

Project Parameters

Large power transmission towers were needed in Hampton, New Jersey, and foundations for these towers needed to be designed. This project consists of designing a foundation for a monopole tower and a lattice tower to last 80 years. Parameters of each location are shown in the table below.

Project Demands		
	Monopole	Lattice Tower
Location	Swampy meadowlands near Ocean	Railyard near ocean
Loading	28,000 kip-ft moment and 230 kips shear	416 kip downward load and 340 kip uplift for each foot
Displacement	1 inch in any direction	1 inch in any direction
Structure Height	160 ft	115 ft
Soil Type	Silty clay with bedrock 110 ft from surface	Underconsolidated Clayey silt with no apparent bedrock
Connection Size	10 ft diameter base	19.5 in X 19.5 in

Because the monopole has only one connection at the base, 48 anchor bolts that extend 7 feet deep are required to resist the huge moment. The Lattice Tower has four feet that spread down to the ground eliminating moments at the base. Regardless, each foot exerts a large downward force.

Challenges and Solutions

There were many issues that needed to be resolved. A few are:

- Not knowing how to do the calculations or understanding the design processes of geotechnical or concrete design.
- Learning how to read CPT data for the geotechnical report.
- Dealing with poor soil in meadowlands.
- Determining stresses inside pile caps.

Project Design

The basic design of both foundations consists of piles and a pile cap. Four friction piles (piles that depend on soil friction around each pile) make up the base of each foot on the lattice tower. Eight end-bearing piles (piles that transfer load through soil to bedrock) make up the base of the monopole foundation. The dimensions of the design are shown below.

Foundation Dimensions		
	Monopole	Lattice Tower
Depth of piles	110 feet from surface	100 feet from surface
Pile Type	Square prestressed concrete	Steel HSS Circular Pile
Pile Spacing	8 feet on center	10 feet on center
Pile Size	1 foot square	22 inch diameter and 5/16 inch thick
Pile Cap dimensions	21 feet square with a thickness of 4 feet	15 feet square with a thickness of 3.5 feet
Pile Cap Materials	Reinforced Concrete	Reinforced Concrete

Tedious amounts of research, in addition to help from Kiewit, was needed to overcome our limited experience. For geotechnical foundations, the Army Corps of Engineers and the FHWA (Federal Highway Administration) have documents that explain in detail design processes, equations, and benefits of different options.

Learning how to read the CPT data required searching the internet and asking for help. The soil data was analyzed in 4-foot layers to determine the friction each soil layer would exert the pile. Long piles were needed to develop enough friction in the poor soil of the meadowlands. Stresses in the pile caps were determined by breaking up the caps into simple trusses and beams and using them to determine the internal forces.

Each pile is connected to the pile cap using welded rebar shaped like an "L" in order to develop connection strength to the concrete. The pile cap sizes were determined by the distance needed between piles and the size of the connection. Steel piles were chosen for the lattice tower because they develop good friction and drive relatively easily. Concrete piles were chosen for the monopole because they are well suited for end bearing and resist corrosion.

Photos and Drawings

