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Soil Mechanic Characterisation of the Siesmic Focus Region of the Earthquake in Hungary in 1985

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SUMMARY The study showed the mathematical evaluation of the soil mechanic parameters of an inhomogeneous area using statistical methods. Namely, starting from ground level the profile was divided into metre zones. The occurrence and the percentage distribution of the different soil types in the layers of the different profiles have been statistically analysed. This method gave a mathematically based picture about the heterogeneity of the seismic focus region. Using this method it is essential that the region investigated has been evenly covered by boreholes providing profiles for the analysis. This method of analysis makes it possible that in a chosen depth one can calculate the expected worst and best values of the physical soil parameters on the basis of the distributional function. Using this method it is also possible to recognize certain areas where the probability of expected building damage due to an earthquake is definite.

1 INTRODUCTION

It is known that Hungary belongs to the peneseismic countries therefore the full analysis of the rare event is very important from the engineering point of view. The full analysis of the outcome of the earthquake in 1985 is not yet carried out but in fact a couple of thousand instances of building damage have been evaluated. With the cooperation of different institutes compilation of a monograph about the earthquake is going on. The complex analysis of the structure damages, and certain seismic calculations, made necessary the soil mechanic investigation of the seismic focus region. Because of financial difficulties it was not possible to obtain new soil samples therefore the data of 188 previous boreholes in the seismic focus region have been analysed. All data provided for statistical analysis were supplied by the Geotechnical Archives of FTV Consulting Engineering.

2 DATA PROCESSING METHOD

The evaluation of the soil mechanic parameters available was carried out in such a manner as to provide a basis for the analysis of the building damages. The area investigated was covered evenly by boreholes therefore the profiles adequately represent the undersoil of the seismic region. In the case of the engineering geological assessment of a bigger area it is expedient to make the evaluation by comparing the conditions at a given depth as required in the study. In this study there was no special depth range to consider, therefore starting from ground level the sample was divided into meter zones and the occurrence and the percentage distribution of the different soil types in the layers of the different profiles have been statistically analysed. The data obtained were analysed by mathematical statistical methods. The different soil mechanic parameters were determined according to the soil types and then the expected value, the standard deviation, the coefficient of variation, the coefficient of skewness and the coefficient of kurtosis were calculated. Regarding the data analysed, please note the following:

/a/ One has to be cautious regarding certain unexpected data because these could be due to a measurement error, sample desiccation, etc. These deficient data could alter the result of the statistical calculation considerably, especially the coefficient of skewness and the coefficient of kurtosis.

/b/ In case of a small sample number such as the coefficient of variation /$n < 30$/,
the coefficient of skewness /$n < 40$/,
the coefficient of kurtosis /$n < 100$/
the result obtained is only informatory.

/c/ The 188 boreholes were carried out at different times therefore this could cause an error in the evaluation of the samples.

/d/ It is possible that certain soil mechanic parameters will have a maximum or minimum limit, which has to be considered at the calculations of the coefficient of skewness.

/e/ The standard deviation increases with the extent of the area investigated and the thickness of the layer. Within the same soil type the soil mechanic parameters could be quite dissimilar due to the different geological origin.

The calculated average was considered characteristic of the seismic focus region. The soil under each building has been analysed and the difference in the soil mechanic parameters from the average was calculated as well as the degree of the building damage. The data analysis is not yet completed for each damaged building, however, it is now obvious that in certain regions where regions where the soil mechanic paramters were below the average the degree of building damage is higher.

3 REVIEW OF THE SOIL MECHANIC CHARACTERISTICS OF PEREMARTON-BERHIDA SEISMIC FOCUS REGION

As was mentioned before the data of 188 boreholes have been found in the Geotechnical Archives of FTV Consulting Engineering which covered the seismic focus region. The average depth of the boreholes was 5.48 m and the range was 0.5 to 15.0m

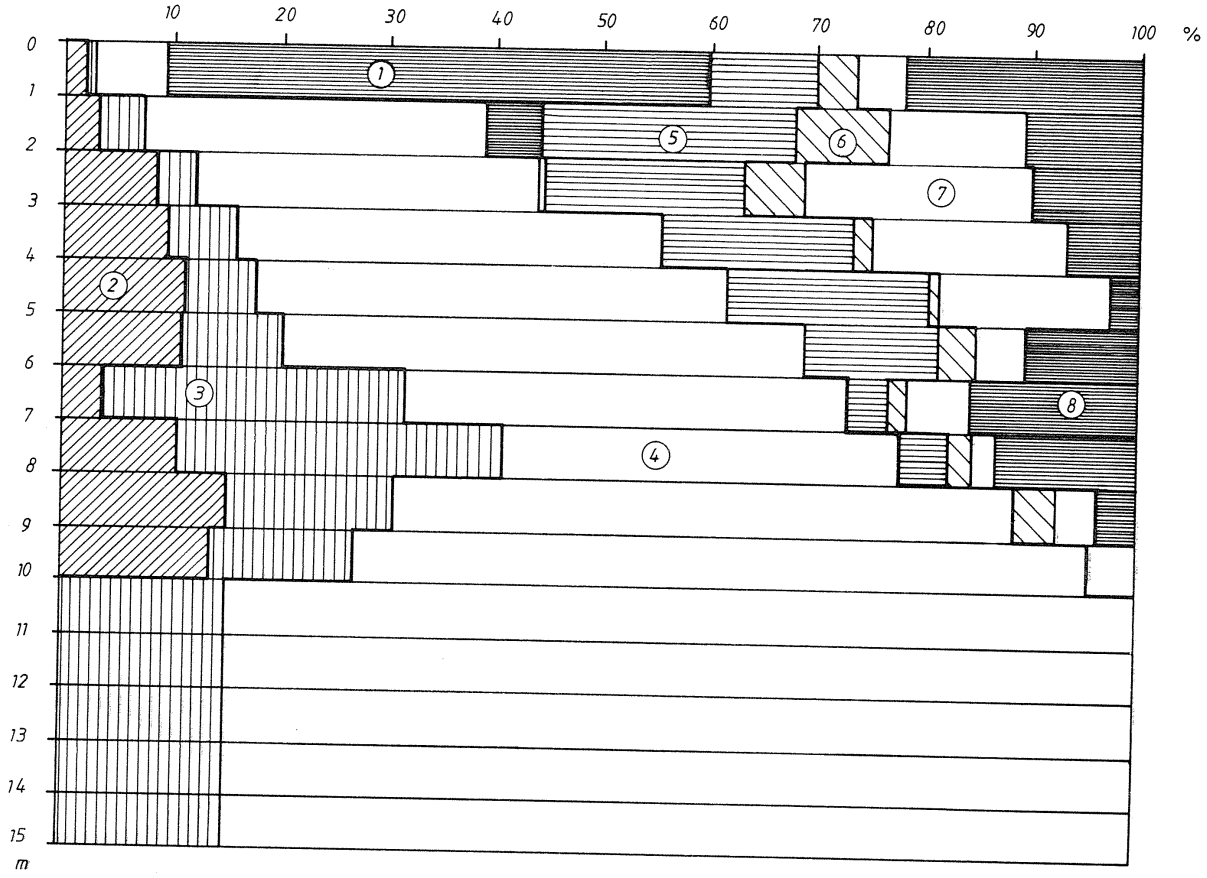
The seismic focus region was covered evenly by the boreholes. Figure 1 shows the percentage distribution of the soil types that occurred in the metre zones. From the soil parameters only those were analysed from which at least five were available in the different layers. The part of the boreholes which was below 10 m was not analysed because the sample number did not reach 5 in a group. Table I contains the statistical results of the soil parameters in metre zones and altogether analyses 588 values.

T A B L E I

COMPREHENSIVE DATA

Depth m	Soil types	Soil parameters	Analysed data					
			No.	Average value	Standard deviation	Coefficient of variation	Coefficient of skewness	Coefficient of kurtosis
0-1	clay	water content (w%)	14	20.8	5.32	25.6	-0.074	2.167
		plasticity index (I_p%)	8	25.9	10.48	40.5	0.774	2.064
	mixed soil with humus	water content (w%)	26	26.6	6.10	22.9	-1.034	3.578
		plasticity index (I_p%)	17	33.8	10.65	31.5	-0.660	1.689
		heating losses(I_v%)	14	11.3	0.93	8.2	-1.163	3.031
1-2	clay	water content (w%)	59	22.4	4.44	19.9	0.463	3.428
		plasticity index (I_p%)	46	30.1	9.00	29.9	8.715	1.699
	sandy gravel	uniformity coefficient (U)	6	87.5	79.91	91.3	0.660	1.723
		average diameter (d_m)	5	12.8	5.31	41.5	0.208	1.432
	silt	water content (w%)	6	19.3	3.40	17.6	0.121	1.180
		plasticity index (I_p%)	5	12.2	1.33	10.9	-0.370	2.217
2-3	clay	water content (w%)	41	24.1	4.49	18.6	-0.058	3.840
		plasticity index (I_p%)	31	32.5	10.17	31.3	-0.192	1.622
		unit weight, wet (ϱ)	6	1.833	0.104	5.5	-0.728	1.945
		void ratio(e)	6	0.803	0.122	15.2	1.386	3.425
		degree of saturation (S_r)	6	0.730	0.158	21.6	-0.321	1.901
	silt	water content (w%)	10	18.2	5.74	31.5	1.231	3.608
		plasticity index (I_p%)	9	13.6	1.34	9.9	-0.532	2.115

Depth m	Soil types	Soil parameters	Analysed data					
			No.	Average value	Standard deviation	Coefficient of variation	Coefficient of skewness	Coefficient of kurtosis
2-3	sand	water content (w%)	8	14.0	3.35	23.9	-0.179	1.665
		uniformity coefficient (U)	6	15.8	23.20	147.1	1.695	4.018
		average diameter (d)	6	0.34	0.38	112.5	1.780	4.184
3-4	clay	water content (w%)	27	25.0	2.12	8.5	-0.255	2.812
		plasticity index (I_p%)	21	28.5	7.90	27.7	0.321	2.334
3-4	sandy gravel	uniformity coefficient (U)	7	90.0	83.89	93.2	9.846	2.266
		average diameter (d)	7	7.1	5.81	82.2	1.405	3.639
4-5	clay	water content /w%/	28	26.3	3.65	13.9	0.517	3.622
		plasticity index /I_p%/	18	28.5	10.50	36.8	0.377	1.782
		unit weight, wet /γ /	8	1.90	0.11	5.6	-0.968	2.178
		void ratio/e/	8	0.88	0.14	15.6	0.276	1.419
		degree of saturation /S_r/	7	0.77	0.11	13.6	0.325	1.598
5-6	clay	water content /w%/	24	26.9	3.42	12.7	-0.507	2.493
		plasticity index /I_p%/	19	29.2	8.25	28.2	0.392	2.500
6-7	clay	water content /w%/	16	27.7	3.36	12.1	0.167	2.022
		plasticity index /I_p%/	12	27.9	7.71	27.6	0.584	2.415
7-8	clay	water content /w%/	11	25.3	3.86	15.3	-1.361	5.045
		plasticity index /I_p%/	6	30.7	9.62	31.4	0.198	1.804
8-9	clay	water content /w%/	10	26.3	4.10	15.6	-0.903	3.235
		plasticity index /I_p%/	8	27.7	6.72	24.2	-0.067	1.421
9-10	clay	water content /w%/	9	28.0	3.37	12.0	-0.367	1.884
		plasticity index /I_p%/	6	25.7	6.42	25.0	-0.189	1.830



1. Soil with humus
2. Fat clay
3. Médium clay
4. Lean clay
5. Silty fine sand
6. Silt
7. Sandy gravel
8. Others

Figure 1.