No. B-6 AN IMPROVED TYPE OF SOIL SAMPLER FOR EXPLORATIONS OF SOIL CONDITIONS AND SAMPLING OPERATIONS

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Summary. The soil sampler described herein was developed over a period of six years, starting in 1930, by engineers of the Materials and Research Department of the California Division of Highways. It was designed to avoid the delay and expense incidental to driving and cleaning out a well casing before taking samples, and has been successfully used in its present form for obtaining undisturbed soil samples to depths of over 250 feet under a wide range of conditions. 232 holes aggregating over 13,000 lineal feet of cores have been cut with the 2" sampler since 1933 in connection with foundation investigations for the San Francisco-Oakland Bay Bridge and other highway, bridge, and grade separation projects.

The equipment was developed not only to reduce the cost of deep sampling, but also to obtain samples in an undisturbed state so as to accurately determine foundation conditions, including moisture content, density, and consolidation. In clay and cemented material samples have been taken to depths of approximately 150' below the bottom of a cased or open hole, thereby greatly reducing the total drilling expense. Practically continuous 2" diameter core samples have frequently been taken to depths of 100 to 200 feet at a total cost of less than $1.00 per foot, including rental of equipment and all operating expenses.

All grades of foundation material have been sampled, the equipment being suitable for use in formations of hardness ranging up to "soft" rock. The sampler unit has been driven as much as two or three feet into bedrock where the material consisted of partially disintegrated sandstone or shale.

Conventional Samplers. Soil samplers used on the preliminary investigation of the San Francisco-Oakland Bridge foundation material (E.N.R., June 23, 1932, P. 891) required casing to just above the elevation at which a sample was desired. After cleaning the casing, samples were obtained to a depth of 18 inches below the bottom of the cased hole. The casing was then driven to the next depth to be sampled, the hole again cleaned, and samples taken as before. Great care and slow methods were required in driving and cleaning the casing so as not to disturb the material immediately below the bottom of the hole.

Conventional equipment (A.S.C.E. Proceedings, May, 1933, P. 804) usually included a vent hole with either a flap or ball valve action at the top of the sampler sections. Sand and silt particles frequently lodged in the valve preventing a satisfactory seal against suction, thus resulting in the loss of the sample.

New Sampler. Prior to and during the period the original borings for the Bay Bridge were under way, The Materials and Research Department was working on the development of a sampler designed to eliminate unsatisfactory and expensive operation features of the conventional type of equipment. The new sampling device developed as a result of these studies (Figs. I and II) is a decided improvement over the old type. A clean open hole is not required and the use of casing is not essential for holes up to 100 feet unless free flowing sand or gravel is encountered. Casing is required only when skin friction becomes too great to permit ready driving and pulling of the sampler. On the foundation study recently completed for the proposed San Francisco Interurban Bay Bridge Terminal and Viaduct construction, 70' to 90' of casing was used to seal off an overlying strata of free flowing eolian and marine sands. Boring and sampling operations were then satisfactorily continued through marine clay and clayey sand to bedrock at depths up to 220' without further casing, at a saving of one-third to one-half the cost under previous methods.

Description of Sampler. The sampler unit (Figs. I and II) consists of a cutting point, sampler sections, couplings, 2" brass tube sample retainers, and a plug, screw, and nut assembly. The cutting point is constructed of tool steel and its outer shape conforms in general with that found by Veihmeyer and Beckett (Soil Science, Vol. 25, 1928, P.147, and Vol.27, 1929, P.381) to be suitable for securing undisturbed samples of agricultural soils.

The sampler sections, couplings, and the cutting point are bored on the inside to receive the brass tube sample retainers. These brass tube retainers permit ready removal of the cores from the sampler and prevent disturbance of the specimens. This part of the outfit is conventional.

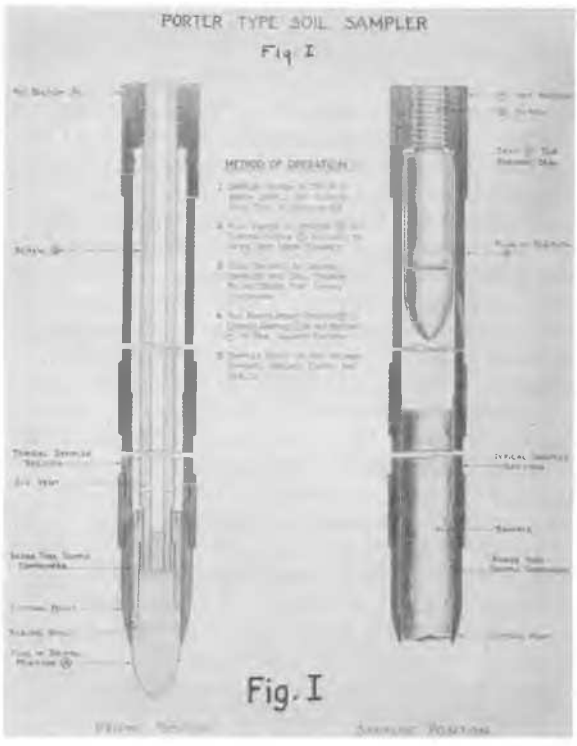
The important element of the new sampler is the plug assembly. First, it plugs the sampler until the depth is reached at which samples are desired; and second, it provides a seal against suction immediately above the top of the sample.

The screw shaft and nut section are provided with a fast pitch, left hand thread, the former being connected to the plug in a manner to permit swivel action.

Extension rods and all sampler sections are provided with suitable size R. H. square threads. In the couplings the ends are butted against a square shoulder in order to prevent excessive thread stress during driving.

Operation. Samples are taken by (1) driving the sampler as a plugged tube to the desired depth; (2) retracting the plug and forcing the open sampler into undisturbed material; (3) retracting the plug further to effect an air tight seal above the sample; (4) withdrawing the entire sampler unit to the surface.

A 3' to 4' length of soil core is normally obtained in one sampling operations. On important work one three to four foot sample is usually taken for each five feet of depth. In many cases, however, the driving record for the plugged sampler furnishes sufficient information regarding the uniformity of the material. In such cases the drilling operations are expedited by taking samples at less frequent intervals. Two samplers complete with plug, screw, and nut assembly are usually kept on rush jobs so that drill operations will not be shut down while samples are being removed and prepared for shipment to the Laboratory.



Samples. The string of 2" long brass tube retainers, with contained sample, are pushed out of the sampler sections immediately following removal from the hole, cut into 2" long sections at the joints between retainers with a fine piano wire saw, capped and weighed. The weight of the 2" long cores, together with examination of the cut surface, immediately furnishes an index to the uniformity and character of the material. Specimens retained for shipment to the Laboratory are at once taped, marked, and sealed with paraffin in order to prevent any change in the original condition.

To determine the extent of disturbance, if any, during sampling, a large specimen of Class A-4 soil having a moisture content of approximately 17% was mixed with 10% flowers of sulphur and consolidated at the Laboratory in alternate layers of light and dark material, 5% by weight of precipitated magnetic oxide being used for coloring. Cores were cut so as to expose any deformation of the strata. As will be noted, there was no apparent disturbance of the material in the core, whereas there is a very marked disturbance in the portion of the original sample outside of the core and adjacent to the sampling tube. The unit weight and moisture content of the 2" x 2" cored specimens checked within one-half of one per cent of the unit weight and moisture of the larger prepared specimen from which the core was cut.

Class A-4 soil was selected because it was the most plastic soil available which could be used without excessive shrinkage and cracking under the heating required to harden before cutting to expose the condition of the soil strata.

Size of Sampler. Two sizes of the type of sampler described herein are now being used by the California Materials and Research Department. One size, of light weight design for hand power and air hammer operation, cuts cores of approximately 1" diameter and is used extensively for preliminary borings ranging up to 50 feet in depth.

The sampler successfully used on deep borings for the last three years cuts a 2" diameter core. The design is suitable, however, for larger diameter samples if desired. The 2" samples are satisfactory for testing and this size sampler is operated with power equipment at a somewhat lower cost than heavier equipment.

When the site of drilling operations is accessible to truck equipment, a churn drill is usually used, with the spudder or walking beam actuating the drop hammer. Any other standard type of power drilling equipment may be used. Borings over the bay and overflow marsh land were made from a barge equipped with a derrick, winch, and jetting facilities. In deep borings the pulling capacity from the barge was sometimes insufficient and jetting was necessary to reduce the skin friction and free the sampler.

Little difficulty has been encountered in freeing the sampler unit with a jet, consisting of lengths of the inside drill rod tubing, washed down along the outside of the sampler unit without a guide. The ground disturbed in driving the sampler is more easily jetted than the undisturbed material away from the hole, and therefore the jet usually follows down directly adjacent to the sampler. In some cases a ring is slipped over the top of the sampler unit and attached near the bottom of the jet to serve as a guide.

Extent Applied in Practice. The 1" hand operated sampler designed in 1930 was perfected and used until 1933 for obtaining samples in penetrable ground to depths of 60 feet. The 2" size sampler was built and put into use during the first half of 1933, since which time approximately 13,000 lin. ft. of 2" borings have been made on major projects. In addition, several thousand feet of hand borings 30 to 50 feet in depth have been made for miscellaneous minor highway and bridge construction projects throughout the State.

On the San Francisco Bay Bridge Terminal Foundation investigation, twenty-one holes were bored from 50' to 220' in depth. During the first part of the work the outfit was not equipped with casing or jetting equipment. An effort was made to drive through the sand strata without casing and jetting, with resultant time loss and increased cost. As soon as the first procedure was abandoned, however, and casing and jetting through an average of 80 ft. of sand strata resorted to, the boring operations speeded up and the cost correspondingly fell off.

The sampler described herein was originally devised by O. J. Porter, Associate Physical Testing Engineer, in charge of aggregate and soil tests and investigational work. J. L. Beatty, Junior Testing Engineer, suggested valuable improvements and George Pomeroy, Chief Machinist of the Department, assisted Porter and Beatty in mechanically perfecting the design.

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DIAGRAMMATIC SKETCH OF
PORTER TYPE SOIL SAMPLER

Fig. II

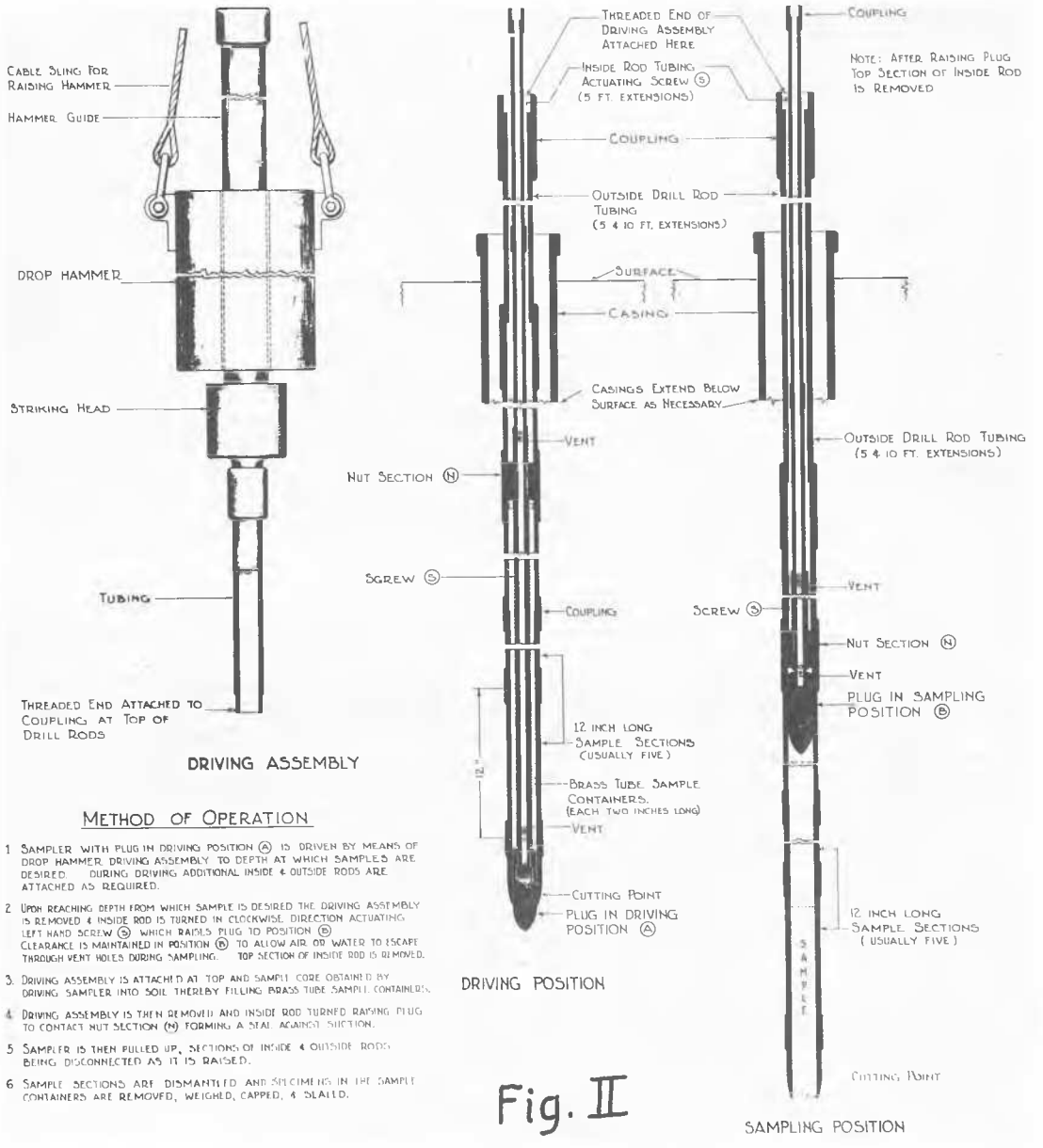

Fig. II

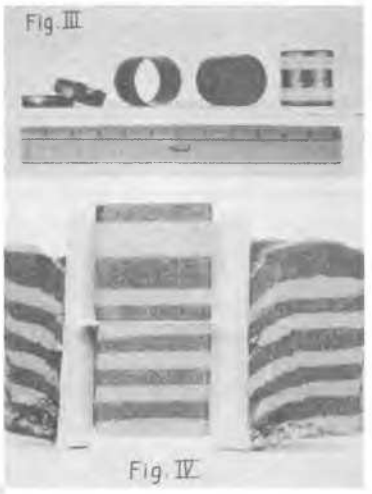

Fig. III showing caps, empty sample container, typical soil specimen after removal from the container, and a typical two inch container and sample sealed and prepared for shipment to the Laboratory.

Fig. IV showing condition of 2" cores cut with a California Type Soil Sampler from a prepared block of Class A-4 soil containing 17% moisture.

The white space between the core and the main block shows the area through which the sampler passed. No disturbance of the soil particles on the periphery of the cores can be noted, whereas there is a very marked disturbance outside of the sampler.

The sampler was driven 12 inches below the bottom of the cores shown; therefore, these cores were forced through from 12" to 15" of the sectional brass tube lining.