ACI 543R-12

Guide to Design, Manufacture, and Installation of Concrete Piles

Reported by ACI Committee 543

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This report presents recommendations to assist the design architect/engineer, manufacturer, construction engineer, and contractor in the design, manufacture, and installation of most types of concrete piles.

Keywords: augered piles; bearing capacity; composite construction; concrete piles; corrosion; drilled piles; foundations; harbor structures; loads; prestressed concrete; quality control; steel reinforcement; soil mechanics; storage; tolerances.

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CHAPTER 1—INTRODUCTION

1.1—General

Piles are slender structural elements installed in the ground to support a load or compact the soil. They are made of several materials or combinations of materials and are installed by impact driving, jacking, vibrating, jetting, drilling, grouting, or combinations of these techniques. Piles are difficult to summarize and classify because there are many types, and new types are still being developed. This report covers only the types of piles currently used in North American construction projects. A pile type can be assigned a wide variety of names or classifications by various agencies, codes, technical groups, and in various geographical regions. No attempt is made herein to reconcile the wide variety of names used with a given pile type.

Piles can be described by the predominant material from which they are made: steel, concrete (or cement and other materials), or timber. Composite piles have an upper section of one material and a lower section of another. Piles made entirely of steel are usually H-sections or unfilled pipe; however, other steel members can be used. Timber piles are typically tree trunks that are peeled, sorted to size, and driven into place. The timber is usually treated with preservatives, but untreated piles can be used when positioned entirely below the permanent water table. The design of steel and timber piles is not considered herein except when used in conjunction with concrete. Most of the remaining types of existing piles contain concrete or a cement-based material.

Driven piles are typically top-driven with an impact hammer activated by air, steam, hydraulic, or diesel mechanisms, although vibratory drivers are occasionally used. Some piles, such as steel corrugated shells and thin-wall pipe piles, would be destroyed if top-driven. For such piles, an internal steel mandrel is inserted into the pile to receive the blows of the hammer and support the shell during installation. The pile is driven into the ground with the mandrel, which is then withdrawn. Driven piles tend to compact the soil beneath the pile tip.

Several types of piles are installed by drilling or rotating with downward pressure, instead of driving. Drilled piles usually involve concrete or grout placement in direct contact with the soil, which can produce side-friction resistance greater than that observed for driven piles. On the other hand, because they are drilled rather than driven, drilled piles do not compact the soil beneath the pile tip and, in fact, can loosen the soil at the tip. Post-grouting may be used after installation to densify the soil under the pile tip.

Concrete piles are classified according to the condition under which the concrete is cast. Some concrete piles (precast piles) are cast in a plant before driving, which allows controlled inspection of all phases of manufacture. Other piles are cast-in-place (CIP), a term used in this report to designate piles made of concrete placed into a previously-driven, enclosed container. Concrete-filled corrugated shells and closed-end pipe are examples of CIP piles. Other piles are cast-in-situ (CIS), a term used in this report to designate concrete cast directly against the earth. Drilled piers and auger-grout piles are examples of CIS piles.

1.2—Types of piles

1.2.1 *Precast concrete piles*—This general classification covers both conventionally reinforced concrete piles and prestressed concrete piles. Both types can be formed by casting, spinning (centrifugal casting), slipforming, or extrusion and are made in various cross-sectional shapes, such as triangular, square, octagonal, and round. Some piles are cast with a hollow core. Precast piles usually have a uniform cross section but can have a tapered tip. Precast concrete piles are designed and manufactured to withstand handling and driving stresses in addition to service loads.