ENCYCLOPEDIA OF ANCHORING

C

ANCHOR TESTING

SECTION C

www.hubbellpowersystems.com
E-mail: hpsliterature@hubbell.com
Phone: 573-682-5521 Fax: 573-682-8714

HUBBELL / CHANCE — CENTRALIA, MO 65240

Rev. 9/13

Utility Screw Anchor Testing

No other element in utility anchoring is as important to a utility as the ultimate performance of the anchors they install. For many years the only in-the-field aids to anchoring were the Chance Soil Classification Chart and the utility's experience with the anchors on another part of the system.

However, when Chance introduced the first utility screw anchors we began an accelerated testing program that led to the early development of the Soil Test Probe. The probe is still widely used to determine soil bearing strength and other soil characteristics related to anchoring. With an ever increasing knowledge of soil mechanics, due to a very comprehensive development and testing program, Chance moved up the anchor development trail from the "No Wrench" screw anchor to the early power-installed screw anchor (PISA®) anchor system.

Further testing by Chance engineers led to the eventual development of reliable and workable soil and anchor application charts. Even with all this experience, early screw anchor designs were limited in the applications to relatively soft homogeneous soils. However, with the improvement in the capabilities of installation equipment, it was possible to develop anchors that could penetrate more difficult soil conditions.

Thorough testing of each new anchor design, metallurgy, shaft, weld and helix supplied information that permitted Chance engineers to make trade-offs to establish optimum performance parameters and user economy. Field tests with the latest model installing equipment brought forth newer, tougher anchors. As additional knowledge was assimilated, a new breed of utility anchors evolved to perform anchoring functions not previously believed possible.

The new PISA®, RR and SS anchors required more powerful, more sophisticated installing tools and equipment. Chance and the remainder of the industry were equal to the challenge and opened up new horizons in screw anchor applications. Today, modern anchor testing and installation equipment has made it possible to install power-installed screw anchors into soils of almost every classification throughout the world.

The many years of anchor testing and development efforts have provided Chance with an accumulation of data of which careful evaluation has brought forth some rather startling discoveries. One such discovery, and of vital importance, is the Chance Torque-Performance hypothesis. This theory states that a correlation exists between "Installation Torque" and "Holding Capacity" for a given anchor. Evaluation of the information we obtained from our testing with the Chance Soil Test Probe revealed that as the probe was driven into firmer soil, the installation torque increased with the soil bearing strength.

Subsequent examination of these soils showed that probe installation torque was directly related to specific soil characteristics. Correlation of these studies lead to the eventual development of the "Torque-Performance" method.

Although probe testing is still used by Chance prior to anchor testing and is recommended for field-testing applications where soil properties are not generally known, it is not always necessary to do so. In fact, it is not usually necessary to pull- test anchors on your system to determine anchor performance. Thousands of anchor pull tests where anchor installation torques were known have resulted in a table of tensile ratings for Chance anchors that are directly related to installation torque. This information can be applied to field applications.

An inexpensive tool developed by Chance to reduce the requirements for field pull testing is a mechanical shear pin, torque limiting device. It is used to determine the performance of PISA® anchors and other Chance anchors where installing torque does not exceed 10,000 ft.-lbs.

Modern Testing

We have discussed the value of testing. Now it is time to illustrate and explain how Chance personnel conduct anchor tests, the type of equipment used and how the test data is evaluated. We will also explain how meaningful anchor testing may be conducted on your system. It is our intention to show minimal equipment requirements and explain the procedures you should employ when conducting anchor performance tests in order to obtain valid performance data.

Chance anchors and tooling are designed to keep up with today's high-torque diggers.

Chance has invested substantial sums into personnel and anchor research and development.

Chance has the personnel and equipment you need to bring modern power-installed anchoring to your system.

Comparing Anchor Performance

When comparing anchors, conclusions relative to anchor superiority are reached only when all anchors have been tested under identically controlled conditions. Any deviations render the tests invalid.

Any engineer familiar with soil mechanics knows that soil is seldom homogeneous. Its dissimilar characteristics are revealed in an irregular pattern by soil tests. Earth is made up of strata varying in thickness, firmness, cohesion, shear strength, moisture and many other factors that regulate a soil's ability to sustain tensile or compressive loading. Soil testing with the Chance earth probe (below) is a major first step prior to anchor testing.

Minor peculiarities in soil composition may have substantial influence on anchor performance and because these variances may occur within a relatively small area, tests to evaluate the relative merit of anchor design must be made on each specimen type in the same area and preferably on the same day.

All specimens should be installed as close as their effect on the soil will permit. For example, expanding anchors, because of the lateral pressures they exert may be spaced 8 to 10 feet apart. Screw anchors may be spaced closer 3 to 5 feet apart.

Close monitoring of the installing effort is possible by observing and recording the torque and down pressure.

The Chance Soil Test Probe enables quick identification of the sub-soil to properly mate anchor and holding requirements.

C

Chance anchor testing results enable us to recommend the right anchors for your locale.

However, it is easy to observe, even without gauges, when one specimen strikes an obstruction and another does not. Specimens should be installed under conditions as nearly identical as is possible. Obviously dissimilarities in the test media exert different mechanical stresses on the anchors which will be reflected in tension or compressive loading capabilities.

Tests conducted on high-strength anchors such as this SS (Square Shaft) multi-helix guy anchor (left) require the same considerations as do anchors of smaller tensile ratings. Spacing is increased between specimens but the attention to torque, rotational speed and down pressure are critical for a comprehensive test.

Other specimens are driven to the same exacting standards. The results are recorded in identical steps for study and analysis.

It is patently false to compare anchor specimens tested in different locations or under less than identical circumstances. Soils in the same general area often show wide variations.

With more than 94 years experience in earth anchor testing of many types or anchors in every state within the continental United States and in areas of Canada and Mexico, we have learned that to truly evaluate design and performance, critical attention should be given to every factor that can have a bearing on the tests. Our testing procedures have been developed with the foregoing in mind. In view of the current interest in testing power-installed screw anchors, the following guide lines are offered:

a. When evaluating anchor types, install three or more at each test site.
b Install the anchors as close as possible, usually within 3 to 5 feet of adjacent anchor.
c. Drive each anchor at the same constant rate of rotation.
d. Weaving affects torque and bearing strength, hold weaving to a minimum.
e. Employ the same driving angle.
f. Install each anchor specimen to the same depth.
g. Make a complete record of each measurable step during the test. Include all data that has a direct relationship to the testing cycle.

ANCHOR TEST REPORT

TEST REPORT NO: [illegible] PROJECT NO: [illegible]
DATE OF TEST: 12 06 97
ANCHOR TYPE: TOUGH ONE 15 (15000 FT. LBS.) CAT. NO: [illegible]
DESCRIPTION: [illegible] DIA HELIX WITH 50 KIP ROD, INSTALLED WITH TOUGH ONE WRENCH AND [illegible] TORQUE INDICATOR
TESTED FOR: ENGINEERING RESEARCH
LOCATION: [illegible] SINK HOLE NEAR ELDRIDGE, MO
[illegible] COUNTY, MISSOURI WEATHER: CLOUDY, COLD 35-40 DEGREES
DEPTH INSTALLED: 7 FEET (ALONG ROD) 7 FEET (VERTICAL) 90 DEGREES (ANGLE)

LOAD TEST RESULTS

TEST LOAD (KIPS)	TIME ELAPSED (MIN)	SCALE READING (IN)	DEFLECTION (IN)
5		0.00	0.00
10		0.02	0.03
10	0.50	0.05	0.05
20		0.22	0.22
20	0.50	0.27	0.22
30		0.38	0.38
30	0.50	0.44	0.44
30	0.50	0.44	0.44
40		0.56	0.56
40	0.50	0.63	0.63
40	0.50	0.63	0.63
45		0.72	0.72
45	0.50	0.72	0.73
45	0.50	0.88	0.88
45	0.50	0.94	0.94
45	0.50	0.97	0.97
45	0.50	0.97	0.97
50		1.25	1.25
50	0.50	1.69	1.69
50	0.50	1.72	1.72
50	0.50	1.72	1.72
55	0.50	1.97	1.97
55	0.50	2.28	2.28
55	0.50	2.34	2.34
55	0.50	2.34	2.34
60		2.56	2.56
60	0.50	2.91	2.91
60	0.50	2.91	2.91
62.5		3.00	3.03
62.5	0.50	3.22	3.22
62.5	0.50	3.22	3.25
62.5	0.50	3.28	3.28
65		3.38	3.38
65	0.50	3.63	3.63
65	0.50	3.72	3.72
65	0.50	3.75	3.75
65	0.50	3.75	3.75
[illegible]		3.19	3.17

INSTALLATION TORQUE

DEPTH ALONG ROD (FT)	INSTALL. TORQUE (LB-FT)	COMMENTS
0.5		
1		
1.5		
2	3.6	
2.5	5	
3	6	
3.5	7.3	
4	[illegible]	
4.5	[illegible]	
5	[illegible]	
5.5	[illegible]	
6	14	
6.5		
7	15 +	

ANCHOR RETRIEVED WITH [illegible] CONE DOWN OF HELIX.

SOIL TEST RESULTS

VERTICAL DEPTH (FT)	TEST DATA	SOIL CLASS

-- SOIL INFORMATION --
SOIL CONSISTED OF ORANGE-RED CLAY MIXED WITH COBBLES OF LIMESTONE. A HARD, [illegible] LAYER OF DETERIORATED LIMESTONE AND CLAY WAS PRESENT AT THE 2.5 FT. LAYER AND AT THE 5-6 FT. LAYER.

RESULT SUMMARY
EFFECTIVE TORQUE (LB FT): 12260 ULTIMATE LOAD (LB): [illegible]
LOAD @ [illegible] (LBS): 65000 LOAD @ [illegible] (LB): 45000

SITE CONDITIONS
CLAY(X) SILT() SAND() GRAVEL(X) COBBLES(X) BOULDERS()
ROCK (TYPE): LIMESTONE
DRY(X) MOIST() SATURATED() HARD() FIRM(X) SOFT()

EQUIPMENT USED: ALTEC D1000 DIGGER DERRICK WITH [illegible], [illegible] TORQUE INDICATOR, TRANSIT, [illegible] PULL TEST UNIT.

TESTED BY: DAN HAMILTON, G. SEIDER
OBSERVED BY: TIM [illegible], KEVIN [illegible], TIM [illegible], MIKE DENNIS

REPORT BY: G. SEIDER
APPROVED BY: [signature]

h. Significant differences in installation torque should be recorded for each anchor type where driving torque is to be credited to anchor design.

i. Remember, variance in down pressures and rotational speed influence the driving effort (installation torque) as well as helix stress.

Tension Testing Screw Anchors

Years of research have resulted in the development of a set of standards for tension testing screw anchors. Proper testing procedures, adequate equipment and precise evaluation of testing data must be combined to ensure valid performance conclusions. Generally such testing follows the illustrated procedures outlined below. A reference scale is affixed to the anchor shaft or the piston of the hydraulic pull test unit. The movement of the scale is observed with a transit and as the anchor moves under tension loading, anchor creep can be observed.

The line of action of the tension load must be in a direct line with the axis of the anchor rod to eliminate side loads on the anchor shaft.

The same rate of loading is applied to each anchor specimen. Increasing the rate of loading will increase apparent load strength. Failure to control the rate of loading negates the validity of the test.

Raise the load is steps. Stop at intervals for anchor creep measurements. Waiting time at each step should be between 3 and 5 minutes.

Hydraulic pull test unit.

Transit is used to measure anchor creep.

This wait provides sufficient time for creep to occur before raising the tension load to the next step. Load may be in 2500 to 5000 pound increments according to anchor size. However, the load increment should never be larger than 25% of the anticipated ultimate load. Remember, the smaller the step the more accurate the evaluation. Record the cumulative creep at each step. Treat each anchor specimen exactly like the first in size of step and hold time.

The test should be discontinued when cumulative creep exceeds 4 inches. An anchor is considered to have failed to sustain an applied load when creep/minute is uniform or increasing. Remember, initially there will be some noticeable creep as the anchor beds itself, recompressing the soil above, which was disturbed during anchor installation. Each load increase will result in additional creep as the soil is further compressed. However, it is creep under sustained load and the cumulative load that is significant for soils of near equal consistency. Multiple tests are required to average local soil variance.

Rules For Tension Load Anchor Testing:

a. Establish a reference point on the rod.
b. Use a transit to observe movement of the reference point.
c. Load evenly and in a direct line with the axis of the anchor rod.
d. Use the same rate of loading for each anchor.
e. Raise load in steps.
f. Steps should never exceed 25% of the expected ultimate load.
g. Wait 3 to 5 minutes and observe cumulative creep.
h. Raise to next step and repeat the waiting period.
i. Discontinue test when anchor creep exceeds 4 inches.
j. Record all data—applied load, creep per minute, etc.
k. Install several anchors of each specimen in local soils of near equal consistency.
l. Make multiple tests.
m. Evaluate recorded test data.

Utility Testing Procedures

Although special anchor installing and pull testing machines are not usually available to the utilities, anchor comparison tests can be conducted in the field, using a standard digger derrick. Procedures for conducting such tests are similar to those established for Chance R&D testing.

Anchor comparison testing in the field requires the same attention to procedures as does manufacturing R&D, if the results are to be considered conclusive.

Special equipment requirements are determined by the test objectives. If the installation torque is to be a major consideration of the tests, a torque indicator is required that will measure installation torque at the anchor.

When sustained tension loading is to be a test objective, suitable pulling equipment and a direct reading torque indicator or dynamometer will be required.

TESTING SEQUENCE

The logical first step in anchor comparison testing is to define the soils at the test site using the soil test probe. The probe eliminates the need for costly and time consuming core sampling.

An adequate supply of anchor specimens should be available, preferably three or more of each type. For example, if the

All pull-test data should be recorded.

The Chance torque indicator turns each anchor installation into a test of anchor holding capacity.

15,000 ft-lb. Tough One® Anchor

test is to include performance comparisons between the single 10" helix, the twin 8" helix and/or the twin 10" helix anchors, at least three specimens of each type should be tested.

HOW YOU INSTALL ANCHORS IS VERY IMPORTANT

When installing screw anchor specimens, they should be no closer than 5 feet apart.

a. Start the anchors in a vertical plane and when the helix has penetrated the soil to a depth of approximately 1 foot, instruct the operator to establish the proper slope.
b. The slope should be the same for each anchor specimen and the slope should be measured.
c. The drive speed and down pressure should be maintained as near constant as possible. Each anchor should be installed under exactly the same conditions. Increasing or decreasing the drive speed and down pressure will give a false torque indication and comparison data will be invalid.
d. Control weaving as much as possible. Digger derrick equipment can be easily overstressed.
e. Align the anchor with the axis of the boom to prevent harmful lateral stresses on the derrick.
f. If obstructions are encountered and anchor refusal should occur, retrieve the anchor and move it to the right or left several feet and try again. However, soil probing should reduce the chances of encountering obstructions that might lead to anchor refusal.

PULL TESTING

Tension withstand can only be determined by applying a sustained tension load on the anchors. The necessary equipment to accomplish this testing phase can be a portable hydraulic, jury-rigged structure, with a dynamometer to portray the applied load. Also place a stationary line across a reference point that has been affixed to the rod of the anchor or to a hydraulic piston of the pulling rig. Creep can be read with reasonable accuracy without the aid of a transit.

It may be possible to arrange for the Chance demonstrator to bring his anchor pulling rig to your demonstration or testing program.

Measures for tension testing on utility properties are the same as for R&D testing at Chance anchor test sites.

a. Load evenly and in a direct line with the axis of the anchor rod.
b. Use the same rate of loading on each anchor specimen.
c. Raise the load in steps. Wait at each step for creep under sustained load.
d. Never make a load step greater than 25% of anticipated total load.

Start anchors in a near vertical position.

With anchor at proper depth, release tooling.

Install eyenut and secure guy.

C

Look to Chance for 100 plus years of anchor expertise.

e. Remember, the smaller the loading step the more accurate the evaluation.
f. Treat each anchor alike in size of steps and hold times.
g. The anchor has failed to sustain an applied load when creep per minute is uniform or increasing. Terminate the test when cumulative creep exceeds 4".
h. Multiple tests are required to average local soil variances.

TORQUE AND PERFORMANCE

A table of anchor performance values is furnished with each tool. These values are the result of many years of correlating installation torque with tension withstand. This data applies to Chance anchors and cannot necessarily be applied to other anchor brands where manufacturing techniques, material specifications and anchor designs are different from those of Chance. These tools are effective for anchoring applications in any soil where PISA® and SS anchors may be installed.

When requested by a utility, a special torque and performance chart is prepared for the utility based on soil conditions indigenous to the local area as illustrated. This is another service performed by Chance anchor men.

Typical anchor test set up.

C