

CHAPTER 1

BASIC CONSIDERATIONS

Section I. DEFINITIONS AND CLASSIFICATIONS

1-1. Definitions.

a. Piles. A pile is a long, columnar element made of timber, steel, concrete, or a combination of these materials (discussed in chapter 2). Piles transmit foundation loads to deeper strata that sustain the loads safely and prevent settling of the supported structure. Piles derive their support from a combination of skin friction along the embedded lengths and end bearing at the tips or bottoms (figure 1-1).

b. Piers. A pier is a pile used to support a horizontal supporting span such as a bridge or archway.

c. Sheet piles. Sheet piles are generally prefabricated or precast members driven vertically into the ground to form a continuous vertical wall. Sheet piles protect bearing piles against scour and the danger of undermining a pier foundation (figure 1-2). They form retaining walls (bulkheads) for waterfront structures (figure 1-3).

d. Friction/end-bearing piles. A pile embedded in soil with no pronounced bearing stratum at the tip is a friction pile (figure 1-4). A pile driven through relatively weak or compressible soils into rock or an underlying stronger material is an end-bearing pile (figure 1-5).

e. Batter piles. Piles driven at an angle are batter piles. They are used to resist heavy lateral or inclined loads or where the foundation material immediately beneath the structure offers little or no resistance to the lateral movement of vertical piles. Batters are driven into a compressible soil to spread vertical loads over a larger area, thereby reducing settlement. They may be used alone (battered in opposite directions) or in combination with vertical piles (figure 1-6). Batter piles can be driven at slopes of 4 degrees to 12 degrees with ordinary driving equipment.

f. Compaction piles. Compaction piles are driven to increase the density of loose, cohesionless soils (figure 1-7) and to reduce settlement, since shallow foundations on very loose deposits of sand or gravel may settle excessively. Piles with a heavy taper are

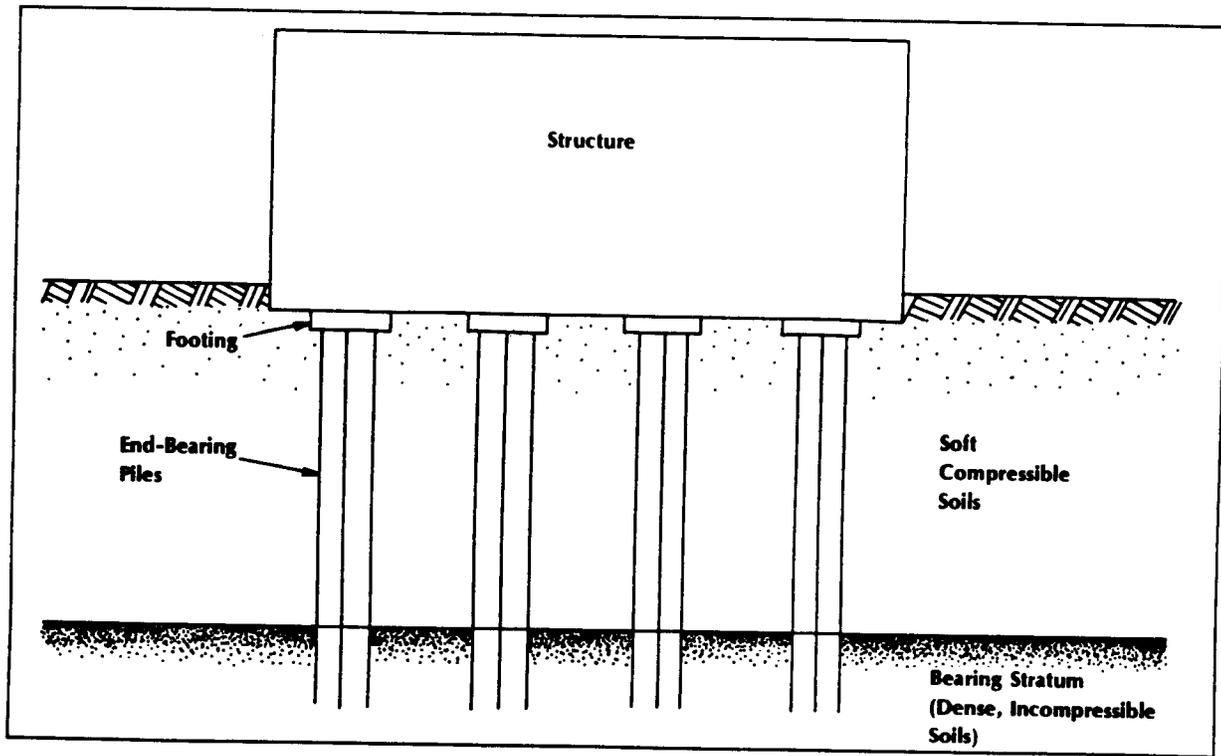


Figure 1-1 Pile foundation for structure support

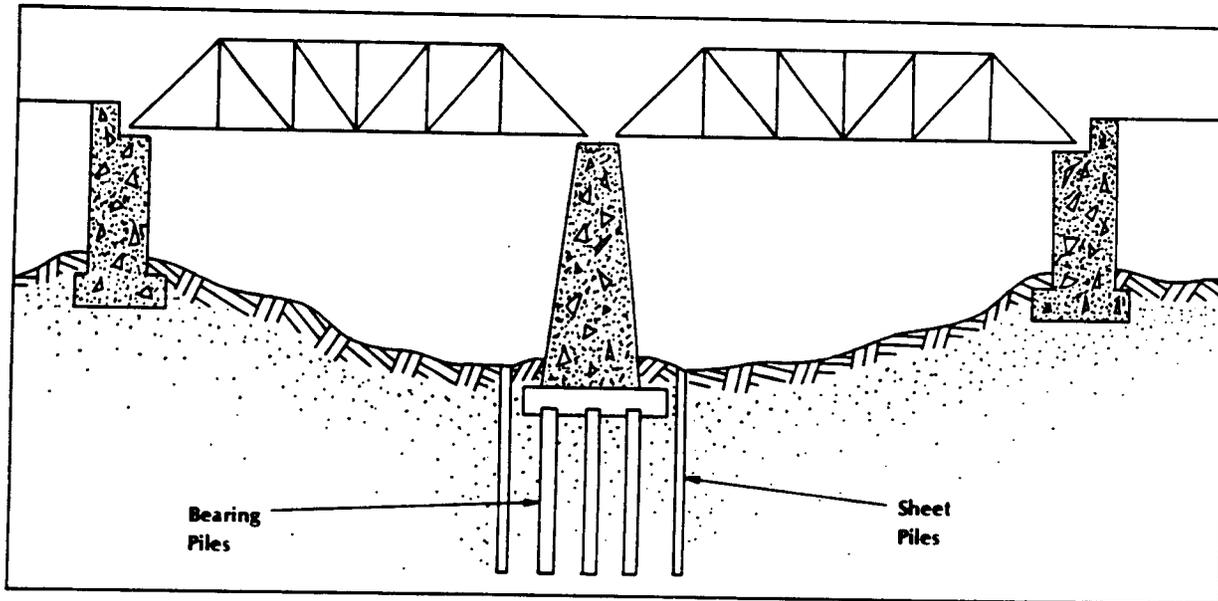


Figure 1-2 Sheet pile protecting a bridge pier

most effective and economical. These piles derive their support primarily from friction.

g. Anchor piles. Anchor piles are driven to resist tension loads. In hydraulic structures, there may be a hydrostatic uplift load that is greater than the downward load on the structure. Anchor piles may be used to anchor bulkheads, retaining walls, and guy wires (figure 1-3).

h. Fender piles. Fender piles are driven to protect piers, docks, and bridges from the wear and shock of approaching ships and floating objects such as ice and debris (figure 1-3).

i. Dolphins. A dolphin is a group of piles driven in clusters to aid in maneuvering ships in docking operations. These dolphins serve the same protective functions as fender piles (figure 1-3).

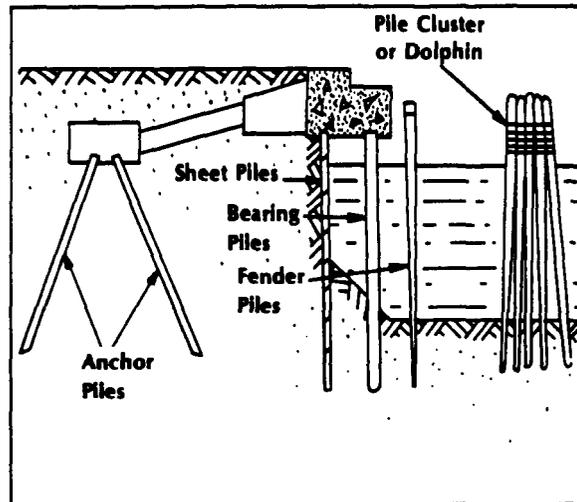


Figure 1-3 Piles in a waterfront structure

1-2. Pile functions.

Several uses of piles are illustrated in figures 1-1 through 1-7. A pile or series of piles are used to constructor reinforce construction to

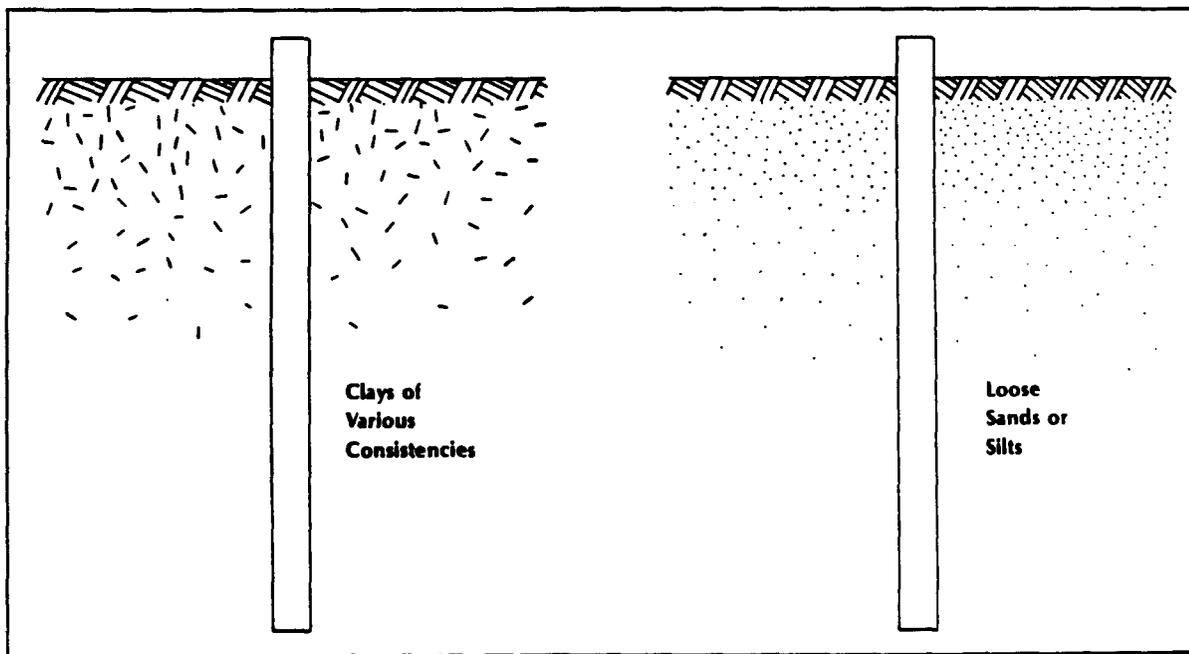


Figure 1-4 Friction piles

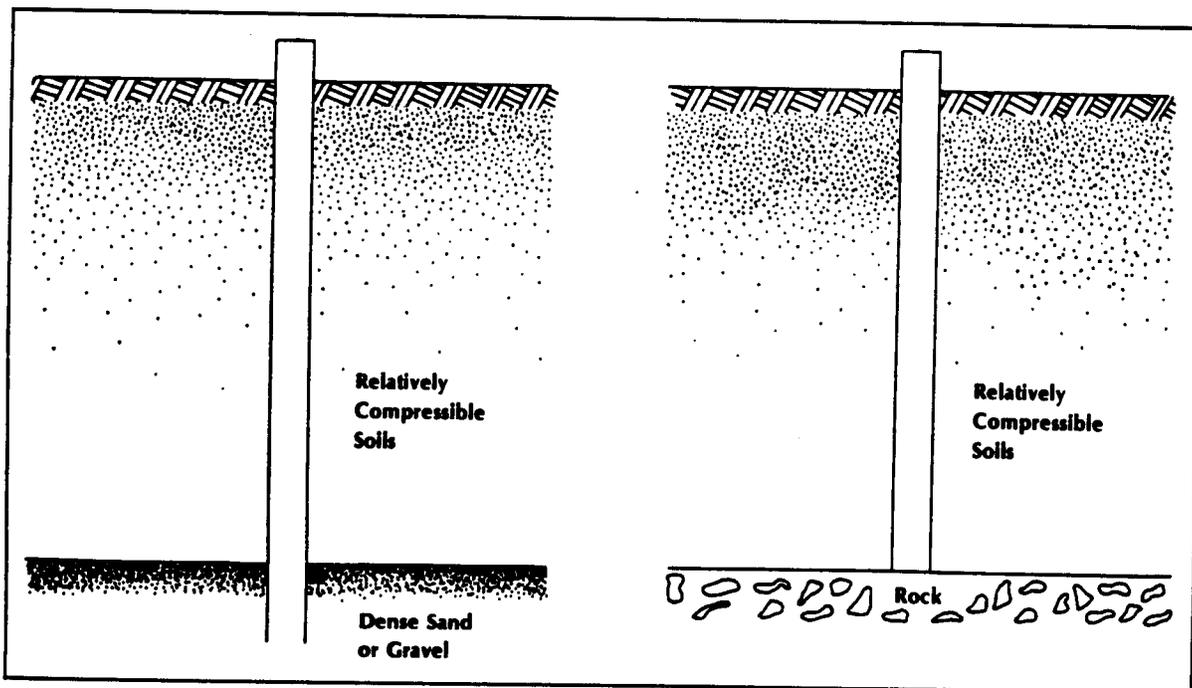


Figure 1-5 End-bearing piles

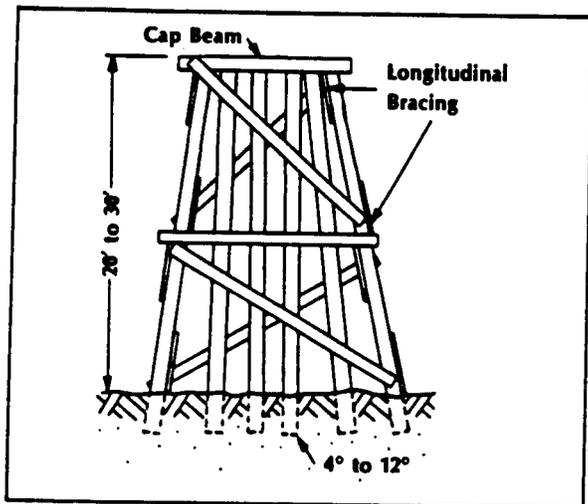


Figure 1-6 Batter piles

establish a stable foundation. Piles are used as follows.

- To transfer the structural load through material or strata of poor bearing capacity to one of adequate bearing capacity.

- To eliminate objectionable settlement.
- To resist lateral loads.
- To serve as fenders to absorb wear and shock.
- To improve load-bearing capacity of soil and reduce potential settlement.
- To transfer loads from overwater structures below the depth of scour.
- To anchor structures subjected to hydrostatic uplift, soil expansion, or overturning.

Section II. PILE SELECTION

1-3. Factors.

Many factors influence the choice of pile types used on a given project. Consideration must be given to the following factors (and others, if applicable).

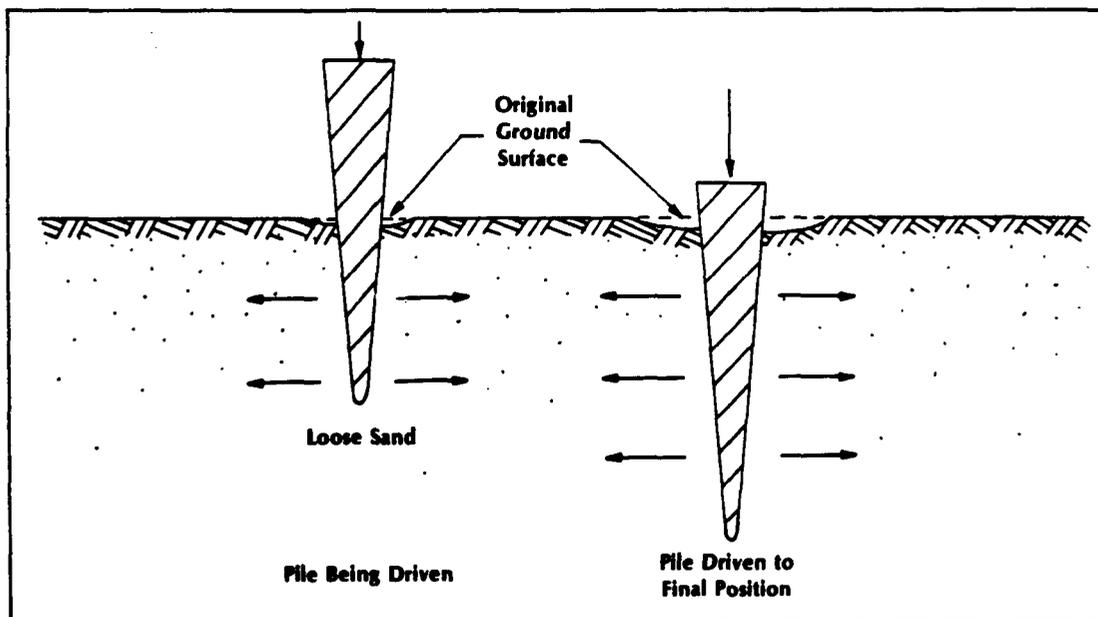


Figure 1-7 Compaction piles

- Type of construction.
- Availability of pile types and sizes.
- Soil and groundwater conditions at the site.
- Anticipated pile loads.
- Driving characteristics of available piles.
- Capabilities of crew and equipment available for handling and driving piles.
- Time available for construction.
- Design life of structure.
- Exposure conditions.
- Accessibility of site and transportation facilities.
- Comparative costs.

14. Construction consideration.

a. Material selection. Piles are made from timber, steel, or concrete. Composite piles, formed of one material in the lower section and another in the upper, are not commonly used in military construction because of the difficulty in forming a suitable joint and the greater complexity of installation.

b. Deliberate construction. Critical structures such as wharves, piers, and bridges on main routes of communication must be well constructed. Deliberate structures warrant high safety factors. These structures require thorough soil investigation and site examination to obtain the information for proper planning and design. This information is essential for safety, economy, and practicality.

c. Hasty construction. In military construction, many pile structures are built hastily after limited reconnaissance. Hasty

TABLE 1-1. TYPES OF BEARING PILES		
Large Displacement	Small Displacement	Nondisplacement
1. Formed at Site Closed end tubular section driven to form a void filled with concrete while withdrawing the section	1. Steel H-Piles	1. Supported a. Permanent (By casing) b. Temporary (1) By casing (2) Boring mud or clay
2. Preformed - Driven in ground and left in position a. Solid (1) Timber (2) Precast Concrete (3) Composite b. Hollow (1) Closed end steel, filled or unfilled after driving (2) Closed end concrete	2. Open End Pipe (May plug during driving)	2. Unsupported
	3. Anchor (Screw)	
	4. Preformed (Driven in prebored hole)	

pile structures are designed with the lowest factors of safety consistent with their importance. In hasty construction readily available materials will be used to construct pile foundations capable of supporting the structure at maximum load for immediate needs. They can be strengthened or rebuilt later.

1-5. Types and sizes.

Piles are classified by use, installation, material, and type of displacement. Classification of piles based on installation technique is given in table 1-1.

a. Large displacement. Large displacement piles include all solid piles such as timber and precast concrete piles. These piles may be formed at the site or preformed. Steel piles and hollow concrete piles, driven closed-ended, also fall within this group.

b. Small displacement. Small displacement piles include steel H-piles, steel pipe piles (if the ground enters freely during driving), screw or anchor piles, and preformed piles driven in prebored holes.

c. Nondisplacement. Nondisplacement piles are formed by boring or other methods of excavation. The borehole may be lined with a casing that is either left in place or extracted as the hole is filled with concrete.

1-6. Soil and groundwater.

Soil and groundwater conditions determine the design and construction of pile foundations. Foundations are successful only if the soil strata, to which the structural loads are transmitted, can support the loads without failure or excessive settlement. Except for end-bearing piles founded on rock, piles depend upon the surrounding soil or that beneath the pile tips for support. Groundwater conditions often dictate the type of piles that must be used and influence the load-carrying capacity of piles. Adequate soil exploration, testing, and analysis are prerequisites to the successful design and construction of all except crude, hasty pile structures. The relation of soil conditions to pile driving and the design of pile foundations are discussed in chapters 5 and 6.

1-7. Comparative costs.

Comparative costs of piling materials are computed on the dollar cost per ton of bearing capacity for the entire foundation. Comparing

piling materials on the basis of cost per linear foot is misleading since the costs of shipping and handling, the job conditions affecting driving techniques, and the relative load-bearing capacities all affect the overall cost.