

THE CAUSES OF LANDSLIDES ON THE ROAD PRISTINA-GJILAN NEAR THE VILLAGE OF MRAMOR¹

Naser Morina

PhD. civil eng. Professor T.H.S.” Mehmet Isai“ 60000 Gjilan; Republic of Kosovo
morina.n@hotmail.com : profnasermorina@gmail.com

ABSTRACT

In order to stabilize the landslide located on the state road N-25/2 near the town of Mramor (Badovce Lake) in the Republic of Kosovo, the following measures were taken: Based on the description of the geotechnical study, study of the area around, the place where the landslide occurred on the right side of the National Road N25.2 directions: Pristina-Gjilan.

Based on the geomechanical study and the study conducted in this study, it was concluded that we do not have negative physical geological phenomena and mass movements of soil or rock masses that threaten the stability of the road body, it was concluded that road damage is not a geological phenomenon.

Based on geotechnical tests in the field, we came to evident data, a program of field research where 6 (six) drilling studies were performed with a depth of 3.00 to 13.00 m.

During drilling, they encountered layers of weak physical and mechanical properties and the studied area has mostly hilly relief.

KEY WORDS: landslide, laboratory testing, Terzaghi method, drainage systems, retaining walls.

¹ review scientific paper

1. INTRODUCTION

This road connecting the capital of the Republic of Kosovo to Pristina for Gjilan is one very important part connecting Pristina - Gjilan and Belgrade-Skopje highway in the south of Serbia.

For a long time since the activation of this landslide since 1974 and the unsuccessful rebuilding of 1983, no one has dealt with this topic, and never one of the competent authorities was interested in paving every year asphalt to handle on both sides of the road as which is shown in Fig. 1, so the measurements of this landslide were made in November 2011.

The task through this topic gives a possible contribution to solve this problem of landslides in the best way, and not to endanger all those who use this important regional road. We also give a possible approximate solution because we also do not have important and accurate landslide analyzes, since no one has ever undertaken the task of the road depot or the Ministry of Infrastructure of the Republic of Kosovo, until 2016, when the works on the MI project from 2015 were conducted.

The aim of this topic of scientific work is to find a solution or raise the awareness of people and road authorities to deal with this problem in this important regional target, to see which cause is to slip on this section of the road, because the lives of many accomplices in the traffic use this road.

2. SLIDING SPEED

Landslide velocities are very different and they depend on the deformation characteristics of the material, morphology, slope of the landslide area, type of landslide, sensitivity of the material to disturbances, etc. Slipping, ie breakdown of the material does not occur immediately, so the speed and its development over time is a very important piece of information for assessing the probability of slipping and assessing the possible way and need for remediation. In addition, velocity and its development over time provide a significant feature for landslide classification [2].

According to Terzaghi (1950), the speed of sliding in the ground in its development goes through the following stages:

- crawling;
- before skating;
- slipping or breaking;

- stabilization.

These sliding phases are not applicable to rock massifs.

Crawling is the first sign of instability of the slope in plastic viscous material. The speed is very small at this stage (up to 3 cm / year) and unchanged, while the shear stresses are slightly less than the strength of the material, so the safety factor is slightly higher than 1. The creep lasts until the safety factor decreases.

Sometimes the crawling phase lasts for a very long time, even centuries, so that slipping never happens. It is considered that when the tangential stresses are not higher than the minimum residual strength, shear failure cannot occur. When the tangential stress required to maintain equilibrium exceeds the minimum residual strength, a breakdown can occur. As the deformations increase, a progressive breakdown occurs, in which the shear strength decreases successively to the minimum residual value (τ_r) at various places on the sliding surface. When this average value of resistance over the entire sliding surface falls to a size less than the ad required to maintain equilibrium, a final breakdown occurs at the most unfavorable surface. (Nonveiller, 1979, 1981) [2].

Stabilization occurs after large deformations in the fracture phase, and the stabilization time will depend on the morphology of the area. At this stage the fracture surface material is in the residual strength phase with a safety factor of about one.

To calculate the stability of the slope, it is necessary to study the properties of the material in the landslide. In a coherent soil, the relationship between deformation and slip strength is complex due to the change in volume in the shear zone with a change in stress, when the pore pressure also changes. With incoherent materials, the case is simpler, because the change in stress has little effect on the effective stresses. It is proposed to calculate the total stresses with strength $\tau_f = c_u$, $\phi = 0$, from fast non-consolidated soil.

3. REHABILITATION

Based on the geotechnical data we have the following results, and we came to the conclusion of the scanning method on the national road N25.2 (Location on Lake Badovc). [3]

- Placing piles on the left side of the road, starting with coordinates: P1, 7520220.71 4720662.86 and to perform with Pilot P41 coordinates: 7520285.71,

4720693.73 with length $L = 72.0\text{m}$ with diameter $\varnothing 100\text{cm}$ at each axial distance of 160cm. The number of pilots ranges from 6.0m to 12.0m [3].

- On the pile head we designed the dimensions: 100x80cm between which there will be a connection between the piles and once as a basis for placing a protective wall with a height of about $h = 170\text{cm}$ which is placed as an extension to the piles to help maintain the upper layers of the structure on the road [3].

4. METODOLOGY

4.1. Field Research works

In order to determine the detailed geological and geotechnical conditions in the area of the facility, in cooperation with the investor, the Ministry of infrastructure (MI), a detailed program was developed that was respected by "GEOKOS A & A". Field investigations were carried out at this site 1819/11/2015 [3].

The field research program carried out 6 (six) drilling studies with a depth of 3.00 to 13.00 m. In the station plan (Appendix 1, Figure 1A), ranking of the drilling study in relation to the station plan is shown.

Since the investor did not mark the drilling in the field, the work was done by Geokos A&A, based on the station plan presented.

The coordinates are shown in the KOSOVAREF project. Labels on drilling position surveys are given in Table 1. [3]

Table 1. Drilling coordinates - probes [3]

Drilling	Coordinate system KOSOVAREF			Groundwater level (m)
	X	Y	Z (relative)	
D - 1	7520241.19	4720635.91	669.31	
D - 2	520262.83	4720667.92	669.57	
D - 3	7520280.81	4720679.13	669.58	
D - 4	7520227.73	4720662.49	669.15	
D - 5	7520253.01	4720677.92	668.46	
D - 6	7520279.91	4720688.78	669.21	

Fig. 1 - Drilling details on site location [3]



Table 2. Notes - Main information on drilling studies [3]

Drilling marks	GW L (m)	Examine in Situ			Sample		
		Proof of SPT			KP SPT	KP	KPP
		pieces	depth	N(SPT)			
D - 1		3	3,00	20	1		3 samples in depth 2,50-3,00 m 5,50-6,00m 7,50-8,00m
			4,50	22	1		
			6,50	23	1		
D - 2		2	2,50	17	1		2 samples in depth 3,00-3,50 m 4,50-5,00m
			4,00	50	1		
D - 3							
D - 4		3	6,00	24	1		3 samples in depth 5,20-5,70 m 10,0-11,50m 12,00-12,40m
			8,00	22	1		
			11,	25	1		

			00				
D - 5		3	5,5 0	18	1		3 samples in depth 6,00-6,50 m 9,0-10,0m 12,00-12,40m
			8,0 0	23	1		
			10, 00	27	1		
D - 6							1 samples in depth 5,00-5,50 m

GWL = groundwater level; SPT = standard penetration test; KP SPT = broken campions, from SPT; KP = damaged campions; KPP = undamaged campions

4.2. Soil load resistance limit

Terzaghi's method (1955)

Terzaghi continues the same as Caquot, but adds some modifications that explain the actual characteristics combined with the action of the foundation.

Under a load transmitted from the ground to the ground, the earth tends to move away from the side, but is limited by the tangential forces that develop between the ground and the ground. Taking this into account, modifications are needed in the description of the state of the earth and the foundation Terzaghi assigns AB and EB sides of the Prandtl triangle, under the influence of the horizontal, which sets the value as a function of mechanical properties of the earth under the base. Thus, $2 = 0$ for the ground below the foundation are considered under the assumption that the fracture surface remains unchanged, the expression term for the limit load [3]:

$$q = A \cdot \gamma \cdot h + C \cdot \gamma \cdot b \quad (1)$$

where C is a coefficient that is a function of the ground friction angle below the base of the foundation and f is the angle defined above.

Following experimental notes, Terzaghi presents factors that depend on the basic form of the foundation.

Again, Terzaghi elaborates the original Prandtl hypothesis which considers behavioral soils to be rigid-plastic. Terzaghi set up this submission for very compact countries. In this case, the load / lowering (level) curve is initially linear,

followed by a curved segment. It is instantaneously broken and the limit load value is easily identified.

In non-compressed soil, however, the load / lowering relationship (level) is expressed as a curved line even at low levels more loaded along a progressive soil breakdown, and the identification of the limit load is not so clear. For very little compressed soil, Terzaghi in the previous formula introduces reduced values for soil mechanical properties such as [3]:

$$\tan\varphi_{rid} = \frac{2}{3} \cdot \tan\varphi_e \cdot c_{rid} = \frac{2}{3} \cdot c \quad (2)$$

Thus Terzaghi's formula takes the form:

$$q_{ult} = c \cdot N_c \cdot s_c + \gamma \cdot D \cdot N_q + 0,5 \cdot \gamma \cdot B \cdot N_Y \cdot s_Y \quad (3)$$

where:

$$N_q = \frac{a^2}{2 \cos^2(45 + \varphi/2)} \quad (4)$$

$$\alpha = e^{(0,75\pi - \varphi/2) \tan\varphi} \quad (5)$$

$$N_c = (N_q - 1) \cot\varphi \quad (6)$$

$$N_Y = \frac{\tan\varphi}{2} \left(\frac{K_{PY}}{\cos^2\varphi} - 1 \right) \quad (7)$$

4.3. Level during consolidation on foreinnere extension (in Edometer)

The calculation of the level of the consolidation limit allows the level of a one-dimensional limit, produced under the forced voltage from the application of the load in the conditions of lateral expansion. Although the assessment with this method should be considered empirical rather than theoretical. Although it is to use and control the influence of different parameters, this makes this method very widespread [3].

The discounting process is in two phases:

The calculation of the vertical tension promotes at different depths using the theory of elasticity. Choice of compression parameters using eco-metric test [3]. Concerning the evidence of restrictive consolidation discounts expressed:

$$\Delta H = H_0 \cdot RR \cdot \log \frac{\sigma'_{v0} + \Delta\sigma_v}{\sigma'_{v0}} \quad (8)$$

If the terrain is very solid ($OCR > 1$), increasing the voltage during the load increase does not cause the consolidation pressure to exceed σ_p ($\sigma'_{v0} + \Delta\sigma_v < \sigma_p$). Or, if the terrain is in normal consolidation conditions, ($\sigma'_{v0} = \sigma_p$) the deformations achieved in the Interval fall under compression calculated as [3]:

$$\Delta H = H_0 \cdot CR \cdot \log \frac{\sigma'_{v0} + \Delta\sigma_v}{\sigma'_{v0}} \quad (9)$$

where:

RR – Primary core pressure

CR – Secondary flow pressure

H_0 – Height of the intel layer

σ'_{v0} – Vertical tension before applying force

$\Delta\sigma_v$ – Increase of vertical stresses during the application of force

As an alternative to RR and CR parameters, we can refer to the constraint consolidation module, but in this case it will be necessary to use estimates in the choice of values taking into account the voltage range ($\sigma'_{v0} + \Delta\sigma_v$) important for the problem [3].

Correct application of this requirement:

Dividing the compression coefficients into smaller ones (max. 2.00m);

Consolidation module calculation for each layer;

Calculation of reduction as the amount of contribution for each division.

Most use these formulas to calculate the reductions in both cases on clay and sand for fine and medium grains, because the modulus of elasticity is derived directly from the evidence of consolidation. However, for larger grain sizes, limiting consolidation is not very important for the global behavior of the layers, and for sands it is recommended to use a static or dynamic penetrometer [3].



Fig. 2 Skating slot on the regional road Pristina - Gjilan [4]



Fig. 3 Slip position R = 1: 4000 [5]

5. CONCLUSION

Stabilization of the existing slip or prevention of potential slip is done by reducing the forces that drive it or by increasing the resistance forces. All remediation measures must contain at least one of these components, and sometimes both.

When repairing landslides, drainage is considered the main method, and very often a modification of the slope geometry is used. Their wide application is also

frequent, because they are cheaper methods compared to the methods from the other two groups, and they are also almost always used in combination with them. For example, if the main method of building a load-bearing structure, it is necessary to complete it with drainage and slope modification.

It is worth mentioning that human inadequate treatment of this area has led to systematic degradation of the terrain (cutting of trees, not removal of surface water), so that landslides have been activated. Sliding is more dangerous, especially when there is heavy precipitation, so the level of the lake rises and approaches the height of the surface on which the landslide is.

The success of landslide remediation or landslide remediation can be discussed only after the application of the monitoring system, ie geodetic measurement of the movement of stabilized points on the profiles in a period of at least two hydrological years.

REFERENCE

1. Marković, P.: Istarživanje i sanacija kilizišta, drugi simpozijum, D. Milanovac june (1995) page 259-260
2. Noviller, E.: Kliženje i stabilizacija kosina , Zagreb (1984)
3. TheresultsoftheresearchtakenfromtheprojectoftheMinistryofInfrastructure ofthe Republic of Kosova
4. Figure fromtheterrain
5. Figure andmapofiisohypse