

5 *Shearwalls* Tutorial 5 – Matching Published Design Example (Canadian)

5.1 Software Version and Standard

This tutorial was completed using WoodWorks® Canada 2020, and CSA O86-19.

5.2 Introduction

As stated in Clause 11.5.5 of the CSA O86-19, it is possible to eliminate or reduce the number of hold-downs within a shearwall, but the process is iterative and time consuming to do by hand or with a spreadsheet. *Shearwalls* is capable of performing these iterations very quickly and can save designers a lot of time. The J_{hd} factor applies a strength reduction to a shearwall segment based on a function of the height of the shearwall, the lengths of the shearwall segments, the overturning restraint force and the basic shear capacity. To eliminate hold-downs, it is necessary for the overturning tension force to be resisted by the wood sheathing of the segments.

There are a few limitations shearwall segments without hold-downs:

- Maximum nail diameter of 3.25 mm
- Minimum nail spacing of 100 mm
- Maximum specified shear strength of 10.3 kN/m
- Maximum shearwall height of 3.6 m

Click [here](#) to download a PDF copy of the Example Statement from the 2017 Wood Design Manual.

Click [here](#) to download the Shearwall file (.wsw) created from going through this tutorial.

5.3 Settings

1. Click on the **Settings** tab located in the menu bar.
2. Click on the **Design** tab in the **Settings** window.
3. Under the **Design procedures** section, select **CSA O86-14 / NBC 2010** from the **Design code** drop-down list.
4. Under the **Design procedures** section, select **NBC Low-rise Fig. I7/8** from the **Wind load generation method** drop-down list.
5. Under the **Design procedures** section, deselect the **Include deflection analysis** check box.
6. Under the **Shearwall rigidity** section, select the **Use shearwall capacity to approximate rigidity** option.
7. Click **OK**.

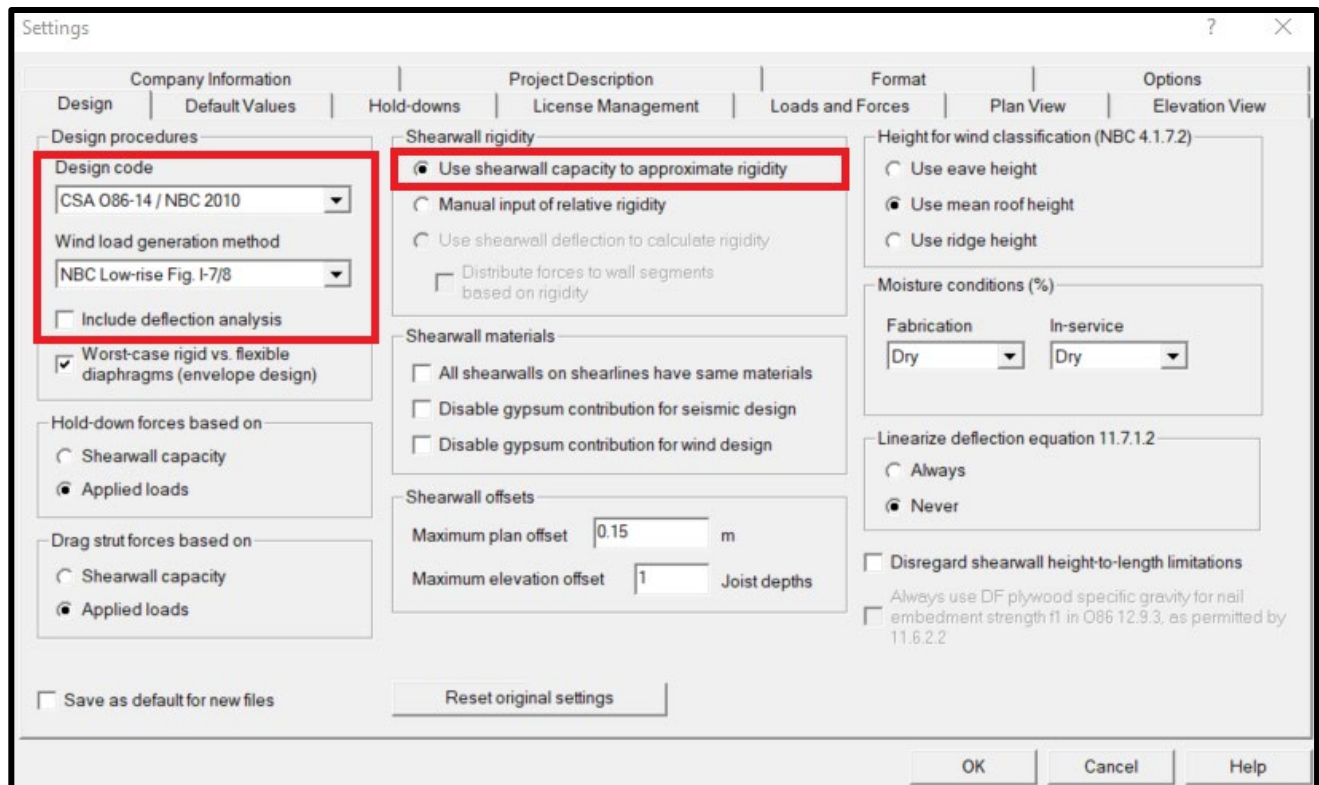


Figure 1: *Shearwalls Tutorial 5 – Design Settings*

5.4 Structure Blocks and Adjusting Levels

1. Click on the **Structure** button on the toolbar.
2. Create a block by clicking and holding the left mouse button.
3. In the **Structure Input** window, under the **Blocks** section, specify the **X extent** as **15 (m)**, the **Y extent** as **10 (m)**, the **X location** as **0 (m)**, and **Y location** as **0 (m)**.
4. Specify **2** as the **No. of levels**.
5. In the **Structure Input** window, under the **Levels** section specify:
 - a. **300** as the **Floor/ceiling depth (m)** for **Level 1** and **Level 2**
 - b. **3** as the **Wall height (m)** for **Level 1** and **Level 2**
 - c. **0** as the **Diaphragm elevation (m)** for **Foundation elevation**
6. In the **Structure Input** window, under the **Diaphragm flexibility** section, deselect the **Rigid Analysis** check box.

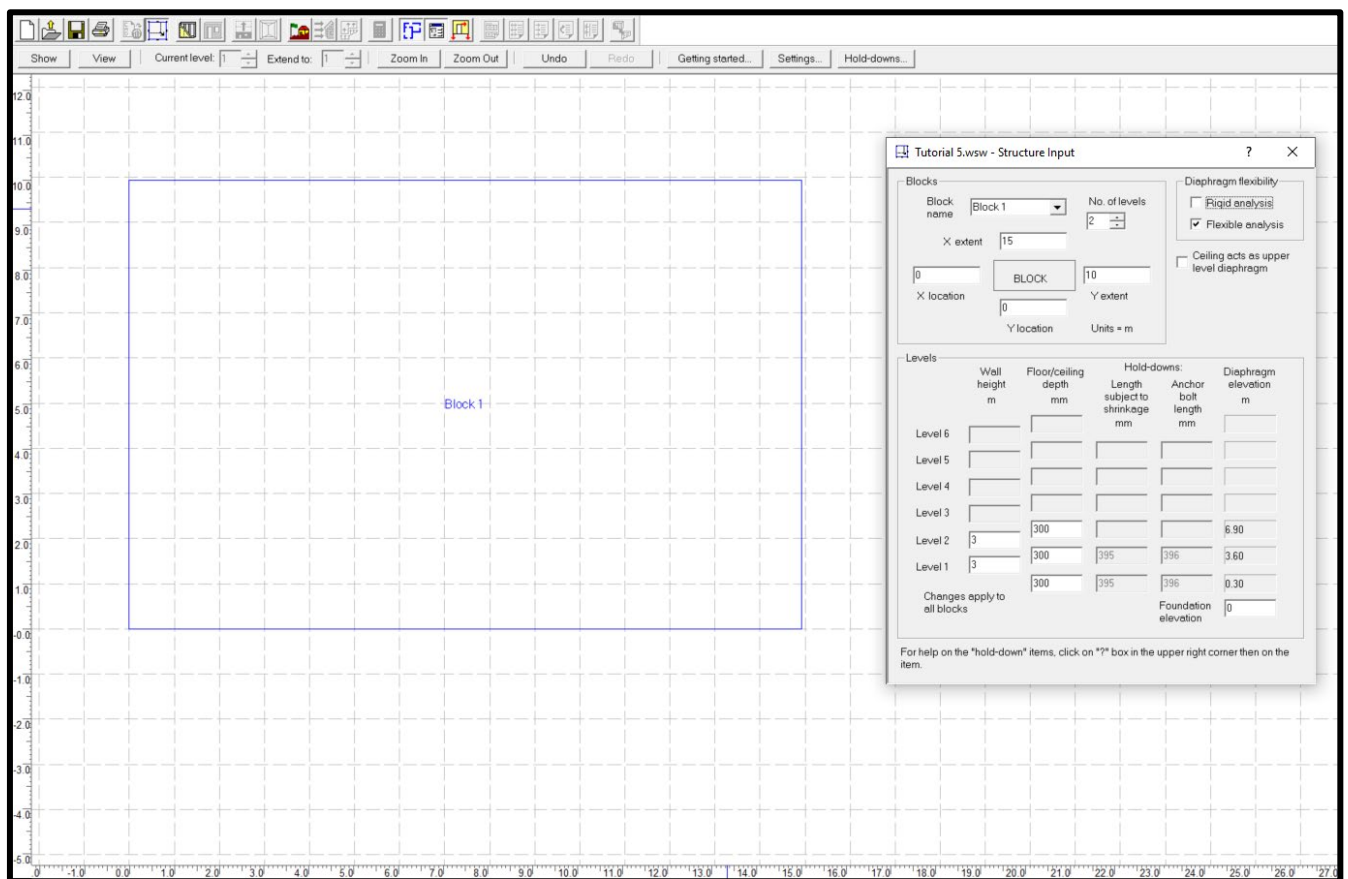


Figure 2: Shearwalls Tutorial 5 – Creating Structure Block and Incrementing Levels

5.5 Openings

1. Click on the **Walls** button on the toolbar.
2. Click on the **Openings** button on the toolbar.
3. In the **Opening Input** window, under the **Wall** section, specify **2 (m)** as the **Width**, **1.2 (m)** as the **Height**, **1 (m)** as the **Offset from bottom**, and **4 (m)** as the **Offset from edge**.
4. Click **Add**.
5. In the **Opening Input** window, select **(new opening)** from the **Openings** drop-down list.
6. In the **Opening Input** window, under the **Wall** section, specify **2 (m)** as the **Width**, **1.2 (m)** as the **Height**, **1 (m)** as the **Offset from bottom**, and **11 (m)** as the **Offset from edge**.
7. Click **Add**.

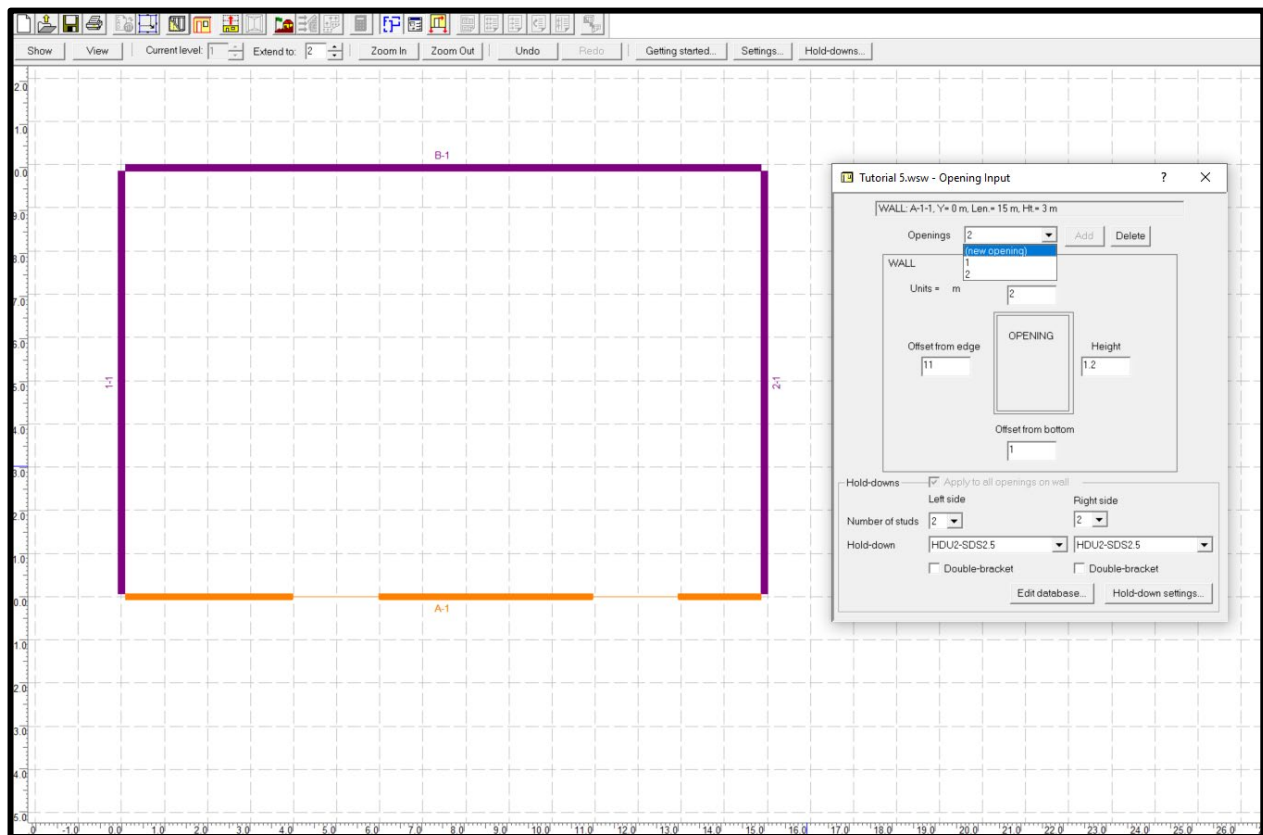


Figure 3: Shearwalls Tutorial 5 – Create Openings in Shearline A

5.6 Roof Shape

1. Click on the **Extend Walls Upwards** button on the toolbar.
2. Click on the **Roof Blocks** button on the toolbar.
3. Click on the **Block 1** structure block.
4. In the **Roof Input** window, under the **Construction** section, select the **Flat roof** check box.

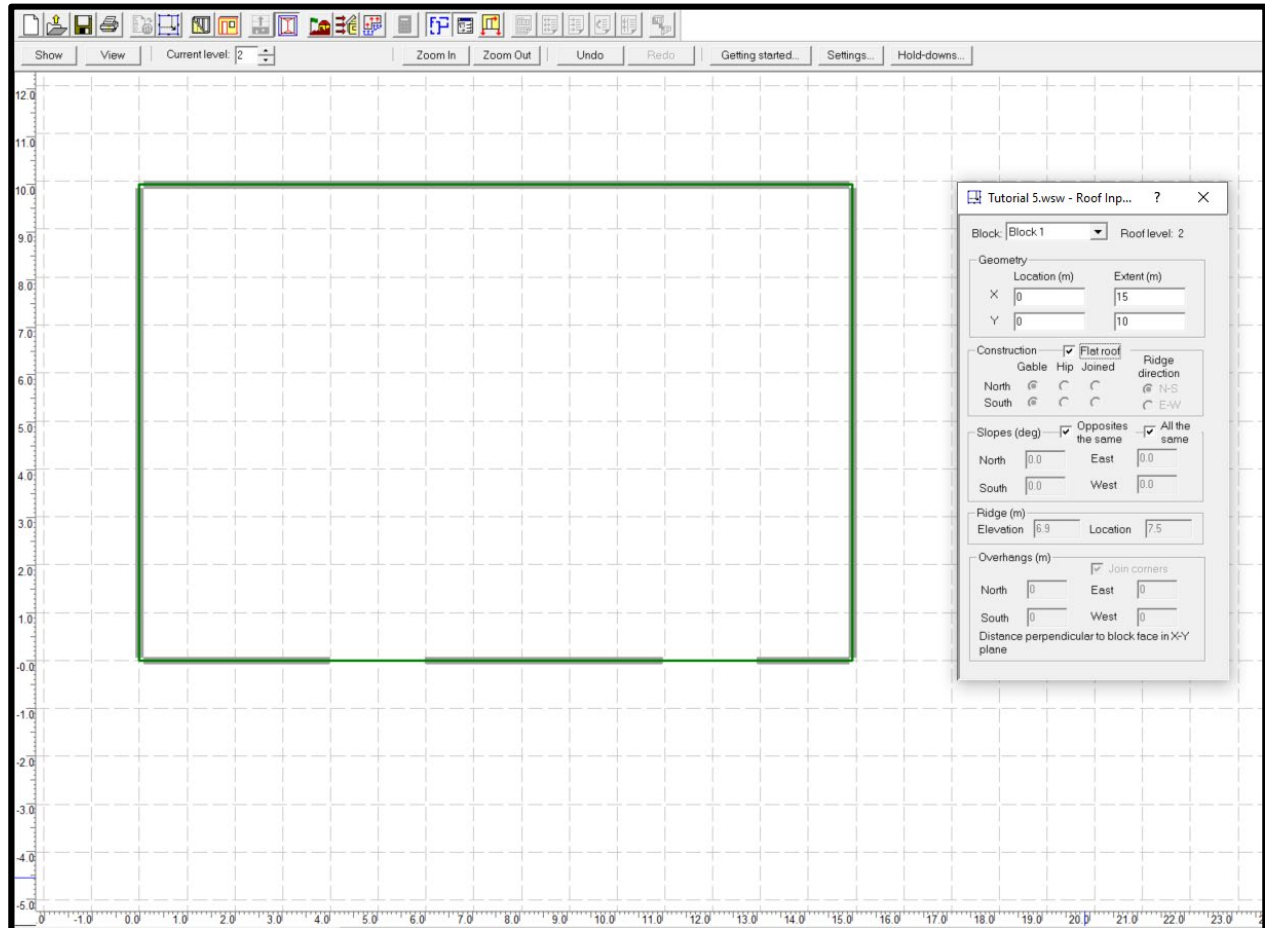


Figure 4: Shearwalls Tutorial 5 – Block 1 Roof Block

5.7 Level 1

5.7.1 Wall Details

1. Click on the **Walls** button on the toolbar.
2. On the menu bar, change the **Current level** to **1**.
3. Select walls **A-1, B-1, 1-1, and 2-1**.
4. In the **Wall and Shearline Input** window, under the **Sheathing** section, specify:
 - a. **OSB** as the **Material**
 - b. **11** as the **Thickness (mm)**
 - c. **2R24** as the **Panel mark**
 - d. **Horizontal** as the **Orientation**
 - e. Select the **Blocking** check box
5. In the **Wall and Shearline Input** window, under the **Fasteners** section, specify:
 - a. **Power-driven nails** as the **Type**
 - b. **2-1/2"** as the **Len.* (in)**
 - c. **3.25** as the **Dia.* (mm)**
 - d. **100** as the **Edge spacing (mm)**
 - e. **300** as the **Interior spacing (mm)**

Figure 5: *Shearwalls Tutorial 5 – Exterior Side of Walls (Level 1)*

6. In the **Wall and Shearline Input** window, under the **Materials for Shearwalls** section click on the **Interior side** tab.
7. In the **Wall and Shearline Input** window, under the **Sheathing** section, specify:
 - a. **GWB Type X** as the **Material**
 - b. **12.5** as the **Thickness (mm)**
 - c. **Horizontal** as the **Orientation**
 - d. Select the **Blocking** check box
8. In the **Wall and Shearline Input** window, under the **Fasteners** section, specify:
 - a. **Drywall screws** as the **Type**
 - b. **1-1/4"** as the **Len. * (in)**
 - c. **200** as the **Edge spacing (mm)**
 - d. **300** as the **Interior spacing (mm)**

The screenshot shows the 'Tutorial 5.wsw - Wall and Shearline Input' window. The 'Standard wall' dropdown is set to 'Standard wall'. The 'Walls 2-1, A-1, 1-1, B-1' section shows 'Hold-down configuration' as 'Hold-downs on all segments', 'Relative rigidity per unit length' as 'Multiple', and 'Shearline' as 'Auto'. The 'Location' is 15 m, 'Start' is 0, 'End' is 10, and 'Height' is 3. The 'Materials for Shearwalls 2-1, A-1, 1-1, B-1, level 1' section has the 'Interior side' tab selected. Under 'Sheathing', 'Material' is 'GWB Type X', 'Thickness' is '12.5 mm', 'Orientation' is 'Horizontal', and 'Blocking' is checked. Under 'Fasteners', 'Type' is 'Drywall screws', 'Len. (in)' is '1-1/4"', 'Edge spacing' is '200 mm', and 'Interior spacing' is '300 mm'. The 'Framing' section shows 'Material' as 'Lumber', 'Thickness b*' as '38 mm', 'Species' as 'S-P-F', 'Width d*' as '89 mm', 'Grade' as 'No. 1/No. 2', and 'Stud spacing' as '400 mm'. The 'Hold-downs for selected walls' section shows 'Left end' and 'Right end' both set to 'HDU2-SDS2 5', with 'Double-bracket' unchecked. The 'Design group(s)' is 'Not designed'.

Figure 6: Shearwalls Tutorial 5 – Interior Side of Walls (Level 1)

5.8 Level 2

5.8.1 Wall Details

1. On the menu bar, change the **Current level** to **1**.
2. Select walls **A-1, B-1, 1-1, and 2-1**.
3. In the **Wall and Shearline Input** window, under the **Sheathing** section, select **Ends of shearwalls & w. req'd** from the **Hold-down configuration** drop-down list.
4. In the **Wall and Shearline Input** window, under the **Sheathing** section, specify:
 - a. **OSB** as the **Material**
 - b. **11** as the **Thickness (mm)**
 - c. **2R24** as the **Panel mark**
 - d. **Horizontal** as the **Orientation**
 - e. Select the **Blocking** check box
5. In the **Wall and Shearline Input** window, under the **Fasteners** section, specify:
 - a. **Power-driven nails** as the **Type**
 - b. **2-1/2"** as the **Len.* (in)**
 - c. **3.25** as the **Dia.* (mm)**
 - d. **150** as the **Edge spacing (mm)**
 - e. **300** as the **Interior spacing (mm)**

Tutorial 5.wsw - Wall and Shearline Input

Standard wall
[Dropdown] Edit standard walls... ☐ Design in group

Walls B-1, 2-1, A-1, 1-1
Hold-down configuration: Ends of shearwalls & w. req'd Relative rigidity per unit length: Multiple Shearline: Auto
Location m: Start 15 End 10 Height 3

Materials for Shearwalls B-1, 2-1, A-1, 1-1, level 2
Exterior side Interior side ☐ Both sides the same
Sheathing: Material: OSB Thickness: 11 mm Panel mark: 2R24 Orientation: Horizontal Blocking ☒ Gypsum underlay: None mm
Fasteners: Type: Power-driven nails Len.* (in): 2-1/2" Dia.* (mm): 3.25 Edge spacing: 150 mm Interior spacing: 300 mm

Framing
Material: Lumber Thickness b*: 38 mm End studs: Left 2 Right 2
Species: S-P-F Width d*: 89 mm
Grade: No.1/No.2 Stud spacing: 400 mm

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 *You can select these items or enter your own value

Figure 7: Shearwalls Tutorial 5 – Exterior Side of Walls (Level 2)

6. In the **Wall and Shearline Input** window, under the **Materials for Shearwalls** section click on the **Interior side** tab.
7. In the **Wall and Shearline Input** window, under the **Sheathing** section, specify:
 - a. **GWB Type X** as the **Material**
 - b. **12.5** as the **Thickness (mm)**
 - c. **Horizontal** as the **Orientation**
 - d. Select the **Blocking** check box
8. In the **Wall and Shearline Input** window, under the **Fasteners** section, specify:
 - a. **Drywall screws** as the **Type**
 - b. **1-1/4"** as the **Len. * (in)**
 - c. **200** as the **Edge spacing (mm)**
 - d. **300** as the **Interior spacing (mm)**

The screenshot shows the 'Tutorial 5.wsw - Wall and Shearline Input' window. The 'Interior side' tab is selected under 'Materials for Shearwalls A-1, 1-1, B-1, 2-1, level 2'. The 'Sheathing' section is configured with 'Material' set to 'GWB Type X', 'Thickness' set to '12.5 mm', 'Orientation' set to 'Horizontal', and the 'Blocking' checkbox checked. The 'Fasteners' section is configured with 'Type' set to 'Drywall screws', 'Len. (in)' set to '1-1/4"', 'Edge spacing' set to '200 mm', and 'Interior spacing' set to '300 mm'. The 'Framing' section shows 'Material' set to 'Lumber', 'Thickness b*' set to '38 mm', 'Species' set to 'S-P-F', 'Width d*' set to '89 mm', 'Grade' set to 'No.1/No.2', and 'Stud spacing' set to '400 mm'. The 'Hold-downs for selected walls' section shows 'Left end' and 'Right end' both set to 'HDU2-SDS2.5', with 'Double-bracket' checked for both. The 'Design group(s)' is set to 'Not designed'.

Figure 8: Shearwalls Tutorial 5 – Interior Side of Walls (Level 2)

5.9 Loads and Forces

5.9.1 Level 1

1. On the menu bar, change the **Current level** to **1**.
2. Click on the **Loads and Forces** button on the toolbar.
3. Select wall **A-1** and in the **Load Input** window, click **Add**.
4. Select the **Add as a factored force directly (parallel) to the shearline**.
5. Under the **Type** section, select the **Wind shear** option.
6. Under the **Profile** section, select the **Point load** option.
7. Under the **Location** section, select **Shear line** and **A** from the **Apply to...** drop-down list.
8. In the **Magnitude** field enter a value of **40 (kN)**.
9. Click **OK**.

Add a New Load

Type

- ☐ Seismic
- ☒ Wind shear
- ☐ Wind C&C
- ☐ Wind uplift
- ☐ Dead load
- ☐ Building mass

Profile

- ☒ Point load
- ☐ Line load
- ☐ Area load

Level(s)

From 1 To 1

Location

Apply to... Shear line

From X= 0 To X= 15

Wind direction Both ways

Tributary width (m) 0.0

Magnitude (kN)

0.0 0.0

☒ Add as a factored force directly (parallel) to the shearline

Distribution method Both

OK Cancel

Figure 9: Shearwalls Tutorial 5 – Add a Wind Shear Point Load (Level 1)

10. Select wall **A-1** and in the **Load Input** window, click **Add**.
11. Under the **Type** section, select the **Dead load** option.
12. Under the **Profile** section, select the **Line load** option.
13. Under the **Level(s)** section, specify **1** as the **From** and **2** as the **To**.
14. Under the **Location** section, select **Wall line** and **A** from the **Apply to...** drop-down list.
15. Under the **Location** section, specify **6** as the **From X =** and **11** as the **To X =**.
16. In the **Magnitude** field enter a value of **0.55 (kN/m)**.
17. Click **OK**.
18. Select wall **A-1** and in the **Load Input** window, click **Add**.
19. Repeat steps 11-13.
20. Under the **Location** section, select **Wall line** and **1** from the **Apply to...** drop-down list.
21. Under the **Location** section, specify **0** as the **From Y =** and **10** as the **To Y =**.
22. In the **Magnitude** field enter a value of **0.55 (kN/m)**.
23. Click **OK**.

5.9.2 Level 2

1. On the menu bar, change the **Current level** to **2**.
2. Click on the **Loads and Forces** button on the toolbar.
3. Select wall **A-1** and in the **Load Input** window, click **Add**.
4. Select the **Add as a factored force directly (parallel) to the shearline**.
5. Under the **Type** section, select the **Wind shear** option.
6. Under the **Profile** section, select the **Point load** option.
7. In the **Magnitude** field enter a value of **20 (kN)**.
8. Click **OK**.

Add a New Load

Type

- ☐ Seismic
- ☒ Wind shear
- ☐ Wind C&C
- ☐ Wind uplift
- ☐ Dead load
- ☐ Building mass

Wall ☐

Profile

- ☒ Point load
- ☐ Line load
- ☐ Area load

Level(s)

From To

Location

Apply to...

From X= To X=

Wind direction Tributary width (m)

Magnitude (kN)

☒ Add as a factored force directly (parallel) to the shearline

Distribution method

OK Cancel

Figure 10: *Shearwalls Tutorial 5 – Add a Wind Shear Point Load (Level 2)*

5.10 Designing Shearwalls

1. Click on the **Run Design** button on the toolbar.
2. Click on the **Accept Design** button on the toolbar.

Note: *Shearwalls* will prompt you to save the project file.

Shearwalls will complete the design, and will automatically generate the **Seismic Load Generation Details**, **Wind Load Generation Details**, **Torsional Analysis Details**, and **Detailed Shearwall Design**. These buttons are displayed on the toolbar.



Figure 11: *Shearwalls Tutorial 5 – Run Design*

5.11 View Results

Click [here](#) to download a PDF of the design summary.

Click [here](#) to download a PDF of the detailed shearwall design.

Flexible Diaphragm Wind Design										
SHEAR RESULTS										
North-south Shearlines	W Gp	For Dir	Wind Case	Shear Force		Vhd (vd) / L		Capacities [kN/m]		Ratio
				FHS [m]	Fv/L [kN/m]	Int	Ext	Jhd Int	Vrs (vpb) / L Ext	Fv/V
East-west Shearlines	W Gp	For Dir	Wind Case	FHS [m]	Fv/L [kN/m]	Int	Ext	Jhd Int	Vrs (vpb) / L Ext	Fv/V
Line A										
Level 2										
LnA, Lev2	-	W->E		11.00	1.33	-	-	-	-	0.44
	-	E->W		11.00	1.33	-	-	-	-	0.48
Wall A-1	2	W->E		11.00	-	0.98	4.93	-	-	-
	2^	E->W		11.00	-	0.98	4.93	-	-	-
Segment 1	-	W->E		4.00	2.63	-	-	1.00	14.05	5.91
	-	E->W		4.00	1.43	-	-	0.50	14.05	2.96
Segment 2	-	W->E		5.00	1.58	-	-	0.60	14.05	3.56
	-	E->W		5.00	1.72	-	-	0.60	14.05	3.56
Segment 3	-	W->E		2.00	0.80	-	-	0.30	15.30	1.79
	-	E->W		2.00	2.85	-	-	1.00	15.30	5.91
Level 1										
LnA, Lev1	-	W->E		11.00	4.00	-	-	-	-	0.72
	-	E->W		11.00	4.00	-	-	-	-	0.74
Wall A-1	1	W->E		11.00	-	0.98	7.09	-	-	-
	1^	E->W		11.00	-	0.98	7.09	-	-	-
Segment 1	-	W->E		4.00	5.81	-	-	1.00	14.05	8.07
	-	E->W		4.00	5.11	-	-	0.85	14.05	6.89
Segment 2	-	W->E		5.00	5.41	-	-	0.93	14.05	7.52
	-	E->W		5.00	5.51	-	-	0.92	14.05	7.43
Segment 3	-	W->E		2.00	4.86	-	-	0.84	15.30	6.76
	-	E->W		2.00	5.99	-	-	1.00	15.30	8.07

Legend:
 Results can have different meaning for shearlines, walls, and wall segments. Results for walls with no openings are the same as those for segments.
 W Gp - Wall design group as listed in Sheathing and Framing Materials tables. "A" means that this wall is critical for all walls in the Standard Wall group.
 Dir - Direction of wind force along shearline. "Both" appears if results are identical for both directions.
 Wind case - Critical low-rise windward corner and load case A or B when using NBC 4.1.7.6; all other results are for this load case. Nothing shown when using 4.1.7.5.
 FHS - Length of full height sheathing along shearline, wall, or segment.
 Fv/L - For shearlines = diaphragm shear force = factored shearline force divided by length of shearline; for wall segments = design shear force = factored shear force divided by length of full height sheathing.
 Vhd(vd)/L - Factored unit sheathing connection resistance = Vrs from O86 11.5.1 without Jhd

Figure 12: Shearwalls Tutorial 5 – Wind Shear Results