LatPro IBC 2009 User Manual

Version 1.0.0

LatPro Lateral Engineering Program

Structural-Calc, LLC

STRUCTURAL-CALC, LLC
LATPRO ENGINEERING PROGRAM

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TECHNICAL SUPPORT

Our LatPro Technical/Customer Support team has limited availability to answers any questions you may have regarding this program Monday through Friday from 11:00 a.m. to 5:00 p.m. Pacific Standard Time (PST), with the exclusion of holidays.

Limited Technical Support is included with a purchase of LatPro which includes answering a reasonable amount of questions/project review based on our discretion. We do respond to most requests, but need to limit those responses to questions that relate to information that is not easily found in the User Manual.

The User Manual is found in PDF format in the support file, which can be found through "My Computer" or using "windows explorer" and going to the directory where you have stored the software. Go to the software file, open the support file and the User Manual is there in PDF format to be opened or printed in hard copy. Also in that file is the Engineering Notes file in Word format, which can be modified by the user for their specific needs, and will be printed out at the end of every LatPro Report.

Accessing Support

We prefer that the user e-mail questions to us and in most cases the accompanying .lat file and a description of the problem, so that we can review the file for possible erroneous or accidental entries. This is the fastest and easiest way to get your project back on track from our technical services department.

All files sent to us are confidential and for our use in fixing problems or helping the user become more familiar with the software only. Please contact us at the email below for more information or questions about our products.

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THE FIRST THINGS TO DO

1. When evaluating or using this software for the first time, we recommend you review the LatPro Quickstart User Guide, the LatPro Demonstration Projects and the LatPro User Manual. These are all included with the LatPro software under "Support" files and LatPro will open directly to the demo files. It is best to follow the steps laid out in the LatPro Quickstart User Guide to understand how to enter the inputs for a new project and give the LatPro User Manual a quick read through.

To open one of the Demonstration Projects, go to the File tab at the top menu and click on it, and then click Open, then click on one of the three demonstration projects. This will open one of three, three-story projects so you will not have to enter all the information to define a structure, before you can see all the features available to you with this powerful software. It helps to have a project open when reading the LatPro Manual for the first time and move through the program while reading the manual.

2. In using the free LatPro Demonstration Software, remember that any project the user is modeling is limited by the LatPro printer functions and in the limited time the user can use the software. After 21 days the software locks and you cannot use it again until it is purchased.

3. LatPro allows the user to enter values at times that are undersized. There are various reasons for this, but they are always displayed in RED, rather than black print and it will show up as an error in the error-check. One reason it may be undersized is when entering the chord of a shear wall, LatPro allows the user to chose a chord that could possibly be valid, if the user also chooses the specific connector that allows it to meet the resistance values necessary. All the RED values need to be re-run and corrected until they are resolved into the correct resisting forces by showing up as black values.

4. To start, we recommend that the user check for errors after entering each subsection of data and clear the errors before moving on.

Table of Contents

1 Getting Started on a Project

LatPro IBC 2009 provides easy lateral analysis for buildings according to the International Building Code (IBC). LatPro also meets the requirements of the California Building Code [CBC] or any other state or local code which has not been modified from the requirements of the 2009 IBC or the ASCE 7-05. LatPro IBC 2009 performs complete wind and seismic calculations, determines what the critical force is, and allows the option to specify appropriate shear walls to resist loads in each gridline.

The objects you see when you open the program are three windows. There is a large input window, a small help information window to the right, and a medium data window below. The large input window asks the user to enter the general project information, general information, seismic information and wind information. The medium sized data window gives the user either the general information or story component information the user entered or the program calculated.

The small help information window to the right gives the user help information as the user's mouse touches an input box. This allows the user to move through the program without having to use this manual except to look up information that is more detailed. It is important to remember not to leave the large input window without hitting the insert button at the bottom of the window to insert the data the user has entered into the program.

The help window (Context Sensitive Help) is optional as well as the Project Summary information (name of the project, date, and who is working on it) and can be turned on and off in the upper bar drop-down menu under "view". The other windows that are always optional to bring up to look at are the shear wall schedules, both LatPro default and User-Defined Schedules, the Connector Schedules including holdown, second and third floor straps, holdowns and threaded rods, existing concrete applications and user-defined connectors. These schedules are provided by the program and listed in the upper bar drop-down menu under "view".

There is one important area under the Options menu that will save a lot of time and gives the user some good options and that is Default Settings. Under default settings, the user can define regularly used items such as green or dry lumber, plywood thickness for LatPro default shear walls, floor spans for straps, sill plate size, sill plate anchor bolt diameter, and two seismic options; shear wall deflection amplification factor Cd and system overstrength factor.

When opening LatPro files, the LatPro program needs to be open. Use the "open" file from the program rather than clicking on the files to open the program.

1.1 Codes

LatPro IBC 2009 is IBC 2009 compliant. LatPro IBC 2009 allows the user the flexibility to design rigid buildings of all heights. Another part of code limits LatPro users to buildings which are defined as not being greater than 60 feet high.

For wind design, the Analytic Wind Method is used, as described in ASCE 7-05 and referenced in the IBC 2009. LatPro includes the wind torsion load cases to allow the design of three-story buildings with a slab floor or 2-story building with a raised floor. The torsion loads are calculated, then distributed to the shear wall gridlines based on wall rigidity.

These load cases are not required for "buildings two stories or less designed with light-frame construction", as listed in the exceptions under ASCE 7-05 Section 6.5.12.3. However, the user can apply the torsion load cases for shorter structures when desired.

This option may also be useful for buildings that have the center of rigidity far from the center of geometry. This occurs when one end of long building has very rigid shear walls and the other end has very flexible shear walls. An example would be where steel manufactured shear walls support one end of the building and light plywood walls support the other end.

For seismic analysis, the Equivalent Lateral Force Procedure is used. This method was chosen over the Simplified Analysis to allow for the design of structures in Seismic Design Categories B, C, D, E, and F with plan and/or vertical irregularities per Table 12.6-1 of the ASCE 7-05.

For all Seismic Irregularities, per Table 12.6-1 Permitted Analytical Procedures, the ASCE allows the use of the Equivalent Lateral Force Analysis for all light-framed structures under three stories and in Occupancy Design Categories I and II, which is exactly what LatPro is designed to do.

It is recommended that you review ASCE 7-05, Section 12.3, Table 12.3-1 and Table 12.3-2 to ensure that your building design meets the requirements of this analytical method. The program uses the ASD design load combinations to check all loading to meet the IBC requirements.

1.2 Recommended Procedure

Information should be entered into the program in the following order:

1.) General / Architectural Information
2.) Wind Information
3.) Seismic Information
4.) Building Design: Building design should be conducted from the top floor to the bottom. To avoid having to re-enter information complete the entire design of a floor before designing the floor below it. The suggested design order for a floor is as follows:
    a. Gridline Layout
    b. Diaphragm Design
    c. Tributary Area Assignment
    d. Shear Wall Design
    e. Shear Wall Chord Member Design and Connector Design
    f. Wind Torsion Load analysis (if applicable)
    g. Post and Post Connector Design (if applicable)
    h. Components and Cladding Design
5.) Error Check: We recommend that the user, use this feature before moving from each of the entries above to the next entry, so as to correct any errors while the information is readily available.
6.) Print Report: The report can be printed in its entirety or just certain parts such as building information or shear walls.

When the program first starts up, you are presented with a three-tabbed input window that includes an area for project information and architectural information. The first tab, titled “General Information”, prompts for information that is needed for building design and some story specific information.

The next tab, titled “Wind Information”, is where you enter information necessary to determine wind forces. The third tab, titled “Seismic Information”, is where you enter site data necessary to calculate seismic forces. Once all of this information has been entered into the database, you can begin the lateral structural design of the building.

2 Project Information

The initial step in beginning a project is to enter the basic project information, such as project name, number, date and user, as shown if Figure 1. All of these input boxes are optional whether the user would like to enter information here or not. These are mainly for your office to keep track of each project and the engineer of each project and will be printed out with each report.

Figure 1. Basic Project Information

After that information has been entered, continue on to the Building Information in the General Information tab.

2.1 General Information Tab

This tab contains input boxes for the **Architectural Information** of the building to be engineered. Enter the number of stories, the height of the structure and the occupancy category. LatPro IBC is limited to occupancy categories I and II, agricultural buildings and most other buildings, except those excluded in table 1-1 of the ASCE 7-05. Most structures are category II and are covered by LatPro.

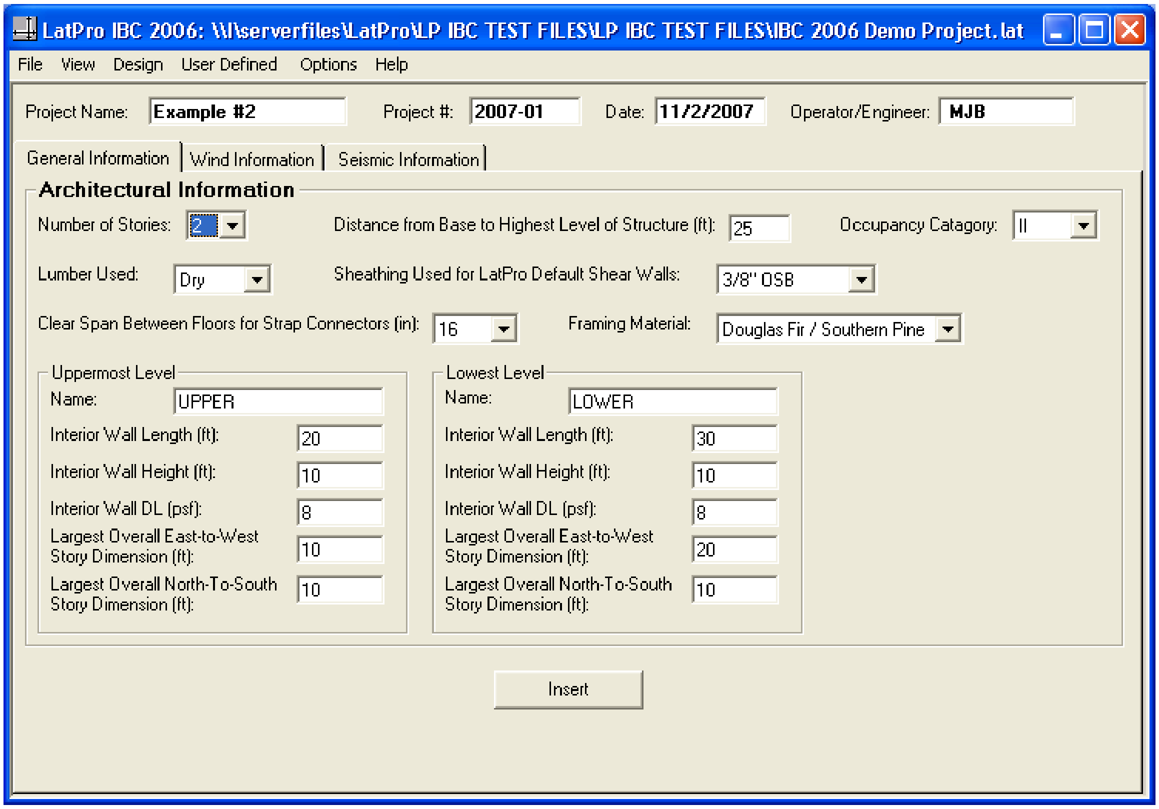


Figure 2. General Information Tab

Next select the Clear Span between floors to determine the proper strap connector capacity values. The clear span input includes all framing between the upper and the lower story shear wall chord member or post.

LatPro IBC allows the user to select different wood species for the wall framing and posts. Choose between Douglas-Fir-Larch/Southern Pine, Hem-Fir, or Spruce-Pine-Fir species groups. The species group affects connector uplift, shear wall unit shear, and post/shear wall chord member capacity values.

Next enter the name(s) of the story(s), depending on how many, (Upper, Main, Lower, etc), the interior wall length, height and dead load weight (psf). The “Largest Overall Story Dimension” input boxes are used to calculate wind pressure and to set the scale for the gridline layout in the design area, enter these values in feet.

2.2 Wind Information Tab

2.2.1 Site and Building Information

The wind information tab is where the site information, topographic effects and building enclosure classification values are entered. The first step is to determine the wind exposure category for the building site based on the surrounding terrain. This exposure category is based upon surface roughness categories that extend around the building site.

To determine the exposure category, refer to section 6.5.6 of ASCE 7-05. Next, refer to ASCE 7-05 figure 6.1 to enter the 3-second gust wind speed for the building location.

Finally, indicate whether the site is within a hurricane prone region. These regions are defined in ASCE 7-05 section 6.2 as:

1. The U.S. Atlantic Ocean and Gulf of Mexico Coasts where the basic wind speed is greater than 90 mph, and
2. Hawaii, Puerto Rico, Guam, Virgin Islands, and American Samoa

Select the Building Enclosure classification (Refer to ASCE 7-05 section 6.2).

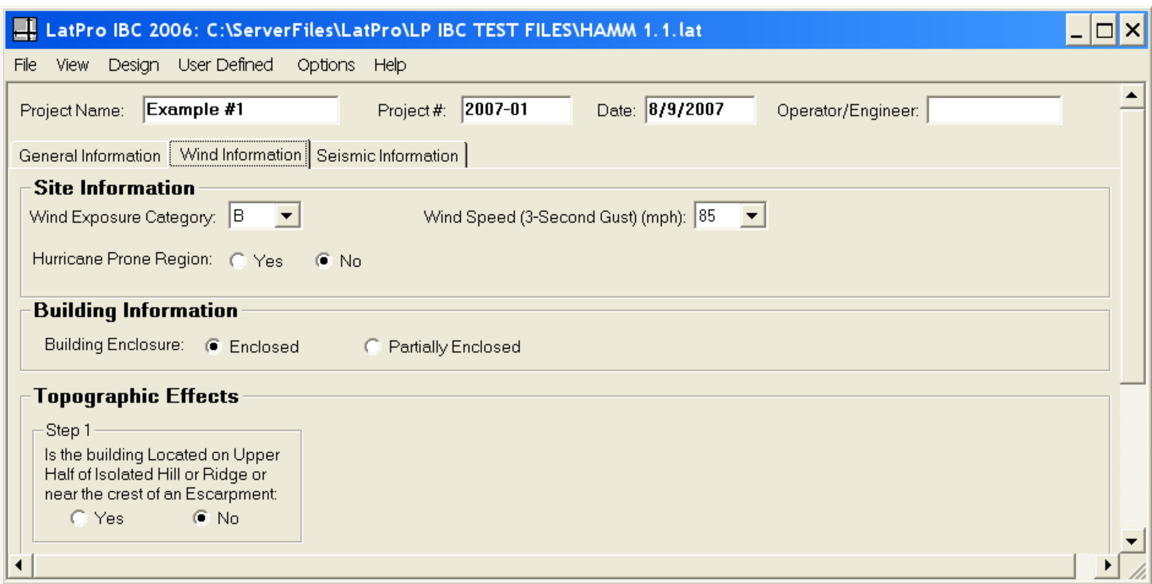


Figure 3. Wind Information Tab

2.2.2 Topographic Effects

In addition to exposure category, the design wind pressure used in the lateral analysis may be significantly affected by topographic features in the vicinity of the building site. Navigate through the series of questions in the program window shown in Figure 4 to determine if the lateral analysis will require accounting for topographic effects.

If the answer is no to any of the questions, then the topographic effects factor is taken as 1.0. If the answer is yes to all of the conditions, select the type of feature as well as the height from the local ground level to the top of the feature.

Next, enter the average slope of the feature as a decimal form of rise over run, along with the distance from the crest of the feature to the building site (upwind or downwind). For more clarification of these dimensions, refer to ASCE 7-05 figure 6-4.

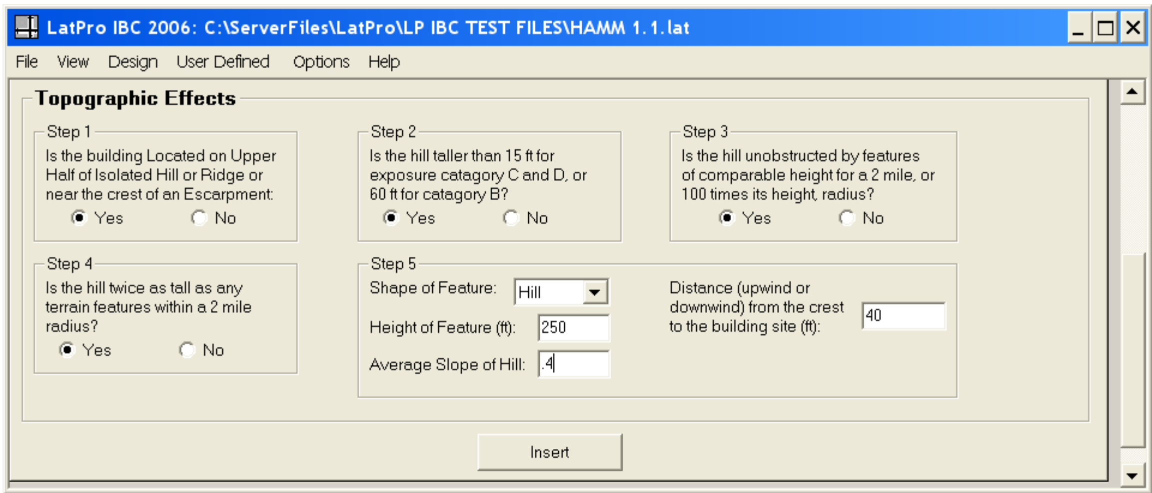


Figure 4. Topographic Effects

2.2.3 Building Site with Dual Exposure Category/Topographic Effect

As stated in ASCE 7-05 section 6.5.6 and IBC 1609.4 an exposure category shall be determined for each wind direction. The current version of LatPro IBC 2009 applies the exposure category to all 4 directions of analysis.

If the exposure varies dramatically with direction or there is a 2-dimensional topographic effect that aligns with the orthographic axis of the building, you may want to analyze the N-S and E-W lateral forces separately to allow for the different design wind pressures.

To do so simply make a copy of the LatPro file using Save As under the File menu after all of the diaphragm information has been entered. Now adjust the exposure category/topographic feature and assign tributary lengths in that axis only.

Continue with the shear wall design. Now use the original file to analyze the forces in the other direction, assigning tributary lengths and shear walls only along the other axis. In the future, an update will be available to include this functionality.

2.3 *Seismic Information Tab*

For seismic analysis, first determine the site class of the building location by Referring to ASCE 7-05 section 20.1 for the definitions of the various site classifications. As stated in section 20.1, when there is insufficient information to determine a classification, Site Class D shall be assumed, unless the authority having jurisdiction determines E or F class soils are present at the site.

Next find the 0.2 second (S_s) and 1.0 second (S_1) Spectral Response Accelerations (at 5% critical dampening, site class B) from the ASCE 7-05 Figures 22-(1-14), IBC Figures 1613.5 (1-14), or from sources on the USGS website at http://earthquake.usgs.gov/research/hazmaps/. These values should be entered as percentages as shown in the ASCE and IBC figures. Also enter the Long-period Transition period value from ASCE 7-05 Figures 20-(15-20).

NOTE: As stated in section 12.8.1.3 of ASCE 7-05, S_s may be assumed as 150% g, S_1 must be determined in accordance with section 11.4.1. With these values entered, you are ready to begin the Building Design phase.

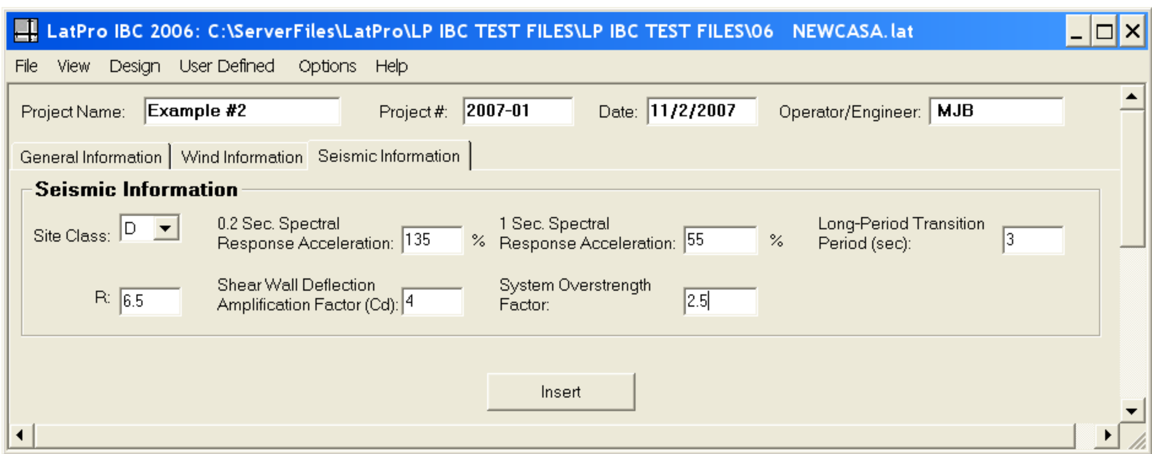


Figure 5. Seismic Information Tab

Redundancy Value: For seismic analysis the lateral seismic force is affected by the redundancy coefficient (or reliability factor) ρ (rho) as shown in ASCE 7-05 equation 12.4-3. The reliability factor is no longer calculated from the story shear ratio as previously required by ASCE 7-02. For seismic design categories D, E and F, rho has a value of 1.3, while for categories A, B and C rho a value of 1.0 is used.

3 Building Design

3.1 User Interface Overview

After entering the building information and selecting Building Design from the Design menu, you will see the Building Design interface, with the three main components: **plan view** area, the **component buttons** to the left, and the **component window** down below. In addition, there will be the Help window and the Seismic Forces window.

The Help window will provide you with additional clarification while entering information. Where applicable, the help text is activated once the cursor is placed within an input box. The seismic forces window keeps a running tab of the seismic weight and story shear, along with the redundancy coefficient.

Note the tabs below the Building Design text in the upper left hand corner, which are used to switch between different stories of the building. This manual will describe the three building design main components and the procedure for lateral design will be outlined in the following section

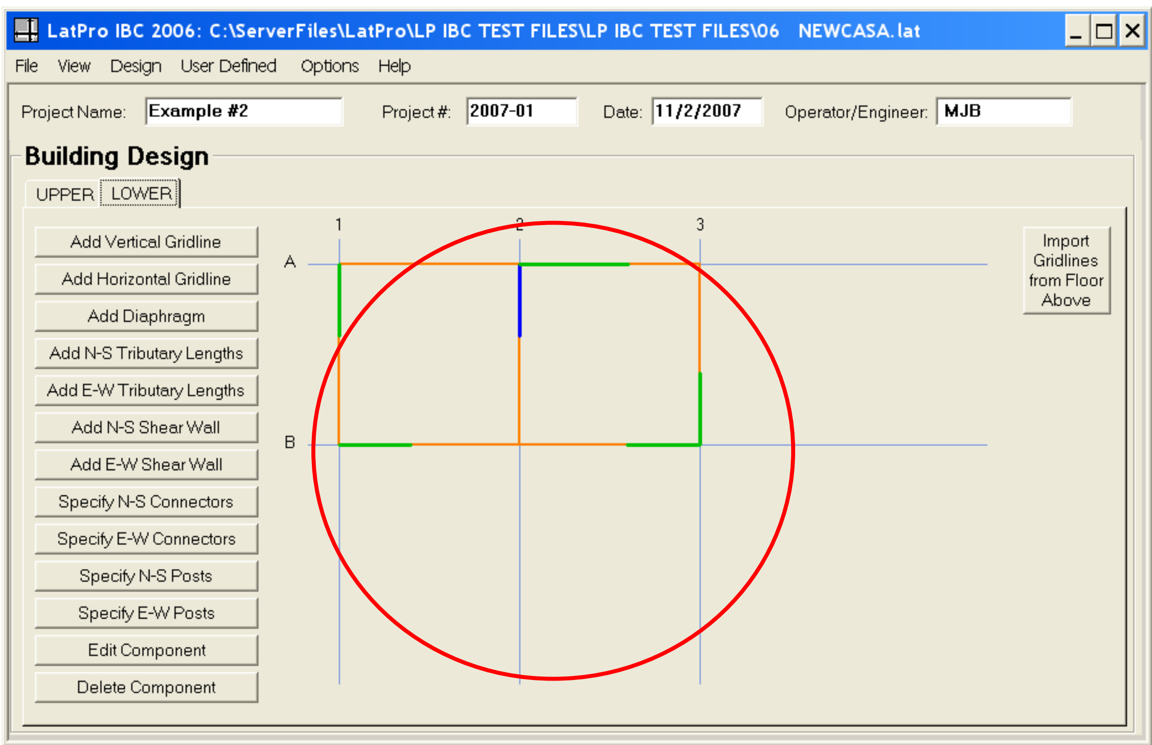


Figure 6. Plan View Building Layout Area of Main Window

3.1.1 Plan View Building Layout

This area is used to display the gridlines, diaphragms and shear walls graphically in plan view. Its purpose is to assist in defining the diaphragms and assigning the tributary widths of the diaphragms to the gridlines. The orientation of the area is laid out so that north points towards the top of the screen.

Gridline convention has been set so north-south gridlines are labeled as numbers while east-west gridlines are letters. After being entered, the gridlines will appear as light blue lines, the diaphragms as orange rectangles, and the shear walls as green line segments.

3.1.2 Component Buttons / Story Components Window

Along the left side of the main LatPro window is a column of buttons used to open input windows for the diaphragm and shear wall design steps. These buttons are circled in Figure 7. In addition to the input windows, there is a spreadsheet in the component window below that displays the pertinent information for each stage of design.

The story components window below the inputs window is a summary of much of the relevant information related to lateral forces. It includes the location of gridlines, most of the information about the diaphragms, the tributary widths of the forces to each shear wall line, and the shear walls.

The diaphragms tab shows the area of each diaphragm, the applied wind shear (plf), the applied seismic shear (plf), whether wind or seismic governs in each direction, the applied weights of the diaphragm and exterior walls, and the height of the diaphragm from the base of the building.

It also graphically controls the building layout window and as the user moves through the story components, the user can see where that component is located in the building layout window. By selecting the up or down button on the right side of the window the user can move around in the building layout.

This graphic interface should guard against many input errors because the user can see that the design entered matches proportionately the design of the building the user is engineering. If the user moves too fast thru the wall list, the walls and lines in Excel will remain a blue color until moving out of that window.

Most importantly, this window gives the user the uplift forces at the base of each shear wall. By highlighting the grid number and the wall number, the user can see exactly which wall type the forces relate to and specify the holdown connections for those forces on each corner of the shear wall.

It is also important to note that in a multi-story building, the user needs to follow the loads down to the foundation. The user needs to add posts below shear walls, add forces from shear walls above to shear walls below, etc. to make sure all lateral forces are transferred down to the foundation of the structure.

At any time, you can review the entered data by clicking on the tabs along the top edge of the component window. To edit any of the entries, first select the proper tab within the component window, then navigate to the entry with the up/down buttons on the far right side. Once the desired entry is highlighted in blue color, you may use the edit component to edit the entry or delete component button to delete the entry, located at the bottom of the button column on the left side.

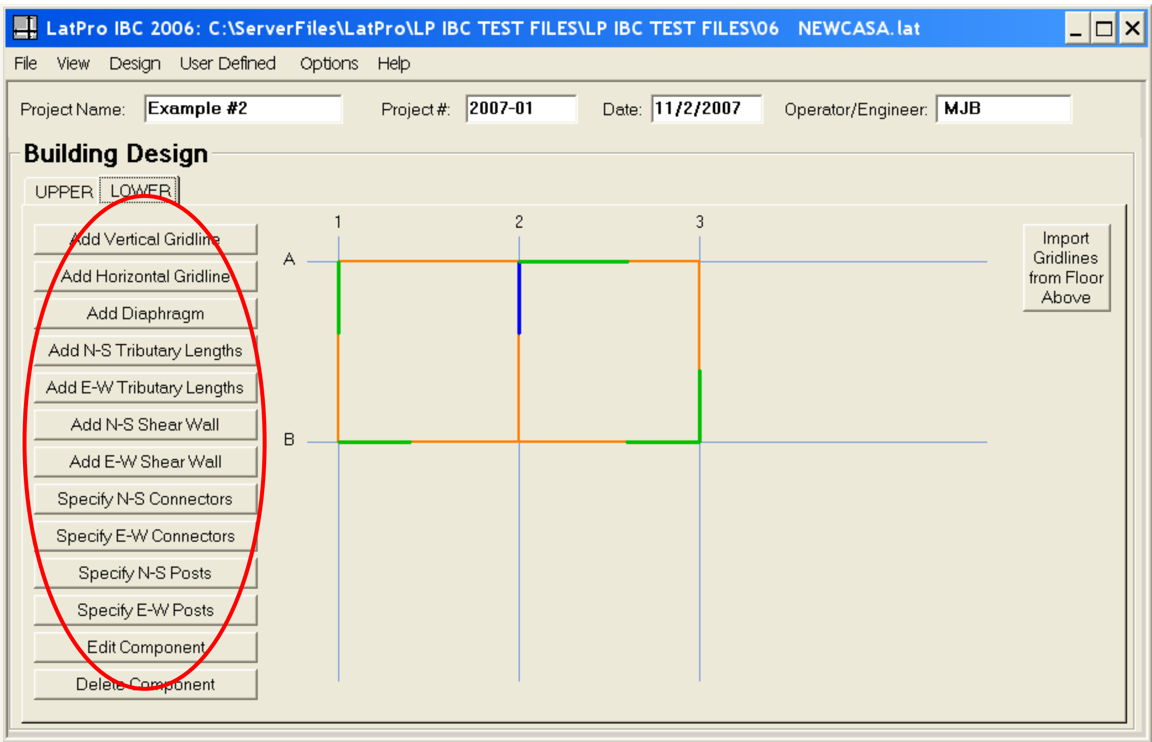
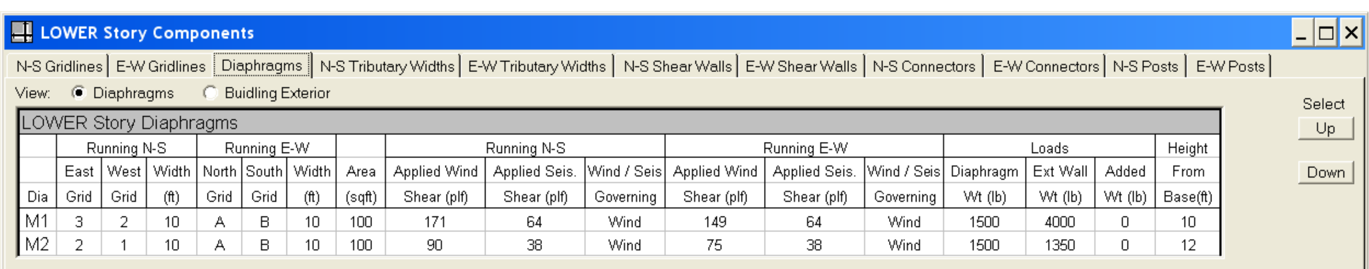


Figure 7. Component Buttons of Main Window



	Running N-S			Running E-W				Running N-S			Running E-W			Loads			Height
	East	West	Width	North	South	Width	Area	Applied Wind	Applied Seis.	Wind / Seis	Applied Wind	Applied Seis.	Wind / Seis	Diaphragm	Ext Wall	Added	From
Dia	Grid	Grid	(ft)	Grid	Grid	(ft)	(sqft)	Shear (plf)	Shear (plf)	Governing	Shear (plf)	Shear (plf)	Governing	Wt (lb)	Wt (lb)	Wt (lb)	Base(ft)
M1	3	2	10	A	B	10	100	171	64	Wind	149	64	Wind	1500	4000	0	10
M2	2	1	10	A	B	10	100	90	38	Wind	75	38	Wind	1500	1350	0	12

Figure 8. Story Components Window

3.2 Design Procedure Overview

The lateral analysis design procedure begins with some site research. After researching the appropriate seismic and wind variables enter the values in the building information input boxes. In a structure, the floor and roof sheathing act as horizontal diaphragms, which transfer the building weight and shear forces to the shear and bearing walls and columns below.

It is recommended to work directly on a set of floor plans, elevations and sections so that there is less possibility for errors in the design and you may be able to catch any unusual structural situations by seeing them visually. Break up the roof and floor areas into rectangular diaphragms that are as large as possible but still use contiguous plywood sheathing.

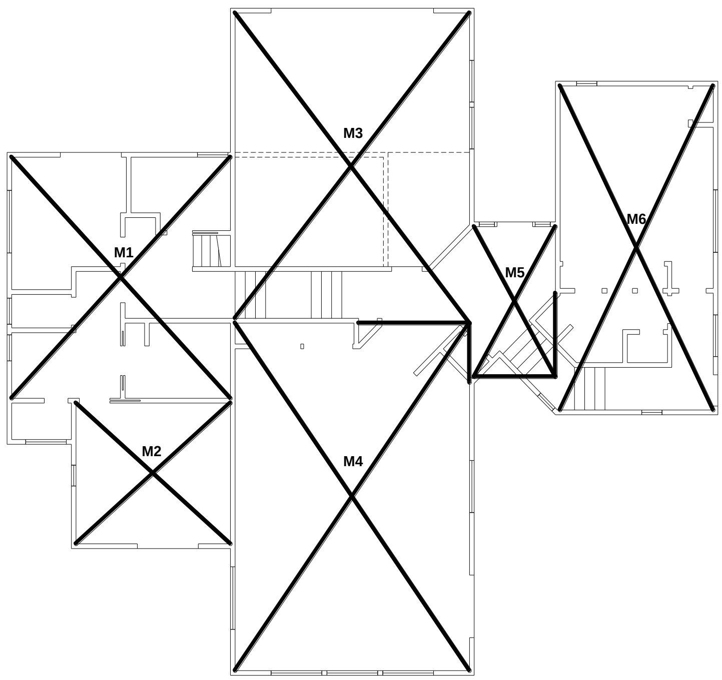


Figure 9. Diaphragm Layout in Plan View

Layout gridlines at all diaphragm boundaries and anticipated shear wall lines. Begin with the roof diaphragm(s) of the uppermost level and work your way down. Be sure to enter <u>all the diaphragms</u> of the structure before starting the design of the shear walls, because all of the seismic dead load needs to be included.

Enter the information for each diaphragm as described below in the Add Diaphragms section. The next step is to transfer the forces acting on the diaphragm to the wall lines by assigning tributary widths. Once all the forces have been allocated, continue on to shear wall sizing and connectors.

3.3 Adding Gridlines

Gridlines are used to help engineers, contractors and building officials to easily locate items on a set of plans. With LatPro, the Gridlines are used to define diaphragm boundaries and wall lines containing intermediate shear walls not on a diaphragm edge.

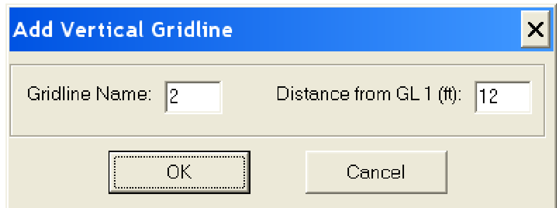


Figure 10. Add Gridline Input Window (For Vertical Gridline)

The Gridlines are important to define all the lines in LatPro where any shear forces will be transferred down through the structure. They can be in the middle of diaphragms as well as on the edges of diaphragms.

To add a vertical or horizontal gridline click on one of the add gridline buttons at the top of the column of building design buttons. Once the window appears, enter in the gridline name and the distance from the first gridline in the new direction as shown in Figure 10.

3.4 Adding Diaphragms

One of the main steps in lateral design in LatPro IBC 2009 is defining the diaphragms. The program efficiently uses wall and roof dimensions to calculate both dead load contributions for seismic forces and areas for wind forces. Figure 11 shows the story convention for the diaphragms, along with their associated wall areas.

The first step is to select the diaphragm type from the pull down menu in the top left corner. The choices are floor, gable/hip roof and other roof. The gable/hip style is the most common roof, when this is selected the values from ASCE 7-05 figure 6-6 are used in wind pressure coefficient calculations.

Currently the other roof option is not functional but in a future version it will allow you to enter the appropriate pressure coefficients (Cp) for dome, arch or other roof types.

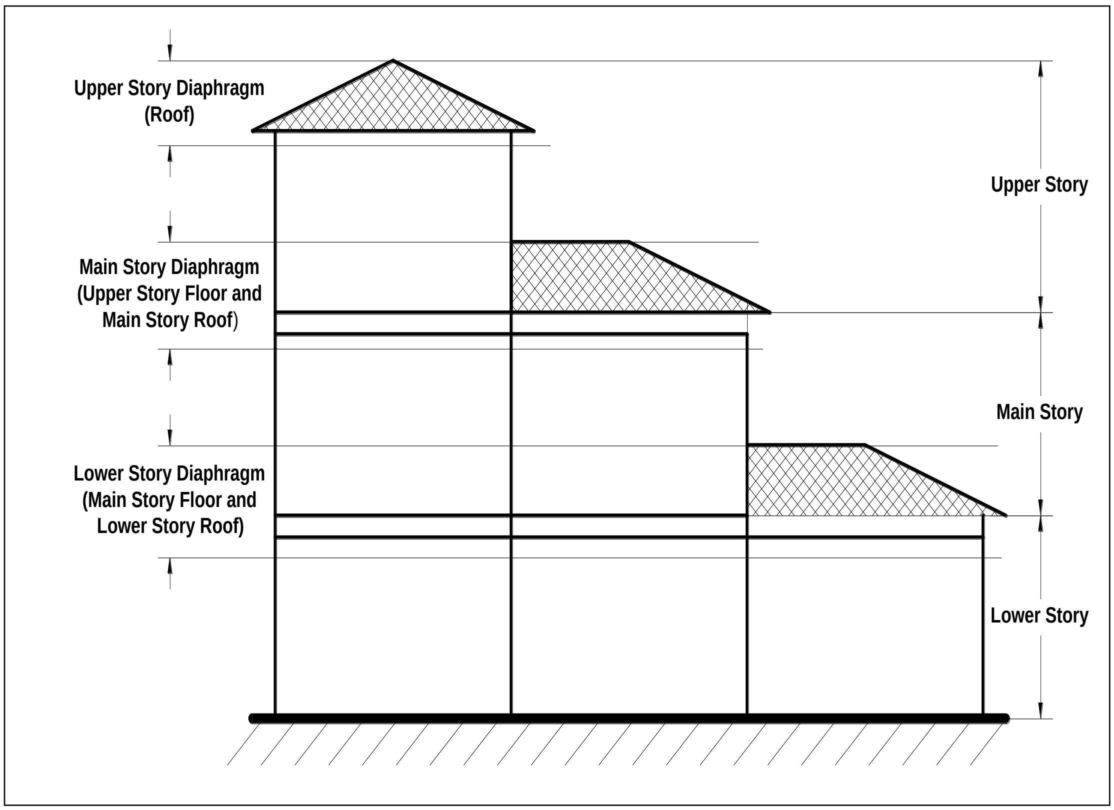


Figure 11. Diaphragm and Story Convention

The input boxes on the Add Diaphragm window are arranged in five groups. The central group, which contains dead load values and general dimensions, is surrounded by input groups for each of the four diaphragm sides. For a detailed description of the dimensions and other inputs for the two diaphragm types, see the following sections.

3.4.1 Roof Diaphragm

After selecting the diaphragm type, begin by filling in the input boxes with the weights in the Diaphragm Weight area in the center group of the Add Diaphragm window. Enter the roof diaphragm and exterior wall dead loads in pounds per square foot. For the diaphragm load, LatPro calculates the area using the dimensions of the defining gridlines.

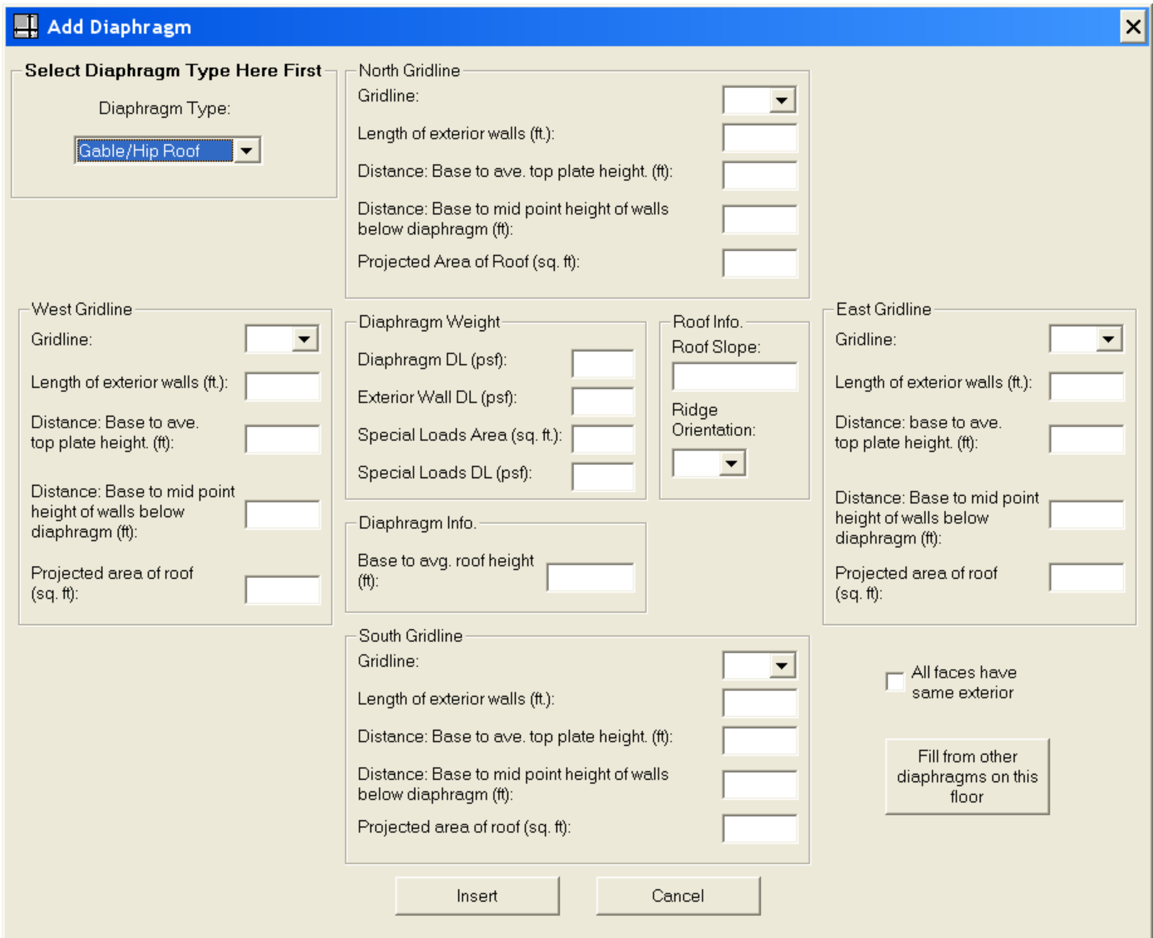


Figure 12. Add Diaphragm Input Window for Roof Diaphragm

Special loads area and weight inputs are used for conditions where there is additional diaphragm weight that needs to be added to the dead load for seismic calculations. Examples include snow loads (where applicable), California roof framing, roof sections having different materials (solar panels), chimneys, eaves, etc.

Enter the roof ridge direction and roof slope. The roof slope input may be entered in decimal form (0.33) of rise over run (4/12). For a one-story building, in entering the base to average roof height, enter the distance from the average ground level bottom plates of the exterior walls of the whole structure to the mean roof height.

For a multi-level structure, to the first floor diaphragm, the user needs to enter the base to the mean height of walls below the diaphragm and then enter the distance from the base to the mean height of the walls above the diaphragm. These dimensions are used to calculate the roof pressure coefficient.

Next, define the diaphragm boundaries, along with the associated exterior wall and roof areas for each side. These wall and roof areas are entered for each face of the diaphragm as displayed in an elevation drawing. In lateral analysis, the wall area affecting the roof diaphragm is half of the area between the floor and top of wall.

In LatPro, three dimensions are used to define this area. The length of exterior walls input is used to set the width of the wall area used for wind pressure and seismic dead load areas. The height of this wall strip is calculated as the difference between the top plate height input and the mid height of the walls below, both dimensions relative to the building base as shown in Figure 13.

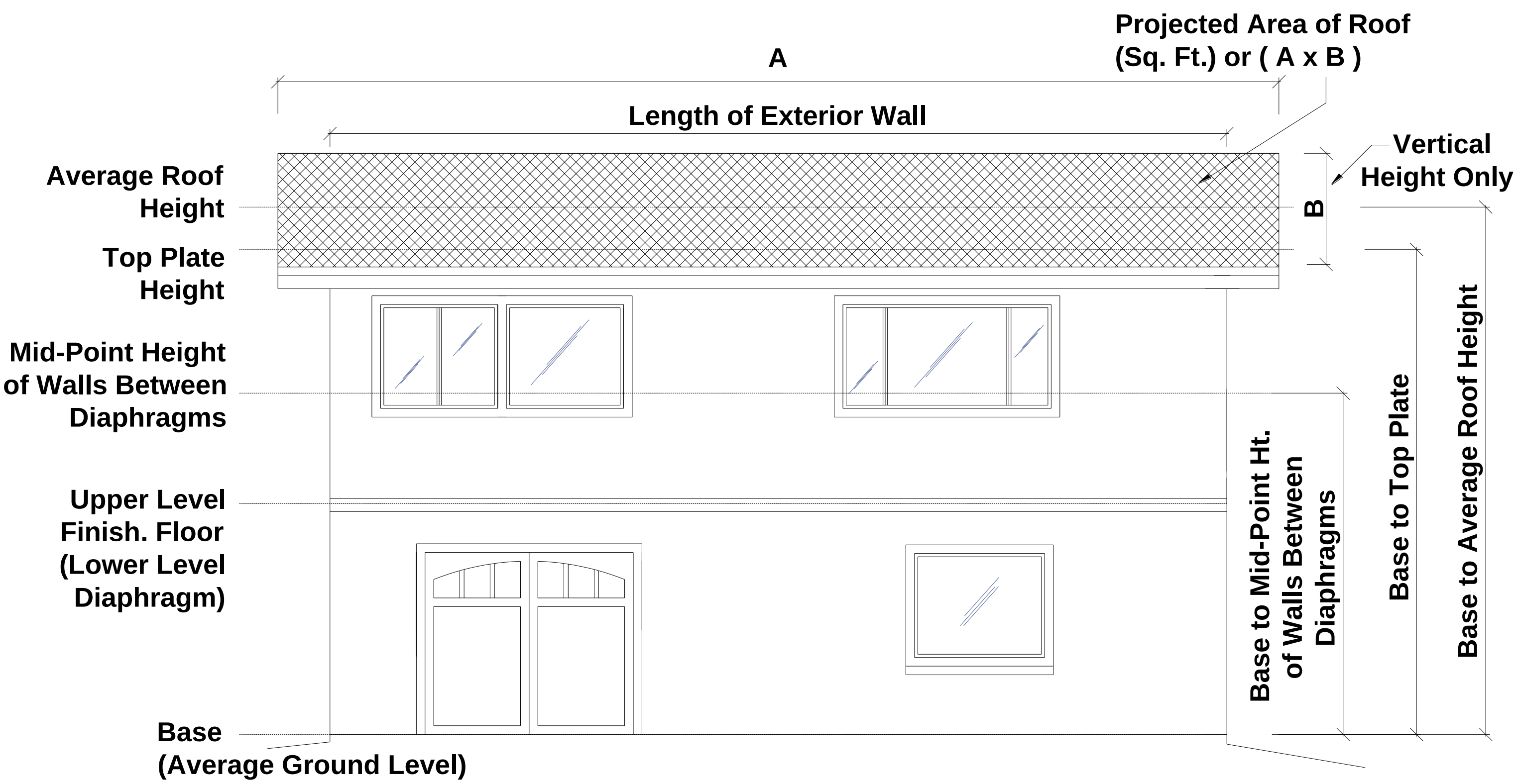


Figure 13. Dimensions Used to Define Roof Diaphragm

It is recommended that the user use an elevation drawing as reference when entering the wall inputs, and especially the projected roof area input. The projected roof area input on the North Gridline input group is the same area as measured on the north elevation drawing.

3.4.2 Floor Diaphragm

After selecting the proper story from the tabs above the component button column of the building design window, click on the add diaphragm button. Next, select floor from the Select Diaphragm Type drop-down list in the upper left hand corner as shown in Figure 14. In the diaphragm loads group enter in the floor dead load, along with any additional dead load using the special loads and area input.

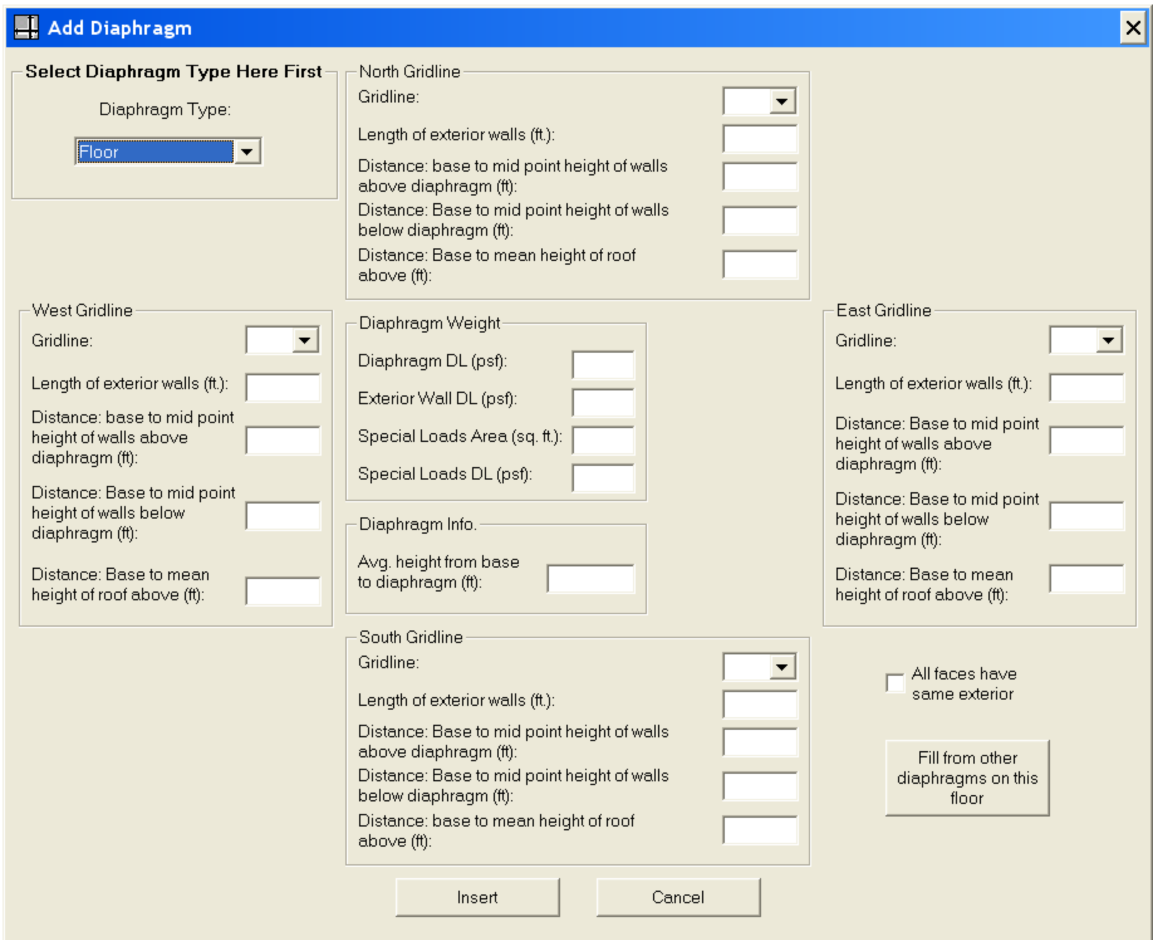


Figure 14. Add Diaphragm Input Window

Enter the exterior wall dead load and the diaphragm height, floor sheathing from base. For each diaphragm side, enter in the three dimensions defining the strip of exterior wall used for wind pressure and seismic dead load calculations: the length of exterior wall, the heights from the building base to the mean height of the walls above and to the mean height of the walls below the floor diaphragm level. These dimensions are illustrated in Figure 15.

It is important to use the average of the mean heights on sloped ground in order to get an accurate area for the force calculations. Once all of the diaphragms have been defined, begin assigning the tributary widths.

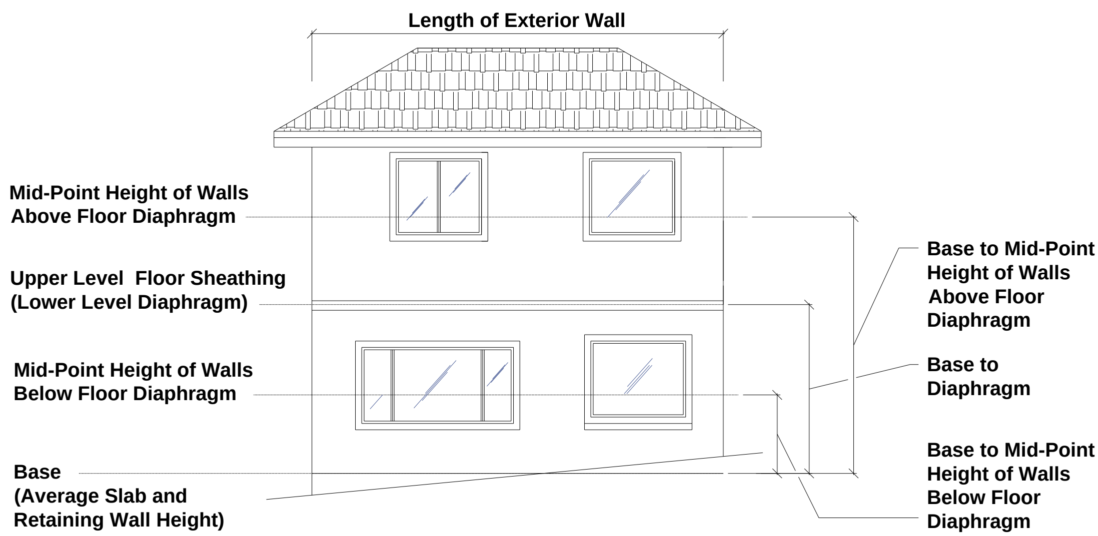


Figure 15. Floor Diaphragm Dimensions

3.5 Tributary Widths

With all of the diaphragm information entered as described previously, the program can calculate the wind and seismic forces. The controlling load for each direction is calculated and the force is divided by the perpendicular dimension of the diaphragm to produce the distributed lateral force. You can check these values in the component window by clicking on the diaphragms tab.

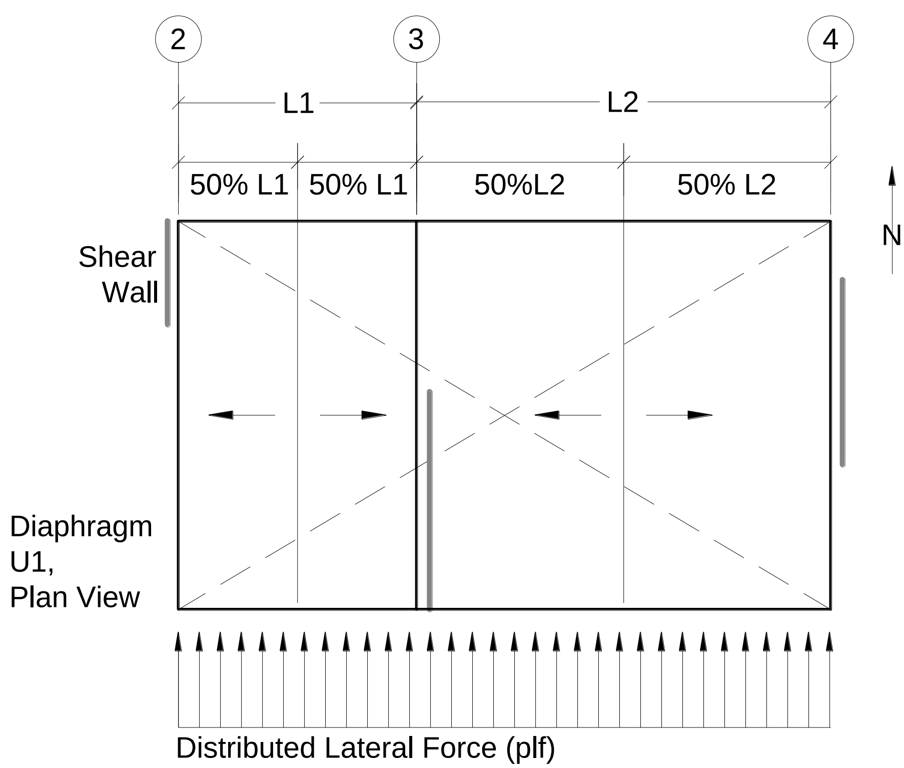


Figure 16. Depiction of Tributary Widths

Cycle through using the up down buttons to see the location of each defined diaphragm in the layout area. The force is distributed to the gridlines by assigning tributary widths. The tributary width is the width of distributed lateral force measured perpendicular to the direction of force, to be assigned to the shear walls on a gridline. Refer to Figure 16 as an example of a diaphragm with an intermediate shear wall.

To assign the force from diaphragm U1 in the N-S direction, you would allocate a percentage of the width between gridlines 2 and 3 to gridline 2, the remaining percentage to gridline 3. The remaining width L2 would be assigned in a similar way to gridlines 3 and 4. After clicking on the “Add N-S Tributary Length” button in the component button column select the percent to allocate from the first pull down arrow.

Next choose the two gridlines that define the section of diaphragm being allocated. Now choose the diaphragm from the fourth pull down arrow and finally the gridline that the force is being allocated to before hitting the insert button. Be sure to allocate 100% of the area of the diaphragm to the gridlines or you will be alerted during the error check stage and in the printed report.

See Figure 17 for an example of the Add Tributary Length Input Window where the user would insert the necessary information. Since LatPro utilizes the flexible diaphragm method, it allows the engineer to increase or decrease the tributary length of the story shear from 1% to 100% depending on the particular situation. Under certain circumstances, like a cantilevered deck that is modeled as a diaphragm, 100% of the deck diaphragm may be allocated to a grid line.

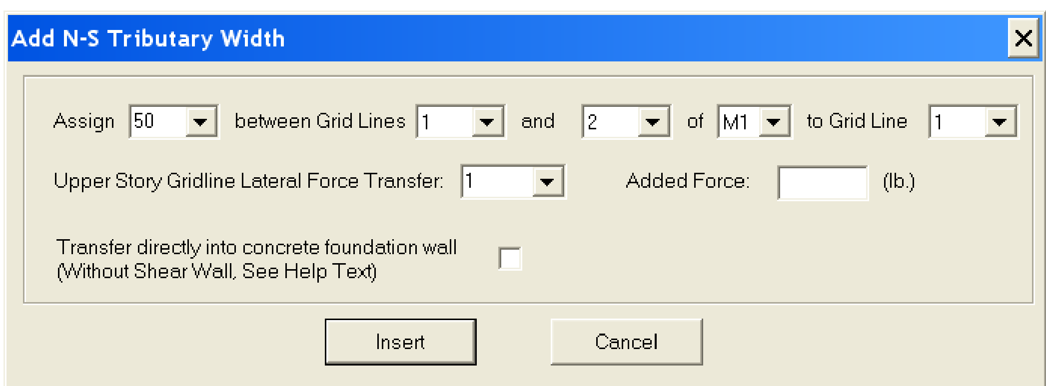


Figure 17. Add Tributary Length Input Window

The designer must make responsible decisions when revising the diaphragm loading from the standard 50% distribution. When there are plan irregularities or diaphragm discontinuities, special consideration is required to ensure the adequate transfer of the story shear to the shear walls through the diaphragms.

For multistory buildings, the designer should transfer lateral forces from gridlines above with the Upper Story Lateral Force Transfer input box. Transfer the forces above by choosing a gridline in the Upper Story Lateral Force Transfer pull down box. This must be done once for each gridline with allocated forces on the story above.

The user may have a hillside structure where one part of a diaphragm is located directly over or attached to a concrete foundation wall. In this case, check the 'Transfer Directly into Concrete Foundation Wall' for that wall line at the bottom of the input window. When this box is checked, an additional input for attachment deflection appears. This input is only used for the wind torsion load cases. If the structure is under three stories, than the analysis is not required (but should be considered if there is a wide variation in wall rigidity), and the displacement input should be ignored. Refer to section 3.8 for more information.

Note that a user can also resolve a wall to the foundation when the 'Raised Floor with Stem Wall Footing' box is checked. This leads to resolving the shear wall connections for the walls above that floor line. The diaphragm may still need to be resolved by checking the 'Transfer Directly into Concrete Foundation Wall' for that wall line also to resolve any diaphragm shear forces that may occur.

When there is an in plane offset (Type 4 vertical irregularity of ASCE 7-05 table 12.3-2) between the an upper story shear wall and a lower story shear wall, the designer will need to verify approved methods necessary to transfer loads down to the foundation. LatPro adds the additional overstrength factor Em, elements supporting the discontinuous system will need to be designed for load combinations using the overstrength factor-refer to ASCE 7-05 section 12.4.3.1 for more information, to posts, connections and holdowns. The designer still needs to add the 1.25 penalty to the connections from the diaphragm to the collector in that wall line.

The user may need to consider other elements such as beams and other connections, and use the overstrength factor in the design of these members. There is also an input box for added lateral forces that could be generated by cantilevered decks, patio covers, etc.

3.6 Shear walls

After all of the forces have been allocated to the gridlines, it is time to size the shear walls. Click on the Add Shear Wall button in the component button column for the appropriate direction. Once the Add Shear Wall window appears, an example is shown in Figure 18, select the desired gridline and the shear wall number that will automatically be assigned for the current wall being sized.

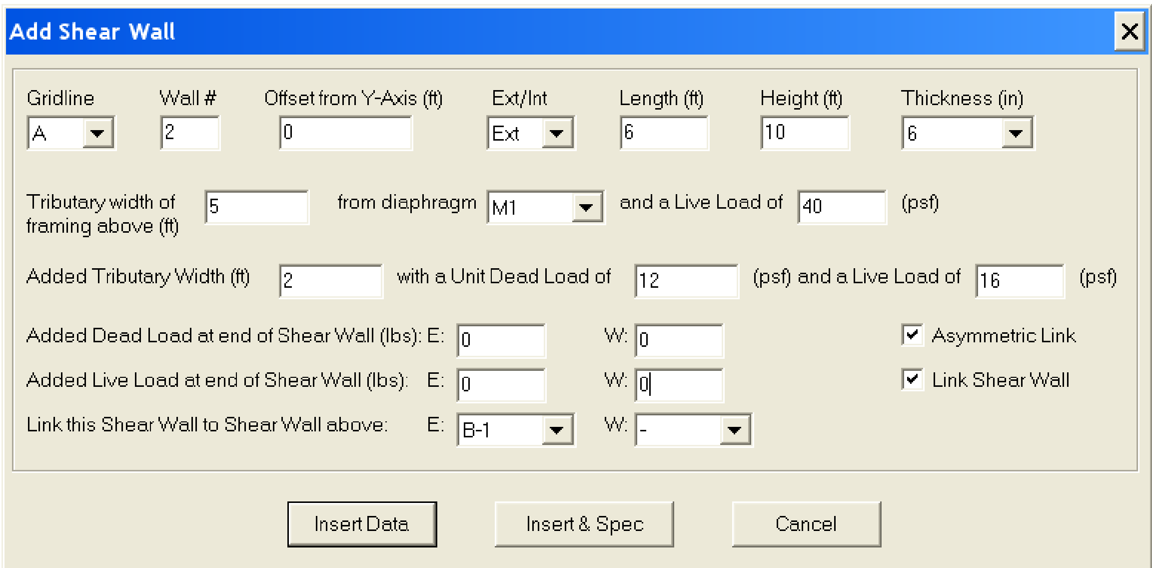


Figure 18. Add Shear wall Input Window

Next locate the shear wall by specifying the offset distance, from the A gridline (for N-S shear walls, from gridline 1 for E-W shear walls) to the near end of the shear wall being specified. As shown in Figure 18 for shear wall 1 and Figure 19 for shear wall 2, the distance entered would be 0 for the offset distance that is depicted in these examples.

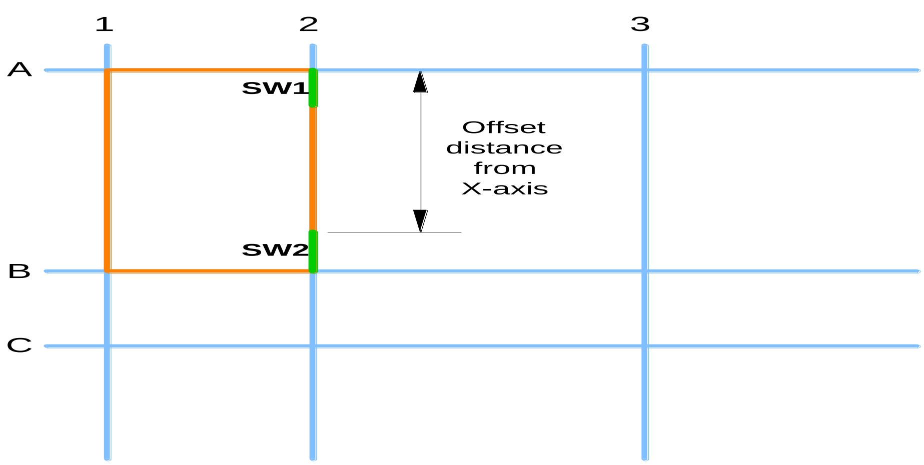


Figure 19. Shear wall Offset Distance from Axis

Next enter the dimensions and vertical loads acting on the shear wall. Enter the length and height of the each shear wall, the tributary width of framing above the wall, live load in psf, and which diaphragm above, that the dead load is coming from. In this window the user can also enter additional tributary loading such as cantilevered decks over walls, equipment, roof eaves etc. which will add additional weight to the wall.

This type of input should only be used for loading that is continuous along the length of the wall. The added tributary width dimension is measured perpendicular to the shear wall length and when multiplied by the unit live and dead loading produces a linear load.

Added Dead Load can also be dead loads from roofs and non-shear walls from stories above. Figure 20 better illustrates this concept, showing where roof framing and a wall above also add additional dead load.

Note that this can only occur where the dead load above has not been used as dead load acting on the shear walls directly above shear walls on the floor below or that load would be used twice. The dead load of the structure cannot be used multiple times to resist the uplift forces from earthquake or wind loads.

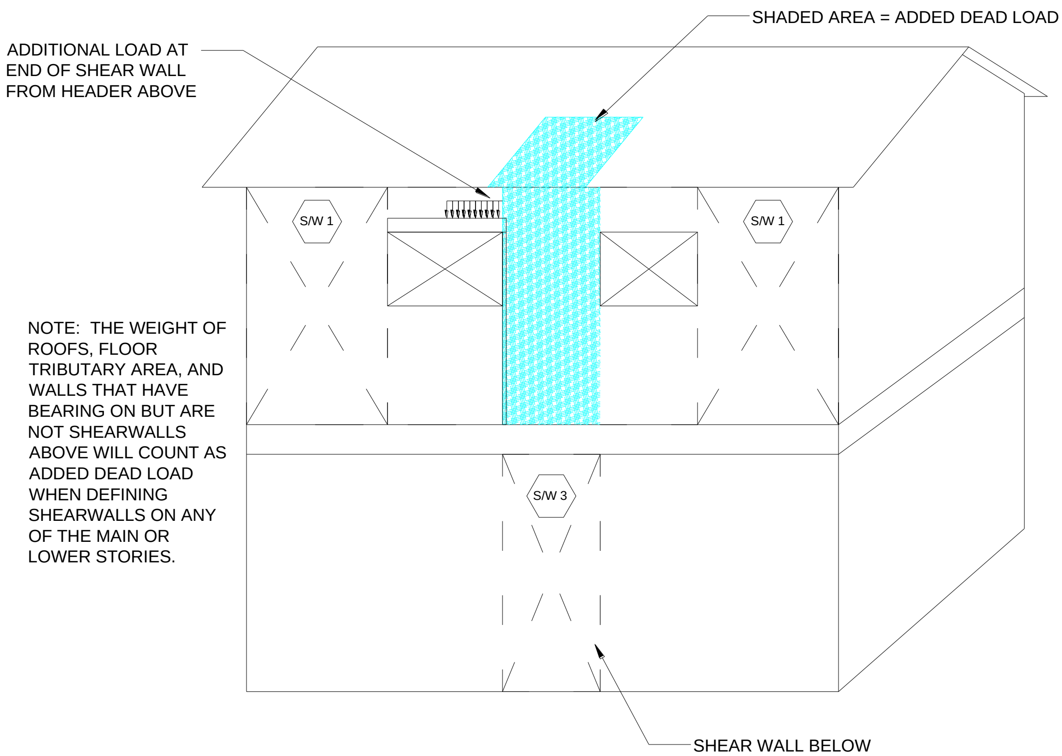


Figure 20. Added dead load diagram

If the shear wall chord is subject to any additional live or dead point loads at the either end of the wall, enter the magnitude of the force in either or both of the **additional load at end of shear wall** boxes. An example of additional point load occurs when a window is located next to the edge of a shear wall. The header could exert an additional axial force on the chord member of the shear wall. These loads are modeled as acting directly over the shear wall chord member so judgment is needed as to when to include such loads and how much to include.

The program uses the dead and live load contributions with the allowable stress design basic load combinations to calculate the controlling shear wall chord member uplift and compression forces. It is especially important to enter accurate values since the loads affect both uplift and compression calculations.

This becomes more important on the lower floors, especially when shear walls are stacked over each other and the uplift loads become very large. On the lower floor, the user needs to determine if one or both edges of a shear wall have a shear wall above linked to the shear wall below. LatPro automatically adds the uplift and compression forces when the shear walls are linked together when the user checks the **link shear wall** box.

For situations where there are different loading and chord member support conditions at the two ends of a shear wall, use the **asymmetric** check box. The most common example where this is useful is when only one side of a shear wall connects to a shear wall below. In this case, LatPro can transfer the wall uplift and compression forces to the shear wall below on one side, and the user can size a post with LatPro to support the other side.

Other situations where this feature is useful include when the walls have different end loading, different support types (single pour vs. double pour footings or existing concrete vs. new footing) or when the wall is linked to different shear walls above or below.

Once the shear wall information is entered, the user has two options; to insert the data into the spreadsheet using “insert data” or “insert and spec.” To properly size the shear walls LatPro needs to have all of the diaphragms entered for the building, and the total length of all the shear walls along a gridline entered.

Use the “insert data” button, for the first one or two shear walls, entered on a gridline. The “Insert data” button will enter the information but will not calculate the unit shear or the type of shear wall required. The “insert data” button is useful to enter the first few anticipated shear wall lengths without wasting time specifying the wall type, since the first few walls will be oversized and need to be resized when more walls are entered. After a couple of walls on a grid line or on the last wall hit the “insert and spec” button and then go back and do that for all the previous walls which had only the data “inserted” into the program.

If you notice in the component window that for a shear wall entered a cell displays #N/A or is blank. This notation is meant to alert the user that this wall is not specified or undersized. After all of the walls have been entered, scroll back to the un-specified shear walls using the up/down buttons in the component window, then click on the edit component button in the button column. Now use the insert & spec button to pull up a list of shear walls appropriate for the given loading and select the shear wall type.

NOTE: It is critical to have all of the seismic dead load accounted for since adding weight, by adding or changing diaphragms, after a wall is sized will change the seismic story distribution coefficient and base shear, affecting the story shear, and the wall shear.

After the shear wall is specified, the program calculates the wall drift. This value is not the final wall drift value since deflection due to the shear wall chord members will change after the chord members and connectors are specified. After specifying connectors, run error check to see if the walls meet drift requirements and correct the shear wall chord member, connector sizes or shear wall type as necessary to reduce story drift to an acceptable value. If necessary, keep upgrading the shear wall type until the story drift is reduced to an acceptable value.

LatPro Default Shear Walls have a minimal panel thickness of 3/8" with 8d (2 ½: x 0.131" common) because they have been adjusted in LatPro based on the IBC 2009 Table 2306.4.1. This table allows the shear values to be increased to the values shown for the 15/32" sheathing with the same nailing provided that, a) studs are spaced a maximum of 16" on center, <u>or</u> b) the panels are applied with long dimension across studs. <u>The user can use these same values using the 15/32" sheathing</u> at the user's choice.

If the loading is higher than the rating for the defined shear walls, no walls will show up in the drop-down shear wall menu, a user-defined option is available or the user can go back and lengthen the shear wall. Select the user-defined wall option and enter the given wall parameters. A typical user-defined wall could be a Simpson Wall, Hardy Panel or another pre-manufactured wall or frame that can handle the required forces.

3.6.1 User Defined Shear walls

One of the best tools in LatPro IBC 2009 is the User Defined Shear wall function found in the main menu bar. This is where the user can add the type of shear wall that the user is used to using, that is required of the project or that the contractor of a particular project would like to use. This includes either site built walls made of plywood sheathing or pre-built walls from a manufacturer including engineer-designed.

These walls remain in the program as defaults, unless the user deletes them in the user defined manager, so that the user does not have to keep defining them for each project. The user defined manager also lets the user edit, add or remove either site built or pre-built shear walls.

It is important that the user enter the correct numbers for maximum seismic and wind shear capacity for the site-built and pre-built user defined shear walls. For site built walls, enter the shear capacity in pounds per linear foot for resistance to those forces. For pre-built walls, enter the total force in pounds that the wall can resist. These are the numbers the program will rely on as accurate to resist the lateral forces.

It is important to recognize the different load values based on bottom connection (concrete, raised floor, upper floor) and vertical load for the pre-built walls, as separate entries will be required for each condition. Also for pre-built shear walls, such as Simpson Strong-walls, Hardy-Panels, or engineered walls, the user needs to enter the amount of drift at the allowable shear.

3.7 Specifying Connectors and Shear Wall Chord Members

After the shear walls have been sized and all of the vertical loads tributary to the shear walls have been entered in the add shear wall input window, the program has all of the information needed to choose the proper anchorage or connectors. LatPro IBC uses the basic load combinations for allowable stress design to calculate the controlling uplift and compression loads.

For wind loading on a roof diaphragm, roof suction is included by taking the negative roof pressure combined with the tributary framing above to calculate uplift in addition to the wall overturning. With these loads determined, the program is now ready to specify the shear wall chord member and connector at each end of the wall. LatPro offers many different connection options for the various shear wall support situations, depending upon the forces and the chord member chosen. If no connector shows up in the menu, then the user needs to revise the chord member or reduce the forces with a longer shear wall, etc.

3.7.1 Connectors

To begin connector design, click on the Specify Connectors button for the appropriate direction (E-W or N-S); this brings up the input window as shown in figure 21. From the pull down tab at the top of the window, choose the wall that you are designing the connection for.

Next, select the proper connection type from the list at the left side of the input window. The top four selections are for shear wall connections to concrete, which require additional dimension inputs to determine the anchor uplift capacities. The lower four connection types are for shear wall connections to wood framing.

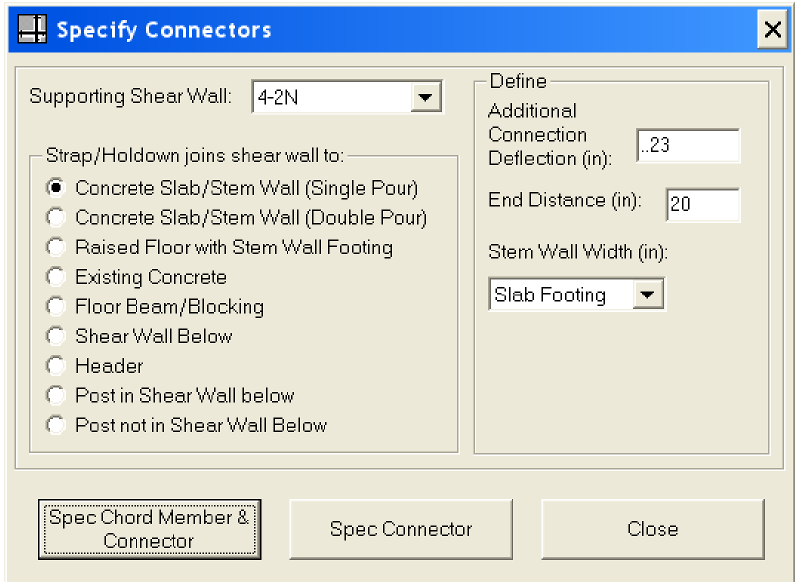


Figure 21. Specify Connector Input Window

Connection Deflection. The Additional Connection Deflection input relates to shearwall drift in addition to the specified Simpson connectors. LatPro IBC checks the shear wall seismic drift against code drift limits. One component of shear wall deflection is holdown assembly displacement. The program automatically includes holdown elongation (values taken from manufacturer catalogs) and sill plate crushing. The Additional Connection Deflection input is for other sources of holdown assembly deflection, such as moist wood shrinkage, fastener slip, and beam rotation (for the Floor Beam/Blocking connection type).

It is also important to enter a number for End Distance unless the wall is at an outside corner where the value should stay zero. LatPro assumes this to be zero unless the user enters a value. LatPro automatically calculates the end distance based on the chord member size and the connector chosen. The width of the concrete is also important, because some holdowns are not allowed to be used without certain minimum widths of concrete. If the user finds very few or no connectors coming up on the drop-down list, then the user should try changing some of these variables, including chord size and concrete width.

3.7.2 Single/Double Pour Concrete, Raised Floor Connectors

Connectors attaching to concrete have minimum spacing and dimension requirements for their installation. In addition, the strap anchor capacities decrease when installed near a foundation corner. For the concrete slab/stemwall, raised floor, and existing concrete connections the program asks for end distance and stemwall width dimensions to determine which connectors may be installed, and the proper capacity for the given location.

The end distance is the dimension parallel to the shear wall length from the outside of the shear wall chord member to the end of the concrete stemwall or slab foundation corner. For stemwall end wall and corner conditions, many connectors have reduced capacity. It may be necessary to move shear walls or provide larger chord members, connectors or concrete wall thickness to provide the appropriate capacity values.

For strap connectors (STHD/HPAHD), when the strap width is less than the shear wall chord member and the user would like the strap to be installed offset towards the inside of the shear wall, include this offset distance in the end distance input box and be sure the plans reflect this distance for construction.

For raised floor connections, the STHDRJ strap anchors use values based on a 17" clear span between the foundation and the bottom of the post/shear wall chord member. This dimension includes the rim joist depth, wall sill plate, foundation sill plate and some edge nailing distance. The other holdown anchors have the same capability, but specify threaded rod to span from the anchor to the foundation.

3.7.3 Existing Concrete Connectors

To specify a connection into existing concrete the user needs to determine what type of location the anchor bolt will be set. When an anchor bolt is set into an existing stemwall, a 6" wall limits the holdown selection to anchors that use 5/8" diameter bolts. For 8" or greater stemwalls, the user may specify anchors that use either 5/8" or 7/8" or greater diameter bolts. However, in both cases the end distance from the actual bolt to the end or corner of the stemwall must be checked according to some manufacturers and the ACI 318-08 requirements.

> **Note:** The minimum edge distance is different than the end distance input. The LatPro program asks the user to combine in the end distance input, in the case of a holdown, the shear wall chord member thickness and the anchor holdown dimension, to the centerline of the anchor bolt, to calculate the actual bolt offset from the concrete corner or stemwall end. In the case of a holdown strap the user enters the distance from the corner or end to the centerline of the strap. LatPro then checks the holdown against the minimum allowed or any reduction in value to the connector.

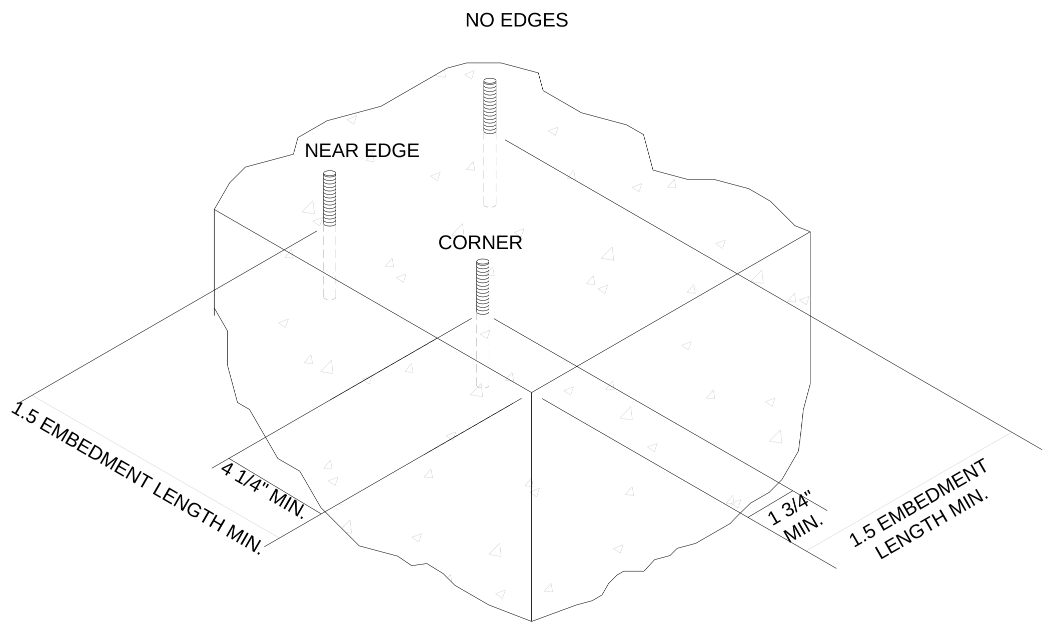


Figure 22. Edge and End Dimensions for Threaded Rod Connections to Existing Concrete

Other options are to install the threaded rod and holdown into a slab footing at a near edge, corner or no edge location as shown in figure 22. The edge distance dimension is perpendicular to the shear wall length, while the end distance is parallel. Simply check the boxes in the connector input window to indicate the anchor location so the program will use the appropriate capacity values.

> **Note:** For existing concrete and all-thread rod, the minimum end and edge distances for the near edge and no edge location is dependent on the threaded rod embedment length. The designer must check the edge and end distance dimension requirements once the embedment length is determined to verify that the proper anchor location was selected.

The connection to existing concrete has been revised to an engineer specified connection and footing because of the new requirements of ACI 318-08. The designer will need to evaluate the existing concrete conditions including cracked or un-cracked, etc. LatPro prints the report using “engineer designed connection” to allow the connection to be designed and added to the report. Simpson also has some epoxy connection software available to help in the design.

3.7.4 Shear Wall to Wood Framing Connectors

Shear Wall Below
In most cases upper story shear walls transfer the uplift and compression forces directly to a shear wall below. For low uplift forces, a MST, MSTC or MSTI strap tie is usually adequate. It is important to select the proper floor to floor clear span value in the building information tab. If the span is greater than 18” then the strap capacity values must be adjusted or specify a user-defined connector.

In high-load shear walls or walls with a high height to width ratio, the user may need to specify a holdown anchor with threaded rod. This requires holdown anchors at each end of the threaded rod to transfer the forces from the upper story shear wall chord member to the lower shear wall chord member. The user must ensure that the upper and lower story shear wall chord members are properly aligned with enough end distance for the foundation anchorage.

Floor Beam or Blocking
When specifying an attachment from an upper story shear wall chord member to either a floor beam or blocking using strap ties, the capacities are based on the post sitting flush on the beam or blocking, with no clear span. Holdown anchors and threaded rod connections are also available; the user should specify the proper bearing plate to protect the supporting member, if this is necessary.

This configuration is a type 4 vertical structural irregularity. The shear wall connector and chord member are sized with the basic load combinations, but the elements supporting the shear wall need to be designed for the load combinations with the seismic overstrength factor. These uplift and compression loads are displayed in the Seismic Edge Member Uplift column and the Seismic Crushing column of the Connector component tab. It is critical to design the floor beam or blocking (and supporting elements) for these loads, be sure to include the allowable stress increase per ASCE 7-05 section 12.4.3.3 if appropriate.

Headers
To connect to a header below, if the clear span is greater than the floor to floor clear span selected in the building information section then the user must define a strap that has the capacity adjusted for the actual shear wall chord member to header clear span, and ensure that the header is deep enough to receive a sufficient number of fasteners. Another option is to enter the Simpson pre-bent strap into the user defined connector list, with the capacity adjusted for actual framing condition.

When a shear wall chord member attaches to a header instead of a shear wall below or a post in a shear wall below, the configuration is a type 4 vertical structural irregularity. For these cases, the shear wall connector and chord member is sized with the basic load combinations, but the elements supporting the shear wall needs to be designed for the load combinations with the seismic overstrength factor.

These uplift and compression loads are displayed in the Seismic Edge Member Uplift column and the Seismic Crushing column of the Connector component tab. It is critical to design the header (and supporting elements) for these loads, be sure to include the allowable stress increase per ASCE 7-05 section 12.4.3.3, if appropriate.

Post in Shear Wall Below

This type of connection occurs when an upper story shear wall is directly above a shear wall below, and the chord members do not line up, This type of connection is designed similar to a connection to a shear wall below, without transferring uplift forces to the lower story shear wall chord member. This connection adds the shear wall to the list in the Specify Posts input window to allow the designer to properly size the post below. See the Add Posts section of the manual for more information about post design

Post Not in a Shear Wall Below

Choose this connection, when either of the shear wall chord members of an upper story shear wall do not stack above a shear wall below (aligned in the same direction). This configuration is a type 4 vertical structural irregularity. If the ‘Post not in shear wall below’ is specified, then a magnified seismic load will be used to calculate the forces acting on the elements supporting the lateral force resisting system. The shear wall connector and chord member will still be sized for the basic load combinations, but the post supporting the shear wall will be designed for the load combinations with the seismic overstrength factor as described in the Add Posts section.

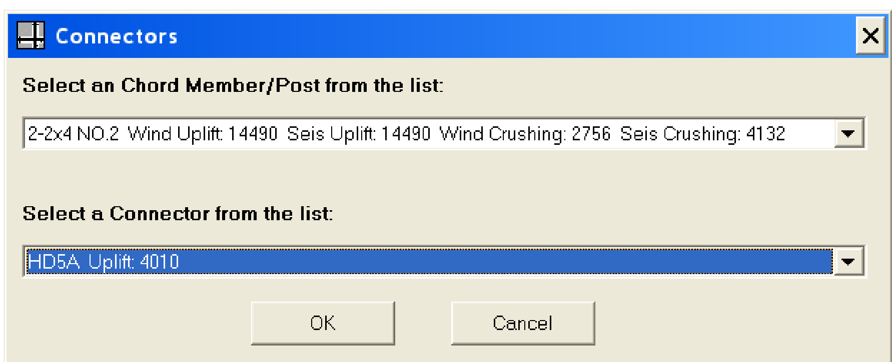


Figure 23. Chord Member/ Connector Selection

After entering the connection type and required inputs click on Spec Chord Member & Connector button to bring up the selection window shown in figure 23. If the engineer determines that any additional uplift forces must be resisted then a stronger connector should be selected to compensate and resist those forces.

User Defined Connector

Similar to shear walls, the user can define a connector not already included in the database. At the bottom of the connector dropdown list in figure 23 will be the 'USER DEFINED…' option. Selecting it and clicking **OK** will show a window as shown in figure 24 where the user can enter the name and maximum allowable uplift for the connector. In addition the user can enter location, installation specifications and any notes to be included with the printed report.

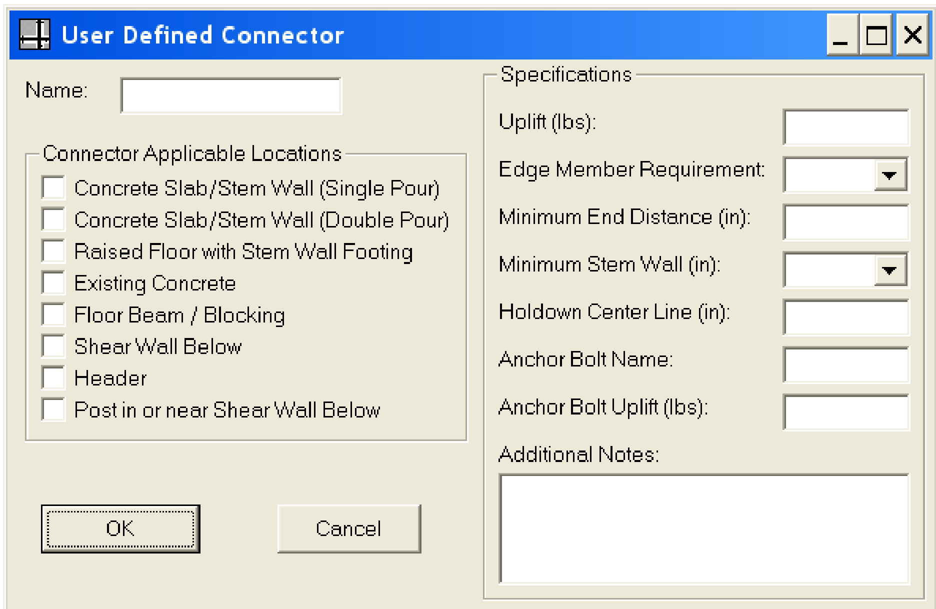


Figure 24. User Defined Connector Input Window

The user is able to specify the connection type and installation requirements so that the User Defined connector will only be available when the requirement conditions are met during input.

The Edge Member Requirement is the minimum nominal shear wall chord member required for the connector being defined.

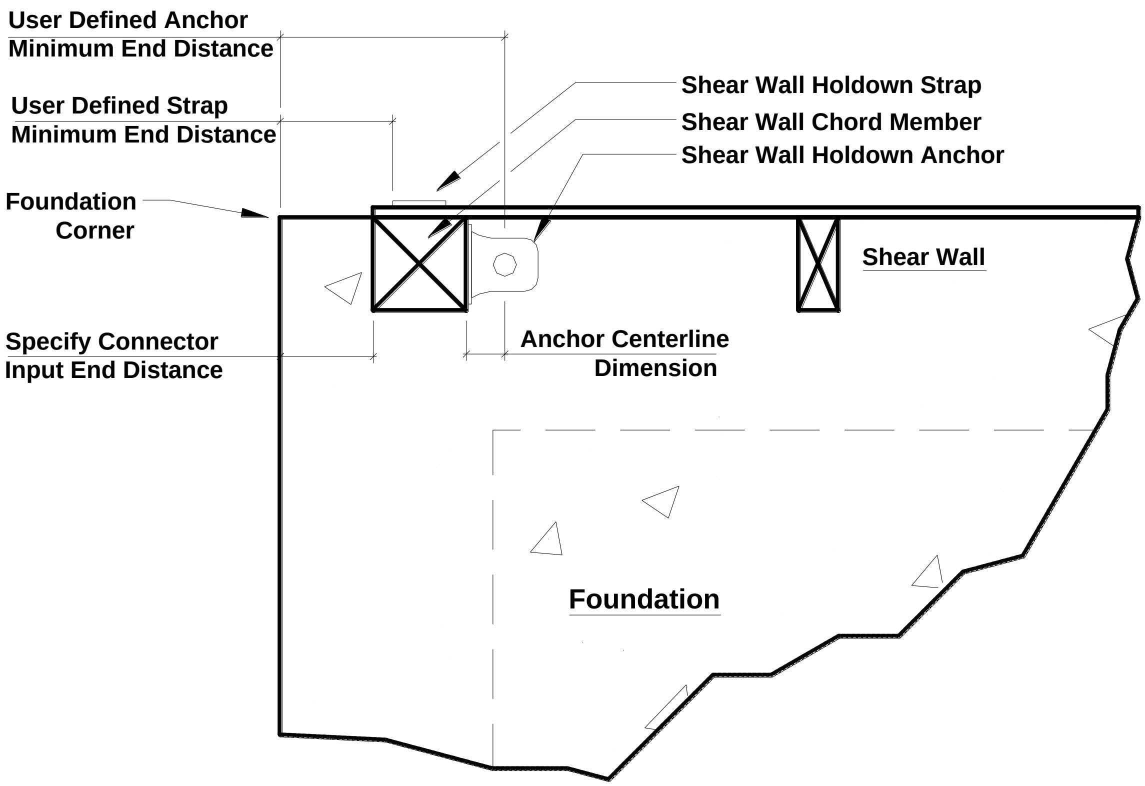


Figure 25. User Defined / Specify Connector Input Dimensions, Plan View

The User Defined minimum end distance is different for strap and anchor bolt holdown connectors. For anchor bolt holdowns, the minimum end distance is the dimension from the bolt centerline to the foundation corner. The minimum end distance is the dimension from the strap edge to the foundation corner for strap type connectors, as shown in figure 25. Only enter in the “end distance” for the distance from the end of the concrete to the closest edge of the shear wall chord.

The Holdown Centerline dimension is for anchor type holdowns. It is the distance from the bolt centerline to the near edge of the shear wall chord member.
For strap connectors, or other connectors that attach to the sheathed side of the shear wall chord member, enter only the distance between the chord member and the edge of concrete and LatPro calculates the strap width. Since the end distance is dependent on the edge member thickness for anchor bolt type connectors, LatPro IBC combines the sum of the Specify Connector input “end distance” (See figure 25), the connector Anchor Centerline dimension, and the shear wall chord member thickness to find the actual connector end distance.

3.7.5 Shear Wall Chord (Edge) Members

LatPro allows the user to specify the shear wall chord (edge) member for all site-built panel walls based on the wall's uplift and compression loads for both wind and seismic load combinations. After clicking the Spec Chord Member & Connector button, LatPro will generate and present a list of adequate edge members and connectors to choose from.

The Spec Connector button is useful when the user has chosen a chord member and wants to change the connector. Clicking this button will allow the user to choose a different connector without having to re-specify the chord member. Be sure to choose the proper framing lumber species group so that LatPro will generate appropriate load capacities in accordance with NDS specifications.

Edge member and post capacities are assumed to be braced in the weak axis by sheathing. For wind loading, the edge member and post capacity is determined with the inclusion of applied wind pressure acting normal to the wall.

Note: Many connectors in the LatPro database require a minimum sized edge member. If the edge member called out is too small for any adequate connector to fit, LatPro will allow the user to re-spec the edge member to a bigger size.

3.8 Wind Torsion Load Analysis

LatPro version 3.0 is capable of applying the Wind Torsion Load Cases 2 and 4 (ASCE 7-05 Figure 6.9, and Section 6.5.12.3). These load cases are required as part of lateral analysis for three-story structures. After the structure has been designed to resist the wind loads from load case 1 (full wind load acting on each axis separately), the user can run the torsion analysis to see if any elements need to be redesigned for load cases 2 and 4.

NOTE: It is very important that all diaphragms have been entered, tributary widths allocated, and shear walls/connectors designed before performing the wind torsion analysis. Perform an ***Error Check*** prior to running the wind torsion analysis to verify that these items have been properly designed.

When the wind torsion analysis is performed, the program will determine shear wall and gridline rigidity, which are used for center of rigidity calculations. After determining these values for each story of the structure, the wind torsion moment will then be distributed amongst the gridlines based on the relative rigidities. The wind torsion moment is calculated from the story force multiplied by 15% of the story dimension measured perpendicular to the wind loading.

To begin the wind torsion analysis, click on the Design menu and select Perform Wind Torsion Analysis. Next the Input window will appear which allows the user to define the boundaries of analysis for each story. Select the gridlines that define the story boundary from the pull-down lists. This is useful for situations where engineering judgment determines that some elements or diaphragms should not be included as part of the torsion analysis.

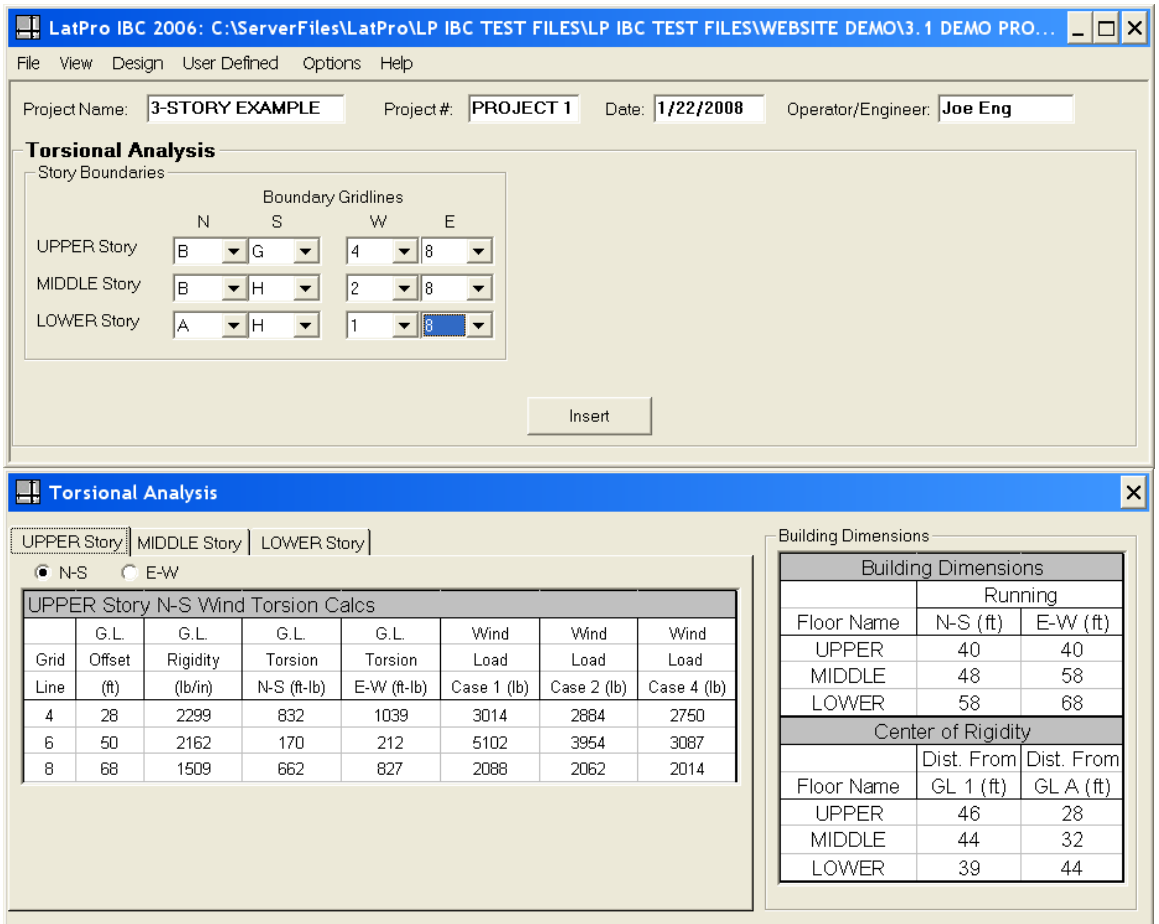


Figure 26. Torsional Analysis Input Window

After entering all the input data and performing the error check, click **Insert** to send the data to the database. LatPro will calculate and present the structures' gridline rigidity and center of rigidity per story. This will update the spreadsheet with the gridline forces for the different wind load cases. These values will be displayed on a story and direction basis. Navigate between floors and N-S, E-W analysis direction by selecting the story tab at the top of the window, and the direction button just below, as shown in Figure 26.

Afterwards the larger gridline force from either Wind load case 2 or 4 will be displayed in the Tributary Widths spreadsheet under the Wind (2, 4) Gridline Force column, next to the Wind (1, 3) Gridline Force column. The larger wind gridline force will be used for the design of elements on that gridline.

Once the new loads have been generated and applied to the gridlines, some elements may need to be re-designed. After running the torsion analysis LatPro will initiate a check to determine which elements are undersized, and produce a list for the user.

Where diaphragms are connected directly to concrete, within the "Add/Edit Tributary Width" window, the user will need to enter the connection displacement in inches (along the gridline). This deflection value is required for the gridline rigidity calculations and torsion moment gridline force distribution. Displacement due to concrete to ledger/sill plate connection and fastener slip for any framing plate connectors or nailed connection between diaphragm framing and ledger/sill plate shall be included in this input value.

If significant changes to the shear walls/connectors are required, resulting from Wind load cases 2 and 4, it is highly recommended that the user run the analysis a second time. This is to account for the changes to the rigidity, and the related effects to the distribution of forces.

3.9 Posts and Post Connectors

LatPro will allow the user to size all posts supporting shear walls for uplift and crushing, and specify the post's connector. To specify posts and post connectors, click on the Specify Posts button. Chose the location of the post based on the selections given in the input window as shown in figure 27.

Post capacities for "Posts that are located in shear walls" are based on calculations assuming buckling is prevented along the weak axis as lateral bracing is provided by wall sheathing and the end fixidity is assumed a pin connection. If the design condition is different from these assumptions the posts should be designed based on the specific configuration of that post.

Posts and their connectors are both specified in the same input window. Posts are referred to by the shear wall that they support. A dropdown list contains all shear walls requiring post support in the story above.

Enter the post's height and any added dead or live load, such as header or beam loads. Click on **Spec Post & Connector** to generate a list of posts that will support both the crushing and uplift loads and to specify the connector. Click **Spec Connector** to only specify a connector, after a satisfactory post size has been chosen.

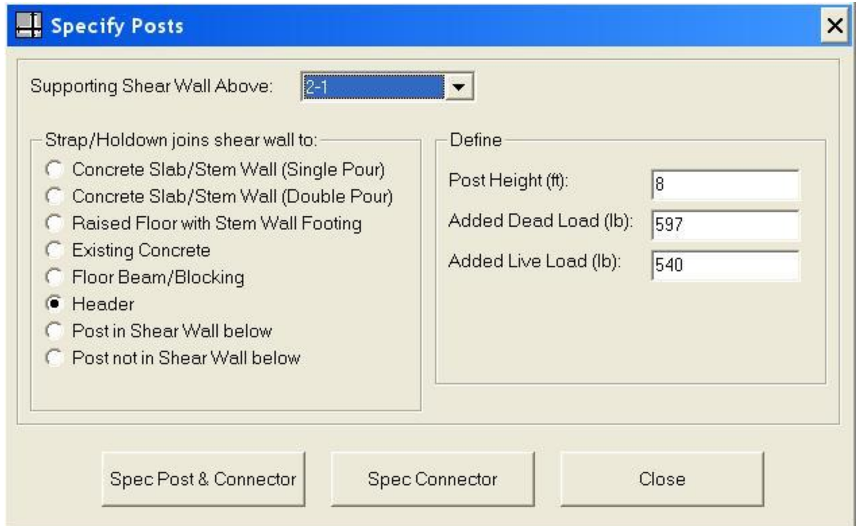


Figure 27. Specify Post Input Window

For posts, LatPro uses seismic load combinations with the System Overstrength factor as defined in ASCE 7-05 section 12.4.3.2. In addition, the post capacity is increased with an allowable stress increase of 1.2 as specified in ASCE 7-05 12.4.3.3. The IBC requires that all supports of shear walls be designed using the overstrength factor including posts, beams, etc.

3.10 Components and Cladding

The LatPro IBC program can perform the analysis of wind pressure on building Components and Cladding. Any element of the building envelope that does not qualify as part of the main wind force-resisting system needs to be designed to withstand the components and cladding design pressure.

To calculate design pressures for a building component or cladding, click on the **Add Components & Cladding** button in the Design Window to bring up:

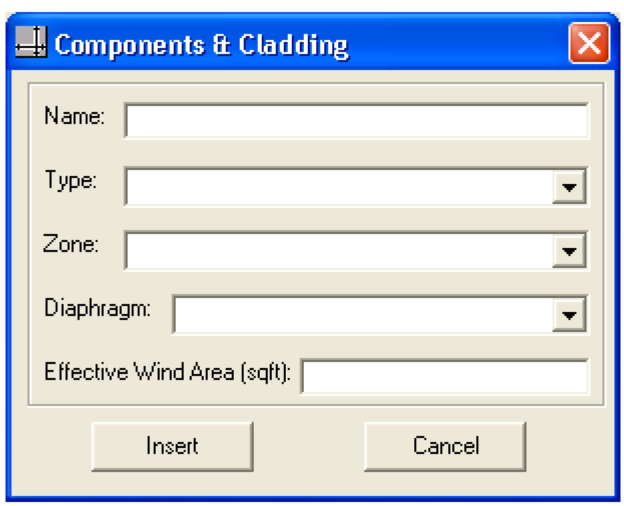


Figure 28. Components & Cladding Input Window

First enter a descriptive name and select the type of component (or cladding) from the pull down menu. Based on whether the component is located near the edge, corner or center of the wall or roof area, select the appropriate zone number as defined in the ASCE 7-05 (Figures 6-11A through 6-14B).

Here is a description of the different zones for a wall component or cladding. The wall stud is either zone 4 or 5. Zone 5 corresponds to the corner or end zone, the wall area that stretches from the building corner a distance 2 ***a***, where ***a*** is defined as the smaller value of 10% of the least horizontal building dimension and 40% of the mean roof height, but not less than either 4% of the least horizontal building dimension or 3 ft. Zone 4 is the interior wall zone, the area that is not zone 5.

The roofs and roof overhangs have similar zone boundary definitions for the edge, corner and interior zones. Refer to ASCE 7-05 figures 6-11A through 6-14B to see which zone the component item is located in.

Next select the diaphragm that the component is considered part of in order to achieve an accurate wind pressure analysis. Finally, enter the Effective Wind Area in square feet of the component. This is the area exposed to wind forces that is directly tributary to the component.

Click **Insert** to add the component to the database. The design positive and negative wind pressure will be calculated and displayed in the database window of the ‘Components & Cladding’ tab as shown below, and printed in the Report output.

UPPER Story Components

N-S Gridlines | E-W Gridlines | Diaphragms | N-S Tributary | E-W Tributary | N-S Shear Walls | E-W Shear Walls | N-S Connectors | E-W Connectors | Components &

UPPER Story Components and Cladding

Name	Type	Zone	Diaphragm	Effective Wind Area (sqft)	Positive Design Pressure (p+)	Negative Design Pressure (p-)
UF Wall Stud	Wall	4	U1	11	28.38	-20.50
UF Wall Stud Corner/Edge Zone	Wall	5	U1	11	28.38	-25.21
Roof Rafter2	Gable/Hip Roof (7° < Slope <= 27°)	2	U1	18	10.13	-28.22
Roof Rafter 3	Gable/Hip Roof (7° < Slope <= 27°)	3	U1	18	10.13	-42.31
Ridge Beam	Gable/Hip Roof (7° < Slope <= 27°)	1	U1	110	7.73	-15.78
Gable End Rake Stud	Wall	4	U1	20	27.64	-19.76
Bay Window Header	**Wall**	**4**	**U1**	**36**	**26.91**	**-19.03**

Figure 29. Components & Cladding Database Window

3.11 Error Check

LatPro IBC has the ability to check for mistakes made during the lateral analysis process. The most common errors are related to incomplete force allocation and insufficient shear walls specified for the given loading. To perform an error check, select error check from the design menu.

The program automatically performs an error check when the report output is selected. After an error check, a window will appear displaying all of the errors encountered. It is useful to use the error window as a reference while making changes to correct the errors. After changes have been made it is critical to close the error check window before performing another error check, otherwise the error list will not be updated. Below is a list of the errors that the program checks for, including a description of the cause and the appropriate steps to correct the error.

Design Error: Story not designed

This error occurs when a story has no diaphragms defined. Either remove the unused story in the Building Information tab or add diaphragms to correct.

Tributary Error: 60% of Diaphragm U1 is allocated in N-S direction

When a diaphragm has more or less than 100% of its tributary width assigned, the error check will display this error along with the diaphragm, percentage and loading direction. Fix this error by adding tributary width allocations for the appropriate diaphragm and direction or editing existing allocations until the entire diaphragm force has been assigned to gridlines.

Tributary Error: Forces on Main Story, N-S Direction, Gridline A are not resisted

If the diaphragm forces have been assigned but no shear walls have been added to resist the gridline forces, the error check will display this tributary error along with the loading direction and gridline label. Correct this error by adding shear walls where necessary.

Lateral Transfer Error: Forces from Upper story, Gridline A in N-S Direction are not transferred to the floor below

If the diaphragms forces have been assigned to a gridline but the forces on that gridline have not been transferred to a tributary allocation on the floor below this error will come up. To fix this error ensure that all tributary allocation on the uppermost floor are either transferred into a concrete foundation (check the 'Transfer directly into concrete foundation wall' box in the 'Add Tributary Length' window) or select all applicable tributary allocations above to gridlines in the lower story (do this by allocating each gridline from the uppermost story into an allocation on the story below, see section 3.5 for more information about transferring lateral forces to the floor below).

Shear wall Error: Lateral forces on Lower Story, Gridline 1, Wall 3 not resisted
When shear walls have design shear loads greater than their allowable shear capacity, this shear wall error will occur. Select the proper story, choose the appropriate shear wall tab in the component window and scroll down with the up and down arrow buttons until the over-loaded shear wall is highlighted blue. Press the edit button at the bottom of the component button column and re-specify the wall by clicking on the “Insert & Spec” button.

Shear wall Error: Deflection exceeds allowable limit
This error occurs when the calculated elastic deflection exceeds the allowable limit as determined from the story drift limitations established in ASCE 7 table 12.12-1. LatPro IBC uses the drift limit for “All other structures” in occupancy categories I and II. The user should increase the shear wall length or specify a higher rated shear wall. Other options include specifying a user-defined shear wall that uses Structural 1 grade sheathing or oversized wall end members to increase wall stiffness.

4 Printing a Report

Once all of the design steps have been completed, select output from the design menu. The output tab has check boxes for different print options, as well as boxes for building description and general notes. Click the print button after selecting the report sections and entering any text to be included.

Building Information report is the general information about the building such as number of stories, external dimensions, etc. Seismic Dead Loads report is the dead load weights, the areas, and the weight times the areas. The Building Exterior report is the longest dimensions, roof type and slope, roof area, wall areas facing each direction per story. The Diaphragms report is the description of all the diaphragms making up the building and the wind and seismic shear force in pounds per linear foot in each direction. The Tributary Allocations report clearly shows the tributary length and force along each grid line.

The Shear walls report lists the number of shear walls on each grid line, each story, the acting unit shear, the acting shear force along the wall line, the shear wall type, and the amount of shear force the shear wall and grid line resist (which will need to be greater than the acting unit shear and acting shear force for the grid line). Required Shear wall Types report lists each type of shear wall required for the structure just once in a list that can be used as a key to the drawings.

Building Description/Notes report information is entered by the user in the Output window. The Engineering Notes report is notes printed by LatPro to go with the final report. As LatPro IBC adds new features more notes will be added to correspond with the manufacturer’s specifications or IBC requirements relating to those features.

5 Design Examples

The following examples demonstrate Add Diaphragm window inputs for a variety of situations that a designer will encounter. These examples are provided to allow the user to become familiar how the inputs affect the distribution of tributary areas.

This section suggests possible methods to aid the design professional in using engineering judgment to produce an accurate analysis of the structure. Assuming that the line of separation between the area tributary to an upper diaphragm and a lower diaphragm is the midpoint of the wall framing, inputs for several building shapes are illustrated in the following drawings, accompanied with explanations.

5.1 Gable End

The gable end condition for a two story building is shown in Figure 30. For the roof diaphragm, the projected roof area is zero. The first step is to determine the average eave height, which is halfway down from the ridge to the side walls.

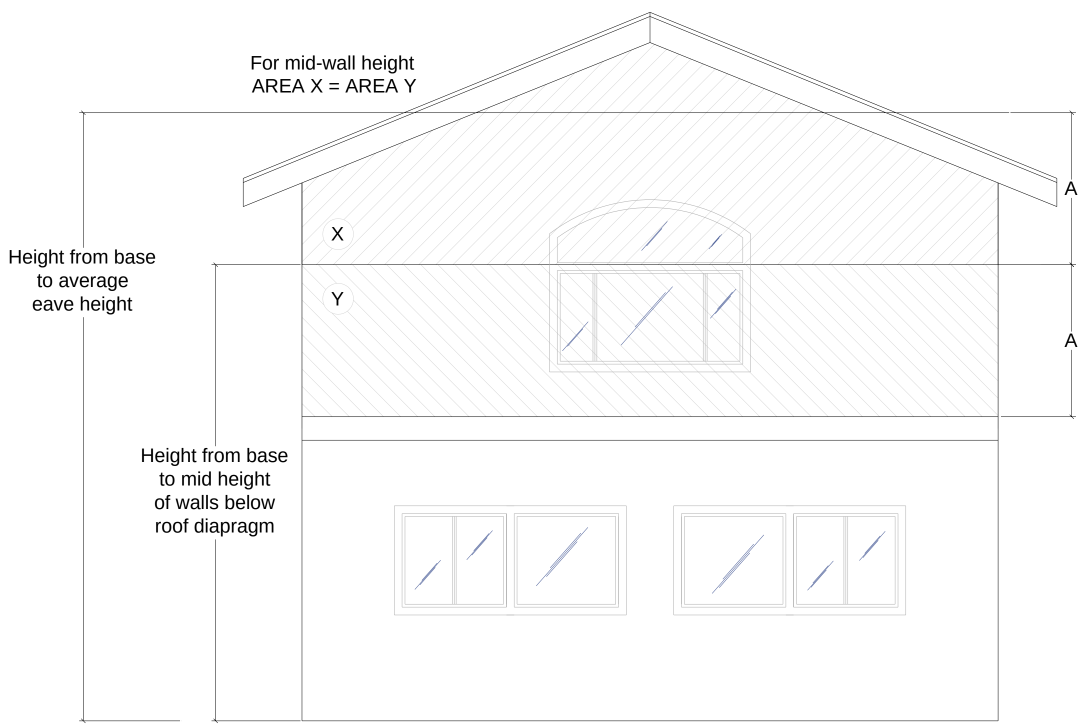


Figure 30. Gable End Dimensions

From that height, the mid-height of walls below diaphragm can be calculated as half the distance from the floor diaphragm below the roof to the average eave height (dimension A in Figure 30). A horizontal line drawn at the mid-height of the walls below the roof diaphragm separates the upper floor wall into two equal areas, as shown in Figure 30.

With these heights determined, the distances from the base to the average eave height and mid-height of walls below diaphragm can be entered. The same mid-height of the upper floor walls is used again in defining the tributary area of the floor diaphragm for the story below the roof (in the “Distance: base to mid-height of walls above diaphragm (ft) input box).

5.2 *Building on Sloped Ground*

For the condition of a house built on sloped terrain, it is important to use the average foundation level as the base elevation. If desired, a more conservative approach would be to take the lowest point as the base level. With the base set, the rest of the input heights can be easily calculated as shown in Figure 31, which depicts the dimensions used to define the upper story floor diaphragm (lower story diaphragm).

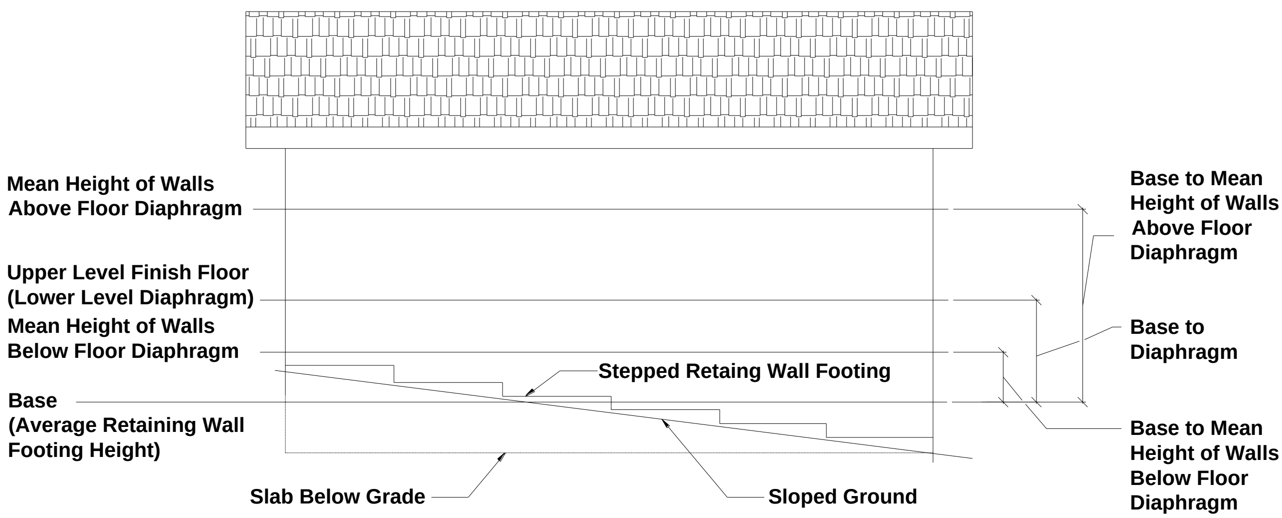


Figure 31. Building on Sloped Ground

5.3 Multi-Level Roofs

Where there are multiple roof heights on the same story, different roof sections should be modeled as separate diaphragms. In this condition the average roof height and mid-wall height below diaphragm input entries would have different values as shown in Figure 32.

When doing wind analysis LatPro will calculate the pressure for each diaphragm based on heights the entered. For seismic analysis LatPro will take the average of all the diaphragm heights to determine the story height used in the seismic force calculations.

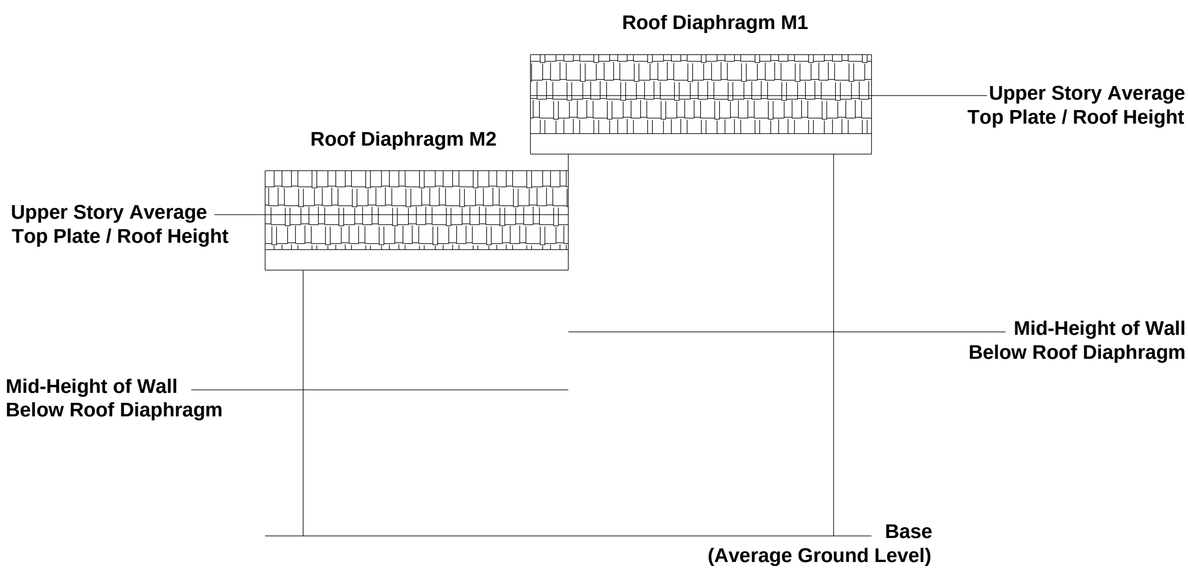


Figure 32. Multi-Level Roof Diaphragms on Same Story

6 Troubleshooting

LatPro will not open when:

NOTE: LatPro will not open if the Microsoft Excel program is already running.

One problem that may occur arises when the program has been opened and then closed. LatPro runs using the Microsoft Excel program in the background. At times when LatPro closes unexpectedly the excel program remains open after LatPro has closed, even though no Excel windows are open.

When the user tries to open LatPro, an error message appears, saying “A copy of LatPro IBC has been opened and then closed”. To check if this is the case, use the windows task manager processes tab to see if excel is running. If so, you will see Excel.exe under the “Image Name” column; highlight the Excel.exe and click on the End Process button to correct this issue. The LatPro program should now open without any problems.

There are not many connectors, chords or posts showing up on the drop-down selection lists to choose from, what do I do?

When entering connectors, it is also important to enter a number for End Distance of the connector to the edge or end of the concrete foundation. LatPro assumes this to be **ZERO** unless the user enters a number. So the connectors can get quite large or the program will not allow any if there is no number entered. The width of the concrete is also important, because some holdowns are not allowed to be used without certain minimum widths of concrete. If the user finds very few or no connectors coming up on the drop-down list, then the user should try changing some of these variables, including end distance, concrete width and chord size.

I get an error message popping up while using the program, what should I do?

The first thing to do is an Error Check is to go to the upper main horizontal menu and choose the Design drop-down menu. In that menu just choose the Error Check selection and LatPro will automatically do an error check on the existing project that is being worked on. These errors should be fixed completely before moving any further on the project.

Structural Calc, LLC recommends that the user use the Error Check function often, at least after every entering all the information of every major section as the user moves through each floor, especially while getting to know the program.

How do I uninstall the program?

LatPro has an "uninstall" file included with the program and is easily accessible from the Start button on your computer screen. In XP go to Start, then All Programs, then LatPro IBC 2009 v*. There will be the uninstall LatPro IBC 2009 choice located there, choose this and it will uninstall the program.

We suggest you save your working engineering files in a different directory so that if you ever delete of an old LatPro directory of an older version of the LatPro program you will not delete your working files.

We are always adding improvements to the program:

We expect that there may be some small bugs with this, especially since we cannot model every design of the thousands of types of structures. The easiest and quickest way to fix these bugs is to email a copy of the file you are working on so we can see the problem first hand with our technicians.

All files emailed to us are kept confidential and are used only for the purpose of getting you back to work as soon as possible. Our technical support e-mail address is support@lateralpro.com.

Thank you for your support of our products!

Structural-Calc, LLC