

WoodWorks Shearwalls Canada - Version History

This document provides descriptions of all new features, bug fixes, and other changes made to the Canadian version of the WoodWorks Shearwalls program since its inception. The most recent major release of Shearwalls is [Version 9.3](#) released in Sept, 2015. This file last updated with changes on August 24, 2015.

Click on the links below to go to the changes for the corresponding release. (DO = Design Office)

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Shearwalls 9.3 – September 11, 2015 – Design Office 9, Service Release 3

This service release provides design for CSA O86-14 standard, as well as allowing continued use of CSA O86-09. The following is an index of links to changes described in more detail below.

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A: CSA O86-14 Design Standard

1. Choice of Design Standards

The program now implements the new CSA O86-14 Engineering Design in Wood Standard. As the National Building Code referencing CSA O86-14 is not yet released, and provincial building codes have not yet mandated the use of O86-14, the program also allows you to continue using CSA O86-09.

Input

a) Design Code Selector

A drop list box called *Design Code* has been added to the Design settings in the *Design procedures* data group, with the choices

CSA O86-09/ NBC 2010

CSA O86-14/ NBC 2010

b) Output

The Design Settings output has been changed from showing only the National Building Code edition to showing *CSA O86-09 / NBC 2010* or *CSA O86-14 / NBC 2010*.

c) Program Information

It shows the edition of the O86 currently being used, and the fact that it is the May 2014 printing of the *CSA O86-14*, in the *About Sizer* box accessed from the *Help* menu and in the *Building Codes* box accessed from *Welcome Box*. In the main body of the *Welcome* box, it indicates that either of these codes can be used.

2. Design Code Clause References

a) Update to 2014

The references to the CSA O86 design code clause numbers in the input forms and screen messages, and in warnings, design notes and other program output, have been updated to show the 2014 edition clause numbers when *CSA O86-14/ NBC 2010* is chosen as the design setting. It continues to show 2009 edition numbers when *CSA O86-09/ NBC 2010* is chosen.

b) On-line Help

The on-line Help has been updated to refer to the CSA O86-14 design code clauses. The unrevised online Help is also included in the installation to allow you to use Help that references O86-09.

3. On-line Design Code

The Design Office installation the on-line 2014 edition of CSA O86 in .pdf form has been made available. program now allows you to view either the CSA O86-14 or CSA O86-09 design code, and both documents are included in the Design Office installation.

4. Program Information

The Welcome box now indicates that both design codes are available. The *Help About Shearwalls* box and the *Building Codes* box show information about the currently selected design code.

a) 5- and 6 Storey Provisions

The *Building Codes* box and the message that appears when you enter more than 4 storeys have been updated to refer to the 5- and 6- storey provisions in the NBC 2015 rather than

the BC Building code. Information about continuous hold-down systems and rotational deflection required for taller structures has been added to the *Building Codes* box

b) Wood Shrinkage and Irregularities

Information about wood shrinkage and irregularities not considered has been removed from the Building Codes box.

5. Design Code References

In all messages, notes, warnings, and output tables, the program shows design code clause numbers for either O86-14 or O86-09, according to which is selected.

The rest of the changes described in this section occur when CSA O86-14 is selected as the design code edition in the Design Settings, unless otherwise indicated.

6. V_{rs} Calculation

For wood-based structural panels, the program now calculates V_{rs} via the expressions in O86 11.5.1

$\phi_{vd} J_D n_s J_{us} J_s J_{hd} L_s$ (lateral nail resistance)

$\phi_{vpb} K_D K_S K_T L_s$ (panel buckling)

The worst case of these two equations is determined for each side of the sheathing, and then the two sides are summed.

Previously only the expression

$\Phi_{vd} K_D K_{SF} J_{ub} J_{sp} J_{hd} L_w$

was used.

The following subsections apply to wood-based panels only; the procedure for gypsum wall board has not changed.

a) V_{hd} calculation

The calculation of V_{hd}, which is just V_{rs} without the J_{hd} factor, for use in determining the J_{hd} factor, considers both the lateral nail resistance and the panel buckling equations, despite the fact that J_{hd} appears only in the nail resistance equation. (This was decided upon after consultation with the design standard authorities.) The procedure for combining sides is thus:

- determine worst case V_{hd} (nailing) vs. V_{rs} (panel buckling) on each side
- combine the sides to calculate J_{hd}
- take V_{rs} nailing = V_{hd} * J_{hd} on each side
- take worst case V_{rs} (nailing) vs. V_{rs} (panel buckling) on each side
- combine the sides again "

b) Resistance Factor ϕ

The resistance factor ϕ has increased from 0.7 to 0.8, the value that has always been used for nail resistance, for both panel buckling and nailing equations.

c) V_{rs} due to Nailing Strength

V_{rs} from O86 11.5.1(b) is calculated as follows:

i. V_d calculation

Unit lateral V_d is now calculated via the equation N_u/s , where N_u is the factored unit lateral nail strength in N from O86 12.9.4.1 and s is the edge nail spacing, rather than tabulated values based on sheathing thickness and nail sizes.

The notes to O86 09 9.4.4 representing strength adjustments for special cases are no longer applied.

ii. Impact on Nail Selection

N_u varies continuously according to nail length, diameter, and penetration depth, whereas Table 9.4.4 provided only a very limited number of choices, conservatively specifying a minimum nail diameter for which the tabulated values were valid, and a required penetration depth.

This means that the choice of nail size has a much bigger impact than before; the program has added more nail sizes and types to the program as described in A: 7 below.

iii. N_u Factors

N_u from 12.9.4.1 is given by $n_u K_{SF} K_D K_T$, with the K factors implemented as follows.

1. Service Factor K_{SF}

The service condition factor KSF comes from O8612.2.1.5 for connections. The same service factor is applied to all walls in the structure based on the in-service and fabrication conditions input in the Design Settings. Green fabrication or wet service conditions correspond to moisture greater than 19%.

For changes in the service factor input, terminology and calculations, refer to A: 12 below.

2. Duration Factor K_D

This is set to 1.15 for both wind and seismic. It does not represent a change from the previous version.

3. Treatment Factor K_T

As the factor for studs is one unless they are incised there is no program input of treatment factor and $K_T = 1$, always.

iv. n_u calculation

n_u is calculated by the yield mode equations in 12.9.4.2. The following inputs correspond to a single shear plane plywood-to-stud connection:

1. Side member thickness t_1

This is the sheathing thickness in mm.

2. Nail diameter d

As input in Wall Input view.

3. Stud embedment strengths f_2, f_3

Determined from density of stud and nail diameter.

4. Penetration length t_2

Nail length minus the sheathing thickness. The ability to include gypsum wallboard underlay in the sheathing thickness has been added because of its effect on nail penetration – see A: 8 below for details.

5. Nail yield strength f_y

Determined from nail diameter.

6. Structural panel embedment strength

Determined from density of sheathing material (CSP, DFP, or OSB), and nail diameter.

v. Ductility check

According to 11.8.1, in order to ensure ductility, the wall should fail in modes d, e, or g from 12.9.4.2.

For each wall design or candidate design for unknown parameters, the program will record whether the lowest value of the nail failure modes for either side of the shearwall is not d, e or g.

If a completely specified wall, or for a failed wall arrived at when all unknown possibilities are exhausted, fails because of the ductility check, the symbol # appears beside the wall capacity in the shear results table and a note below the table indicates a design failure and the reason.

The program passes over candidate designs for which the ductility check fails. If the program cannot find a design, and at least one wall that had sufficient capacity was rejected because of nail ductility, the symbol @ appears by the wall capacity and a message below the table informs you what happened.

vi. J_D Factor for Diaphragm and Shearwall Construction

This factor is set to 1.3 at all times.

vii. Number of Shear Planes n_s

As mid-panel shearwalls are not to be included in this version, the value of n_s is always 1.

viii. Unblocked Factor J_{us}

The nomenclature for this factor has changed, but in terms of engineering design there have been no changes to program

ix. Spacing Factor J_s

This factor is implemented according to O86 11.4.1, a formula based on panel edge spacing. It is less than one for spacing less than 150 mm, and equal to one for larger spacing.

d) V_{rs} due to Panel Buckling Strength

V_{rs} from O86 11.5.1(c) is calculated as follows:

i. v_{pb} Calculation

The following parameters are used in the equation for specified panel buckling strength v_{pb} :

1. Axial Stiffness $B_{a,90}$, $B_{a,0}$

The axial stiffness values $B_{a,90}$, $B_{a,0}$ from tables 9.3A, 9.3B and 9.3C for each plywood or OSB thickness, and no. of plies for plywood and panel marking for OSB, have been added to the program. The value B_v was already in the program for use in deflection analysis.

For both B_a and B_v , if you enter a larger sheathing thickness value than is in the dropdown list, but one in table 9.3A-C, the correct value for that size from 9.3A-C is used. Previously, for B_v the program used the value from the largest thickness in the dropdown list. If you type in a larger thickness than is in the table, the input is rejected with a warning.

2. Panel Sizes a, b

As the buckling resistance gets larger as the smallest dimension of the sheet used gets smaller (because of the "b" in the denominator of the v_{pb} equation the critical panel), the critical panel within the a segment is the largest one. Therefore, full 4 x 8 sheets are used for those segments that are larger than 4 feet wide for vertical sheathing and 8

feet for horizontal orientation. For smaller segments, the size of the largest component panel is determined, for example a 6 foot segment uses 4' x 6' for horizontal sheathing and 4' x 8' for vertical. A segment 3 feet wide uses 3 x 8 for vertical and 3 x 4 for horizontal.

ii. Service Condition Factor K_S

For wet service conditions as input in the design settings, the program uses K_S from Table 9.4.2 and applies factor of 0.80. Wet fabrication conditions do not apply to plywood.

Note that wet service conditions are no longer allowed for OSB or gypsum wallboard, see D: 1 below.

iii. Treatment Factor K_T

Due to the rarity of use of treatment factors for plywood and OSB, the program does not include an input for treatment and this factor is always 1.0.

iv. Duration Factor K_D

This is set to 1.15 for both wind and seismic.

e) Design Results Output Tables

i. Shear Design Table

In the Shear Design table, the total force on the wall or segment F_v and the corresponding capacity V_r have been removed from the table to make room, and because they are not particularly useful to the designer.

Where the table previously had one unit capacity V_{hd}/L , it now shows unit capacities for nail resistance and panel buckling separately, headed by $V_{hd} (vd) / L$ and $V_{rs} (vpb) / L$, respectively. The table shows values for interior and exterior sheathing sides for each. The combined V_{rs}/L is still shown.

Corresponding changes have been made to the explanatory legend below.

ii. Framing Materials Table

The J_{sp} column and legend entry have been removed from the Framing Materials table, as it no longer applies for O86-14.

iii. Sheathing Materials Table

In the Sheathing Materials table, the J_{ub} heading and legend description have changed to J_{us} .

f) Design Notes

Design notes appear below the Sheathing Materials table that indicate sheathing and nailing requirements, and adjustments to strength for particular configurations. The following changes have been made to these notes:

i. Blocking Requirements

Add design code references 11.4.4 and 9.4.4 for O86-14 and O86-09, respectively. Add sentence saying unblocked panels must be staggered.

ii. Nailing Requirements

Add design code references 11.5.3.4 and 9.5.3.4 for O86-14 and O86-09, respectively. Clean up character spacing issues.

iii. Framing and Panel Requirements

Add design code references 11.5.3.2 and 9.5.3.2 for O86-14 and O86-09, respectively. Change “wide” to “thick” to make stud dimension clearer. Show metric or imperial thicknesses according to units selected. Clean up character spacing issues

iv. Shear Strength Upgrade for Stud Spacing 400 mm or Less

This is Note 1 or Note 2 in Shearwalls, and is from the asterisk (*) under O86-09 Table 9.5.1A. This note has been removed for the O86-14. Minor formatting improvements for 09.

v. Double Studs at Panel Edges for 50 mm Edge Nailing

In Shearwalls, this is Note 3 for O86-09 and Note 1 for O86-14, and is from the symbol f under O86-09 Table 9.5.1A. Show metric or imperial thicknesses and nail spacing according to units selected. For imperial, say “*minimum 3-by or double 2-by*”. Add 11.5.3.5 a reference for O86-14. Minor formatting improvements.

vi. Double Studs at Panel Edges for 75 mm Edge Nailing and 3.66 mm Nails

In Shearwalls, this is Note 4 for O86-09 and Note 2 for O86-14, and is from the symbol \neq under O86-09 Table 9.5.1A. Show metric or imperial thicknesses and nail spacing according to units selected. For imperial, say “*minimum 3-by or double 2-by*”. Add 11.5.3.5 b reference for O86-14. Minor formatting improvements.

vii. Staggered Panel Edges on Opposite Sides

In Shearwalls, this is Note 5 for O86-09 and Note 3 for O86-14, and is Note (3) under O86-09 Table 9.5.1A. Add 11.5.3.5 reference for O86-14. Minor formatting improvements.

viii. J_n Factor for Non-Standard Nails

In Shearwalls, this is Note 6 for O86-09, and has been eliminated for O86-14, as there is no J_n factor.

ix. MSR Grade

In Shearwalls, this is Note 7 for O86-09, and has been eliminated for both design codes. Refer to D: 6 below for more details.

x. OSB Panel Marking

In Shearwalls, this is Note 8 for O86-09 and Note 4 for O86-14. Add design code references 11.5.3.3 and Table 9.5.1A Note 6 for O86-14 and O86-09, respectively. Fixed problem with panel marking output, refer to D: 7 below, (Change 216).

g) Detailed Design Results

Upon design, the program outputs a new file containing intermediate design data, called [projectname].swd. A menu item and toolbar button each called *Detailed Shearwall Design* access this file and show it in a reader similar to the one showing the Load Generation and Torsional Analysis log file.

i. Symbols

The output starts with a table showing all the symbols used in the equations governing shearwall design and shown in the headers for the tables in this file. Each line shows the symbol, definition, two columns for units employed, and the reference to the O86-14 clause where the symbol is defined or used.

The first unit is for those that appear in the equations as published in the O86, and the second one is for the units that are shown in the tables below. For imperial units, the first set will be metric and the second set imperial. For metric units, the columns usually show

the same units, except for cases that the table shows for example kN rather than N for formatting convenience.

ii. Equations

The symbols are followed by a section showing the equations employed, along with the design code clause reference for each one.

iii. Constant Data

There are two lines of data that are the same for all shearwalls. The first line shows data that can't be changed by the user, the second shows ones that can, or may be in future versions of the software. These lines contain the safety factor ϕ , diaphragm factor J_D , duration factor K_D , service factors K_S and , treatment factors K_{Tp} and K_{Tn} , and number of shear planes n_s .

iv. Data for Entire Shearwall.

For each shearwall, there is a line for data that are independent of the wall segment or sheathing side, showing wall height and total shear force V_r in each direction on the wall.

v. Panel Buckling V_{rs}

For each shearwall, there is a table showing the data needed for panel buckling V_{rs} calculations from O86 11.5.1(c). There is a separate line for each shearwall segment between openings and for the interior and exterior sheathing sides. The data shown are segment length, sheathing thickness, shear force per unit length, unit panel buckling strength v_{pb} , panel buckling factor K_{pb} , critical panel dimensions a and b , panel axial strengths B_{a0} and B_{a90} , shear through thickness rigidity B_v , and parameters η (eta) and α (alpha).

vi. Nailing V_{rs}

For each shearwall, there is a table showing the data needed for nailing V_{rs} calculations from 11.5.1(b). There is a separate line for interior and exterior surface. The data shown are nail diameter, panel thickness, nail penetration length, shear strength V_{hd} per unit length, unit shear strength v_d , fastener spacing factor J_S , unblocked factor J_{US} , nail spacing, factored nail strength N_u , yield modes a, b, d, e, f and g for unfactored nail strength nu . marking the critical mode with an asterisk (*) and indicating whether it is ductile or non-ductile.

vii. J_{hd} and V_{rs}

For each shearwall, there is a table showing the data needed for hold-down factor J_{hd} and the determination of final shear strength V_{rs} . For each wall segment, the program shows the V_{hd} on each surface derived from the critical panel buckling or nailing V_{rs} ; the combined V_{hd} , then for each force direction it shows the uplift force P_{ij} used for J_{hd} , hold-down factor, J_{hd} , and the resulting combined worst-case V_{rs} on each surface of the wall.

7. Nail Types and Sizes

As the calculation of shear strength V_{rs} now depends on the exact nail diameter and nail penetration length, and given the prevalence of power driven nails, the program has greatly expanded the selection of nails available in Shearwalls. Unless otherwise indicated, these changes apply regardless of whether O86-09 or O86-14 is selected as the design code.

a) Fastener Types

Previously the nail types available for structural sheathing were *Common wire nails* and *Non-standard nails*. The program now allows the following choices

Common wire nails
 Spiral nails
 Ring nails
 Power-driven nails

Power-driven nails correspond to the previous *Non-standard nails*, with changes to functionality described below.

b) Manually-driven Nails

i. Lengths and Diameters

The following table shows the correspondence between diameter and length for each fastener type now available in Shearwalls:

Length (in)	Length (mm)	Common wire nails		Spiral nails		Ring nails	
		in	mm	in	mm	Nom in	Nom mm
1-3/4	44	-		-		0.109	2.769
2	51	0.113	2.87	0.120	3.048	0.120	3.048
2	51	-	-	-	-	0.134	3.404
2-1/4	57	0.113	2.87	-	-	-	-
2-1/2	64	0.131	3.33	0.120	3.061	0.134	3.404
3	76	0,148	3.76	0.135	3.429	0.148	3.76
3-1/4	83	0,148	3.76	0.135	3.429	-	

ii. Dependence on Sheathing Size

For CSA O86-14 design, the program no longer limits the fasteners used based on sheathing size. All nail sizes are allowed for all sheathing thicknesses. For CSA O86-14, only nails that meet the min. penetration in Table 9.5.1A are allowed.

iii. Ring Nail Design Diameter

For ring nails, the value shown for diameter is the size of the wire the nails are made from. The nominal values are shown in the user interface, but for design, the program subtracts 2 mm = .0075" to arrive at the root diameter to be used for the design equations.

iv. 2" Ring Nail Diameters

In previous versions of the program there is a one-to-one correspondence between nail length and diameter. Now there are now two diameters for 2" ring nails. In this case, if you select ring nails, the program selects by default the first of the diameters, 3.048mm, which you can then change. This diameter is be used for design for unknown nail length when the cycle reaches 2".

c) Power-driven Nails

i. Lengths and Diameters

The following table shows the correspondence between diameter and length for power-driven nails available in Shearwalls:

Length	Diameter
--------	----------

in	mm	in	mm
1-7/8	44	0.131	3.33
2	51	0.113	2.87
2	51	0.131	3.33
2	51	0.120	3.048
2-1/8	54	0.48	3.76
2-1/4	57	0.92	2.33
2-1/4	57	0.99	2.50
2-1/4	57	0.105	2.68
2-1/4	57	0.113	2.87
2-3/8	60	0.113	2.87
2-1/2	64	0.120	3.048
2-1/2	64	0.131	3.33
2-5/8	67	0.148	3.76
2-3/4	70	0.148	3.76
3	76	0.120	3.048
3	76	0.131	3.33
3	76	0.148	3.76
3-1/4	83	0.148	3.76

Previously the lengths and diameters available for non-standard nails were the same as those for common wire nails, the difference being that you could enter your own value for non-standard nails.

ii. Unknown Nail Sizes

The program now allows you to specify unknown length for power-driven nails, and the program cycles through the possible lengths to achieve design.

If a known nail length is selected, the program lists the diameters for that known nail length only and select the first by default, as the program does not cycle through nail diameters. .

If unknown is entered as the nail length, then all possible nail diameters are listed. If you select one of these nail diameters the program will continue to show unknown for nail length, and when the design loop runs, it will only design for nails that have that diameter.

If the diameter is unknown and you in a nail length, the program selects the diameter corresponding to the closest nail in the list to the nail length that was typed in.

iii. Minimum Nail Length

As per NBC Table 9.23.3.5.A, you cannot enter a nail length less than 1.75” – the program will revert to the previous value and issue an explanatory message. Previously there was no lower limit on nail length in Shearwalls.

If a nail is entered between 1.75” and 2” in length, a message appears saying that the nail should be ring-threaded, as per Table 9.23.3.5.A,

iv. Maximum Nail Length

As per the intent of O86 14 (see A: 7.d) below), you cannot enter a nail diameter greater than 3.76 mm – the program reverts to the previous value and issues an explanatory message. Although previous to O86-14 there was no upper limit, this limit is imposed regardless of whether O86-09 or CSA O86-14 is selected in the Design Settings.

v. Design Routine

When the length and diameter are left as “Unknown”, if when cycling through lengths the program arrives at one that has more than one diameter, it chooses the one corresponding to the common wire nail of that length.

vi. Output

Previously, in the Sheathing Materials table, the size of a non-standard nail was rounded off and converted to the closest fractional size, one which is often the same as a standard nail. Now, power driven nails are output in decimal format to distinguish them from standard nails that are in fractional format.

d) Limiting Nail Diameters

The program is was using nail diameters listed in the CSA O86, from the CSA B111 standard, however it has been determined that these diameters do not correspond to the wire gauges currently used to manufacture nails, which are from the ASTM F1667 standard. Several limitations are based on the nail diameters, such as O86-14 11.4.5.5 that limits nail diameters when anchorages are used to 3.25 mm, and 11.3.1.1, which says that shearwalls must use nails 3.66 mm or less.

We have changed those limitations 3.33 mm and 3.76 mm, respectively, to correspond to the nail diameters we use in the program for nails of the corresponding lengths.

The messages that appear when these limitations are imposed have been modified to explain this decision. In addition, if a nail between 3.66 and 3.76 is used in design, or a nail between 3.25 and 3.33 when $Jhd < 1$, a new note appears below the sheathing materials table saying that the nail conforms to the intent of 11.3.1.1 or 11.4.5.5.

8. Gypsum Underlay

The program now includes the ability to gypsum underlay because it affects nail penetration and therefore shear strength for O86-14. This feature is also available if O86-09 is selected, and in this case affects whether a nail length achieves minimum penetration for shear resistances in Table 9.5.1

a) Input

Choices of no gypsum underlay, $\frac{1}{2}$ ”, and $\frac{5}{8}$ ” underlay have been included in the *Sheathing* data group of the *Wall Input* form. The default is *None*.

b) Design

For O86-14, the penetration depth used to determine the nail strength described in A: 6.c)iv.4 above is reduced by the thickness of the underlay.

For O86-09 the set of nail lengths listed in the input control and used to cycle through for unknown design does not include nails that do not meet min. penetration depths in table 9.5.1A.

c) Output

A column “GU” has been added to the Sheathing Materials by Wall Group table showing the gypsum underlay thickness, with an explanatory legend entry.

9. Nail Slip for Deflection e_n

The following changes apply to the calculation of nail slip deflection e_n , which is one of the components of shearwall deflection:

a) Wood Structural Panels

For CSA O86-14, instead of the table from O86-09 A.9.7 the program implements the equation from O86 09 A11.7., which depends on the same inputs – spacing s , diameter d , and shear force v .

For green fabrication conditions, the program multiplies the values from the equation by 2.0. Note that there is no longer an upper limit on the load for which e_n values are tabulated, so that the program no longer issues warnings in the Design Results that the load per fastener is too high, and has removed this from the list of things that the Design Summary page does not handle.

b) Gypsum Wallboard

Previously, the program uses a constant deflection of 0.03 inches = .0762 mm. The O86- 14 design code says to use 0.76 mm. This slight adjustment has been made.

Refer to D: 1 below for changes to restrict the use of GWB to dry service and fabrication conditions.

10. Restricting Materials based on Anchorage Selection

The Design Setting *Materials Restrictions for Anchorages* has been removed from the program, and user interface no longer contains a restricted set of sheathing thicknesses, nail sizes, or nail spacings based on these settings. Given the new shearwall design equations based on nail size and penetration, it is no longer practical to predict ahead of time what materials cannot be included due to the restrictions in 11.4.5.5 regarding the applicability of $J_{hd} < 1$.

The program now behaves as if the setting *Over-ride hold down selection to achieve design* is always selected. In other words, unless you have specified in the *Wall Input* view that hold-downs are to be used, the program applies hold-downs only where needed to achieve design, otherwise anchorages are used.

Upon reading project files from previous versions, the program will reset the materials restrictions setting to *Over-ride hold down selection to achieve design*, so that the behaviour of these projects will change.

11. Gypsum Wallboard (GWB) Design

The following changes apply to when gypsum wallboard is used as a shear-resisting material.

a) Maximum Percentage GWB for Wind

O86-09 Table 9.5.4 for *Maximum Percentage Gypsum Wallboard*, which previously applied to both wind and seismic design, has been moved to O86-14 11.8.8, a section that is for seismic design only. Accordingly, for wind design the program no longer calculates the gypsum wallboard percentages, the *Maximum Percentage Gypsum* table is no longer output, and design failure warning messages no longer shown on the screen or in the results output. This change has been implemented regardless of whether O86-09 or O86-14 is chosen as the design code, as WoodWorks has been informed that it was always the intention that these restrictions applied to seismic loading.

b) GWB Percentages for R_d and $R_o = 1$

A sentence has been added to O86 11.8.8 saying that the R_d and R_o values can each be reduced to 1.0 if the GWB percentages are exceeded. Previously it was an absolute requirement that the GWB percentages not be exceeded. The program therefore no longer displays a *Maximum Percentage Gypsum Wallboard* table for seismic design if R_d and R_o are both less than or equal to 1.0, outputting an explanatory note instead.

The operation of various screen warning messages and output warning notes that appear when gypsum wallboard limitations have been modified to take the possibility that R_d and R_o both equal 1.0 into account.

c) Storey Drift Limitation for Gypsum Wallboard

A sentence has been added to O86 11.8.8 saying that gypsum wallboard does not contribute to seismic resistance if the interstorey drift ratio is greater than 1.0%, that is, if the drift of one storey relative to another is greater than 1% of storey height, as opposed to the 1%, 2% or 2.5% allowed now by NBC 4.1.8.13.(3) according to building type.

To implement this, the program now records the largest drift of any shearline with GWB that is active for design on each storey and force direction. In the storey drift table, if some shearlines on the level/direction indicated have GWB and some do not, for that level/direction the worst case GWB deflection and shearline with the maximum deflection are both output, unless they are the same shearline.

If a shearline fails because it has active GWB and its storey drift is between 1% allowed for gypsum and the percentage allowed for the building type as per NBC 4.1.8.13 (3), then double asterisks (**) appear at the design ratio and a modified failure warning appears.

d) GWB Shear-through-thickness for Deflection B_v

For gypsum wallboard, the shear-through-thickness value B_v has changed from 7005 N/mm to 7000 N/mm, as per CSA O86 11.7.1.2. Previously O86 did not provide guidance for this value, and *Shearwalls* was using 40,000 lbs/in converted to N/mm. The program still displays 40,000 lbs when imperial units are chosen.

This change is in effect regardless of whether O86-09 or O86-14 is chosen as the design code.

12. Service Condition Factor K_{SF}

The fabrication moisture content for which any value greater is considered to be green in O86-14 Table 12.2.1.5 and a non-unity factor is applied, has changed from 15% to 19%. This change has been implemented to the service condition factor applied to nail withdrawal and shear strength calculations. In addition the default for new files has changed from 15% to 19%.

Refer also to B: 14 below *Moisture Conditions Description in Design Settings Input and Output*.

B: Other Engineering Design

1. Unit Nail Resistance N_u for Anchorage Deflections

The following problems in determining the value of N_u used in O86-09 9.7.1.1 for the anchorage component of shearwall deflection, when calculating embedment strength f_1 of the sheathing in 10.9.4.2, were corrected:

a) Yield Mode Equations for Anchorage Deflections (Bug 2986)

The program erroneously used the value of the dead load component of the hold-down force in N in place of the nail diameter in mm.

If there are no dead loads at the hold-down location, or dead loads less than or just a little more than 10 N, then the program would calculate the wrong f_1 value in the yield mode equations, and non-conservatively so. If there are dead loads significantly greater than 10N (which is very small), then the program would not include the yield mode terms that include f_1 when determining the hold-down values. That is, it would use yield mode b only. This will also be a non-conservative error in most cases.

This bug interacted with bug 2991, below, which results in very large anchorage deflections, so that if there are significant dead loads, this bug counteracted the other bug so that together they create unreliable results.

b) Sheathing Specific Gravity for Anchorage Deflections (Bug 2991)

In determining the value of N_u used in O86-09 9.7.1.1 for the anchorage component of shearwall deflection, when calculating embedment strength f_1 of the sheathing in 10.9.4.2, the program used sheathing specific gravity values 1/10 of those listed in O86-09 10.9.4.2. They were $G = 0.049$ for DFP and 0.042 for CSP and OSB, as opposed to 0.49 and 0.42 , respectively. This caused anchorage deflections to be roughly order of magnitude larger than they should be, however this varied widely from shearwall to shearwall. This error could also cause forces to the individual shearlines to be distributed to the segments incorrectly in an unpredictable way

This bug interacted with bug 2986, above, which caused the f_1 value never to govern if there were significant dead loads, so this bug would have no additional effect in that case. If there are dead loads, this bug counteracted the other bug so that together they create unreliable results.

2. Shearwall Capacity Hold-down Method in the Calculation of Deflections (Bug 2999)

When shearwall capacity is used as the design force for hold-down design, either via the design settings or because it is required due to seismic irregularities, this value was also used to determine the hold-down component of shearwall deflection. As this is not the intent of the use of shearwall capacity to ensure sufficient hold-down strength, the calculation for deflection now always uses applied force to determine hold-down displacement, regardless of the design setting for hold-down forces or the existence of irregularities.

a) Determination of Irregularities after Redesign (Bug 2998)

After determining the structural irregularities, the program if necessary changes the hold-down method to capacity and then recalculates deflections, redistributes loads based on these deflections, and sometimes redesigns the structure. However, because hold-down deflections were based on shearwall capacity, reconfigured building may not have the same irregularities as before, but the program does not recalculate them. It was therefore possible that irregularities shown in the output and those that actually apply to the structure did not match.

In particular, the deflections used to determine B_x , the torsional sensitivity, were not the same as the ones that are shown in the output for the redesigned building. It could even happen that the program determined the building was torsionally irregular, changed the hold-down setting, and the redesigned building was no longer torsionally irregular.

This situation can no longer occur, because the change in hold-down method to being capacity-based no longer affects deflections.

3. Non-standard Nail Diameters (Bug 2664)

When a non-standard nail diameter was entered, the program ignored it and used the diameter of a standard nail with the input length. The standard diameter appeared in the Sheathing Materials table, and the shear capacity reduction factor in A9.5.1.2 was not applied. When deselecting the wall then reselecting it, the standard diameter would reappear.

Non standard nails are now called "power driven" nails, and function as intended. The program uses the nail length and nail diameter in the new design equations for shearwall shear resistance based on nail strength from O86-14 11.5.1, and the nail diameter in the design procedure from A9.5.1.2 when O86-09 is selected.

4. Wind Load Storey Drift Table (Bug 3032)

The program now outputs a *Storey Drift* for wind loads, showing the maximum deflection of any shearline for every storey and direction, and compares it with the limit in NBC 4.1.3.5 3) of 1/500 of storey height. Note that sentence 4) of this 4.1.3.5 exempts industrial buildings and sheds,

however Shearwalls does not take this into account and outputs a storey drift table for all structures. Please disregard the table for industrial buildings and sheds.

A failure for wind storey drift is output in the Design Summary along with the new secondary seismic design checks described in B: 6 *Nail Deformation en for Deflection from O86 Table A.9.7*

The following problems relating the nail deformation e_n value from CSA O86-09 Table A.9.7 have been corrected for when CSA O96-09 is selected as the design code. They do not affect program behavior when O86-14 is selected.

a) e_n for Larger Nail Sizes (Bug 2583)

When a nail size other than the smallest one in the table was chosen, the program used an e_n from the next smallest standard nail size rather than the nail size selected. This resulted in a greater than expected nail slippage component of deflection. This problem did not occur when a non-standard nail intermediate between two standard sizes was entered; in that case the program correctly selected the lower value.

b) Warning Message for Nails Less than Minimum Diameter (Bug 3079)

If a you entered a nail diameter less than 2.84, the lowest value in the table, the program issued a warning message under the Deflection table in the Design Results about loads per nail being over the highest allowable, even if the loads were within range. The e_n value used was for the *largest* diameter and highest loading.

The program now disallows selection of nails less than 2.84 mm in diameter if deflection analysis is turned on.

c) e_n when Loads Greater than Maximum (Bug 3079)

If the load per nail was greater than the highest allowable, the program used highest nail slip value for the 3.66 mm diameter nails, or 0.98 mm, not the deflection value for the nail that was selected. As this is the largest diameter, which has the lowest deflection, it creates non-conservative deflections for all other diameters.

Note that a warning message is still issued in this circumstance because even though the e_n is now for the correct nail size. it corresponds to loading less than what is actually on the nail.

Special Seismic Checks in Design Summary (*Change 220*) below.

5. Standard Walls and Design Groups

The following problems related to standard walls, design groups, and the interaction between them, were corrected

a) Saving of Standard Walls Modified in Wall Input View (Bug 3015)

Upon exiting the program, it saved the changes made to Standard Walls that occur when changes are made to walls in the structure while "Design in Group" is checked. Therefore changes you might inadvertently make while modifying walls could affect the standard walls used for future sessions.

Now, the program asks you whether you want to save the standard walls when exiting standard wall mode and when exiting the program. When exiting the program this prompt only appears if a wall has ever been modified in this way.

Previously, the program saved standard the standard wall file that is used for future sessions when saving a new standard wall, deleting a standard wall, leaving standard wall mode, or selecting a new standard wall in the drop down list in standard wall mode. It now only saves the standard walls when leaving standard wall mode and when exiting the program.

b) Creation of Standard Wall from Wall in Structure (Bug 3025)

The *Design in Group* feature proved to be difficult to implement for a wall that had been created input of walls in the structure rather than via Standard Wall input, because there is no standard wall associated with the wall and design groups are accomplished through standard walls.

For this reason, the program now allows you to create standard walls from regular walls as follows:

When clicking "Edit Standard Walls" while there is a wall selected which does not match any standard wall, the program now asks you if you wish to create a standard wall based on the selected wall. If you create a standard wall in this way, the *Design as Group* setting is checked for the standard wall and the *Design in Group* checked for the selected wall. This feature enhances the program usability in general, similar to the creation of a new font style in a word processor using the font attributes of the selected text.

c) Persistence of "Design as Group" Checkbox in Standard Wall Mode (Bug 3022)

When you unchecked the *Design as Group* checkbox in Standard Wall mode, the change is not retained when selecting another standard wall or exiting the box, making it impossible to specify that standard walls are not designed as a group.

d) Standard Wall Name Persistence when not Designing as Group (Bug 3026)

Sometimes, after selecting a standard wall that is not designed as a group, the standard wall name goes blank in the input field rather than showing the selected standard wall. This has been corrected.

This happened most often when multiple walls were selected and has been corrected. .

e) Design as Group for Multiple Identical Wall Groups (Bug 3026)

When design as group is activated for a standard wall that has the same materials as another standard wall group, the program sometimes assigned individual shearwalls to the wrong design group, that is, to a design group for a standard wall group other than the one designated for that wall.

6. Nail Deformation e_n for Deflection from O86 Table A.9.7

The following problems relating the nail deformation e_n value from CSA O86-09 Table A.9.7 have been corrected for when CSA O96-09 is selected as the design code. They do not affect program behavior when O86-14 is selected.

a) e_n for Larger Nail Sizes (Bug 2583)

When a nail size other than the smallest one in the table was chosen, the program used an e_n from the next smallest standard nail size rather than the nail size selected. This resulted in a greater than expected nail slippage component of deflection. This problem did not occur when a non-standard nail intermediate between two standard sizes was entered; in that case the program correctly selected the lower value.

b) Warning Message for Nails Less than Minimum Diameter (Bug 3079)

If you entered a nail diameter less than 2.84, the lowest value in the table, the program issued a warning message under the Deflection table in the Design Results about loads per nail being over the highest allowable, even if the loads were within range. The e_n value used was for the *largest* diameter and highest loading.

The program now disallows selection of nails less than 2.84 mm in diameter if deflection analysis is turned on.

c) e_n when Loads Greater than Maximum (Bug 3079)

If the load per nail was greater than the highest allowable, the program used highest nail slip value for the 3.66 mm diameter nails, or 0.98 mm, not the deflection value for the nail that was selected. As this is the largest diameter, which has the lowest deflection, it creates non-conservative deflections for all other diameters.

Note that a warning message is still issued in this circumstance because even though the e_n is now for the correct nail size. it corresponds to loading less than what is actually on the nail.

7. Special Seismic Checks in Design Summary (Change 220)

In the Design Summary, the program previously reported a list of items that were not included among the checks being summarized, even though the program made those checks in the course of seismic design. Now, these checks are reported as having passed or failed. These checks are:

- Percentage gypsum wallboard from O86-14 11.8.8 or O86-09 9.5.4
- Storey drift from NBC 4.1.8.13(3) and O86-14 11.8.8.
- Seismic Irregularities from NBC 4.1.8.6
- Over-capacity ratio from O86-14 11.8.3.2 or O86-09 9.8.3.2

8. Message Box for Gypsum Wallboard Rd Factor

The following problems relate to the message box that appears when the Force Modification factor R_d selected in the Site dialog is not the one appropriate for the materials used, and have been corrected

a) Gypsum Walls with R_d Greater than 2 (Bug 2968)

The message box during load generation indicating that an R_d factor of more than 2 should not be used when there are gypsum materials in the structure was not appearing when all the walls with gypsum sheathing had both sides sheathed with gypsum. This has been corrected.

b) Gypsum Walls with $R_d = 2$ and Ignore Gypsum Unchecked (Bug 2674)

While generating loads for shearwalls with gypsum on one side and the R_d set to 2, the value appropriate to gypsum walls, with the setting for ignoring gypsum unchecked, the program nonetheless issued a message that this setting was active and the offering to either change the R_d value or uncheck the setting.

If you selected "No" to uncheck the setting, the setting remained unchecked program continued to generate loads with the correct R_d value.

9. Percent Resisted by Gypsum Table

The following problems related to the *Percentage Storey Shear Resisted by Gypsum Wallboard* table used to implement O86-09 Table 9.5.4 have been corrected.

a) Percent Resisted by Gypsum Table when no Gypsum Present (Bug 3013)

The table no longer appears if there is no gypsum wallboard on the structure

b) Direction Percent Resisted by Gypsum Calculation (Bug 3014)

When calculating gypsum and wood capacity only one force direction case was considered: the east-to-west or north-to-south case. Therefore when the table indicated was displaying results from the south or west direction, it was actually displaying the results for the opposite direction. The program now calculates the percentage shear force in each direction independently.

10. "Improper Argument" error for OSB Sheathing (Bug 3012)

Upon designing walls with OSB sheathing with unknown panel marking, sheathing thickness and non-standard nails selected, an "Improper Argument" error message appeared and an incorrect J_n factor was calculated, invalidating design.

This has been corrected.

11. Elevation View Failure Message for Passing Walls (Bug 3007)

Elevation view was sometimes showing the FAILED design message for interior walls even though the walls passed design. This could happen when you had selected to allow anchorages rather than hold-downs on the wall, and the design setting was set to allow the program to "over-ride" the use of anchorages if necessary and impose hold-downs. This has been corrected.

12. Both Direction Output in Storey Drift Table (Bug 3018)

In the storey drift table, the program used to output *Both* to indicate, for example that the results apply to both E->W and W->E. However, this table also includes results from the other orientation, in this case N->S and S->N, so it was unclear what *Both* referred to. The program now says e.g. *E<->W* when indicating the results apply to both directions rather than *Both*.

13. Moisture Conditions Label (Change 217)

The notation (%) has been added to the data group label for the *Moisture Conditions* settings, to indicate that the numbers shown are percentage moisture content.

14. Moisture Conditions Description in Input and Output (Change 218)

Adjacent to the input of Moisture Content in the Design Settings, the program now indicates whether the value is dry, wet, or green (O86-14), or dry, wet, seasoned, or unseasoned (O86-09). This is now also indicated in the Design Results echo of the Design Settings.

15. Extra Null Lines in C&C Design Table (Bug 3035)

For some cases in which not all of the wall design groups are standard walls, and when only one of rigid or flexible design is performed, the program prints out an extra line for each C&C result in the output table with 0 load and 0 capacity, additional one wall design groups not related to any actual walls are created with, with 0 load and 0 capacity. These problems have been corrected

16. Plan View Legend Wording for Failed Walls (Change 177)

The line in the plan view legend explaining the red color for failed walls now indicates that it is a "Capacity" failure, to clarify that other types of failures now reported in the *Design Summary* are not highlighted.

C: Loads and Forces

1. Duplicate and Missing Low Rise Wind Loads (Bug 3002)

The program would sometime take portions of low-rise wind loads generated for one corner load case and assign them to another corner load case, creating duplicate loads for one case and gaps in the other case. This was most likely to occur if the structure is heavily indented, and has been corrected.

2. Centre of Mass and Center of Rigidity in Plan View (Feature 218)

The program now shows the location of the center of loads and the center of rigidity of the structure, for both wind and seismic loading. These appear in *Load Generation* action when *Rigid* forces are chosen for display. Two small dots with the symbols CL and CM appear. You can turn on and off the display of these points using the Show menu.

The distance between these points in each direction is the moment arm used for torsional analysis for rigid diaphragm distribution.

3. C&C Wind Loads in Both Directions (Change 176)

When adding a new C&C load, it is now possible to select "Both ways" for wind direction, as the program now distinguishes between suction C&C loads for both nail withdrawal and sheathing strength, and bearing wind loads which impact sheathing strength only. .

4. Crash Upon Input of C&C Load (Bug 176)

Starting with version 9, after entering a C&C wind load in Load Input form, and if there are no generated loads, the program would crash upon exit from the dialog. This has been corrected.

5. Update of Add Load Dialog Input (Bug 3005)

The following corrections have been made to the *Add a New Load* dialogue box:

a) Wind C&C Loads

When *Wind C&C* is selected,

- The *Apply to...* input was limited to *Building face* but the list was filled with wall lines. The *Apply to* input now shows *Wall lines*
- The magnitude labels *From* and *To* changed to *Interior* and *End* but failed to consistently update back to *From* and *To* when a different type was selected.

b) Apply to Selected Walls

When *Apply to... Selected Walls* was selected, the *From* and *To* location did not update properly so that the load would not be applied to just the extent of the selected wall.

c) Dead Loads On Building Face

You can no longer apply dead load and building mass loads to an entire building face. These loads are more appropriate to a wall line

d) Element for Wall Line Loads

For wind shear and seismic loads the *Element* was always shown to be *Face* even when applied to a wall line. It now shows the wall line it was added to.

e) Width of Load List (Bug 3077).

The list of input loads has been widened to show the *Profile* column without scrolling.

6. Missing Elevation View Forces in for No Deflection Analysis (Bug 3003)

When the Design Setting was set to exclude deflection analysis, the shear flow arrows for diaphragm shear and base shear and the segment shear force arrows did not show up in elevation view. This has been corrected.

7. Missing Snow Load Note in Load Generation Dialog (Bug 2988)

Under *Seismic Loads* in the *Generate Loads* dialog, the note giving the percentage of snow load used was missing. It has been restored to the program.

8. Nonsensical Torsional Forces in Log file for Low Rise Wind Design (Bug 3006)

Generating low-rise wind loads on a structure with a flat roof would sometimes show nonsensical output in the log file for the rigid distribution torsional forces for low-rise case B wind loads. As these cases have a net zero wind load in the direction with nonsensical output, this did not affect design. It has been corrected

9. Multi-block Low Rise Height to Width Setting (Change 183)

The Design Setting which indicated whether the structure height to width ratios are based on a single block or multiple blocks has been removed from the program, as it had no effect. This setting had been put in the program as part of ongoing development to implement multi-block low rise procedures; however this feature has not yet been released.

10. Site Information Output

The following changes have been made to the Design Results output pertaining to wind and seismic load generation site information:

a) Wind and Seismic Load Generation Procedure (Change 196)

For design method, the USA ASCE 7 seismic load generation procedure was showing, and for wind, the "N" was missing from NBC. These problems have been corrected and the program now shows the full NBC procedure for both.

For wind design, the program was showing the choice of low rise (Fig. I-7/8) or all-heights (Fig-15), but that information is also in the Design Settings output. Instead, in the Site Information the program now shows *Static Procedure from NBC 4.1.7.*

b) Cgi Notation (Change 198)

CGI has changed to *Cgi*.

11. Detailed Load Generation Results in Log File

The following changes have been made to the log file showing detailed wind and seismic load generation information:

a) Log File for New Project (Change 184)

Pressing log file button for a new project displayed the results from the last unsaved session. The log file button is now enabled until loads have been generated.

b) File Header (Changes 187, 179)

The following changes have been made to the log file header block:

- the date and time now appear at the top of the file instead of each title block of the wind, seismic and torsional analysis information. The unnecessary word "Time:" has been removed.
- the header now includes the version number of the software,
- the program name, version, filename and date are separated by a blank line from the design code information below.
- The header was not appearing if was seismic only loading and thus no wind load generation section. This has been corrected

c) Page Numbers (Change 188)

Since the log file was placed in a viewer within the Shearwalls program with version 9.0, page numbers no longer appeared. This has been corrected

d) Table Alignment in Viewer (Change 214)

The log file was designed to be shown in Windows Notepad, which has a tab width of 8. The new internal text viewer uses a tab width of 6, so some output tables were misaligned with their headers. Tab stops have now been replaced by spaces to avoid this problem.

e) References to NBC (Change 191)

The references to NBC design code clauses now follow the format NBC uses when referring internally to other sections of the publication, e.g. 4.1.7.1.(6)(c) . Previously there had been inconsistent formatting.

f) Fractional Exponents in Equations (Change 192)

The formatting of fractional exponents in equations has been changed from fractional to decimal to conform with NBC formatting, e.g. $(h/10)^{1/5}$ is changed to $(h/10)^{0.2}$

g) Site Info and Legend Format (Change 189)

Information in the log file site information and definitions legends that was previously separated by semi-colons has been placed on a separate line for readability

h) Formatting of Subsections (Change 201)

Where a subsection of the report contains more than one simple table, a blank line has been placed after the heading to the subsection to indicate that all the information below it pertains to that heading.

i) Wind Load Legend Nomenclature and Formatting (Change 190)

The following changes have been made to the legend to the wind load section of the log file

- C_g – *Internal* is changed to C_{gi} - *Internal*
- P for Pressure has changed to p ; also changed in the equation below and column headers
- *Commentary 31* changed to *Commentary I-31*
- $LC = \text{Case A or B}$ changed to $LC = \text{Load Case A or B in Figure I-7}$
- Added line $Dir = \text{direction (WW = windward, LW = Leeward)}$

j) References to C_e Equations (Change 193)

The reference to the equations for exposure factor C_e from the NBC has been made more exact, changing 4.1.7.1 5) to 4.1.7.1.(5)(a). and 4.1.7.1.(5)(b). for open terrain and rough terrain respectively.

k) Main Wind Force vs. C&C Loads (Change 194)

Main Wind Force and C&C loads have been split into separate tables for readability. Previously there were two sets of headers for the tables and you had to correlate information for the type of load being read with the correct header line.

l) C_{ei} and C_{gi} Format for C&C Loads (Change 195)

The internal exposure and gust co-efficients C_{ei} and C_{gi} are now output to 2 decimal places instead of 1, similar to C_e and C_i .

m) Seismic Method (Change 199)

The design code clause reference has been added to the seismic design method shown in the header to the section on seismic load generation, and the redundant output of 2 lines repeating the NBC design code under the seismic site information have been removed.

n) Seismic Site Information

The following changes have been made to the echo of the user-input Site Information

- i. Seismic Site Information and Legend Titles and Location (Change 200)

The output of Site Information for seismic load generation has been made consistent with wind by removing the words "User Input" and placing it first in the sequence of information reported.

ii. Importance Category (Change 202)

Risk in the seismic Site information section has been renamed *Importance category* and moved to be adjacent to the *Importance Factor I_e*.

iii. Fv Formatting (Change 203)

The extra spaces before the output of Fv in the seismic Site Information have been removed.

iv. Ta and Rd, Ro in Seismic Site Information (Change 205)

The seismic site information now indicates whether the Ta used is from the equation listed below or from the user input over-ride, and indicates that the value is shown in the Base Shear table. It also indicates that Rd and Ro are in the Base Shear table, in order to make it clear that these values are input and not calculated.

o) Seismic Legend (Changes 210-211)

The following changes have been made to the *Symbols* section for seismic load generation

- This section has been renamed *Legend*, consistent with Wind output.
- The definition of Vx has been removed, as it does not apply to NBC design.
- For Fx, *design seismic force...* has changed to "*lateral force...* so that it matches NBC usage.
- wi and wx are changed to Wx and Wi for consistency with NBC notation

p) Seismic Equations (Change 204)

The following changes have been made to the Equations section for seismic load generation:

- The definitions have been removed from in front of V, Ta, Ft and Vx since these are already supplied in the Legend section.
- *Segment Lateral Force: Vp* and *Top Storey Shear Force: Vn* have been removed, as they are from old design code editions and are now obsolete.
- The words *hn in m* have been added to the expression for Ta to indicate for imperial output that that expression is valid only when Ta is in metric units.
- wi and wx are changed to Wx and Wi for consistency with NBC notation.

q) Calculation of Base Shear Table (Changes 212)

The following changes have been made to the Calculation of Design Base Shear section:

- The value of hn, the height of the top level, is now shown below the Calculation of Design Base Shear
- The notation *T* has been changed to *Ta*, for consistency with NBC and the rest of the report
- The notation *S* has been changed to *S(T)*

r) Distribution of Base Shear to Stories (Changes 206-209, 212)

The Distribution of Base Shear to Stories table often appeared in a puzzling, ragged format because an earlier format with the stories arrayed horizontally was shown along with the current format with the rows arranged vertically. This has been corrected, and the following changes have also been made:

- When you chose in the Format Settings to show distances in feet and inches, the table would show the storey height that way rather than in decimal format, which is used for all output reports.
- The final column is now headed by an Fx instead of Vx, in keeping with NBC terminology
- The name of the table has been changed to *Distribution of Base Shear to Levels*, to avoid the complication of differing spelling of the word storey for USA and Canada.

D: Materials

1. OSB and GWB in Wet Service Conditions (Bug 3000)

Oriented strand board (OSB) and gypsum wallboard (GWB) are no longer allowed for wet service conditions, as these materials are not permitted for wet service conditions according to O86-14 9.4.2 and Table 11.5.4 Note 2, respectively. When you try to add one of these materials to a structure for which wet service conditions is set, the program disallows the entry. If such materials exist in the structure, the program disallows entry of in-service moisture content greater than 15% (O86-14) or 19% (O86-09). An on-screen explanatory warning is issued when the program rejects a change.

The program also changes the in service moisture content from existing files, when opened, if GWB or OSB is used anywhere in the structure.

Because CSA O86 A.11.7 for gypsum wallboard nail slip deflection e_n is for dry fabrication conditions only, changes resulting in these GWB along with green fabrication conditions and deflection-based force distribution cause the setting for ignoring non-wood-panel materials for design to be set. If the setting for deflection based force distribution is not set, the program allows green fabrication conditions but issues an on-screen message and a warning under both the *Deflection* table and the *Storey Drift* table in the *Design Results*.

2. Plywood Sheathing Plies (Bug 2994)

The following problems relating to the selection of plywood sheathing plies in the Wall Input view have been corrected”

a) Available Plies

Not all the selections for plywood sheathing plies from tables 7.3A and 7.3B were available for each thickness. In particular, 3-ply 12.5 and 6- ply 15.5 were not included. These had been added for CSA O86-09 but not incorporated in the software until now.

b) Default Plies

When the thickness is changed, the program now defaults to the no. of plies for the most commonly available material as shown by the asterisk in Table 7.3A and 7.3b

3. Custom Plywood Thickness (Bug 2994)

The following problems occurred when custom plywood thicknesses were entered, rather than using a standard value from the list. This is not recommended and rarely done because such thicknesses are not available commercially. They have been corrected nonetheless

a) Ply Selection

After typing in a custom thickness for plywood, the selection of plies remained the same as for the previously entered standard thickness. The program now updates to show plies that are available for the closest standard thickness that is smaller than the entered custom thickness.

b) Zero B_v

When determining the shear-through-rigidity thickness, B_v , for the shear deflection calculation in O86-09 9.7.1.1, the program would sometimes use a value of zero for B_v because the number of plies was invalid for the next smallest thickness. This caused the vH_s/B_v term to be undefined in the deflection equation.

c) B_v for Sizes Greater Than 18.5mm

There exist values in Table 7.3A and 7.3B for shear-through-thickness rigidity B_v for panels thicker than 18.5mm, but if a custom thickness is entered that is larger than 18.5 mm, the program still used B_v values associated with 18.5mm that were as much as 60% smaller than in reality. Note that the use of panels greater than 18.5 mm is exceedingly rare.

d) Upper Limit on Sheathing Thickness

You could type in sheathing values greater than 31.5, the largest for which values exist in Tables 7.3A and B. Since such plywood does not exist in practice, the program now limits input to 31.5 mm.

4. Nail Penetration Imperial Unit Format (Change 180)

The nail penetration shown in the Sheathing Materials table is now formatted as a decimal instead of as a fraction when in imperial units.

5. Nail Diameter Format (Change 219)

For non-standard (now power-driven) nail input in Wall Input view and output in the Sheathing Materials table, the program shows the millimeter value with 2 digits precision, without truncating trailing zeroes, e.g "3.00" instead of "3".

6. MSR Grade Design Note (Change 215)

The Note 7 giving the MSR grade under the Sheathing Materials table in the Design Results output has been eliminated, and instead, under *Species* if the framing material type is MSR or MEL, the word "MSR" or "MEL" appears in front of the species name. The eliminated note had the following problems:

- It was under the Sheathing Materials table but should have been under the Framing Materials table.
- It output the E grade for MSR, but since deflection design was implemented, that value was added to the Framing materials table.
- It said "MSR" even if it is MEL. There was no way of knowing it was MEL.
- It repeated itself unnecessarily
- It should have said "for framing members", not "as framing members".

7. OSB Panel Marking Design Note (Change 216)

The Note 8 giving the OSB panel marking under the Sheathing Materials table in the Design Results output repeated itself for every wall with the marking, which defeated the purpose of creating the note. This has been corrected and it now outputs out each marking M1, M2, or M3 just once.

E: Program Operation

1. Extend Upwards Operation (Bug 3073)

In extending upwards in stages, the program created an extra level on the level above the one you selected to extend to, and uses the original block outline to create that level instead of the modified footprint. You could then only extend from that level upwards. For example, extending to level 2 on a 4-storey structure, the program copied the modified footprint to level 2 and added the original footprint to level 3, and placed you on level 3. If you extend to a level below the top, the extra level was placed on the topmost level and the process was complete.

This extra level is no longer added when extending levels in stages, for example if you extend to level 2, the program merely copies the modified ground floor level to level 2 and places you there to proceed.

2. Settings Dialog for Medium and Large Display Size (Bug 3068)

It was sometimes not possible to view the all of the Settings input tabs when medium or large *Display Size* was selected in Windows. In particular, it could happen that you were unable to click the buttons at the bottom that close the boxes.

These boxes have now been reorganized in a shape similar to that of a typical computer screen, so that the entire box fits in the view regardless of the display option selected.

3. "Getting Started" Steps Display (Change 181)

The list of steps helping you to get started using the Shearwalls program has been placed in a scrollable view and formatted with bold titles for each step. The number of steps had become too large to fit on the screen without a scroll bar.

4. Main Toolbar (Change 197)

The following changes have been made to the main toolbar:

- *Results View* has been renamed *Design Results*
- *Design Results* has now been grouped with icons for detailed output for load generation and torsional analysis (formerly Log file) and the new Detailed Shearwall Design output
- *Design Results* has now shows rectangles representing tabular data to differentiate it from the detailed text results.
- *Form View* has been changed to *Input Form*.

5. WoodWorks Sales and Technical Support Contact Information (DO Change 6)

In both the *Key code Registration* box and the *Help About* box, we have

- removed word *Support* from "*Sales Support*"
- asked users to provide company name rather than address,
- removed fax as a means of communication.
- emphasized email instead of phone as a means of contact
- changed the email address to be a link that opens an email message

6. Parentheses in the *Help About* box (DO Change 7)

Where parentheses were used in the *Help About*, the closing parenthesis appeared inverted at the start of the line instead of where it should have been. These occurred around things like the date of publication and the relevant parts of design code publications, and have been replaced with a dash as a means of delineating them.

7. Apply Button in Settings Dialog (Change 185)

The "Apply" button has been removed from the Settings dialog because it had no effect.

8. Update of Roof Overhang Input (Change 186)

In the roof input form, the roof overhang values were being set to zero when switching from a flat roof to a sloped roof and back again. They are now restored to their previous values.

9. Image File Wording in Message (Change 182)

In a message saying that the CAD file had not been imported, the words *Windows metafile* have been changed to *image file*, as several types of images are now imported.

10. Typo in Out-of-date Design Message Box (Change 178)

The repeated word “design” has been removed from the message box that appears telling you that your structure has changed and your previous design is out of date.

Shearwalls 9.2.1 Hot Fix – March 16, 2015

This version was sent to individual users to address Bug 3002 - Duplicate and Missing Low Rise Wind Loads, which is listed under [Version 9.3](#), the first version distributed to the general public with this fix.

Previous Versions

An asterisk () indicates that the change was added to this record after the release of the version in which the change occurred.*

Shearwalls 9.2 – November 19, 2014 - Design Office 9, Service Release 2

1. Upper Level Failures In Hold-down Design Summary (Bug 2948)

The *Hold-down Design* table of the *Design Summary* output was reporting walls as having failed hold-down design for multiple building levels when it only failed hold-down design on the lowest level listed. This has been corrected.

2. Duplicate Wall Wind Shear Loads for Additional Roof Blocks (Bug 2946)

After additional blocks are created for roofs only, with no attached walls, the program was creating a duplicate set of wall wind shear loads for walls on the other blocks. For multi-storey buildings this was happening on all levels except the top level.

If the project file was saved and then re-opened and then loads were re-generated the duplicate loads were no longer being created. This has been corrected.

3. Crash on Accept Design for Exterior Non-Shearwalls (Bug 2934)

When there were non-shearwalls on the exterior of the building with C&C loads, Shearwalls would crash when the *Accept Design* button was pressed. This has been corrected.

4. Crash After Deleting Additional Roof Block (Bug 2947)

After additional blocks are created for roofs only, with no attached walls, and wind loads were generated on these blocks, then one of these blocks is deleted, the program would sometimes crash the next time you tried to save the file, re-generate loads, or run design. This has been corrected.

5. Plan View Freeze for Exterior Non-Shearwalls showing Design Group Numbers (Bug 2935)

If you elected to show the design group numbers for each wall in Plan View via the *Show* menu, the drawing would not be updated if there were non-shearwalls on the exterior surface of the building with C&C loads. The Plan View drawing would freeze up until you disabled this option. This has been corrected.

6. C&C Design Results for Non-shearwalls on Exterior Walls (Bug 2937)

The *Components and Cladding* table in the *Design Results* was not including results for exterior shearlines which had only non-shearwalls on the line. This has been corrected and results now appear for these walls.

7. Materials Output for Non-shearwalls on Exterior Walls (Bug 2936)

The *Sheathing Materials* and *Framing Materials by Wall Group* tabled *by* in the Design Results were not including results for exterior shearlines which had only non-shearwalls on the line. This has been corrected and results now appear for these walls.

8. Wind Suction Title (Change174)

The title in the program output "Wind Suction Design" has been changed to "Out-of-plane Wind Design". This is because the governing condition can be either suction or bearing of wind.

9. Ctrl-C Operation (Bug 2964)

Previously pressing Ctrl-C caused a file close, when the standard operation that users expect is to copy selected text in an edit control, leading to significant frustration. This has been corrected and Ctrl-C now copies text and there is no shortcut for closing a project file. .

Shearwalls 9.1 – October 29, 2014 - Design Office 9, Service Release 1b

1. Accept Design for Existing Files (Bug 2903)

For saved project files, the *Accept Design* button was defaulting to accept flexible wind design, instead of the currently selected load case and distribution method. If there were no wind loads the *Accept Design* button had no effect. This has been corrected.

2. Inconsistent Design Results on Consecutive Runs for Capacity-based Distribution (Bug 2904)

The program was producing different rigid load distributions and wall designs on consecutive design runs for the *Use shearwall capacity to approximate rigidity* rigid distribution setting.

None of the design runs could be assumed to be correct due to instability in the updating of segment rigidities. This has been corrected.

3. Relative Rigidity in Wall Input View after Accept Design (Bug 2909)

After pressing *the Accept Design* button the relative rigidity in the Wall Input view was showing 1.0 instead of the rigidity from the accepted design wall.

This is just a display issue and the correct rigidity was used in design. It has been corrected.

4. Gypsum Wallboard Shear Rigidity B_v in Design Results (Bug 2911)

When imperial units are used, the shear rigidity B_v value for gypsum wallboard shown in the sheathing information table of the design results was the correct value divided by 12. This was a display issue only and did not affect design. It has been corrected.

Note that this value comes from the USA SDPWS in the absence of Canadian guidance.

5. Rigidity Shown in Wall Input for Redundant Wind Directions (Bug 2913)

When the Wind directions $S \rightarrow N$, $E \rightarrow W$ and $N \rightarrow S$, $W \rightarrow E$ are selected in the Show menu, the Rigidity shown in Wall Input view was a nonsensical value. This was a display issue only and the correct rigidity was used in the shearwall design. It has been corrected.

6. Non-shearwall C&C Failure for Rigid-only Design (Bug 2919)

If only rigid diaphragm analysis is selected in the Structure Input view, the program shows failure for non-shearwalls in elevation view, even if the walls are strong enough to resist design. In the *Components and Cladding* table, the program showed a warning that these walls do not have shear resisting materials, even if they did.

This problem disappeared if you chose to do both rigid and flexible design. It has now been corrected.

7. Zero Magnitude Wind Load Generation for Flat Roofs (Bug 2922)

Occasionally when wind loads with zero magnitude were generated on single faces of buildings with flat roofs. This problem occurred only sporadically and has been corrected.

8. Selection of Standard Walls that Differ Only by End Studs (Bug 2923)

When selecting a standard wall to assign to a physical wall, the number of wall studs was not being accounted for, so that if there were two standard walls that were identical except for the number of wall studs it sometimes would cause the program to assign the wrong standard wall to the selected wall. It was also not possible to select one of the standard walls in the Edit standard wall view.

Whether or not it happened depended on the order of the near-identical standard walls in the list of walls. It has been corrected.

9. Redundant Design Groups with Differing Penetration Depths (Bug 2924)

Sometimes extra, unnecessary design wall groups were being created with a nail penetration depth 1mm larger than another wall group, when the walls should actually be in the same wall group and have the same nail penetration depth. This occurred only sporadically and has been corrected.

10. Unknown Values on Interior Wall Surface (Bug 2925)

In wall input view, if you selected "*Both sides the same*" and specified unknown values, and then deselected *Both sides the same*, the unknown values were still recorded in the interior

sheathing, even though design for unknowns is not done independently for interior sheathing. If these unknown values were not changed, the program would design using the weakest materials in the list, and would show question marks (?) in the *Wall Design Groups* output table for the interior sheathing.

Now, when you deselect *Both sides the same*, the program changes any unknown values on the interior surface to the weakest possible. Unless changed, these materials now show up in the Design Group Output.

11. Crash for Failed Walls with Non-shearwall Shearlines (Bug 2926)

Starting with version 9, the program would sometimes crash after designing a structure in which some wall lines are entirely non-shearwalls, and some other lines have walls do not have sufficient shear capacity to resist the applied force. This has been corrected.

12. Program Version for Saved Files (Change 173)

The program now records the version of the program used to save a project file and shows it in the About Shearwalls box when the file is opened. This feature is primarily used internally at WoodWorks for diagnostics.

Shearwalls 9.0.1 – October 8, 2014 - Design Office 9, Service Release 1a

1. Persistence of Manually Input Wall Rigidities (Bug 2895)

Starting with version 9, when manually input rigidities are selected as the rigidity method in the Design settings, the program re-set all relative rigidities to one when distributing loads.

Since load distribution is done before design, it was no longer possible to set manual rigidities that are then used in design, and the manual option was identical to the “equal rigidities” option. This has been corrected and the program again allows you to manually set the rigidity to be used for each wall in the structure.

13. Relative Rigidity as Parameter for Design as Group (Bug 2897)

If you change the manually input relative rigidity for one wall in a standard wall group, the program no longer applies it to all walls in that group, nor does it present a message box warning you of this. Instead, different walls within different groups can have different relative rigidities.

Note that when the Design Setting *All shearwalls on shearline have same materials* was set, the program did not apply the relative rigidity to all walls within a line walls in a line. The behaviour for design groups is now consistent with that approach. Rigidity usually depends on the geometry of the wall so it cannot be specified for all walls within a group or line containing walls of differing lengths.

The program still includes relative rigidity amongst those parameters in a Standard wall that can be used to create the initial values for a set of walls. However, it no longer includes rigidity among those parameters that define a standard wall when identifying what standard wall a physical wall pertains to.

Shearwalls 9.0 – Oct 1, 2014, Design Office 9, Service Release 1

This release corrected the problem with the Design Office installation that disabled the input of .pdf CAD files (Feature 126). No changes were actually made to the Shearwalls program itself, hence the same version number as the previous version, 9.0.

Shearwalls 9.0 – Sept 17, 2014 - Design Office 9

This is a major release of the software containing many new features and small improvements. The following table of contents can be used to navigate to detailed descriptions of the program changes.

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A: Engineering Design

1. Worst Case Design

Previously, when wall parameters were left as unknown, Shearwalls designed separate walls for wind design, seismic design, rigid distribution, flexible distribution, and both force directions – a possibility of 8 designed walls for each physical wall in the structure. In practice, at most 4 walls would be designed, because forces in opposing directions are similar, and often only two or three walls would result. It was left to the designer to compare these walls manually and choose the one that was strong enough for all load cases. If you wanted to see design results for the selected wall, it was necessary to “accept” the design for that case and to run the design again. Now, the program automatically determines the worst case of wind and seismic, and for opposing force directions, and designs one wall that is evaluated for all these load cases. Optionally, you can also have the program determine the worst case of rigid and flexible diaphragms.

a) Worst Case Wind vs. Seismic Load Case (Feature 12)

i. Shearwall Design

Previously, the program determined the wall parameters needed to resist the forces from the applied wind loads, and then did so for seismic loads separately. As a result, the program could create separate wall groups for the same physical wall, one for wind design and one for seismic design.

The program now compares the walls designed for wind and seismic and selects the wall that has the highest capacity. That wall is then used to redistribute forces on the line if deflection is the force distribution criterion, and to redistribute forces to the shearlines for the rigid diaphragm procedure.

ii. Output – Shear Design Table

The wall groups are indicated by numbers in the *Shear Design* table, which are defined in the *Sheathing and Framing Materials by Wall Group* tables. For a particular wall, the same number now appears for seismic and wind design; previously they could be different.

In the Critical Response column of the table for wind design, the program outputs an “S” beside the response ratio if the critical case was seismic and the wall had unknown parameters. Similarly, a W is printed beside the column in the seismic table if the critical case was wind. This alerts you to the reason that a wall might be designed with materials that are much higher than needed to resist the loads from the design case shown.

The legend has been modified to explain the meaning of these letters.

b) Worst Case Rigid Diaphragm vs. Flexible Distribution Method (Feature 69)

Many designers prefer to consider diaphragms to be semi-rigid, and in the absence of a complex numerical model of the structure, wish to design for the worst case of rigid and flexible diaphragm distribution, to cover the whole envelope of possible diaphragm rigidities. Shearwalls now allows for that approach.

i. Design Setting

A checkbox has been added to the *Design Settings* called

Worst-case rigid vs. flexible diaphragms (envelope design).

The default for new program installations that this setting is on, but this can be changed. The setting is disabled if you have not chosen to design for both rigid and flexible diaphragms (the choice is in the Structure input).

ii. Shearwall Design

If the *Worst case rigid vs. flexible setting* is not selected, program determines the wall parameters needed to resist flexible diaphragm distribution forces, and then does so for rigid forces separately. As a result, the program can create separate wall groups for the same physical wall, one for rigid diaphragm design and one for flexible design.

If the setting is selected, the program first designs a wall for flexible diaphragm forces. When designing for rigid forces, if they are lower than flexible force, the program simply uses the wall designed with the flexible force. If they are higher than the flexible force, it replaces the wall designed for flexible forces with the one designed for rigid forces. For deflection-based intra-shearline distribution, the wall is then processed again for flexible forces on the next iteration of the design procedure, as the distribution of forces within the shearline may change slightly due to the new wall stiffness.

iii. Output – Shear Design Table

The wall groups are indicated by numbers in the *Shear Design* table, which are defined in the *Sheathing and Framing Materials by Wall Group* tables. If you have selected the *Worst-case rigid vs. flexible diaphragms* design setting, then for a particular wall, the same number appears for rigid and flexible design. If that setting is not selected, they can be different.

Please note that if the *Worst case rigid vs. flexible setting* is set, the wall materials appearing in table for rigid diaphragm design may have been designed for a higher force for flexible diaphragm design, and vice-versa. If the program designs walls that appear to be much stronger than needed, this is the most likely reason.

c) Worst Case of Opposing Force Directions

It is possible for the force in one direction to be slightly different than the force in the opposing direction. For wind design, this can occur for a mono-slope roof or eccentric ridge line. For both wind and seismic design, it can occur when forces are distributed due to deflection and there are asymmetries in the hold-down devices or hold-down forces. An example of this is when openings do not line up and vertical compression forces from the floor above are added to tension forces from the floor below.

In rare circumstances, such difference could cause the program to design a different wall for the east->west direction than the west<-east direction, and similarly for north-south walls.

i. Shearwall Design

The program now determines the largest force on any segment in the shearline, in either direction, and designs the wall materials for that force.

ii. Output – Shear Design Table

When different forces existed, two lines of results instead of one were output in the *Shear Design* table for each wall in the shearline. If different wall materials were selected by the program for these forces, a different wall design group number could be shown for the two directions.

The program still outputs separate design results for the opposing force directions if they are different, but this is to show the performance of the wall with respect to the different forces. The design group number shown for the opposing directions is now always the same.

d) Worst Case of Wind Shear vs. Wind C&C Design (Bug 2848)

In determining the worst case wall on the structure, the program considers wind shear, nail withdrawal, and C&C sheathing design.

The procedure has one slight imperfection in that thicker sheathing, which is optimal for out of plane sheathing strength and for shear design, makes for weaker nail withdrawal strength due to reduced penetration. So when determining the strongest wall, one wall may be stronger for suction and for shear but another may be stronger for nail withdrawal. In such a case, the program uses the wall with thicker sheathing. It is extremely rare for the wall to fail for nail withdrawal as a result.

e) Design Failures

There exists a small possibility that when distributing loads using the rigid diaphragm method to a stronger wall than was designed using that method, the rigid distribution routine could load the shearline to the extent that the wall fails despite being stronger than the one that previously passed.. This can happen when a wall designed for seismic is used to resist wind loads (or vice versa), or when a wall designed for flexible distribution is used for rigid diaphragm forces.

Although unlikely, it has the highest chance of happening when using deflection-based design and the effect of increased stiffness is greater than the increase in wall capacity. If this occurs, the program alerts you to the situation via a note under the *Shear Results* table. The wording of the existing note that appears if this occurs for other reasons has been modified to take into account this possibility.

The same thing could conceivably happen for the flexible diaphragm method and distribution *within* a shearline using deflection based rigidity, but it is highly unlikely because all segments on the wall have the same shearwall materials.

f) SHEARLINE, WALL and OPENING DIMENSIONS Table

Because this table no longer shows a list of design groups for each wall, showing at most two for rigid and flexible design, the heading to this column is "Wall group rather than Wall Group(s). A note below the table has been added when worst case rigid and flexible is not selected, explaining why two group numbers may appear.

2. Wall Design Groups (Feature 17)

The program now allows you to specify that groups of walls with unknown parameters wind up with the same material specification after design. The program designs the wall for the most heavily loaded wall in the group.

For example, all interior walls on a certain level, or all exterior walls in the structure, can be specified to be the same. Previously such walls would often have slightly different material specifications, which is not usually practical for construction.

a) Standard Walls

The program uses the existing Standard Wall mechanism for this feature. You are able to indicate which standard wall groups are to be designed as a group, and within the standard wall group, which walls are to be included in the group design. It may be necessary therefore to make more standard wall groups than were previously used to make default walls.

For example, if you had a Standard Wall called Exterior Shearwalls that was used as a starting point for design of all exterior walls, but want the same set of wall materials to be designed on each story of the structure, but possibly lighter walls on the upper storeys, then you would make 4 new groups called Exterior Shearwalls Lev 1, Exterior Shearwalls Lev 2, etc.

b) Design as/in Group Input

A checkbox has been added to the Standard Wall input called *Design as a group* and in the regular wall input mode called *Design in group* . The checkbox in the standard wall mode means that all the walls of that standard wall that also have the checkbox checked will be designed as a group in the sense that they will wind up with identical materials after design. Those individual walls that do not have the checkbox checked are treated as if they were not part of a standard wall group. Those standard walls that do not have the checkbox checked function as current standard walls, that is, as default walls only.

i. Default Setting

The standard wall checkbox will default to being checked if a new standard wall is made. The standard walls shipped with the program will have the checkbox checked by default.

ii. Updates

If you uncheck the *Design as a group* check box for a standard wall, then all the checkboxes for walls of that group are unchecked and disabled. If you check a standard wall box that had been unchecked, then all of the standard walls in the program are checked and enabled.

If you select a Standard Wall for an individual wall when previously it had a different standard wall or no standard wall, then the individual wall's checkbox will be checked and enabled if the standard wall box is checked. If it is not, it is unchecked and disabled.

If you change a wall so that it becomes identical to a standard wall and then becomes one of those standard walls, the checkbox will be unchecked regardless of whether the standard wall *Design as Group* checkbox is checked or unchecked, but it will still be enabled. This is because the wall was not made a standard wall deliberately, so you are unlikely to want it to be grouped with those walls for design.

iii. Default Walls

When walls are made in the program using standard walls, then the individual wall's checkbox will be checked and enabled if the standard wall box is checked. If it is not, it will be unchecked and disabled.

iv. Standard Wall Deletion

If you delete a standard wall, then the program goes through all the walls that had been that standard wall, and unchecks *Design in group*

v. Previous Versions

Walls from existing files from versions before the feature was implemented have their individual wall *Design in group* checkbox unchecked by default.

c) Wall Attributes

Previously, when attributes such as materials or wall type were changed for individual walls, the wall would no longer be identified as being a standard wall. If standard walls are changed, then all the walls that were created with that wall were not identified with that standard wall. For those standard walls designed as groups, this has changed, and membership in the standard wall group persists through material changes.

i. Change of Wall Attribute

If you change an attribute of a wall that is currently one of a standard wall group, and both the standard wall and the individual wall are to be part of a design group, then the program will issue a warning saying "All walls of the [standard wall group] will also have the selected change." There is a "*Don't show this box again*" checkbox in the message to allow you to avoid having the box appear repeatedly.

If you don't want the attribute to change for all walls in the group, then just change it back to what it was and deselect the *Design in Group* box for those walls you do not want to change.

If you change an attribute of a wall that is a standard wall but does not have the *Design as Group* checkbox checked, then the program will allow the change with no message and in most cases it will cause the wall to no longer be part of the standard wall group. No other walls will receive the change.

ii. Change of Standard Wall Attribute

If you change at least one attribute of a wall that has the *Design as Group* box checked, when exiting the box, the same message as for individual walls appears, saying all members of the Standard Wall group will receive the change, allowing you to suppress further instances of the message.

If the *Design as Group* box is not checked, then a change in wall attributes will cause all the walls that were previously one of the standard walls to no longer be a standard wall, as the program currently behaves.

d) Multiple Standard Walls with Same Materials

Previously, the program would not allow you to create more than one standard wall with the same material specification. For those standard walls that are designed as a group, this restriction has been relaxed in order that you can use for example the same material specification with unknowns that become different wall specifications when the unknowns are determined by the program in order to meet design requirements.

For example, you can have different standard wall groups on each floor of the building, each with the identical materials when unknowns are included, which however become different walls when the program designs for the different loading scenarios on each floor.

i. Automatic Identification of Standard Wall Group

Currently, if the program identifies that a change in a wall makes it identical to a standard wall, it assigns it to that standard wall. If you have multiple standard walls with the same specification, it randomly chooses which of these standard walls to assign the wall to. This has little impact, because the *Design in group* is unchecked in this case. You can manually change the standard wall the wall is associated with and check *Design in Group* if you want it to be grouped with a different wall.

e) Standard Wall File Synchronization

When a file is saved with standard wall groups, and the standard wall definitions are later changed, or standard walls are deleted, while in another project, and the original file is opened up again, some of the grouped walls have no standard wall associated with them.

If this happens, new standard walls are created with the materials from the grouped walls, and given names Std Wall 1, Std Wall 2, etc. These walls are later saved as standard walls that can be opened with any project. You can then either delete them, rename them, or reconcile them with the changed standard walls that were originally used to create them.

f) Design Procedure

After the design iterations, and before the final design check, the program compares the design capacities of all walls in a group. It then the materials of the wall with the highest capacity to all the walls in the group, then recalculates the wall deflections, redistributes loads to the walls, and outputs design tables for the new walls.

i. Design Failure

It is possible for the new load distribution to create a situation that the critical wall in the design group might elsewhere fail elsewhere on the structure where a weaker wall had passed. When this happens, a warning appears in the Shear Design table of the output. The existing warning that appears when this occurs for other reasons has been reworded to reflect this possibility,

ii. Wall Grouping

The existing system of comparing all the designed walls to establish design groups with identical materials, which are identified by numbers, has been retained. The fact that walls within a Standard Wall group will have the same materials cause them to be grouped with the same group number.

Walls that are not part of Standard Wall groups are also grouped and assigned group numbers as they currently are.

g) Accept Design

Changes have been made to the recently added *Accept Design* feature because there are no longer separate designs for wind and seismic, so the choices in the selection menu are now just Rigid *Diaphragm* and *Flexible Diaphragm* rather than *Rigid, Wind*, etc.

The sub-submenu item has been changed to say *Accept* from *Accept Design*. .
When you have activated the *Worst Case Rigid and Flexible* feature, , both *Rigid* and *Flexible* are checked but disabled, and the *Accept* item is the only one that is enabled.

h) Output

i. FRAMING MATERIALS by WALL GROUP Table

The name of the Standard Wall associated with a wall group, if there is one, is included in a column that has been added to this table. It is possible that more than one Standard Wall yields the same materials when designed; in that case the line is repeated with the same group number. If there is no Standard wall associated with the group number because it came from walls that were not grouped, the line appears blank.

The table has been renamed accordingly to *FRAMING MATERIALS and STANDARD WALL by WALL GROUP*.

ii. SHEAR DESIGN Table

A hat symbol (^) appears beside the wall group number for the wall that is critical for that group, that is, the wall that had the heaviest loading and for which the wall materials designed were used for all other walls in that group.

The legend has been modified to explain this and to refer to Standard Wall groups.

iii. SHEARLINE, WALL and OPENING DIMENSIONS Table

The legend has been modified to refer to Standard Wall groups.

iv. DEFLECTION Table

The legend has been modified to refer to Standard Wall groups.

3. Highlight of Failing Walls (Feature 75)

If a wall failed design for the design case (wind shear, wind C&C, seismic, rigid diaphragm, or flexible diaphragm) shown on the screen, then the failing wall appears in red. The colour for a selected wall, which used to be red, is now orange. If a failing wall is selected, it appears as a darker shade of red.

A note at the bottom of the screen indicates that orange is for selected walls and red for failing walls. It also indicates the design case being shown on the screen.

4. Design Summary (Feature 138)

To allow you to identify walls and hold-downs that fail design without having to scan the full design results report, the program now includes a design summary. It appears in the Design Results report before the shear results for the first design case (just after the loads are output). In addition, the program alerts you with a pop-up message if any walls fail.

a) Message Box for Wall Failure

If any walls fail for any design case (rigid diaphragm, flexible diaphragm, wind shear, wind C&C, seismic), the program shows a message box on the screen that gives the levels and the design cases that the failure occurs. It tells you to go to the Design Results or to see the highlighted walls in Plan View (see Feature 75, above)

b) Wall Failure Summary

For each design case (wind shear loads - rigid diaphragm, wind shear loads - flexible diaphragm, components and cladding wind loads - out-of-plane sheathing, components and cladding wind loads - nail withdrawal, seismic loads - flexible diaphragm, seismic loads - rigid

diaphragm) the design summary either indicates that there were no under-capacity walls, or gives a list on each level of the names of the walls that failed.

c) Hold-down Failure Summary

For each design case (wind shear loads - rigid diaphragm, wind shear loads - flexible diaphragm, , seismic loads - flexible diaphragm, seismic loads - rigid diaphragm) the design summary either indicates that there were no under-capacity hold-downs, or gives a list on each level of the names of the walls that contained under-capacity hold-downs.

d) Table Menu Item

The *Go to Table* menu that appears when the Design Results are shown now includes an item for *Design Summary*.

5. 500mm Stud Spacing for Unblocked Factor (Feature 173)

The program now allows input of 500mm (19.2") stud spacing, corresponding to 1/5th of the length of a standard sheet of plywood. When 500 mm or 19.2" is selected, the program uses the unblocked factor in O86 Table 9.33 for 500 mm.

6. Hold-down Offset Subtraction from Overturning Moment Arm (Bug 2731, Change 165)

The program did not subtract the hold-down offset from the moment arm when calculating overturning hold-down forces, despite the fact that O86 9.5.6.1 requires it and that the disabled checkbox in the Hold-down settings indicates that it is to be subtracted.

Since 9.5.6.1 says you should use the centre of the end stud as your hold-down offset for moment arm calculations, we now allow you to use the centre of the end wall stud assembly that you input in Wall Input View for each wall in the structure. A checkbox in the Hold-down settings is used for this. The default value is to be checked.

When drawing, the program now draws the tension side hold-down at the full stud thickness from the wall end, because it depicts the bracket, not the center of the bolt through the studs.

7. Hold-down Force Accumulation Tolerance (Change 169)

The program now accumulates hold-downs forces from the floor above with the one on the floor below when these forces are that are offset by as much as 1.5 " in plan. This is the minimum distance from wall end.

8. Non-convergence of Deflection-based Distribution to Segments (Bug 2770)

Occasionally, Shearwalls is unable to distribute forces to the shearwall segments by equalizing the deflection of each segment due to non-convergence of the numerical routine used.

a) Warning Message

If this happens, the program now outputs a note below the Shear Design table indicating the affected shearlines.

b) Inconsistency of Deflection and Design Forces

In such a case, the force on the segment used for shearwall design could be markedly different than the force used for deflection analysis. This has been corrected, and they are .now the same. However, it should be noted that these forces do not result in equal deflections on the shearlines, and the value selected is just one in the succession of non-converging iterations that can oscillate between very different values. We recommend turning to capacity-based rigidities for load distribution if this occurs.

9. Uplift Loads on Walls with Openings (Bug 2744)

When uplift loads were added to a wall with openings, the elevation view displays incorrect values superimposed on top of one another. Each opening added to the wall caused an additional increase in the incorrectness of the uplift load magnitude. The incorrect uplift load magnitude was used to calculate hold-down forces, which were shown in Plan View, Elevation View, and the Hold-down Design table.

10. Verification of Stable Design in Final Design Check Iteration (Bug 2743)

The program was doing a full load distribution and wall design during the final design check loop. The design check loop was intended to use the previous iteration's load distribution and designed walls to verify that the wall design / distribution achieved a stable design. By doing a full load distribution and wall design on the last iteration the verification check was not identifying when the wall design / load distribution does not achieve a stable design, and not issuing the appropriate warning. This has been corrected.

11. Design for Distribution of Forces to Shearwall Segments Based on Rigidity

The following problems occurred when the *Distribute forces to wall segments based on rigidity* and the *Use shearwall deflection to calculate rigidity* Design Settings were both selected. They have been corrected:

a) Selection of Critical Segment in Design for Unknowns (Bug 2730)

The program did not take into account the distribution of forces on individual shearwall segments between openings when determining the critical segment for design. Instead it considered only the lowest *Jhd* value from all segments on the wall. As a result, walls with "unknown" material or hold-down choices sometimes failed design when the program should have designed a stronger wall that would pass.

b) Design Ratio and Failure Warnings for Segmented Walls (Bug 2884)

When forces are distributed to individual segments via deflection, in the design loop the program evaluates the wall via the force vs. capacity of the critical segment. However, in the design report, it shows only the force vs. capacity for the entire wall, that is, the sum of the forces vs. the sum of capacities, as per O96 9.5.1. Therefore walls that fail design and can be passed over in the design loop can pass when each parameter is selected by the user.

This has been corrected by showing the design ratios in the output for each segment on the wall, and failure warnings for if any one of them is under capacity.

12. Output Warnings for Inadequate Stud Thickness for Hold-downs (Bug 2825)

If you selected a hold-down that is not rated for the thickness of wall studs at the end of the wall, then the program did not design for that hold-down and it used the displacement over-ride entered in the settings. It issued a warning in the hold-down design and hold-down displacement tables to that effect.

Since the wall studs do not necessarily include "cripple" or "jack" studs beneath the window that can contribute to hold-down strength, the program now issues a warning to the effect that extra cripples or jack studs are needed, and continues with hold-down design using the capacity and displacement for the least thick stud assembly that the hold-down is rated for. The warning is no longer in red indicating a failed design.

13. Hold-down Stud Width for Capacity and Elongation (Bug 2826)

If there are multiple entries for hold-down capacity for different stud widths, and the entries are listed with the larger stud width before the smaller width and the wall's stud width is greater than

both entries, the program used the capacity and elongation for the smaller stud width even if the larger width was the closer match. This has been corrected.

14. Levels and Directions for Out-of-Plane and Weak Storey Seismic Irregularities (Bug 2824)

Shearwalls sometimes reported the wrong building level or direction for which a Type 5 irregularity (Out-of-Plane) occurred. This irregularity could also be incorrectly allowed or disallowed due to the Weak Storey (Type 6) irregularity as it was using the wrong level or direction. These problems have been corrected.

15. NBCC Terminology (Change 164)

All references in the program to NBCC, meaning National Building Code to the correct acronym for the building code, NBC.

B: Building Model and Program Operation

1. Design and Load Distribution Processing Time

The time taken to design shearwalls and to distribute and draw loads and forces has been markedly improved, by a factor of at least twenty, so that delays that used to occur in the operation of the program have been reduced to manageable levels.

a) Slow Processing Time when Designing Complicated Structures (Bug 1837)

When a project had a combination of many shearlines, many exterior surfaces, many blocks, and multiple stories, the time taken to analyze and design the structure could be very slow, sometimes as much as 30-60 minutes. Such a structure now takes 1-2 minutes. Smaller, less complicated structures also design much faster, so that a building that used to take a few minutes to design now designs in a matter of seconds.

b) Slowdown in Updating the Drawing of Loads (Bug 2750)

Once loads had been generated, every time you went into *Load Generation* action or *Loads and Forces* action, the drawing of the building and loads in plan view would hang for many seconds, especially for complex buildings with a large number of loads. This also happened while you scrolled the view, selected walls, moved the window, edited loads, etc.

This has been corrected and the drawing of the loads has been accelerated by a factor ranging from a small amount to up to several thousand times, depending on the complexity of the building. The delay in drawing loads is now a fraction of a second and manageable.

2. Multiple Extend Upwards (Feature 193)

The program allows you to extend your walls upwards in stages, that is, extend walls up through a more limited number of levels than to the top of the building. However, in order to maintain a closed envelope, you must always extend the walls through at least one level and cannot build a level from scratch.

For example, for a five storey structure, you can make a floor plan, extend to floor 2, then be on floor 3, make a floor plan, extend only to floor 3 (that is, not at all), then make another floor plan, and extend it from level 4 to 5. Unlike the current operation, the level indicator in the data bar is active during this process to allow you to do this.

a) Level Inputs

Two inputs, one to show the level that you are on and one to show the level that you are copying it up to, that is the range of levels. The levels are called *Current level* and *Extend to*.

The *Current Level* input is always disabled and is there to show you the range. Once the process is complete, it becomes enabled to select levels and *Extend to* disappears.

b) Operation

If you choose an intermediate storey, or don't extend at all by selecting the same storey, then press extend, the program then

- extends to the level selected,
- creates a new floor plan from the blocks for the next unextended level,
- Sets the current level to the next unextended level
- Sets the in Extend to to the highest level,
- outputs a prompt explaining how to proceed

If you extend to a level that is one below the highest level, the program in fact extends to the highest level and copies the next-to-highest level to that level.

c) Undo and Redo

The *Undo* and *Redo* commands are active during this process and allow you to go back and try again if you have made a mistake.

3. Accept Design (Feature 153)

The other WoodWorks programs, Connections and Sizer, allow you to transfer the design results from a successful design back to the input fields, replacing unknown values on those fields. This allows you to experiment with and tweak your design, for example to use fewer different types of materials at the expense of optimal strength in some areas.

This ability has now been added to the Shearwalls— you can transfer the design results for all walls in the structure from one of the four design cases – combinations of Rigid or Flexible Diaphragm, and Wind or Seismic.

a) Design Case Menu

A sub-menu now appears in the *Action* menu called *Accept Design*. When dropped down, it gives the choice of the four design cases for which to accept design.

If one of the Design Cases is selected in the *Accept Design* Menu, loads from that design case is shown on the screen. However, this is not reciprocal, if you select another design case via the Show menu, the Accept Design case does not change. In this way, you can always check the design case that was used to accept the design.

b) Accept Design Command

The Accept Design command is invoked either from the Accept Design submenu, or via a button at the far right of the main program toolbar.

c) Re-running Design

When you rerun design after Accepting design, the program may fail for other design cases than the one accepted, because the unknown values have been replaced by ones strong enough for that design case but not for others. If that is the case, you can reset some parameters to unknown, then re-run design and then select the critical case for "Accept Design". After a few iterations of this procedure, you can achieve a design that satisfies all design cases .

d) Non-Shearwalls

Non-shearwalls are updated only if they were designed for C&C wind loading.

4. Log File in Viewer (Feature 208)

The log file which provides load generation and rigid diaphragm analysis details has now been integrated into the program and appears in a window within the program framework. Previously the program invoked the Notepad program to show the log file results. The window is called Load Generation and Torsional Analysis Details. The menu and status bar descriptors have also been updated.

5. Log File Button (Change 120)

A button has been added to the main program tool bar to invoke the log file, and to toggle the log file viewer on and off. The log file button has been removed from the toolbars attached to the windows for Plan, Results, and Elevation views.

6. Getting Started Steps (Change 122)

The *Getting Started* dialog has been updated to reflect the current state of the program. The text shown for *Roofs* and *Generate Loads* has been changed and a new step, Step 14, *Log File Output*, has been added

7. Crash after Moving Opening then Entering One (Bug 2856)

Occasionally, after moving openings on upper level storeys, then creating a new opening on the same wall, the program would crash. This has been corrected.

8. Creation of Perpendicular Non-shearwalls (Bug 2880)

After one segment of an exterior non-shearwall is perpendicular to the wall to create two perpendicular joining segments, those segments are designated shearwalls rather than non-shearwalls. They otherwise had the same materials as the non-shearwalls. This has been corrected and they remain non-shearwalls.

9. Location of Standard Walls File for Network Installations (Bug 2776)

For network installations, the file that stores the standard walls was previously located on each local client machine. The standard walls file is now located on the network server in the same location as the materials and hold-down databases. This was needed now that the standard wall groups are used for design grouping.

C: Load Generation

1. List of Cities for Default Seismic and Wind Data (Feature 209)

The list of cities shown in the Default Settings from which you select the location for your wind speed q and seismic parameters S_a ($T = 0.2, 0.5, 1.0, 2.0$) has been expanded. Previously it included a list of 80 major centers across Canada. Now it includes all the municipalities listed in Appendix C of NBCC, a total of 670 cities.

A dropdown list of all provinces and territories has been added to the program, and you first select your province and a list of cities in that province appears, with the capital city appearing by default. You then pick the city closest to your design location.

Shearwalls project files from previous versions will use the city closest to the one in the old list, for example Kitchener-Waterloo will now be Kitchener and Chicoutimi is now Saguenay. The new list of cities also contains the proper spelling of cities in terms of including accents and hyphens.

2. C&C Loads

The following improvements have been made to the treatment of Component and Cladding loads and C&C design.

a) C&C Loads Per Wall Line (Feature 206)

Because different wall lines can have different reference heights h because they are on different blocks, but be on the same face of the building in terms of N, S, E, W directions, the program now assigns separate C&C loads to each wall line. If the wall line includes walls from more than one block, the highest C&C load from the blocks is used.

As a result, C&C loads are shown in plan view on each wall line with exterior walls. Previously only one C&C load was shown for each building face .

b) Windward Pressure (Feature 207)

Previously the program used the worst case of the outward (suction) C&C pressure for both sheathing strength and nail withdrawal design, although it is possible for the combination of windward external pressures and negative internal pressure to be greater than leeward internal pressures and positive internal pressure. This caused somewhat conservative design for nail withdrawal, which is applicable only when exterior forces are outward.

Furthermore, some users were confused by the discrepancy between their calculations for windward pressures and the C&C pressures on the screen for a windward load direction shown.

Accordingly, shearwalls now calculates the windward and leeward pressures separately and uses the leeward for nail withdrawal design.

i. Plan View

Shearwalls now shows both the windward pressure if the displayed wind direction is directed towards a surface, e.g. for the west face for west to east loads. It previously showed the leeward (suction) pressure.

ii. Elevation View

Both the leeward and windward pressures are now shown in elevation view.

iii. Design

The worst of leeward and windward pressures are used for sheathing design. Only leeward pressures are used for nail withdrawal.

c) Reference Height for C_e (Bug 2500)

The reference height used for calculation of windward velocity pressure coefficient C_e is now the actual height at the top the level in question, rather than the eave height of the structure. This applies to both external and internal pressures. As the C_e factor at the 20m level is 0.82, and the minimum C_e is .70, the C&C loads can be conservative by as much as 17% on the lower levels, however, since the C&C load on lower levels does not tend to govern because of the accumulated shear forces on lower levels, this change has little effect for most designs.

3. Leeward I-15 Method Reference Height for C_e (Bug 2810)

Starting with version 8.11, the program was using the eave height of the building as the reference height for h for calculating leeward C_e for for the I-15 method, however, Commentary I- 7 (b) says to use 1/2 the building height. This is a conservative bug effecting taller structures, as the minimum value of 0.7 for rough terrain and 0.9 for open terrain is imposed for shorter

structures. The bug affects buildings taller than 12.5 meters for rough terrain and buildings greater than 6 metres for open terrain.

For a 20-meter building, for rough terrain the program was using a .82 C_e when it should be 0.7, for a 17% conservative error, and for open terrain, it is using 1.15 when it should be 1.00, for a 15% error. This has been corrected.

4. Crash on Load Generation for Closely Spaced Walls (Bug 2687)

The program sometimes crashed during seismic load generation when walls are positioned such that they could belong to more than one shearline.

5. Crash when Generating Loads on Merged Walls (Bug 2882)

Starting with version 8.3, if walls are segmented then merged again, the program crashes when generating loads. This has been corrected.

6. Torsional Irregularity for Wall Lines with Zero FHS (Bug 2738)

When determining the deflections on extreme shearlines to derive the B_x from NBC 4.1.8.11 (9) for Irregularity 7 – Torsional Sensitivity, the program was failing to identify those exterior wall lines that do not have full height sheathing, so are not in fact shearlines. It was assigning zero storey drift at the building edge in those cases, which also caused the program to be more likely than it should assign a high B_x .

Now, if the outermost wall lines do not have full height sheathing, the program uses the next closest shearline with full height sheathing, which may in fact consist of interior walls.

7. Message for Applicability of I-15 Method for Multi-block Structures (Bug 2738)

The message about applicability of I-15 method for multi-block structures no longer has the comment about the C_p factors on the block the wall was originally part of, which was rendered obsolete by the fix to Bug 2473 in version 8.2, below

8. No Species Group in Initialization File (Change 2738)

If the installation does not have a current initialization file for the materials database (database.ini), so that the species group is not identified, the program now uses a stud density of 0.42 corresponding to S-P-F for anchorage deflection calculations. Previously the program would crash. This problem would not ordinarily be encountered by regular users of the program and was a problem primarily for internal testing.

D: Drawings and Graphical Input

1. Import of Bitmap and PDF Versions of CAD Files (Feature 126)

Previously, the program allowed input only of Windows Metafile (.wmf) or Enhanced Metafile (.emf) file formats for CAD drawings to use as a template to draw your structure. Now, the program allows you to input bitmap (bmp) and portable document format (pdf) files. The program converts the pdf to a bitmap before drawing it.

a) Input

The *CAD Import Wizard* for importing of the CAD drawings has been updated to allow the following file types wmf, .emf

Metafiles (*.wmf, *.emf)

Bitmaps (*.bmp)

PDF (*.pdf)

b) Operation

The operation of the program is the same for bitmap files and pdf files converted to bitmaps as it is for the metafiles the program was previously restricted to.

2. Adding Openings over CAD Import (Feature 150)

As it was difficult to see openings on imported CAD drawings as the solid shearwalls in plan view obscured them, the drawing for the openings action when CAD drawing is showing has been modified to allow you to see openings. Segmented shearwalls are transparent with diagonal lines. Perforated walls have hatches and the non-shearwall is blank as before. If there is no CAD import showing, then shearwalls are shown in solid colour as before.

3. Graphical Selection of Openings (Feature 23)

Previously, an opening could only be selected via a drop list in the Opening Input form. Now in the *Openings* action of *Plan View*, if you select anywhere within the thickness of the wall over the extent of any of the openings, then the opening selected is the one available for editing in the input form.

4. Display of Wall Group Name (Feature 102)*

The program now allows you display the name of the standard wall used for each wall in both Plan view, which is now also the wall design group. This is controlled by a checkbox in the Display group of the Options setting. It defaults to being checked. If all walls on a shearline have the same materials, the name is shown only once.

5. Slowdown in Updating the Drawing of Loads (Bug 2750)

Once loads had been generated, every time you went into Load Generation action or Loads and Forces action, the drawing of the building and loads in plan view would hang for many seconds, especially for complex buildings with a large number of loads. This also happened while you scrolled the view, selected walls, moved the window, edited loads, etc.

This has been corrected and the drawing of the loads has been accelerated by a factor ranging from a small amount to up to several thousand times, depending on the complexity of the building. The delay in drawing loads is now a fraction of a second and manageable.

6. Appearance of Load Arrows (Bug 1952)

For large structures, the arrows in *Plan* view representing applied loads became much more widely spaced than for smaller structures, and the arrowhead was not visible. This has been corrected and the appearance of the load arrows is similar for large and small structures.

7. Color of Text in Load Generation Legend (Bug 2815)

The *Unfactored generated shear load* and *Vertical elements required* items in the legend that appears on load generation are now coloured blue like the rest of the legend, not orange.

8. Plan View Update Quality (Change 161)

The plan view now draws more smoothly without flashing on changes or when scrolling

E: Data Input

1. Standard Wall Copy (Feature 178)

Previously, to create a copy of a Standard Wall was done in a roundabout way that not all users were aware of. (by pressing *Add*, then selecting from a list of Standard walls). To make it more evident, we added a *Copy* button to allow you to copy an existing Standard wall. You must make at least one change to this standard wall before it can be saved.

The old way of copying a Standard wall still exists alongside the new one for those users who are more comfortable with it.

2. Default Load Type when Adding Loads (Feature 141)

The program used to revert to the *Dead* load type each time you added a new load. Now it uses the type of whatever load is selected in *Wall Input View*, which is the last load previously added. This allows you to enter multiple loads of the same type without resetting the load type on each one.

Note that the very first load you enter will now default to the type of the first generated load in the list, instead of *Dead*. If there are no generated loads, then *Wind shear* will be the type of the first load entered.

3. Creating Standard Walls with Unknowns (Bug 2887)

Sometimes when trying to save a new standard wall with some parameters set as "unknown", the program would not allow it, presenting a message box saying that all fields had not been filled in. This happened frequently for OSB materials and occasionally for other materials, and has been corrected.

4. Default Thickness for OSB Sheathing. (Bug 2805)

The program defaulted to a particular panel marking when OSB was selected, rather than to *Unknown* as it does for other inputs, and to a particular thickness when a panel marking is selected, without even allowing for *Unknown* thickness. This has been corrected and when OSB is selected, the panel marking and thickness default to *Unknown*.

5. Unknown OSB Interior Panel Markings (Bug 2881)

It had been possible to select "Unknown" as the *Panel marking* for OSB for interior wall side. Unknowns are not supposed to be in the interior wall selections because the program does not design for unknowns on the interior side unless both sides are the same.

Selecting "unknown" resulted in a zero shear deflection for that wall to be zero. Shear deflection is ordinarily only a small component of deflection, so the impact of selecting unknown was often negligible.

6. Conversion of Imperial Units for Wall Framing Thickness (Bug 2804)

For imperial units, a value typed into the Framing "Width d" is interpreted by the program as being a metric value and immediately converted to imperial by dividing the value by 25.4. This incorrect value was then used for design. This has been corrected.

7. Tool Tips for Wind Load Generation Controls (Bug 2675)

When you hovered your mouse over the input controls of the *Wind Loads* group of the generate loads box, small "tool tip" messages appeared, but they did not appear for the seismic loads controls or other buttons in the dialog box. In addition, the *Exclude roof portions* checkbox mistakenly gave the message for C&C loads.

Messages have been added for all inputs in this box and the *Exclude roof portions* message has been corrected.

8. Input of Invalid Wall Location (Bug 2754)

Changing the location of a wall via the input field in the Wall Input dialog of a wall to a location that was invalid because it is outside the building perimeter, intersects with another wall, etc., caused the program to crash. The program now shows an error message and does not allow the wall to be made.

9. Editable Ply and Panel Marking Input Box (Bug 2807)

Starting with version 8, the field that is used for Plywood plies and for OSB Panel marking is editable, when it should be a non-editable selection list. Typing data into this box did not cause a problem; the program simply ignored it and used the default for the designed thickness.

10. Enabling of Double-Bracket Boxes in Openings View (Bug 2813)

In openings view, if no wall is selected, all inputs were greyed out except for the two double-bracket checkboxes at the bottom. With no wall selected, or with a wall with no openings selected, clicking on one of these the double bracket checkboxes caused a crash. These controls are now disabled when no walls are selected, and will not cause a problem when clicked.

11. Wall Framing and Hold-down Behaviour on Multiple Selection (Bug 2816)

When multiple walls with varying properties are selected, none of the fields on the Framing or Hold-down sections of Wall Input View were set to be blank to signify an indeterminate selection. This does not currently happen for any field in the *Framing* or *Hold-down* sections in *Wall Input View*, instead showing the value of the most recently-selected wall. This is purely a display issue; the actual properties of each wall are correctly maintained.

12. User Interface Rearrangement

The input fields in throughout the user interface have been rearranged somewhat for better alignment, to ensure that all data selections are completely visible in all boxes, that dropdown lists drop down to reveal all choices without scrolling, correct minor typos, etc.

In the Wall Input View, the position of Thickness and Plies inputs have been reversed to better reflect the interdependency of these inputs.

13. Design Code Clause Number in Design Settings for Collector Force Method for Irregularities (Change 151)

The reference to the design code clause 4.1.8.15(6) in the Design Settings about the applicability of capacity based collector forces for irregularities has been changed to the correct 4.1.8.15(4). This was due to a renumbering for NBC 2010 vs 2005.

14. Default Setting for Save as Default (Change 159)

The default setting for *Save as default for new files* for Default Values and Company Information settings has been changed from being unchecked by default to being checked by default.

15. Location of Wall Dead Load Input (Change 153)

The input for creating special wall dead loads for J_{hd} calculations was in the wind section of the *Load Generation* dialog, when it applies to both wind and seismic. This has been corrected

16. Project Files With Hold-downs Deleted from Database (Bug 2827)

When loading a project file that contains hold-downs that don't exist in the current hold-down database, the missing hold-downs were added to the database but the Cap S-P-F field is populated with a nonsensical value. This has been corrected.

17. Message for No Species Group in Database.ini File (Change 167)

If you do not have a current database.ini file so that the species group is not identified, an error now appears on the screen and a stud density of 0.42 corresponding to S-P-F is used for anchorage deflection calculations. Previously the program would show nonsensical hold-down design, which also affected deflection calculations.

Please note that if this situation occurs, the program repeats the message many times. If you continue to dismiss the message, the design will eventually complete normally. This will be corrected for the next version of the Shearwalls. The situation that an incorrect database.ini file is on the computer ordinarily exists only in internal testing environments.

F: Text Output

1. Shear Results Output for Shearlines which Extend over Part of Structure (Bug 2822)

The program output only one line of shear results data when there is only one shearwall on the line, on the assumption that the information for the line will be identical to that for the wall. However, when the shearline did not extend the whole distance between exterior walls, the shearline length is different than the wall length. The V/L value shown in the shear results output was that for the shearline, that is, the diaphragm shear flow, and not the design shear flow that is needed for the wall. The design ratio therefore did not correspond to the force V/L and the resistance V_r/L values shown in the line.

This was a display issue only, not affecting design, and has been corrected.

2. Cumulative Storey Shear in Seismic info Table (Change 137)

The value of storey shear for *All* levels has been removed from the Seismic Info table. Below the table, the following lines now appear

Storey shear – Sum of factored, vertically accumulated shearline forces on level, including torsional effects.

Total unfactored base shear – *[value]*

3. Shearwall Wall and Opening Dimensions Table Legend (Change 162)

The *Shearwall Wall and Opening Dimensions* table legend has been updated to make it more readable and fix minor typos. Each item now appears on a separate line, similar to other legends. Improved explanations are given for wall groups and wall length.

4. Component and Cladding Design Table (Bug 2885)

The following corrections have been made to the Components and Cladding design tables that show out-of-plane sheathing and nail withdrawal design:

a) Interior Walls on Same Line as Exterior Walls

When a shearline goes from the interior to the exterior of the structure, the program output a line of design results for walls that are on the interior of the structure and are not loaded.

Those lines would show zero nail withdrawal force but non-zero sheathing force. These lines have been removed.

b) Duplicate Entries for the Same Wall Group

The program output a line of data for each shearwall in a line, however showed results by wall group rather than by individual walls. Therefore there were duplicate lines when more than one wall on a line had the same wall design group. This has been corrected and the program shows only one line for each design group on a shearline.

5. Output of B_x for Torsional Irregularity (Change 154)

If there is a torsional irregularity (No 7), the program now outputs the B_x value that caused the irregularity, as defined in 4.1.8.11(9). It appears in a note under the Seismic Information table.

6. Design Code Clause in Irregularities Table (Change 152)

The notes to the irregularities table had the following mistakes, which have been corrected: 4.1.8.15-6 was changed to 4.1.8.15-4 ; 4.1.8.15-2 changed to 4.1.8.15-5, and 4.1.8.15-2 changed to 4.1.8-7.

7. Code reference for Gust Effect Factors in Log File (Change 166)

The NBC reference for gust effect factors C_g and C_{gi} have been corrected from 4.1.7.6 a) , 4.1.7.6 b) and 4.1.7.6 c) to 4.1.7.1.(6)(a), 4.1.7.1.(6)(b), and 4.1.7.1.(6)(c).

8. Panel Marking in Sheathing Materials Output (Bug 2808)

The panel marking in the notes to the Sheathing materials table was repeated over and over again for each wall that has that panel marking. It is now output just once.

9. Log File for Torsional Analysis Changes (Changes 138-141)

The following problems with the Torsional Analysis section of the log file have been corrected:

- The program output information at the head of the torsional analysis section of the log file about flexible analysis even if it was not done because there are no seismic loads.
- Flexible seismic design was still performed when it is not possible to do torsional analysis because of lack of shearwalls.
- The explanation about Flexible Seismic appeared of context at the top of the file log file section on torsional analysis, not on every floor as it should.
- The note for accidental eccentricity appeared for seismic even though it is about wind.
- The line for wind loads showed the building dimension perp to force and says that the accidental eccentricity is 10D when there was no eccentricity

10. Shear Design Table Legend (Change 172)

In the legend to the shear design table, the design code reference for O86 section 9.4.5.2 has been changed to Figure 9.4.5.2, the description of the F_v/V description has been clarified, and the reference to 9.5.1(a) has been moved from Shearlines to Walls.

11. Default Design Results View (Change 155)

When the Design Results button is pressed, the default view is now 'Preview' which shows a full page of design results, rather than "Wide View", which fills the horizontal extent of the window, usually zooming in on the top part of the page.

12. Blank Page in Output (Change 157)

The blank page that was print out at the end of the Design Results has been removed

13. Capitalization of Load Case (Change 142)

Changed e.g *Low-rise case A* to *Low-rise Case A*

Shearwalls 8.4 – Design Office 8, Service Release 4 – September 13, 2013

1. Update of Inputs Related to Hold-downs (Bug 2683)

When the *All shearwalls on shearlines have same materials* setting is selected, making changes to the *Hold-down*, *Double-bracket*, *Apply to openings*, *Number of end studs#*, and *Hold-down configuration* options in wall input view had no effect. The program merely reverted to the previously selected value. This has been corrected

2. Moving Wall Lines with User Applied Forces (Bug 2676)

Starting with version 8 of the program, moving a wall that is on a shearline with a directly applied shearline force caused the program to crash. This has been corrected.

3. Update of Unknown Nail Spacing Input (Bug 2667)

When *Both sides same* is selected, the edge spacing did not include the *Unknown* option, and this persisted for both exterior and interior side when the checkbox was deselected. This has been corrected, and *Unknown* is again allowed when both sides are the same.

4. Nonsensical Values for Anchorage Deflection (Bug 2677)

Under certain circumstances, the program reported extremely high negative values for anchorage deflection in the Hold-down displacement table. These unrealistic displacements were used in the calculations for deflection, creating nonsensically high deflections.

This has been corrected. It happened under the following circumstances:

a) Zero Force on Segment

When the distribution of forces within a line resulted in zero force on a segment, because other stiffer segments draw the entire load.

b) Negative Uplift

When there is no uplift force at a location, that is, the counteracting dead load and/or compressive force from above is greater than the overturning force.

Shearwalls 8.31 – Design Office 8 Service Release 3 – March 12, 2013

Please also consult the entries for version [8.3](#) below to view all the changes since the last version released to the general public.

1. Uplift Forces Shown in Hold-down Displacement Table (Bug 2641)

The values shown in the Hold-down displacement table for uplift force P were mistakenly showing forces factored for Ultimate Limit States (4.2.4.1), whereas deflection calculations use serviceability limit states (4.2.4.2). As a result, it was possible to have a positive load showing in the table, but zero shown as the elongation, because the serviceability-factored load is negative and not acting as an uplift load.

This has been corrected and the forces showing are those factored for serviceability limit states. Note that the value used for determining the amount of hold-down deflection is in fact ultimate

limit state, because it is compared to the hold-down capacity for ULS to determine the proportion of maximum elongation. Otherwise, all values used for hold-down displacement calculations are SLS.

The ULS values are shown in the Hold-down design table.

2. Serviceability vs. Ultimate Limit States in Table Legends (Bug 2641)

The legends to the following tables for wind design have been changed to make it clear whether loads and forces are factored for ultimate limit states (ULS), serviceability limit states, or unfactored, and whether they include an importance factor if otherwise unfactored:

Wind Shear Loads

Wind Uplift Loads

Wind C&C Loads

Shear Design

Deflection

Hold-down Displacement

3. Directionality of Uplift Wind Loads (Bug 2638)

a) Blank Input for Wind Uplift Force Direction

Starting with version 8.1, we allow the wind uplift forces to be entered for each wind direction separately, but by default, when an uplift load was selected, nothing appeared in the wind direction box. If you proceeded to enter the loads without selecting a direction, or both directions, then the wind uplift did not get included in the combined hold-down forces, and the separate wind uplift component of the hold-down force that was shown in elevation view and in the output report was unreliable.

In addition, a load entered with blank direction showed up as blank in the Load Input dialog edit field, *E->W* in the load list, and *Both directions* in the load list in the output report. In fact it acted as none of these

The default showing in this box is now “Both Ways”, and it is never allowed to be blank.

b) Display of Uplift Loads Entered in Both Directions

If a selection was made for the wind direction before adding the load, the combined hold-down forces were correct; however the uplift component appeared in elevation view for both directions, when it shouldn't have.

Different loads entered west to east and east to west (the usual case) were shown superimposed and thus garbled in plan view and in elevation view, along with the uplift components of the hold-downs.

These problems have been corrected.

c) Editing Wind Uplift Loads

The following problems in the *Load Input* screen used for editing existing loads were corrected:

All loads showed up in the load list as *E->W*, even if they were *W->E* or *Both Ways*. An *E->W* load selected showed the direction in the edit box as blank.

4. Restriction of Shearwall Materials when All Segments have Hold-downs (Bug 2625)

The program restricts the nail spacings available for selection to be at least 100 comply with O86 9.4.5.5 a) when you have indicated in the design settings you want the program to apply these material restrictions. However, it does so even when you have indicated in the Hold-down

configuration in Wall Input view that hold-downs are on all segments, so that J_{hd} cannot be less than one, as 9.4.5.5 stipulates.

It is likely that the program applies other restrictions on nail size and sheathing capacity in this case as well.

It was possible to get around this problem by changing the design setting so that materials are not restricted; however this affected all walls, even those that have anchorages.

This has been corrected and the program does not apply material restrictions to walls that have hold-downs on all segments.

5. Apply Load Change Message (Change 119)

After first entering the Load Input view, changing loads prompted you to apply changes when none had been made. This has been corrected

6. Seismic Load Generation Input Typos (Change 121)

The spelling of *Self-weights* has been corrected from *Self Weights*. The "Generate building masses first..." section title has been extended to fit the ellipses.

7. Getting Started Steps (Change 116)

The *Getting Started* dialog has been updated to reflect the current state of the program. The text shown for *Roofs* and *Generate Loads* has been changed and a new step, Step 14, *Log File Output*, has been added.

Shearwalls 8.3 – Design Office 8 Service Release 3 – Feb 27, 2013

This version of Shearwalls was released to only a limited number of users for use in a training seminar. The changes listed here are also in the [8.31](#) version of the program released to the general public.

A: Component and Cladding (C&C) Design

1. Update to CSA O86-09 for Sheathing Strengths for C&C Design (Bug 2628)

a) Plywood

The allowable Component and Cladding (C&C) plywood loads have been updated to new values from the CSA O86 2010 Tables 7.3A-7.3B, from the O86 2001 values that were being used.

The following materials have been added:

- 3-ply 12.5 mm and 6-ply 15.5 mm plywood, for both Doug-fir (DF) and Canadian Softwood Plywood (CSP).

For the following materials, allowable strengths have increased for at least one stud spacing:

- DF: 18.5 mm, 7 ply 0° (horizontal orientation);
- CSP: 3 ply 7.5 mm and 9.5 mm; 4 ply and 5 ply 12.5 mm; 5 ply 15.5 mm; 7 ply 18.5 mm; all 0°.

For the following materials, allowable strengths have decreased for at least stud spacing:

- DF: 4 ply 15.5 mm, 0°; 5 ply and 6 ply 18.5 mm, 0 and 90°.

- CSP: 3 ply, 9.5 mm, 90°; 4 ply and 5 ply 15.5 mm, 0°; 5 ply and 6 ply 18.5 mm, 0 and 90°.

Note that CSP 5 ply, 15.5 mm, 0° is in both lists because it decreased for 304.8 stud spacing and increased for 406.4 and 609.6 spacing.

b) OSB

The OSB Type 1 material has been removed, as it is no longer in CSA O86. It had been in table 7.3C

The Construction OSB values, which were in Table 7.3D, did not change for CSA O86 2010 Table 7.3C

2. Incorrect Sheathing Strength Values for C&C Design

a) 18.5 mm, 7 ply Doug Fir Plywood (Bug 2629)

In generating the allowable C&C loading on of horizontal Douglas-fir plywood 18.5 mm x 7 plies, an bending strength m_p' value of 100 n/mm/mm was used, instead of the correct 1100 from Table 7.3A, 0° orientation. The bending strength was correspondingly 11 times lower than it should be, and the allowable loads 7-11 times lower depending on stud spacing.

b) 9.5 mm 2R24 OSB (Bug 2631)

The allowable C&C load for 9.5 mm 2R24 OSB sheathing was 7.4 when it should have been 7.94. This has been corrected.

3. C&C Design Table in the Results Output

a) Nail Withdrawal Design Ratio (Bug 2637)

The design ratio in the Design Results output for nail withdrawal shows the end zone ratio for both end zones and interior zones. It now shows the correct ratios.

This problem did not affect design, as the end zone ratio is used for nail design.

b) Sheathing Strength Design Code Reference (Change 132)

In the legend a reference to CSA O86 Tables 7.3A-C was added, with an explanation of the bending and shear criteria used.

c) Precision of Imperial Nail Withdrawal Values (Change 130)

The number of digits precision for Imperial nail withdrawal force and capacity has been changed from whole pounds to 10ths of a pound.

d) Design Code Reference for Nail Withdrawal Capacity (Change 133)

The design code reference for nail withdrawal capacity was mistakenly showing 10.9.4, when it should be 10.9.5. This has been corrected.

B: Wind Load Generation

1. Interior Zone C&C Loads for the I-15 Method (Bug 2633)

Starting with version 8.2 of the program, for the I-15 (all heights) wind load generation method, the program was generating interior zone Component and Cladding (C&C) loads using the 1.2 C_p^* coefficient from Figure I-8 and end zone loads with the 0.9 coefficient when it should be reversed. These loads appear in plan view, elevation view, and the C&C table of the design results.

As a result, the program designed for nail withdrawal for lighter than expected end zone loads, but may show a failing design ratio in the output for the heavier than expected interior zone

loads. It conservatively designed for sheathing strength using heavier than expected interior loads.

2. C_p and C_g Factors in the Log File for I-15 Method C&C Design (Bug 2635)

a) Combined vs Separate C_p and C_g

The Component and Cladding (C&C) loads for the NBC Commentary I - 15 method in the log file showed a combined pressure coefficient and gust factor $C_p C_g$, when in fact they are separate factors, similar to the main shear force resisting system (MWFRS) factors for this method. They are now shown as separate C_p and C_g factors.

The combined internal factor $C_g C_{pi}$ is also now shown separately as C_{gi} and C_{pi} .

b) Inclusion of Internal Factors in External Factors

The factor showing was the difference between external and internal forces (NBCC 4.1.7.1 3), which was contradicted by the legend to the table. It now shows the external coefficients only (4.1.7.1 1).

c) Inclusion of C_e for Internal Factors

The combined internal factor mistakenly included the value of exposure factor C_e for internal pressures, but this has been resolved by splitting the combined factor up.

3. Wind Load Generation Log File Legend (Bug 2635)

The legend in the log file which defines the symbols used for wind load generation procedures has been improved in the following ways

- Separate legends for I-7 and I-15 wind load generation methods (Change 131)
- Design code references have been added for all symbols from NBCC and the Commentary
- Combined pressure coefficient and gust factor no longer given for I-15 procedure, replaced by separate definitions of C_p and C_g factors.
- Separate definitions for internal and external factors
- Explanations of load Magnitude and Start and End given
- Separate table header for C&C load items which differ from MWFRS items. They are no longer indicated by asterisks and a difficult-to-spot note.
- Now indicates that velocity pressure is one in fifty year pressure.

C: Load Distribution

1. Accumulation of Direct Shearline Force for Seismic Design (Bug 2630)

Starting with Shearwalls version 8, when a seismic direct shearline force was applied to a shearline, the program did not include that force in the rigid diaphragm design shear. The direct forces did show up in both plan view and elevation view, but not accumulated with forces on the line from the generated loads, so the numbers overlap. This has been corrected and the seismic direct shearline forces are once again included in the design shear force.

2. Distribution Method for Seismic Direct Shear Forces (Bug 2632)

Starting with version 8.1 the Distribution Method control in the Load Create and Load Edit dialog boxes was disabled and showing *Both* when entering or editing manually entered seismic direct shear forces. This has been corrected and you can again distinguish between rigid and flexible distribution methods when adding a direct shearline force.

Shearwalls 8.2 – Design Office 8 Service Release 2 – January 9, 2013

A: Force Distribution and Engineering Design

1. Elevated Dead Load Magnitude and Reduced J_{hd} Factor (Bug 2565)

Starting with version 8.11, dead loads over openings did not accumulate properly, creating two sets of overlapping loads in load view over openings, with a load used for hold-down creation and J_{hd} calculation that is much too large. Therefore, there is too heavy a countervailing dead force at hold-down locations, and the J_{hd} factors that are calculated via 9.4.5.2,3 are significantly too small, as J_{hd} is directly related to hold-down force P . Both of these are non-conservative errors, and have been corrected.

2. Non-wall Dead Loads Treated as Wall Dead Loads (Bug 2571)

Entering a dead wall load caused subsequently entered dead loads to be treated as dead wall loads, even if the checkbox for wall dead loads is not checked. As a result, the uplift restraining force P in 9.4.5.3 for hold-down factor J_{hd} did not include these loads, resulting in a smaller than expected P and larger than expected J_{hd} , a non-conservative error. This equation is used wherever an anchorage exists above a hold-down. This problem has been corrected.

3. Nail Slip Deflection of Unloaded Gypsum Wallboard (Bug 2577)

When the constant nail slip deflection for gypsum wallboard (GWB) is so much greater than the deflection for the wood side that it draws no load, the program was still assigning the constant nail slip deflection to GWB. As a result, the deflection of the shearline was much greater than it should be, and its stiffness is much less, causing it to draw less loading under rigid diaphragm distribution or when loads are distributed to dissimilar materials along a shearline. This happened most often under low loading conditions, and has been corrected.

4. OSB Shear Deflection Values for Deflection Design (Bug 2582)

For the OSB construction sheathing thicknesses other than the smallest for each panel marking, the program used zero for shear deflection rather than the actual shear deflection. The program now gives the correct shear deflection in this case.

5. Segment Shear Value in Deflection Table when Both Sides Same (Bug 2584)

When there is the same sheathing on both sides of the shearwall, the v value reported in the deflection table is the shear going into just one of the sides, so it is in fact $\frac{1}{2}$ the total shear applied to the segment. The resulting deflections calculated are correct; however the program was showing a misleading shear value. The program now shows the total shear going into the segment in this case.

6. Shear Deflection for Custom Sheathing Thicknesses (Bug 2585)

If you type in a sheathing thickness rather than a standard one, the shear deflection was set to zero. This has been corrected and the program now uses the deflection for the next smallest sheathing.

7. Nonsense Hold-down Values at Gable End of Monoslope Roof (Bug 2509)

When there is a monoslope roof, the hold-down calculations at the gable end yielded nonsense values indicative of a divide-by-zero situation. These hold-down forces appeared in all output and were used in the design of hold-downs at these locations. This has been corrected.

8. Crash for Walls Spanning Multiple Blocks at Gable End (Bug 2510)

When all of the following criteria are met

- A wall is directly under a gable end
- The wall spans more than 1 block
- The last block in the block list doesn't have any sides that are collinear with the wall

The program crashed when performing load and force distribution. This occurred regardless of whether there are actually any loads on the structure. This sometimes happened when loading a file and the program proceeds to the load view stage.

9. Torsional Sensitivity Seismic Irregularity Detection(Bug 2523)

The torsional sensitivity irregularity for rigid seismic design (NBCC 2010 Table 4.1.8.6 Irregularity Type 7), was not being detected when it should have been. The program was mistakenly comparing the deflections due to positive and negative torsion for each outer edge shearline. It should have been comparing the deflections of the opposite outer edge shearlines, and is now doing so.

The incorrect calculations would rarely result in a torsional irregularity being detected.

10. Irregularity Message Typo (Change 128)

The message that appears when seismic irregularities 4-6 are detected has been corrected to refer to *APEGBC* instead of *APERGBC*.

D: Load Generation

1. Base Shear due to Manual Building Masses on North-South Lines (Bug 2518)

When a building mass is manually added to a North-south shearline, the seismic load from the resulting mass did not contribute to base shear on the structure, creating lower-than-expected forces distributed to the building levels. However, the seismic load from the building mass is created, using the base shear computed without the contribution of that load. Furthermore, when any seismic load is entered manually, it is not included in the base shear to be distributed to the rest of the building. This is not incorrect, but has been made more evident to the user via a note beneath the seismic information table and in the log file.

2. External Pressure Coefficients for Wall Loads (Bug 2595)

Starting with version 8.11 of the program, instead of the expressions for external pressure coefficient, C_p , based on height to depth ratio from NBCC 2010 Figure I-15, the program always used the value of 0.27 in the range $0.25 < H/D < 1.0$, resulting in loading that was less than half of what it should be. This has been corrected and the program uses $0.27(H/D + 2.0)$ for windward walls and $-0.27(H/D + 0.88)$ for leeward walls.

Note that for buildings in these ranges are ordinarily designed using the low-rise method, I-7, but Shearwalls does not use this method for multi-block structures, and it is likely not be used for flat roofs, so this problem is likely to have occurred for these types of structures.

3. External Pressure Coefficient for Leeward Roofs (Bug 2596)

Because NBCC Figure I-15 is only applicable to flat-roofed buildings, a decision was made to apply the external pressure coefficients for walls, C_p , to the vertical projection of roof panels.

However, the coefficient applied to leeward roofs was not following the wall coefficient calculation based on height to depth ratio. Instead it was using the worst case leeward wall coefficient, -0.5, resulting in heavier-than expected loading for h/d ratios less than 1. This has been corrected and the program is applying the coefficients 0.27(H/D) for $0.25 < H/D < 1.0$ and 0.3 for $h/d < .25$. Note that for buildings in these ranges are ordinarily designed using the low-rise method, I-7, but Shearwalls does not use this method for multi-block structures, and it is likely not be used for flat roofs, so this problem is likely to have occurred for these types of structures.

11. Low Rise Wind Loads Due to Note 8 for Positive $C_p C_g$ Coefficients (Bug 2550)* *corrected for Canadian references and terminology*

Low-rise wind loads due to Note 8 of Structural Commentary Figure I-7, that specifies zone 3 loads on a portion of a zone 2 windward roof, were being generated for high angles with positive Zone 2 co-efficient $C_p C_g$ when they should be limited to low angles with negative $C_p C_g$. The resulting zone 3 loads have a negative coefficient that combined with the loads with a positive zone 2 coefficient to reduce the total load on the roof, creating non-conservative wind loading. This has been corrected.

4. MWF Wind Loads All-heights Coefficients in Log File (Bug 2501)

The $C_p C_g$ coefficient shown in the log file for main wind force resisting system loads for the all-heights wind generation was divided by the C_e factor when it should not have been. This has been corrected.

5. All-heights Co-efficients for Walls Extending Between Blocks (Bug 2473)

When a building is made from multiple intersecting blocks, the program creates two walls along one of the sides of an "L", but only one wall along the side of another. The two walls are assigned to different blocks for wind load creation, but one the one wall extending between two blocks and until now was assigned to only one block for wind load generation. When this occurs you have no way of splitting the long wall up and manually assigning different blocks to the separate walls. This also occurs when you manually joined walls from separate blocks.

This could create incorrect wind loads for blocks with radically different height-to-width ratios, for example, that a wall extends from a one-storey block to high one with several stories. It has been corrected and the program internally splits the wall up and assigns the co-efficients from the correct blocks to the walls.

Refer to an explanation in the Help files, under Canadian wind load procedures, for a picture and more details.

E: Data Input

Note that the version of this document originally included with Shearwalls 8.2 mistakenly included two changes that have since been removed: Apply Load Change Message (Change 119) and Seismic Load Generation Input Typos (Change 121).

1. Standard Wall Relative Rigidity (Bug 2522)

The "Relative Rigidity" input for Standard walls was not reflected in the individual walls' relative rigidity. The program now considers relative rigidity field when comparing walls to see if they match standard walls.

2. Bolt Diameter Input in Hold-down Database for Decimal Imperial Formatting (Bug 2517)

When the Thickness Imperial formatting setting is set to Decimal, then the list of bolt shaft diameters in the Hold-down database input shows nonsensical values like "1/1". If you select one of these, or attempt to enter a value like .45, the program converted it to 0, 1, or a nonsense value the next time the box is opened. This has been corrected.

3. Hold-down Database Message (Change 116)

The message indicating that one hold-down had to be completed before another selection had a grammar error.

4. Apply Load Change Message (Change 119)

After first entering the Load Input view, changing loads prompted you to apply changes when none had been made. This has been corrected

5. Seismic Load Generation Input Typos (Change 121)

The spelling of *Self-weights* has been corrected from *Self Weights*. The "Generate building masses first..." section title has been extended to fit the ellipses.

6. Arrange Icons Menu Item (Change 129)

The *Arrange Icons* menu item was removed from the *Windows* menu as it was obsolete and had no function.

F: Text Output

1. Wind Load Importance Factor for Deflection (Bug 2576)

The program now indicates in the legend to the deflection table that the shearline forces are multiplied by the ratio of the serviceability to strength importance factors, or in the case of Normal importance, 0.75. For this case, the shearline force that appears in the table is a factor of 0.75/1.4 less than the strength force (1.4 being the wind load factor.) Since the legend did not indicate that it is factored, some users expected it to be just 1/1.4 times the shearwall design force.

2. Log file for Wind Generation (Changes 115,124.142)

The output of wind loads for the log file has been updated as follows:

- NBCC references have been added to each equation.
- The *Iw* in the Site information has been expanded to *Importance factor: Iw*.
- Spaces have been added to pressure equations to make them more readable.
- For Fig I-15 generation method the following changes have been made:
 - The columns and legend entries for the low-rise values windward corner, Case A or B, and slope have been removed;
 - The combined CgCp column has been separated into individual columns for Cp and Cg, with corresponding changes to the legend. For C&C loads, the combined CgCp value is output between the Cg and Cp columns.

3. Log File output of Area Load Magnitude (Bug 2483)

The magnitude of C&C loads and MWFRS loads created as area loads showed up as zero for metric output and a very small number like 0.1 for imperial output. They are now shown as they appear on the screen, with numbers like 0.455 kN/m² or 24.3 psi.

A line has been added below the table saying "Magnitudes are area loads for C&C and line loads for MWFRS loads" or "Magnitudes are area loads", depending on how the loads were generated

4. Precision of Design Shear Values in Shear Results Output (Bug 2495)

Starting with version 8, the design shear values in pounds per linear foot, Fv/L, appear in the shear results table as whole numbers. Previously they had 0.1 plf accuracy, which has been restored.

5. ASD Typo in Hold-down Displacement Table (Change 118)

In the hold-down displacement table, it now says ASD, not ADS, when referring to load combinations

6. Bending Term in Deflection Table Legend (Change 127)

In the legend for to the deflection table, the numerator to the expression for the bending term started with a 2 when it should have been a 3. The correct equation was used for design; this is just an output typo.

General Program operation

Note that the version of this document originally included with Shearwalls 8.2 mistakenly included the change Getting Started Steps (Change 116) that has since been removed.

1. Failure to Open a Project File (Bug 2088)

Periodically the program issued an "Unexpected file format" or "WoodWorks has stopped working message" when opening a project file. When this occurred the file could not be used and if there was no backup file, then the project had to be reconstructed. This has been corrected.

2. Back-up Files (Change 123, Feature 203)

The program now saves two files to the Windows 7 folder

C:\Users\[username]\AppData\Local\WoodWorks\CWC\Canada\8 – BackupPre.wsw and BackupPost.wsw. The first of these saves a project file immediately before design or load generation, the second saves the file after design or load generation.

These files are accessed in the following situations

- if an unsaved file is lost after a successful design or load generation is made, for example by an automatic system reboot. Either file can be used for this.
- The file BackupPre is used to record the state of the program before design/generation, so that if a fatal error occurs during one of these processes, you will have a file to send WoodWorks technical support for diagnosis. In most cases, this file cannot be used to continue work, as the error will likely occur again on the next design.
- The file BackupPost is used to continue work if an error occurs during design or load generation, or at any other time. It will return you the state you were in when the last successful design or generation occurred. Then you can try to remake the changes you made to your structure, and it is possible the error will not re-occur. If it does, contact Woodworks Technical support and they will try to diagnose the problem and find a work-around.

The folder that these files are saved to in Windows XP is C:\Documents and Settings\[username]\Local Settings\Application Data\WoodWorks\CWC\Canada\8\.

Shearwalls 8.11 – Design Office 8 Service Release 1 – May 22, 2012

Some of the changes listed below first appeared in [Shearwalls 8.1](#), which was released as an Educational version only. These changes are indicated by *Version 8.1* in the change name line

A: Engineering Design

1. Crash on Design with Non-shearwalls (Bug 2395 – Version 8.1)

In some cases, the program crashed when designing a structure that has a non-shearwall and deflection design is enabled. This has been corrected.

2. Wall Height at Gable Ends for Hold-down Force Calculation (Bug 2465)

In order to include the portion of an end wall that is beneath a gable end as part of a shearwall, for the purpose of hold-down force calculations, the program now calculates the wall height at a gable end as being the distance from the base of the wall to the height of the sloping roof at the end of a wall segment.

The average of the heights at both ends of the segment under a gable end is used as the moment arm h in the hold-down force calculation $R = vh$, where R is the hold-down force and v is the shear per unit foot directed horizontally. Previously the height of the upper level was used as the wall height. Refer to the Shearwalls Help topic *Hold-down Forces* for further explanation.

3. Creation of Wall Groups due to Hold-down Data (Bug 2323)

The program created wall design groups based on hold-down information such as "number of brackets", hold-down type, and number of end studs. It no longer does so for the following reasons:

- The *Sheathing and Framing Materials* output does not show these values, so there was no evident difference between wall groups.
- These parameters do not affect design of the wall, just deflection
- These parameters differ from other wall group parameters in that they can be different for different walls on the line when "dissimilar materials" are not allowed. Therefore a line would have two groups designed for it, and only one of these was used for design.
- The default hold-down configuration is to have single bracket on first level and double on others, so by default wall 2 wall groups were made even if all materials are the same.

4. Negative Jhd Factor for Hold-downs on All Walls (Bug 2445)

For a particular project, two walls on one level were not designed, so that the program showed vertical elements rather than wall ends at the hold-down locations, the hold-downs were not designed, and a spurious message regarding a negative J_{hd} appeared. Upon examination, this problem was caused by incorrect conversion of joist spacing when toggling between metric and imperial modes. This has been corrected.

5. Inclusion of Gypsum Capacity for Tall Walls (Bug 2447)

When using imperial units, if the height of a wall was greater than > 3.6 m with gypsum sheathing, the capacity of the wall was not zero as it should be according to CSA O86 Table 9.5.4 note 2. When using metric units, the capacity was zero as it should be. This has been corrected.

6. Extraneous Message when Running a Design (Bug 2439)

In some rare instances, when running a design you get an inaccurate message saying that due to a change in the structure, the last design is no longer valid, and asking you to design again. If you choose to design again, the design proceeds without a problem. This problem has been corrected.

7. Irregularity Check Warning (Change 110 – Version 8.1)

The NBCC reference in the Type 4 - In-Plane Stiffness irregularity check warning message has been updated to refer to sentence 4) of 4.1.8.15 instead of sentence 6). This message is output when the lower storey within a vertical discontinuity has a lower capacity than the storey above. Also, the spelling mistake in the word *Stiffness* has been corrected.

B: Loads and Load Generation

1. Wind Uplift Load Directionality (Feature 115)

The program now allows you to specify the direction for wind uplift loads, that is, the lateral direction of wind force with which the uplift load is associated. Therefore you can enter uplift loads that correspond to the uplift coefficients for the windward and the leeward surfaces in NBCC Figure I-7 for low rise loads and Figure I-15 for all heights. Previously the one wind uplift load applied to a surface would be used for both the windward and the leeward cases. This involved the following program changes:

a) Input

The *Wind direction* input is now enabled and allows you to choose either direction or *Both*, similar to a *Wind shear* load.

b) Graphics

In the *Plan View* and *Elevation View*, the wind uplift force is only drawn if the direction of the uplift force matches the direction of load direction selected in the *Show* menu.

c) Hold-downs

Different uplift forces are used to create combined hold-downs at the same location for different force directions. These appear in the *Hold-down Design* table.

d) Output

A *Direction* column was added to the *Uplift Loads* table,

2. Building Mass Generation for Separate Floors (Bug 2386 – Version 8.1)

When self-weights were entered in stages for several levels of the structure, and building masses and loads generated at each stage, the loads due to the lower portion of the wall mass from the storey above were not included in the calculation if the loads were generated from top to bottom. Similarly, the loads due to the upper portion of the wall mass from the storey below were not included twice in the calculation if the loads were generated from bottom to top.

Furthermore, the calculation of total building mass used only the masses from floors that had already been generated, leading to a different result than if the loads had been generated all at once.

These problems lead to significantly non-conservative loading when the loads are generated in stages, particularly when it is done from top to bottom of the structure.

They have been corrected and the program now generates the correct seismic loads when building masses are generated in stages. Note that the seismic loads that are generated for a

particular level after the entire structure is complete will be different than those at an intermediate stage, because of the difference in total building mass. The loads generated at the intermediate stages should not be used for design.

3. Low Rise Wind Generation for Multiple Blocks that are Deleted (Bug 2430)

When walls were created using multiple blocks, then all but one of the roof blocks are deleted, the program considered it a single block building when deciding whether low-rise wind loads were allowed. The program used the walls created from only one of the original constituent blocks to determine the height to width ratio, and disallowed buildings that should be allowed. If the one block used had an allowable h/w ratio, then the program generated wind loads on only the walls on that block, and not on the rest of the building. Now, if multiple blocks are used to create the walls, wind loads cannot be generated for low-rise load design, and you are alerted with a message.

4. All-heights Wind Load Coefficients

The following changes apply to the implementation of the NBCC Structural Commentary Figure I-15 method for “high-rise” structures, that Shearwalls uses on all structures for which the low-rise method is not permissible.

a) All-heights Pressure Coefficients C_p for $H/D < 1$ (Bug 2469)

The program now applies the wall pressure co-efficients C_p given in Figure I-15 when the height-to-depth ratio is less than 1.0. Previously it was using the maximum values, that is, those for $H/D > 1$ regardless of the dimensions of the building. This created conservative loading by as much as 33% for windward walls and 66% for leeward walls. The “D” used is the depth of the building block that the wall or roof panel was part of when the walls or roofs were originally created. The H used is the eave height for walls and the ridge height for roofs. Refer to 5b) below, for the depth used for irregular structures.

b) Interior Zone Local C&C Coefficients (Bug 2480)

The program now implements the local coefficients ± 0.9 for component and cladding (C&C) loads on windward surfaces. These coefficients apply to sheathing and nailing design, as they are intended for components roughly the size of a window according to Commentary I-29. Previously the program was using the coefficient -1.0, from the 1995 NBCC.

c) End Zone Local C&C Coefficient (Bug 2480)

The program now implements the local coefficients -1.2 for C&C loads on the end zones of windward surfaces. These coefficients apply to nailing design, as they are suction forces. Previously the program was not using separate end zone wind pressures for nail withdrawal, or showing them in the plan or elevation view.

d) $C_p C_g$ Value for C&C Loads in Log File (Bug 2480)

The combined pressure and gust $C_p C_g$ coefficient shown in the log file for all-heights C&C loads for the all-heights method did not correspond to the C_p coefficient multiplied by the C_g factor; instead included the C_e factor as well. This has been corrected.

e) C_e Value for C&C Loads in Log File (Bug 2480)

The exposure factor C_e in the log file for all-heights C&C loads was always shown as 1.0. The correct factor now appears.

5. Structure Height-to-width Ratio

a) Building Width for Low-rise Restriction (Change 112, Bug 2466)

When determining the height-to-width ratio of the structure for use in the low-rise load restriction in NBCC Structural Commentary I-26, that is, height/ width < 1, the the smallest of the two plan dimensions of the storey with the largest such dimension is now used as the width.. Previously the smallest plan dimension of the smallest storey was used, leading to situations whereby this ratio might be determined by a small penthouse. Judgement must now be exercised in using this method for a structure that has an extensive one-storey base with a narrow multi-storey tower above.

b) Building Depth for All-heights C_p (Change 112, Bug 2466)

In determining H/D for Commentary Figure 1-15, the program uses the storey with the largest plan dimension. Note 1 to Figure 1-15 says to use the dimension of the building at the base, which in almost all cases will be the largest storey.

c) Application of All-heights Restriction (Bug 2432)

When generating wind loads using NBCC Commentaries I-15 all-heights design procedure, if the structure has a height-to-width ratio greater than 4, the wind loads were generated even though NBCC 4.1.7.2 states that dynamic analysis is needed, so that the methods currently in *Shearwalls* are not applicable. (Dynamic analysis was not implemented due to the rarity of such buildings that also adhere to height restrictions for wooden buildings.) Now, an error message is displayed and the wind loads are not generated for height to width ratios greater than 4.

d) Building Width for All-heights Restriction (Bug 2466)

When determining the height-to-width ratio of structures with unevenly sized storeys for the purposes of the I-15 all heights restriction, the program now uses the procedure given in 4.1.7.(3), that is, $w = \sum h_i w_i / \sum h_i$, where h_i = height above grade to level i ; and w_i = width at height h_i .

e) All-heights vs. Low Rise Building Width

Note that the building width definition in 4.1.7.2 (3) when considering the applicability of dynamic analysis to all buildings is not used for low-rise height-to-width ratios because the NBCC Structural commentaries in Figure 1-1 assign two separate symbols to these dimensions, w , and D_s , respectively, and they have different descriptors – the minimum building width in each wind direction, and the smallest plan dimension in each direction.

6. Multi-block All-heights Warning Message (Change 113)

A warning message has been added for the case that the NBCC Commentaries I-15 all-heights design procedure is used with multi-block structures, explaining that the program is for buildings with rectangular plan.

7. Precision of Velocity Pressure q in Log File (Change 114)

In the log file, the precision of the velocity pressure (q) output in kPa units has been increased from 1 to 3 digits. Velocity pressures are published to two digits precision, so the program was rounding the input precision. Three digits accommodates users who interpolate between locations.

8. Log File output of Area Load Magnitude (Bug 2484)

The magnitude of C&C loads and MWFRS loads created as area loads appeared in the log file as zero for metric output and a very small number like 0.1 for imperial output. They are now shown as they appear on the screen, with numbers like 0.455 kN/m² or 24.3 psi. A line has be added in the output saying "*Magnitudes are area loads for C&C and line loads for MWFRS loads*" or "*Magnitudes are area loads*", depending on how the loads were generated.

C: Data Input and Program Operation

1. Standard Walls

The following problems with the operation of the Standard Wall input were introduced with Version 8 of the program, unless otherwise noted:

a) Saving Newly Added Standard Walls (Bug 2365– Version 8.1)

When adding a new Standard Wall you could not save the new standard wall unless you had selected an existing standard wall as the basis for the new wall. If you had selected a standard wall as a basis, the material, species and grade fields are not initialized and must be edited in the Edit Standard Walls view before exiting the view. If this is not done then you would lose any standard walls that you had created in any session and Shearwalls reverts to using the original set of standard walls. These problems have corrected.

b) Non-blank Fields when Adding New Standard Wall (Bug 2367– Version 8.1)

Originally, when creating a new standard wall, the program would blank out all material input fields, forcing the user to choose each one in turn. After choosing one, it would only trigger the selection of another one if there was only one choice for that input. This functionality became successively degraded with each release, and an increasing number of fields became either non-blank from the start, or become selected when another controlling field is selected. Other fields, however, remain blank, creating an inconsistent look and behaviour. All fields now remain blank, if there is more than one choice, until you select each of them in turn.

c) Standard Wall Identification (Bug 2418)

In *Wall Input* view, the program did not always identify walls that are created identically to an existing standard wall as being that standard wall, because of inaccuracies concerning the stud thickness and depth. For example, this would occur when the width or depth were changed, than changed back to those for the original standard wall. This has been corrected.

d) Standard Wall Default Setting (Feature 139)

Because the default standard wall selected in the *Default Settings* applies only to the walls created from the blocks when first entering *Wall Input* view, the name of the *Standard Wall* data group box has been changed to *Standard wall for exterior footprint*. A note has been placed in the box explaining that new interior walls depend on what is selected in *Wall Input* view.

2. Stud Width and Thickness

The following problems with the new inputs for stud thickness and width in *Wall Input* view were corrected

a) Conversion of Custom Stud Width and Thickness (Bug 2410)

When you entered your own width or thickness (rather than selecting a value) this number was divided by 25.4 before being used in design, and the smaller value appeared when you entered the view again. This resulted in very large deflections due to bending, and correspondingly low wall stiffnesses. It could also skew the distribution of loads to shearlines and within a line in a way that could be conservative or non-conservative for shearwall design. The unit conversion causing this problem has been corrected.

b) Stud Thickness and Depth Unit Label (Bug 2415)

While in Wall Input view, if you changed from imperial units to metric units or visa-versa, then the unit label of the stud thickness and depth were displayed in the original units, not the units switched to. It would remain that way until any other operation was done in this view. The correct units now appear in all circumstances.

3. Legend Checkbox in Options Settings (Bug 2398– Version 8.1)

The following issues with the operation of the Display Legend item in the Options Settings have been corrected.

Control of Material Specification

Turning this option off also controlled the sheathing and framing materials as well as the legend in Elevation View, even though there are separate options the material specification. Now it controls only the legend.

a) Plan View

A legend option has been added to control the display of the legend in Plan View.

b) Position of Legend Checkbox

The legend option no longer appears between the similar options sheathing and framing, it appears below them.

4. Hold-down Settings Dimensional Units (Bug 2468)

a) Retention of Precision

The values input into the Hold-down Settings box could lose precision when updating after the following operations

- After being saved as a default for new files
- Being converted between imperial and metric
- In some cases, upon re-entering hold-down settings view
- On the case of the over-rides, immediately after entering the data

These problems have been corrected, and in general values appear to 1/10 of a millimetre and 1/1000 of an inch, however the program will show even millimetre amounts without the decimal, and will remove all but one trailing zero after the decimal place for inches. If more precise values are entered, they will be retained internally, but will be replaced by the rounded value if view is re-entered and another value is modified.

b) Bolt Hole Tolerance

In metric units, the default bolt hole tolerance would sometimes appear as 0.0625 mm, that is 1/16th of a millimetre. It is meant to be the metric equivalent of 1/16" . This has been corrected.

5. Spin Controls for Building Levels in Generate Loads Input View (Bug 2387 - Version 8.1)

The spin controls beside the *Building Level* inputs in the *Generate Loads* input form went missing, so that you had to type in a value instead of scrolling to it. They have been restored.

6. Deflection Analysis Setting Update (Bug 2327)

In *Design Settings*, the default values of the *Shearwalls Rigidity* options were not being reset when the *Include deflection analysis* checkbox was reselected. Now, if you choose to do deflection analysis, *Use shearwall deflection to calculate rigidity* and *Distribute forces to wall segments based on rigidity* are automatically selected.

7. Version Number in Program Name (Change 111)

Shearwalls now has the version number in the name of the program that appears in the program title bar, and over icons that appear in the start menu. This enables you to quickly identify the version of the program you are running.

8. Streamline Network Version Setup (Design Office Feature 8)

The procedure to set up multiple users running the program from a network server has been streamlined, as follows:

a) Copying of Shearwalls.ini file.

Previously, you had to manually copy a version of the *Shearwalls.ini* file to all the client machines. The program now does this automatically.

It is still necessary to modify the Sizer.ini in the server to indicate it is a network version and give the location of the program on the server. A new step is required, to copy the files from the *Program Data* area of the server for *All Users* to the corresponding folder in the *Program Files* area of the server. In other words, the *Shearwalls.ini* file on the server will be found in one of the following locations

```
Windows 7 - C:\ProgramData\WoodWorks\CWC\Canada\8\  
Windows XP - C:\Documents and Settings\All Users\Application  
Data\WoodWorks\CWC\Canada\8\  

```

After modification, it has to be copied (not only moved) to the following location, if the default installation was selected:

```
C:\Program Files (x86)\Woodworks\Cdn\Sizer\  

```

The advantage of this approach is that the file has to be copied only once, and within one machine, rather than distributed to several machines.

b) Modification of Database.ini File

With the introduction of new locations for database and setting files with Version 8, the network installation required you to modify the file Database.ini by indicating it was a network installation. This is no longer necessary.

c) Instructions in "Read Me" File

The instructions in the Shearwalls *Read Me* file have been modified to explain the new procedure. In addition, the following corrections have been made:

- The instructions regarding key code security instruct you to contact WoodWorks sales, rather than using a key code that is delivered with the software.
- Instructions were given for those users who wish to modify the database files on their local machine using Database Editor on the server. These have been removed, as this procedure is not possible.

D: Output and Graphics

1. Interior Non-shearwall Material Information in Elevation View (Bug 2352)

For interior non-shearwalls, or for exterior non-shearwalls for seismic-only design, known material input was showing up as *Unknown* in the elevation view material output. Now, if material input is defined for an interior or seismic non-shearwall, then it shows up in the material information. If the inputs are left as unknown, they appear as unknown as there is no design for interior or seismic non-shearwalls.

Note that if shearlines are not restricted to *All walls the same* and there is more than one non-shearwall on a shearline only the material information for the southernmost or westernmost non-shearwall is shown.

2. Floor Joist Length in Elevation View(Bug 2383)

In *Elevation* view, for a multi-storey structure with an upper storey overhanging the storey below, the floor joist of the upper storey did not extend below the overhanging upper storey but only to the end of the storey below. The overhanging portion of the upper storey was therefore without a floor, and vertical elements supporting it had a gap between the top of the element and the supported portion of the building.

The program now draws the floor based on the length of the wall above. Now an end portion of a wall that has no wall above it will no longer show a floor area above it. Such a wall may or may not in reality have a floor area; it could support a sloped roof instead.

This is a display issue only that has no effect on load distribution or design.

3. Overlapping Hold-down Forces at Vertical Elements in Elevation View (Bug 2389)

When compression and tension hold-down forces are distributed downwards by a vertical element, these forces shown in *Elevation* view at the bottom of the element were drawn overlapping each other. Furthermore the arrowhead for compression hold-down force in these locations was often drawn within the joist depth rather than outside it as it is usually drawn. This problem has been corrected and the compression and tension forces are shown on either side of the bottom of the vertical element, with a compression arrow of the correct size.

4. Overlap of Structure and Legend/Materials In Elevation View (Bug 2405– Version 8.1)

In *Elevation* view, lower portions of the wall elevations often overlapped with the legend and materials specification. These problems were more noticeable in *Selected Walls* mode, and for deep joist depths on the first level being drawn. This has been corrected.

5. Wall Name in Shearline, Wall and Opening Dimension Table (Bug 2420)

In the *Shearline, Wall and Opening Dimension* table, the wall name had a extraneous, trailing number indicating the building level, for example if there are two walls on a shearline on the first floor they are named A-2-1 and A-1-1. The extra "-1" on the end was removed.

Shearwalls 8.1 – Design Office 8 Service Release 1, Educational Version – February 3, 2012

This version of Shearwalls was released as an Educational version only. The changes made for this version are listed in the later [Shearwalls 8.11](#) release, with *Version 8.1* indicated in the change name line.

Shearwalls 8.0 – Design Office 8 - November 14, 2011

This is a major upgrade to the software, containing several extensive new features and many small improvements. The most significant new features are

**Update to the [NBCC 2010 Design Code](#) and [CSA 086-09 Standard](#)
**Database of [Hold-down Connections](#) and [Hold-down Design](#)
**Shearwall Deflection Analysis for [Storey Drift](#) and [Stiffness-based](#)
Load Distribution
Iterative Load Distribution and Design of Shearwalls******

Here is an index to all of the changes to the program. Click on any of the items to go to the description of the feature or change.

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A: Update to CSA 086-09 from CSA 086-01

1. CSA O86 Design Standard

The program has been updated for the CSA 086-09 *Engineering design in wood* design standard. The previous version was based on CSA 086-01.

The 086-09 implemented is the 2010 reprint that includes Update No. 1.

These changes are reflected in the program Welcome box, the Building Codes box, and the About Shearwalls box.

2. Deflection of Shearwalls

The program now implements the new shearwall deflection requirements given in 9.7. The details are given in D: below, Deflection Analysis, with relevant changes also in C: Hold-down Connections and **Error! Reference source not found. Error! Reference source not found.**

Note that several of the following changes depend on the seismic load generation value $I_E F_a S_a(0.2)$. I_E , F_a , and S_a are defined in NBCC 4.1.8.5(1), 4.1.8.11(6), and 4.1.8.4(1), respectively. It is shown above the Seismic Irregularities table.

3. Over-capacity Coefficient*

The program checks the over-capacity coefficient from CSA O86 9.8.3.1 for structures three or more storeys in height and when $I_E F_a S_a(0.2)$ is greater than or equal to greater than 0.35, as per 9.8.1.

The shear capacity and over-capacity ratio of each floor has been added to the Seismic Information table for each floor and direction. The storey shear shown is now the vertically accumulated shear used for shearwall design rather than the single storey shear distributed to each floor during seismic load generation. (The single storey shear can still be found in the log file under seismic load generation.)

The ratio of overcapacity for level 2 to level 1 is shown at the bottom of the table. A note below indicates that it is within the acceptable range of 0.9 and 1.2, a warning is issued if it is outside that range.

**This description modified in March, 2013.*

4. Hold-downs in High Seismic Zones

When $I_E F_a S_a(0.2)$ is greater than or equal to greater than 0.35, as per 9.8.1, seismic hold-down forces based on applied loads are increased 20% as per 9.8.2. The legend under the Hold-down Design table has been revised to reflect this.

a) Capacity vs Applied Load

This factor is not applied if shearwall capacity is used to create hold-down forces, rather than applied loads. However if 1.2 x applied load is greater than shearline capacity, that value is used and a note below the Hold-down design table indicates this.

b) Elevation View

The legend in Elevation view shows the 1.2 factor and 9.8.2 reference when it is applied

9. Seismic Drag Strut Force Factor

Seismic drag strut forces based on applied loads are increased 20% as per 9.8.6. Note that this is *not* contingent on the value of $I_E F_a S_a(0.2)$, as per 9.8.7.3. The legend under the Drag Strut Forces table has been revised to reflect this.

a) Capacity vs Applied Load

This factor is not applied if shearwall capacity is used to create drag strut forces, rather than applied loads. However if 1.2 x applied load is greater than shearline capacity, that value is used and a note below the Drag Strut Forces table indicates this.

b) Elevation View

The legend in Elevation view shows the 1.2 factor and 9.8.6 reference.

10. Unblocked Shearwall Limitations

a) Maximum Height

The maximum height of an unblocked shearwall has increased from 2.44m to 4.88m, as per the change in 9.4.4.

b) Height-to-width Ratio

The maximum height-to-width ratio for unblocked shearwall has been reduced to 2:1 from 3.5:1, as per the new limitation in 9.4.4. An item has been added to the Design Settings output echo to show the ratios for blocked and unblocked shearwalls (despite the fact that this has been removed from the design settings choices, see *Program Operation* change 104 below.)

c) Unblocked Vertical Sheathing

When the vertical orientation of sheathing is selected, blocking was disabled and unchecked, but the program treated the wall as blocked because of the assumption that the edges of a 4x8 sheet are supported on the studs and bottom and the top plate. Given the new height requirements, the program now allows you to specify whether vertical sheathing is blocked or unblocked.

11. Importance Factor

The Importance factor for earthquake loads, used in seismic load generation, was changed in 4.2.3.2 from 1.0 to 0.8. However, Shearwalls 7.22 had been using the 0.8 importance factor, based on NBCC 2005 4.1.8.5, so change to the program was made.

12. OSB Type 2 Sheathing

As the CSA O86 no longer lists OSB Type 1 Sheathing, it has been removed as an input choice. If a file is opened from a previous version that contains OSB Type 1, then the material type of this wall is changed to construction OSB and the grades A,B or C are changed to 2R24, 1R24_2F16 and 2R32_2F16 respectively. If the thickness specified is outside of the range of the valid thicknesses for that marking type then the thickness is set to the smallest thickness for that marking type.

B: Update to NBCC 2010 from NBCC 2005

1. National Building Code of Canada

The program has been updated for the 2010 National Building Code of Canada (NBCC). The previous version was based on NBCC 2005.

This change is reflected in the program Welcome box, the Building Codes box, and the About Shearwalls box.

2. Torsional Sensitivity Irregularity

The program now detects torsional sensitivity irregularity 7 from Table 4.1.8.6, by determining the ratio B in 4.1.8.11(9). Note that this is not a new design code clause, but implementation was made possible by the deflection analysis added to the program.

a) Torsional Analysis Changes

Previously, for each extreme shearline *Shearwalls* determined only torsional component for the direction of accidental eccentricity that augmented the direct force on that line. Now the program determines the torsional forces and resulting deflections for each combination of extreme shearline and moment direction, + or -, to determine the $\bar{\delta}_{max}$ values needed.

b) Rigid Diaphragm Analysis Procedure

The program checks whether the rigid diaphragm analysis procedure is allowed according to 4.1.8.11 (10) by checking that the maximum B of all B_x on each level as defined in 4.1.8.11(9) is less than or equal to 1.7, or that $I_E F_a S_a(0.2)$ is less than 0.35.

c) Torsional Irregularity Table

The program now indicates within the table whether each floor and direction has Irregularity 7, and which ones fail because it has the irregularity and $I_E F_a S_a(0.2)$ is greater than 0.35. If it does fail, a note appears below the table saying that rigid diaphragm design results are not valid.

d) No Deflection Analysis

If you have chosen to disable deflection analysis in the Design Settings, then this check is not performed. The Irregularities table indicates it is detected by the user, not the program, puts n/a in the Irregular and Fails columns, and places a note below the table explaining the reason and what can be done about it.

3. Accidental Torsion for Flexible Diaphragms (Feature 125)

The program now implements NBCC Structural Commentary J 178, which says.

Structures with flexible diaphragms are designed so that their loads, including the effects of accidental torsion, are distributed to the vertical elements using the tributary area concept. Accidental torsion should be taken into account by moving the center of mass by +/- 0.05D_{nx} and using the largest seismic loads for the design of each vertical element.

Note that the 2010 Wood Design Manual (WDM) Example 1, Seismic Design Considerations (p470) includes this force by adding 5% to the total shearline force.

a) Calculation Procedure

Noting that to direct (non-torsional) component of the shearline force should be that determined by tributary area distribution, this can be achieved by setting the rigidities K to the flexible shearline force, seeing that

$$F_{di} = F * K_i / \sum K_i ,$$

using the notation in the Log file, F being the total force. In that case, the center of mass CM = Centre of rigidity CR, and we are including just the accidental eccentricity e_a and not the eccentricity of the structure or loads. We also do not consider the torsional moment J in the other direction, as none of the loads are in the other direction. The torsional component on each line is then

$$F_{ti} = T * K_i * d_i / (J_x)$$

where d_i is the distance of the shearline from the centre of load and

$$J_x = \sum K_i * d_i^2 ; T = F * e_a$$

Shearlines already heavily loaded get higher contributions of accidental torsion, rather than those that are stiffer as in the case of rigid analysis. With seismic analysis, the distribution of load is proportional to the distribution of the mass of building material, which itself is proportional to the “area” that the NBCC commentary is referring to. So with this method, the torsional component is distributed using the tributary area concept as the NBCC mandates.

b) Verification of Calculation Procedure

To show that a simple case of uniform load on a rectangular building is consistent with the WDM example, consider a 20 m wide building with 1 kN/m force the diaphragm.

$$F = 20 \text{ kN}; F_{d1} = F_{d2} = 10 \text{ kN}; K_1 = K_2 = 10 \text{ kN}; e_a = 1 \text{ m}; d_i = 10 \text{ m}; T = 20 \text{ kN-m}; J = 2000 \text{ kN-m}^2$$

$$F_{t1} = F_{t2} = 20 \text{ kN-m} \times 10 \text{ kN} \times 10 \text{ m} / 2000 \text{ kN-m}^2 = 1 \text{ kN} \\ = 5\% F$$

c) Log File Output

The title of the entire section of the log file for torsional analysis has been changed from “RIGID DIAPHRAGM ANALYSIS” to “TORSIONAL ANALYSIS”, in recognition that some of the output now pertains to flexible analysis. A section is added at the top of the results called, FLEXIBLE SEISMIC DESIGN. The assumptions given in section a), above, are shown first, then the

results are given as they are for rigid diaphragm analysis. The source of the accidental eccentricity is given as NBCC Structural Commentary J 178.

4. Minimum Seismic Base Shear

Previously, NBCC 4.1.8.11 (b) for minimum seismic base shear V was the base shear based on $S(T = 2.0)$, and applied to all structures. Now, the requirement for walls is shearwalls is 4.1.8.11 (a) , the minimum shear based on $S(T = 4.0)$. As the program has no input for $S(T = 4.0)$, and elsewhere in the program, we assume periods are not greater than $T = 0.5$ based on the height of the structure, we have dropped the minimum base shear as not applying to wood structures. You could conceivably enter a large enough period that the minimum is achieved, but that would not represent a realistic structure.

C: Hold-down Connections

1. Hold-down Types and Properties

a) Hold-down Assembly

The hold-downs in shearwalls connect the wall end studs on an upper level to either the corresponding stud on a lower level or anchored to the foundation. Continuous tie rod systems extending over multiple building levels are not included in this version of Shearwalls.

i. Vertical Connection

Hold-downs include either an anchor bolt or threaded rod which connects upper and lower brackets or straps, or a continuous strap extending from upper to lower level.

ii. Horizontal Fasteners

The connection from bracket or strap to the upper and lower studs is made via bolts or nails, however this distinction is not implemented in the program as an overall capacity and displacement is specified for each hold-down, and the strengths and slippages of the components of the hold-down not needed.

iii. Single or double bracket

Hold-downs are designated as being either single-bracket or double bracket, indicating that the hold-down has a bracket or strap on one floor or both. By default, hold-downs on the ground level are single-bracket, and upper-level hold-downs are double-bracket. The data in the hold-down database are published for one bracket only and are doubled when the hold-down is designated as double bracket in the Shearwalls program.

iv. Shrinkage Compensating Device

You can designate that the hold-down includes a mechanical device to adjust for the shrinkage of the perpendicular-to-grain wood between the extreme hold-down fasteners, so that such shrinkage is not included in the calculations for shearwall deflection.

b) Displacement and Capacity Sources

There are three possible sources of vertical hold-down displacement that affects shearwall deflection:

- anchor bolt elongation,
- bracket or strap elongation,
- slippage of horizontal bolts or nails.

Similarly, the capacity of the hold-down takes into account the possible failure in tension of the bracket or strap, the anchor bolt in tension, and the connection of the horizontal fasteners to the wood studs.

The published data are assumed to include all of these sources, except that displacement values include the elongation of the anchor bolt to a maximum length. Elongation of the portion of the anchor bolt greater than that length is analysed separately.

c) Method of Determining Displacement

Hold-downs are designated according to the method we use for determining the vertical displacement under loading, as follows.

i. Displacement at Actual Force

With this method, ratio of the capacity of the hold-down to the maximum capacity is multiplied displacement to give the displacement used for deflection analysis and storey drift. This assumption of linear may not be correct, due to the non-linear effects of fastener slippage. This would yield non-conservative results for storey drift determination. However, the choice also affects load distribution to and within shearlines using stiffness analysis, for which the effect may be conservative or non-conservative.

ii. Displacement at Maximum Capacity

With this method, the published displacement at maximum capacity is used regardless of the shearwall force. This ensures conservative storey drift calculations. This choice also affects load distribution to and within shearlines using to stiffness analysis, for which the effect may be conservative or non-conservative.

2. Hold-down Database

The program includes a database of standard hold-downs, which you can edit using a database editor incorporated in Shearwalls to update hold-down properties or add new hold-downs

a) Database File

The *Database* folder of the WoodWorks installation contains a file called *Holddowns.mdb*, which is a Microsoft Access database of hold-downs used by the Shearwalls program. *Shearwalls* now includes an editor to modify the database, but it is also possible to modify the file directly via Microsoft Access.

b) Database Structure

The database consists of two tables, a Hold-down table that contains the properties of the hold-down that are relevant to Shearwalls design, and a Displacement table which contains hold-down capacities and displacements corresponding to each combination of minimum stud width and depth. The record in the displacement table contains a reference ID to the hold-down that uses that displacement record.

i. Hold-down Table

The hold-down table contains the following data:

- Name
- Whether it includes an anchor bolt
- Anchor bolt diameter
- The maximum anchor bolt length for which the published elongation applies
- Whether for this hold-down, we use displacement at maximum capacity for deflection analysis
- Whether the hold-down includes a shrinkage compensation device
- Whether the hold-down is to be used as the default hold-down for new projects in Shearwalls

The meaning of these variables is described more fully in the section on Database Input.

ii. Displacement Table

The hold-down displacement table is needed for hold-downs for which the entire assembly displacement is published. For those hold-downs for which only the bracket or strap elongation is published, then only one displacement record is needed, corresponding to the elongation of the bracket or strap. The displacement of anchor bolt and horizontal fasteners is calculated separately by Shearwalls using the information in the Hold-down table.

c) Initial Hold-downs

The file in the Shearwalls installation contains a limited number of hold-downs, from the Simpsons Strong-Tie ICC acceptance criteria AC155.

i. Screw mounted Hold-downs

The hold-downs in the initial database that are connected to the upper and lower studs via screws, from the ICC acceptance criteria AC155, are HDU2-SDS2.5, HDU4-SDS2.5, HDU5-SDS2.5, HDU8-SDS2.5, HDU11-SDS2.5, and HDU14-SDS2.5..

ii. Nailed and Bolted Hold-downs

There are no hold-downs in the initial database that are fastened with nails or bolts to the wall studs, however it is possible to add this type of hold-down to the database.

iii. Strap Hold-downs

There are no hold-downs in the initial database consisting of one continuous strap without an anchor bolt; however it is possible to add this type of hold-down to the database.

d) Single vs Double Bracket Hold-downs

The displacement data in the hold-down database applies to just one bracket or strap of a hold-down. In the program, hold-downs designated as double-bracket have the displacement values doubled, and the maximum anchor bolt length is also doubled. The capacity data applies to each bracket of the hold-down, and is never doubled.

When creating a hold-down with a continuous strap, you can either

- enter hold-down data that apply to the elongation of the entire strap and the total number of fasteners, top and bottom, and designate it as single-bracket in Shearwalls
- enter hold-down data that apply to the elongation of $\frac{1}{2}$ the strap, and designate it as double-bracket in Shearwalls.

3. Hold-down Database Editor

The program includes an editor to view and modify the hold-down data. This editor should be used to update hold-downs for newly published product information from the hold-down manufacturer. It can be also used to add new hold-downs.

a) Access

The database editor is accessed from the following locations:

- An item in the main menu
- A button in the *Plan View* and *Design Results* window's toolbars
- A button in the *Hold-down* data group in *Wall Input* and *Opening Input* views

b) Context sensitive help

Each of the input controls within the database editor has context-sensitive help, explaining its purpose and use. If you click on the question mark in the upper left hand corner of the view, then on the input control a small yellow box appears with the description of the item.

The following are brief descriptions of the input fields within the box; for more details, use the context-sensitive help in the program.

c) Hold-down Selection Controls

The *Hold-down* selector, *New* and *Delete* buttons, and *Default...* checkbox are used to control the current hold-down being edited.

i. Hold-down Selector

The hold-down selection dropdown is used to both select the hold-down for viewing and editing properties, to name a new hold-down, or to rename the hold-down by typing over the existing name. It sorts the hold-downs from the database alphabetically.

ii. New

Changes the input mode to refer a new hold-down being created rather than an existing one being edited.

iii. Delete

Used to delete the currently selected hold-down from the database. Must delete incomplete entries before exiting box.

iv. Default hold-down in Shearwalls

Indicates that this hold-down is the one that is used when new walls are created in Shearwalls.

d) Vertical Bolt (add'l elongation)

This group pertains to the anchor bolt which connects the upper hold-down bracket or strap to lower bracket or strap, or to the foundation or some other anchoring mechanism.

i. No/with anchor bolt

Radio buttons allow you to indicate that the connection does not have an anchor bolt, disabling the other controls and causing the program to dispense with anchor bolt calculations.

ii. Diameter

Shank diameter of anchor bolt, used in tensile strength and elongation calculation, – can select from list or enter custom size.

iii. Max Length for Given Elongation

The length of anchor rod the manufacturer used in tests to determine the displacement or elongation, usually found in a note in the product literature or evaluation reports. Elongation for any excess bolt length is calculated separately by Shearwalls.

e) Options

There are checkboxes in the view for the following options:

i. Shrinkage Compensating Device

If hold-down a mechanical device to adjust for the shrinkage of the perpendicular-to-grain wood between the extreme hold-down fasteners.

ii. Always use Elongation at Maximum Capacity

A checkbox is used to implement the choices described in *Method of Determining Displacement* in 1c, above.

f) Displacement

This Data Group allows you to enter different hold-down capacities and/or displacements depending on stud width, thickness, and species group.

i. Elongation/Displacement List box

This box allows you to replicate the tables that appear in the hold-down product literature that have different hold-down capacities and/or displacements for each stud species, thickness and/or width.

The values apply to only one bracket in a two-bracket hold-down.

ii. All

Entering the word "All" means that the capacity and displacement applies to all values of the thickness or width of the thickness or depth.

iii. New

Creates a new record corresponding to a line in the table of product information.

iv. Delete

Delete an entire record consisting of one line of the Displacement table. You must delete any incomplete lines before exiting the dialog.

v. Note

For any line in the table, you can enter a note corresponding to the one that appears in the product literature and/or evaluation report to show in the design results any further restrictions on the use of the hold-down, such as on the wood grade or specific gravity.

4. Hold-down Input

a) Hold-downs Data Group

There is similar input for hold-downs at two places in the program – the *Wall Input* form and *Opening Input* form. In each place, a hold-down data group contains the following input fields:

i. Hold-down drop-list

For both left and right ends, used to select the hold-down to be used from the list in the database.

ii. Single- or double-bracket

A checkbox indicates that the hold-down is double bracket, that is, the displacement and maximum anchor bolt length entered in the hold-down database applies to only one-half of the assembly, and is doubled for the hold-down assembly used.

iii. Apply to Openings

When this is checked, the inputs apply to all openings on the wall as well as the wall end studs, saving you the effort of updating all the openings manually.

The input of these data applies to all selected walls.

b) Framing Input

The following has been added to the *Framing* data group of the wall input view:

i. Grade

The grade value is now active for all materials. Previously it was active only for MSR and MEL, for which grade data is needed for the specific gravity, which affects for shearwall capacity.

ii. Thickness and Width

In wall input view, the stud thickness (b dimension) and width (d dimension) is input, either by selecting from a list of nominal sections from the database or by typing your own

actual value in. The input control behaves in a similar manner to the *Width* and *Depth* input in Sizer.

iii. Note that the thickness (b) and width (d) terminology for studs is consistent with product literature, and should not be confused with the width (b) and depth (d) terminology for all members in Sizer.

It is assumed to apply to all studs in the wall, including those at openings and wall ends (which can be built-up from more than one stud.)

iv. Number of End Studs

Typically wall ends are at least doubled and at times more plies are added to provide tensile or compressive strength or connection strength for the hold-downs. The input of the number of end studs at both left and right end has been added to allow the program to select the hold-down capacity and displacement for the Assembly displacement method (see **Error! Reference source not found.**). The program does not as yet design the built-up studs themselves.

This input has also been added to the *Hold-downs* data group (see a) above) in the Opening Input view for the wall studs at the hold-down locations at each side of an opening.

c) Structure Input

New inputs have been added to the Structure Input form that allow for input of parameters that apply to all hold-downs on a single building level.

i. Length Subject to Shrinkage

This input indicates the total vertical extent of perpendicular-to-grain wood members spanned by the hold-down device. Typically the depth of the floor joists plus two top plates on the lower level and one bottom plate on the upper level. For ground level, it depends on the sill plate configuration. Used in hold-down wood shrinkage calculations.

ii. Anchor bolt length

This indicates the required length of the hold-down anchor bolt, if one exists for a particular hold-down. Typically the length subject to shrinkage plus flooring material thickness. However, in some situations it could be quite different, for example when wood I-joists are used. The I-joist web is included in the anchor bolt length but not in the length subject to shrinkage.

iii. Context sensitive help

Each of these fields have context-sensitive help explaining their use, accessed via the question mark box at the top of the dialog box.

5. Hold-down Settings

A new page has been added to the Settings input for hold-down data that apply to all hold-down locations in the structure.

a) Context sensitive help

Each of the input controls within this settings page has context-sensitive help, explaining its purpose and use. If you click on the question mark in the upper left hand corner of the view, then on the input control a small yellow box appears with the description of the item.

The following are brief descriptions of the input fields within the box; for more details, use the context-sensitive help in the program.

b) Hold-down forces

A new group box is added to include options affect the generation of hold-down forces from shearline forces on segments.

i. Hold-down Offset

This has been moved to this page from the *Default Values* page. In addition, the following capability is added:

If a value is entered that is greater than or equal to $\frac{1}{2}$ a shearwall segment length, the program reverts to the factory default value of 38 mm for that segment. It issues no warning in this case, it is evident only by the placement of the hold-down in elevation view and its position as listed in the Hold-down Design table.

ii. Subtract Offset...in Moment Arm Calculation

A checkbox indicates whether the program subtracts the hold-down offset from the wall length when calculating the overturning moment arm. For the Canadian version, this is disabled and checked, as CSA O86 9.5.6 specifies that the length is to the centre of the end stud(s), implying subtraction of $\frac{1}{2}$ the end stud width.

iii. Include Joist Depth...in Moment Arm Calculation

A checkbox indicates whether the program includes the floor depth above the wall in the wall height h when calculating the overturning moment arm. For the Canadian version, this is disabled and checked, as CSA O86 Figure 9.4.5.2 specifies that you include the joist depth.

c) Displacement d_a for Deflection – Override Hold-down Properties

The inputs in this data group allow you to replace the vertical hold-down displacement components from with constant values for all hold-downs in the program. They also allow you to specify values for these components if they cannot be calculated or are not available from the hold-down database for a particular hold-down. A warning appears in the output if this situation occurs.

i. Displacement

ii. If box is checked, the program uses the input value as the elongation for all hold-downs in the structure that have combined elongation/slippage, overriding the hold-down database value. If box is not checked, it uses the override value only when a value is not available from the database for the stud size that the hold-down is attached to. This value is also used for the displacement of anchorages attached to gypsum-wallboard-sheathed walls, for which there is no design equation in the CSA O86.

iii. Shrinkage

If box is checked, the program uses the input value as the wood shrinkage value for all hold-downs in the structure, overriding the value calculated using moisture content and length subject to shrinkage on each floor.

d) Displacement d_a for Deflection – Wood Properties and Construction Detail Settings

Data for hold-down displacement calculations that cannot be entered independently at each hold-down location is entered here.

i. Default Length Subject to Shrinkage

Used to enter the proportion of the floor depth as input in the Structure input view, plus the depth of other wood members such as wall top and bottom plates that is subject to

shrinkage. This value can be adjusted for individual floors in Structure Input view, it is of primary use in creating defaults for new files for these values.

ii. Crushing of Bottom Plate at End Stud

The deformation of the bottom wall plate beneath the end chord studs at the compression end of the shearwall. The “factory” default is 0.04 corresponding to lumber loaded to capacity for perpendicular compression according to the USA NDS 4.2.6. A value of 0.02 corresponds to lumber loaded to 73% capacity.

iii. Other (miscuts, gaps, etc.)

Additional sources of vertical shearwall displacement are input here at the discretion of the designer. This could include allowance for studs that are cut too short or without square-cut ends

iv. Bolt hole tolerance

The difference between drilled hole diameter in the studs and the diameter of the horizontal bolt shank. For Assembly displacements that include slippage (see 1b, above), any value greater than 1/16” is added to the published displacement, which includes the effect of standard size bolt holes. For separate slippage and elongation, the entire value is added to the calculated slippage.

6. Hold-down Design

a) Hold-down Location

The program performs the design check for hold-down capacity at each wall or opening end.

i. Vertical elements

There is currently no mechanism for entering hold-downs at the base of vertical elements transferring a force from an upper storey via a vertical element to a location on a lower story that is not a wall or opening end on that story. so is no hold-down design for those hold-down locations.

b) Design Check

For each design case (wind, seismic, and both force directions), the program checks the capacity of the hold-downs at each hold-down location against the combined factored uplift force. The combined force includes:

- shear overturning
- counteracting dead load
- wind uplift

c) Design Method

This is a design check only on a hold-down selected for the hold-down location. The program does not at this time cycle through various possibilities to find a hold-down.

d) Anchorages

The program does not perform the design check at hold-down locations where there are anchorages.

7. Output

a) Hold-down Design Table

The Hold-down and Drag Strut table has been split into two tables, one for hold-downs and one for drag struts. The new Hold-down design table includes hold-down capacity design information.

i. Hold-down Device

A column has been added to indicate the name of the hold-down device from the database used at hold-down location. If there is an anchorage there, the program just says *Anchorage*.

ii. Capacity

The capacity of the hold-down at that location

iii. Crit Resp.

The ratio of combined, factored hold-down force to capacity. A value greater than one indicates a failed design.

iv. Legend

The legend has been split up to show information pertaining to each column on a separate line, edited for clarity. Information about uplift force for perforated walls for staggered openings added. Lines describing new data added.

v. Notes

Note for dead load factor removed and value of factor placed in legend..

b) Hold-down Displacement Table

New table has been added giving the components of shearwall displacement for hold-downs. It is described in the section on deflection output, below.

D: Deflection Analysis

Shearwalls now calculates the deflection of each wall segment between openings for each design case (wind, seismic, rigid, flexible, E->W, W->E) according to CSA O86 9.7. It uses this deflection to

- determine the storey drift, and check that it is within allowable limits
- distribute loads to segments within a shearline based on equal deflection of segments
- determine rigidities for the rigid diaphragm method of distributing loads to shearwalls

As deflection analysis can be costly in terms of processing time, this feature is optional. It is controlled by a checkbox in the design settings.

1. Deflection Calculations

a) Four- term equation

The equation implemented is the four-term equation from O86 9.7.1.1 It is

$$\Delta_{SW} = \frac{2VH_S^3}{3EAL_S} + \frac{vH_S}{B_v} + 0.0025H_S e_n + \frac{H_S}{L_S} d_a$$

The meaning of the variables is given in the following sub-sections..

The four terms in the equation give the contribution to deflection from the following sources, in order

- *Bending*: Bending of vertical shearwall chords (wall segment end studs)
- *Shear*: In-plane shear deformation of sheathing
- *Nail slip*: Slippage of nails fastening sheathing to top and bottom wall plates
- *Hold-downs*: Slippage of fasteners connecting hold-downs to studs, elongation of hold-downs, wood shrinkage and crushing at hold-down location, and additional displacement due to mis-cuts, gaps, etc.

b) Seismic Multiplier

For seismic design, the resulting deflection is multiplied by $R_d R_o / I_e$, as per NBCC 4.1.8.13.

c) Unit shear v

i. Load Combinations and Factors

For segmented shearwalls, the unit shear v is vertically accumulated serviceability shear force, that is, the shear force per unit foot unfactored by the 1.4 load combination factor for wind design, as per CSA O86 4.2.4.2.

For seismic design, it is the same as the force that is used for shearwall design and which appears in the elevation view at the bottom of the shearwall.

ii. Distribution of v Within Wall

The second and third terms of this equation apply to the sheathing, which can be different for each side of a composite wall.. Both sides require a shear value v (the third term does so indirectly through e_n). Refer to j) below for an explanation of how shear is apportioned to each side of a composite wall.

iii. Distribution of v to Segments Within Shearlines

The distribution of v within a shearline depends on the selection of *Shearwall Rigidity per Unit Length* and *Distribute Forces to Wall Segments based on Rigidity* in the *Design Settings*. For more details, refer to subsection 3 below

d) Shearwall height H_s

The shearwall height H_s is the distance from the bottom of the bottom wall plate to the top of the top wall plate, exclusive of floor joists or other building elements not part of the wall.

e) Segment length L_s

The length L_s is the length of an individual full-height segment between openings, and the calculations are performed for each segment separately.

f) End Chord Bending Deflection

The first term in the equation relates to the in-plane bending of the shearwall chords, that is, the wall end studs.

i. Modulus of Elasticity E

An input field has been added to Shearwalls to allow for input of the grade of the wood end studs. The modulus of elasticity is then taken from the WoodWorks database of material properties.

ii. Cross sectional area A

This is the section area end studs, which are typically built-up members. Shearwalls now allows you to input wall end stud thickness, width, and number of end studs (see C: 4.b) above), from which the cross-sectional area is calculated.

iii. End Post Composition

Shearwalls does not allow for wall chord posts that are not made up of built-up wall studs but it is possible to model such a situation by typing in a value for the stud thickness, as it has no effect on shearwall design. However you cannot change the wall stud species to the one for the end post without having an effect on shearwall design, which depends on specific gravity. For MSR/MEL you cannot change the grade without having an effect on design.

g) Panel Shear Deflection

The second term relates to the in-plane shear deformation of the shearwall

i. Shear Stiffness B_v

The value for shear –through –thickness rigidity B_v is taken from Table 7.3A-C in CSA O86-09, and from the USA Special Design Provisions for Wind and Seismic (SDPWS) Table C4.2.2B for gypsum wallboard..

ii. Shear Value v

Refer to j) below for an explanation of how shear is apportioned to each side of a composite wall.

h) Nail Slip Deflection

The third term is related to the slippage of nails fastening the sheathing to the top and bottom shearwall chords, i.e top and bottom wall plates.

i. Fastener Slip e_n

The fastener slip e_n is taken from O86 Table A.9.7 for wood panels and for the USA SDPWS Table C4.2.2D for gypsum wallboard. Note that the slip is non-linear with respect to shear-per-fastener V_n for wood structural panels, but does not depend on v at all for gypsum, it is a constant.

ii. Fastener Load V_n

The load per fastener V_n is calculated by dividing the shear-per-unit-length v by the user-input panel edge spacing, yielding the force on each edge fastener.

iii. Composite Walls

Refer to j) below for an explanation of how shear is apportioned to each side of a composite wall.

iv. Interpolation

The deflections are interpolated for loads per nail in between the values listed. It is not interpolated for nail size when non-standard nails are input, it uses the value for the smaller nail.

v. Maximum Load Per Fastener

The program limits the fastener shear to the maximum in Table A.9.7. If it is exceeded, it uses the maximum deflection and issues a warning under the Deflection table.

We determined that this level of loading always results in shearwall design failure for which a failure message is already output anyway.

vi. Unseasoned lumber

For unseasoned lumber, that is lumber with fabrication moisture content less than 19%, the deflection values are doubled as per note 2.

vii. Unblocked walls

For unblocked walls, a nail spacing of 150mm is used in place of the actual nail spacing to comply with CSA O86 9.7.1.2.

i) Unblocked Walls

For unblocked walls, the shearwall deflection is divided by the unblocked factor J_{ub} as per CSA O86 9.7.1.2.

j) Distribution of v to Sides of Composite Wall

For composite walls, the 2nd and 3rd terms of the equation, shear and nail slippage, apply separately to each side of the shearwall, which may have different materials.

i. Equal Deflections

Shearwalls apportion shear to each side of the wall by adjusting the v value until the deflection due to shear plus nail slippage is the same on both sides of the wall. Note that this equalisation is done regardless of whether equalisation of deflections for all segments along a line is being done according to the selection of force distribution design settings described in subsection 3 below.

ii. Zero Shear

Slippage to non-wood-panel materials is a constant, which in many cases creates a larger slippage deflection than is possible for shear plus slippage even when all load is placed on the wood panel. In these cases, all the force is placed on the wood panel side. The deflection for that segment is the nail slippage plus shear from the wood panel side, and does not include the constant gypsum slippage.

Note that in this case, despite the fact that the entire load is assigned to the wood side for purposes of deflection analysis and storey drift, the program still uses the sheathing on both sides of the shearwall for shearwall capacity calculations according to the procedures for combining shearwall capacity in the CSA O86.

2. Hold-down Deflection

The fourth term in the deflection equation relates to the displacement of the shearwall anchorage devices and the movement of the wood material at the hold-down location. The following sections give the various components which are added to give vertical hold-down displacement d_a .

a) Displacement

Refers to the elongation in tension of the hold-down brackets or straps plus anchor bolt elongation, plus the slippage of fasteners attaching the brackets or strap to the wall studs.

i. Database value

The hold-down database contains the strength-level displacement that occurs at the maximum capacity.

ii. Displacement/Elongation at Maximum Capacity

If this method (see C: 1.c) above) is selected for a particular hold-down, the program uses the database maximum value regardless of the force.

iii. Displacement/Elongation at Actual Force

If this method is chosen, then the program divides factored hold-down force by the capacity, then multiplies this ratio by the strength-level displacement.

iv. Additional bolt length

In some cases, separate elongation of the anchor bolt is added to the database deflection. This happens when the published displacement or elongation is for an anchor bolt which is shorter than the one input in Structure input view for the level the hold-down is on. The elongation for the additional length is calculated. Note that in this case, for double bracket hold-downs, the published length is doubled before being compared to the actual length in the program.

The elongation of the length L of bolt that is to be analyzed is PL/AE , where A is the bolt cross-sectional area, E is the steel modulus = 29000000 psi and P is the strength level hold-down force at that location.

b) Shrinkage

Refers to the wood shrinkage that occurs between fabrication and service of the perpendicular-to-grain wood members spanned by the hold-down.

It is calculated when the hold-down does not include a shrinkage compensating device.

i. Calculation

The vertical shrinkage displacement is $0.002 \times (\% \text{ fabrication moisture content} - \% \text{ in-service moisture content}) \times \text{shrinkage length}$ for that building level from the Structure input view.

ii. Moisture content input

The fabrication and in-service moisture content are input in the Design Settings. Previously you could input only whether it was greater or less than 19%, for use in nail withdrawal design. Now the actual moisture content is input.

iii. In service Greater than Fabrication

If for some reason in service moisture content is greater than fabrication, shrinkage is set to zero.

c) Crush

The wood crush as input in the Hold-down settings is applied to all hold-down locations in the program. Typically ranges from 0.2 – 0.4”

d) Additional Components

The additional components in the “Other – miscuts/gaps” input of the Hold-down settings are applied to all hold-down locations in the program.

e) Anchorages

i. Wood panels

Vertical displacement of anchorages as opposed to hold-downs is determined for walls with wood panels via the equation in 9.7.1.1 for this situation. If the wood construction of one side of the wall differs with the other in any way, both sides are calculated and the smaller deflection of the two is taken. This is equivalent to ignoring the contribution to stiffness of the weaker side.

ii. Gypsum wallboard

For walls sheathed entirely with gypsum, the displacement over-ride from the Hold-down settings is used, as there is no guidance for this in the O86. If a wall has wood on one side and gypsum on the other, the gypsum is ignored.

iii. Unblocked walls

For unblocked walls, a nail spacing of 150mm is used in place of the actual nail spacing to comply with CSA O86 9.7.1.2.

3. Shear Distribution to Wall Segments Within Shearline

a) Design Settings

The way that force is distributed with a line depends on the Design Settings *Shearwall Rigidity per Unit Length* and *Distribute Forces to Wall Segments based on Rigidity*.

i. Shearwall Rigidity per Unit Length

In the data group called *Shearwall Rigidity per Unit Length*, (previously known as *Rigid Diaphragm Analysis*), a new method has been added to the previous three selections – *Use shearwall deflection to calculate rigidity*.

If any of the three methods that were in previous versions of the program are selected, then deflections in general will be different for each segment along the line, as distribution within the line is based on shearwall capacity. The largest deflection is taken to be the one used for storey drift calculations.

ii. Distribute Forces to Wall Segments based on Rigidity

This setting has been added to allow you to distribute forces based on the *Use shearwall deflection to calculate rigidity* choice to each wall within the shearline based on rigidity. If checked, the program will attempt to equalise deflections along the shearline. If it is not checked, distribution within the line is based on shearwall capacity, and deflections in general will be different for each segment along the line, and the largest deflection is taken to be the one used for storey drift calculations.

b) Equalisation of Deflection

If both the new *Distribute Forces to Wall Segments based on Rigidity* box is checked, and the new *Use shearwall deflection to calculate rigidity* button is selected, then the program will attempt through an iterative procedure to equalise deflections on the shearline, by redistributing the shear force v to the segments until the deflections calculated with 9.7.1.11 are the same.

i. Zero Force

Because deflection is highly dependent on aspect ratio of the segments, and the hold-down forces and hold-down devices employed at each segment, deflection can be highly variable along a line, so that some segments draw negligible force. Furthermore, some segments have constant components to deflection (non-wood-panel nail slip, hold-down overrides, extra hold-down components) that yield a deflection with minimal loading that is higher than the deflection on other segments even if all the shearline load was applied to that segment.

ii. If these situations occur, the program assigns zero load to those segments that are drawing negligible loads (less than 1 N), and equalises the deflection on the remaining segments. The segment that gets zero force is treated as an opening or a non-shearwall for the purpose of final hold-down and drag strut calculations..

iii. Non-convergence

The mathematical system used to model shearwall deflections along a line is not necessarily determinate. On occasion, the routine is unable to equalise deflections along a line, oscillating between solutions that do not equalise deflections. In this case, the deflections that arise from the last iteration before a limit is reached are used.

4. Rigid Diaphragm Analysis

If the design setting *Use shearwall deflection to calculate rigidity* is selected, the program determines shearline rigidity for rigid diaphragm analysis by summing the rigidities of all

segments along the line, where the rigidity is defined as the force on the segment divided by the deflection of the segment.

a) Equal Deflections

If deflections have also been equalised along the line via *Distribute Forces to Wall Segments based on Rigidity*, then this is equivalent to dividing the total force on the line by the deflection.

b) Change to Manual Input

If you change the setting from *Use shearwall deflection to calculate rigidity* to *Manual input of relative rigidity*, in order to adjust the rigidities, the rigidities that appear in the input for a particular wall are the sum of the rigidities for all segments along the line, divided by the wall length.

5. Story Drift Calculations

For seismic design only, Shearwalls implements NBCC 4.1.8.13 by checking the maximum amplified story drift for any shearline against the allowable limits on each level, and for each force direction (E->W, W->E, N->S, S->N).

a) Storey Drift Calculation

i. Maximum Deflection

The maximum deflection is the largest deflection on any shearline, calculated as described above. If deflections on a line have been equalised (see 4.a) above), it is the common deflection of all walls on the line. If not, it is the largest deflection for any segment on the line.

ii. Deflection Amplification Factor

The deflections are multiplied by the amplification factor from 4.1 8.13 (2) : $R_d R_d / I_E$. The R values can be input into the Site Dialog, but unless they were over-ridden, they are the values from NBCC Table 4.1.8.9

The importance factor I_E calculated from the Occupancy category entered in the sited dialog is used.

b) Allowable Drift Calculation

The allowable drift is calculated according to NBCC 4.1 8.13 (3)..

i. Story height

The storey height h_s for each level is the wall height plus the upper floor thickness.

ii. Occupancy Category

The existing input for Occupancy category from the Site dialog is used.

c) Provisions Not Implemented

i. Sway Effects

The program does not implement NBCC 4.1.3.2(12) regarding sway effects, that is, the effect of vertical loading acting on the structure in its displaced configuration. .

ii. Rotational Deflection

The program does not consider the effect of rotation, that is, the deflection that is caused by the fact that walls on upper floors are rotated due to the deflection on the floor below. This deflection is not mandated in the NBCC or CSA O86, but is addressed in the APEGBC Technical and Practice Bulletin for .5 and 6 Storey Wood Frame Residential Building Projects. We hope to implement this in a future version of the program

d) Output

A new table has been added showing the storey drift calculations for each level and force direction on that level, and indicating success or failure of the storey drift check. Refer to 6.f) below for details.

6. Output

a) Design Settings

i. Shearwall Relative Rigidity

In the *Design Settings* Table, to reflect the changes in the Settings Input, *Rigid Diaphragm Analysis* is renamed *Shearwall Relative Rigidity*. The choices have been modified to be more explanatory. The new input field for deflection says *Deflection-based stiffness of wall elements*,

ii. Design Shearwall Force/Per Length

This corresponds to the new checkbox in the input *Distribute Forces to Wall Segments based on Rigidity*. If this is checked, it says *Deflection-based stiffness of wall elements*, if not it says *Based on Wall Capacity*.

b) Shearwalls Materials Table

Because of the need to add information for deflection design, the shearwalls materials table has been split into two tables, one for sheathing materials and one for framing materials.

i. Sheathing materials

- *Material name*: The material name has been expanded somewhat from the abbreviated name in previous versions, but is still not the full name that appears in the input view.
- *B_v* – A column has been added for the value of B_v from Table 7.3A-C in CSA O86-09, and from the USA Special Design Provisions for Wind and Seismic (SDPWS) Table C4.2.2B for all other materials.

ii. Framing materials

For the framing materials table, only one line is needed for each wall design group, instead of the two needed for sheathing materials on each side of the wall. The fields that have been added are

- *Stud grade*
- *Stud thickness b* (actual)
- *Stud width d* (actual)
- *Modulus of elasticity E*, in millions of psi or MPa

A note has been added below the table saying

Check manufacturer requirements for stud size, grade, and specific gravity (G) for all shearwall hold-downs.

c) Storey Information Table

Columns have been added for the anchor bolt length and the length subject to shrinkage, as input in the Structure Input view.

d) Hold-down Displacement Table

A table has been added to show the components of vertical hold-down displacement d_a due to the main elongation, displacement, slippage, shrinkage, crush, and additional sources. It has the following fields.

i. Wall and Segment

The wall segment between openings is shown as e.g. B-3, 2 = second segment on Wall 3 on Shearline B.

ii. Force Direction

E->W, N->S, etc. Can be "Both" if the data is identical in both directions because forces and hold-downs used are the same. In that case only one line is output instead of two.

iii. Hold-down

The hold-down name from the database that is selected at the tension end of the segment. There is limited space for the name, so it may be truncated.

iv. Uplift Force

The unfactored hold-down force at that location, including force transferred from floors above, and including the dead, shear and overturning components..

v. Elong/Disp

This gives the vertical displacement for hold-downs, that is, the combined elongation and slippage

- Manuf – This is the displacement for the hold-down with the maximum anchor bolt length given in the manufacturers literature, or with no bolt contribution those hold-downs that do not include it
- Add – This is the elongation additional bolt length in excess of the manufacturer's maximum, or the elongation of the entire bolt for those hold-downs that do not include anchor bolt elongation
- d_a – Vertical displacement due to elongation = Manuf + Add

vi. Slippage

This input does not apply to the Canadian version of the program, and dashes (-) appear in these columns.

vii. Shrinkage d_a

The calculated displacement due to wood shrinkage. The moisture contents appear in the legend below, and the length subject to shrinkage on each level appear in the Story Information table.

viii. Crush + Extra

The value of wood crushing plus any additional components entered in the hold-down settings appears in one column. Although this column usually holds the same value for all segments, it is possible that at some locations the crush is zero because there is no compression force at the usual compression end of the shearwall.

ix. Total d_a

The total vertical displacement for each segment, or sum of the displacement, shrinkage, crush, and additional displacements, is output in a column.

x. Hold-down deflection

The resulting horizontal in-plane segment deflection from the hold-downs, or d_a multiplied by the segment aspect ratio H_s/L_s , is output in a column. This value is then transferred to the Deflection table. ‘

xi. Anchorages

For anchorages, in place of the displacement value, the program outputs, e.g.

($nu = 153$)

giving the value of the unit lateral nail resistance N from O86 10.9.4, needed in the equation for anchorages in 9.7.1.1.

xii. Legend

The legend spells out the calculations that are used to arrive at each value, giving the value of any needed data not in the table such as percent moisture content and steel modulus of elasticity.

e) Deflection Table

i. Wall and Segment

The wall segment between openings is shown as e.g. B-3, 2 = second segment on Wall 3 on Shearline B.

ii. Wall Group

The wall design group

iii. Force Direction

E->W, N->S, etc. Can be "Both" if the data is identical in both directions because forces and hold-downs used are the same. In that case only one line is output instead of two.

iv. Wall Surface

Some of the columns (shear deflection and nail slip) have different values for different sides of the wall. To calculate them, different v values for each side of the wall are used as well. Therefore for each segment, if it is a composite wall, there are two lines output.

v. Wall surfaces are output as they are in the shear table, as Int or Ext for perimeter walls, and 1 or 2 for interior walls.

vi. Shear v

The unfactored unit shear value on the segment (that is, strength level shear for seismic design) is output. The proportion that goes into each side of the wall for composite walls is given.

This value depends on the distribution method input in the Design Settings, and when deflections are equalised, in many cases it can be zero. See 3.b)i above.

vii. Segment width L

This is the full length of the segment between the outside edges of the wall end studs.

viii. Wall height H

Although this does not change for all segments within a level, it is output in a column as it is integral to the calculations.

ix. Bending

For the bending component, the following are output on the first of the two lines for the wall segment:

- End stud section area A
- Resulting deflection

x. Shear Deflection

The calculated shear deflection is output on both lines for the wall segment. The legend shows the calculation.

xi. Nail slip

The following values are shown for the nail slip:

- Shear force per panel edge fastener V_n
- e_n value from from O86 Table A.9.7 for wood panels and for the USA SDPWS Table C4.2.2D for gypsum wallboard.;
- Resulting deflection

If the value exceeds the maximum value in the Table A.9.7, the maximum value is used. The program places an asterisk beside the value and issues the following warning.

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

xii. Hold-down Deflection

This value is transferred from the Hold-down Displacement table, where the components of hold-down displacement are given.

xiii. Total Deflection

Deflection from bending + shear + nail slip + hold-down, as per O86 9.7.1.1

Note that shear + nail slip should be the same for both sides of a composite wall, or else one side has zero force and the shear + nail slip for the other side is used. If this is not the case because the numerical procedure failed, the largest shear + nail slip is used.

xiv. Legend

The legend spells out the calculations that are used to arrive at each value, giving design code references and where to find data not in this table, e.g. the Stud modulus of elasticity in the Framing materials table.

f) Storey Drift Table

A table has been added to the program to show the storey drift calculations ASCE 7 equation 12.8-15 and the allowable storey drift from ASCE 7 Table 12.2-1. The allowable drift is shown for each level; the maximum storey drift for any shearwall on the level is shown on one line for each force direction below the allowable values.

i. Wall height

The wall height h is shown for each building level, along with the storey height h_{sx} for that level, which is the wall height plus the upper floor thickness.

ii. Allowable drift

The allowable drift calculated according to NBCC 4.1 8.13 (3) is shown for each level only.

iii. Amplification Factor R_d R_o

The value of the force modification factors $R_d * R_o$ as they are used for the amplification in 4.1 8.13 (2), are entered on each line. Note that these values can be different for different force directions.

iv. Importance Factor I

The importance factor I calculated from the Occupancy category entered in the sited dialog. This is the same for the entire structure, but is repeated in the table to show all variables for a calculation on the same line.

v. Maximum Deflection and Line

For each force direction on each level, the table shows the largest of the deflections on any shearline in the force direction as well as the line the maximum was on.

vi. Amplified Deflection

The program shows the maximum amplified deflection on the same line.

vii. Response Ratio

The ratio of the maximum amplified deflection to the maximum allowable is shown.

viii. Failure Message

The program places an asterisk (*) beside any response ratio that is greater than 1.00. A red failure message appears below the table.

ix. Legend

A legend has been added explaining each column in the table.

g) Table Legends

To all the above tables a legend has been added to the table or an existing legend improved such that it shows detailed information pertaining to each column on a separate line.

h) Show Menu and Display Options Toggles

For all the above tables, items have been added to the *Show* menu and the *Display* checkboxes in the *Options* settings that allow you to turn off the tables in the screen display and in the printed output, to reduce the volume of output, similar to all other tables.

i) Elevation View

i. Segment Forces

The force on each shearwall segment arising from the distribution of forces described in 3 above are depicted by small arrows at the top of the wall at each segment, with the force in pounds on that segment shown.

E: Shearwall Design Iterations

This section refers to the iterations needed to design shearwalls for the unknown values in order to determine the stiffness and/or capacity needed for load and force distribution, then to go back and redesign based on the new load distribution.

1. Previous Versions

a) Structural Iteration for Irregularities

For seismic design, the program went through two iterations of designing the entire structure as follows.

i. Iteration 1

The program designed using the user-input method of designing for hold-downs and drag struts.

ii. Iteration 2

The program determines irregularities on the structure, and if *Applied Force* had been used as the method of determining hold-down and drag strut forces, the program program redesigns the entire structure, determining hold-down and drag strut forces for the shearlines affected by irregularities by shearwall capacity, to comply with NBCC 4.1.8.15-6 where applicable.

b) Rigid Distribution

i. Rigidity based on Shearwall Capacity

The program designed walls for flexible diaphragm design, and then used the rigidities based on the capacity of those walls for rigid diaphragm shearwall design. .

It did not go back and recalculate rigidities for the new walls designed for rigid design, and continued to show the flexible-designed shearwall rigidities as the rigidities of the rigid-designed walls.

ii. Equal Rigidity or Manual Rigidity Entry

For these distribution methods, the rigidity is independent of shearwall design, so no iterations were necessary.

c) Distribution within a line

Before the introduction of deflection analysis, if you selected not to allow dissimilar materials on the line, it was possible to determine load distribution within a line based on relative capacities and identify the critical wall for design ahead of time and an extra design iteration was not needed.

If dissimilar materials are allowed, the program must design each wall separately so that the design could result in a redistribution of loads, and a iterations were performed to design the wall and redistribute loads until a there was no difference in walls designed.

d) Hold-down vs Anchorage Loop

If the user chooses to allow anchorages, the program does several iterations of design based upon trying to counteract a failed design by increasing the Jub factor. On the first loop it places the hold-downs only where they are required by CSA O86. Then it places them at the ends of the shearline, then at the ends of all walls, then at the ends of all segments.

This acts in concert with the Design Setting that indicates whether hold-downs should be at those locations, and the setting that allows you to over-ride these locations to achieve design.

2. Structural Iteration for Irregularities

The program still performs two designs of the structure for the purposes of determining irregularities, however this is now part of a larger design sequence that includes a third run for final design check.

Note that the iteration for irregularities has taken on added significance because of the introduction of deflection analysis. If the program automatically calculates certain hold-down forces using shearwall capacity, these hold-down forces impact the hold-down component of the deflection equation.

3. Design Iterations Per Level

a) Reasons for New Iterations

i. Stiffness Analysis

Now that load distribution can be affected by the stiffness due to deflection analysis, it is no longer possible to predict ahead of time which wall segment will be critical design, and an iterative procedure is required.

ii. Rigid Analysis

It is an improvement to the program to redesign walls for rigid analysis based on the stiffnesses from the rigid analysis. This improvement became especially important because of the variations in wall rigidity that result from deflection analysis.

Therefore, on each level, first for rigid, and then for flexible, the program runs through two iterations of shearwall design.

b) Iteration 1

The first iteration is used to design shearwalls to determine rigidities and capacities for load and force distribution for the second, final design iteration.

i. Distribution to Shearlines

For flexible analysis, distribution to shearlines is independent of shearwall design, and is the same for both iterations.

For rigid analysis, if *Shearwalls have equal rigidity* or *Manual input of relative rigidity* is selected, then the relative rigidity of the shearlines is also independent of shearwall design, and is calculated by the sum of the wall lengths multiplied by either 1 or the manual input.

For the other rigid analysis options (*Use shearwall capacity* or *Use shearwall rigidity*), the rigidities of the shearwalls designed on the second iteration of *flexible* design are used as the rigidities for the first iteration of *rigid* design.

ii. Distribution within Line

With shearline forces established, on the first iteration, for both flexible and rigid design:

If *Distribute forces to wall segments based on rigidity* is **not** selected, or if *Shearwalls have equal rigidity* is selected, the program distributes equal force per unit foot to segments within the line.

If *Manual input of relative rigidity* is selected, then the user input rigidities are used to distribute forces to each shearwall.

Otherwise, the force is distributed each shearwall using the relative capacities of the shearwalls. Since walls are not yet designed, the deflections are not known at this point, and the selection of *Use shearwall deflection to calculate rigidity* must use the capacity method on the first iteration.

iii. Shearwall Design

With possibly different forces distributed to each wall, the walls are designed. This shearwall design is used to determine rigidities for the second iteration.

c) Iteration 2

i. Force distribution

If *Shearwalls have equal rigidity* or *Manual input of relative rigidity* is selected, there is no reason for a second iteration, and the program stops at the first iteration, and delivers design results for the shearwall design for the first iteration.

Otherwise, using the walls designed with iteration one, the program determines the force distribution using rigidities derived from either shearwall capacity or deflection analysis, according to the design setting selected. The force distribution is for distribution of loads to shearlines using the rigid diaphragm method, and distribution to forces within shearlines using both methods.

ii. Distribution to Shearlines

The rigidity of a shearline is estimated using the capacity method by the capacity of the designed wall on that shearline, in lbs/in, and by the deflection method by

$$\Sigma F_i/\Delta_i,$$

where F_i and Δ_i are the forces and deflections on each segment. If forces are also distributed within the line based on deflection, so that deflections are equalised, this is just F/Δ , the total force over the common deflection. Loads are then distributed to the lines using the torsional rigid diaphragm method.

iii. Distribution within Shearlines

If the setting *Distribute forces to wall segments based on rigidity* is selected, for both the rigid and flexible method, then the program calculates the force distribution on the line based on relative rigidities of segments on the line. Otherwise equal force distribution is assumed.

If *Use shearwall deflection to calculate rigidity* is selected, then different forces are placed on all full-height segments.

If *Use shearwall capacity* is selected, the different forces can be placed on each shearwall. At this stage, the program distributes loads based on the actual factored capacity of the walls from the last iteration.

iv. Design

Each shearwall is again designed.. Note that these walls may have different deflections and possibly capacities than those used to distribute forces to design the walls; this is dealt with by the Final Design Check, below.

d) Number of Iterations

It would have been possible to continue this process to further iterations. This was not done because:

i. Distribution of Loads to Shearlines

An iterative procedure for rigid diaphragm analysis would tend to concentrate loads on a particular shearline. That is, a heavily loaded line would require more capacity, would become more stiff, would draw more load, and so on. This is not a desirable shearwall design for other reasons.

ii. Final Design Check

The final design check described below now traps and indicates to the user those rare cases where walls passing on the second iteration failed the final design check. This was deemed preferable to the increased processing time that would be needed for all designs if there were more iterations.

iii. Non-convergence

If we established the condition for ending the iterations that shearwall design did not change from one iteration to the next, it would be possible for the procedure to oscillate from one solution to another without ending.

4. Final Design Check

a) Structural Design Check

For the entire structure, forces are distributed based on the capacities, stiffnesses, and shear resistance distribution of the walls designed on the second per-level iteration and the hold-down and drag strut procedures determined value from the second structural iteration for irregularities, if one was needed.

The designed walls are then checked against the new forces, and the results reported in the Design Check output. :

b) Reasons for Check

i. Output Report Consistency

This ensures that the output reports show the force distribution, the p value, the shearwall deflection, and shearwall design capacity from the same set of walls.

ii. Possibility of Failure

Although it rarely occurs, it is possible that the walls designed on the second iteration cannot withstand the forces created from their rigidities. The design check shows this situation, indicating to the user via the following warning message that the problem is to do with design iterations and can be remedied by more manual input.

Warning: For shearline(s) [A, B, C, ..., 1, 2, ...], a shearwall that passed the design check on the initial run failed the final check when forces were redistributed to shearlines and/or wall segments within a line using [shearwall deflection, shearwall capacity]. Try to adjust wall materials to achieve a passing design, or choose a different force distribution option in the Design Settings.

F: Other Engineering Design Issues

1. Shear Strength of Unblocked Shearwall (Bug 2250)

The shear strength for an unblocked wood-based shearwall, according to the asterisked note to CSA O86-01 Table 9.4.4, is the shear strength for a blocked shearwall 600 mm stud spacing and 150 mm edge nail spacing, regardless of the actual composition of the shearwall, multiplied by the J_{ub} factor. Shearwalls instead used the actual nail and stud spacings for the shearwall to determine shear strength, ignoring the note. Since 600 mm stud and 150 edge spacing are the maxima, this created non-conservative resistances. The program now applies the note.

Note that the asterisked note for a strength increase in Table 9.5.1A is not applied, even if the actual stud spacing is 400 or less, because it is overridden by this requirement.

2. Gypsum Wall Board for Wet Service Conditions (Bug 2251)

If wet service conditions are selected in the design settings, the program now does not consider the shear resistance for gypsum, as per Table 9.5.1B note 2. A note appears under both the Seismic Information table and Shear Results table to that effect.

3. Segment Output in Seismic Shear Results Table (Bug 2275)

In the Seismic Shear Results table, the segment rows indicated that the F_v and F_v/L values were for "Both" directions when the actual values for the opposing directions were different. The values that were shown for "Both" were for the S->N and W->E directions, and the opposing directions were not shown.

The problem did not occur for the "Wall" rows when there were no segments.

4. Gypsum Wallboard Storey Capacity for One Directional Loading (Bug 2273)

In the 'Percentage Storey Shear Resisted by Gypsum Wallboard' table, the gypsum wallboard (GWB) capacity was reported as zero when there is a force in only one direction of a particular orientation, e.g only North-South, but not South->North. This problem would ordinarily occur only in test cases and not realistic structures.

5. Percent Gypsum Shear for Asymmetric Wind Loads (Bug 2264)

The percentage storey shear resisted by gypsum for shearlines where the wind shear in one direction is not equal to the wind shear in the opposite direction incorrectly used the shear load in the opposite direction in the calculation. This has been corrected.

G: Load Distribution and Accumulation

1. Bi-Directional Seismic Rigid Diaphragm Analysis (Bug 2282)

The program did not do seismic rigid diaphragm analysis in both force directions, it only analysed east-to-west and south-to-north directions. This became problematic when deflection analysis was added to the program; due to hold-down configuration, stiffness can be different in opposing directions, so that rigid analysis is required in opposing directions.

Note that direction of force was being considered when distributing shear within the line, based on the stiffness of individual segments, as it should be.

In Plan view, the seismic shear force was displayed as a bi-directional force, now it is displayed as a directional force (similar to how wind forces are displayed). When you select to display critical forces, the worst case seismic force on each shearline is now displayed.

2. Wind Uplift Loads over Openings (Bug 2132)

When a wind uplift load is applied to an entire wall line, the uplift load did not appear over openings in elevation view, and the load over the openings was not distributed to the hold-down forces at the sides of the opening.

3. Shearlines with Zero Capacity and Non-zero Shear Force (Bug 2211)

Shearlines that have no shear capacity because some of the constituent walls are composed entirely of segments that are too narrow, and all the other walls on the shearline are sheathed entirely with gypsum and *Ignore gypsum* setting is selected, would nonetheless receive shear load. This resulted in failed shearwalls and a warning that J_{hd} factor is less than zero. The program now identifies this case and does not include the shearline line in the load distribution process, for both rigid and flexible loading.

4. Full Height Sheathing Output for Excluded Gypsum Walls (Bug 2355)

Shearwalls that have no shear a capacity because they are sheathed entirely with gypsum and *Ignore gypsum* setting is selected would show a non-zero length of full-height sheathing in the *Shearline, Wall and Opening Dimensions* table. Now the program shows a zero length in this case. The legend at the bottom has been modified to indicate that the FHS column refers to the full height sheathing *available for shear resistance*.

Because the *Ignore gypsum* setting is set separately for seismic and wind design, an extra column has been added to the table to show full-height sheathing length for wind and seismic separately.

5. Accidental Eccentricity Reference in Log File for Medium Rise Wind Loads (Bug 2295)

In the log file, the reference to the accidental eccentricity for low rise wind loads, used the seismic NBCC clause 4.1.8.11 10) rather than the correct wind reference: NBCC Structural Commentary 36, 37 Fig I-16 Case A.

The seismic reference might lead one to believe that 10% D should be used rather than the zero accidental eccentricity the program is correctly using.

6. Low-rise Wind Load Rigid Diaphragm Cases in Log File (Change 91)

The titles to the sections in the log file for low rise rigid diaphragm wind load cases have changed from Longitudinal and Transverse to Case A and Case B to match the terminology in the NBCC Structural Commentary Figure I-7.

7. Design Cancel (Change 100)

Fixed “Cancel” of design such that it cleans up the what it is doing on the current floor and then exits. Previously it was doing large amounts of unnecessary processing, and the box would freeze on the screen, but not do anything or affect the program.

H: Load Generation

1. Maximum Seismic Base Shear V_{max} in Log File Output. (Bug 2054)

The log file did indicate when the maximum seismic base shear value V_{max} from 4.1.8.11 2) c) governs. In this case, the program showed this value as the resulting base shear V , but it does not correspond with the S value shown, or with the equation that is shown above.

Now a note is output below the Calculation of the total design base shear table noting that V is calculated using 4.1.8.11 2)c) equation, and (*unless 4.1.8.11 2) c) used*) has been added to the base shear equation:

2. Input of T Greater than Maximum (Bugs 2281, 2130)

Previously, the program did not prevent you from entering a value of T in the site information box greater than the maximum limit on T given by NBCC 4.1.8.11 3) d) iii), that is, $0.1(h)^{0.75}$. A period this entered would be used for load generation without any warning or note appearing in the output.

Now the program does not allow you to enter a period greater than the maximum allowed.

3. Vertical Location of Upper Wall Load (Bug 2107)

The bottom of generated wind area loads on the upper portion of walls was not midway up the wall, instead midway plus $\frac{1}{2}$ the floor depth. This created a higher z -value used for the evaluation of the exposure coefficient and the topographic factor. The effect was conservative and small, creating wind loads at most 3% too heavy.

4. Area Load Tributary Width and Magnitude Reporting (Bug 2108)

Automatically generated area loads on the lower half of walls are given a vertical tributary width that is derived from the upper half of the storey, so it includes the joist depth of the storey above when it shouldn't. These incorrect widths are shown in the load lists in the load input screen and Design Results.

The incorrect width is used in creating the load intensity shown in these lists, so that the total load on the wall segment remains the same as if the correct tributary width was used. The line load created on the diaphragm and shown in plan view is also correct, so this problem has no impact on force generation or design

I: Input and Output

1. Menus and Toolbars

a) Window Bars

The bars that appear at the top of the Plan View, Elevation View, and Design Results View have been modified as follows

i. Settings

The *Settings...* item has been removed to the right of the bar, in order that items that refer to the operation of the window appear first.

ii. Hold-down and Log File Items (Change 60,68)

iii. The button *Hold-downs* has been added to invoke the Hold-down database editor, and the button *Log File* has been added to open the Log File. These appear to the right of the bar.

iv. Ellipses Removed (Change 60)

Ellipses (...) have been removed from those items that do not lead to a dialog box appearing – *Show, View, Preview, Wide View*.

v. Starting Out (Change 76)

The button that was called “Help” that invoked the “Getting Started with Shearwalls” box has been renamed *Getting Started...* It remains visible now throughout program operation; it used to disappear after walls were extended upwards.

2. Input Dialogs

a) General

i. Metric Force Input Precision (Change 80)

The number of digits displayed after the decimal place when forces input as kilonewtons are refreshed has been increased from 1 to 2.

b) Getting Started with Shearwalls

This box has been updated to

- better describe the sequence of program operations, for example creating openings for all levels before extending walls.
- describe more fully the purpose of blocks as eventual roof shapes
- better indicate how to perform key operations, such as the shift-key wall move and navigating within the design results output
- add the Load Input, Design, and Design Results steps to complete the process
- include information about hold-down connections and deflection analysis

c) Structure Dialog

i. Status Bar Messages (Change 58)

Status bar messages have been added to explain the use of each of the input fields in the box.

d) Wall Input View

i. Default Sheathing Orientation

The default sheathing orientation for standard walls has been changed from vertical to horizontal sheathing.

ii. Both Sides Same for Sheathing Thickness and Orientation (Change 74)

After checking the checkbox that indicates both exterior and interior surfaces have the same sheathing materials specification, and making changes to the sheathing thickness or orientation, the sheathing on the opposite side to the one you were editing before you checked the box was not being updated for the changed property. This results in walls that are supposed to have the same sheathing on either side not being treated as such in the design engine. If the sheathing also has unknowns, it is possible for the design engine not to design the interior side (Side 2), outputting question marks in place of materials specifications and zero design capacity.

iii. Unknown" Exterior Gypsum Wallboard Thickness (Bug 2200)

If gypsum wallboard sheathing with more than one choice of thickness is selected as the material for the exterior surface, the choice of "unknown" was unavailable from the drop down list of thicknesses to choose from.

Now, "unknown" is available, unless there are structural wood materials on the other side of the wall.

iv. Building Level in Wall Materials Input Label (Bug 2291)

The label on the group box surrounding the wall materials often showed a building level other than the one you had selected to modify the materials on. It now shows the correct level.

v. Five Ply Plywood for 12.5 mm Thickness (Change 84)

Although you could select five-ply plywood for plywood of 12.5mm thickness, the five plies revert to four plies when the selected wall was no longer selected. This has been corrected.

e) Openings Input

i. Impact Resistant Checkbox (Bug 2153)

The Impact – resistant checkbox is shown in the Openings view, but has no effect for the Canadian version of Shearwalls

f) Load Generation

i. Snow Load Proportion Note (Bug 2053)

The note corresponding to the asterisk beside the input of snow mass was missing. It now says "25% used, see NBCC 4.1.8.2" .

g) Default , Options and Format Settings

i. Default Floor Depth

In the *Default Settings*, the setting *Floor joist depth (in)* has been renamed *Floor depth (in)*, because the depth includes flooring materials as well as the joist depth.

ii. Default Wall Thickness

In the *Default Settings*, the *Wall thickness* has been changed to *Wall display thickness*, to emphasize that the input affects only the drawing on the screen, and not the actual thickness of the wall studs used for hold-down deflection analysis. The default for that purpose is set via the stud size in the default Standard Wall.

iii. Default Shearline Elevation Offset (Bug 2198)

The default shearline elevation offset has been set to 1 joist depth from 0.5 joist depths. 1/2 of the default 10" joist depth is less than the default plan offset of 6", so that a shearwall on a multi-storey building that was within the plan offset or another would nonetheless be placed on a different shearline, so that it complied with the elevation offset with walls on the level above. For example, a wall offset 6" on the floor below, but not above, would be placed on its own shearline.

The problem was exacerbated by the fact that 1/2 the default joist depth was less than the default snap increment, and walls must be created at least one snap increment apart. Therefore this problem would occur in every case for users using the default shearwalls settings.

iv. Shearwall Material Options for Elevation View (Bug 2150)

In the Display group in the Options Settings, and the corresponding menu items in the Show menu for Elevation View,

- The “Nailing” choice was removed because the nailing is on the same line as the sheathing.
- An item has been added to turn on and off the legend, to allow for more vertical space.

v. Obsolete Options

The checkboxes for *Design Warnings* and *Shearwall Segments Table* have been removed. They were obsolete items that had no effect on the program.

vi. Gridline Snap Increment Setting (Bug 2188)

Changing the *Mouse click interval* in the View Settings causes the *Display Gridlines every ___ snap increments* to change automatically when exiting the box in order to maintain the same gridline display distance as before the changes. However, it did so even if the you had changed the *Display gridline* manually. Now, the program checks if it has been changed manually before automatically adjusting.

h) Design Settings

i. Include Deflection Analysis

A checkbox has been added allowing you to disable the new Deflection Analysis feature, which can be costly in terms of programming time. This checkbox controls other inputs dependent on deflection analysis, such as the *Use shearwall deflection to calculate rigidity* setting.

ii. Wind Load Design Procedure (Change 105)

Change *Wind load design standard* to *Wind load design procedure*. There is only one standard, the choice is of procedures within that standard.

iii. Shearwall Rigidity per Unit Length

The data group previously known as *Rigid Diaphragm Analysis* has been changed to *Shearwall Rigidity per Unit Length*, because this rigidity is used for both the distribution of applied loads to the shearlines using the rigid diaphragm method, and for distribution within a line if the *Distribute Forces to Wall Segments based on Rigidity* box is checked.

A new method has been added to the previous three selections – *Use shearwall deflection to calculate rigidity*.

Refer to the section in *Deflection on Shear distribution within a line* for the significance of this setting.

iv. Distribute Forces to Wall Segments based on Rigidity

A checkbox has been added called *Distribute Forces to wall Segments based on rigidity*. It is active only if

Refer to the section in *Deflection on Shear distribution within a line* for the significance of this setting.

v. Height-to-width Ratio (Change 104)

The input for maximum ratio, height to width has been removed from the program, as the CSA O86 mandates this ratio separately for blocked and unblocked shearwalls.

vi. Disregard Shearwall Height to Width Limitations (Change 104)

A checkbox has been added to allow you to disregard the height to width limitations entirely. This is ordinarily used to allow for proprietary non-wood shear resisting elements.

vii. Moisture Conditions

The moisture conditions allow for entry of the precise moisture content, if the “*Use deflection analysis*” setting is checked, as moisture content is needed to calculate shrinkage. A moisture content of 19% or greater corresponds to wet service or fabrication conditions upon which design factors are based.

3. Output

a) Table Headings, Legends and Notes

i. Design Case in Heading

At the top of each table, and at the top of each page of results for each table, the design case is now given in brackets, e.g. (*rigid wind design*). Previously this just appeared at the top of new pages in the *Shear Results* table.

ii. Separate Lines

The following legends have been broken into separate lines for each item for enhanced readability:

- Sheathing Materials
- Framing Materials
- Shear Results
- Hold-down Design
- Drag Struts

iii. Additional Information

The following legends have been improved:

- Sheathing Materials
- Framing Materials
- Shear Results
- Hold-down Design
- Drag Struts

Among the more common improvements are

- Adding descriptions for table rows and columns that previously did not have one
- Integrating notes into the legend, and eliminating duplication of information in notes and legend
- Adding design code clause references
- Updating design code references to CSA O86-09
- Changing terminology to match exactly that in the design code
- Referencing other tables when necessary.

iv. Legend-Note Separation

A blank line has been inserted between the legend and the notes for all tables, for better readability.

v. Failure Messages (Change 70)

Any warning message indicating design failure in any way is now in red type. For example nail withdrawal design warnings

vi. Hold-down and Drag Dtrut Calculation Procedure (Change 83)

The program now indicates in the legend whether the hold-down and drag strut design force shown is based on applied shear force or shearwall capacity. A setting in the Design Settings controls this.

b) Design Settings table

i. Hold-down and Drag Strut Force Calculation Method

Two lines have been added

Drag strut forces based on

Hold-down strut forces based on

These then show *Applied forces* or *Shear capacity*.

The setting had been in the program, but not echoed in the output.

ii. Design Shear Wall Force/Length

A cell labelled *Design Shear Wall Force/Length* has been added to reflect values in the cell come from the new design setting, *Design shear force based on wall rigidity*.

iii. Height-to-width Ratio (Change 104)

Despite the fact that the user has no control over this, we still show this value, which is now always 3.5, and added the unblocked height-to-width ratio limit of 2.0

iv. Disregard Height to Width Ratios (Change 104)

This setting is manifested by dashes appearing in the Height-to-width ratio field.

c) Site Information

i. Calculated Period (Bug 2279)

In the Site Information section of the Design Results, the calculated period shown was the one entered in the Site Dialog, rather than the period calculated in 4.1.8.11. The entered period is also shown, so these two lines were always the same.

d) Percentage Storey Shear Resisted By Gypsum Wallboard Table (Change 80)

In this table, some of the lines dividing the columns have been removed to make the table have a more consistent format with other tables.

e) Components and Cladding Table

i. No Capacity Message (Change 73)

When a material such as gypsum wallboard that has no sheathing C&C capacity was used on an exterior surface, the program was outputting a warning note saying it failed the withdrawal capacity check, and another saying that the material on the exterior has no shear capacity. Only the second note, about no shear capacity, is output now.

f) Irregularities Table and Screen Messages

i. Notes for Drag Strut and Hold-down Capacity Provisions (Bug 2021)

The correction made for version 7.2, listed below, was reverted to the previous behaviour for subsequent versions, 7.21 and 7.22. This correction has been restored.

ii. Reference to Capacity of Elements Supporting Discontinuous Walls (Change 85)

A reference to clause 4.1.8.15-4 was showing up instead as ????. This was in a warning message saying that drag struts and hold-downs on floors below a discontinuity must be designed for the capacity of the upper floor.

iii. Irregularity Check Warning Message Box (Change 86)

The message box that appears on the screen when the design fails due to Irregularity 4 for in-plane stiffness or Irregularity 6 for a weak storey, from NBCC 4.1.8.6, appeared when the irregularities existed in the walls designed for flexible diaphragm analysis only. If these irregularities existed for rigid diaphragm analysis, but not flexible, the box for Irregularity 6 did not appear, and the box for Irregularities 3,4 and 5 either didn't appear

or didn't mention Irregularity 4 for stiffness. The boxes now appear for rigid analysis when they should.

4. Miscellaneous

i. Drag Strut Spelling (change 82)

Wherever the word *dragstrut* appears in Shearwalls, it has been changed to *drag strut*.

J: Installation and System Issues

1. Program Data File Locations (Bug 2265)

Because Windows 7 and Windows Vista operating systems do not allow write access to the Program Files folders to those users who are not running the program as Administrator, making it impossible for them to save changes to the stud material database, the hold-down database, settings, and standard walls, these files are now placed in a new location by WoodWorks.

It was also necessary for those users who were not administrators on their computers to enter a key code each time the program was run.

These restrictions were more severe on Windows 7 than Vista.

The program now stores the support files for the program in the following folders

Windows 7/Vista:

C:\Users\[username]\AppData\Local\WoodWorks\CWC\Canada\8\

Windows XP

C:\Documents and Settings\[username]\Local Settings\Application Data\WoodWorks\CWC\Canada\8\

The program also saves the files to the following folders:

Windows 7

C:\ProgramData\WoodWorks\CWC\Canada\8\

Windows XP

C:\Documents and Settings\All Users\Application Data\WoodWorks\CWC\Canada\8\

These are repositories for the files to be copied to each new user's data folders when they first use the program. This allows a system administrator to install the program, but others to use it without restrictions.

A more complicated set of procedures for network installations is described in the Read Me files for each program.

2. Log File Issues

i. Crash for Non-Administrators Due to Temporary Log File (Bug 1990)

For Windows Vista and Windows 7 operating systems, those users who do not have administrator privileges can experience a crash when running a project that has previously been designed, Shearwalls would crash. Deleting or renaming the log file in the project folder prevented the crash.

The program now places the temporary file that it uses to construct the log file in the folder designated by Windows for program data, preventing the crash.

ii. Log File Closing (Change 75)

The program now automatically closes the log file when a document is closed. Previously the log file remained open even if Shearwalls was exited. This occasionally caused program crashes when a log file remained open for a file that was then reopened.

Shearwalls 7.22 – Feb 9, 2010 - Design Office 7, Service Release 3

This version was released to correct the following problem that was introduced in 7.21

1. Framing Material and Species Input (Bug 2114)

When the framing material or species was changed In the Wall Input form, the program did not record the change, instead reverting to the default value the next time that input field was accessed, or when the building was designed.

As a result, the calculation for shear capacity always used the density value Spruce-Pine-Fir,, which according to NBCC 9.4.3 has a species factor of 0.8, therefore is conservative for Douglas Fir and Hem-Fir materials and non-conservative for Northern Species. In addition, the desired material specification does not appear in the Design Results output.

This problem precluded the use of MSR and MEL materials, or any custom materials you enter in Database Editor.

It was still possible to change your framing material and species specification via standard walls – you first create a standard wall, select the desired materials, and then select the standard wall as your shearline wall.

The following changes were also made:

3. Relative Rigidity for Standard Walls (Bug 2120)

When the *Shearwall Rigidity* design setting is not *Manual input*, the program now allows the input of a relative rigidity for Standard Walls. It can then be used on walls created from those standard walls for projects with different rigidity settings, or if you change the rigidity setting in the same project. Previously, it the program disabled the rigidity input, and displayed the same for standard walls as it does for regular walls, that is to show “1.00 (Wind design)” and assign a value of 1.0.

4. Name Field for Standard Walls (Bug 2119)

The *Name* input for Standard Walls was widened to coincide with the length of the wall names in the dropdown list.

5. Unsorted Openings* (Bug 2099)

This bug was never detected in the Canadian version of the program, but the fact it was in the USA version leads to the strong possibility that it could occur for Canada as well:

Although the program sorts the openings input in Opening view from left to right on the wall, occasionally the sequence of openings becomes unsorted in the course of program operation. Attempts have been made to capture this problem and resort them to avoid problems that were occurring in the following program areas.

a) Full-height sheathing Determination

We have now ensured openings are sorted in determining the length of full-height sheathing segments, and all the effects this has on force distribution and shearwall design.

b) Hold-down force Determination

We have now ensured openings are sorted in determining the segment length to be used in hold-down force calculations

c) Drag strut Force Determination

We have now ensured openings are sorted in determining the length of shearwall segments to be used in drag strut force calculations.

d) Shearline Force Determination

We have reduced the possibility that unsorted openings are affecting shearline force calculations, but it is possible that unsorted openings could still be having an effect in this area. If you see suspicious shear results, check for unsorted openings; it may be necessary to re-enter the openings.

Shearwalls 7.21 – Oct 1, 2009 - Design Office 7, Service Release 2a

This version was released to correct the following problems that were introduced in 7.2

1. Reversal of Seismic Sa Values (Bug 2060)

In the Site dialog, the value of the damped spectral response acceleration factor $Sa(T=0.2)$ showed the value for $Sa(1.0)$, and $Sa(1.0)$ showed the value for $Sa(0.2)$. If you had entered these values manually, then these incorrect values were also used in the load generation process, so that the generated base shear was typically much less than it should be, resulting in non-conservative design. These values were also reversed when displayed in the Design Results output and log file reports.

Note that the values of $Sa(1.0)$ and $Sa(0.2)$ were also reversed when loaded into the Site dialog boxes from the table of values for the city selected in the Design Settings. As the values were reversed again when used in design and output, if they were not changed in the Site dialog, the correct values were used to generate seismic loads and appeared in the output reports. However, if the values in the Site dialog were corrected before design, or if values for a city not in the list were manually input, then the $Sa(0.2)$ and $Sa(1.0)$ values were switched in the design process, causing significantly non-conservative loading.

6. Crash for Non-shearwalls (Bug 2080)

In version 7.2, if there are any non-shearwalls on the structure, and the “Disable gypsum contribution” setting is not set, the program crashes when performing Design. This has been rectified. Note that the “Disable gypsum” setting is not the default setting, so that this crash was highly likely to occur.

The following problems were also corrected:

7. Random Design Crash (Change 50)

A random and very infrequent crash on Shearwall design was removed.

8. Version History in Installation (Change 51)

It is now possible to access this document directly from an icon on the start menu rather than indirectly through the Readme files.

Shearwalls 7.2 – July 30, 2009 - Design Office 7, Service Release 2

This is a free service release update to address issues submitted by our users since the release of version 7, and also to implement more improvements to the software.

A: Load Generation

1. Seismic Response Modification Factor (Bug 1904)

The message upon seismic load generation that allows you to change the NBCC seismic response modification factor R to the one appropriate for the materials being used has been improved in the following ways:

2. R_d and R_o

The program now applies the message on changes to both R_d and R_o in NBCC 2005 4.1.8.9, rather than just R , as in the NBCC 1995.

a) In Presence of Gypsum

Currently, when gypsum materials are present, the program allows you to override the warning message and use an R_d value greater than 2.0, the value in NBCC table 4.1.8.9 for gypsum and wood in combination.

Now the program gives you a choice of automatically selecting the *Disable gypsum contribution* or changing the R value to one less than or equal to 2.0.

b) No Gypsum Present

The program now warns you if you have unnecessarily entered a value of 2.0 or less, corresponding to gypsum materials, when there are no such materials in a particular direction. It allows you to change the value to 3.0, the value for wooden shearwalls in Table 4.1.8.9

c) Disable Gypsum Contribution Setting Checked

The program now warns you if you have unnecessarily set the *Disable gypsum contribution* design setting with an R_d value of 2.0 or less for a particular direction. It offers you the choice of automatically deselecting the setting, or increasing the R_d value to 3.0, the value for wooden shearwalls in Table 4.1.8.9

d) Analysis in Both Directions

The above messages and actions are taken independently for each force directions, to comply with 4.1.8.9 (3). The program had been making the changes to both directions, even if they applied to only one.

3. Seismic Load Generation

a) Building Mass on Flat Roof Overhangs (Bug 1890)

Shearwalls does not create building masses or for those portions of flat roofs that are part of the overhang, resulting in lower seismic loading for those roofs due to the absent building mass and snow load. This problem has been corrected by not allowing structures with flat roofs to have overhangs. To correct existing projects with flat roofs you need to enter the *Roof Input* dialog and deselect and reselect the flat roof. Doing this sets the overhangs to zero.

b) Irregularities for Five- and Six Storey Structures (Feature 131)

The program implements the British Columbia Building Code (BCBC) provision 4.1.8.10 (4) for 5- and 6 storey structures, that Irregularities 4 (In-Plane Offset) and 5 Vertical Discontinuity, are not allowed for these structures when $IEF_a S_a(0.2) > 0.35$. The program detects this condition and adds the note to this effect under the Seismic Irregularities table. A warning note that

appears on the screen also refers you to the APEGBC April 2009 Bulletin for 5-and 6-storey Residential Buildings, section 3.5.2 c) or www.housing.gov.bc.ca for more information.

c) Irregularities Notes for Drag Strut and Hold-down Capacity Provisions (Bug 2021)

The note below the Seismic Irregularity table and on-screen warning that appear for Irregularities 3 (Vertical Geometry) and 4 (In-plane Discontinuity) and 5 (Out-of-plane Offset) indicated that seismic design results were not valid because a the capacity of the lower storey within the discontinuity had a lower capacity than the upper storey, contravening NBCC 4.1.8.15-2. In fact, this clause says that the elements on the lower storey supporting the upper storey should be designed using the upper storey capacity.

These messages have therefore been changed to indicate only that the drag strut and hold-down forces are calculated using the lower storey capacity when they should be using the higher upper storey capacity. Also, the separate notes have been made for Irregularities 3/5 and 4, indicating that the capacities are storey capacities for 3 and 5 and shearline capacity for 4.

1. Structural Limits

a) Structural Wood Panels Required (Bug 1904)

The program now checks that each storey has at least some structural wood panels on each level, if that is not the case, load generation for both wind and seismic loads is aborted. This is to comply with CSA O86 9.5.4 and Table 9.5.4.

b) OSB Construction Sheathing (Change 45)

The program was internally omitting OSB Construction from the list of wood-based materials, so that it is possible that buildings with these materials and without gypsum wallboard could be incorrectly restricted as if they had gypsum wallboard, which is not allowed in Design Categories E and F and less than 35 feet in Category D.

B: Load Distribution

1. Shearline Force Distribution

a) Rigid Diaphragm Results in Log File (Bug 1803)

Refer to the [Output](#) section of this list for extensive changes made to the detailed log file output for Rigid Diaphragm distribution.

b) Shearlines and Walls with no Capacity (Features 48, 89)

The ability to now have walls composed entirely of gypsum wallboard combined with the *Ignore gypsum ...* Design Setting, creates the possibility of shearwalls and shearlines with no capacity. The program treats these as if they were composed entirely of non-shearwalls, and distributes no load to these walls and lines.

2. Drag Strut Forces

The following problems were addressed, pertaining to the "*Drag strut forces based on shearwall capacity*" design setting. This setting was added for version 7.1 of the software. .

a) Shearwall Capacity Used for Drag Strut Forces (Bug 1897)

When using applied force in the calculations, the program takes the difference of cumulative shear flow at top and design shear at the bottom of the wall. When using shearwall capacity, the program was using the capacity in place of design shear, thus summing capacities for different walls in the line.

We replaced this approach with one that uses the cumulative shear forces, as before, and then factors them with the ratio of design shear to shear capacity for the wall that contains the drag strut. Note that this ratio is actually the same for all walls on the line, because shear is distributed to wall segments according to wall capacity.

b) Shear Flow in Drag Strut Force Calculation (Bug 1901)

When shear capacity was used in place of the design shear, the shear flow transmitted from upper diaphragm to top of shearwall that was used in the drag strut calculations for this setting was always zero. This was creating drag strut forces that were too large, or sometimes to not be created when they should be.

c) Differing Drag Strut Forces in Opposing Directions (Bug 2016)

The drag strut forces reported in the *Drag Strut and Hold-down* table were randomly taken from either the east-west or west-east force direction (similarly for N->S and S->N), so that when forces from these directions differ, only half the force values are reported. The reported forces could be a confusing mixture of forces from each direction that did not correspond to any elevation view diagram. Note that because of hold-down configuration rules, it is often the case that the drags strut forces are different in each direction.

This problem has been corrected by outputting the drag strut value for both force directions for each drag strut location.

d) Walls with No Capacity (Feature 49,89)

The ability to now have walls composed entirely of gypsum wallboard combined with the *Ignore gypsum ...* Design Setting, creates the possibility of shearwalls with no capacity. The program omits these walls in the drag strut force calculations.

e) Irregularities Notes for Drag Strut Provisions (Bug 2021)

Refer to the section on section on Seismic Load Generation above for an explanation of the Seismic Irregularity notes and warnings that appear for NBCC 4.1.8.15-2 pertaining to Irregularities 3, 4, and 5 affecting drag strut force calculations.

3. Hold-down Forces

a) Default Hold-down Offset (Change 39)

The “factory” default hold-down offset has been reduced from 150 mm to 75 mm, in recognition that the chord force is actually transferred to the hold-down connection at the centre of the chord, not where the hold-down bolt goes through the floor joist.

b) Walls with No Capacity (Feature 49,89)

The ability to now have walls composed entirely of gypsum wallboard combined with the *Ignore gypsum ...* Design Setting, creates the possibility of shearwalls and with no capacity. The program recognizes these walls and does not create hold-down forces for them.

c) Irregularities Notes for Hold-down Provisions (Bug 2021)

Refer to the section on section on Seismic Load Generation above for an explanation of the Seismic Irregularity notes and warnings that appear for NBCC 4.1.8.15-2 pertaining to Irregularities 3, 4, and 5 affecting hold-down force calculations.

C: Engineering Design

1. Shearwall Materials

a) Gypsum on Exterior Wall (Feature 89)

It is now possible to have gypsum wallboard on the exterior of the of a perimeter wall. The program does not perform C&C wind design in this case, and issues a warning to that effect in the *Design Results* output.

b) No Materials on Exterior Wall (Feature 49)

It is now possible to specify *None* as the material on the exterior of the of a perimeter wall. The program does not perform C&C wind design in this case, and issues a warning to that effect in the *Design Results* output

c) Primary Design Surface (Features 49, 89)

Previously, the exterior surface of a perimeter wall, and the side designated as Side 1 of an interior partition, was designated as the primary design surface in the case that materials were different on either side. You were able to designate some parameters for that surface as unknown, and the program would design for these values.

Now, the side of the wall that has structural (plywood, fibreboard, OSB) materials is designated as the primary side, and the side with gypsum or no materials is the non-designed side. If both sides have structural materials, then the primary side is the exterior of perimeter walls and Side 1 of interior walls, as before.

d) OSB Construction Sheathing (Change 45)

The program was internally omitting *OSB Construction* from the list of wood-based materials, so that the program may in some cases not have accurately imposed the restrictions on material strength due to hold-down/anchorage restrictions in CSA O86 9.4.5.5.

2. Maximum Gypsum Wallboard Contribution (Feature 131)

The program now includes an improved implementation of CSA O86 Table 9.5.4 which specifies the maximum gypsum contribution on any level of the structure, in each direction.

a) Check for Total Capacity vs. Force

The program checks on each level and in each direction, that the total capacity of all walls on that level is at least as great as the total force. In this case, at least some of the shearwalls will have failed, and the program does not go on to check for minimum wood capacity or maximum gypsum capacity as indicated in the following sections.

b) Check for Minimum Wood Capacity

After shearwall design, the program checks that there is sufficient capacity from wood panels in the designed shearwalls to satisfy the requirements of CSA O86 Table 9.5.4 if all force were to be distributed to those wood panels. It does so independently on each level and for each force direction, for both wind and seismic design.

If the wood capacity is not at least 100% minus the allowable GWB percentage, the program regards this as a design failure and indicates so via a message box on the screen, and via failure notes under the *Shear Design* table and the new *Gypsum Wallboard Percentage* table, and via "FAILED" showing on the walls of that level on elevation view.

Refer also to the section on Output below for a full description of the *Gypsum Wallboard Percentage* table.

c) Check for Maximum Gypsum Capacity

After shearwall design, the program checks if the percentage of total shear force taken by gypsum wallboard exceeds the maximum in CSA O86 Table 9.5.4. In determining the shear force taken by GWB, it assumes that the force into composite wood/gypsum shearwalls is distributed proportionally to material capacity. It does so independently on each level and for each force direction, for both wind and seismic design.

If there is greater than the maximum allowable gypsum contribution, the program offers you the choice of ignoring gypsum wallboard contribution in design and redesigning, or proceeding with the design anyway. For seismic design, it also offers you the opportunity to regenerate loads on the structure with the revised response modification R value appropriate to all-wood systems.

If you choose not to redesign, the program presents a warning under the *Shear Design* table and the new *Gypsum Wallboard Percentage* table indicating that you must ensure that sufficient shear force is distributed to wooden panels to avoid excess gypsum contribution.

Refer also to the section on Output below for a full description of the *Gypsum Wallboard Percentage* table.

d) Ignore Gypsum Wallboard in Design

If you have selected the “*Ignore gypsum wallboard*” design setting for either or both of wind and seismic design, the program does not do the abovementioned Check for Minimum Wood Capacity or Check for Maximum Gypsum Capacity for that design case, instead putting a note explaining this in place of the *Gypsum Wallboard Percentage* table. ‘

e) Storeys Greater than 3.6m

On all storeys greater than 3.6m in height, the gypsum contribution to shear resistance is automatically ignored in load distribution and design to comply with *to* Table 9.5.4 Note 2.. This applies to both wind and seismic design. This is done regardless of the design setting that disables gypsum contribution for all levels. The program indicates in the notes to the Shear Results table and the *Gypsum Wallboard Percentage* table that GWB has been ignored for this reason.

f) Five- and Six-storey Structures

For five- and six-storey structures, all gypsum contribution to shear resistance is automatically ignored in load distribution and design, on all levels of the structure, because CSA O86 Table 9.5.4 does not yet include 5- and 6- storey structures. The program indicates in the notes to the *Shear Results* table and in a note that appears in place of the *Gypsum Wallboard Percentage* table that GWB has been ignored for this reason.

Note that there are proposed changes to the BC Building Code that allow gypsum wallboard on 5- and 6- storey structures, and these will be implemented in the software at a future date. Refer to BC Building Code Branch at: http://www.housing.gov.bc.ca/building/wood_frame/index.htm and APEGBC Guidelines at <http://www.apeg.bc.ca/ppractice/documents/ppguidelines/5and6StoreyWoodFrameBulletin.pdf>

g) Previous Implementation

Please note that this implementation replaces a previous one that was in Shearwalls 2002, but was dropped for version 7.0 because it was deemed inadequate. The previous implementation divided the sum of the capacity of the gypsum wall board panels on a building level by the sum of the capacity of all walls the level, and compared with the limits in 9.5.4. This implementation did not take into account directionality and therefore did not include the Jhd factor in the total capacity.

In this implementation, the program merely sent a message to the screen indicating that there was excessive gypsum capacity. As it was not possible in this version to have walls composed solely of gypsum wallboard, this message rarely appeared.

3. Shear Design

a) Service Condition Factor K_{sf} for Shear Design (Change 22)

The moisture condition K_{sf} Factor is now applied to the shear design, according to CSA O86 9.4.2. The in-service and fabrication service conditions as input in the *Design Settings* are applied according to CSA O86 Table 10.2.1.5 for nails.

b) Optimization of Design (arising from Feature 131)

Certain steps were taken to speed up the shear design routine by eliminating redundant calculations.

c) OSB Construction Sheathing (Change 45)

d) The program was internally omitting *OSB Construction* from the list of wood-based materials, so that the program may in some cases have determined that the shearwall had zero capacity if it had only *OSB Construction* materials and “*Ignore gypsum*” was set in the *Design Settings*. It may also have misapplied height-to-width ratio restrictions in this case.

4. Component and Cladding (C&C) Wind Design

a) Design for Exterior Shearwalls with No C&C Resistance (Change 36)

As it is now possible for there to be no materials, or non-structural (gypsum) materials on the exterior walls, the program recognizes this situation and outputs a warning in the C&C Design Table. Refer to the Output section of this list for more details.

D: Input and Program Operation

1. Informational Dialog Boxes

a) Design Codes in About Box (Change 41)

The program now indicates the design codes and standards implemented in the program: CSA O86-01, including 2003 Update and 2005 Supplement, and NBCC 2005.

b) Welcome Dialog Via Help Menu (Change 44)

The Welcome box can now be accessed from the Help menu, so that you do not have to restart the program to access the information in this box.

c) Building Codes Box (Feature 131)

A *Building Codes* dialog box has been added, accessed via a button in *Welcome* dialog. This dialog

- Repeats the information in the *Welcome* dialog regarding design codes implemented by the program
- Indicates that Shearwalls does not take into account shearwall deflection or wood shrinkage, nor does it detect certain irregularities
- Indicates which Mid-rise provisions for 5- and 6-storey structures are included and which are not.
- Directs you to <http://www.apeg.bc.ca/ppractice/documents/ppguidelines/5and6StoreyWoodFrameBulletin.pdf> for more information about Mid-rise structures.

2. Structure Input

a) Wall Height Check upon Return to Structure View (Bug 1787)

The program did not perform the check on allowable wall height input in *Structure* input form, if you had returned to that form from a later view in the sequence. Therefore, it was possible to

accidentally enter a zero height wall, which would cause the program to crash. Now the program checks that a legitimate wall height is input whenever the *Structure* view is exited.

b) Five- and Six Storey Structures (Feature 131)

Upon adding fifth building level, the program issues an on-screen message informing that only some of the provisions for 5-and 6-storey structures in the British Columbia Building Code are implemented in the program, directing you to the Building Codes box, accessed from the Welcome dialog, to find out which are implemented. The message also refers you to the BC Building Code Branch at http://www.housing.gov.bc.ca/building/wood_frame/index.htm and Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) Guidelines at <http://www.apeg.bc.ca/ppractice/documents/ppguidelines/5and6StoreyWoodFrameBulletin.pdf>

3. Wall Input View

a) Wall Surface Input Mechanism (Change 32, Feature 49)

- The drop list for selecting *Wall Surface* in the *Wall Input* view has been replaced by two tabs called *Interior side* and *Exterior side* (*Side 1* and *Side 2* for interior partitions). These tabs contain all the input fields that previously were visible when *Exterior* and *Interior* were chosen from the drop list.
- The choice *Both sides same* has been replaced by a checkbox that causes the input to be compressed into one tab called *Both sides*. As before, the materials that are displayed are the ones that were on the exterior side (or *Side 1*) before the box is checked.
- The choice *Exterior only* has been removed, as it can be achieved by specifying *None* for the interior side of the wall.

b) Wall Material Choices

- Previously, the material choices for interior walls were the same as those for exterior walls, and assumed that one surface would not have gypsum materials. Now, the program provides the entire list of choices for both sides of interior walls, to allow for the common situation of gypsum on both sides. (Bug 1891)
- The sheathing materials *None* and *GWB Type X* (gypsum wallboard) are now available on the exterior surfaces of exterior walls. Previously these surfaces had to have wooden sheathing (Feature 89)
- The choice *None* has been added for the exterior side, to allow for no structural materials on the outside of a structure with structural materials on the inside surface. The program does not include the selection *None* if *None* is selected on the other side of the wall, in other words, shearwalls must have sheathing on at least one side. (Feature 49)

c) Side with Unknowns (Features 49, 89)

Previously, the exterior side of perimeter walls and *Side 1* of interior partitions could have unknown parameters for sheathing thickness, nail size, and nail spacing. Now, the side of the wall that has structural (plywood and OSB) materials can have unknowns, and the side with gypsum or no materials does not have them. If both sides have structural materials, then the program reverts to its previous behaviour.

d) Nomenclature Changes and Reorganisation

- The label *Wall segment* referring to the geometry of a selected shearwall has been changed to *Shearwall*, as the data refer to the entire shearwall, not an individual segment between openings.(Change 34)
- The sheathing material name *Gypsum X* has been changed to *GWB Type X*. The abbreviated form that appears in output reports is *GWB*. (Change 16)
- The label *Relative rigidity* has been changed to Relative rigidity per unit length. (Change 20)
- The *Design Group(s)* text field indicating what design groups have been created for the selected wall has been moved from near the top to the bottom of the input form. (Change 35)

e) Multiple Wall Selection Problems

The following problems have been corrected:

- *Both Sides Same (Bug 1994)* - In the wall input dialog, after more than one wall is selected, and then "Both Sides the Same" is selected, the individual walls are often not designated as "both sides the same" when selected, and some of the fields have the original value in them, that is, were not properly updated for all of the walls selected.
- *Gypsum Wallboard (Bug 1993)* - After selecting more than one wall, and selecting *Gypsum X* (now *GWB Type X*) on the interior wall surface in the wall input dialog, the fastener type appeared as a blank. If left blank, the selected *GWB* materials are not included in the design capacity of the wall. However, selecting a fastener type allowed for design..

f) Incorrect Parameter Message for OSB (Change 47)

Under certain restricted circumstances, when trying to create a wall a message appears saying "Incorrect parameter". These circumstances are

- Interior wall
- OSB materials
- hold-down configuration other than "All Segments"
- previous sheathing thickness greater than 12 mm
- anchorage design setting is set to "restrict materials" or "restrict materials but override when unknown".

4. Standard Walls

a) Crash on Standard Wall Cancel (Bug 1889)

When editing a Standard Wall, then pressing *Cancel*, *Shearwalls* would crash. This happened only for existing projects that are reopened, not for new files. This has been fixed.

b) Standard Wall Name Label (Change 40)

The label "Name" was mistakenly removed from the Standard Wall input form for version 7.1. It has been restored.

c) Standard Wall Dropdown Box Length (Change 14)

The dropdown box for Standard walls has been lengthened, so that you do not think that only one standard wall can be created because that is all that is shown without scrolling.

d) Selection of Standard Walls for C&C Design (Change 37)

As it is now possible to have non-structural materials on exterior surfaces, and because all walls should be available for seismic design, the program no longer issues a message and prevents you from selecting a standard wall for the exterior of the building that cannot withstand wind C&C loads.

5. Loads

a) Partial Wall Load Input (Bug 1911)

When adding a line load in the load Input dialog when "Selected Wall" is set as the "Apply to.." selection, then changing the locations such that they are less than the full extent of the wall, the load was still being added to the full length of the selected wall. This has been corrected such that the load has the reduced extent entered.

6. Settings

a) Moisture Conditions (Change 22)

- In the *Design Settings*, the group heading *Nail Withdrawal Conditions* has been renamed to *Moisture conditions for Ksf*, as they are now applied to shear design as well as C&C design.
- The choices in the Fabrication box have been changed from "Wet", "Dry" to "Unseasoned", "Seasoned" to correspond with CSA O86 terminology. The In-service choices have not changed.

b) Hold-down Force Setting Persistence (Change 24)

The *Design* setting *Holddown forces based on Shearwall capacity* was not saved when the project file was saved, so it would be reset to the default value, *Holddown forces based on Applied loads* when projects were re-opened.

c) Design Settings in Data Bar (Change 30)

The "*Design...*" button on the Data bar has been renamed to "*Settings...*", to avoid confusion with the *Design* button in the toolbar which causes a design to be run.

d) Immediate Effect of Default Settings (Changes 25, 26)

In the *Default Settings* page:

- The explanation has been revised to indicate that only *Roof geometry* settings depend on exiting Structure View.
- An asterisk has been added the *Holddown offset* to indicate that it has immediate effect.

e) Note in Design Settings (Change 21)

The word "However" and the design code name "NBCC" has been added to the note at the bottom of the Design Settings box indicating seismic discontinuity exception to the use of Applied Force for hold-down and drag strut calculations.

E: Output

1. General Output Changes

a) Legends and Notes (Change 9)

- The Design Results have been updated so that the notes under the tables are in plain face to distinguish them from the legends, which are in italic.

- Those notes that are considered warnings that indicate design failure are now output in red and are the last notes printed.
- A heading of 'Legend:' now precedes the legends and the program now consistently places the heading "Notes" before notes.

b) Text-based (.wsr) Output Files (Bug 1886)

The program no longer outputs Shearwalls text-based results files (.wsr), as they have not been maintained since the enhanced output was introduced for Shearwalls 2004 USA.

The extension .wsr has been removed from the filename on the header of the printed file output, which in fact can be output as .rtf or .pdf.

2. Design Settings

a) Moisture Conditions (Change 22)

In the *Design Settings*, the group heading "Nail Withdrawal Conditions " has been renamed to "Service Conditions", as they are now applied to shear design as well as C&C design.

The items under *Fabrication* have been changed from "Wet", "Dry" to "Unseasoned", "Seasoned" to correspond with CSA O86 terminology.

3. Material and Structural Data

a) Species Factor J_{sp} Output for Gypsum Surfaces (Bug 1992)

In the Materials by Wall Group output table, the species factor J_{sp} shown for an interior Gypsum X surface is that of the external (non-gypsum) surface, however, J_{sp} does not apply to gypsum wall surfaces according to CSA O86 9.5.1. For gypsum materials, which can now appear on either surface, that the J_{sp} value does not exist is now indicated by a "-".

b) Gypsum Wallboard Notes (Bug 1904, Feature 131)

The following notes are now output under the *Materials by Wall Group* for gypsum wallboard materials.

When gypsum is present, a note has been placed under the Materials table indicating that a balanced distribution of gypsum is needed to comply with CSA O86 9.5.4 (2).

c) Imperial Joist Depth in Storey Information Table (Bug 2019)

When Imperial is the unit system, the joist depths in the were given as 25.4 times the depth in inches, that is, converted to millimetres, but the label still read inches. The program now outputs values in inches.

d) J_{sp} in Materials Table for GWB*

In the Materials table, a "-" is now output as species factor for gypsum wallboard, as J_{sp} does not apply to GWB.

4. Shear Design Table

a) Gypsum Wallboard Limitation Warnings and Notes (Feature 131)

The program now indicates under the Shear Design table if there are failures or concerns arising from CSA O86 9.5.4 and Table 9.5.4. It does so separately for the wind design and shear design tables, as follows:

- There is a red failure message if on any level in any direction there is insufficient capacity from wood panels to resist the remaining storey force after the maximum gypsum contribution from Table 9.5.4 is taken away.

- There is a red warning message if the percentage of storey shear resisted by gypsum is greater than the maximum allowed by Table 9.5.4.
- If at least one storey is greater than 3.6 m, a note indicates that the gypsum wallboard contribution to shear resistance is ignored for all walls on that storey.
- When the structure has more than four storeys, a note indicates that the gypsum wallboard contribution to shear resistance is ignored for all walls in the structure for that reason.
- When gypsum wallboard is present, a note indicates a balanced distribution of gypsum is needed to comply with CSA O86 9.5.4 (2).
- If some shearwall sides have zero capacity because you have disabled the gypsum contribution in the design settings, a note indicates this.

Refer to the section on *Maximum Gypsum Wallboard Contribution* in the Engineering Design Changes in this list for more information.

b) Service Factor K_{sf} in Legend (Change 23)

The legend in the *Shear Design* table now gives the service factor K_{sf} that is now used in design followed by a description (e.g. *dry seasoned*).. Previously it said " $K_{sf}= 1(\text{dry})$ " at all times..

5. Components and Cladding Table

a) Components and Cladding Table Legend (Change 17,18)

Legend under Component and Cladding (C&C) table in Design Results has been elaborated on further. It now gives Commentary numbers and figures from the NBCC Structural commentaries, and explains the combination of interior and exterior pressure co-efficients for each method. It also refers to table I-8 instead of I-7 from the 1995 NBCC.

b) Exterior Shearwalls with No C&C Resistance (Change 36)

As it is now possible for there to be no materials, or non-structural (gypsum) materials on the exterior walls, for such a shearline, a double asterisk (**) is output as the response ratio in the C&C results table, indicating the following beneath the table: ****WARNING - No exterior sheathing material or sheathing has no C&C capacity.**

6. Drag Strut and Hold-down Table

a) Drag Strut Forces in Opposing Directions

The drag strut forces reported in the Drag Strut and Hold-down table are randomly taken from either the east-west or west-east direction (similarly for N->S and S->N), so that when forces from these directions differ, only half the force values are reported. The has two columns headed with arrows were used to show the direction the drag struts forces themselves were pointing, not the force direction on the shearline. They are now used to show the drag strut force for loading in each direction for each drag strut location.

7. Seismic Information and Seismic Irregularities Table

a) Header in the Seismic Information Table (Bug 1907)

In version 7.1 of the software only, the Column header '*Length of SFRS, E-W N-S* ' was not output in the Seismic Information table. It has been restored.

b) Irregularities Notes for Drag Strut and Hold-down Capacity Provisions (Bug 2021)

Changes were made to the notes regarding the NBCC 4.1.8.15-2 provision for Irregularities 4, 5, and 6. Refer to the section on Seismic Load Generation for more information.

8. Gypsum Wallboard Table (Feature 131)

Separate tables are now output for each design case (rigid, flexible, wind, seismic) giving the relevant data to implement the restrictions on gypsum wallboard contribution in CSA O8 Table 9.5.4

a) No Table Output

In the following circumstances, no table is output and an explanatory note appears instead:

- For five- and six storey structures, because Table 9.5.4 does not yet include these structures.
- If you have chosen to ignore gypsum wallboard contribution to design shearwall resistance in the Design Settings.

b) Table Data

The table outputs the following data for each storey and each direction of force:

- *Storey number*
- *Maximum GWB Percentage* – Maximum gypsum wallboard contribution allowed from Table 9.5.4, or if the storey is greater than 3.6m in height, zero.
- *GWB Capacity* – Total capacity of all gypsum wallboard on storey, regardless of distribution of forces to the wall segments
- *Wood Capacity* – Total capacity of all plywood and OSB panels on shearline, regardless of distribution of forces to the wall segments.
- *Total Force* – Sum of all factored shearline forces on that level in that direction
- *Wood Capacity %* - The total wood capacity on the line as a percentage of the total force applied to the line. This value indicates whether sufficient wood panels are available to resist the , The program considers it a failure if this value is less than 100% minus the allowable gypsum contribution. In that case a
- *Force Resisted by GWB* – The percentage of shear force that is actually resisted by GWB panels on the shearline, assuming that force into composite walls is distributed according to relative capacity of the wood and gypsum sides.
- *% Force Resisted by GWB* – This is the force resisted by GWB as a percentage of the total factored shearline force. If this value is greater than the maximum allowed by Table 9.5.4, the program issues a warning that you must redistribute the excess gypsum force to the wooden shearwalls.

c) Legend

A legend appears at the bottom of the table explaining the above data.

d) Insufficient Total Resistance Failure

If there is insufficient total resistance on a particular storey and direction to resist the total force, then two exclamation marks (!!) appear in the % gypsum column in place of the data, and a red failure note starting with !! appears below the table. In this case, at least some of the walls on the shearline will have failed, and there is little point in checking the % gypsum contribution.

e) Insufficient Wood Capacity Failure

If there is insufficient capacity from wood panels available to resist the remaining storey force after the maximum gypsum contribution from Table 9.5.4 is taken away, then one exclamation mark (!) appears beside the *Wood Capacity %* data for that storey and direction. A red failure note starting with ! appears below the table.

f) Excessive Gypsum Wallboard Contribution Warning

A note appears saying that the If the percentage of storey shear resisted by gypsum wallboard on a particular storey and direction is greater than the maximum allowed by Table 9.5.4, then indicating that you must modify the design to ensure sufficient shear force is redistributed to wooden panels to avoid excess gypsum contribution.

g) Notes

- If at least one storey is greater than 3.6 m, a note indicates that the gypsum wallboard contribution to shear resistance is ignored for all walls on that storey.
- A note is always output indicating that a balanced distribution of gypsum wallboard is needed to comply with CSA O86 9.5.4 (2).

9. Elevation View

a) Gypsum Wallboard Failure (Feature 131)

If for any level shown in elevation view in the selected direction there is insufficient is sufficient capacity from wood panels to resist the remaining storey force after the maximum gypsum contribution from Table 9.5.4 is taken away, the program

- Indicates with in large bold letters “FAILED” on all shearwalls on the line for the failing levels
- Prints separate failure notes for the cases that just one level or several levels are displayed.

Note that the program does not in elevation view indicate the warning for excessive gypsum resistance to shear force that appears in the *Gypsum Wallboard Percentage* table and in the *Shear results* table. This is because this situation depends on distribution of shear force, and the line selected may not be one in which force is distributed to gypsum wallboard.

10. Rigid Diaphragm Analysis in Log File (Bug 1803)

The Rigid Diaphragm Analysis section of Log File has been modified in the following ways:

a) Explanatory Line for Rigidity Selection

A line has been added at the top of the section that indicates the Shearwall Rigidity selection in the Design Settings, and to explain what rigidity units are employed with each selection. For “Shearwall capacity”, force units are used (kN, lbs or kps), for “Equal rigidities” (per unit length), length units are used (m or ft), and if it is “Manual input of relative rigidity”, then they are treated as dimensionless numbers.

b) Symbols and Equations

A consistent set of symbols has been introduced, and equations given for all symbols, so that the source of all output data can be traced. Where applicable, design code references also added. Note that in many cases a symbol is used before the place in the output that the symbol is defined by its own equation.

c) Units

- Unit Indicators

The Indicator of length and force units has been removed from the header, and instead, the units are placed on all individual items in the report. The formatting of the units has changed slightly, in that the units are placed in brackets after the label for an item, rather than after the last value output for that item

- Force Units Employed

Previously, only kN were used, even when imperial units were selected in the Format Settings. Now for the Imperial units selection in the Format Settings, either lbs, kips, or

kN are used according to the Force format setting. Note that other portions of the log file continue to be output in metric units even when for the imperial format setting selection.

d) Formatting

- The output is now consistent in its use of hyphens (-) and colons (:).
- The length of the dashed line has been shortened, and all output is constrained to remain within that line, so that it prints on one page in Notepad with a 9 font.
- For to the initial section of data that is output for the X-direction and the Y-direction on the same line, the previously ragged data has been placed in two columns, for the X-direction and Y-direction, with the letters x and y appended to the symbols, e.g. Jx and Jy for Torsional Rigidity J. These symbols are later referred to in the separate results for the E-W and N-S directions, making it clear which is used for which direction of force.

e) Center of Rigidity

The word “of” has been added to “Center of Rigidity”, which can now be m or ft, along with symbol Cr and equation.

f) Building Dimension D

A line for building dimension D, perpendicular to the force direction, has been added, as this is used in the eccentricity calculation. .

g) Accidental eccentricity

- The output “Acc Eccentricity” has been removed for wind design, which does not impose an additional accidental eccentricity. For seismic design, it is now on its own line, with “acc” fully spelled out, equation and units shown, symbol ea.
- A note has been added to the end of this section of output indicating the design code reference for eccentricity.

h) Total Rigidity

- The symbol Kt, equation, and units employed have been added to the Total Rigidity line
- Previously the program was indicating that this value was in metres for all selections of the “Shearwall rigidity” Design Setting, however the value for the “Rigidity based on capacity” setting was in fact in kN, as it was the sum of all shearwall capacities. The program now indicates it is kN, lbs, or kips for that setting, depending on what unit system is in use.
- Length units continue to be used for the “Equal rigidity” (per unit length)” setting, as this value is just the sum of shearwall lengths.
- For the “Manual input” setting, this value is the shearwall length multiplied by the relative rigidity input in wall view, so no unit is used.

i) Torsional Rigidity

- Torsional rigidity has been placed on its own line. The symbol J, equation, and units employed have been added to the Torsional Rigidity label.
- Previously the program was indicating that this value was in m³ for all selections of the “Shearwall rigidity” Design Setting, however the value for the “Rigidity based on capacity” setting was in fact in kN-m². The program now indicates it is kN-m²., lbs-ft², or kips-ft² for that setting, depending on what unit system is in use
- The value for the “Equal rigidity” (per unit length)” setting uses shearwall length to approximate rigidity, so the output is in m³ or ft³.
- For the “Manual input” setting, the rigidity component is the shearwall length multiplied by the relative rigidity input in wall view, so no unit is used.
- If the value to be output exceeds 1,000,000, then it is expressed in scientific notation, with 4 decimal places shown. Otherwise, it is shown to one decimal place for metric output and none for imperial.

j) Concentrated Load

Symbol F added.

k) Center of Load

Symbol Cl added

l) Torsional Eccentricity

For all torsional load cases (seismic [and all-heights wind]), a line has been added giving the torsional eccentricity $e_t = Cl - Cr$ (center of load minus center of rigidity).

m) Torsions

- Torsions are now output on their own line, with symbol T and units (lbs-ft, kips-ft, or kN-m). They are no longer output in scientific notation.
- Separate equations have been added for each load case showing whether a torsional eccentricity due of $Cl - Cr$, an accidental eccentricity, or both, are used. If it is a non-torsional load case (low rise wind), torsions $T = 0$ are shown along with an explanation giving design code reference.

n) Shearline Forces

A section has been added giving the equations used for the torsional, direct, and total shearline forces shown in the shearline table below.

o) Shearline Table

- In the heading, the torsional load cases used to read "+10 Dnx -10Dnx" These were missing a % sign, but the line has been reformatted and these symbols removed. It now shows torsional shearline forces as F_{ti-} , F_{ti+} , and the resultant F_{ti} , with the definition of the F_{ti} 's in terms of Dnx shown in the equations above. Note that the resultant F_{ti} column has also been shifted in the table.
- A column has been added for the distance l_i from the Center of Rigidity Cr to the shearline, as that is needed in the calculations of shearline forces.
- The table headings have been reworded slightly and now include the symbol for each item
- The unit shown for Rigidity was previously always "m", even though for the "Rigidity based on capacity" Design Setting "Rigidity based on capacity" the value was in fact kN. Now the value shown is kN, lbs or kips for that design setting, m or ft for the "Equal rigidities" (per unit length) setting, and no unit for the "Manual input" setting.

p) Output in Absence of Wind or Seismic Loading (Change 15)

In the Rigid Diaphragm Analysis section of the Log File, some information for wind or for seismic analysis was being output even when there were no loads of that type on the structure. The title for that design type and the lines pertaining to rigidity and eccentricity were output, but not the shearline table below. This occurred only when the Shearwalls rigidity setting selection is not "Use shearwalls capacity ...". The program now omits all wind analysis when there are no wind loads, and similarly for seismic loads.

q) Repetition of Rigid Diaphragm Log File Output (Bug 1878)

The rigid diaphragm section of the log file results were often repeated twice, one for each iteration of the design process. Only the final iteration is now output.

F: Installation

1. Windows Metafile Example (Bug 1966)

The windows metafile, 'example.wmf' that is referenced in the Shearwalls Tutorial of the User Guide has been restored to the installation. It had been removed unnecessarily along with some obsolete sample project files.

Shearwalls 7.1 – July 28, 2008 - Design Office 7, Service Release 1

This is a free service release update to address issues submitted by our users since the release of version 7.0 on December 21, 2007 and also to implement non-critical bug fixes and small improvements which previously had been deferred.

A: Shearwall Design

1. Crash on Design of Short Shearwalls (Bug 1839)

Performing a design on a structure that contains a shearwall that does not contain any shearwall segments that meet the minimum height-to-width restriction was causing the program to crash. This has been rectified.

1. P_j and P_{top} Values in Calculation of J_{hd} Factor (Bug 1841)

When both dead loads and "dead wall" loads are present on the same wall, the program was not separating the dead and dead wall loads when calculating uplift restraint forces P_{ij} and P_{top} in CSA O86 9.4.5.2 and 9.4.5.3, causing these values and therefore hold-down effect factor J_{hd} to be incorrect.

2. R_j Value in Calculation of J_{hd} Factor (Bug 1842)

In the calculation of the overturning force R_j used in calculating uplift restraint forces P_i and P_j in O86 9.4.5.2 was incorrectly subtracting the 150mm hold-down offset that was introduced in version 7 from the segment length L . This caused the hold-down effect factor J_{hd} to be slightly smaller than it should be on all levels except the top level.

3. C&C Results in Elevation View for Non-Shearwalls (Bug 1832)

When a non-shearwall is loaded with Components and Cladding (C&C) wind loads, in *Elevation View* the program was displaying design parameters as unknown, and both the capacity and load as zero. In the *Design Results*, the materials and the C&C design results are correctly displayed. Both areas of the program display now display the correct C&C design results.

4. C&C Table Legend in Design Results

Legend under *Component and Cladding (C&C)* table in *Design Results* has been clarified. It now indicates that forces are factored, and includes nail withdrawal design code clause O86 10.9.4.

5. Alternating Wall Designs (Bug 1840)

Running a design on a structure with walls loaded in only one direction, the program was generating two sets of designed materials, which would alternate each time design was invoked.

6. Relative Rigidity for Standard Walls (Feature 175)

Added relative rigidity field to standard wall definition so that you can create multiple walls with same rigidity. Only active if the setting *Manual input of shearwall rigidity* is checked. It defaults to 1.0 for new standard walls.

7. Seismic Allowable Shear Capacity Zero (Bug 1652)

Saving prior to designing a structure with narrow wall segments caused the seismic allowable shear capacity to be calculated as zero in *Elevation View* and the *Design Results* report. However, running "Design" immediately after opening the project yields a valid non-zero seismic allowable shear capacity.

B: Load Distribution

1. Shear Force Distribution for Walls Designed with High Capacity

Under certain circumstances, the forces distributed to shearwall segments were based on J_{hd} values calculated for anchorages, even though the design required hold-downs. This occurred when the wall had unknown design parameters, and the wall selected by Shearwalls for design had a shear strength greater than 10.3 kN/m, requiring hold-downs due to CSA 086-01 9.4.5.5(a).

2. Vertical Loads on Shearlines with Non-shearwall Segments (Bug 1682)

Manually input dead and uplift loads on shear lines are now included on non-shearwall segments, and distributed to the floors below via the same hold-down force mechanism as for shearwalls. Previously no loads were created for these portions of the walls, and these loads were not properly tracked down the structure.

3. Drag Struts for non-FHS Segments (Bug 1683)

Drag strut force calculations were incorrectly adding a force due to non full height sheathing (non-FHS) segments to the adjacent force from an adjacent FHS when the non-FHS segment was at the end of a wall, creating higher drag strut forces than the correct ones, and creating an additional drag strut force location.

4. Lack of Warning for Rigid Non-Design (Bug 1759)

When the program does not have sufficient loaded shearlines using the flexible distribution (i.e. two per direction), so that the program cannot perform rigid distribution, a message box now warns the user of this situation.

5. Torsional Load Case Heading in Log File (Bug 1853)

The heading in the log file for the torsional load cases for rigid diaphragm analysis given by NBCC 2005 4.1.8.11 10) i and ii, was mistakenly showing the load cases from the 1995 NBC. It has been corrected to show plus or minus 10% of the building width, as follows:

Torsion Load Cases
+10% Dnx -10% Dnx

C: Load Generation and Display

1. Wind Load Generation on Multiply-joined Roof Blocks (Bug 1758)

When three blocks were aligned in one direction, and when the "Exclude roof portion cover by other roof" option is checked, for the ASCE-7 medium rise method, loads were not displayed on the screen nor did they contribute to design loads on the structure.

2. Unfactored Loads in Elevation View Legend

Lines were added in the *Elevation View* legend to show symbols for wind uplift and dead loads, also indicating that these loads are unfactored.

3. C&C Loads in Elevation View

Changed the description for C&C loads to the right of the walls in elevation view from "C & C" to "*Unfactored C&C Load*"

4. Ce vs Ce* in Log file (Bug 1224)

When topographic factor is present, the exposure factor Ce factor is now presented in the log file as C*, as per the NBCC design code nomenclature.

5. Seismic Load Magnitude Formatting (Bug 1256)

In the Seismic load table of the results output, the program now outputs 2 decimal places precision for all output.

D: Building Model

1. Select All Feature

It is now possible to select all walls while in the Wall Action in plan view for editing and moving, via a menu item in the Edit menu. You can also use Ctrl-A keystroke to do the same thing.

2. Move Structure Feature

It is now possible to move the entire structure, while the Wall action, by

- a) being in the *Wall* action in plan view
- b) using the *Select All* Command
- c) pressing the *Shift* key on the keyboard
- d) also depressing the left mouse button
- e) selecting a point in plan view and moving the mouse in the direction of the move.

Note that all walls are selected, but the roof moves as well.

3. Changing Structure Ceiling Depth (Bug 1728)

Changing the ceiling depth of the top floor in the structure input dialog after walls have already been created is no longer incrementing the wall heights of existing walls on the top floor by the ceiling depth.

4. Upward Extending of Non-Shear Walls (Bug 1779)

When the Extend Walls button is invoked, non-shear walls on the first level are no longer copied as shear walls on the top level.

E: Program Operation

1. Meta File and Project File in Separate or Renamed Folders (Bug 1740)

If a CAD metafile is not in the same folder as when it was first imported, the program prompts the user to browse for the location of the CAD metafile to display, but Shearwalls was unable to retrieve and display the file selected by the user. This has been rectified, and you now have the ability to send complete project specifications, including the CAD file, to other WoodWorks users.

2. Log Filename Persistence (Bug 1851)

The filename of the log file was not updated when you changed the project file name. Therefore, when a design was run when the project is still called "Untitled.log" it maintained that name, even after the project file was given a more meaningful name. The log file file name is now updated to correspond to the project file's current filename.

3. Rigid Distribution Information Clearing in Log File (Bug 1852)

- The rigid distribution analysis in the log file is no longer being recorded for each design run of the software, when it should be clearing each time.
- The program no longer repeats the title, date and time for each building level. These are now output only at the start of the analysis.

4. Truncated Elevation View Material Information and Legend (Change 6)

The printed version of the Shearwalls output form was cutting off the legend and wall material information at the length of the wall, even when there was room on the page to print it. This has been corrected.

5. Unreadable Design Results with Combination Printers (Bug 1790)

For certain printers, the design results reports shown both on the screen and as printed were very narrow with a large right margin. All information was unreadable. This occurred primarily with printers that combined print, fax and/or scanning capability. Steps were taken to correct the problem, and these were effective on the one printer model that was tested.

6. OCX Files in Installation (Change 7)

Updated VSPrint and VSPDF OCX files that are included in the installation to implement the enhanced report viewer/print utility with the most recent versions of these files.

7. Immediate Effect of Default Settings (Bug 1693)

In the *Default Settings* page, the asterisk indicating immediate effect of *Roof Slope* was truncated, and for *Roof Overhang* it was missing completely. They have been restored.

Shearwalls 7.0 – December 21, 2007 - Design Office 7

The changes to Shearwalls for Version 7 listed below take into account the changes in the National Building Code of Canada (NBCC) for the 2005 Edition vs. NBCC 1995. These and other changes are also taken from the January 2003 Update and the January 2005 Supplement to the CSA O86-01 Standard. Further information was taken from the NBCC Structural Commentaries.

Many other changes, not related to new design codes, are also listed. The following are highlights of the changes, with links to the full description below, followed by an index to the changes, followed by the descriptions of the changes themselves.

Highlights

Design Code Updates

The program implements the new procedures for National Building Code of Canada (NBCC) for the 2005 Edition, replacing those of NBCC 1999, for both [wind](#) and [seismic](#) load generation.

Other changes are taken from the January 2003 Update and the January 2005 Supplement to the CSA O86-01 Standard, and further information was taken from the NBCC Structural Commentaries.

Seismic Irregularities

The program now analysis the structure for [irregularities](#) according to NBCC Table 4.1.8.6 and other parts of NBCC 4.1.8. It outputs a [table](#) of seismic irregularities, detects the irregularities in the structure, and informs you when the regularity invalidates design, identifying the precise location of the irregularity and the reason for design failure.

Undo/Redo Feature

The program now allows the user to revert graphical input operations in the interactive *Plan View* and data input operations in its associated input forms, and to restore the actions that were undone.

Building Model Improvements

The program now allows you to [exclude shadowed portions](#) of the roof and walls when generating wind loads, allows up to [six building levels](#) , and allows [CAD import on each level](#).

Load and Force Distribution Improvements

The program has implemented [offsets](#) and [new load combinations](#) for hold-down and compression force calculations, allows you to specify [shearwall capacity](#) for drag strut calculations, and has updated the [accidental eccentricity](#) factors for rigid distribution.

Improved Graphics

There are now [explanatory legends](#) in *Plan* view and *Elevation* view, a view showing all the [critical forces](#) in one diagram, depiction of [vertical load transfer elements](#), and improved [layout of forces](#) in *Elevation* view.

Enhanced Output Reports

The program has a [new output report viewer](#) with formatted, graphical output organised into easy-to read tables. It also allows such features as navigation tools, zooming, page range printing, and file output to .pdf or .rtf files. All tables have been provided with [legends](#) explaining the headings, the data, and certain design assumptions.

Documentation

An up-to-date version of the On-line [CSA-O86-01](#) design standard in .pdf format has been provided. The on-line help has been updated to reflect the current program and converted to Vista-compatible [Html help](#). The current design codes are displayed in the user interface and design reports.

Bugs

Numerous problems with program operation have been resolved, in the following areas: [wind load generation](#), [seismic load generation](#), [modelling](#) the structure, [user input](#), load and force [distribution](#) through the structure, [shearwall design](#), [graphics](#), [output of design results](#), and [file operations](#).

Important: You may need to re-examine past projects in light of these issues.

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A: Wind Load Generation

1. NBCC 2005 Wind Load Generation

a) Importance Categories and Factors

Input of importance categories in Table 4.1.2.1 and calculation of factors in 4.1.6.1 has been implemented. The importance factor has been added to the equation for wind pressures in 4.1.7.1.

b) Importance Input

The *Building use* input in the *Site Dialog* has been changed to *Importance category*, the new categories have been implemented, and a full description of the categories from table 4.1.2.1 has been added

c) Reference Wind Velocity

Velocity pressure q in 4.1.7.1(4) has changed. It is now based on a probability of 1-in-50 year return period. It was previously 1-in 10 for CC, 1-in-30 MWFRS, and 1-in-100 for post disaster. These inputs have been removed from the Site Dialog. Only one input is now in the *Site Dialog*.

d) Default Reference Wind Velocity

The default reference wind velocity in the Design Settings can now be set via a dropdown list giving the design q for dozens of Canadian cities, taken from Appendix C of the NBCC.

e) Exposure Factor C_e

A dropdown list has been added to the site dialog to allow selection of open or rough terrain.

The factor C_e has been changed according to from 4.1.7.1(5) has been implemented:

- $(h/10)^{0.2}$ but not less than 0.9 for open terrain (essentially the same as in NBCC 1995 and Sizer 2002a)
- $0.7(h/12)^{0.3}$ but not less than 0.7 for rough terrain.

f) Gust Factor C_g

The gust factor C_g from 4.1.7.1(6) has been implemented:

- $C_g = 2.0$ for main structural members (6a),
- $C_g = 2.5$ for C&C loads (6b)

g) Gust Factor C_{gi}

An input field has been added to allow user input of the internal gust factor C_{gi} to allow for detailed calculations allowed for in 4.1.7.1(6) c

h) Internal Pressure Co-efficient C_{pi}

New internal pressure co-efficients C_{pi} have been implemented according to NBCC structural Commentary I-31.

- For Category 1, the lower range has been changed from -0.30 to -0.15
- For Category 2, the range has changed from -0.7 to 0.7 to -0.45 to 0.3
- Category 3 is the same

i) Low-rise Note 8 – Low-slope Windward Loads

In in the design results, log file, and load list in load input view, references to Note 9 regarding the splitting of windward loads on, low-sloped roofs has been changed to Note 8.

j) Low rise Note 5 Roof Slope Angle

Note 5 to Figure I-7 allows eave height as reference height for angles less than 7 degrees now, instead of 10.

k) Component and Cladding Reference Height

Note 5 regarding reference height based on roof angle has been removed for component and cladding wall design. The reference height shown in the diagram is always mean roof height.

l) Figure I-7 Procedure

We removed reference to “Medium-rise” and “All heights” when referring to this figure, and instead refer to it as the Fig. I7 procedure. The design code refers to it as a procedure for flat-roofed structures, but Shearwalls uses it for all roof types, as an alternative to the low-rise method for those structures that do not conform to the low-rise limitations.

2. Overlapping Building Elements (Shadowing)

m) Input

Add setting in Load Generation options for "Exclude roof portion covered by other roof. It is checked by default.

n) Load Generation

If checked, the program discounts the redundant loads that are created when one building roof surface is in front of another. In doing so, it divides the roof panels into triangular and trapezoidal segments, increasing the number of wind loads on the structure. It takes into account end zones and NBCC I-7 Note 8 loads when splitting up roof.

o) Walls and Roofs

If a roof frames into a wall on the same storey of a taller block, then the covered portion of the wall is excluded. In some cases the portion of a roof covered by a wall is excluded.

3. Wind Load Generation Bugs

p) Wind Load Generation On Vertically Discontinuous Walls (Bug 1797)

The wind loads generated on an upper level wall that is not the same extent as the lower wall, use the extent of the lower wall for the loads on the bottom half of the upper level wall.

Therefore, many configurations received more or less loading than they should, for example:

- A wall that is common to two blocks in plan, but exists on an upper level on only one of the blocks.
- Overhangs or cantilevers

q) Load Generation after Block Size Change (Bug 1768)

The ridge elevation was not being properly updated upon change in block size, resulting in inaccuracies in many aspects of load generation in this case, including:

- the tributary width of wind loads
- calculations using mean roof height or ridge height

This problem would be corrected if you modified the roof via the roof input dialog after changing block size. As most users modify the blocks, then proceed to define the roof, it rarely occurs in normal practice.

r) Exposure Factor for Imperial Units (Bug 1670)

When imperial units were selected, the exposure Factor C_e reported in the *Design Results* and used for wind load generation was always 1.72, but it should be related to building height by NBCC 1995 Table 4.1.8.1. As a consequence, wind loads are increased by between 40% and 90%. When metric units were selected, the exposure factor was correct.

s) Zero-overhang roof wind loads (Bug 1697)

When generating loads on the side panels of gable end roofs with no overhang, extra tiny loads were sometimes showing up at the edges of the roof in *Plan View*. They no longer appear.

t) Low-rise Note 8 Loads on Hip Ends (Bug 1623)

For hip roofs, the loads on the upper portion of the hip ends generated according to the Low-rise Method in NBCC Commentary B7 Note 9 (now I7 Note 8) led to positive wind loads despite the fact that they have negative coefficients. This has been corrected

u) End zones (Version 2002a)

Problems with definition of end zone on convoluted structures were fixed in Version 2002a.

v) Wind loads on trapezoidal roof panels (Version 2002a)

Problems that occasionally occurred with wind loads on trapezoidal roof panels were fixed in Version 2002a.

w) Flat Roof Load Generation (Bug CSW7-12)

The program was creating both Case A and Case B loads for only one direction on the structure in the case of a flat roof, leading to unequal loading for square structures. The program now considers only the loads in the direction of the force for flat roofs, which have the same coefficients for Case A and Case B.

x) Generation after Wall Move via Keyboard Input (Bug CSW7-13)

When loads are generated after walls are moved by changing their co-ordinates in the wall input form, wind loads were not generated on some of the moved portions of the walls. This affected structures such as L-shaped, U-shaped, and those with vertical irregularities and has been corrected.

B: Seismic Load Generation

1. NBCC 2005 Wind Load Generation

a) Seismic Design Not Required

A design note indicates seismic design not required if $f S(0.2)$ as defined in sentence 4.1.8.4(6) less than or equal to 0.12

b) Maximum Building Height

Seismic design is not allowed for buildings over a maximum mean roof height h_n of 20 metres or 60 feet, in order that the design provisions that apply for $T_a \leq 0.5$ are used. This height also roughly corresponds to the maximum number of stories allowed for wood-frame construction. A warning message appears when seismic design is attempted for taller buildings.

c) Site Classes

The Soil Category input has been changed to Site Class, with the classes and abbreviated descriptions from Table 4.1.8.4A.

d) Spectral Response Acceleration Input

Damped spectral response accelerations: $S_a(0.2)$, $S_a(0.5)$, $S_a(1.0)$, $S_a(2.0)$ edit boxes have been added to the *Site Information* input form.

e) Default Spectral Response Acceleration

The default values of the spectral response accelerations that appear for new files, and are specified in the Design Settings via a dropdown list giving these values for dozens of Canadian cities, taken from Appendix C of the NBCC and Table J-2 of the structural commentaries.

f) F_a and F_v Values

Values of acceleration- and velocity-based site co-efficients F_a and F_v have been implemented in accordance with Tables 4.1.8.4B and 4.1.8.4C. Linear interpolation for is used for intermediate values of $S_a(0.2)$ and $S_a(1.0)$

g) F_a and F_v for Site Class F

Acceleration- and velocity-based site co-efficients, F_a and F_v edit boxes have been added to the *Building Site* dialog for user input. These are activated for site class F to allow for user determination of these values according to 4.1.8.4 (5), which calls for site-specific geotechnical investigations.

h) Spectral Acceleration Values $S(T)$

To comply with 4.1.8.4(6), spectral acceleration values $S(T)$ are determined as follows (where T is the period in the direction in question):

- $F_a S_a(0.2)$ for $T \leq 0.2s$
- $F_v S_a(0.5)$; $F_a S_a(0.2)$ whichever is smaller for $T = 0.5s$
- $F_v S_a(1.0)$ for $T \leq 1.0s$
- $F_v S_a(2.0)$ for $T = 2.0s$

i) Force Modification Factors

To comply with 4.1.8.9, the existing input for R has been changed to input two factors for each direction: ductility- related force modification Factor R_d , and overstrength-related force modification factor R_o .

j) Additional System Restrictions

To comply with 4.1.8.10, *Additional System Restrictions*, the program does not allow seismic design for Post disaster building shall have an SFRS with R_d or 2.0 or less. The user is notified in this case.

k) Fundamental Period T

The fundamental period T is now calculated according to 4.1.8.11 3 c), $T = 0.05 (h_n)^{3/4}$, where h_n is the mean roof height of the structure.

l) Earthquake Force V

The earthquake force V is calculated according to 4.1.8.11:

- $V = S(T_a) M_v I_{EW} / (R_d R_o)$
- $V_{min} = S(2.0) M_v I_{EW} / (R_d R_o)$
- $V_{max}(R_d \geq 1.5) = 2/3 S(0.2) I_{EW} / (R_d R_o)$

m) Higher Mode Factor M_v

A higher mode factor of M_v of 1.0 is used, corresponding to $T_a < 1.0$ from Table 4.1.8.11, which in turn corresponds to all buildings less than the maximum height restriction given above..

n) Importance Factor

The categories for importance factor have changed, but the seismic co-efficients for the corresponding factors (4.1.8.5) are the same as in NBCC 1995. Refer to the section on Wind Load Generation for changes to Importance Categories and input of these categories.

2. Irregularity Analysis

a) Irregularity Table

The program now analysis the structure for irregularities according to NBCC Table 4.1.8.6 and the references to these irregularities throughout the NBCC 4.1.8. For each irregularity, the table contains

- Irregularity Number
- Type of Irregularity from 4.1.8.6
- References

- Whether the irregularity is detected by the program or must be checked manually by the user of the program
- The level, shearline, and force direction for which the program is irregular. The words “Must check” are placed in this column if other parameters are such that the user must check for the existence of the irregularity.
- The level, shearline, and direction for which the program fails design due to the existence of the irregularity and other parameters making design illegal.
- The numbers of the notes below the table that apply to the irregularity

b) Warnings

The program issues bold warnings in advance of the table of two circumstances:

- If design fails because the program detects an irregularity and illegal seismic design parameters for that irregularity
- If the program detects design parameters such that the user must check for an irregularity that the program cannot detect.
- Warnings

c) Key Parameters

In advance of the table, the program outputs

- the value of $I_e F_a S_a(0.2)$, upon which many of the rules for irregularities are based
- a note saying that only the provisions based on T_a less than 0.5s and height less than 20 m are considered, as the program restricts seismic design to heights less than that

d) Notes

Notes are output below the table giving

- reasons for failure or that seismic design is not permitted
- reasons that the user must check for an irregularity or other parameters
- reasons that a check is not required or that an irregularity does not apply
- other explanatory information

There are a total of 21 possible notes. The notes are presented as a, b, c, d.. to avoid confusion with the irregularity numbers. The letter(s) for the note(s) applicable to the irregularity are given in the table for that irregularity.

e) Irregularity list

After the table and notes, the program lists the irregularities, giving a description of the irregularity and an explanation of how Shearwalls treats the irregularity. .

f) Screen messages

When a discontinuity is found that causes design to fail, or the program detects when the user must check for a discontinuity, following shearwall design a total of 7 possible explanatory warning messages are sent to the screen. These messages are for

- Post-Disaster and Types 1 or 7
- Post disaster and Type 3, 4, or 5
- Type 3, 4, 5 - And there is a weak storey, so no design.
- Type 3, 4, 5 - No weak storey, but program uses shearwall capacity in place of design shear for hold-down calculations
- Type 6, and seismic design not permitted unless design forces factored by $R_o R_d$
- Type 6, Seismic design not permitted
- User must check for Type 7.

g) Type 1 - Vertical stiffness

Design code references: NBCC 4.1.8.7-1c, 4.1.8.10-2a, NBCC Commentaries J-126.

If applicable, must be checked by user, who can use relative rigidities of shearlines in Shearwalls

h) Type 2 - Weight (mass)

Design code references: NBCC 4.1.8.7-1c.

No effect for buildings less than 20 m height and $T_a < 0.5$, or all buildings in Shearwalls.

i) Type 3 - Vertical Geometry

Design code references: NBCC 4.1.8.7-1c, 4.1.8.10-2a, 4.1.8.15-2, Commentaries J-126,156.

Shearwalls checks using the nearest and farthest points from all walls in a storey for each direction. It shows the storey with a long SRFS in the table, and the affected direction(s)

j) Type 4 - In-Plane Offset

Design code references: NBCC 4.1. 8.7-1c, 4.1.8.10-2a, 4.1.8.15-2, Commentaries J-126,156, 207.

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.

k) Type 4 - In-plane stiffness

Design code references: NBCC 4.1.8.7-1c,10-2a, 4.1.8.15-2, Commentaries J-126,156, 207.

Shearwalls compares the rigidity of collinear shearwall segments on adjacent storeys. It shows both upper and lower storey in table, e.g. 4,3, and shearlines affected.

l) Type 5 - Out-of-plane

Design code references: NBCC 4.1.8.7-1c, 4.1.10-2a, 4.18.15-2, Commentaries J-126,156.

Shearwalls detects wherever shearwalls do not exist on a shearline for particular level, and the program has transferred the force from the shearline on the floor above directly into the diaphragm. It shows the storey without shear-resisting elements in the table, and the directions(s) affected

m) Type 6 - Weak Storey

Design code references: NBCC 4.1.8.7-1c, 4.1.8.10-1,2b, Commentaries J-126, 156.

Shearwalls determines the total capacity of all shearwalls for each direction on each level, and reports weaker lower levels in the table

n) Type 7 - Torsional Sensitivity

Design code references: NBCC 4.1.10-2a, 4.1.8.11-9,10, Commentaries J-127, J177-9 .

Ratio B of maximum to average storey displacements is greater than 1.7. Shearwalls does not at this time perform deflection analysis, so this must be calculated by the user

o) Type 8 - Non-orthogonal

Design code references: NBCC 4.1.8.7-1c, Commentaries J-127.

Shearwalls does not currently allow input of skewed shearwalls, so this irregularity does not apply.

3. Seismic Load Generation Bugs

a) Roof Height for Vertical Force Distribution (Bug CSW7-7)

The height h_n for the highest floor used for vertical force distribution as per NBCC 1995 4.1.9.1 (13) (now NBCC 2005 4.1.8.11 (6)) was using the eave height of the roof, rather than the mean roof height. It now uses the mean roof height.

b) Snow Mass on Flat Roofs (Bug 1645)*

Snow mass was not accounted for when building mass was generated on a structure in which all roof blocks are set as a flat roof.

C: Building Model

1. Undo/Redo Feature

The program now allows the user to revert graphical input operations in the interactive Plan View and data input operations in its associated input forms, and to restore the actions that were undone

a) User Control

An *Undo* and a *Redo* button are added to the control bar above the Plan View window. These items are also placed in the *Edit* menu. In addition, the keystrokes *Ctrl-Z* and *Ctrl-Y* activate the undo and redo commands, respectively.

b) Affected Views

This feature is active in the *Structure*, *Walls*, *Openings*, and *Roofs* actions, in both *Plan View* and its associated data input forms. It is not active in the *CAD Import*, *Site Dialog*, *Load Generation Loads and Forces*

c) Affected Operations

Operations that create a change to the physical structure of the building are affected, such as moving or resizing blocks, walls, openings and roof panels, or changing the material composition of walls.

Merely moving the mouse, selecting a new object, or navigating amongst input controls, and changing building levels or views, are not included. Changing certain input controls that have no immediate effect on the building, like *Roof slope - Opposites the same* are also not included.

d) No. of Consecutive Undo's

As many as five consecutive operations can be undone, and redone again.

e) Interaction with File Save Command

The undo sequence is preserved through *File Save* commands, so that the user can undo and redo after saving. A document that has an operation undone then redone is still considered a changed document by Windows.

2. CAD Import, Upper Levels

This version extends the ability to import a Windows metafile exported from CAD software to the upper levels of the structure. Previously only the first level footprint could be imported.

a) CAD Import Wizard

The Wizard has been expanded to be a CAD Import Input View, similar to the other input views, that controls the file input for each level. It also continues operate as a wizard that guides you through the positioning and scaling process.

b) Drawings Required

If you choose not to import a metafile for a particular level, the metafile for the floor below will be shown. The first level file is required.

c) Scaling Factors

You can choose to bypass the scaling operation for any level but the ground level by specifying that any upper floor metafile has the same scaling factor as the level below.

d) Display

Once the input, positioning, and scaling process is complete, the metafiles for a particular floor will be visible in any other action of *Plan View*, when you press the CAD Import button.

3. Six Levels

Shearwalls now allows input of buildings to a maximum of six levels, as opposed to the four levels previously allowed. This allows for the maximum of 5 levels allowed for certain structures in IBC (Table 503), plus one below-grade level.

a) Structure Input

The spin control which is used to create the number of levels on each block now has an upper limit of 6 rather than 4. The *Structure* input dialog has two additional levels for which wall height and floor/ceiling depth can be entered.

b) Graphics

The Levels controls in Plan View and Elevation View now have an upper limit of six levels rather than four. Elevation view can now display all six levels at once.

c) Data input

The Generate Loads View, Load Input View, and Add load dialog filters for input and viewing loads now extend to 6 levels.

d) Text output

All Design results tables have been expanded to show more sections of data corresponding to building levels, and/or show levels up to 6 rather than 4 in the *Level* column:

e) Analysis and Design

All load generation, vertical and horizontal load distribution, and shearwall design begin the design cycle on up to the 6th level rather than the 4th, including two more iterations corresponding to the extra levels. Note that this can result in significantly heavier loading than for four stories, and a corresponding increase in processing delay.

4. Current Building Model Bugs

a) Three Block Roof Joining (Bug 1777)

The roof on the middle block in a 3-block configuration, when all three blocks have the same width, was not joining with the other two blocks.

b) Monoslope Roof Creation (Bugs 1599 and 1600)

It was not possible to change the roof angle in roof input view in order to create a 90-degree panel for a monoslope roof situation.

The program behaviour when attempting to create a monoslope roof via a movement of the ridge location was erratic and unpredictable. It was only possible for some building configurations

Monoslope roofs were thus difficult to achieve.

c) Monoslope Roof Ridge Direction (Bug 1667)

After changing the ridge direction for monoslope roofs, the program would revert to the original ridge direction on the next user input action.

d) Zero Wall Height for Uneven Blocks (Bug 1569)

If the ceiling joist depth is changed while entering the data in the *Structure Input* form for a block with fewer stories than other blocks, the wall height on the storey above the lower block's ceiling depth, on the taller block, was being set to zero. This has been corrected

e) Extend Walls Crash (Bugs 1440 and 1783)

The *Extend Walls* feature was causing Shearwalls to crash, for complex multi-block structures where adjoining blocks differ in levels by 2 or more, particularly when the blocks are arranged in an L- or U- shape.

Occasionally the program would crash upon pressing *Extend Walls* for any type of structure. due to random numerical precision issues.

f) Changing Storey Height after Extend Walls (Bug CSW7-35)

If the storey height is changed in *Structure* input after *Extend Walls* is invoked and when imperial units are employed, the walls would sometimes not be moved to the height of the storey that was raised, causing a gap between the wall and the diaphragm above.

5. Older Building Model Bugs

The following bugs may or may not have been fixed in version 2002a, but have definitely been rectified in the Sizer 7 Version.

a) Block problems

- When certain configurations of three or more blocks were created such that they were diagonally abutting and Roof action selected Shearwalls would freeze.
- When three blocks, with identical Y coordinates, were created, with the center block containing more levels than the outside blocks, the roof on the centre block was corrupted.
- When multiple blocks were created, and a wall from a block, which had blocks on either side, was first segmented and the new wall segment was moved, the blocks became disjoint and a gap appeared.
- When two blocks with different levels were created, and their bordering walls were manipulated such that the higher block had a smaller footprint at the interface, upon extending the walls to upper levels, walls were created that were longer than they should have been.
- When three blocks were defined sequentially, with the outer blocks set to have 2 levels and the middle block set to have one level, upon extending the walls to upper levels upper level walls were generated for the middle block.

b) Roof problems

- The slope of certain roof panels which joined other panels slopes were being set incorrectly causing erroneous looking roof diagrams and affected wind load calculations involving roof slopes.
- When two adjacent blocks were positioned such that they both had an outside wall at the same X or Y coordinate the roofs did not join, and it was impossible to make them joins
- When the roof configuration such as roof type, slope, location and/or elevation was modified the change was not reflected in adjacent block's roofs which were joined before the change.

c) Wall problems

- When three or more adjacent blocks were defined such that the middle block had fewer levels than the outside blocks, the extension of walls to upper floors caused the program to hang.
- When exterior walls connected to interior walls were moved, the program could shut down when walls were extended upwards.
- Under certain circumstances the automatic deletion of walls, resulting from the movement of wall segments, would cause the application to crash.

D: Input

1. Load Input

a) Loads Action Sequence

The program now requires entry into *Loads and Forces* view before proceeding to the *Design* command, and upon first entering the *Loads and Forces* view provides the user with advice as to which types of manually entered loads might be required.

The *Design* button and menu item will remain disabled until you first enter the *Loads and Forces* view. The message given below will appear when you first enter *Loads and Forces*.

b) Load View Entry Message

If loads have not been generated in the *Load Generation* action, the message reminds you to generate loads, and then advises about

- dead and uplift loads for hold-down calculations
- using direct shearline forces to model buildings adjoining other structures

If loads have already been generated, the program provides the same advice about dead, uplift loads and direct shearline forces, and also about the following loads that cannot be generated:

- from large installations, parapets, etc
- from complicated roofs

c) Direct Shearline Forces Label

The label in the group box in the *Add Loads* dialog that currently says *Implement as a factored force applied directly* has been changed to *Add as a factored force directly (parallel) to the shearline*.

d) Load Generation Commands

The buttons called

Generate and add to Loads,
Regenerate Loads

have been renamed to make their functionality more clear, they are now

Generate loads on selected levels,
Delete all and regenerate

The button named *Delete all generated loads* remains the same.

2. Settings Input

a) Drag strut Forces Based on

An input has been added to allow the user to choose whether drag struts are based on shearwall capacity or applied load, similar to hold-down forces.

b) Drag strut and Hold-down Force note

A note has been added to indicate that the user choice of “Applied loads” for hold-down and drag strut forces will be over-ridden by “Shearwall capacity” for seismic discontinuities, due to NBCC 4.1.8.15 (2).

3. Input Bugs

a) User-applied Wind Shearline Forces (Bug 1593)

When entering wind loads on a building face, the default extent of the load was furthest extent of shear resisting elements in the orthogonal direction to the wind loads, and not the length of the building face bearing those loads, when there were non-shearwalls at the ends.

b) Distribution Method for User-applied Shearline Forces (Bug 1596)

The *Distribution method* of user-applied shearline forces was not saved with the project file, so the *Distribution method* for such a force was being reset to *All Distribution Methods* when reopening the project file. This has been corrected

c) Default Wind Load Extent (Bug 1778)

When checking the "Implement as a factored force applied directly", the wind direction changes to "East to West" from "Both directions", so that often loads were inadvertently entered only in one direction.

d) East-west Shearline Forces in Load Input List (Bug 1590)

For *East->west or West->east* wind shearline forces input directly, the load direction displayed in the load list of load input view was the opposite of the input force. This did not occur for north-south forces, and had no effect on load analysis or design.

e) Levels in Load Input (Bug CSW7-10)

The range of levels in the *Add a New Load* input form is now synchronized with the range of levels in the *Load Input* form. Previously it was resetting to 1 to the maximum number of levels in the structure. The default should be the same as the "Levels" in the "Load Input" dialogue box

f) Wall Type Update on Change of Standard Wall (Bug 1730)

The wall type shading in the *Plan View* drawing did not update immediately upon selection of a new standard wall.

g) Rigid Diaphragm Loads and Forces Settings (Bug 1769)

In the Settings->Loads and Forces section of the menu, the Rigid diaphragm check boxes for plan and elevation view displayed the settings saved for the Flexible diaphragm selections.

h) Point Load on Opening End (Bug 1464)

When a point load was added to a wall directly over the start or end of an opening, the program was crashing.

i) Deleting User-applied Forces

The program would crash any time a user-applied shearline force was deleted. This has been corrected.

j) Status Bar Messages (Bug 1617)

The status bar was not displaying any message for the Site Dialog or any of its controls, while for the Wall Input, Roof Input, Generate Loads and Load Input views the messages were displayed only for some of the input controls and were truncated in a few instances. New status bar messages have been made for all controls in these views, and truncated status bar messages have been abbreviated.

k) Inconsistent Capitalisation (Bug 1453)

Input fields throughout the program composed of two or more words were inconsistently capitalised. The style is now sentence case unless it is a title to a window

E: Load and Force Distribution

1. Hold-down and Compression Forces

a) Hold-down offset

A setting has been added to the Default Settings page allowing input of the distance from the end of a wall or opening that a hold-down can be located. It can be saved for a particular

project, and as a default value to be used for new files. A value of zero cannot be entered, so there must be some hold-down offset. The "original default setting that comes with the program is setting is 3"

b) Hold-downs at Contiguous Walls

The hold-down offset means that compression forces at the end of one wall are not at precisely the same location as tension forces at the end of the other. In Sizer 2004b, these forces were cancelling.

c) Hold-down Force Magnitude

The moment arm used for hold-down force calculations is

- For anchorages, the segment length minus the largest of 300mm and twice the hold-down offset,
- For hold-downs, twice the hold-down offset.

d) Vertical Force Accumulation

Where a compressive force lines up with a tension force on the floor below, such as for offset openings, the program now correctly uses the difference between these forces as the resulting force. Previously it was adding the magnitude of the tension force in one direction to the tension force in the opposite force direction.

e) Wind and Dead Load Combinations

The new load combination for combining wind and dead loads at hold-down locations from NBCC 4.1.3.2 is used – $0.95D + 1.4W$. The wind factor has changed from 1.5 and the dead factor from 0.85.

The dead load factor for dead loads combined with wind loads used for compression forces combined is 1.25, as it is not counteracting uplift.

f) Compression Force Load Combination (Bug CSW7-19)

The load combination $1.25D + 1.4W$ has been implemented for downward compression forces. Previously, the program was erroneously using the $0.9D$ combination.

g) Irregularities

If the program detects In-plane or Out-of-plane irregularities 3, 4, or 5 from Table 4.1.8.6. If there is a weak storey below, design is not allowed, if there is, all hold-down and drag strut forces use the shearwall strength rather than the applied force, according to 4.1.8.15 (2).

h) Anchorage restrictions

An anchorage can now be placed only where there is a tension end of a shearwall on the floor below, so that the force is distributed directly to the wall chord and the hold-down or anchorage below. Previously the anchorage force could be distributed through the shearwall from mid-segment to the shearwall ends.

A note was added to the hold-down table when hold-downs rather than anchorages were created for that purpose.

Vertical Elements for Hold-downs

Where previously an anchorage force would meet a shearwall on the floor below at mid-segment, the program creates a vertical element and a hold-down force, and transfers the force through that element further down through the structure.

i) Design Setting for Force Calculation

A new *Design Setting* allows you to choose whether to use the applied shear load or the tabulated shear strength in calculating hold-down forces. The default value is applied shear, you should change this when designing connections if the design code specifies tabulated shear.

When shear capacity is required due to seismic irregularities, then this takes precedence due to

2. Distribution of Loads to Shearline Forces

a) Rigid Seismic Load Distribution

A accidental eccentricity of 10 percent of the building width at each level has been added to the torsional moments for rigid diaphragm load distribution for seismic loads, to comply with 4.1.8.11 10 (a).

b) Rigid Wind Load Distribution

In the absence of any provisions to add wind load eccentricity, the torsional moments for wind load distribution now consider only the moments due to asymmetric loading, and no accidental eccentricity.

3. Drag Strut Forces

a) Design Setting for Force Calculation

A new *Design Setting* allows you to choose whether to use the applied shear load or the tabulated shear strength in calculating drag strut forces. The default value is applied shear, you should change this when designing connections if the design code specifies tabulated shear.

b) Calculations Seismic Irregularity

Furthermore, the program automatically changes the calculation to shear strength in the presence of a seismic irregularity when such an irregularity calls for it. Refer to the section on seismic irregularity analysis.

4. Load and Force Distribution Bugs

a) Drag Strut Forces for Wind and Seismic (Bug CSW7-40c)

Since version 2002 was released, when wind and seismic forces were both present on a shearline, the drag strut force calculations were incorporating both wind and seismic shear forces, rather than each separately, resulting in a much too heavy drag strut design force.

b) Hold-down Force Distribution into Interior of Wall Segment (Bug 1795)

The calculations for Hold-down force distribution from an upper wall to the interior of a wall segment below were using the shearline ends rather than the wall ends, resulting in miscalculation of the force magnitude and misappropriation of these forces to the line end rather than wall end. Affected only shearlines with multiple walls.

The program now transfers these forces directly downwards via a vertical element.

c) Compression Hold-down Force Accumulation (Bug 1796)

Compression hold-down forces shown in elevation view were showing the forces from that level only, without including the accumulated force from the levels above.

d) Rigid distribution of negative direct loads (Version 2002b)

Before version 2002b, the calculation for torsional shear force for the rigid distribution method, was omitting the negative direct loads

e) Critical Negative Wind Loads (Version 2002b)

Before version 2002b, in the unlikely circumstance that negative wind loads are critical, the program was creating hold-down forces in wrong direction and not designing walls correctly

f) Distribution of Wind Uplift Loads to Openings. (Version 2002b)

Before version 2002b, The partitioning of line loads over openings and non-FHS segments were incorrect when wind uplift loads were present and seismic building masses were also present.

F: Shearwall Design

1. Shearwall Design Bugs and Minor Improvements

a) Design Search Failure for Openings at End of Line (Bug CSW7-17)

The design search would fail to find passing shearwalls when an opening existed exactly at the beginning or end of a shearline.

b) Wall Groups Designed for Opposing Directions (Bug CSW7-41)

The program was not always ensuring that the wall materials designed for opposing force directions were the ones needed for the strongest of the two cases, instead it could design separate materials for opposing directions. It now reports just one material wall group for the wind case, and one for the seismic case.

c) Similar Materials on Shearline (Bug CSW7-42)

The program was not ensuring that the materials designed for the critical wall were transferred to all other walls on the line when the *All shearwalls on shearline have same materials* design option was selected. The program would then report different wall groups and materials for the same shearline.

d) Blocked Gypsum Sheathing Capacity (Bug 1589)

Shear capacity of blocked gypsum incorrectly follows the rules for unblocked gypsum (CSA 086-01, Table 9.5.1B, Note 1) in that it is being reduced when frame stud spacing is greater than 400mm. This results in a conservative shear capacity.

e) Non-shearwalls Contribute to Shearline Capacity (Bug 1587)

In the *Shear Results* table of the *Design Results*, the total shear capacity of the shear line and the design ratio were including the capacities of wall segments that exceed FHS aspect ratio check in the total shear capacity of the shear line. However, the program was not using these incorrect values for shearwall design, instead using the correct individual segment values.

f) C&C Loads for Sheathing Design (Bug CSW7-43)

The C&C loads used for sheathing design were the lower interior zone loads rather than the higher end zone loads. This resulted in non-conservative design, and has been corrected.

g) Nail Withdrawal Failure for Non-loaded Surfaces (Bug 1586)

As a result of bug 1587, above, for known sheathing capacity and no C&C loading, Shearwalls sometimes report failure in *Elevation View* because of zero nail withdrawal capacity

h) Nail Withdrawal Capacity (Bug CSW7-44)

The nail withdrawal capacity was not incorporating the 0.6 safety factor ρ according to 10.9.5.2 of CSA O86. This resulted in non-conservative design, and has been corrected.

i) Nail Sizes Greater than 3" (Bug CSW7-48)

Due to instabilities created by the application of 9.4.5.5a), the restriction in nail size to less than 3.25" for $J_{hd} < 1$, nail sizes greater than 3" have been removed. Nail sizes that large tend to split plywood anyway

As a result, some designs that required nail sizes larger than 3" to pass the nail withdrawal check in areas of high C&C wind loading will now fail. If this happens, an increase in interior spacing is needed.

j) J_{hd} Factor for Non-aligned Shearwall Segments (Capacity (Bug CSW7-45)

When the end of a shearwall segment with hold-downs occurs where there is no segment end on the floor above, the program was applying CSA O86 9.4.5.3 for a J_{hd} factor < 1 , which is the literal interpretation of that clause.

However, we believe that the intent of the clause is to apply this clause when an anchorage exists above a hold-down to account for the fact that the upper storey anchorage force will be transferred through the lower storey sheathing, reducing the shear capacity of the lower storey. Therefore, CSA O86 9.4.5.3 is no longer applied when there is no anchorage above the hold-down location.

k) J_{hd} Factor Warning for One-storey Structures (Bug 1635)

For a single-storey building, in the Results View, under "SEISMIC DESIGN" for both Flexible and Rigid Diaphragm, the following message would appear:

*** Warning - design capacity is exceeded because Vrs is zero due to negative Jhd factor even though, for a single-storey building, Jhd should never be less than 1*

l) Seismic Compression Force Location (Offset)*

For seismic design, the location of compression hold down is offset from end of wall by twice the user input hold-down offset rather than just that offset. As a consequence, the compression and tension hold-downs at an opening end are offset from each other, and the program assigned some of the dead load to one of the hold-downs and some to the other, rather than the full dead load to both.

G: Graphics

1. Titles and Legends

Explanatory legends explaining the meaning of the symbols used for loads and forces in Elevation View and in Plan View have been added. Separate legends appear for wind and seismic design, and for *Loads and Forces* action versus *Generate Loads* action

a) Plan View, Loads and Forces Legend

A legend is added to the bottom left corner of the view. It shows the symbols for shearline forces, hold-down forces, compression forces, vertical elements, applied shear loads, dead loads, uplift loads, and discontinuous shearline forces applied as loads.

b) Plan View, Generate Loads Legend

A legend is added to the bottom left corner of the view. It shows the symbols for generated shear point loads and line loads, generated building masses, and floor areas for mass generation. Forces or user-applied loads are not shown in this action.

c) Load Factors and Combinations

When the legends indicate that loads and forces are factored or unfactored, it means that they are or are not multiplied by the load combination factor.

There is a line at the bottom of the plan view screen indicating load combination being used for hold-down and compression force calculations.

d) Elevation view Legend

A legend is added to the bottom right corner of the view. It shows the symbols for tension hold-down and anchorage, and compression, forces for shear overturning, dead, uplift and combined, hold-down magnitudes; load combination factors; shearline forces; the meaning of

the various shear force arrows, and the symbol for drag strut forces. Slightly different legends appear for seismic and wind output.

e) Elevation View Title Block

The large amount of empty space above the title bar in Elevation View has been reduced to the size of a reasonable margin.

The title block has been reconfigured differently for printing and for screen display. It now shows,

On the first line in print mode,

"Elevation View"

On the second line in print mode, first line in screen mode

shearline name

shearline location

building levels shown

On the third line, in print mode, still on the first line on screen

rigid or flexible design case

wind or seismic design

2. Hold-down forces, anchorages, and compression forces

a) Critical Hold-down Forces

The *Critical Forces* choice under *Load Direction* in *Plan View*, shows the critical tension hold-down force at each vertical force collector location. For low-rise wind loads, it shows the critical force for all reference corners.

This item should be selected if you want a drawing showing all of your hold-down forces in *Plan View*.

Note that the *Holddowns and Drag Struts* table in the Results output also shows the critical vertical forces at each hold-down location. .

b) Hold-down offset

Hold-downs are now moved inside the wall by the [hold-down offset](#) distance, and compression hold-downs can no longer coincide with tension hold-downs.

c) Vertical Discontinuities

Hold-downs from the floor above now appear on the level when there are no walls on that level, carried through by a vertical element, which is shown as doubled wall stud in elevation view. .

d) Compression Forces

- Compression forces are now drawn whenever the net force is directed downwards, even in the case that downward dead load dominates upward overturning force.
- In Elevation View, A vertical arrow symbol is used to distinguish compressive forces from hold-downs, and has been extended downwards through the joist area. The negative sign is no longer shown for these forces. The hold-down magnitude text is now positioned such that the adjacent compression and tension forces do not overlap
- In *Plan* view, compression forces are shown by a circle and the letter C. No magnitude is shown, as the force does not include other gravity load combinations and is thus not of sufficient interest to merit the clutter on the screen

3. Vertical elements

a) Location

Vertical elements are created wherever a hold-down or compressive force is created, and it does not coincide with a wall or opening end (plus or minus hold-down offset) on the level below. They correspond to either columns or strengthened wall studs.

b) Depiction in Elevation View

This is depicted as of two light solid lines spaced 3" apart, and a dotted line in the middle of them, representing a built-up double wall stud. The element centred on the hold-down of compression force, except where walls meet as described below.

The element extends from the bottom of the upper floor joist to the top of the lower joists, except over openings, where the element extends down to the opening top.

c) Depiction in Plan View

In Plan View they appear as small squares, the same width as a wall, with a dark blue colour (dark red when a wall is selected). They replace the hold-down or compression force symbol where they exist.

d) Contiguous walls

When two forces exist where segmented walls meet, usually tension and hold-down forces separated by twice the hold-down offset, the program depicts only one vertical element, centred between the forces.

e) Display setting

You are able to turn on and off the display of vertical elements via *Settings... Display*, separately for *Elevation View*. This display setting is also implemented in the *Show* menu.

4. Horizontal Forces

a) Critical Forces

The *Critical Forces* choice under *Load Direction* in *Plan View*, shows shearline forces in both directions, and the critical tension hold-down force at each vertical force collector location. For low-rise wind loads, it shows the critical force for all reference corners.

For wind design, applied loads are not shown as their direction would conflict with the forces reported. For seismic design, the loads are shown..

b) Diaphragm Shear Flow

The diaphragm shear flow at the top of the diagram now extends the entire width of the shearline, from the extreme exterior wall at one end to the extreme exterior wall on the other, through all gaps in the shearline, and over openings and non-shearwalls. Previously it was incorrectly shown over walls only.

c) U-shaped Buildings

When there is a gap in the shearline that is actually external to the building, due to a structure that is U-shaped in plan or in elevation, the program continues to show the diaphragm shear flow across the gap that is absent a diaphragm and also drag strut forces leading into the gap.

This indicates more clearly to the user that the program does not yet deal correctly with this situation from a load analysis standpoint. The WoodWorks development team is working on a solution to this problem, and suggestions from users on how to distribute loads in such structures are welcome.

d) Seismic Direction

In *Plan View*, now only two of the four selections of the *Load Direction* choices currently available for wind are available for seismic, rather than four. The loads and shearline forces are still shown as bi-directional arrows

e) Negative shearline forces (Version 2002b)

For version 2002b and 7, for forces from negative loading, the program reverts the direction of the arrows and displays the magnitude as positive.

f) Drag Strut Forces

The drag strut forces that occur at wall ends have been moved up closer to the top of the wall. All the forces have been provided with a circle at one end to distinguish them from shearline forces and to emphasize that, like tension hold-downs, a mechanical connection is required.

g) Shearline Point Force

In *Elevation View*, shearline force arrow has been reduced in size, includes the entire tail, and no longer goes missing when there is a gap in the walls at the end of a shearline.

5. Graphics Bugs

a) Opening Colour due to Gray Block Outline (Bug 1694)

The gray outline of blocks and roofs is no longer being drawn over walls, and openings. It was discolouring walls and obscuring openings

b) Force Symbols on Non-Shearwalls in Elevation View

The design shear was displayed at the base of non-shearwalls in the elevation view if the non-shearwall was once a shearwall, and persisted after another design was run.

After changing the wall type in an entire shearline from shearwalls to non-shearwalls, the shearline forces were still being displayed in elevation view after the next design

c) Failed Walls in Elevation View (Bug CSW7-16)

When either an opening or a segment too narrow for design existed at the end of a shearline, that line would not display the word FAILED over the elevation view drawing when the shearwall design failed for that wall.

H: Design Results Output

1. New Viewer and Report Format

a) Report Viewer

- Full page, page width or zoom
- Navigation between pages with control at top of view
- Navigation directly to table with menu in toolbar
- Keyboard and mouse navigation

b) Organisation of data

- The output is now reorganized into four major sections: *Project Information*, *Structural Data*, *Loads*, and *Design Results*
- Show button menu reorganized and table menu organized to reflect organization of the results tables
- The display of all loads tables can be toggled on or off with single menu selection
- Pagination, page breaks after tables, table title and continued on each page
- Automatically switches between landscape and portrait to fit tables option
- No longer shows titles if tables or sections are not shown.

c) Formatting

- Bold, Arial font headings and titles, fixed pitch table data, notes in italics
- Tables have distinct headings and columns
- Borders around tables

- Blank lines inserted in tables with subtitle to delineate shearline or level

d) Legends

The *Materials*, *Dimensions*, *Loads*, and all *Design Results* tables now have a legend below the table which

- gives the meaning of all the columns in the table
- defines any abbreviations used
- provides additional design notes as needed.

e) File Output

User can choose to save output in

- Rich text file (.rtf) format or
- portable document format (.pdf).

f) Printing

- Able to print individual pages or page ranges.
- New setting in Format page allows you to activate automatic switching to landscape mode for font sizes greater than 10 in results view

2. New and Removed Tables

a) Remove Shearwall Segments table

- All but the shear force and capacity information now resides in the *Shearline, Wall and Opening Dimensions* table.
- The shear force and capacity are now listed in the Shear Results tables.

b) Add Seismic Information table

- Building mass and storey shear moved here from storey information table
- Show storey shear in both force directions
- Added length of SFRS (seismic force resisting system) to be used in irregularities analysis (see B2 above)

c) Add Irregularities Table

- Added *Seismic Irregularities* table described in the Seismic Load Generation section (B2, above), with warnings, notes, and irregularity list

3. Changes to existing tables

a) Company and Project Information

- Now in form of table
- Listed only if company or project information is entered in settings dialog

b) Design Settings

- Now organised into a table
- Gives full name and year of design standard, and wind standard clause used (Fig I-15 or I-1/8)
- Add nail withdrawal moisture content conditions, for fabrication and service
- Add anchorage restriction settings
- Add dissimilar materials setting
- Add setting for height restriction for wind loads
- Remove sheathing combination, not relevant to Canada
- Remove wind capacity increase, not relevant to Canada
- Remove seismic load reduction factor, not relevant to Canada

c) Site Information

- Now organised into a table

- Expand definition of occupancies
- Wind:
 - Update design code used
 - Add units for velocity pressure
 - Add *Internal Gust Factor CGi*
 - Add *Terrain*
 - Add *Topographic Information* section.
- Seismic::
 - Add reference to seismic procedure in NBCC used.
 - Remove *Seismic Zone*, and *Zonal Ratio*,
 - Replace *Soil Category* with site class
 - Add $S_a(T)$ for $T = 0.2, 0.5, 1.0,$ and 2.0
 - Replace Z_a, Z_v with F_a, F_v .
 - Replace R with *Ductility Factor Rd* and *Overstrength Factor Ro*

d) Story Information

- The *Building Mass* and *Story Shear* are no longer presented here. They have been moved to the new *Seismic Information* table

e) Block and Roof Information

- *Location* and *Extent* are now shown for both directions.
- *Ridge Location* and *Ridge Elevation* now refer to the absolute values.
- The relative values also included as *Ridge Offset* and *Ridge Height*
- Gives ridge direction

f) Materials by Wall Group

- Add legend explaining headings .

g) Shearline, Wall and Opening Dimensions

- Added legend explaining headings
- Organised into separate sections for E-W and N-S shearwalls
- Add subheadings for line and level
- Added column for full height sheathing.

h) Wind Shear Loads

- Loads now sorted much better by Block, Load Case, Direction, Location etc,
- Can be shown combined (as accumulated by program) or separately (as entered). *Separately* is default.
- Removed level column, as table is organised by levels
- Added *Block* and *Element* columns
- Low rise reference corner and wind case are both listed in the *Load Case* column.
- The magnitude column is split into *Magnitude Start* and *End*
- The tributary width column is renamed *Trib Ht* which better represents the value
- Added legend

i) Wind, Seismic Shear Forces (applied directly)

- Corrected ragged output

j) Wind C&C Loads

- Removed name column, that used to simply contain "Wall"
- Added *Block* column. Previously it was unclear what block the load came from
- Fixed bug that reversed the values in the interior and end zones.

k) Dead Loads and Uplift Loads

- Heading for these loads did not correspond to data in columns – this has been corrected

- Corrected ragged output of rows
- Separate columns for start and end magnitude
- Move tributary width column

l) Building Masses

- Added legend explaining columns, and building elements
- Separate columns for start and end magnitude
- Remove level column (table organised by levels)

m) Seismic Loads

- Remove level column (table organised by levels)
- Separate columns for start and end magnitude
- Added legend, including explanation of seismic loads as combination of masses on many elements

n) Shear Results

- Added legend explaining all the columns and data within them, incorporating the notes that were previously below the table.
- Add subheadings for line and level
- Added comma between low rise-reference corners to distinguish them

o) Drag strut and Hold-down Forces

- Added legend explaining the meaning of the headings and the data within the columns.
- Changed dead load to show factored load, to be consistent with shearline force.
- Added "Line" subheadings
- Changed the heading for the from *Holddown Force [lbs]* to *Tensile Holddown Force [lbs]*
- Added explanatory notes for vertical elements and for moment arm used in force calculation.
- Added numbered notes for those hold-downs (rather than anchorages) required due to irregularities

p) Components and Cladding by Shearline

- Added legend explaining meanings of headings and data
- Added column for service condition factor for moisture conditions
- Reorganized into north-south and east-west shearline sections

4. Other changes

a) Drag Strut and Hold-down Note

In both the *Drag strut and Hold-down Forces* table of the *Design Results*, and *Elevation View*, a note has been added to indicate that the user choice in the *Design Settings* of *Applied Load* for hold-down and drag strut force has been over-ridden by *Shearwall Capacity* for seismic irregularities due to NBCC 4.1.8.15 (2).

b) Dissimilar Materials in Elevation View (Issue CSW7-36)

If walls with dissimilar materials exist on the same shearline, then the program shows the materials for the strongest wall. Note that this wall may not be composed of the heaviest materials, due to the affect of the J_{hd} factor.

There is now also a note in this view indicating that you should consult the design results for the materials for each wall on the line.

5. Output Bugs

a) Shear Capacity Results when there are Non-shearwalls (Bug CSW7-9)

When a shearline consists of one shearwall and at least one non-shearwall, the Shear Results table the output was not showing the capacity information Vhd/L, Jhd and V, for that line.

b) Fastener Spacing Unit Label (Bug 1664)

The units beside the input for fastener "Inter. Spacing" (field spacing) were displayed as mm, when the values in the list were in inches.

c) Fastener Penetration Units (Bug 1773)

The fastener penetration information in the Materials by Wall Group table was always displayed in millimetres even though it should display in inches when Imperial units are selected.

d) 75mm Edge Nail Spacing (Bug CSW7-37)

The program was reporting 75mm edge nail spacing as 70mm. The design calculations were using 75mm.

e) Fastener Information in Elevation View (Bug 1572)

Imperial units fastener information in Elevation View showed metric nail thickness without displaying mm, incorrectly showed metric edge spacing, and showed a fractional value for field spacing that was slightly different than the round number input into program.

f) Imperial Capacities in Elevation View (Bug CSW7-24)

Nonsensical values were showing for elevation view for shear capacity and C&C capacity in the elevation view material specification, due to unit conversion problems.

g) Shear Capacities for Zero-length Segments (Bug CSW7-30b)

When shear capacities differ for different segments, the program was outputting results for zero-length segments, causing repetition.

h) Header on Printed Design Results (Bug 1167)

The header information and page numbers were present only on the first page of the design results printout.

i) Maximum Font Size for Page Width (Bug 1330)

The printed text output in 10 size font did not completely fit onto the width on regular letter-size page. It now prints fits with 11 size font.

j) Wind Uplift and Dead Loads Table Headers (Bug 1775)

The headers for wind uplift loads and dead loads were the same as the ones for building masses, when they should have headings appropriate to these loads. As a result, the Profile column was misaligned.

k) Incomplete Design Material Specification

For large, complicated structures with openings and non-shearwalls, for some shearlines the Materials table contained "?" for nail spacing or sheathing thickness.

I: Documentation and File Operations

1. On-line help

a) Review

The on-line help has been reviewed to make sure it is up-to-date with current program operation and current design code references.

b) HTML Help

The Help system used is now HTML Help, which is compatible with the Windows Vista operating system, as well as previous versions of Windows

c) Release Notes

Extensive Release notes describing all changes to the program have been added for this version, in the html file *New Features*, which is included with the installation.

d) Bizarre Font in Old Operating Systems*

For version 2002, the content of the Shearwall help file used bizarre Wingding font when Windows 95, Windows 98 and Windows NT operating systems are being used

2. On-line CSA O86

a) CSA O86 -01 (2005)

The on-line CSA O86 -01 design standard in .pdf format supplied with WoodWorks Sizer has been updated and includes the January 2003 Update No 1 1 and the January 2005 Supplement.

b) Adobe Acrobat 8

The on-line design code now works with the most recent versions of Adobe Acrobat.

3. Design Code References

A design note has been added to both the Welcome box and to the Design Results design notes giving the editions of the NBCC and CSA O86 used in the program. All program references to design codes have been updated.

4. File Operation Bugs

a) Opening Files from Previous Versions (Bug 1458) *

Project files from previous major versions could not be opened with version 2002/2002a in the same session that a version 2002/2002a file had been opened or saved. Version 7 can open files from previous versions in all situations..

b) File Save Flag (Bug 1704)

After many of the user operations, the program was not indicating to Windows that a project file had been modified, leading to cases where you could close a file without being notified to save it. This has been rectified.

Shearwalls 2002a - October 29, 2004 - Design Office 2002 (Service Release 1)

This Service Release consisted of a review of all known problems and user issues with Shearwalls and a resolution to any of these that were significant and/or simple to resolve.

Bug Fixes and Features Overview

- A. Building Model and Program Operation
 - 1. Unexpected Shut Down
 - 2. Update of Joining Roof Configuration

3. Removal of Indentations
 4. Wall Segmentation Shutdown
 5. Interior Walls Protrude outside Building
 6. Merging Walls - Effect on Roof Joining
 7. Roof Joining of Abutting Blocks
 8. Wall Creation for Uneven No of Storeys
 9. Roof Joining Error for Unusual Configuration
 10. Three-Block Upper Level Wall Creation
 11. Upward Extension of Three Block Structure
 12. Roofs on Three Block Multilevel Buildings
 13. Joined Roof Panel Slopes
 14. Uneven Number of Stories
 15. Segmentation of Middle Block Walls
 16. Roof Generation on Diagonally Abutting Blocks.
 17. Wall Height Warning Message
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- B. Engineering Design
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 2. Negative Critical Design Shear Forces
 3. Duplicate Wall Groups, Exterior Sheathing Only
 4. Duplicate Wall Groups, Different Hold-down Configuration
 5. Incomplete Design Material Specification
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- C. Seismic Load Generation
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 3. Building Mass of Line of Non-shearwalls
 4. Building Mass of Intersecting Roof Blocks
 5. Zero Point Building Masses in Plan View
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 7. Metric vs Imperial Roof Masses
 8. Zero Point Building Masses in Plan View
- D. Wind Load Generation
1. Topographic Factor
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 3. Height h for Ce
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 6. Low-rise Tributary Width
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- E. Load Distribution

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- G. Text Output
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- H. Graphical Output
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 2. Design Shear on Non-Shearwalls in Elevation View
 3. Shearline Forces on a Non-Shearwall in Elevation View
 4. Update of Forces in Elevation View
 5. Hold-down Symbols in Plan View

Bug Fixes and Features Details

- A. Building Model and Program Operation
1. Unexpected Shut Down
Shearwalls no longer closes down frequently when creating roofs, segmenting walls or generating loads.
 2. Update of Joining Roof Configuration
When the configuration of a roof is changed, the configuration of a roof joined to that roof is now changed
 3. Removal of Indentations
The program no longer shuts down when the wall that forms the face of indentaion or protrusion is moved so as to eliminate the indentation and form a line with other walls.
 4. Wall Segmentation Shutdown
Program no longer shuts down on wall segmentation using Wiindows XP

operating system, in particular when you segment wall 2-1 of Quick Start Tutorial of the user manual.

5. Interior Walls Protude outside Building
It is no longer possible to move exterior walls such that interior walls extend outside of the building
6. Merging Walls - Effect on Roof Joining
Merging walls on two abutting blocks caused the blocks to abut rather than overlap, and the roofs not to join or to be able to be joined manually.
7. Roof Joining of Abutting Blocks
For certain configurations, when blocks join but do not overlap, the roof of the smaller block did not join the larger one.
8. Wall Creation for Uneven No of Storeys
For joining blocks with different number of levels, changing wall location before extension upwards no longer creates disattached walls on the upper level.
9. Roof Joining Error for Unusual Configuration
Attempting to create a structure with at least three blocks arranged so that the first block contains an entire wall of the second block, and the third block diagonally abuts the second block, caused the program to hang on roof creation.
10. Three-Block Upper Level Wall Creation
When three adjacent blocks are defined such that the middle block has fewer levels than the outside blocks, the extension of walls to upper storeys no longer creates walls on the middle block where there is no storey.
11. Upward Extension of Three Block Structure
When extending a structure with three colinear blocks of different levels, all blocks were given the same number of levels.
12. Roofs on Three Block Multilevel Buildings
Roof creation no longer fails for center block in three adjacent block multi-level building with different numbers of levels.
13. Joined Roof Panel Slopes
Joined roof panels' slopes were occasionally set using the wrong connecting roof panel.
14. Uneven Number of Stories
For buildings with uneven numbers of stories, the program would occasionally shut down when changing views.
15. Segmentation of Middle Block Walls
When the external walls of the middle blocks of three or more blocks are segmented and then moved, gaps between the blocks, such that the blocks become disjoined, no longer appear.
16. Roof Generation on Diagonally Abutting Blocks.
Program no longer shuts down on roof generation for diagonally opposed blocks that do not overlap.
17. Wall Height Warning Message
After decreasing the wall height a warning message appeared even if the wall was within limits.
18. Default Values Settings
The operation of default settings for new files has changed. If no file is open, all settings automatically are saved for new files. If a new file is opened only the Default Values settings are set to Save for New Files. A note in the settings box

indicates those Default Value settings which have an effect on current file operation.

19. Main Menu Key Shortcuts

Several main menu key shortcuts have been repaired. "Alt+I" and "Ctrl+U" now work for Log File and for User Manual, respectively; Extend Walls has been changed to Alt+E and Plan View to Alt+P; and Ctrl-P prints.

20. Species when Multiple Walls Selected*

The framing *Species* field did not appear blank in *Wall Input View* when different wall studs species exist for walls selected simultaneously in *Plan View*. The value that appeared could even be one that is not an attribute of any selected wall. This has been fixed

21. Help File Font*

The content of the Shearwall help file used unreadable Wingding font when Window 95, Window 98 and Window NT operating systems were being used. This affected about 15% of users.

B. Engineering Design

1. Seismic Design with Unknown Stud Spacing

Walls with unknown stud spacing always failed for seismic design.

2. Negative Critical Design Shear Forces

Negative critical design shear forces were not being considered, causing incorrect creation of hold-downs and approval of failed walls in design search.

3. Duplicate Wall Groups, Exterior Sheathing Only

Multiple wall groups with identical materials were being generated when walls had sheathing on exterior surface only.

4. Duplicate Wall Groups, Different Hold-down Configuration

Duplicate wall groups with the same material configuration are no longer created when hold-down configuration is different.

5. Incomplete Design Material Specification

For large, complicated structures with openings and non-shearwalls, for some shearlines the Materials table contained "?" for nail spacing or sheathing thickness.

6. Wall Group Number

The Design Group(s) number shown in the Wall Input form is now updated after running design.

7. Extra Wall Group in Materials Table

For wind design only, an extra wall group, which was not used anywhere, was sometimes being created.

8. Ce on Windward Walls

The NBCC Ce factor was too small on gable ends and too large on walls due to coarseness in the numerical integration routine.

C. Seismic Load Generation

1. Seismic Load Generation on Complicated Structures

For large buildings containing many indentations and protrusions, the generation of seismic loads caused the application to shut down.

2. Reversal of Fundamental Period T

The calculated N-S and E-W fundamental period T values were reversed, so that the wrong default values appeared in the Site dialog and would be used to generate seismic loads if not changed.

3. Building Mass of Line of Non-shearwalls
The building mass of shearlines composed entirely of non-shearwalls, is now being included in generation of seismic building masses.
4. Building Mass of Intersecting Roof Blocks
The building mass values shown in the Seismic Information Table no longer include the overhang on the intersecting portion of two roof blocks.
5. Zero Point Building Masses in Plan View
Numerous seismic point building masses were showing up in the plan view drawing adjacent to building corners.
6. Upper Level Wall Building Masses
The wall building mass created for the upper storey was based on the full height of the wall rather than half the height. However the seismic loads generated from these masses were based on the correct height.
7. Metric vs Imperial Roof Masses
Small differences due to rounding between metric and imperial roof masses have been eliminated.
8. Zero Point Building Masses in Plan View
Numerous seismic point building masses were showing up in the plan view drawing adjacent to building corners.

D. Wind Load Generation

1. Topographic Factor
The program was using values in mm rather than m for hill dimensions in NBC 1995, Commentaries B 18; eq. (6) page 1, causing app. 10% error in the topographic factor calculated.
2. Wall Load Generation after Roof Move.
After a roof block was unattached from the rest of the roof, the loads for the walls on that block were not being generated in the same session.
3. Height h for Ce
The height h reported in the logfile for NBCC Ce factor for windward walls is slightly low due to an error in the numerical integration used to calculate it.
4. Ce on Gable End
The program was amplifying the NBCC Ce value slightly on the gable end by averaging over the height as if it was a rectangular surface instead of a triangle.
5. Width of NBCC Zone 2 Low Rise Loads
When applying Note 9 from Figure B-7, NBCC- 95 Com. B the program was mistakenly moving the dividing line in zone 2 by a small portion of the eave width.
6. Low-rise Tributary Width
When windward roofs are divided according to NBCC Com. Figure B-7, note 9, the area load tributary width shown in Load Input View for each zone was the entire roof panel height instead of the heights of the divided zones.
7. Wind Pressure on Gable Ends
A too low height h was being used to calculate the NBCC Ce factor on windward gable ends, resulting in lower than expected

E. Load Distribution

1. Rigid Distribution to One Shearline in each Direction
Program was attempting rigid distribution to one shearline in each direction, even though torsional rigidity cannot be calculated in this case. It now disallows such configurations.

2. Display of Manually-entered Wall Rigidities
Removed the e.g (Wind Design) from the Wall Rigidities input field for manually entered rigidities, and now apply the input rigidity to both wind and seismic design.
3. Vertical Distribution of Load Combination Factor
When shearlines on upper stories did not have any walls directly bellow, in the flexible distribution method the load combination factor was being re-applied as the force was distributed from an upper level to the level below.

F. Data Input

1. Unknown Edge Spacing
The "unknown" option was missing from the edge spacing dropdown when the Restrict materials and override option was set in the Design Settings, causing incorrect edge spacing data to appear in the Materials table of the Design Results
2. Blank Input Fields for OSB Materials
For OSB materials, the nail length and stud spacing drop down boxes no longer appear blank at times.
3. Default Tributary Width
Manually entered area wind loads now have default tributary width.
4. Zero Ceiling Depth
The default ceiling depth in Structure Input View, is now set to zero instead of the same value as joist depth.
5. Save as Default Operation
In the Settings, the Save As Default checkbox was by default not checked when a file was not open. Now, if a file is not open, this is checked and disabled, and when a file is open, it is unchecked and enabled.
6. Effect of Default Setting
A message now indicates that changing Site information in the Default Settings does not have an immediate effect on these values in Site Dialog box, but the wall, opening, and roof defaults do have an immediate effect.
7. Fit to Print on One Page
The option "Adjust font size so that text output fits on one page" in the Format Settings has been removed.
8. Note when Resetting View Settings
When "Reset Original Settings" was selected in the View Settings, a note about choice of unit systems no longer appears.
9. View Area and Snap Increment Menu Item
View Area and Snap Increment selections in the View data filter bar no longer cause Default Values settings to appear rather than View Settings
10. Overhang Group Box Covered
Attempt to change roof overhang no longer causes the overhang group box to be covered by a line.
11. Data Visibility in Input Controls
Adjusted size and position of several controls in Wall Input form and Site Dialog to allow data to be completely visible.
12. Underscores in Input Forms
Small underscores that appeared randomly in the text labels of several input views have been removed.

G. Text Output

1. Truncated Log File
Log file no longer truncates before reporting of log file data is complete.
2. Saving Log File
The log file is now not available when the project is reopened.
3. Roof Masses in Design Results
The roof masses are no longer listed as zero in the Block Information table of the Design Results. This was always the case for existing files, and for new files for some roof panels.
4. Hill Shape in Design Results
In the topographic information of the Building Site section of the Design Results, the Hill Shape is now being shown.
5. Above and Below Escarpment Crest Reversal
"Above" and "Below" crest of escarpment are no longer reversed in the Site Information of the Design Report.
6. Units for Hold Down and Dragstrut Forces
In the Design Results, units are now displayed for the Hold Downs and Dragstrut Forces table.
7. Direction Heading in Shear Results Table
East-West section of Shear Results table no longer reads North-South Shearlines.

H. Graphical Output

1. Elevation View Layout
Numerous improvements were made to the appearance and readability of the Elevation View display and printout, such that the elements have appropriate sizes and do not obscure one another.
2. Design Shear on Non-Shearwalls in Elevation View
The design shear was displayed at the base of non-shearwalls in the elevation view if the non-shearwall was once a shearwall, and would persist after another design is run.
3. Shearline Forces on a Non-Shearwall in Elevation View
After changing the wall type in an entire shearline from shearwalls to non-shearwalls, the shearline forces were still being displayed in elevation view after the next design.
4. Update of Forces in Elevation View
Forces on the walls are now shown in Elevation View after selecting the Generate Loads action. Previously, the Load Input View had to be selected before going to Elevation View.
5. Hold-down Symbols in Plan View
Symbols for adjacent hold-downs on large buildings no longer obscure the display of force values.

Shearwalls 2002 - November 18, 2002 - Design Office 2002

Version 2002 has had improvements to Version 99 that are so numerous and extensive that it can be considered a new program. The following is an index to the new features that are listed in more detail below.

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Detailed Descriptions:

- A. Installation Features
1. New Keycode system
Refer to the KEYCODE SECURITY section above for details.
 2. New Installation
Shearwalls is now part of an integrated installation of all the components of WoodWorks Design Office 2002. Previously, each component was installed separately
- B. Building Model Features
1. Multi-storey design
Designs up to 4 stories, transferring shear, overturning, dead load, and uplift forces down through structure. Displays walls from any number of floors in elevation view.
 2. Levels information
Foundation elevation, wall heights and floor and ceiling depths for each storey

have been added. The format of the input fields has been made demonstrative of the structure. It is possible to return and modify these data at any time.

3. Multiple blocks

The program allows input of multiple building blocks for ease of initial wall creation, roof modelling, different levels in one building, and low rise wind load generation. The program automatically joins intersecting blocks to create an exterior shell of walls.

4. Roof module

The program automatically creates roofs on each building block, joins the roofs, and allows the user to change the roof size, position, construction, slope, ridge location and overhangs.

C. Load Features

1. New Load Types and Profiles

The user can input wind shear, wind C&C, wind uplift, seismic or dead loads. These can be point loads, line loads, area loads, trapezoidal loads, or triangular loads. These are all displayed graphically next to the loaded building elements.

2. Site information

The now contains a dialog box for the input of topographic, climate and seismologic site information, and building characteristics such as enclosure and use, for the generation of wind and seismic loads. It calculates fundamental period T based on the building model.

3. Wind Load Generator

The software now generates main wind force resistance system (MWFRS) and component and cladding (C&C) wind loads on the entire structure or on specific components using the NBCC 1995 4.1.2 low-rise (Commentary B, Figure B7) or medium-rise (Commentary B, Figure B14/15) simplified procedures.

4. Low-rise Load Cases

The program generates all 8 low-rise load cases corresponding to wind at of the 4 windward corners of the building, and Case A or Case B wind directions. It designs the shearline force resulting from the strongest of these loads per shearline. You can view each of these cases independently via the display menus.

5. Seismic Load Generator

The software now generates seismic shear loads on the entire structure or any part of the structure, based on the mass of specific components. It uses the static analysis from the NBCC 1995 4.1.9 and Structural Commentary J.

6. Building Masses

The program automatically generates building masses based on user input self weights of walls, roof, floors and ceilings for use in seismic load generation. The users can enter their own building masses.

7. Dead loads and Uplift loads

The user can enter dead loads and roof uplift loads, and these will be transferred down through the structure. The program reports their value at hold-down locations. You can now distinguish wall dead loads from others for use in hold-down factor Jhd calculations

8. Load Accumulation

The loads shown on the screen are the derived by accumulating all the overlapping loads applied to the diaphragm edge at a building face, so that a load envelope is achieved. Similarly, vertical loads and masses area accumulated

along shearlines. You can see the loads that were originally input or generated in the load list.

D. Design Forces

1. Automatic Load Distribution

User can input wind loads or seismic loads to a building face, and these will be distributed to the shearwalls by the rigid diaphragm method and the flexible diaphragm method. The user may add forces manually to adjust the automatically distributed forces.

2. Rigid Diaphragm Method

The program distributes loads to shearwalls using rigid diaphragm method, and outputs design results based upon these shearwall forces. It examines all 4 torsional load cases described in NBCC 4.1.9.2(28) User can base the relative rigidity on shearwall strength, or manually enter rigidities.

3. Flexible Diaphragm Method

The program distributes loads to shearwalls loads based on tributary width between shearlines, and outputs design results based upon these shearwall forces. The assumption is that for irregular structures, drag strut collectors are present to allow the diaphragms to be oriented in the direction of the loads in both orthogonal directions.

4. Force Distribution Along Shearline

If the user selects to use dissimilar materials along a shearline, the program distributes the shearline force to each segment based upon the material resistance of the segment.

5. Holddown and Drag Strut Forces

Overturning, dead, uplift components of holddown forces are shown at openings and wall ends, or the user can choose to combine these. Drag strut forces are shown at openings and wall ends. Drag struts and holddowns are also reported in an output table.

6. Vertical Force Distribution and Overturning Forces.

The program now takes into account the presence or absence of hold-downs or anchorages at the top and bottom of each restraint location in determining the overturning forces and vertical force distribution. It can do this for special cases such as vertically offset openings.

E. Shearwall Design

1. Seismic Design

User enters seismic loads and program performs separate force distribution for them. It designs for these forces separately from the wind loads, and also reports the design results separately.

2. Leeward/Windward Wind Design

User can enter and the program generates leeward wind loads, windward loads, or loads that apply to either situation. Program designs shearlines for loads in each direction. It first determines the worst of all low-rise load cases in each direction.

3. C&C Design

C&C Design is performed for exterior walls that are not designated as shearwalls, and for shearwalls, the worst case of shear and C&C loads will govern the design.

4. New CSA O86-01 Provisions
The program fully implements all the shearwall design provisions from the new CSA O86-01, Chapter 9.
5. Jhd Factor
The program computes the new Jhd factor described in CSA O86-01 9.4.5. based upon the presence or absence of hold-downs at the ends of wall segments between openings, non-shearwalls, or ends of the shearline.
6. Hold-down Configuration
The user can specify whether hold-downs are to be at the ends of walls, ends of segments, or ends of the shearlines in the Wall Materials input.
7. Iterative Hold-down Design
The user can instruct the program to over-ride the selection of hold-down locations in order to achieve a successful design. It strategically adds hold-downs to increase the Jhd factor until a design is achieved
8. Iterative Design for Dissimilar Materials.
If dissimilar materials are chosen, and some materials are unknown, the program designs the shearwalls, distributes the forces, then repeats this process until a stable design is achieved

F. Materials

1. Material List
The materials and resistances specified by CSA O86-01 are used, rather than those listed in the USA Wood Frame Construction Manual.
2. Gypsum Wallboard
Gypsum sheathing has been added as a material, as allowed by CSA-O86-01. The program adjusts the R value used for seismic load generation based upon the presence of gypsum wallboard.
3. Construction Sheathing OSB
This material has been added to the program, using the same shear resistance values as Design Rated, Type 1 OSB, but with different resistance to C&C loads. This material is identified by Panel Marking, and the program will implement the equivalence to thickness.
4. OSB Grades and Plywood No. Of Plies
The program now allows input of these parameters, which affect panel strength in bending and shear-through-section for C&C design.
5. New Sheathing Thicknesses
The program will implement the new thicknesses specified by CSA O86-01 for resistance to shear. These are 11.0 mm and 15.0 mm for OSB and 15.5 mm for plywood. In addition, 18.5 mm (18.0 mm) is added for resistance to C&C loads.
6. Nail Sizes
The program has included input fields for both nail length and diameter, and has implemented the new provisions basing shear strength on the diameter and minimum penetration. The program reports nail penetration.
7. Nail Factor Jn
The user is allowed to enter non-standard nail sizes and the program implements the strength calculations described in O86 9.5.1A(5) and Appendix A9.5.1.
8. Framing Species and Species Factor Jsp
The new table 9.4.3 for species factor Jsp has been implemented. Glulam, MSR, and MEL have been added to the list of framing materials. The provisions regarding MSR and MEL grades have also been added.

9. Unblocked factor Jub

The program now allows blocked or unblocked horizontal panels, and implement the blocking factor Jub for unblocked shearwalls as specified in O86 9.4.4

10. Dissimilar Materials

The program implements CSA O86 9.3.3.4, which allows for dissimilar materials along a shearline. The user can select whether to allow dissimilar materials or make all the shearwalls in a line have the same materials.

G. Design Results Reporting

1. New Sections

Sections for design settings, storey information, roof geometry, site information, and building masses input have been added.

2. Results Formatting

Much improved reporting of design results, with separate tables for each type of input load; wall materials, shearlines; shear results; C&C results; wall segments, openings, holddown and drag strut forces.

3. Load Lists

The seismic and wind shear loads listed are the accumulated loads, not those entered or generated. These are sorted in such a way as to make correlation with the generated loads easy.

4. Design Notes

Numerous design notes referring to specific sections of the CSA O86 -01 or NBCC have been added to the end of each table indicating any special situations or where a design code note has been applied.

5. Results Filtering

User may choose which tables from which design runs to view or print using the display menus.

6. Log file

A log file is output showing intermediate calculations and detailed information for wind load generation, seismic load generation, and rigid diaphragm design. The log file can be accessed from the menu

H. User interface features

1. Elevation View

Elevation view selectively displays shear flow, drag strut forces, holddown forces, and C&C loads. Sheathing and nailing capacities are displayed next to the design materials. The user can select to view any number of storeys, and either force direction along a shearline. The program displays anchorages, hold-downs, and compression forces with different symbols.

2. Show menus

Toolbars menus have been added to allow user to show or hide items on the screen or printed output. The same settings can be viewed and changed all at once in the settings dialog. The type of loads and forces to be viewed, roofs, wall names, gridlines, and building masses can all be toggled on and off.

3. New menus

Right mouse click menus and menus on each window provide quick access to some of the graphics and design features such as resizing the windows, viewing, display, and design settings.

4. Wall material input

This view has been streamlined somewhat, and the operation has been made more stable.

5. Graphical input
Interactive graphics have been improved, making it easier to select, segment, resize, and move walls and openings. More tolerance has been added to the mouse operations.
 6. Zoom Feature
 - There are now two buttons on the plan view bar, one for Zoom In and one for Zoom Out. The program increases or decreases the viewing area by a certain percentage when the buttons are pressed, while maintaining the same west and south view limits.
 - The percentage that the view is zoomed each time a button is clicked is specified in the View Settings - the user can choose a zooming increment anywhere from 1% to 100%.
 7. Load List
The loads listed in the Load Input form now have 8 separate categories describing their location, direction, load case, etc, and can be sorted by any one of these categories by clicking on the category.
- I. Program Settings
1. Default Settings
A new default setting page has been created for the existing default dimensions and the following additions:
 - Initial wind load generation site information
 - Initial roof geometry
 - Building mass self-weights
 - Floor/ceiling depth
 - Standard walls on top floor and on other floors.
 2. Design Settings
Settings have been added for:
 - choosing the wind load generation method,
 - the height used for restrictions on these methods;
 - rigidity method for rigid diaphragm analysis;
 - dissimilar or similar materials along shearline;
 - enabling gypsum wallboard contribution to shear strength;
 - whether to allow the program to override the choice of hold-down locations.
 - vertical elevation offset of shearlines
 3. Options Settings
Settings to turn on and off the display have been added for :
 - Roof outline in other views
 - Design Results tables.
 4. Loads and Forces
A "tower of settings" has been added to organise the display of generated, accumulated, and user input loads and forces in plan view, elevation view, and design results view. The form shows which of these interact with each other and in what way, as many are exclusive. These settings can also be changed via the Show... menus.
- J. Bug fixes
1. Wall Operations

- Crash when attempting to segment walls right to the end of the wall is fixed.
 - Annoying line that appeared when creating the first wall has been removed.
 - No longer possible to create gaps in exterior shell of building
2. Scrolling
- If the view limits were set to zoom into a region such that scrolling was necessary to see the whole building, scroll bars did not necessarily appear, nor did they appear for a CAD import that is bigger than the view limits. (This was a problem in Windows 95/98 only)
 - When an existing file is opened, or when the view limits are changed, or when a CAD file is first dimensioned, the program now sets the position of the scroll bars to the co-ordinates of the view limits. This way the view that the user sees on the screen exactly corresponds to the one set in the settings until the user first uses the scroll bar.
3. Memory Leak
- Using Shearwalls on a Windows 98 machine for a period of time severely depleted the Windows GDI resources, causing failure of program graphics. This has been fixed.

Version 99 - Dec 1, 1998

First version to incorporate Canadian design provisions.

1. Version now designs according to CSA O86.1-94.
2. Revised the Form for entering wall data. The form now displays materials for both sides of a wall simultaneously. Standard walls are now created and modified on a separate form.
3. The program now prevents you from creating walls of insignificant length.

Version 97b – April 22, 1998

1. Imported CAD drawing information is now saved in the project file so that when a file is re-opened the CAD drawing is automatically imported.
2. A message box now appears if you attempt to draw more than one block in the Block Action.
3. The snap increment is now displayed and saved in inches. This should solve problems with round-off that prevented users from decreasing the snap increment.
4. An Examples folder containing a 7-step example has been added. The online Help contains a description of the steps.
5. Wall selection with the mouse pointer has been improved.
6. An endless loop where the message "Opening cannot exceed past end of the wall" was displayed has been fixed.
7. The imported CAD file can now printed.

Version 97 - Feb 1, 1998

Initial version of program used provisions from USA Wood Frame Construction Manual. Program had the following capabilities

- Input of one rectangular block, and convert that block to shearwalls
- Input of one building level only
- Reconfiguration of exterior walls, maintaining closed envelope
- Input of interior walls
- Input of wall materials, including unknowns to be designed by Shearwalls
- Input of openings in shearwalls
- Automatic shearline generation using “bandwidth” approach
- Input of point forces directly on shearlines
- Design shearwalls using WFCM provisions
- Calculation and display of hold-down forces
- Design, view and display settings and options
- Project info and company info input
- Elevation view output showing forces and design materials for a shearline
- Rudimentary design results report
- Print and print preview of all graphics and reports.