Book review

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Design of shallow foundations.
ASCE Press, 1999, 374+VIII p.

The book is divided in three parts.

Part I, "Types of loads and types of soils", consists of four introductory chapters dealing in brief with the most common types and configurations of buildings and foundations, and with the computation of loads acting onto foundations. In Chapter 4 a summary presentation of classifications and properties of soils is reported.

Some minor criticism may be expressed on the balance of arguments (Chapter 2, "Gravity loads on foundations", is 15 pages long; Chapter 3, "Lateral loads on foundations", 42 pages; Chapter 4, "Classifications and properties of soils", 26 pages). There are some misleading statements such as: "Sand strength is relatively insensitive to footing shape" (page 77). On the whole, however, Part I of the book may be considered acceptable for a very simple and practical design manual.

Part II consists of four chapters: Chapter 5, "Strength and pressure dispersion (*sic*) in soils"; Chapter 6, "Calculation of allowable pressure"; Chapter 7, "Settlement of foundations in a soil mass"; Chapter 8, "Calculation of settlements".

The reviewer feels incapable of presenting in a proper way the content of these chapters, that is really fireworks like; probably the best way is that of reporting some selected specimens.

Page 105, under the heading: "Permeability, Effective Stress and Submergence"

The apparatus that is traditionally used to demonstrate permeability in soils is shown schematically in fig. 5.1. In fig. 5.1a, the soil sample is saturated but not submerged. The somewhat imaginary term *saturated* (the italics are in the original text) means that all pores are filled with water under *neutral pressure*. At neutral pressure, the pore water exerts neither negative capillary pressure on the soil particles nor positive buoyancy on them.
The overall average intergranular pressure p', also called *effective pressure* or *effective stress,* is computed as:

$$p' = H\gamma_{sat} \qquad (5\text{-}1)$$

where γ_{sat} is the saturated unit weight and H the height of the sample".

After the above statement, no more mention is found in the whole book to effective stress, nor to concepts as drained and undrained. As a consequence, the shear strength of soils is discussed at page 122, under the heading: "The Coulomb Equation for the Strength of Soils", in the following way:

"As a point of review, the shear strength of a clay has been shown to be numerically equal to the cohesive strength of the clay,

$$s = c \qquad (5\text{-}20)$$

Similarly, the shear strength of a sand has been shown to be its frictional resistance,

$$s = p \tan \phi \qquad (5\text{-}21)$$

For pure sands or pure clay, it is thus quite simple to find the shear strength of either soil from the foregoing relations.
Most soils, however, are neither pure sands nor pure clays. As indicated in the classification card of Table 4-3, most soils are mixtures of sands and clays, being distinguished only by the amount of material being retained or passed by the No 200 sieve. The shear strength of such a mixture should obviously be some combination of the two.
The shear strength of a soil mixture can be taken to be the direct sum of its shear strength due to cohesion plus its shear strength due to friction:

$$s = c + p \tan \phi \qquad (5\text{-}22)$$

While there may be some occasional inconsistencies in directly summing the two shear strengths, the result is generally adequate for the design of shallow foundations. Equation (5-22) is the Coulomb equation; it is the equation that defines the shear strength of general mixtures of clays and sands. In any general solution for the failure load or failure mechanism in a soil mass, the Coulomb equation is the governing equation".

At page 188, under the heading; "The Consolidation Test for Clay Soil"

"As with other engineering materials such as steel or concrete, the calculation of deformations in soil begins with a stress-strain curve. In soils, however, the stress-strain curve takes a somewhat different form due simply to the nature of the soil. The strain is best viewed as a change in void ratio and the stress is best viewed as the log of the vertical pressure p. The reason for using a log scale for pressures comes as a result of the extremely slow rate of consolidation as pore water pressure approaches to zero".

At page 203, under the heading: "Fragmentation and Settlement in Sands", after having expressed the strange opinion that a reduction of volume in sand is a result of grain crushing,

"Elastic deformation on sand is a type of deformation that has no counterpart (or very little) in clays. Elastic deformations occur immediately upon application and release of load. Like distortion settlements, they affect the entire building footprint and are not a major source of unequal settlements between footings. Elastic deformations in soils are usually of little consequence in foundation design and are usually ignored".

At page 234, under the heading: "Settlement Calculations in Sands",

"The settlement S is taken as the integral of strain ε_z occurring at a depth z over a pressure bulb of height h,

$$S = \int_0^h \varepsilon_z \, dz = \int_0^h \frac{\sigma_z}{E_z} dz \qquad (8\text{-}21)$$

where, by definition, $\varepsilon_z = \sigma_z/E_z$, in which σ_z is stress (pressure) and E_z is the elastic modulus. The pressure σ_z is variable, but it can also be expressed as the increase in contact pressure p under the footing (a constant) times a variable influence factor I_z, that is $\sigma_z = p\, I_z$. Hence:

$$S = p \int_0^h \frac{I_z}{E_z} dz \qquad (8\text{-}22)$$

The influence factor I_z represents the variation in strain along the depth of the pressure bulb".

At page 239, under the heading: "Modulus of Subgrade Reaction",

"The units of the modulus of subgrade reaction are generally given in the handbooks in kips/ft^3 (or kips/ft^2/ft of settlement) though units of kips per square foot per inch of settlement would be more meaningful. Unlike the modulus of elasticity, the modulus of subgrade reaction is only partially elastic (if it is elastic at all), with most of the settlement it describes being a permanent change in void ratio in the soil mass.

The modulus of subgrade reaction is heavily time dependent. It can vary widely over a year's time, or with rapidity of loading or even with daily changes in water content. Any effort to define the modulus of subgrade reaction must somehow account for this variability with time. Due largely to such variability, earlier efforts to define a constant for the modulus of subgrade reaction have meet with failure".

Part III of the book consists of two chapters: Chapter 9: "Effects of Soil-Structure interaction", and Chapter 10: "Comparative Selection of Footing Sizes". Part IV also includes two chapters: Chapter 11: "Other Topics in Foundation Design", and Chapter 12: "Field Tests and Soil Report". These two parts are essentially devoted to practical suggestions for the design. Some memorable statements can be found, though not so frequently as in Part II. For instance at page 255, under the heading; "Estimated Pressure-settlement Relationships", there is a table giving the estimated pressure on soils to produce 1 inch of settlement as a function of the friction angle, without any consideration of footing size. In this table 16 values of ϕ, from 28° to 43°, are considered and the corresponding values of the pressure are given with four or five figures!

At page 253, under the heading: "Field Sampling and Testing",

"As clay content increases, however, the vane shear test described in Chapter 5 becomes more accurate than the penetration tests such as SPT and Dutch cone".

And, on page 354,

"It is again emphasized that these field tests reveal only the total shear strength of the soil. They do not provide a means to distinguish between the amount of strength that is derived from cohesion or the amount due to internal friction. Nor is there any direct assessment of settlements: the judgement of the geotechnical engineer will provide the primary evaluation of settlements when the test program is limited to these two field tests".

Many other examples could be quoted, but the reviewer believes that the above specimens are sufficient to give a feeling of the book.

In his preface, the Author states that the design of shallow foundations necessarily involves two disciplines: soil mechanics and structural mechanics. It is intended that the book will set forth a balanced presentation.

The reviewer is afraid that this intention has been betrayed, and that the use of the term "mechanics" is completely out of place in this context.

As usual, in the back cover of the book the publisher claims that: "Any statement expressed ... are those of the individual authors and do not necessarily represent the views of the ASCE, which takes no responsibility...". In spite of this caution, one cannot but be surprised that a similar book is published by the American Society of Civil Engineers. Somewhere in the reviewing and accepting system of the Society there must be a serious leak!

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