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DEVICE FOR THE RAPID TEST IN SITU OF THE RESISTANCE OF FOUNDATION GROUNDS

by

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DEVICE FOR THE RAPID TEST IN SITU OF THE RESISTANCE OF FOUNDATION GROUNDS
(A translation)

DEGUILLAUME, Rene (Consulting engineer, Algiers) - Appareil d'essai rapide et sur place de la résistance des terraine de fondation; Le Génie Civil, tome 125, no. 2, pp. 30-32, January 15, 1948.

Translated by Mrs. Séverine Britt, U. S. Geological Survey, April, 1950.

The accurate knowledge of the mechanical properties of the foundation ground for structures, roads and railroads is frequently very useful. Methods have been available for some fifteen years for the determination of these properties in geotechnical laboratories. 1/ However the application of these methods is delicate and requires many samplings at various depths and at different times of the year; consequently they are slow and expensive.

When it is only a question of a preliminary investigation, it may be sufficient to make a rapid determination of the maximum pressure that the planned structure may exert on the ground without settling, tilting or breaking up.

1/A detailed account of the methods for the determination in the laboratory of the properties of soils and foundation grounds has been given in the Génie Civil of Dec. 3, 1932, p. 553, and in the nos. of April 27 and May 4, 1940, p. 276 and 291.

Principle. This information can be deduced from the results given by the driving of piles for the support of the foundation raft of the structure. The Belgian engineer Dorsinfang has conceived for that purpose a portable device called "Compressimeter", inspired from pile driving, which gives directly the loading strength R of a soil as a function of the penetration h in that soil of a pile of weight p driven in by a piledriver of weight P. The principle and the description of this small device, 1.70 m high was given in the Génie Civil of January 26, 1935, p. 91.

The inventor shows that

$$Rh = \frac{P^2 H}{P + p} \tag{1}$$

formula in which H is the length of stroke of the piledriver. For the same piledriver with the same length of stroke H on the same pile, the right-hand side of this equation is a constant of the instrument and the loading strength R (given in kg/cm^2 for instance) is represented as a function of h by an equilateral hyperbola. The results so obtained agree with those given by the test under static loads by means of the device shown in fig. 1.

In 1929, at a time when Algiers did not yet have a Soil laboratory, an instrument similar to that of Dorsinfang, but lighter and less cumbersome, was used by the author. It proved very useful. The description of this modified device and its operation are given below.

In their "Considérations théoriques sur le battage des pieux" (Theoretical considerations on pile-driving), Noé and Troch gave a formula which shows that under equal conditions, a steel pile (because of being more dense and more elastic) can overcome the resistance to driving more easily than a concrete pile and still more easily than a wood pile.

With a steel pile, there is consequently an advantage in using a heavy pile-driver; the optimum relation of the weights of the piledriver and of the pile is then equal to 4, instead of 2/3 if the pile is of concrete or of wood, as shown in a formula established and adopted by the people of the Netherlands.

Thus the problem was nearly solved in 1929, but the best shape for the point of the pile remained to be found and the coefficient of safety was still to be determined. A conical point with a half-angle of 20^{o} at the top, as indicated by Benabenq 2/, was first adopted.

2/ A. Mesnager - Cours de béton armé, 1921, p. 244, Dunod editeur.

In 1936, the Corps of Engineers of the Army, when planning the building of barracks at the aviation center of Blida, used a device for static tests (fig. 1) to determine the resistance of the foundation ground. Its operation is easy to understand. The results of these tests were compared with those given by the author's device. In order to make them agree, and thus to avoid the use of a coefficient of correction and to reduce to an acceptable value the penetration of the pile, (say 60 mm instead of 85mm), 58^{o} was adopted for the angle α . It is possible that another value may still be preferable.

Description. The apparatus is supported by a tripod provided with a guide G for the percussion device and a Cardan's suspension which assures the verticality of the fall of the piledriver M on an anvil E under which the pile D is screwed. The piledriver is provided with spring grips g which open when the driver is released. A pulley revolving on a threaded rod brings the point of the pile to the level of the ground. The pile-driver which is fastened to two fine and very flexible steel cables, is raised by means of a crank.

The device includes five piles of various sections but which are of the same weight because they are hollow, which allows the weight to be controlled by the addition of ballast.

The tripod, when closed, is 1.15 m long; when set up, its height is approximately 1 m. The whole device, with its five piles weighs only 21 kgs and may easily be carried in a passenger car.

The formula used is:

$$RH = \frac{P^2H}{(P+p)s} + \frac{(P+p)h}{s} \qquad (2)$$

where the notations are the same as for formula (1), with the difference of s being introduced, which is the section of the pile varying according to the nature of the ground from 16.25 cm^2 for the largest pile to 5.167 cm^2 for the smallest.

The pile is struck 10 times and the total penetration h is measured; from the result, the value of R is deduced. This value is given by the hyperbolas on figure 4 for the five piles with values of h between 10 and 100 mm. The ten-blow driving test lasts only a few minutes.

Practically, after a value of R has been obtained for a spot of the ground, it is advisable to be sure that results of the same order are obtained for two other points on both sides of the first one and far enough away not to be influenced by the lateral reactions of the soil caused by the first driving. Thus the piles no. 2 and 4 may be used if the first driving was carried out with pile no. 3, the most frequently used; penetrations different from that of pile no 3 are found but they give the same value R as obtained by pile No. 3.

Results. This device had been used for private concerns when in 1939 the "Service de la Colonisation et de l'Hydraulique" requested to use it in the region of Sersou where plans were being made for the construction of a heavy building on marshy and loose ground.

At first, different and quite insufficient bearing strengths were found, but a bed of gray marl was encountered, and concordant values were obtained that averaged 18 kg/cm^2, which is a very acceptable value. The tests made in the soil laboratory of Algiers confirmed the good bearing capacity of the marl bed, and it was concluded that 16 kg/cm^2 could be adopted, a value that should not be exceeded because of risks that could result from the possible swelling of the marl.

Later, results that agreed even better were found in calcareous loam at a depth of 2 to 2.60 m in the vicinity of Algiers.

If anomalies or great divergences were to occur, their cause should evidently be studied through laboratory tests, taking into account the geologic, climatic and meteorologic conditions.

The value of the angle α of the point which is most suitable for each type of soil remains to be determined, especially when decomposed schist or mica-schist are involved in the investigation.

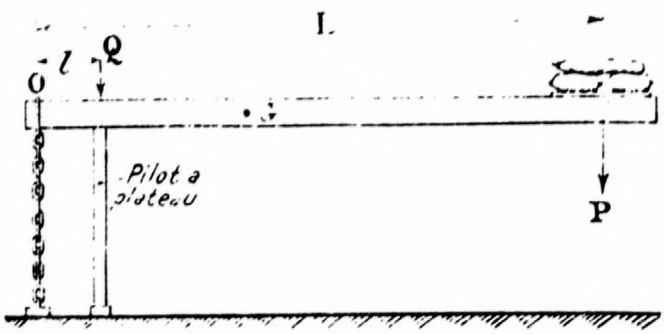

Fig. 1. — Appareil du Génie militaire d'Alger pour la mesure de l'enfoncement d'un pilot sous l'action de charges statiques.

Fig. 1

Device of the Corps of engineers of Algiers for the determination of the penetration of a pile under the action of static loads.

G - Centre of gravity
O - Centre of rotation
The equation corresponding to this device is

$$R = \frac{Q}{s} = \frac{9P + 667.50}{s}$$

Q being the load of the sheet pile
P the load of the lever, and
s the section of the sheet of the pile in cm^2

The maximum penetration of the pile is 10 mm and the weight of the device with no load is 155 kg.

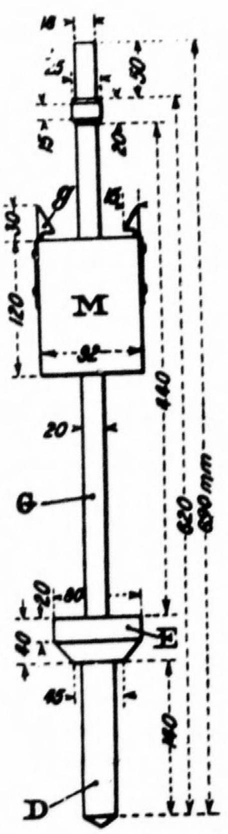

Fig. 2. — Schéma de l'organe de percussion.

E, enclume ; — G, guidage ; — M, mouton ; — D, pilo ; — g, griffes à ressort.

Fig. 2

Diagram of the percussion device

E - anvil
G - guide
M - piledriver
D - pile
g - spring grips

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Fig. 3. — Appareil en station avant la chute du mouton.

Fig. 3
Device set up before the fall of the hammer

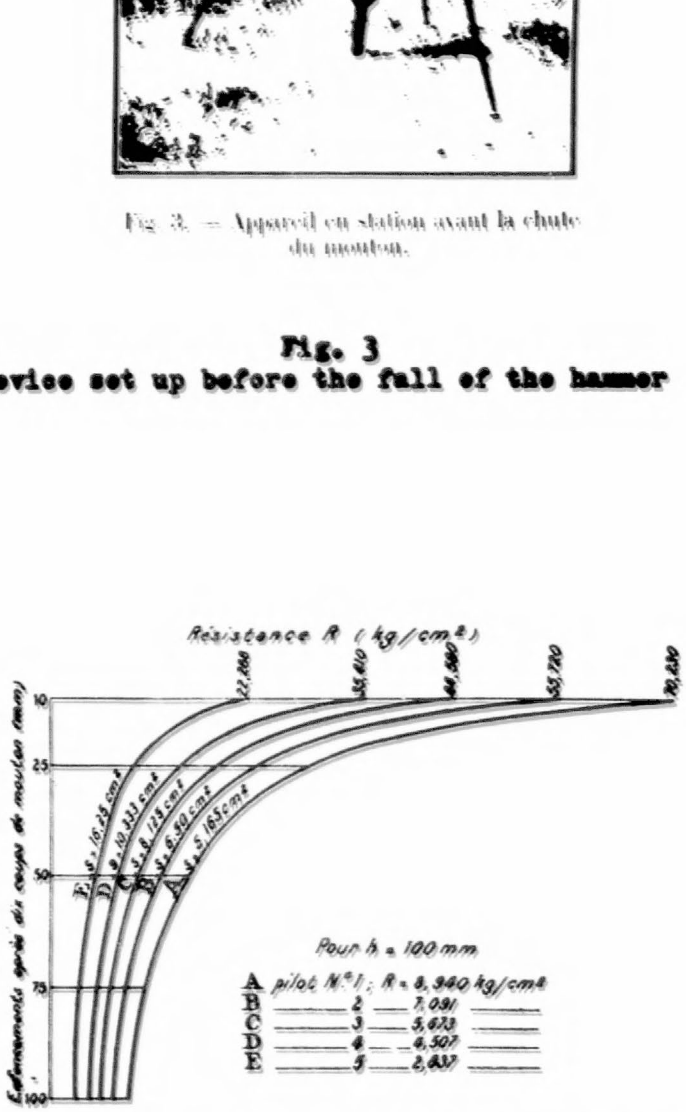

Fig. 4. — Forces portantes R du sol en fonction de l'enfoncement total *h*, pour les différents pilots.

Fig. 4
Bearing strengths R of the soil as a function of the total penetration h for the various piles

1) Enfoncements apres dix coups de mouton (mm)
Penetration after ten blows of the hammer (mm)