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Technical Bulletin

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Deep Foundations

Introduction:

Deep foundations typically consist of piles, drilled piers, or caissons and they transmit loads to a deeper, more suitable soil or rock formation. A deep foundation system is generally more expensive than a shallow foundation system, but may be required when shallow soils cannot adequately support the anticipated loads.

Future Technical Bulletins will cover specific details of each type of foundation system as well as general capacities, lengths and installation techniques.

Common Reasons for Using Deep Foundations:

- Large design loads
- Poor soil bearing capacity (very loose or soft soils)
- Excessive settlements
- Site constraints

Geotechnical Engineers consider anticipated structural loading, soil borings, and site layout to determine which foundation system is most suitable for the project. Occasionally, where weak soils are present, ground improvements such as soil compaction, chemical injection, or preloading may be an economical alternative to deep foundations. Geotechnical Engineers determine the most suitable system and outline their recommendations in the Geotechnical Report.

Types of Deep Foundations:

- Piles are slender members (or column elements) which transfer load to a suitable deep soil or rock stratum. Piles utilize skin friction, end bearing (tip) resistance, or a combination to resist the supported loads. Piles can be utilized to resist compressive, tensile and/or lateral loads. Piles are typically installed by driving, drilling, jetting, or jacking.
  - Wood:
    - Round timber piles driven or jetted into the ground
    - Typically 8" tip/12" butt diameter with 15' to 50' length
    - Lower cost and capacity than other pile types
    - Easy to acquire
  - Concrete:
    - Precast piles are reinforced square or octagonal cross-sections driven into the ground
      - Typical size is 10" to 14" and 30' to 120' length
      - Harder to acquire since they must be cast and allowed to cure
      - High capacities and cost efficient

Precast piles in place

- Concrete (cont'd):
  - Auger-cast (cast-in-place) piles installed by drilling a shaft and injecting pressurized grout as the auger is removed
    - Typically 14" to 18" diameter and 50' to 100' length
    - Installed around vibration sensitive structures (i.e. hospitals, older buildings)
- Steel:
  - H-section and HSS pipe piles driven into the ground
  - Typically 8" to 14" H-piles and 8" to 24" diameter HSS pipe piles, 40' to 200' long.
- Composite:
  - Hollow steel member filled with concrete
  - Steel HSS pipe piles driven into ground and filled with concrete

Composite piles in place

- Drilled Piers or Caissons are essentially piles with a larger cross-section.
  - Typically 24" to 60" diameter and 20' to 200' long
  - Transfer loads to the soil similar to piles, but usually have greater capacities
  - Installed by drilling a shaft into the ground and then filling it with concrete
  - Steel reinforcing is placed in the shaft before or after concrete is poured
  - Shaft may be encased with a metal shell (casing) to prevent the shaft from collapsing. Casing also allows the bottom of the shaft to be cleaned and inspected to insure proper bearing conditions. Casing may be left in-place or gradually withdrawn as the shaft is filled with concrete.
  - Typically designed as end-bearing members, neglecting the skin friction, unless they are socketed into rock

Drilled piers in place

- Specialty Piles:
  - Helical Screw Piles:
    The primary application is underpinning or remediation of existing shallow foundations. Screw piles typically consist of a steel shaft with two or more helices near its tip. They are installed using a high-torque hydraulic drive head which 'screws' the anchors into a stable soil strata. Steel shaft extensions can be added to achieve the desired depth.
  - Micro Piles:
    These are small diameter drilled and grouted piles. They are constructed by drilling a borehole, placing reinforcement, and filling the hole with grout. Micro Piles may be considered as a substitute for conventional piles or as a method to improve soil bearing capacity for a shallow foundation system.

Installation of micro piles

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