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DETERMINATION OF MATERIAL CONSTANTS OF SOILS BY MEASUREMENT

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Improving the facilities available at the Laboratories of the Department of Mechanics of the University of Agricultural Sciences, creeping and relaxation measurements were performed on two types of soil provided by the Department of Soil Science of the Agricultural Faculty of the University. The characterisation of the soils — as given by the same Department — is presented in Appendices I and II.

In the first series of experiments the dependence of the three material constants E, λ, ϑ occuring in the differential equation of the Poynting—Thomson body in case of uniaxial stress on the rate of increasing of load was investigated. Performing and evaluating the series of creeping tests the trend of this dependence could be successfully determined — the results are presented in Table 1. The data figuring in the Table are the rate of increasing of load $\dot{\delta}$, the moisture content of the soil in weight %, the length of the specimen before the experiment l, and its cross-section at the same time L_0. The value of average error H was abtained by summing the differences of the corresponding measured and calculated values and dividing by the number of measurements, while the corrected variance K was determined by summing the squared differences of the measured and calculated values and dividing by the number of measurements minus one. The total length of measurement period T and the values of rupture force F read at the rupture of the specimens after the experiment are also indicated. On the basis of the registered values of material constants it can be concluded unambigously that the values of the creeping and relaxation coefficients (λ and ϑ resp. are increasing with the enhancement of $\dot{\delta}$, while the values of the elastic modulus E scatter around a relatively constant value. It should be noted here that

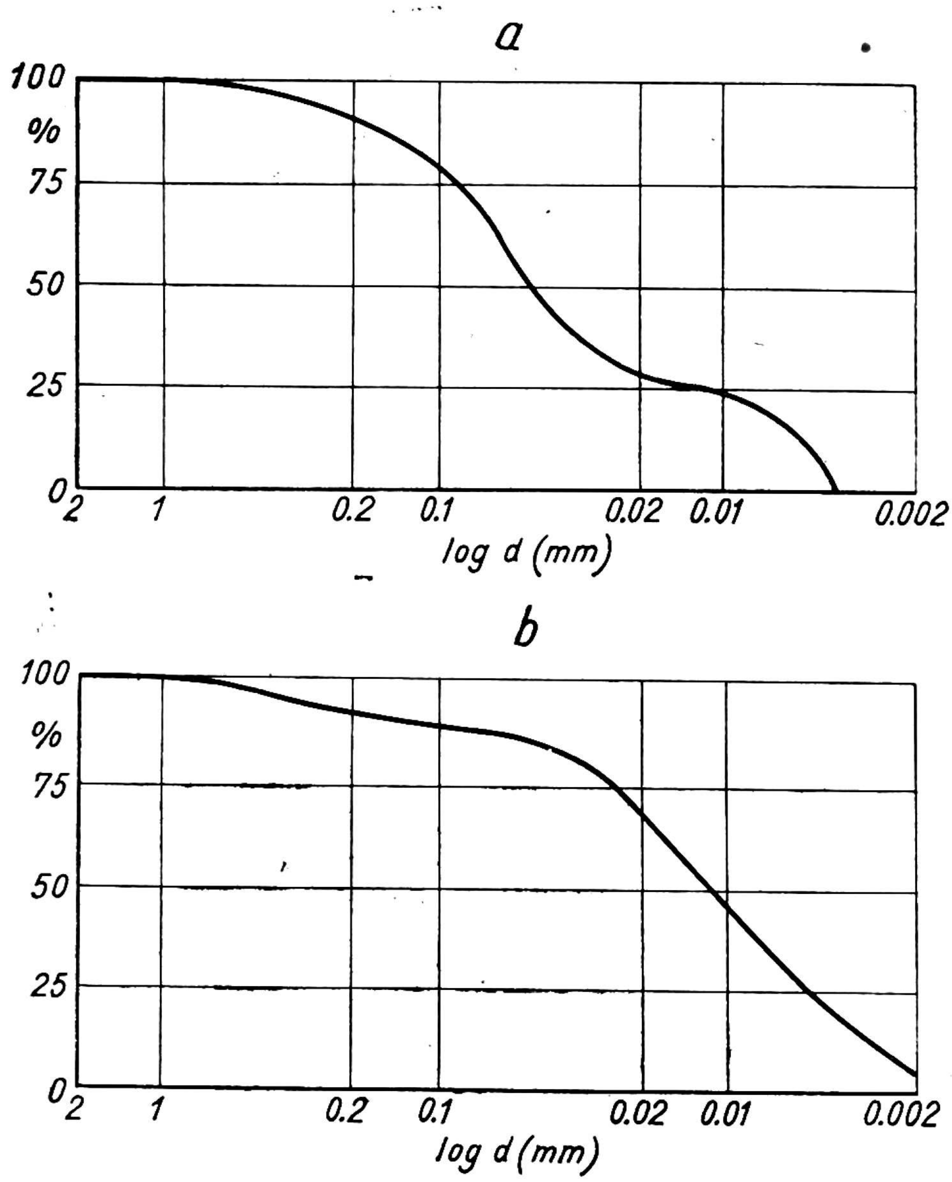

Fig. 1. Granularity of investigated soils: *a* — brown earth from Gödöllö, *b* — brown earth from Pásztó

on the strength of the results of testing measurements in course of the experiments the actual level of stress was 25 kp/cm^2.

In the second series of experiments in addition to the rate of increasing of load also the moisture content of the specimens was varied. The values of material constants obtained by performing and evaluating the experiments are contained in Tables 2, 3, and 4. The values of Tables 2 and 3 are results of creeping experiments whereas those in Table 4 refer to relaxation experiments. What might strike the reader is the great value of the elastic modulus E in the 1st measurement of Table 4. It has the reason that the pressing force applied at preparing the specimen was 50 kp — it had a value of 10 kp at the first series of experiments, 15 kp at the second. This calls attention to the necessity of a subsequent investigation of the effect of the pressing force applied at preparing the specimen — that influences the compactness of the soil — on the values of material constants. Apart from this single result the values obtained

Table 1

Erosion version C_{sz} of brown wood land of Gödöllö

$\frac{kp}{cm^3\,min}$	Moisture content in %	l cm	L_{0_2} cm	E kp/cm^2	kph/cm^2	h	H $.10^{-3}$	min	K $.10^{-6}$	F kp
1.3150	1.0454	4.305	4.526	4734.2	1170,0	0.0952	3.9841	1176	2.6623	130.0
4.7814	1.0375	3.971	4.590	3048.4	4839.8	0.0840	0.5315	2828	0.5730	108.3
5.8120	1.0555	4.272	4.272	5287.1	0,1409	0,11409	0.1864	1650	0.0530	108.0
8.2785	1.1470	4.140	4.630	2386.6	4054.3	0.1091	1.3223	2570	3.7650	101.0
8.3223	1.2289	4.302	4.660	2616.8	4716.1	0.1473	0.92200	5391	2.6180	123.8
10.6970	1.3279	3.897	4.707	3590.6	6430.8	0.2003	3.9282	3048	3.8011	135.2
40.3270	1.1672	4.355	4.690	4052.1	12608.0	0.4060	0.2590	320	0.0878	128.0
45.2850	1.1270	4.275	4.526	4158.6	13781.0	0.4260	0.4226	5437	0.2581	137.5

H — average error,
T — period of measurement,
K — corrected variance,
F — rupture force.

Table 2

Erosion version C_{sz} of clayey chernozem brown wood land soil (Pàsztó)

Moisture content in %	l/d	T min	kp/cm²	1/min	.10⁻³	E kp/cm²	kp h/cm²	hours	Average error	Corrected variance .10⁻⁶
28.06	1.179	2358	0.465	0.0929	10.361	15.8	73.3	1.7431	2.3064	6.9636
28.06	2.371	1547	0.444	0.0634	6.924	21.9	106.7	1.6933	1.8657	4.7168
29.14	2.023	1459	0.351	0.0877	6.487	18.3	77.9	1.4171	1.9832	4.8789
29.16	2.358	1395	0.371	0.0742	6.661	19.8	66.1	1.0425	1.5518	3.1492
29.03	2.320	1400	0.371	0.0529	10.225	13.7	32.1	0.8309	2.9887	11.8510
29.90	2.200	1402	0.307	0.0384	5.564	19.4	61.2	1.2072	1.0750	1.4662
29.94	1.973	2870	0.349	0.0872	14.591	9.3	24.7	0.9689	5.5890	40.5830
30.03	2.300	2690	0.460	0.0128	7.062	10.5	25.0	1.0112	5.7311	55.2140
30.20	1.947	1810	0.330	0.0412	31.948	4.1	9.9	0.9046	9.8345	13.1450
30.55	2.371	2780	0.377	0.0377	3.090	40.2	266.9	1.9408	0.6588	0.6245
31.66	2.073	1765	0.220	0.0629	10.651	7.1	22.6	1.2388	4.5454	25.9740
32.10	1.918	1550	0.240	0.0600	10.589	11.5	44.7	2.3902	1.5529	4.6604

Table 3

Erosion Wversion C_{sz} of clayey chernozem brown land soil (Paszto)

Moisture content in %	l/d	T min	kp/cm²	1/min	.10⁻³	E kp/cm²	kp h/cm²	hours	Average error	Corrected variance .10⁻⁶
3,81	2.198	1195	58.38	3.1559	8.274	5210.0	23345.0	3.0249	0.6912	62.6050
3.87	2.421	1365	59.31	7.9084	10.0999	5166.2	9834.3	1.5906	0.4078	46.6750
4.00	2.121	1383	60.89	1.9964	10.166	5125.6	8616.4	1.3559	0.6807	58.3430
4.06	1.836	1578	56.14	4.3181	9.036	4946.3	12749,0	1.7912	0.6290	58 4020
4.23	2.117	2587	34.74	0.3776	7.012	4124.7	9974.0	1.0943	2.8499	194.3100
4.32	2.365	1495	58.00	1.1601	6.860	5998.0	16100.0	1.6121	0.1344	3.7588
4.47	2.018	1770	34.32	1.8065	7.407	3537.3	17191.0	3.5430	0.3984	28.3650
4.58	2.116	2332	21.93	1.1536	4.430	3547.7	14769,0	2.9427	0.1499	3.7281
4.61	2.298	1313	38.49	1.9247	6.824	4675.5	10461.0	1.8036	0.2468	9.5444
4.65	2.254	1430	47.31	2.0571	11.099	3517.4	10488.0	2.0772	0.4722	36.3861
4.72	2.395	1362	59.77	9.1960	6.695	6282.8	9878.2	1.0637	0.3053	13.4760
5.71	2.129	1492	20.63	1.1462	5.473	2481.9	13188.0	3.2085	0.5426	46.4150
6.37	2.056	2405	35.63	2.0177	7.445	2087.2	9866.3	1.8726	0.6464	55.7470
10.47	2.444	1410	12.60	1.2602	3.996	859.2	3341.6	0.9654	0.4727	42.5701

Table 4

Erosion version C_{sz} of clayea chernozem brown wood land soil (Paszto)

Moisture content in %	l/d	T min	kp/cm²	1/min	$.10^{-3}$	E kp/cm²	kp h/cm²	hours	Average error	Corrected variance $.10^{-6}$
3.91	1.934	1426	72.786	1.9154	6.5051	8015.4	21160.0	1.7977	0.5975	14.22
4.10	1.957	892	71.278	6.7884	9.0953	5678.0	10249.0	1.2833	10.4500	13.33
4.25	2.094	1389	53.118	1.0840	4.0026	9171.8	21821.0	1.5109	2.1900	11.21
4.29	1.870	1574	57.510	1.1981	9.2296	3262.8	25606.0	3.9156	35.1300	22.61
4.30	1.965	1396	35.335	0.6795	6.3353	2969.5	22779.0	3.8777	17.8591	5.02
4.32	2.245	1918	35.432	0.5715	6.7518	1672.0	24186.0	4.2427	25.6251	18.97
4.42	2.071	1402	35.927	2.9939	8.3985	3171.1	12685.0	2.9392	0.7741	4.62
4.43	1.883	1452	69.822	4.3637	9.5718	5226.6	17179.0	2.3168	4.0555	26.11
4.72	1.985	1441	78.471	7.1337	9.7311	4872.2	36328.0	4.4681	2.2291	60.02
4.67	2.117	2242	36.385	2.2741	4.6819	4175.9	36518.0	4.6371	4.9851	3.44
4.76	2.030	2718	77.285	8.5873	11.8031	4832.5	15176.0	2.2991	2 3310	25.00
5.84	2.114	1501	31.211	1.7339	6.4851	732.1	16139.0	3.2259	1.8791	12.99

from creeping and relaxation tests proved to be in a good agreement. This supports the appropriateness of the Poynting—Thomson model for describing the mechanical behaviour of soils. The average error (only for the period of increasing load of the relaxation experiments) and the corrected variance (only for the relaxation period of the relaxation experiments) were calculated by a computer here too, just like for the first series of experiments. However, I should like to call attention to the fact that due to the diversity of the length of time and the number of measurements only a relative comparison of these values of the two series of experiments can be made. Unlike Table 1, Tables 2, 3, and 4 contain the ratio of the length l and diameter d of the specimens before the measurement, the level of load σ and the value of deformation at the moment when increasing of the load stops ε_0. Processing of the values of material constants listed in the Tables, that is to say, determination of the functional dependence of material constants on the rate of increasing load and the moisture content of soil is still in progress due to the difficulties being raised up at fitting a function of two variables.

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OKREŚLENIE STAŁYCH MATERIAŁOWYCH GLEBY

Streszczenie

Autor przeprowadził badania stałych reologicznych gleby przy różnych wilgotnościach i prędkościach naprężenia. W pierwszym cyklu badań zmieniano prędkość obciążenia i stwierdzono względną stałość modułu sprężystości oraz podobną tendencję zmian współczynników pełzania i relaksacji. Następnie zmieniono wilgotność próbki. Wyniki potwierdzają przydatność modelu Poyntinga-Thomsona do opisu mechanicznego zachowania się gleby.

С. Надь

ОПРЕДЕЛЕНИЕ МАТЕРИАЛЬНЫХ КОНСТАНТ ПОЧВЫ

Резюме

Автором проводились исследования реологических констант почвы для различных увлажнений и скоростей напряжения.

В первом цикле исследований изменяли скорость нагрузки, причем установили относительную стабильность модуля эластичности и подобную тенденцию изменений коэффицентов ползучести и релаксации. Затем изменяли влажность образца. Полученные результаты подтвердили пригодность модели Пойнтинга-Томсона для описания механического поведения почвы.