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DEFORMATION AND STRENGTH OF SOILS CONSIDERING THE INFLUENCE OF PRELIMINARY CYCLIC EFFECTS

Abstract: *The paper presents the results of experimental studies on the deformability and strength of sandy soils taking into account the influence of pre-cyclic effects.*

Key words: *soil, sand, loading, deformation, cyclic impact.*
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Introduction

For buildings and constructions operating in the quasi-static regime and undergoing at a certain stage of the action of cyclic stress, the important is to assess the effect of the latter on the deformability and the strength of the soil of their foundations.

Materials and Methods

To this end, four series of tests were performed. The experiments were carried out in the triaxial apparatus design E. I. Vorontsov-M. I. Hasbergen [1,2]. Two types of sandy soils were investigated: fine sand and medium-sized sand. Soils are uniform, average density of addition.

The first and second series of experiments are devoted to the study of soil strength and deformability under static (single) loading. Both types of soils were used in the tests. At the first stage, the soils were subjected to isotropic compression with a given pressure, at the second stage, deviatoric loading with increasing average normal voltage until the destruction of the soil sample was carried out.

In the third and fourth series of experiments, the influence of preliminary cyclic impact on the strength and deformability of soils was studied. The tests were carried out with fine sand in air-dry state and medium-sized sand at two moisture conditions (air-dry and humidity 0.04). In the first phase, soils were subjected to isotropic compression with a given pressure, in the second phase when reaching the deviatoric σ_i / σ_i^* loading a specified level of stress produced by partial unloading on the size $n = \sigma^{ц} / \sigma^{cm}$ and quasi-static cyclic effect with the specified amplitude n until the stabilization of the increments of deformation, and then by the application of a static load to the soil specimen was brought to failure path "flattening" (Fig.1, trajectory P).

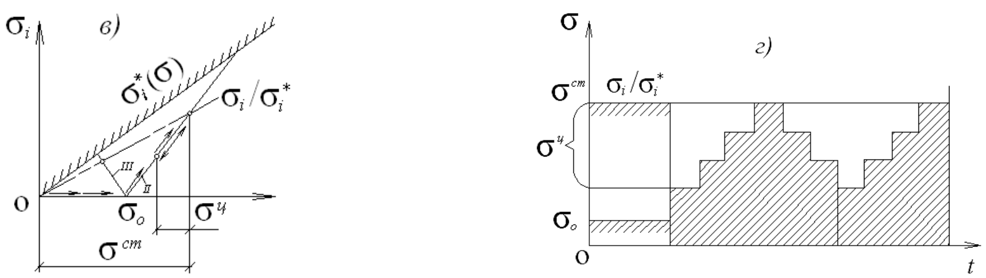

Figure 1. Trajectories and modes of cyclic loading.

The methods of such tests can be found in more detail in [4-8].

As shown by the results of soil testing at static (single) loads along the trajectory P (Fig.2-3, curves 1), the character of the bulk and shear deformation of fine and medium-sized sand in the air-dry state is identical. However, medium-sized sand has a much larger than fine sand, the tendency to seal.

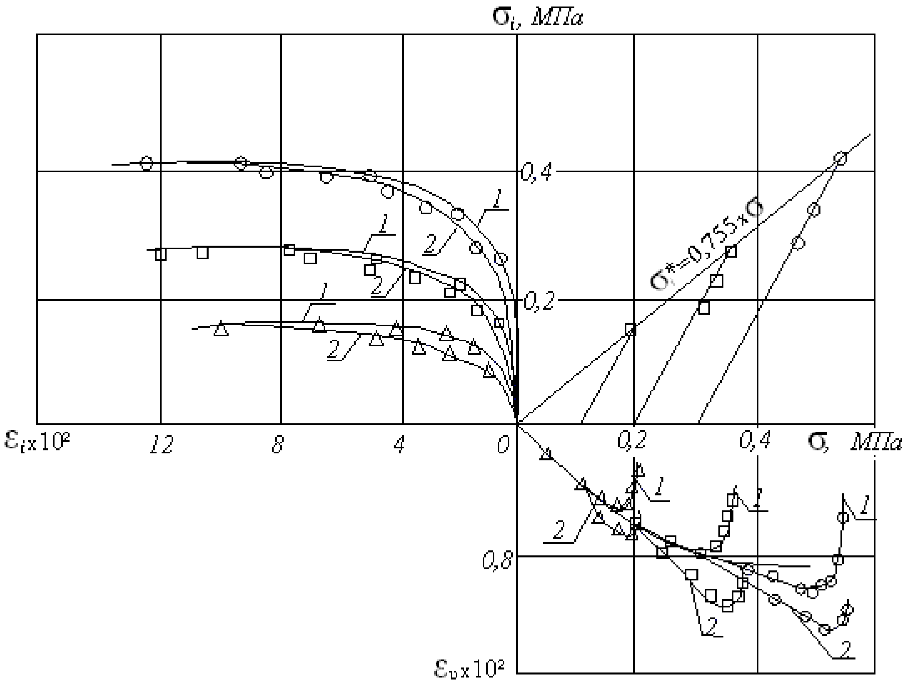

Figure 2. Passport triaxial soil tests. Fine sand, air-dry: 1-static; 2-cyclic

The influence of preliminary cyclic influence on soil deformability is characterized by the development of additional both volume and shear deformations in comparison with single loading (curves 2 in Fig.2-3). In the field of statistical deviatoric compaction the volume deformability is characterized to compaction in comparison with single loading [1,2]. The value of this additional compaction, all other things being equal, depends on the type and condition of the soil. In the field of statistical deviatoric loosening, the studied soils have a smaller tendency to loosening than under single loading.

The strength characteristics determined by statistical processing of experimental data show that in General, the strength parameters of the soils studied depend to varying degrees on the type and condition of the soil (table 1).

Table 1

Values of the maximum intensity of shear stresses under single loading and pre-cyclic action.

Name of soil	The density of dry soil	Humidity	Stress, MPa			Deviations %
			σ_o	σ^*_i	$\sigma^*_{i(N)}$	
The sand is fine	1,56	0,02	0,20	0,260 0,258	0,256 0,262	+1,54 -1,55
			0,30	0,396 0,400	0,398 0,393	-0,50 +1,75
Medium-sized sand	1,63	0,01	0,20	0,262 0,257	0,259 0,261	+1,14 -1,55
			0,30	0,391 0,387	0,386 0,390	+1,28 -0,77
		0,04	0,20	0,238 0,242	0,243 0,239	-2,10 +2,24
			0,30	0,355 0,352	0,352 0,353	+1,12 -0,28

Note: the numerator and denominator are the results of two repetitions.

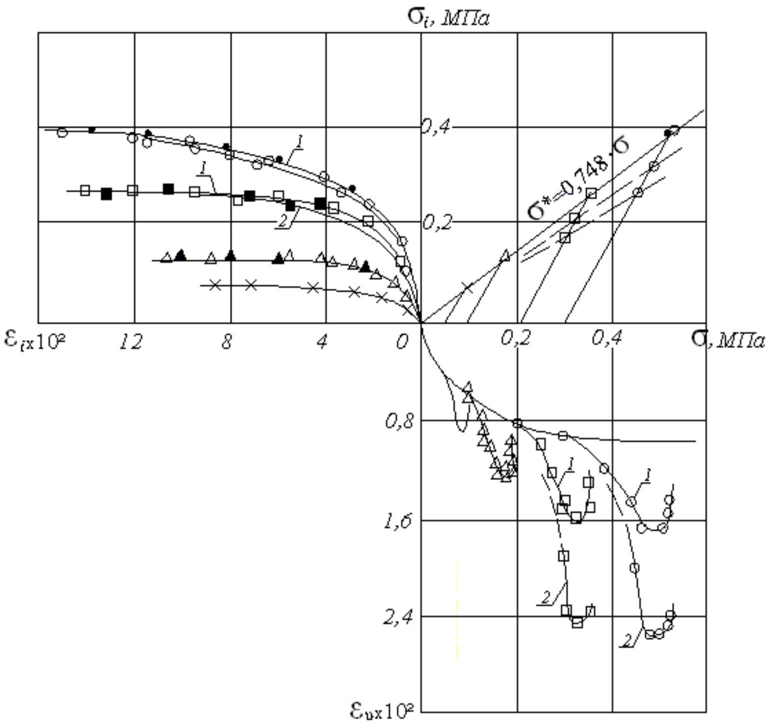

Figure 3. Passport triaxial soil tests. Sand of medium size, in the air-dry state: 1-static; 2-cyclic

Conclusion

Comparison of the values of the maximum intensity of shear stresses for the corresponding values of the stress of hydrostatic compression obtained under single loading and pre-cyclic action of sandy soils (table.1), indicate that their deviations do not exceed ±3%. Moreover, the lack of regularity in the deviations can be attributed to their dispersion due to the accuracy of sample preparation and measurement in the devices.

Thus, in the General case, the preliminary cyclic impact has a significant impact on the deformability of soils, while their impact on the strength is not established, and this is consistent with the results [1,2,9,10].

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