Statistically Controlled Engineering Soil Survey

THOMAS K. LIU and THOMAS H. THORNBURN
Respectively, Associate Professor and Professor of Civil Engineering
University of Illinois

ABRIDGMENT

•ONE OF THE most common practices of roadway soil survey specifies that soil borings should be made at regular intervals along the alignment of the proposed transportation route. However, this approach is not satisfactory since it fails to take into consideration the distribution and the variability in the properties of various types of surficial soils encountered throughout the proposed alignment. A method for distributing the soil borings on the basis of the variability of individual soil types and their distribution along a proposed alignment is thus proposed.

The proposed method is illustrated for an hypothetical highway alignment approximately 3.4 miles long in Will County, Ill., which has an up-to-date pedological soil survey map. In connection with the Illinois Cooperative Highway Research Program, an extensive soil investigation program was conducted by testing samples from five or more sites of each pedological soil type encountered in the county. For each soil type, the mean, standard deviation, and coefficient of variation (which expresses the standard

TABLE 1

Soil Type No.	Total Length in 100 Ft	No. of Borings		
		On Basis of Max. Coef. of Var.	On Basis of Avg. Coef. of Var.	At 150-Ft Interval
59	6.5	5	5	4
67	16.5	14	13	11
145	20.5	10	13	14
146	43.5	18	18	29
152	27.5	32	32	19
232	33.0	19	15	23
293	4.5	4	4	2
294	8.0	2	3	5
318	6.0	8	9	4
325	5.5	3	3	4
326	7.0	4	4	4
Total	178.5	119	119	119

Paper sponsored by Committee on Exploration and Classification of Earth Materials and and presented at the 44th Annual Meeting.

deviation as a percentage of the mean) values of the liquid limit, plasticity index, percent fines (<0.074 mm), and percent clay (<0.002 mm) were calculated. Both the maximum and average coefficient of variation values for the four index properties of the C-horizon of each soil type are used as statistical control factors. In this way, the relative variability of various soil types encountered by the hypothetical alignment are taken into account. The product of the length of each soil type area measured along the alignment and its maximum or average coefficient of variation value is defined as the sampling factor.

The total number of borings to be made within a section of the alignment for the Federal-Aid Interstate System is determined by assuming that borings will be required on the average for the two divided lanes at an interval of one every 150 ft. It is also planned that at least one boring must be made in each soil-type area. The rest of the borings are proportioned in each soil-type area according to the ratio of its individual sampling factor to the sum of the sampling factors for the entire section. The results of the two distribution procedures are summarized in Table 1.

The following observations can be made from Table 1:

1. The number of borings distributed in each soil type is approximately the same whether the maximum or the average coefficient of variation value was used as the statistical control factor because either of these two coefficients expresses the same relative variability among the soil types.
2. The number of borings required on the basis of sampling at regular intervals is nearly doubled for Soil Types 152, 293, and 318 in the case where the borings are distributed on a statistical basis. Conversely, for Soil Types 146, 232, and 294, the number of borings is nearly halved. The test data clearly show that the physical properties of the first group of soil types are more variable than those of the second group.

Because this boring program takes advantage of knowledge of the variability of any given natural soil unit, it will avoid the following problems resulting from a regular pattern of soil borings:

1. The possibility of missing a detrimental soil type which may cause problems out of proportion to the size of area it occupies;
2. The chance of placing a very small number of borings in an extremely erratic soil type which may be responsible for the major engineering problems along the proposed alignment; and
3. The sampling of a uniform soil type many more times than necessary to determine its average characteristics and variability.

The complete manuscript is published as University of Illinois, Civil Engineering Studies, Soil Mechanics Series No. 9. Copies of that publication can be obtained from the authors.