DESIGN-BUILDING THE BALLAST SECTION AND SUBGRADE

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ABSTRACT: In the article analyzing the work of the ballast prism and the groundbed, two-layer geotextile reinforcement is proposed based on the analysis. A formula is presented for calculating the slope of the recess slopes during high-speed train traffic, taking into account the seismic impact. We recommend an empirical formula for determining the slope laying. The main advantages of reinforcement are defined.

KEYWORDS: Adbed, Track superstructure, Sleepers, Fill, Recesses, Geotextile, High-speed train, Earthquake resistance.

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I. INTRODUCTION

For the Republic of Uzbekistan with rapidly developing high-speed train traffic and the possible impact of seismic forces on complex engineering structures such as Railways, it is necessary to ensure reliable operation of the road in this complex combination of loads. Research shows that the amplitude-frequency characteristics of high-speed trains are similar to low-intensity seismic impacts [1]. Therefore, it is logical that if the earthquake resistance of the structure is provided, then safe high-speed traffic will also be provided, the difference will be in the calculated seismicity of the structure.

II. RESULTS AND DISCUSSION

The ballast prism offers two-layer geotextile reinforcement-Fig. 1. In the research presented in the paper - [2], a two-layer crushed stone of various fractions is proposed to increase the contact area of the sleeper and crushed stone, increasing the resistance of sleepers to horizontal shear, reducing the stress concentration in the crushed stone.

The geotextile layer between these layers increases the area of force transfer to the lower layer, which is the roadbed, which ultimately reduces the compressible layer, that is, the vertical sediment of the roadbed will be less by 15-20%.

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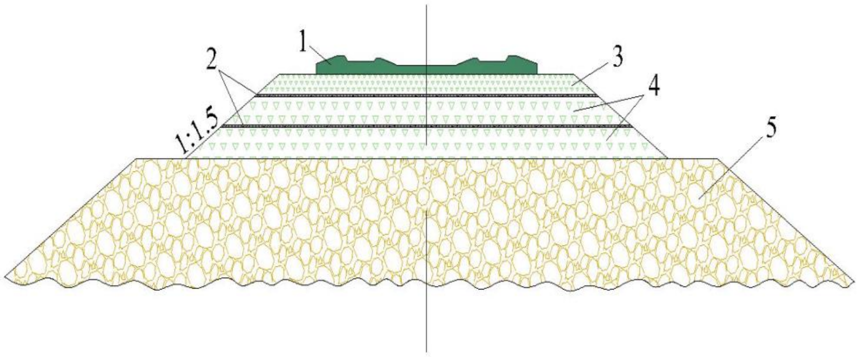

Fig. 1: Ballast Prism with Geotextile.

1-sleeper; 2-geotextile; 3-layer of fine rubble; 4-layer of large crushed stone; 5-roadbed.

Geotextile lining allows to extend the working life of the ballast prism due to a more uniform distribution of loads from trains, which reduces its fragmentation and the degree of contamination from dust ingress. All this justifies the additional costs of geotextile and more complex technology for the construction of a ballast prism, since the normal operation of the latter increases by 2-3 times, which will allow the road to get a significant economic effect during operation.

A ballast prism (Fig. 1) with slopes of 1:1.5 reduces the stress in the ballast prism, its stability to the action of horizontal forces that occur on curved sections increases, and the consumption of crushed stone increases by only 3-5%.

By increasing the slope of the slope of the ballast prism, the stability of the ballast prism to the action of vibration loads from high-speed train traffic and possible earthquakes increases.

When external vibration impacts on the ballast prism, the most vulnerable node is the slopes from which its destruction begins, and geotextile reinforcement ensures its stability, which positively affects the stable operation of the entire structure. Edge stresses arising in the cantilever part of the ballast prism, where the slopes are located, are significantly reduced by the geotextile gasket.

The roadbed that passes through the recess must be compacted to a depth of 2m to a standard seal, and reinforced with geotextile at a depth of 0.3 m. This ensures stable operation of the upper structure of the track, reduces vibration effects on the slopes of the recess and partially protects them from collapse.

The technology of production of earthworks should guarantee not only high compaction of the soil, but also uniform both in the length of the structure and in its height. Insufficient and uneven compaction of the soil is dangerous. The greatest damage is caused by alluvial earth structures, including the roadbed, which is primarily due to the low degree of soil moisture. [6,7,8, 9].

The upper layer of the roadbed in the recess must be compacted with a compaction coefficient equal to K_y = 1,01, the lower layer under the geotextile layer must be compacted to K_y = 1,0. According to the wave theory of academician of the Academy of Sciences of the UzSSR Rakhmatulin, the highly dense prism of the ground of the roadbed leads to mutual damping of longitudinal and transverse waves [5].

In a compacted ground environment, the wave length increases and the wave amplitude decreases, which creates favorable conditions for the operation of the entire structure during high-speed train traffic and possible seismic effects [4].

The steepness of the slopes of the recess during high-speed train traffic, and taking into account the possible seismic impact, it is recommended to calculate using the formula obtained experimentally:

$$m_{\text{ск}} = m_0 + \frac{0{,}6\ \varphi_d\ K_c\ K_1}{L + m_0 h} \quad (1)$$

L – the length of the ground core – Fig. 2;

- for sandy soils: L = 2,2h;

- for clay soils: L =3,2h;

h – recess depth;

K_c – the estimated coefficient of seismicity;

K_1 – calculated coefficient that takes into account the allowed damage to railways (K_1=0,25) – SNiP;

m_0 – the coefficient of laying the slope of the excavation of the roadbed without taking into account the seismicity of the area and high-speed train traffic (in clay and gravelly soils m_0=1,5, when the soil is sandy m_0=1,75).

The calculated coefficient of seismicity is determined based on the initial seismicity determined from the map of seismic zoning along the route of the projected railway with refinements depending on the slope, the water table, the height of the embankment of the roadbed and the depth of the excavation, which is given in [3]. To account for high-speed train traffic that creates similar fluctuations of weak earthquake intensity of 6-7 points [2], the calculated seismic coefficient is taken at low embankments of the earthbed K_c=0,0125 at high K_c=0,05.

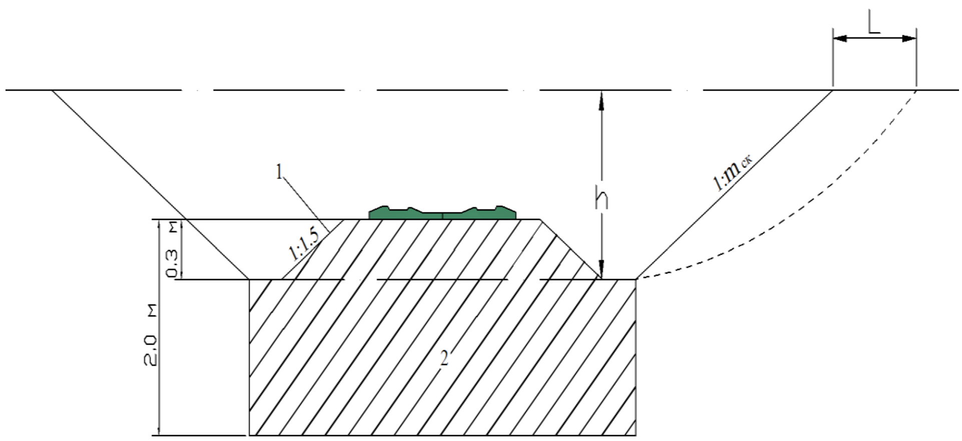

Fig. 2: Construction of the Excavation of the Roadbed with Geotextile Reinforcement-1 and Compacted Base -2.

φ_d – the dynamic coefficient of soil characteristics of the roadbed taking into account geotextile reinforcement is equal to:

a) clay φ_d =10;
b) loams φ_d =17;
v) gravel, crushed stone φ_d =30;
g) large sand φ_d =40;
d) medium sand φ_d =50.

For the embankment of the roadbed, taking into account the reinforcement of the soil of the accepted density with the possible impact of seismic forces and high-speed train traffic, we recommend an empirical formula for determining the slope laying – m_{ca};

$$m_{ca} = m_0 + \frac{K_c\varphi_d}{B_0+2m_0H} \quad (2)$$

B_0 – width of the main platform of the roadbed.

K_c, m_0, φ_d – notation from formula (1).

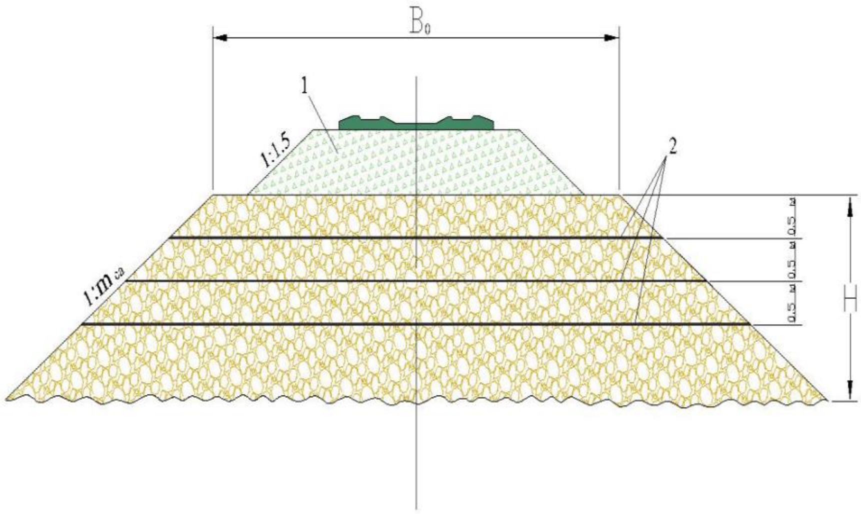

Fig. 3: The Roadbed in the Embankment with Geotextile Reinforcement of the Soil.
1-reinforced ballast prism; 2-geotextile layer;
H – height of the embankment of the roadbed.

Reinforcement of the soil of the roadbed is the most effective structural measure to ensure its seismic resistance, as it allows the soil to resist the tensile stresses that occur during earthquakes. Rebar in the ground can serve as materials that have sufficient tensile strength and have the necessary value of the coefficient of friction with the ground at its different humidity. A prerequisite for rebar is resistance to corrosion and a certain elasticity of the rebar (in this case, the material can be metal, wood, plastics and synthetic waste [10].

In order to create a steep slope and to avoid soil precipitation from the layers between the rebar, the slope is lined. The most acceptable solution to the design of the lining, as shown by experiments, is a concrete lining with approximate dimensions adopted in hydraulic engineering construction. [11].

Reinforcing the ground of the roadbed provides an increase in the time between repairs of the track maintenance. The impact load of rolling stock on culverts is reduced, which reduces the soil layer above the culvert or viaduct by 0.5 m.

Soil reinforcement in transport construction is becoming more widespread, which is due to a number of advantages of armogrunt structures – their ability to perceive significant tensile forces, which determines less sensitivity to uneven precipitation of the base, increased resistance to seismic impacts, due to greater flexibility and better adaptation in the ground environment compared to traditional ones. [12].

The slopes of embankments and excavations of subgrade newly constructed roads, it is necessary to strengthen water-soluble polymers that enhance soil, especially sand, which allows the rapid emergence of vegetation, and it will beautify the overall appearance of the road and contributes to the development of tourism in the country [13].

III. CONCLUSION

The volume of earthworks, when reinforcing the soil, is reduced by increasing the steepness of the embankment slopes and recesses, that is, the right-of-way for the railway is reduced, and this meets modern environmental requirements.

Reinforcement of the ballast prism and the roadbed reduces the roughness of the track, which creates favorable conditions for the movement of the train and the safety of the track.

Metal, geotextile, reinforced concrete, etc., as well as their combinations are used as reinforcing materials. Recently, geotextile materials are increasingly used, the General list of which includes almost 200 items made from oil (polyamides, polyesters, polypropylene), wood pulp (viscose, acetate) and made in the form of woven, non-woven and mesh panels.

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