peared that there was a considerable difference between the average values $F_I = 3000$ cm min and $F_{II} = 475$ cm.min, that is to say that there was an important difference in the permeability by water of the two samples of peat.

The greater permeability by water of the peat near II will probably have been the cause that the disturbance of equilibrium which had been expected at the outset dit not take place.

Further another 10 measurements were carried out near km 31.750 of this railway (III) where strengthening of the road-bed must be executed in the central part of the town of Gouda. 4)
From the values $F_{III} = 145$ cm.min (fig. 8) found in this case III it appears that the kind of peat in this region has a good permeability, which enables the strengthening of this section of the railway to be very simple and inexpensive.

CONCLUSION.

Carrying out measurements of permeability by water with the apparatus as described above in peat at any place is possible without great expense and will clear the insight into the behaviour which may be expected of the liquid phase and therefore of the soil as a whole, when a load is brought to bear onto it.

As to how far measurements in clay and sand soils may have practical significance should be investigated further.

REFERENCES.

1) Vide the author's article under section VIII.
2) For further particulars concerning the execution of this experimental section near Gouda we refer to the author's publication in "de Ingenieur" of 1947 nos.26 and 27.
3) Vide Proceedings of the International Conference on Soil Mechanics 1936 Vol. I page 7).
4) Vide the author's article on this subject in section VIII.

-o-o-o-o-o-o-

III b 2

SIMPLE FIELD TESTS FOR SOILS

A.H. GAWITH, M.C.E., A.M.I.E.Aust.
Engineer for Tests, Country Roads Board of Victoria
Melbourne, Australia

1. Owing to the differences in soils encountered over a length of roadway it is not possible to perform the more elaborate soil tests on all the variations encountered. It is necessary to use those tests which give the greatest return of information for the least expenditure of time and labour in testing. Further, it is desirable that there should be established a system of tests which can be done by relatively unskilled operators, with a minimum of equipment, and which bear a known relation to the more difficult tests.

2. The simple linear shrinkage test has been used and provided that the mould is filled at a definite moisture content, e.g. either the Field Moisture Equivalent or the Liquid Limit, reproducible results are obtainable. The mould can be of any convenient length, e.g. 10 inches or 20 centimetres, and cross section, and may be formed by splitting a piece of 1 inch internal diameter tube longitudinally and attaching end pieces.

The soil, sieved through a No. 36 B.S. (No. 40 U.S.) sieve is brought to the Liquid Limit by the addition of water, the consistency being checked by the hand liquid limit test, (A.S.T.M. D423-39), but the actual moisture content is not determined. The mould is filled, struck off level, and then allowed to dry in air overnight and then in an oven. The percentage reduction of length of the soil pat is measured. Results of experiments with 282 samples of soils indicate that the test can be used to give an indication of the liquid limit and plasticity index. Regression equations fitted by the method of least squares to the means of arrays of linear shrinkage are shown in Table 1.

TABLE 1

Percentage of all tests in which(a) or(b) occurs	(a) Actual Plasticity Index will exceed	(b) Actual Liquid Limit will exceed
1%	P.I. = 3.08(LS) + 3.6	L.L. = 30.5 + 3.11(LS)
5%	P.I. = 2.74(LS) + 2.8	L.L. = 26.4 + 2.87(LS)
10%	P.I. = 2.61(LS) + 2.3	L.L. = 23.9 + 2.81(LS)
50%	P.I. = 2.34(LS) - 0.49	L.L. = 15.5 + 2.71(LS)
90%	P.I. = 2.03(LS) - 2.9	L.L. = 7.2 + 2.59(LS)
95%	P.I. = 1.96(LS) - 3.7	L.L. = 4.7 + 2.54(LS)
99%	P.I. = 1.58(LS) - 4.3	L.L. = 0.2 + 2.34(LS)

3. An analysis was made of the results of tests on 533 samples of soils which had been tested by the Highways and Local Government Department of South Australia. For these samples the linear shrinkage test had been carried out on material passing the No. 7 B.S. (No. 8 U.S.) sieve and California Bearing Ratio tests at 100 per cent of standard A.A.S.H.O. compaction had also been performed.

A correlation coefficient of -0.797 was found between linear shrinkage and the logarithm of the California Bearing Ratio, the regression equation being
log. (C.B.R.) = 1.68 - 0.085 (Linear Shrinkage) with standard error of estimate 0.25. The results of sieve analyses of these soils were not available.

4. There were available the results of tests on 159 samples of soil on which the California Bearing Ratio test at 95 per cent of Modified A.A.S.H.O. compaction had been performed, as well as linear shrinkage tests on the material passing No. 36 B.S. (No. 40 U.S.) sieve, and sieve analyses on the No. 7, No. 36 and No. 200 B.S. sieves. These results were examined by the method of linear multiple correlation and the regression equations, correlation coefficients and standard errors of estimates are shown in Table 2, where

Y = logarithm of California Bearing Ratio
X_1 = linear shrinkage from the liquid limit on material passing No. 36 B.S. sieve
X_2 = percentage passing No. 36 B.S. sieve
X_3 = percentage passing No. 7 B.S. sieve
X_4 = percentage passing No. 200 B.S. sieve

TABLE II

Regression equation	Correlation Coefficient	Standard error of estimate of Y
1. $Y = 1.99-0.042X_1-0.0009X_2+ -0.0051X_3-0.0016X_4$	0.732	0.241
2. $Y = 2.00-0.042X_1-0.0074X_2+ -0.0021X_4$	0.732	0.241
3. $Y = 2.06-0.046X_1-0.0074X_2$	0.724	0.243
4. $Y = 1.44-0.052X_1$	-0.656	0.265

The percentage passing the No. 36 sieve (X_2) had little effect on the estimate and equation 2. was used as the basis of an alignment chart for estimating the California Bearing Ratio.

5. It is realized that the California Bearing Ratio test is not in itself an entirely satisfactory basis for estimating the relations of the simpler tests to the actual stability of the soil. Further, the methods of statistical analysis used have been relatively simple and the work is now being extended to an examination of multiple curvilinear correlations between various tests, particularly with regard to the effect of the proportions of various particle sizes, in which case there is evidence that the relationship is not linear.

6. The objects of this investigation have been,
a) to obtain information of immediate value in the control of works in the field.
b) to establish relations between test methods preparatory to carrying out a field examination of pavement thicknesses and their relation to soil, traffic and climate.

-o-o-o-o-o-o-

III b 3

DETERMINATION IN SITU OF THE SHEAR STRENGTH OF UNDISTURBED CLAY BY MEANS OF A ROTATING AUGER

LYMAN CARLSON
The Royal Swedish Geotechnical Institute

INTRODUCTION.

The shear strength of clay is usually determined in the laboratory from samples taken from different depths of the ground. In Sweden the investigation is generally carried out by means of unconfined compression test or cone test. Usually the shear strength, thus obtained, increases only slightly with the depth under the surface of the ground. It is often smaller than the "real" strength, calculated from slides that have occurred in the same soil. This discrepancy may depend partly on disturbance of the sample caused by the sampler, partly on changes in the sample due to decrease of pressure when the sample is extracted. The decrease op pressure is likely to have a considerable effect on the results as pointed out by S. Odenstand. 1)

These errors can never be entirely eliminated when the investigation is carried out on