



Christy
November 5, 2003

ENGINEERING with the SPREADSHEET
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Summary of Tank Test Measurements

Please refer to the D sized drawing for measurement recordings.

The soils engineer predicted less than **1/4"** settlement under working loads for individual piles. It appears that our greatest settlement is on the order of **1/8"**.

Targets were glued to foundation columns on Friday, October 24, 2003. The water fill process began on Thursday the 29th and was finished on Sunday, November 2nd.

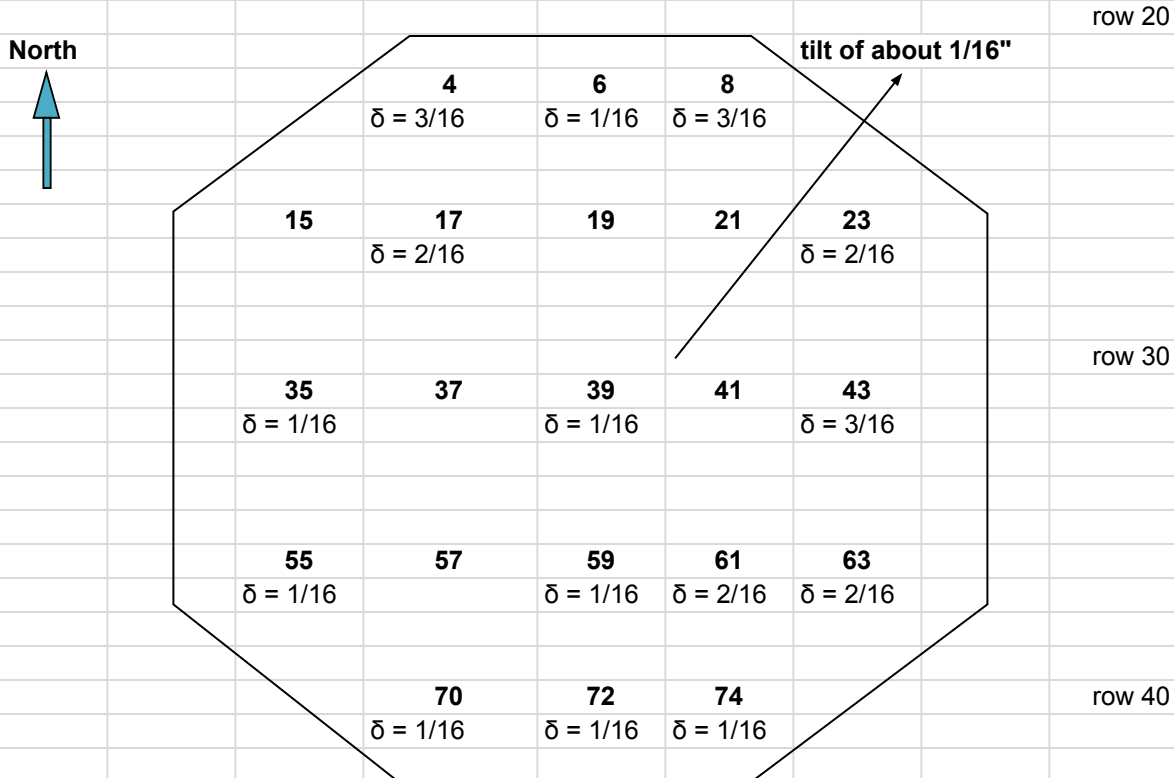
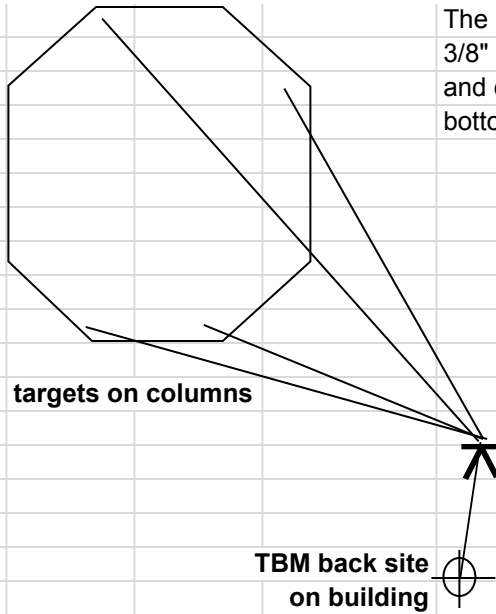
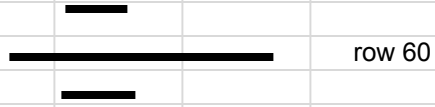


Figure 54-1. Laser Level Measurements of Column Settlements

North



The laser level dot is about 1/8" at 80 ft and 3/8" at 130 ft. The dot can be split in half by eye and can also be split by marking the top and bottom of the dot and calculating the middle.



targets on columns

laser level

TBM back site on building

Figure 54-2 Laser Level Plan View



red and white reflective tape on targets

Figure 54-3 Enlargement of Targets on Columns



Figure 54-4 Tank Elevation Looking Northwest

COLUMN SHORTENING

5 and 3 Lb. lead weights were hung on monel line from the bottom of the deck.

monel 0,000778 /100° F /100 ft coefficient of expansion
 Temperatures varied from 43° F on Sunday to 57° F on Monday and

row 100

results in about a $132" / 1200 * 14° F * 0.000778 \text{ in/in} = 0.0012"$ of lengthening.
 Temperature lengthening is a nominal issue in these measurements.



3 mechanical dial gages during the water loading test.
 The electronic dial gage was used only on the day of the air overpressure test.



laser tape measure from pile cap to deck underside

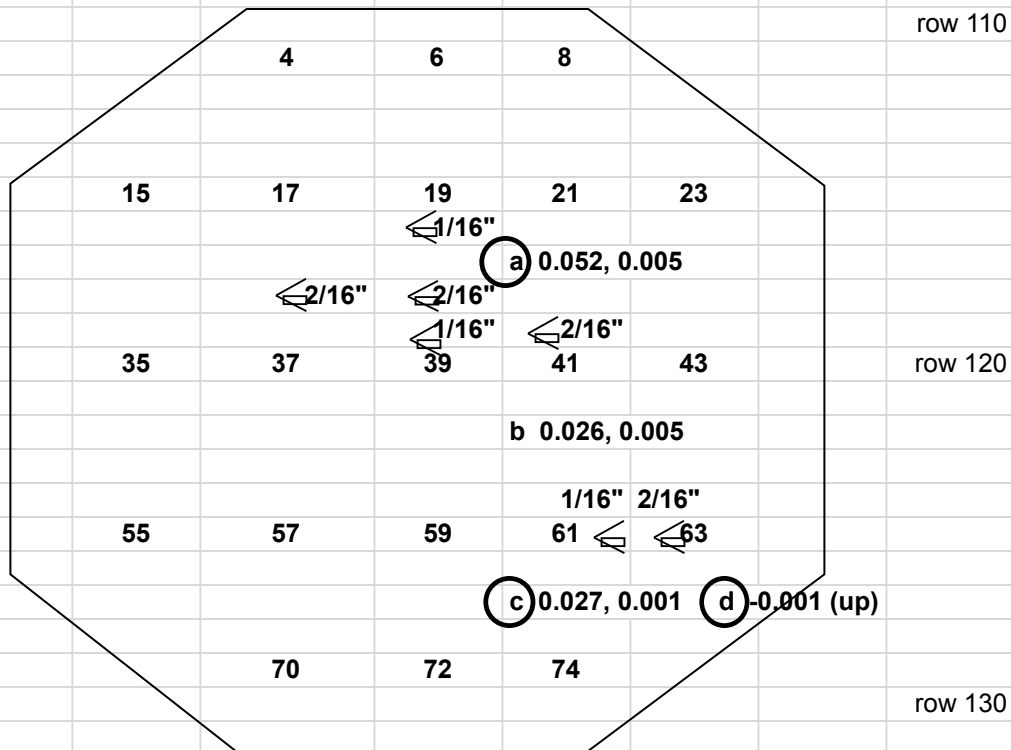


Figure 54-5 Dial Gage Telltales and Laser Measurements

Note: The \leftarrow symbol indicates a $<$ painted on the concrete and the laser's position on that $<$. Laser measurements were made with a Hilti PD25.

COLUMN SHORTENING -- Continued

For reference: $1/16" = 0.0625"$

0.007" calculated deflection down

shortening say $0.026 - 0.007 - 0.0035 = 0.016"$

0.0035" estimated deflection up

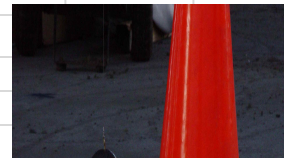
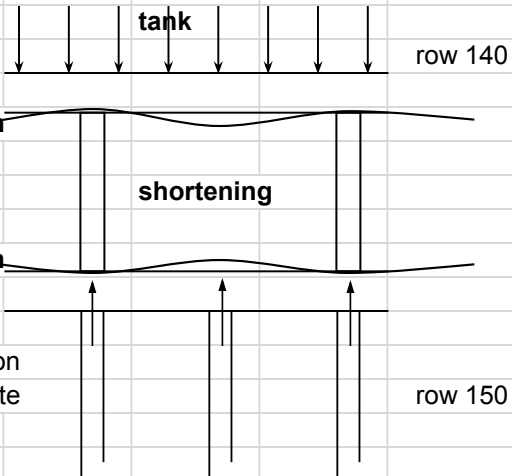
Estimate (measured) column load(s) from telltale information
Convert column reinforcing to an equivalent area of concrete
and add to the gross area of the column.

As	52,96	in ²	
Aconcrete	399	in ²	
n	8,04	unitless	
Aeffective	825	in ²	$8.04 * 52.96 + 399$

Figure 54-6 Foundation Partial Elevation

For stress in the column(s)

138" line length



$E \epsilon = \sigma$			
E	3605	k/in ²	
ϵ	1,159E-04	in/in	0.016 in /138 in
σ	0,418	k/in ²	3605 k/in ² * 1.159E-04
P measure	345 k		0.418 k/in ² * 825 in ²

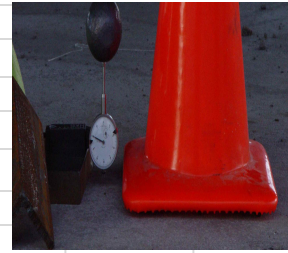
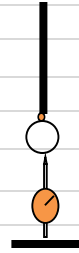


Figure 54-7. Mechanical Dial Gage Telltale with 5-pound Lead Weight

The average design values for columns 39 to 139 and 41 to 141 is **470k**.

Tank	741	k	empty weight
Deck	1839	k	concrete deck weight
P DL Avg	123	k /column	(741 + 1839) /21 columns
P calculate	347 k		470 - 123

E	concrete modulus of elasticity
ϵ	strain
σ	stress
P	force

The P measured value of **345 k** compares favorably with P calculated water test weight of **345 k**.

COLUMN SHORTENING -- Continued

For deflections during the 3.75 psi overpressure

Calculate the change in column force using the change in the distance between the bottom of the deck and the top of the pile cap.

δ	0,005	in	measured during the test
ϵ	0,0000362	in/in	0.005/138
σ	0,1306159	k/in ²	3.62E-05 * 3605
P measure	108 k		0.130616 k/in ² * 825 in ²



54-8 Electronic Dial Gage Telltale with 3-Pound Lead Weight

P calculate	106 k		0.00375 k/in ² *144 in ² /ft ² * 14ft * 14ft
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The P measured of **108 k** compares favorably to the P calculated of **106 k**.

Note that electronic dial gage d indicates **-0.001"** (up). This amounts to about **22k** reduction in force in column force because the shell and anchor bolts of the inner tank are pulling up against the deck.

The mechanical dial gage c indicates **+0.001"** (down) is also in keeping with the inner tank shell uplift. row 200

The foundation appears to have performed as designed.

Sincerely,

Craig T. Christy, P.E.

