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GYPSUM AND SALINE SOILS

LE GYPSE ET LES SOLS SALINS

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SYNOPSIS : The following problems are suggested for discussion: a. Engineering case histories; b. Engineering classifications developed for gypsum and saline soils; c. Special investigations of gypsum and saline soils mechanical properties; d. Parameters, characterizing specific mechanical properties of gypsum and saline soils.

The following problems are suggested for discussion.

a. First of all practice of construction and maintenance of industrial and civil buildings and structures, then hydrotechnical, land-reclamation and other constructions built on gypsum and saline soils; examples of deformations and damages of buildings and structures.

Gypsum and saline soils are widely spread in the most countries situated in the arid and semiarid regions. In the last 20-30 years construction increased considerably in these regions due to opening and developing of uranium, gold, non-ferrous metal deposits, oil- and gas-fields, development of land-reclamation works.

Gypsum and saline soils are characterized by specific mechanical properties which are changing during short-term watering and long-term filtration of water or solutions. In particular, considerable deformations and strength changes of these soils take place as a result of soil dissolving. Another main problem is high corrosion activity of gypsum and saline soils (this problem we don't touch in this discussion).

During 40-50 years extensive researches of gypsum and saline soils had been carried out already in connection with road, hydrotechnical and land-reclamation construction.

It was established that saline soils use during road construction must be regulate by some limiting content of easily-soluble salts. This content exceeding causes damage of base and road-bed.

Observations of hydrotechnical and land-reclamation structures showed that dissolving of gypsum and saline soils takes place during long-term filtration of water. As a result soils deformability and permeability increase

occurs. In the countries of former Soviet Union many cases of deformations of hydrotechnical and land-reclamation structures were fixed.

At the same time it is considered that such problem should not be in civil and industrial construction because small amount of water infiltrates into the base of foundations. In this connection in 50-60 years site investigations, base and foundation design were carried out practically as for usual soils (without salts content). But numerous cases of deformations and damages of structures compelled specialists to solve this problem.

Let's see only 2 examples of buildings numerous deformations. In the 50-60 years more than 200 civil buildings were constructed on gypsum coarse-gravel and clayey soils in Erevan (Armenia). In the middle of the 80 years about 100 buildings were subjected to deformations. These deformations were so considerable that more than 20 buildings were pulled down.

In the 60 years in Tbilisi (Georgia) 129 four-storeyed civil buildings were constructed on gypsum clayey soils. In the middle of the 80 years 30 buildings were in near collapsible state and needed strengthening-restoration works. Some of buildings were pulled down.

Observations showed that in both cases deformations of buildings were connected with water infiltration into the base of foundations and dissolving of soils. As a result collapsible and long-term suffosion deformations of base took place due to wetting by atmospheric precipitations, watering of trees as well as due to leakage from water-carried pipes.

Surprisingly but the information about civil and industrial buildings deformations in the regions with gypsum and saline soils is practically absent in the publications of other countries. Sometimes impression arises that this problem has local importance only for some

limited number of countries.

- b. Engineering classifications developed for gypsum and saline soils.

In the State Standards of the former Soviet Union soils with easily-soluble salts and gypsum content are conditionally concerned with the general group of saline soils. Saline soils are those that contain no less than minimum amount of water-soluble salts in ratio to weight of absolutely dry soil:

- coarse-gravel - 2% with sandy filler content less than 40% or with silty - clayey filler content less than 30%; 0,5 % with sandy filler content 40% and more; 5% with silty-clayey filler content 30% and more;
- sandy - 0,5% ;
- sandy-clay and silty-clay - 5% ;
- clay - 10%.

These limits were estimated as corresponding to conditional state above which strength properties are changed and collapsible and suffosion deformations are appeared during short- and long-term watering.

There are also more detailed classifications developed with regard to type of soil, qualitative composition and content of salts, kind of construction.

In the 40-50 years two engineering classifications were developed for saline clayey soils (with easily-soluble salts) used in road construction. These classifications were based on the criterion that salts content in soil during road-bed construction had not exceed the amount of salts that may be dissolved in the water that corresponds to optimum moisture of soil with maximum density. Subsequently these classifications were used non-substantiated in other kinds of construction. Another classifications for saline soils have not developed yet in the countries of the former Soviet Union.

At the same time many engineering classifications of gypsum soils are developed for road construction, land-reclamation, hydrotechnical, civil and industrial construction. Groups of soils (mainly clayey) with different gypsum content are stood out into these classifications. Special requirements for site investigation were developed for these groups; averaged values of mechanical parameters and their change during long-term watering were given; criterion of using these soils as a base of foundation and as a construction materials were stated.

Nevertheless it is necessary to note:
a. Contradictory character of engineering classifications of gypsum soils; b. Some difficulties in their comparison and unification; c. Different criteria that were used for developing classifications (in some case this criterion is suffosion stability, in other case - possibility of collapse, in the third case - petrological peculiarities etc.); d. Absence of classifications for some kinds of soils (sands, coarse-gravels etc.).

- c. Special investigations of gypsum and saline soils mechanical properties - equipment, apparatus, methods.

It is evident that special tests of gypsum and saline soils must be made side by side with usual determination of mechanical properties.

Laboratory compression-filtration tests are carried out for determination of suffosion compression. Main scheme of this test includes use of constant pressure to sample and long-term filtration of water or solution through the soil. Special equipment and apparatus were worked out for this purpose.

Plate tests with long-term watering of base are carried out in-situ to determining suffosion deformations. These tests give most reliable parameters but they are labour-consuming and long-term. Duration of plate tests changes from several months to more than 1 year.

Equipment, apparatus and laboratory investigation methods were developed to determine strength changes of gypsum and saline soils during dissolving of sample. But these tests are so complex that only some published results on this problem one can find in special literature.

- d. Parameters, characterizing specific mechanical properties of gypsum and saline soils.

Parameters of gypsum and saline soils to be determined use the results of special tests. These parameters are used for calculation of deformability and bearing capacity of structures base and for prediction of its behaviour in time.

A lot of hydrochemical parameters are known to be proposed for calculation of dissolving or salinization processes of soil massif. Methods of experimental determination of these parameters have been developed in detailed.

At the same time universal parameters characterizing mechanical properties of saline and gypsum soils have not developed yet.

In the countries of the former Soviet Union the following parameters have been determined on the base of the results of in-situ and laboratory deformation tests of gypsum and saline soils during long-term filtration of water or solutions: a. Relative suffosion compression E_{sf} with the corresponding values of pressure P and degree of salts leaching β ; b. Initial pressure of suffosion compression P_{sf} ; c. Critical degree of salts leaching β_c after which intensive suffosion deformation begins. There are other parameters for characterizing peculiarities of deformative properties of soils with salts content.

The changes of strength parameters during soil dissolving are characterized by means of the angle of internal friction and cohesion intercept with limiting or any intermediate value of degree of salts leaching.

There are many problems connected with investigation of gypsum and saline soils and construction on these soils. But the discussion on this topic has been included into the program of international conference on SMFE practically for the first time. So we had to limit the list of main problems. The further progress in developing the foundation engineering on gypsum and saline soils is impossible without solution of these abovementioned four problems.