OBSERVATION AND TESTING OF WINSLOW HELICAL ANCHORS

NORTHSTAR ESTATES, BEAZER HOMES
ALEXANDER ROAD, EAST OF MLK BLVD.
NORTH LAS VEGAS, NEVADA

FOR

PACIFIC HOUSING SYSTEMS, INC.

PROJECT NO. 16-189/7193-01
DECEMER 22, 2005

Purcell, Rhodes & Associates

No. 16-189/7193-01
December 22, 2005

Mr. Jim Winslow
Pacific Housing Systems, Inc.
696 San Ramon Valley Blvd., Ste 213
Danville, CA 94526

Subject: **OBSERVATION AND TESTING OF WINSLOW HELICAL ANCHORS**
Northstar Estates, Beazer Homes
Alexander Road, East of Martin Luther King Blvd.
North Las Vegas, Nevada

Reference: Owens Geotechnical, Inc., October 13, 2005, "Geotechnical Exploration Report, Northstar Estates, Alexander Rd. East of Martin Luther King Blvd., North Las Vegas, Nevada."

Dear Mr. Winslow:

As requested, our firm has provided full-time observation services during the installation of the three helical anchors installed as prototype foundation anchors at the above referenced site. Our observation services consisted of verifying and recording torque versus depth values during the installation of the helical anchors and also observing the depths at which firm bearing soils were encountered below the active subsoils estimated at approximately 15 feet below existing grade. Proof-load tests were performed of the installed anchors by applying a vertical 70 kip load to the center anchor with uplift forces acting on the outer two anchors with displacement measurements made of each anchor under the designed loading conditions.

Our services commenced on November 2, 2005, with a meeting of representatives of Pacific Housing Systems and Beazer Homes. At this meeting, it was determined that the anchors would be installed within an area where an over-excavation of approximately 10 feet had occurred with replacement as engineered fill. The general area was on the east side of Globe Street, where Globe Street meets Equator Street. On November 3 and 4, 2005, the three Winslow Helical Test

Anchors were installed by Pacific Housing Systems in order to demonstrate by a proof-load test the structural integrity of the Winslow Helical Anchor foundation system. Our report on the results and comments on the proof-load test follows:

Installation

The majority of the day on November 3 was dedicated to transporting the necessary equipment to the installation location and setting up the apparatus for the anchor installation. The installation of the helical anchors was done using a CAT 321C track-mounted excavator with a hydraulically driven torque converter capable of producing a maximum torque value of 25,086 ft-lbs at 6092 psi. The hydraulic system of the CAT 321C on the day of testing had a maximum hydraulic pump pressure of 5000 psi, which produced a corresponding torque value of 20,593 ft-lbs. The range of installation torques for the anchors was set at 19,537 - 20,593 ft-lbs dependent on the density of the material encountered at the different anchor installation locations and the size of the helix blade diameters. Table I, illustrates the records of the torque versus depth readings obtained during installation as recorded by our Field Engineer for the three anchors installed.

The design of the helical anchor installation depths, helix diameter, and number of helixes per anchor were based on the soil parameters set forth in the referenced report by Owens Geotechnical, Inc., dated October 13, 2005. The report recommended a helical anchor design with a 14-inch diameter lower helix blade and a 16-inch diameter upper blade to support a vertical load of 31 kips and resist an uplift force of 15.5 kips.

During the installation of the east anchor (No. 1), it was noted due to the density and nature of the soil at a depth of 14 feet, the maximum 20,593 ft-lbs torque output of the 321C Caterpillar had been reached indicating refusal had occurred to further anchor penetration. In order to encounter less resistance for the balance of the two anchors and achieve the desired depths for the center and west anchor, the upper helix blade was reduced in the field to a 14-inch diameter helix. This allowed

for less resistance of the cutting blade and therefore, the final installation depths of the last two anchors were 19 feet providing a comparison of uplift resistance at two depths, 14 and 19 feet for anchors No. 1 and No. 3, while testing the center anchor at 19 feet for the designed loading condition.

Proof-Load Test

Four proof-load test cycles for the three anchors were performed using an I-beam capable of minimum deflection under loads of 100 kips, and a hydraulic jack capable of producing loads in excess of 100 kips. A load cell readout device was used to monitor the applied loads to the anchors. With the beam attached to the two outside anchors, a vertical load of 30 kips was initially applied to the center compression anchor for approximately two hours. No movement was observed during the two hour test on the three anchors. The load was then increased to 60 kips and was monitored for movement for an additional two hours with a maximum displacement of 1/16-inch recorded for each anchor. The load was then increased to 70 kips for a third two-hour period, at which time, measurements were taken and the center compression member moved an additional 1/16-inch with no movement noted on the two outside tension members. The load was then increased to 90 kips for a short duration to check the punching shear resistance of the center anchor and then returned to the 70 kips load with no further movement observed. Table I and Table 2, summarizes the results of the installation torque values and proof-load testing displacement for each load sequences and anchor tested. Anchor No. 1 at a 14 ft. depth had a 14-inch and 16-inch helix, while Anchor Nos. 2 and 3 at 19 ft. depth had 14-inch diameter helix blades. These variables were introduced into the test cycle to expedite the installation process and to demonstrate the inherent strength of the Winslow Foundation System under changed depth and helix size configuration.

Discussion

North Las Vegas is well known for its caliche deposits and it was anticipated that random caliche material would be encountered in the anchor installation process. During the initial installation of a

helical anchor at a depth of 10 feet on November 3, 2005, it was noted that a hard material causing anchor obstruction was encountered as evident by the increased torque values and a grinding noise occurring as the helical anchor advanced with little or no depth variation during installation procedures. After attempting to break through this layer, the anchor was removed to examine the helix blade revealing the lower helix blade had been bent from the obstruction. Two other anchors were then installed at new locations in line with the test layout to the design depth without an installation problem associated with the buried caliche materials.

The three anchors installed were in proper alignment for the proof-load test and the 70 kip proof-load test was successfully performed. The proof-load test revealed a minor movement of the center helix of 1/8-inch even with a short term load of 90 kips, which further demonstrates the strength of the Winslow Foundation system without adverse movement under maximum compression or uplift forces. The two end uplift anchors moved only 1/16-inch with Anchor No. 1 at a depth of 14 ft. and a larger 16-inch diameter helix and Anchor No. 3 at 19 ft. deep with two 14-inch diameter helixes. The shallow Anchor No. 1 had a maximum uplift of 35 kips and the deeper anchor No. 3 had a maximum uplift of 55 kips with no movement for the 90 kips maximum compression load condition.

Conclusion

The installation and proof-load test of the Winslow Helical Anchor system has demonstrated the strength and reliability of the proposed helical anchor foundation system. Fine tuning of the anchor assembly, including blade size and depth of embedment may be warranted to achieve a balanced design for the foundation components and the depth into the subsoil materials for the final production residential foundation system.

The current depth requirement is based on the active zone of 15 feet where potential moisture content variations occur. It may be useful to perform a sample saturation test with variable depth anchors to determine the active zone, which can be accomplished by installing a permeable anchor shaft at various depths with measured uplift movement from the expansive soils after maintaining a

constant water head in the center pipe for time periods measured each day for one week.

If you should have any questions or require additional information, please feel free to contact this office at your earliest convenience.

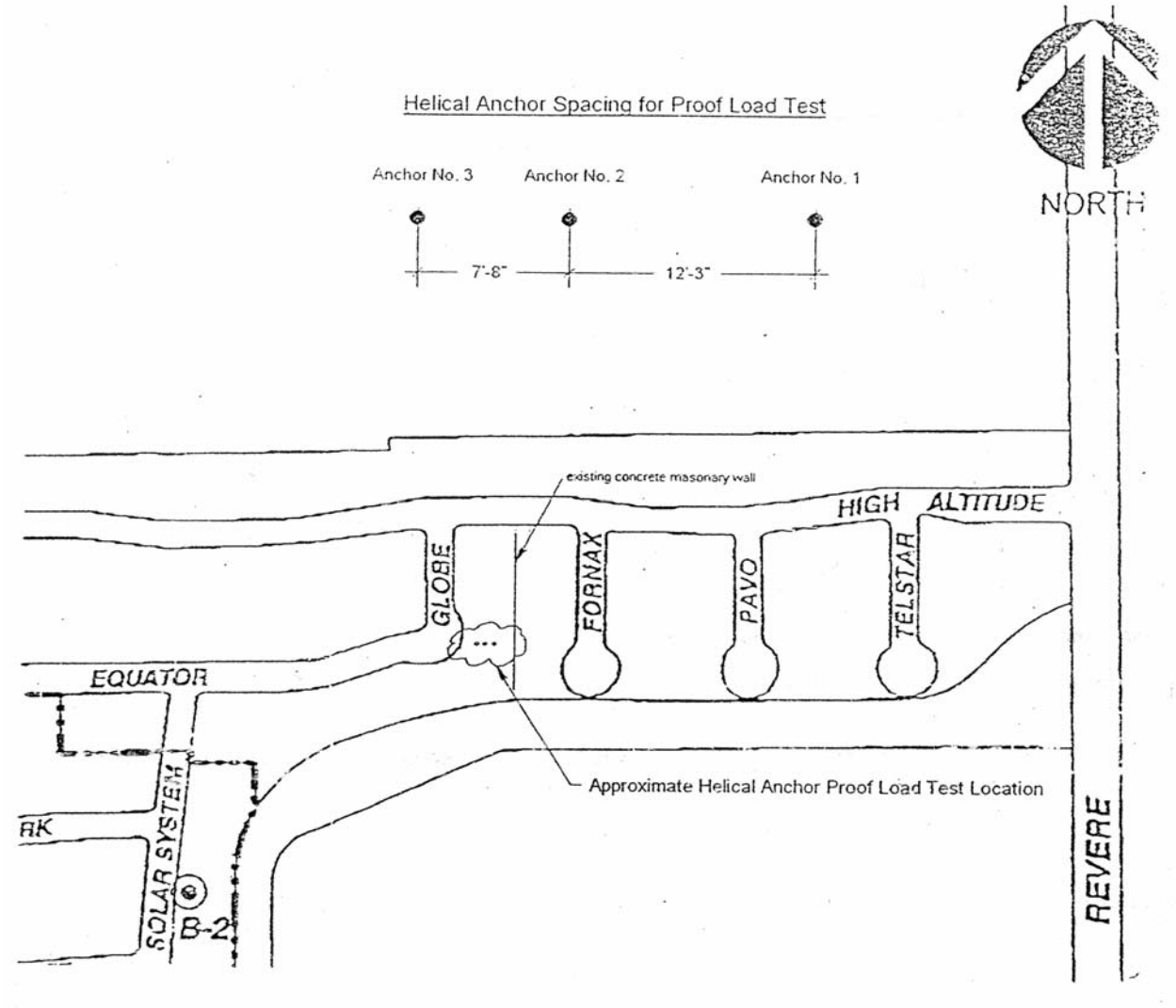
Reviewed by:

Daniel J. Rhoades, P.E.
Principal
G.E. 716, Expires: 06/30/07

Very truly yours,

PURCELL, RHOADES & ASSOCIATES

John L. Maier
Staff Engineer



Note: Plan View map of Northstar Estates Subdivision, North Las Vegas, Nevada acquired from "Geotechnical Exploration Report, Northstar Estates, Alexander Rd. E/O MLK Blvd., North Las Vegas, Nevada," Dated October 13, 20005, prepared by Owens Geotechnical, Inc.

Purcell, Rhodes & Associates

Geotechnical Environmental Materials Testing

SITE PLAN AND PROOF LOAD TEST LOCATION
Northstar Estates, North Las Vegas, Nevada

Date	Drawn by	Checked by	Job No.	Figure
12/22/05	JLM	DJR	7193-01	1
SCALE	CLIENT			SHEET
Not to scale	Pacific Housing Systems, Inc.			1/1

Table 1

Torque vs Depth Field Data Sheets

Northstar Estates
North Las Vegas, Nevada

Anchor No.	Date	Depth ft.	Pressure psi (x100)	Torque %	Torque Ft-lbs.	Remarks
1	11/3/05	1	12	24	4942	1,14" diameter lower helix and 1, 16" diameter upper helix ½" thick, and 3/8"thick, 3.5" diameter hub
		2	12	24	4942	
		3	20	40	8237	
		4	25	50	10297	
		5	30	60	12356	
		6	35	70	14415	
		7	40	80	16475	
		8	45	90	18534	
		9	47	94	19358	
		10	47	94	19358	
		11	47	94	19358	
		12	47	94	19358	
		13	47	94	19358	
		14	50	100	20593	
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				
		26				

Table 1

Torque vs Depth Field Data Sheets

Northstar Estates
North Las Vegas, Nevada

Anchor No.	Date	Depth ft.	Pressure psi (x100)	Torque %	Torque Ft-lbs.	Remarks
2	11/4/05	1	12	24	4942	2, 14" diameter helix ½" thick, and 3/8" thick, 3.5" diameter hub
		2	12	24	4942	
		3	25	50	10297	
		4	17	34	7002	
		5	20	40	8237	
		6	25	50	10297	
		7	35	70	14415	
		8	40	80	16475	
		9	45	90	18534	
		10	47	94	19358	
		11	47	94	19358	
		12	47	94	19358	
		13	47	94	19358	
		14	47	94	19358	
		15	47	94	19358	
		16	47	94	19358	
		17	47	94	19358	
		18	47	94	19358	
		19	47	94	19358	
		20				
		21				
		22				
		23				
		24				
		25				
		26				

Table 1

Torque vs Depth Field Data Sheets

Northstar Estates
North Las Vegas, Nevada

Anchor No.	Date	Depth ft.	Pressure psi (x100)	Torque %	Torque Ft-lbs.	Remarks
3	11/4/05	1	12	24	4942	2, 14" diameter helix ½" thick, and 3/8" thick, 3.5" diameter hub
		2	12	24	4942	
		3	15	30	6178	
		4	20	40	8237	
		5	20	40	8237	
		6	20	40	8237	
		7	35	70	14415	
		8	45	90	18534	
		9	47	94	19358	
		10	45	90	18534	
		11	45	90	18534	
		12	47	94	19358	
		13	47	94	19358	
		14	47	94	19358	
		15	47	94	19358	
		16	47	94	19358	
		17	47	94	19358	
		18	47	94	19358	
		19	47	94	19358	
		20				
		21				
		22				
		23				
		24				
		25				
		26				

Table 2

Proof Load Test Summary

Test 1

Load (kips)	Test No.	Vertical Movements (in.) Center Compression Anchor No. 2	Left Tension Anchor No. 3	Right Tension Anchor No. 1
18.5	1	---	0	---
30	1	0	---	---
11.5	1	---	---	0

Load (kips)	Test No.	Vertical Movements (in.) Center Compression Anchor No. 2	Left Tension Anchor No. 3	Right Tension Anchor No. 1
36.9	2	---	1/16	---
60	2	1/16	---	---
23.1	2	---	---	1/16

Load (kips)	Test No.	Vertical Movements (in.) Center Compression Anchor No. 2	Left Tension Anchor No.3	Right Tension Anchor No. 1
43.1	3	---	0	---
70	3	1/16	---	---
26.9	3	---	---	0

Load (kips)	Test No.	Vertical Movements (in.) Center Compression Anchor No. 2	Left Tension Anchor No. 3	Right Tension Anchor No. 1
55.4	4	---	0	---
90	4	0	---	---
34.6	4	---	---	0

Table 2

Proof Load Test Summary

SUMMARY OF TOTAL VERTICAL MOVEMENT (in.)

Test No.	Load (kips)	Center Compression Anchor	Left Tension Anchor	Right Tension Anchor
1	30	0	0	0
2	60	1/16	1/16	1/16
3	70	0	1/16	0
4	90	0	0	0
TOTAL		**1/16**	**1/8**	**1/16**

Observation and Testing of Winslow Helical Anchors
Northstar Estates, Beazer Homes (Alexander Rd. East of MLK Blvd.)
North Las Vegas, Nevada