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RELIABILITY OF THE RISK ANALYSIS IN MAKING DECISIONS ABOUT VARIANT SOLUTIONS ACCEPTABILITY OF THE PLANNED ROAD

Abstract:

Realization of the infrastructural structures is connected with the decisions based on hazard geotechnical insight occurrence and risk analysis in the planned road zone. Adopting new road route, the risk which correspond to the subject route is accepted and it requires appropriate technical solutions. In this work, in example of the new road has pointed on the quality risk analysis importance by making decision about proposed route acceptance of the new road.

Keywords: New road, geotechnical hazard, risk, decision

ПОУЗДАНОСТ АНАЛИЗЕ РИЗИКА У ДОНОШЕЊУ ОДЛУКА О ПРИХВАТЉИВОСТИ ВАРИЈАНТНИХ РЈЕШЕЊА ПЛАНИРАНЕ САОБРАЋАЈНИЦЕ

Сажетак:

Реализација инфраструктурних објеката повезана је са одлукама темељеним на сагледавању хазардних геотехничких појава и анализи ризика у зони планиране саобраћајнице. Усвајањем трасе нове саобраћајнице прихваћен је и ризик који припада предметној траси, што захтијева одговарајућа техничка рјешења. У раду је, на примјеру нове саобраћајнице, указано на важност квалитетне анализе ризика у доношењу одлуке о прихватљивости предложене трасе нове саобраћајнице.

Кључне ријечи: Нова саобраћајница, геотехнички хазард, ризик, одлука

1. INTRODUCTION

The road design process is excelled with high complex ion and multidisciplinary level. To define spatial position these structures which are “laying” on the ground, it is needed different kind parameter analysis, including risk analysis. The scope and kind of the previous analysis, depending of the road significance and desired service level will be different. The final result of all analysis and itself design process is the route, chosen so that with minimal environment disruption and minimal investments, acceptable solution can be provided [2:199-200]. The most important methodological step for appropriate risk management is risk assessment. Assessment and risk analysis is complex procedure which by indirect way describes all problem measure endangered environment and resulting repercussions. Risk analysis is the key phase in risk management and it provides basis for management risk system. In it needed data related for identified risks and realization of the set goals can be got. Risk analysis is very complicated procedure, in which many parameters and occurrences can be taking into consideration, analysis conducting always should perceive from costs aspect which it will produce. It is needed to do event generation on the project area, frequency determination, intensity and other properties potential catastrophic occurrences. Also, historical analysis data should be done and project area characteristics (seismic, geological, topographical, atmospheric) which may have influence on natural hazard probability in the future and consider probability and consequences of every hazard element on the environment, and do evaluation (low, middle, high). Probability and consequence for every hazard scenario should be considered for the subject risk [1]. Deficiency of quality assessment and risk analysis on the subject area of exploring in zone of planned road has become to the bad projected solutions and significantly price increase and prolongation of the works deadlines, which have been presented in this work.

2. DESCRIPTION OF THE SUBJECT ROUTE ROAD

In frame of this chapter the basic space and structural characteristic of the new projected highway E – 75 have been presented. The subject of analysis in this work is section Grdelica – Caričina Dolina. The highway route on this section is passing through two types of different topographical features: plains – highway route is on the South Morava river diluvium, hilly – with route in the cut or in the deep cut with the steep slopes of the left coast South Morava river. At the section beginning, the route comes in the Grdelica’s gorge and extends in parallel to the Niš – Skoplje railway, to the highway M-1 and regional road R-214. Because of the topographical and infrastructural limitations, route passes along the valley and crosses the South Morava river seven times by structures of the different lengths. In the zone of the Predejane settlement, the highway route is in the tunnel because hilly ground in that area [3:21-22]. One very important area characteristic of the highway E -75 is existing of the intense exodynamic processes which occur in the way of the surface decomposition, erosion and layering but also sliding and scattering. The process of the surface decomposition is present on the whole area and thickness of the decomposed parts depends primarily from the age and lithological structure of rock mass, then from external influence intensity. The process of the surface erosion and linear erosion are especially visible in Grdelica’s gorge. Relatively steep ground sides become to the uniform erosion transformation, to concentration atmospheric precipitate in waterfalls which destroy and taking away the ground. These waterfalls become torrent which thickness even goes up to the 20 m. The South Morava River has in total 2092 tributaries which genesis corresponds to the different hydrographical classes of the water roads family. Water spills were often in the past, especially in Grdelica’s gorge area and this area can be considered like a world water phenomenon. Ditches are common for Grdelica’s gorge area, where it has been registered them around 200. They are relatively fixed by dikes after catastrophic water spills. Sliding and dispersal process also is connected for the Grdelica’s gorge area and it mainly arises in case of a half-bounded loose material [3:35-36].

3. PROJECT APPROACH ANALYSIS

On the figure 1. it has been shown subject road location. From point A to the point B it has been constructed a road in the cut in length of around ca. 1300 m. Another part from point B to the point C in length of ca. 1000 m a tunnel has been constructed (a variant solution constructed).



Figure 1 *The subject road*

Realization of this variant solution is constructed through the phases. Based on previously collected data, designing has begun and afterwards and performing. Immediately after works completion it has come to the stability disruption of conditionally stable slope and landslide activation just in front of the tunnel (Figure 2). Formed landslide was threatening the highway route, performed slopes and support structures but also structures beyond expropriation on the slope.



Figure 2 *Formed landslide on the slope 2*

By project task is required that rehabilitation solution for land slide and slope stabilization should be performed in phases with two supporting structures from piles K1 and K2. During structure K1 performing, which has a role to protect directly highway hull, certain sliding body activities have been registered, and they have been interpreted by activating an even more unfavorable slip mechanism compared to the solution model. Considering that situation on the ground has been changed, beside almost designed supporting structures K1 and K2, another supporting structure was designed from pile K3 (Figure 3).

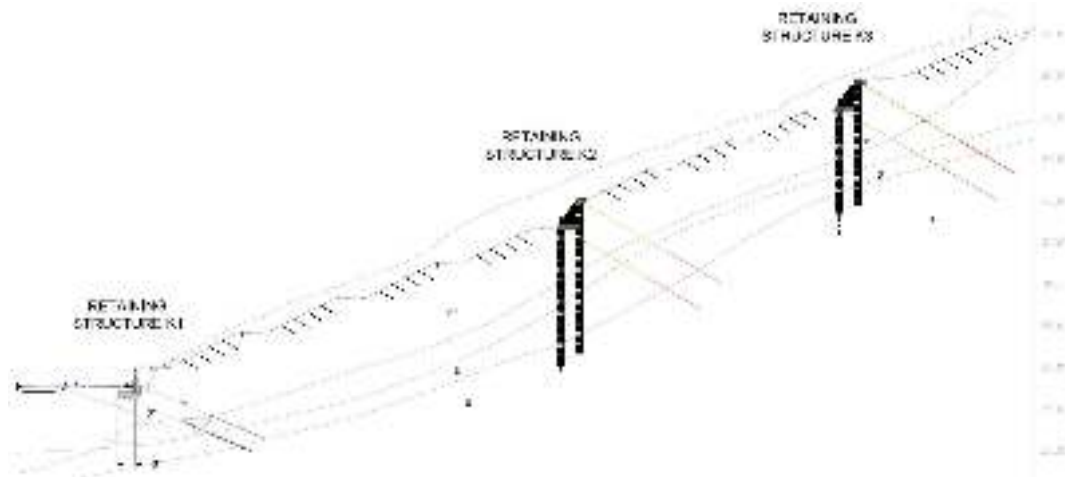


Figure 3 Retaining structure

In the meantime, additional geotechnical fieldwork, exploratory works and exploratory wells were carried out in which inclinometers and piezometers were installed, as well as an appropriate laboratory tests which were the basis for study which has served like one of the substrates to access the rehabilitation and stabilization process subject slope. Based on the results obtained geotechnical results, engineering-geological ground mapping and defined spread of the colluvial process on the slope, registered landslides elements (scars, jumps, belly, crack sand similar), it has been defined mechanism of the process which has served like basis for static analysis and slope stabilization problem solving.[4:1-2] Activities listed have caused prolongations of the completion deadlines and work price increase. Previous testing and exploring were not enough good analyzed hazard occurrence on subject location, and therefore the risk could not be analyzed, so it was not evaluated that sliding will occur. Parallel with work performing on the slope 2, the works on the slope 1 are performing also. It is about the same problem, so by original design solutions (supporting structure from micro piles with geotechnical anchors) it could not get the permanently solution. Unloading of the work and reinforcement of the slope with protective nets and anchors is carried out (Figure 4).



Figure 4 Formed landslide on the slope 1

If at the beginning there were complete information about geotechnical substrate, probably it would be considered other variant solutions. It is possible that design solution, in the goal of optimality, could require also the road route correction (by situation and by height). Probably and final defined solution would be optimal, but that done in the beginning phase, in the high measure would eliminate additional costs due to the work extension, deadlock in design, and finally, direct income loss from previous road commissioning [2:202-203]. By analyzing previous listed problems related for wrong assessment and risk analysis, a conclusion is imposed that all happenings could be avoided by tunnel tube prolongation from the point A to the point C (Figure 5).



Figure 5 Tunnel tube extension

Comparing two variants, there is conclusion that insufficient research and insufficient analysis, but also bad substrate preparation for designed documentation, inevitably leads to the performing works price increases and deadlines completion prolongation. Constructed tunnel is about one kilometer long (B-C). Constructed tunnel construction value along one meter was ca. 16 800 euros. Landslides rehabilitation construction value on the slope 2 is ca. 89 000 euros. Tunnel tube prolongation is about 1300 m. In the table 1 there were shown total structures lengths, also as performing time and costs. Listed data analysis gives the conclusion that the tunnel construction on the subject location would be more cost effective than slope rehabilitation, with less period of construction.

Table 1

	Road A-B/Slope 2	Tunnel part of the road
Construction beginning	2014./2017.	Assessment: ca. 2 years
Construction end	2020.	
Lenght (m)	1300 m/420 m	1300 m
Price (euros)	ca. 89 000 euros per m	ca. 16 800 euros per m

4. CONCLUSION

All listed problems in this work start on the bad risk analysis. Correct and good risk assessment for some hazard occurrence should show which problem we will potentially face with during designing and constructing. Based on the small cognition scope, on the concrete road example, the risk analysis was not correctly done what has caused multiple price increases of the project. There is always the question which scope of the geotechnical works is needed for good basis for design in all phases and how reliable that data is. Constructing of the geotechnical works (retaining structures and tunnels) is one of the most expensive and the most challenging activities in constructing. Time period and costs directly depend from geotechnical research works. Timely perceived geotechnical conditions can facilitate or, in opposite also to get worse constructing process. On time noticed and analyzed geotechnical conditions are base for quality design and successful and quality constructing. Reliability is defined like a safe work probability of the infrastructure system when the resistance of the system is grater or equal to the load. The reliability analysis thus set, does not consider time variability of the load and resistance, but observes the most unfavorable possible load, what in literature is called static reliability analysis. In cases when infrastructural systems have longer life span and they are susceptible to different natural processes, it is needed to follow the coincidence of load occurrence and possible resistance changes of the system during the time. Such examples are time-dependent reliability analysis. Geotechnical ground properties are of the particular importance for design, because in the high measure they have influence on the designed solution, feasibility and costs. Therefore, geotechnical researches and testing, also as observations present the base for design, constructing and structure maintenance. In many cases geological and geotechnical conditions can adjudicate for the variant (design) solution selection. This is especially related to an optimal corridor selection and new road route. On example of the highway route section, just in front of the tunnel, it is indicated on the importance of the quality risk analysis by making decisions about acceptability of the proposed new road route.

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