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PND has performed planning, design, and construction inspection for a significant number of marine facilities. These projects have included the design of floating and fixed docks, passenger boarding gangways, fender systems, and upland facilities that are used by various sized vessels, including 1,000-foot-plus cruise ships, ferry vessels, and recreational facilities for pleasure craft. As a firm that specialises in these types of projects, PND has the advantage of knowing the detailed requirements related to all phases of the design, construction, operation and maintenance.
SPIN FIN® PILES

SPIN FIN piles are a cost saving alternative for many pile foundation applications. This PND proprietary invention consists of a pipe pile equipped with angled plate fins. When driven, these piles rotate into the ground and achieve pile capacities far in excess of conventional piles. The strength is derived from the pile tips end bearing.

FUNCTION

PND has performed extensive pile tests in a variety of soils including sand, silt, clay, silt with cohesion, gravel, and dense till. The screw-shaped tip on the pile and friction from the pile shaft give the SPIN FIN pile its strength.

The graphic below represents a SPIN FIN pile under tension and compression. When the pile is pulled in tension, a soil cone (visible in gray) is created that increases the capacity of the pile. By activating the soil cone, the SPIN FIN tip generates significantly more resistance to tensile loads than that of a conventional pile. Similar results are attained for compression piles.

APPLICATION

These piles have been in use since 1983, when PND first developed them. Since then, thousands of piles have been installed in a variety of applications:

- Limited overburden – Pile tensile capacities have been tested in excess of 800 kips with a pile embedment as little as 50 feet.
- Soft soils – Pile lengths have been reduced by as much as 50% with the use of SPIN FIN tips in softer soils.
- Seismic capacity – The SPIN FIN pile exhibits significant reserve strength with cyclic loading that has advantages in seismic events.
- Energy absorption – SPIN FIN piles can absorb a huge amount of energy through deflection without loss of strength. This is significant in applications such as breasting dolphins.

SPIN FIN piles are often used in docks, dolphins, retaining wall tiebacks, wave barriers, seismic anchors and other pile foundations where anticipated uplift or impact load may cause failure. Because of their load deformation characteristics, these piles allow substantial pile overload deformation without catastrophic failure even after repeated loading.

PILE’S COST SAVINGS

A reduction in the number of piles necessary and length of piles in an application creates significant cost savings for the client. Savings are also evident in construction time because the process results in shorter and fewer piles being driven, reducing crane and equipment size.

The dolphins on this page provide a comparison of structure between the SPIN FIN pile and that of a conventional pile. Cost savings are clear with a cursory review.
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**SPIN FIN® PILE’S COST SAVINGS**

**TYPICAL CONCRETE PILE WITH CAST-IN-PLACE CONCRETE CAP**

- **TRIPLE QUICK RELEASE MOORING HOOK ASSEMBLY WITH CAPSTAN**
- **560 KIP MOORING LOAD**
- **(4) 30”Ø x 130’ LONG STEEL COMPRESSION PILES**
- **(5) 30”Ø x 130’ LONG STEEL TENSION PILES**
- **15’x27’x4’ CONCRETE CAP**

**SPIN FIN PILE WITH PREFABRICATED STEEL CAP**

- **560 KIP MOORING LOAD**
- **12’x12’ PREFABRICATED STEEL DOLPHIN CAP**
- **(3) 24”Ø x 130’ LONG TENSION PILES**
- **(2) 24”Ø x 120’ LONG COMPRESSION PILES**

**STRUCTURE HEIGHT: 25 feet**

**MOORING LOAD: 280 ton horizontal**

**SOIL CONDITIONS: Shown on diagram**
SPIN FIN® piles have been successfully driven using both conventional impact and vibratory hammers, with templates and accessories. Driving the SPIN FIN pile causes rotation as predicted by the path on the outside of fins. Steel pipe piles with in-lead splicing allow the advantage of construction in very deep water or wherever deep pile penetration may be required. PND has designed dolphins that have been built in water depths over 100 feet deep.
PND has performed a significant number of SPIN FIN® pile load tests in a variety of soil conditions that include cyclic, tensile and compressive tests. These tests generally follow ASTM D3689-83, Section 7.7, “Quick Load Test Method for Individual Piles.” Piles are restrained from rotation. Pile failure is commonly defined as the point that constant jacking pressure (from continuous jacking) results in continual pile movement. The strength of the SPIN FIN tip is evident when shown compared with load test results for smooth pipe piles such as in the Colton Interchange work done for Caltrans (detailed below).

PORT MACKENZIE CYCLIC TESTING

Soil strata consisted of 50 feet of gravel fill underlain with dense silty clay. A 24-inch diameter pipe pile with 6-inch fins was driven a total of 79 feet below grade.

CALTRANS COLTON INTERCHANGE

Soil strata was generally fine-grained sand with some silt, clay and gravel to depth with effective SPT values from 10 to 50. Sixteen inch diameter pipe piles with eight inch SPIN FIN tips were driven 56 feet.
SEATTLE'S BELL STREET PIER

Bell Street Pier is a unique facility which provides public moorage, cruise ship operations, a conference facility, public viewing and waterfront restaurants. This multiuse facility for the Port of Seattle uses PND innovations that provided cost effective construction while meeting varied operational requirements. It incorporates the use of the Partial Penetrating Wave Barrier and platform docks, both with lateral resistant battered SPIN FIN® piles. The facility integrates steel and concrete design.

Soil conditions consisted of soft marine sediment from a mud line elevation of -15 feet to -30 feet Mean Lower Low Water (MLLW) over a silty sand (SPT=20) to -45 feet MLLW overlaying dense till (SPT=50). A 24-inch pipe pile with 9-inch SPIN FIN tips was driven to approximately 45 feet.
**AJ CRUISE SHIP DOCK DOLPHINS**

This facility in Juneau, Alaska provides berthing for 1,100-foot-long cruise ships, and includes a series of steel pile mooring and breasting dolphins with fender systems that use SPIN FIN® piles.

Deep soft soils and structure heights of over 100 feet above seabed required some pile lengths in excess of 300 feet. The use of the SPIN FIN pile tips provided additional load carrying capacity to support mooring and breasting loads in the soft soil conditions.

**VALDEZ SINGLE POINT MOORING PILES**

This 100-kip mooring point was successfully installed, and driven to bedrock refusal with a mudline elevation of -100 feet MLLW, approximately 40 feet of soft marine sediments, and a 1 vertical to 3 horizontal ground slope.

The SPIN FIN tip was calculated to have increased the ultimate pile tensile capacity from 20 kips (smooth pile) to 80 kips, adequate for the anticipated vertical load demand.
This vehicular bridge spans the Kalama River in southwest Washington. The 380-foot span steel I-girder bridge is supported by battered SPIN FIN® piles at each abutment. The use of the SPIN FIN piles supports the bridge for dead, live, and seismic loads, and also results in a significant reduction in pile length.

Seven hundred feet of curved elevated railroad structure and repair of another 200 feet of bridge crossing were designed using SPIN FIN piles outside of Longview, Washington. The new bridge structure is supported by driven steel piles on 50-foot centers spanned by rolled steel girders and an open deck.

The new structure minimizes the number of piles by using large diameter piles in a rigid frame system along with SPIN FIN tips. Minimizing the number of piles in the reconstruction was critical in shortening project duration and lowering construction impacts.
The West Dock Causeway Bridge is located along a 2 mile gravel causeway which extends into the Beaufort Sea near Prudhoe Bay, Alaska. The main bridge is a 700 foot long 4-span crossing that crosses a breach that accommodates fish passage and water flow.

Ice breaking piers incorporate SPIN FIN® pile tips for increased pile pullout (tension) capacity, modular pier cap construction for reduced field installation requirements, batter pile grouping for significant lateral structure load capacity, and driven pile technology for permafrost conditions.

A batter pile tension test was conducted using jacking frames, calibrated jacks and dial gauges. The batter pile was selected because of its high anticipated exposure to severe ice forces.

Soil conditions consisted of frozen and unfrozen silts, sands and gravels; and ice lenses. In the region down to approximately -50 feet MLLW, soils were frozen due to the permafrost shadow caused by the original causeway fill. Between -50 feet and -200 feet MLLW, the soils ranged from thawed to marginally frozen. Below this elevation permafrost conditions were encountered. Thirty-six inch diameter pipe piles equipped with eight inch SPIN FIN tips were driven 190 feet.
A new design for the Seattle waterfront’s Pier 69 brought the structure up to current seismic codes. The design included a new 26,000-square-foot, steel-pipe-pile-supported dock with a concrete deck, utilizing SPIN FIN® piles for support.

The 24-inch piles were arranged in 2- and 3-pile clusters. The new dock was then connected to the existing 85,000-square-foot, three story building. The rehabilitated pier houses the Port of Seattle’s Headquarters.
The Seward Port Rail Car Coal Dump was designed to support 800,000 tons of coal per year for export.

A part of the project included depressed rail car unloading hoppers feeding a stacker reclaimer. Proximity of facility retaining walls to tracks required tiebacks extending under the tracks. SPIN FIN® tension piles were first used in 1985 for these battered wall tiebacks.
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