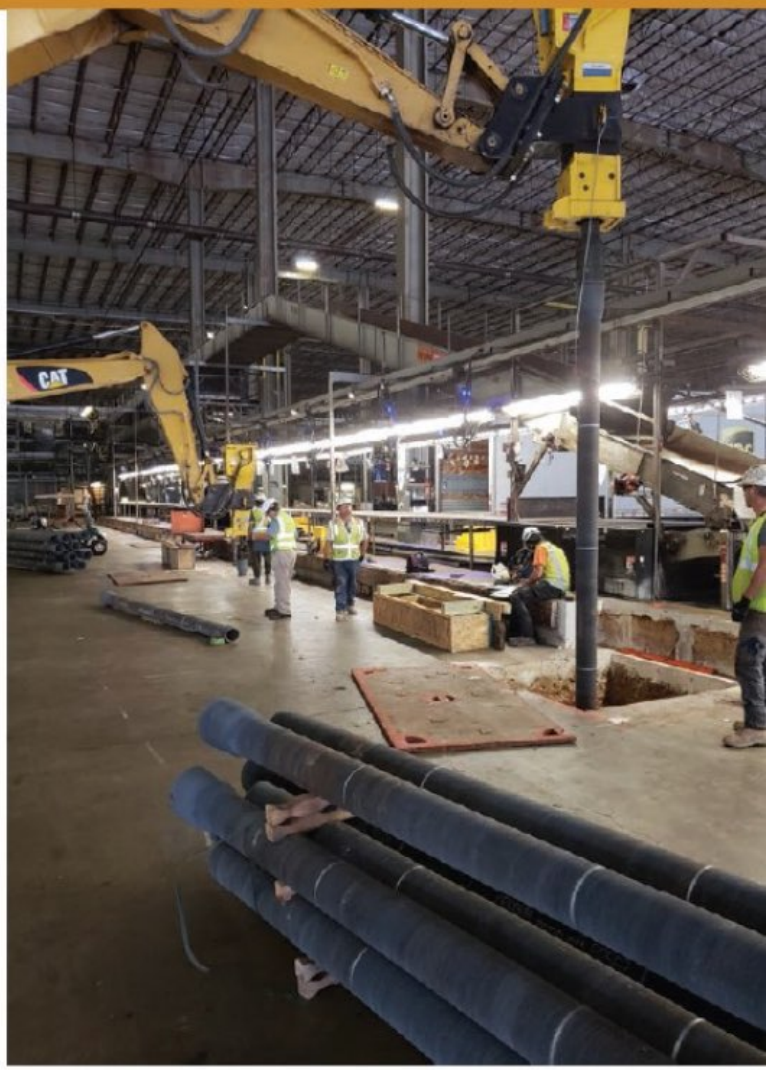


Foundation Support for International Shipping Company

GeoStructures, Inc. earned a Project of the Year Award in the $500,000 to $2 Million category

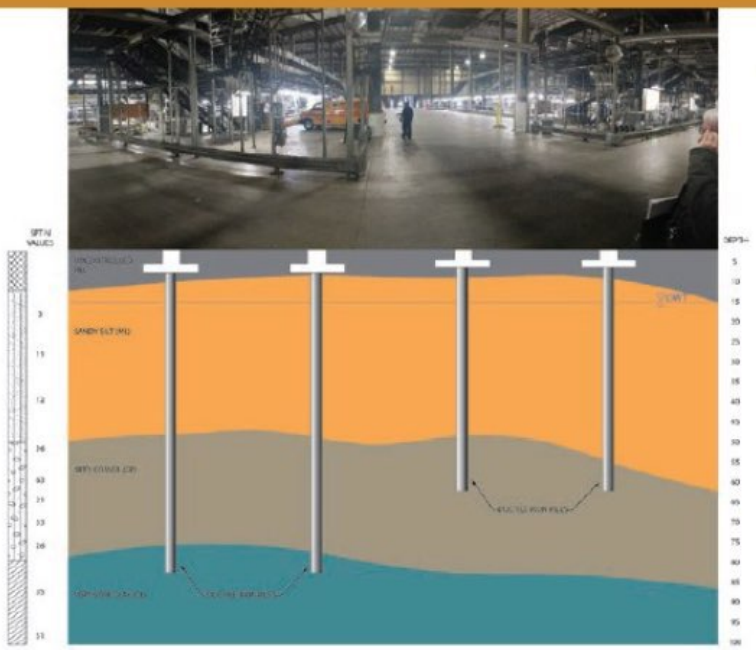
Submitted by GeoStructures, Inc.

Photos courtesy of GeoStructures, Inc.

The foundation support for this international shipping company's project had to be constructed inside the active warehouse under an expedited schedule without disruption to concurrent facility operations. The client required areas of the building be turned over on a nightly basis for use by their operations. This meant that cleanup of pressure grout and spoils generation, along with minimal vibration, were of paramount concern. GeoStructures and fellow PDCA member, DuroTerra, worked with the project geotechnical engineer, Dynamic Earth, to develop a unique application of small-diameter DuroTerra ductile iron piles (DIPs), driven inside with low headroom equipment, to successfully achieve 90 to 150-ton ultimate capacity in soil without a pressure grouted bond between the pile grout-soil interface. Over 300 piles approximately 75 feet long were successfully installed with multiple rigs in less than a month to meet the client's turnover dates – a feat that would not have easily been accomplished using drilled micropiles or other deep foundation techniques.

Innovative methods

Small diameter DIPs were driven in five-meter sections with a unique plug-and-drive connection that develops a cold (friction) weld when driven using a high frequency breaker hammer



Using a design-build approach and multiple load tests performed as production progressed, the designers were able to optimize pile design lengths, capacities and reduce the number of piles to support the footings in the dense lower alluvium and the hard-residual clays.

mounted on an excavator, which rapidly advances the pile through soil with minimal vibration. The compression fit bell and spigot connection enables DIP sections to be driven to depths of more than 100 feet and achieve moderate to high capacity in end bearing. Although only used as reaction anchors on this project, the system can also be installed with an oversized end cap to create a grouted friction pile by pumping grout during installation.

Unique application of piles

DuroTerra DIPs, typically driven to end bearing on rock, achieved their capacity terminating in dense granular and stiff clays as project geotechnical borings did not encounter rock.

Construction problems and creative solutions

The challenges

Adding deep foundation support within an existing active warehouse facility presented several challenges to the team:

1. Finding a cost-effective foundation solution which could be installed in an efficient, time-sensitive manner.
2. Constructing foundations inside the active building without disruption to operations or generating spoils and with minimal vibration.
3. Develop 90- to 150-ton ultimate pile capacity in soil where the bearing stratum generally began 65 feet or deeper below ground surface and rock was not reachable.
4. Install piles inside the warehouse with low headroom equipment and minimal horizontal clearance working around existing structure and active distribution equipment.

Soil conditions consisted of five to 10 feet of sandy fill with variable amounts of clay and organics, overlying 50 to 55 feet of very loose to loose alluvial sands, underlain by 20 to 25 feet of denser alluvial sands, overlying stiff to hard residual clays. Grouted micropile and ground improvement options were not compatible with the operational restrictions or soil conditions, so the geotechnical engineer recommended a DIP foundation be used to support the new column footings.

The solutions

GeoStructures and new PDCA member, DuroTerra, worked with the project geotechnical engineer, Dynamic Earth, to recommend supporting the new mezzanine footings on a DIP foundation system. DIPs had numerous advantages over a drilled micropile or traditional driven pipe or H-pile:

1. Uses a high frequency impact hammer for installation, which reduces vibrations to very low levels.
2. DIP elements come in 16.4-foot (5 m) long sections with a bell and spigot connection, which eliminated the need for threaded or welded splices, minimized waste and provided a workable length pile for the limited site head room, all things that sped up construction.
3. Installed with a small excavator, allowing for construction with as little as 22 feet of headroom working within a small footprint at each pile cap location.
4. Driven to end bearing, the DIPs did not require a pressure grouting operation to develop capacity between the grout-soil interface.

Using a design-build approach and multiple load tests performed as production progressed, the designers were able to optimize pile design lengths, capacities and reduce the number of piles to support the footings in the dense lower alluvium and the hard-residual clays.

Project management

Production DIPs were installed to the top of the bearing stratum about 65 feet below ground surface while four static axial load tests were performed concurrently to maintain the aggressive schedule. Once load tests confirmed DIP design capacity, piles were driven to final tip elevation.

Design changes to driven piles

The project team ultimately selected DIPs over drilled micropile or traditional pile or steel piles due to cost, schedule, operational and performance advantages. This was the right solution for the client. ▼