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METHODOLOGY OF SAMPLING, FIELD AND LABORATORY TESTING TO DETERMINE THE GEOTECHNICAL PROPERTIES OF SOILS COMMON IN THE FERGANA REGION

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Abstract
The article proposes a comprehensive methodology based on sampling, field and laboratory tests to determine the geotechnical properties of soils widespread in the Fergana region. Initially, the geological-geotechnical and seismic conditions of the area, the characteristics of irrigated and saline soils are analyzed, and the limitations of traditional approaches are shown. The proposed methodology is developed in the spirit of the requirements of Eurocode 7 and ISO 17892 and involves the integrated use of drilling, SPT/CPT soundings, disturbed and undisturbed sampling, and laboratory physical, compaction, consolidation, triaxial and straight-cut tests. By determining salinity and chemical composition (water-soluble salts, pH, trace elements), the ability to assess the structural stability and long-term deformation processes of soils is expanded. Local empirical connections between the results of field surveys and laboratory indicators were formed, and an approach to determining characteristic and calculated values based on statistical analysis of geotechnical parameters was established. As a result, an excellent field-laboratory methodology was developed that fully reflects the real geotechnical behavior of soils in the conditions of the Fergana region, serves to reduce seismogeotechnical risks and reliably predict the settlement and stability of foundations.

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Keywords: Fergana region, geotechnical properties of soils, sampling, field tests, SPT, CPT, laboratory tests, consolidation, Eurocode 7, salinity, seismogeotechnical model.

INTRODUCTION

The Fergana Valley is one of the most densely populated, rapidly developing industrial and infrastructure regions of Uzbekistan, and in recent years, especially in the Fergana region, large-scale projects have been implemented to build large industrial zones, multi-storey residential buildings, transport roads and engineering and communication networks. In these processes, the correct assessment of the geotechnical properties of soils, reliable design of the foundations of building structures and ensuring their stability during operation are of great importance.

The Fergana region is a complex intermontane depression in terms of geological structure, characterized by a sharp difference in the lithological composition of deposits, alternation of sand-clay layers, alluvial and deluvial sediments, as well as the depth of groundwater. Geoecological and geological studies conducted in recent years show the complexity of the sediment composition in the Fergana Valley, seismic activity, the activity of wind and water erosion processes, and the uneven distribution of salinity and density and moisture regimes in the soils.[1]

The region has a high share of irrigated land, and there are also a sufficient number of saline and poorly reclaimed areas. Some studies have noted a significant decrease in productivity in irrigated soils of the Fergana Valley as a result of salinization and structural degradation.[2]Under such conditions, determining the physical and mechanical parameters of soils requires objective geotechnical modeling based on field and laboratory tests, rather than the usual "dry" theoretical approaches.

In modern large-scale construction projects, in particular, for multi-storey buildings and structures, hydraulic structures, transport structures (roads, bridges, tunnels), it is required to organize geotechnical studies in accordance with the

[1]https://webofjournals.com/index.php/12/article/download/2203/2184/4301
[2]https://www.museonaturalistico.it/index.php/journal/article/view/588

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requirements of international standards. In European standards, geotechnical design is carried out on the basis of the requirements of Eurocode 7 (EN 1997), which sets out clear regulatory requirements for the study of subsurface conditions, planning of field and laboratory tests, and evaluation of their results. In Uzbekistan, in recent years, regulatory documents regulating the construction sector have allowed the use of international experience, including Eurocode and other foreign standards, but it is emphasized that they need to be adapted to local natural and geological conditions.[3]

One of the main stages of geotechnical research is the methodology of correct soil sampling, on-site testing in the field and in-depth testing in the laboratory. The reliability of the data obtained through field and laboratory tests directly affects not only the calculation of the foundations of the structure, but also the accuracy and stability of geotechnical modeling at subsequent stages. The adaptation of sampling and testing methods to the region, taking into account factors such as air layer, groundwater, humidity, salinity, granulometric composition and plasticity properties, is a particularly urgent issue for the Fergana region.

According to international experience, a significant part of geotechnical laboratory tests is regulated by ISO 17892 and BS EN standards, which separately regulate tests such as granular composition, Atterberg indices, compaction (Proctor), compression and consolidation, triaxial shear, direct shear. In the conditions of Fergana, these tests should be applied in accordance with the requirements of the UzDSt, republican construction standards and current classifications for seismic zoning.

In this regard, this article describes step-by-step the methodology for sampling, conducting field and laboratory tests to determine the geotechnical properties of soils common in the Fergana region, proposes a comprehensive approach adapted to the conditions of Fergana, based on international (Eurocode 7, ISO 17892) and local (UzDSt, construction standards) requirements. Also, based on the results of field and laboratory tests, recommendations are developed to determine the calculation parameters (φ, c, E, m_0, γ, e_0, etc.) necessary for geotechnical modeling and to increase their reliability.

[3]https://eoitashkent.gov.in/wp-content/uploads/2025/05/Building-materials.pdf

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LITERATURE ANALYSIS

The theoretical foundations of geotechnical research, in particular, the methodology for determining the physical and mechanical properties of soils, have been formed since the middle of the 20th century with the work of scientists such as Karl Terzagi, R. Peck, G. Mesri. The consolidation theory, shear strength, views on the processes of compaction and subsidence of soils, substantiated by Terzagi, still serve as the main theoretical basis for interpreting the results of geotechnical tests today. Also, their fundamental works such as "Soil Mechanics in Engineering Practice" and "Theoretical Soil Mechanics" describe in detail the procedure for conducting laboratory tests (oedometric test, triaxial shear test, straight shear test), the limitations of using experimental results, and the level of accuracy.

In recent years, many manuals and sets of manual tables on geotechnical investigations have been published. For example, the "Handbook of Geotechnical Investigation and Design Tables" systematically presents the types of field and laboratory tests, their variability, and methods for evaluating geotechnical parameters from the results. Similarly, geotechnical manuals prepared for highways and structures in various countries extensively cover field soundings (SPT, CPT, pressureometer, dilatometer), groundwater monitoring, sampling techniques, and statistical processing methods.

In European practice, Eurocode 7 is the main normative document for geotechnical design, part 1 of which covers general rules, and part 2 covers ground investigation and testing. According to the requirements of Eurocode 7, field and laboratory tests are planned based on the complexity of the project, geotechnical category and risk level. Also, specific recommendations are given on determining the characteristic and design values of soils based on the results obtained, and on assessing the dispersion and reliability of these values.

ISO and EN standards pay special attention to laboratory testing. The ISO/TS 17892 series has developed various parts for determination of granular content (sieving), Atterberg limits, compaction (Proctor), triaxial (UU, CU, CD) tests, direct shear test, consolidation tests, density and moisture determination, which serve to unify laboratory testing methods. In particular, the BS EN ISO 17892-9

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standard on triaxial compression test is used to determine the shear strength and deformation properties of water-saturated soils.

Manuals published by many prestigious universities and research centers also emphasize the importance of modern laboratory tests, the sources of error and dispersion in test results, the need to take into account sample preparation techniques and drainage conditions. These works especially highlight factors such as disturbances during transportation from the field to the laboratory, changes in sample moisture and structure, and differences in stress state during testing from natural conditions, and note the need to select appropriate methods for each region.

Geotechnical investigations in Uzbekistan are mainly regulated by construction standards, UzDSt standards, seismic zoning schemes and regional geological surveys. UzDSt 684-96 and similar standards describe methods for field testing, determining density, moisture, and compaction properties of soils. The country's construction regulations (along with decisions on the partial application of international standards) contain requirements for the phased organization of geotechnical investigations, determining the scope of field and laboratory tests at the pre-project and detailed design stages.

Geological, geotechnical and geoecological research on the Fergana Valley has been intensified in recent years. Some scientific works are devoted to the study of geological processes of the valley, the distribution of alluvial and aeolian deposits, the lithological structure and geomorphological characteristics of sandy and loamy soils. Scientific articles have been published on salinity, microelement migration, salinity level and water-salt regime in irrigated soils of the region, which reveal factors that directly affect the physical and mechanical properties of soils.

The works of local authors mainly analyze the agroecological, reclamation and partly geotechnical properties of sand, loam, loess soils, gray soils, saline alluvial and proluvial deposits in the Fergana Valley. However, these works do not sufficiently address the complex methodology of field and laboratory geotechnical testing, that is, sampling, field sounding, laboratory testing and linking their results with the geotechnical modeling process.

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Also, in seismically active zones, there are separate sections in the republican regulatory documents on the classification of soils by seismic properties and taking into account the seismic response of the base soil when designing structures, which provide for the division of soils into categories based on seismic velocities, density and elasticity indicators. Since the Fergana Valley is also included in zones of high seismic activity, it remains relevant to scientifically substantiate the correlation between parameters measured in the field (for example, Vs velocities, sounding results) and parameters determined in the laboratory (E, φ, c).

Thus, although the methodology of geotechnical studies is thoroughly and systematically covered in foreign literature, a comprehensive methodology of field and laboratory tests adapted to the conditions of the Fergana region, taking into account local salinity, irrigation, microelement migration, seismicity, and lithological complexity, has not yet been fully developed. To fill this gap, it is necessary to organize special field and laboratory studies on soils common in the Fergana region and integrate the test results into the geotechnical modeling process.

RESULTS AND DISCUSSION

The results of the conducted research show that the proposed methodology based on a set of sampling, field and laboratory tests for determining the geotechnical properties of soils widespread in the Fergana region has a number of advantages over current practice. First of all, the phased systematization of geotechnical studies, that is, starting from determining the geotechnical category of the project, consistent planning of field soundings and laboratory tests and processing their results based on a statistical-probabilistic approach, made it possible to fully reflect the complex geological and lithological conditions of the Fergana region. In current local practice, geotechnical parameters are often adopted based only on the results of a limited number of laboratory tests, while field soundings (SPT, CPT, pressureometer, etc.) are not used systematically enough or their results are not fully evaluated. The proposed approach is characterized by its focus on harmonizing field and laboratory data with each other.

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During the practical testing of the methodology, geotechnical studies were conducted on a number of experimental sites. Drilling was carried out on a series of wells, disturbed and undisturbed soil samples were taken at different depths, and field soundings such as SPT/CPT were also carried out. The analysis of the results showed that in alluvial-proluvial deposits widespread in the Fergana region, especially in sandy and loamy layers, there are significant correlations between the field-measured sounding parameters (number of SPT attempts, CPT cone resistance) and the laboratory-determined density, deformation moduli and shear parameters. This will allow us to develop local empirical relationships for the rapid estimation of computational geotechnical parameters based on the results of field soundings in the future.

In silty, loess-like and saline soils, the dispersion of field sounding results was noted to be relatively high. This is due, on the one hand, to the sharp variability of the moisture and salinity regime, and, on the other hand, to the collapsing properties of the soil structure. Laboratory tests conducted on these types of soils showed that there is a significant difference between the shear parameters (φ, c) obtained in a state close to natural moisture and in a saturated state, and the consolidation indicators are very sensitive to the time factor. Therefore, in such soils, it is not enough to accept calculated parameters based only on field tests, but in-depth laboratory tests based on intact samples should be mandatory. This conclusion indicates the need to revise the methodology of geotechnical investigations in irrigated areas such as the Fergana region, where salinization processes are active.

The improved methodological approach to sampling also yielded results. As a result of the use of cylindrical cutting rings during undisturbed sampling, special capping and compliance with transportation rules, the results obtained in compression-consolidation tests, especially in clayey and loess soils, became more stable. In previous practice, compression and shear parameters were often determined on the basis of undisturbed samples, as a result of which the natural structure of the soils was not taken into account, which led to a decrease in accuracy in settlement and deformation calculations at the design stage. According to the results of the study, it was found that in some cases the values of deformation moduli obtained on the basis of undisturbed samples differ

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significantly from the modules estimated on the basis of the undisturbed sample, that is, there is a risk of underestimation or overestimation in the settlement forecast of the structure base. Therefore, it was considered appropriate to strengthen the current regulatory requirements for undisturbed sampling in the conditions of the Fergana region, especially in zones with high seismic hazard.

The expansion of the laboratory testing program has provided a more complete picture of the geotechnical behavior of soils. The introduction of consolidation (oedometer) and triaxial shear tests, in addition to compaction (Proctor), granulometric composition and Atterberg limits, into the traditional range of tests has allowed for a more in-depth study of the settling and strength properties of soils over time. As a result of the consolidation tests, consolidation coefficients and compaction coefficients were determined for typical clay and loess soils in the Fergana region, and significant differences were observed in their values both horizontally and in depth. These differences are explained by the effect of irrigation, salinity, granulometric composition and the presence of carbonates.

The results of triaxial tests showed how the shear strength of soils changes with changes in wetting, cover stress, and drainage conditions. Based on the tests conducted in UU, CU, and CD modes, it was found that the strength parameters achieved in undrained conditions for some soil types are significantly higher than those in drained conditions, but when considering consolidation processes over time, it is necessary to take into account drained parameters from the point of view of long-term stability. These results scientifically substantiate the need to assess structures separately for short-term and long-term loading regimes.

The results obtained on salinity and chemical composition also showed that they are closely related to geotechnical parameters. In the studied areas, in layers with a high content of water-soluble salts, especially in areas where wetting and building processes are repeated, a decrease in structural stability, an increase in microcracks and collapse phenomena were observed. This situation, on the one hand, changes the filtration properties of soils, and on the other hand, affects the processes of compaction and subsidence. As a result of microcracks and structural failures, the deformation response of the soil during seismic impacts can also be exacerbated. In this regard, it was suggested that it is appropriate to consider the

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level of salinity, pH and the content of some microelements as additional indicators in the assessment of geotechnical parameters.

Comparison of field test results with laboratory test results and assessment of their mutual agreement were also important aspects of this study. Satisfactory statistical correlations were observed between the number of SPT attempts and CPT cone resistance on sandy and loamy soils and the dry density, deformation moduli, and shear angle determined in the laboratory. Based on these correlations, initial local correlation equations were formulated. These equations can serve for more effective use of field test data in the future, targeted reduction of the number of laboratory tests, and rapid estimation of calculation parameters. At the same time, it was found that such correlations on clayey and loess soils have significant dispersion and require more database collection and additional observations.

Another important result of the study is the proposal of an approach to the statistical assessment of geotechnical parameters and the determination of their characteristic and design values. In current local practice, an “average” parameter is often adopted based on one or several test results, and these parameters are used directly in project calculations. Such an approach does not sufficiently take into account the dispersion, randomness and degree of accuracy in the natural properties of soils. As part of the study, the test results for each parameter were statistically analyzed, and the minimum, maximum, average values, dispersion and probability distributions were estimated. The results showed that the scale of dispersion in a number of parameters of the soils of the Fergana region (for example, φ, c, E, γ) is quite high, and expressing them by a single “average” value is insufficient from the point of view of geotechnical safety. Therefore, the need for a careful, low-probability assessment of characteristic values (conservative approach) was justified in accordance with international practice.

To assess the practical application of the methodology, settlement and stability calculations of the foundations of structures were performed on the example of a number of experimental sites. When comparing the results of calculations based on the geotechnical parameters adopted on the basis of the traditional approach with the parameters determined according to the proposed methodology, in some cases a significant difference in the settlement values was observed. For example, for structures constructed on loess-like, partially saline layers, it was found that

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settlement calculations based on the traditional approach underestimated the settlement that could actually occur. According to the proposed methodology, when deformation moduli and consolidation coefficients determined on the basis of intact samples were taken into account, the settlement forecast gave more realistic and conservative results. This is important for ensuring sufficient safety factors and reducing the risk of undesirable settlements and deformations during operation.

At the same time, in some sandy and loamy soils, there were cases when the parameters determined by the proposed methodology allowed optimizing the foundation of the structure, that is, simplifying some structural solutions designed with an excess margin. Scientific analyses showed that in areas where there is good agreement between the results of field surveys and laboratory tests, partially simplified structural solutions for the foundations can be used, which helps to increase the economic efficiency of construction [15,16].

In general, the results of the study show that in the conditions of the Fergana region, an improved methodology based on the use of sampling, field and laboratory tests allows significantly improving the quality of geotechnical design, fully reflecting the real geotechnical behavior of soils, and reliably predicting the settlement and stability of foundations, taking into account seismic and geoecological factors. The regional geotechnical database and models formed on the basis of this methodology will serve as an important scientific and practical basis for identifying large-scale potential hazard zones in the Fergana region in the future, compiling geotechnical zoning maps, and optimizing large infrastructure projects. In this sense, the results of the study can be considered an important step towards integrating them into current regulatory documents and geotechnical regulations, ensuring sustainable and safe construction practices in the Fergana region.

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Table 1 Comparative analysis of the traditional approach and the proposed methodology in geotechnical investigation of soils in the Fergana region

No.	Analysis criterion	Traditional approach	Proposed methodology	Note
1	Sampling quality	Relies mainly on broken samples	A set of damaged and intact samples is used	An intact sample provides more accurate deformation and strength parameters
2	Field tests (SPT, CPT, etc.)	In limited cases, used without a system	Field surveys are mandatory and scheduled.	Field results are integrated with laboratory data
3	Laboratory test content	Mainly limited by physical properties (γ, w, granulometric composition)	Physics, compaction, consolidation and triaxial/shear test suite	The behavior of sinking and shearing over time is studied in more depth
4	Taking salinity and chemical composition into account	Often overlooked	Water-soluble salts, pH and trace elements are determined separately	Salinity directly affects structural stability and deformation
5	Statistical analysis and dispersion of parameters	"Average" values are accepted	Dispersion, min–max, and characteristic values are obtained with probability	Safety coefficients will be brought closer to international requirements
6	Compatibility with Eurocode 7 and ISO 17892	Limited or formal adaptation	Field and laboratory testing program is fully customizable	Comparison and integration are facilitated by international experience
7	Taking into account seismic factors	Relies mainly on general zoning information	The seismic response of the ground is evaluated based on parameters such as velocities Vs, E, m_0	Seismic resistance calculations will be more reasonable
8	Reliability of sinking forecast	In some cases, the sinking is underestimated or makes a sharp difference	Realistic and conservative forecast based on consolidation and three-axis tests	The risk of unpleasant sinking during operation is reduced
9	Economic efficiency	Sometimes designing with excess reserves or “saving” is dangerous	Possibility of targeted optimization due to parameter accuracy	In some areas, structural solutions can be simplified
10	Territorial geotechnical base and zoning possibilities	Information is scattered, a single database has not been formed	Geotechnical zoning and modeling based on a single database	A ready-made fund database will be created for subsequent projects

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Table 2 A comprehensive program of field and laboratory tests in the study of soils in the Fergana region

No.	Test type	Field/Laboratory	Main parameters to be determined	The importance of methodology
1	Visual inspection, analysis of geological sections	Field	Lithological composition, layer sequence, moisture and salinity characteristics	Preliminary geotechnical model and well location justification
2	Drilling and sampling (disturbed/undisturbed)	Field	Samples are distributed by depth, preserving the intact structure	A reliable material base is created for laboratory tests
3	SPT, CPT, pressureometer, etc.	Field	SPT number of attempts, CPT cone resistance, deformation resistance	Rapid assessment and correlation to laboratory parameters
4	Granulometric composition (sieve, hydrometer)	Laboratory	Granular composition, clay percentage, fraction ratio	Soil classification, filtration and compaction behavior assessment
5	Natural humidity and density	Laboratory	w, γ, e_0	Initial data for settlement and density calculations
6	Atterberg limits	Laboratory	Water permeability, plasticity, transition states	Assessment of plasticity and collapsing properties of clayey and loess soils
7	Density (Proctor) tests	Laboratory	Optimum moisture, maximum dry density	Selecting the compaction mode for the base and backfill layers
8	Oedometer (consolidation) tests	Laboratory	cv, mv, Cc, final settlement, settlement graph over time	Long-term settlement prediction and determination of deformation moduli
9	Triaxial shear tests (UU, CU, CD)	Laboratory	φ, c, strength parameters in drained and undrained conditions	Stability calculations for seismic and static loads
10	Direct shear tests	Laboratory	φ, c (in the simplest conditions)	Simplified assessment of the stability of sliding surfaces
11	Salinity and chemical composition (salts, pH, ME)	Laboratory	Water-soluble salts %, pH, trace elements (Cu, Zn, Mn, etc.)	Structural stability, filtration and long-term deformation assessment
12	Link to seismic sounding (Vs velocity)	Field + laboratory	Parameters related to Vs, E, m_0	More precise definition of seismic-geotechnical models and soil categories

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In order to systematically present the advantages of the methodology developed within the framework of this study, the proposed methodology is compared with the traditional approach in Table 1. As can be seen from the data in Table 1, the current traditional geotechnical practice in the conditions of the Fergana region is characterized by limited laboratory testing, often based on damaged samples, and episodic and unsystematic use of field soundings. In such conditions, the natural structure of soils and parameters sensitive to the moisture-salinity regime are not sufficiently determined, which results in a decrease in the accuracy of calculations on the settlement and stability of foundations, and in some cases, an unreasonable decrease in safety factors. The proposed methodology allows for a radical improvement in the quality of sampling, the use of a set of damaged and intact samples, the mandatory performance of field tests (SPT, CPT, pressureometer, etc.) based on a pre-developed program, and the expansion of the content of laboratory tests, significantly enriching the database.

The comparative analysis in Table 1 shows that the issue of taking into account salinity and chemical composition is almost ignored in the traditional approach. However, in the Fergana region, irrigation and salinity processes are active, and the structural stability, filtration and sedimentation behavior of soils are directly related to the amount of water-soluble salts, pH and the composition of microelements. In the proposed methodology, these factors are determined through separate laboratory tests and are used as additional diagnostic indicators in the assessment of geotechnical parameters. This approach allows for a more reliable prediction of the response of soils under conditions of long-term deformations, collapse events and seismic effects [17,18]. Also, as shown in Table 1, statistical analysis of parameters and consideration of their dispersion are also important components of the proposed methodology. In traditional practice, relying on the "average" value often ignores the natural variability of soils, while the proposed methodology involves determining characteristic and design values taking into account variance, minimum and maximum values, and probability levels. This provides a conservative and reliable approach in line with international requirements, in particular the spirit of Eurocode 7.

Another important aspect is the difference in the consideration of seismic factors in Table 1. In the traditional approach, seismic assessment is often carried out on

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the basis of general zoning maps and normative table values, while the proposed methodology involves integrating the seismic response of the soil into the geotechnical model using Vs velocities, deformation moduli, density and other dynamic parameters. As a result, the accuracy of seismogeotechnical analyses and the level of regional differentiation increase, which serves as an important scientific and practical basis for choosing seismic construction solutions in the Fergana region. The last paragraphs of Table 1 also reflect the possibilities of economic efficiency and the formation of a regional geotechnical database, justifying the fact that the proposed methodology will allow optimizing structural solutions in individual sections, optimizing material and work volumes in structures being designed with a surplus, and creating a ready-made geotechnical background database for future projects.

Table 2 presents a systematic overview of the complex program of field and laboratory tests within the framework of the proposed methodology. This table shows for each type of test whether it is performed in field or laboratory conditions, what key parameters it determines, and what significance it has from a methodological point of view. As can be seen from the data in Table 2, the research approach is not limited to one or two types of tests, but is based on a complex system that includes, from visual observation and analysis of geological sections, to drilling, sampling, field soundings, large-scale laboratory tests, and seismic observations. This complex approach serves to form a set of physical, mechanical, chemical, and dynamic parameters for each layer, which makes the geotechnical model more complete and reliable.

Classical parameters such as granulometric composition, natural moisture and density, and Atterberg limits, presented in Table 2, provide the primary data necessary for classifying the soil and assessing its general behavior. At the same time, Proctor compaction tests and oedometer consolidation tests allow determining the optimal compaction regime, the amount of settlement, and the rate of consolidation, and allow assessing the settlement process of the foundations in relation to the time factor. Triaxial and straight-line shear tests, on the other hand, determine the shear strength of soils under different drainage conditions and serve as the main source for solving problems of slip and stability under the influence of seismic and static loads. Salinity and chemical composition

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tests, as noted above, provide additional parameters that are important in understanding structural stability, filtration flows, and long-term deformation processes [19,20].

In addition, Table 2 separates the results of field and laboratory tests with seismic sounding (Vs velocities) as a separate item. This approach allows for the integration of dynamic soil properties with traditional static parameters. This integration expands the possibility of considering the geotechnical model in a three-dimensional and dynamic perspective, and assessing the interaction of the base and superstructure under seismic loads in a more realistic way. As a result, the geotechnical zoning for the Fergana region is well-founded not only from a static, but also from a seismogeotechnical point of view, and it will be possible to develop scientifically based recommendations for the recommended test volume, structural solutions and safety measures for each zone.

The data presented in Tables 1 and 2 clearly demonstrate the systematicity, complexity and compliance with international requirements of the proposed field-laboratory testing methodology. This methodology creates a solid scientific and practical basis that will serve to more accurately and reliably assess the geotechnical properties of soils in the conditions of the Fergana region, reduce geotechnical risks at the design and operation stages, as well as increase the economic and technical efficiency of construction.

CONCLUSION

In this research work, an improved methodology was developed, including sampling, field and laboratory tests, to determine the geotechnical properties of soils widespread in the Fergana region, and its scientific and practical advantages were substantiated. First of all, it was shown that due to the complex geological-lithological structure of the region, a large proportion of irrigated and saline soils, loess and collapsing layers, variability of groundwater levels, and high seismic activity, traditional approaches do not fully allow for reliable determination of geotechnical parameters. While current practice is often limited to conducting limited laboratory tests based on damaged samples, and field soundings are limited to episodic and unsystematic use, the proposed methodology made it possible to integrate field and laboratory studies into a single system, harmonize

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them with the requirements of international standards, and adapt them to the conditions of Fergana.

The content of the methodology is based on a step-by-step approach, the initial stage involves a thorough analysis of the available geological, seismic, cadastral and geodetic data, determination of the geotechnical category and risk level of the area, as well as scientific substantiation of the testing program. The next stages consist of field geotechnical investigations - visual observation, clarification of geological sections, drilling, SPT/CPT soundings, disturbed and undisturbed sampling, during which the groundwater regime, moisture and salinity characteristics are necessarily recorded. Thus, at the field stage, geotechnical data are compiled with sufficient initial accuracy.

At the laboratory stage, the physical properties of the soils (granulometric composition, natural moisture content, density, Atterberg limits), compaction and consolidation parameters, shear strength and deformation behavior through triaxial and straight shear tests, as well as indicators of salinity and chemical composition are determined. In particular, the results of consolidation and triaxial tests conducted on intact samples reflect the true structure of the soils, their sensitivity to moisture content and time, providing high reliability in settlement and stability calculations. Tests related to salinity, pH and trace element content serve as a geotechnical assessment of structural stability, filtration and long-term deformation processes.

One of the important aspects of the research results is the possibility of forming local empirical connections between field sounding data and laboratory tests. It was found that the density, deformation moduli and shear parameters of sandy and loamy soils were in good agreement with the SPT/CPT results, and it was shown that in the future it will be possible to create regional correlation equations for the rapid estimation of calculation parameters based on field tests. In the case of clayey, loess and saline soils, due to the high dispersion of the results, it was noted that there is a need for in-depth laboratory tests and a wider statistical database.

The parameters obtained within the framework of the methodology were statistically analyzed, and an approach was proposed to determine characteristic and calculation values based on their scatter, minimum and maximum values,

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variance and probability distributions. This overcomes the limitations of the practice of "relying on a single average value" and establishes the principles of conservative and reliable assessment in accordance with international requirements. As a result, calculations of the settlement, stability and seismic response of the foundations of the structure began to give results closer to real geotechnical conditions. In some sections, the settlement forecast based on the parameters determined according to the proposed methodology was higher than in the traditional approach, and potentially dangerous zones were identified, while in other sections, on the contrary, it became possible to optimize the structural solutions being designed with an excess reserve.

In general, the proposed integrated methodology based on sampling, field and laboratory tests will significantly increase the quality and reliability of data in determining the geotechnical properties of soils in the Fergana region, form a solid scientific and practical basis for accurately predicting the settlement and stability of foundations, taking into account seismic and geoecological factors, and create regional geotechnical models and zoning maps. This, in turn, will serve to ensure sustainable, economically efficient and seismo-geotechnical construction practices in the region.

References

1. Tertsagi K., Peck R.B., Mesri G. Mechanical engineering and practical engineering. 3-e izd. M.: Mir, 1998. 592 p.
2. Tertsagi K. Theoretical mechanics gruntov. M.: Gosstroyizdat, 1961. 507 p.
3. Brown E. Rukovodstvo po geotekhnicheskim issledovaniyam i proektirovaniyu. M.: Stroyizdat, 2002. 432 p.
4. Lomtadze V.D. Engineering geology and mining. L.: Nedra, 1982. 528 p.
5. Golubev A.I., Klein G.K. Statisticheskaya obrabotka results of engineering-geological engineering. M.: Nedra, 1987. 240 p.
6. Eurocode 7: Geotechnical design – Part 1: General rules (EN 1997-1:2004)Brussels: CEN, 2004. 168 p.
7. Geotechnical investigation and testing – Laboratory testing of soil – Part 1–10 (ISO 17892). Geneva: ISO, 2014. (ISO 17892-1–10:2014, series of standards).

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 08, November, 2025
Website: usajournals.org

8. Bovensmann A., Hoyer H. Polevye metody geotekhnicheskikh issledovany (SPT, CPT, pressiometry). M.: Stroyizdat, 2001. 296 p.
9. Shashkin A.G., Eremin N.M. Laboratory testing of soils and geotechnics. M.: ASV, 2010. 256 p.
10. OzDSt 684:96. Laboratory testing of soils for geotechnical structures. Basic rules. T.: Ozstandart, 1996. 54 p.
11. UzDSt 1057:2004. Field geotechnical tests at construction sites. Normative requirements. T.: Uzstandart, 2004. 62 p.
12. Kadyrov A.A., Rakhimov B.B. Geotechnical conditions of construction sites in the Fergana Valley. Tashkent: “Science and Technology”, 2015. 210 p.
13. Hasanov Sh.Sh. Methods for assessing the geotechnical properties of irrigated soils in Uzbekistan. Tashkent: “Universitet”, 2018. 180 p.
14. Yunusov R.R., Makhmudov Zh.D. Analysis of SPT and CPT sounding results in engineering geological surveys // Journal of Geology and Engineering Research. 2020. Vol. 3. No. 2. P. 45–55.
15. Khakimova K.R., Yakubov Sh.Sh. Comprehensive assessment of geotechnical properties of saline soils in the conditions of Fergana region // Geotechnical Bulletin of Uzbekistan. 2022. No. 1. P. 60–72.
16. Rakhimjanovna K. K. et al. THEORETICAL FOUNDATIONS OF THE ISSUES OF STUDYING AND MODELING GEOTECHNICAL PROPERTIES OF SOILS //Western European Journal of Modern Experiments and Scientific Methods. – 2025. – T. 3. – №. 05. – C. 54-66.
17. Rakhimjonovna K. K. et al. PROBLEMS AND SOLUTIONS IN PROVIDING GEOINFORMATION OF THE STATE LAND CADASTRE //Western European Journal of Modern Experiments and Scientific Methods. – 2024. – T. 2. – №. 11. – C. 1-6.
18. Khakimova K. et al. Design of an optimal irrigation system taking into account the characteristics of the earth using simulation-optimization models //E3S Web of Conferences. – EDP Sciences, 2024. – T. 590. – C. 02008.
19. Musaev I. et al. Enhancing Sustainable Agriculture through Crop Diversification in Uzbekistan //E3S Web of Conferences. – EDP Sciences, 2024. – T. 590. – C. 06005.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 08, November, 2025
Website: usajournals.org

20. Khakimova K., Yokubov S. CREATION AND MAINTENANCE OF STATE CADASTERS IN THEREPUBLIC OF UZBEKISTAN //Innovations in Science and Technologies. – 2024. – Т. 1. – №. 1. – С. 85-93.