

FB MultiPier v.4

Pile Group Example

Professor's Driven Pile Institute

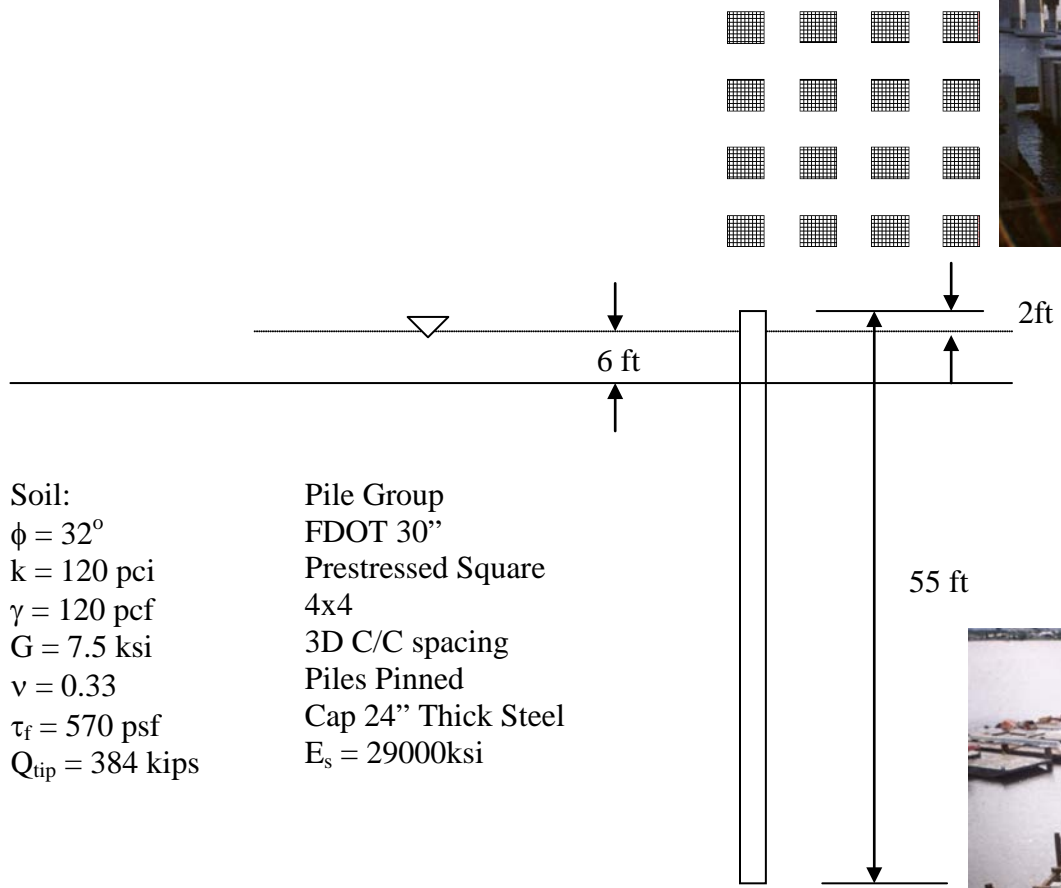
Utah State University – June 24, 2015

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Deep Foundations – FB-MultiPier

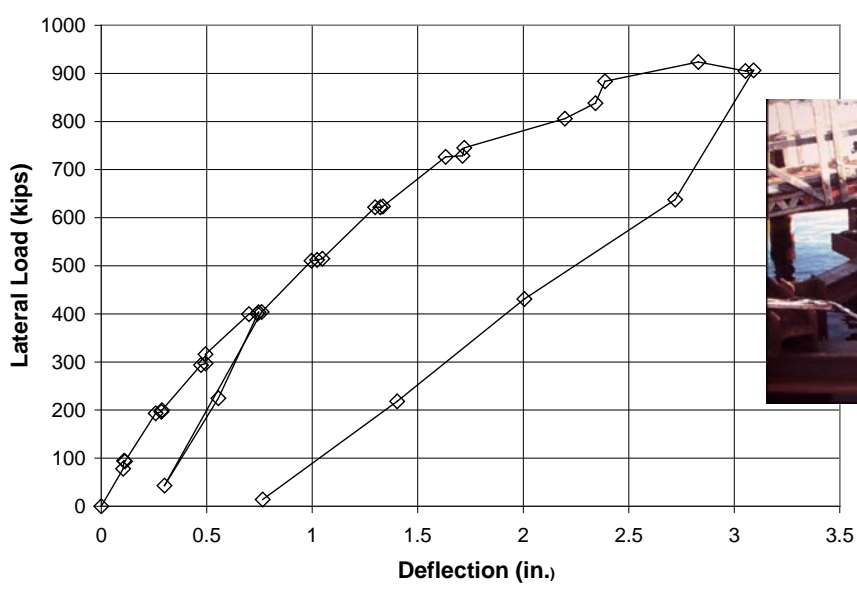
Example 2: 4x4 Pile Group - Roosevelt Bridge Example



Predict Deflections for Lateral Loads:

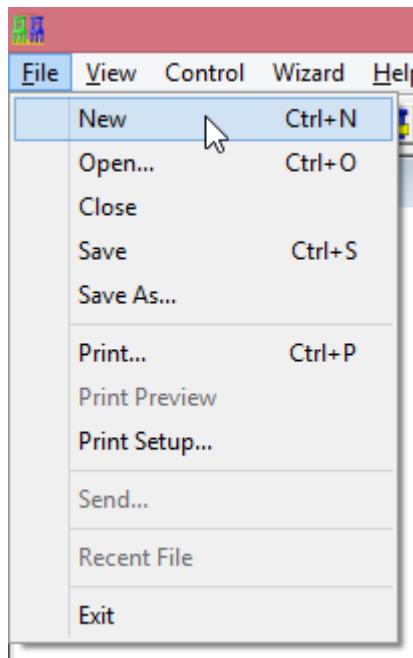
Lateral Load (kips)
0
125
250
375
500
625
750
875
1000

Rosevelt Bridge Lateral Load Test

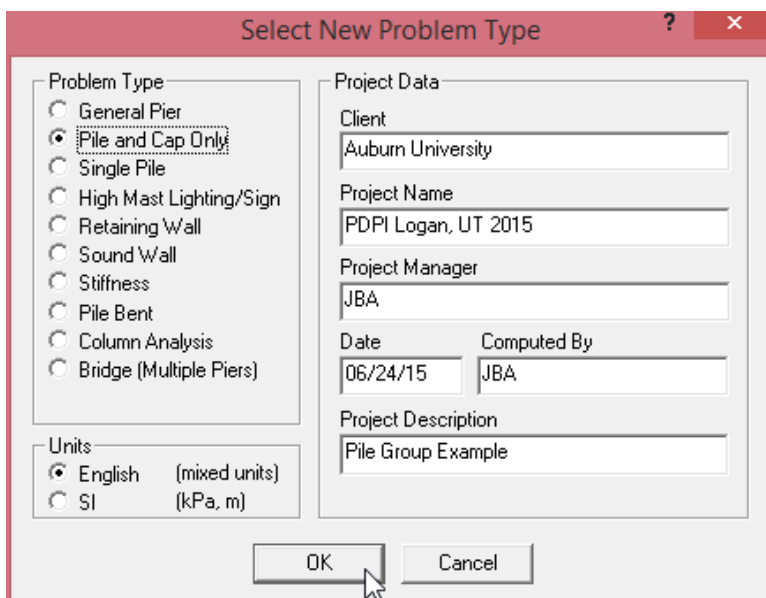




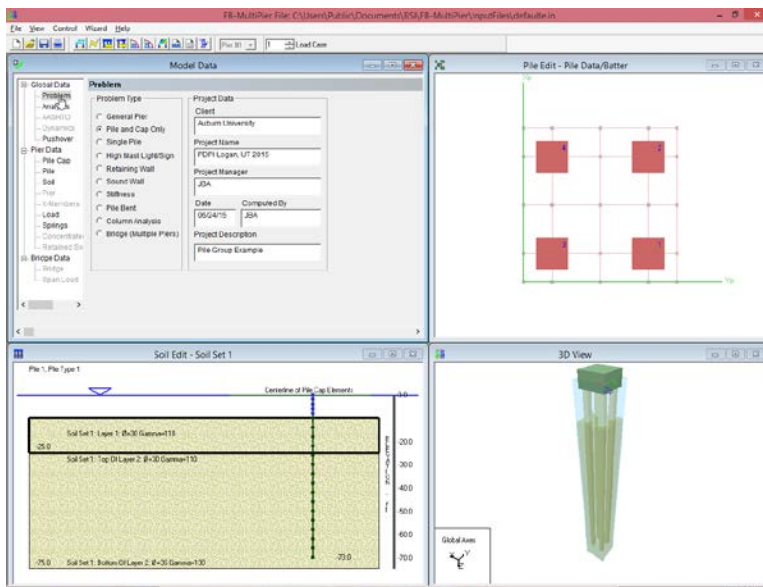
Start “FB-MultiPier” by selecting the shortcut on your desktop, or find “BSI > FB –MultiPier> FB – MultiPier” under the Start Menu.



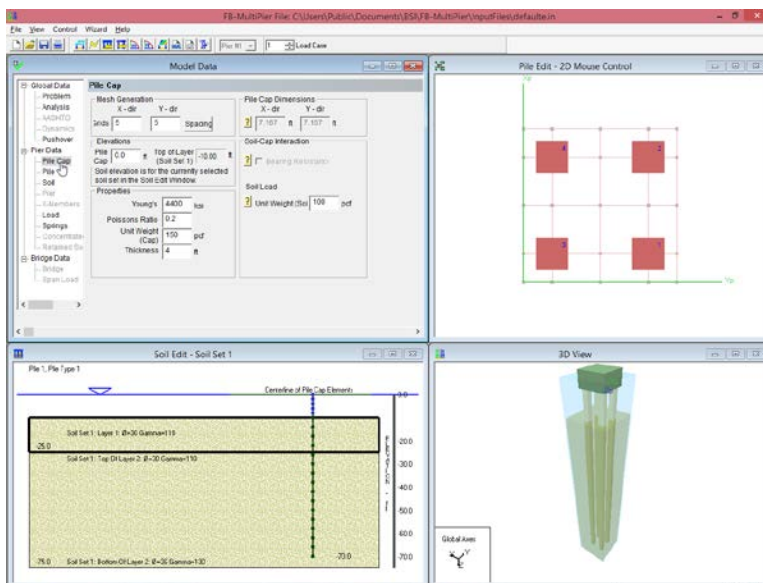
Select File>New from the menu at the top to create a new file.



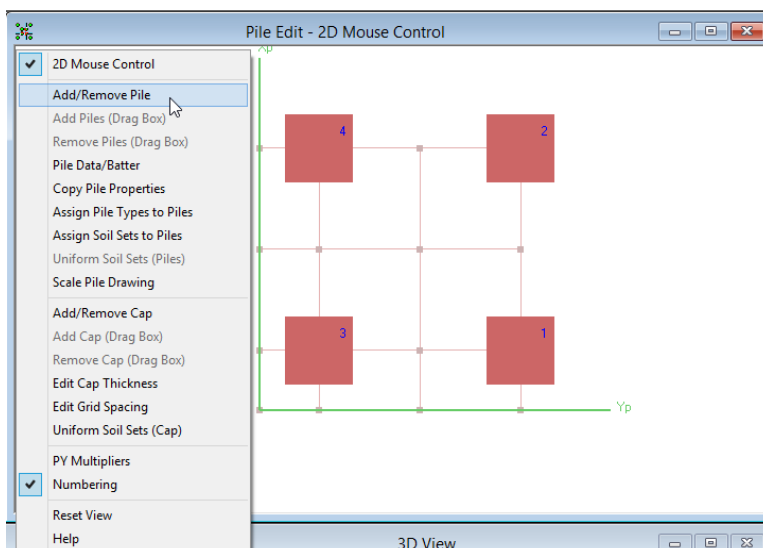
Fill in the appropriate project information. Select, for this case, choose Problem Type “Pile and Cap Only” Finally set Units to “English (mixed units)”. Click OK to continue.



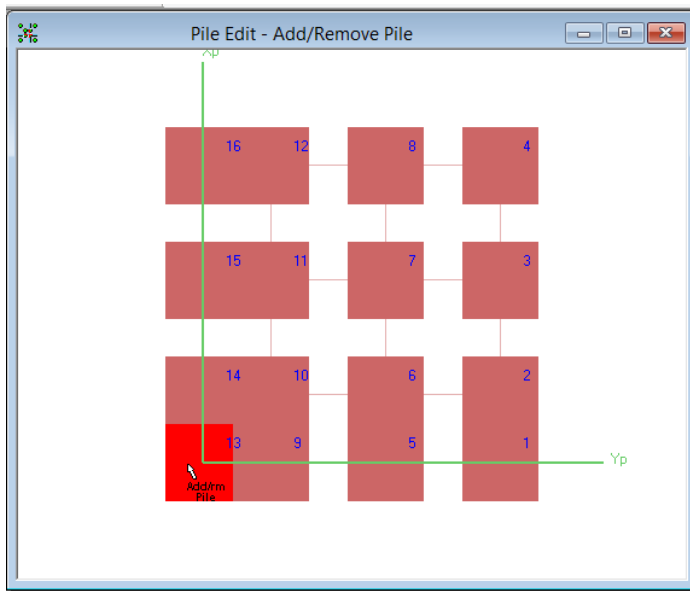
he editor windows will now appear. The top left window is the Model Data window where most info is entered. The top right window is the Pile Edit window shows the pile group in plan. The bottom left window is the Soil Edit window where the soil stratigraphy is shown. A 3-D view of the pile group is shown in the bottom right pane. A default problem is automatically loaded which you will need to change



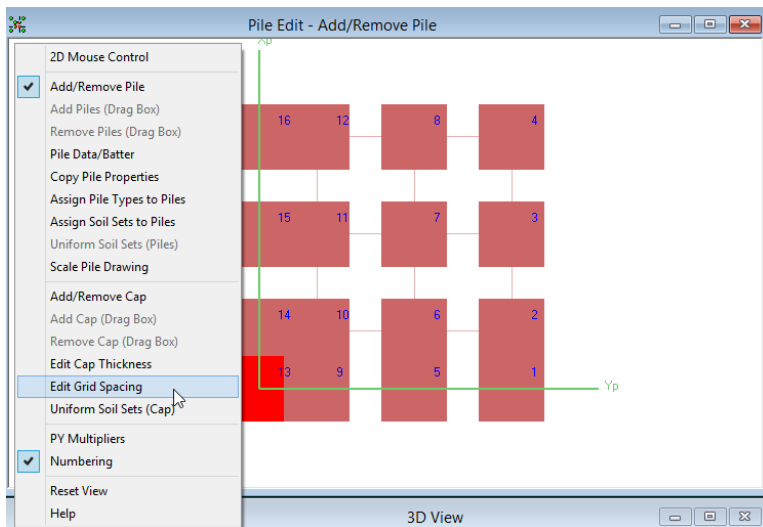
Select "Pile Cap" from the Menu. Change the number of grid points to 4 x 4.



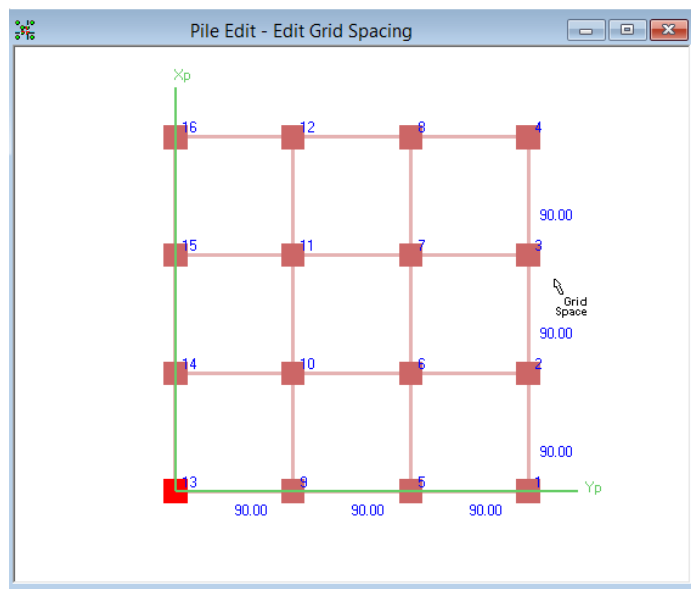
The resulting pile cap will need adjustment for spacing and placement of piles. Right click in the "Pile Edit" window and select "Add/Remove Pile," click on the cap node points to add piles to all the nodes.



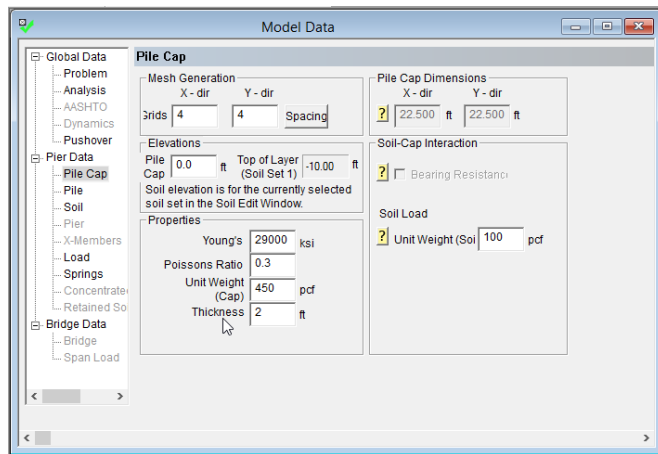
The spacing will now need to be adjusted to 3d or 3 X 30" center-to-center between the piles in both directions.



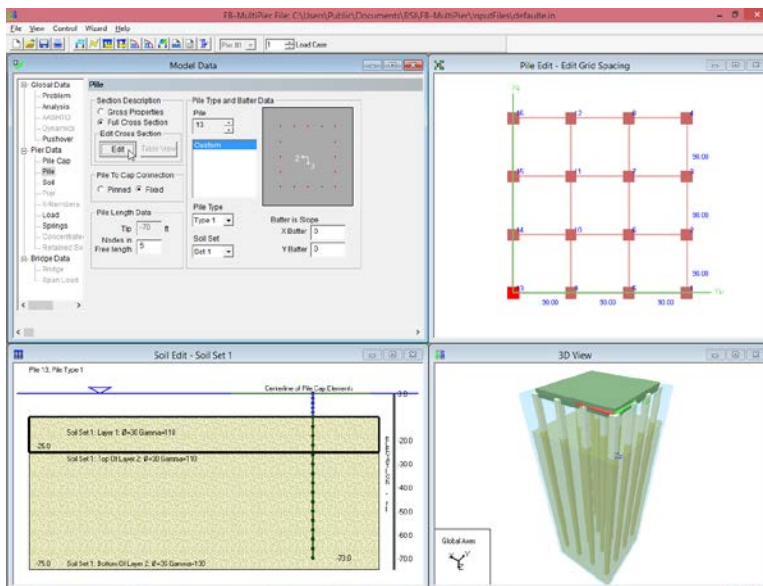
Right click in the "Pile Edit" window and select "Edit Grid Spacing." Click on the grid spacing numbers to change them. There is also a table entry option.



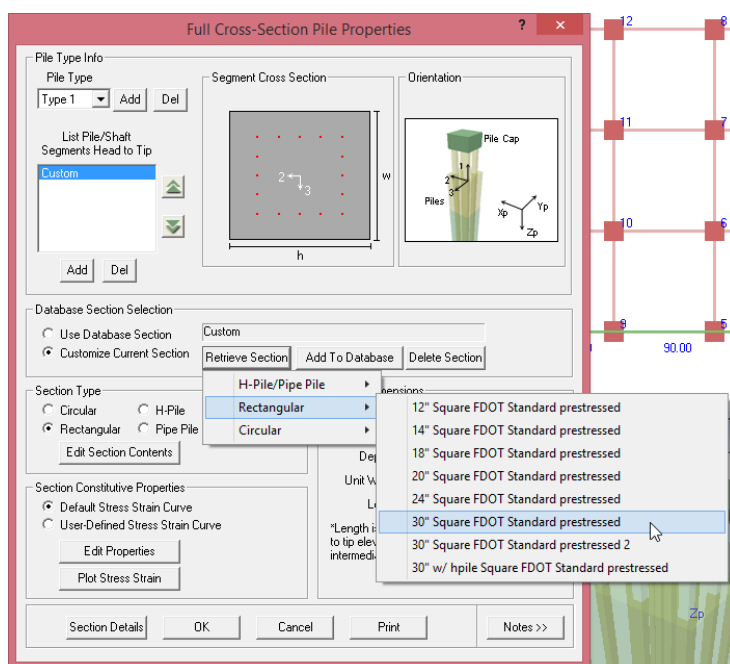
The resulting pile group should look symmetrical and the correct spacing (90 inches center-to-center) can be seen in the blue numbering.



The cap is steel. Enter 29000ksi for the Young's Modulus, 0.3 for Poisson's Ratio, 2 ft for thickness and unit weight of 450pcf.



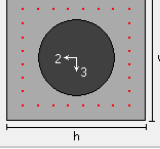
Select "Pile" from the Menu. Click "Edit" under "Edit Cross Section."

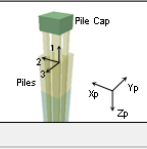


The pile section used in this analysis is the FDOT 30" Standard. Under "Database Section Selection," click on "Retrieve Section" and select "30" square FDOT Standard Prestressed."

Full Cross-Section Pile Properties

Pile Type Info
 Pile Type: Type 1 [Add] [Del]
 List Pile/Shaft Segments Head to Tip:
 30" Square FDOT Star [Add] [Del]

Segment Cross Section


Orientation


Database Section Selection
☒ Use Database Section: 30" Square FDOT Standard prestressed
☐ Customize Current Section [Retrieve Section] [Add To Database] [Delete Section]

Section Type
☐ Circular ☐ H-Pile
☒ Rectangular ☐ Pipe Pile
 [Edit Section Contents]

Section Dimensions
 Width (w): 30 in
 Depth (h): 30 in
 Unit Weight: 150 pcf
 Length: 55 ft
 *Length is the distance from center of pile cap to tip elevation, or between the nodes of intermediate segments

Section Constitutive Properties
☒ Default Stress Strain Curve
☐ User-Defined Stress Strain Curve
 [Edit Properties] [Plot Stress Strain]

[Section Details] [OK] [Cancel] [Print] [Notes >>]

Change the pile length to 55ft.
 Click OK to continue.

Model Data

Pile

Section Description
☐ Gross Properties
☒ Full Cross Section
 [Edit] [Table View]

Pile To Cap Connection
☒ Pinned ☐ Fixed

Pile Length Data
 Tip: -55 ft
 Nodes in Free length: 5

Pile Type and Batter Data
 Pile: 13
 30" Square FDOT Star
 Pile Type: Type 1
 Soil Set: Set 1
 Batter is Slope
 X Batter: 0
 Y Batter: 0

Under "Pile to Cap Connection," select Pinned (not typical but is the case for modeling the load test). This concludes the structural input.

Model Data

Soil

Soil Layer Data
 Soil Set: Set 1 [Del]
 Soil Layer: Layer 1 [Del]
 Soil Type: Cohesionless
 Unit Weight: 110 pcf

Soil Layer Models
 Lateral: Sand (Reese) [Edit]
 Axial: Driven Pile [Plot]
 Torsional: Hyperbolic [Group]
 Tip: Driven Pile [Table]
☐ Specify Top and Bottom Layer Properties

Soil Importing
 Retrieve soil data from: Import

Soil Strength Criteria
 Internal Friction Angle: 30 Deg
☐ Cyclic Loading
 [Edit SPT]

Elevations
 Water Table: 0 ft
 Top of Layer: -10 ft
 Bottom of: -25 ft

Select "Soil" from the menu in the Model Data pane. Note that the "Soil Layer" drop down box contains the layers shown in the "Soil Edit" pane below.

Model Data

Soil

Soil Layer Data

Soil Set: Set 1 [Del]

Soil Layer: Layer 2 [Del]

Soil Type: Cohesionless

Unit Weight: 110 pcf

Soil Layer Models

Lateral: Sand (Reese) [Edit]

Axial: Driven Pile [Plot]

Torsional: Hyperbolic [Group]

Tip: Driven Pile [Table]

☒ Specify Top and Bottom Layer Pr

Soil Importing

Retrieve soil data from: Import

Soil Strength Criteria

Internal Friction Angle: 30 Deg

☐ Cyclic Loading [Edit SPT]

Elevations

Water Table: 0 ft

Top of Layer: -25 ft

Bottom of: -75 ft

Since we will be using a single soil layer for this example, select layer 2 then hit the delete key to remove the layer.

Model Data

Soil

Soil Layer Data

Soil Set: Set 1 [Del]

Soil Layer: Layer 1 [Del]

Soil Type: Cohesionless

Unit Weight: 120 pcf

Soil Layer Models

Lateral: Sand (Reese) [Edit]

Axial: Driven Pile [Plot]

Torsional: Hyperbolic [Group]

Tip: Driven Pile [Table]

☐ Specify Top and Bottom Layer Pr

Soil Importing

Retrieve soil data from: Import

Soil Strength Criteria

Internal Friction Angle: 32 Deg

☐ Cyclic Loading [Edit SPT]

Elevations

Water Table: 0 ft

Top of Layer: -6 ft

Bottom of: -100 ft

Set the Soil Type, for Layer 1, to “cohesionless.” Enter Total Unit Weight equal to 120 pcf. Enter a friction angle of 32°. Set the top of the layer at -6ft and the bottom at -100ft (for proper embedment). The water surface is at 0ft.

Model Data

Soil

Soil Layer Data

Soil Set: Set 1 [Del]

Soil Layer: Layer 1 [Del]

Soil Type: Cohesionless

Unit Weight: 120 pcf

Soil Layer Models

Lateral: Sand (O'Neill) [Edit]

Axial: Sand (O'Neill) [Plot]

Torsional: Sand (API) [Group]

Tip: Driven Pile [Table]

☐ Specify Top and Bottom Layer Pr

Soil Importing

Retrieve soil data from: Import

Soil Strength Criteria

Internal Friction Angle: 32 Deg

☐ Cyclic Loading [Edit SPT]

Elevations

Water Table: 0 ft

Top of Layer: -6 ft

Bottom of: -100 ft

Under Soil Layer Models, use the drop down box by “Lateral” to choose the lateral soil type, in this case, Sand (O’Neill).

Additional Soil Properties

Lateral Model
Sand (O'Neill)

32 Internal Friction Angle deg

120 Total Unit Weight pcf

120 Subgrade Modulus lb/in³

OK Cancel Print

Click “Edit.” The unit weight and friction angle will be copied from before. Enter the value for subgrade modulus, 120 pci. Click “OK” to continue.

Model Data

Global Data
Problem
Analysis
AASHTO
Dynamics
Pushover
Pier Data
Pier Cap
Pier
Soil
X-Members
Load
Springs
Concentrated
Retained Soil
Bridge Data
Bridge
Span Load

Soil

Soil Layer Data
Soil Set Set 1 Del
Soil Layer Layer 1 Del
Soil Type Cohesionless
Unit Weight 120 pcf

Soil Importing
Retrieve soil data from Import

Soil Strength Criteria
Internal Friction Angle 32 Deg
☐ Cyclic Loading
Edit SPT

Soil Layer Models
Lateral Sand (O'Neill) Edit
Axial Driven Pile Plot
Driven Pile Group
Drilled Shaft Sand Table
Driven Pile Sand (API)
Custom T-Z
☐ Specify top and bottom layer properties

Elevations
Water Table 0 ft
Top of Layer -6 ft
Bottom of -100 ft

Under Soil Layer Models, use the drop down box by “Axial” to choose the axial soil type, in this case, Driven Pile.

Additional Soil Properties

Axial Model
Driven Pile

120 Total Unit Weight pcf

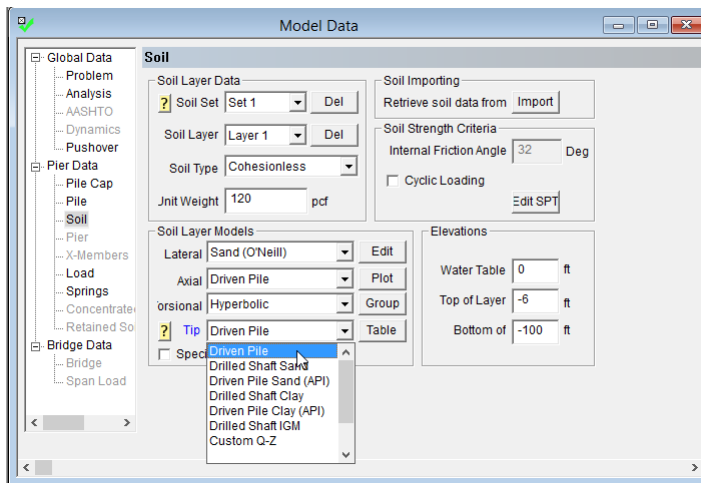
7.5 Shear Modulus ksi

0.3 Poisson's Ratio

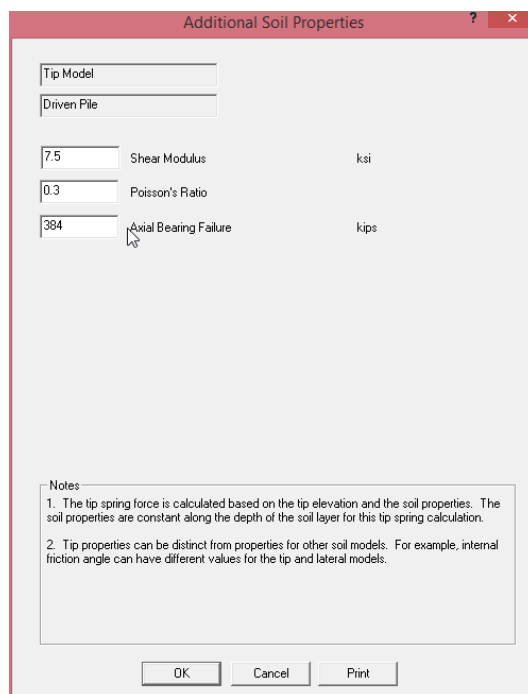
570 Ultimate Unit Skin Friction psf

OK Cancel Print

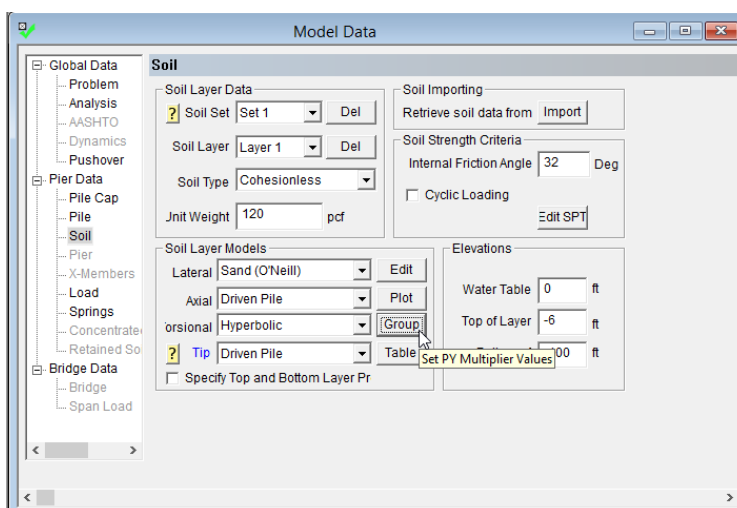
Click “Edit.” The unit weight and friction angle will be copied from before. Enter the value for shear modulus, 7.5ksi, Poisson’s Ratio, 0.3, Vertical Failure Shear, 570psf. Click “OK” to continue.



Under Soil Layer Models, use the drop down box by “Tip” to choose the lateral soil type, in this case, Driven Pile.



Click “Edit.” Enter the value for shear modulus, 7.5ksi, Poisson’s Ratio, 0.3, Axial Bearing Failure, 384kips. Click “OK” to continue.



The far field or pile group interaction is modeled using p-y multipliers. Click on the Group button to edit the multipliers.

Advanced Soil Data ? x

Pile System is: 4 in X 4 in Y

Multiplier Values

	X	Y	
Use PY Multipliers Specified	0.800000	0.800000	Lead
Use PY Multipliers all = 1	0.400000	0.400000	
Tip Spring Only	0.300000	0.300000	
No Soil	0.300000	0.300000	Trail

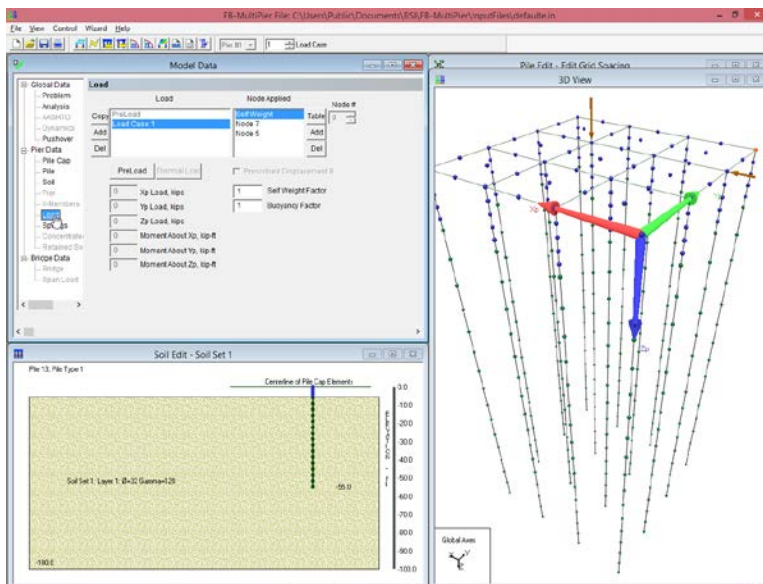
Defaults

Note: For multiple pier models, the option "Use PY Multipliers all = 1" sets all PY Multipliers for all piers equal to 1. If the intention is to only set some piers' multipliers to 1, then select "Use PY Multipliers Specified" and manually set the desired piers' multipliers to 1.

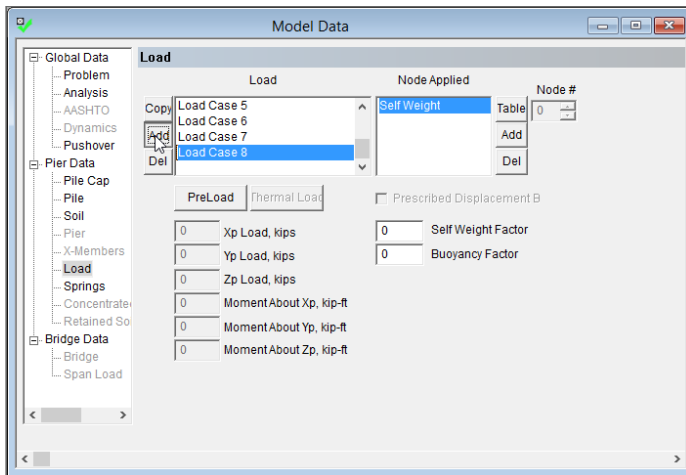
Axial Pile Group Efficiency

OK Cancel Print

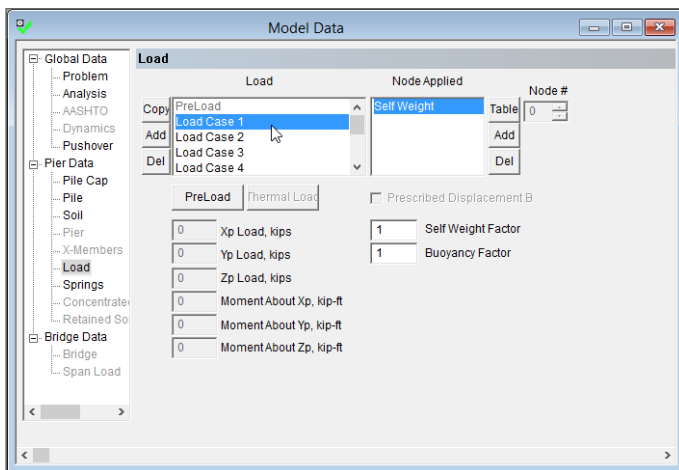
We would like to set the multipliers to the default value of 0.8, 0.4, 0.3, 0.2....0.2., 0.3. Click the Defaults button to set the multipliers



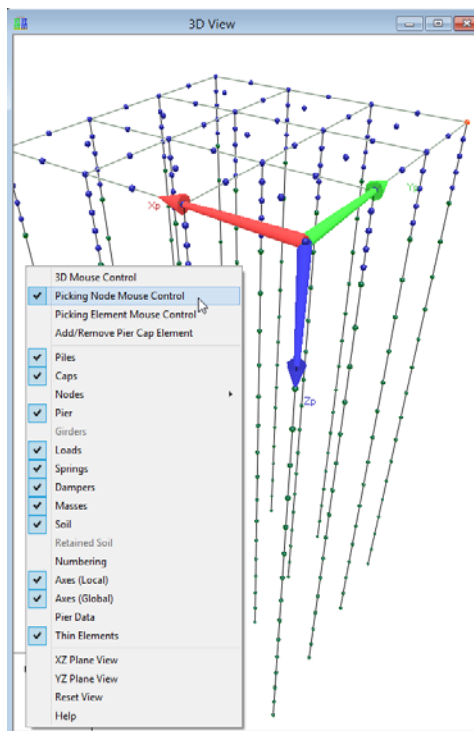
Next, we need to specify the loads on the pile. Now, choose "Load" tab in the model data window.



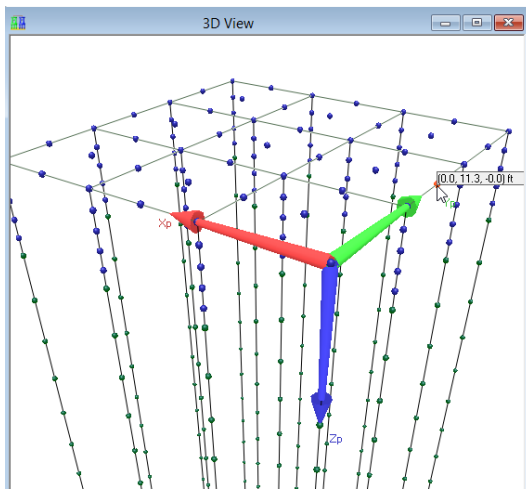
One load case is specified by default. In this problem there are 8 load cases. Click the Add button to add additional load cases.



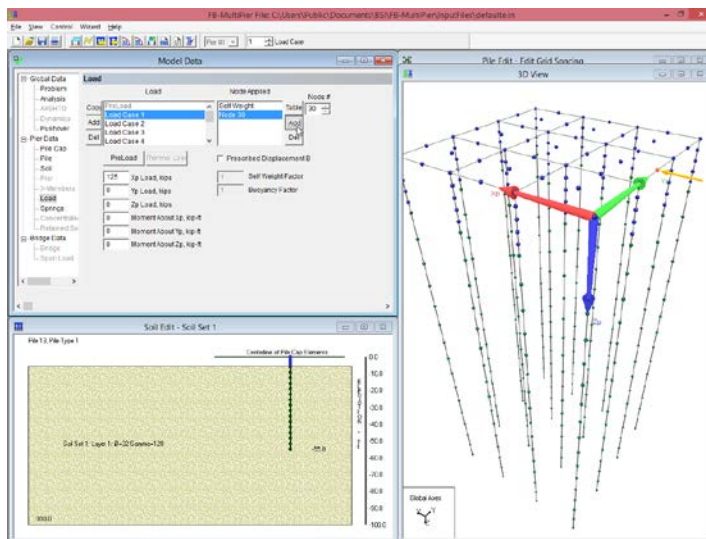
Select Load Case 1. In this problem, the lateral load was applied on the edge of the pile cap. Remove all default loads. Load cases 2 through 8 should have no loads by default.



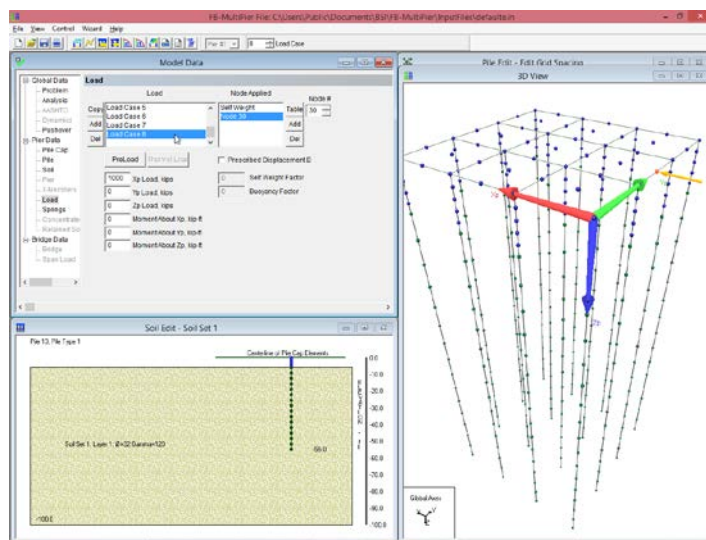
Right click near the pile group in the 3d View window. Select “Picking Node Mouse Control”



Select Load Case 1. Click on the center node on the side of the pile cap.

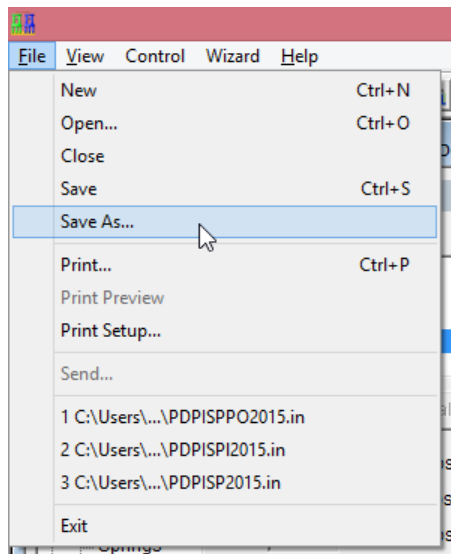
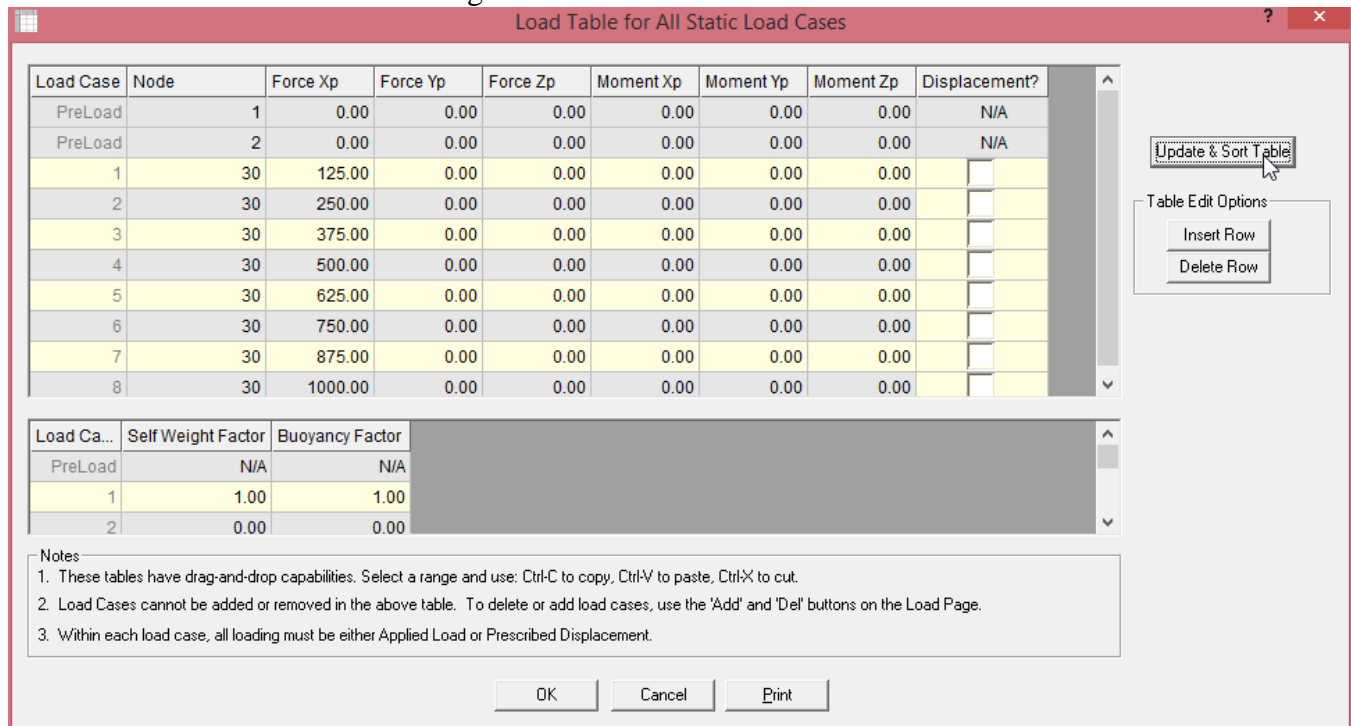


Now under Node Applied, a new node number should appear. Click “Add” to add a load there.



Enter 125 in the x direction. You should see a horizontal vector pointing in the – x direction. Repeat these steps for each of the remaining 7 loads 250, 375, 500, 625, 750, 875, 1000.

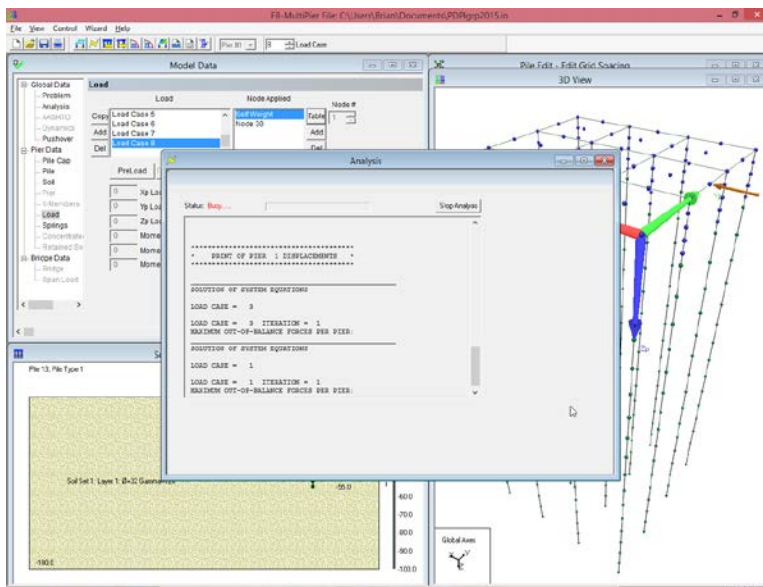
You can edit some information using the load table



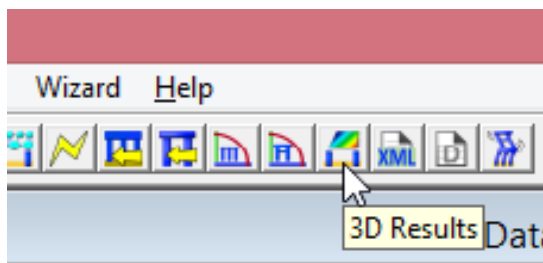
Use the “Save As...” command to save your problem before the analysis.



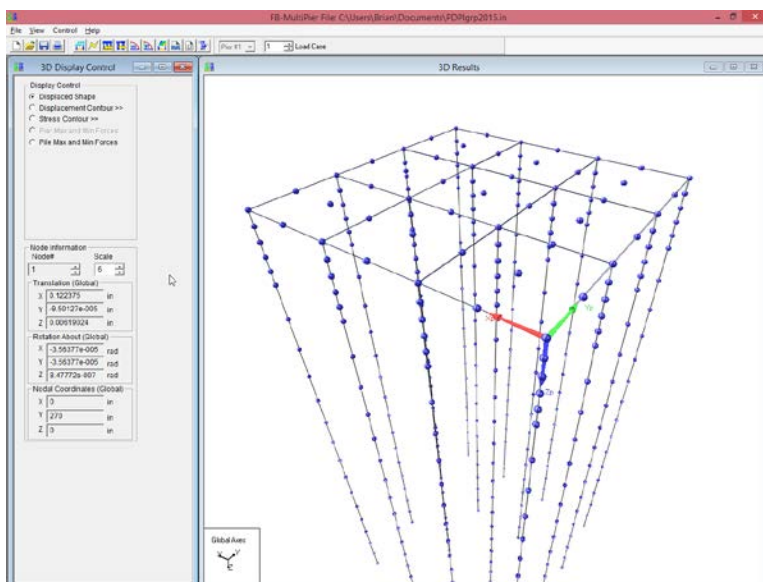
The next step will be to perform the analysis. Click on the lightning bolt icon to run the analysis. You will get a warning that you will force a file save, accept and continue



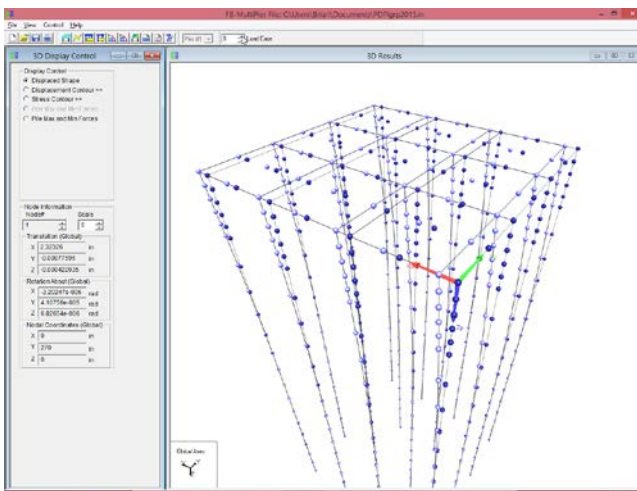
The iterative process of FB-MultiPier will be shown while the analysis progresses.



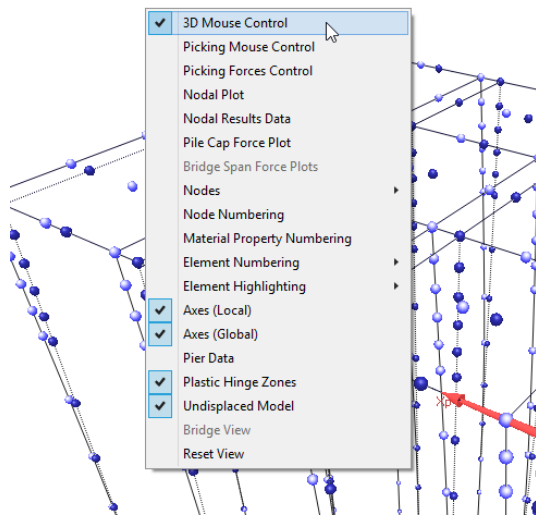
Once the analysis is complete, click on the 3D Results icon to see a graphical depiction of the analysis.



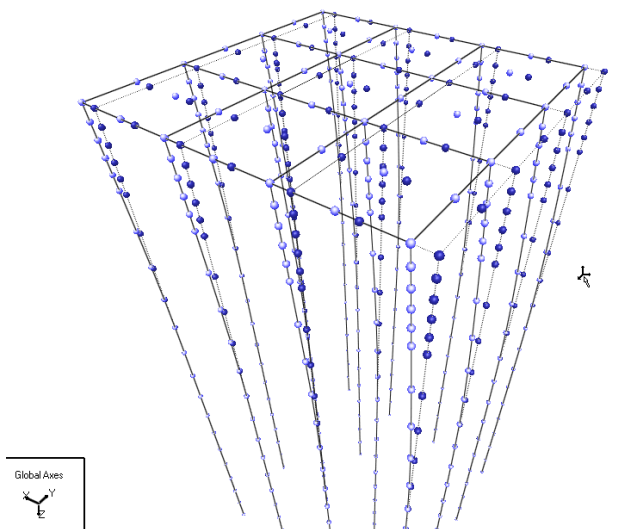
In the tool bar area, you can select the load case to view. In the 3D Display Control pane, you can select which node to display displacements or rotations, as well as the nodal coordinates. A 3 Dimensional representation of the results is shown in the 3D View pane.



The deflected shape for load case 8 is shown here.



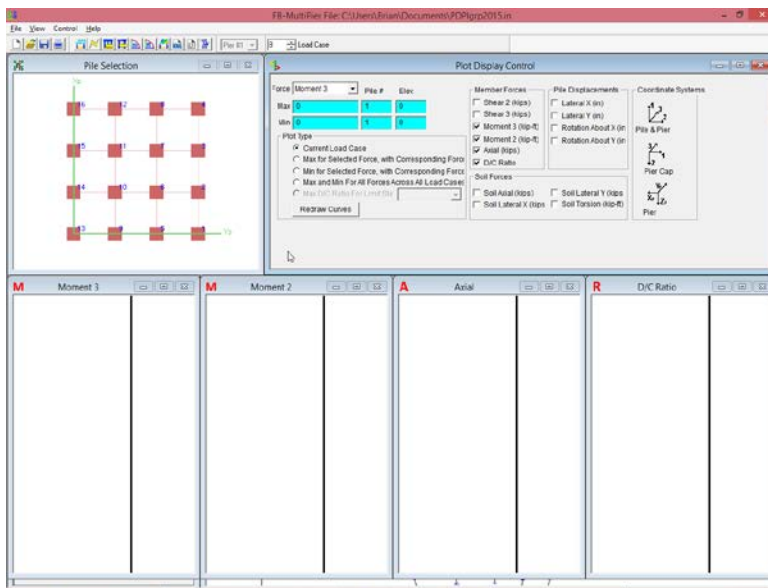
It may be useful to rotate, resize, or move the model. Right click in the 3D Results window and choose 3D Mouse Control.



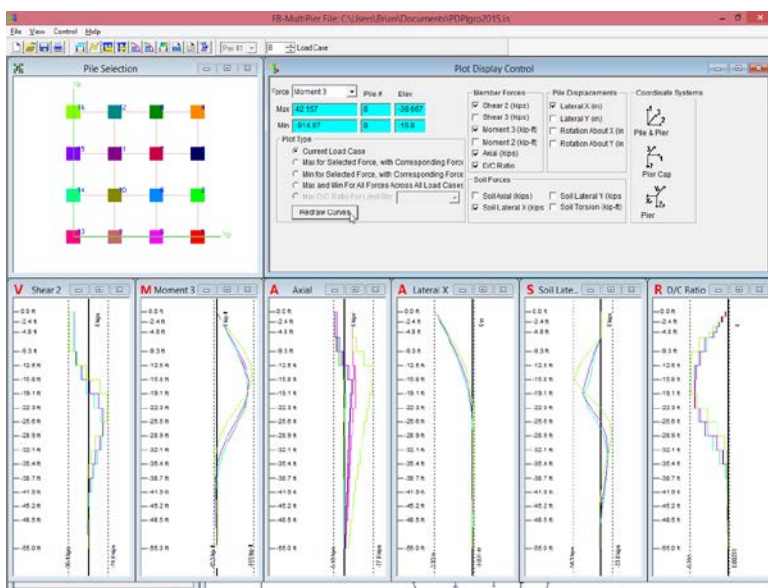
By clicking the left mouse and dragging, the model can be rotated in all directions. Holding shift and left click dragging will translate the model. Control and left click dragging will allow you to resize the model. Note this also works in the 3D View window of the input portion of the program.



Next, click on the Pile Results button in the toolbar. This will open a series of pile results windows.



The pile results window is shown. In the Plot Display Control window, select the quantities you would like to view plotted versus pile depth. In the Pile Selection window, select the piles you would like to plot.



The selected quantities will be color coded with the selected pile shown in each of the individual plot windows.