It is obvious that peat and also clay and peat are consolidating, during the cone test and in particular the sounding test, under the pressure exerted by the cone on the sample. So the increase of the frictional resistance during these tests is not negligible.

The data for the effective angle of friction for clay and loam seem to be reasonable, also those for peat found out of the cone test and seem to justify the theoretical values. For the sounding cone in peat such high values are found, that it must be supposed that the frictional resistance increases during the test as result from the load being applied on the cone. With regard to these circumstances we come to the provisional conclusion that the surface cone resistance is about 7 x, the sounding cone resistance 11 x the cohesion, except for peat where the s.c.r. is up to 21 x the cohesion. The sounding test does not give any direct particulars relating to the compressability of the soil.

No. B-4

EXPLORATION OF SOIL CONDITIONS AND SAMPLING OPERATIONS

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The object of the exploration of soil conditions under structures is the extraction of undisturbed samples of the soil for Laboratory testing and for accurate soil classification. A description of the soil conditions is given in papers No. C-1 and D-1. This paper deals mainly with the experience of the Laboratory in soil extraction and with the preservation of samples. In all the boring operations, the hand operated gear was used with 6" or 8" lining tubes. The driving of the extraction pipe is done by a 50 kg. drop hammer. In all the borings the water level was at few meters below the ground level.

The first extraction pipes used were 50 mm. diameter tubes 40 cm. long, and inside surface slightly smoothed. Exit of water inside the pipe was a direct one through the holes in the connecting pipe (Fig. 1^a). Results showed, however, that considerable compression took place, with an average of about 30% in quite stiff clays. This was measured by the difference between the distance through which the pipe has been driven, and the length of the extracted sample. This method is evidently an approximate one, but it showed that compression had taken place. Various attempts were made with an inlet of a smaller diameter than the rest of the pipe, and in this way compression was reduced to about 10%.

The 50 mm. pipes were later substituted by 100 mms. pipes (Fig. 1^b), the exit remaining the same as in the first type. The disturbance was in general less than in the 50 mms., but the removal of the samples from the pipes, especially for silty soils subjected them to a good deal of disturbance. Split pipes were later used, but against expectations, in many cases of clay samples and invariably in silty ones, the samples sheared along diametral plane of the split, when attempt was made to remove the two split halves from the sample. (Fig. 1^c).

The Laboratory resorted later to an extraction pipe after the design of A. Casagrande. The cutting edge was carefully machined, and made about 2 mm. smaller in diameter than the remainder of the pipe. The use of a wire loop to shear off the sample before pulling up for extraction did not prove very satisfactory. (Fig. 1_a^d).

Sometimes the valve provided at the top for the exit of water failed to act and as a result the sample was forced out of the pipe soon after the extraction pipe began to be lifted upwards. Later, however, the same type was used with 120 mm. diameter and with a rubber tube attached to the exit, and this may be connected to a small hand operated suction pump. (Fig. 1^e).

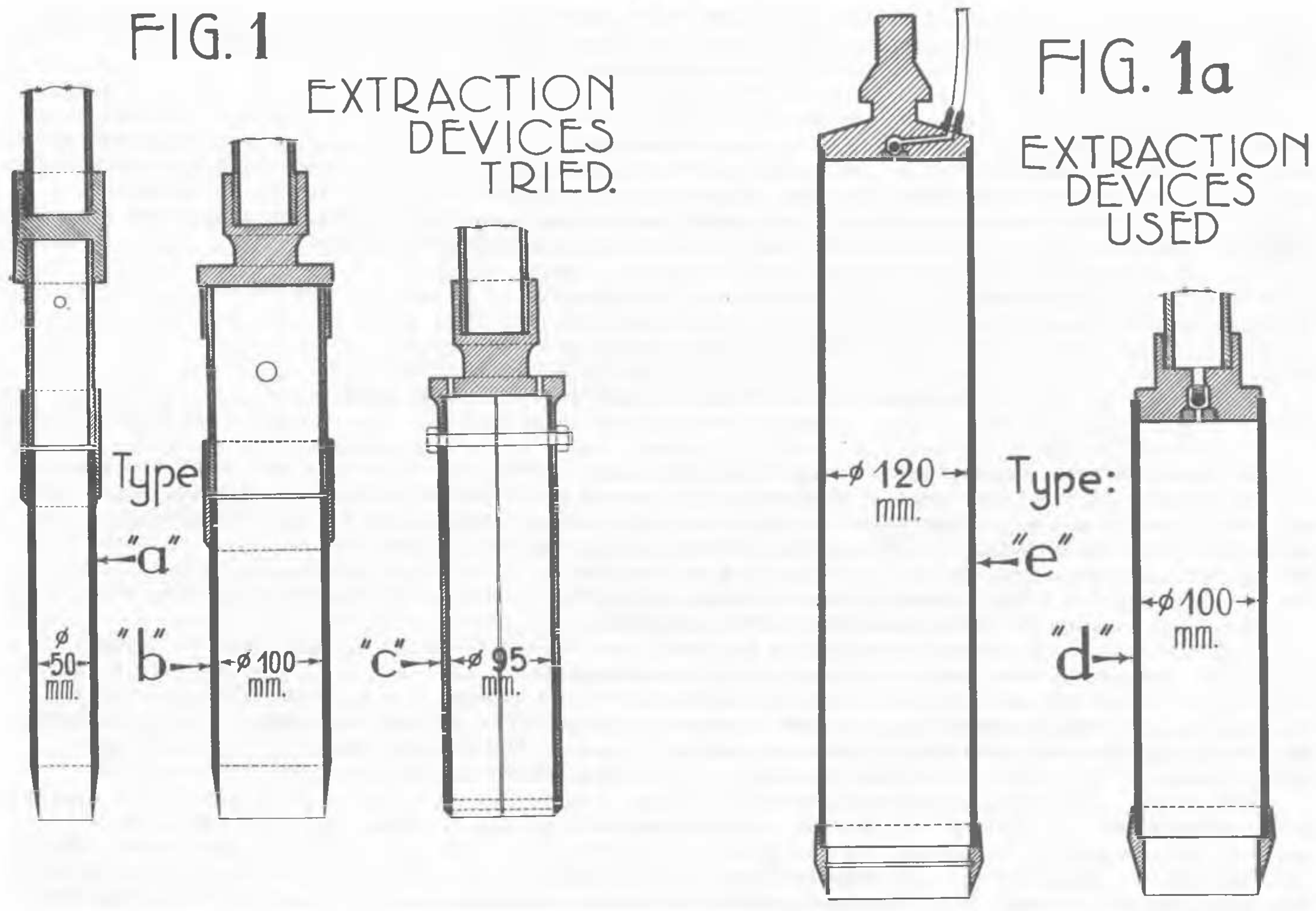
A sample extracted by this method was considered undisturbed if it kept its shape without expansion to fill the 1 mm. gap. The compression of samples by this pipe appears to be negligible, and was not deducted when measured by the method described before.

Generally speaking, it proved satisfactory in all cases of cohesive clays with the compressive strength "q_d" above 0.8 kg/cm2. Most samples of the dark clay, and practically all samples of the brown clay (the properties of these clays are fully discussed in papers No. C-1 and D-1) kept their shape, and they were assumed therefore undisturbed. Pure dark clay samples are however difficult to extract with this type because they are liable to slip out although the suction pipe used in type (1_a^e) helped to prevent slipping. Clays weaker than q_d 0.8 kg/cm2, and silty soils all seem to suffer certain amount of disturbance, because they expand and fill the 1 mm. gap. There are, however, certain types of clays which cannot be extracted undisturbed with this or any other similar type driven or pressed into the soil. Brittle, slated clays, clays with tendency to break up into small bits, and similar types are disturbed. In almost all types of soils, it has been found necessary to extract a sample of about 30 cm. length, because one had to discard the upper 10 or 15 cm. as disturbed samples, because most samples are extracted under water level.

The practice adopted at first was to paraffin the samples in the pipes and keep them in store until required. This did not prove very satisfactory because in many cases rusting took place and penetrated through the sample especially along the surfaces between soils of different types. Further shrinkage of the paraffin cover often caused small gaps and sample became no longer air tight.

Samples paraffined directly by a coat of 5-7 mm. of a hot mixture of ceresine and paraffin gave satisfactory results in the case of cohesive soils, although the cover is liable to get damaged through transport. Samples kept inside airtight glass jars, behaved in a similar way. Non-cohesive soils got disturbed through transport and in many cases lost their shape.

The method which gave the least disturbance seemed to be where the sample had been paraffined by a thin coat, placed inside a glass jar of sufficient diameter, and where paraffin had been poured all round.



Conclusions

Samples suffer two main types of disturbances during the extraction; one through the driving of the cutting edge into the soil and the other is through friction during the passage of the sample into the extraction pipe. The former disturbance is not overcome by any type of pipes described. The extent of this disturbance is not known. Although the principle underlying the possible elimination of this source may be conceived through several ways, yet the development of these various possibilities into practical devices has not yet been attempted, and therefore no recommendations can be given about them. With the Casagrande device, the second source of disturbance seems negligible when compared with other possible sources of disturbance during transport, and swelling before and during fitting in the compressibility apparatus. (See Mr. Tschebotareff's paper No. D-1). We postponed studying further refinements until it could be combined with the elimination of all these sources of disturbance together.

Nevertheless, the present types of extraction devices have proved the only known means for the proper classification of soils. Each type of clay met with (See paper No. C-1) has different varieties which behave differently under pressure or when remoulded. Streaks of small depths of fine sands or silts, (see definition in paper No. C-1), layers of baked clays, crumbling types, which are often met with in borings in Egypt can never be classified through any extraction device of the auger or valve types, where the soil is mixed together and badly disturbed.

Very misleading informations have been recorded in documents as a result of the impossibility of proper classification, and this was only discovered when the Laboratory devices have been used when verifications of the first borings were demanded.

Therefore, apart from the defects related to soil sampling for Laboratory tests, the experience of the Laboratory seems to indicate that these or similar devices will be relied upon entirely for proper soil classification in future. All members of the staff of the Laboratory have taken part in the boring work and are of the same opinion.