

Push Piers and Geo-Lock® Wall Anchors

Project: UMKC - Oak Hall
Location: Kansas City, MO
Date: June 2014

Challenge:

Oak Hall is a five-story building on the University of Missouri-Kansas City (UMKC) campus. Up to three inches of differential settlement was observed between the building's western exterior walls and their adjoining interior corridor walls. UMKC wished to stabilize and potentially lift the settled portion of the structure, which would include underpinning 160 feet of the west side of the building, as well as 50 to 80 feet of the north and south wall returns.

The ground surface around Oak Hall slopes downward from east to west. The east foundation wall, retaining about 12 feet of soil, had leaned inward due to the unbalanced lateral earth pressure. The structural engineer evaluating the building settlement was concerned that stabilizing and lifting the west side of the building could exacerbate the inward lean of the wall section on the opposite side of the structure. Therefore, laterally stabilizing the eastern wall section was specified to coincide with the underpinning operations.

The geotechnical investigation identified a soil profile consisting of six to 17.5 feet of medium stiff to stiff residual clay with shale and limestone fragments, over interlayered, weathered shale and limestone. Auger refusal on hard limestone was observed at depths from 9.5 to 30 feet.

Solution:

A system of hydraulically-driven push piers was selected as the ideal method to stabilize and potentially lift the settled portion of the building. Forty-one (41) Model 288 (2.875-inch O.D. by 0.165-inch wall) push piers were installed to support design working loads up to 25 kips and sixty-two (62) Model 350 (3.50-inch O.D. by 0.165-inch wall) push piers were installed to support design working loads up to 28 kips. A pair of either Model 288 or 350 push piers was installed where design loads at specified pier locations exceeded 28 kips. The piers were installed to depths from 20 to 24 feet below the existing footing and at an eight-foot maximum center-to-center spacing. Due to the presence of "floating" shale and limestone observed in the upper soil profile, the structural engineer specified pre-drilling at each pier location to ensure the piers would bear on competent bedrock. Hydraulic cylinders were then utilized to load the piers to at least 1.5 times the design load. The piers were grout filled and the upper several feet of the piers below the bracket encased in concrete. Hydraulic lift cylinders were fitted to the installed pier assemblies and connected in series to uniformly reload the piers and lift the exterior wall approximately 0.5 inch back toward its original elevation. Two full-scale compression load tests (one for each shaft size) were performed prior to production pier installation to verify the deflection-to-load response. Load tests were completed away from the building using a typical load frame anchored with helical piles.

Lateral stabilization of the eastern wall section included a deadman-type wall system utilizing Geo-Lock® earth anchors. Twenty-six anchor (26) locations were spaced up to six feet on-center to resist a design working tension load of 9.3 kips. The anchors were installed by driving 0.75-inch-diameter threaded rod through holes drilled five feet below the top of the wall. The threaded rods were connected to earth anchor plates located within continuous trenches 25 to 42 feet from the building. The trenches were then filled with concrete. The interior connection detail included continuous, steel channel walers.

Project Summary

Structural Engineers: Structural Engineering Associates; SFA Design Group
Geotechnical Engineer: Terracon Consultants, Inc.
General Contractor: KBR, Inc.
Certified Installer: Foundation Recovery Systems
Products Installed: (41) FSI PP288 Push Piers, (62) FSI PP350, Installed Depths from 20 to 24 feet, Design Working Push Pier Loads ≤ 28 kips; (26) Geo-Lock® Wall Anchors, Design Working Load of 9.3 kips



Predrilling at production pier location



Lift cylinders fitted to installed piers



Pier shafts encased in concrete



Pouring deadman wall to encase Geo-Lock® earth anchor plates



Tightening anchor system at interior waler