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Evaluation of ground deformation modulus definition by in situ and laboratory test methods

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ABSTRACT.

For today, the obtaining responsibility of baseline data for the soil base increases, which characterizes their strength and deformability. Deformation modulus E is one of the deformability parameters. There are various methods of determining E. This method has several disadvantages. In oedometer soil test a ring of small size is used. It causes a number of factors affecting the test results. The number of these factors reaches thirty according to Professor A.K. Larionov. The greatest influence on the formation of deformations in the sample have zones of plastic deformation at the contact with the upper and lower stamps of the device. According to our data these zones at the top and bottom of the sample have limited distribution - 2 ... 3 mm.

Key words: deformation modulus, oedometer test, in situ test.

INTRODUCTION

Today, the load on the buildings and structures base is significantly increased. It increases the responsibility of obtaining the source data for soil foundation base that characterize their strength and deformability. The deformation modulus *E* is one of the parameters of deformability. There are various methods for deformation modulus *E* determining. In Ukraine soil deformation in most cases is determined based on oedometer soil test in laboratory because of their relative simplicity and availability [3].

However, this method has several disadvantages. In the oedometer soil test a ring of small size is used. This raises a number of factors affecting the test results. The number of these factors reaches thirty according to Professor A.K. Larionov [1]. Special tests shows the greatest effect on the formation of the deformation zone in the sample have the plastic deformation at the contact with the upper and lower device stamp. These deformations are accompanied by the formation of the crumled structure and transition (buffer) zones, as well as provide a smooth transfer of pressure on the soil sample. According to our researches, these zones at the top and bottom of the sample have limited distribution - 2 ... 3 mm.

It can be argued that the difference in *E* values observed in the comparison of oedometer and other methods, due to these factors. As numerous tests shows the greatest difference observed in the results of in situ plate loading and oedometer tests.

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This difference depends on the soil type and condition can be 2 ... 10 times.

It is confirmed by the alluvial sands tests on the experimental site. The resulting difference in deformation modules of sand obtained by oedometer tests and in situ was 1.7 ... 2.3 times.

Addiction comparison of values E_{PLT} and E_{oed} from pressure for most types of soil shows (Figure 1) that the oedometer tests have greatest uncertainty in the definition of the load range, although in theory it is difficult to study. Very often, in practice, as the characteristic values of the examined deformation modulus as defined by the oedometer curve in the pressure range of 0.1 ... 0.2 MPa, thus meant that when the ground occurrence depth changes and pressure under the foundation changes, the pressure range for the definition of E should be updated.

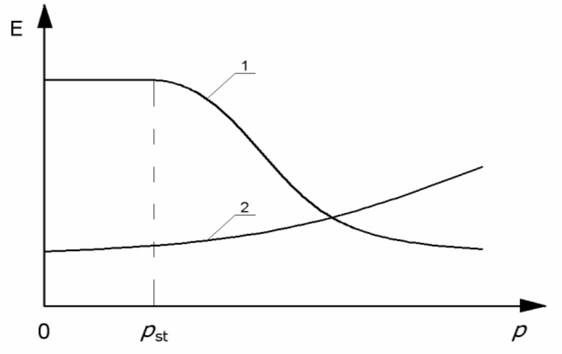

Figure 1. Generalized comparative evaluation of in situ deformation modulus (1) and oedometer (2) test modulus.

Obviously, oedometer tests do not account the possibility of the development of plastic deformation in the actual basis, and therefore exclude the bearing capacity the pressure increasing p may even lead to higher values of E.

On the other hand, it is known that loading history can cause corresponding changes in the deformations that cannot be uniquely determined without regard to the nature of the build-up pressure underside foundation base. That’s why it’s important to change the standard procedure of soil tests of samples in the oedometer. This methodology should be consistent with the nature of the base load in the real consequences.

1. IN SITU TEST.

Static load tests of the round stamp type I area of 5000 cm^2 carried out according to the Ukrainian standards on the central axis of the pits with a step of 10 m in the bottom surface of trenches, 24 points in two sectors to obtain the soil deformation modulus. Calculation of soil deformation modulus based on the results of in situ test with load stages from 50 to 300-350 kPa.

According to in situ tests the graphs of dependence of deformations from pressure are built S = f (p). In the graph with help of the averaging line the values Δp and ΔS are calculated.

The ground deformation modulus E, MPa calculated for the linear portion of the graph by the formula: $E = (1-v2) * Cr * K1 * D * Ap / \Delta S$. The testing scheme by the static load on the stamp is shown on Fgure 2.

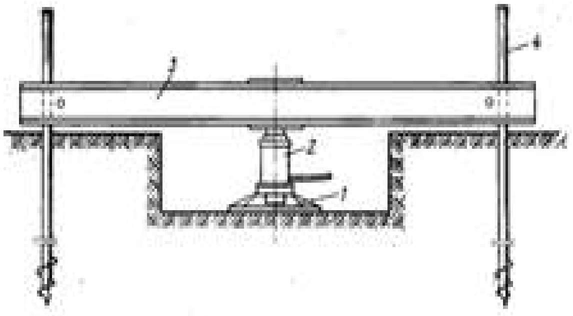

Figure 2. Soil testing scheme by the static load on the stamp

Typical plots of the deformation dependance from the pressure are shown in Figure 3.

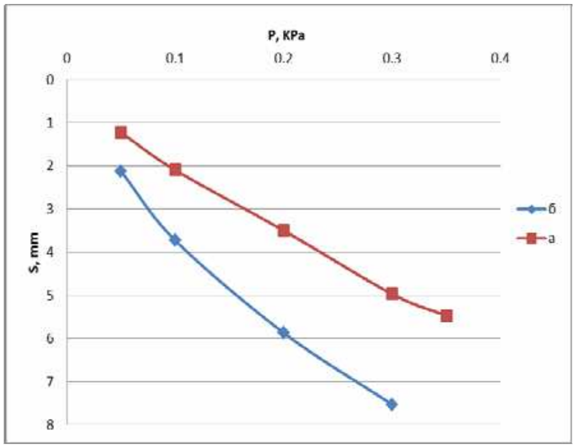

Figure 3. Characteristic curves of in situ soil tests. a – sector I, b – sector II.

2. LABORATORY TESTS.

For the laboratory tests soil were sampled at the points of in situ tests. The selection and storage of soil samples for laboratory tests conformed with Ukrainian standards. Samples weighing up to 1.5 kg transferred to the geotechnical laboratory.

Laboratory tests carried out in accordance with normative requirements, governing the procedure of laboratory tests.

The carried out classification parameters is 6 grain-size distribution of filled soil.

Oedometer test (determination of oedometer deformation modulus) performed on the disturbed samples with the set (as determined in the field) density and moisture content in the odometer loading up to 0.4 MPa at a natural moisture (6 determinations).

Determination of shear strength parameters (angle of internal friction and cohesion) is also performed. The compression and shear soils test results are presented in Table 1. The characteristic compression curves are shown in Fig. 4

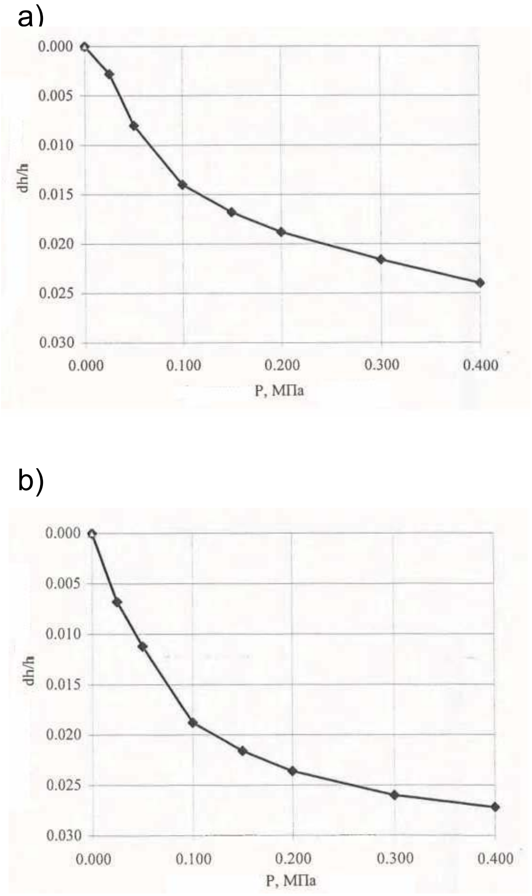

Figure 4. a and b – typical oedometer curves

Table 1. Physical and mechanical characteristics of soil

Stamp number	The soil sampling depth, m	Soil type	characteristics		
			φo	*c*, MPa	*E*, MPa
53	0,2-0,3	dusty sand	26	0,010	20,9
54	0,2-0,3	fine sand	29	0,002	11,95
57	0,2-0,3	dusty sand	26	0,008	21,6
58	0,2-0,3	fine sand	28	0,004	22,25
61	0,2-0,3	fine sand	28	0,003	18,1
64	0,2-0,3	dusty sand	25	0,012	17,0
The average values			27	0,007	18,6

3. THE RESULT OF THE WORK.

The average values of the soil dry density defined by the cutting ring method at predetermined points in the field of in situ testing are: Pd = 1.79 g / cm^3 Pd = 1.78 g / cm^3 (sector II.)

High soil dry density submitted by fine and dusty sand, due to the inclusion in them of rubble up to 15-30%.

Average values of in situ test deformation modulus are as follows: E_{PLT} = 31.0 MPa (section I), E_{PLT} = 28.0 MPa (section II).

The average oedometer soil deformation modulus values E_{oed} =18,6 MPa.

The correlation coefficient between the compression deformation modulus and modulus obtained by in situ test, which depends on the diameter of the stamp and the depth of investigation is m_k = 1,6.

The territory of the planned research, in general is flat, the absolute level of the ground surface are ~ 113.55 m.

The geological structure includes technogenic soils (t_{IV}), represented by fine and dusty sand with gravel inclusion up to 15-30%. During investigations groundwater levels are not met, it is located approximately at a depth of 3.0 - 3.5 m from the level of 113.50 m.

The average values soil dry density is ρ_d = 1,78-1,79 g / cm^3.

4. CONCLUSIONS

1. Average values soil deformation modulus, some of in situ tests at up E_{PLT} = 29.5 MPa oedometer E_{oed} = 18.6 MPa.

2. The deformation of the soil sample is uneven on the adjustment of the sample;

3. The crumpling of sample significantly affects the deformation modulus value;

4. The coefficients m_k correlation established in Ukraine as an overall average for the clay loam and sandy loam, do not account the structural strength and depend on the type, density and soil conditions;

5. Crumple zone occurs also during in situ plate test, it is commensurate with crumple zone in the odometer. When calculating the foundation drafting soil crumpling can be ignored, but in the oedometer test, due to the small sample size, crumple zone deformation significantly underestimate the value of deformation modulus and overstate the drafting of the building and consequently increase the cost of construction.

6. In Eurocode 7 [2] in order to avoid malfunctioning determineing the deformation of the module differentiated definition accepted, and in odometer tests are often used with some oedometer curve unloading branch approximation.

LITERATURE

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