APPENDIX D

STRUCTURAL CALCULATIONS

APPENDIX D

STRUCTURAL CALCULATIONS

STEEL PILE PROPERTIES

STEEL CONSTRUCTION

A Manual for Architects, Engineers and Fabricators of Buildings and Other Steel Structures

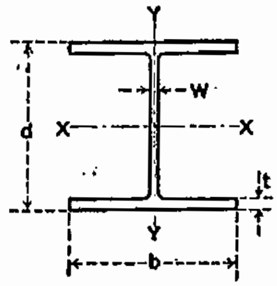
Fifth Edition

Twenty-third Printing

1958

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
NEW YORK, N. Y.

Printed in the United States of America



H BEARING PILES

DIMENSIONS AND PROPERTIES FOR DESIGNING

Section Number and Nominal Size	Weight per Foot	Area A	Depth d	Flange Width b	Flange Thickness t	Web Thickness W	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I′	Axis Y-Y S′	Axis Y-Y r′
	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
BP 14 14x14½	117	34.44	14.234	14.885	.805	.805	1228.5	172.6	5.97	443.1	59.5	3.59
	102	30.01	14.032	14.784	.704	.704	1055.1	150.4	5.93	379.6	51.3	3.56
	89	26.19	13.856	14.696	.616	.616	909.1	131.2	5.89	326.2	44.4	3.53
	73	21.46	13.636	14.586	.506	.506	733.1	107.5	5.85	261.9	35.9	3.49
BP 12 12 x 12	74	21.76	12.122	12.217	.607	.607	566.5	93.5	5.10	184.7	30.2	2.91
	53	15.58	11.780	12.046	.436	.436	394.8	67.0	5.03	127.3	21.2	2.86
BP 10 10 x 10	57	16.76	10.012	10.224	.564	.564	294.7	58.9	4.19	100.6	19.7	2.45
	42	12.35	9.720	10.078	.418	.418	210.8	43.4	4.13	71.4	14.2	2.40
BP 8 8 x 8	36	10.60	8.026	8.158	.446	.446	119.8	29.9	3.36	40.4	9.9	1.95

PART IV

STANDARD SPECIFICATIONS AND CODES

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings; as revised June 1949. (For brevity this document is referred to in the Manual as the A.I.S.C. Specification.)

Code of Standard Practice; as revised April 26, 1956.

AMERICAN INSTITUTE OF BOLT, NUT AND RIVET MANUFACTURERS

Tentative Specifications for Cold Riveted Construction; September, 1942.

AMERICAN SOCIETY FOR TESTING MATERIALS

Specifications for Steel for Bridges and Buildings. A.S.T.M. Designation A7-46.

Specifications for Structural Rivet Steel. A.S.T.M. Designation A141-39.

AMERICAN WELDING SOCIETY

Application of and Extracts from Code for Arc and Gas Welding in Building Construction.

UNITED STATES DEPARTMENT OF COMMERCE

Minimum Design Loads in Buildings and other Structures; as sponsored by the National Bureau of Standards and adopted by American Standards Association, A58.1—1945.

(3) BENDING.

Tension on extreme fibers of rolled sections, plate girders, and built-up members.

(See Section 26 (a))	20,000

Compression on extreme fibers of rolled sections plate girders, and built-up members.

With $\frac{ld}{bt}$ not in excess of 600,	20,000
With $\frac{ld}{bt}$ in excess of 600,	$\frac{12{,}000{,}000}{\frac{ld}{bt}}$

in which l is the unsupported length and d the depth, of the member; b is the width, and t the thickness, of its compression flange; all in inches; except that l shall be taken as twice the length of the compression flange of a cantilever beam not fully stayed at its outer end against translation or rotation.

Stress on extreme fibers of pins	30,000

Fiber stresses in butt welds, due to bending, shall not exceed the values prescribed for tension and compression, respectively.

Fully continuous beams and girders may be proportioned for negative moments which are maximum at interior points of support, at a unit bending stress 20 percent higher than above stated; provided that the section modulus used over supports shall not be less than that required for the maximum positive moments in the same beam or girder, and provided that the compression flange shall be regarded as unsupported from the support to the point of contraflexure.

For columns proportioned for combined axial and bending stresses, the maximum unit bending stress Fb, Sect. 12 (a) may be taken at 24,000 pounds per square inch, when this stress is induced by the gravity loading of fully or partially restrained beams framing into the columns.

(4) SHEARING.

Rivets	15,000
Pins, and turned bolts in reamed or drilled holes	15,000
Unfinished bolts	10,000
Webs of beams and plate girders, gross section	13,000
Weld Metal	
on section through throat of fillet weld, or on faying surface area of plug or slot weld	13,600
on section through throat of butt weld	13,000

(Stress in a fillet weld shall be considered as shear on the throat, for any direction of applied stress. Neither plug nor slot welds shall be assigned any values in resistance to stresses other than shear.)

Table 1.1a (Cont'd.)
Historical Summary of ASTM Specifications for Structural Steel

Date	Specification	Material	Yield Point, ksi	Tensile Strength†, ksi
1949	A6-49T* * Issued as a tentative standard covering delivery requirements for A7 steel.			
	A7-49T	Structural Steel	½ Tensile Str. ≥33	60/72
	A141-49T	Rivet Steel	28	52/62
1958	A373-58T	Structural Steel	32	58-75
1961	A7-61T	Structural Steel		
		All shapes	33	60/75
		Plates/bars to 1½ in.	33	60/72
		Plates/bars over 1½ in.	33	60/75
1962	A36-62T	Structural Steel		
		All shapes	36	58/80
		Plates to 8 in.	36	58/80
		Bars to 4 in.	36	58/80
1963	A242-63T	HSLA Steel:		
		Group 1 shapes & plates/bars to ¾ in.	50	70
		Group 2 shapes & plates/bars over ¾ to 1½ in.	46	67
		Group 3 shapes & plates/bars over 1½ to 4 in.	42	63
	A440-63T	High-Strength Steel:		
		Group 1 shapes & plates/bars to ¾ in.	50	70
		Group 2 shapes & plates/bars over ¾ to 1½ in.	46	67
		Group 3 shapes & plates over 1½ to 4 in.	42	63

L-PILE ANALYSIS
(PILE POINT OF FIXITY CALCULATION)

Halcrow

PROJECT

SUBJECT L-Pile Analysis

SHEET NO. ____ OF ____

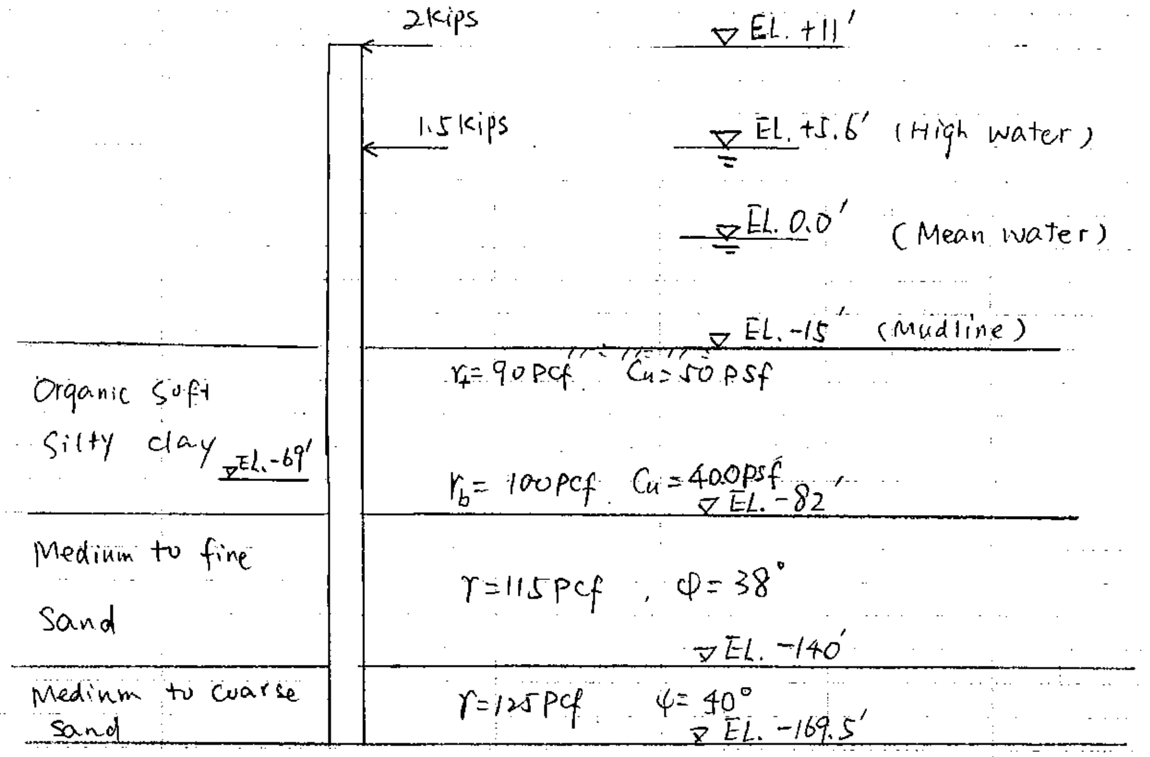
JOB NO.

MADE BY M, Hu DATE 4/23/09

CHKD. BY ____ DATE ____

HP 14x89 , $I = 326 in^4$

(13.83"x 14.7")



From L-Pile analysis, It's found that the fixity depth will be (38'-26') = 12' from the mudline.

===

LPILE Plus for Windows, Version 4.0 (4.0.10)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

===

This program is licensed to:

humi
HALCROW

```
Path to file locations:      C:\Documents and Settings\HuMi\Desktop\
Name of input data file:     HP.lpd
Name of output file:         HP.lpo
Name of plot output file:    HP.lpp
Name of runtime file:        HP.lpr
```

Time and Date of Analysis

Date: April 23, 2009   Time: 16:25:35

Problem Title

HP PILE

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-Specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip

I2

- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 128
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 2166.00 in
Depth of ground surface below top of pile = 312.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	13.830	326.0000	203.3000	29000000.000
2	2166.0000	13.830	326.0000	203.3000	29000000.000

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 312.000 in
Distance from top of pile to bottom of layer = 1116.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 1116.000 in
Distance from top of pile to bottom of layer = 1812.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 1812.000 in
Distance from top of pile to bottom of layer = 2166.000 in

p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	312.00	.01600
2	1116.00	.02180
3	1116.00	.03040
4	1812.00	.03040
5	1812.00	.03620
6	2166.00	.03620

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	312.000	.34700	.00	.02000	.0
2	1116.000	2.77800	.00	.02000	.0
3	1116.000	.00000	38.00	------	------
4	1812.000	.00000	38.00	------	------
5	1812.000	.00000	40.00	------	------
6	2166.000	.00000	40.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

I4

Static loading criteria was used for computation of p-y curves

---

Distributed Lateral Loading

Distributed lateral load intensity defined using 2 points

Point No.	Depth X in	Dist. Load lbs/in
1	58.800	-125.00000
2	70.800	-125.00000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Shear force at pile head = -2000.000 lbs
Slope at pile head = .000 in/in
Axial load at pile head = .000 lbs

(Zero slope for this load indicates fixed-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Specified shear force at pile head = -2000.000 lbs
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = .000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	-5.002	917084.6109	-2000.0000	2.624E-17	19452.8837	0.0000
16.922	-4.988	883240.8609	-2000.0000	.001611	18735.0017	0.0000

I5

33.844	-4.947	849397.1109	-2000.0000	.003162	18017.1197	0.0000
50.766	-4.881	815553.3609	-2000.0000	.004652	17299.2377	0.0000
67.688	-4.790	781709.6109	-3057.6172	.006081	16581.3557	0.0000
84.609	-4.675	712072.1292	-4115.2344	.007418	15104.2294	0.0000
101.531	-4.539	642434.6476	-4115.2344	.008631	13627.1030	0.0000
118.453	-4.383	572797.1659	-4115.2344	.009718	12149.9767	0.0000
135.375	-4.210	503159.6842	-4115.2344	.010681	10672.8504	0.0000
152.297	-4.021	433522.2025	-4115.2344	.011519	9195.7240	0.0000
169.219	-3.820	363884.7208	-4115.2344	.012233	7718.5977	0.0000
186.141	-3.607	294247.2391	-4115.2344	.012822	6241.4713	0.0000
203.063	-3.386	224609.7574	-4115.2344	.013286	4764.3450	0.0000
219.984	-3.158	154972.2757	-4115.2344	.013626	3287.2187	0.0000
236.906	-2.925	85334.7940	-4115.2344	.013841	1810.0923	0.0000
253.828	-2.689	15697.3123	-4115.2344	.013932	332.9660	0.0000
270.750	-2.453	-53940.1693	-4115.2344	.013897	1144.1603	0.0000
287.672	-2.219	-123577.6510	-4115.2344	.013738	2621.2867	0.0000
304.594	-1.988	-193215.1327	-4115.2344	.013455	4098.4130	0.0000
321.516	-1.764	-262852.6144	-4002.5901	.013047	5575.5394	13.3135
338.438	-1.547	-328677.7898	-3728.1576	.012517	6971.8004	19.1218
355.359	-1.340	-389027.4495	-3355.9820	.011875	8251.9166	24.8657
372.281	-1.145	-442256.8056	-2888.1895	.011131	9380.9994	30.4227
389.203	-.963250	-486774.6128	-2329.0260	.010300	10325.2959	35.6649
406.125	-.796334	-521079.7794	-1684.9423	.009398	11052.9653	40.4595
423.047	-.645200	-543799.3802	-991.3057	.008445	11534.8856	41.5216
439.969	-.510537	-554629.2819	-290.7035	.007462	11764.6058	41.2827
456.891	-.392673	-553637.8781	400.9258	.006470	11743.5765	40.4611
473.813	-.291578	-541060.4509	1073.4688	.005490	11476.7884	39.0269
490.734	-.206871	-517307.6682	1716.2004	.004543	10972.9525	36.9377
507.656	-.137832	-482977.7932	2317.4288	.003648	10244.7590	34.1217
524.578	-.083423	-438877.1868	2863.6491	.002823	9309.3121	30.4362
541.500	-.042306	-386061.1699	3337.1411	.002084	8188.9969	25.5259
558.422	-.012883	-325935.8173	3705.5469	.001447	6913.6386	18.0161
575.344	.006668	-260651.5671	3729.8179	9.221E-04	5528.8515	-15.1475
592.266	.018324	-199704.7925	3414.1307	5.101E-04	4236.0694	-22.1637
609.188	.023931	-145104.5820	3012.8490	2.015E-04	3077.9085	-25.2639
626.109	.025144	-97738.6854	2572.8599	-1.583E-05	2073.1994	-26.7385
643.031	.023395	-58029.3534	2117.0478	-1.552E-04	1230.8987	-27.1340
659.953	.019890	-26089.8476	1661.7243	-2.305E-04	553.4089	-26.6808
676.875	.015594	-1790.3722	1220.2079	-2.555E-04	37.9768	-25.5022
693.797	.011244	15206.5623	804.1218	-2.435E-04	322.5564	-23.6751
710.719	.007354	25424.1238	424.0006	-2.071E-04	539.2878	-21.2515
727.641	.004235	29556.3335	89.6791	-1.579E-04	626.9388	-18.2621
744.563	.002010	28459.2006	-189.1928	-1.060E-04	603.6668	-14.6979
761.484	6.48E-04	23153.3385	-401.3488	-5.978E-05	491.1207	-10.3769
778.406	-1.29E-05	14876.0509	-461.3911	-2.575E-05	315.5457	3.2805
795.328	-2.23E-04	7538.1320	-367.7597	-5.688E-06	159.8963	7.7858
812.250	-2.05E-04	2429.6832	-235.9200	3.232E-06	51.5376	7.7963
829.172	-1.14E-04	-446.2865	-113.9522	5.008E-06	9.4665	6.6191
846.094	-3.59E-05	-1426.8873	-18.1563	3.331E-06	30.2666	4.7031
863.016	-1.18E-06	-1060.7622	38.1817	1.105E-06	22.5005	1.9555
879.938	1.45E-06	-134.6741	32.7552	3.490E-08	2.8567	-2.5969
896.859	1.22E-09	47.7979	3.9805	-4.285E-08	1.0139	-.8040
913.781	-1.05E-11	.040893	-1.4123	-3.597E-11	8.674E-04	.1666
930.703	-4.32E-16	-3.478E-04	-.001208	3.113E-13	7.377E-06	1.452E-04
947.625	3.53E-18	-1.449E-08	1.028E-05	1.276E-17	3.074E-10	-1.214E-06

I6

964.547	1.46E-22	1.165E-10	4.282E-10	-1.043E-19	2.472E-12	-5.143E-11
981.469	-1.13E-24	4.901E-15	-3.443E-12	-4.320E-24	1.040E-16	4.069E-13
998.391	0.000	-3.736E-17	-1.448E-16	0.0000	7.926E-19	1.738E-17
1015.	0.000	-1.585E-21	1.104E-18	0.0000	3.362E-23	-1.305E-19
1032.	0.000	1.148E-23	4.683E-23	0.0000	2.436E-25	-5.615E-24
1049.	0.000	0.0000	-3.393E-25	0.0000	0.0000	0.0000
1066.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1083.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1100.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1117.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1134.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1151.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1168.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1185.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1201.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1218.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1235.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1252.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1269.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1286.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1303.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1320.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1337.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1354.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1371.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1388.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1405.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1421.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1438.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1455.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1472.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1489.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1506.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1523.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1540.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1557.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1574.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1591.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1608.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1625.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1641.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1658.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1675.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1692.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1709.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1726.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1743.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1760.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1777.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1794.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1811.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1828.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1844.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1861.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1878.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000

1895.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1912.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1929.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1946.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1963.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1980.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
1997.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2014.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2031.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2048.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2064.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2081.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2098.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2115.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2132.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2149.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2166.	0.000	0.0000	0.0000	0.0000	0.0000	0.0000

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =    -5.00169272 in
Computed slope at pile head      =    2.62435E-17
Maximum bending moment           =     917084.611 lbs-in
Maximum shear force              =      -4115.234 lbs
Depth of maximum bending moment  =          0.000 in
Depth of maximum shear force     =        270.750 in
Number of iterations             =             25
Number of zero deflection points =             21
```

Summary of Pile-head Response

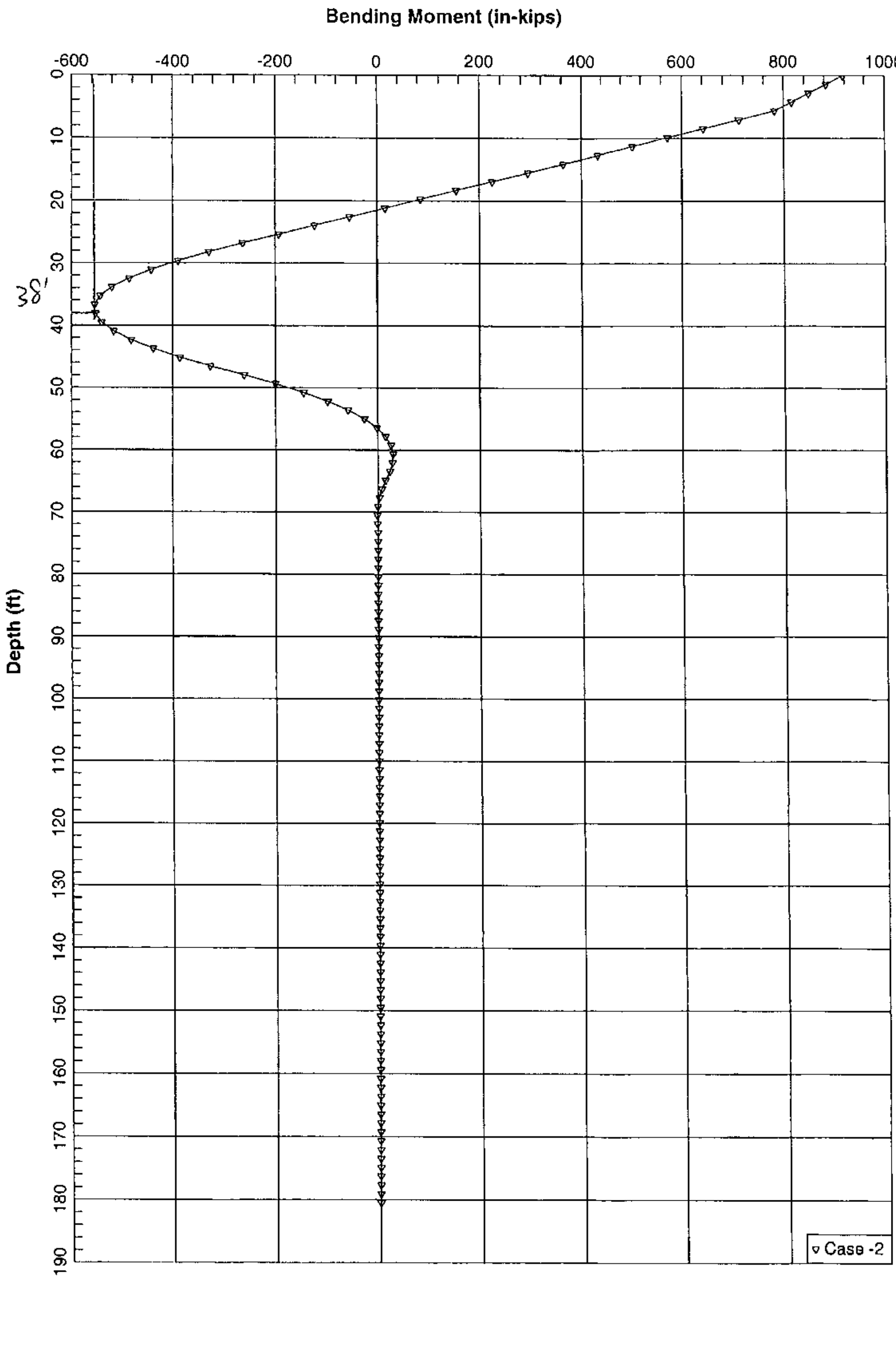
Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

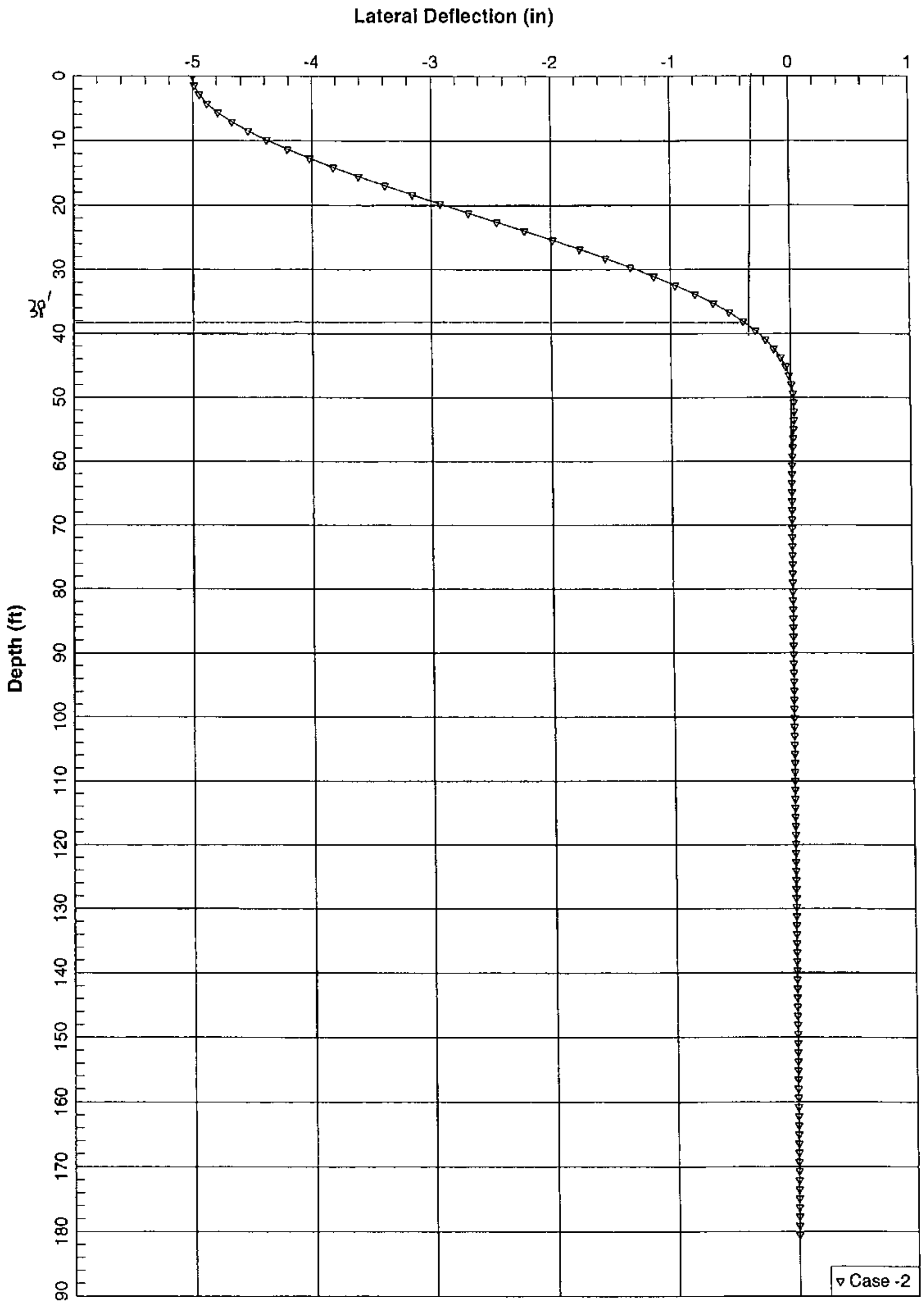
BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
2	V= -2000.000	S= 0.000	0.0000	-5.0017	917084.6109	-4115.2344

I8

The analysis ended normally.



Bending Moment (in-kips)
-600
-400
-200
0
200
400
600
800
1000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
38
Case -2



Lateral Deflection (in)
-5
-4
-3
-2
-1
0
1
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
▿ Case -2

DEAD LOADS

Halcrow **NOAM CALCULATION SHEET**

No: 1	Rev:
By: JC	Date: 5/29/2009
Check By:	Date: 5/30/2009

Project: PIER 40 CONDITION SURVEY

Subject: DEAD LOAD CALCULATIONS FOR STEEL H-PILE LOAD RATING CALCS.

References/Results

PIER SHED

DEAD LOAD FOR THE PIER SHED INCLUDES THE DECK PLANKS WITH 2 IN. WEARING SURFACE, PILE CAPS, PILE CAPS BEAMS, AND SELF-WEIGHT OF PILE

ELEMENT	VOLUME	CONC. UNIT WEIGHT (KIPS/CF)	LOAD (KIPS)
DECK PLANKS	364.6	0.15	54.7
PILE CAPS	45.0	0.15	6.8
BEAMS	75.0	0.15	11.3
SELF-WEIGHT	-	-	2.9
TOTAL			**75.6**

TRIBUTARY AREA

SPAN 12.5 FT

WIDTH 25 FT — AREA 312.5 SF

DECK PLANKS

DECK THICKNESS 12 IN.

WEARING SURFACE 2 IN.

TOTAL THICKNESS 1.2 FT — VOLUME 364.6 CF

PILE CAPS

WIDTH 3 FT

LENGTH 3 FT

HEIGHT 5 FT — VOLUME 45.0 CF

PILE CAPS BEAMS

WIDTH 2 FT

HEIGHT 3 FT — VOLUME 75.0 CF

SELF-WEIGHT

PILE LENGTH 33 FT

LBS./FT 89 LBS./FT — LOAD 2.9 KIPS

Halcrow — **NOAM CALCULATION SHEET**

No: 2	Rev:		
Project: PIER 40 CONDITION SURVEY	By: JC	Date: 5/29/2009	
Subject: DEAD LOAD CALCULATIONS FOR STEEL H-PILE LOAD RATING CALCS.	Check By:	Date: 5/30/2009	

References/Results

TRUCK COURT

DEAD LOAD FOR THE TRUCK COURT INCLUDES THE DECK PLANKS WITH 2 IN. WEARING SURFACE, PILE CAPS, PILE CAPS BEAMS, AND SELF-WEIGHT OF PILE

ELEMENT	VOLUME	CONC. UNIT WEIGHT (KIPS/CF)	LOAD (KIPS)
DECK PLANKS	504.7	0.15	75.7
PILE CAPS	45.0	0.15	6.8
BEAMS	123.6	0.15	18.5
SELF-WEIGHT	-	-	2.4
TOTAL			**103.4**

TRIBUTARY AREA

SPAN 20.6 FT

WIDTH 21 FT — AREA 432.6 SF

DECK PLANKS

DECK THICKNESS 12 IN.

WEARING SURFACE 2 IN.

TOTAL THICKNESS 1.2 FT — VOLUME 504.7 CF

PILE CAPS

WIDTH 3 FT

LENGTH 3 FT

HEIGHT 5 FT — VOLUME 45.0 CF

PILE CAPS BEAMS

WIDTH 2 FT

HEIGHT 3 FT — VOLUME 123.6 CF

SELF-WEIGHT

PILE LENGTH 27 FT

LBS./FT 89 LBS./FT — LOAD 2.4 KIPS

References/Results

FINGER PIER

DEAD LOAD FOR THE TRUCK COURT INCLUDES THE DECK PLANKS WITH 2 IN. WEARING SURFACE, LONG. BEAM, TRANS. BEAMS, AND SELF-WEIGHT OF PILE

ELEMENT	VOLUME	CONC. UNIT WEIGHT (KIPS/CF)	LOAD (KIPS)
DECK PLANKS	262.5	0.15	39.4
LONG. BEAM	168.8	0.15	25.3
TRANS. BEAM	75.0	0.15	11.3
SELF-WEIGHT	-	-	4.5
TOTAL			**80.4**

TRIBUTARY AREA

SPAN 22.5 FT

WIDTH 10 FT — AREA 225.0 SF

DECK PLANKS

DECK THICKNESS 12 IN.

WEARING SURFACE 2 IN.

TOTAL THICKNESS 1.2 FT — VOLUME 262.5 CF

LONG. BEAM

WIDTH 2.5 FT

HEIGHT 3 FT — VOLUME 168.8 CF

TRANS. BEAM

WIDTH 2.5 FT

HEIGHT 3 FT — VOLUME 75.0 CF

SELF-WEIGHT

PILE LENGTH 50 FT

LBS./FT 89 LBS./FT — LOAD 4.5 KIPS

PILE LOAD RATINGS – PIER SHED

Halcrow

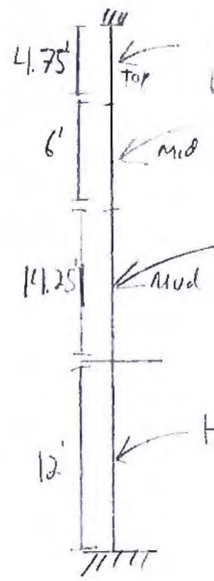
PROJECT HRPT (Severe Pile Agg...)
SUBJECT Pier Shed Compressive Capacity

SHEET NO. 1 OF
JOB NO.
MADE BY BC DATE 5/14
CHKD. BY MWang DATE 4/8/14

Calc. Global Buckling Capacity (Severe piles)

Trib Area: 312 sqft ✓

Dead Load: 75.6 kip ✓



Top: Flange 0.274 ✓, Web: 0.378 ✓, A_s 13.32 in² ✓

Mid: Flange .271 ✓, Web: .270 ✓, A_s = 11.54 in² ✓

Mud: Flange 0.425 ✓, Web 0.413 ✓, A_s 18.62 ✓

Assume: 50% Moment transfer at the top

Fully fixed at the Mud line

Per Inspection, Minor axis buckling will not control as major axis is controlled by local buckling

From Stadd

Applied load -170 kip ✓

Buckling factor: 7.02 ✓

170 kip · 7.02 = 1193.4 kip ✓ (Euler Buckling Load)

Calc Fe @ Critical section

Critical section happends in the mud line section where buckling is critical (at mud pile)

A_s = 18.62 in² ✓

$$F_e = \frac{1193.4k}{18.62\,in^2} = 64.09\ ksi$$ ✓

Halcrow

PROJECT HRPT
SUBJECT Pier Shed

SHEET NO. 2 OF
JOB NO.
MADE BY BC DATE 5/14
CHKD. BY Murdoch DATE 4/8/14

Find $\left(\frac{K}{r}\right)$ for system

$L = 444''$ ✓

$F_e = \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{r}\right)^2} \Rightarrow \quad \frac{K}{r} = \frac{\sqrt{\frac{\pi^2 \cdot E}{F_e}}}{L} \Rightarrow 0.15$ ✓

$F_y = 36$ ksi ✓

$\frac{KL}{r} = 0.150 \cdot 444 = 66.82$ ✓

$4.71 \cdot \sqrt{\frac{29000}{36 \text{ ksi}}} = 133.7$ ✓

$\frac{KL}{r} < 4.71 \sqrt{\frac{29000}{36 \text{ ksi}}}$ ✓

AISC E3-2 $\quad F_{cr} = \left[0.658^{36/64.0}\right] \cdot 36 = 28.4$ ✓

Pile will buckle at critical stress w/ $A_s = 18.62 \text{ in}^2$ ✓

$P_n = 28.4 \text{ ksi} \cdot 18.62 \text{ in}^2 = 528.8$ kip ✓

$\Omega = 1.67$ ✓

$\boxed{P_n = 316.32 \text{ kip}}$ ✓

Halcrow

SHEET NO. 3 OF

PROJECT P/S

JOB NO.

SUBJECT

MADE BY BC DATE 5/14

CHKD. BY Mushi(DATE 4/8/14

Consider slender elements over the Avg. amount of section loss

Section is thinest at the top of the pile

$b = 14.7/2 = 7.35''$ ✓

$t = 0.274''$ ✓

$b/t = 26.8$ ✓

AISC E-7

$0.56 \cdot \sqrt{\frac{E}{F_y}} = 15.894$ ✓

$1.03 \cdot \sqrt{\frac{E}{F_y}} = 29.23$ ✓

$b/t < 29.23$ ∴ Use (E 7-5)

(b/t = 26.8)

$Q_s = 1.415 - 0.74 (b/t) \cdot \sqrt{\frac{F_y}{E}}$ ✓ (b/t = 26.8; $\sqrt{F_y/E}$ = 0.035)

$Q_s = 0.716$ ✓

Apply to AISC (E3-2) - cons.

$F_{cr} = Q_s \left[0.658^{\frac{QF_y}{F_e}} \right] \cdot F_y$ ✓

$= 21.78$ ksi ✓

Apply 'Q' factor @ critical section of pile

$A_s = 18.62$ in² ✓

$P_n = 18.62$ in² $\cdot$ 21.78 ksi ✓

$P_n = 405.5$ kip ✓

$\frac{P_n}{\Omega} = \frac{405.5 \text{ kip}}{1.67} = 242.8$ kip ✓

MB BC 5/14
CH MHall 4/8/14

```
*****************************************************
*                                                   *
*           STAAD.Pro V8i SELECTseries4             *
*           Version  20.07.09.31                    *
*           Proprietary Program of                  *
*           Bentley Systems, Inc.                   *
*           Date=    MAY  5, 2014                   *
*           Time=    12:13: 1                       *
*                                                   *
*      USER ID: CH2M HILL                           *
*****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Avg(Severe).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
    10. MEMBER INCIDENCES
    11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
    12. 25 19 20; 26 20 5
    13. START USER TABLE
    14. TABLE 2
    15. UNIT INCHES KIP
    16. WIDE FLANGE
    17. TOP
    18. 13.3299 13.8 0.398 14.7 0.274 445.686 145.131 0.480084 5.4924 8 0556
    19. MID
    20. 11.5471 13.8 0.27 14.7 0.271 417.059 143.495 0.28203 3.726 7.9674
    21. MUDLINE
    22. 18.6203 13.8 0.473 14.7 0.425 644.601 225.118 1.20911 6.5274 12.495
    23. 50%PILE
    24. 14.5475 13.8 0.575 13.8 0.25 429.481 109.714 0.986568 7.935 6.9
    25. 50%FLG12
    26. 13.6475 13.8 0.575 12 0.25 388.166 72.2107 0.967818 7.935 6
    27. 33%PILE
    28. 12.245 13.8 0.475 14.7 0.2 367.152 106.004 0.557101 6.555 5.88
    29. END
    30. UNIT FEET KIP
    31. DEFINE MATERIAL START
    32. ISOTROPIC STEEL
    33. E 4.176E+006
    34. POISSON 0.3
    35. DENSITY 0.489024
    36. ALPHA 6.5E-006
    37. DAMP 0.03
    38. END DEFINE MATERIAL
```

```
39. UNIT INCHES KIP
40. CONSTANTS
41. BETA 0 MEMB 8 9
42. MATERIAL STEEL ALL
43. MEMBER PROPERTY AMERICAN
44. 9 UPTABLE 2 TOP
45. 7 8 UPTABLE 2 MID
46. 20 TO 23 UPTABLE 2 MUDLINE
47. MEMBER PROPERTY AMERICAN
48. 4 24 TO 26 TABLE ST HP14X89
49. SUPPORTS
50. 4 FIXED
51. 10 FIXED BUT FY
52. MEMBER RELEASE
53. 9 END MPY .5 MPZ .5
54. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
55. JOINT LOAD
56. 10 FY -170
57. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	12	**NUMBER OF MEMBERS**	11
NUMBER OF PLATES	0	**NUMBER OF SOLIDS**	0
NUMBER OF SURFACES	0	**NUMBER OF SUPPORTS**	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 61

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	7.02252
2	13.31198
3	18.92311
4	26.81848

58. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAY 5,2014 TIME= 12:13: 1 ****

```
************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone               Web / Email         *
*  USA        +1  (714) 974-2500                           *
*  UK         +44 (0) 808 101 9246                         *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE     +33 (0) 1 55238400                           *
*  GERMANY    +49 0931 40468                               *
*  INDIA      +91 (033) 4006-2021                          *
*  JAPAN      +81 (03)5952-6500    http://www.ctc-g.co.jp  *
*  CHINA      +86 21 6288 4040                             *
*  THAILAND   +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL.

Job Name HRPT (PS) Local [illegible] [Assuming Avg Section]

Subject

Job No.

Sheet No. 1

Date

Computed By BC 5/14

Checked By MWdn 4/8/14

[illegible]: (Severe Pile)

w/ Avg [illegible]

[illegible] ✓

[illegible] ✓

A_s = 13.29 in² ✓ ([illegible])

36 [illegible] = [illegible] kip ✓

$\frac{P_n}{\Omega}$ = $\frac{[illegible] \text{ kip}}{1.67}$ = [[illegible] kip] ✓

Major Pile

F: 0.414 ✓

W: 0.441 ✓

A_s = 17.89 ✓

$\frac{P_n}{\Omega}$ = [385.6 kip] ✓

Moderate Pile

F: 0.459 ✓

W: 0.442 ✓

A_s = 19.24 in² ✓

$\frac{P_n}{\Omega}$ = [415.19 kip] ✓

Minor Pile

F: 0.525 ✓

W: 0.433 ✓

A_s = 21.59 in² ✓

$\frac{P_n}{\Omega}$ = [465.41 kip] ✓

CH2MHILL.

Job Name: HRPT Pier 40

Subject: P/S Lateral (Severe)

Job No.:

Sheet No.: 1

Date:

Computed By: 3/14

Checked By: MWahl 4/8/14

LC3

$D_L + L_L + C + 0.3W + 0.3W_a$ ✓

12.5% Allowable Over Stress ✓

D_L } From axial analysis ✓

L_L → 100psf ✓

Current ML [illegible] ✓

Typ [illegible] ✓

Wind ML 555 [illegible] ✓

Typ [illegible] ✓

Wave: [illegible] ✓

Typ [illegible] ✓

Lateral U/R

LC-31

Avg Severe pile

U/R [0.441] ✓ @ Typ [illegible]

[For Bending U/R see STAAD output]

LC5

$D_L + C + W + W_V$ ✓ Typ

Allowable overstress 140% ✓

U/R [.39] ✓ @ Typ

CH2MHILL.

Job Name HRPT Pier 40

Subject P/S Lateral Sewer Pile

Job No.

Sheet No. 2

Date

Computed By BC 5/14

Checked By MWOM 4/8/14

LC 7

$D_L + E$

Allowable overstress: 133% ✓

X-axis: U/R 1.[illegible] @ Top ✓

Y-axis: U/R 1.[illegible] @ Top ✓

LC 8

$D_L + L_L + Ice$

Allowable overstress: 140% ✓

U/R: [illegible] @ Top ✓

LC 9

$D_L + L_L + C + W + Ice$

Allowable overstress: 150% ✓

U/R: [illegible] @ Top ✓

Halcrow

PROJECT HRPT	SHEET NO. 4 OF
SUBJECT P/S [illegible] Summary	JOB NO.
	MADE BY BC DATE 3/14
	CHKD. BY. MWohl DATE 4/8/14

Assume 100 PSF L_L ✓

Trib area 312 Sq ft ✓ 100 #/Sq. ft = 31.2 kip for L_L ✓

Total Axial load $L_L + D_L$ = 106.8 kip ✓

HRPT Load case over stress factor

	(D_L+L_L)	U/R for Axial force (FLB 242.2 kip Controls) (Flange Local Buckling)
LC3 125% =	85.44 kip $\left(\frac{106.8}{1.25}\right)$ ✓	0.351 $\left(\frac{85.44}{242.2}\right)$ ✓
LC7 133% =	80.3 kip $\left(\frac{106.8}{1.33}\right)$ ✓	0.330 ✓
LC5 LC8 140% =	76.28 kip $\left(\frac{106.8}{1.40}\right)$ ✓	0.314 ✓
LC9 150% =	71.2 kip $\left(\frac{106.8}{1.5}\right)$ ✓	0.293 ✓
LC1 100% =	106.8 kip $\left(\frac{106.8}{1.0}\right)$ ✓	0.439 ✓

LC1: Assume 300 PSF Total Axial 169.2 [illegible] 300 PSF OK

Use AISC H1-1A

[illegible] ✓ * Includes L/C [illegible] ✓

[illegible] ✓

[illegible] ✓

[illegible] ✓

[illegible] ✓ [illegible] ✓ [illegible] 100 psf

LC5 calc?

U/R [illegible]

0.14 0.049 [illegible] 0.8 ✓ ok w/ 100 PSF

LC7 [illegible]

[illegible] 0.038 [illegible] 1.04 ✓ NG ✓

LC9 0.07 [illegible] .083 [illegible] 1.026 ✓ NG ✓

U/R Axial Moment [illegible]

CH2MHILL SUBJECT: Aditional Axial load due to lateral | BY | SHEET NO. 5 of | DATE | PROJECT NO.

MB BC 5/14

Aditional Axial load

LC 5|

C + W + Wa

U/R LC5

$1\,kip + 10.6\,kip + 5.2\,kip = \frac{(16.8\,kip \div 1.4)}{242.8} = 0.049$ ✓

LC 8|

Ice

U/R LC8

$1.4 \div \left(\frac{13.2\,kip}{242.8\,kip}\right) = 0.038$ ✓

LC 9|

C + W + Ice

U/R LC9

$1 + 10.6 + 18.5 = \frac{(30.1 \div 1.5)}{242.8} = 0.083$ ✓

MB B 5/14
Ch Mwah 4/8/14

```
****************************************************
*                                                  *
*          STAAD.Pro V8i SELECTseries4             *
*          Version  20.07.09.31                    *
*          Proprietary Program of                  *
*          Bentley Systems, Inc.                   *
*          Date=    APR 30, 2014                   *
*          Time=    13:31:43                       *
*                                                  *
*     USER ID: CH2M HILL                           *
****************************************************
```

Severe

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending_Pier Shed_LC3.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.7975 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
    10. MEMBER INCIDENCES
    11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
    12. 25 19 20; 26 20 5
    13. START USER TABLE
    14. TABLE 2
    15. UNIT INCHES KIP
    16. WIDE FLANGE
    17. 20%TOP
    18. 8.4175 13.8 0.35 14.7 0.125 244.377 66.226 0.212793 4.83 3.675
    19. 20%MID
    20. 7.49875 13.8 0.175 14.7 0.175 274.277 92.6546 0.0765497 2.415 5.145
    21. 20%MUDLINE
    22. 17.285 13.8 0.425 14.7 0.4 605.874 211.851 0.959851 5.865 11.76
    23. TOPAVG
    24. 13.3299 13.8 0.398 14.7 0.274 445.686 145.131 0.480084 5.4924 8.0556
    25. MIDAVG
    26. 11.5471 13.8 0.27 14.7 0.271 417.059 143.495 0.28203 3.726 7.9674
    27. MUDLINEAVG
    28. 18.6203 13.8 0.473 14.7 0.425 644.601 225.118 1.20911 6.5274 12.495
    29. END
    30. UNIT FEET KIP
    31. DEFINE MATERIAL START
    32. ISOTROPIC STEEL
    33. E 4.176E+006
    34. POISSON 0.3
    35. DENSITY 0.489024
    36. ALPHA 6.5E-006
    37. DAMP 0.03
    38. END DEFINE MATERIAL
```

```
 39. UNIT INCHES KIP
 40. CONSTANTS
 41. BETA 0 MEMB 8 9
 42. MATERIAL STEEL ALL
 43. MEMBER PROPERTY AMERICAN
 44. 9 UPTABLE 2 TOPAVG
 45. 20 TO 23 UPTABLE 2 MUDLINEAVG
 46. MEMBER PROPERTY AMERICAN
 47. 4 24 TO 26 TABLE ST HP14X89
 48. MEMBER PROPERTY AMERICAN
 49. 7 8 UPTABLE 2 MIDAVG
 50. SUPPORTS
 51. 4 10 PINNED
 52. LOAD 3 LOADTYPE WIND  TITLE WIND (MAJOR AXIS)
 53. JOINT LOAD
 54. 4 MZ 595
 55. 10 MZ 493
 56. LOAD 5 LOADTYPE FLUIDS  TITLE CURRENT (MAJOR AXIS)
 57. JOINT LOAD
 58. 4 MZ 49.2
 59. 10 MZ 75.6
 60. *MEMBER LOAD
 61. *7 8 20 TO 23 UNI GZ 0.00157
 62. LOAD 7 LOADTYPE WIND  TITLE WAVE (MAJOR AXIS)
 63. JOINT LOAD
 64. 4 MZ 458.4
 65. 10 MZ 355.2
 66. LOAD COMB 4 HRPT LOAD CASE 3
 67. 3 0.24 5 0.8 7 0.24
 68. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	**12**	**NUMBER OF MEMBERS**	**11**
NUMBER OF PLATES	**0**	**NUMBER OF SOLIDS**	**0**
NUMBER OF SURFACES	**0**	**NUMBER OF SUPPORTS**	**2**

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 3, TOTAL DEGREES OF FREEDOM = 66

```
***WARNING- INSTABILITY AT JOINT [illegible] DIRECTION [illegible]
PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
K-MATRIX DIAG=  6.5424866E+02 L-MATRIX DIAG= -1.7053026E-13 EQN NO       35
[illegible]

 69. PARAMETER 1
 70. CODE AISC
```

```
71. FYLD 36 ALL
72. LX 206.4 MEMB 7 TO 9 20 22
73. UNB 206.4 MEMB 7 TO 9 20 22
74. UNT 206.4 MEMB 7 TO 9 20 22
75. LX 237.6 MEMB 4 21 23 TO 26
76. UNB 237.6 MEMB 4 21 23 TO 26
77. UNT 237.4 MEMB 4 21 23 TO 26
78. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
4 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.211	3
		0.00 T	0.00	595.00	0.00
7 ST	MIDAVG		(UPT)		
		PASS	AISC- H1-3	0.321	3
		0.00 T	0.00	-331.27	63.00
8 ST	MIDAVG		(UPT)		
		PASS	AISC- H1-3	0.342	3
		0.00 T	0.00	-353.32	9.00
9 ST	TOPAVG		(UPT)		
		PASS	AISC- H1-3	0.444	3
		0.00 T	0.00	-493.00	57.00
20 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.090	3
		0.00 T	0.00	176.89	0.00
21 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.070	3
		0.00 T	0.00	-137.38	50.82
22 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.037	3
		0.00 T	0.00	72.14	0.00
23 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.123	3
		0.00 T	0.00	-242.14	42.75
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.179	3
		0.00 T	0.00	506.78	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.148	3
		0.00 T	0.00	418.57	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.117	3
		0.00 T	0.00	330.35	0.00

79. LOAD LIST
80. FINISH

```
*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 30,2014   TIME= 13:31:44 ****

************************************************************
*      For questions on STAAD.Pro, please contact          *
*      Bentley Systems or Partner offices                  *
*                                                          *
*            Telephone              Web / Email            *
* USA       +1  (714) 974-2500                             *
* UK        +44 (0) 808 101 9246                           *
* SINGAPORE +65 6225-6158                                  *
* FRANCE    +33 (0) 1 55238400                             *
* GERMANY   +49 0931 40468                                 *
* INDIA     +91 (033) 4006-2021                            *
* JAPAN     +81 (03)5952-6500   http://www.ctc-g.co.jp     *
* CHINA     +86 21 6288 4040                               *
* THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
* Worldwide  http://selectservices.bentley.com/en-US/      *
*                                                          *
************************************************************
```

MB 5/14
Ch MWall 4/8/14

severe

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    APR 30, 2014                  *
*           Time=    13:31: 3                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending_Pier Shed_LC5.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
    9. 15 0 19.7975 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
   10. MEMBER INCIDENCES
   11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
   12. 25 19 20; 26 20 5
   13. START USER TABLE
   15. TABLE 2
   16. UNIT INCHES KIP
   17. WIDE FLANGE
   18. TOPAVG
   19. 13.3299 13.8 0.398 14.7 0.274 445.686 145.131 0.480084 5.4924 8.0556
   20. MIDAVG
   21. 11.5471 13.8 0.27 14.7 0.271 417.059 143.495 0.28203 3.726 7.9674
   22. MUDLINEAVG
   23. 18.6203 13.8 0.473 14.7 0.425 644.601 225.118 1.20911 6.5274 12.495
   25. END
   26. UNIT FEET KIP
   27. DEFINE MATERIAL START
   28. ISOTROPIC STEEL
   29. E 4.176E+006
   30. POISSON 0.3
   31. DENSITY 0.489024
   32. ALPHA 6.5E-006
   33. DAMP 0.03
   34. END DEFINE MATERIAL
   35. UNIT INCHES KIP
   36. CONSTANTS
   37. BETA 0 MEMB 8 9
   38. MATERIAL STEEL ALL
   39. MEMBER PROPERTY AMERICAN
   40. 9 UPTABLE 2 TOPAVG
```

```
42. 20 TO 23 UPTABLE 2 MUDLINEAVG
43. MEMBER PROPERTY AMERICAN
44. 4 24 TO 26 TABLE ST HP14X89
45. MEMBER PROPERTY AMERICAN
46. 7 8 UPTABLE 2 MIDAVG
47. SUPPORTS
48. 4 10 PINNED
49. LOAD 3 LOADTYPE WIND  TITLE WIND (MAJOR AXIS)
50. JOINT LOAD
51. 4 MZ 595
52. 10 MZ 493
53. LOAD 5 LOADTYPE FLUIDS  TITLE CURRENT (MAJOR AXIS)
54. JOINT LOAD
55. 4 MZ 49.2
56. 10 MZ 75.6
57. *MEMBER LOAD
58. *7 8 20 TO 23 UNI GZ 0.00157
59. LOAD 7 LOADTYPE WIND  TITLE WAVE (MAJOR AXIS)
60. JOINT LOAD
61. 4 MZ 458.4
62. 10 MZ 355.2
63. LOAD COMB 6 HRPT LOAD CASE 5
64. 3 0.714 5 0.714 7 0.714
65. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	12	NUMBER OF MEMBERS	11
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 3, TOTAL DEGREES OF FREEDOM = 66

```
***WARNING    INSTABILITY AT JOINT  [illegible]  DIRECTION = MY
PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
K-MATRIX DIAG=  6.5424866E+02 L-MATRIX DIAG= -1.7053026E-13 EQN NO      35
[illegible]

66. PARAMETER 1
67. CODE AISC
68. FYLD 36 ALL
69. LX 206.4 MEMB 7 TO 9 20 22
70. UNB 206.4 MEMB 7 TO 9 20 22
71. UNT 206.4 MEMB 7 TO 9 20 22
72. LX 237.6 MEMB 4 21 23 TO 26
73. UNB 237.6 MEMB 4 21 23 TO 26
```

74. UNT 237.6 MEMB 4 21 23 TO 26
75. CHECK CODE ALL

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
4 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.279	6
		0.00 T	0.00	787.26	0.00
7 ST	MIDAVG		(UPT)		
		PASS	AISC- H1-3	0.431	6
		0.00 T	0.00	-444.52	63.00
8 ST	MIDAVG		(UPT)		
		PASS	AISC- H1-3	0.459	6
		0.00 T	0.00	-473.85	9.00
9 ST	TOPAVG		(UPT)		
		PASS	AISC- H1-3	0.594	6
		0.00 T	0.00	-659.59	57.00
20 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.122	6
		0.00 T	0.00	239.22	0.00
21 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.091	6
		0.00 T	0.00	-178.70	50.82
22 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.051	6
		0.00 T	0.00	99.92	0.00
23 ST	MUDLINEAVG		(UPT)		
		PASS	AISC- H1-3	0.162	6
		0.00 T	0.00	-318.01	42.75
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.237	6
		0.00 T	0.00	669.94	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.196	6
		0.00 T	0.00	552.63	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1 3	0.154	6
		0.00 T	0.00	435.32	0.00

76. LOAD LIST
77. FINISH

```
*********** END OF THE STAAD.Pro RUN ***********

  **** DATE= APR 30,2014   TIME= 13:31: 3 ****

************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone               Web / Email         *
*  USA       +1  (714) 974-2500                            *
*  UK        +44 (0) 808 101 9246                          *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE    +33 (0) 1 55238400                            *
*  GERMANY   +49 0931 40468                                *
*  INDIA     +91 (033) 4006-2021                           *
*  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp   *
*  CHINA     +86 21 6288 4040                              *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

MB BC 5/14
ch MWarl 4/8/14

```
****************************************************
*                                                  *
*          STAAD.Pro V8i SELECTseries4             *
*          Version  20.07.09.31                    *
*          Proprietary Program of                  *
*          Bentley Systems, Inc.                   *
*          Date=    APR 30, 2014                   *
*          Time=    13:36:35                       *
*                                                  *
*     USER ID: CH2M HILL                           *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending_Pier Shed_LC8.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 20.4075 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
    10. MEMBER INCIDENCES
    11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
    12. 25 19 20; 26 20 5
    13. START USER TABLE
    15. TABLE 2
    16. UNIT INCHES KIP
    17. WIDE FLANGE
    18. TOP
    19. 13.3299 13.8 0.398 14.7 0.274 445.686 145.131 0 480084 5.4924 8.0556
    20. MID
    21. 11.5471 13.8 0.27 14.7 0.271 417.059 143.495 0.28203 3.726 7.9674
    22. MUDLINE
    23. 18.6203 13.8 0.473 14.7 0.425 644.601 225.118 1.20911 6.5274 12.495
    25. END
    26. UNIT FEET KIP
    27. DEFINE MATERIAL START
    28. ISOTROPIC STEEL
    29. E 4.176E+006
    30. POISSON 0.3
    31. DENSITY 0.489024
    32. ALPHA 6.5E-006
    33. DAMP 0.03
    34. END DEFINE MATERIAL
    35. UNIT INCHES KIP
    36. CONSTANTS
    37. BETA 0 MEMB 8 9
    38. MATERIAL STEEL ALL
    39. MEMBER PROPERTY AMERICAN
    40. 9 UPTABLE 2 TOP
```

42. 20 TO 23 UPTABLE 2 MUDLINE
43. MEMBER PROPERTY AMERICAN
44. 4 24 TO 26 TABLE ST HP14X89
45. MEMBER PROPERTY AMERICAN
46. 7 8 UPTABLE 2 MID
47. SUPPORTS
48. 4 10 PINNED
49. LOAD 4 LOADTYPE ICE TITLE ICE (MAJOR AXIS)
50. JOINT LOAD
51. 4 MZ 1146
52. 10 MZ 861.6
53. LOAD COMB 7 HRPT LOAD CASE 8
54. 4 0.714
55. PERFORM ANALYSIS

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	**12**	**NUMBER OF MEMBERS**	**11**
NUMBER OF PLATES	**0**	**NUMBER OF SOLIDS**	**0**
NUMBER OF SURFACES	**0**	**NUMBER OF SUPPORTS**	**2**

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 66

***WARNING - INSTABILITY AT JOINT [illegible] DIRECTION = [illegible]
PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
K-MATRIX DIAG= 7.2487886E+02 L-MATRIX DIAG= 5.6843419E-14 EQN NO 35
[illegible]

56. PARAMETER 1
57. CODE AISC
58. FYLD 36 ALL
59. LOAD LIST
60. PARAMETER 2
61. CODE AISC
62. LX 244.8 MEMB 4 21 23 TO 26
63. UNB 244.8 MEMB 4 21 23 TO 26
64. UNT 244.8 MEMB 4 21 23 TO 26
65. LX 199.1 MEMB 7 TO 9 20 22
66. UNB 199.1 MEMB 7 TO 9 20 22
67. UNT 199.1 MEMB 7 TO 9 20 22
68. CHECK CODE ALL

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
4 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.406	4
		0.00 T	0.00	1146.00	0.00
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.546	4
		0.00 T	0.00	-563.17	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.585	4
		0.00 T	0.00	-603.87	9.00
9 ST	TOP		(UPT)		
		PASS	AISC- H1-3	0.776	4
		0.00 T	0.00	-861.60	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.142	4
		0.00 T	0.00	278.31	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.154	4
		0.00 T	0.00	-301.59	58.14
22 ST	MUDLINE		(UPT)		
		PASS	SHEAR -Y	0.048	4
		0.00 T	0.00	85.01	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.252	4
		0.00 T	0.00	-494.89	42.75
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.348	4
		0.00 T	0.00	983.22	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.291	4
		0.00 T	0.00	820.44	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.233	4
		0.00 T	0.00	657.66	0.00

69. FINISH

```
*********** END OF THE STAAD.Pro RUN ***********

     **** DATE= APR 30,2014   TIME= 13:36:36 ****

************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*             Telephone              Web / Email           *
*  USA        +1  (714) 974-2500                           *
*  UK         +44 (0) 808 101 9246                         *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE     +33 (0) 1 55238400                           *
*  GERMANY    +49 0931 40468                               *
*  INDIA      +91 (033) 4006-2021                          *
*  JAPAN      +81 (03)5952-6500    http://www.ctc-g.co.jp  *
*  CHINA      +86 21 6288 4040                             *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL.

Job Name HRPT

Subject PS Mayor Pile (Euler Buckling)

Job No.

Sheet No. 1

Date

Computed By BC 5/14

Checked By MWaml 4/8/14

Calc Global Buckling Major Capacity

Trib area: 312 ft ✓

DL: 75.6 kip ✓

Top	Mid	Mud Line
F: .414" ✓	.227" ✓	.497 ✓
W: .441" ✓	.281" ✓	.478 ✓

From STADD

Applied load: -170 kip ✓

BF = 8.23 ✓

Euler Buckling load = 1399.1 kip ✓

Calc Fe @ critical section @ Node 15 (Mudline pile section)

$A_s = 20.73 in^2$ ✓

$f_e = \frac{1399.1 \text{ kip}}{20.285 in^2} = 68.97$ ksi ✓

L = 444" ✓

$\frac{k}{r} = \frac{\sqrt{\frac{\pi^2 E}{F_e}}}{L} \Rightarrow 0.145$ ✓

$F_y = 36$ ksi ✓

$\frac{KL}{r} = 64.38$ ✓

Critical section ✓ $A_s = 20.73 in^2$

$F_{cr} = \left[0.658^{36/68.97}\right] \cdot 36 = 28.9$ ksi ✓

$\frac{P_n}{\Omega} = 28.9 \text{ ksi} \cdot 20.73 in^2 =$ **359.17 kip** ✓

CH2MHILL.

Job No.
Sheet No. 2
Job Name HRPT Pier 40
Date
Subject PS Major Pile Local Buckling
Computed By BC 5/14
Checked By MWahl 4/8/14

Local buckling "will happen" @ top of pile (Most critical ...)

$b = 7.35''$ ✓

$t = .414''$ ✓

$b/t = \frac{7.35}{.414} = 17.75$ ✓

$\lambda_r = 0.56 \cdot \sqrt{\frac{E}{F_y}} \Rightarrow 15.89 < b/t$ ✓ ∴ Flange @ top is slender ✓

Use AISC (E 7-5)

$Q_s = 1.415 - 0.74 \cdot (b/t) \cdot \sqrt{\frac{F_y}{E}}$

$= 1.415 - 0.74 \cdot (17.75) \cdot \sqrt{\frac{35}{29000}}$

$= 0.15$ ✓

Apply Q to (E 3-2) ✓

Apply "Q" @ critical section ✓ Conserv. $A_s = 20.77 in^2$ ✓

$F_{cr} = Q_s \left[0.658^{\left(\frac{Q F_y}{F_e}\right)}\right] F_y$

$= 24.778$ ksi ✓

$\frac{P_n}{\Omega} = \boxed{344.8 \text{ kip}}$ ✓

CH2MHILL.

Job Name HRPT

Subject PS Major Pile lateral

Job No.

Sheet No.

Date

Computed By BC 5/14

Checked By MWah 4/8/14

L/C 3

Ok w/ Secure Pile ✓

L/C 5

Ok w/ Secure Pile ✓

L/C 7

Y Axis

Fails @ Mid pile ✓

U/R = 1.22 ✓

X-Axis

Fails @ Mid Pile

U/R @ 1.464 ✓

L/C 8

[illegible] By [illegible] ✓

L/C [illegible] ([illegible]) ✓

[illegible] ✓

[illegible] 0.055 [illegible] 0.125 ok ✓

[illegible] ✓

U/R w/ 100 PSF L_L

D_L = 75.6 kip ✓

L_L w/100 psf = [illegible] kip ✓

Total Axial [illegible] ✓

	D_L + L_L	U/R
140%	76.22 kip ✓	0.221 ✓
150%	71.2 kip ✓	[illegible] ✓

FLB controls 344.8 kip

MB 12 5/14
Ch MWahl
4/8/14

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    MAY  2, 2014                  *
*           Time=    11:55:19                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Major.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
    10. MEMBER INCIDENCES
    11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
    12. 25 19 20; 26 20 5
    13. START USER TABLE
    14. TABLE 2
    15. UNIT INCHES KIP
    16. WIDE FLANGE
    17. TOP
    18. 17.8923 13.8 0.441 14.7 0.414 625.635 219.273 1.06624 6.0858 12.1716
    19. MID
    20. 10.4908 13.8 0.286 14.7 0.227 364.056 120.204 0.218702 3.9468 6.6738
    21. MUDLINE
    22. 20.7331 13.8 0.478 14.7 0.497 730.417 263.239 1.66929 6.5964 14.6118
    23. END
    24. UNIT FEET KIP
    25. DEFINE MATERIAL START
    26. ISOTROPIC STEEL
    27. E 4.176E+006
    28. POISSON 0.3
    29  DENSITY 0.489024
    30. ALPHA 6.5E-006
    31. DAMP 0.03
    32. END DEFINE MATERIAL
    33. UNIT INCHES KIP
    34. CONSTANTS
    35. BETA 0 MEMB 8 9
    36. MATERIAL STEEL ALL
    37. MEMBER PROPERTY AMERICAN
    38. 9 UPTABLE 2 TOP
```

```
39. *9 UPTABLE 2 50%PILE
40. *9 UPTABLE 2 33%PILE
41. *9 UPTABLE 2 50%FLG12
42. 7 8 UPTABLE 2 MID
43. 20 TO 23 UPTABLE 2 MUDLINE
44. MEMBER PROPERTY AMERICAN
45. 4 24 TO 26 TABLE ST HP14X89
46. SUPPORTS
47. 4 FIXED
48. 10 FIXED BUT FY
49. MEMBER RELEASE
50. 9 END MPY 0.5 MPZ 0.5
51. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
52. JOINT LOAD
53. 10 FY -169.2
54. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	12	NUMBER OF MEMBERS	11
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 61

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	8.23859
2	14.45484
3	21.40278
4	29.36024

55. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAY 2,2014 TIME= 11:55:19 ****

```
 ***********************************************************
 *        For questions on STAAD.Pro, please contact       *
 *        Bentley Systems or Partner offices               *
 *                                                         *
 *             Telephone           Web / Email             *
 *  USA       +1  (714) 974-2500                           *
 *  UK        +44 (0) 808 101 9246                         *
 *  SINGAPORE +65 6225-6158                                *
 *  FRANCE    +33 (0) 1 55238400                           *
 *  GERMANY   +49 0931 40468                               *
 *  INDIA     +91 (033) 4006-2021                          *
 *  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp  *
 *  CHINA     +86 21 6288 4040                             *
 *  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
 *                                                         *
 *  Worldwide  http://selectservices.bentley.com/en-US/    *
 *                                                         *
 ***********************************************************
```

MB Pz 5/14

Ch HVLW1 4/8/14

Major Pile

```
*****************************************************
*                                                   *
*           STAAD.Pro V8i SELECTseries4             *
*           Version  20.07.09.31                    *
*           Proprietary Program of                  *
*           Bentley Systems, Inc.                   *
*           Date=    APR 30, 2014                   *
*           Time=    14:59: 6                       *
*                                                   *
*      USER ID: CH2M HILL                           *
*****************************************************
```

```
    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending_Pier Shed_LC9.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
    9. 15 0 19.7975 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
   10. MEMBER INCIDENCES
   11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
   12. 25 19 20; 26 20 5
   13. START USER TABLE
   14. TABLE 2
   15. UNIT INCHES KIP
   16. WIDE FLANGE
   17. TOP
   18. 17.8923 13.8 0.441 14.7 0.414 625.635 219.273 1.06624 6.0858 12.1716
   19. MID
   20. 10.2505 13.8 0.268 14.7 0.227 360.49 120.2 0.200263 3.6984 6.6738
   21. MUDLINE
   22. 20.7331 13.8 0.478 14.7 0.497 730.417 263.239 1.66929 6.5964 14.6118
   23. END
   24. UNIT FEET KIP
   25. DEFINE MATERIAL START
   26. ISOTROPIC STEEL
   27. E 4.176E+006
   28. POISSON 0.3
   29. DENSITY 0.489024
   30. ALPHA 6.5E-006
   31. DAMP 0.03
   32. END DEFINE MATERIAL
   33. UNIT INCHES KIP
   34. CONSTANTS
   35. BETA 0 MEMB 8 9
   36. MATERIAL STEEL ALL
   37. MEMBER PROPERTY AMERICAN
   38. 9 UPTABLE 2 TOP
```

```
40. 20 TO 23 UPTABLE 2 MUDLINE
41. MEMBER PROPERTY AMERICAN
42. 4 24 TO 26 TABLE ST HP14X89
43. MEMBER PROPERTY AMERICAN
44. 7 8 UPTABLE 2 MID
45. SUPPORTS
46. 4 10 PINNED
47. LOAD 3 LOADTYPE WIND  TITLE WIND (MAJOR AXIS)
48. JOINT LOAD
49. 4 MZ 595.2
50. 10 MZ 463.2
51. LOAD 4 LOADTYPE ICE  TITLE ICE (MAJOR AXIS)
52. JOINT LOAD
53. 4 MZ 1146
54. 10 MZ 861.6
55. LOAD 5 LOADTYPE FLUIDS  TITLE CURRENT (MAJOR AXIS)
56. JOINT LOAD
57. 4 MZ 75.6
58. 10 MZ 49.2
59. LOAD COMB 9 HRPT LOAD CASE 9
60. 5 0.67 3 0.67 4 0.67
61. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	12	**NUMBER OF MEMBERS**	11
NUMBER OF PLATES	0	**NUMBER OF SOLIDS**	0
NUMBER OF SURFACES	0	**NUMBER OF SUPPORTS**	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 3, TOTAL DEGREES OF FREEDOM = 66

```
***WARNING    INSTABILITY AT JOINT   [illegible]   DIRECTION   MZ
PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
K-MATRIX DIAG=  9.0325176E+02 L-MATRIX DIAG=  1.1368684E-13 EQN NO       35
[illegible]
```

```
62. PARAMETER 1
63. CODE AISC
64. FYLD 36 ALL
65. LOAD LIST
66. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
4 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.400	9
		0.00 T	0.00	1217.26	0.00
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.771	9
		0.00 T	0.00	-602.79	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.827	9
		0.00 T	0.00	-646.13	9.00
9 ST	TOP		(UPT)		
		PASS	AISC- H1-3	0.488	9
		0.00 T	0.00	-920.58	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.128	9
		0.00 T	0.00	299.45	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.136	9
		0.00 T	0.00	318.06	50.82
22 ST	MUDLINE		(UPT)		
		PASS	SHEAR -Y	0.051	9
		0.00 T	0.00	93.61	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.224	9
		0.00 T	0.00	-523.90	42.75
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.343	9
		0.00 T	0.00	1043.92	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.286	9
		0.00 T	0.00	870.58	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.229	9
		0.00 T	0.00	697.24	0.00

```
67. PARAMETER 2
68. CODE AISC
69. LX 206 MEMB 7 TO 9 20 22
70. UNB 206 MEMB 7 TO 9 20 22
71. UNT 206 MEMB 7 TO 9 20 22
72. LX 237.58 MEMB 4 21 23 TO 26
73. UNB 237.58 MEMB 4 21 23 TO 26
74. UNT 237.58 MEMB 4 21 23 TO 26
75. FINISH
```

```
*********** END OF THE STAAD.Pro RUN ***********

  **** DATE= APR 30,2014   TIME= 14:59: 6 ****

************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone              Web / Email          *
*  USA        +1  (714) 974-2500                           *
*  UK         +44 (0) 808 101 9246                         *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE     +33 (0) 1 55238400                           *
*  GERMANY    +49 0931 40468                               *
*  INDIA      +91 (033) 4006-2021                          *
*  JAPAN      +81 (03)5952-6500    http://www.ctc-g.co.jp  *
*  CHINA      +86 21 6288 4040                             *
*  THAILAND   +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL.

Job Name: HRPT Pier 40

Subject: PS Moderate Pile (Euler Buckling)

Job No.:

Sheet No.: 1

Date:

Computed By: B 5/14

Checked By: MWOM 4/3/14

Calc 6 B of Pile (Moderate Pile)

Top	Mid	Bottom
F: .459" ✓	F: .325" ✓	F: .50[illegible]" ✓
W: .448" ✓	W: .257" ✓	W: .472 ✓
A_s = 19.27 sq in ✓	A_s = 12.93 in² ✓	A_s = [illegible] ✓

From stadd

Applied load -170 kip ✓

BF: 2.[illegible] ✓

E. Buckling load = [illegible] kip ✓

F_e @ Critical section (Node 15)

F_e = [illegible] = [illegible] ksi ✓

L = 444" ✓

$\frac{k}{r}$ = [illegible] ✓

$\frac{KL}{r}$ = [illegible] ✓

F_{cr} = [illegible] ✓

$\frac{P_n}{\Omega}$ = 35[illegible] kip ✓

MB BC 5/14
Ch MWan

```
****************************************************
*                                                  *
*          STAAD.Pro V8i SELECTseries4             *
*          Version  20.07.09.31                    *
*          Proprietary Program of                  *
*          Bentley Systems, Inc.                   *
*          Date=    MAY  2, 2014                   *
*          Time=    12: 6:55                       *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed_Moderate.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
    10. MEMBER INCIDENCES
    11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
    12. 25 19 20; 26 20 5
    13. START USER TABLE
    14. TABLE 2
    15. UNIT INCHES KIP
    16. WIDE FLANGE
    17. TOP
    18. 19.2657 13.8 0.448 14.7 0.459 680.495 243.101 1.33378 6.1824 13.4946
    19. MID
    20. 12.9345 13.8 0.257 14.7 0.325 482.523 172.08 0.410821 3.5466 9.555
    21. MUDLINE
    22. 20.827 13.8 0.472 14.7 0.503 736.36 266.411 1.69563 6.5136 14.7882
    23. END
    24. UNIT FEET KIP
    25. DEFINE MATERIAL START
    26. ISOTROPIC STEEL
    27. E 4.176E+006
    28. POISSON 0.3
    29. DENSITY 0.489024
    30. ALPHA 6.5E-006
    31. DAMP 0.03
    32. END DEFINE MATERIAL
    33. UNIT INCHES KIP
    34. CONSTANTS
    35. BETA 0 MEMB 8 9
    36. MATERIAL STEEL ALL
    37. MEMBER PROPERTY AMERICAN
    38. 9 UPTABLE 2 TOP
```

```
39. *9 UPTABLE 2 50%PILE
40. *9 UPTABLE 2 33%PILE
41. *9 UPTABLE 2 50%FLG12
42. 7 8 UPTABLE 2 MID
43. 20 TO 23 UPTABLE 2 MUDLINE
44. MEMBER PROPERTY AMERICAN
45. 4 24 TO 26 TABLE ST HP14X89
46. SUPPORTS
47. 4 FIXED
48. 10 FIXED BUT FY
49. MEMBER RELEASE
50. 9 END MPY 0.5 MPZ 0.5
51. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
52. JOINT LOAD
53. 10 FY -169.2
54. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	12	NUMBER OF MEMBERS	11
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 61

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	8.65055
2	16.36930
3	22.07895
4	32.08441

55. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAY 2,2014 TIME= 12: 6:56 ****

```
************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*           Telephone            Web / Email               *
*  USA       +1  (714) 974-2500                            *
*  UK        +44 (0) 808 101 9246                          *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE    +33 (0) 1 55238400                            *
*  GERMANY   +49 0931 40468                                *
*  INDIA     +91 (033) 4006-2021                           *
*  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp   *
*  CHINA     +86 21 6288 4040                              *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL.

Job Name: HRPT Pier 40

Subject: PS Minor Pile (EB)

Job No.:

Sheet No.: 1

Date:

Computed By: BC 5/14

Checked By: MWdh 4/8/14

Calc GB of Pile (Minor)

Section

Top	Mid	Bottom
F: .525" ✓	F: .225" ✓	F: .484 ✓
W: .483" ✓	W: .322" ✓	W: .465 ✓
$A_s = 21.59\ in^2$ ✓	$A_s = 10.88\ in^2$ ✓	$A_s = 20.45\ in^2$ ✓

From STADD

BF = 8.54 ✓ (Buckling Factor)

E. Buckling Load = 1451.8 kip ✓

Critical Section (Node 15) (at mudline)

$A_s = 20.45\ in^2$ ✓

$F_e = 70.99$ ksi ✓

$\frac{K}{r} = .143$ ✓, $\frac{KL}{r} = 63.49$ ✓ Use (E3-2)

$F_{cr} = 29.11$ ksi ✓

$\boxed{\frac{P}{\Omega} = 356.53\ kip}$ ✓

Check Flange Slenderness @ thinnest point (Assume repair only)

$b/t = \frac{7.35}{.484} = 15.186$ ✓ $< \lambda_r$ → 15.39 ✓ ∴ Flange is not slender ✓

MB BC 5/14
Ch. MWahl
4/8/14

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    APR 16, 2014                  *
*           Time=    14:38:19                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Minor.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12 MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 0 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0; 18 0 3 0; 19 0 6 0; 20 0 9 0
    10. MEMBER INCIDENCES
    11. 4 4 18; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5; 24 18 19
    12. 25 19 20; 26 20 5
    13. START USER TABLE
    14. TABLE 2
    15. UNIT INCHES KIP
    16. WIDE FLANGE
    17. TOP
    18  21.5932 13.8 0.483 14.7 0.525 763.79 278.065 1.89697 6.6654 15.435
    19. MID
    20. 10.8849 13.8 0.322 14.7 0.224 367.344 118.627 0.258737 4.4436 6.5856
    21. MUDLINE
    22. 20 4531 13.8 0.485 14.7 0.484 716.458 256.362 1.5991 6.693 14.2296
    23. END
    24. UNIT FEET KIP
    25. DEFINE MATERIAL START
    26. ISOTROPIC STEEL
    27. E 4.176E+006
    28. POISSON 0.3
    29. DENSITY 0.489024
    30  ALPHA 6.5E-006
    31  DAMP 0.03
    32. END DEFINE MATERIAL
    33. UNIT INCHES KIP
    34. CONSTANTS
    35. BETA 0 MEMB 8 9
    36. MATERIAL STEEL ALL
    37. MEMBER PROPERTY AMERICAN
    38. 9 UPTABLE 2 TOP
```

```
39. 7 8 UPTABLE 2 MID
40. 20 TO 23 UPTABLE 2 MUDLINE
41. MEMBER PROPERTY AMERICAN
42. 4 24 TO 26 TABLE ST HP14X89
43. SUPPORTS
44. 4 FIXED
45. 10 FIXED BUT FY
46. MEMBER RELEASE
47. 9 END MPY 0.5 MPZ 0.5
48. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
49. JOINT LOAD
50. 10 FY -169.2
51. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	12	NUMBER OF MEMBERS	11
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 61

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	8.54468
2	15.04405
3	22.22354
4	30.02812

52. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 16,2014 TIME= 14:38:19 ****

```
************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone              Web / Email          *
*  USA       +1  (714) 974-2500                            *
*  UK        +44 (0) 808 101 9246                          *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE    +33 (0) 1 55238400                            *
*  GERMANY   +49 0931 40468                                *
*  INDIA     +91 (033) 4006-2021                           *
*  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp   *
*  CHINA     +86 21 6288 4040                              *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL SUBJECT ______ BY ______
SHEET NO. ___ of ___ DATE ______
PROJECT NO. ______

MB BL 5/16

Pier Shed Short EL

Original calcs took pile length to be 3? (longest pile + 12')
This is too conservative for most of the pier shed
The max measured length on the first third of the pier is 19 which gives a total pile length of 31

Same cross sectional properties as previous severe pile
Same assumptions as before.
Applied load -170 kip
From Stadd
Buckling factor 9.54
170k · 10.57 = 1621.8 k (Euler Buckling)
Calc F_e @ critical section
$A_s = 18.62\ in^2$

$$\frac{1621.8k}{18.62\ in^2} = 87.1\ ksi = f_e$$

$$\frac{Kl}{r} = \sqrt{\frac{\pi^2 \cdot E}{F_e}} = 57.32$$

$$F_{cr} = \left[0.658^{36/87.1}\right] 36 = 30.28\ ksi$$

Pile will buckle at critical section $A_s = 18.62\ in^2$

$$P_n = \frac{30.28\ ksi \cdot 18.62\ in}{1.67} = 337.625$$

CH2MHILL SUBJECT ______ BY ______
SHEET NO. ___ of ___ DATE ______
PROJECT NO. ______

MB: DC 5/16

Section loss at the top of the pile will be the same with the short and long piles

∴ $\frac{b}{t}$ ratio will be the same

$Q_s = 0.716$

Apply to (E 3-2)

$F_{cr} = Q_s \cdot \left[0.658^{Q_s F_y/F_e}\right] \cdot F_y$

$= 0.716 \cdot \left[0.658^{\frac{.716 \cdot 36}{87.1}}\right] \cdot 36 = 22.77\ ksi$

$P_n = \frac{18.62 \cdot 22.77\ ksi}{1.67} = 253.913\ kip$

L/C 8)

U/R Axial

$\left(\frac{106.8\ k}{253.91\ k}\right) \cdot 1.4 + 0.037 + \left(8/9 \cdot .776\right) = 1.027$

(.301; .689)

L/C 9)

$\left(\frac{75.6\ k}{253.91\ k} \cdot 1.5\right) + \quad + \left(8/9 \cdot .829\right) = 1.013$

(0.198; 0.736)

PILE LOAD RATINGS – TRUCK COURT

Halcrow

PROJECT: HRPT Truck Court
SUBJECT: Compressive Capacity (Severe)

SHEET NO. 1 OF
JOB NO.
MADE BY: BC DATE: 4/8/14
CHKD. BY: MWahl DATE: 4/8/14

Calc Global Buckling Capacity (Severe)

Trib area: 432 sqft ✓

Dead load: 103 kip ✓

El.: 30' ✓

(Section in Model)

Top

F: 0.400" ✓

W: 0.425" ✓

A_s = 17.285 in² ✓

Assume 50% Moment release at the top of pile.
Full fixed at the mud line ✓

Mid

F: 0.200 ✓

W: 0.225 ✓

Mud

F: 0.400 ✓

W: 0.500 ✓

A_s = 18.26 in² ✓

From staad:

Applied load: 167.8 kip ✓

Buckling Factor: 10.51 ✓ - see Staad output

Euler Buckling Load →

$$\frac{1763.58 \text{ kip}}{18.26 \text{ in}^2} = 96.58^{ksi} = F_c \checkmark$$

Find Approx $^{k}/_{r}$

L = 360" ✓

$$\frac{k}{r} = \frac{\sqrt{\frac{\pi^2 \cdot E}{F_c}}}{L} = 0.151 \checkmark$$

Halcrow

PROJECT: HRPT TC	SHEET NO. ____ OF ____
SUBJECT: Axial	JOB NO. ____
	MADE BY: BC DATE: 5/8/14
	CHKD. BY: MWAN DATE: 4/8/14

$\frac{KL}{r} = 360'' \cdot 0.151 = 54.36 \checkmark < 4.71 \cdot \sqrt{\frac{29{,}000}{36}} = 133.7$ ✓

USE AISC E3-2

$F_{cr} = \left[0.658^{36/96.58}\right] \cdot 36 = 30.79\ ksi$ ✓

Pile will buckle at critical section $A_s = 18.26 in^2$ (Bottom Section) ✓

$P_n = 18.26 in^2 \cdot 30.79 ksi = 562.4\ kip$ ✓

$\boxed{\frac{P_n}{\Omega} = 336.76\ kip}$ $\Omega = 1.67$ ✓

Consider Slender Elements at the top of the pile

$b = 7.35''$ ✓ (A Avg. flange reading is used as FLB will happen over a larger area of the flange) ✓

$t = 0.450''$ ✓

$b/t = 16.3$ ✓

$b/t > 0.56 \times \sqrt{\frac{29000}{36}} = 15.9$

$b/t < 1.03 \sqrt{\frac{29000}{36}} = ...$ ✓

Apply (E 7-5) 16.3 .035

$Q_s = 1.415 - 0.74 \left(b/t\right) \cdot \sqrt{\frac{F_y}{E}}$

$Q_s = .992$ ✓

Apply to base E 7-2

$F_{cr} = .992\left[0.658^{.992 \cdot 36/96.58}\right] \cdot 36$

$F_{cr} = 30.6\ ksi$ ✓

conserv as global and local buckling will not occur in same location

A_s @ bot of the of Pile = $18.26 in^2$

$P_n = 558.75 kip$ $\boxed{\frac{P_n}{\Omega} = 334.6\ kip}$ ✓

Halcrow

PROJECT T/C
SUBJECT

SHEET NO. 3 OF
JOB NO.
MADE BY Pr DATE 4/8/14
CHKD. BY Mudhl DATE 4/8/14

Check Local crushing of min section of the Flange

$A_s = 17.285 \, in^2$ ✓

$P_n = 17.285 \times 36 \, ksi = 622.26$ ✓

$\frac{P_n}{\Omega} = 372.6 \, kip$ ✓

Local Buckling Controls ✓

Capacity 334.6 kip ✓

Allowable Live load: 334.6 k (Capacity) − 103 kip (DL) = 231.6 kip ✓

$\frac{231.6 \, kip}{432 \, sqft} = .536 \, k/ft^2 =$ **536.1 psf** ✓

*No Lateral Load on truck court ✓

MB BC 5/8/14

Tuesday, May 06, 2014, 12:47 PM

CH. Muhl
4/8/14

```
****************************************************
*                                                  *
*          STAAD.Pro V8i SELECTseries4             *
*          Version  20.07.09.31                    *
*          Proprietary Program of                  *
*          Bentley Systems, Inc.                   *
*          Date=    MAY  6, 2014                   *
*          Time=    11:16: 6                       *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Severe Truck Court.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 7 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
    10. MEMBER INCIDENCES
    11. 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5
    12. START USER TABLE
    13. TABLE 1
    14. UNIT FEET KIP
    15. WIDE FLANGE
    16. ORIGINAL
    17. 0.179247 1.15 0.05125 1.225 0.05125 0.0428327 0.0157136 0.000156934 -
    18. 0.0589375 0.125563
    19. 0.25_THICK
    20. 0.0741319 1.15 0.0208333 1.225 0.0208333 0.0186353 0.00638368 1.07251E-005 -
    21. 0.0239583 0.0510417
    22. 0.375_THICK
    23. 0.110547 1.15 0.03125 1.225 0.03125 0.027312 0.00957706 3.59853E-005 -
    24. 0.0359375 0.0765625
    25. 0.4375_THICK
    26. 0.128592 1.15 0.0364583 1.225 0.0364583 0.0314958 0.0111744 5.69753E-005 -
    27. 0.0419271 0.0893229
    28. 0.5_THICK
    29. 0.146528 1.15 0.0416667 1.225 0.0416667 0.0355786 0.0127722 8.4796E-005 -
    30. 0.0479167 0.102083
    31. 0.3125_THICK
    32. 0.0923948 1.15 0.026042 1.225 0.026042 0.023026 0.0079803 2.0887E-005 -
    33. 0.0299483 0.0638029
    34. 0.125_THICK
    35. 0.0372842 1.15 0.010417 1.225 0.010417 0.00953593 0.00319164 1.34862E-006 -
    36. 0.0119796 0.0255217
    37. TABLE 2
    38. UNIT INCHES KIP
```

```
39. WIDE FLANGE
40. 20%TOP
41. 17.285 13.8 0.425 14.7 0.4 605.874 211.851 0.959851 5.865 11.76
42. 20%MID
43. 26.535 13.8 0.225 14.7 0.2 641.025 116.177 0.129278 3.105 5.88
44. 20%MUDLINE
45. 18.26 13.8 0.5 14.7 0.4 619.605 211.904 1.16887 6.9 11.76
46. 50%PILE
47. 14.5475 13.8 0.575 13.8 0.25 429.481 109.714 0.986568 7.935 6.9
48. 50%FLG12
49. 13.6475 13.8 0.575 12 0.25 388.166 72.2107 0.967818 7.935 6
50. 33%PILE
51. 12.245 13.8 0.475 14.7 0.2 367.152 106.004 0.557101 6.555 5.88
52. END
53. UNIT FEET KIP
54. DEFINE MATERIAL START
55. ISOTROPIC STEEL
56. E 4.176E+006
57. POISSON 0.3
58. DENSITY 0.489024
59. ALPHA 6.5E-006
60. DAMP 0.03
61. END DEFINE MATERIAL
62. UNIT INCHES KIP
63. CONSTANTS
64. BETA 0 MEMB 8 9
65. MATERIAL STEEL ALL
66. *9 UPTABLE 2 50%PILE
67. *9 UPTABLE 2 33%PILE
68. *9 UPTABLE 2 50%FLG12
69. MEMBER PROPERTY AMERICAN
70. 9 UPTABLE 2 20%TOP
71. 20 TO 23 UPTABLE 2 20%MUDLINE
72. MEMBER PROPERTY AMERICAN
73. 7 8 UPTABLE 2 20%MID
74. 4 TABLE ST HP14X89
75. SUPPORTS
76. 4 FIXED
77. 10 FIXED BUT FY
78. MEMBER RELEASE
79. 9 END MPY 0.5 MPZ 0.5
80. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
81. JOINT LOAD
82. 10 FY -167.8
83. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	9	NUMBER OF MEMBERS	8
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 43

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	10.51111
2	18.35732
3	28.93738
4	36.68349

84. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAY 6,2014 TIME= 11:16: 7 ****

```
************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*             Telephone              Web / Email           *
*  USA       +1  (714) 974-2500                            *
*  UK        +44 (0) 808 101 9246                          *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE    +33 (0) 1 55238400                            *
*  GERMANY   +49 0931 40468                                *
*  INDIA     +91 (033) 4006-2021                           *
*  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp   *
*  CHINA     +86 21 6288 4040                              *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL.

Job No. ______

Sheet No. 1

Job Name: HRPT

Date: ______

Subject: T/C Mayor Pile Capacity

Computed By: RC 4/8/14

Checked By: MWahl 4/8/14

Global buckling (Mayor Pile)

Top	Mid	Bottom
F: .452 ✓	F: .[illegible] ✓	F: .488 ✓
W: .49 ✓	W: .326 ✓	W: .5[illegible] ✓
A_s = 19.6 ✓	A_s = 13.8 ✓	A_s = 20.81 ✓

From Staad

Applied Load: [illegible] kip ✓

BF: [illegible].43 ✓

EBL = 2085.75 kip ✓

$F_e = \frac{2085.75 \text{kip}}{20.81 \text{in}^2} = 100.228$ ksi ✓

Critical Section @ Node 16

L = 360" ✓

$\frac{KL}{r} : \sqrt{\frac{\pi^2 \cdot E}{Fc}} = 7\ 53.41$ ✓

F_{cr} = 27.15 ksi ✓

$\frac{P_n}{\Omega}$ = **338.3 kip** ✓

Check FLB

b/t = 16.26 ✓

Q_s = 1.415 − 0.74(16.26)[illegible]

Q_s = .991 ✓

F_{cr} = 30.73 ✓

$\frac{P_n}{\Omega}$ = **382.[illegible]** ✓

MB BC 5/8/14

CH. MWahl 4/8/14

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    APR 16, 2014                  *
*           Time=    16:57:38                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************

    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Major Truck Court.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 4 0 7 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
    9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
   10. MEMBER INCIDENCES
   11. 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5
   12. START USER TABLE
   13. TABLE 2
   14. UNIT INCHES KIP
   15. WIDE FLANGE
   16. TOP
   17. 19.6078 13.8 0.49 14.7 0.452 679.715 239.424 1.41072 6.762 13.2888
   18. MID
   19. 13.8706 13.8 0.326 14.7 0.326 496.841 172.629 0.491372 4.4988 9.5844
   20. MUDLINE
   21. 20.8105 13.8 0.504 14.7 0.488 724.476 258.494 1.68616 6.9552 14.3472
   22. END
   23. UNIT FEET KIP
   24. DEFINE MATERIAL START
   25. ISOTROPIC STEEL
   26. E 4.176E+006
   27. POISSON 0.3
   28. DENSITY 0.489024
   29. ALPHA 6.5E-006
   30. DAMP 0.03
   31. END DEFINE MATERIAL
   32. UNIT INCHES KIP
   33. CONSTANTS
   34. BETA 0 MEMB 8 9
   35. MATERIAL STEEL ALL
   36. MEMBER PROPERTY AMERICAN
   37. 9 UPTABLE 2 TOP
   38. 20 TO 23 UPTABLE 2 MUDLINE
```

```
35. MEMBER PROPERTY AMERICAN
40. 7 8 UPTABLE 2 MID
41. 4 TABLE ST HP14X89
42. SUPPORTS
43. 4 FIXED
44. 10 FIXED BUT FY
45. MEMBER RELEASE
46. 9 END MPY 0.5 MPZ 0.5
47. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
48. JOINT LOAD
49. 10 FY -167.8
50. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	9	NUMBER OF MEMBERS	8
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 43

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	12.43459
2	22.83334
3	31.42424
4	45.25114

51. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 16,2014 TIME= 16:57:38 ****

```
************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*             Telephone              Web / Email           *
*  USA        +1  (714) 974-2500                           *
*  UK         +44 (0) 808 101 9246                         *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE     +33 (0) 1 55238400                           *
*  GERMANY    +49 0931 40468                               *
*  INDIA      +91 (033) 4006-2021                          *
*  JAPAN      +81 (03)5952-6500    http://www.ctc-g.co.jp  *
*  CHINA      +86 21 6288 4040                             *
*  THAILAND   +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

CH2MHILL.

Job Name ______________________ Job No. ______________________

Subject: T/C Moderate Pile Sheet No. 1

Date ______________________

Computed By: [initials] 5/8/14

Checked By ______________________

Global Buckling Moderate Pile

Top	Mid	Bot
F .4[illegible] ✓	[illegible] .516 ✓	F .447 ✓
W .447 ✓	[illegible] .[illegible]62 ✓	W .47[illegible] ✓
A_s = 1[illegible] ✓	A_s = 21.07 ✓	A_s = 19.23 ✓

From STAAD

Applied Load [illegible]57.8 ✓

BF: [illegible] ✓

LBL: [illegible] kip ✓

F_e = 107.155 ksi ✓

L = 360"

$\frac{KL}{r} = \sqrt{\frac{\pi^2 E}{F_e}}$ = 51.62 ✓

$F_{cr} = \left[0.658^{36/107.1}\right] 36$ = 31.27 ksi ✓

$\frac{P_n}{\Omega}$ = 360.14 kip ✓

Check FLB (Local Buckling)

$b/t = \frac{7.35}{.405}$ = 17.1[illegible] ✓ Top Flange is Slender

Q_s = 1.415 − 0.74[illegible]([illegible]) [illegible]

= 0.967 ✓

A_s = 19.23 Apply to (E 7-2)

$F_{cr} = .967\left[.658^{\frac{[illegible]}{107.15}}\right] 36$

= 30.3[illegible] ksi ✓

$\frac{P_n}{\Omega}$ = 349.[illegible] kip ✓

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    APR 17, 2014                  *
*           Time=    10:28:21                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Moderate Truck Court.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 4 0 7 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0; 9 0 32.25 0; 10 0 37 0
     9. 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
    10. MEMBER INCIDENCES
    11. 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15; 23 17 5
    12. START USER TABLE
    13. TABLE 2
    14. UNIT INCHES KIP
    15. WIDE FLANGE
    16. TOP
    17. 18.3821 13.8 0.448 14.7 0.428 643.66 226.689 1.1563 6.1824 12.5832
    18. MID
    19. 21.0692 13.8 0.462 14.7 0.516 749.733 273.286 1.76609 6.3756 15.1704
    20. MUDLINE
    21. 19.2334 13.8 0.472 14.7 0.447 670.577 236.764 1.32766 6.5136 13.1418
    22. END
    23. UNIT FEET KIP
    24. DEFINE MATERIAL START
    25. ISOTROPIC STEEL
    26. E 4.176E+006
    27. POISSON 0.3
    28. DENSITY 0.489024
    29. ALPHA 6.5E-006
    30. DAMP 0.03
    31. END DEFINE MATERIAL
    32. UNIT INCHES KIP
    33. CONSTANTS
    34. BETA 0 MEMB 8 9
    35. MATERIAL STEEL ALL
    36. MEMBER PROPERTY AMERICAN
    37. 9 UPTABLE 2 TOP
    38. 20 TO 23 UPTABLE 2 MUDLINE
```

```
39. MEMBER PROPERTY AMERICAN
40. 7 8 UPTABLE 2 MID
41. 4 TABLE ST HP14X89
42. SUPPORTS
43. 4 FIXED
44. 10 FIXED BUT FY
45. MEMBER RELEASE
46. 9 END MPY 0.5 MPZ 0.5
47. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
48. JOINT LOAD
49. 10 FY -167.8
50. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	9	NUMBER OF MEMBERS	8
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 43

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	12.28600
2	25.04458
3	31.40695
4	47.45310

51. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 17,2014 TIME= 10:28:22 ****

```
***********************************************************
*      For questions on STAAD.Pro, please contact         *
*      Bentley Systems or Partner offices                 *
*                                                         *
*            Telephone              Web / Email           *
* USA        +1  (714) 974-2500                           *
* UK         +44 (0) 808 101 9246                         *
* SINGAPORE +65 6225-6158                                 *
* FRANCE     +33 (0) 1 55238400                           *
* GERMANY    +49 0931 40468                               *
* INDIA      +91 (033) 4006-2021                          *
* JAPAN      +81 (03)5952-6500    http://www.ctc-g.co.jp  *
* CHINA      +86 21 6288 4040                             *
* THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                         *
* Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                         *
***********************************************************
```

CH2MHILL

Job Name HRPT TC Local Crushing [w/ Avg pile]

Subject

Job No.

Sheet No.

Date

Computed By BC 5/8/14

Checked By MWahl 4/8/14

Local Crushing

Truck Court Severe Pile

F: .447 in ✓

W: .459 in ✓

A_s = 19.07 in² ✓

36 ksi · 19.07 in² = 686.52 kip ✓

$\frac{P_n}{\Omega}$ = 411.09 kip ✓

Major Pile

F: 0.452" ✓

W: 0.490" ✓

A_s = 19.60 in² ✓

$\frac{P_n}{\Omega}$ = 422.51 ✓

Moderate Pile

F: 0.428 ✓

W: 0.448 ✓

A_s = 18.38 in² ✓

$\frac{P_n}{\Omega}$ = 396.21 ✓

Minor Pile

No data

PILE LOAD RATINGS – FINGER PIER

CH2MHILL.

Job Name HRPT Finger Pier [illegible]

Subject

Job No.

Sheet No.

Date

Computed By [illegible] 5/8/14

Checked By MWdh 5/8/14

Global Buckling (severe)

Top	Mid	Bot
F .259	F .454	F [illegible]
W .407	W .354	W [illegible]
A_s 13.02	A_s 18.29	A_s 17.61

From STADD

Applied Load: 175.6 kip

BF: 4.48

EBL: 785.69 kip

$F_e = \frac{785.69 \text{ kip}}{17.61} = 44.6$ ksi

L = 552"

$\frac{KL}{r} = \sqrt{\frac{\pi^2 E}{F_e}} = 80.109$

$F_{cr} = [0.658^{F_y/F_e}]\,36 = 25.70$ ksi

A = 17.61 in²

P_n = 452.7 kip

$\frac{P_n}{\Omega} = 271.07$ kip

CH2MHILL SUBJECT HPP1 [illegible] BY

SHEET NO [illegible] of DATE

PROJECT NO.

BC 5/8/2014

ch MWahl

5/8/14

Check FLB (Flange Local Buckling)

$b/t = \frac{7.35''}{0.259} = 28.37$ ✓

$28.37 < 1.03 \cdot \sqrt{\frac{29000}{36}}$ ✓

$Q_s = 1.415 - 0.74 \cdot (28.37) \cdot \sqrt{\frac{F_y}{E}}$ ✓

$Q_s = 0.675$ ✓

Apply to AISC E7-2 conserv.

$F_{cr} = 0.675 \cdot (0.658^{\ldots}) \cdot 36$ ✓

$F_{cr} = 19.345$ ksi ✓

$P_n = 19.345 \text{ ksi} \cdot 17.61 \text{ in}^2 = 340,665$ ✓

$\frac{P_n}{\Omega} = 204$ kip ✓

MB [illegible] 5/8/2014

[illegible] 5/8/14

```
*****************************************************
*                                                   *
*           STAAD.Pro V8i SELECTseries4             *
*           Version  20.07.09.31                    *
*           Proprietary Program of                  *
*           Bentley Systems, Inc.                   *
*           Date=    MAY  6, 2014                   *
*           Time=    11:41:53                       *
*                                                   *
*      USER ID: CH2M HILL                           *
*****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Avg Severe Finger Pier.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
     9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
    10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
    11. MEMBER INCIDENCES
    12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
    13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
    14. START USER TABLE
    15. TABLE 2
    16. UNIT INCHES KIP
    17. WIDE FLANGE
    18. TOP
    19. 13.0204 13.8 0.407 14.7 0.259 428.563 137.195 0.468752 5.6166 7.6146
    20. MID
    21. 18.2981 13.8 0.384 14.7 0.454 663.15 240.418 1.16038 5.2992 13.3476
    22. MUDLINE
    23. 17.6174 13.8 0.411 14.7 0.418 624.984 221.373 1.01575 5.6718 12.2892
    25. END
    26. UNIT FEET KIP
    27. DEFINE MATERIAL START
    28. ISOTROPIC STEEL
    29. E 4.176E+006
    30. POISSON 0.3
    31. DENSITY 0.489024
    32. ALPHA 6.5E-006
    33. DAMP 0.03
    34. END DEFINE MATERIAL
    35. UNIT INCHES KIP
    36. CONSTANTS
    37. BETA 0 MEMB 8 9
    38. MATERIAL STEEL ALL
    40. MEMBER PROPERTY AMERICAN
```

```
41. 1 24 TO 26 TABLE ST HP14X89
42. MEMBER PROPERTY AMERICAN
43. 9 UPTABLE 2 TOP
44. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
45. MEMBER PROPERTY AMERICAN
46. 7 8 UPTABLE 2 MID
47. SUPPORTS
48. 1 FIXED
49. 10 FIXED BUT FY
50. MEMBER RELEASE
51. 9 END MPY 0.5 MPZ 0.5
52. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
53. JOINT LOAD
54. 10 FY -175.6
55. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	15	NUMBER OF MEMBERS	14
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 79

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	4.48064
2	9.25367
3	12.28145
4	18.32388

56. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAY 6,2014 TIME= 11:41:53 ****

```
************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone              Web / Email          *
*   USA       +1  (714) 974-2500                           *
*   UK        +44 (0) 808 101 9246                         *
*   SINGAPORE +65 6225-6158                                *
*   FRANCE    +33 (0) 1 55238400                           *
*   GERMANY   +49 0931 40468                               *
*   INDIA     +91 (033) 4006-2021                          *
*   JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp  *
*   CHINA     +86 21 6288 4040                             *
*   THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*   Worldwide  http://selectservices.bentley.com/en-US/    *
*                                                          *
************************************************************
```

CH2MHILL.

Job Name HRPT FF LC w/Avg Pile

Subject

Job No.

Sheet No.

Date

Computed By Bc 5/8/2014

Checked By MWdl 5/8/14

Local Crushing

Finger Pier (Severe Pile)

F: 0.254" ✓

W: 0.407" ✓

A_s: 13.02 in² ✓

36 ksi · 13.02 in² = 468.72 kip ✓

$\frac{P_n}{1.67}$ = 280.67 kip ✓

Major Pile

F: .390" ✓

W: .445 ✓

A_s = 17.26 in² ✓

$\frac{P_n}{\Omega}$ = 378.53 kip ✓

Moderate Pile

F: .449" ✓

W: .430" ✓

A_s = 18.75 in² ✓

$\frac{P_n}{\Omega}$ 404.2 kip ✓

Minor Pile

F: 0.611" ✓

W: 0.608" ✓

A_s = 25.6 in² ✓

$\frac{P_n}{\Omega}$ = 551 kip ✓

CH2MHILL

SUBJECT FP Lateral [illegible]
[illegible]

BY
SHEET NO 1 of DATE
PROJECT NO

MB [illegible] 5/8/14
ch MWahl 5/8/14

Load Case [illegible]
V/R 0.192 ✓

Load Case 5

[Moment V/R From STADD See attached Output] ✓

V/R : 0.214 ✓

Load Case

V/R 0.627 @ Top ✓

Load Case 8

V/R 0.861 @ Top ✓

Load Case 7

V/R 0.895 @ Top ✓

For [illegible] Pile

F & B Controls

204 k – Capacity ✓

Live Load

100 PSF : [illegible] kip ✓

300 PSF : 67.5 kip

D_L = 80.4 kip ✓

Superimposed D_L (to account for structure on [illegible])

[illegible] 15 kip ✓

Combined Axial & Moment ✓

Load Case 1

Total Axial [illegible] = 15[illegible] kip ✓

L_L D_L SD_L

V/R = 0.[illegible]

[illegible] 300 psf

Load Case [illegible] ✓

Additional Axial

1.4 + 2 + 1.4 = 4.8 k – see attached Etab output

$\left[\frac{[illegible] + 80.4 + [illegible] + [illegible]}{204 \text{ kip}}\right] + [8/9 \cdot 0.198] = 0.624$ ✓

CH2MHILL SUBJECT ______ BY ______

SHEET NO 2 of ______ DATE ______ BC MB 5/8/2014

PROJECT NO. ______

Ch MWahl 5/8/14

Load Case 5

$\left[\frac{6.75+8 \ldots}{2.04k}\right] \div 1.4 + 8/9 \cdot \ldots = 0.590$ ✓

OK w/ 100 PSF ✓

Load Case 7

$\left[\frac{6.75k + \ldots + 7.3k}{204k}\right] \div 1.33 + 8/9 \cdot 0.627 \quad .91$ ✓ OK ✓

Load Case 8

$\left[8\ldots + 6.75k + 35k + \ldots 5k\right] \div 1.4 + 8/9 \cdot 0.861 = 1.27$ N/G

D, D, M, L ... 204k

~~other page / Said 0.949~~ Corrected BC 5/13

Load Case 9

$\left[\frac{80.4 + 6.75 + (1.4 \cdot 12.0) + 35}{2.04}\right] \div 1.5 + 8/9 \cdot .895 = 1.21$ ✓ N/G ✓

0.410

* For L/C 8 & 9 Please see Appendix 1

MB BC 5/14
CH MW 1
5/14

Severe Pile

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    MAY  6, 2014                  *
*           Time=    15:50:10                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending__Finger Pier LC3.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9.89 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
    9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.0875 0; 17 0 15.5625 0
   10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
   11. MEMBER INCIDENCES
   12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
   13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
   14. START USER TABLE
   15. TABLE 1
   16. UNIT FEET KIP
   17. WIDE FLANGE
   18. ORIGINAL
   19. 0.179247 1.15 0.05125 1.225 0.05125 0.0428327 0.0157136 0.000156934 -
   20. 0.0589375 0.125563
   21. 0.25_THICK
   22. 0.0741319 1.15 0.0208333 1.225 0.0208333 0.0186353 0.00638368 1.07251E-005
   23. 0.0239583 0.0510417
   24. 0.375_THICK
   25. 0.110547 1.15 0.03125 1.225 0.03125 0.027312 0.00957706 3.59853E-005 -
   26. 0.0359375 0.0765625
   27. 0.4375_THICK
   28. 0.128592 1.15 0.0364583 1.225 0.0364583 0.0314958 0.0111744 5.69753E-005 -
   29. 0.0419271 0.0893229
   30. 0.5_THICK
   31. 0.146528 1.15 0.0416667 1.225 0.0416667 0.0355786 0.0127722 8.4796E-005
   32. 0.0479167 0.102083
   33. 0.3125_THICK
   34. 0.0923948 1.15 0.026042 1.225 0.026042 0.023026 0.0079803 2.0887E-005 -
   35. 0.0299483 0.0638029
   36. 0.125_THICK
   37. 0.0372842 1.15 0.010417 1.225 0.010417 0.00953593 0.00319164 1.34862E-006 -
   38. 0.0119796 0.0255217
```

```
39. TABLE 2
40. UNIT INCHES KIP
41. WIDE FLANGE
42. TOP
43. 13.0204 13.8 0.407 14.7 0.259 428.563 137.195 0.468752 5.6166 7.6146
44. MID
45. 18.2981 13.8 0.384 14.7 0.454 663.15 240.418 1.16038 5.2992 13.3476
46. MUDLINE
47. 17.6174 13.8 0.411 14.7 0.418 624.984 221.373 1.01575 5.6718 12.2892
48. 50%PILE
49. 14.5475 13.8 0.575 13.8 0.25 429.481 109.714 0.986568 7.935 6.9
50. 50%FLG12
51. 13.6475 13.8 0.575 12 0.25 388.166 72.2107 0.967818 7.935 6
52. 33%PILE
53. 12.245 13.8 0.475 14.7 0.2 367.152 106.004 0.557101 6.555 5.88
54. END
55. UNIT FEET KIP
56. DEFINE MATERIAL START
57. ISOTROPIC STEEL
58. E 4.176E+006
59. POISSON 0.3
60. DENSITY 0.489024
61. ALPHA 6.5E-006
62. DAMP 0.03
63. END DEFINE MATERIAL
64. UNIT INCHES KIP
65. CONSTANTS
66. BETA 0 MEMB 8 9
67. MATERIAL STEEL ALL
68. MEMBER PROPERTY AMERICAN
69. 1 24 TO 26 TABLE ST HP14X89
70. MEMBER PROPERTY AMERICAN
71. 9 UPTABLE 2 TOP
72. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
73. MEMBER PROPERTY AMERICAN
74. 7 8 UPTABLE 2 MID
76. SUPPORTS
77. 1 10 PINNED
79. LOAD 3 LOADTYPE WIND  TITLE WAVE
80. JOINT LOAD
81. 1 MZ 204
82. 10 MZ 204
84. LOAD 4 LOADTYPE WIND  TITLE WIND Y AXIS
85. JOINT LOAD
86. 1 MZ 80.4
87. 10 MZ 79.2
89. LOAD 5 LOADTYPE WIND  TITLE CURRENT
90. JOINT LOAD
91. 1 MZ 19.2
92. 10 MZ 25.2
94. LOAD COMB 6 HRPT LOAD CASE 3
95. 3 0.24 4 0.24 5 0.8
97. PERFORM ANALYSIS
```

```
       P R O B L E M   S T A T I S T I C S
       -----------------------------------

  NUMBER OF JOINTS          15  NUMBER OF MEMBERS       14
  NUMBER OF PLATES           0  NUMBER OF SOLIDS         0
  NUMBER OF SURFACES         0  NUMBER OF SUPPORTS       2

        SOLVER USED IS THE IN-CORE ADVANCED SOLVER

  TOTAL PRIMARY LOAD CASES =      3, TOTAL DEGREES OF FREEDOM =      84

***WARNING - INSTABILITY AT JOINT [illegible] DIRECTION = MY
 PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
 K-MATRIX DIAG=  5.5741491E+02 L-MATRIX DIAG=  3.1263880E-13 EQN NO      14
 ***NOTE - VERY WEAK SPRING ADDED FOR STABILITY

   98. PARAMETER 1
   99. CODE AISC
  100. FYLD 36 ALL
  101. LX 325.3 MEMB 4 7 TO 9 20 TO 23
  102. UNB 325.3 MEMB 4 7 TO 9 20 TO 23
  103. UNT 325.3 MEMB 4 7 TO 9 20 TO 23
  104. LX 226.7 MEMB 1 TO 3 24 TO 26
  105. UNB 226.7 MEMB 1 TO 3 24 TO 26
  106. UNT 226.7 MEMB 1 TO 3 24 TO 26
  107. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.072	3
		0.00 T	0.00	204.00	0.00
2 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.052	3
		0.00 T	0.00	97.57	0.00
3 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.038	3
		0.00 T	0.00	70.96	0.00
4 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.022	3
		0.00 T	0.00	36.45	0.00
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.088	3
		0.00 T	0.00	-155.22	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.091	3
		0.00 T	0.00	-161.87	9.00
9 ST	TOP		(UPT)		
		PASS	AISC- H1-3	0.198	3
		0.00 T	0.00	-204.00	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.066	3
		0.00 T	0.00	108.65	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.027	3
		0.00 T	0.00	45.46	0.00
22 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.046	3
		0.00 T	0.00	77.05	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.011	3
		0.00 T	0.00	17.74	42.75
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.063	3
		0.00 T	0.00	177.39	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.053	3
		0.00 T	0.00	150.78	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.044	3
		0.00 T	0.00	124.17	0.00

108. LOAD LIST 6
109. FINISH

```
*********** END OF THE STAAD.Pro RUN ***********

  **** DATE= MAY  6,2014   TIME= 15:50:10 ****

************************************************************
*       For questions on STAAD.Pro, please contact         *
*       Bentley Systems or Partner offices                 *
*                                                          *
*            Telephone              Web / Email            *
* USA       +1  (714) 974-2500                             *
* UK        +44 (0) 808 101 9246                           *
* SINGAPORE +65 6225-6158                                  *
* FRANCE    +33 (0) 1 55238400                             *
* GERMANY   +49 0931 40468                                 *
* INDIA     +91 (033) 4006-2021                            *
* JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp    *
* CHINA     +86 21 6288 4040                               *
* THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
* Worldwide  http://selectservices.bentley.com/en-US/      *
*                                                          *
************************************************************
```

Severe Pile

MB BC 5/14

(+) MWH 5/8/14

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    MAY  6, 2014                  *
*           Time=    15:53:32                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************

     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending__Finger Pier_LC5.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 11.16 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
     9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
    10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
    11. MEMBER INCIDENCES
    12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
    13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
    14. START USER TABLE
    15. TABLE 1
    16. UNIT FEET KIP
    17. WIDE FLANGE
    18. ORIGINAL
    19. 0.179247 1.15 0.05125 1.225 0.05125 0.0428327 0.0157136 0.000156934 -
    20. 0.0589375 0.125563
    21. 0.25_THICK
    22. 0.0741319 1.15 0.0208333 1.225 0.0208333 0.0186353 0.00638368 1.07251E-005 -
    23. 0.0239583 0.0510417
    24. 0.375_THICK
    25. 0.110547 1.15 0.03125 1.225 0.03125 0.027312 0.00957706 3.59853E-005 -
    26. 0.0359375 0.0765625
    27. 0.4375_THICK
    28. 0.128592 1.15 0.0364583 1.225 0.0364583 0.0314958 0.0111744 5.69753E-005 -
    29. 0.0419271 0.0893229
    30. 0.5_THICK
    31. 0.146528 1.15 0.0416667 1.225 0.0416667 0.0355786 0.0127722 8.4796E-005 -
    32. 0.0479167 0.102083
    33. 0.3125_THICK
    34. 0.0923948 1.15 0.026042 1.225 0.026042 0.023026 0.0079803 2.0887E-005 -
    35. 0.0299483 0.0638029
    36. 0.125_THICK
    37. 0.0372842 1.15 0.010417 1.225 0.010417 0.00953593 0.00319164 1.34862E-006 -
    38. 0.0119796 0.0255217
```

```
39. TABLE 2
40. UNIT INCHES KIP
41. WIDE FLANGE
42. TOP
43. 13.0204 13.8 0.407 14.7 0.259 428.563 137.195 0.468752 5.6166 7.6146
44. MID
45. 18.2981 13.8 0.384 14.7 0.454 663.15 240.418 1.16038 5.2992 13.3476
46. MUDLINE
47. 17.6174 13.8 0.411 14.7 0.418 624.984 221.373 1.01575 5.6718 12.2892
48. 50%PILE
49. 14.5475 13.8 0.575 13.8 0.25 429.481 109.734 0.986568 7.935 6.9
50. 50%FLG12
51. 13.6475 13.8 0.575 12 0.25 388.166 72.2107 0.967818 7.935 6
52. 33%PILE
53. 12.245 13.8 0.475 14.7 0.2 367.152 106.004 0.557101 6.555 5.88
54. END
55. UNIT FEET KIP
56. DEFINE MATERIAL START
57. ISOTROPIC STEEL
58. E 4.176E+006
59. POISSON 0.3
60. DENSITY 0.489024
61. ALPHA 6.5E-006
62. DAMP 0.03
63. END DEFINE MATERIAL
64. UNIT INCHES KIP
65. CONSTANTS
66. BETA 0 MEMB 8 9
67. MATERIAL STEEL ALL
68. *9 UPTABLE 2 50%PILE
69. *9 UPTABLE 2 33%PILE
70. *9 UPTABLE 2 50%FLG12
71. MEMBER PROPERTY AMERICAN
72. 1 24 TO 26 TABLE ST HP14X89
73. MEMBER PROPERTY AMERICAN
74. 9 UPTABLE 2 TOP
75. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
76. MEMBER PROPERTY AMERICAN
77. 7 8 UPTABLE 2 MID
78. SUPPORTS
79. 1 10 PINNED
81. LOAD 3 LOADTYPE WIND  TITLE WAVE
82. JOINT LOAD
83. 1 MZ 204
84. 10 MZ 204
86. LOAD 4 LOADTYPE WIND  TITLE WIND Y AXIS
87. JOINT LOAD
88. 1 MZ 80.4
89. 10 MZ 79.2
91. LOAD 5 LOADTYPE WIND  TITLE CURRENT
92. JOINT LOAD
93. 1 MZ 19.2
94. 10 MZ 25.2
95. LOAD COMB 6 HRPT LOAD CASE 5
96. 5 0.714 3 0.714 4 0.714
98. PERFORM ANALYSIS
```

```
       P R O B L E M   S T A T I S T I C S
       -----------------------------------

  NUMBER OF JOINTS          15  NUMBER OF MEMBERS       14
  NUMBER OF PLATES           0  NUMBER OF SOLIDS         0
  NUMBER OF SURFACES         0  NUMBER OF SUPPORTS       2

       SOLVER USED IS THE IN-CORE ADVANCED SOLVER

  TOTAL PRIMARY LOAD CASES =     3, TOTAL DEGREES OF FREEDOM =      84

***WARNING - INSTABILITY AT JOINT     [illegible] DIRECTION = MY
 PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
 K-MATRIX DIAG=  4.9767912E+02 L-MATRIX DIAG=  2.5579538E-13 EQN NO      14
 ***NOTE - VERY WEAK SPRING ADDED FOR STABILITY

   99. PARAMETER 1
  100. CODE AISC
  101. FYLD 36 ALL
  102. LX 310.1 MEMB 4 7 TO 9 20 TO 23
  103. UNB 310.1 MEMB 4 7 TO 9 20 TO 23
  104. UNT 310.1 MEMB 4 7 TO 9 20 TO 23
  105. LX 241.9 MEMB 1 TO 3 24 TO 26
  106. UNB 241.9 MEMB 1 TO 3 24 TO 26
  107. UNT 241.9 MEMB 1 TO 3 24 TO 26
  108. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.077	6
		0.00 T	0.00	216.77	0.00
2 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.054	6
		0.00 T	0.00	102.78	0.00
3 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.039	6
		0.00 T	0.00	74.28	0.00
4 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.015	6
		0.00 T	0.00	25.26	0.00
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.092	6
		0.00 T	0.00	-167.95	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.096	6
		0.00 T	0.00	-175.08	9.00
9 ST	TOP		(UPT)		
		PASS	AISC- H1-3	0.214	6
		0.00 T	0.00	-220.20	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.069	6
		0.00 T	0.00	118.08	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.030	6
		0.00 T	0.00	50.40	0.00
22 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.049	6
		0.00 T	0.00	84.24	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.010	3
		0.00 T	0.00	-17.74	42.75
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.067	6
		0.00 T	0.00	188.27	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.057	6
		0.00 T	0.00	159.77	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.046	6
		0.00 T	0.00	131.28	0.00

109. LOAD LIST 6
110. FINISH

```
*********** END OF THE STAAD.Pro RUN ***********

  **** DATE= MAY  6,2014   TIME= 15:53:33 ****

************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone             Web / Email           *
*   USA        +1  (714) 974-2500                          *
*   UK         +44 (0) 808 101 9246                        *
*   SINGAPORE +65 6225-6158                                *
*   FRANCE     +33 (0) 1 55238400                          *
*   GERMANY    +49 0931 40468                              *
*   INDIA      +91 (033) 4006-2021                         *
*   JAPAN      +81 (03)5952-6500    http://www.ctc-g.co.jp *
*   CHINA      +86 21 6288 4040                            *
*   THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*   Worldwide  http://selectservices.bentley.com/en-US/    *
*                                                          *
************************************************************
```

Severe Pile

MB BC 5/14

```
****************************************************
*                                                  *
*           STAAD.Pro V8i SELECTseries4            *
*           Version  20.07.09.31                   *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    MAY  1, 2014                  *
*           Time=    14:50:25                      *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending__Finger Pier_LC7.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9.69 0; 5 0 12.23 0; 7 0 26.25 0; 8 0 31.5 0
    9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
   10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
   11. MEMBER INCIDENCES
   12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
   13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
   14. START USER TABLE
   16. TABLE 2
   17. UNIT INCHES KIP
   18. WIDE FLANGE
   19. TOP
   20. 13.0204 13.8 0.407 14.7 0.259 428.563 137.195 0.468752 5.6166 7.6146
   21. MID
   22. 18.2981 13.8 0.384 14.7 0.454 663.15 240.418 1.16038 5.2992 13.3476
   23. MUDLINE
   24. 17.6174 13.8 0.411 14.7 0.418 624.984 221.373 1.01575 5.6718 12.2892
   26. END
   28. UNIT FEET KIP
   29. DEFINE MATERIAL START
   30. ISOTROPIC STEEL
   31. E 4.176E+006
   32. POISSON 0.3
   33. DENSITY 0.489024
   34. ALPHA 6.5E-006
   35. DAMP 0.03
   36. END DEFINE MATERIAL
   38. UNIT INCHES KIP
   39. CONSTANTS
   40. BETA 0 MEMB 8 9
   41. MATERIAL STEEL ALL
   43. MEMBER PROPERTY AMERICAN
```

```
 44. 1 24 TO 26 TABLE ST HP14X89
 45. MEMBER PROPERTY AMERICAN
 46. 9 UPTABLE 2 TOP
 47. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
 48. MEMBER PROPERTY AMERICAN
 49. 7 8 UPTABLE 2 MID
 51. SUPPORTS
 52. 1 10 PINNED
 54. LOAD 1 LOADTYPE ICE  TITLE EARTHQUAKE (MAJOR AXIS)
 55. JOINT LOAD
 56. 1 MZ 876
 57. 10 MZ 860.4
 58. LOAD COMB 2 HRPT LOAD CASE 7
 59. 1 0.75
 61. PERFORM ANALYSIS


        P R O B L E M   S T A T I S T I C S
        -----------------------------------

   NUMBER OF JOINTS          15  NUMBER OF MEMBERS       14
   NUMBER OF PLATES           0  NUMBER OF SOLIDS         0
   NUMBER OF SURFACES         0  NUMBER OF SUPPORTS       2


        SOLVER USED IS THE IN-CORE ADVANCED SOLVER

   TOTAL PRIMARY LOAD CASES =      1, TOTAL DEGREES OF FREEDOM =       84


***WARNING -  INSTABILITY AT JOINT      9  DIRECTION = MY
 PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
 K-MATRIX DIAG=  5.5741491E+02 L-MATRIX DIAG=  1.1368684E-13 EQN NO       14
 ***NOTE -  VERY WEAK SPRING ADDED FOR STABILITY


  62. PARAMETER 1
  63. CODE AISC
  64. FYLD 36 ALL
  65. LX 297.2 MEMB 7 TO 9 20 TO 23
  66. UNB 297.2 MEMB 7 TO 9 20 TO 23
  67. UNT 297.2 MEMB 7 TO 9 20 TO 23
  68. LX 254.76 MEMB 1 TO 4 24 TO 26
  69. UNB 254.76 MEMB 1 TO 4 24 TO 26
  70. UNT 254.76 MEMB 1 TO 4 24 TO 26
  71. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.310	1
		0.00 T	0.00	876.00	0.00
2 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.224	1
		0.00 T	0.00	423.03	0.00
3 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.164	1
		0.00 T	0.00	309.78	0.00
4 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.086	1
		0.00 T	0.00	162.94	0.00
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.348	1
		0.00 T	0.00	-652.79	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.363	1
		0.00 T	0.00	-681.10	9.00
9 ST	TOP		(UPT)		
		PASS	AISC- H1-3	0.836	1
		0.00 T	0.00	-860.40	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.261	1
		0.00 T	0.00	454.61	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.106	1
		0.00 T	0.00	185.66	0.00
22 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.184	1
		0.00 T	0.00	320.13	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.043	1
		0.00 T	0.00	-74.61	39.99
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.270	1
		0.00 T	0.00	762.76	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.230	1
		0.00 T	0.00	649.51	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.190	1
		0.00 T	0.00	536.27	0.00

73. FINISH

```
           *********** END OF THE STAAD.Pro RUN ***********

             **** DATE= MAY  1,2014   TIME= 14:50:25 ****

      ************************************************************
      *         For questions on STAAD.Pro, please contact       *
      *         Bentley Systems or Partner offices               *
      *                                                          *
      *             Telephone              Web / Email           *
      *  USA        +1  (714) 974-2500                           *
      *  UK         +44 (0) 808 101 9246                         *
      *  SINGAPORE +65 6225-6158                                 *
      *  FRANCE     +33 (0) 1 55238400                           *
      *  GERMANY    +49 0931 40468                               *
      *  INDIA      +91 (033) 4006-2021                          *
      *  JAPAN      +81 (03)5952-6500     http://www.ctc-g.co.jp *
      *  CHINA      +86 21 6288 4040                             *
      *  THAILAND   +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
      *                                                          *
      *  Worldwide  http://selectservices.bentley.com/en-US/     *
      *                                                          *
      ************************************************************
```

CH2MHILL.

Job Name HRPT Pier 40

Subject Finger Pier Major Pile

Job No.

Sheet No. 1

Date

Computed By Bc 5/14

Checked By MHdn 5/8/14

Calc GB of Pile (Global Buckling) ✓

Section (Major Pile)

Top	Mid	Bottom
F: 0.39" ✓	F .453 ✓	F .412 ✓
w: 0.435" ✓	w .417" ✓	w .440 ✓
A_s = 17.78 in² ✓	A_s = 18.69 in² ✓	A_s = 17.82 in² ✓

Assume 50% / Cons Moment release @ top, [illegible] @ Mid

From STADD

Applied Load 175.5 kip tot — Mid Pile (Conservative)

BF. 4.86 (Buckling factor) ✓

Critical Section @ (Node 17) ✓ Mid pile.

E.B. Load = 853.4 kip (Euler Buckling)

F_e @ critical section

$F_e = \frac{853.4\ kip}{17.82\ in^2} = 47.89\ ksi$ ✓

$\frac{K}{r} = \frac{\sqrt{\frac{\pi^2 \cdot E}{F_e}}}{L} \Rightarrow \frac{\sqrt{\frac{\pi^2 \cdot 29000}{47.89}}}{552''} \Rightarrow 0.140$ ✓

$\frac{KL}{r} = 77.30 < 133.6$ ✓ (AISC E3-2)

$F_{cr} = 0.658^{(36/47.89)} \cdot 36$ ✓

$= 26.2\ ksi$ ✓

$\frac{P_n}{\Omega_c} = $ **279.57 kips** ✓

1.67

CH2MHILL.

Job No. ______
Sheet No. 2
Date ______
Computed By BC 5/14
Checked By CH MWM 5/8/14

Job Name HKPT Pier 40

Subject FP Mayor Pile (FLB)

Flange Local buckling

Check FLB @ Top of the pile

*Use A_s of Critical Section

$b/t = \frac{7.35''}{0.39} = 18.84$ ✓ flange is Slender ✓

Use E 7-5

$Q_s = 1.415 - 0.74 (18.84) \sqrt{\frac{36}{29000}}$

$= 0.923$ ✓

Apply Q_s to E(7-2) (Conserv.) ✓

$F_{cr} = 0.923 \cdot [0.658^{(.923 \cdot 36/47.24)}] \cdot 36$ ✓

$= 24.85$ ksi ✓

$\frac{P_n}{\Omega} = \frac{24.85 \cdot 17.82 in^2}{1.67} = $ **265.1 kip** ✓

CH2MHILL SUBJECT ______ BY ______
SHEET NO. ____ of ____ DATE ______
PROJECT NO. ______

MB BC 5/15/2014

L/C 8 & 9 Please see Appendix 1

L/C 3, 5 ok w/ Severe Piles, hence ok w/ major

L/C 7 ok by inspection, slight over stress w/ severe
hence ok w/ Major.

MB BC 5/14

Ch MWahl 5/8/14

```
*****************************************************
*                                                   *
*           STAAD.Pro V8i SELECTseries4             *
*           Version  20.07.09.31                    *
*           Proprietary Program of                  *
*           Bentley Systems, Inc.                   *
*           Date=    APR 16, 2014                   *
*           Time=    15:12:27                       *
*                                                   *
*      USER ID: CH2M HILL                           *
*****************************************************
```

```
    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Major Finger Pier.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9 0; 5 0 12 0; 7 0 26.25 0; 8 0 3[illegible].5 0
    9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
   10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
   11. MEMBER INCIDENCES
   12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
   13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
   14. START USER TABLE
   15. TABLE 2
   16. UNIT INCHES KIP
   17. WIDE FLANGE
   18. TOP
   19. 17.7807 13.8 0.485 14.7 0.39 604.828 206.598 1.07645 6.693 11.466
   20. MID
   21. 18.695 13.8 0.417 14.7 0.453 667.855 239.905 1.22266 5.7546 13.3182
   22. MUDLINE
   23. 17.8222 13.8 0.44 14.7 0.412 623.053 218.213 1.05381 6.072 12.1128
   24. END
   25. UNIT FEET KIP
   26. DEFINE MATERIAL START
   27. ISOTROPIC STEEL
   28. E 4.176E+006
   29. POISSON 0.3
   30. DENSITY 0.489024
   31. ALPHA 6.5E-006
   32. DAMP 0.03
   33. END DEFINE MATERIAL
   34. UNIT INCHES KIP
   35. CONSTANTS
   36. BETA 0 MEMB 8 9
   37. MATERIAL STEEL ALL
   38. MEMBER PROPERTY AMERICAN
```

```
39. 1 24 TO 26 TABLE ST HP14X89
40. MEMBER PROPERTY AMERICAN
41. 9 UPTABLE 2 TOP
42. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
43. MEMBER PROPERTY AMERICAN
44. 7 8 UPTABLE 2 MID
45. SUPPORTS
46. 1 FIXED
47. 10 FIXED BUT FY
48. MEMBER RELEASE
49. 9 END MPY 0.5 MPZ 0.5
50. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
51. JOINT LOAD
52. 10 FY -175.6
53. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	15	NUMBER OF MEMBERS	14
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 79

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	4.86092
2	9.59280
3	13.18304
4	19.07985

54. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 16,2014 TIME= 15:12:28 ****

```
***********************************************************
*         For questions on STAAD.Pro, please contact      *
*         Bentley Systems or Partner offices              *
*                                                         *
*              Telephone              Web / Email         *
*  USA       +1  (714) 974-2500                           *
*  UK        +44 (0) 808 101 9246                         *
*  SINGAPORE +65 6225-6158                                *
*  FRANCE    +33 (0) 1 55238400                           *
*  GERMANY   +49 0931 40468                               *
*  INDIA     +91 (033) 4006-2021                          *
*  JAPAN     +81 (03)5952-6500     http://www.ctc-g.co.jp *
*  CHINA     +86 21 6288 4040                             *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                         *
*  Worldwide  http://selectservices.bentley.com/en-US/    *
*                                                         *
***********************************************************
```

CH2MHILL.

Job Name HRPT P-40

Subject FP Mid Pile

Job No.

Sheet No. 1

Date

Computed By BC 5/14

Checked By CB McGill 5/8/14

Calc GB of Pile (Moderate Pile) ✓

Section

Top	Mid	Bot
F: .449 ✓	F: .478 ✓	F: .420 ✓
W: .43 ✓	W: .275 ✓	W: .420 ✓
A_s = 17.75 in ✓	A_s = 17.58 ✓	A_s = 17.79 ✓

From STADD

Applied Load: 175.6 kip ✓

BF: 5.03 (Buckling factor) ✓

EB Load 883.2+ kip ✓ [Critical section @ node 17 (Bottom section)] mid pile

$F_e = \frac{883.26 \text{ kip}}{17.79} = 49.65$ ksi ✓

$\frac{K}{r} = 0.140$ ✓

$\frac{KL}{r} = 75.92$ ✓

$F_{cr} = 0.658^{36/49.65} \cdot 36$

$= 26.5$ ksi ✓

$\frac{P_n}{\Omega} =$ **282.29 kip** ✓

CH2MHILL.

Job Name

Subject FP Mod Pile

Job No.

Sheet No. 2

Date

Computed By

Checked By MWahl 5/8/14

MB BC 5/8/14

Check F&B @ Thin Flange (Bottom) ✓

$b/t = \frac{7.35}{0.420} = 17.5$ ✓ $> .56 \cdot \sqrt{\frac{29000}{36}}$ ✓

$Q_s = 1.415 - 0.74 (17.5) \sqrt{\frac{36}{29000}}$

$= .958$ ✓

Apply Q_s to (E 7.2)

$\frac{KL}{r} \leq 4.71 \sqrt{\frac{E}{QF_y}}$ ✓

$F_{cr} = .958 \left[0.658^{(.958 \cdot 36 / 49.55)} \right] 36$ ✓

$= 25.79$ ksi ✓

$\frac{P_n}{\Omega} =$ **271.73 kip** ✓

L/C 3, 5, 7, ... ok w/ Major or Sens pile

⇒ hence ok for moderate pile

Ck MWH
5/8/14

```
 ******************************************************
 *                                                    *
 *           STAAD.Pro V8i SELECTseries4              *
 *           Version  20.07.09.31                     *
 *           Proprietary Program of                   *
 *           Bentley Systems, Inc.                    *
 *           Date=    APR 16, 2014                    *
 *           Time=    15:48:39                        *
 *                                                    *
 *      USER ID: CH2M HILL                            *
 ******************************************************
```

```
      1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Moderate Finger Pier.STD
      2. START JOB INFORMATION
      3. ENGINEER DATE 12-MARCH-2014
      4. END JOB INFORMATION
      5. INPUT WIDTH 79
      6. UNIT FEET KIP
      7. JOINT COORDINATES
      8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
      9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
     10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
     11. MEMBER INCIDENCES
     12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
     13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
     14. START USER TABLE
     15. TABLE 2
     16. UNIT INCHES KIP
     17. WIDE FLANGE
     18. TOP
     19. 18.7485 13.8 0.43 14.7 0.449 665.43 237.795 1.22902 5.934 13.2006
     20. MID
     21. 17.7912 13.8 0.42 14.7 0.42 629.017 222.437 1.04612 5.796 12.348
     22. MUDLINE
     23. 17.7912 13.8 0.42 14.7 0.42 629.017 222.437 1.04612 5.796 12.348
     24. END
     25. UNIT FEET KIP
     26. DEFINE MATERIAL START
     27. ISOTROPIC STEEL
     28. E 4.176E+006
     29. POISSON 0.3
     30. DENSITY 0.489024
     31. ALPHA 6.5E-006
     32. DAMP 0.03
     33. END DEFINE MATERIAL
     34. UNIT INCHES KIP
     35. CONSTANTS
     36. BETA 0 MEMB 8 9
     37. MATERIAL STEEL ALL
     38. MEMBER PROPERTY AMERICAN
```

```
39. 1 24 TO 26 TABLE ST HP14X89
40. MEMBER PROPERTY AMERICAN
41. 9 UPTABLE 2 TOP
42. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
43. MEMBER PROPERTY AMERICAN
44. 7 8 UPTABLE 2 MID
45. SUPPORTS
46. 1 FIXED
47. 10 FIXED BUT FY
48. MEMBER RELEASE
49. 9 END MPY 0.5 MPZ 0.5
50. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
51. JOINT LOAD
52. 10 FY -175.6
53. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	15	NUMBER OF MEMBERS	14
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 79

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	5.03402
2	9.84173
3	13.40354
4	19.42029

54. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 16,2014 TIME= 15:48:40 ****

```
*********************************************************
*        For questions on STAAD.Pro, please contact     *
*        Bentley Systems or Partner offices             *
*                                                       *
*            Telephone             Web / Email          *
*  USA       +1  (714) 974-2500                         *
*  UK        +44 (0) 808 101 9246                       *
*  SINGAPORE +65 6225-6158                              *
*  FRANCE    +33 (0) 1 55238400                         *
*  GERMANY   +49 0931 40468                             *
*  INDIA     +91 (033) 4006-2021                        *
*  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp  *
*  CHINA     +86 21 6288 4040                           *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                       *
*  Worldwide  http://selectservices.bentley.com/en-US/  *
*                                                       *
*********************************************************
```

CH2MHILL.

Job Name HRPT Pier 40

Subject Minor Pile

Job No.

Sheet No. 1

Date

Computed By

Checked By MW 5/8/14

MB DC 5/8/14

Calc Global Buckling Pile (Minor Pile)

Section

Top	Mid	Bot
F: .611" ✓	F: .421 ✓	F: .52 ✓
W: .603" ✓	W: .493" ✓	W: .545" ✓
A_s = 15.61 in ✓	A_s = 12.76 in ✓	A_s = 22.24 in ✓

From Staad

Applied: 175.6 kip tot ✓

BF: 5.91 ✓

E.B.L = 1037.8 kip ✓

F_e @ Critical Section (Node 17) — at mid pile where global buckling is most critical

$F_e = \frac{1037.8 \text{ kip}}{22.24 \text{ in}} = 46.66 \text{ ksi}$ ✓

$\frac{KL}{r} = \sqrt{\frac{\pi^2 E}{F_e}}$ 78.32 ✓

Use (E3-2) ✓

$F_{cr} = 0.658^{35/46.66} \cdot 35 = 26.06$ ✓

$\frac{P_n}{\Omega} = 347.1$ kip ✓

Check FLB

$b/t = \frac{7.35}{.52} = 14.13 < \lambda_r$ ∴ No FLB ✓

*Did not consider Moment/bending as all L/C are satisfied with Major or Secondary Piles ✓

```
****************************************************
*                                                  *
*          STAAD.Pro V8i SELECTseries4             *
*          Version  20.07.09.31                    *
*          Proprietary Program of                  *
*          Bentley Systems, Inc.                   *
*          Date=    APR 16, 2014                   *
*          Time=    16: 9:52                       *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Column_Shed Minor Finger Pier.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
     9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
    10. 18 0 -6 0; 19 0 -3 0; 20 0 0 0
    11. MEMBER INCIDENCES
    12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
    13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
    14. START USER TABLE
    15. TABLE 2
    16. UNIT INCHES KIP
    17  WIDE FLANGE
    18. TOP
    19. 25.6108 13.8 0.608 14.7 0.611 882.563 323.711 3.1777 8.3904 17.9634
    20. MID
    21. 18.7657 13.8 0.493 14.7 0.421 643.452 223.015 1.24882 6.8034 12.3774
    22. MUDLINE
    23. 22.2422 13.8 0.545 14.7 0 52 768.742 275.471 2.06648 7.521 15.288
    24. END
    25. UNIT FEET KIP
    26. DEFINE MATERIAL START
    27. ISOTROPIC STEEL
    28. E 4.176E+006
    29. POISSON 0.3
    30. DENSITY 0.489024
    31. ALPHA 6.5E-006
    32. DAMP 0.03
    33. END DEFINE MATERIAL
    34. UNIT INCHES KIP
    35. CONSTANTS
    36. BETA 0 MEMB 8 9
    37. MATERIAL STEEL ALL
    38. MEMBER PROPERTY AMERICAN
```

```
39. 1 24 TO 26 TABLE ST HP14X89
40. MEMBER PROPERTY AMERICAN
41. 9 UPTABLE 2 TOP
42. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
43. MEMBER PROPERTY AMERICAN
44. 7 8 UPTABLE 2 MID
45. SUPPORTS
46. 1 FIXED
47. 10 FIXED BUT FY
48. MEMBER RELEASE
49. 9 END MPY 0.5 MPZ 0.5
50. LOAD 1 LOADTYPE DEAD  TITLE DEAD+WEARING SURFACE
51. JOINT LOAD
52. 10 FY -175.6
53. PERFORM BUCKLING ANALYSIS MAXSTEP 200
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	**15**	**NUMBER OF MEMBERS**	**14**
NUMBER OF PLATES	**0**	**NUMBER OF SOLIDS**	**0**
NUMBER OF SURFACES	**0**	**NUMBER OF SUPPORTS**	**2**

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 79

CALCULATED BUCKLING FACTORS FOR LOAD CASE 1

MODE	BUCKLING FACTOR
1	5.91744
2	11.78776
3	15.70296
4	22.69195

54. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= APR 16,2014 TIME= 16: 9:52 ****

```
*************************************************************
*        For questions on STAAD.Pro, please contact          *
*        Bentley Systems or Partner offices                  *
*                                                            *
*            Telephone              Web / Email              *
*  USA       +1  (714) 974-2500                              *
*  UK        +44 (0) 808 101 9246                            *
*  SINGAPORE +65 6225-6158                                   *
*  FRANCE    +33 (0) 1 55238400                              *
*  GERMANY   +49 0931 40468                                  *
*  INDIA     +91 (033) 4006-2021                             *
*  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp     *
*  CHINA     +86 21 6288 4040                                *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                            *
*  Worldwide  http://selectservices.bentley.com/en-US/       *
*                                                            *
*************************************************************
```

CH2MHILL

SUBJECT: Appendix 1 | BY | SHEET NO. ___ of ___ | DATE | PROJECT NO.

MB BC 5/15/2014

Finger Pier

Ice load w/New loads

New loads from Alex W are Based On Most stressed Pile in Sap 2000 Model

L/C 8

Top of Pile: 714 kin
Bot of Pile: 373 kin
Axial: -6.2 kip

Both load Cases include D_L and HRPT Allowable Over Stress

L/C 9

Top of Pile: 684.5 kin
Bot of Pile: 378 kin
Axial: -8.2 kip

L/C 8

	Lateral	Axial
Severe Pile: U/R	2.309 @ Top	N/G
Major Pile: U/R	1.246 @ Top	N/G 0.918
Mod. Pile: U/R	1.033 @ Top	$\left(\frac{6.2}{274}\right) = .022 + \left(1/g \uparrow 1.033\right) = 0.94$ Mod Pile ok
Minor Pile: U/R	0.945 @ Mid Pile	

L/C 9

	Lateral	Axial
Severe Pile U/R	2.214 @ Top	N/G
Mayor Pile U/R	1.195 @ Top	N/G
Mod Pile U/R	0.989 @ Top	$\frac{8.2k}{274k} = 0.029$ ok w/ Moderate pile
Minor Pile U/R	0.905 @ Mid	

Mod Pile

MB Bc 5/15/2014

```
****************************************************
*                                                  *
*          STAAD.Pro V8i SELECTseries4             *
*          Version  20.07.09.31                    *
*          Proprietary Program of                  *
*          Bentley Systems, Inc.                   *
*          Date=    MAY 15, 2014                   *
*          Time=    14:16:57                       *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending_ Finger Pier_LC9.STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 12-MARCH-2014
     4. END JOB INFORMATION
     5. INPUT WIDTH 79
     6. UNIT FEET KIP
     7. JOINT COORDINATES
     8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9.89 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
     9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
    10. 18 0 -6 0; 19 0 -3 0; 20 0 0.83 0
    11. MEMBER INCIDENCES
    12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
    13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
    14. START USER TABLE
    15. TABLE 1
    16. UNIT FEET KIP
    17. WIDE FLANGE
    18. ORIGINAL
    19. 0.179247 1.15 0.05125 1.225 0.05125 0.0428327 0.0157136 0.000156934 -
    20. 0.0589375 0.125563
    21. 0.25_THICK
    22. 0.0741319 1.15 0.0208333 1.225 0.0208333 0.0186353 0.00638368 1.07251E-005 -
    23. 0.0239583 0.0510417
    24. 0.375_THICK
    25. 0.110547 1.15 0.03125 1.225 0.03125 0.027312 0.00957706 3.59853E-005 -
    26. 0.0359375 0.0765625
    27. 0.4375_THICK
    28. 0.128592 1.15 0.0364583 1.225 0.0364583 0.0314958 0.0111744 5.69753E-005 -
    29. 0.0419271 0.0893229
    30. 0.5_THICK
    31. 0.146528 1.15 0.0416667 1.225 0.0416667 0.0355786 0.0127722 8.4796E-005 -
    32. 0.0479167 0.102083
    33. 0.3125_THICK
    34. 0.0923948 1.15 0.026042 1.225 0.026042 0.023026 0.0079803 2.0887E-005 -
    35. 0.0299483 0.0638029
    36. 0.125_THICK
    37. 0.0372842 1.15 0.010417 1.225 0.010417 0.00953593 0.00319164 1.34862E-006 -
    38. 0.0119796 0.0255217
```

```
39. TABLE 2
40. UNIT INCHES KIP
41. WIDE FLANGE
42. TOP
43. 18.7485 13.8 0.43 14.7 0.449 665.43 237.795 1.22902 5.934 13.2006
44. MID
45. 17.5853 13.8 0.275 14.7 0.478 672.35 253.085 1.15935 3.795 14.0532
46. MUDLINE
47. 17.7912 13.8 0.42 14.7 0.42 629.017 222.437 1.04612 5.796 12.348
48. 50%PILE
49. 14.5475 13.8 0.575 13.8 0.25 429.481 109.714 0.986568 7.935 6.9
50. 50%FLG12
51. 13.6475 13.8 0.575 12 0.25 388.166 72.2107 0.967818 7.935 6
52. 33%PILE
53. 12.245 13.8 0.475 14.7 0.2 367.152 106.004 0.557101 6.555 5.88
54. END
55. UNIT FEET KIP
56. DEFINE MATERIAL START
57. ISOTROPIC STEEL
58. E 4.176E+006
59. POISSON 0.3
60. DENSITY 0.489024
61. ALPHA 6.5E-006
62. DAMP 0.03
63. END DEFINE MATERIAL
64. UNIT INCHES KIP
65. CONSTANTS
66. BETA 0 MEMB 8 9
67. MATERIAL STEEL ALL
68. MEMBER PROPERTY AMERICAN
69. 1 24 TO 26 TABLE ST HP14X89
70. MEMBER PROPERTY AMERICAN
71. 9 UPTABLE 2 TOP
72. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
73. MEMBER PROPERTY AMERICAN
74. 7 8 UPTABLE 2 MID
75. SUPPORTS
76. 1 10 PINNED
77. LOAD 3 LOADTYPE WIND  TITLE WAVE
78. JOINT LOAD
79. 1 MX 378
80. 10 MX 684
82. *LOAD 4 LOADTYPE WIND  TITLE WIND
83. *JOINT LOAD
84. *1 MZ 66
85. *10 MZ 77
86. *LOAD 5 LOADTYPE WIND  TITLE CURRENT
87. *JOINT LOAD
88. *1 MZ 20
89. *10 MZ 35
90. *LOAD 7 LOADTYPE WIND  TITLE ICE
91. *JOINT LOAD
92. *1 MZ 49.2
93. *10 MZ 844.8
94. *LOAD COMB 2 HRPT LOAD CASE 9
95. *3 0.67 4 0.67 5 0.67 7 0.67
```

```
96. PERFORM ANALYSIS


        P R O B L E M   S T A T I S T I C S
        -----------------------------------

  NUMBER OF JOINTS           15  NUMBER OF MEMBERS      14
  NUMBER OF PLATES            0  NUMBER OF SOLIDS        0
  NUMBER OF SURFACES          0  NUMBER OF SUPPORTS      2


       SOLVER USED IS THE IN-CORE ADVANCED SOLVER

  TOTAL PRIMARY LOAD CASES =      1, TOTAL DEGREES OF FREEDOM =      84

***WARNING    INSTABILITY AT JOINT      3   DIRECTION   RY
 PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
 K-MATRIX DIAG=  5.7408111E+02 L-MATRIX DIAG=  3.9790393E-13 EQN NO      14
***NOTE    VERY WEAK SPRING ADDED FOR STABILITY


  97. PARAMETER 1
  98. CODE AISC
  99. FYLD 36 ALL
 100. LX 372 MEMB 3 4 7 TO 9 20 TO 23
 101. UNB 372 MEMB 3 4 7 TO 9 20 TO 23
 102. UNT 372 MEMB 3 4 7 TO 9 20 TO 23
 103. LX 180 MEMB 1 2 24 TO 26
 104. UNB 180 MEMB 1 2 24 TO 26
 105. UNT 180 MEMB 1 2 24 TO 26
 106. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.330	3
		0.00 T	-378.00	0.00	0.00
2 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.159	3
		0.00 T	-100.96	0.00	0.00
3 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.092	3
		0.00 T	58.11	0.00	46.68
4 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.169	3
		0.00 T	106.83	0.00	25.32
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.732	3
		0.00 T	557.02	0.00	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.755	3
		0.00 T	574.34	0.00	9.00
9 ST	TOP		(UPT)		
		PASS	AISC- H1-3	0.989	3
		0.00 T	684.00	0.00	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.688	3
		0.00 T	435.82	0.00	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.429	3
		0.00 T	271.32	0.00	0.00
22 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.558	3
		0.00 T	353.57	0.00	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.299	3
		0.00 T	189.07	0.00	0.00
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.270	3
		0.00 T	-308.74	0.00	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.209	3
		0.00 T	239.48	0.00	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.132	3
		0.00 T	-151.06	0.00	0.00

107. *LOAD LIST 6
108. FINISH

```
           *********** END OF THE STAAD.Pro RUN ***********

             **** DATE= MAY 15,2014   TIME= 14:16:58 ****

       ************************************************************
       *         For questions on STAAD.Pro, please contact       *
       *         Bentley Systems or Partner offices               *
       *                                                          *
       *             Telephone             Web / Email            *
       *  USA       +1  (714) 974-2500                            *
       *  UK        +44 (0) 808 101 9246                          *
       *  SINGAPORE +65 6225-6158                                 *
       *  FRANCE    +33 (0) 1 55238400                            *
       *  GERMANY   +49 0931 40468                                *
       *  INDIA     +91 (033) 4006-2021                           *
       *  JAPAN     +81 (03)5952-6500    http://www.ctc-g.co.jp   *
       *  CHINA     +86 21 6288 4040                              *
       *  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
       *                                                          *
       *  Worldwide  http://selectservices.bentley.com/en-US/     *
       *                                                          *
       ************************************************************
```

Mod Pile

MB BC 5/15/2014

```
****************************************************
*                                                  *
*         STAAD.Pro V8i SELECTseries4              *
*         Version  20.07.09.31                     *
*         Proprietary Program of                   *
*         Bentley Systems, Inc.                    *
*         Date=    MAY 15, 2014                    *
*         Time=    14:20:26                        *
*                                                  *
*      USER ID: CH2M HILL                          *
****************************************************
```

```
    1. STAAD SPACE
INPUT FILE: Pier40_Individual_Bending__Finger Pier_LC8.STD
    2. START JOB INFORMATION
    3. ENGINEER DATE 12-MARCH-2014
    4. END JOB INFORMATION
    5. INPUT WIDTH 79
    6. UNIT FEET KIP
    7. JOINT COORDINATES
    8. 1 0 -9 0; 2 0 3 0; 3 0 6 0; 4 0 9.89 0; 5 0 12 0; 7 0 26.25 0; 8 0 31.5 0
    9. 9 0 32.25 0; 10 0 37 0; 15 0 19.125 0; 16 0 22.6875 0; 17 0 15.5625 0
   10. 18 0 -5.53 0; 19 0 -3 0; 20 0 -0.27 0
   11. MEMBER INCIDENCES
   12. 1 1 18; 2 2 3; 3 3 4; 4 4 5; 7 7 8; 8 8 9; 9 9 10; 20 7 16; 21 15 17; 22 16 15
   13. 23 17 5; 24 18 19; 25 19 20; 26 20 2
   14. START USER TABLE
   16. TABLE 2
   17. UNIT INCHES KIP
   18. WIDE FLANGE
   19. TOP
   20. 18.7485 13.8 0.43 14.7 0.449 665.43 237.795 1.22902 5.934 13.2006
   21. MID
   22. 17.5853 13.8 0.275 14.7 0.478 672.35 253.085 1.15935 3.795 14.0532
   23. MUDLINE
   24. 17.7912 13.8 0.42 14.7 0.42 629.017 222.437 1.04612 5.796 12.348
   26. END
   27. UNIT FEET KIP
   28. DEFINE MATERIAL START
   29. ISOTROPIC STEEL
   30. E 4.176E+006
   31. POISSON 0.3
   32. DENSITY 0.489024
   33. ALPHA 6.5E-006
   34. DAMP 0.03
   35. END DEFINE MATERIAL
   36. UNIT INCHES KIP
   37. CONSTANTS
   38. BETA 0 MEMB 8 9
   39. MATERIAL STEEL ALL
   41. MEMBER PROPERTY AMERICAN
```

```
42. 1 24 TO 26 TABLE ST HP14X89
43. MEMBER PROPERTY AMERICAN
44. 9 UPTABLE 2 TOP
45. 2 TO 4 20 TO 23 UPTABLE 2 MUDLINE
46. MEMBER PROPERTY AMERICAN
47. 7 8 UPTABLE 2 MID
48. SUPPORTS
49. 1 10 PINNED
50. LOAD 4 LOADTYPE ICE  TITLE ICE (MAJOR AXIS)
51. JOINT LOAD
52. 1 MX 393
53. 10 MX 714
55. *1 MZ 376
56. *10 MZ 840
58. LOAD COMB 7 HRPT LOAD CASE 8
59. 4 1
60. *4 0.714
62. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

NUMBER OF JOINTS	15	NUMBER OF MEMBERS	14
NUMBER OF PLATES	0	NUMBER OF SOLIDS	0
NUMBER OF SURFACES	0	NUMBER OF SUPPORTS	2

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 84

```
***WARNING - INSTABILITY AT JOINT [illegible] DIRECTION = RY
PROBABLE CAUSE SINGULAR-ADDING WEAK SPRING
K-MATRIX DIAG= 5.7408111E+02 L-MATRIX DIAG= 1.0231815E-12 EQN NO      14
***NOTE - VERY WEAK SPRING ADDED FOR STABILITY
```

```
63. PARAMETER 1
64. CODE AISC
65. FYLD 36 ALL
66. LX 372 MEMB 9 3 4 23 21 22 20 7
67. UNB 372 MEMB 9 3 4 23 21 22 20 7
68. UNT 372 MEMB 9 3 4 23 21 22 20 7
69. LX 180 MEMB 2 26 25 24 1
70. UNB 180 MEMB 2 26 25 24 1
71. UNT 180 MEMB 2 26 25 24 1
72. CHECK CODE ALL
```

STAAD.Pro CODE CHECKING - (AISC 9TH EDITION) v1.0
****

ALL UNITS ARE - KIP INCH (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
1 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.343	4
		0.00 T	-393.00	0.00	0.00
2 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.165	4
		0.00 T	-104.22	0.00	0.00
3 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.097	4
		0.00 T	61.59	0.00	46.68
4 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.177	4
		0.00 T	112.37	0.00	25.32
7 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.765	4
		0.00 T	581.64	0.00	63.00
8 ST	MID		(UPT)		
		PASS	AISC- H1-3	0.788	4
		0.00 T	599.69	0.00	9.00
* 9 ST	TOP		(UPT)		
		FAIL	AISC- H1-3	1.033	4
		0.00 T	714.00	0.00	57.00
20 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.719	4
		0.00 T	455.30	0.00	0.00
21 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.448	4
		0.00 T	283.83	0.00	0.00
22 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.584	4
		0.00 T	369.57	0.00	0.00
23 ST	MUDLINE		(UPT)		
		PASS	AISC- H1-3	0.313	4
		0.00 T	198.10	0.00	0.00
24 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.270	4
		0.00 T	-309.49	0.00	0.00
25 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.217	4
		0.00 T	-248.61	0.00	0.00
26 ST	HP14X89		(AISC SECTIONS)		
		PASS	AISC- H1-3	0.160	4
		0.00 T	-182.91	0.00	0.00

73. FINISH

```
*********** END OF THE STAAD.Pro RUN ***********

  **** DATE= MAY 15,2014   TIME= 14:20:27 ****

************************************************************
*        For questions on STAAD.Pro, please contact        *
*        Bentley Systems or Partner offices                *
*                                                          *
*              Telephone              Web / Email          *
*  USA       +1  (714) 974-2500                            *
*  UK        +44 (0) 808 101 9246                          *
*  SINGAPORE +65 6225-6158                                 *
*  FRANCE    +33 (0) 1 55238400                            *
*  GERMANY   +49 0931 40468                                *
*  INDIA     +91 (033) 4006-2021                           *
*  JAPAN     +81 (03)5952-6500     http://www.ctc-g.co.jp  *
*  CHINA     +86 21 6288 4040                              *
*  THAILAND  +66 (0)2645-1018/19 partha.p@reisoftwareth.com*
*                                                          *
*  Worldwide  http://selectservices.bentley.com/en-US/     *
*                                                          *
************************************************************
```

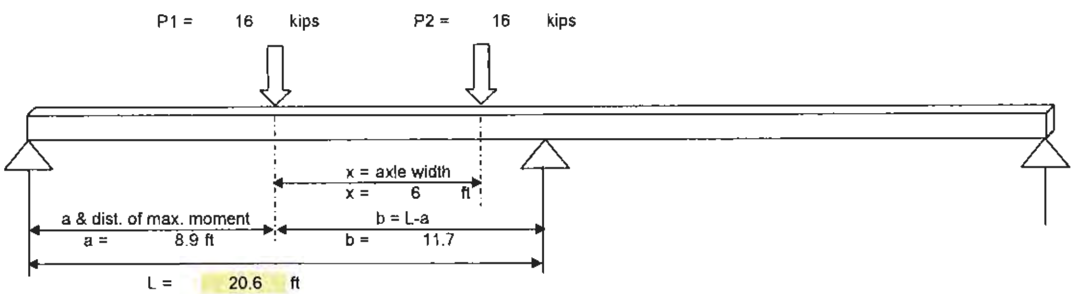
BEAM LOAD RATINGS – NOTES TO USER

Halcrow

Vehicle Particulars

Gross Vehicle Weight =	40,000 lbs	Front to Rear Axle Spacing =	14 ft
Rear Axle Weight =	32,000 lbs	Axle Width =	6 ft
Rear Axle Wheel Load =	16,000 lbs		
Front Axle Wheel Load =	4,000 lbs		

For Maximum Moment Due to Vehicle Load @ P1 Location

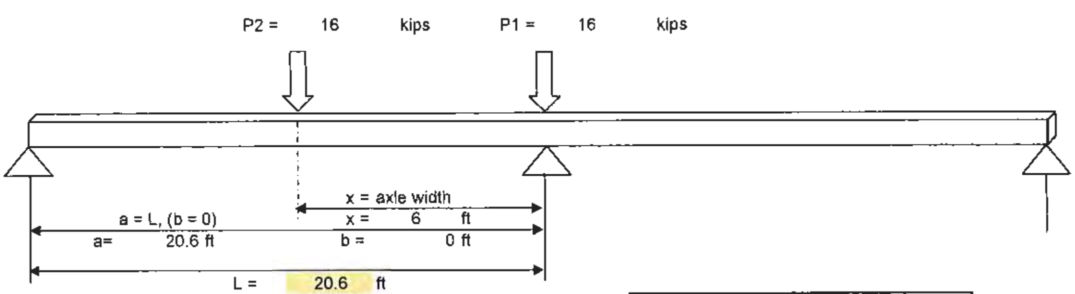


$$M_{P1}(@P_1)=\frac{P_1ab}{4L^3}\left(4L^2-a(L+a)\right)$$

$$M_{P2}(@P_1)=R1(a)=\frac{P_2(L-(a+x))}{4L^3}\left(4L^2-(a+x)(L+a+x)\right)$$

Moment due to Vehicle Load Only		
M(P1) =	68.36799	k-ft
M(P2) =	62.78059	k-ft
Unfactored M_{max} =	131.15	k-ft
Factored M_{max} =	209.84	k-ft

For Maximum Shear Due to Vehicle Load @ Middle Support



$$V_{P1}(@P1)=\frac{P_1a}{4L^3}\left(4L^2+b(L+a)\right)$$

$$V_{P2}(@P1)=\frac{P_2(L-x)}{4L^3}\left(4L^2+x(2L-x)\right)$$

Shear Due to Vehicle Load Only		
V(P1)	16	kips
V(P2)	12.75073	kips
Unfactored V_{max} =	28.75	kips
Factored V_{max} =	46.00	kips

BEAM LOAD RATINGS – PIER SHED

Halcrow

PIER SHED
300 PSF

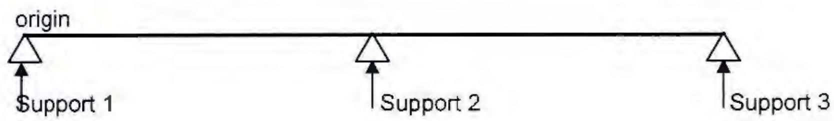
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	12.5
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	30
SDL (lb/ft^2)	0
LL (lb/ft^2)	300
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	0
Impact Factor	15%
Loc. of Max. Moment (ft)	0.0
Unfactored point load 2 (k)	0
Impact Factor	15%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	6.0
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	12.5
Dist. of P2 from P1(ft)	6.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	45.9375	3.675	55.13	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	6.25	0.50	7.50	0.60
DL due to line load	0.00	0.00	0.00	0.00
Total DL	52.19	4.18	62.63	5.01
Total LL	78.75	6.30	126.00	10.08
Total Loading	130.9375	10.475	**188.625**	**15.09**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	115.08	165.78
Max negative moment (k-ft):	-204.59	-294.73
Maximum Shear (k):	55.65	80.17

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

PIER SHED
300 PSF

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	30	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	1	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]
Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	
c	2.1592	
Es	0.0328	

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	11	1.41	1.56	N/A	0.5
2	3	9	0	0	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

PIER SHED
300 PSF

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	4.68	2.34	Area of steel in bottom layer
$As_2 (in^2)$	0.00	0.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	4.68	2.34	Total area of steel
e (in)	0.71	0.71	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	25.80	25.80	Depth from top compression fiber to center of steel
a (in)	3.67	1.84	Depth of compression section
M_n (k*in)	4485.26	2328.52	
ΦM_n (k*in)	4036.73	2095.67	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	50.55	50.55
V_s (k)	117.92	58.96
$V_n = V_c + V_s$ (k)	168.47	109.51
ΦV_n (k)	126.35	82.13

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\,bd \quad [\text{ACI } 318\text{-}05\,(11.3.1.1)]$$

$$V_s = \frac{A_s f_y d}{s} \quad [\text{ACI } 318\text{-}05\,(11.5.7.2)$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
336.39	174.64	165.78	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
126.35	82.13	80.166	N/A

Halcrow

PIER SHED
H20 TRUCK

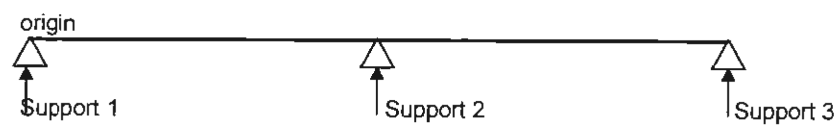
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	12.5
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	30
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	16
Impact Factor	15%
Loc. of Max. Moment (ft)	5.4
Unfactored point load 2 (k)	16
Impact Factor	15%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	11.4
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	12.5
Dist. of P2 from P1(ft)	6.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	45.9375	3.675	55.13	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	6.25	0.50	7.50	0.60
DL due to line load	0.00	0.00	0.00	0.00
Total DL	52.19	4.18	62.63	5.01
Total LL	0.00	0.00	0.00	0.00
Total Loading	52.1875	4.175	**62.625**	**5.01**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	98.07	138.64
Max negative moment (k-ft):	-76.61	-89.96
Maximum Shear (k):	48.02	67.96

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	30	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	1	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	2.1592
Es	0.0328

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	11	1.41	1.56	N/A	0.5
2	3	9	0	0	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

PIER SHED
H20 TRUCK

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	4.68	2.34	Area of steel in bottom layer
$As_2 (in^2)$	0.00	0.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	4.68	2.34	Total area of steel
e (in)	0.71	0.71	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	25.80	25.80	Depth from top compression fiber to center of steel
a (in)	3.67	1.84	Depth of compression section
M_n (k*in)	4485.26	2328.52	
ΦM_n (k*in)	4036.73	2095.67	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	50.55	50.55
V_s (k)	117.92	58.96
$V_n = V_c + V_s$ (k)	168.47	109.51
ΦV_n (k)	126.35	82.13

$$M_n = A_s f_y \left(d - \frac{a}{2}\right)$$

$$V_c = 2\sqrt{f'_c}\,bd \quad \text{[ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \quad \text{[ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	**Reduced Moment Capacity (k-ft)**	**Factored Positive Moment (k-ft)**	**% Overstress**
336.39	174.64	138.64	N/A
Original Shear Capacity (k-ft)	**Reduced Shear Capacity (k)**	**Factored Shear (k)**	**% Overstress**
126.35	82.13	67.956	N/A

Halcrow

PIER SHED
FIRE TRUCK

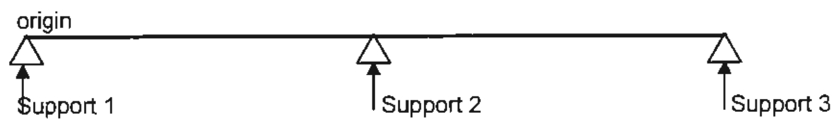
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	12.5
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	30
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	24
Impact Factor	0%
Loc. of Max. Moment (ft)	5.4
Unfactored point load 2 (k)	24
Impact Factor	0%
Dist. from Max. Moment (ft)	8
Location from origin (ft)	13.4
Location btwn supports	Btwn 2&3

Loc. of Max. Shear (ft)	12.5
Dist. of P2 from P1(ft)	8.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	45.9375	3.675	55.13	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	6.25	0.50	7.50	0.60
DL due to line load	0.00	0.00	0.00	0.00
Total DL	52.19	4.18	62.63	5.01
Total LL	0.00	0.00	0.00	0.00
Total Loading	52.1875	4.175	**62.625**	**5.01**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	112.77	162.19
Max negative moment (k-ft):	-76.36	-89.56
Maximum Shear (k):	56.70	81.85

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

PIER SHED
FIRE TRUCK

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	30	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	1	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]
Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	
c	2.1592	
Es	0.0328	

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	11	1.41	1.56	N/A	0.5
2	3	9	0	0	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Beam Moment Capacity			
	Original	Reduced	
As_1 (in^2)	4.68	2.34	Area of steel in bottom layer
As_2 (in^2)	0.00	0.00	Area of steel in second layer
As_3 (in^2)	0.00	0.00	Area of steel in third layer
As_T (in^2)	4.68	2.34	Total area of steel
e (in)	0.71	0.71	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	25.80	25.80	Depth from top compression fiber to center of steel
a (in)	3.67	1.84	Depth of compression section
M_n (k*in)	4485.26	2328.52	
ΦM_n (k*in)	4036.73	2095.67	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	50.55	50.55
V_s (k)	117.92	58.96
$V_n = V_c + V_s$ (k)	168.47	109.51
ΦV_n (k)	126.35	82.13

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\,bd \quad \text{[ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \quad \text{[ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
336.39	174.64	162.19	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
126.35	82.13	81.848	N/A

Halcrow

PIER SHED
PILE CAP CHECK
RESCUE TRUCK REAR AXLE WHEELS ON PILE CAP

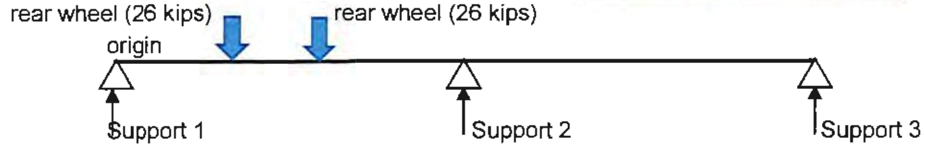
Loading Module

General Inputs		
Tributary width for beam (ft)	21	
Clear span of beam (ft)	12.5	
Weight of concrete (lb/ft^3)	150	
Slab thickness (in)	14	
Beam width (in)	16	BEAM B-11
Beam depth (in)	30	BEAM B-11
SDL (lb/ft^2)	0	
LL (lb/ft^2)	0	
Dead line load (k/ft)	0	
Dead Load Factor	1.2	
Live Load Factor	1.6	

Point Loads	
Unfactored point load 1 (k)	26
Impact Factor	0%
Loc. of Max. Moment (ft)	5.4
Unfactored point load 2 (k)	26
Impact Factor	0%
Dist. from Max. Moment (ft)	8
Location from origin (ft)	13.4
Location btwn supports	Btwn 2&3

Loc. of Max. Shear (ft)	12.5
Dist. of P2 from P1(ft)	8.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	45.9375	3.675	55.13	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	6.25	0.50	7.50	0.60
DL due to line load	0.00	0.00	0.00	0.00
Total DL	52.19	4.18	62.63	5.01
Total LL	0.00	0.00	0.00	0.00
Total Loading	52.1875	4.175	**62.625**	**5.01**



Rear wheels spaced 8 ft apart on the beam. Fire truck wheelbase is 17.2 ft.
Axle load = 52 kips so each wheel is 26 kips

Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	107.13	153.19
Max negative moment (k-ft):	-87.16	-106.83
Maximum Shear (k):	59.58	86.45

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	30	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]
Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	
c	2.1592	
Es	0.0328	

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	11	1.41	1.56	N/A	0.5
2	0	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

PIER SHED
PILE CAP CHECK
RESCUE TRUCK REAR AXLE WHEELS ON PILE CAP

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	4.68	2.34	Area of steel in bottom layer
$As_2 (in^2)$	0.00	0.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	4.68	2.34	Total area of steel
e (in)	0.71	0.71	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	25.80	25.80	Depth from top compression fiber to center of steel
a (in)	3.67	1.84	Depth of compression section
M_n (k*in)	4485.26	2328.52	
ΦM_n (k*in)	4036.73	2095.67	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	50.55	50.55
V_s (k)	117.92	58.96
$V_n = V_c + V_s$ (k)	168.47	109.51
ΦV_n (k)	126.35	82.13

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\, bd \quad \text{[ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \quad \text{[ACI 318-05 (11.5.7.2)]}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
336.39	174.64	153.19	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
126.35	82.13	86.450	5.26%

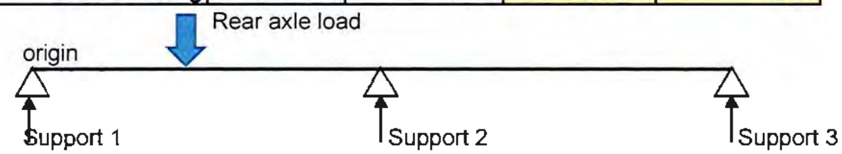
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	12.5
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16 Beam B-11
Beam depth (in)	30 Beam B-11
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	45
Impact Factor	15%
Loc. of Max. Moment (ft)	5.4
Unfactored point load 2 (k)	0
Impact Factor	0%
Dist. from Max. Moment (ft)	0
Location from origin (ft)	5.4
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	12.5
Dist. of P2 from P1(ft)	0.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	45.9375	3.675	55.13	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	6.25	0.50	7.50	0.60
DL due to line load	0.00	0.00	0.00	0.00
Total DL	52.19	4.18	62.63	5.01
Total LL	0.00	0.00	0.00	0.00
Total Loading	52.1875	4.175	**62.625**	**5.01**



Rear wheels spaced 8 ft apart on the beam. Fire truck wheelbase is 17.2 ft.
Axle load = 52 kips so each wheel is 26 kips
Actual rear axle wheel loads (spaced 8 ft apart) coming into beam is 42.1 kips - say 45 kips (see sketch)

Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	179.33	268.80
Max negative moment (k-ft):	-81.54	-97.85
Maximum Shear (k):	67.18	98.62

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	30	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	2.5910
Es	0.0269

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	11	1.41	1.56	N/A	0.6
2	0	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

PIER SHED
PILE CAP CHECK
RESCUE TRUCK REAR AXLE STRADDLING PILE CAP

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	4.68	2.81	Area of steel in bottom layer
$As_2 (in^2)$	0.00	0.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	4.68	2.81	Total area of steel
e (in)	0.71	0.71	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	25.80	25.80	Depth from top compression fiber to center of steel
a (in)	3.67	2.20	Depth of compression section
M_n (k*in)	4485.26	2773.61	
ΦM_n (k*in)	4036.73	2496.25	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	50.55	50.55
V_s (k)	117.92	58.96
$V_n = V_c + V_s$ (k)	168.47	109.51
ΦV_n (k)	126.35	82.13

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\, bd \ \text{[ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \ \text{[ACI 318-05 (11.5.7.2)]}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
336.39	208.02	268.80	29.22%
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
126.35	82.13	98.616	20.07%

BEAM LOAD RATINGS – TRUCK COURT

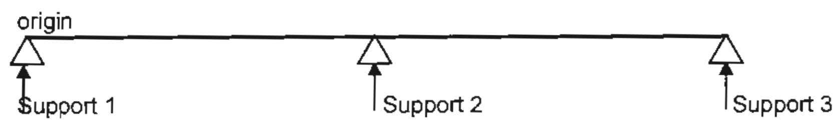
Halcrow

TRUCK COURT
150 PSF

Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	20.6
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	36
SDL (lb/ft^2)	0
LL (lb/ft^2)	150
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	64.89	3.15	103.82	5.04
Total Loading	152.955	7.425	**209.502**	**10.17**



Point Loads	
Unfactored point load 1 (k)	0
Impact Factor	15%
Loc. of Max. Moment (ft)	0.0
Unfactored point load 2 (k)	0
Impact Factor	15%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	6.0
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	6.0

Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	221.54	303.45
Max negative moment (k-ft):	-393.86	-539.47
Maximum Shear (k):	73.32	100.43

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]
Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	
c	4.1522	
Es	0.0190	

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
150 PSF

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	3.00	1.50	Area of steel in bottom layer
$As_2 (in^2)$	3.00	3.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\,bd \text{ [ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \text{ [ACI 318-05 (11.5.7.2)]}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
513.34	388.16	303.45	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
151.22	97.17	100.429	3.36%

Halcrow

TRUCK COURT
H20 TRUCK
(rear axle at P1)

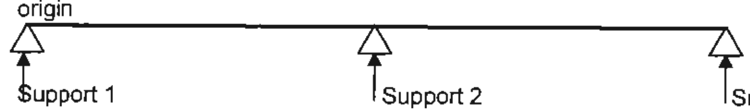
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	20.6
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	36
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	27.4
Impact Factor	15%
Loc. of Max. Moment (ft)	8.9
Unfactored point load 2 (k)	0
Impact Factor	15%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	14.9
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	6.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	0.00	0.00	0.00	0.00
Total Loading	88.065	4.275	**105.678**	**5.13**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	260.97	366.77
Max negative moment (k-ft):	-226.77	-272.12
Maximum Shear (k):	69.62	94.50

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

TRUCK COURT
H20 TRUCK
(rear axle at P1)

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	4.1522
Es	0.0190

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
H20 TRUCK
(rear axle at P1)

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	3.00	1.50	Area of steel in bottom layer
$As_2 (in^2)$	3.00	3.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}bd \text{ [ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \text{ [ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
513.34	388.16	366.77	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
151.22	97.17	94.499	N/A

Halcrow

TRUCK COURT
H20 TRUCK
(both rear wheels on Span 1)

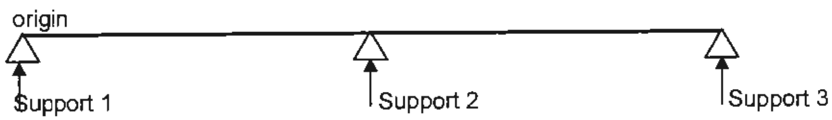
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	20.6
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	36
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	16
Impact Factor	15%
Loc. of Max. Moment (ft)	8.9
Unfactored point load 2 (k)	16
Impact Factor	15%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	14.9
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	6.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	0.00	0.00	0.00	0.00
Total Loading	88.065	4.275	**105.678**	**5.13**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	236.50	327.50
Max negative moment (k-ft):	-195.58	-222.21
Maximum Shear (k):	70.97	96.66

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

TRUCK COURT
H20 TRUCK
(both rear wheels on Span 1)

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	4.1522
Es	0.0190

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
H20 TRUCK
(both rear wheels on Span 1)

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	3.00	1.50	Area of steel in bottom layer
$As_2 (in^2)$	3.00	3.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\, bd \;\; [\text{ACI 318-05 (11.3.1.1)}]$$

$$V_s = \frac{A_s f_y d}{s} \;\; [\text{ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
513.34	388.16	327.50	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
151.22	97.17	96.660	N/A

Halcrow

TRUCK COURT
FIRE TRUCK
(rear axle at P1)

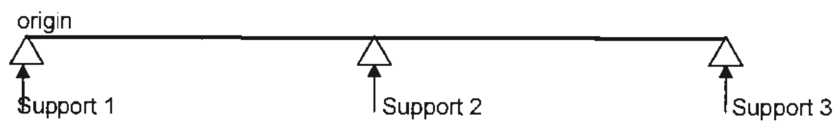
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	20.6
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	36
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	38.7
Impact Factor	0%
Loc. of Max. Moment (ft)	8.9
Unfactored point load 2 (k)	0
Impact Factor	0%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	14.9
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	6.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	0.00	0.00	0.00	0.00
Total Loading	88.065	4.275	**105.678**	**5.13**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	291.54	415.73
Max negative moment (k-ft):	-226.77	-272.12
Maximum Shear (k):	80.92	112.58

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

TRUCK COURT
FIRE TRUCK
(rear axle at P1)

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]
Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	
c	4.1522	
Es	0.0190	

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
FIRE TRUCK
(rear axle at P1)

Beam Moment Capacity			
	Original	Reduced	
As_1 (in^2)	3.00	1.50	Area of steel in bottom layer
As_2 (in^2)	3.00	3.00	Area of steel in second layer
As_3 (in^2)	0.00	0.00	Area of steel in third layer
As_T (in^2)	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f_c'}bd \text{ [ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \text{ [ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
513.34	388.16	415.73	7.10%
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
151.22	97.17	112.579	15.86%

Halcrow

TRUCK COURT
FIRE TRUCK
(both rear wheel on Span 1)

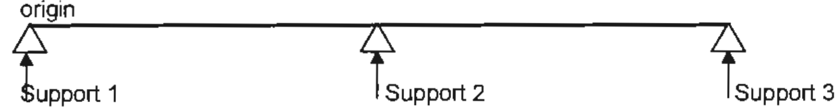
Loading Module

General Inputs	
Tributary width for beam (ft)	21
Clear span of beam (ft)	20.6
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	16
Beam depth (in)	36
SDL (lb/ft^2)	0
LL (lb/ft^2)	0
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	24
Impact Factor	0%
Loc. of Max. Moment (ft)	8.9
Unfactored point load 2 (k)	24
Impact Factor	0%
Dist. from Max. Moment (ft)	8
Location from origin (ft)	16.9
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	8.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	0.00	0.00	0.00	0.00
Total Loading	88.065	4.275	**105.678**	**5.13**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	253.10	354.12
Max negative moment (k-ft):	-202.73	-233.65
Maximum Shear (k):	83.19	116.22

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

TRUCK COURT
FIRE TRUCK
(both rear wheel on Span 1)

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]
Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	
c	4.1522	
Es	0.0190	

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
FIRE TRUCK
(both rear wheel on Span 1)

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	3.00	1.50	Area of steel in bottom layer
$As_2 (in^2)$	3.00	3.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\,bd \text{ [ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \text{ [ACI 318-05 (11.5.7.2)]}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
513.34	388.16	354.12	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
151.22	97.17	116.221	19.61%

Halcrow

TRUCK COURT
PILE CAP CHECK
RESCUE TRUCK REAR AXLE STRADDLING PILE CAP

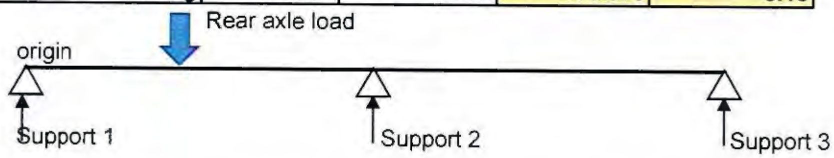
Loading Module

General Inputs		
Tributary width for beam (ft)	21	
Clear span of beam (ft)	20.6	
Weight of concrete (lb/ft^3)	150	
Slab thickness (in)	14	
Beam width (in)	16	Beam B-3
Beam depth (in)	36	Beam B-3
SDL (lb/ft^2)	0	
LL (lb/ft^2)	0	
Dead line load (k/ft)	0	
Dead Load Factor	1.2	
Live Load Factor	1.6	

Point Loads	
Unfactored point load 1 (k)	45
Impact Factor	15%
Loc. of Max. Moment (ft)	8.9
Unfactored point load 2 (k)	0
Impact Factor	0%
Dist. from Max. Moment (ft)	0
Location from origin (ft)	8.9
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	0.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	0.00	0.00	0.00	0.00
Total Loading	88.065	4.275	**105.678**	**5.13**



Rear wheels spaced 8 ft apart on the beam. Fire truck wheelbase is 17.2 ft.
Axle load = 52 kips so each wheel is 26 kips
Actual rear axle wheel loads (spaced 8 ft apart) coming into beam is 42.1 kips - say 45 kips (see sketch)

Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	347.08	504.70
Max negative moment (k-ft):	-226.77	-272.12
Maximum Shear (k):	87.22	122.66

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	4.1522
Es	0.0190

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
PILE CAP CHECK
RESCUE TRUCK REAR AXLE STRADDLING PILE CAP

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	3.00	1.50	Area of steel in bottom layer
$As_2 (in^2)$	3.00	3.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\,bd \text{ [ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \text{ [ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
513.34	388.16	504.70	30.02%
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
151.22	97.17	122.659	26.24%

Halcrow

TRUCK COURT
PILE CAP CHECK
RESCUE TRUCK REAR AXLE WHEELS ON PILE CAP

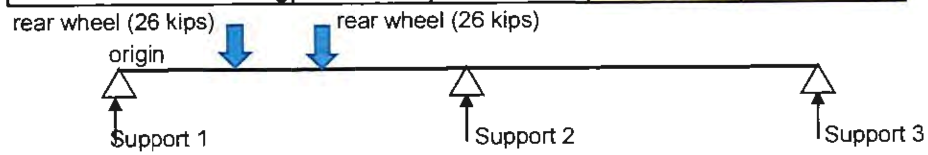
Loading Module

General Inputs		
Tributary width for beam (ft)	21	
Clear span of beam (ft)	20.6	
Weight of concrete (lb/ft^3)	150	
Slab thickness (in)	14	
Beam width (in)	16	BEAM B-3
Beam depth (in)	36	BEAM B-3
SDL (lb/ft^2)	0	
LL (lb/ft^2)	0	
Dead line load (k/ft)	0	
Dead Load Factor	1.2	
Live Load Factor	1.6	

Point Loads	
Unfactored point load 1 (k)	26
Impact Factor	0%
Loc. of Max. Moment (ft)	8.9
Unfactored point load 2 (k)	26
Impact Factor	0%
Dist. from Max. Moment (ft)	8
Location from origin (ft)	16.9
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	20.6
Dist. of P2 from P1(ft)	8.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	75.705	3.675	90.85	4.41
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	12.36	0.60	14.83	0.72
DL due to line load	0.00	0.00	0.00	0.00
Total DL	88.07	4.28	105.68	5.13
Total LL	0.00	0.00	0.00	0.00
Total Loading	88.065	4.275	**105.678**	**5.13**



Rear wheels spaced 8 ft apart on the beam. Fire truck wheelbase is 17.2 ft.
Axle load = 52 kips so each wheel is 26 kips

Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	263.60	370.93
Max negative moment (k-ft):	-200.72	-230.45
Maximum Shear (k):	86.61	121.68

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Concrete Beam Module

Beam Inputs		
b (in)	16	Width of beam
h (in)	36	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	2	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	4.1522
Es	0.0190

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	3	9	1.128	1	N/A	0.5
2	3	9	1.128	1	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	3.5	0.5	0.2	0.5

Halcrow

TRUCK COURT
PILE CAP CHECK
RESCUE TRUCK REAR AXLE WHEELS ON PILE CAP

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	3.00	1.50	Area of steel in bottom layer
$As_2 (in^2)$	3.00	3.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	4.50	Total area of steel
e (in)	1.63	1.98	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	30.87	30.52	Depth from top compression fiber to center of steel
a (in)	4.71	3.53	Depth of compression section
M_n (k*in)	6844.57	5175.47	
ΦM_n (k*in)	6160.12	4657.93	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	60.50	59.80
V_s (k)	141.13	69.75
$V_n = V_c + V_s$ (k)	201.63	129.56
ΦV_n (k)	151.22	97.17

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\,bd \text{ [ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \text{ [ACI 318-05 (11.5.7.2)]}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	**Reduced Moment Capacity (k-ft)**	**Factored Positive Moment (k-ft)**	**% Overstress**
513.34	388.16	370.93	N/A
Original Shear Capacity (k-ft)	**Reduced Shear Capacity (k)**	**Factored Shear (k)**	**% Overstress**
151.22	97.17	121.685	25.23%

BEAM LOAD RATINGS – FINGER PIER

Halcrow

FINGER PIER
275 PSF

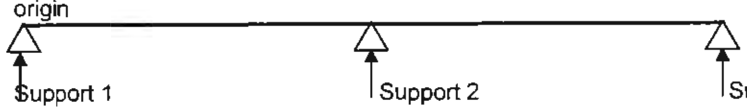
Loading Module

General Inputs	
Tributary width for beam (ft)	10
Clear span of beam (ft)	25.5
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	14
Beam width (in)	30
Beam depth (in)	48
SDL (lb/ft^2)	0
LL (lb/ft^2)	275
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	0
Impact Factor	0%
Loc. of Max. Moment (ft)	0.0
Unfactored point load 2 (k)	0
Impact Factor	0%
Dist. from Max. Moment (ft)	8
Location from origin (ft)	8.0
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	25.5
Dist. of P2 from P1(ft)	8.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	44.625	1.75	53.55	2.1
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	38.25	1.50	45.90	1.80
DL due to line load	0.00	0.00	0.00	0.00
Total DL	82.88	3.25	99.45	3.90
Total LL	70.13	2.75	112.20	4.40
Total Loading	153	6	**211.65**	**8.30**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	274.32	379.48
Max negative moment (k-ft):	-487.69	-674.63
Maximum Shear (k):	71.63	99.08

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

FINGER PIER
275 PSF

Concrete Beam Module

Beam Inputs		
b (in)	30	Width of beam
h (in)	48	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	1	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	1.4764
Es	0.0863

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	6	9	1.128	1	N/A	0.5
2	3	9	0	0	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	12	0.5	0.2	0.5

Halcrow

FINGER PIER
275 PSF

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	6.00	3.00	Area of steel in bottom layer
$As_2 (in^2)$	0.00	0.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	6.00	3.00	Total area of steel
e (in)	0.56	0.56	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	43.94	43.94	Depth from top compression fiber to center of steel
a (in)	2.51	1.25	Depth of compression section
M_n (k*in)	10243.46	5197.03	
ΦM_n (k*in)	9219.12	4677.32	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	161.43	161.43
V_s (k)	58.58	29.29
$V_n = V_c + V_s$ (k)	220.01	190.72
ΦV_n (k)	165.01	143.04

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\, bd \ \text{[ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \ \text{[ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	**Reduced Moment Capacity (k-ft)**	**Factored Positive Moment (k-ft)**	**% Overstress**
768.26	389.78	379.48	N/A
Original Shear Capacity (k-ft)	**Reduced Shear Capacity (k)**	**Factored Shear (k)**	**% Overstress**
165.01	143.04	99.081	N/A

DECK LOAD RATINGS – PRESTRESSED CONCRETE

Halcrow	NOAM CALCULATION SHEET	No: 1	Rev:
Project:	PIER 40 CONDITION SURVEY	By: MO	Date: 5/29/2009
Subject:	LOAD RATING FOR PRECAST PRESTRESSED PLANK WITH EXPOSED STRANDS	Check By: JC	Date: 5/30/2009

References/Results

MATERIAL PROPERITES

CONCRETE

F'c = 5000 PSI

REINFORCING DEFORMED BARS — DWG NO. F-23

Fy = 20000 PSI

HIGH TENSILE STEEL TENDONS - 7 WIRE

3/8 IN. DIAMETER A = 0.0799 in^2. — DWG NO. F-23

INITIAL PRESTRESS FORCE PER TENDON = 14000 LBS — DWG NO. F-23

DESIGN PRESTRESS FORCE PER TENDON 11000 LBS — DWG NO. F-23

STRESS IN TENDON AFTER PRESTRESS = 175219 PSI

ASSUME INITIAL PRESTRESS FORCE = 175219 PSI = 0.82Fpy — ACI 18.5.1

Fpy = 213681.7 PSI = 214 ksi

Fpy= 0.85Fpu Fpu = 251.4 ksi = 250 ksi

Fse = 137672.1 PSI = 137.7 ksi = EFFECTIVE STRESS IN PRESTRESSING

DETERMINE FLEXURAL CAPACITY OF PLANK

DUE TO THE SPALLS AND EXPOSED PRESTRESSING STRANDS ALONG THE BOTTOM OF THE PLANK, ASSUME ONLY THE SECOND LAYER OF PRESTRESSING REMAINS.

FOR THE PURPOSES OF THIS ANALYSIS, ASSUME PRECAST PLANK NUMBER P1 / P2 WHICH HAVE THE FOLLOWING PROPERTIES:

NUMBER OF STRANDS IN SECOND LAYER = 17 (assumes all strands in second layer are intact)

NUMBER OF STRANDS IN BOTTOM LAYER = 10 (assumes 10 out of 25 strands are still intact)

LENGTH OF PLANK = 20.5 FT

ORIGINAL DEPTH OF PLANK = 12 IN.

EFFECTIVE REMAINING DEPTH OF PLANK = 10.56 IN. (ADD 2 IN. TO CoG) — CoG of both layers of strands calculated to be 3.44 IN. from bottom of plank

CONCRETE COVER ON BOTTOM LAYER OF PRESTRESSING = 2 IN.

CONCRETE COVER ON SECOND LAYER OF PRESTRESSING = 4 IN.

B = WIDTH OF PLANK = 5 FT

Ap = AREA OF PRESTRESSING STEEL = 2.157 in^2. FOR BOTTOM AND SECOND LAYERS

DETERMINE THE RATIO OF EFFECTIVE PRESTRESS TO ULTIMATE STRENGTH OF STEEL

$\frac{f_{pe}}{f_{pu}}$ RATIO = 0.6 > 0.50, THEREFORE APPROXIMATE EQUATIONS BY ACI MAY BE USED — ACI 18.7.2

Halcrow	**NOAM CALCULATION SHEET**	No: 2	Rev:
Project:	PIER 40 CONDITION SURVEY	By: MO	Date: 5/29/2009
Subject:	LOAD RATING FOR PRECAST PRESTRESSED PLANK WITH EXPOSED STRANDS	Check By: JC	Date: 5/30/2009

References/Results

CALCULATE THE SPAN TO DEPTH RATIO TO DETERMINE APPLICABLE EQUATION

ASSUME UNBONDED TNEDONS

SPAN TO DEPTH RATIO = 23.3 < 35 — ACI 18.7.2

$$f_{ps} = f_{se} + 10000 + \frac{f_c'}{100\rho_p}$$

stress in prestressing steel at nominal flexural strength — ACI EQUATION 18-4

fps shall not be taken greater than fpy and (fse+60000)

d_p = effective depth to prestressing steel = 8.56 IN.

ρ_p = A_p / bd_p = 0.0042 STEEL RATIO FAILURE

β_1 = 0.85 — ACI 10.2.7.3

f_{ps} = 159575.86 PSI = 159.6 KSI

CALCULATE NOMINAL FLEXURAL STRENGTH OF PLANK

$$M_n = A_p f_{ps}\left(d - \frac{a}{2}\right)$$

where $$a = \frac{A_p f_{ps}}{0.85 f_c' b}$$

a = 1.3500 in.

Mn = 2714.433 k-in = 226.2 ft-kips

a = 1.086 in.

Mn = 2759.944 k-in = 230 ft-kips

Φ = 0.9

DESIGN FLEXURAL STRENGTH = ΦM_n = 207.00 ft-kips — ΦMn = 207.00 ft-kips

DETERMINE REMAINING LIVE LOAD CAPACITY OF PLANK BASED ON FLEXURAL STRENGTH

DEAD LOAD = 15375 LBS =	750	LB/FT	(12 in. PC PLANK ONLY)
	125	LB/FT	(2 IN. TOPPING)
TOTAL UNFACTORED DEAD LOAD =	875	LB/FT	
FACTORED DEAD LOAD w_D =	1050	LB/FT	(USE A FACTOR OF 1.2) — ACI 9.2

Halcrow NOAM CALCULATION SHEET	No: 3	Rev:
Project: PIER 40 CONDITION SURVEY	By: MO	Date: 5/29/2009
Subject: LOAD RATING FOR PRECAST PRESTRESSED PLANK WITH EXPOSED STRANDS	Check By: JC	Date: 5/30/2009

References/Results

PRECAST PLANKS ARE SIMPLY SUPPORTED

DEAD LOAD MOMENT = $w_D L^2 / 8$ = 55157.81 ft-lbs
55.16 ft-kips

TOTAL REMAINING MOMENT CAPACITY IN PLANK = 151.84 ft-kips

UNFACTORED LIVE LOAD = 2.89 k/ft

Live Load Factor = 1.6

ALLOWABLE FACTORED LIVE LOAD = 1.81 k/ft

ALLOWABLE LIVE LOAD = 0.361 ksf = 361.3 PSF
say 360 PSF

ALLOWABLE LIVE LOAD BASED ON FLEXURE 360 PSF

ALLOWABLE POINT LOAD = 29.63 kips

CALCULATE THE SHEAR CAPACITY OF PLANK

$$V_c = \left(0.6\sqrt{f_c'} + 700\frac{V_u d_p}{M_u}\right) b_w d$$

ACI 11.4.2

Vc shall not be taken less than the following:

$V_c = 2\sqrt{f_c'} b_w d$ = 89604.57 LBS = 89.6 kips

DEAD LOAD SHEAR = $w_D L / 2$ = 10762.5 LBS = 10.76 kips

TOTAL REMAINING SHEAR CAPACITY IN PLANK = 78.84 kips

UNFACTORED LIVE LOAD = 7.69 k/ft

ALLOWABLE FACTORED LIVE LOAD = 4.81 k/ft > 2.89 k/ft

SINCE THE FACTORED LIVE LOAD BASED ON SHEAR IS HIGHER THAN THAT CALCULATED FOR FLEXURE, THE LIVE LOAD FOR FLEXURE GOVERNS.

CONCLUSIONS

ALTHOUGH THE PLANK HAS AN ALLOWABLE LIVE LOAD OF 360 PSF, THIS SHOULD BE REDUCED TO 300 PSF.

THIS APPLIES ONLY TO PRECAST PLANK NUMBERS P1 AND P2, AND PLANKS WITH SIMILAR PROPERTIES TO P1 AND P2.

ALLOWABLE LIVE LOAD

360 PSF

Halcrow NOAM CALCULATION SHEET	No: 4	Rev:
Project: PIER 40 CONDITION SURVEY	By: MO	Date: 5/29/2009
Subject: LOAD RATING FOR PRECAST PRESTRESSED PLANK WITH EXPOSED STRANDS	Check By: JC	Date: 5/30/2009

CALCULATION OF CENTER OF GRAVITY OF PRESTRESSING STRAND LAYERS

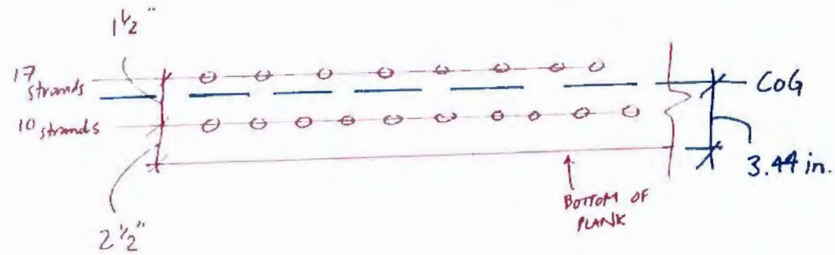
Assume plank's bottom layer of prestressing is half missing

No. of strands; area per strand per DWG F-23

2nd layer = 17 × 0.0799 = 1.3583 in.^{2}

bot. layer = 10 × 0.0799 = 0.799 in.^{2}

2.1573 in^2



2nd layer : 1.3583 (4) = 5.4332 in^3

bot layer : 0.799 (2.5) = 1.9975 in.^{3}

7.4307 in^3

$$\frac{7.4307}{2.1573} = 3.44 \text{ in. from bottom}$$

DECK LOAD RATINGS – CAST-IN-PLACE CONCRETE

Halcrow

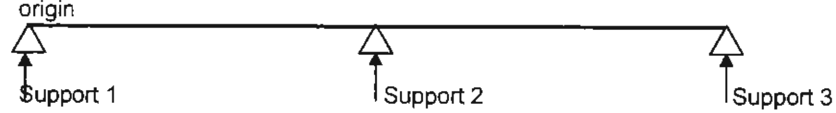
Loading Module

General Inputs	
Tributary width for beam (ft)	1
Clear span of beam (ft)	10.0
Weight of concrete (lb/ft^3)	150
Slab thickness (in)	0
Beam width (in)	12
Beam depth (in)	15
SDL (lb/ft^2)	0
LL (lb/ft^2)	275
Dead line load (k/ft)	0
Dead Load Factor	1.2
Live Load Factor	1.6

Point Loads	
Unfactored point load 1 (k)	0
Impact Factor	15%
Loc. of Max. Moment (ft)	0.0
Unfactored point load 2 (k)	0
Impact Factor	15%
Dist. from Max. Moment (ft)	6
Location from origin (ft)	6.0
Location btwn supports	Btwn 1&2

Loc. of Max. Shear (ft)	10.0
Dist. of P2 from P1(ft)	6.0

Loading	Unfactored Load		Factored Load	
	Total (k)	Distributed (k/ft)	Total (k)	Distributed (k/ft)
DL due to slab	0	0	0.00	0
DL due to SDL	0.00	0.00	0.00	0.00
DL due to self weght	1.88	0.19	2.25	0.23
DL due to line load	0.00	0.00	0.00	0.00
Total DL	1.88	0.19	2.25	0.23
Total LL	2.75	0.28	4.40	0.44
Total Loading	4.625	0.4625	**6.65**	**0.67**



Unfactored Moments	Unfactored	Factored
Max positive moment (k-ft):	3.25	4.67
Max negative moment (k-ft):	-5.78	-8.31
Maximum Shear (k):	2.31	3.33

Reactions at Support	Unfactored	Factored
Moment at Support 1 (k-ft):		
Moment at Support 2 (k-ft):		
Reaction at Support 1 (k):		
Reaction at Support 2 (k):		

Halcrow

Concrete Beam Module

Beam Inputs		
b (in)	12	Width of beam
h (in)	15	Depth of beam
f'c (ksi)	3.75	Strength of concrete
Wc (lb/ft^3)	150	Weight of concrete
fy (ksi)	40	Strength of steel reinforcing
Lc (bottom) (in)	3	Clear cover to bottom reinforcement
Lc (top) (in)	2	Clear cover to top reinforcement
εc	0.003	Max strain in concrete
εs	0.00138	Max strain in steel
β	0.85	[ACI 318-05 10.2.7.3]
Layers of rebar	1	

Φ (flexure)	0.9	[ACI 318-05 9.3.1]
Φ (shear)	0.75	[ACI 318-05 11.1]

Ec (ksi)	3712.5	[ACI 318-05 8.5.1]
Ey (ksi)	29000	

c	0.1907
Es	0.1730

Beam Longitudinal Reinforcing

Row of Reinforcing	Number of Bars	Bar Size	Reinforcing Bar Diameter (in.)	Area per Bar (in^2)	Clear Distance from Reinforcing Row Below (in.)	% Section Remaining (0≤x≤1)
1	1	5	0.625	0.31	N/A	0.5
2	3	3	0	0	1	1
3	0	0	0	0	1	1

Beam Stirrups

Bar Size	Distance o/c (in)	Diameter (in)	Area of steel (in^2)	% Section Remaining (0≤x≤1)
4	12	0.5	0.2	0.5

Beam Moment Capacity			
	Original	Reduced	
$As_1 (in^2)$	0.31	0.16	Area of steel in bottom layer
$As_2 (in^2)$	0.00	0.00	Area of steel in second layer
$As_3 (in^2)$	0.00	0.00	Area of steel in third layer
$As_T (in^2)$	0.31	0.16	Total area of steel
e (in)	0.31	0.31	Dist. to center of steel, 0 = bottom of long. reinforcement
d (in)	11.19	11.19	Depth from top compression fiber to center of steel
a (in)	0.32	0.16	Depth of compression section
M_n (k*in)	136.72	68.86	
ΦM_n (k*in)	123.04	61.97	

Beam Shear Capacity		
	Original	Reduced
V_c (k)	16.44	16.44
V_s (k)	14.92	7.46
$V_n = V_c + V_s$ (k)	31.36	23.90
ΦV_n (k)	23.52	17.93

$$M_n = A_s f_y \left(d - \frac{a}{2} \right)$$

$$V_c = 2\sqrt{f'_c}\, bd \ \text{[ACI 318-05 (11.3.1.1)]}$$

$$V_s = \frac{A_s f_y d}{s} \ \text{[ACI 318-05 (11.5.7.2)}$$

Results for Two Equal Span Continuous Beam			
Original Moment Capacity (k-ft)	Reduced Moment Capacity (k-ft)	Factored Positive Moment (k-ft)	% Overstress
10.25	5.16	4.67	N/A
Original Shear Capacity (k-ft)	Reduced Shear Capacity (k)	Factored Shear (k)	% Overstress
23.52	17.93	3.325	N/A

CURRENT AND ICE LOAD CALCULATION

Halcrow Yolles

Project: PIER 40				Project No.	No.
Design: AJW	Drawn:	Checked:	Date: 4/14/09	W.P. No.	Scale
Subject: CURRENT LOAD ON PILE				Reference	

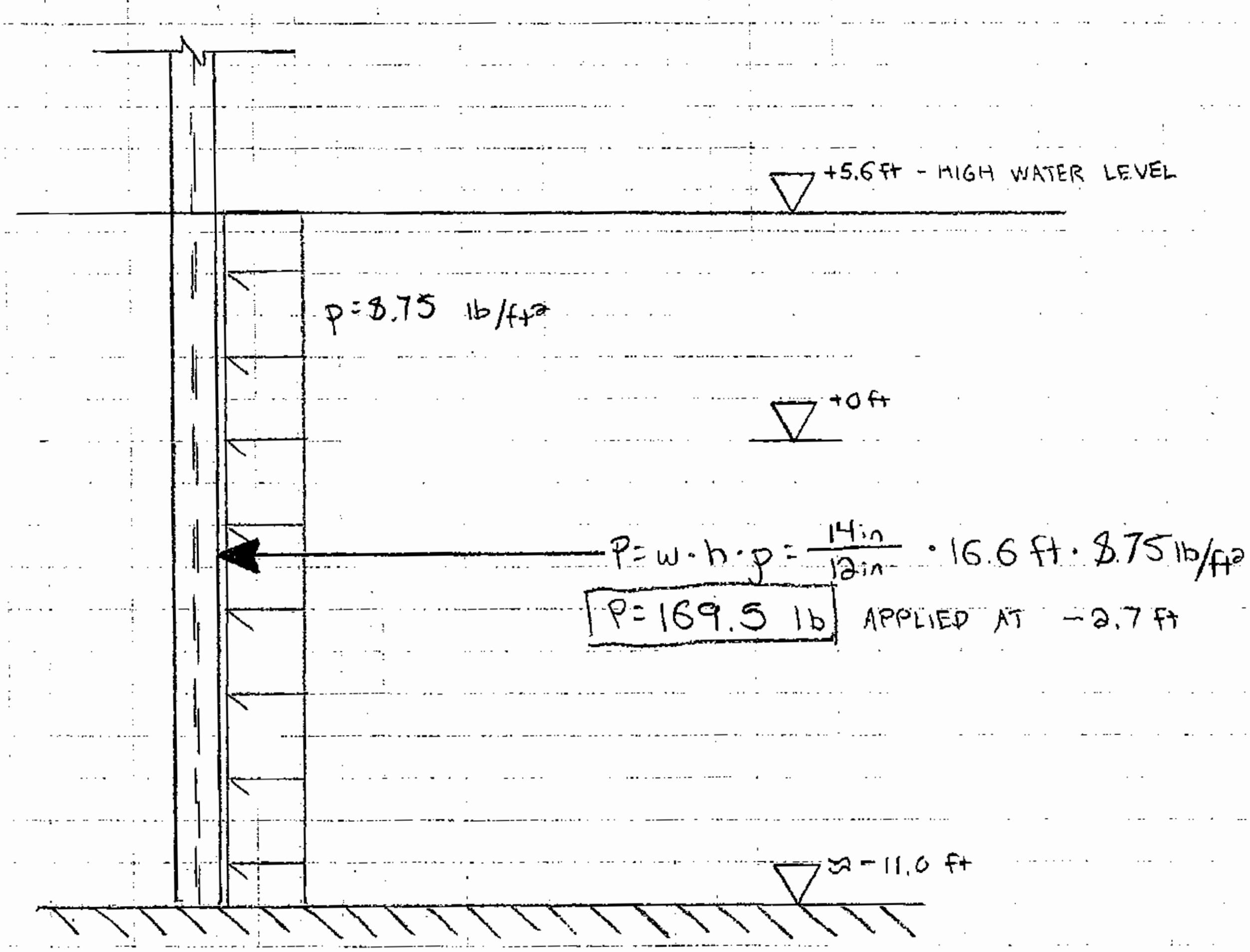
AS PER AASHTO STANDARD SPECIFICATIONS FOR BRIDGE DESIGN 2007 w/2008 REVISIONS

§ 3.7.3

$C_D = 1.4$

$V = 2.5\ \text{ft/s}$

$$p = \frac{C_D \cdot V^2}{1000} = \frac{1.4 \cdot (2.5\ \text{ft/s})^2}{1000} = .00875\ \text{K/ft}^2 = 8.75\ \text{lb/ft}^2$$



$$P = w \cdot h \cdot p = \frac{14\ \text{in}}{12\ \text{in}} \cdot 16.6\ \text{ft} \cdot 8.75\ \text{lb/ft}^2$$

P = 169.5 lb APPLIED AT −2.7 ft

Halcrow Yolles

Project: PIER 40				Project No.	No.
Design: AJW	Drawn:	Checked:	Date: 4/13/09	W.P. No.	Scale
Subject: DYNAMIC ICE LOAD ON PILE				Reference	

AS PER AASHTO STANDARD SPECIFICATIONS FOR BRIDGE DESIGN 2007 w/ 2008 REVISIONS

§ 3.9.2.2

$w_{max} = 14 \text{ in} = 1\frac{1}{6} \text{ ft}$

$t = 8 \text{ in} = \frac{2}{3} \text{ ft}$

$p = 100 \text{ psi} = 14.4 \text{ ksf}$

$\frac{w}{t} = \frac{1\frac{1}{6}\text{ ft}}{\frac{2}{3}\text{ ft}} = 1.75 < 6$, THEREFORE $F = \min(F_c, F_B)$

$$F_c = C_a \cdot p \cdot t \cdot w$$

$$= \left(\frac{5t}{w+1}\right)^{.5} \cdot p \cdot t \cdot w$$

$$= \left(\frac{5 \cdot \frac{2}{3}\text{ ft}}{1\frac{1}{6}\text{ ft} + 1}\right)^{.5} \cdot 14.4 \text{ ksf} \cdot \frac{2}{3}\text{ ft} \cdot 1\frac{1}{6}\text{ ft}$$

$$= 13.89 \text{ K}$$

F_B = NEED NOT BE CONSIDERED BECAUSE $\alpha < 15$ AS PER C.3.9.2.2

$F = 13.89$ K AT +5.6 ft, HIGH WATER LEVEL

ICE ABRASION = $F_A = .11 \cdot F = .11 \cdot 13.89 =$ **1.53 K**

AT +5.6 ft, HIGH WATER LEVEL

WAVE LOAD CALCULATION

Halcrow, Inc
22 Cortlandt Street
New York, NY 10007
Tel (212) 608-3990 Fax (212) 566-5059
www.halcrow.com

Technical note

Project	Hudson River Park – Pier 40	**Date**	May 15, 2009
Note	Wave Forces on Pile Cap beam and piles at Pier 40 Expansion Bridge Structure	**Ref**	
Author	Furong Zhang, Atilla Bayram		

INTRODUCTION

This memorandum presents the results of wave force calculations on the edge beam and piles at the Pier 40 Finger Pier Extension in the Hudson River.

ENVIRONMENTAL PARAMETERS

Extreme wave climate at the site is provided in Hudson River Park Structural Design Guidelines Rev. B report prepared by Arup (Arup, 2001). Table 1 summarizes environmental parameters. Table 2 documents tidal planes published by NOAA for Battery Park City. It is based on 1983-2001 tidal epoch. Local water depth in front of the structure is taken as 9.14 m-MLLW (30 ft-MLLW) as it is given in project drawing. The deck level has been set at +3.42m-MLLW. The design water level is selected as+1.56 m-MLLW.

Table 1- Wave parameters for the Pier 40 Finger Pier Extension Structure

Direction	H_s (m)	T_p (s)	Local water depth (m-MLLW)
Southerly	3.04	5.40	9.14
Westerly	1.05	2.60	9.14

Table 2- Tidal Planes at Battery Park City Station

Tidal Planes	Water Level (m)
100 yr Flood, Level 3 Hurricane	3.62
Highest Observed Water Level (9/12/1960)	3.12
MHHW	**1.56**
MHW	1.46
NGVD 1929	0.57
MLW	0.07
MLLW	**0.00**
Lowest Observed (2/276)	-1.24

WAVE FORCES ON PILE CAP BEAM

The beams are 12.2 m in length (dimensions perpendicular to the direction of wave travel) with a cross-section of 1.3 m x 1.3 m (see Fig. 1). In order to calculate the forces on the beam the method by McConnell et al. (2004) was used. An excel spreadsheet was prepared to facilitate the calculations. Detailed calculations are attached. Table 3 summarizes predicted quasi-static and maximum (i.e. short duration impact) horizontal forces on the beam.

Uplift forces due to waves was not considered. The wave force on the Finger Pier Extension is considered to be the worst case condition and will therefore be applied to the Pier Shed structure as well.

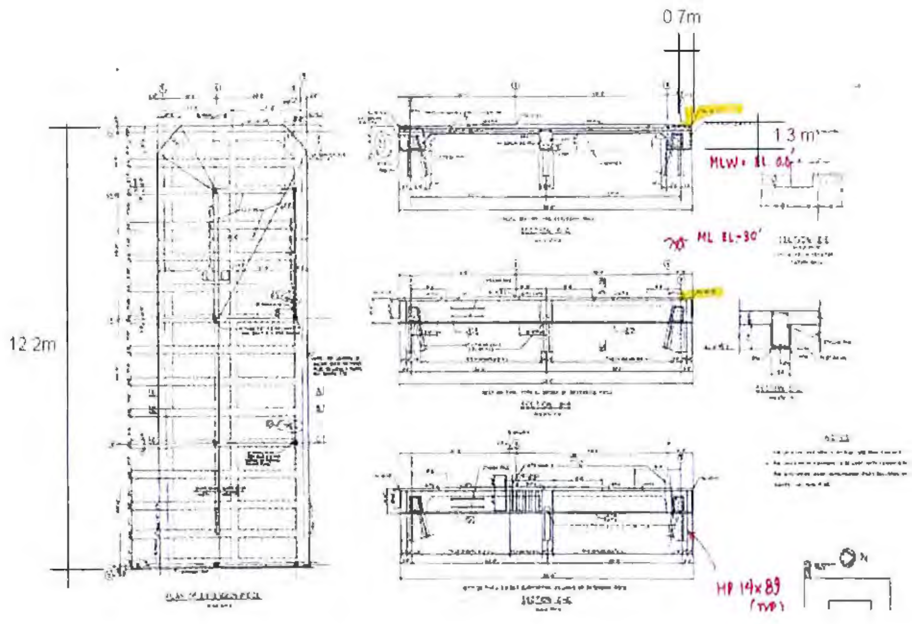


Fig. 1 Pier 40 Finger Pier Extension Structure Cross Section

Table 3- Total wave force on the edge beam (12.2 m x 1.3 x 1.3 m)

Force (kN)	Wave Directions	
	Southerly	Westerly
$F_{h, qs+}$	169.3 (38 kips)	2.8
$F_{h, max}$	423.2 (95 kips)	6.9

Use this for design

The wave force on the edge beam is distributed over contact area of 12.2 m x 1.3 m, or 15.86 m^2, which is equivalent to 171 SF. The wave force on the edge beam is therefore equal to 223 PSF.

A wave force of 223 PSF will be applied to the structural model. Because these extreme wave conditions are wind induced, the waves will be applied simultaneously with wind under the provided loading combinations.

WAVE FORCES ON PILE

Existing piles which support the deck slab are similar in size to HP14x89 steel H-piles. Force due to waves on the pile is estimated using Morrison equations as recommended in Shore Protection Manual (USACE SPM 1984). Pile cross section is assumed to be circular in order to simplify the calculations. Table 4 summarizes predicted total maximum force, and associated moment with moment arm with respect to the sea bed. Detailed calculations are attached. In short, the total maximum force on the pile is estimated to be 3915 N. The force is estimated to be applied at a point 8.2 m above the sea-bed.

Table 4- Wave forces on the pile

Directions	F_{max} (N)	Moment arm from mud line (m)
Southerly	3914.9 (0.88 kips)	8.2
Westerly	887.4 (0.2 kips)	10.3

Due to the relatively small load, these forces will not be applied to the structural model of the pile.

References

Arup, 2001, "Hudson River Park Structural Design Guidelines", Arup, NY, USA.

McConnell, K, William, Allsop, Ian, Cruickshank, 2004," Piers, Jetties and Related Structures Exposed to Waves - Guidelines for Hydraulic Loading, Thomas Telford, 250p.

USACE Shore Protection Guideline (SPM), 1984, Vol. II, Coastal Engineering Research Center, 19

Halcrow

Source: Pier, Jetties and Related Structures Exposed to Waves- Guidelines for Hydarulic Loading-2004 by McConnell at al.

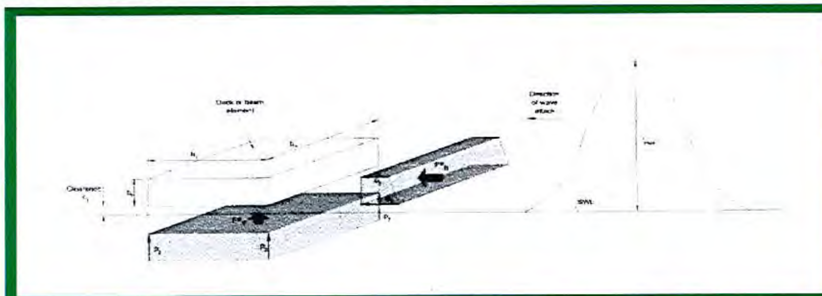


Fig. 5-5- Definitions of basic wave forces (after McConnell et al.)

INPUT DATA

Local Water Depth h_1 (m-MLLW)	9.14	
Design Water Level (m-MLLW)	1.56	
Deck Elev. (m-MLLW)	3.42	
H_s (m)	3.1	
h (m)	10.7	
T_m (s)	5.4	
N_z	660	Number of waves during the storm
B_w (m)	12.2	Deck width perpendicular dominant wave dir.
B_L (m)	1.3	Deck length (in direction of wave attack)
B_h (m)	1.3	Deck slab height
ρ_s (kg/m^3)	1030.0	Density of seawater
g (m/s^2)	9.8	Gravitational accleration
ρ_c (kg/m^3)	2400.0	Density of concrete
Coefficient for Vertical Force (quasi-static), C_v	1.0	Input- Table 5.5- Allsop et al. (2004)
Coefficient for Horizontal Force (quasi-static), C_h	1.0	Input- Table 5.7- Allsop et al. (2004)
$F_{h,max}$ / F_{vqs} Ratio	2.5	Input- Fig. 5-29 (There is also detail calc method to find Fmax but it requires prediction of natural period of oscillation for the structure and not included in here)

L_o (m)	45.5	Deep water wavelength
k_o (m^{-1})	0.1381	Deep water wave number
L (m)	42.0	Local wavelength
H_{max} (m)	5.49	Max. wave height
η_{max} (m)	3.84	Max. wave crest elevation (selected as $0.7*H_{max}$)
C_l (m)	0.56	Clearance between Design Water Level and Deck Bottom

Wave Forces on Deck-Southerly

Halcrow

p_1 (N/m^2)	20036.8			Hydrostatic pressure at the top of the deck element
p_2 (N/m^2)	33172.4	80.3	kips/ft^2	Hydrostatic pressure at the bottom of the deck element
F_{h^*} (kN)	421.9			
a	0.45	Input- Table 5.6- Allsop et al. (2004)		
b	1.56	Input- Table 5.6- Allsop et al. (2004)		
F_{hqs} (kN)	169.3	37.9	kips	Max. positive (seaward) quasi-static (pulsating) force
p_{hqs} (kN/m^2)	10.7	222.8	pound/ft^2	Max. positive (seaward) quasi-static (pulsating) pressure

Table 5.4. Coefficients for prediction of vertical wave forces using Equation (5.19)
(after McConnell at al., 2004)

Wave load and configuration	*a*	*b*
Upward vertical forces (seaward beam and deck)	0.82	0.61
Upward vertical forces (internal beam only)	0.84	0.66
Upward vertical forces (internal deck, two- and three-dimensional effects)	0.71	0.71
Downward vertical forces (seaward beam and deck)	-0.54	0.91
Downward vertical forces (internal beam only)	-0.35	1.12
Downward vertical forces (internal deck, two-dimensional effects)	-0.12	0.85
Downward vertical forces (internal deck, three-dimensional effects)	-0.80	0.34

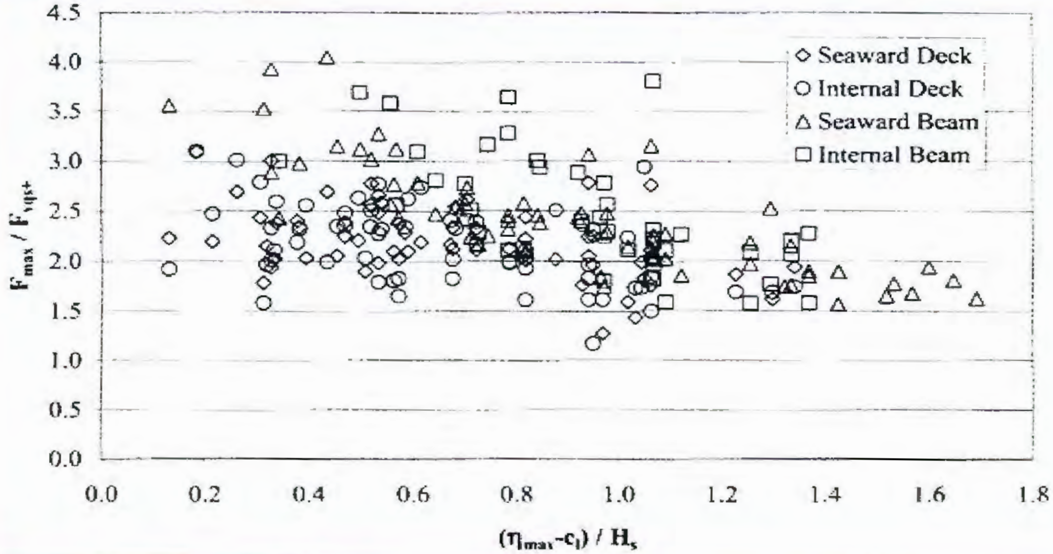
Table 5.5. Coefficients for upper and lower limits of test data
(after McConnell at al., 2004)

Wave load and configuration	C_{upper}	C_{lower}
Upward vertical forces (seaward beam and deck)	1.5	0.5
Upward vertical forces (internal beam only)	1.4	0.5
Upward vertical forces (internal deck, two- and three-dimensional effects)	2.2	0.1
Downward vertical forces (seaward beam and deck)	1.6	0.4
Downward vertical forces (internal beam only)	1.8	0.5
Downward vertical forces (internal deck, two-dimensional effects)	2.1	-
Downward vertical forces (internal deck, three-dimensional effects)	1.4	0.65

Halcrow

Table 5.7. Coefficients for upper and lower limits of test data
(after McConnell at al., 2004)

Wave load and configuration	C_{upper}	C_{lower}
Shoreward horizontal forces, F_{hqs-} (seaward beam)	2	0.25
Shoreward horizontal forces, F_{hqs+} (internal beam)	1.8	-
Seaward horizontal forces, F_{hqs-} (seaward beam)	2	0.15
Seaward horizontal forces, F_{hqs-} (internal beam)	3	-



Ratio of vertical impact forces to quasi-static forces (after McConnell et al. 2004)

Wave Forces on Deck-Southerly

Halcrow

Source: SPM 1984 (Morrsion Eq.)

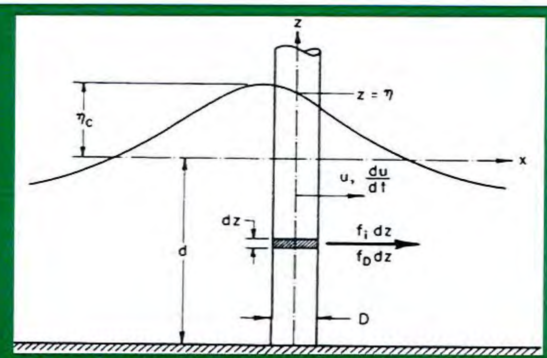


Fig. 1 Definition sketch of wave forces on a vertical cylinder (SPM 1984).

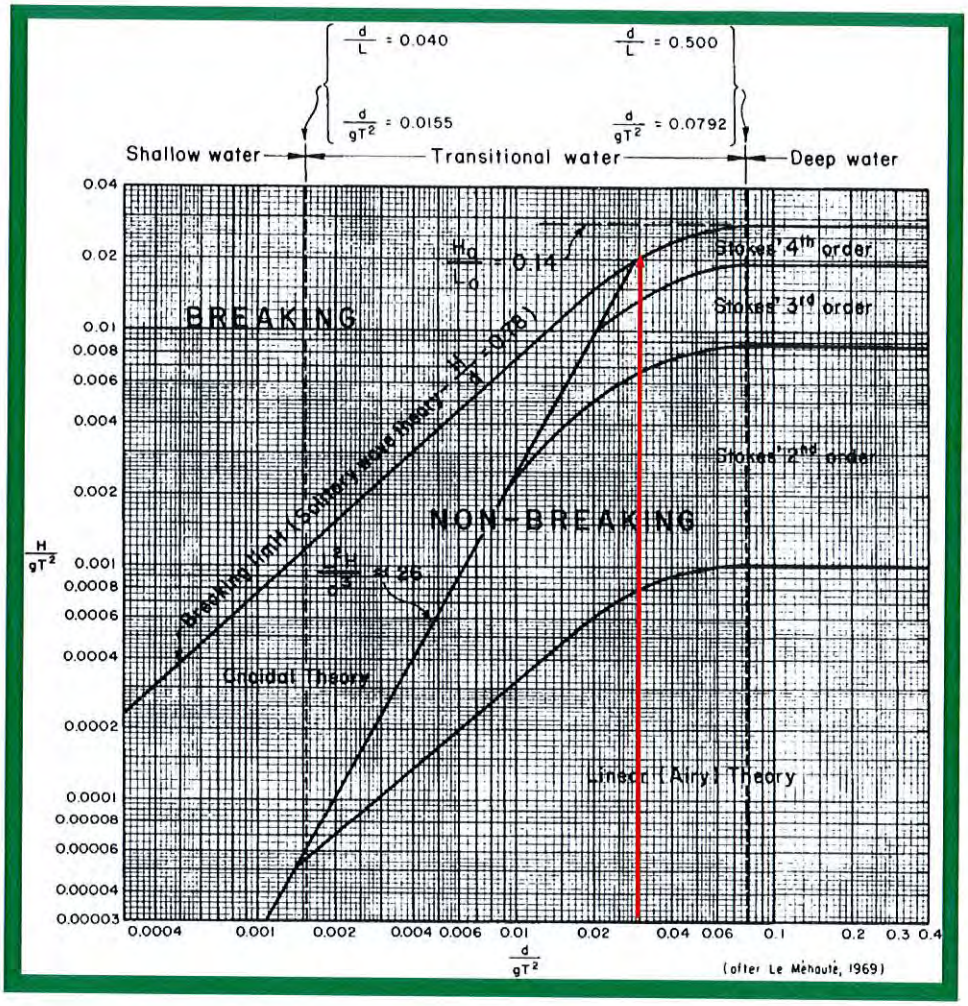
INPUT DATA

Local Water Depth h_1 (m-MLLW)	9.14	
Design Water Level (m-MLLW)	1.56	
H_s (m)	3.05	
d (m)	10.70	
T_p (s)	5.94	
N_z	660.00	Number of waves during the storm
D (m)	0.35	
ρ_s (kg/m^3)	1030.00	Density of seawater
g (m/s^2)	9.81	Gravitational accleration
ρ_c (kg/m^3)	2400.00	Density of concrete
Drag Coefficient, C_D	0.70	Input- Fig.
Inertia Coefficient , C_M	1.50	Input- Fig

L_o (m)	55.0	Deep water wavelength
k_o (m^{-1})	0.1142	Deep water wave number
L (m)	48.6	Local wavelength
H_{max} (m)	5.49	Max. wave height

Halcrow

$d/(gT_p^2)$	0.0309								
$H_b/(gT_p^2)$	0.020	←	Read from Fig. 7.75						
H_b (m)	6.9								
$H_{m0}/(gT_p^2)$	0.0088								
K_{IM}	0.44	←	Read from Fig. 7.71	Using	$H_b/H=$	0.44	&	$d/(gT_p^2)$	0.0309
K_{DM}	0.29	←	Read from Fig. 7.72	Using	$H_b/H=$	0.44	&	$d/(gT_p^2)$	0.0309
F_{IM} (N)	1956.9								
F_{DM} (N)	3339.2								
w	0.25								
ϕ_m	0.17	←	Read from Fig. 7.76 ~ 7.79	Using	$H_{m0}/(gT_p^2)$	0.0088	&	$d/(gT_p^2)$	0.0309
F_{MAX} (N)	3914.9	or	880.1 lbf						
S_{IM}	0.58	←	Read from Fig. 7.73	Using	$H_b/H=$	0.44	&	$d/(gT_p^2)$	0.0309
S_{DM}	0.82	←	Read from Fig. 7.74	Using	$H_b/H=$	0.44	&	$d/(gT_p^2)$	0.0309
M_{IM} (N.m)	12,144.7								
M_{DM} (N.m)	29,298.0								
w	0.25								
α_m	0.13	←	Read from Fig. 7.80 ~ 7.83	Using	$H_{m0}/(gT_p^2)$	0.0088	&	$d/(gT_p^2)$	0.0309
M_{MAX} (N.m)	32,033.11	or	23,626.41 lbf x m						
r (m)	8.18	or	26.84 ft						



d/L = 0.040
d/L = 0.500
d/gT² = 0.0155
d/gT² = 0.0792
Shallow water
Transitional water
Deep water
H₀/L₀ = 0.14
Stokes' 4th order
Stokes' 3rd order
BREAKING
Stokes' 2nd order
NON-BREAKING
H/gT²
Cnoidal Theory
Linear (Airy) Theory
d/gT²
(after Le Méhauté, 1969)

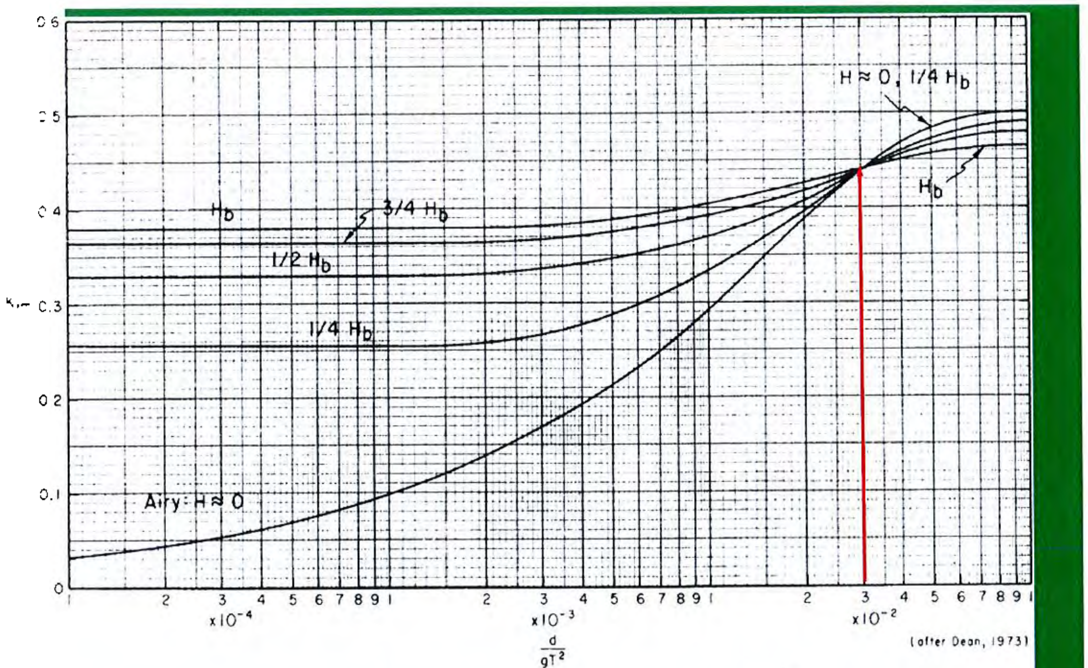


Figure 7-71. K_{im} versus relative depth, d/gT^2.

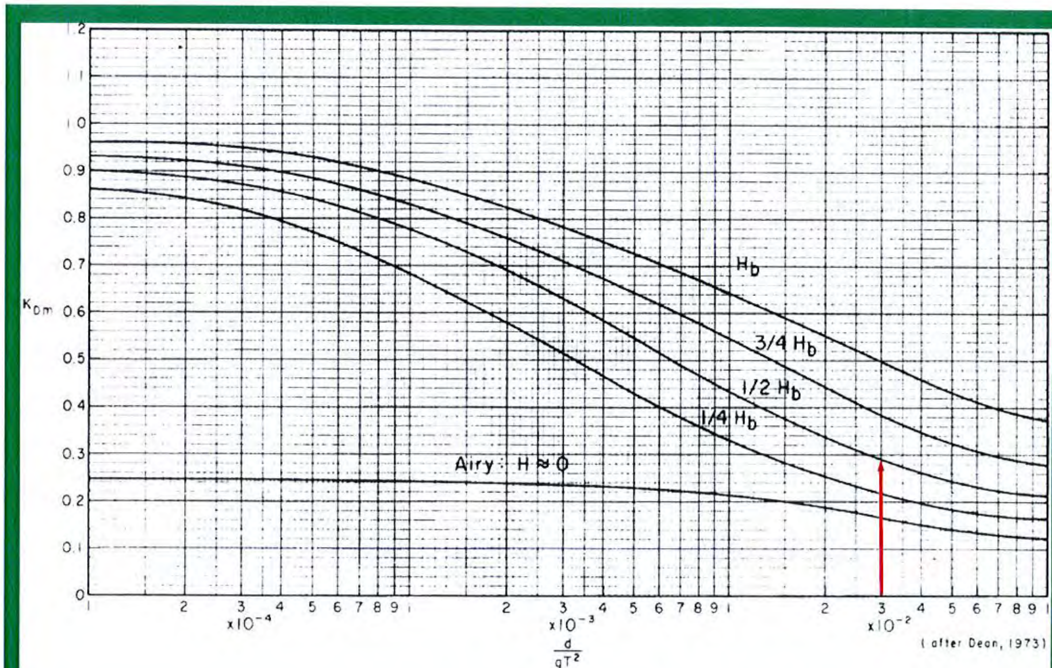


Figure 7-72. K_{Dm} versus relative depth, d/gT^2.

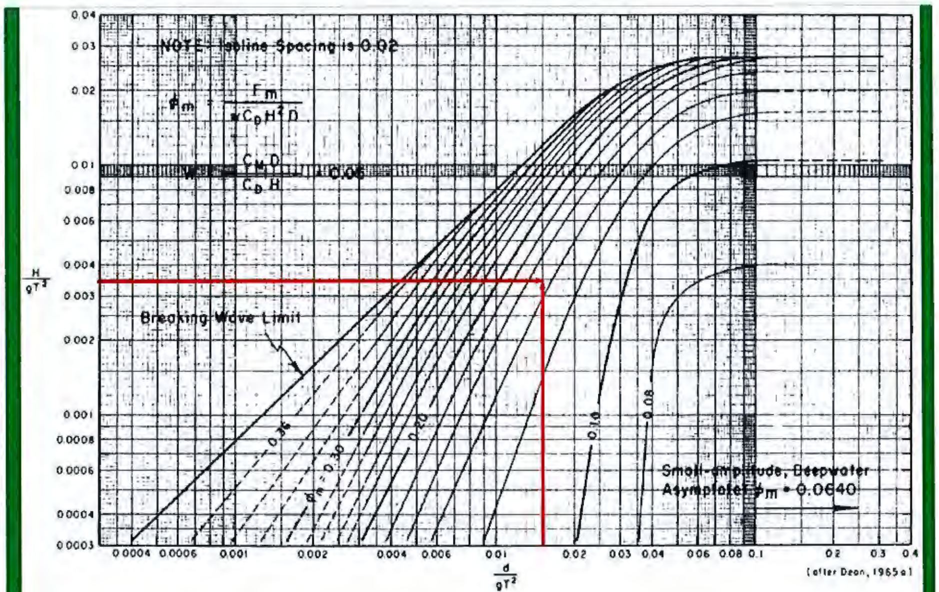


Figure 7-76. Isolines of ϕ_m versus H/gT^2 and d/gT^2 ... (W = 0.05) .

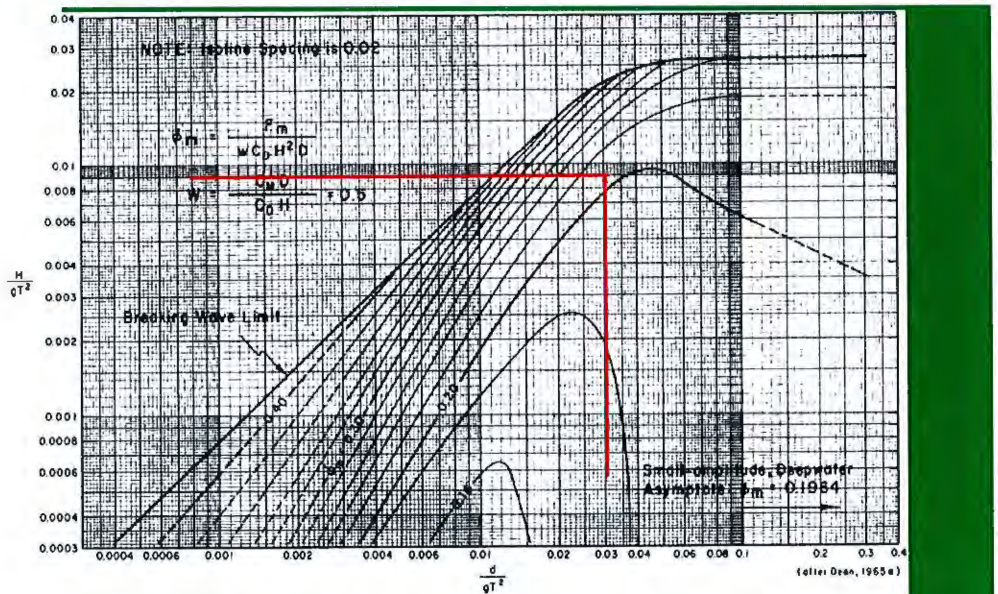


Figure 7-78. Isolines of ϕ_m versus H/gT^2 and d/gT^2 ... (W = 0.5) .

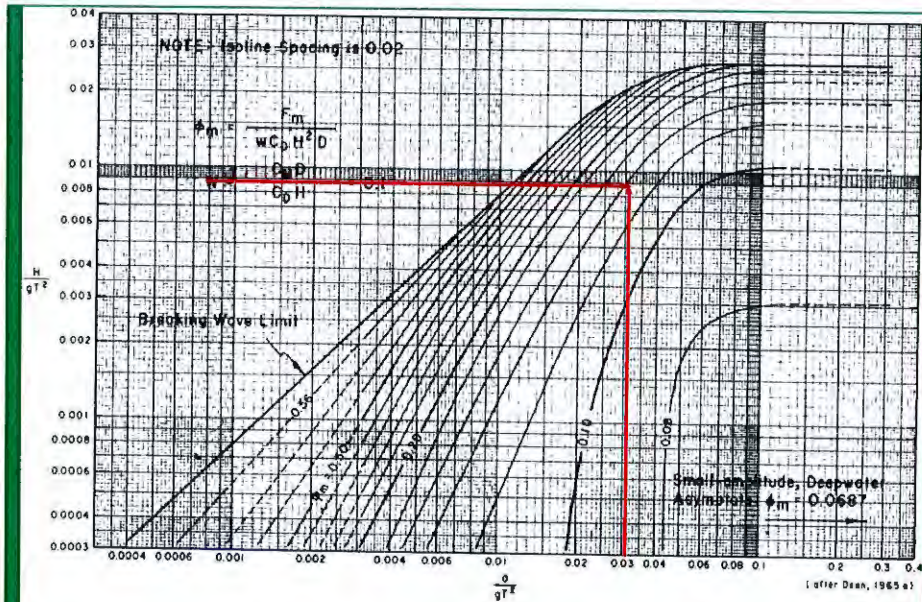


Figure 7-77. Isolines of ϕ_m versus H/gT^2 and d/gT^2 ... (W = 0.1) .

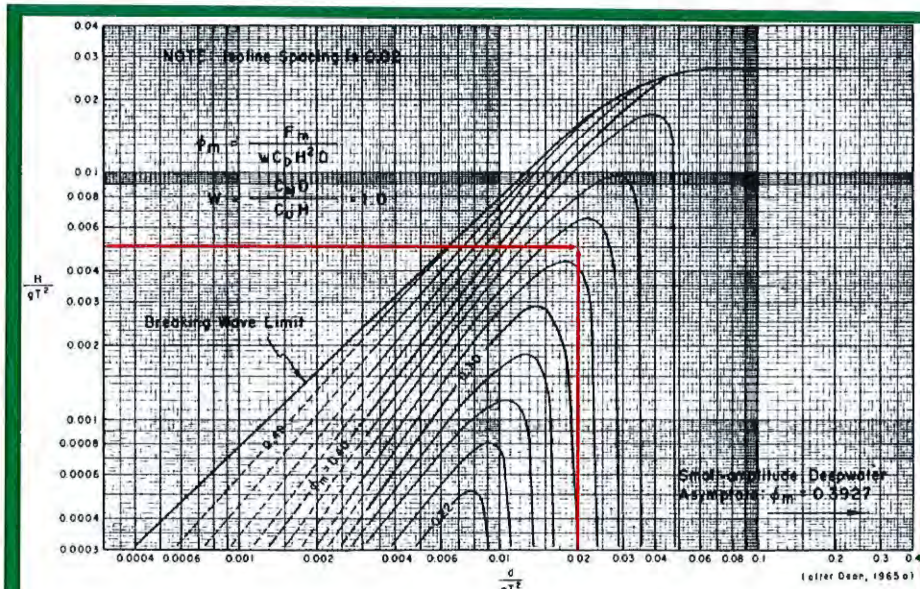


Figure 7-79. Isolines of ϕ_m versus H/gT^2 and d/gT^2 ... (W = 1.0) .

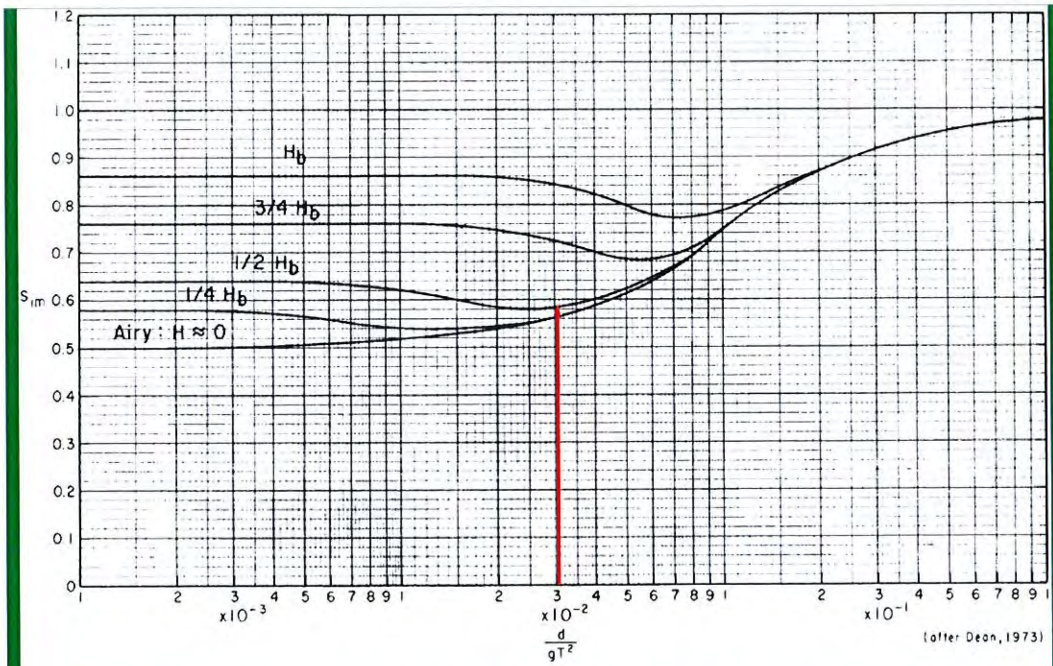


Figure 7-73. Inertia force moment arm, S_{im}, versus relative depth, d/gT^2.

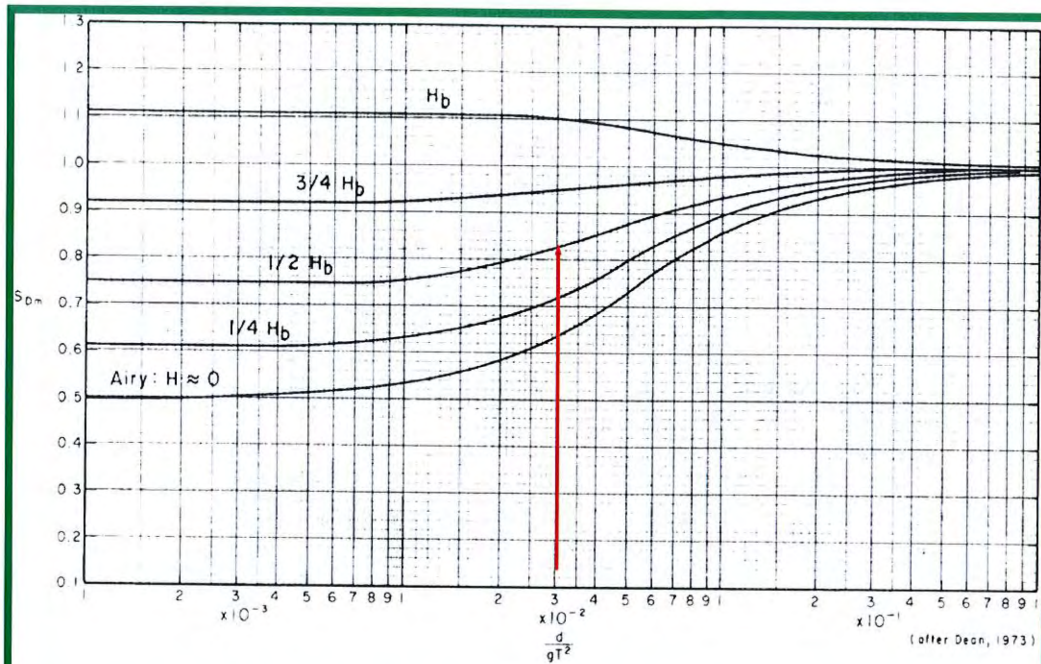


Figure 7-74. Drag force moment arm, S_{Dm}, versus relative depth, d/gT^2.

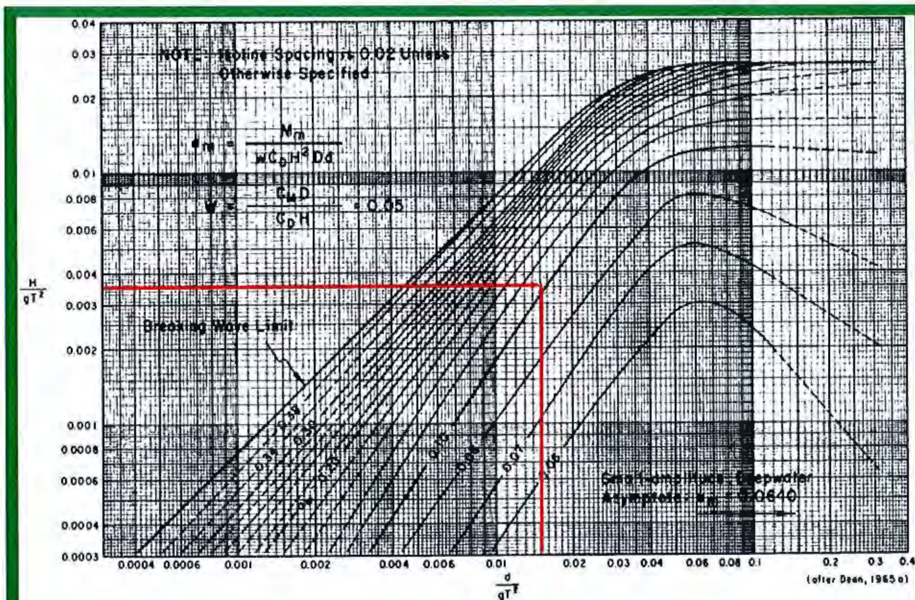


Figure 7-80. Isolines of α_m versus H/gT^2 and d/gT^2 ... (W = 0.05) .

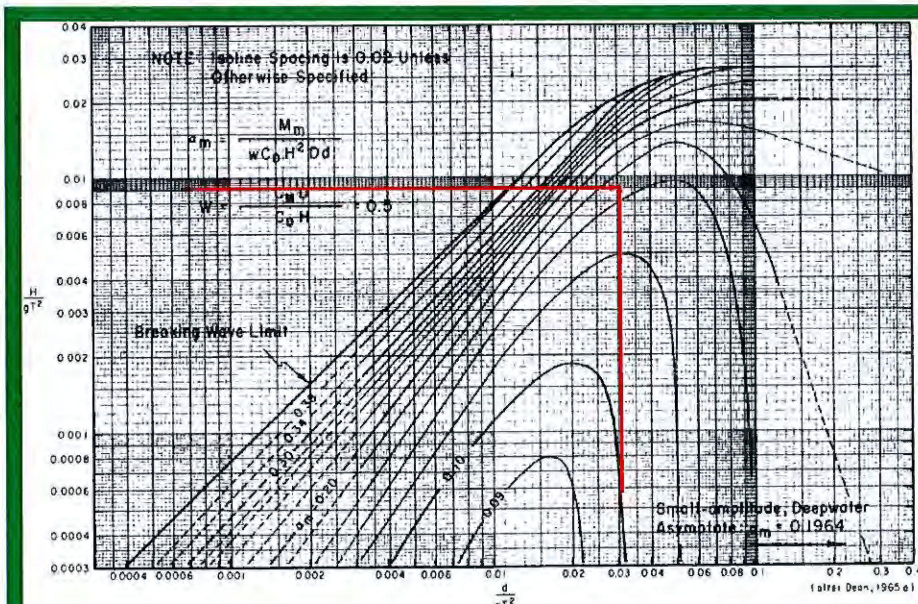


Figure 7-82. Isolines of α_m versus H/gT^2 and d/gT^2 ... (W = 0.5) .

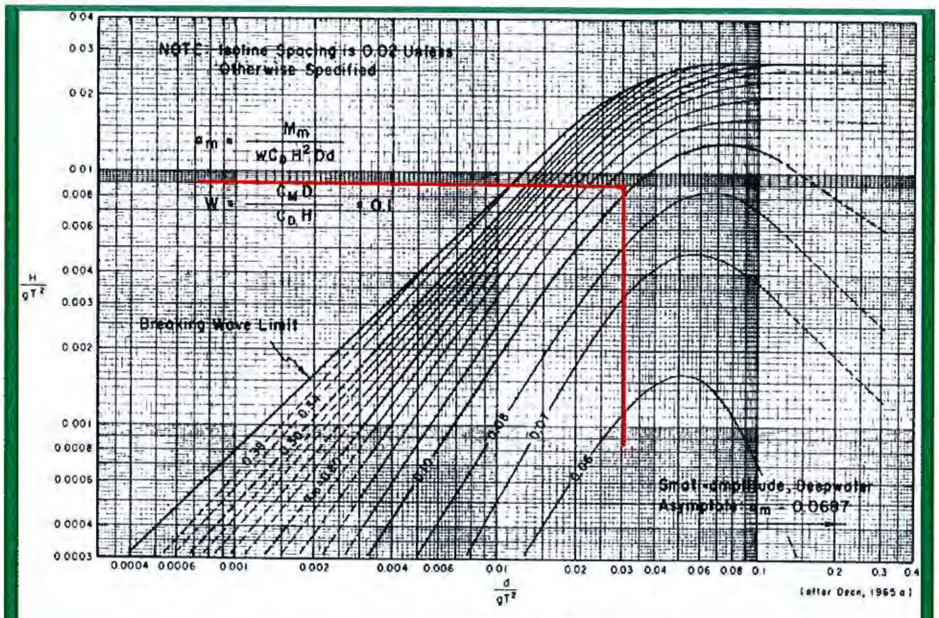


Figure 7-81. Isolines of α_m versus H/gT^2 and d/gT^2 ... ($W = 0.1$) .

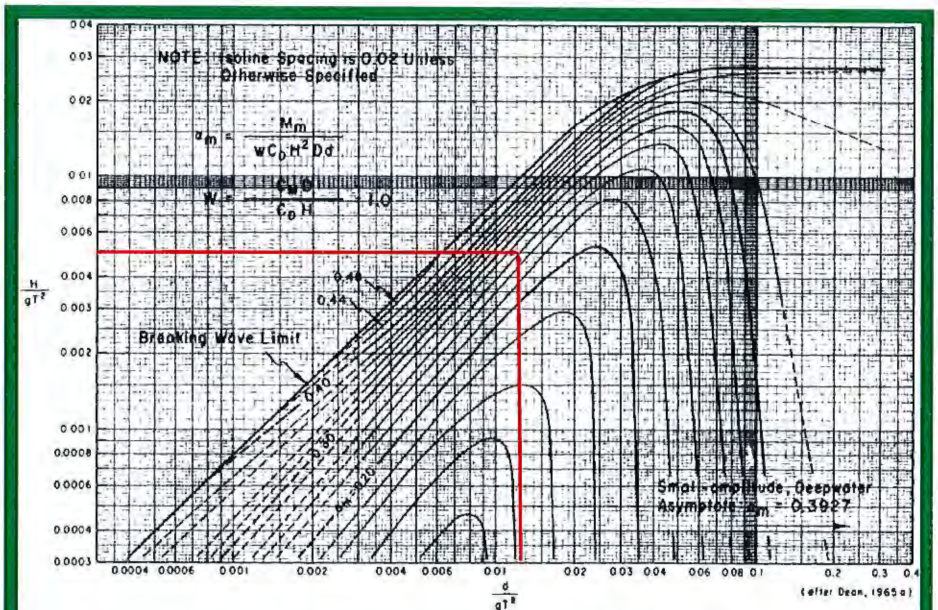
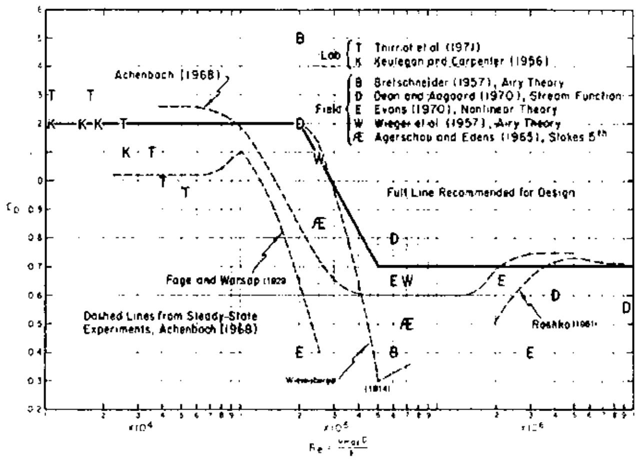


Figure 7-83. Isolines of α_m versus H/gT^2 and d/gT^2 ... ($W = 1.0$) .



$$\left.\begin{aligned} C_M &= 2.0 \quad \text{when} \quad R_e < 2.5 \times 10^5 \\ C_M &= 2.5 - \frac{R_e}{5 \times 10^5} \quad \text{when} \quad 2.5 \times 10^5 < R_e < 5 \times 10^5 \\ C_M &= 1.5 \quad \text{when} \quad R_e > 5 \times 10^5 \end{aligned}\right\}$$

Figure 7-85. Variation of drag coefficient C_D with Reynolds number R_e.

MOORING ANALYSIS

HALCROW, INC.

CONTRACT NO.:	D01080350	Calc.		Sheet	1	Cont'd	
Client:	Hudson River Park Trust	Project	HUDSON RIVER PARK BERTH 40				
Title:	MOORING ANALYSIS FOR HORNBLOWER INFINITY						

PURPOSE

To perform mooring analysis using quasi static method for preliminary design in order to predict maximum mooring load for safe mooring of Hornblower Infinity at Hudson River Park Berth 40. Compare the mooring results with previous mooring study done for LILAC.

DESIGN BASIS AND UNCONFIRMED ASSUMPTIONS

1. As per Reference 1, considered parameters are:
   Maximum wind speed = 110 MPH (~96 knots) and
   Current velocity = 2.0 knots
2. The location of the ship along the pier is assumed as shown through appendix 3.
3. Bollards are assumed to have 100 ton working capacity.
4. The mooring cables are assumed to have infinite strength.
5. Mooring line attachment points on the bollards are taken as effectively 1ft above the pier deck.
6. The pier height is considered 11 feet above low water datum (MLLW).
7. Future dredge depth is assumed as 50 ft from datum.
8. Each timber fender is assumed vertical, cylindrical and has constant c/s of 12" dia. The fenders are made of Southern Pine (Structural no. 2, medium grain).Elastic Modulus = 1400 ksi
9. C/C distance between timber fenders is 8 ft.
10. Fender piles fixity point is calculated 11 ft. below mudline. Mudline is at EL - 15.00'.
11. Type of mooring lines used in the analysis is Steel Wire of 143 kips strength.
12. The Mooring Arrangement Plan is attached with OPTIMOOR Report sheet (Appendix 5).
13. Water level (distance between MLLW and MHHW) = 5.12'
14. Width of estuary is considered as 2640 ft.
15. Distance between ship and fenders is 3'
16. Bollards are assumed to be 4 ft far from the fenders.
17. Fender Performance curve is generated based on calculations shown through appendix 4.
18. Ship impacts the fenders at 5ft above the datum (MLLW).

19. Port side of the vessel is facing the berth.
20. The vessel target is the midship of the vessel. Berth target is the bollard G (see Mooring Arrangement Plan, Appendix 5. The distance between the vessel and ship target is 50'.
21. As per reference 1, Significant wave coming from south : Wave height = 10.00' ; Wave period = 5.4 Secs
22. During regular tide, HWL EL.= 5.12' ; LWL EL.= 0.0' , Time lag at slack = 60 mins (assumed)
23. Flat side points of the vessels are assumed same as LBP points on aft and forward sides.
24. Tidal velocity = 0.2 Knots/ft tide for EBB and 0.6 Knots/ft tide for flood condition.
25. Ship windage area is based on calculations by OPTIMOOR.
26. The soil type under mud line is soft clay.

DESIGN PROCEDURES

Mooring analysis is performed using OPTIMOOR. Following case is studied:

CASE I: Analysis for USCGC LILAC (WAGL – 227)

<u>SHIP DATA:</u>

OVERALL LENGTH = 205.3'

LBP = 190' (assumed)

DEPTH = 22.8' (Draft + Free board (scaled from Fig in appendix 1)

BEAM = 46.4'

DRAFT = 7.9' (Light draft)

Trim (Draft aft minus draft forward) = 0.0' (assumed)

BODY OF CALCULATION

The analysis was performed for:

- Wind speed = 96 knots; Wind direction = 90^0 from North.
- Current velocity = 2.0 knots; Current direction = 90^0 from North
- Wave height = 10.00' ; Wave direction = 90^0 from North; Wave period = 5.4 Secs

CONCLUSIONS

The maximum lateral force (thrust) under wind, wave and current (including tidal current) actions is observed on fender gg (See Arrangement plan, appendix 2).

Maximum lateral load noticed on fender gg = 19 kips

Total lateral load on the deck = 253 kips

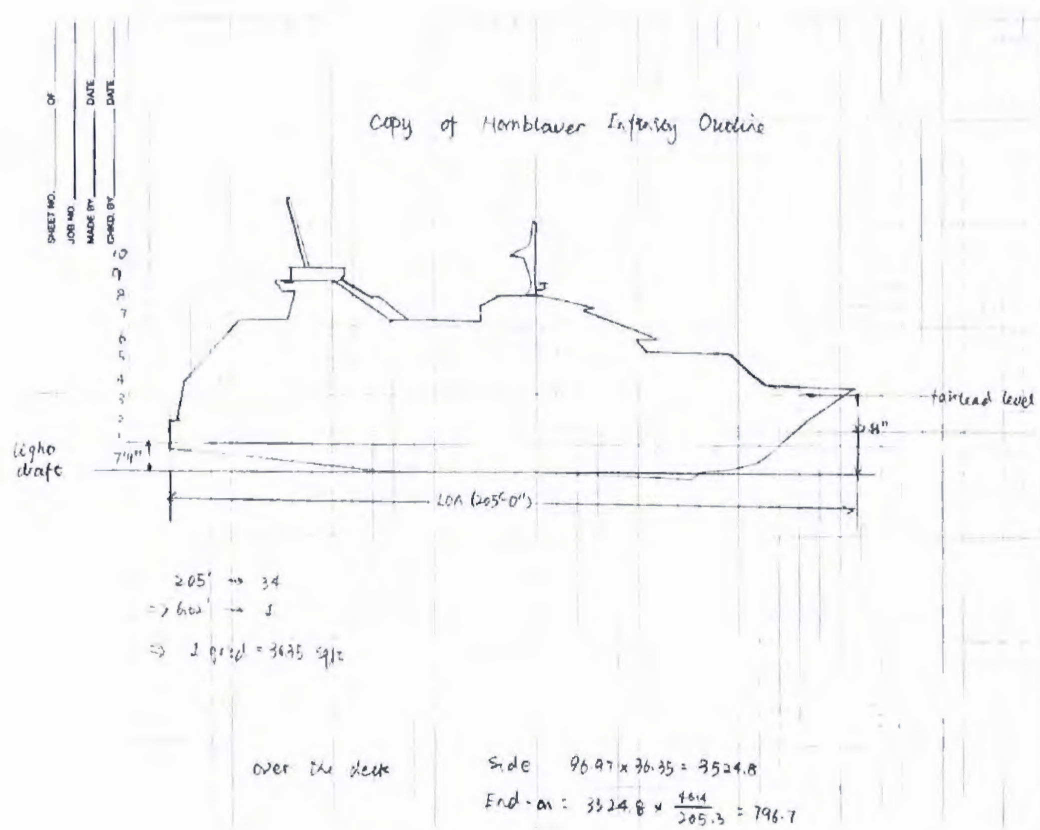
As the environmental loads push the vessel towards the vessel, two of the mooring lines are in slack and rest two don't experience high tensile forces.

Based on the results of the mooring analysis, the total lateral load imposed on the fender system and pier structure over the 190 ft length (LBP) of the vessel is 253 kips, or 1.2 kips per ft along the length of the concrete edge beam. Below table shows the comparison with the mooring loads generated by LILAC.

	LILAC	Hornblower Infinity
Vessel parameters		
LOA (ft)	173.3	205.3
Beam (ft)	32	46.4
Draft (ft)	11.25	7.9
Side windage area (ft^2) above deck	2702	3524
Mooring results		
Maximum fender load (kips)	19	19
Total lateral load on the deck (kips)	192	253
LPB (ft)	160	190
Pressure the concrete edge beam (kips/ft)	1.2	1.33
Fender number within parallel body	15	18

APPENDIX 1:

Geometry and mooring points location of Hornblower Infinity



APPENDIX 2:
OPTIMOOR INPUT AND OUTPUT FILES

Berth Data for BERTH 40: HUDSON PAR

(file C:\OPTIMOOR\pier 40 rerun\Berth40_Hudson_River_Park.bth)
Units in ft & kips

Left to Right of Screen Site Plan Points:	0°
Width of Estuary (for Current):	2640
Pier Height (Fixed) above Datum:	11.0
Dredged Depth below Datum:	50.0
Dist of Berth Target to Right of Origin:	520.0
Wind Speed Specified at Height:	33.0
Current Specified at Depth:	mean

Hook/ Bollard	X-Dist to Origin	Dist to Fender Line	Ht above Berth	Allowable Load
A	20.0	4.0	1.0	220
B	90.0	4.0	1.0	220
C	180.0	4.0	1.0	220
D	270.0	4.0	1.0	220
E	350.0	4.0	1.0	220
F	430.0	4.0	1.0	220
G	520.0	4.0	1.0	220
H	600.0	4.0	1.0	220
I	700.0	4.0	1.0	220
J	800.0	4.0	1.0	220

Fender	X-Dist to Origin	Ht above Datum	Width Along Side	Face Contact Area (ft²)
aa	664.0	11.0	1.0	11.0
bb	672.0	11.0	1.0	11.0
cc	680.0	11.0	1.0	11.0
dd	688.3	11.0	1.0	11.0
ee	488.0	11.0	1.0	11.0
ff	496.0	11.0	1.0	11.0
gg	504.0	11.0	1.0	11.0
hh	512.0	11.0	1.0	11.0
ii	520.0	11.0	1.0	11.0
jj	528.0	11.0	1.0	11.0
kk	536.9	11.0	1.0	11.0
ll	544.0	11.0	1.0	11.0
mm	552.0	11.0	1.0	11.0
nn	560.0	11.0	1.0	11.0
oo	568.0	11.0	1.0	11.0
pp	576.0	11.0	1.0	11.0
qq	584.0	11.0	1.0	11.0
rr	592.0	11.0	1.0	11.0
ss	600.0	11.0	1.0	11.0
tt	608.0	11.0	1.0	11.0
uu	616.0	11.0	1.0	11.0
vv	623.9	11.0	1.0	11.0
ww	632.0	11.0	1.0	11.0
xx	640.0	11.0	1.0	11.0
yy	648.0	11.0	1.0	11.0
zz	656.0	11.0	1.0	11.0

Fender Load-Compression Data

Fender								
aa	0	100	200	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
bb	0	100	200	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft

cc	0	100	200	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
dd	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
ee	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
ff	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
gg	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
hh	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
ii	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
jj	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
kk	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
ll	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
mm	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
nn	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
oo	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
pp	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
qq	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
rr	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
ss	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
tt	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
uu	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
vv	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
ww	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
xx	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
yy	0	100	300	300	400	500	600	kips
	0.03	2.08	4.17	6.25	8.34	10.43	12.50	ft
zz	0	100	300	300	400	500	600	kips

HALCROW, INC.

CONTRACT NO.: D01080350 Calc. Sheet 7 Cont'd
Client: Hudson River Park Trust Project HUDSON RIVER PARK BERTH 40
Title: MOORING ANALYSIS

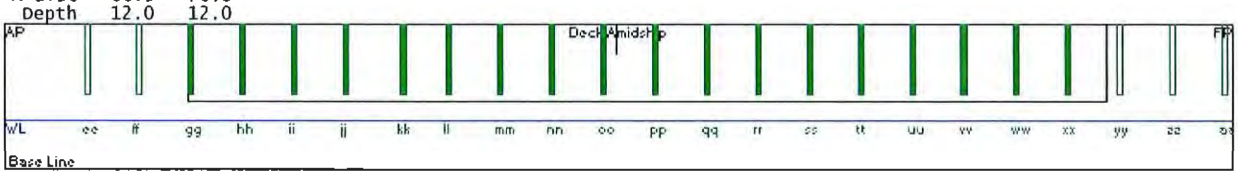
0.03 2.08 4.17 6.25 8.34 10.43 12.50 ft

Vessel Data for Hornblower infinity

(file C:\OPTIMOOR\pier 40 rerun\Berth40_Hornblowerinfinity.vsl)
Units in ft, inches, & kips
Longitudinal datum at Midship

LBP: 190.0
Breadth: 46.4
Depth: 22.8
Target: 0.0 fwd from midship and 0.0 above deck at side
End-on projected windage area: 796 above deck level
Side projected windage area: 3525 above deck level
Fendering possible from: 0.350 LBP aft of midship
to: 0.400 LBP fwd of midship
Current drag data based on: OPTIMOOR (Generic Data)
Wind drag data based on: OCIMF Tanker (U-shaped Bow)

Flatside Contour		
X-dist	-66.5	76.0
Depth	12.0	12.0



Line No.	Fair-Lead X	Fair-Lead Y	Ht on Deck	Dist to Winch	Brake Limit	Pre-Tension	Line Size-Type-BL	Tail Segment-1 Lgth-Size-Type-BL
1	92.6	23.2	0.0	0.0		0.0	3.7 SW 143	
2	77.2	23.2	0.0	0.0		0.0	3.7 SW 143	
3	-49.9	23.2	0.0	0.0		0.0	3.7 SW 143	
4	-88.2	23.2	0.0	0.0		0.0	3.7 SW 143	

Codes for Types of Line:
SW: Steel Wire (steel core)

Static Mooring Response for Hornblower infinity at BERTH 40: HUDSON PAR

Units in ft & kips (file C:\OPTIMOOR\pier 40 rerun\Berth40_Hudson_River_Park.OPT)
Remarks:
Static Time sweep up to: 1141 Apr 24 2009
Water Level: 1.32 above Datum
Draft: 7.9
Trim: 0.0
Bottom Clearance: 43.4

Deck Level at Target: 5.2 above pier
Significant Wave Ht: 10.01
Wave Mean Period: 5.4 sec
Wave Direction True: 90°
Wave Direction to Berth X-axis: 90°
Current: 2.82 knots
Current Direction True: 90°
Current Direction to Berth X-axis: 90°
Wind Speed: 96 knots
Wind Direction True: 90°
Wind Direction to Berth X-axis: 90°

Fwd Offset of Vessel Target: 50.0 from Berth Target
Total End-On Windage Area: 1487
Total Side Windage Area: 6356

HALCROW, INC.

CONTRACT NO.: D01080350 Calc. Sheet 8 Cont'd

Client: Hudson River Park Trust Project HUDSON RIVER PARK BERTH 40

Title: MOORING ANALYSIS

	Longitudinal	Transverse	Yaw Moment/LBP
Wave Drift Force:	0.0	26.4	0.5
Current Drag Force:	0.0	21.1	0.0
Wind Drag Force:	-14.1	204.8	-11.2
Total Force:	-14.1	252.3	-10.7

Vessel Moves(at Target):	0.1 fwd	0.3 inw	-0.1° stbd	0.0 up
	0.0 fwd	0.3 inw	-0.1° stbd	0.0 up

Line to Bollard	Pull -in	Tot.Line Length	In-Line ±Motion	Winch Slippage	Worst Time	Line Tension	Percent Strength
1-I	0.00	37.8			1141	0.0	0%
2-G	0.00	127.3			1141	5.4	4%
3-H	0.00	80.1			1141	0.0	0%
4-F	0.00	52.1			1141	8.8	6%

Fender	Thrust	Compression	Pressure	Contact Area
gg	19	0.42	1.7	100%
hh	18	0.41	1.7	100%
ii	18	0.40	1.6	100%
jj	17	0.39	1.6	100%
kk	17	0.37	1.5	100%
ll	16	0.36	1.5	100%
mm	16	0.35	1.4	100%
nn	15	0.34	1.4	100%
oo	14	0.33	1.3	100%
pp	14	0.31	1.3	100%
qq	13	0.30	1.2	100%
rr	13	0.29	1.1	100%
ss	12	0.28	1.1	100%
tt	11	0.27	1.0	100%
uu	11	0.26	1.0	100%
vv	10	0.24	0.9	100%
ww	10	0.23	0.9	100%
xx	9	0.22	0.8	100%

Hook/ Bollard	X- Force	Y- Force	Other X-Load	Other Y-Load	Total Horiz Force	Direction in Plan	Uplift
F	8.8	0.6			8.8	86°	0.7
G	5.4	0.1			5.4	88°	0.2

Approximate natural periods
Surge: 4.0 Sway: 7.3 secs

PIER SHED STRUCTURAL MODEL

Halcrow

PIER 40 ANALYSIS SUMMARY

TYPE OF CONSTRUCTION

Steel H piles (14BP89) were driven to the hard rock below the mud and silt soil. The mud elevation varies between 10 to 30 feet below Mean Sea Level (MSL). The concrete decks were built on the top of steel piles. The top elevation of decks is at 11' above MSL. The concrete decks consist of precast 12" solid concrete slabs and cast-in-place concrete girders. There is a 2" asphaltic concrete wearing surface on the top of slab. The referenced structural drawings are available by Roberts and Schaefer Co. dated April 1957.

A two-story building was built on the perimeter of the pier, creating an "O" shaped structure. The building serves as parking spacing in majority of the area, and an office space on the east end. The building is composed of 6" deep precast concrete slabs, "I" beams, reversed "T" girders and cast-in-place concrete columns. The referenced structural drawings are available by Roberts and Schaefer Co. dated February 1960.

The lateral system of building to resist the wind and earthquake is the concrete moment connection system. The first floor is about 20 feet in height, and the second floor is about 18 feet in height. There is a 3 foot high parapet at the top of the building perimeter.

LATERAL ANALYSIS ASSUMPTION

The following approaches and assumptions are taken in the modelling:

1) The fixed point of "H" pile at base is at the 12'-0" below the mud line. It was verified by the "LPILE" analysis based on soil report by Mueser Rutledge Consulting Engineers dated April 1979 with boring holes at the west side of the pier.
2) Top of "H" pile is treated as fixed point within the concrete deck systems (girders or slabs).
3) The portions of the pier divided by expansion joints act independently to the lateral loads.
4) Steel piles are of the yielding strength F_y = 36 ksi, based on bearing pile properties in "Steel Construction" AISC Fifth Edition 1958.
5) Average concrete strength is 4.375 ksi. Concrete is cracked. The properties for the concrete members of structure with cracked sections, base on ACI 318 - 05:

   Beams.................................0.35 I_g
   Columns..............................0.70 I_g
   Slabs...................................0.25 I_g

DESIGN LOADS

1) Self – weight of structure: to be calculated by ETABS and SAP automatically.

2) Superimposed dead load, including topping: on building slab 20 psf and on pier slab 30 psf.

3) Wind: ASCE 7-98, 110 MPH, Exposure C and I_w = 1.0.

4) Wave: 223 PSF on edge beam (north-south direction only)

5) Seismic: NYC Building Code 2004, A = 0.15, site coefficient = 1.2 and I_e = 1.0.
   R_w = 5 for main pier, R_w = 3 for finger pier

6) Ice: 8" thick ice, and 14 Kips acting on piles and 1.54 Kips on side of piles. (north-south direction only)

7) Current: current velocity to be 1.5 knots and acting on piles with 10.2 plf.

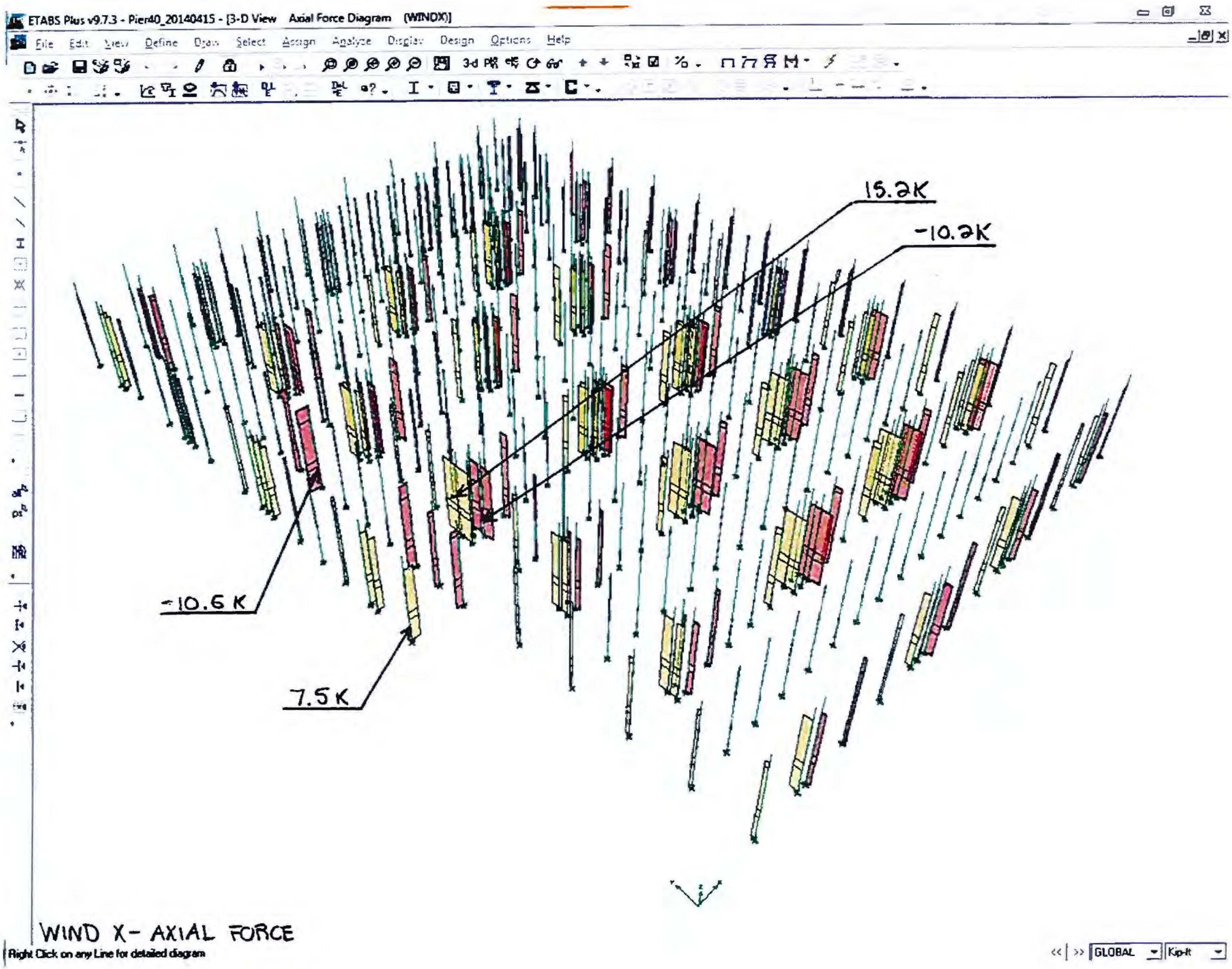
ANALYSIS PROCEDURE

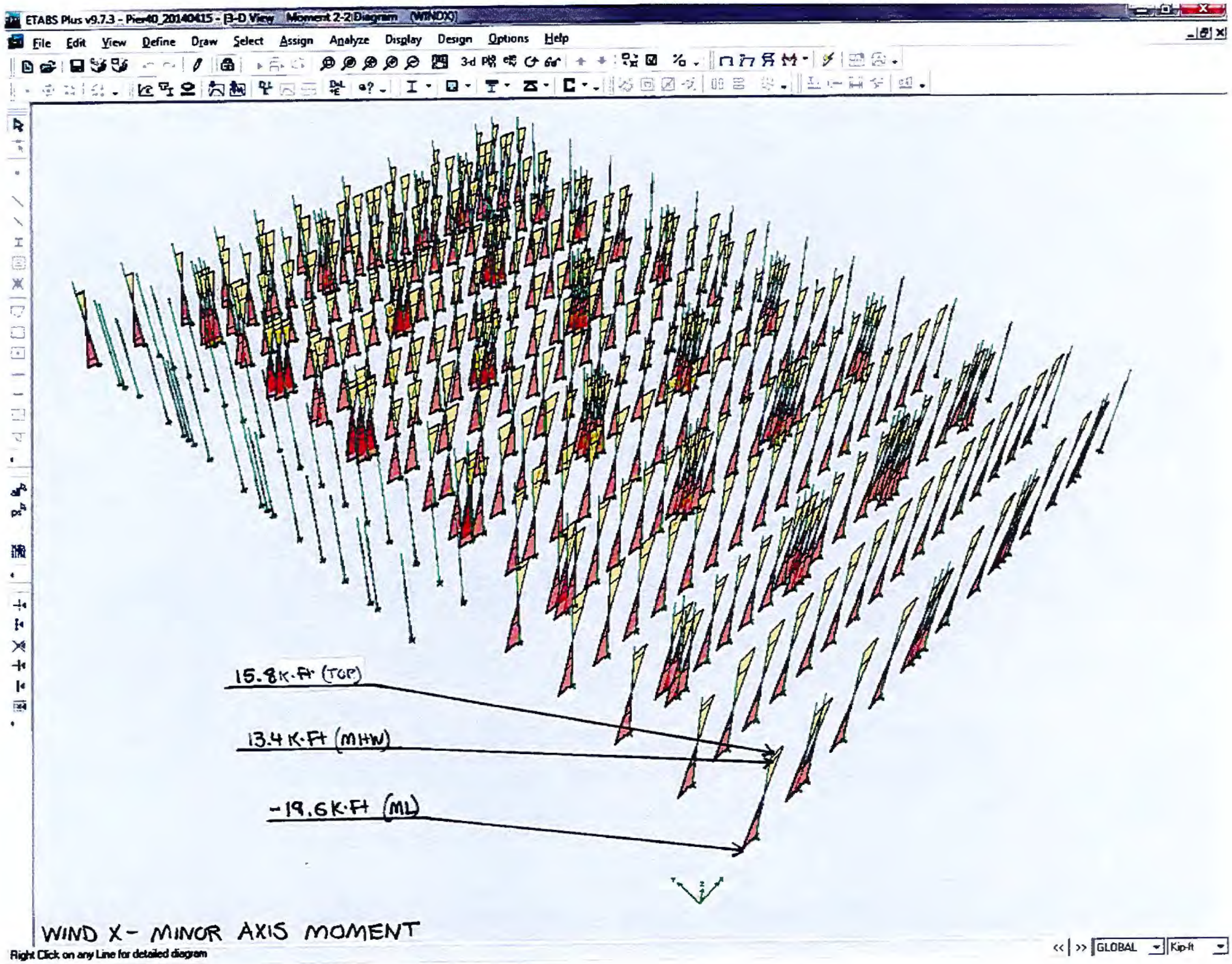
Given the complexity of the structures, a series of three-dimensional computer analyses was conducted using the ETABS and SAP computer programs, both developed by Computers and Structures Inc., of Berkeley, California.

Previous experience with other structures had established the importance of incorporating gravity loads directly into the lateral analysis. Accordingly, ETABS and SAP were used to evaluate building and pier movements and the distribution of forces within the columns due to the gravity loads. P-Delta effects are automatically included in the ETABS and SAP analyses.

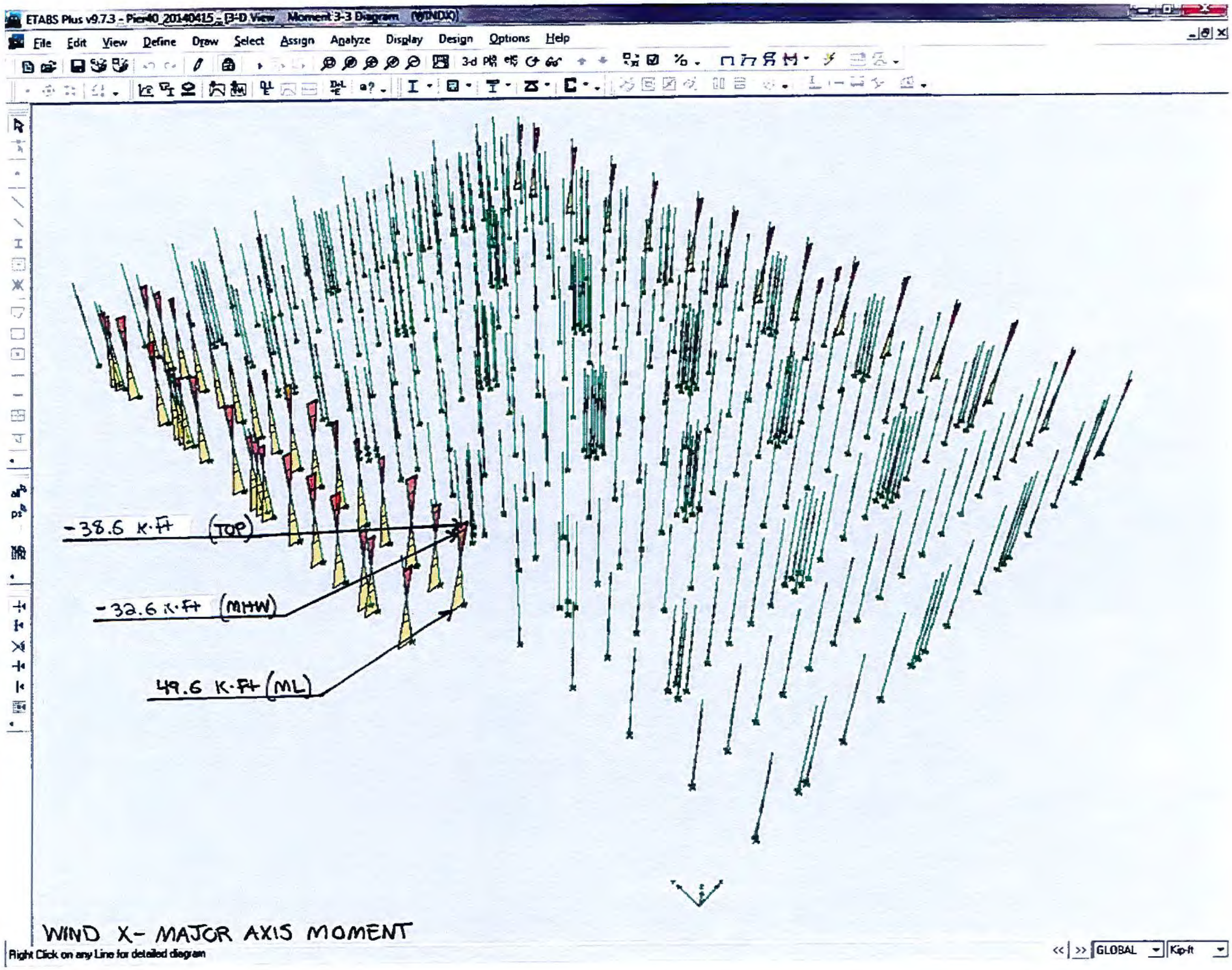
Two portions of the pier are taken to represent the actual building and pier situation. One is taken from the North – West corner of the pier with a 300x220 foot portion; and the other one is from the "finger pier," a narrow portion of pier at South – West corner jutting into deeper water. The finger pier has been modelled in SAP due to the geometry of the structure's battered piles.

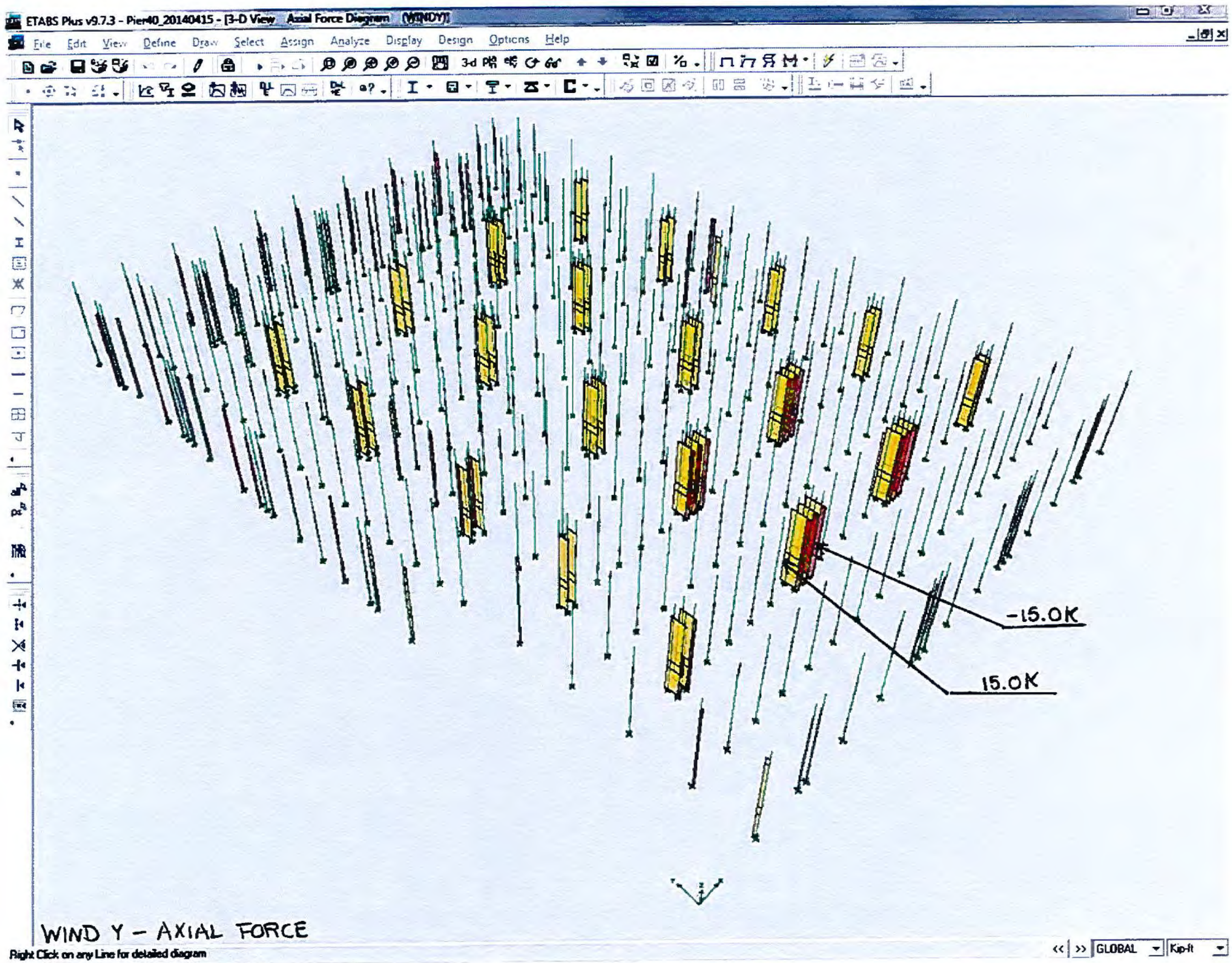
The models are dependent on the average mud line elevation. The outer piles in the N-W are assumed to 15'-0" below MSL (Mean See Level) and interior ones are 12'-0" below MSL. The mud line under the finger pier is taken as 30'-0" below MSL.

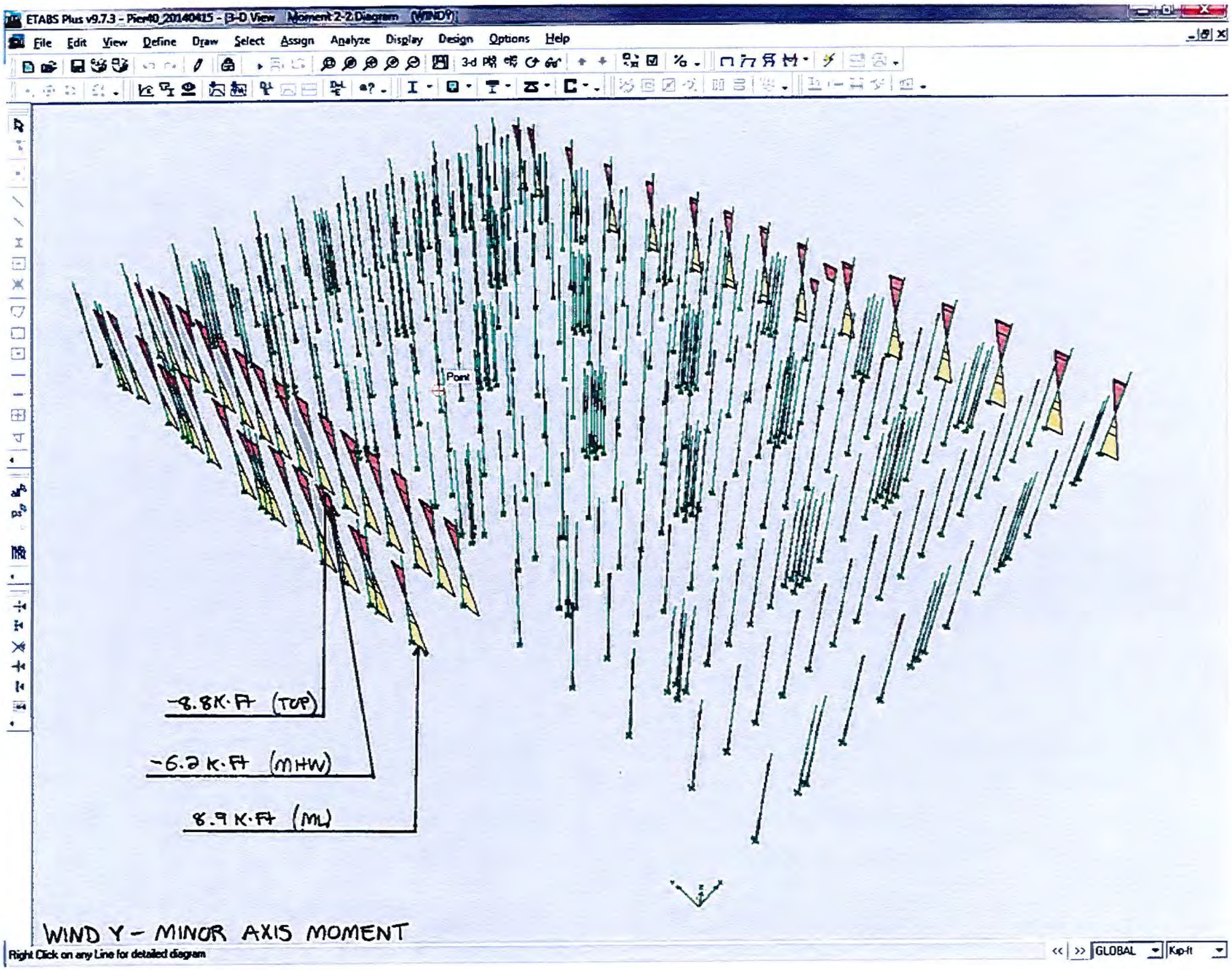

ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Axial Force Diagram (WINDX)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
15.2K
-10.2K
-10.6 K
7.5 K
WIND X- AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

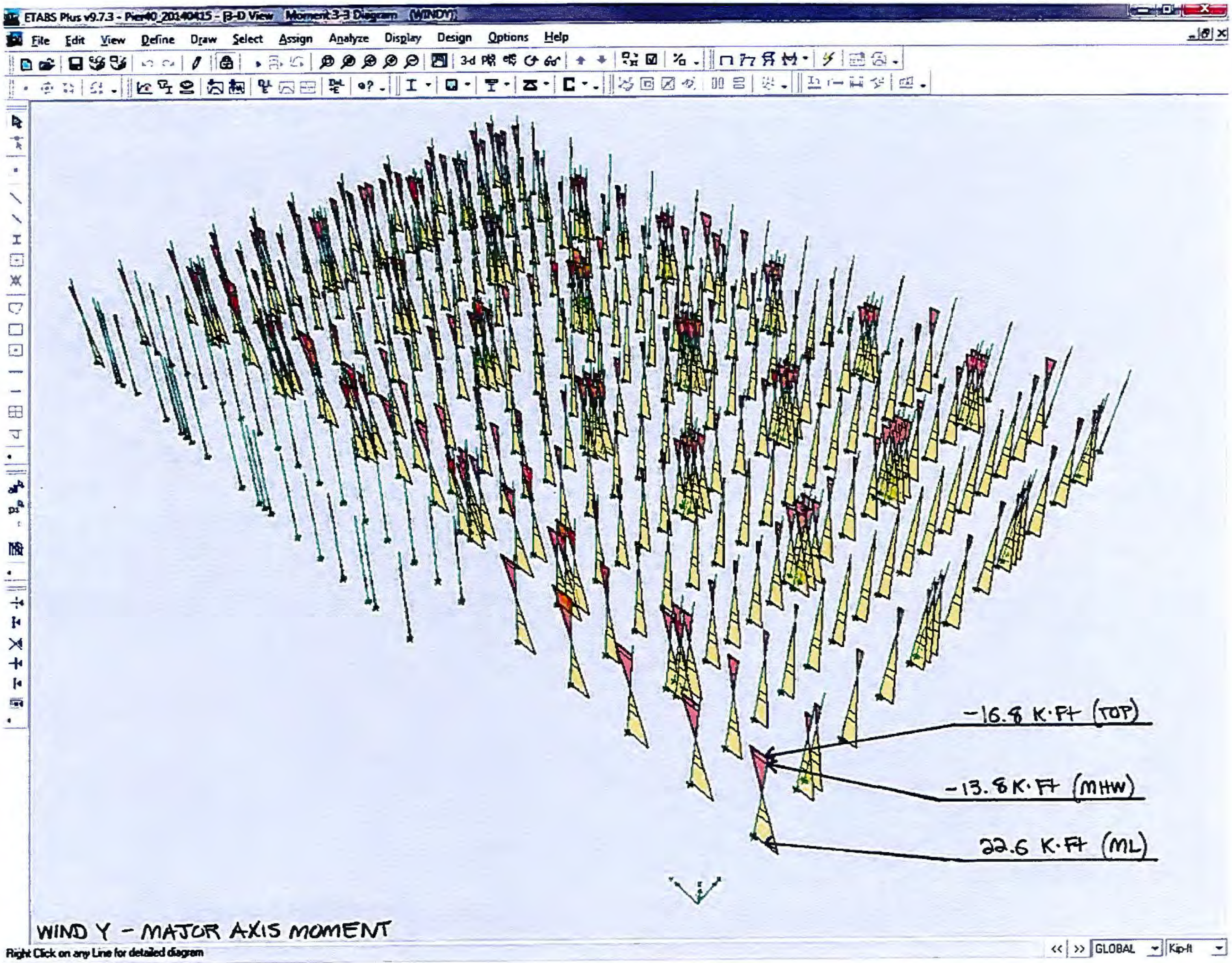


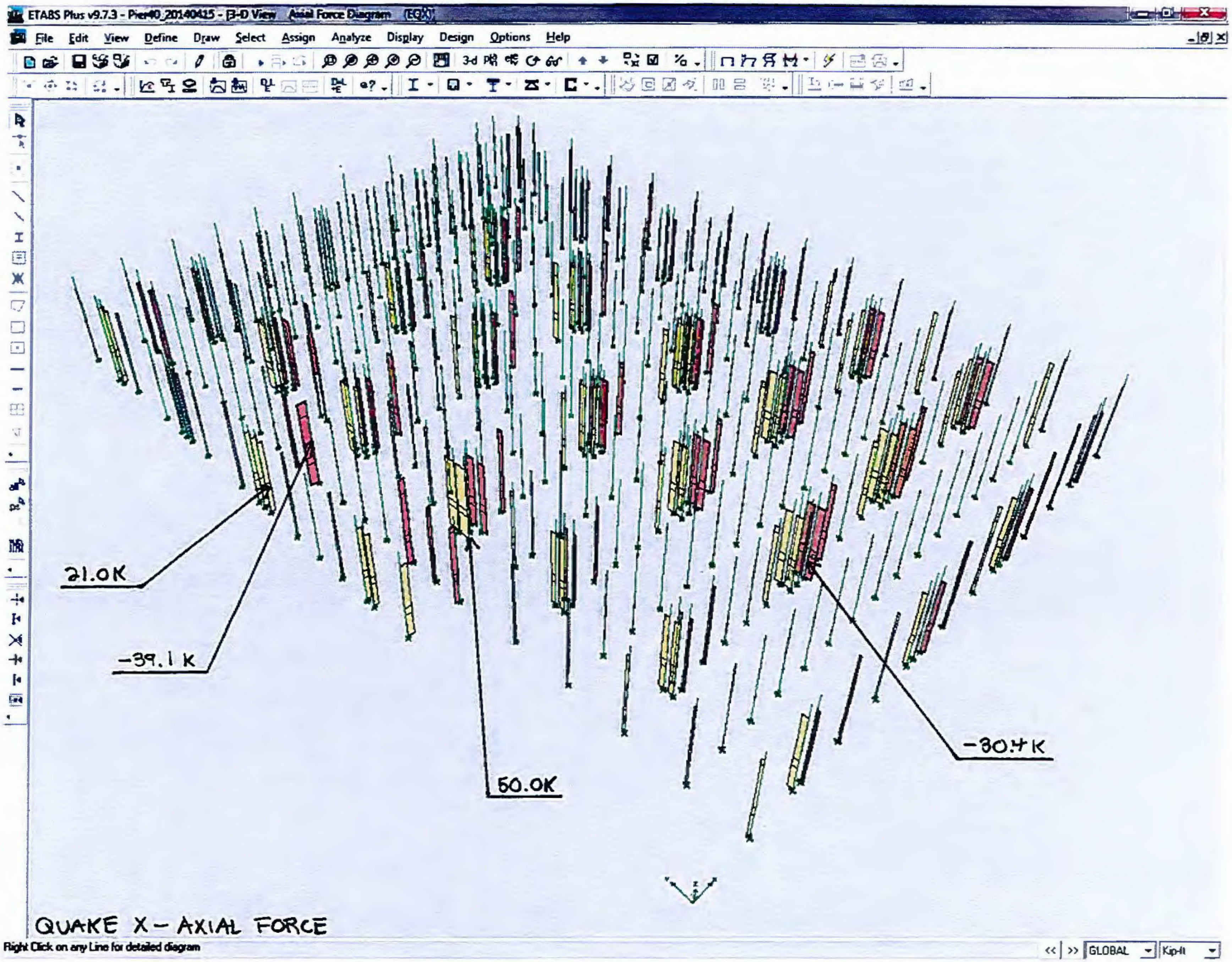
ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Moment 2-2 Diagram (WINDX)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
15.8K·Ft (TOP)
13.4 K·Ft (MHW)
-19.6K·Ft (ML)
WIND X - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

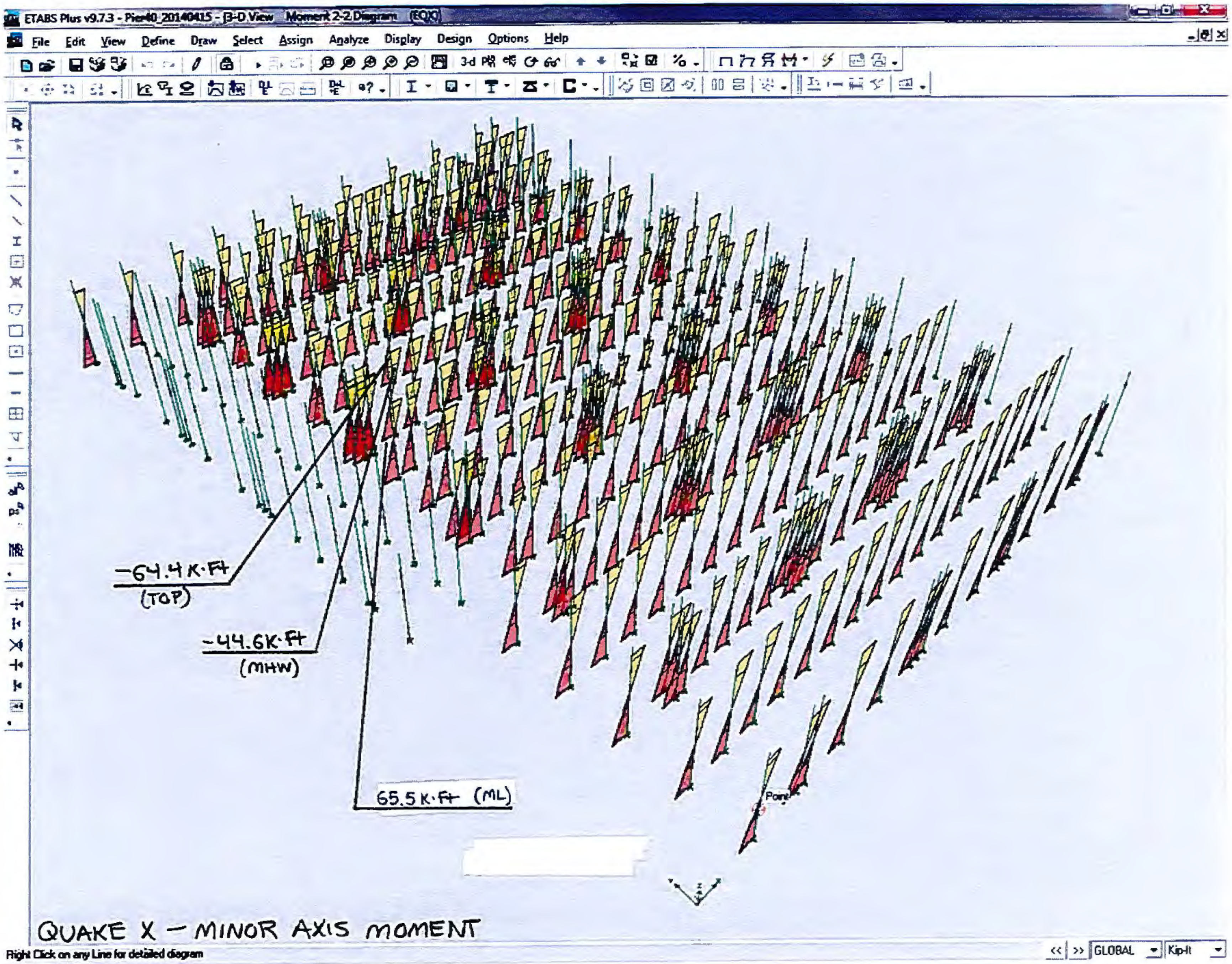

ETABS Plus v9.7.3 - Pier40_20140415 - (3-D View Moment 3-3 Diagram (WINDX))
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-38.6 K·Ft (TOP)
-32.6 K·Ft (MHW)
49.6 K·Ft (ML)
WIND X- MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

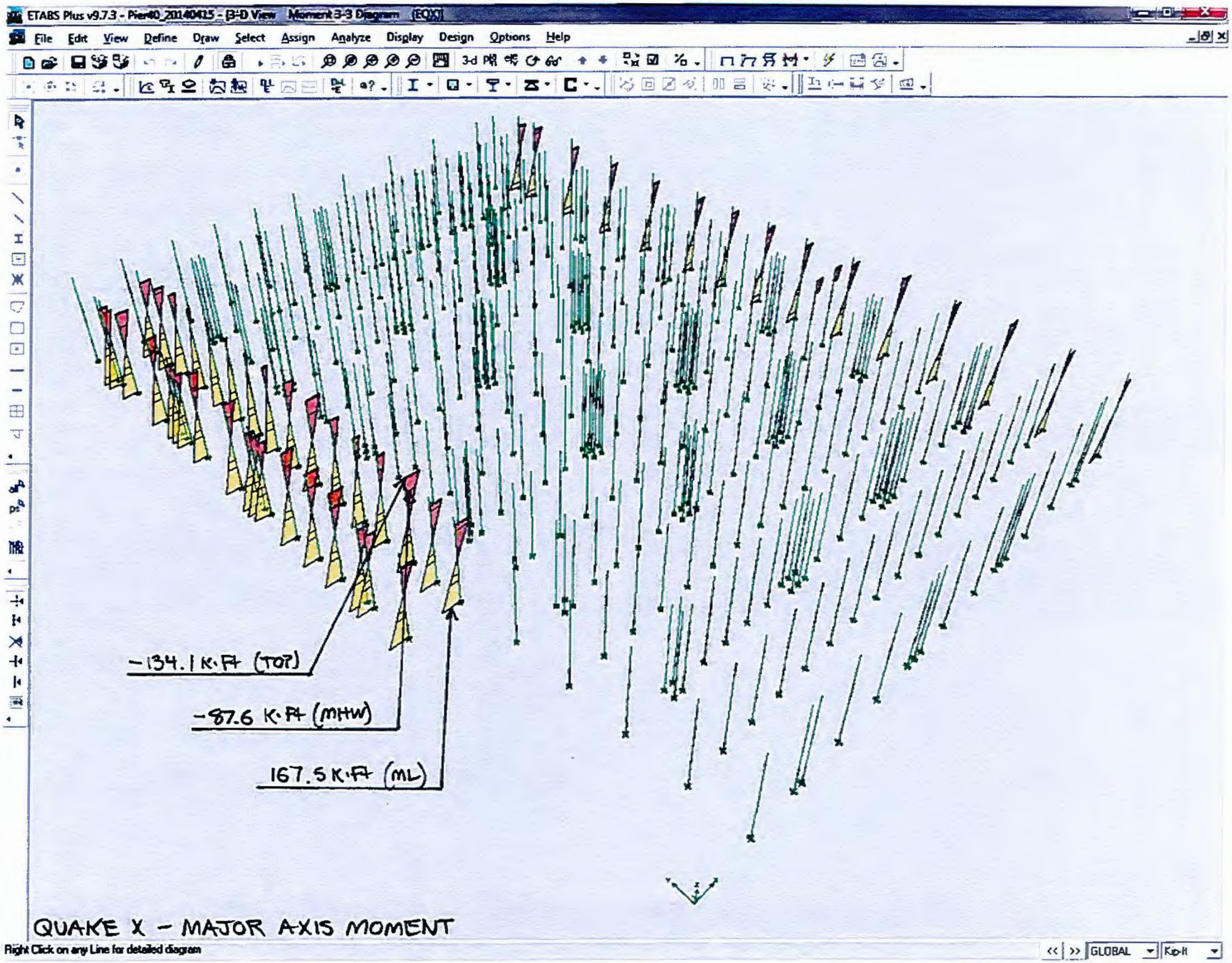

ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Axial Force Diagram (WINDY)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-15.0K
15.0K
WIND Y - AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

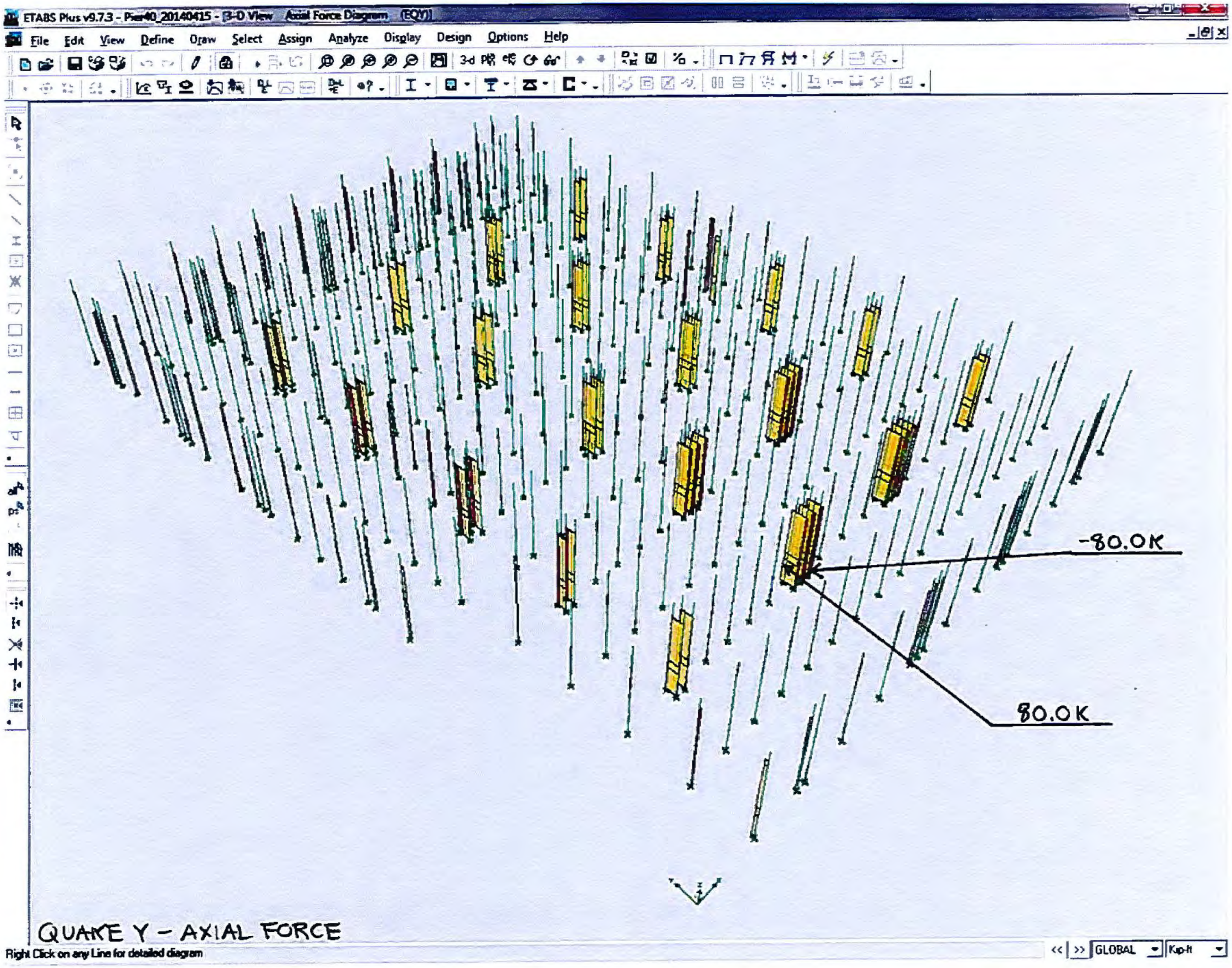

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Moment 2-2 Diagram (WINDY)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
Point
-8.8K·FT (TOP)
-6.2 K·FT (MHW)
8.9 K·FT (ML)
WIND Y - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

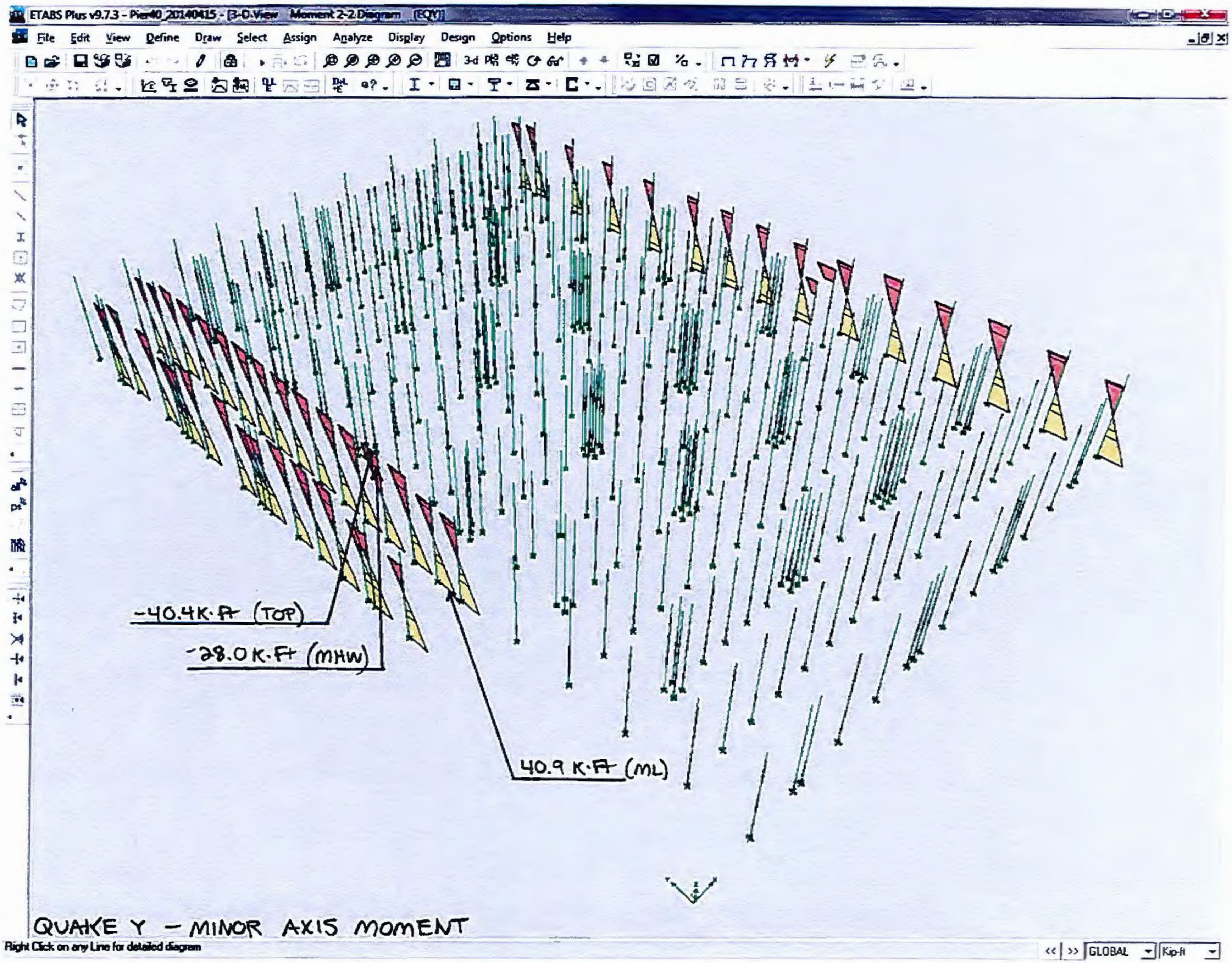

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Moment 3-3 Diagram (WINDY)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-16.8 K·Ft (TOP)
-13.8 K·Ft (MHW)
22.6 K·Ft (ML)
WIND Y - MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

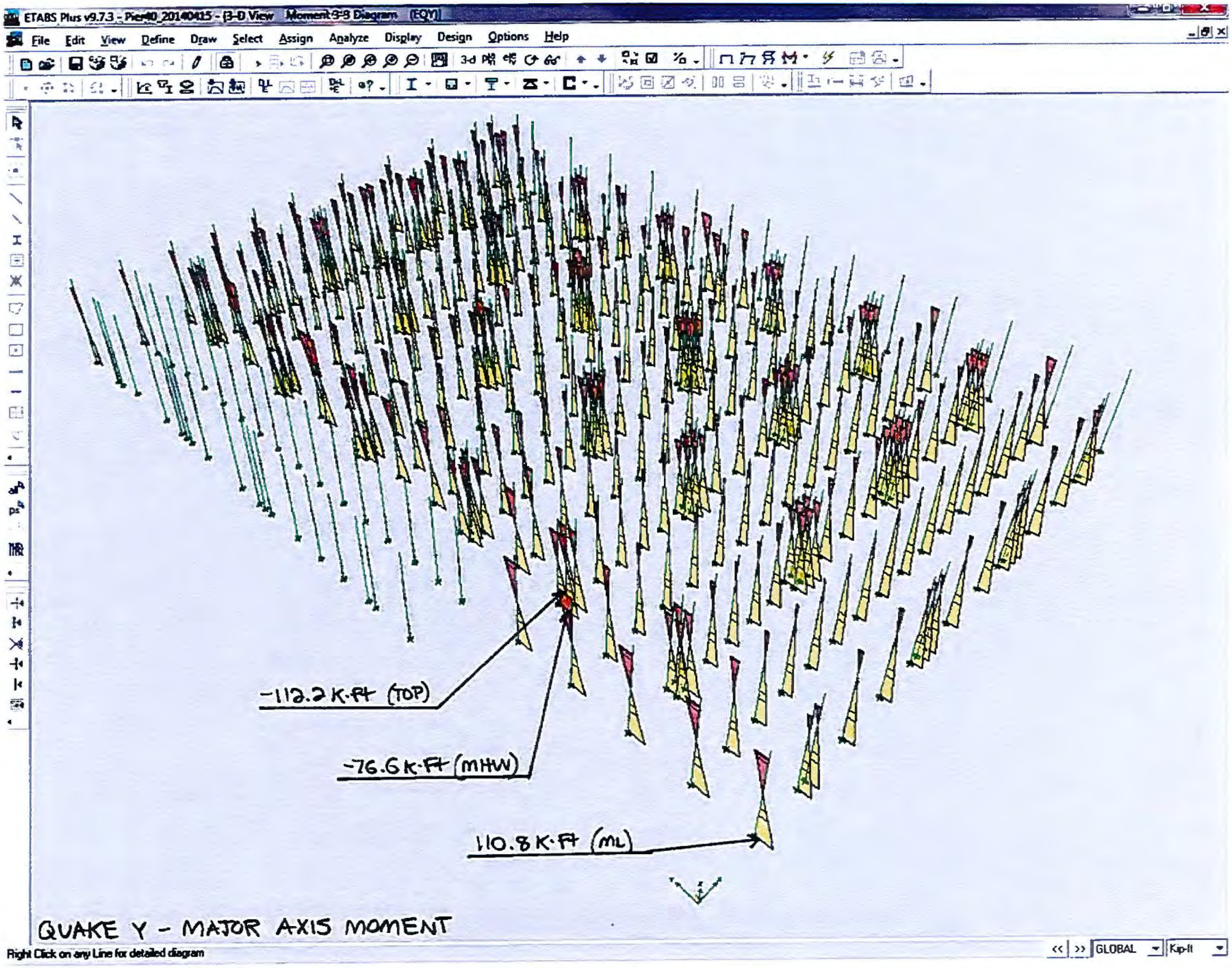

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Axial Force Diagram (EQX)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
21.0K
-39.1 K
50.0K
-30.4 K
QUAKE X – AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

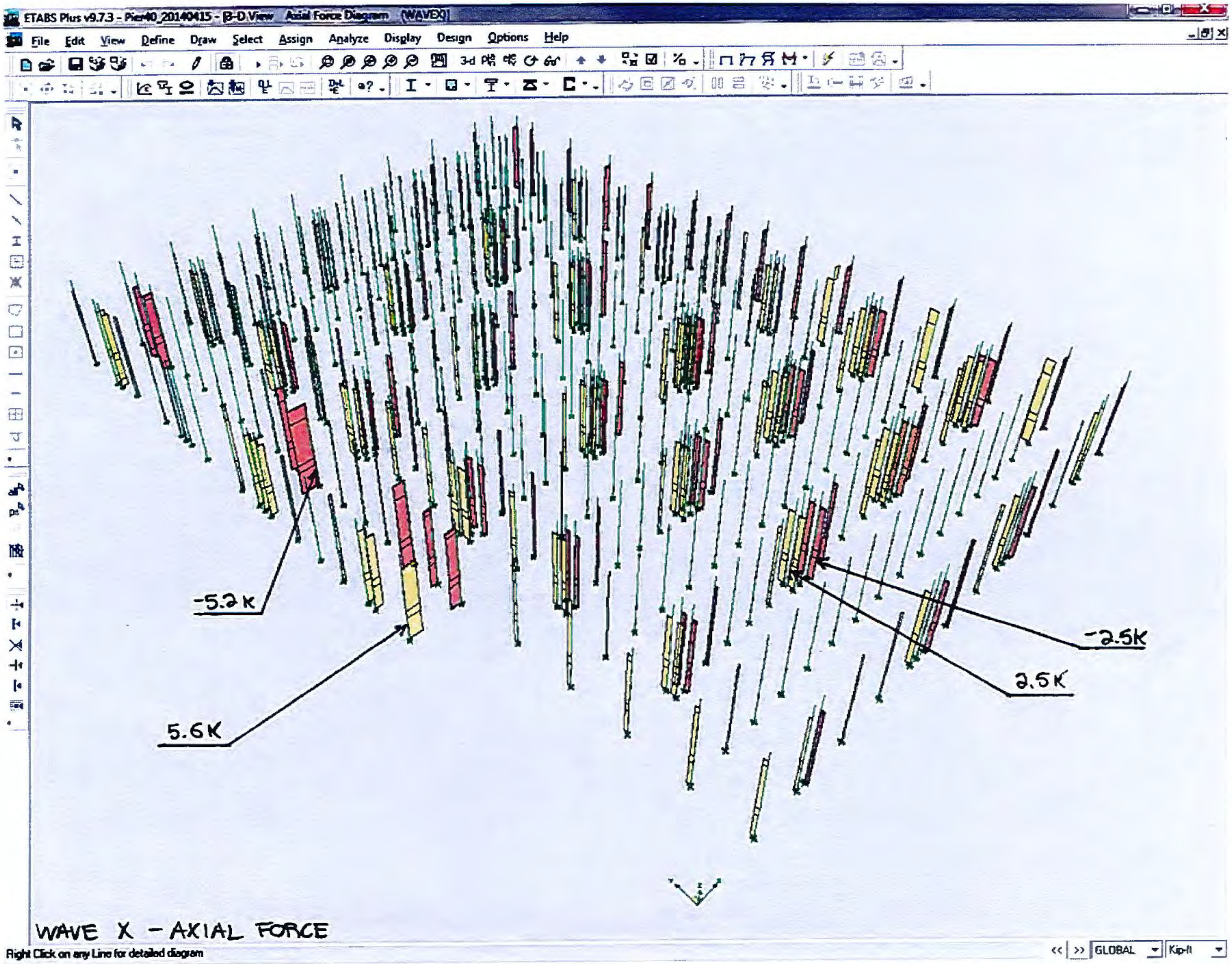

ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Moment 2-2 Diagram (EQX)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-64.4 K·Ft
(TOP)
-44.6K·Ft
(MHW)
65.5 K·Ft (ML)
Point
QUAKE X - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

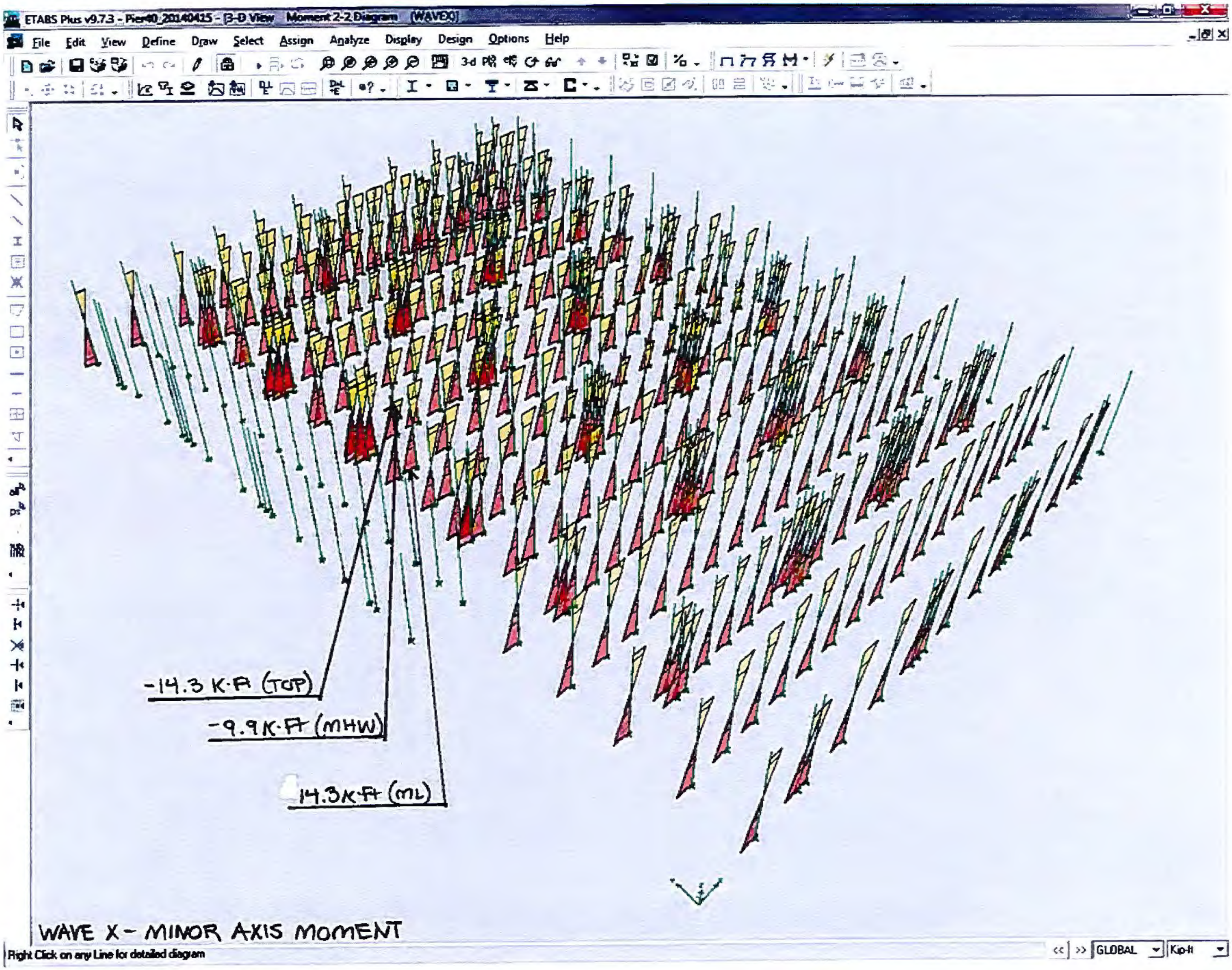

ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Moment 3-3 Diagram (EQX)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-134.1 K·Ft (TOP)
-87.6 K·Ft (MHW)
167.5 K·Ft (ML)
QUAKE X - MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

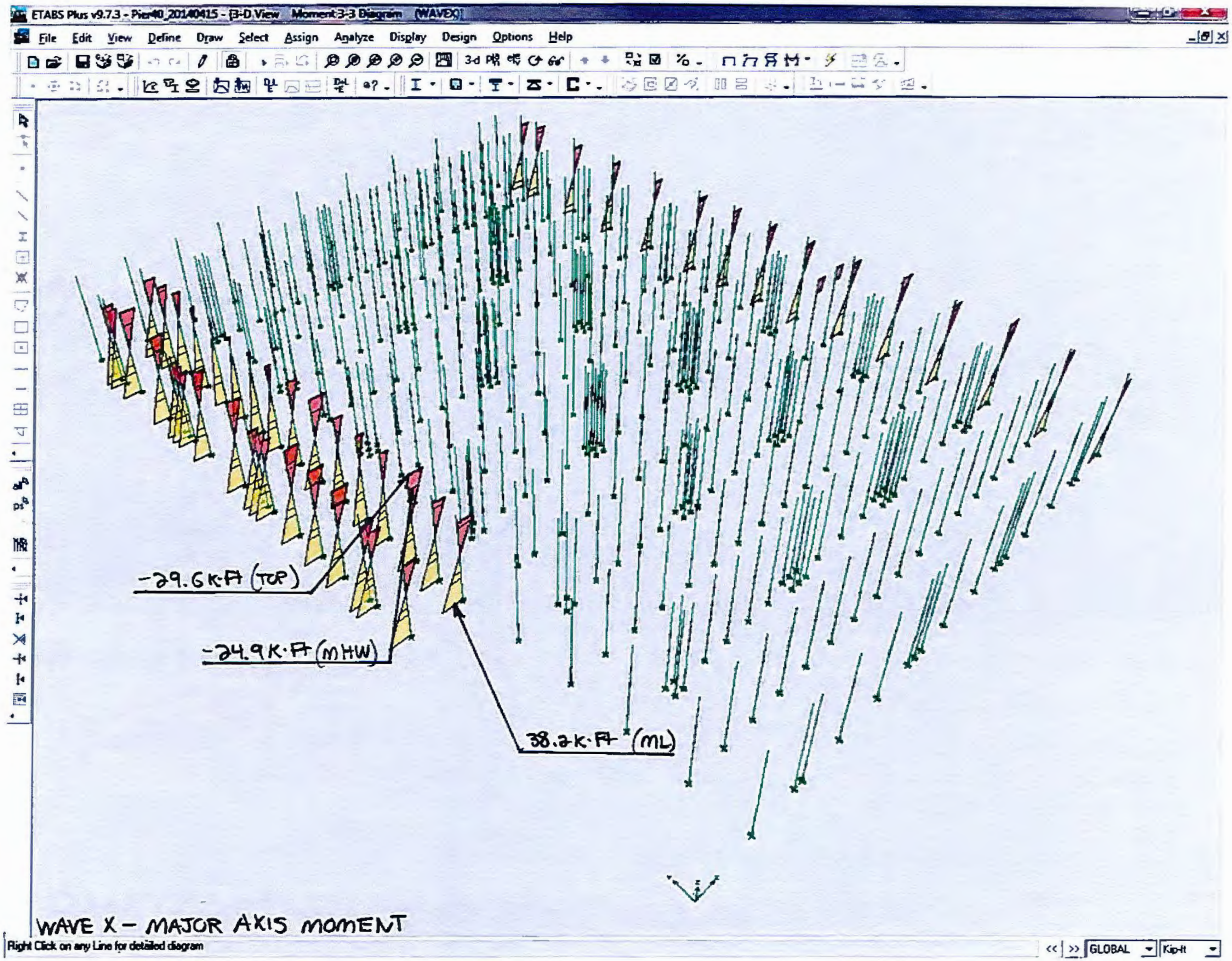

ETABS Plus v9.7.3 - Pier40_20140415 - (3-D View Axial Force Diagram (EQY))
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-80.0K
80.0K
QUAKE Y - AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft


ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Moment 2-2 Diagram (EQY)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-40.4K·Ft (TOP)
-28.0K·Ft (MHW)
40.9 K·Ft (ML)
QUAKE Y - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

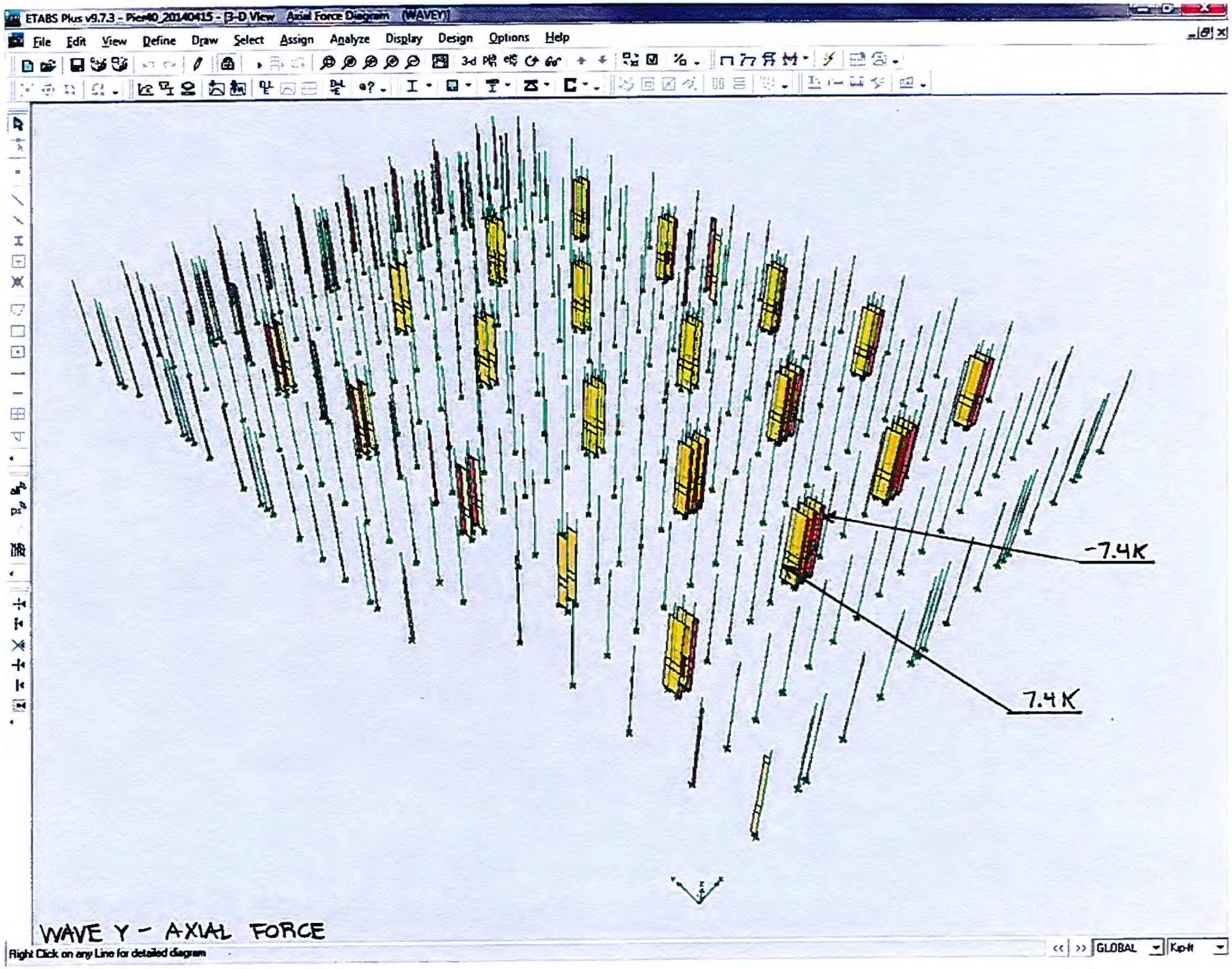

ETABS Plus v9.7.3 - Pier40_20140415 - (3-D View Moment 3-3 Diagram (EQY))
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-112.2 K·Ft (TOP)
-76.6 K·Ft (MHW)
110.8 K·Ft (ML)
QUAKE Y - MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

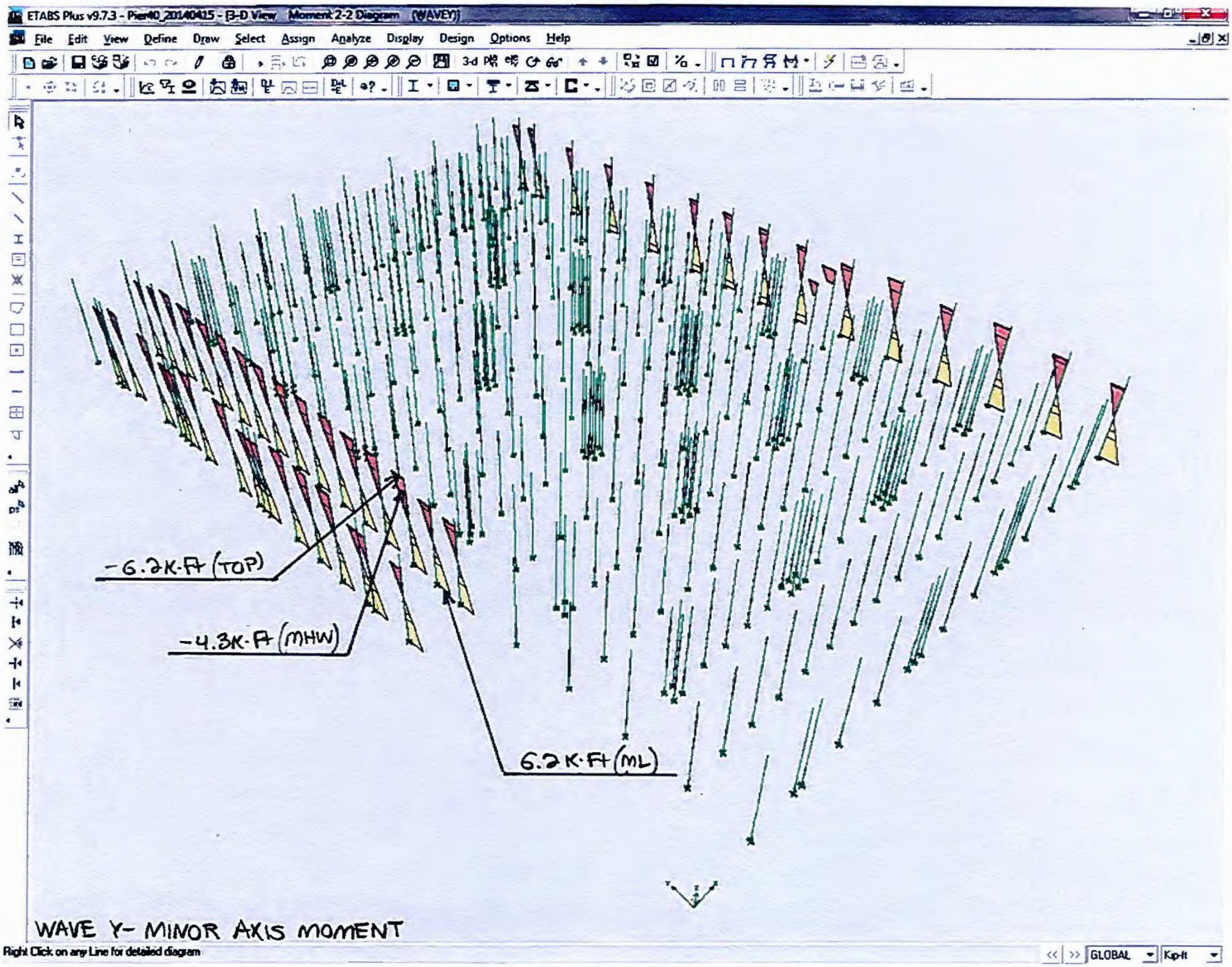

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Axial Force Diagram (WAVEX)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-5.2K
5.6K
-2.5K
2.5K
WAVE X - AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft


ETABS Plus v9.7.3 - Pier40_20140415 - (3-D View) Moment 2-2 Diagram (WAVEX)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-14.3 K·Ft (TOP)
-9.9 K·Ft (MHW)
14.3 K·Ft (ML)
WAVE X - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

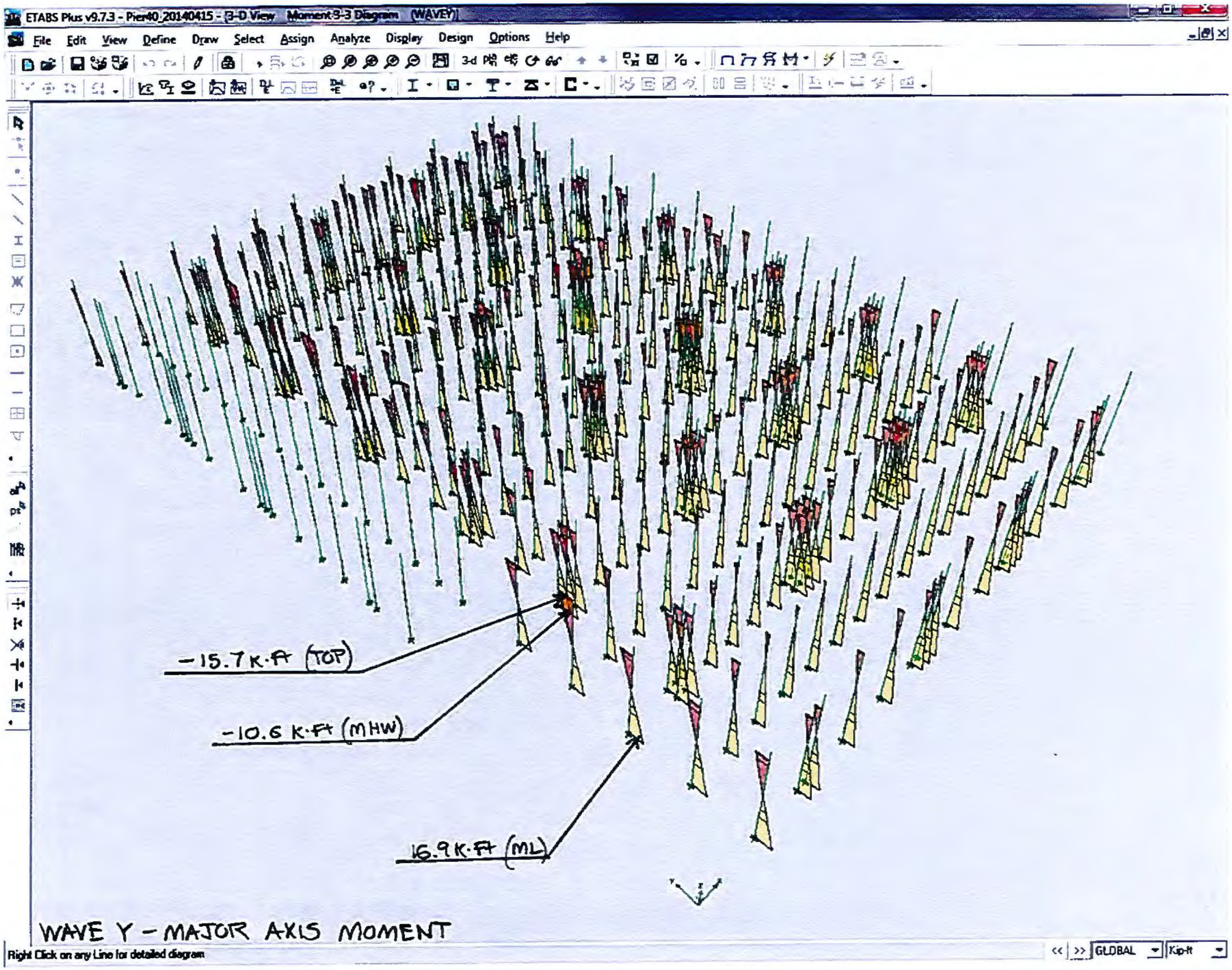


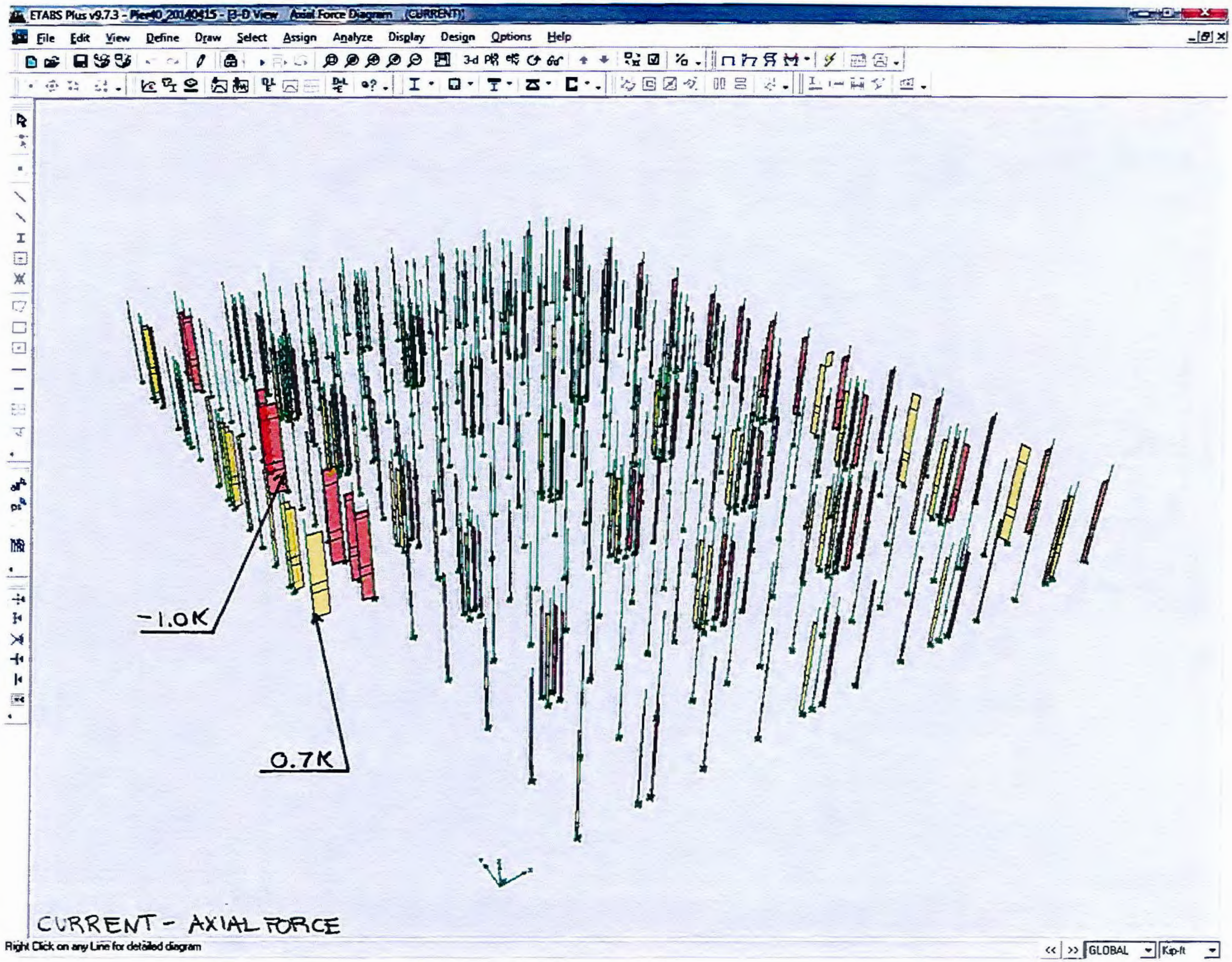
ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Moment 3-3 Diagram (WAVEX)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-29.6K·Ft (TOP)
-24.9K·Ft (MHW)
38.2K·Ft (ML)
WAVE X – MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

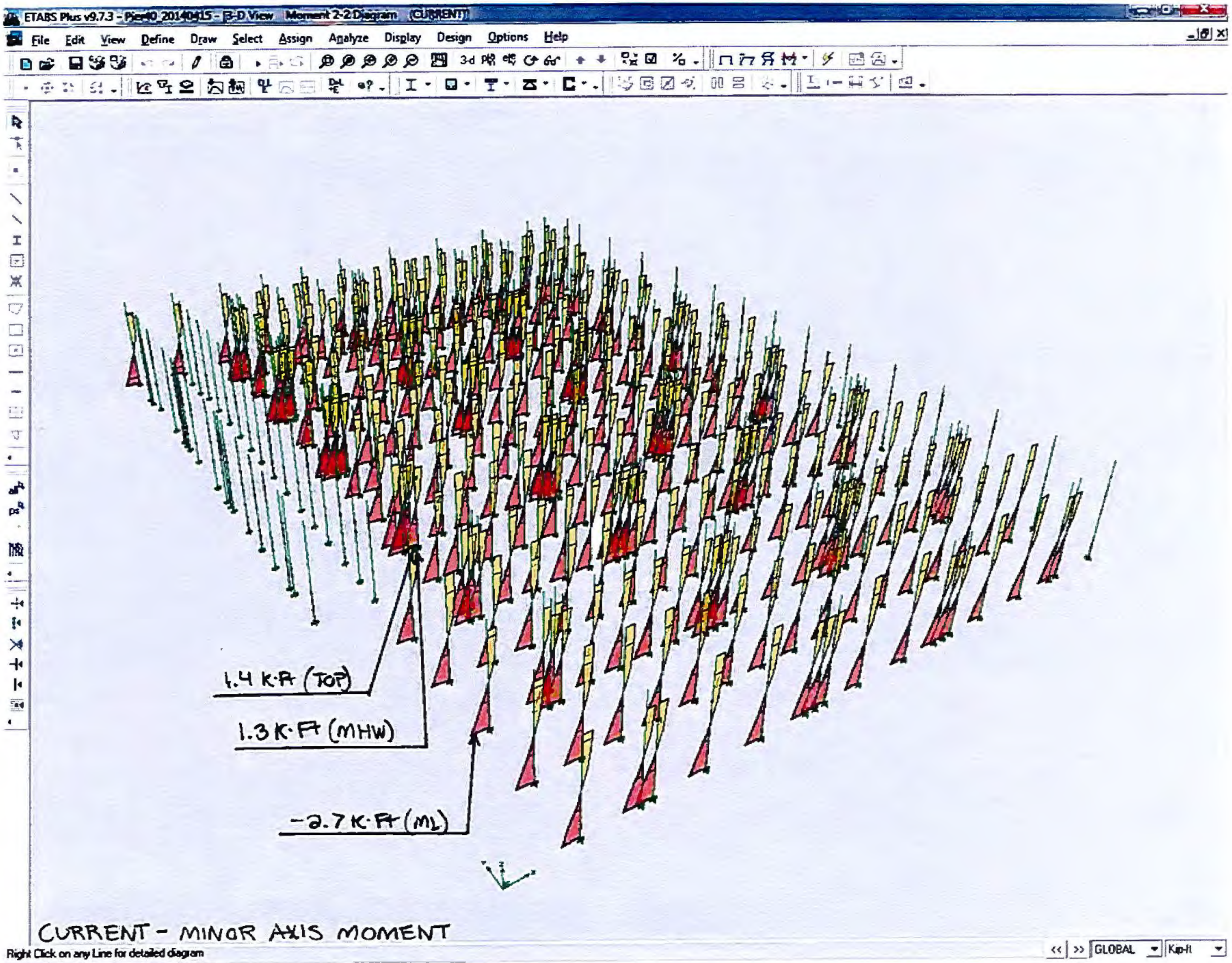

ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Axial Force Diagram (WAVEY)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-7.4K
7.4K
WAVE Y - AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

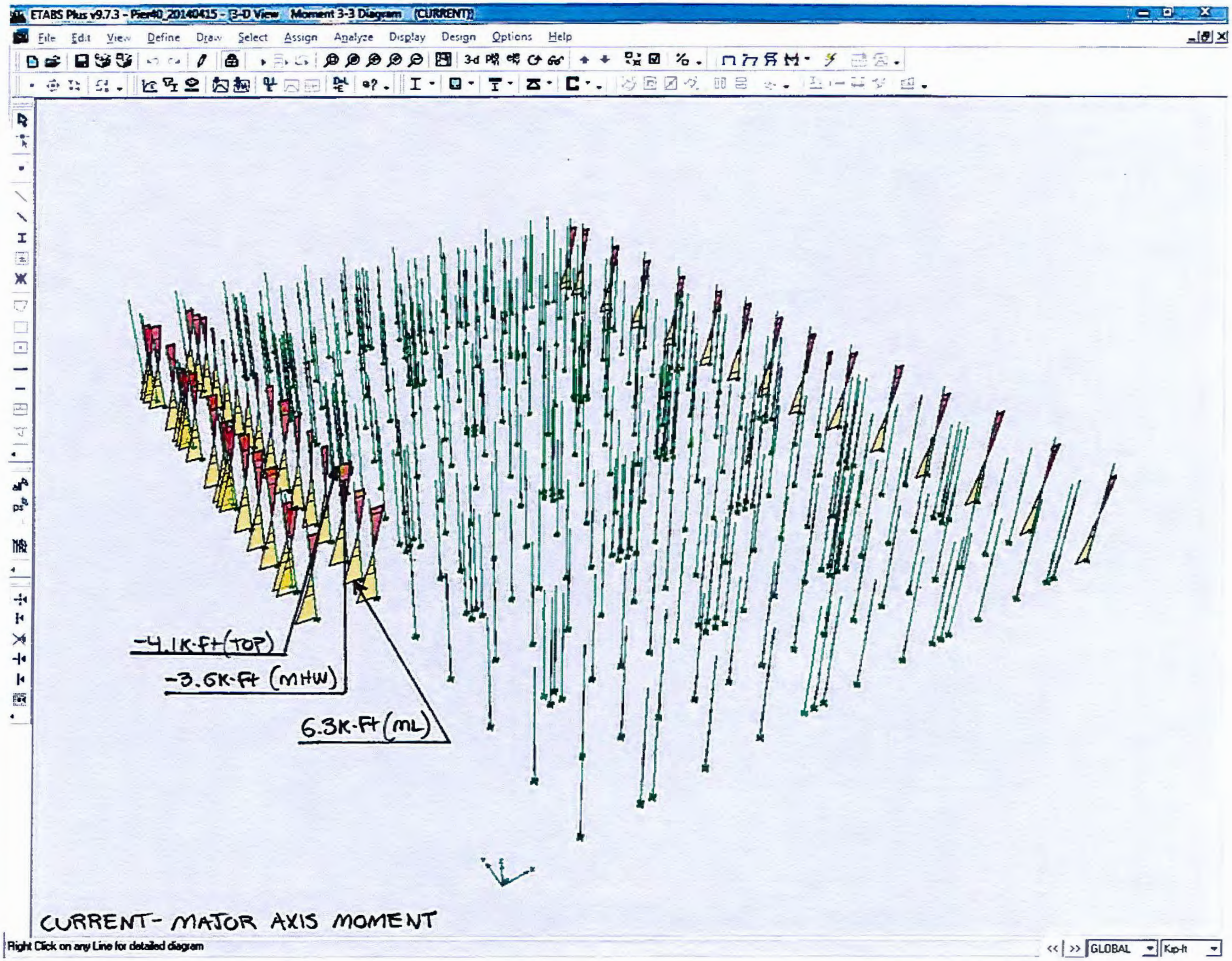


ETABS Plus v9.7.3 - Pier40_20140415 - [3-D View Moment 2-2 Diagram (WAVEY)]
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-6.2K-Ft (TOP)
-4.3K-Ft (MHW)
6.2K-Ft (ML)
WAVE Y- MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

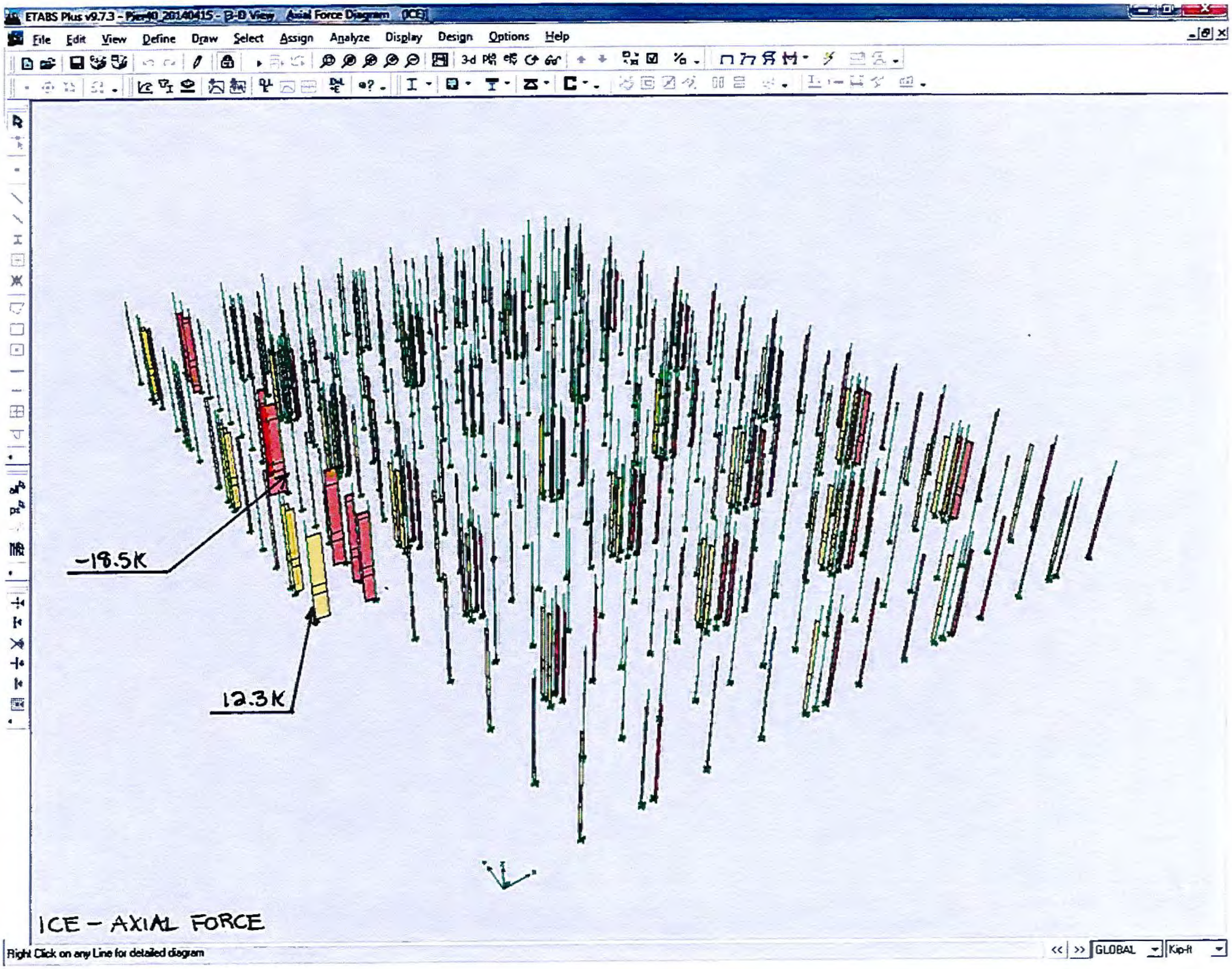

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Moment 3-3 Diagram (WAVEY)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-15.7 K·Ft (TOP)
-10.6 K·Ft (MHW)
16.9 K·Ft (ML)
WAVE Y - MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

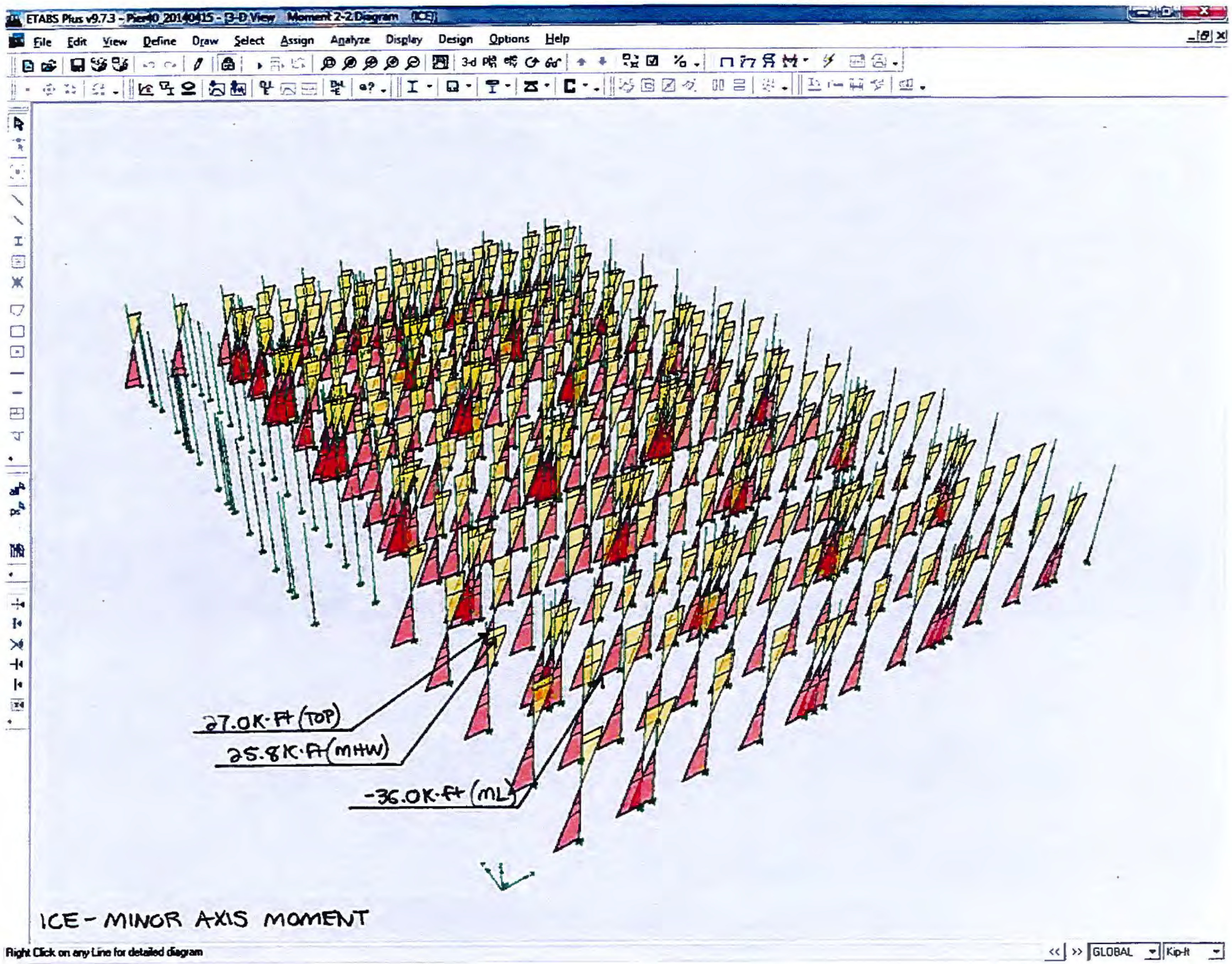

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Axial Force Diagram (CURRENT)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-1.0K
0.7K
CURRENT - AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

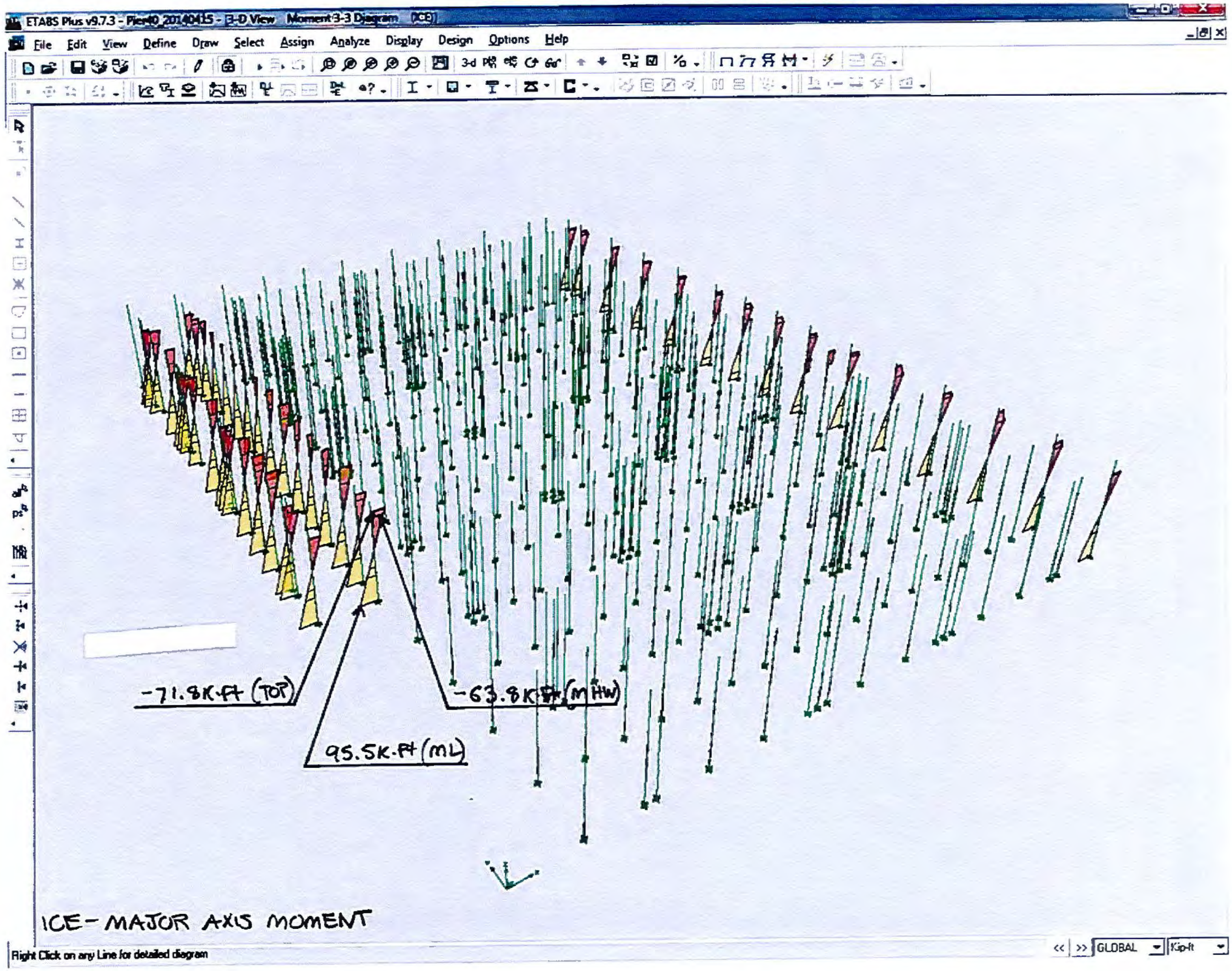

ETABS Plus v9.7.3 - Pier10_20140415 - 3-D View Moment 2-2 Diagram (CURRENT)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
1.4 K·Ft (TOP)
1.3 K·Ft (MHW)
-2.7 K·Ft (ML)
CURRENT - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft



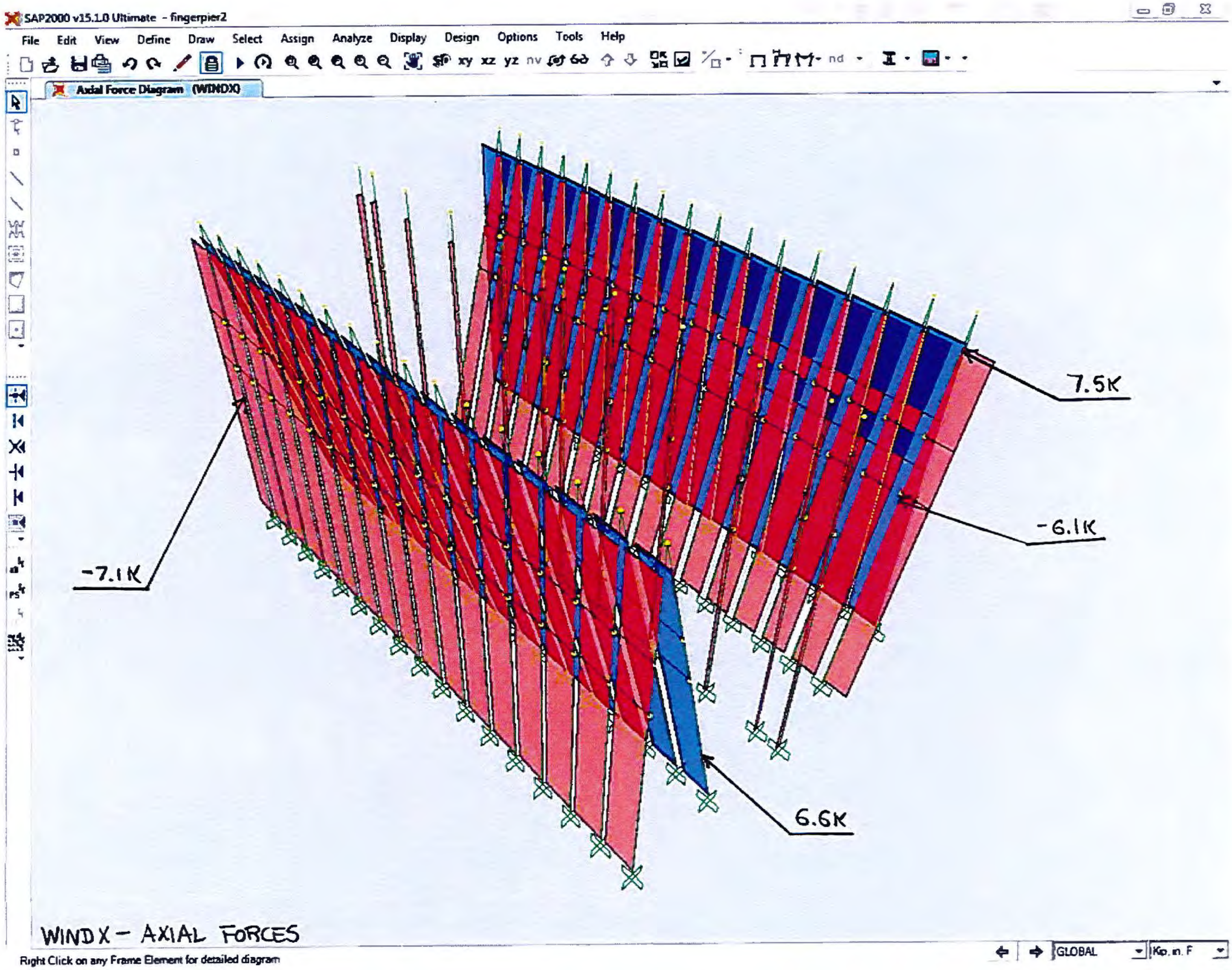
ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Moment 3-3 Diagram (CURRENT)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-4.1K-Ft (TOP)
-3.6K-Ft (MHW)
6.3K-Ft (ML)
CURRENT- MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

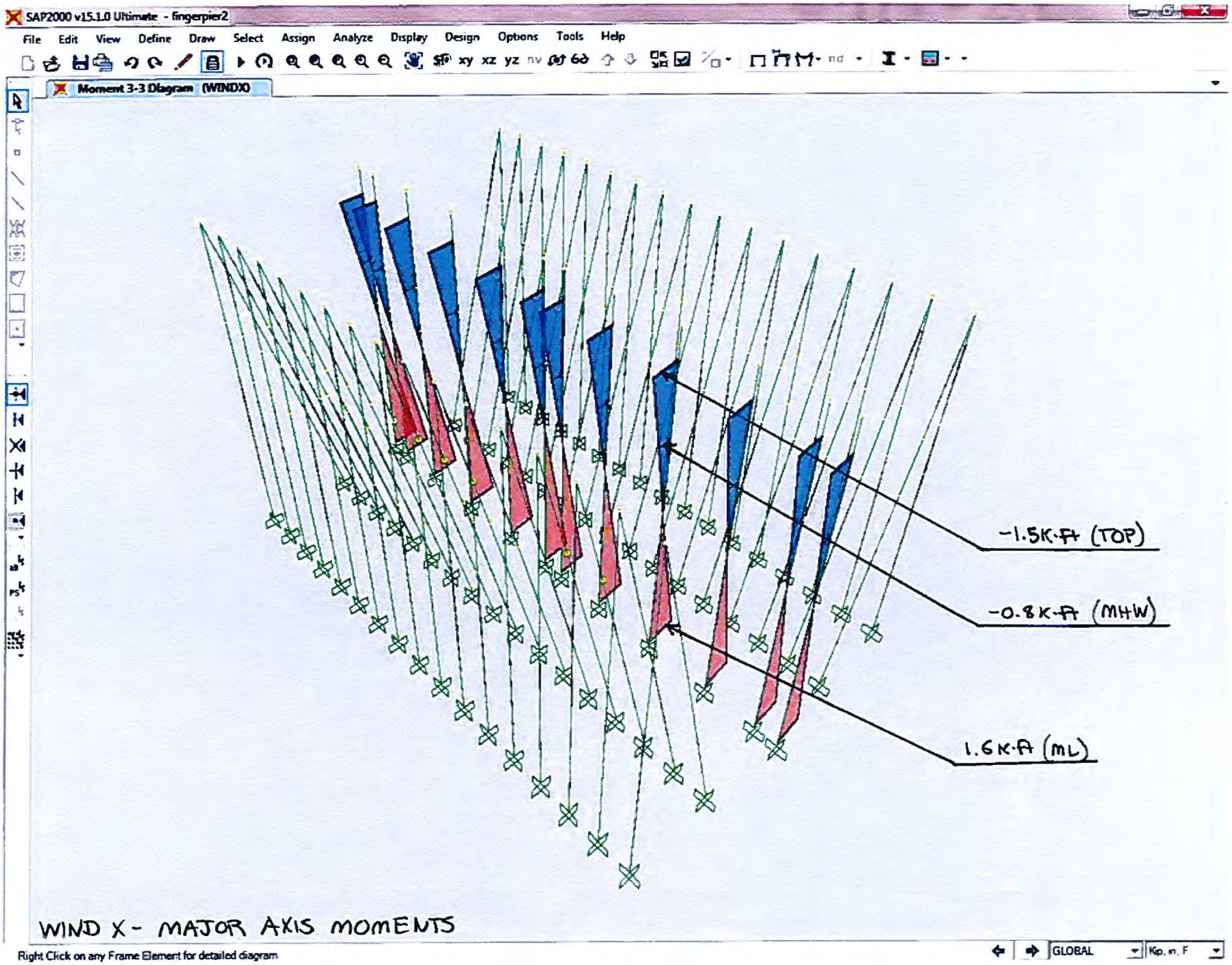

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Axial Force Diagram (ICE)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-18.5K
12.3K
ICE - AXIAL FORCE
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft


ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Moment 2-2 Diagram (ICE)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
27.0K-Ft (TOP)
25.8K-Ft (MHW)
-36.0K-Ft (ML)
ICE - MINOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

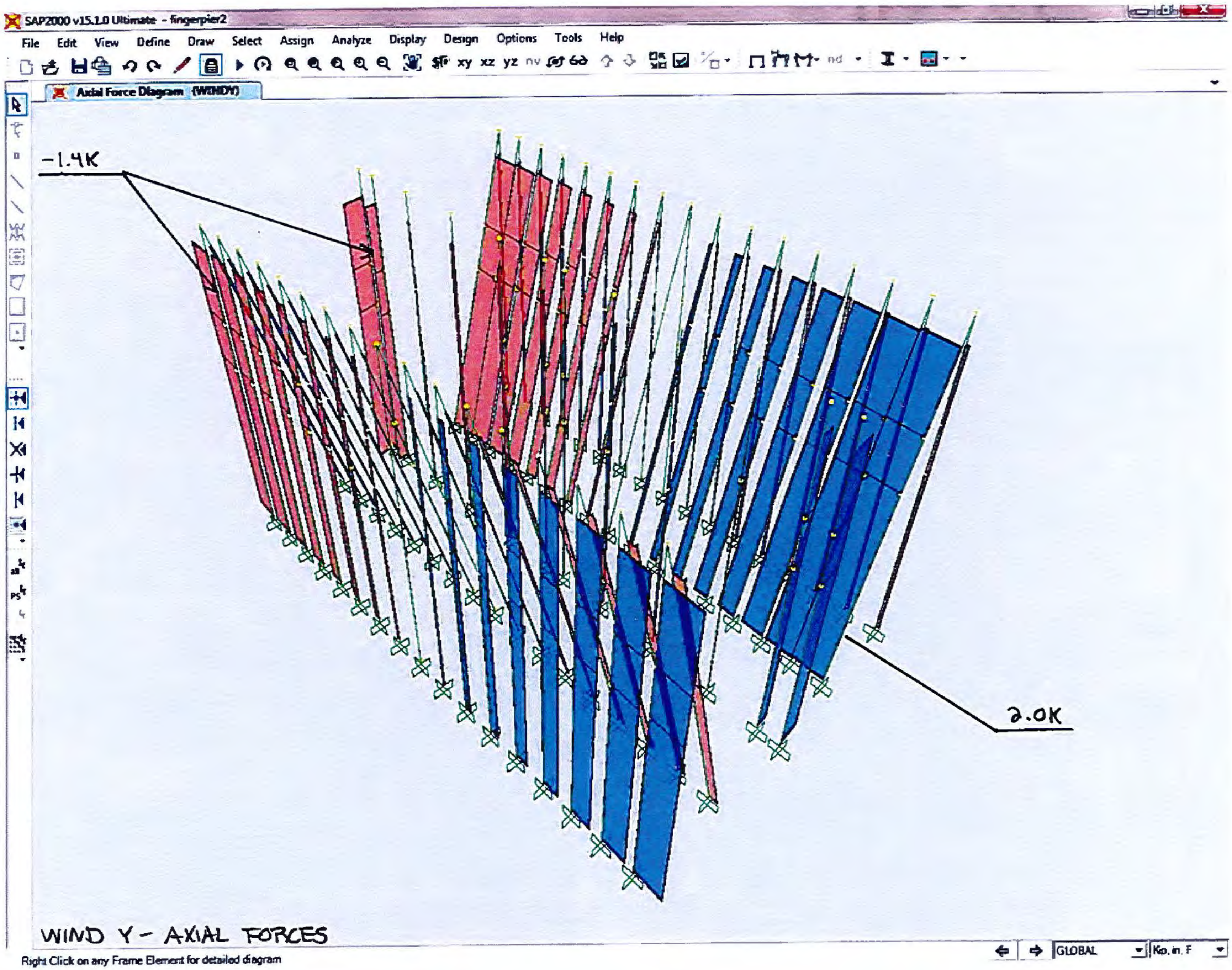

ETABS Plus v9.7.3 - Pier40_20140415 - 3-D View Moment 3-3 Diagram (ICE)
File Edit View Define Draw Select Assign Analyze Display Design Options Help
-71.8K-ft (TOP)
-63.8K-ft (MHW)
95.5K-ft (ML)
ICE - MAJOR AXIS MOMENT
Right Click on any Line for detailed diagram
GLOBAL
Kip-ft

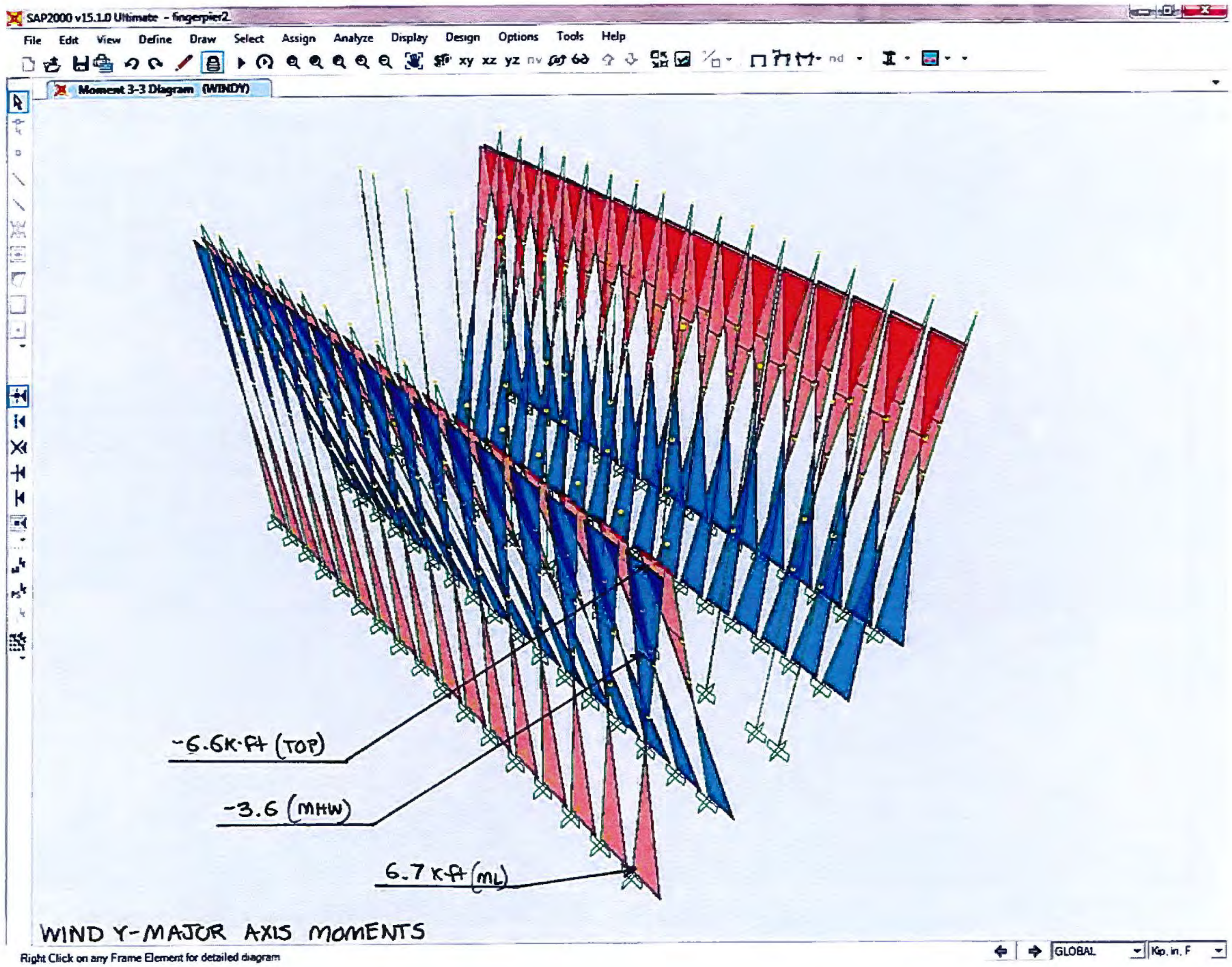
FINGER PIER STRUCTURAL MODEL


SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (WINDX)
7.5K
-6.1K
-7.1K
6.6K
WINDX - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

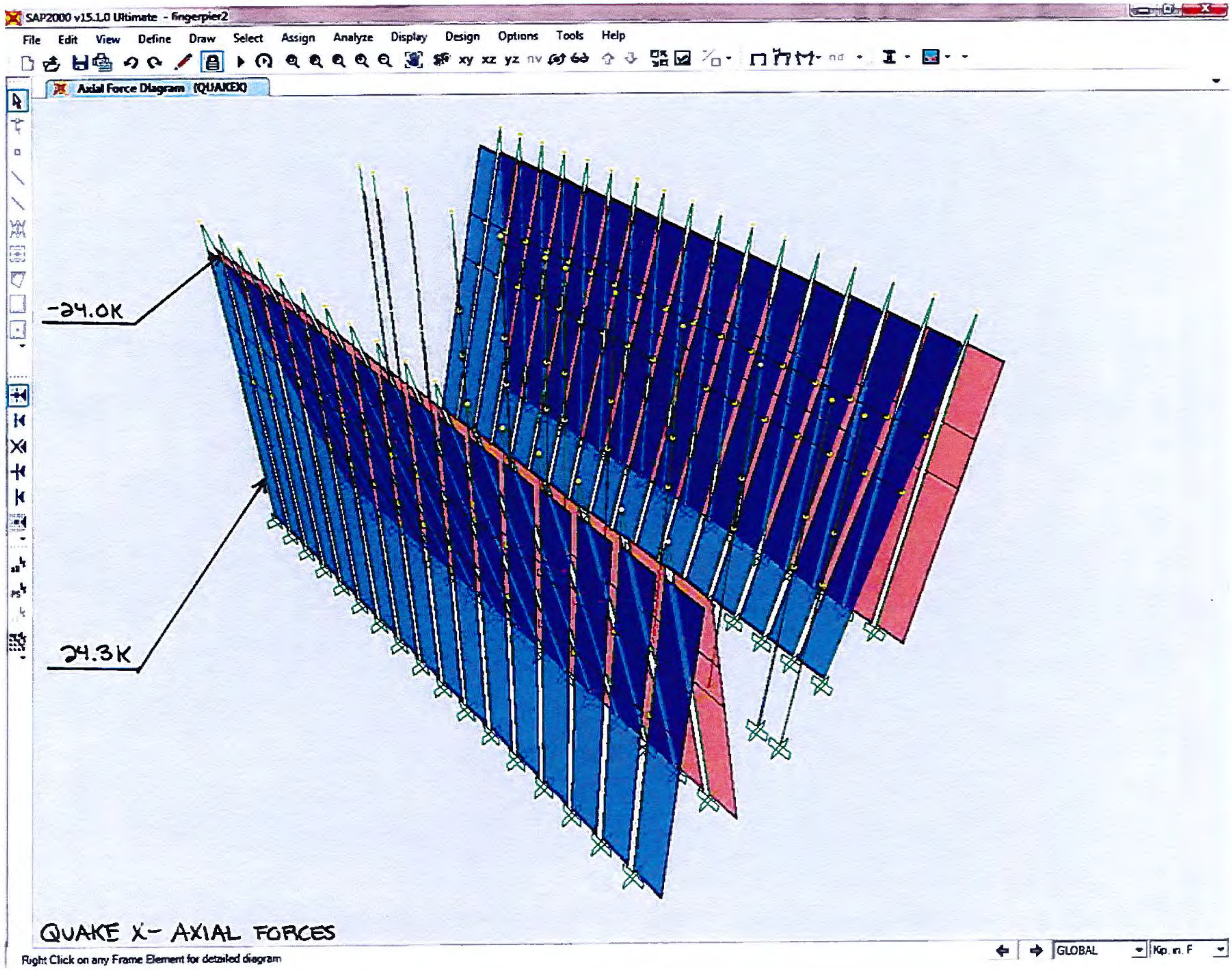


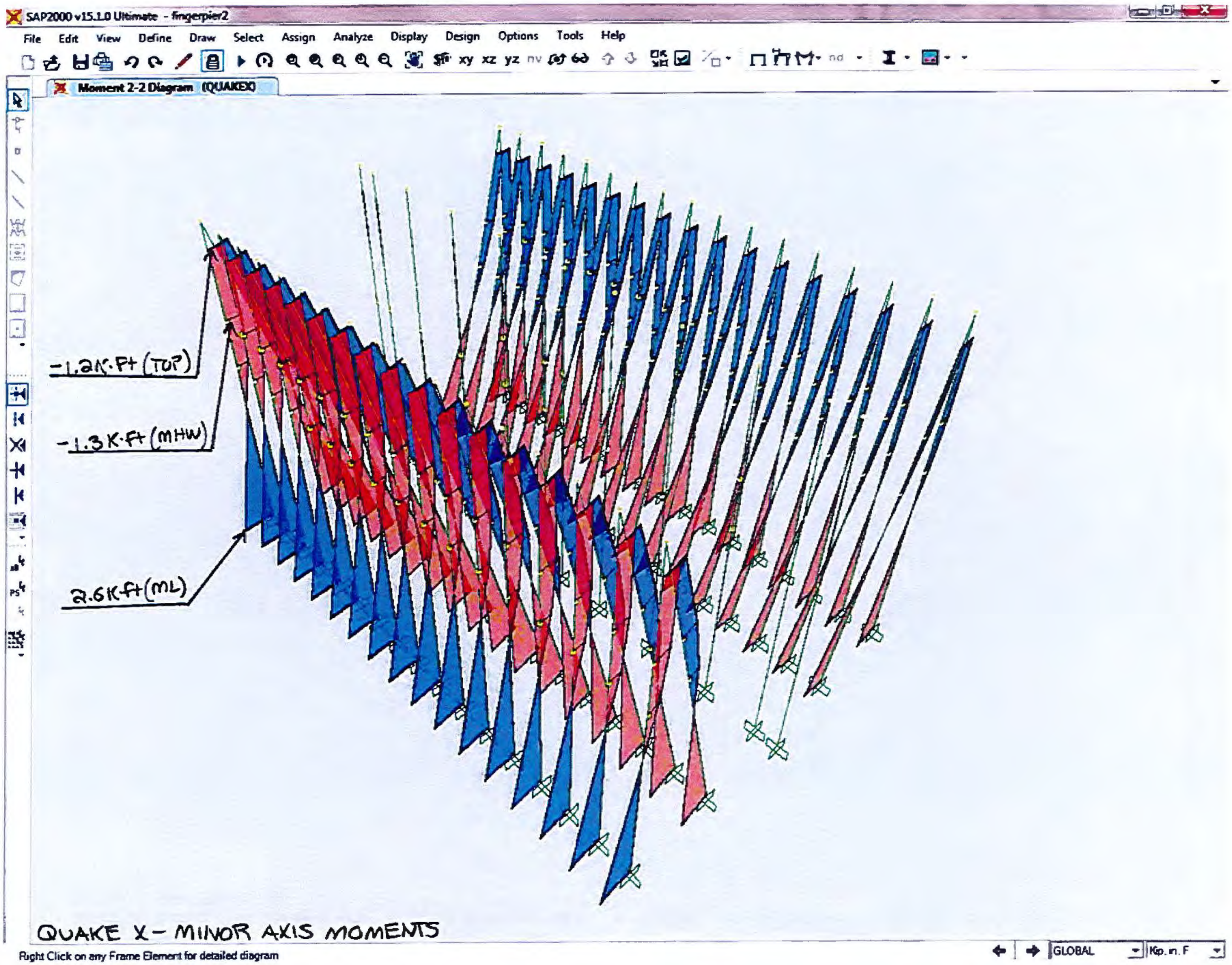
SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (WINDX)
-1.5K·ft (TOP)
-0.8K·ft (MHW)
1.6K·ft (ML)
WIND X - MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

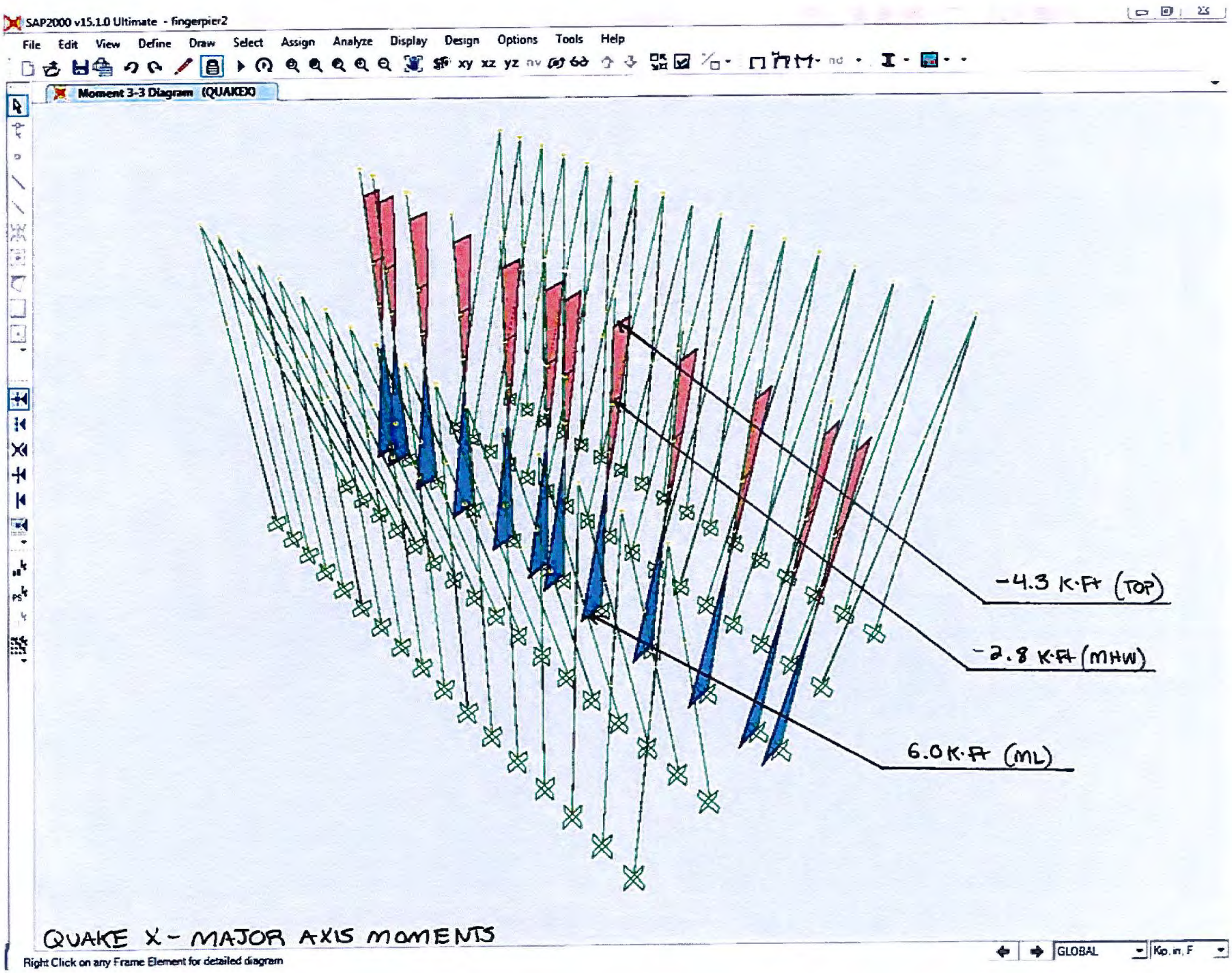

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (WINDY)
-1.4K
2.0K
WIND Y - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

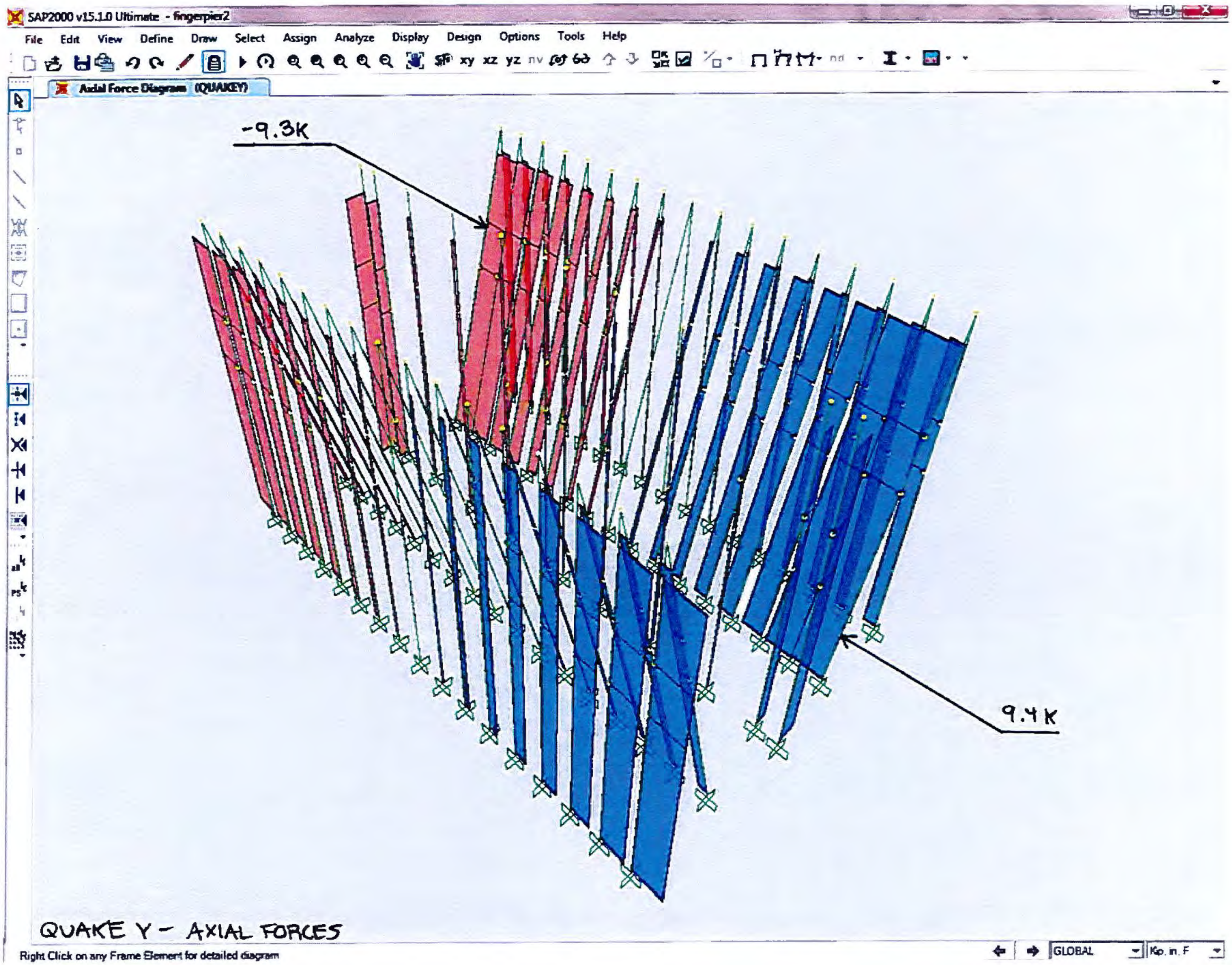


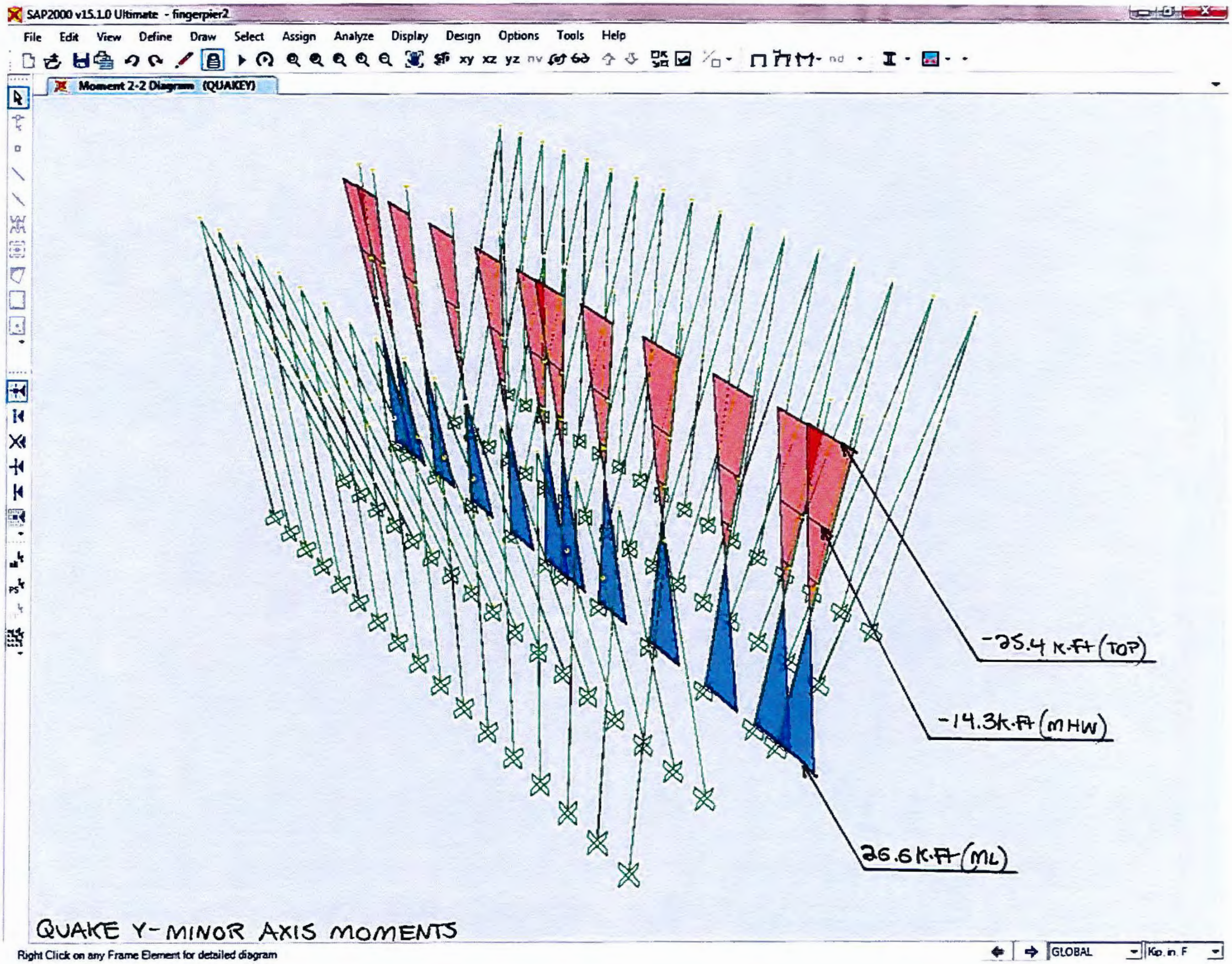
SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (WINDY)
-6.6K·ft (TOP)
-3.6 (MHW)
6.7 K·ft (ML)
WIND Y-MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

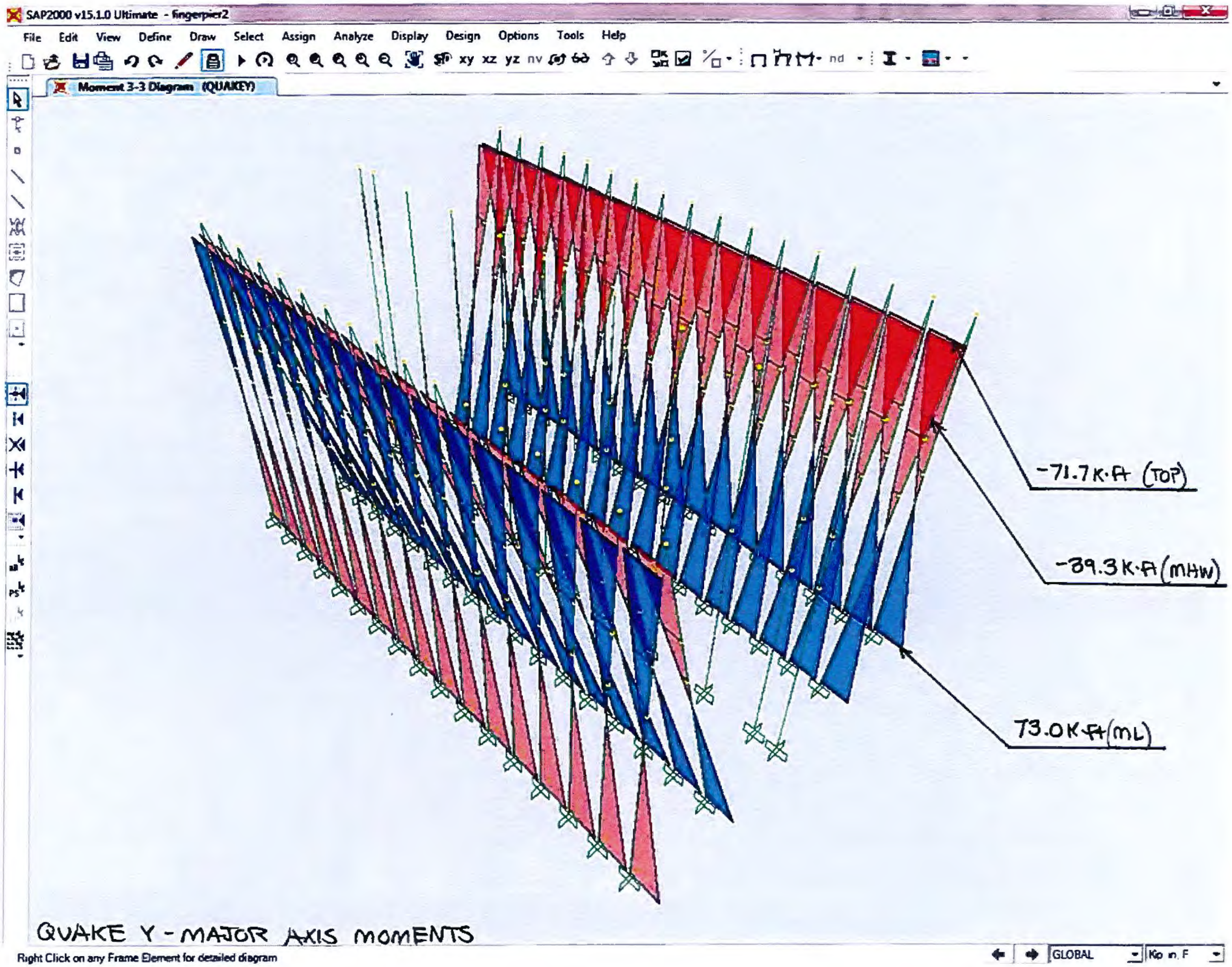

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (QUAKEX)
-24.0K
24.3K
QUAKE X- AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

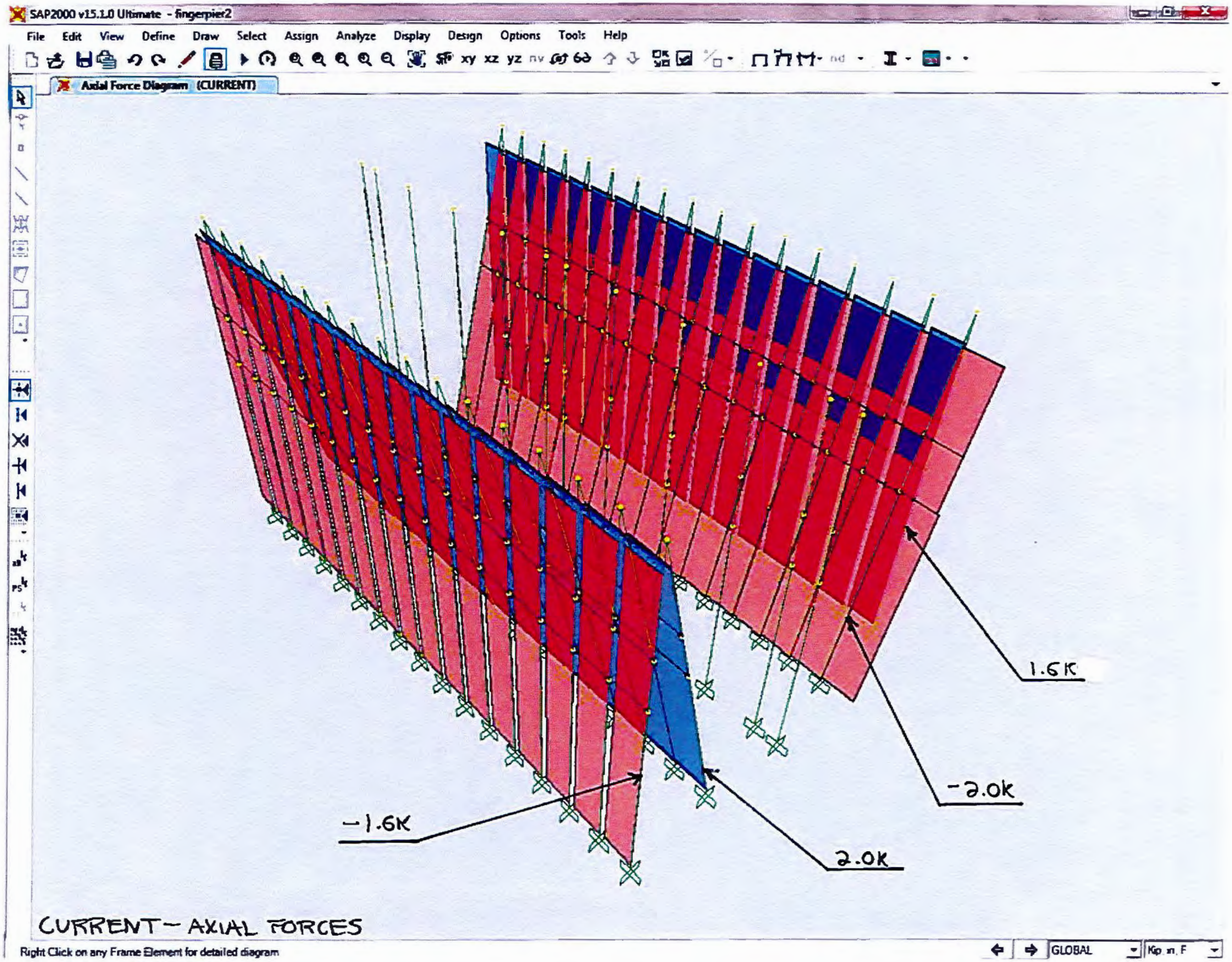

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 2-2 Diagram (QUAKEX)
-1.2K·Ft (TOP)
-1.3K·Ft (MHW)
2.6K·Ft (ML)
QUAKE X - MINOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

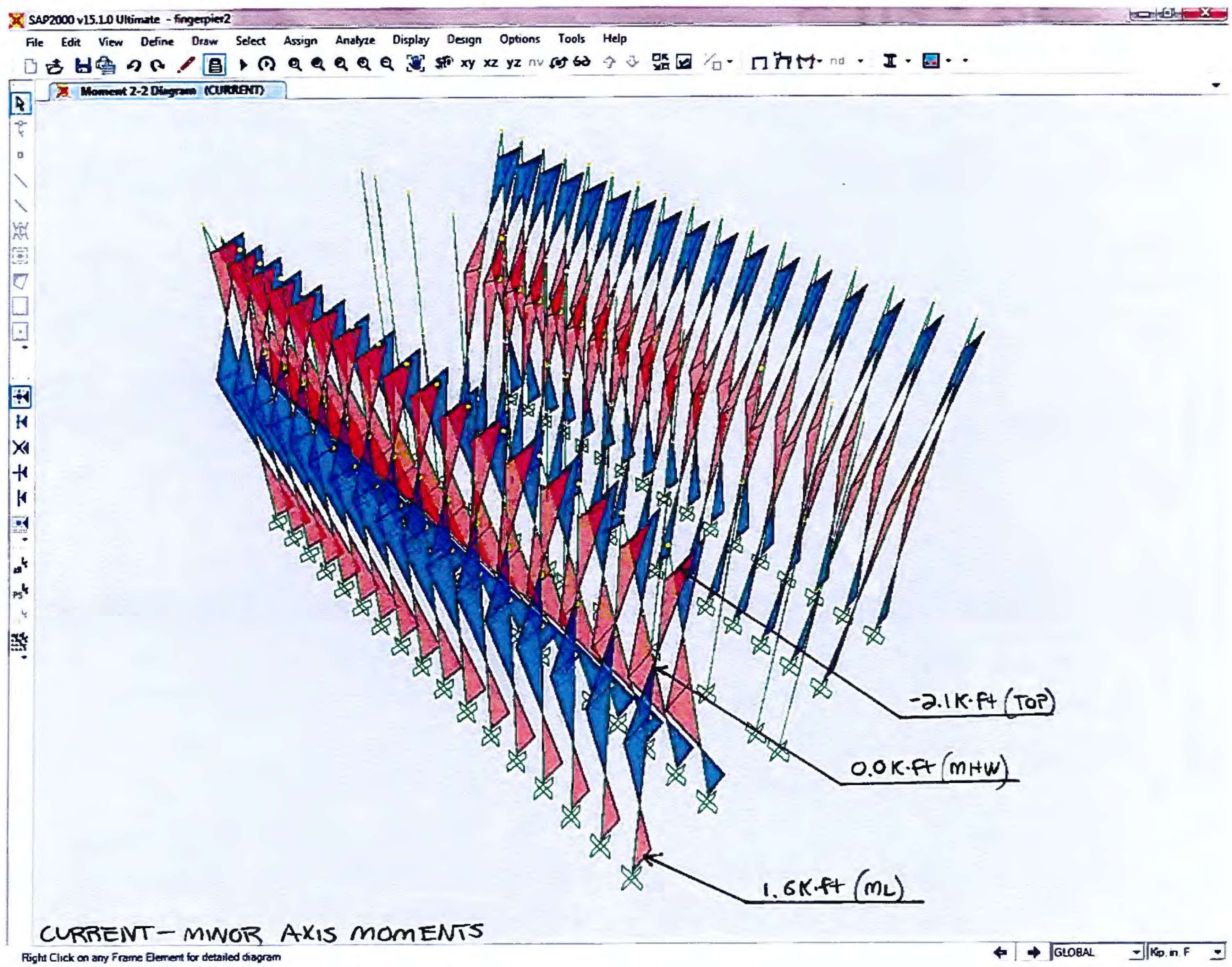

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (QUAKEX)
-4.3 K·Ft (TOP)
-2.8 K·Ft (MHW)
6.0 K·Ft (ML)
QUAKE X - MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

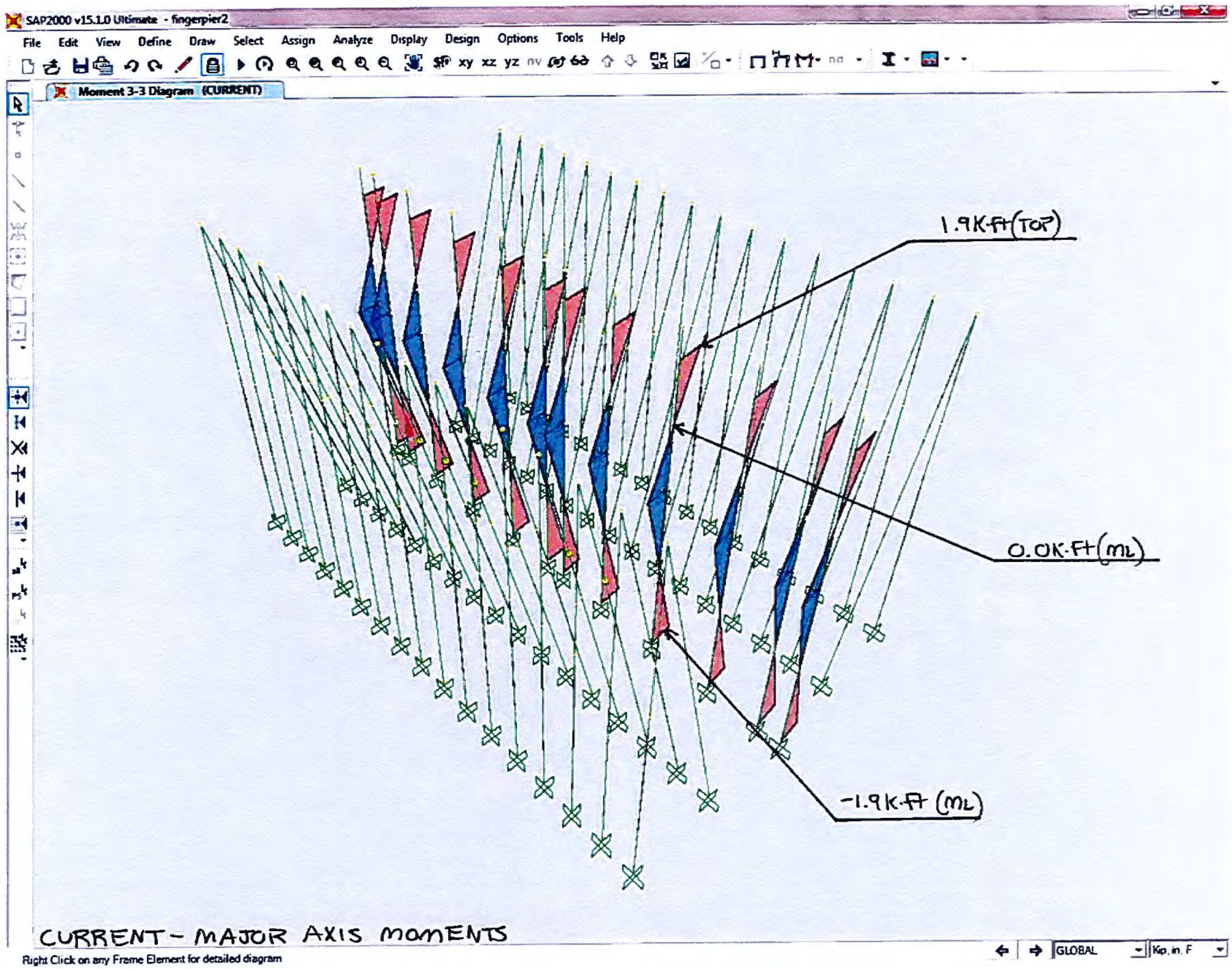

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (QUAKEY)
-9.3K
9.4K
QUAKE Y - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

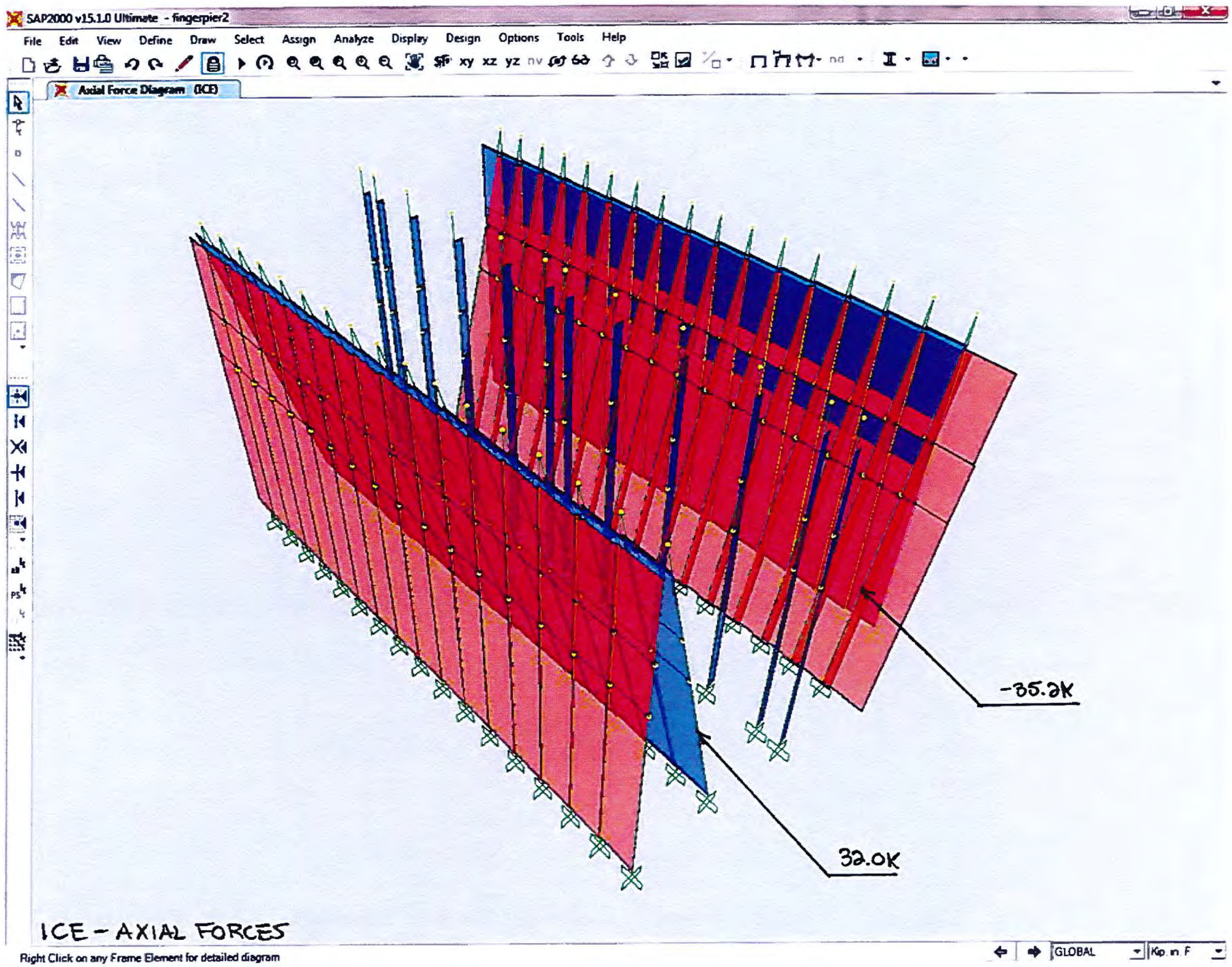

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 2-2 Diagram (QUAKEY)
-25.4 K-Ft (TOP)
-14.3K-Ft (MHW)
26.6 K-Ft (ML)
QUAKE Y-MINOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

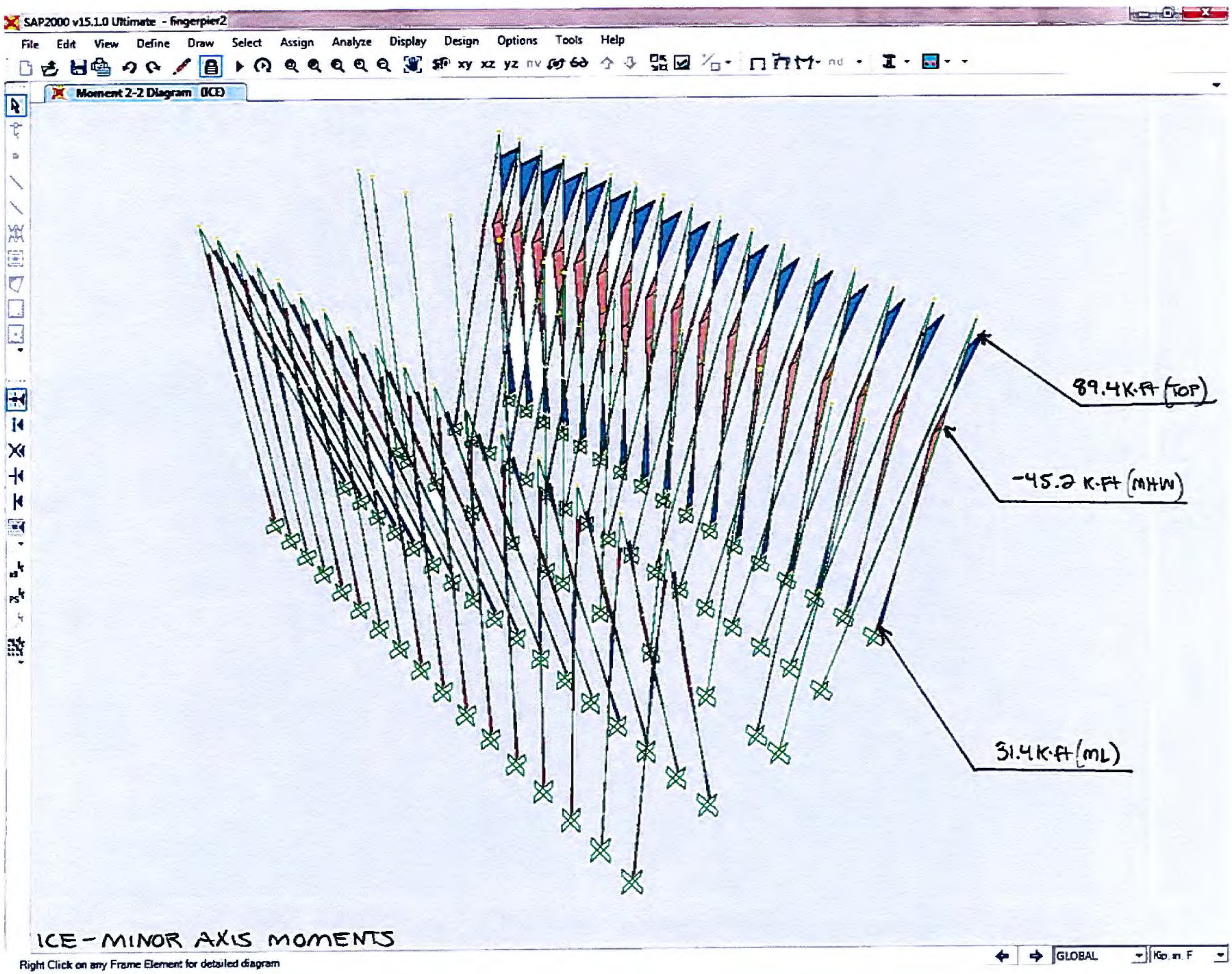

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (QUAKEY)
-71.7 K·ft (TOP)
-39.3 K·ft (MHW)
73.0 K·ft (ML)
QUAKE Y - MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL

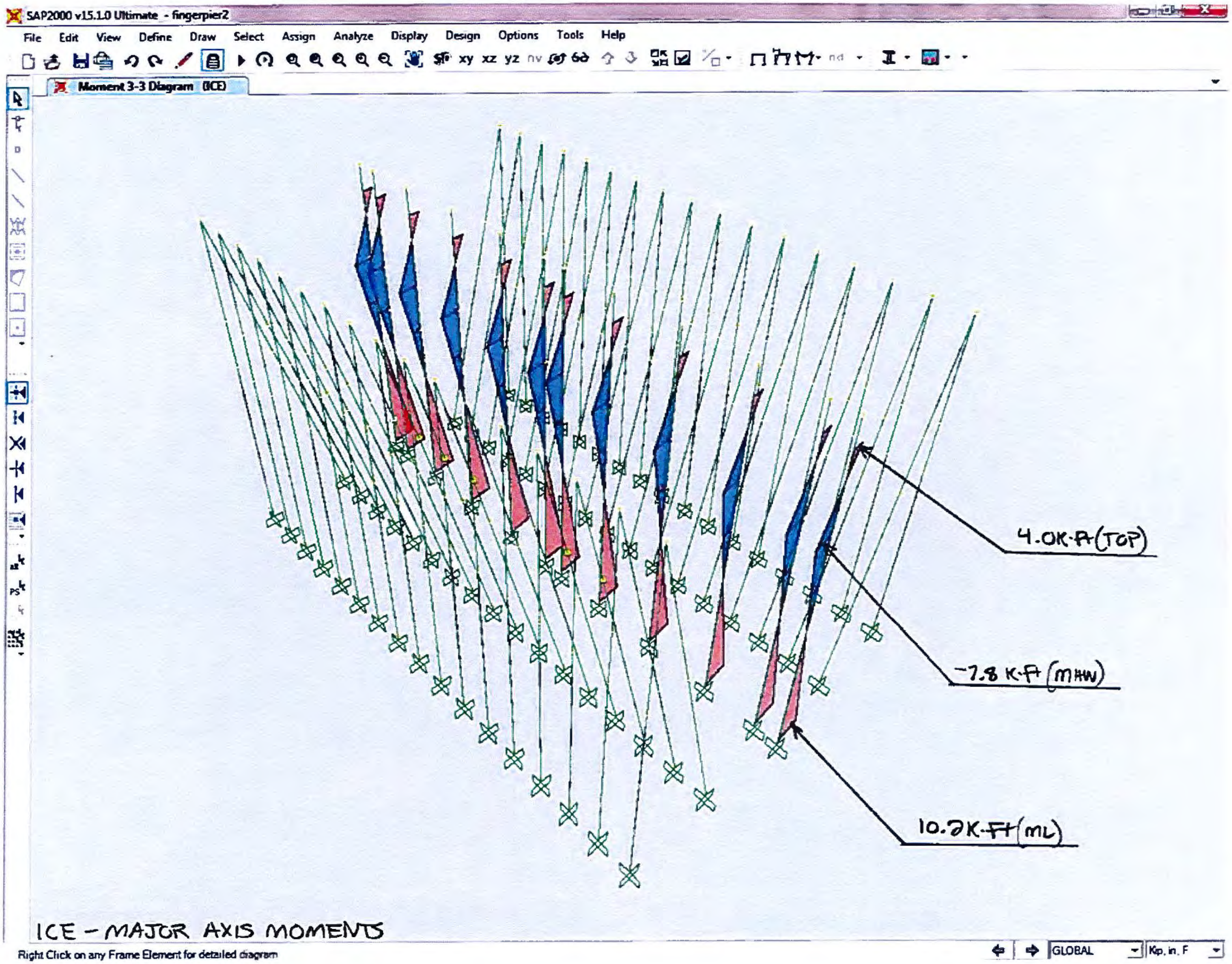

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (CURRENT)
1.6K
-2.0K
-1.6K
2.0K
CURRENT - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

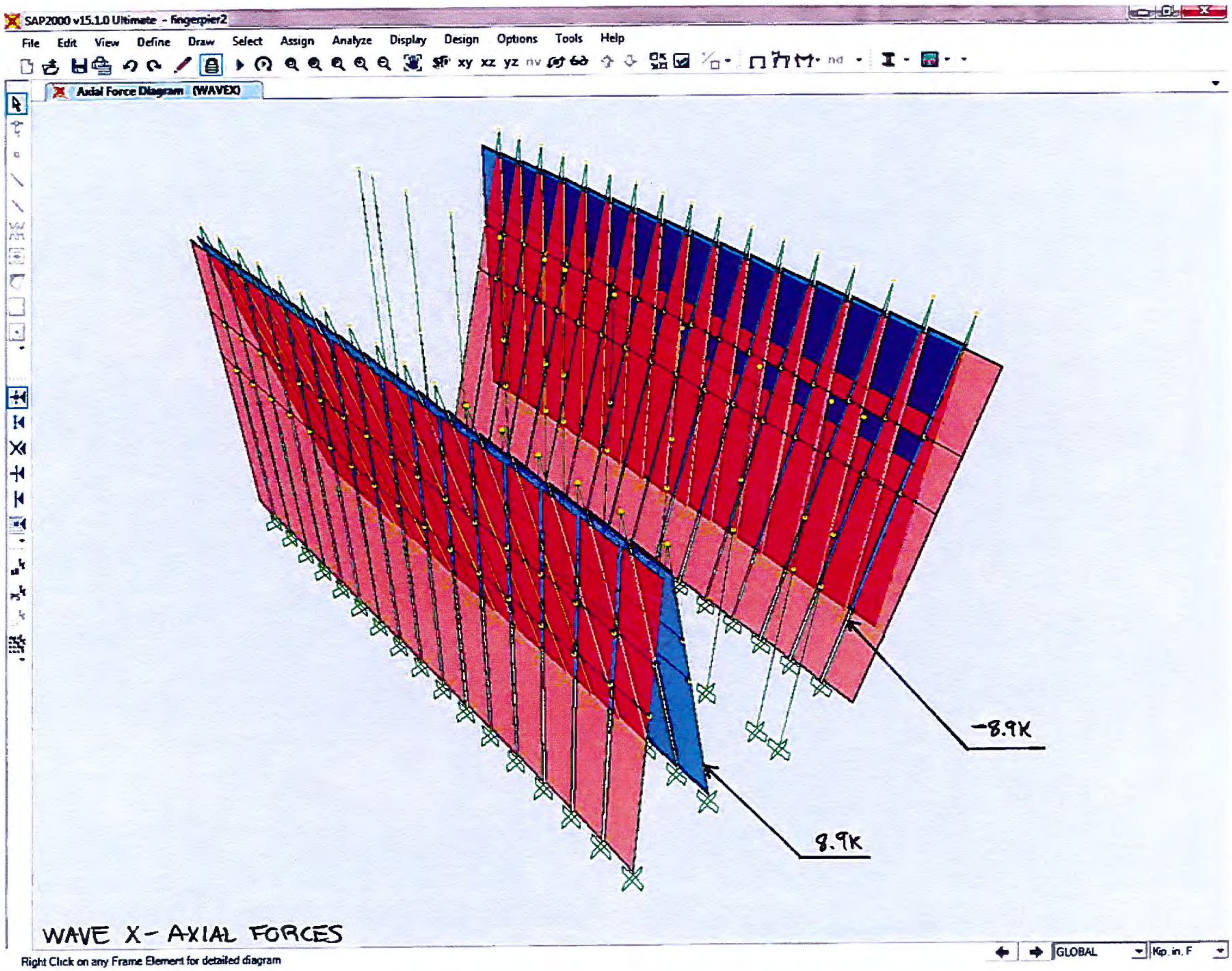

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 2-2 Diagram (CURRENT)
-2.1K·ft (TOP)
0.0K·ft (MHW)
1.6K·ft (ML)
CURRENT – MINOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

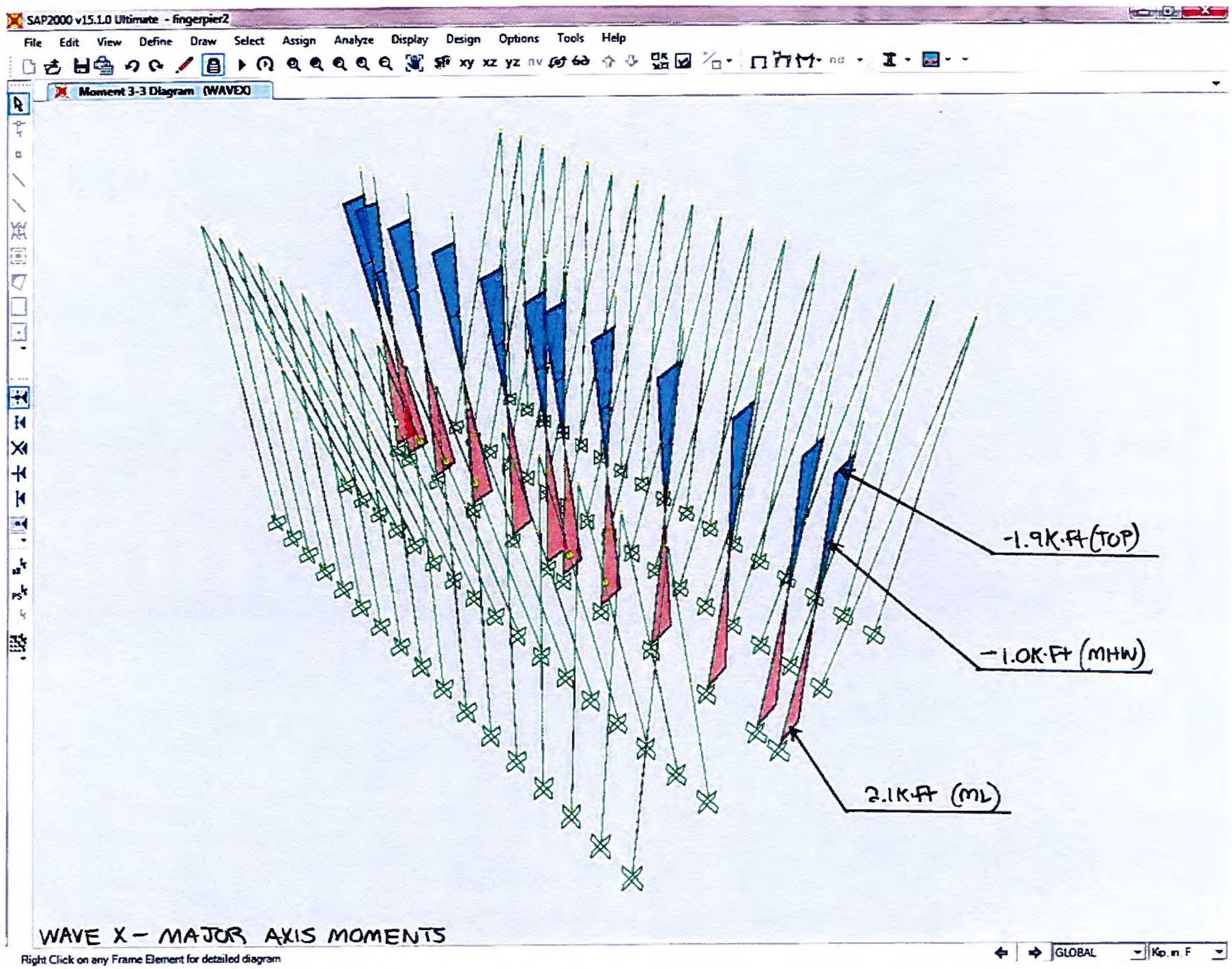

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (CURRENT)
1.9K-Ft (TOP)
0.0K-Ft (ML)
-1.9K-Ft (ML)
CURRENT - MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

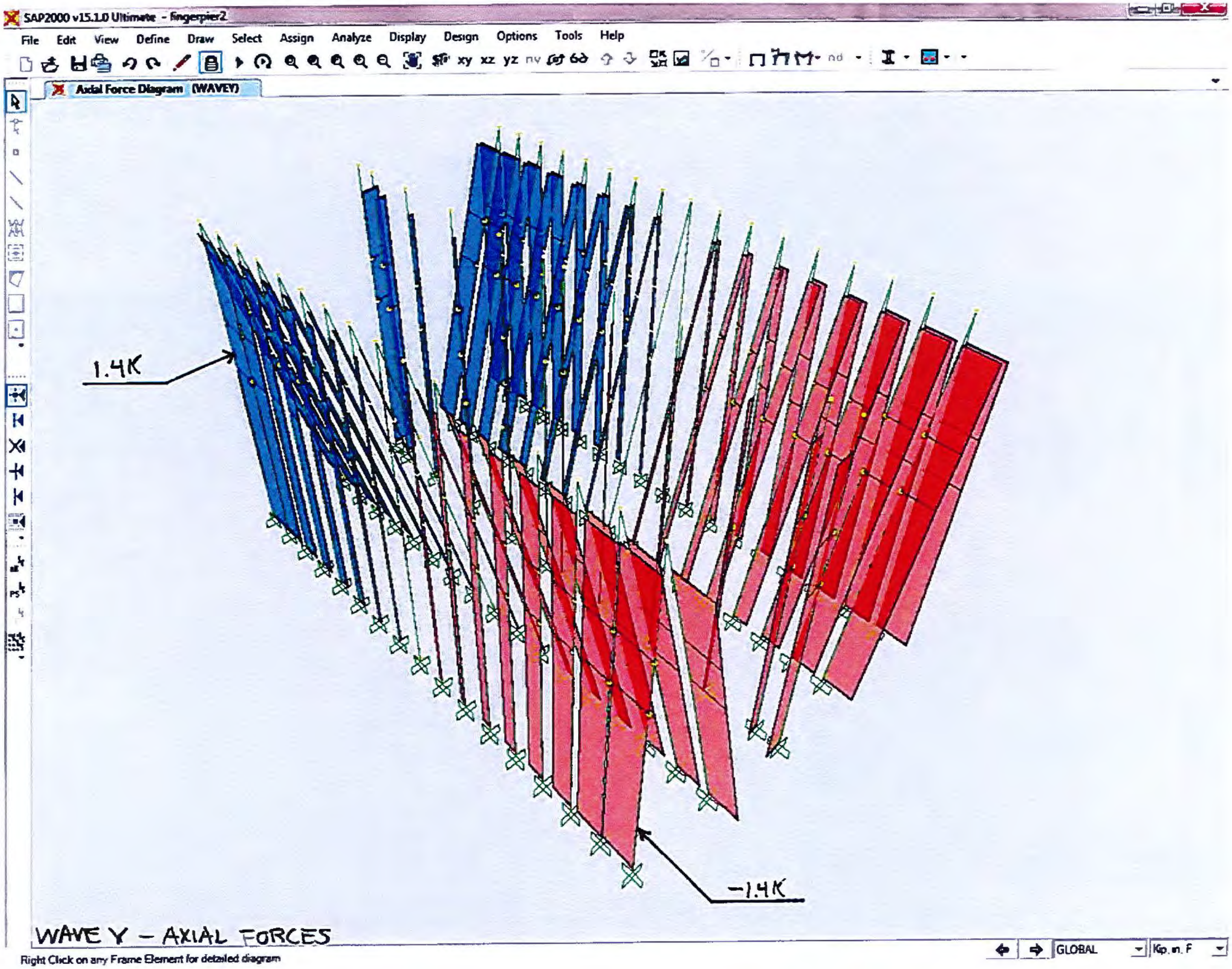

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (ICE)
-35.2K
32.0K
ICE - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F

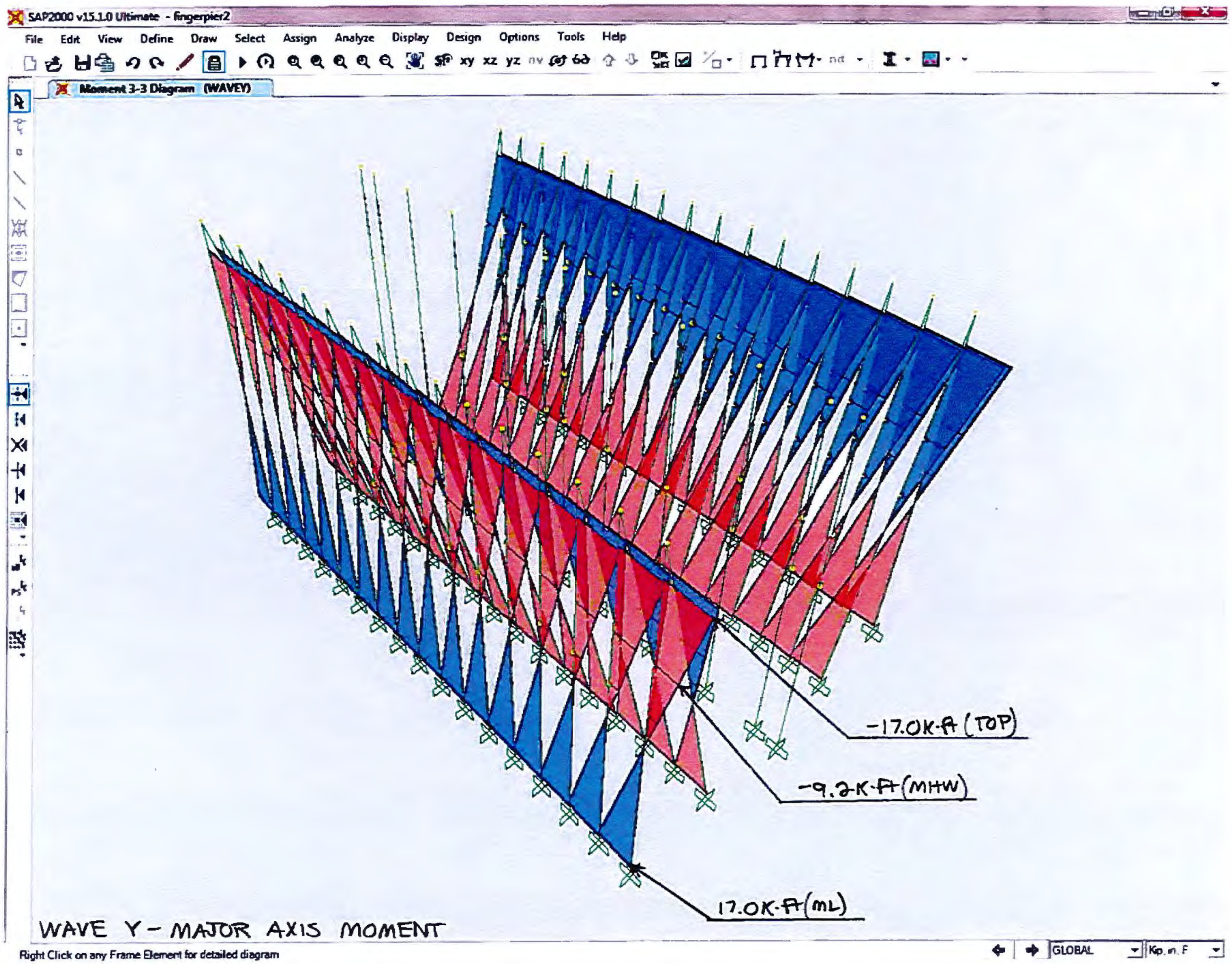

SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 2-2 Diagram (ICE)
89.4K·ft (TOP)
-45.2 K·ft (MHW)
31.4K·ft (ML)
ICE - MINOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL


SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (ICE)
4.0K·ft (TOP)
-7.8 K·ft (MHW)
10.2K·ft (ML)
ICE - MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F


SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (WAVEX)
-8.9K
8.9K
WAVE X - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F


SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (WAVEX)
-1.9K·Ft (TOP)
-1.0K·Ft (MHW)
2.1K·Ft (ML)
WAVE X – MAJOR AXIS MOMENTS
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F


SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Axial Force Diagram (WAVEY)
1.4K
-1.4K
WAVE Y - AXIAL FORCES
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F


SAP2000 v15.1.0 Ultimate - fingerpier2
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help
Moment 3-3 Diagram (WAVEY)
-17.0K·ft (TOP)
-9.2K·ft (MHW)
17.0K·ft (ML)
WAVE Y - MAJOR AXIS MOMENT
Right Click on any Frame Element for detailed diagram
GLOBAL
Kip, in, F