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NCEL
Techdata Sheet

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Pile Driven Plate Anchors for Fleet Moorings

Technology has been developed for designing and installing plate anchors using conventional pile driving techniques. Plate anchors resist loading in any direction and are suitable for most Fleet mooring applications. They are especially attractive for situations involving complex seafloors, bottom obstructions, shallow water, or short scope mooring applications. Large holding capacities can be expected from small, inexpensive anchor configurations, installed with readily available marine equipment. Installation can be achieved by any standard YD crane barge with four-point mooring capability, and a template to guide the pile follower system during driving. An anchor ready for installation at Pearl Harbor is shown as Figure 1.

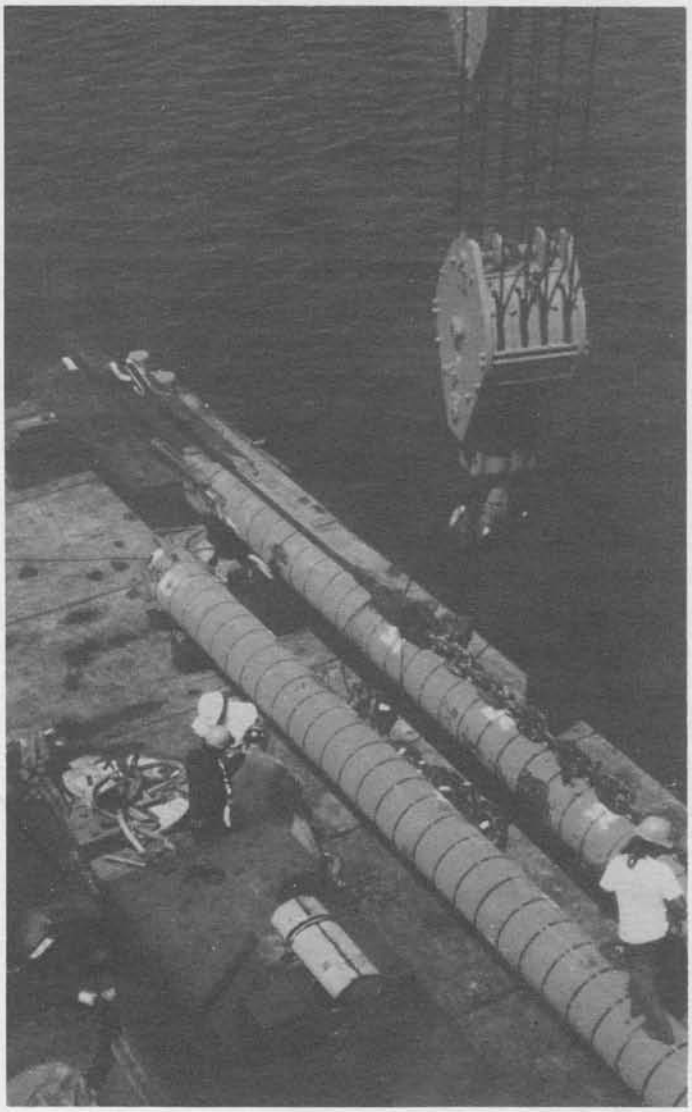

Figure 1
Pearl Harbor mud anchor attached to follower.

SYSTEM CONCEPT

The driven plate anchor concept is illustrated in Figure 2. The anchor is connected to a structural member called a follower and driven into the seafloor using a conventional vibratory or impact pile driver. After reaching the required depth of embedment, the pile driver and follower are removed. The

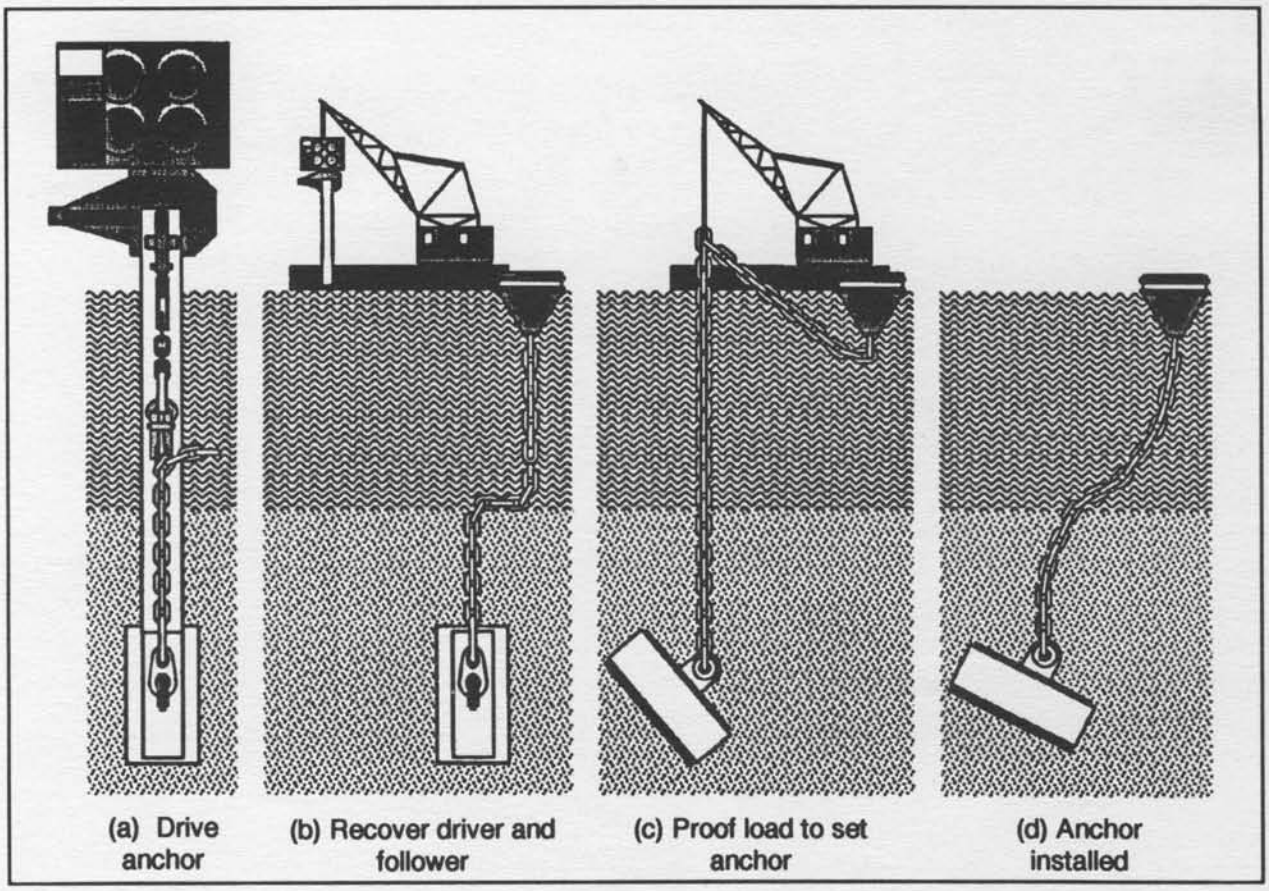

Figure 2
Driven plate anchor concept of operation.

anchor is now ready for load testing, first to set or key the anchor and then to verify capacity. The anchor can be load tested immediately following driving with a barge crane or buoyed off for future testing. For multiple leg moorings, proof testing between opposite mooring buoys is recommended.

DESCRIPTION

Because of the flexibility of this system, anchors can be tailored to meet a broad range of bottom conditions and driving resistances. Numerous anchor configurations are possible, limited mainly by the imagination of the designer. One anchor configuration used successfully for Navy moorings is shown in Figure 3. This anchor was fabricated by welding a steel plate to a section of wide flange beam and attaching a padeye. The hinged keying flaps, shown in Figure 3, are used in soft soils to reduce keying distance. The area of the anchor that resists pullout, in this case the plate, is selected to provide the required capacity at the available seafloor soil strength, see Chapter 6 of the NCEL Handbook for Marine Geotechnical Engineering. The size of the structural beam, the padeye, and the plate thickness are controlled by longitudinal bending and shear forces.

The anchor is driven into the bottom using a follower that is recovered when driving is completed. The follower can be any structural member of sufficient length and stiffness to drive the anchor to the required depth. A maximum length of follower based on rea-

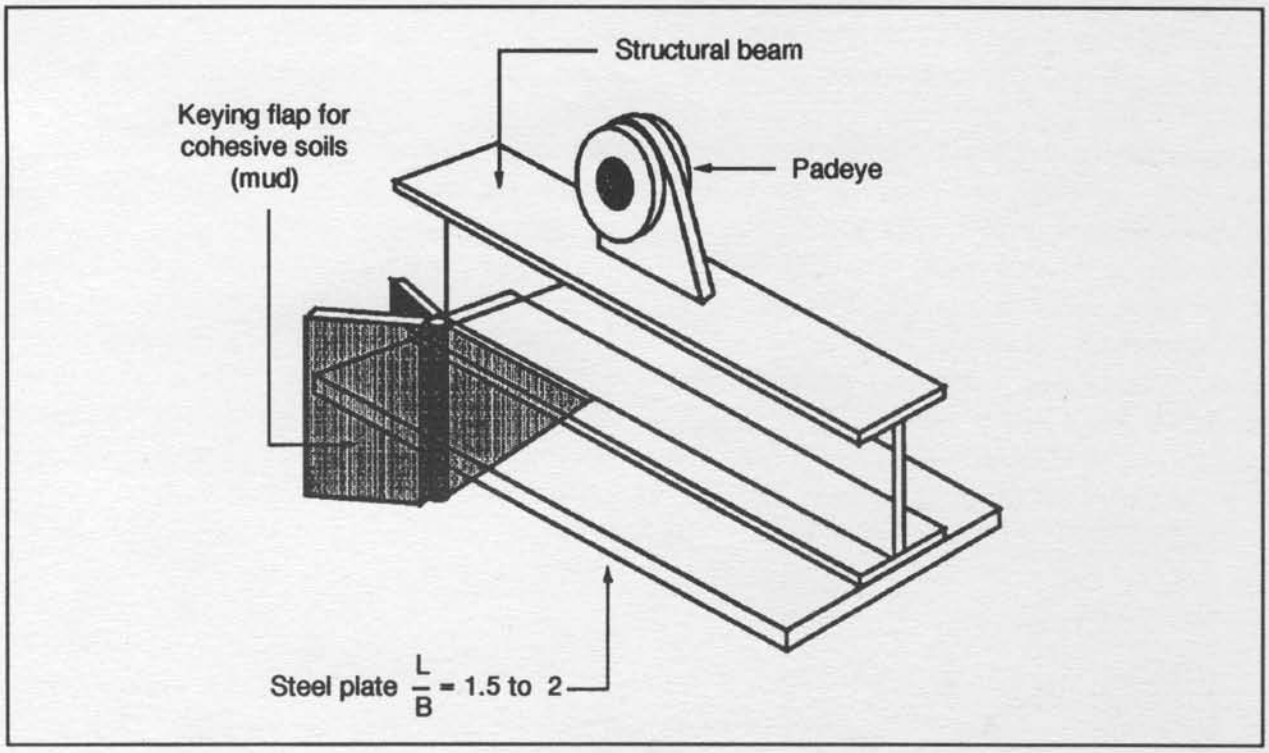

Figure 3
Driven plate anchor configuration.

sonable handling from a Navy YD crane barge is about 100 feet.

Contact between the anchor and follower is maintained during driving by a guide at the base of the follower that restrains the anchor. To maintain contact before setting the anchor on the bottom, the anchor chain is stretched out and attached through a turnbuckle to the padeye near the upper end of the follower. When the anchor is seated in the bottom, the chain is released from the follower before continuing the driving.

For anchors in soft cohesive soils that are loaded horizontally, it is beneficial to place a section of wire between the anchor and the anchor chain. This enhances anchor line cutting into the seafloor and achieves a keyed orientation at greater embedment depth. The length of wire rope must be selected so that it remains buried below the mud line to minimize corrosion and abrasion. With sands there is minimal anchor line cutting into the sea bed, so an all-chain anchor line is recommended.

DRIVING OPTIONS

The anchors can be emplaced using an impact hammer, or in most situations a vibratory hammer. A vibratory hammer adapted for use underwater can reduce the length of the follower. Because of their efficiency, plate anchors capable of high loads can be emplaced with light drivers; in fact in soft clay, such as found in many Navy harbors, it is possible to reach design depths by free-falling the anchors under the weight of the follower system.

APPLICATIONS

Plate anchors were recently used to install Mooring No. 16 at the Naval Inactive Fleet Maintenance Facility (NISMF) in Middle Loch

at Pearl Harbor (Figure 1), in very complex bottom conditions. Extreme variations in the mud thickness at the site made it necessary to use plate anchors that would satisfy the design load (200 kips horizontal at the buoy) either in the mud or in a stiff underlying alluvium. Based on this work and tests carried out in dense sands in San Diego harbor, several refinements to driven plate anchor technology were made. Additional moorings using driven plate anchors are currently scheduled for the NISMF, at Pearl Harbor, San Diego, the Columbia River at Portland, Oregon; and for a floating drydock at Guam. These plate anchors are suitable for all Fleet moorings but are particularly recommended for situations where non-dragging anchors are required, such as for Mediterranean moorings, drydocks, or confined mooring areas.

Design drawings of several sizes of plate anchors for use in sands, stiff clay, and soft mud are available from NCEL. However, these are meant only as representative designs. A major advantage of this system is its ability to adapt to a broad range of situations without difficulty.

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