RISA-3D
Rapid Interactive Structural Analysis- 3 Dimensional

Masonry Wall Panel Feature: Introduction and Tutorial
Introduction

This hands-on guide will help introduce you to the RISA Masonry Wall Panel, and walk you through an example start-to-finish with helpful information along the way. This is intended for both experienced and first-time users of RISA-3D.

All the action items in this guide are indicated with bullets shown below:

- Action Item

This guide is intended to show you the basics of the wall panel feature with a brief description. If you have further questions beyond this guide, please refer to the RISA-3D General Reference and the online help file.

Note: If you are not familiar with RISA-3D, you should also complete the RISA-3D User’s Guide available on the RISA web site: www.risa.com.
Masonry Codes & Materials

Let’s start by setting the design code:

- Click on the Global Parameters icon.
- Choose the Codes tab.
- Select the Masonry code from the drop down list: ACI 530-08: ASD.

![Image of Global Parameters window]

- Click OK.

Let’s create the material for the masonry wall:

- Click on Materials tab on the Data Entry toolbar:
• Click on the **Masonry** tab at the top of the dialog box.

• Change the **Concrete Matl Properties** by typing directly in the cell:
  
  \[
  E = 1800 \\
  G = 720 \\
  f’m = 2
  \]

  ![Masonry Properties Table]

• Click on the **X** in the upper right corner to close the spreadsheet.

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

Let’s start by creating the wall:

- Start by clicking on the icon on top of the Graphic Editing toolbar.
  (If you don’t see this toolbar press the icon or Ctrl-G)

You should now see the dialog box Draw Wall Panels, which is shown here:

![Draw Wall Panels dialog box]

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

Choose which type of wall:

- Left click the Masonry radio button.

- Set Material Set to Concrete Matl.

- Left click on Apply. This mouse will appear and you are ready to start drawing.
Using the drawing grid to create a 12’ high rectangular wall:

- Left click on the bottom left corner (0,0,0),
- Move your cursor to 12’ height and left click on (0,12,0),
- Move the cursor to the top right corner and left click on (12,12,0),
- Left click on the last point (12,0,0).
- Right-click the mouse or press Esc to stop drawing.

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

Let’s open the Wall Panel Editor:

- Double click on the wall panel to view the Wall Panel Editor.

We’ll create a window and a door opening:

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

Clicking the Render button will allow you to see the grids better.

The lower left corner of the Wall Panel Editor defines the grids in the editor. You can modify these grids to match your openings.
Let’s create the window opening:

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

Let’s change the drawing grid to locate the openings:

- In the Draw Toolbox, click in the box next to the Grid Increments V (Vertical), and type 48@.25.
- Press Tab to activate the new grid.

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.

Now let’s create a door opening:

- Click on the icon if you don’t see the mouse showing this icon.
- Left click on the bottom left corner (8,0,0).
- Drag the mouse to the top right corner (11,7.75,0) and left click on the grid intersection.
- Right click to stop drawing openings.

Masonry walls 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: If you make a mistake, you can delete an opening by using the Delete tool.
In RISA, we define a wall strip for design of the masonry and this strip is called a region. Regions are rectangular. To create them you 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.

The program will automatically create Wall Regions. The user can delete regions or create custom regions by clicking the icon.

Let’s review the Region design parameters:

The masonry design and reinforcement is 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 to view the Region design parameters.

The quickest way to edit this information is in the Wall Design Rules spreadsheet. If you need a special reinforced region, you can click Custom to edit only this region.

- Click OK to close the region details.
Lintels

Let’s review the Lintel design parameters:

- Double left click **directly inside the window opening** to view the Lintel design parameters.

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

The lintel design parameters are also set in the **Wall Design Rules** spreadsheet. If you have several lintels in the same wall that are required to be different, you can click **Custom** to edit only a single lintel.

- Click **OK** to close the lintel details.
Boundary Conditions

Let’s assign a boundary condition to the bottom of the wall:

The wall panel boundary conditions need to be defined from within the wall panel editor:

- Left click on the **Boundary Condition** button at the top of the screen.
- Left click on the **Fixed** button.
- Press **Apply**.

Select any grid intersection on the bottom of the wall.

You will see graphically in orange the **Fixed Boundary** condition at the base.

Right click to escape.

We are now finished with all modifications to the wall geometry:

- Click **OK** in the **Wall Panel Editor** and you’re back into the **RISA-3D** interface.

You’ll see that the bottom of the wall has a Fixed graphic drawn for the entire length.

The **Use Check Box** determines which condition will be applied for the respective translation/rotation condition.

If you make a mistake in this dialog, just press **Clear Use** and select the fixity you want.

Wall panel boundary conditions are defined as continuous for the entire edge.

If you only have point supports for your wall panel you can define these as **Boundary Conditions** the same way as you would for Beams/Columns.

**Note:** **RISA-3D** automatically adds a boundary condition to wall panels at the lowest elevation in the structure. If you do not want this to occur you must use the **Wall Panel Editor** to set the base of the wall to a Free Boundary condition.
Assigning Design Parameters

Wall Design Rules

Wall Panel parameters are based off the Wall Design Rules spreadsheets. The block size and grouting are defined in the Masonry Wall tab.

- Open the Wall Design Rules from the Data Entry toolbar, and click on the Masonry Wall tab.
  (If you don’t see your Data Entry toolbar, click on the icon).

- **Block Nominal Width**: Select 10”
- **Block Grouting**: Select Partially Grouted
- Check Reinforced Box

Here we will walk through the different input options available for Masonry In-Plane design.

- Click on the Masonry In tab
- **Vertical Bar Size**: Select #5
- **Bars Per Cell**: Select 1
- **Min Bound Zone Width**: Select 8
- **Max Bound Zone Width**: Select 16
- **Horizontal Bar Size**: Select #6
- Check 1.5x Shear Inc
- Uncheck Transfer Load

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.
Here we will walk through the different input options available for Masonry Out-of-Plane design.

- Click on the **Masonry Out** tab
- **Bar Size:** Select #8
- **Bar Space Min:** 8”
- **Bar Space Max:** 24”
- **Bar Placement:** Select Center
- **Mortar Type:** Select **Type M or S**
- **Cement Type:** Select Portland, Lime/Mortar

Here we will assign the window Lintel Design Parameters:

- Click on the **Masonry Lintel** tab
- **Depth:** Type 16
- **Bearing Length:** Type 8
- **Bar Size:** Select #5
- **Min # Bars per Layer:** Type 1
- **Max # Bars per Layer:** Type 3
- **Number of Layers:** Select 1
- **c/c Spacing of Layers:** Leave blank
- **Distance to Bot:** Type 4.5

We are now finished with the Design Rules for all Regions & Lintels:

Click [X] to exit **Wall Design Rules** spreadsheet.
Loading

To view the steel member better, click on the **Rendered** icon twice, and the **Snap to Isometric** view tool.

Now let’s create the Basic Load Cases:

- Open the **Basic Load Cases** spreadsheet on the **Data Entry** toolbar or press the **BLC** 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 X** 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 **BLC Description** column.

- Select **WLZ (Wind Load Z)** from the **Category** drop-down menu.

- Exit **BLC** spreadsheet by clicking the **X** on the top right corner.

**Note:** You must define the **Category** in order to use the **Load Combination Generator**.

**Typing a -1 in the Y Gravity column creates a Basic Load Case which includes self-weight.**
Add a distributed load to the wall:

- Click **Distributed Load** icon.
- Select **Y** for **Direction** in the drop-down menu.
- Type **-0.1** as the **Start Magnitude**, **End Magnitude** will automatically fill in.
- Select **Basic Load Case 1: Dead Load**.
- Click **Apply Load by Clicking Members/Wall Panel Edges Individually**.
- Press **Apply**.

- Click on the top of the wall.
- Right click or press Esc to finish applying distributed loads.
Let’s add the wind load as a surface load:

- Click **Surface Loads for Walls** icon.
- Set **Direction** to **Z**.
- Type **0** for the **Start Location**.
- Type **12** for the **Height**.
- Type **-0.02** for the **Top Magnitude**.
- Type **-0.015** for the **Bottom Magnitude**.
- Select **Basic Load Case 3: Wind Load Z**.
- Select **Apply Load by Clicking the Wall Panels Individually**.
- Click **Apply**.
- Click on the Wall.
- Right click or click **Esc**.
Let’s add a point load of wind load, representing how an adjacent wall is loading this wall:

- Click on Joint Load icon.
- Select This is a Load.
- Select Direction X from the dropdown list.
- Type Magnitude 10.
- Select Basic Load Case 2: Wind Load X.
- Select Apply Load by Clicking/Boxing Joints.
- Click Apply.
- Click or box Node N2.
Designing the Wall

Let’s create the Load Combinations using the LC Generator:

- Open the Load Combinations spreadsheet by selecting the LC icon at the top of the screen.
- Select LCGenerator icon.
- Select United States for the Load Combination Region.
- Select 2012 IBC ASD for the Load Combination Code.
- Click Generate.
- Click Wind tab.
- Click the X and Z button under 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 Combinations spreadsheet will automatically generate all the load combinations from the IBC 2012 and should look like the picture to the left.
To display loads, we will work with the loading display toolbar at the top of the screen.

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

- Toggle the loads display to On by clicking the icon. The load display control panel is on the top of the screen.

- Click on the toggle icon to switch to the Load Combinations LC.

- Select the LC5 in the drop-down dialog.

You should now see the Load Combination 5: IBC 16-10(b) = DL + 0.6 WL 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 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.
Results

Reviewing Results:

- Select the **Wall Panel Design** spreadsheet from the **Results** toolbar (If you don’t see your **Results** toolbar, click the icon).

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

The **Region** entry corresponds to the 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 1.0 for either of these values indicates failure.

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

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

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

The **Lintel** results give 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 pure flexure of the **Lintel**. **Axial** force is not considered in this code check at all. The **Shear UC** gives the code check for shear. A value greater 1.0 for either of these values would indicate failure.

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

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

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

For slender wall design additional checks and analyses are required. These are reported in the region’s detail report.

- Close the **Wall Panel Design** spreadsheet
All the reinforcing can be reviewed in a spreadsheet format:

- Select the Concrete Reinforcing spreadsheet from the Results toolbar.

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

- Close Concrete Reinforcing spreadsheet.

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 LC5: IBC 16-12(a)(b).
- Click Solve.
- Left click the Detail button on the left hand side of the screen.
- Click anywhere on the Wall Panel.
- Take a look at the output:

The Detail Report is only available for single combination solutions or Batch solutions.

The top of the detail report will control the view.

You can toggle the Lintel display or the Region display by clicking in the drop down box at the top of the screen.

You can also choose which Region or Lintel you would like to review by clicking in the left side drop-down box shown below. The Region will also allow you to view results for In-Plane and Out of Plane by clicking in the right side drop down box.
The top section of the detail report echoes all of the 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.

The last section will provide a cross sectional drawing of the boundary zone width and reinforcement.
The top section of the detail report echoes the entire user defined input.

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.

The last section will provide a cross sectional drawing of the Out-of-Plane Reinforcement.
The top section of the detail echoes the entire user defined input.

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

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

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 the Masonry Wall Panel in RISA-3D. RISA-3D has Wall Panels in Masonry, 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 or the Help from within RISA-3D.

If you have any questions, comments or suggestions feel free to email us at support@risa.com, call us at 949-951-5815 or FAX 949-951-5848.

Thank you for choosing RISA!