The Writer is particularly indebted to Dr A. N. Schofield for several discussions on the relevance of the theory of plasticity, and in particular the normality condition, to soil mechanics.

Yours faithfully,

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8 March, 1963.

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The Secretary,
The Institution of Civil Engineers.

DEAR SIR,

Mr Lo has presented a most interesting Paper on "Shear strength properties of a sample of volcanic material of the Valley of Mexico" (*Géotechnique*, 12 : 4 : 303–318).

To obtain the Hvorslev parameters for the undisturbed clay samples, Lo uses the $(\sigma_1 - \sigma_3)/2$ and $(\sigma_1' + \sigma_2')/2$ (at failure) curves. This procedure does not illustrate the effect of the scatter in test results, on the possible range in values of ϕ_e and c_e.

The data given in the Author's Tables 1 and 2 is shown plotted in Fig. 1. Mean values of ϕ_e and c_e may be obtained from this plot. The scatter of Lo's results is large; the following lines may be drawn for the undisturbed samples:

Table 1

Line	ϕ_e	k	Description
A	40°	0·057	Mean line for all samples
B	53°	0·023	Mean lines overconsolidated samples with $330 > w_i > 320\%$
C	28°	0·158	Mean line for normally consolidated samples

The equivalent preconsolidation pressure was taken as the vertical principal consolidation stress. Samples I-1, I-11 and I-8, consolidated in the laboratory along the recompression curve, were not plotted. It is evident from Fig. 1 that taking a mean value of 40° for ϕ_e with the available data is a rather bold step.

Comparison of lines *B* and *C* in Fig. 1 suggests that the structural breakdown that takes place in Mexico City clay, when the preconsolidation pressure is exceeded, may change the value of the true friction angle. It is well known that once the preconsolidation pressure is exceeded for this clay, a large variation in properties takes place. This effect is illustrated by

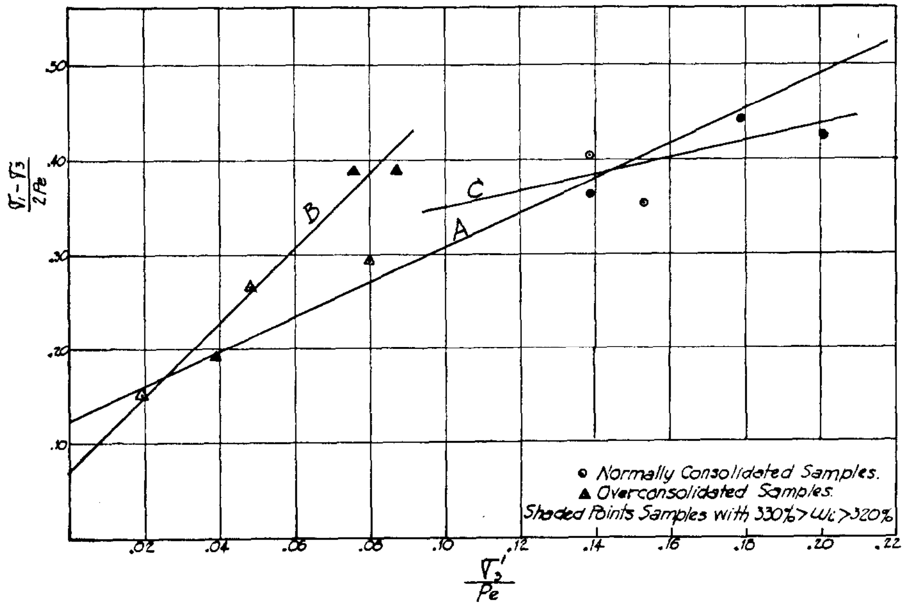

Fig. 1. Determination of ϕ_e and c_e from triaxial tests. Undisturbed Mexico City clay

the data in Fig. 3. Permeability was measured directly at the end of each loading increment in the consolidation test. The preconsolidation pressure for this sample is around 1 kg/sq. cm. The effect of the structural breakdown is clearly evident. One might properly raise the question: are the Hvorslev's parameters applicable to a clay that exhibits such pronounced structural effects?

From the data in Fig. 6, Lo concludes that ϕ_e for the remoulded clay is zero. In Fig. 2, Lo's data in Table 3 (remoulded samples) has been plotted in the same way as for the undisturbed samples.

In this case, several mean lines may also be drawn for the remoulded samples. Two are sketched in to illustrate that a slight difference in interpretation of the data changes the value of ϕ_e significantly.

Table 2

Line	ϕ_e	k
D	13°	0·28
E	0°	0·42

If line D is taken as the mean line there is a closer agreement with Lo's value of ϕ_e obtained from measurements of the inclination of the failure planes in unconfined compression tests. A discrepancy of 10° is not usual for remoulded clays. The discrepancy obtained by Gibson (6°) for Shellhaven clay, as quoted by Lo, applies to undisturbed samples. For remoulded clays where isotropy is approximately satisfied, Gibson obtained very good agreement between the results of α tests and drained shear tests.

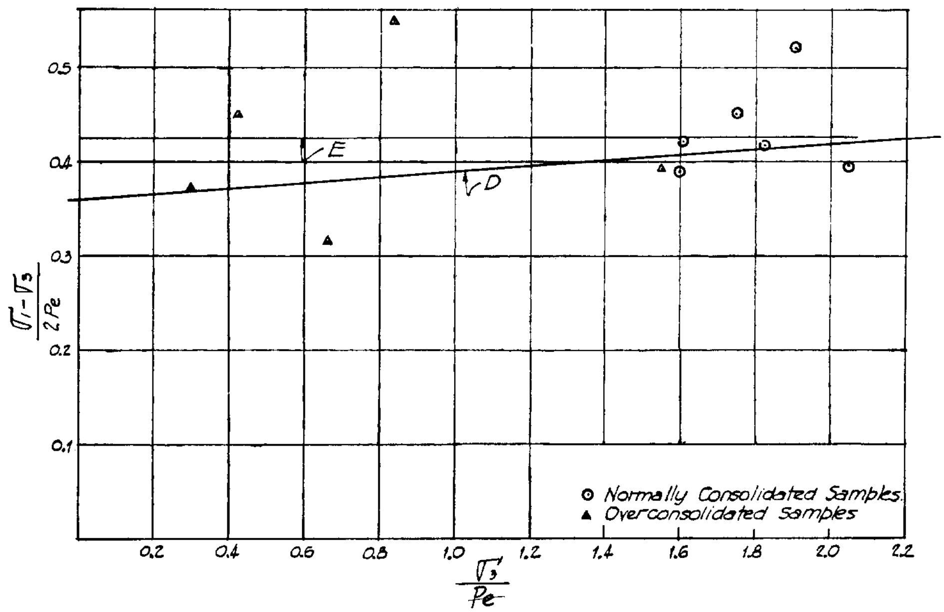

Fig. 2. Determination of ϕ_e and c_e from triaxial tests. Remoulded Mexico City clay

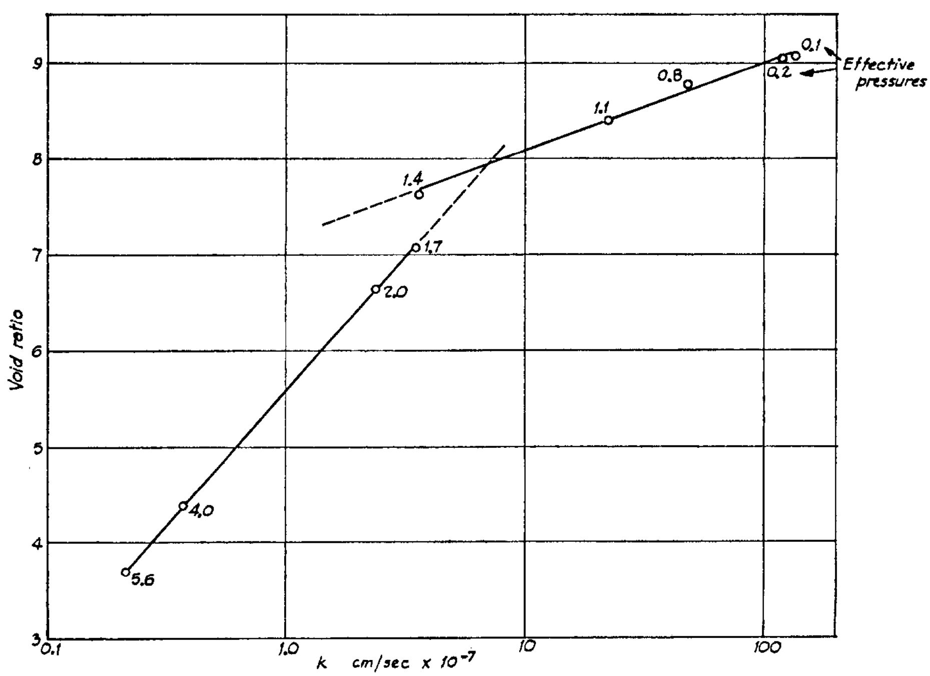

Fig. 3. Variation of permeability with void ratio. Undisturbed Mexico City clay

Previous investigators have taken p_e equal to the normal consolidation stress on the failure plane when calculating the value of k_o. For samples consolidated anisotropically, for small values of k_o and large values of ϕ_e, the normal consolidation stress on the potential failure plane may be very different from any of the consolidation principal stresses. For instance for $k_o = 0{\cdot}4$ and $\phi_e = 40°$ the normal stress on the failure plane is one-half of the maximum principal stress. It may be convenient in the present investigation to refer the value of k to p_e on the potential failure plane in order to establish a comparison with other types of clay.

If we take $\phi = 40°$ for Mexico City clay, and p_e as the normal preconsolidation pressure on the potential failure-plane, the corresponding value of Hvorslev's k parameter is 0·13 for the undisturbed clay.

In the year 1960, Dr J. L. White made a composition analysis of "Mexico City clay" at Purdue University, determining: X-ray diffraction patterns, infra-red records, base exchange capacity, organic matter content and ion concentration in the pore-water. It was found that most of the material was amorphous, a small amount of calcite and quartz were detected but there was no evidence of crystalline clay minerals. These results were confirmed by differential thermal analysis and X-ray diffraction patterns conducted by Dr R. T. Martin at Massachusetts Institute of Technology and the results reported (Girault 1960, and Leonards and Girault, 1961). It is encouraging that Dr Moum's studies incorporating the advantages of electron microscopy, confirm these findings.

The Writer has studied the results of analysis where the ion concentration in the pore-water was determined for several samples of "Mexico City clay" and also for water from different shallow and deep wells within Mexico City. The shallow wells are entirely within the clay formation and the deep wells pump from sand and gravel strata under the clay layers. It is to be noted that all the analyses (including Dr Moum's) show great differences in ion concentration.

To interpret these results, it is necessary to consider the seepage patterns within the Valley of Mexico. Intensive pumping from deep wells located under the city area has caused water to flow horizontally from the valley edges—through the deep sandy layers interbedded in the clay deposits. (These pervious strata gradually rise to the surface near the mountains.) The water-table near the centre of town is at a depth of 6–9 ft. It is fed by rainwater, leaky water mains, and broken sewer pipes, and has remained at this depth for several years, in spite of the downward seepage of water through the clay layers. It is well known that clay samples from different locations or depths are being percolated with waters from different sources and with various salt concentrations, thus influencing the ion concentration in the clay pore-water.

Yours faithfully,

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May, 1963.

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