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Carbonaceous breeds as the material of engineering protection of Imeretinskaya valley (Sochi)

Alexander Bakalov *and Andrey* Lavrusevich*

Moscow State University of Civil Engineering, Yaroslavskoe shosse, 26, Moscow, 129337, Russia

Abstract. The experience of the use of carbonaceous breeds during the formation of the engineering protection embankments, in the territory of Imeretinskaya Valley is considered in the article. It is demonstrated how the measures of the engineering protection were held in the difficult engineering-and-geological conditions. The experiment on the use of local carbonaceous material took place on certain quarters, because of the lack of volumes of material of the embankment of the engineering protection. The soils of the Kamensk limestone quarry were used, different options of dumping of the carbonaceous soil were applied. It is proved that crushed-stone mix from carbonaceous material raises the indicators of the mechanical characteristics due to the natural cementing ability. In case when crushed-stone mix of lime marl was higher than the ground water level, calcium oxide promoted strengthening of the breed, allocating the connections, cementing the layers. There were the surface sediment and the deformation of structures in the sites, where crushed-stone mix of carbonaceous structure was waterlogged. The increase in the durability of soils of dumping because of the formation of the monolithic plate in the embankment basis from carbonaceous breeds can be used when carrying out engineering protection in the similar engineering-and-geological conditions.

1. Introduction

The following key indicators are necessary for the first approximation for the definition of rock: mineral structure, structural-and-textural features, and reaction from 10% of HCl for carbonates. Rather wide range of changes of structures, structures and textures, depending on the formation of conditions is characteristic of the carbonaceous breeds. The carbonaceous breeds make up to 29% of the total amount of sedimentary rocks [1]. In most cases there are not carbonaceous minerals as impurities; these are terrigenous debris in the form of silt or sandy grains, which give the corresponding adjective in the name of breed: silt or sandy limestone or dolomite. The common form of impurity is the clay material, which forms the clay-and-carbonaceous breed (marl), which contain 25...50% of clay

* Corresponding autour: lavrusevich@yandex.ru

material along with the carbonaceous component [1, 2]. The research on the use of carbonaceous breeds for the structures of soil embankments with various types of covering, are carried out insufficiently and the possibility of their use for these purposes is lit in special technical literature poorly, though there are separate publications, including, those connected with the hydraulic engineering structures and road construction [3, 4, 5, 6]. The technology of construction of the soil embankment from carbonaceous breeds is not rather studied and fulfilled. However, the existence of a quarry with unlimited stocks of carbonaceous breeds near Imeretinskaya Valley, allowed to reduce transportation costs, cost and total amount of material for the engineering protection.

Imeretinskaya Valley became the site of construction of sports facilities for carrying out a wide complex of sporting events of the Olympic Games 2014 (coastal cluster).

According to the Construction Regulations 11-105-97 Imeretinskaya Valley is among the territories with difficult engineering-and-geological conditions (the III category of complexity) [7]. First of all, that means the presence of lagoon clay (considerable in distribution and in thickness capacity) and peaty soils of plastic and fluid consistence (the module of deformation of the such soils of the basis was ranging from 0.3...1.9 up to 0.4 MPas), as well as loams, sandy loams and sands, including dusty fraction which can be subject to the colliquation in case of seismic influence. Other features are the wide spread of boggy lands and the waterlogged territories, high seismic activity of the area, almost ubiquitous and year-round presence of perched groundwater [8-16].

The hydrogeological conditions are characterized by the development of perched groundwater and the complex of aquifers in Quarternary and the Neogene-Paleogene, alluvial and marine sediments. The ground waters depth changes within each year. During the rainy periods ground water comes to the surface on some sites; that leads to flooding and bogging of the territory, to the increase in the zone of the intrusion of ocean salty waters deep into the coasts, to the uneven consolidation of soils on the areas of engineering protection, to the rearrangement of the seabed of the coastal zone and to the destruction of the coast protection structures. The suffosion-and-erosion phenomena are widely developed. The considerable technogenic loading makes their negative impact on the components of the ecosystem of the territory.

2. Methods and algorithms

According to the materials of the last years research and the actual materials, received during engineering-and-geological research for the Olympic facilities and also considering the composite engineering-and-geological, hydrogeological litho- and hydrodynamic conditions of the Imeretinskaya Valley, the following measures of the engineering protection of the territory against flooding, abrasion and suffosion were carried out:
Fig. 1. Scheme of the artificial increase in the level of the surface of Imeretinskaya Valley. The sites of dumping below mark +3.5 m are shown green (the Black Sea level is taken for absolute zero; - 0.26 m of the Baltic Sea level is taken for - 0.26 m).

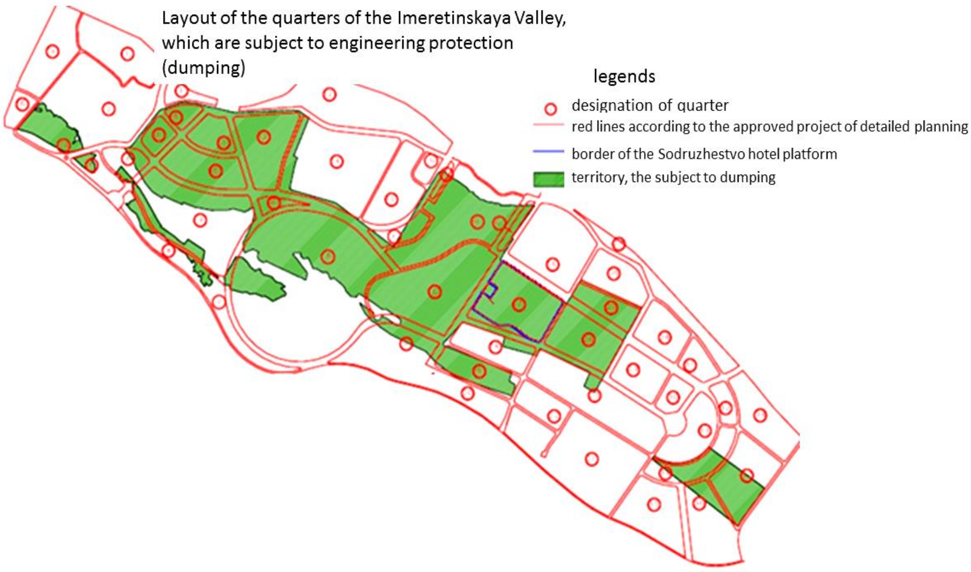

Fig. 1. Scheme of the artificial increase in the level of the surface of Imeretinskaya Valley. The sites of dumping below mark +3.5 m are shown green (the Black Sea level is taken for absolute zero; - 0.26 m of the Baltic Sea level is taken for - 0.26 m)

1. Dumping of carbonaceous material (in some quarters) and of beforehand washed gravelly-sandy material of polymineral structure up to marks of 2.5-3.5 m (the Black Sea level is taken for absolute zero; - 0.26 m of the Baltic Sea level is taken for - 0.26 m) for 67% of the territory of the lowland with the underlay of a horizontal drainage is carried out. Laying of the horizontal drainage, was carried out with advancing of the installation-and-construction works.

The main characteristics of soils of the embankments are following: filtration coefficient is not less than 2 m/days, content of clay particles is no more than 10%, the bulk factor is not less than 0.95. Such value of a filtration coefficient is accepted according to the assessment of the effectiveness of the excess of the pressure between drains (ring drains and drains cuts) with the distance among them 100 m. Besides, when calculating the balance, the infiltration delivery due to technogenic influence was considered. In case of the increase in marks of the territory of Imeretinskaya Valley the conditions of natural and artificial drainage of underground waters were met, not to create a backup for them. However, the untimely laying of drainages on certain quarters of engineering protection, led in certain cases to significant flooding of the territory. Especially the situation was aggravated during the periods of intensive rains.

2. Ground water level on the existing marks as lowering of the level of ground waters could lead to the consolidation of the lemon oozes and soft silty clays, lying in the basis of the most part of the territory, and, as the result, to deformations and possible destructions of the built buildings and constructions, was stabilized. Dumping in the bottom of engineering protection of some quarters with, marl of calcareous crushed stone unstable to water influence, was the second reason of stabilization of ground water level.

3. Laying of the stormwater drainage system and construction of a new drainage system was carried out (the horizontal closed tubular drainage with filter sprinkling, the beam

horizontal drainage locally and also mountain channels, turnpike drainage collectors, pump stations and treatment facilities).

4. The coastal zone for was strengthened in order to decrease of negative impact of abrasion processes was strengthened.

When constructing the facilities of the Olympic complex on Imeretinskaya Valley, the specialists of Krasnodartransstroy LLC carried out the experimental dumping of local carbonaceous material (limestone, lime marl and their transitional differences from the Kamensk pit which is in 20 km) because of the shortage of volumes of the embankment of engineering protection.

The complete alternation of laying of the carbonaceous soil consisted in subdivision of large blocks of marl and limy to fraction the 70-120th, 40-70th and 20-40th on career, loading and transportation them to the territory of Imeretinskaya Valley, with the subsequent dumping, planning and a layer-by-layer rolling. The greatest steepness of slopes of the 3-meter embankment made up 1:1-1.5 [17].

Crushed stone and gruss from lime marl with strength indicators of 40-60 MPas, which fall into the categories of low-strong, generally entered for dumping of the layer of engineering protection. Their colour was light grey, to yellowy-brown, volume weight φ _ 0=2.54-2.57 t/m3, the content of (CaCO3) is from 80.8 to 82.4%. When soaking by water marls break up to pieces on microcracks, turning into the crushed stone, which is very unstable to destruction as the result of further soaking.

For carrying out monitoring of the consolidation of soils of the basis and engineering protection on the pilot sites of quarters E, 36, 10, 11, 13, partially C, N and quarter 9, laying of eight experienced and experimental sites (everyone had the area of 50x50 m^2), various processing methods and ways with application for studying of strength indicators of constructive layers from carbonaceous soils of engineering protection in time were carried out.

Three options of dumping of carbonaceous material were applied (Figure 2):

1) dumping of the site with carbonaceous mix completely on the quarters E, 36, 19, mix 70-120 mm with wedging the large fractions to smaller particles (20-40 mm). The "zone" of interpenetration (basis soils and carbonaceous mix) is about 0.3 m;

2) dumping of the area with carbonaceous mix completely on the quarters C, N, 11.13, mix 40-70 mm with wedging the large fractions to smaller particles (10-20 mm). The "zone" of the interpenetration is about 0.4 m (Figure 3);

3) dumping on the pilot square of the bottom of 1.2 m with carbonaceous mix on the quarter 9, mix 40-70 mm with wedging the large fractions to smaller particles (10-20 mm) and overlapping the soil of dumping. The "lower zone" of the interpenetration is about 0.4 m. The overlying soil of dumping is 0.1 m.

On other quarters dumping was carried out. Some innovative methods were applied for the acceleration of the process of consolidation of weak soils of the basis and engineering protection [19-20].

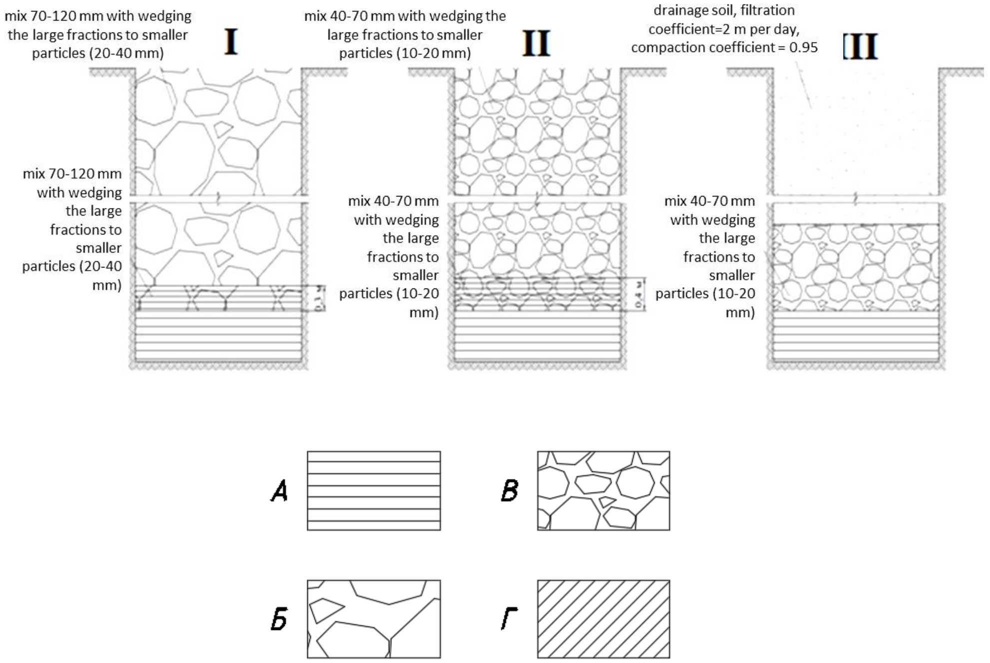

Fig. 2. Three options (I-III) of dumping of carbonaceous material on the pilot sites:
A) the weak spreading soils (peat, oozes, loams);
B) fraction of 70x120 mm of lime marl with wedging the large fractions of 20x40 mm;
C) fraction of 40x70 mm of lime marl with wedging the large fractions of 10x20 mm; D) the sand-gravel mix, delivered from Abkhazia by sea

Fig. 3. Dumping of marl-and-limy soil on the pilot site H (the northern part of the quarter). The thickness of the layer of dumping is from 0.5 to 1.6 m

The cementing ability of limestones is known for long. It is to a greater or lesser extent shown during the arrangement of soil embankments of different purposes. Weak limestones, having the high cementing ability, after consolidation form monolithic layers in the embankment body. However, the cementing ability of carbonates is insufficiently studied and is not considered in construction, since the durability of the stone skeleton from few strong limestones considerably decreases even in case of small humidification.

When dumping a layer, its rolling and filling the space between the grains of a layer with more fine-grained material, allows to obtain the considerable consolidation; the subsequent ongoing efforts are distributed already between a large number of grains and, eventually (on a limit) - on all the surface of grains, transferring them to a stressed state of comprehensive compression, at which specific pressure will be much less, than on platforms of contacts of the blank framework, and the work with stone material in the layer is considerably facilitated (Figure 4) [3].

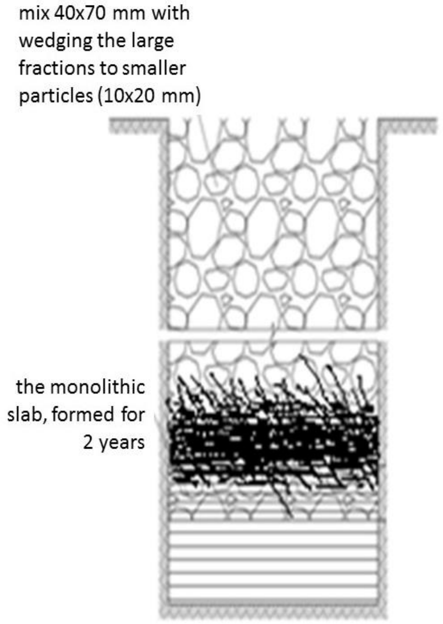

Fig. 4. Formation of the monolithic layer in the basis of the carbonaceous embankment of the quarter N after 2 years from the moment of the formation of the embankment. The thickness of the consolidated layer is about 0.3 m.

3. Results

After dumping of the layer of its rolling and consolidation there is a change of a causticity of the environment; that causes a recrystallization of limy particles and gradual change of coupling of cementation type. As a result, the allocated secondary calcite begins to form strong crystallization communications between the grains. There is a process of recrystallization of limestone and formation of communications from crystals of secondary calcite between particles. It leads to the aggregation of small particles of calcareous material, and there are porosities in it and free particles from couplings and units in such quantity that their micro movement are not summarized and do not cause micro cracks during contraction or change of temperatures, as they are distributed throughout all the volume of material [3].

Under the influence of the static load from the built construction or dynamic load from traffic, there is crushing and consolidation of stone material in the poured-out crushed-stone layer; that leads to the decrease of contact conditions until these efforts do not decrease to the limit, corresponding to the durability of material and will not cause permanent deformations (Figure 5). However, the effectiveness of the use of low-strong limestone as material of engineering protection it is possible only in case of its reliable isolation from moisture penetration. Otherwise, under the influence of water there is a destruction of large fractions into smaller, the increase in the area of interaction with water and the complete transition of breed to clay (mealy) mass. At the same time, because of the increase in strength indicators of the constructive layer of the basis of the embankment from carbonaceous material, the need for consumption of crushed stone for the additional layer of the basis decreases almost twice. In this regard, it can be received up to 30% of economy of crushed stone and up to 25% of depreciation of road clothes at a term of the use low-strength limestones stacked in the basis of embankments.

However, along with the matters of profitability of construction, it is also necessary to consider the quality of the received constructive layers, the reliability of their work in the basis of engineering protection, taking into account the lack of humidification and the of growth of static and dynamic loads.

Fig. 5. The smooth sedimentation (to 0.9 m) of the roadbed as the result of residual consolidation of soils of the basis and carbonaceous soils of the embankment is visible essential

4. Conclusions

1. The measures of engineering protection of Imeretinskaya Valley weare held. Unique Olympic facilities of the coastal cluster were built. The Olympic Games of 2014 came to the end successfully . Unfortunately, the complex monitoring of the environment of Imeretinsky Valley for initiation of any efficient measures for the prevention of negative processes have not been organized.

2. On some sites the values of the angle of internal friction decrease considerably and there is a change of crystallization communications with the connectivity of the water and colloid nature because of failures in the work of the drainage system. The influence of vibration and especially of low-frequency pulsation loadings leads to the colliquation of soil. It is enough to give examples of decompaction of soils of the roadbed in various points of the Imeretinskaya Valley. And that is only about the road network. Owing to "closeness" of some objects there is no possibility of overseeing of other engineering structures of the coastal cluster (Fig. 5).

3. The carried-out dumping, made in 2009-2011 of mix of carbonaceous breeds on the sites of some quarters of Imeretinsky Valley, proved that eventually they increased their durability at the expense of self-cementation forces, and the friable calcareous material

during the use in the basis of the embankment of engineering protection turns into the monolithic plate with the considerable distributing ability.

4. The increase in the durability of soils of dumping due to the formation of the monolithic plate in the embankment basis from carbonaceous rocks, can be used when carrying out the engineering protection in similar engineering-and-geological condition.

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