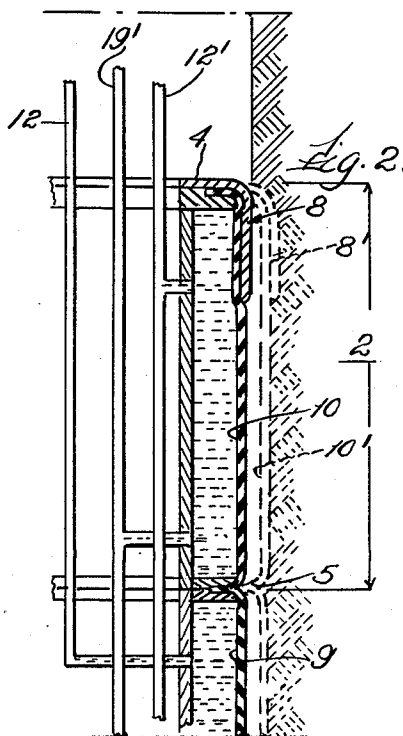
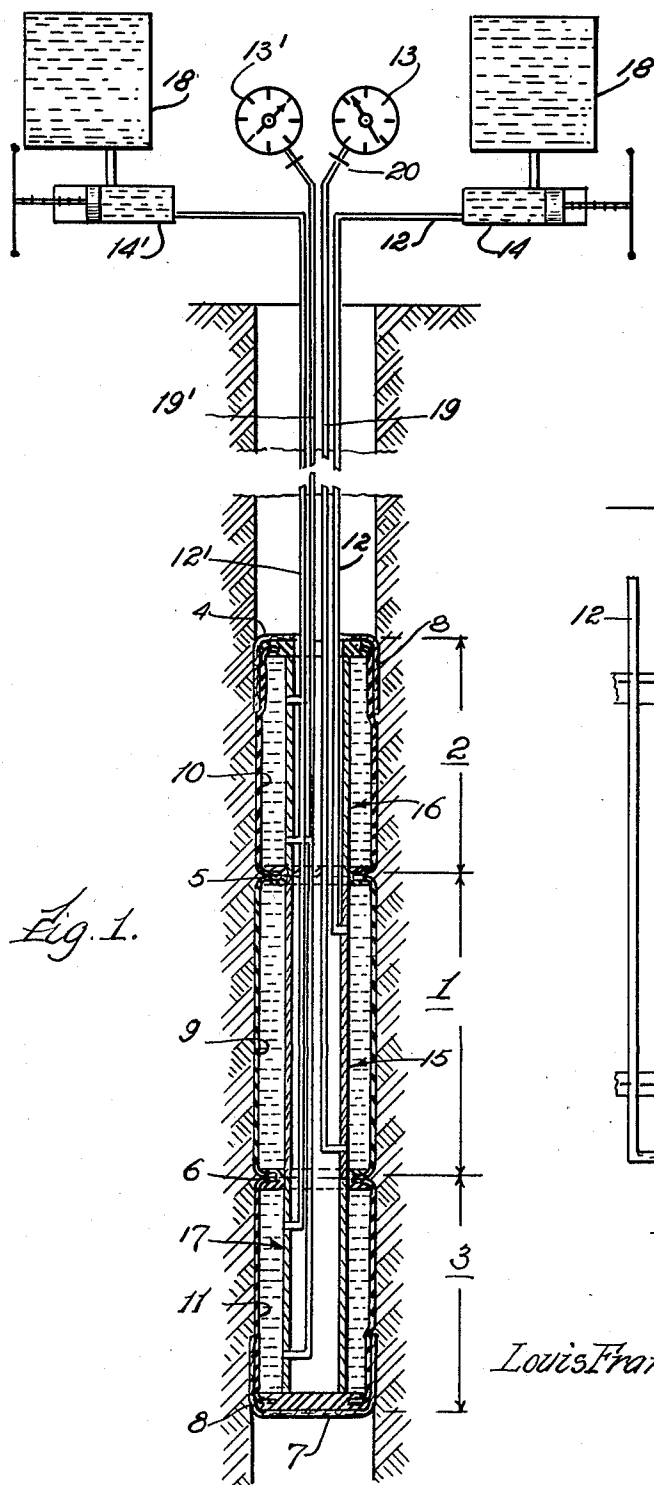


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SOIL TESTING APPARATUS

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SOIL TESTING APPARATUS

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1 Claim. (Cl. 73—84)

This invention relates to a new soil testing apparatus. A large portion of the difficulties encountered in foundation work is due to the nature of the soil. Researches carried out during recent decades have permitted a better understanding of the foundation problems and it was considered as good practice to require the measure of compressibility and strength of the soil at practically every site which was considered for a structure of any importance. Engineers began to bore holes in order to obtain soil samples with elaborate sampling devices. The samples were forwarded to soil mechanics' laboratories to be analyzed. The results were often very poor and the method was expensive and time wasting.

I have developed a new means to measure the compressibility and the strength of the soil directly in the ground.

The advantages of my apparatus are that it yields immediate and inexpensive field results of the main soil characteristics required to compute a foundation and to control the compaction of earth dams. The results are reliable for any soil.

My equipment is very light and can be used very easily in remote and deep sites. The equipment is lowered in a bore hole at the desired depth. It is designed to apply a uniform and gradually increasing pressure on the wall of the bore hole and to measure the correlative increase in diameter of the bore hole. With my apparatus, at any pressure and at any depth, the lower the compressibility of the soil the larger the increase in diameter. Furthermore, the apparatus measures the limit pressure, which is the maximum pressure that the soil can sustain without bursting.

It is among the objects of my invention to plot the curves of the increase in diameter of the hole in relation to the pressure in the cell. The mechanical properties of the soil are computed through a physical and mechanical interpretation of these plots.

Referring to the drawings, Fig. 1 is a sectional diagrammatic view of my soil testing apparatus; and Fig. 2 is an enlarged longitudinal sectional view showing the cell when expanded.

The pressure on the soil is applied by means of cylindrical inflatable elastic and distortable cell structures, which, referring to the drawing, I have denoted therein by reference numerals 1, 2, and 3. Each cell structure consists of rigid tubular cores 15, 16 and 17 and of expansible tubular hermetic elements 9, 10 and 11, sleeved over the core and tightly fixed at its extremities 4, 5, 6 and 7 on rings.

Each cell structure is thus in the shape of a cylindrical toroid, the outer wall only of which is deformable while the other walls are rigid. The three cells 1, 2 and 3 are furthermore rigidly clamped to each other by means of a number of tie bolts while maintaining the independence of each cell.

At the upper end of the upper cell and lower extremity of the lower cell, special protection collar 8 made of stiff leather and fixed on rings, is required for restricting end

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expansion and bursting of the expansible elements 10 and 11. It is required that the elastic membranes 9, 10 and 11 be thin enough to contact the entire surface of the bore hole, even under a very low inside pressure.

The details of the longitudinal half section cell structure are shown in enlarged Fig. 2. One end of the cell arrangement is omitted as both ends of the device are the same.

The detailed view in Fig. 2 shows in dotted lines the conditions of the cell when expanded. The initial outer deformable wall 10 of the cell structure has been displaced to 10'; the end protection 8 has been displaced to 8' and prevents the deformable membrane from expanding upward between the ring 4 and the wall of the bore hole.

An equal pressure is applied in each of the three cell structures. As some secondary effects take place at the upper and lower boundaries of the stressed portions of the hole, the increase in diameter of the hole is not equal in the central cell structure and in the upper and lower cells.

Diagrams of the displacement of the soil at selected depths may be plotted as a function of the pressure inside the cell and of the speed of the time required for the build-up of the pressure. The physical and mechanical characteristics of the soil can then be deduced from these diagrams and mechanical equations, their interpretation being based upon the fact that, upon inflating the cell structures, isostatic surfaces of revolution are generated in the soil coaxially with the said cells.

When studying the phenomenon from a theoretical point of view, the above interpretation and equations are more mathematically accurate when the isostatic surfaces approximate most closely to cylinders.

In order to take this fact into account, the increase of diameter of the hole, is only measured at the level of central cell 1.

In order to measure the increase in diameter of the hole, the central cell structure is filled up with an incompressible fluid such as oil, water or alcohol. As the length of the cell structure cannot change, there is a direct correlation between the increase in diameter of the hole and the increase in volume of the cell.

Incompressible fluid under pressure may be applied from the ground surface for expanding the central cell through a pump 14 and conduit means 12 connected to the core of the cell and communicating with the interior of the expansible element. The calibrated reservoir 18 connected with the pump is used to measure the quantity of fluid introduced under pressure.

As the fluid should be incompressible and no air bubbles should remain in the cell, a return conduit means 19 with a valve 20 is connected with the cell and used to evacuate the air completely.

A pressure gage 13 connected to the return conduit means 19 is used when the valve 20 is closed in order to measure the pressure applied in the cell.

Fluid under pressure may be applied from the ground surface for expanding the upper and lower cell through a pump 14' and conduit means 12' connected to the cores of the cells 2 and 3. A pressure gage connected to a return conduit means 19' is used to measure the pressure applied in the upper and lower cell.

The test is carried out as follows: the cell structures are lowered in a bore hole at the desired depth; an incompressible fluid is applied under pressure in the central cell through pump 14. As the pump is connected to a calibrated reservoir, the volume of the fluid in the corresponding cell is always known. Simultaneously, fluid is applied under pressure in the upper and lower cell through pump 14' in such a way that the pressure read on the pressure gage 13' be always equal to the pressure

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read on the pressure gage 13. The volume injected through the pump 14 is plotted against pressure read on the pressure gage 13 or 13'.

From the foregoing, it is believed that the apparatus for practicing my invention will be readily comprehended by persons skilled in the art. It is to be clearly understood, however, that various changes in the apparatus herewith shown and described as outlined above, may be resorted to without departing from the spirit of the invention, as defined by the appended claim.

Having thus described my invention, I claim:

Apparatus for measuring compressibility and bearing capacity of soil comprising a cell structure to be lowered into a test bore hole, said cell structure being a multiple cell arrangement having a main cell and outer cells whereby the outer cells restrict endwise expansion of the main cell when pressure is applied, each said cell structure comprising a rigid tubular core, an expansible tubular hermetic element sleeved over said core, conduit

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means connected to the core and communicating with the interior of said expansible element, whereby fluid under pressure may be applied from the ground surface for expanding said element, means for measuring the quantity of fluid introduced into said expansible element, and pressure gages communicating with said conduit means for measuring the pressure applied thereto.

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