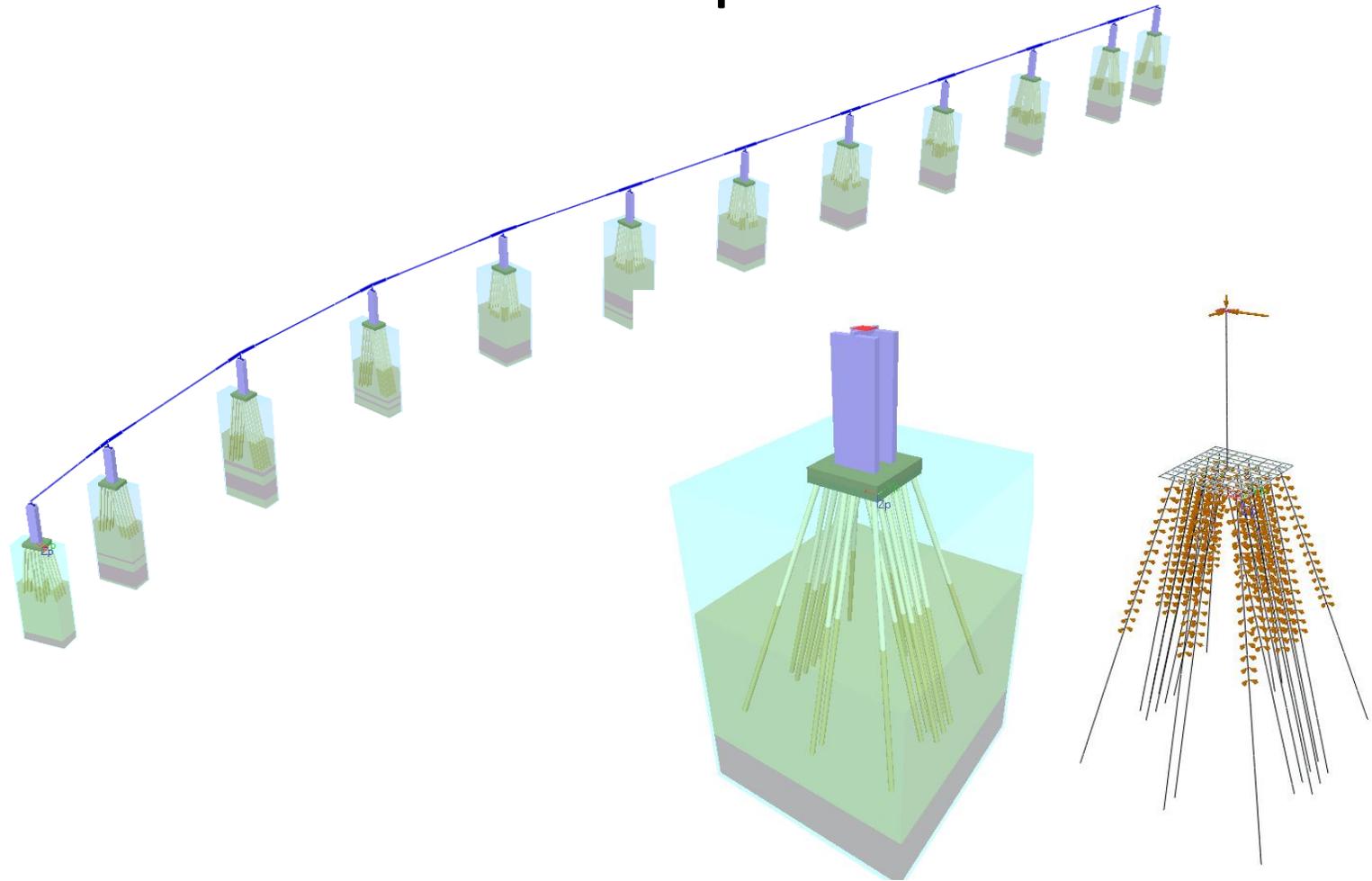


FB-MultiPier Update

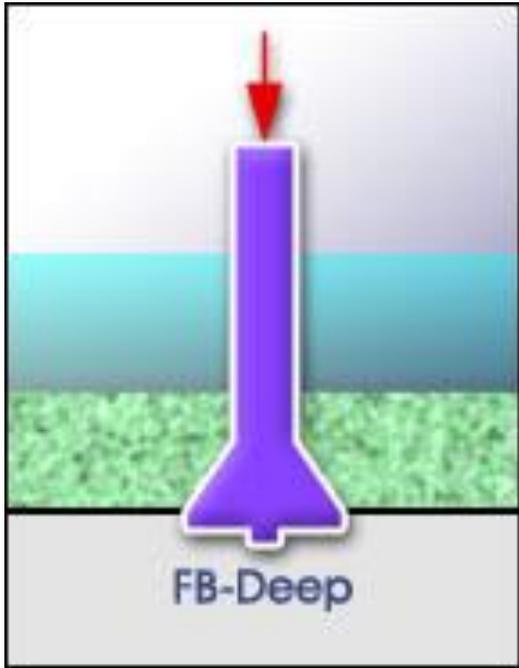
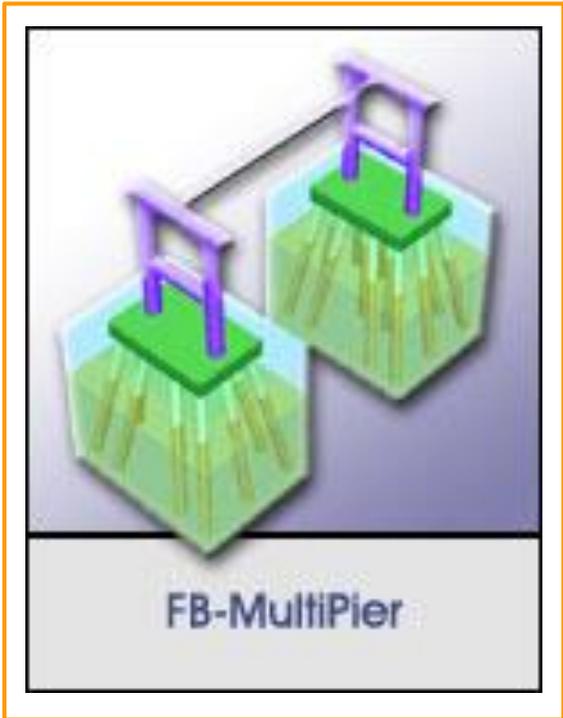


Jae H. Chung, Ph.D. and Henry T. Bollmann, P.E.
Bridge Software Institute
University of Florida
Gainesville, Florida
June 11, 2014

Agenda

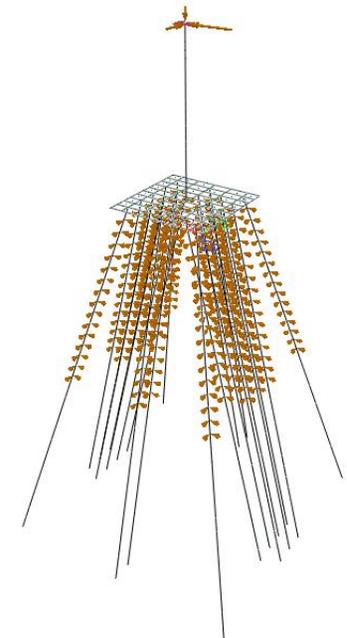
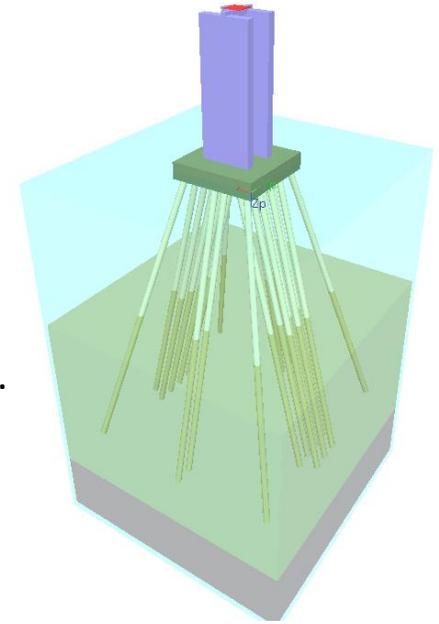
- Part I: FB-MultiPier New Features of Upcoming Releases and Medium-Term Development (presented by Jae Chung)
- Part II: Use of Design Tables and Model Showcase (presented by Henry Bollmann)

Bridge Software Institute (BSI) Products



FB-MultiPier Software Program

- Nonlinear Finite Element Analysis Tool for Use in Bridge Design Application
 - Material nonlinearity and large-deformation (p-delta effect) can be analyzed using a 3-D frame finite element formulation coupled with soil resistance (4 nonlinear soil springs per each node of FE structure frame).
 - Quasi-static and dynamic analyses can be performed either separately or simultaneously.
 - Simplified input process in geometric definition of pier components and automated FE mesh (structural skeleton) generation saves time and makes it easy for model calibration.
 - Biaxial Moment-Interaction Diagram and easy-to-use materials modeling options are a few to mention.
 - Analysis capabilities of coupled soil-structure interaction is the main strength of the program.



Features for Upcoming Releases: Pile Cap Summary Forces (V4.19.1)

- Flexure
 - Max positive moment
 - Max negative moment
- Shear
 - Max magnitude shear force
- Force Envelopes
 - Across all load cases
 - Per load case

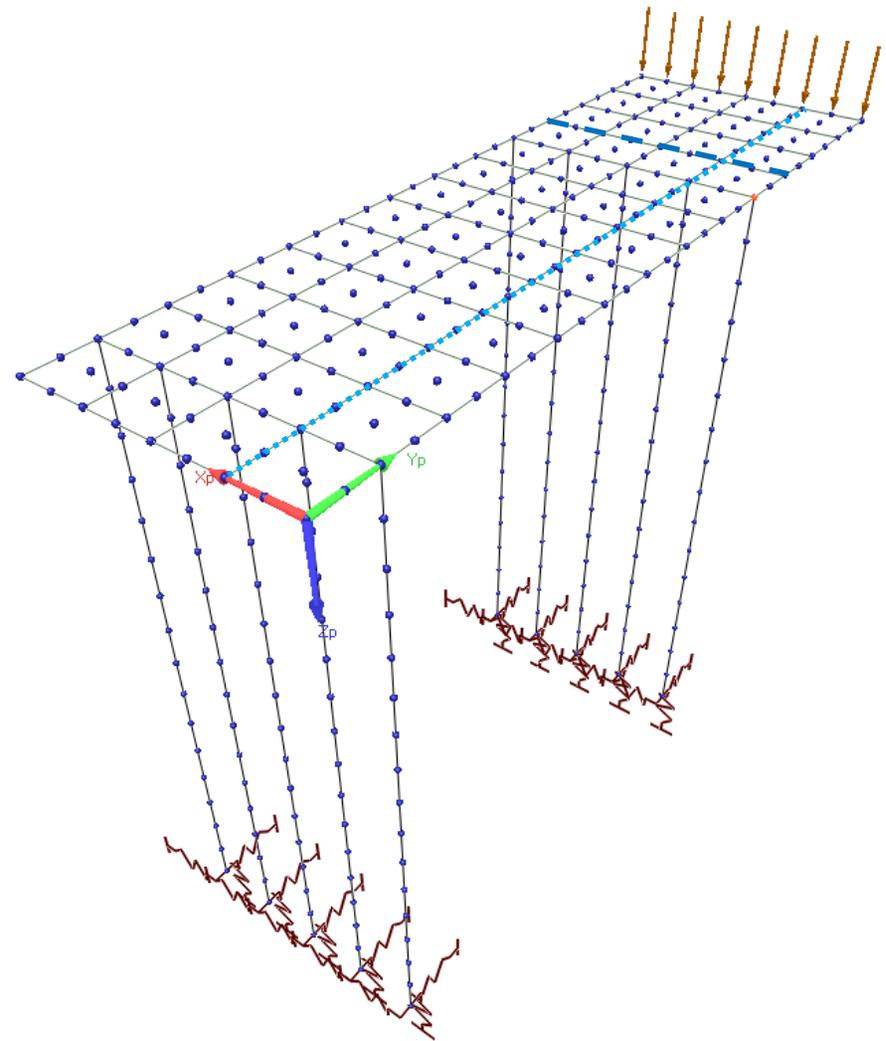
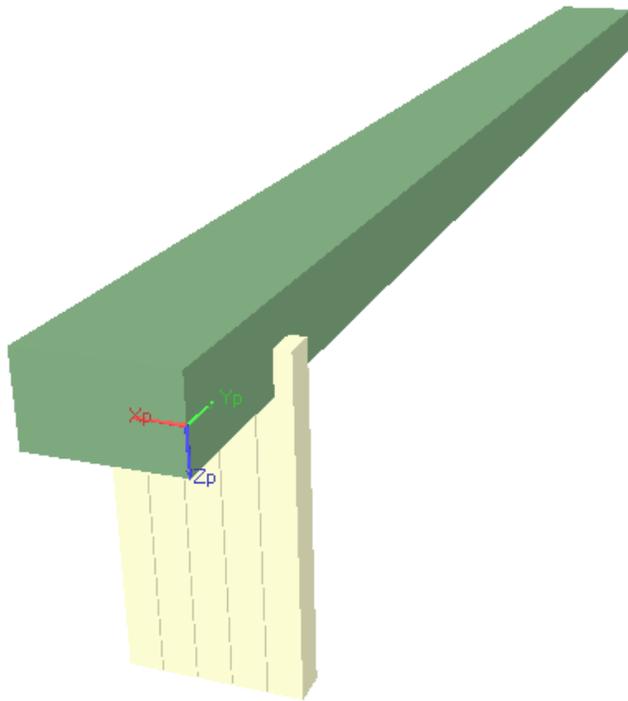
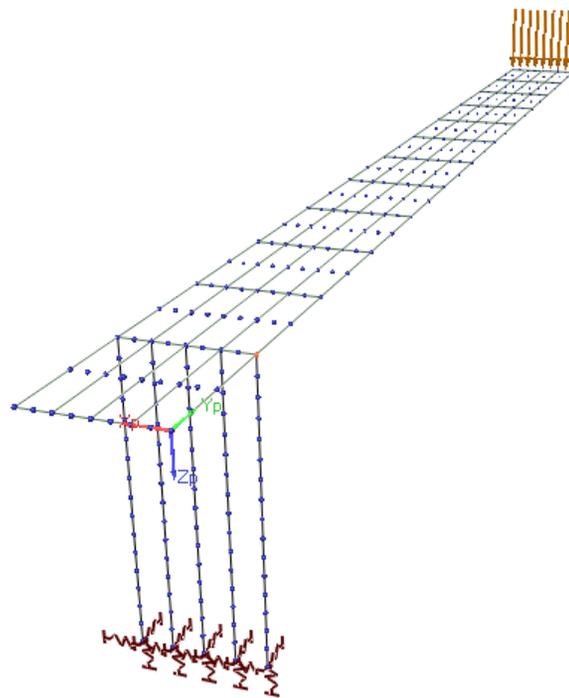


Illustration of Pile Cap Summary Forces (V4.19.1)

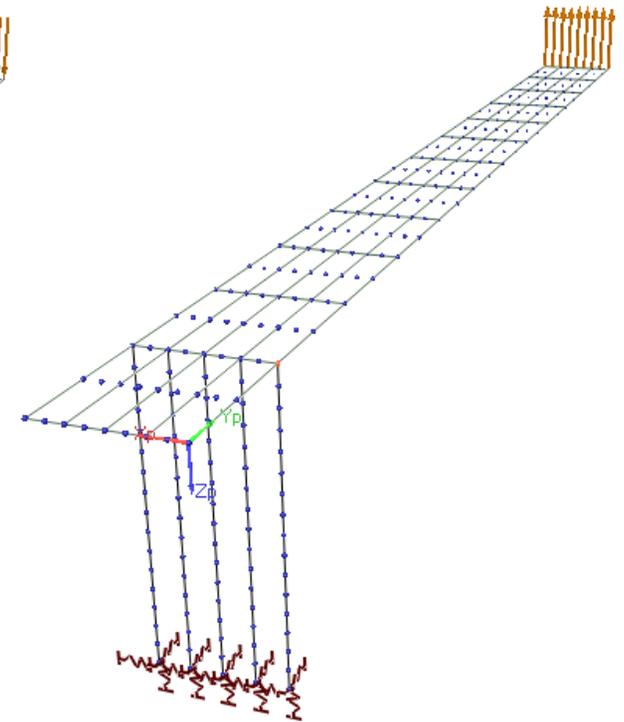
- Pile Cap Summary Force Calculations



Pile and cap model



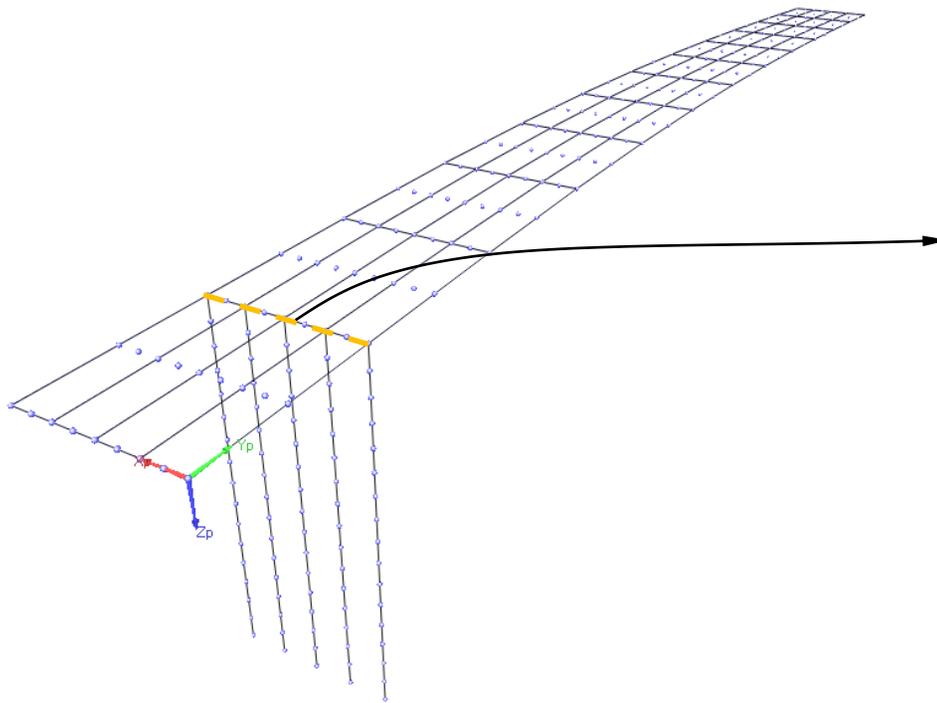
Load Case 1



Load Case 2

Pile Cap Summary Forces (V4.19.1)

- 3D results
- Graphical selection of section



Pile Cap Forces

Node	X Coordinate (in)	Y Coordinate (in)	Z Coordinate (in)
60	100.00	240.00	0.00
199	87.50	240.00	0.00
59	75.00	240.00	0.00
198	62.50	240.00	0.00
58	50.00	240.00	0.00
197	37.50	240.00	0.00
57	25.00	240.00	0.00
196	12.50	240.00	0.00

Notes

1. The 'Generate' button will collect the moment and shear forces for the selected pile cap nodes.
2. The 'Deselect All' button clears the table of all currently selected nodes.
3. Select 'All Load Cases' to extract force data from all load cases. Select 'Load Case Specific' to use only the currently selected load case in the toolbar.
4. Use the mouse and the 'Control' key to select multiple nodes in the '3D Results' window.
5. To de-select a node (that is already selected), click on the node in the '3D Results' window while holding down the 'Control' key.
6. Central nodes of the pile shell elements cannot be selected.
7. Select 'End Point Nodal Selection' to let the program automatically select all nodes in between two selected nodes.

Force Data

All Load Cases M1 M2 Load Case Specific

Generate Deselect All

Max. Moment M2: 1000.20 kip-ft Load Case: 2

Min. Moment M2: -1000.20 kip-ft Load Case: 1

Max. Shear (abs) S23: 10.07 kips Load Case: 1

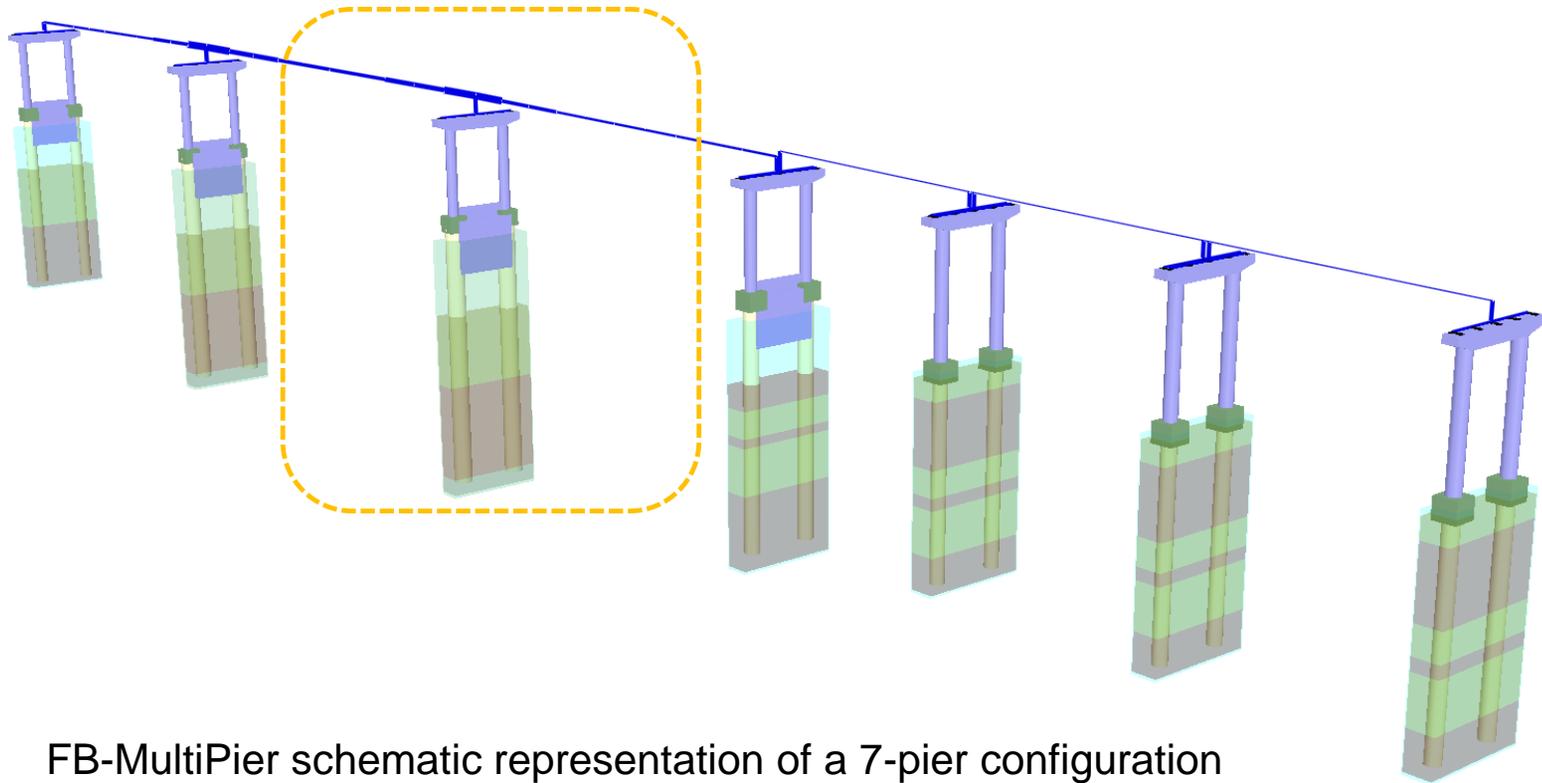
Max. Moment M2

Min. Moment M2

Plot Zero Datum End Point Nodal Selection Close Print

Features for Upcoming Releases: One-Pier Two-Span Model (V4.20)

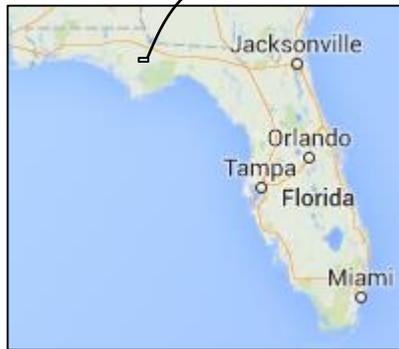
- Simplified Bridge Model for Dynamic Analysis
 - A single pier of interest
 - Two Adjacent Spans
 - 6 DOF's discrete springs are at both ends of the two adjacent spans



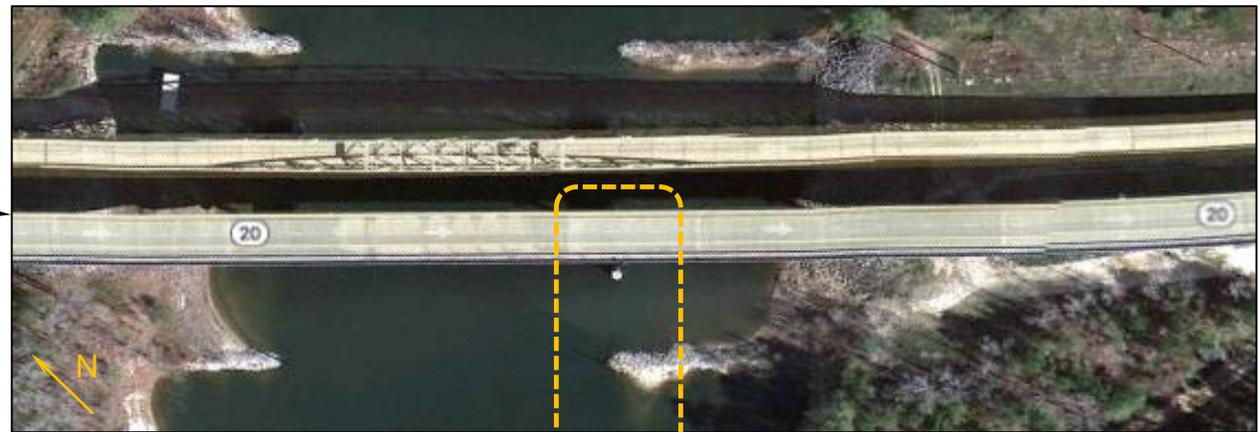
FB-MultiPier schematic representation of a 7-pier configuration

Illustration of OPTS Model

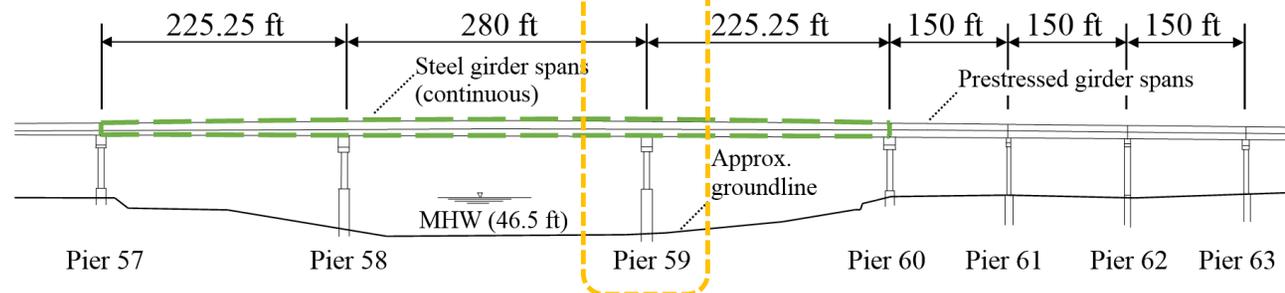
- Multiple-pier model of SR-20 Apalachicola River Bridge
 - Eastern channel pier (Pier 59) subjected to lateral dynamic loading



Source: Google maps

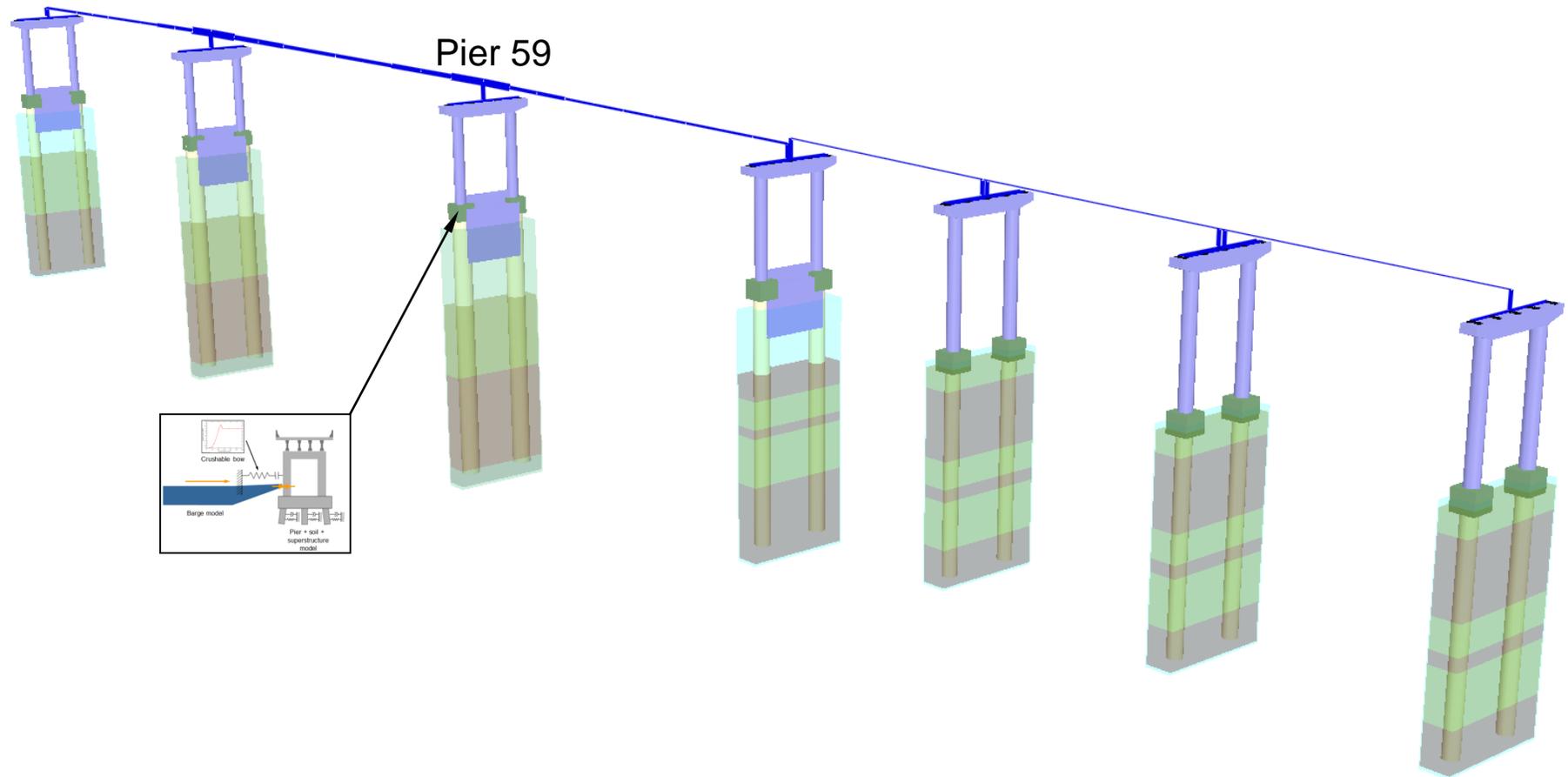


Source: Google maps



FB-MultiPier Analysis

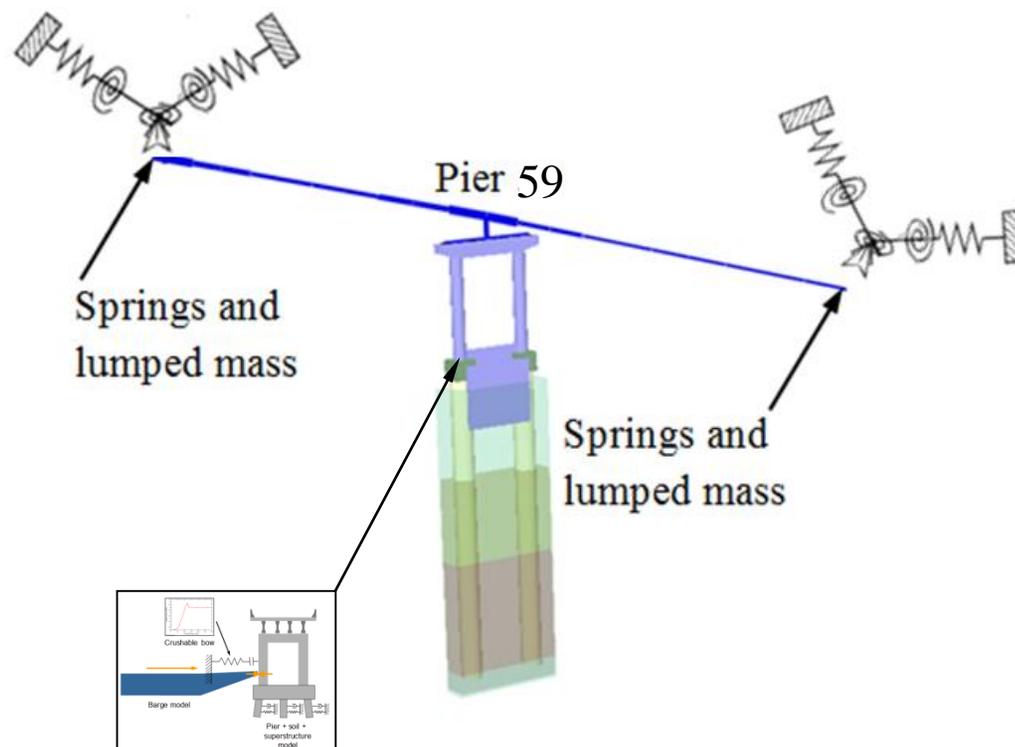
- Seven-Pier model of SR-20 Apalachicola River Bridge
 - Lateral dynamic load on Pier 59



4 sec simulation in 112 min.

FB-MultiPier Analysis Model

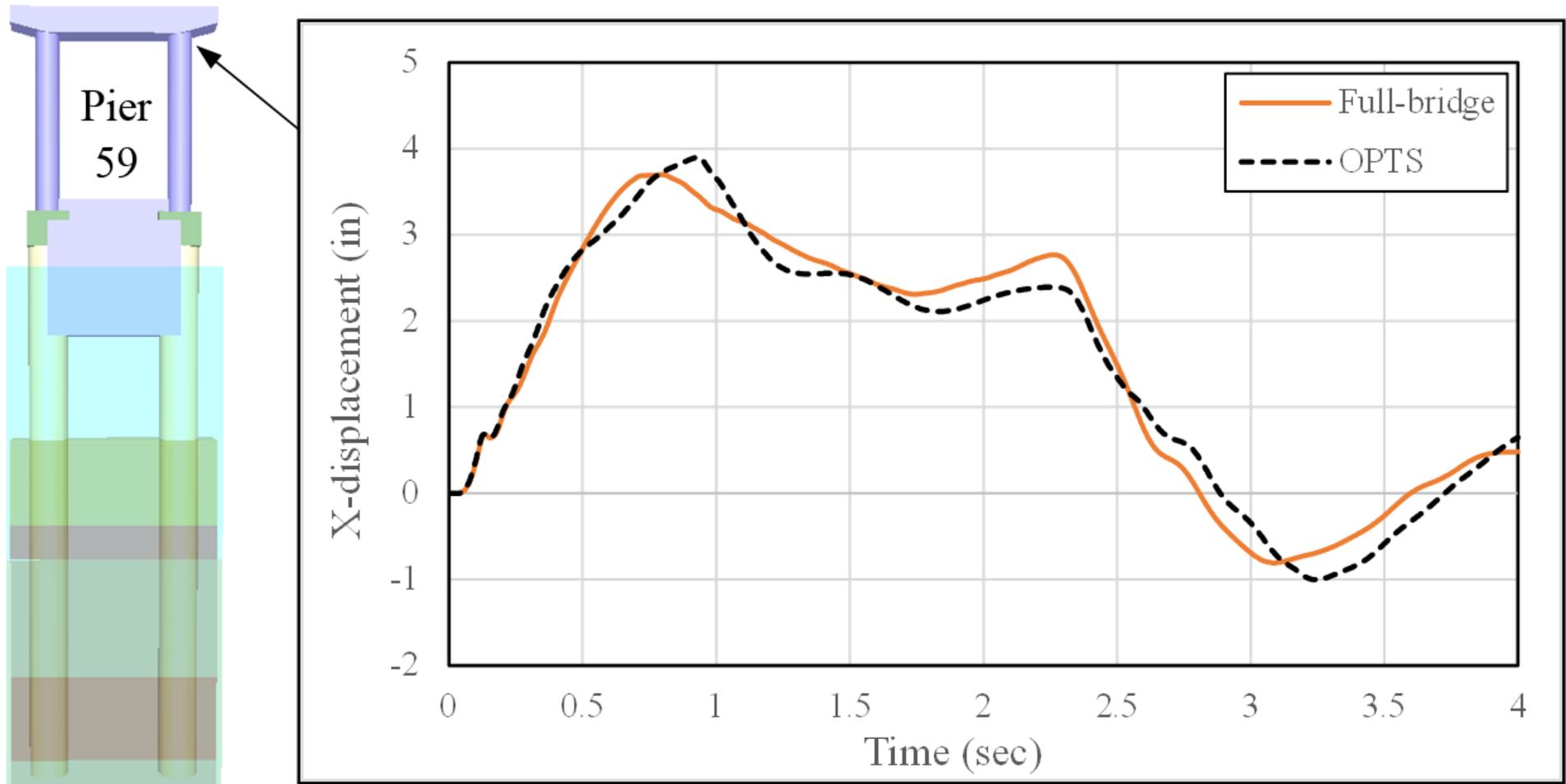
- OPTS modeling approach
 - Lateral dynamic load on Pier 59



4 sec simulation in 5 min.

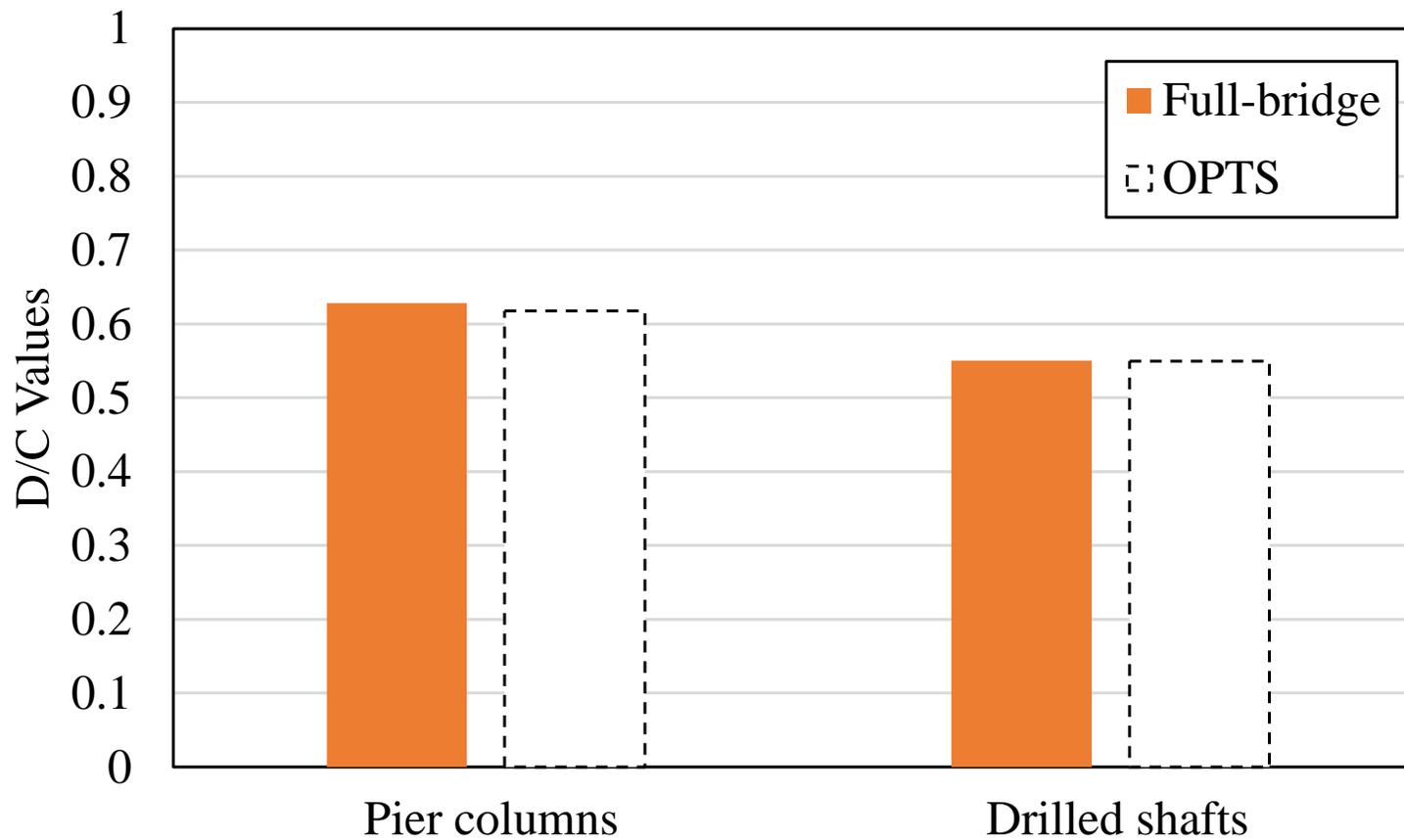
Comparison of Analysis Results

- Lateral displacement prediction



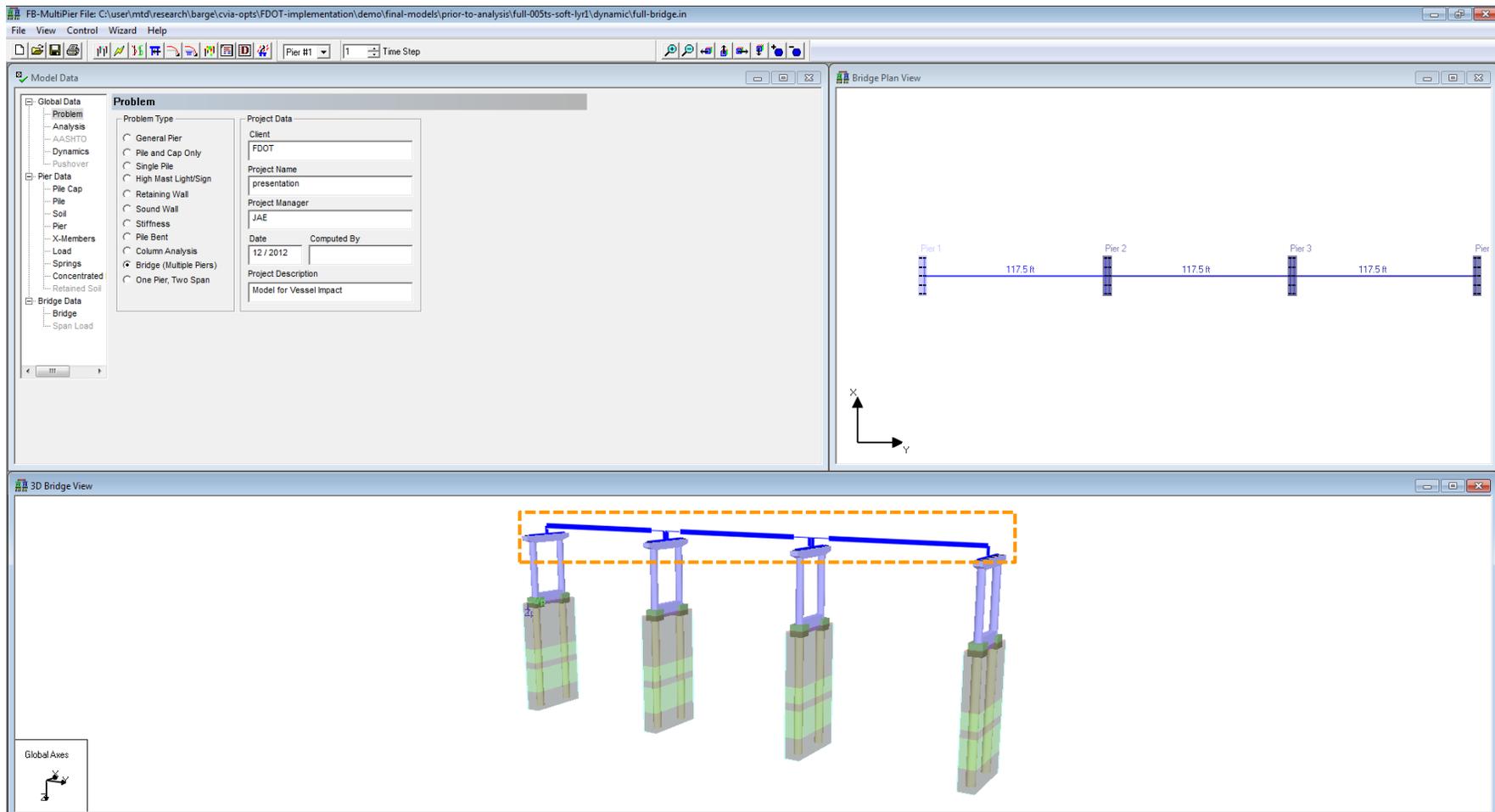
Analysis Results

- Comparison of 7-pier model vs OPTS
 - 2% difference in maximum D/C values



Thermal Load Effects in Piers (V4.21)

- Implemented in Beta Version of FB-MultiPier
 - Can generate AASHTO TU, TG reactions at bearings



FB-MultiPier GUI

Superstructure Configuration (V4.21)

Girder And Slab Dimensions

Span Properties
 Span: Span 1 Copy Span

Girder Type
 Steel
 Concrete
 Box

Structural Configuration
 Uniform
 Prismatic

Bearings Per Box Girder
 One Two

Geometry
 Static

Dimensions
 Slab
 Slab Width: in
 Slab Depth: in
Expand
Print

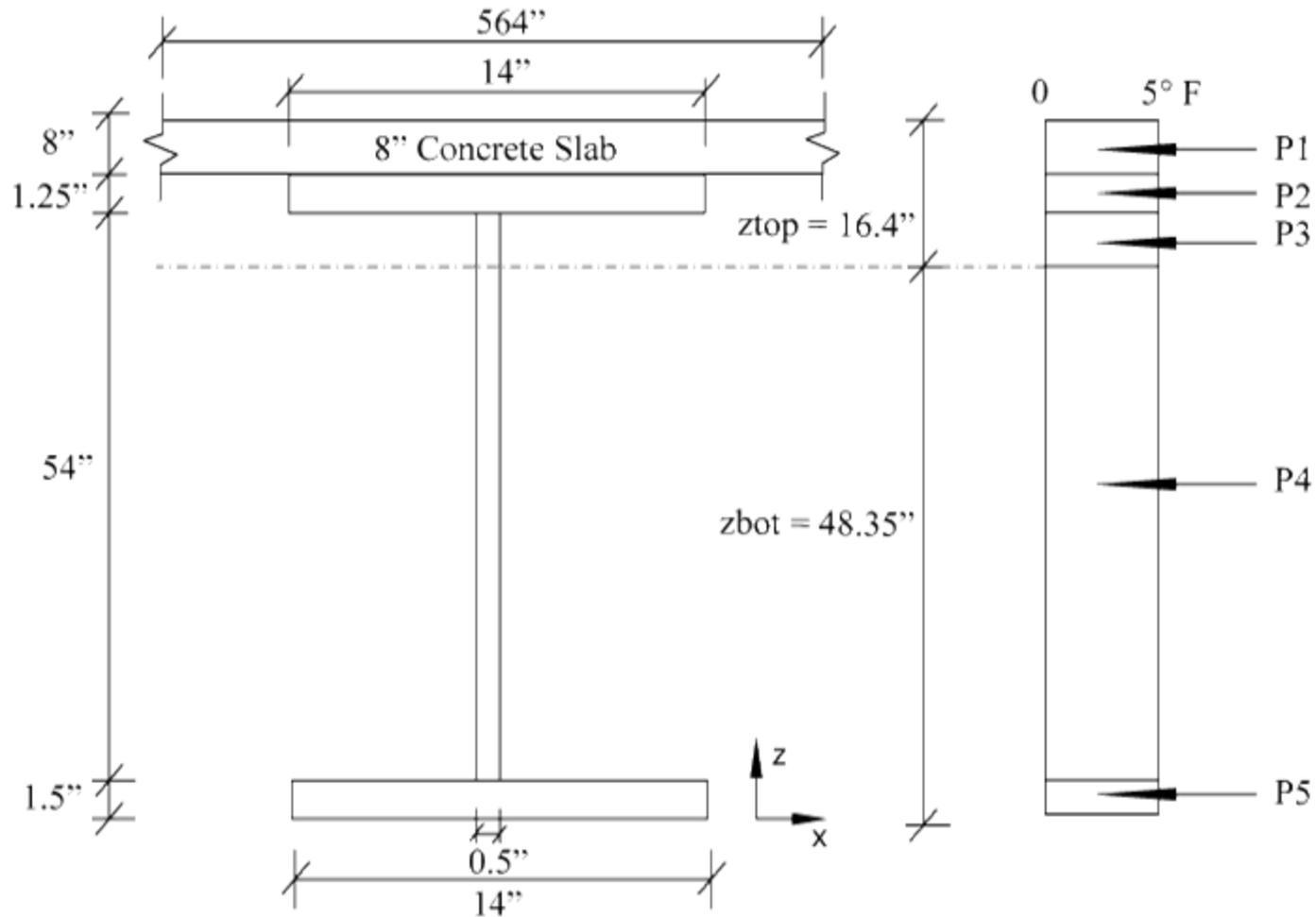
Element	Girder	Top Flange Depth (in)	Top Flange Width (in)	Top Taper Depth (in)	Web Depth (in)	Web Width (in)	Bottom Taper Depth (in)	Bottom Flange Depth (in)	Bottom Flange Width (in)
1	ALL	4.00	24.00	3.00	40.00	6.00	3.00	8.00	30.00
2	ALL	4.00	24.00	3.00	40.00	6.00	3.00	8.00	30.00
3	ALL	4.00	24.00	3.00	40.00	6.00	3.00	8.00	30.00
4	ALL	4.00	24.00	3.00	40.00	6.00	6.00	8.00	30.00
5	ALL	4.00	24.00	3.00	40.00	6.00	3.00	8.00	30.00
6	ALL	4.00	24.00	3.00	40.00	6.00	3.00	8.00	30.00

Model Viewing
 Element 1 Update

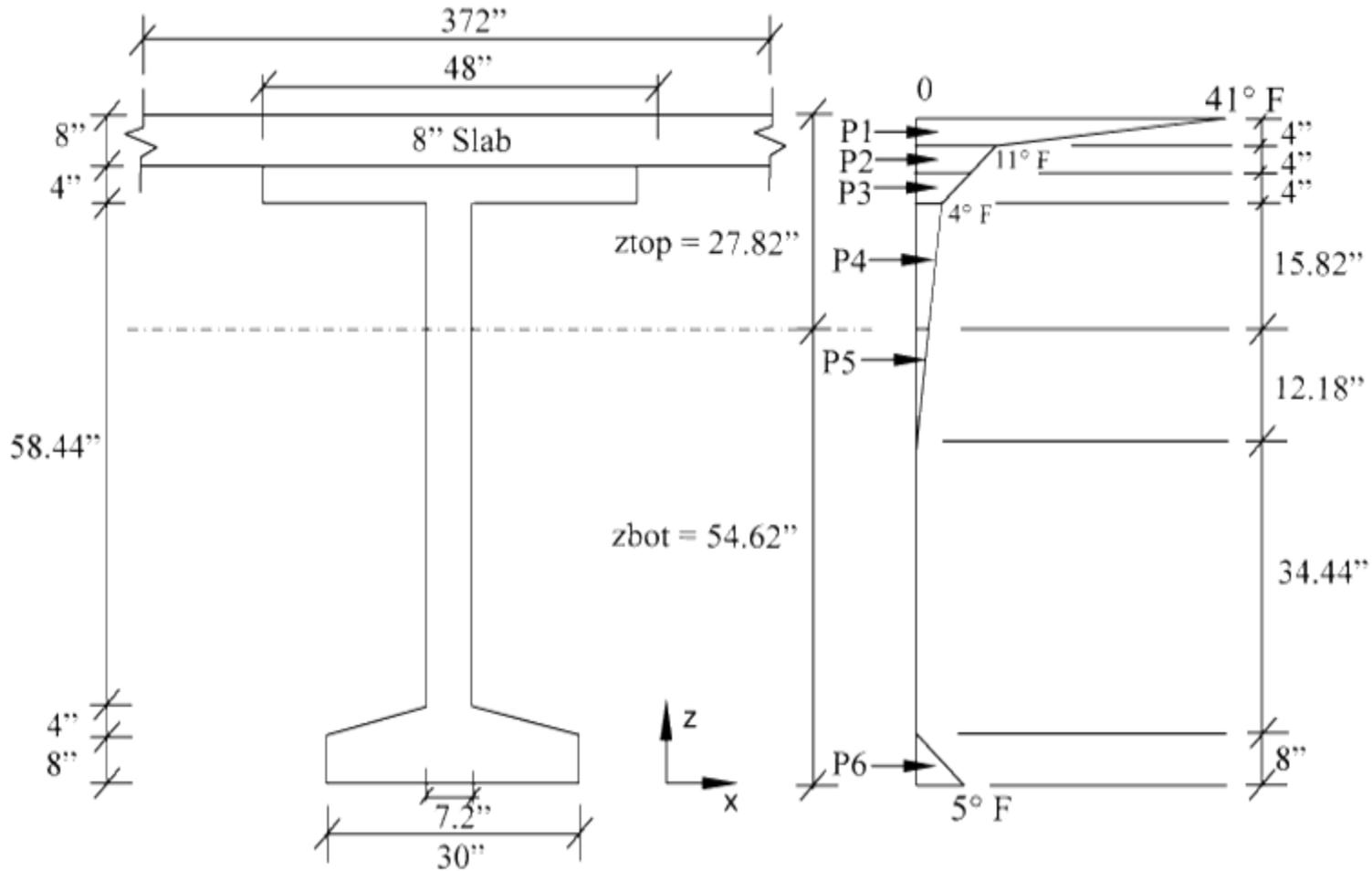
Notes
 1. The number of girders is dictated by the number of bearings. This value is set on the 'Bearing Locations' dialog.
 2. Click the 'Update' button to redraw the span and girders, using the current data in the 'Dimensions' table.

OK Cancel Bearings

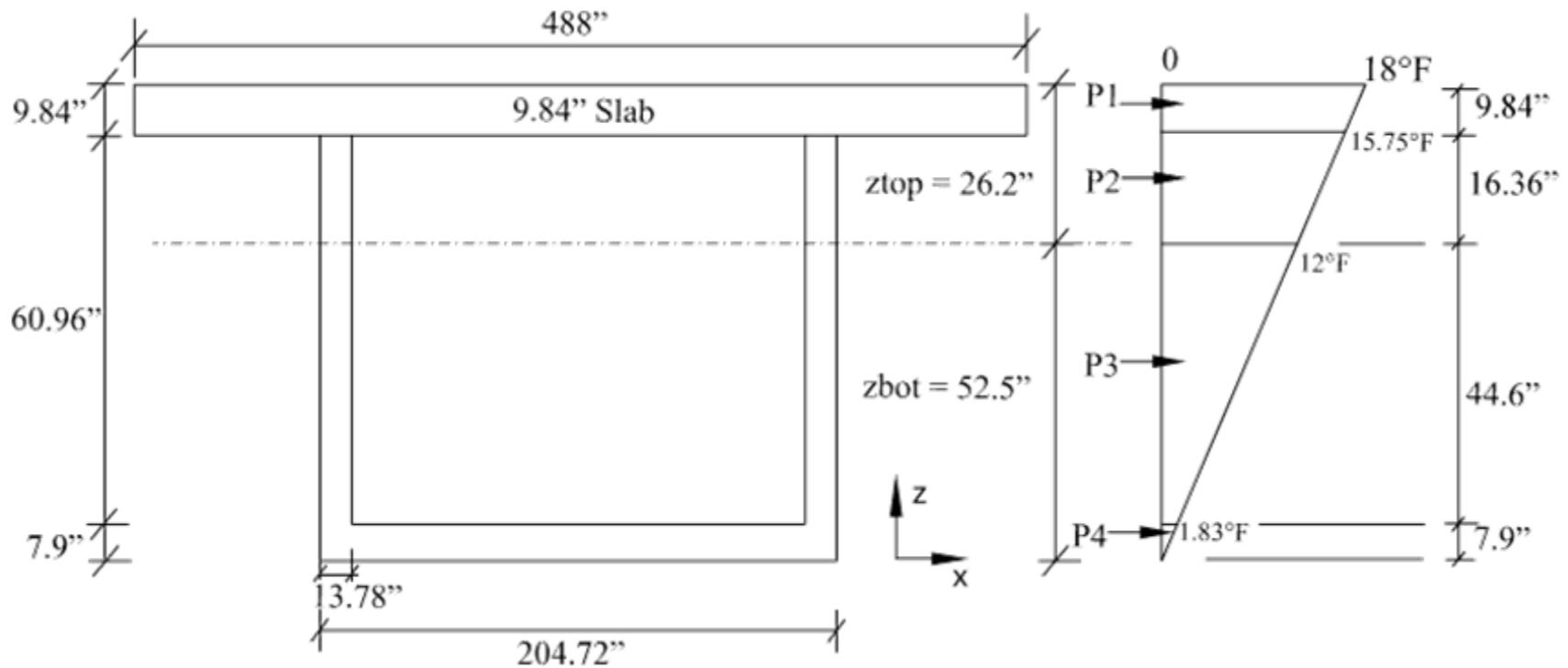
Uniform Temperature Loading: TU (V4.21)



Thermal Gradient Loading: TG (V4.21)



Span-Thermal Loading : User's Option (V4.21)



AASHTO Span-Thermal Loading : User's Option (V4.21)

Span Thermal Data

Non-AASHTO
 AASHTO TU
 AASHTO TG

Span: Span 1

Reference Temperature: deg F

Notes:

- The Reference Temperature applies to all spans.
- The Girder Type of the currently selected span dictates how the temperatures are input in the table below. The girder type is set on the 'Girder and Slab Dimensions' dialog.

Temperature Locations

Slab coefficient of thermal expansion, elastic modulus and unit weight

Slab Top Temperature

Slab Bottom Temperature

...No. Girders...

Girder: coefficient of thermal expansion, elastic modulus and unit weight

Girder Properties

Coefficient of Thermal Expansion: in/in deg F

Elastic Modulus: ksi

Unit Weight: pcf

Slab Properties

Coefficient of Thermal Expansion: in/in deg F

Elastic Modulus: ksi

Unit Weight: pcf

Top Temperature: deg F

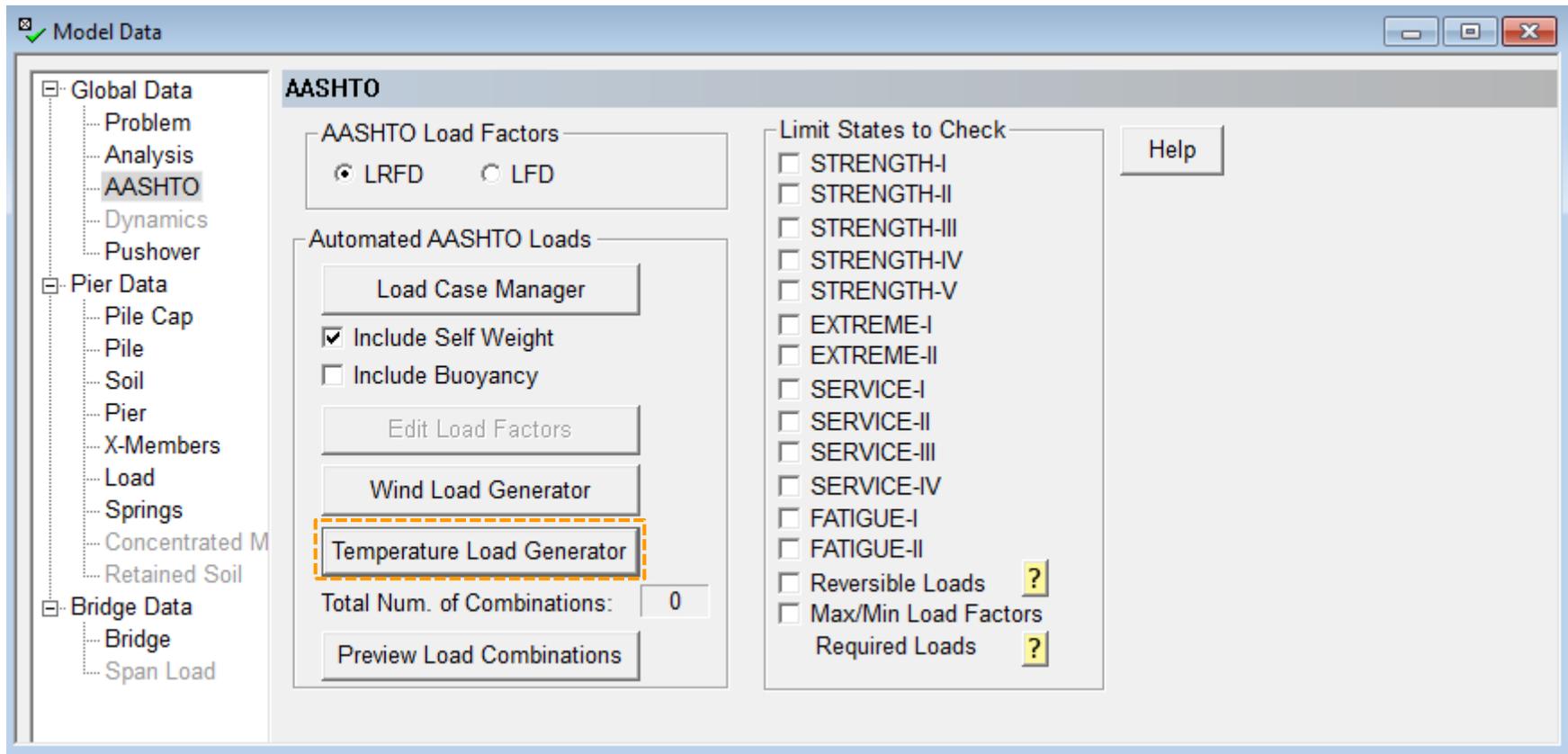
Temperature 4 inches From Top: deg F

Bottom Temperature: deg F

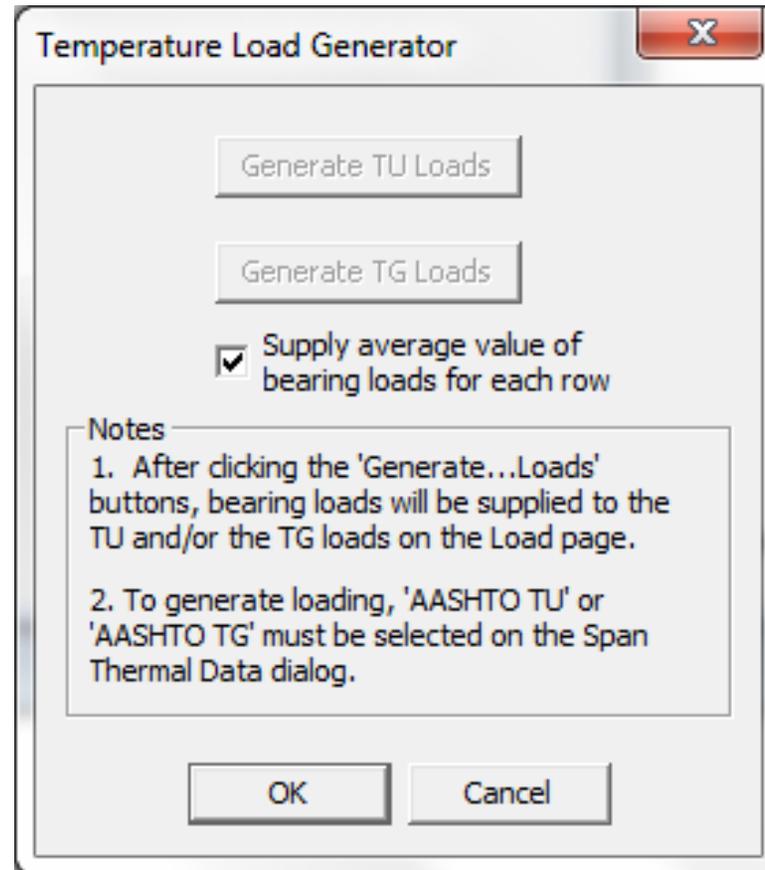
Girder Temperatures and Depths

Expand	Element	Girder	T1	T2	T3	D3	T4	D4	T5	D5	T6	T7
Print			(deg F)	(deg F)	(deg F)	(in)	(deg F)	(in)	(deg F)	(in)	(deg F)	(deg F)
Image	1	ALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	ALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	ALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	ALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	ALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	ALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7	All	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Application of Span-Thermal Loading (V4.21)

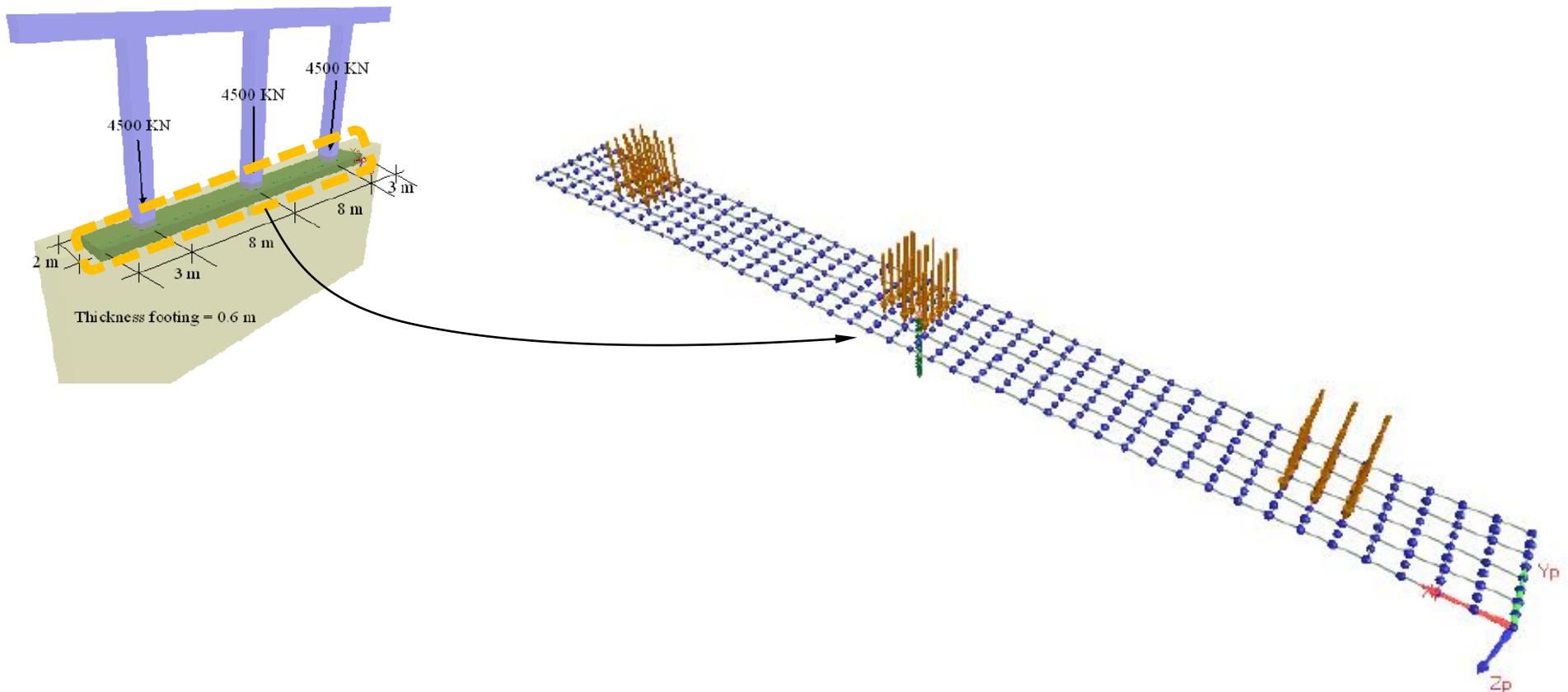


Span-Thermal Loading (V4.21)



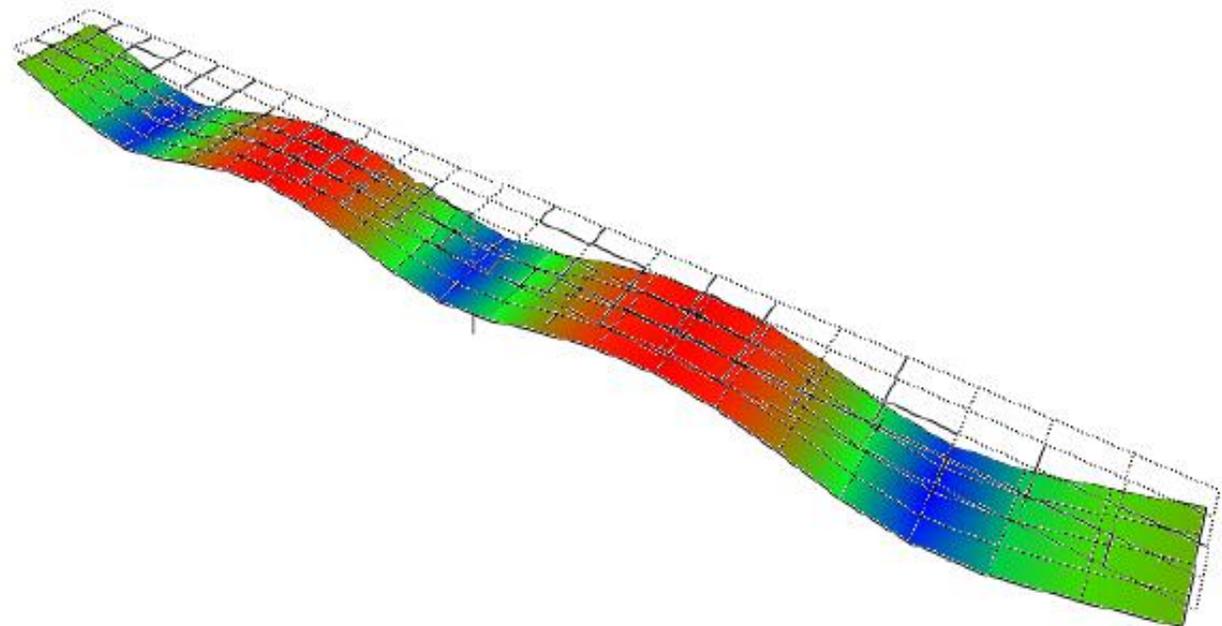
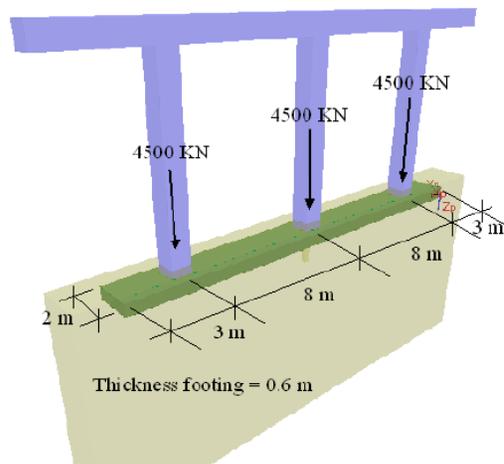
Shallow Foundation Modeling (~2016)

- Spread (or Strip) footings
- Options to model overlying structure and/or pile foundation as usual



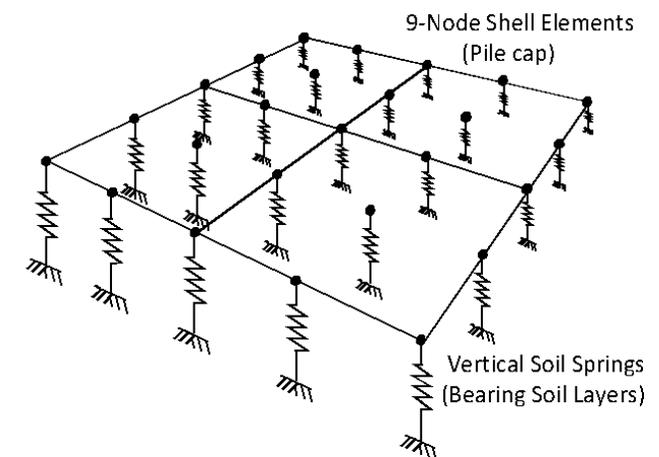
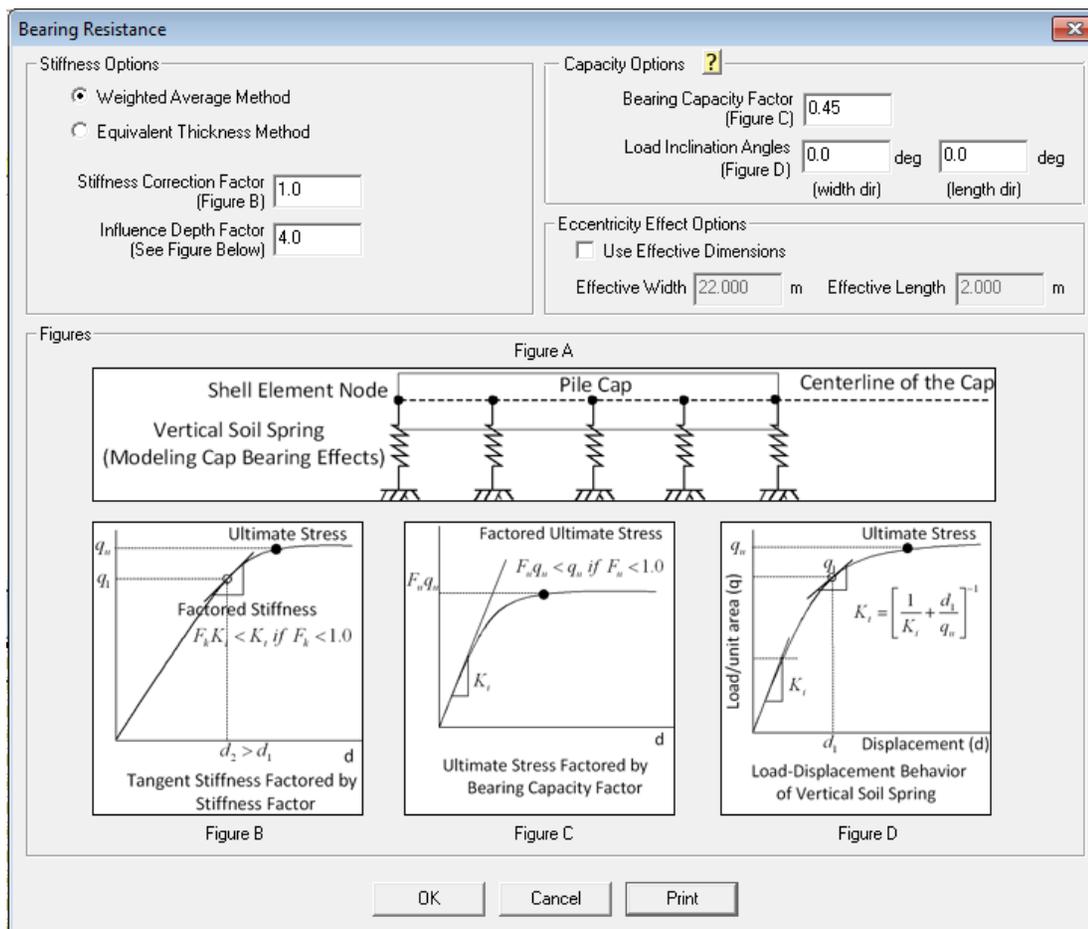
Shallow Foundation Modeling (~2016)

- Nonlinear Soil-Structure Interaction Analysis
 - Numerical integration of vertical stress through a depth
 - Resultant internal forces in finite shell elements coupled with soil resistance
 - Computation of ultimate bearing resistance and settlement distribution



Shallow Foundation Modeling (~2016)

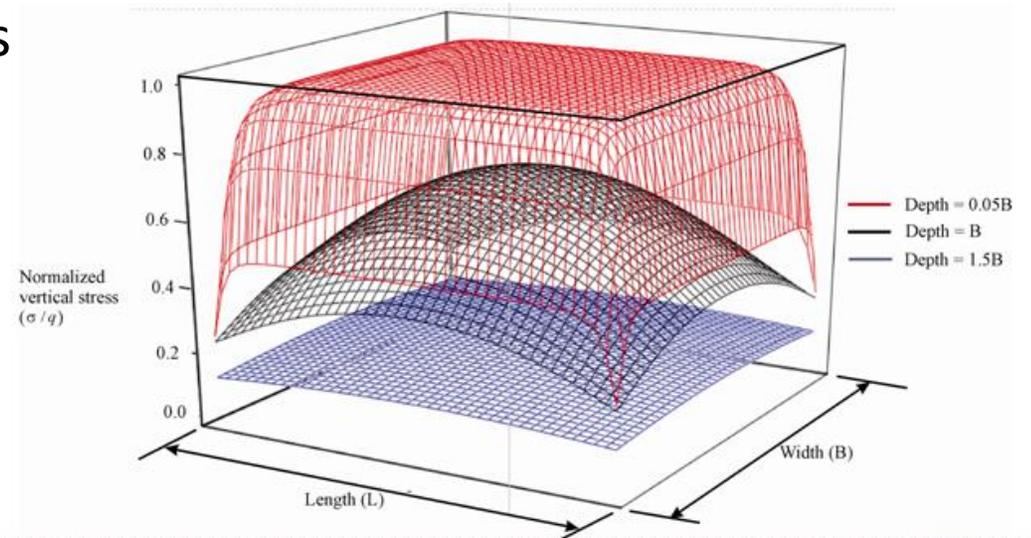
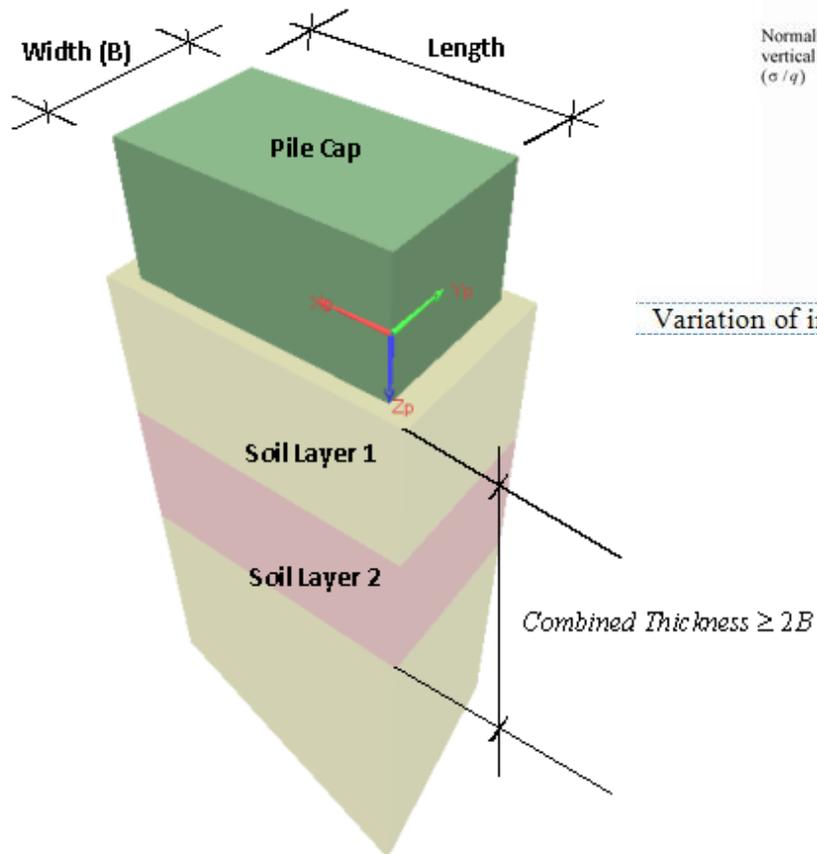
- Partially implemented in a Beta Version of FB-MultiPier for academic education purposes
- Hyperbolic constitutive model (Duncan and Chang)
- Nathan Newmark's stress superposition method, i.e., Stress-Influence Method



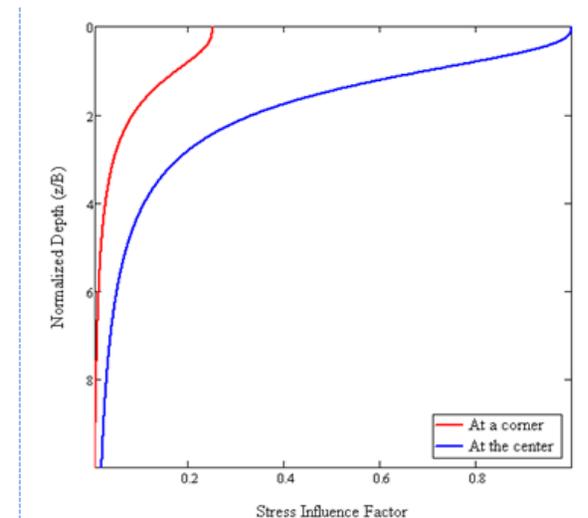
Shallow Foundation Modeling Dialog

Shallow Foundation Modeling (~2016)

- Limitation of existing theories
- Need for strain-based method



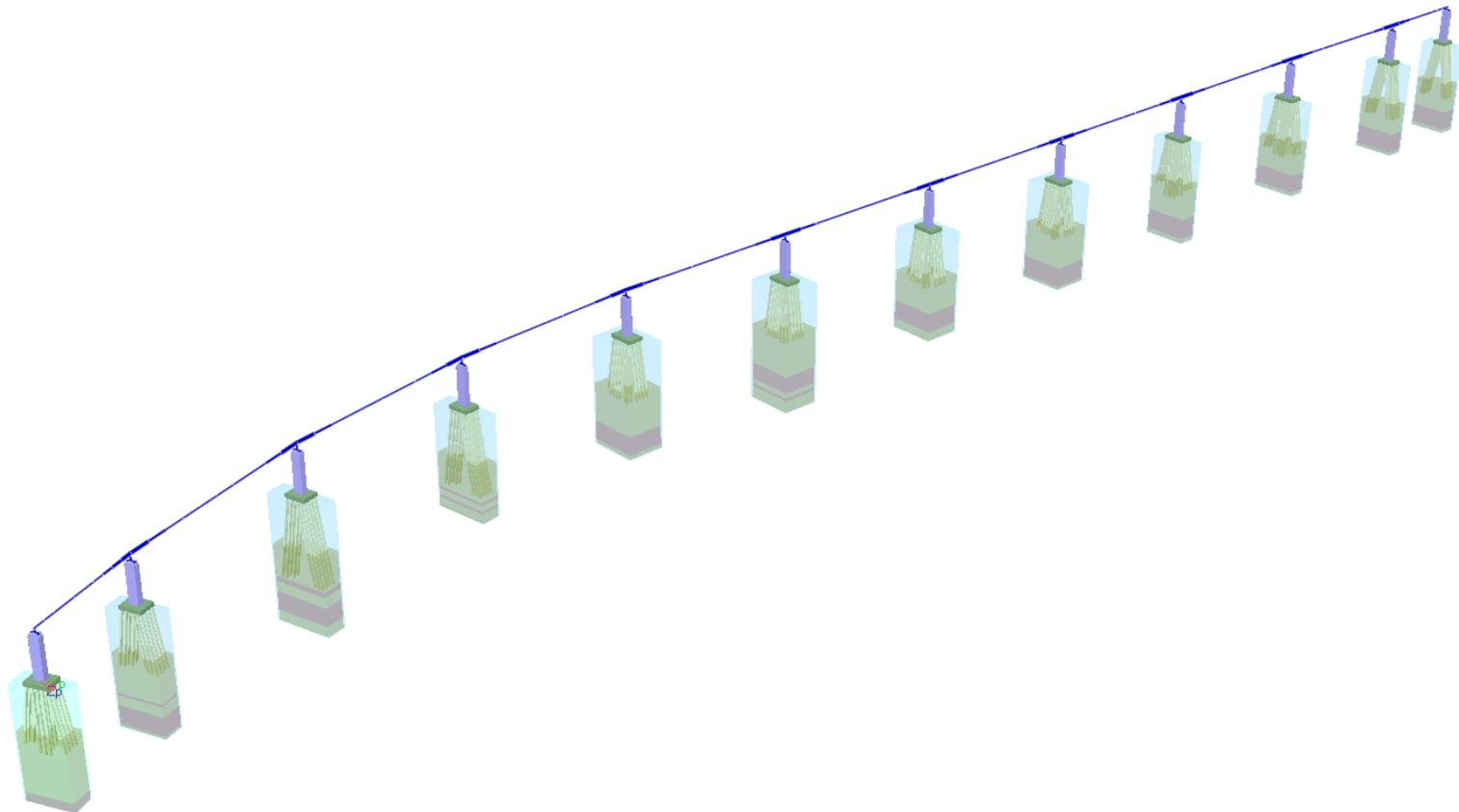
Variation of induced vertical compressive stresses beneath a rectangular shallow foundation



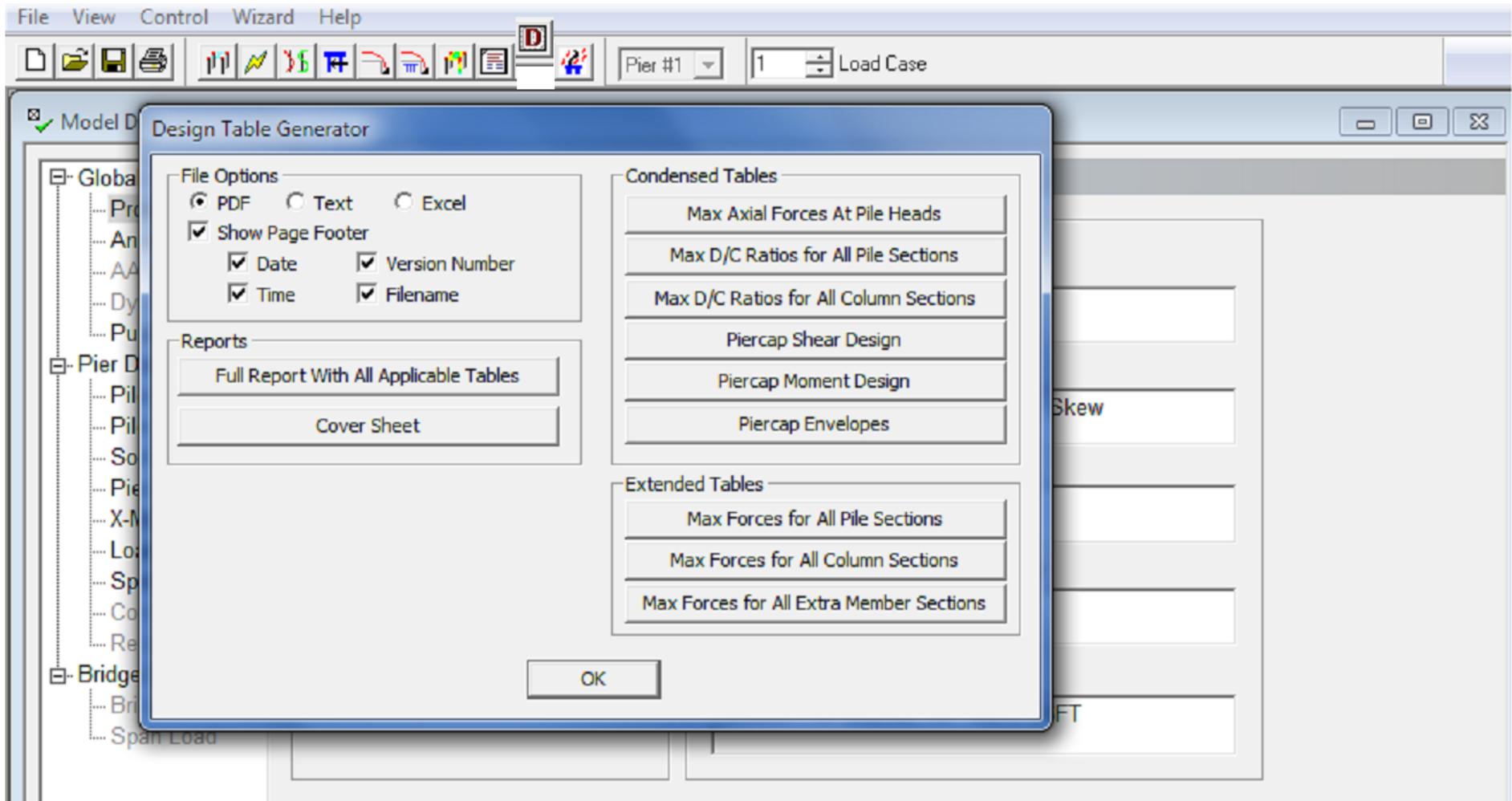
(b) Variation of the influence factors beneath the corner (red) and the center (blue)

FB-MultiPier Update: Part 2

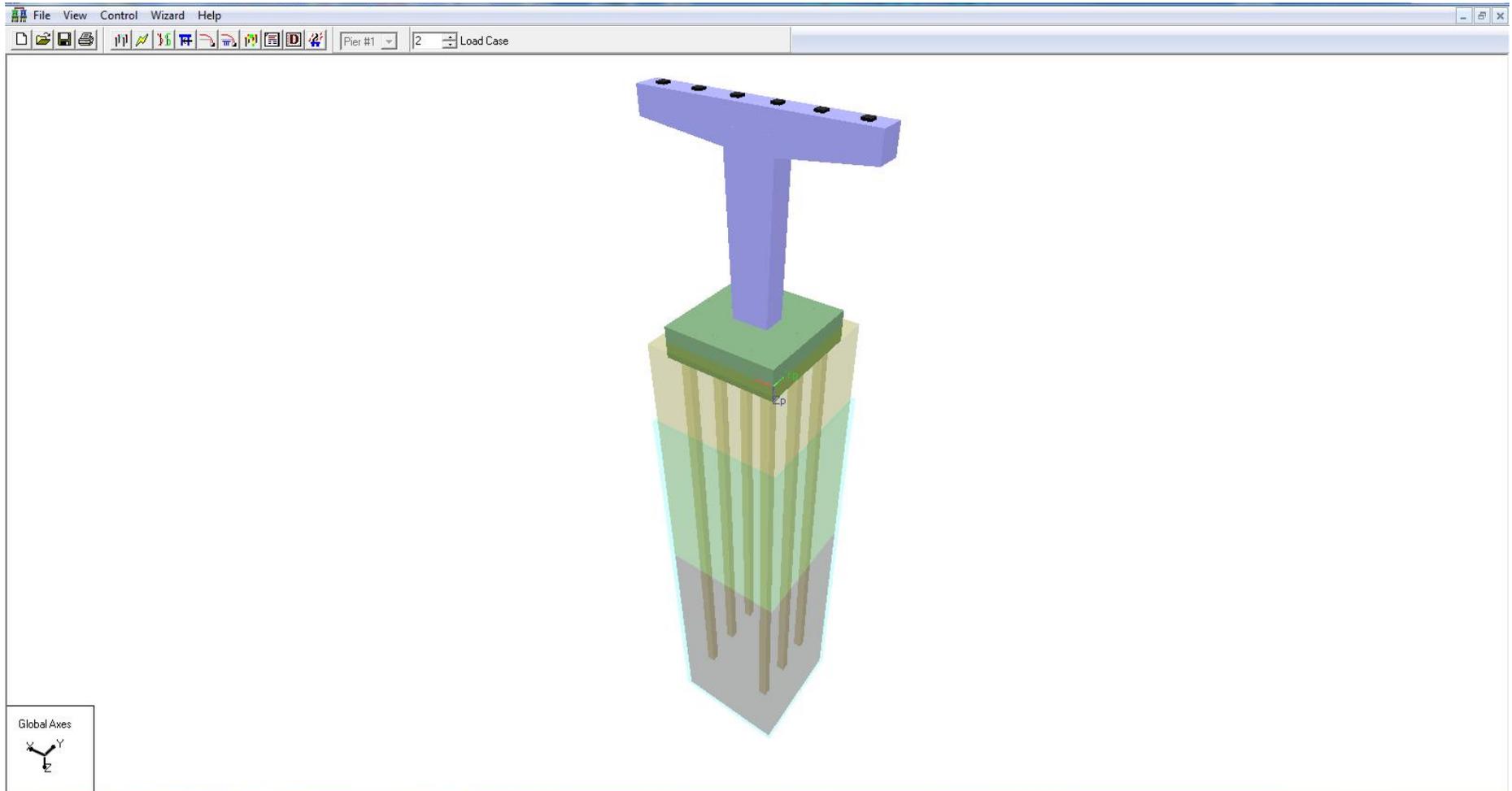
Use of Design Tables and Model Showcase



Design Tables



Example Pier for Design Tables



Pile Axial Forces

Maximum Axial Forces at All Pile Heads
(USE TO COMPARE TO PILE DRIVE CAPACITY)
MAXIMUM COMPRESSION AND MAXIMUM TENSION FORCES

MAXIMUM STRENGTH CASE DATA

PIER	PILE	LOAD COMB	AASHTO-LRFD	MAX TENSION (kips)	D/C (ratio)	LOAD COMB	AASHTO-LRFD	MAX COMP (kips)	D/C (ratio)
1	1	***	***	none	***	2	STRENGTH-I	-423.42	0.39
1	2	***	***	none	***	35	STRENGTH-V	-333.74	0.31
1	3	***	***	none	***	32	STRENGTH-V	-354.03	0.33
1	4	***	***	none	***	9	STRENGTH-III	-313.04	0.29
1	5	***	***	none	***	40	STRENGTH-V	-425.11	0.39
1	6	***	***	none	***	28	STRENGTH-V	-324.42	0.30

MAXIMUM SERVICE CASE DATA

PIER	PILE	LOAD COMB	AASHTO-LRFD	MAX TENSION (kips)	D/C (ratio)	LOAD COMB	AASHTO-LRFD	MAX COMP (kips)	D/C (ratio)
1	1	***	***	none	***	95	SERVICE-I	-330.41	0.30
1	2	***	***	none	***	99	SERVICE-I	-264.75	0.24
1	3	***	***	none	***	95	SERVICE-I	-280.03	0.26
1	4	***	***	none	***	89	SERVICE-I	-209.84	0.19
1	5	***	***	none	***	104	SERVICE-I	-337.13	0.31
1	6	***	***	none	***	92	SERVICE-I	-257.39	0.24



Max D/C in the Piles

File Edit View Window Help

Tools Sign Comment

Maximum Demand/Capacity Ratio For All Pile Properties (Cross Sections)

Pile Properties Data for Pier 1

MAXIMUM STRENGTH CASE DATA

PROP NO.	PILE NO.	ELEM NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (Kips)	F22 (Kips)	F33 (Kips)	M22 (Kip-ft)	M33 (Kip-ft)	TORQUE (Kip-ft)	D/C (Ratio)
1	1	43	121	2	STRENGTH-I	I	-424.92	13.18	-30.68	-172.57	-74.16	-28.42	0.69

MAXIMUM SERVICE CASE DATA

PROP NO.	PILE NO.	ELEM NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (Kips)	F22 (Kips)	F33 (Kips)	M22 (Kip-ft)	M33 (Kip-ft)	TORQUE (Kip-ft)	D/C (Ratio)
1	1	43	121	99	SERVICE-I	I	-287.09	12.84	-19.28	-108.47	-72.23	-16.56	0.49

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Max D/C in the Columns

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Tools Sign Comment

Maximum Demand/Capacity Ratio For All Column Properties (Cross Sections)

Column Properties Data for Pier 1

MAXIMUM STRENGTH CASE DATA

PROP NO.	COLUMN NO.	ELEM NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (Kips)	F22 (Kips)	F33 (Kips)	M22 (Kip-ft)	M33 (Kip-ft)	TORQUE (Kip-ft)	D/C (Ratio)
2	1	5	82	72	STRENGTH-V	I	-897.50	-38.41	93.86	2913.01	3529.76	890.99	0.63
3	1	6	83	72	STRENGTH-V	I	-890.01	-38.41	93.86	2443.70	3337.70	890.99	0.52
4	1	7	84	72	STRENGTH-V	I	-872.46	-38.41	93.86	1974.40	3145.64	890.99	0.41
5	1	8	85	72	STRENGTH-V	I	-854.01	-38.41	93.86	1505.10	2953.58	890.99	0.31
6	1	9	86	72	STRENGTH-V	I	-834.66	-38.41	93.86	1035.80	2761.52	890.99	0.23
7	1	10	87	72	STRENGTH-V	I	-814.41	-38.41	93.86	566.50	2569.46	890.99	0.16

MAXIMUM SERVICE CASE DATA

PROP NO.	COLUMN NO.	ELEM NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (Kips)	F22 (Kips)	F33 (Kips)	M22 (Kip-ft)	M33 (Kip-ft)	TORQUE (Kip-ft)	D/C (Ratio)
2	1	5	82	104	SERVICE-I	I	-934.72	-31.88	70.55	2202.76	2766.76	659.99	0.45
3	1	6	83	104	SERVICE-I	I	-926.40	-31.88	70.55	1850.03	2607.34	659.99	0.36
4	1	7	84	104	SERVICE-I	I	-906.90	-31.88	70.55	1497.31	2447.92	659.99	0.29
5	1	8	85	104	SERVICE-I	I	-886.40	-31.88	70.55	1144.58	2288.50	659.99	0.22
6	1	9	86	104	SERVICE-I	I	-864.90	-31.88	70.55	791.85	2129.08	659.99	0.16
7	1	10	87	104	SERVICE-I	I	-842.40	-31.88	70.55	439.13	1969.66	659.99	0.12

Friday, April 25, 2014 12:56:53 PM, v4.19, C:\BIG_DOG\FB_Multipier_Models_Expo_2014\Design_Tables_for_Expo.in Page 1 of 1

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Send Link

Store Files

Pier Cap Shear Design Data

File Edit View Window Help

1 / 3 82.6%

Tools Sign Comment

Pier Cap Shear F22 Design

Pier Cap Shear F22 Design, Pier 1:
Maximum (+) Shear Forces at the Left and Right of the Bearings and at the Left Face, Right Face and Centerline of Supports

STRENGTH CASE DATA

LOCATION & SIDE	ELEM NO.	PROP NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (Kips)	F22 (Kips)	F33 (Kips)	M22 (Kip-ft)	M33 (Kip-ft)	TORQUE (Kip-ft)	D/C (Ratio)
Brg 1 L	13	23	92	5	STRENGTH-I	J	0.00	-6.75	0.00	-0.00	-10.01	-0.00	0.00
Brg 1 R	14	22	92	17	STRENGTH-III	I	-18.51	-81.76	0.00	0.00	-10.01	0.00	0.00
Brg 2 L	18	18	97	17	STRENGTH-III	J	-18.51	-96.88	0.00	-0.00	-544.87	0.00	0.12
Brg 2 R	19	17	97	17	STRENGTH-III	I	-37.02	-177.87	0.00	-0.00	-544.87	0.00	0.11
Col 1 LF	23	13	101,102	17	STRENGTH-III	I,J	-37.02	-192.14	0.00	-0.00	-1470.02	0.00	0.29
Brg 3 L	23	13	102	17	STRENGTH-III	J	-37.02	-195.15	0.00	-0.00	-1662.92	0.00	0.33
Brg 3 R	24	12	102	17	STRENGTH-III	I	-55.52	-282.16	0.00	-0.00	-1662.92	0.00	0.31
Col 1 LCL	26	10	88	17	STRENGTH-III	J	-55.52	-291.61	0.00	-0.00	-2523.45	0.00	0.46
Col 1 RCL	27	26	88	9	STRENGTH-III	I	55.52	469.49	-0.00	-0.00	-4257.09	0.00	0.84
Brg 4 L	29	28	107	9	STRENGTH-III	J	55.52	456.37	-0.00	-0.00	-2868.46	0.00	0.60
Brg 4 R	30	29	107	9	STRENGTH-III	I	37.02	328.37	-0.00	-0.00	-2868.46	0.00	0.60
Col 1 RF	30	29	107,108	9	STRENGTH-III	I,J	37.02	324.18	-0.00	-0.00	-2543.23	0.00	0.54
Brg 5 L	34	33	112	9	STRENGTH-III	J	37.02	304.37	-0.00	0.00	-971.67	0.00	0.24
Brg 5 R	35	34	112	9	STRENGTH-III	I	18.51	170.37	-0.00	0.00	-971.67	0.00	0.24
Brg 6 L	39	38	117	9	STRENGTH-III	J	18.51	149.37	-0.00	0.00	-13.90	0.00	0.01
Brg 6 R	40	39	117	1	STRENGTH-I	I	-0.00	9.38	-0.00	-0.00	-13.90	0.00	0.00

SERVICE CASE DATA

LOCATION & SIDE	ELEM NO.	PROP NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (Kips)	F22 (Kips)	F33 (Kips)	M22 (Kip-ft)	M33 (Kip-ft)	TORQUE (Kip-ft)	D/C (Ratio)
Brg 1 L	13	23	92	89	SERVICE-I	J	0.00	-7.50	0.00	-0.00	-11.12	0.00	0.00
Brg 1 R	14	22	92	89	SERVICE-I	I	-6.47	-134.93	5.00	-0.00	-11.12	-0.00	0.00
Brg 2 L	18	18	97	89	SERVICE-I	J	-6.47	-151.73	5.00	-30.00	-869.93	-0.00	0.20
Brg 2 R	19	17	97	89	SERVICE-I	I	-12.93	-277.59	10.00	-30.00	-869.93	-0.00	0.19
Col 1 LF	23	13	101,102	89	SERVICE-I	I,J	-12.93	-293.44	10.00	-80.00	-2297.63	-0.00	0.46
Brg 3 L	23	13	102	89	SERVICE-I	J	-12.93	-296.79	10.00	-90.00	-2591.91	-0.00	0.52
Brg 3 R	24	12	102	89	SERVICE-I	I	-19.40	-421.08	15.00	-90.00	-2591.91	-0.00	0.51
Col 1 LCL	26	10	88	89	SERVICE-I	J	-19.40	-431.58	15.00	-135.00	-3870.76	-0.00	0.73
Col 1 RCL	27	26	88	89	SERVICE-I	I	19.40	369.42	0.00	0.00	-3333.72	0.00	0.64
Brg 4 L	29	28	107	89	SERVICE-I	J	19.40	358.92	0.00	0.00	-2241.33	0.00	0.46
Brg 4 R	30	29	107	89	SERVICE-I	I	12.93	257.21	0.00	0.00	-2241.33	0.00	0.46
Col 1 RF	30	29	107,108	89	SERVICE-I	I,J	12.93	253.86	0.00	0.00	-1986.63	0.00	0.41
Brg 5 L	34	33	112	89	SERVICE-I	J	12.93	238.01	0.00	0.00	-756.81	0.00	0.18
Brg 5 R	35	34	112	89	SERVICE-I	I	6.47	132.87	0.00	0.00	-756.81	0.00	0.18
Brg 6 L	39	38	117	89	SERVICE-I	J	6.47	116.07	0.00	0.00	-11.12	0.00	0.01
Brg 6 R	40	39	117	89	SERVICE-I	I	0.00	7.50	-0.00	-0.00	-11.12	0.00	0.00

Friday, April 25, 2014 13:00:55 PM, v4.19, C:\BIG_DOG\FB_Multipier_Models_Expo_2014\Design_Tables_for_Expo.in Page 1 of 3

Sign In

Export PDF

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Adobe SendNow

Verify your file is received. Send files online instead of email.

Select File:

Design_Tables_for_Expo_Max_Pi...

1 file / 13 KB

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Store Files

Shear Envelope

Envelopes

Select Envelopes: Pier 1: Pier Cap F22 Shear Envelope: STRENGTH

Project Data
 Project Name: Date:
 Project Description: Computed By: HTB
 Job ID: Checked By:

Pier 1: Pier Cap F22 Shear Envelope: STRENGTH

F22 (kips) vs. Pier Cap X Coordinate (ft)

Maximum (+)

X' Coordinate ft	F22 kips
3.000	-6.750
3.000	-81.760
9.000	-96.880
9.000	-177.870
14.000	-192.140
15.000	-195.150
15.000	-282.160
18.000	-291.610
18.000	469.490
21.000	456.370
21.000	328.370
22.000	324.180
27.000	304.370

*Only positive values in the above table are used to plot the positive envelope.

Minimum (-)

X' Coordinate ft	F22 kips
3.000	-9.380
3.000	-274.380
9.000	-295.380
9.000	-472.880
14.000	-492.690
15.000	-496.880
15.000	-648.130
18.000	-661.250
18.000	291.610
21.000	282.160
21.000	195.150
22.000	192.140
27.000	177.870

*Only negative values in the above table are used to plot the negative envelope.

Moment Envelope

Envelopes

Select Envelopes: Pier 1: Pier Cap M33 Moment Envelope: STRENGTH

Project Data:
 Project Name: _____ Date: _____
 Project Description: _____ Computed By: HTB
 Job ID: _____ Checked By: _____

Pier 1: Pier Cap M33 Moment Envelope: STRENGTH

M33 (kip-ft) vs Pier Cap X Coordinate (ft)

X' Coordinate ft	M33 kip-ft
3.000	-10.010
9.000	-544.870
14.000	-1470.020
15.000	-1662.920
18.000	-2523.450
21.000	-1662.920
22.000	-1470.020
27.000	-544.870
33.000	-10.010

Maximum (+)

X' Coordinate ft	M33 kip-ft
3.000	-10.010
9.000	-544.870
14.000	-1470.020
15.000	-1662.920
18.000	-2523.450
21.000	-1662.920
22.000	-1470.020
27.000	-544.870
33.000	-10.010

*Only positive values in the above table are used to plot the positive envelope.

X' Coordinate ft	M33 kip-ft
3.000	-13.900
9.000	-1721.710
14.000	-4135.790
15.000	-4629.520
18.000	-6593.420
21.000	-2868.460
22.000	-2543.230
27.000	-971.670
33.000	-13.900

Minimum (-)

*Only negative values in the above table are used to plot the negative envelope.

Data Exporting

The screenshot displays a Microsoft Excel spreadsheet titled "Design_Tables_for_Expo_Max_PierCap_Moment_Design.xml [Read-Only] - Microsoft Excel". The spreadsheet contains a table of data for "Pier Cap M33 Moment Design".

LOCATION & SIDE	ELEM NO.	PROP NO.	NODE NO.	LOAD COMB	AASHTO-LRFD	I/J	FAX (kips)	M22 (kip-ft)	M33 (kip-ft)	D/C (Ratio)
Brig 5	35	34	112	9	STRENGTH-III	I	18.51	0.00	-971.67	0.24
Brig 6	39	38	117	32	STRENGTH-V	J	-7.79	0.00	-13.90	0.00
SERVICE CASE DATA										
Brig 1	13	23	92	89	SERVICE-I	J	0.00	0.00	-11.12	0.00
Brig 2	18	18	97	95	SERVICE-I	J	6.47	-179.99	-1236.81	0.29
Col 1 LF	23	13	101, 102	96	SERVICE-I	I,J	12.93	429.99	-3016.63	0.63
Brig 3	23	13	102	96	SERVICE-I	J	12.93	479.99	-3381.33	0.70
Col 1 CL	26	10	88	96	SERVICE-I	J	19.40	659.98	-4848.72	0.94
Brig 4	30	29	107	89	SERVICE-I	I	12.93	0.00	-2241.33	0.46
Col 1 RF	30	29	107, 108	89	SERVICE-I	I,J	12.93	0.00	-1986.63	0.41
Brig 5	35	34	112	89	SERVICE-I	I	6.47	0.00	-756.81	0.18
Brig 6	39	38	117	95	SERVICE-I	J	-6.47	0.00	-11.12	0.00

Location & Side Key:

- Col = Column
- LF = left face of Column
- RF = right face of Column
- CL = centerline of Column
- Brig = Bearing
- LR = bearing is in the left row
- RR = bearing is in the right row

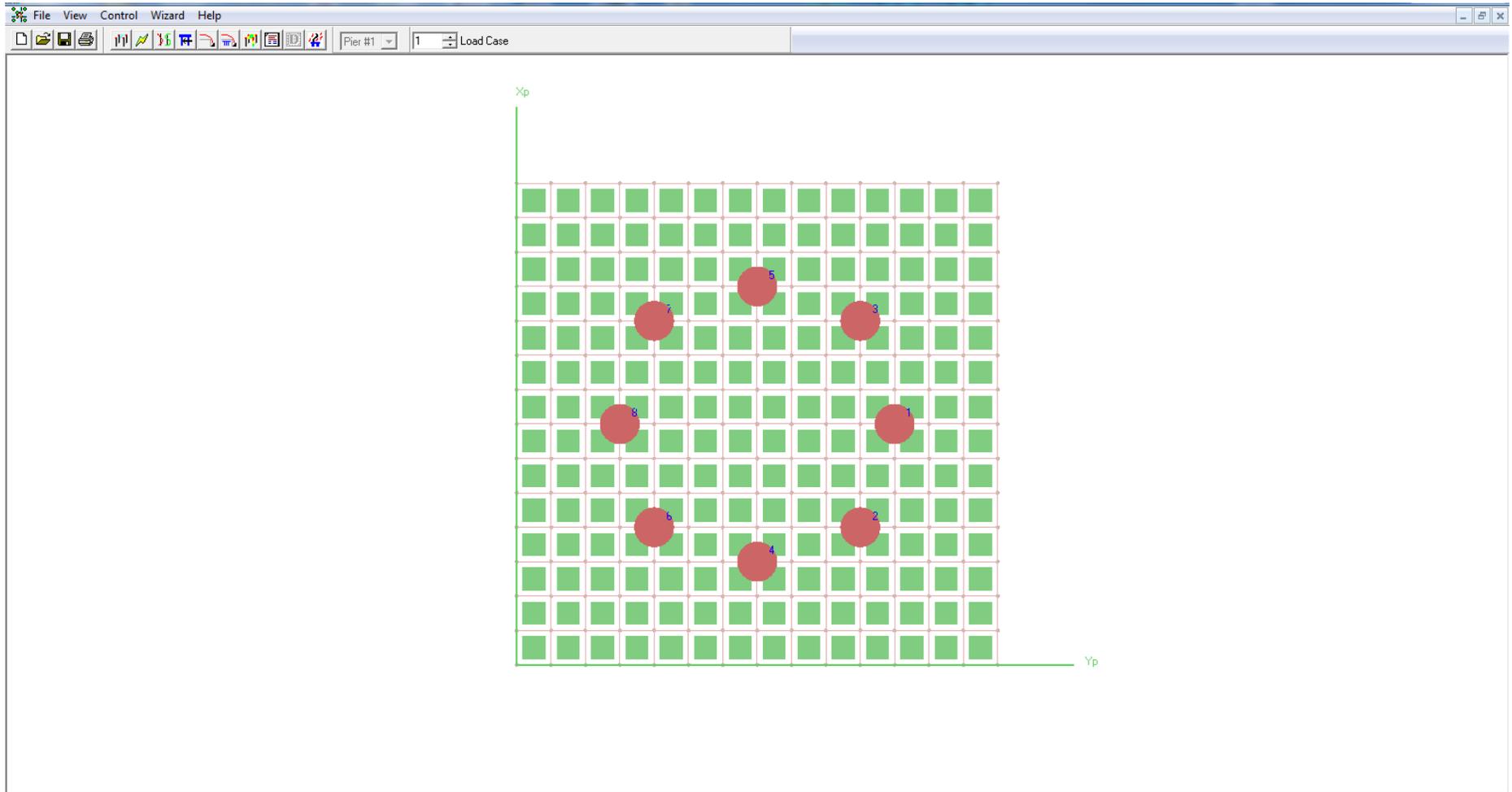
Agenda

- Use of Design Tables
- **Model Showcase**
- Summary

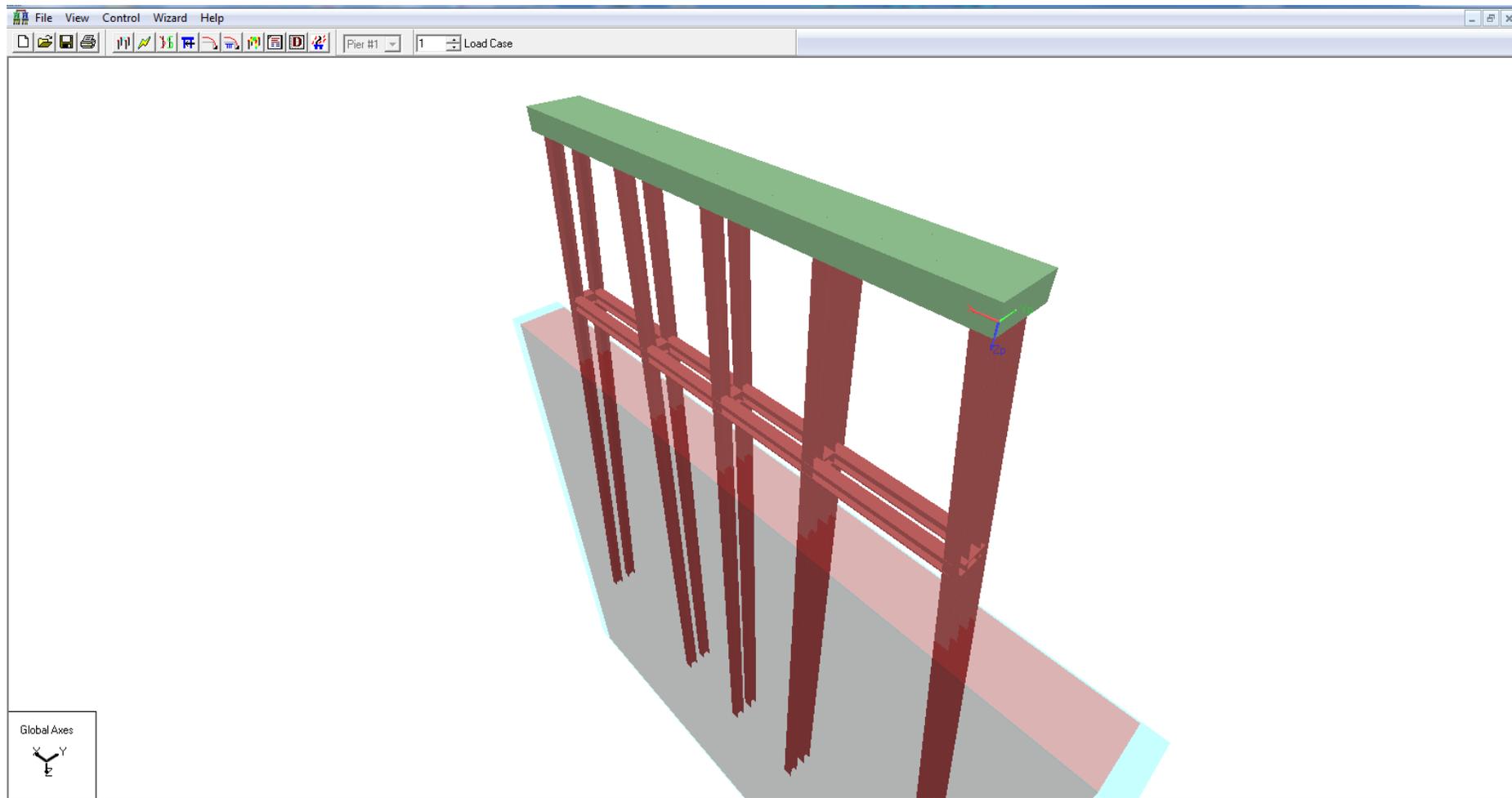
FB-Multiplier Models

YOU MADE THESE!!!!!!

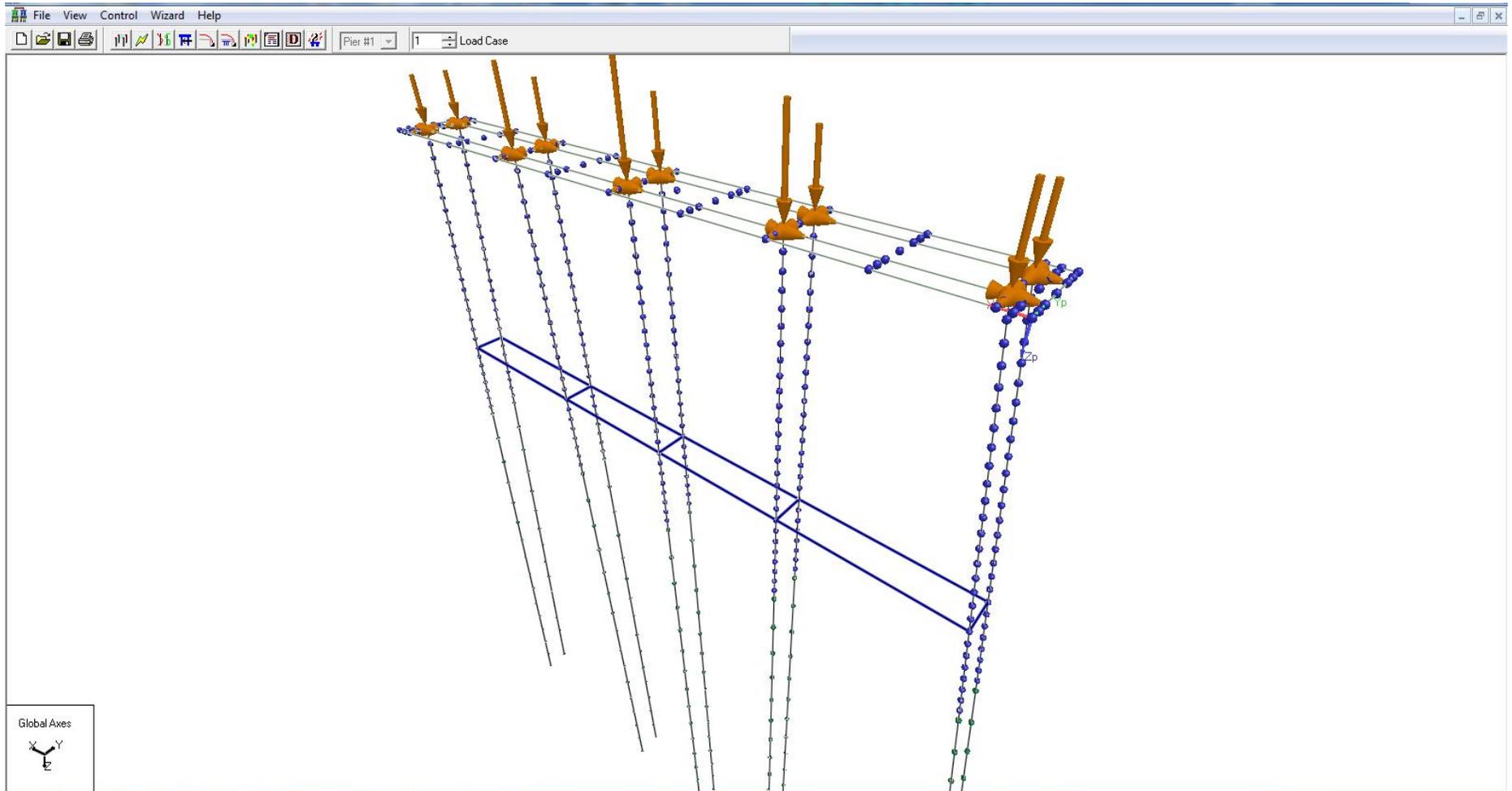
Any Pile Layout



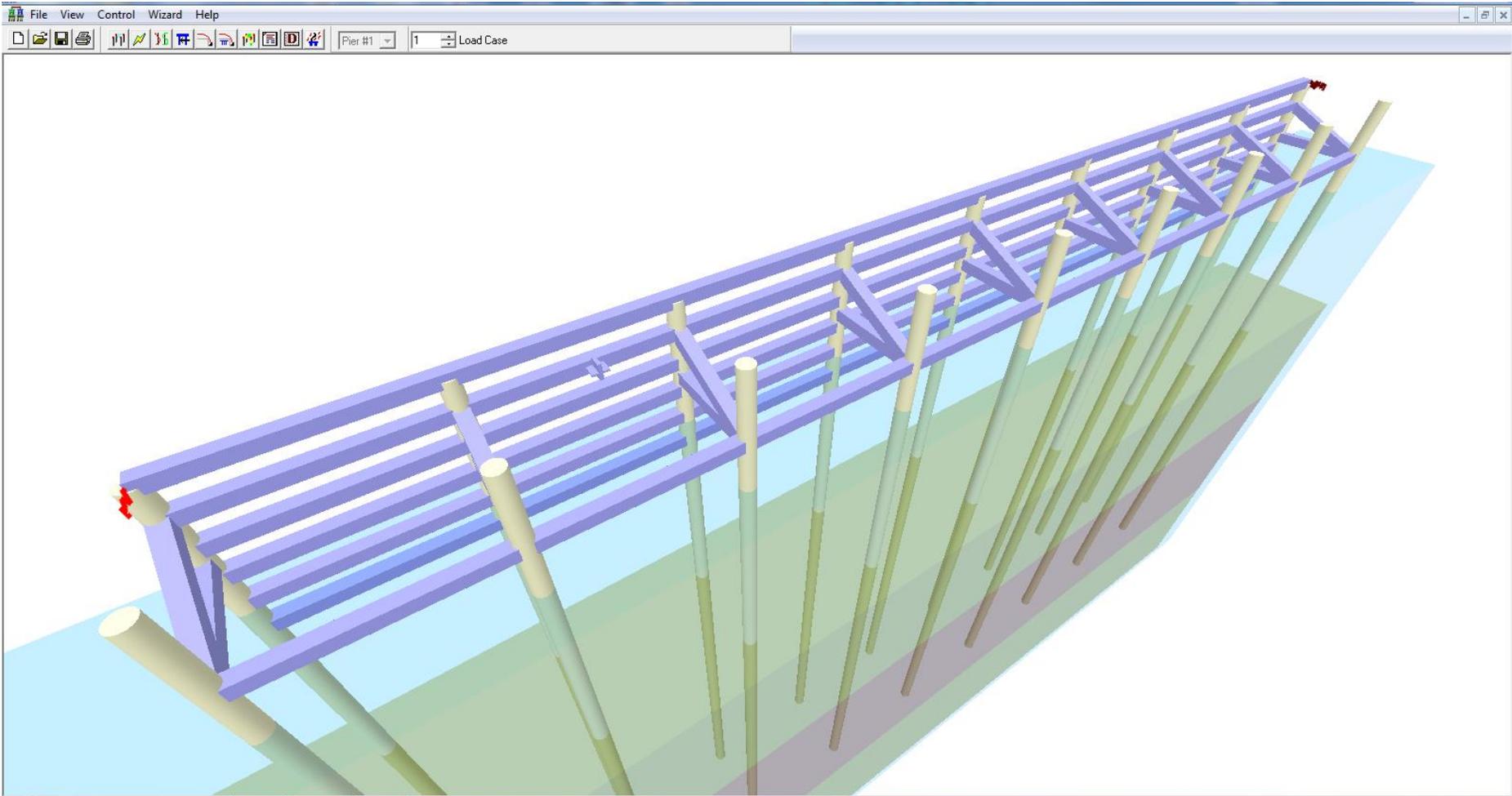
Steel H-Piles and Bracing



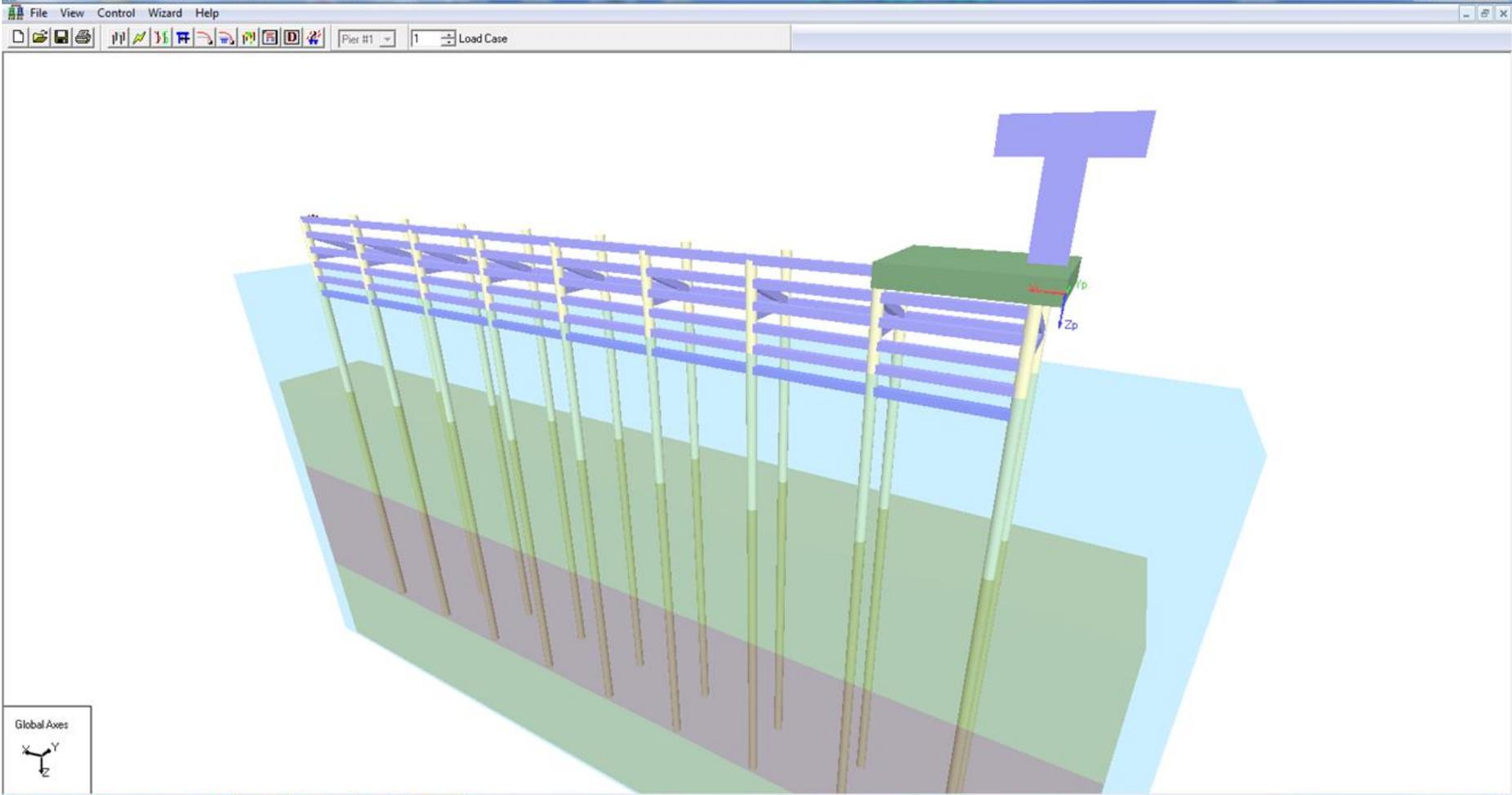
“Thin View” Extra Member Bracing



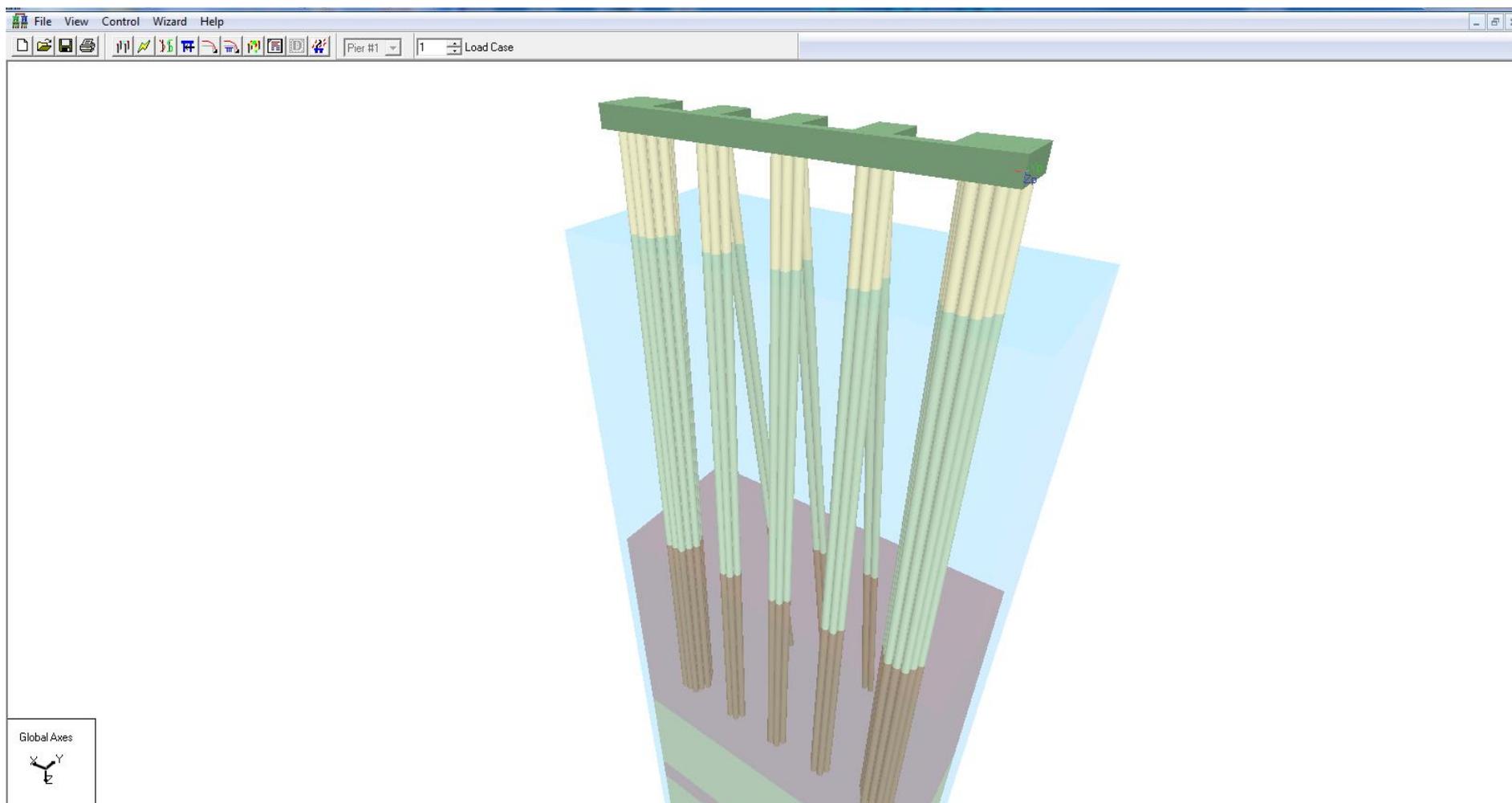
Barge Fender at Port Canaveral



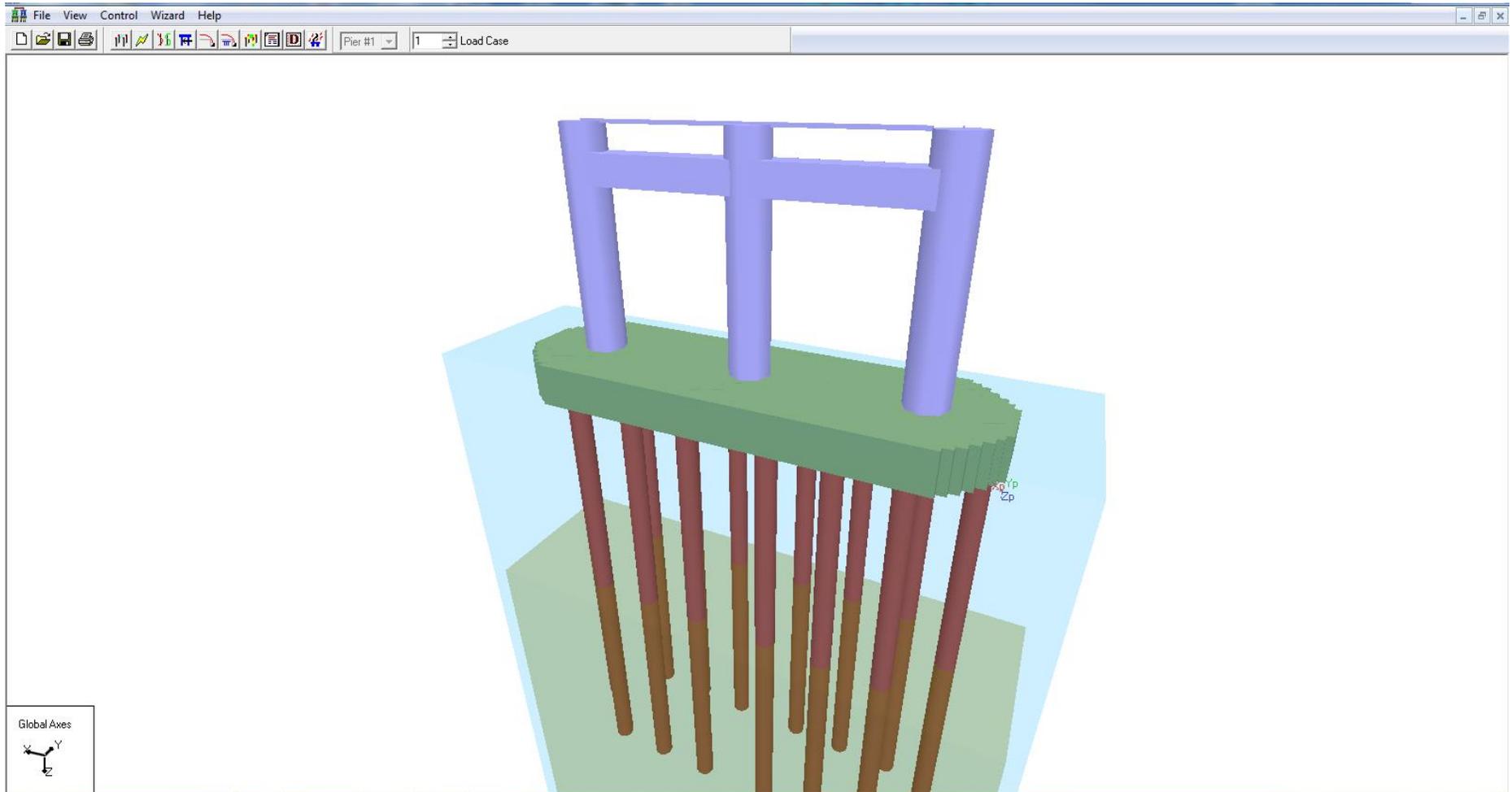
Edited General Pier Model



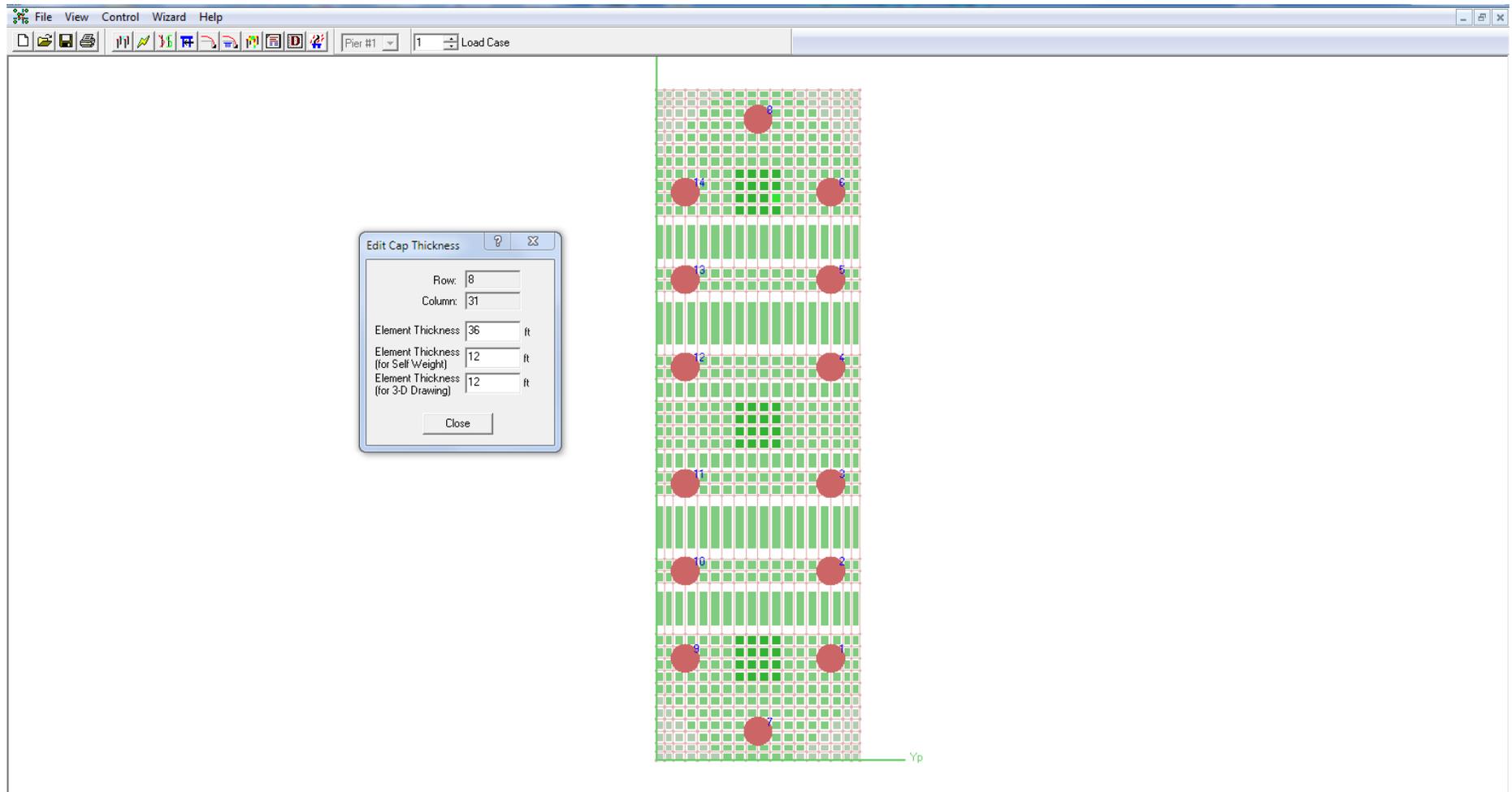
Multiple Timber Pile Clusters



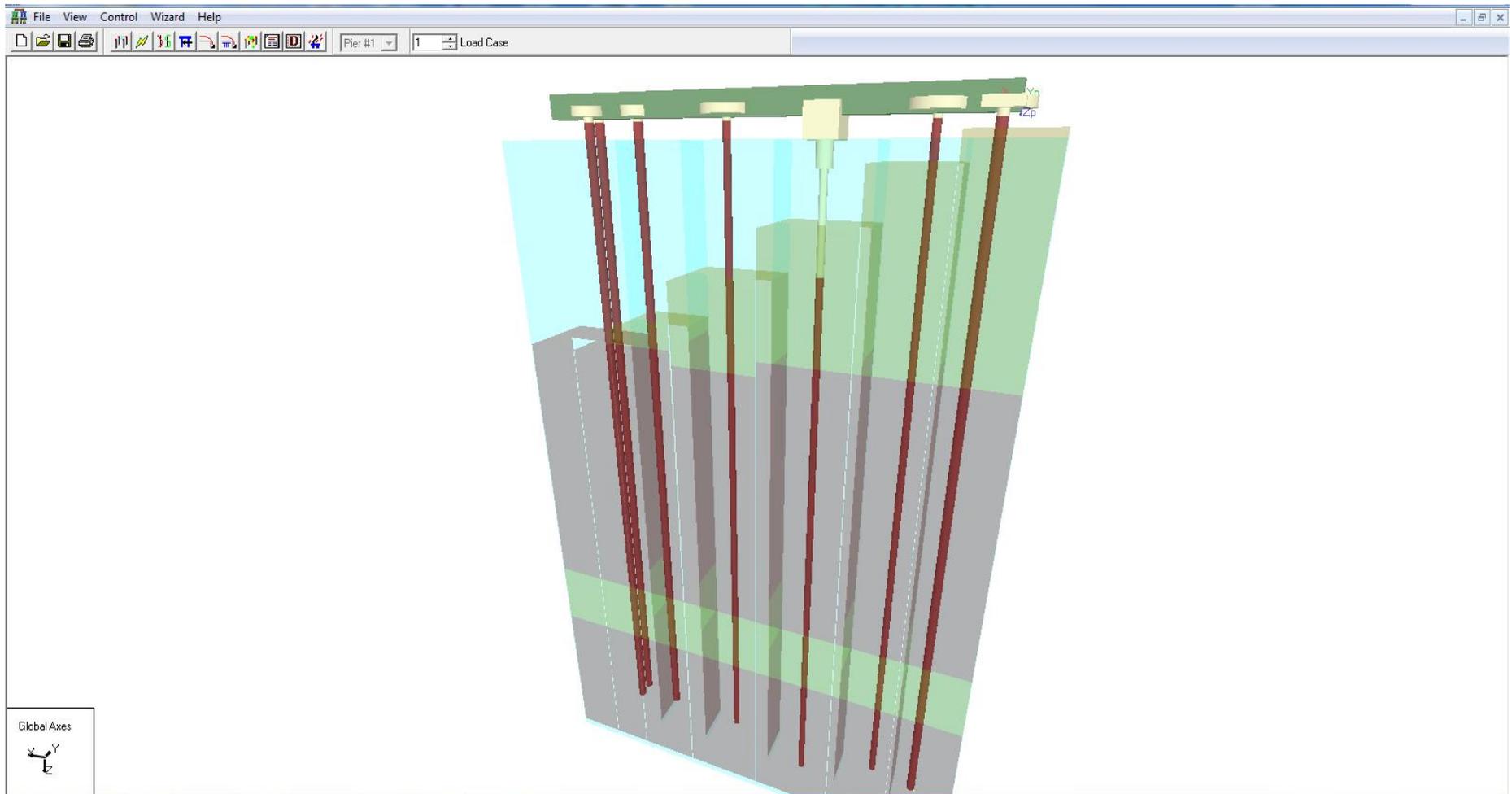
Pipe Piles, Strut, Reduced Pier Cap Stiffness



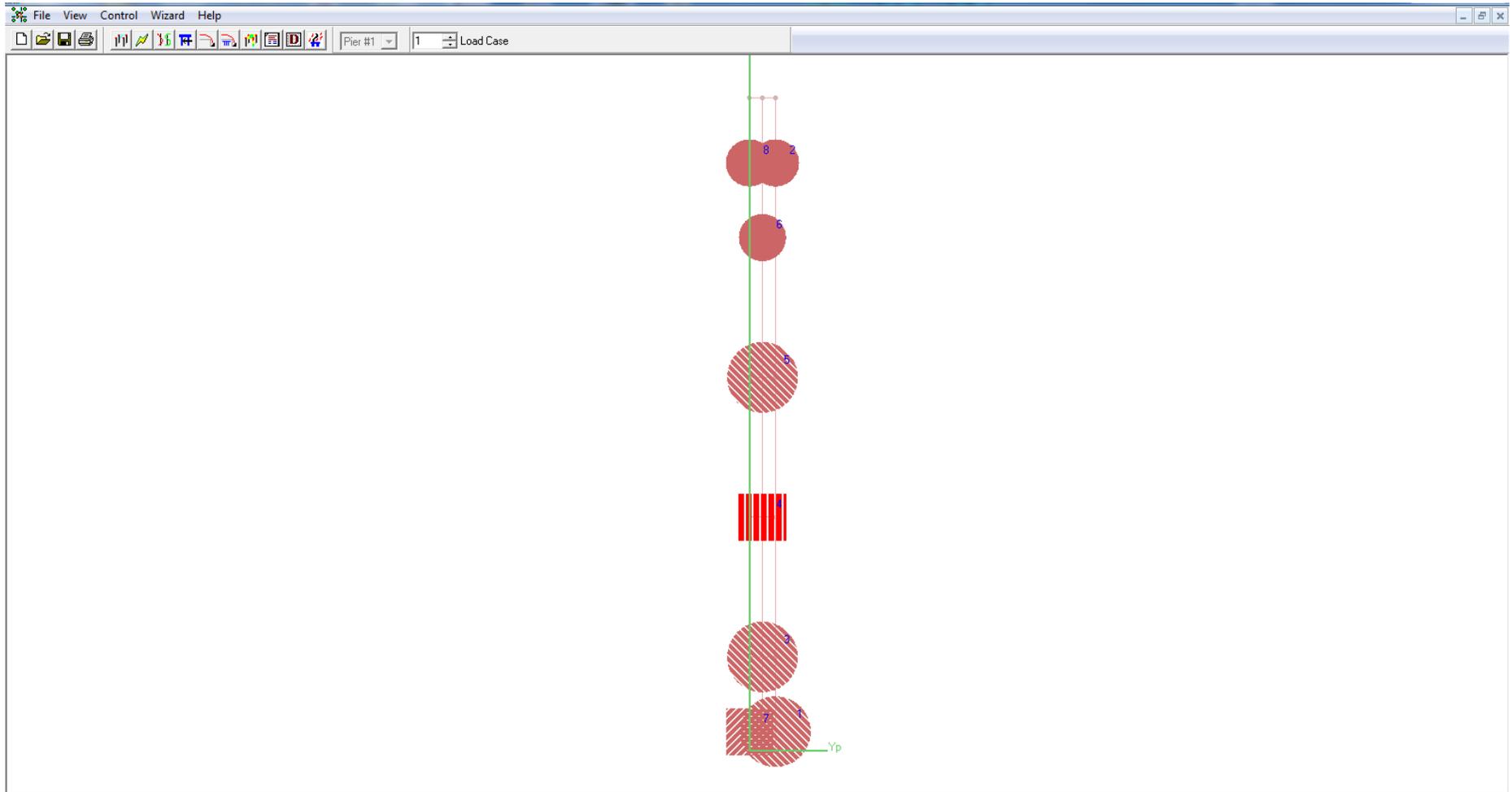
Cap Thickened and Some Elements Removed



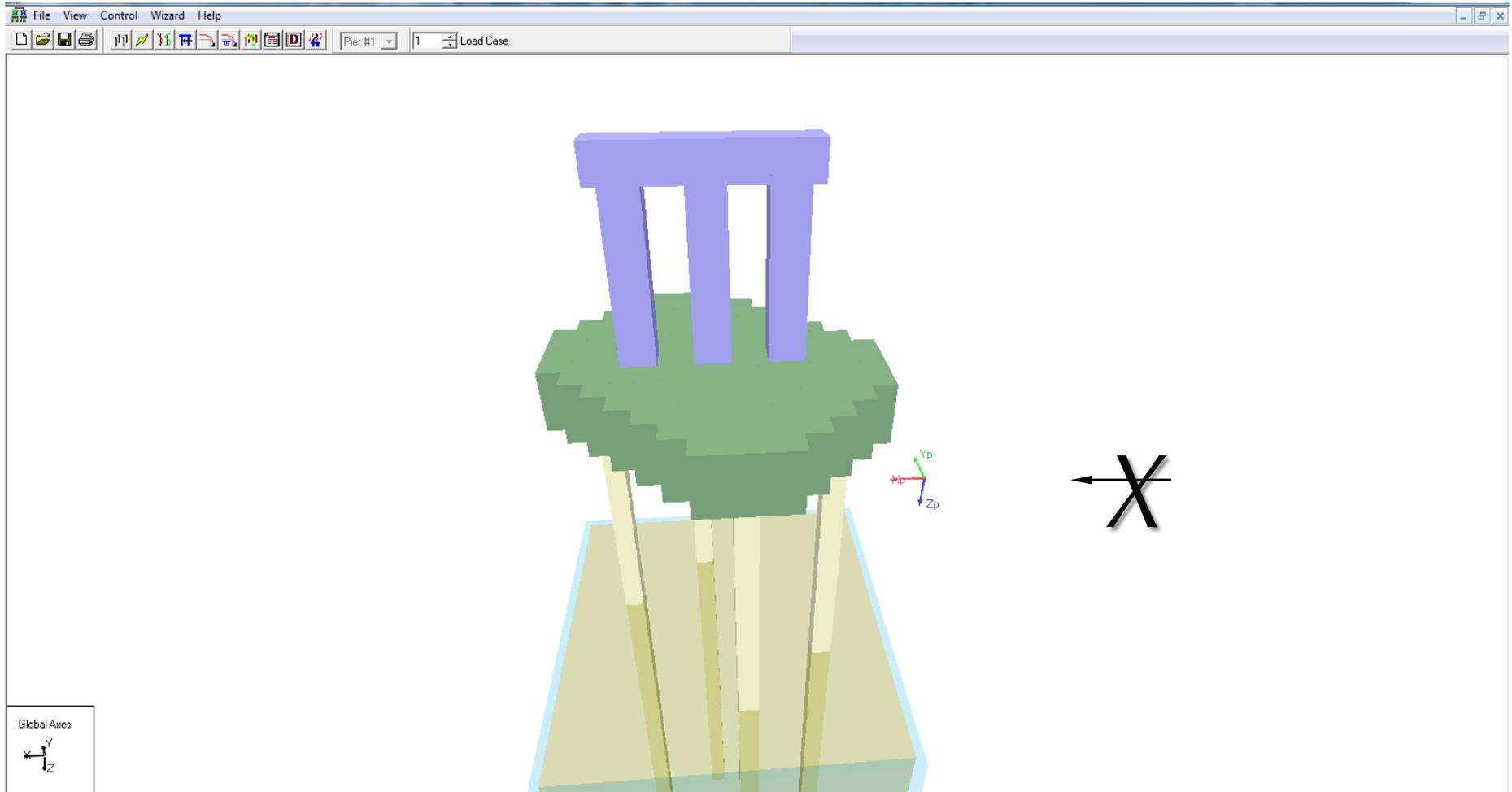
6 Soil Sets and 4 Pile Types



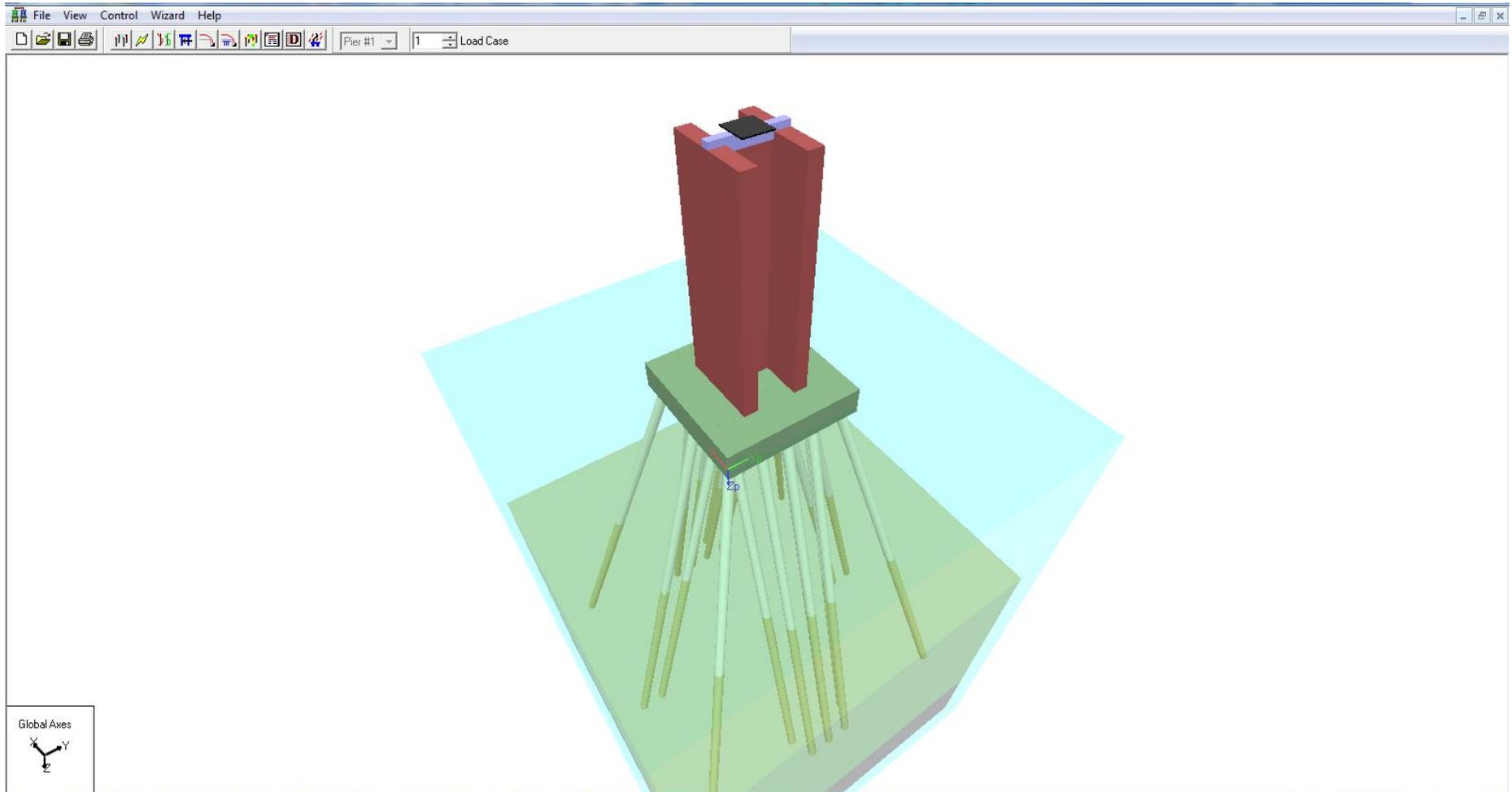
4 Pile Types



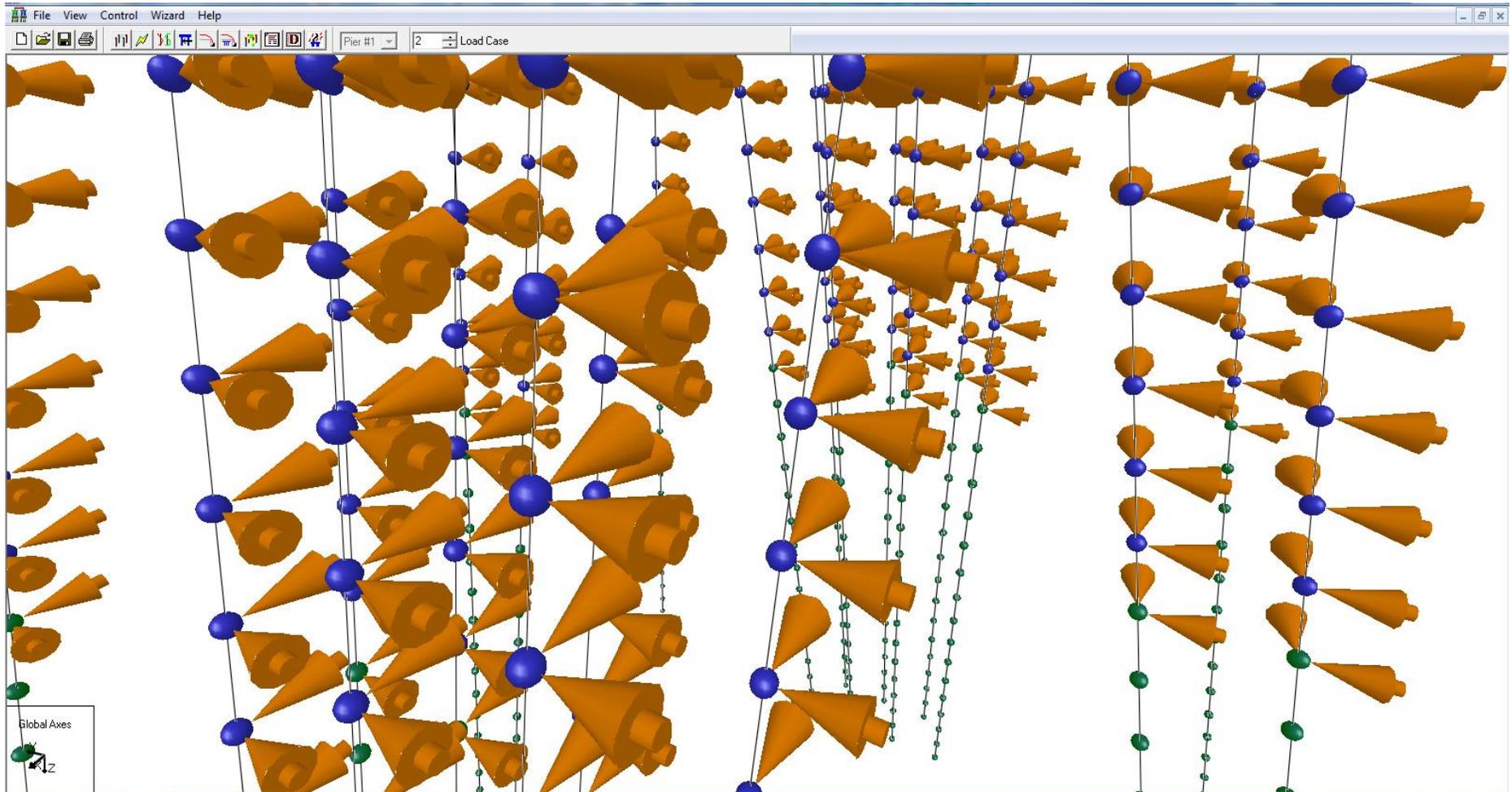
Cap Skewed to Pier



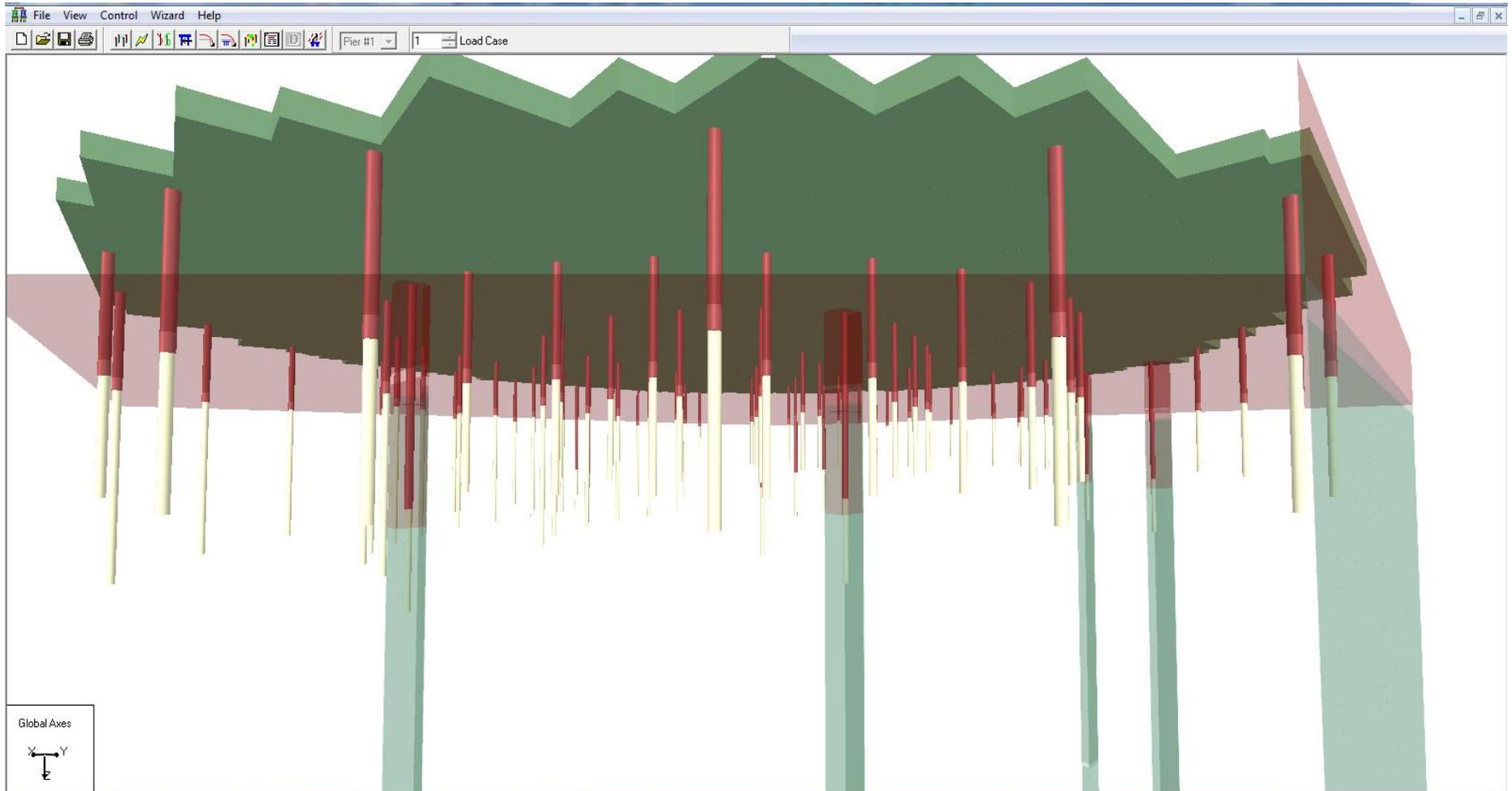
Bonner Bridge (H-Pile Pier)



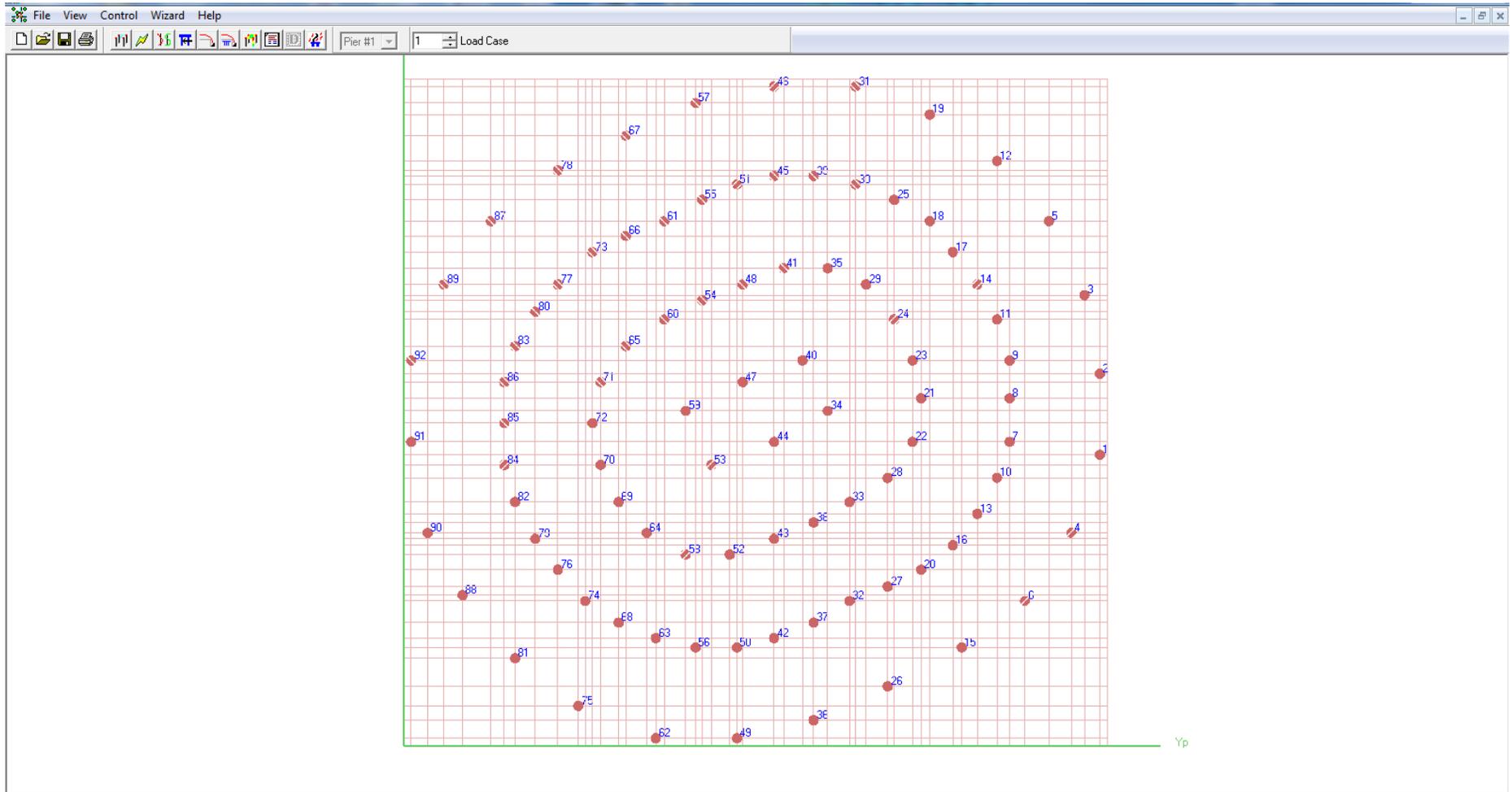
X and Y Loads at Every Pile Node



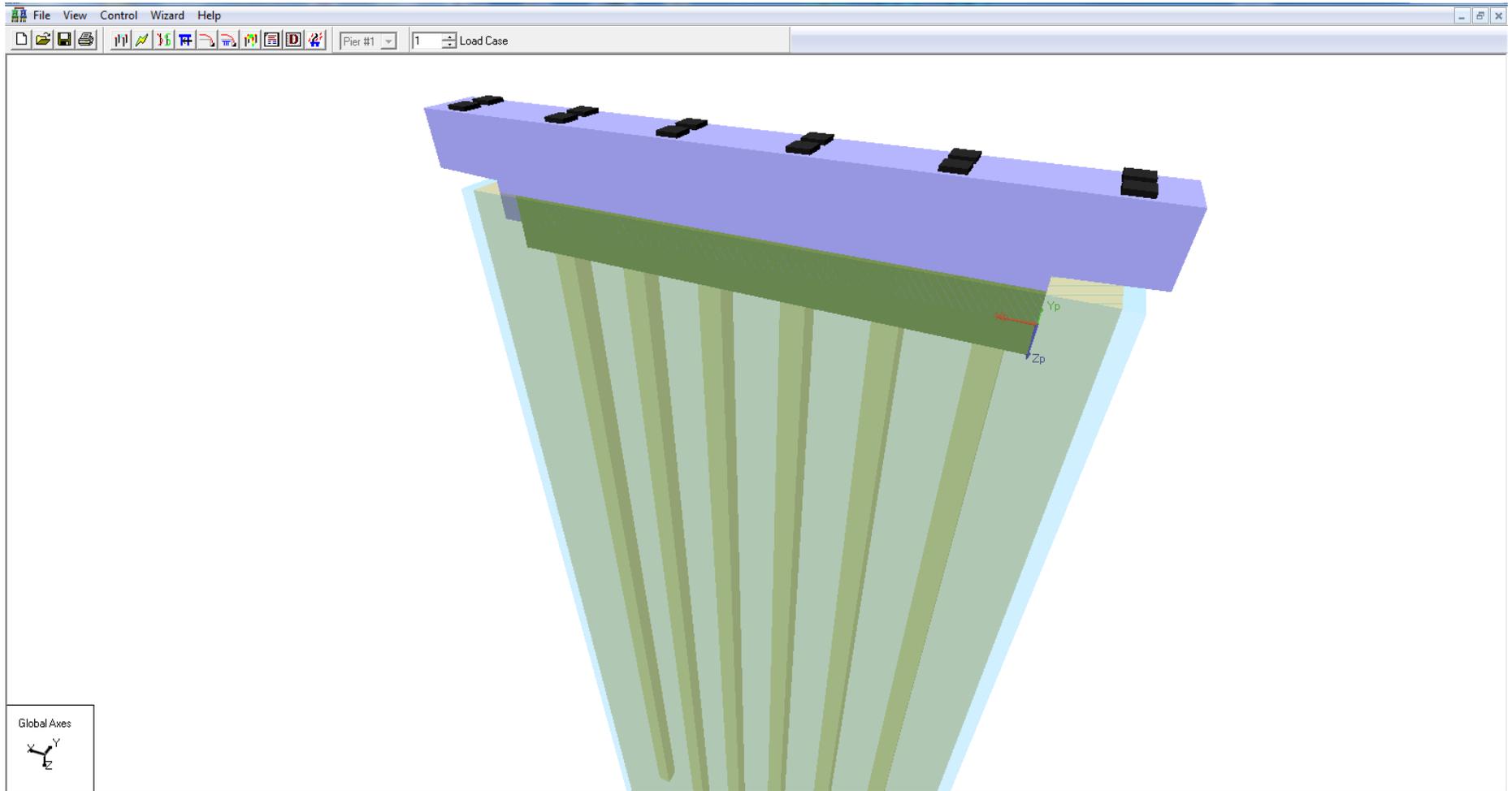
Oxidation Basin



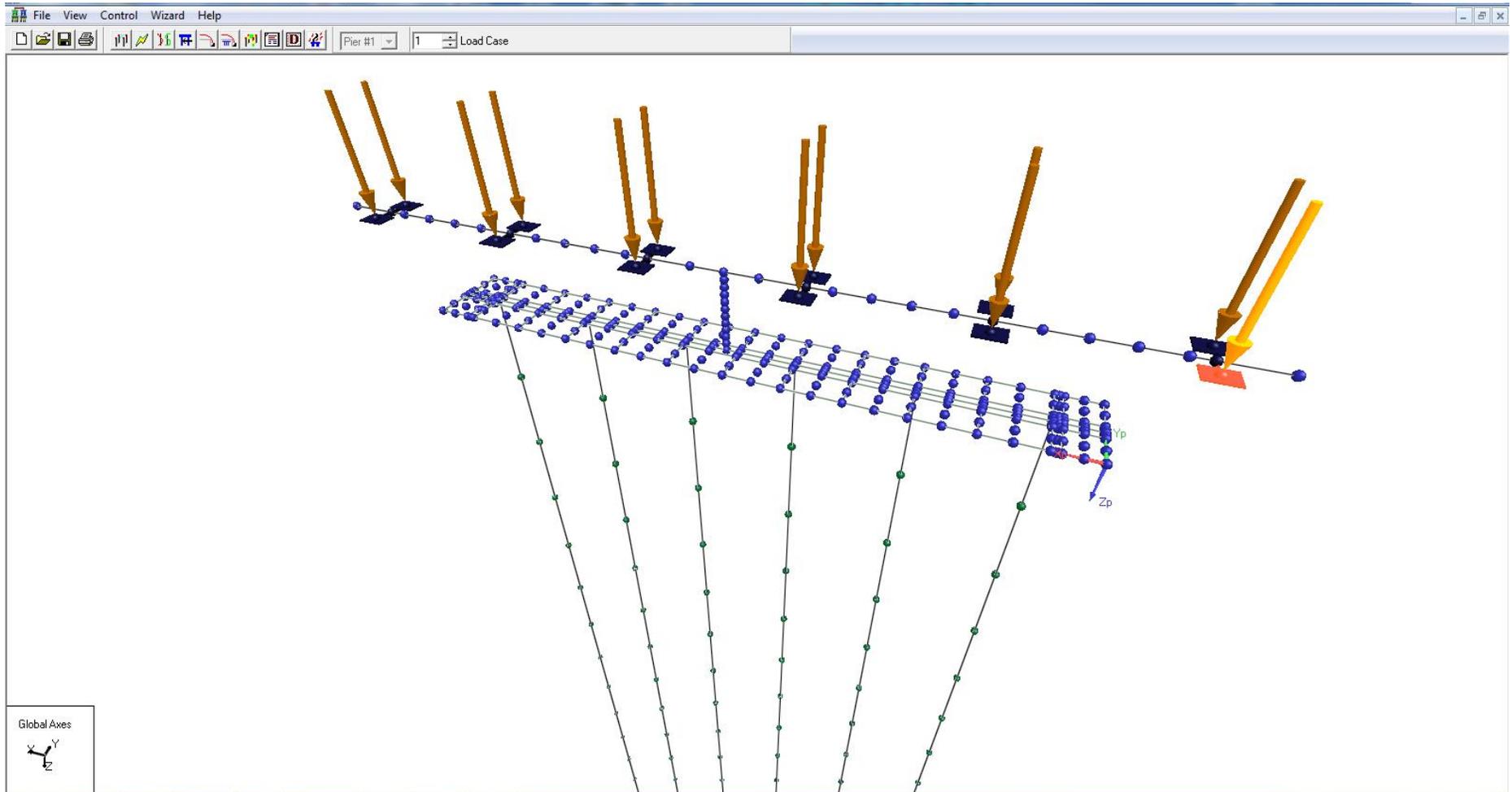
Oxidation Basin (Plan View)



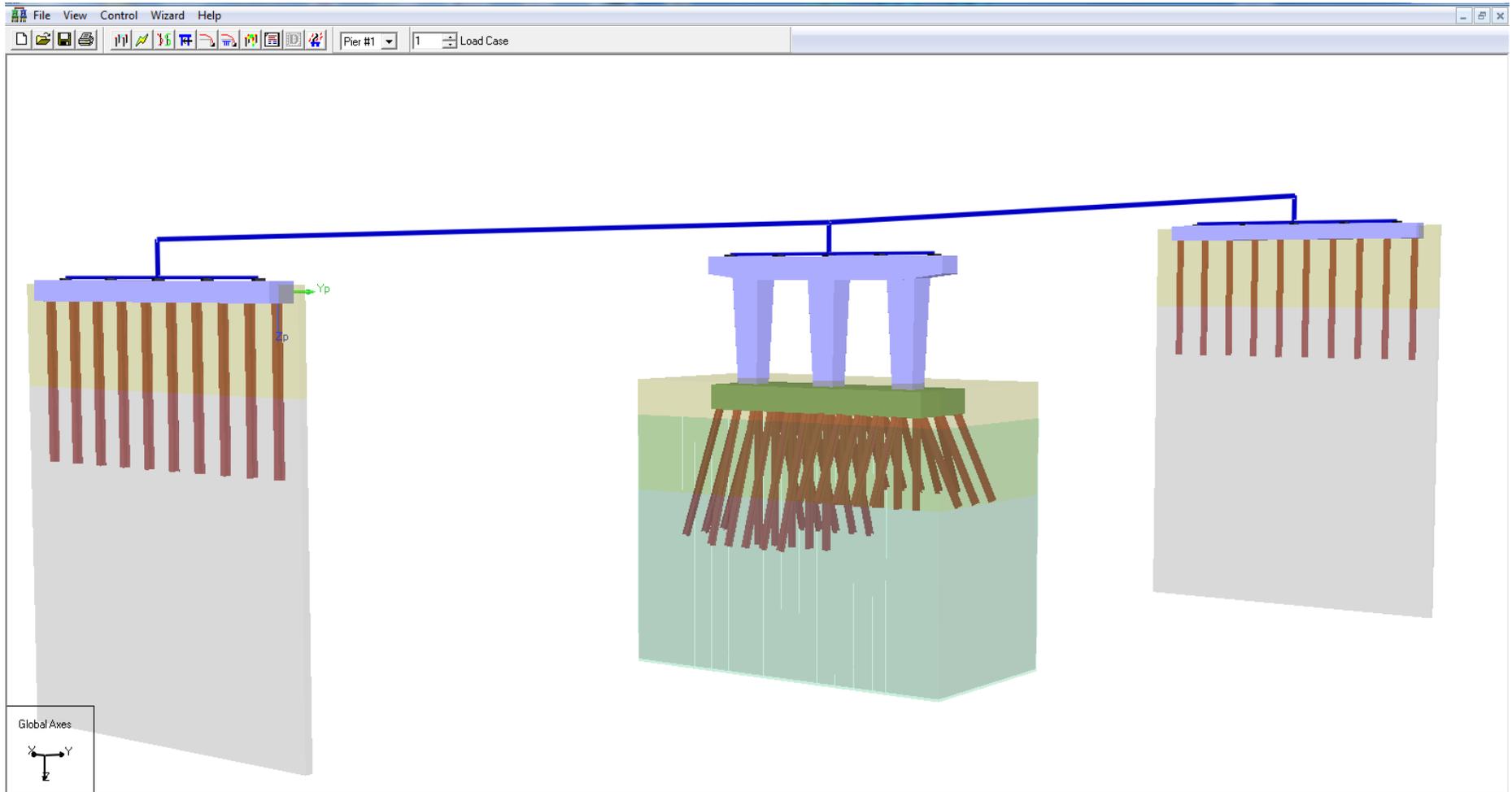
General Pier



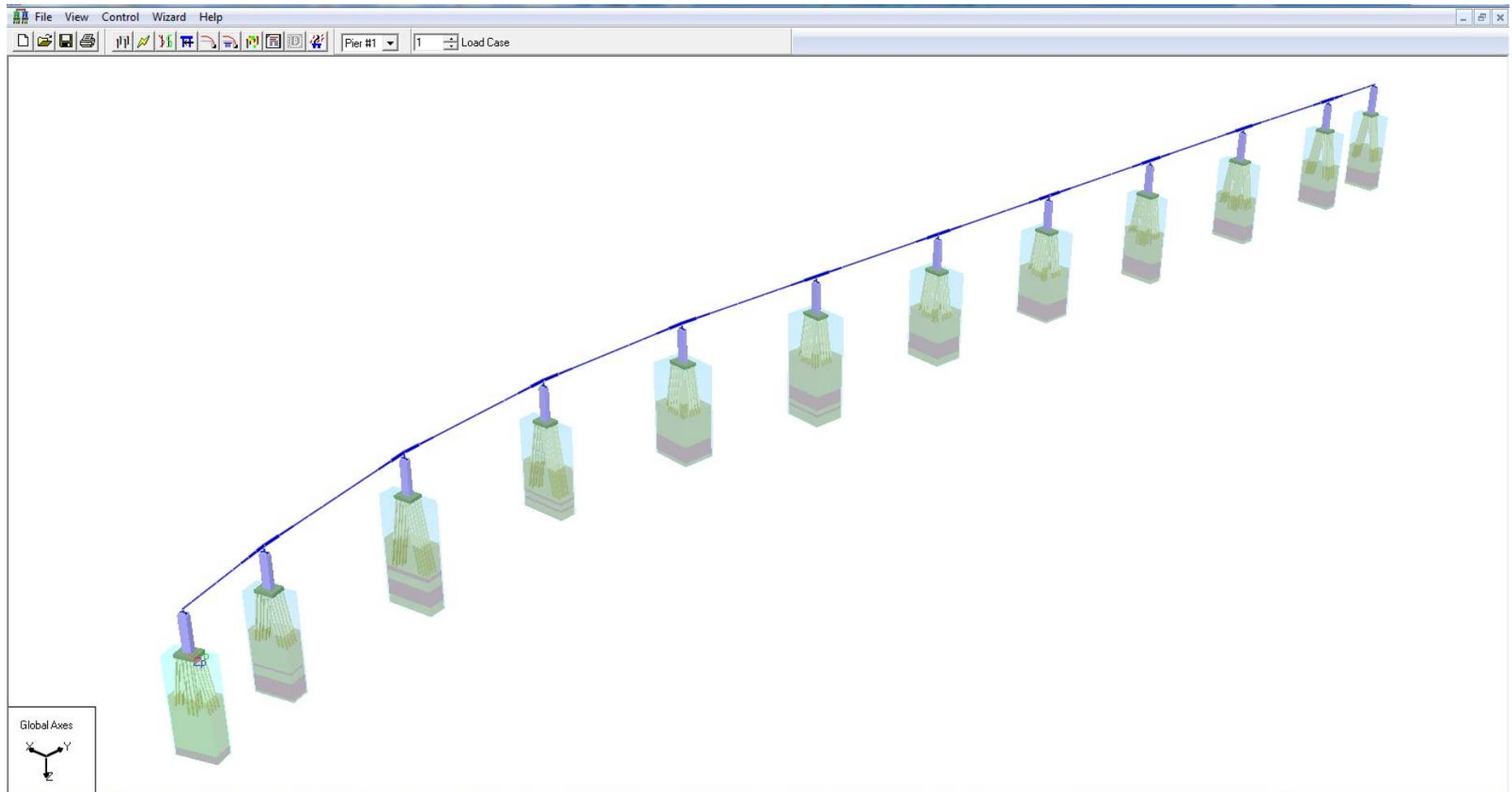
“Thin View”



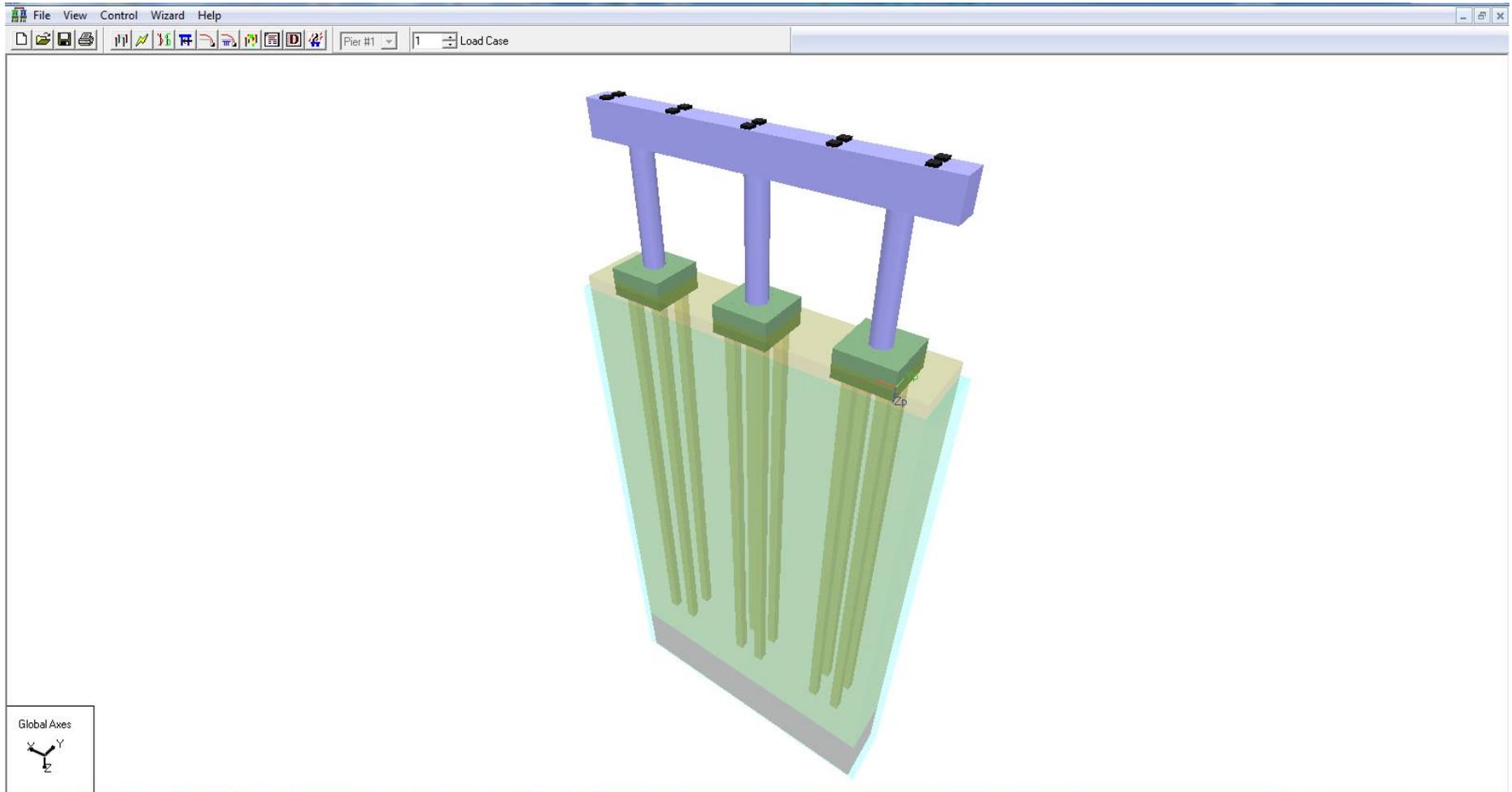
Two-Span Bridge



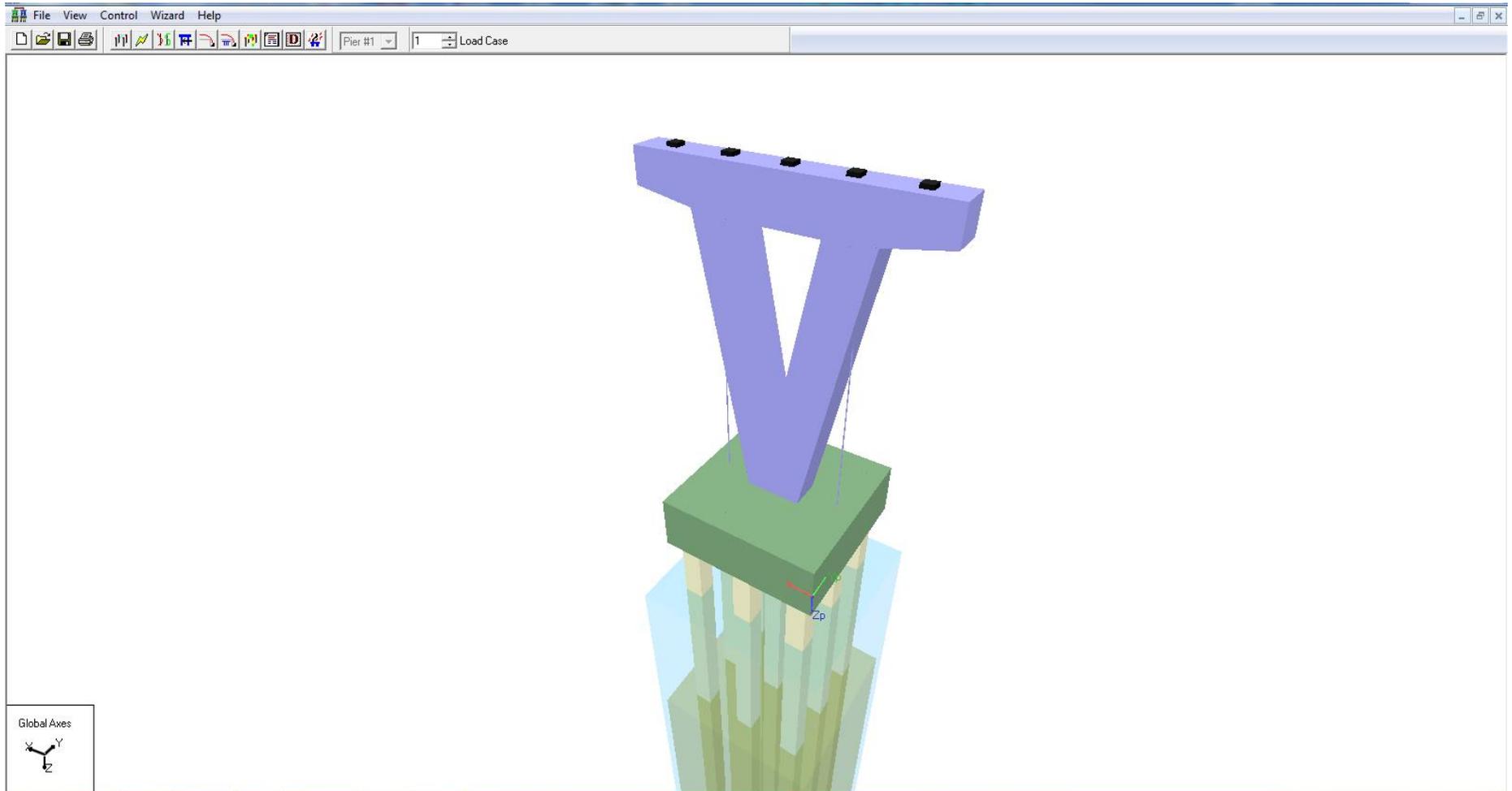
Eleven-Span Bridge (Curved)



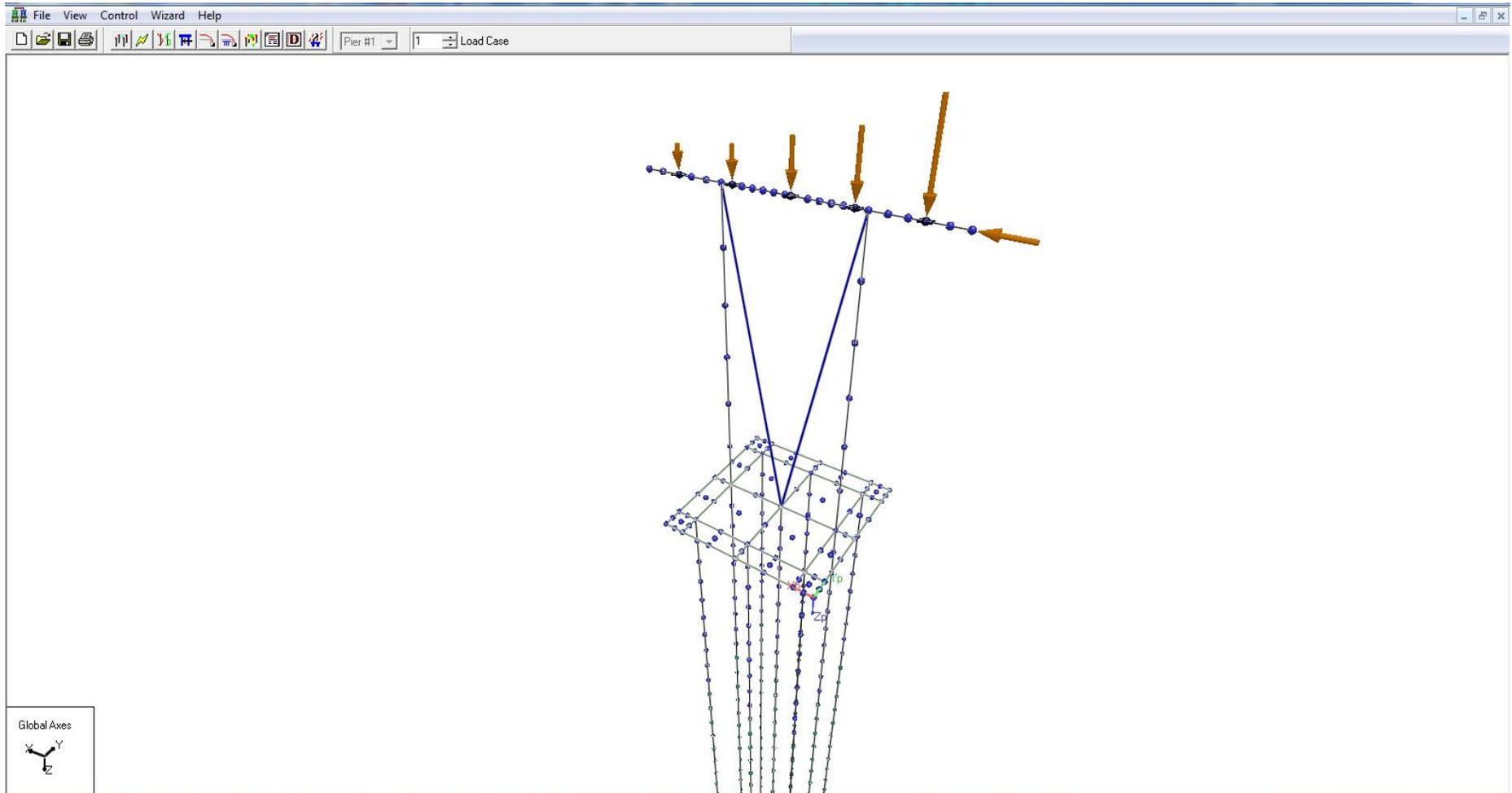
Typical Pier



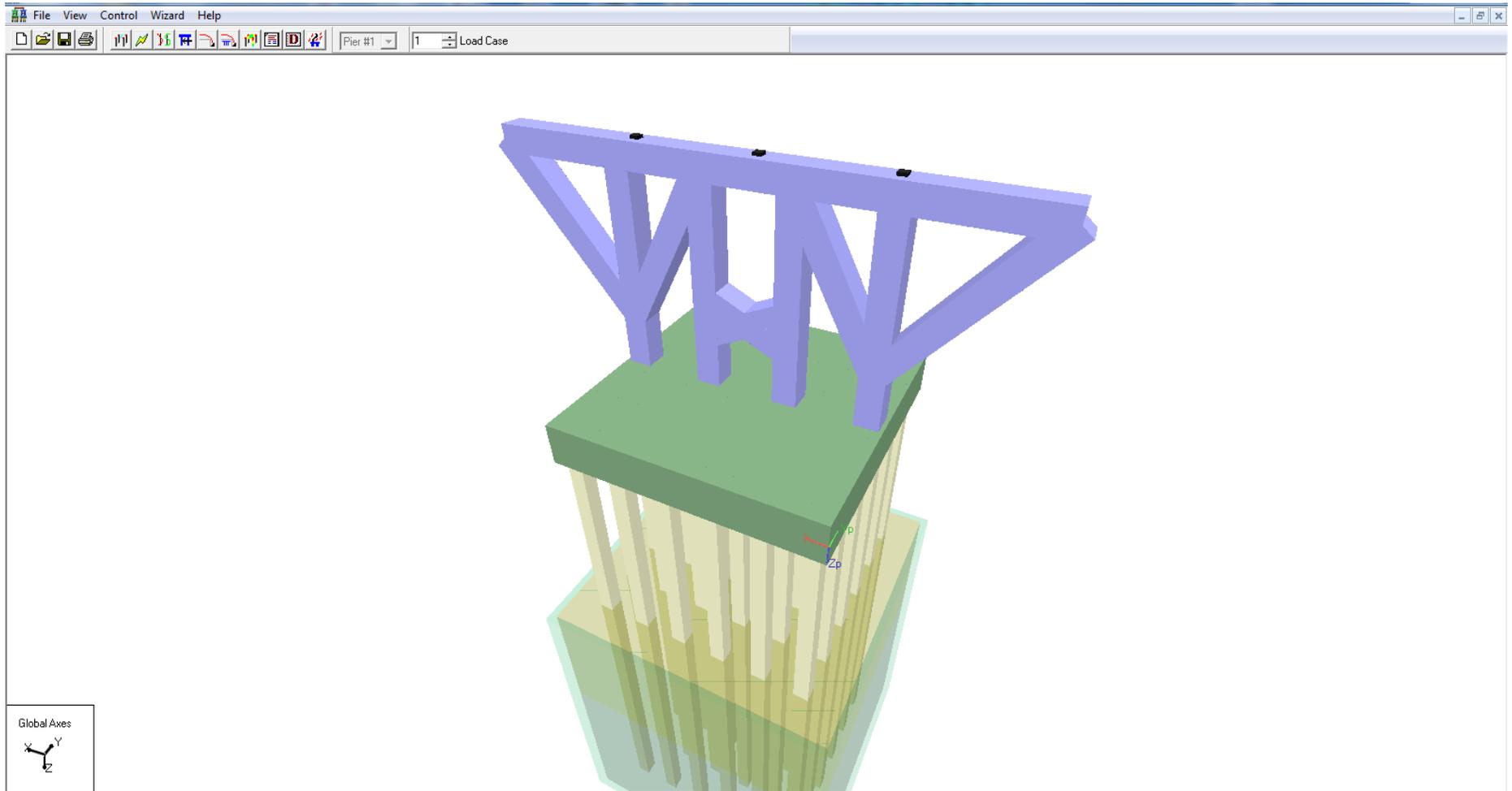
V-Pier



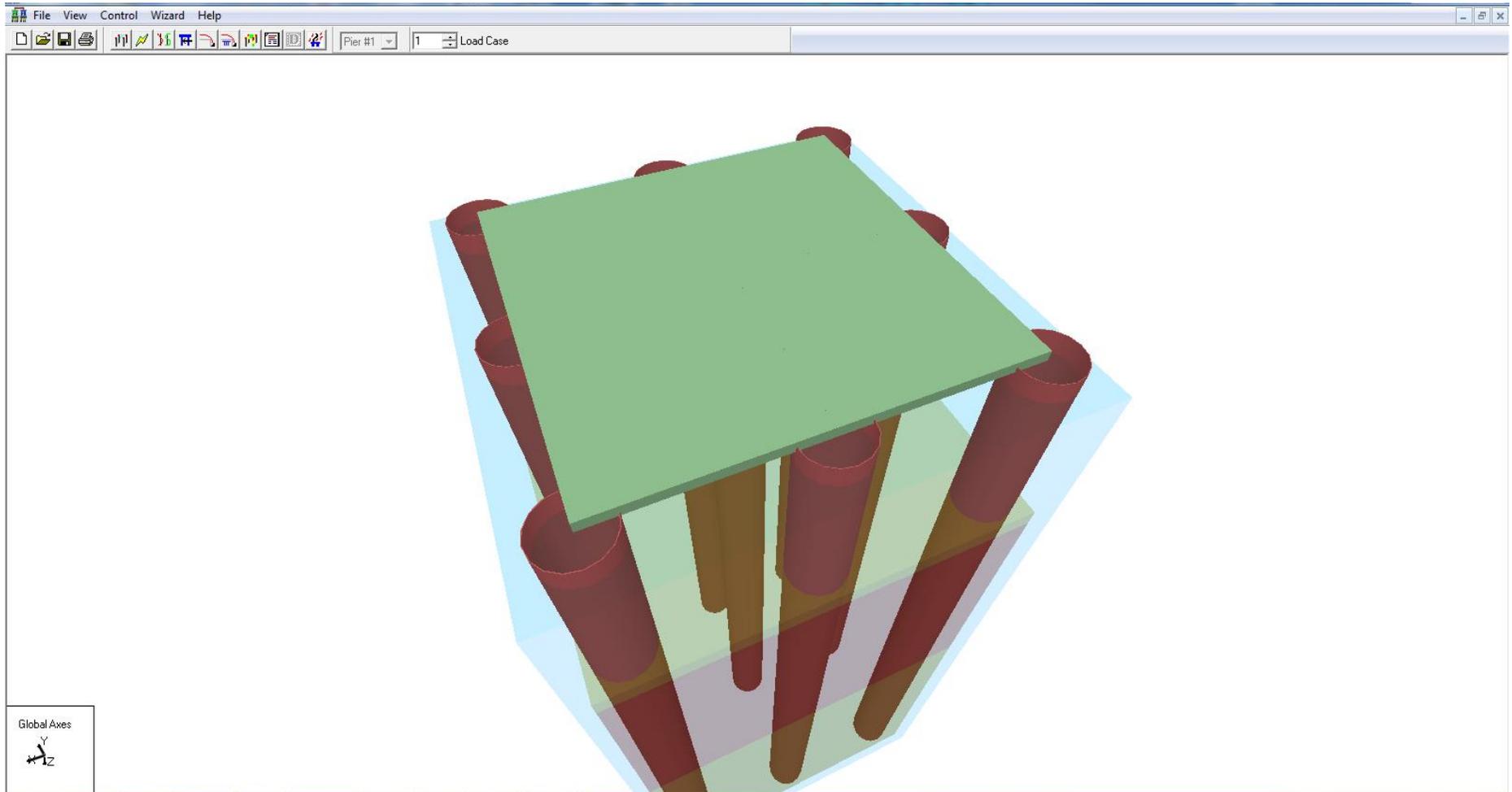
V-pier (Thin View)



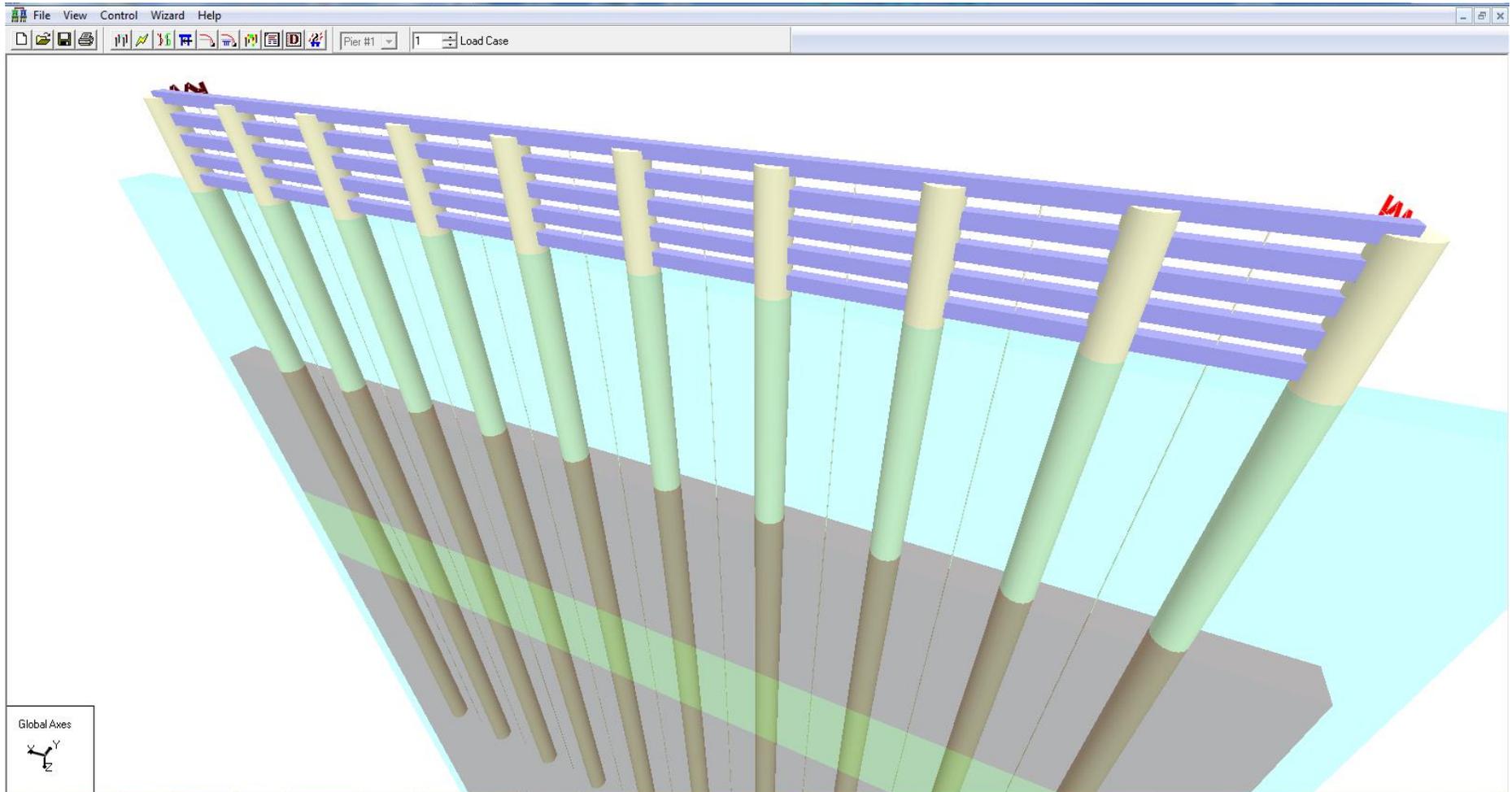
Interesting...HmMMM



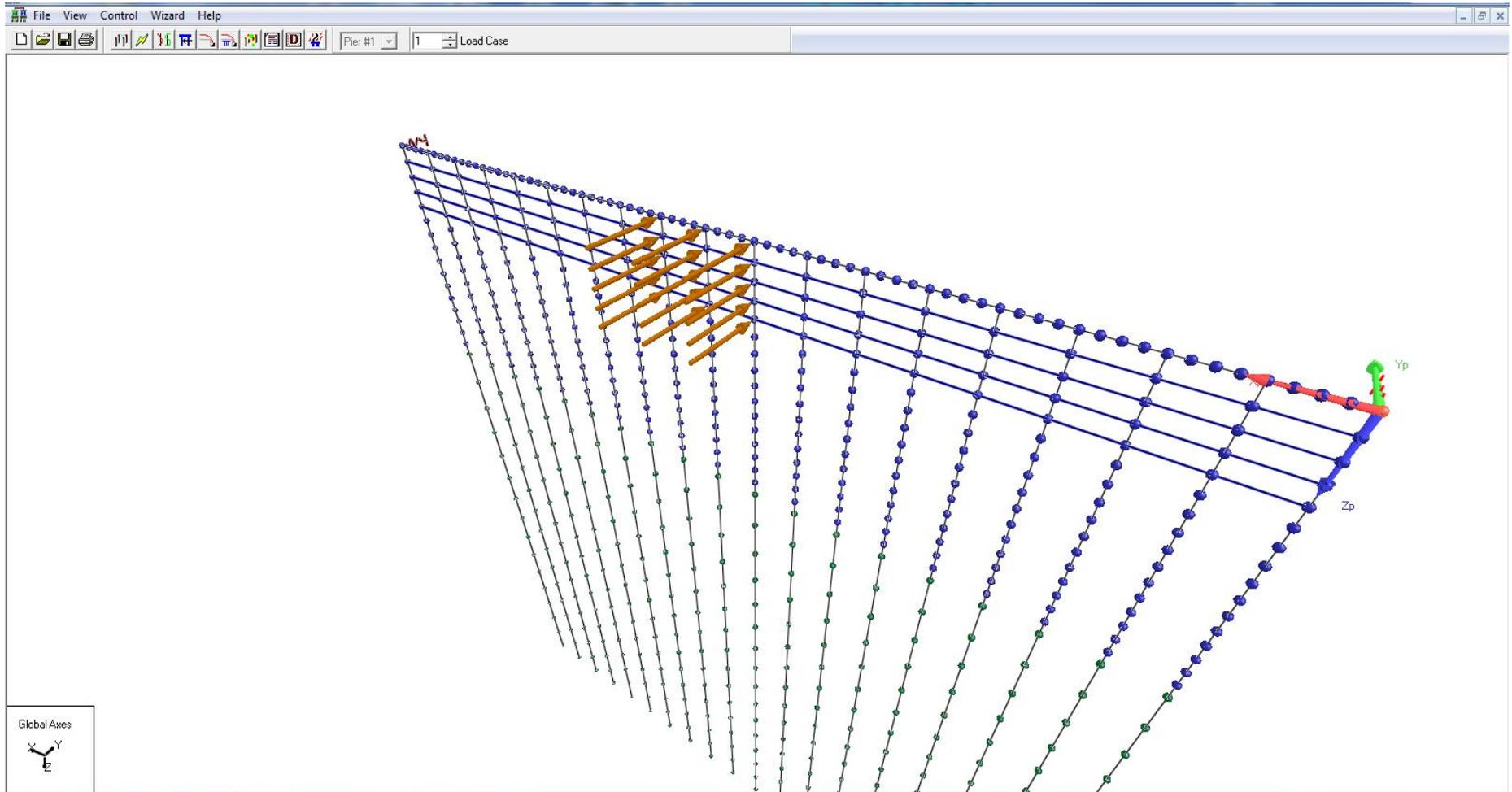
Cofferdam



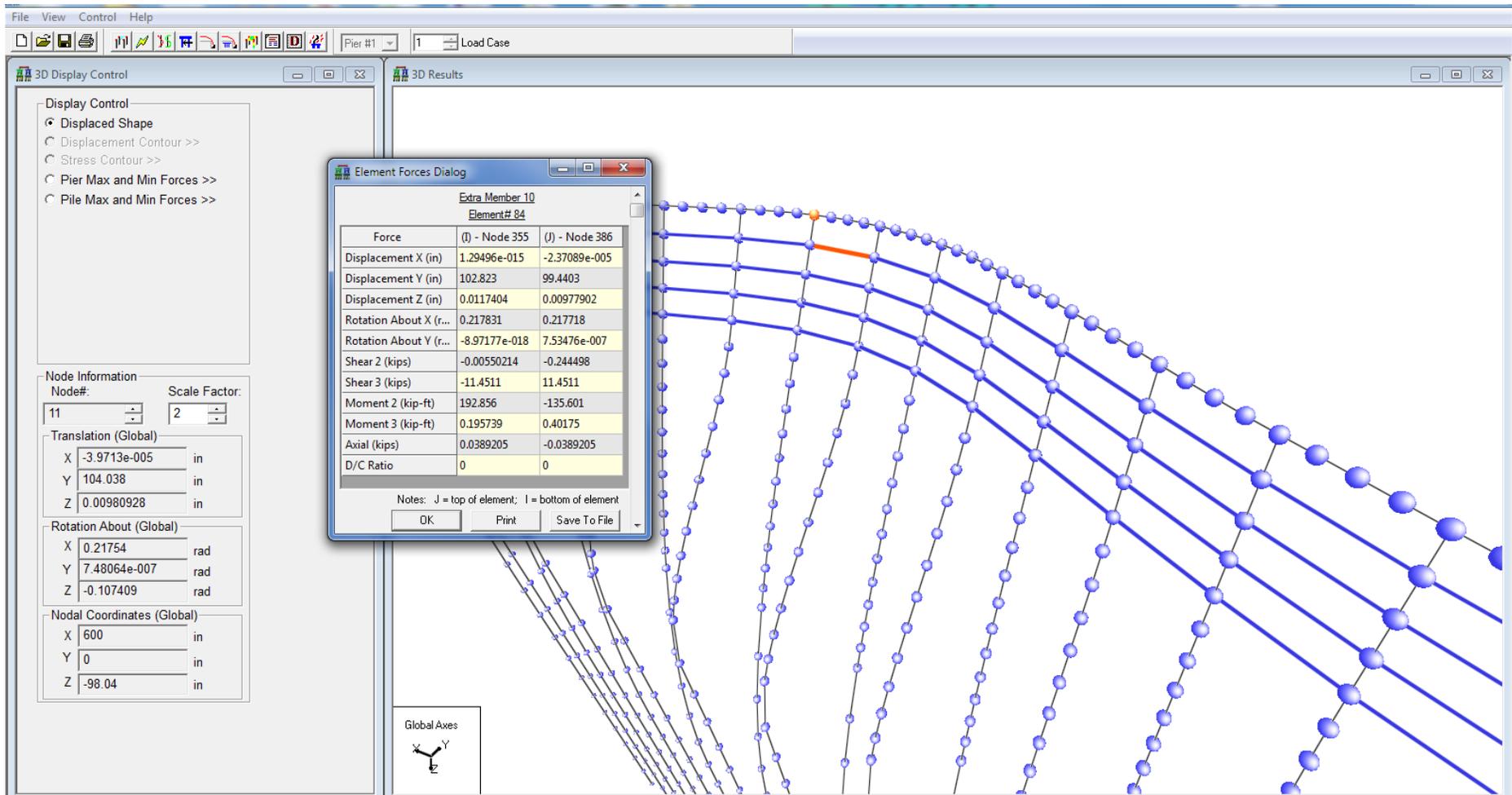
Fender Dummy Piles



Loading Dummy Piles



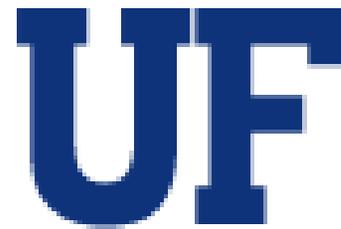
3D Results Window



Summary

- Design Tables
 - Conveniently Report Design Forces and Envelopes
- Model Showcase
 - Endless Possibilities

Acknowledgements



Bridge engineers (you!)

Thank you for your time!

