MICROPILES

Micropiles offer a cost-effective and efficient means to overcome a variety of foundation construction challenges.

Above: Installation of micropiles to support bridge abutments and piers at a restricted access mountain site. HBI also constructed permanent shoring adjacent to the bridge abutments.

Center: A compact drill rig is used to install micropiles in low headroom to support an addition to a medical building.

Micropiles, also known as minipiles, pin piles, needle piles, or root piles, are small-diameter drilled piles. They offer a viable alternative to conventional piling techniques, particularly in the following conditions:

- restricted access
- low headroom
- challenging subsurface conditions
- environments sensitive to noise or vibration

Micropiles originated in Italy after the second World War to repair damaged structures, and the U.S. construction industry widely accepted them in the late 1980s. Micropiles are a unique foundation element because of the ability to install them in very limited access conditions and through a wide range of subsurface conditions.

Hayward Baker, Inc. (HBI) has designed and constructed micropiles for four decades. HBI’s design, management, and field staff have micropile experience in nearly all geologic conditions and for all types of projects. Applications include underpinning, foundation support, slope stabilization, earth retention, and seismic retrofit. Having the most extensive and diverse fleet of drilling equipment enables HBI to match the equipment with the demands of the project. Whether it’s a small single-rig project or one requiring multiple rigs and multiple shifts, HBI can deliver.
Micropiles transfer loads to competent strata to control settlement and provide structural support. Construction is possible at sites with limited headroom or access, settlement or vibration concerns, or sensitive adjacent structures.

**New Loads in Congested Areas**
Compact drill rigs make construction in limited headroom or access areas possible, permitting facility upgrades or repairs with minimal disruption to the facility.

**Underpinning/Arresting Structural Settlement**
Micropiles can remediate settling foundations or increase the capacity of existing foundations. They can also underpin foundations adjacent to planned excavations to prevent settlement.

**Challenging Ground Conditions**
A variety of drilling techniques are available to handle challenging ground conditions such as boulders, karst, and mine geology.

**Seismic Retrofit**
Existing structures can be retrofitted to meet seismic design requirements. Micropiles can transfer loads through liquefiable soils to competent bearing strata.

**Sensitive Areas**
Sensitive areas such as hospitals, aquariums, and schools benefit from the low noise and low vibration levels associated with micropile installation.

**Slope Stabilization**
The Micropile Slide Stabilization System (MS3) can be used to enhance the stability of slopes.

1. Upgrades to a busy commuter rail station required micropiles to be installed in low headroom to support the railway viaduct.
2. Micropiles being used as soldier piles to stop movement of a slope behind a country club with limited access.
3. Micropiles being installed to stabilize a nine-mile segment of an elevated expressway which was distressed due to karst-induced settlement.
4. Installation of micropile casing for a parking garage seismic retrofit.
5. Replacement of an aging rail bridge required micropiles.
6. Cap beam of a reticulated micropile wall installed to arrest movement of a slope behind a luxury resort.
**Micropile Procedures**

A variety of installation methods and micropile configurations are available to meet the needs of the project. One of the more common installation procedures is illustrated below.

1. Begin drilling and/or installation of casing
2. Complete drilling to targeted depth
3. Remove inner drill string (if used)
4. Place reinforcement and install grout by tremie method
5. Pull casing to top of bond zone and inject additional grout under pressure
6. Complete pile

**Design Considerations**

Available geotechnical information is reviewed and evaluated to determine the correct construction procedures for the micropiles, including the selection of equipment, tooling, grout mix design, and drilling methodology.

Micropiles are suited for any type of ground, with capacities ranging from as little as 50 kips (222 kN) to over 2,000 kips (8.90 MN). Steel reinforcement is used to increase the load capacity and stiffness of the micropile. Design must take into account the loading conditions, the structural capacity, and the geotechnical load capacity of bearing strata.

The required micropile geometry depends primarily on the soil conditions and the applied loads. Since soil properties and structural loads vary from project to project, a range of micropile configuration options is needed. HBI offers the full range of micropile systems and can design and construct the most cost effective solution for any project. HBI also has the capability of combining its micropile technology with one or more of its other specialty geotechnical techniques to meet unique or complex project requirements.
**Micropile Drill Rig**
Hayward Baker selects the drilling rig and construction procedure for each micropile project based on site access constraints and the subsurface conditions. In open access sites, larger drills or crane mounted leads can be very productive, reducing cost. Compact rigs allow construction at tight access, low headroom sites. Shortening the drill mast and using threaded drill casing allows micropiles to be installed with less than 8 feet (2.4 m) of headroom. Although the rigs used in these situations are small, the rotary heads are powerful enough to install micropiles into the targeted bearing layer.

**Casing**
Micropile casing most commonly consists of mill secondary, API Grade N80 (80 ksi [550 MPa] yield) steel pipe. It is typically flush threaded using specially designed tapered pipe threads. Micropile casing is often used as the drill rod during installation.

**Cement Grout**
Grouting operations typically use a neat cement grout. In regions with karst or porous formations, low mobility grout can be used to reduce grout loss. Admixtures that control bleed, improve flowability, reduce water content, and retard set may also be used in the grout.

**Reinforcement**
Reinforcement typically consists of a single steel bar. The bar can vary from 60 ksi (410 MPa) conventional reinforcing bar to 150 ksi (1,030 MPa) high strength thread bar.

Installation of micropiles in the basement of an existing parking garage to support a new shear wall that was part of a building upgrade. HBI used a compact drill rig to access this low headroom site.

A section of threaded micropile casing is being added during construction.

Lowering the threaded steel reinforcing bar into the micropile casing.
Quality Control . . .

Load testing verifies that the pile design safely meets the performance requirements.

Pre-Construction
All available geotechnical information and site conditions are reviewed and evaluated to determine the correct design and construction approach for the micropiles, including the selection of equipment, tooling, grout mix design, and drilling method.

During Construction
Daily records maintained for drilling and grouting operations include:

- Pile identification
- Pile location
- Date
- Time of drilling
- Time of grouting
- Soils encountered
- Advancement resistance
- Grout volume
- Grout pressure

Samples of the grout used to construct the piles are cast into cube or cylinder molds. After curing, they are tested in accordance with applicable ASTM standards to verify that the grout strength meets the required unconfined compressive strength.

Post-Construction
Load testing is performed in general accordance with the appropriate ASTM test procedure. In most cases the quick load procedure is used. The test pile is typically loaded to twice the design load to verify pile capacity. The test pile can be fully instrumented to measure the performance of the pile during testing. Data from strain gauges can be used to determine the load transfer to the soil over the length of the micropile bond zone.
Advantages of Hayward Baker Micropiles

Micropiles offer a cost-effective and efficient means to controlling settlement and providing structural support or earth retention. Other advantages of using Hayward Baker for your micropile needs include:

- **Comprehensive fleet of rigs and tooling for difficult subsurface conditions and limited access**
- **Over 40 techniques enable mid-project modifications to the foundation system if required**
- **Nearly 40 years of experience with a wide variety of applications**
- **Experienced at constructing micropiles for a variety of structures, loads, foundation connections, and subsurface conditions from completing over 2,000 micropile projects**
- **Capable of providing value-engineering proposals**

An example of our experience with a wide variety of applications—this remote, restricted access site for transmission lines required helicopters to mobilize equipment and materials.

You have a strong partner with Hayward Baker

Hayward Baker, Inc. (HBI) is North America’s leader in geotechnical construction, offering the full range of construction services for foundation rehabilitation, settlement control, liquefaction mitigation, soil stabilization, groundwater control, slope stability, excavation support, underpinning, and environmental remediation. HBI is annually ranked #1 in the profession by Engineering News-Record (ENR).

Headquartered in Hanover, Maryland, HBI has over 30 offices servicing North and Central America. Since its inception, HBI has established itself in the forefront of geotechnical specialty contracting, evolving and expanding to meet the increasingly complex needs of the construction community. HBI offers design-build and bid-build services for the widest array of geotechnical construction applications.

HBI has the experience and innovation to assist engineers, contractors, and owners with identifying and constructing the most economical solution that satisfies the requirements of each project, typical or unique.