TOPOGRAPHIC WORKS NECESSARY TO PREVENT LANDSLIDE ON FOREST ROADS

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***Abstract**: The forest road is a permanent communication route which includes all the works related to the optimal development of the traffic: bridges, signs, consolidation works or any other constructions or arrangements included in the forest road project. Considering the location of these communication routes, as well as the natural and anthropic factors that influence their lifespan, through this project we aimed to present the usefulness of topographic works for raising and tracking the action of natural phenomena that influence the infrastructure of a exploitation road. These works have the role of providing a more detailed and precise digital terrain model of the situation in order to develop constructive technical solutions to counteract the destructive activity of these phenomena.*

***Keywords:** landslide, topographic network, forest road, Digital Terrain Model, topographic plan, cross-sections profiles, longitudinal profile*

1. Introduction

Forest roads are part of the category of private roads whose destination is to satisfy their own transport requirements in forestry. In order to manage the forest fund as judiciously as possible, these roads also deserve the activities intended for the transport of wood material, being classified as exploitation roads. Due to their location and environmental conditions, these roads are frequently affected by landslides.

By their manifestation, landslides are movements of rocks that are part of mountain slopes, hills or other anthropogenic works. The displacements of the terrain can be manifested either transversely or longitudinally in relation to the slope of the affected terrain. They do not cause significant material damage compared to other natural disasters but can lead to the partial or total destruction of some constructions or infrastructure works.

Although there is a wealth of information on landslides and their imminent danger, in Romania, few elements are known about the direct impact of landslides on roads and the costs involved. In most areas, the construction of roads in forested areas or river basins are the triggers for landslides.

The objectives to be achieved through this project are represented by the identification of major impact areas in order to establish measures to reduce the risks of landslides. At the same time, the works performed will serve to achieve and identify the areas subject to climate risks determined on the basis of precipitation, land geology, their use and the degree of urbanization on the area.

2. Materials and Methods

Through the mechanism of a landslide, a series of negative effects are identified, among which can be mentioned:

- partial or total destruction of buildings;
- partial or total blockage of watercourses and the formation of natural accumulations of water with potential for flooding;
- partial or total destruction of municipal networks;
- partial or total destruction as well as blocking of communication routes.

Based on these, this project aims to detail the set of engineering topographic works undertaken in order to track a landslide. The topographic work was undertaken on the Râul Mic Cugir Forest Road, KM 8+500-»8+600, where due to the precipitations and the constant formation of the torrents, the infiltration waters destabilized the embankment of the road and led to its rupture. The topographic elevation has the role of providing a situation dealt with the geographical location of the fissure, the elaboration of transversal profiles along the axis in order to elaborate a solution to prevent its rupture in the future.

Fig 1. Forest road affected by landslides

Spatial Data Acquisition

The stage of spatial data acquisition is preceding the topographic works and consists in collecting the drawings that present the interest area of the works with the help of which the work tactics will be elaborated.

The land reconnaissance phase consists in establishing the position of the component points of the topographical network in relation to the location of the orientation points received from the beneficiary. The points of the topographic network are necessary in order to adapt to the existing geographical data framework, being the possibility that the beneficiary's network is in a particular system compared to the national system.

The topographic network was materialized by MessPunkt topographic bolts embedded in wooden stakes arranged to ensure a line of observation between at least 3 points.

The topographic survey was performed with the total Leica TCRM1201 station, using the Resection program to measure the polar coordinates of the detail points.

Data processing and preparation of the situation plan

Due to the topographic method of raising the detail points, the measurements do not require post-processing in a dedicated program. Due to this fact, we will proceed to the card editing of the situation plan in the CAD environment by joining the specific points of each type of detail. The 3DPolyline command will be used and Layers will be created for each geomorphological and infrastructure entity (slope, ditch, parapet, shaft, etc.).

On the situation plan, the landslide area and the road breaking area will be highlighted by a line of greater thickness.

Once the drawing stage is completed, the transversal profiles and contours will be drawn up through the TopoLT and ProfLT programs. The transversal profiles will be cut perpendicularly on the axis of the existing road in order to capture the geomorphology of the natural terrain, of the existing road and of the fissure / landslide. A longitudinal profile will also be drawn up along the axis in order to establish its slope.

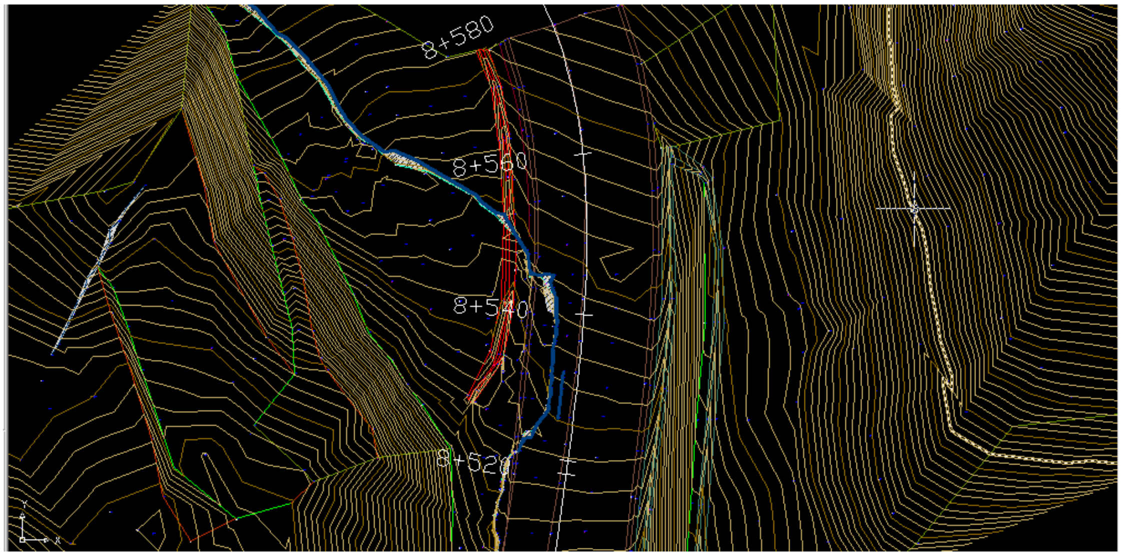

Fig. 2 Cartographic editing in the CAD environment - Situation plan

Drawing contours and cross-sections

The creation of the level curves is performed with the help of the TopoLT program, these having the role of demarcating the areas that have the same elevation and highlight the slopes of the land in the area of interest.

The topographic plan obtained in the CAD environment has the role of data background in the elaboration of the strategy to combat the destructive phenomena through a system of collecting torrent waters and their discharge outside the safety zone of the exploitation road.

The cross-sectional profiles and the longitudinal profile are the background on which the above-mentioned system will be designed so as to maximize efficiency and reduce execution costs for the implementation of the torrent collection system.

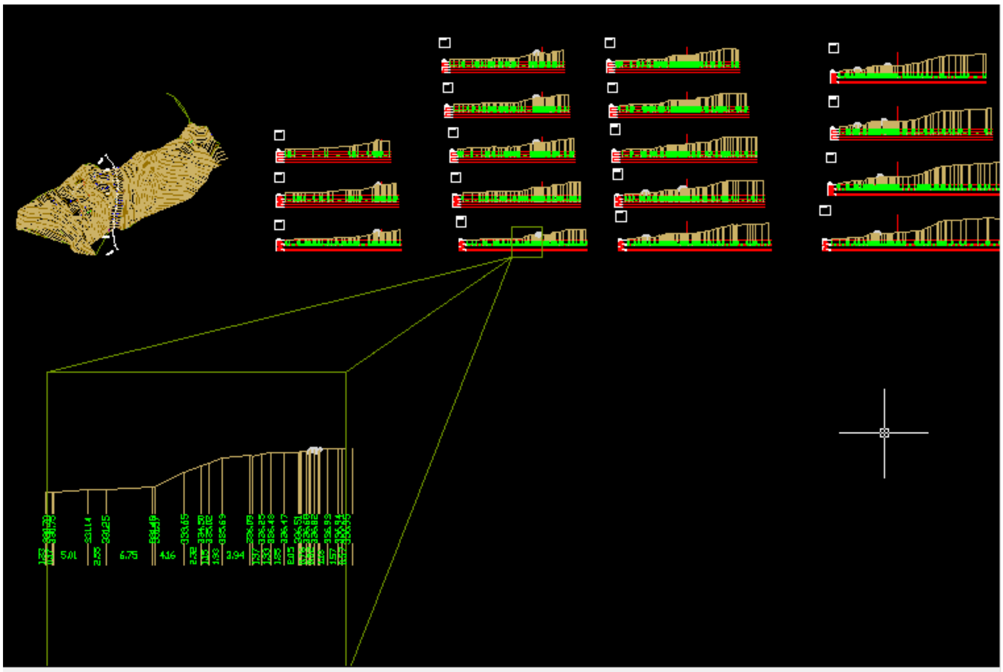

Fig 3. Drawing up the transversal profiles

In order to integrate the data into an information system accessible on several platforms, we resorted to converting the location plan to .kmz format and uploading it to the Google Earth platform. It can be accessed and viewed from any device, the navigation being in real time on the ground in order to obtain the route to the point of interest.

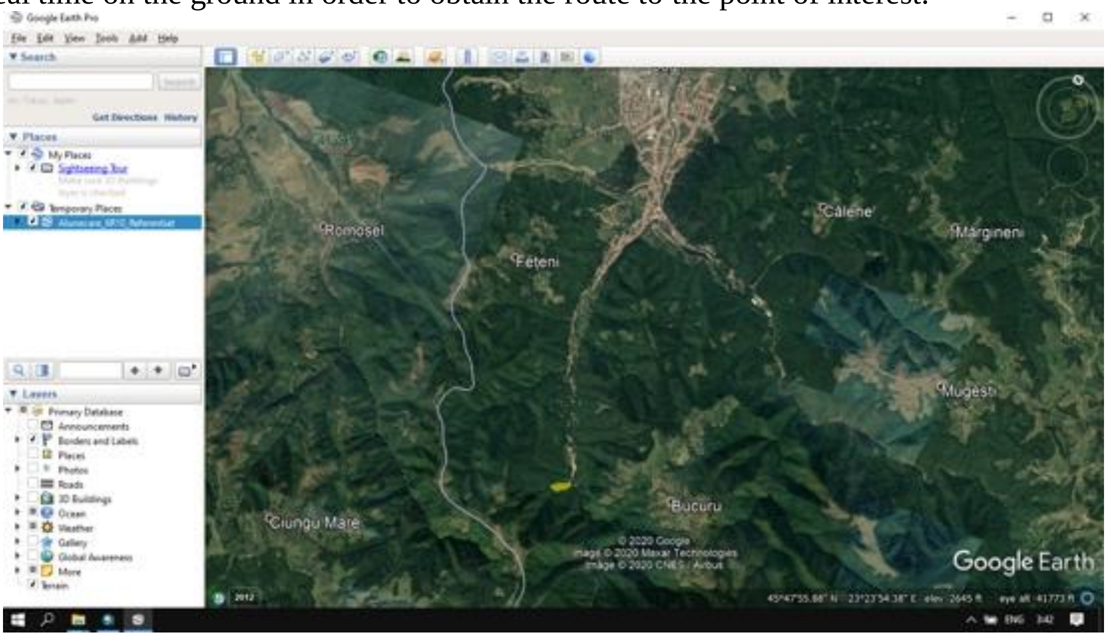

Fig 4. Identification of the objective through the Google Earth platform

To convert topographic data from stereographic coordinates to WGS84 coordinates, the projection system used by GoogleEarth, the ArcMap program was used through the Convert to KMZ option in the ArcCatalog tree, which has implemented the coordinate transcaling algorithm based on transformation parameters from a system projection to another.

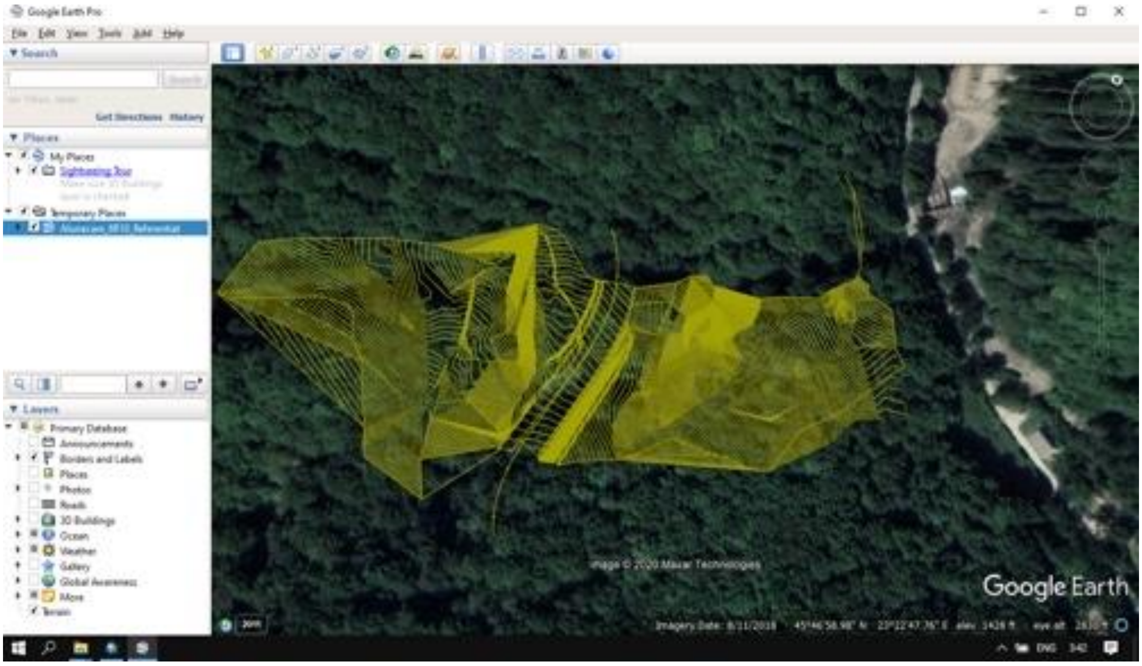

Fig 5. Integration and visualization of data within the Google Earth platform

3. Results and Discussion

Following the topographic survey and the topographic plan, a situation plan was developed by the designer in which the technical solution of building a bridge for crossing the road and channeling water from the slope to the nearby valley was offered.

Fig 6. The proposed situation plan for the arrangement of the affected area

From the situation plan prepared by the designer and based on the technical solution offered, the defining elements of the arrangement of the riverbed and the bridge will be extracted in order to materialize them in the field.

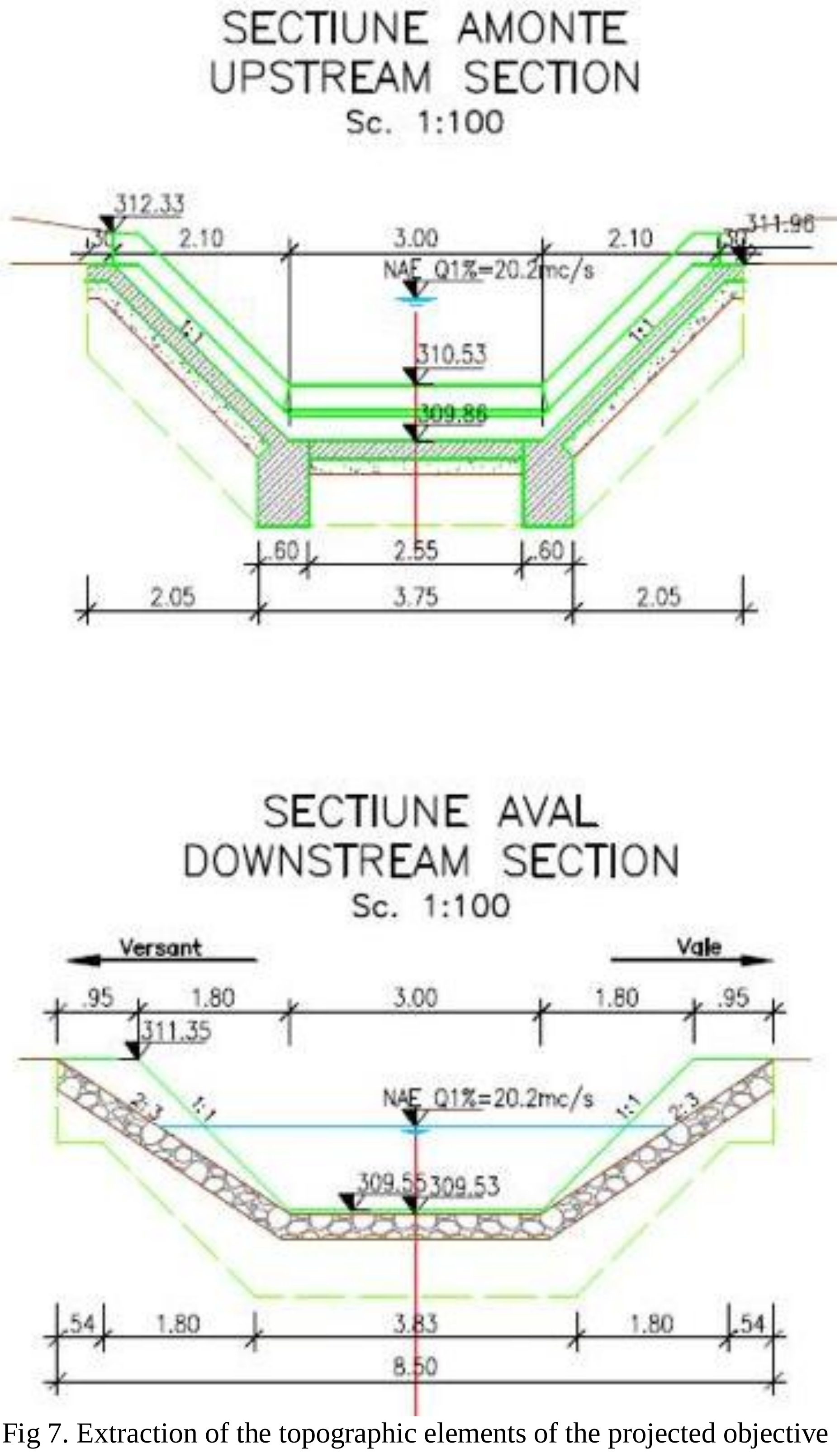

Fig 7. Extraction of the topographic elements of the projected objective

4. Conclusions

In order to prevent and combat landslides, a number of measures are needed, including:

- The need to execute large-scale topographic works to ensure an overview of the studied area;
- The need for forecasts on the stability of slopes by topographic interpolations;
- The obligation to periodically verify these objectives from a topographical point of view;
- Identifying the conditions of occurrence and manifestation of landslides;
- Identification and early planning of customized prevention measures for each case;
- Ensuring the drainage of water from the slopes by adequate hydrotechnical works;
- Afforestation and grassing of slopes;
- Avoiding the location of engineering objectives in areas where the terrain is prone to frequent landslide processes.

In this context, the need for topographic works is reinforced by their usefulness for designing and solving infrastructure problems such as the one mentioned at the same time with the optimal positioning of the designed structures in relation to the geomorphology of the land.

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