CORROSION EVALUATION FOR HUBBELL COMBO-PILE SHAFT HELICAL FOUNDATIONS

PROJECT: Carroll Peak Elementary School

ESTIMATION OF LIFE OF HELICAL FOUNDATIONS:
C11164

REQUEST:

It was requested that an estimate be made of the life of the combo-pile shaft helical foundations material proposed for use on this project.

GIVEN:

Following chart of resistivity and pH values provided by Charles Jackson on behalf of Jay Sappington via Josh Lindburg with Helical Concepts .

Depth Below Ground (feet)	Resistivity (OHM-CM)	pH
4-5	330	6.96
14-15	250	7.01
24-25	500	7.08

The following was provided to define the helical foundation to be used.

Ultimate capacity=70 kips; Design Compression Load = 35 kips
SS200/RS3500 pile system
6"-8"-10"-12" configuration
Job Location: Fort Worth, TX
Estimated Installation Depth: 20 to 30 feet

ASSUMPTIONS:

No steel or galvanize loss rates were given or estimated, so it is assumed that data found in National Bureau of Standards Circular #579, 1957, are appropriate for use as indication of corrosion rates to be anticipated at this site.

STEEL LOSS RATE:

Corrosion rate data can be found for site number 2 in Dallas, Texas, in NBS Circular #579. The soil is described as “Bell Clay.” The values for steel loss rates and zinc loss rates from site number 2 will be considered.

Table 6 on pages 19 and 20 in Circular #579 gives the following values.

Soil No.	Resistivity Ohm-cm	pH
2	684	7.3

Loss rates are reported for Soil No. 2 in table 13 on page 26 as follows:

	Loss In Weight (oz/ft^2)	Calculated Ave Loss in Wt / Yr (oz/ft^2)
	1.5"	1.5"
Years	Pipe	Pipe
2.1	2.4	0.75
4.0	3.0	0.576
5.9	3.4	0.456
7.9	3.6	0.456
12	5.9	0.492
17.6	8.1	0.460

The average of the above loss rates will be considered in estimation of the life of steel in the ground. The average of the loss rates **for steel** is **0.646 oz/ft^2/year**.

The life of the helical screw foundation shaft is the allowable weight loss divided by the rate of loss per year.

ZINC LOSS RATE

Table 65 on page 110, gives loss rates of zinc on galvanized pipe and galvanized steel sheet. The loss rates of zinc for soil number 2 is as follows.

Soil No.	Time (yrs)	Average Loss (oz/ft2)	Loss / Year ($oz/ft^2/yr$)
2	9.92	0.44	0.044

The rate of loss **for zinc** is **0.044 oz/ft^2/year** and will be used for further calculations.

ANOTHER WAY TO OBTAIN STEEL LOSS RATE:

That data in NBS Circular #57can be presented in a number of forms. The last page of this evaluation, Figure A-5 is one form which is available in the Chance Civil Construction Technical Design Manual Appendix A page A-7.

Review of the given resistivity values reveals that use of a resistivity of 200 ohm-cm is conservative and thus will be used here. The pH of 7 will be used to enter Figure A-5. So entering Figure A-5 with 200 ohm-cm and pH of 7, we find that the loss in weight by corrosion is approximately 10 oz/sq ft/10 year period. This reduces to **1.0 oz/sq ft/year for steel**.

MATERIAL THICKNESS LOSS OF PIPE SHAFT:

Only the pipe shaft will be considered as its location near the surface will deem it the most likely candidate if corrosion occurs.

The RS3500.300 pipe shaft is 50 ksi material. Since we will use the ultimate load of 70 kips for calculations, no reduction in the material strength will be used, i.e. there will be a safety factor of 2 in the calculations based on use of ultimate load.

Area of 3.5" o.d. pipe with 0.300 wall = π(D^2/4 – d^2/4) = 3.02 sq in

Required Shaft Area = Load / Material Strength = 70 kips / 50 ksi = 1.4 sq in

Allowable Area Loss = Area 3.5' pipe – Required Shaft Area = 1.62 sq in

Determine thickness of material that can be lost:

A = π (D^2/4 – d^2/4)
A = 1.62 sq in
D = 3.5 in
So, d = 3.19 in

Thickness that can be lost = (D – d) / 2 = **0.154 in** of thickness

Convert allowed thickness loss to allowable weight loss ounces / square foot.

Weight of Steel: 490 lbs/cu ft

Allowable weight loss:0.154 in x 490 lbs/cu ft x (1 ft/12 in) x 16 oz/lb = **100.6 oz/sq ft**

Two different loss rates for steel have been calculated:
0.646 oz/sq ft/year was determined from Dallas, Texas data.
1.0 oz/sq ft/year was determined from the graph for conservative resistivity and pH values.

Using the most conservative loss rate, we find a steel life of:

100.6 0z/sq ft / loss rate of 1 oz/sq ft/yr = **100.6 years estimated life of steel**

TIME FOR GALVANIZE LOSS:

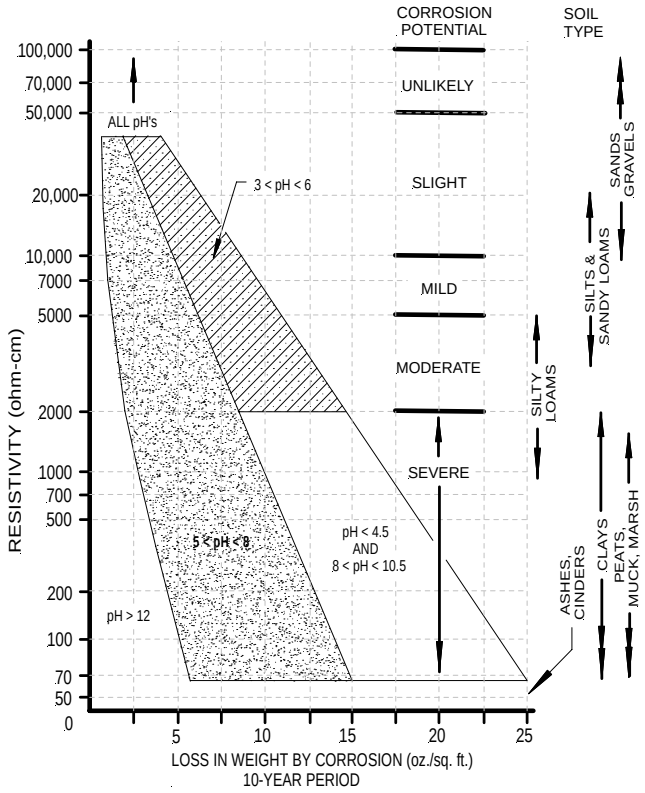
Per ASTM A153 Coating B the zinc thickness is 1.8 oz/ft^2

Estimated Time to Loose Galvanize

(1.8 oz/ft^2) / (0.044oz/ft^2/yr) = **40.9 years**

TOTAL ESTIMATED LIFE OF THE PIPE:

100 years + 40 years (galvanize) = 140 years



Steel Loss Due to Corrosion
Figure A-5

Romanoff's data can also be arranged in easy-to-use graphs or tables. *Figure A-5* provides a preliminary estimate for metal corrosion loss of bare steel if specific information is available on the soil (soil type, pH and resistivity). *Figure A-5* provides a technique for quickly assessing those situations for which concern and design consideration for corrosion must be taken into account when metallic structures are placed below ground. For example, a clay soil with resistivity of 2000 ohms/cm and a pH of 6 will have an average metal loss rate of approximately 5 oz/ft^2/10yrs, or 0.5 oz/ft^2/yr. This figure was developed from the results of the NBS studies in addition to similar field experimentation results as presented in the *Proceedings*, Eighth International Ash Utilization Symposium, Volume 2, American Coal Ash Association, Washington, DC, 1987.