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Landslide risk management during rehabilitation of transportation infrastructure

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Summary

The extensive rehabilitation works of transportation infrastructure are required by the increase of the traffic intensity in respect to speed and safety issues. Moreover, important damages are developed as consequences of local instability or a landslide activity in the zone of interest.

Landslide risk is defined by the vulnerability of the zone of interest multiplied with the landslide probability. The risk elements are continuously modified by the economic development of that zone.

Previous landslide activity recorded in the area of interest can be useful in terms of assessing the movement level and the activity of the rock mass. Although landslide probability is not assessed by accurate mapping of Romanian territory, more important should be the assessment of the vulnerability in the zones of high landslide potential that currently exists to large extent in most parts of the country.

Maps of the landslide potential can enter larger details when projects of road rehabilitation are developed in areas where the risk elements have increased significantly over the last decade.

When developing projects of road rehabilitation involving the increase of the traffic lanes, the landslide risk is increased and thus mitigation measures are necessary to consider. There are active measures and passive measures, and strongly orientated to protect the risk elements against life threat and property loss.

Monitoring systems can be organized as part of the risk management in order to set up alarm levels when recording displacements or water levels that generate the idea of increased landslide potential.

The paper presents management issues for risk assessment and mitigation solutions to reduce the landslide risk during road rehabilitation works.

KEYWORDS: risk management, landslide, road rehabilitation, mitigation solutions

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1. INTRODUCTION

The cost-effective management of the natural disaster is a base concept for the long term development of all societies. Once the present problems related to landslides are defined as part of the natural disaster issue, new approaches and methods are needed that will simultaneously allow: the improvement of prognosis related to the place, time and characteristics of these natural phenomena, creating scenarios concerning the optimum strategies to adopt when such a disaster is triggered, as well as the adoption of post-disaster strategies in order to reduce the damages and re-install the normality within the community [1]. Elements that define such methods based on geo-sciences bring to attention a sum of experiences related to the field of landslide management with interventions on reducing the effects on society at large.

2. RISK ELEMENTS TO LANDSLIDES IN ROAD REHABILITATION

Various guidelines and research paper concluded that risk is general considered as a measure of the probability and vulnerability of an adverse effect to health, property or the environment. More accurately presented risk is defined as [2]:

- For life loss – the annual probability that the person most at risk will lose his/her life when considering the landslide hazard, the temporal and spatial probability and vulnerability of the person;
- For property loss – the annualized loss when considering the elements at risk, their temporal and spatial probability and vulnerability.

Elements at risk consist of the population, buildings and engineering works, social and economical activities, environmental features in the area potentially affected by the landslide hazard. As an example, the presence of a road in an area with a landslide hazard involves different elements at risk when compared to dwellings developed on a natural slope – figure 1 [3].

Once landslide risk has been analyzed and evaluated, the treatment component is naturally the following step to deal with the landslide event. In this respect, typical options would include:

- To accept the risk when risk is confined to acceptable domain;
- To avoid the risk when a new construction is in question in the potential area of a landslide risk, abandoning the project and looking for alternative construction sites where risk is acceptable;

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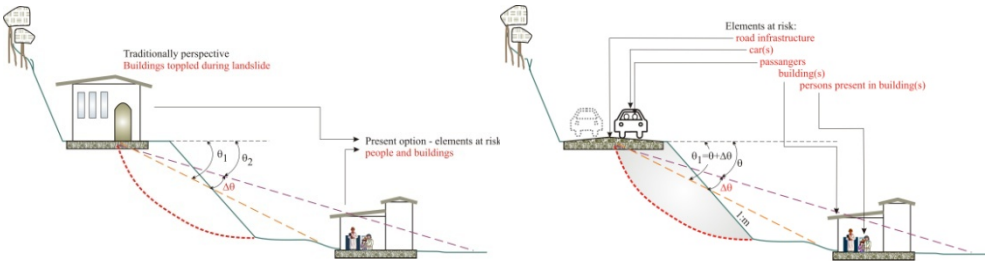

Figure 1. A different perspective of the landslide risk when various constructions change the nature of the elements at risk

- To reduce the likelihood that would require consolidation/stabilization measures to control triggering aspects; after implementation, the risk would fall within acceptable domain.
- To reduce consequences by setting defensive measures of stabilization.

3. CASE STUDY ON ROAD REHABILITATION

Rehabilitation design of roads relies on the site investigation results in order to accommodate both the pavement design with the re-assessed soil parameters and potential new retaining structures or bridges with the modified site conditions.

The rehabilitation design of the road sector on DN17 - 217+900km – 217+750km is part of the ECOLANES research project. The soil investigation performed on the site represented the first stage identification of the site conditions and is mainly referring to the existing soil characteristics under the present road structure. Disturbed and undisturbed soil samples have been removed, transported to the faculty laboratory of geotechnical engineering and subjected to laboratory tests to evaluate physical and mechanical soil parameters [4]. The concluded results of the investigation have been used in various design models proposed for the pavement design.

Economical and Sustainable Pavement Infrastructure for Surface Transport – ECOLANES is an FP6 STREP project with the aim of developing design and manufacture of new construction concepts for road infrastructure in order to meet the reduction of the construction cost and time by almost 15%,

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the energy consumption during construction by 40% and involve waste materials and minimize maintenance activities.

Roller compacted concrete – RCC involves as a construction material for rigid pavements steel fiber reinforced concrete that may alter the perspective of pavement design related to the joint interdistance between plates, the thicknesses of layers involved in the pavement structure and consequently meet the cost and time reductions aimed by the project.

One of the project stages refers to an experimental road sector performed according to the new design and technology established along the previous stages with RCC.

The sector is located in the North-Eastern part of Romania, on the National Road 17 between 217+900km – 217+750km (figure 2). The site conditions were investigated within the working group from the Technical University "Gheorghe Asachi", Faculty of Civil Engineering and Building Services, Iasi, Romania, assisted by the representatives from the Romanian National Road Authority.

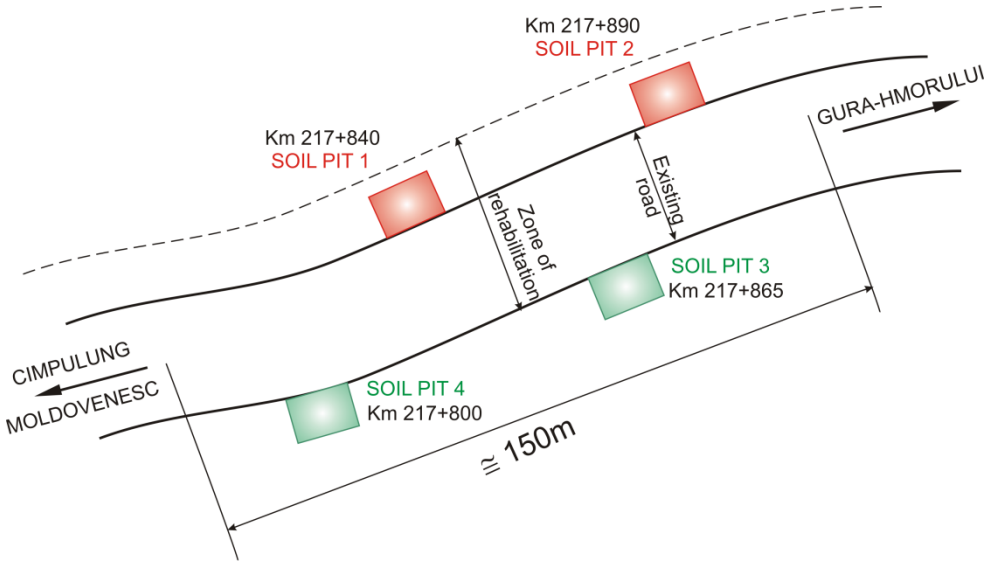

Figure 2. Road sector conditions investigated for the rehabilitation project

The investigation points were set to accommodate both sides of the road given the fact that transversally, the existing road suggests a mixed profile - Figure 3.

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The earth filling works have been performed at an inadequate compaction degree and thus, potential local landslides can be triggered under the road structure.

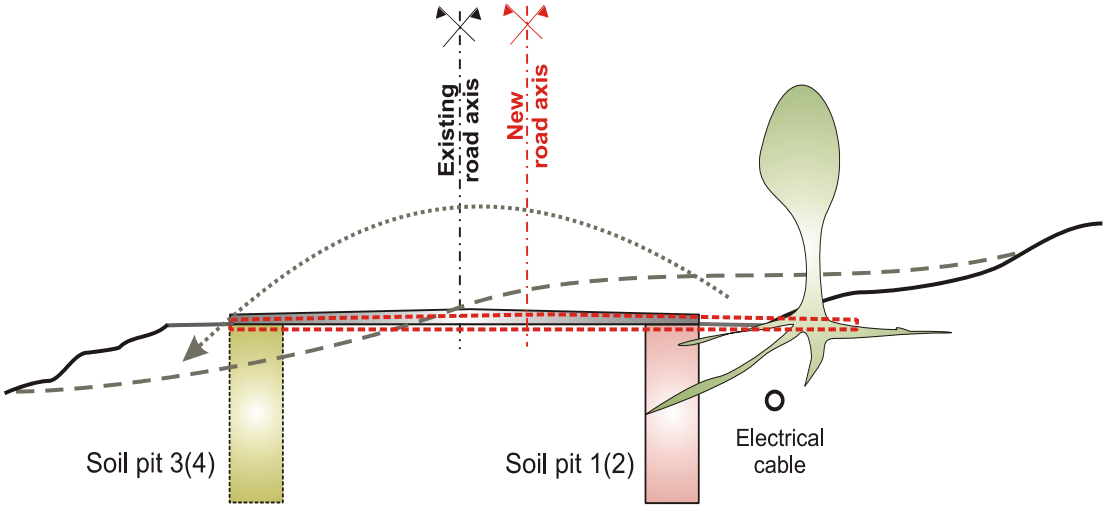

Figure 3. Cross section of the road sector in the initial site conditions

The road rehabilitation is intended to improve the traffic intensity and thus, a supplementary lane is added to the existing ones. The elements at risk are increased and the risk evaluation is modified by the change in the vulnerability for the new lane – Figure 4.

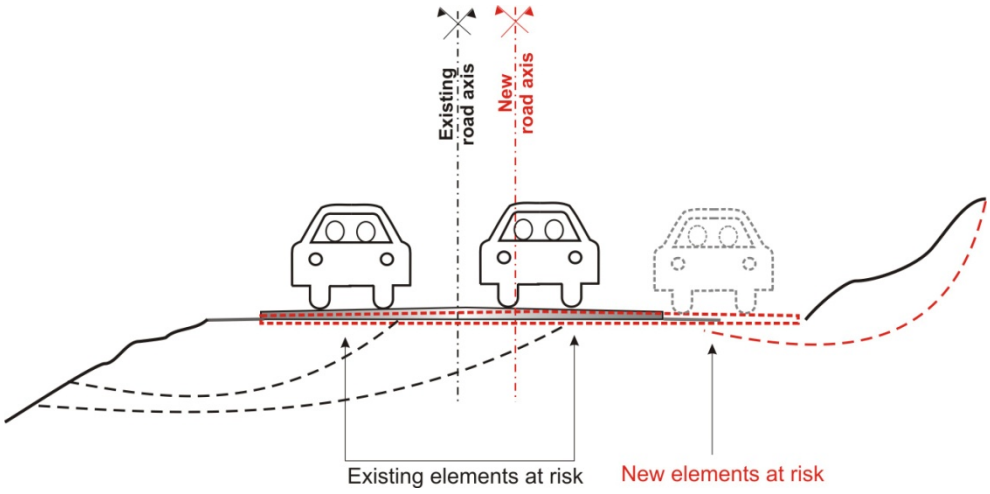

Figure 4. Risk evaluation based on different elements at risk after the road rehabilitation

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Although cross sections may induce a clear perspective of the affected area, the top view of the developed soil movement is more effective to assess vulnerabilities and risks involved – figure 5.

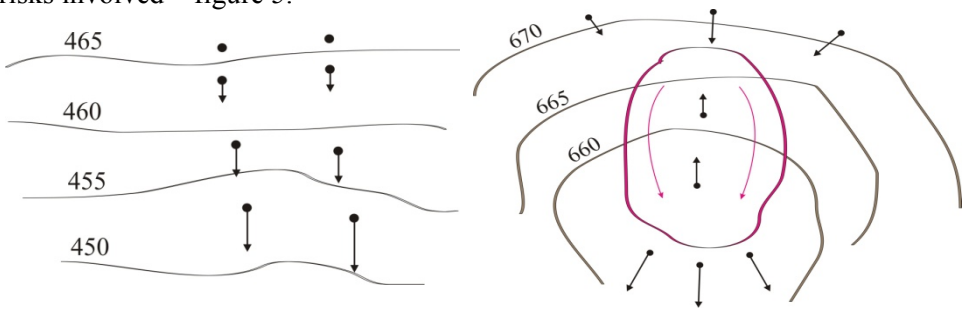

Figure 5. The assessment of the spatial development of the soil movement contributes to an accurate risk evaluation related to the road itself

The presented case is in a zone of low to medium landslide potential, but local landslides may occur up-hill the new constructed lane. Risk is non-existing for human loss but there is a risk as a property loss related to road structure and vehicles travelling in the area.

4. CONCLUSIONS

The national guides to create risk and hazard zoning related to landslides represent instruments that complete to a certain extent the necessary tools to implement the landslide control in Romania. Road rehabilitation projects increase the elements at risk. Mitigation measures to reduce the landsliding risk are considered based on the risk itself and thus, risk evaluation is very important and a national guide is the first necessary step in risk zoning.

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