OUTLOOK ON THE POSSIBILITY FOR SLOPE STABILITY EVALUATION ACCORDING TO PETROPHYSICAL DATA

Alfred FRASHERI*, Foto DHIMA**, Burhan ÇANGA*
* Faculty of Geology and Mining, Polytechnic University of Tirana
** Institute of Hydrotechnical Studies and Design, Tirana

Results of the geophysical data for in-situ evaluation of the physical-mechanical properties of the rocks in the unstable slopes in Albania are presented.

Albania represents a mountainous country with complicated geology. There are unstable mountain and hill's slopes. Developing of new landslides or re-activation of the old ones is mainly due to construction works. Construction such as hydrotechnical works, civil, industrial, urban and rural constructions and infrastructure, particularly last years, as well as destroy of equilibrium in ecological systems through deforestation etc., have contributed to landslide development. Landslides are located in the deluvial deposits, and in the altered-bedrock. The slipping bodies of some landslides have very big volume, more 50 million cubic meters.

Hydrotechnical works in Albania are generally constructed in conditions of rugged terrain and in geological formations in which the land sliding phenomena is often present. There are observed active landslide in the lakeshores of hydroelectric power plants, which represents a great geological risk. In some villages there are destroyed some buildings, accompanied with victims. This phenomenon has been more evidently activated after the construction of hydrotechnical works. The exploitation period of more than 25 years of such a huge hydrotechnical work has influenced to the physical-mechanical properties at various parts of this landslide. One of typical landslide was developed at lakeshore of the Vau Dejes Lake of Hydropower Plant at Northwestern Albania. The activity of year's movement of water level at Vau Dejes Lake of has caused a big landslide at eolated, weathered and destroyed serpentine rocks.

GEOPHYSICAL IN-SITU TEST METHODIC

Slope stability study and monitoring of the active landslides in Albania was carried out by integrated geological-geophysical engineering and geodesic observations. In-situ geophysical investigation and monitoring have been programmed in three phases:

1. Surface integrated geological-geophysical surveys and installation of geodesic markers.
2. Drilling of the shallow boreholes, hole-hole seismic surveys and wells logging.
3. Periodical geophysical and geodesic observation in the boreholes and in the Earth surfaces.

The basic method has been the high frequency refracted seismic. Geophone setting in the survey line has distances from 0.5-43 meters, according to the object's size and the required seismic depth investigation. The longitudinal and transversal waves were recorded through the time intercept method. The natural seismic- acoustic activity in side and out side of slipping body has been observed for a continuous time of 5 seconds. Creating the seismic waves is performed by mechanical shock. A seismic 12-channel station ECHO-2 of Canadian Firm SCINTREX makes the recording. The proceeding of records is made by the company's software package. According to surveys data the Vp longitudinal waves velocity and those Vs transversal waves are calculated, as well as the layer thick. The depth of the seismic investigation was about 25-27 m.

Electrical Schlumberger soundings and profiling have performed to investigate and monitoring of the landslides. Electrical soundings were performed by the Schlumberger array, with spacing up to AB/2 = 500 m, which provided a survey depth of 120-150 m. Profiling are performed multiple Schlumberger arrays, with two depths investigations, according to the required depth investigation for each object.

Together with the geophysical methods mentioned above, in some landslides were also applied the micromagnetic and microgravity surveys. In boreholes has programmed to carry out hole-hole seismic tomography of longitudinal and shear waves, density gamma-gamma logging, neutron-gamma logging, electrical logging, velocity acoustic logging and deviation recording.

Samples of soil and rocks from the study area were analyzed in the laboratory for determination of their physical-mechanical properties and petrography studies in thin sections.

According to the interpretation of geophysical surveys results was carried out a study of the shape and structure of the slipping body, physical-mechanical properties of the slipping body and bedrock estimation, and evaluation of the level of the landslide natural seismic-acoustic activity. Physical-mechanical properties of the rock evaluation in landslide areas have successfully represented an important information, related with the slipping body mapping, study of slope stability and dynamics of the landslide's development.

ANALYZE OF THE RESULTS

Ragami landslide is located in the shores of the Vau Dejes Lake. It is developed in the ophiolitic formation represented by serpentinized rocks. The slipping body represents a big mass of serpentinite which are eolated, destroyed and covered by a thin layer of deluvions. According to the geological surveys at 1992, has not exist this landslide. Landslide has significantly developed during these last ten years. Slipping body has multiplied surface and volume during this period. The front part of the slipping body is located along the shores of the lake. This part has the shape of a scarp about 2 -3 m high, and represent a destroyed, schistose and mylonitized serpentinites. In this landslide can be noticed three detachment superficial levels:

- The first one 35 - 45 m from the shore, with a horizontal dislocation of about 2 m.
- The second one about 70 - 90 m from the shore, with a vertical detachment of an amplitude of about 2 m.
- The third one about 115 - 130 m from the shore. This is the newest level and has the lowest amplitude.

In fig. 1 is presented the integrated engineering geophysical- section of the slipping body. Two main sliding plains separate this body. These plains are broken up.

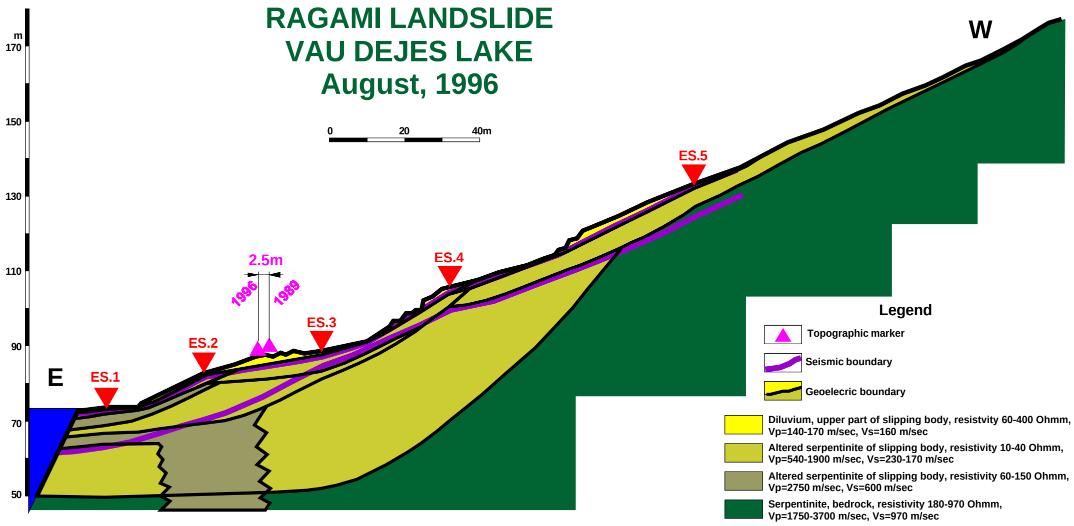


Fig. 1. Engineering integrated geophysical section of the Ragami landslide.

The first plain is at depths of 5 - 7 m, while the second one reaches up to 22 m. The lowest part of the second plain touches the lake, under the water level. In this way, the sliding body has a block like nature.

The physical - mechanical properties of the rock massif of the slipping body are lower than those of the basement rocks, not touched by the sliding phenomena. The micro movements in the slipping body are very intensive and have a wide frequency band, while outside the body there is no such activity.

In the Tab. 1 and Tab. 2 there are presented physical-mechanical properties of the rocks of the slipping body of Ragami Landslide.

Tab. 1

PHYSICAL PROPERTIES IN LANDSLIDE'S AREA

Layer Number	Thickness, in meters	Resistivity in Ohmm	Density, in g/cm^3	Wave Velocity, in m/sec		Lithology
				Vp	Vs	

SLIPPING BODY						
1	0.7	76.4	1.34	210	160	Deluvium
2	4.0	29.5	1.61	540	230	Breaking serpentinite
3	6.5	46.5	2.45	3700	680	Water-bearing serpentinite,
4	17.4			1500		Breaking serpentinite
BED ROCKS						
		485	2.56	3500	1920	Serpentinite

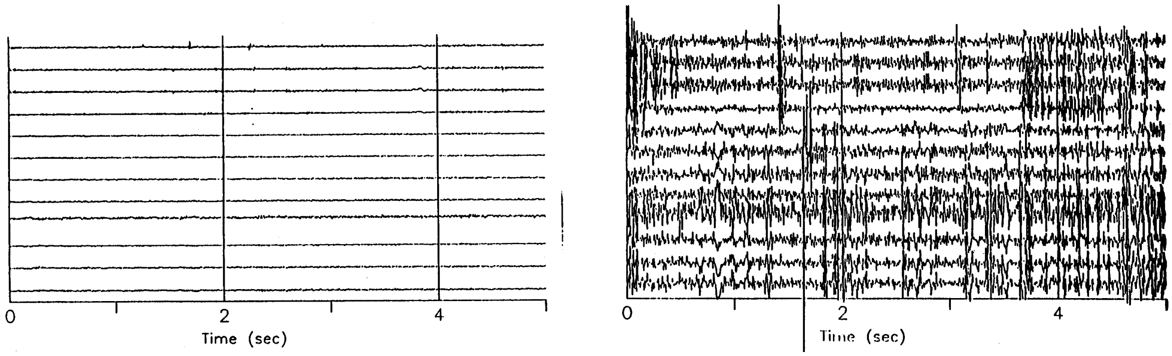
Tab. 2

ECHANICAL PROPERTIES IN LANDSLIDE'S AREA

Layer Number	Poisson Coefficient	Dynamic Module of Elasticity, E_d^s in $*10^5$ KG/cm^2	Rigidity Module G, in $*10^5$ KG/cm^2	Volume Compression, σ, in $*10^5$ KG/cm^2	Rock state
SLIPPING BODY					
1	0.35	0.00370	0.00140	0.00420	soft rocks
2	0.39	0.02413	0.00868	0.03630	Destroyed, shattered rocks
3	0.48	0.56586	0.19167	3.26503	Cleavages and fissured rocks
4		0.26325	0.09608		Destroyed, shattered rocks
BED ROCKS					
	0.29	2.46271	0.96199	1.91408	Compact rocks

According to the data showed in Tab. 1 and Tab.2, results that four layers, which have different physical-mechanical properties, have constructed the slipping body. First layer represents the deluvial cover. Layers 2 and 4 represent by destroyed-shattered serpentinite. Among them there is located the serpentinite individualization. This third layer characterized by low electrical resistivity and shear waves velocity. We have interpreted this decreasing by water presence in the cleavages and fissured serpentinite.

The dynamic of slop move is also expressed in the natural seismic-acoustic activity. The micro-movements in the slipping body are very intensive and have a wide frequency band, while outside the body there is no such activity (Fig. 2).



Outside of slipping body Inside of slipping body

Fig. 2. Natural seismic-acoustic activity in the Ragami landslide area

CONCLUSIONS

1. The big thick and volume slipping bodies represent Ragami active landslide in shores of the Vau Dejes Lake.
2. In the profiles, where integrated geophysical surveys have been conducted, were fixed the body of the landslide. In these profiles were also clearly fixed the sliding plains.
3. The structure of the slipping body and its dynamic stands in the foundation of the patterning on the landslide development. Besides the others, the height of the hydro power plant dam is directly defined from this pattern.
4. The block like nature of the sliding bodies brings to the conclusion that in general these bodies can not fall immediately as a whole, in any kind of velocity.

5. Geophysical-engineering studies have a triple character: to study the soil of the landslide area, in-situ evaluation of the physical-mechanical properties of soil, rocks and in-situ monitoring of landslide phenomenon.

ACKNOWLEDGMENTS

The authors thank the generous cooperation with our colleagues Ass. Prof. Dr. Ludvig Kapllani, and Dipl. Eng. Entel Xinxo, from Faculty of Geology and Mining, for collaboration during the field surveys and interpretation of in-situ geophysical investigation. Thanks also to Ministry of Public Economy and Privatization and Faculty of Geology and Mining for the good conditions created for the performing of the geophysical in- situ investigations in the hydrotechnical works. We thank the Institute of Informatics and Applied Mathematics, in particularly Prof. Dr. Neki Frasheri for good scientific collaboration, in the processing and analysis of geophysical data, and Institute of Study and Projecting of Hydrotechnical Works.

REFERENCES

Frasheri A., Kapllani L., Nishani P., Çanga B., Xinxo E, 1999. Project for in-situ investigation of the hydrotechnical works during the construction and exploitation. Faculty of Geology and Mining. Polytechnic University of Tirana. Research and Developing National Program: Geology, Exploitation and Mineral processing, 1995-1998 years.