Review paper
UDC: 624.014.2.04
DOI: 10.7251/afts.2015.0713.025D
COBISS.RS-ID 5435416

AN EXAMPLE OF „MODERN CONSTRUCTION OF THE FACILITY“

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Abstract

Today's building of facilities does not follow the study of the characteristics of the terrain on which the facility is constructed. The period of rapid construction, which can be called the "modern construction" does not follow the quality of constructed facilities. Usually it is the uncontrolled building, where is only important to build a facility without taking into account the conditions of its construction and safety during exploitation.Many steps before and during the construction of facilities are neglected, which is reflected in their safety, especially after its construction.

The paper gives an example of a negative construction of facilities, as well as an overview of what is within the geological research andstudies of the field that need to be done to adequately define the geological and geotechnical characteristics of the terrain, as the basis on which the facility is constructed. This example is just one of many negative examples today.

Key words: modern construction, research of the field, facilities, sediments

INTRODUCTION

The complexity of the geological structure and the need to harmonize the facility with nature, in foundation zone, as well as in the immediate surroundings, is giving the growing importance to the scientific fields of geology and environmental protection. How to build and construct a facility that will establish a new natural balance between the soil and its structures, and that will not cause a disturbance of the natural environment in which it is located? Also special importance is given to the preservation and stability of the facility and its immediate surrounding, during exploitation.

Today during the "modern construction of facilities," which may be termed rapid uncontrolled building, all previous phases of preparation for the construction of facility are neglected, as well as after its construction, that is, the exploitation of the object. It remained only one goal, to quickly and with less invested funds build the facility, without taking into account the consequences that could arise during the building and the immediate environment to which the facility has an impact.

Results of modern construction of facilities, are differently visible in time. Some are noticed during construction or immediate exploitation, and some with delay, depending on weather factors. It is important to emphasize that most of the facilities built like that remains stable, but today it is not allowed the construction of facilities of poor quality that threaten its stability and its immediate surroundings. All facilities require prior preparation phase through the study of of the field in terms of its stability, then preserving the stability of the facility and the natural environment in the period of its duration.

An example of modern construction without sufficiently studied characteristics of the field will be shown through the construction of the facility type of production or service halls, where it was built faster in relation to the study of the terrain on which is built. Only after the construction of the foundation, was significantly approached to the study of the field, given that the building was built in the levee. Characteristics of the levee and the complexity of geological structure immediately below the levee showed justification for geological research. Investigated site is located on a mountain type of relief, and represents the northern slopes of the mountain Majevica in the area of Ugljevik.

CHARACTERISTICS OF THE FACILITY

Facility for its features has no special significance and foundation method. However, the location where it is located, seeks the harmonization of the facility and the natural environment in which it is based, given the complexity of the geological structure. The facility measures are 72,0x 35,0 m, P + 0. Height of the facility is 14,5 m, with a usable area of2.320,00 m^2. Performed project documentation was based on the "fast geological investigations" that did not yield the required results, as evidenced in the excavation of the foundation. However, the construction the facility is continued, arguing that the thickness of the leveeis significant, and that it is consolidated in the previous period of about thirty years.

After the construction of the foundation, it was launched an activity to do new research that would define the characteristics of the terrain to the depth of the impact of the foundation, although the depth at which is was installed was unknown. Research has not depended on further construction, so obtained results remained as a contribution to the project documentation of the facility, that is not harmonized with them.

Field research conducted at six (6) exploration boreholes with depth of around 10.0 and showed different characteristics in terms of geology from assumed with whom was started the design and construction of the facility. Also, the complexity of the geological structure on a small area, and thus the area where the facility is located, demanded a higher level of exploration, especially in the analysis of individual lithological members that have an impact on the depth of the foundation of the structure.

GEOLOGICALCHARACTERISTICS OF THETERRAIN

Basic data on the site are taken from previously prepared documents related to wider and narrower area [1,2]. Area and closer environment in relation to the genesis, are characterized by two types of relief: fluvio- accumulation and erosion-denundation. From the point of hypsometrical and morphometric characteristics plains and mountain type are developed.

Plain type or fluvial - accumulating type of relief has been developed at altitudes of about 180.0 meters above sea level in the northwestern part, to 200.0 meters above sea level on the south coast. Represent the accumulation area of Mezgrajica river, which flows west from the researched location, southeast - northwest direction. Thereby forms narrow valley which covers the area north, northwest and south of the researched field, Figure 1.

Mountain type or erosion - denundation type of relief has been developed east and west of the valley of the river Mezgrajica.

Microlocation exploration area belongs to the hilly zone and erosion denudation type of relief developed at altitudes above 200.0 meters above sea level. Positioned on the far western edge of the slope which by direction southeast - northwest surrounding the valley. Natural morphology of the researched location is as well as its closer environment altered by disposing of material of excavated coal during exploitation in the OCM Bogutovo Village, and the surface of the terrain iscovered by technogenic levee.

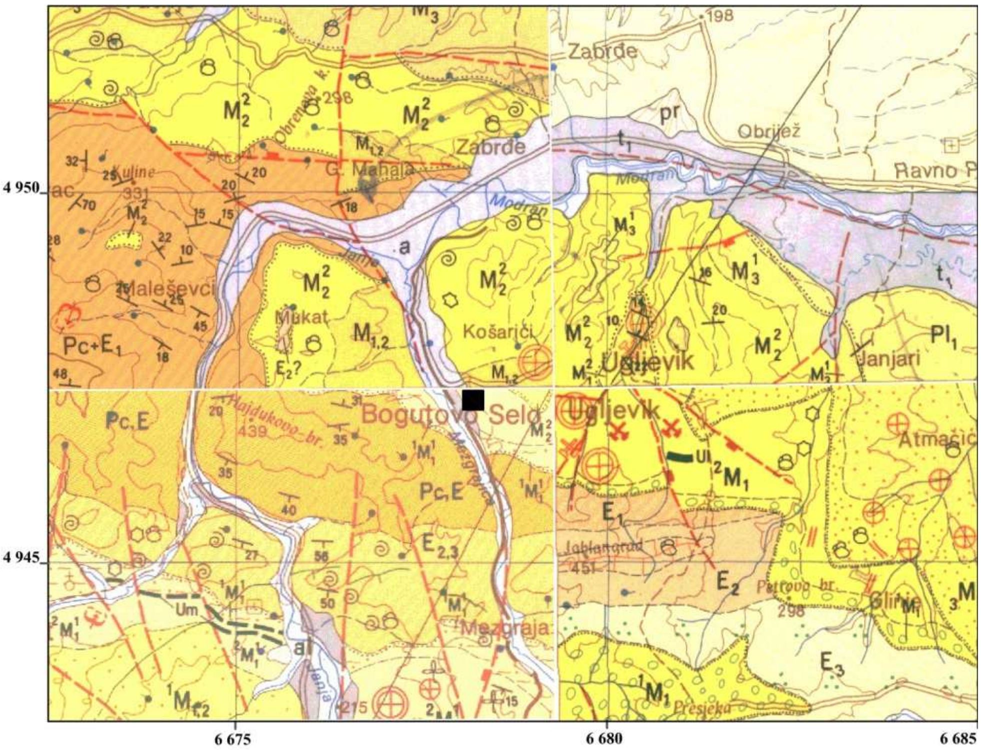

Figure 1. The position of research locations on the geological map

The terrain on which began construction of the facility, as well as its closer and broader environment is constructed of sediments of Quaternary and Tertiary (Neogene) age whose provision is confirmed by the General Geological Map SFRJ 1: 100 000, sheet Tuzla and sheet Brcko with interpreters.

The oldest sediments separated on the surface are freshwater lake sediments with coal lower of Miocene ($^1M_1^1$). This member is a side facial equivalent to "Slavinovici" and "lipovackih limestone" and "red series" of Tuzla basin. Lower zone ($^1M_1^1$) represents the basal series of conglomerates and roughly grain sandstone over which lie clays, sandstones, marls and limestones of gray, green and red colours. The total thickness of the zone is approximately 50.00 m. It builds the surface of terrain south of the researched location. Transgressively through these sediments in the north part of the field of researched location were separated sediments of lower - middle Miocene ($M_{1,2}$) which build the surface of the terrain in the valley of Mezgrajica, and are presented with green and red (floor) clays, coal layer, which contains a number of mollusks shells, then marls with ostracod and tuffites clay. In the immediate environment of researched location on the surface are extracted sediments that belong to layers of Baden Tortonian (M_2^2).

Tortonian sediments are of marine origin and are represented by sandstones, clays and marls with subordinate limestones. The package starts with basal conglomerates, and in some places the most common are sandy clay with Flabellipecten Besser and Corbula giba with foraminifers characteristic for the lower and middle Torton. Creations of the Quaternary (Q) are located along water flow Mezgraja and are presented with river terraces, alluvial and proluvialfacies.

- First terrace (t_1) contains heterogeneous gravel riverbed facies, with water wetted aleurites and sands, and alevrites ofloess habitus
- proluvial (pr) sediments have extremely limited range where in floodplain cone are alevrites, sands and fine-grained gravel
- alluvial (al, a)sediments through the riverbed of Mezgraja are represented with gravel, sand,alevrites and clays.

Alluvial sediments - proluvial (drp), as a product of slope processes and river erosion have been developed on the slopes and from east and west surrounded by the river valley of Mezgrajica.

According to the tectonic zoning OGK sheet Brcko, study area and its environs belong to the border area between the two structural units of the facial. These are: structural - facial unit of picked complex of Majevica and units of the Neogene basins and Ugljevik Neogene pool. The first is characterized by shales and sandstones and other is build of Miocene sediments, mainly marl and marl rocks.

Tectonic lines are registered. Analysis of the data with the results of previous studies and new research works established the existence of faults or fault zones. It is the fault of direction north north-west - south east, which extends along the valley of the river Mezgrajica.

A detailed review of the characteristics of the field on the part of the location, separates the leveeof insufficiently defined mightiest. It was created during disposal of tailings pit mine thirty years ago. The natural morphology of the terrain is not known, nor the possibility of the levee in this part of the field, especially the facility. Earlier the levee in the immediate area was removed, so it could be seen his composition on the front section. It is made of clay and marl sediments with large pieces of marl, limestone and sandstone.

Fluctuations of time occasions during the year, have changed his appearance and characteristics in relation to the levee in the deeper parts of the terrain, as well as one that is closer to the ground surface, but completely covered. At locations where construction of the facility began, levee was removed to a depth of 5.0 m. Farther away from the location of the facility already are several objects behind which is an open pit mine. On the surface of the terrain does not exist the natural and landscaped water streams or water, although the terrain is all swampy especially in the levee.

Field research on the location of the building in addition to the engineering geological mapping, also included exploration works in order to determine the geology and geotechnical characteristics of the present lithological members, to the depth of the impact o facility. The scope of works has been harmonized with regulations that define the research for this type of facilities, but it is inadequate in relation to the complexity of the geological structure of the field [3], Figure 2.

GEOTECHNICAL CHARACTERISTICS OF THE TERRAIN

Detailed engineering geological mapping is included in the wider area where started the construction. Registered are natural corms and corms in cuts that are open during the period of exploitation of the open pit or any research for the proposed facility. During mapping, significant attention was paid to the separation of older sediments substrate ground (potential occurrence of solid rocks or stone and half stony rocks, semi-consolidated and unconsolidated rocks) of semi-consolidated and unconsolidated (talus, alluvial - eluvial, proluvial, and alluvial) sediments, as well as registration area covered with materials of technogenic origin (levee). Also, there were all phenomena with water saturated soil, soil water beep and other similar phenomena in the field, which may be of importance for the assessment of conditions for the construction facilities.

Exploration drilling was carried out on the corner points and the central part of the facility, Figure 2. The core is extracted in the full percentage and are taken undisturbed and disturbed samples from each lithological change. Also in the borehole were made experiments of SPT, on every three meters.

During the execution of exploration drilling a detailed engineering-geological mapping of the core was carried out whereby done in detail the identification and classification of drilled material. A special attention was given to defining the lithological composition, micro fissure rock material, character of fissure and its dependence on temperature after removing the core, appearance of the water in different layers and possible connections between them and other phenomena that would indicate drenching of the sediments, especially at the surface portion where is a layer of the levee.

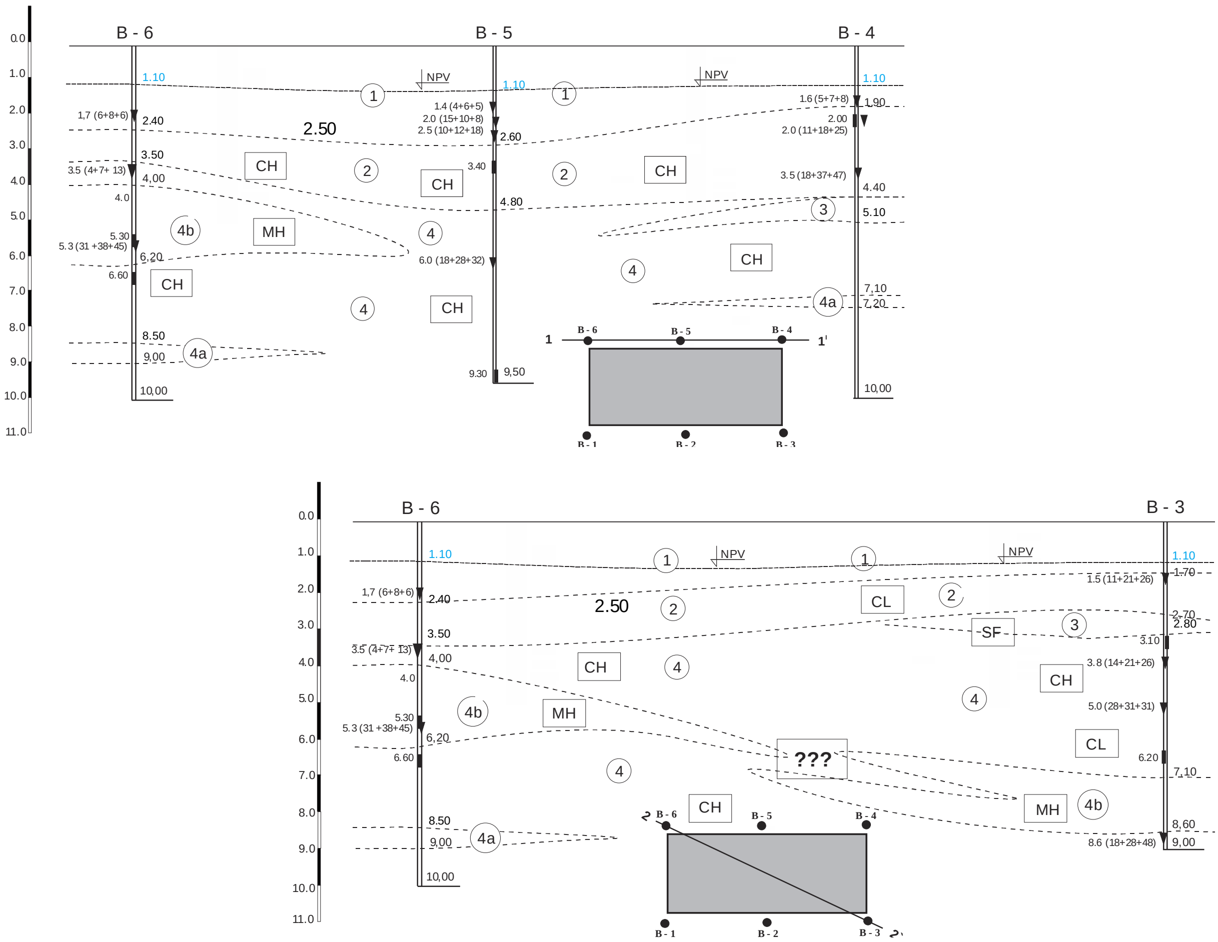

Figure 2. Profile of the terrain at the researched location
1. levee, 2. silty clay, 3. sand dust, 4. sandy clay marl, 4a. sandy clay, 4b. coaly glina

After engineering geological mapping of the core, samples were taken for laboratory tests. The sampling plan was adjusted on the basis of new data and data from surrounding works in order for samples to be taken from the same lithologic members at different depths from neighboring works, with the aim of detailed coverage on lithostratigraphic vertical step and horizontal spreading of individual members. Sampling was done in-line.

With conducted field investigations and laboratory tests is seen geological structure and degraded coatings. In the geological structure of the ground to a depth of research, participate technogenic materials and natural sediments in which packages are separated from loose and friable sedimentary rock, presented by the following layers:

- Technogenic materials – levee
- Weakly bound rock - clay, sand, clay, marl and sand dust
- Unbound rocks - clayey sand

Geomechanical characteristics with display of limit values of parameters for all layers, as seen in the vertical profile are the following:

Levee completely covers the surface of the field, where stands the surface layer of derbis material embedded over the embankment before the start of construction of the planned facility. Below is previously deposited material from the open pit mine, which consists of clayey and sandy clayey sediments, mightiest of about 2.5 m. The layer is under water in the lower part and with very little penetration resistance [4,5]. Featured parameters for geotechnical analyzes are:

- bulk density $\gamma = 20,00 kN/m^3$
- friction angle $_{(SPT)}$ $\varphi = 30^0$
- cohesion $c = 5,0 kN/m^2$
- modulus of compressibility $M_{v(SPT)} = 9,959\ kN/m^2$
- coefficient (by USBR) $k = 4,59x\ 10^0$do $5,21\ x\ 10^{-1}$cm/sec

Sandy clay CL - CH group contains a high percentage content of sandy components low to high plasticity, yellow-brown, with the occasional presence of carbonic color. A layer of clay is present across the entire site and represents a natural layer from the previously removed soil part and disposed levee**.** Mightiest of the layer is different from 1,0 - 3,0 m and the lower limit is more difficult to be set as a part where the layer is directly bonded to marly clay. In some parts of the terrain below the clay layer lies a layer of sand, of variable mightiest from 1.00 m to 2.90 m. The parameters for geotechnical analyzes are:

- bulk density $\gamma = 18,80 kN/m^3$
- friction angle $_{(SPT)}$ $\varphi = 17^0$
- cohesion $c = 33\ kN/m^2$
- modulus of compressibility $M_v = 3,200\ kN/m^2$
- coefficient (by USBR) $k = 2,29x\ 10^{-5}$do $8,08x\ 10^{-7}$cm/sec

Clayey sand SC has no continual spreading and is of lens character, embedded between layers of clay, sand and clay, sandy marl, mightiest to 2.7 m. SPT experiments revealed a good compaction, and the parameters for geotechnical analysis are:

- bulk density $\gamma = 20,10 kN/m^3$
- friction angle $_{(SPT)}$ $\varphi = 39^0$
- cohesion $c = 5,0 kN/m^2$
- modulus of compressibility $M_{v(SPT)} = 20,200\ kN/m^2$
- coefficient (by USBR) $k = 2,32x\ 10^{-4}$cm/sec

Clay, sandy, marl CL is a gradual transition from the clay layer sand and contains interlayers of sand and carbonaceous clay. Continuously extends across the entire site, and overburden portion was difficult to determine, especially in the part where there is no layer of sand, and is a direct contact with a layer of clay sand.

Within the layers are separated interlayers of sand with the tag (4a), and carbonaceous clay (4b). Layers of sand are of 0.1 to 0.7 m and are characterized by the yellow, bad brown, with small pieces of sandstone parts to 1.0 cm. Coaly clay (4b) is characterized by the presence on the diagonal facility at the location, mightiest about 1.5 m, Figure 2.

Sediments of this layer are well consolidated and separated parameters for further calculations are as follows:

- bulk density $\gamma = 19,10 kN/m^3$
- friction angle $_{(SPT)}$ $\varphi = 16^0$
- cohesion $c = 25,0 kN/m^2$
- modulus of compressibility $M_v = 2,800\ kN/m^2$
- coefficient (by USBR) $k = 2,86x\ 10^{-5}$do$7,56x\ 10^{-7}$cm/sec

Hydrogeological characteristics of the research sites were not observed in a wider area, but the location is seen in the part referring to her research by using boreholes. Earlier terrain morphology was altered, and surface streams were relocated. However, the terrain with water saturated in partof piled materials and surface sediments.

According to the results of geomechanical drilling and laboratory tests it can be concluded that the ground to a depth of about 10.0 m from hydrogeological aspects in relation to their hydrogeological function is build by the following types of rocks:

- good permeable sediments and
- medium to low permeable weakly boundedsediments.

Good permeable sediments, are according to field research, mainly in the layer of the levee, which is of different compaction. Filtration coefficient is determined on samples from the levee4,59x $10^0$to 5,21 x 10^{-1}cm/sec (byUSBR).

Medium to low permeable sediments are related to the combination of two (2) clay with different content of sand component and layer three (3) sand that has a substantial content of the clay particles. Layer three (3) in some parts has a better permeability, and it can be incorporated into a good water permeable rocks, but such detail study of the layer has not been carried out. Otherwise layer in the lower part is closer to the low permeable sediments. Generally filtration coefficient by USBR is in the range of2,25x 10^{-5}to8,08x 10^{-7}cm/sec.The possibility of movement of storm water on vertical and horizontal directions in the deeper parts of the court, broadly speaking, is small, although it can be significant in parts with the presence of sand particles.

Less water permeable sediments observed in the vertical direction represent continuity to the marl clay (4), where the coefficient of filtration by USBR is in ranges4,24x 10^{-6}to8,03x 10^{-7}cm/sec.However, a better permeability within the layer (4) has an interlayes of carbonaceous clays, especially in the field where are present coal and sand.

Seismicity of the field is determined according to the seismological map of the SFRY, 1987, for return periods of 100, 200 and 500 years. The site is located on the border V and VI degree of MSK-64, for the return period of 100 years, and for the return period of 200 years of seismic activity in the area of level VII of MSK-64, and for the return period of 500 years seismicity location is also in the zone level VII of MSK-64th.

DISCUSSION

The choice of location for the construction of the mentioned facility was not accompanied by previous studies of the terrain. They did not know enough about the location, primarily about earlier morphological characteristics of the terrain and artificially altered morphology due to depositing material from a nearby open pit mine. Mightiest of deposit material, as well as its features, completely differed in relation to the data before and after the investigations of the terrain. It was found that the mightiest of the levee is not several dozen meters, but a few meters, and its consolidation is minimum. Characteristics of levees vary at a short distance, as determined by field studies and laboratory tests [6], whose data often differ, particularly in parts of the dam that are less consolidated and more with water saturated.

Partially different data were linked to other layers in the vertical profile, which shows the presence of frequent changes, ie sedimentation was stormy, so no layer at the surface part has continuity of sedimentation. Also, their geotechnical characteristics are variable, but not so much that a special modelwould need to bedone for each borehole.Given the succession of layers, ie often the presence of interlayers, it can be concluded that the extent of the investigative work is inadequate [7]. For thus movementof interlayers or layers, it is requireda higher level of exploration, which would require multiple boreholes on a smaller distance [8,9].

However, according to the present level of exploration of layers of bad characteristics, which can be considered as interlayers, are of less mightiest, so in general it does not significantly affect the characteristics of the soil when we observe it like a complete package. A layer of sand clayey that has in some places slightly higher mightiest, has characteristics that can fit in the package of layers, making a model of layers of approximately the same characteristics, table 1.

Table 1. Model of the terrain according to the results of carried outsurveys

Label of work	Label of layer	Depth of layer of – to	Type of layer	The initial modulus of compressib.	Bulk density	Effective cohesion	Effective angle of shearing resistance
	-	(m)	-	(kN/m^2)	(kN/m^3)	(kN/m^2)	(^{o})
B – 1 – 6	**1**	0.0 - 2.5	Levee*	-	-	-	-
	2	2.5 - 4.5	Clay sandy	5 000	19.2	24	14
	3	4.5 - 10.0	Clay marly, sand clayey	3500	19.3	22	12

** adopted values*

For building foundation in the terrain of complex geological structure in the small area are needed more detailed data and setting up a safer model, which requires a greater degree of exploration.

The layer of the levee, which is located at the surface is not suitable for the foundation of any objects therein. Foundations that are mentioned property should be carried out at a depth greater than 2.5 m, or should be removed the existing layer of levee, and established the foundations on natural ground.

A layer of sand clayey is of favorable geotechnical characteristics in the study, but there is no continuity of spreading.

Interlayer of carbonaceous clays has no continuous spreading. In some of its intervals are interlayers of coal thickness of a few centimeters. Coaly clay on some parts of the researched site lies the shallower, of about same mightiest, but according to the present stage of exploration has no continuity of spreading, Figure 2. Generally, the court on this profile, as well the whole location is characterized by "a restless sedimentation“.

By field observation of drilled cores, it was noted the presence of water near the levee and in sandy sediments, although the sample was examined in the laboratory, these sediments can not be classified as of good water permeability, due to the percentage content of clay dusty particles. However field mapping is linked to the observation of a larger interval so that priority is given to these information in relation to the laboratory.

On the field and in boreholes were not performed hydrogeological tests, or embedded piezometers for observation of groundwater levels, so the hydrogeological characteristics obtained by laboratory testing and calculated by the USBR can be taken as approximate, which generally display characteristics of a layer.

Comment of those investigations, which were carried out after the construction of the foundations of the existing facility is attached to the subject in a negative sense. Initiate objectwas not followed by the necessary geological research, as well as documentation of the method of its foundation. At the time of research was not known the depth of foundation of facility, and research have been conducted for the purposes of the study, which is an integral part of project documentation.

The present level of exploration of the terrain shows that the foundations of mentioned facility should be done at a depth greater than 2.5 m, or should be removed the existing layer of levees and established the foundation on natural ground.

To what extent the project will be further adapted to provide the characteristics of the terrain is unknown, but it is difficult to adjust the characteristics of the terrain, of already commenced facility.

Additional works will be much bigger and more complex, which will increase the cost of building, but not so much the security after its construction.

(Received September 2015, accepted Oktober 2015)

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