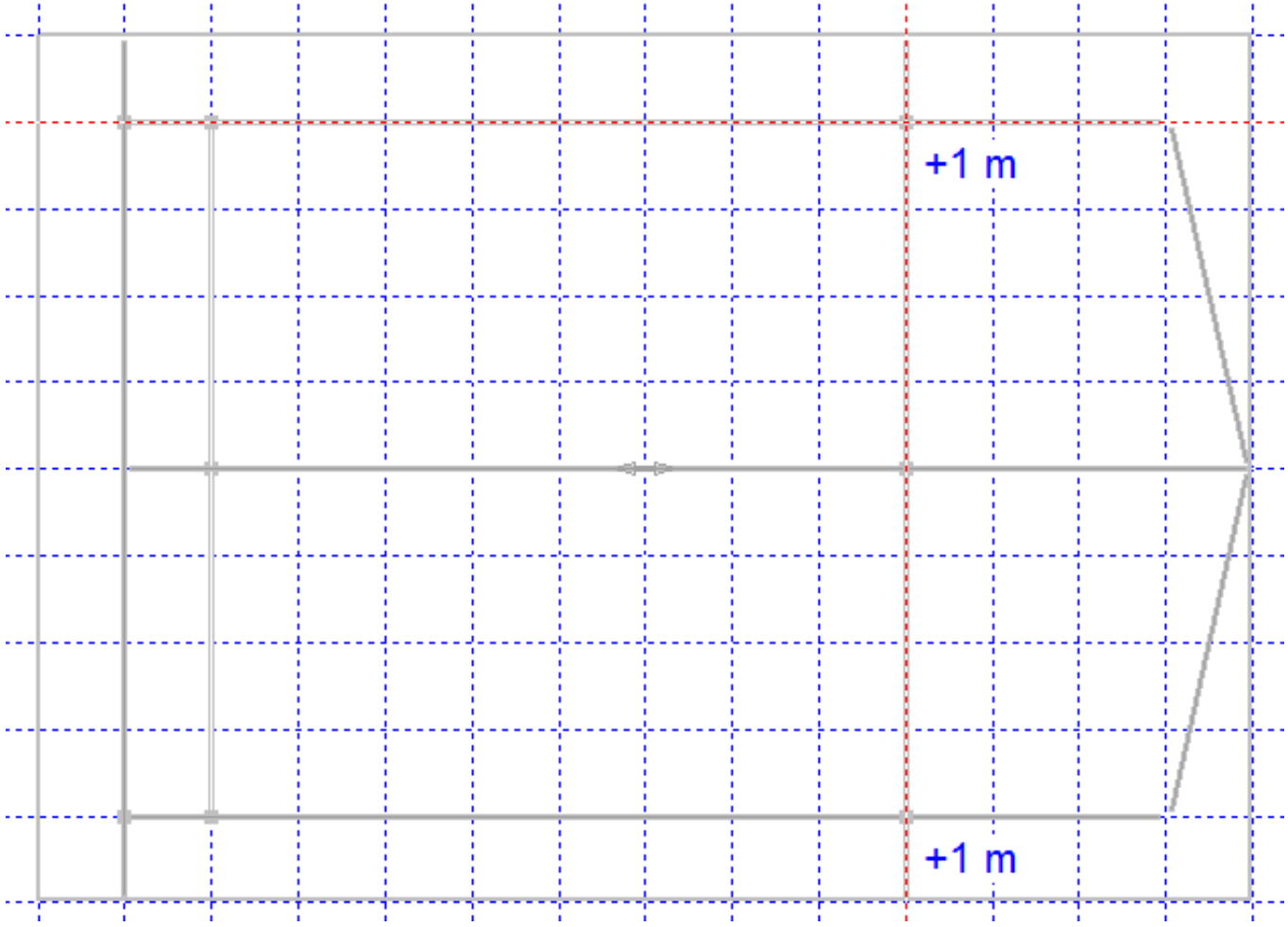
Raise Gridpoints

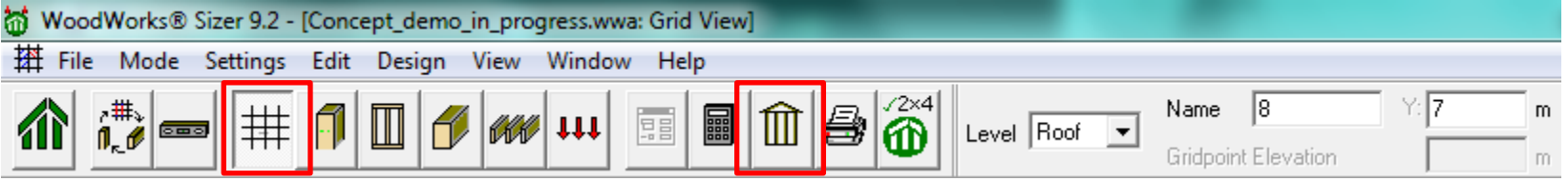
- Allows for the creation of sloped members
- Select the gridpoint over an east column at the roof level
- Change the elevation to 7 m in the “Gridpoint Elevation” input box on the top toolbar





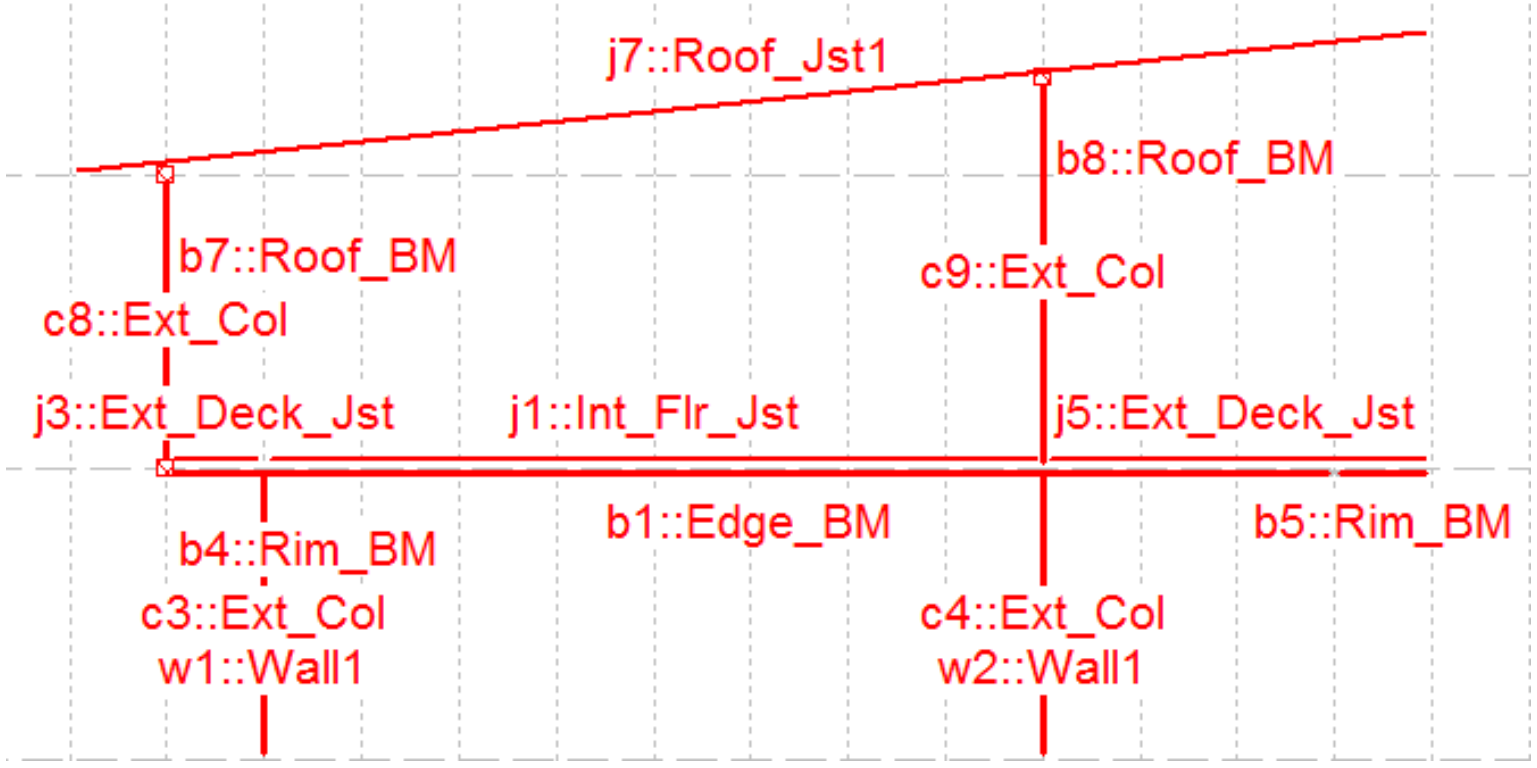
Raise Gridpoints

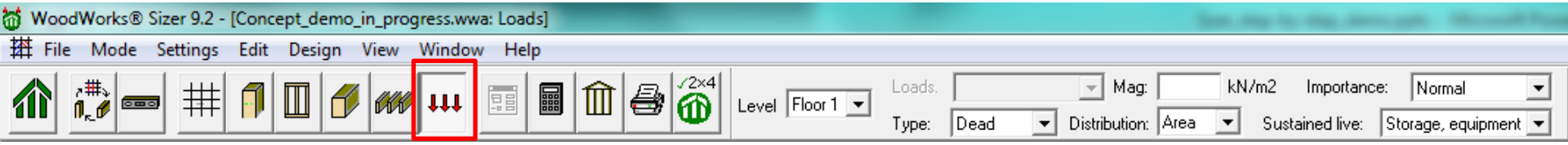




Cut a Section (Elevation View)

- Select an E-W gridline (highlighted red)
- Press the “Elevation View” button on the top toolbar

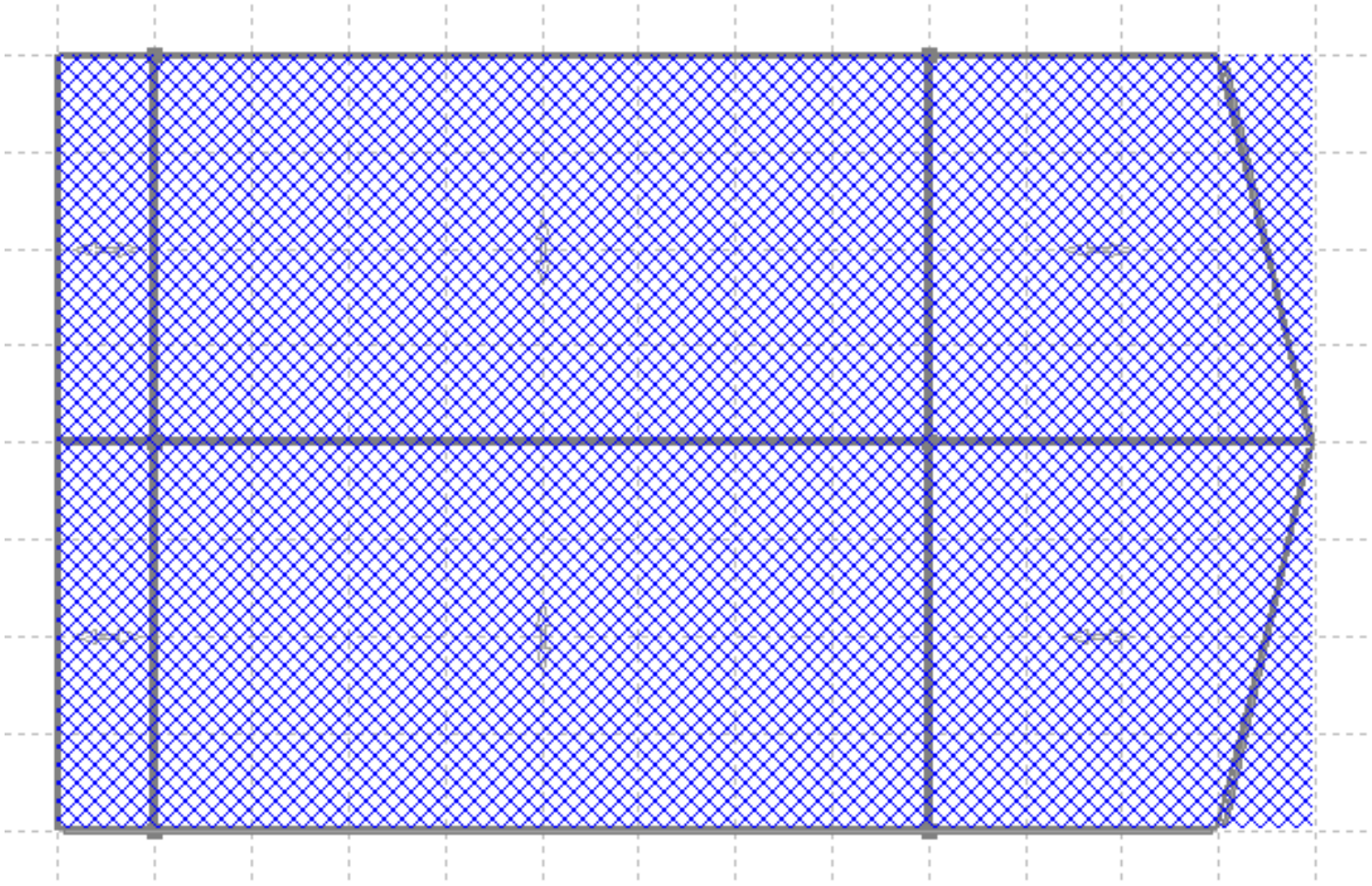


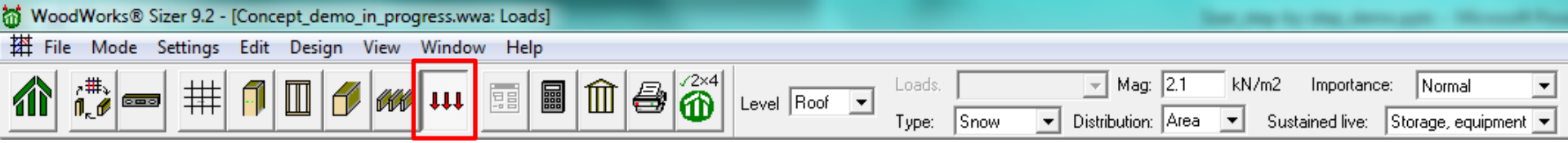


Add Loads to Floor 1

- Select “Load View” button from top toolbar
- Use the drop down menus on the top toolbar to specify:
- Normal importance factor
- 0.5 kPa dead load
- 2.4 kPa live load
- Click and release on a corner of the load area, then click & release on the next corner, etc.
- Load area can be outside of building footprint

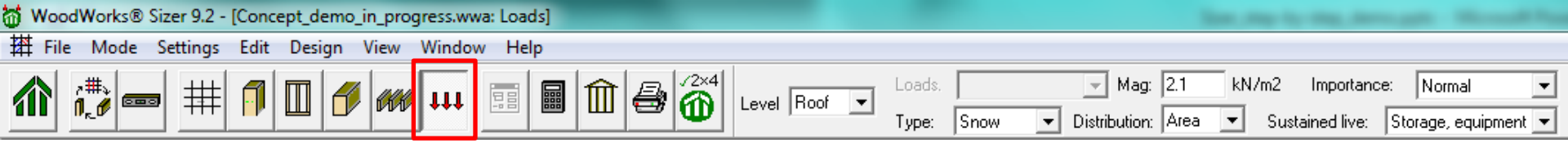
Add Loads to Floor 1





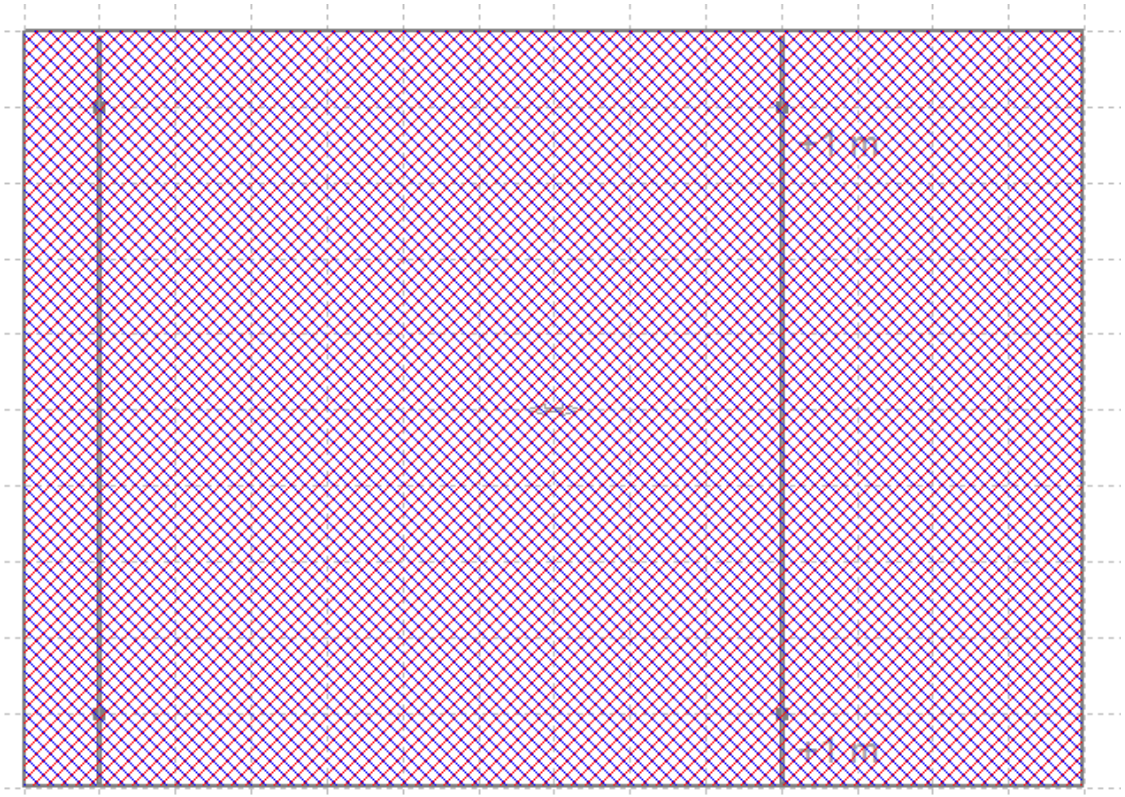
Add Loads to Roof

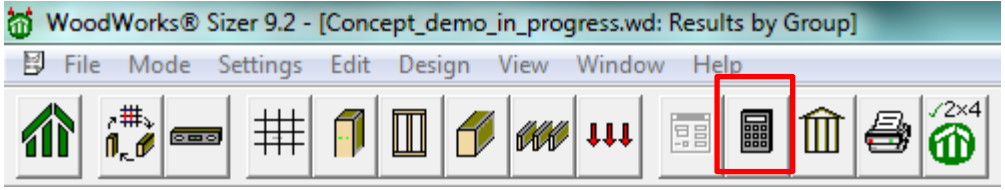
- Select “Load View” button from top toolbar
- Use the drop down menus on the top toolbar to specify:
- Normal importance factor
- 0.5 kPa dead load
- 2.1 kPa snow load
- Click and release on a corner of the load area, then click & release on the next corner, etc.
- Load area can be outside of building footprint



Add Loads to Roof

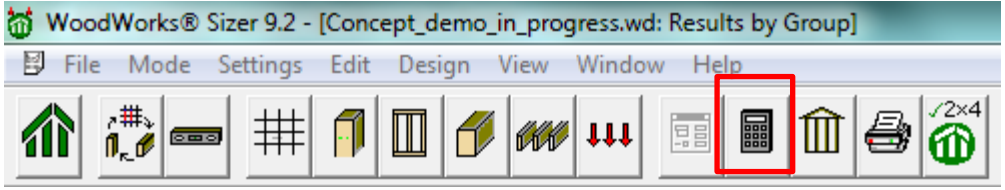
- Click on the load area (highlights red) to:
  - Modify the load type, magnitude, etc.
  - Delete load by pressing the “Delete” button





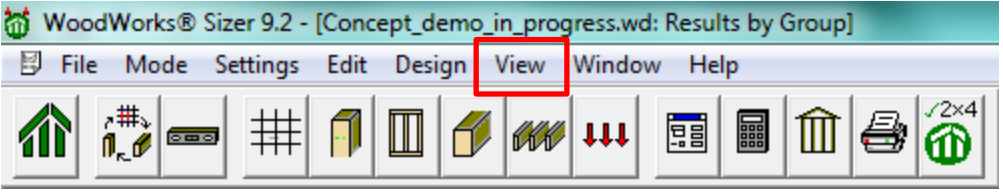
Design Output – Results by Group

- Determines the worst case loading for a single member in each design group & designs for this critical member
- Results by group are shown for each level
- If same design group on multiple levels (e.g. “Ext_Col”), software considers the lower level as the critical member & uses this member design for all levels
- Critical members (worst case loading) are shown for each design group



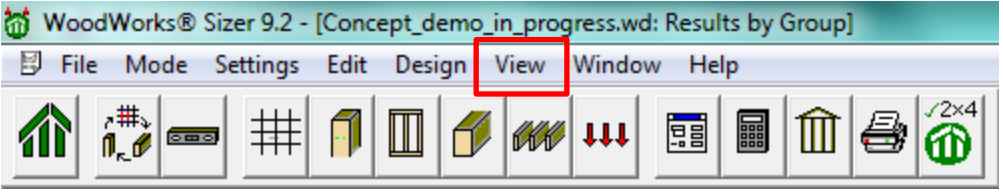
Design Output – Results by Group

- Refer to Design Notes for important information:
  - Bearing design: available only in beam/column mode
  - Built-up beams/columns: connection of individual plys
  - Beam restraint at points of bearing: lateral and rotational
  - Calculation of lateral stability factor (K_L)
  - SCL assumptions (dry service, no preservatives, DL ≤ 0.5LL)
- For critical members (*i.e. major load carrying elements*) detailed design is required in beam/column mode
- Always refer to SCL manufacturer literature for additional design requirements



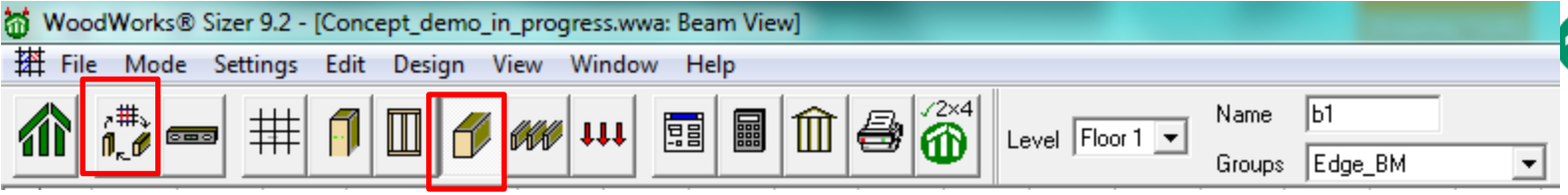
Design Output – Results by Member

- Use the “View” pull-down menu on the top tab to select “Results by Member”
- Design results are provided for each member
- Critical design ratios (*factored load/factored resistance*) are provided for:
  - Moment (+ve & -ve)
  - Shear
  - Axial
  - Deflection
  - Fire
- Vibration design results provided in beam mode



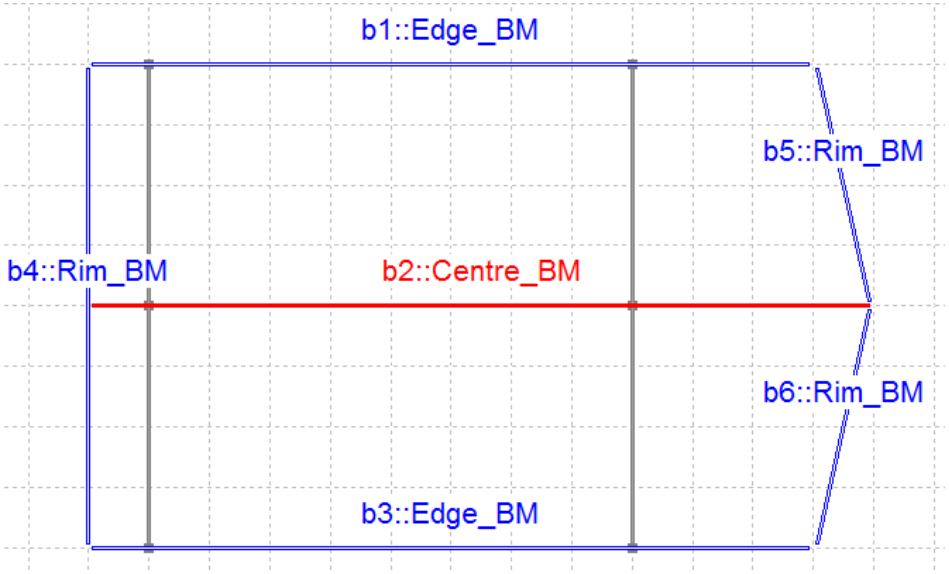
Design Output – Material List

- Provide total length & number of pieces for each design group
- Includes quantity lengths for single bottom plate & double top plates of stud walls
- Includes quantities for rim joists (trimmers) for each joist area

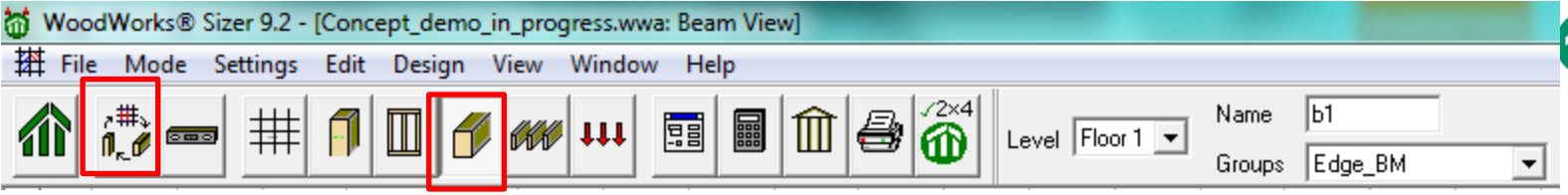


Transfer Member to Beam Mode

- In Beam view on Floor 1, select “Centre_BM” – critical design ratio for moment is 0.91 (*Results by Group*)
- Select “Centre_BM” (highlights red):

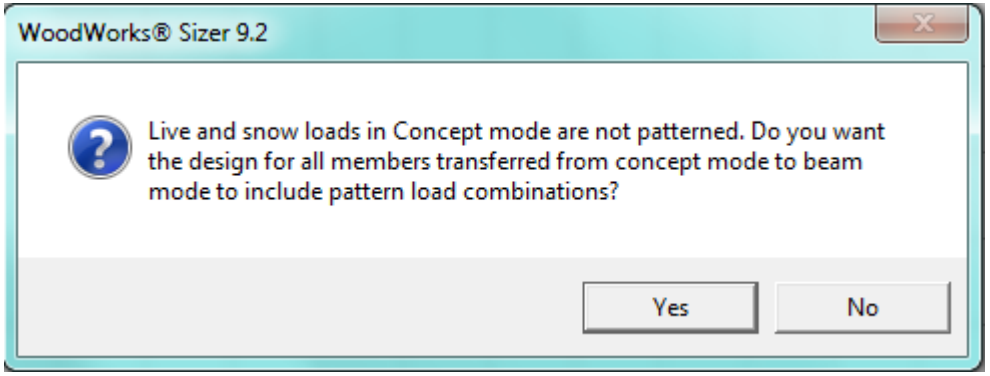


- Press “Switch Modes” button on top toolbar

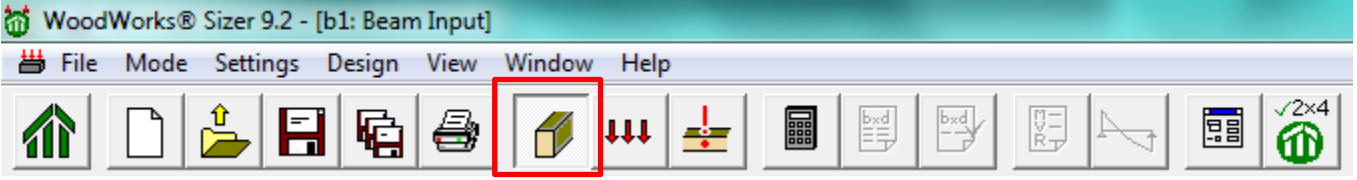


Concept Mode Assumptions

- Pattern loading is accounted for in Concept Mode

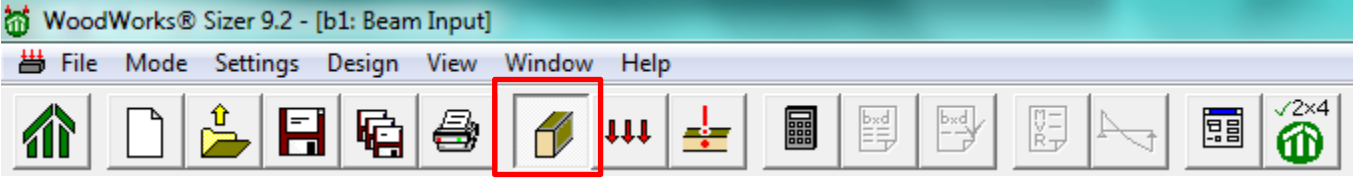


- Cumulative loads are transferred to beam mode & displayed as line loads
- Span lengths & slope are transferred to beam mode
- Member type & section properties are transferred
- Service condition (wet/dry) transferred



Beam Mode – Beam View

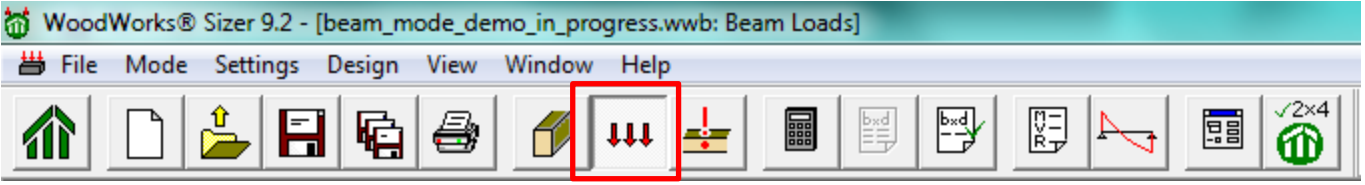
- Span lengths & span type (design, clear, full)
- Pitch/slope
- Oblique angle (biaxial bending)
- Input section size (175 x 570) calculated in Concept mode
- Additional deflection criteria in Beam mode
- Preservative treatment only available in Beam mode
- Lateral support spacing
  - Concept mode assumes either full lateral support or none
  - In reality, lateral support spacing at 300 mm (floor joist spacing)



Beam Mode – Beam View

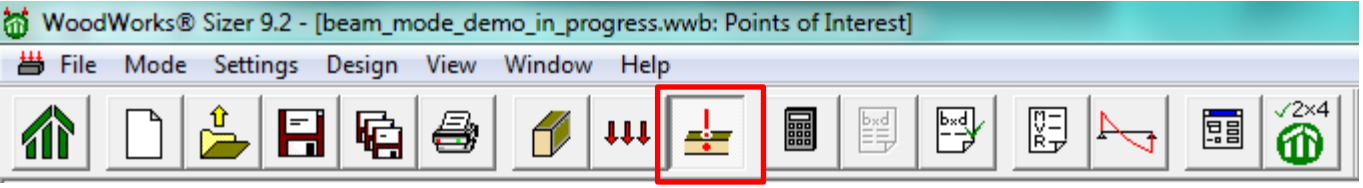
- Support for bearing & notch design
- Support properties transferred from Concept mode
- Input supporting column dimension from Concept mode (3 ply 2x8; bearing length = 184 mm, width = 114 mm)
- Software will calculate bearing design for supporting member (*column crushing parallel-to-grain*) and supported member (*glulam crushing perp.-to-grain*)

- Interior notches not allowed in glulam (end notches only)



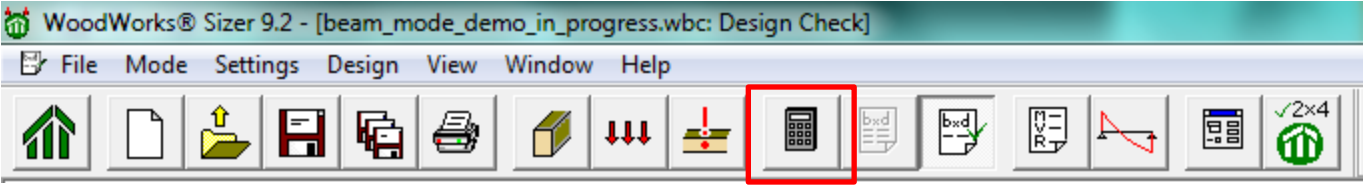
Beam Mode – Loads View

- Applied beam loads are transferred from Concept mode
- Loads are patterned (P) in Beam mode
- Ability to add additional load types (*triangular, trapezoidal, applied moment, partial line, etc.*)
- Member self-weight (*applied automatically or manually*)
- Add moving concentrated load (*required for some occupancy types under NBC Part 4*)
- Omit load combinations which contain both live + snow



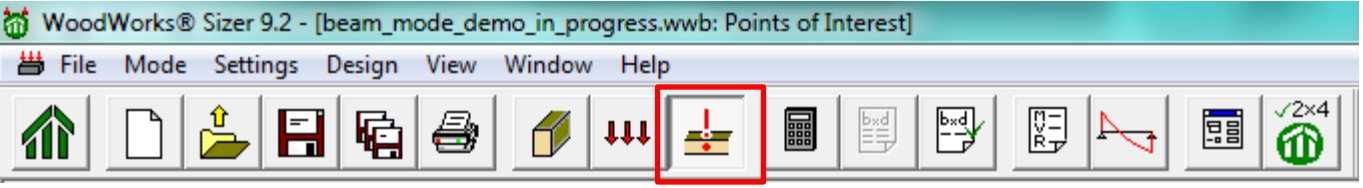
Beam Mode – Points of Interest

- Useful to determine the moment & shear at a specific location along the length of the beam
- Can use this information to check capacity of residual section size at locations of service penetrations
- Create a point of interest at 5 m location



Beam Mode – Design Check

- Press “Run Design” button
- Summary of loading
- Unfactored & factored reactions
- Bearing design for column and beam (*fails for beam*)
- Member properties input summary
- Factored loads vs. resistances (*fails for deflection*)
- Specified strengths & modification factors
- Critical load combinations for each design criteria



Beam Mode – Design Check

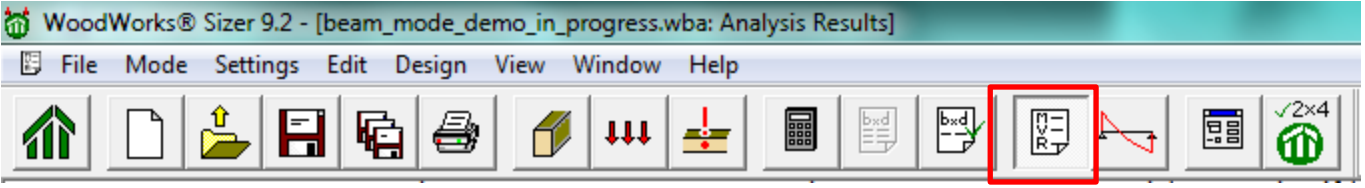
LEVEL 1 - FLOOR

Member	Group	Ply-bxdxL	+Mom	-Mom	Shear	Axial	Defl'n	Fire	Critical
	- -								
Centre_BM		175x570x13.00m	0.44	0.91	0.67	-	0.67	0.90	Bend

WARNING: This section violates the following design criteria: Deflection and bearing

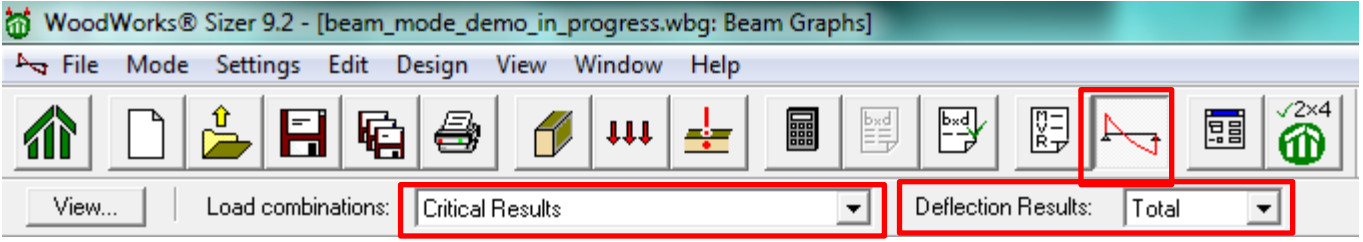
Force vs. Resistance and Deflection using CSA-O86-09:

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear (b)	Vf @d = 76.86	Vr = 91.12	kN	
Shear (a)	Wf = 147.05	Vr = 216.39	kN	Wf/Vr = 0.68
Moment(+)	Mf = 128.02	Mr = 170.97	kN-m	Mf/Mr = 0.75
Moment(-)	Mf = 135.94	Mr = 149.98	kN-m	Mf/Mr = 0.91
Deflection:				
Interior Perm	2.1 = <L/999	22.2 = L/360	mm	0.09
Live	20.5 = L/391	22.2 = L/360	mm	0.92
Total	22.4 = L/357	44.4 = L/180	mm	0.50
Cantil. Perm	5.9 = L/678	22.2 = L/180	mm	0.27
Live	46.3 = L/86	22.2 = L/180	mm	2.08
Total	52.2 = L/76	44.4 = L/90	mm	1.17
Fire	tf = 67	FRR = 60	min	FRR/tf = 0.90*



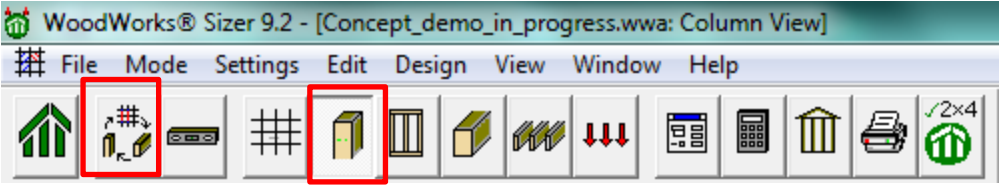
Beam Mode – Analysis Results

- Tabulated results of load inputs
- ULS & SLS load combinations, building importance factors, & illustrated load patterns
- Tabulated moment & shear values for each span
- Vertical reactions
- Moment & shear at points of interest for each load combination
- Duration of load (Kd) calculations for each load combination & pattern



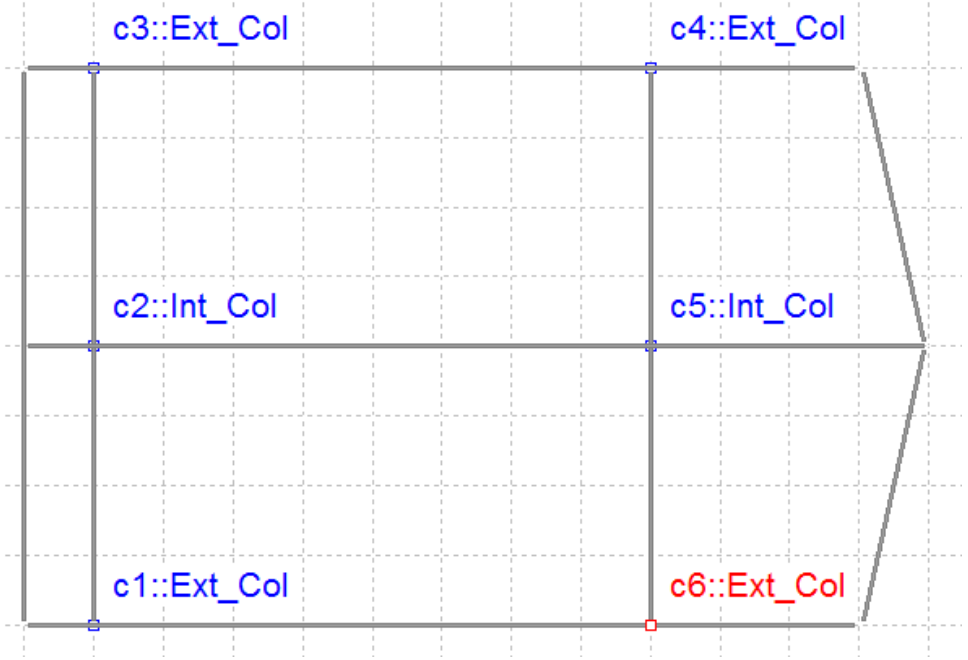
Beam Mode – View Diagrams

- Diagrams for:
  - Vertical reactions, shear, bending, & deflection
- Magnitude of shear, bending, deflection is shown at points of interest (5 m location)
- Cycle through the “Load combinations” pull-down menu on top toolbar
  - Load envelope provided for each load combination
- Deflection diagrams provided for total, live, permanent for all load combinations

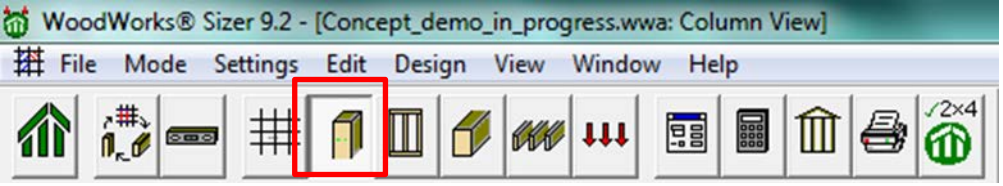


Transfer Member to Column Mode

- In Column view on Floor 1, select “c6: Ext_Col”:

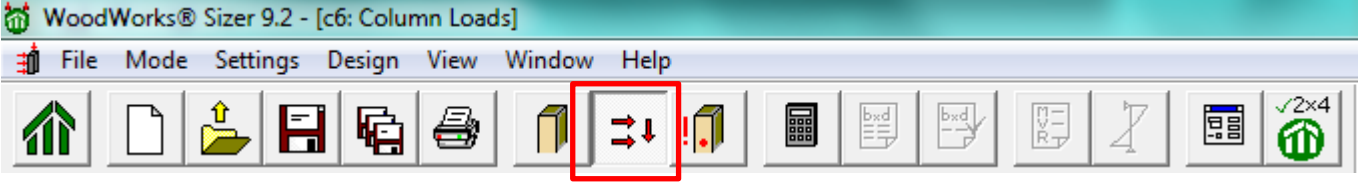


- Press “Switch Modes” button on top toolbar



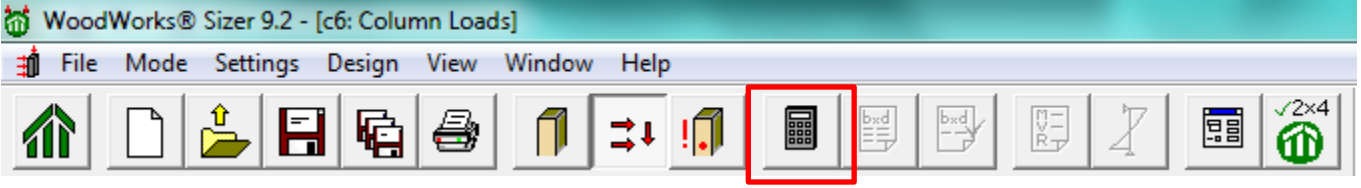
Column Mode – Column View

- Column length & type
- Input section size (241 x 241) calculated in Concept mode
- Deflection limits apply to lateral deflection (not vertical)
- Preservative treatment only available in Column mode
- Lateral support spacing & end conditions
  - Concept mode assumes either full lateral support or none
  - Concept mode assumes pin-pin end conditions
- Support conditions for bearing design



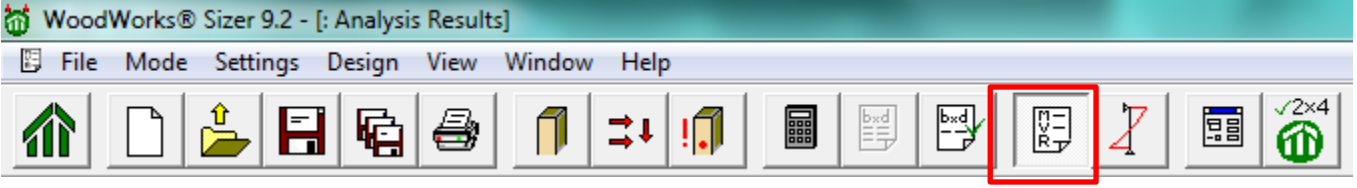
Column Mode – Loads View

- Cumulative loads are transferred from Concept mode
- Add additional loads including lateral loads
  - Add wind load of 1 kPa, tributary width = 4 m
- Member self-weight (*applied automatically or manually*)
- Apply auto-eccentricity (*16.7% of column thickness*)



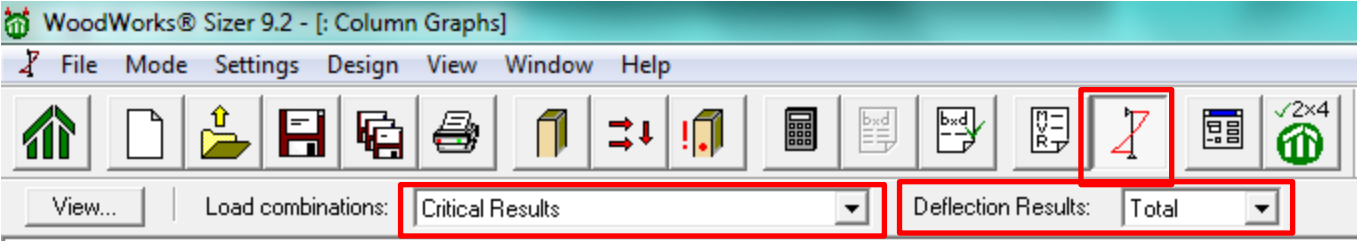
Column Mode – Design Check

- Press “Run Design” button
- Summary of loading
- Unfactored & factored reactions
- Member properties input summary
- Factored loads vs. resistances (*fails for interaction*)
- Specified strengths & modification factors
- Critical load combinations for each design criteria
- Inputs for calculations (*stiffness, unsupported length, etc.*)



Column Mode – Analysis Results

- Tabulated results of load inputs
- ULS & SLS load combinations, eccentricity, & importance factors for different load types
- Tabulated axial, moment, & shear values
- Moment & shear at points of interest for each load combination
- Duration of load (Kd) calculations for each axial and lateral load combination



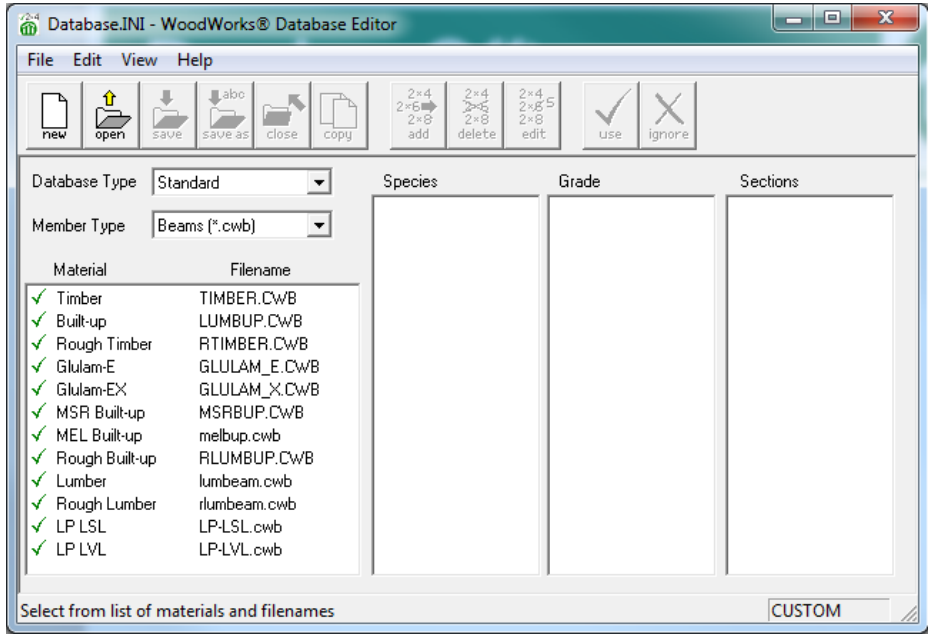
Column Mode – View Diagrams

- Diagrams for:
  - Reactions (bearing & lateral), shear, bending, & deflection
- Magnitude of shear, bending, lateral deflection is shown at points of interest
- Cycle through the "Load combinations" pull-down menu on top toolbar
  - Load envelope provided for each load combination
- Deflection diagrams provided for total, live, permanent for all load combinations

SIZER
Gravity Design

- **Concept mode**
  - **Beam mode**
  - **Column mode**

DATABASE EDITOR
Add proprietary products



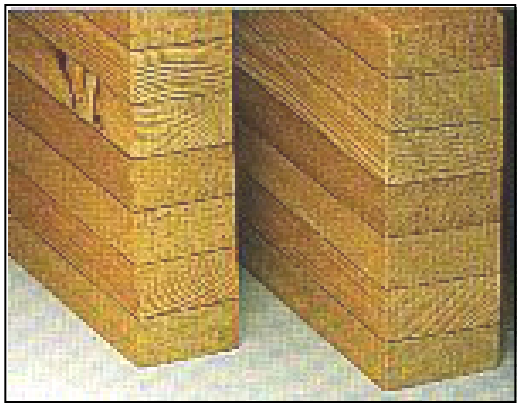
SHEARWALLS
Lateral Design (Wind and Seismic)

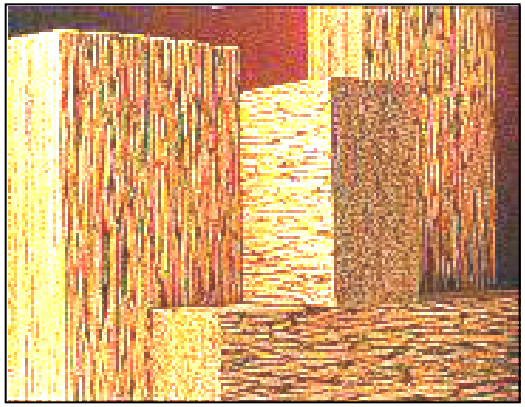
CONNECTIONS
Fasteners

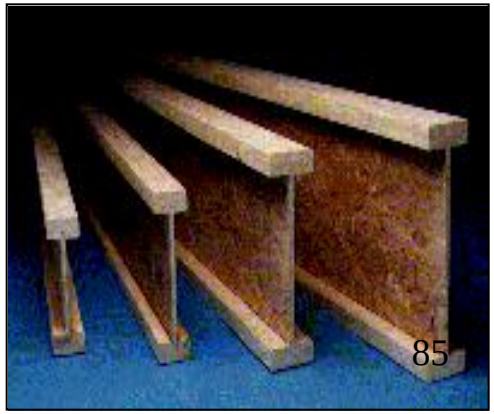
DATABASE

Two data bases: Standard and Custom

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



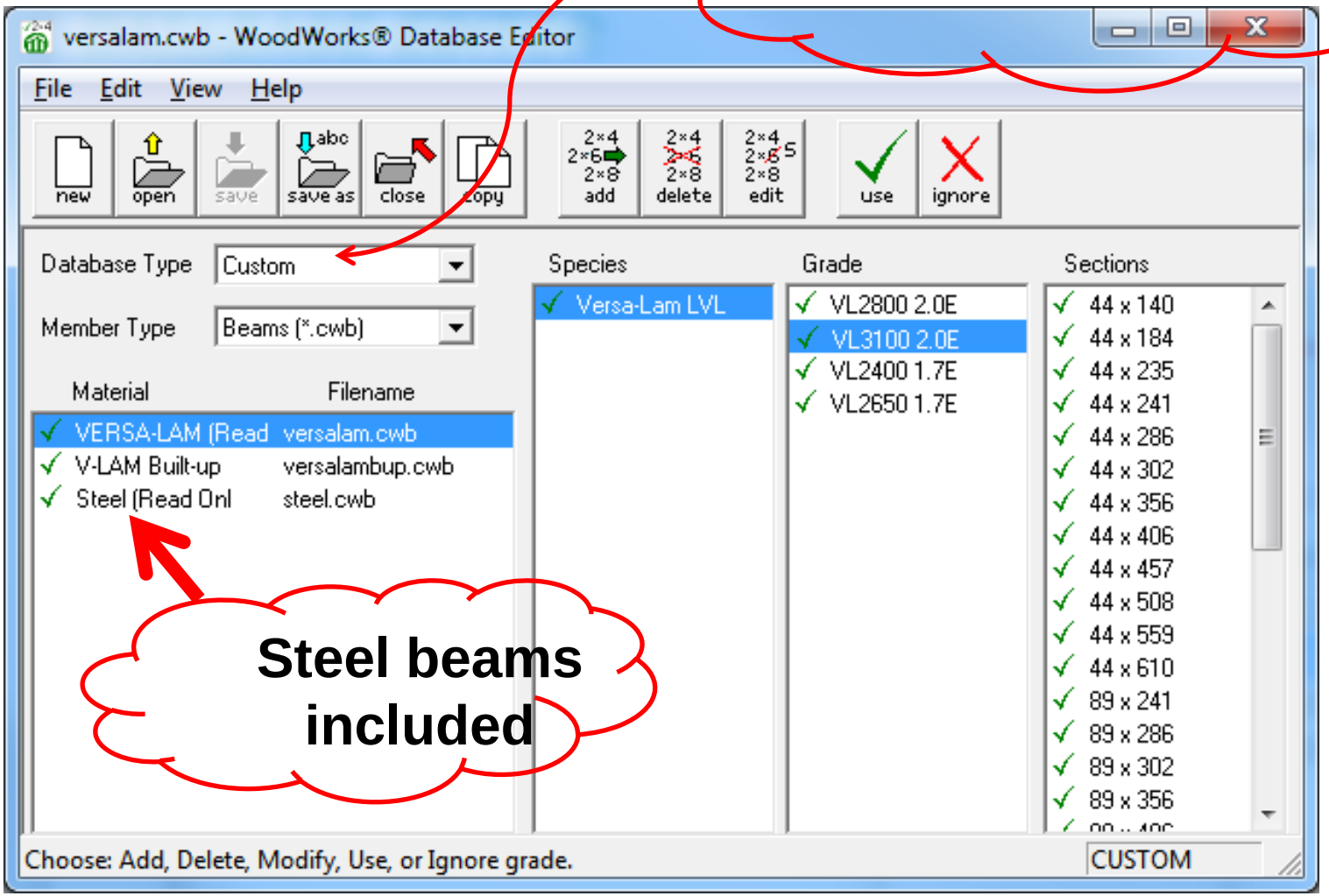




DATABASE EDITOR

Add proprietary products

Custom database can be added to as needed



Steel beams included

Custom versions of Sizer:

Canada

Canada and US

US

US

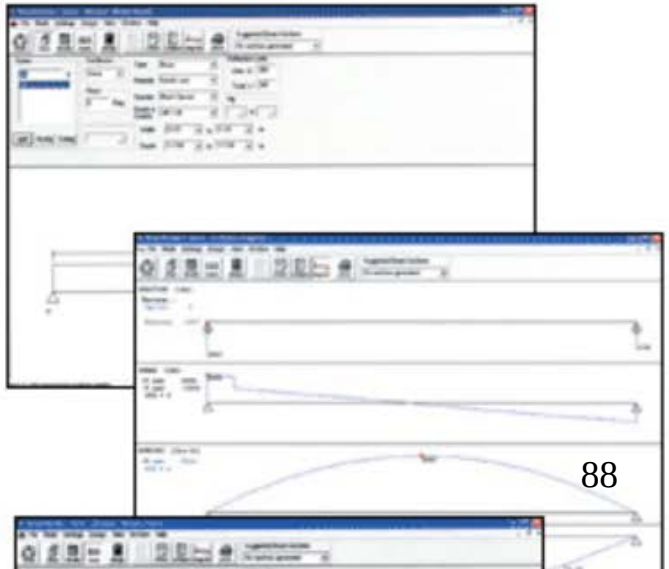
Canada

Products included in generic Cdn Sizer:

Software

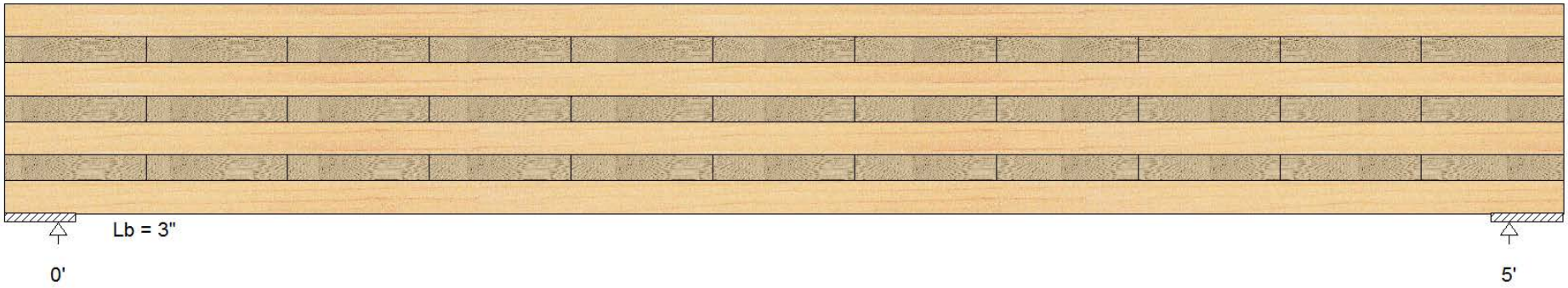
Nordic Sizer

WoodWorks® Sizer is a software program that can be used to design entire structures or single members (joists, beams, columns and studs) using the full range of engineered wood products: glulam, prefabricated wood I-joists, and structural composite lumber.

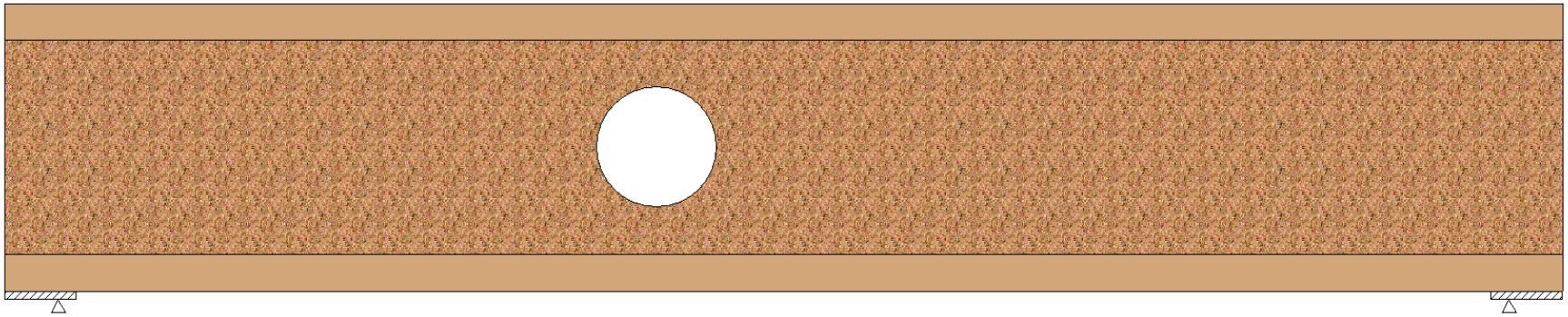


For sizing wood beams:

- Analyzes and designs simple and/or multiple span beams with cantilevers
- Automatically patterns live loads for multiple span



Nordic X-Lam Floor Slab Industrial, E1 220-7S 8-11/16" (12" width)



Links to Sizer:

WoodWorks® SOFTWARE FOR WOOD DESIGN

cadwork wood

cadwork is the leading 3D-CAD/CAM software for all fields of timber construction. Using a variety of specialized modules it offers a complete solution from drafting to manufacturing.

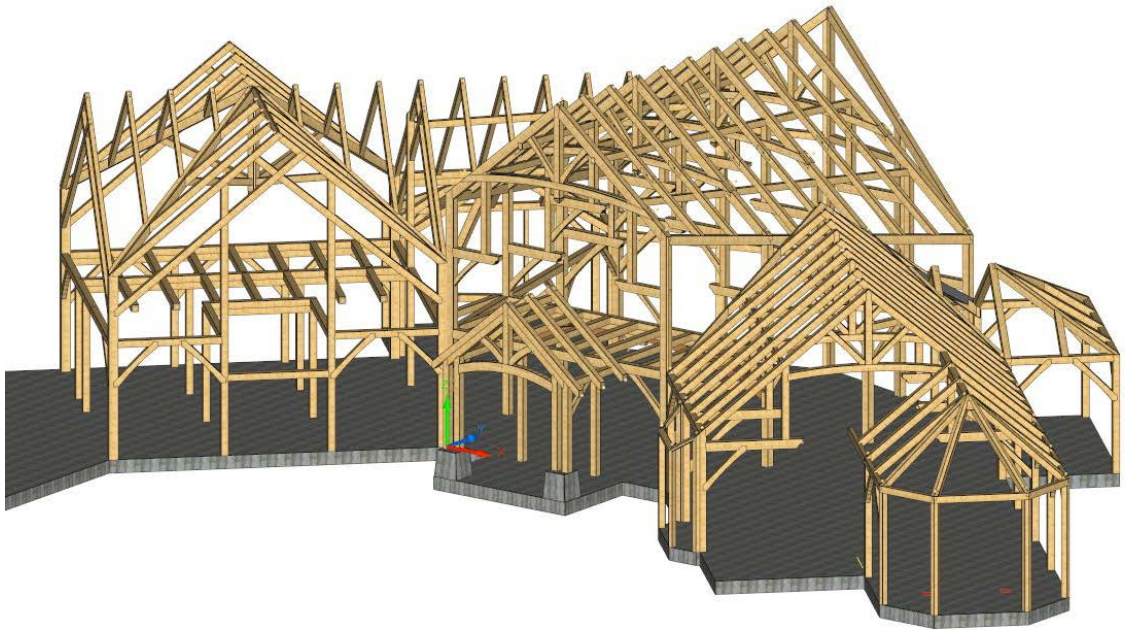
AUTODESK

StrucSoft solutions

Revit -Sizer link via MWF

Metal Wood Framer

REVIT



Creating a Custom Database

Creating a Custom Database

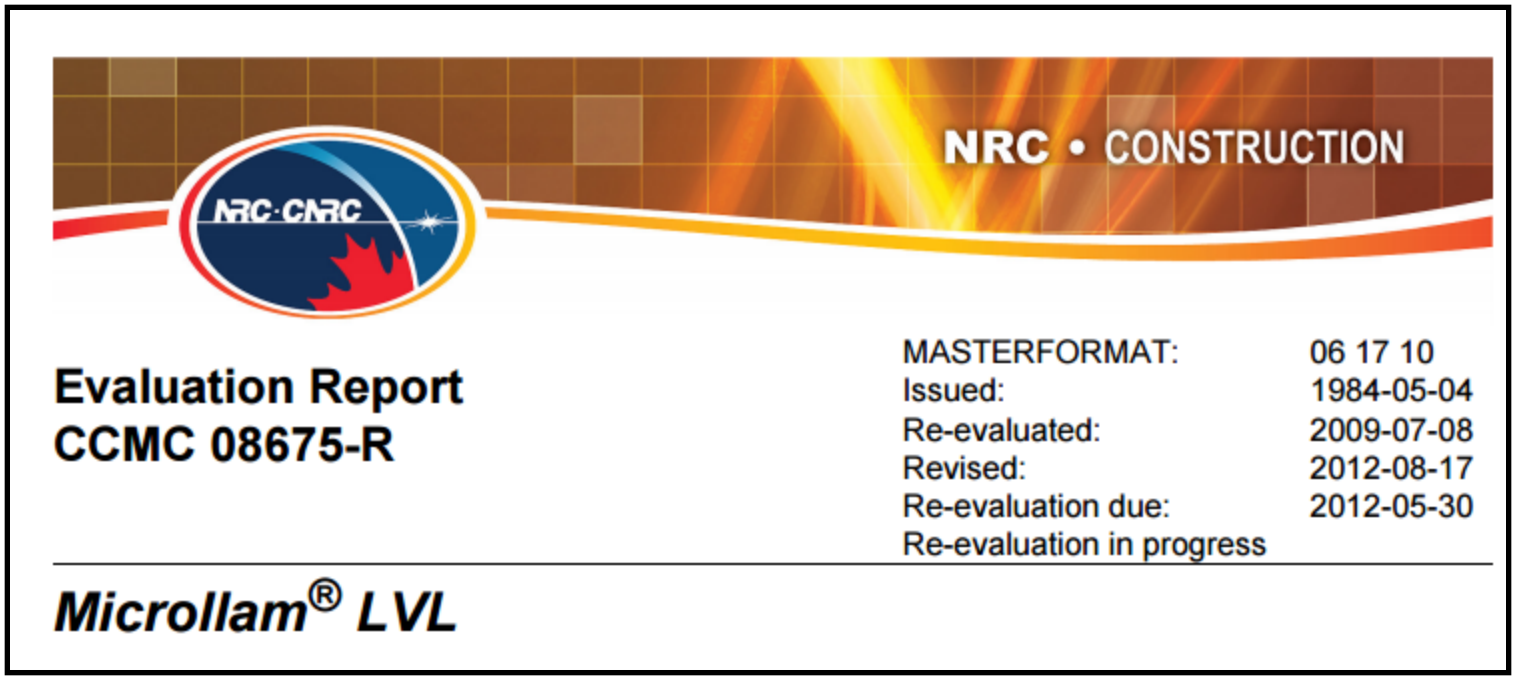
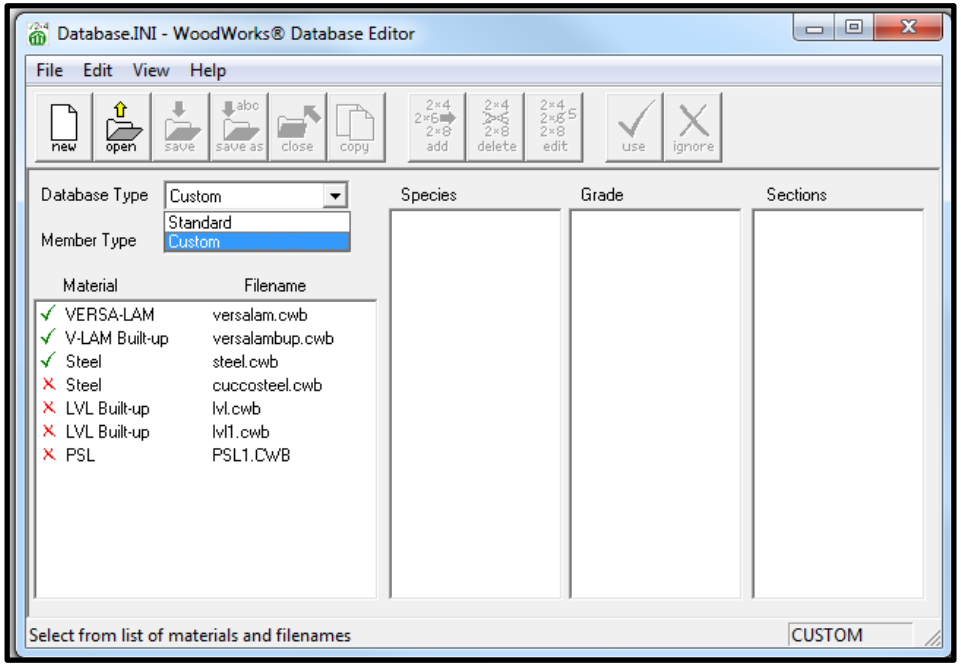


Table 4.1.1 Product specified strengths (MPa)[2][9]

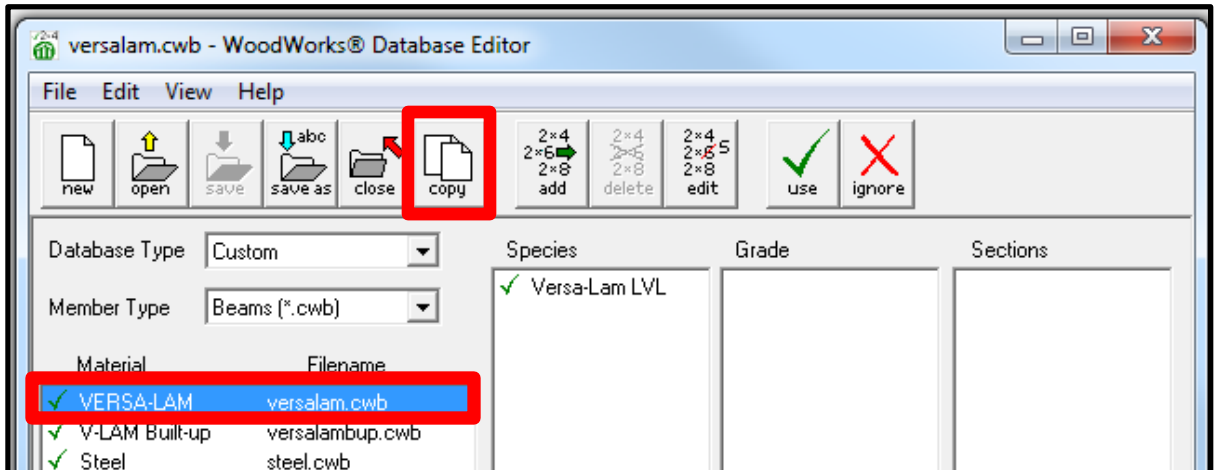
Billet Material Thickness	Grade Species[1]	Axial		Joist/Beam				Plank/Deck		
		F_t[3]	F_c	F_b[4][5]	F_v[6]	MOE	$F_c$perp[7]	F_b[8]	F_v[10]	$F_c$perp[7]
19 mm to 89 mm	1.8 SP	20.05	26.15	31.15	3.65	12 410	11.05	36.80	Note(10)	6.60
	1.9 SP	21.55	27.60	33.15	3.65	13 100	11.05	39.20	Note(10)	6.60
	2.0 SP	23.00	29.00	35.05	3.65	13 790	11.05	41.45	Note(10)	6.60
	2.2 SP	25.85	31.60	39.00	3.65	15 170	11.05	46.05	Note(10)	6.60
	2.4 SP	28.80	33.90	42.90	3.65	16 550	11.05	50.70	Note(10)	6.60
	2.6 SP	31.65	36.00	46.80	3.65	17 925	11.05	55.35	Note(10)	6.60

Step 1: Open Database Editor

Step 2: Modify Database Type to Custom

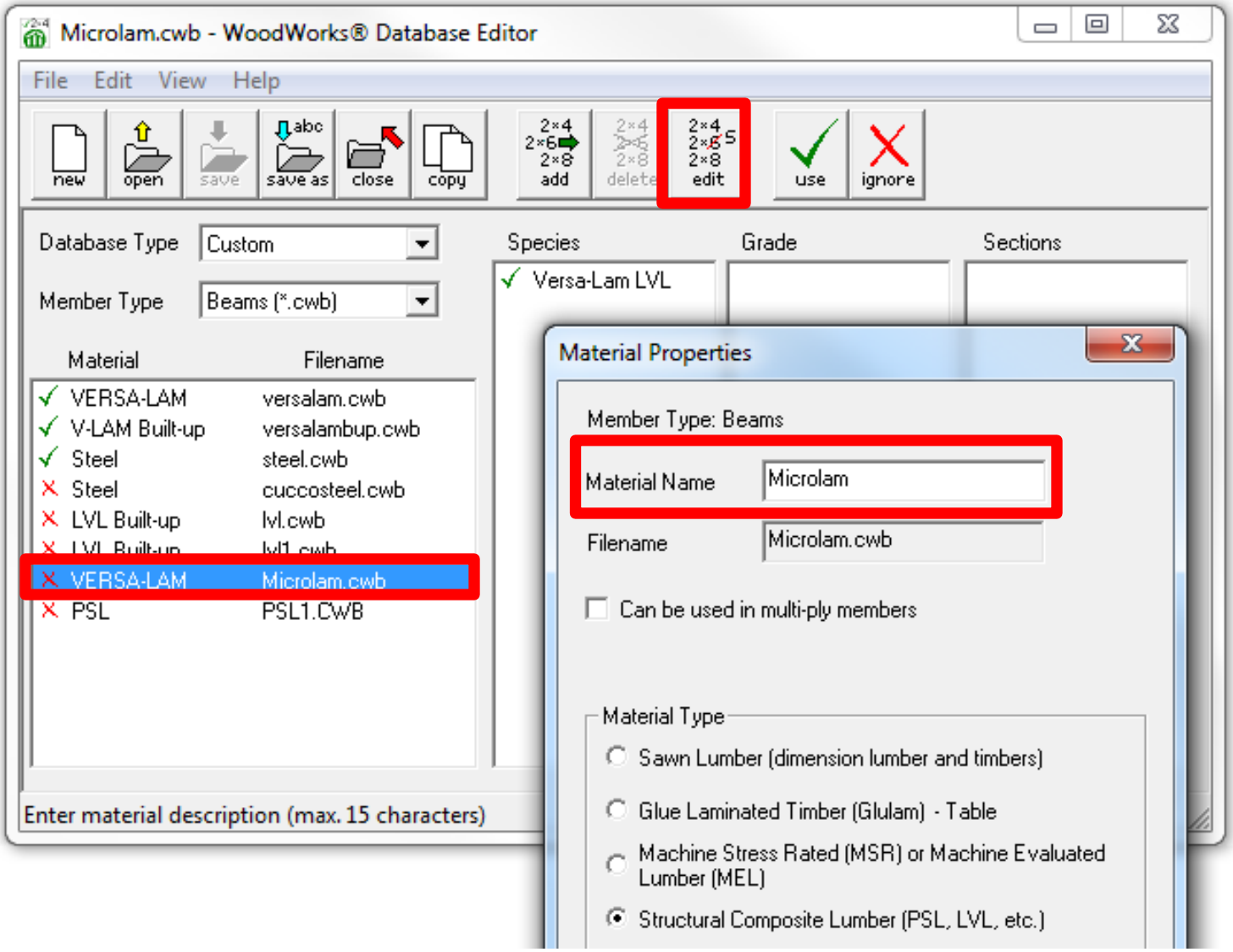


Step 3: Select VERSA-LAM from Material list, Click ***Copy***

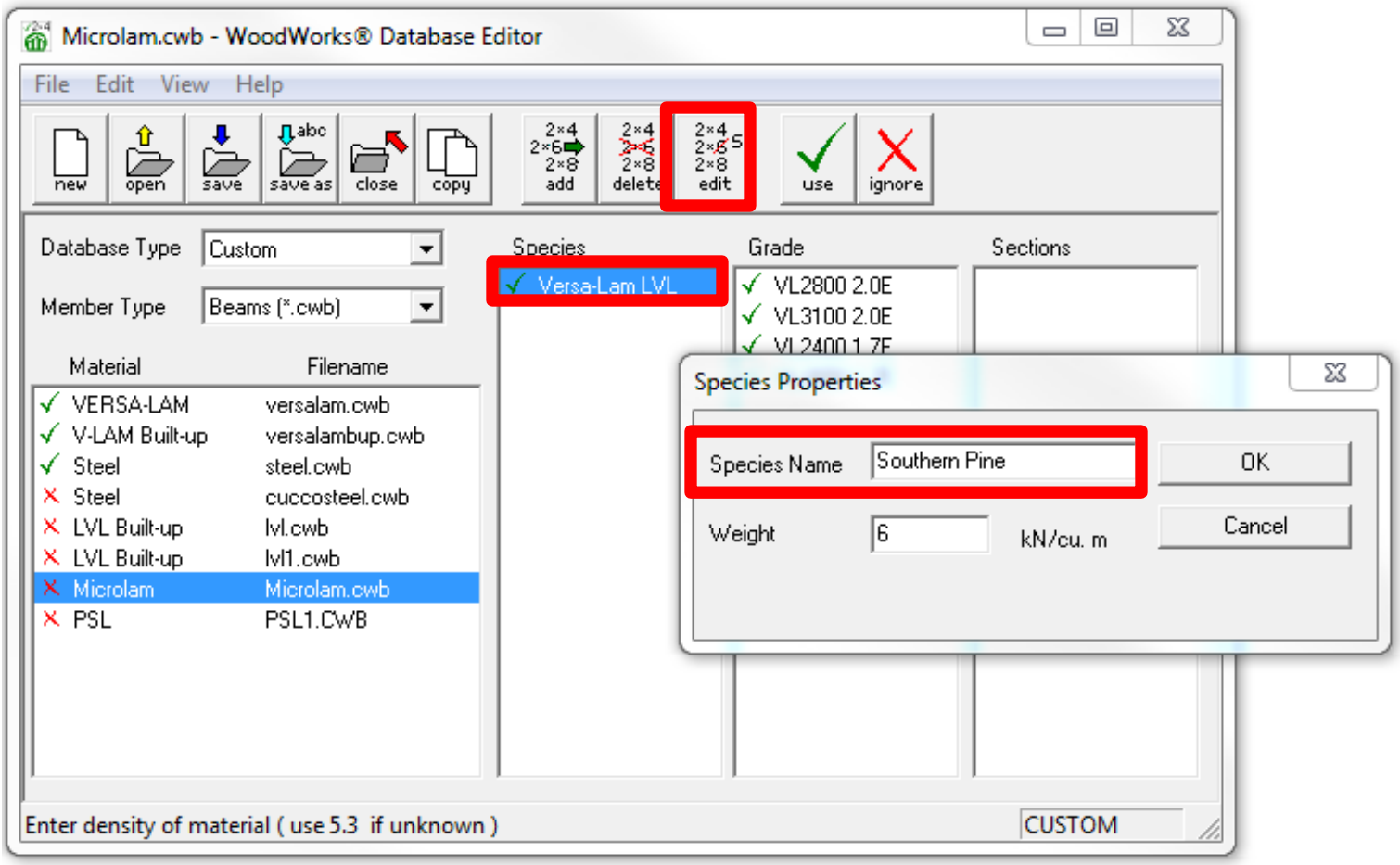


Step 4: Name database “Microlam”

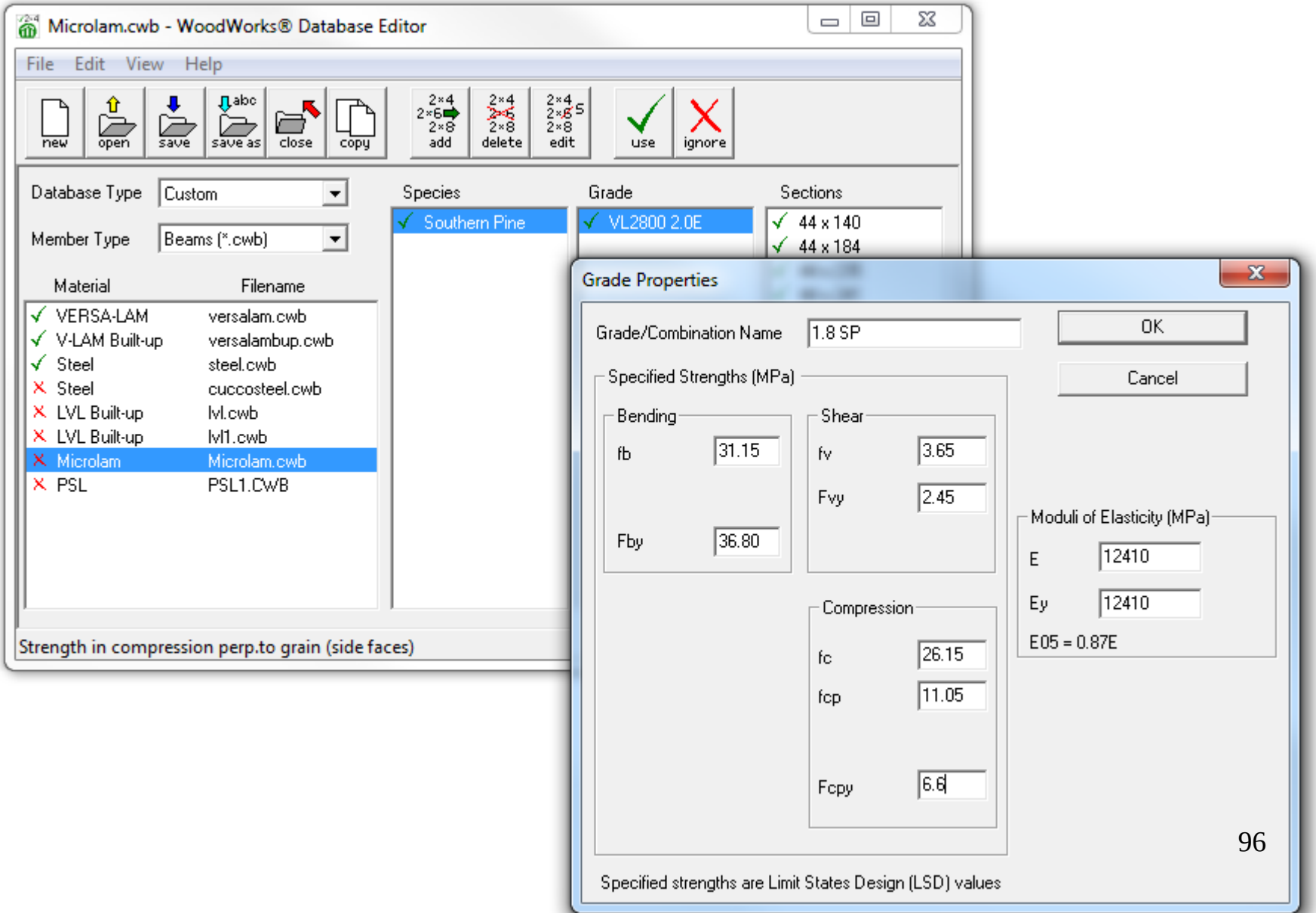
Step 5: Click on the copy of the Versalam database, click ***Edit***, rename Material Name ***Microlam***, Click ***OK***



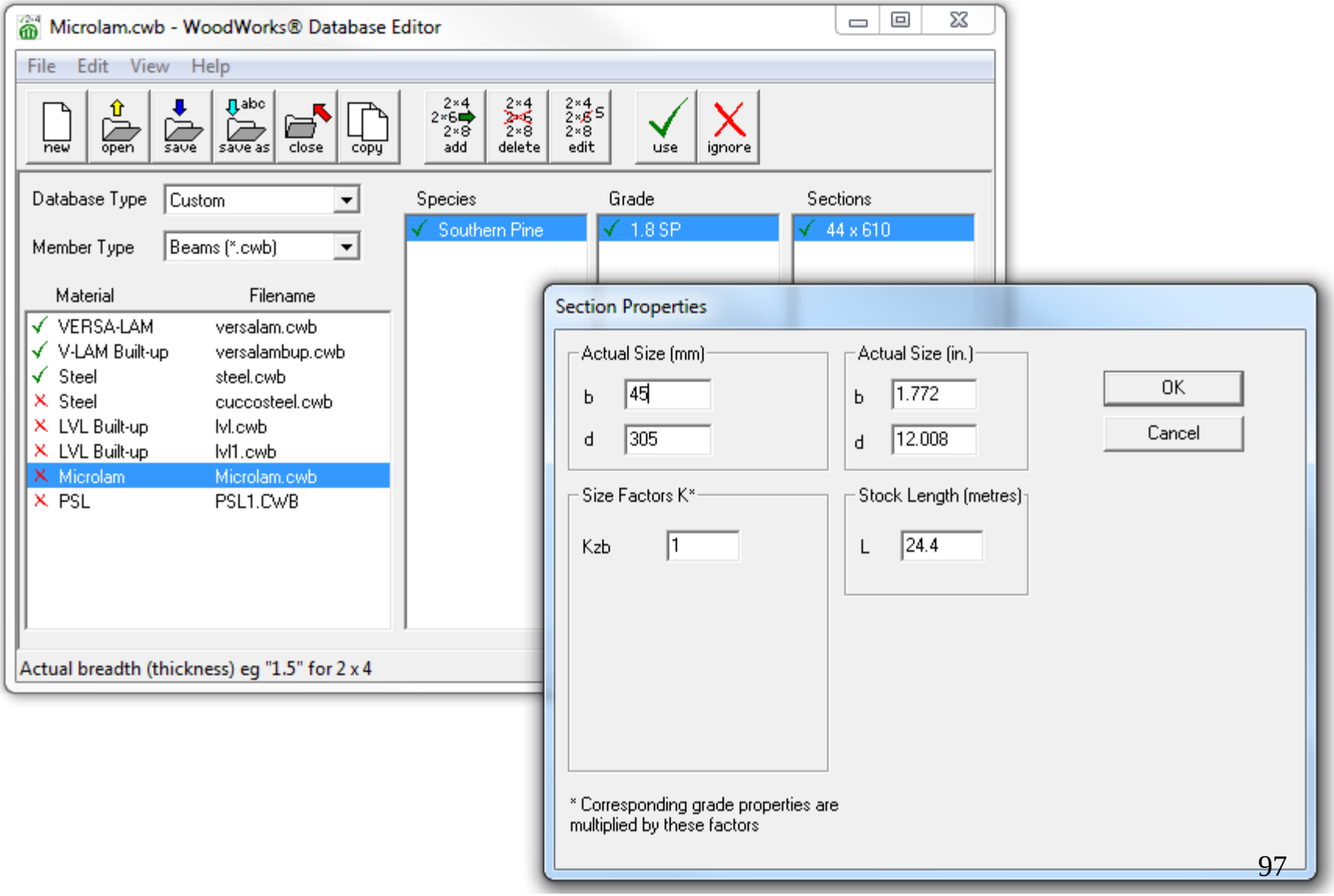
Step 6: Click on Species, Click ***Edit***, rename Species Name ***Southern Pine***, Click ***OK***.



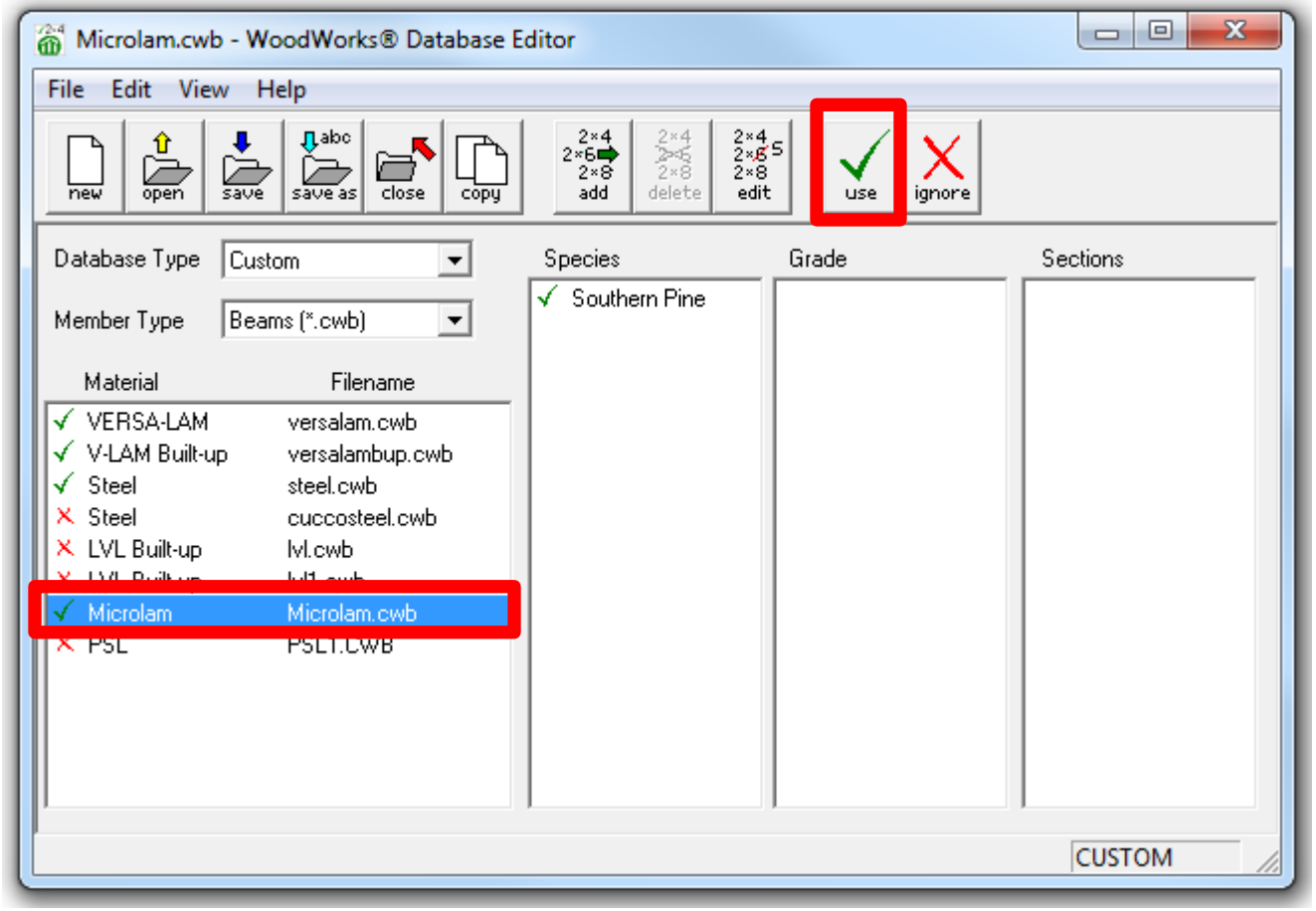
Step 7: Click on Grades, Click ***Edit***, rename Grade/Combination Name to ***1.8 SP***. Input various Strength Properties. Click ***OK***.



Step 8: Click on Sections, Click ***Edit***. Input section Sizes. Click ***OK***.



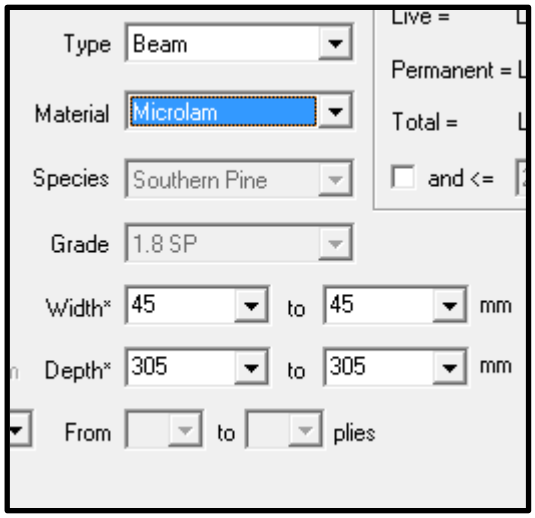
Step 9: Click on Material and Filename, Click ***Use***.



Step 10: Close Database editor, saves changes to newly created custom Database.

Step 11: Open Sizer Beam Mode

Step 12: Design Beam, Scrutinize results



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

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	Vf @d = 2.81	Vr = 30.06	kN	Vf/Vr = 0.09
Moment(+)	Mf = 2.69	Mr = 5.75	kN-m	Mf/Mr = 0.47
Perm. Defl'n	0.3 = <L/999	8.5 = L/360	mm	0.04
Live Defl'n	1.0 = <L/999	8.5 = L/360	mm	0.12
Total Defl'n	1.4 = <L/999	16.9 = L/180	mm	0.08

Additional Data:

FACTORS:	f/E(MPa)	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	3.7	1.00	1.00	1.000	-	1.00	1.00	-	#2
Fb+	31.1	1.00	1.00	1.000	0.294	1.00	1.00	-	#2
Fcp	11.1	-	-	1.000	-	1.00	1.00	-	#-
Es	12410	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Bearing    : Support 1 - LC #2 = 1.25D + 1.5L
              Support 2 - LC #2 = 1.25D + 1.5L
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)  f=fire
 All Load Combinations (LCs) are listed in the Analysis output
```

CALCULATIONS:

```
 Deflection:  EI =   1320e06 kN-mm2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Lateral stability (+): Lu = 3.05 m  Le = 5.85 m  CB = 29.69
```

$$\Delta = \frac{156\ WL^4 \times 10^6}{Ebd^3} + \frac{2\,400\ WL^2}{Ebd}$$

SIZER
Gravity Design

- **Concept mode**
  - **Beam mode**
  - **Column mode**

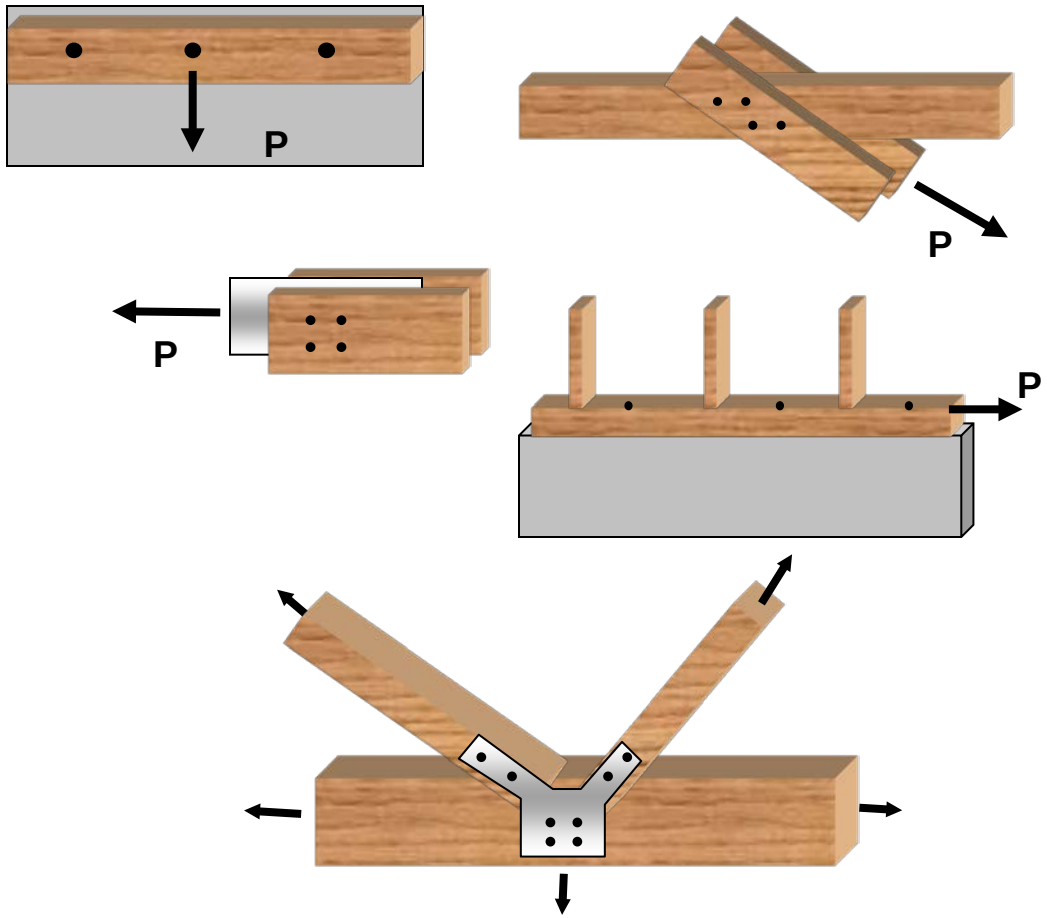
DATABASE EDITOR
Add proprietary products

SHEARWALLS
Lateral Design (Wind and Seismic)

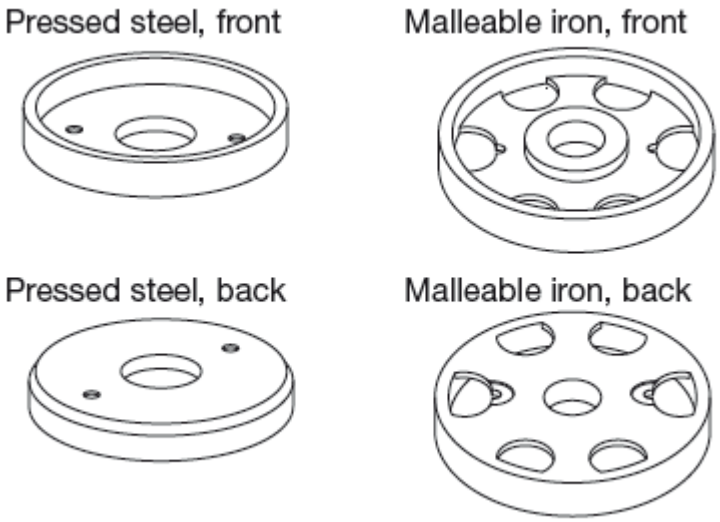
CONNECTIONS
Fasteners

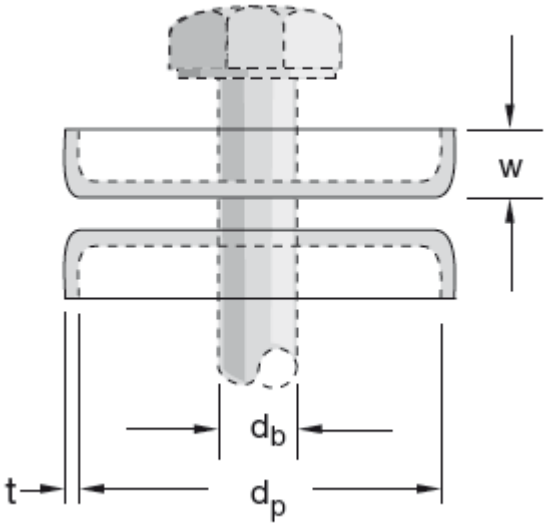
CONNECTIONS

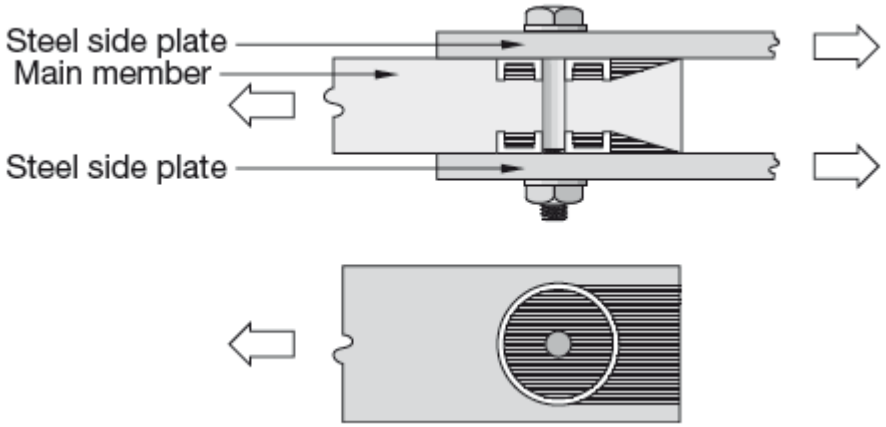
- Single and Double shear connections
- Wood to wood, concrete or steel
- Beam to Column, Beam to Beam, Column to base



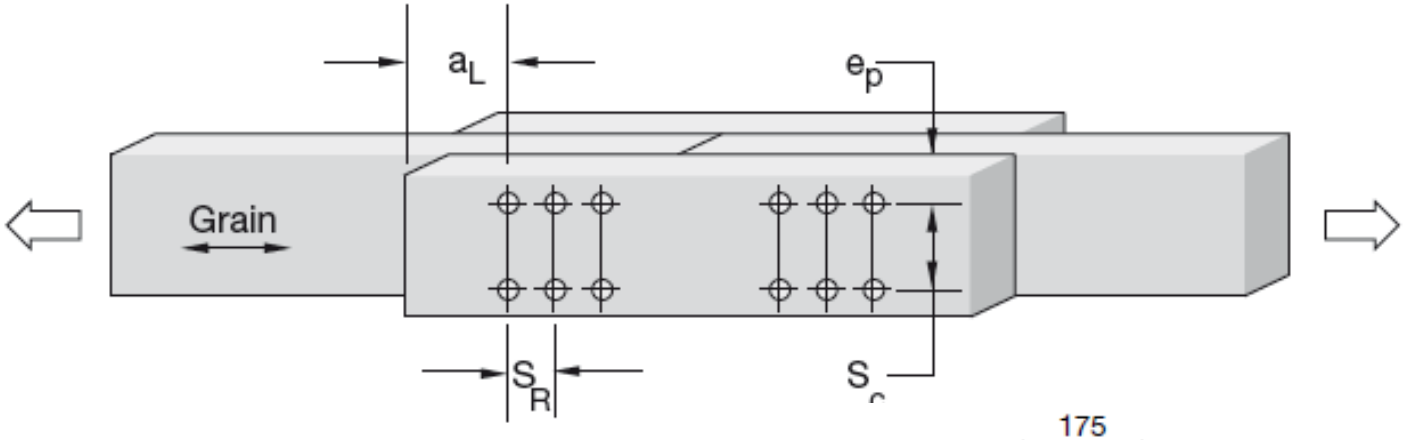
Shear Plates

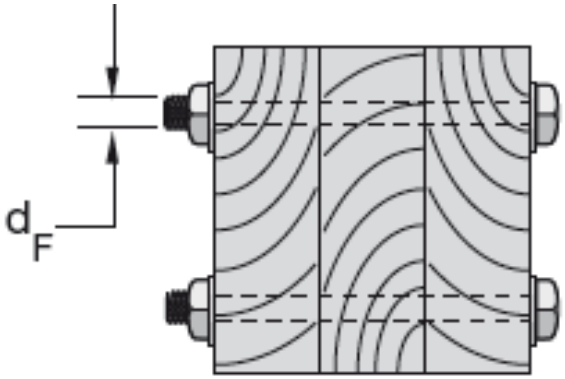


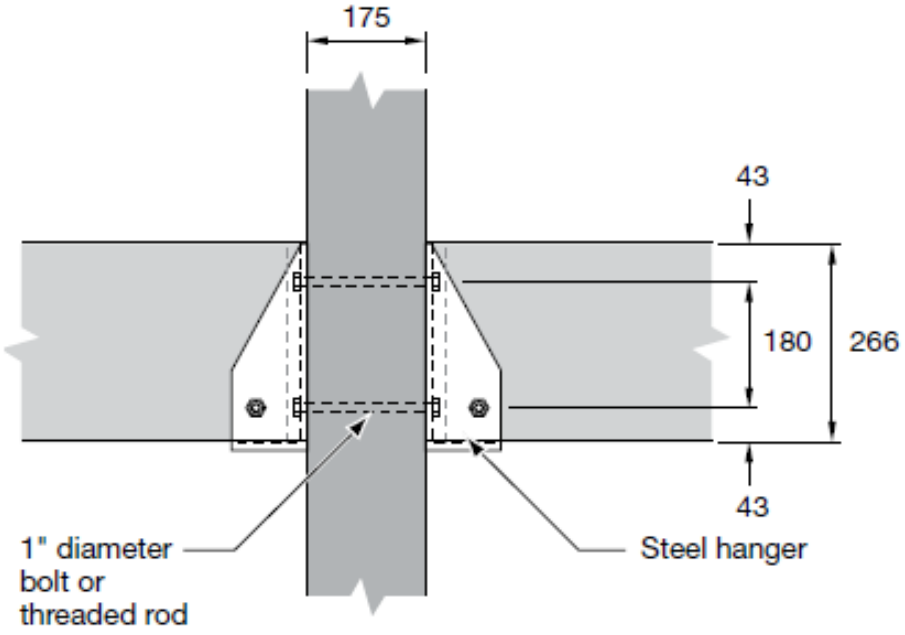




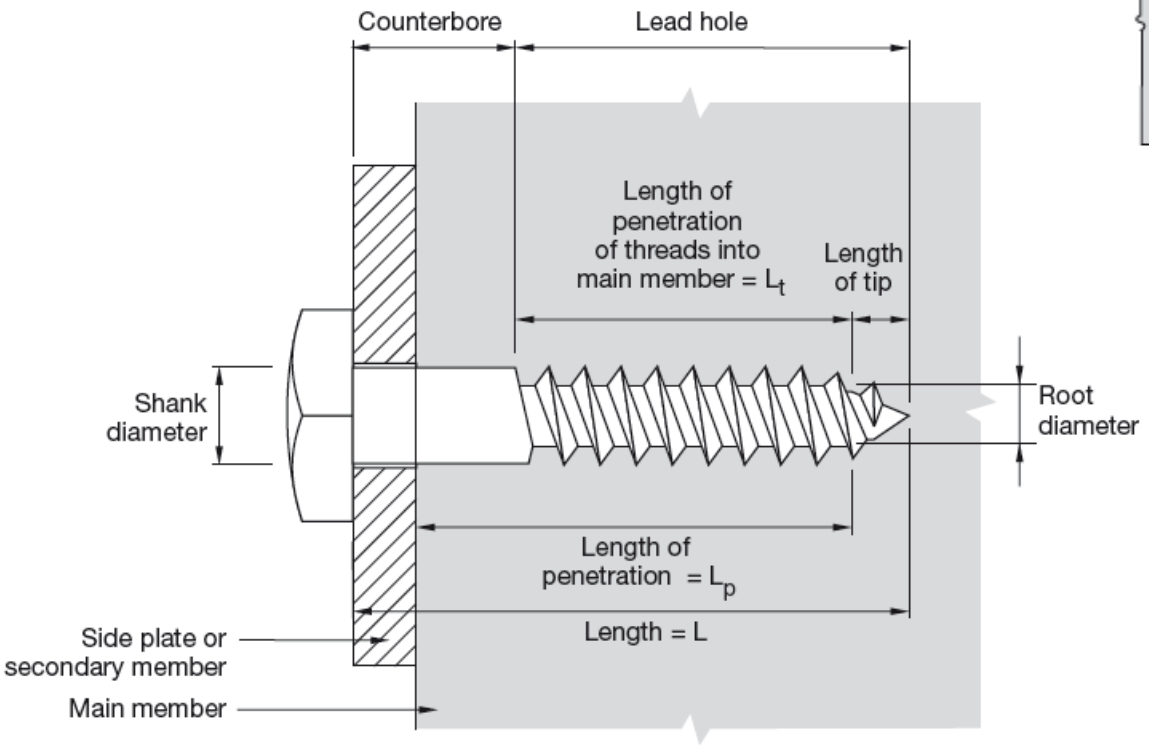
Bolts

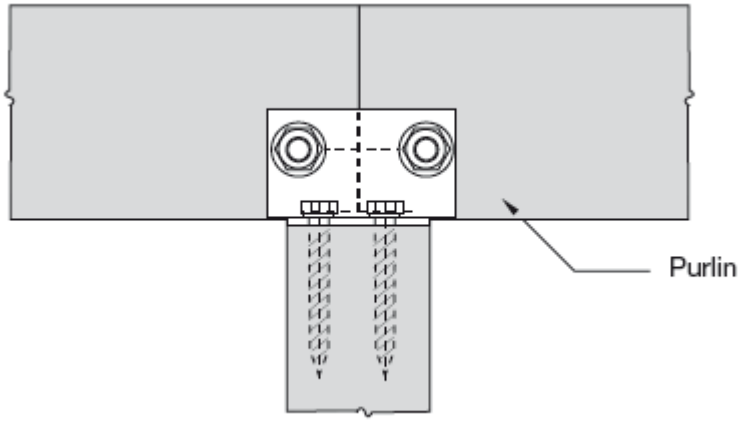

a_L
e_p
Grain
S_R
S_c

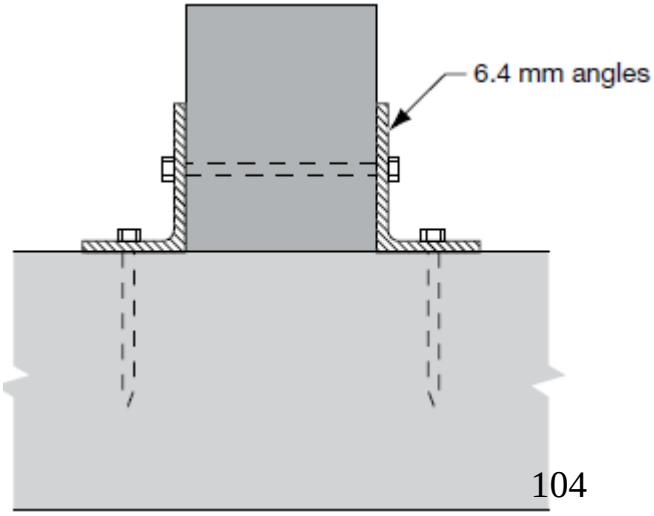

d_F


175
43
180
266
43
1" diameter
bolt or
threaded rod
Steel hanger

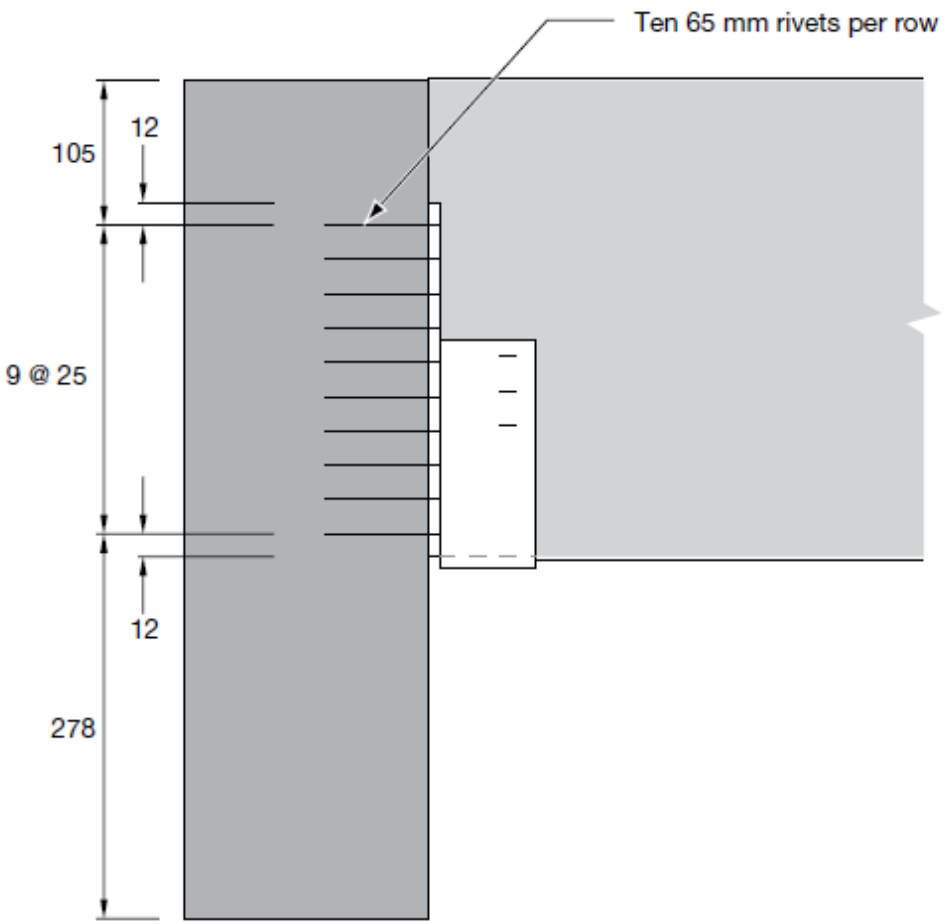
Lag Screws


Counterbore
Lead hole
Length of penetration of threads into main member = L_t
Length of tip
Shank diameter
Root diameter
Length of penetration = L_p
Length = L
Side plate or secondary member
Main member

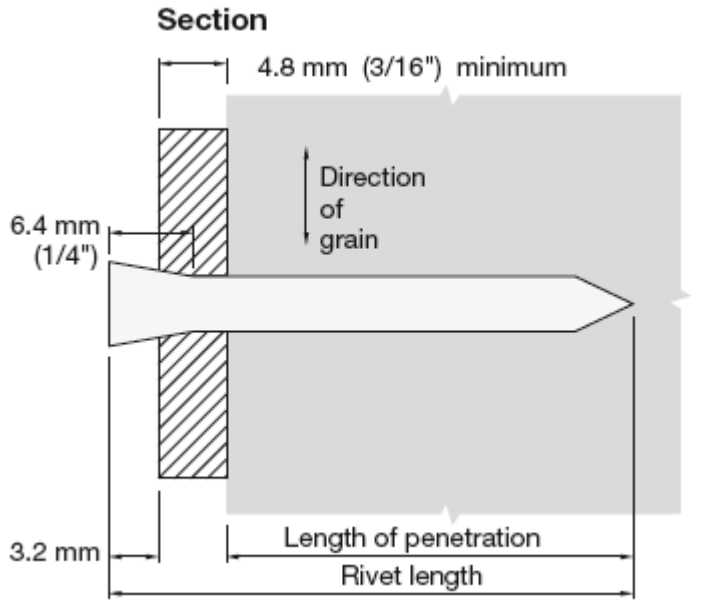

Purlin

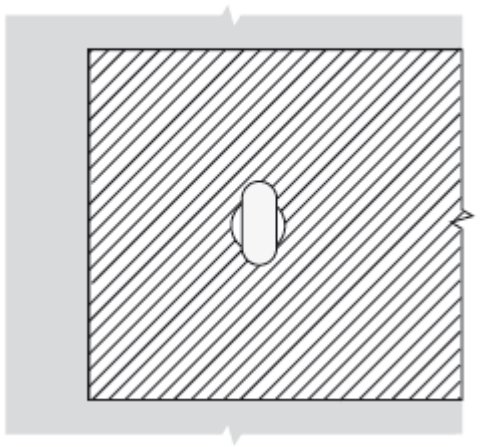

6.4 mm angles

Timber Rivets



Sample Rivet Connection



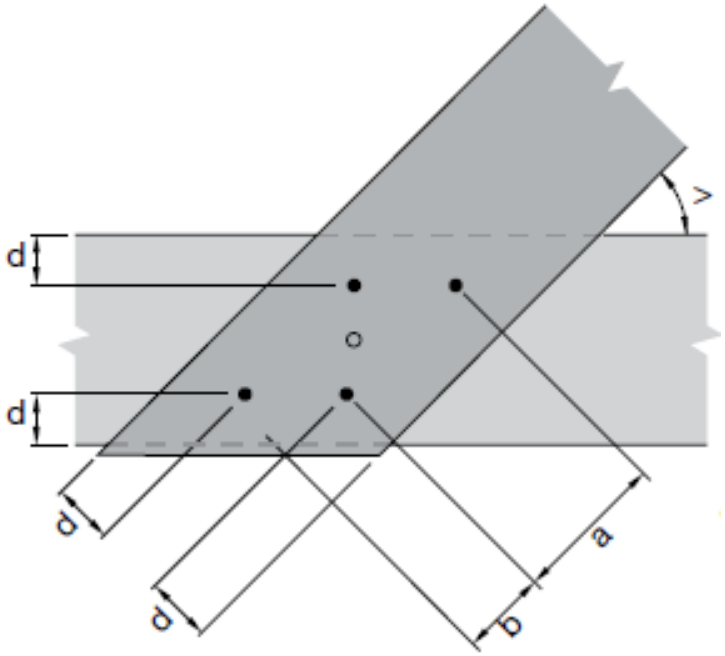


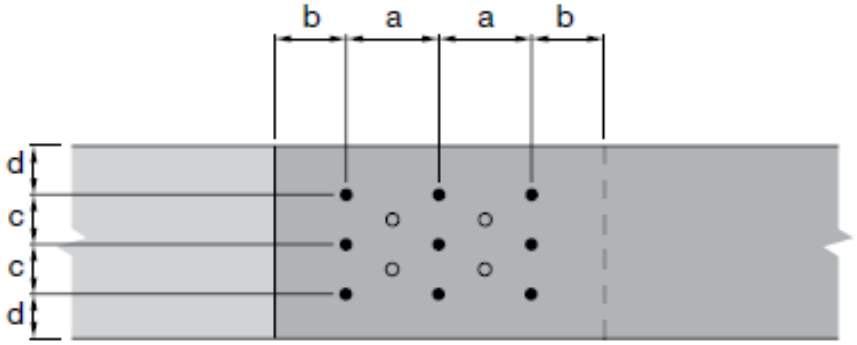
Nails

WoodWorks® SOFTWARE FOR WOOD DESIGN

Common lengths mm	in.
100 to 350	4 to 14
125 to 250	5 to 10
25 to 150	1 to 6
19 to 125	3/4 to 5
25 to 100	1 to 4
28 to 80	1-1/8 to 3-1/4
13 to 75	1/2 to 3
50 to 63	2 to 2-1/2
19 to 63	3/4 to 2-1/2

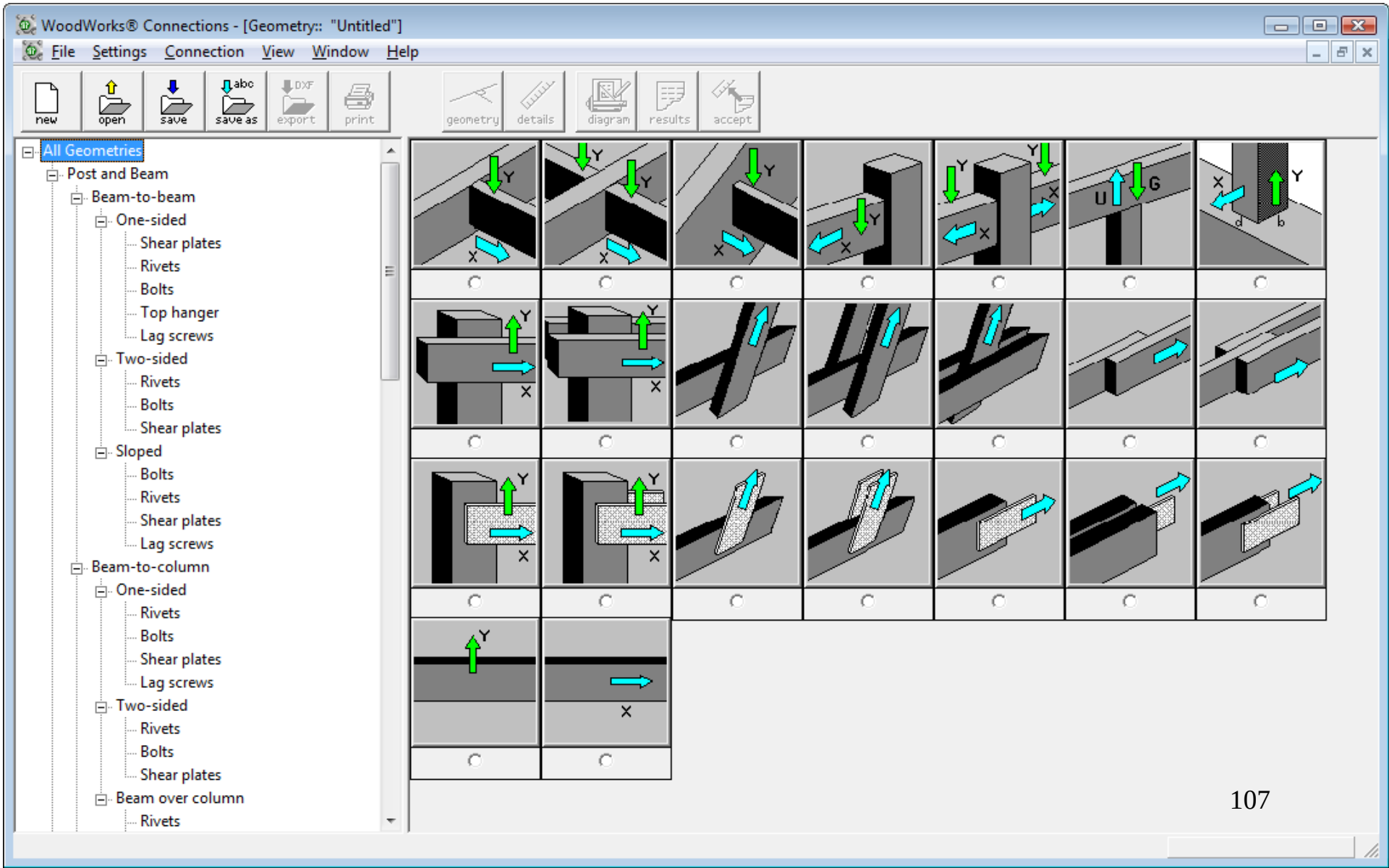
Common lengths mm	in.
38 to 63	1-1/2 to 2-1/2
28 to 50	1-1/8 to 2
19 to 50	3/4 to 2
19 to 50	3/4 to 2
19 to 50	3/4 to 2
31 to 44	1-1/4 to 1-3/4
31	1-1/4
25 to 28	1 to 1-1/8





CONNECTIONS

Connections and associated Fasteners on first screen

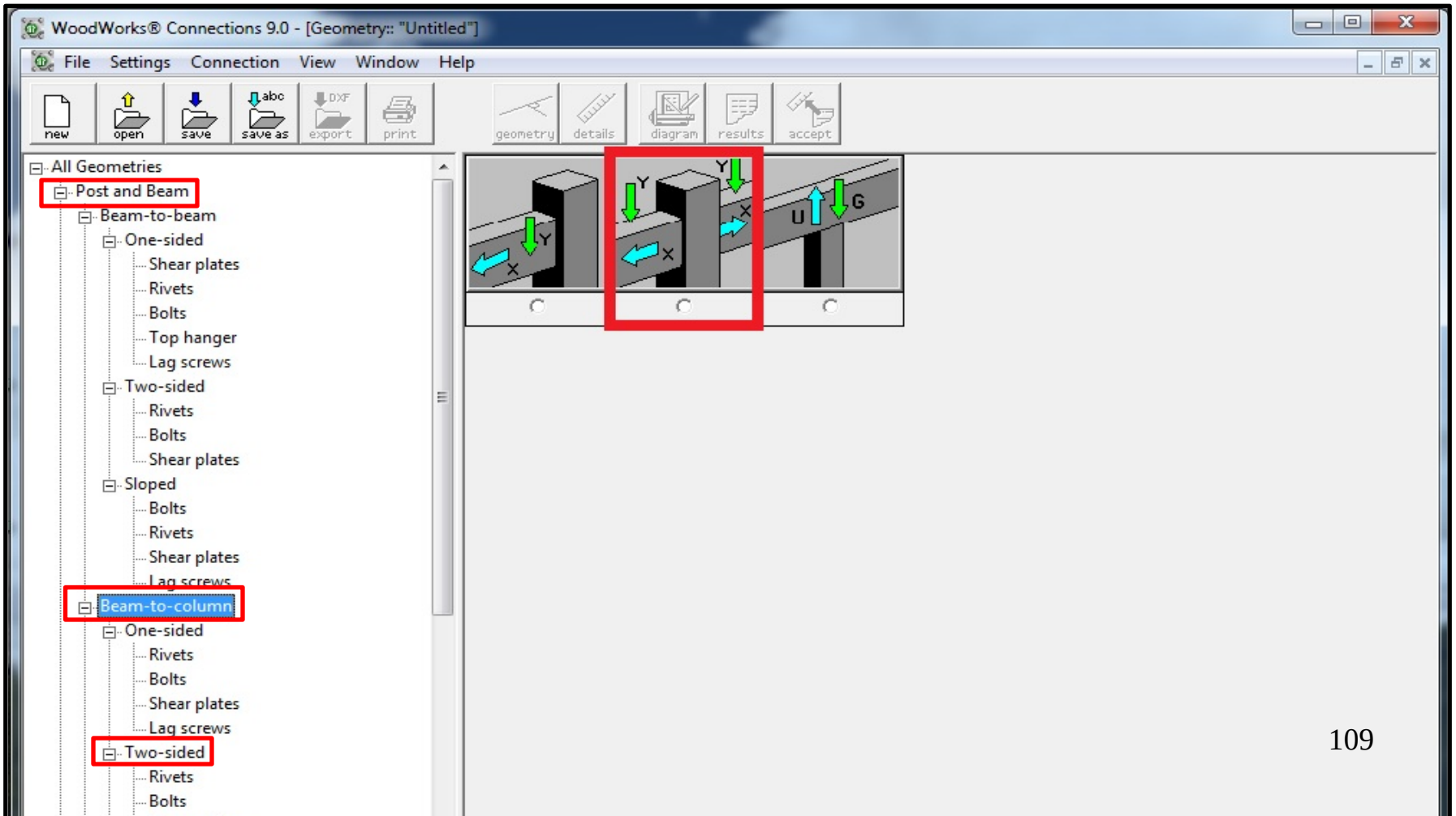


Beam to Column Bolt Connection Example

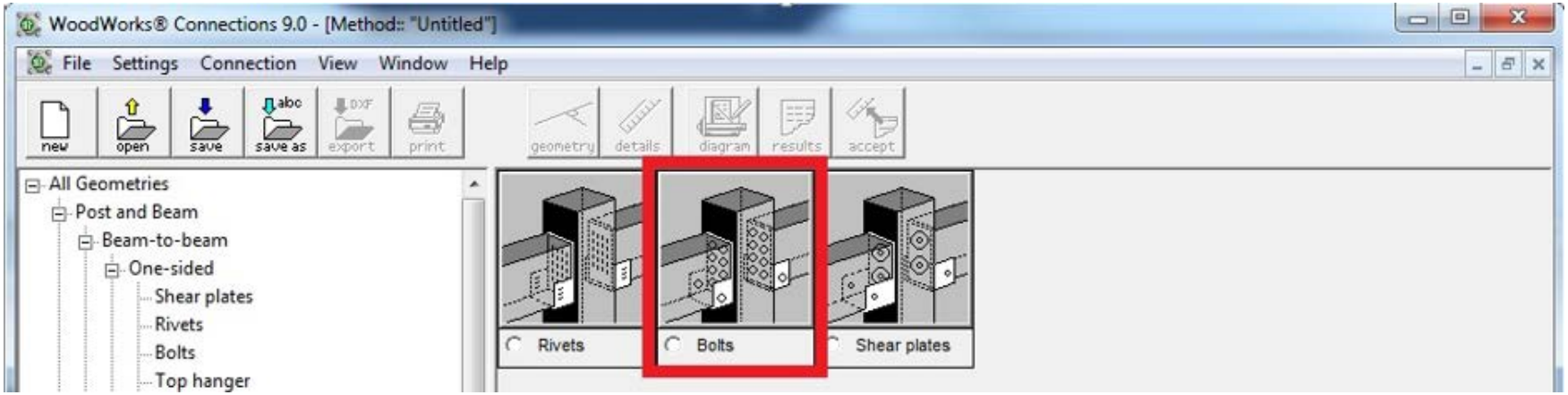
Example 1 on page 261 of the 2010 Wood Design Manual

Step 1: Click the ***New*** button on the toolbar.

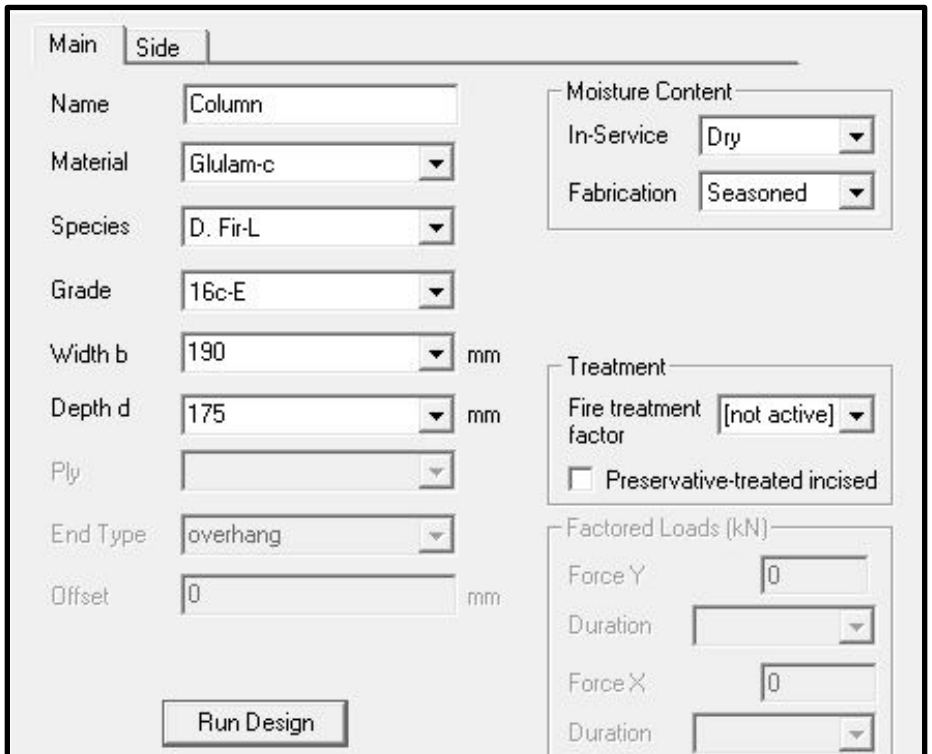
Step 2: Select the connection type ***Post and Beam, Beam-to-column, two-sided*** configuration.



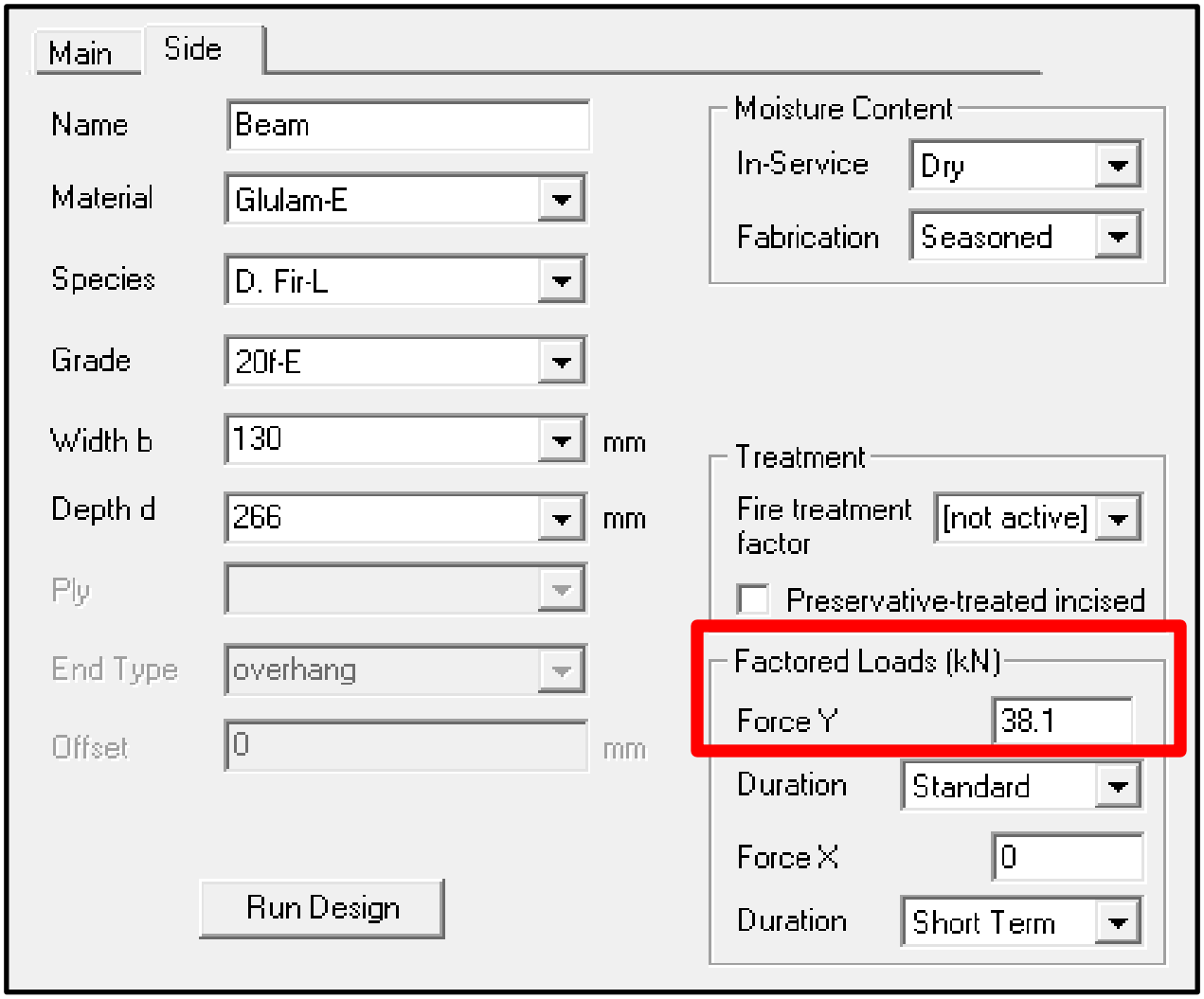
Step 3: Select the Bolts connection type.



Step 4: Specify Main Member Details



Step 5: Specify Side Member Details



Step 6: Specify Factors Force Y of 38.1 kN

Step 7: Specify Face Plate Details

	Face Plate		Side Plates
Bolt Diameter	1 (25.4)	inches (mm)	(unknown)
Rows per Plate	1		(unknown)
Bolts per Row	2		(unknown)
Spacing Between	(unknown)	mm	(unknown)
Spacing Within Rows	(unknown)	mm	(unknown)
Plate Thickness	6	mm	6
Plate Steel Grade	CSA G40.21M 300W		CSA G40.21M 300W
Max. Plate Length	266	mm	147

Step 8: Run Design, Review and Accept Design Results

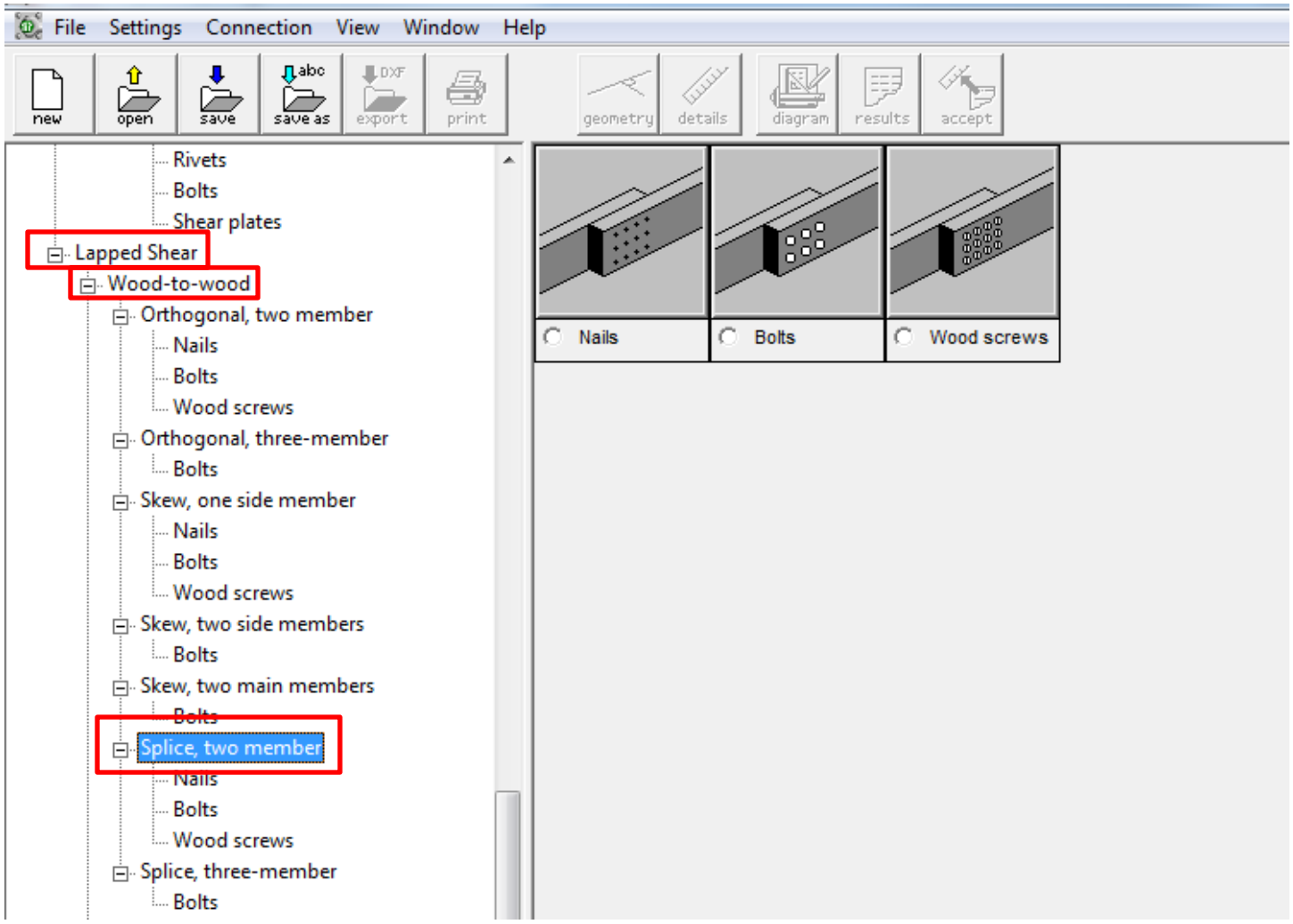
Design Results:
  Face Plates:
    Factored load: Pf = 38.10 kN
    Embedment strength par: fP = 19.05 MPa
    Embedment strength: f theta = 19.05 MPa (10.4.4.3.3.1)
    Yielding resistance: Nr = 98.37 kN Ratio: 0.77 (10.4.4.2(a),3)
    Row shear resistance: PRr = 99.32 kN (10.4.4.4)
    Brittle resistance: Pr = 99.32 kN Ratio: 0.38 (10.4.4.2(b))

Screw Lap Splice Connection Example

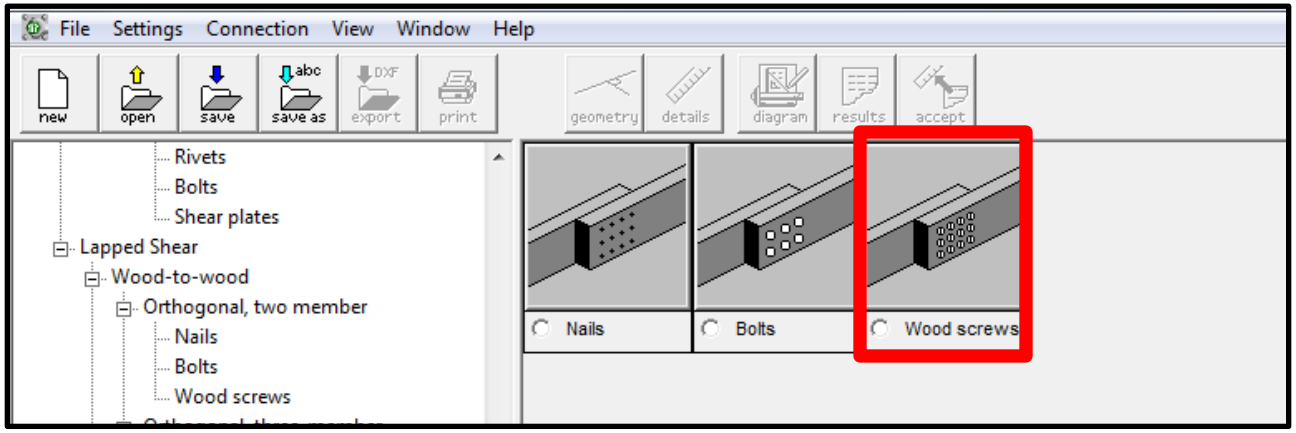
Example 1 on page 250 of the 2010 Wood Design Manual

Step 1: Click the ***New*** button on the toolbar.

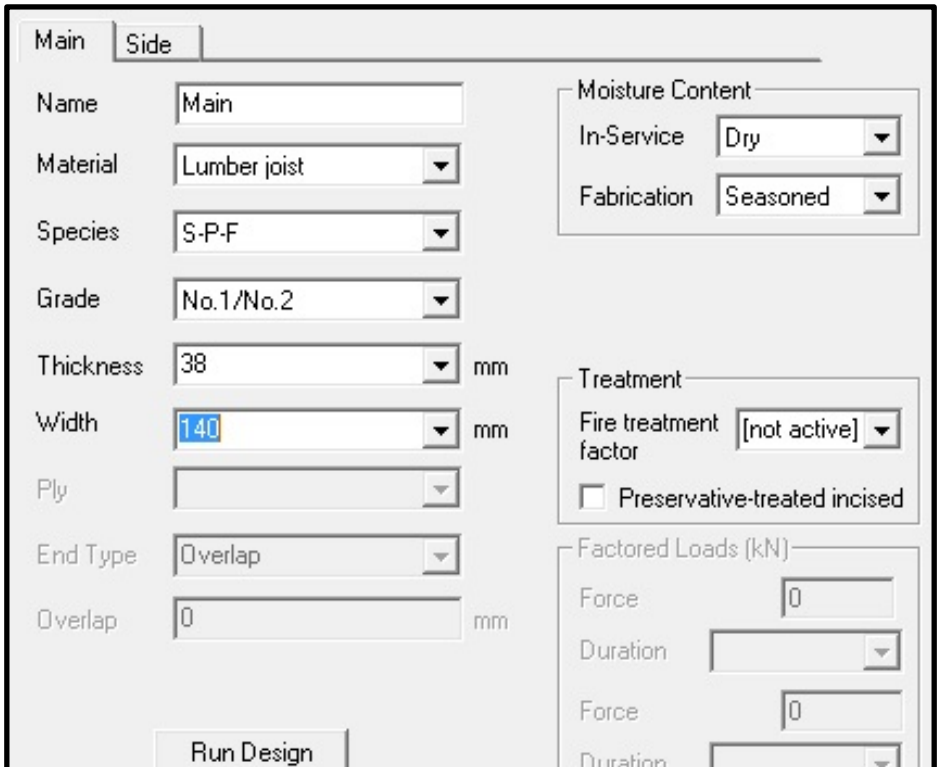
Step 2: Select the connection type ***Lapped Shear, wood-to-wood, Splice two-member*.**



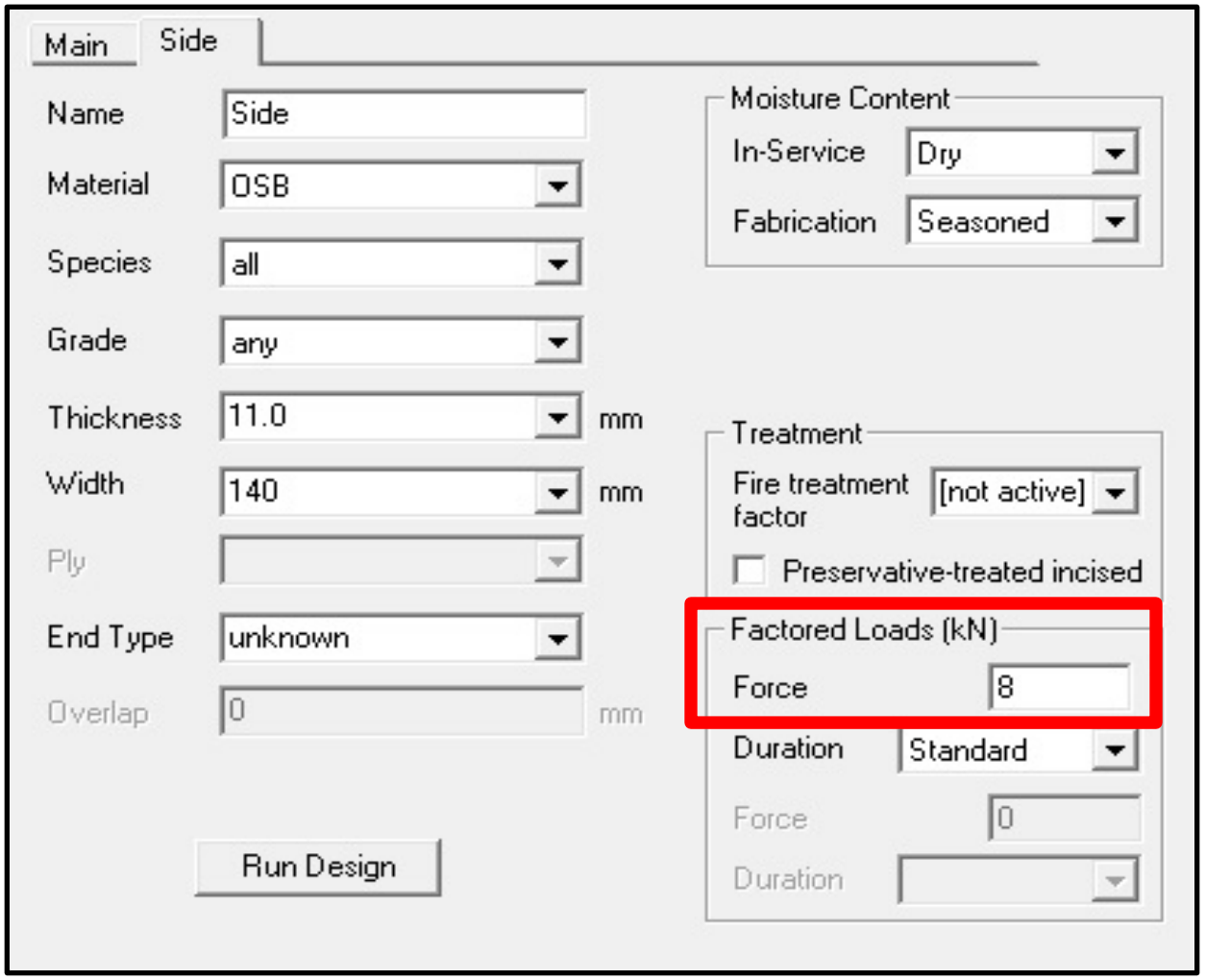
Step 3: Select the Bolts connection type.



Step 4: Specify Main Member Details

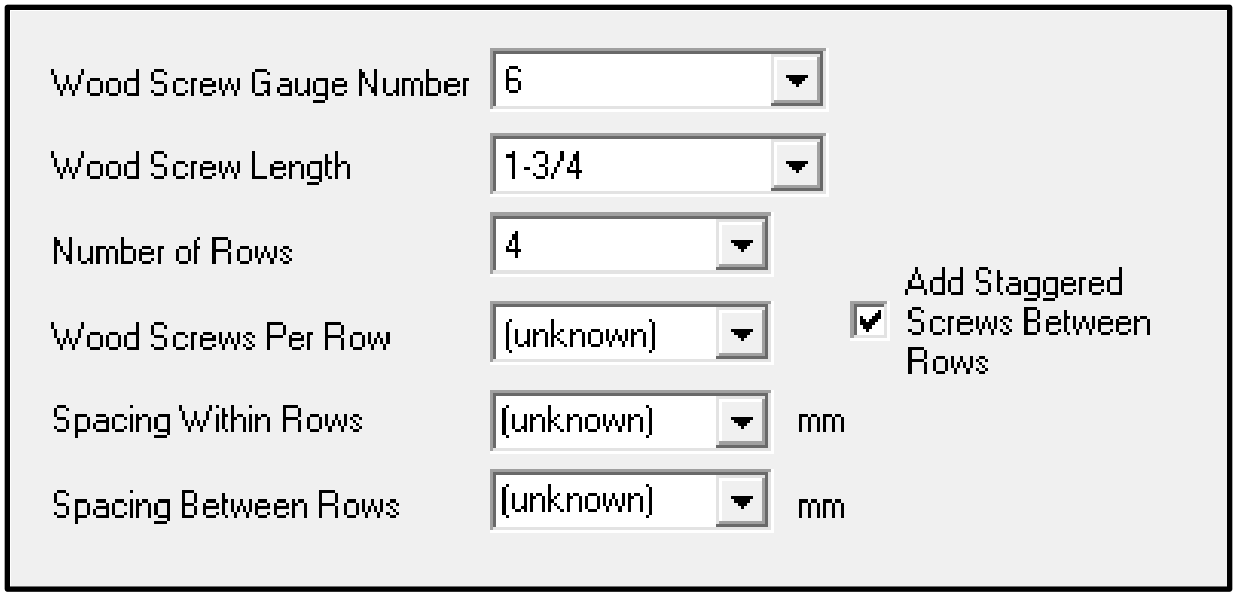


Step 5: Specify Side Member Details

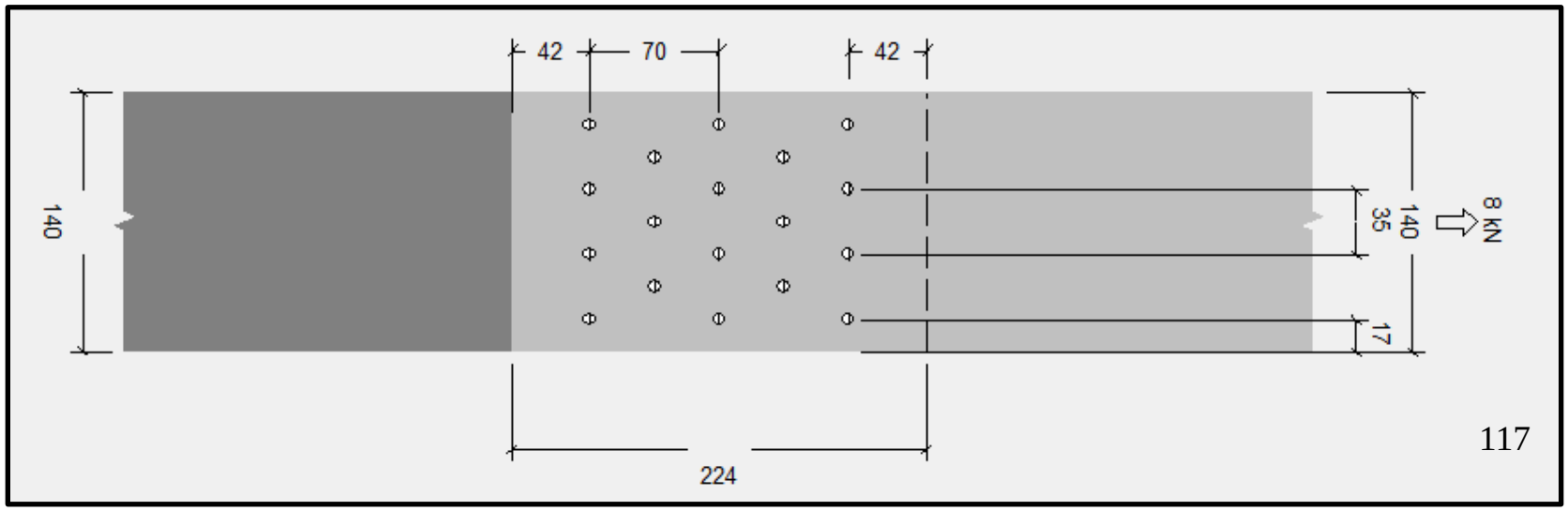


Step 6: Specify Factors Force of 8 kN

Step 7: Specify Face Plate Details



Step 8: Run Design, Review and Accept Design Results



SIZER
Gravity Design

Concept mode
- **Beam mode**
- **Column mode**

DATABASE EDITOR
Add proprietary products

SHEARWALLS
Lateral Design (Wind and Seismic)

CONNECTIONS
Fasteners

How Does Part 9 deal with Lateral Loads?

No Lateral load Design Required unless structure is in a High Seismic or High Wind Load Zone

High Seismic Zones:

Sa(0.2) > 0.70

Locations in Atlantic Canada that meet Requirements for High Seismic:

None

High Wind Zones:

HWP 1/50 years > 0.80 kPa

Locations in Atlantic Canada that meet Requirements for High Wind:

Bonavista N.L. (0.84 kPa)

Cape Race N.L. (1.05 kPa)

St. Anthony N.L. (0.87 kPa)

NBC Part 4 vs. NBC Part 9

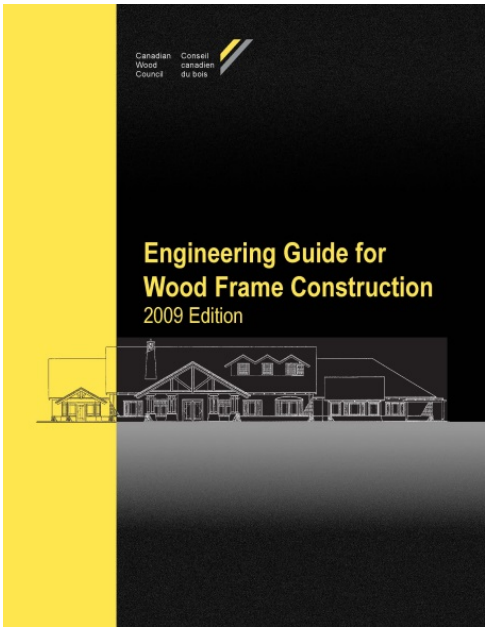
Part 4:

- Engineered Design
- CSA O86

WoodWorks Software Follows a Part 4 Design

Part 9:

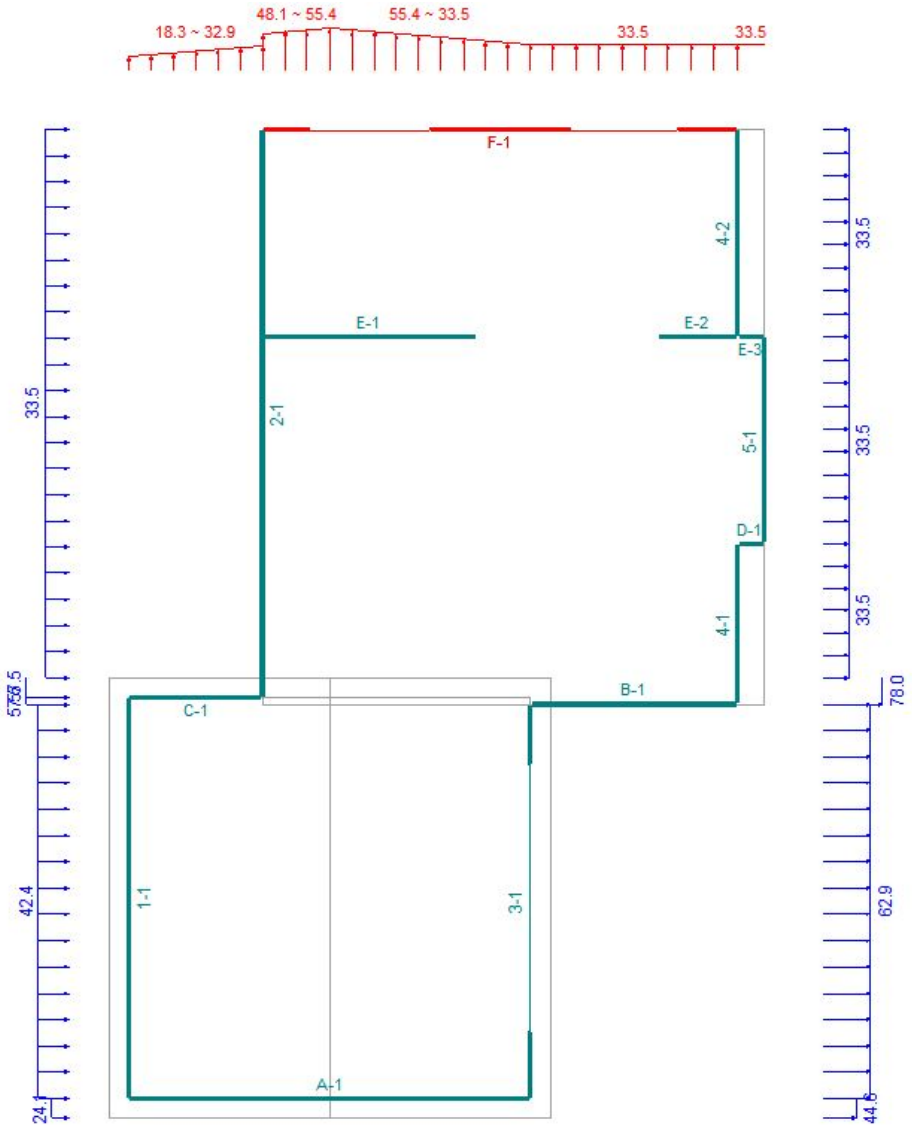
- Prescriptive Design
- Section 9.23.13 of NBC



Required amount of wall bracing, Further Guidance Provided in CWC "Engineering Guide for Wood Frame Construction" (Available through CWC Webstore)

SHEARWALLS

Lateral Design (Wind and Seismic)



WoodWorks® SOFTWARE FOR WOOD DESIGN

Wind and seismic load generation at the click of a button. Enter City, or building code climatic info.

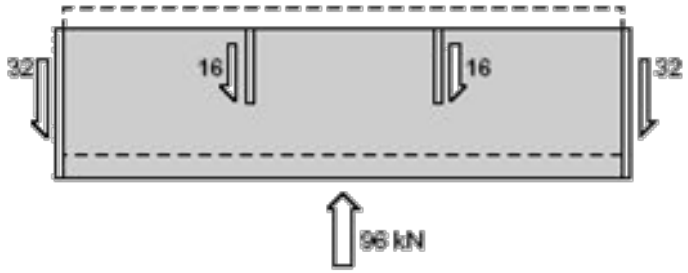
Additional loads can be added manually.

Forces are distributed using both rigid (stiffness) and flexible (tributary area) diaphragm assumptions.

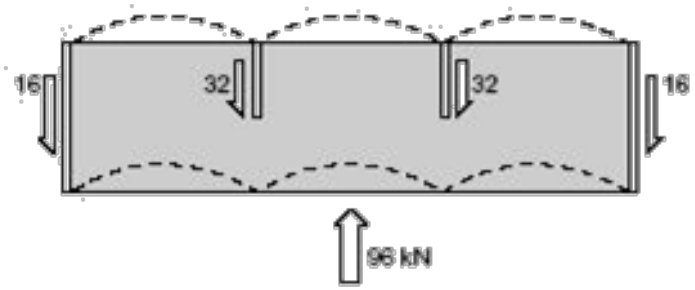
Shearwalls designed for worst case distribution and load

SHEARWALLS

Distributes the automatically generated loads to each shear wall



Rigid diaphragm (Stiffness)



Flexible diaphragm (Tributary area)

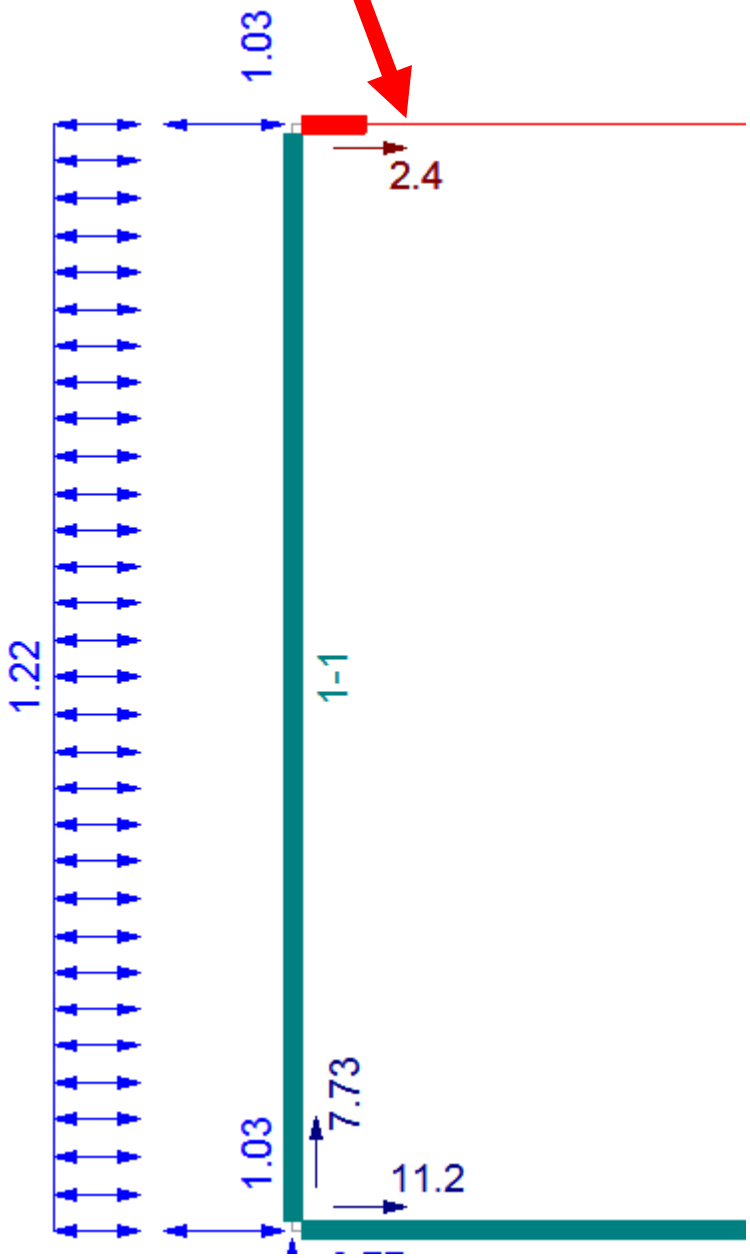
Designs for wind suction

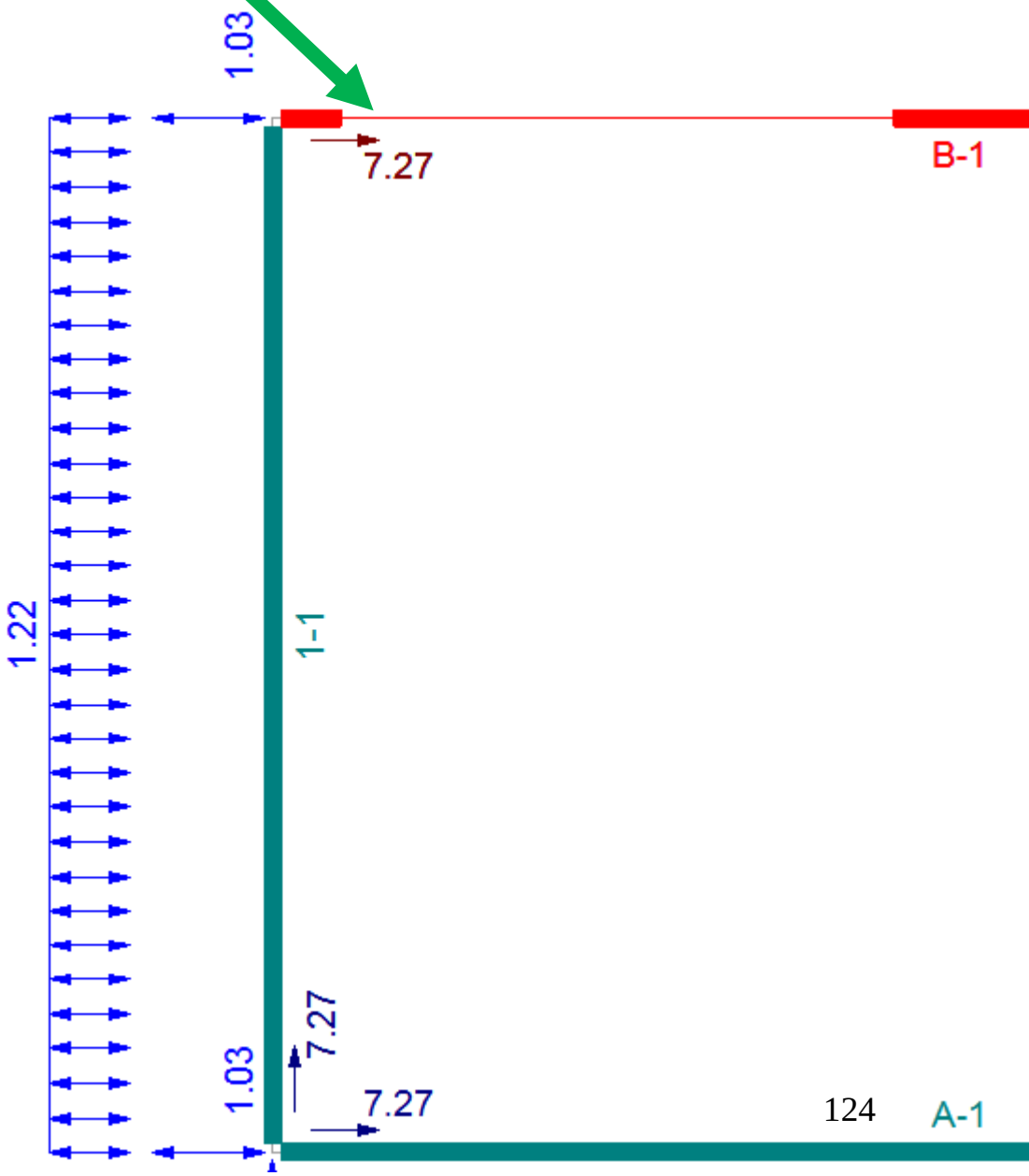
Designs for shear

Envelope Design Approach

- **Program automatically designs shearwalls for the worst case of wind and seismic for both flexible and rigid diaphragm distribution**
- **ie. 4 loading cases for each segment – program designs for worst case scenario**
- **Light-frame wood structures should behave somewhere between flexible and rigid diaphragm distribution. The envelope procedure ensures that all possible loading cases are taken into account for the design.**

Rigid and Flexible distribution





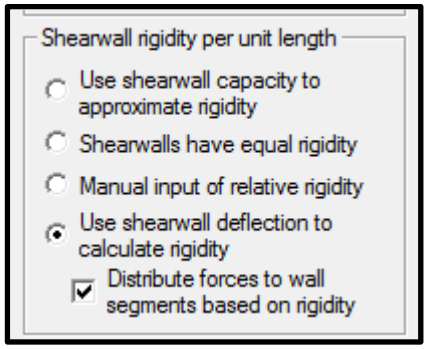
Deflection-based rigidity vs. Capacity-based rigidity

Deflection Based Rigidity (Default Setting):

- Program equalizes deflection along a shearline, by equalizing deflections along each segment within the shearline

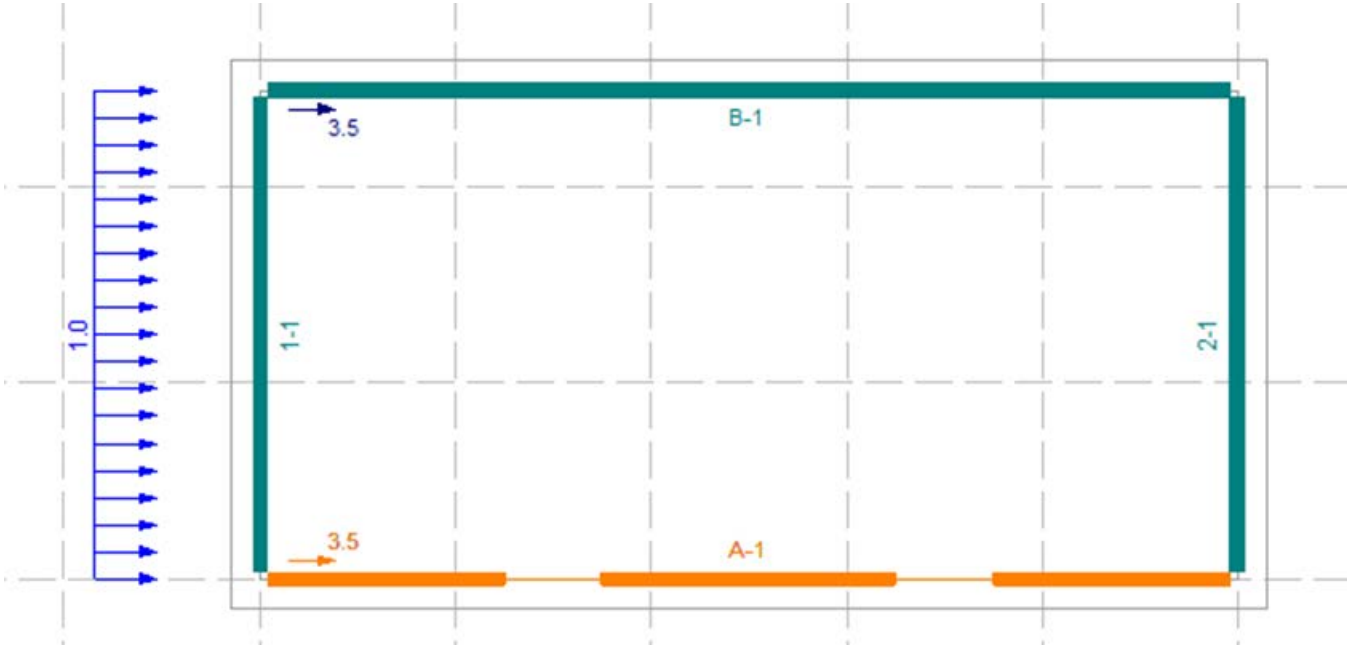
- Forces are distributed to each segment within a shearline based on the calculated equalized deflection

- i.e. what force is required in each segment to create an equal deflection along a shearline?

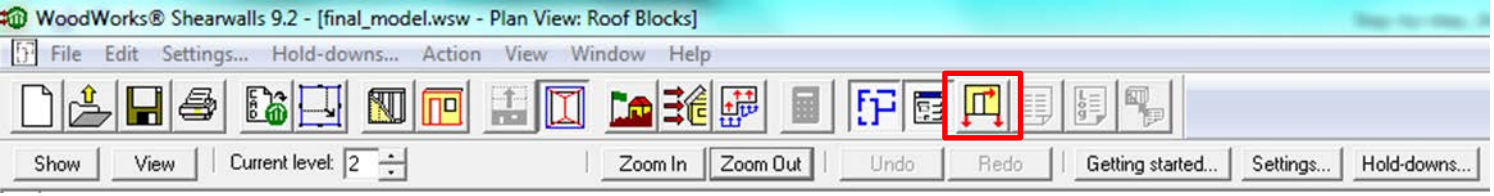


Rigidity: 1/ deflection = stiffness

Flexible distribution to the shearline

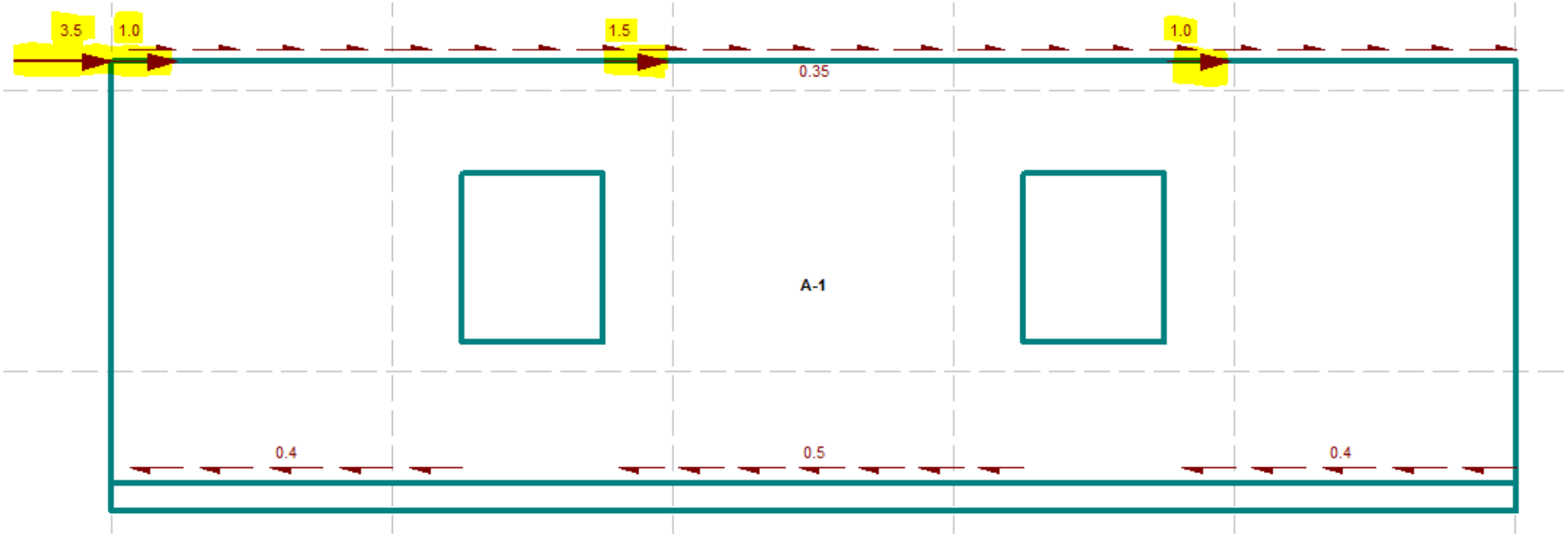


Deflection-based distribution within the Shearline



Force distribution within shearlines

Rigidity: 1/ deflection = stiffness



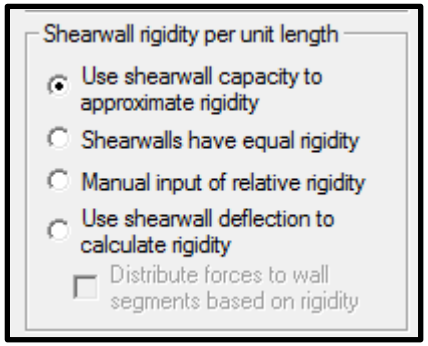
Deflection-based rigidity vs. Capacity-based rigidity

Capacity Based Rigidity:

- The forces are distributed to a shearline based on the relative capacity of the shearline

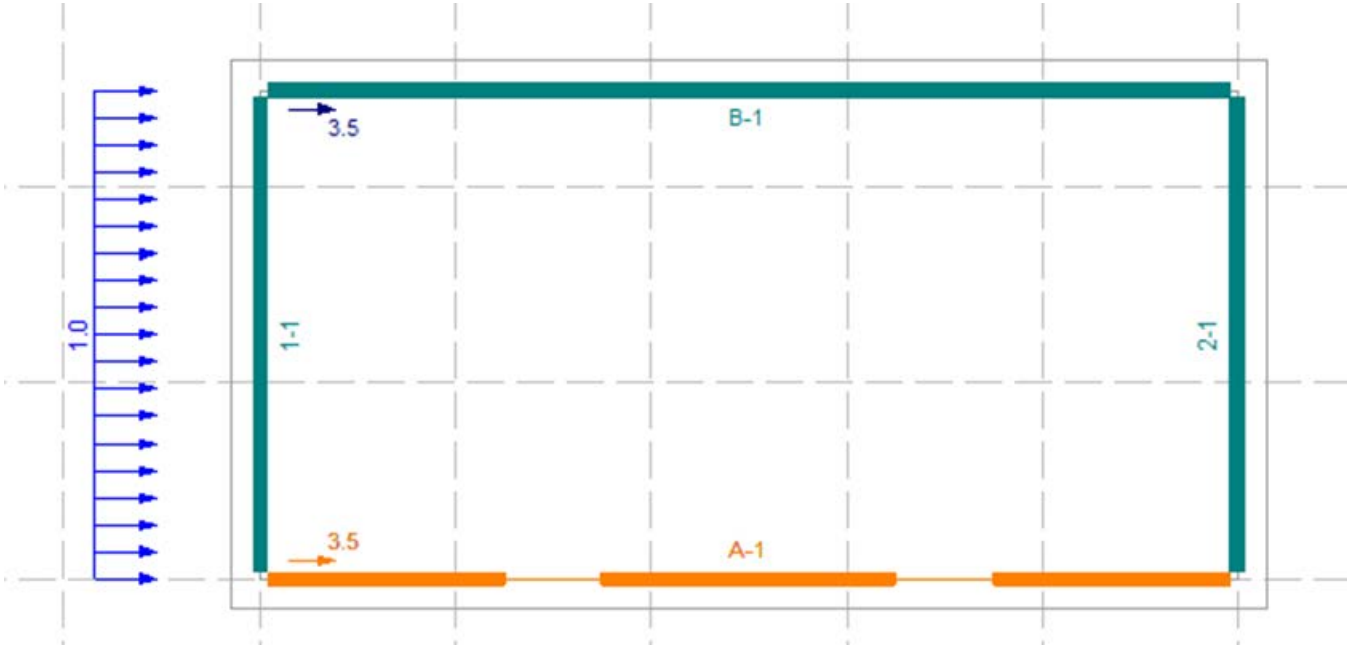
- Forces are distributed to each segment within the shearline based on the relative capacity of each segment

- The capacity is used as a proxy to estimate the stiffness of the each segment or shearline

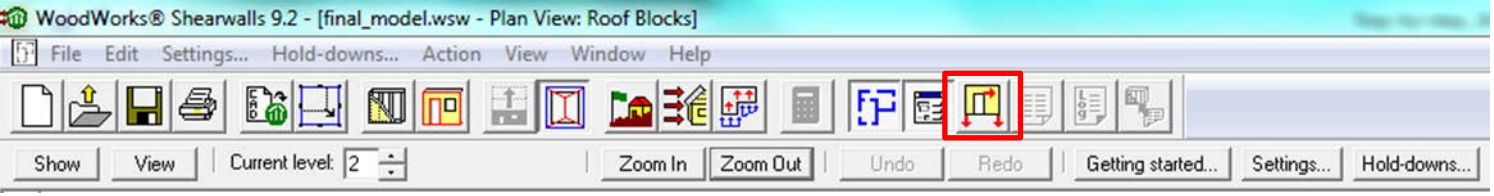


Rigid: capacity approximates stiffness

Flexible distribution to the shearline

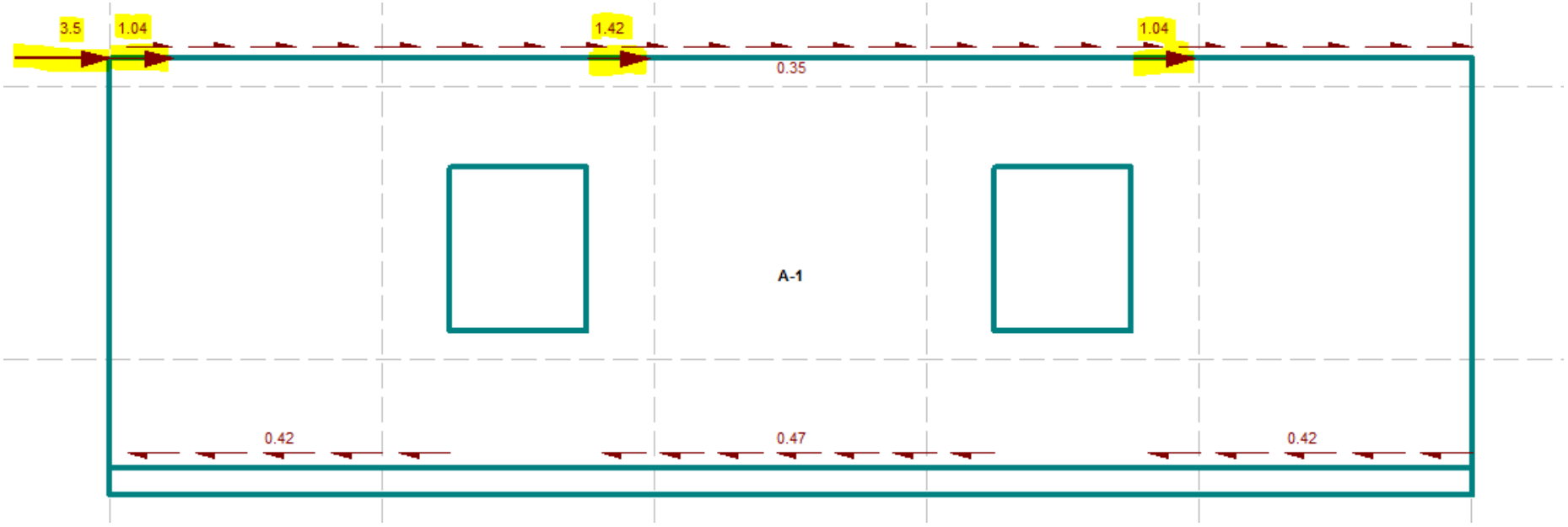


Capacity-based distribution within the Shearline



Force distribution within shearlines

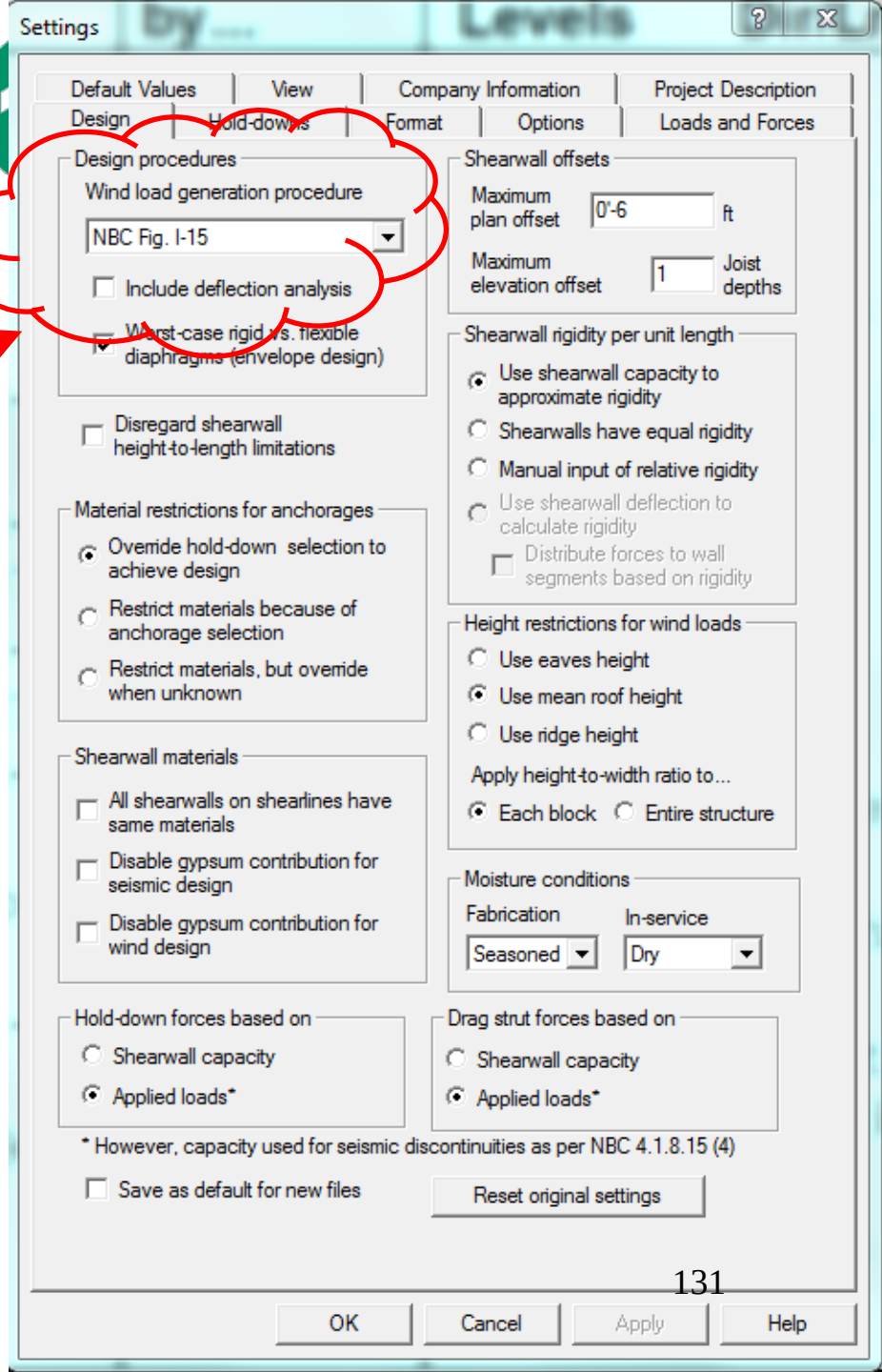
Rigid: capacity approximates stiffness



SHEARWALLS

Lateral Design (Wind and Seismic)

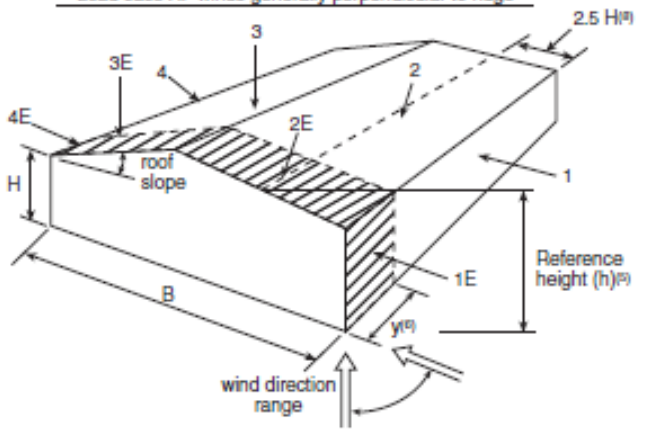
Wind load design procedure selection (I-15 or I-7/8)



SHEARWALLS
Lateral Design (Wind and Seismic)

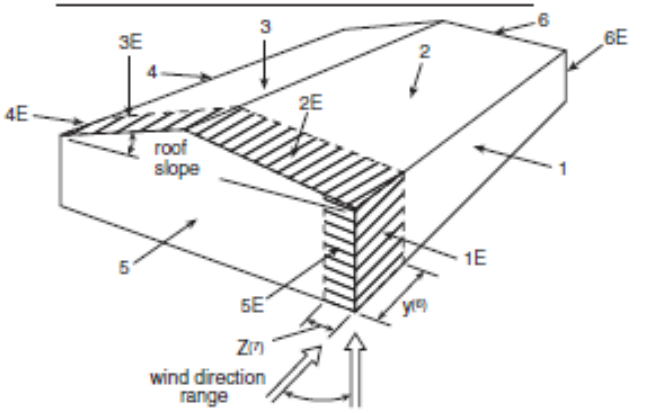
Low rise I-7 (Lateral - MWFRS)

Load case A: winds generally perpendicular to ridge



Roof slope	Building surfaces							
	1	1E	2	2E	3	3E	4	4E
0° to 5°	0.75	1.15	–1.3	–2.0	–0.7	–1.0	–0.55	–0.8
20°	1.0	1.5	–1.3	–2.0	–0.9	–1.3	–0.8	–1.2
30° to 45°	1.05	1.3	0.4	0.5	–0.8	–1.0	–0.7	–0.9
90°	1.05	1.3	1.05	1.3	–0.7	–0.9	–0.7	–0.9

Load case B: winds generally parallel to ridge



Roof slope	Building surfaces											
	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
0° to 90°	–0.85	–0.9	–1.3	–2.0	–0.7	–1.0	–0.85	–0.9	0.75	1.15	–0.55	–0.8

Figure I-7
External peak composite pressure-gust coefficients, C_pC_g, for primary structural actions arising from wind load acting simultaneously on all surfaces

Low rise I-8 components and cladding for…

- sheathing
- fastener withdrawal

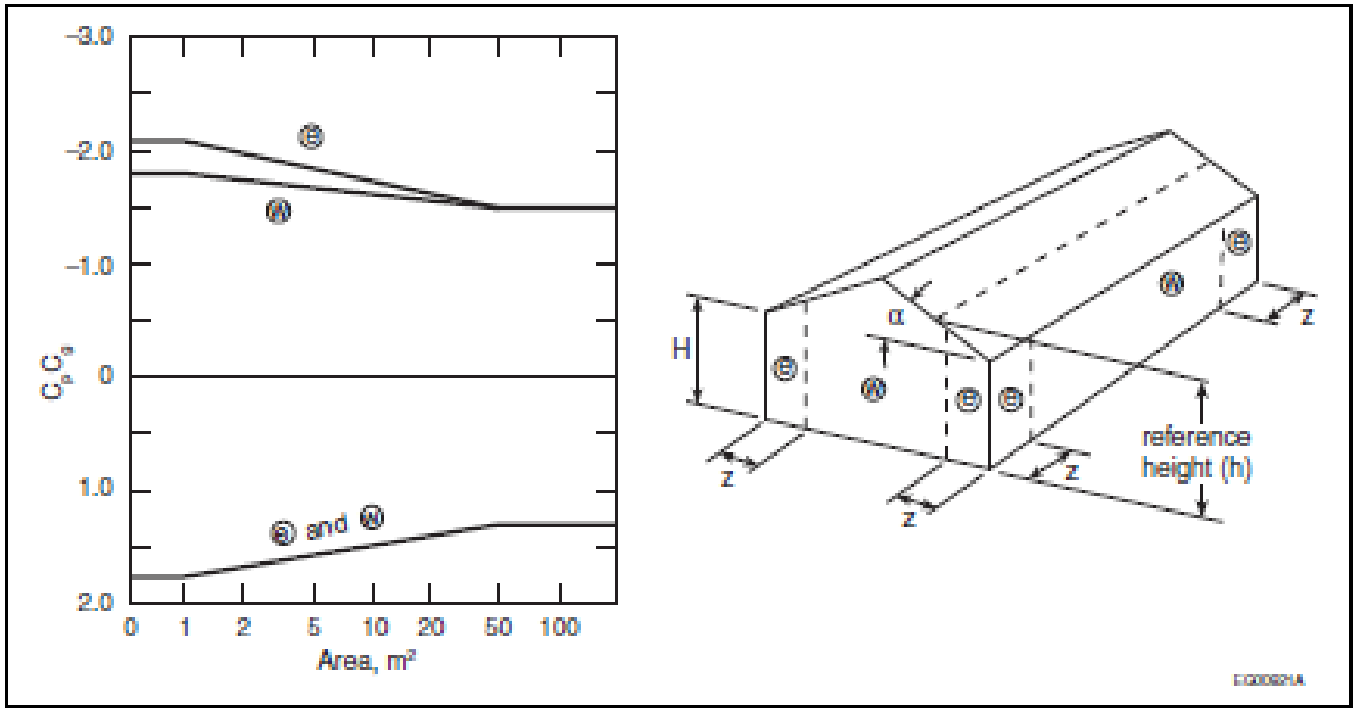


Figure I-8
External peak composite pressure-gust coefficients, C_pC_g, on individual walls for the design of structural components and cladding

All-heights I-15 (MWFRS and C&C)

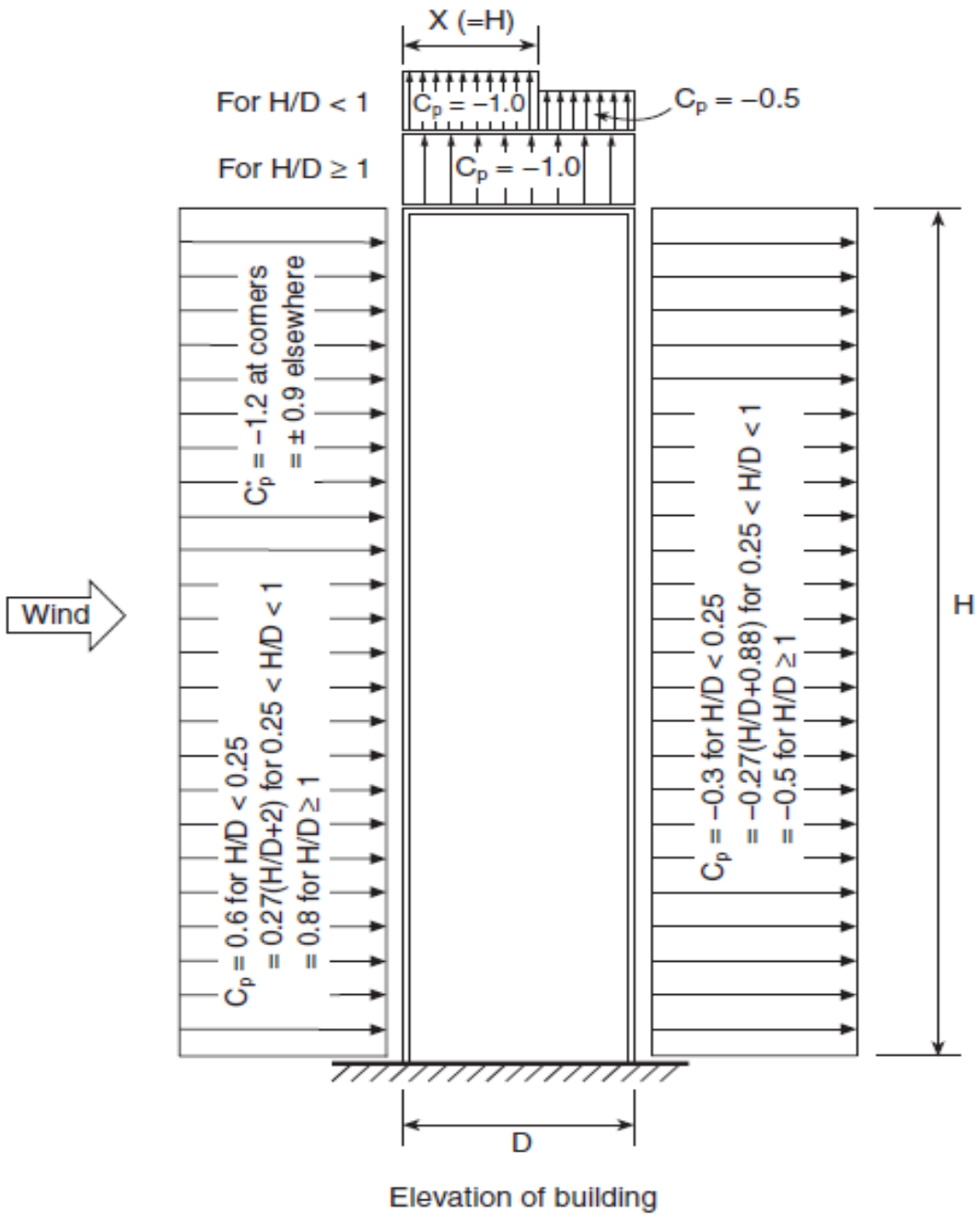


Figure I-15
External pressure coefficients, C_p and C_p^*, for flat-roofed buildings

WoodWorks® SOFTWARE FOR WOOD DESIGN

Hills and Escarpments input

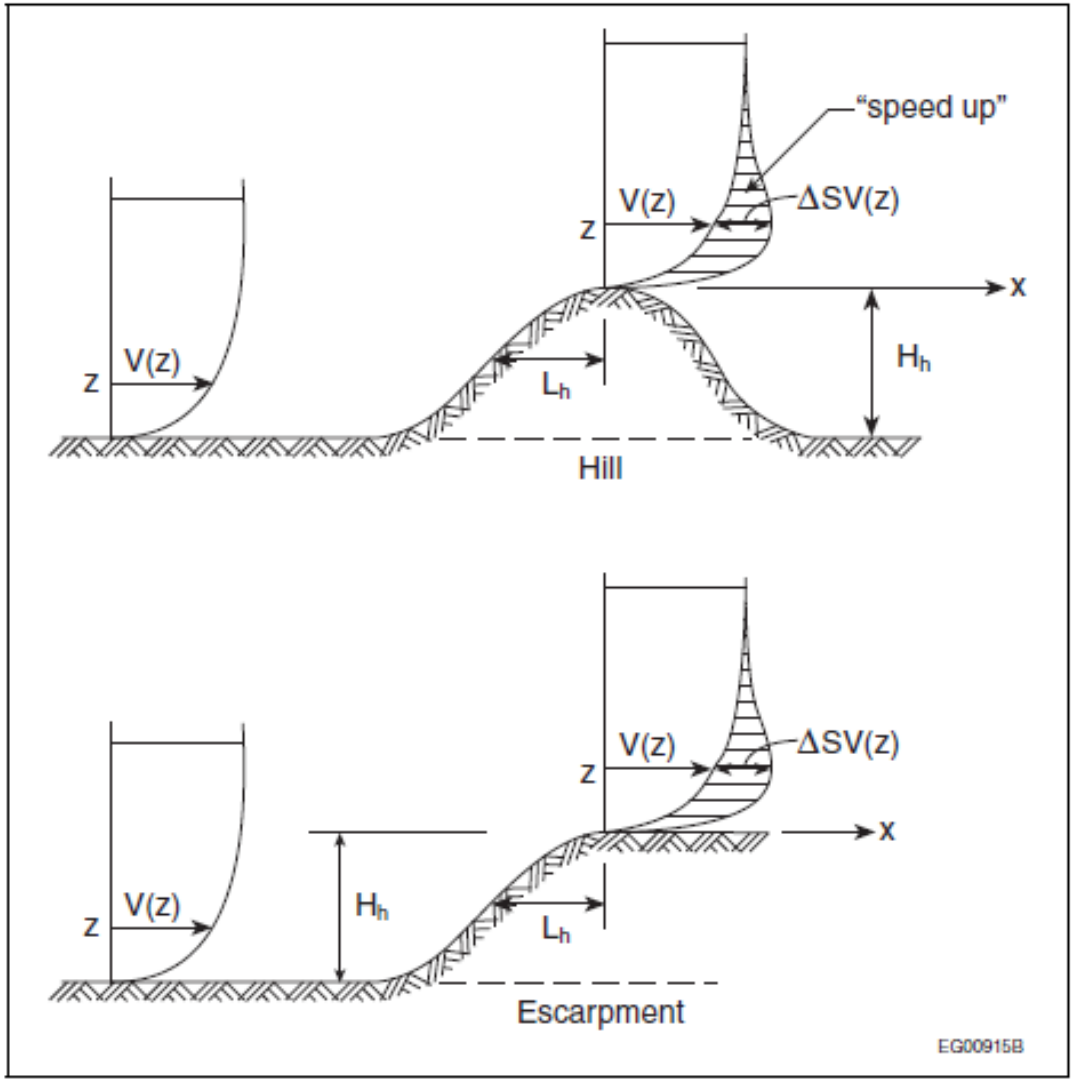


Figure I-6
Definitions for wind speed-up over hills and escarpments

Rough or Open Terrain option

Seismic

Newton's Second Law

$F = m^* a$

$V = W^* S(T_a) ^*factors$

$V = W \times S(T_a) \times M_v \times I_E / (R_d R_o)$

$S(T_a)$ = Acceleration as a function of T_a

T_a = Fundamental period of building

W = Weight of building

M_v = Higher mode effect factor

I_E = Importance factor

R_d = Ductility-related force modification factor

R_o = Overstrength-related force modification factor

Seismic

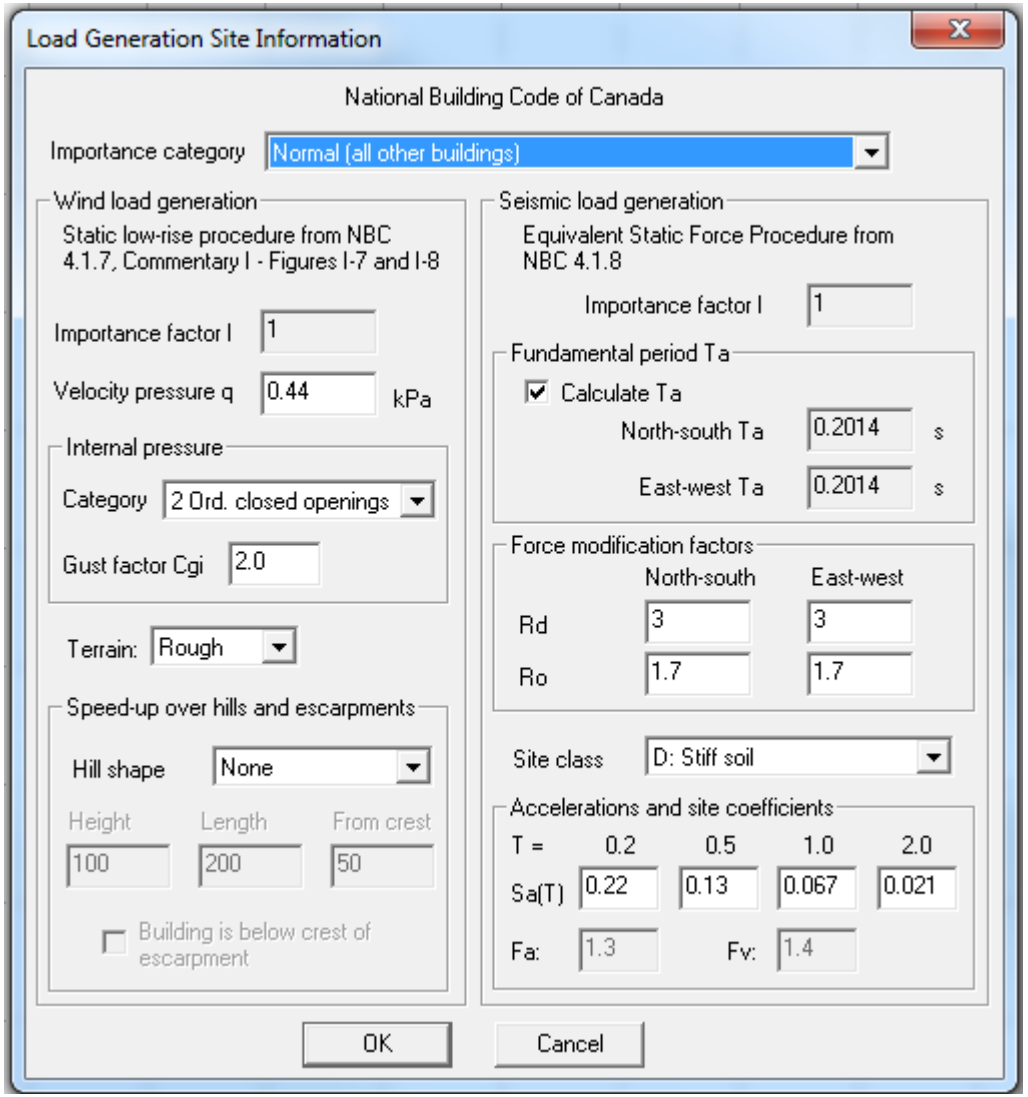
Equivalent Static Force Procedure, allowed if:

- Seismic $I_E F_a S_a(0.2) < 0.35$, any structure
- Any seismic $I_E F_a S_a(0.2)$, Regular shape, H<60 m, T_a<2 s
- Any seismic $I_E F_a S_a(0.2)$, Irregular shape*, H<20 m, T_a<0.5 s

*except torsional sensitivity where Dynamic analysis required; software automatically detects and notifies

Typical wood structures: T<0.50 seconds, H<20m (65ft)

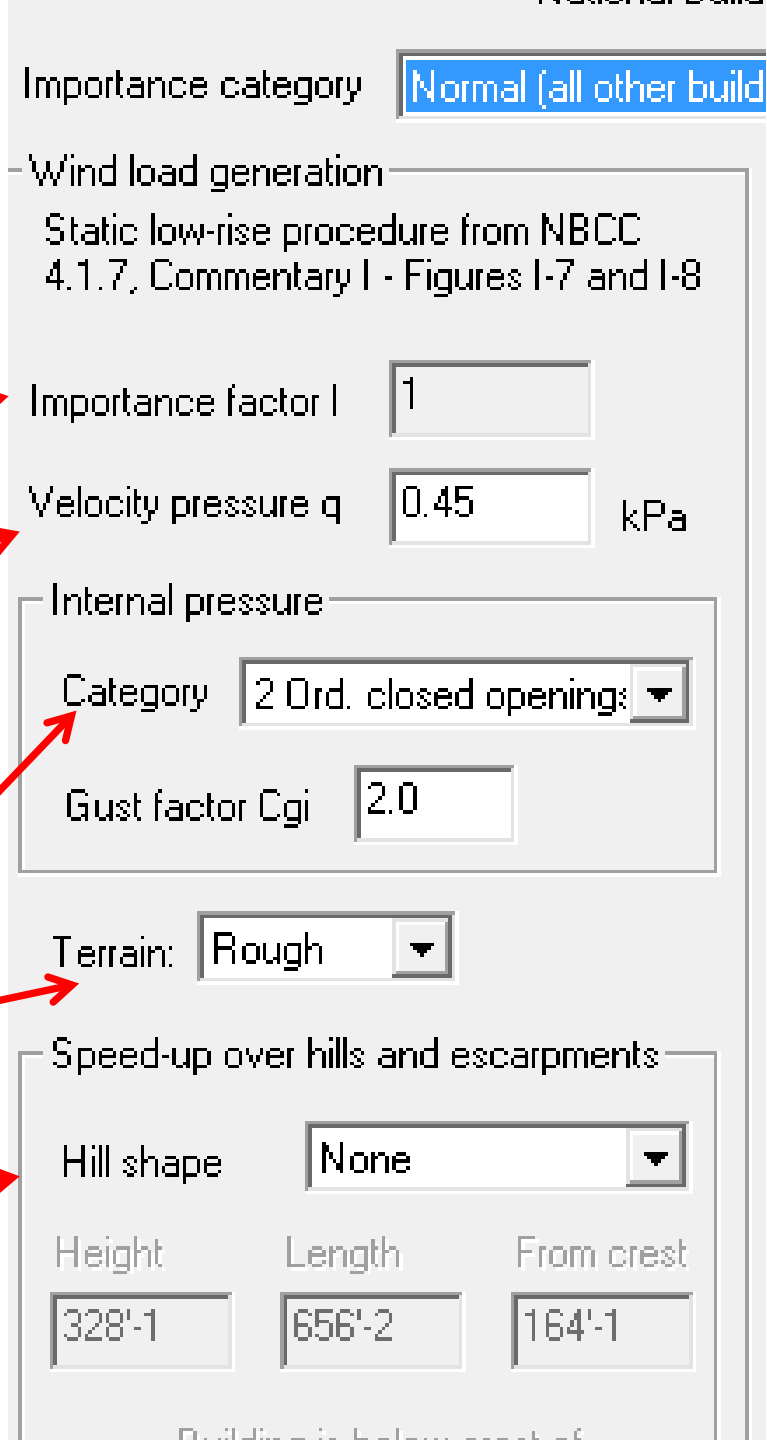
Load Generation and Site Information



SHEARWALLS

Wind

- **Importance category**
- **$q_{1/50}$ vel. pressure by location or manually input**
- **Internal pressure added to C&C for sheathing / nails**
- **Terrain and Hill shape**



Seismic

SHEARWALLS

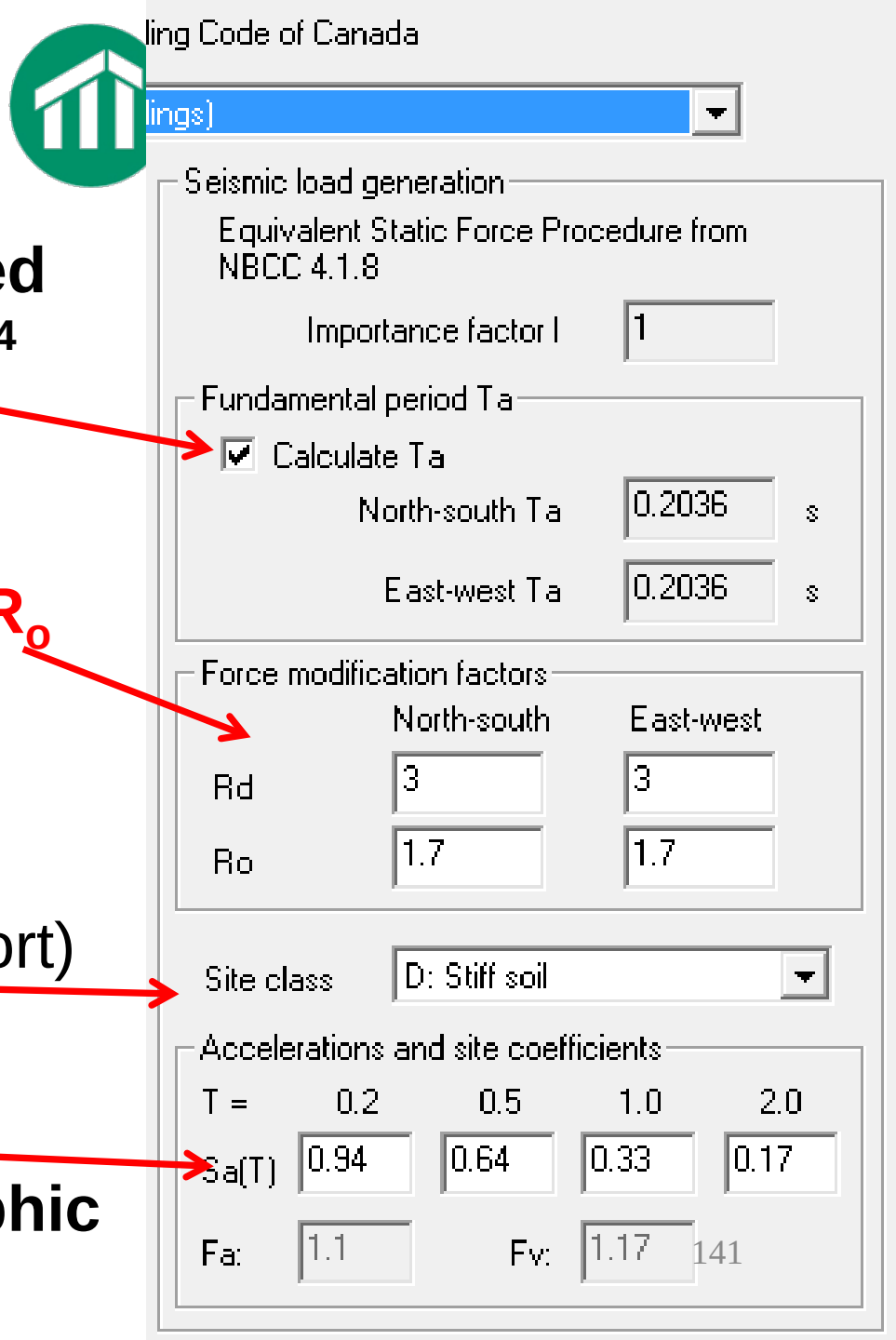
Code Period calculated based on building height 0.05 $(h_n)^{3/4}$ with user override

Ductility R_d & Overstrength R_o auto determined

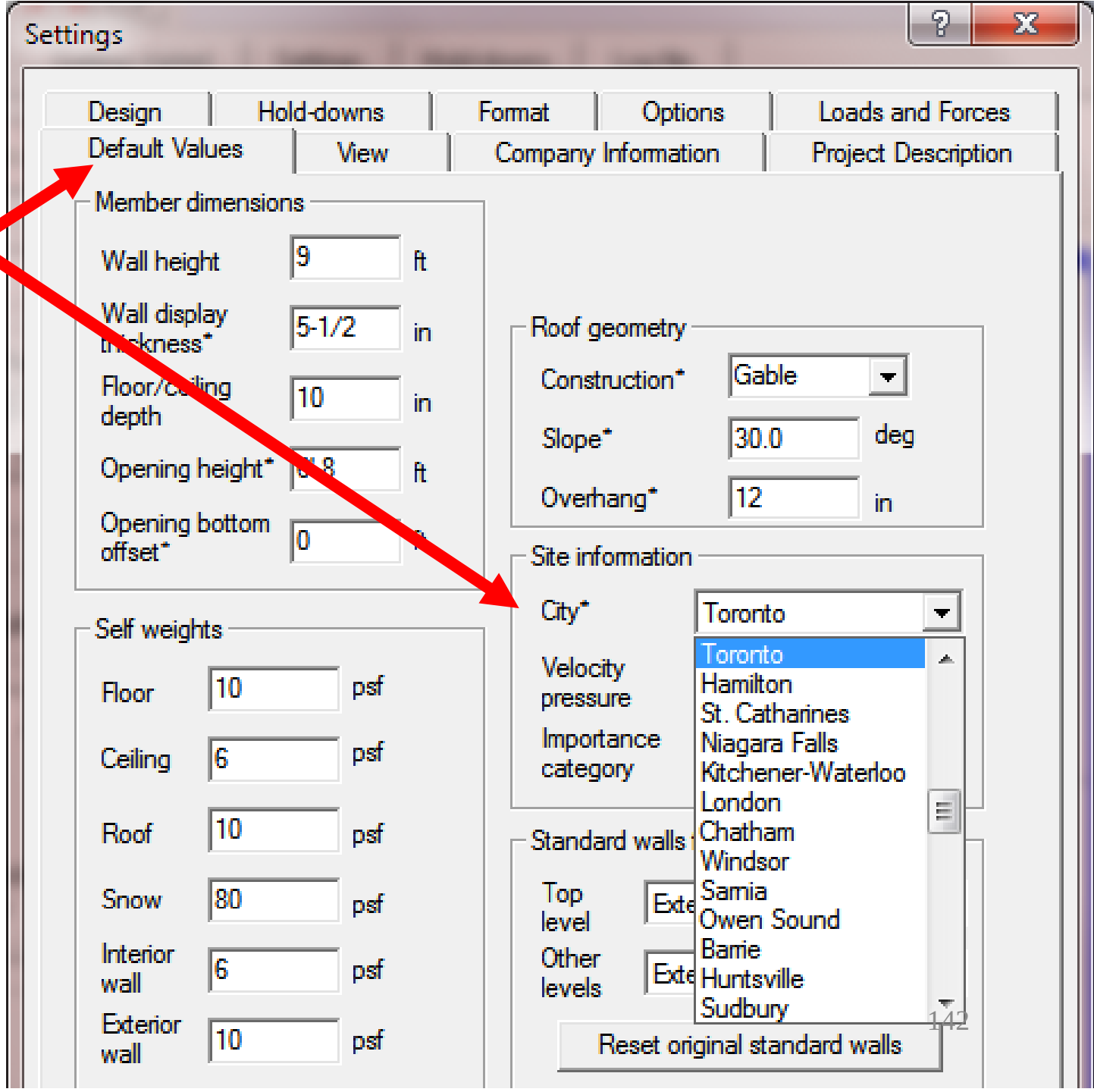
Default: wood sheathed, no GWB

Site class (soil) (geotech report)

Spectral accelerations automatic based on geographic location (climatic data)



SHEARWALLS


Settings
Design
Hold-downs
Format
Options
Loads and Forces
Default Values
View
Company Information
Project Description
Member dimensions
Wall height
9
ft
Wall display thickness*
5-1/2
in
Floor/Ceiling depth
10
in
Opening height*
ft
Opening bottom offset*
0
Self weights
Floor
10
psf
Ceiling
6
psf
Roof
10
psf
Snow
80
psf
Interior wall
6
psf
Exterior wall
10
psf
Roof geometry
Construction*
Gable
Slope*
30.0
deg
Overhang*
12
in
Site information
City*
Toronto
Velocity pressure
Importance category
Toronto
Hamilton
St. Catharines
Niagara Falls
Kitchener-Waterloo
London
Chatham
Windsor
Samia
Owen Sound
Barrie
Huntsville
Sudbury
Standard walls
Top level
Other levels
Reset original standard walls

Seismic and Wind design data

Table C-2 (Continued)

Province and Location	Moist. Index	Ann. Tot. Ppn., mm	Driving Rain Wind Pres-sures, Pa, 1/5	Snow Load, kPa, 1/50		Hourly Wind Pressures, kPa		Seismic Data[1]			
				S_s	S_r	1/10	1/50	$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$
Timmins (Porcupine)	0.75	875	100	2.9	0.3	0.29	0.37	0.16	0.094	0.056	0.018
Toronto Metropolitan Region											
Etobicoke	0.80	800	160	1.1	0.4	0.34	0.44	0.21	0.12	0.065	0.021
North York	0.82	850	150	1.2	0.4	0.34	0.44	0.19	0.11	0.066	0.021
Scarborough	0.87	825	160	1.2	0.4	0.36	0.47	0.19	0.11	0.068	0.022
Toronto (City Hall)	0.86	820	160	0.9	0.4	0.34	0.44	0.22	0.13	0.067	0.021

Seismic hazard values

Natural Resources Canada | Ressources naturelles Canada

Canada

2010 National Building Code of Canada seismic hazard calculator

Latitude	Longitude
45:24	-75:41 longitudes in Canada should be entered as negative values
Number of closest points for interpolation	Parameter to display on map (values for all 5 parameters will be determined)
7 points	Sa (0.2)
Enter location place name	Type of structure
Ottawa	
Company/Organiza	
CWC	
Calculate	

Site Coordinates: **45.4** °N **75.6833** °W
User File Reference: **Ottawa**
Requested by: **Rob Jonkman, CWC**

National Building Code interpolated seismic hazard values
~~2%/50 years (0.000404 per annum) probability~~

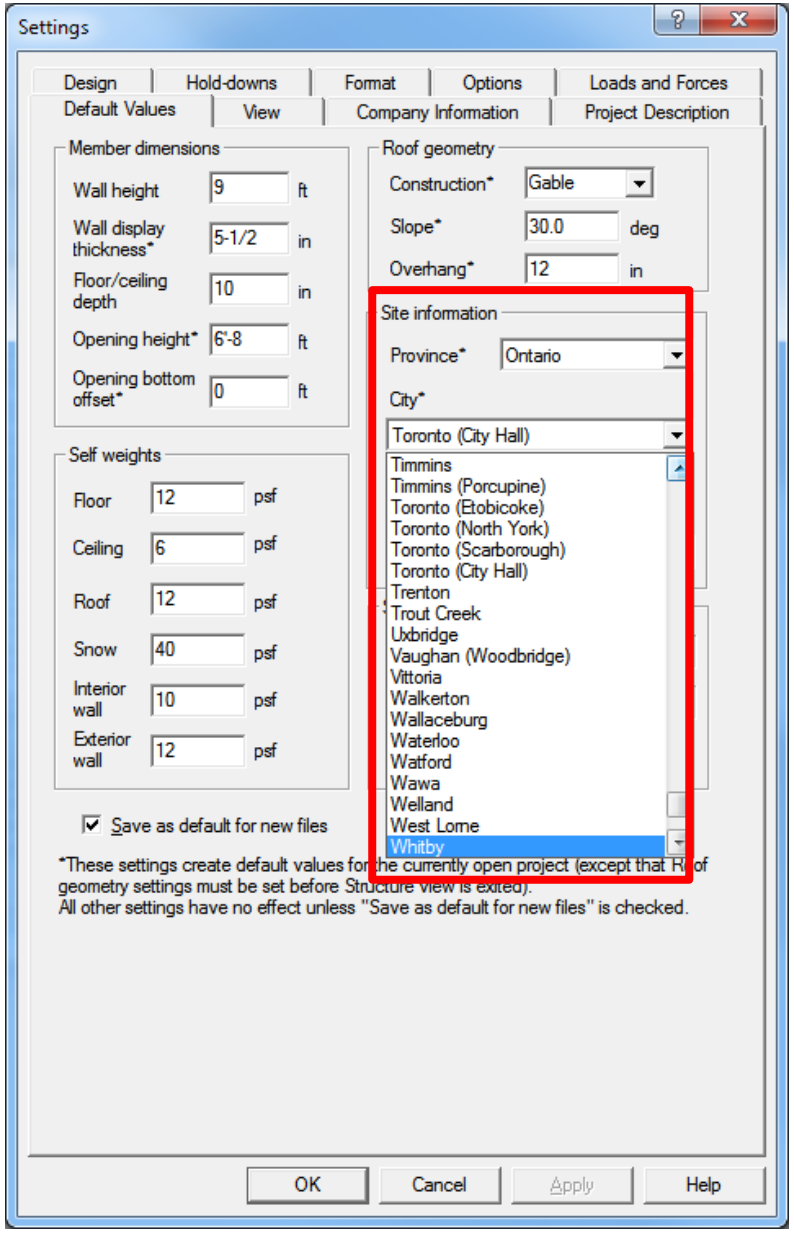
Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA	
0.635	**0.309**	**0.138**	**0.046**	**0.324**	g

$S_a(T)$: Ottawa

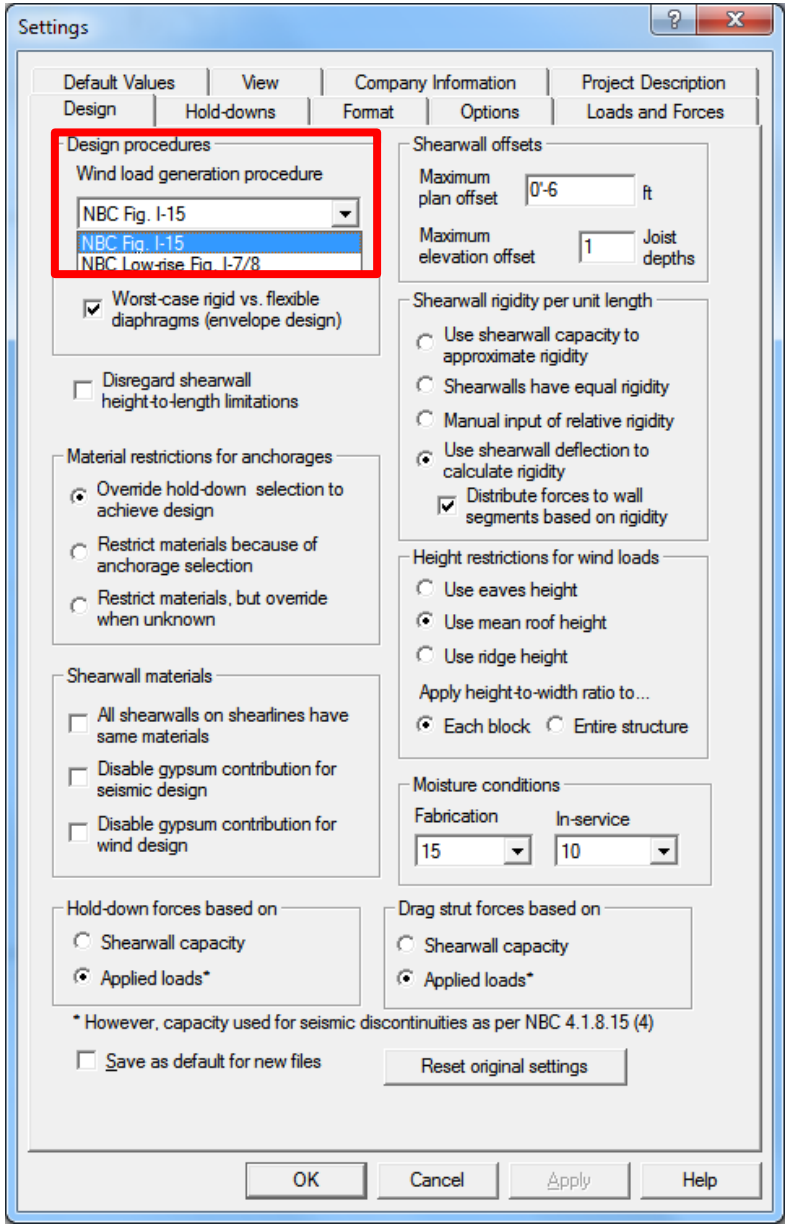
http://earthquakescanada.nrcan.gc.ca/hazard/interpolator/index_e.php

In most cases, its very easy…:

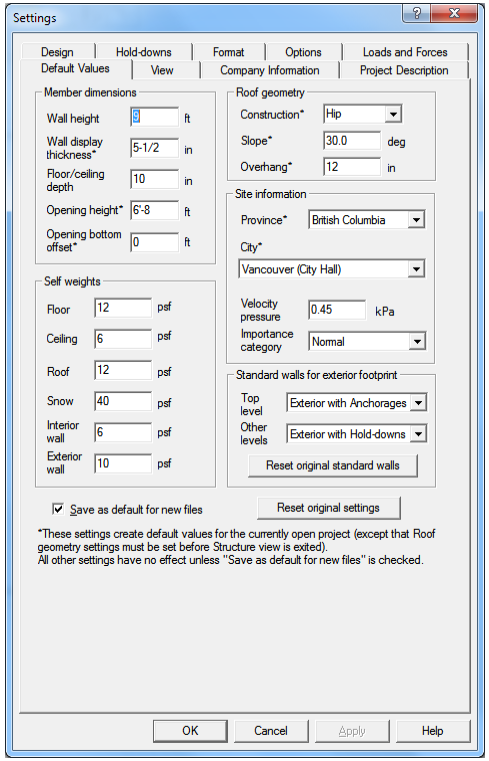
1. Pick City:



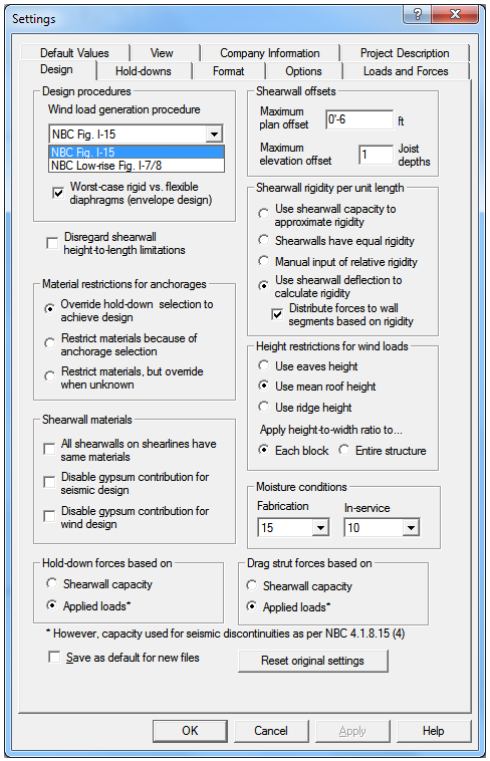
2. Pick Wind generation procedure:



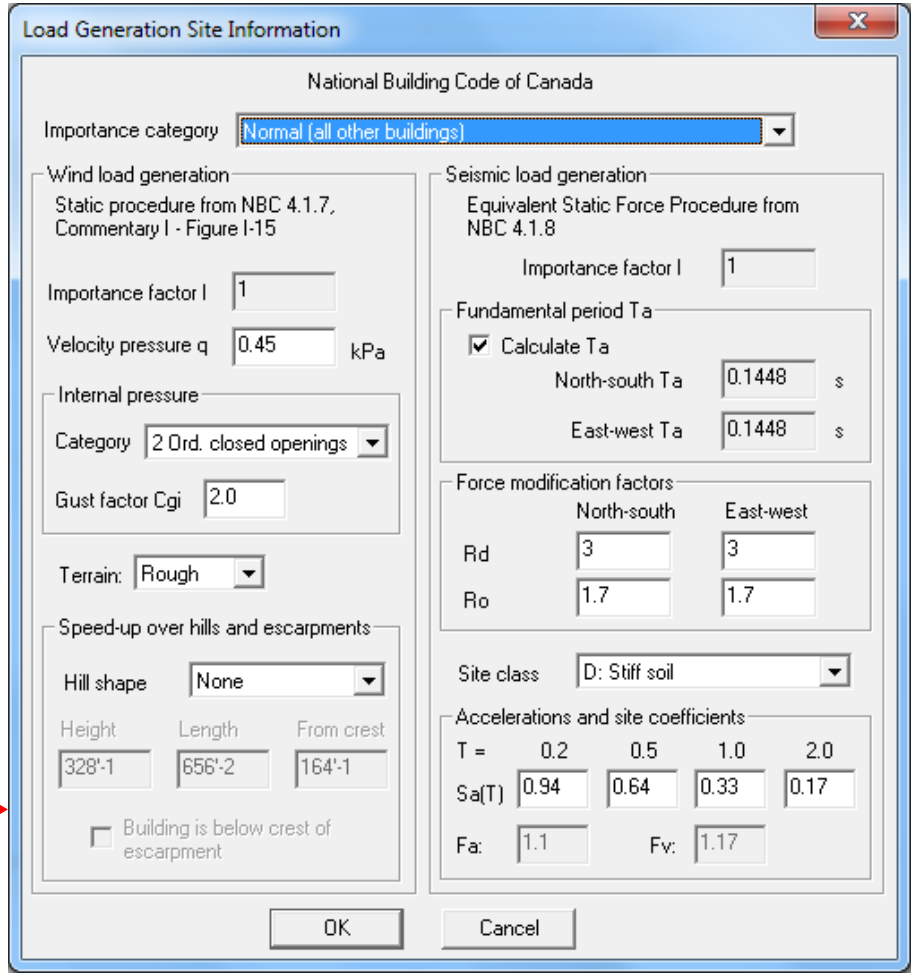
1. Pick City



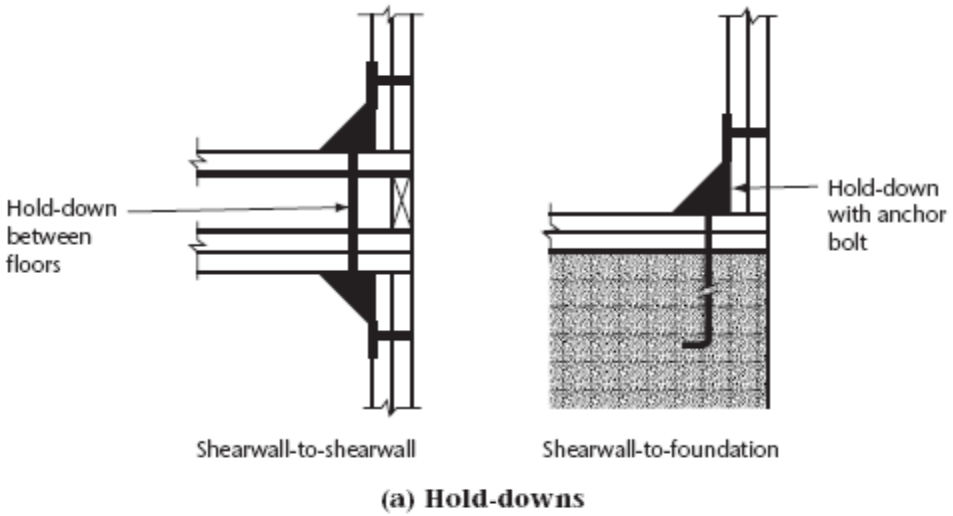
2. Pick wind procedure



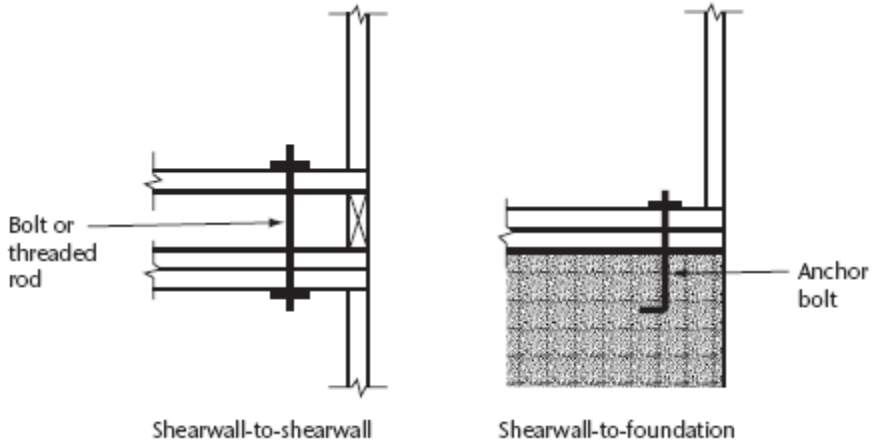
3. Pre-populated wind and seismic info



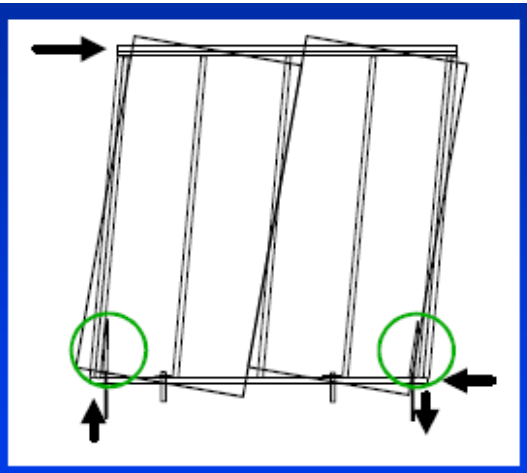
Hold-downs and Anchorages



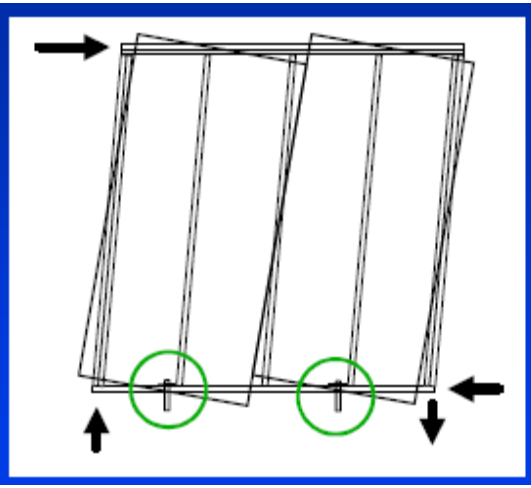
(a) Hold-downs



- Hold downs resist overturning

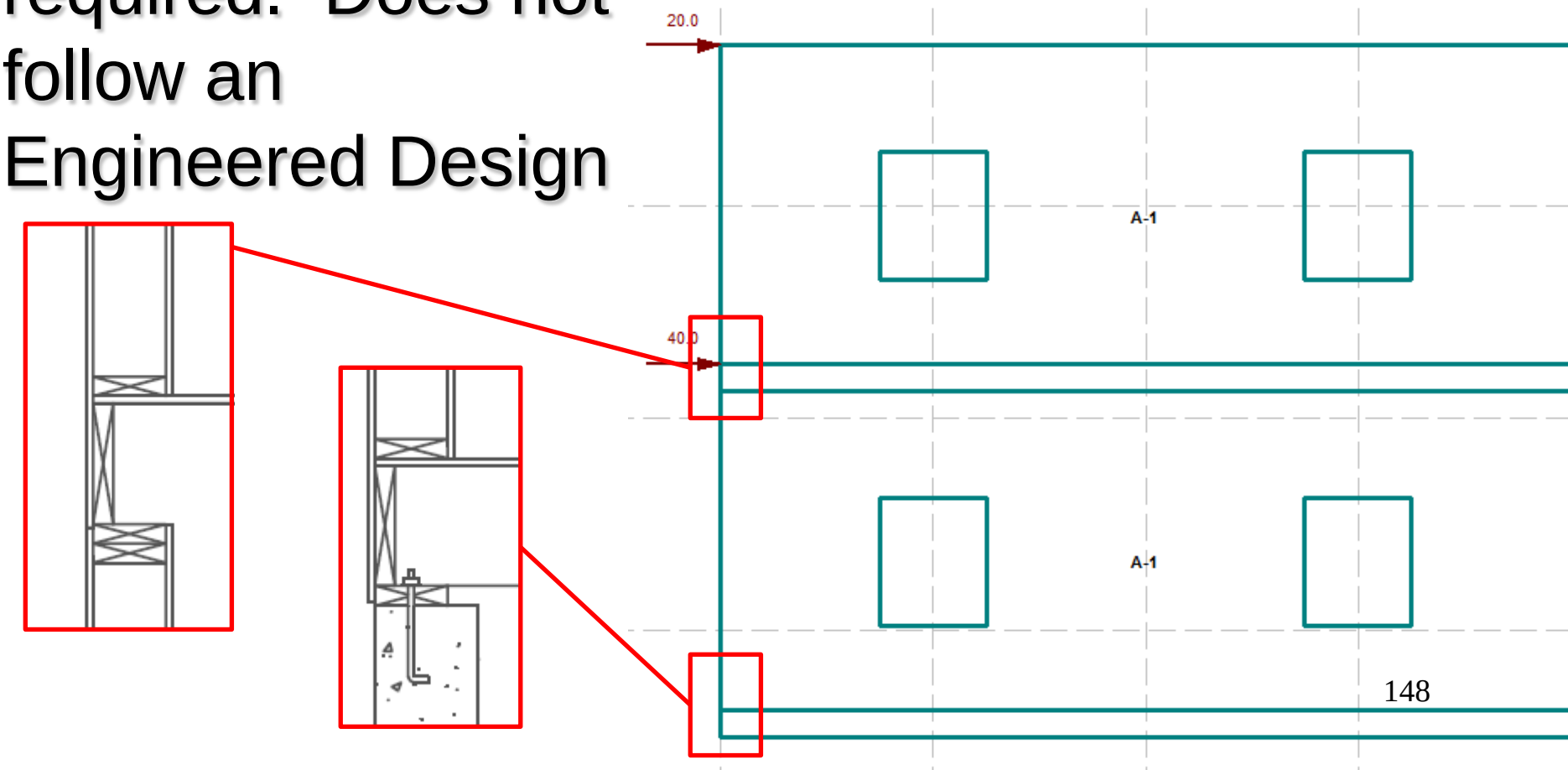


- Anchor bolts resist base shear

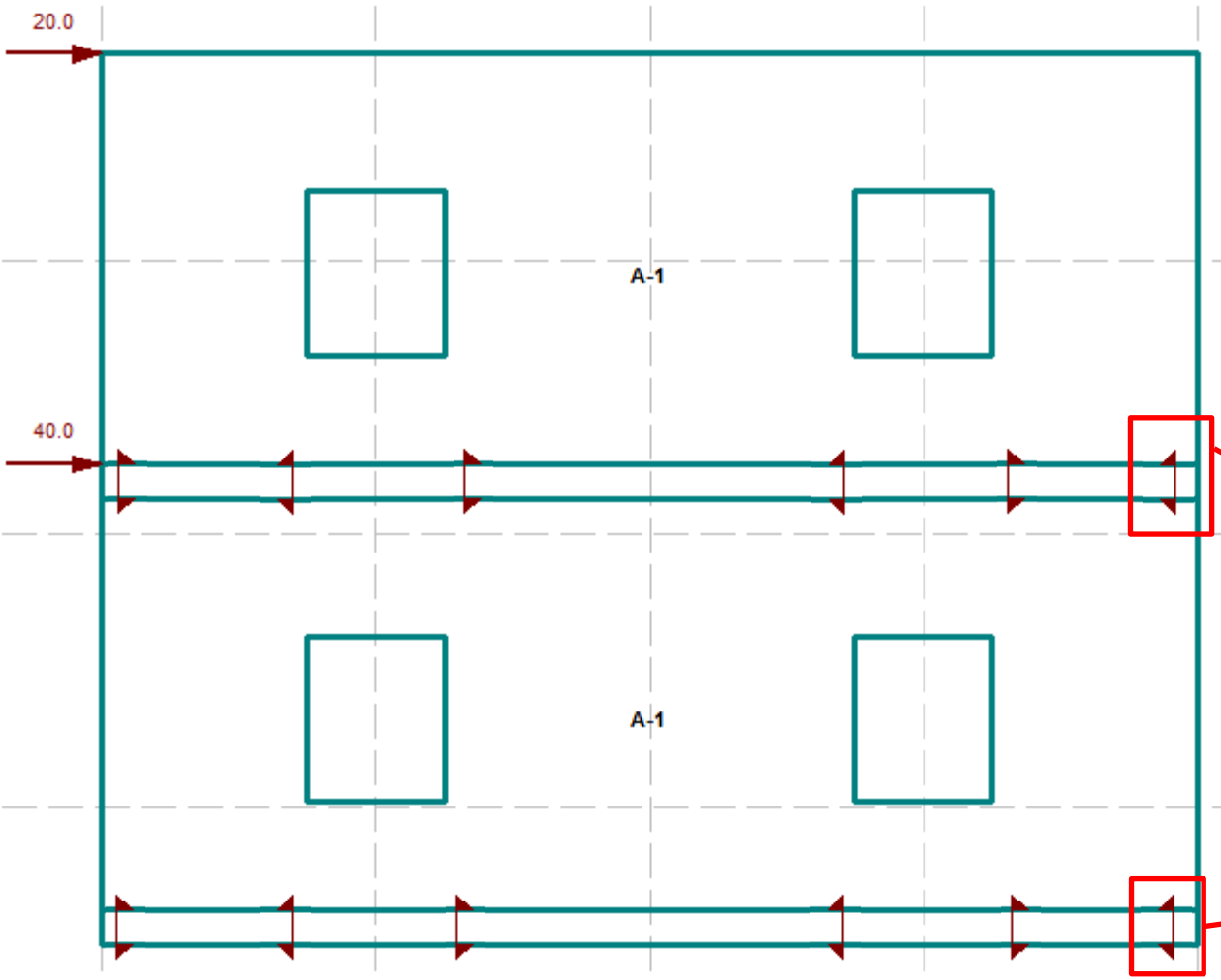


Typical light-frame Wood Building Designed Following Part 9 of the NBC (Prescriptive Design)

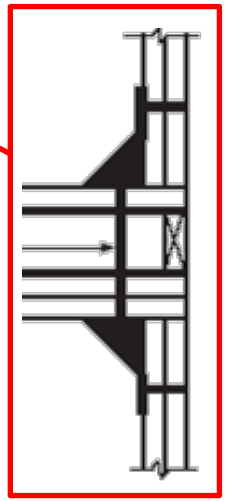
No Hold-downs required. Does not follow an Engineered Design

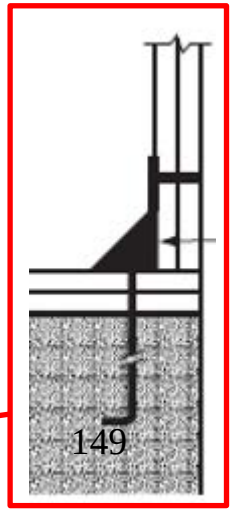


Typical light-frame Wood Building Designed Following Part 4 of the NBC (Engineered Design)



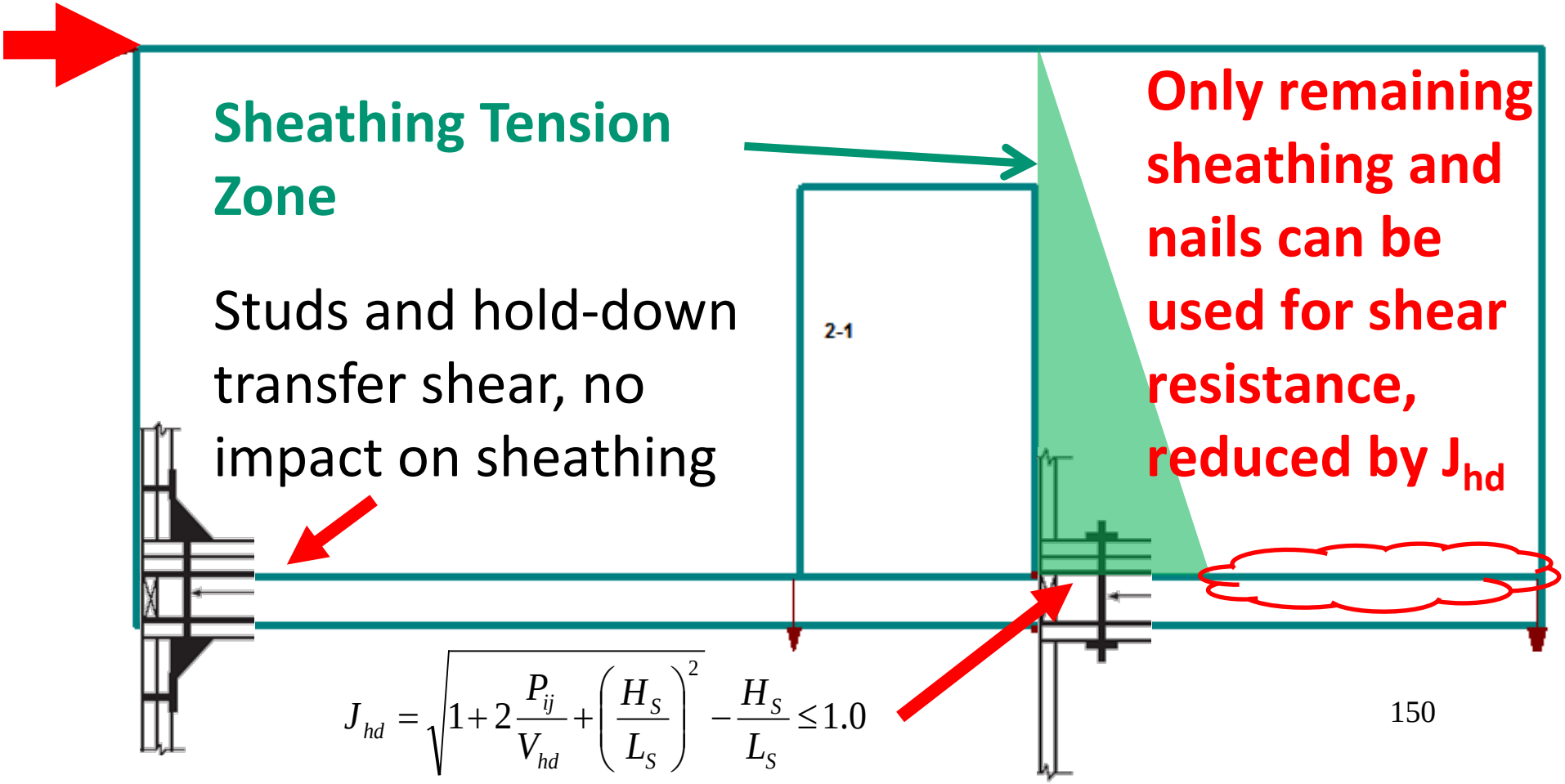
Hold-downs on each Segment (Jhd=1.0)



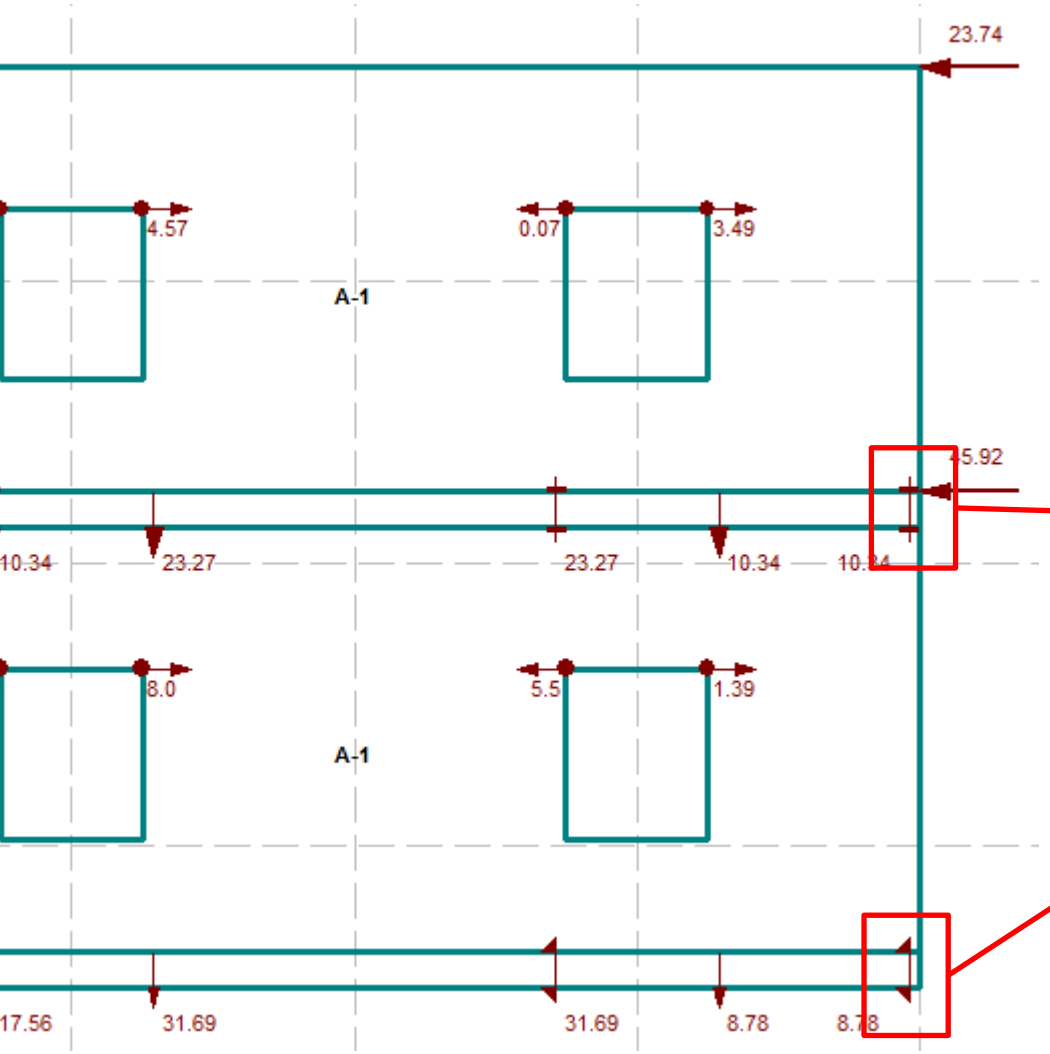


Shearwall Segments Without Hold-downs

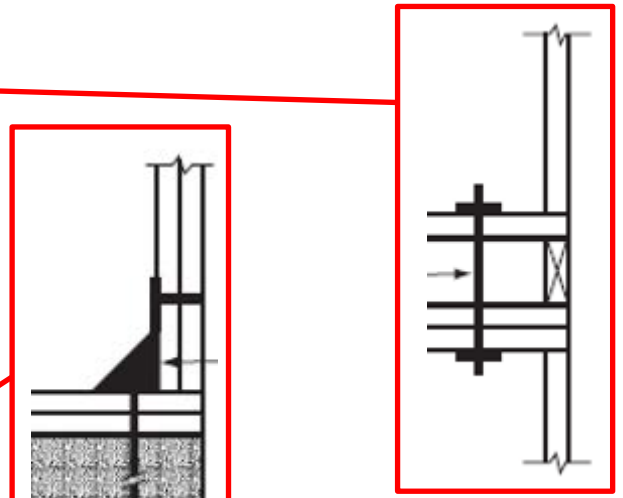
- **Nails resist overturning**
- **Overturning tension force is resisted by the sheathing**

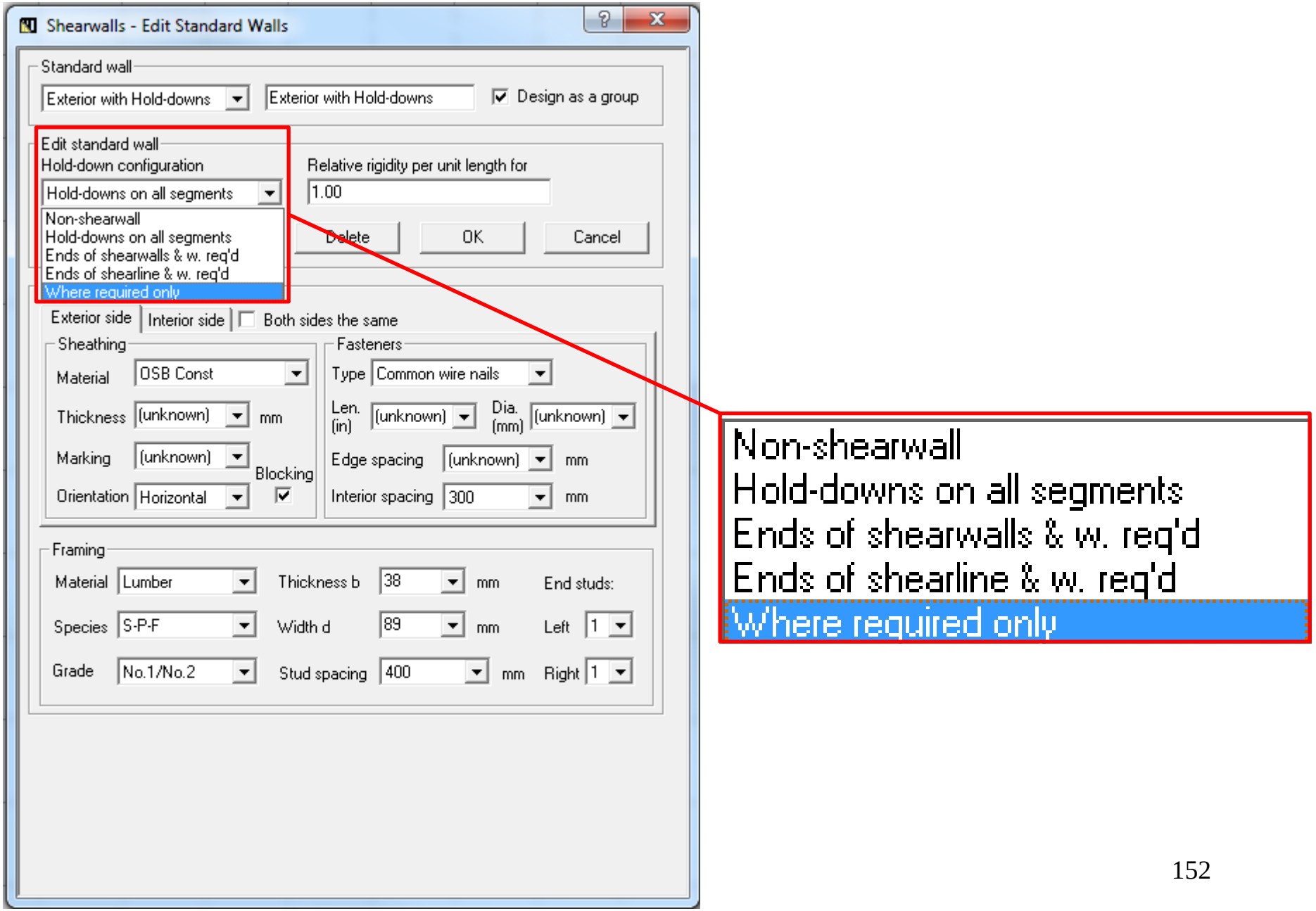


Typical light-frame Wood Building Designed Following Part 4 of the NBC (Engineered Design)



Hold-downs where required or replaced by anchorage (Jhd<1.0)





Non-shearwall
Hold-downs on all segments
Ends of shearwalls & w. req'd
Ends of shearline & w. req'd
Where required only

File Edit Settings... Action View Window Help

Design | Format | Options | Loads and Forces

Default Values | View | Company Information | Project Description

Wall dimensions

Wall height: 8 ft

Wall thickness*: 5-1/2 in

Floor/ceiling depth: 10 in

Opening height*: 6'-8 ft

Opening bottom offset*: 0 ft

Hold-downs

Hold-down offset*: 1.5 in

Roof geometry

Construction*: Gable

Slope*: 30.0 deg

Overhang*: 12 in

Site information

City*: Vancouver

Velocity pressure: 0.48 kPa

Importance category: Normal

Self weights

Floor: 10 psf

Ceiling: 6 psf

Roof: 10 psf

Snow: 10 psf

Interior wall: 6 psf

Exterior wall: 10 psf

Standard walls

Top level: Exterior with Anchorages

Other levels: Exterior with Hold-downs

Reset original standard walls

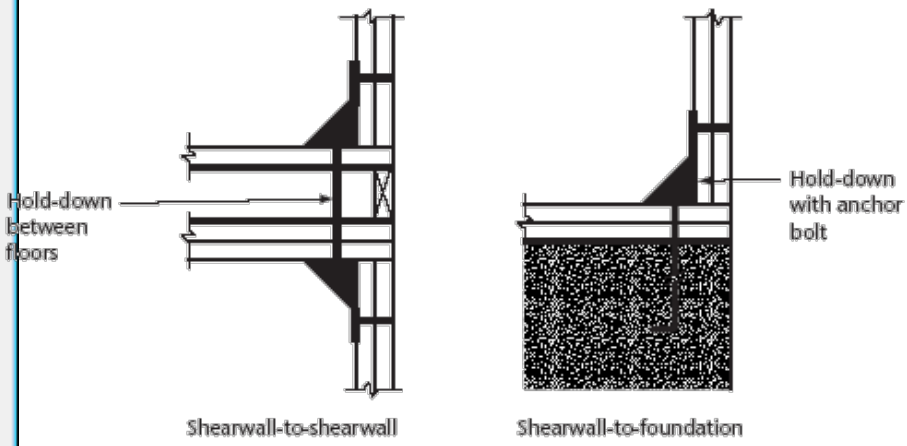
Save as default for new files

Reset original settings

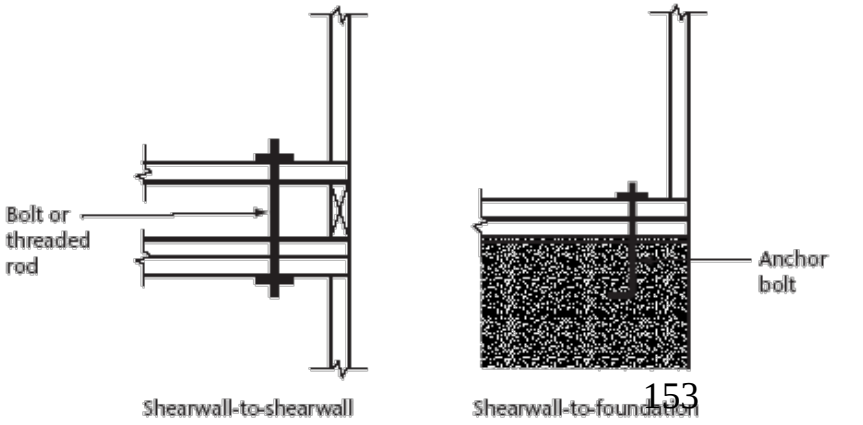
*These settings create default values for the currently open project (except that Roof geometry settings must be set before Structure view is exited).
All other settings have no effect unless "Save as default for new files" is checked.

OK Cancel Apply

Design with or without hold downs…



(a) Hold-downs



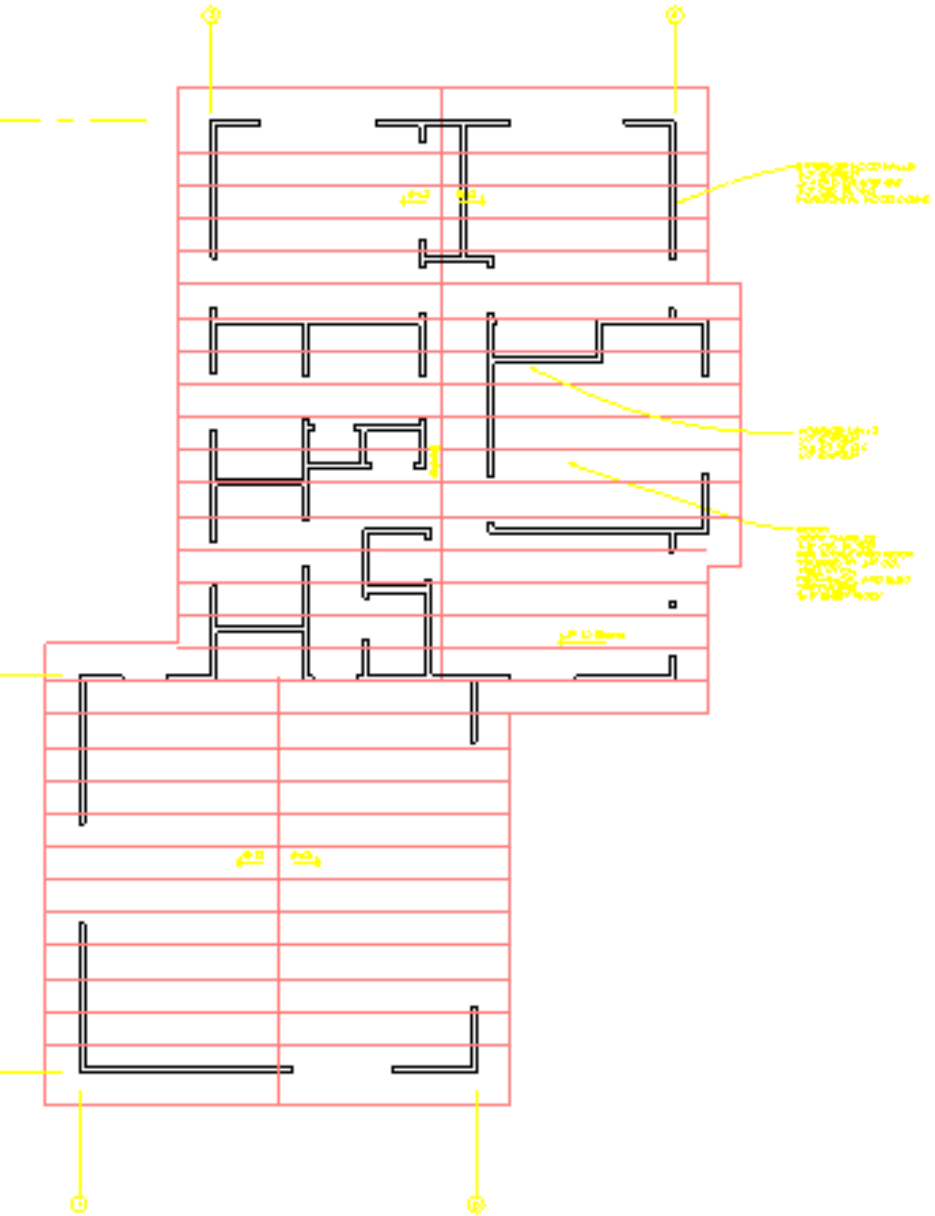
(b) Anchorages

Getting to Know WoodWorks Shearwalls:

Step-by-Step Demo

March 25, 2015

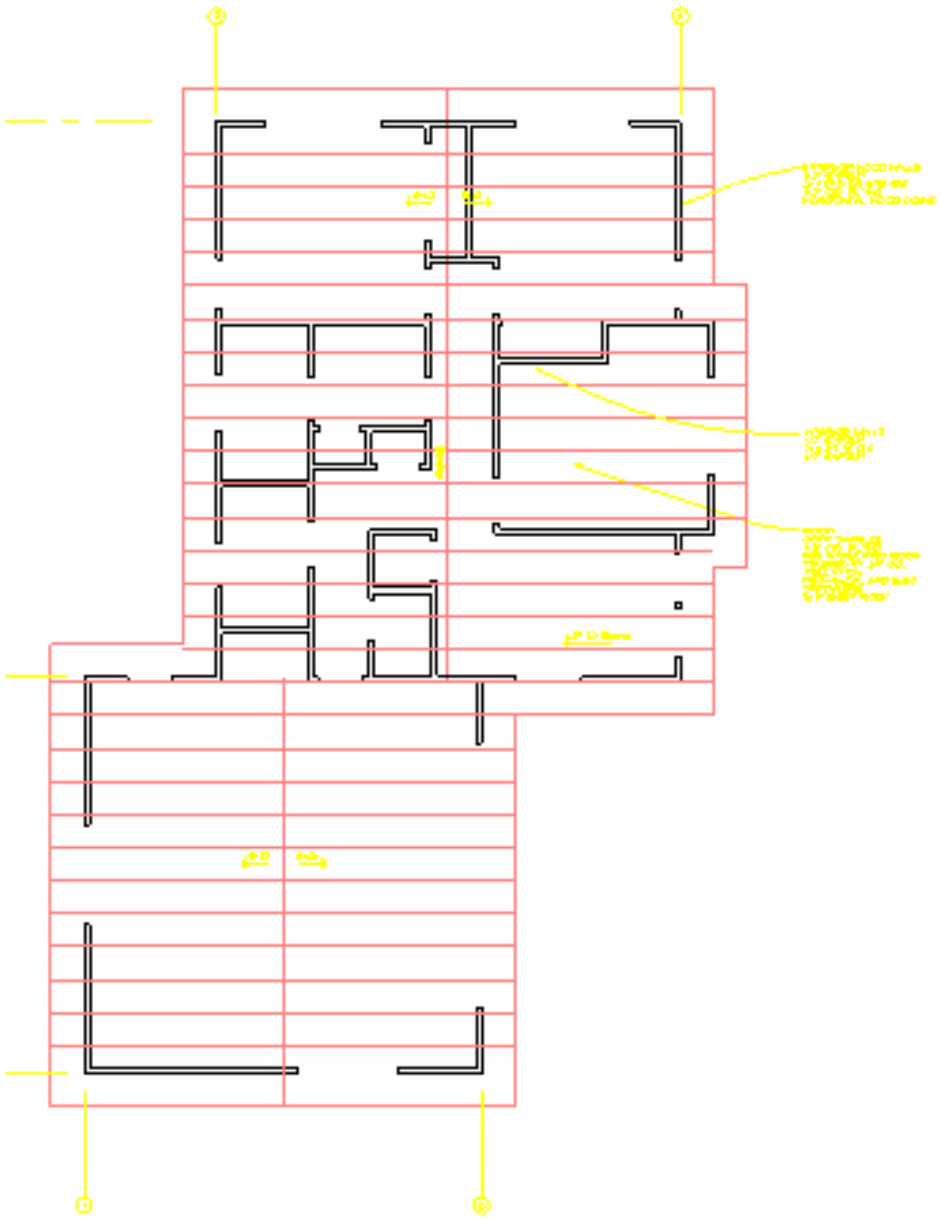
Adam Robertson, M.A.Sc., P.Eng.
Technical Support
support@woodworks-software.com
1.800.844.1275



WoodWorks®
SOFTWARE FOR WOOD DESIGN

Demo learning points

- File import
- Create shearwalls
- Add openings
- Break shearlines and shift walls
- Lateral wind, C&C wind, and seismic load: automatic generation
- Basic design output and log files



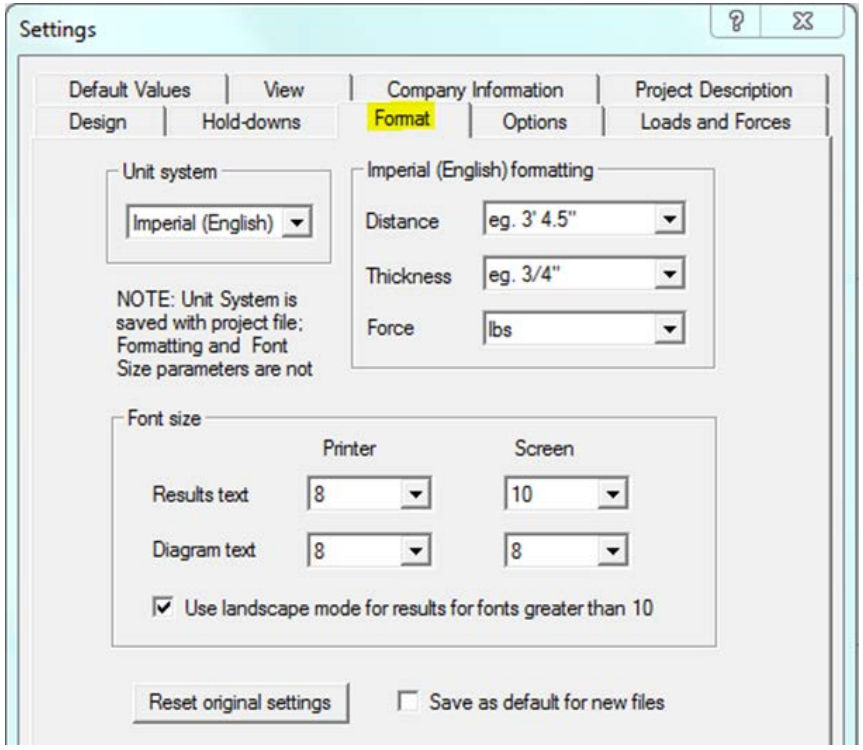
Provided with:

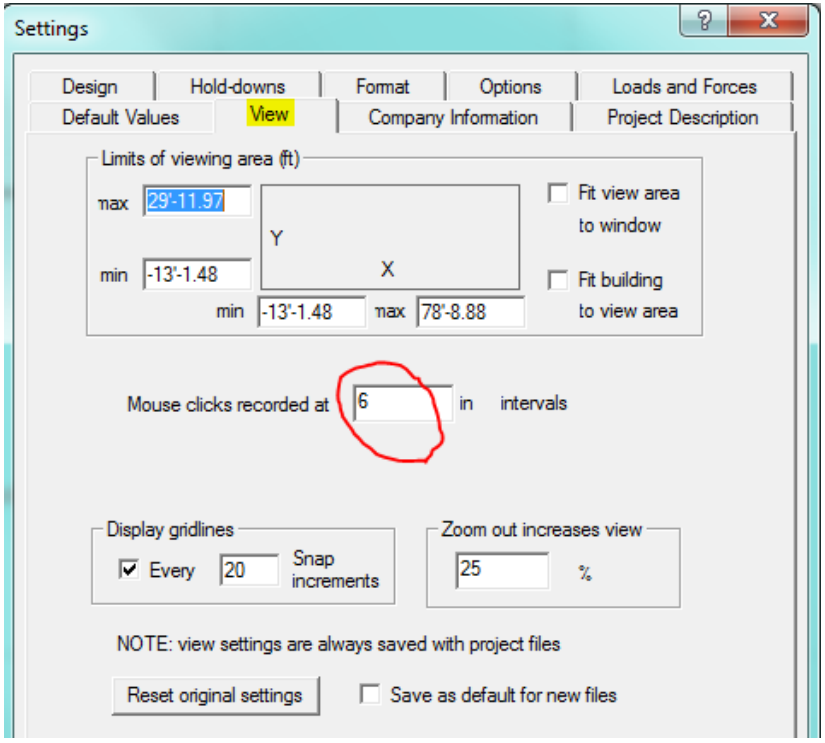
1) example_CAD.pdf

2) Shearwalls_example.wsw

Settings

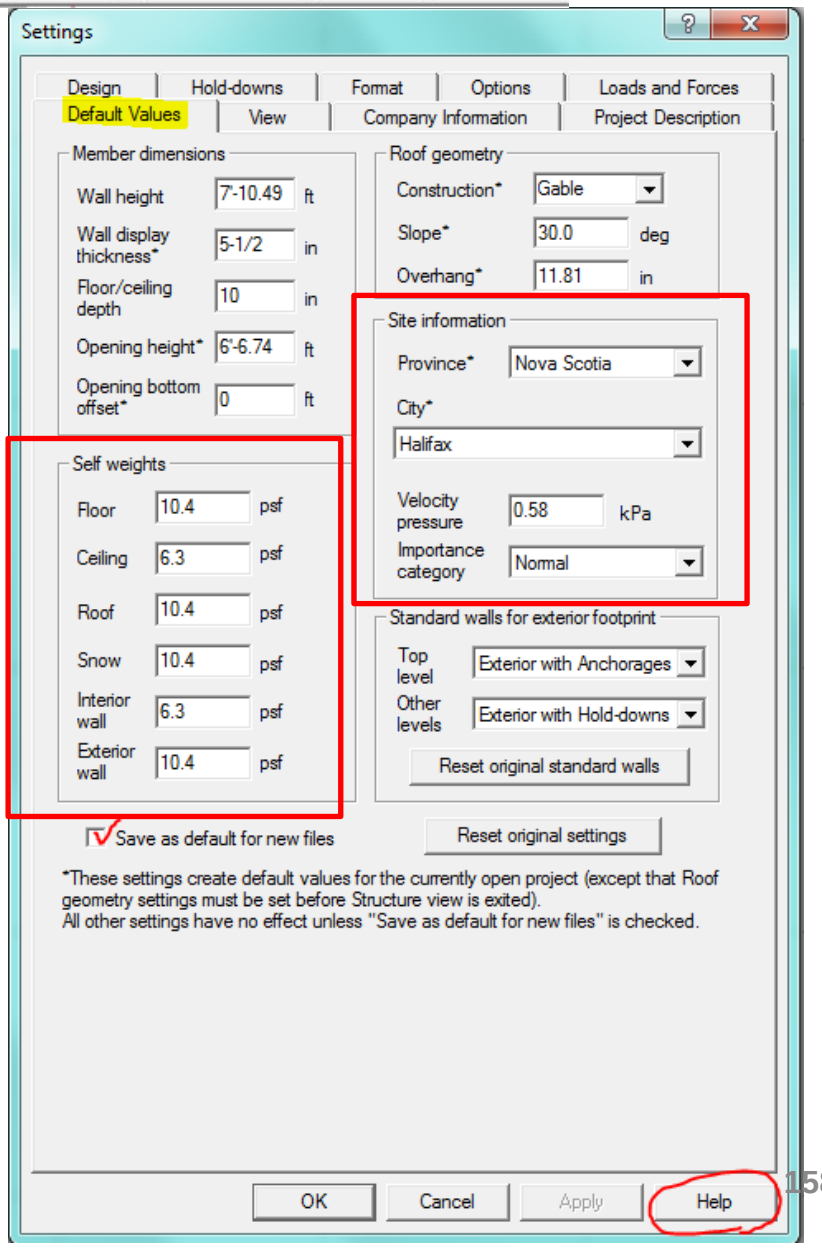
- Default is metric units
  - Click OK to take effect
- Snap increment
  - Should be a whole number





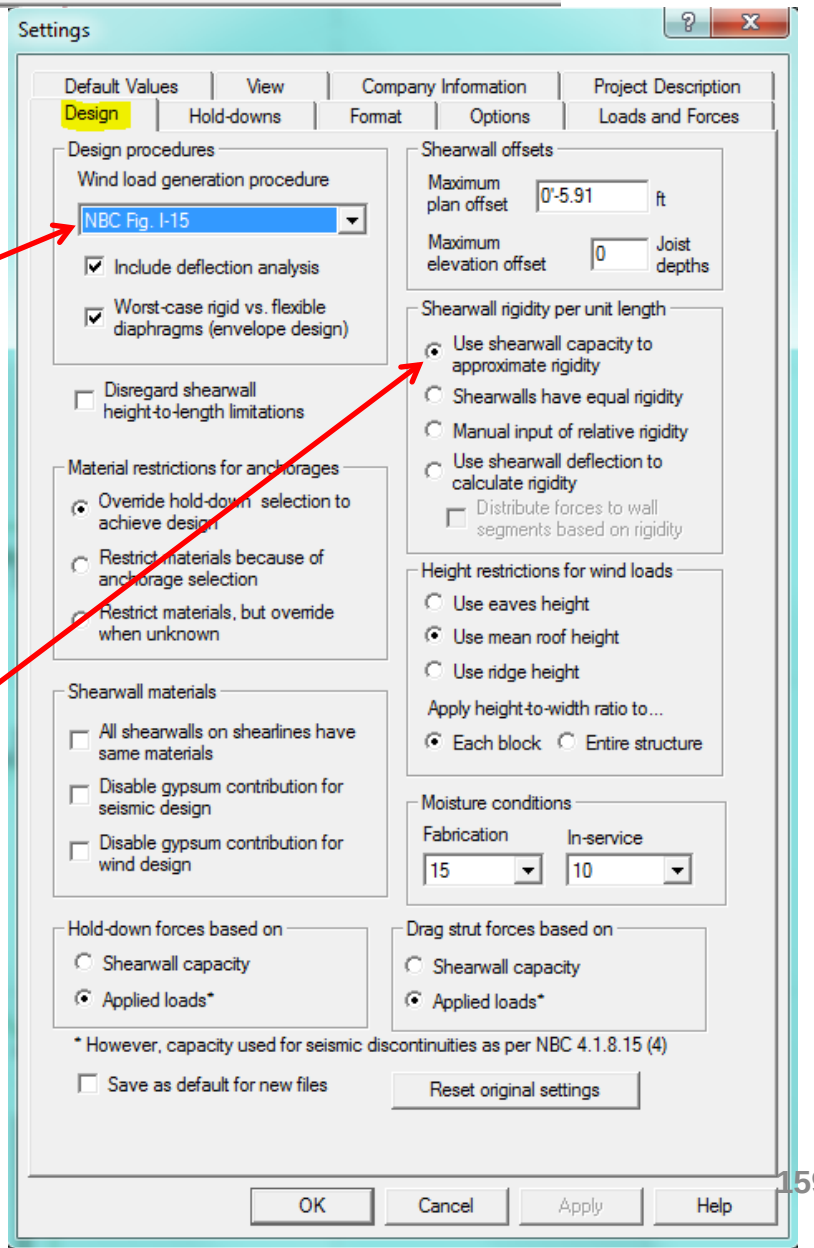
Settings

- Default Values
  - Site Location to populate wind and seismic values
  - Self weights used to calculate seismic base shear
  - All default values can be tailored and toggled manually at other input points as you build a specific model



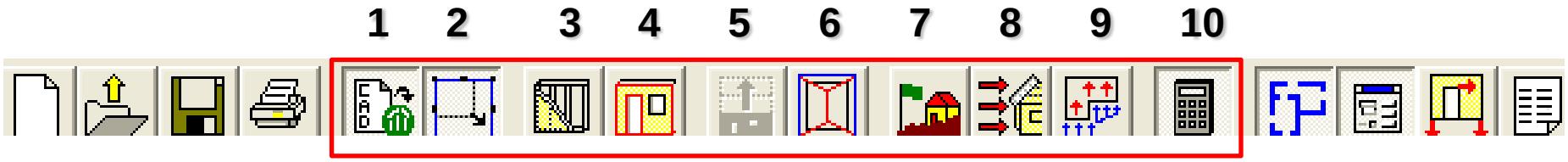
Settings

- Design analysis
  - NBCC wind design figure
  - Anchorage restrictions
  - Disable gypsum contribution
  - Moisture conditions
  - Shearwall offsets
  - Calculation of rigidity
  - Building height
  - Forces for hold-down & drag strut design

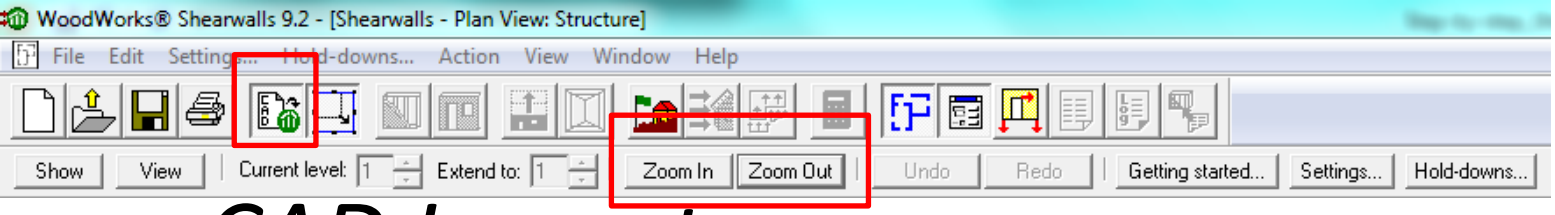


File Edit Settings... Action View Window Help

Action menu and toolbar shortcuts

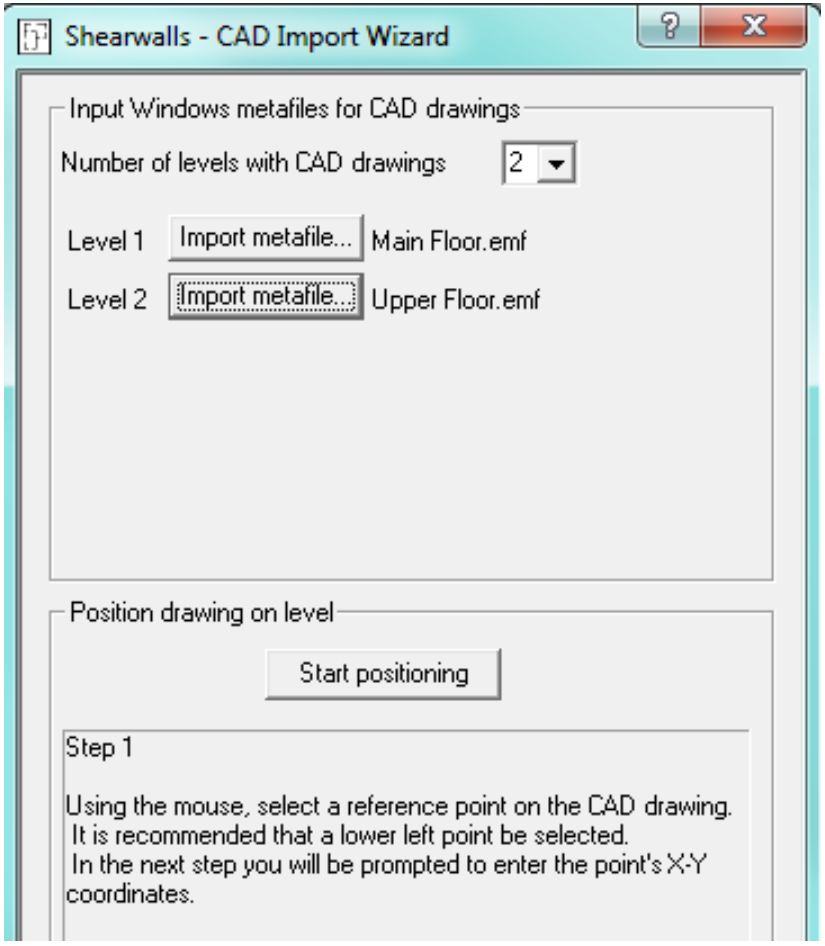


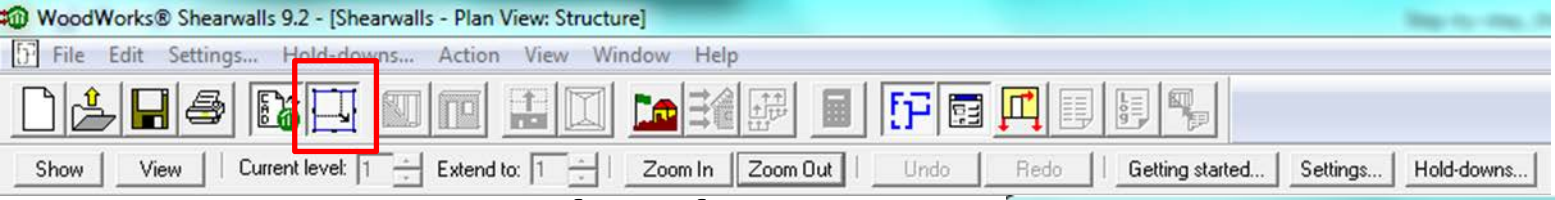
1. Import CAD drawing as template (optional)
2. Draw block(s) around outline of building, include number of storeys
3. Wall definition
4. Opening definition
5. Extend openings upwards
6. Roof
7. Site information
8. Generate loads based on site information
9. Manually input loads
10. Run design



CAD Import

1. Specify # of levels
2. Export metafile (.pdf, .emf, .wmf, .bmp) for each level from CAD & import each level
3. Select “Start positioning”
4. Use Zoom controls to place crosshairs on CAD drawing
5. Input (x,y) coordinates & distances

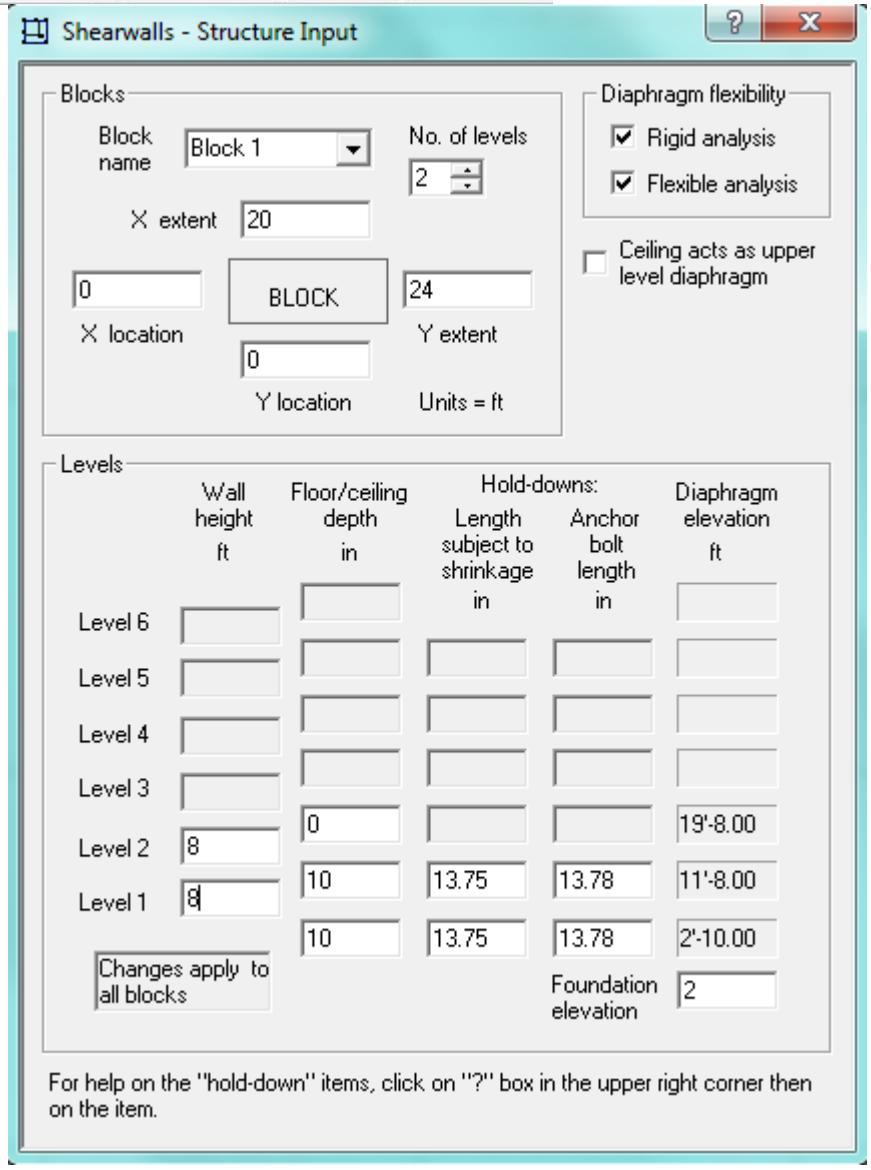


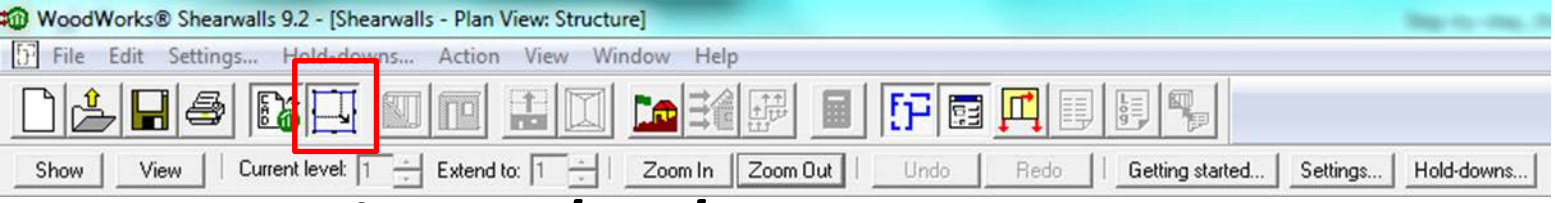


WoodWorks® SOFTWARE FOR WOOD DESIGN

Creating Blocks

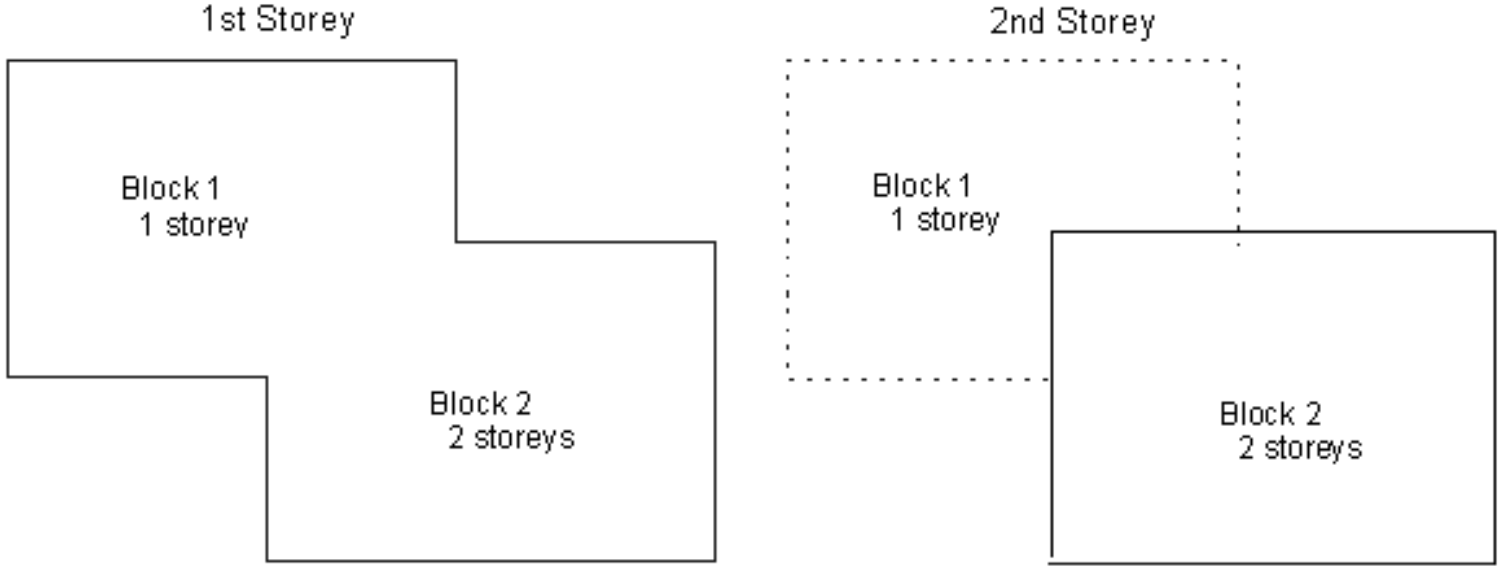
- Used to distinguish building sections of dissimilar height (i.e. # of floors)
- Walls can be created & moved within a block
- Walls can later be created outside a block
- Each block is associated with a single roof type





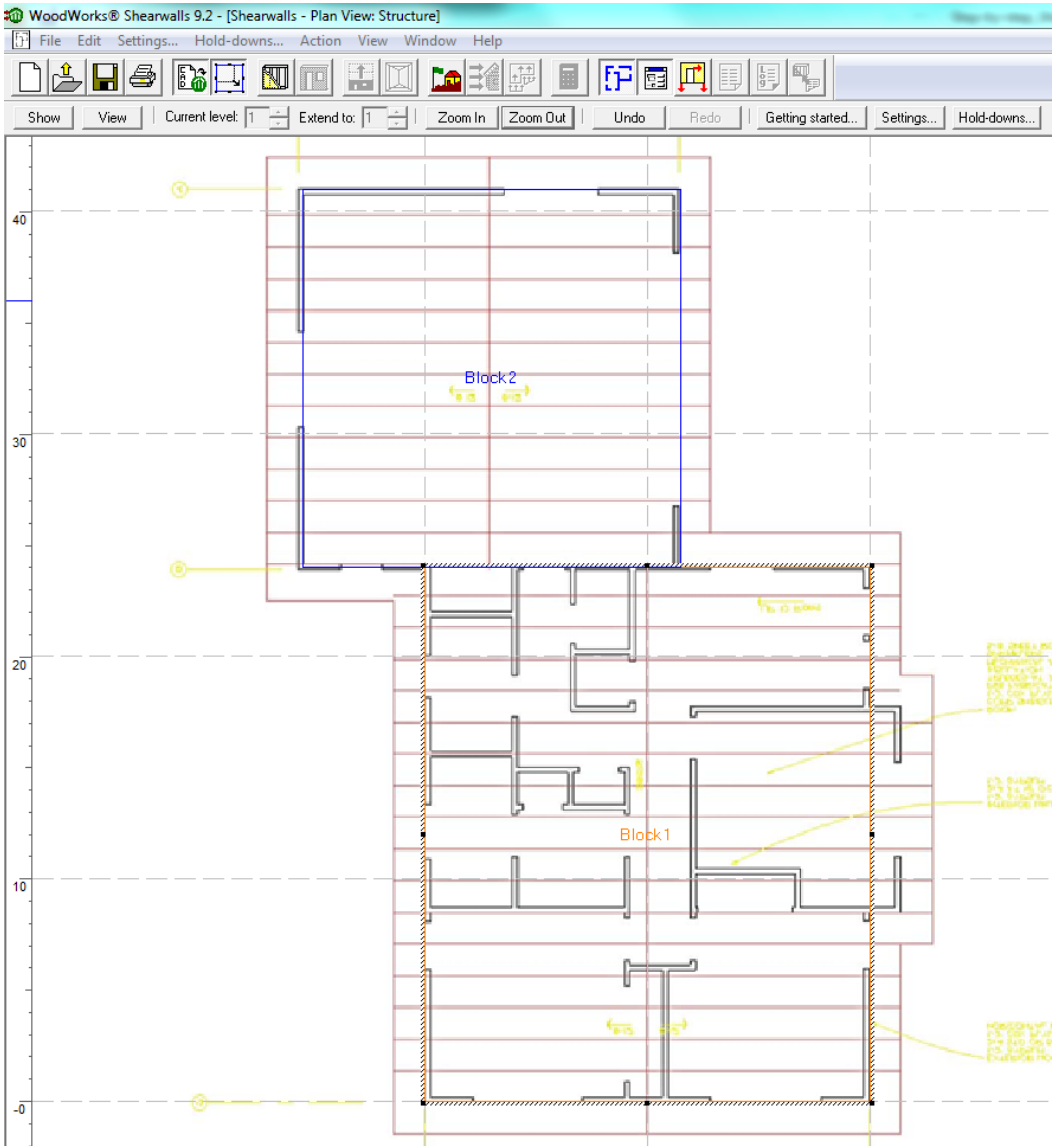
Creating Blocks

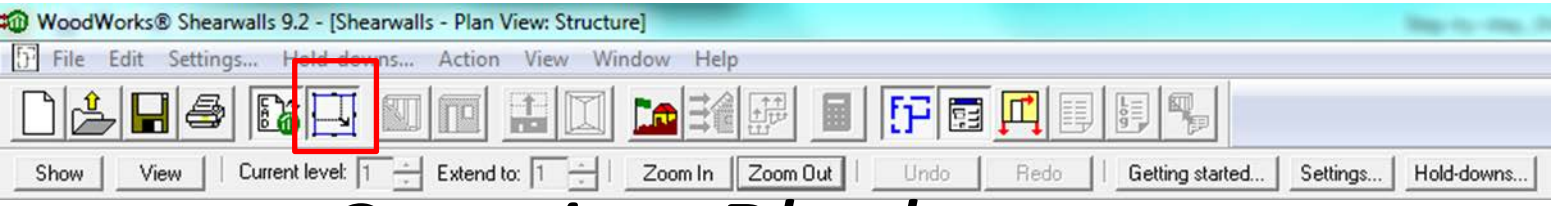
- Only exterior walls are associated with a block and will be extended upwards
- Interior walls must be created at each level (for overlapping blocks)



Creating Blocks

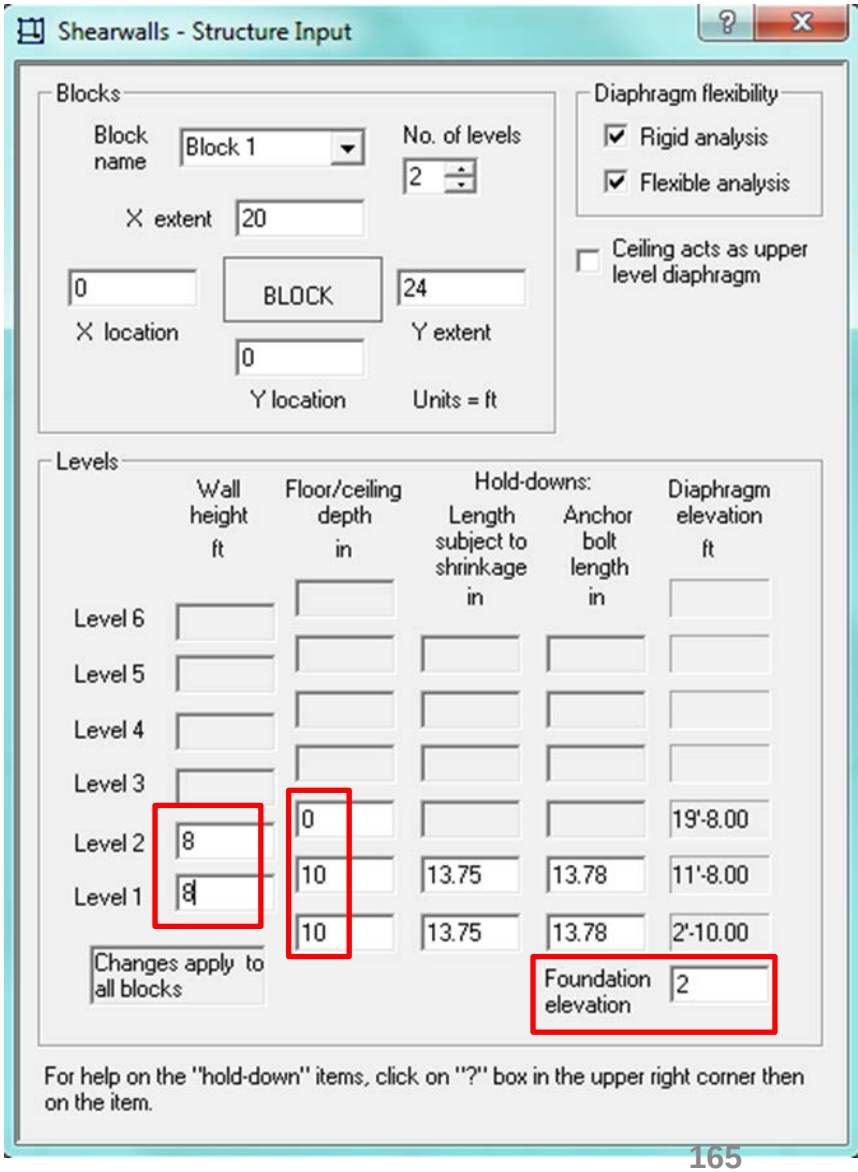
- Individual roof blocks can be added later





Creating Blocks

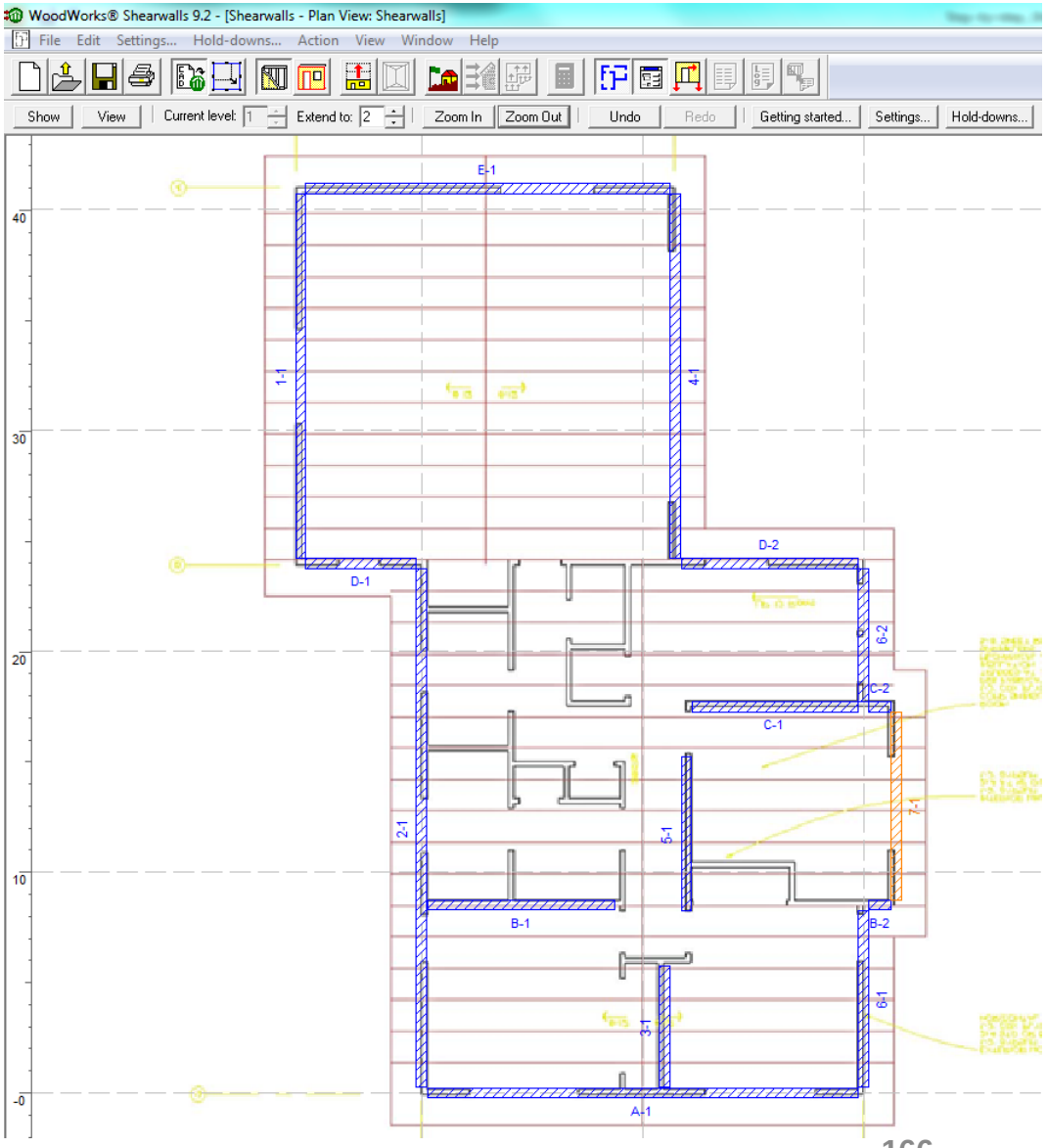
- Change wall height to 8 ft for Level 1 and Level 2
- Floor/ceiling depth = 10 in.
- Revise foundation elevation to 2 ft. above grade

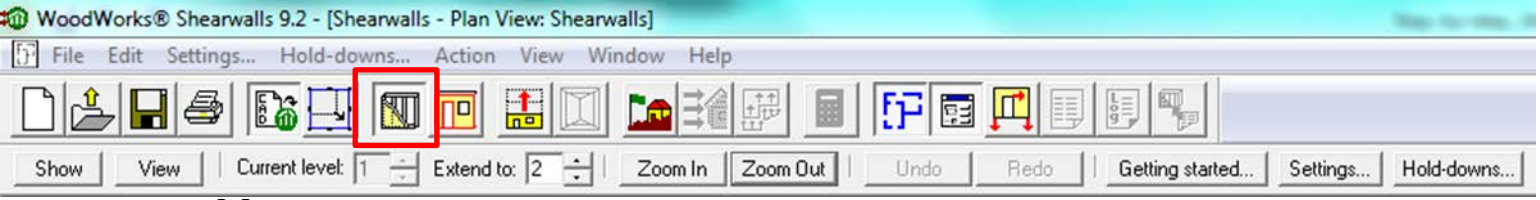


WoodWorks® SOFTWARE FOR WOOD DESIGN

Creating Walls

- Layout shearwalls over CAD plan view
- Break walls: left-click within wall, hold and drag along wall, release
- Shift walls: Hover cursor over a wall, press shift, left-click, hold and drag, release
- Create interior walls: left-click, hold and drag, release

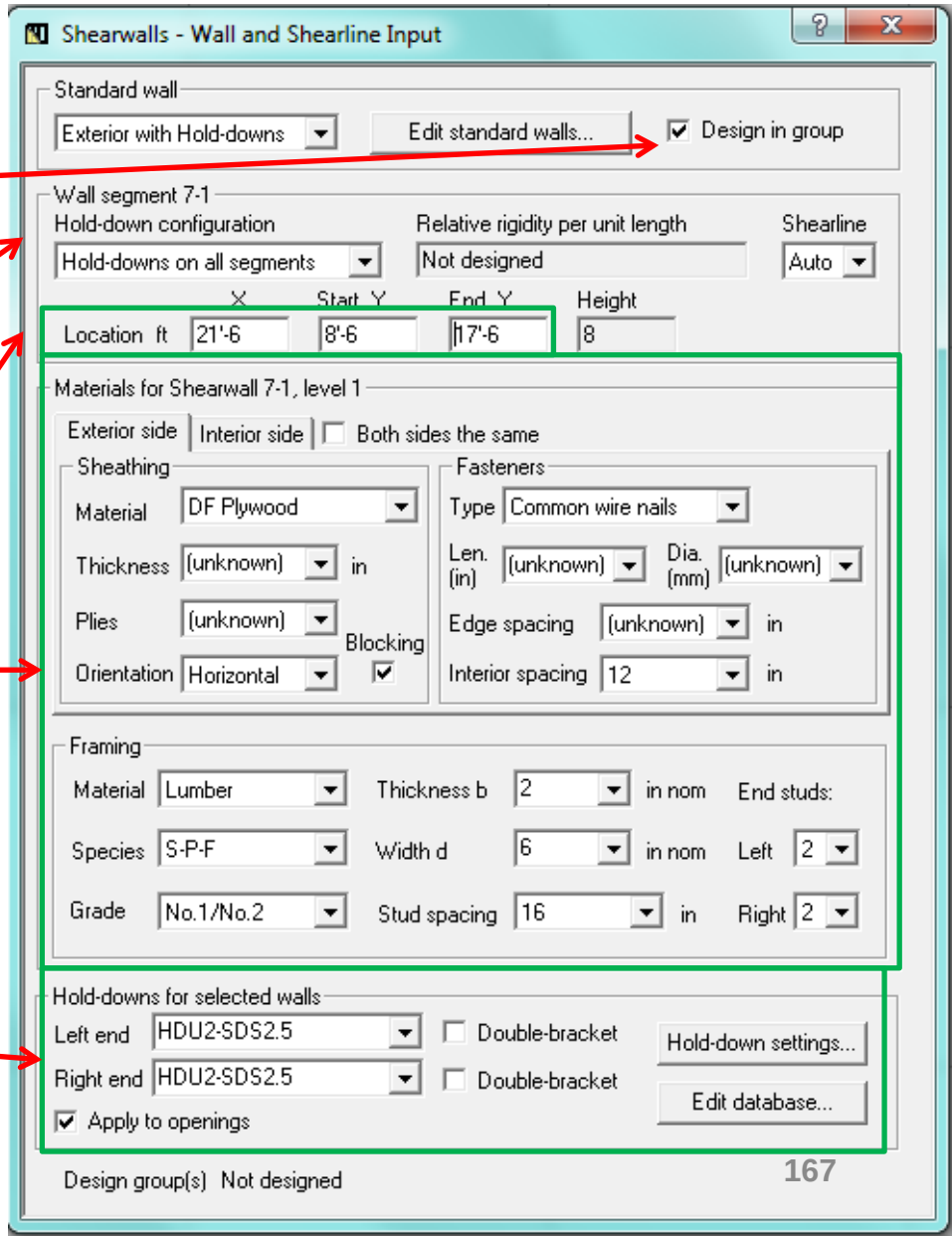




WoodWorks® SOFTWARE FOR WOOD DESIGN

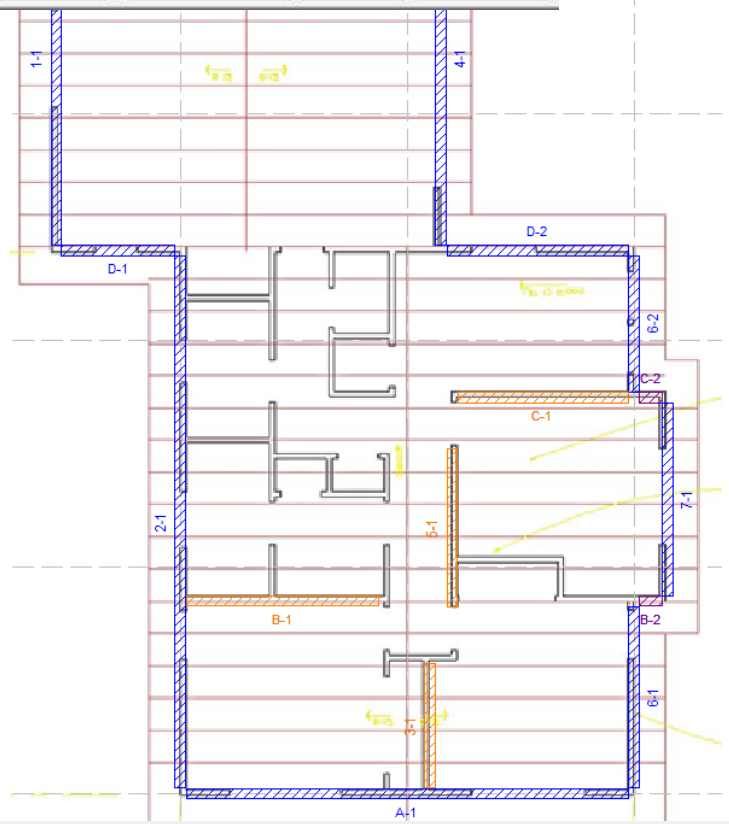
Wall Construction

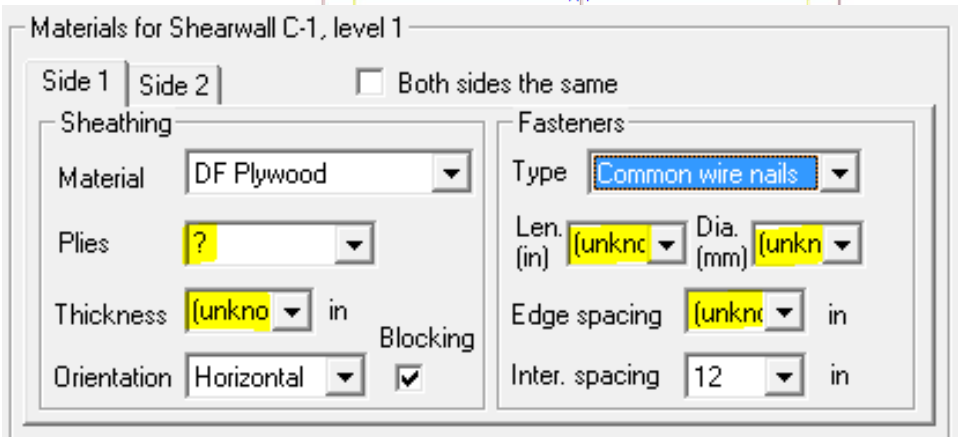
- Design in group
- Hold-downs (J_{hd} = 1.0) vs. anchorages (J_{hd} < 1.0)
- Adjust exact wall length & location
- Select sheathing, nailing & framing
- Select hold-downs from generic database or edit database to add custom hold-downs

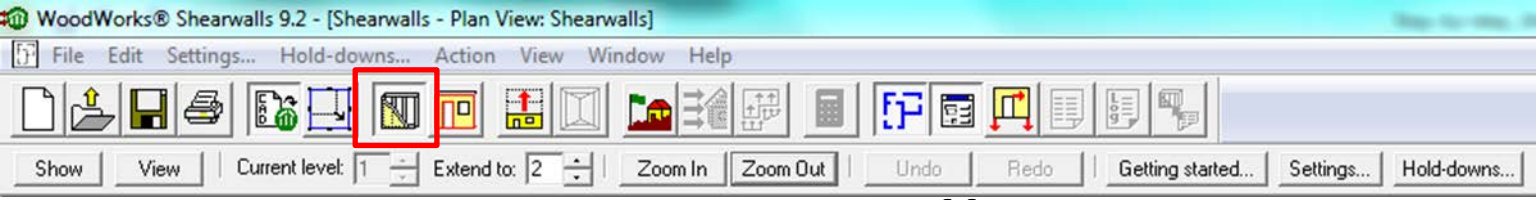


Creating Walls

- Select multiple walls at once by holding the Ctrl key and clicking on multiple walls
  - Useful for specifying the same wall make-up for multiple shearwall lines (on one level)
- Software will select for 'unknown' values

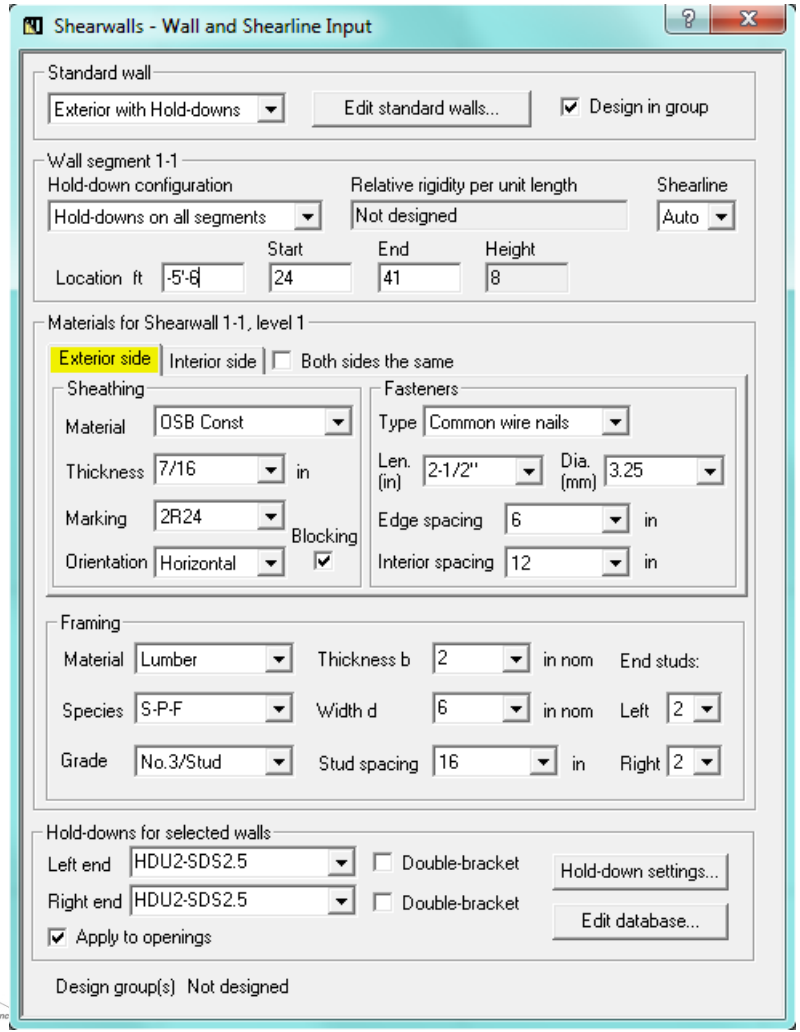


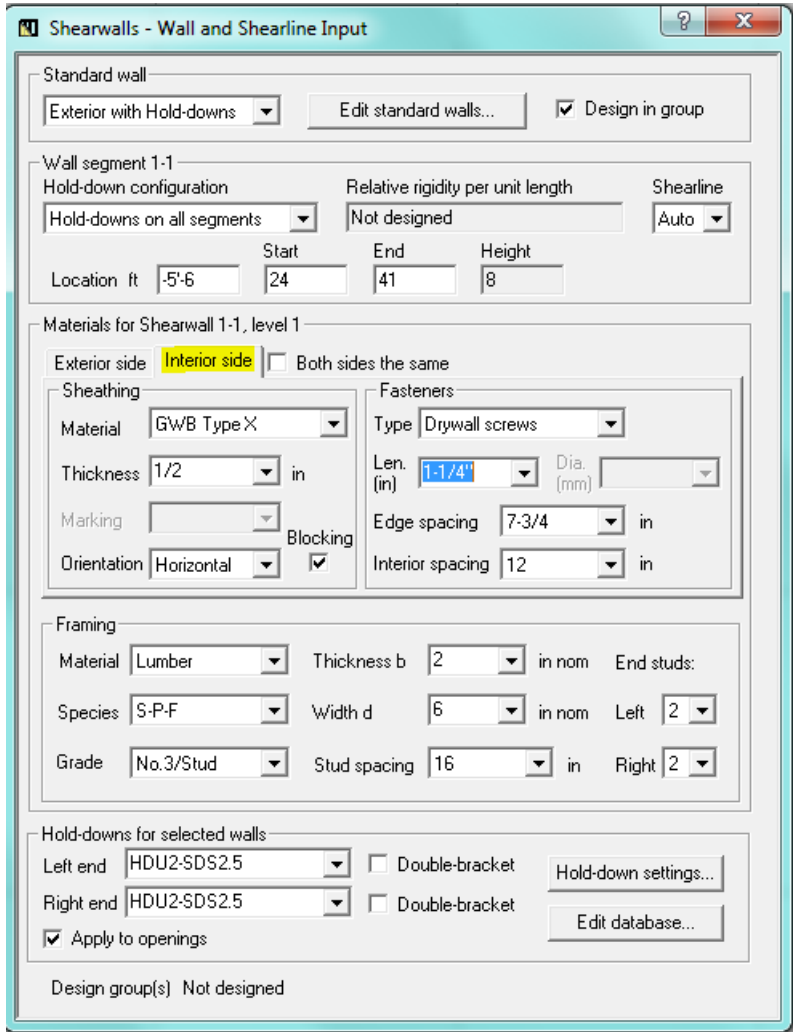




Creating Walls

- Typical exterior shearwall:





Creating Walls

- Typical interior shearwall:

final_model.wsw - Wall and Shearline Input

Standard wall: Interior Shearwall 2.3 | Edit standard walls... | Design in group

Wall segment 4-1

Hold-down configuration	Relative rigidity per unit length	Shearline
Hold-downs on all segments	Not designed	Auto

	X	Start Y	End Y	Height
Location ft	12	8	15'-6	8

Materials for Shearwall 4-1, level 2

Both sides | Both sides the same

Sheathing: Material GWB Type X; Thickness 1/2 in; Plies; Orientation Vertical; Blocking

Fasteners: Type Drywall screws; Len. (in) 1-1/4"; Dia. (mm); Edge spacing 7-3/4 in; Interior spacing 12 in

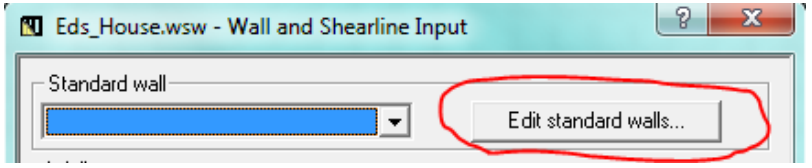
Framing: Material Lumber; Species S-P-F; Grade No.3/Stud; Thickness b 2 in nom; Width d 4 in nom; Stud spacing 16 in; End studs: Left 1, Right 1

Hold-downs for selected walls: Left end HDU2-SDS2.5 Double-bracket; Right end HDU2-SDS2.5 Double-bracket; Apply to openings; Hold-down settings...; Edit database...

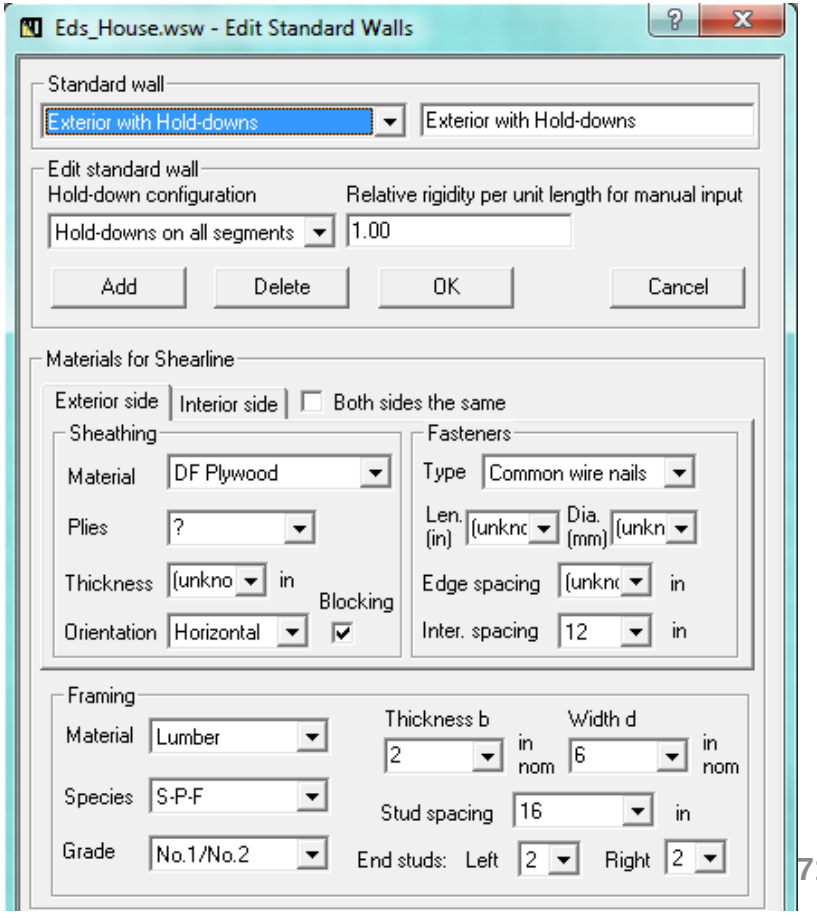
Design group(s) Not designed

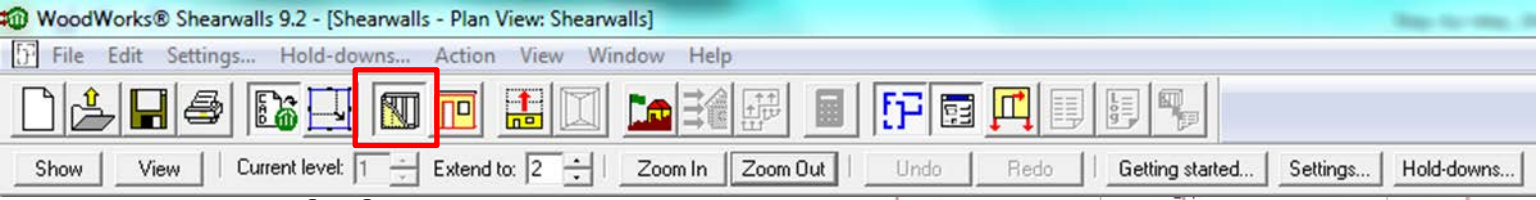
Creating Standard Walls

- Select “Edit standard walls…”:



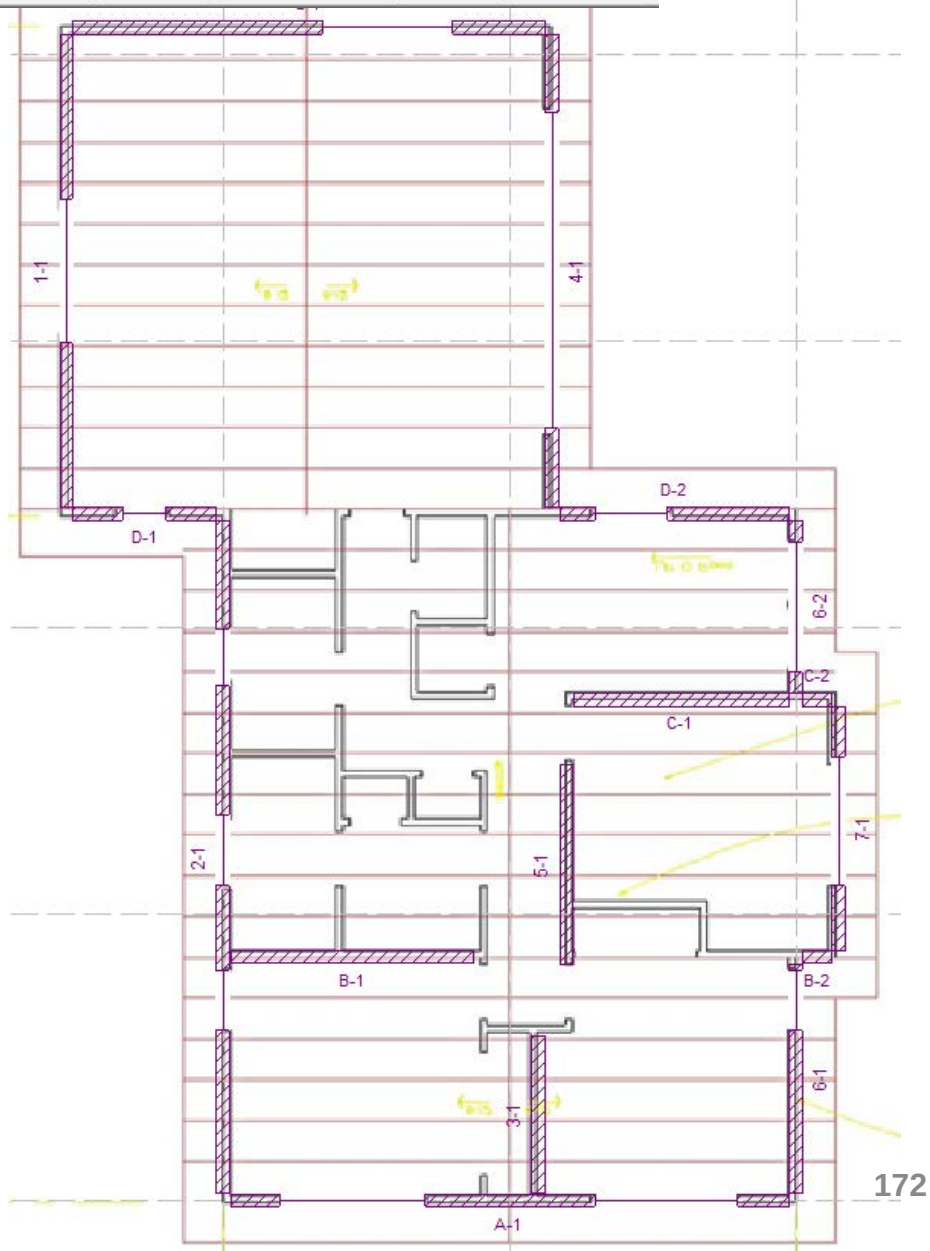
- Input custom standard wall properties

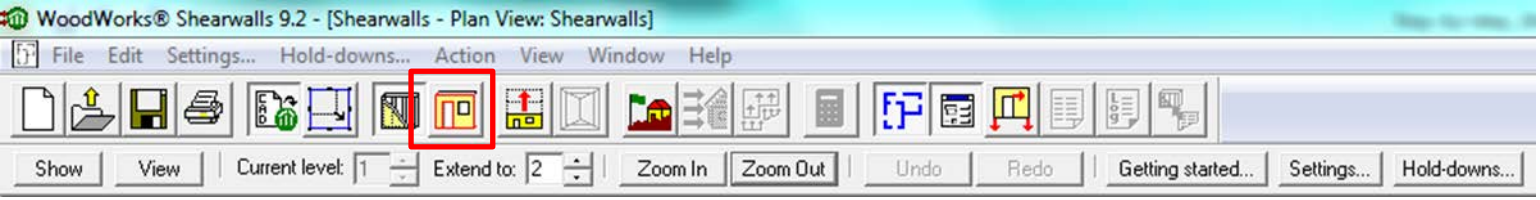




Add Openings

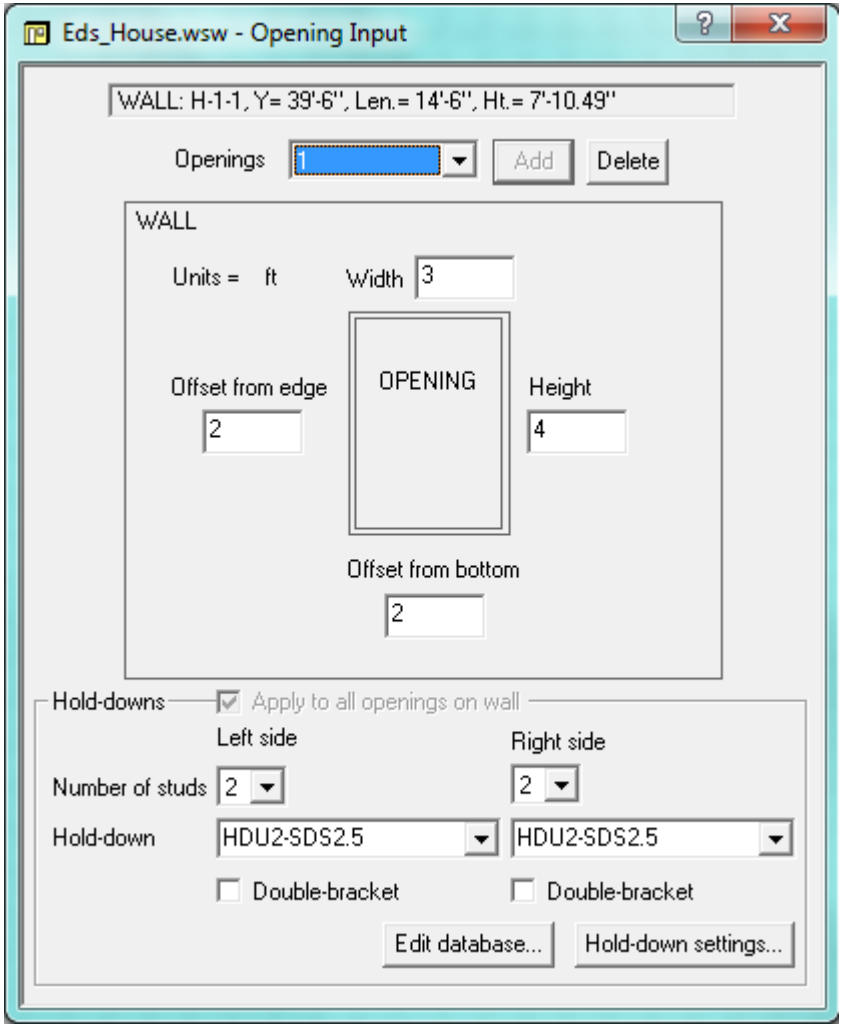
- Highlight shearline
- Press left mouse button and drag straight line over opening
- Release left mouse button
- Opening dimensions can be refined in Form View window





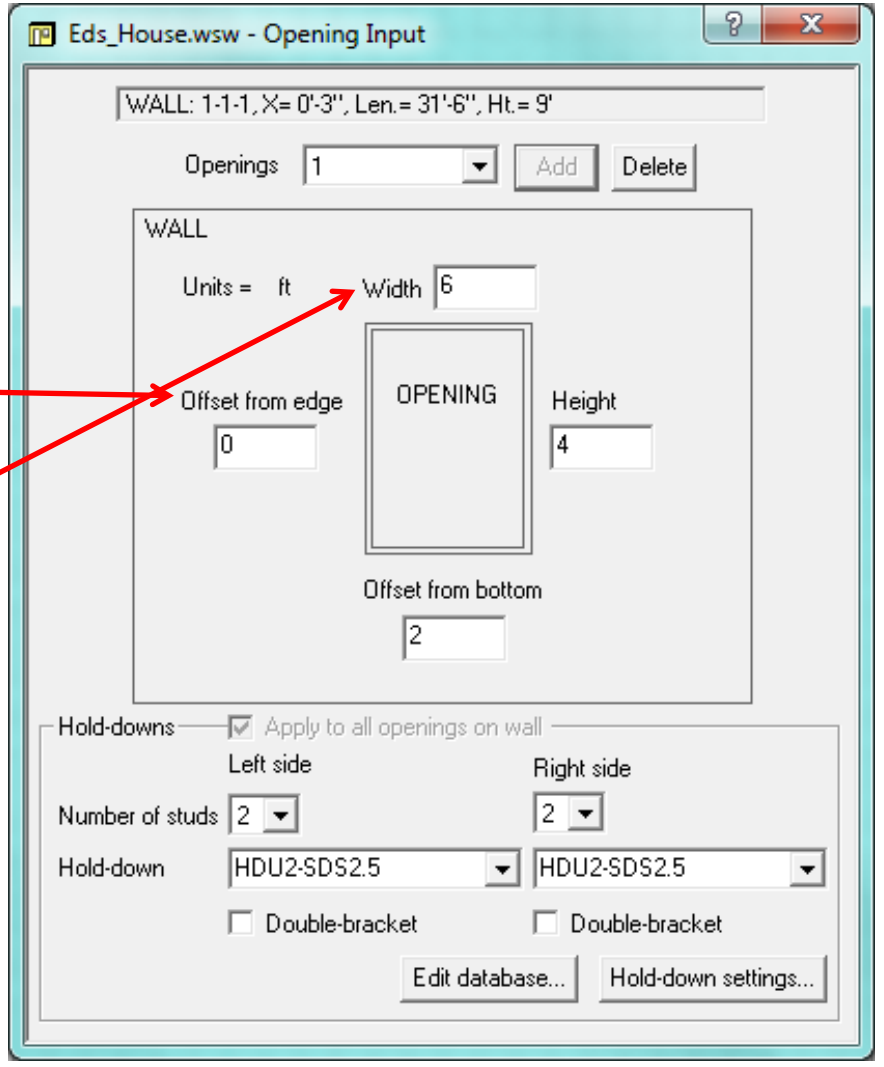
Add Openings

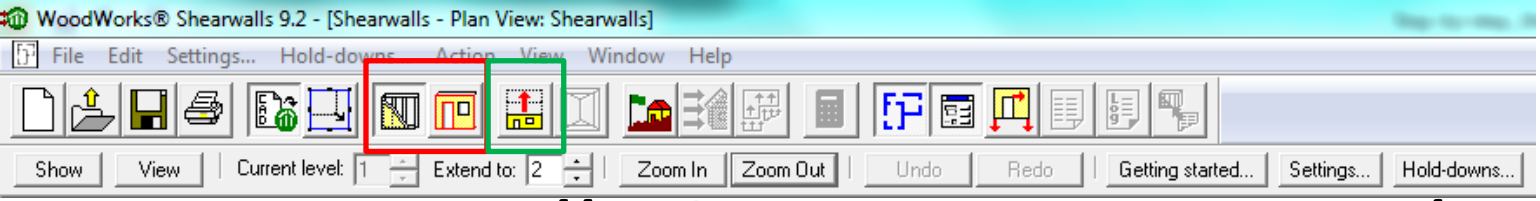
- Openings define full-height shearwall segments
- Weight of opening considered same as weight of wall
- Not possible to manually specify opening in diaphragm (can be modeled – *see Manual Load Input*)



Add Openings

- Highlight shearline
- Specify opening offset from left edge (for E-W walls) or bottom (for N-S walls)
- Specify opening width
- Opening height and offset from bottom can be left as default values (no influence on design)



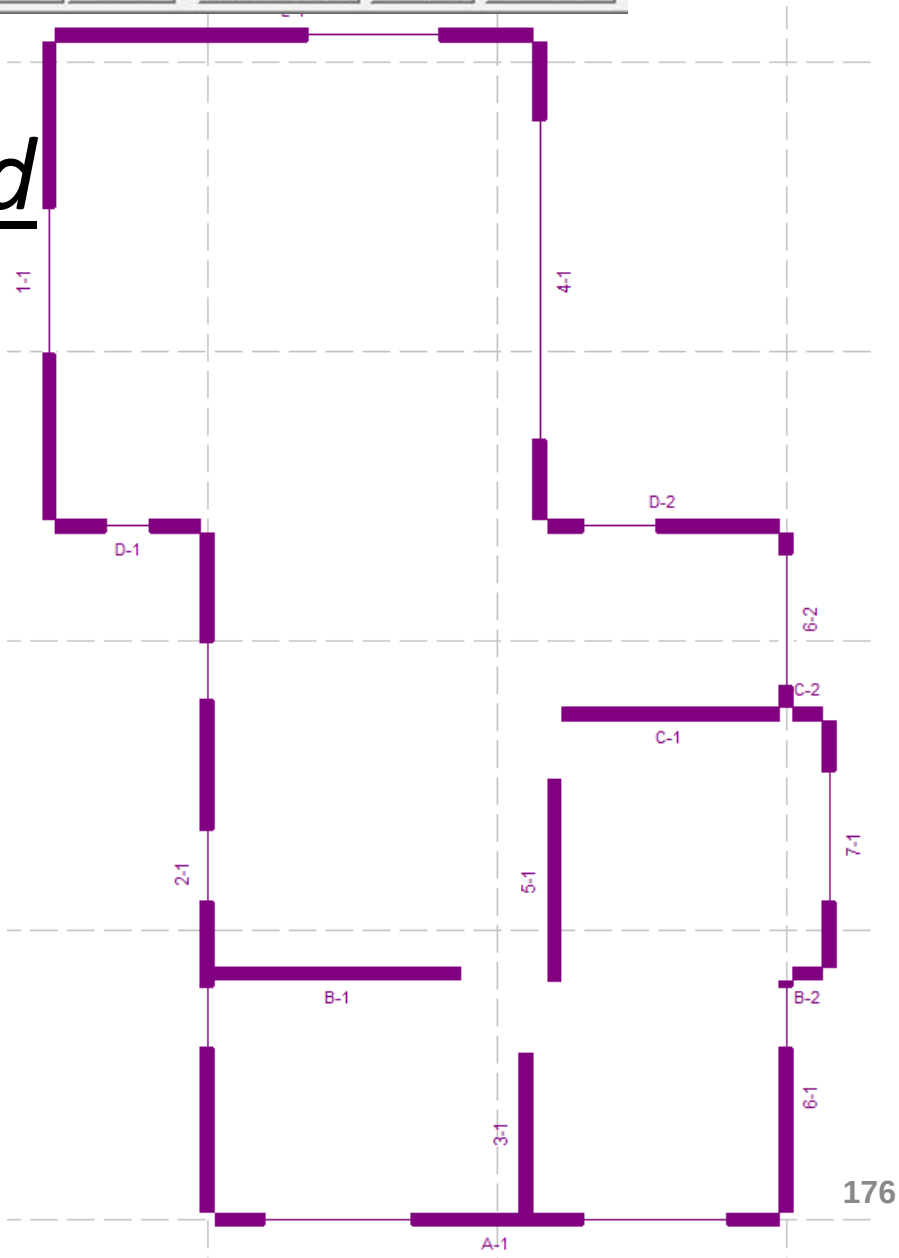


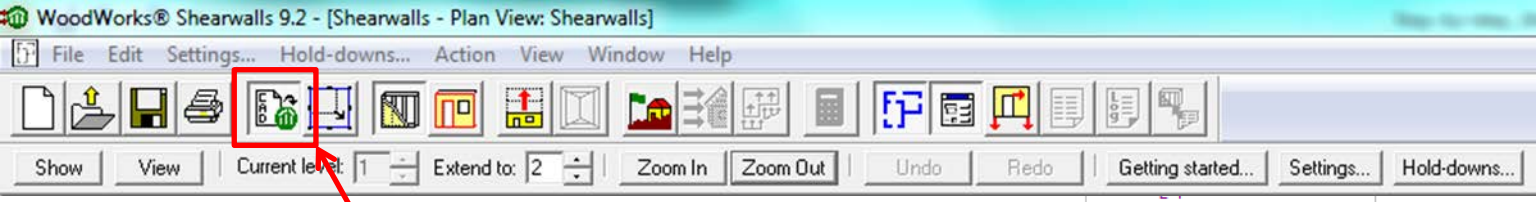
Creating Walls & Openings Template

- Initially, user can create exterior wall layout & window/door openings template on Level 1
  - This template can be copied upward to subsequent floors, using “Extend Walls Upwards” button
- If wall layout & window/door openings vary as building height increases:
  - Move directly to “Extend Walls Upwards” button, then perform floor-by-floor layout of shearwall locations and window/door openings

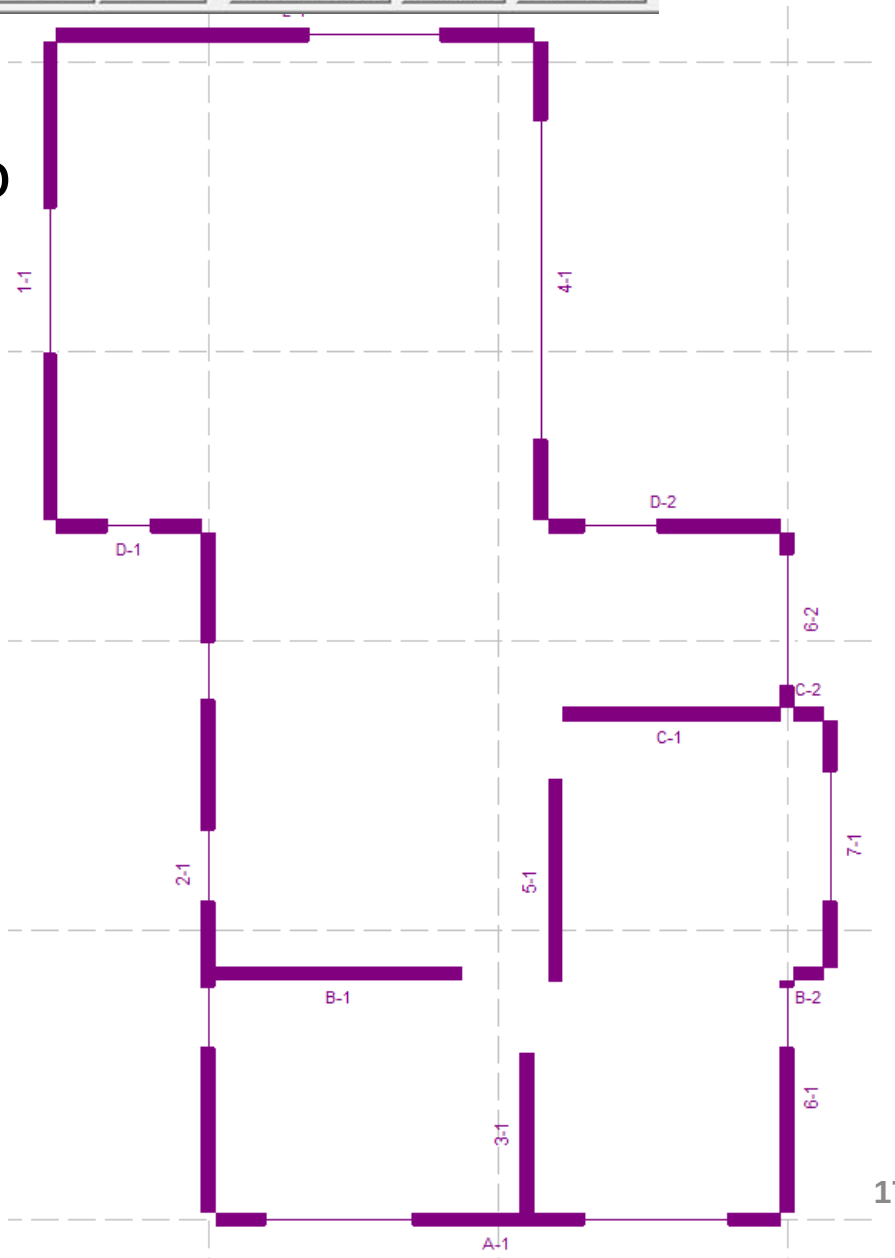
Extend Walls Upward

- Ground floor shearwall layout is extended up to floors above



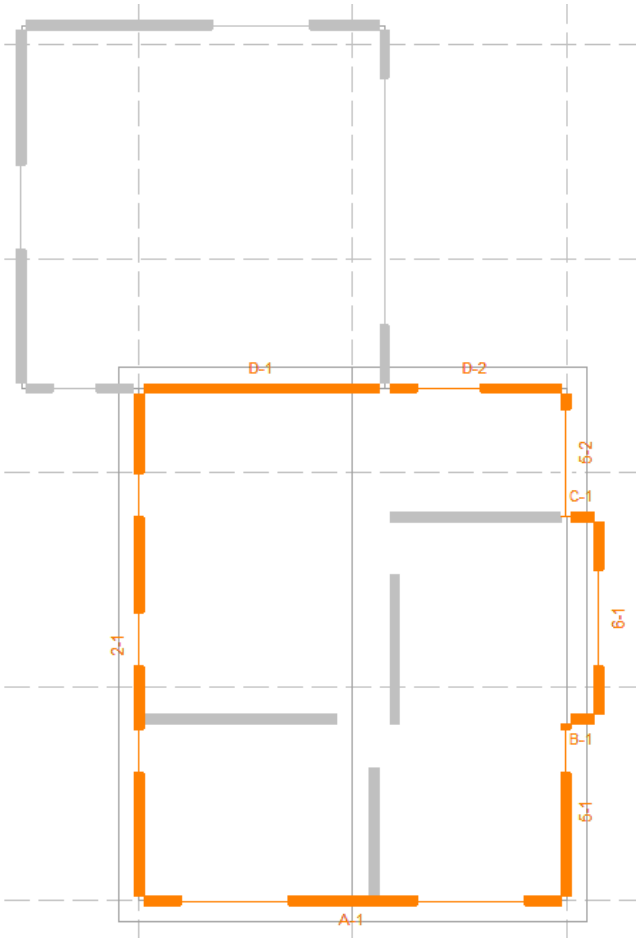


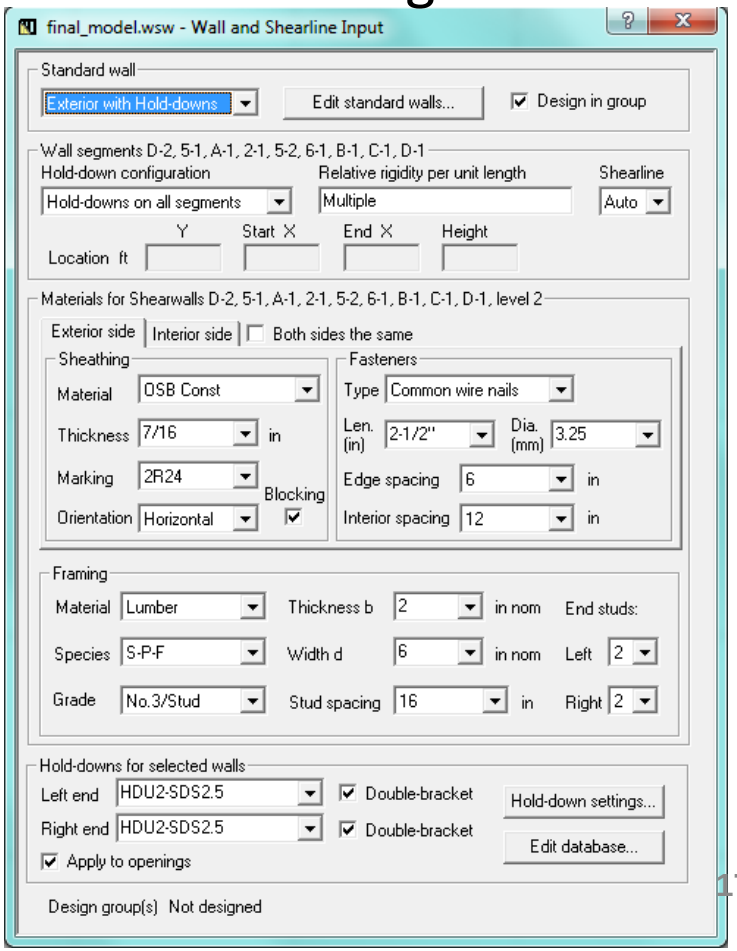
- Use CAD Import button to add/remove CAD overlay



Creating Walls

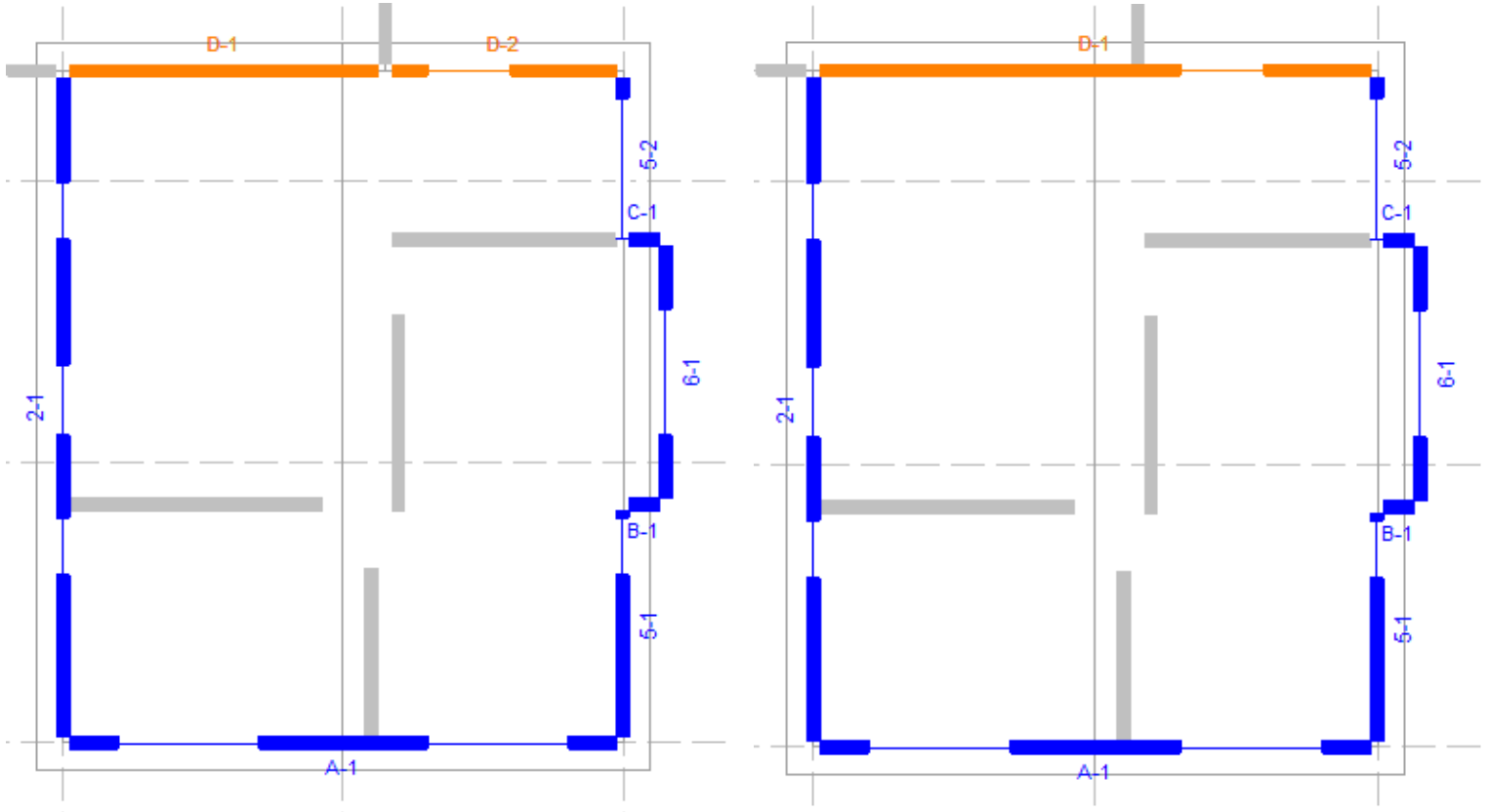
- Change Level 2 exterior shearwall to typical construction:
  - Default for top floor is exterior wall with anchorages

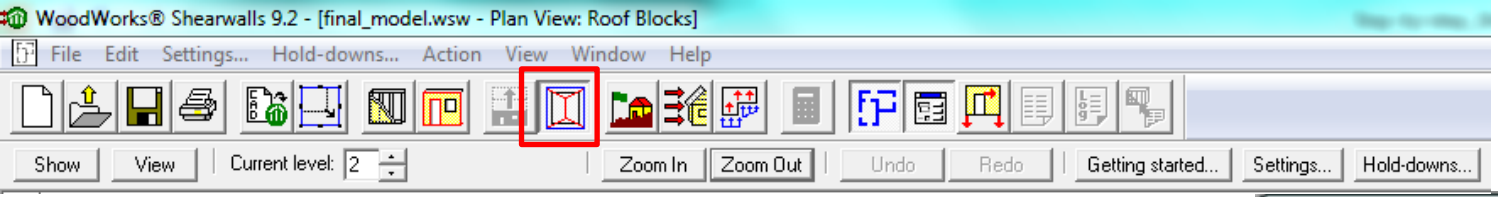




Creating Walls

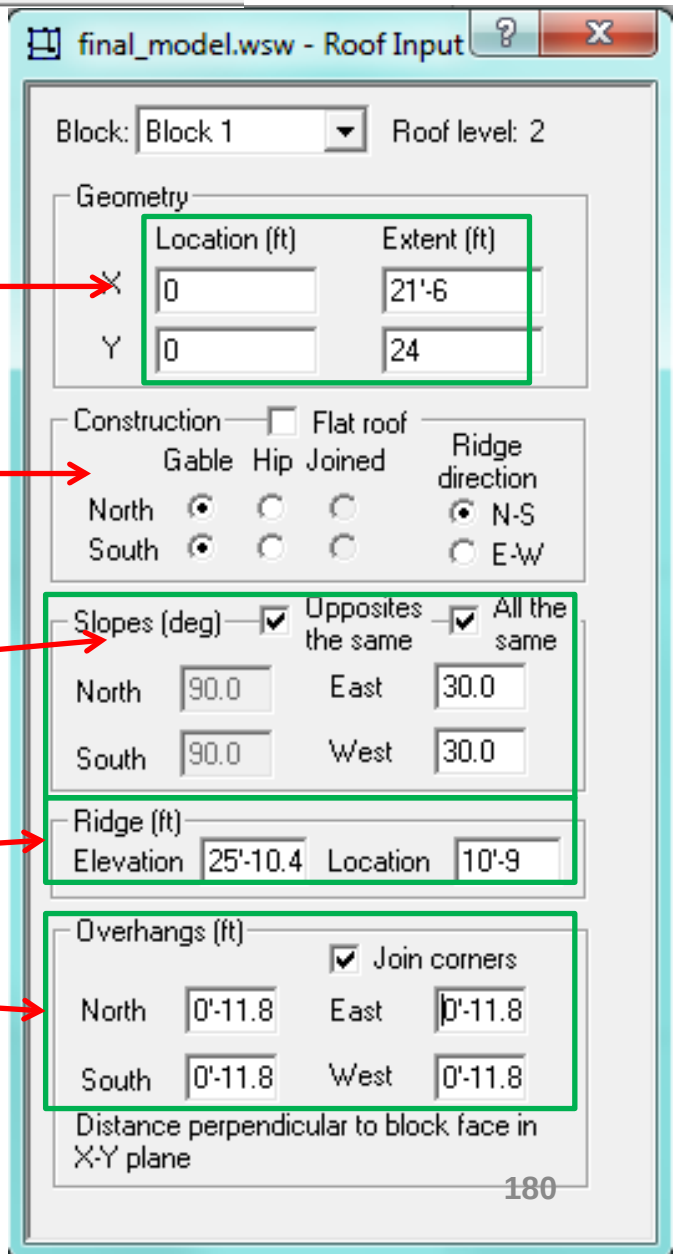
- Merge wall D-1 and D-2 on Level 2:
  - Select both wall segments using the Ctrl key
  - Right click after they are both highlighted and select “Merge”



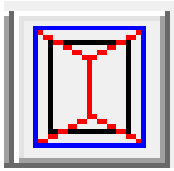


Add Roof

- Adjust roof block size (use x,y coordinates or drag roof block to overly CAD drawing)
- Roof type
- Adjust roof slope
- Adjust ridge location to overlay CAD drawing ridge line
- Adjust overhang distances

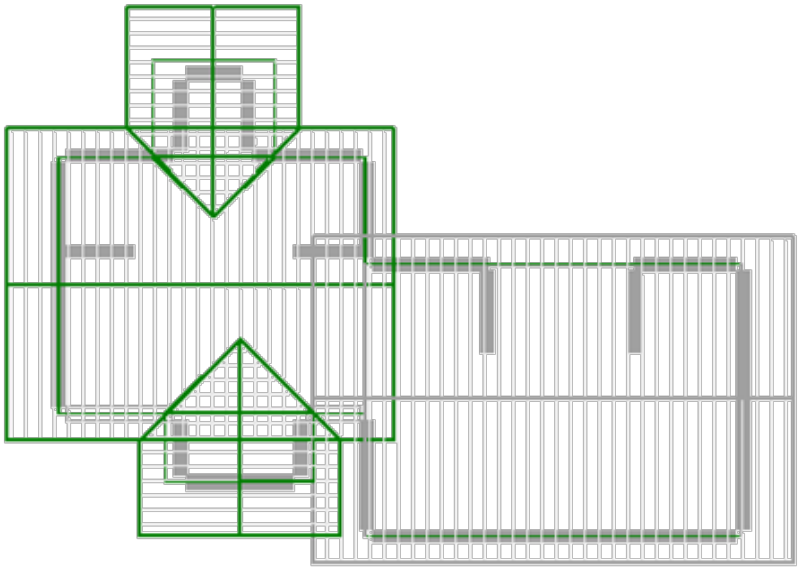


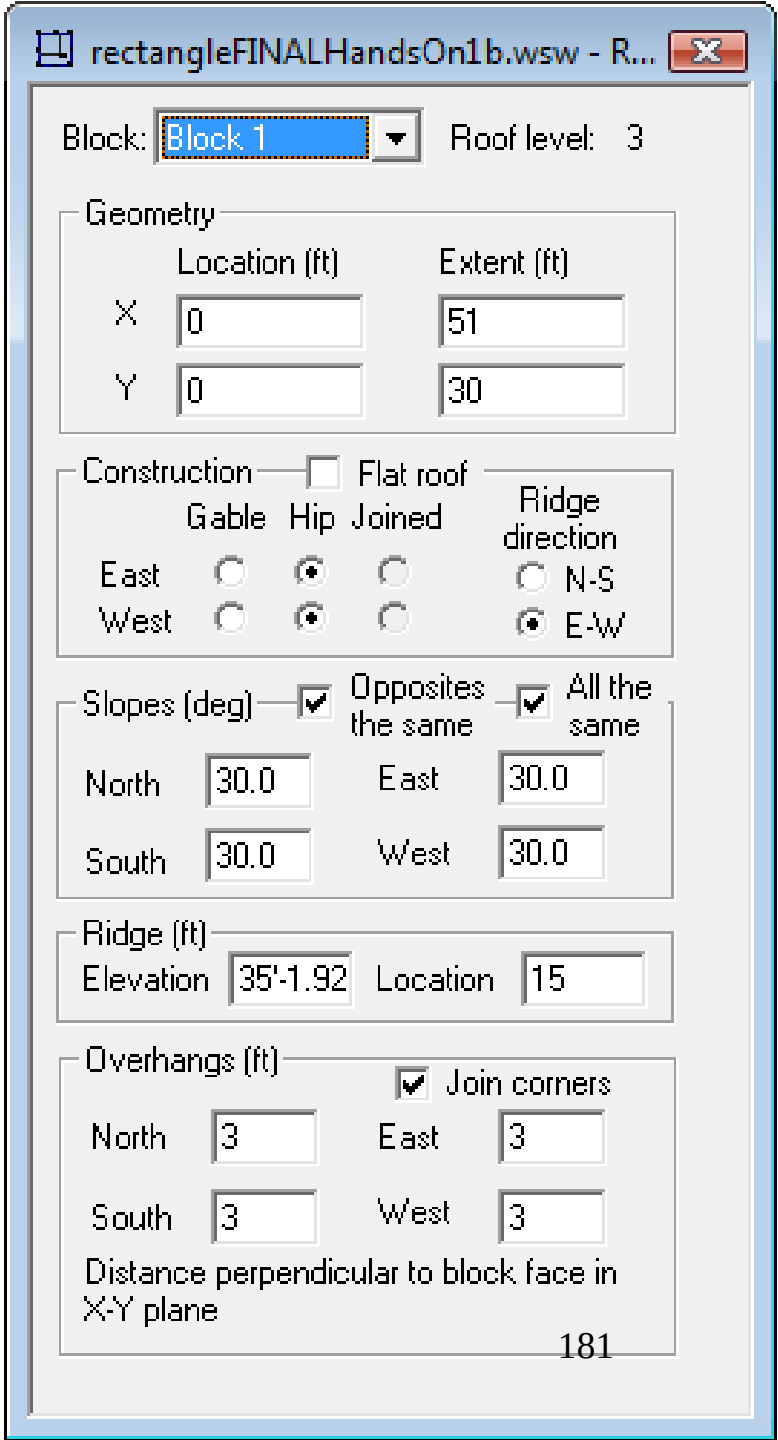
Roof Shape and Mass is needed for both Wind and Seismic Load Generation.

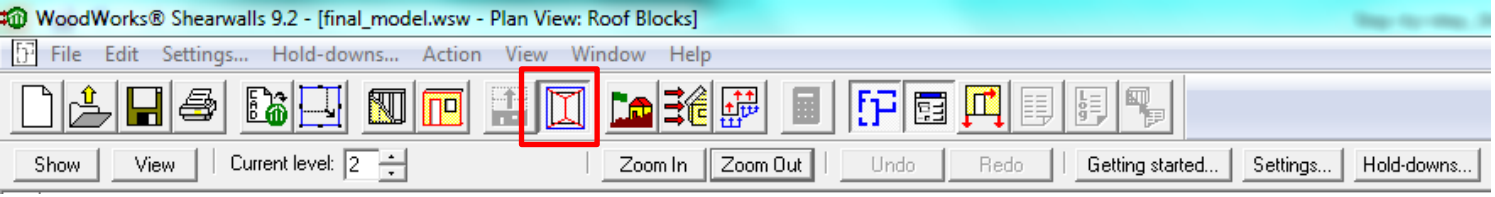


Roofs are created whenever a block is created

Additional blocks not associated with any walls can be created at any time



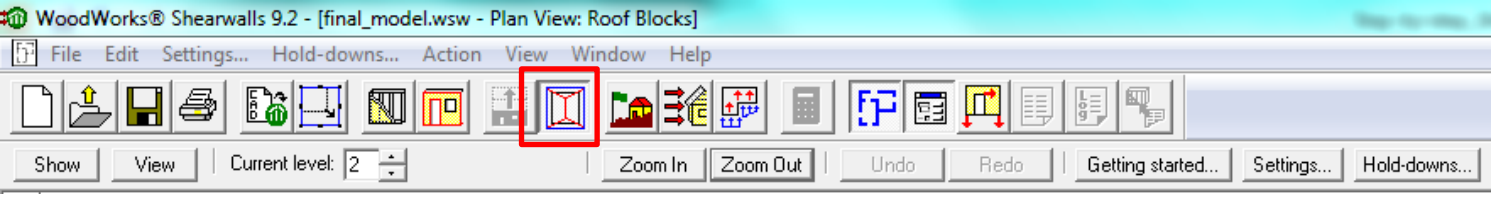




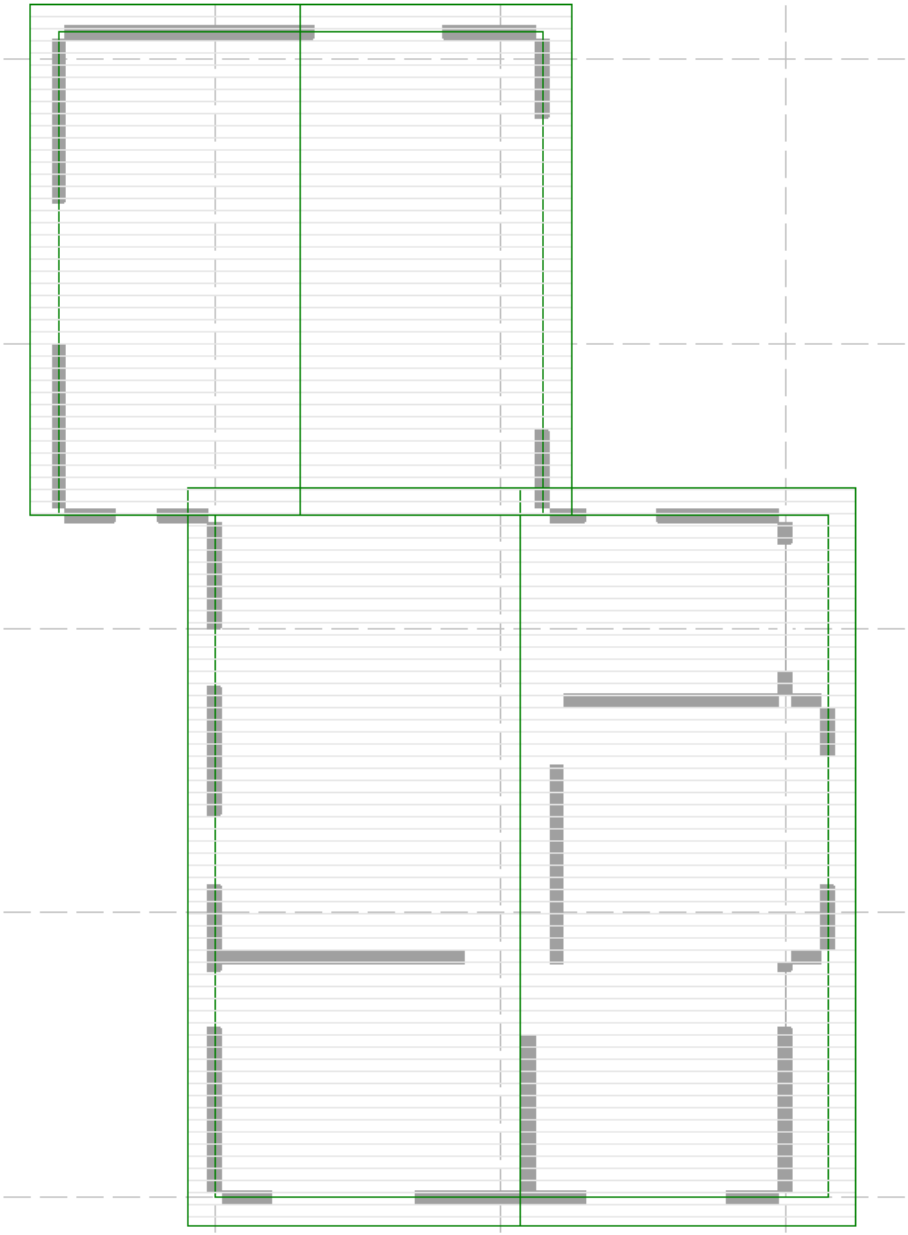
Add Roof

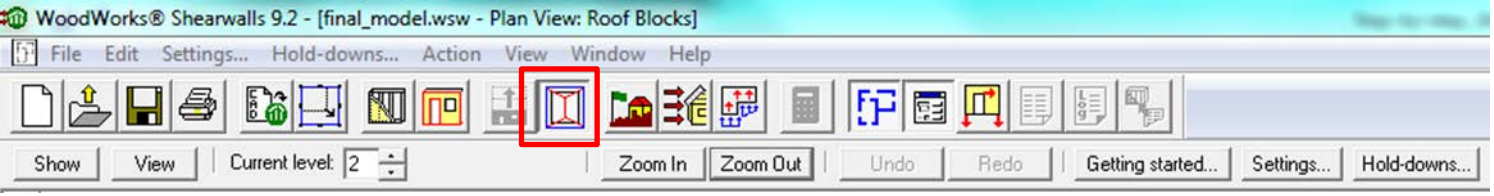
- Monosloped roofs
  - Can be entered by moving ridge in line with wall
  - Vertical surface from top of shearwall to top of ridge will be treated as a roof panel (not a wall) for the windward side & may use conservative Cp values

- Mansard roofs & arched roofs cannot be explicitly modeled using the software
  - Not covered explicitly in NBCC


WoodWorks® Shearwalls 9.2 - [final_model.wsw - Plan View: Roof Blocks]
File Edit Settings... Hold-downs... Action View Window Help
Show View Current level: 2 Zoom In Zoom Out Undo Redo Getting started... Settings... Hold-downs...

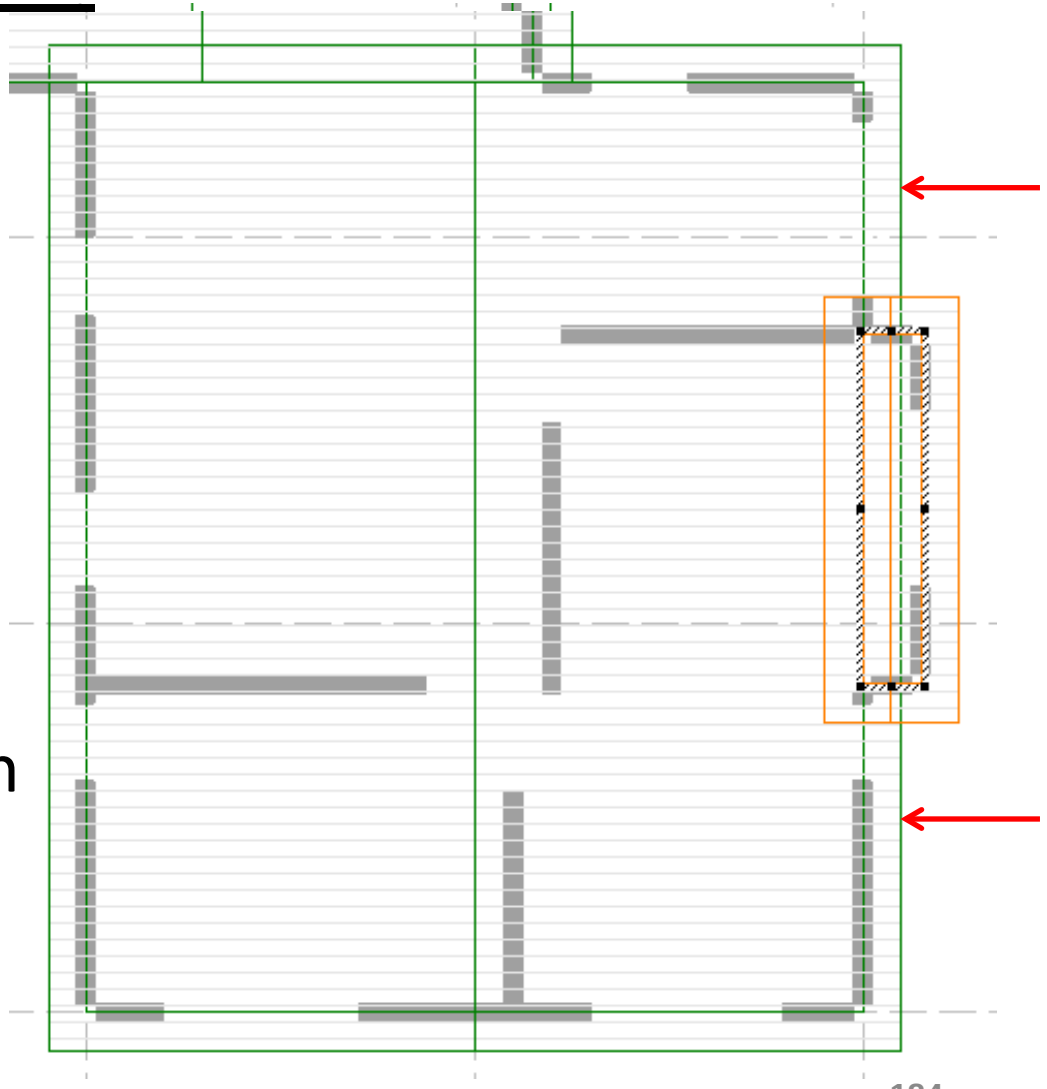
Gable Roof

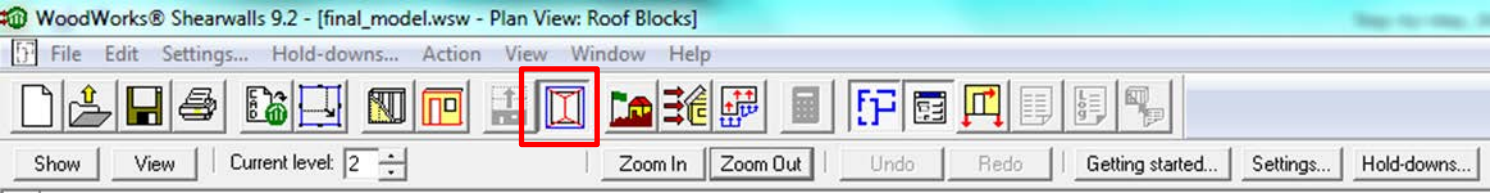




Add Dormers

- Shift east side of main roof block left
- Create new roof block over bump-out by left-clicking and dragging new roof block to touch existing main block

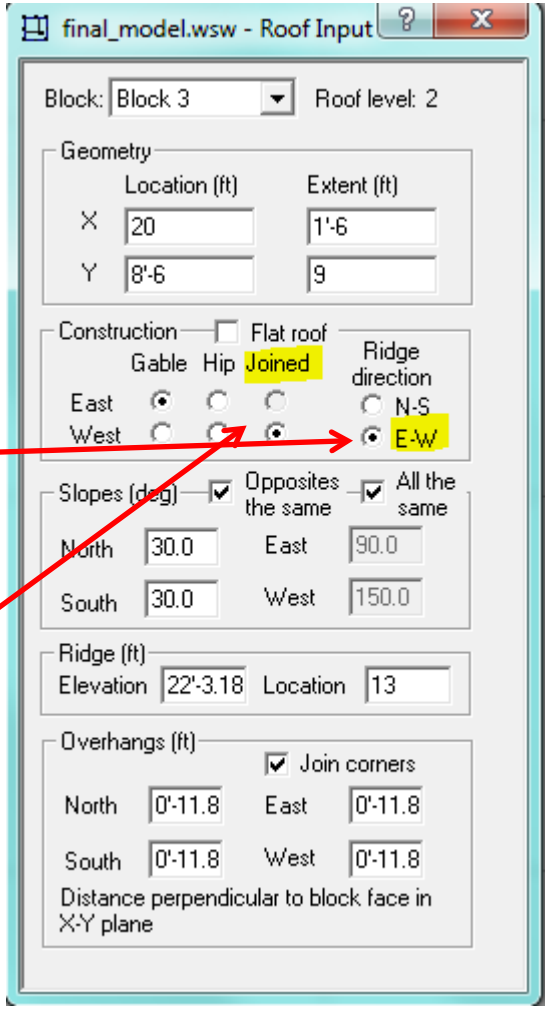




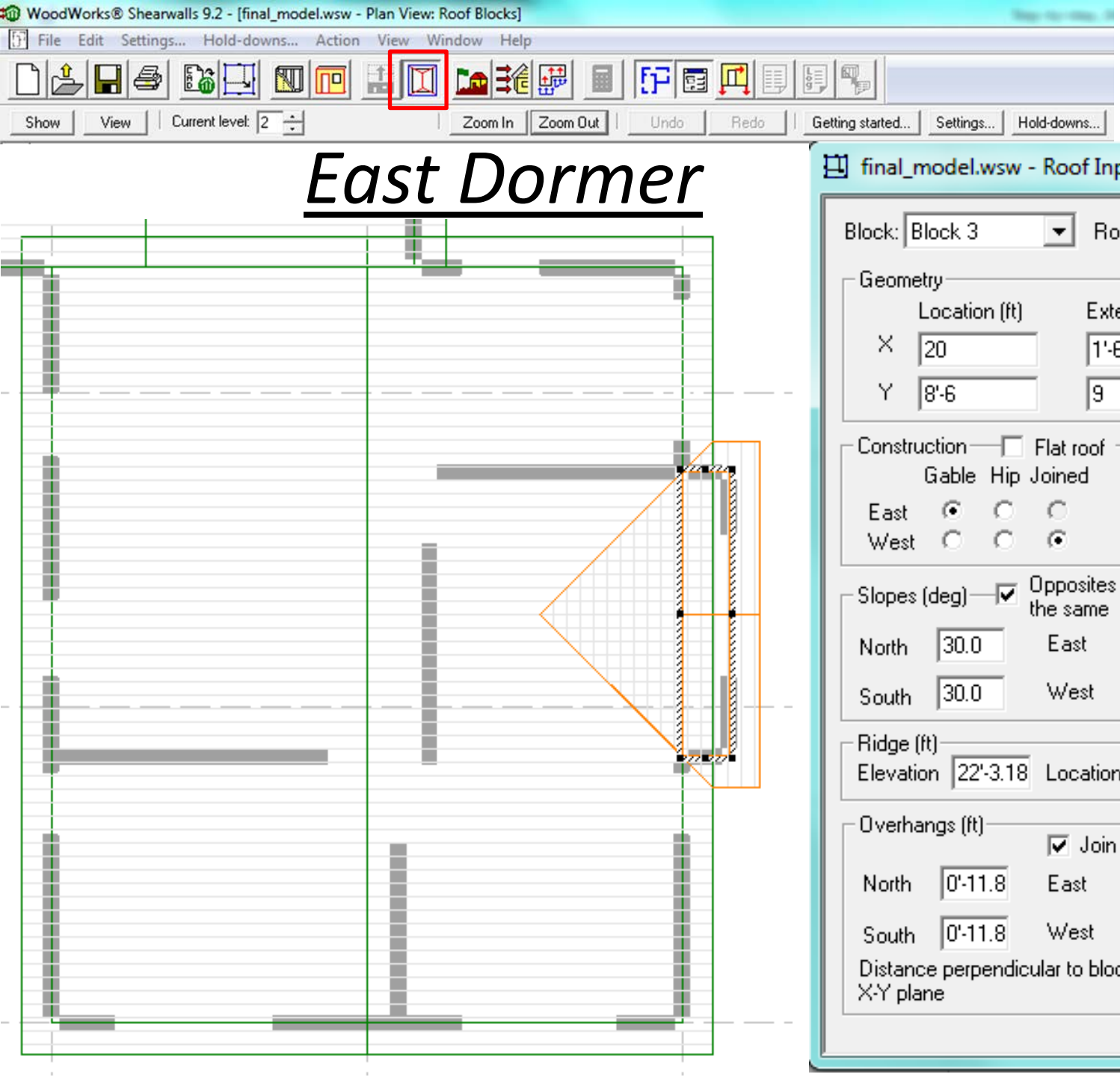
Add Dormers

To join dormer to main roof:

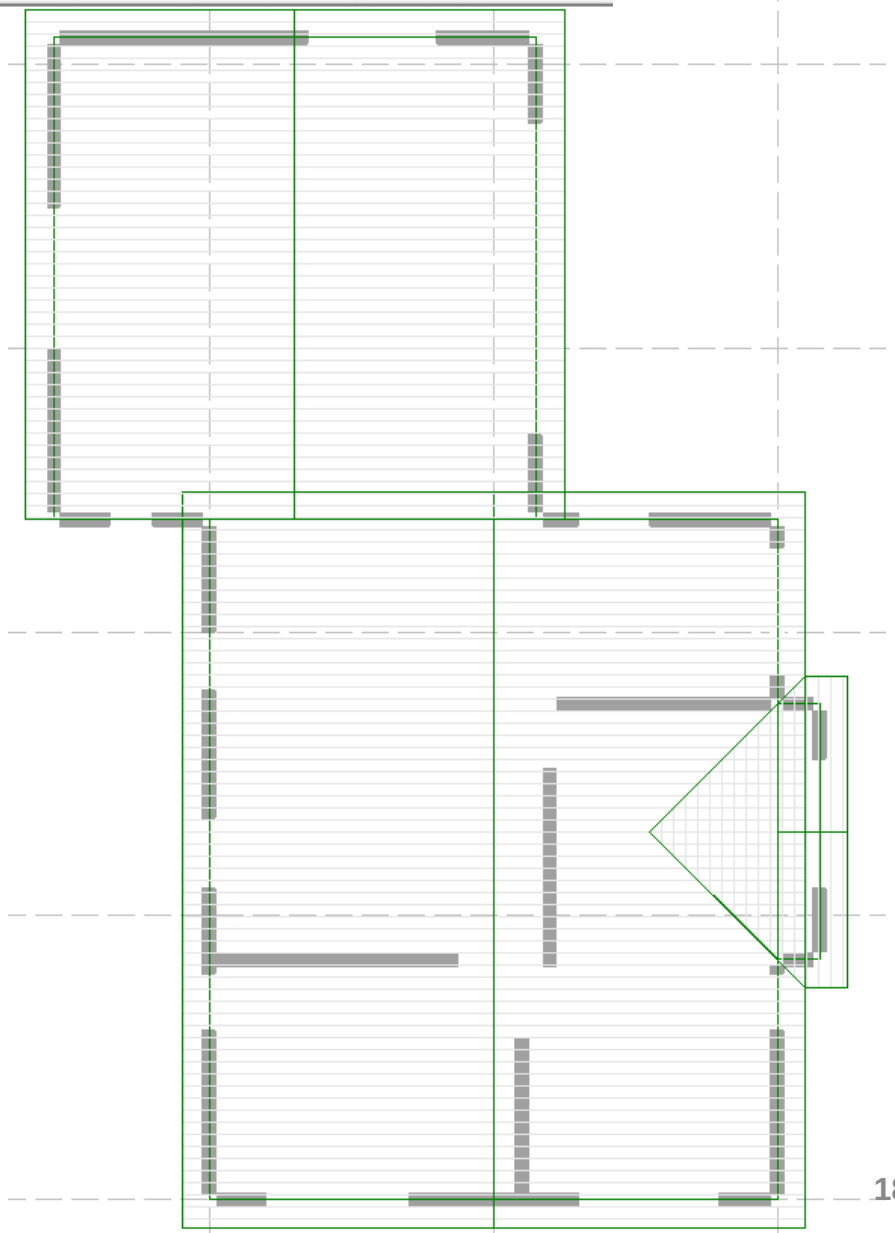
- Change ridge direction to E-W
- Select "Joined" on the West side

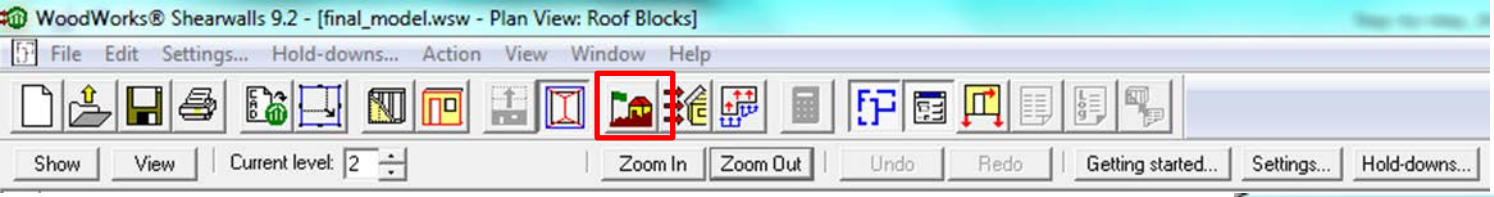


East Dormer


WoodWorks® Shearwalls 9.2 - [final_model.wsw - Plan View: Roof Blocks]
File Edit Settings... Hold-downs... Action View Window Help
Show View Current level: 2 Zoom In Zoom Out Undo Redo Getting started... Settings... Hold-downs...
final_model.wsw - Roof Input
Block: Block 3 Roof level: 2
Geometry
Location (ft) Extent (ft)
X 20 1'-6
Y 8'-6 9
Construction Flat roof
Gable Hip Joined
East
West
Ridge direction
N-S
E-W
Slopes (deg) Opposites the same All the same
North 30.0 East 90.0
South 30.0 West 150.0
Ridge (ft)
Elevation 22'-3.18 Location 13
Overhangs (ft)
Join corners
North 0'-11.8 East 0'-11.8
South 0'-11.8 West 0'-11.8
Distance perpendicular to block face in X-Y plane

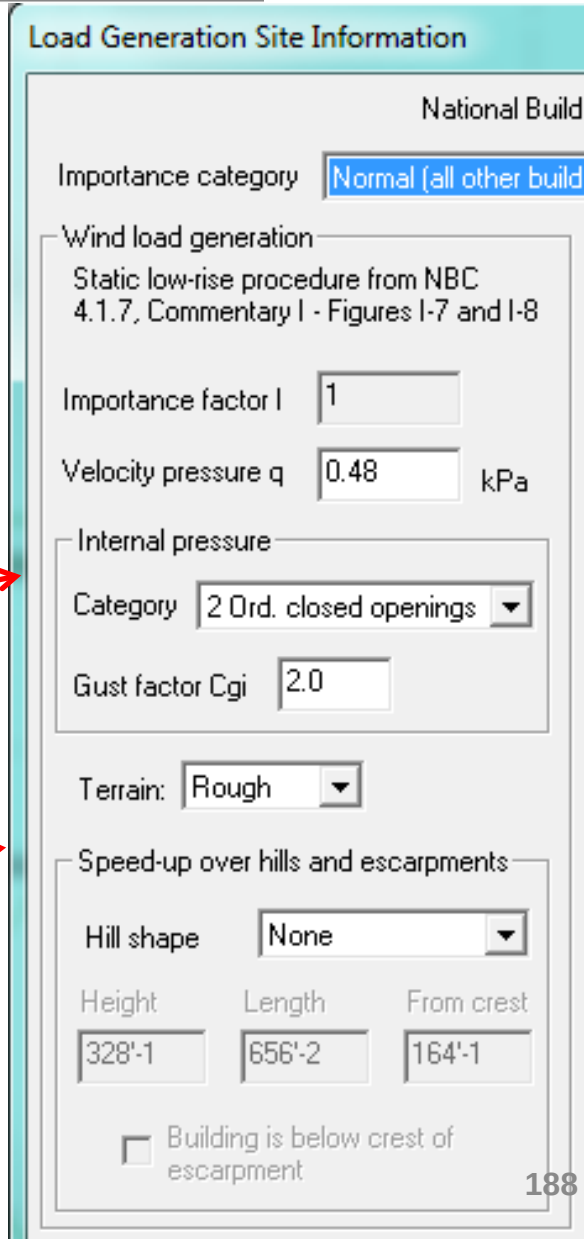
Complete Roof

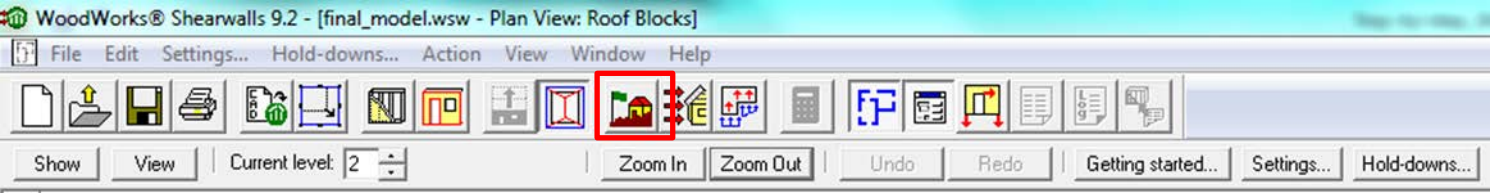




Modify Site Information

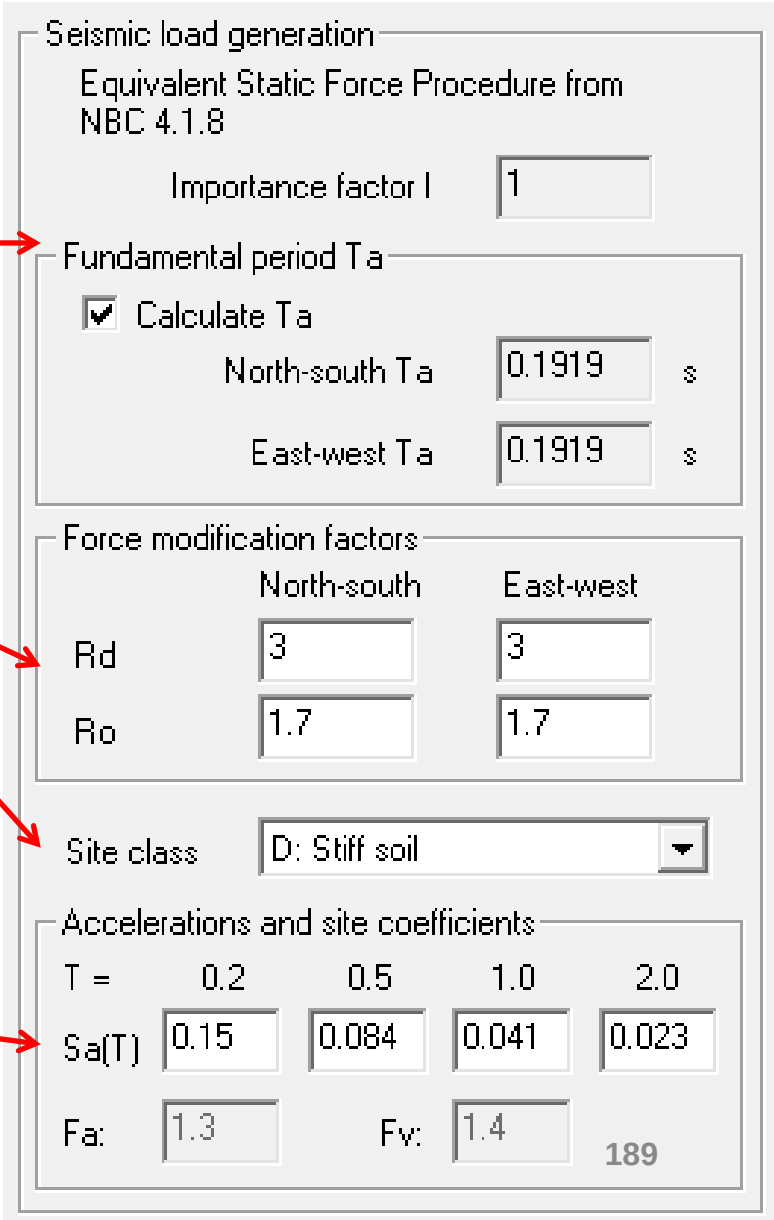
- Importance category
- $q_{1/50}$ vel. pressure by location or manually input $q_{1/50}$
- Internal pressure only used for C&C loads
- Terrain & hill modification (refer to NBCC 2010 for applicability)

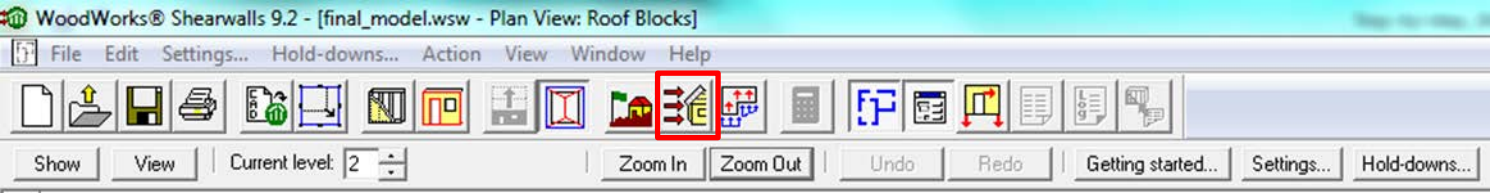




Modify Site Information

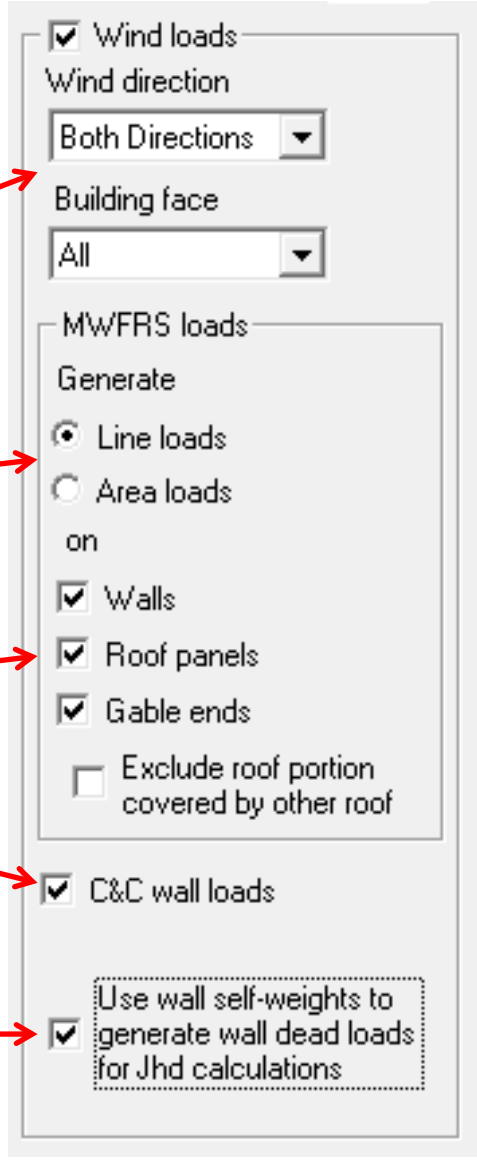
- Calculate period or input manually
- Ductility & over strength factors
  - Default assumes wood sheathed walls & no lateral resistance provided by gypsum
- Site class (from geotech report)
- Spectral accelerations automatically populated based on geographic location

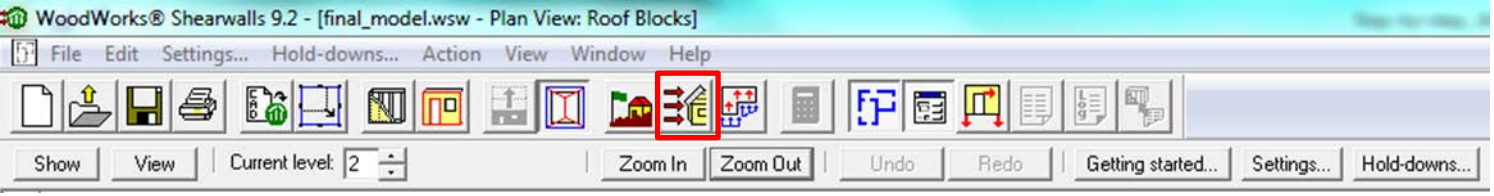




Load Generation - Wind

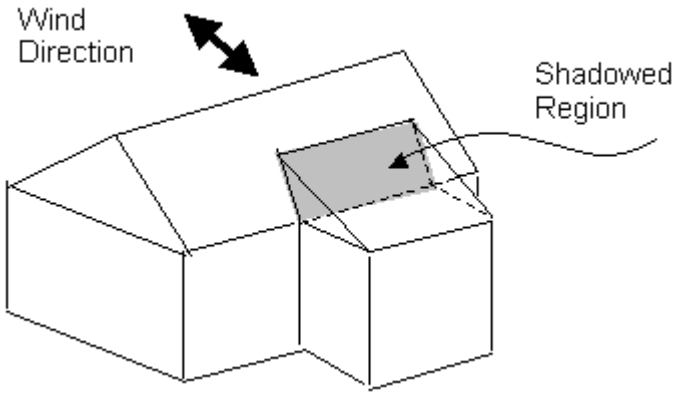
- Can choose to generate wind load for only one direction or face
- Loads can be displayed in plan as either line or area loads
- Can choose to exclude wind on certain elements
- C&C = components & cladding – used to design for sheathing & nails
- Wall self-weights used to counteract overturning forces

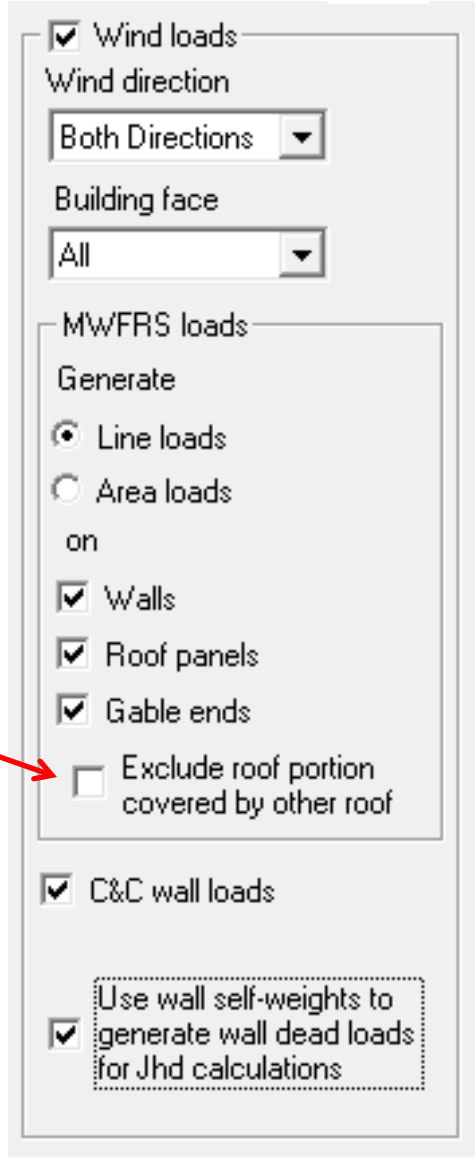


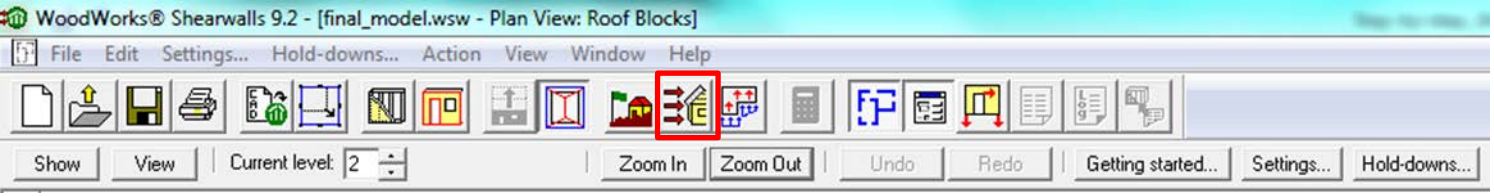


Load Generation - Wind

- Shadowed area is excluded from wind generation

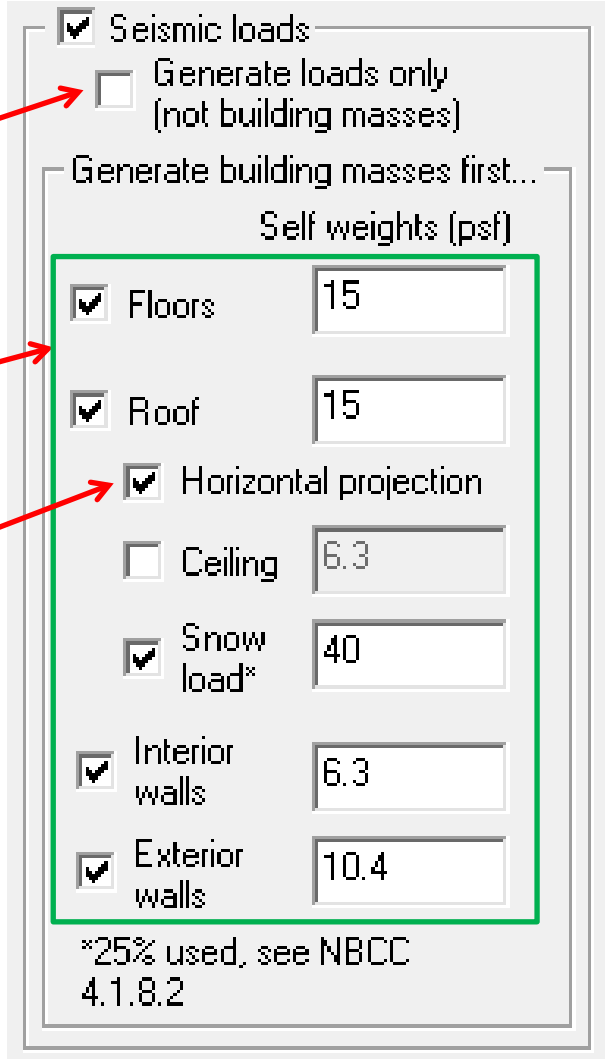




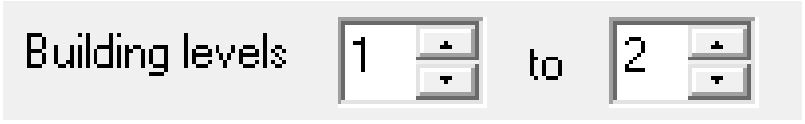


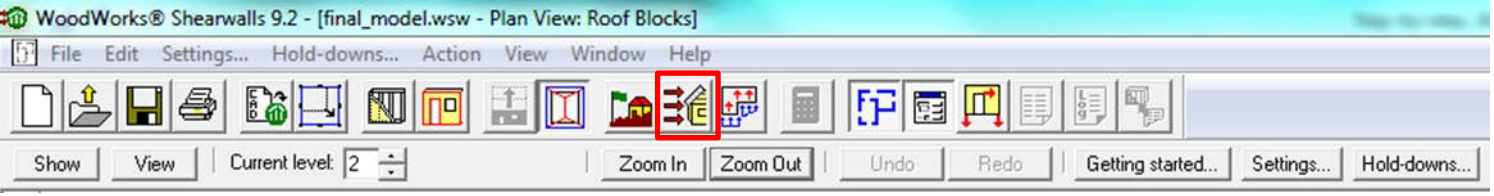
Load Generation - Seismic

- Used to generate manually applied loads in order to retain building masses
- Building masses used to determine base shear & vertical seismic load distribution
- Roof can be horizontal projection

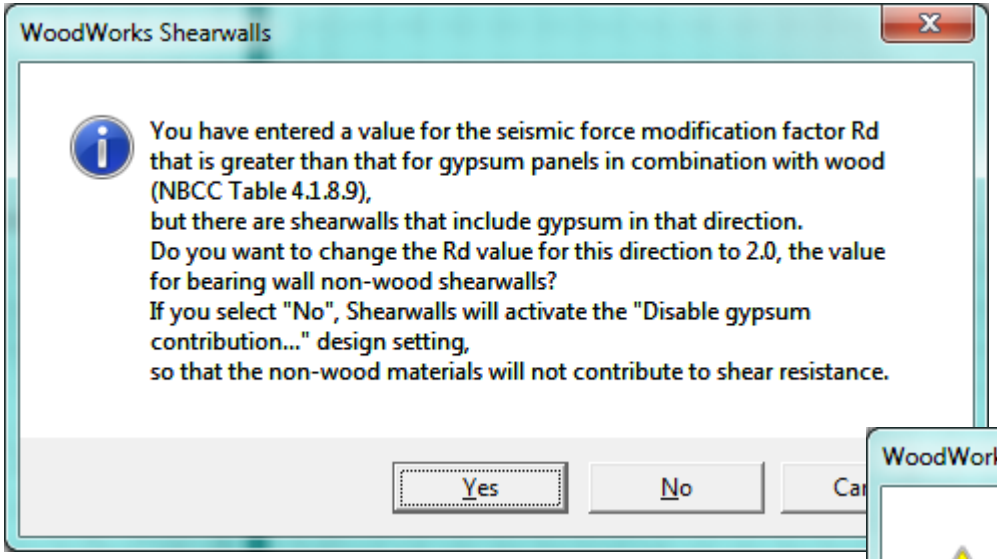


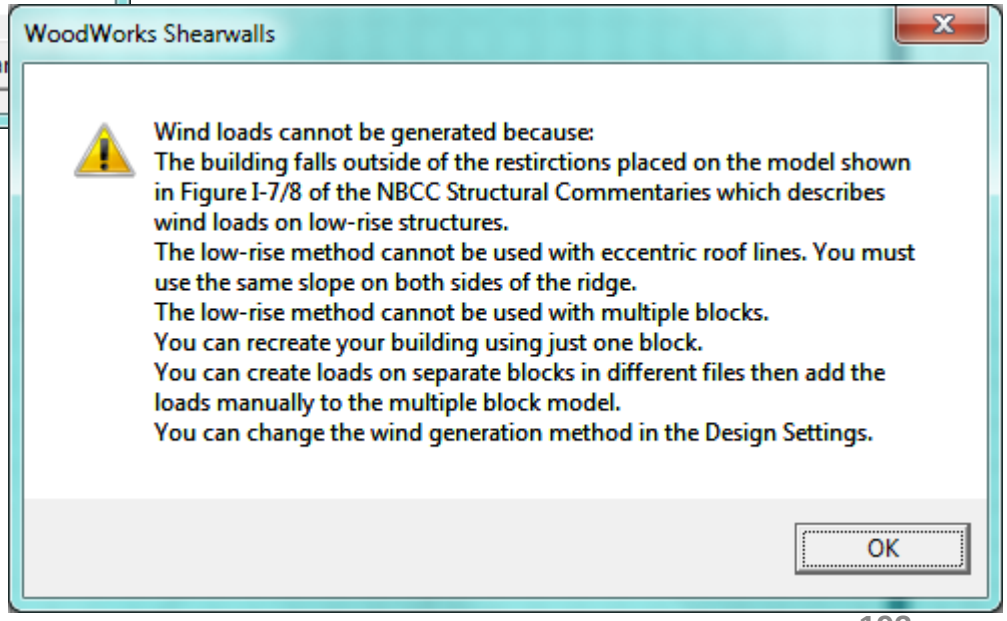
- Choose which levels to generate loads

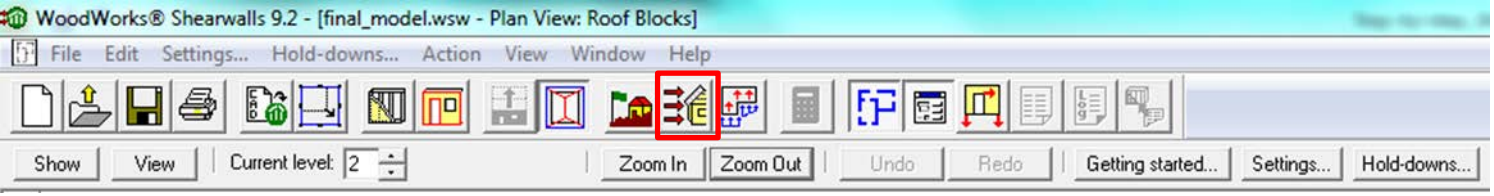




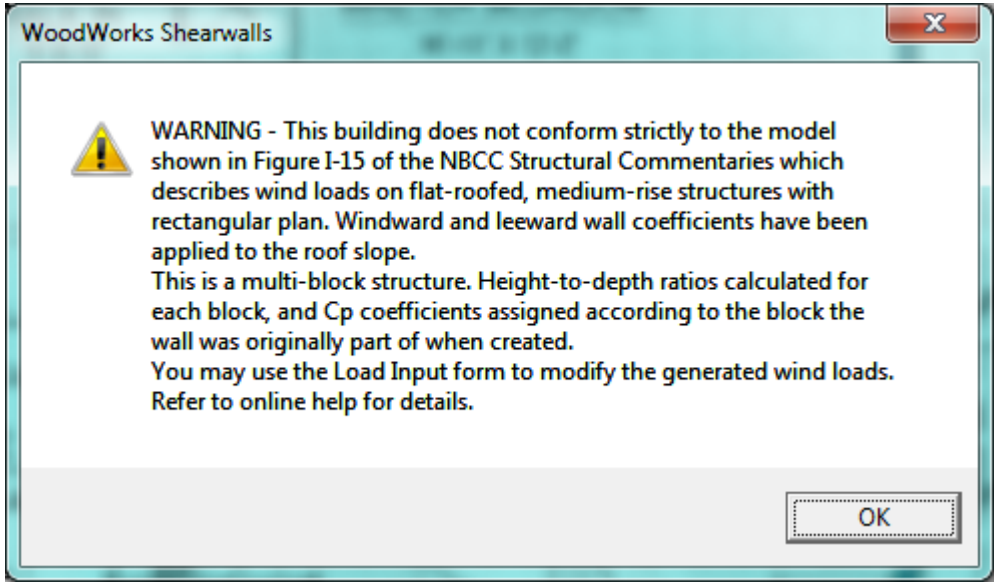
Load Generation – Warning Messages

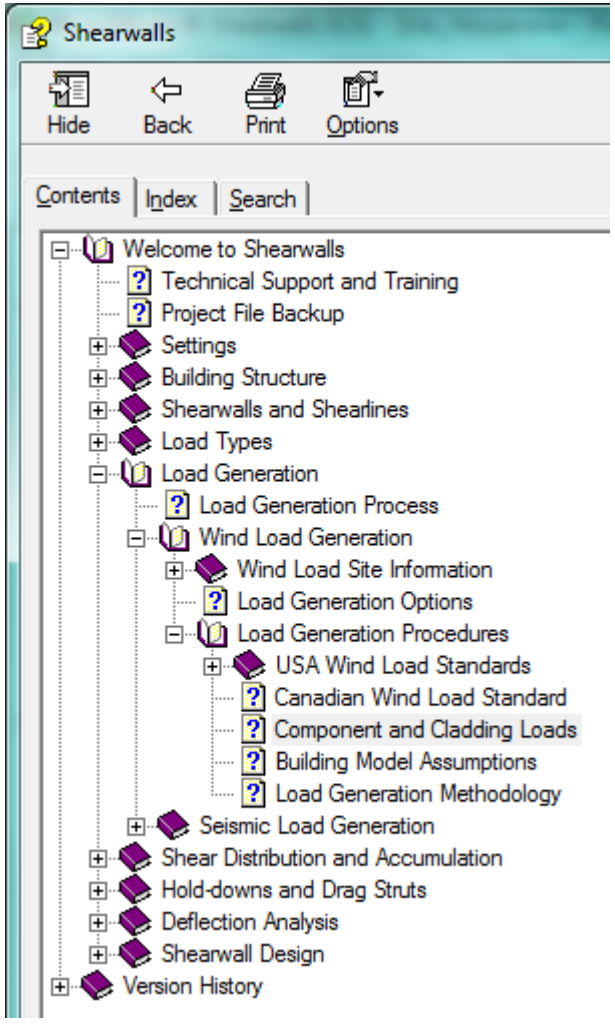




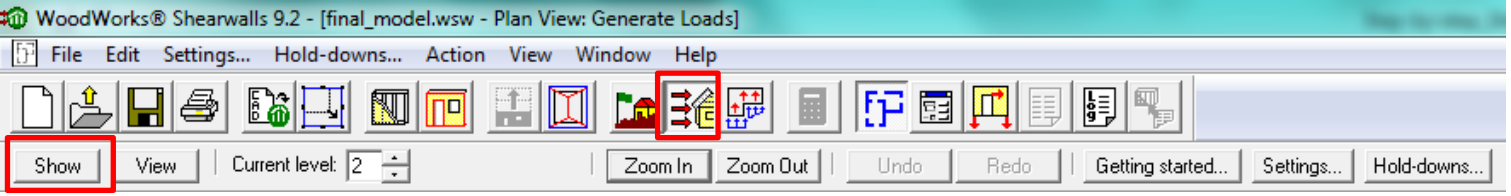


Load Generation – Warning Messages



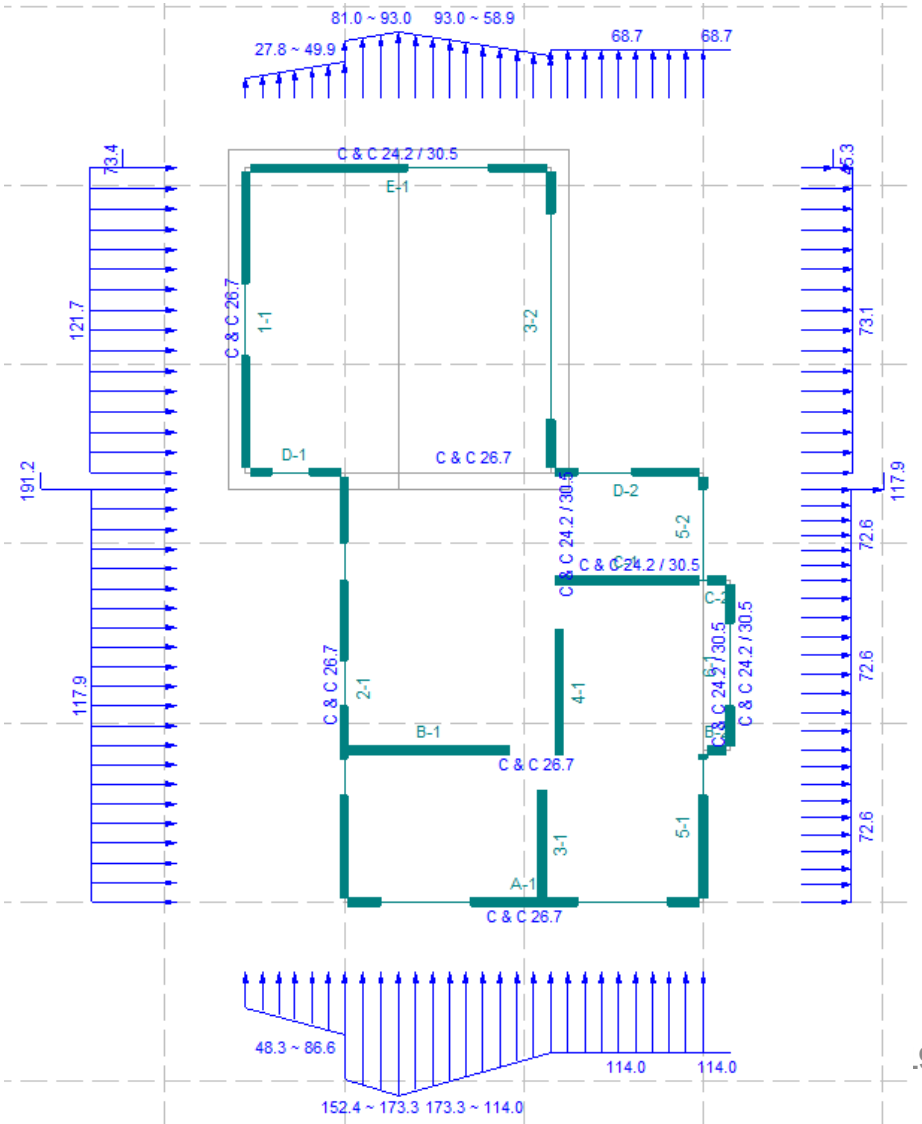


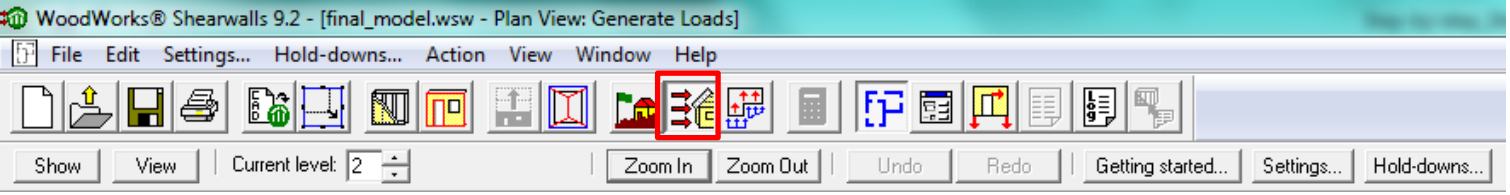
- "*Help*" on top toolbar, then "*Shearwalls Help…*" or press F1



Wind Load Generation – MWFRS

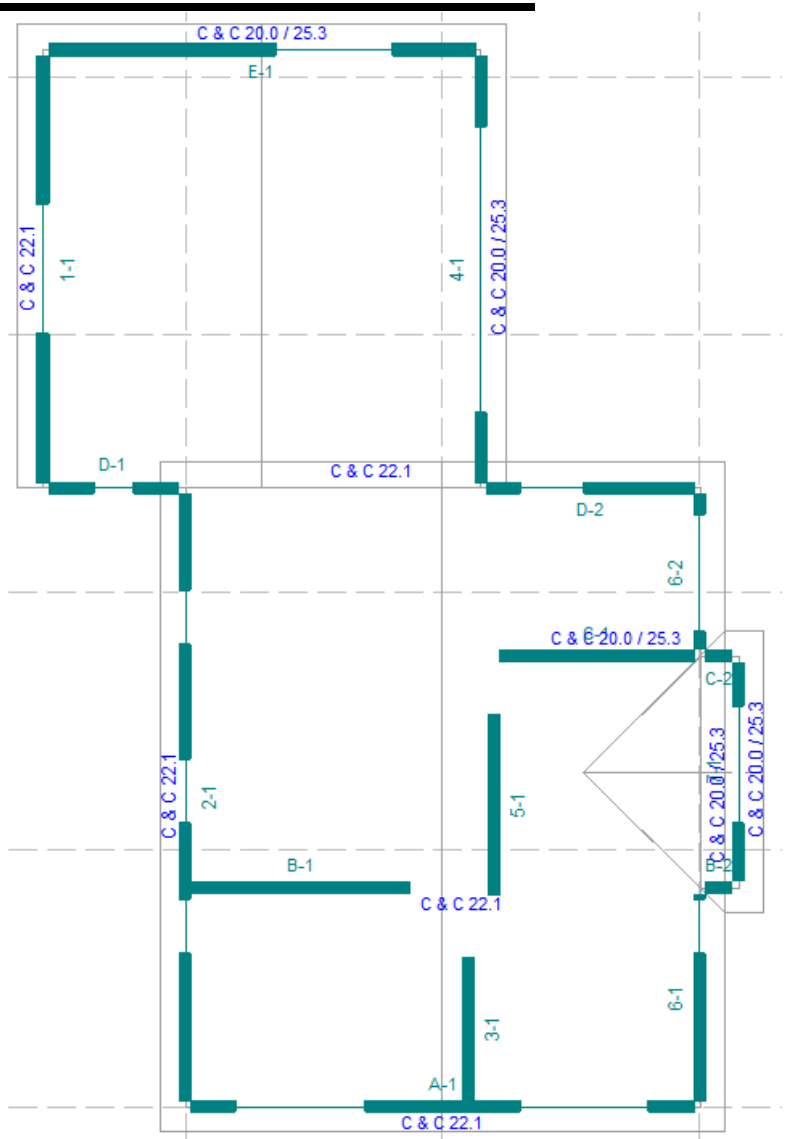
- Scroll between levels to view loads allocated to each level
- Toggle “Show” menu on top left toolbar to switch between seismic & wind
- Unfactored line loads

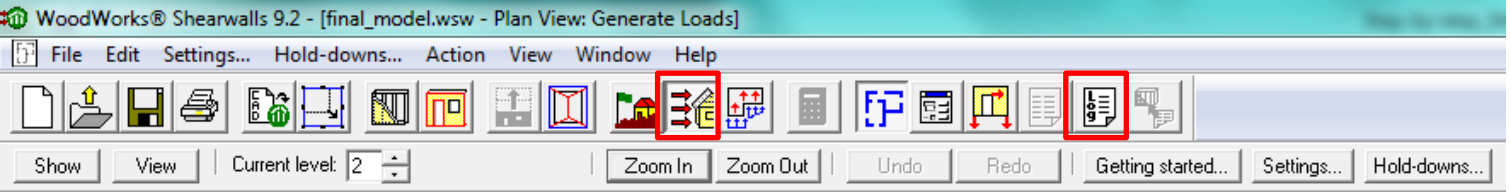




Wind Load Generation – C&C

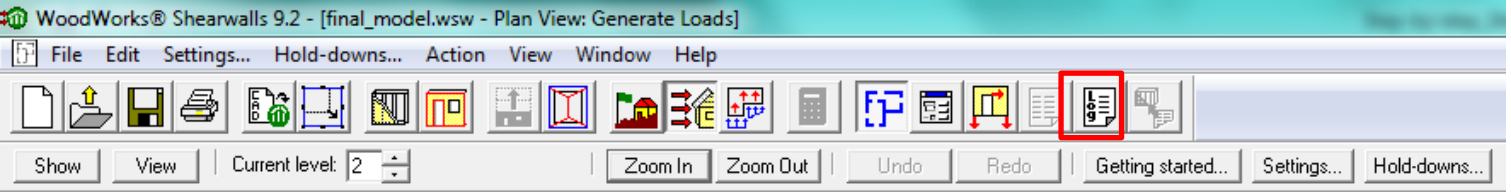
- Does not generate C&C loads on roofs and does not design roof sheathing
- Unfactored area load
- Interior/end (last 4 ft.)





Log File

- Shows unfactored wind and seismic loads
- Can be used to check calculation inputs for wind load generation and base shear
- Gives detailed calculation for torsional analysis



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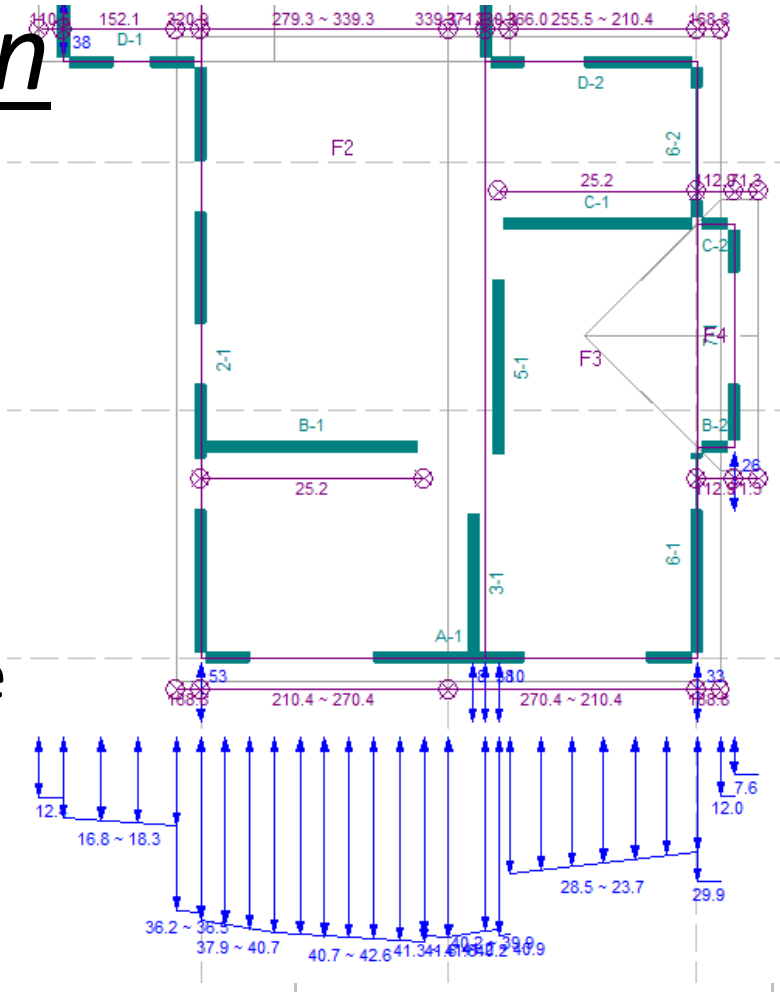
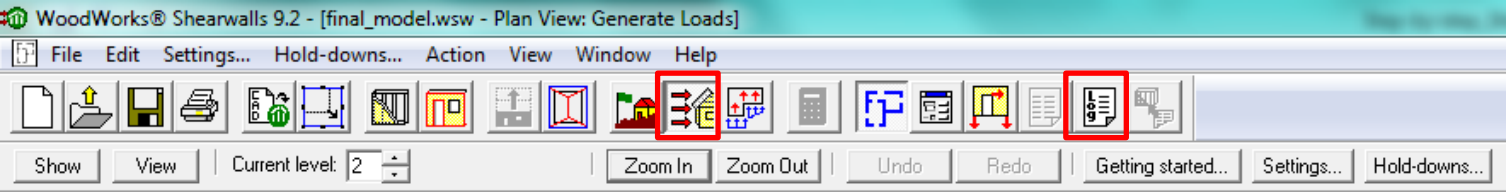
Wind Load Generation – log file calcs

```
WoodWorks® Shearwalls Log File for final_model.wsw
Design Code: National Building Code of Canada 2010

--------------------------------------------------------------------------------
                          Wind Load Generation
MWFRS Procedure: NBC Fig. I-15
C&C Procedure: Components and Cladding
Time: Mar. 20, 2015  12:18:33
--------------------------------------------------------------------------------
Site information:
Enclosure = 2 Ord. closed openings
Occupancy = Normal (all other buildings); Importance factor Iw = 1.00;
Velocity pressure q = 0.580 kPa
Terrain = Rough

Legend:
P - Design wind pressure (see Equations); q - 1 in 50 velocity pressure from Table C-2
Ce - Exposure factor from 4.1.7.1.5 5)
Cei - Internal exposure factor using reference height h = 1/2 eave height (Commentary I-8)
Cg - Gust effect factor from 4.1.7.1 (6) (a) for MWFRS and 4.1.7.6 b) for C&C
Cg - Internal gust effect factor from 4.1.7.1 (6) (c), or Commentary I-22 as input in Site dialog
Cp - External pressure coefficient from Figure I-15, uses Cp* for C&C loads
Cpi - Internal pressure coefficient from Commentary 31
Iw - Importance factor from Table 4.1.7.1
h - Reference height for Ce calculation from Commentary I-7(b).
Lev - Building level; Fc - Building face; Zn - C&C end or interior zone
Trib - Max vert. extent of loaded surface; Start, End - Horz. extent of resulting load
Mag(S),(E) - MWFRS: Magnitude of resulting diaphragm line load at start/end, C&C: Area load

Equations:
MWFRS Pressure Equation: P = Iw q Ce Cg Cp; from NBC 4.1.7.1 1)
C&C Pressure Equation:   P = Iw q Ce Cg Cp - Iw q Cei Cgi Cpi; from NBC 4.1.7.1 3)
Other Equations:         Ce = max(0.9, (h/10)^1/5) for open terrain; from NBC 4.1.7.1 5)
                         Ce = max(0.7, (h/12)^3/10) for rough terrain; from NBC 4.1.7.1 5)

Units: ft, lbs

Block 1: EW x NS = 21.50 x 24.00  Mean Roof Height = 22.55
--------------------------------------------------------------------------------
MWF: Lev Fc Dir Zn     h     p    Ce   Cg    Cp   Trib  Start/ End/    Mag(S)/ Mag(E)
C&C: Lev Fc Dir Zn     h     p    Ce   Cg    Cp   Trib   Cei   Cgi      Cpi     Mag )
--------------------------------------------------------------------------------
MWF   1  N  WW       9.25  12.91 0.70 2.00  0.76  4.83  11.5   20.0     62.4    62.4
MWF   1  N  WW       9.25  12.91 0.70 2.00  0.76  4.83  20.0   21.5     62.4    62.4
MWF   1  N  LW       9.83  -7.78 0.70 2.00 -0.46  4.83  11.5   20.0     37.6    37.6
MWF   1  N  LW       9.83  -7.78 0.70 2.00 -0.46  4.83  20.0   21.5     37.6    37.6
C&C   1  N  LW  End 10.83 -30.53 0.70 2.50 -1.20  4.83   0.7    2.0      0.30    30.5
C&C   1  N  LW  Int 10.83 -24.17 0.70 2.50 -0.90  4.83   0.7    2.0      0.30    24.2
```

Seismic Load Generation

- Toggle “Show” menu on top left toolbar to switch between wind & seismic
- Only direct shear loads shown (see log file for torsional analysis)
- Legend on bottom left

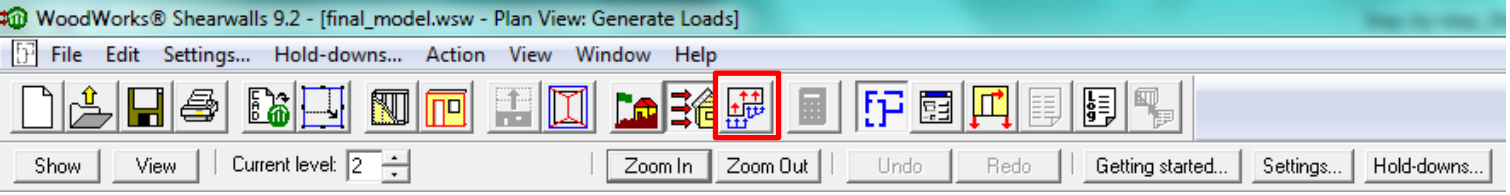




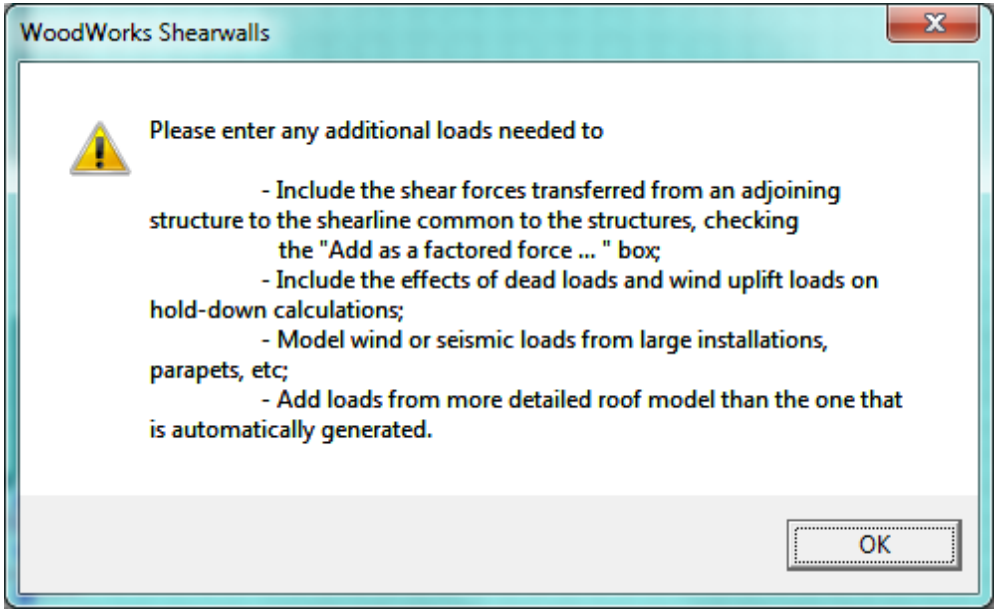
Seismic Load Generation

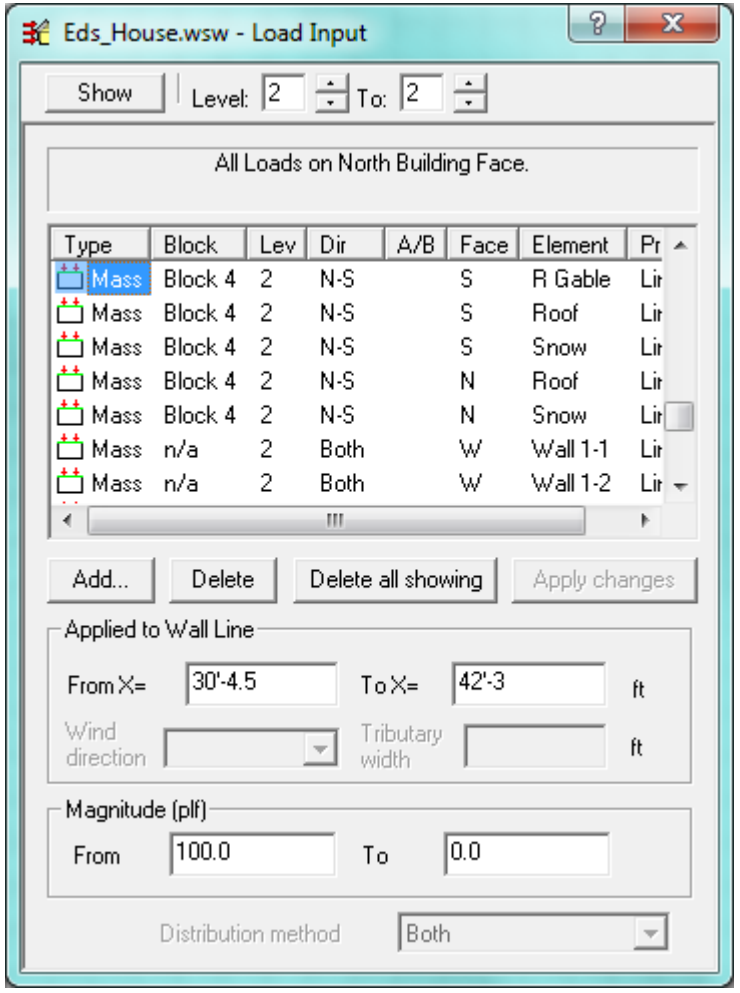
- Log file calculations
- Click “Log file…” on top toolbar

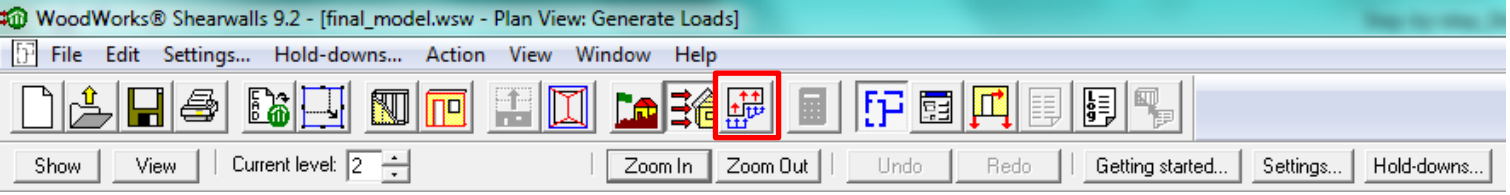
```
--------------------------------------------------------------------------------
                    Seismic Load Generation

Procedure: National Design Code of Canada

Time: Mar. 20, 2015  12:18:33

--------------------------------------------------------------------------------
Symbols:
V    - minimum lateral seismic force            W    - total seismic dead load
Vx   - design story shear on story x            Rd   - SFRS ductility force modification factor
Fx   - design seismic force applied to level x  Ro   - overstrength force modification factor
S(T) - design spectral response acceleration    hn   - height of level n
Sa(T)- 5% damped spectral response acceleration hx   - height of level x
Ta   - fundamental period of vibration          hi   - height of level i
Fa   - acceleration based site coefficient      wi   - weight of level i
Fv   - velocity based site coefficient          wx   - the portion of W assigned to level x
Mv   - higher mode factor                       Ft   - Top floor force
Ie   - importance factor

Equations:
Minimum Lateral Seismic Force: V = S(Ta) Mv Ie W / (Rd Ro) (unless 4.1.8.11 2) c) used)
Structure Period: Ta = 0.05 hn^(3/4)
Top Floor Force: Ft = 0.07 Ta V
Story Shear: Vx = (V - Ft) hx wx / SUM(wi hi)
Top Storey Shear Force: Vn = Ft + Fn
Segment Lateral Force:  Vp = v I Sp Wp


User Input Site Information:
Design code    = National Building Code of Canada 2010
Seismic method = National Building Code of Canada 2010
Risk Normal (all other buildings)
Regular structure
Importance factor Ie = 1.00
Site Class = D
Sa(0.2) = 0.23;   Sa(0.5) = 0.15;   Sa(1.0) = 0.09;   Sa(2.0) = 0.03
Fa = 1.30;                  Fv = 1.40

Units: ft, lbs


Calculation of the total design base shear:

N<->S: Rd = 2.000;  Ro = 1.700;  T = 0.192;  S = 0.299;  W = 51957 lbs;  Mv = 1.0;  V = 3046 lbs;
E<->W: Rd = 2.000;  Ro = 1.700;  T = 0.192;  S = 0.299;  W = 51957 lbs;  Mv = 1.0;  V = 3046 lbs;

Note: 4.1.8.11 2) c): V = 2/3 S(0.2) Ie W / (Rd Ro) used for N<->S V.
Note: 4.1.8.11 2) c): V = 2/3 S(0.2) Ie W / (Rd Ro) used for E<->W V.
Manually added or modified seismic loads and forces do not contribute to seismic base shear,
nor are they included in the distribution of base shear to building levels

Distribution of total design base shear to stories:

   Level  Height[ft]   Weight[lbs]  Height * Weight
   ------------------------------------------------
     1    8'-10        31861        254888.000
     2    19'-8.64     20096        381824.000
```



Manual Load Input

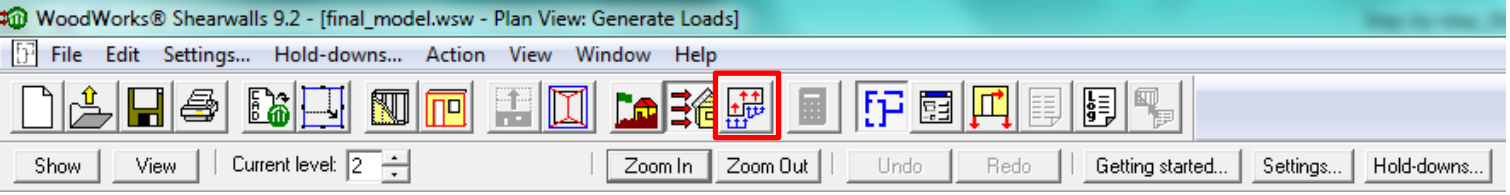






Manual Load Input

- Input wind uplift loads & dead loads – these will affect hold-down & anchorage design
- Add loads from external installations (cisterns/tanks, equipment, etc.) which will contribute to base shear
- Input additional load if floor weight changes from one area to another on the same level
- Model diaphragm openings using a negative building mass equal and opposite to floor mass on that level



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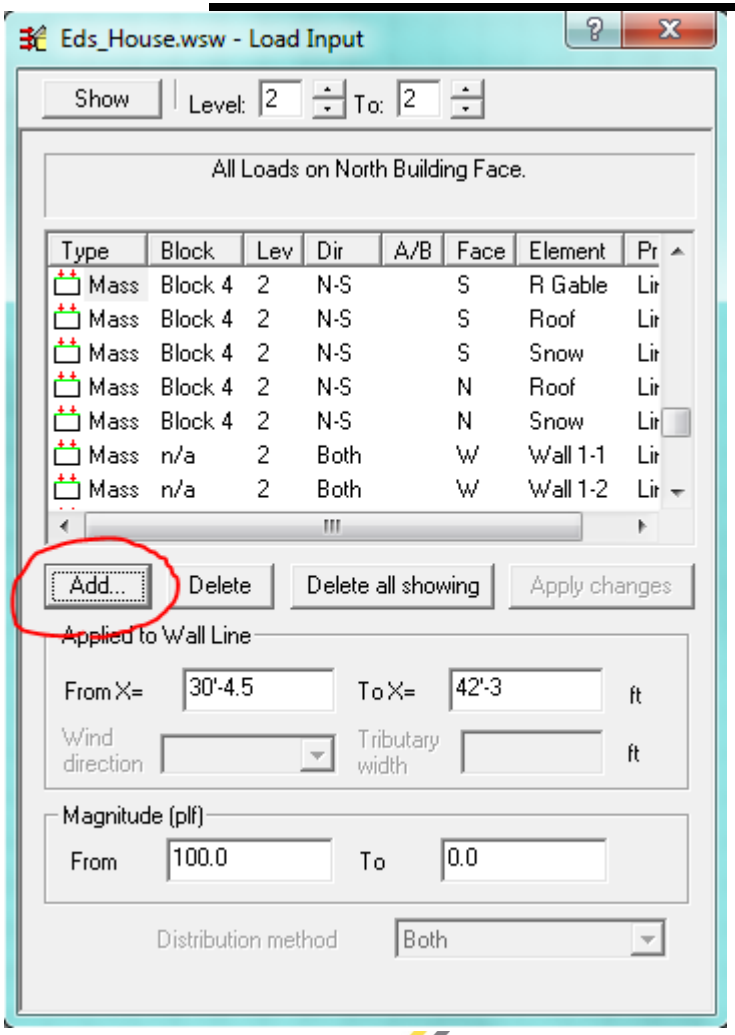
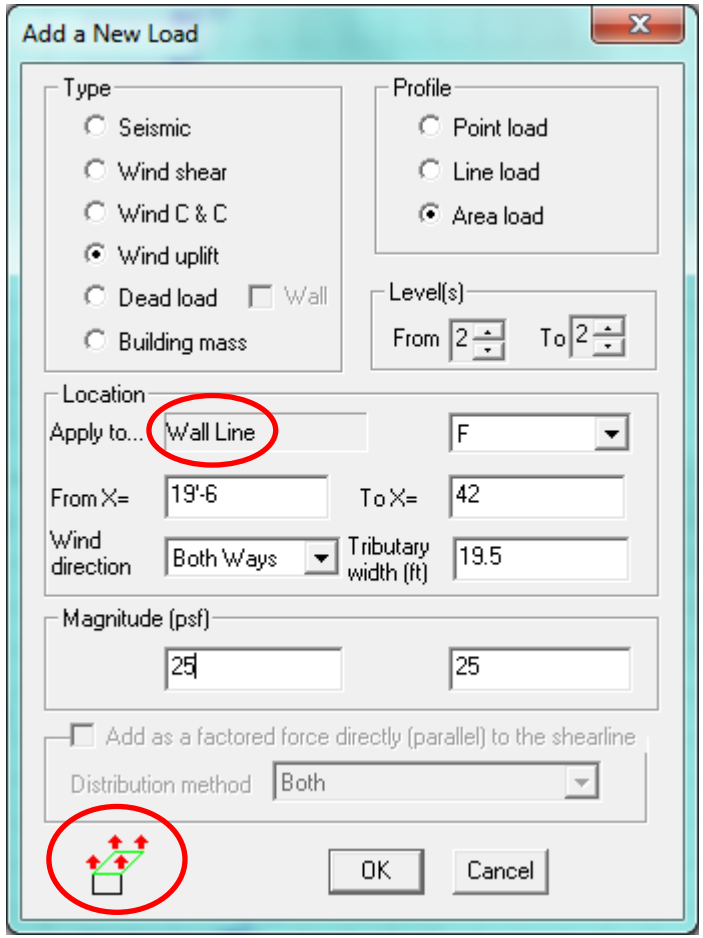
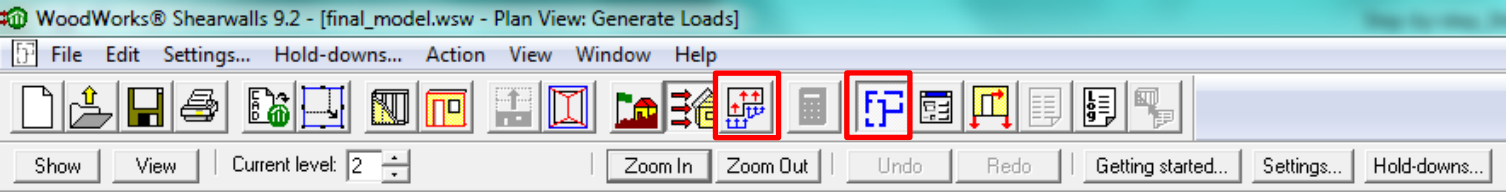
Manual Load Input

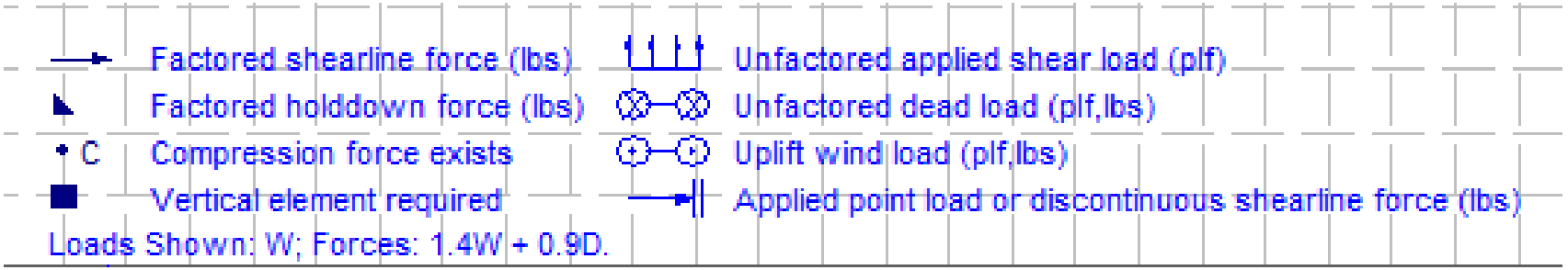




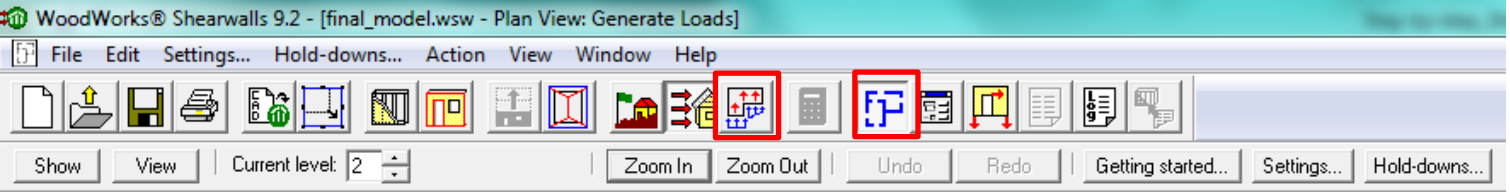


Loads & Forces – Plan View

- Refer to legend in bottom left corner of plan view



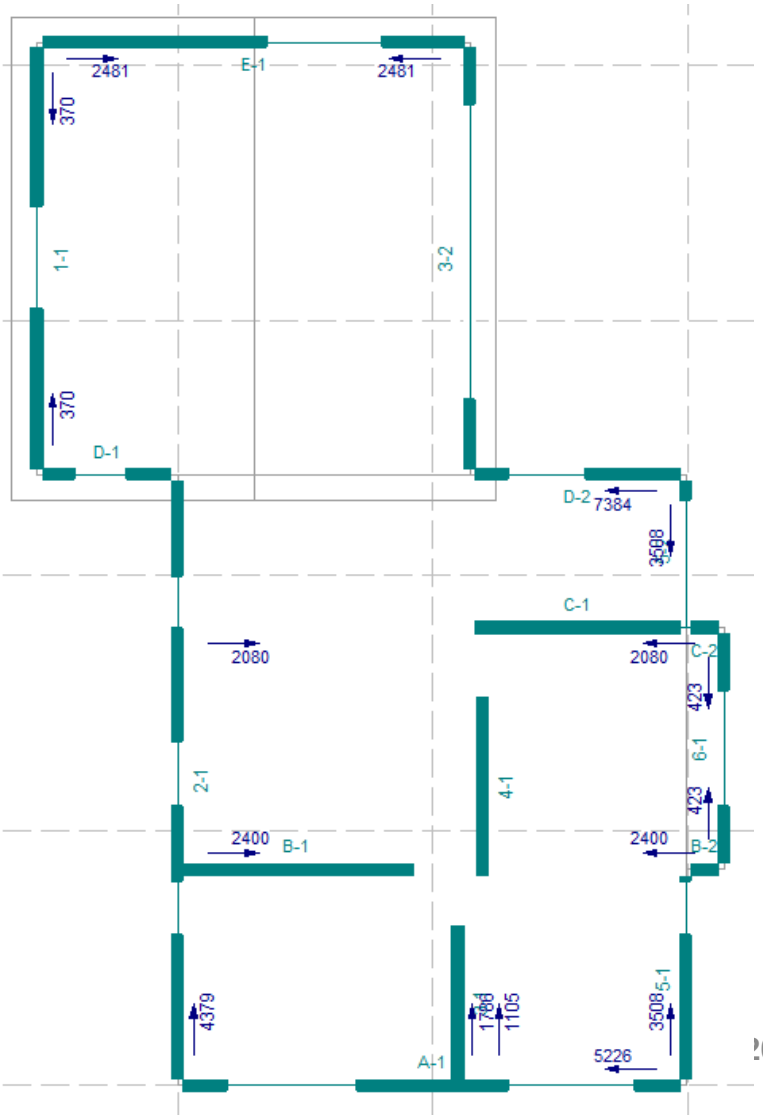
- Wind load factor = 1.4
- DL resistance factor = 0.9
- Vertical elements required if shearwall above terminates at the mid-point of shearwall below (see elevation view for graphical representation)

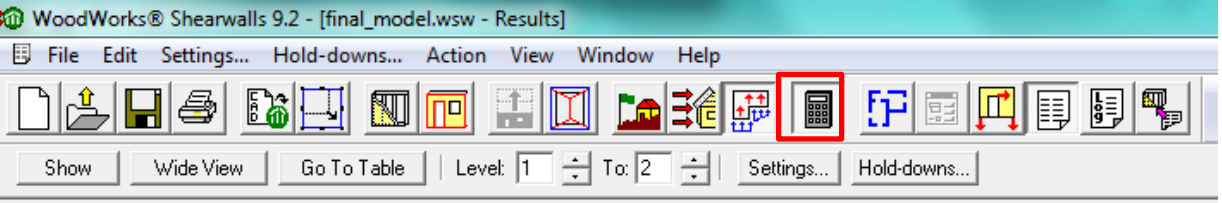


Loads & Forces – Plan View

- Use “Show” menu to toggle information shown in plan

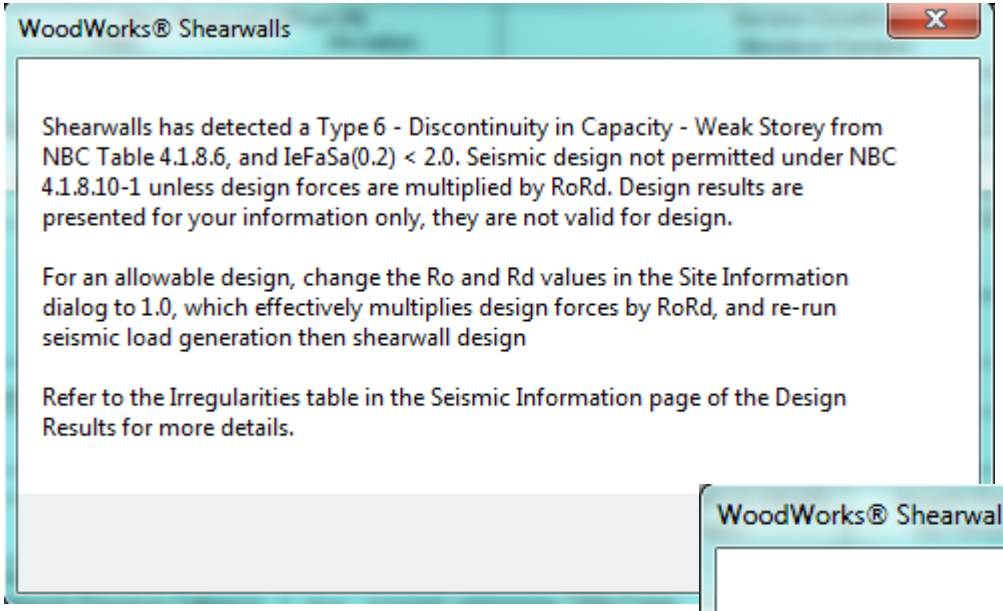
- Wind or Seismic
- Forces → Flexible
- Load direction → Critical forces



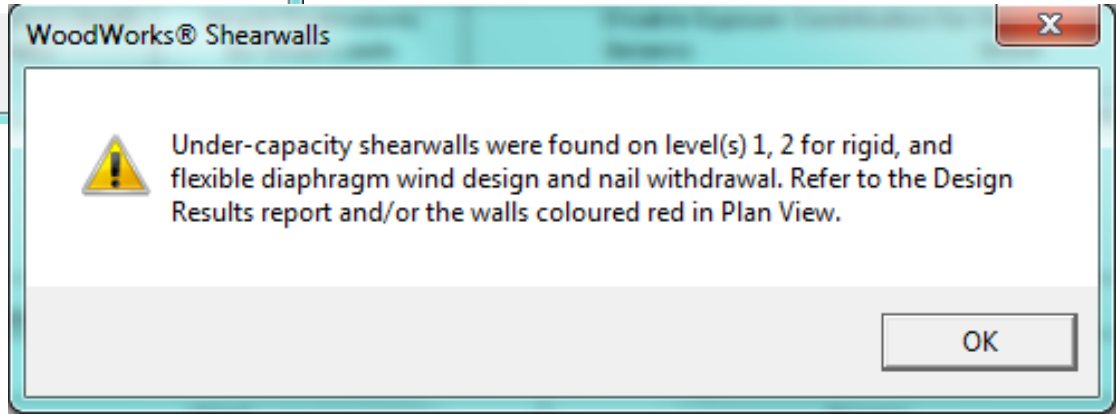


Results – Warning Messages

- Software detects irregularities

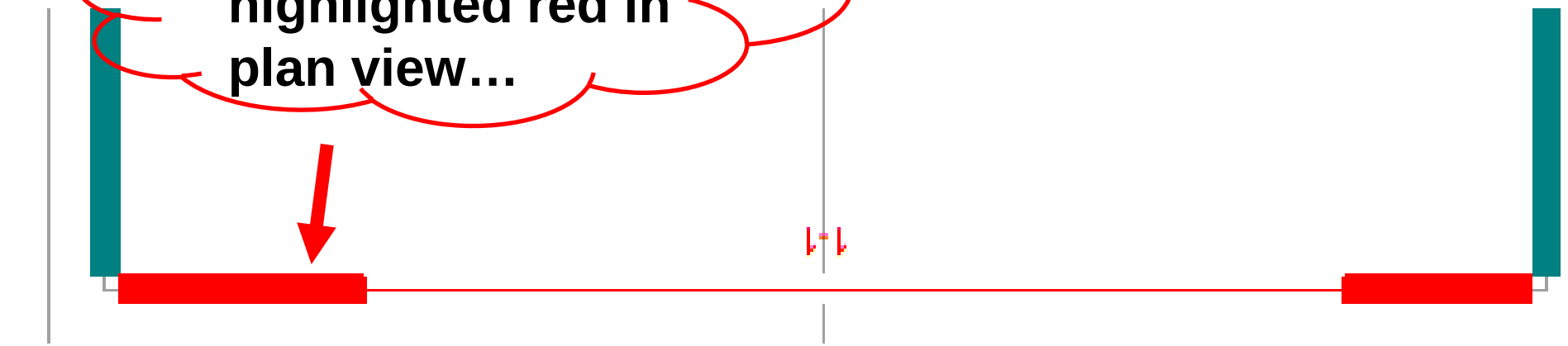


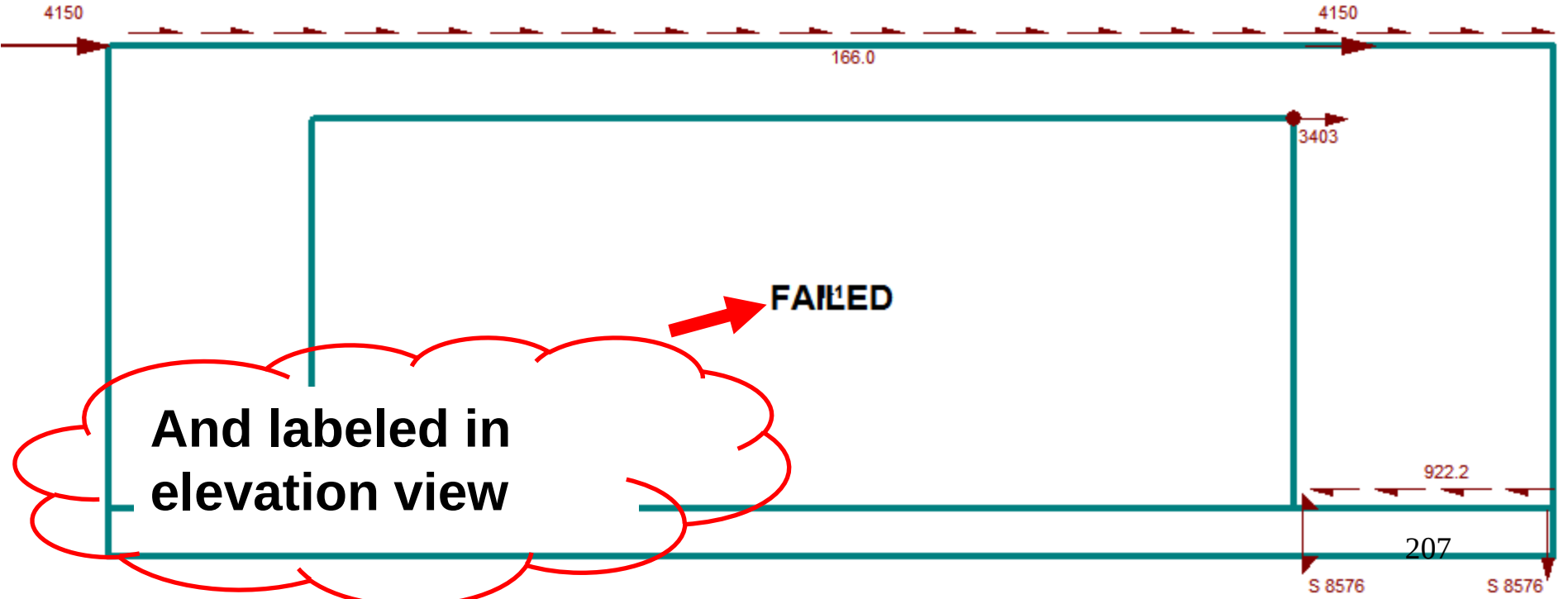
- Under-capacity walls



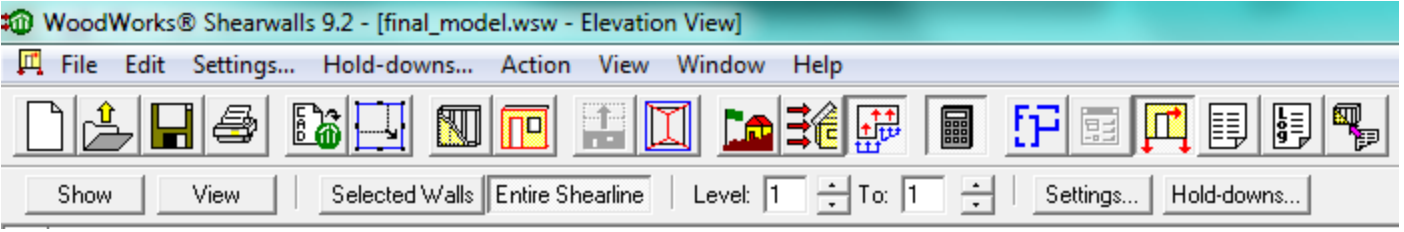
WoodWorks®
SOFTWARE FOR WOOD DESIGN

Failing walls are highlighted red in plan view…





And labeled in elevation view



Loads & Forces – Elevation View

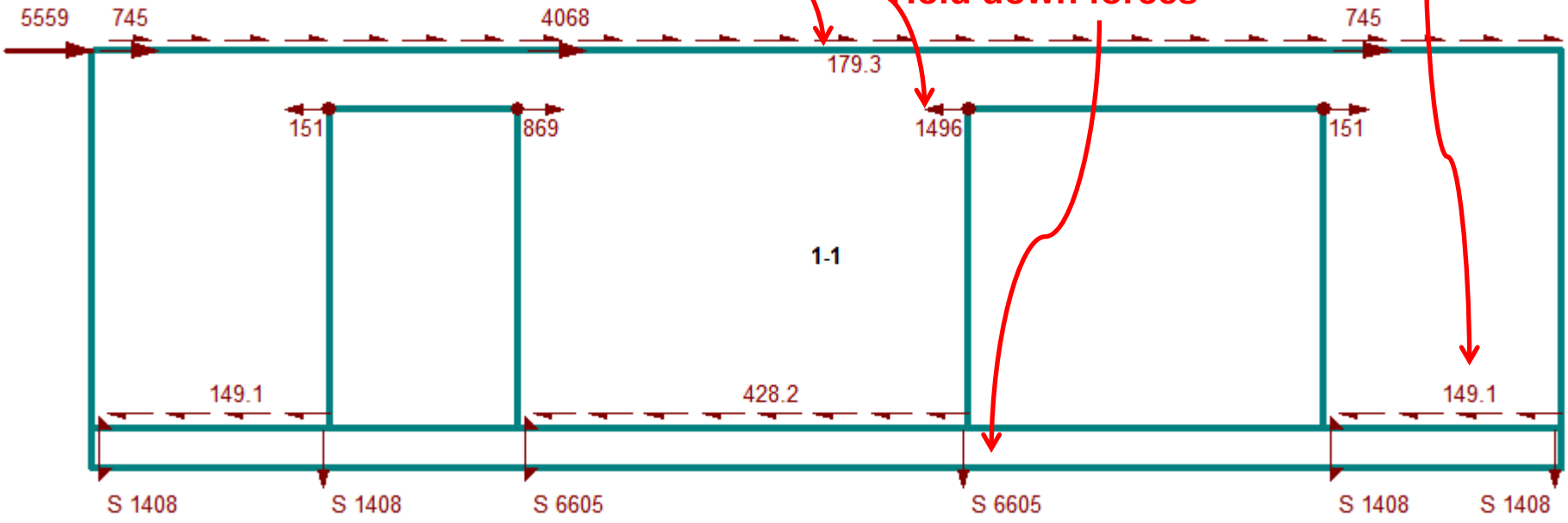
Shear wall force

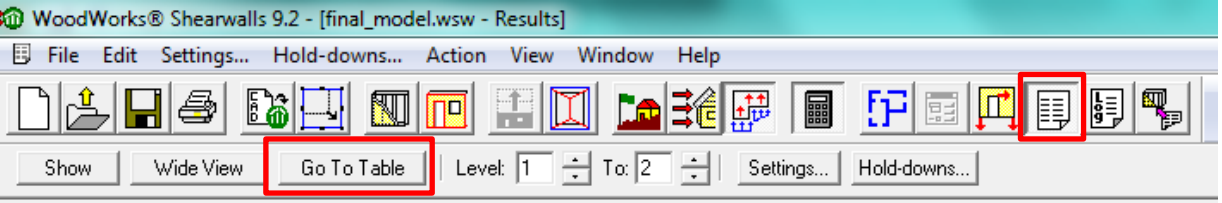
Shear wall force at top per unit length

Drag strut forces due to openings

Shear wall force at base of segments

Hold down forces





Results – Design Summary

- Go To Table -> Design Summary

Design Summary

SHEARWALL DESIGN

Wind Shear Loads, Flexible Diaphragm
The following under-capacity walls were found:
Level 1: A-1, B-1, 4-1, C-1, 5-1, D-2
Level 2: A-1, 5-1

Wind Shear Loads, Rigid Diaphragm
The following under-capacity walls were found:
Level 1: A-1, B-1, C-1, D-2, E-1
Level 2: A-1

Components and Cladding Wind Loads, Out-of-plane Sheathing
All shearwalls have sufficient design capacity.

Components and Cladding Wind Loads, Nail Withdrawal
The following under-capacity walls were found:
Level 1: 1-1, A-1, 2-1, B-2, B-1, 3-1, 3-2, C-1, C-2, 5-1, 5-2, 6-1, D-2, D-1, E-1
Level 2: A-1, 2-1, B-1, C-1, 5-2, 5-1, 6-1

Seismic Loads, Flexible Diaphragm
All shearwalls have sufficient design capacity.

Seismic Loads, Rigid Diaphragm
All shearwalls have sufficient design capacity.

HOLDDOWN DESIGN

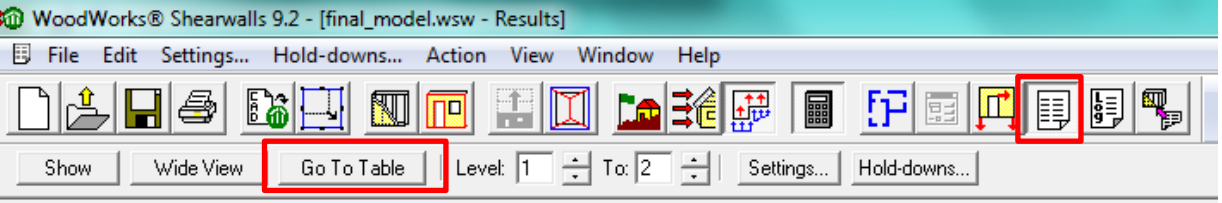
Wind Loads, Flexible Diaphragm
Under-capacity hold-downs were found on the following walls:
Level 1: A-1, D-2, 2-1, 5-1
Level 2: A-1, 5-1

Wind Loads, Rigid Diaphragm
Under-capacity hold-downs were found on the following walls:
Level 1: A-1, D-2, E-1, 2-1, 5-1, 6-1
Level 2: A-1, D-1

Seismic Loads, Flexible Diaphragm
Under-capacity hold-downs were found on the following walls:
Level 1: A-1, D-2, 5-1

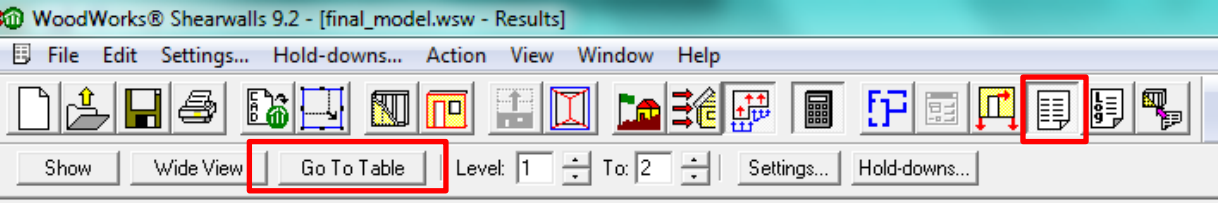
Seismic Loads, Rigid Diaphragm
Under-capacity hold-downs were found on the following walls:
Level 1: A-1

This Design Summary does not include failures that may occur for the following reasons:
Percentage of gypsum wallboard (O86 Table 9.5.4) – Refer to the Gypsum Wallboard Percentage table
Excessive fastener slippage (O86 Table A.9.7) – Refer to the Deflection table
Excessive storey drift (NBC 4.1.8.13 (3)) – Refer to the Storey Drift table
Seismic irregularities (NBC 4.1.6.6) – Refer to the Seismic Irregularities table
Over-capacity ratio violation (O86 9.8.3.2). – Refer to the Seismic Information table.



Navigating Results Output

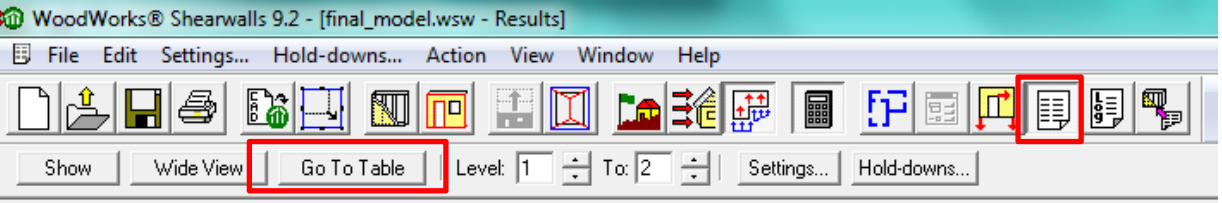
- Use “Go To Table” as an index
- Project Information – echoes user inputs
- **Structural Data**
  - Tabular summary of building, wall, roof dimensions
  - Sheathing & framing materials by wall group
  - Wall & opening dimensions (FHS for wind vs. seismic)
  - Building masses (also shown in plan view)



Navigating Results Output

- **Loads**
  - Wind shear
  - C&C

  1.4W factor not included in load tables or plan view
  - Dead (*only these resist overturning & factored by 0.9*)
  - Uplift (*includes manually applied loads*)
  - Building masses (*also shown in plan view*)
  - Seismic (*direct force only, torsional not included*)
- All loads are unfactored in results tables & plan view
- All tables & plan view loads include ULS importance factor



Navigating Results Output

- **Wind Design –** Shear Results

- Flexible diaphragm

SHEAR RESULTS

North-south Shearlines	Wl Gp	For Dir	Wind Case	Shear Force FHS [ft]	Fv [lbs]	Fv/L [plf]	Capacities [plf] Vhd/L Int	Vhd/L Ext	Jhd	Vrs/L	V [lbs]	Ratio Fv/V
Line 4												
Ln4, Lev1	-	Both		7.50	1105	46.0	-	-	-	-	863	1.28*
Wall 4-1	2	Both		7.50	1105	147.3	58	58	1.00	115	863	-

Wall Group (W Gp) shown here corresponds to the wall group on the sheathing and framing materials tables.

*WARNING - Design capacity has been exceeded.

Information that can be used to create shearwall schedules:

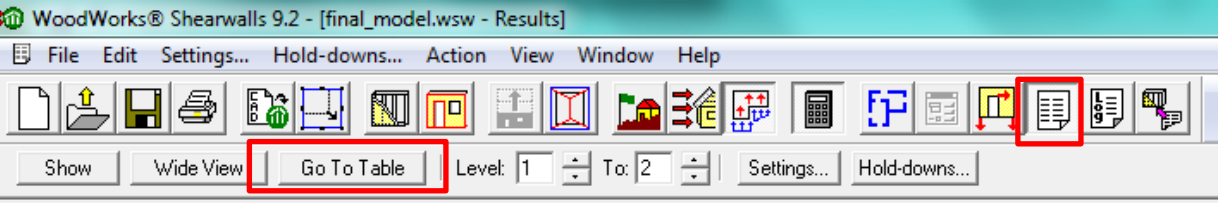
SHEATHING MATERIALS by WALL GROUP [mm]

Wall		Sheathing:	Grade/				Fasteners			Spacing				
Grp	Surf	Material	Ply	Thk	Or	Bv	Dia	Len	Pen	Edg	Int	Bk	Jub	#
1	Ext	OSB Const	M1	9.5	Horz	10000	3.25	2-1/2	54	150	300	Y	1.0	1,8
2	Both	GWB	-	15.9	Horz	7005	-	1-1/4	16	150	300	Y	1.0	10

Legend:
Grp - Wall design group number, used to reference wall in other tables (created by program)
Surf - Exterior or interior surface when applied to exterior wall

FRAMING MATERIALS and STANDARD WALL by WALL GROUP

Wall Grp	Species	Grade	b mm	d mm	Spcg mm	Jsp	E MPa	Standard Wall
1	S-P-F	No.1/No.2	38	140	400	0.8	9500	Exterior with Anchorages
2	S-P-F	No.1/No.2	38	140	400	-	9500	Interior Shearwall



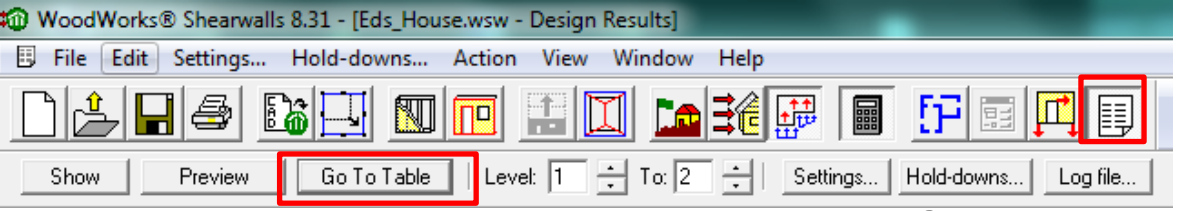
Navigating Results Output

- **Wind –** Hold-down Design
  - Flexible diaphragm

HOLD-DOWN DESIGN (flexible wind design)

Level 1 Line-Wall	Posit'n	Location [ft] X	Y	Note	Tensile Holddown Force [lbs] Shear	Dead	Uplift	Cmb'd	Hold-down	Cap [lbs]	Crit Resp.
Line 1											
1-1	L End	-5.50	24.12		262			262	HDU2-SDS2.5	2900	0.09
1-1	L Op 1	-5.50	30.38		262			262	HDU2-SDS2.5	^2900	0.09
1-1	R Op 1	-5.50	34.62		262			262	HDU2-SDS2.5	^2900	0.09
1-1	R End	-5.50	40.88		262			262	HDU2-SDS2.5	2900	0.09
Line 2											
2-1	L End	0.00	0.12		3264			3264	HDU2-SDS2.5	2900	1.13*
2-1	L Op 1	0.00	5.88		3246			3246	HDU2-SDS2.5	^2900	1.12*
2-1	R Op 1	0.00	8.12		3412			3412	HDU2-SDS2.5	^2900	1.18*
2-1	L Op 2	0.00	10.88		3393			3393	HDU2-SDS2.5	^2900	1.17*
2-1	R Op 2	0.00	13.62		3312			3312	HDU2-SDS2.5	^2900	1.14*
2-1	L Op 3	0.00	17.88		3294			3294	HDU2-SDS2.5	^2900	1.14*
2-1	R Op 3	0.00	20.12		3336			3336	HDU2-SDS2.5	^2900	1.15*
2-1	R End	0.00	23.88		3318			3318	HDU2-SDS2.5	2900	1.14*

*WARNING - Design capacity has been exceeded.



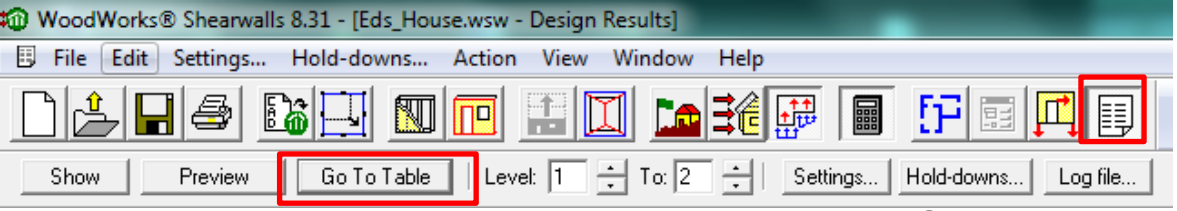
Navigating Results Output

- **Maximum % Gypsum Wallboard**

Software checks (*both directions for wind + seismic*):

- Total capacity (wood + gyp.) ≥ Applied force
- Total capacity wood ≥ 100% - max % gyp. (each floor)
- Max gyp. capacity ≤ Table 9.5.4 CSA O86-09 (*assuming force distribution based on relative capacity*)

- 5- & 6- storey structures – gyp. contribution is ignored



Navigating Results Output

- **Wind Design** – Max GWB

NORTH <-> SOUTH [lbs]

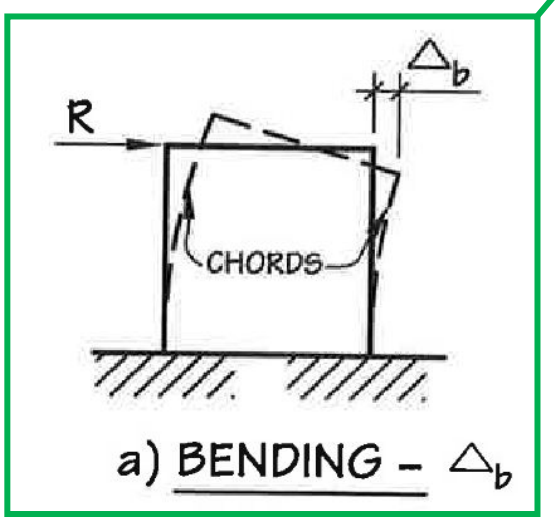
S	Max GWB	Capacity GWB	Capacity Wood	N -> S Total Force	N -> S Wood Cap %	N -> S Resisted by GWB Force	N -> S Resisted by GWB %	S -> N Total Force	S -> N Wood Cap %	S -> N Resisted by GWB Force	S -> N Resisted by GWB %
1	60%	4768	13481	11503	117.2	3472	30.2	11572	116.5	3492	30.2
2	80%	1914	8175	4532	180.4	860	19.0	4532	180.4	860	19.0

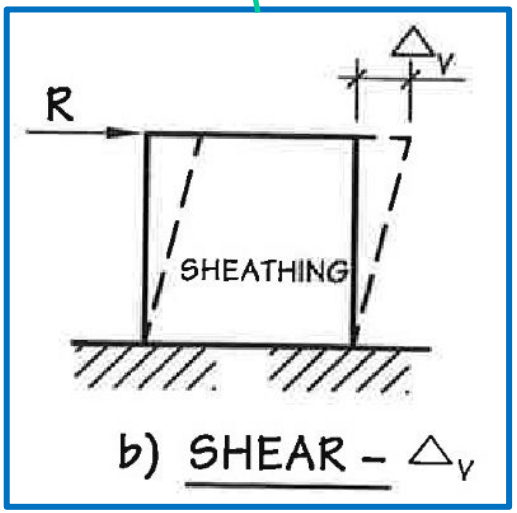
Wood cap % - *Wood capacity available as a percentage of the total shear force, must be at least (100% – maximum allowable GWB)*

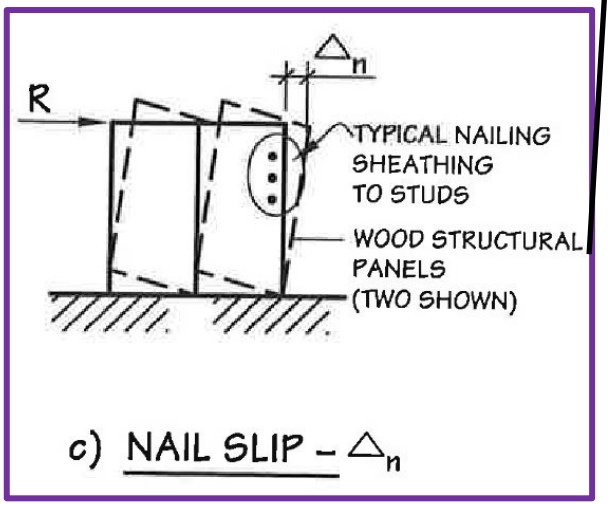
Force resisted by GWB – Total of forces resisted by GWB, assuming sides of composite walls resist force based on relative capacity

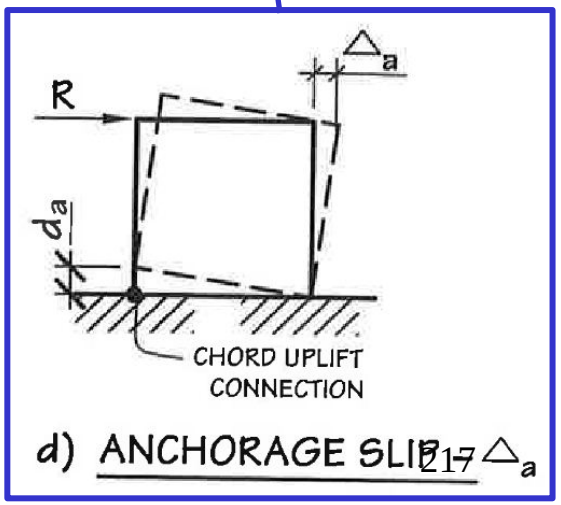
Notes:
According to 9.5.4 Note (2), there should be a balanced spatial distribution of gypsum wallboard and wood-based panels on every level in each direction.

$$\Delta_{sw} = \frac{2vH_s^3}{3EAL_s} + \frac{vH_s}{B_v} + 0.0025H_s e_n + \frac{H_s}{L_s} d_a$$







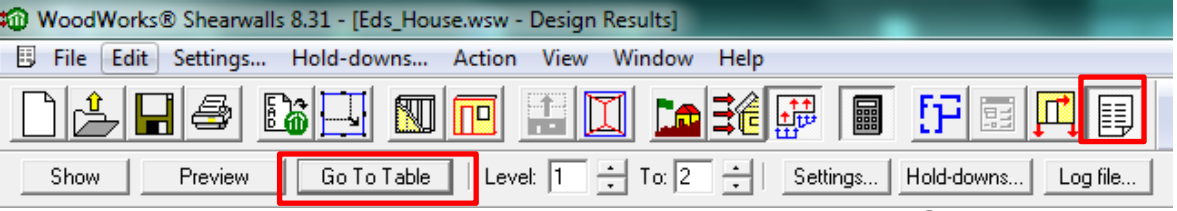


Deflection output

$$\Delta_{sw} = \frac{2vH_s^{\,3}}{3EAL_s} + \frac{vH_s}{B_v} + 0.0025H_s e_n + \frac{H_s}{L_s} d_a$$

DEFLECTION (flexible seismic design)

Wall, segment	W Gp	Dir	Srf	v plf	L ft	H ft	Bending A sq.in	Bending Defl in	Shear Defl in	Nail slip Vn lbs	Nail slip en in	Nail slip Defl in	Hold Defl in	Total Defl in
Level 1														
Line 1														
1-1	2	Both	Ext	146.2	20.33	9.00	16.5	.002	.042	72	.010	.070	0.13	0.24
Line 2														
2-1	2	Both	Ext	146.2	20.33	9.00	16.5	.002	.042	72	.010	.070	0.13	0.24
Line A														
A-1	1	Both	Ext	64.0	46.67	9.00	16.5	.000	.022	32	.004	.029	0.01	0.06
Line B														
B-1,1	1	Both	Ext	46.7	9.33	9.00	16.5	.001	.016	23	.003	.021	0.23	0.27
B-1,2		Both	Ext	71.9	12.67	9.00	16.5	.001	.025	35	.005	.033	0.21	0.27
B-1,3		Both	Ext	100.5	16.33	9.00	16.5	.002	.034	49	.007	.046	0.19	0.27



Navigating Results Output

- **Shearwall Deflection**

Wall, segment	W Gp	Dir	Srf	v plf	L ft	H ft	Bending A sq.in	Bending Defl in	Shear Defl in	Nail slip Vn lbs	Nail slip en in	Nail slip Defl in	Hold Defl in	Total Defl in
Level 2														
Line 3														
3-1	6	S->N	Ext	765.1	5.25	8.00	16.5	.025	.107	377*	.039	.235	0.84	1.21
		S->N	Int	66.5					.160	44	.030	.183		
		N->S	Ext	749.8	5.25	8.00	16.5	.024	.105	369*	.039	.235	0.83	1.19
		N->S	Int	65.6					.157	43	.030	.183		

v - SLS-factored shear force on wall segment = Design shear force / 1.4 wind factor x 0.75 SLS importance factor / 1.0 ULS importance factor

Defl - Horizontal shearwall deflection due to given term:

Bending = 8vH^3 / EAL; A - Cross sectional area of segment end stud(s); E - Stud mod. of elasticity from Framing Materials table

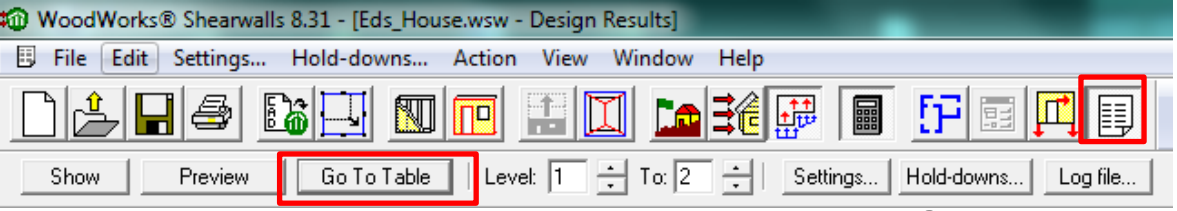
Shear = vH / Bv; Bv - Shear-through-thickness rigidity from Table 7.3A-C, value is in Sheathing Materials table

Nail slip = .762H x en; en – From Table A.9.7; Vn - Shear force per nail along panel edge

Hold – Hold-down = da x H/L; refer to Hold-down Displacement table for components of da

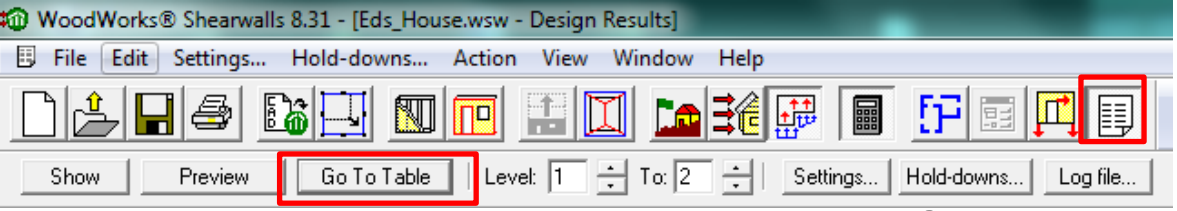
Total Defl = Deflection from bending + shear + nail slip + hold-down, as per 9.7.1.1

*WARNING - Maximum load per fastener Vn from Table A.9.7 exceeded. Maximum Vn used but it underestimates actual deflection.



Navigating Results Output

- **Shearwall Deflection**
- Shear may or may not be distributed to both sides of composite (wood + gyp.) wall for deflection calculation
- Either shear is distributed to both sides of wall until deflection on both sides is equal, or
- All shear force is placed in wood panel when deflection of gypsum is > deflection of fully loaded wood panel (*this occurs because slippage is a constant term for non-wood sheathing*)
- Only applied for deflection & storey drift not ULS capacity



Navigating Results Output

- **Wind Suction Design –** Components & Cladding

Out-of-plane Wind Design

COMPONENTS AND CLADDING by SHEARLINE

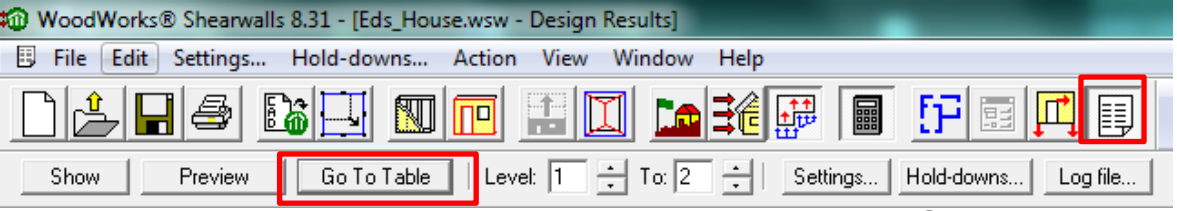
North-South Shearlines			Sheathing [psf]			Fastener Withdrawal [lbs]					Service Condition Factor
			Force	Cap	Force/ Cap	Force		Cap	Force/Cap		
Line	Lev	Grp				End	Int		End	Int	
1	1	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00
2	1	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00
	2	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00
3	1	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00
5	1	1	42.7	0.0	**	0.0	0.0	45.2	0.00	0.00	1.00
	2	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00
6	1	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00
	2	1	42.7	248.7	0.17	55.2	48.3	45.2	1.22*	1.07*	1.00

Force - For low-rise: Factored C&C end zone exterior pressures added to interior pressure (Commentary 31), using with negative (suction) exterior co-efficient and minimum area in Figure I-8

Force - For Figure 1-15 method: Factored C&C pressure using the worst-case combination of negative and positive exterior and interior coefficients (not necessarily suction)

Cap - Out-of-plane bending and shear capacity of exterior sheathing, using mp and vpb strengths from O86 Tables 7.3A-C. Assumes continuous over 3 spans, except for vertical panels and 24" stud spacing.

*WARNING - Nail withdrawal design capacity is exceeded.
**WARNING - No exterior sheathing material or sheathing has no C&C capacity.



Navigating Results Output

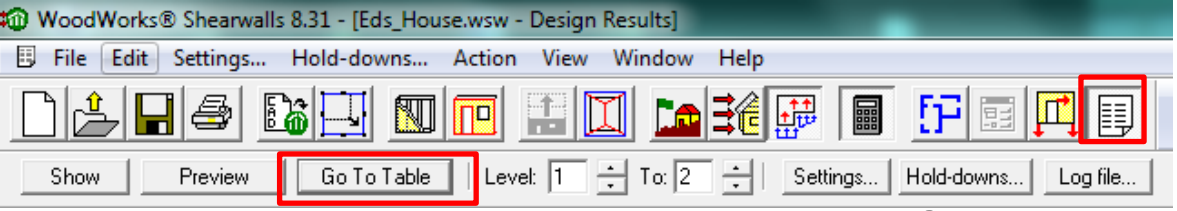
- **Seismic Design –** Base Shear

SEISMIC INFORMATION

Level	Mass [lbs]	Storey Shear [lbs] E-W	Storey Shear [lbs] N-S	Shear Capacity [lbs] E-W	Shear Capacity [lbs] N-S	Over-capacity E-W	Over-capacity N-S	Length of SFRS [ft] E-W	Length of SFRS [ft] N-S
2	20096	1974	1988	8142	10089	4.12	5.07	21.5	24.0
1	31861	3394	3449	10037	18249	2.96	5.29	27.0	41.0
All	51957	-	-					-	-

Storey shear - Sum of factored, vertically accumulated shearline forces on level, including torsional effects.
Total unfactored base shear - 3046 lbs

- Base shear – torsional effects *not* included (*detailed calculation shown in log file*)
- Torsional effects included in storey shear
- Overcapacity ratio (C_2/C_1) does not apply, < 3-storeys



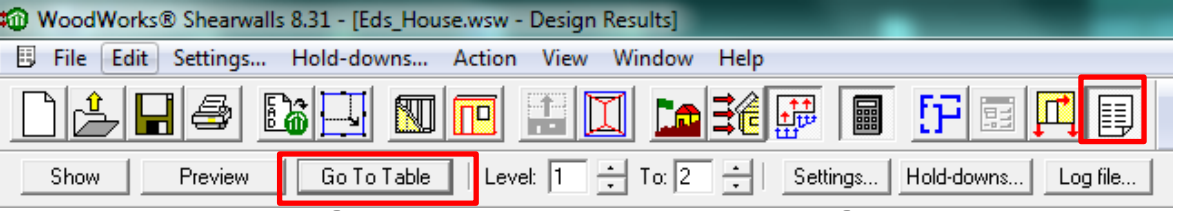
Navigating Results Output

- **Seismic Design –** Flexible – Shear Results

- ULS capacity → design passes for all shearwalls

SHEAR RESULTS (flexible seismic design)

North-south Shearlines	W Gp	For Dir	Shear Force FHS [ft]	Fv [lbs]	Fv/L [plf]	Capacities [plf] Vhd/L Int	Vhd/L Ext	Jhd	Vrs/L	Vr [lbs]	Ratio Fv/V
Line 1											
Level 1											
Ln1, Lev1	-	Both	13.00	171	10.1	-	-	-	-	4602	0.04
Wall 1-1	1	Both	13.00	171	-	67	287	-	-	4602	-
Segment 1	-	Both	6.50	86	13.2	-	-	1.00	354	2301	-
Segment 2	-	Both	6.50	86	13.2	-	-	1.00	354	2301	-
Line 2											
Level 2											
Ln2, Lev2	-	Both	17.50	951	39.6	-	-	-	-	6195	0.15
Wall 2-1	1	Both	17.50	951	-	67	287	-	-	6195	-
Segment 1	-	Both	6.00	326	54.3	-	-	1.00	354	2124	-
Segment 2	-	Both	3.00	163	54.3	-	-	1.00	354	1062	-
Segment 3	-	Both	4.50	245	54.3	-	-	1.00	354	1593	-
Segment 4	-	Both	4.00	217	54.3	-	-	1.00	354	1416	-



Results – Irregularities Table

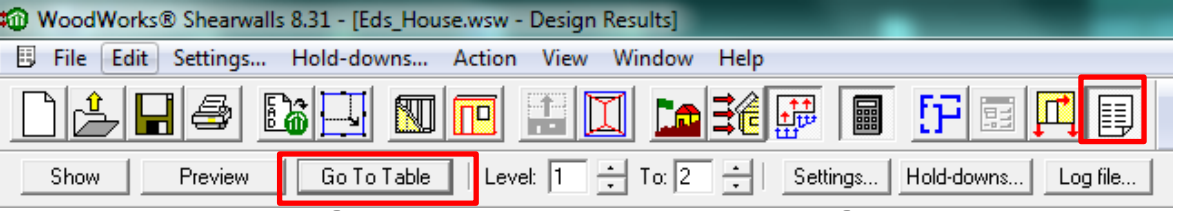
- Go To Table → Seismic Design → Flexible/Rigid Diaphragm Design → Seismic Irregularities

IRREGULARITIES (NBC Table 4.1.8.6)

IeFaSa(0.2) = 0.299
Only those provisions for Ta less than 0.5s and height less than 20 m are considered.

Irregularity No.	Type	NBC 4.1.8... Commentary	Detected by...	Irregular for... Levels	Irregular for... Dir/Ln	Fails for... Levels	Fails for... Dir/Ln	Notes
1	Vertical Stiffness	7-1c, 10-2a J-126	User	n/a	n/a	None	None	a
2	Weight (mass)	7-1c	User	n/a	n/a	None	None	b
3	Vertical Geometry	7-1c,10-2a,15-2 J-126,156	Program	1	N-S	None	None	c
4	In-Plane Offset	7-1c,10-2a,15-2 J-126,156,207	Program	2,1	D	None	None	c
4	In-Plane Stiffness	7-1c,10-2a,15-2 J-126,156,207	Program	None	None	None	None	-
5	Out-of-Plane	7-1c,10-2a,15-2 J-126,156	Program	None	None	None	None	-
6	Weak Storey	7-1c,10-1,2b J-126,156	Program	None	None	None	None	-
7	Torsional Sensitivity	7-1,10-2a,11-9,10b J-127,J177-9	Program	None	None	None	None	-
8	Non-Orthogonal	7-1c J-127	n/a	n/a	n/a	n/a	n/a	d

Notes:
a) Check for irregularity not required because this is not a post-disaster building.
b) Not required for buildings less than 20 m with Ta less than 0.5.
c) Irregularity has no effect since IEFaSa(0.2) < 0.35
d) Not applicable, as all buildings modelled by Shearwalls are orthogonal.



Results – Irregularities Table

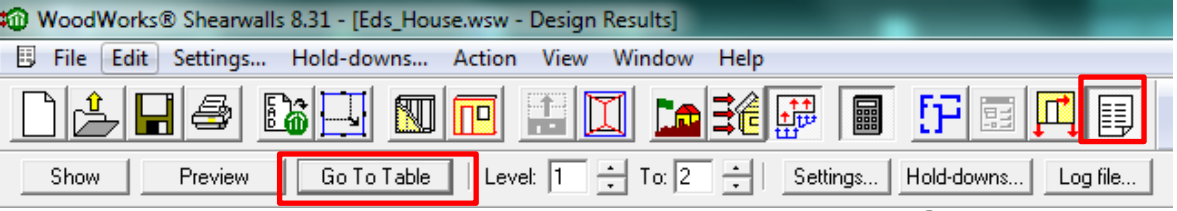
- Notes & descriptions provide a synopsis of the requirements outlined in NBCC Table 4.1.8.6

3. Vertical geometric: Horizontal dimension of SFRS in any storey more than 130% of that in adjacent storey. Shearwalls checks using the nearest and farthest points from all walls in a storey for each direction. It shows the storey with the long SRFS in the table, and the affected direction(s).

4. In-plane discontinuity (offset). In plane offset of a lateral force-resisting element in the storey below. Shearwalls detects whenever the ends wall segments on adjacent storeys do not line up to within 3". It shows both upper and lower storey in table, e.g. 4,3, and shearlines affected.

c) Irregularity has no effect since IEFaSa(0.2) < 0.35

IeFaSa(0.2) = 0.299



Navigating Results Output

- **Seismic Design –** Interstorey Drift

STOREY DRIFT (flexible seismic design)

Level	Dir	Wall height ft	Actual Storey Drift (in) RdRo	I	Max defl	Line	Amp defl	Allowable Storey Drift hs ft	Drift in	Ratio
1		8.00						8.83	2.65	
	Both		3.4	1.00	0.59	6	2.02			0.76
	Both		3.4	1.00	1.14	D	3.87			1.46*

RdRo – Amplification factor from Site Dialog and NBCC Table 4.1.8.9, used in 4.1.8.13(2)

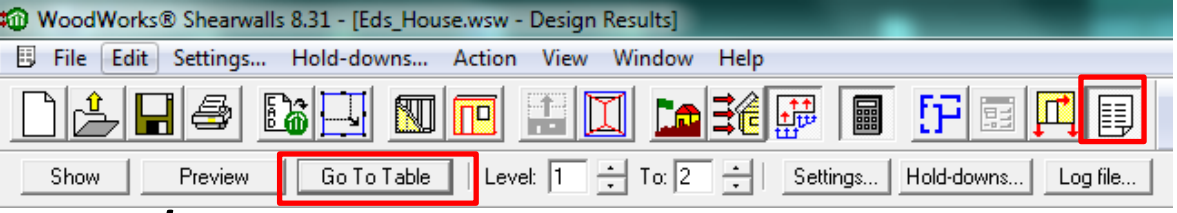
I – Importance factor, used in 4.1.8.13(2)

Max defl – Largest deflection for any shearline on level in this direction; refer to Deflections table
Line – Shearline with largest deflection

hs – Storey height in 4.1.8.13(3) = Height of walls plus joist depth between this level and the one above.

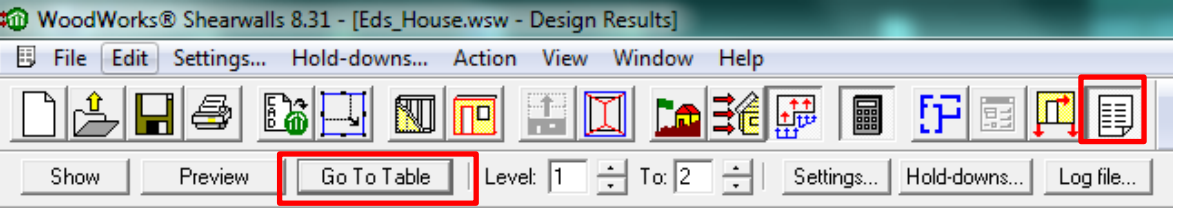
Amp defl – Largest amplified deflection on level in this direction using 4.1.8.13(2) = defl x RdRo/I

*FAILURE – Story drift on this level is greater than maximum allowed according to NBCC 4.1.8.13 (3).



1st Iteration Design Summary

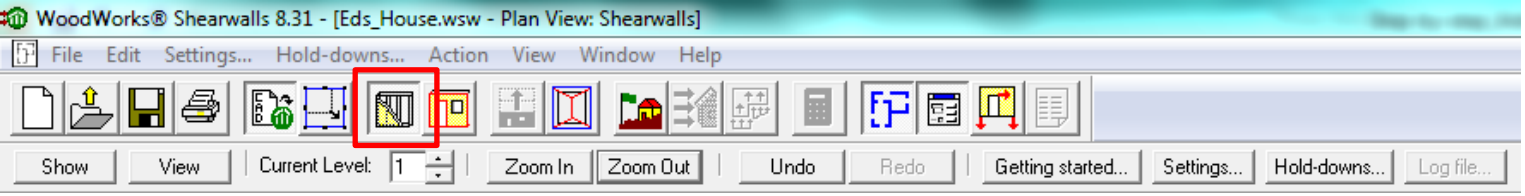
- Shearwall capacity failures for wind flexible design (ULS)
- Hold-down capacity failures for wind (ULS)
- Nail withdrawal exceeded for wind C&C (ULS)
- No prescribed wind deflection limits (SLS) – *only absolute value is provided in output*



Revise Design

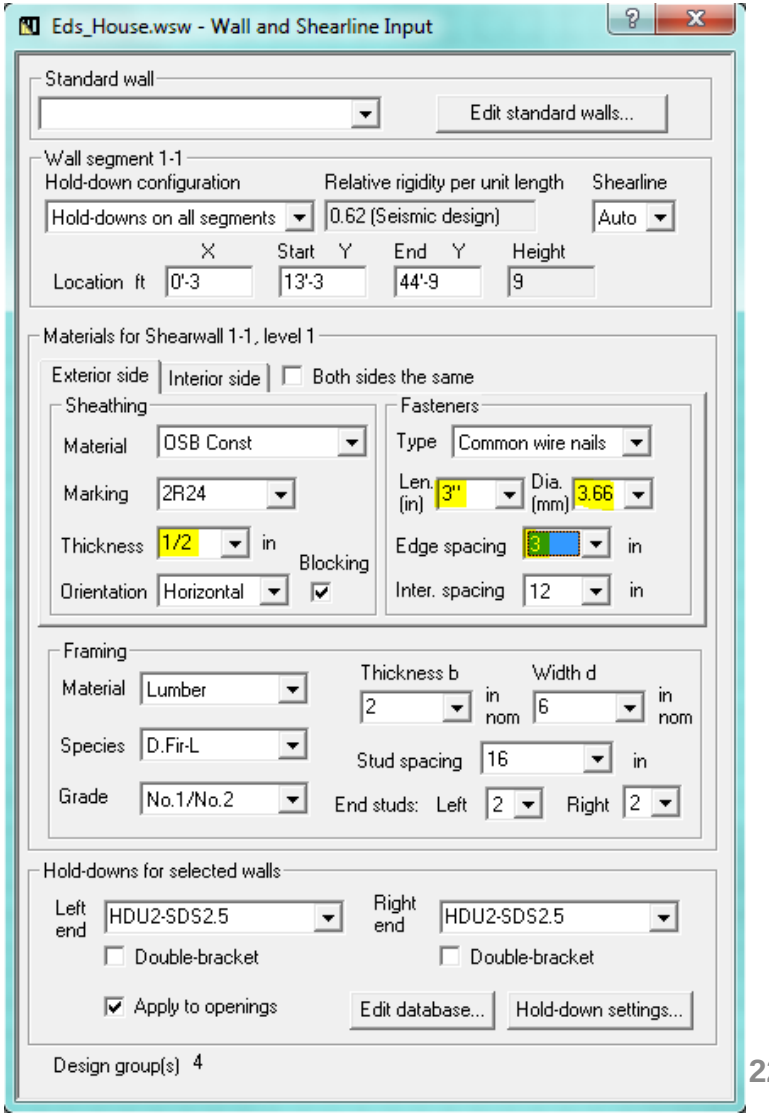
Options:

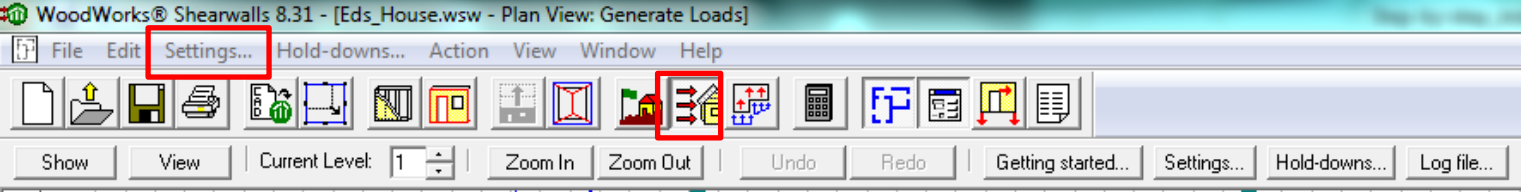
- Change wall make-up
  (decrease edge nail spacing, increase sheathing thickness, increase nail diameter)
- Change rigid distribution method
- Increase hold-down capacities
- Add double bracket hold-downs
- Ignore gypsum contribution for wind and/or seismic
  (Max gyp %, RdRo increases -> base shear decreases)



Modify Walls

- Decrease edge nail spacing
- Increase sheathing thickness
- Increase nail diameter

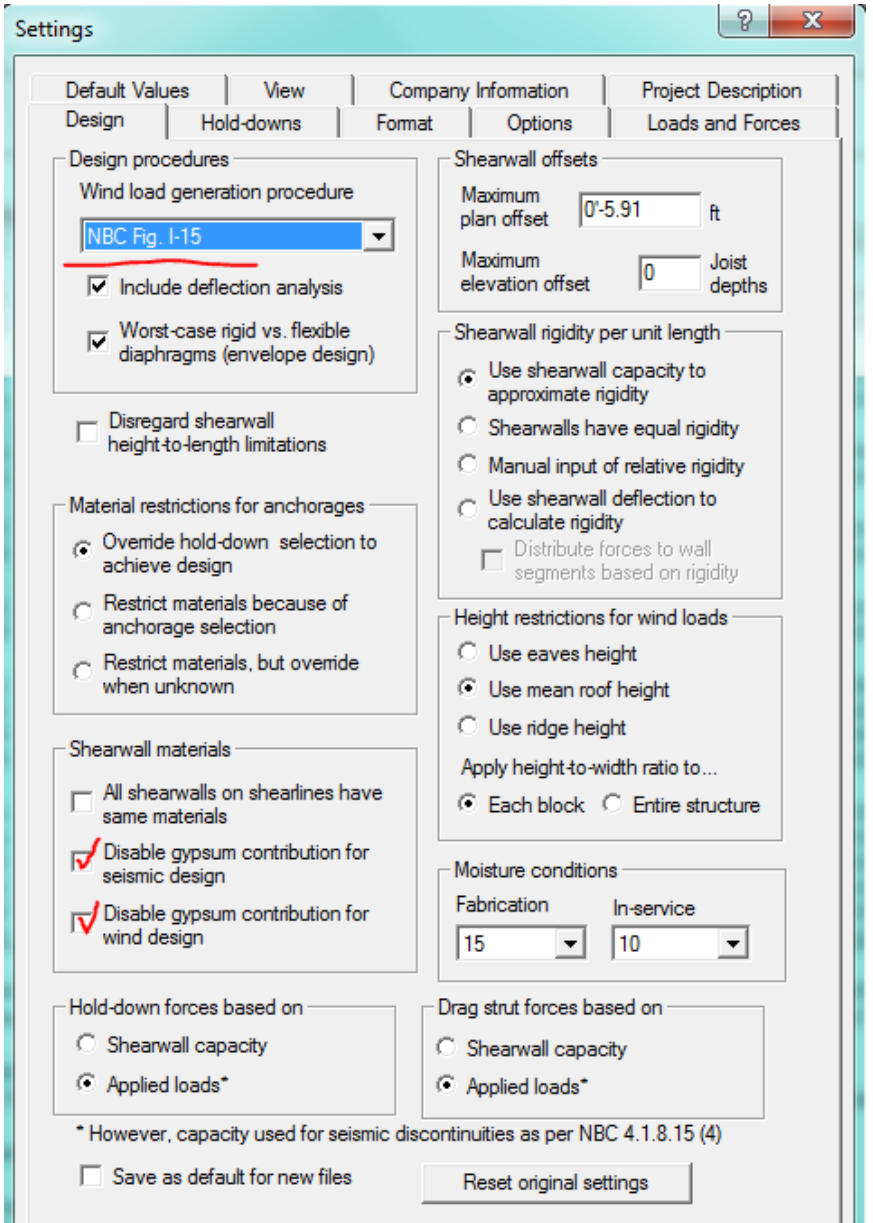


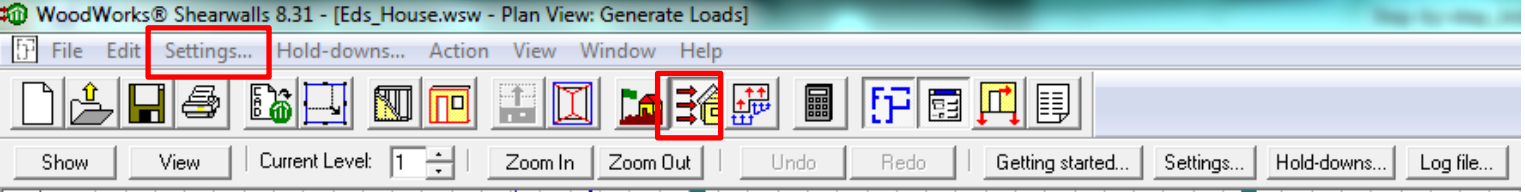


Revise Design

- Change wind load design procedure (I-7/8 vs. I-15)

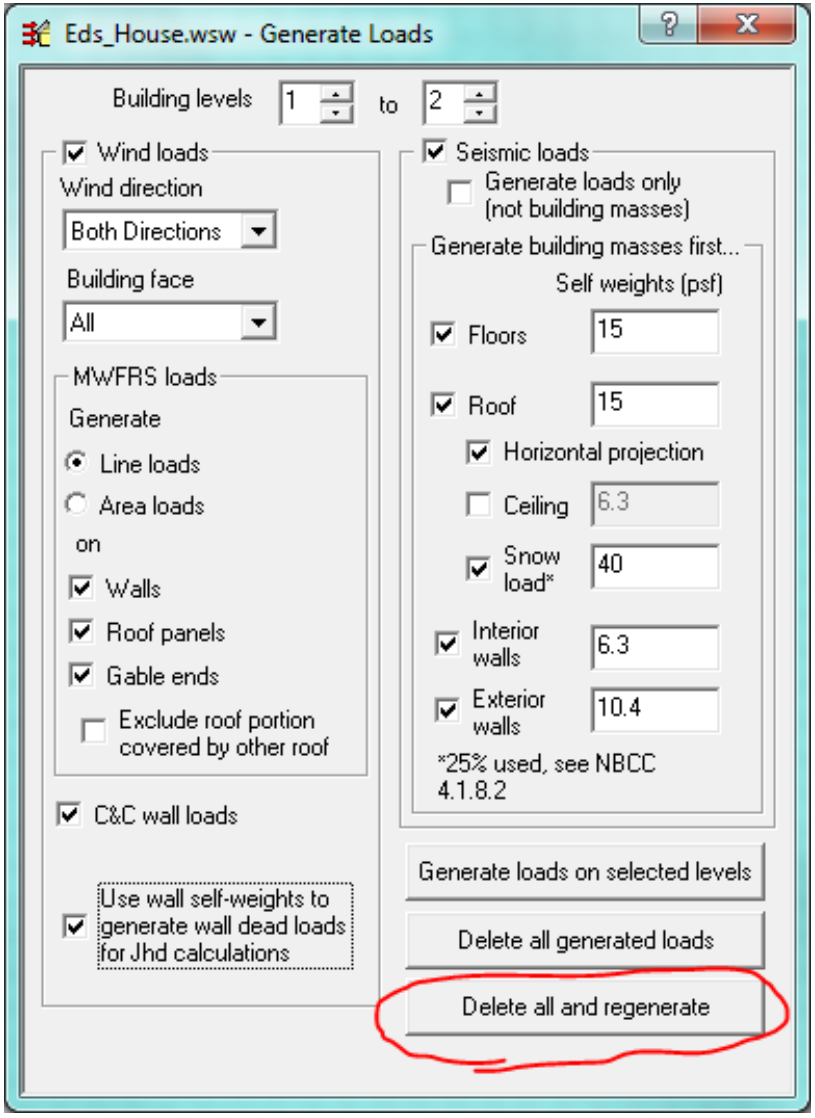
- Try ignoring gypsum contribution for wind and/or seismic





Revise Design

- Delete all & regenerate loads, as seismic loads will be decreased due to increased R_dR_o
- Re-run design

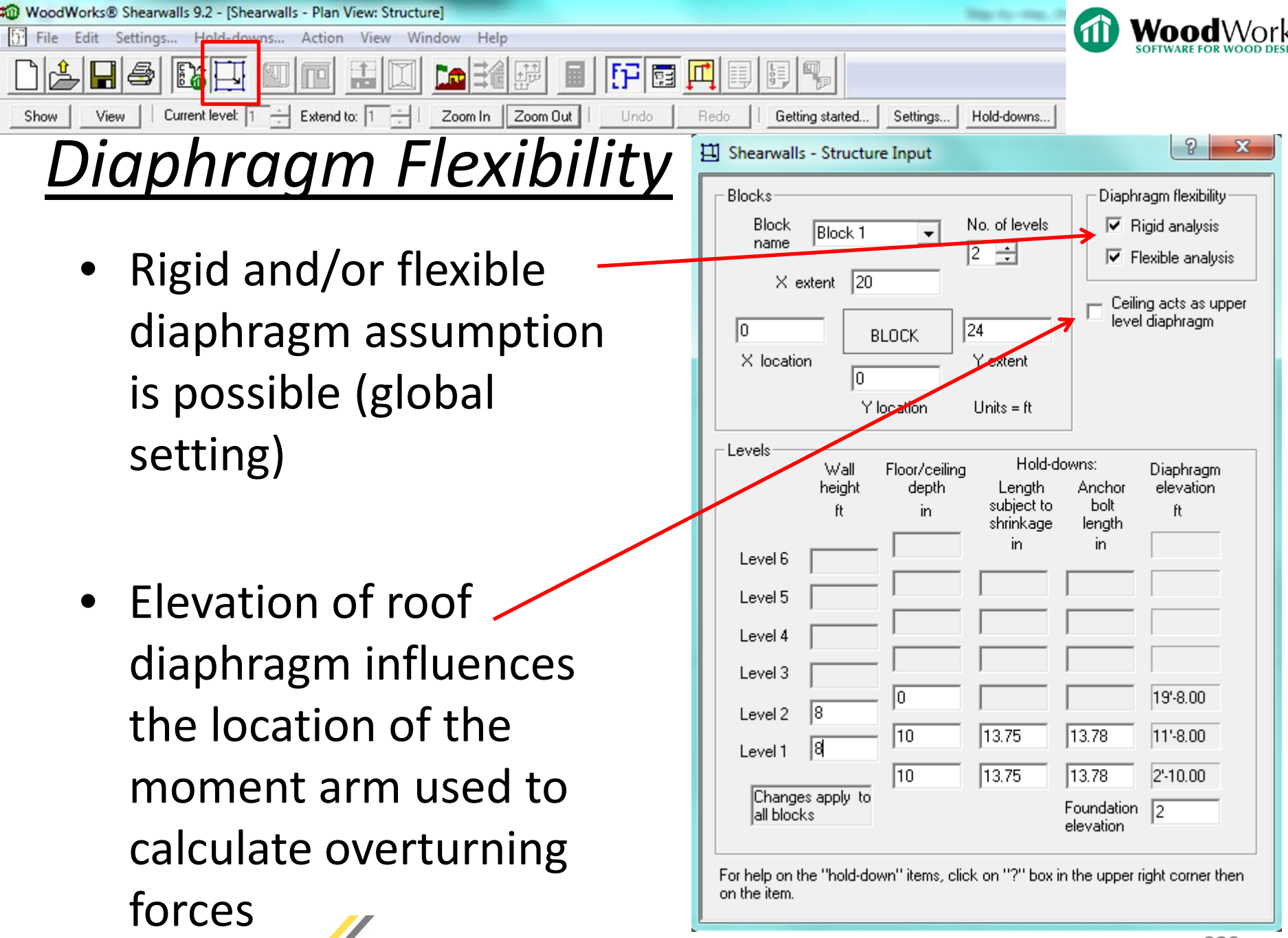


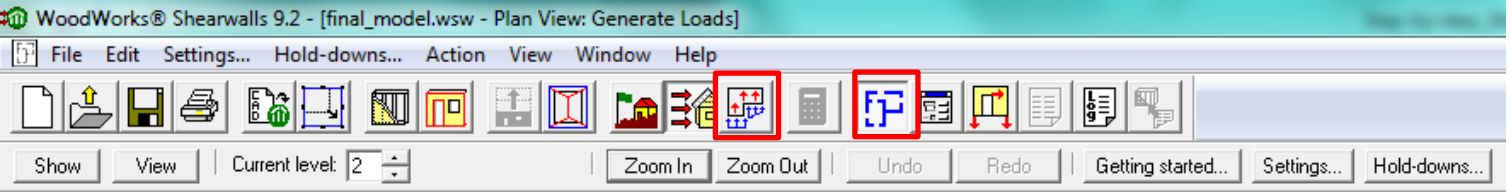
Sample Lateral Design Approach

1) Resolve any irregularities
2) Address ultimate limit states (ULS)
   a) Shearwall capacities (flexible, rigid, envelope)
   b) Hold-down capacities (flex, rigid, envelope)
   c) Max gypsum percentages (incl. or excl. gyp. contribution)
   d) Wind suction (adjust nailing, sheathing, stud spacing)
3) Address serviceability limit states (SLS)
   a) Interstorey drift (adjust wall make-ups, hold-downs)
   b) Compare max shearwall deflection to max diaphragm deflection → determine if flexible or rigid applies
4) Design force transfer elements (drag struts, anchorages, vertical uplift elements, sill plate nailing, etc.)

Diaphragm Flexibility

- Rigid and/or flexible diaphragm assumption is possible (global setting)
- Elevation of roof diaphragm influences the location of the moment arm used to calculate overturning forces

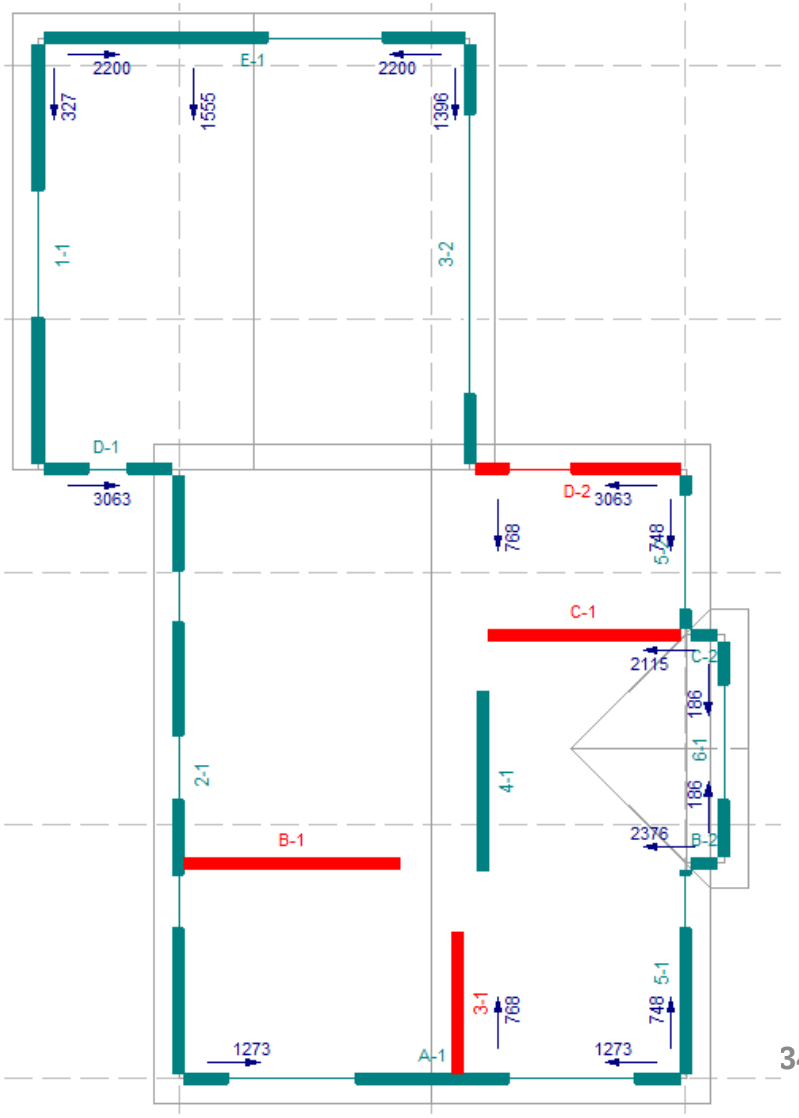


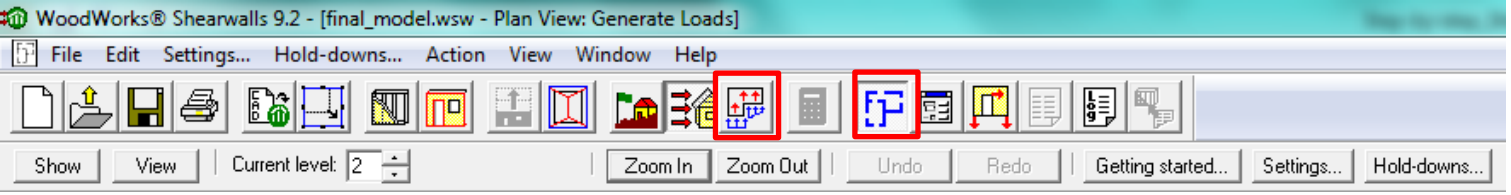


Loads & Forces – Wind Flexible

- Use “Show” menu to toggle information shown in plan

- Wind
- Forces → Flexible
- Load direction → Critical forces

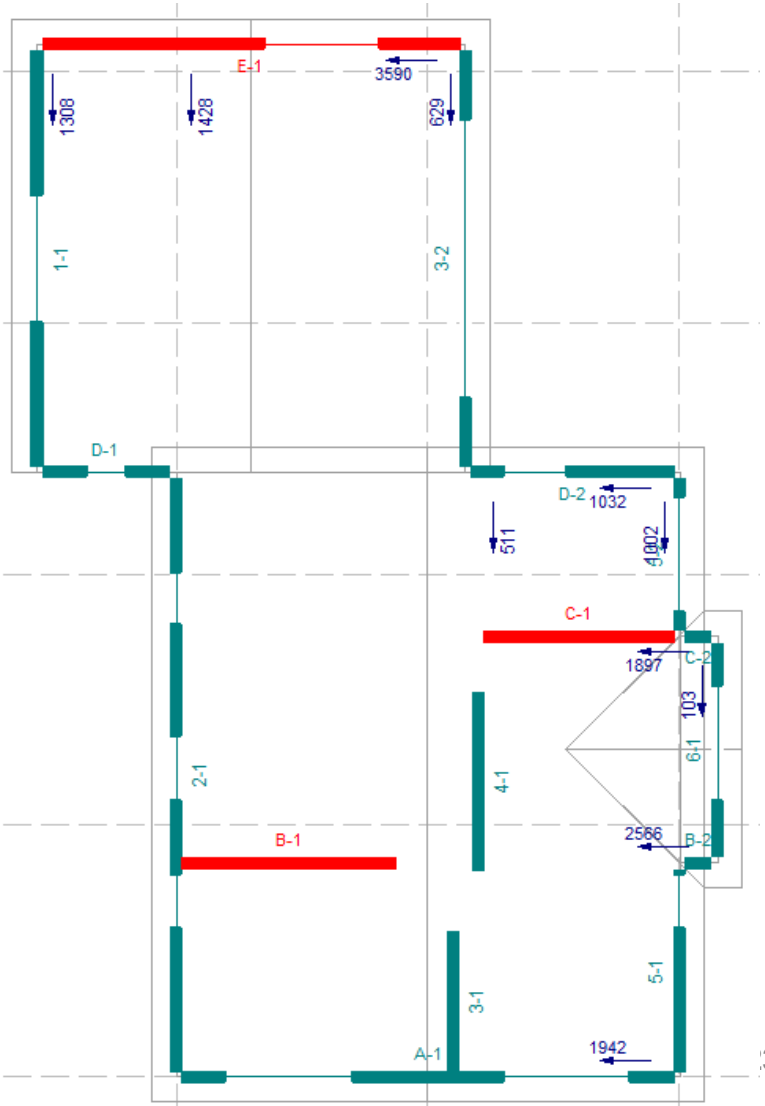


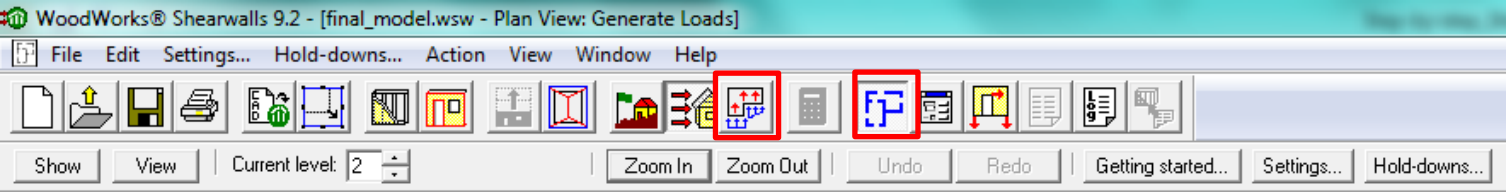


Loads & Forces – Wind Rigid (stiffness)

- Use “Show” menu to toggle information shown in plan

- Wind
- Forces → Rigid
- Load direction → Critical forces

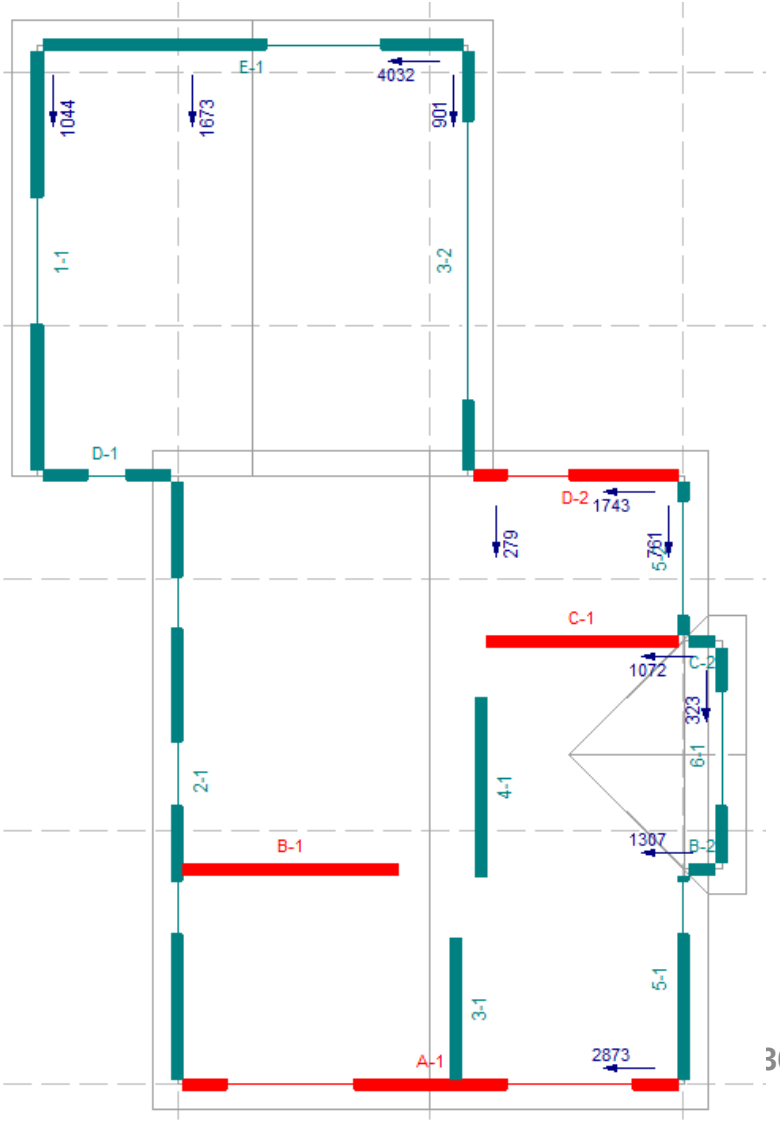




Loads & Forces – Wind Rigid (capacity)

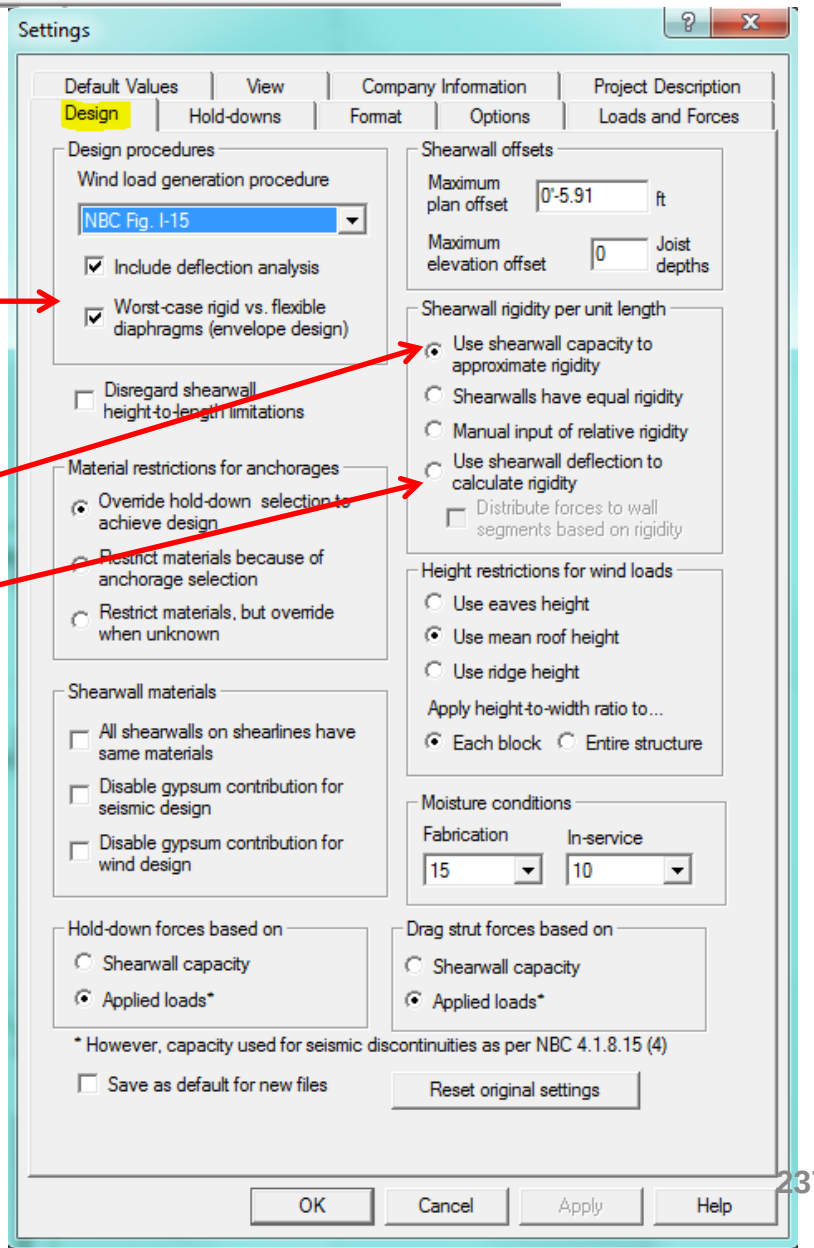
- Use “Show” menu to toggle information shown in plan

- Wind
- Forces → Rigid
- Load direction → Critical forces



Settings

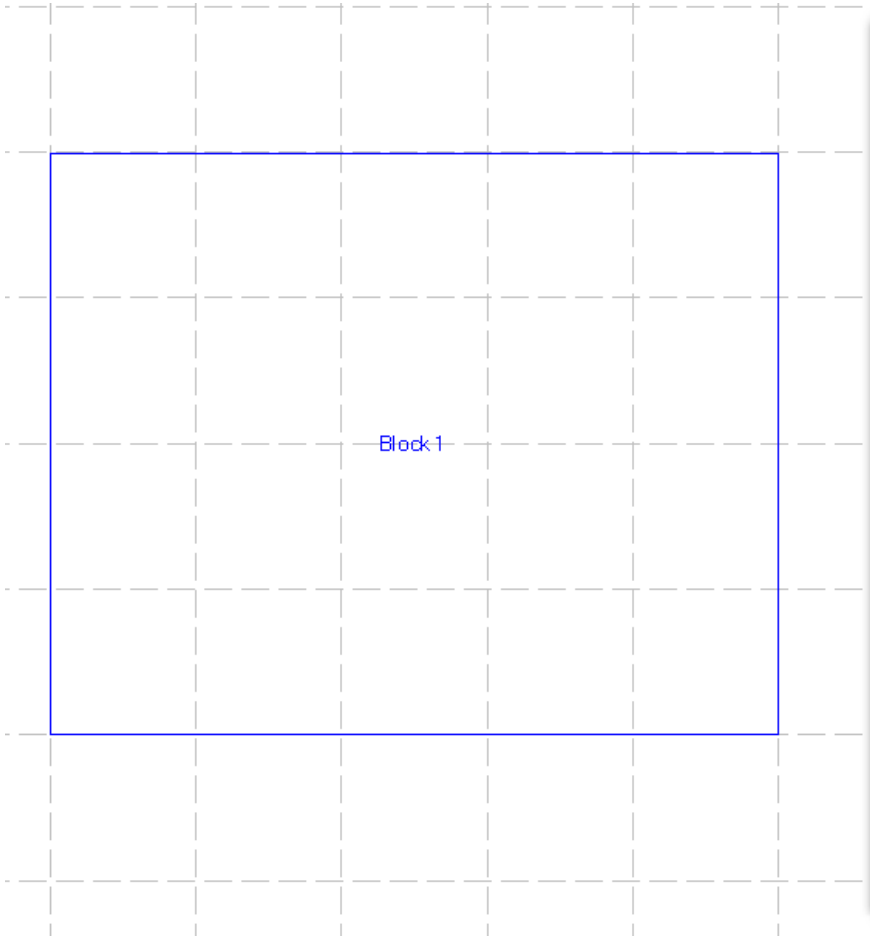
- Design tab
  - Worst-case
  - Calculation of rigidity
    - Capacity-derived
    - Deflection-derived

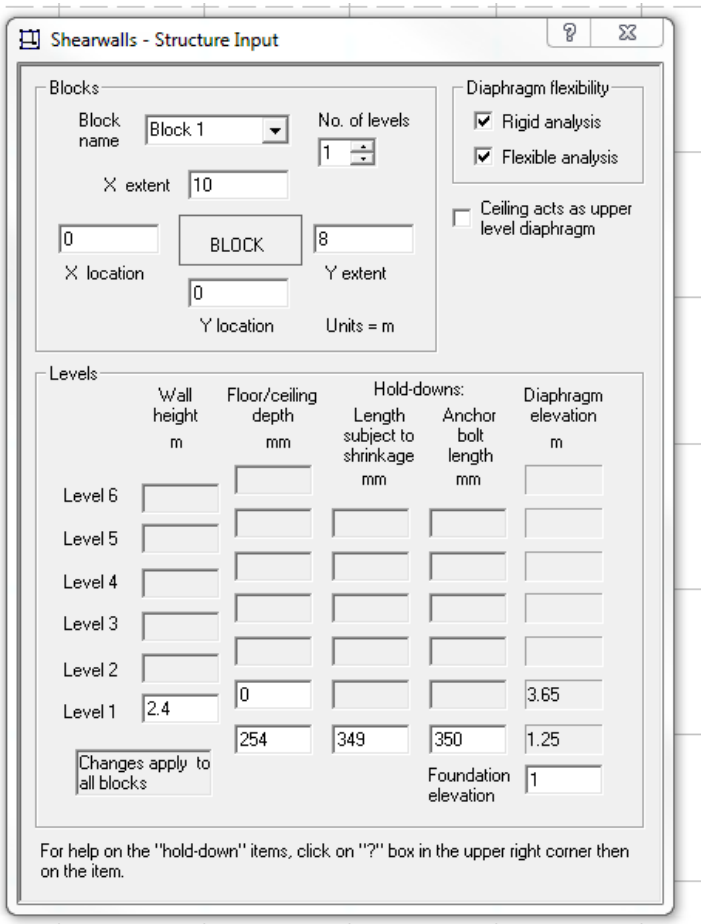


How do I Design a Single Shearwall?

How Do I Design a Single Shearwall?

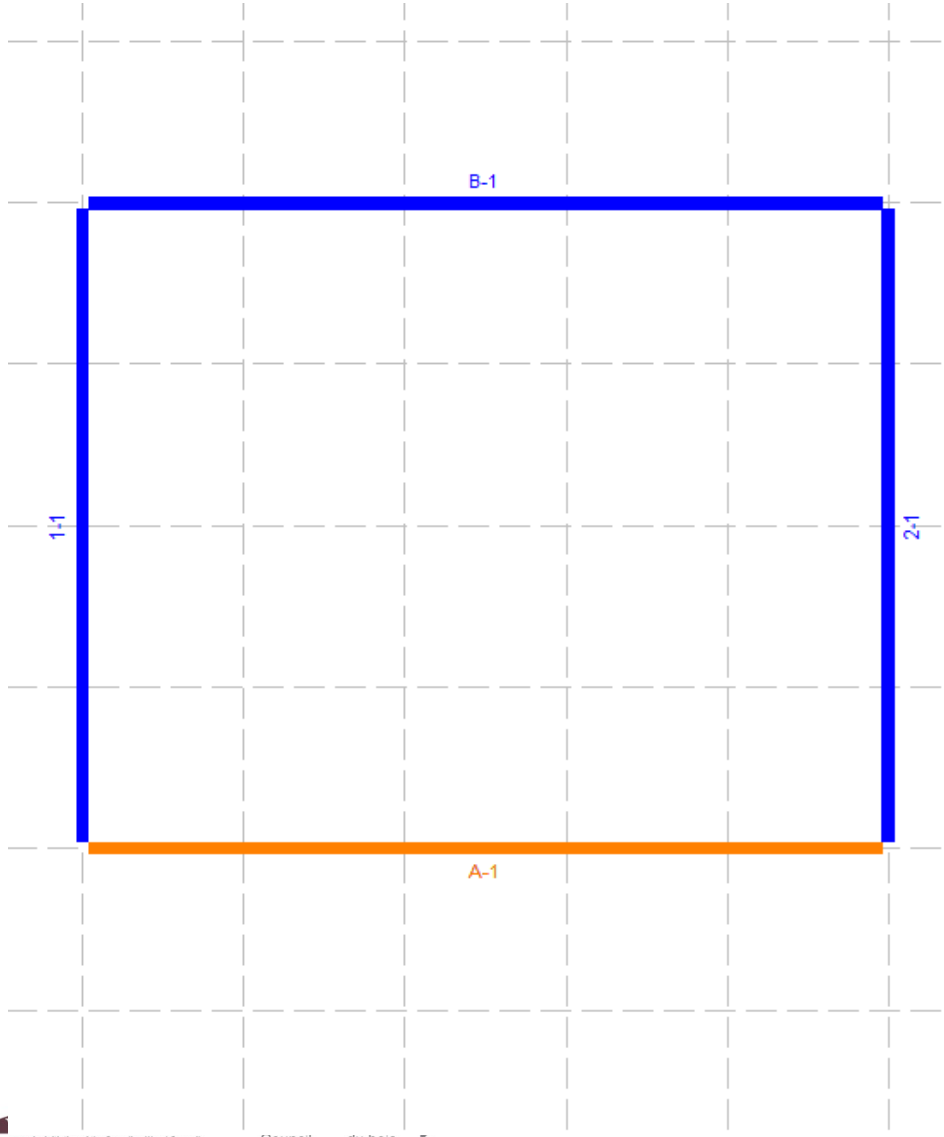
Step 1: Draw a Block and adjust Wall Height and length as Desired

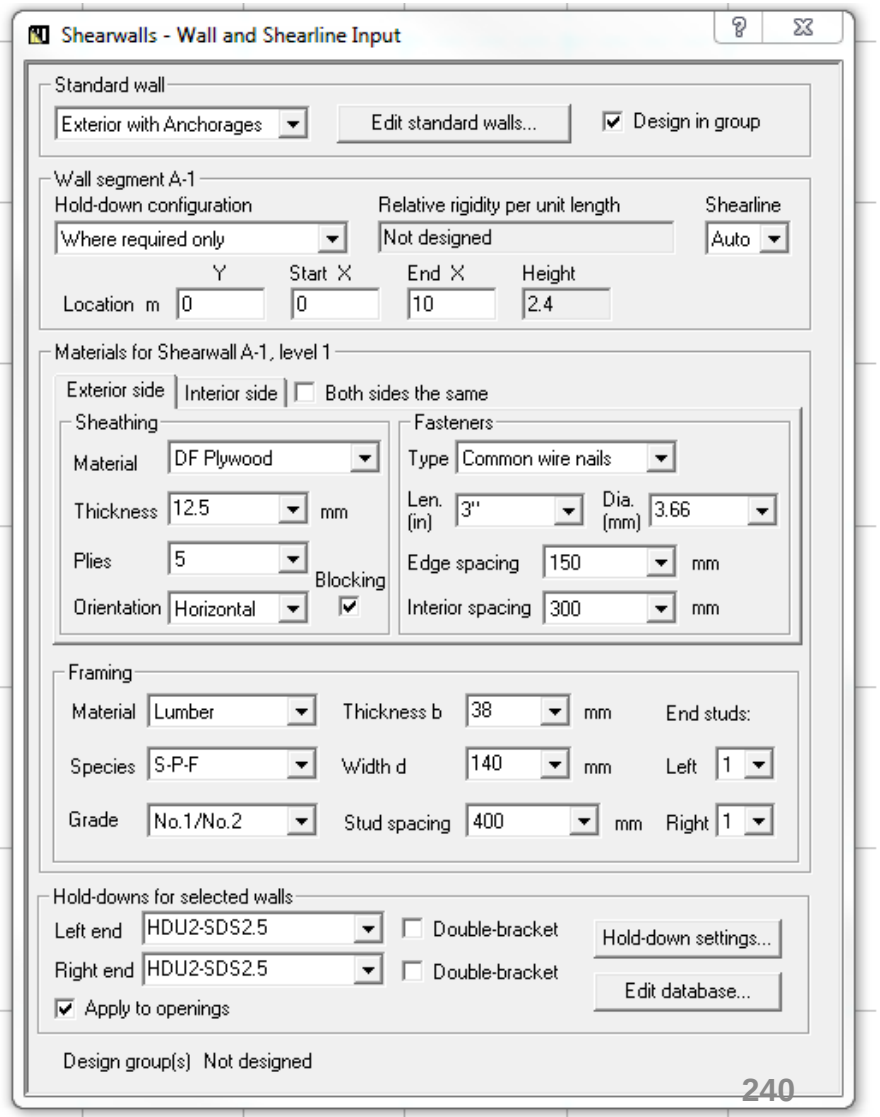




How Do I Design a Single Shearwall?

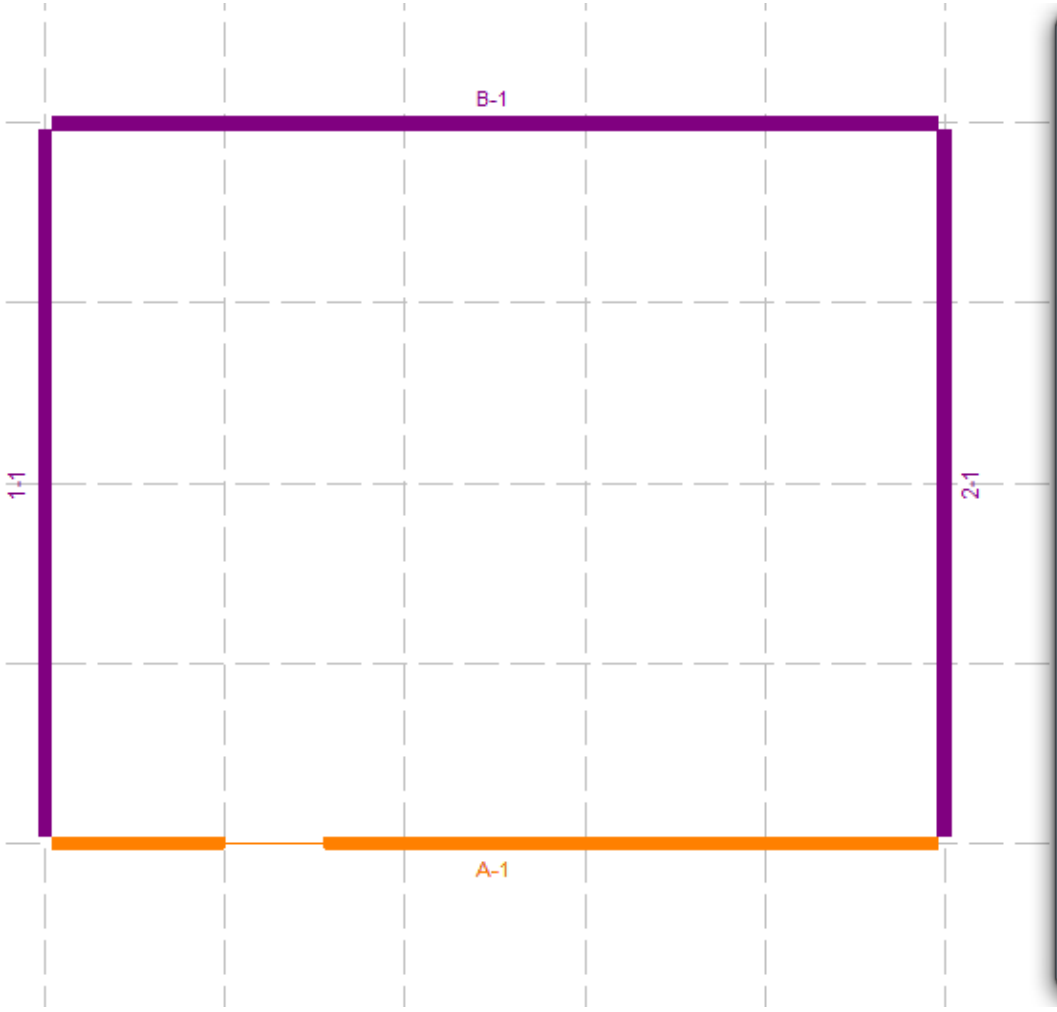
Step 2: Click on Wall View and Input Wall Parameters as desired

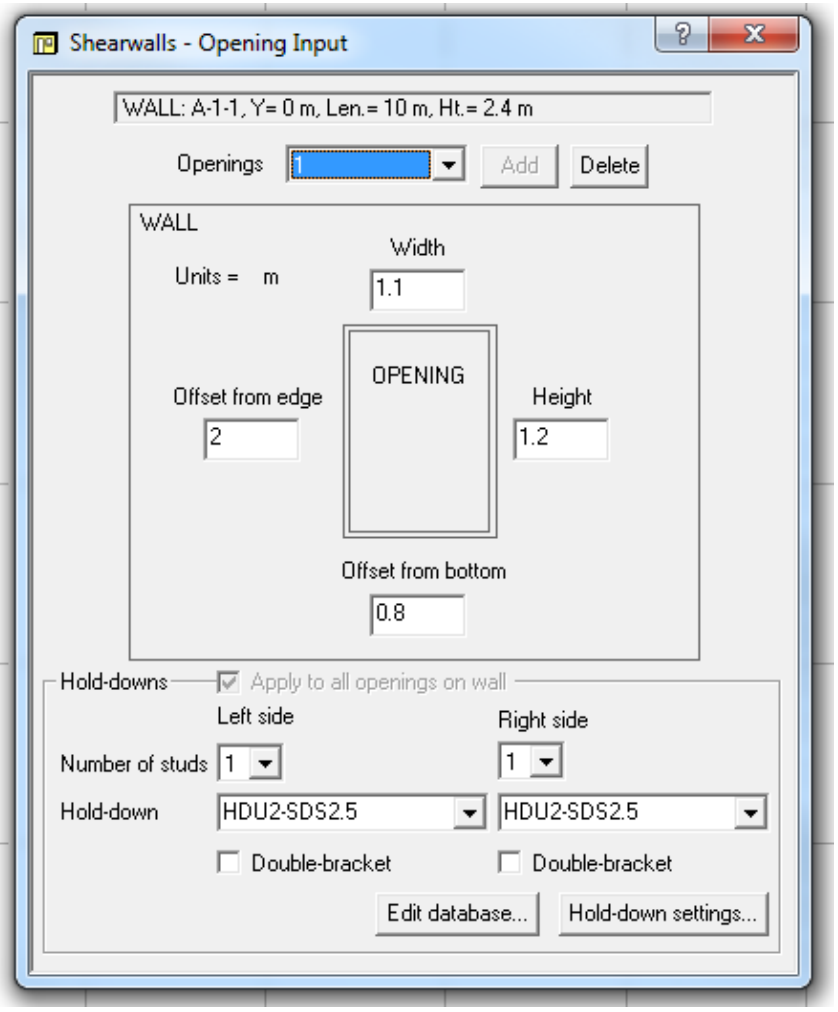




How Do I Design a Single Shearwall?

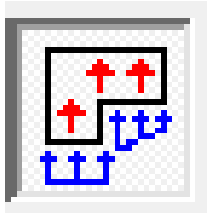
Step 3: Click on Openings View and Add openings as desired

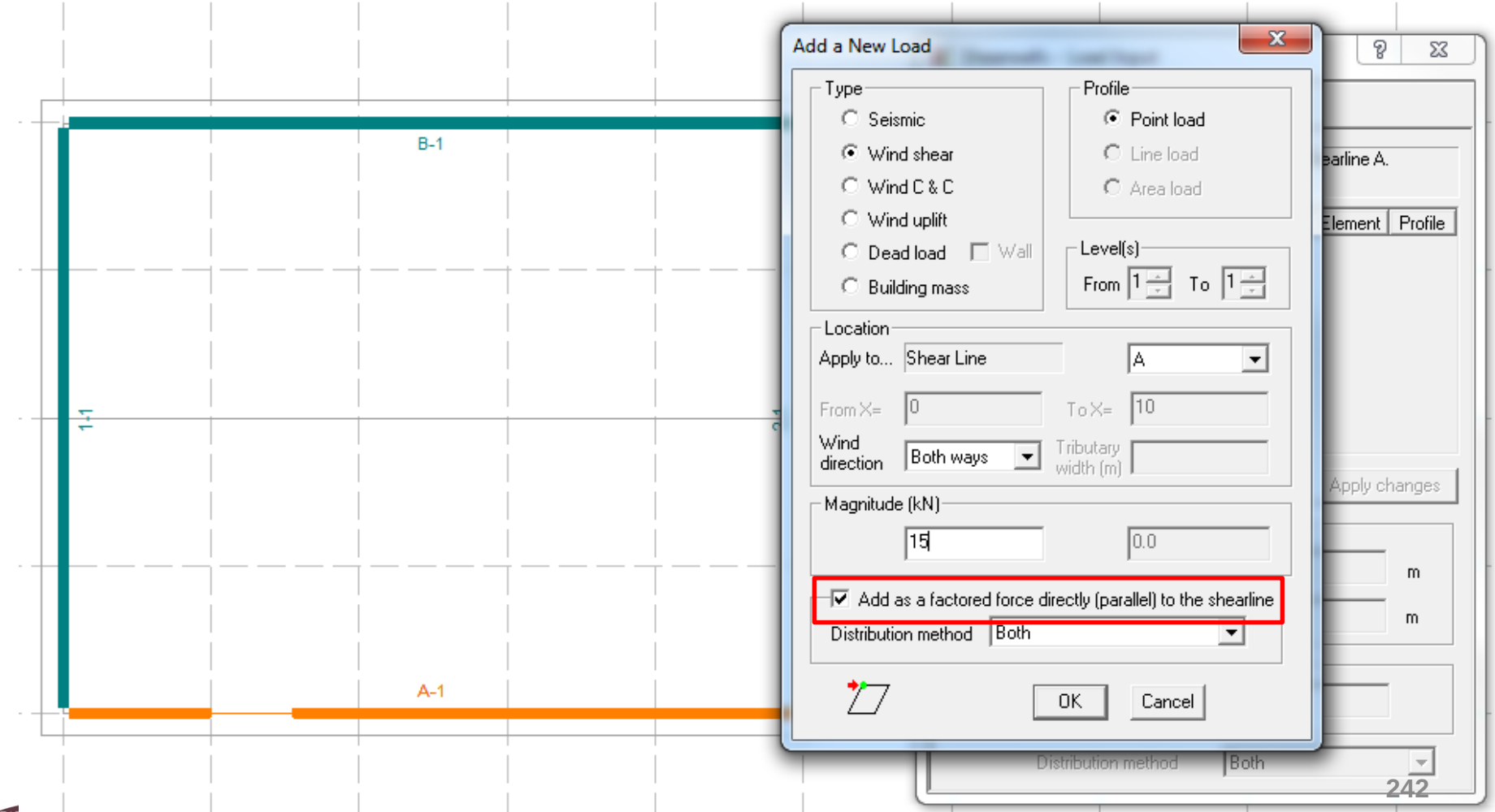




How Do I Design a Single Shearwall?

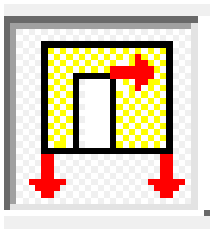
Step 4: Click on Roof Block, skip ahead to *Loads and Forces* View. Click Add Loads button. Add desired load, take note of the *Factored Load* check box.





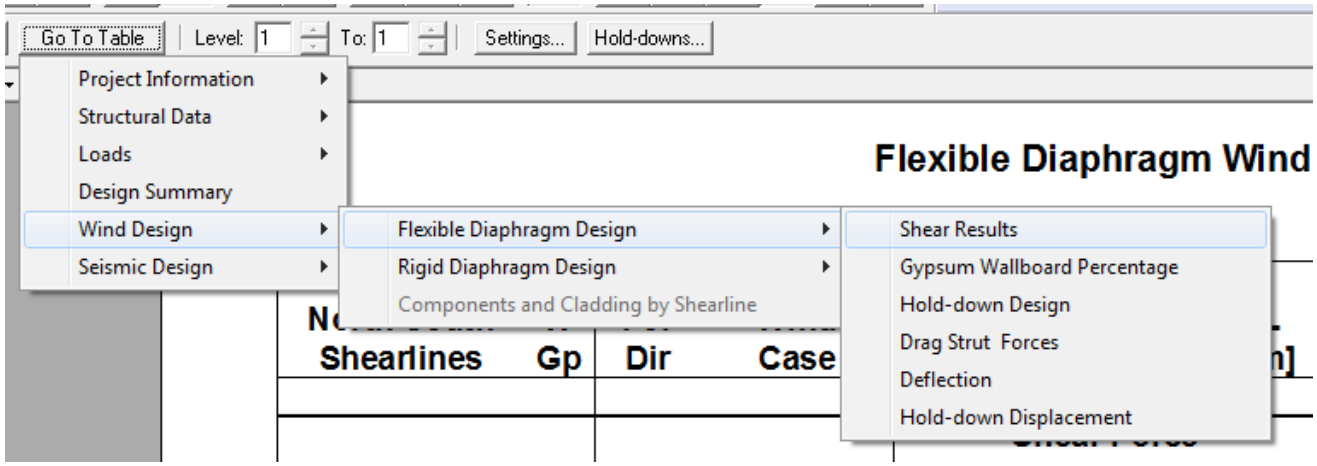
How Do I Design a Single Shearwall?

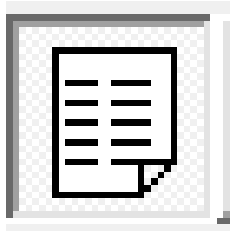
Step 5: Run Design and Review Results. In Plan View, select Wall A-1, and switch to elevation view using the icon. Using the Show button, display the load you input.



How Do I Design a Single Shearwall?

Step 6: Review design results further in the Results View. Using the Go To Table button, display the load you input.





SHEAR RESULTS

North-south Shearlines	W Gp	For Dir	Wind Case	Shear Force FHS [m]	Shear Force Fv [kN]	Shear Force Fv/L [kN/m]	Capacities [kN/m] Vhd/L Int	Capacities [kN/m] Vhd/L Ext	Capacities [kN/m] Jhd	Capacities [kN/m] Vrs/L	Capacities [kN/m] Vr [kN]	Ratio Fv/V
East-west Shearlines	**W Gp**	**For Dir**	**Wind Case**	**Shear Force FHS [m]**	**Shear Force Fv [kN]**	**Shear Force Fv/L [kN/m]**	**Capacities [kN/m] Vhd/L Int**	**Capacities [kN/m] Vhd/L Ext**	**Capacities [kN/m] Jhd**	**Capacities [kN/m] Vrs/L**	**Capacities [kN/m] Vr [kN]**	**Ratio Fv/V**
Line A Level 1												
LnA, Lev1	-	Both		8.90	15.0	1.50	-	-	-	-	30.5	0.49
Wall A-1	1^	Both		8.90	15.0	-		5.41	-	-	30.5	0.49
Segment 1	-	Both		2.00	1.1	0.56	-	-	0.36	1.96	3.9	0.28
Segment 2	-	Both		6.90	13.9	2.01	-	-	0.71	3.85	26.5	0.52

Future Improvements and Updates

- **Update to CSA O86-14 & NBCC 2015**
  - Include continuous tiedown systems
  - Update to comply with mid-rise provisions
- **Unification of Sizer and Shearwalls**
  - Input your structure just once
  - Improved vertical load distribution
- **More precise connections**
  - Specify location of fasteners

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For further training:

1. Read User Guide (pdf), do tutorials
2. Video tutorials on website
3. See ‘help’ menu for engineering questions and assumptions