46th International Scientific Conference EXPERIMENTAL STRESS ANALYSIS 2008
Department of Mechanics of Materials, VŠB - Technical University of Ostrava
June 2 - 5 2008, Horní Bečva, Czech Republic

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# REQUIREMENTS FOR THE RESULTS OF A GEOTECHNICAL SURVEY NEEDED TO FOUNDATION DESIGN OF COMPLICATED STRUCTURES

# POŽIADAVKY NA VÝSLEDKY GEOTECHNICKÉHO PRIESKUMU POTREBNÉ PRE NÁVRH ZALOŽENIA NÁROČNEJ STAVEBNEJ KONŠTRUKCIE

**Abstract**

This contribution presents the definition of important quantitative and qualitative requirements for the realization and results of a geotechnical survey. The results have to inform the designer about characteristic properties of the subsoil which are very important for reliable foundation design of structures. Requirements for experimental measuring of strength and deformation characteristics of soils are dealt with in detail.

**Abstrakt**

Príspevok sa zaoberá definovaním nevyhnutných kvantitatívnych a kvalitatívnych požiadaviek na realizáciu a výsledky geotechnického prieskumu, ktorý má poskytnúť projektantovi reprezentatívne vlastnosti zemín podložia potrebné pre spoľahlivý návrh založenia stavebných konštrukcií. Podrobnejšie sa venujeme požiadavkám na výsledky experimentálnych meraní pevnostných a deformačných charakteristík zemín.

## 1 INTRODUCTION

In the design of geotechnical structures have to prove that any limit state is not over step. The limit states may by occurred in the subsoil or in the structure but as combined failure of both parts, too. In the whole design process in geotechnical structures the most complicated is the determination of the representative material characteristics of structure subsoil. These parameters are determined on the basis of geotechnical investigations. The most complete requirements on the geotechnical investigation results in the EN 1997:2004 EUROCODE 7 – 1st and 2nd part are defined [1, 2].

In the next part of this paper we shall focus our attention to the geotechnical research from the design point of view according to 3rd geotechnical category i.e. for difficult structures founded into complicated foundation conditions. In the following part of the paper the concrete example of the geotechnical investigation results is presented.

## 2 PRACTICAL EXAMPLES OF INTERPRETATION OBTAINED RESULTS OF GEOTECHNICAL CONDITIONS

In the framework of reconstruction project Nuclear Power Plant V-1 (JE V-1) in Jaslovske Bohunice a detailed geotechnical investigation was realized. The object of investigation the

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representative properties of subsoil of the pump-stations and cooling towers were determined. Discussed objects belong technological unit of “Technological Water Important” are very significant from the point of view of the power plant operation. In the region of active zone subsoil of design objects a loess soils (risk of structural collapse) and neogen clay soils with high plasticity (risk of swelling) are occurring. To detect the tendency of the subsoil on the structural collapse and swelling the laboratory strength and deformation tests in the various boundary conditions were realized. We are mainly oriented on the influence of water saturation; cyclic loading and unloading on the size of the mechanical soil properties (shear strengths and oedometric module deformation parameters).

With respect to the character of tested soil samples genesis, physical state and level of stresses a many samples (especially in lower values of normal stresses) subjected to the anisotropic shear tests behave as a very dalliance. This samples a significant difference between maximal (peak) and residual (minimal) shear strengths occur. In many samples magnitude of the maximal strength was not identified due this fact that the soil samples behave as a contracted (volume decrease). As was previous noted the course of shear strength mobilize depends on the various factors. The results of the cyclic shear tests were evaluated as a dependence of shear strength characteristics (angle of internal friction and cohesion) on the number of cycles (Figs. 1, 2). From the shear tests were fined parameters of shears strength with increasing number of cycles decrease. The decrease of shear strength due to failure of cementing bond between individual granules gradually increaseas dilatance, smoothing and orientation of individual particles on the sliding surfaces. The decrease of shear strength in dependence on the length of sliding area very negatively manifest mainly in slope stability and earth pressures calculations. In the solutions of the stability problems the important strength soil parameters are determined. Due this facts the residual values of strength of soil ($\phi_r$ , $c_r$) are considered as a standard´s local strength characteristics.

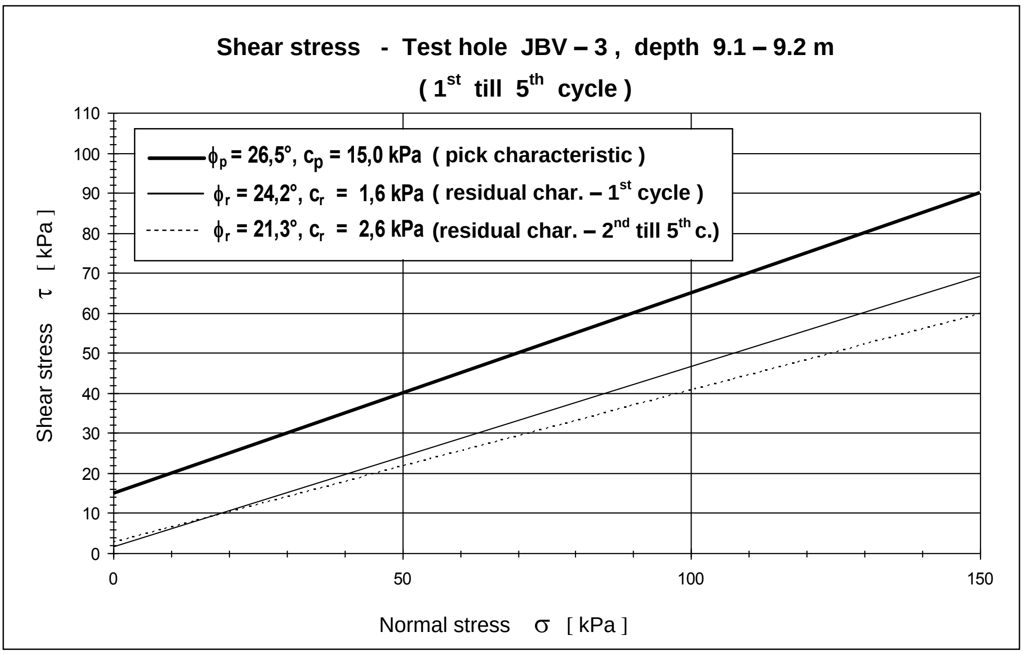


**Fig. 1** Evaluation of the “peak” and “residual” shear strength

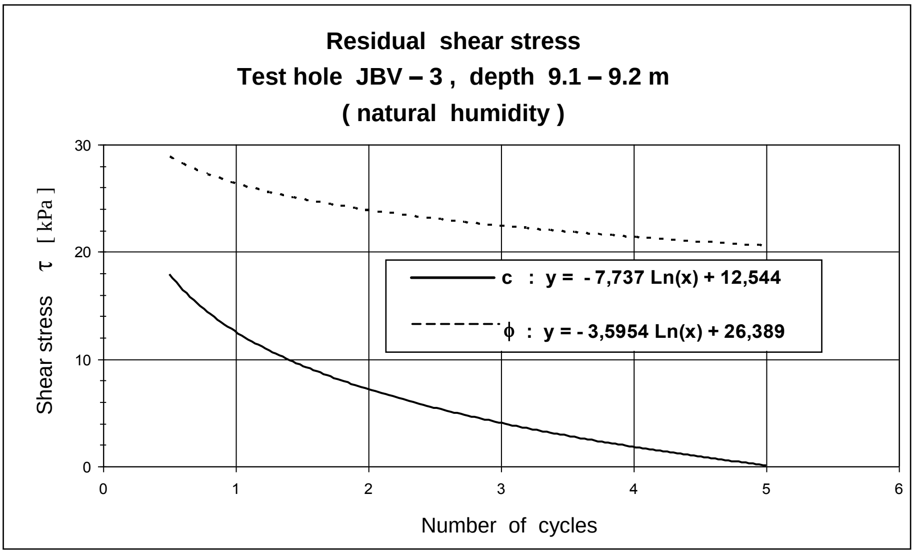


**Fig. 2** Influence of cyclic load on the value of the residual shear strength in natural humidity

Deformation characteristics of soil on the non-failed soil samples in the standard oedometric devices with diameter of sample 100.0mm with free ring were determined. With regard to these samples the consolidation each of them was loaded by reconsolidation compress stresses corresponding to geostatic pressure in depth of withdraw samples. After 24 hours reconsolidation the samples were unloaded on normal stress value 50.0kPa. On these preparing samples and application of original geostatic stress the load was gradually increased. Consolidation in chosen loading steps was minimally 24 hours, while the loading continually increase until last loading step. Usually in under load 350.0kPa the tested soil in oedometric devices was saturated. The significant deformations changes (structural collapse) in sample (JBV-1, depth 8.6-8.7m) with value of the consolidation coefficient $i_{mp}$=3.4% were registered (Fig. 3).

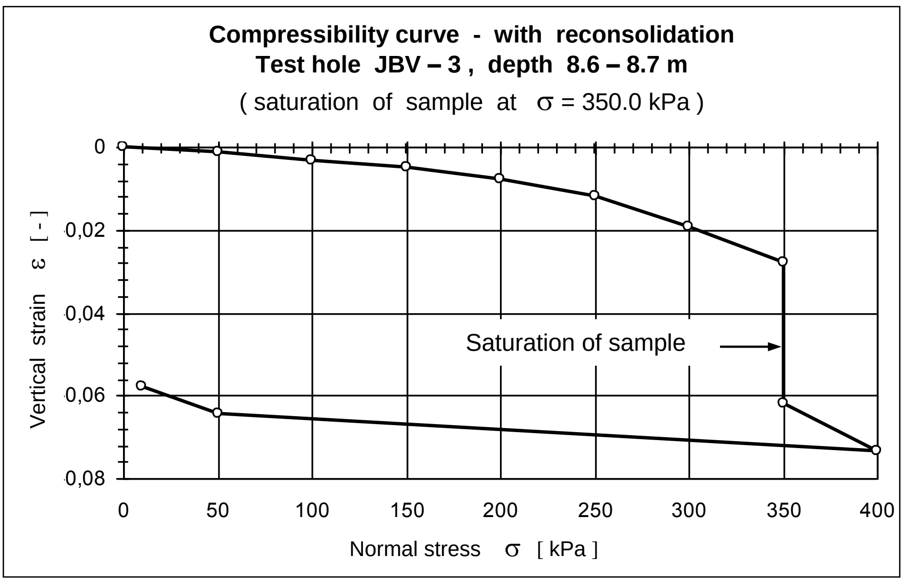


**Fig. 3** Evaluation of compressibility curve and structural collepse of loess ( $i_{mp}$=3,4 % )

Some of the soil samples containing more like 15.0% particles less then 0.005mm diameter swelled. Samples of neogen clays were extremely swelled. Measured swelling pressure had value maximally 350.0kPa. After maximal consolidation stress the samples were gradually unloaded on the value 50.0kPa and 10.0kPa. From the measured values the oedometric deformation and elastic module were calculated. On Fig. 4 the example of compressibility evaluation with loading and unloading steps of neogen clay soil is displayed.

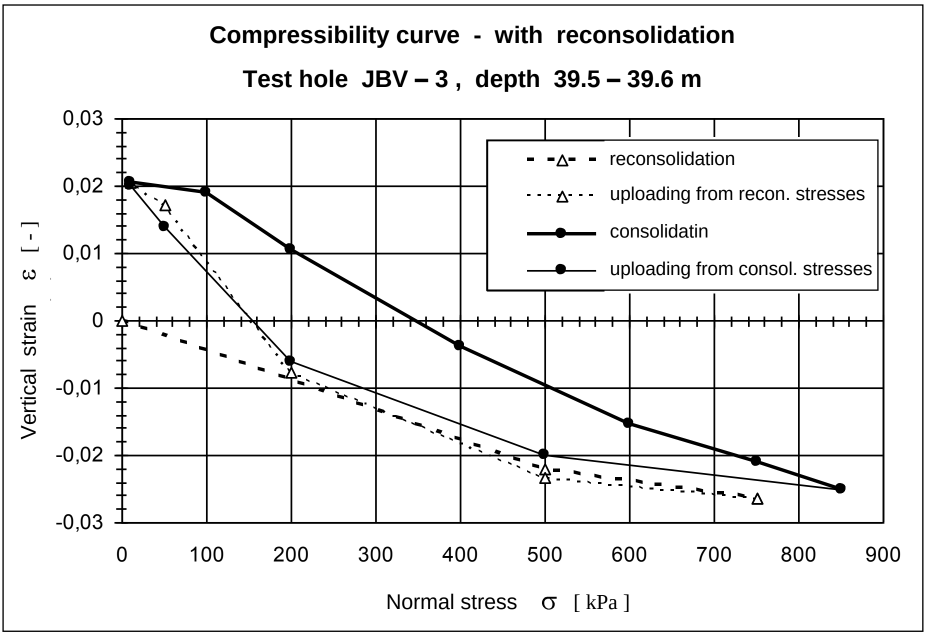


**Fig. 4** Evaluation of compressibility curve with loading and unloading steps

## 3 CONCLUSIONS

In definition of requirements on geotechnical investigation results the structural and realized needs of designed building have to take into account. The geotechnical investigation have to provide sufficiently amounts data about subsoil and regime of underground water in building site in its surroundings and representative soil properties necessary for geotechnical design (shear strength, deformations module). Designer is irretrievable and important in formulated quantitative and qualitative requirement on geotechnical investigation results. Reliable and optimal design of building structures dependence on the quality of geotechnical investigation results.

### REFERENCES


[1] KUZMA, J. et. al. Geotechnical investigation. Reconstruction of JE V-1 in Jaslovske Bohunice, TVD 1st and 2nd Block. (In Slovak). Bratislava: STU. 2000. 126 pp.

[2] EN 1997-1:2004 EUROCODE 7 - Geotechnical design – Part 1: General rules.

[3] EN 1997-2:2004 EUROCODE 7 - Geotechnical design – Part 2: Ground investigation and testing.

[4] STN 73 1001 Foundation of structures.



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