RISA-3D
Structural Analysis Software for Every Material

Masonry Wall Panel: Introduction & Tutorial
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Introduction

This hands-on guide will help introduce you to the RISA-3D Masonry Wall Panel functionality, while also walking you through a start to finish example, including helpful tips and tricks along the way. This tutorial is intended for both experienced and first-time RISA-3D users and can be completed in a single sitting.

All the “actionable steps” in this tutorial are indicated with bullets as shown below:

- Actionable Step

This guide is intended to show teach the basics of the masonry wall panel functionality. If you have further questions that fall outside of the scope of this guide, please refer to the RISA-3D General Reference Guide and the online Help file.

**Note:** If you are not familiar with RISA-3D, you should also complete the tutorials available on the RISA website at [https://risa.com/documentation](https://risa.com/documentation).

The RISA-3D Masonry Wall Panel: Introduction & Tutorial is compatible with RISA-3D v18 or higher.
Masonry Codes & Materials

Let's start by setting the design code:

- Click on the Model Settings icon.
- Choose the Codes tab.
- Select the Masonry code from the drop-down list: **TMS 402-16: ASD**.
- Click OK.

Next, let's create the material for the masonry wall:

- Click on the Materials button on the Data Entry panel:
- Click on the Masonry tab at the top of the dialog box
- Change the Concrete Matl properties by typing directly in the cell:
  
  - E = 1800 ksi
  - G = 720 ksi
  - f'm = 2 ksi

- Click on the in the upper right corner to close the spreadsheet.

Masonry Design Codes in RISA-3D:

- TMS 402-16 ASD & Strength
- ACI 530-13 ASD & Strength
- ACI 530-11 ASD & Strength
- ACI 530-08 ASD & Strength
- ACI 530-05 ASD & Strength
- ACI 530-99 ASD
- UBC 97 ASD & Strength

TIP: RISA-3D has a variety of default material properties available; you can save your own default materials available by pressing the default icon at the top of the screen when the Materials spreadsheet is open.
Creating Wall Geometry

Let’s start by drawing the wall:

• Click on the icon on the Draw Elements section on the Home tab.

• You should now see the Properties Panel update with design properties specific to Wall Panels:

You can draw a wall by clicking on existing nodes or drawing the wall using a grid. We will draw a wall using the drawing grid.

Choose which type of wall:

• Select Masonry from drop-down menu.

• Select Material Set: Concrete Matl.

• The mouse cursor will appear with crosshairs and you are ready to start drawing.
Using the drawing grid to create a 12’ high rectangular wall:

- Click on the bottom left corner (0,0,0),
- Move the cursor to the top right corner and left click on (12,12,0),
- Right-click the mouse or press Esc to stop drawing.

The wall panel will be created after the second click of the mouse and should look like the picture above.

Let’s open the Wall Panel Editor to add openings:

- Double click on the Wall Panel to view the Wall Panel Editor. A new Walls tab will appear in the Ribbon Toolbar.
Next, change the drawing grid in order to locate the openings:

- In the Drawing Tools section, click in the box next to Horizontal (ft), clear the current entry and type 2,2.5,3.5,3
- In the Drawing Tools section, click in the box next to the Vertical (ft), clear the current entry and type 2@3,1.75
- Press the Tab key to complete the input

The grid will automatically resize to adjust to the new scale. You can also toggle the grid display on and off by clicking the icon.

With the grid set, create a window and a door opening:

- Click on the Openings icon at the top left of the Wall Panel Editor to create an opening.

Let’s create the window opening:

- Using the Wall Grid coordinates, left click on the bottom left corner of the opening (2,3,0).
- Move the mouse to the top right corner (4.5,6,0) and left click on the grid intersection.

Now let's create a door opening:

- Left click on the bottom left corner (8,0,0)
- Move the mouse to the top right corner (11,7.75,0) and left click on the grid intersection.
- Right click to end the command.

Note: In the Drawing Grid and Wall Grid, you may use symbols such as:

- `@` (to specify multiple, equally spaced increments).
- `/` (to subdivide a larger increment into smaller increments).
- `,” (to enter multiple increments in the increment field).

The Wall Grid within the Wall Panel Editor is a tool that guides your placement of openings. The grid is independent of your model, so you may change the grid as you build the wall without changing anything in your model.
The wall should now look like the picture shown below.

Wall Panels can have rectangular openings. You can click on any location on the grid to create an opening.

Openings can be created anywhere on the wall panel except the upper and side edges.

**Note:** You can utilize the **Delete** tool to remove the openings if you make a mistake.

Now we can add boundary conditions (supports):

- Click the **Create New Boundary Conditions** icon in the top left of the **Wall Panel Editor**
- For this wall panel, we will choose the **Fixed** support option. Additionally, since the support is being assigned within the **Wall Panel Editor**, the boundary condition will be assigned as **Continuous** along the edge of the wall panel.
- Select a node along the bottom edge of the wall panel to apply the boundary condition.
- Right click to end the command.

Other **boundary** conditions can be used. It is possible to modify all six degrees of freedom in the model (translation in X, Y and Z and rotation in X, Y and Z). The preset options for boundary conditions include:

- Free
- Fixed
- Roller
Lintels

Let's review the lintel design parameters:

- Double left click directly inside the window opening to view the **Lintel** design parameters, in this example select **Edit/View Existing Wall Design Rule**

- If the lintels do not show, use the toggle icon to turn them on.

The lintel selection is based on the design rule assigned in the **Wall Panel Design Rules** or you can create a **Custom Opening** where each opening within the wall is defined separately.

- Click **Cancel**.

We will review the header Design Rule in the next section.
Assigning Design Parameter Regions

Let’s define regions inside the wall for design/analysis of the masonry shear wall:

- Select the Generate Wall Regions Automatically icon.

The wall drawing should now look like the picture above.

Let’s now review the Region Design Parameters:

The masonry design parameters and reinforcement are specified as part of the Wall Design Rules. The Wall Design Rule will automatically update the design parameters for the entire wall. In the next section, we will review the Wall Design Rules. You can review the design parameter named “Typical” that is being applied to this wall:

- Double left click directly inside the Region R6 and click Edit/View the Existing Wall Design Rule to view the Region Design Parameters.

The information can be edited directly in this dialogue or can be edited in the Wall Design Rules spreadsheet. Additionally, if you need a special reinforced region, you can click Convert to Custom to edit only this region.

- Click OK to close the region details.
- Click on the icon in the upper right corner to close the wall panel editor.

What is a Region?

In RISA, we define a wall strip for design as a Region. In reference codes this is referred to as a full height wall segment or pier.

Regions must be rectangular. To create them, use the cursor to select two nodes or grid intersections which define the lower left corner and upper right corner of the region.

Note: Regions cannot overlap openings.

RISA automatically creates regions for walls. However, it is also possible to manually create Regions by selecting Design Wall Regions Manually icon.
Wall Design Rules

Let's review the Design Rule from the Properties Panel of the masonry wall.

- Select the masonry wall and click on the ellipsis button next to Design Rule
- Click Edit/View the Existing Wall Design Rule and set the wall panel design parameters as shown in the dialogue below.

The dialogue allows for all of the wall design parameters to be assigned and modified in one location.

- Click OK when you have assigned the parameters correctly.

Wall Panel parameters can also be assigned directly in the Wall Design Rules spreadsheet.

- Select Wall Design Rules from the Data Entry panel

- Click on the Masonry Lintel tab and set the properties for lintel design as shown on the next page.

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**Block Nominal Width:** This is used to calculate thickness of masonry walls. This value is used along with the value of grout/bar spacing to determine the effective thickness of the wall. The effective thickness is based on tables B-3a and B-3b of the Reinforced Masonry Engineering Handbook, by Amrhein, Copyright 1998.

**Block Nominal Length:** This value is used to optimize the boundary zone length of the masonry walls. It is assumed that there are 2 cells per block (typical for concrete masonry) and based on the value of Bars Per Cell we can increment the value of the boundary zone while incrementing the number of bars in the boundary zone.
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- Depth: 16”
- Bearing Length: 8”
- Bar Size: #5
- Min # Bars Per Layer: 1
- Max # Bars Per Layer: 3
- Num of Layers: 1
- c/c Sp of Layers: N/A
- Dist to Bot: 4.5
- Stirrup Size: #4
- Analysis Method: Simply Support

Click to exit the Wall Design Rules.

To better view the wall, in the 3D view, click on the Rendered Icon found in the Quick View section of the Home tab twice and the Snap to Isometric view option ISO.

Optimizing the Wall Panels

RISA will design and optimize the wall panels based on the criteria in the Wall Panel Design Rules. Additionally, there is an option in the Model Settings Settings that will enable optimization of walls upon solution. If you want to check an existing wall, you can explicitly select the wall panel size and make sure to turn off the wall optimization.

Note: If you want to view the wall panel rendered at 100%, click on the Model View Settings button and click the Wall Panels tab and select 100% using the sliding scale.
Loading

We first need to create the Basic Load Cases:

- Open the Basic Load Case spreadsheet on the Data Entry toolbar or press the icon.
- Type Dead Load on the first line under the BLC Description column.
- Select DL (Dead Load) from the Category drop-down menu.
- Type -1 into the Y Gravity column.

Let's add wind load case:

- Type Wind Load on the second line under the BLC Description column.
- Select WLX (Wind Load X) from the Category drop-down menu.
- Type Wind Load Z on the third line under the BLC Description column.
- Select WLZ (Wind Load Z) from the Category drop-down menu.
- Exit BLC Spreadsheet by clicking the icon on the top right corner.

Add a distributed load to the wood wall:

- Click on Distributed Load icon.
- Select Y for Direction in the drop-down menu.
- Select Basic Load Case 1: Dead Load.
- Type -0.1 as the Start Magnitude and the End Magnitude will automatically populate.
- Select Click to Apply and then click on top of the wall.
The wall should now look like the image below with the distributed load applied.

Let's add a point load of wind load to this wall:

- Click on Nodal Load icon.
- Select LOAD (L).
- Select Basic Load Case 2: Wind Load X.
- Select Direction X from the dropdown list.
- Magnitude: 2 kips
- Select Click to Apply.

- Click on or draw a box around Node N2.

Nodal loads can only be applied in the global directions. We can tell that this is the global axis because the X is capitalized.

Wall Panels can have uniform or tapered surface loads. The direction of the load is applied to the Global Z direction. The global axis is always indicated with capital letters and the local axis is indicated by lower case letters.

When you have openings in your wall panel, the load that is attributed to the opening(s) in the wall panel is applied as a transient load distributed around the openings. You can view these by going to View > Model View Settings > Loads > Check Include Transient (Wall) after solution.
The wall should now look like the image below with the point load applied.

Let’s add a surface load of wind load to this wall:

- Click on Wall Surface Load icon.
- Select Direction Z from the dropdown list.
- Select Basic Load Case 3: Wind Load Z.
- Select Tapered Load Distribution.
- **Top Magnitude**: -0.02 ksf
- **Bottom Magnitude**: -0.015 ksf
- **Load Height**: Entire Wall
- Select Click to Apply and click on the wall.

Wall Panels can have uniform or tapered surface loads.

The direction of the load is applied to the Global Z direction.

The global axis is always indicated with capital letters and the local axis is indicated by lower case letters.

When you have openings in your wall panel, the load that is attributed to the opening(s) in the wall panel is applied as a transient load distributed around the openings. You can view these by going to View > Model View Settings > Loads > Check Include Transient (Wall) after solution.
The wall should now look like the image below with the surface load applied.

With the loads applied to the masonry wall, we can now create load combinations prior to analysis and design.
Load Combinations

Let’s create the load combinations using the LC Generator:

- Open the **Load Combination** spreadsheet by selecting the **Icon** at the top of the screen.
- Select **LC Generator**
- Select **United States** for the **LC Region**.
- Select **2018 IBC ASD** for the **LC Code**.
- Uncheck **RLL, SL and RL**
- Click **Generate** to create gravity load combinations.
- Select the **Wind** tab.
- Click the **X and Z** button under the **Wind Load Options**
- Select the **Reversible** checkbox.
- Click **Generate**.
- Click **Close**.

The LC Generator allows you to create load combinations quickly based on the code you select.
The Load Combination spreadsheet will automatically generate all the load combinations from the IBC 2018 and should look like the picture below:

- Close the LC Spreadsheet.

Let’s review the loads as they are applied to the wall:

- Toggle on the loads display by clicking the icon if they’re not already turned on.

- The load display control panel is on the top of the screen.

- Click on the drop-down menu to switch Type to Load Combination.

- Select the LC7 in the drop-down dialog.

You should now see the Load Combination 7: IBC 16-12 (a) (b) = DL + 0.6 WLZ displayed on your screen as below.
With all the loads applied, let’s run the analysis:

- Click the **Analysis and Design** icon.
- Select the **Envelope (Only) of Marked Combinations** radio button.
- Click **Solve**.

A **Single** solution will only solve the selected load combination. An **Envelope** solution will solve multiple load combinations and the results will show only the maximum and minimum. The **Batch** solution will solve multiple combinations and the results will be retained for every solution.
Designing the Wall

Reviewing results:

- Select the Wall Panel Design spreadsheet from the Results panel.

- To view the different results for wall panels, click on the tabs at the top: Masonry In, Masonry Out, Masonry Lintel.

Each spreadsheet consists of design results for the wall panel broken down into each individual design region and includes the following information:

- The Wall Panel Label and Region correspond to the wall panel labels and regions defined in the Wall Panel Editor.

- The Combined UC entry gives the code check due to axial force plus bending. The Shear UC shows the code check for shear effects. A value greater than 1.0 for either of these values indicates failure.

- The Fa or Pn*Phi reports the allowable axial stress or axial capacity.

- The Fb or Mn*Phi reports the calculated allowable bending stress or moment capacity for the region.

- The Fv or Vn*Phi reports the calculated allowable shear stress or shear capacity for the region.
The **Masonry Lintel** tab gives the results for the masonry lintels that span over user defined openings in the wall. They can also be viewed by looking at the detail report associated with each opening.

- The **Flexural UC** entry gives the code check due to pure flexure of the Lintel. Axial force is not considered in this code check. The **Shear UC** gives the code check for shear. A value greater than 1.0 for either of these values would indicate failure.

- The **Fa or Pn*Phi** reports the allowable axial stress or axial capacity.

- The **Fb or Mn*Phi** reports the calculated allowable bending stress or moment capacity for the region.

- The **Fv or Vn*Phi** reports the calculated allowable shear stress or shear capacity for the region.

Let’s take a closer look at the wall reinforcement:

- Select the **Concrete Reinforcing** spreadsheet from the **Results** panel.

- To view the different results for wall panels, click on the tabs at the top: Masonry Wall, Masonry Lintel.

- Close the **Concrete Reinforcing** spreadsheet.
Detailed Reports

Let’s take a closer look at the wall by viewing the Detail Report:

- Click the Analysis and Design Icon.
- Select the Single Combination radio button.
- Select LC7: IBC 16-12 (a) (b).
- Click Solve.
- Click the Detail button on the left-hand side of the screen.
- Click anywhere on the wall panel. The Detail Report Summary will open.

Wall Summary Detailed Report

The top section of the Detail Report echoes the entire user defined input.
**Effective Depth:** This gives you the distance from the compression face of the region to the centroid of tension reinforcement within that region.

The next section will display the envelope axial, shear and moment diagrams as well as a summary of the code checks.

The next section will provide the design details for axial, bending and shear.

**Note:** You may click on any of the **Limit States** to view an expanded detailed calculation.

The last section will provide a cross sectional drawing of the boundary zone width and reinforcement.
The **Equivalent Solid Thickness** is obtained by dividing the volume of the solid material in the wall by the face area of the wall. This is used in calculating the axial stress in the wall. A good reference for this value is the Reinforced Masonry Engineering Handbook, 5th ed. by James Amrhein, specifically, Tables B-3a and B-3b.

The next section will display the envelope axial, shear and moment diagrams as well as a summary of the code checks.

The next section will provide the design details for axial, bending and shear.

**Note:** You may click on any of the Limit States to view an expanded detailed calculation.

The last section will provide a cross sectional drawing of the Out-of-Plane reinforcement.
This section will provide the design details for bending and shear.

Note: You may click on any of the Limit States to view an expanded detailed calculation.

The last section will provide a cross sectional drawing of the lintel.

Note: In the Help file within RISA-3D and the RISA-3D General Reference both provide explicit descriptions of nearly all of the values in the report.
Conclusion

If you have completed the tutorial you should now be familiar with modeling, analyzing and designing masonry wall panels in RISA-3D. In addition to masonry wall panels, RISA-3D has wall panels in Wood and General materials. To learn more about the other materials or if you wish to know more about specific features, you can refer to the RISA-3D General Reference Guide or the Help from within RISA-3D.

If you have any questions, comments or suggestions feel free to email us at support@risa.com or call us at 949-951-5815.

Thank you for choosing RISA!