VOLUME II

PROCEEDINGS OF THE CONFERENCE ON

IN SITU MEASUREMENT of soil properties

June 1-4, 1975

North Carolina State University • Raleigh, North Carolina

Specialty Conference of the

Geotechnical Engineering Division • ASCE

Cosponsored by

North Carolina Section • ASCE

Department of Civil Engineering

and

Division of Continuing Education

North Carolina State University

Published by

American Society of Civil Engineers

345 East 47th Street

New York, N.Y. 10017

$24.00

A NEW IN SITU TEST FOR THE MEASUREMENT OF HORIZONTAL SOIL DEFORMABILITY

By S. Marchetti[1]

INTRODUCTION

This contribution presents some work carried out at L'Aquila University on a new in situ test,performed with a flat dilatometer equipped with expandable plane membranes.

The device is driven statically into the soil using the standard equipment and rods used for the static cone penetration test, and therefore no borehole is required.

The test was primarily developed to investigate the values of soil modulus E_s for laterally loaded driven piles,where horizontal movements are also preceded by penetration.

It was then felt that many deformability and settlement problems could be more accurately solved using the results of this test rather than those of SPT or SCPT.

Experimental work is now being done to determine the engineering problems for which the use of the test may be of practical help.

DESCRIPTION

The device consists essentially of a stainless steel plate, having cross section 2 x 8 cm, carrying on both surfaces a thin steel circular membrane, having diameter D = 6 cm,flush with the plate surface (fig.1).

[1]Asst. Prof. of Soil Mechanics, L'Aquila University, Italy.

Fig. 1 flat dilatometer : tip with expandable plane membranes.

Increasing the air pressure at the back of the membranes, the membranes move against the soil. When the center of each membrane has moved 1 mm, the exceeding input pressure is vented and a value p_{max} of pressure is read.

The main purpose of this test is to measure the increment of pressure Δp required at the back of the expandable membranes to produce 1 mm displacement at the center of each membrane.

OPERATIONS

In analogy with the static cone, the test is performed at vertical intervals of 20 cm.

At each depth the air pressure at the back of the membranes is increased through pneumatic tubes. An electrical contact is established when the membranes first start moving, abandoning their back seats, and the corresponding air pressure p_o is read.

Successively the pressure increases up to the limit value p_{max}, which is read at the ground surface control unit.

The 1 mm displacement, which starts air venting, is related to the increment of pressure $\Delta p = p_{max} - p_o$, and the deformation modulus may then be obtained, as indicated ahead.

Usually two cycles of loading are performed. The time required for the two cycles is approximately 1 minute.

Two corrections to the pressure p_{max} readings are applied; one to account for the drop of pressure along the tubings, the second to account for the pressure required to obtain 1 mm membrane displacement without the soil. Due to the flat geometry of the device, the last correction is quite small, which is essential for soft soils.

DATA INTERPRETATION

The obtained data are analysed using the theory of elasticity. The vertical plane of simmetry allows to study the problem as one membrane on an elastic half space, neglecting the thickness of the dilatometer.

The elastic solution has been obtained under the assumption that, outside of the membrane, the surface of the elastic half space is not allowed to displace normally.

Further, it is assumed that no redistribution of pressure can be introduced by the membrane, i.e. the soil is uniformly loaded by the membrane; this assumption is justified by the high relative flexibility of the membrane with respect to any soil.

Under these assumptions, the solution for the central displacement "s" is given by the equation

$$s = \Delta p \cdot D \frac{1-\nu^2}{E} \frac{2}{\pi}$$

Hence, for s = 1mm, the equation becomes

$$\frac{E}{1-\nu^2} \approx 38. \ \Delta p$$

It is noted that for 1 mm center displacement, the maximum axial strain of the soil compressed by the membrane is of the order of 1.5%, and it is much lower elsewhere. The overall deformation pattern is therefore mainly within the elastic range, which is confirmed by the small decrease of pressures p_{max} and p_0 obtained in subsequent loading cycles.

An example of measured $E/(1-\nu^2)$ profile is given in fig.2.

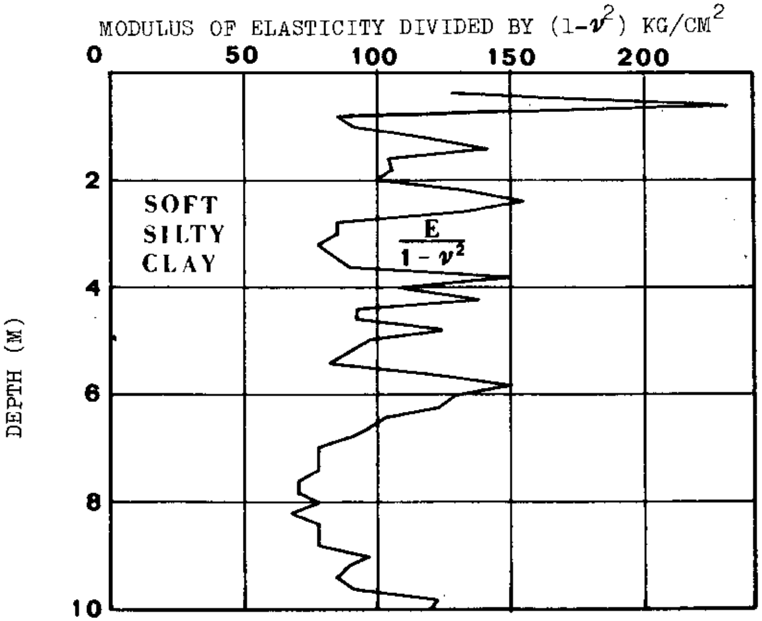

Fig.2 Example of soil modulus profile obtained with the flat dilatometer

CHARACTERISTICS OF THE TEST

a) No borehole is required for this test; scatter due to variable soil disturbance is eliminated.

b) The test results are independent from the operator.

c) The test is economic and fast (its cost is comparable with static cone penetration test).

d) The test is highly reproducible.

e) The test can performed offshore, without borehole, even with vertically moving vessel(rods are disconnected from vessel when inflating membranes).

PRESENT WORK

Presently efforts are directed towards assessing correlations between test results and engineering soil properties, so that indications of the test may eventually be of help in the following problems

a) Soil modulus E_s for laterally loaded piles.
b) Settlement analysis
c) Relative density and liquefaction characteristics of cohesionless soils.
d) Shaft bearing of driven piles.