Title **September 24, 2013**

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 Shearwalls 8, released in November, 2011. The most recent service release update is Shearwalls 8.4 , released in September, 2013.

This file last updated with changes on August 27, 2013.

Click on the links below to go to the changes for the corresponding release.

Version History

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.

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 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_pC_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_gC_{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 Jhd calculation that is much too large. Therefore, there is too heavy a countervailing dead force at hold-down locations, and the Jhd 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 it's 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 Defection 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. Nail Deformation en for Larger Nail Sizes (Bug 2583)

When a nail size other than the smallest was chosen, the program used a nail deformation en from Table A9.7 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, and has been corrected.

6. 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 ½ 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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*.

B: 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.

4. Low Rise Wind Loads Due to Note 8 for Positive C_pC_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_pC_g when they should be limited to low angles with negative C_pC_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.

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

The C_pC_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.

6. 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.

C: 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.

D: 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 and 124)

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.

E: 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 J_{hd} 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) CpCg Value for C&C Loads in Log File (Bug 2480)

The combined pressure and gust CpCg 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 rations 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. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

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 $I_EF_aS_a(0.2)$. 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 $I_EF_aS_a(0.2)$ 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 $I_EF_aS_a(0.2)$ 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

2. 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 $I_EF_aS_a(0.2)$, 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.

3. 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.

4. 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.

5. 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 ration 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 δ_{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 +/- 0.05*D_{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

$$F_{di} = F * K_i / \Sigma K_i \ ,$$

using the notation in the Log file, F being the total force. In that case, the center if 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

$$J_x = \Sigma K_i * d_i^{\,2} \ ; T = F * e_a$$

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.

$F = 20$ kN; $F_{d1} = F_{d2} = 10$ kN; $K_1 = K_2 = 10$ kN; $e_a = 1$ m; di = 10 m; T = 20 kN-m; J = 2000 kN-m2

$F_{t1} = F_{t2} = 20$ kN-m x 10 kN x 10m / 2000 kN-m2 = 1kN

= 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 ½ 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 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 ½ 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 ½ 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 da 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

$$\Delta_{SW} = \frac{2VH_S^3}{3EA\,L_S} + \frac{vH_S}{B_v} + 0.0025H_S e_n + \frac{H_S}{L_S} d_a$$

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_dR_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 apportions 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 x (% fabrication moisture content – % in-service moisture content) x 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 then 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.
- *Bv* – 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 da 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
- da – 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 da

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 Vn from Table A.9.7 exceeded. Maximum Vn 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 his 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 Rd Ro

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 peformed 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) Iteration1

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

$$\Sigma F_i/□_I,$$

where F_i and □$_I$, 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/□, 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 □ 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 Fv and Fv/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 ½ 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 Diaphra*gm *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. Rd and Ro

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 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 $IEF_aS_a(0.2) > 0.35$. 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, he 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 sayings “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 Jsp 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 "Ksf= 1(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 forcec 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 progam

- 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 m^3 for all selections of the "Shearwall rigidity" Design Setting, however the value for the "Rigidity based on capacity" setting was in fact in kN-m^2. The program now indicates it is kN-m^2., lbs-ft^2, or kips-ft^2 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 m^3 or ft^3.
- 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 et = 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 Fti-, Fti+, and the resultant Fti, with the definition of the Fti's in terms of Dnx shown in the equations above. Note that the resultant Fti column has also been shifted in the table.
- A column has been added for the distance li 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 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 Rj used in calculating uplift restraint forces P_t and Pj 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.

Index to Changes

A: Wind Load Generation

1. NBCC 2005 Wind Load Generation

a) Importance Categories and Factors

Input of importance categories in Table 4.1.2.1and 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:

- Cg = 2.0 for main structural members (6a),
- Cg = 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 Ce 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 <= 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: Sa(0.2), Sa(0.5), Sa(1.0), Sa(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 Sa(0.2) and Sa(1.0)

g) F_a and F_v for Site Class F

Acceleration- and velocity-based site co-efficients, *Fa* and *Fv* 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):

- $F_aS_a(0.2)$ for T<=0.2s
- $F_vS_a(0.5)$; $F_aS_a(0.2)$ whichever is smaller for T=0.5s
- $F_vS_a(1.0)$ for T<=1.0s
  $F_vS_a(2.0)$ 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 Rd 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:

- $V = S(T_a)\ M_vI_EW / (R_dR_o)$
- $V_{min} = S(2.0)\ M_vI_EW/(R_dR_o)$
- $V_{max}(Rd >= 1.5) = 2/3\ S(0.2)\ I_EW/(R_dR_o)$

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 and 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 $I_EF_aS_a(0.2)$, upon which many of the rules for irregularities are based
- a note saying that only the provisions based on Ta 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 RoRd
- 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 Ta < 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 meets 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)

Sine 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 was 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 Sa(T) for T = 0.2, 0.5, 1.0, and 2.0
  - Replace *Za, Zv* with *Fa, Fv.*
  - 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 Protude 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
18. Default Values Settings
19. Main Menu Key Shortcuts

B. Engineering Design

1. Seismic Design with Unknown Stud Spacing
2. Negative Crritical Design Shear Forces
3. Duplicate Wall Groups, Exterior Sheathing Only
4. Duplicate Wall Groups, Different Hold-down Configuration
5. Incomplete Design Material Specification
6. Wall Group Number
7. Extra Wall Group in Materials Table
8. Ce on Windward Walls

C. Seismic Load Generation

1. Seismic Load Generation on Complicated Structures
2. Reversal of Fundamental Period T
3. Building Mass of Line of Non-shearwalls
4. Building Mass of Intersecting Roof Blocks
5. Zero Point Building Masses in Plan View
6. Upper Level Wall Building Masses
7. Metric vs Imperial Roof Masses
8. Zero Point Building Masses in Plan View

D. Wind Load Generation

1. Topographic Factor
2. Wall Load Generation after Roof Move.
3. Height h for Ce
4. Ce on Gable End
5. Width of NBCC Zone 2 Low Rise Loads
6. Low-rise Tributary Width
7. Wind Pressure on Gable Ends

E. Load Distribution

1. Rigid Distribution to One Shearline in each Direction
2. Display of Manually-entered Wall Rigidities
3. Vertical Distribution of Load Combination Factor

F. Data Input

1. Unknown Edge Spacing
2. Blank Input Fields for OSB Materials
3. Default Tributary Width
4. Zero Ceiling Depth
5. Save as Default Operation
6. Effect of Default Setting
7. Fit to Print on One Page
8. Note when Resetting View Settings
9. View Area and Snap Increment Menu Item
10. Overhang Group Box Covered
11. Data Visibility in Input Controls
12. Underscores in Input Forms

G. Text Output
1. Truncated Log File
2. Saving Log File
3. Roof Masses in Design Results
4. Hill Shape in Design Results
5. Above and Below Escarpment Crest Reversal
6. Units for Hold Down and Dragstrut Forces
7. Direction Heading in Shear Results Table

H. Graphical Output
1. Elevation View Layout
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 storys 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 he 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 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 Crritical 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 holdown 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 Iinformation 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 adjecent 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 manualy 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 Setttings, 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 checbox 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 Resutls
   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 InpuI View had to be selected before going to Elevation View.
5. Hold-down Symbols in Plan View
   Symbols for adjacent holddowns 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.

A. Installation Features
    1. New Keycode system
    2. New Installation
B. Building Model Features
    1. Multi-story design
    2. Levels information
    3. Multiple blocks
    4. Roof module
C. Load Features
    1. New Load Types and Profiles
    2. Site information
    3. Wind Load Generator
    4. Low Rise Load Cases
    5. Seismic Load Generator
    6. Building Masses
    7. Dead loads and Uplift loads
    8. Load Accumulation
D. Design Forces
    1. Automatic Load Distribution
    2. Rigid Diaphragm Method
    3. Flexible Diaphragm Method
    4. Force Distribution Along Shearine
    5. Holddown and Dragstrut Forces
    6. Vertical Force Distribution and Overturning Forces
E. Shearwall Design
    1. Seismic Design
    2. Leeward/Windward Wind Design
    3. C&C Design
    4. New CSA O86-01 Provisions
    5. Jhd Factor
    6. Hold-down Configuration
    7. Iterative Hold-down Design
    8. Iterative Design for Dissimilar Materials.
F. Materials
    1. Material List

2. Gypsum Wallboard
3. Construction Sheathing OSB
4. OSB Grades and Plywood No. Of Plies
5. New Sheathing Thicknesses
6. Nail Sizes
7. Nail Factor Jn
8. Framing Species and Species Factor Jsp
9. Unblocked factor Jub
10. Dissimilar Materials

G. Design Results Reporting
1. New Sections
2. Results Formatting
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H. User interface features
1. Elevation View
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4. Wall material input
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I. Program Settings
1. Default Settings
2. Design Settings
3. Options Settings
4. Loads and Forces

J. Bug Fixes
1. Wall Operations
2. Scrolling
3. Memory Leak

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 holddown 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 achievedSimilarly, 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 be 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 there 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.