A Review Of The Series

By John A. Focht, Jr.

THE SERIES of 13 articles on timber pile foundations represents about 300 years of experience accumulated by the authors in their active practice of foundation engineering as consultants and contractors. If consideration is given to the closest associates of the individual authors, the gross technical experience producing this "know-how" is at least a millenium. Yet, as implied in several of the articles, the most significant contributions to and advancements in the state-of-the-art for pile foundations have occurred within the last 20 to 30 years. Engineering design and construction of timber pile foundations have evolved from the concept of "pound a pole into the ground until it won't go" to one combining theoretical and empirical soil mechanics principles with carefully conceived construction techniques and practices that take into account soil conditions, structure loads, pile material characteristics and costs.

DESIGN

The references cited in the several articles with a few additions constitute a "must" reading list for the engineer engaged in the design of timber pile foundations. As a convenience to the reader, this selected bibliography on pile foundations is included as part of this series summary.

The authors of the articles in this series which relate to design are unanimous in advocating use of the static method for predicting pile capacities rather than dynamic driving formulas. The static method for predetermining the penetration of a pile to carry a specific ultimate load is based on empirical data gathered from model studies and field load tests and interpreted in

John A. Focht, Jr., P.E.
Vice President and Chief Design Engineer
McClelland Engineers, Inc., Houston, Texas

In more than 20 years of practice in the field of soil mechanics and foundation engineering, Mr. Focht has been very closely associated with design and construction of pile foundations. He received the ASCE Middlebrooks Award in 1957 and its James Laurie Prize in 1959 for papers on pile foundations.

A registered professional engineer in Texas, Louisiana and Arkansas, Mr. Focht received his B. S. in Civil Engineering from the University of Texas in 1944 and an M. S. in Civil Engineering from Harvard University in 1947. He worked five years at the Waterways Experiment Station in Vicksburg before joining McClelland Engineers, Soil and Foundation Consultants in 1953. He was recognized by the University of Texas in 1964 as a Distinguished Engineering Alumnus.

He is a Fellow in the American Society of Civil Engineers, Member of the Consulting Engineers Council of Texas and Member of the Houston Engineering and Scientific Society. Besides serving on several committees of the ASCE Soil Mechanics and Foundations Division, he has been president of the Houston Branch, ASCE.

accordance with accepted soil mechanics theories. The ultimate pile capacity, Q, at a given penetration is the sum of Q_s, the shaft or skin friction load, and Q_p, the end bearing or point load so that

$$Q = Q_s + Q_p = fA_s + qA_p$$

In this equation, A_s and A_p represent, respectively, the embedded surface area and the pile end area; f and q represent, respectively, the unit skin friction or soil-pile adhesion and the unit end bearing. Successful application of the static method depends upon proper selection of values of f and q for the particular combination of soil conditions, pile type, pile dimensions, kind of load and method of installation. Articles 2 through 6, in particular Article 3 by Baker, present procedures for estimating values of f and q from soil mechanics and foundation engineering studies.

The necessity for proper foundation investigations to permit adequate and economical pile design by the static method as well as for construction guidance was emphasized throughout this series. Knowledge of soil stratigraphy and properties is essential to utilization of the static method to predict the capacity of piles acting either singly or in groups to resist either tensile or compressive loads. This same knowledge is vital if the contractor is to be able to intelligently plan and direct installation of the piles. An excellent summary listing of the soil data required from a foundation investigation where pile foundations are contemplated is contained in the American Wood Preservers Institute booklet "Timber Foundation Pile Study" prepared in 1966 by Dames and Moore.

The data obtained from a foundation investigation would be interpreted and utilized slightly differently by each of the series authors. Yet the range of their predicted capacities of timber piles would be small for most soil conditions, and their other design recommendations would be very similar. The greatest difference would probably be for piles deriving most of their capacity from penetration into stiff to very stiff overconsolidated clays because of differences in predicted adhesion between pile and soil. Baker and Enkeboll indicate in Articles 3 and 4 that the ultimate soil-pile adhesion may be taken for design purposes as great as 2300 to 2500 psf. Lundgren and Capozzoli in Articles 5 and 1 suggest design values in the order of 1500 psf. Tomlinson[26] suggested in 1957 that the limiting adhesion of stiff clays on timber piles would be about 1000 to 1200 psf. Use of the variable reduction factor derived by Woodward et al [27] with soil shear strenths up to 4000 psf also indicates a limiting adhesion of about 1000 psf. Our experience with timber piles in stiff to very stiff clays along the Texas-Louisiana Gulf Coast supports the use of the lesser values in the order of 1200 psf. A need remains for systematic evaluation of a large number of additional load tests on timber piles to define the factors influencing the adhesion mobilized by timber piles in strong overconsolidated clay. The absence of complete agreement among the authorities on the selection of adhesion values for one soil condition in no way detracts from their basic agreement on the static method as *the* appropriate design technique to predict pile capacities.

LOAD TESTS

Use of load tests as part of the design-and-construction process is cited consistently throughout this series. Load tests on timber piles are desirable for the following circumstances with the degree of desirability increasing with the number of factors involved in a single situation.

1. A large and important project
2. Design pile loads of more than 25 tons
3. Anticipated hard driving
4. Anticipated substantial use of jetting or predrilling
5. Unusual soil conditions

For maximum usefulness in checking the design computations and in verifying the adequacy of the installation technique, load tests must be carried to failure. Load tests properly planned, scheduled and executed can couple design to installation and be a transition from theory to practice.

CONSTRUCTION

Articles 10, 11 and 13 by Lowry, Gilbert and Coull point up the importance of construction supervision by both the engineer and the contractor. Similar emphasis on inspection was made in "Timber Foundation Pile Study." This booklet also describes in detail several aspects of pile installation equipment and procedures not covered in this series of articles. The appropriate degree of supervision and inspection during driving of timber piles on a given project will be a function of the design factor of safety, design load, job size, type of structure, soil conditions and anticipated installation problems. A high degree of supervision is particularly desirable for design working loads of more than 25 tons on timber piles, and for soil conditions producing difficult and variable installation problems. On such assignments the pile driving supervisor must be fully cognizant of the design assumptions, the anticipated variations in soil conditions, the job specifications, and the