CALCULATION OF THE RESERVE COEFFICIENT OF LOCAL STABILITY OF THE SLOPES OF THE ROADBED REINFORCED WITH A VOLUMETRIC GEOGRID

Lesov Kuvandik Saginovich*; Tadjibayev Sherzod Amirkulovich**

*Tashkent State University of Transport,
Tashkent, UZBEKISTAN

**Tashkent State University of Transport,
Tashkent, UZBEKISTAN
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ABSTRACT

The article gives a calculated estimate of the slope of the embankment of the railway roadbed reinforced with a three-dimensional geogrid. Calculations are made to determine the coefficient of the reserve of local stability of the slopes of the roadbed when laying a volumetric geogrid on geosynthetic material.

KEYWORDS: *Calculation, The Slope, The Stock Of Local Stability, Three-Dimensional Geocell, Roadbed*

INTRODUCTION

In the modern conditions of construction and operation of railways in Uzbekistan, the introduction of resource-saving structures in earthworks projects is becoming increasingly relevant. The choice of design is an urgent and complex task in the complex construction of communication routes, in which at each stage of design and especially in the production of works, the engineering-geological and climatic characteristics continuously change. The methodology for solving this problem is based on constant monitoring of the characteristics in order to determine their joint impact on the resulting indicators **[1-3].**

The situation is complicated by the fact that a significant part of the roads under construction are located in areas with difficult climatic and geological conditions, including in places where sand dunes, saline soils, and weak foundations are distributed.

When designing and building embankments on sand dunes, it is necessary to solve problems related to their insufficient load-bearing capacity, the possibility of large sediments that flow for a long time.

The strategic objectives of the development of JSC "Uzbekiston Temir yollari" at the present stage are to increase the capacity and carrying capacity of railway lines, the development of high-speed and high-speed passenger services. The solution of these problems requires the strengthening of the existing roadbed of railway.

The main tasks of strengthening the existing roadbed are:

- estimated slope estimation of railway embankment embankment with reinforced geogrid;

- Calculation of the coefficient of local stability reserve (*Kres*) of the soil filled in the geogrid.

Basic calculation methods and their application conditions

Spatial (volumetric) geogrid or geocell material (hereinafter referred to as geogrid): geosynthetic material of a spatial "honeycomb" or similar cellular structure according to Figure 1, which is formed from interconnected geofields, produced in the form of a folding module and delivered in the form of packages in the folded state (international designation – in accordance with ISO 10318 – GCE, designation in accordance with ODM 218.5.005-2010 – GST) **[5].**

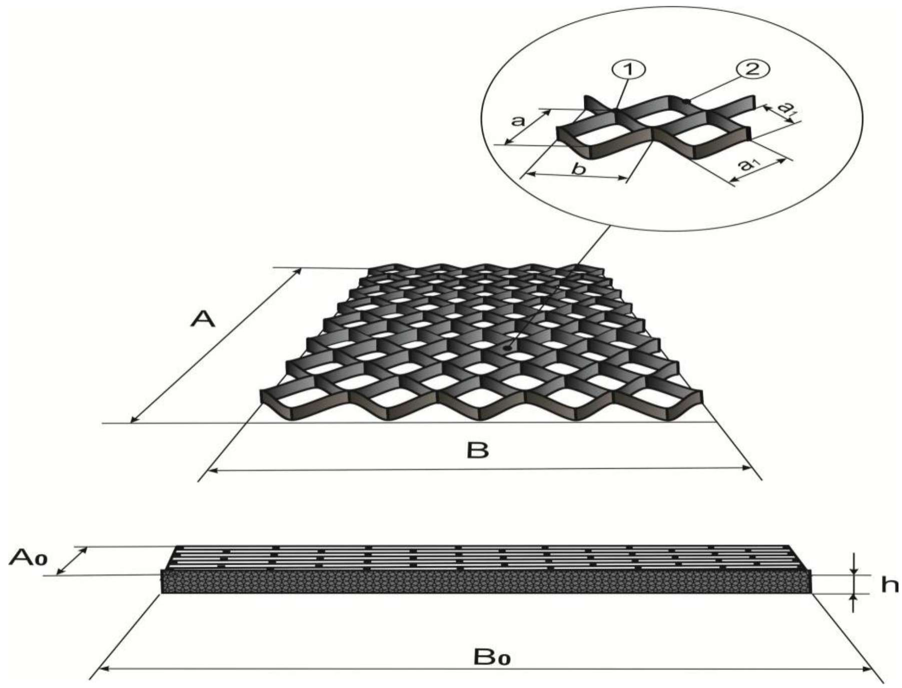

Figure 1. General scheme of geogrids in working (stretched) condition (a) and transport (folded) state (b)

1 – welded seams; 2 – geopolicy; and the length and width of the module (A – direction tensile); A_0 and B_0 is the length and width of the package; a and b are the size of a cell diagonally in the direction of length and width; a_1 is the width of the cell; h – height of the geogrid (width geopolicy)

The slopes of the railway trackbed are one of the most vulnerable elements in the event of water and wind impacts. In the general structure of methods for improving the operational reliability and durability of roads of all categories, the primary importance should be given to methods for ensuring the stability of the slopes of the roadbed **[2].**

As practice shows, as well as the studies carried out confirm that in cases where the issues of choosing the type and ensuring the stability of anti-deflationary and anti-deformation (ADAD) strengthening of slopes are not given due importance, deformations occur within the entire roadbed (roadsides, main site, slopes), as well as beyond it (drainage ditches), the elimination of which requires significant costs. At the same time, the choice of the type, assessment and ensuring the stability of the (ADAD) for strengthening the slopes of the roadbed is relevant and requires an integrated approach.**[2]**

Currently, there are the following types of ensuring the stability of the slopes of the earth bed of railways **[4]:**

- regulation of surface runoff and protection of the roadbed from its harmful effects;
- lowering or interception of groundwater;
- heat protection devices and coatings;
- supporting structures;
- soil reclamation.

Modern world experience shows that in recent years, when strengthening the slopes of the earth bed of railways in foreign countries geosynthetic materials are widely used. One of these materials is a three-dimensional geogrid.

It is known that there are several methods for calculating the stability of the roadbed of railways. These methods are calculated under different conditions, i.e., when calculating stability in free slopes(slopes), seismic areas, and the influence of water in the ground.

The coefficient of local stability reserve *(Kres)* of the soil filled into the geogrid is determined by the following formula:

$$K_{res} = \frac{\Sigma T_{hol}}{\Sigma T_{weight}} > 1,25$$

where ΣT_{hol} - is the sum of the forces holding the structure of the reinforcement on the slope in the calculation of the required number of modules for the height of the slope and one module of the geogrid for the length of the roadbed.

ΣT_{weight}-the shear force from the weight of the reinforcement structure based on the required number of modules for the height of the slope and one module of the geogrid for the length of the roadbed.

In order to strengthen the earth bed of the railway on sandy soils, experimental studies were conducted on the Bukhara – Misken railway section using geosynthetic materials. The geometric dimensions of the roadbed and the characteristics of the soil are taken from engineering and geological reports JSC "BOSHTRANSLOYIHA" the removal of an "Existing railway station, Tunguluk -Burgutli-Miskin with the flood zone Shurbulak reservoir":

- embankment height $H_e = 5.0$ *m;*
- width of the main platform $B_{mp} = 7.6$ *m;*
- laying of the slope *m=2*
- slope laying angle $\beta_0 = 27°$
- fine dune sand of medium density
- volumetric weight of the soil γ_e = 15,9 кN/м^3;

- the adhesion of soil C_e = 2кPa;
- angle of internal friction of soil $\varphi = 28^o$.

Characteristics of the filler:

- volumetric weight of the soil γ_f = 15,9 кN/м^3;
- the adhesion of soil C_f = 2кPa;
- angle of internal friction of soil $\varphi = 28^o$.

Characteristics of a three-dimensional geogrid ARMACELL:

- length of a module A - 5400 mm
- module width, B - 3137 mm
- module height, h=100 mm
- joint strength R_s=8 kN/m.

The calculation sequence:

We accept a geogrid with a height of h=100 mm. Then, taking into account the excess thickness of the aggregate over the geogrid, h'=h+30=130 mm

The required number of grid modules for the height of the reinforced slope is determined by the following formula:

$$N=\frac{L}{A}=\frac{11.2\cdot 1000}{5400}=2.07 \text{ pc.}$$

The minimum number of mounting anchors on the upper and lower faces of the module, provided that the anchor is installed in the end cell, is

$$n_{nod\,1}^{anc\,h}=\frac{2\cdot B}{a}=\frac{2\cdot 3137}{200} = 32 \text{ pc.}$$

on the side faces of the module, provided that the anchor is installed through the cell

$$n_{nod\,2}^{anc\,h}=\frac{A}{2\cdot a}=\frac{5400}{2\cdot 200}=14 \text{ pc.}$$

taking into account the device of the adjacent module, inside the module with a step between the anchors of 0.8 m

$$n_{nod\,3}^{anc\,h}= \frac{A\cdot B}{80^2}=\frac{5400\cdot 3137}{800^2}=26 \text{ pc.}$$

The total required number of mounting anchors per module is

$$n_{nod}^{anc\,h}=n_{nod\,1}^{anc\,h}+n_{nod\,2}^{anc\,h}+n_{nod\,3}^{anc\,h}=32+14+26=72 \text{ pc.}$$

The value of the shear force from the weight of the structure of the reinforced slope is determined by the following formula:

$$T_{weight}=N\cdot n_{cell}\cdot a^2\cdot h'\cdot \gamma_f \cdot sin\beta_0$$

$$T_{weight}=\frac{2{,}07\cdot 300\cdot 200^2\cdot 130}{1000^2}\cdot 15{,}9\cdot sin27°=2.3\ t/m=23кN/m$$

We determine the holding force created by the forces of friction and adhesion on the sliding surface. By $\varphi_{rb} = \varphi_f = 28^o$ we accept $tg\varphi' = tg\ \varphi_f = tg28^o$

By $C_{rb} = C_f = 0{,}2\ t/m^2$ we accept $C' = C = 0{,}2 t/m^2$

When laying a geogrid on a geosynthetic material, the reduced values of the strength parameters for the sliding surface are taken according to the formulas:

$tg\varphi'' = 0{,}6 \cdot tg\varphi' = 0{,}6 \cdot tg28$

$C'' = 0{,}1 \cdot C' = 0{,}1 \cdot 0{,}2 = 0{,}02$

Then:

$T_{fr} = N \cdot n_{cell} \cdot a \cdot b[\cdot h' \cdot \gamma_f \cdot \cos\beta_0 \cdot tg\varphi'' + C''] = 2.07 \cdot 300 \cdot \frac{200^2}{1000^2} \cdot [\frac{130}{1000} \cdot 1.59 \cdot \cos 27 \cdot 0.6 \cdot tg28 + 0.02] = 1.98\ m/м = 19{,}8$ кN/m

Additional resistance force that occurs in anchored nodes with a coefficient for damage during construction and the duration of the impact of loads $K_s = 4$;

$T_{nod}^{anc\,h} = N \cdot n_{nod}^{anc\,h} \cdot \cdot \frac{h \cdot R_s}{K_s} = 2.07 \cdot 72 \cdot \frac{10}{100} \cdot \frac{8}{4} = 29{,}8$кN/m

In the absence of a stop at the base of the roadbed, we determine the value of the passive pressure of the natural base:

$T_{bas} = \frac{\gamma_{bas} \cdot (h')2}{2} \cdot tg^2(45° + \frac{\varphi_{bas}}{2}) = \frac{1{,}59 \cdot (\frac{130}{1000})2}{2} \cdot tg^2(45° + \frac{28}{2}) = 0{,}372 m/м = 3{,}72 кN/m$

The total force holding the reinforcement structure on the slope:

$\Sigma T_{hol} = T_{fr} + T_{nod}^{anc\,h} + T_{bas} + T_{anch} = 19{,}8 + 29{,}8 + 3{,}72 = 53{,}32 кN/m$

The total shear force is:

$\Sigma T_{sh} = T_{weight} = 23 кН/м$

We determine the calculated coefficient of the local stability margin:

$K_{res}^{cal} = \frac{\Sigma T_{\text{hol}}}{\Sigma T_{sh}} = \frac{53{,}32}{23} = 2{,}31 > K_{res} = 1{,}25$

CONCLUSION

1. Volumetric geogrids are successfully used in the construction of railways in many countries of the world. They are mainly used to strengthen the slopes of embankments, recesses and cones of railway bridges. Protection of slopes and embankment slopes is a serious problem in railway construction.

2. The problem of ensuring the stability of the roadbed is especially important for lines where the introduction of high-speed and high-speed traffic is envisaged. In this problem, the main attention of domestic and foreign scientists is paid to improving the design for strengthening the slopes of the railway roadbed, ensuring its stability and stability.

3. Geogrids are designed for volumetric reinforcement of soil or aggregate material in order to form a composite layer "soil (material) plus geogrids", which has improved performance properties in relation to the aggregate.

4. The performed theoretical calculations show that the coefficient of local stability reserve *(Krez)* of the soil filled into the geogrid increases by 60-80 %. Based on this, it can be seen that the use of three-dimensional geogrids in strengthening the slopes and slopes of the embankment of the earthen bed of railways gives a decent effect.

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