

THE RESIDENCES – PARKING GARAGES

Location: Oklahoma City, OK

Project Type: Residential



DUROTERRA™



DUCTILE IRON PILE ADVANTAGES

- High capacity compression and tension load resistance
- Rapid turn-key operation (design through installation)
- Superior load test performance

INTRODUCTION

Construction of “The Residences” mixed-use development in downtown Oklahoma City involved multiple buildings including two 5-story parking garages. Column loads from the 5-story garage exceeded 1,000 kips. Of particular importance were the compression and tension loads requiring support at the shear walls. Static dead and live loads were more than 30 kips per foot with additional overturning loads (compression and tension) from seismic loading of about 800 kips at each end of the walls.

GEOTECHNICAL CONDITIONS

Subsurface conditions encountered at the parking garage locations generally consisted of intermixed layers of loose to medium dense silty sand and soft to stiff sandy silt, silt and clay. These soils extended about 45 feet to rock. Groundwater was encountered at depths of about 15 feet.

PROJECT CHALLENGES

Provide a cost-effective solution for support of both compression and tension loads along heavily-loaded shear walls.



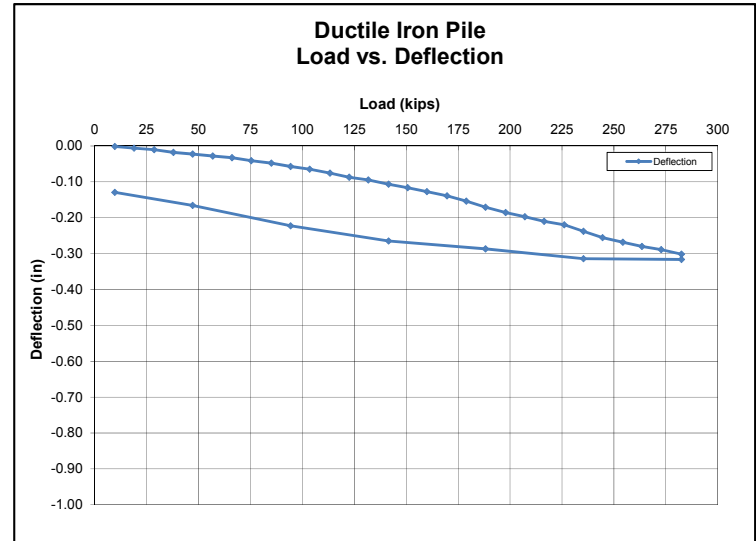
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DESIGN AND CONSTRUCTION SOLUTION

The soil profile and loading conditions were well-suited for rigid inclusions using a Geopier® GeoConcrete® Column (GCC) to support high static compression loads. However, the large overturning loads at the shear walls required a solution to control both compression and tension loads. Engineers at Ground Improvement Engineering, LLC developed a plan to use Geopier GCCs across the majority of the buildings and grouted Ductile Iron Piles to resist combined compression and tension loading at the shear walls.

The Ductile Iron Pile design featured Series 170/7.5 and 170/9.0 piles (170 mm diameter with wall thicknesses of 7.5 or 9.0 mm) with an oversized 270 mm conical end cap. The oversized end cap creates an annular space during driving of the pile. Sand cement grout is continuously pumped through the wet drive shank, down through the pile and out through grout ports in the end cap to completely encapsulate the pile with grout during driving. The end result is a fully-grouted pile that develops substantial grout-to-ground bonding for friction capacity. Further, the design required all piles be installed with the high-frequency percussion hammer to bedrock by achieving “set” of less than one inch of movement in 50 seconds. A high strength 1-¼” diameter Grade 150 ksi center bar was inserted into each pile to resist tension loads. The combination of the end-bearing on rock and grout-to-ground bonding developed compression and tension capacities of up to 190 kips and 85 kips, respectively.

Peterson Contractors, Inc. installed a total of 62 Ductile Iron Piles in addition to 355 GCCs for foundation support. All Ductile Iron Piles terminated on rock at depths on the order of 45 feet. As many as 20 Ductile Iron Piles (~900 LF) were installed in a single day. Load testing was performed on a non-production Ductile Iron Pile with reactions provided by Ductile Iron Piles loaded in tension. The test results confirmed acceptable performance results and showed less than 0.3 inches of movement at loads in excess of 275 kips with only 0.12 inches of net deflection. The project demonstrates how the use of the Ductile Iron Piles are an effective supplement to other systems to solve a variety of design challenges.



PROJECT TEAM

DIP Installation Partner: Peterson Contractors, Inc.
DIP Design Partner: Ground Improvement Engineering, LLC
Geotechnical Engineer: METCO
General Contractor: CMS Willowbrook
Structural Engineers: Connect Structural Engineering, Inc.