

Wind Loads on a Two-storey Gable-ended Building

An Introductory Tutorial to
WoodWorks Canadian Shearwalls 2002

Introduction

- **The following introductory example illustrates how WoodWorks Canadian Shearwalls 2002 generates wind loads according to the procedures for low-rise buildings described in Figure B-7 of the NBC 1995 Structural Commentaries (Part 4)**
- **The presentation includes descriptive slides and screen captures from the software.**

- **Note that this simple example is meant to serve as an introduction to using the new load generation features of the software and that more complex buildings can be modeled**
- **Seismic load generation, load distribution to shearlines and shearwall design will be covered in separate tutorials**

Given Values and Assumptions

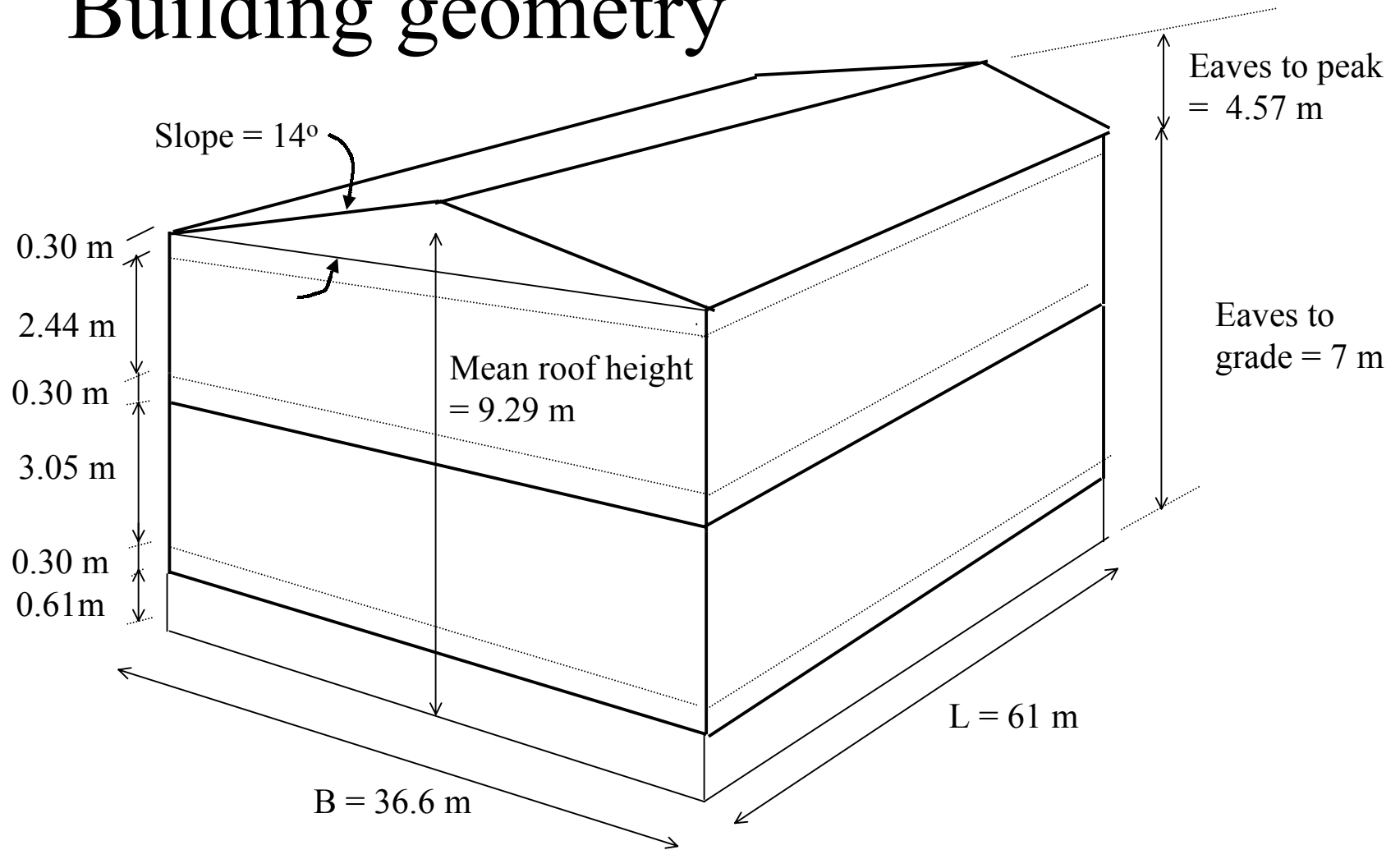
- **Building geometry (see next page):**

- Two storey gable-ended
- Length = 30 m
- Width = 30 m
- Wall height:
 - Ground storey = 2.44 m
 - Second storey = 3.05 m
- Floor depth = 0.30 m
- Foundation height above grade = 0.61 m

- **Location: Kemptville, ON**

- Reference velocity pressure, $q_{1/30} = 0.37$ kPa

Building geometry



Wind Load Generation

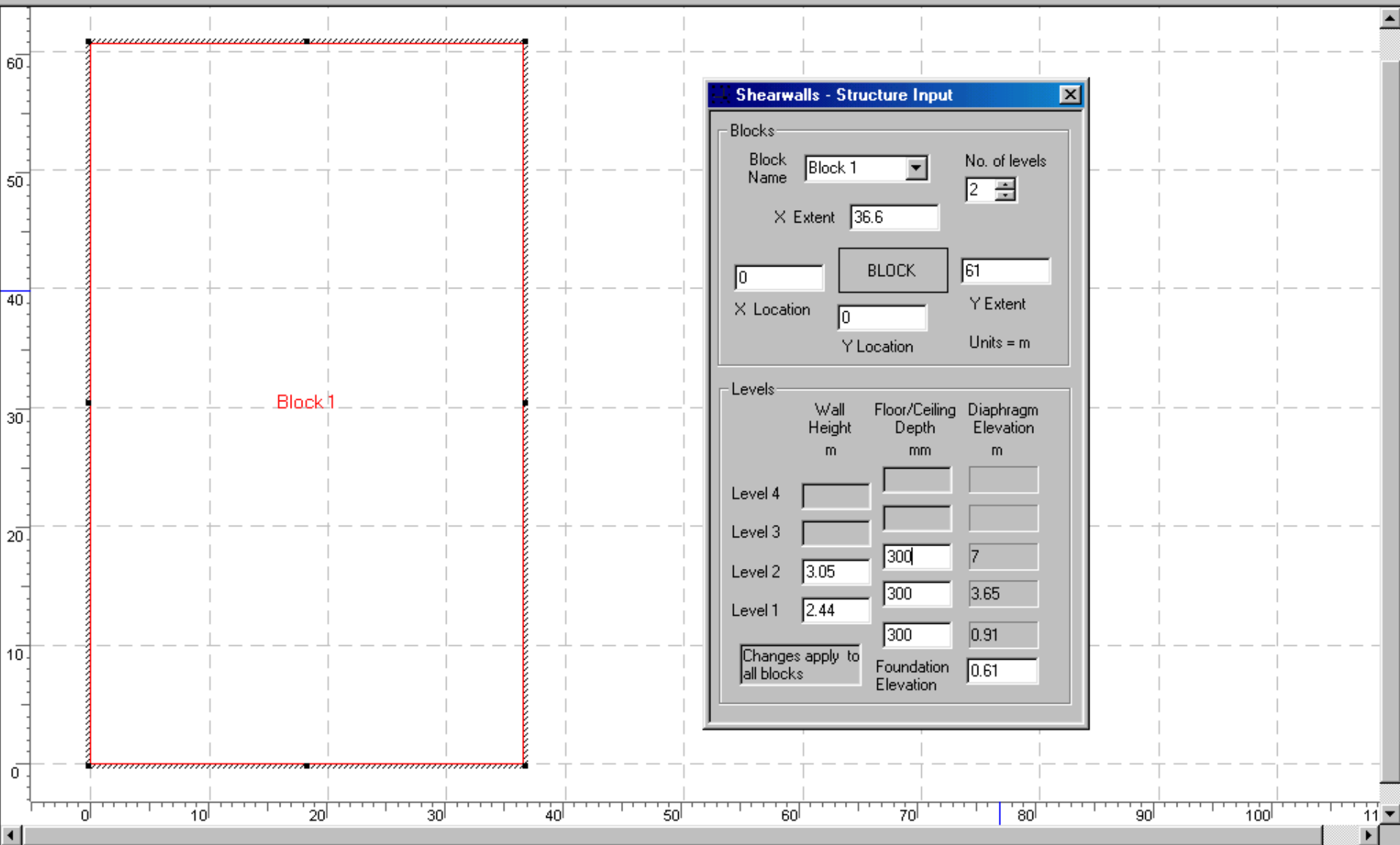
Wind loads can be generated in five steps with *WoodWorks Shearwalls*. In the next pages, each step is described followed by corresponding screen captures of the software input/output.

Step 1- Create the Building Block

NOTE: When **SHEARWALLS** is started, Plan View and the Structure Input Form are shown. Save the file as NBCCLowRiseWind.wsw. (Note: Demo files cannot be saved.)

- **In *Plan View*, Click grid point 0,0 and drag diagonally to create a block**
- **Use the *Structure Input Form* to define a two story, 36.6m by 61m building block :**
 - **Change the X and Y extents to 61 and 36.6 m respectively**
 - **Change number of levels to 2**
 - **Enter a foundation elevation of 0.61m, wall heights of 2.44 and 3.05 m and floor depths of 300 mm**
- **To adjust the view, use the Zoom feature or select *View/Fit Building to Viewing Area* from the main menu**

Note: The grid, viewing area and snap settings can be changed in the *Settings* menu under the *View* tab.



Shearwalls - Structure Input

Blocks

Block Name: No. of levels:

X Extent:

X Location: Y Location:



Y Extent: Units = m

Levels

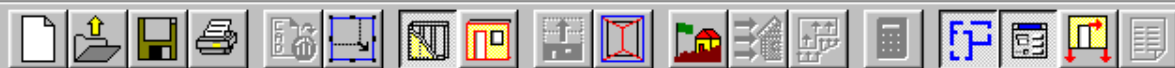
	Wall Height m	Floor/Ceiling Depth mm	Diaphragm Elevation m
Level 4	<input type="text"/>	<input type="text"/>	<input type="text"/>
Level 3	<input type="text"/>	<input type="text"/>	<input type="text"/>
Level 2	<input type="text" value="3.05"/>	<input type="text" value="300"/>	<input type="text" value="7"/>
Level 1	<input type="text" value="2.44"/>	<input type="text" value="300"/>	<input type="text" value="3.65"/>
		<input type="text" value="300"/>	<input type="text" value="0.91"/>
		Foundation Elevation	<input type="text" value="0.61"/>

Changes apply to all blocks

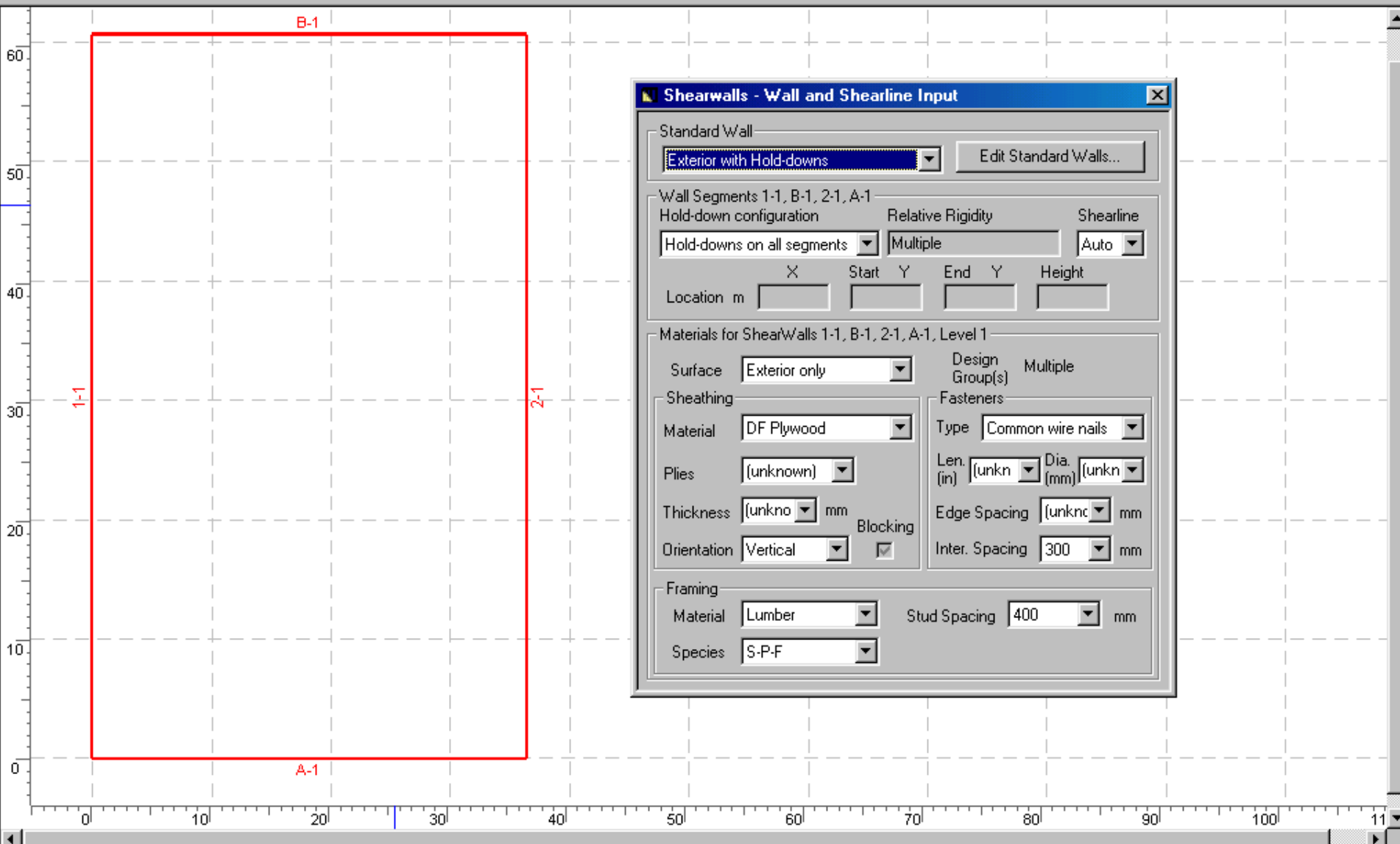
Step 2 – Define the Shearwalls

- **Click the *Walls* button** –  **The outside walls of the building will appear in bold and the *Wall and Shearline Input* form will open**
- **Click the *Extend Walls Upward* button** 
- **Design the upper level walls of the building as exterior shearwalls with hold-downs around window openings:**
 - **Set the *current level* to ‘2’ (pull-down just above grid area)**
 - **Select all exterior walls by clicking on each, in turn, while holding the Ctrl key; they will appear in red.**
 - **On the input form, select *Exterior with Hold-downs* from the *Standard Wall* pull-down menu**
 - **Note that the form can be used to specify the hold-down configuration, the sheathing on the exterior and interior of each wall, as well as the fasteners and framing material**
- **Following the same procedure, define the lower level walls as *Exterior with Hold-downs***

Note that a wall may be defined as a non-shearwall using the hold-down configuration pull-down.



Show... View... Design... Current Level: 1 Zoom In Zoom Out



Shearwalls - Wall and Shearline Input

Standard Wall
 Exterior with Hold-downs Edit Standard Walls...

Wall Segments 1-1, B-1, 2-1, A-1
 Hold-down configuration: Hold-downs on all segments
 Relative Rigidity: Multiple
 Shearline: Auto

Location m	X	Start Y	End Y	Height

Materials for ShearWalls 1-1, B-1, 2-1, A-1, Level 1

Surface: Exterior only Design Group(s): Multiple

Sheathing
 Material: DF Plywood
 Plies: (unknown)
 Thickness: (unkno) mm
 Orientation: Vertical Blocking

Fasteners
 Type: Common wire nails
 Len. (in): (unkn) Dia. (mm): (unkn)
 Edge Spacing: (unknc) mm
 Inter. Spacing: 300 mm

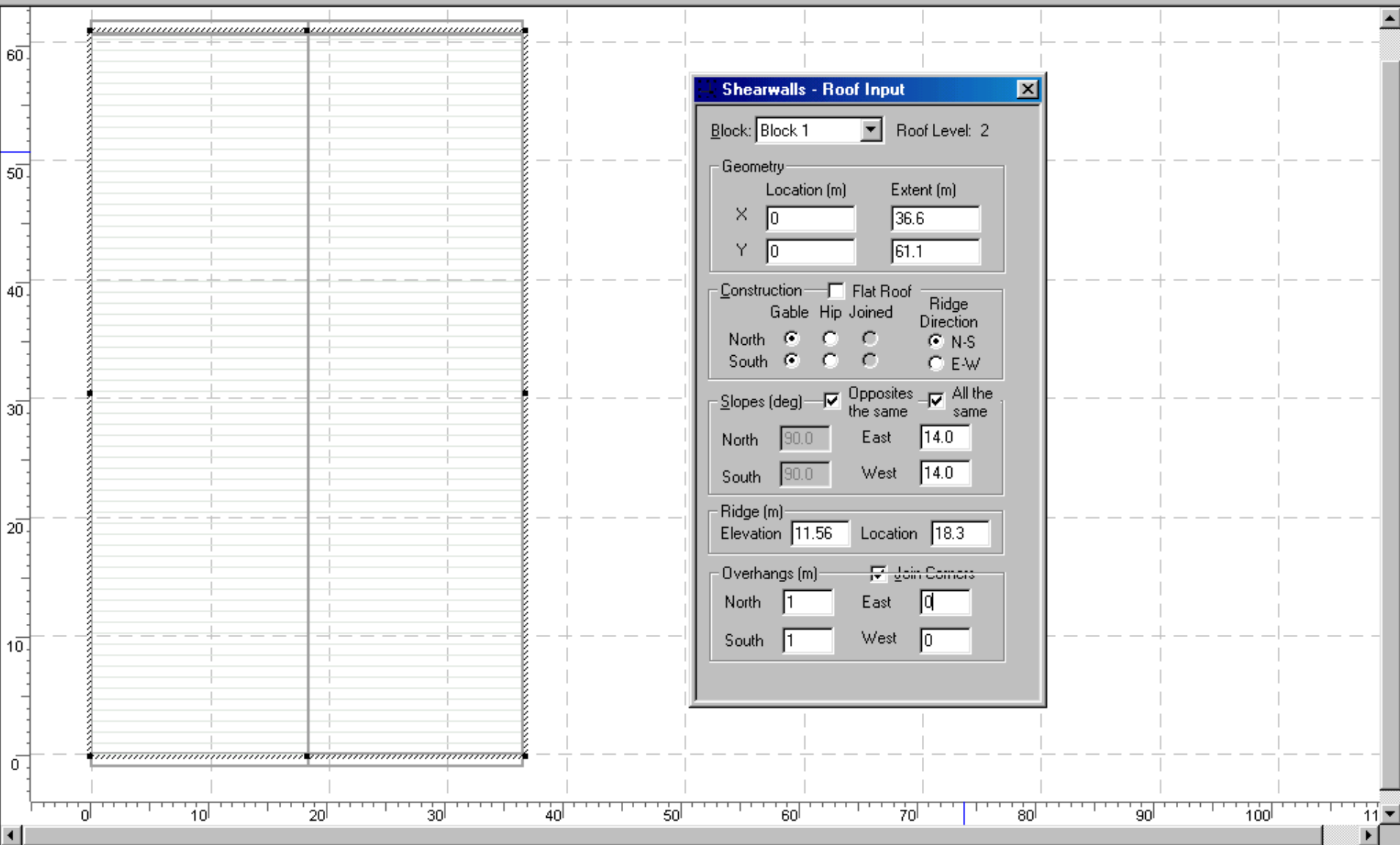
Framing
 Material: Lumber Stud Spacing: 400 mm
 Species: S-P-F

Step 3: Create the Roof

- **Click the *Roof Blocks* button; the *Roof Input* form will open**
- **Select the block and use the form to specify a *N-S Ridge Direction, Gable on the North and South ends, 14⁰ slopes on the East and West roof panels and 1 m North and South Overhangs***
- **The *ridge elevation* and *ridge location* will automatically adjust to match the roof slopes**

File Edit Settings... Action View Window Help

Show... View... Design... Current Level: 1 Zoom In Zoom Out



Shearwalls - Roof Input

Block: Block 1 Roof Level: 2

Geometry

	Location (m)	Extent (m)
X	0	36.6
Y	0	61.1

Construction Flat Roof

Gable Hip Joined Ridge Direction

North N-S

South E-W

Slopes (deg) Opposites the same All the same

North	90.0	East	14.0
South	90.0	West	14.0


Ridge (m)

Elevation	11.56	Location	18.3
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Overhangs (m) Join Corners

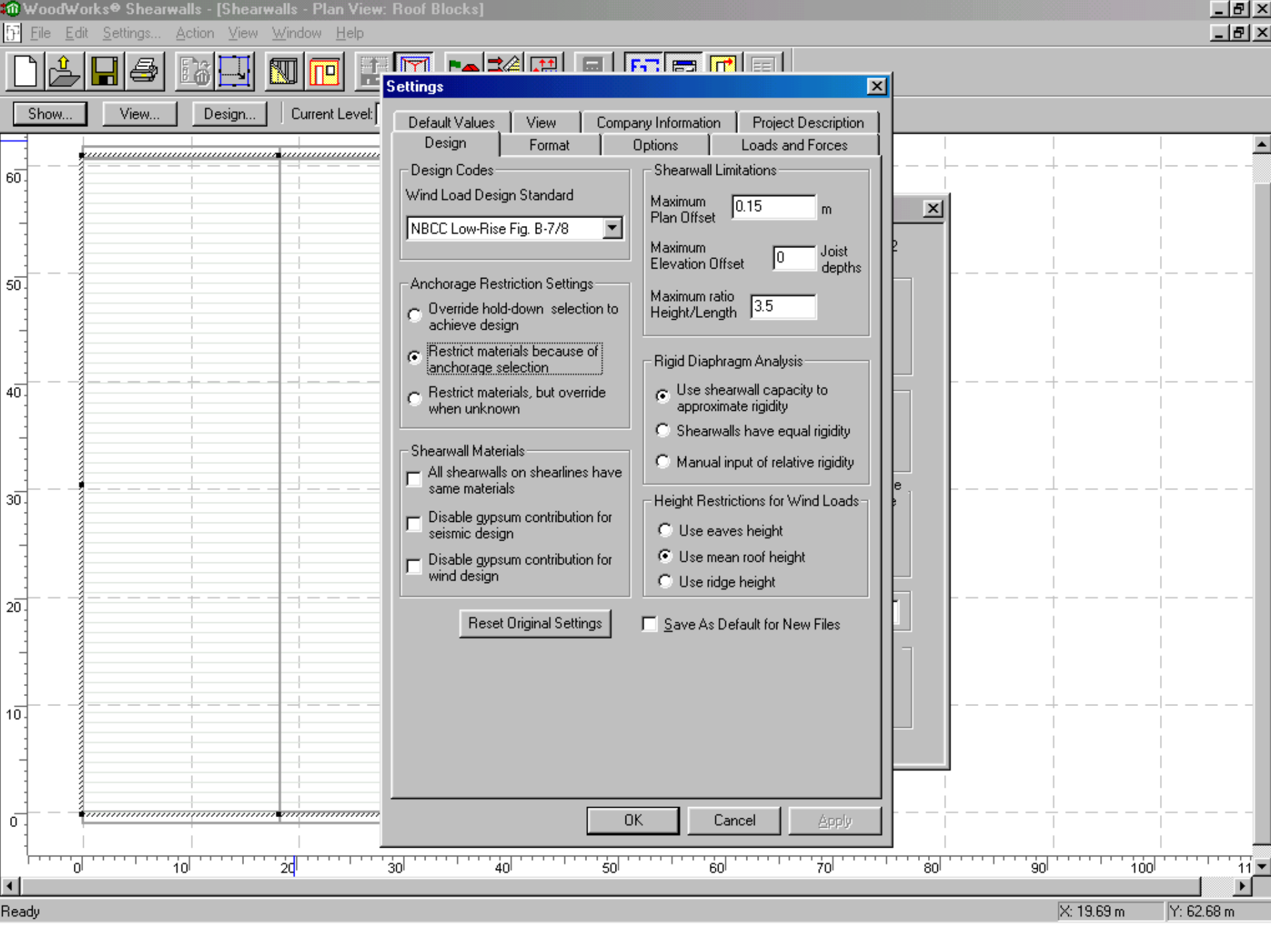
North	1	East	0
South	1	West	0

Step 4: Specify Site Information

- **From the *Design* tab of the *Settings* menu, choose *NBCC Low-Rise Fig. B-7/8* as the *Wind Load Design Standard***
- **Click the *Building Site* button ; the *Load Generation Site Information* form will open**
- **Specify a 1/30 hourly wind pressure, $q_{1/30} = 0.37$ kPa (corresponding to the wind pressure listed for Kemptville, ON in Appendix C of the NBCC)**

Note: In this example, wind loads are generated according to the NBCC Low-rise provisions, described in Figure B-7 of Commentary B of the Structural Commentaries to Part 4.

As an alternative, users can choose the NBCC Medium-rise provisions (see Figure B-14 of Commentary B) from the *Design* tab of the *Settings* menu.



Settings

- Default Values
- View
- Company Information
- Project Description

- Design
- Format
- Options
- Loads and Forces

Design Codes

Wind Load Design Standard

NBCC Low-Rise Fig. B-7/8

- Anchorage Restriction Settings
- Override hold-down selection to achieve design
 - Restrict materials because of anchorage selection
 - Restrict materials, but override when unknown

- Shearwall Materials
- All shearwalls on shearlines have same materials
 - Disable gypsum contribution for seismic design
 - Disable gypsum contribution for wind design

Shearwall Limitations

Maximum Plan Offset m

Maximum Elevation Offset Joist depths

Maximum ratio Height/Length

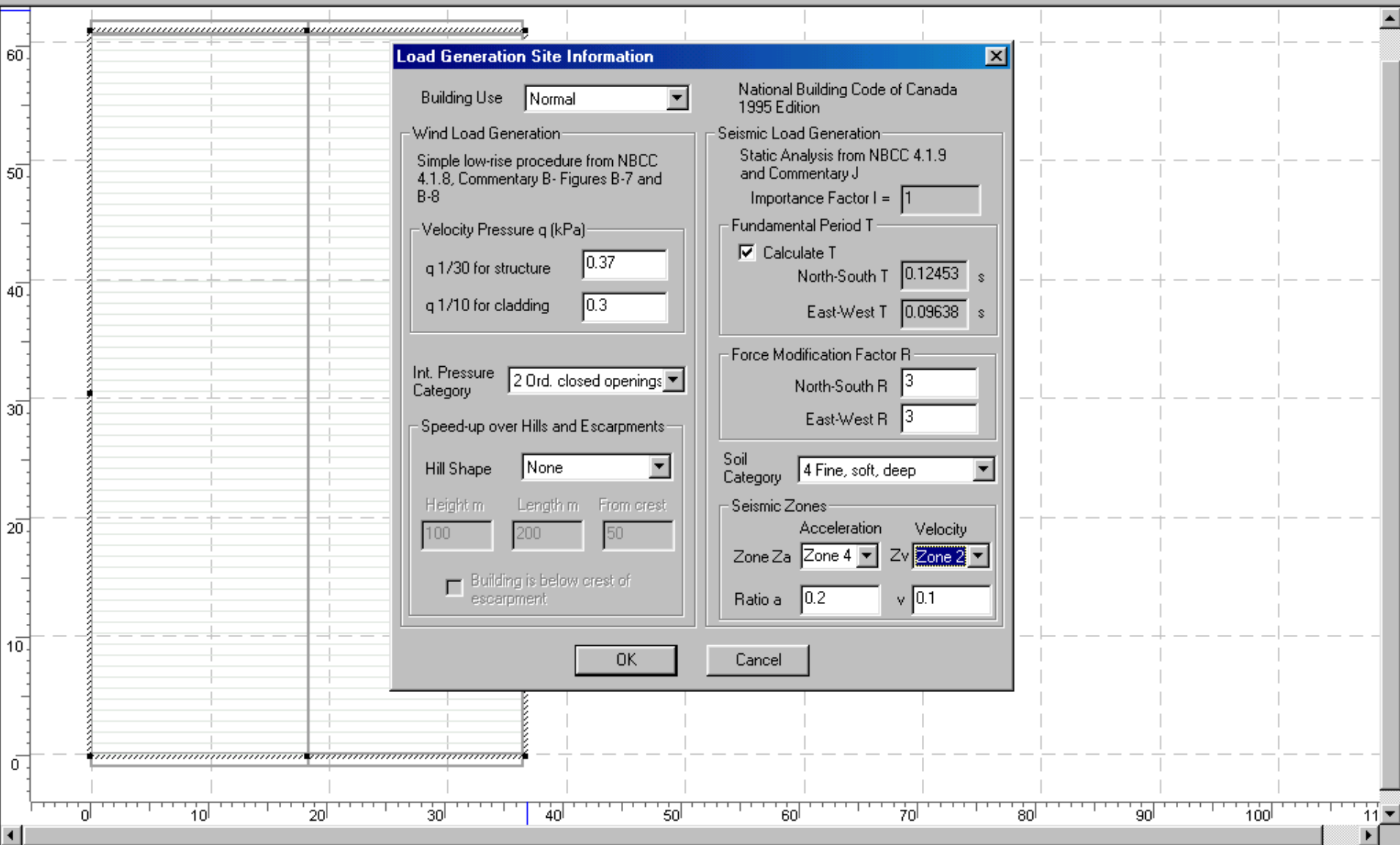
- Rigid Diaphragm Analysis
- Use shearwall capacity to approximate rigidity
 - Shearwalls have equal rigidity
 - Manual input of relative rigidity

- Height Restrictions for Wind Loads
- Use eaves height
 - Use mean roof height
 - Use ridge height

Reset Original Settings

Save As Default for New Files

OK Cancel Apply



Load Generation Site Information

Building Use: Normal

National Building Code of Canada
1995 Edition

Wind Load Generation
Simple low-rise procedure from NBCC
4.1.8, Commentary B- Figures B-7 and
B-8

Velocity Pressure q (kPa)

q 1/30 for structure: 0.37

q 1/10 for cladding: 0.3

Int. Pressure Category: 2 Ord. closed openings

Speed-up over Hills and Escarpments

Hill Shape: None

Height m: 100 Length m: 200 From crest: 50

Building is below crest of escarpment

Seismic Load Generation
Static Analysis from NBCC 4.1.9
and Commentary J

Importance Factor I = 1

Fundamental Period T

Calculate T

North-South T: 0.12453 s

East-West T: 0.09638 s

Force Modification Factor R

North-South R: 3

East-West R: 3

Soil Category: 4 Fine, soft, deep


Seismic Zones

Acceleration Zone Za: Zone 4 Velocity Zone Zv: Zone 2

Ratio a: 0.2 v: 0.1

OK Cancel

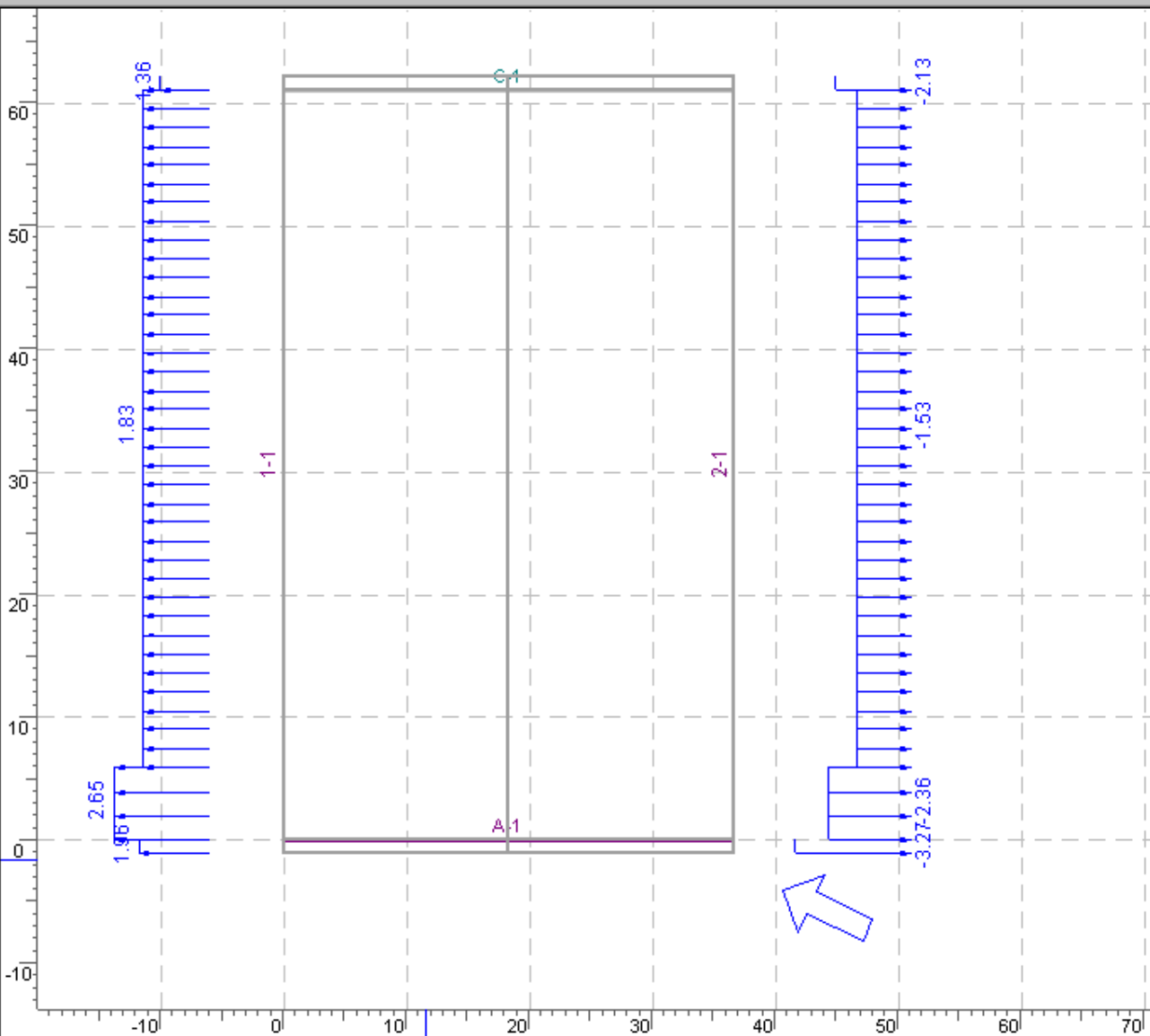
Step 5: Generate Wind Loads

- **Click Generate Loads button  , the *Generate Loads* form will open**
- **Generate wind loads on all building faces for all load cases described in Figure B-7 of the NBCC Structural Commentaries:**
 - **Remove the check next to *Seismic Loads* and add a check to *Wind Loads***
 - **Under *Wind Direction*, select *Both Directions***
 - **Under *Building Face*, select *All***
 - **Check *Line Loads on Walls, Roof Panels* and *Gable Ends***
 - **Press the *Generate and Add to Loads* button**
- **Wind loads acting on the Main Wind Force Resisting System (MWRFS) will be displayed graphically**

File Edit Settings... Action View Window Help



Show... View... Design... Current Level: 2 Zoom In Zoom Out



Shearwalls - Generate Loads

Building Levels to

Wind Loads
Wind Direction:
Building Face:

Seismic Loads
 Generate loads only (not building masses)

Generate Building Masses first...
Self Weights (kN/m²)

<input checked="" type="checkbox"/> Floors	<input type="text" value="0.5"/>
<input type="checkbox"/> Ceiling	<input type="text" value="0.3"/>
<input checked="" type="checkbox"/> Roof	<input type="text" value="0.5"/>
<input checked="" type="checkbox"/> Horizontal Projection	
<input checked="" type="checkbox"/> Snow Load	<input type="text" value="0.5"/>
<input type="checkbox"/> Interior Walls	<input type="text" value="0.3"/>
<input checked="" type="checkbox"/> Exterior Walls	<input type="text" value="0.5"/>

C&C Wall Loads

Use wall self-weights to generate wall dead loads for Jhd calculations

Low-rise Wind Load Cases

Building Code

The National Building Code of Canada requires consideration of wind acting on the building from any direction. Following the low-rise procedure of Structural Commentary B (Figure B-7 of the *User Guide*), this requirement is met by examining eight distinct load cases, as described below.

Each corner of the building is considered, in turn to be the windward corner. For each windward corner, two load cases are to be examined:

Case A - wind acting generally perpendicular to the roof ridge; and

Case B - wind acting generally parallel to the roof ridge.

The software takes all eight of these cases into account.

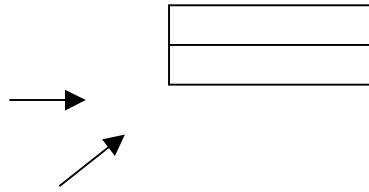
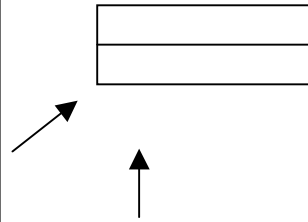
NBCC Low-Rise Load Cases

Windward corner

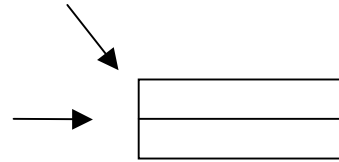
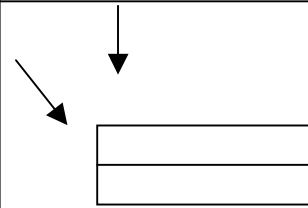
Case A: winds generally \perp to ridge

Case B: winds generally \parallel to ridge

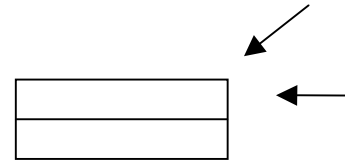
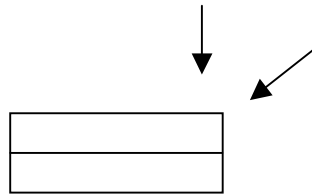
SW



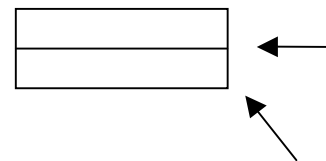
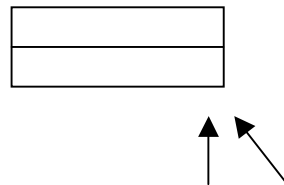
NW



NE



SE

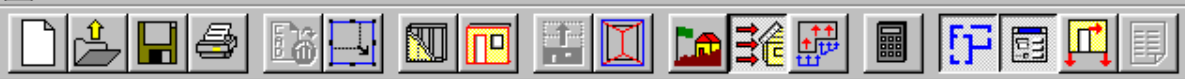


Arrows represent the range of wind direction considered for each case.

Software Output

Each of the low-rise wind load cases can be viewed separately in *WoodWorks Shearwalls*.

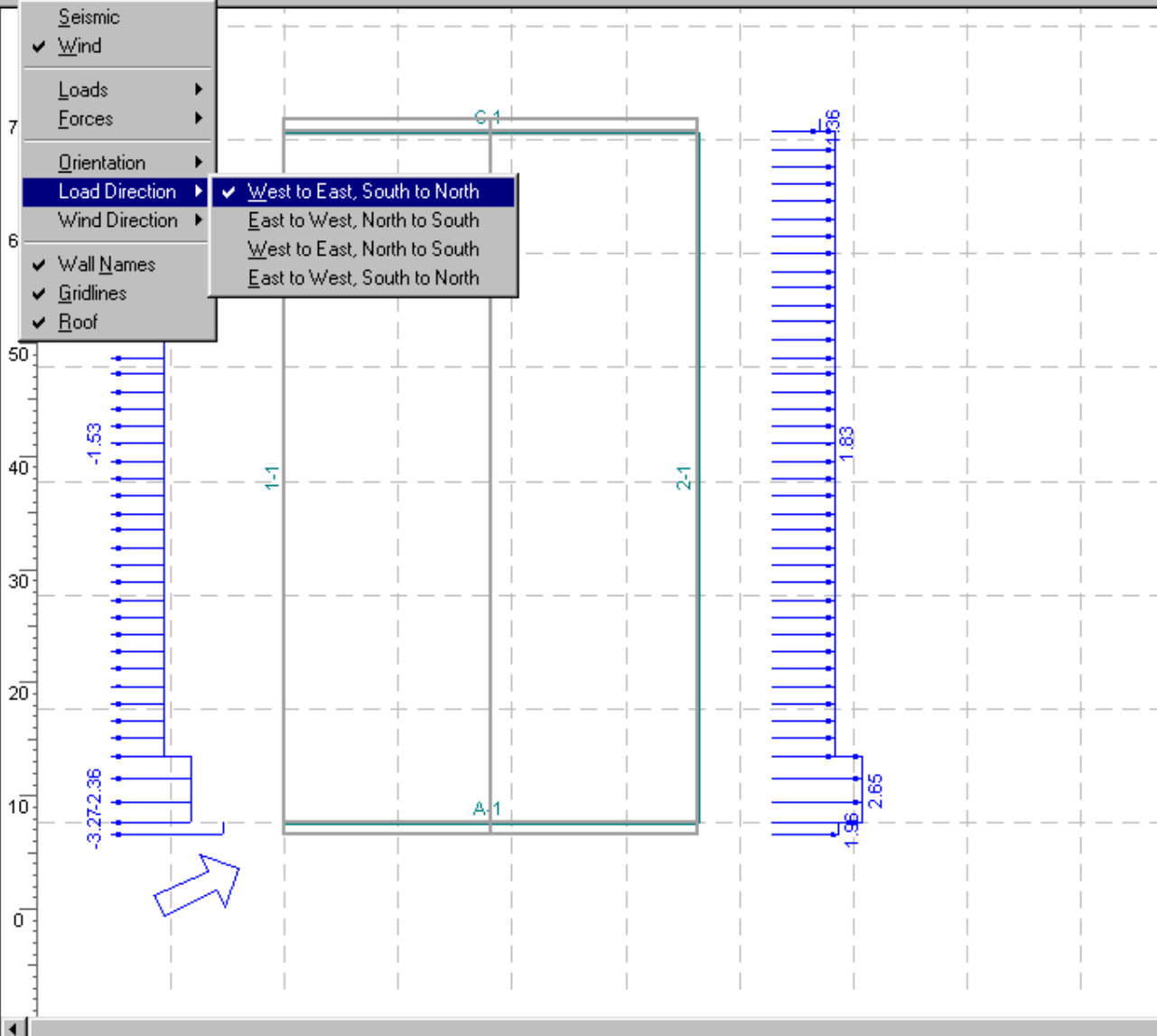
- **Click the *Show...* button (top left between view area and main menu) – a drop-down menu will appear**
- **From the top area of the *Show* menu, make sure that *Wind* is checked (*Seismic* loads can be shown as an alternative, provided they were generated)**
- **Select the windward corner using the *Load Direction* option of the *Show* menu.**
 - **To consider the South-West corner as windward, select a *Load Direction* of *West to East, South to North***
- **Two load cases are considered for each windward corner. Use the *Wind Direction* option of the *Show* menu to specify which load case to display**
 - **To view Case A, wind generally perpendicular to the ridge, with the South-West corner as windward, select a *Wind Direction* of *East-West***
 - **To view Case B loads for the same windward corner, change the *Wind Direction* to *North-South***



Show... View... Design... Current Level: 2 Zoom In Zoom Out

- Seismic
- Wind
- Loads
- Forces
- Orientation
- Load Direction
- Wind Direction
- Wall Names
- Gridlines
- Roof

- West to East, South to North
- East to West, North to South
- West to East, North to South
- East to West, South to North



NBCCLowRiseWind3.wsw - Generate Loads

Building Levels 1 to 2

Wind Loads

Wind Direction: Both Directions

Building Face: All

MWFRS Loads

Generate

Line Loads

Area Loads

on

Walls

Roof Panels

Gable Ends

C&C Wall Loads

Seismic Loads

Generate loads only (not building masses)

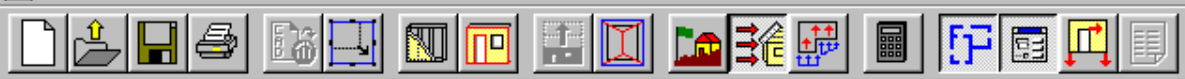
Generate Building Masses first.

Self Weights (kN/m²)

<input checked="" type="checkbox"/> Floors	0.5
<input type="checkbox"/> Ceiling	0.3
<input checked="" type="checkbox"/> Roof	0.5
<input checked="" type="checkbox"/> Horizontal Projection	
<input checked="" type="checkbox"/> Snow Load	0.5
<input type="checkbox"/> Interior Walls	0.3
<input checked="" type="checkbox"/> Exterior Walls	0.5

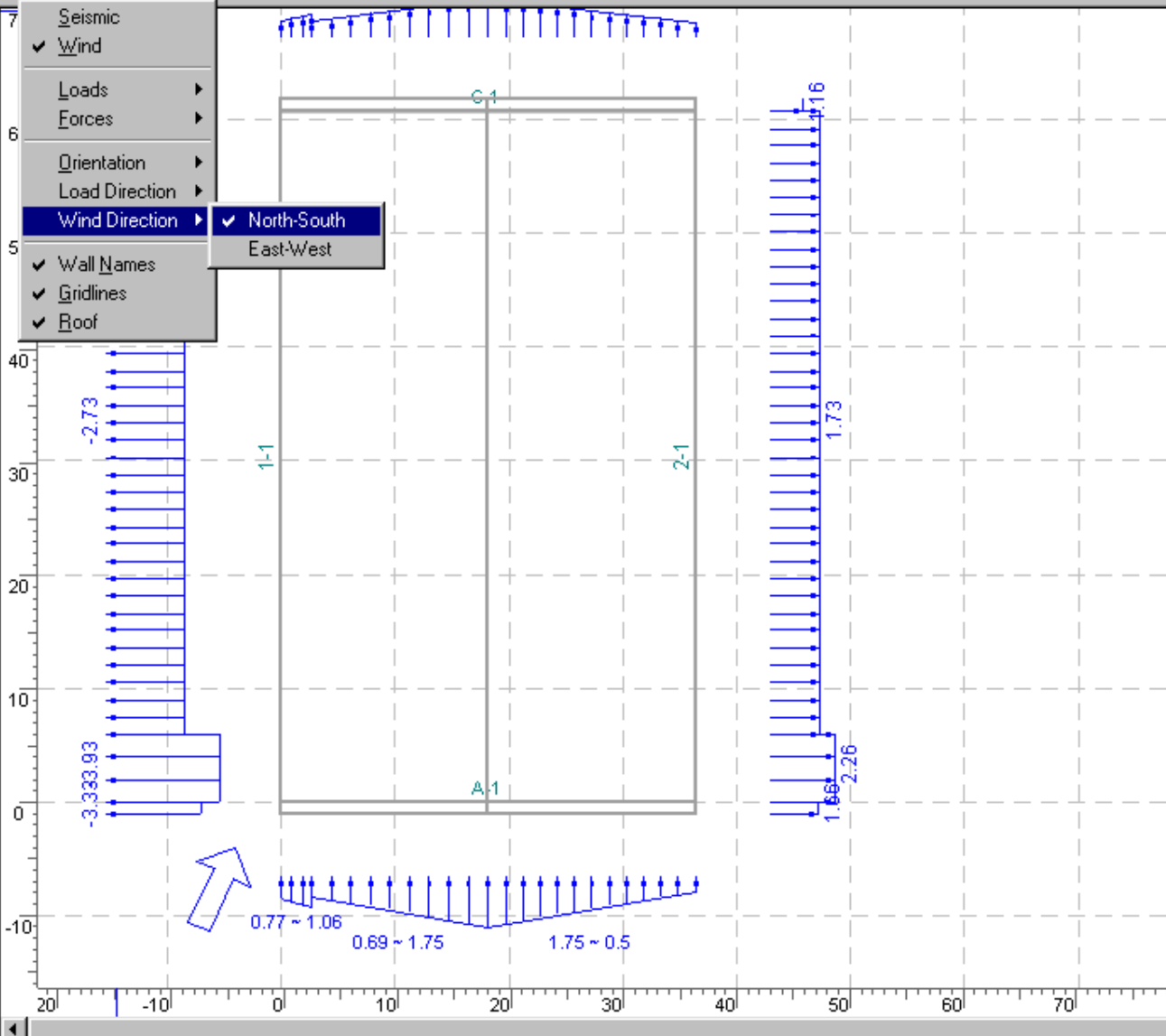
Use wall self-weights to generate wall dead loads for Jhd calculations

Generate and Add To Loads Regenerate Loads Delete All Generated Loads



Show... View... Design... Current Level: 2 Zoom In Zoom Out

- 7 Seismic
- ✓ Wind
- Loads >
- Forces >
- Orientation >
- Load Direction >
- Wind Direction >
 - ✓ North-South
 - East-West
- 5 ✓ Wall Names
- ✓ Gridlines
- ✓ Roof



NBCCLowRiseWind3.wsw - Generate Loads

Building Levels to

Wind Loads

Wind Direction:

Building Face:

MWFRS Loads

Generate

Line Loads

Area Loads

on

Walls

Roof Panels

Gable Ends

C&C Wall Loads

Seismic Loads

Generate loads only (not building masses)

Generate Building Masses first.

Self Weights (kN/m²)

Floors

Ceiling

Roof

Horizontal Projection

Snow Load

Interior Walls

Exterior Walls

Use wall self-weights to generate wall dead loads for Jhd calculations

Generate and Add To Loads Regenerate Loads Delete All Generated Loads

- **Use *Load Direction* in combination with *Wind Direction* to view the other six low-rise load cases**
- **The software will take all eight of these load cases into account in determining the forces acting on the shearlines**
- **Note that the generated loads can be edited using the Load Input Form.**