## FB MultiPier v.4

## Pile Group Example

Professor's Driven Pile Institute

Utah State University – June 24, 2015

J. Brian Anderson (jbanders@auburn.edu)

Department of Civil Engineering Auburn University









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.

Select	New Problem Type ? ×
Problem Type C General Pier Pile and Cap Only C Single Pile C High Mast Lighting/Sign C Retaining Wall C Sound Wall C Sound Wall C Stiffness C Pile Bent C Column Analysis C Bridge (Multiple Piers) Units C English (mixed units) C SI (kPa, m)	Project Data Client Auburn University Project Name PDPI Logan, UT 2015 Project Manager JBA Date Computed By 06/24/15 JBA Project Description Pile Group Example
	DK Cancel

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-tocenter 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."



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



	Model Data	x
Global Data     Problem     Analysis     AASHTO     Dynamics     Pushover     Pier Data     Pile Cap     Pile     Soit     Pile     Soit     Concentrate     Retained So     Bridge Data     Bridge     Span Load	Soil       Soil Layer Data       Soil Importing         ?       Soil Set       Set       Importing         Soil Layer       Layer 1       Del       Soil Strength Criteria         Soil Type       Cohesionless       Internal Friction Angle       30       Deg         Jnit Weight       110       pcf       Cyclic Loading       Edit SPT         Soil Layer Models       Edit       Plot       Top of Layer       Top of Layer       10       ft         ?       Tip       Driven Pile       Table       Bottom of       -25       ft	
<		>

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

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.

<b>•</b>	Model Data	- • •
Global Data     Problem     Analysis     AASHTO     Dynamics     Pushover     Pier Data     Pile Cap     Pile     Soil     Pier     X-Members     Load     Springs     Concentrate     Retained So     Bridge Data     Bridge     Span Load	Soil         Soil Layer Data         Soil Layer Jata         Soil Layer Layer 2         Soil Layer Layer 2         Joint Weight 110         pc         Soil Layer Models         Lateral Sand (Reese)         Plot         Plot     <	
<		>

2	Model Data	x
Global Data	Soil	
- Problem - Analysis - AASHTO - Dynamics - Pushover D- Pier Data	Soil Layer Data     Soil Importing       Retrieve soil data from Import     Soil Importing       Soil Layer Layer 1     Del       Soil Type Cohesionless     Internal Friction Angle	
Pile Cap Pile Soil Pier X-Members	Jnit Weight 120 pcf Edit SPT	
Load Springs Concentrate	Axial Driven Pile  Plot Vater Table  t t t t t t t t t t t t t t t t t t	
Bridge Data	?     Tip Driven Pile     Table     Bottom of -100 ft       Specify Top and Bottom Layer Pr     Specify Top and Bottom Layer Pr	
Span Load		
<		>

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

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



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

	Additional So	I Properties	?
Lateral Model Sand (O'Neill)			
32	Internal Friction Angle	deg	
120	Total Unit Weight	pcf	
120	Subgrade Modulus	lb/in^3	
6			

Model Data

▼ Del

▼ Del

pcf

•

▼ Edit

▼ Plot

Group

Table

Soil Importing

Soil Strength Criteria

Cyclic Loading

Retrieve soil data from Import

Internal Friction Angle 32

Elevations

Water Table 0

Top of Layer -6

Bottom of -100 ft

🕀 Global Data

🚊 Pier Data

Problem

Analysis

AASHTO

Dynamics

Pushover

Pile Cap

X-Members

Concentrate Retained So

Pile

Soil

Pier

Load

😑 Bridge Data

<

- Bridge --- Span Load

Springs

Soil

Soil Layer Data

? Soil Set Set 1

Jnit Weight 120

Soil Layer Models

Lateral Sand (O'Neill)

Axial Driven Pile

 Orisional
 Driven Pile

 Orilled Shaft Sand
 Oriven Pile Sand (API)

 Custom T.Z.
 Oriven T.Z.

Custom T-Z Specity Top and Boltom Layer Pr

Soil Layer Layer 1

Soil Type Cohesionless

Deg

ft

ft

Edit SPT

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.



Axial Model				
Driven Pile				
120	Total Unit Weight		pcf	
7.5	Shear Modulus		ksi	
0.3	Poisson's Ratio			
570	Ultimate Unit Skin Frictio	n	psf	
	ОК	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.

2	Model Data
📮 Global Data	Soil
Problem	Soil Layer Data
Analysis	2 Soil Set Set 1 ▼ Del Retrieve soil data from Import
AASHTO	
Dynamics	Soil Layer 1 - Del Soil Strength Criteria
Pusnover	Internal Friction Angle 32 Deg
Pile Can	Soil Type Conesioness
Pile	Jnit Weight 120 pcf Edit SPT
Soil	
···· Pier	Soil Layer Models Elevations
···· X-Members	Lateral Sand (O'Neill)   Edit
Load	Axial Driven Pile   Plot  Water Table  0  ft
Springs	Top of Laver -6 #
Concentrate	
Retained So	? Tip Driven Pile Table Bottom of -100 ft
Bridge	Speci Driven Pile
Span Load	Driven Pile Sand (API)
	Drilled Shaft Clay
	Driven Pile Clay (API)
	Drilled Shaft IGM Custom 0-7
_	v
	(

Lib wood	
Driven Pile	
7.5 Shear Modulus	ksi
0.3 Poisson's Ratio	
384 Axial Bearing Failure	kips
Notes	e tip elevation and the soil properties. The
Notes 1. The tip spring force is calculated based on th soil properties are constant along the depth of th	e tip elevation and the soil properties. The e soil layer for this tip spring calculation.
Notes 1. The tip spring force is calculated based on th soil properties are constant along the depth of th 2. Tip properties can be distinct from properties friction angle can have different values for the tip	ie tip elevation and the soil properties. The e soil layer for this tip spring calculation. for other soil models. For example, internal p and lateral models.
Notes 1. The tip spring force is calculated based on th soil properties are constant along the depth of th 2. Tip properties can be distinct from properties friction angle can have different values for the tip	e tip elevation and the soil properties. The e soil layer for this tip spring calculation. for other soil models. For example, internal o and lateral models.

<b>*</b>	Model Data
Global Data     Problem     Analysis     AASHTO     Dynamics     Pushover     Pier Data     Pile Cap     Pile Cap     Pile Cap     Pile Cap     Pile Cap     Pile     Soil     Pile     Soil     Soi	Soil       Soil Layer Data       Soil Importing         ?       Soil Set Set 1 • Del       Retrieve soil data from Import         Soil Layer       Layer 1 • Del       Soil Strength Criteria         Soil Type       Cohesionless •       Internal Friction Angle       32       Deg         Jnit Weight       120       pcf       Soil Strength Criteria       Internal Friction Angle       32       Deg         Soil Layer Models       Cyclic Loading       Edit       Cyclic Loading       Edit       Soil Type Cohesionless       Water Table       1         Soil Layer Models       Edit       Plot       Top of Layer       6       1         Valial Driven Pile       Table       Set PY Multiplier Values       00       1         ?       Tip Driven Pile       Table       Set PY Multiplier Values       00       1         Specify Top and Bottom Layer Pr       Set PY Multiplier Values       00       1
<	>

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.

Advance	ed Soil Da	ta	? ×
Pile System is: 4 in X 4 in Y Multiplier Values X Y			
Use PY Multipliers Specified	0.800000	0.800000	Lead
Use PY O Multipliers	0.400000	0.400000	
all = 1 Tip Spring	0.300000	0.300000	
C Only 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         1			
ОК	Cance	P	rint

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.

<b>v</b>	Model Data
B- Global Data     Problem     Analysis     Analysis     Analysis     Analysis     Analysis     Dynamics     Dynamics     Pier Data     Pile Cap     Pile     Soil     Pier     X-Members     Concentrate     Retained So     Bridge     Span Load	Load Load Case 5 Load Case 5 Load Case 7 Load Case 7 Load Case 7 Def Case 7 Load Case 7 Def Ca
•	Model Data
E- Global Data Problem Analysis AASHTO	Load         Node Applied         Node #           Copy         PreLoad         ^         Sett Weight         Table

Table 0 - A-

Add

Del

🔲 Prescribed Displacement B

1

11

Self Weight Factor

Buovancy Factor

Pushover

Pier Data Pile Cap

Pile

Soil

Pier

X-Me

Load

Springs

Retained

--- Bridge --- Span Load

Bridge Data

< <

Add Load Case 2 Load Case 3

Del Load Case 4

PreLoad

1

Xp Load, kips

Yp Load, kips

Zp Load, kips

Moment About Xp, kip-ft

Moment About Yp, kip-ft

Moment About Zp, kip-ft

One load cases 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

Load Table for All Static Load Cases									? ×		
Load Case	Node	Force Xp	Force Yp	Force Zp	Moment Xp	Moment Yp	Moment Zp	Displacement?	^		
PreLoad	1	0.00	0.00	0.00	0.00	0.00	0.00	N/A			
PreLoad	2	0.00	0.00	0.00	0.00	0.00	0.00	N/A		Update & Sort Table	
1	30	125.00	0.00	0.00	0.00	0.00	0.00			<u> </u>	
2	30	250.00	0.00	0.00	0.00	0.00	0.00			Table Edit Options	
3	30	375.00	0.00	0.00	0.00	0.00	0.00			Insert Row	
4	30	500.00	0.00	0.00	0.00	0.00	0.00			Delete Row	
5	30	625.00	0.00	0.00	0.00	0.00	0.00				
6	30	750.00	0.00	0.00	0.00	0.00	0.00				
7	30	875.00	0.00	0.00	0.00	0.00	0.00				
8	30	1000.00	0.00	0.00	0.00	0.00	0.00		~		
Laston	O-KW-S-H-F-H-	D	-1								
Load Ca	Self weight Factor	Buoyancy Fa	ctor						Â		
PreLoad	N/A		N/A								
1	1.00		1.00								
2	0.00		0.00						~		
Notes	las have drag and dra	n onnahilition Cu		lune: Chil C to ea	neu Chill ( to poo	to Ohl V to out					
2 Load Case	<ol> <li>I nese tables have grag-and-grop capabilities. Select a range and use: Ltri-t to copy, Ltri-V to paste, Ltri-X to cut.</li> <li>I and Cases as the added or removed in the should table. To delete or addiced as see use the 'Add' and 'Del' butters as the Load Pase.</li> </ol>										
3 Within ear	<ol> <li>Load Cases cannot be added on removed in the addressing of the device of add todates, use the Add and bet buttons on the Codd Fage.</li> <li>Additional problem of the codd Fage.</li> </ol>										
<ol> <li>winnin each road case, an roading must be either Applied Load or Prescribed Displacement.</li> </ol>											
				OK	Cancel	Print	1				



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 if 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.



3D Mouse Control

Picking Mouse Control Picking Forces Control Nodal Plot Nodal Results Data Pile Cap Force Plot

Bridge Span Force Plots

Material Property Numbering Element Numbering

Node Numbering

Element Highlighting Axes (Local) Axes (Global) Pier Data Plastic Hinge Zones Undisplaced Model

Bridge View Reset View

Nodes

~

6

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.

entrel Help al ministration (M	ALAIMI Incorrect	FB-Muth-Res File: CAlifient/Enum/Documents/PDPlgrp2015in	- 0 X						
Pile Selection	C C C C	Piot Display Control							
	:	Tercel Momenta         Pile # Dee:         Minimis / Forcet         Pile Degliaramente         Checklonik Brystein           Base         Base         Base         Pile Degliaramente         Checklonik Brystein           Pile Degliaramente         Checklonik Brystein         Checklonik Brystein         Discertain Brystein         Discertain Brystein           Pile Degliaramente         Minimis Brystein         Checklonik Brystein         Discertain Brystein         Discertain Brystein           Pile Degliaramente         Minimis Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein           Pile Degliaramente         Minimis Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein           Or minimis Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein           Checklowide Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein           Checklowide Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein           Checklowide Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein         Discertain Brystein           Checklowide Brystein							
		C Mark and the Far Ar room Arous AN Lead Clase C C Mark the Thermost Research AN Lead Clase C C Mark the Thermost Research AN Lead Clase C Restaw Clases C Feer Soli Lateral X (tops C Soli Torsion (tio-R) Peer							
	_	<b>b</b>							

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.